

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

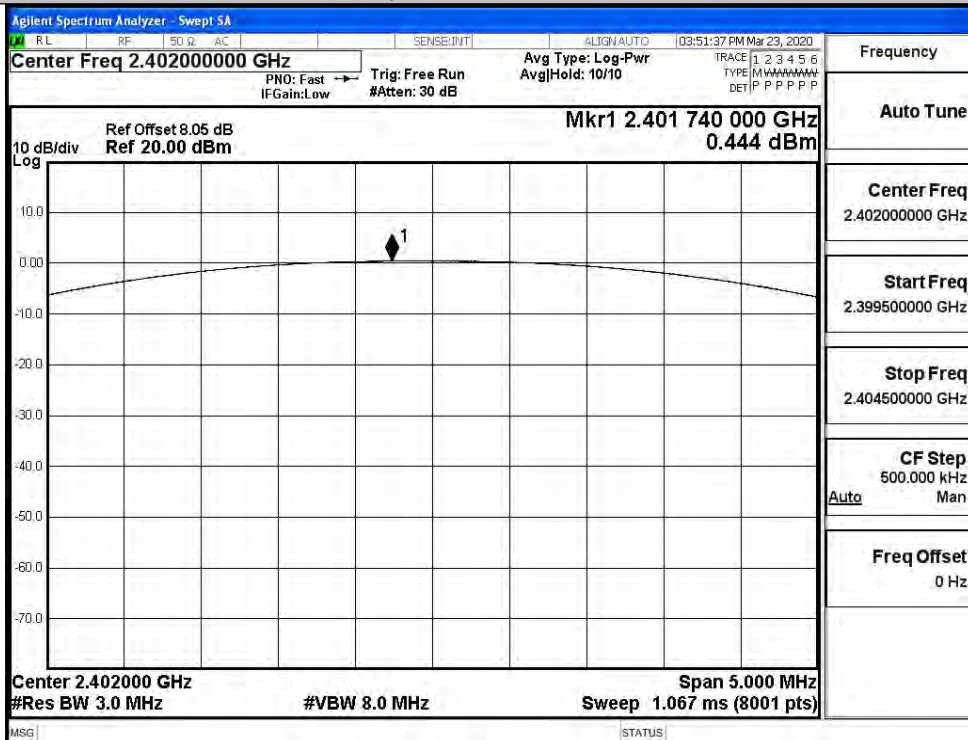
Temperature:	25 ° C
Relative Humidity:	50%
ATM Pressure:	100.0 kPa
Test Engineer:	Alisa Huang
Supervised by:	Li Huan

A.1 Maximum Conducted Peak Output Power

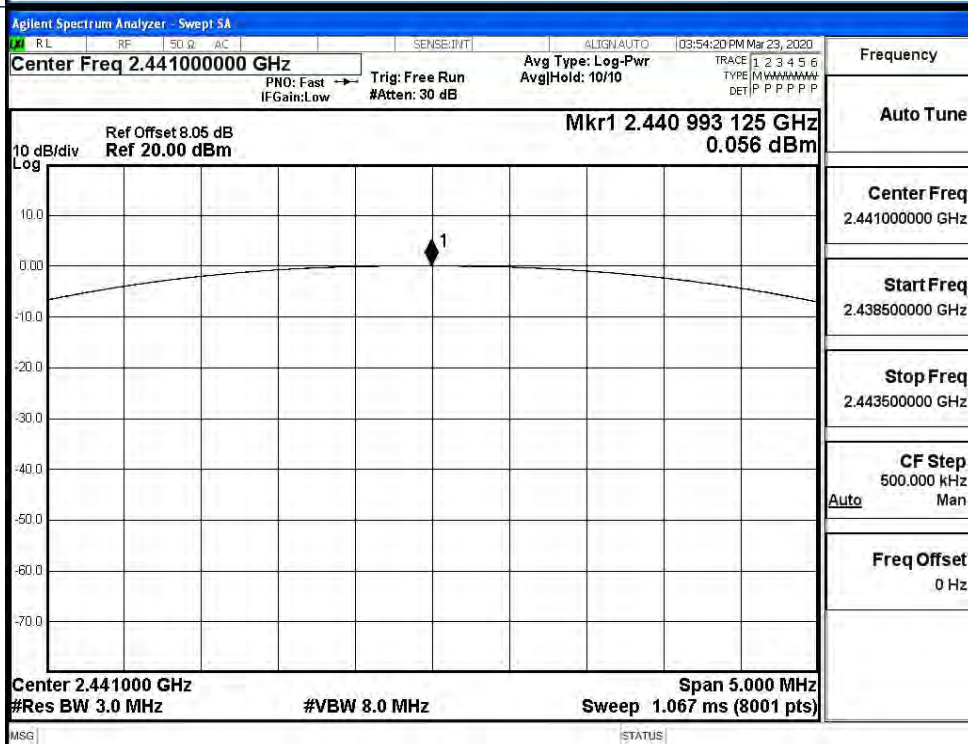
Mode	Channel.	Maximum Peak Output Power [dBm]	Limit [dBm]	Verdict
GFSK	LCH	0.444	30	PASS
	MCH	0.056	30	PASS
	HCH	-0.183	30	PASS
$\pi/4$ DQPSK	LCH	2.931	21	PASS
	MCH	2.601	21	PASS
	HCH	2.373	21	PASS
8DPSK	LCH	3.607	21	PASS
	MCH	3.339	21	PASS
	HCH	3.142	21	PASS

Test Graphs

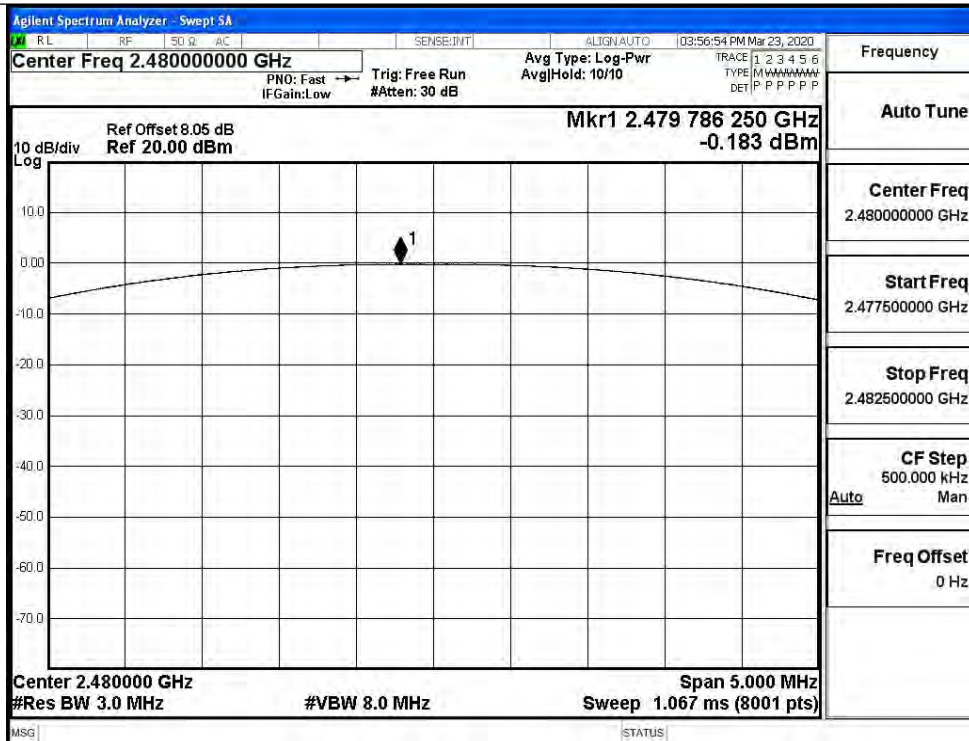
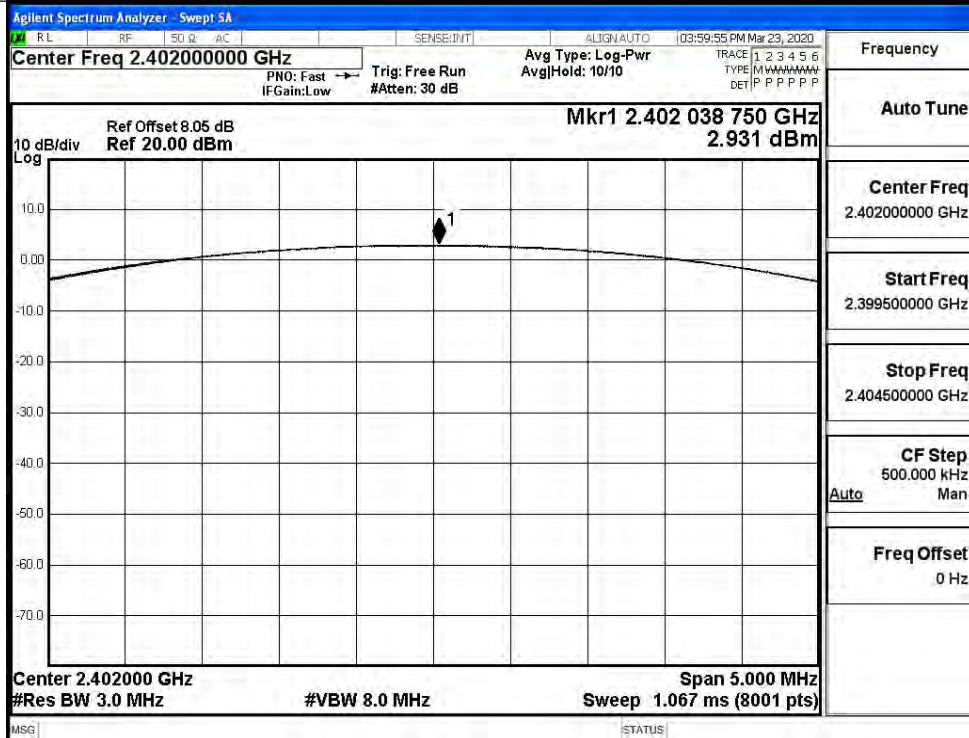
GFSK/LCH

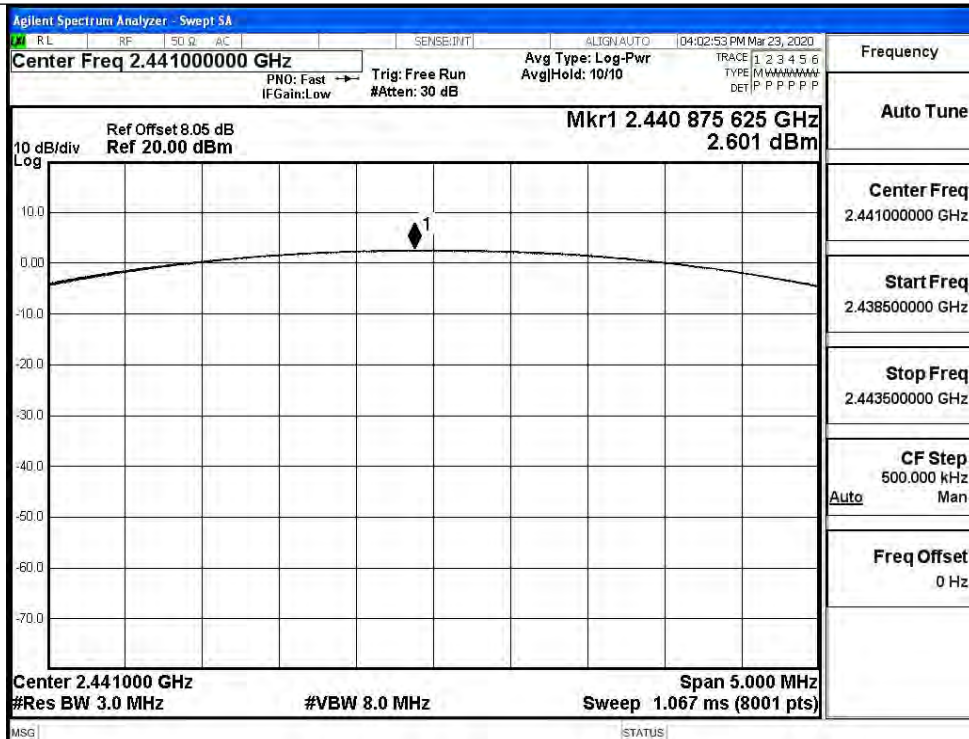
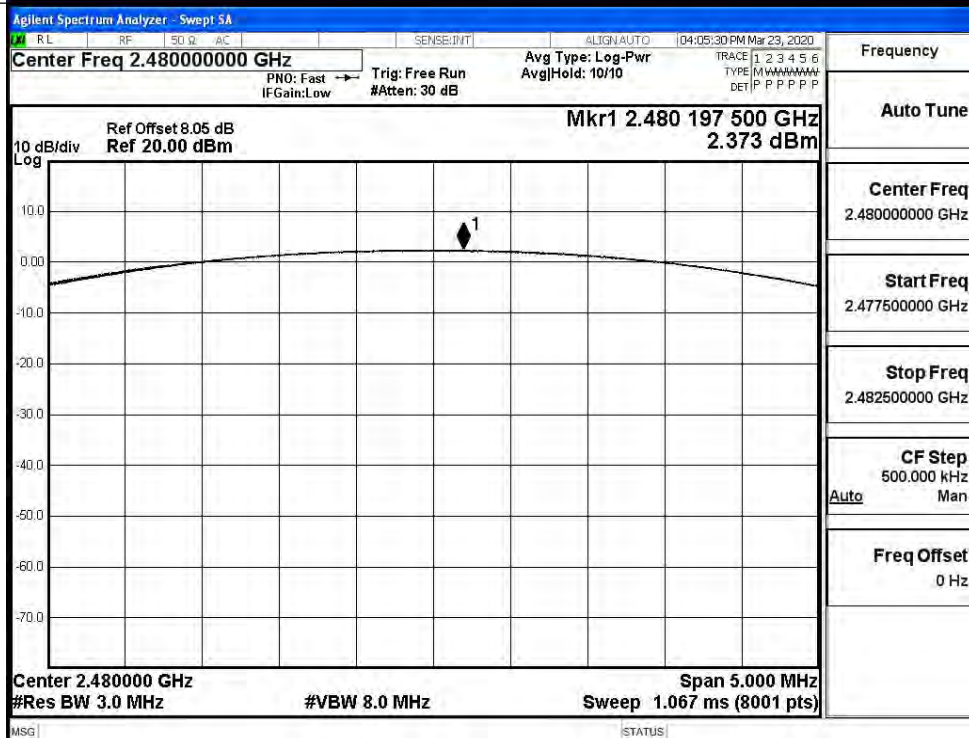


GFSK/MCH

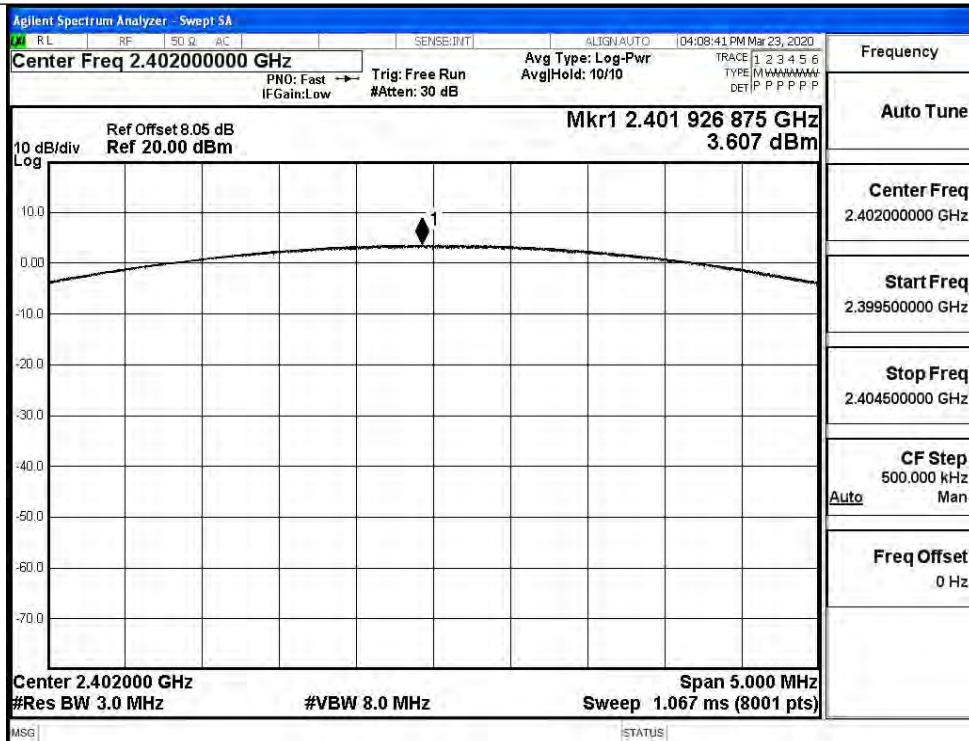


GFSK/HCH

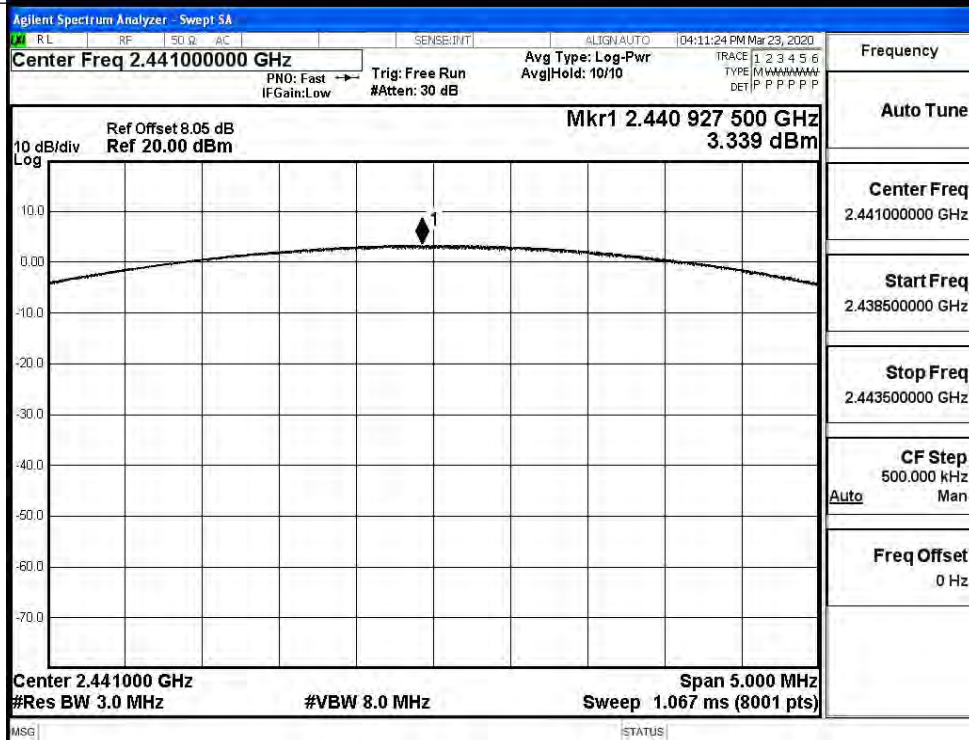
 π /4DQPSK/LCH

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

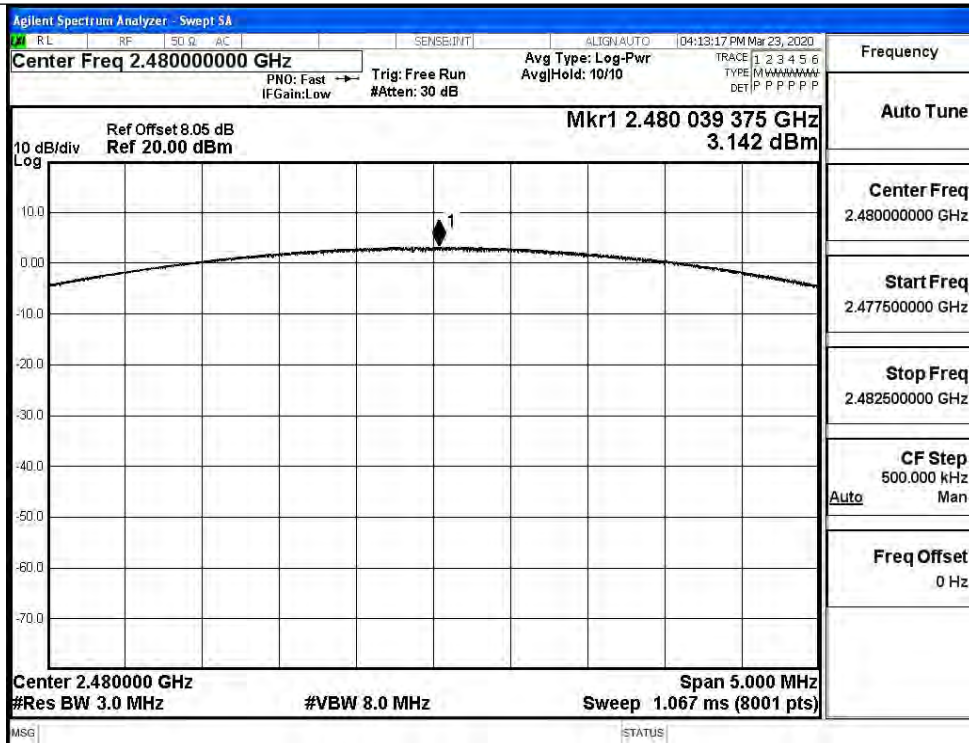
8DPSK/LCH



8DPSK/MCH



8DPSK/HCH

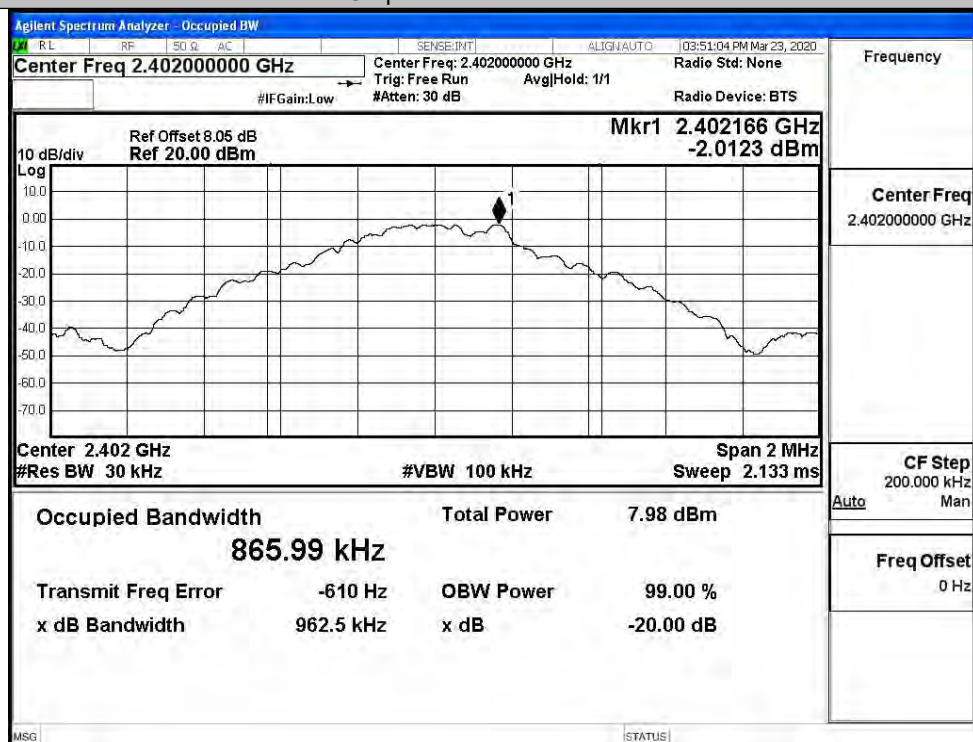


A.2 20dB Bandwidth

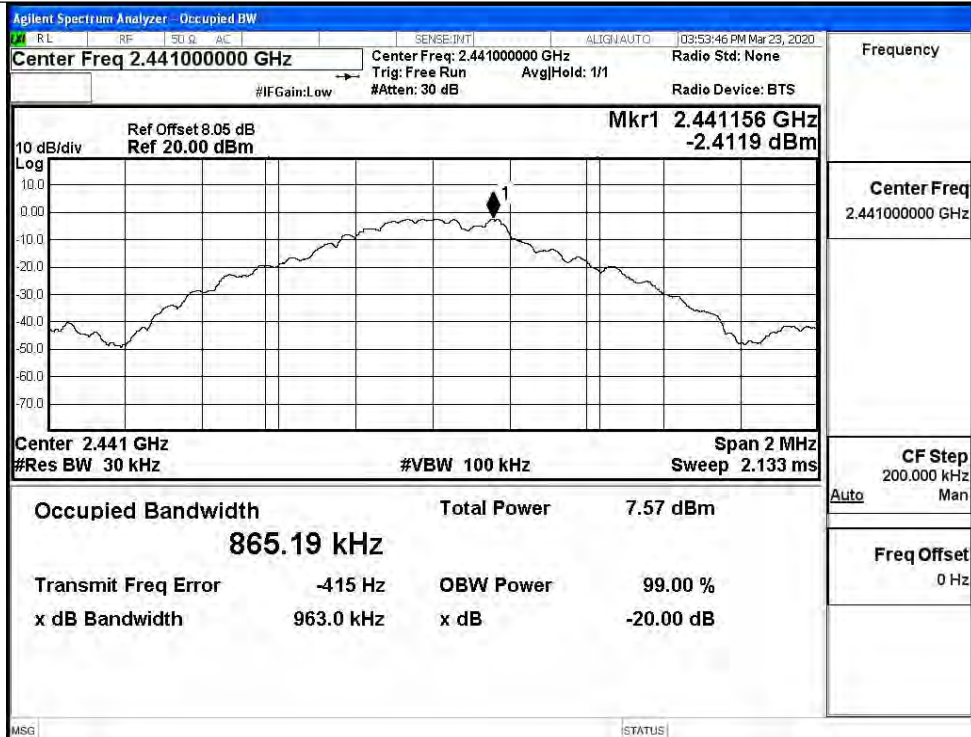
Mode	Channel.	20dB Bandwidth [MHz]	Limit [MHz]	Verdict
GFSK	LCH	0.9625	Not Specified	PASS
	MCH	0.9630	Not Specified	PASS
	HCH	0.9600	Not Specified	PASS
$\pi/4$ DQPSK	LCH	1.336	Not Specified	PASS
	MCH	1.340	Not Specified	PASS
	HCH	1.344	Not Specified	PASS
8DPSK	LCH	1.319	Not Specified	PASS
	MCH	1.321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

