

## Appendix A

### RF Test Data for BT V5.0(BDR/EDR) (Conducted Measurement)

Product Name: True Wireless Earbuds

Trade Mark: Happy Plugs

Test Model: Air 1 Plus

#### Environmental Conditions

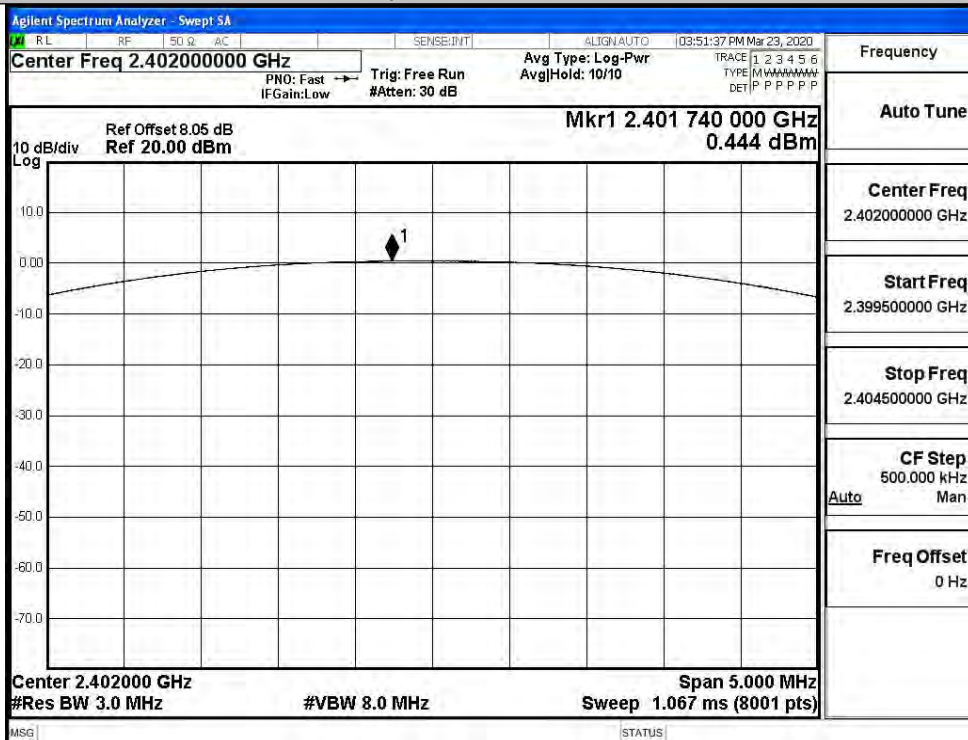
|                    |             |
|--------------------|-------------|
| Temperature:       | 25 ° C      |
| Relative Humidity: | 50%         |
| ATM Pressure:      | 100.0 kPa   |
| Test Engineer:     | Alisa Huang |
| Supervised by:     | Li Huan     |

#### A.1 Maximum Conducted Peak Output Power

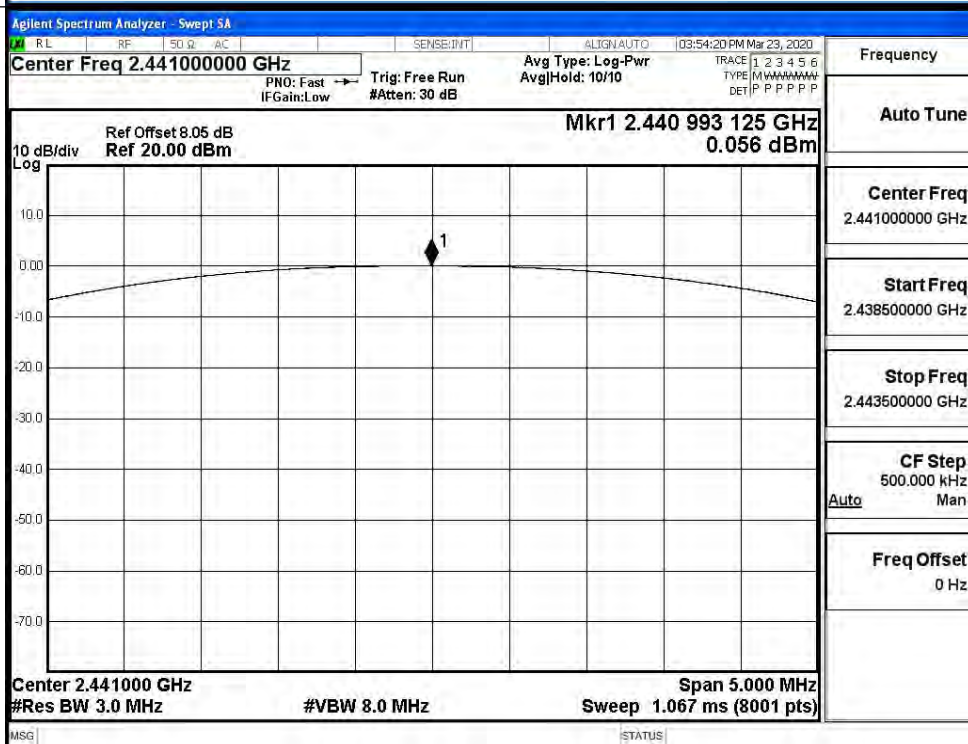
| Mode          | Channel. | Maximum Peak Output Power [dBm] | Limit [dBm] | Verdict |
|---------------|----------|---------------------------------|-------------|---------|
| GFSK          | LCH      | 0.444                           | 30          | PASS    |
|               | MCH      | 0.056                           | 30          | PASS    |
|               | HCH      | -0.183                          | 30          | PASS    |
| $\pi/4$ DQPSK | LCH      | 2.931                           | 21          | PASS    |
|               | MCH      | 2.601                           | 21          | PASS    |
|               | HCH      | 2.373                           | 21          | PASS    |
| 8DPSK         | LCH      | 3.607                           | 21          | PASS    |
|               | MCH      | 3.339                           | 21          | PASS    |
|               | HCH      | 3.142                           | 21          | PASS    |

## Test Graphs

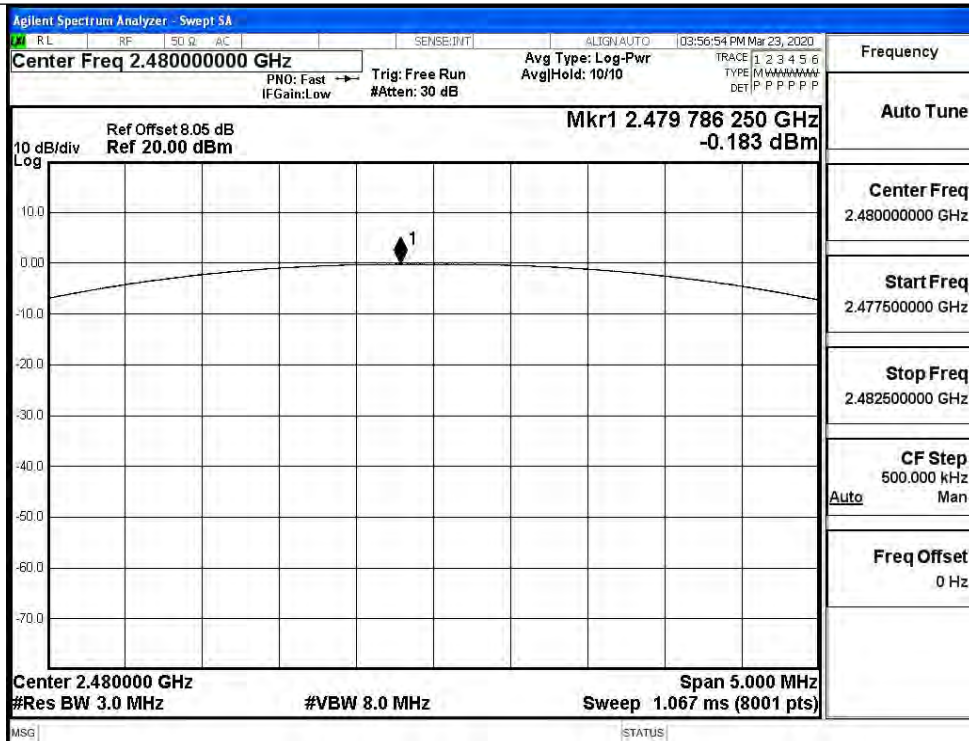
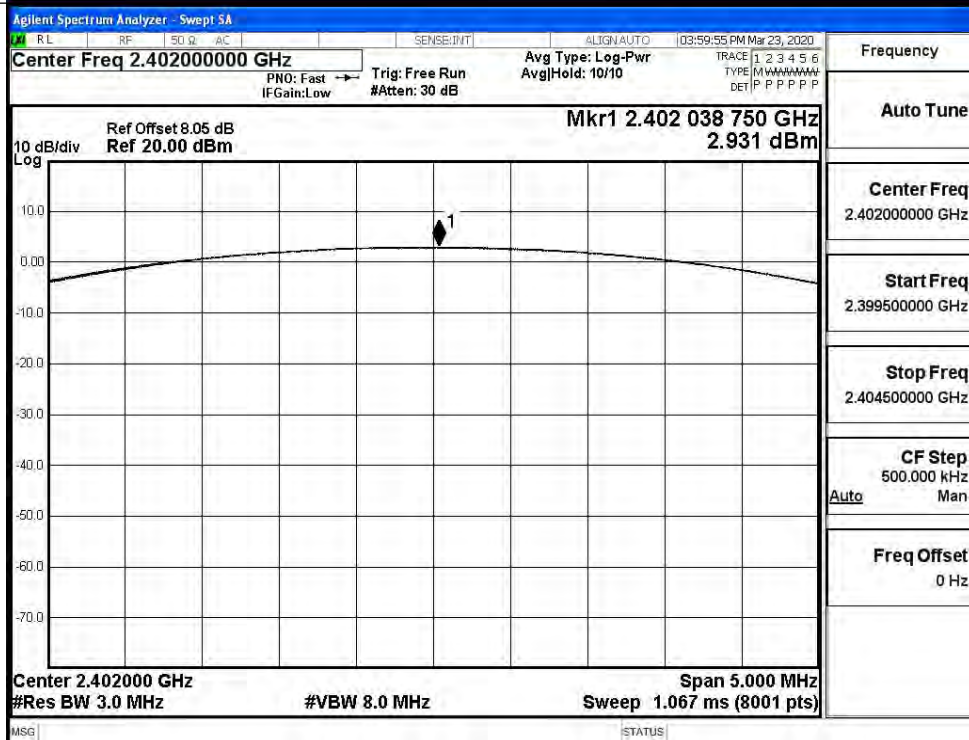
GFSK/LCH

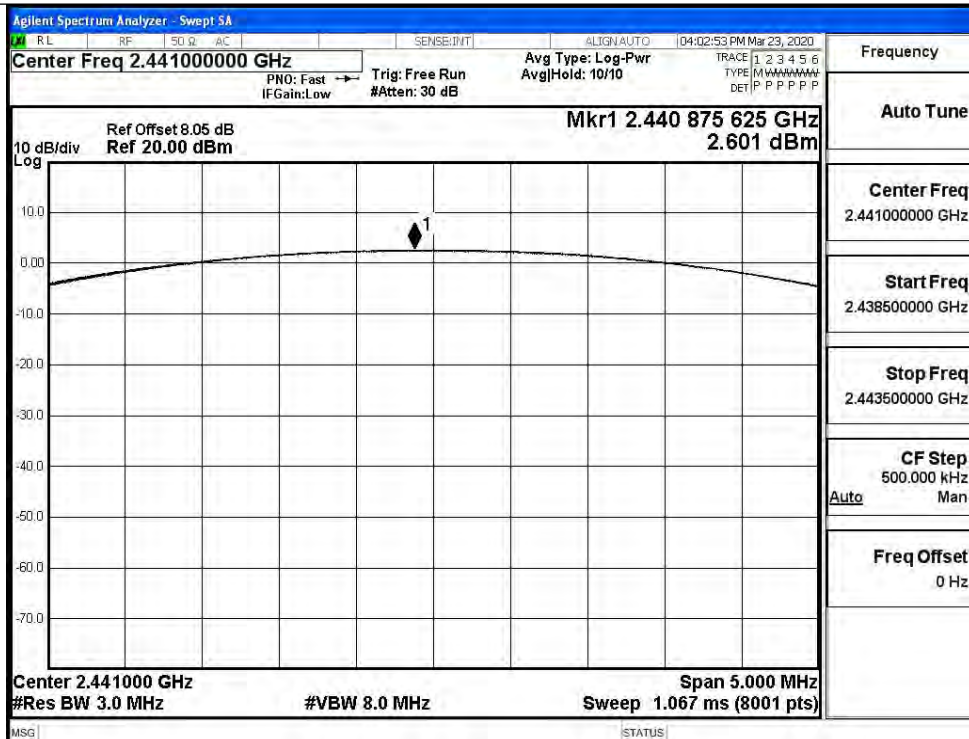
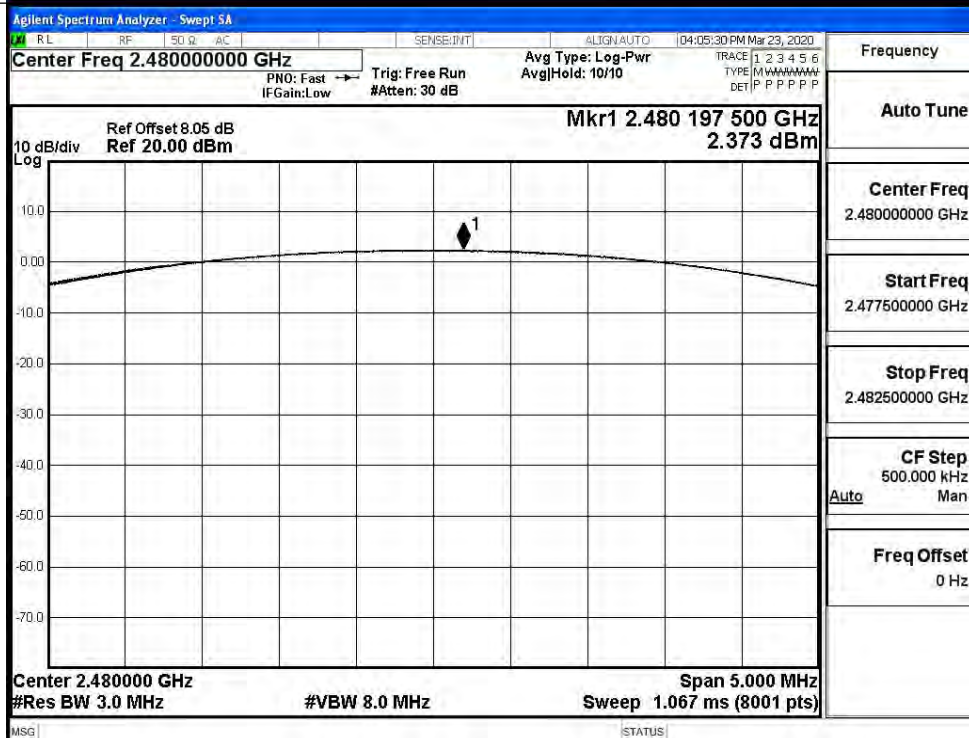


GFSK/MCH

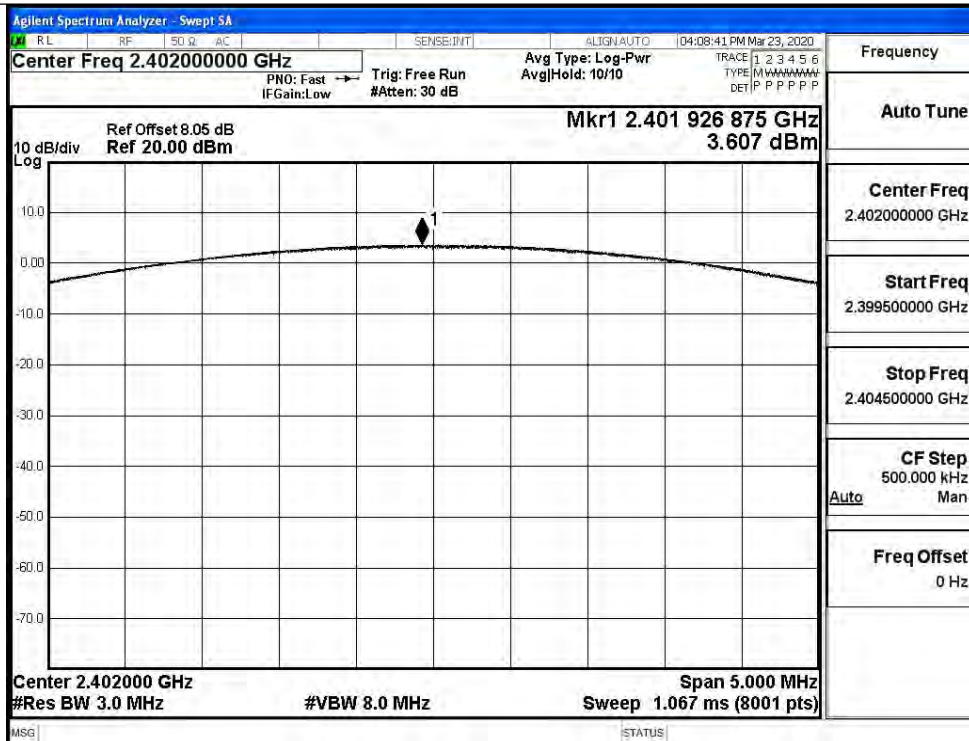


GFSK/HCH

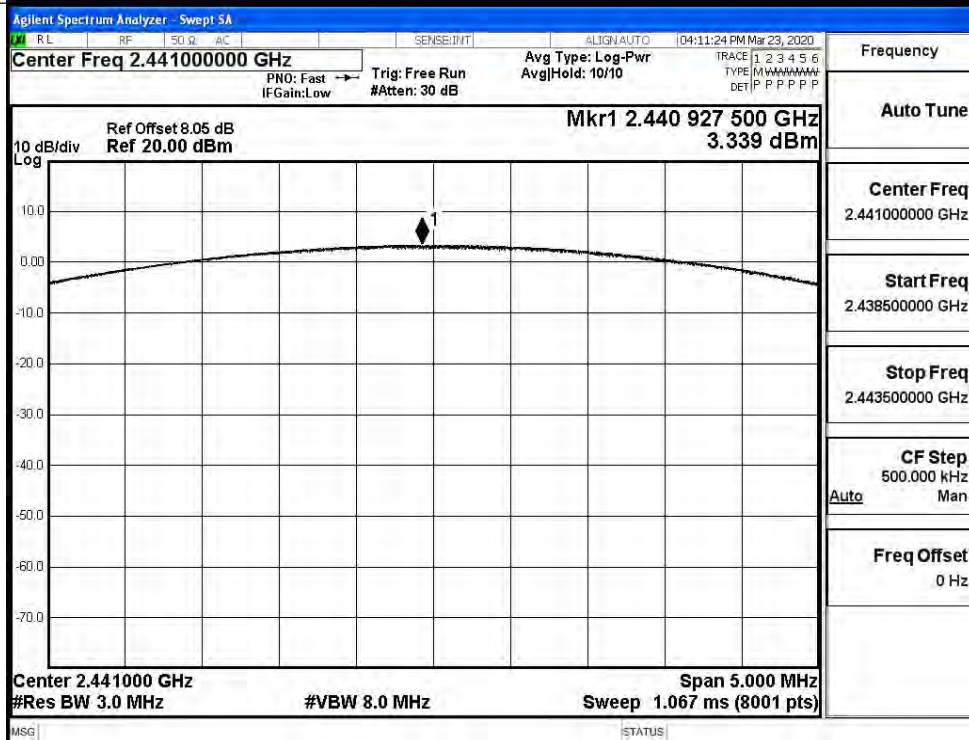
 $\pi$ /4DQPSK/LCH

$\pi/4$ DQPSK/MCH $\pi/4$ DQPSK/HCH

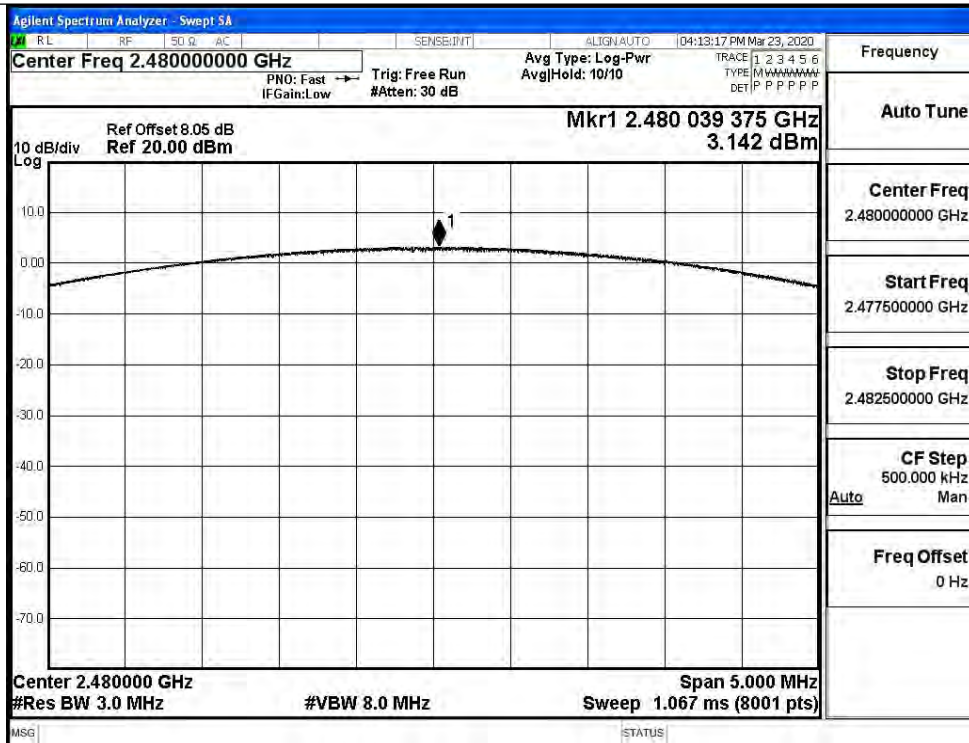
8DPSK/LCH



8DPSK/MCH



8DPSK/HCH

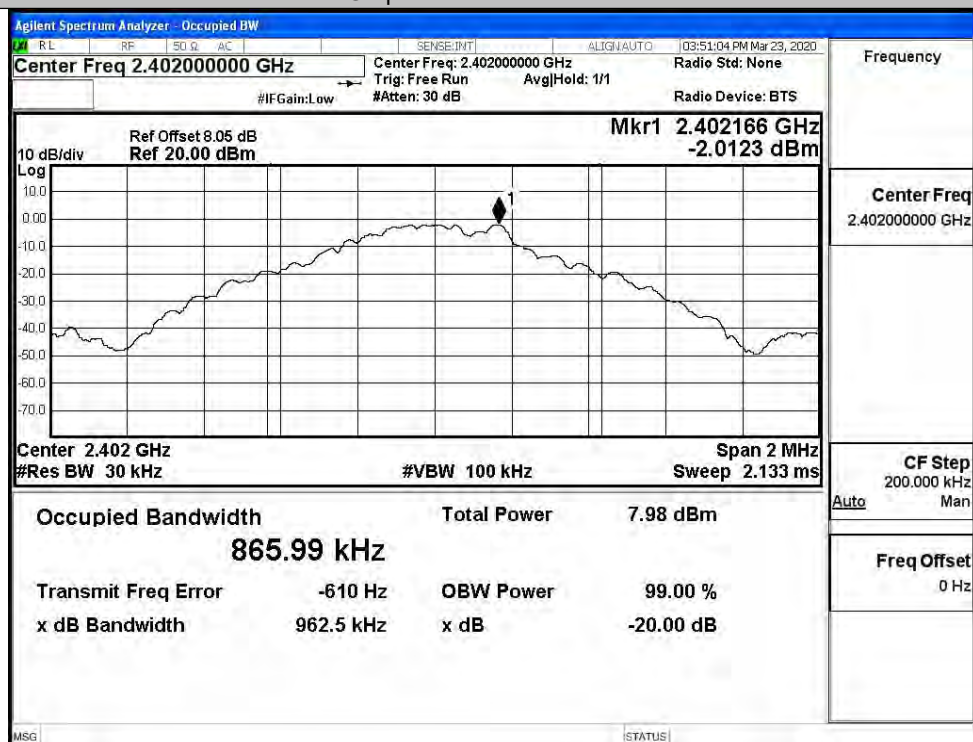


## A.2 20dB Bandwidth

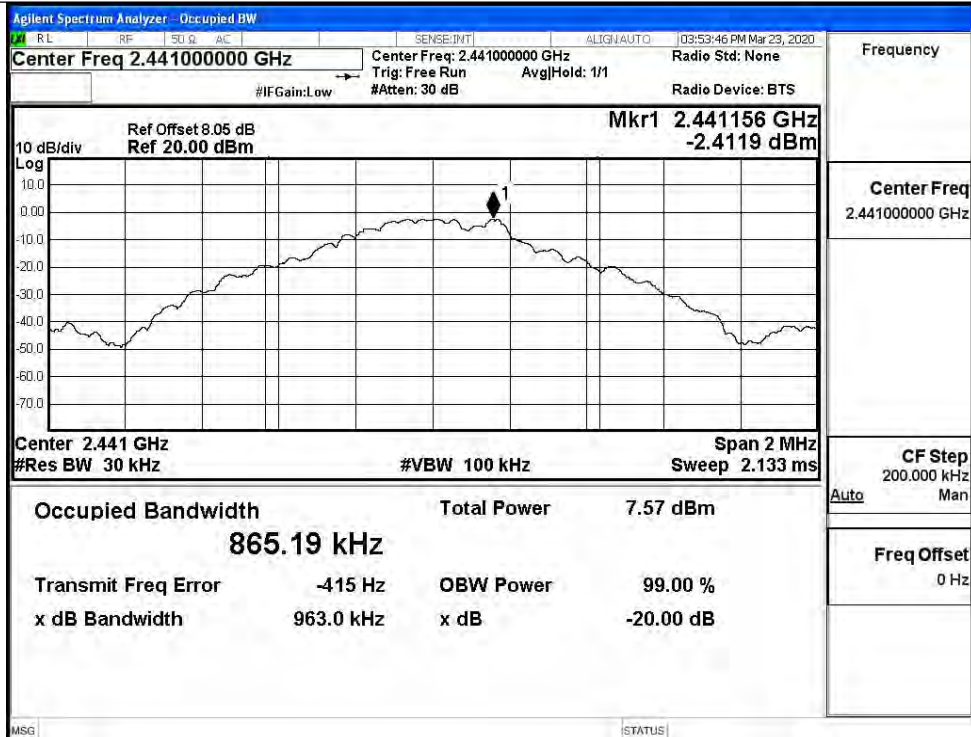
| Mode          | Channel. | 20dB Bandwidth [MHz] | Limit [MHz]   | Verdict |
|---------------|----------|----------------------|---------------|---------|
| GFSK          | LCH      | 0.9625               | Not Specified | PASS    |
|               | MCH      | 0.9630               | Not Specified | PASS    |
|               | HCH      | 0.9600               | Not Specified | PASS    |
| $\pi/4$ DQPSK | LCH      | 1.336                | Not Specified | PASS    |
|               | MCH      | 1.340                | Not Specified | PASS    |
|               | HCH      | 1.344                | Not Specified | PASS    |
| 8DPSK         | LCH      | 1.319                | Not Specified | PASS    |
|               | MCH      | 1.321                | Not Specified | PASS    |
|               | HCH      | 1.299                | Not Specified | PASS    |

