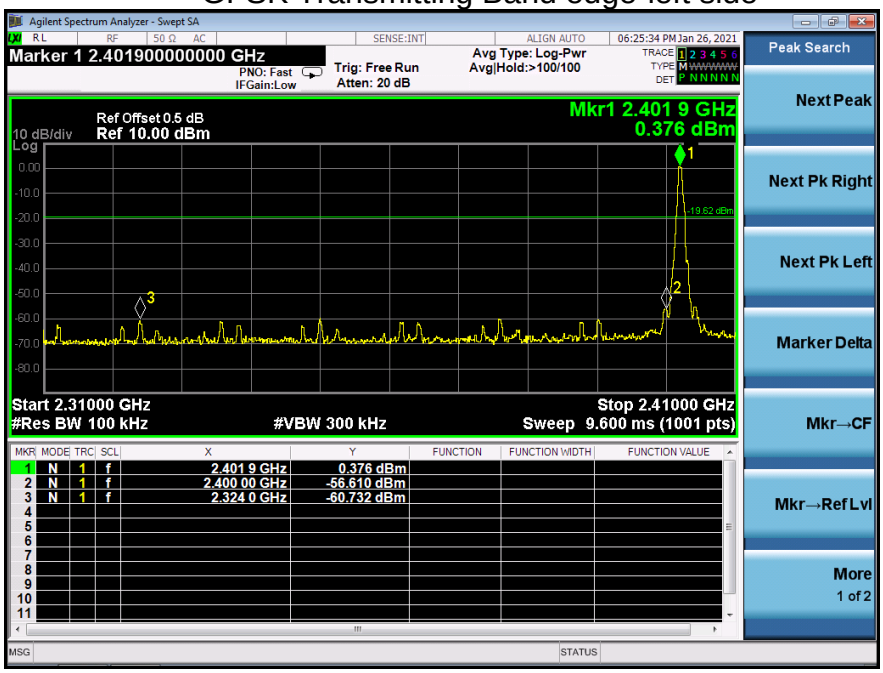
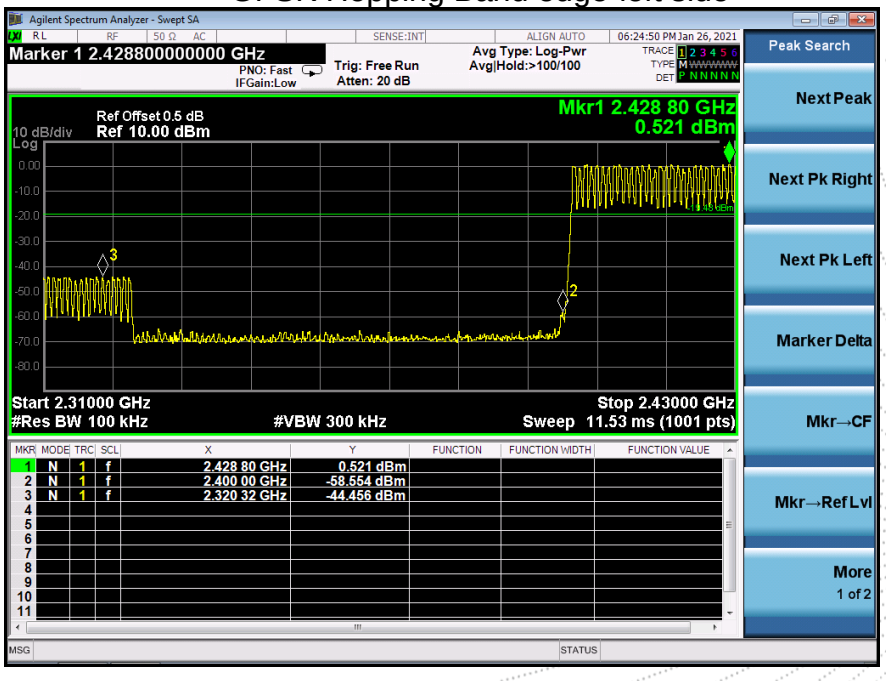
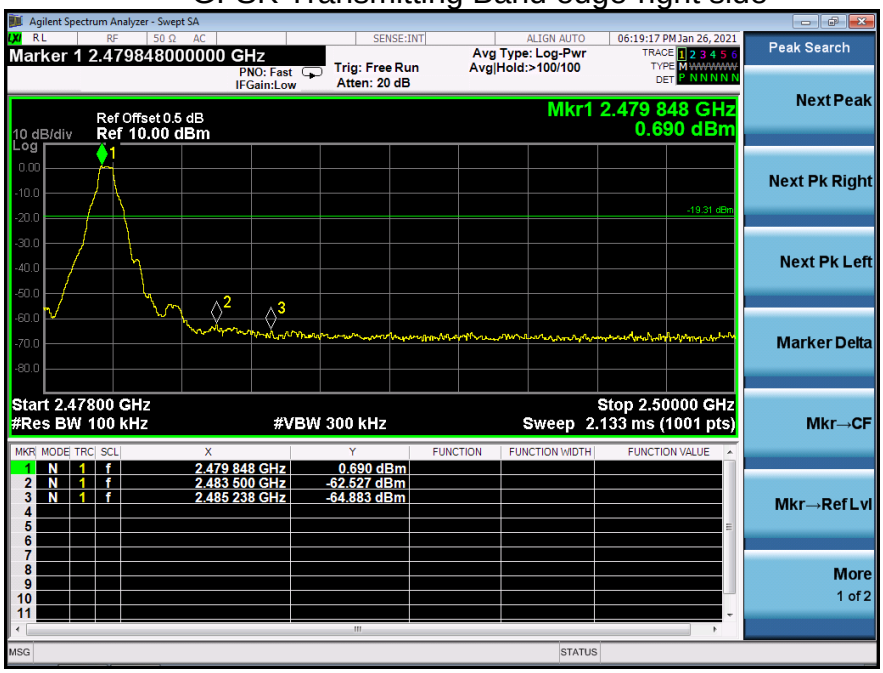
GFSK Transmitting Band edge-left side



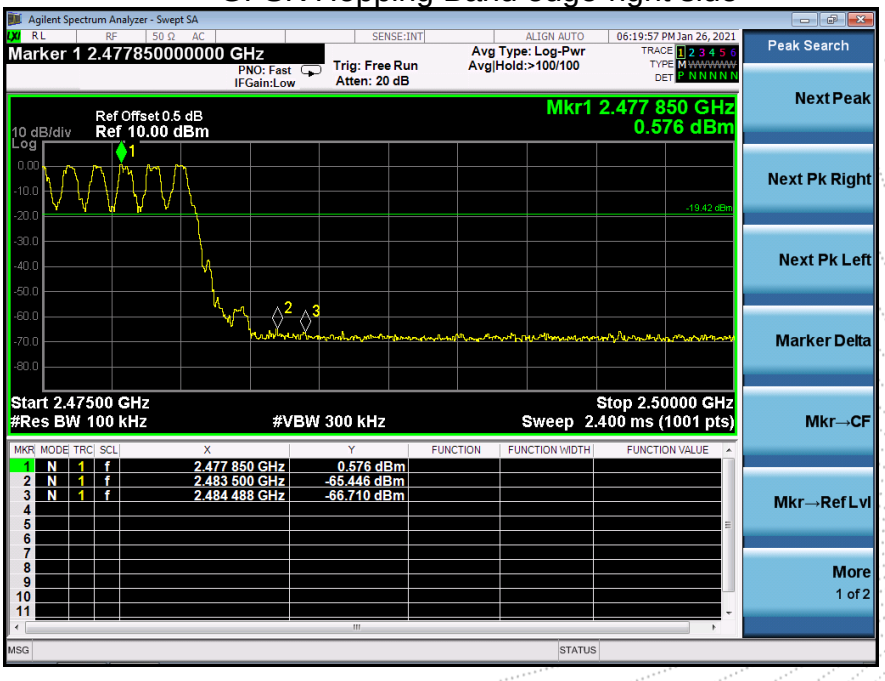

GFSK Hopping Band edge-left side



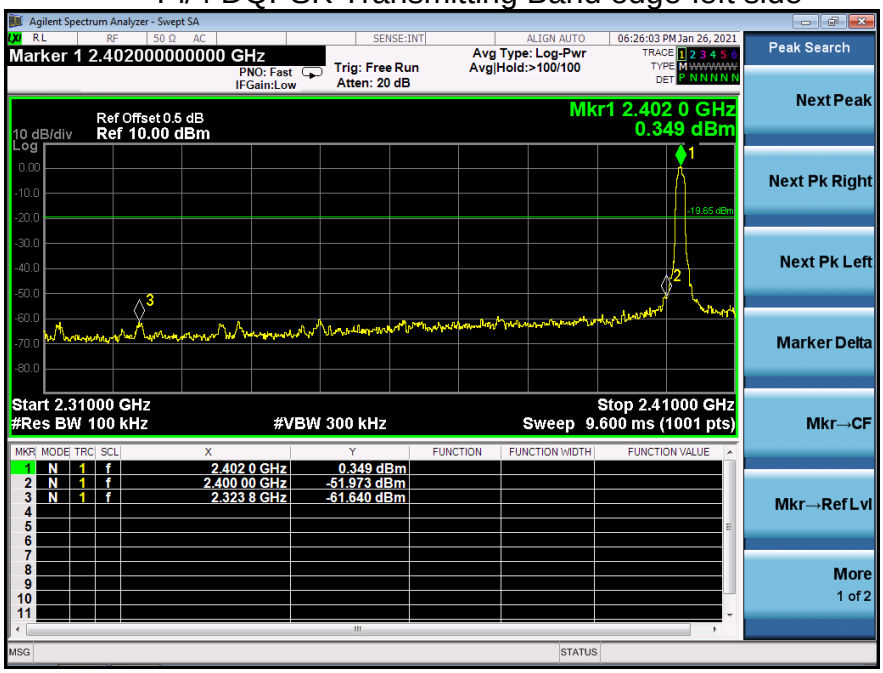
GFSK Transmitting Band edge-right side



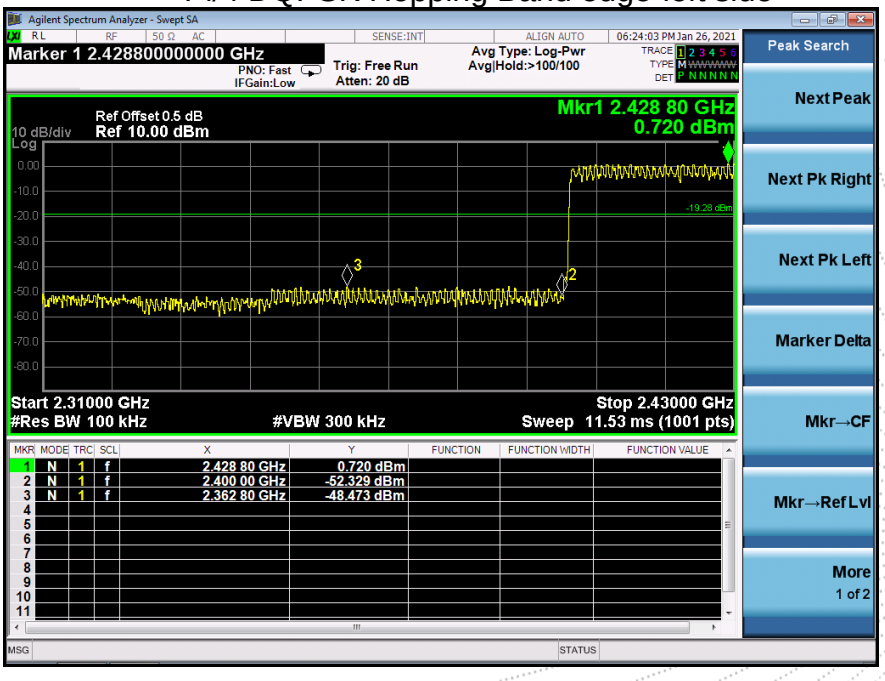

GFSK Hopping Band edge-right side



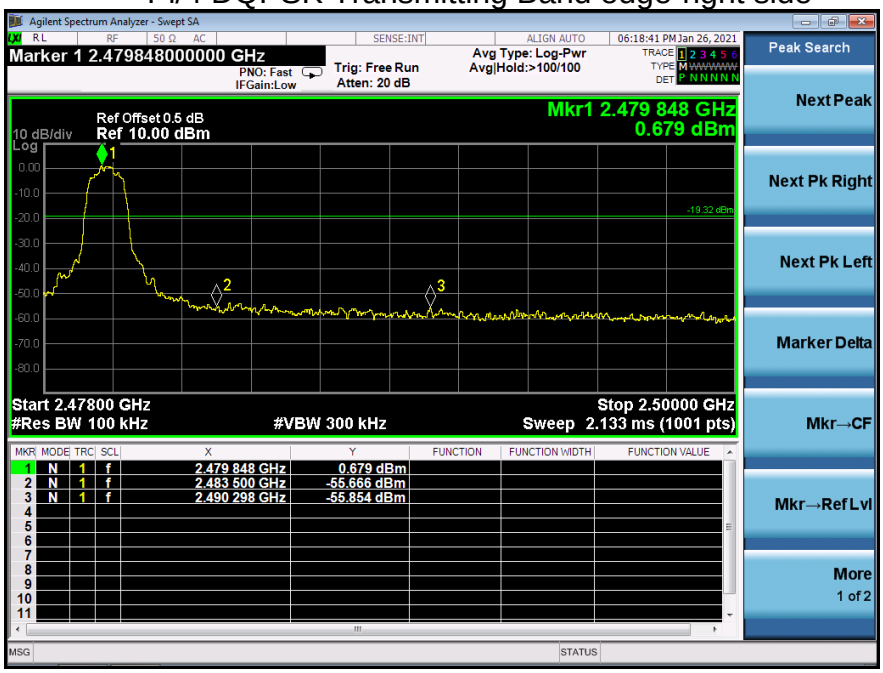
Pi/4 DQPSK Transmitting Band edge-left side



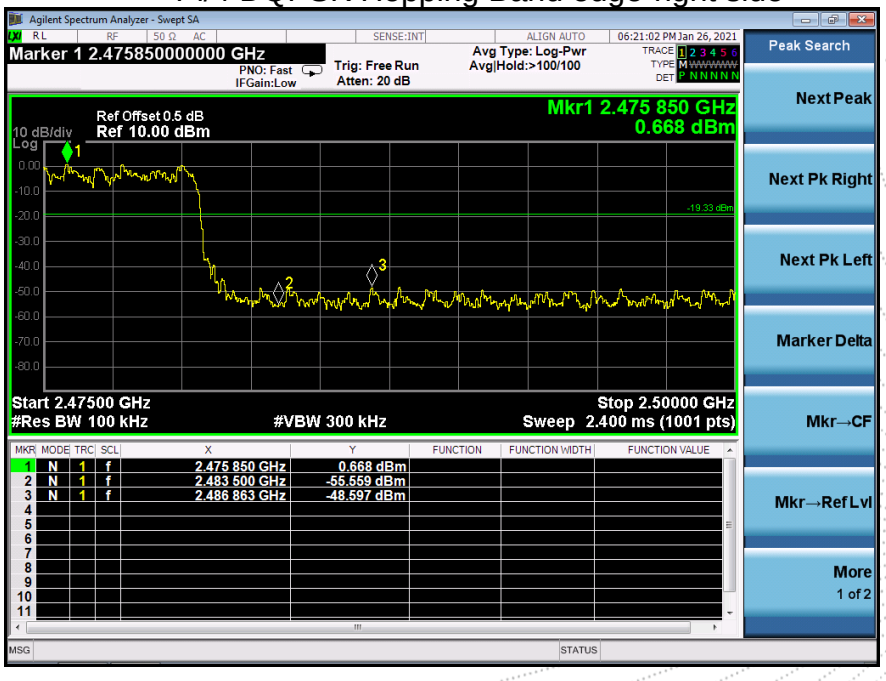

Pi/4 DQPSK Hopping Band edge-left side



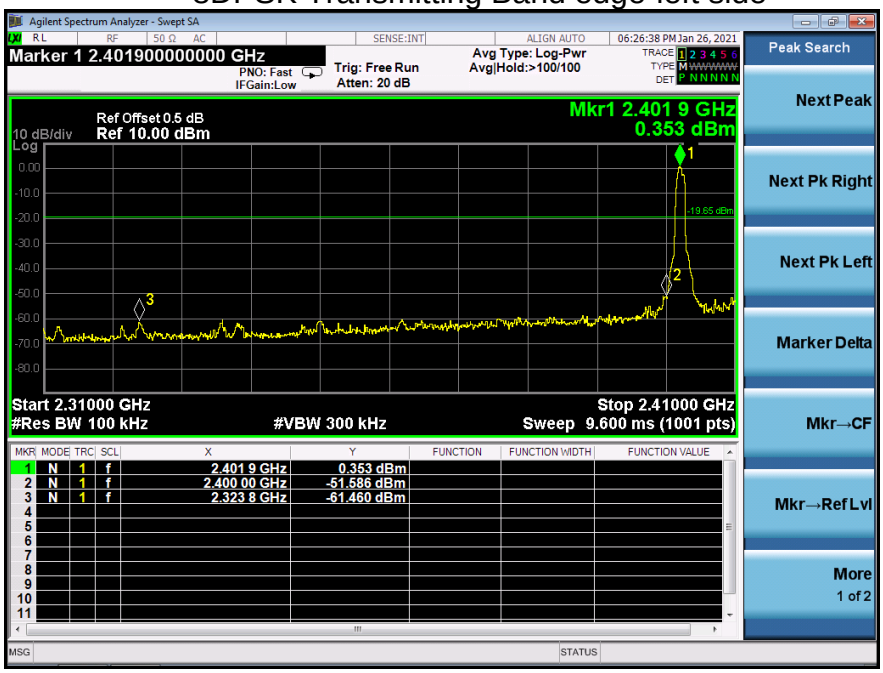
Pi/4 DQPSK Transmitting Band edge-right side