Test Graphs

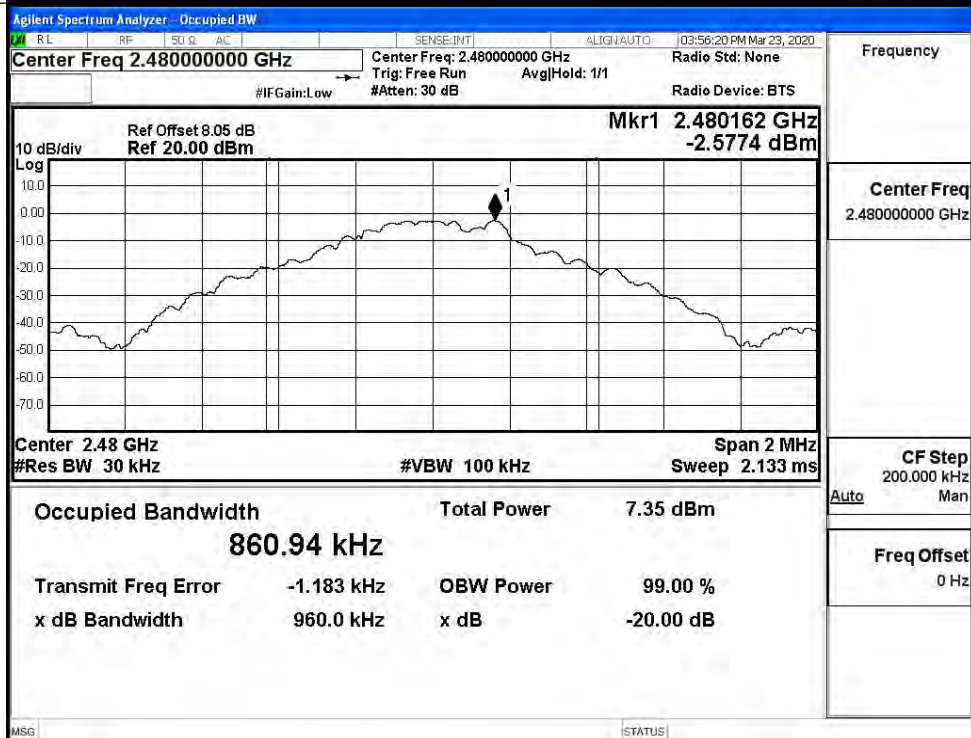
GFSK/LCH

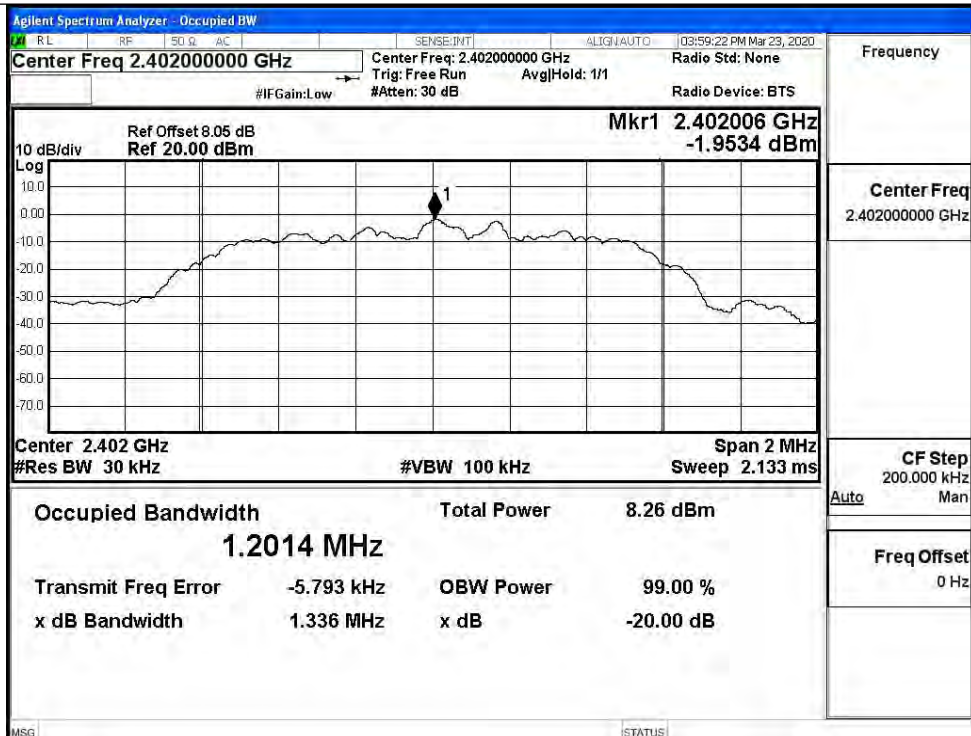
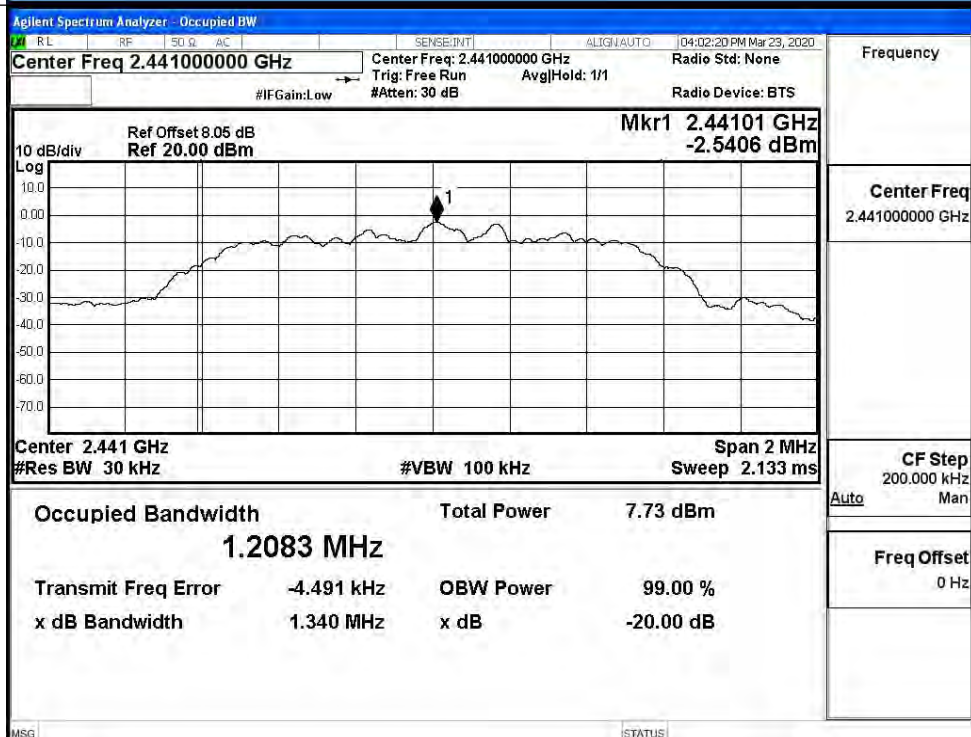


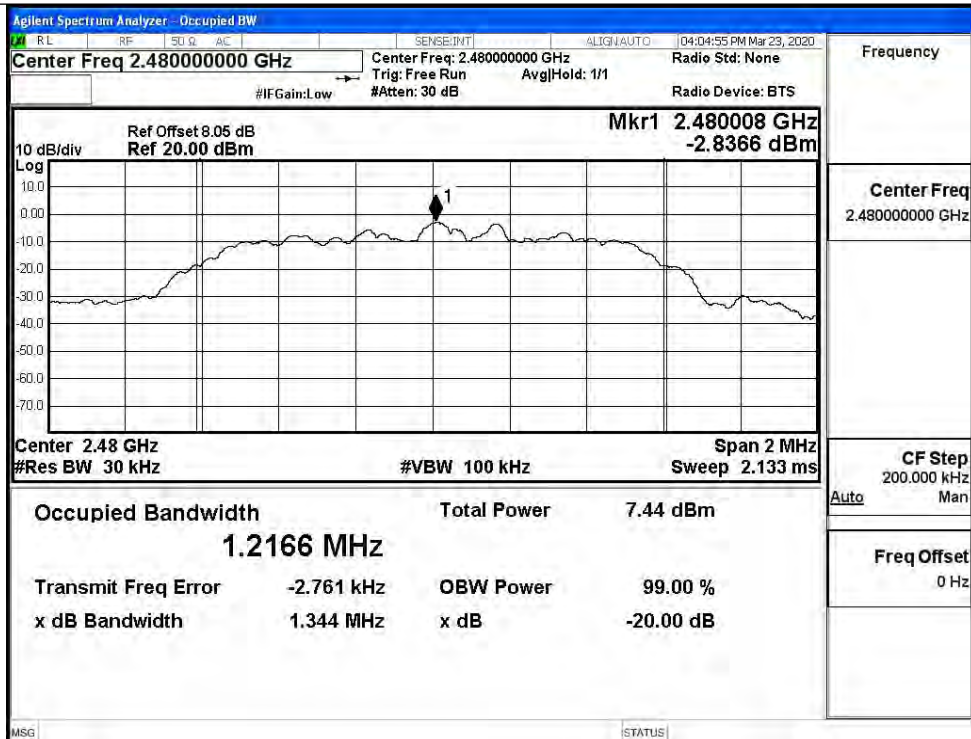
GFSK/MCH



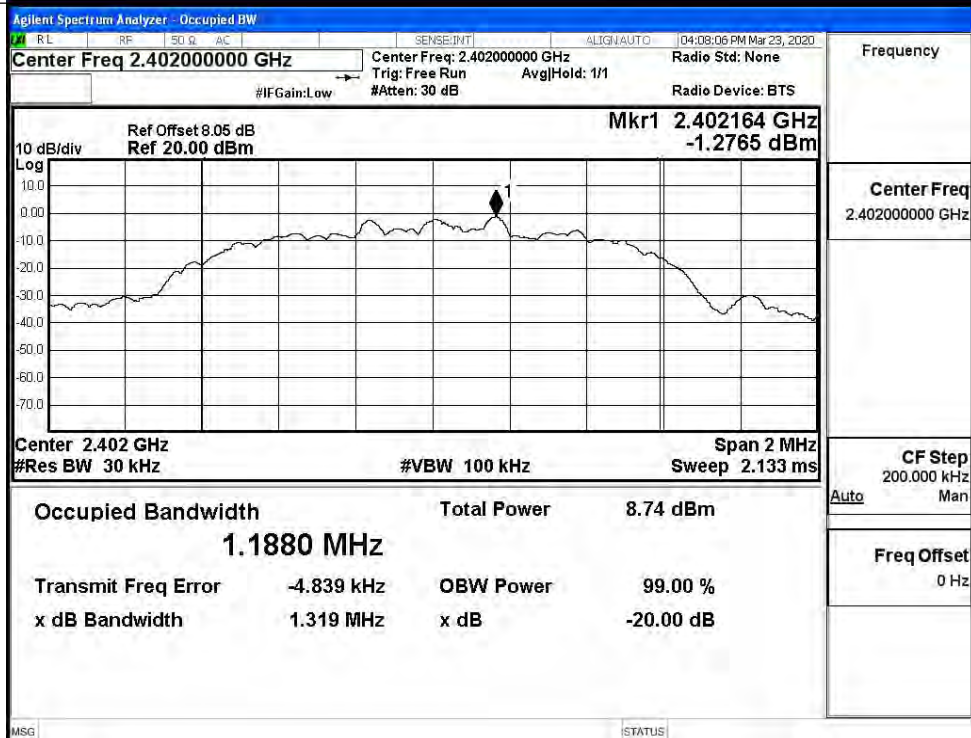
GFSK/HCH



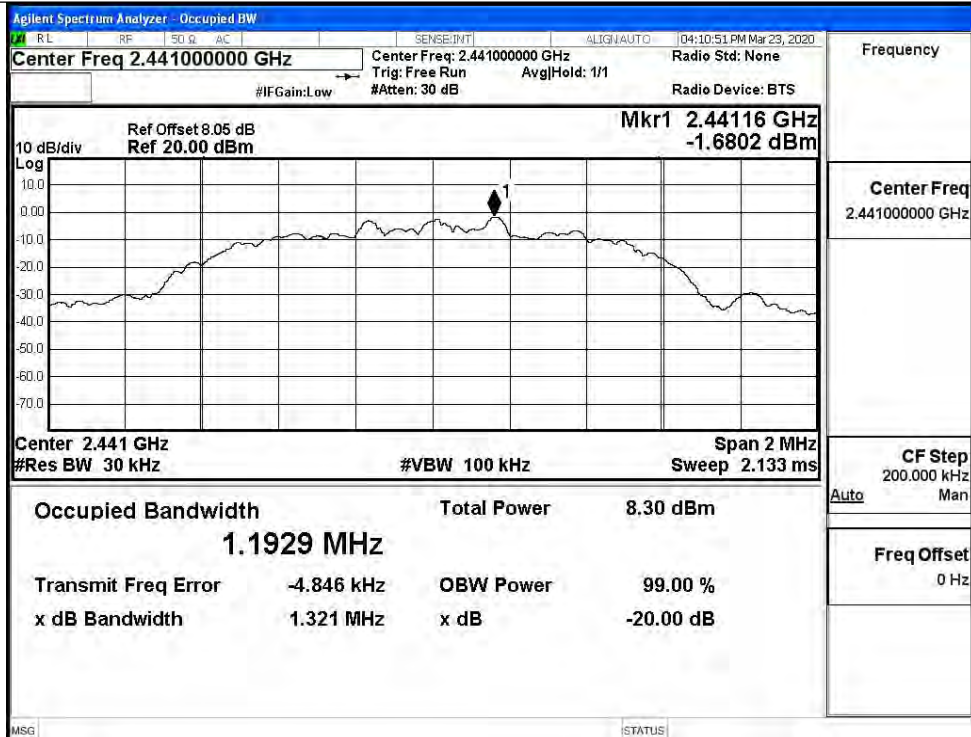
$\pi/4$ DQPSK/LCH $\pi/4$ DQPSK/MCH

$\pi/4$ DQPSK/HCH

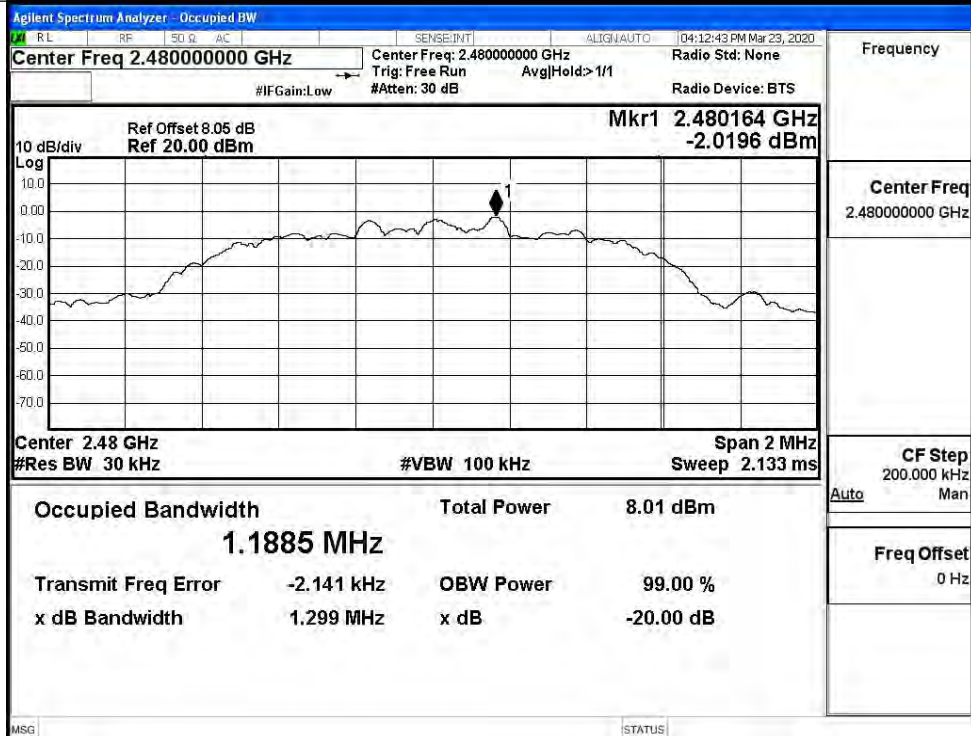
8DPSK/LCH



8DPSK/MCH



8DPSK/HCH

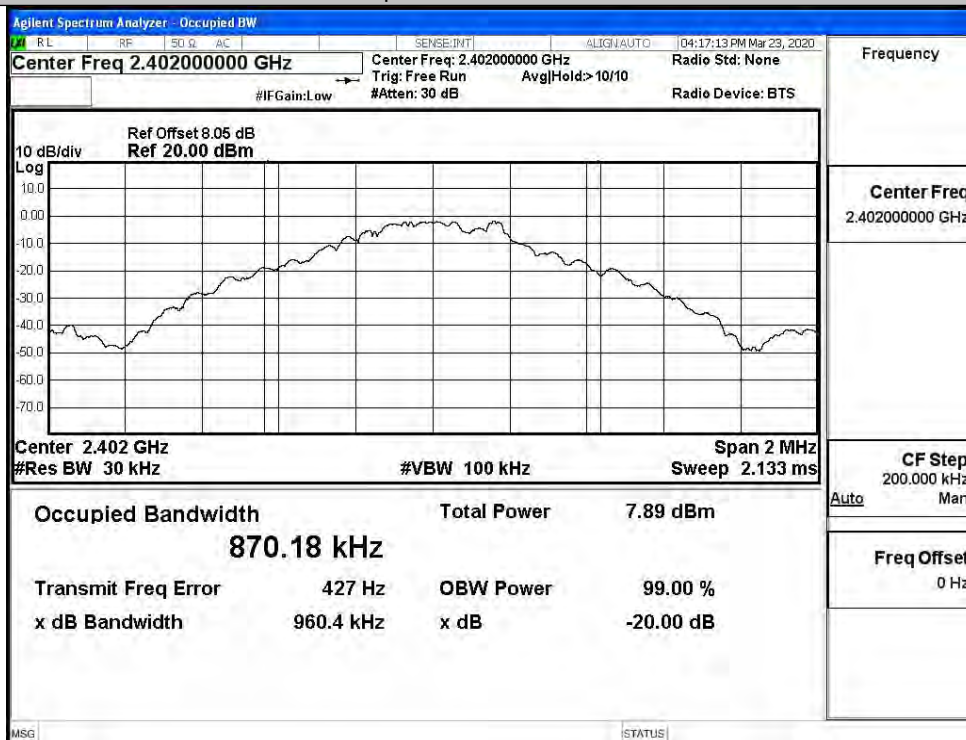


A.3 Occupied Bandwidth

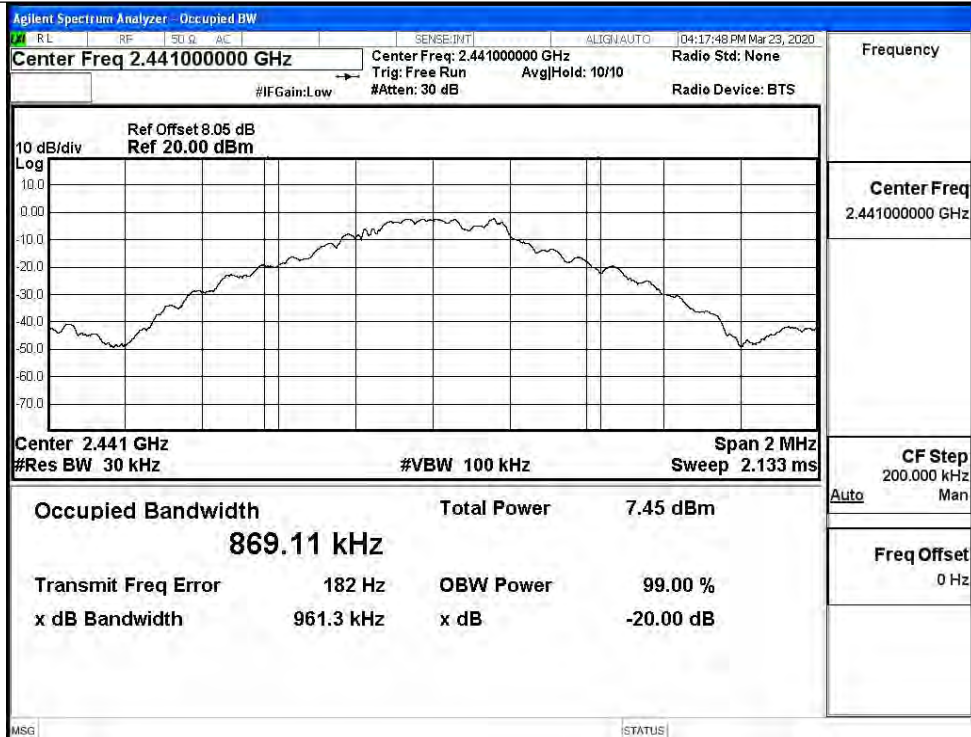
Mode	Channel.	Occupied Bandwidth [MHz]	Limit [MHz]	Verdict
GFSK	LCH	0.87018	Not Specified	PASS
	MCH	0.86911	Not Specified	PASS
	HCH	0.86450	Not Specified	PASS
$\pi/4$ DQPSK	LCH	1.2005	Not Specified	PASS
	MCH	1.2082	Not Specified	PASS
	HCH	1.2199	Not Specified	PASS
8DPSK	LCH	1.1927	Not Specified	PASS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

Test Graphs

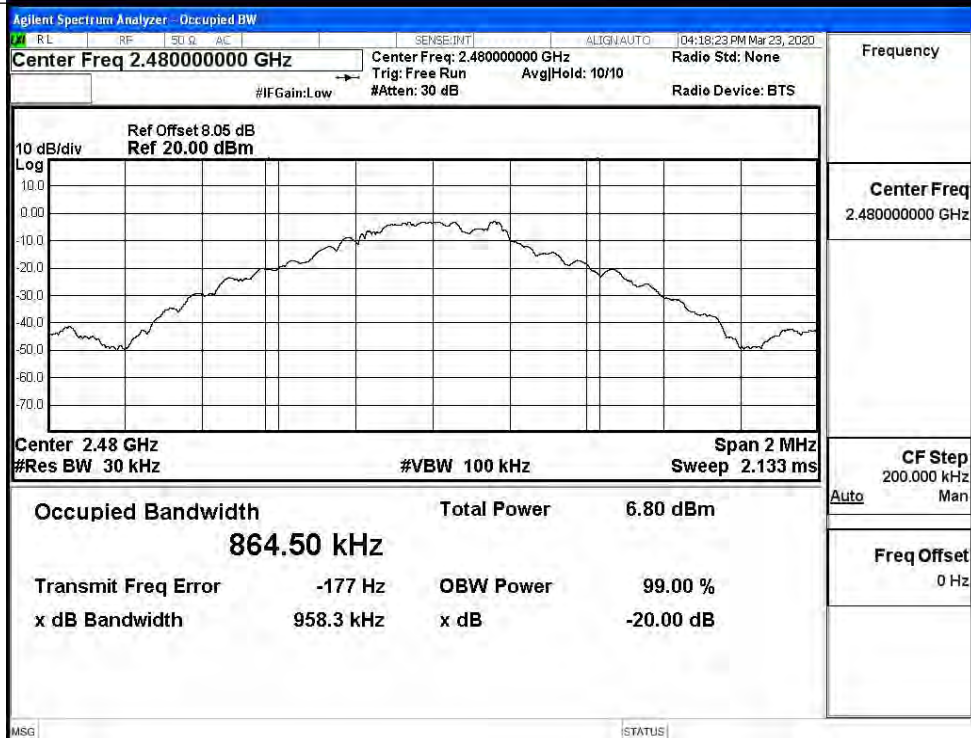
GFSK/LCH

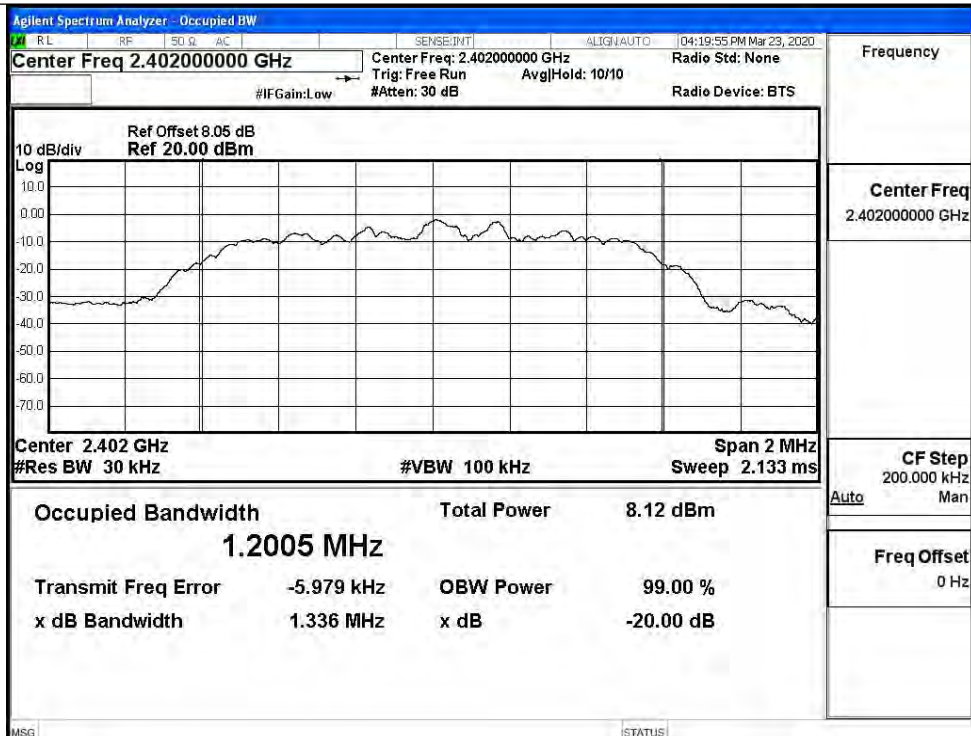
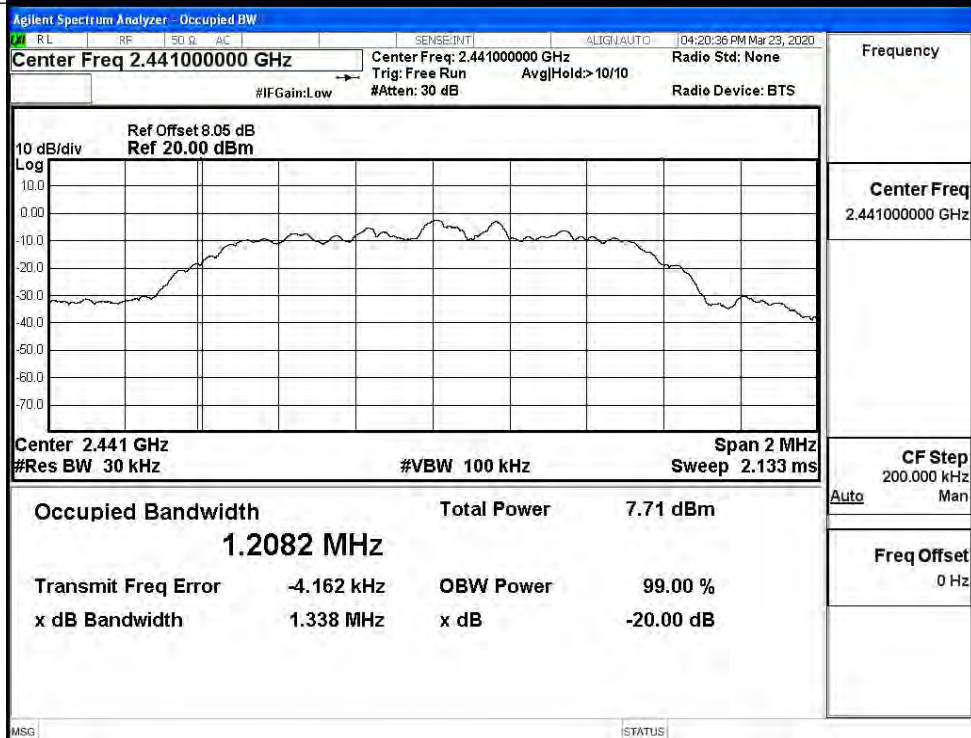


