

9 kHz ~ 25 GHz Data (Modulation : 8DPSK)

▪ Lowest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|------------|----------------------|-----------------|----------------|-------------|
| 2389.27 | H | X | PK | 46.13 | 0.78 | N/A | N/A | 46.91 | 74.00 | 27.09 |
| 2389.56 | H | X | AV | 34.31 | 0.78 | -24.79 | N/A | 10.30 | 54.00 | 43.70 |
| 4803.48 | V | X | PK | 47.14 | 7.63 | N/A | N/A | 54.77 | 74.00 | 19.23 |
| 4804.07 | V | X | AV | 36.10 | 7.63 | -24.79 | N/A | 18.94 | 54.00 | 35.06 |

▪ Middle Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|------------|----------------------|-----------------|----------------|-------------|
| 4881.98 | V | X | PK | 46.83 | 7.30 | N/A | N/A | 54.13 | 74.00 | 19.87 |
| 4881.89 | V | X | AV | 35.31 | 7.30 | -24.79 | N/A | 17.82 | 54.00 | 36.18 |

▪ Highest Channel

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|------------|----------------------|-----------------|----------------|-------------|
| 2483.95 | H | X | PK | 48.74 | 1.16 | N/A | N/A | 49.90 | 74.00 | 24.10 |
| 2483.97 | H | X | AV | 36.25 | 1.16 | -24.79 | N/A | 12.62 | 54.00 | 41.38 |
| 4959.85 | V | X | PK | 46.83 | 7.48 | N/A | N/A | 54.31 | 74.00 | 19.69 |
| 4959.88 | V | X | AV | 34.55 | 7.48 | -24.79 | N/A | 17.24 | 54.00 | 36.76 |

▪ Note.

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.

- Calculation of distance factor = $20 \log(\text{applied distance} / \text{required distance}) = 20 \log(1 \text{ m} / 3 \text{ m}) = -9.54 \text{ dB}$

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. D.C.F Calculation. (D.C.F = Duty Cycle Correction Factor)

- Time to cycle through all channels = $\Delta t = T \text{ [ms]} \times 20 \text{ minimum hopping channels}$, where $T = \text{pulse width} = 2.88 \text{ ms}$

- $100 \text{ ms} / \Delta t \text{ [ms]} = H \rightarrow \text{Round up to next highest integer, to account for worst case, } H' = 100 / (2.88 \times 20) = 1.74 \approx 2$

- The Worst Case Dwell Time = $T \text{ [ms]} \times H' = 2.88 \text{ ms} \times 2 = 5.76 \text{ ms}$

- $D.C.F = 20 \log(\text{Worst Case Dwell Time} / 100 \text{ ms}) \text{ dB} = 20 \log(5.76 / 100) = -24.79 \text{ dB}$

4. Sample Calculation.

Margin = Limit – Result / Result = Reading + T.F + D.C.F / T.F = AF + CL – AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain.

Band Edge Data (*Hopping mode*)

- Modulation : GFSK

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|------------|----------------------|-----------------|----------------|-------------|
| 2388.67 | H | X | PK | 46.06 | 0.78 | N/A | N/A | 46.84 | 74.00 | 27.16 |
| 2388.86 | H | X | AV | 34.49 | 0.78 | -24.79 | N/A | 10.48 | 54.00 | 43.52 |
| 2484.11 | H | X | PK | 47.52 | 1.16 | N/A | N/A | 48.68 | 74.00 | 25.32 |
| 2484.12 | H | X | AV | 37.31 | 1.16 | -24.79 | N/A | 13.68 | 54.00 | 40.32 |

- Modulation : $\pi/4$ DQPSK

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor(dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|------------|----------------------|-----------------|----------------|-------------|
| 2389.11 | H | X | PK | 46.24 | 0.78 | N/A | N/A | 47.02 | 74.00 | 26.98 |
| 2389.02 | H | X | AV | 34.06 | 0.78 | -24.79 | N/A | 10.05 | 54.00 | 43.95 |
| 2484.00 | H | X | PK | 47.73 | 1.16 | N/A | N/A | 48.89 | 74.00 | 25.11 |
| 2483.98 | H | X | AV | 36.07 | 1.16 | -24.79 | N/A | 12.44 | 54.00 | 41.56 |

- Modulation : 8DPSK

| Frequency (MHz) | ANT Pol | The worst case EUT Position (Axis) | Detector Mode | Reading (dBuV) | T.F (dB/m) | D.C.F (dB) | Distance Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|-----------------|---------|------------------------------------|---------------|----------------|------------|------------|----------------------|-----------------|----------------|-------------|
| 2388.32 | H | X | PK | 45.92 | 0.78 | N/A | N/A | 46.70 | 74.00 | 27.30 |
| 2388.58 | H | X | AV | 34.07 | 0.78 | -24.79 | N/A | 10.06 | 54.00 | 43.94 |
| 2484.02 | H | X | PK | 47.19 | 1.16 | N/A | N/A | 48.35 | 74.00 | 25.65 |
| 2484.13 | H | X | AV | 36.04 | 1.16 | -24.79 | N/A | 12.41 | 54.00 | 41.59 |

▪ Note.

1. No other spurious and harmonic emissions were found greater than listed emissions on above table.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.

- Calculation of distance factor = $20 \log(\text{applied distance} / \text{required distance}) = 20 \log(1 \text{ m} / 3 \text{ m}) = -9.54 \text{ dB}$

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. D.C.F Calculation. (D.C.F = Duty Cycle Correction Factor)

- Time to cycle through all channels = $\Delta t = T \text{ [ms]} \times 20 \text{ minimum hopping channels}$, where $T = \text{pulse width} = 2.88 \text{ ms}$

- $100 \text{ ms} / \Delta t \text{ [ms]} = H \rightarrow \text{Round up to next highest integer, to account for worst case, } H' = 100 / (2.88 \times 20) = 1.74 \approx 2$

- The Worst Case Dwell Time = $T \text{ [ms]} \times H' = 2.88 \text{ ms} \times 2 = 5.76 \text{ ms}$

- $D.C.F = 20 \log(\text{Worst Case Dwell Time} / 100 \text{ ms}) \text{ dB} = 20 \log(5.76 / 100) = -24.79 \text{ dB}$

4. Sample Calculation.

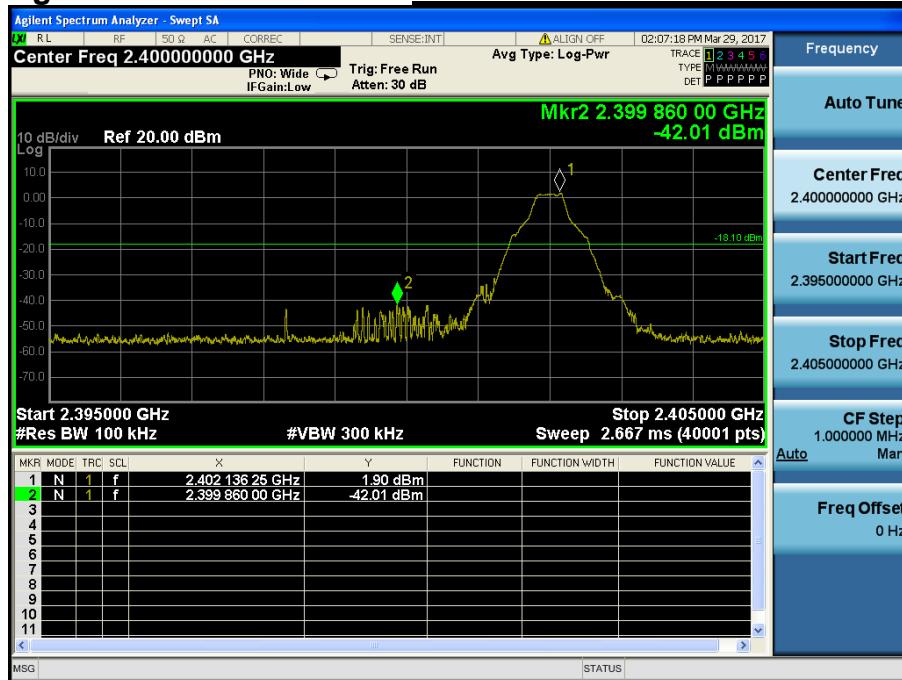
Margin = Limit – Result / Result = Reading + T.F + D.C.F / T.F = AF + CL – AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain.

7.4.3.1. Conducted Spurious Emissions

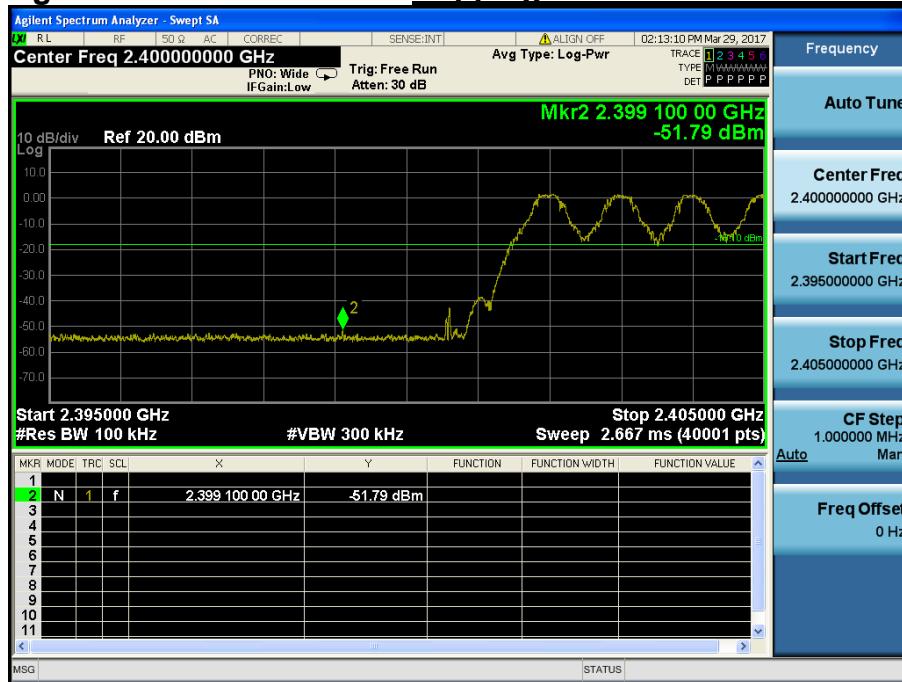
Low Band-edge

Lowest Channel & Modulation : GFSK



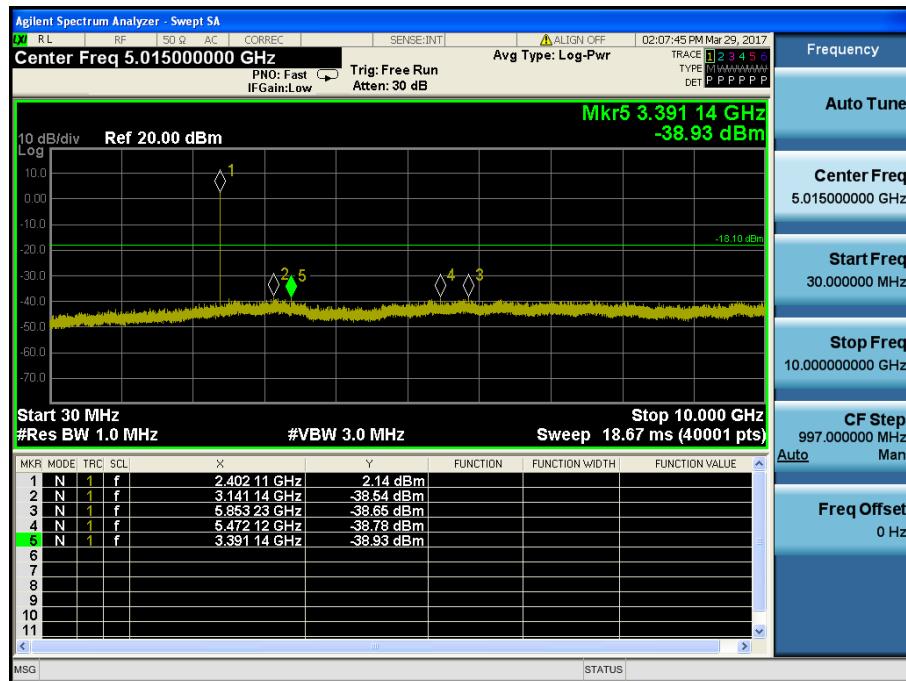
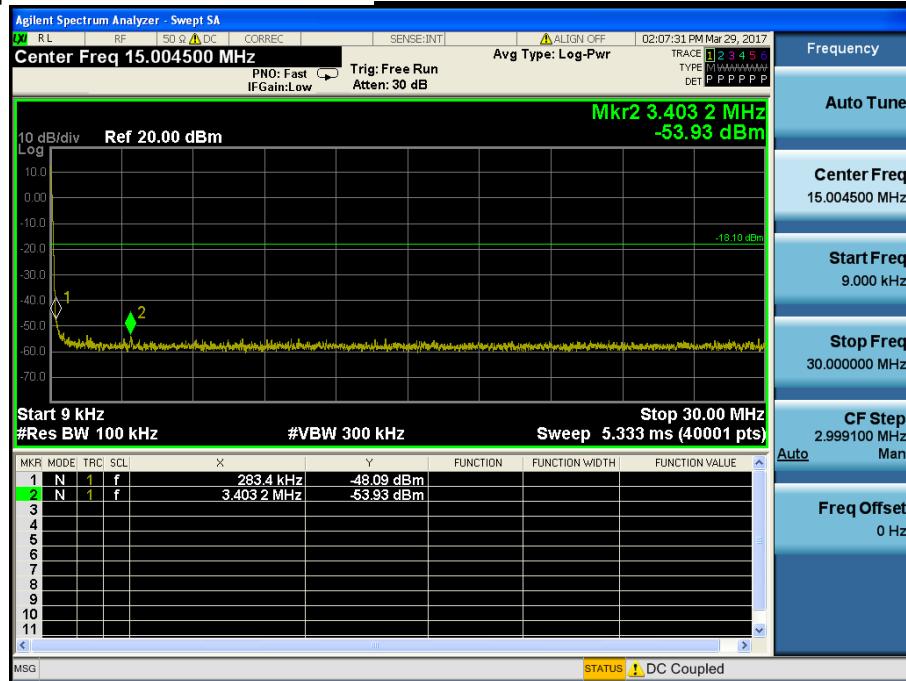
Low Band-edge

