

1 GHz ~ 25 GHz Data (Modulation : 8DPSK)

▪ Lowest Channel

Frequency (MHz)	ANT Pol	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)
2384.98	V	Y	PK	45.45	1.69	N/A	N/A	47.14	74.00	26.86
2384.89	V	Y	AV	37.28	1.69	-24.79	N/A	14.18	54.00	39.82
3843.18	H	X	PK	45.52	3.96	N/A	N/A	49.48	74.00	24.52
3843.07	H	X	AV	36.89	3.96	-24.79	N/A	16.06	54.00	37.94
4803.25	V	Y	PK	45.88	5.45	N/A	N/A	51.33	74.00	22.67
4804.05	V	Y	AV	34.47	5.45	-24.79	N/A	15.13	54.00	38.87
7206.14	H	Y	PK	44.36	7.86	N/A	N/A	52.22	74.00	21.78
7206.20	H	Y	AV	33.64	7.86	-24.79	N/A	16.71	54.00	37.29

▪ Middle Channel

Frequency (MHz)	ANT Pol	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)
4882.78	V	Y	PK	44.71	5.64	N/A	N/A	50.35	74.00	23.65
4881.76	V	Y	AV	34.45	5.64	-24.79	N/A	15.30	54.00	38.70
7322.22	H	Y	PK	43.96	8.04	N/A	N/A	52.00	74.00	22.00
7322.76	H	Y	AV	32.70	8.04	-24.79	N/A	15.95	54.00	38.05

▪ Highest Channel

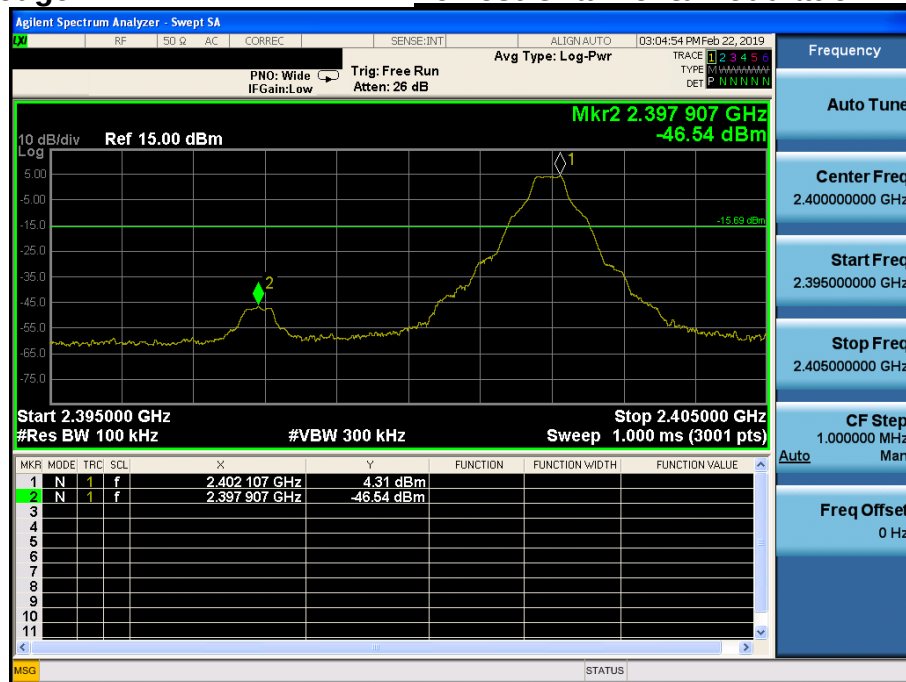
Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2487.73	V	Y	PK	53.91	1.82	N/A	N/A	55.73	74.00	18.27
2487.59	V	Y	AV	49.13	1.82	-24.79	N/A	26.16	54.00	27.84
4960.26	V	Y	PK	43.88	5.76	N/A	N/A	49.64	74.00	24.36
4959.66	V	Y	AV	33.43	5.76	-24.79	N/A	14.40	54.00	39.60
7440.25	H	Y	PK	43.81	7.87	N/A	N/A	51.68	74.00	22.32
7439.80	H	Y	AV	32.93	7.87	-24.79	N/A	16.01	54.00	37.99

▪ Note.

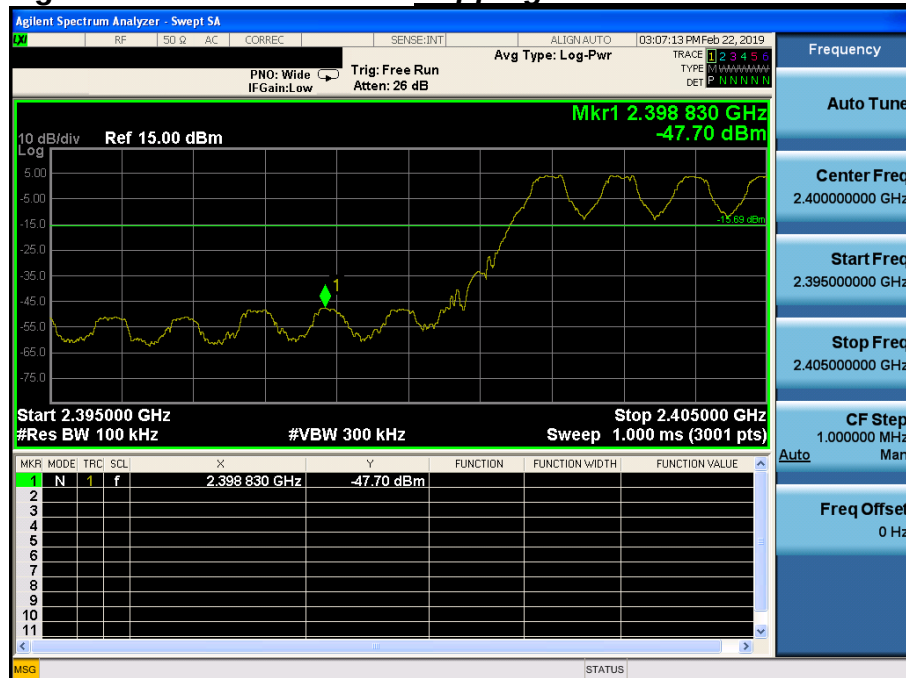
- The radiated emissions were investigated 1 GHz to 25 GHz. And no other spurious and harmonic emissions were found above listed frequencies.
- Information of Distance Factor
For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.
- Calculation of distance factor = $20 \log(\text{applied distance} / \text{required distance}) = 20 \log(1 \text{ m} / 3 \text{ m}) = \underline{\underline{-9.54 \text{ dB}}}$
When distance factor is "N/A", the distance is 3 m and distance factor is not applied.
- 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.
- D.C.F Calculation. (D.C.F = Duty Cycle Correction Factor)
Refer to the original test report for D.C.F.
- Time to cycle through all channels = $\Delta t = T [\text{ms}] \times 20$ minimum hopping channels, where T = pulse width = **2.88 ms**
- $100 \text{ ms} / \Delta t [\text{ms}] = H \rightarrow$ 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 = $20 \log(\text{The Worst Case Dwell Time} / 100 \text{ ms}) \text{ dB} = 20 \log(5.76 / 100) = \underline{\underline{-24.79 \text{ dB}}}$

7.4.2. Conducted Spurious Emissions

Low Band-edge

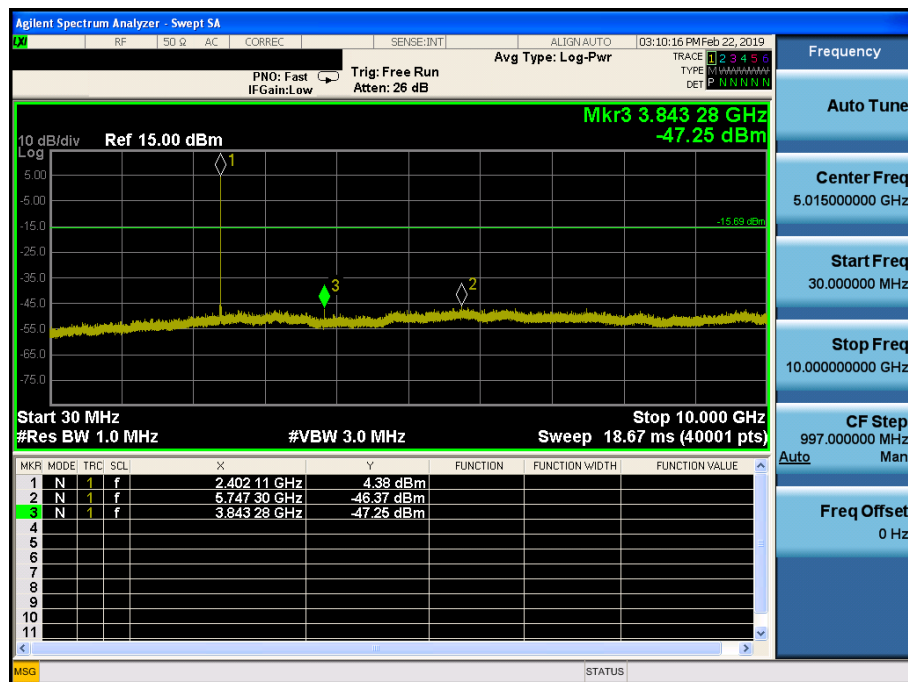
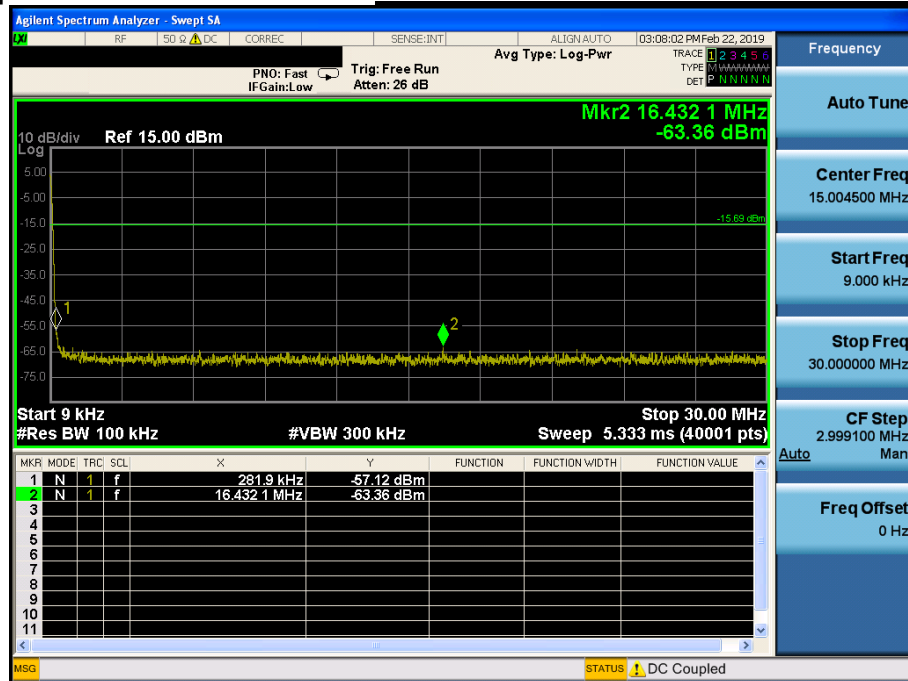
Lowest Channel & Modulation : GFSK