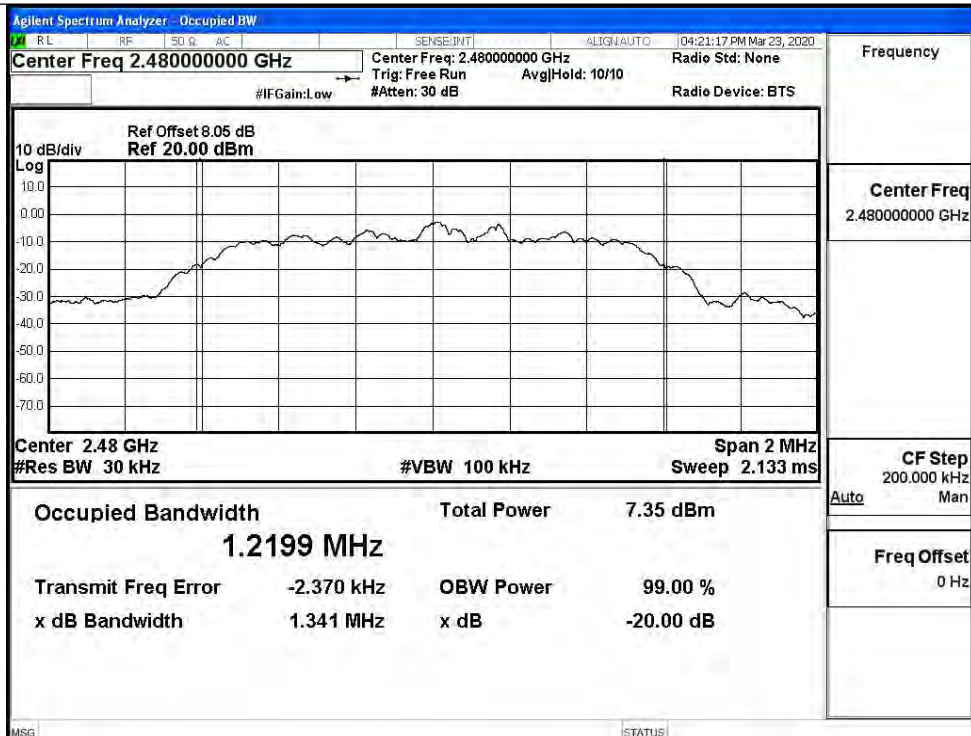
GFSK/MCH



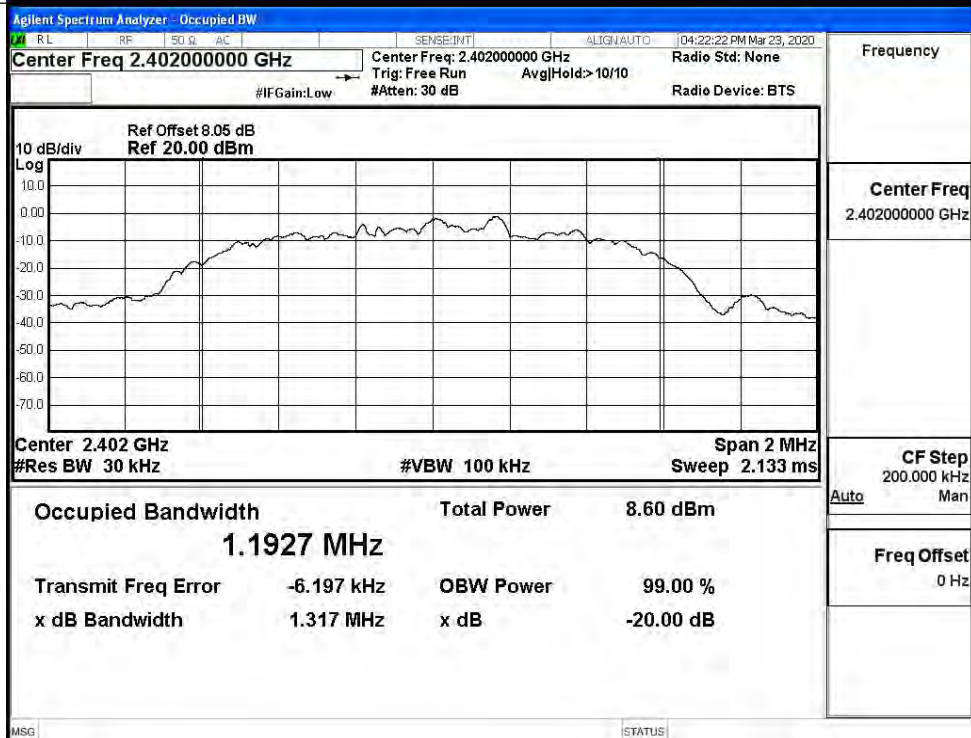
GFSK/HCH



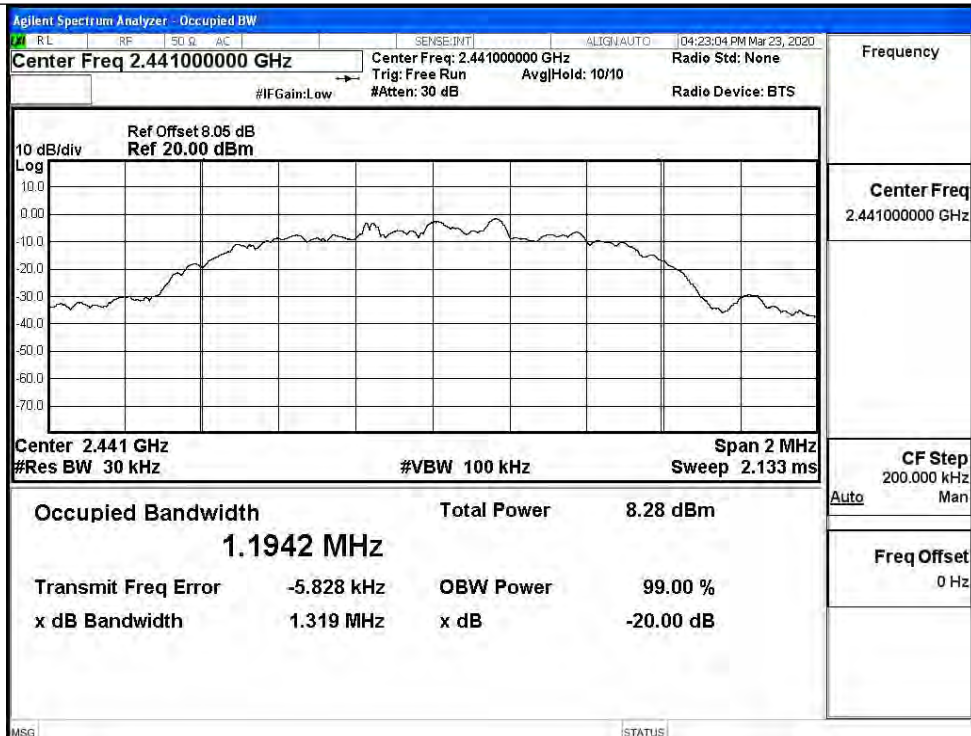
$\pi/4$ DQPSK/LCH $\pi/4$ DQPSK/MCH

$\pi/4$ DQPSK/HCH

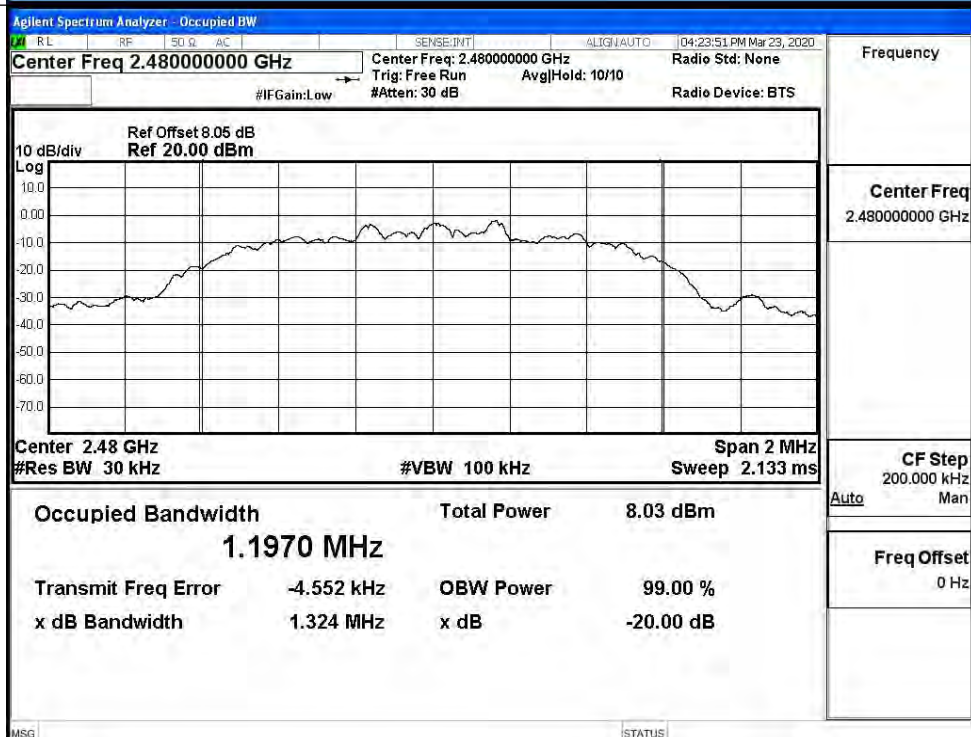
8DPSK/LCH



8DPSK/MCH



8DPSK/HCH

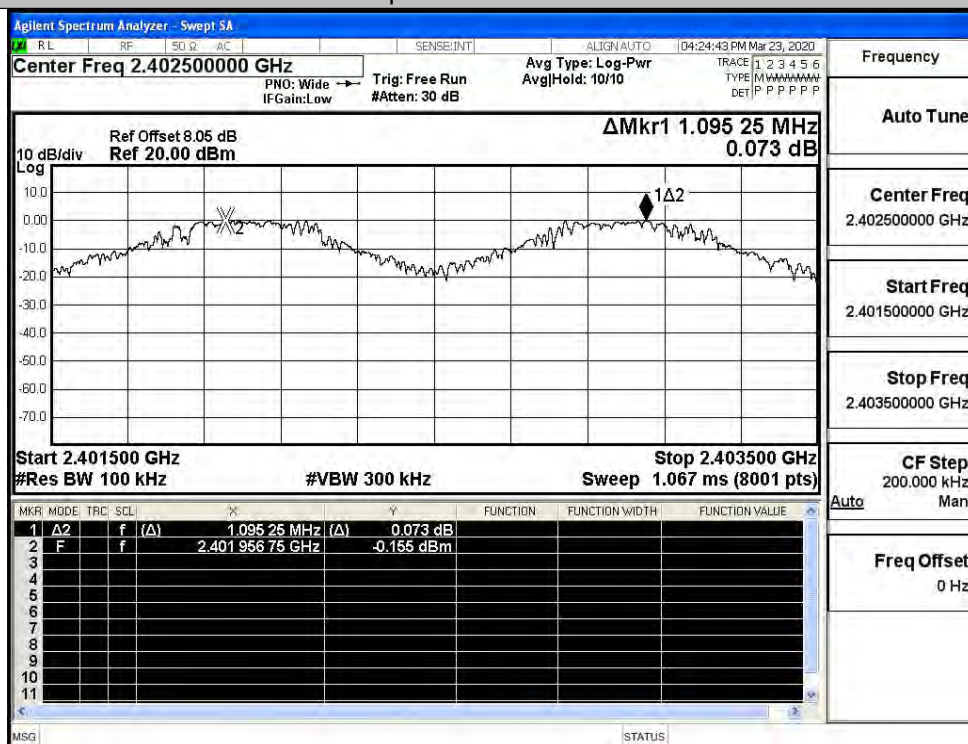


A.4 Carrier Frequency Separation

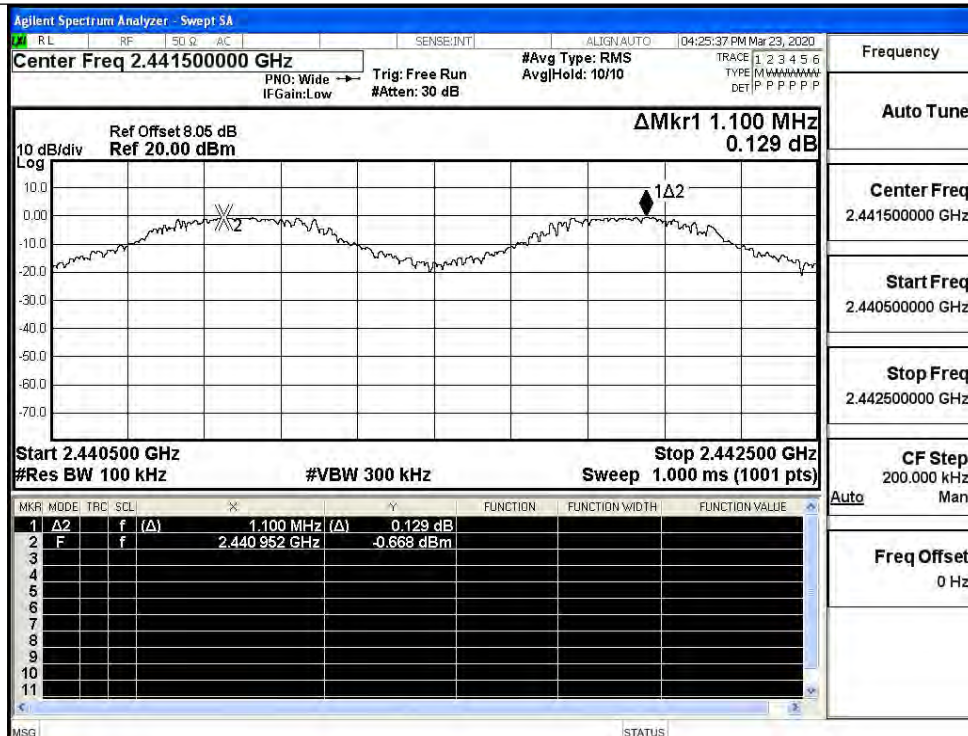
Mode	Channel.	Carrier Frequency Separation [MHz]	Limit [MHz]	Verdict
GFSK	LCH	1.095	0.642	PASS
	MCH	1.100	0.642	PASS
	HCH	1.012	0.642	PASS
$\pi/4$ DQPSK	LCH	0.956	0.896	PASS
	MCH	1.022	0.896	PASS
	HCH	1.000	0.896	PASS
8DPSK	LCH	0.998	0.881	PASS
	MCH	1.006	0.881	PASS
	HCH	0.964	0.881	PASS

Test Graphs

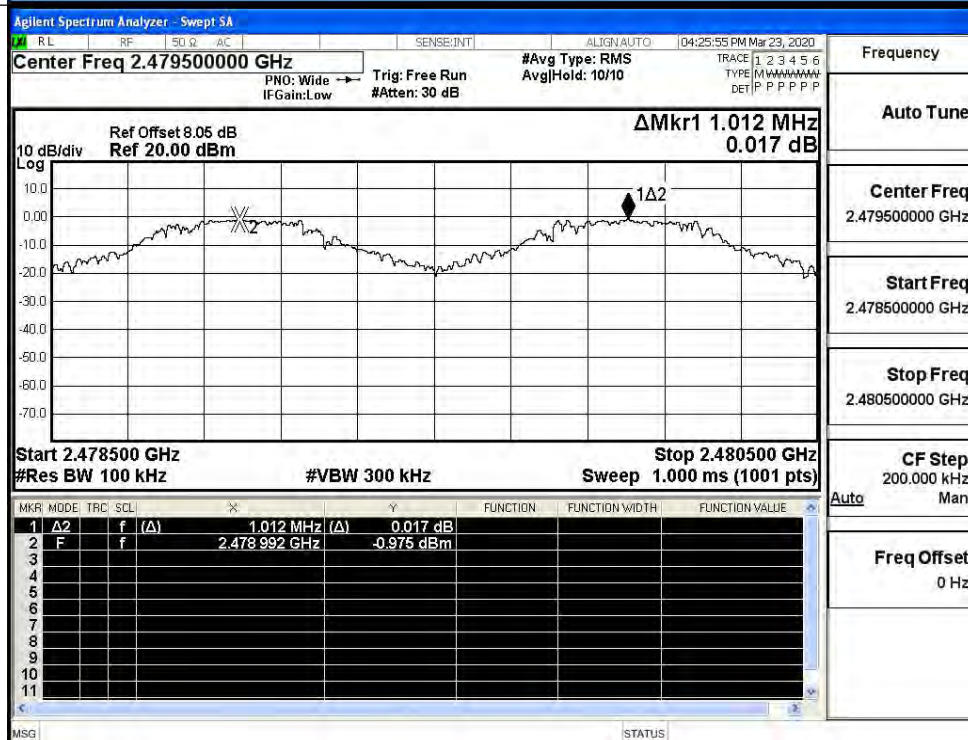
GFSK/LCH

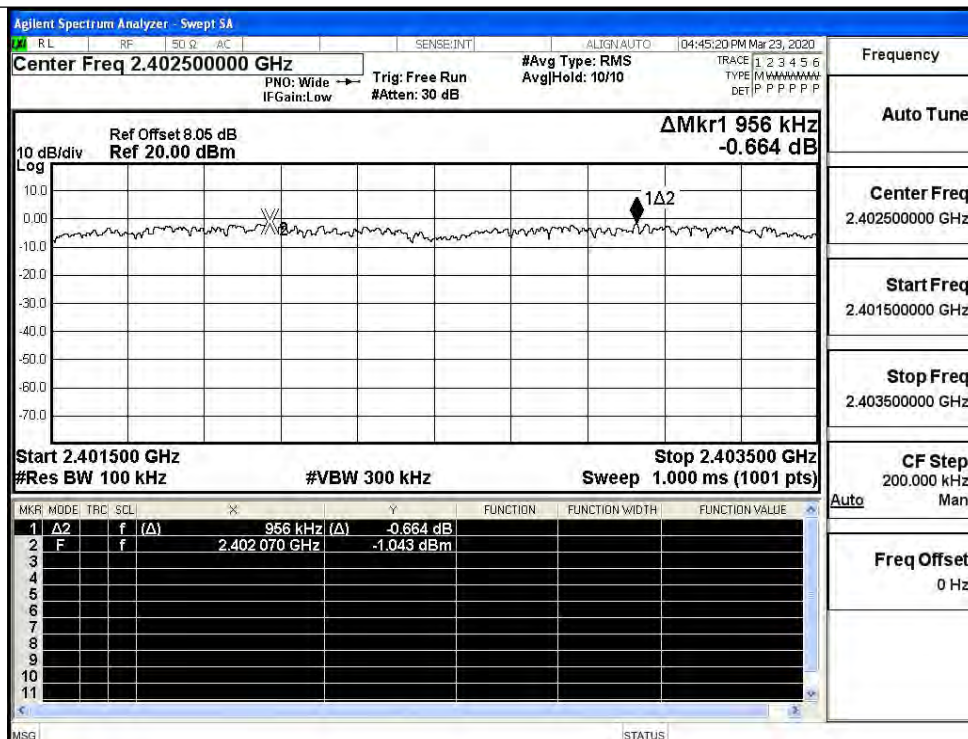
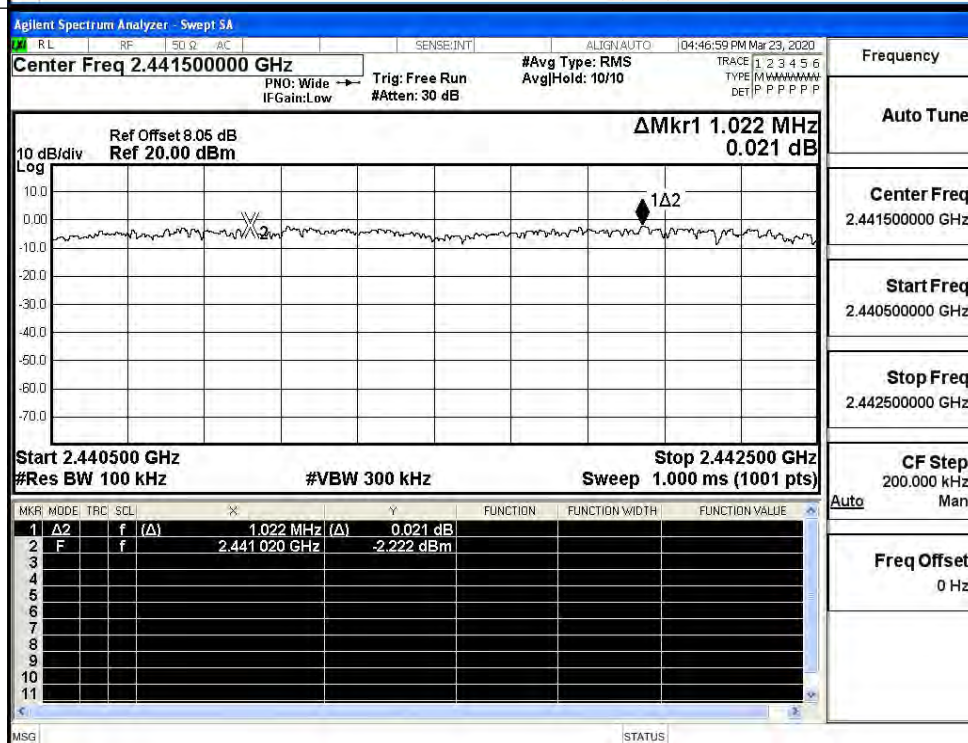