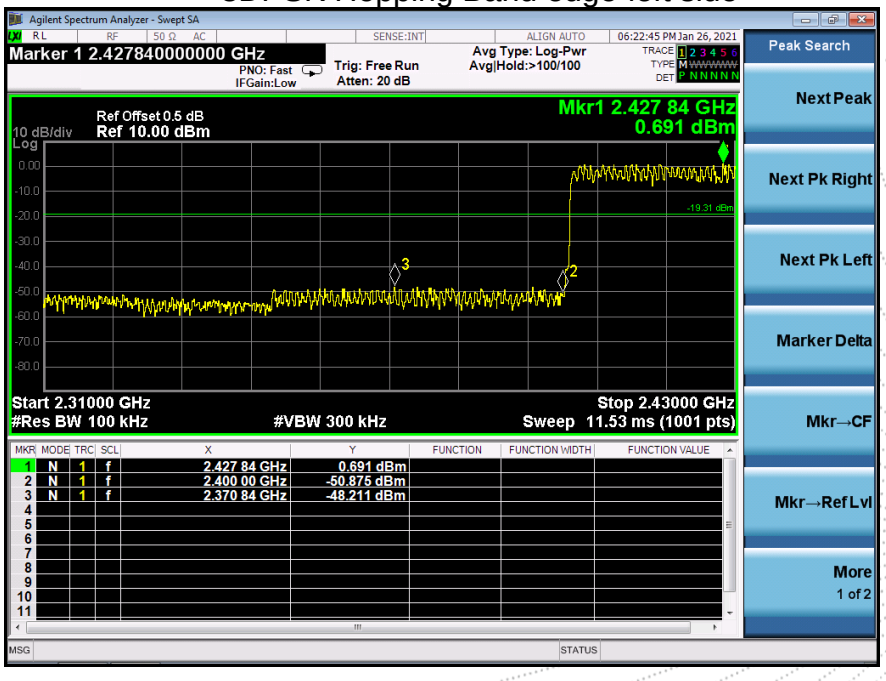

Pi/4 DQPSK Hopping Band edge-right side



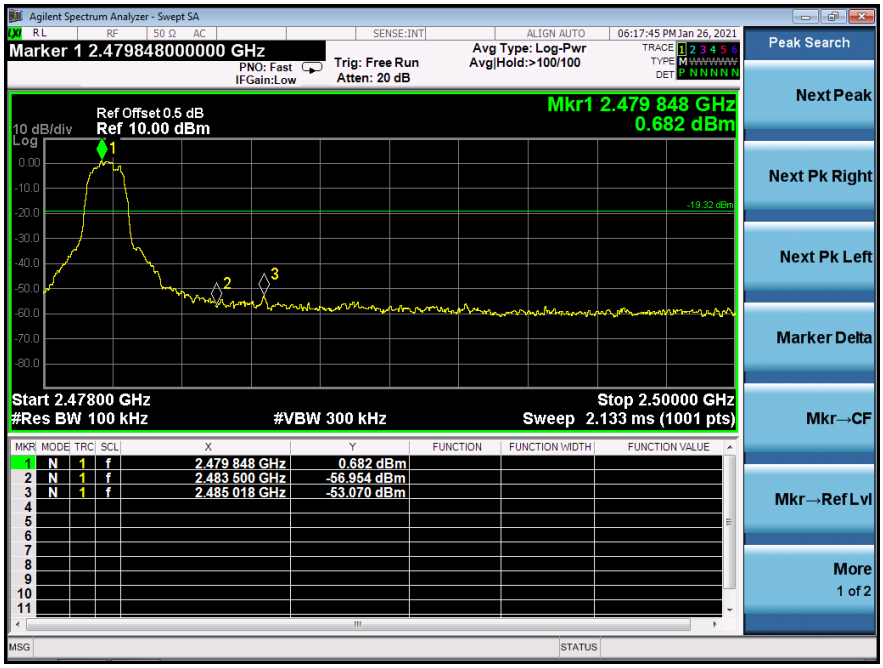
8DPSK Transmitting Band edge-left side



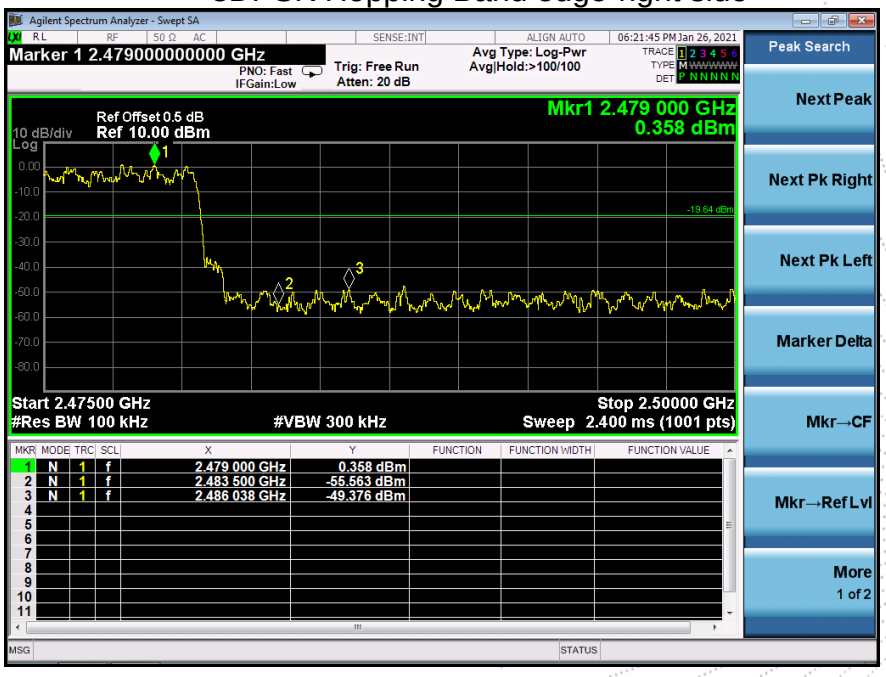

8DPSK Hopping Band edge-left side



8DPSK Transmitting Band edge-right side




8DPSK Hopping Band edge-right side



# 10. 20 DB BANDWIDTH

## 10.1 Block Diagram Of Test Setup

## 10.2 Limit

N/A

## 10.3 Test procedure

1. Set RBW = 30kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission. .

## 10.4 Test Result

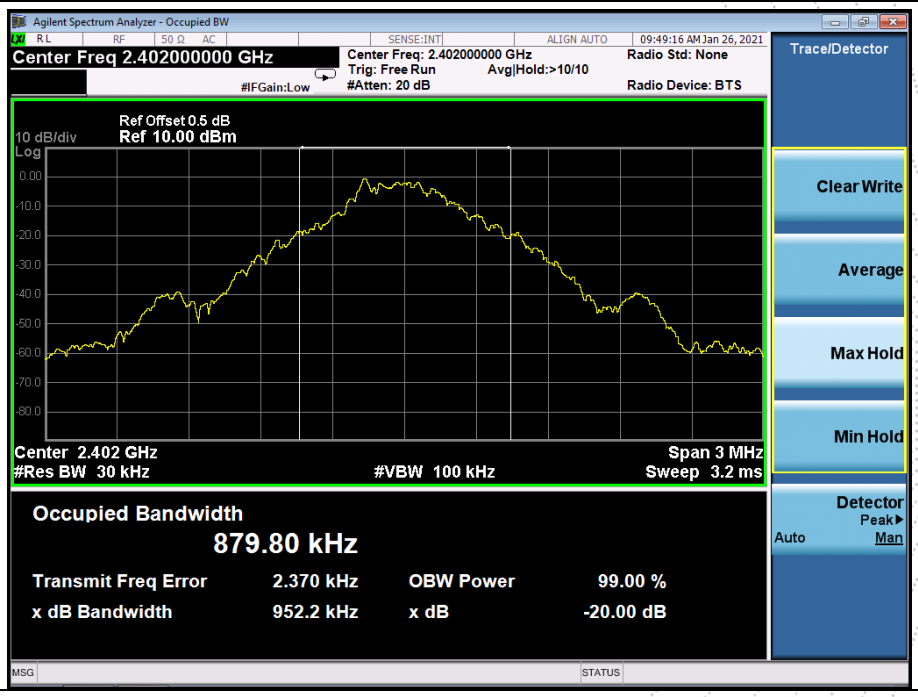
| | | | |
|---|---|---|---|
| Temperature： | 26℃ | Relative Humidity： | 54% |
| Test Voltage ： | DC 3.7V | Remark | N/A |

Left

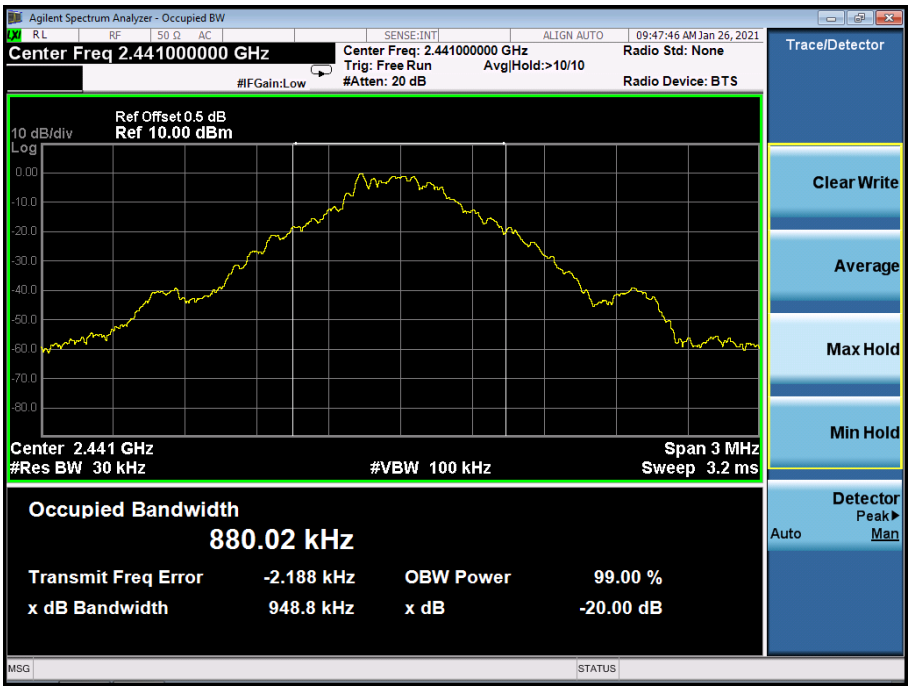
| Modulation | Test Channel | Bandwidth(MHz) |
|---|---|---|
| GFSK | Low | 0.952 |
| GFSK | Middle | 0.949 |
| GFSK | High | 0.953 |
| Pi/4 DQPSK | Low | 1.289 |
| Pi/4 DQPSK | Middle | 1.286 |
| Pi/4 DQPSK | High | 1.286 |
| 8DPSK | Low | 1.294 |
| 8DPSK | Middle | 1.285 |
| 8DPSK | High | 1.300 |