Low Band-edge

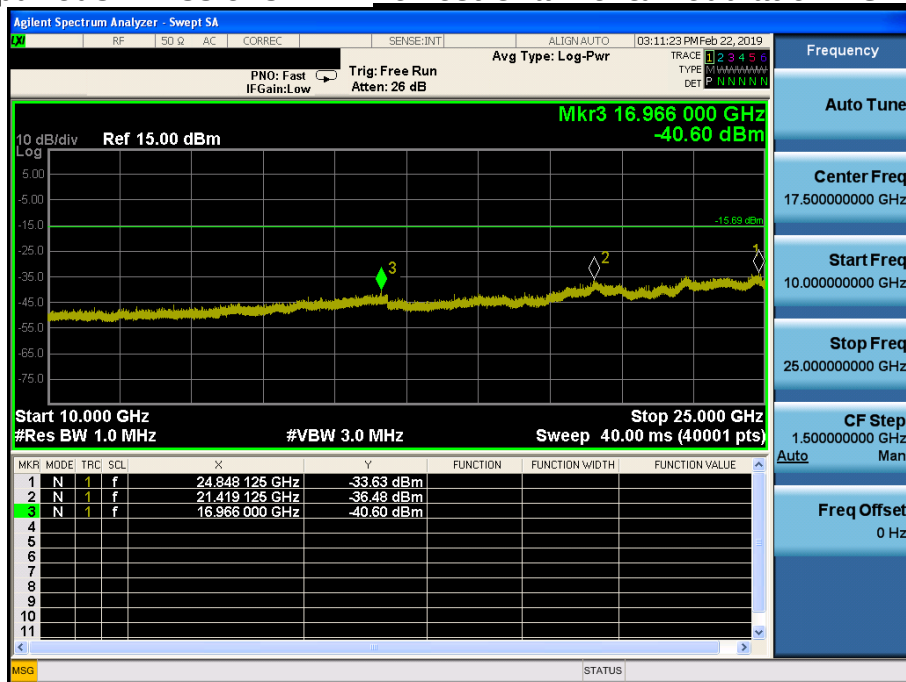
Hopping mode & Modulation : GFSK

Conducted Spurious Emissions

Lowest Channel & Modulation : GFSK



Conducted Spurious Emissions Lowest Channel & Modulation : GFSK



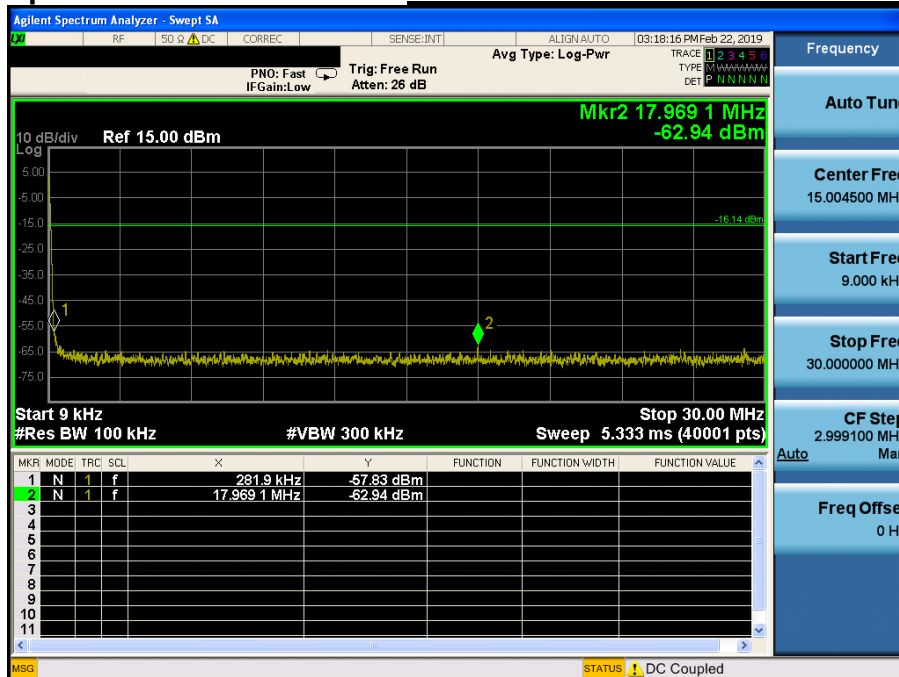
Reference for limit

Middle Channel & Modulation : GFSK



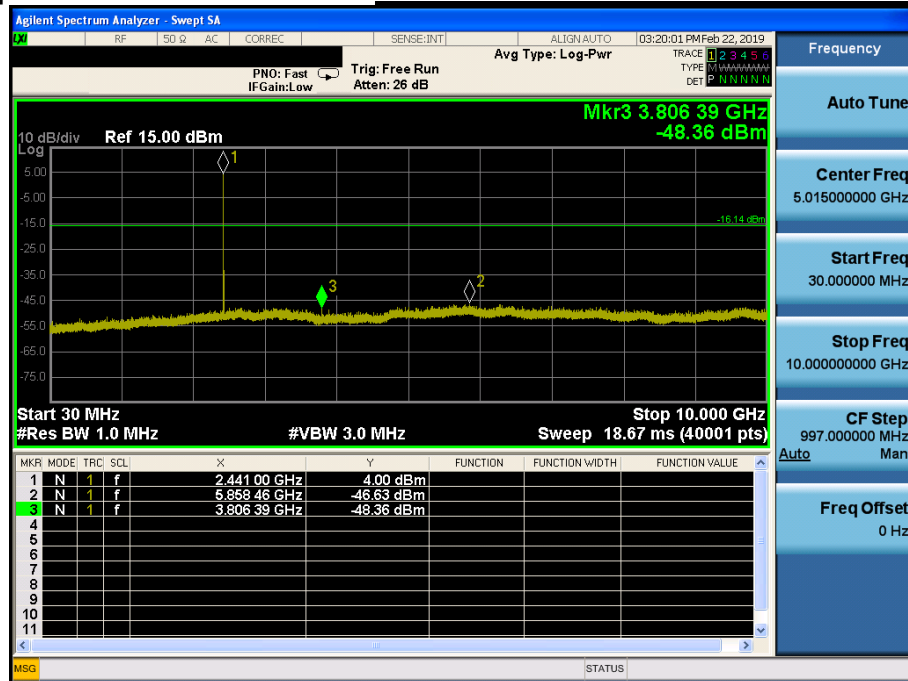
Conducted Spurious Emissions

Middle Channel & Modulation : GFSK

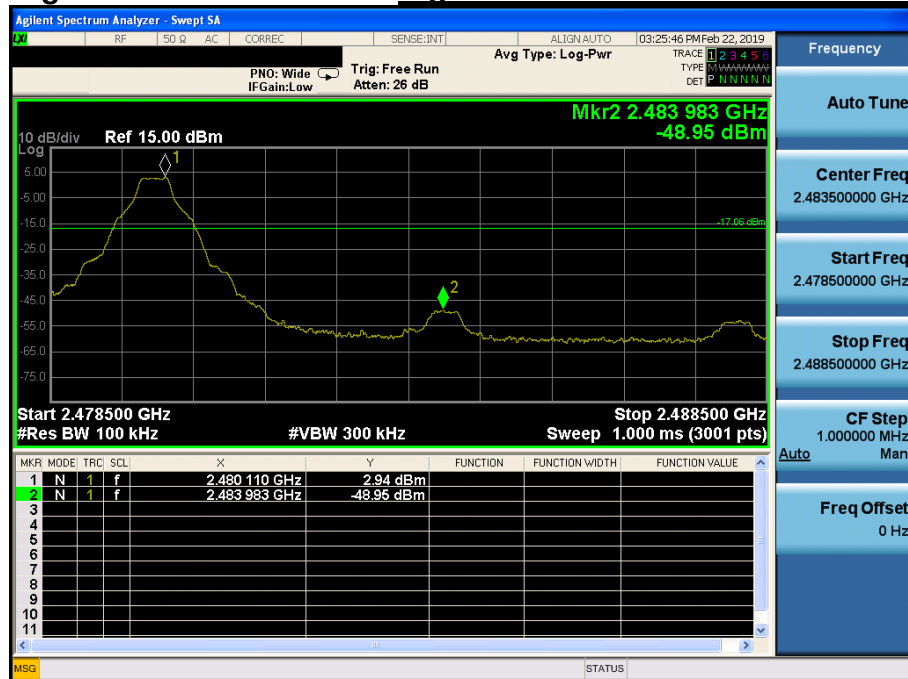


Conducted Spurious Emissions

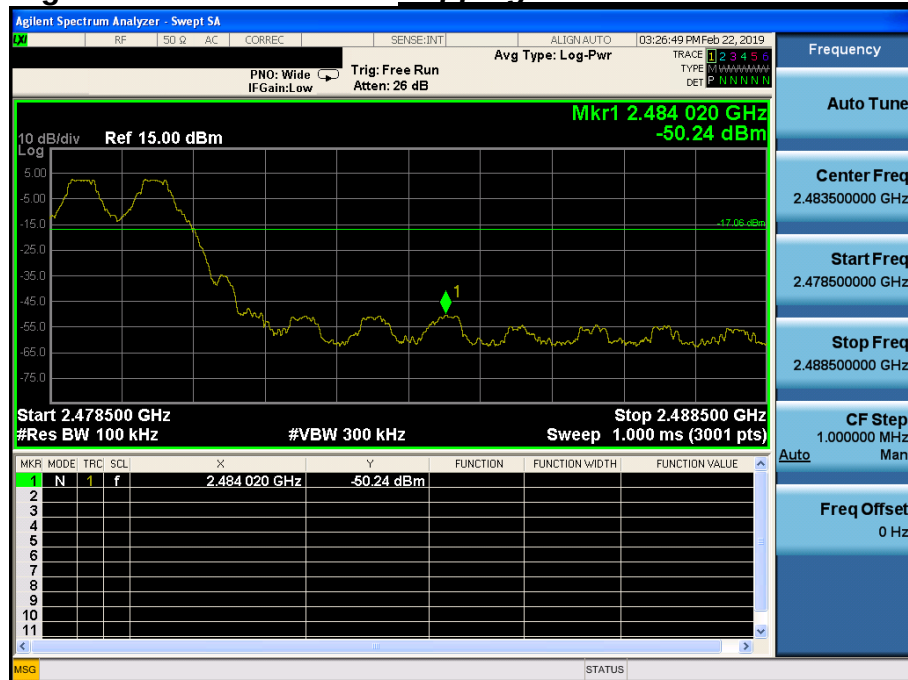
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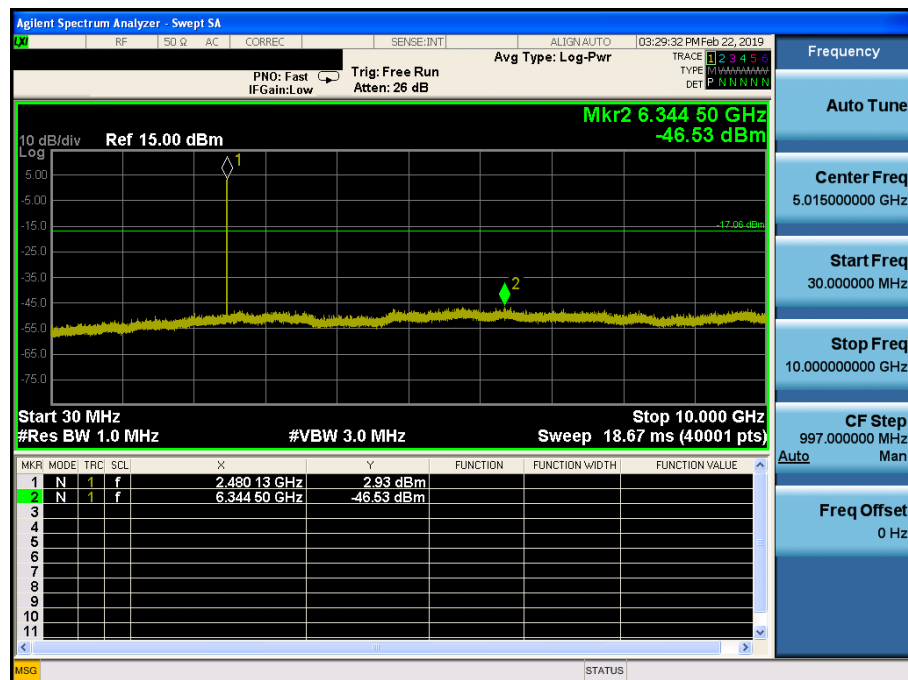
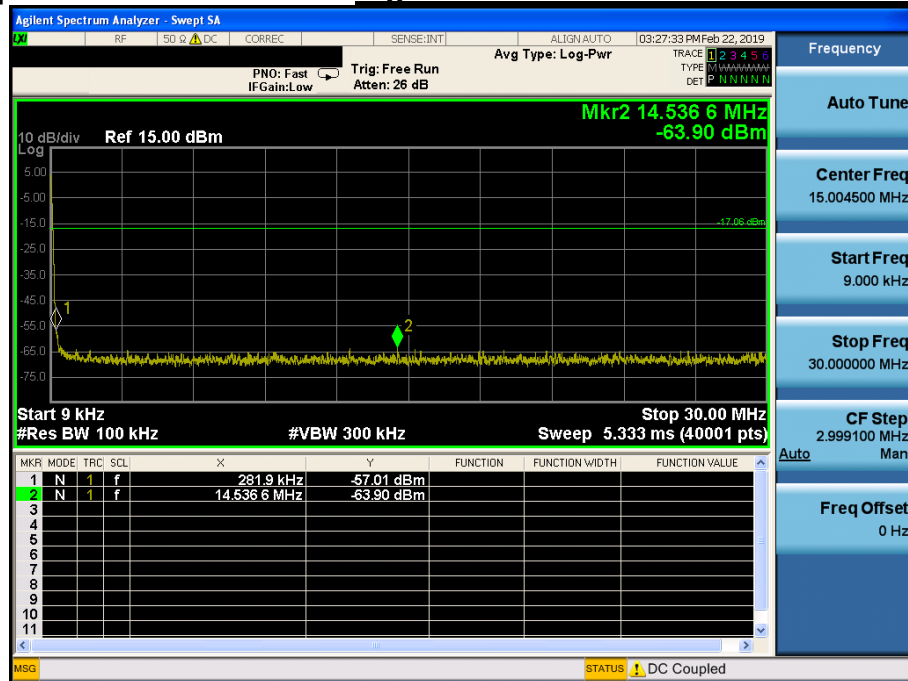
High Band-edge