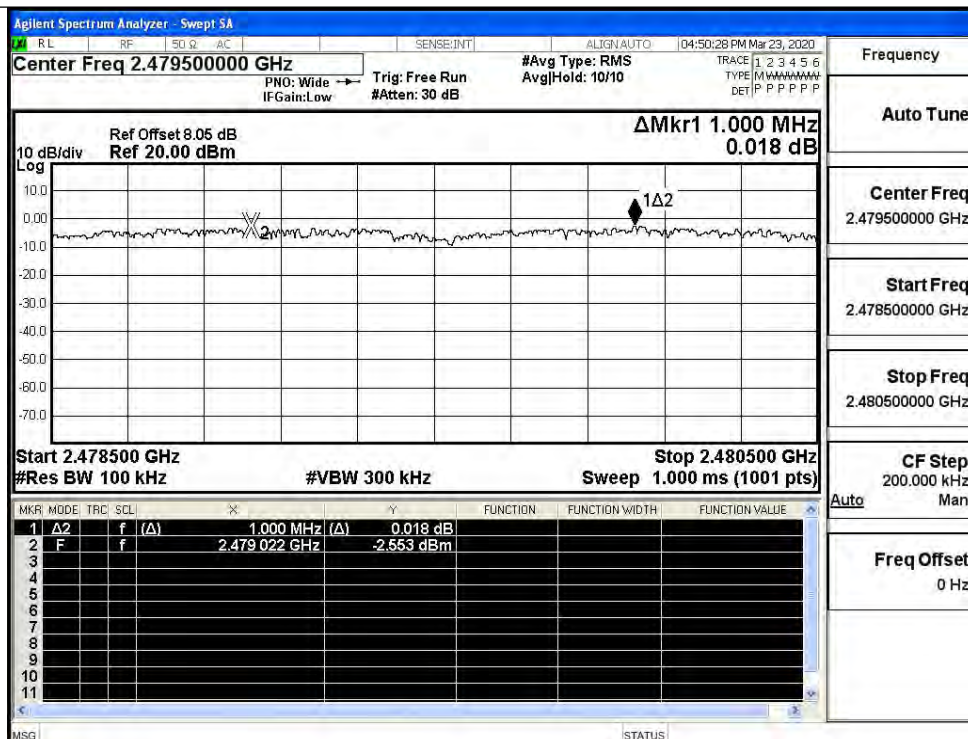
GFSK/MCH



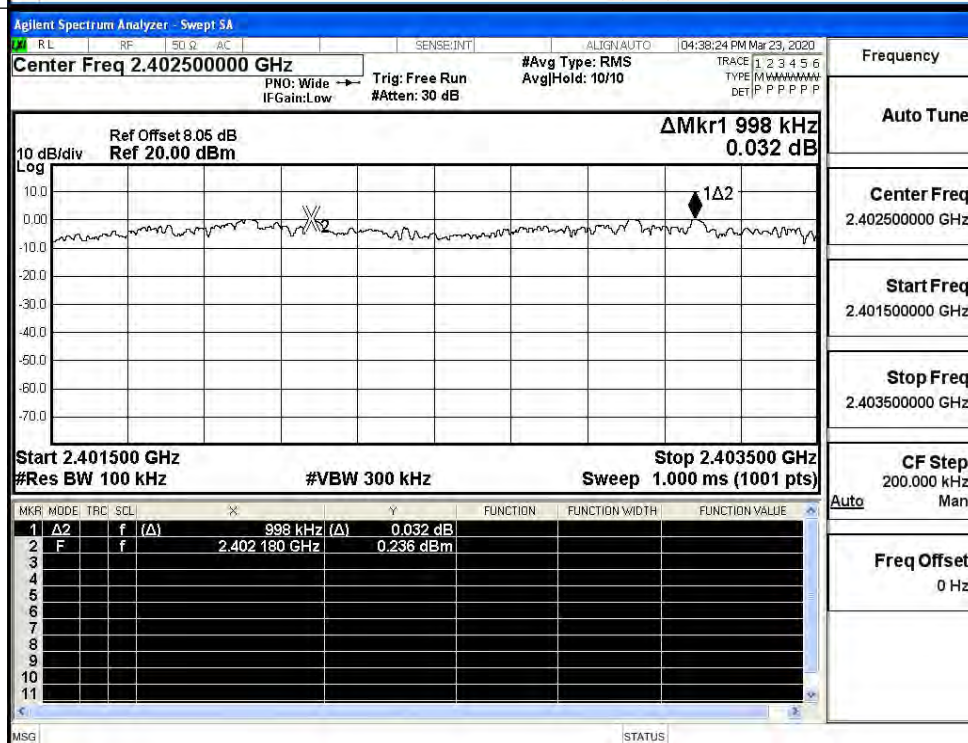
GFSK/HCH



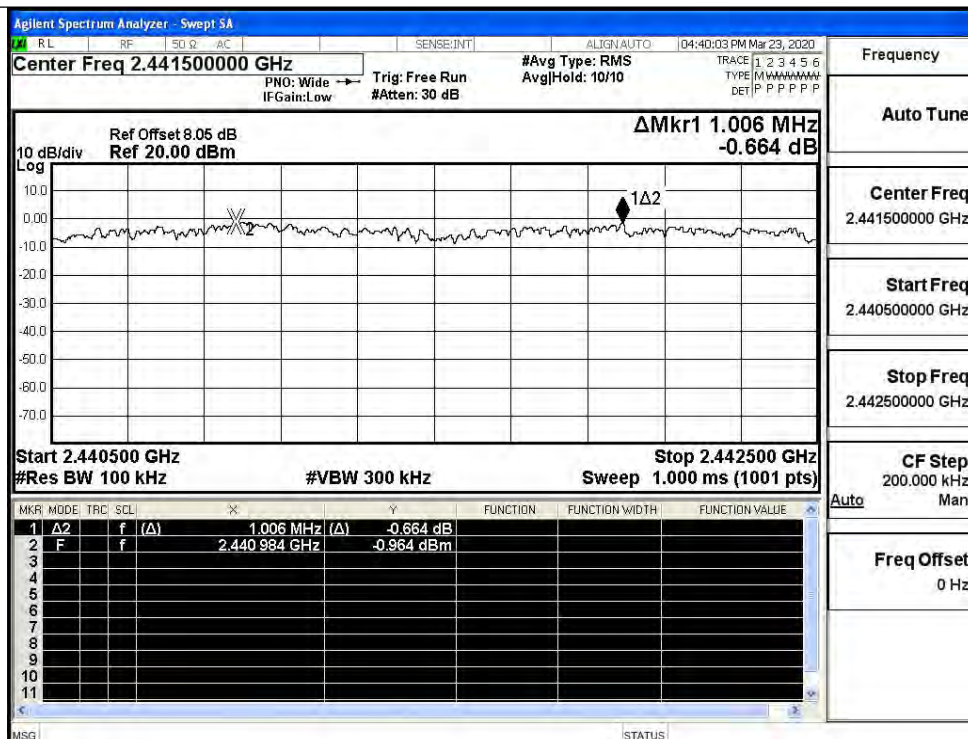
$\pi/4$ DQPSK/LCH $\pi/4$ DQPSK/MCH

$\pi/4$ DQPSK/HCH

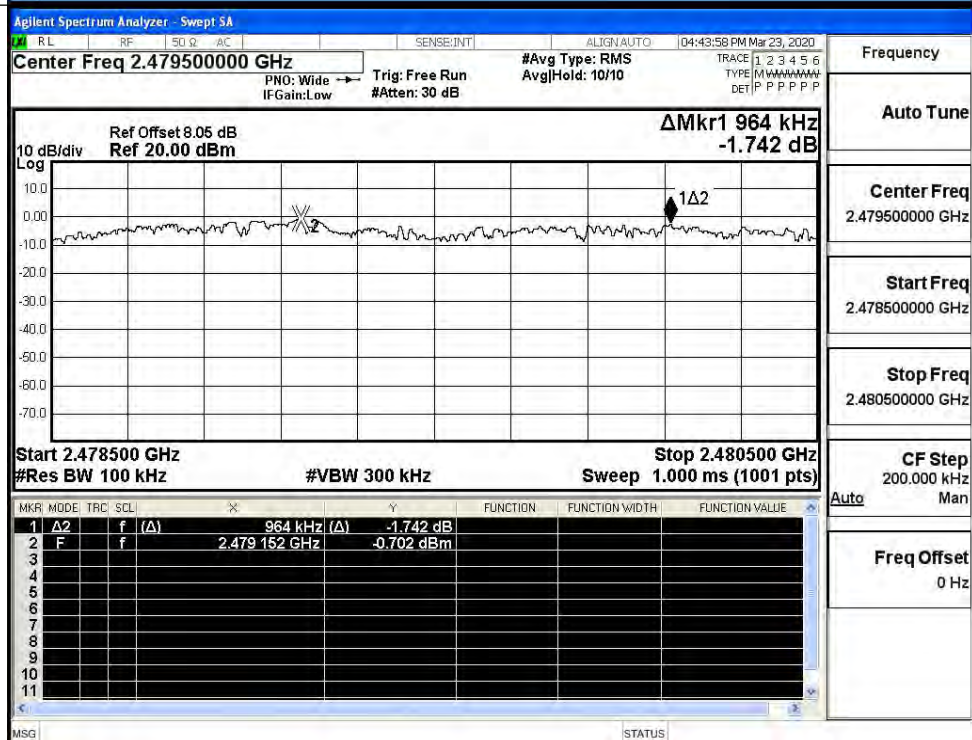
8DPSK/LCH



8DPSK/MCH



8DPSK/HCH

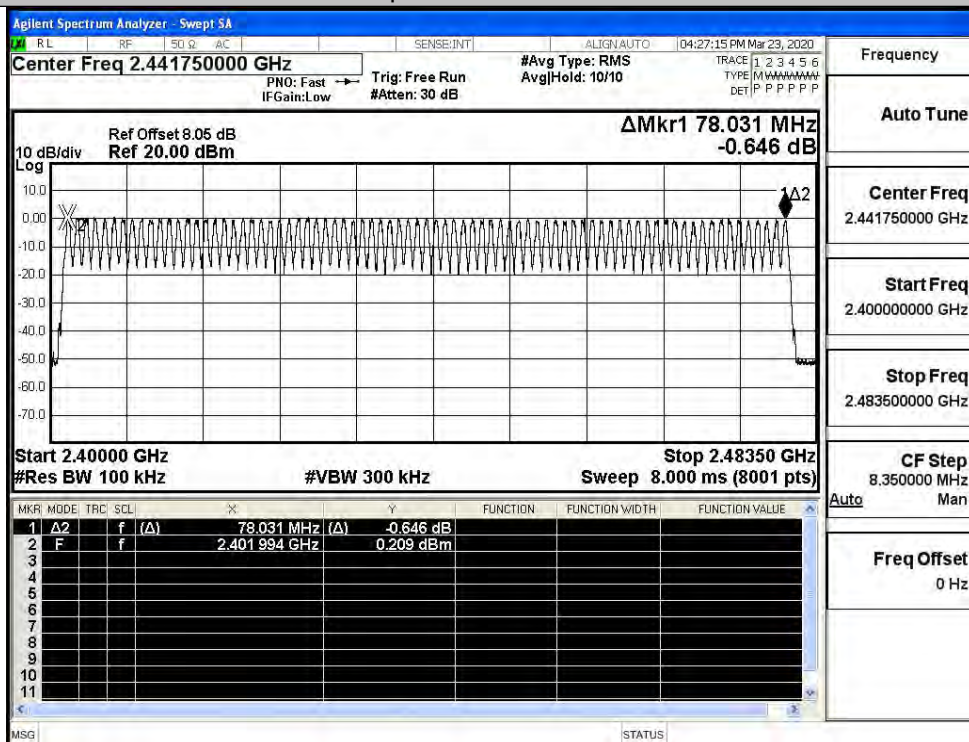
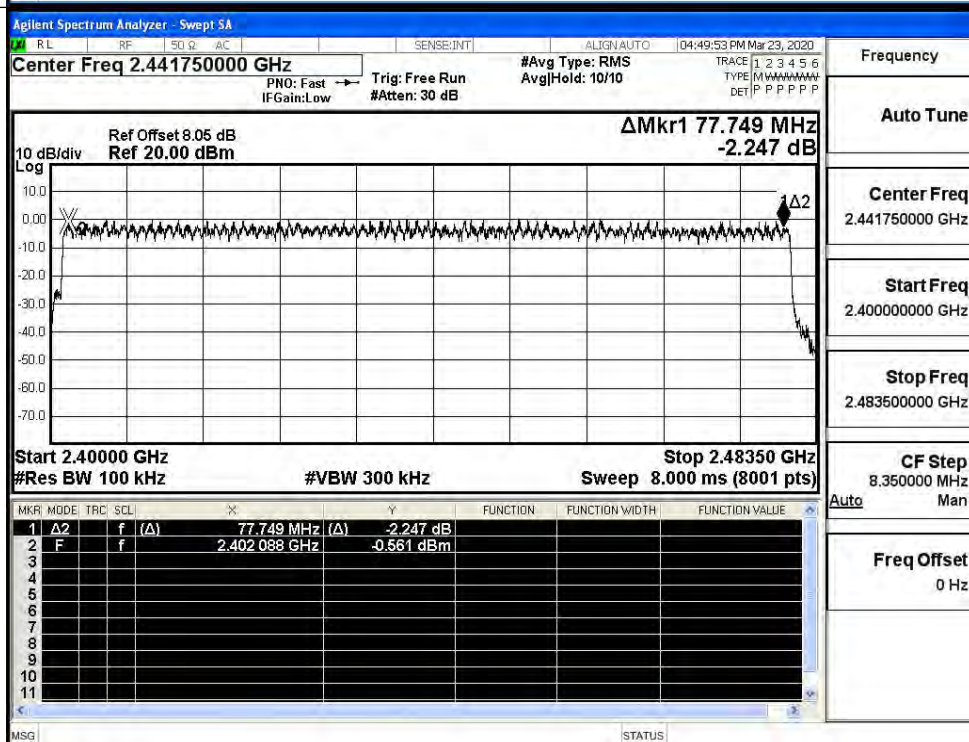


A.5 Hopping Channel Number

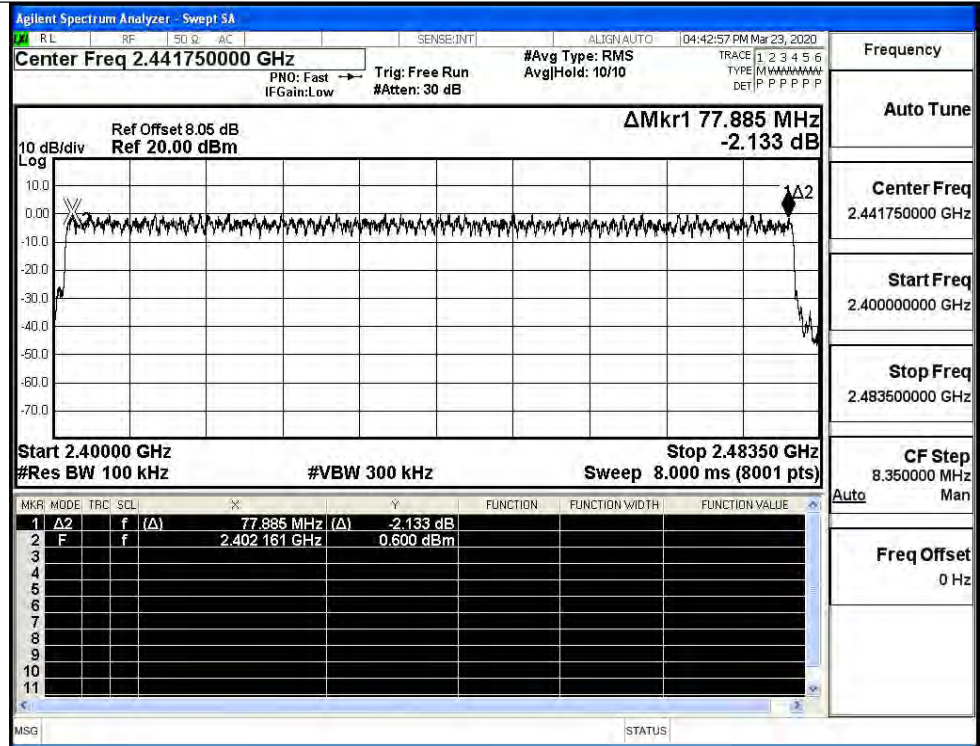
Mode	Channel.	Number of Hopping Channel [N]	Limit [N]	Verdict
GFSK	Hop	79	≥ 15	PASS
$\pi/4$ DQPSK	Hop	79	≥ 15	PASS
8DPSK	Hop	79	≥ 15	PASS

Test Graphs

GFSK/Hop

 $\pi/4$ DQPSK/Hop

8DPSK/Hop

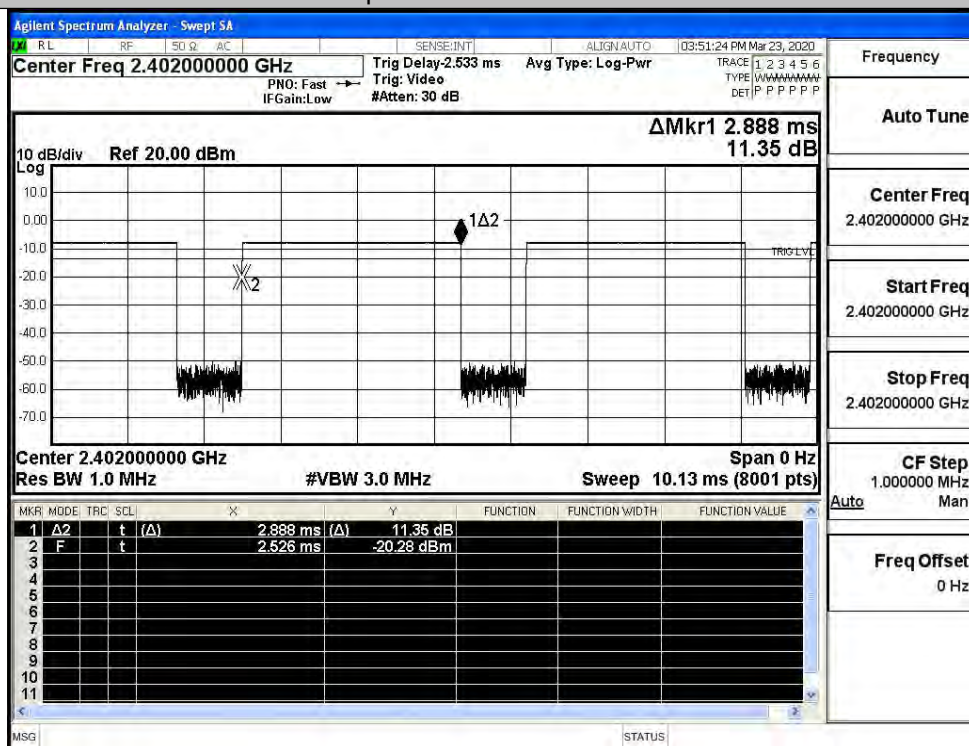


A.6 Dwell Time

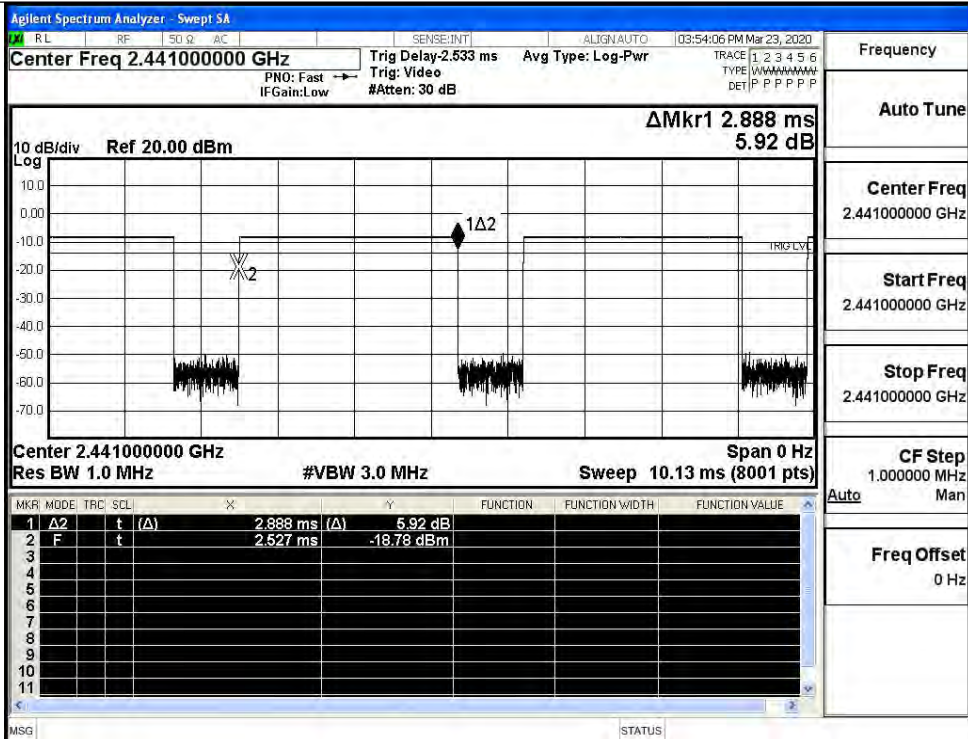
Mode	Packet	Channel	Burst Width [ms/hop/ch]	Total Hops[hop*ch]	Dwell Time[s]	Limit [s]	Verdict
GFSK	DH5	LCH	2.89	106.7	0.308	0.4	PASS
	DH5	MCH	2.89	106.7	0.308	0.4	PASS
	DH5	HCH	2.89	106.7	0.308	0.4	PASS
$\pi/4$ DQPSK	2DH5	LCH	2.89	106.7	0.308	0.4	PASS
	2DH5	MCH	2.89	106.7	0.308	0.4	PASS
	2DH5	HCH	2.89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