Hopping mode & Modulation : GFSK



Conducted Spurious Emissions

Lowest Channel & Modulation : GFSK



Conducted Spurious Emissions

Lowest Channel & Modulation : GFSK



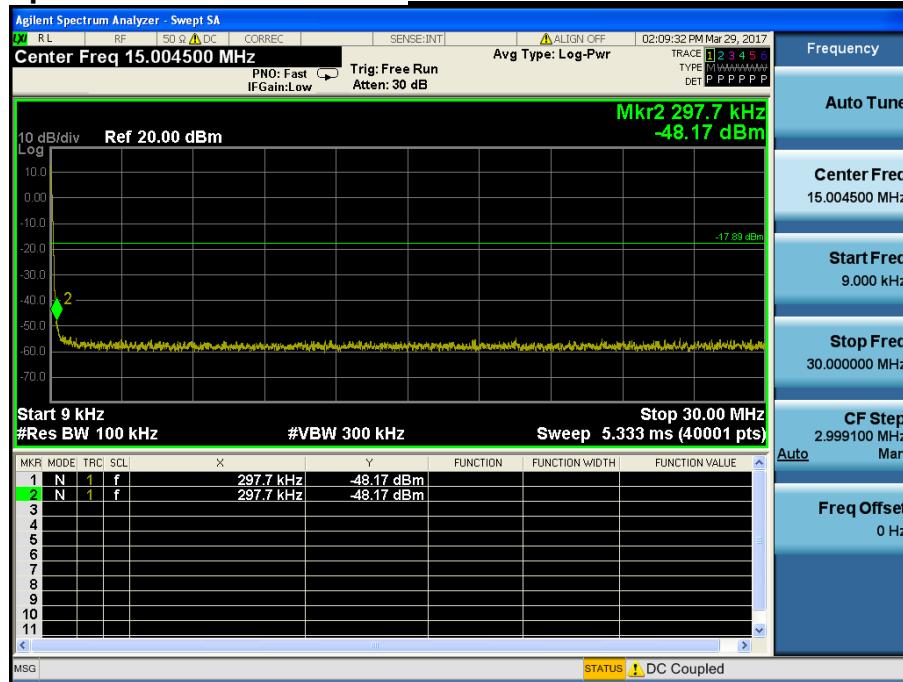
Reference for limit

Middle Channel & Modulation : GFSK



Conducted Spurious Emissions

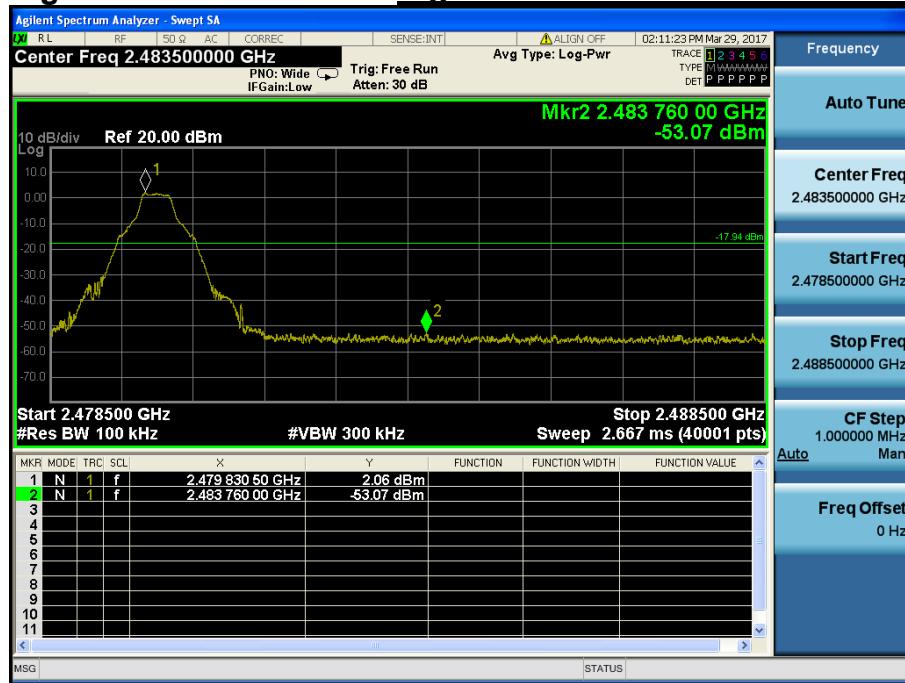
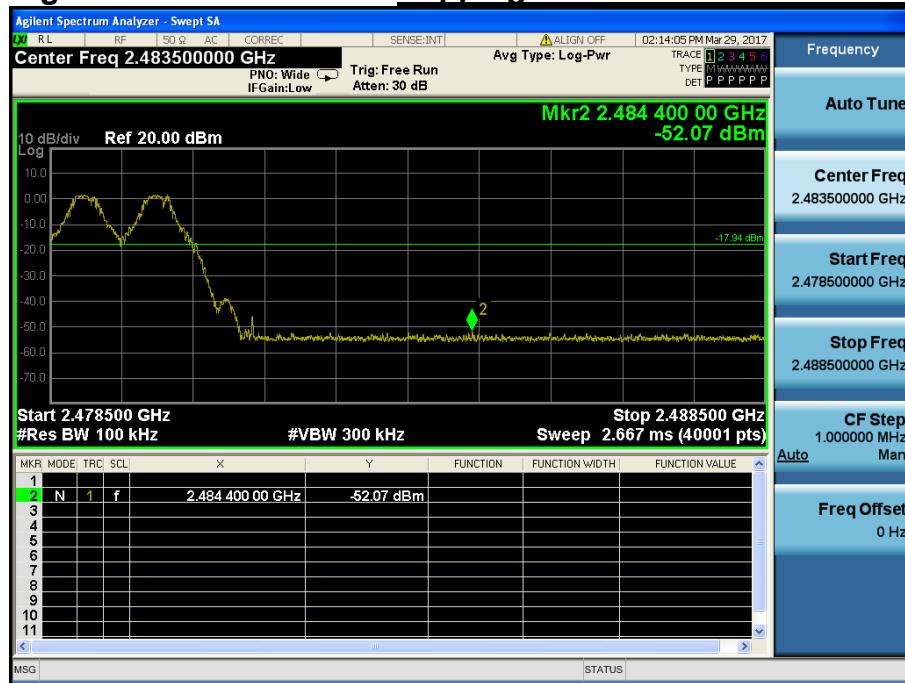
Middle Channel & Modulation : GFSK



Conducted Spurious Emissions

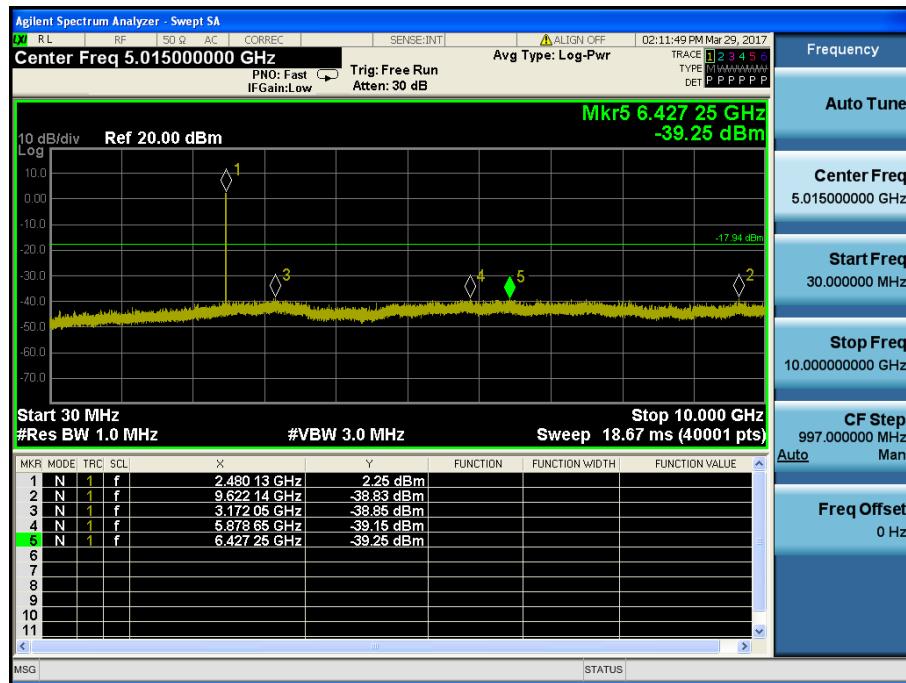
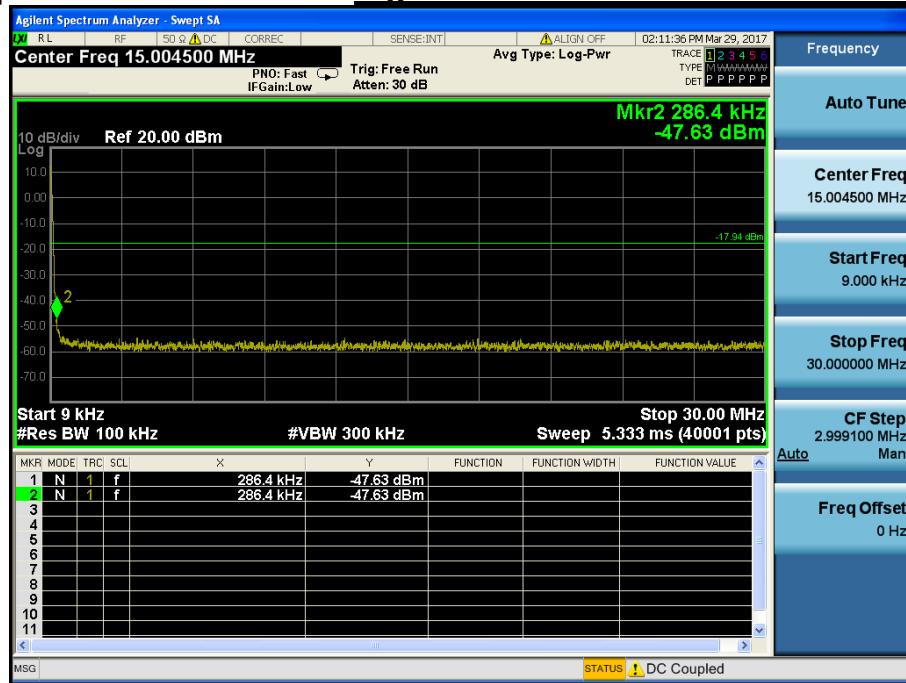
Middle Channel & Modulation : GFSK



High Band-edge
Highest Channel & Modulation : GFSK

High Band-edge
Hopping mode & Modulation : GFSK


Conducted Spurious Emissions

Highest Channel & Modulation : GFSK

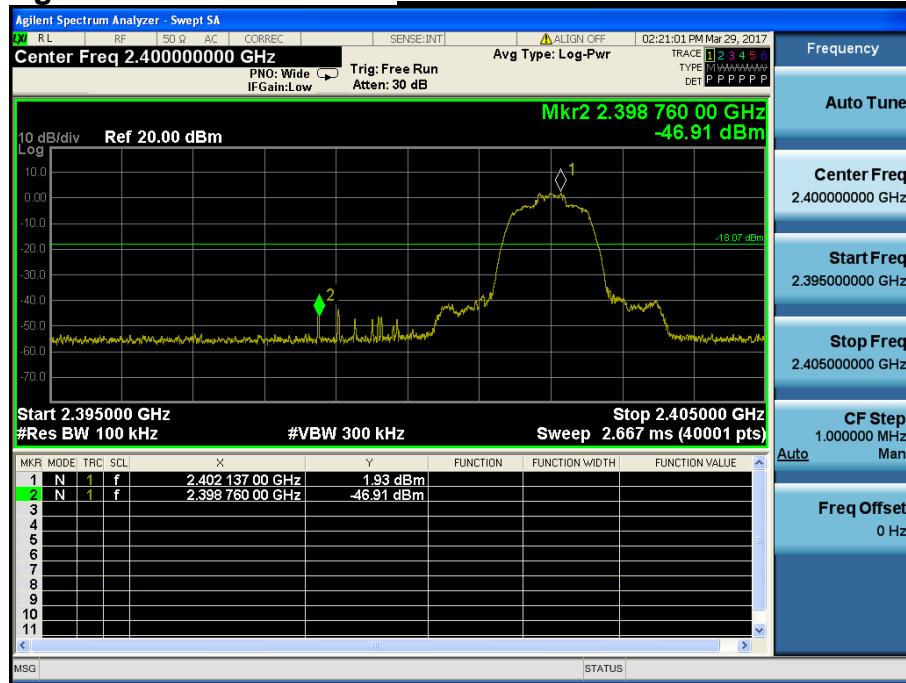


Conducted Spurious Emissions

Highest Channel & Modulation : GFSK

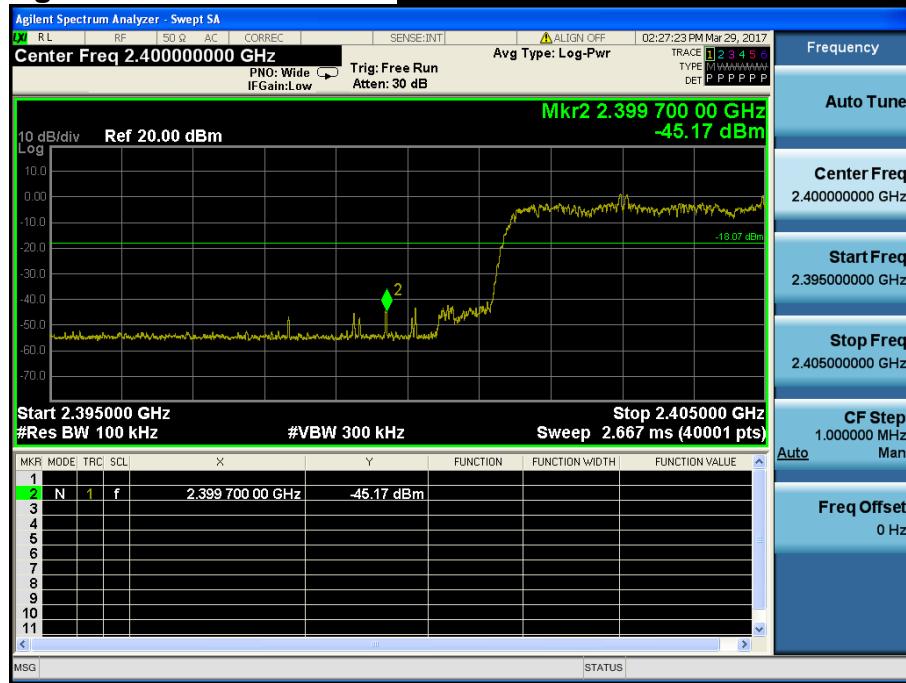

Low Band-edge

Lowest Channel & Modulation : $\pi/4$ DQPSK

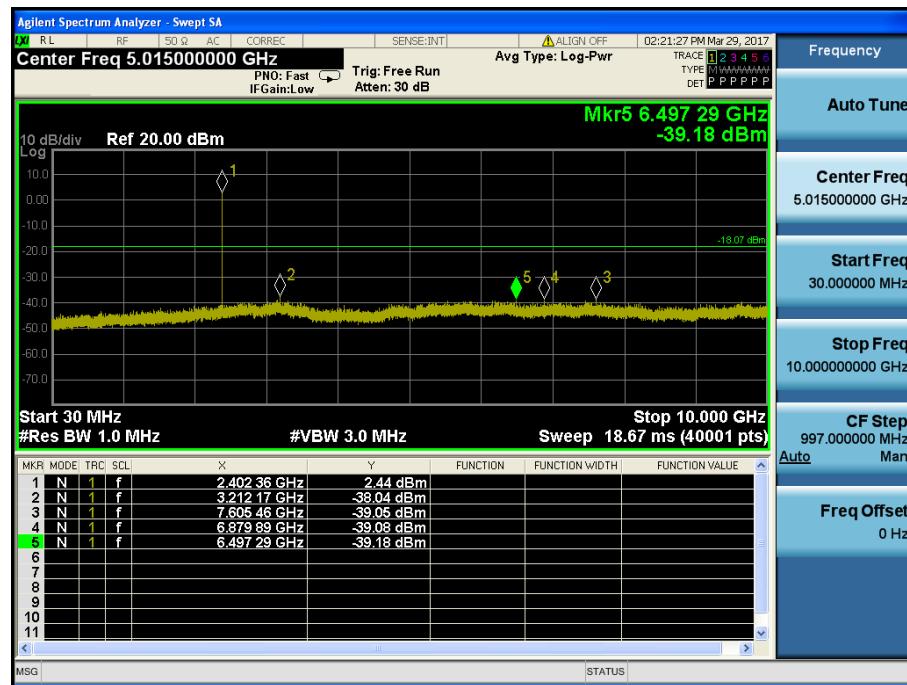
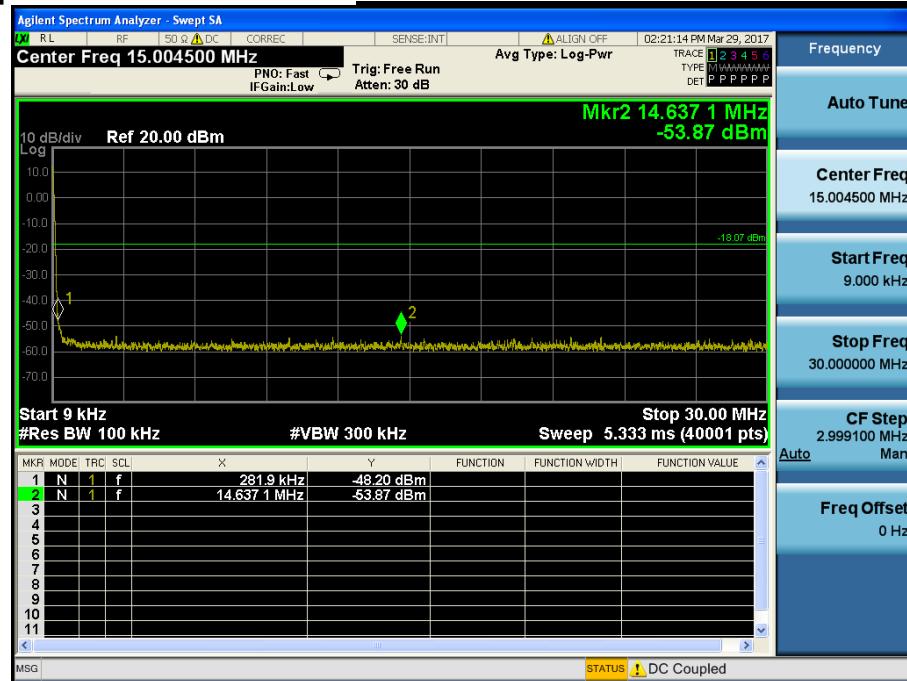


