

Appendix A

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

Product Name: Wireless Earbuds

Trade Mark: HYPHEN

Test Model: HYPHEN

Environmental Conditions

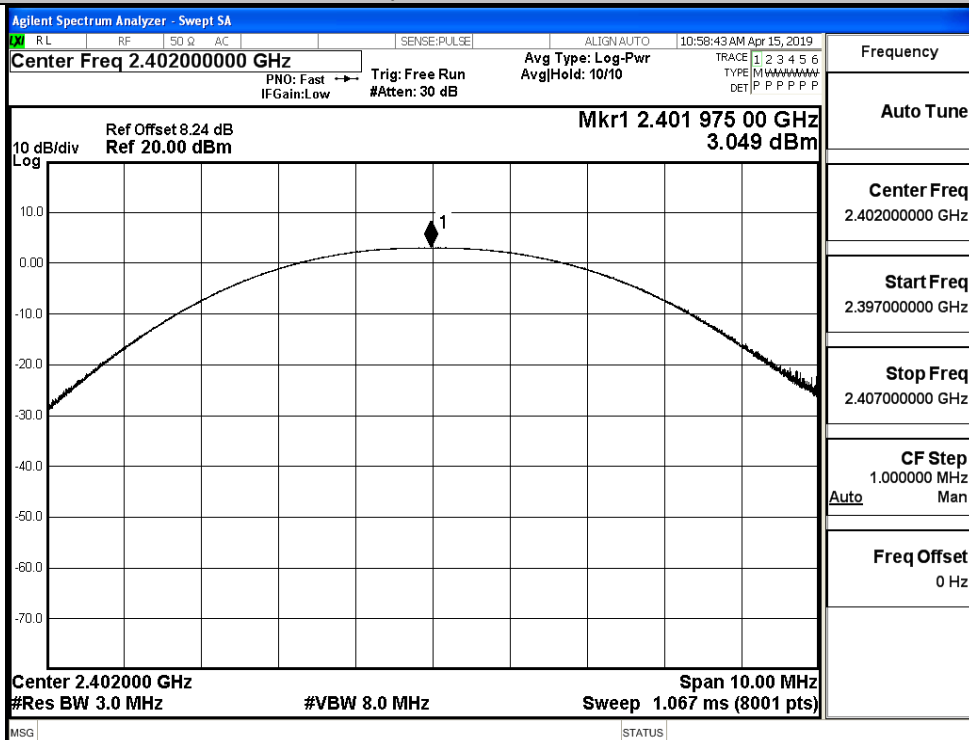
Temperature:	24.1 ° C
Relative Humidity:	52.9%
ATM Pressure:	100.0 kPa
Test Engineer:	David.Luo
Supervised by:	Tom.Liu

A.1 Maximum Conducted Peak Output Power

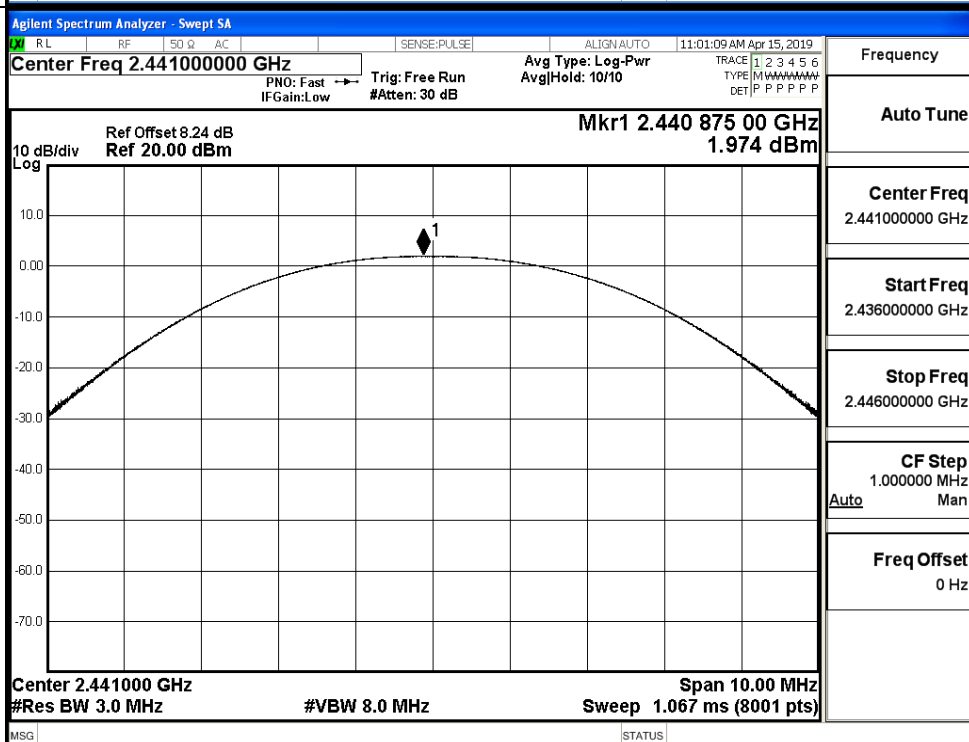
Mode	Channel.	Maximum Peak Output Power [dBm]	Limit [dBm]	Verdict
GFSK	LCH	3.049	21	PASS
	MCH	1.974	21	PASS
	HCH	3.737	21	PASS
$\pi/4$ DQPSK	LCH	5.018	21	PASS
	MCH	5.417	21	PASS
	HCH	5.860	21	PASS
8DPSK	LCH	4.714	21	PASS
	MCH	5.911	21	PASS
	HCH	5.573	21	PASS

Test Graphs

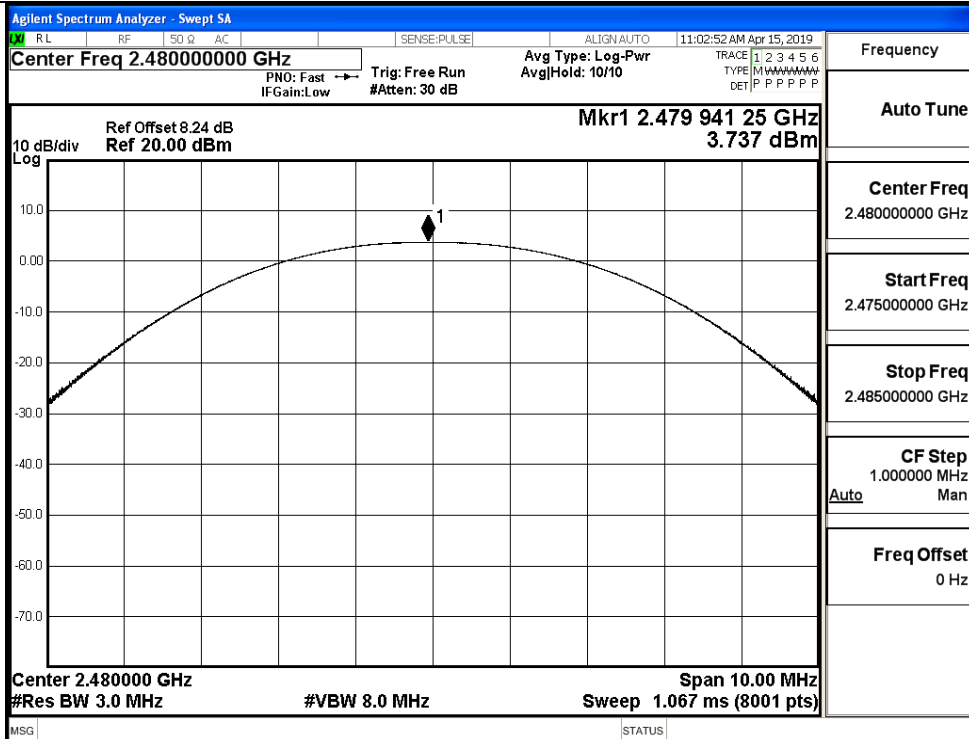
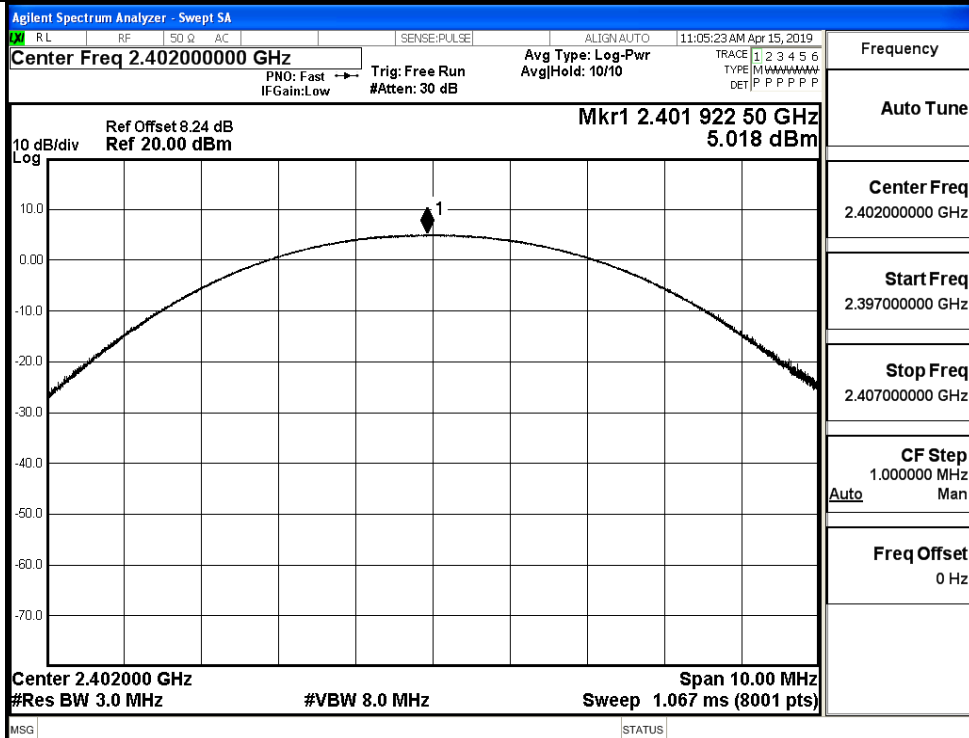
GFSK/LCH

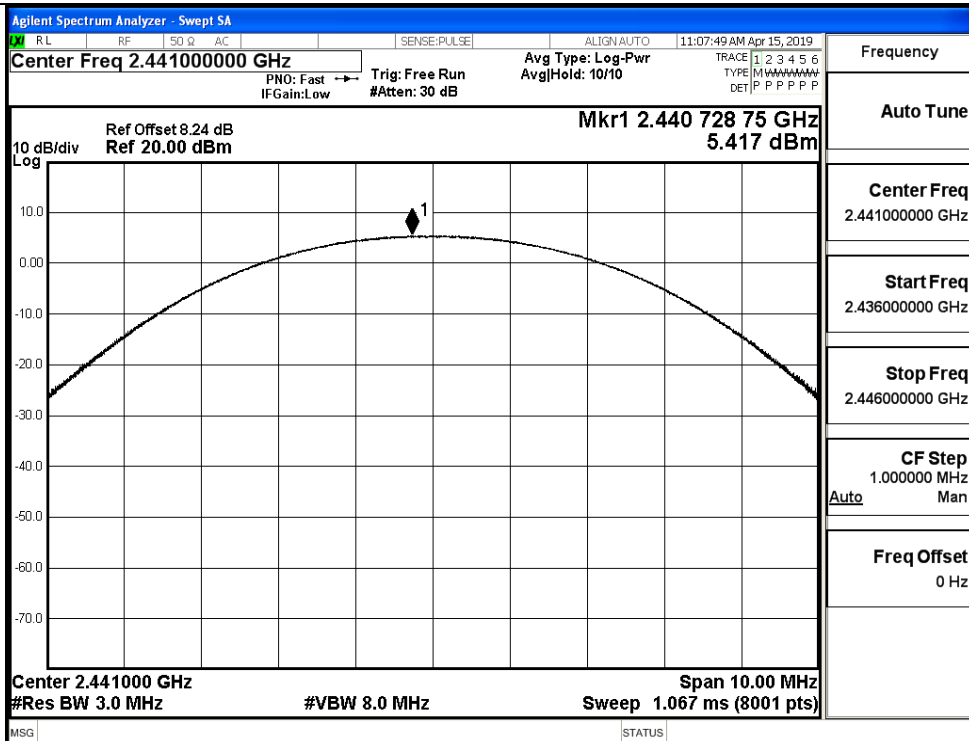
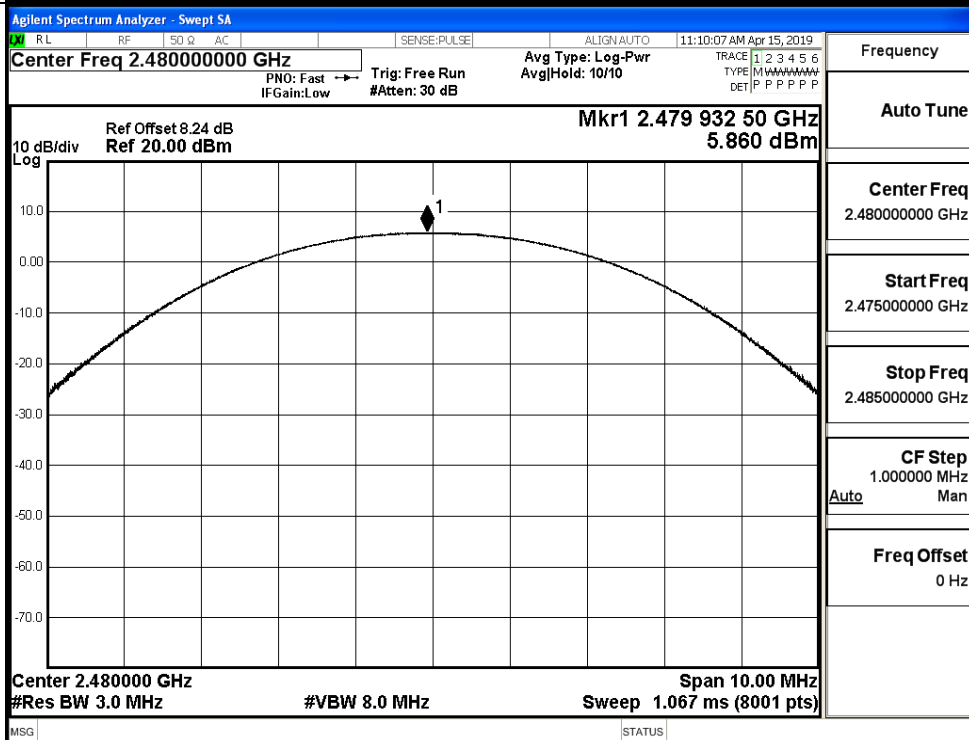