Test Graphs

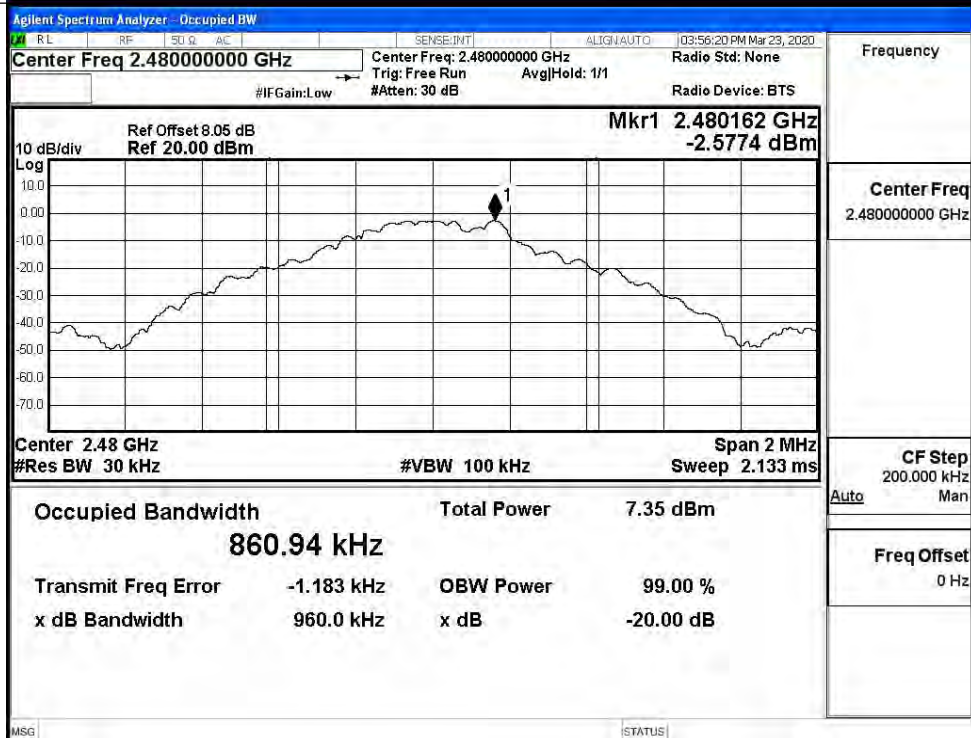
GFSK/LCH

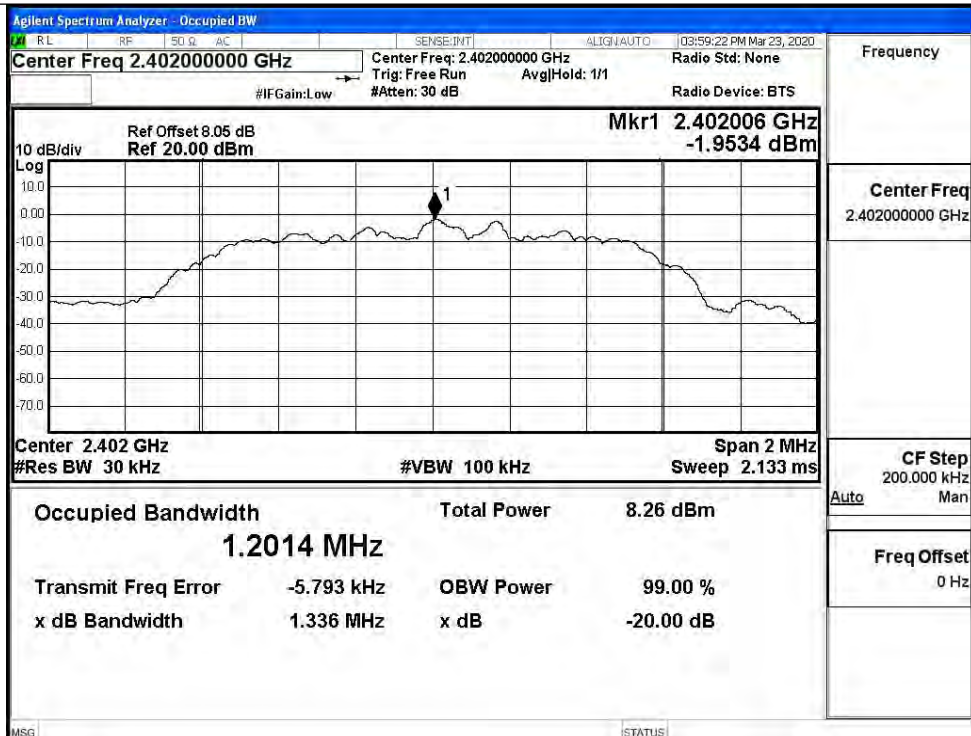
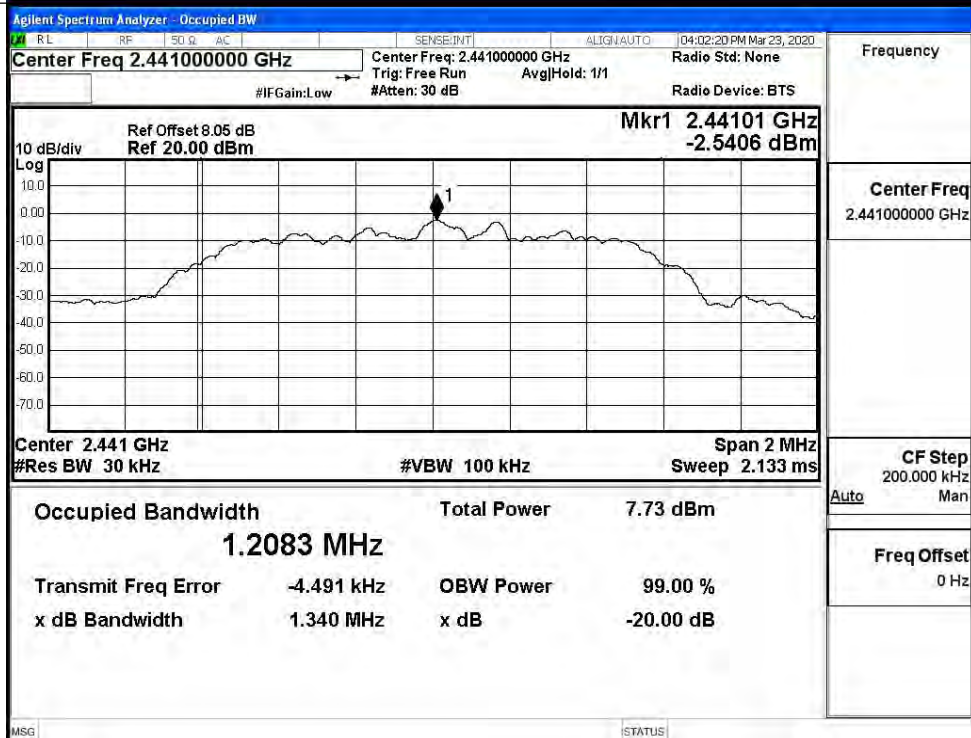


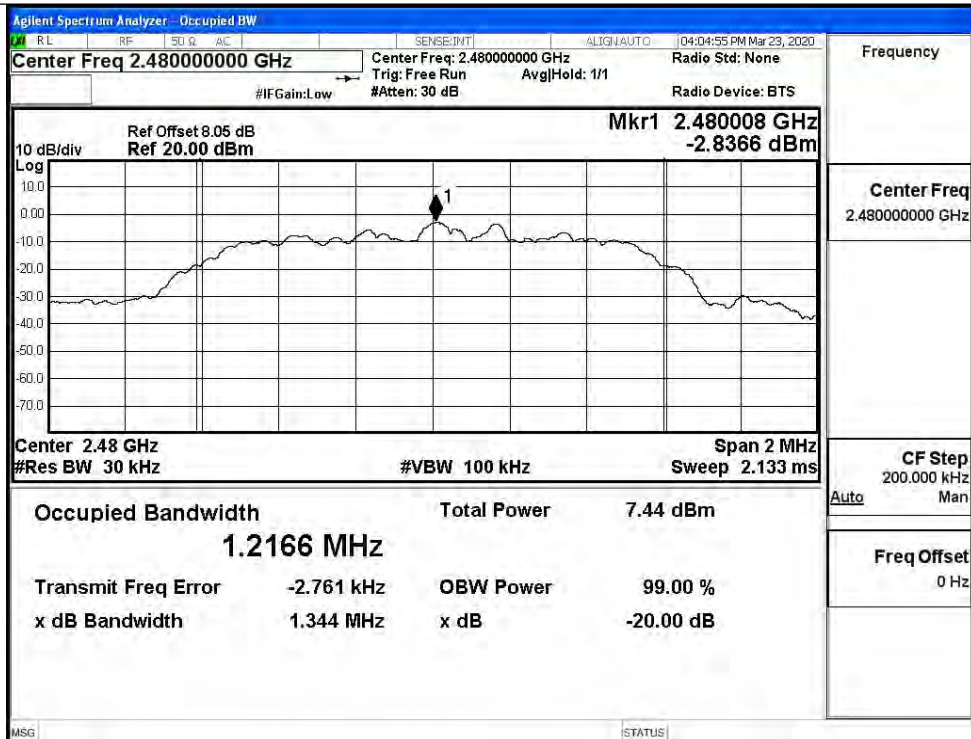
GFSK/MCH



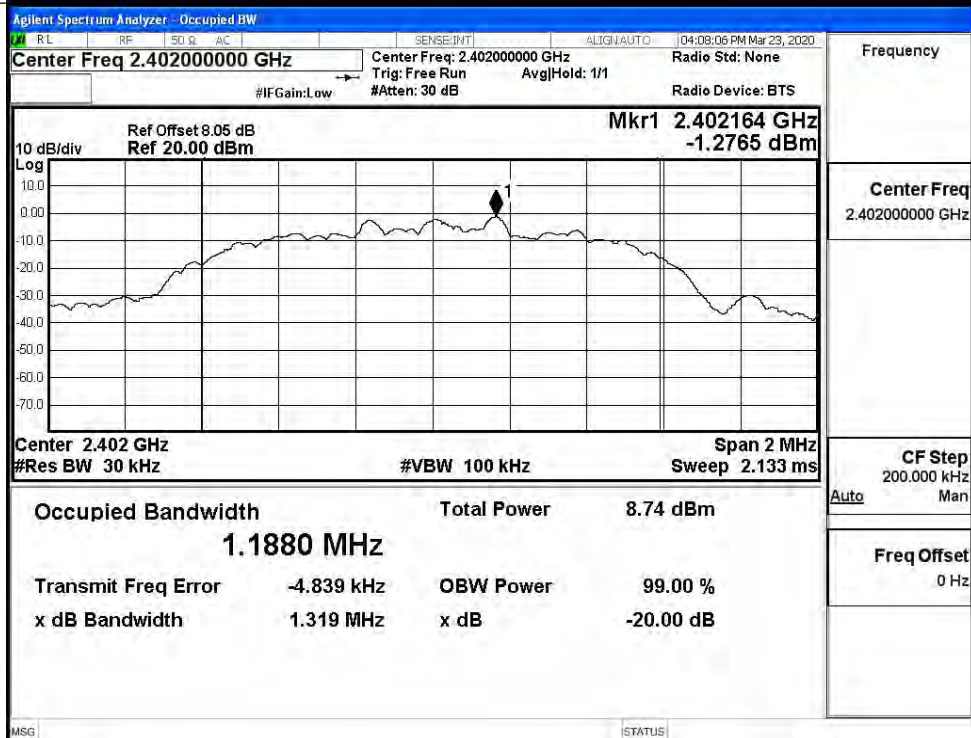
GFSK/HCH



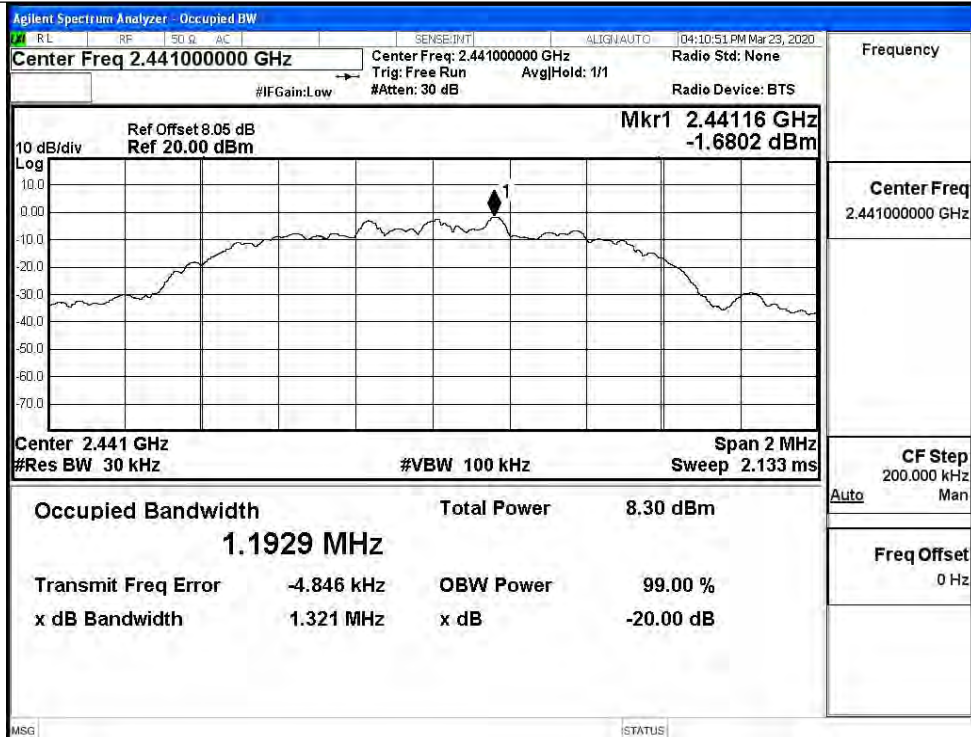
$\pi/4$ DQPSK/LCH $\pi/4$ DQPSK/MCH

$\pi/4$ DQPSK/HCH

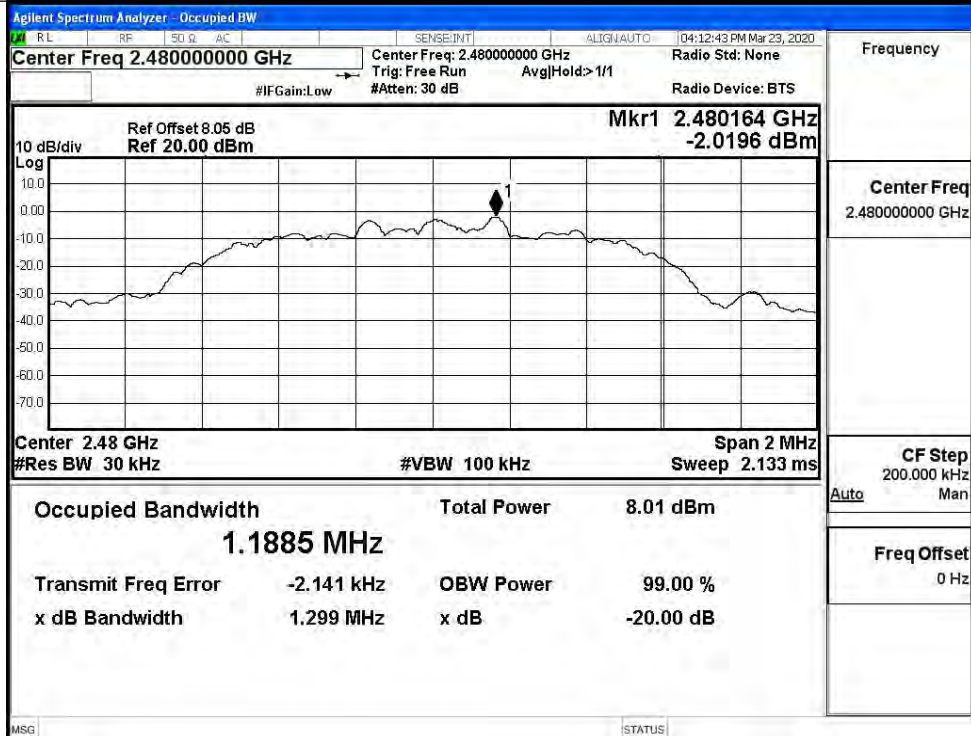
8DPSK/LCH



8DPSK/MCH



8DPSK/HCH

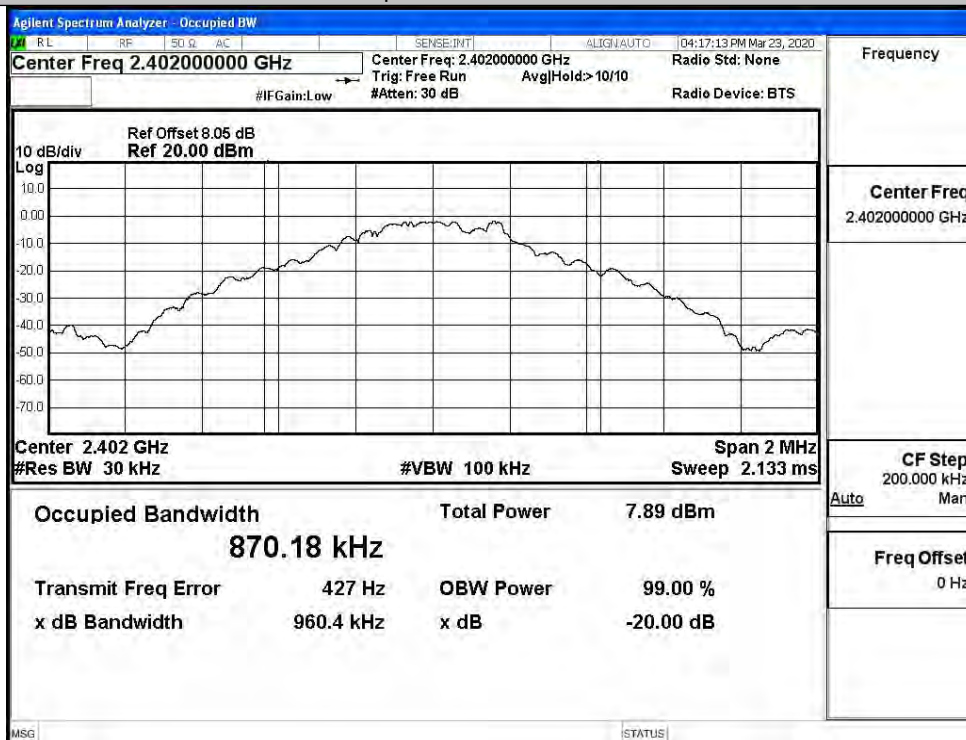


### A.3 Occupied Bandwidth

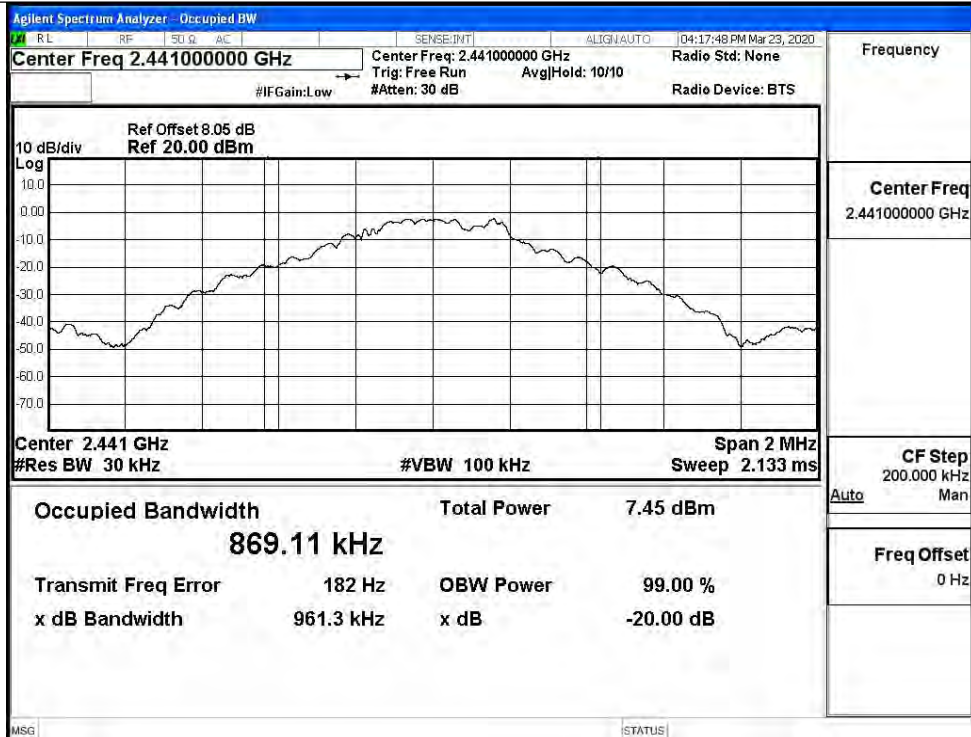
| Mode          | Channel. | Occupied Bandwidth [MHz] | Limit [MHz]   | Verdict |
|---------------|----------|--------------------------|---------------|---------|
| GFSK          | LCH      | 0.87018                  | Not Specified | PASS    |
|               | MCH      | 0.86911                  | Not Specified | PASS    |
|               | HCH      | 0.86450                  | Not Specified | PASS    |
| $\pi/4$ DQPSK | LCH      | 1.2005                   | Not Specified | PASS    |
|               | MCH      | 1.2082                   | Not Specified | PASS    |
|               | HCH      | 1.2199                   | Not Specified | PASS    |
| 8DPSK         | LCH      | 1.1927                   | Not Specified | PASS    |
|               | MCH      | 1.1942                   | Not Specified | PASS    |
|               | HCH      | 1.1970                   | Not Specified | PASS    |

Test Graphs

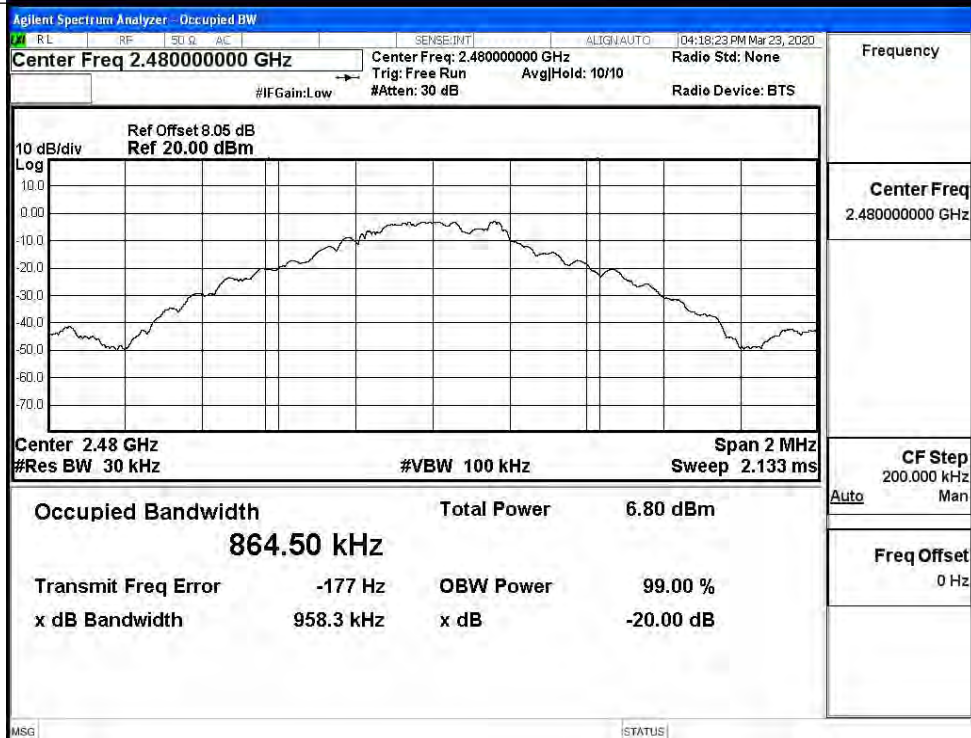
GFSK/LCH

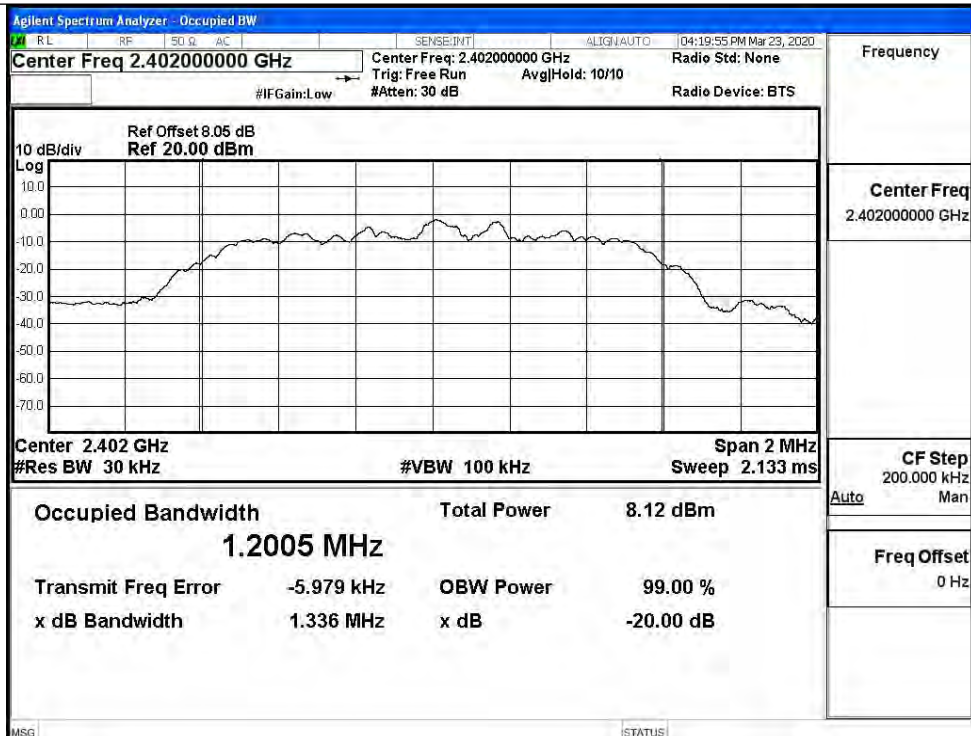
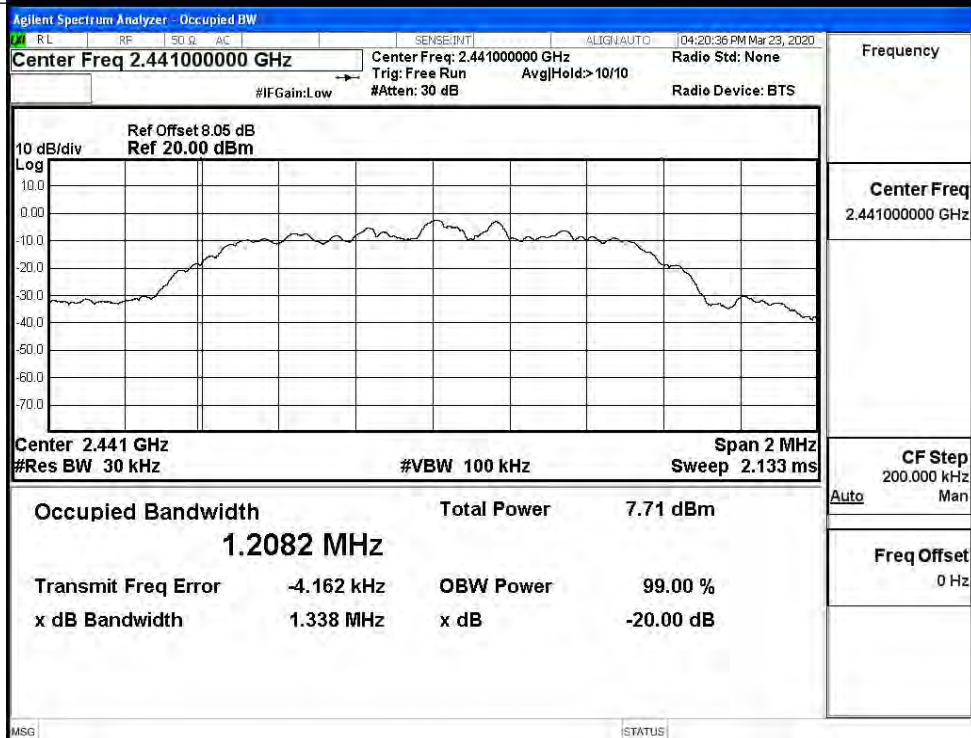