**Test plots**

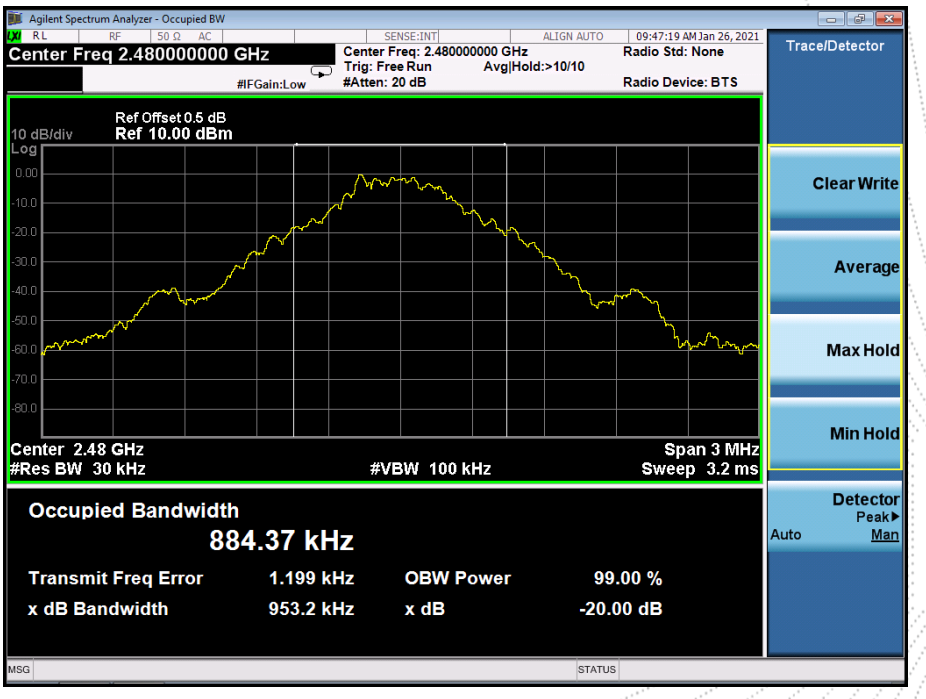
**GFSK Low Channel**



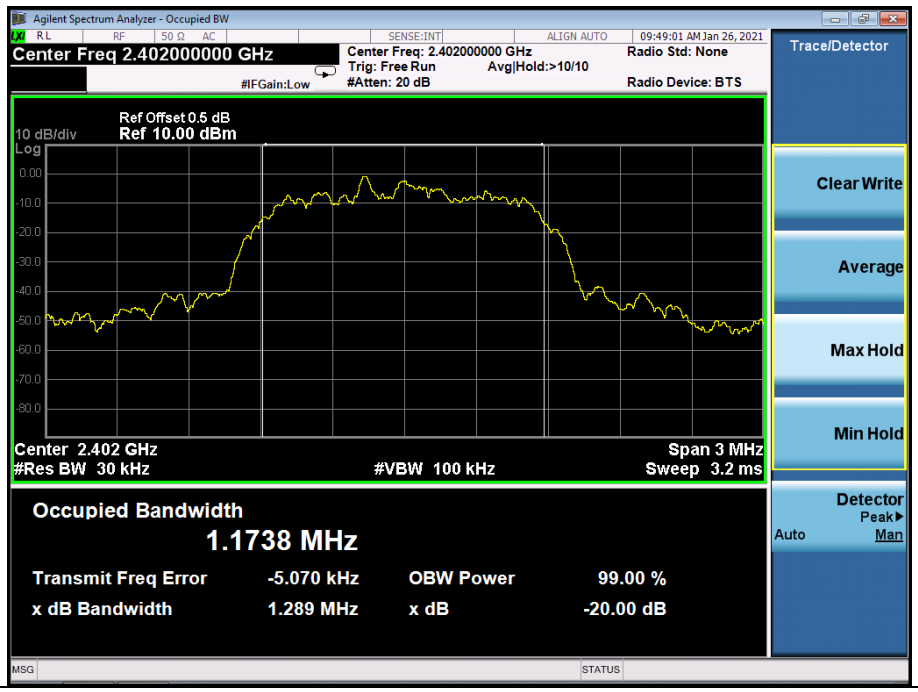
## GFSK Middle Channel



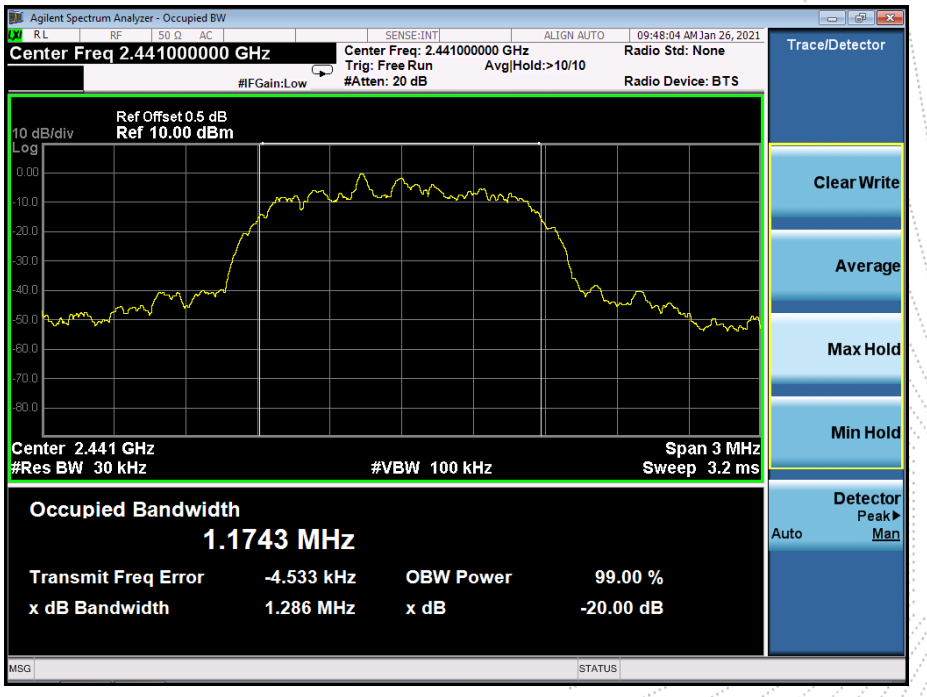

## GFSK High Channel



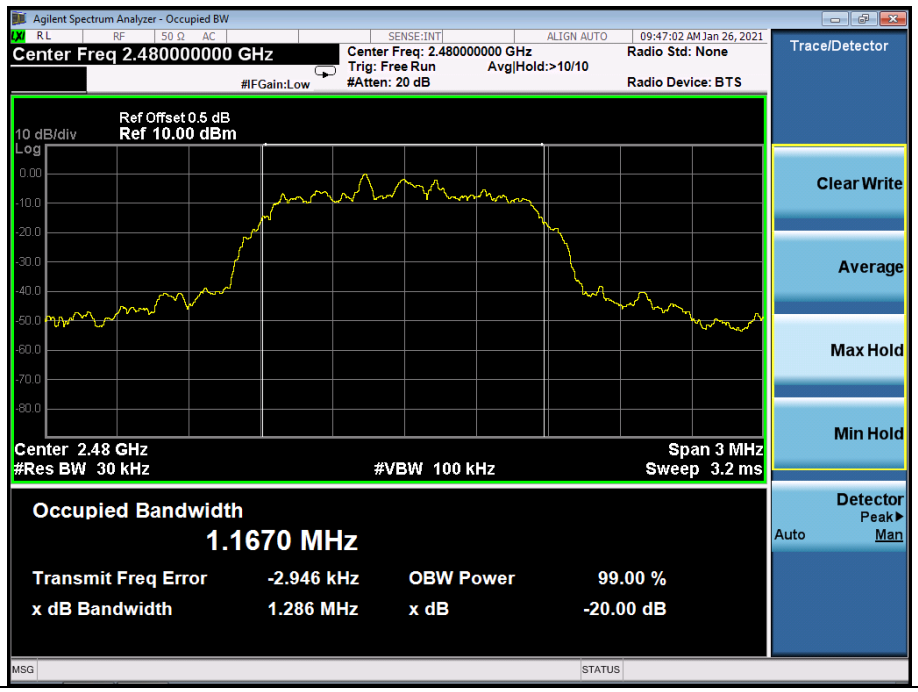
## Pi/4 DQPSK Low Channel



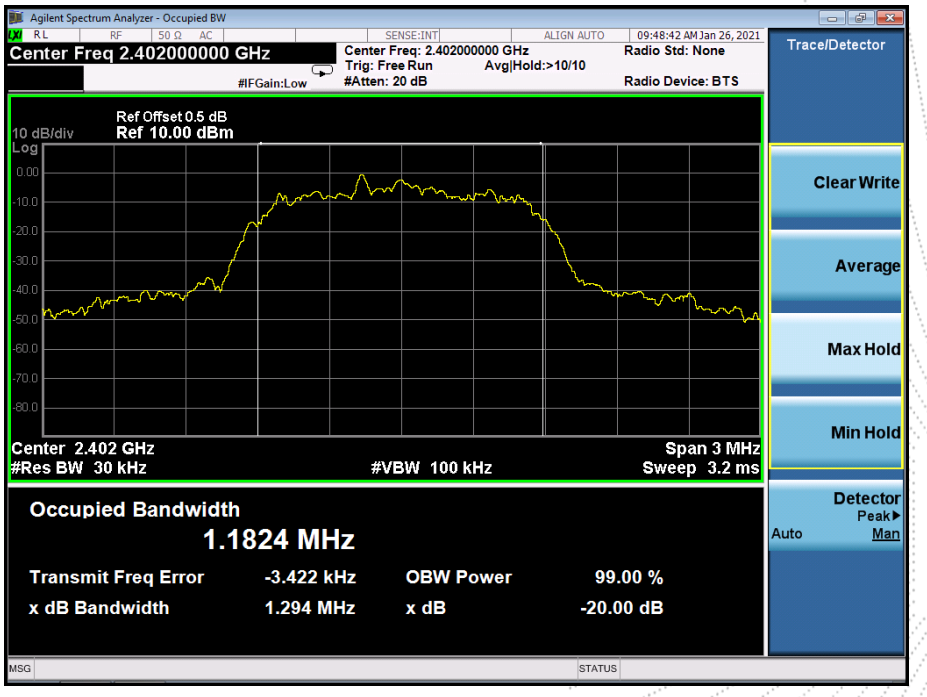

## Pi/4 DQPSK Middle Channel



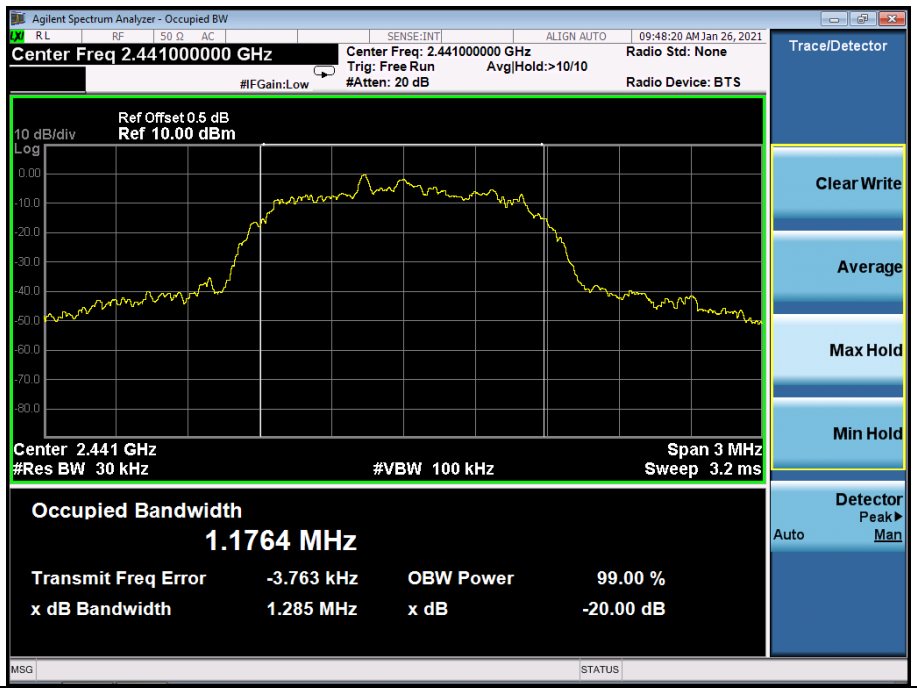
## Pi/4 DQPSK High Channel



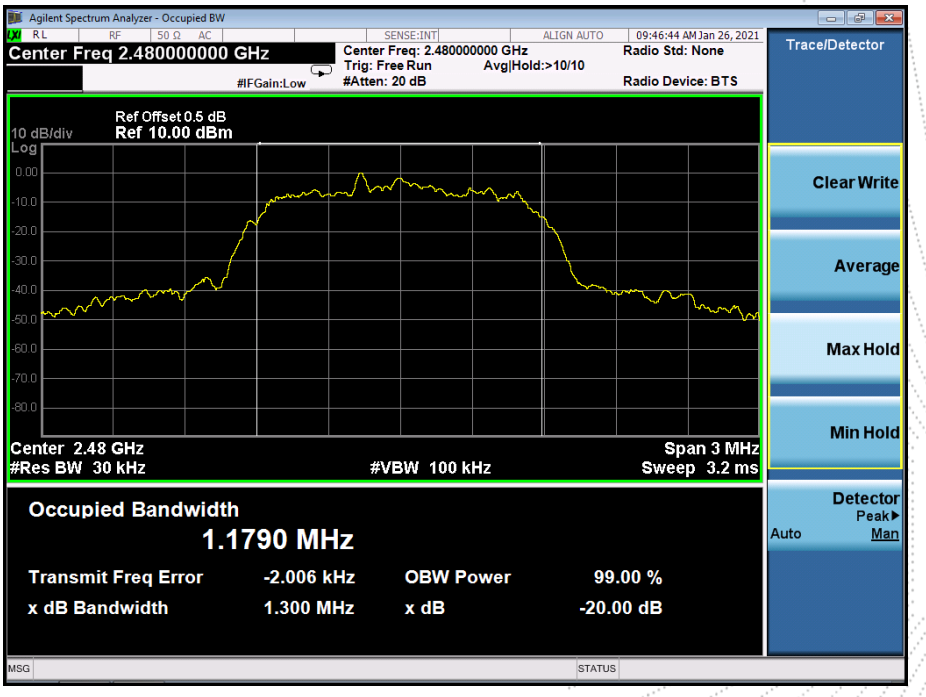

## 8DPSK Low Channel



## 8DPSK Middle Channel




## 8DPSK High Channel

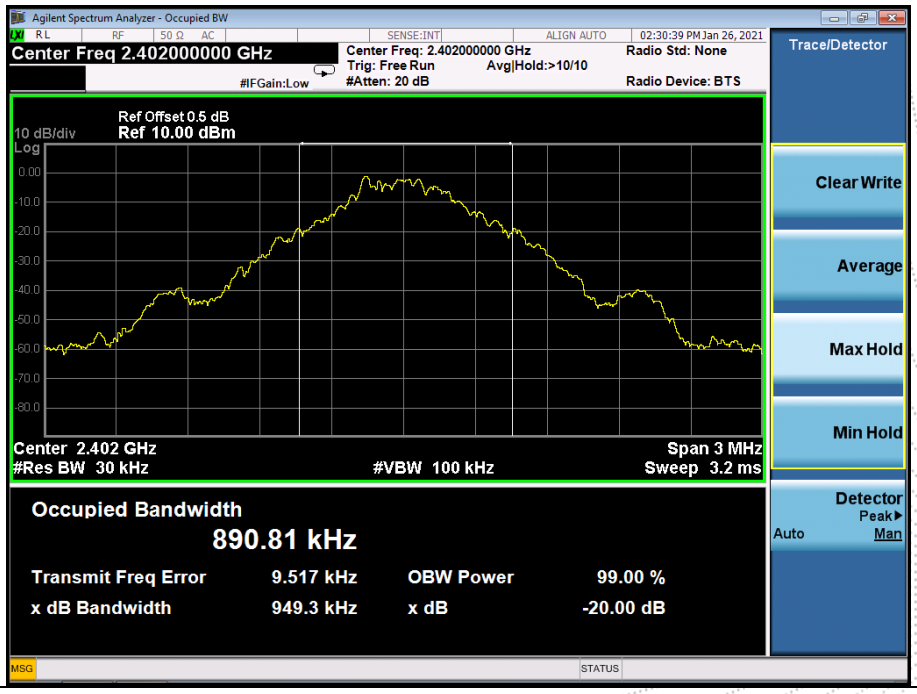


Right

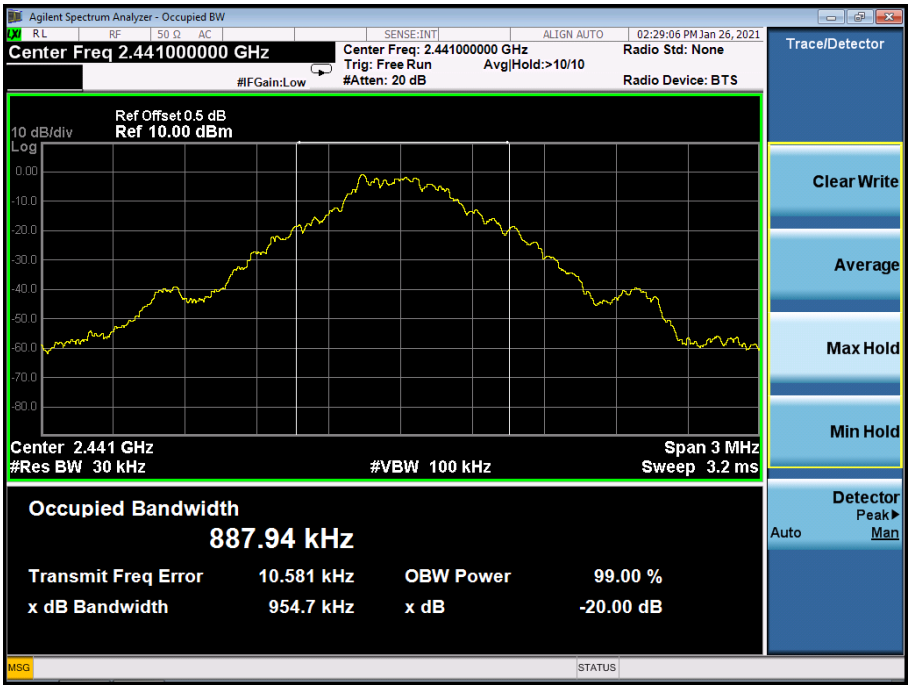
| Modulation | Test Channel | Bandwidth(MHz) |
|---|---|---|
| GFSK | Low | 0.949 |
| GFSK | Middle | 0.955 |
| GFSK | High | 0.952 |
| Pi/4 DQPSK | Low | 1.285 |
| Pi/4 DQPSK | Middle | 1.290 |
| Pi/4 DQPSK | High | 1.271 |
| 8DPSK | Low | 1.295 |
| 8DPSK | Middle | 1.297 |
| 8DPSK | High | 1.298 |