Low Band-edge

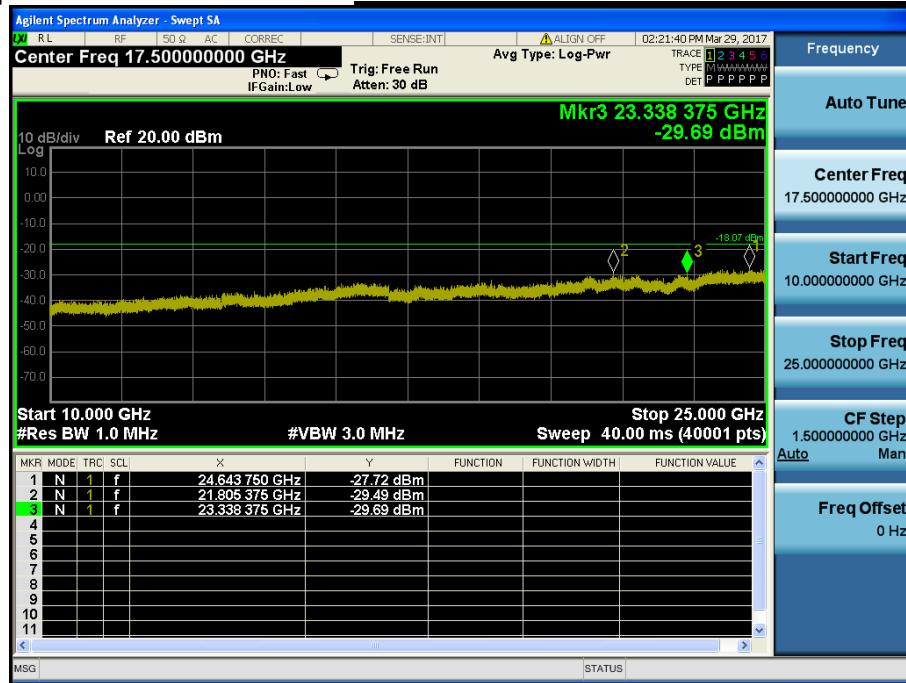
Hopping mode & Modulation : $\pi/4$ DQPSK



Conducted Spurious Emissions

Lowest Channel & Modulation : $\pi/4$ DQPSK


Conducted Spurious Emissions

Lowest Channel & Modulation : $\pi/4$ DQPSK


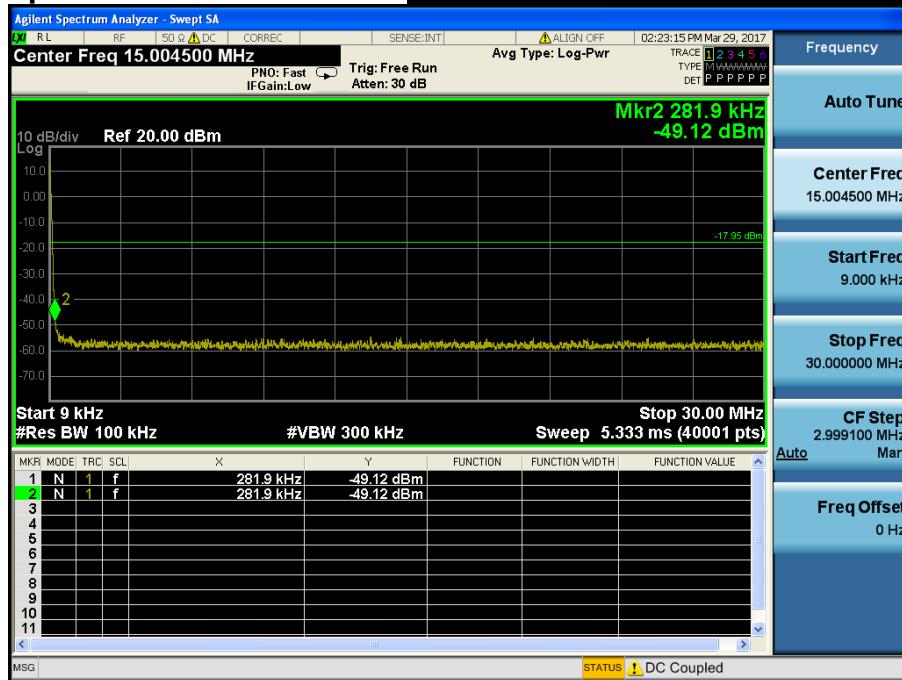
Reference for limit

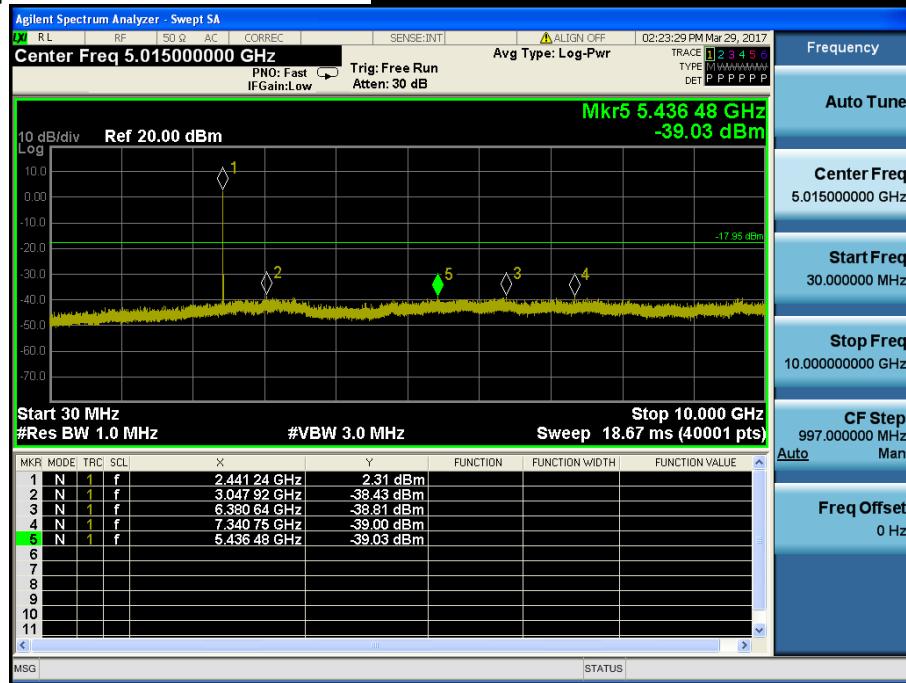
Middle Channel & Modulation : $\pi/4$ DQPSK



Conducted Spurious Emissions

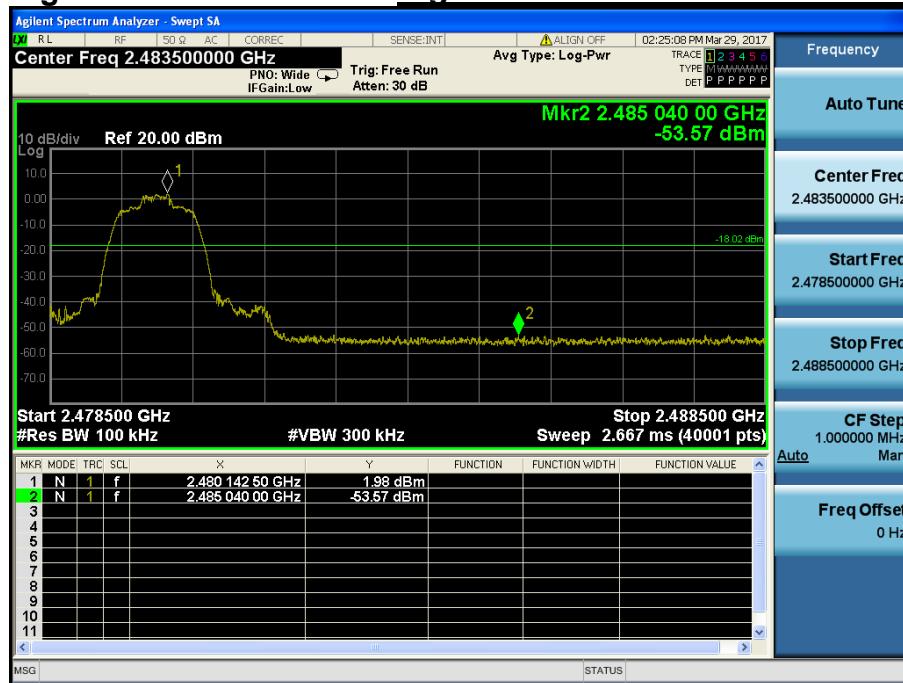
Middle Channel & Modulation : $\pi/4$ DQPSK



Conducted Spurious Emissions
Middle Channel & Modulation : π/4DQPSK


High Band-edge

Highest Channel & Modulation : $\pi/4$ DQPSK

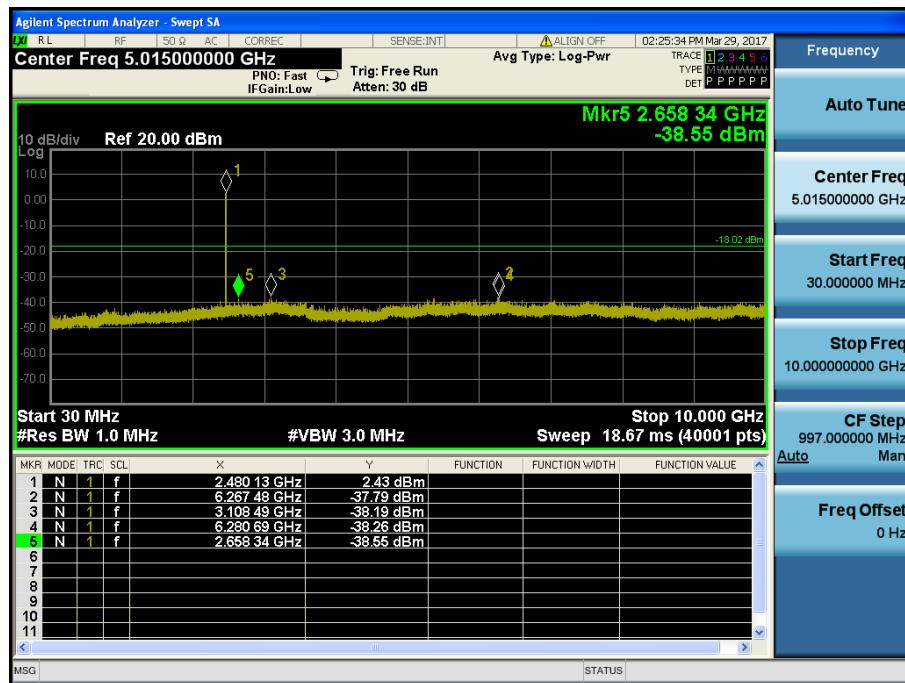
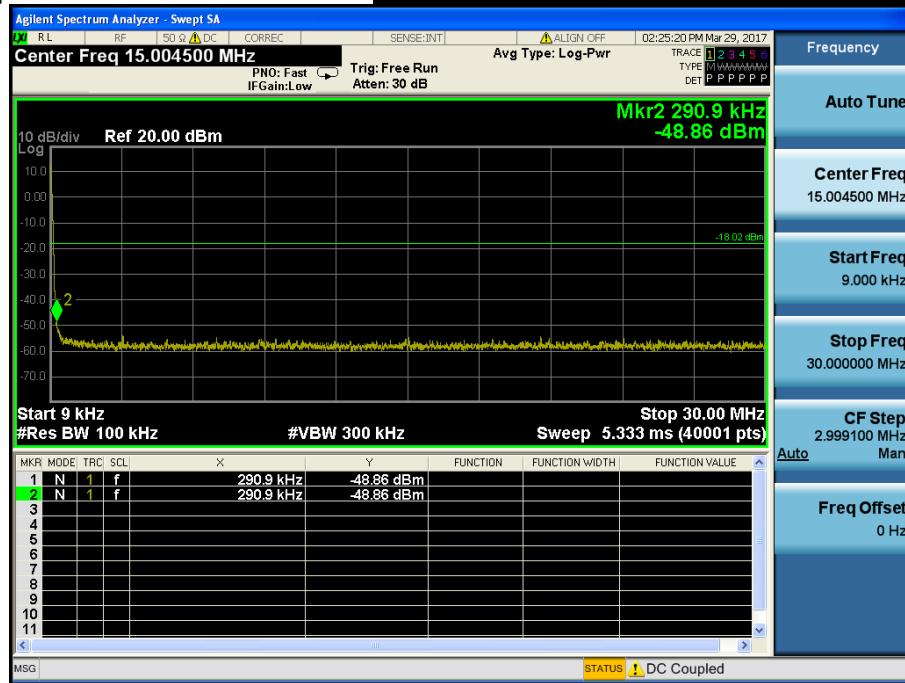


High Band-edge

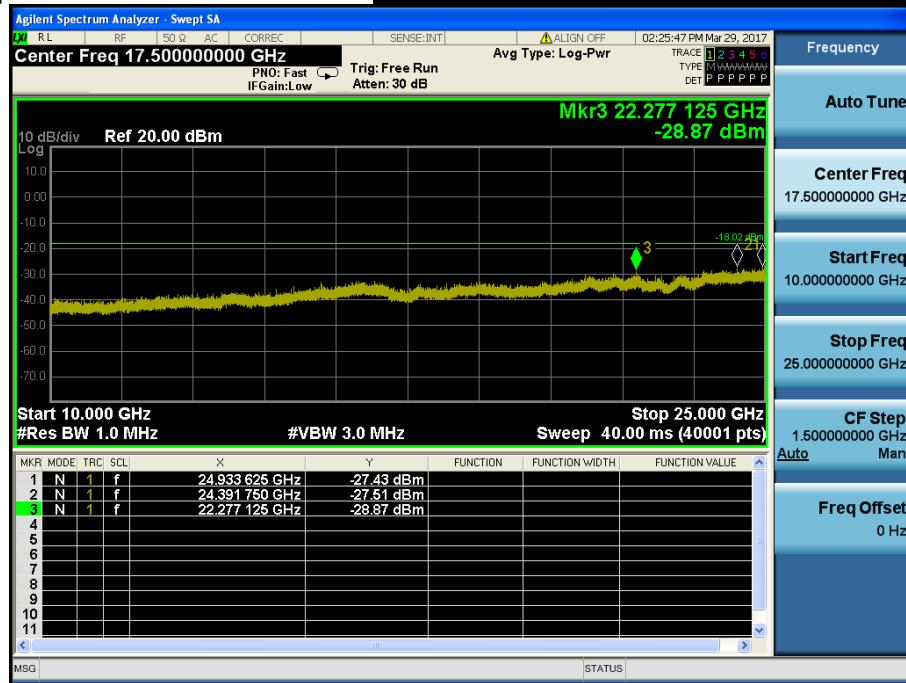
Hopping mode & Modulation : $\pi/4$ DQPSK