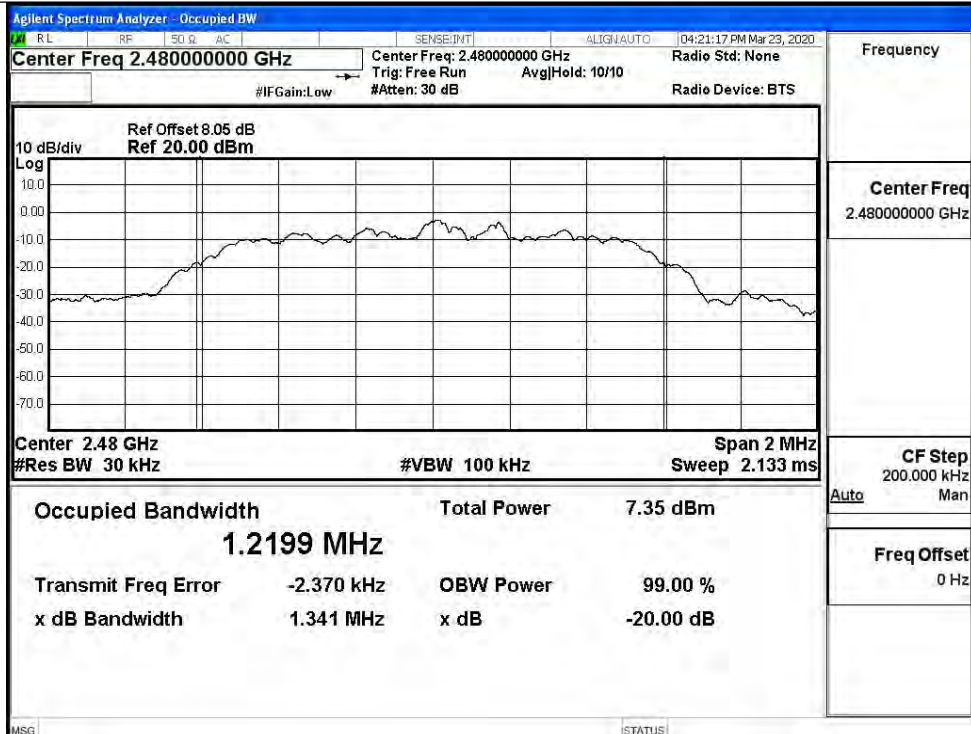
GFSK/MCH



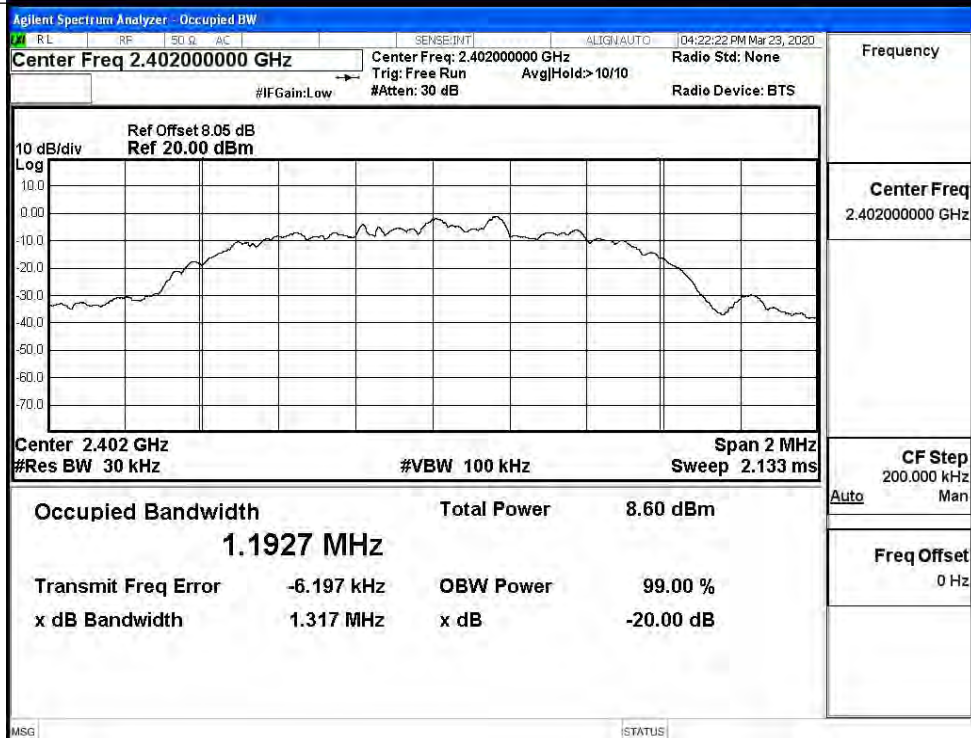
GFSK/HCH



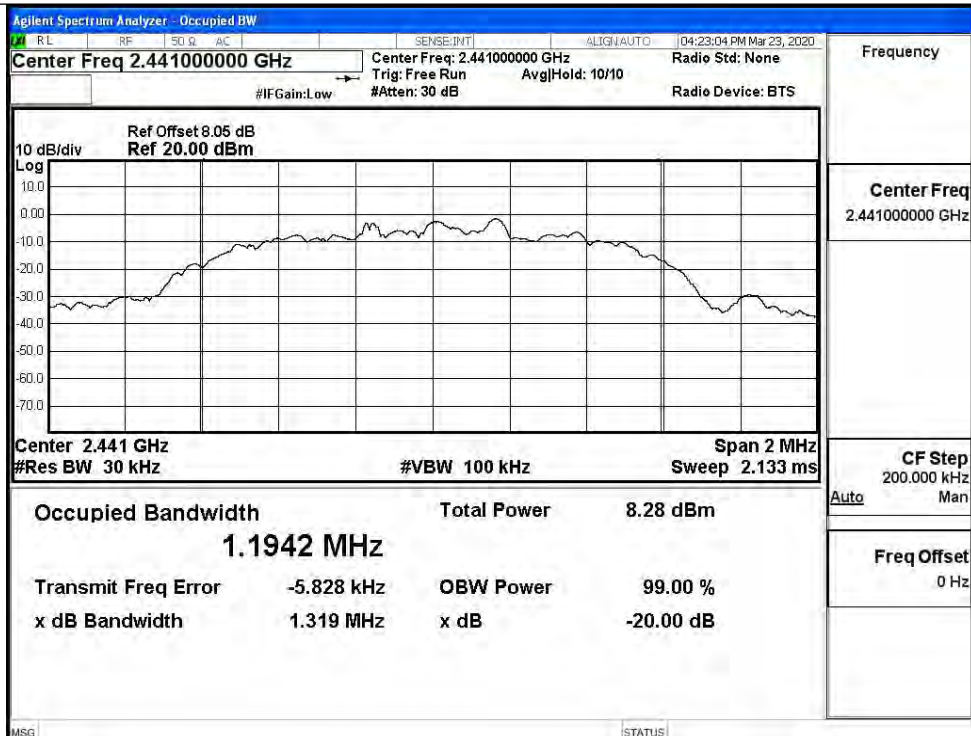
$\pi/4$ DQPSK/LCH $\pi/4$ DQPSK/MCH

$\pi/4$ DQPSK/HCH

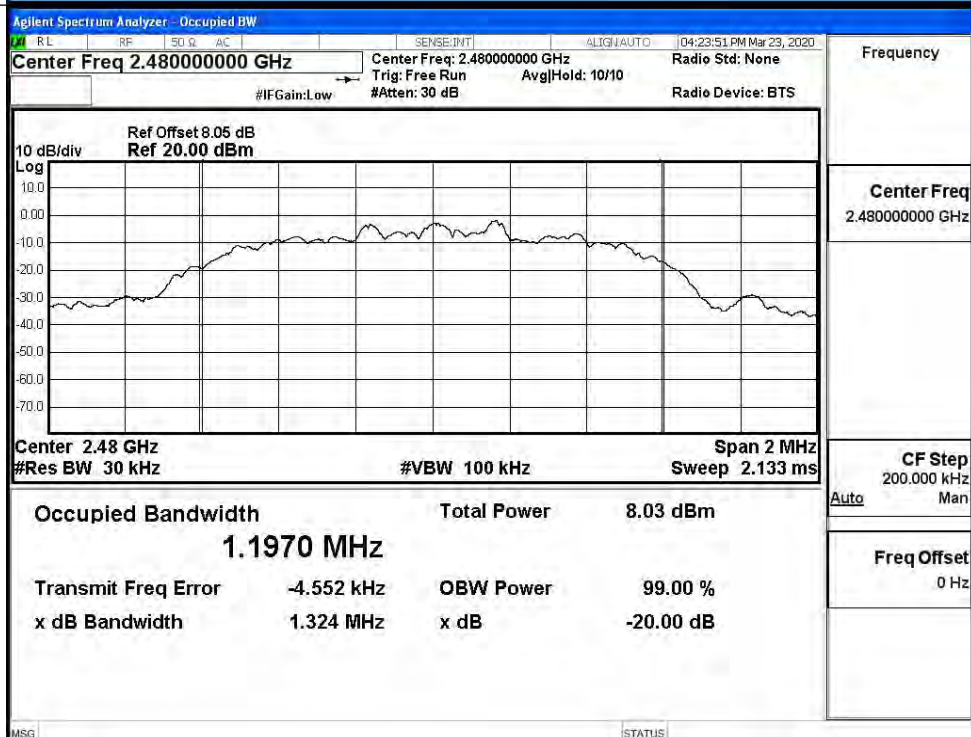
8DPSK/LCH



8DPSK/MCH



8DPSK/HCH

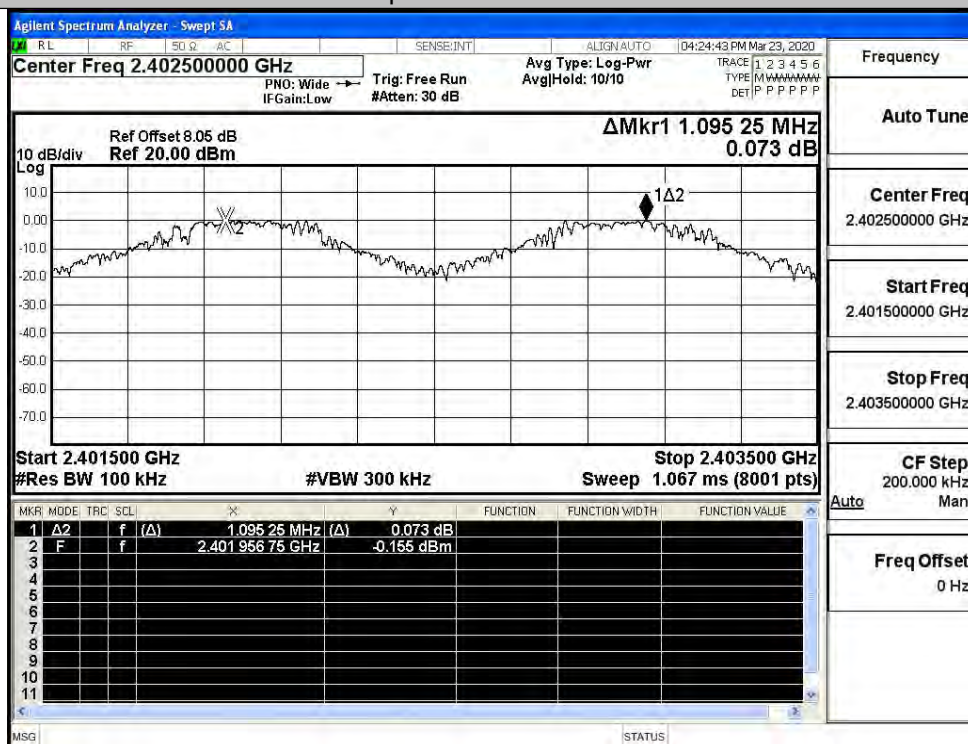


## A.4 Carrier Frequency Separation

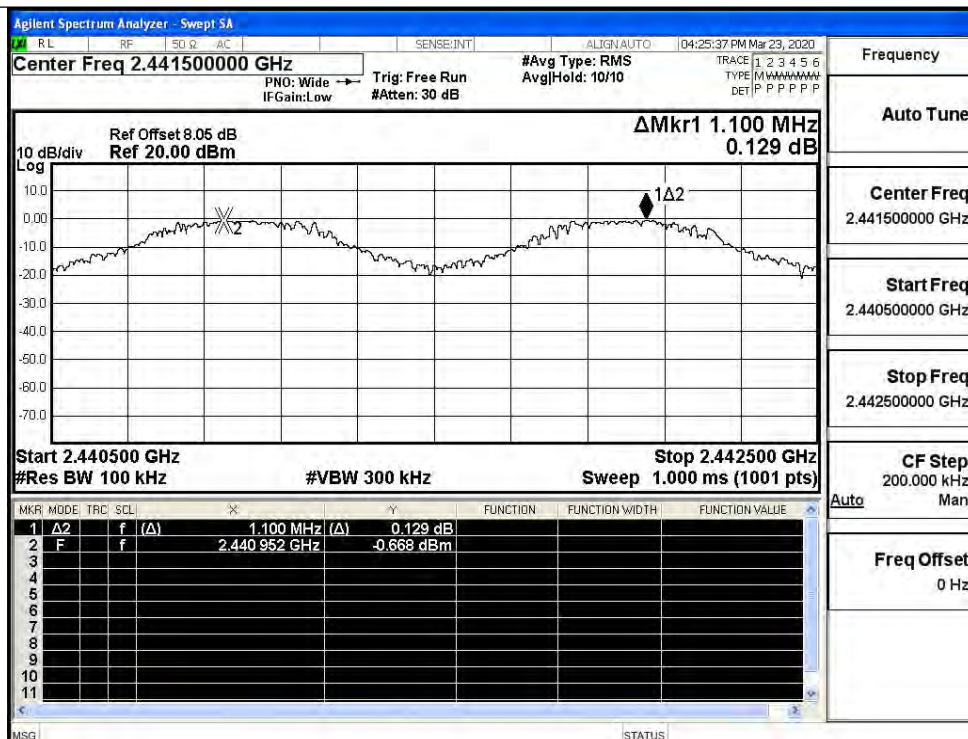
| Mode          | Channel. | Carrier Frequency Separation [MHz] | Limit [MHz] | Verdict |
|---------------|----------|------------------------------------|-------------|---------|
| GFSK          | LCH      | 1.095                              | 0.642       | PASS    |
|               | MCH      | 1.100                              | 0.642       | PASS    |
|               | HCH      | 1.012                              | 0.642       | PASS    |
| $\pi/4$ DQPSK | LCH      | 0.956                              | 0.896       | PASS    |
|               | MCH      | 1.022                              | 0.896       | PASS    |
|               | HCH      | 1.000                              | 0.896       | PASS    |
| 8DPSK         | LCH      | 0.998                              | 0.881       | PASS    |
|               | MCH      | 1.006                              | 0.881       | PASS    |
|               | HCH      | 0.964                              | 0.881       | PASS    |

### Test Graphs

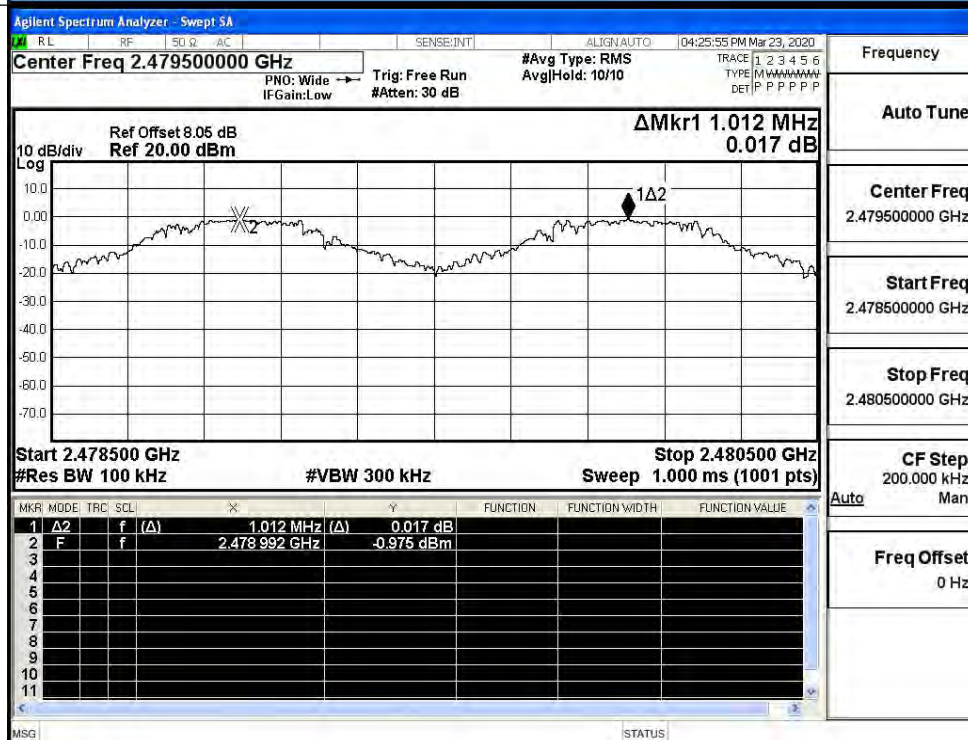
GFSK/LCH

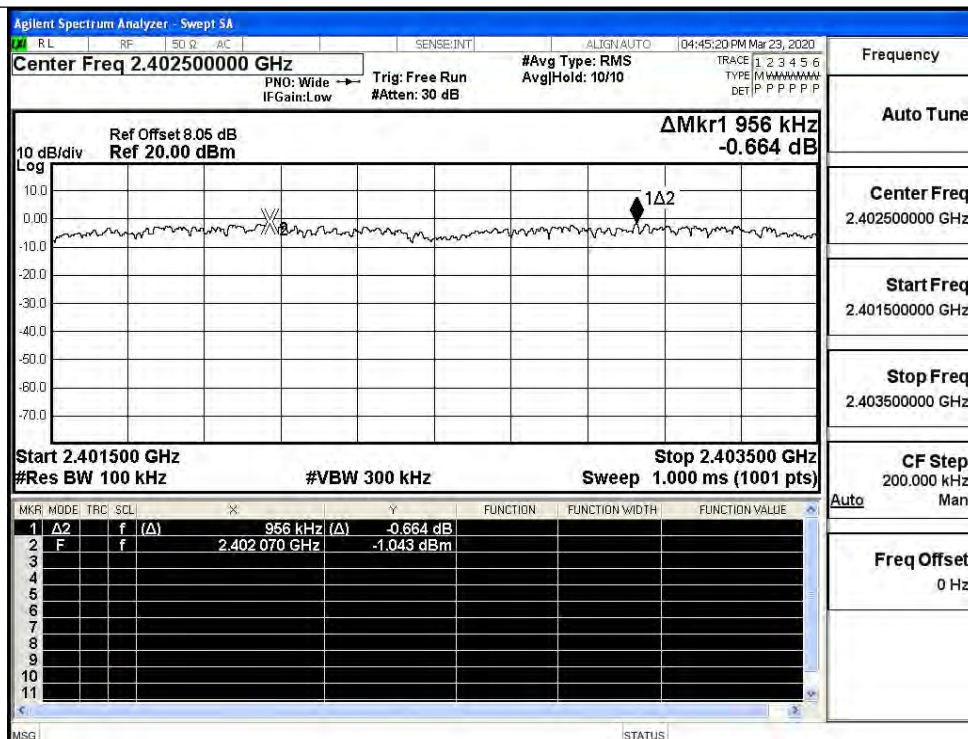
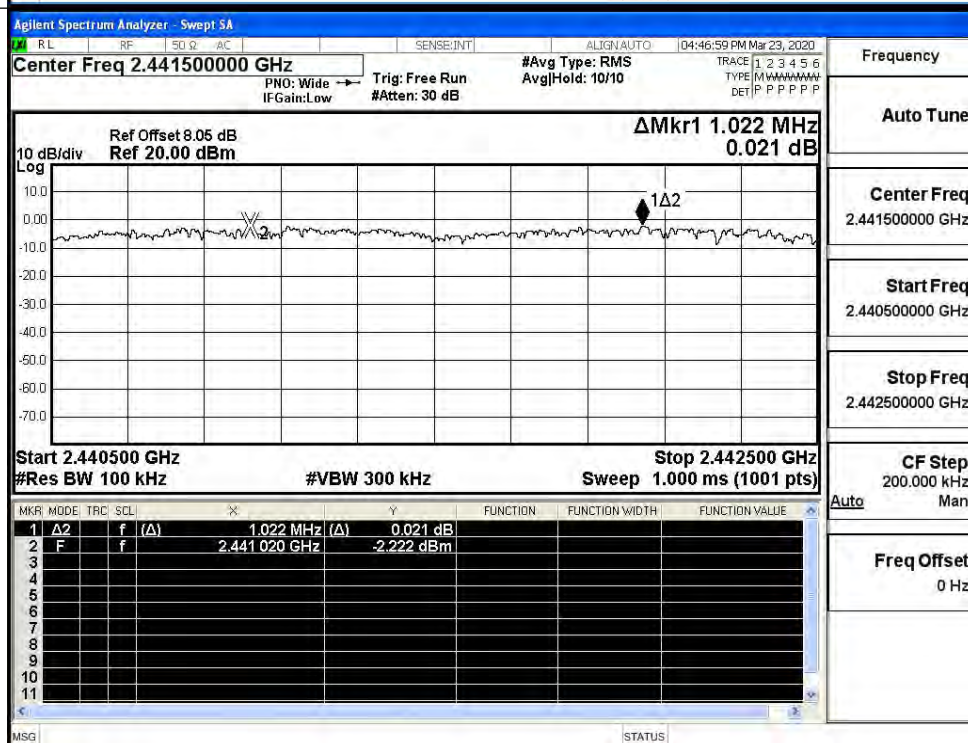