**Test plots**

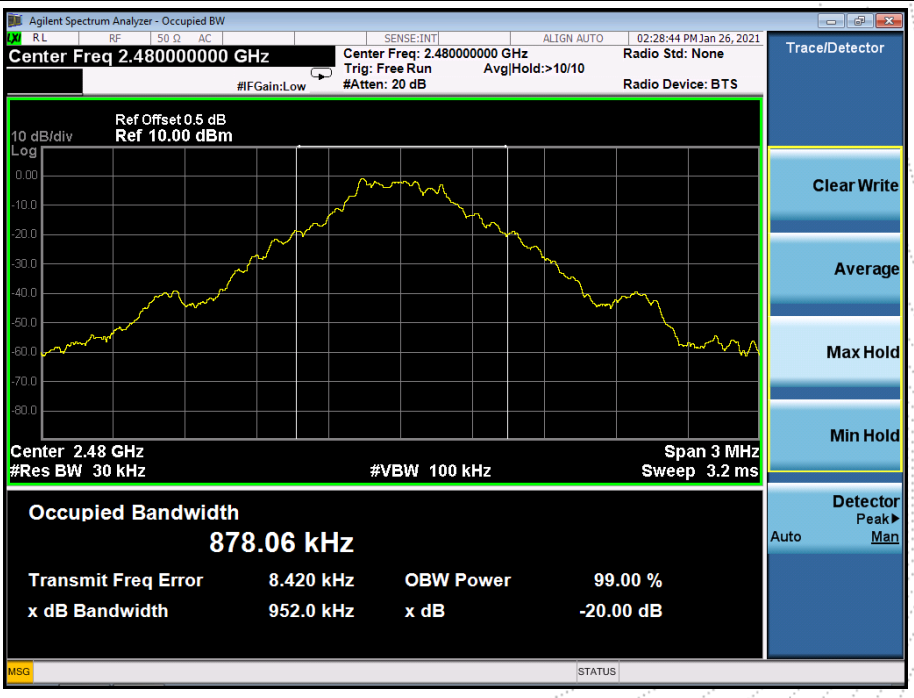
**GFSK Low Channel**



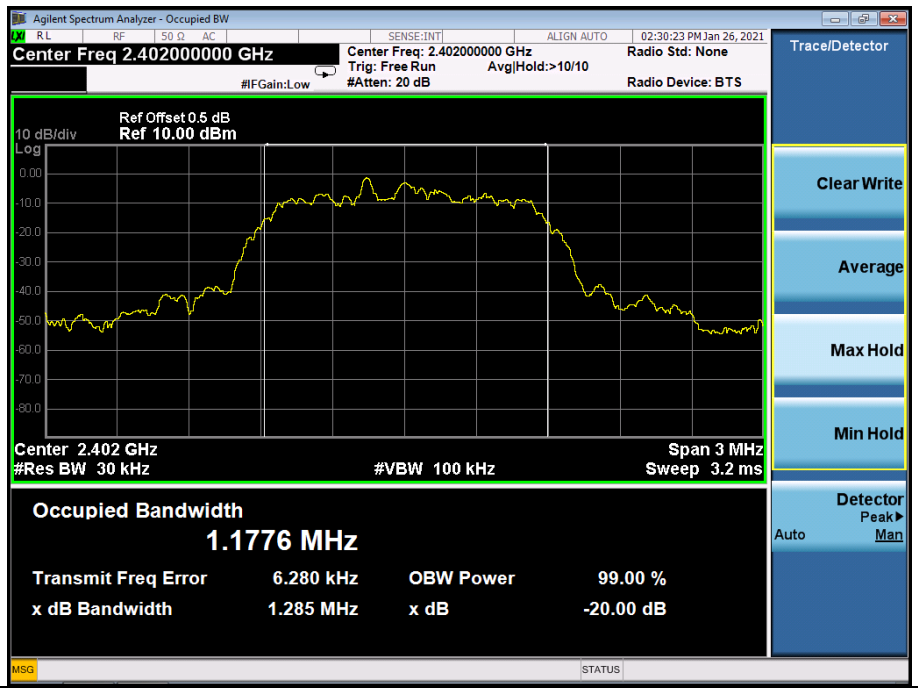
## GFSK Middle Channel



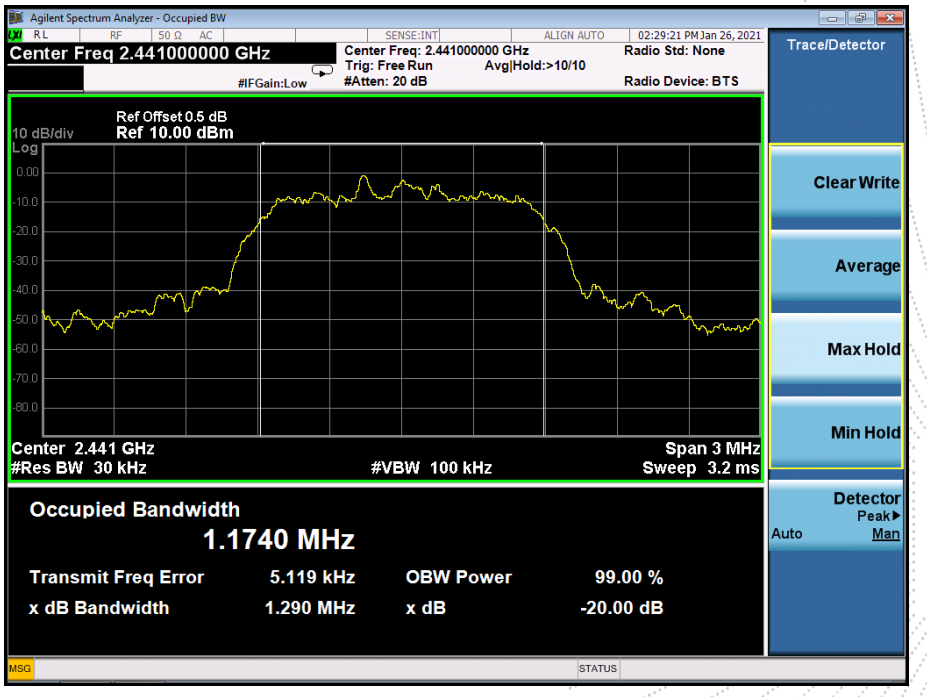

## GFSK High Channel



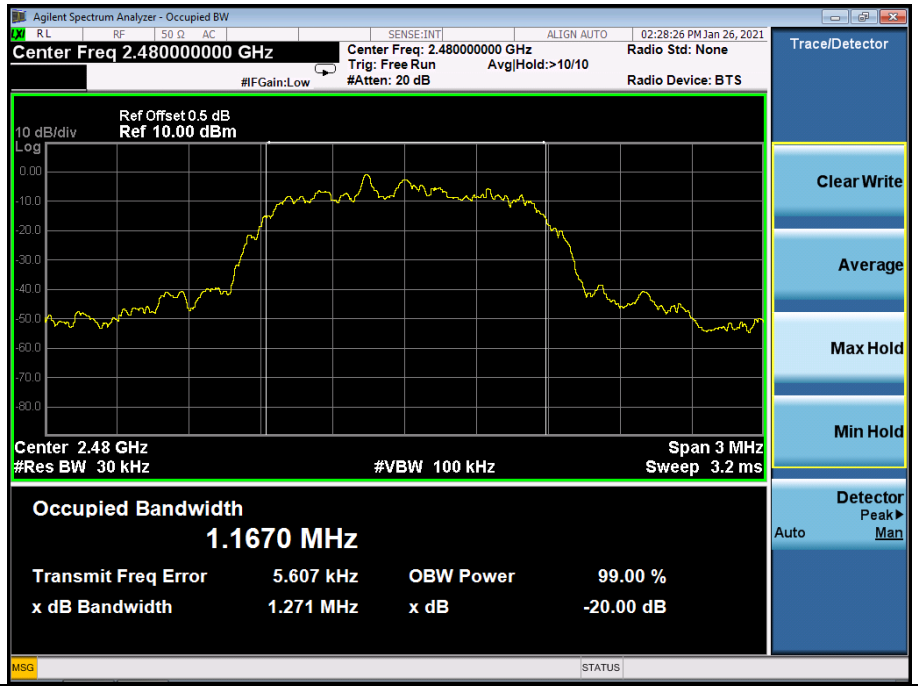
## Pi/4 DQPSK Low Channel



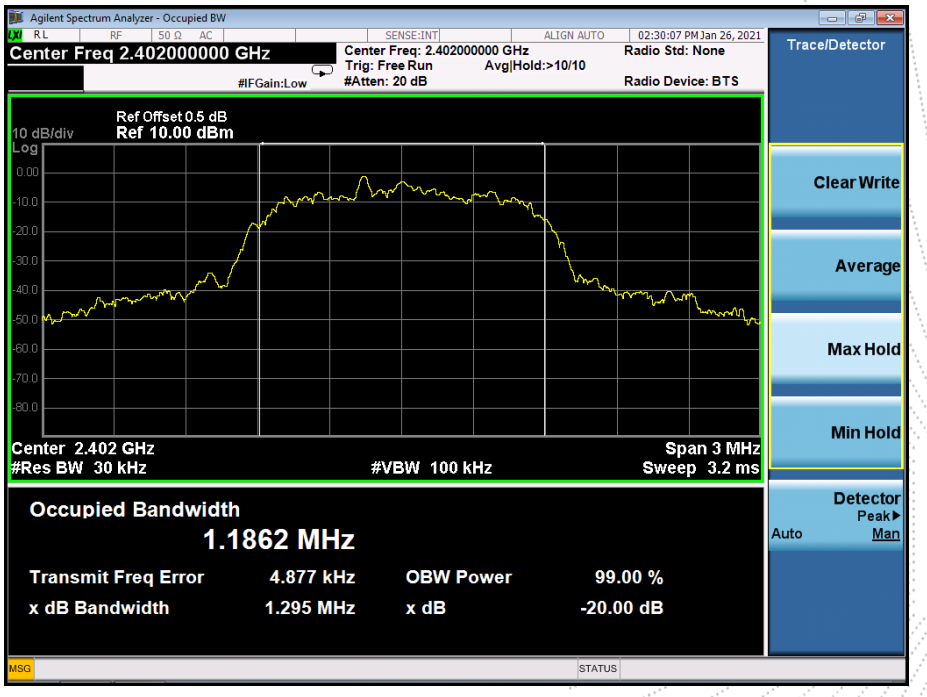

## Pi/4 DQPSK Middle Channel



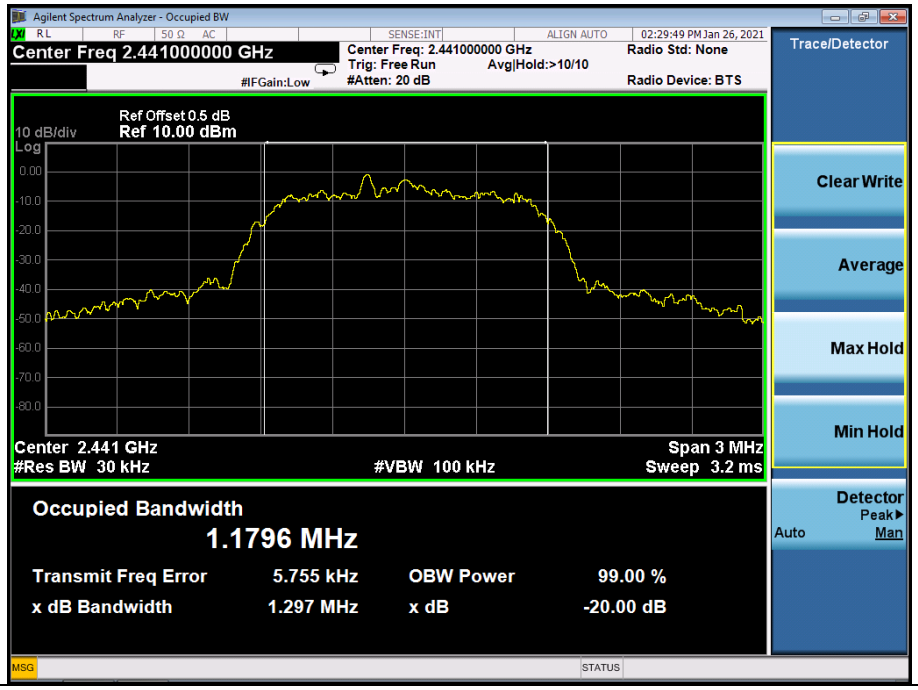
## Pi/4 DQPSK High Channel



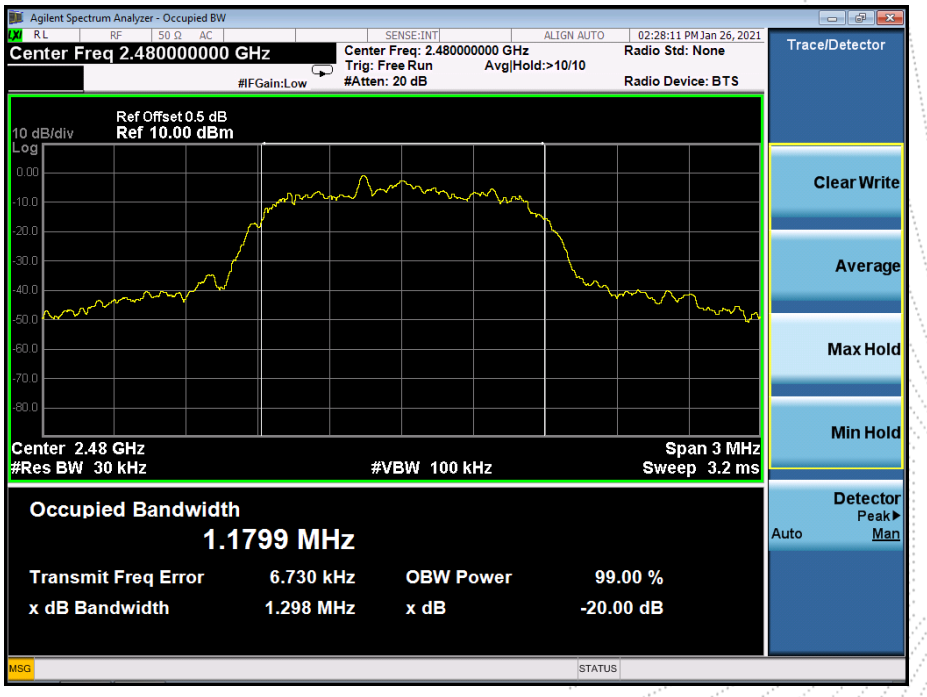

## 8DPSK Low Channel



## 8DPSK Middle Channel




## 8DPSK High Channel



# 11. MAXIMUM PEAK OUTPUT POWER

## 11.1 Block Diagram Of Test Setup

## 11.2 Limit

| FCC Part15 (15.247) , Subpart C | | | | |
|---|---|---|---|---|
| Section | Test Item | Limit | Frequency Range (MHz) | Result |
| 15.247(b)(1) | Peak Output Power | 0.125 watt or 21dBm | 2400-2483.5 | PASS |

## 11.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set the spectrum analyzer: RBW = 3MHz. VBW = 3MHz. Sweep = auto; Detector Function = Peak.

3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

## 11.4 Test Result

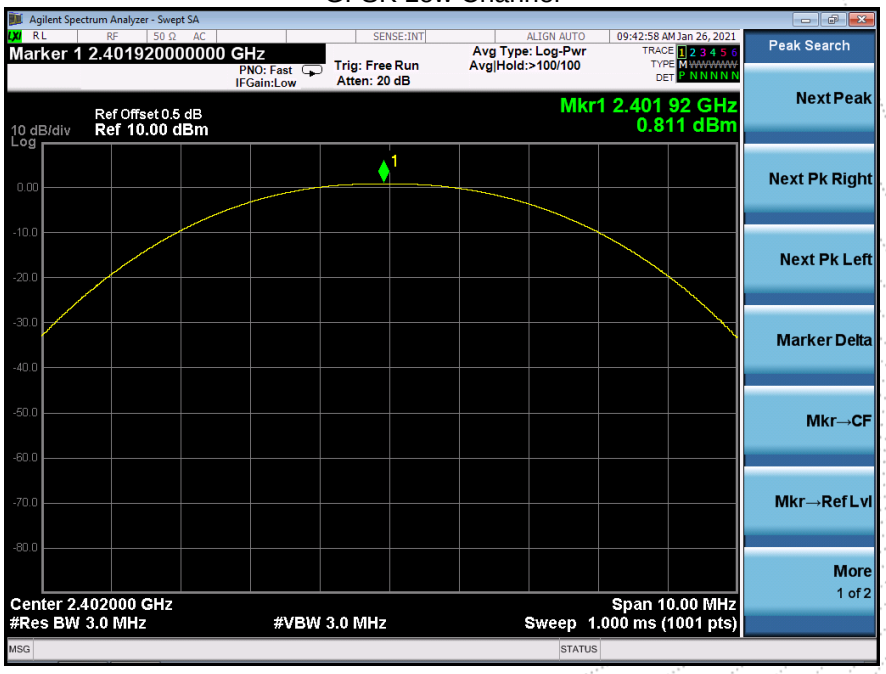
| | | | |
|---|---|---|---|
| Temperature： | 26℃ | Relative Humidity： | 54% |
| Test Voltage ： | DC 3.7V | Remark: | N/A |

Left

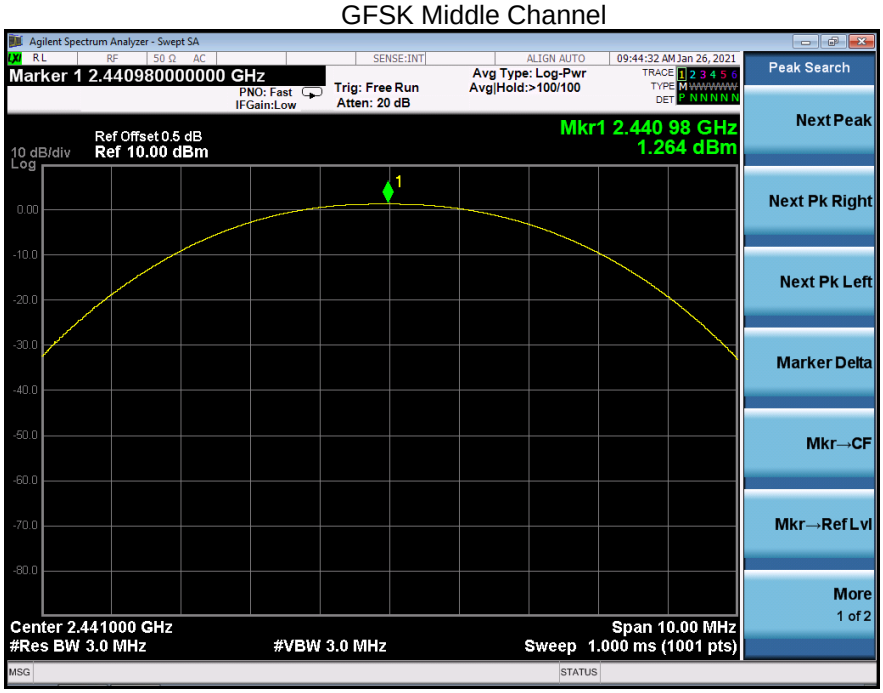
| Modulation | Test Channel | Output Power (dBm) | Limit (dBm) |
|---|---|---|---|
| GFSK | Low | 0.811 | 21 |
| GFSK | Middle | 1.264 | 21 |
| GFSK | High | 1.380 | 21 |
| Pi/4 DQPSK | Low | 3.261 | 21 |
| Pi/4 DQPSK | Middle | 3.699 | 21 |
| Pi/4 DQPSK | High | 3.803 | 21 |
| 8DPSK | Low | 3.840 | 21 |
| 8DPSK | Middle | 4.276 | 21 |
| 8DPSK | High | 4.372 | 21 |