GFSK/MCH

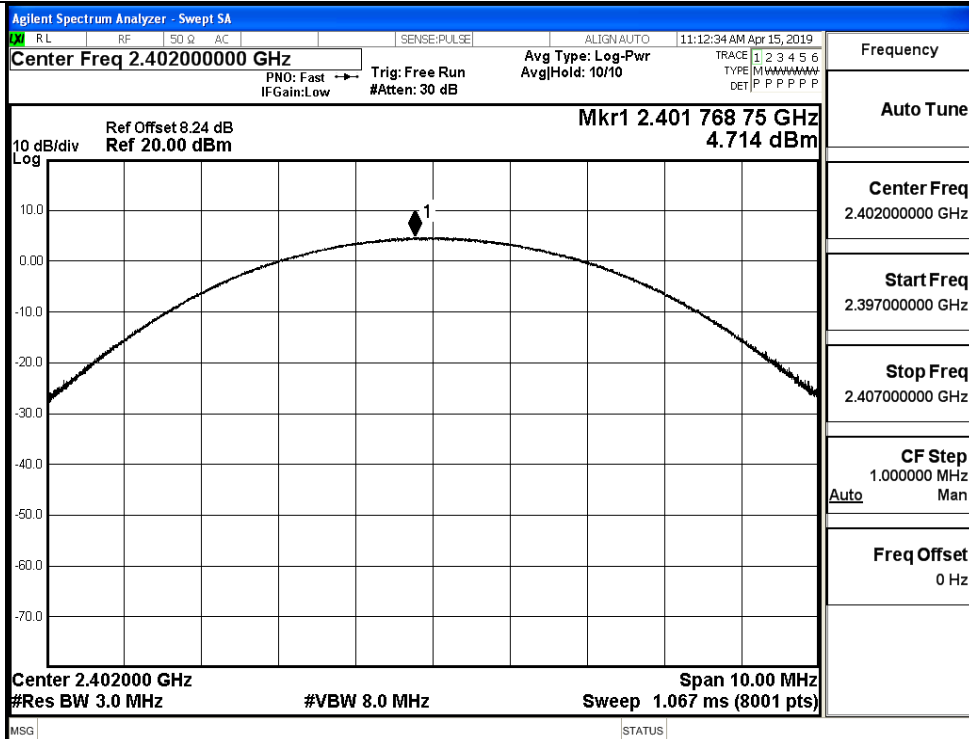


GFSK/HCH

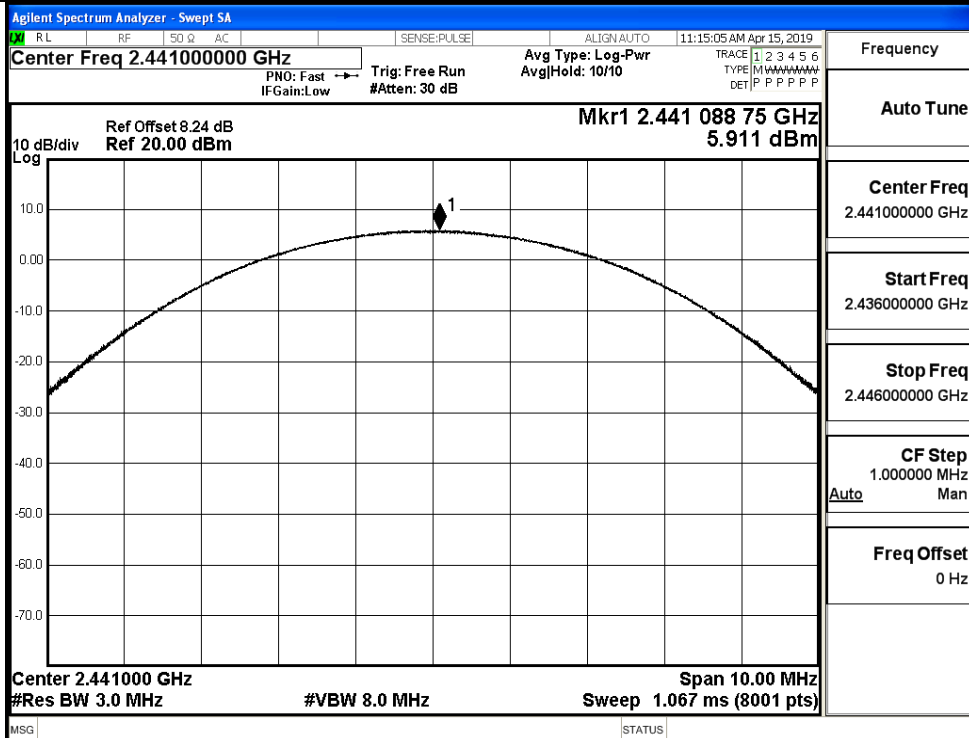
 π /4DQPSK/LCH

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

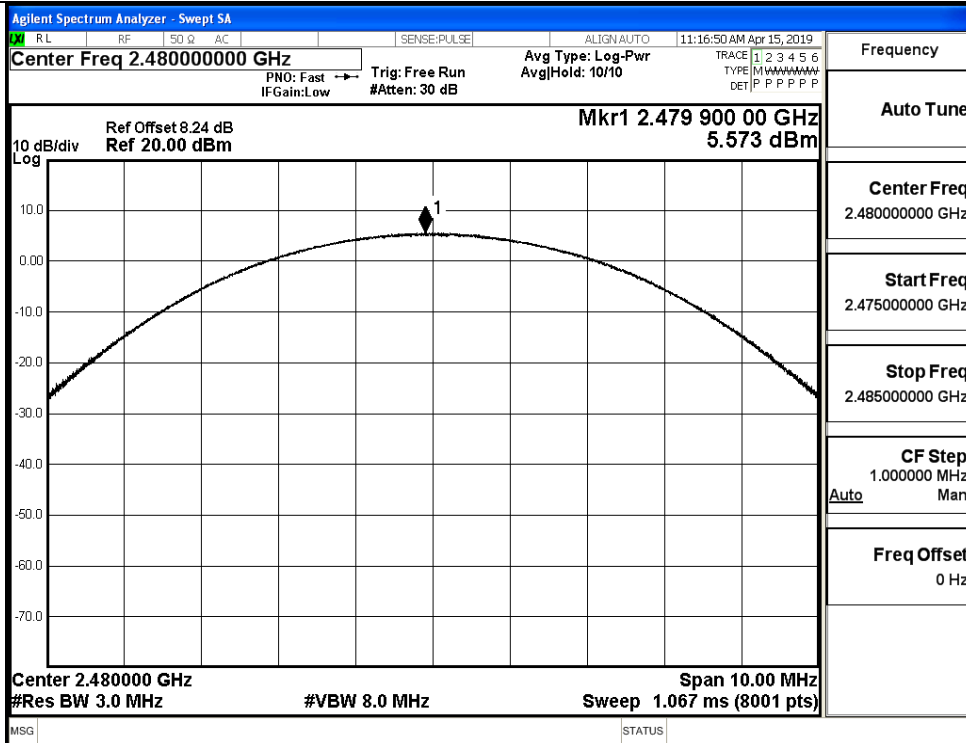
8DPSK/LCH



8DPSK/MCH



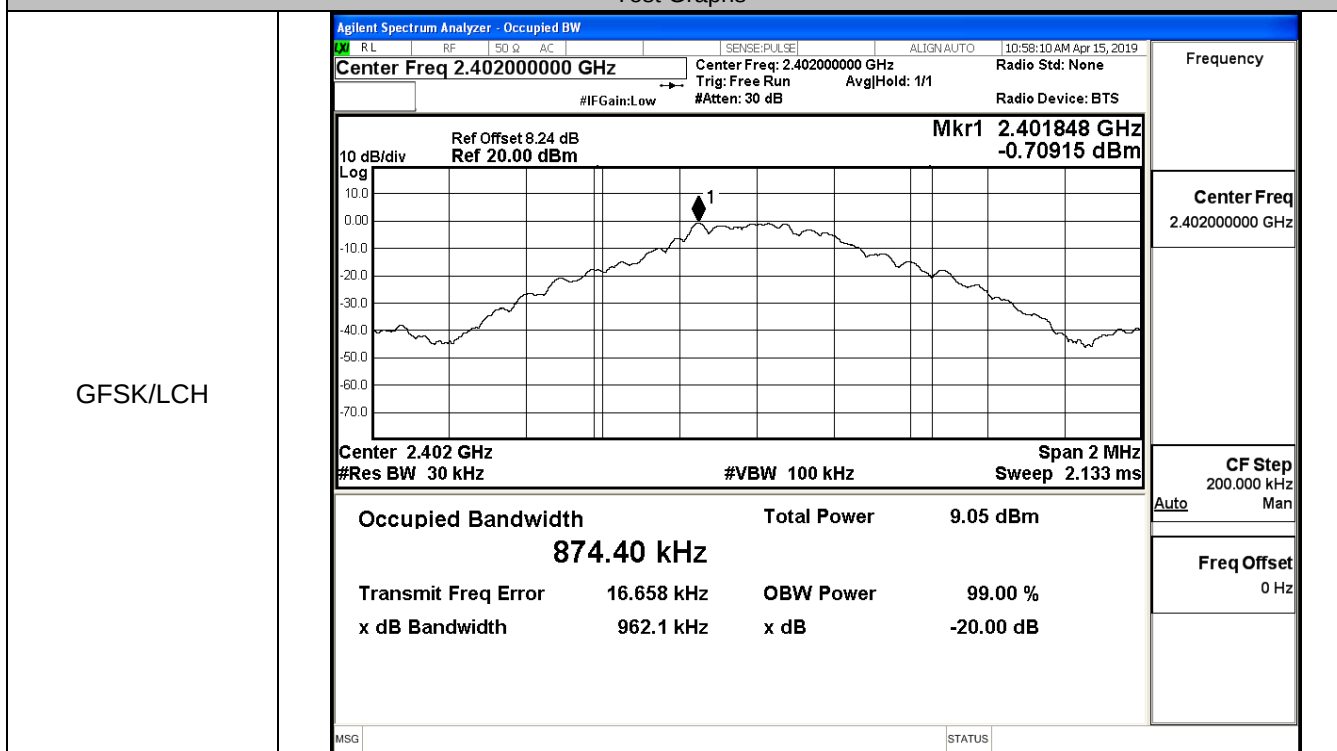
8DPSK/HCH



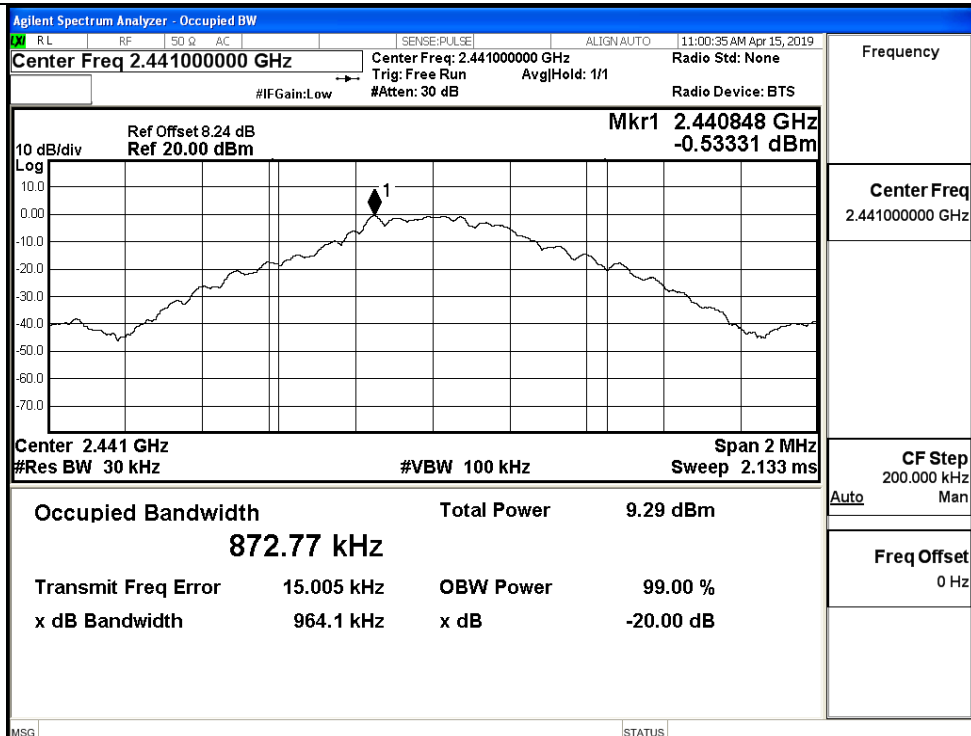
A.2 20dB Bandwidth

Mode	Channel.	20dB Bandwidth [MHz]	Limit [MHz]	Verdict
GFSK	LCH	0.9621	Not Specified	PASS
	MCH	0.9641	Not Specified	PASS
	HCH	0.9652	Not Specified	PASS
$\pi/4$ DQPSK	LCH	1.282	Not Specified	PASS
	MCH	1.282	Not Specified	PASS
	HCH	1.283	Not Specified	PASS
8DPSK	LCH	1.302	Not Specified	PASS
	MCH	1.303	Not Specified	PASS
	HCH	1.302	Not Specified	PASS

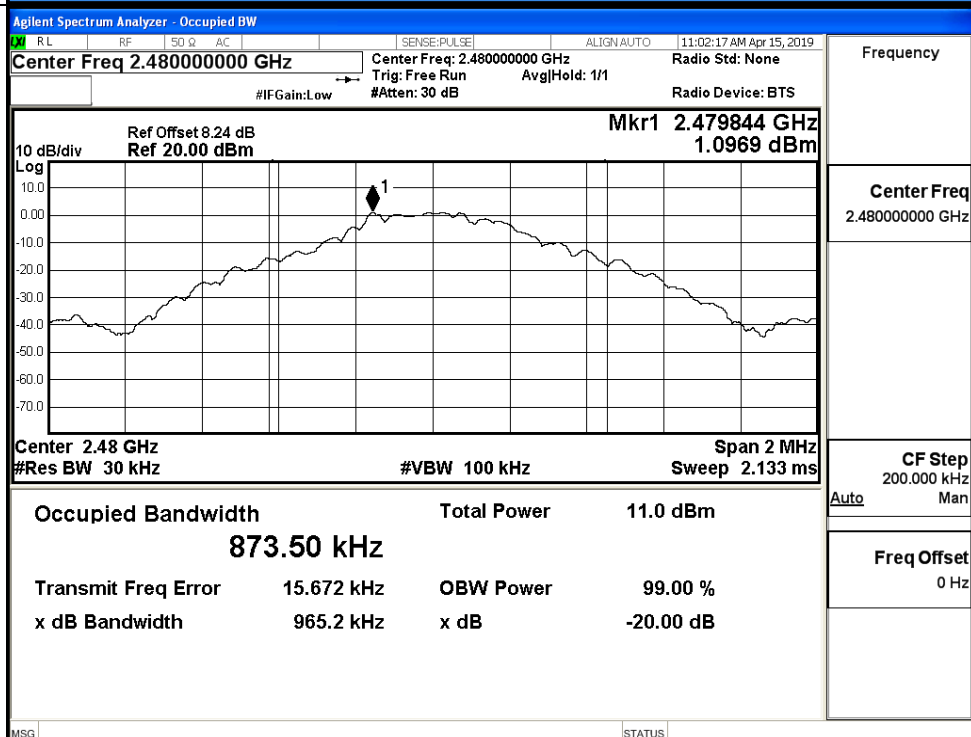
Test Graphs

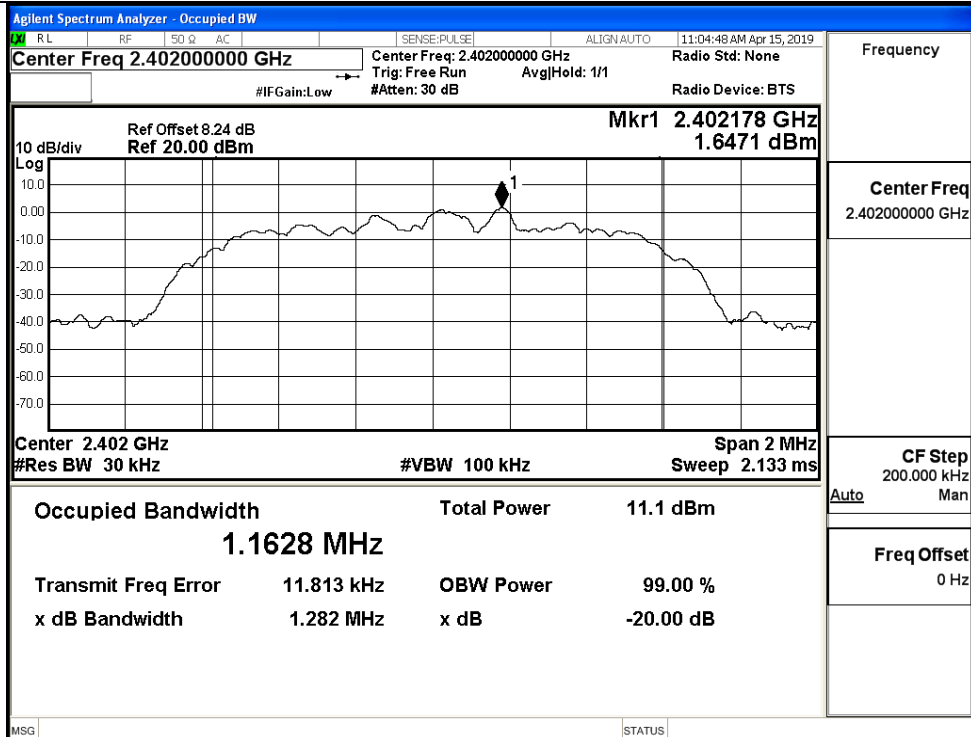
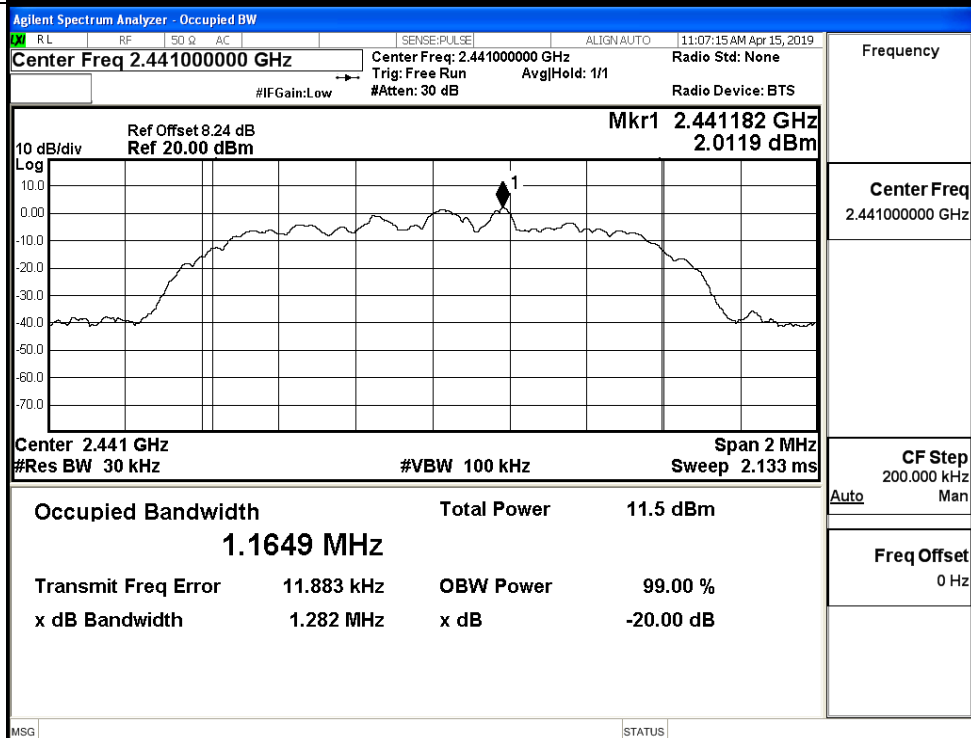