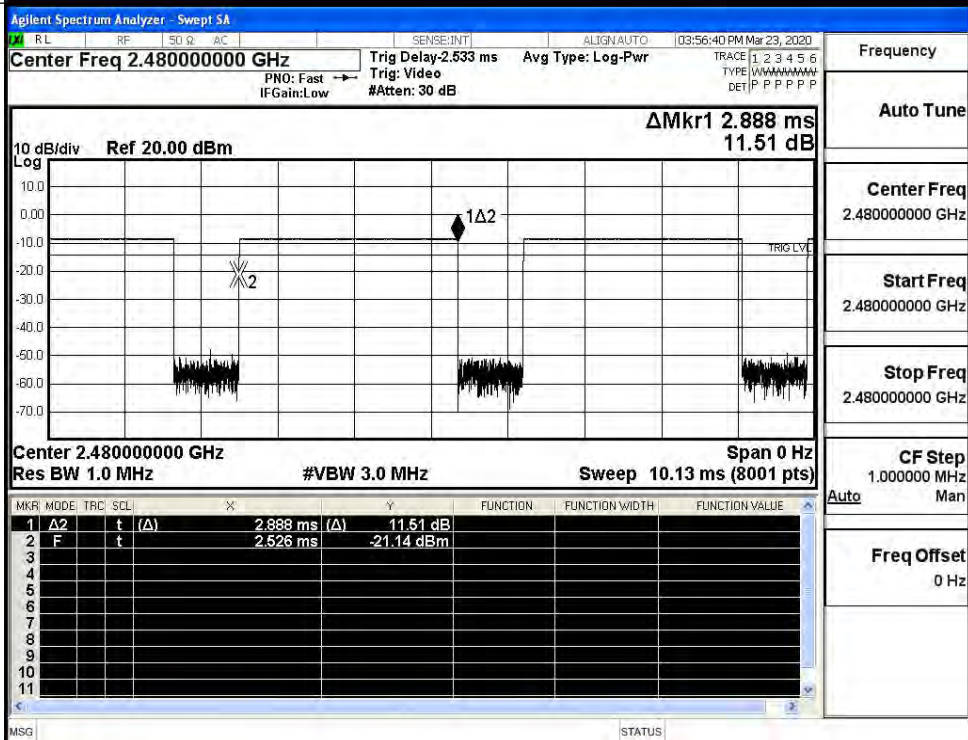
GFSK_DH5/LCH



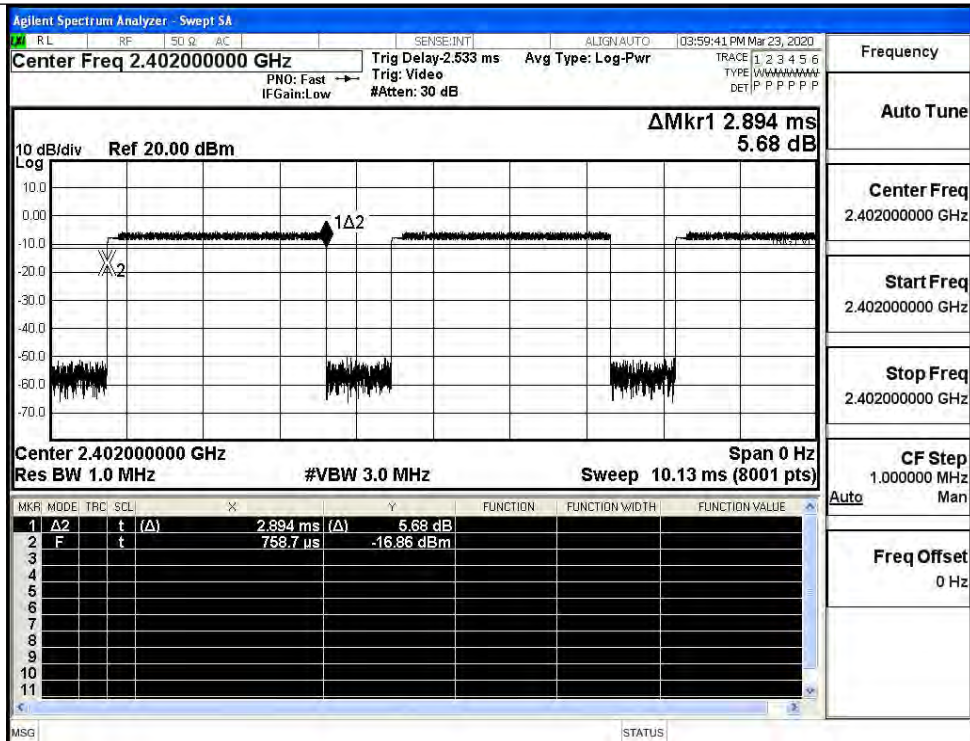
GFSK_DH5/MCH



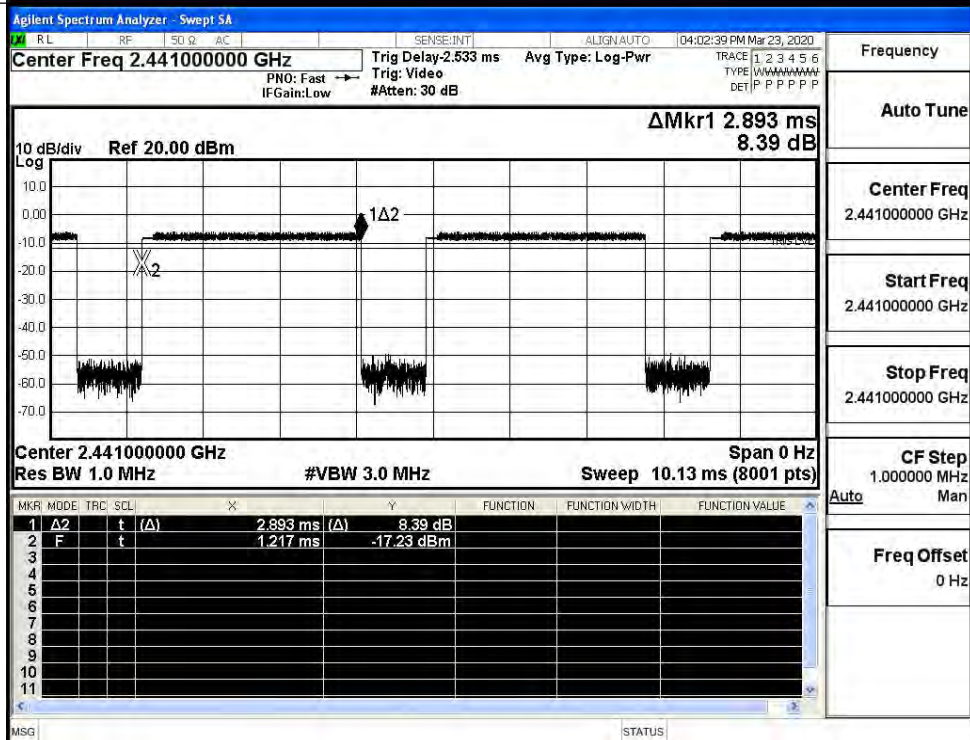
GFSK_DH5/HCH



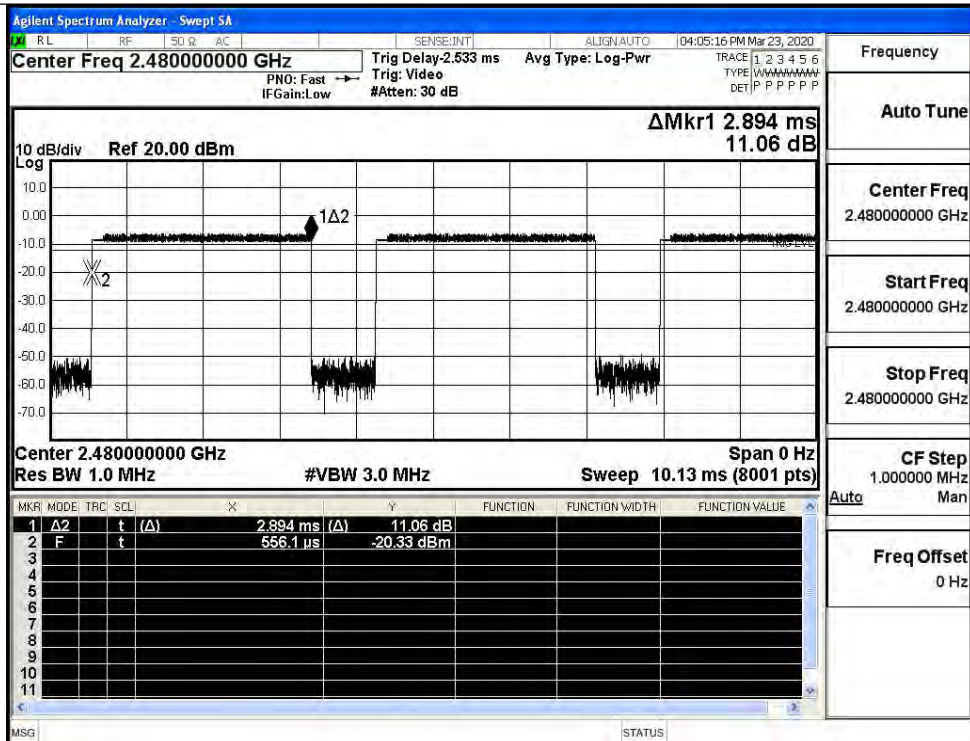
$\pi/4$ DQPSK
_2DH5/LCH



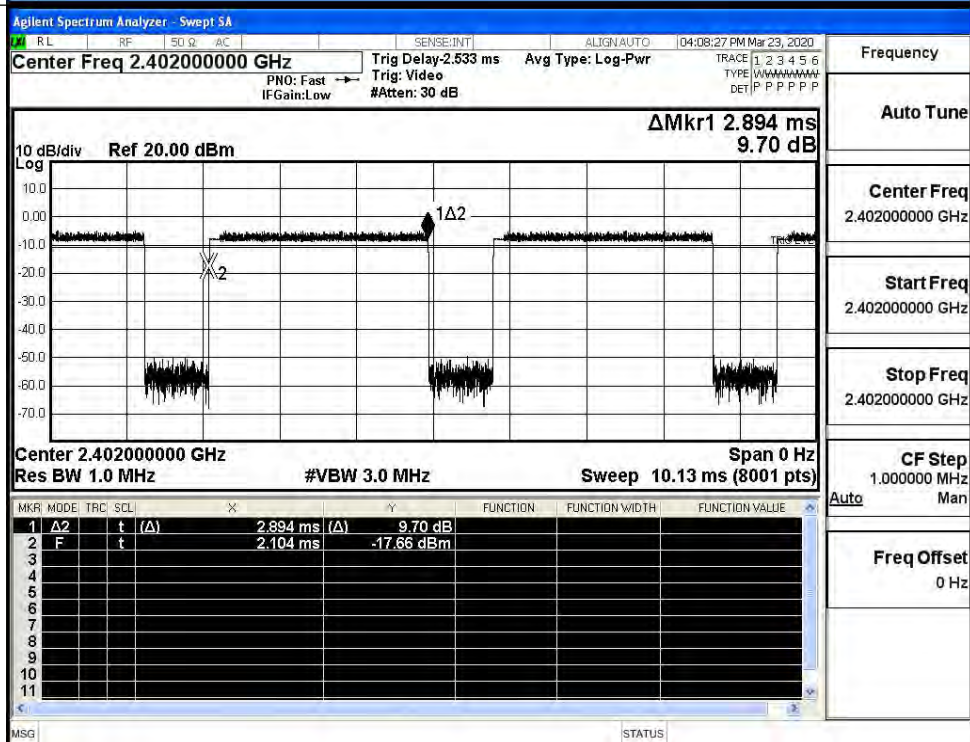
$\pi/4$ DQPSK
_2DH5/MCH



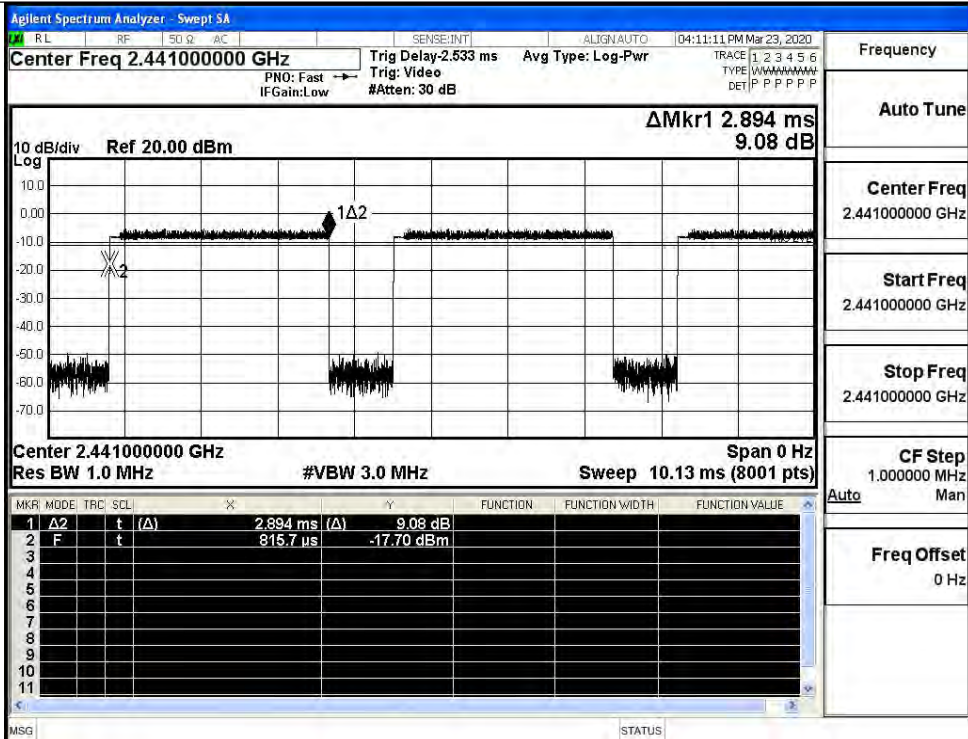
$\pi/4$ DQPSK
_2DH5/HCH



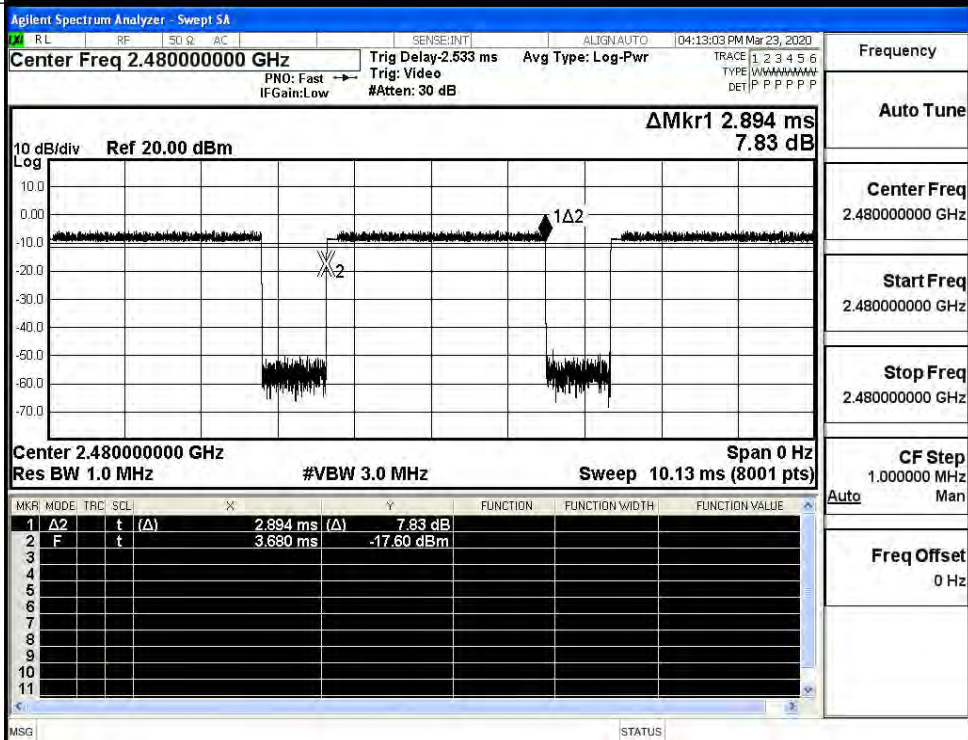
8DPSK _3DH5/LCH



8DPSK_3DH5/MCH



8DPSK_3DH5/HCH

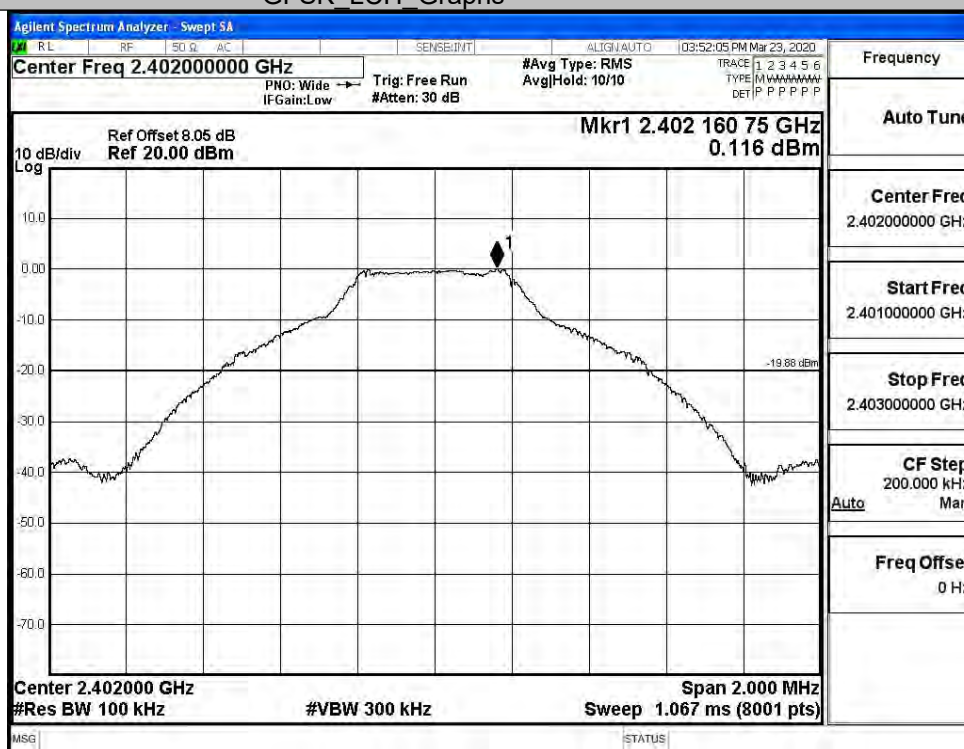


A.7 RF Conducted Spurious Emissions

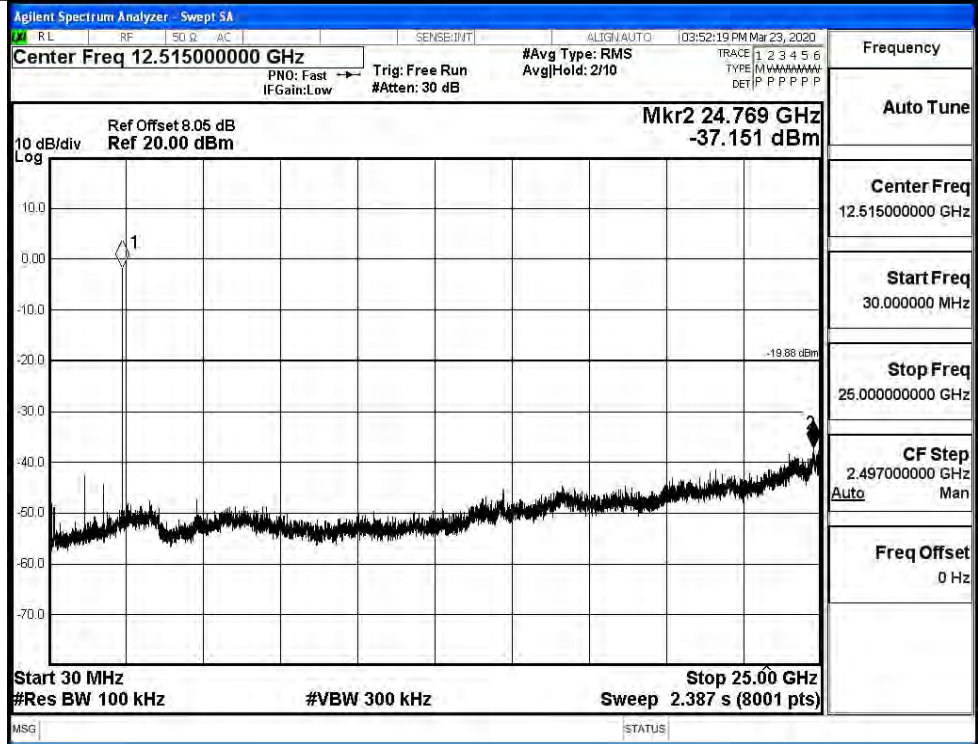
Mode	Channel	Pref [dBm]	Max. Level [dBm]	Limit [dBm]	Verdict
GFSK	LCH	0.116	-37.151	-19.884	PASS
	MCH	-0.093	-37.837	-20.093	PASS
	HCH	-0.335	-37.786	-20.335	PASS
$\pi/4$ DQPSK	LCH	0.24	-37.233	-19.760	PASS
	MCH	-0.391	-37.822	-20.391	PASS
	HCH	-0.528	-37.536	-20.528	PASS
8DPSK	LCH	0.097	-37.497	-19.903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