**Test plots**

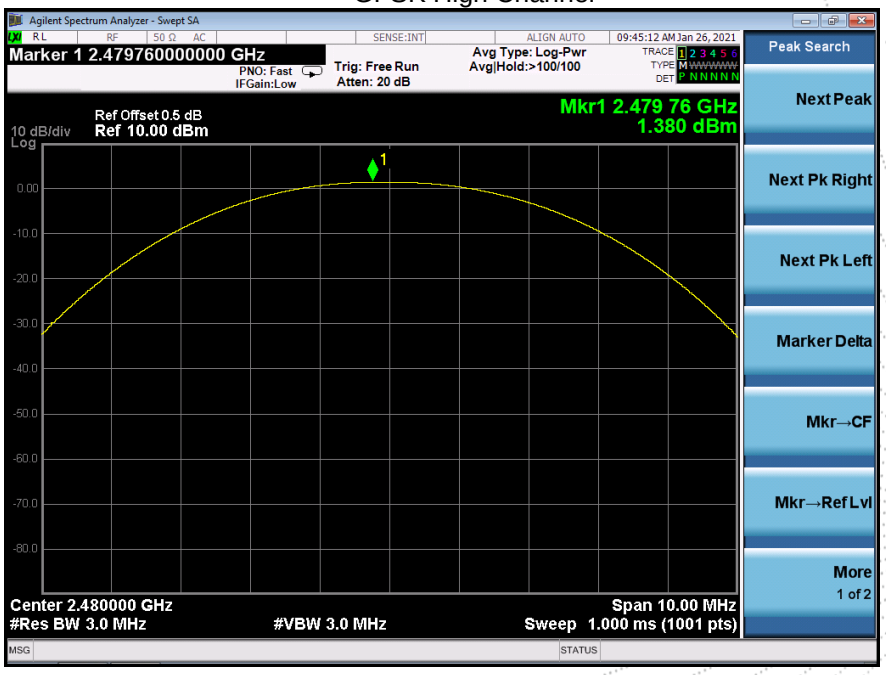
GFSK Low Channel



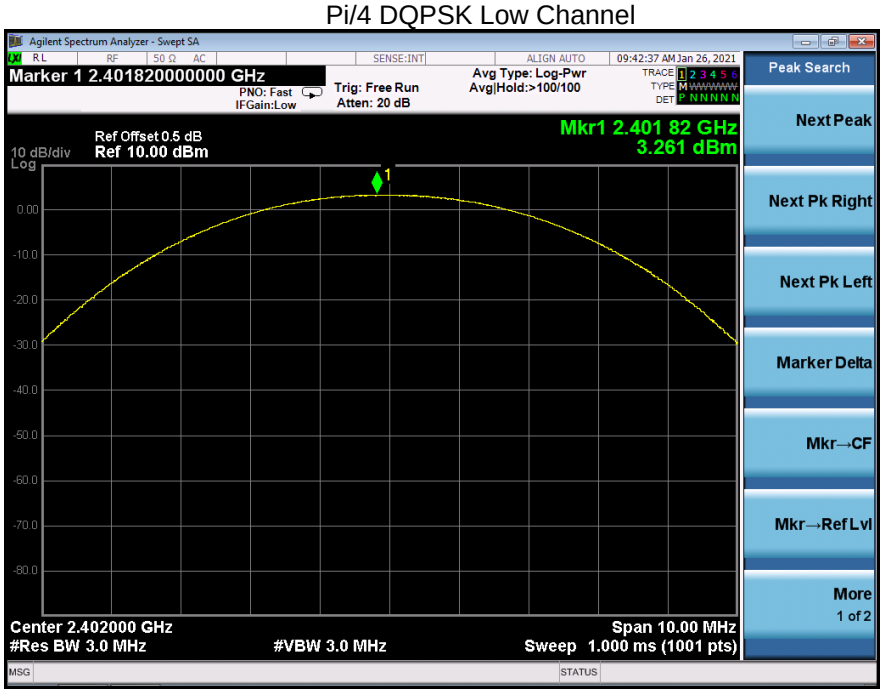
GFSK Middle Channel



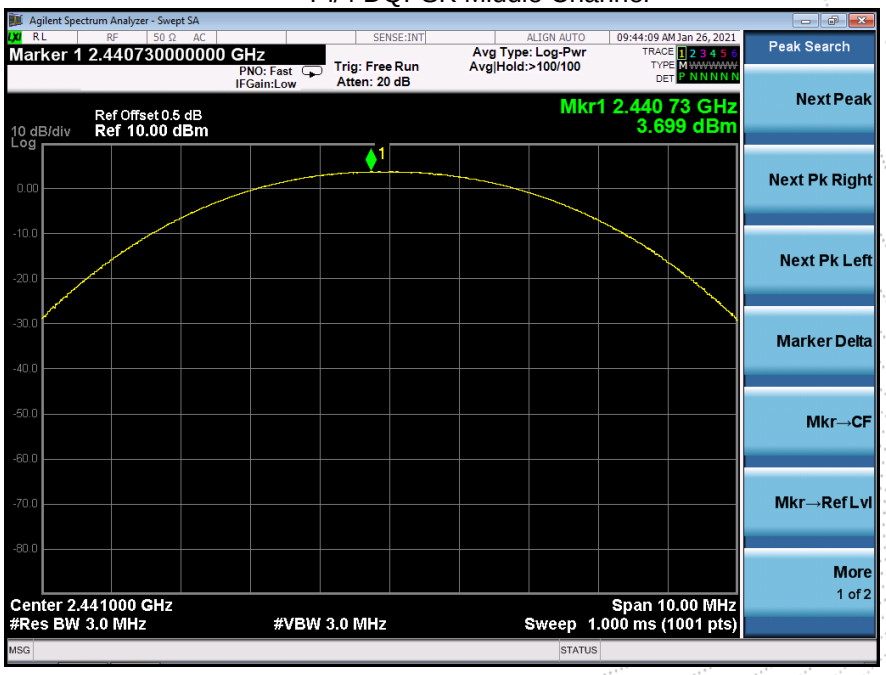

GFSK High Channel



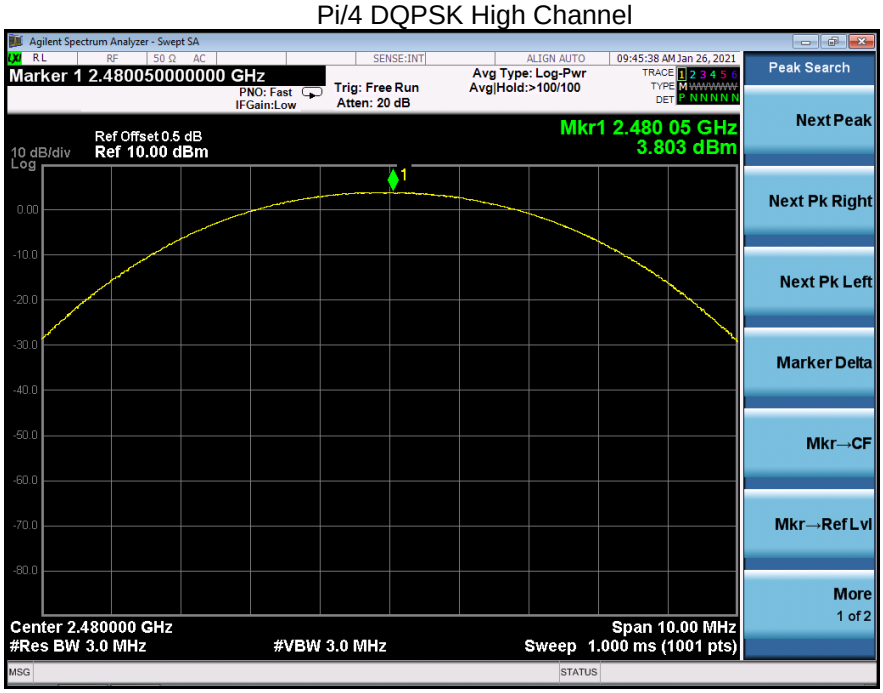
Pi/4 DQPSK Low Channel



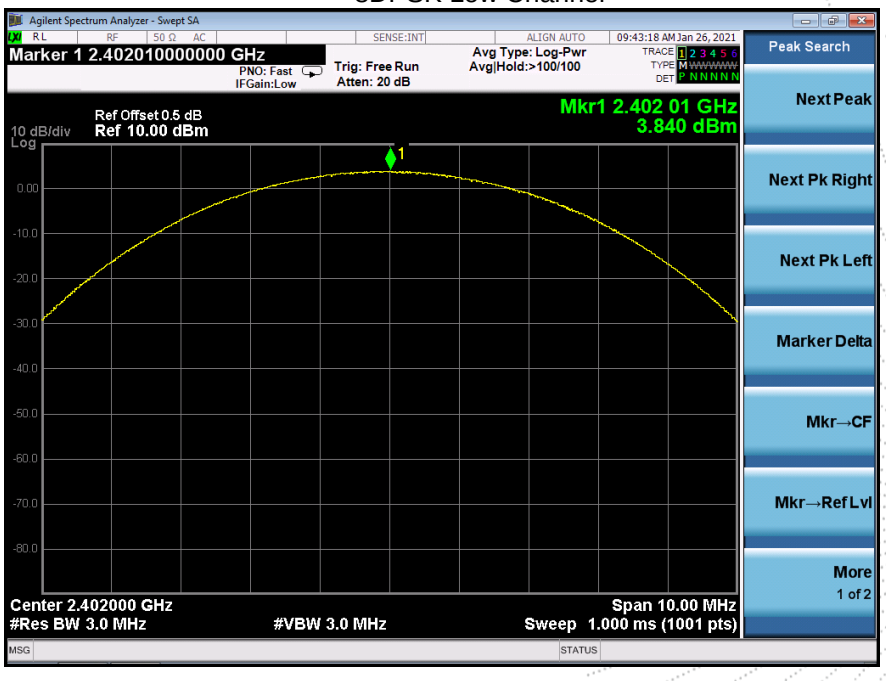

Pi/4 DQPSK Middle Channel



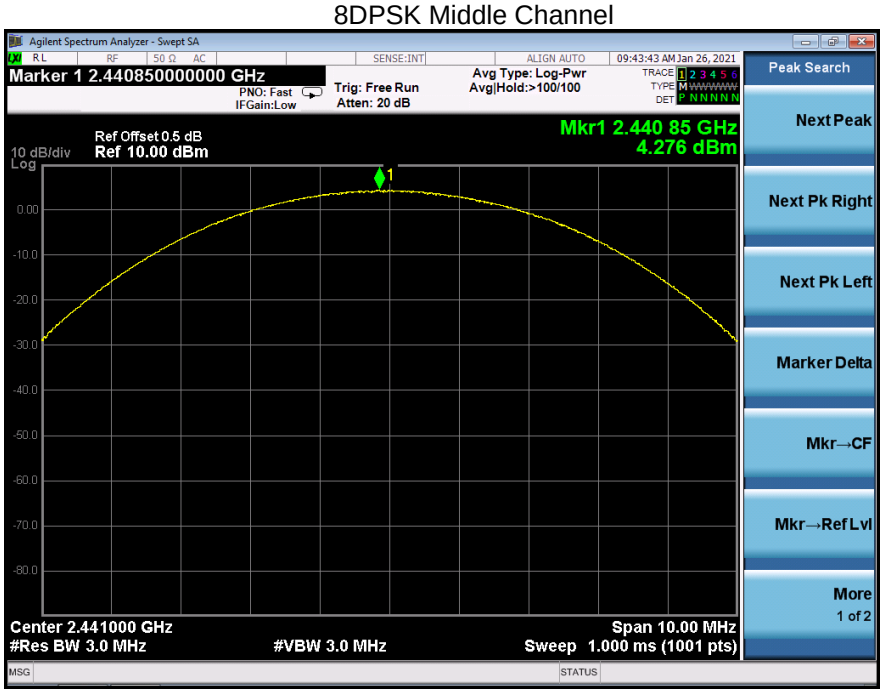
Pi/4 DQPSK High Channel



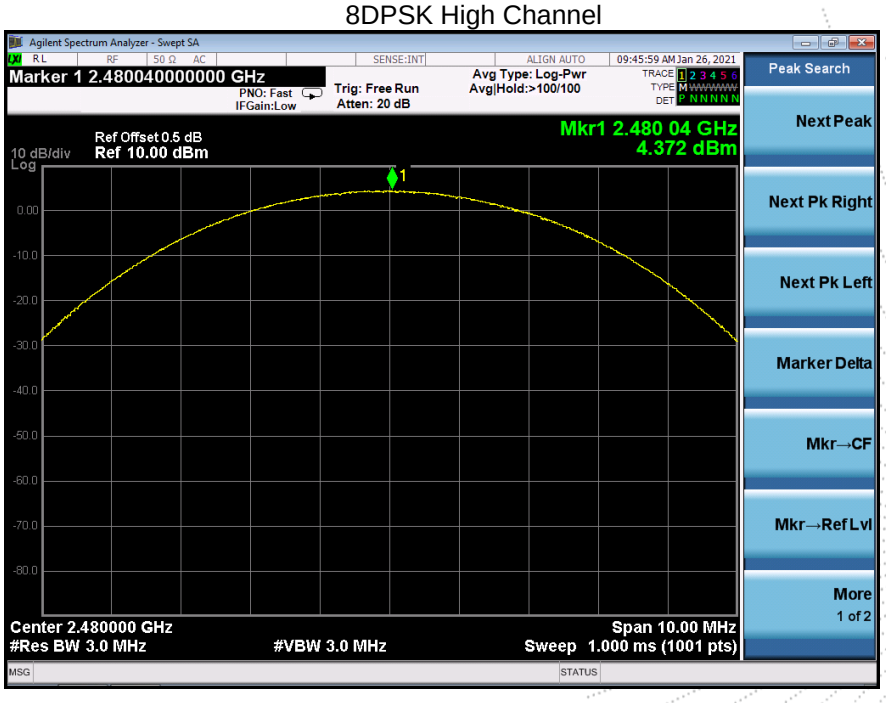

8DPSK Low Channel



8DPSK Middle Channel




8DPSK High Channel

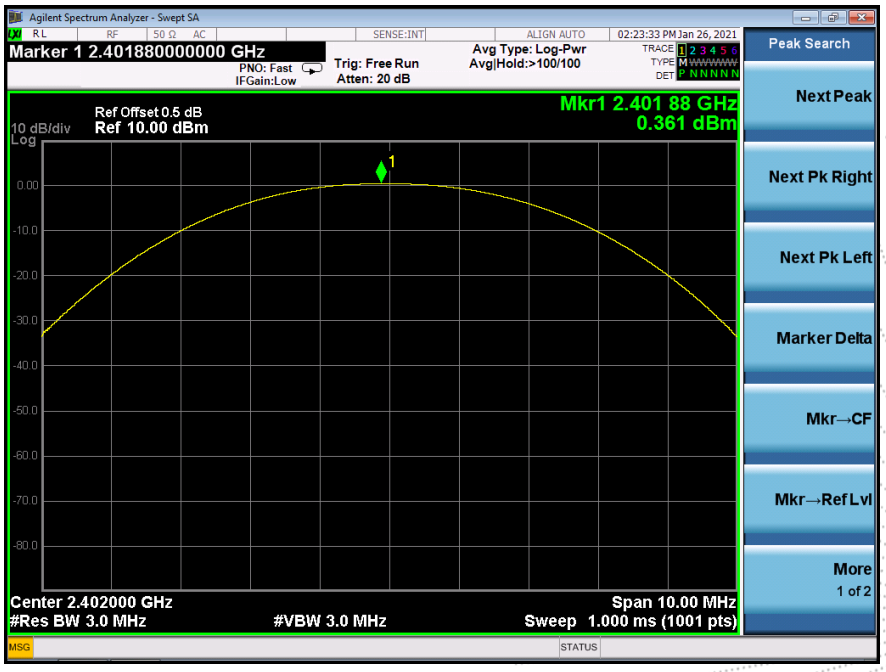


Right

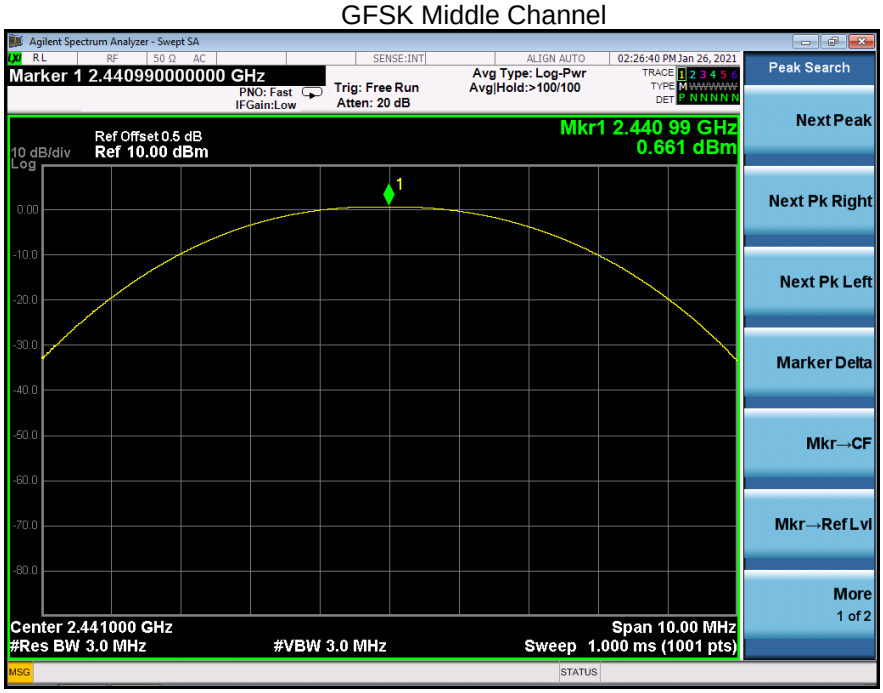
| Modulation | Test Channel | Output Power (dBm) | Limit (dBm) |
|---|---|---|---|
| GFSK | Low | 0.361 | 21 |
| GFSK | Middle | 0.661 | 21 |
| GFSK | High | 0.639 | 21 |
| Pi/4 DQPSK | Low | 2.824 | 21 |
| Pi/4 DQPSK | Middle | 3.139 | 21 |
| Pi/4 DQPSK | High | 3.091 | 21 |
| 8DPSK | Low | 3.357 | 21 |
| 8DPSK | Middle | 3.705 | 21 |
| 8DPSK | High | 3.669 | 21 |