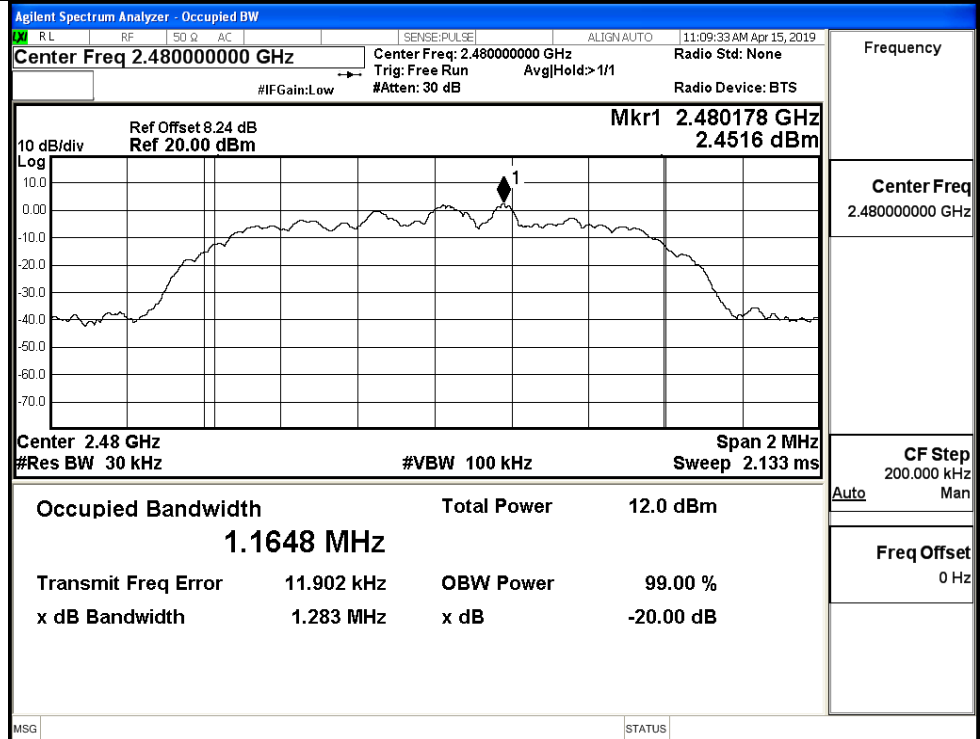
GFSK/MCH



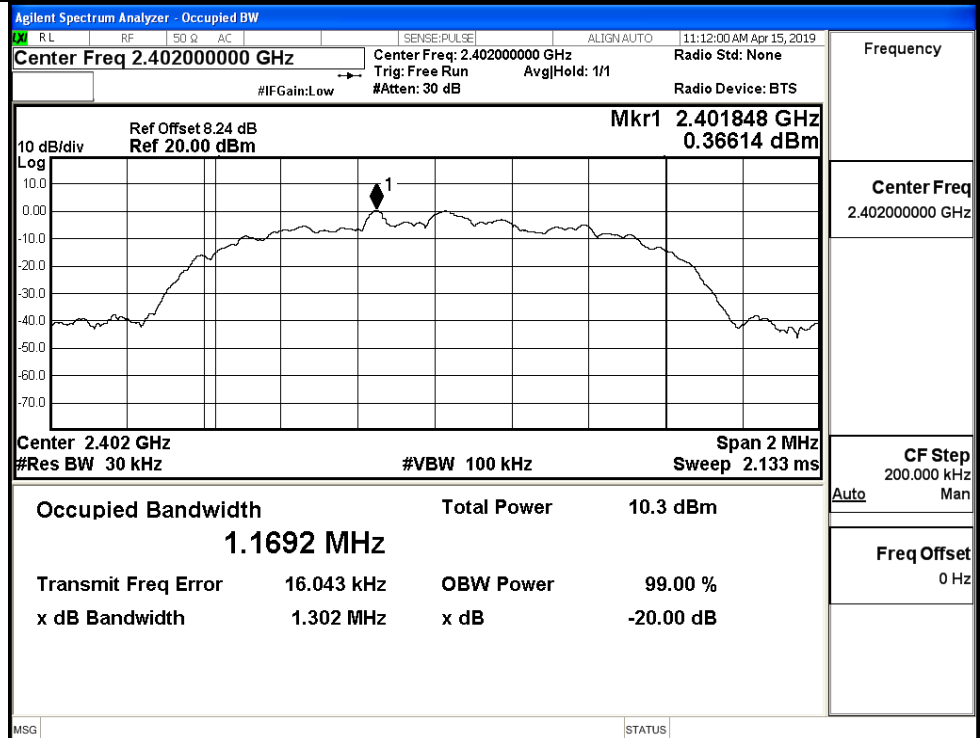
GFSK/HCH



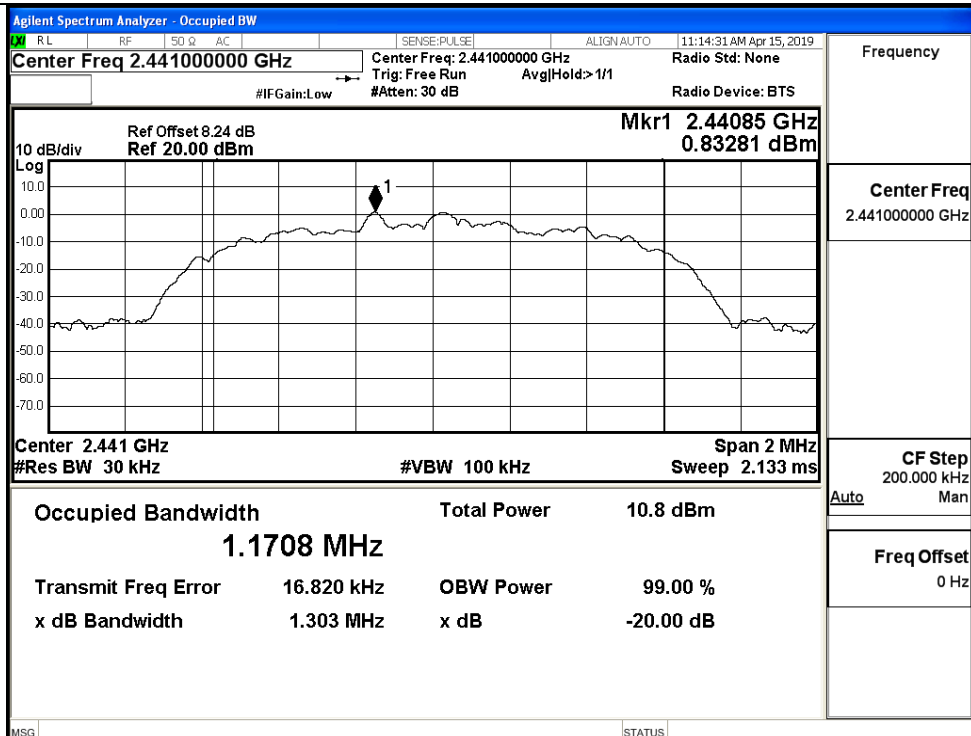
$\pi/4$ DQPSK/LCH $\pi/4$ DQPSK/MCH

$\pi/4$ DQPSK/HCH

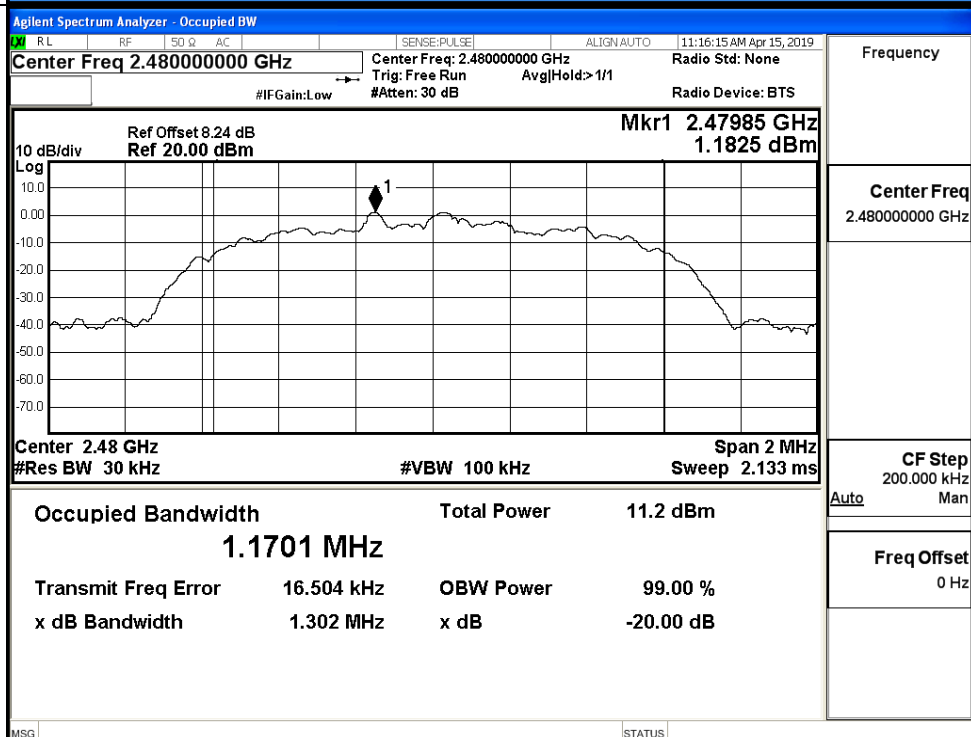
8DPSK/LCH



8DPSK/MCH



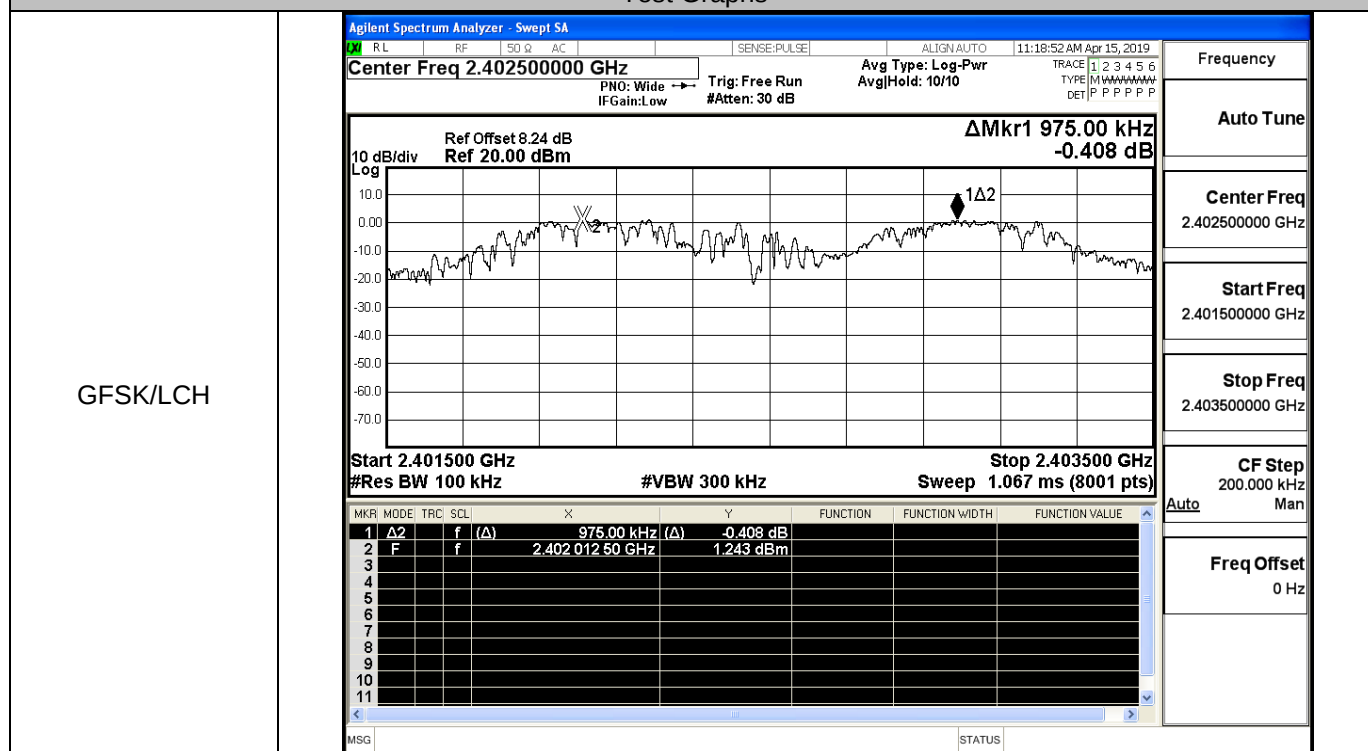
8DPSK/HCH



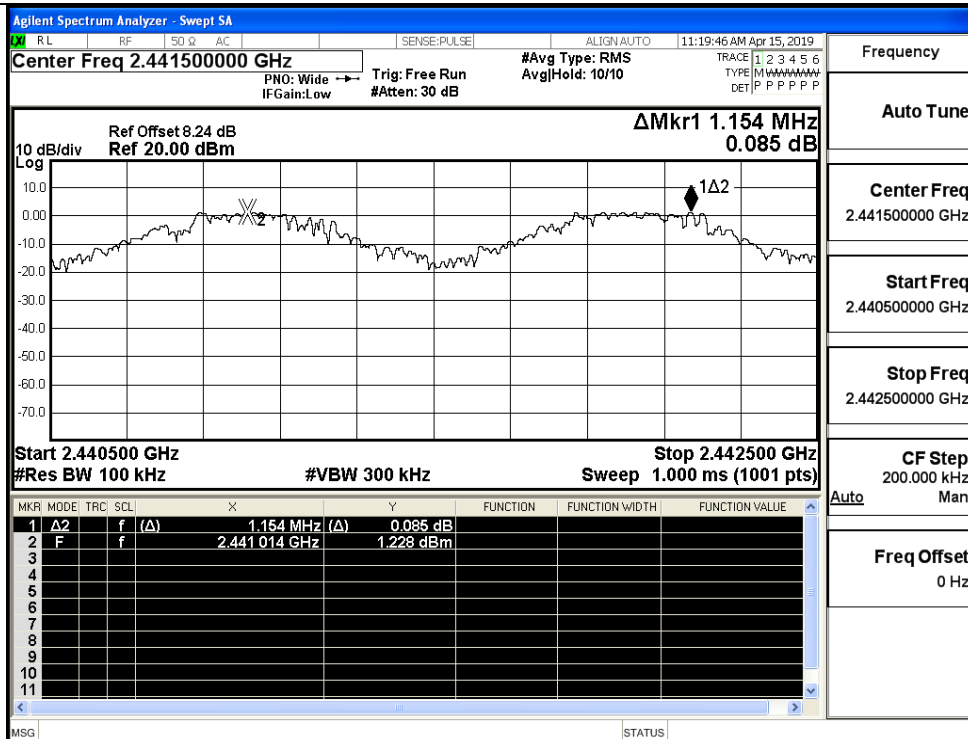
A.3 Carrier Frequency Separation

Mode	Channel.	Carrier Frequency Separation [MHz]	Limit [MHz]	Verdict
GFSK	LCH	0.975	0.643	PASS
	MCH	1.154	0.643	PASS
	HCH	1.010	0.643	PASS
$\pi/4$ DQPSK	LCH	0.992	0.855	PASS
	MCH	0.872	0.855	PASS
	HCH	1.044	0.855	PASS
8DPSK	LCH	0.990	0.869	PASS
	MCH	0.942	0.869	PASS
	HCH	1.194	0.869	PASS

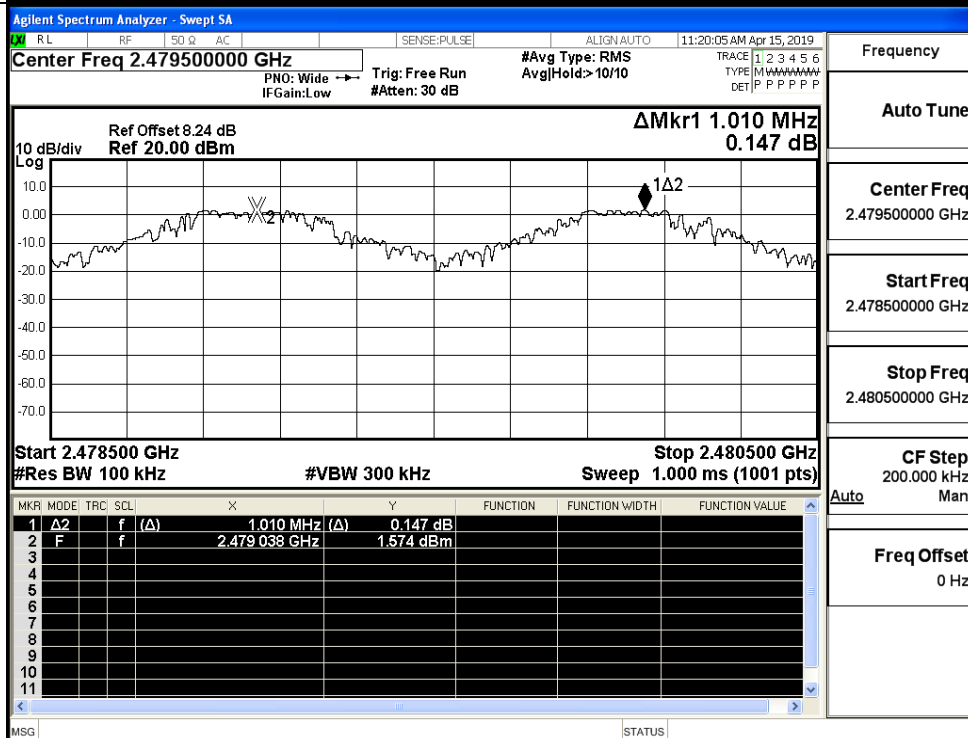
Test Graphs

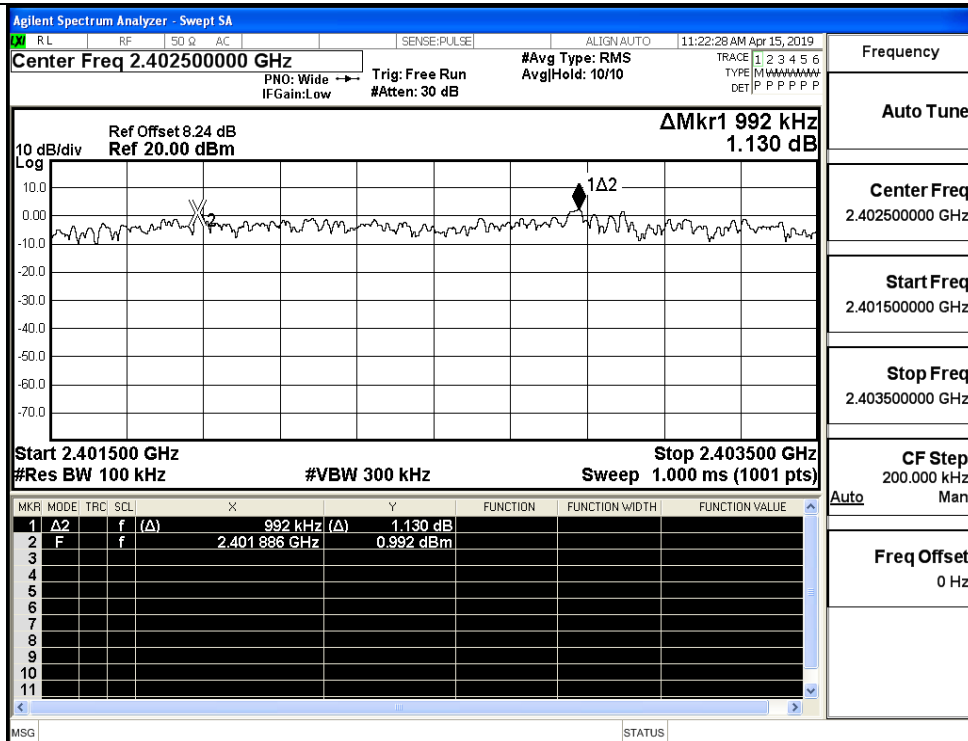
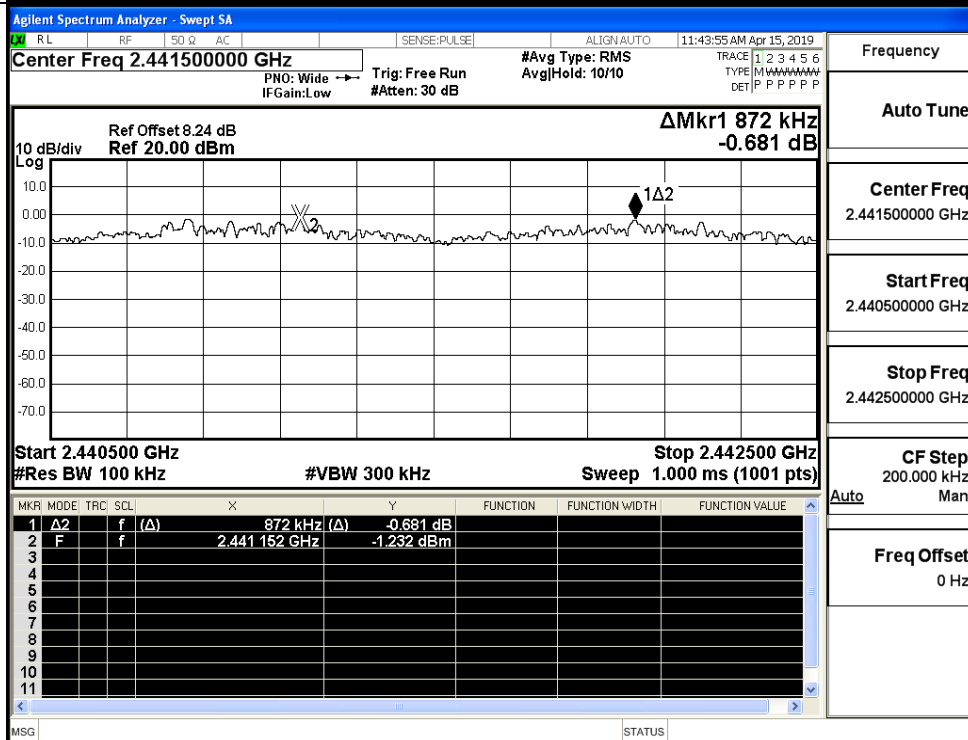