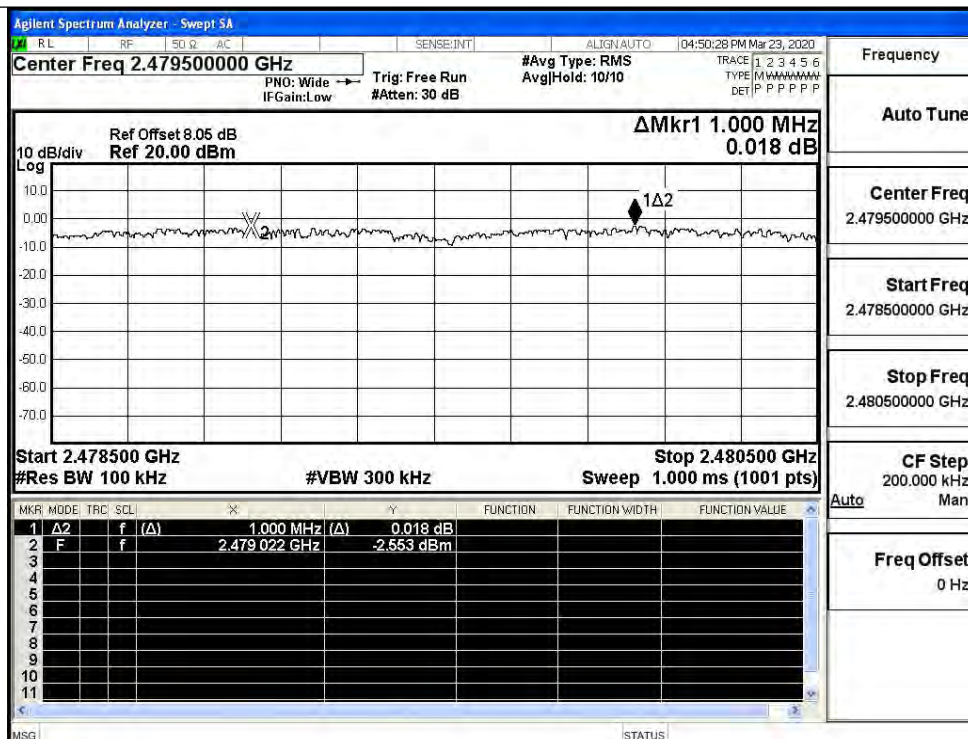
GFSK/MCH



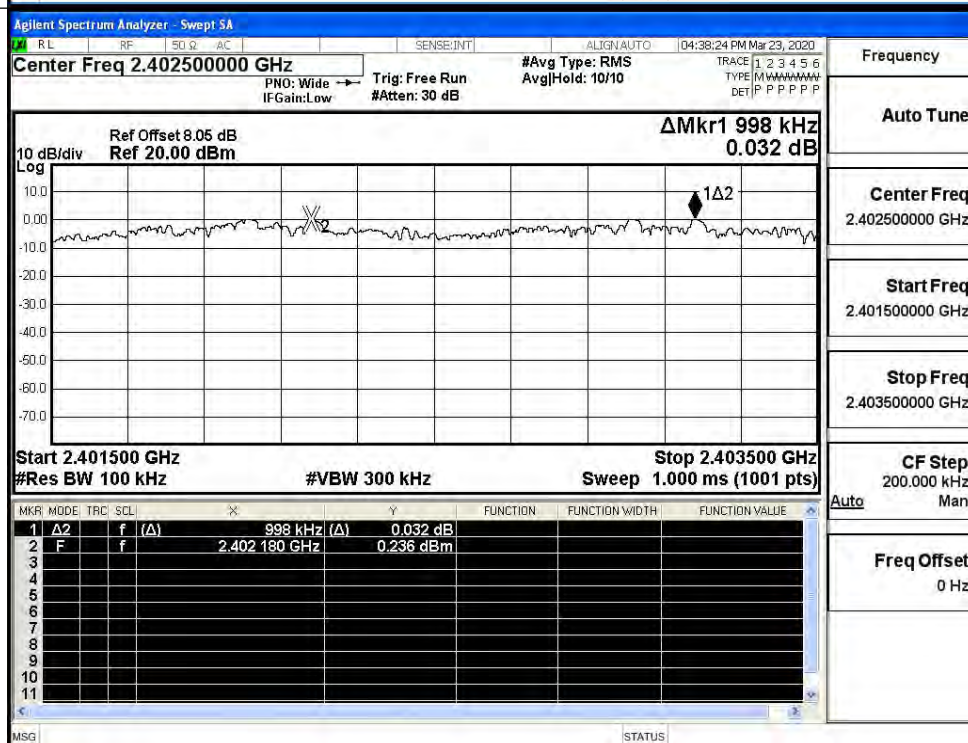
GFSK/HCH



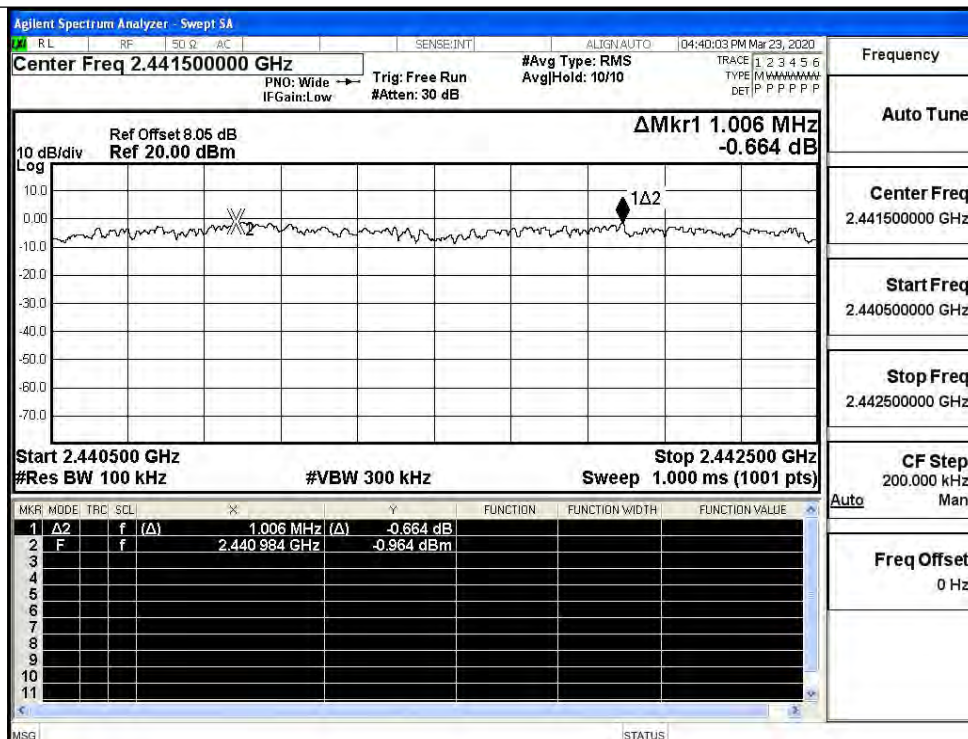
$\pi/4$ DQPSK/LCH $\pi/4$ DQPSK/MCH

$\pi/4$ DQPSK/HCH

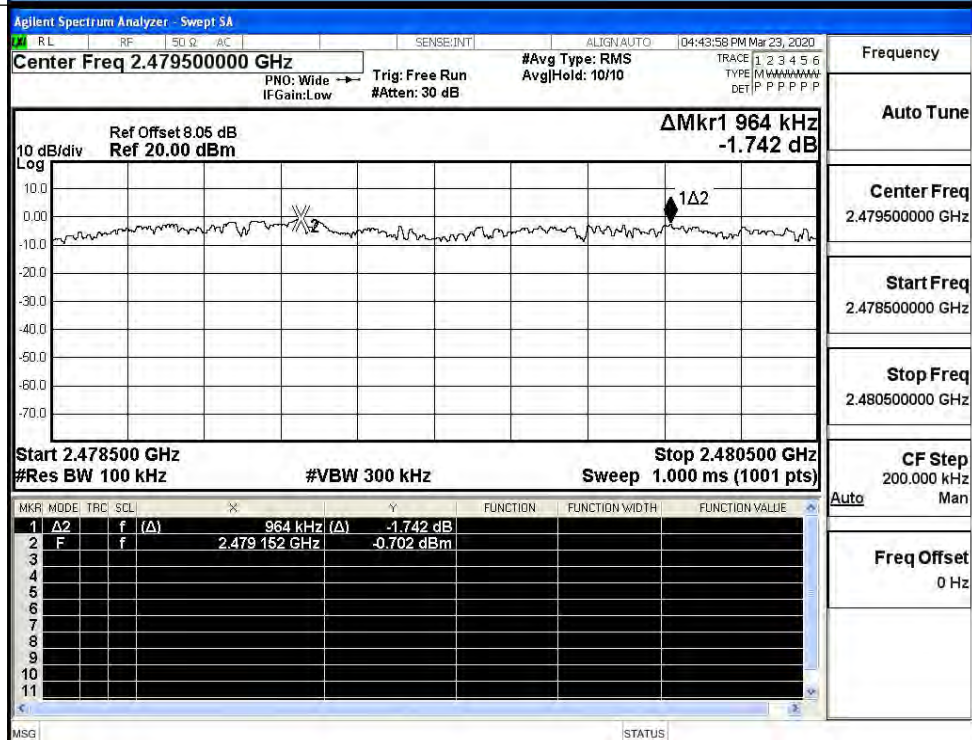
8DPSK/LCH



8DPSK/MCH



8DPSK/HCH

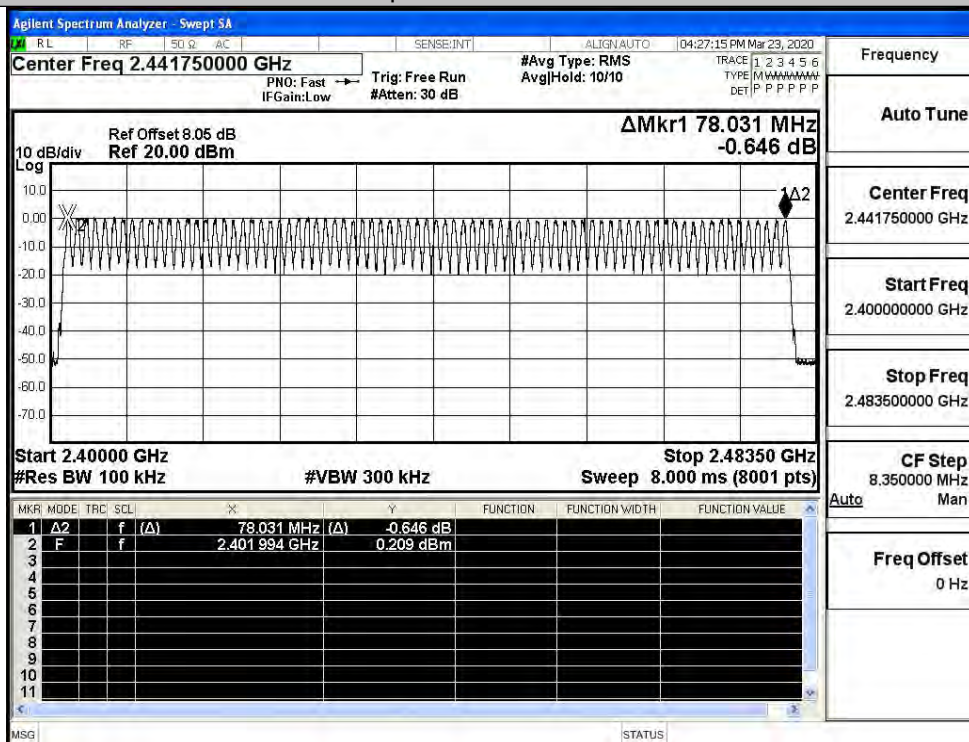
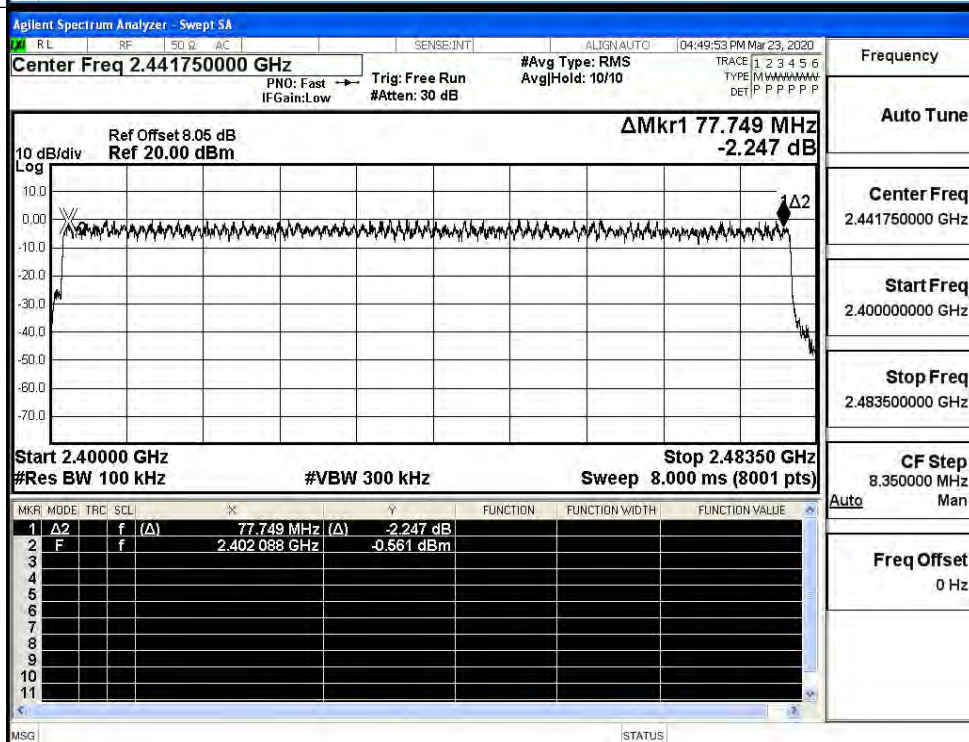


## A.5 Hopping Channel Number

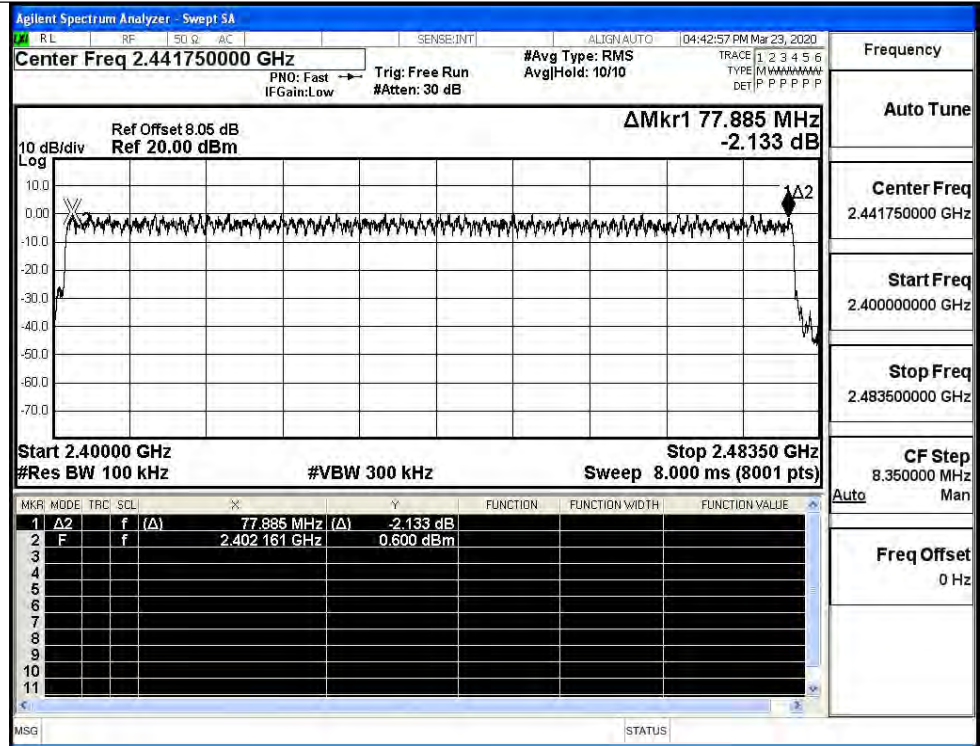
| Mode          | Channel. | Number of Hopping Channel [N] | Limit [N] | Verdict |
|---------------|----------|-------------------------------|-----------|---------|
| GFSK          | Hop      | 79                            | >=15      | PASS    |
| $\pi/4$ DQPSK | Hop      | 79                            | >=15      | PASS    |
| 8DPSK         | Hop      | 79                            | >=15      | PASS    |

## Test Graphs

GFSK/Hop

 $\pi/4$ DQPSK/Hop

8DPSK/Hop

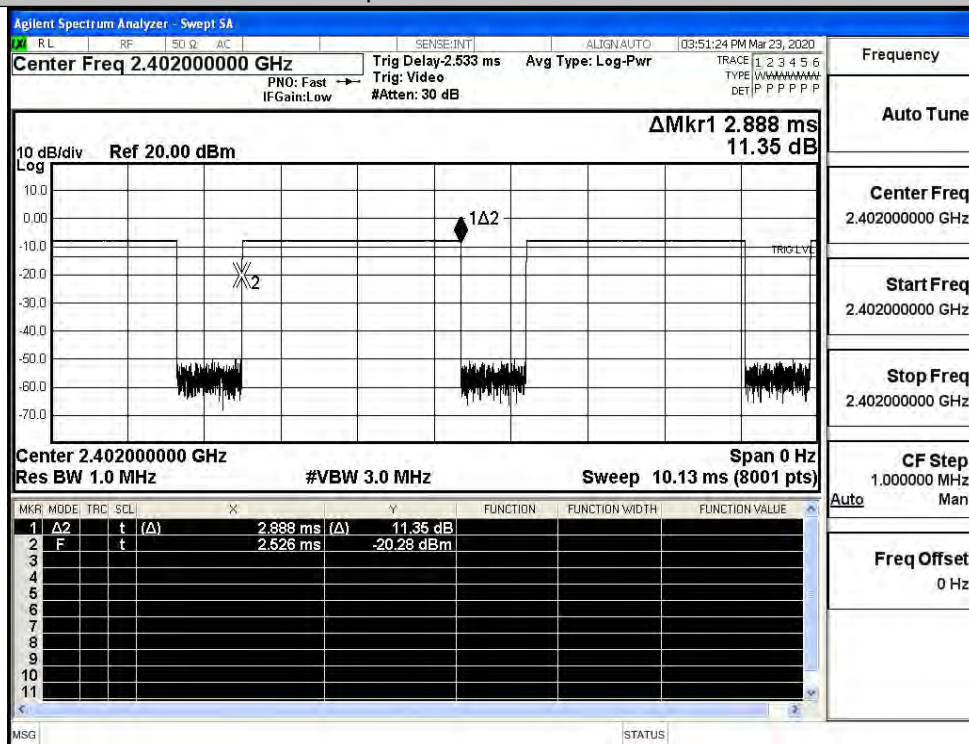


## A.6 Dwell Time

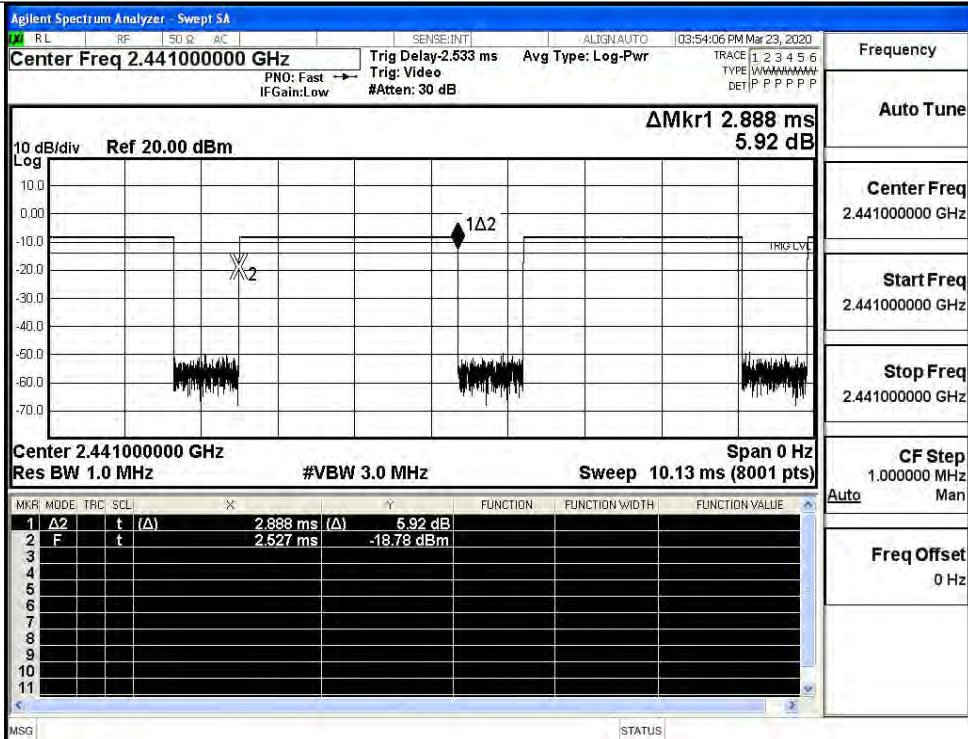
| Mode          | Packet | Channel | Burst Width<br>[ms/hop/ch] | Total<br>Hops[hop*ch] | Dwell Time[s] | Limit [s] | Verdict |
|---------------|--------|---------|----------------------------|-----------------------|---------------|-----------|---------|
| GFSK          | DH5    | LCH     | 2.89                       | 106.7                 | 0.308         | 0.4       | PASS    |
|               | DH5    | MCH     | 2.89                       | 106.7                 | 0.308         | 0.4       | PASS    |
|               | DH5    | HCH     | 2.89                       | 106.7                 | 0.308         | 0.4       | PASS    |
| $\pi/4$ DQPSK | 2DH5   | LCH     | 2.89                       | 106.7                 | 0.308         | 0.4       | PASS    |
|               | 2DH5   | MCH     | 2.89                       | 106.7                 | 0.308         | 0.4       | PASS    |
|               | 2DH5   | HCH     | 2.89                       | 106.7                 | 0.308         | 0.4       | PASS    |
| 8DPSK         | 3DH5   | LCH     | 2.89                       | 106.7                 | 0.308         | 0.4       | PASS    |
|               | 3DH5   | MCH     | 2.89                       | 106.7                 | 0.308         | 0.4       | PASS    |
|               | 3DH5   | HCH     | 2.89                       | 106.7                 | 0.308         | 0.4       | PASS    |