**Test plots**

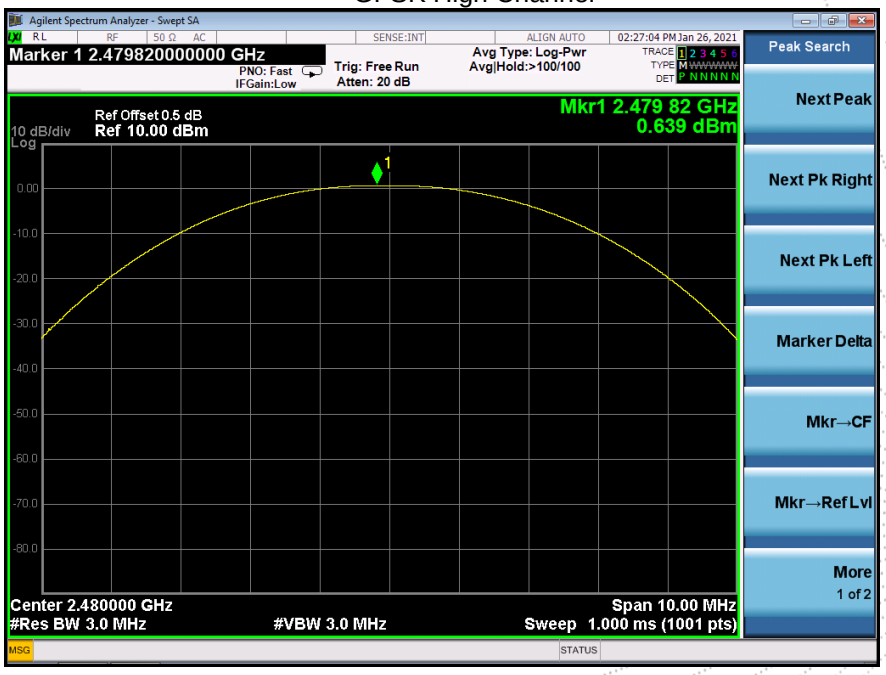
GFSK Low Channel



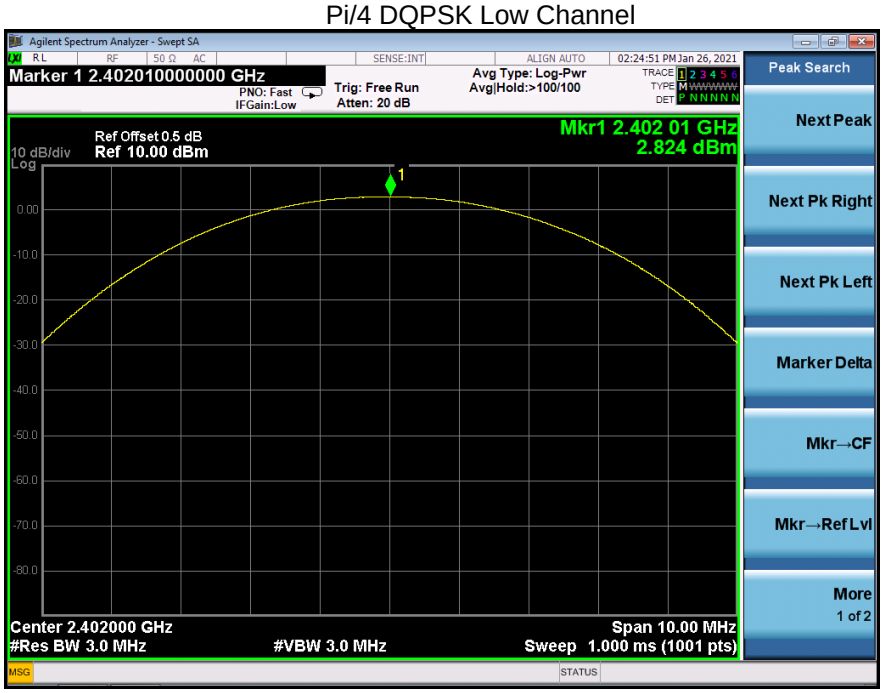
GFSK Middle Channel



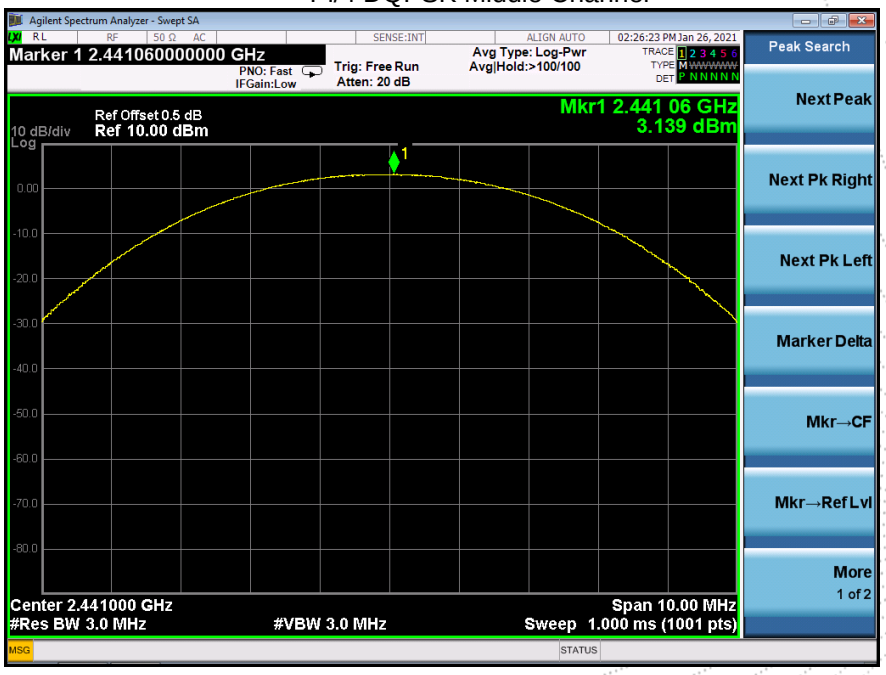

GFSK High Channel



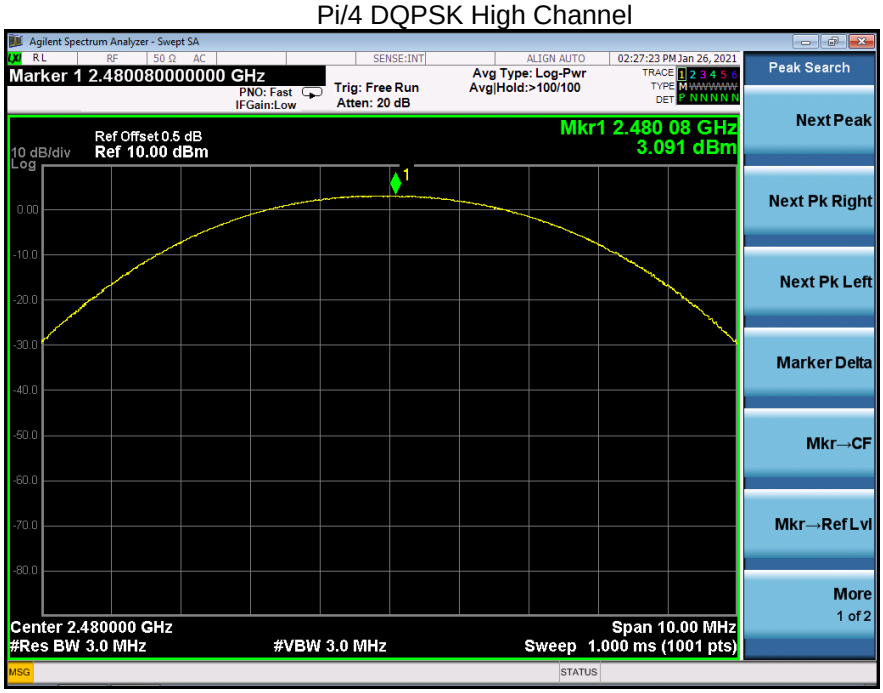
Pi/4 DQPSK Low Channel



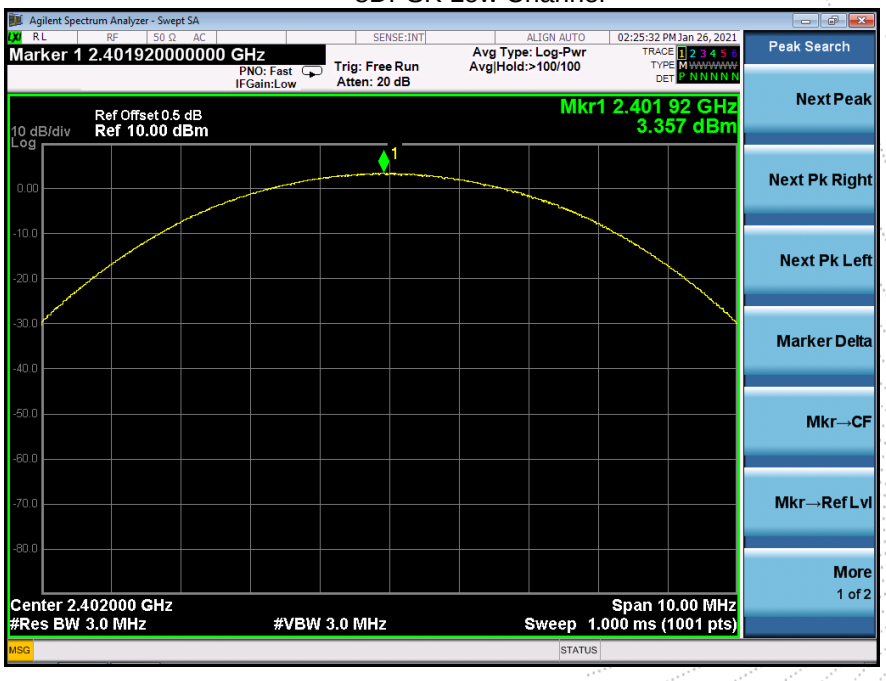

Pi/4 DQPSK Middle Channel



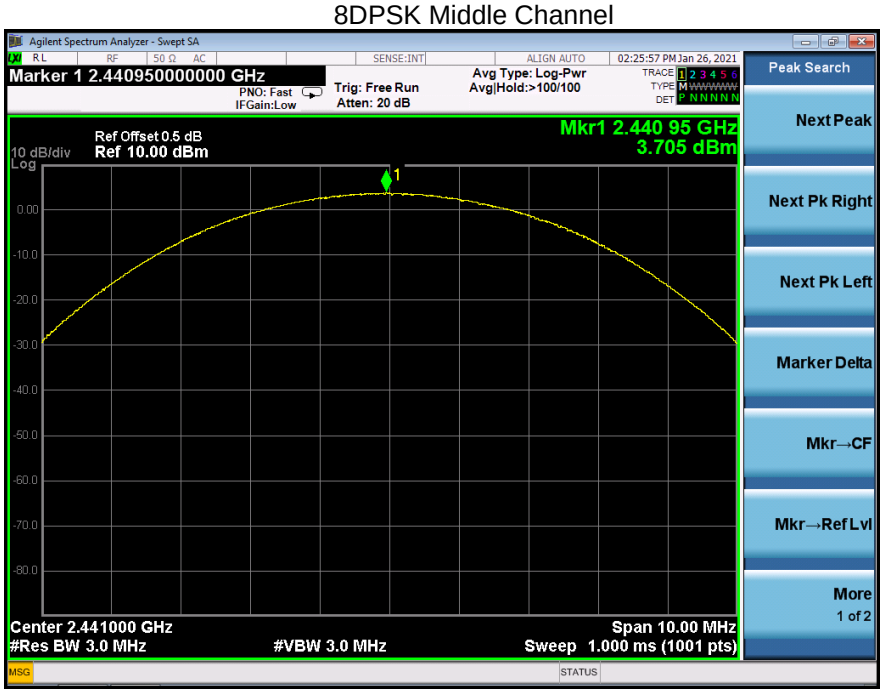
Pi/4 DQPSK High Channel



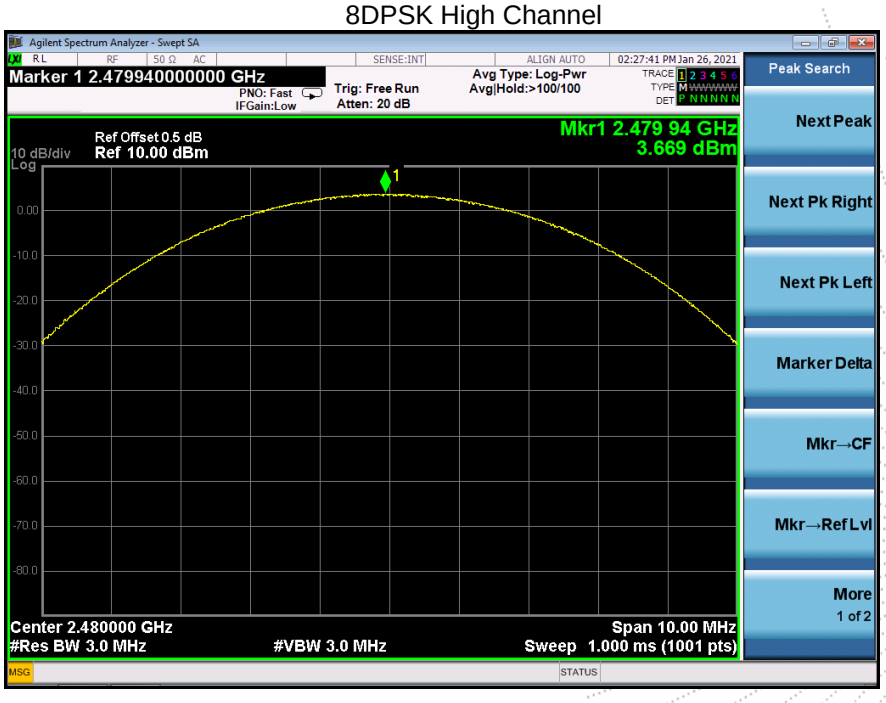

8DPSK Low Channel



8DPSK Middle Channel

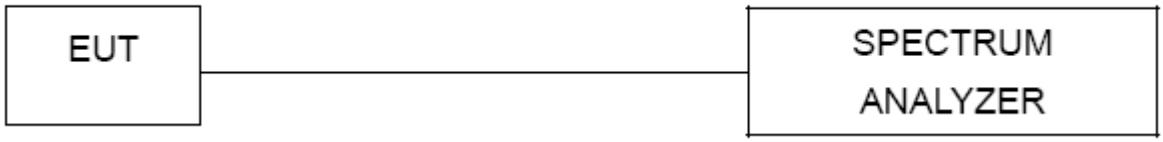



8DPSK High Channel



# 12. HOPPING CHANNEL SEPARATION

## 12.1 Block Diagram Of Test Setup




## 12.2 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, provided the systems operate with an output power no greater than 0.125W.

## 12.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port

to the spectrum.

2. Set the spectrum analyzer: RBW = 30kHz. VBW = 100kHz , Span = 2.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

## 12.4 Test Result

Left

| Modulation | Test Channel | Separation (MHz) | Limit(MHz) | Result |
|---|---|---|---|---|
| GFSK | Low | 0.998 | 0.635 | PASS |
| GFSK | Middle | 1.000 | 0.633 | PASS |
| GFSK | High | 1.004 | 0.635 | PASS |
| Pi/4 DQPSK | Low | 1.002 | 0.859 | PASS |
| Pi/4 DQPSK | Middle | 0.992 | 0.857 | PASS |
| Pi/4 DQPSK | High | 1.004 | 0.857 | PASS |
| 8DPSK | Low | 0.996 | 0.863 | PASS |
| 8DPSK | Middle | 0.998 | 0.857 | PASS |
| 8DPSK | High | 0.996 | 0.867 | PASS |

**Test plots**

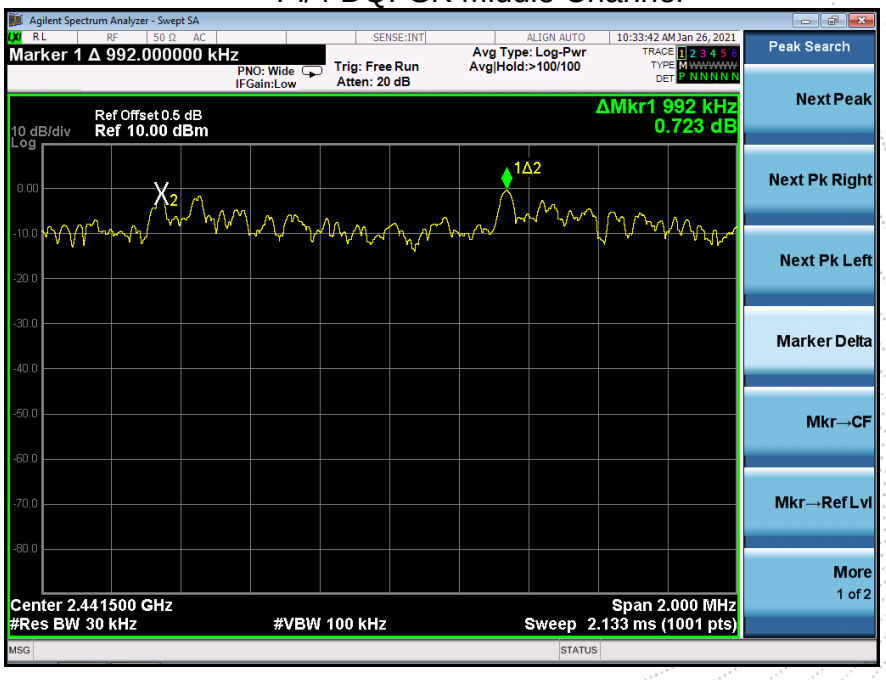
GFSK Low Channel

GFSK Middle Channel

GFSK High Channel

Pi/4 DQPSK Low Channel

Pi/4 DQPSK Middle Channel



Pi/4 DQPSK High Channel

8DPSK Low Channel

8DPSK Middle Channel

8DPSK High Channel

Right

| Modulation | Test Channel | Separation (MHz) | Limit(MHz) | Result |
|---|---|---|---|---|
| GFSK | Low | 1.000 | 0.633 | PASS |
| GFSK | Middle | 0.994 | 0.637 | PASS |
| GFSK | High | 1.000 | 0.635 | PASS |
| Pi/4 DQPSK | Low | 0.998 | 0.857 | PASS |
| Pi/4 DQPSK | Middle | 1.000 | 0.860 | PASS |
| Pi/4 DQPSK | High | 1.002 | 0.847 | PASS |
| 8DPSK | Low | 0.998 | 0.863 | PASS |
| 8DPSK | Middle | 1.000 | 0.865 | PASS |
| 8DPSK | High | 0.994 | 0.865 | PASS |