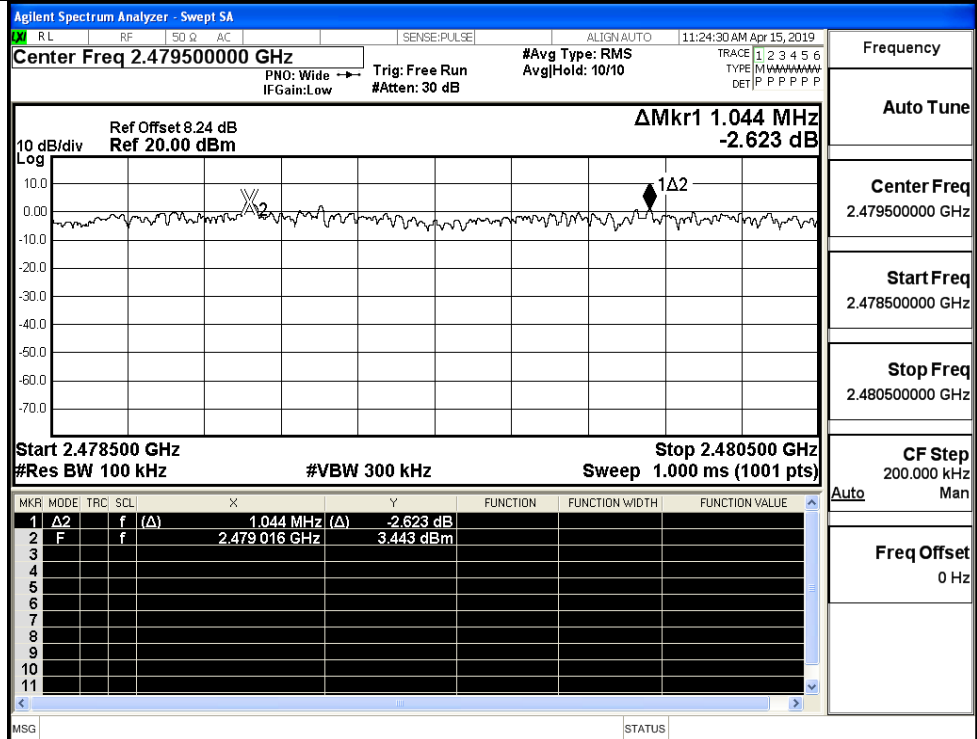
GFSK/MCH



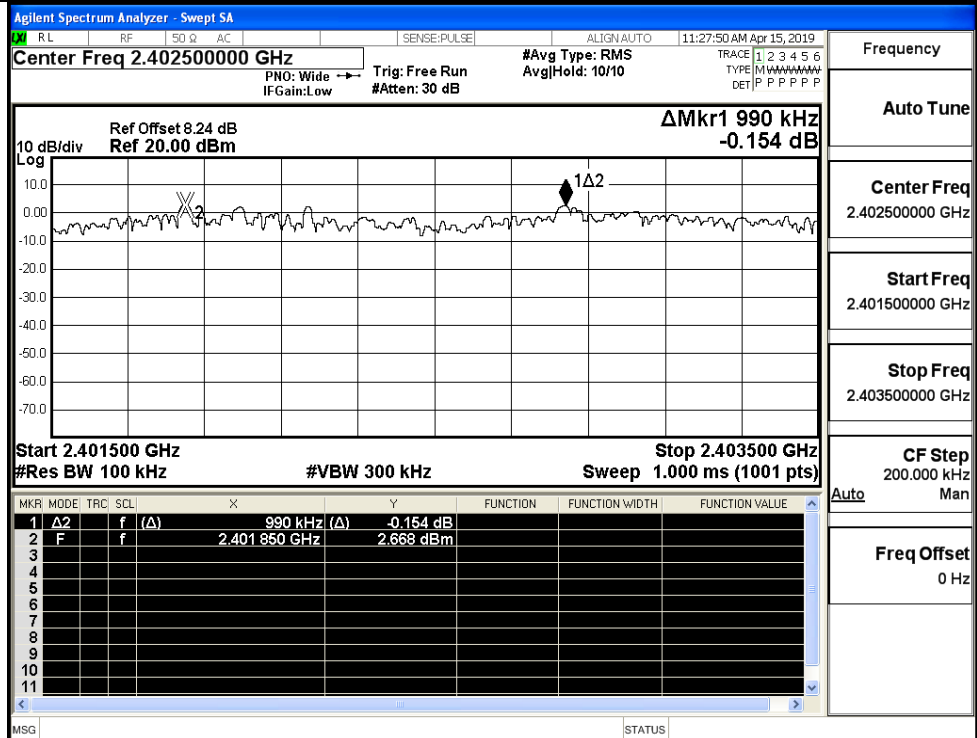
GFSK/HCH

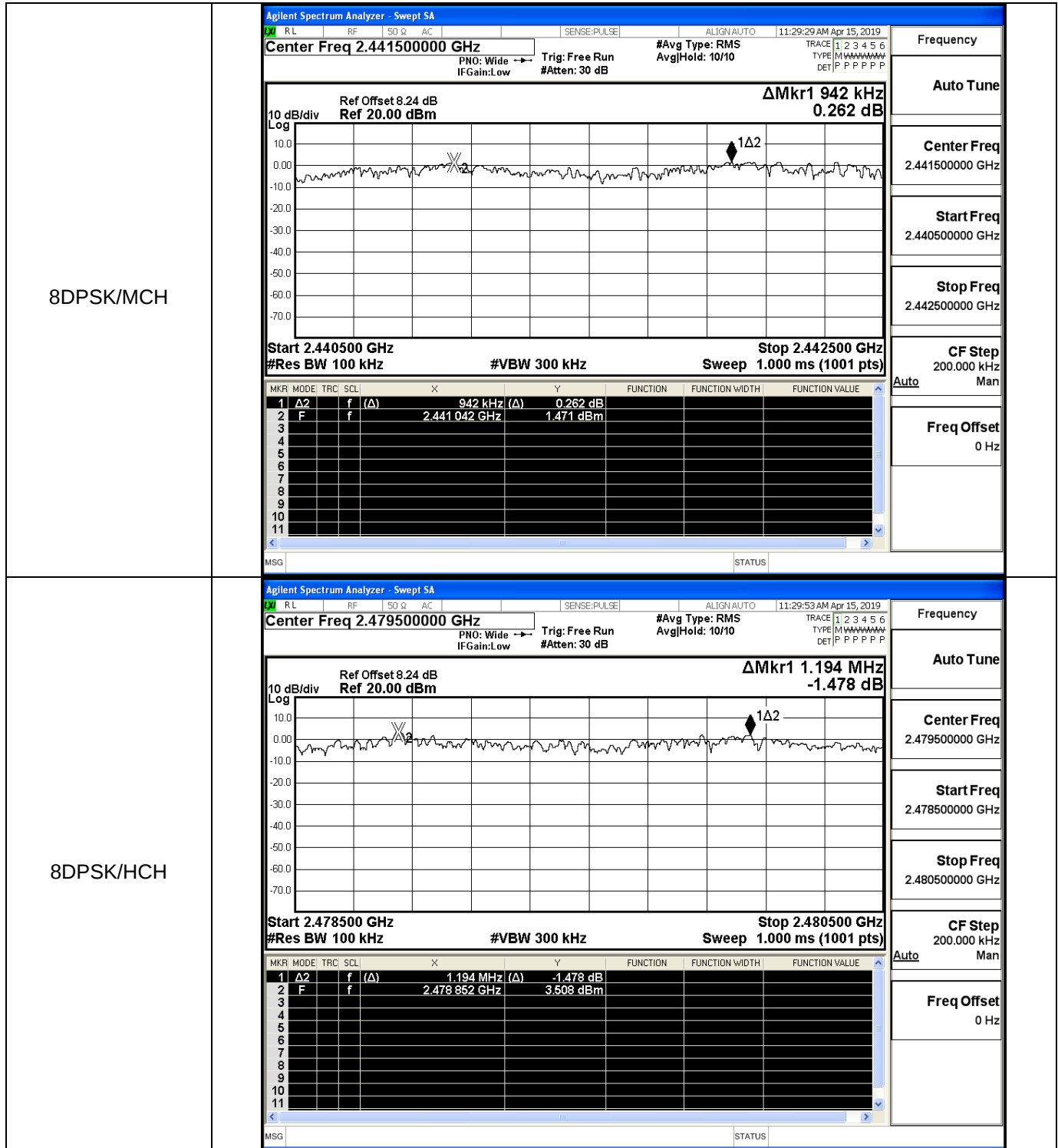


π /4DQPSK/LCH π /4DQPSK/MCH

$\pi/4$ DQPSK/HCH

8DPSK/LCH



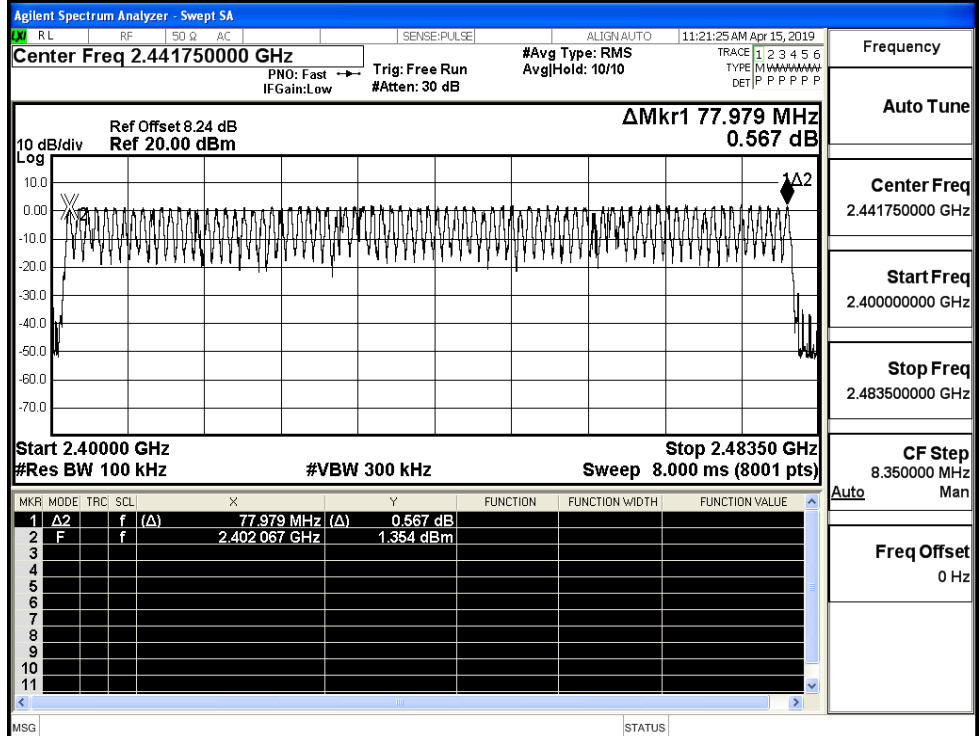
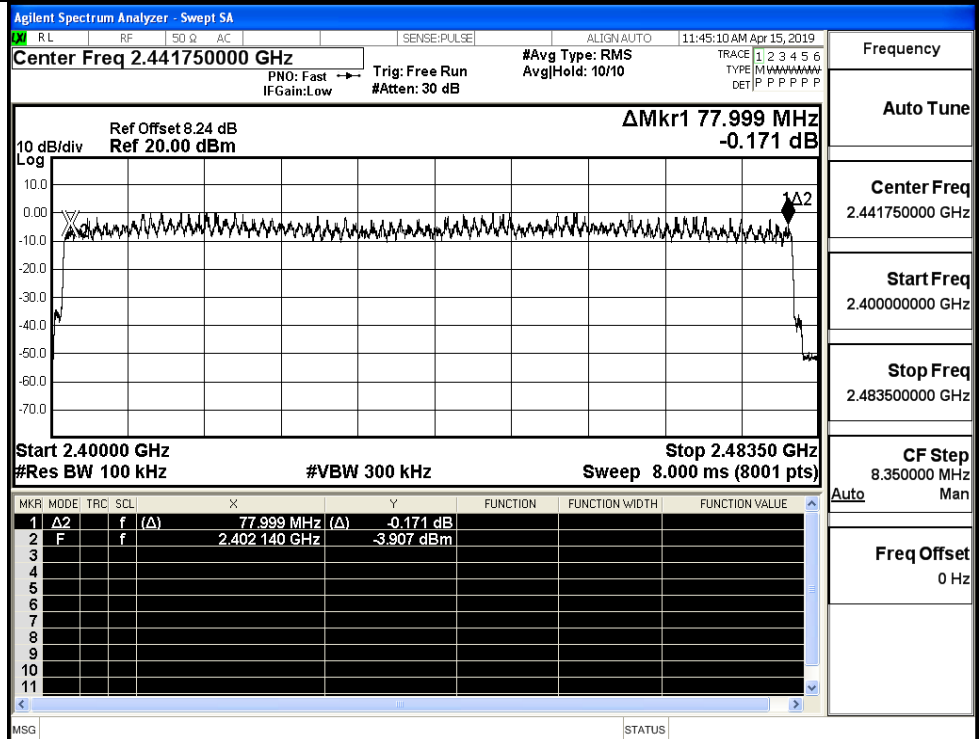


A.4 Hopping Channel Number

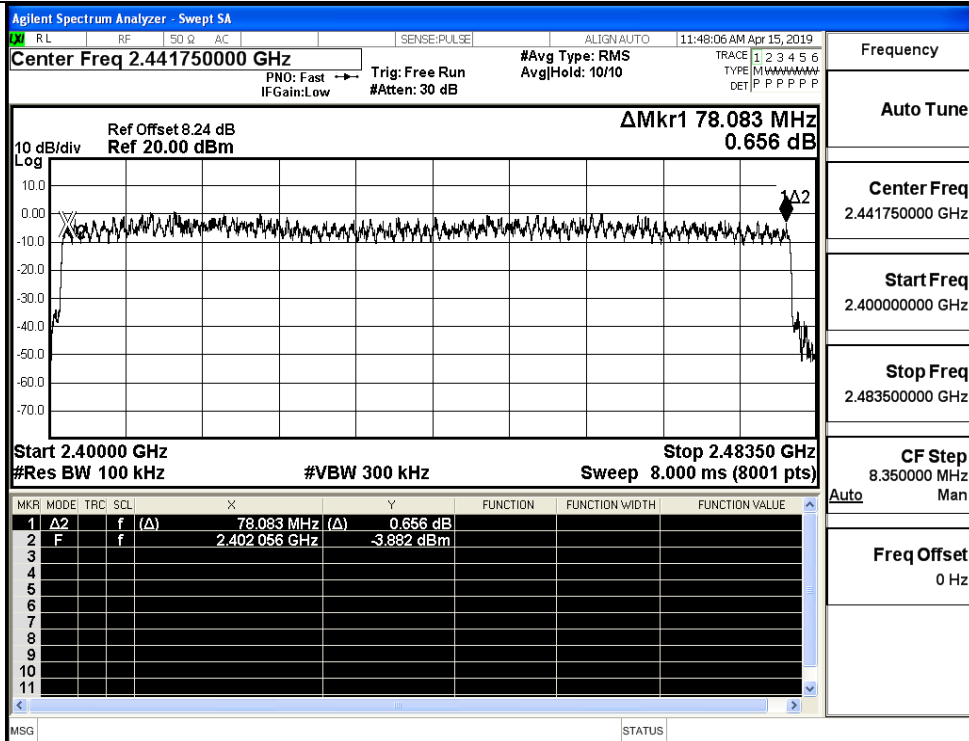
Mode	Channel.	Number of Hopping Channel [N]	Limit [N]	Verdict
GFSK	Hop	79	>=15	PASS
$\pi/4$ DQPSK	Hop	79	>=15	PASS
8DPSK	Hop	79	>=15	PASS

Test Graphs

GFSK/Hop

 $\pi/4$ DQPSK/Hop

8DPSK/Hop

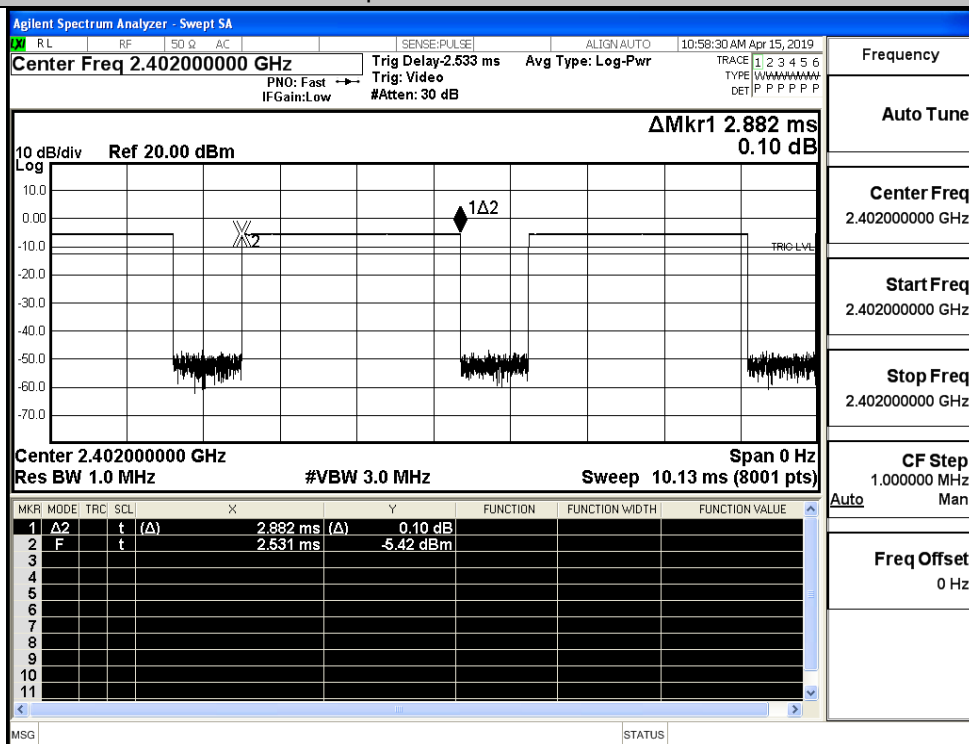


A.5 Dwell Time

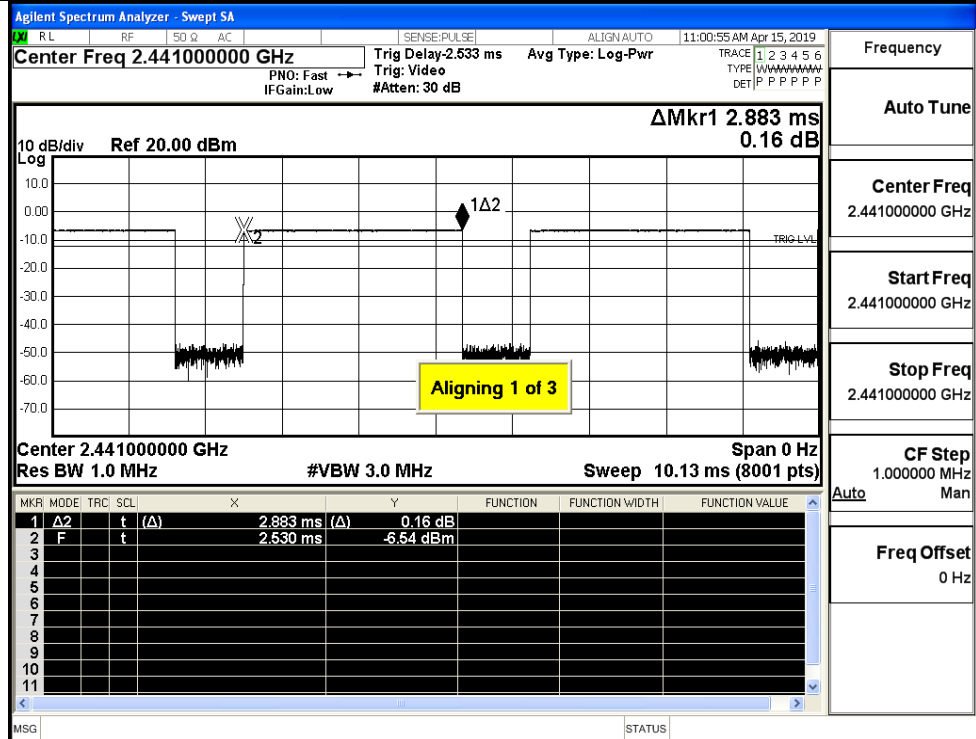
Mode	Packet	Channel	Burst Width [ms/hop/ch]	Total Hops[hop*ch]	Dwell Time[s]	Limit [s]	Verdict
GFSK	DH5	LCH	2.88	106.7	0.307	0.4	PASS
	DH5	MCH	2.88	106.7	0.307	0.4	PASS
	DH5	HCH	2.88	106.7	0.307	0.4	PASS
$\pi/4$ DQPSK	2DH5	LCH	2.88	106.7	0.308	0.4	PASS
	2DH5	MCH	2.88	106.7	0.308	0.4	PASS
	2DH5	HCH	2.88	106.7	0.308	0.4	PASS
8DPSK	3DH5	LCH	2.88	106.7	0.308	0.4	PASS
	3DH5	MCH	2.88	106.7	0.308	0.4	PASS
	3DH5	HCH	2.88	106.7	0.308	0.4	PASS

Test Graphs

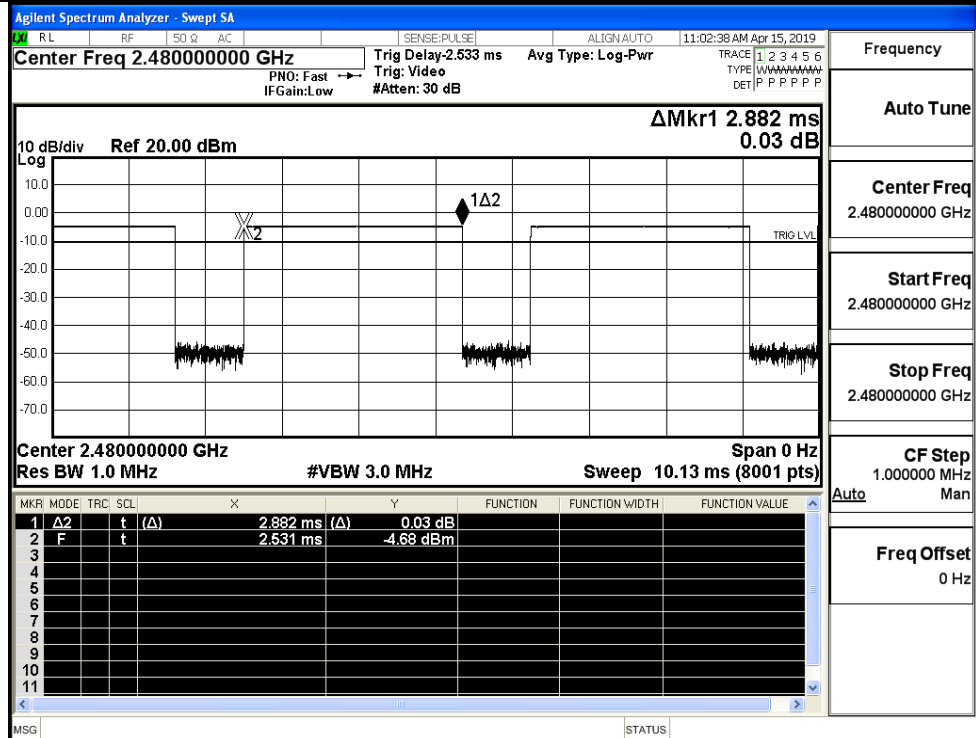
GFSK_DH5/LCH



GFSK_DH5/MCH



GFSK_DH5/HCH



Agilent Spectrum Analyzer - Swept SA

RL RF 50 Ω AC SENSE: PULSE ALIGN: AUTO 11:05:09 AM Apr 15, 2019

Center Freq 2.402000000 GHz Trig Delay: 2.533 ms Avg Type: Log-Pwr PNO: Fast IF Gain: Low Trig: Video #Atten: 30 dB TRACE 1 2 3 4 5 6 TYPE TYPE P P P P P P DET

10 dB/div Ref 20.00 dBm Δ Mkr1 2.885 ms -0.54 dB

Center 2.402000000 GHz Span 0 Hz
Res BW 1.0 MHz #VBW 3.0 MHz Sweep 10.13 ms (8001 pts)

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	Δ 2	t	(Δ)	2.885 ms	-0.54 dB			
2	F	t		1.459 ms	-4.75 dBm			
3								
4								
5								
6								
7								
8								
9								
10								
11								

MSG STATUS

Frequency

Auto Tune

Center Freq 2.402000000 GHz

Start Freq 2.402000000 GHz

Stop Freq 2.402000000 GHz

CF Step 1.000000 MHz

Auto Man

Freq Offset 0 Hz

Agilent Spectrum Analyzer - Swept SA

RL RF SO Q AC SENSE:PULSE ALIGN:AUTO 11:07:35 AM Apr 15, 2019

Center Freq 2.441000000 GHz Trig Delay: 2.533 ms Avg Type: Log-Pwr PNO: Fast IF Gain: Low Trig: Video #Atten: 30 dB TRACE 1 2 3 4 5 6 TYPE P P P P P P P DET

10 dB/div Ref 20.00 dBm Δ Mkr1 2.885 ms -0.55 dB

Center 2.441000000 GHz Span 0 Hz
Res BW 1.0 MHz #VBW 3.0 MHz Sweep 10.13 ms (8001 pts)

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	Δ 2	t	(Δ)	2.885 ms	(Δ) -0.55 dB			
2	F	t		2.530 ms	-4.34 dBm			
3								
4								
5								
6								
7								
8								
9								
10								
11								

MSG STATUS

Frequency
Auto Tune
Center Freq 2.441000000 GHz
Start Freq 2.441000000 GHz
Stop Freq 2.441000000 GHz
CF Step 1.000000 MHz
Auto Man
Freq Offset 0 Hz

[illegible]

Agilent Spectrum Analyzer - Swept SA

RL RF 50 Ω AC SENSE:PULSE ALIGN:AUTO 12:00:38 PM Apr 15, 2019

Center Freq 2.402000000 GHz Trig Delay: 2.533 ms Avg Type: Log-Pwr PNO: Fast IF Gain: Low Trig: Video #Atten: 30 dB TRACE 1 2 3 4 5 6 TYPE P P P P P P P P DET P P P P P P P P