Highest Channel & Modulation : GFSK

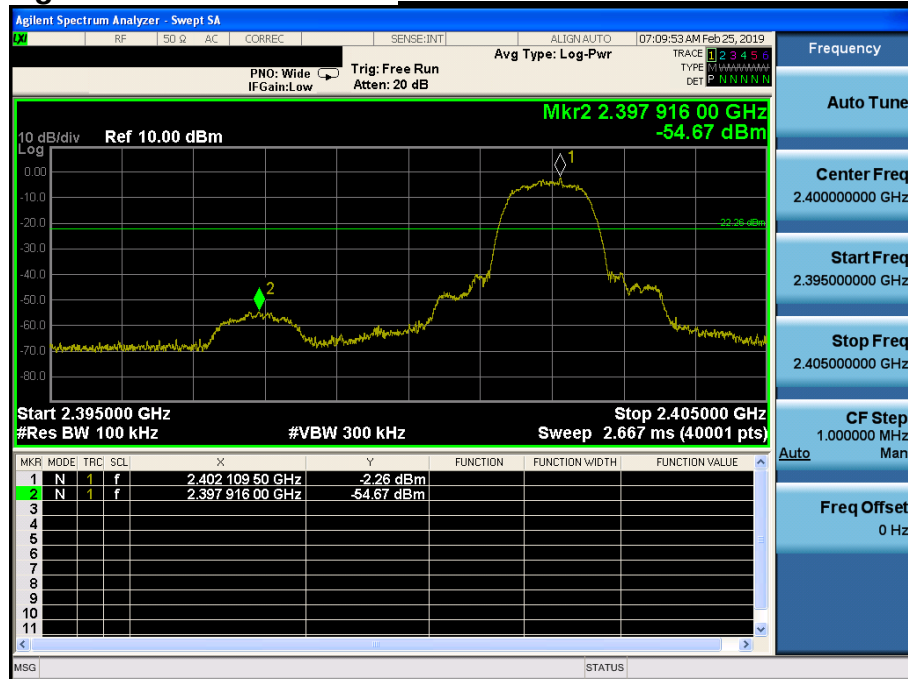
High Band-edge

Hopping mode & Modulation : GFSK

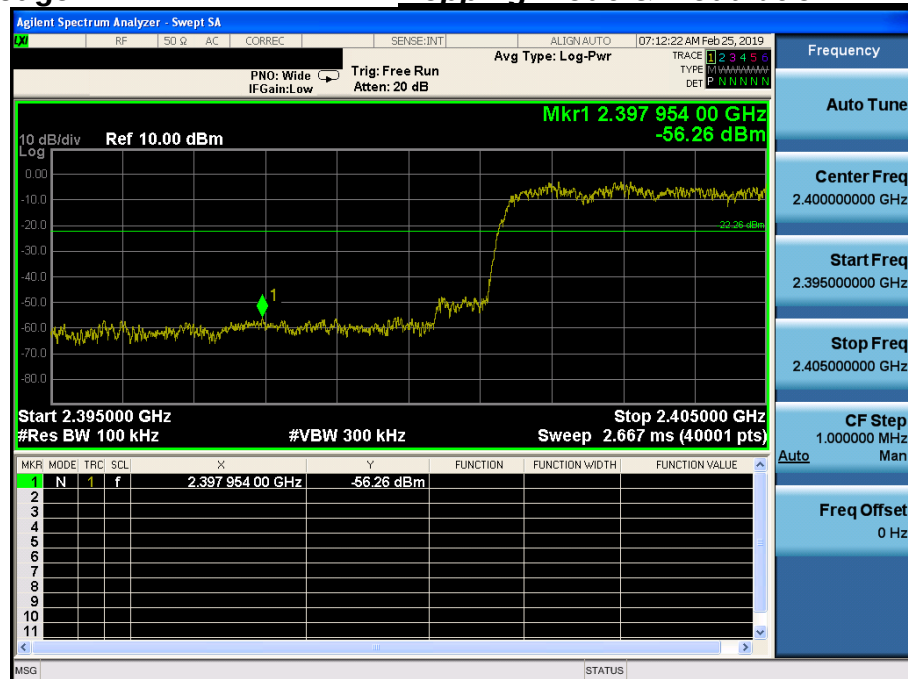
Conducted Spurious Emissions *Highest Channel & Modulation : GFSK*

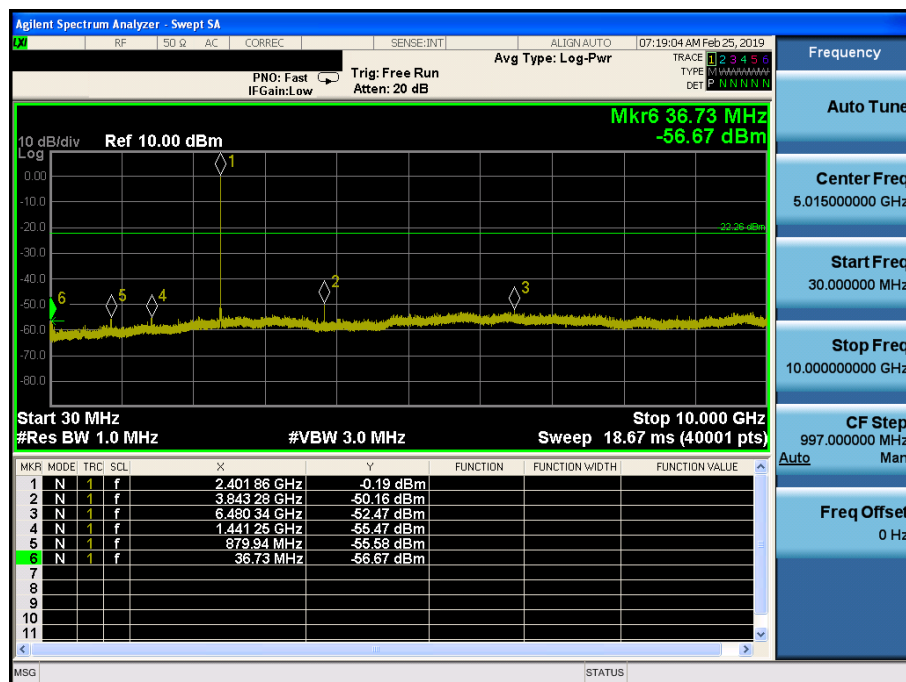
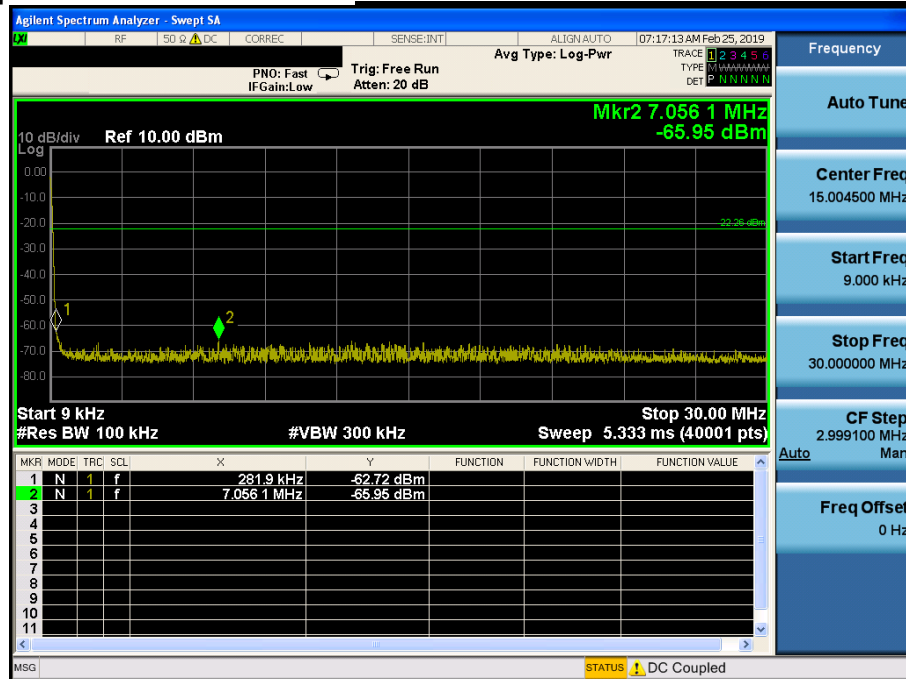


Low Band-edge

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

Low Band-edge

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

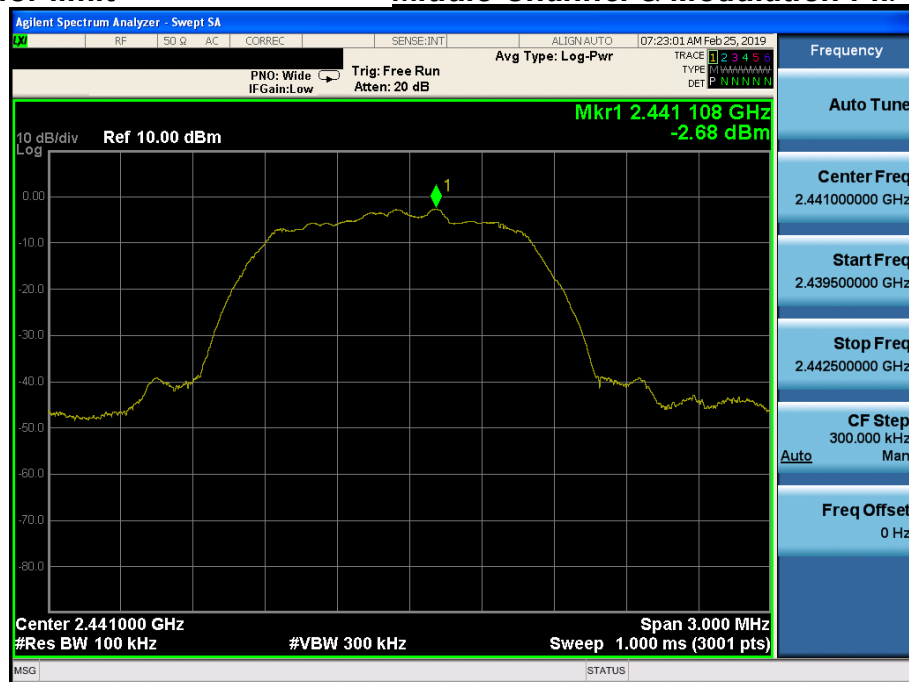
Conducted Spurious Emissions ***Lowest Channel & Modulation : $\pi/4$ DQPSK***

Conducted Spurious Emissions *Lowest Channel & Modulation : $\pi/4$ DQPSK*



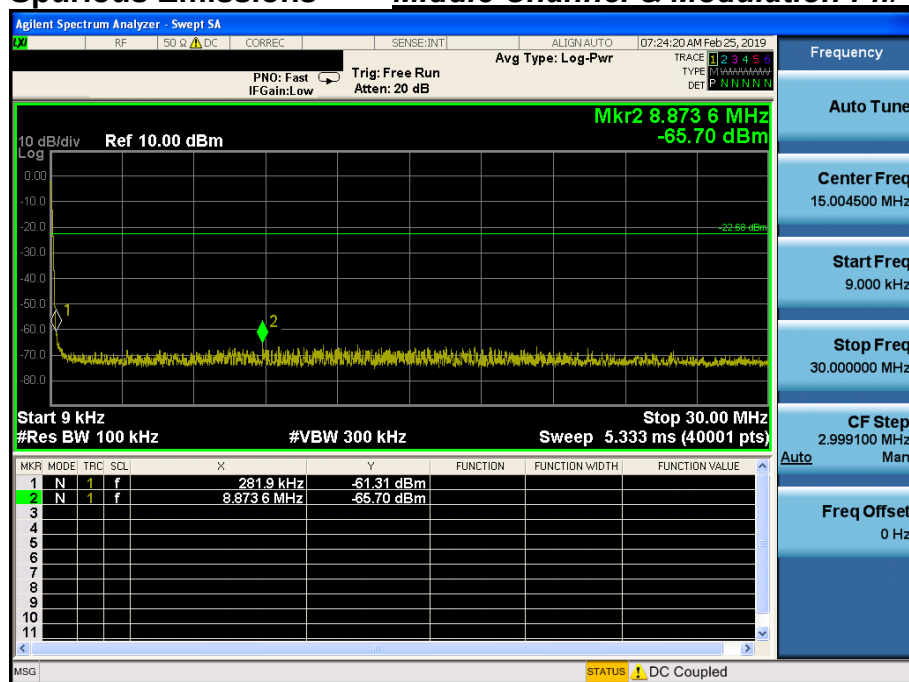
Reference for limit

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

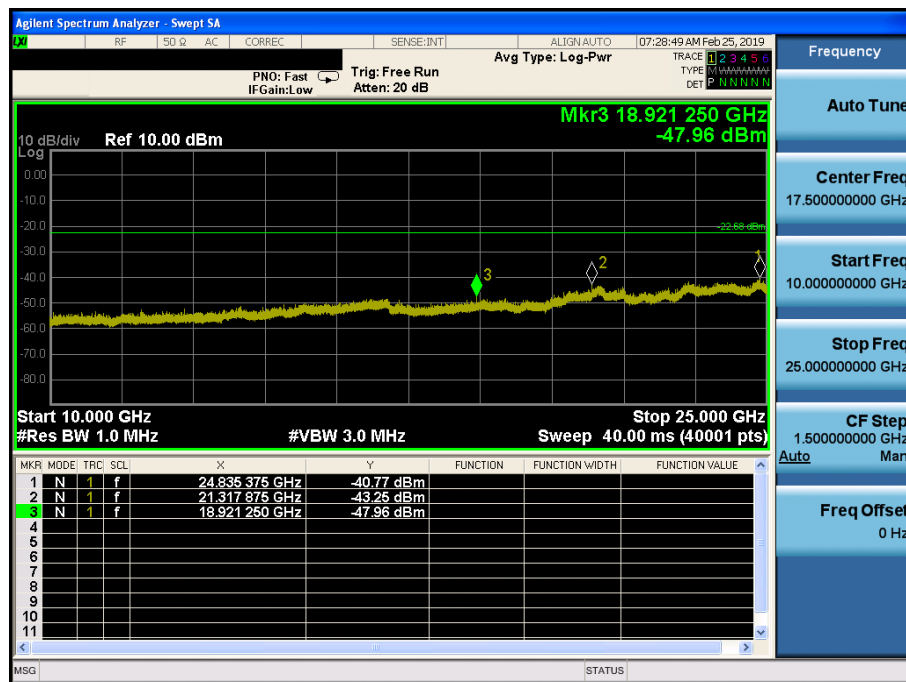
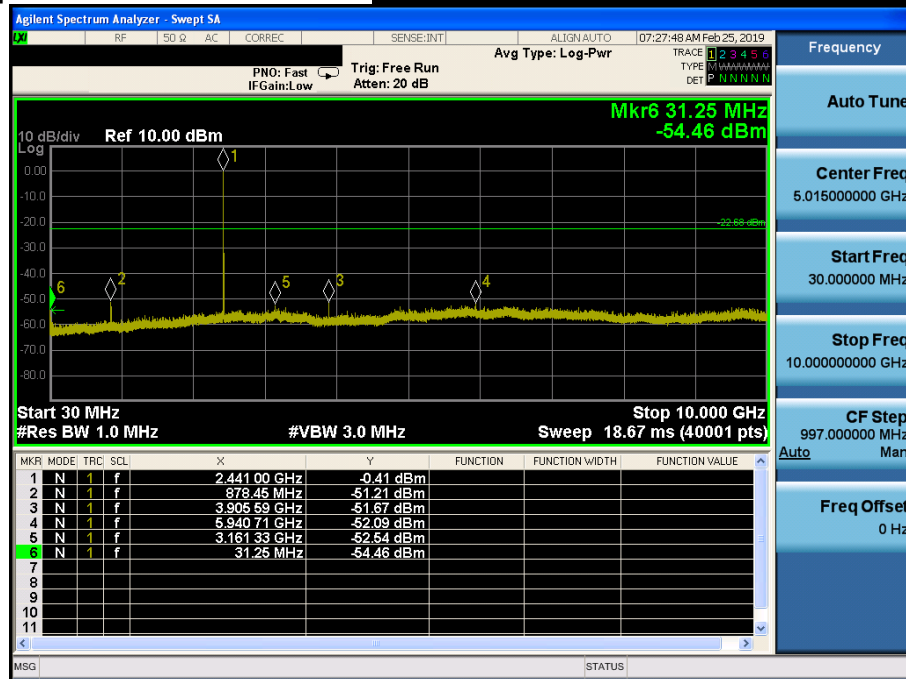