**Test plots**

GFSK Low Channel

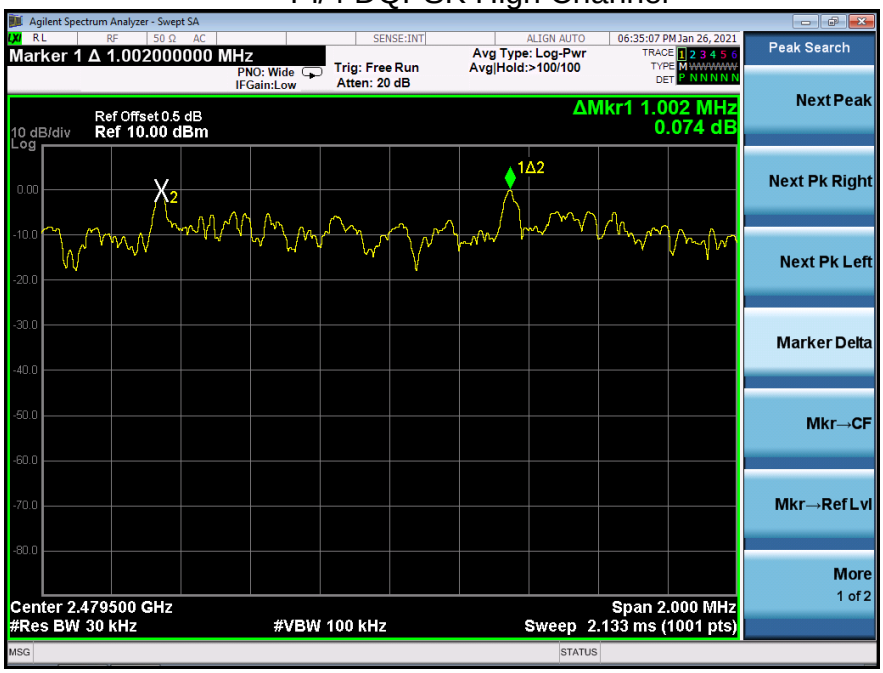
GFSK Middle Channel

GFSK High Channel

Pi/4 DQPSK Low Channel

Pi/4 DQPSK Middle Channel

Pi/4 DQPSK High Channel




8DPSK Low Channel

8DPSK Middle Channel

8DPSK High Channel

# 13. NUMBER OF HOPPING FREQUENCY

## 13.1 Block Diagram Of Test Setup

## 13.2 Limit

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

## 13.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.

3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.

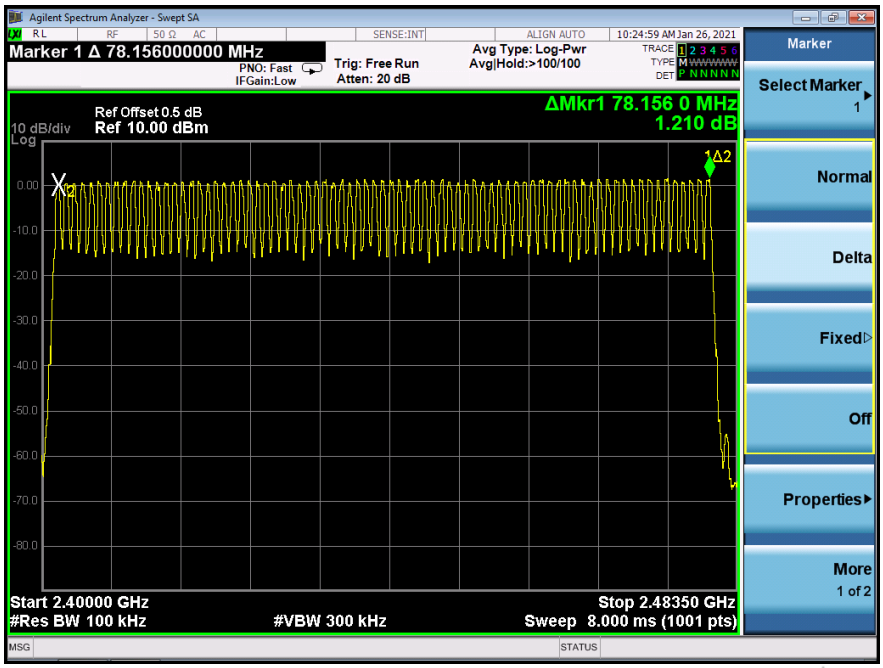
4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

## 13.4 Test Result

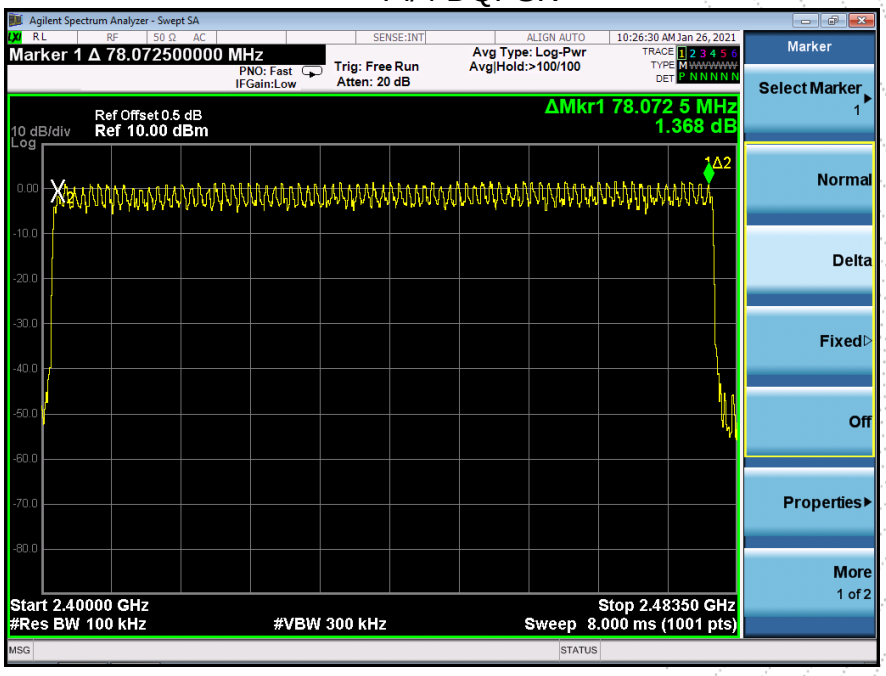
**Test Plots:**

Left

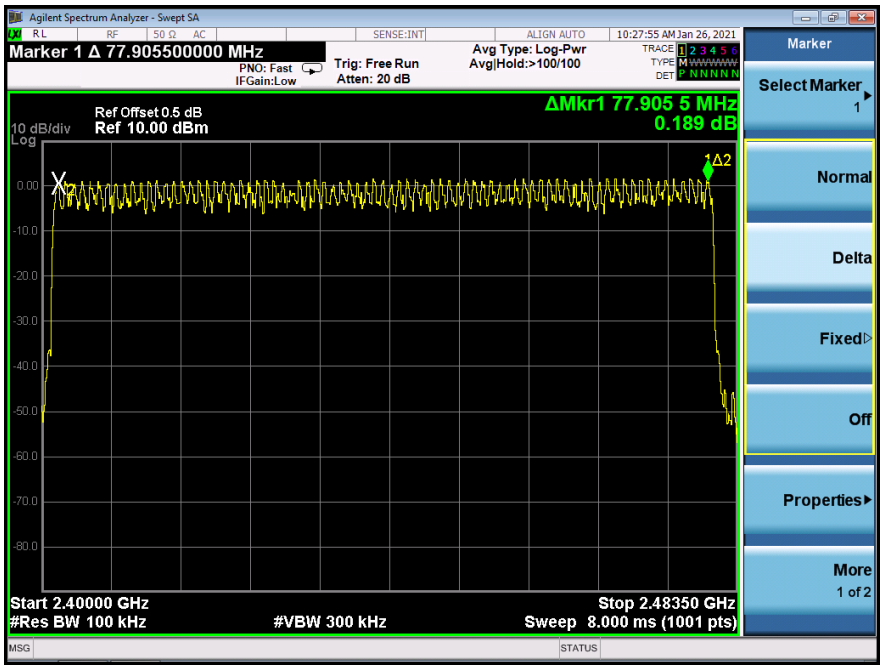
79 Channels in total
GFSK




Pi/4 DQPSK

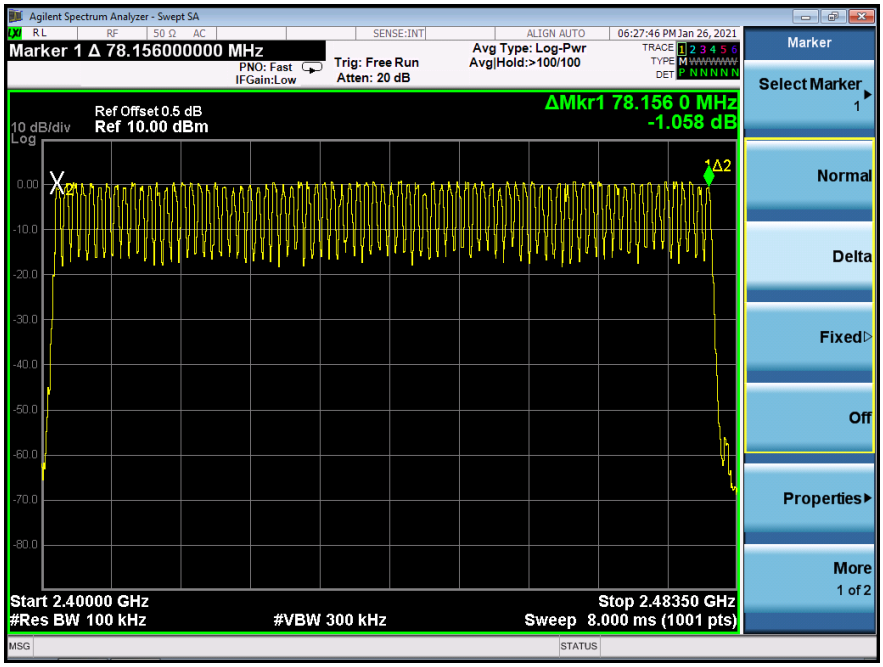


8DPSK

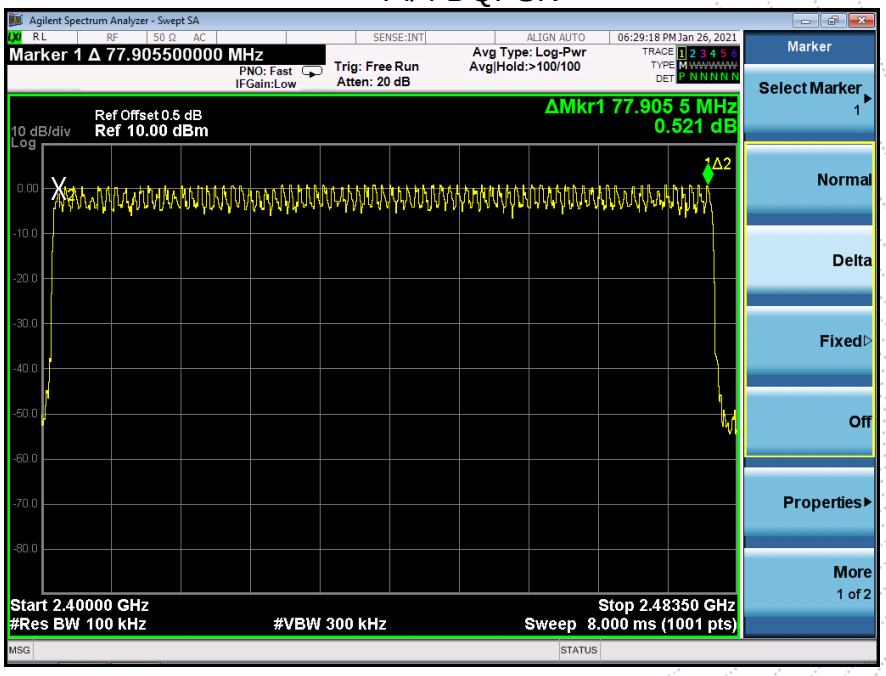

Agilent Spectrum Analyzer - Swept SA
Marker 1 Δ 77.905500000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
10:27:55 AM Jan 26, 2021
Ref Offset 0.5 dB
10 dB/div
Ref 10.00 dBm
Log
ΔMkr1 77.905 5 MHz
0.189 dB
Start 2.40000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.48350 GHz
Sweep 8.000 ms (1001 pts)
Marker
Select Marker
Normal
Delta
Fixed
Off
Properties
More
1 of 2

Right

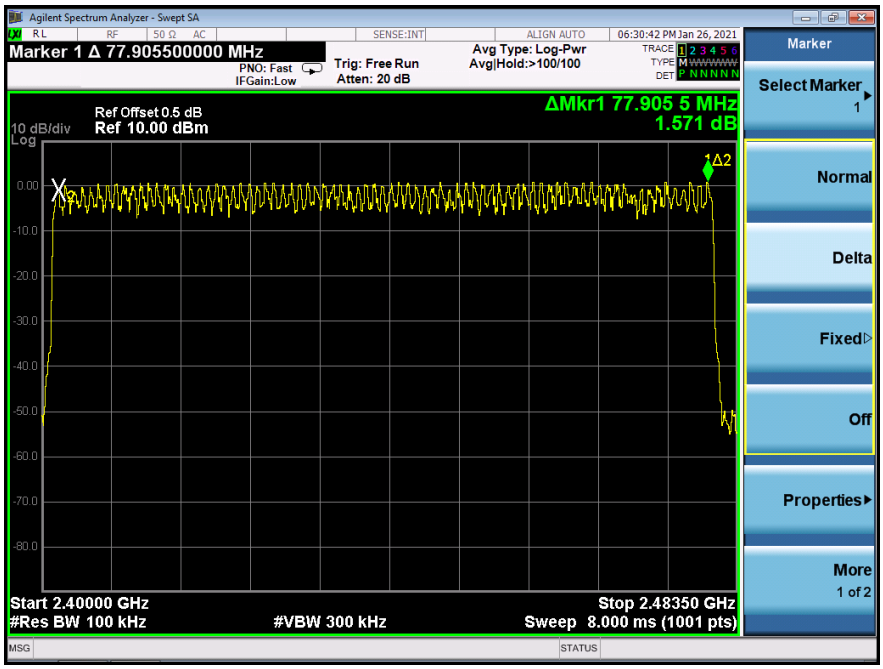
79 Channels in total
GFSK




Pi/4 DQPSK

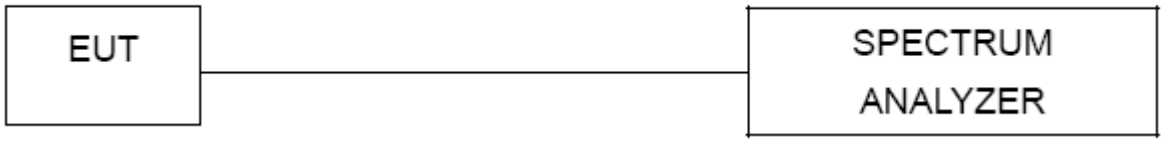


8DPSK


Agilent Spectrum Analyzer - Swept SA
Marker 1 Δ 77.905500000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 20 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
06:30:42 PM Jan 26, 2021
Ref Offset 0.5 dB
10 dB/div
Ref 10.00 dBm
Log
ΔMkr1 77.905 5 MHz
1.571 dB
Start 2.40000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.48350 GHz
Sweep 8.000 ms (1001 pts)
Marker
Select Marker
Normal
Delta
Fixed
Off
Properties
More
1 of 2

# 14. DWELL TIME

## 14.1 Block Diagram Of Test Setup




## 14.2 Limit

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

## 14.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.

2. Set spectrum analyzer span = 0. Centred on a hopping channel;

3. Set RBW = 1MHz and VBW = 3MHz.Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.

4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

## 14.4 Test Result

DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).
DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).
DH1 Packet permit maximum 1600 / 79 /2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

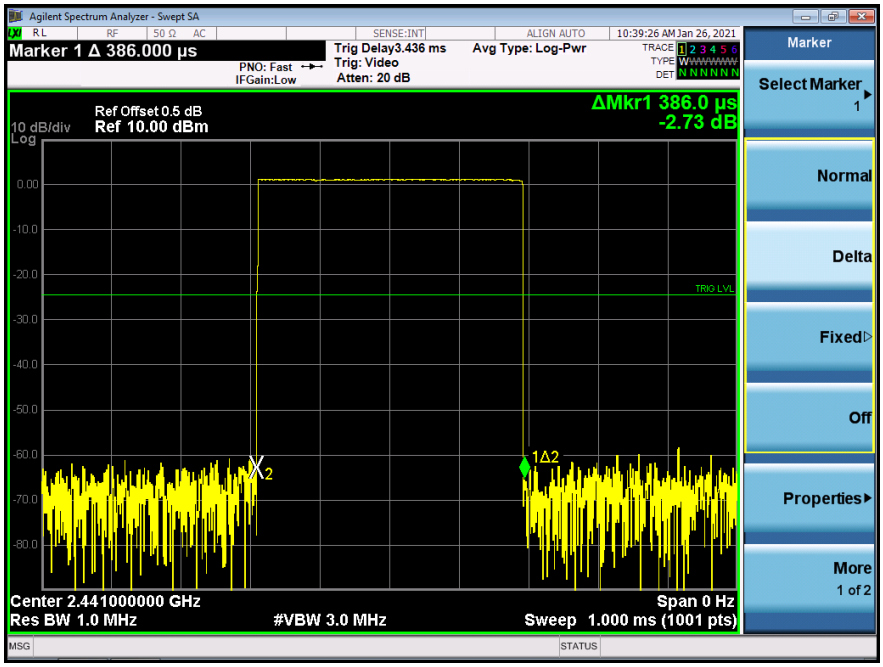
DH5:1600/79/6*0.4*79*(MkrDelta)/1000
DH3:1600/79/4*0.4*79*(MkrDelta)/1000
DH1:1600/79/2*0.4*79*(MkrDelta)/1000
Remark: Mkr Delta is once pulse time.