GFSK LCH Graphs

Pref

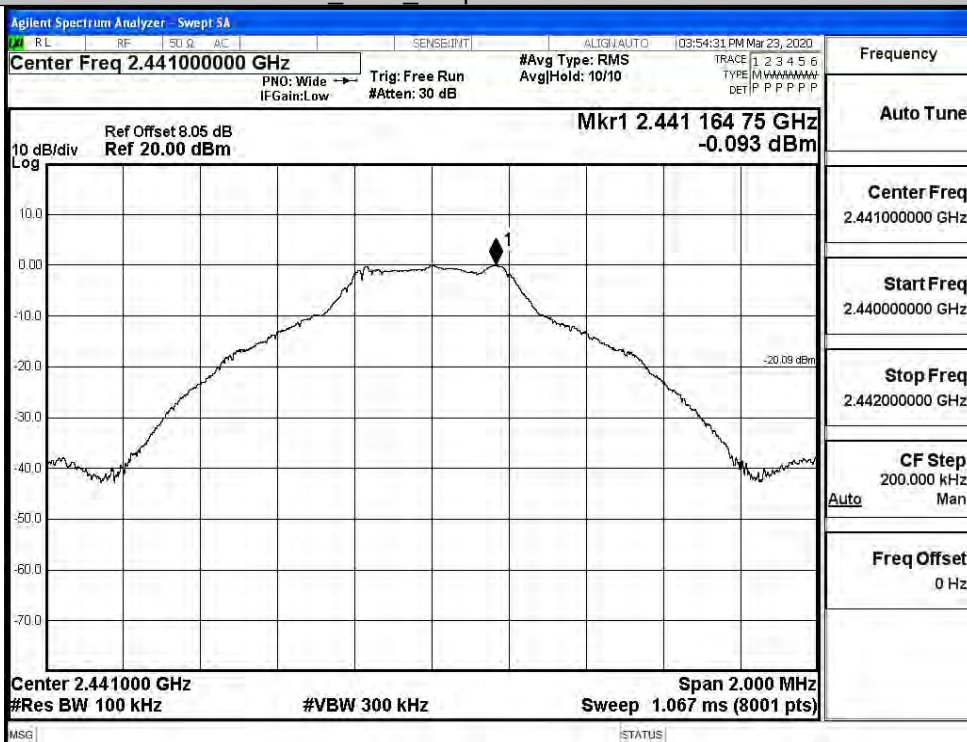


Puw

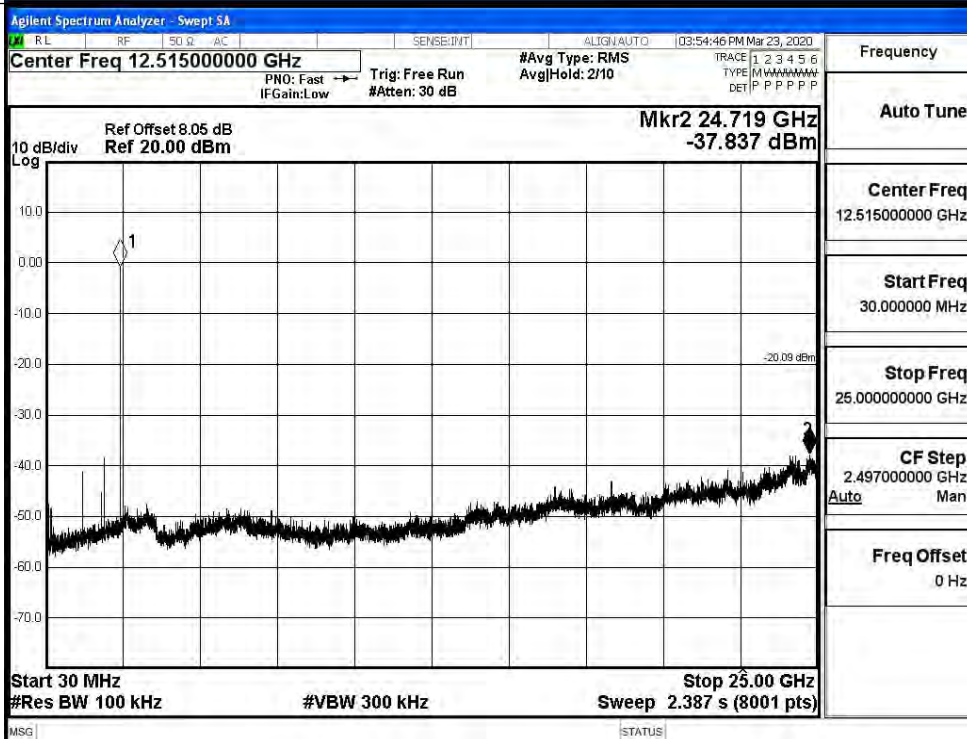


GFSK_MCH_Graphs

Pref

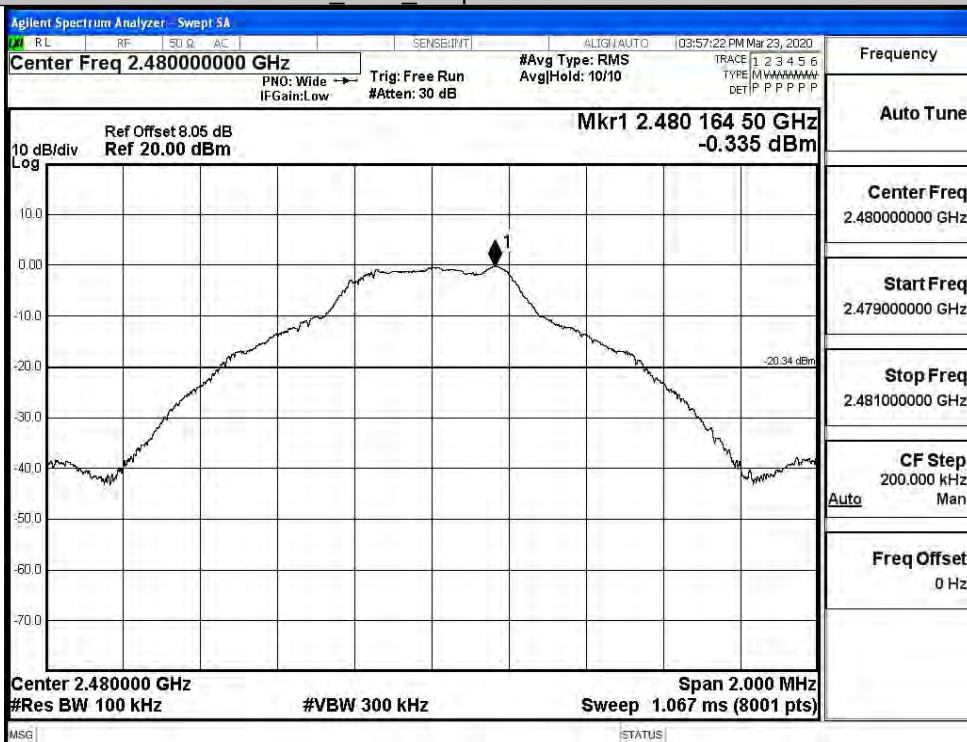


Puw

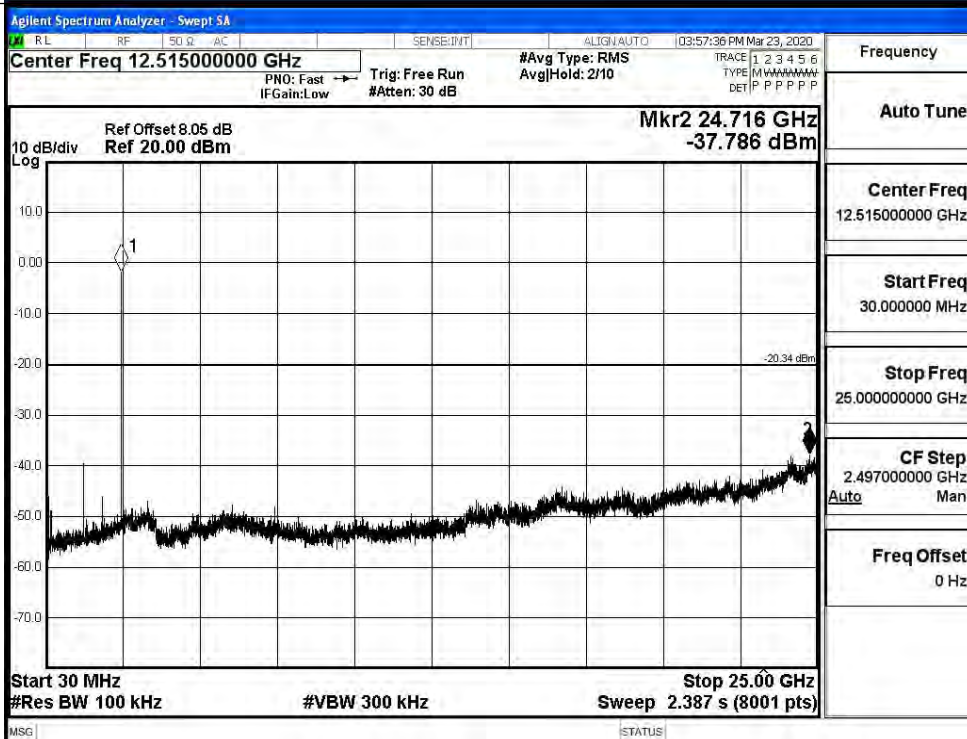


GFSK HCH_Graphs

Pref

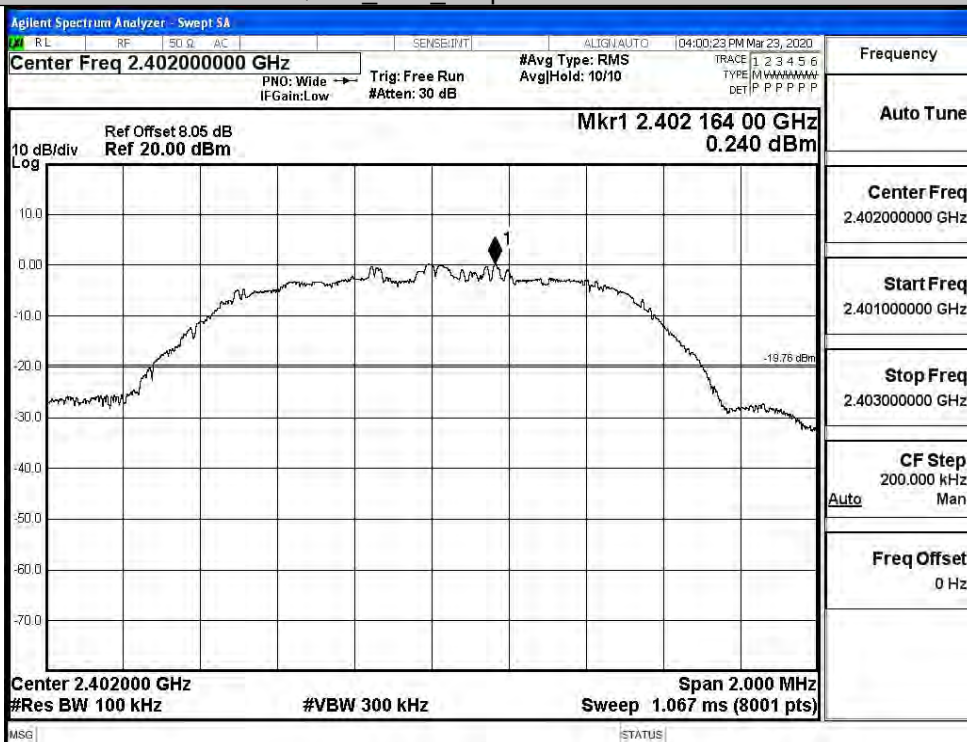


Puw

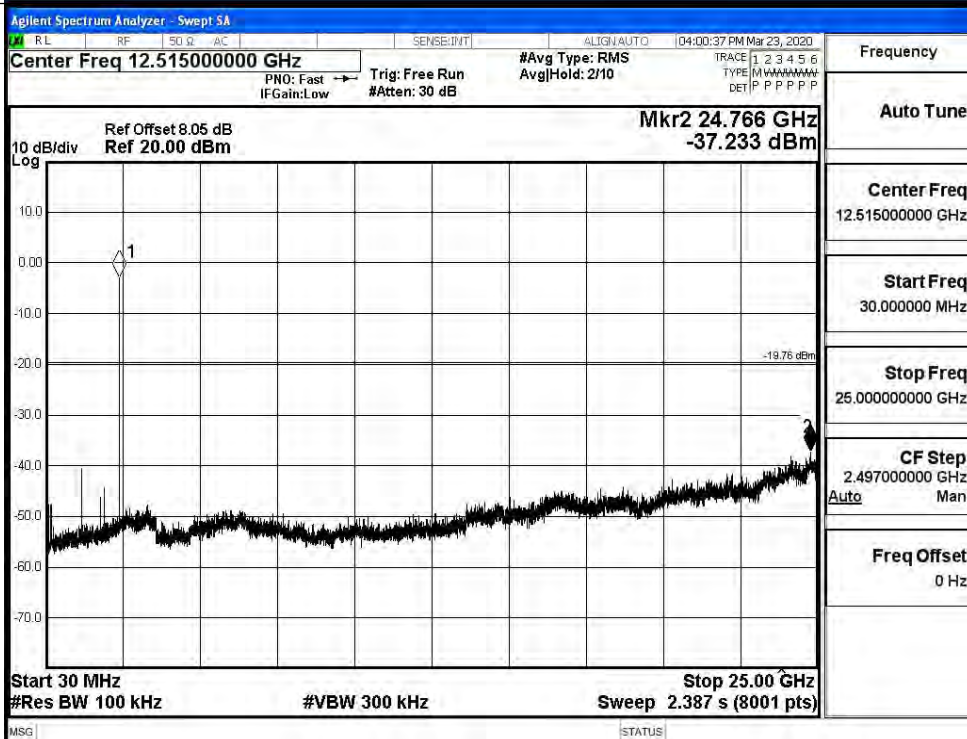


$\pi/4$ DQPSK LCH_Graphs

Pref

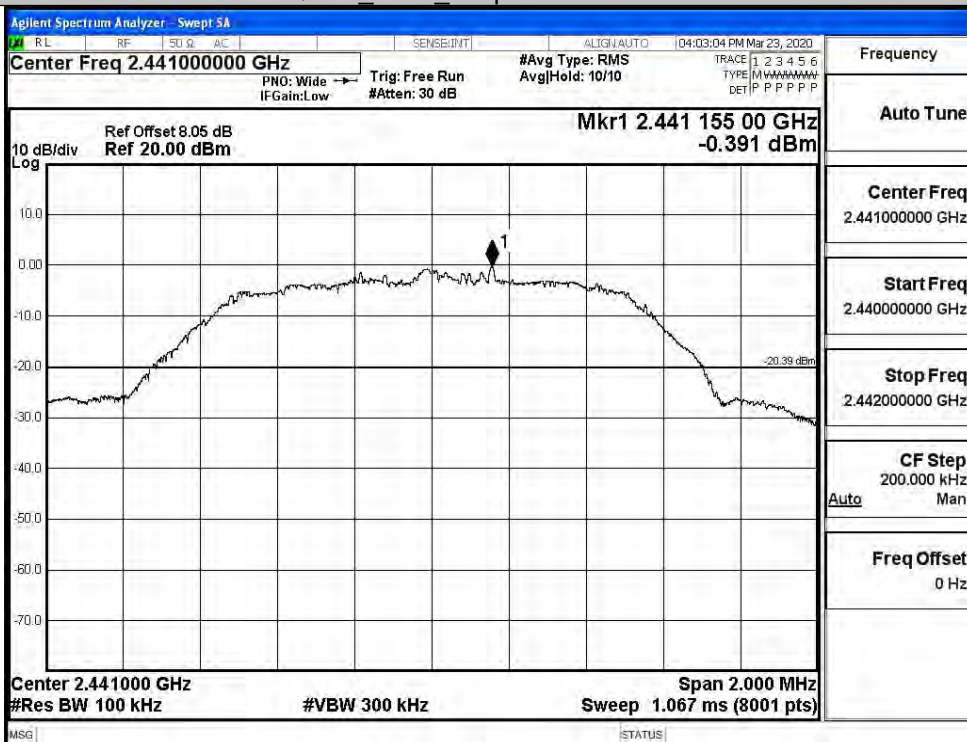


Puw

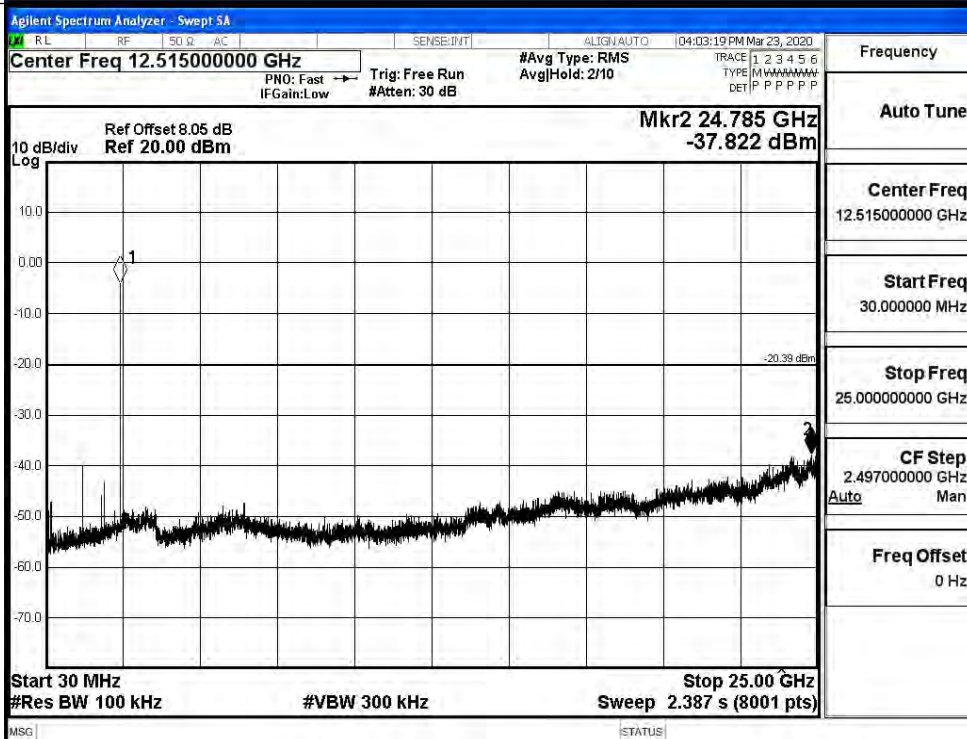


π /4DQPSK_MCH_Graphs

Pref

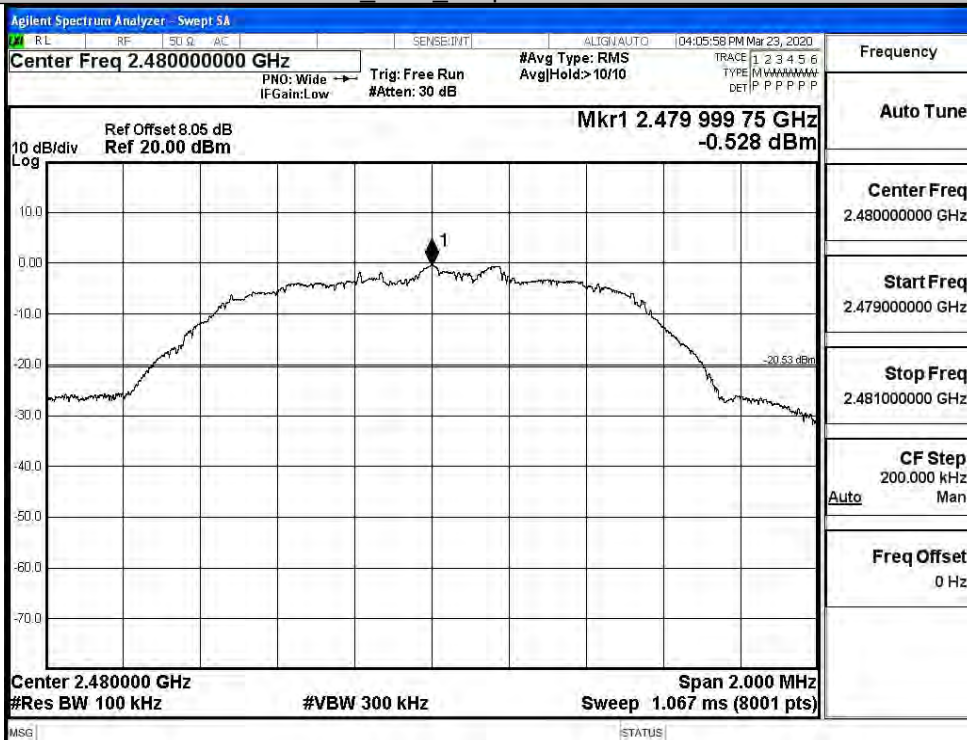


Puw



π /4DQPSK HCH_Graphs

Pref

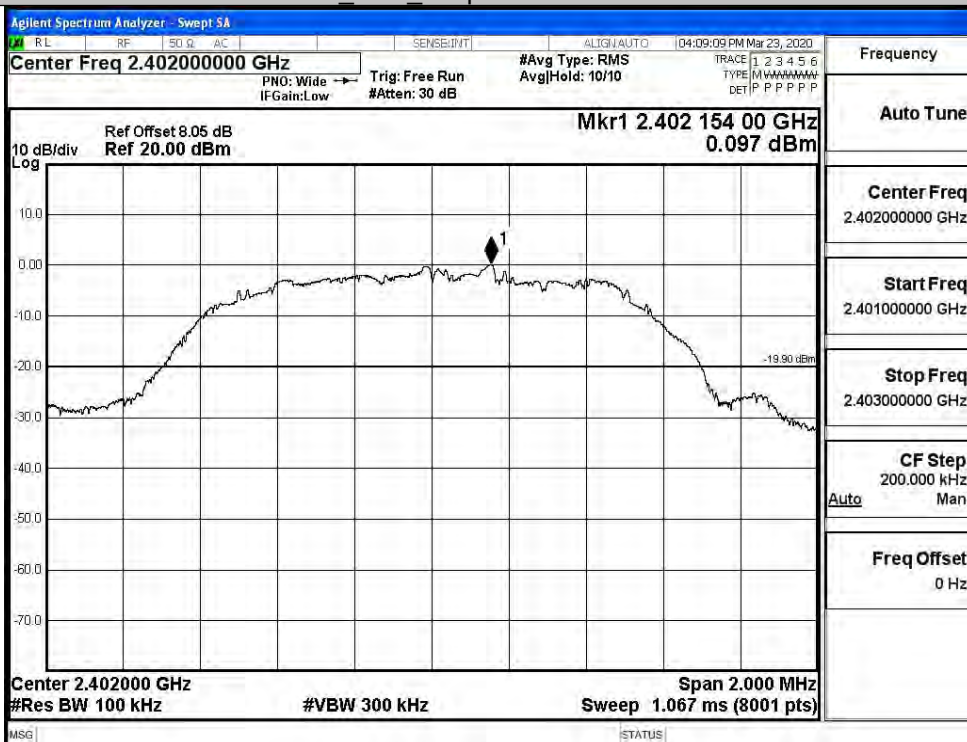


Puw

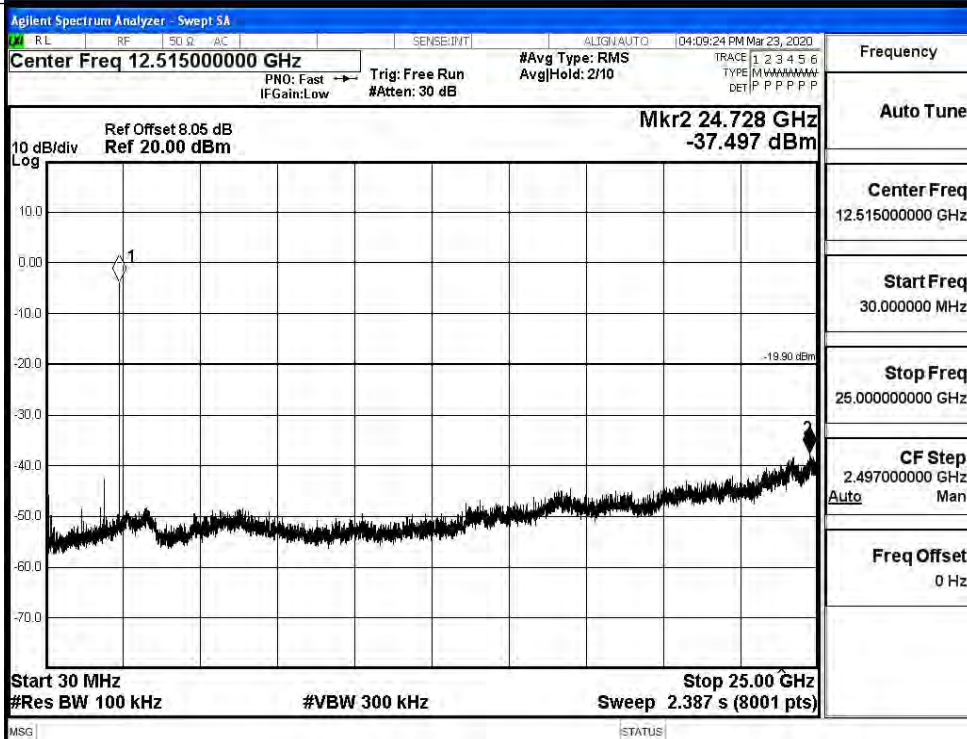


8DPSK_LCH_Graphs

Pref

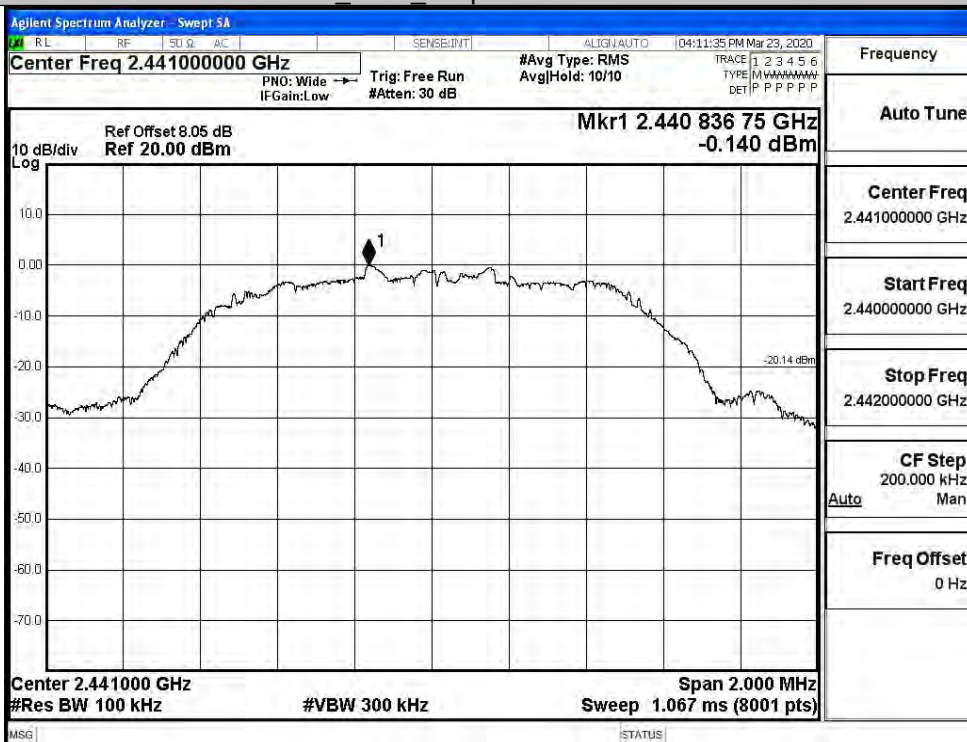


Puw

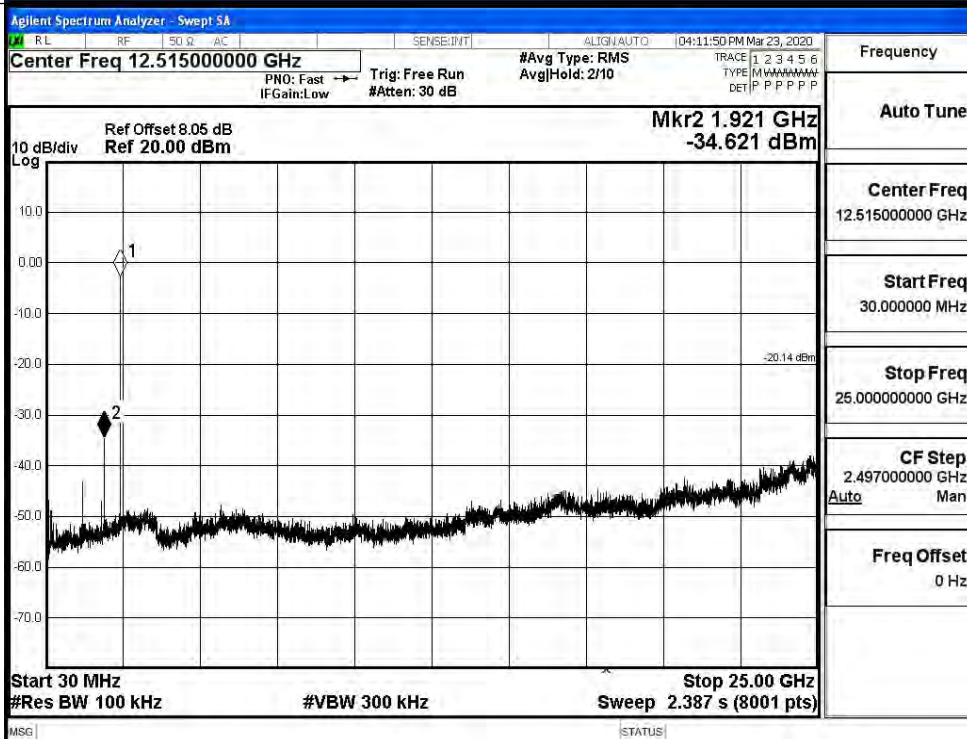


8DPSK_MCH_Graphs

Pref

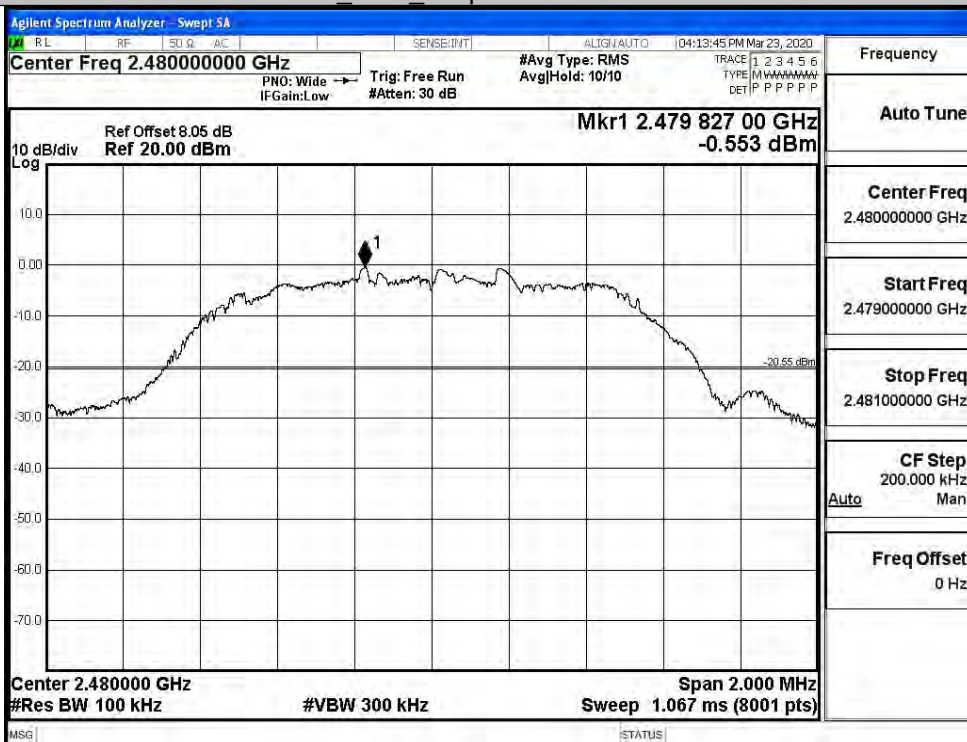


Puw

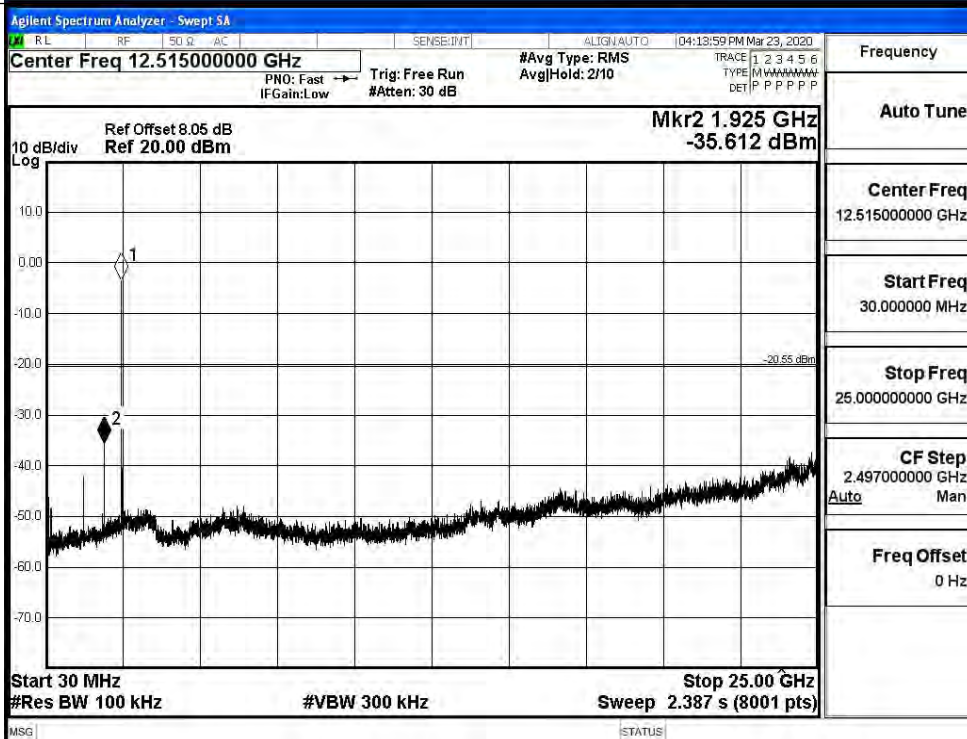


8DPSK_HCH_Graphs

Pref



Puw

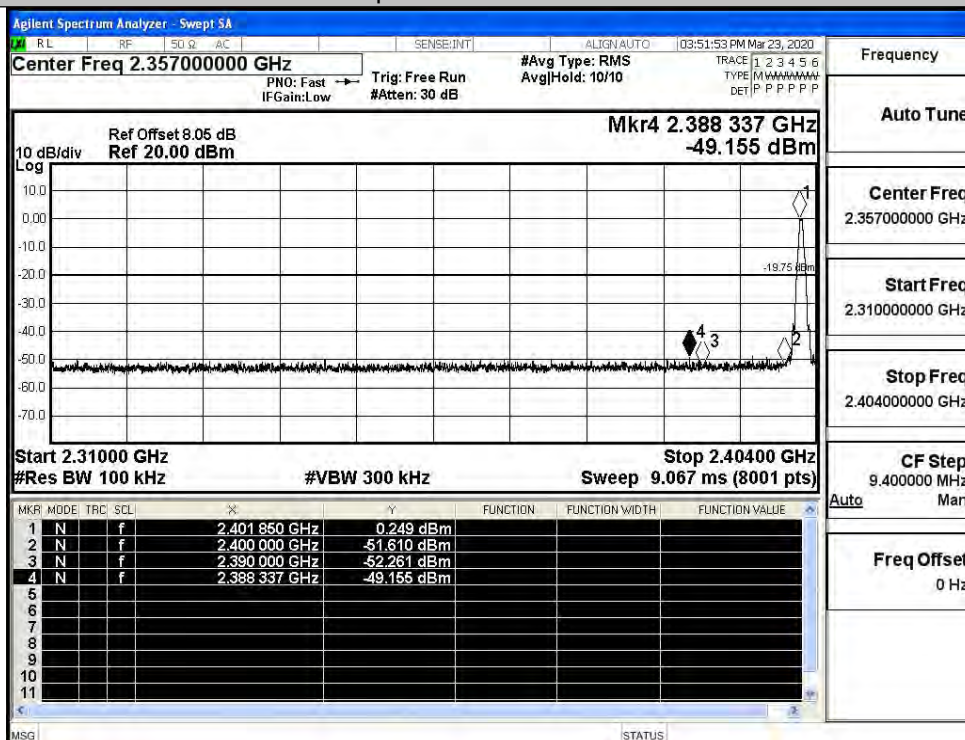


A.8 Band-edge for RF Conducted Emissions

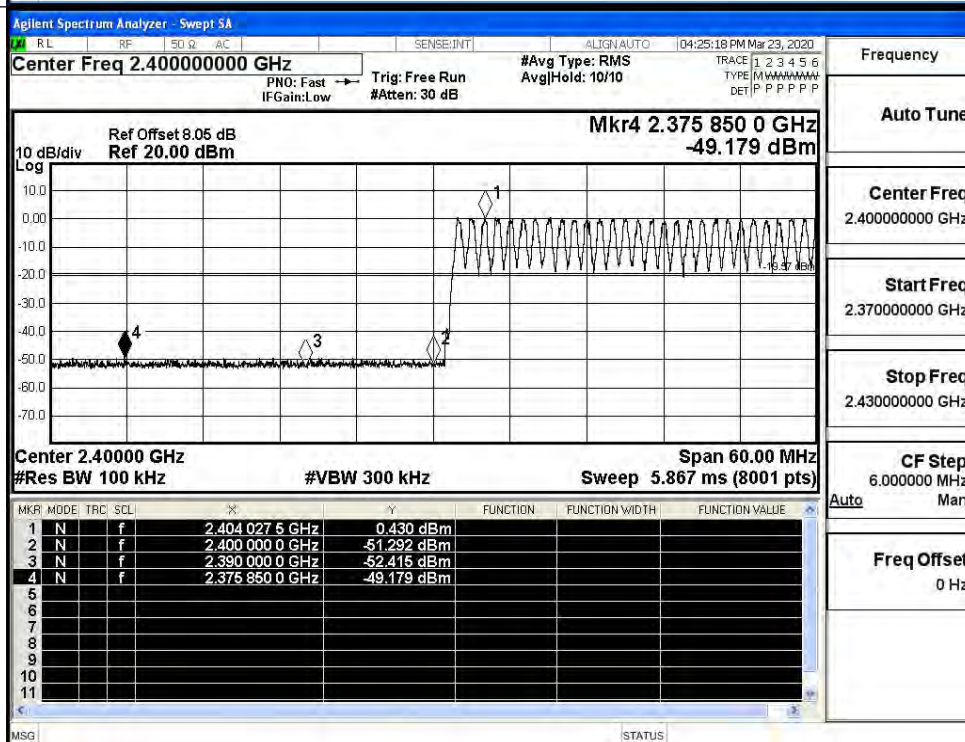
Mode	Channel	Carrier Frequency [MHz]	Carrier Power [dBm]	Frequency Hopping	Max Spurious Level [dBm]	Limit [dBm]	Verdict
GFSK	LCH	2402	0.249	Off	-49.155	-19.75	PASS
			0.430	On	-49.179	-19.57	PASS
	HCH	2480	-0.359	Off	-49.179	-20.36	PASS
			-0.165	On	-48.634	-20.17	PASS
$\pi/4$ DQPSK	LCH	2402	-0.538	Off	-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