10 dB/div Ref 20.00 dBm ΔMkr1 2.888 ms -0.22 dB

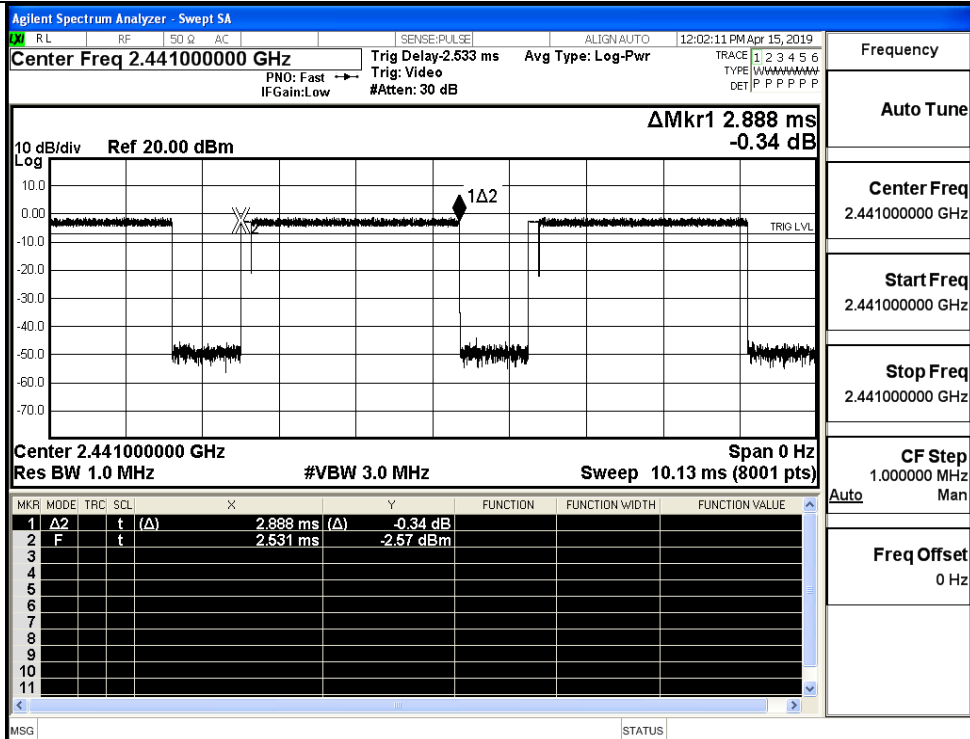
Center 2.402000000 GHz Span 0 Hz
Res BW 1.0 MHz #VBW 3.0 MHz Sweep 10.13 ms (8001 pts)

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	Δ2	t	(Δ)	2.888 ms	(Δ) -0.22 dB			
2	F	t		1.859 ms	-2.13 dBm			
3								
4								
5								
6								
7								
8								
9								
10								
11								

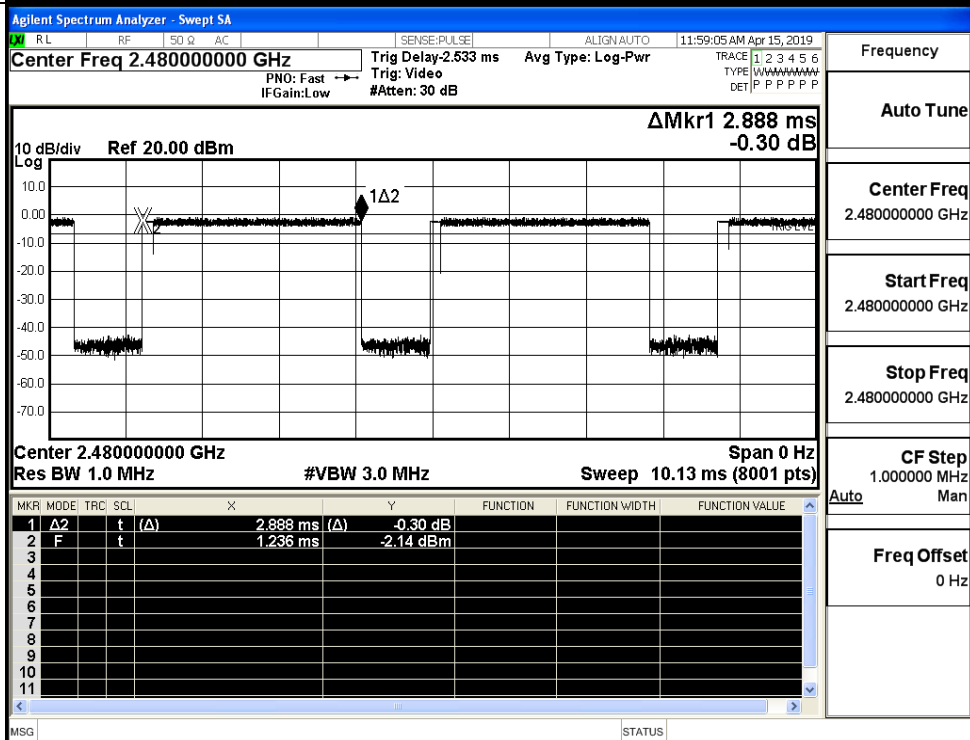
MSG STATUS

Frequency Auto Tune Center Freq 2.402000000 GHz Start Freq 2.402000000 GHz Stop Freq 2.402000000 GHz CF Step 1.000000 MHz Man Freq Offset 0 Hz

8DPSK_3DH5/MCH



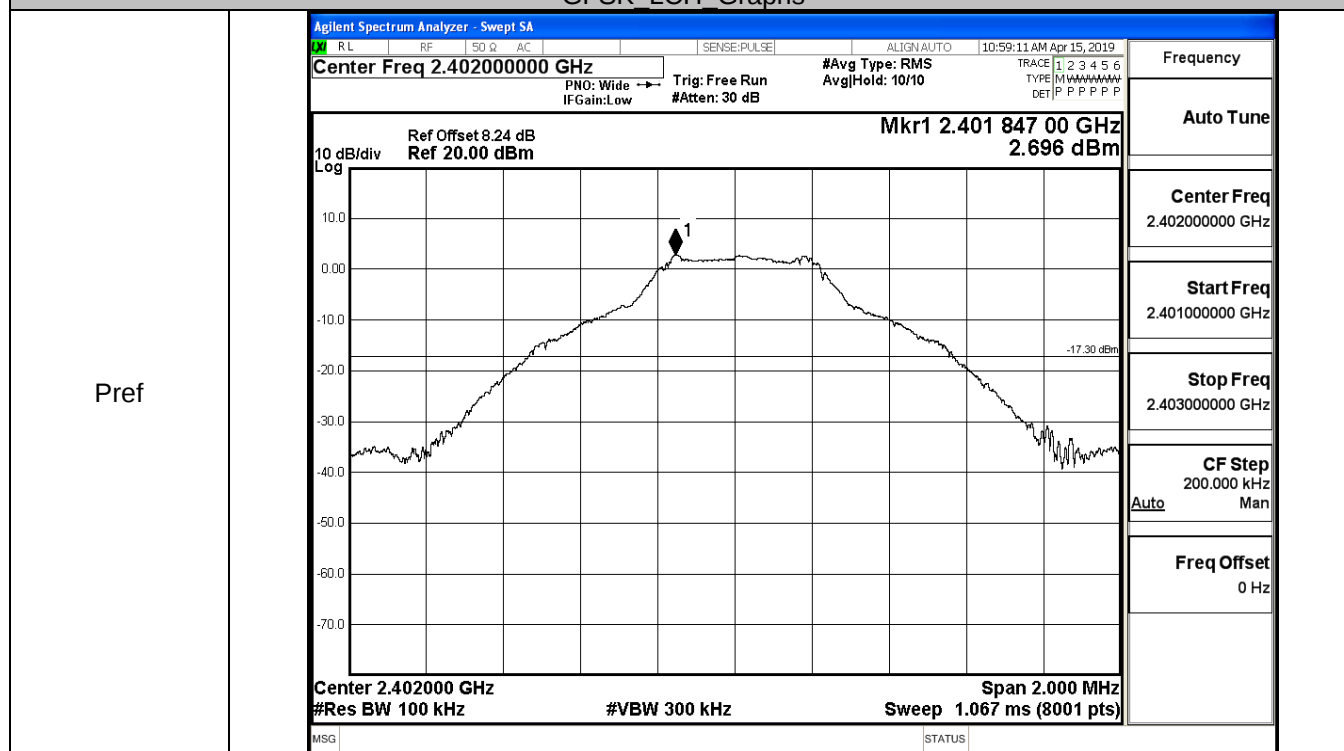
8DPSK_3DH5/HCH



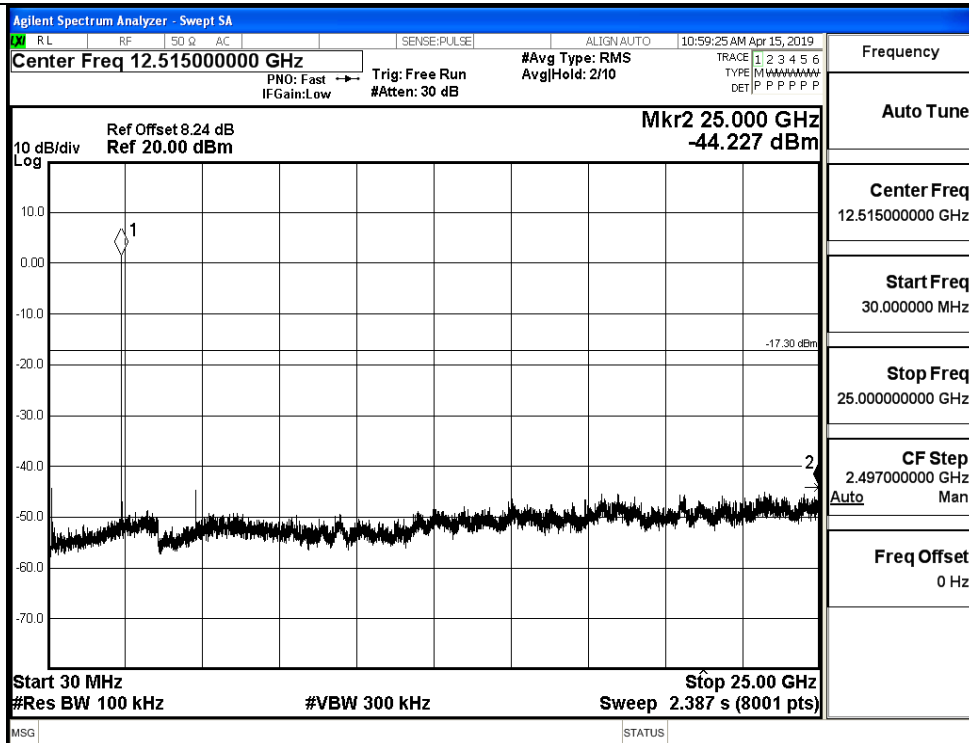
A.6 RF Conducted Spurious Emissions

Mode	Channel	Pref [dBm]	Max. Level [dBm]	Limit [dBm]	Verdict
GFSK	LCH	2.696	-44.227	-17.304	PASS
	MCH	1.657	-33.025	-18.343	PASS
	HCH	3.511	-39.992	-16.489	PASS
$\pi/4$ DQPSK	LCH	3.398	-44.860	-16.602	PASS
	MCH	3.836	-42.757	-16.164	PASS
	HCH	4.35	-41.479	-15.650	PASS
8DPSK	LCH	2.485	-43.729	-17.515	PASS
	MCH	3.883	-40.696	-16.117	PASS
	HCH	3.397	-44.584	-16.603	PASS