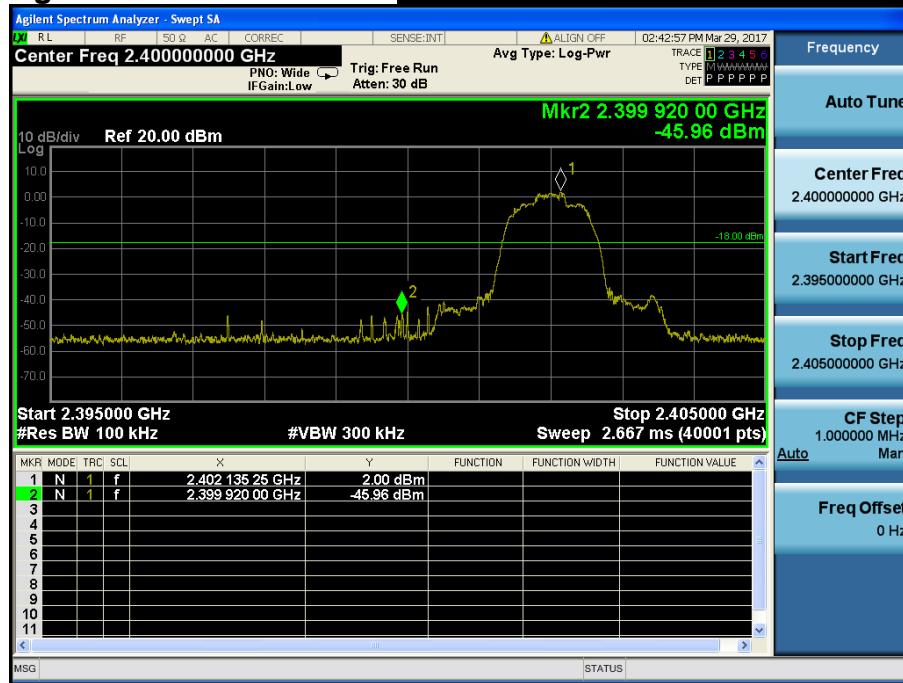
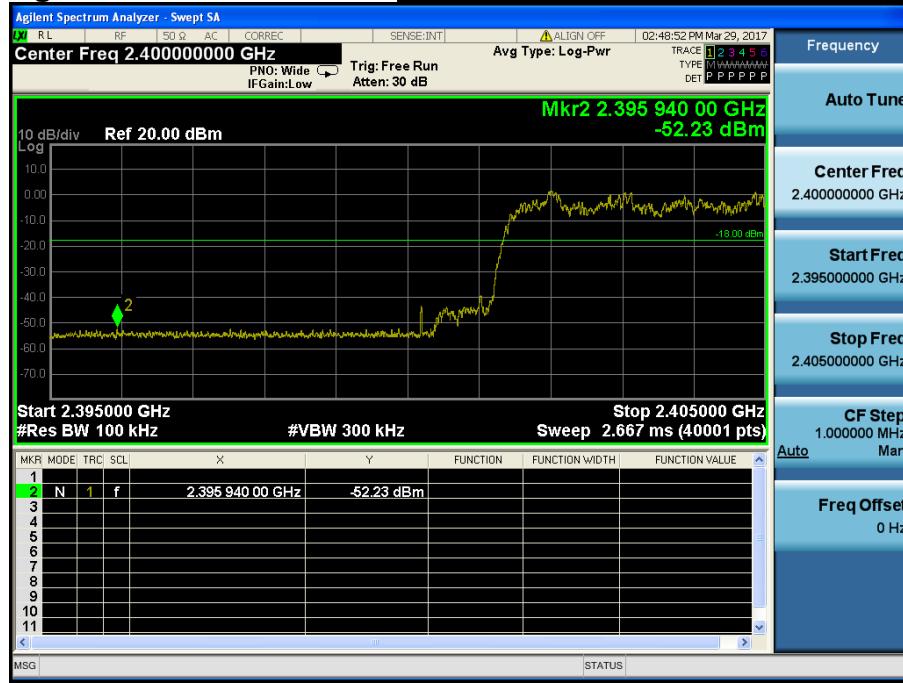


Conducted Spurious Emissions

Highest Channel & Modulation : $\pi/4$ DQPSK


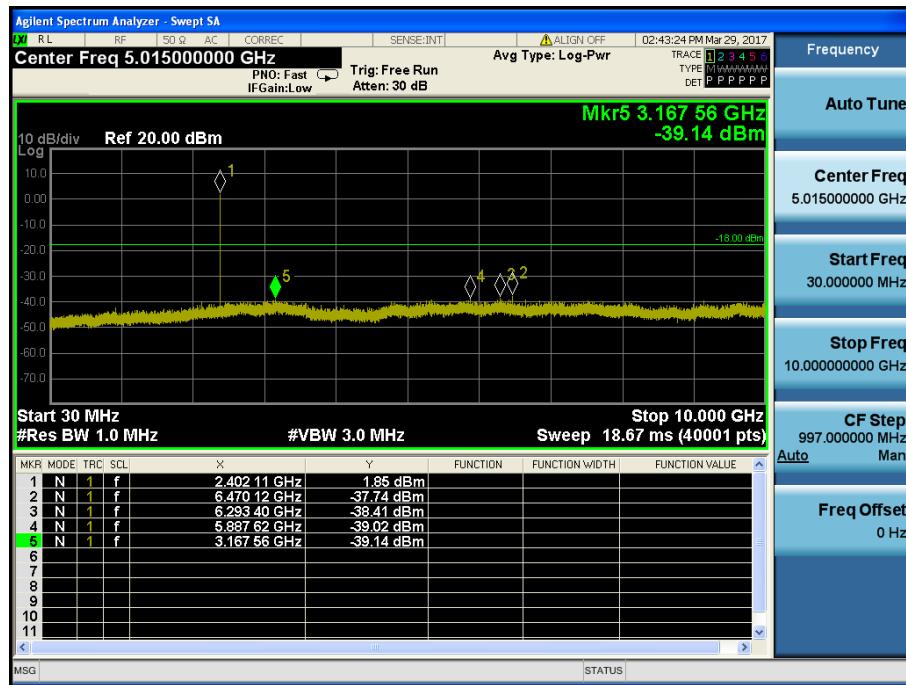
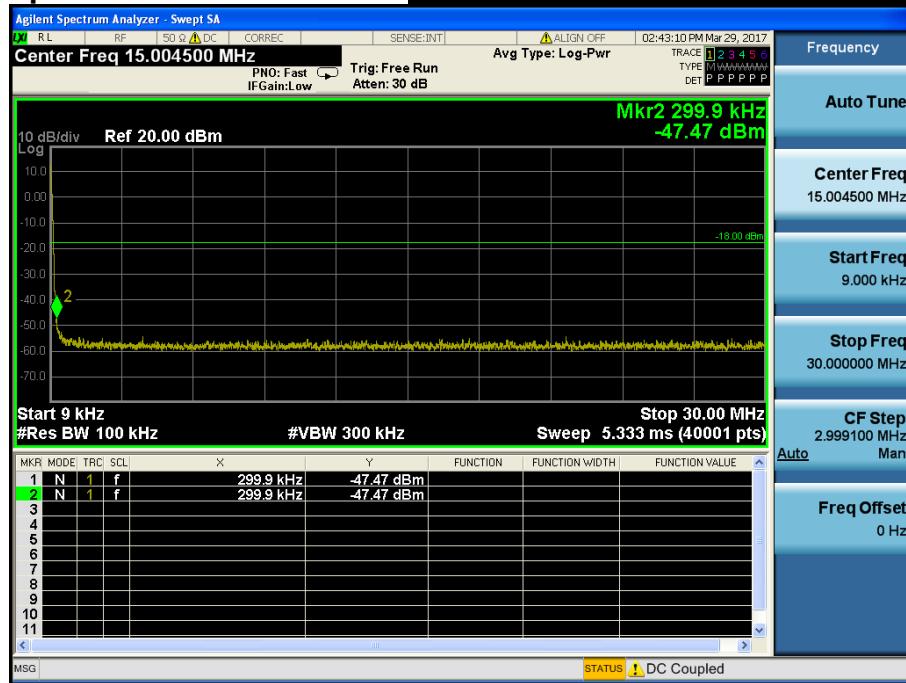
Conducted Spurious Emissions