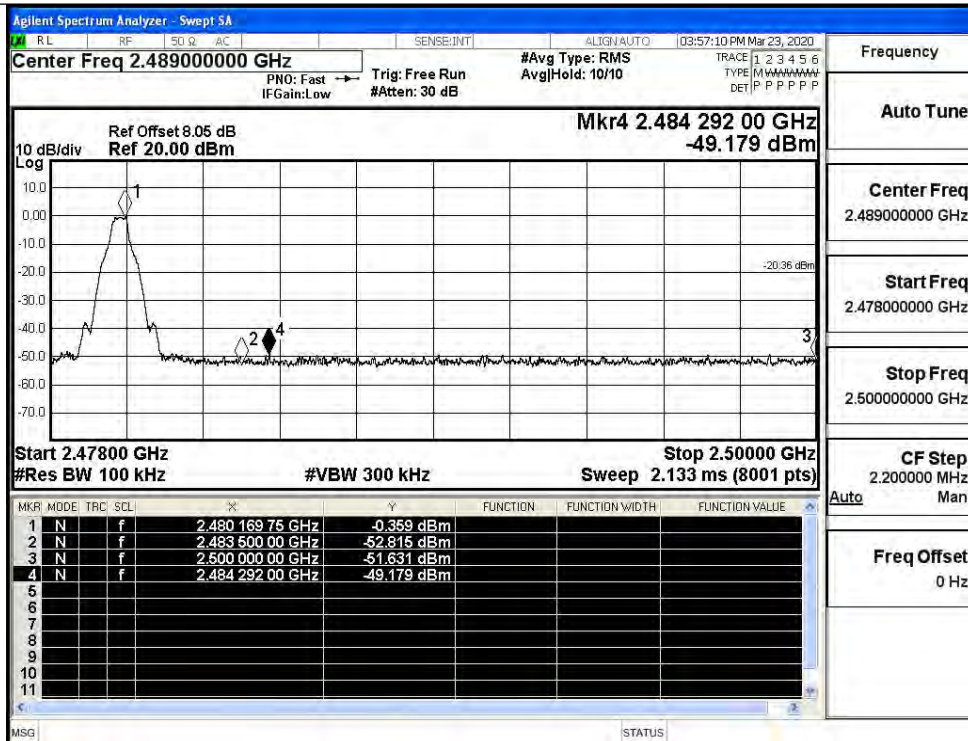
GFSK/LCH/No Hop



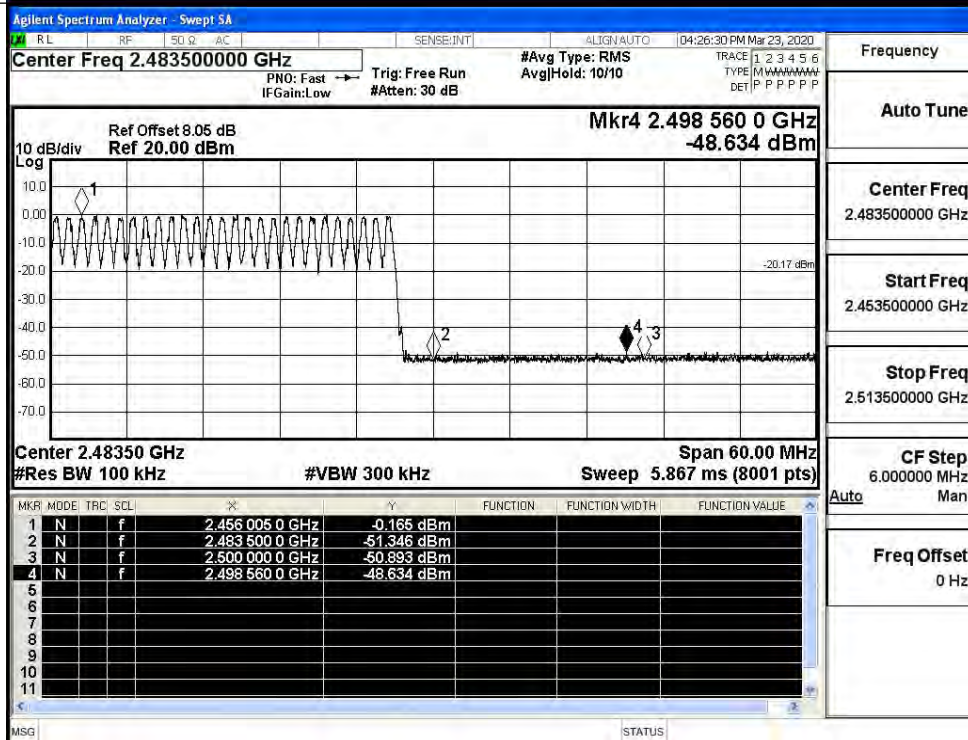
GFSK/LCH/Hop



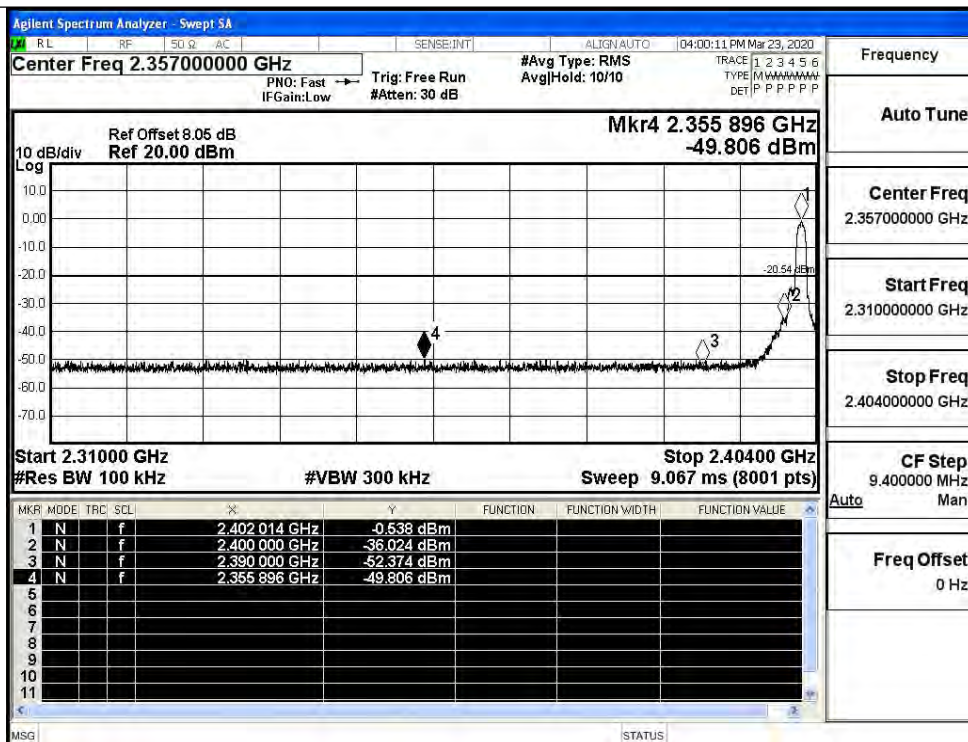
GFSK/HCH/No Hop



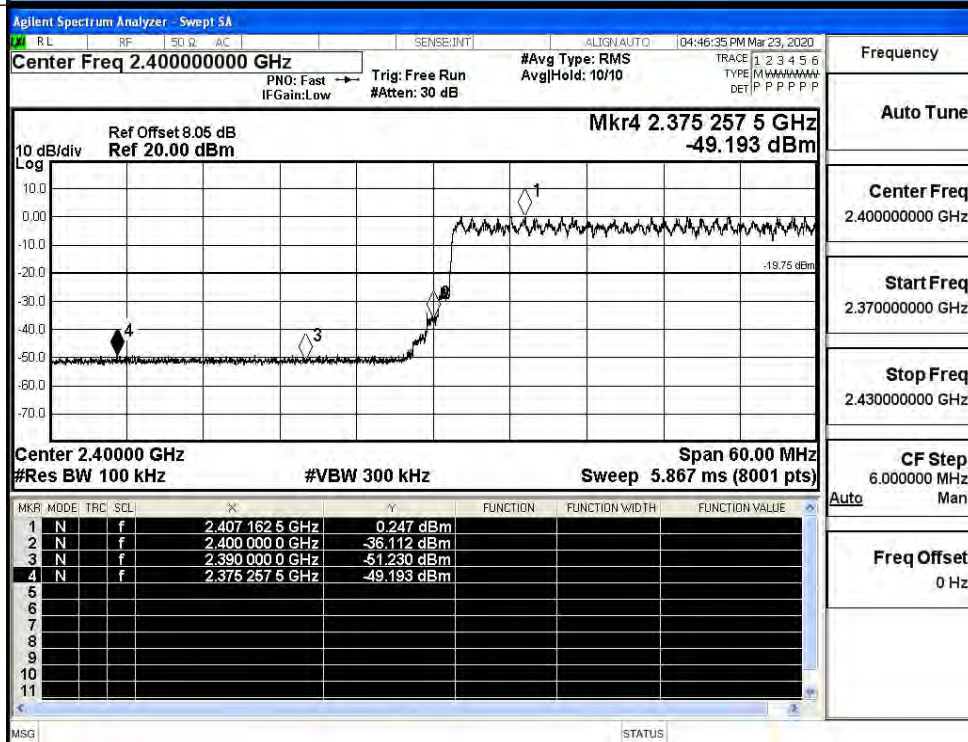
GFSK/HCH/Hop



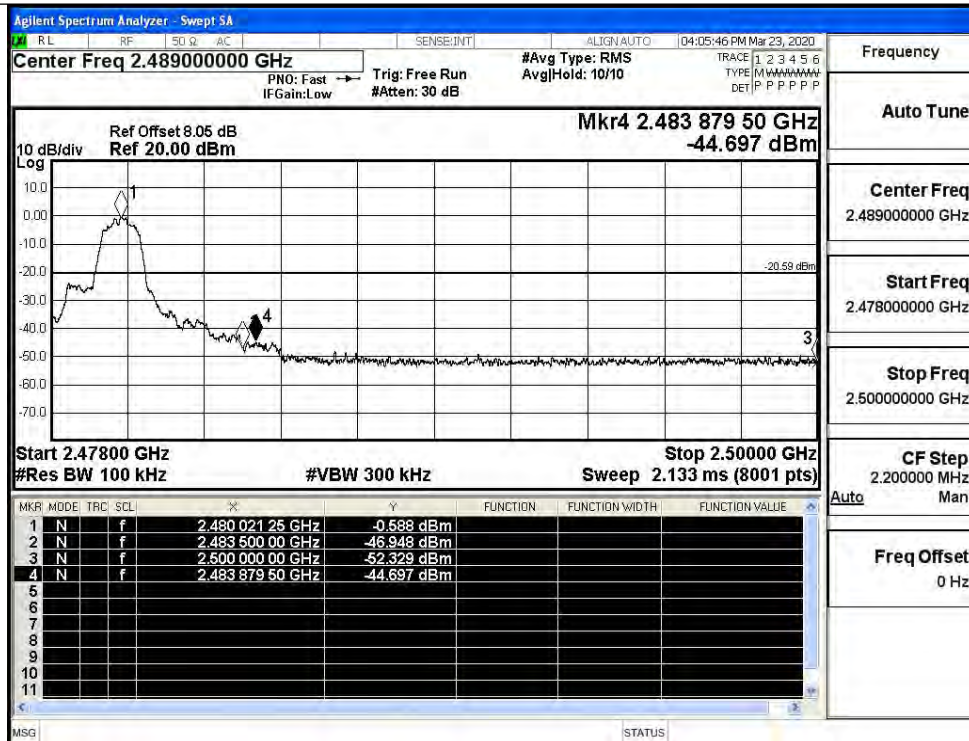
$\pi/4$ DQPSK/LCH/No
Hop



$\pi/4$ DQPSK/LCH/Hop



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

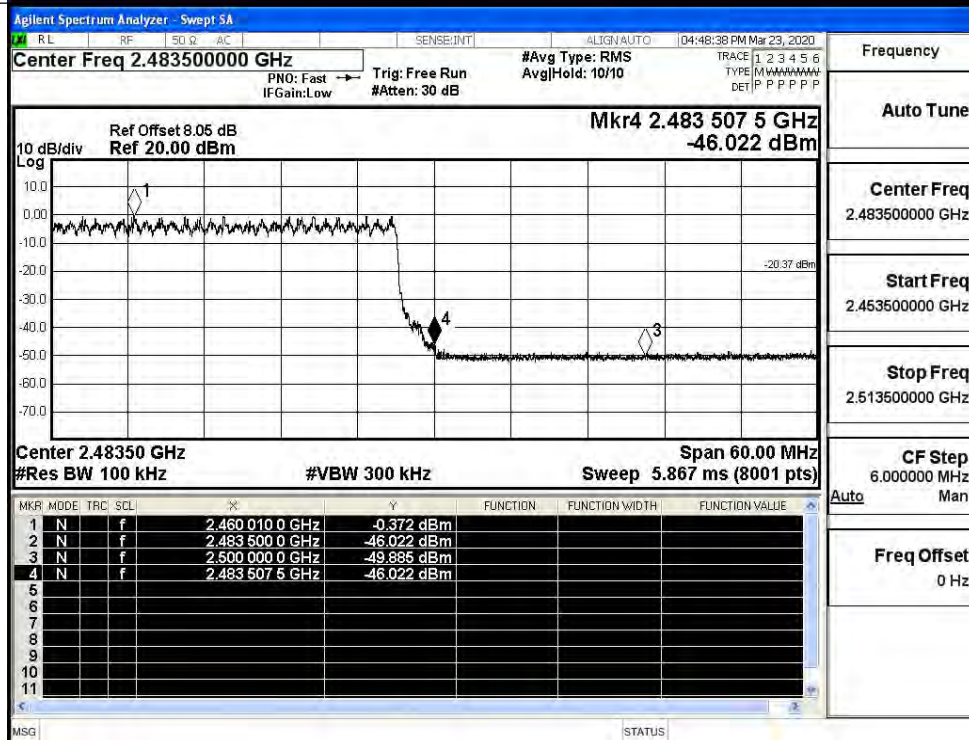


Frequency

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

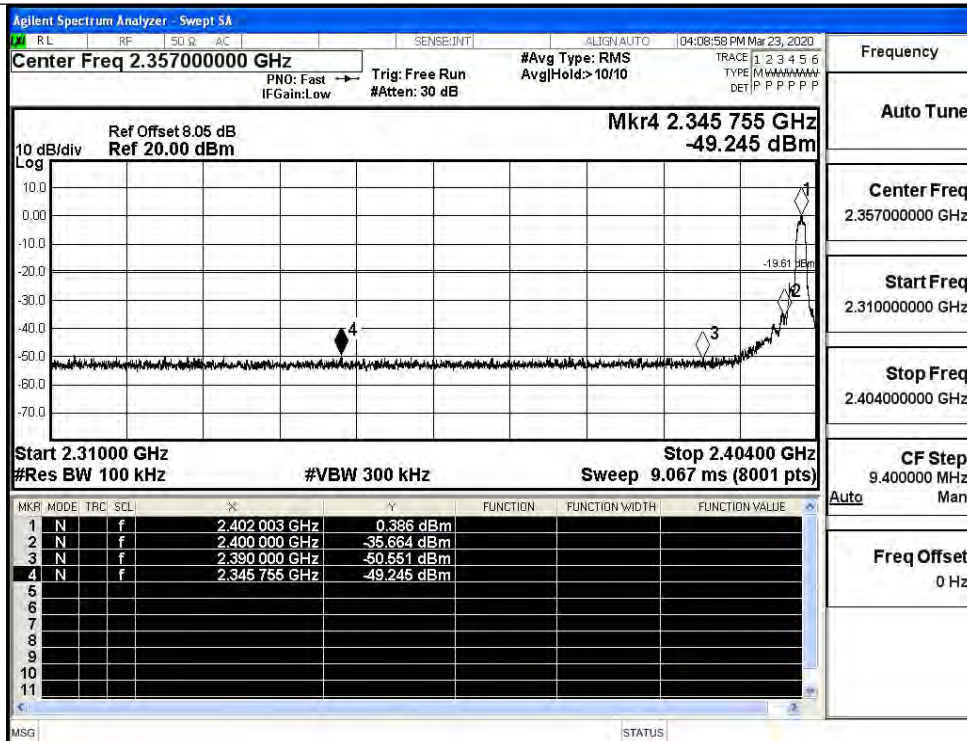


Frequency

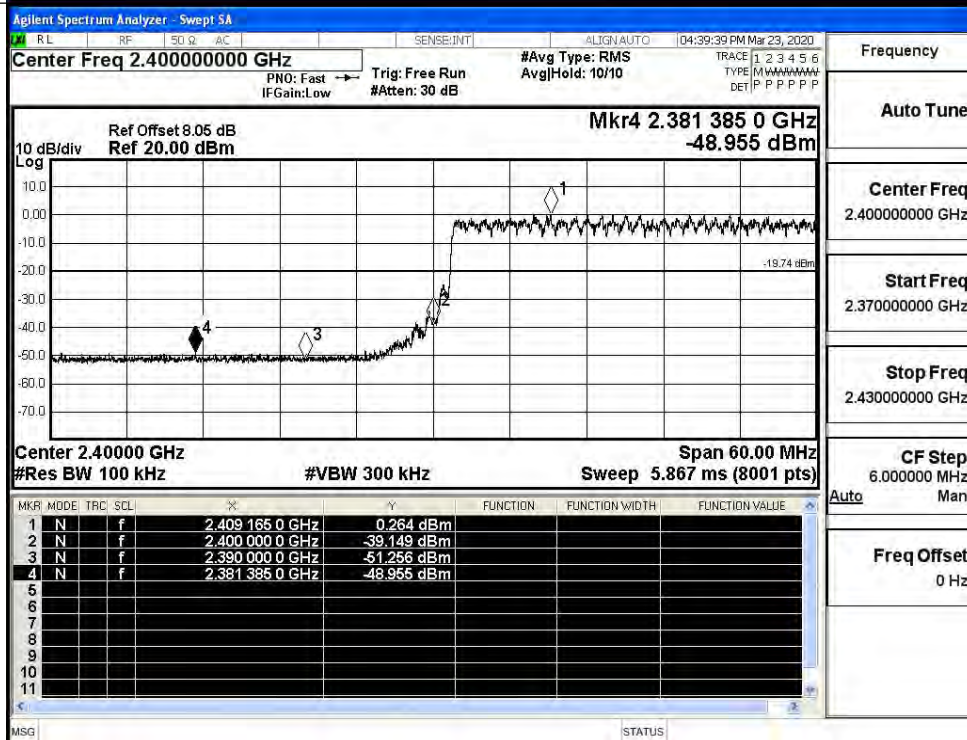
Auto Tune

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

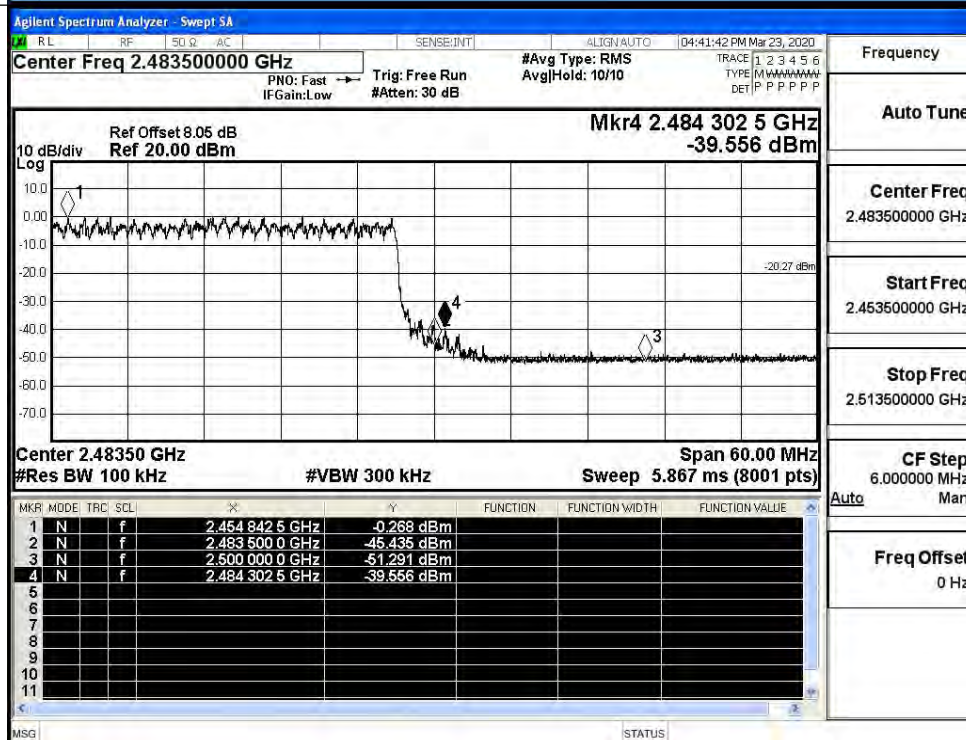
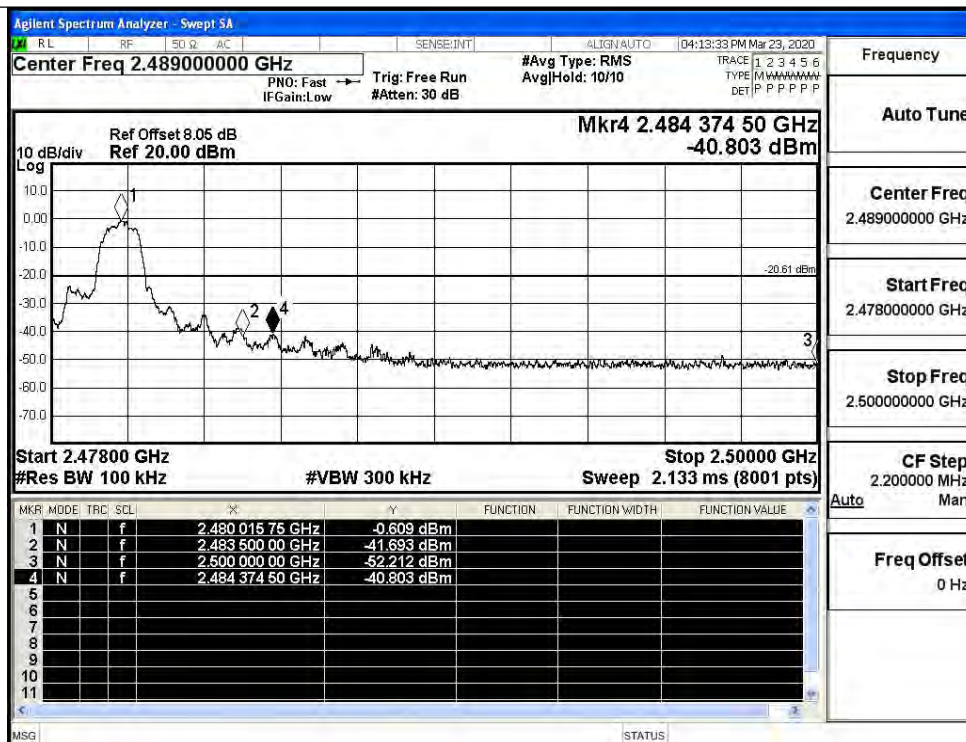
8DPSK/LCH/No Hop