Conducted Spurious Emissions

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



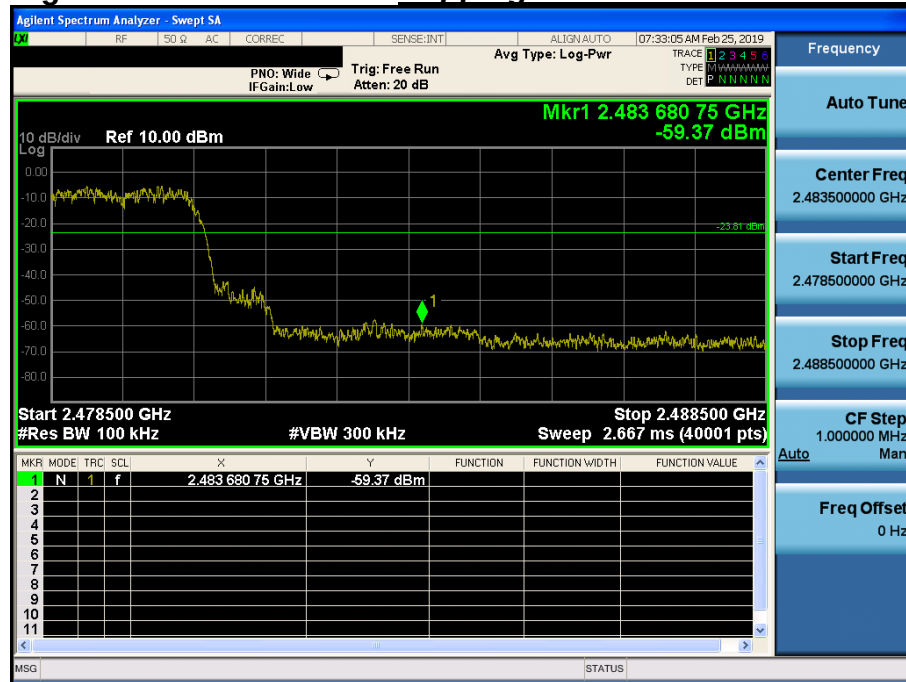
Conducted Spurious Emissions *Middle Channel & Modulation : $\pi/4$ DQPSK*



High Band-edge

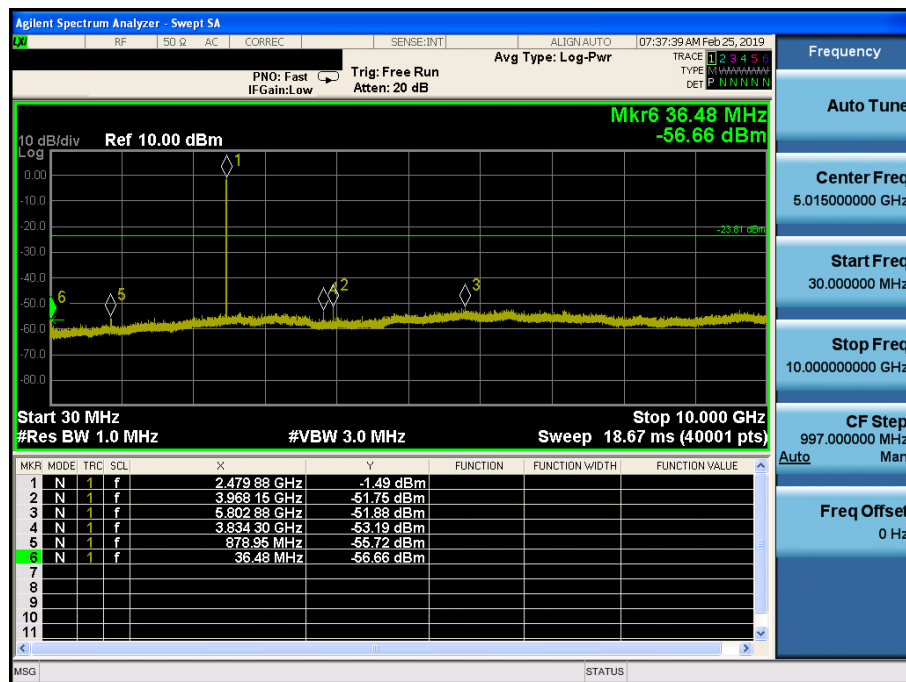
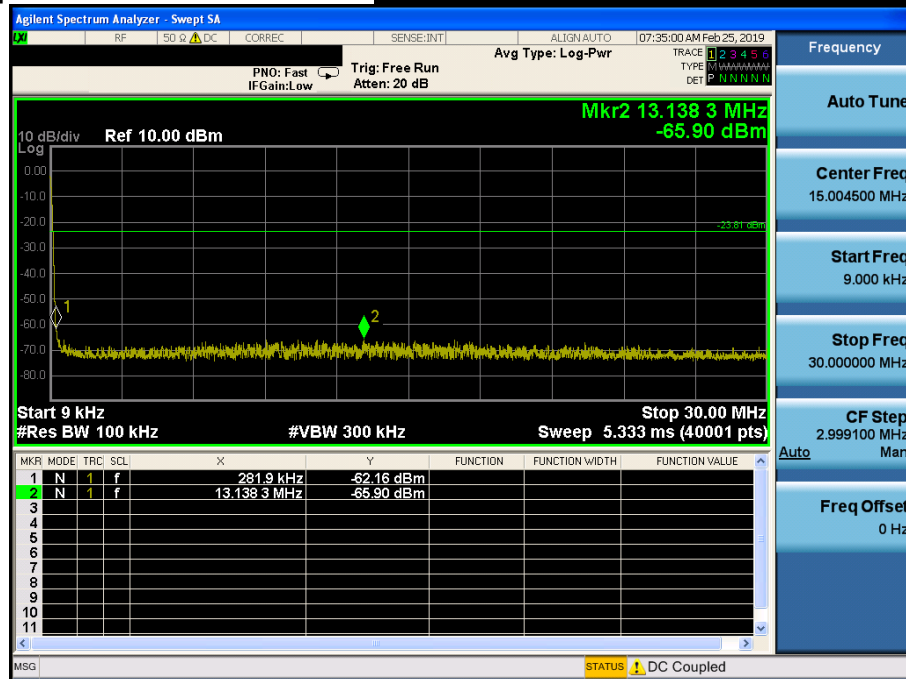
Highest Channel & Modulation : $\pi/4$ DQPSK

High Band-edge

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

Conducted Spurious Emissions

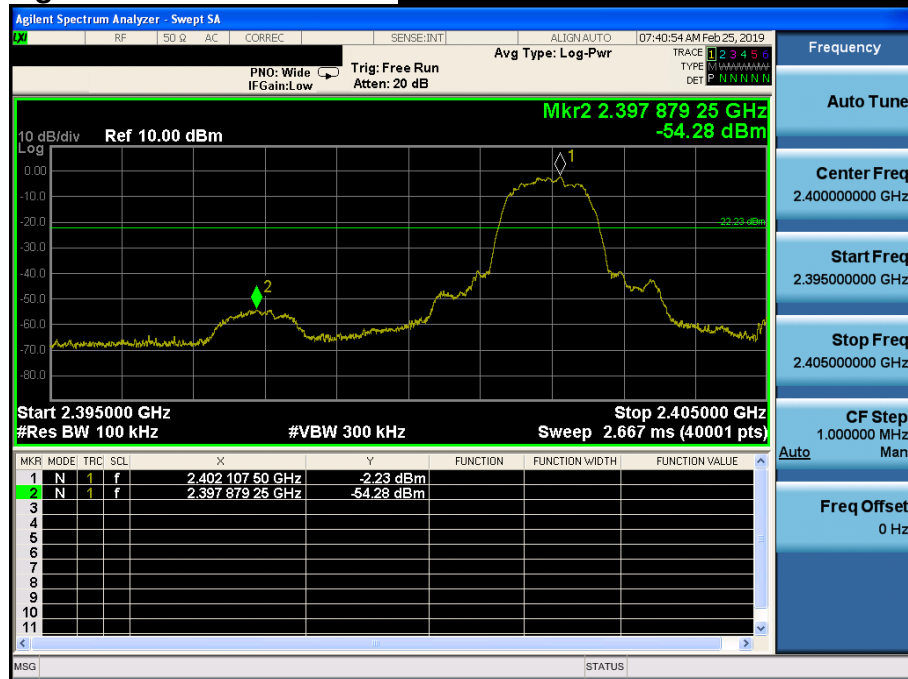
Highest Channel & Modulation : $\pi/4$ DQPSK



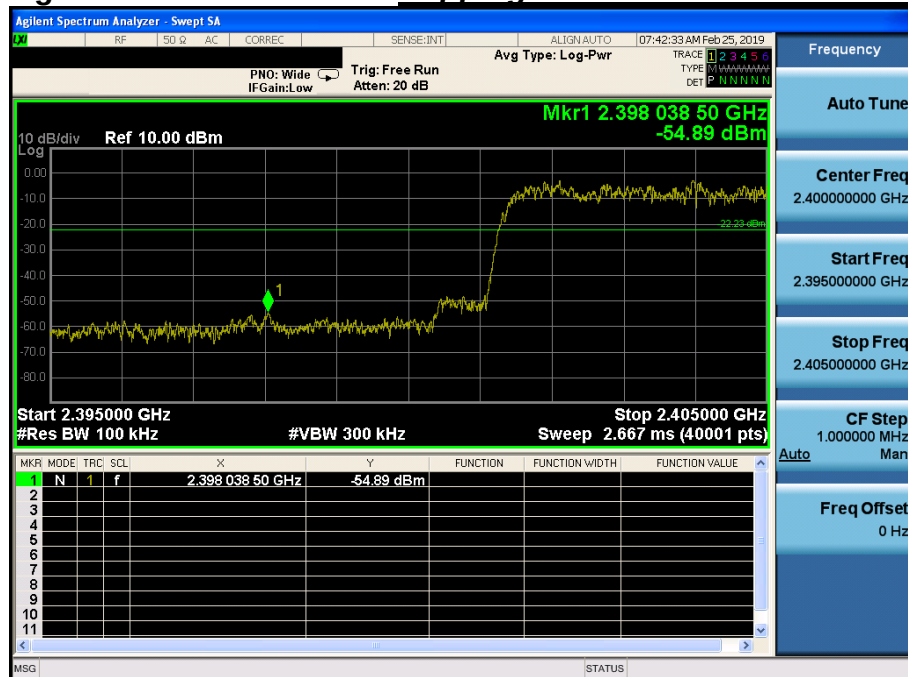
Conducted Spurious Emissions *Highest Channel & Modulation : $\pi/4$ DQPSK*