GFSK LCH Graphs

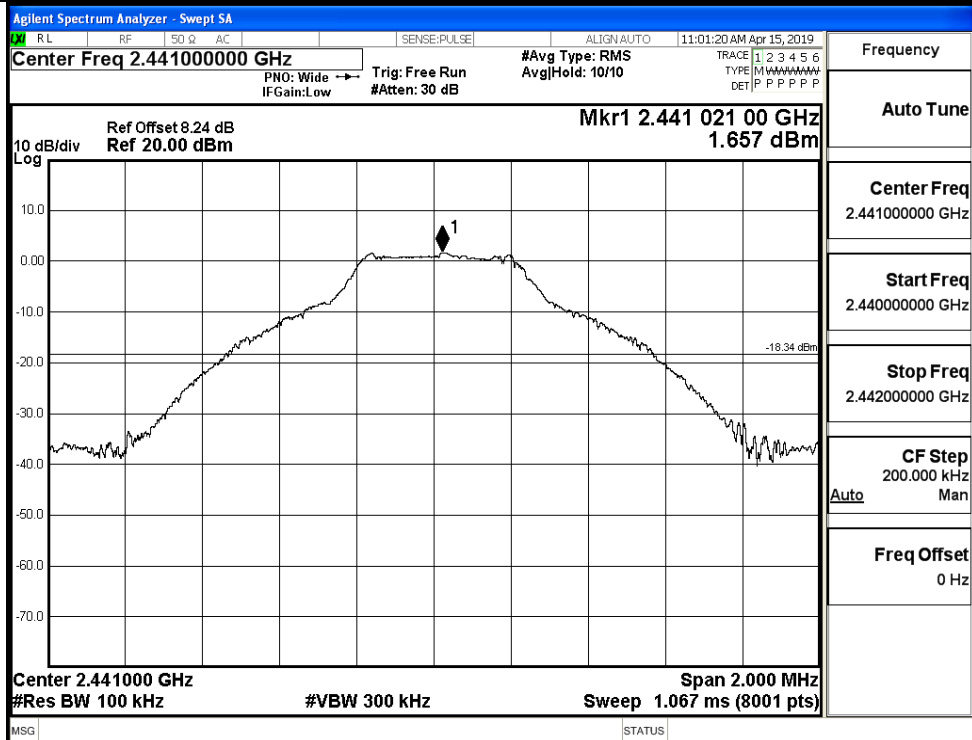


Puw

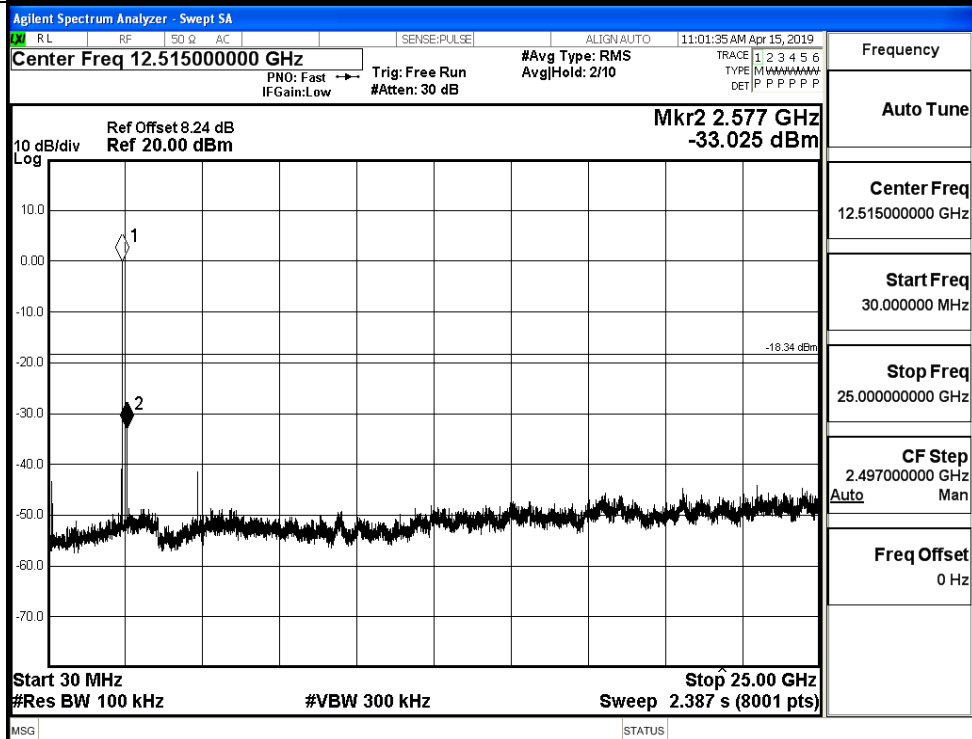


GFSK MCH Graphs

Pref

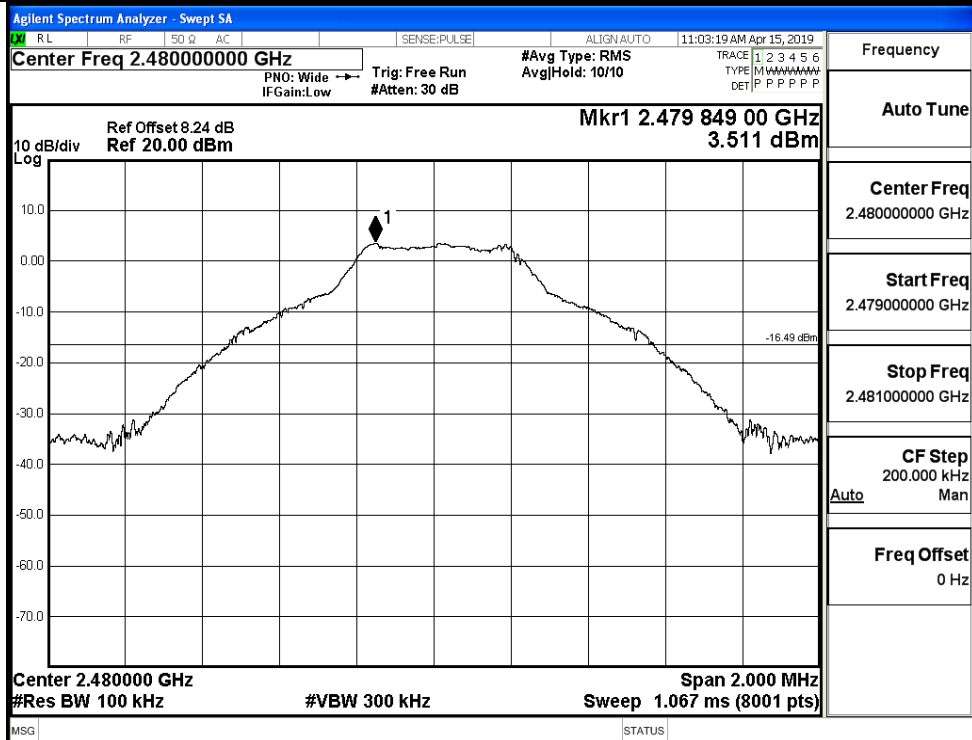


Puw

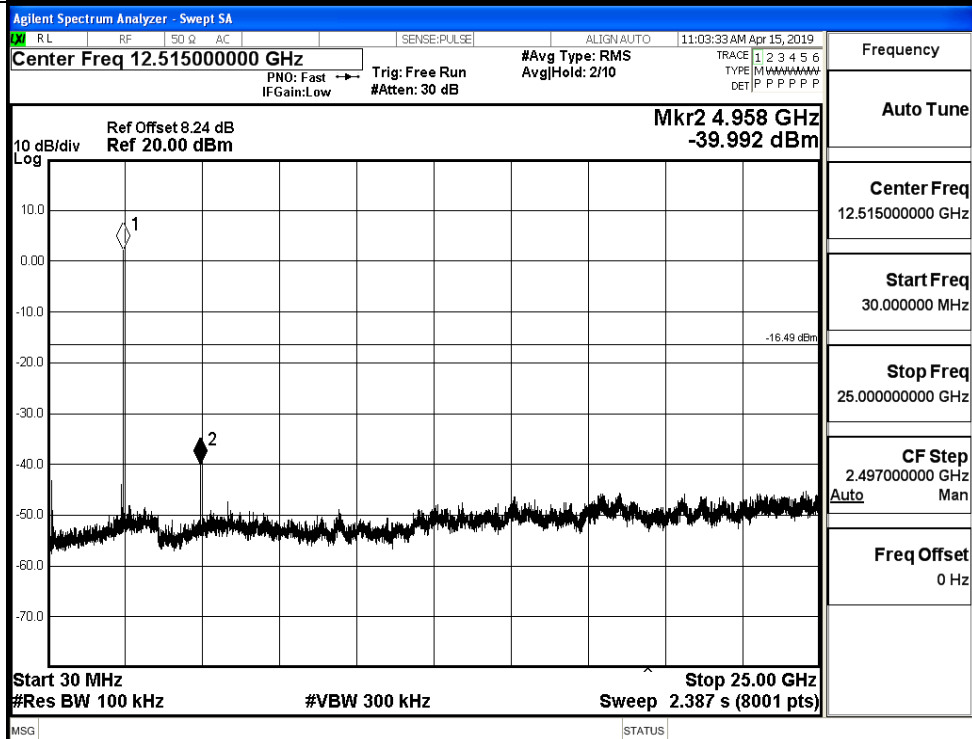


GFSK HCH Graphs

Pref

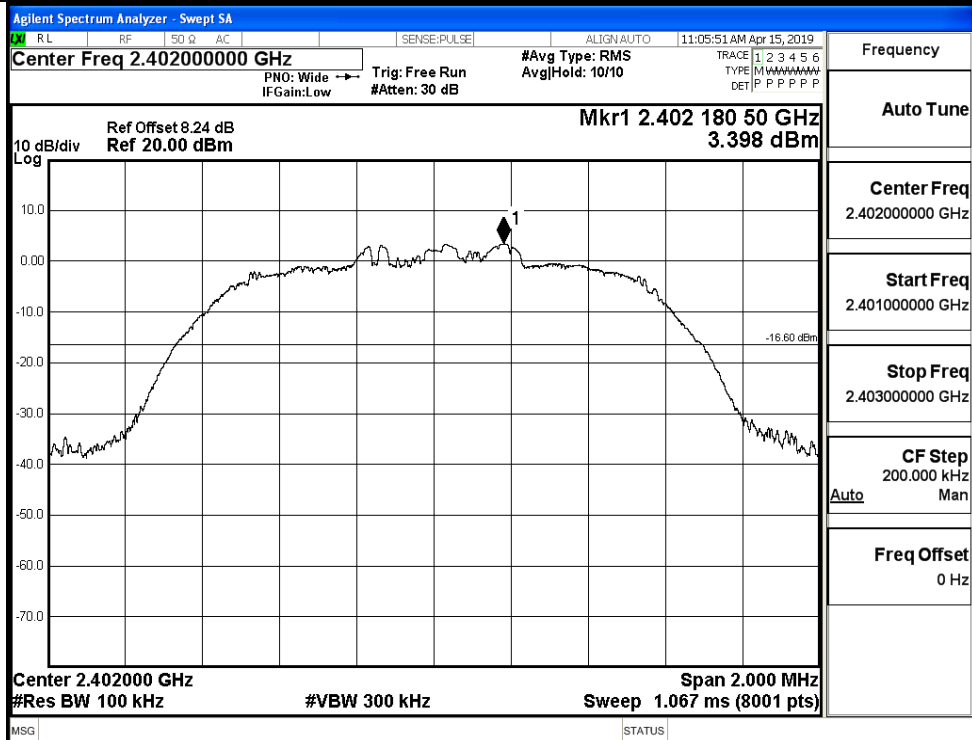


Puw

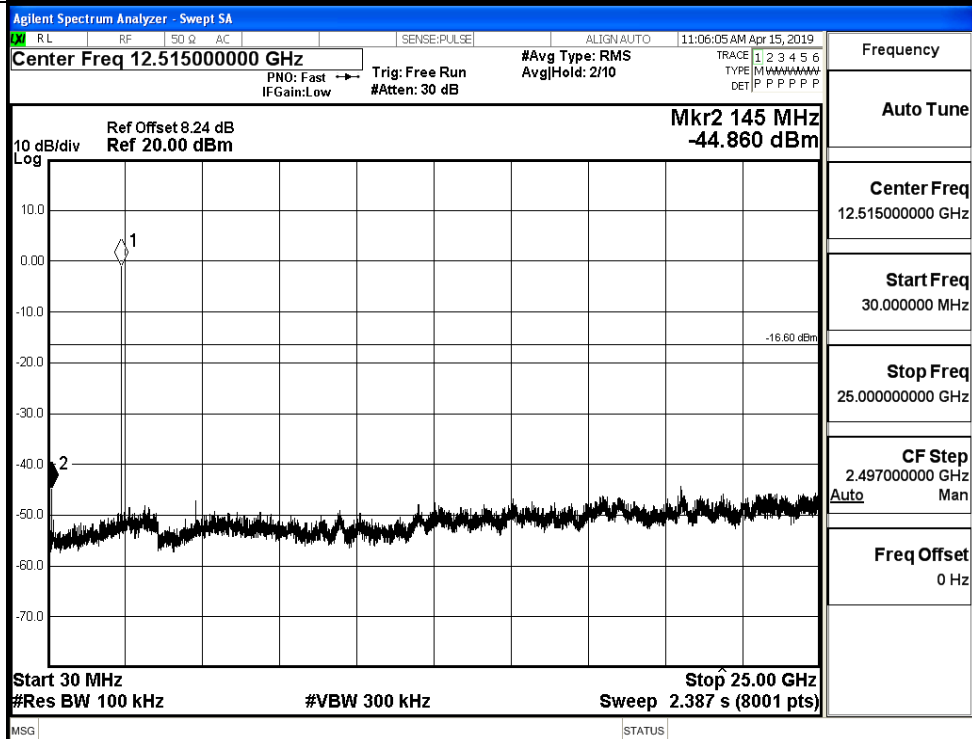


$\pi/4$ DQPSK LCH Graphs

Pref

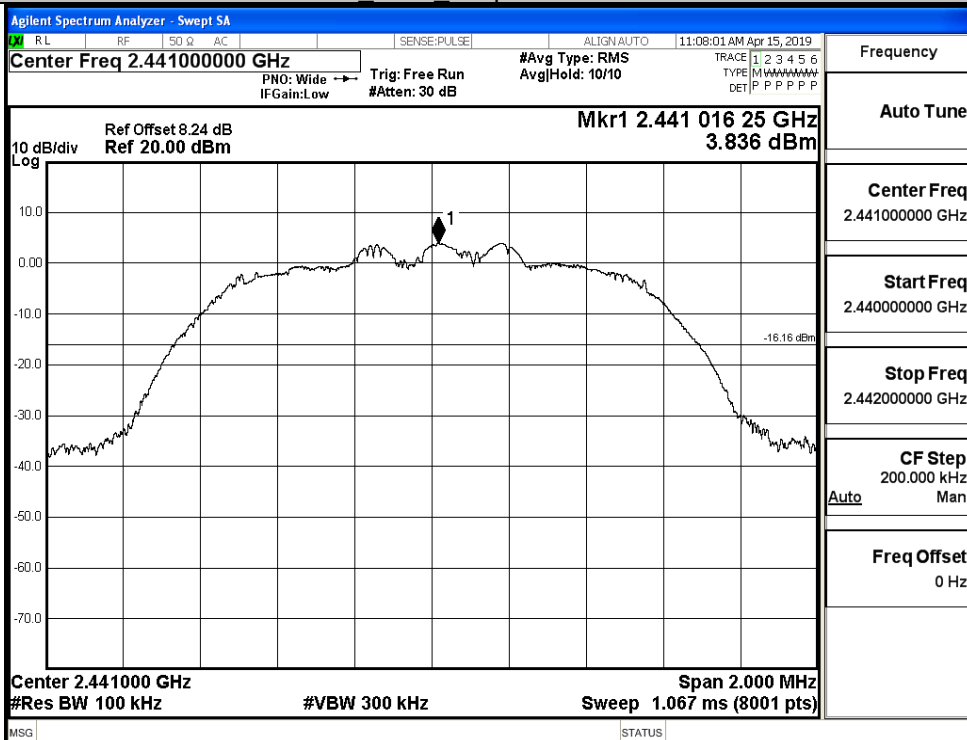


Puw

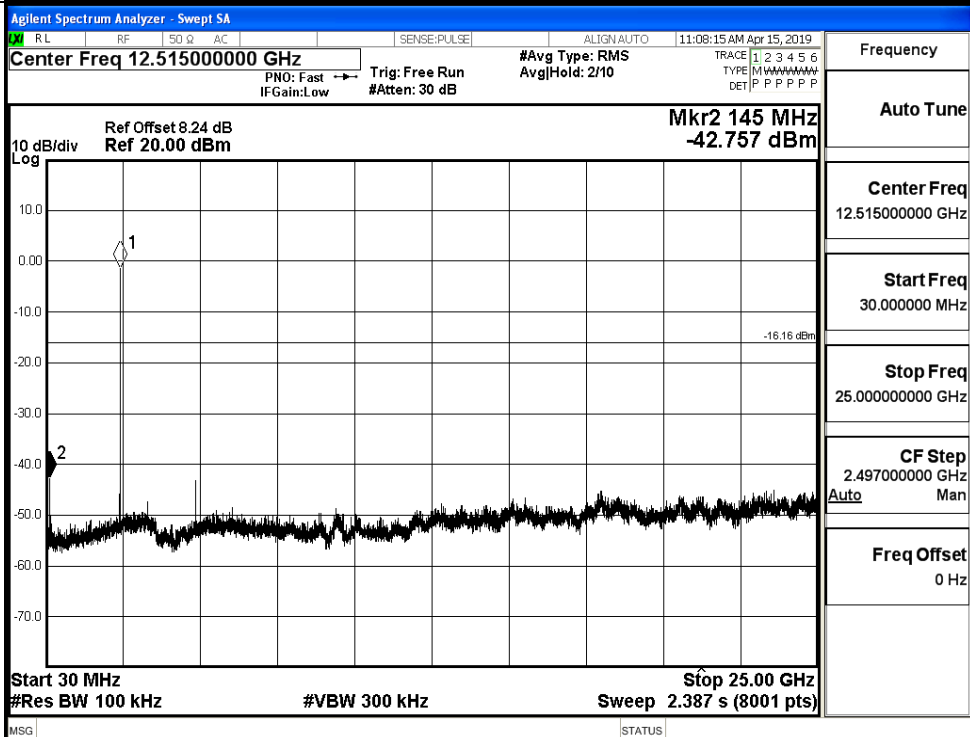


π /4DQPSK MCH Graphs

Pref

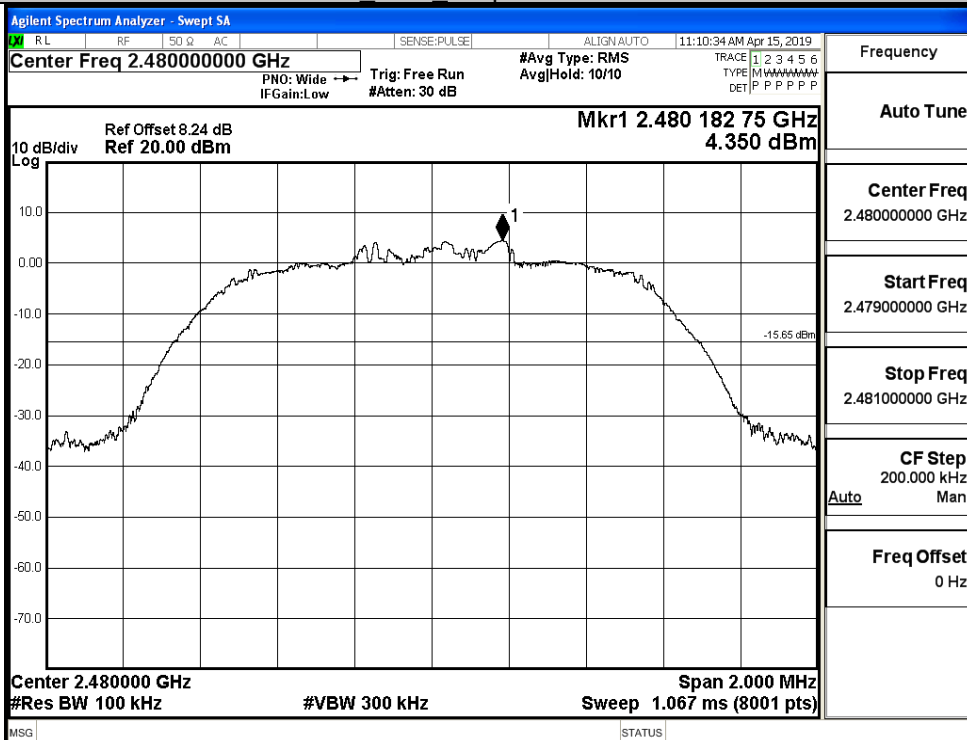


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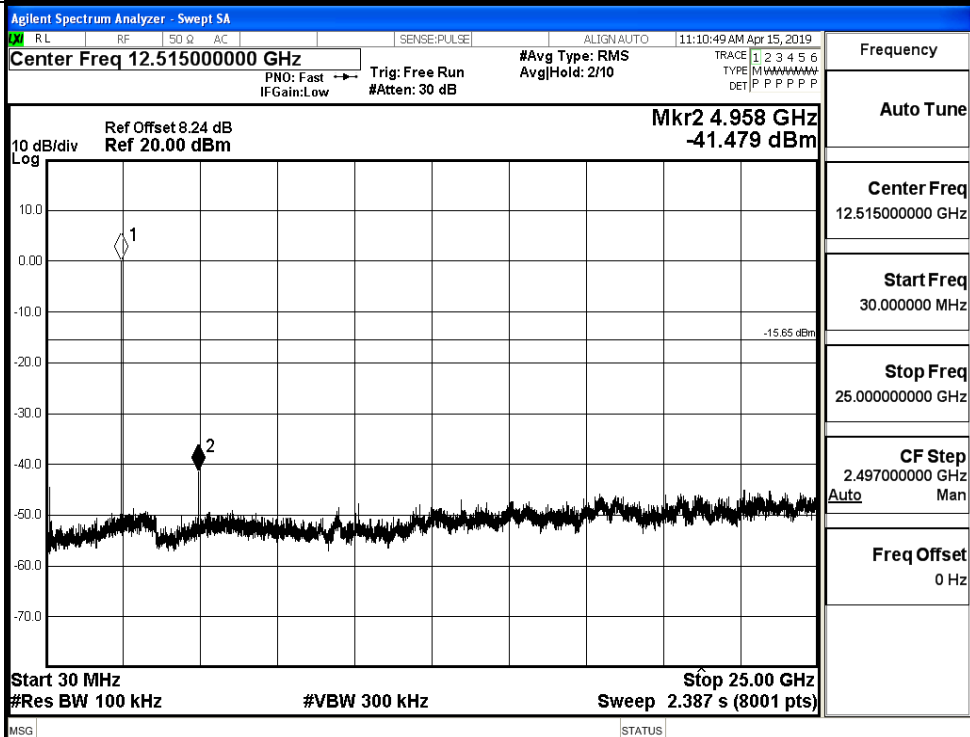