Test Graphs

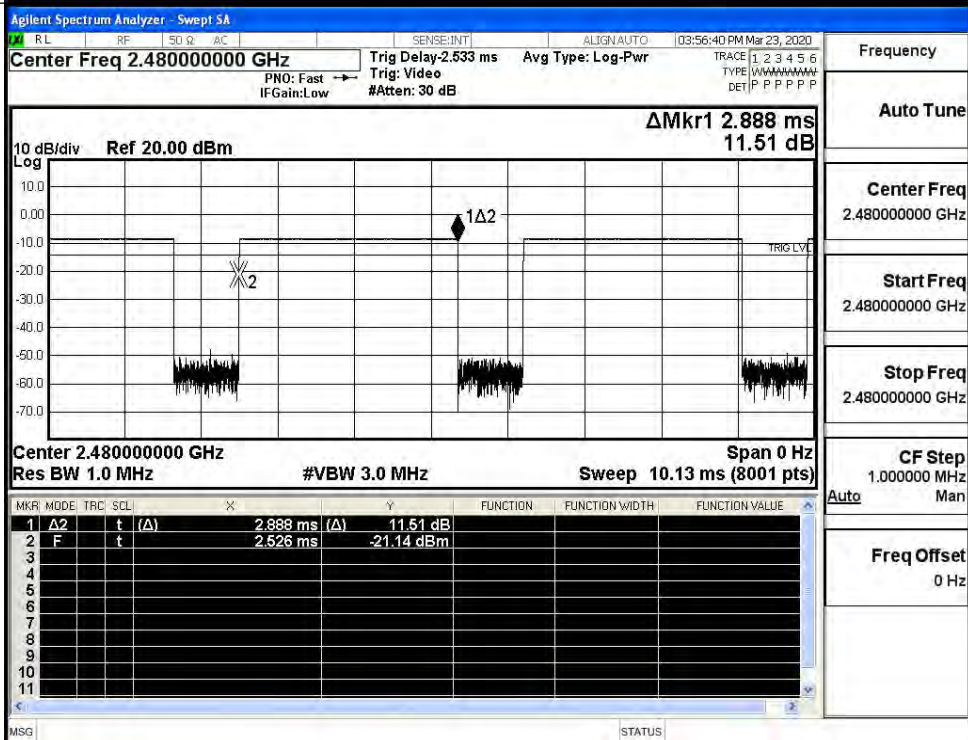
GFSK\_DH5/LCH



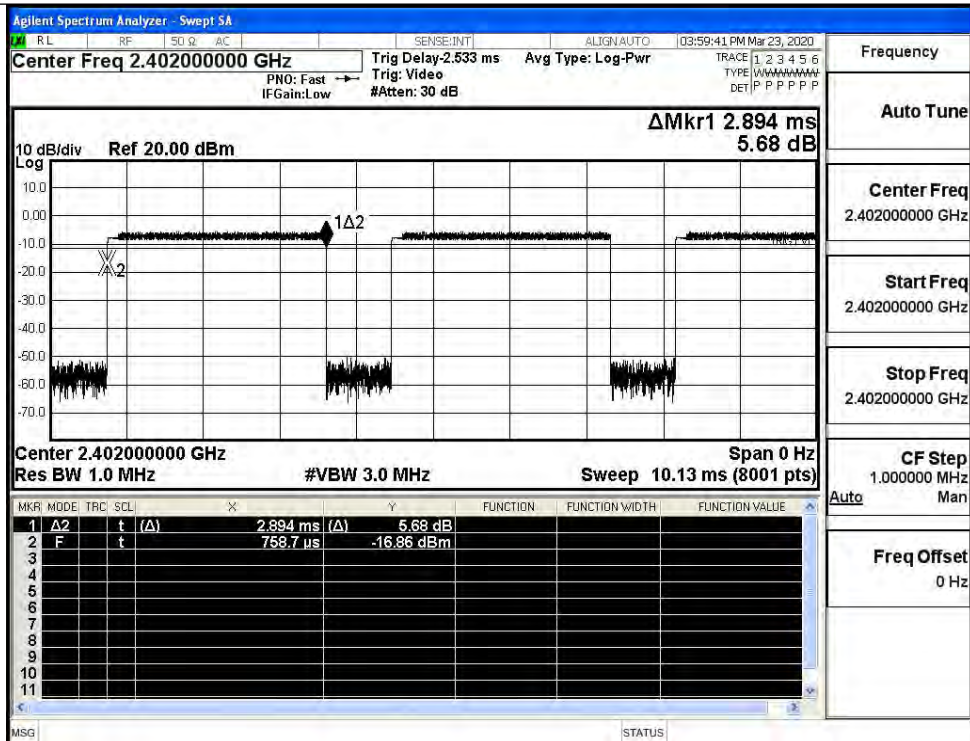
GFSK\_DH5/MCH



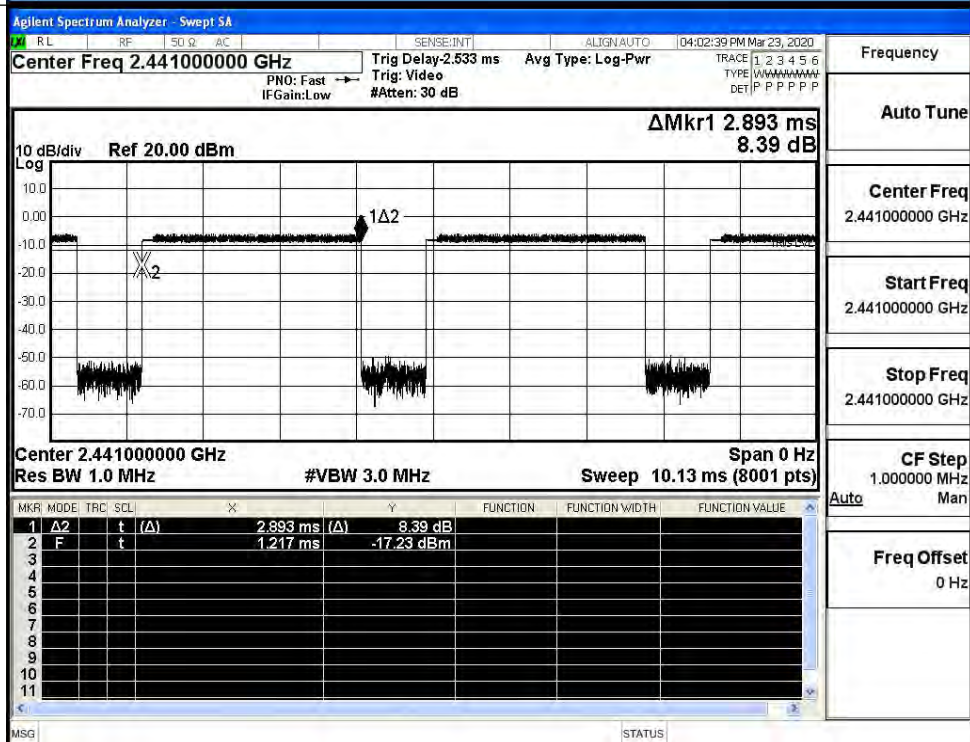
GFSK\_DH5/HCH



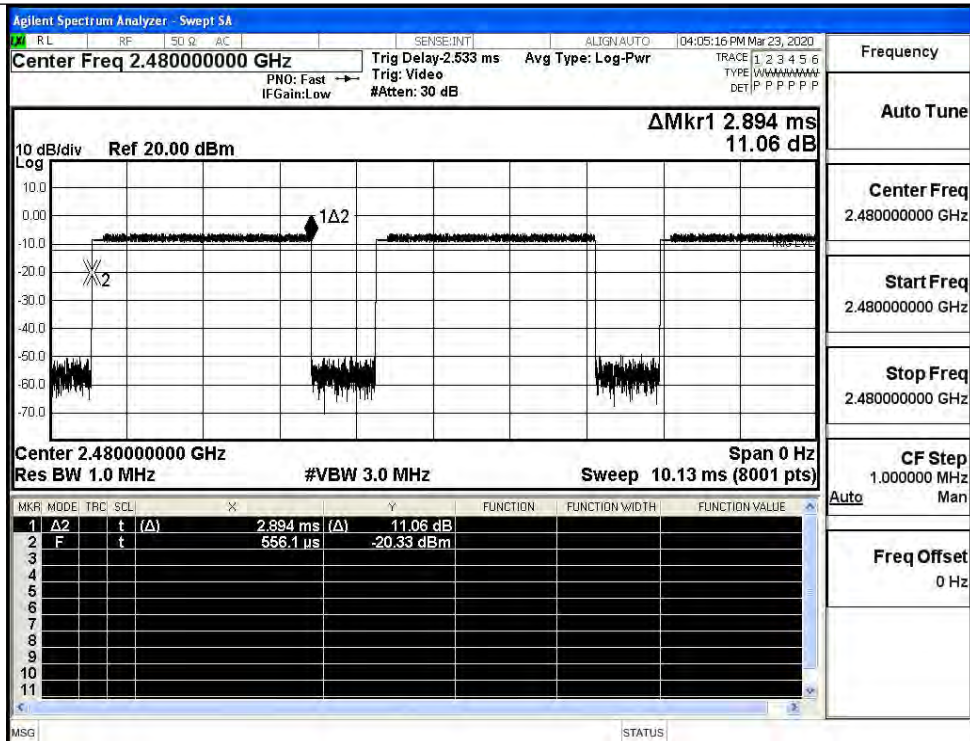
$\pi/4$ DQPSK  
\_2DH5/LCH



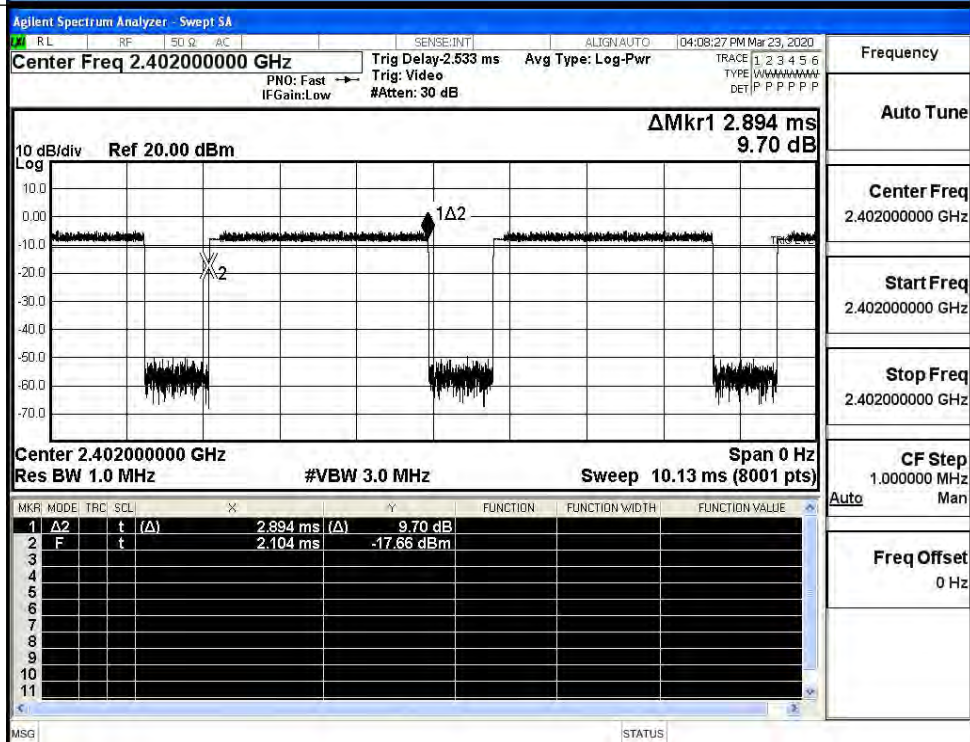
$\pi/4$ DQPSK  
\_2DH5/MCH



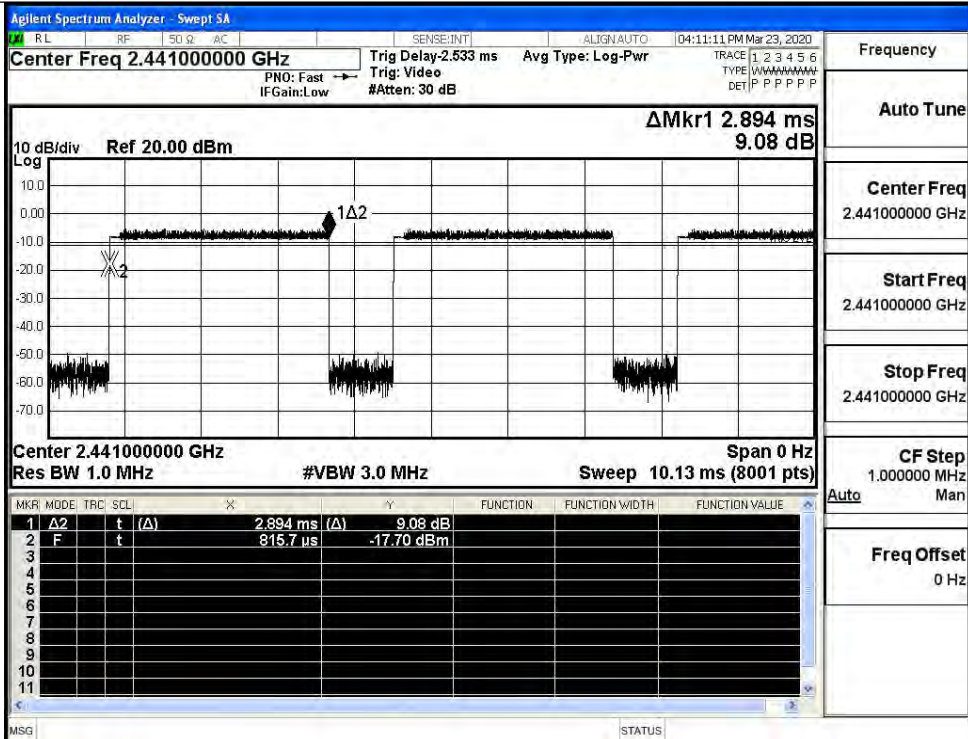
$\pi/4$ DQPSK  
\_2DH5/HCH



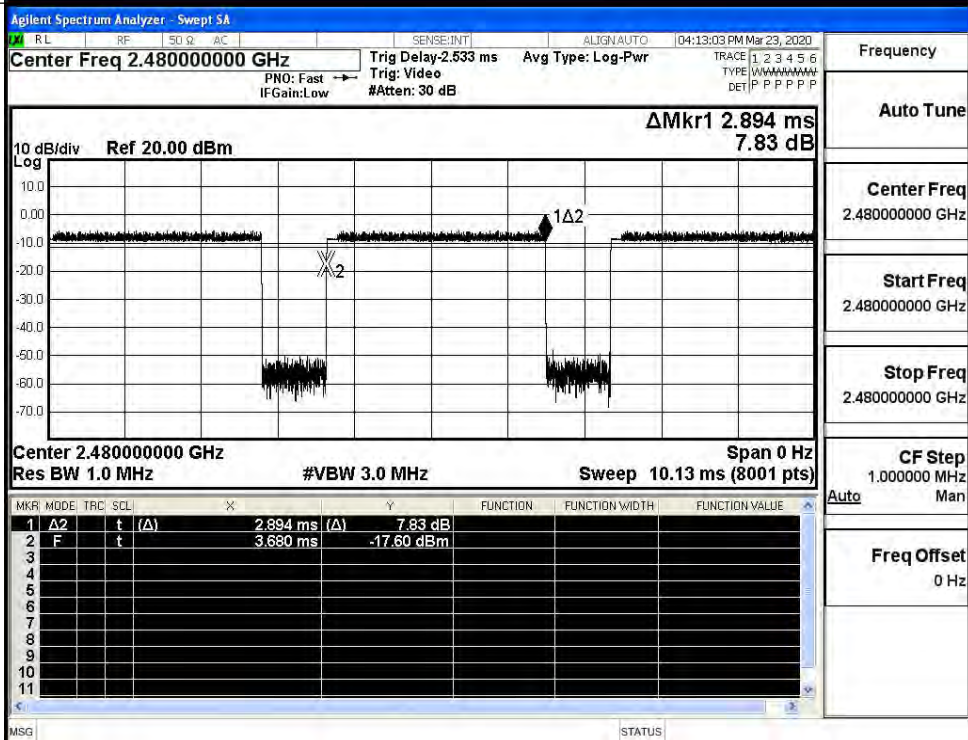
8DPSK \_3DH5/LCH



8DPSK\_3DH5/MCH



8DPSK\_3DH5/HCH

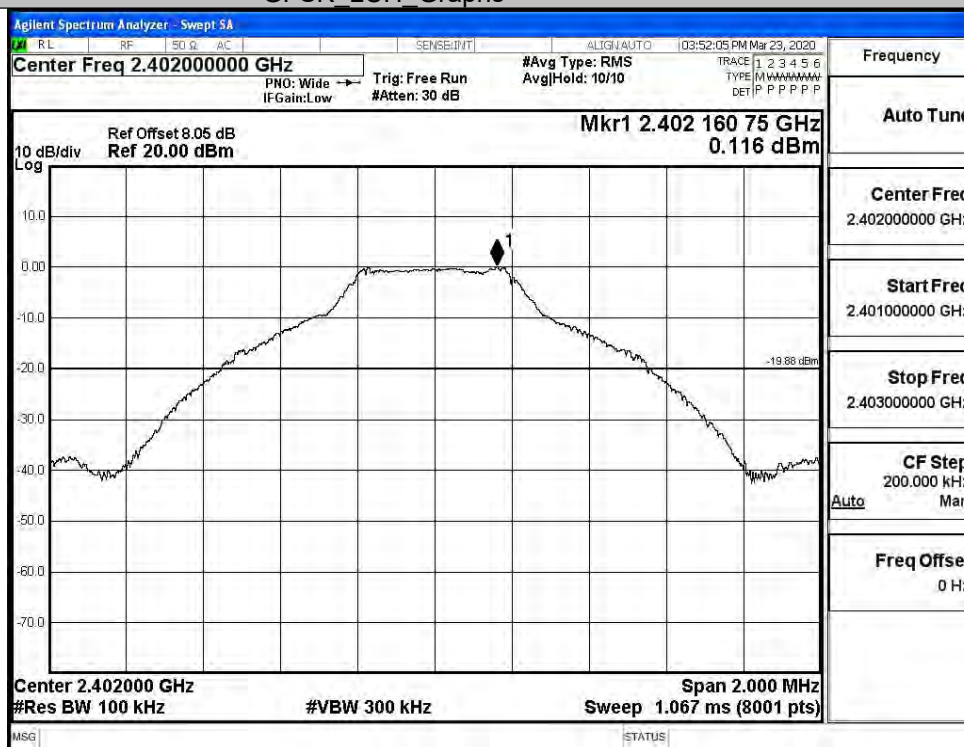


## A.7 RF Conducted Spurious Emissions

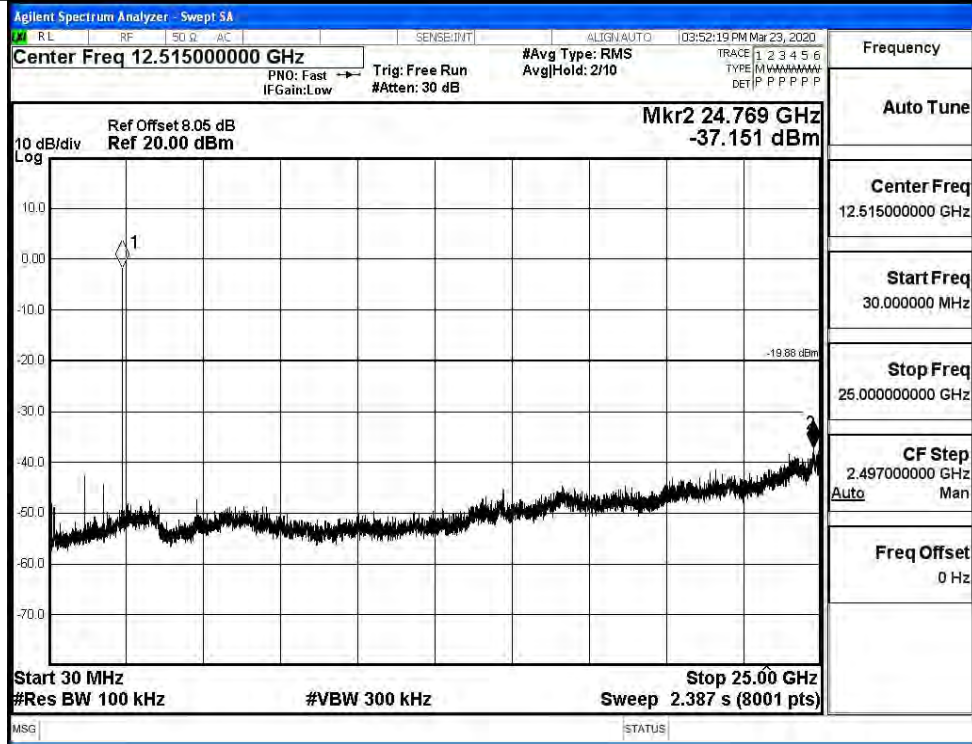
| Mode          | Channel | Pref [dBm] | Max. Level [dBm] | Limit [dBm] | Verdict |
|---------------|---------|------------|------------------|-------------|---------|
| GFSK          | LCH     | 0.116      | -37.151          | -19.884     | PASS    |
|               | MCH     | -0.093     | -37.837          | -20.093     | PASS    |
|               | HCH     | -0.335     | -37.786          | -20.335     | PASS    |
| $\pi/4$ DQPSK | LCH     | 0.24       | -37.233          | -19.760     | PASS    |
|               | MCH     | -0.391     | -37.822          | -20.391     | PASS    |
|               | HCH     | -0.528     | -37.536          | -20.528     | PASS    |
| 8DPSK         | LCH     | 0.097      | -37.497          | -19.903     | PASS    |
|               | MCH     | -0.14      | -34.621          | -20.140     | PASS    |
|               | HCH     | -0.553     | -35.612          | -20.553     | PASS    |