Low Band-edge

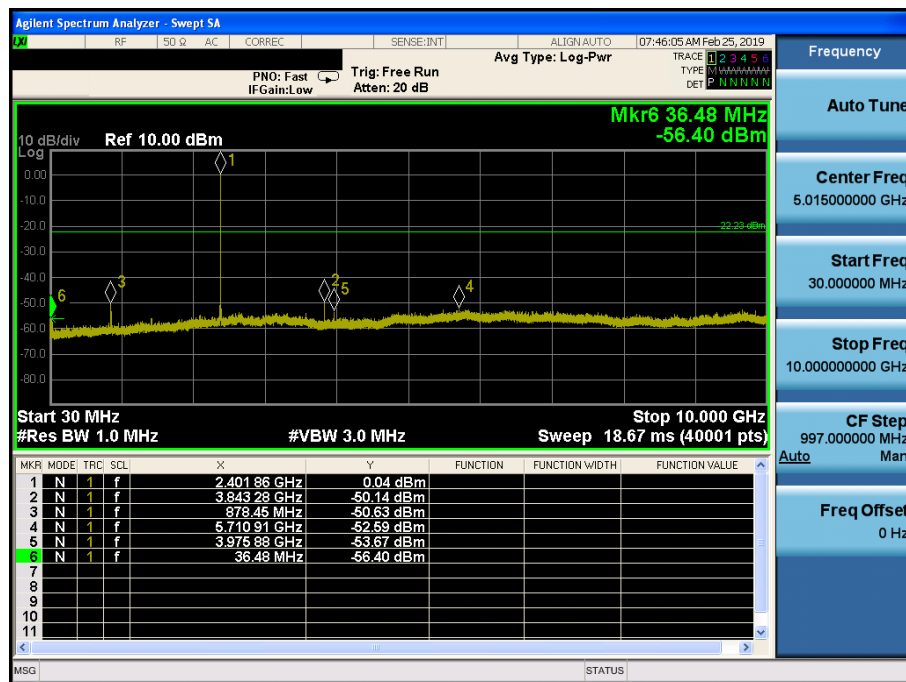
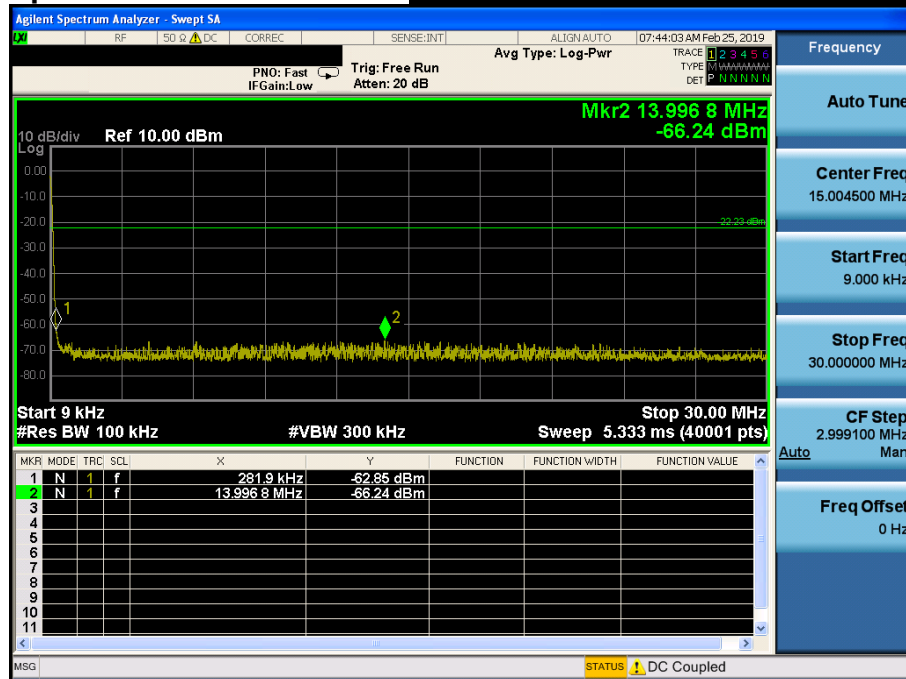
Lowest Channel & Modulation : 8DPSK

Low Band-edge

Hopping mode & Modulation : 8DPSK

Conducted Spurious Emissions

Lowest Channel & Modulation : 8DPSK

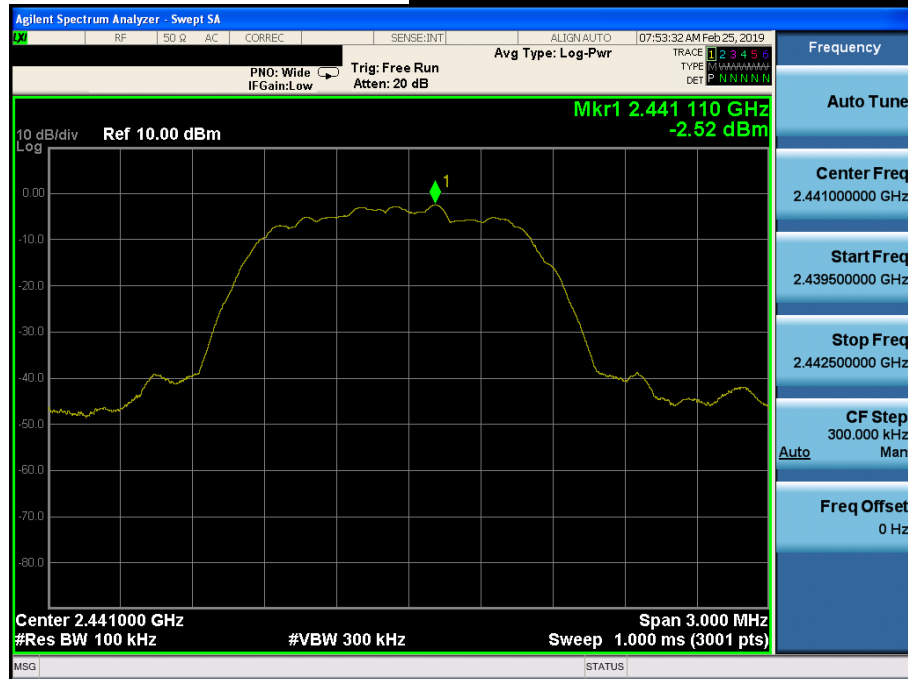


Conducted Spurious Emissions

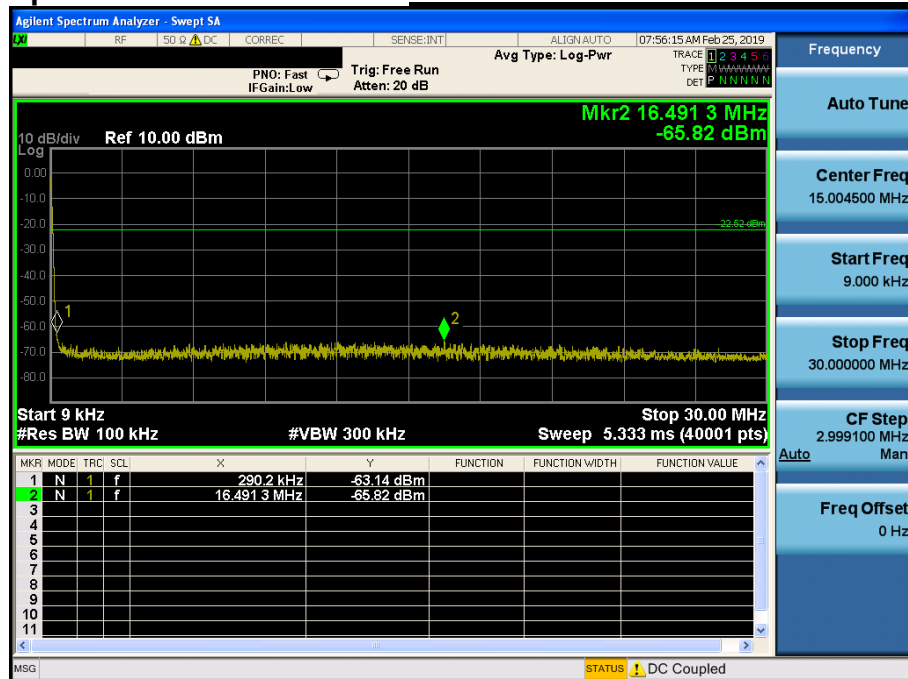
Lowest Channel & Modulation : 8DPSK



Reference for limit

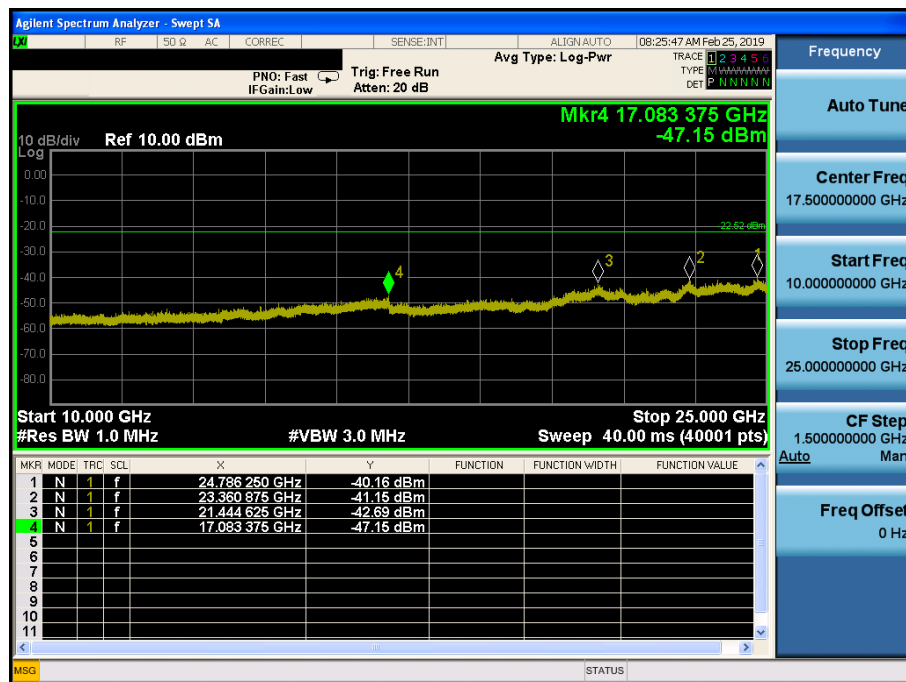
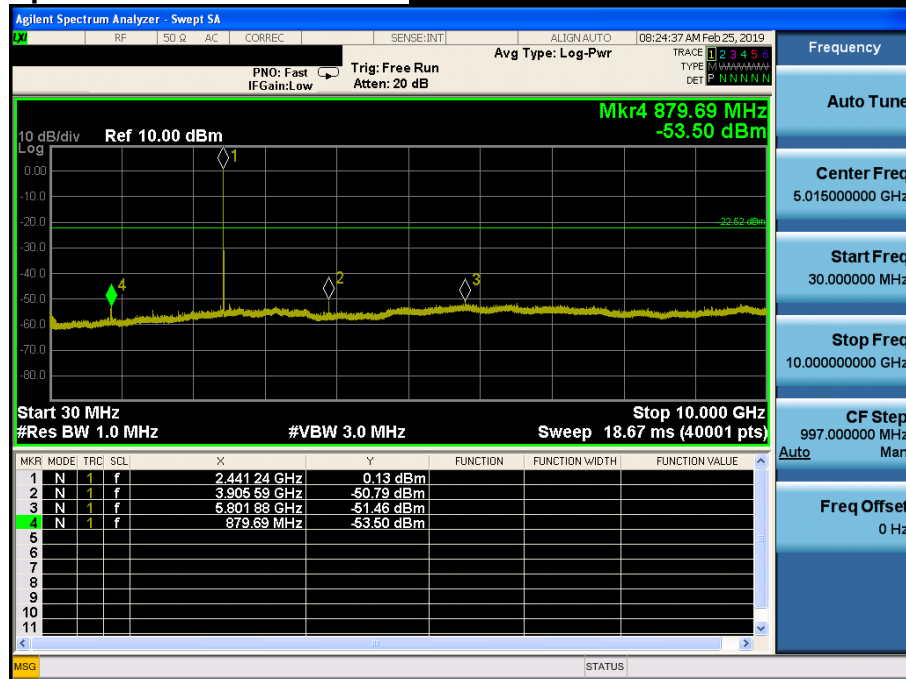
Middle Channel & Modulation : 8DPSK