Highest Channel & Modulation : $\pi/4$ DQPSK


Low Band-edge
Lowest Channel & Modulation : 8DPSK

Low Band-edge
Hopping mode & Modulation : 8DPSK


Conducted Spurious Emissions

Lowest Channel & Modulation : 8DPSK



Conducted Spurious Emissions

Lowest Channel & Modulation : 8DPSK

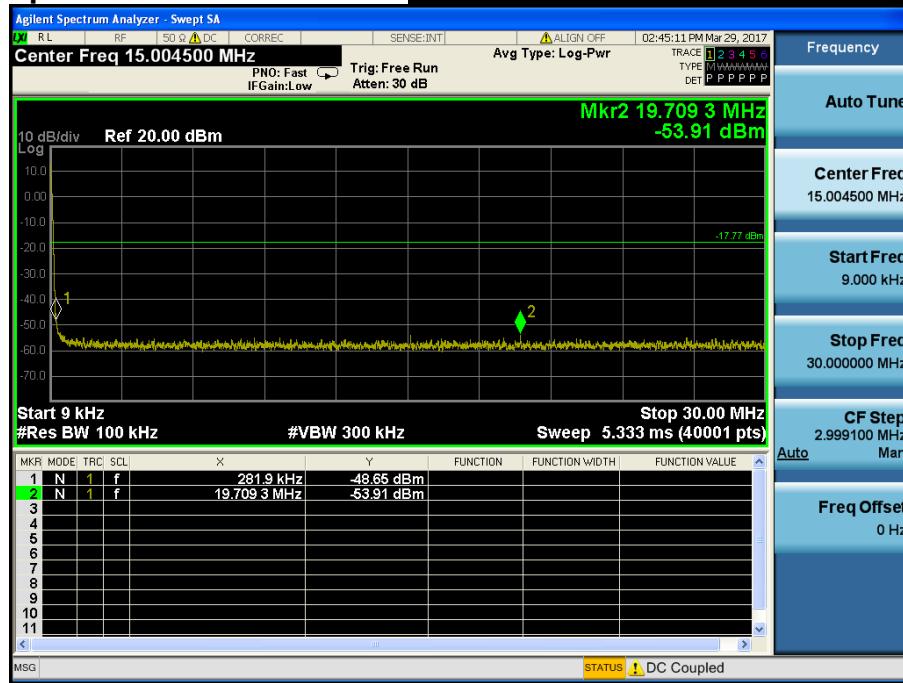

Reference for limit

Middle Channel & Modulation : 8DPSK



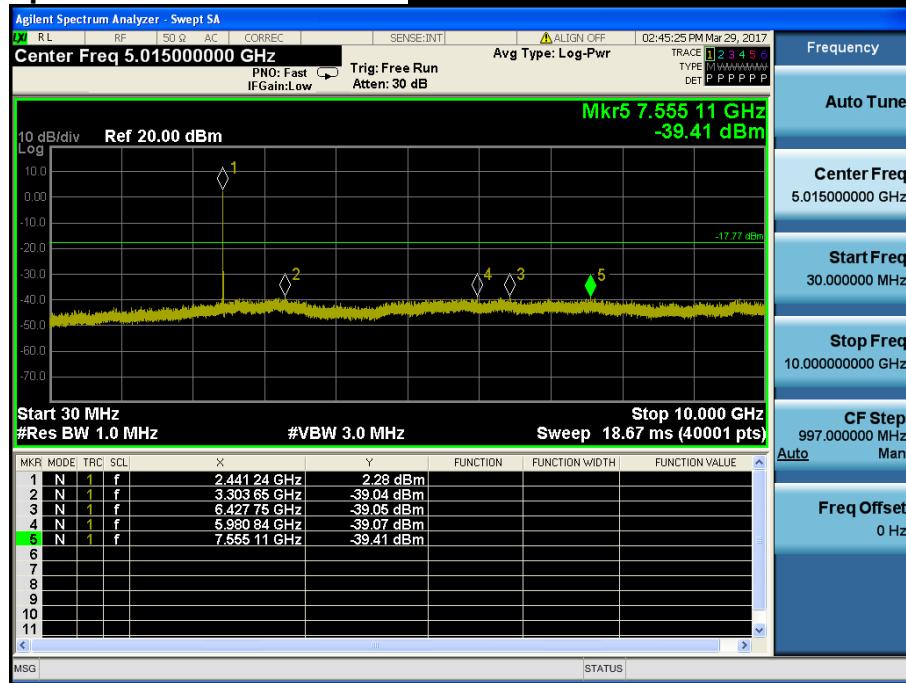
Conducted Spurious Emissions

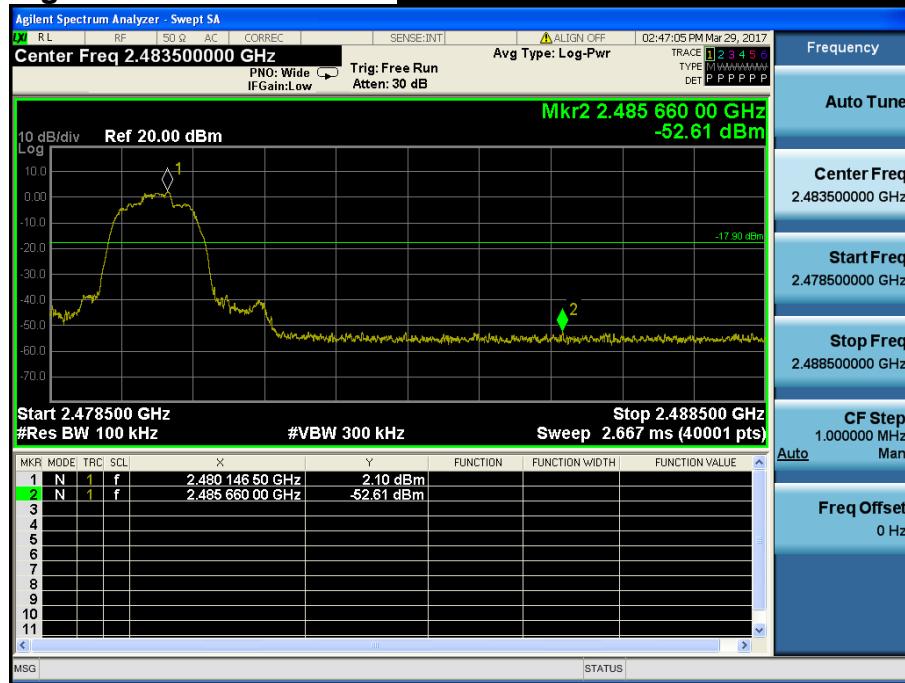
Middle Channel & Modulation : 8DPSK

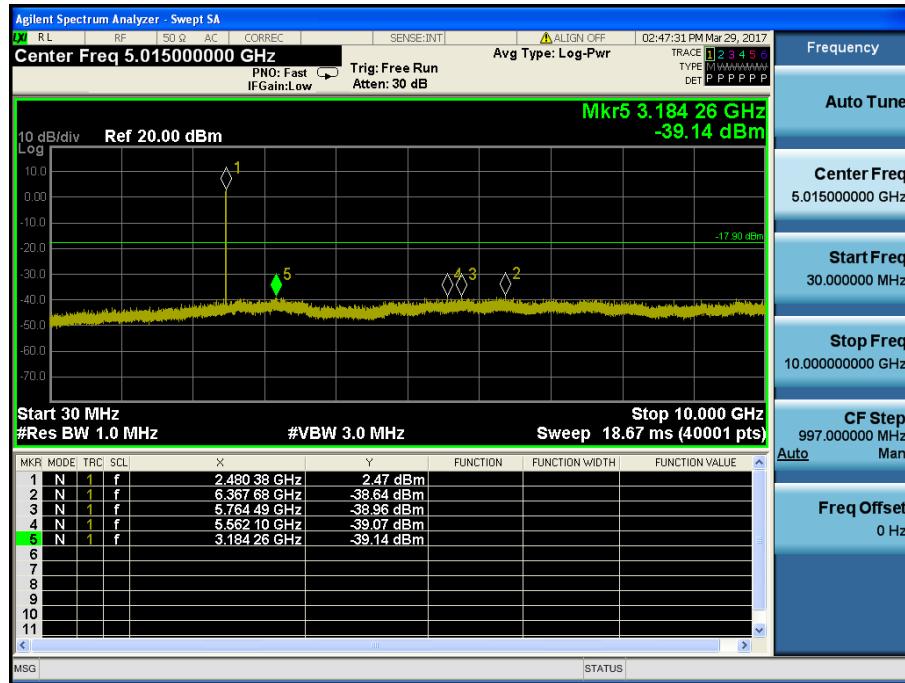
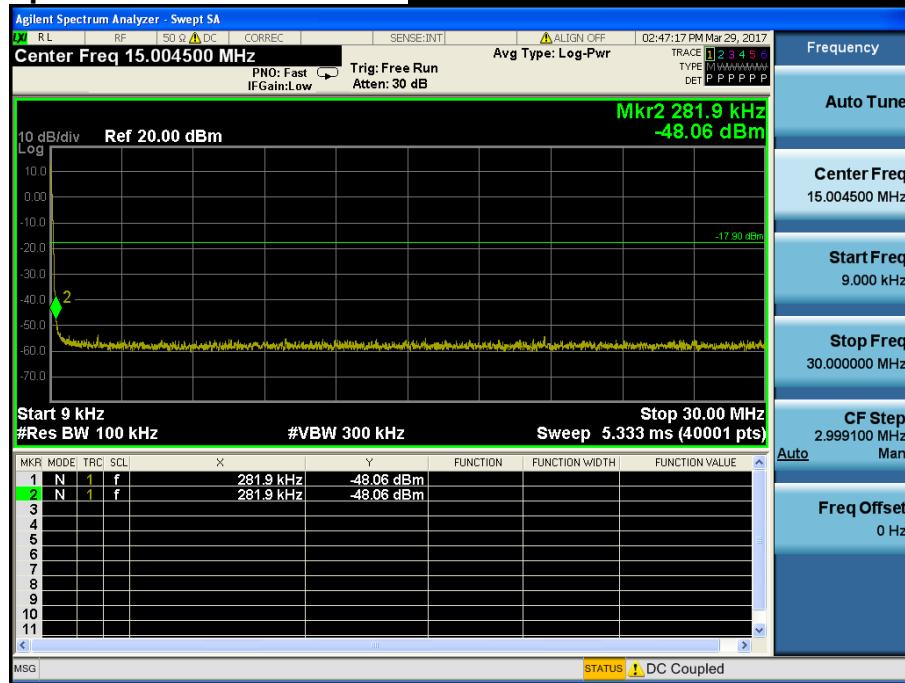


Conducted Spurious Emissions

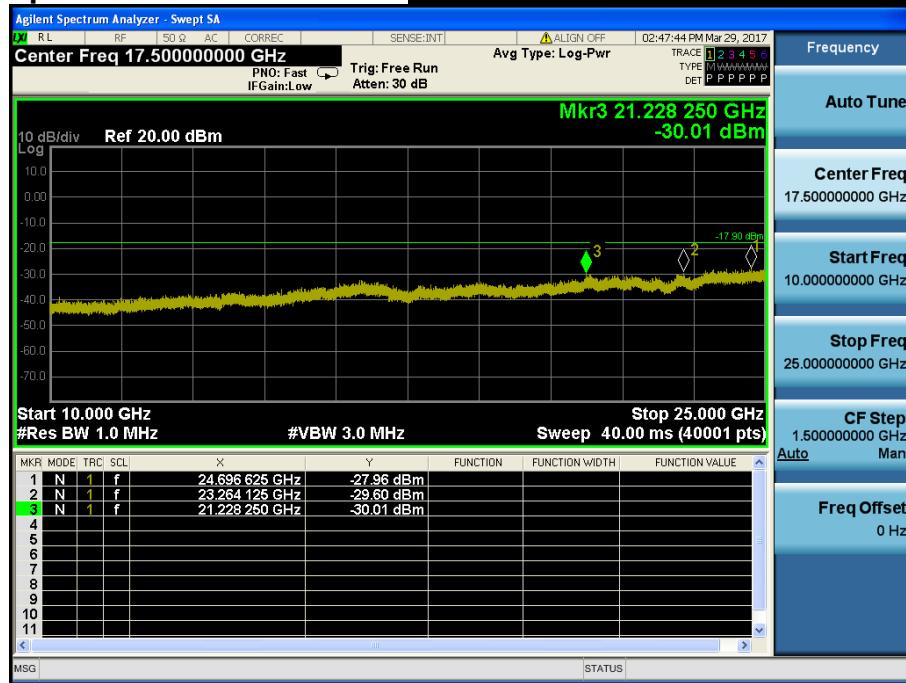
Middle Channel & Modulation : 8DPSK



High Band-edge
Highest Channel & Modulation : 8DPSK

High Band-edge
Hopping mode & Modulation : 8DPSK


Conducted Spurious Emissions
Highest Channel & Modulation : 8DPSK


Conducted Spurious Emissions

Highest Channel & Modulation : 8DPSK


8. Transmitter AC Power Line Conducted Emission

8.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

8.2 Limit

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network (LISN).

Compliance with the provision of this paragraph shall be on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

| Frequency Range (MHz) | Conducted Limit (dBuV) | |
|-----------------------|------------------------|------------|
| | Quasi-Peak | Average |
| 0.15 ~ 0.5 | 66 to 56 * | 56 to 46 * |
| 0.5 ~ 5 | 56 | 46 |
| 5 ~ 30 | 60 | 50 |

* Decreases with the logarithm of the frequency

8.3 Test Procedures

Conducted emissions from the EUT were measured according to the ANSI C63.10.

1. The test procedure is performed in a 6.5 m x 3.5 m x 3.5 m (L x W x H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) x 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

8.4 Test Results

NA

9. Antenna Requirement

Describe how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT.

Conclusion: Comply

The antenna type is a SMD antenna. The antenna is attached permanently using soldering (Refer to Internal Photo file.)

- Minimum Standard :

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 shall be considered sufficient to comply with the provisions.

10. Occupied Bandwidth (99 %)

10.1 Test Setup

Refer to the APPENDIX I.

10.2 Limit

Limit : Not Applicable

10.3 Test Procedure

The 99 % power bandwidth was measured with a calibrated spectrum analyzer.

The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately $3 \times$ RBW.

Spectrum analyzer plots are included on the following pages.

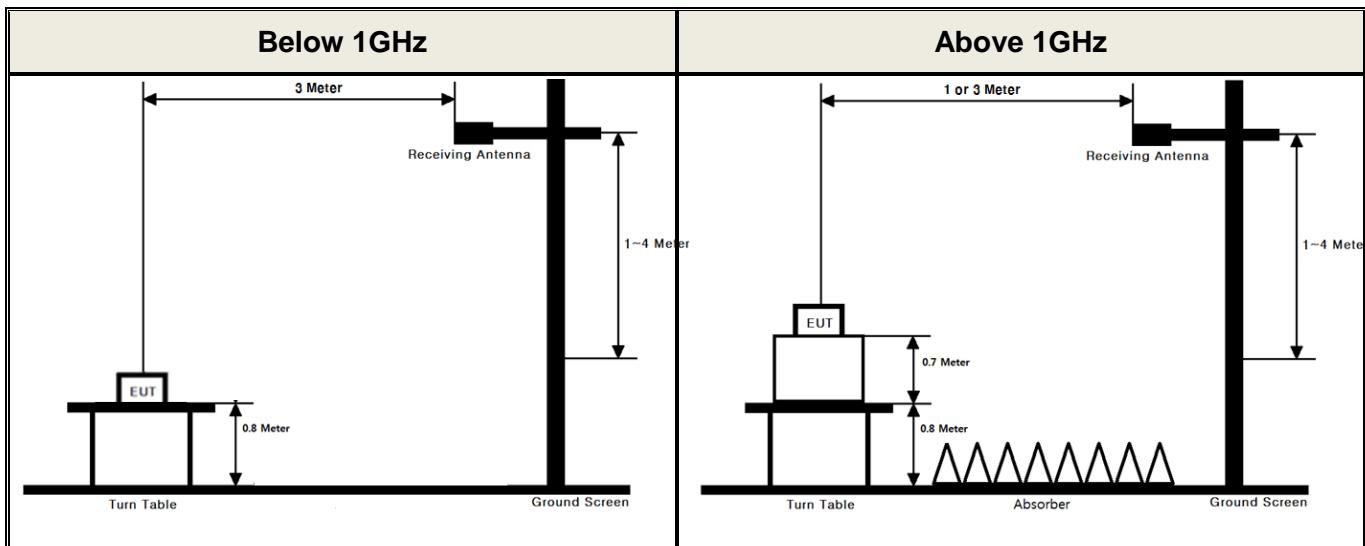
10.4 Test Results

NA

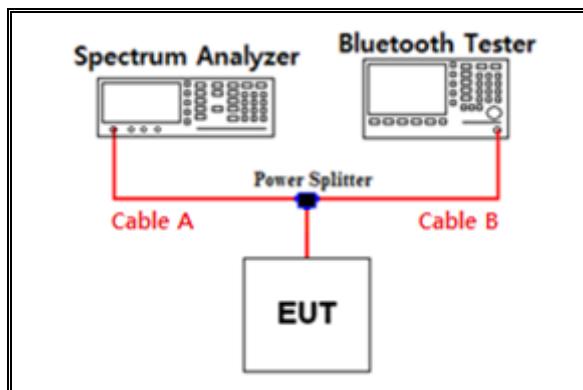
APPENDIX I

Test set up diagrams

▪ Radiated Measurement



▪ Conducted Measurement



Path loss information

| Frequency (GHz) | Path Loss (dB) | Frequency (GHz) | Path Loss (dB) |
|----------------------|----------------|-----------------|----------------|
| 0.03 | 6.69 | 15 | 10.40 |
| 1 | 6.97 | 20 | 11.17 |
| 2.402 & 2.441 & 2480 | 7.60 | 25 | 13.39 |
| 5 | 8.33 | - | - |
| 10 | 9.49 | - | - |

Note 1 : The path loss from EUT to Spectrum analyzer were measured and used for test.

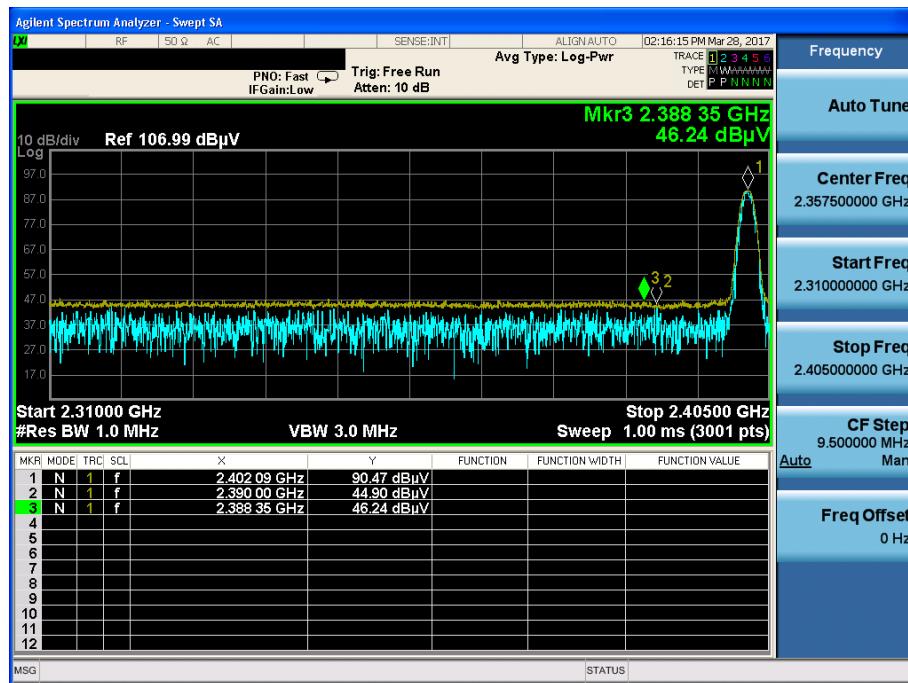
Path loss (S/A's Correction factor) = Cable A + Power splitter