GFSK LCH Graphs

Pref

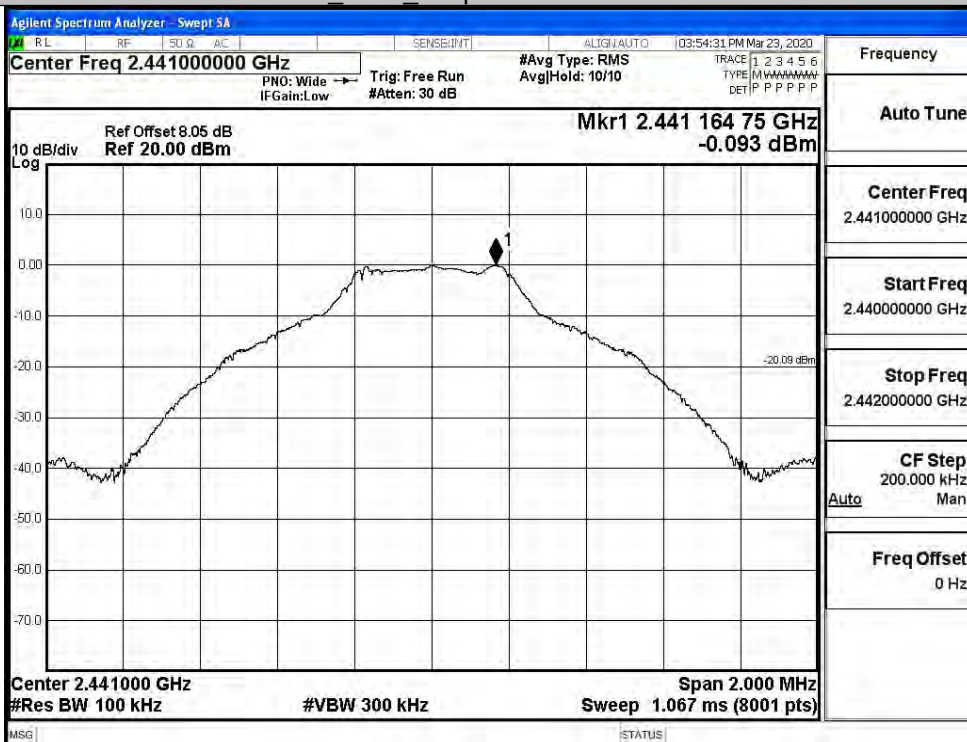


Puw

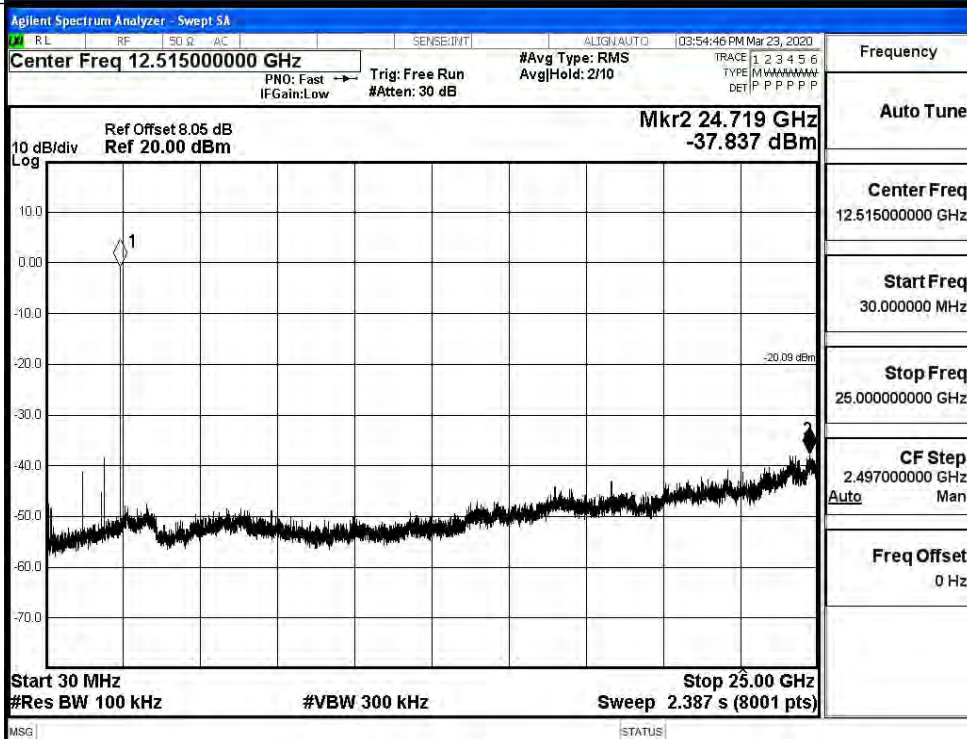


## GFSK\_MCH\_Graphs

Pref

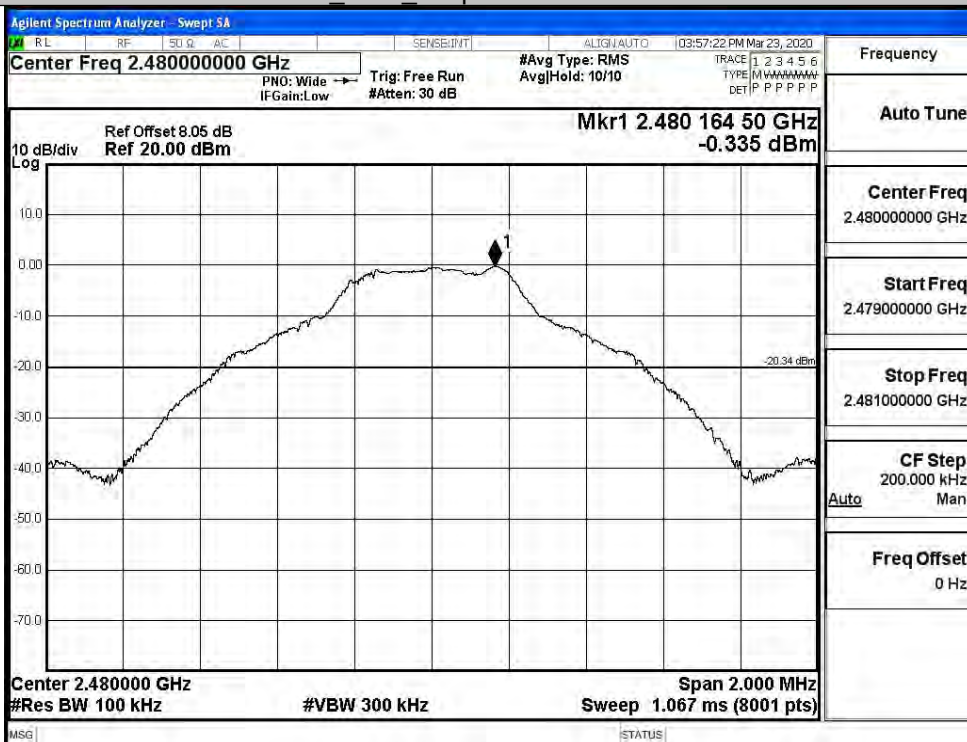


Puw

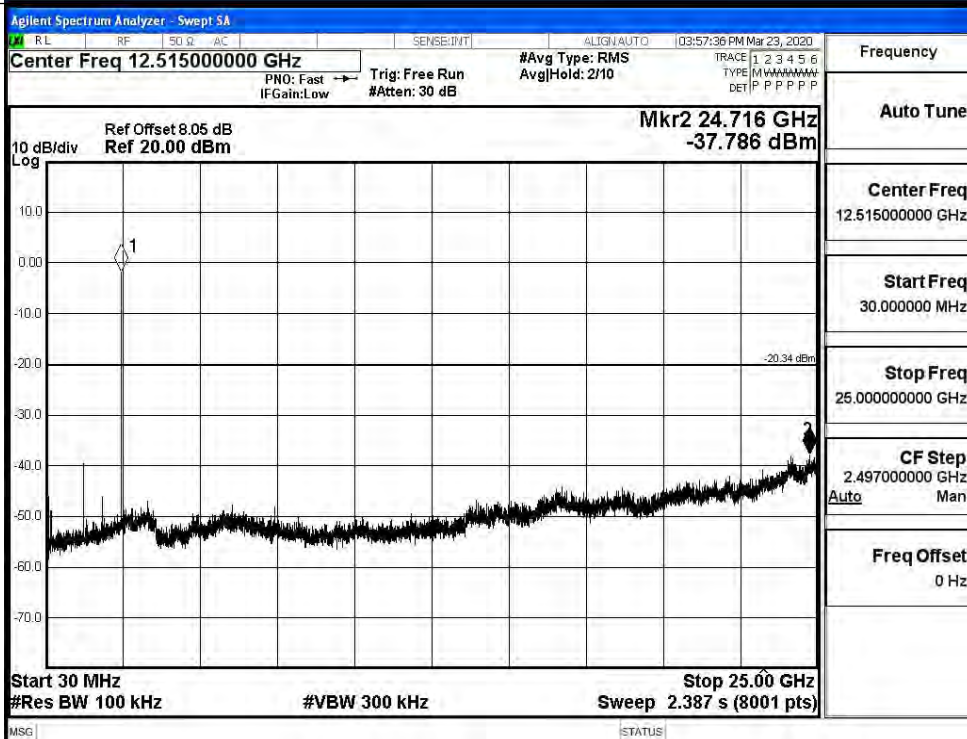


## GFSK HCH\_Graphs

Pref

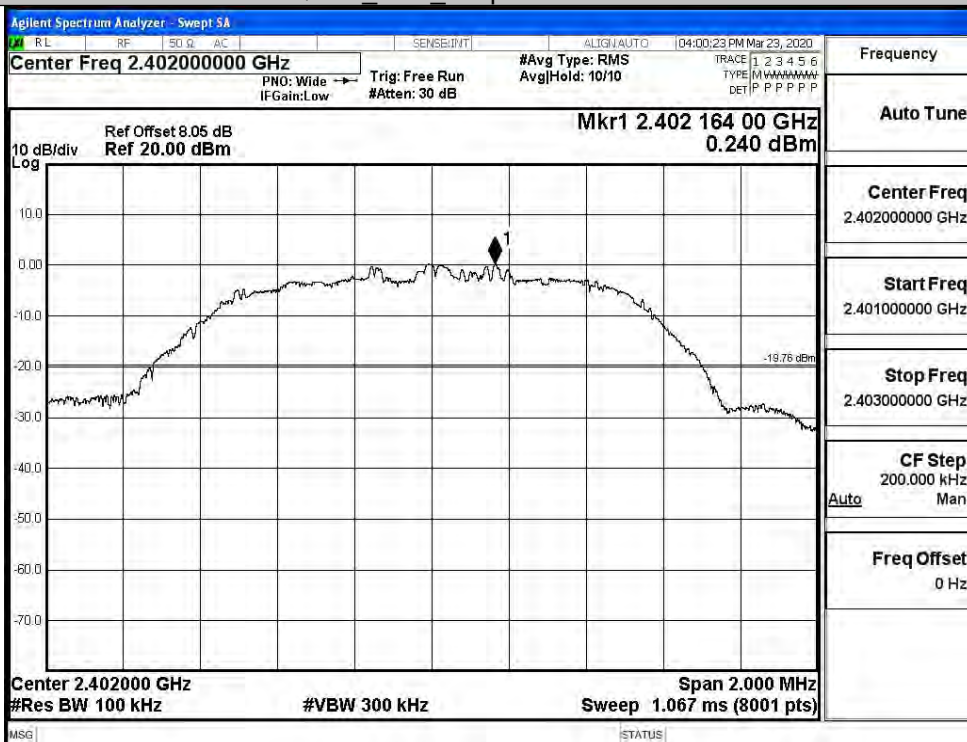


Puw

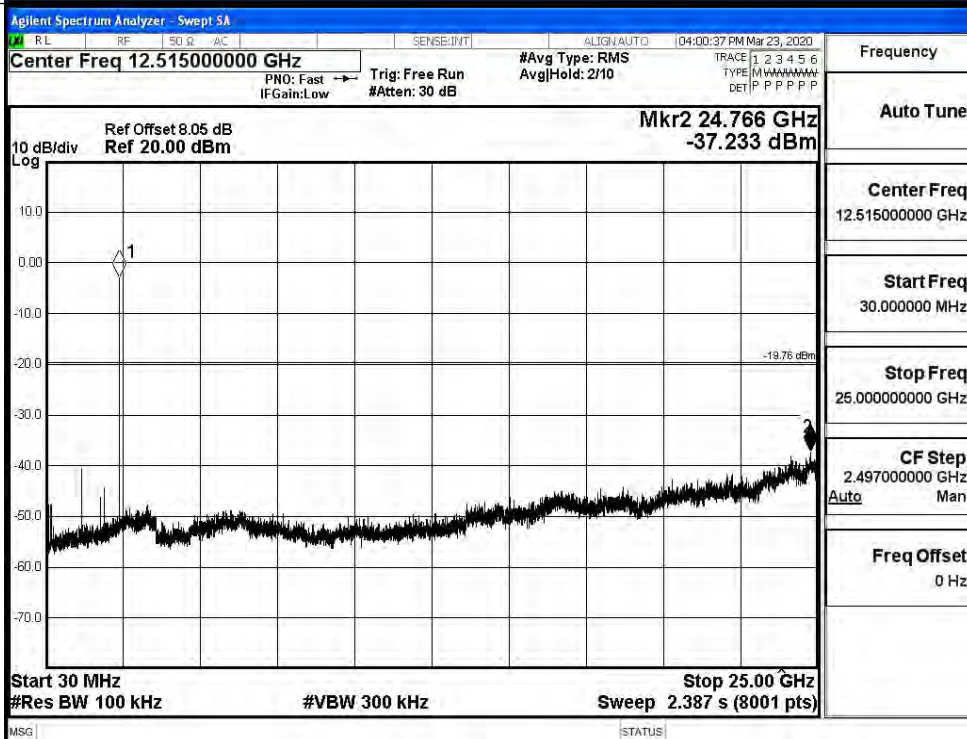


$\pi/4$ DQPSK LCH\_Graphs

Pref

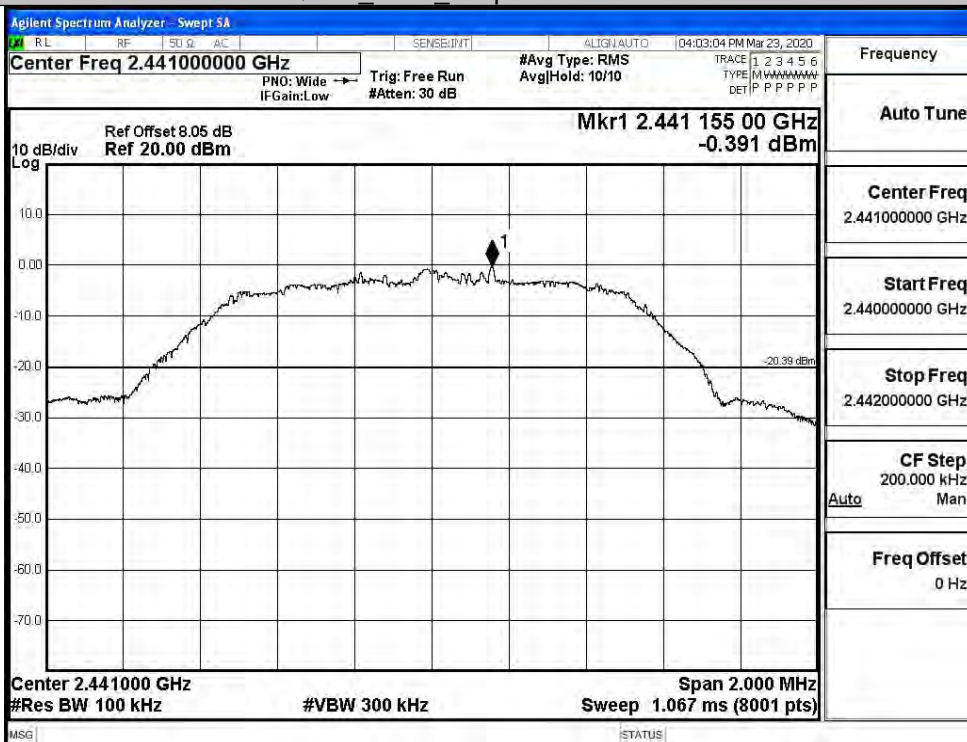


Puw

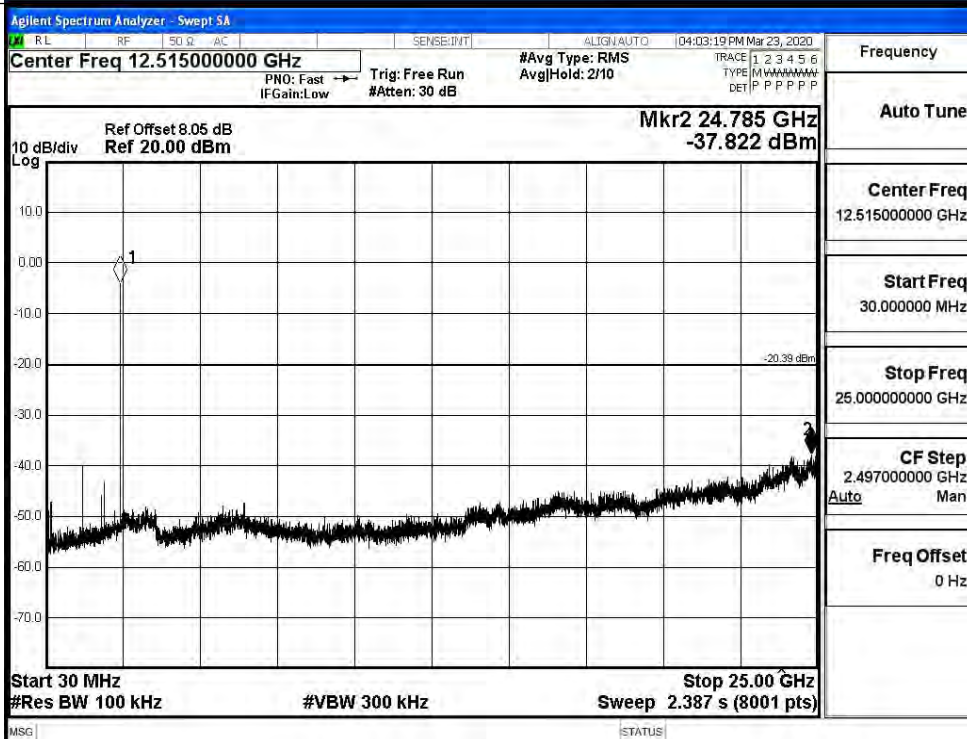


$\pi$ /4DQPSK\_MCH\_Graphs

Pref

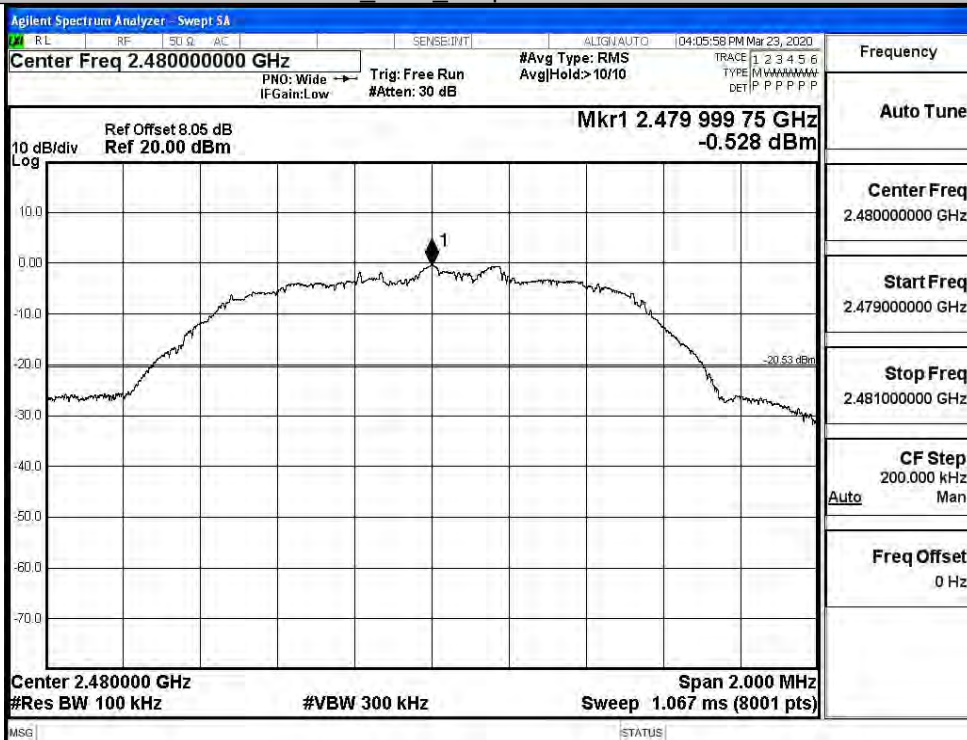


Puw



$\pi$ /4DQPSK HCH\_Graphs

Pref

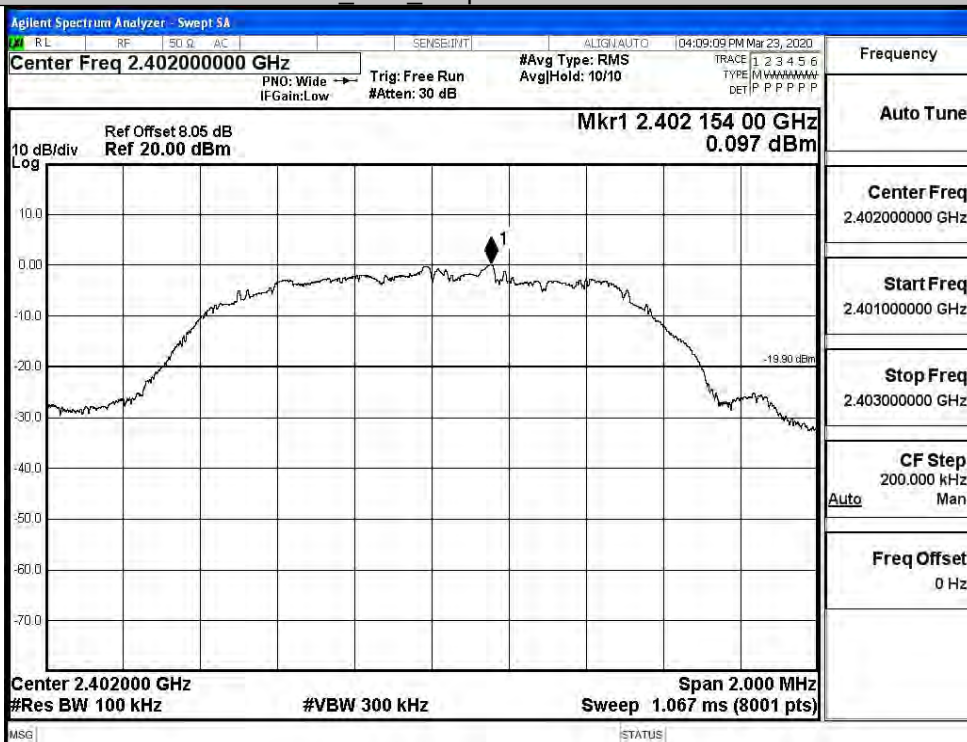


Puw

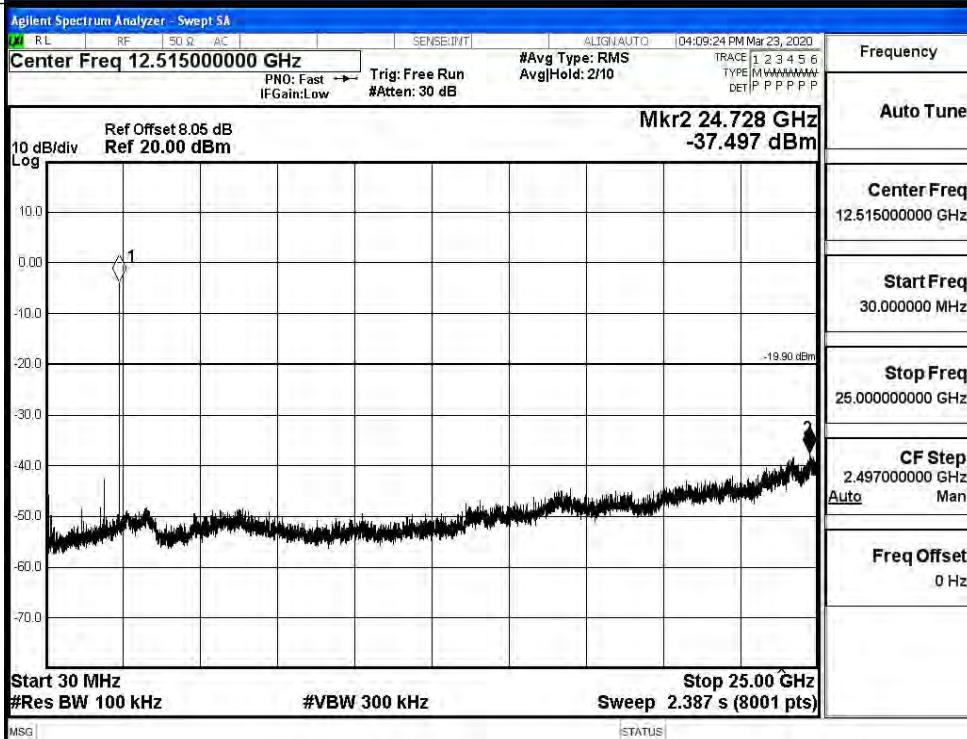


## 8DPSK\_LCH\_Graphs

Pref

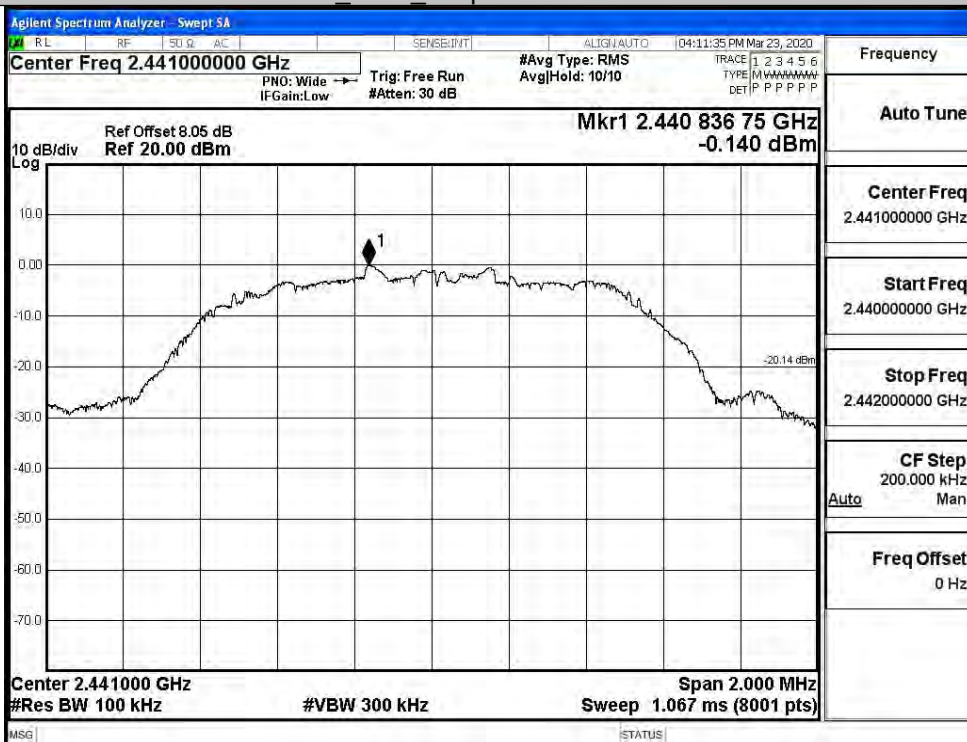


Puw

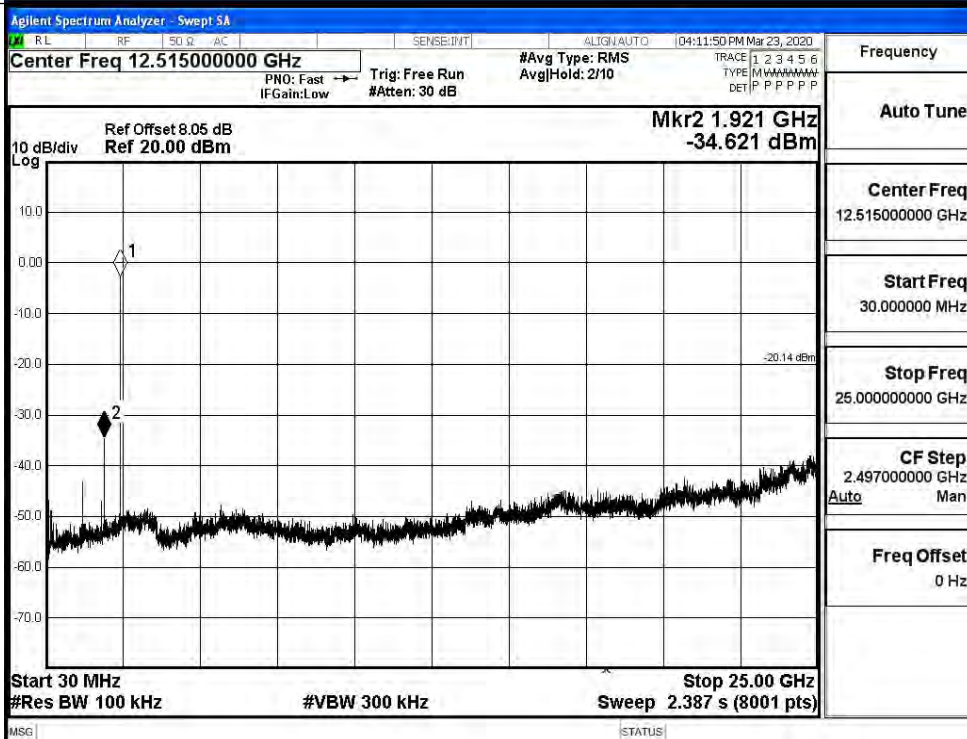


## 8DPSK\_MCH\_Graphs

Pref

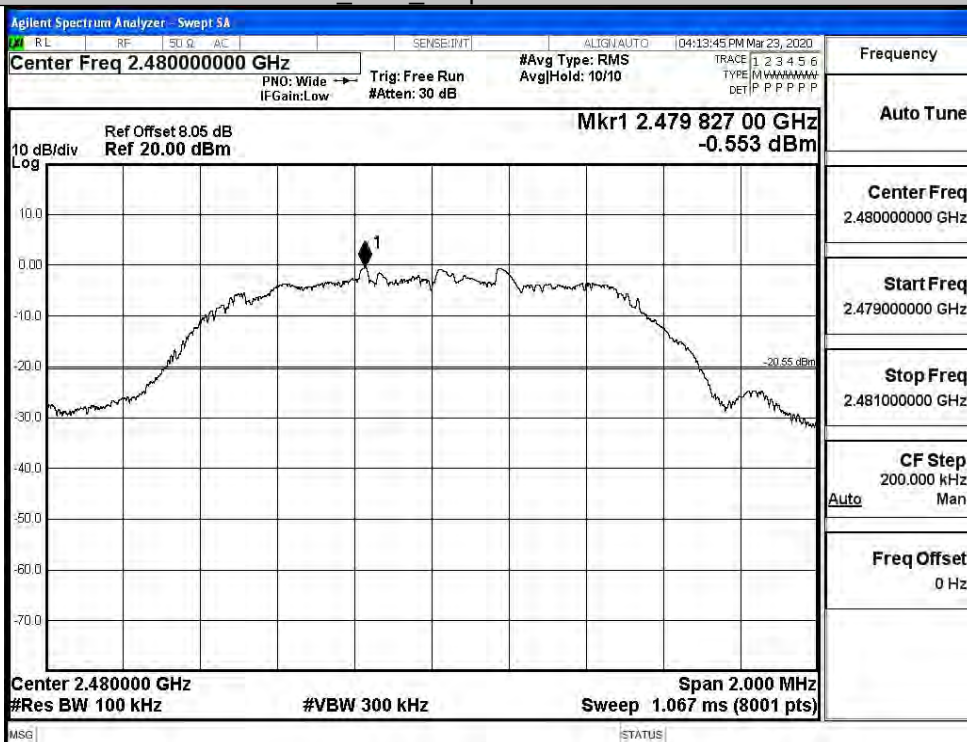


Puw

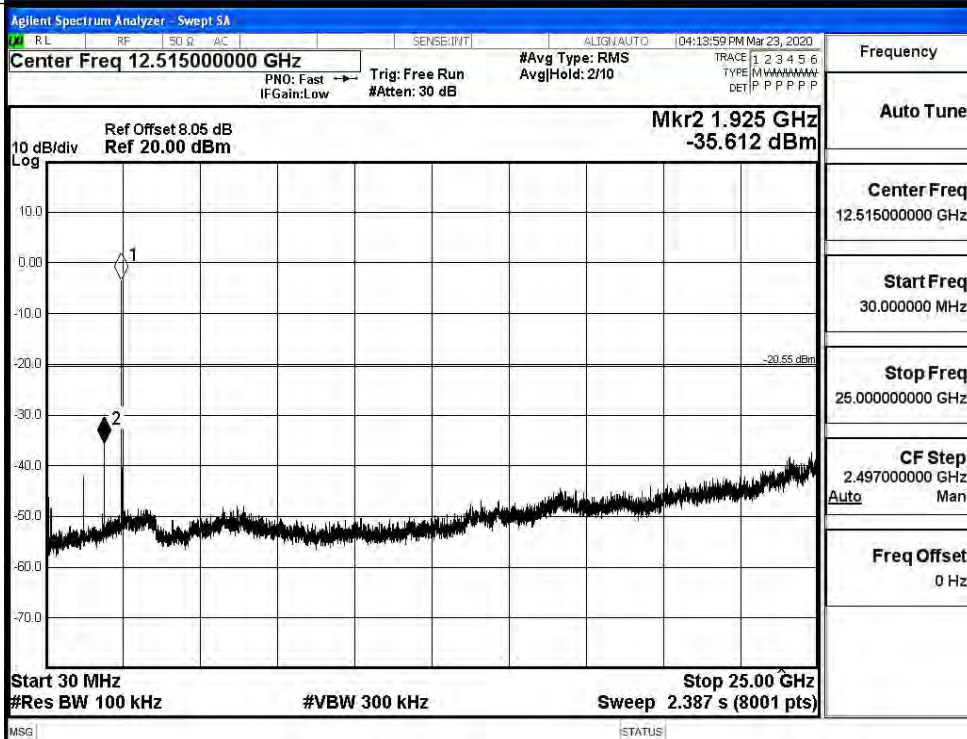


## 8DPSK\_HCH\_Graphs

Pref



Puw

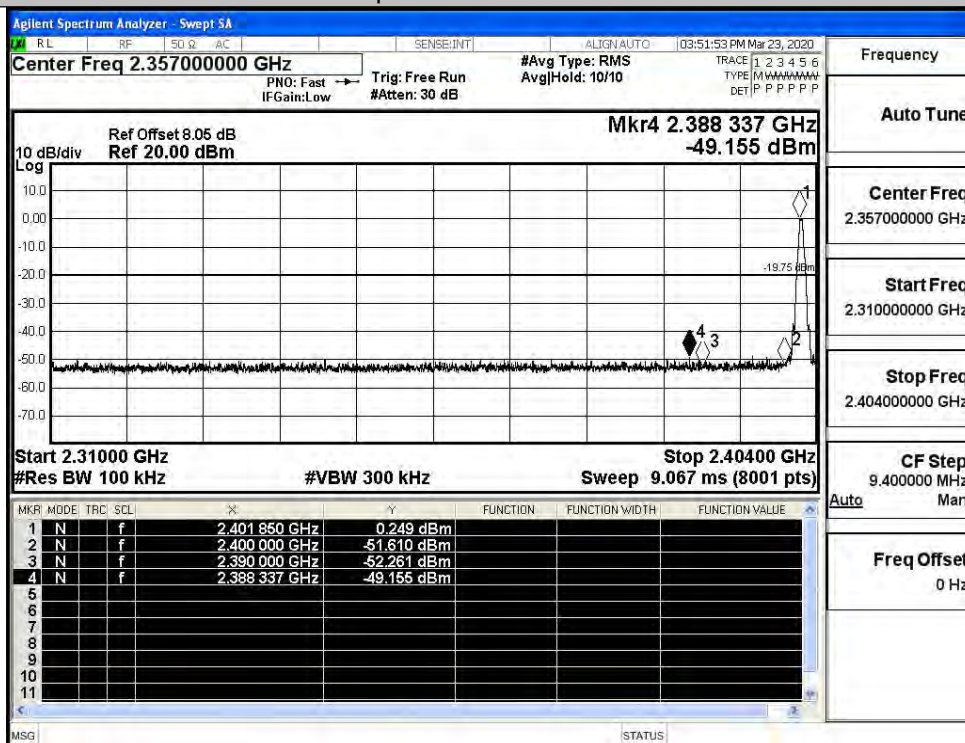


**A.8 Band-edge for RF Conducted Emissions**

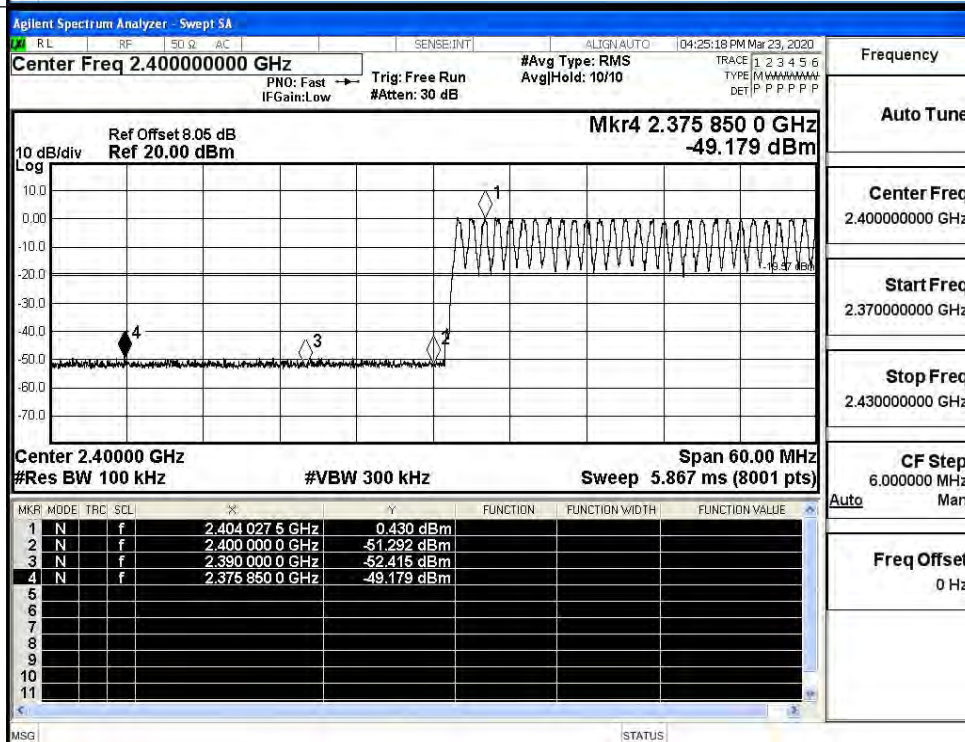
| Mode          | Channel | Carrier Frequency [MHz] | Carrier Power [dBm] | Frequency Hopping | Max Spurious Level [dBm] | Limit [dBm] | Verdict |
|---------------|---------|-------------------------|---------------------|-------------------|--------------------------|-------------|---------|
| GFSK          | LCH     | 2402                    | 0.249               | Off               | -49.155                  | -19.75      | PASS    |
|               |         |                         | 0.430               | On                | -49.179                  | -19.57      | PASS    |
|               | HCH     | 2480                    | -0.359              | Off               | -49.179                  | -20.36      | PASS    |
|               |         |                         | -0.165              | On                | -48.634                  | -20.17      | PASS    |
| $\pi/4$ DQPSK | LCH     | 2402                    | -0.538              | Off               | -49.806                  | -20.54      | PASS    |
|               |         |                         | 0.247               | On                | -49.193                  | -19.75      | PASS    |
|               | HCH     | 2480                    | -0.588              | Off               | -44.697                  | -20.59      | PASS    |
|               |         |                         | -0.372              | On                | -46.022                  | -20.37      | PASS    |
| 8DPSK         | LCH     | 2402                    | 0.386               | Off               | -49.245                  | -19.61      | PASS    |
|               |         |                         | 0.264               | On                | -48.955                  | -19.74      | PASS    |
|               | HCH     | 2480                    | -0.609              | Off               | -40.803                  | -20.61      | PASS    |
|               |         |                         | -0.268              | On                | -39.556                  | -20.27      | PASS    |