Conducted Spurious Emissions

Middle Channel & Modulation : 8DPSK

Conducted Spurious Emissions

Middle Channel & Modulation : 8DPSK



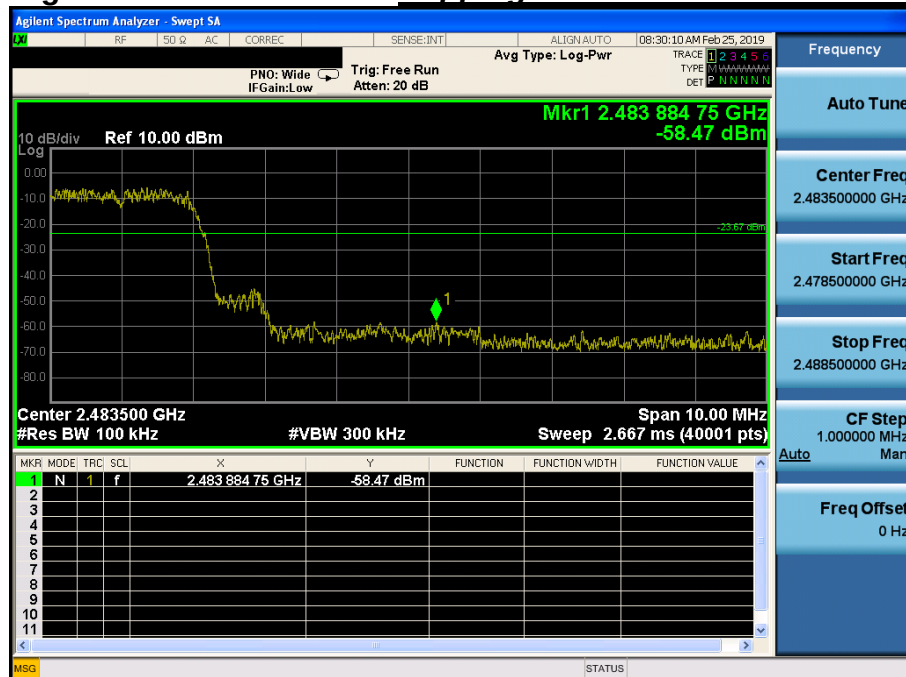
High Band-edge

Highest Channel & Modulation : 8DPSK



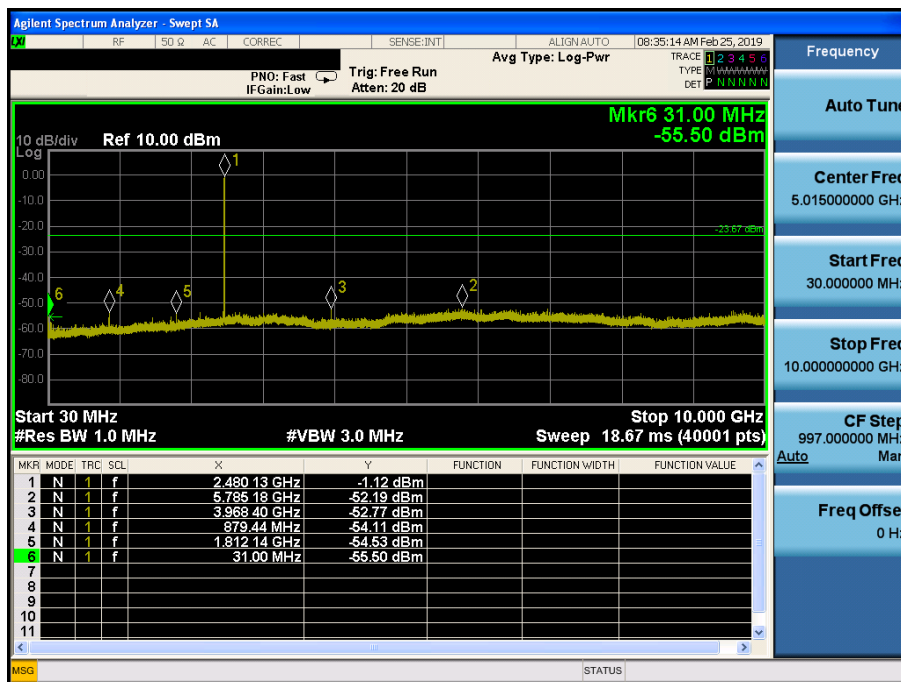
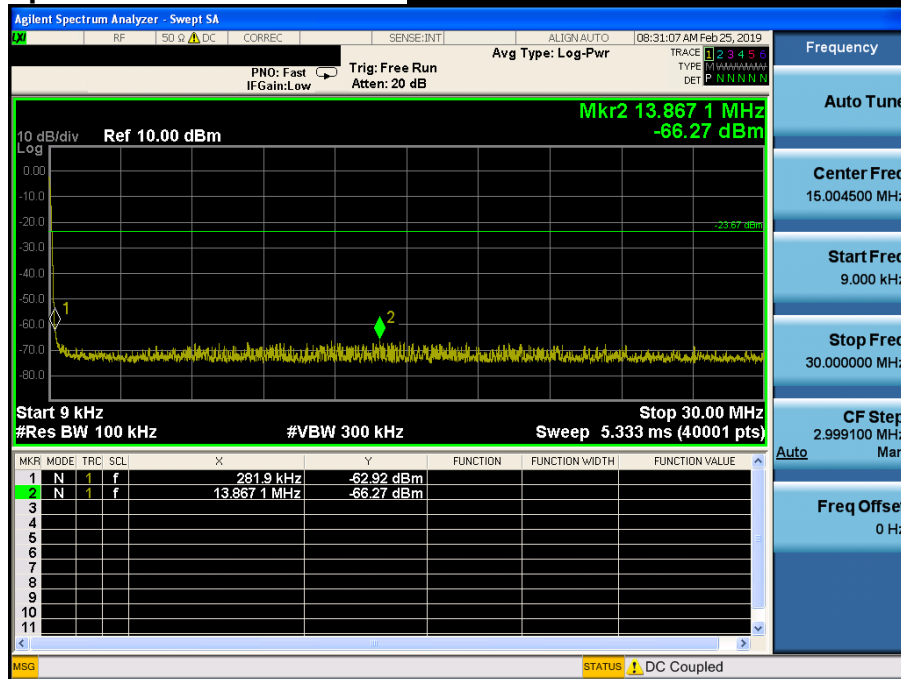
High Band-edge

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 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 × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 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

AC Line Conducted Emissions (Graph)

Results of Conducted Emission

DTNC

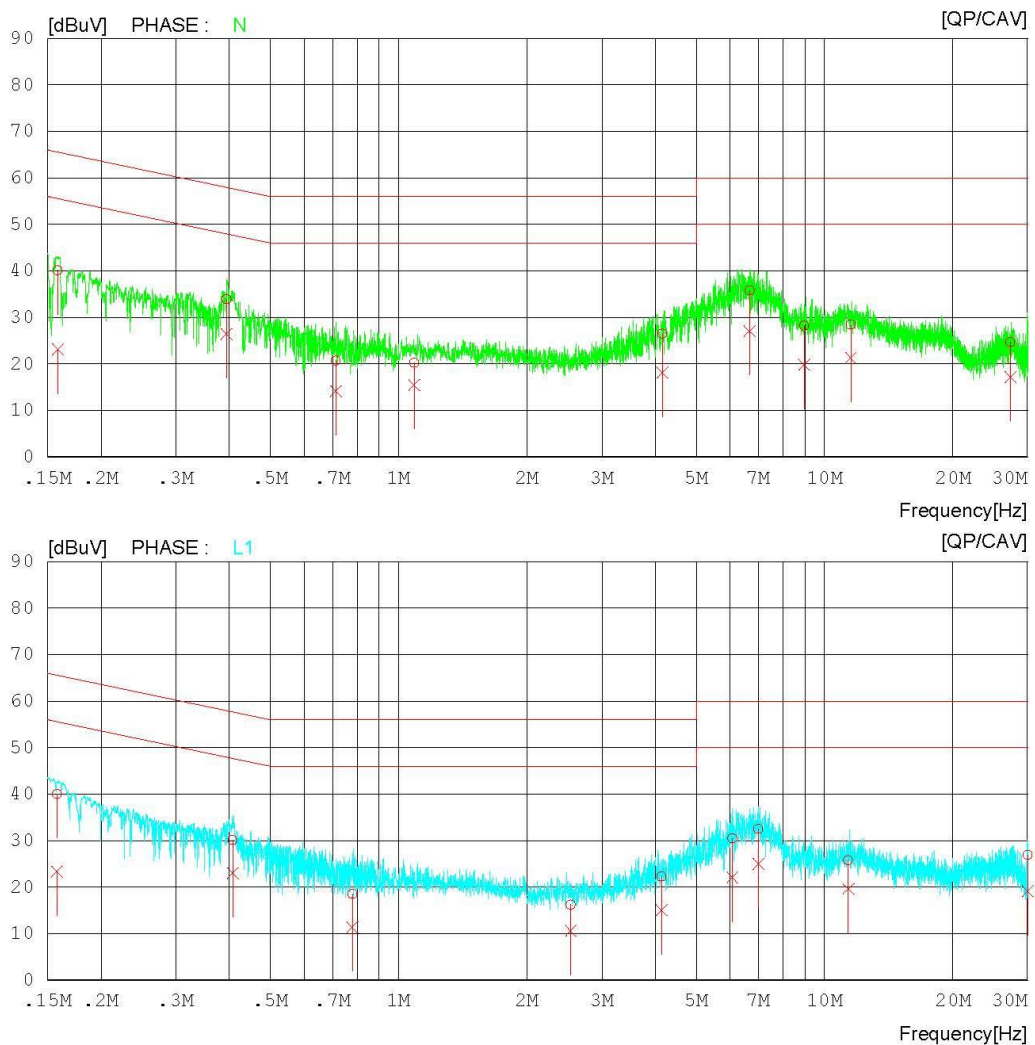
Date 2019-04-12

Order No.
Model No. NCFG0012018
Serial No.
Test Condition BT

Reference No.
Power Supply 120 V, 60 Hz
Temp/Humi. 23 °C / 45 %
Operator Sun Geun Lee

Memo

LIMIT : FCC P15.207 QP
FCC P15.207 AV



AC Line Conducted Emissions (List)

Results of Conducted Emission

DTNC

Date 2019-04-12

Order No.
Model No. NCFG0012018
Serial No.
Test Condition BT

Reference No.
Power Supply 120 V, 60 Hz
Temp/Humi. 23 'C / 45 %
Operator Sun Geun Lee

Memo

LIMIT : FCC P15.207 QP
FCC P15.207 AV

NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	CAV [dBuV]		QP [dBuV]	CAV [dBuV]	QP [dBuV]	CAV [dBuV]	QP [dBuV]	CAV [dBuV]	
1	0.15840	30.16	13.23	9.94	40.10	23.17	65.55	55.55	25.45	32.38	N
2	0.39484	23.87	16.51	9.95	33.82	26.46	57.96	47.96	24.14	21.50	N
3	0.71214	10.69	4.14	9.97	20.66	14.11	56.00	46.00	35.34	31.89	N
4	1.08820	10.22	5.55	9.97	20.19	15.52	56.00	46.00	35.81	30.48	N
5	4.16060	16.40	8.02	10.12	26.52	18.14	56.00	46.00	29.48	27.86	N
6	6.67000	25.55	16.82	10.22	35.77	27.04	60.00	50.00	24.23	22.96	N
7	8.96840	17.89	9.56	10.30	28.19	19.86	60.00	50.00	31.81	30.14	N
8	11.52020	17.98	10.96	10.39	28.37	21.35	60.00	50.00	31.63	28.65	N
9	27.30260	13.95	6.49	10.70	24.65	17.19	60.00	50.00	35.35	32.81	N
10	0.15779	30.06	13.42	9.94	40.00	23.36	65.58	55.58	25.58	32.22	L1
11	0.40774	20.14	13.05	9.95	30.09	23.00	57.69	47.69	27.60	24.69	L1
12	0.77879	8.47	1.39	9.96	18.43	11.35	56.00	46.00	37.57	34.65	L1
13	2.53640	6.19	0.53	10.04	16.23	10.57	56.00	46.00	39.77	35.43	L1
14	4.14900	12.10	4.86	10.11	22.21	14.97	56.00	46.00	33.79	31.03	L1
15	6.07940	20.27	11.84	10.20	30.47	22.04	60.00	50.00	29.53	27.96	L1
16	6.99740	22.21	14.78	10.22	32.43	25.00	60.00	50.00	27.57	25.00	L1
17	11.37240	15.39	9.24	10.38	25.77	19.62	60.00	50.00	34.23	30.38	L1
18	29.96506	16.16	8.34	10.72	26.88	19.06	60.00	50.00	33.12	30.94	L1

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 is permanently printed on the PCB.

Therefore this E.U.T Complies with the requirement of §15.203

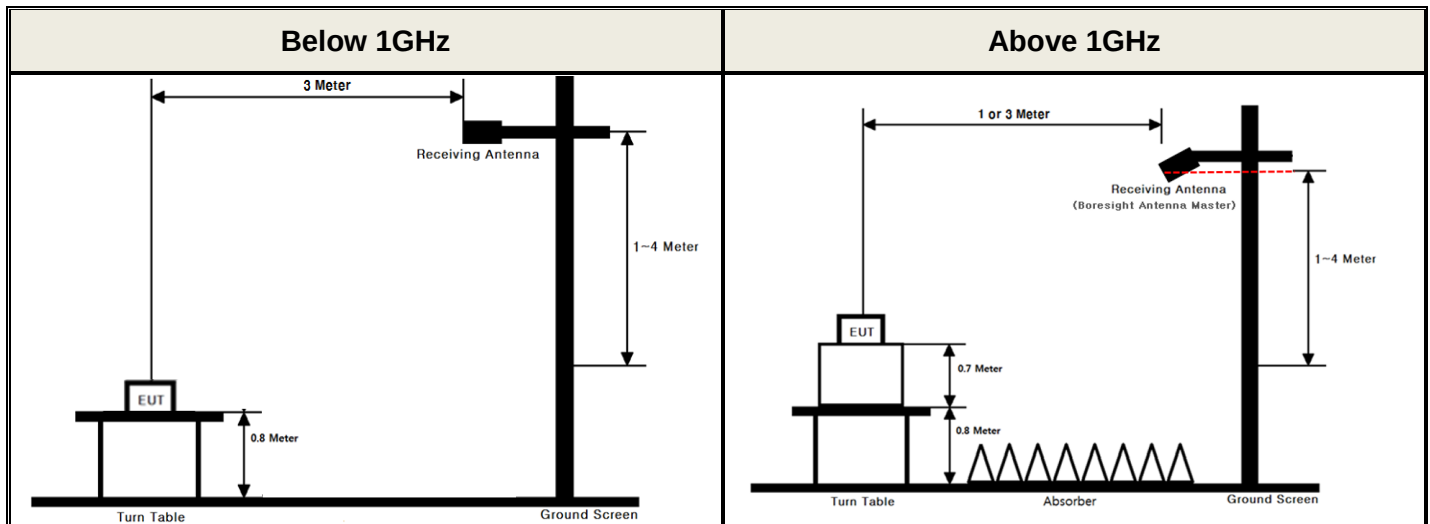
- Minimum Standard :

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.