π /4DQPSK HCH Graphs

Pref

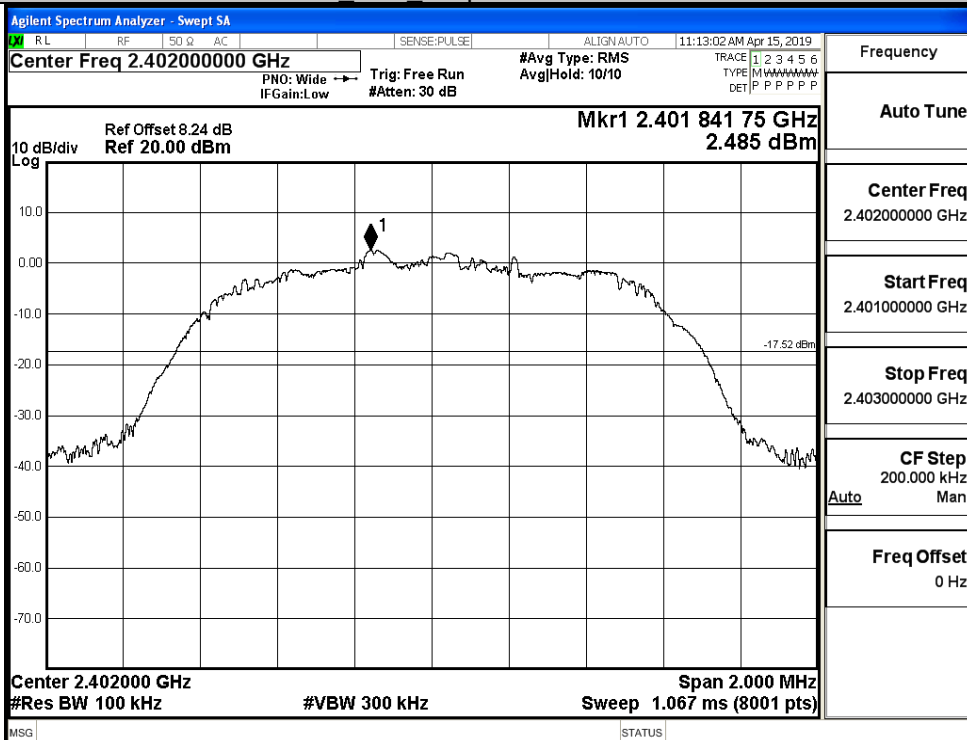


Puw

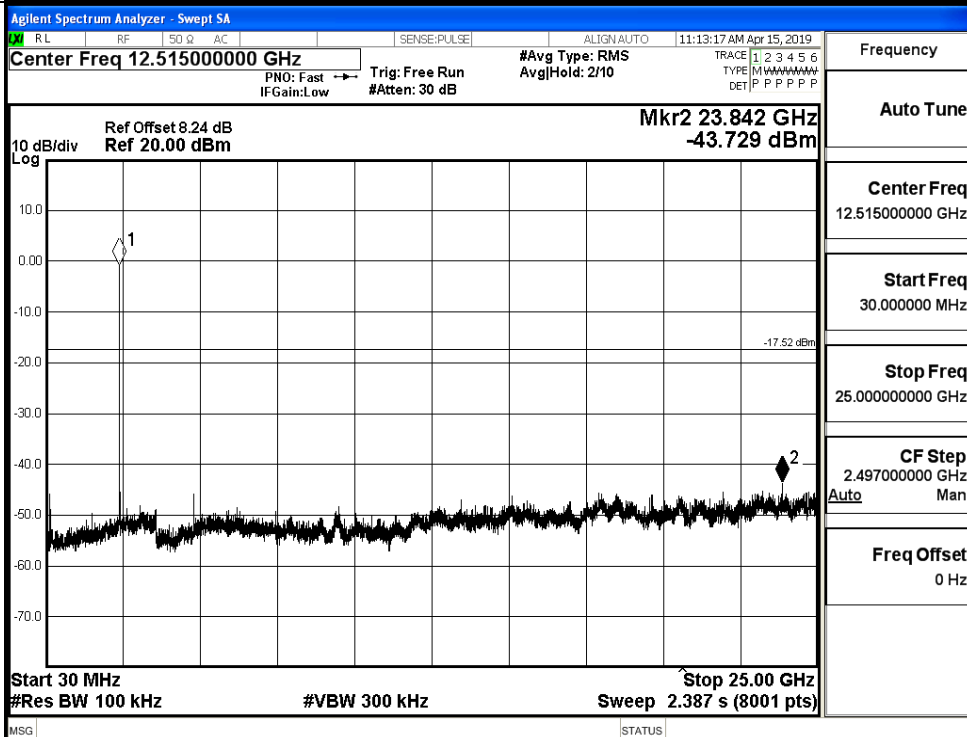


8DPSK LCH Graphs

Pref

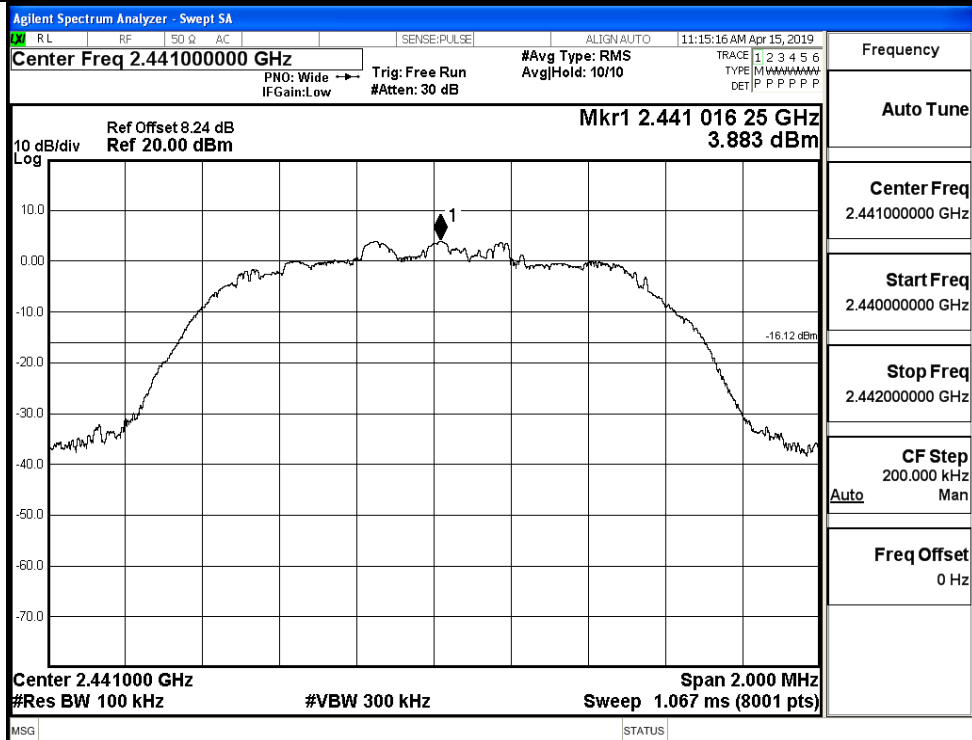


Puw

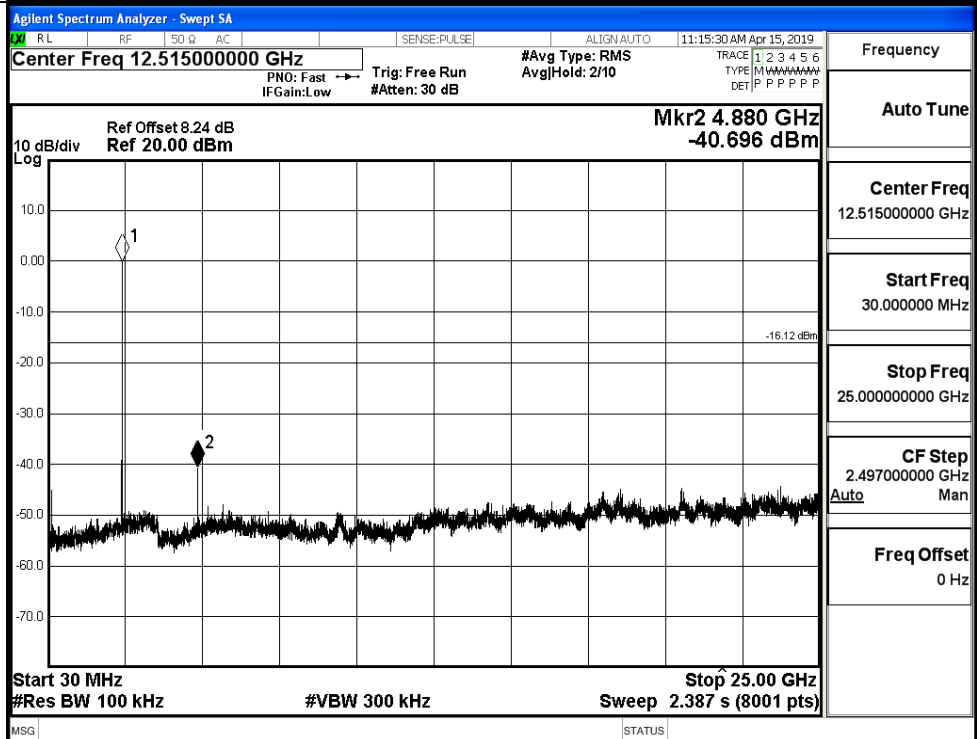


8DPSK MCH Graphs

Pref

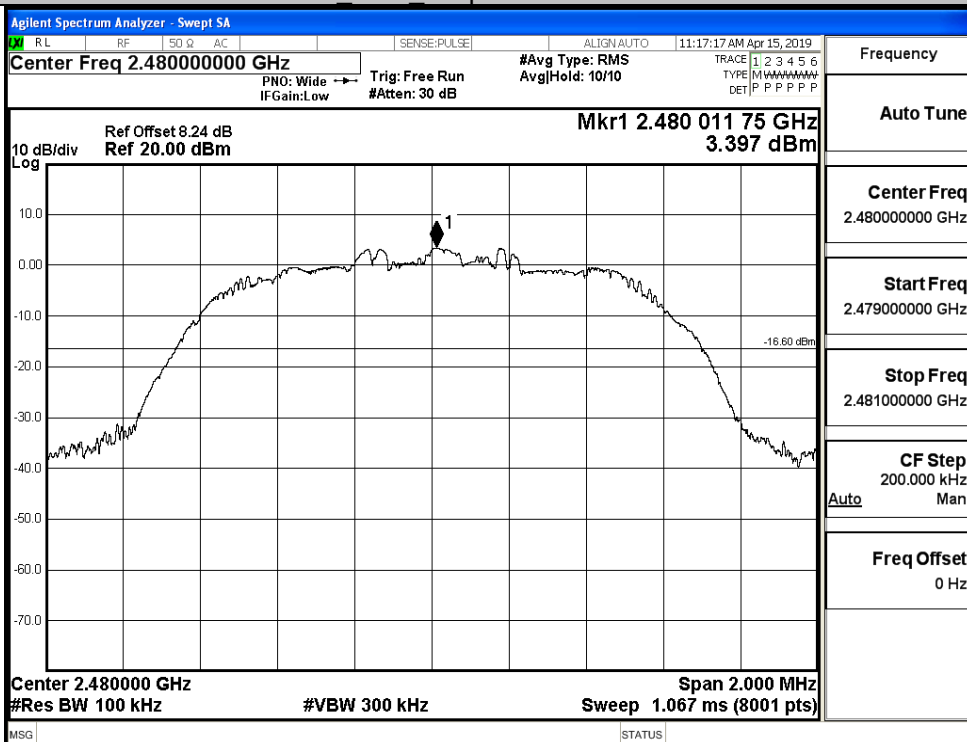


Puw

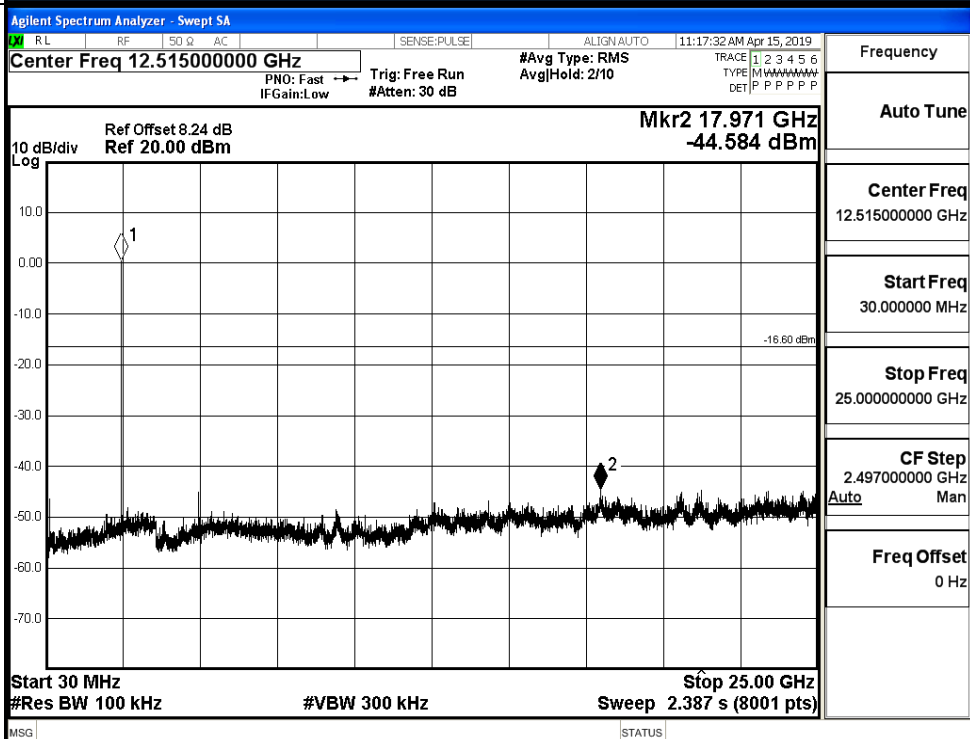


8DPSK_HCH Graphs

Pref



Puw

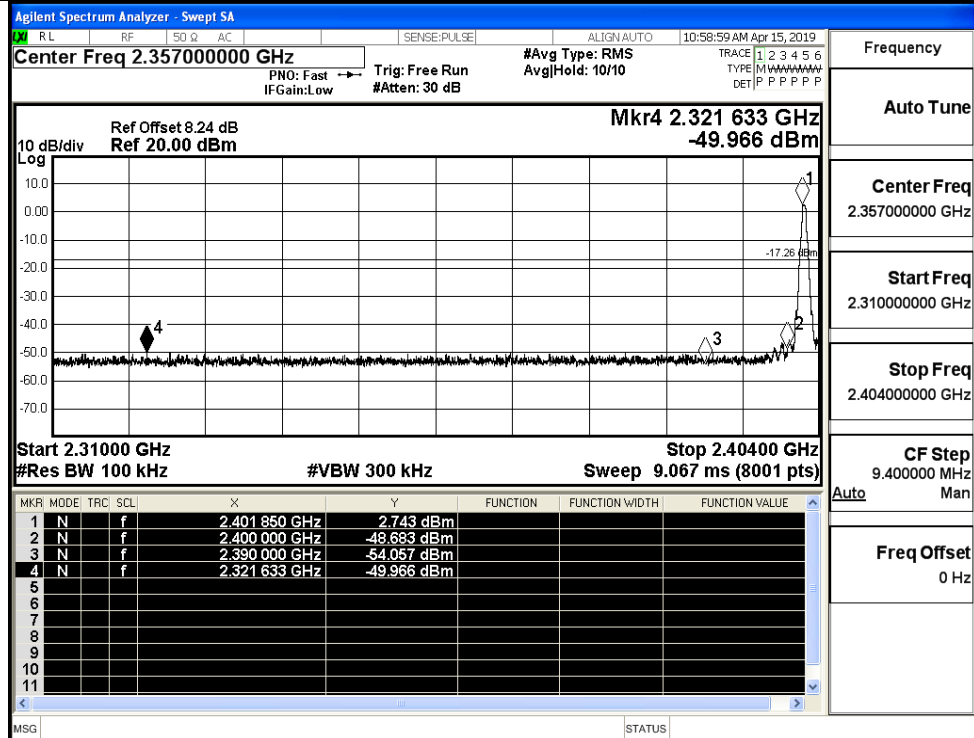


A.7 Band-edge for RF Conducted Emissions

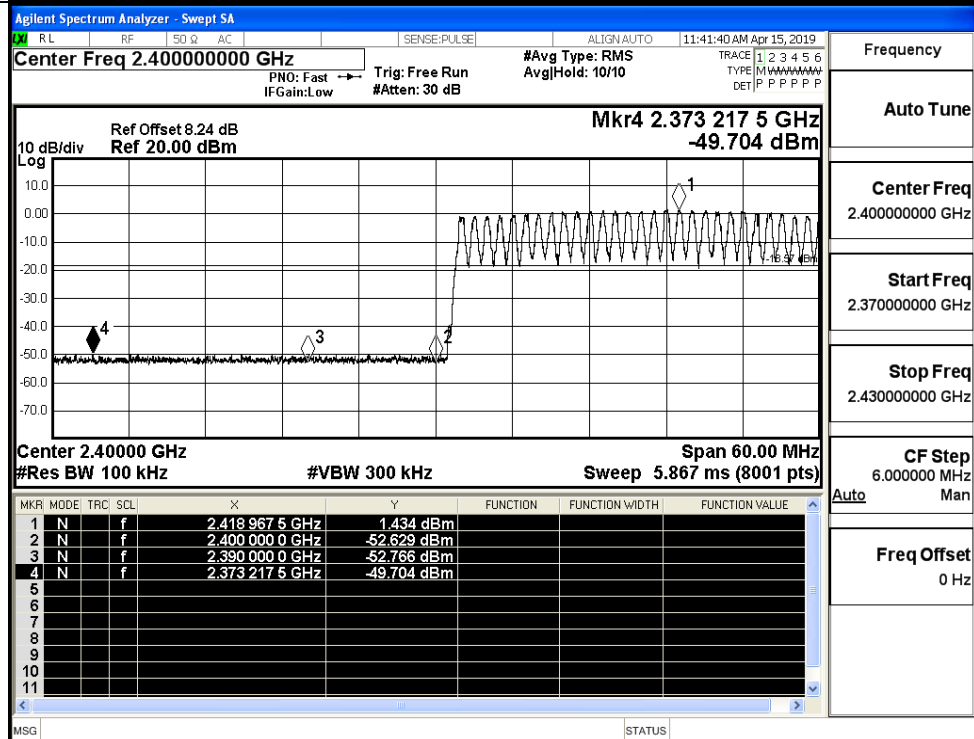
Mode	Channel	Carrier Frequency [MHz]	Carrier Power [dBm]	Frequency Hopping	Max Spurious Level [dBm]	Limit [dBm]	Verdict
GFSK	LCH	2402	2.743	Off	-49.966	-17.26	PASS
			1.434	On	-49.704	-18.57	PASS
	HCH	2480	3.683	Off	-47.578	-16.32	PASS
			2.493	On	-41.020	-17.51	PASS
$\pi/4$ DQPSK	LCH	2402	3.508	Off	-49.523	-16.49	PASS
			0.323	On	-49.221	-19.68	PASS
	HCH	2480	4.274	Off	-48.947	-15.73	PASS
			3.690	On	-38.830	-16.31	PASS
8DPSK	LCH	2402	2.569	Off	-49.374	-17.43	PASS
			0.363	On	-49.039	-19.64	PASS
	HCH	2480	3.470	Off	-48.575	-16.53	PASS
			3.619	On	-42.057	-16.38	PASS