APPENDIX II

Unwanted Emissions (Radiated) Test Plot

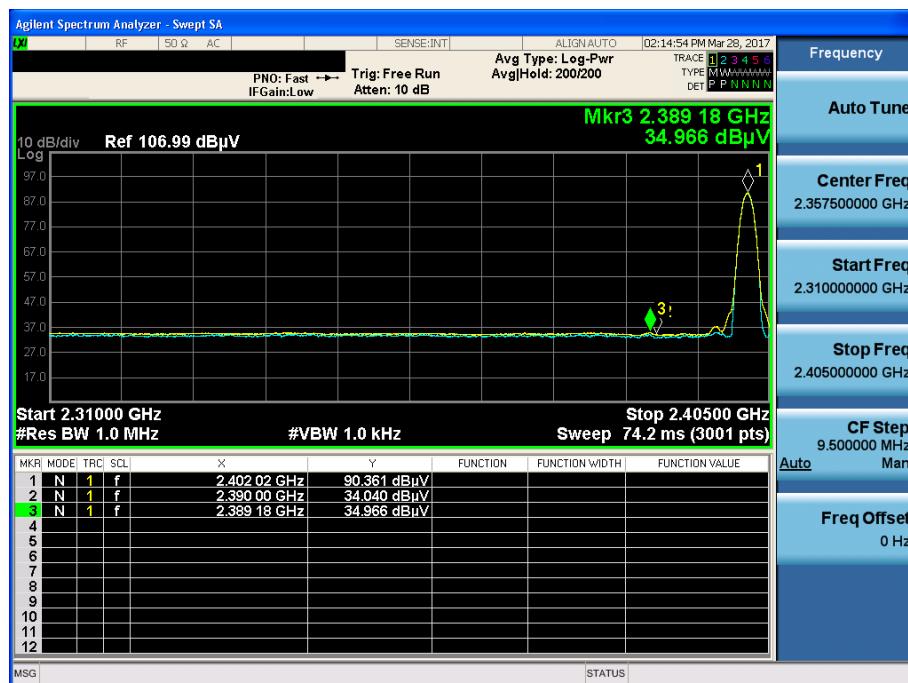
GFSK & Lowest & X & Hor

Detector Mode : PK



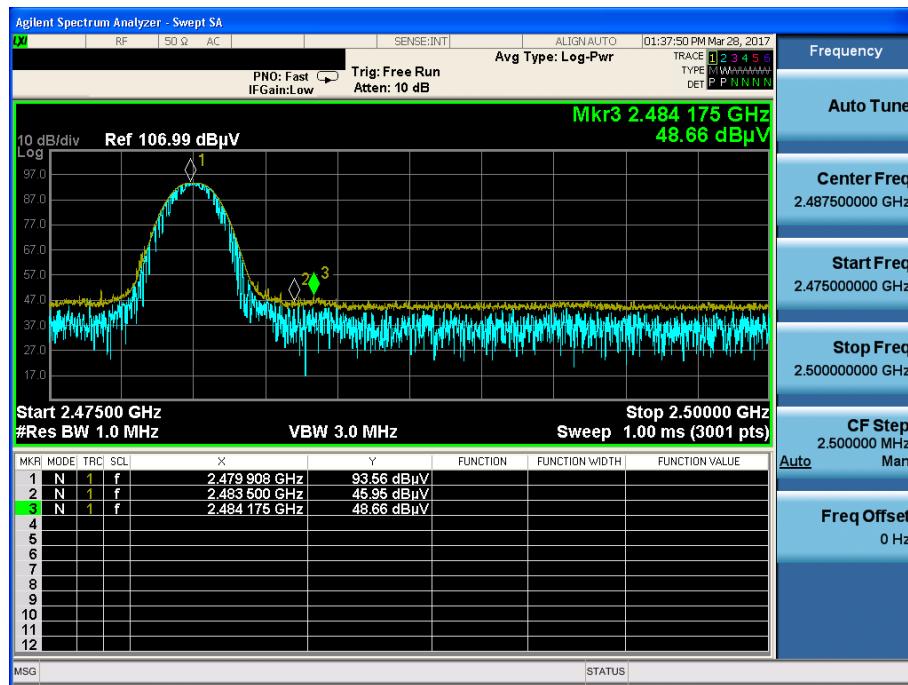
GFSK & Lowest & X & Hor

Detector Mode : AV



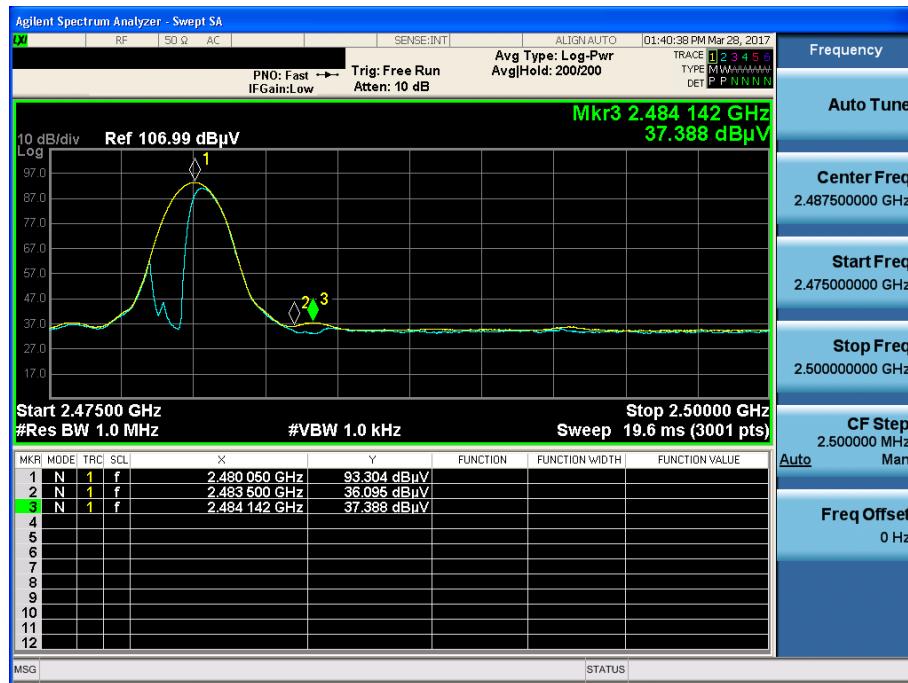
GFSK & Highest & X & Hor

Detector Mode : PK



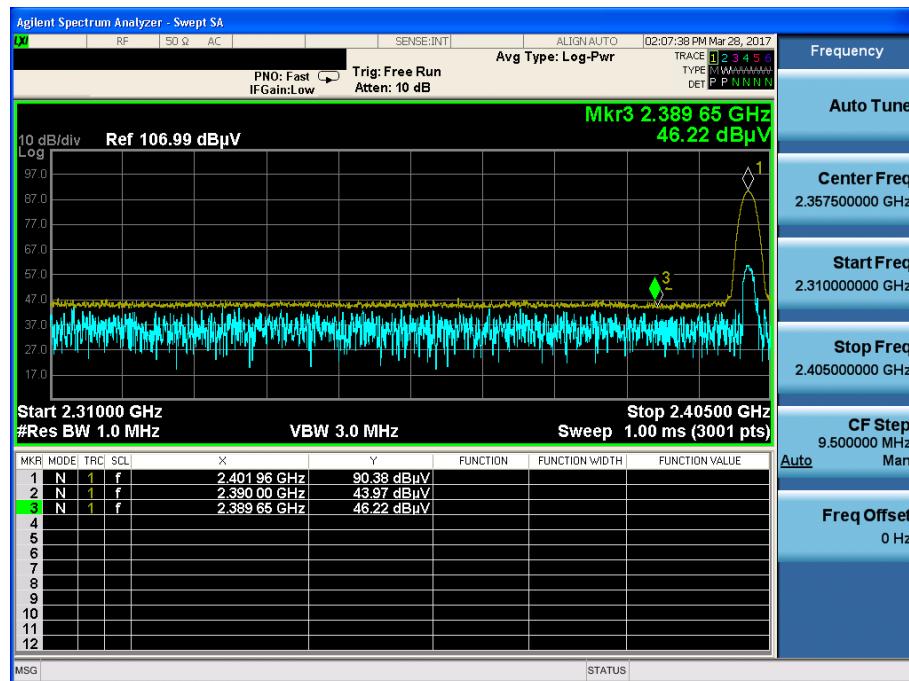
GFSK & Highest & X & Hor

Detector Mode : AV



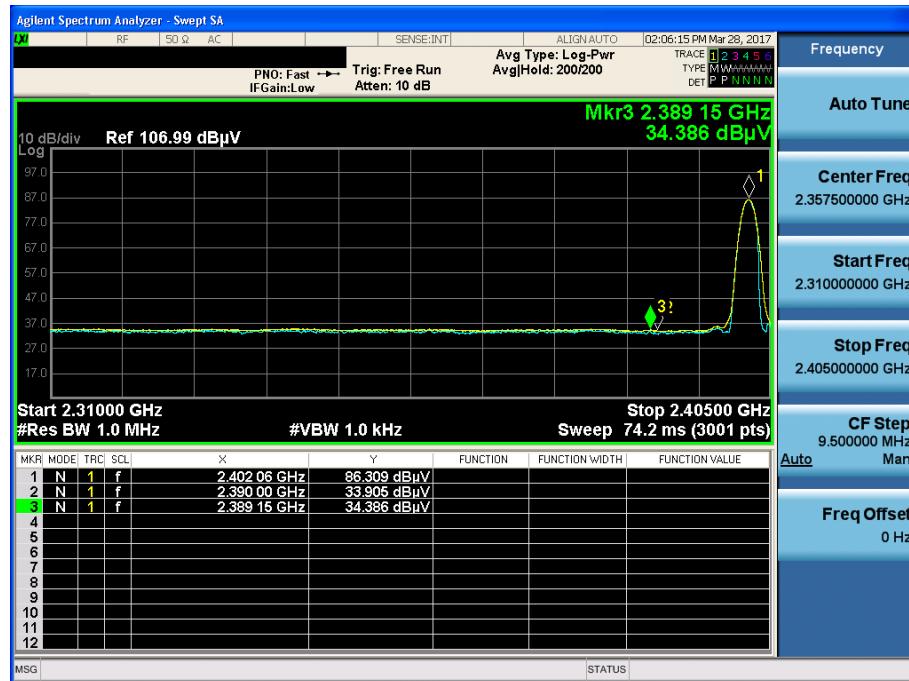
π/4DQPSK & Lowest & X & Hor

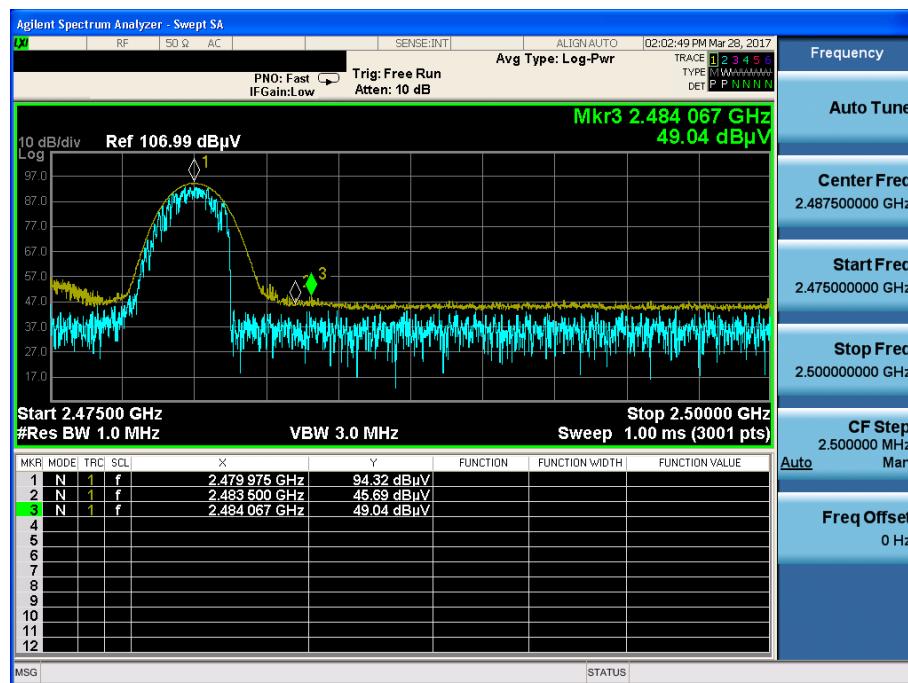
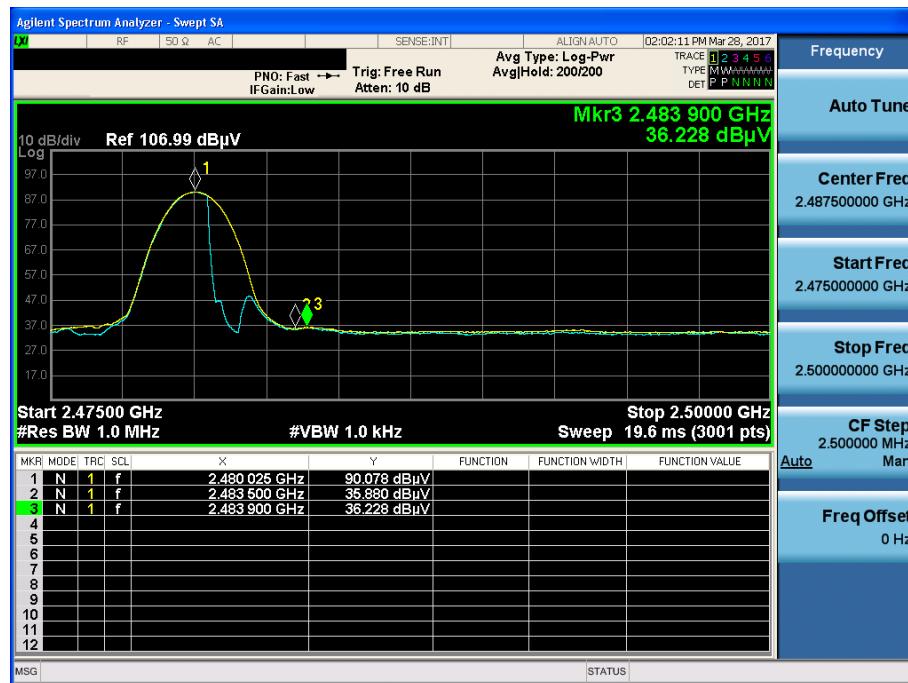
Detector Mode : PK