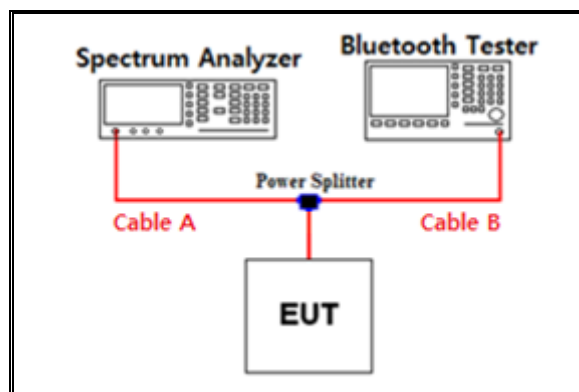
APPENDIX I

Test set up diagrams

▪ Radiated Measurement



▪ Conducted Measurement



Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	6.13	15	9.72
1	6.88	20	10.81
2.402 & 2.441 & 2.480	7.36	25	11.52
5	8.06	-	-
10	9.29	-	-

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

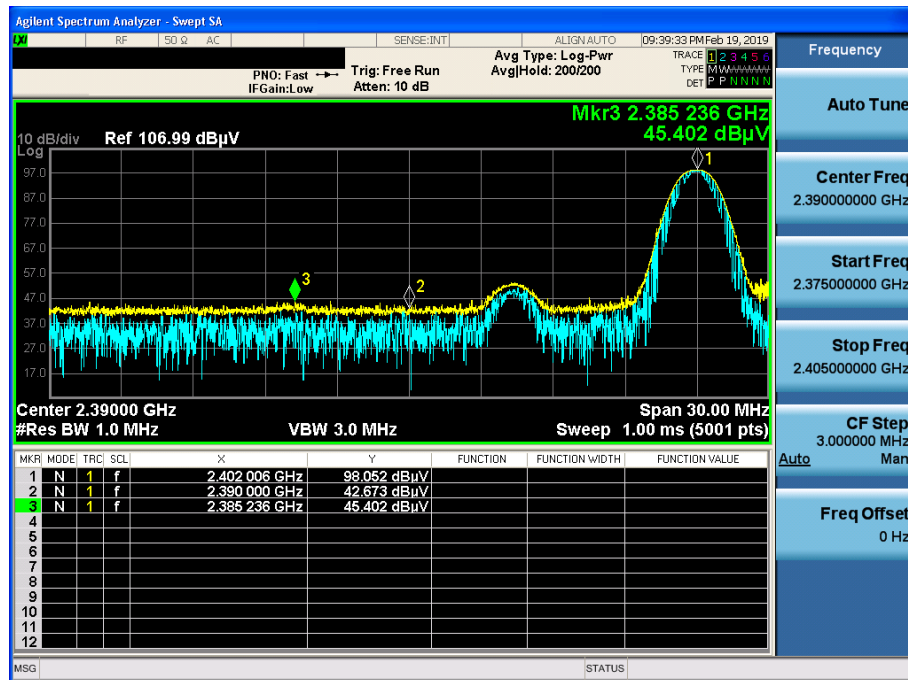
Path loss (S/A's Correction factor) = Cable A + Power splitter