## Test Graphs

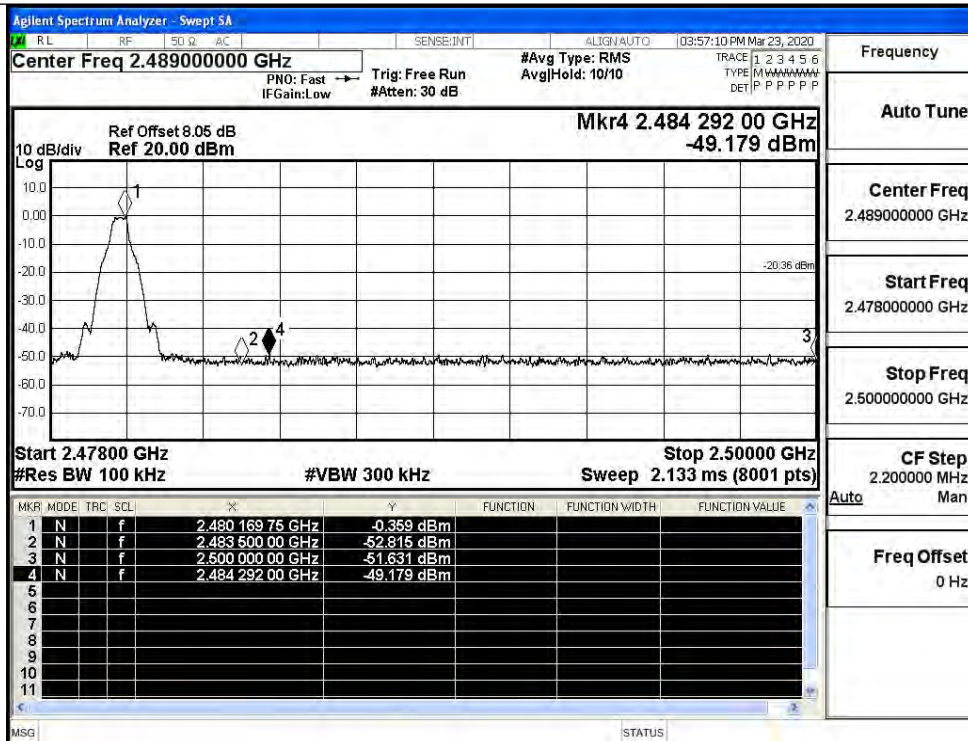
GFSK/LCH/No Hop



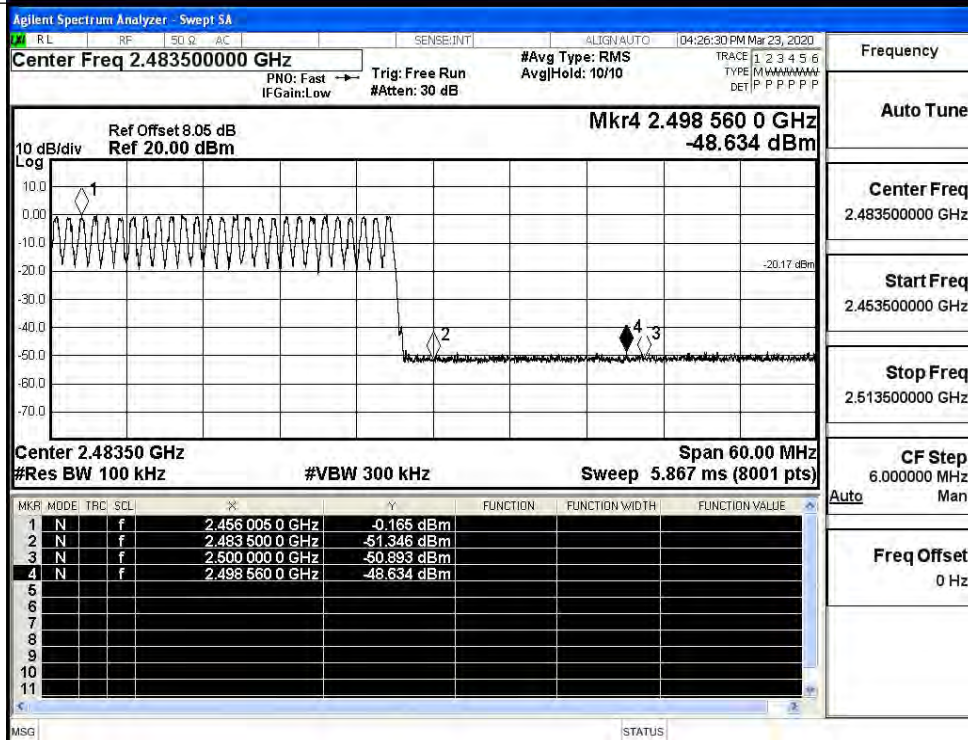
GFSK/LCH/Hop



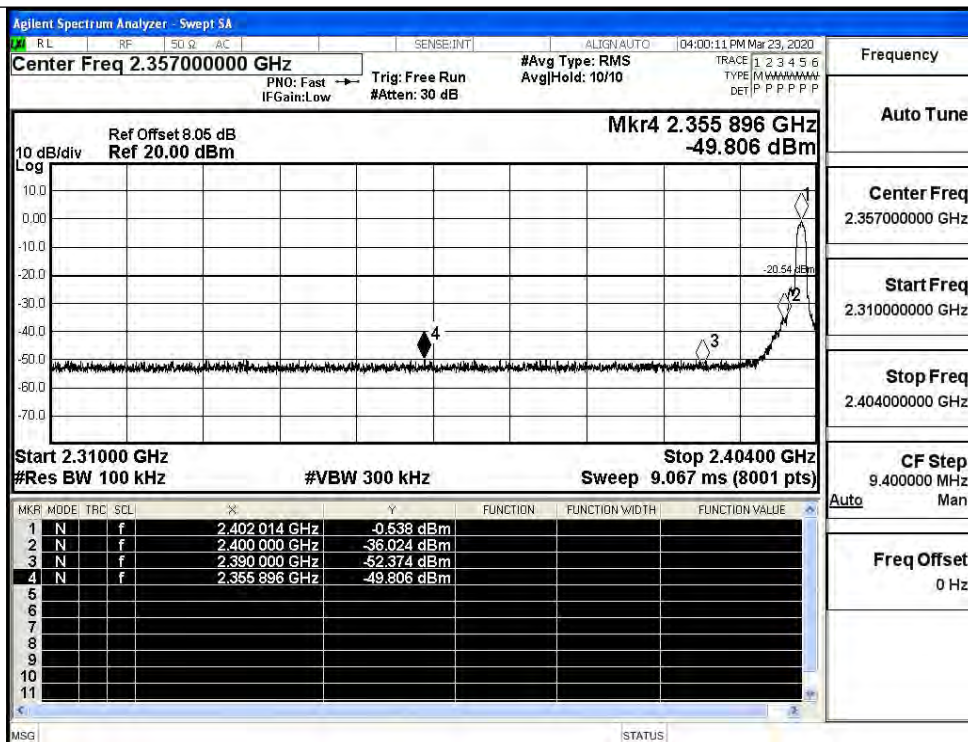
GFSK/HCH/No Hop



GFSK/HCH/Hop



$\pi/4$ DQPSK/LCH/No  
Hop



Frequency

Auto Tune

Center Freq  
2.357000000 GHz

Start Freq  
2.310000000 GHz

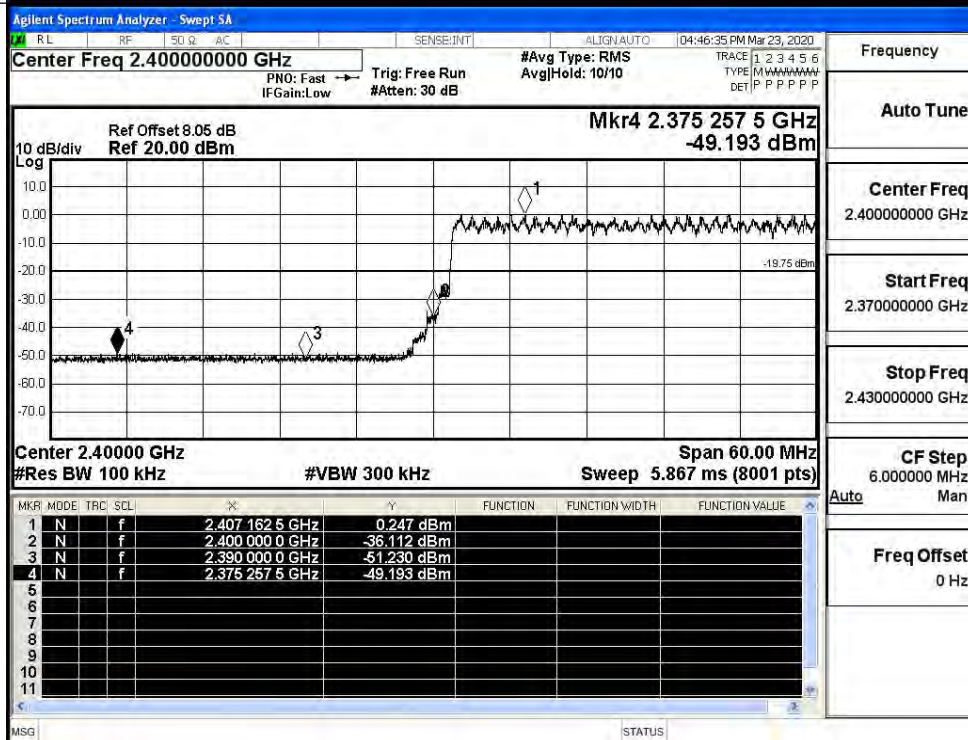
Stop Freq  
2.404000000 GHz

CF Step  
9.400000 MHz

Auto Man

Freq Offset  
0 Hz

$\pi/4$ DQPSK/LCH/Hop



Frequency

Auto Tune

Center Freq  
2.400000000 GHz

Start Freq  
2.370000000 GHz

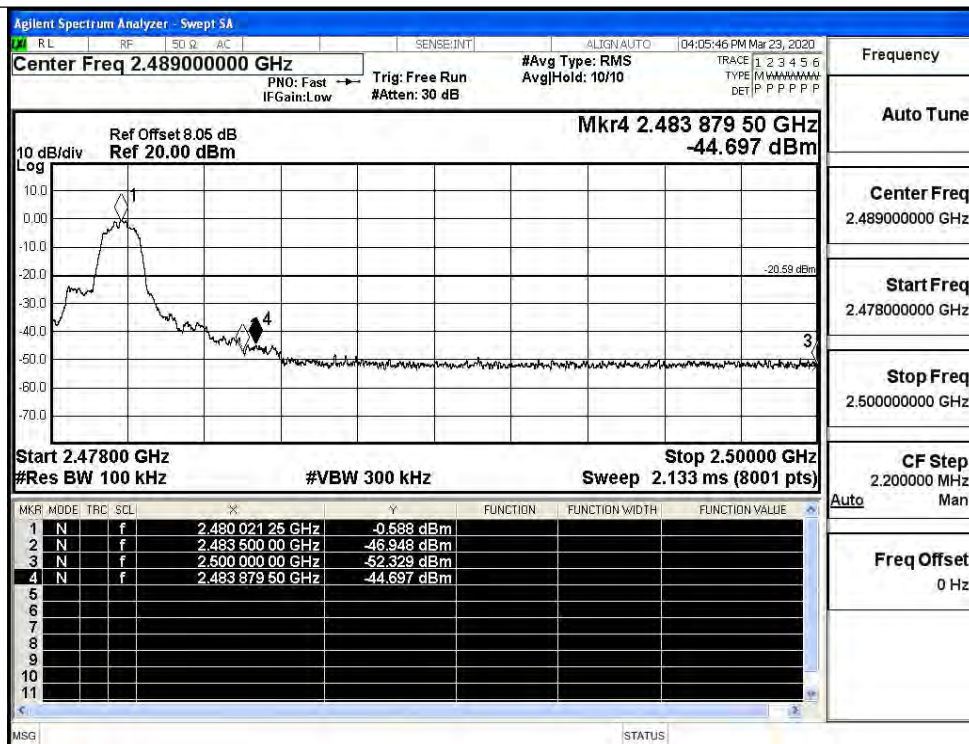
Stop Freq  
2.430000000 GHz

CF Step  
6.000000 MHz

Auto Man

Freq Offset  
0 Hz

$\pi/4$ DQPSK/HCH/No  
Hop

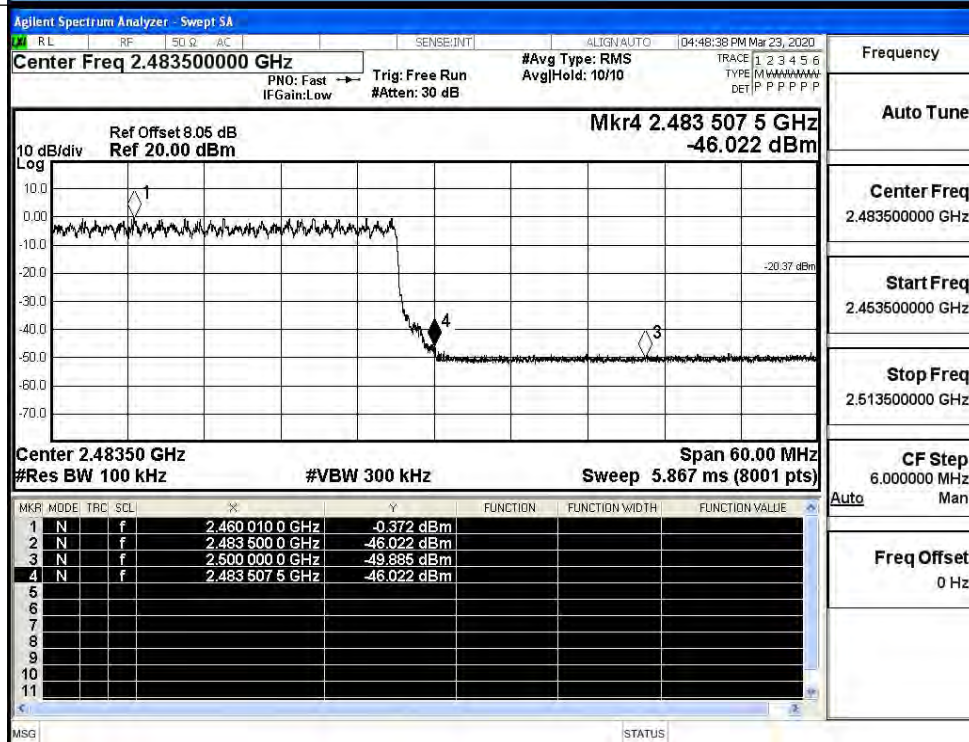


Frequency

Auto Tune

Center Freq  
2.489000000 GHzStart Freq  
2.478000000 GHzStop Freq  
2.500000000 GHzCF Step  
2.200000 MHz  
Auto ManFreq Offset  
0 Hz

$\pi/4$ DQPSK/HCH/Hop

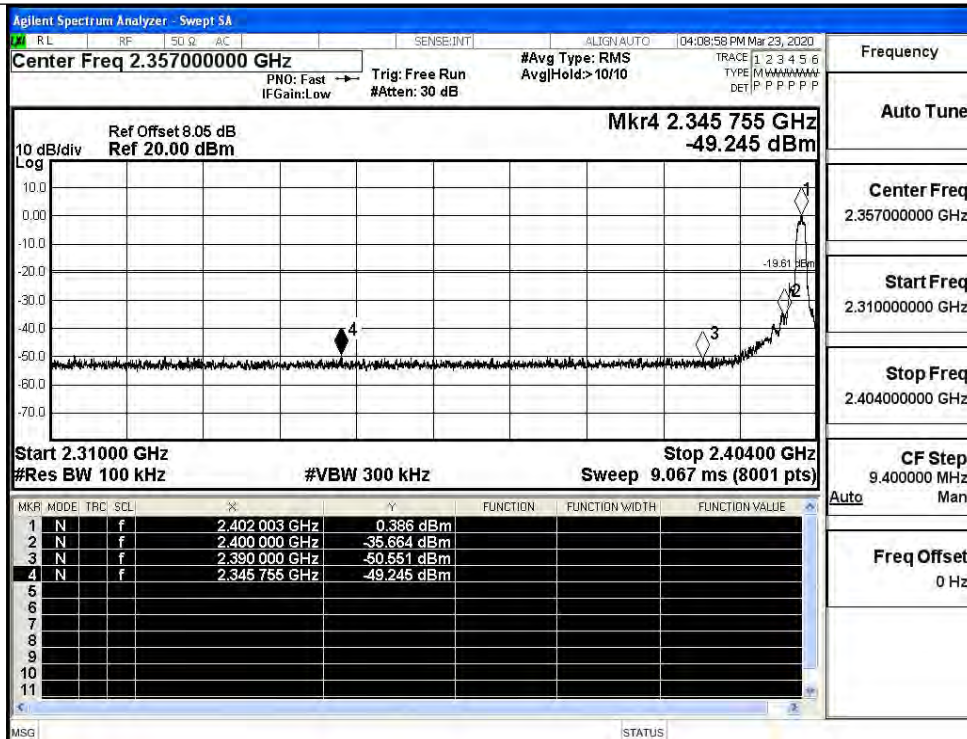


Frequency

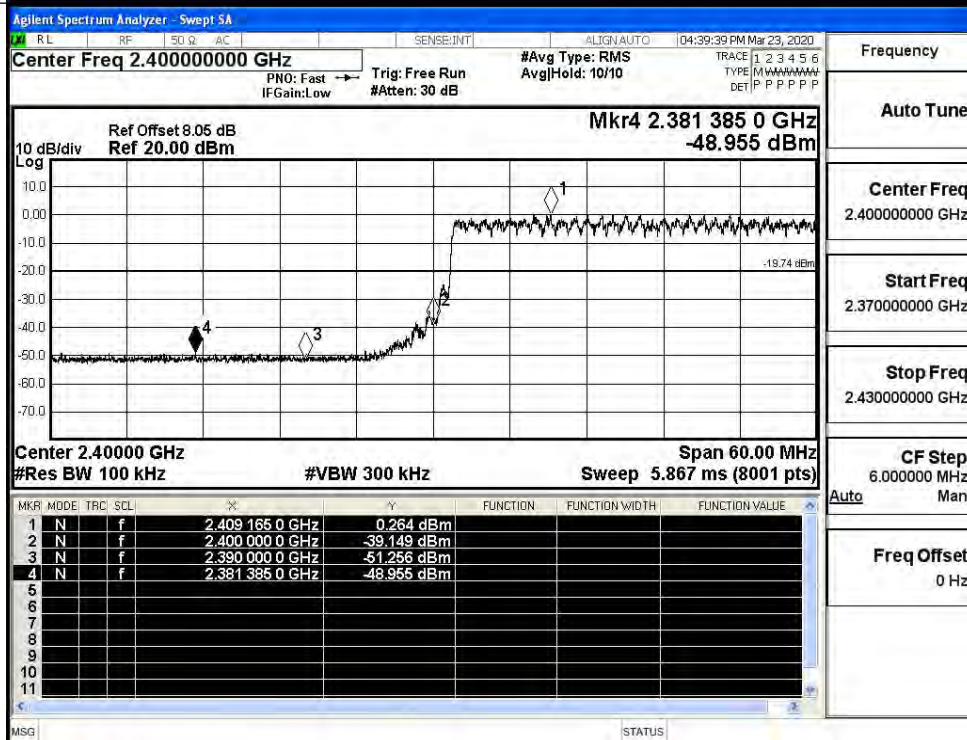
Auto Tune

Center Freq  
2.483500000 GHzStart Freq  
2.463500000 GHzStop Freq  
2.513500000 GHzCF Step  
6.000000 MHz  
Auto ManFreq Offset  
0 Hz

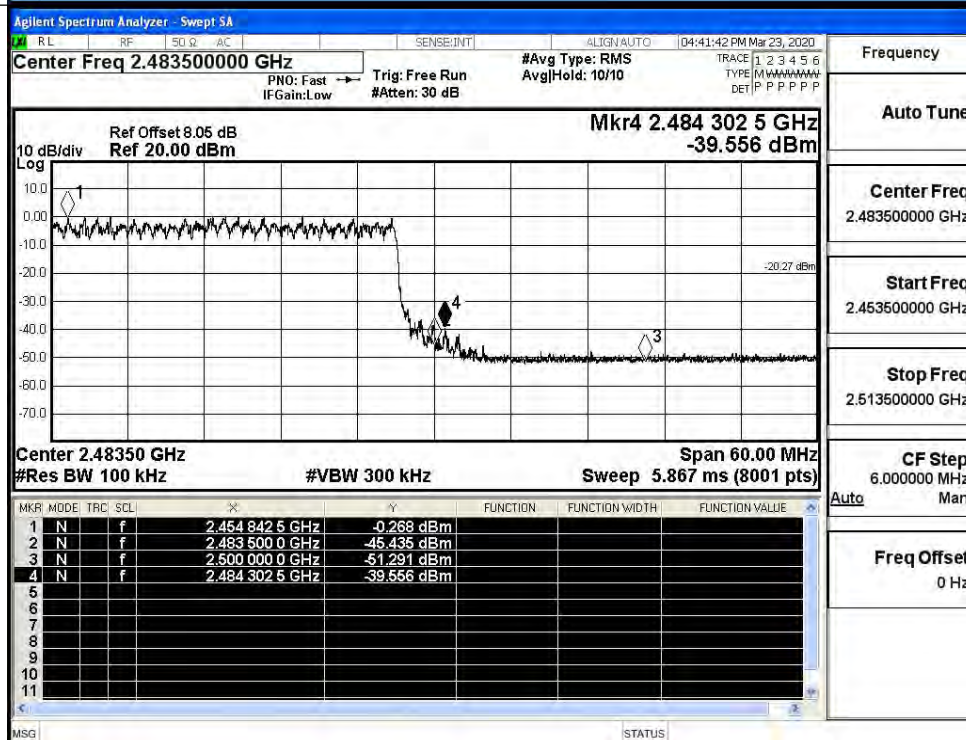
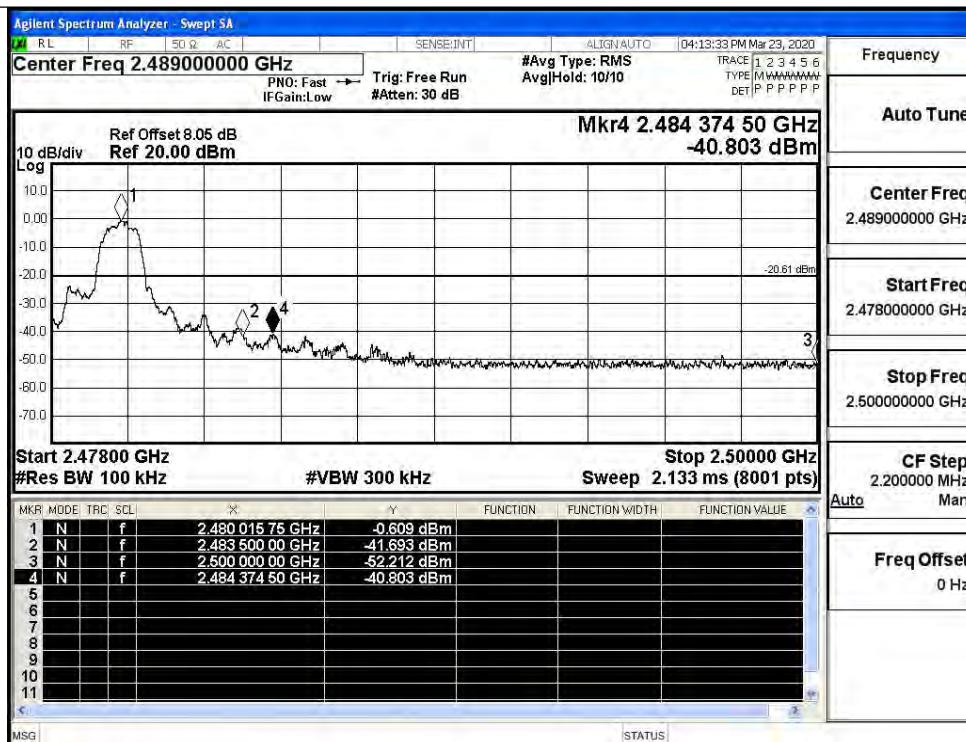
8DPSK/LCH/No Hop