π/4DQPSK & Lowest & X & Hor

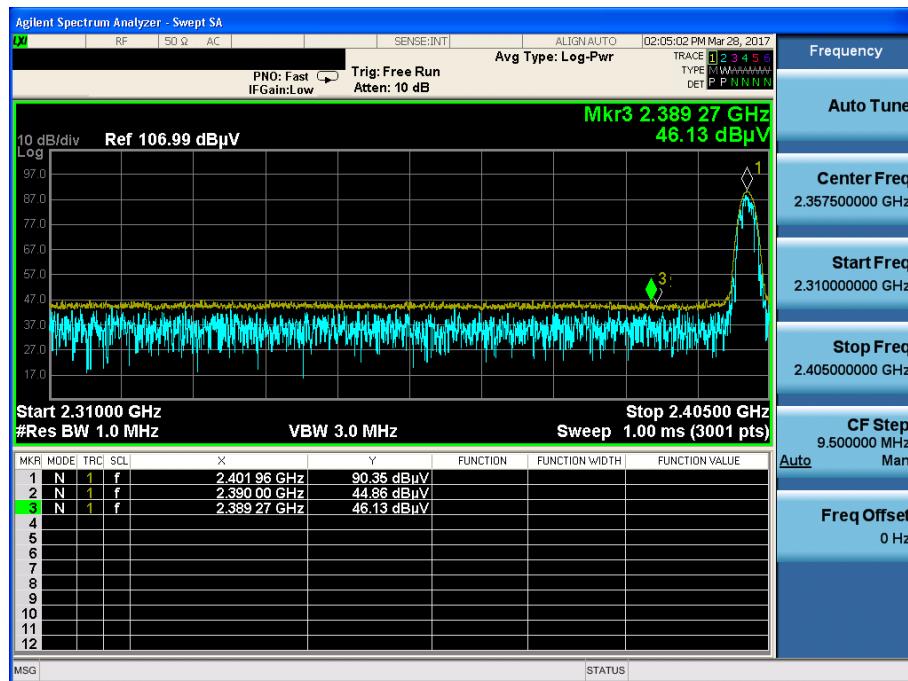
Detector Mode : AV



π/4DQPSK & Highest & X & Hor
Detector Mode : PK

π/4DQPSK & Highest & X & Hor
Detector Mode : AV


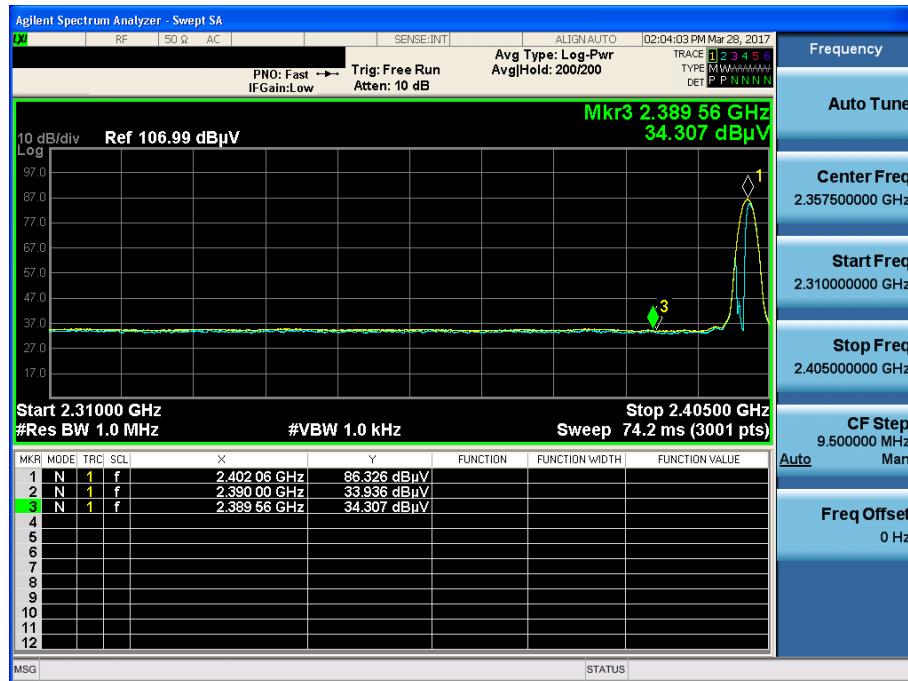
8DPSK & Lowest & X & Hor

Detector Mode : PK



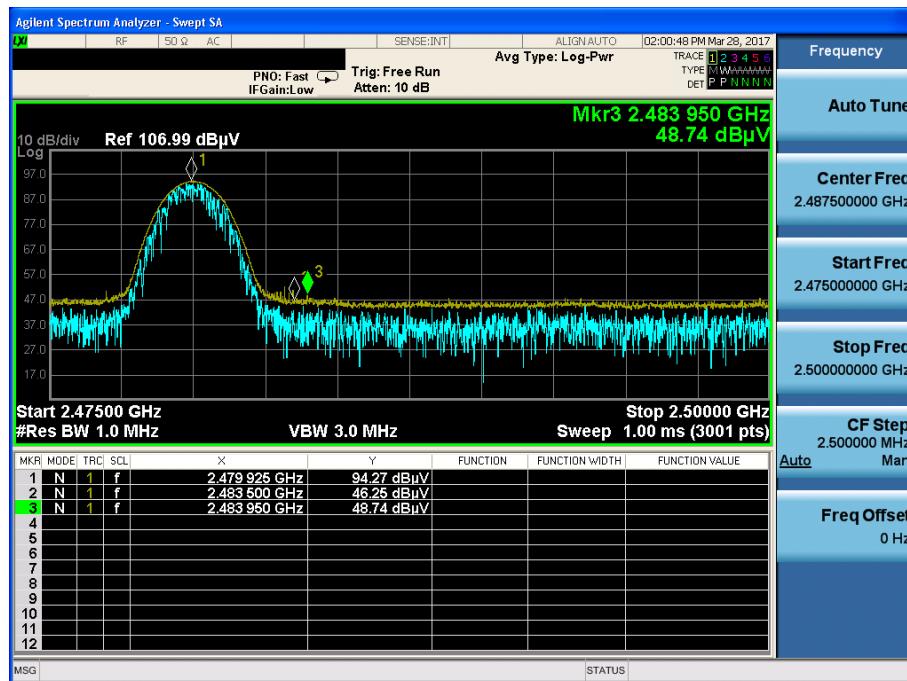
8DPSK & Lowest & X & Hor

Detector Mode : AV



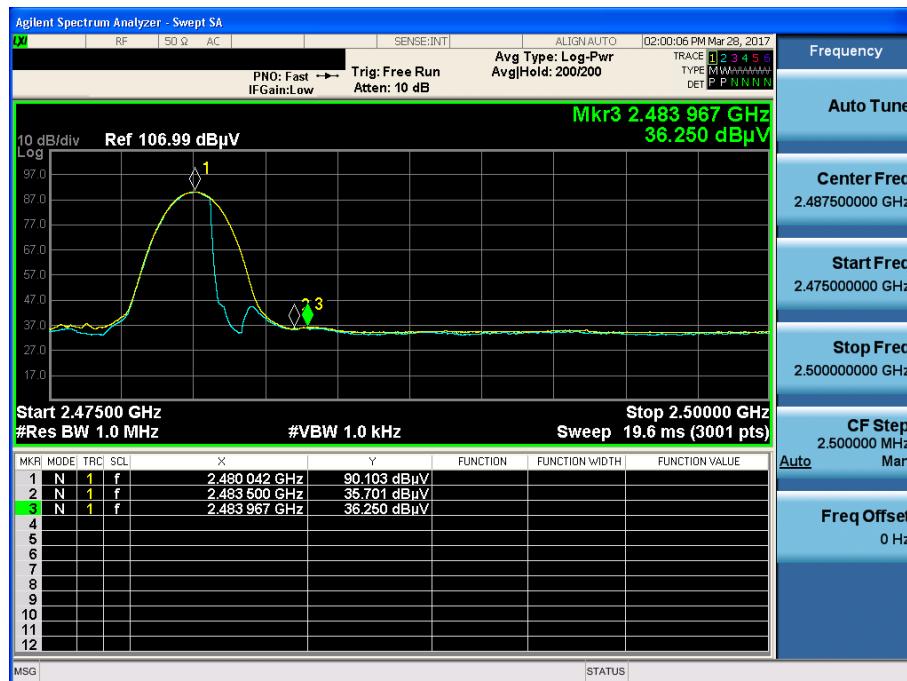
8DPSK & Highest & X & Hor

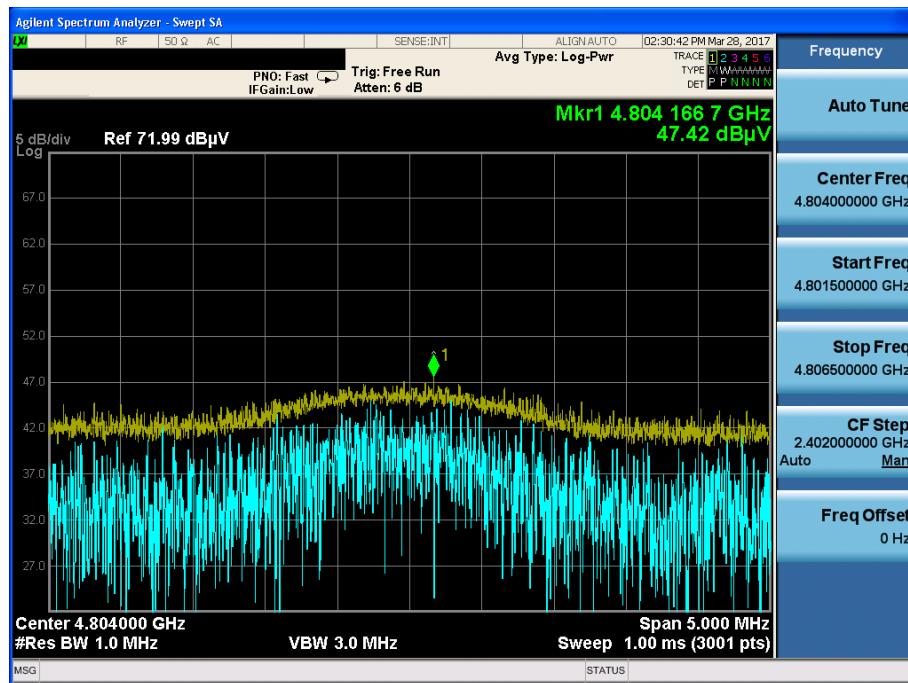
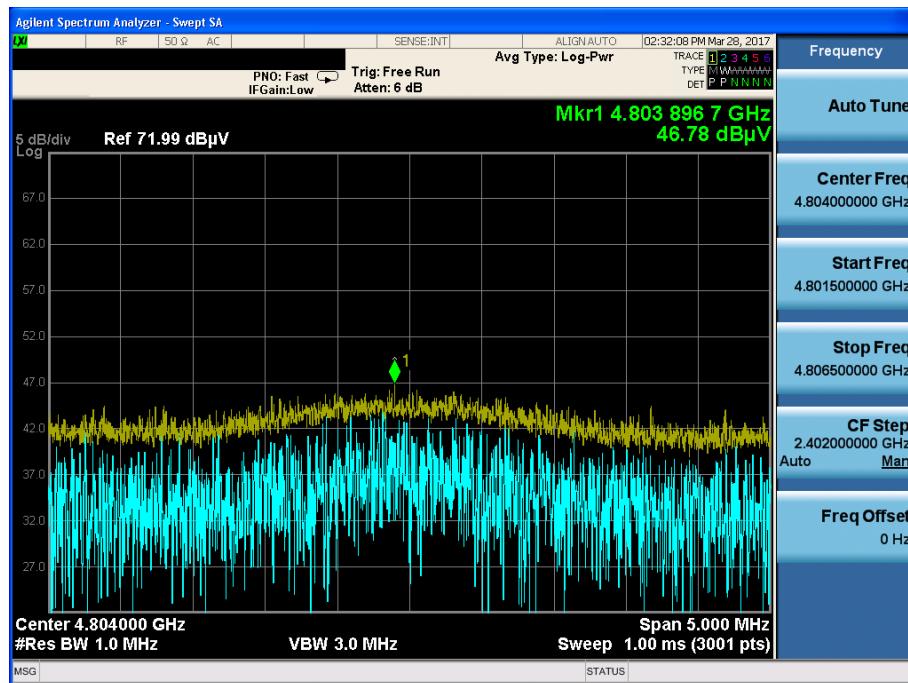
Detector Mode : PK



8DPSK & Highest & X & Hor

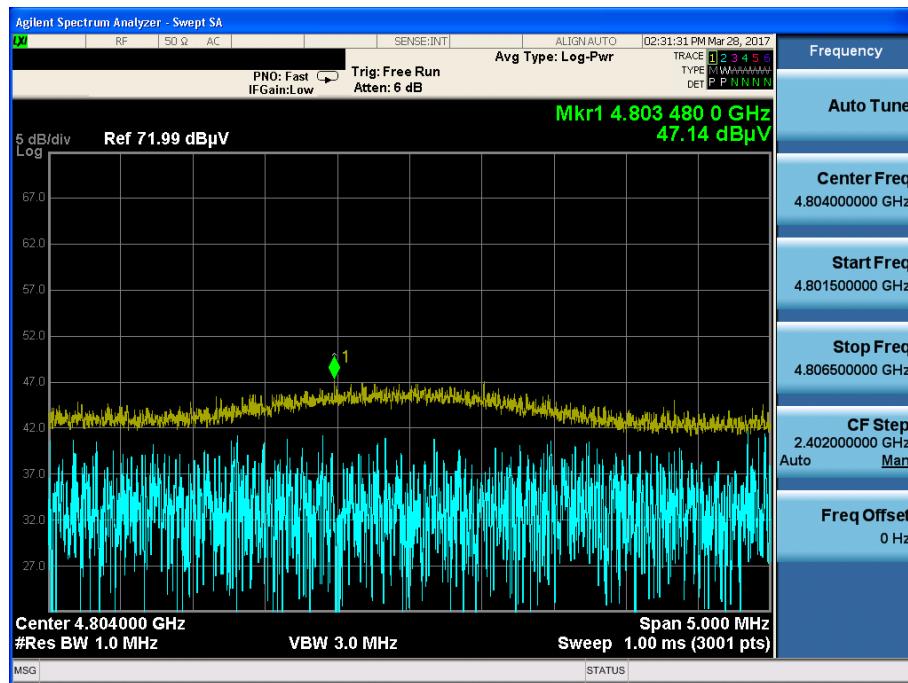
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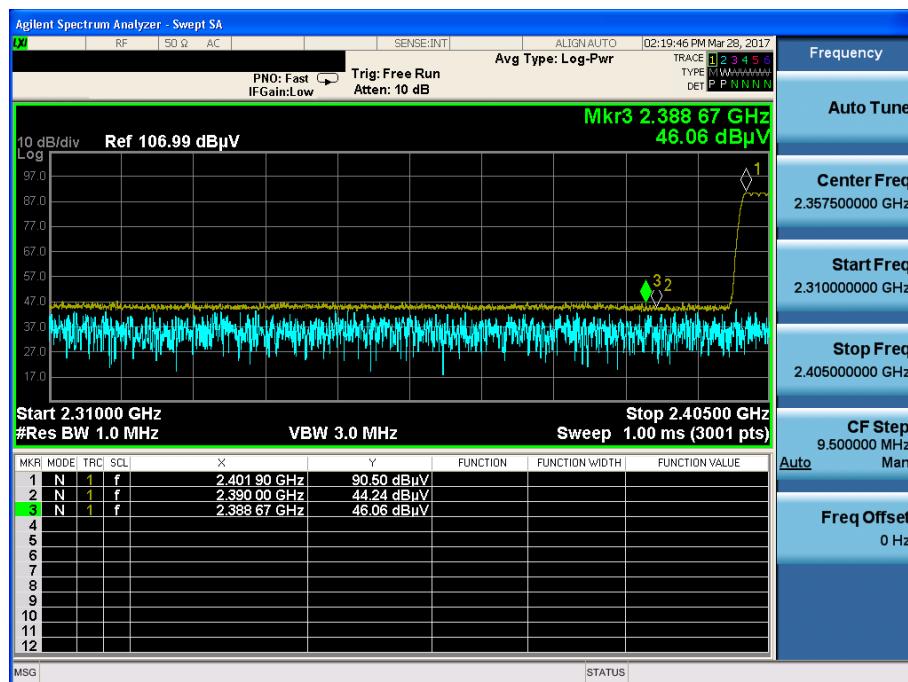
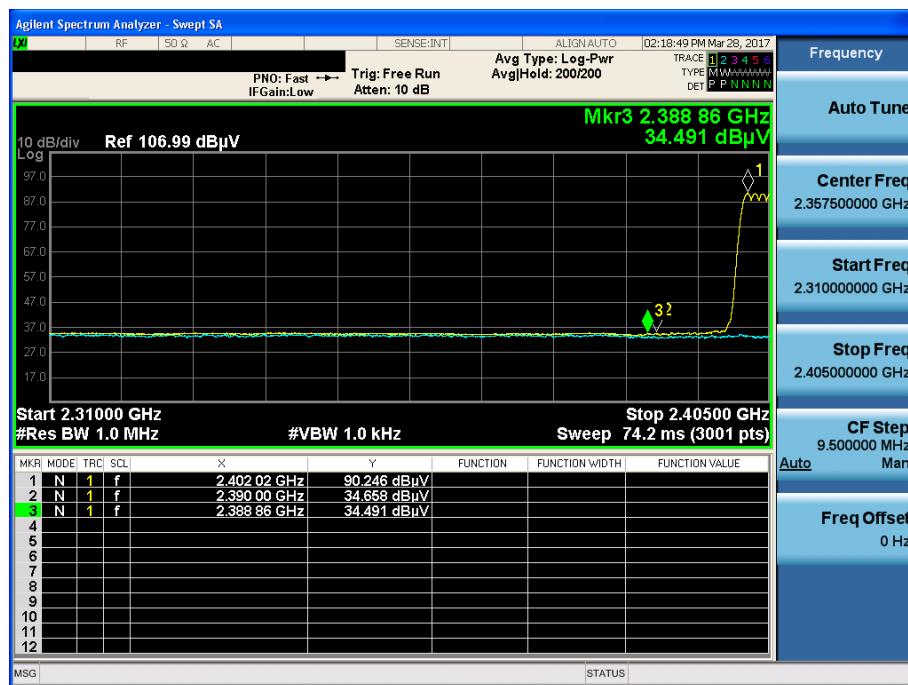


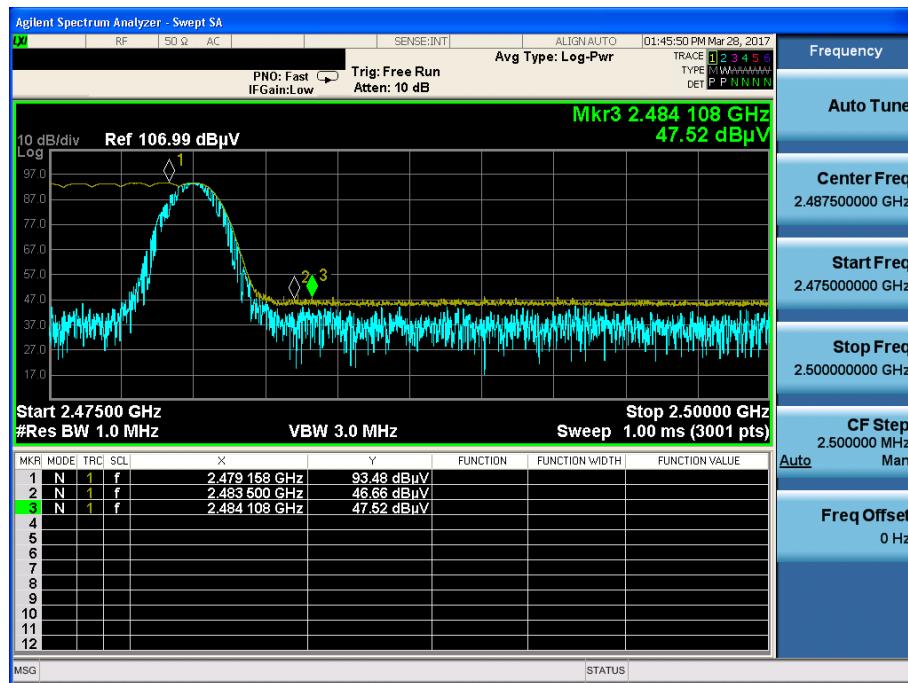
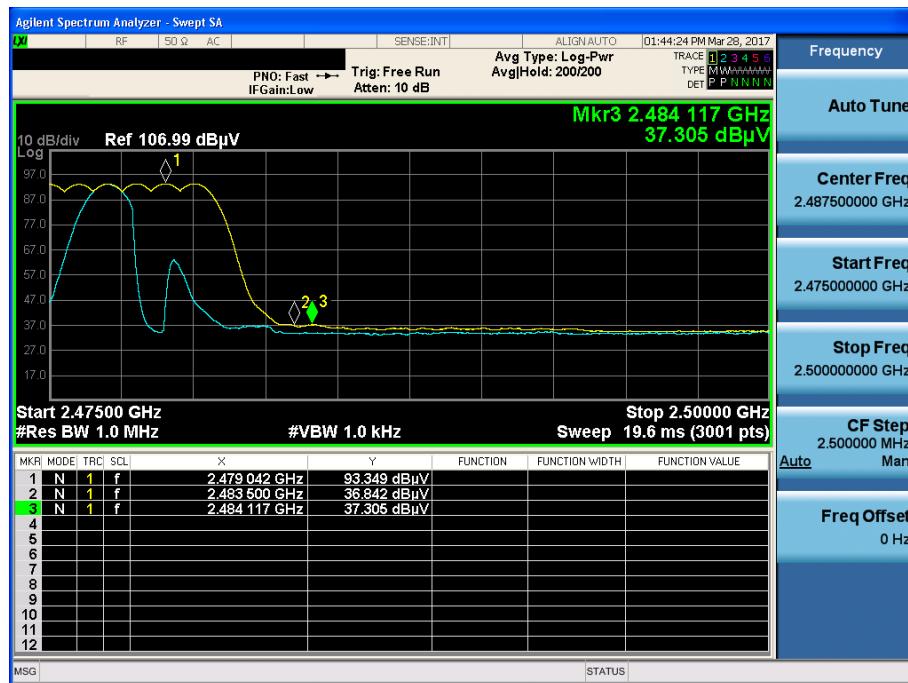
GFSK & Lowest & X & Ver
Detector Mode : PK