APPENDIX II

Unwanted Emissions (Radiated) Test Plot

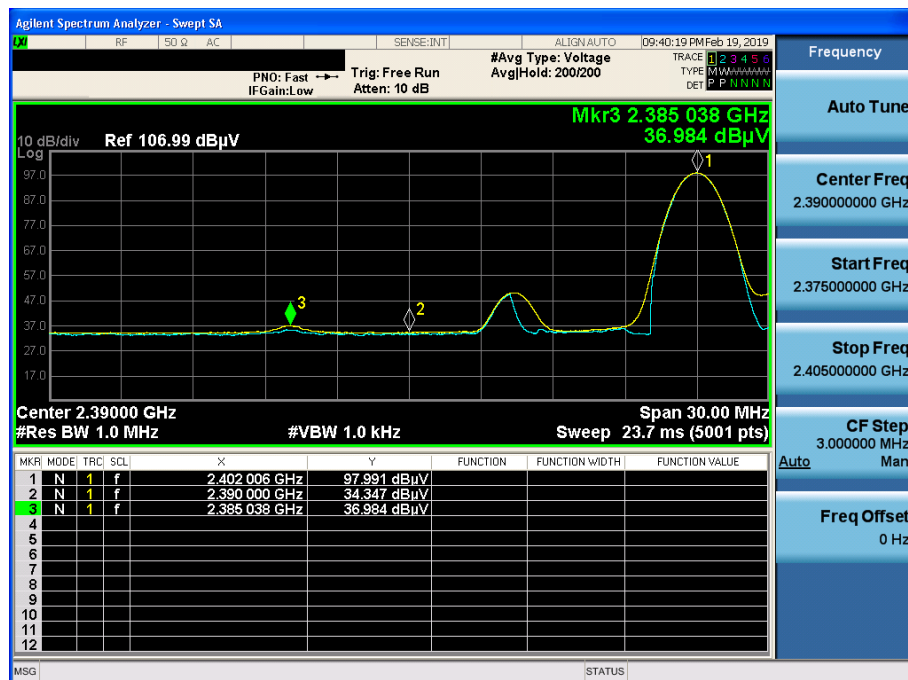
GFSK & Lowest & Y & Ver

Detector Mode : PK



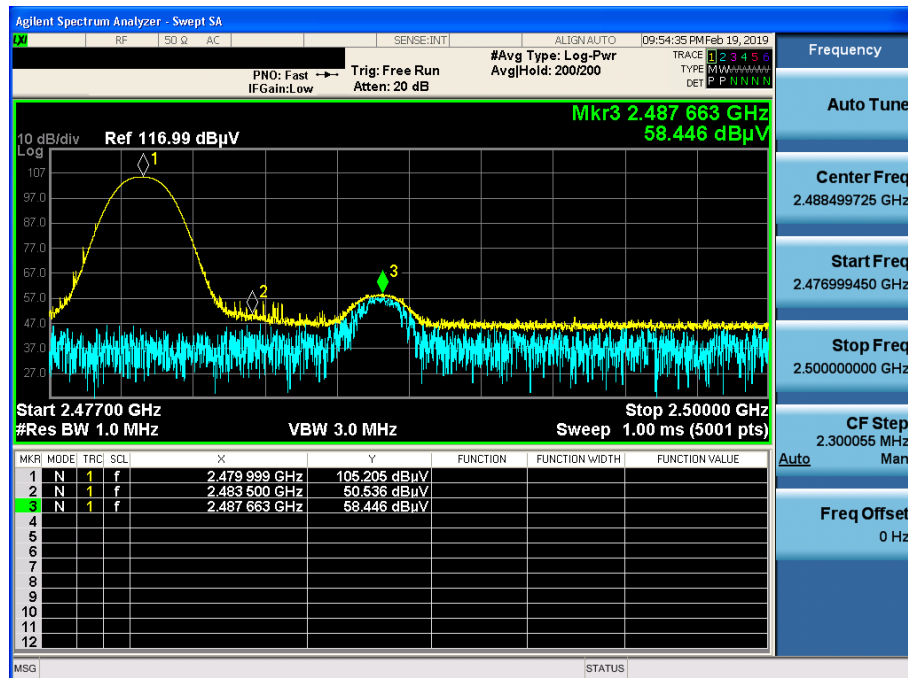
GFSK & Lowest & Y & Ver

Detector Mode : AV



GFSK & Highest & Y & Ver

Detector Mode : PK



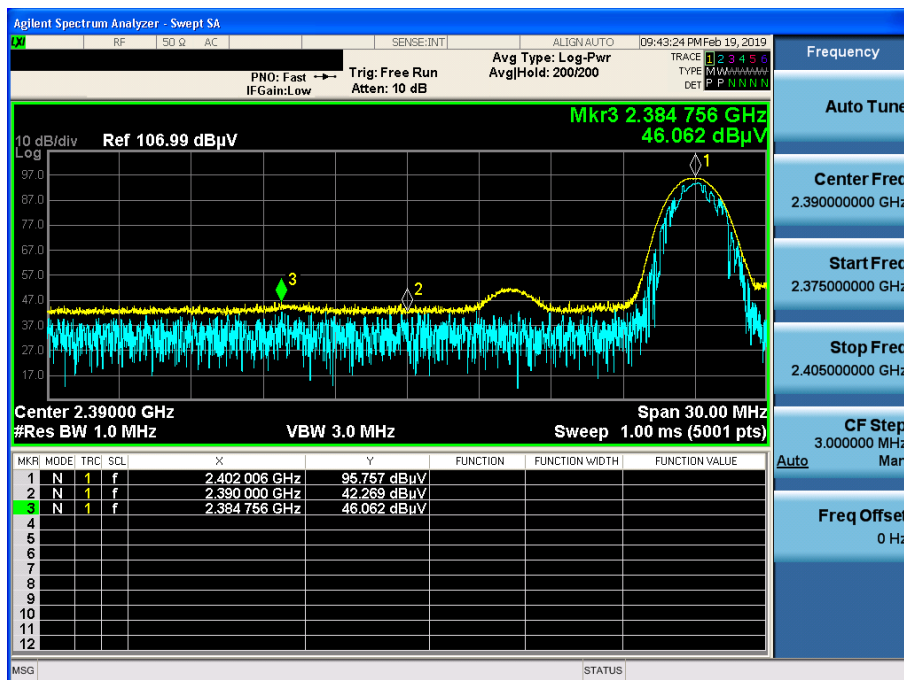
GFSK & Highest & Y & Ver

Detector Mode : AV



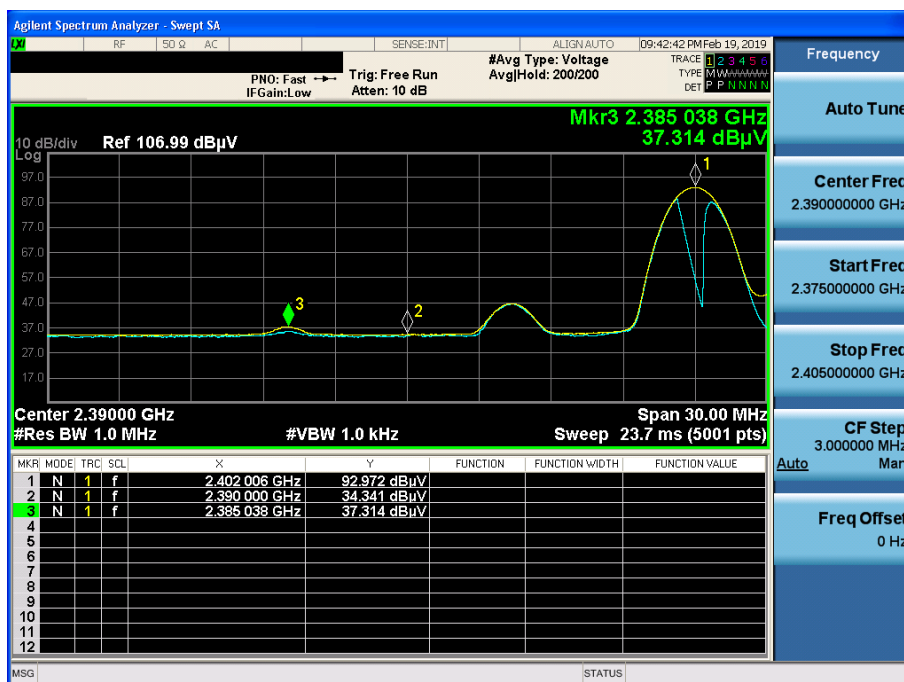
$\pi/4$ DQPSK & Lowest & Y & Ver

Detector Mode : PK



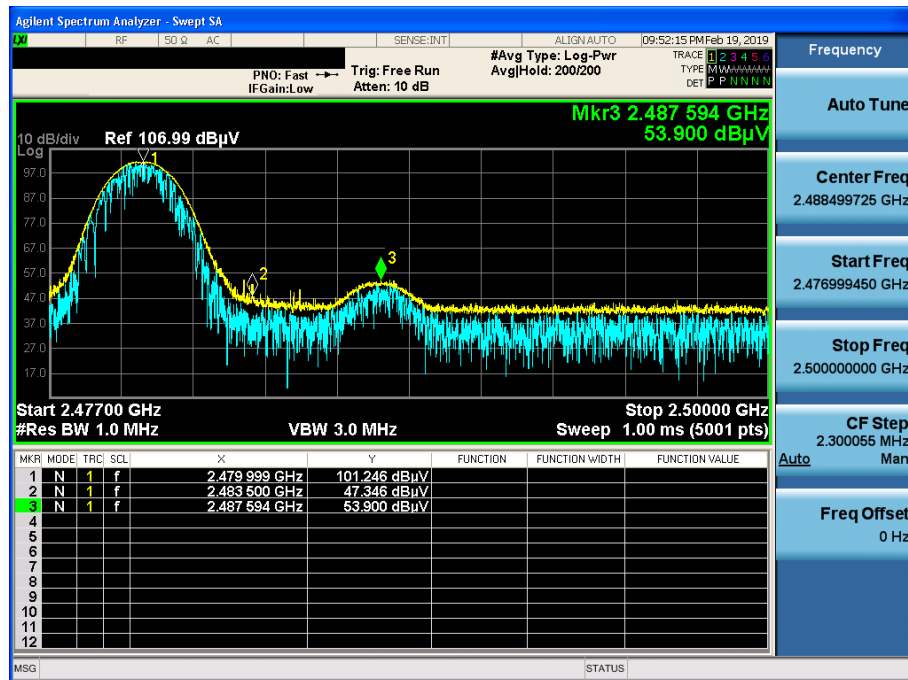
$\pi/4$ DQPSK & Lowest & Y & Ver

Detector Mode : AV

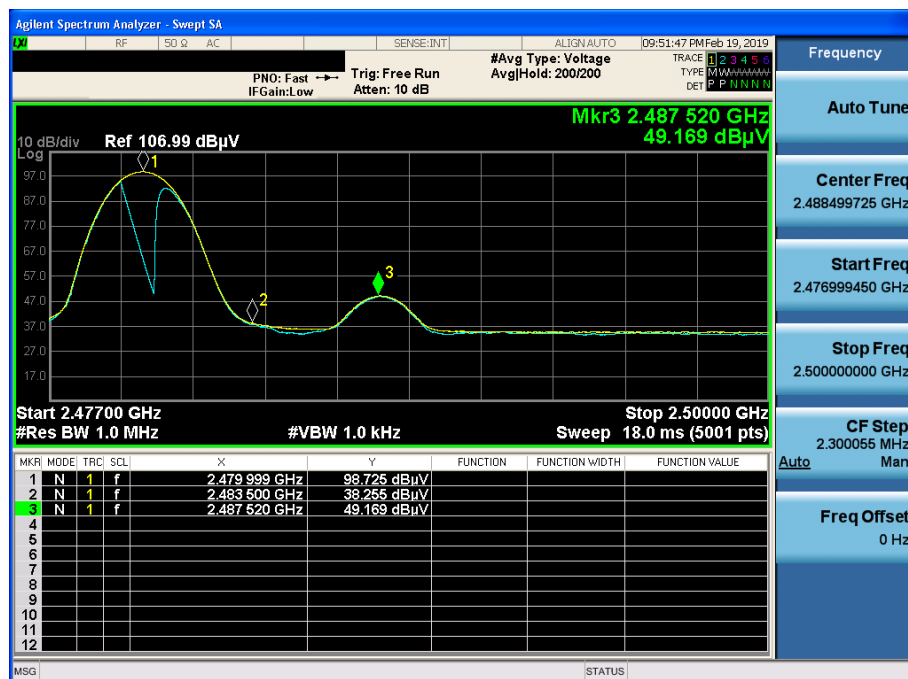


π /4DQPSK & Highest & Y & Ver

Detector Mode : PK

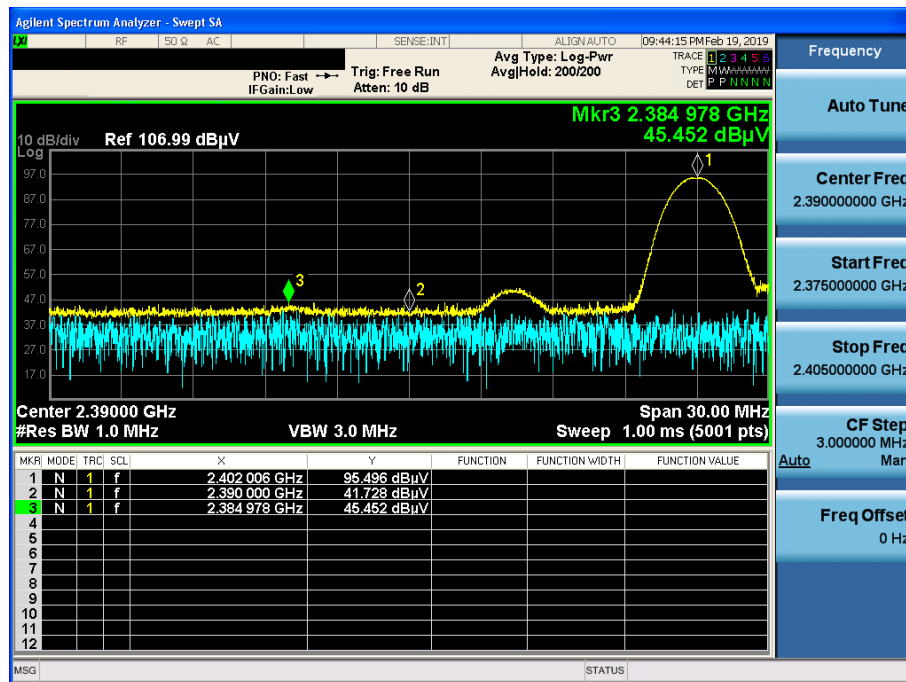
 π /4DQPSK & Highest & Y & Ver

Detector Mode : AV



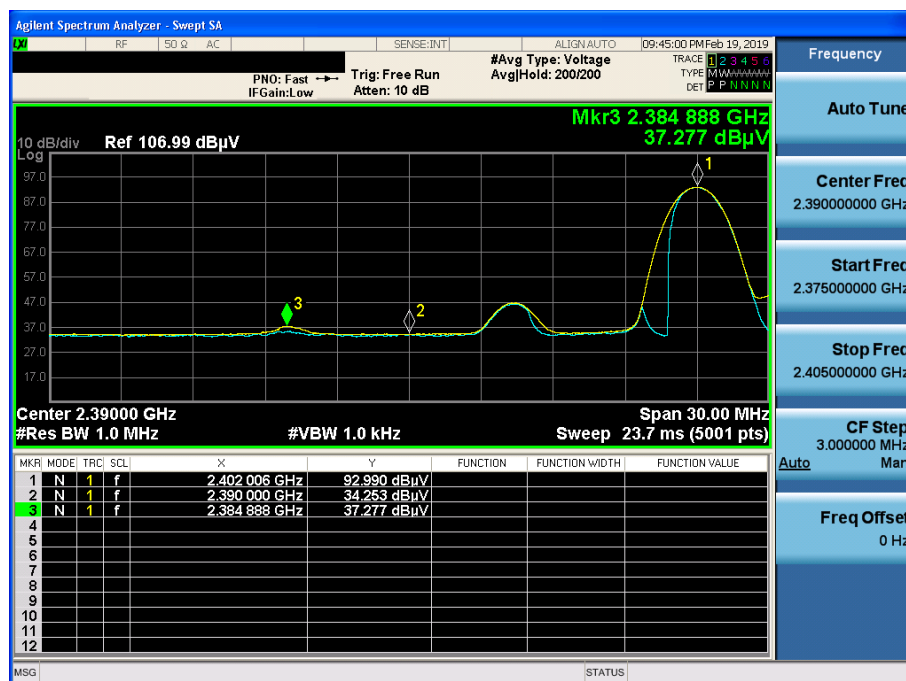
8DPSK & Lowest & Y & Ver

Detector Mode : PK



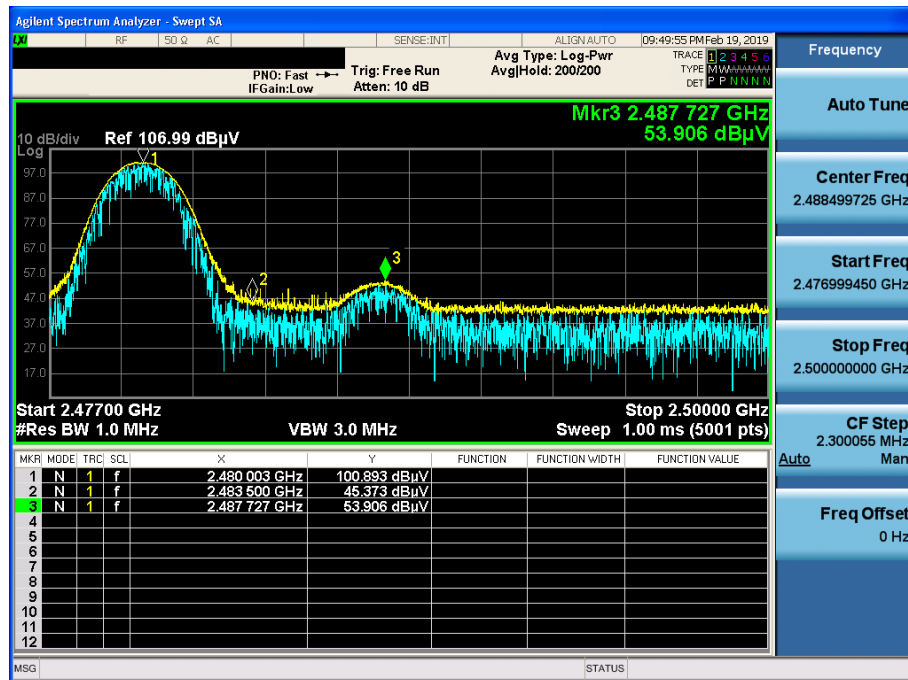
8DPSK & Lowest & Y & Ver

Detector Mode : AV



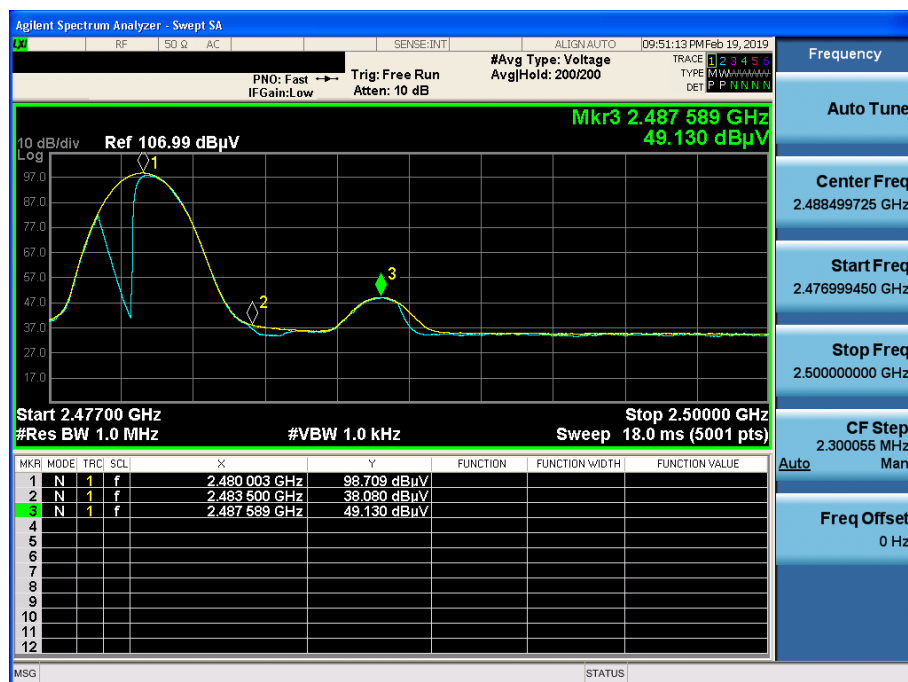
8DPSK & Highest & Y & Ver

Detector Mode : PK



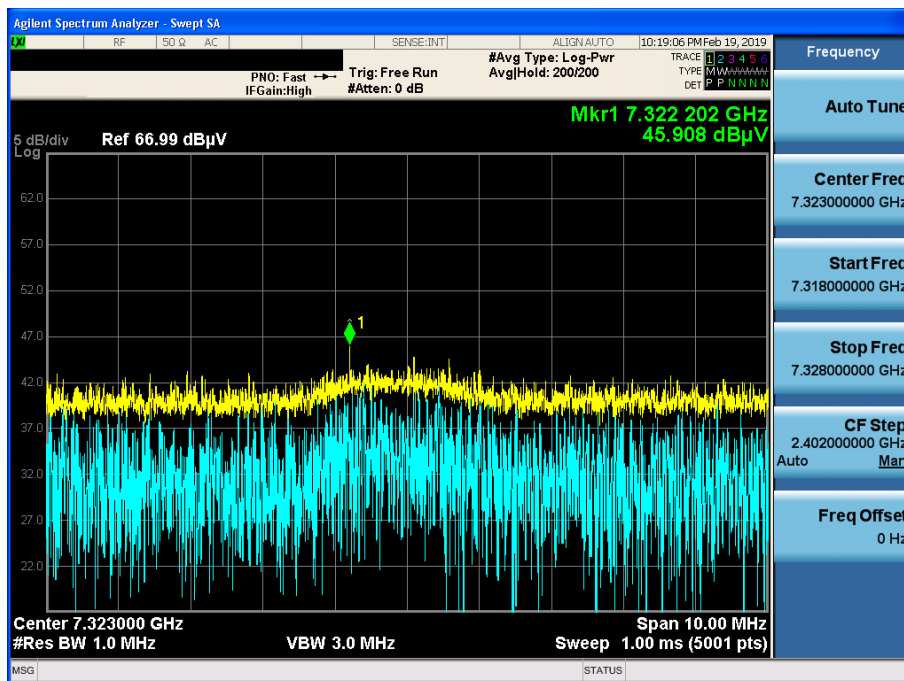
8DPSK & Highest & Y & Ver

Detector Mode : AV



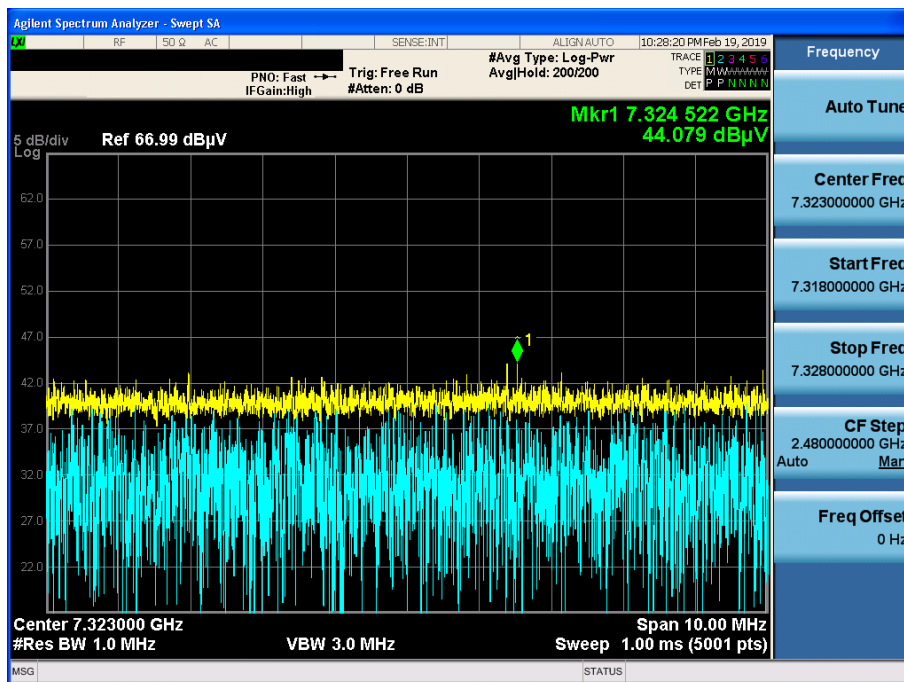
GFSK & Middle & Y & Hor

Detector Mode : PK



$\pi/4$ DQPSK & Middle & Y & Hor

Detector Mode : PK



8DPSK & Lowest & Y & Hor

Detector Mode : PK