Left

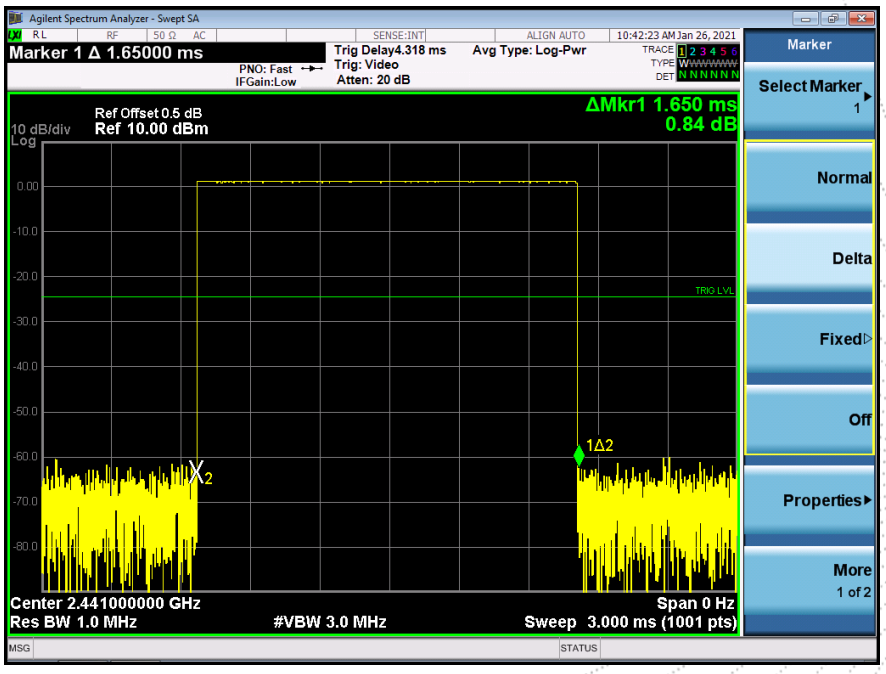
| Modulation | Channel Data | Packet | pulse time(ms) | Dwell Time(s) | Limits(s) |
|---|---|---|---|---|---|
| GFSK | Middle | DH1 | 0.386 | 0.124 | 0.4 |
| | | DH3 | 1.650 | 0.264 | 0.4 |
| | | DH5 | 2.910 | 0.310 | 0.4 |
| Pi/4DQPSK | Middle | 2DH1 | 0.394 | 0.126 | 0.4 |
| | | 2DH3 | 1.650 | 0.264 | 0.4 |
| | | 2DH5 | 2.910 | 0.310 | 0.4 |
| 8DPSK | Middle | 3DH1 | 0.394 | 0.126 | 0.4 |
| | | 3DH3 | 1.650 | 0.264 | 0.4 |
| | | 3DH5 | 2.910 | 0.310 | 0.4 |

## Test Plots

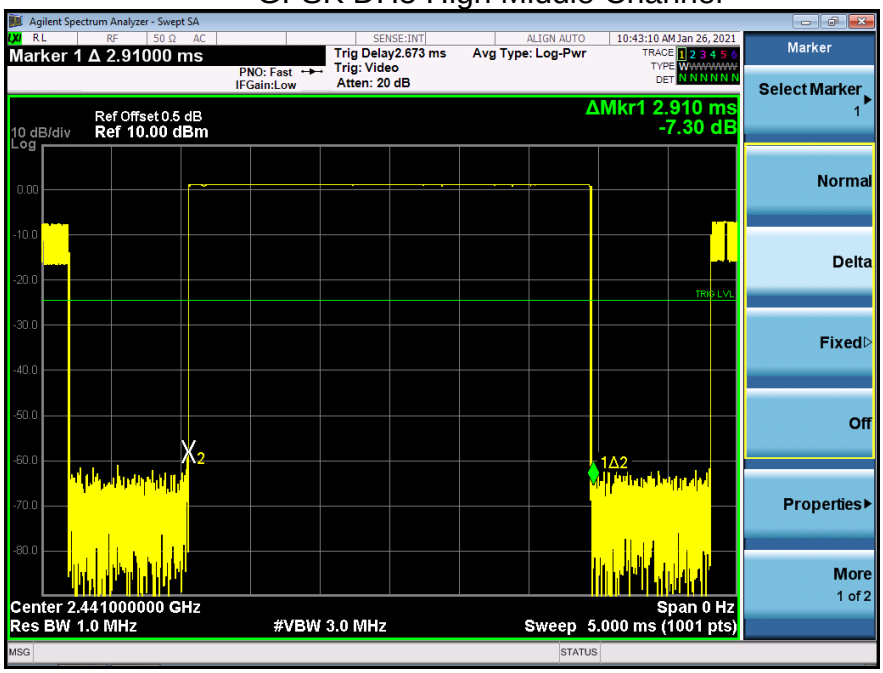
GFSK DH1 Middle Channel



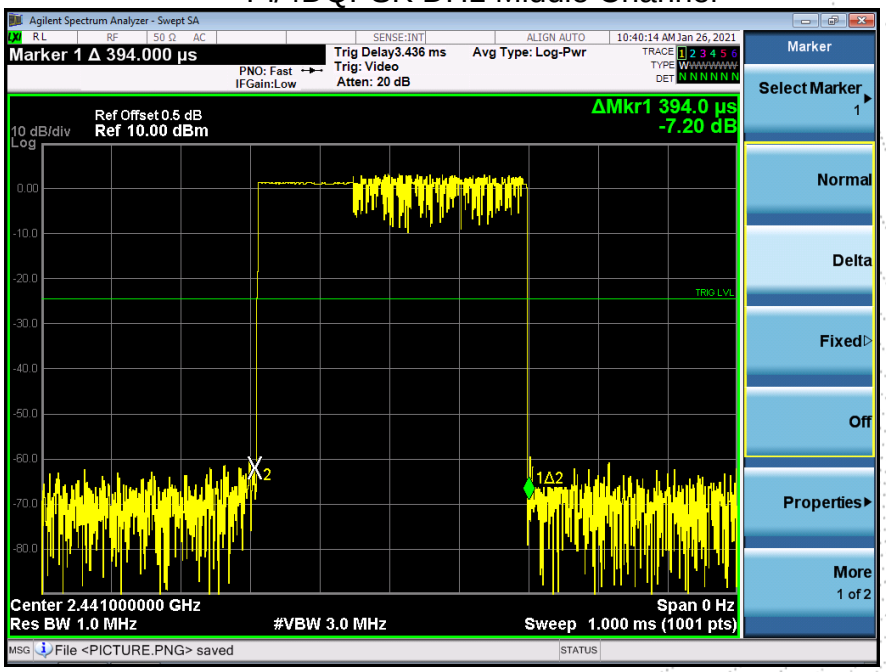

GFSK DH3 Middle Channel



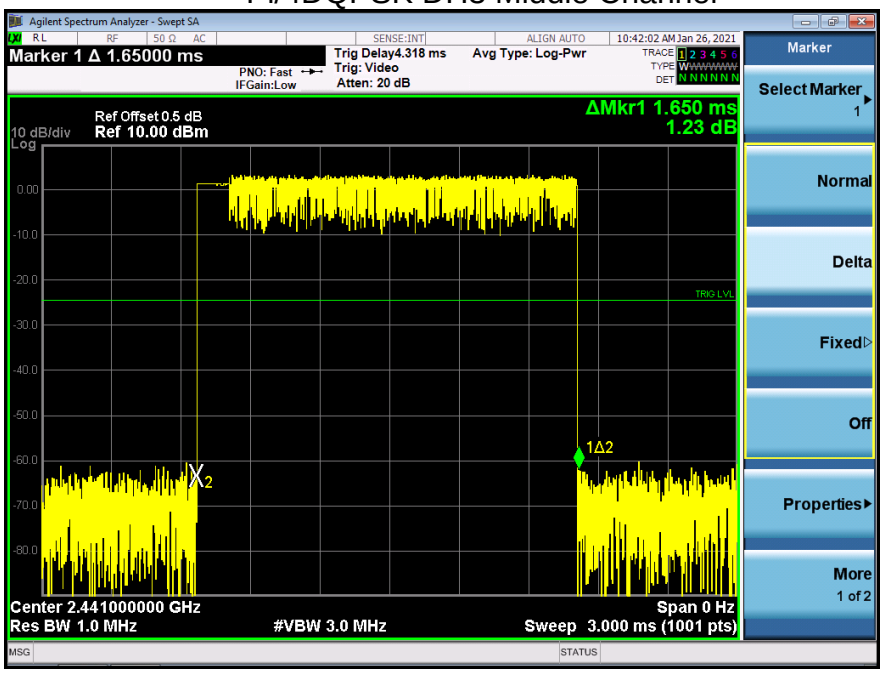
GFSK DH5 High Middle Channel



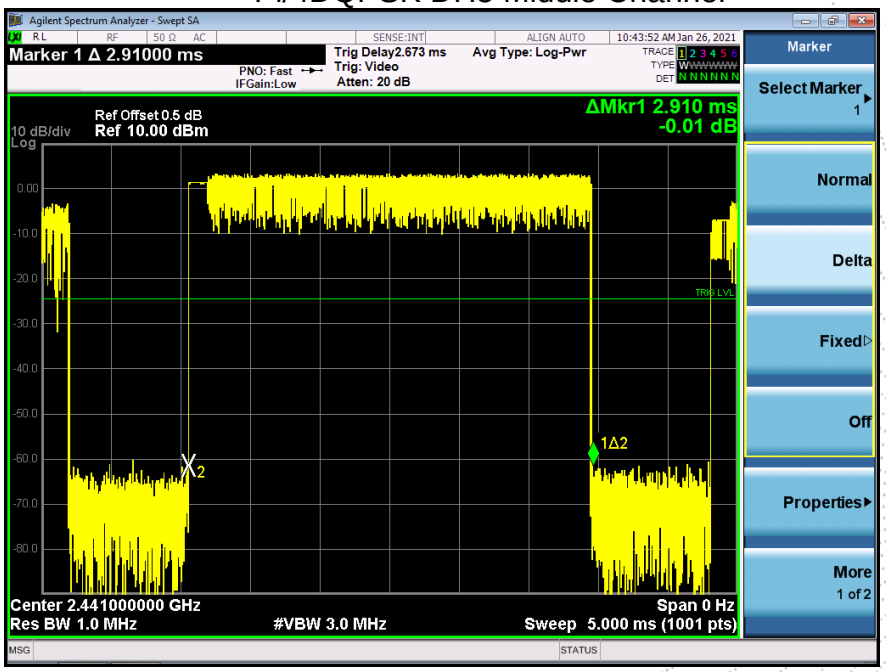

Pi/4DQPSK DH1 Middle Channel



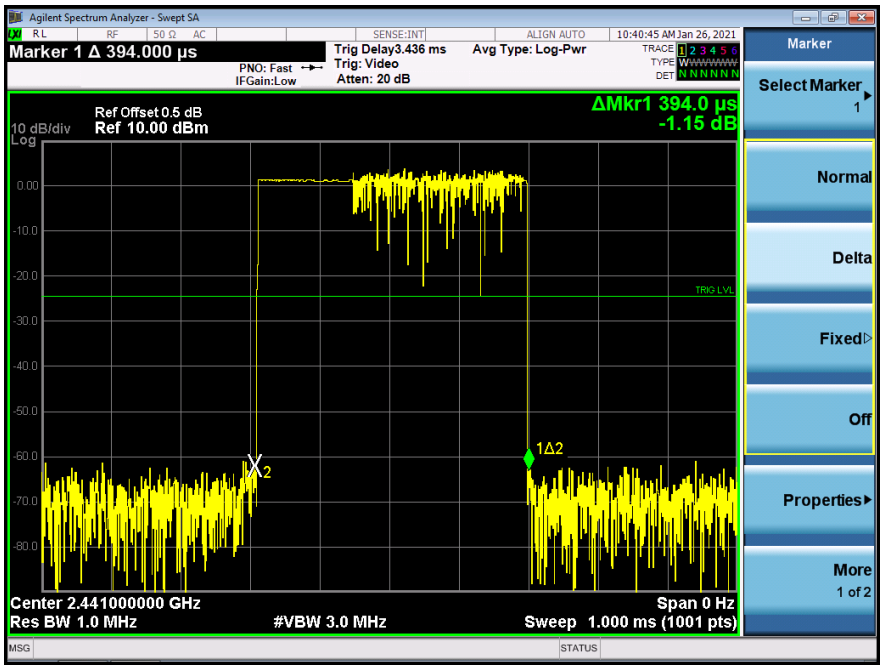
Pi/4DQPSK DH3 Middle Channel



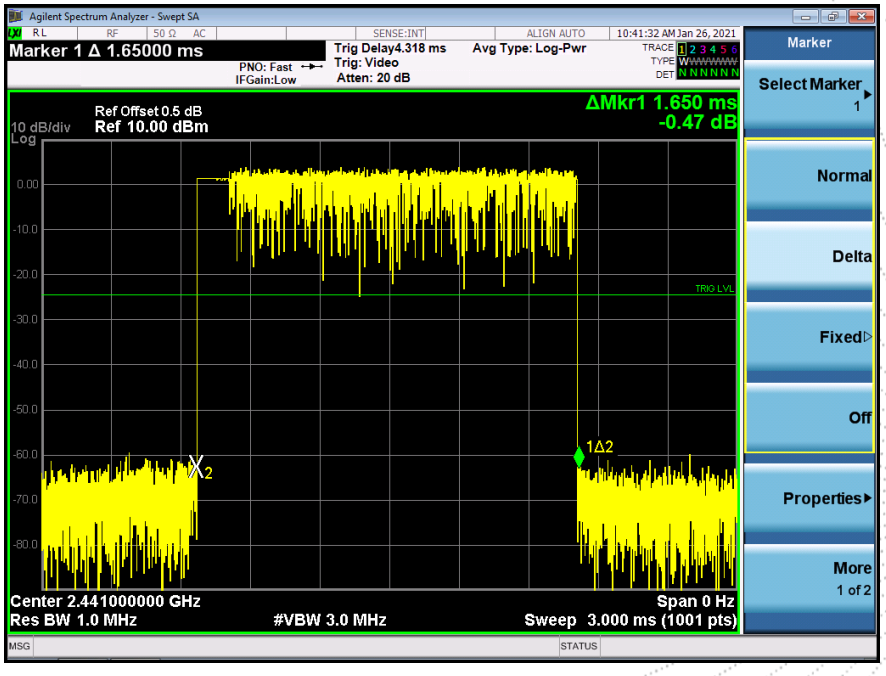
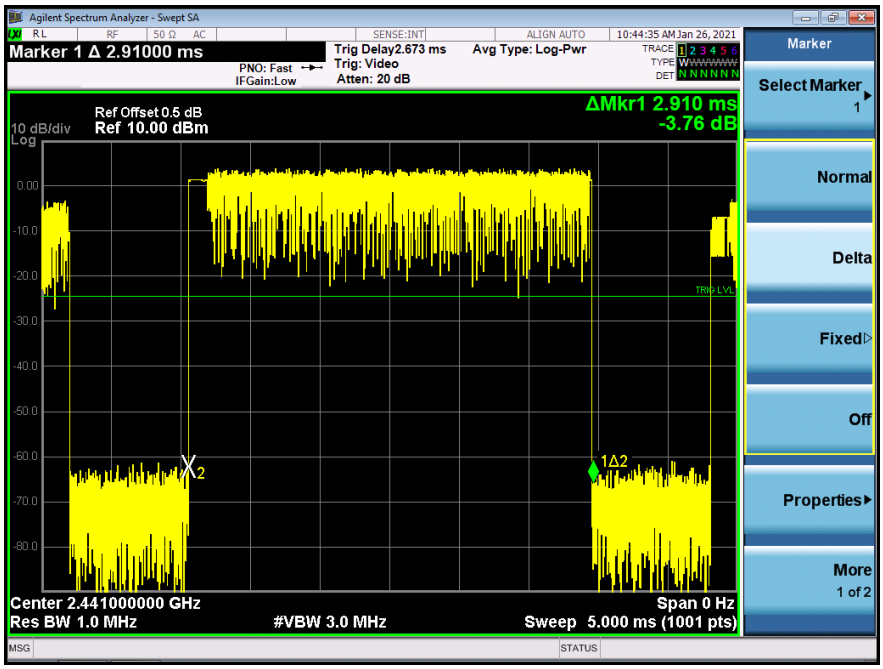

Pi/4DQPSK DH5 Middle Channel



8DPSK DH1 Middle Channel




8DPSK DH3 Middle Channel



8DPSK DH5 Middle Channel