π/4DQPSK & Lowest & X & Ver
Detector Mode : PK


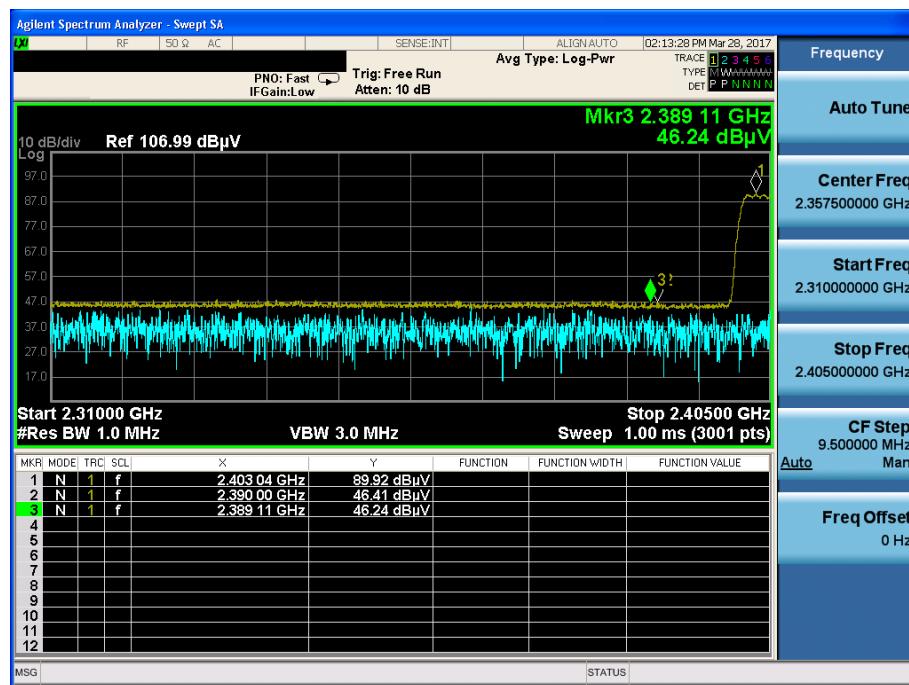
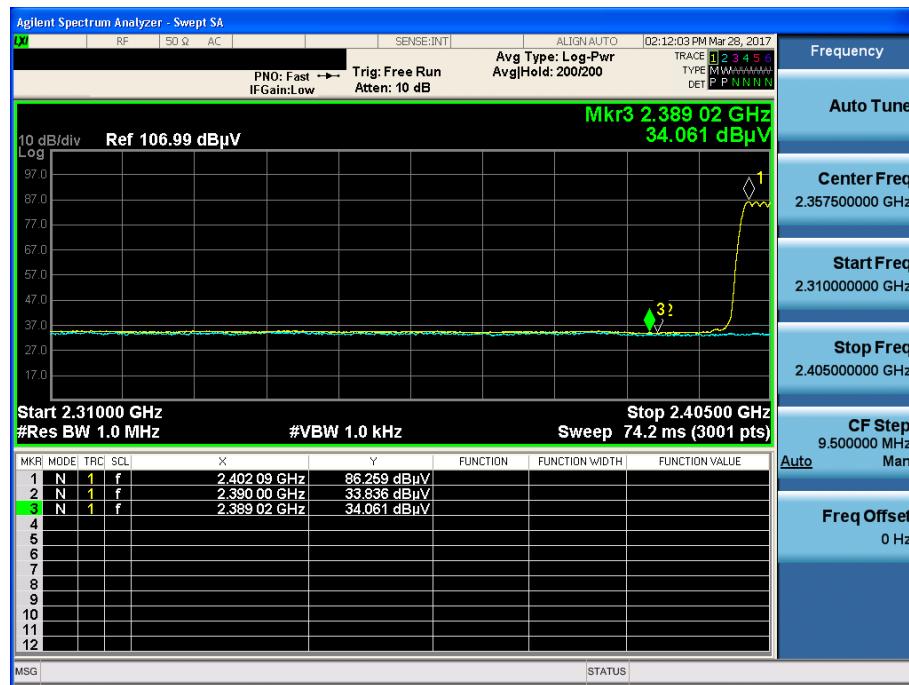
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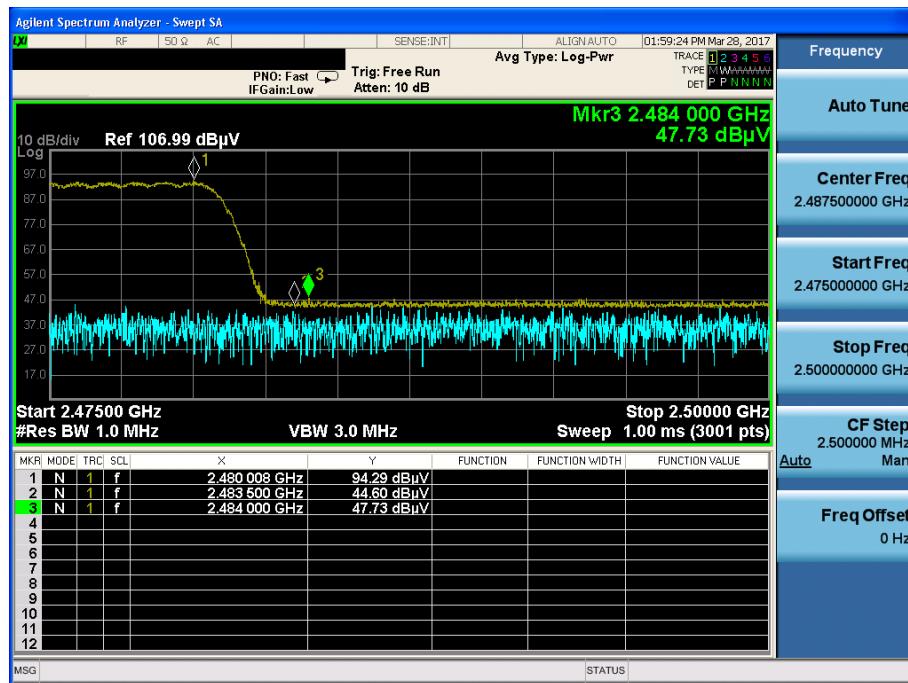
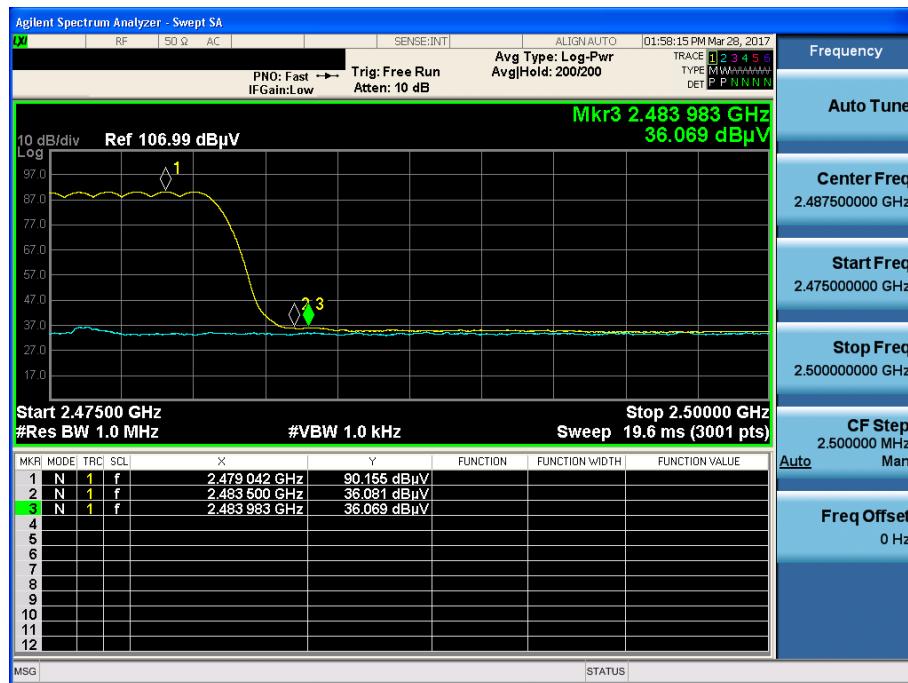
Detector Mode : PK



GFSK & Hopping mode & X & Hor
Detector Mode : PK

GFSK & Hopping mode & X & Hor
Detector Mode : AV


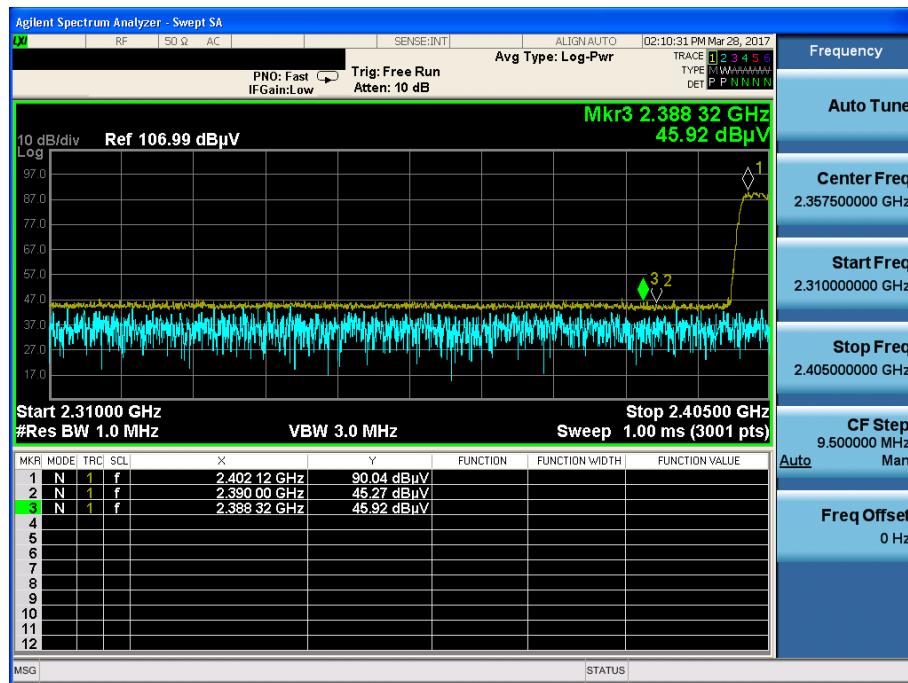
GFSK & Hopping mode & X & Hor
Detector Mode : PK

GFSK & Hopping mode & X & Hor
Detector Mode : AV


π/4DQPSK & Hopping mode & X & Hor
Detector Mode : PK

π/4DQPSK & Hopping mode & X & Hor
Detector Mode : AV


π/4DQPSK & Hopping mode & X & Hor
Detector Mode : PK

π/4DQPSK & Hopping mode & X & Hor
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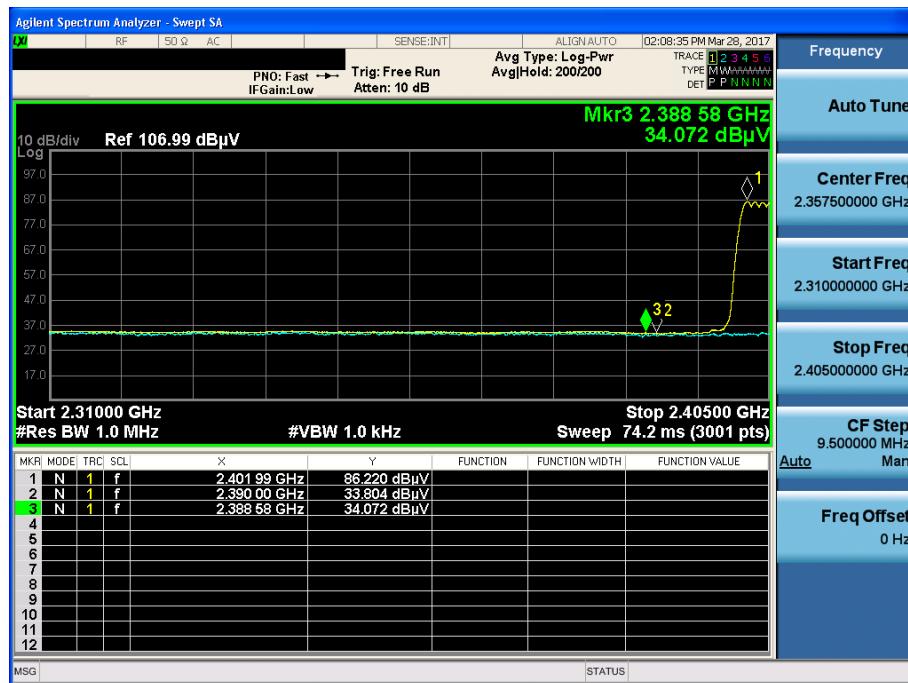
8DPSK & Hopping mode & X & Hor

Detector Mode : PK



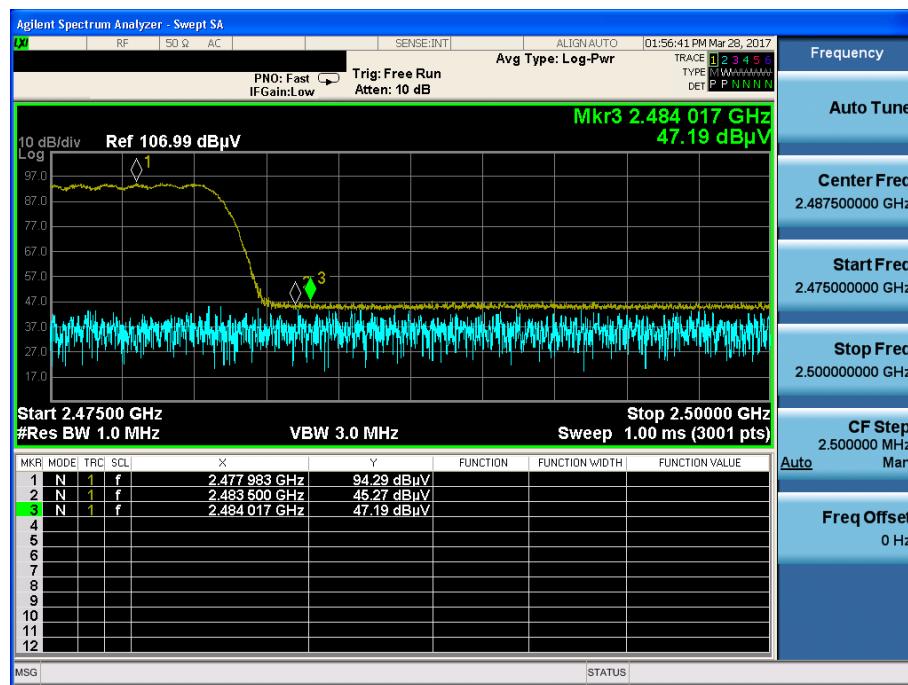
8DPSK & Hopping mode & X & Hor

Detector Mode : AV



8DPSK & Hopping mode & X & Hor

Detector Mode : PK



8DPSK & Hopping mode & X & Hor

Detector Mode : AV