8DPSK/LCH/Hop



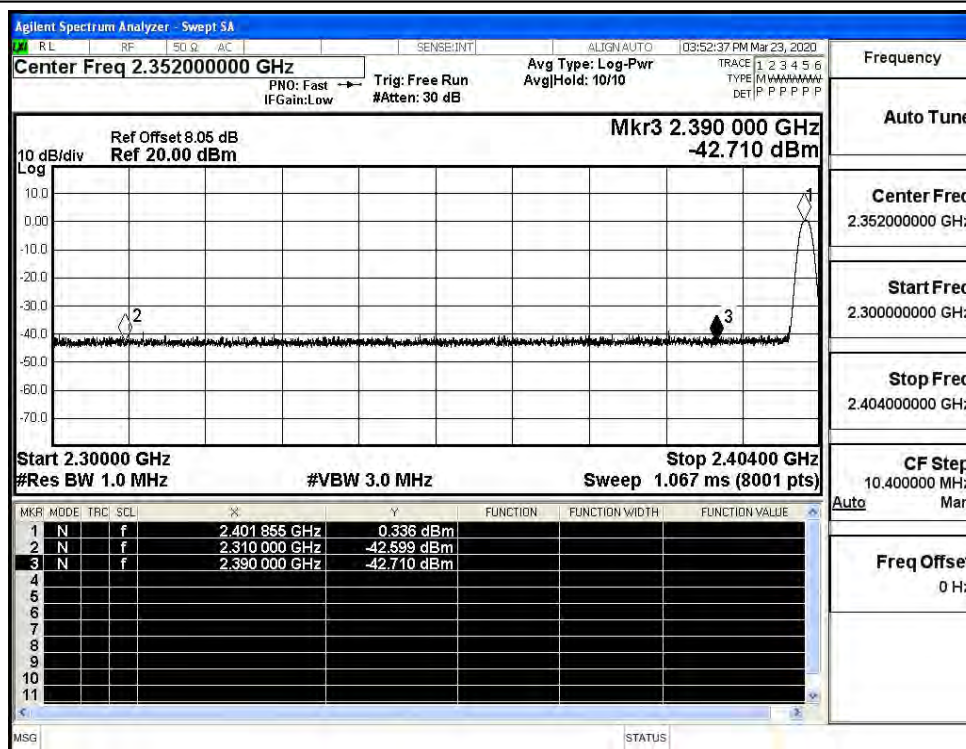
8DPSK/HCH/Hop



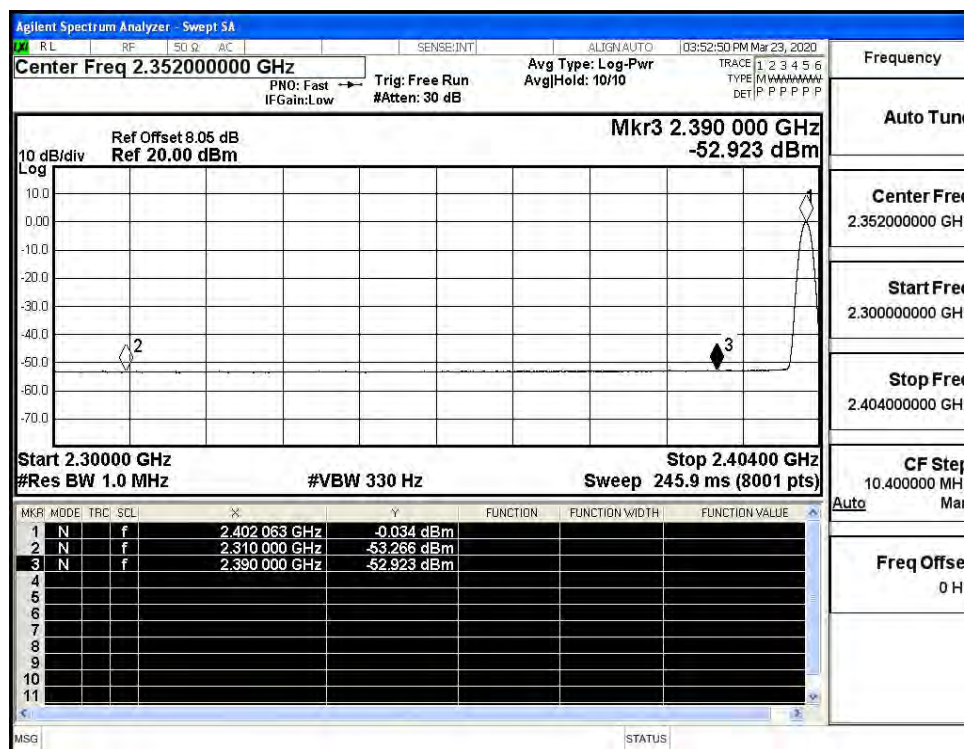
## A.9 Restrict-band band-edge measurements

| Test Mode     | Hopping | Freq.  | Power [dBm] | Gain | Ground Factor | E [dBuV/m] | Detector | Limit [dBuV/m] | Verdict |
|---------------|---------|--------|-------------|------|---------------|------------|----------|----------------|---------|
| GFSK          | Off     | 2310.0 | -42.60      | 2.0  | 0             | 54.66      | PEAK     | 74             | PASS    |
|               | Off     | 2310.0 | -53.27      | 2.0  | 0             | 43.99      | AV       | 54             | PASS    |
|               | Off     | 2390.0 | -42.71      | 2.0  | 0             | 54.55      | PEAK     | 74             | PASS    |
|               | Off     | 2390.0 | -52.92      | 2.0  | 0             | 44.33      | AV       | 54             | PASS    |
|               | Off     | 2483.5 | -42.12      | 2.0  | 0             | 55.13      | PEAK     | 74             | PASS    |
|               | Off     | 2483.5 | -52.32      | 2.0  | 0             | 44.94      | AV       | 54             | PASS    |
|               | Off     | 2500.0 | -41.81      | 2.0  | 0             | 55.45      | PEAK     | 74             | PASS    |
|               | Off     | 2500.0 | -52.29      | 2.0  | 0             | 44.96      | AV       | 54             | PASS    |
| $\pi/4$ DQPSK | Off     | 2310.0 | -43.52      | 2.0  | 0             | 53.73      | PEAK     | 74             | PASS    |
|               | Off     | 2310.0 | -53.25      | 2.0  | 0             | 44.01      | AV       | 54             | PASS    |
|               | Off     | 2390.0 | -43.18      | 2.0  | 0             | 54.08      | PEAK     | 74             | PASS    |
|               | Off     | 2390.0 | -52.90      | 2.0  | 0             | 44.36      | AV       | 54             | PASS    |
|               | Off     | 2483.5 | -30.60      | 2.0  | 0             | 66.66      | PEAK     | 74             | PASS    |
|               | Off     | 2483.5 | -48.23      | 2.0  | 0             | 49.03      | AV       | 54             | PASS    |
|               | Off     | 2500.0 | -41.97      | 2.0  | 0             | 55.29      | PEAK     | 74             | PASS    |
|               | Off     | 2500.0 | -52.21      | 2.0  | 0             | 45.05      | AV       | 54             | PASS    |
| 8DPSK         | Off     | 2310.0 | -44.03      | 2.0  | 0             | 53.23      | PEAK     | 74             | PASS    |
|               | Off     | 2310.0 | -53.39      | 2.0  | 0             | 43.87      | AV       | 54             | PASS    |
|               | Off     | 2390.0 | -41.73      | 2.0  | 0             | 55.53      | PEAK     | 74             | PASS    |
|               | Off     | 2390.0 | -52.78      | 2.0  | 0             | 44.47      | AV       | 54             | PASS    |
|               | Off     | 2483.5 | -28.56      | 2.0  | 0             | 68.70      | PEAK     | 74             | PASS    |
|               | Off     | 2483.5 | -48.86      | 2.0  | 0             | 48.40      | AV       | 54             | PASS    |
|               | Off     | 2500.0 | -42.83      | 2.0  | 0             | 54.43      | PEAK     | 74             | PASS    |
|               | Off     | 2500.0 | -52.24      | 2.0  | 0             | 45.02      | AV       | 54             | PASS    |

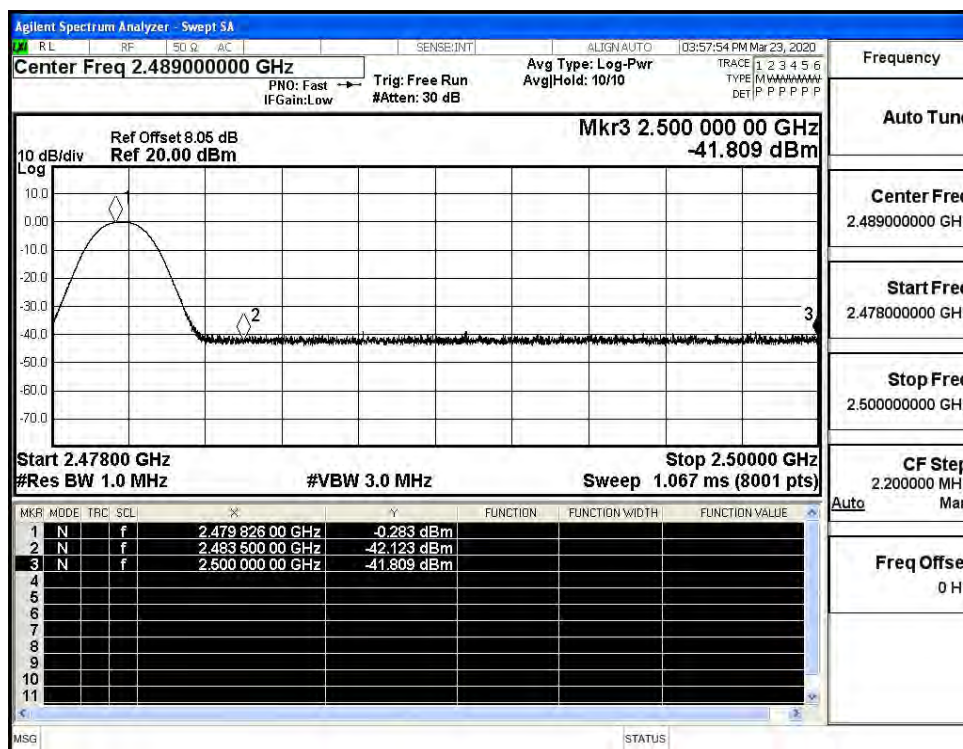
## Restrict-band band-edge measurements\_Hopping Off\_GFSK\_PEAK (Low Channel)



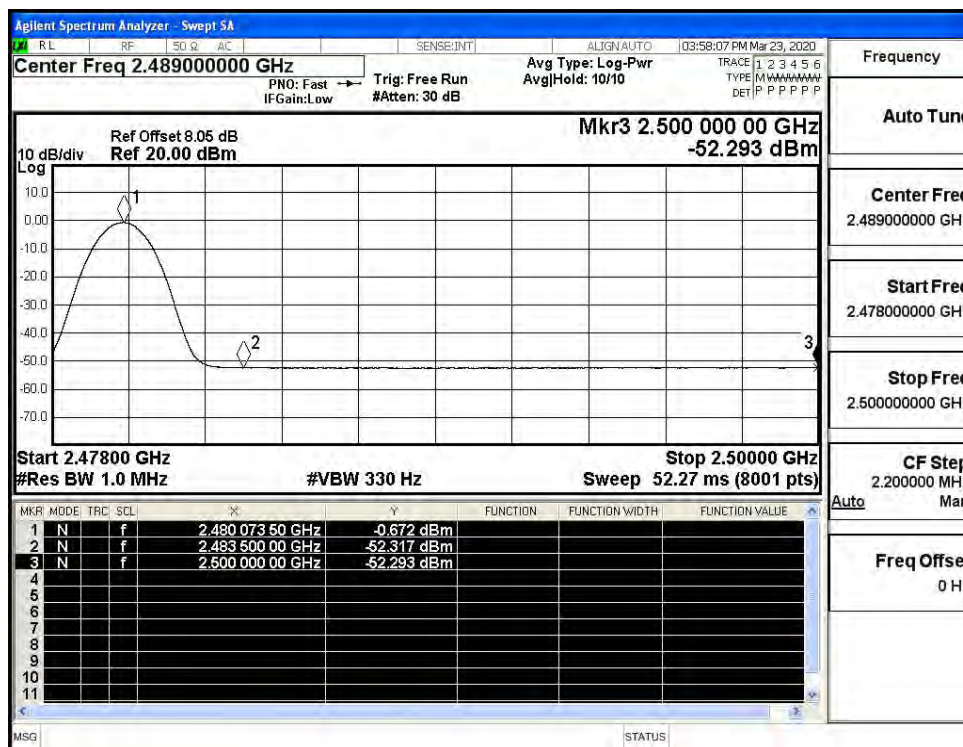
## Restrict-band band-edge measurements\_Hopping Off\_GFSK\_Average (Low Channel)

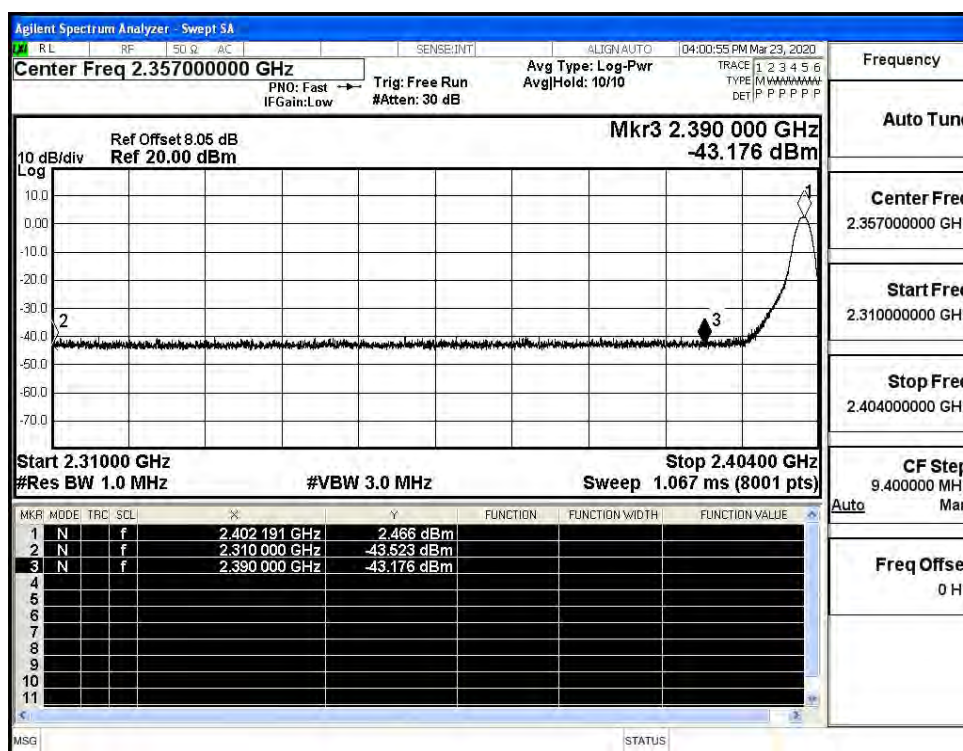
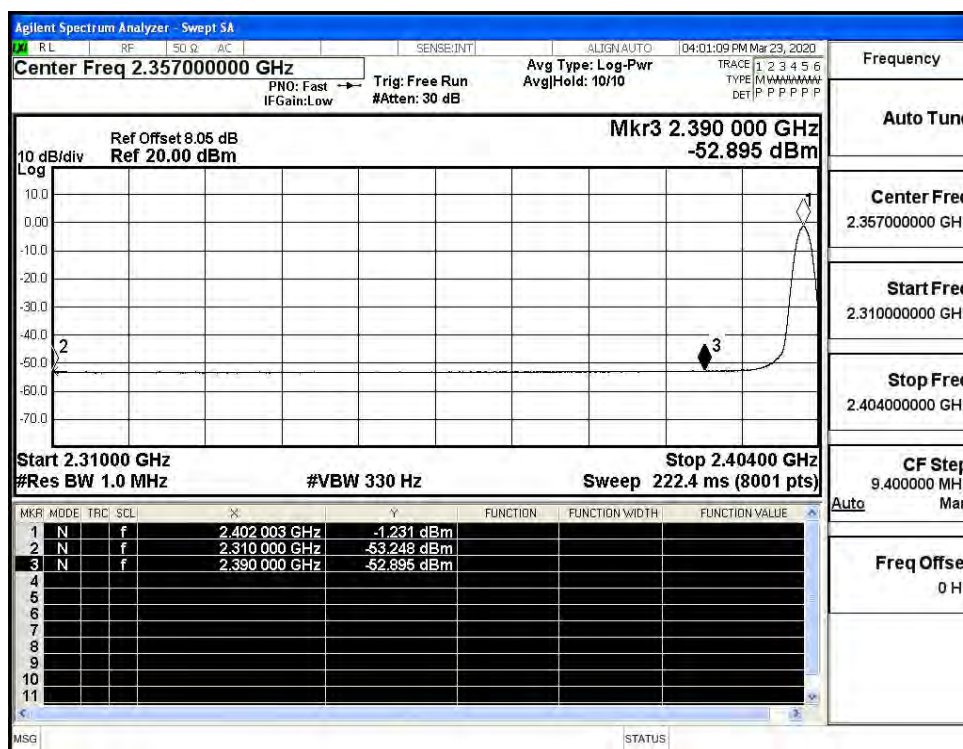


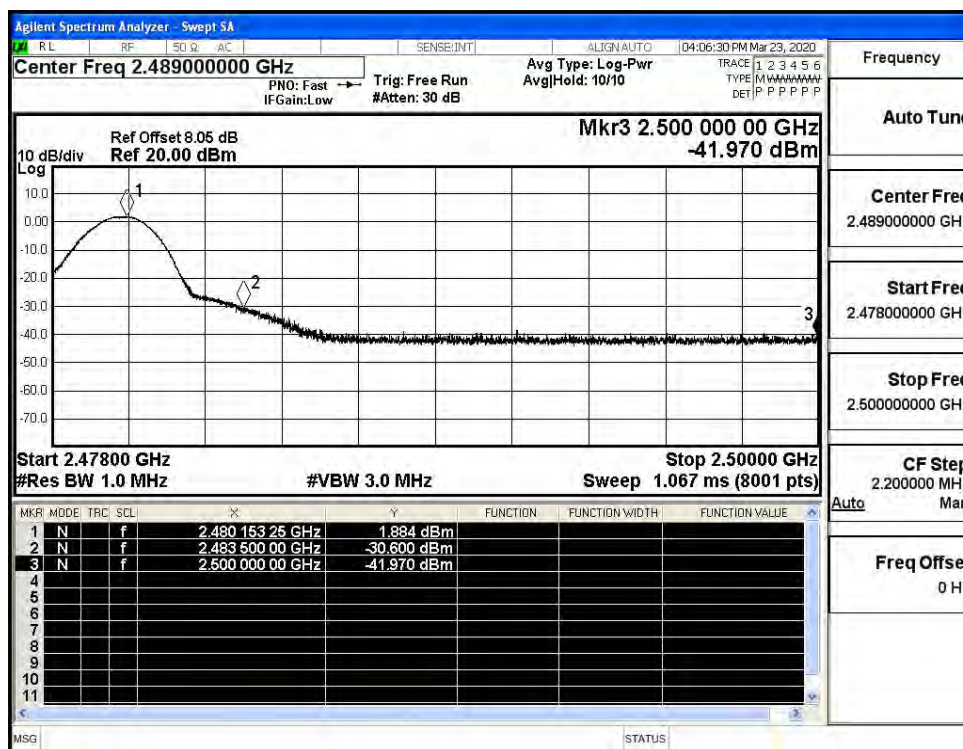
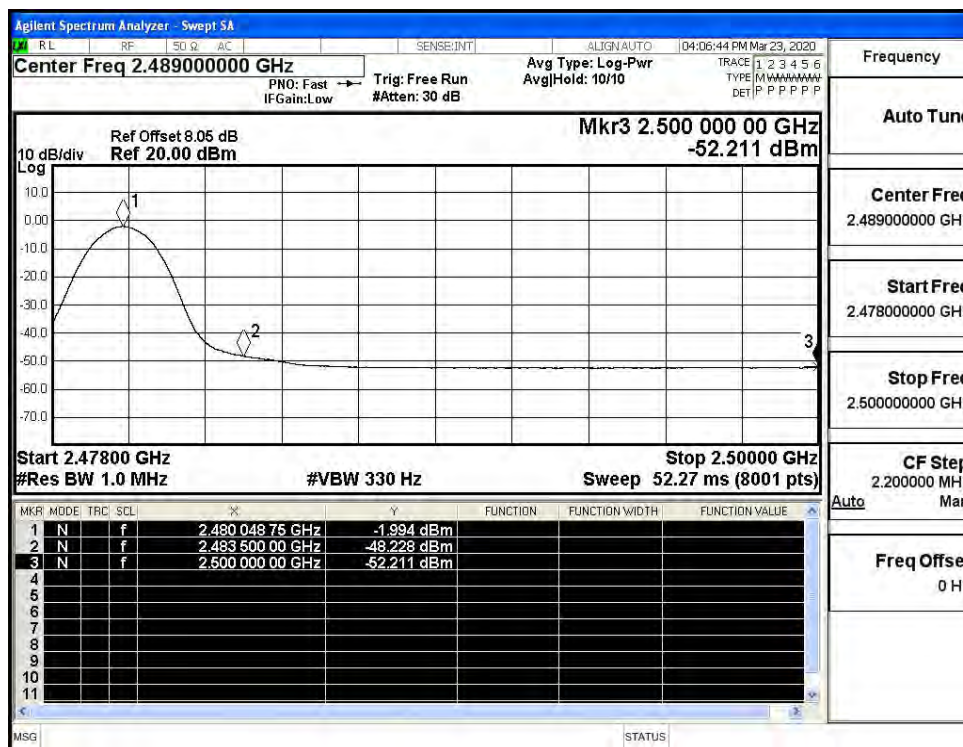
## Restrict-band band-edge measurements\_Hopping Off\_ GFSK\_PEAK (High Channel)



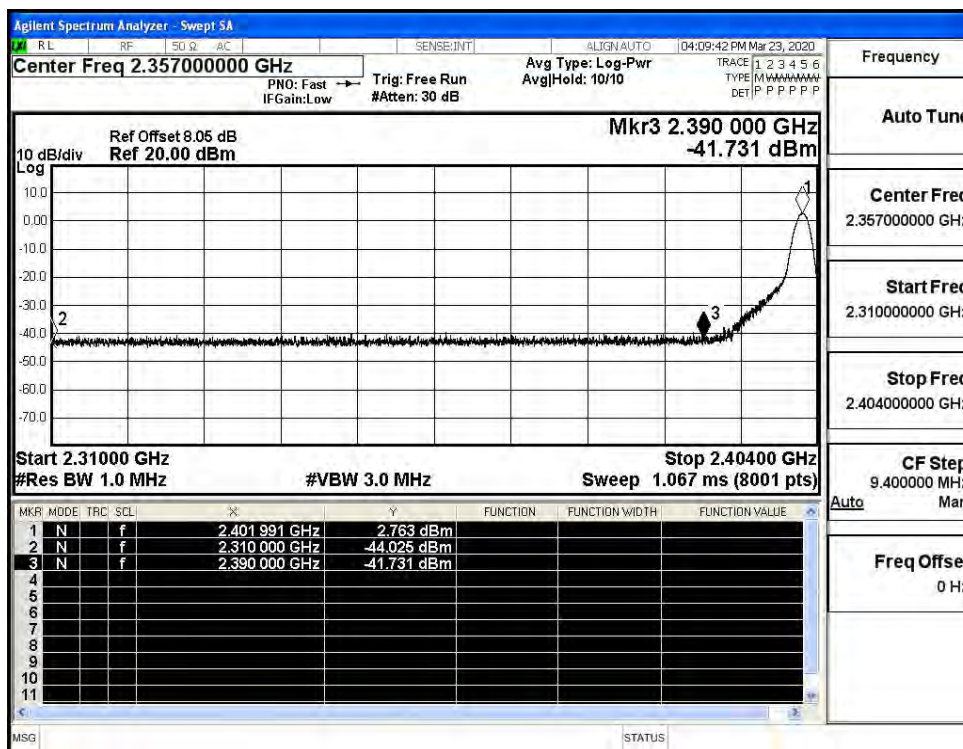
## Restrict-band band-edge measurements\_Hopping Off\_ GFSK\_Average (High Channel)



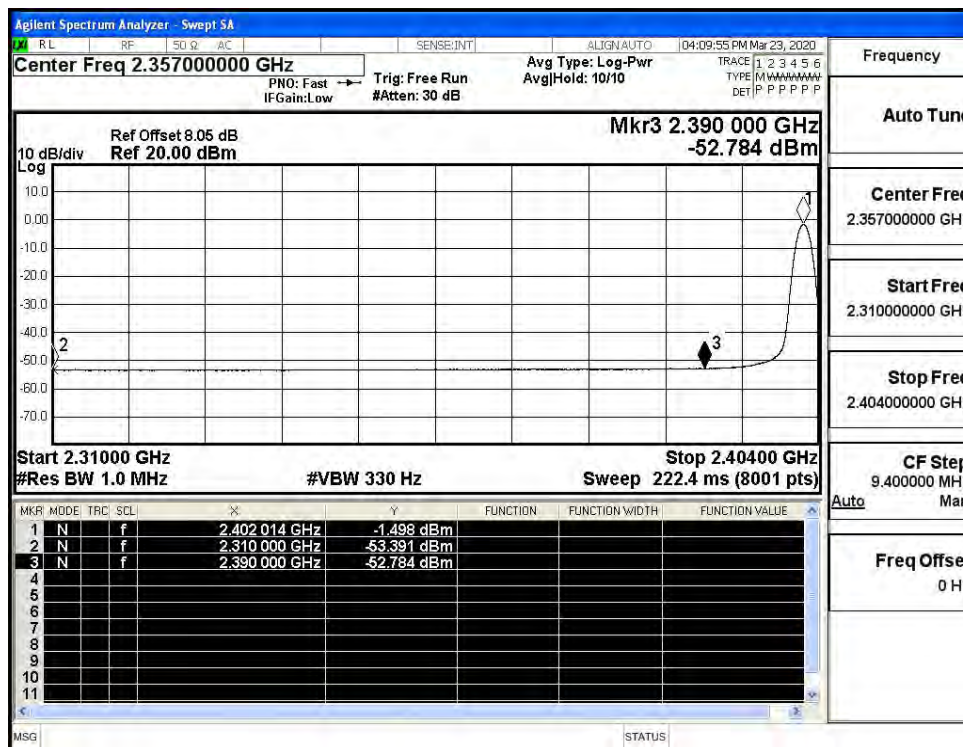
Restrict-band band-edge measurements\_Hopping Off  $\pi/4$ -DQPSK\_PEAK (Low Channel)Restrict-band band-edge measurements\_Hopping Off  $\pi/4$ -DQPSK\_Average (Low Channel)

Restrict-band band-edge measurements\_Hopping Off  $\pi/4$ -DQPSK\_PEAK (High Channel)Restrict-band band-edge measurements\_Hopping Off  $\pi/4$ -DQPSK\_Average (High Channel)

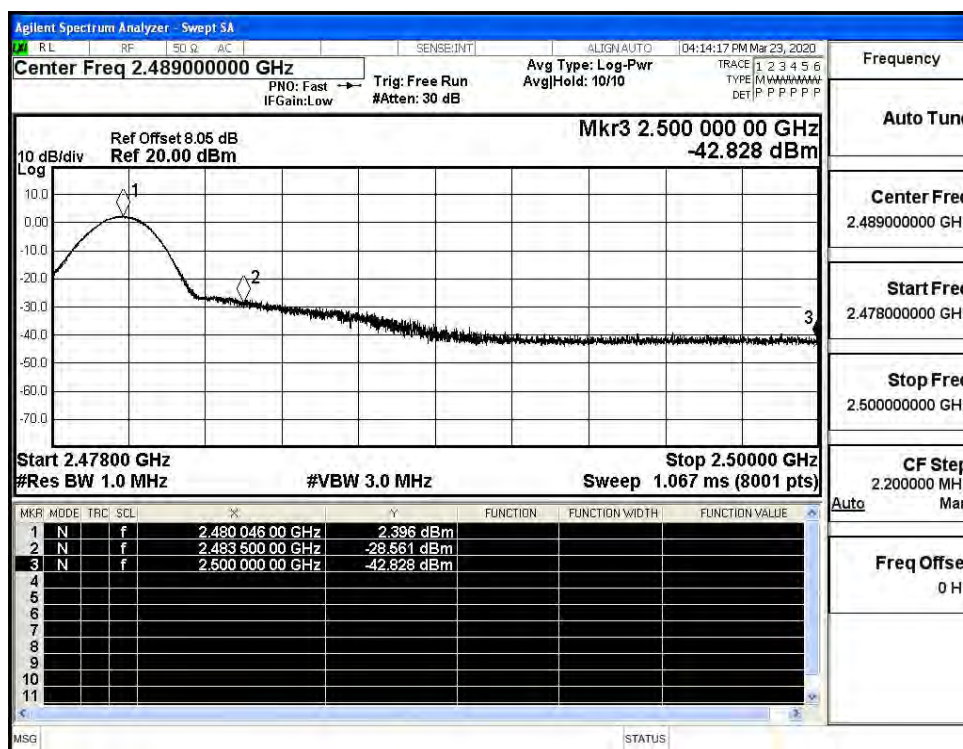
## Restrict-band band-edge measurements\_Hopping Off\_8DPSK\_PEAK (Low Channel)



## Restrict-band band-edge measurements\_Hopping Off\_8DPSK\_Average (Low Channel)



## Restrict-band band-edge measurements\_Hopping Off\_8DPSK\_PEAK (High Channel)



## Restrict-band band-edge measurements\_Hopping Off\_8DPSK\_Average (High Channel)