8DPSK/LCH/Hop



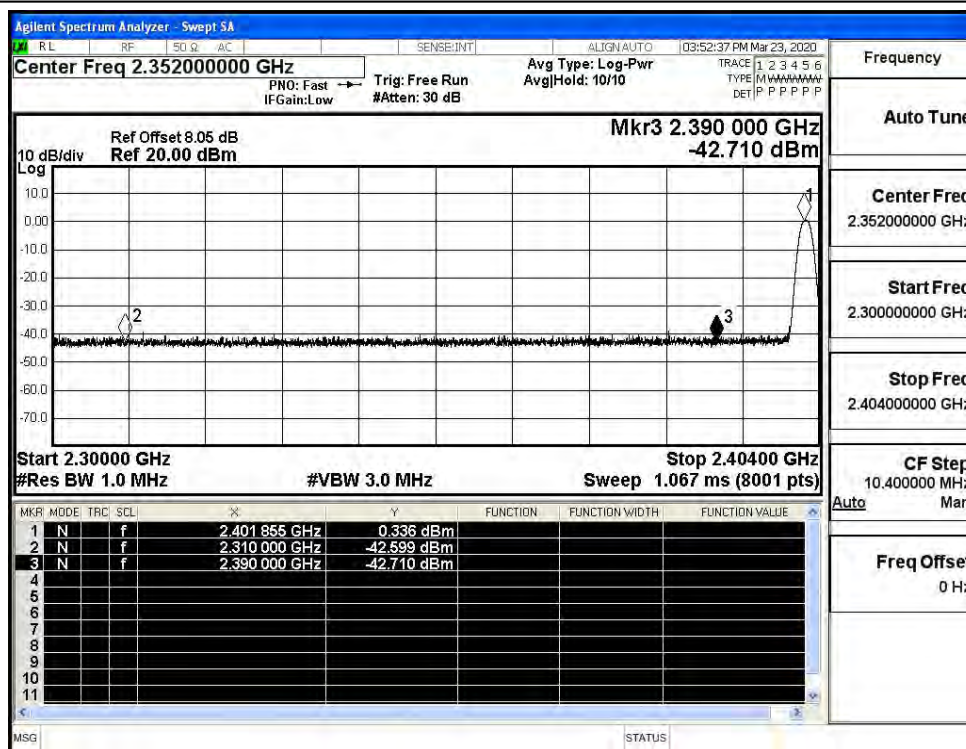
8DPSK/HCH/Hop



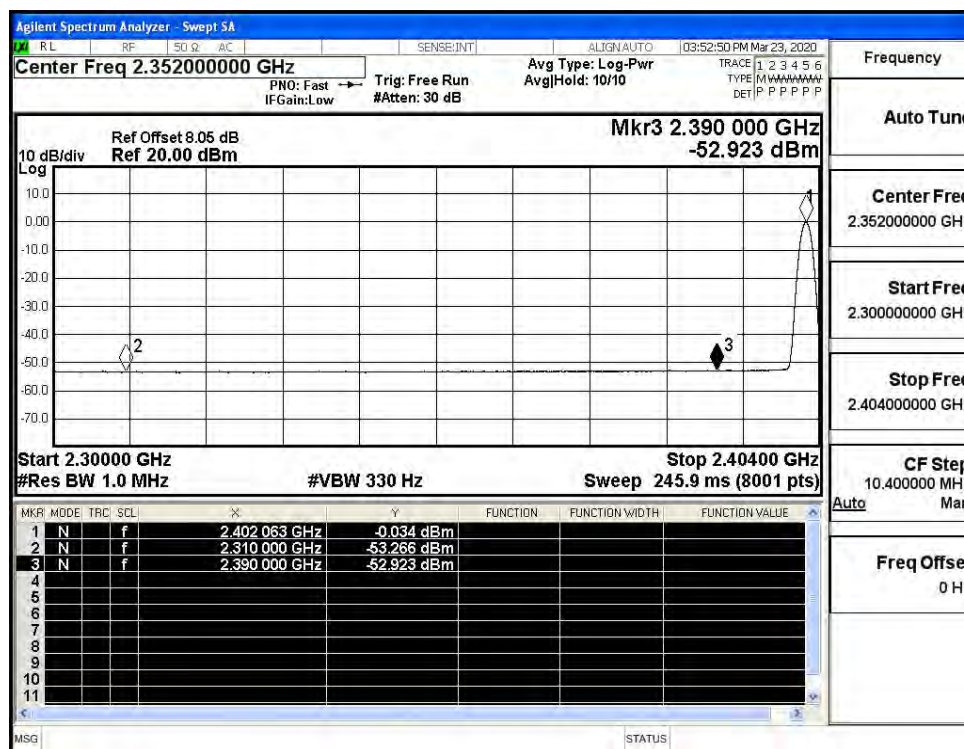
A.9 Restrict-band band-edge measurements

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

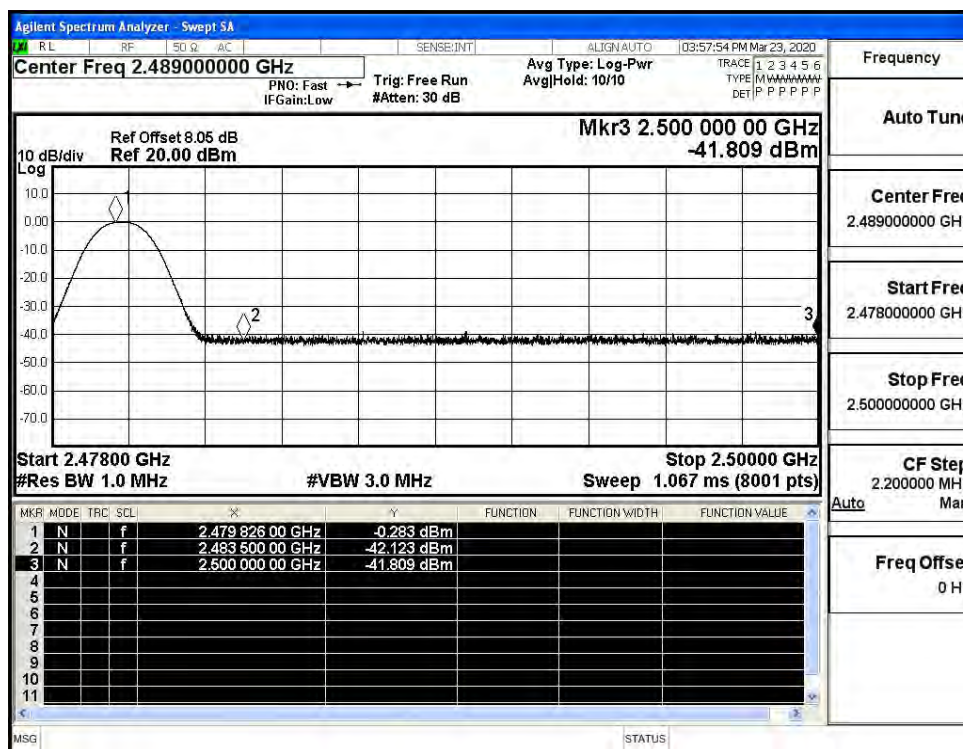
Restrict-band band-edge measurements_Hopping Off_GFSK_PEAK (Low Channel)



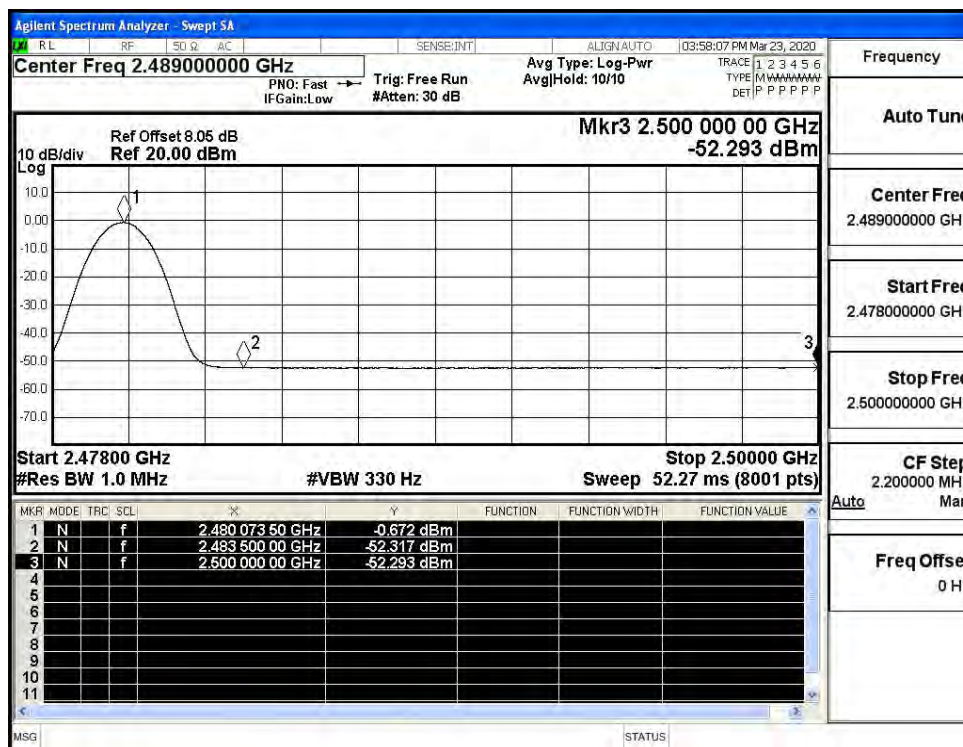
Restrict-band band-edge measurements_Hopping Off_GFSK_Average (Low Channel)

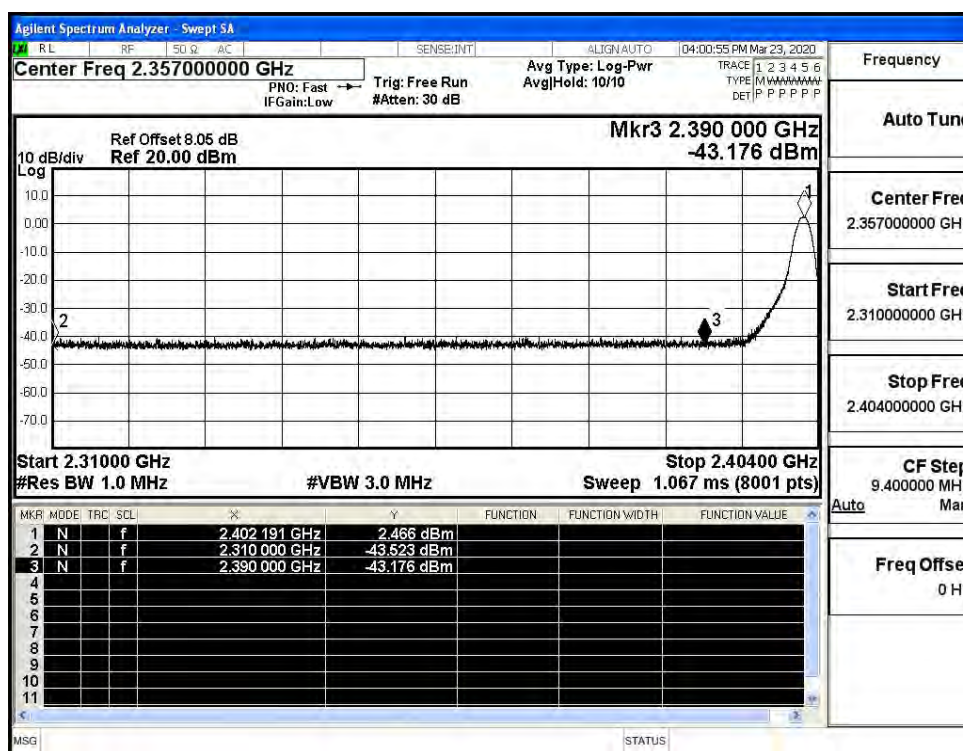
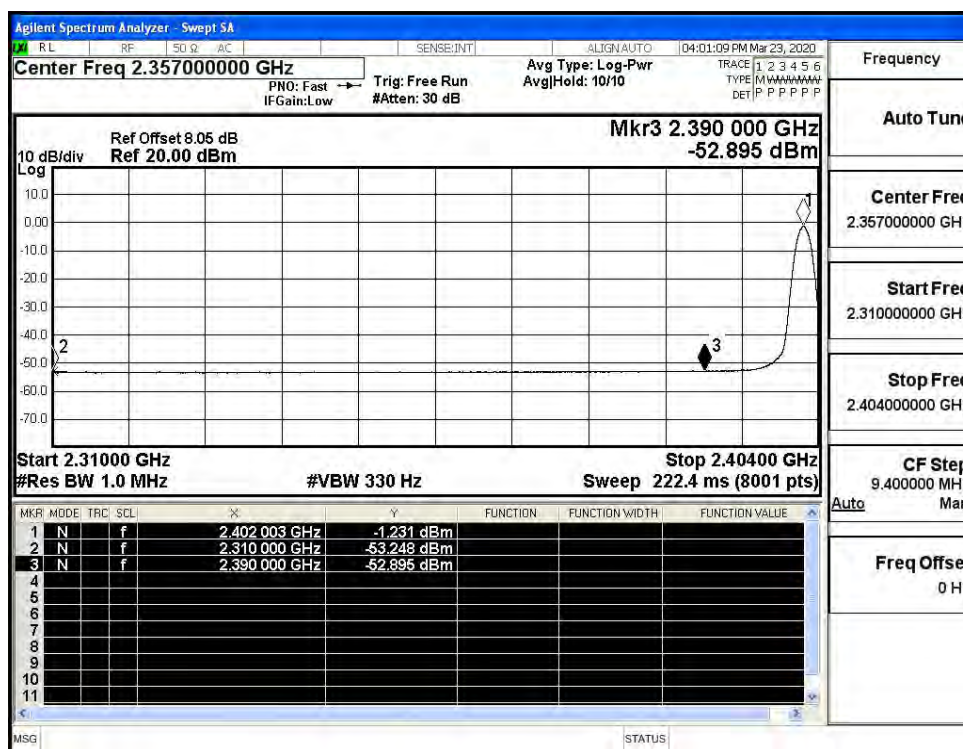


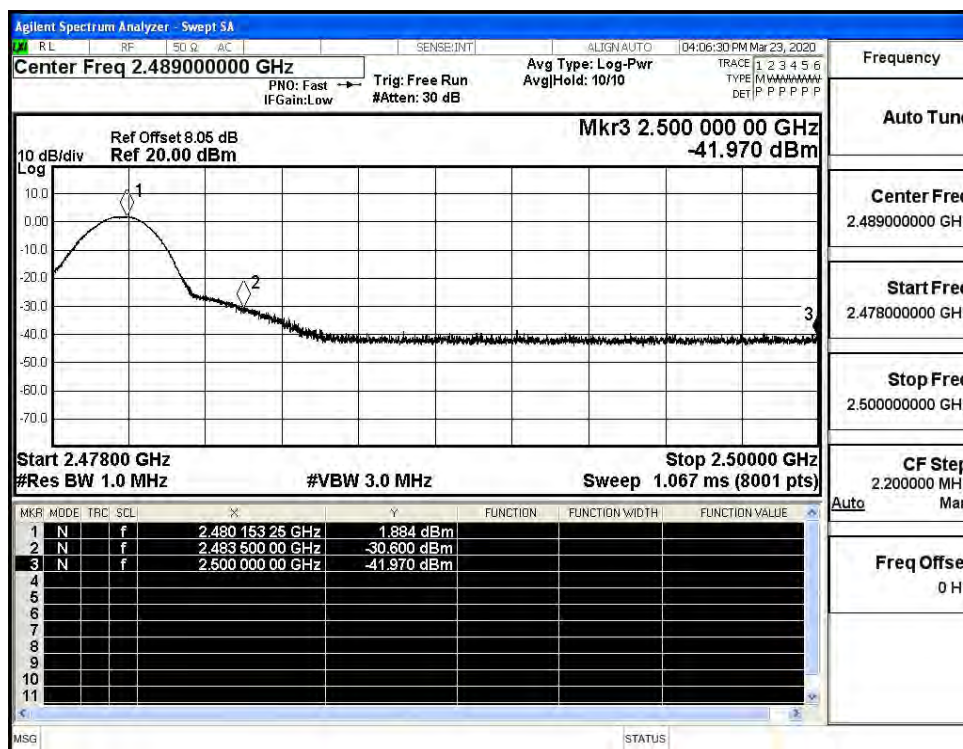
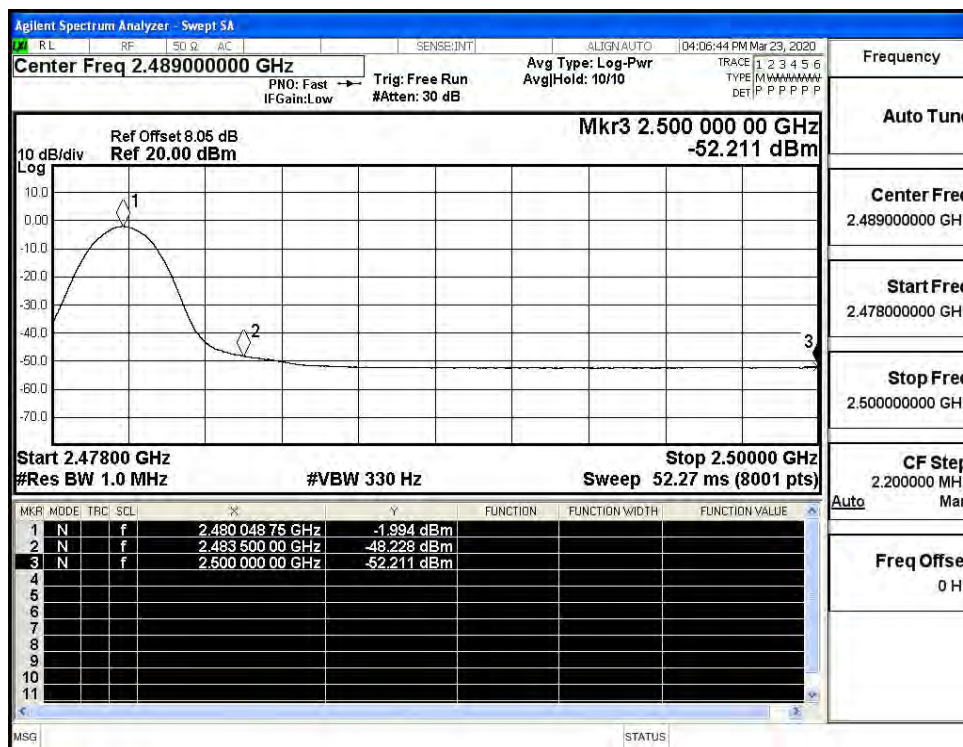
Restrict-band band-edge measurements_Hopping Off_ GFSK_PEAK (High Channel)



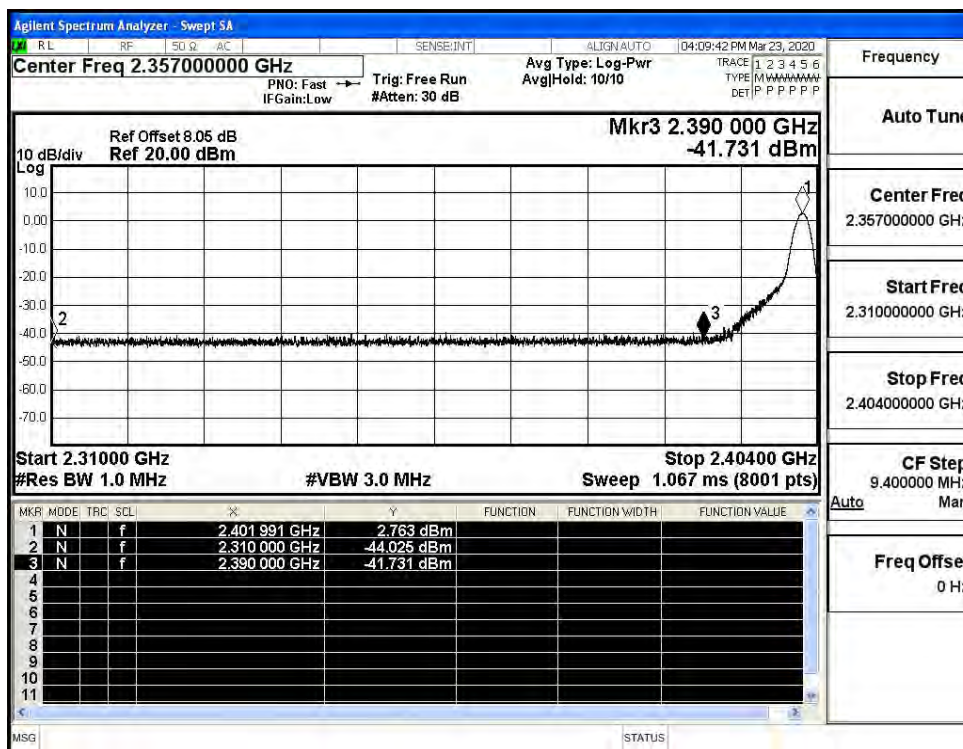
Restrict-band band-edge measurements_Hopping Off_ GFSK_Average (High Channel)



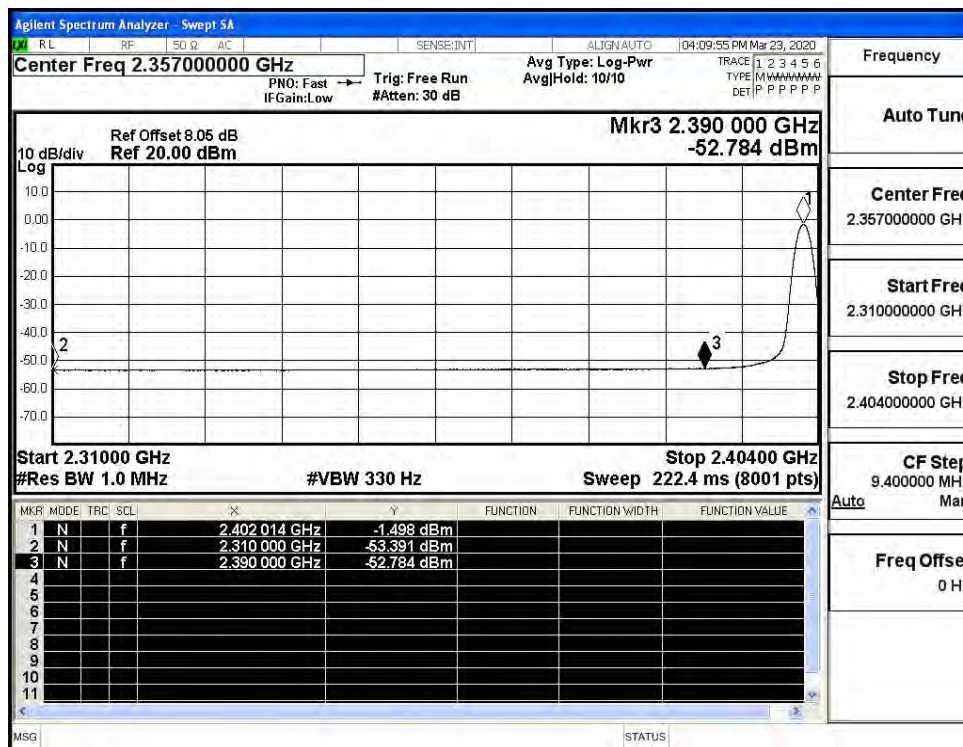
Restrict-band band-edge measurements_Hopping Off $\pi/4$ -DQPSK_PEAK (Low Channel)Restrict-band band-edge measurements_Hopping Off $\pi/4$ -DQPSK_Average (Low Channel)

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)

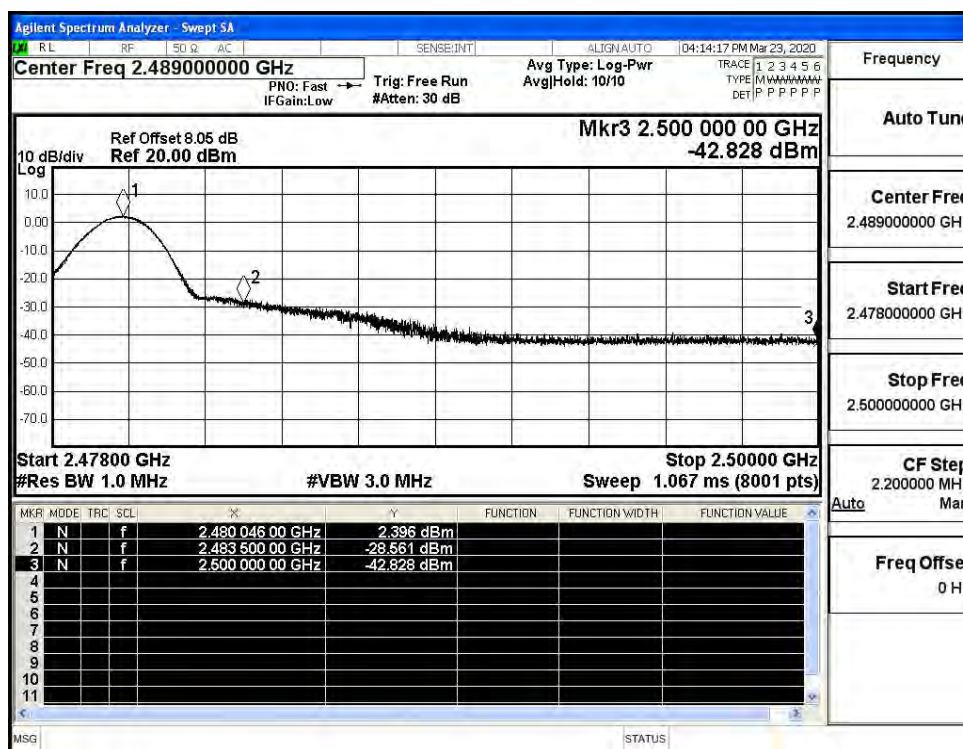
Restrict-band band-edge measurements_Hopping Off_8DPSK_PEAK (Low Channel)



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)