Test Graphs

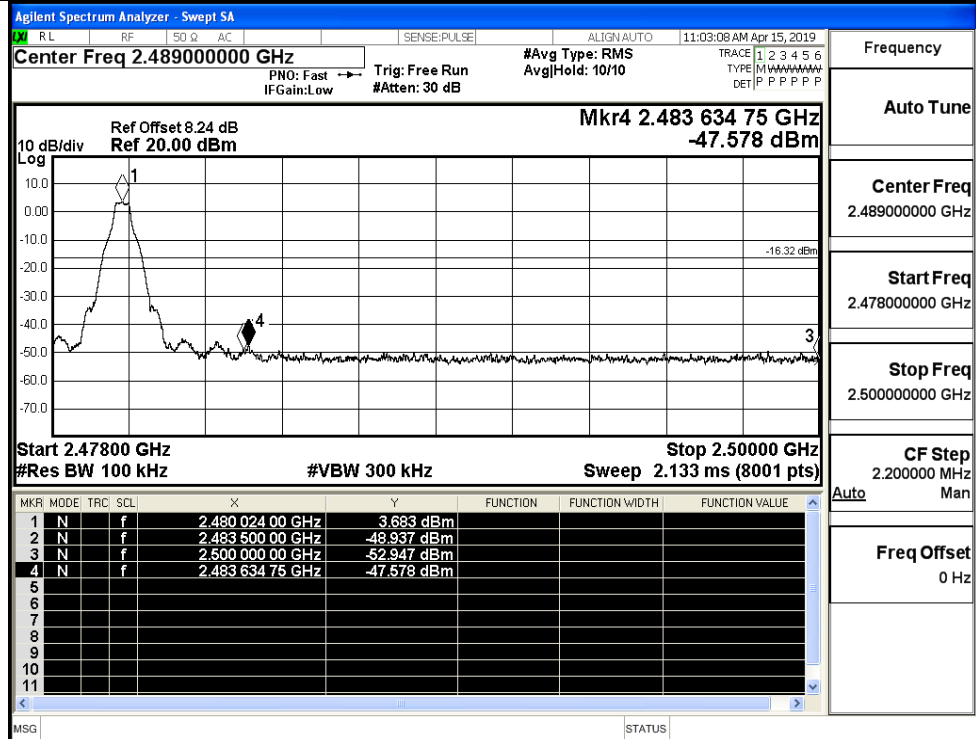
GFSK/LCH/No Hop



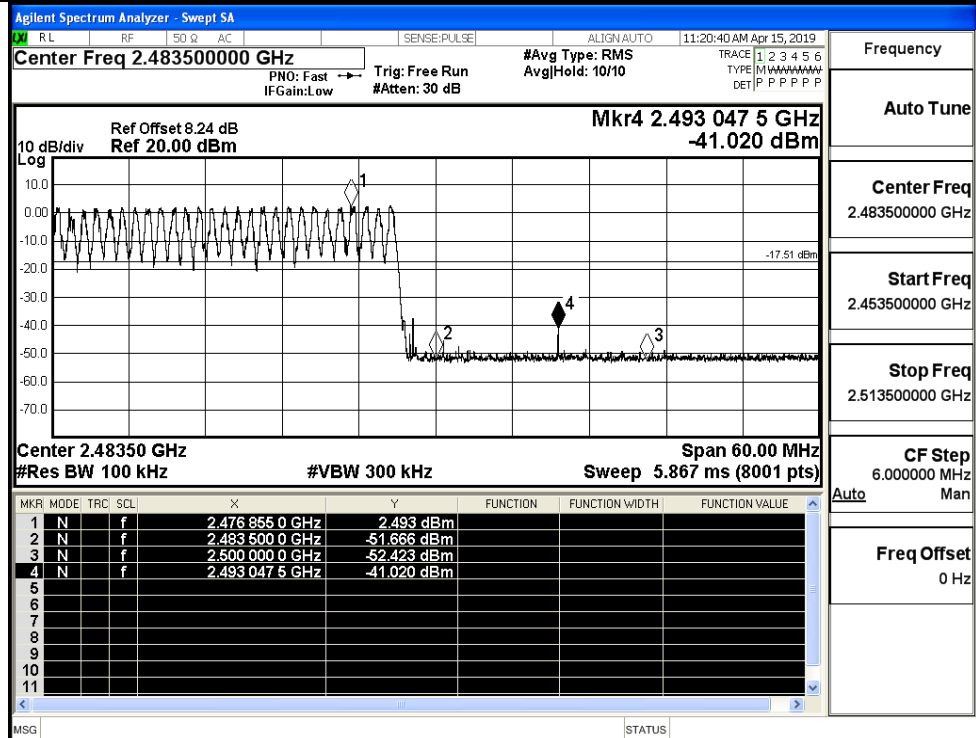
GFSK/LCH/Hop



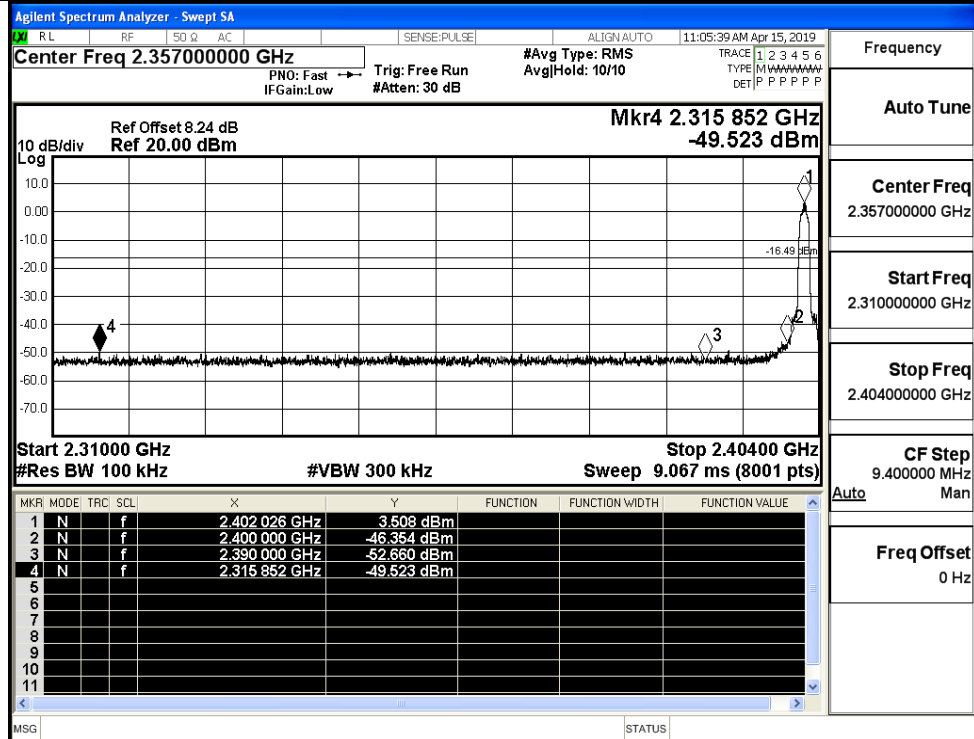
GFSK/HCH/No Hop



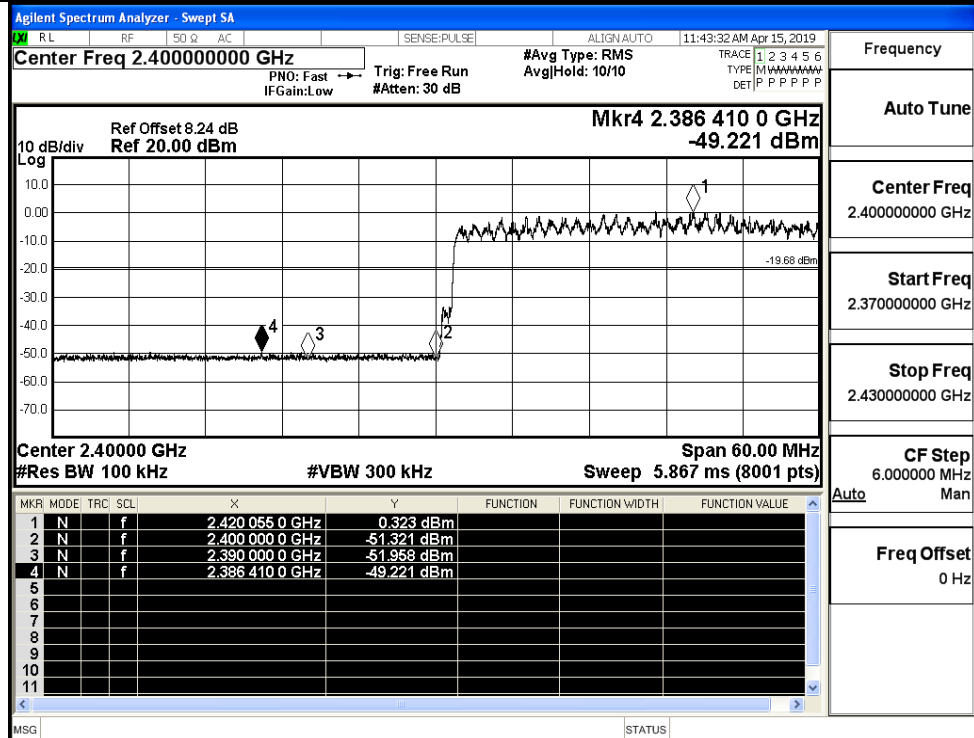
GFSK/HCH/Hop



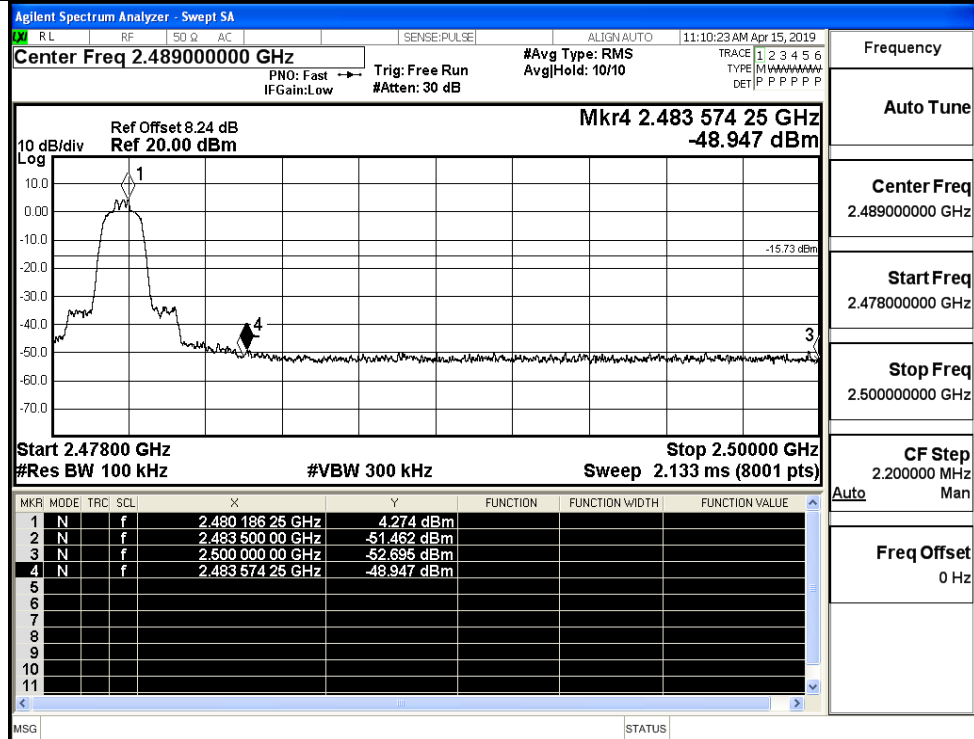
$\pi/4$ DQPSK/LCH/No
Hop



$\pi/4$ DQPSK/LCH/Hop



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

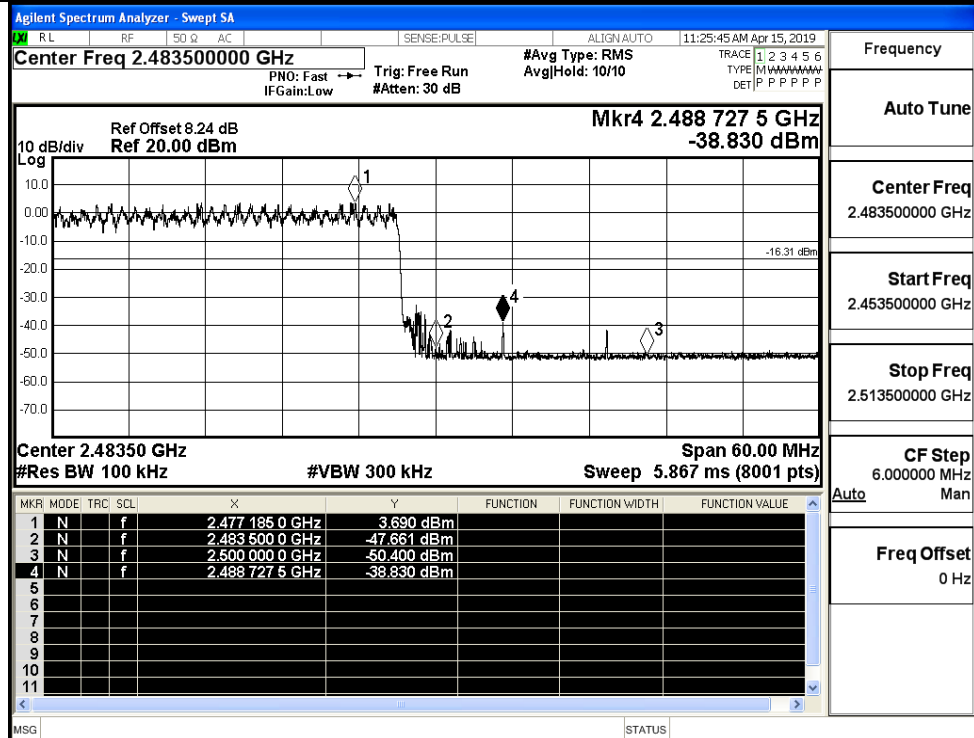


Frequency

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

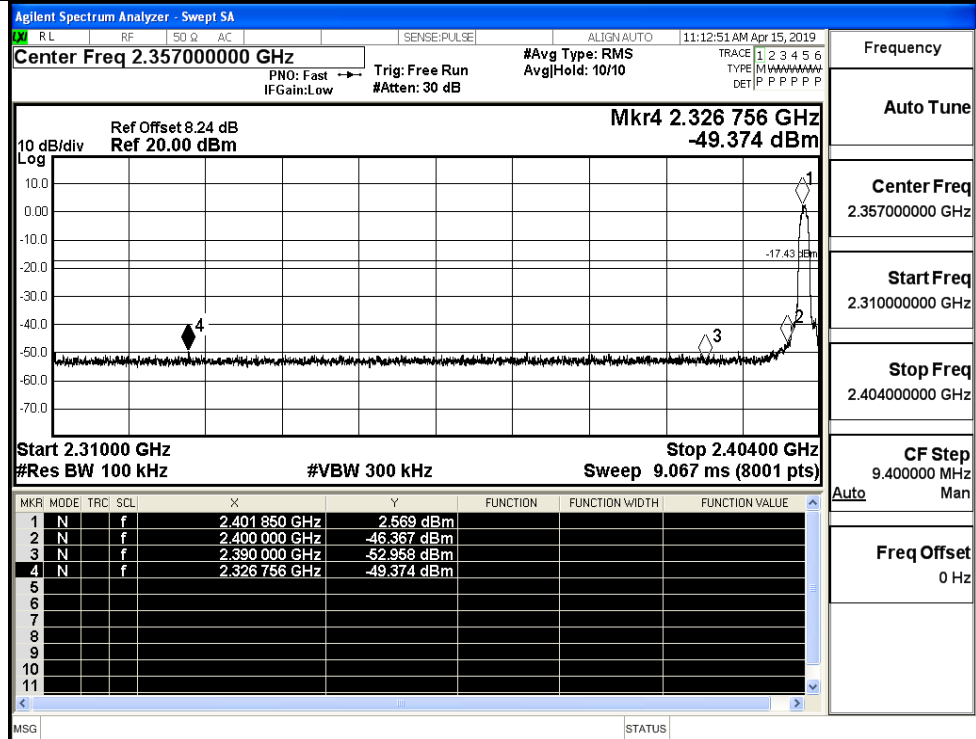


Frequency

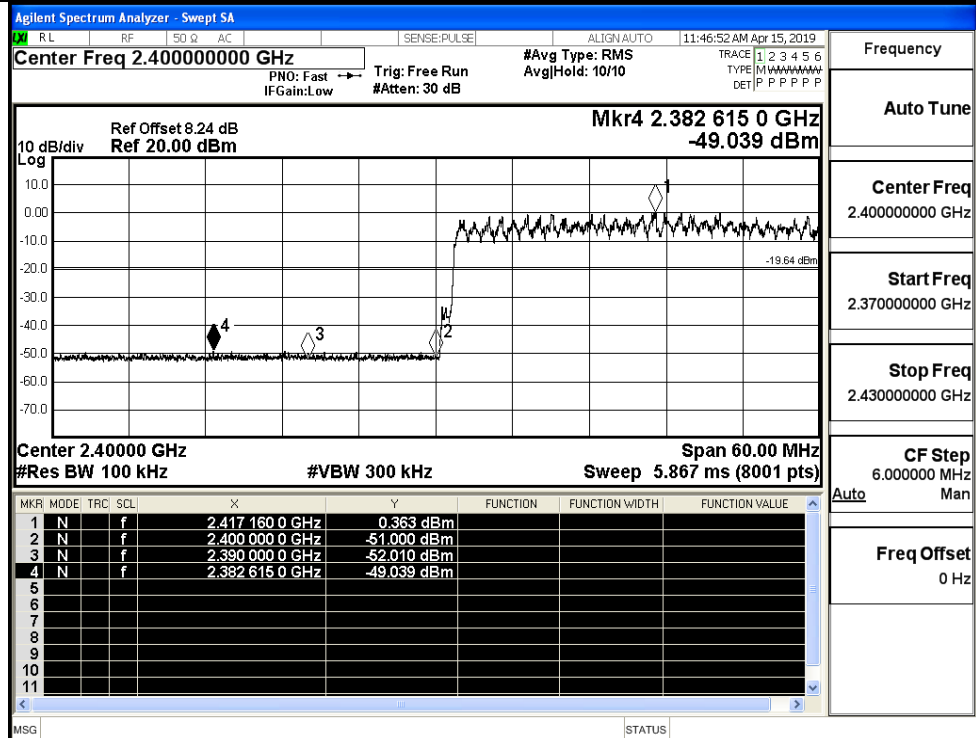
Auto Tune

Center Freq
2.483500000 GHzStart Freq
2.453500000 GHzStop Freq
2.513500000 GHzCF Step
6.000000 MHz
Auto ManFreq Offset
0 Hz

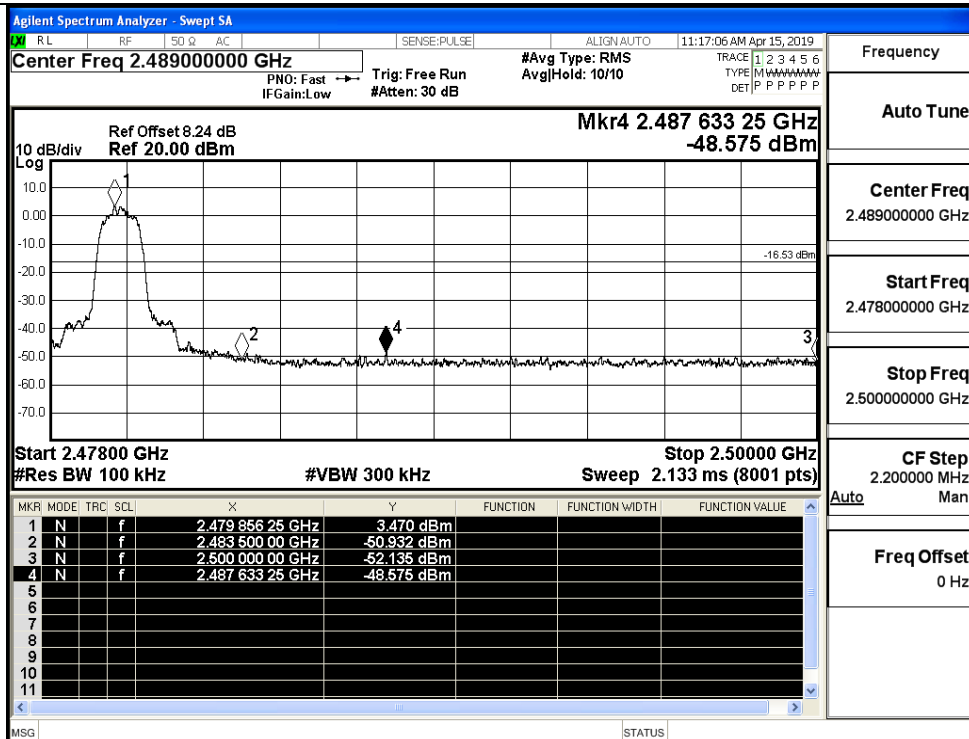
8DPSK/LCH/No Hop



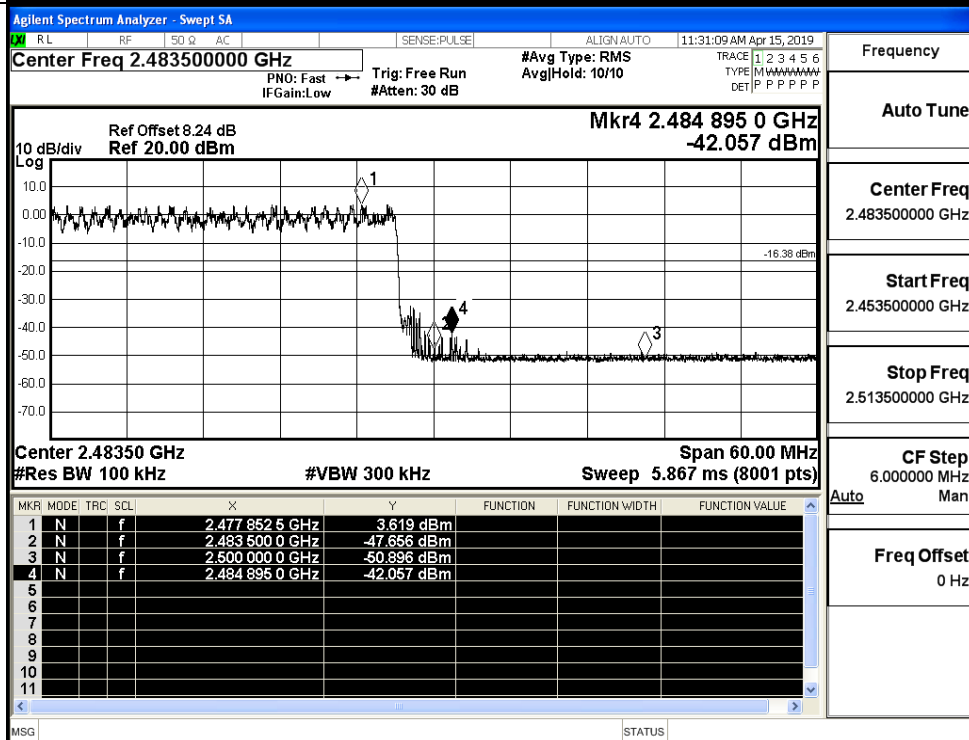
8DPSK/LCH/Hop



8DPSK/HCH/No Hop



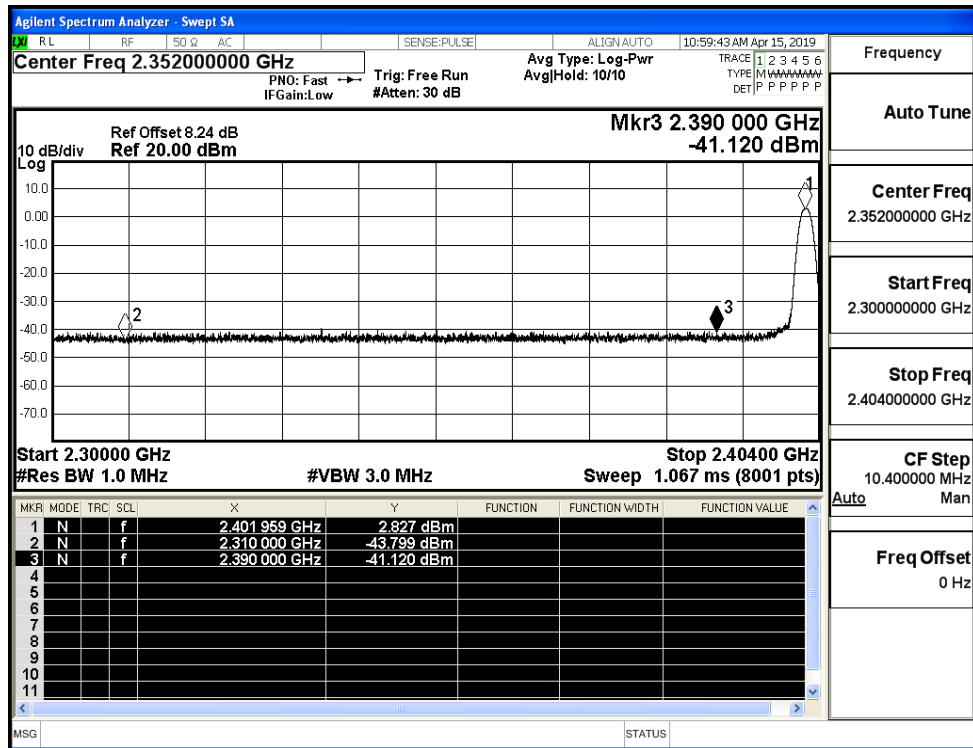
8DPSK/HCH/Hop



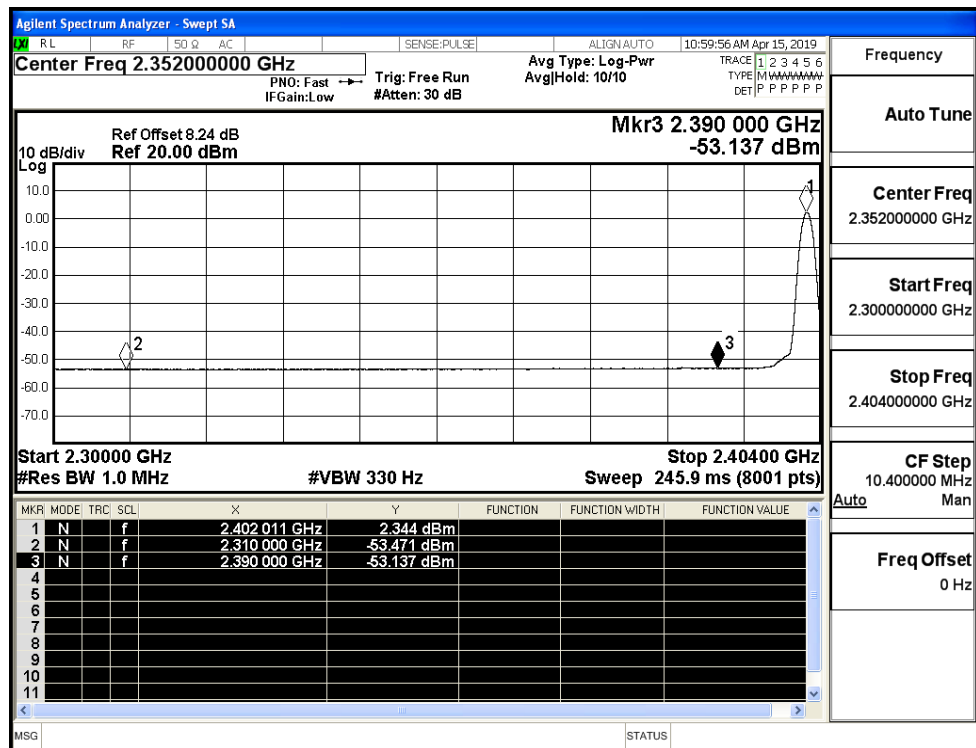
A.8 Restrict-band band-edge measurements

Test Mode	Hopping	Freq.	Power [dBm]	Gain	Ground Factor	E [dBuV/m]	Detector	Limit [dBuV/m]	Verdict
GFSK	Off	2310.0	-43.80	2.0	0	53.46	PEAK	74	PASS
	Off	2310.0	-53.47	2.0	0	43.79	AV	54	PASS
	Off	2390.0	-41.12	2.0	0	56.14	PEAK	74	PASS
	Off	2390.0	-53.14	2.0	0	44.12	AV	54	PASS
	Off	2483.5	-40.80	2.0	0	56.46	PEAK	74	PASS
	Off	2483.5	-50.22	2.0	0	47.04	AV	54	PASS
	Off	2500.0	-42.12	2.0	0	55.14	PEAK	74	PASS
	Off	2500.0	-52.84	2.0	0	44.42	AV	54	PASS
$\pi/4$ DQPSK	Off	2310.0	-44.32	2.0	0	52.94	PEAK	74	PASS
	Off	2310.0	-53.50	2.0	0	43.75	AV	54	PASS
	Off	2390.0	-43.59	2.0	0	53.67	PEAK	74	PASS
	Off	2390.0	-53.10	2.0	0	44.16	AV	54	PASS
	Off	2483.5	-40.92	2.0	0	56.34	PEAK	74	PASS
	Off	2483.5	-50.52	2.0	0	46.73	AV	54	PASS
	Off	2500.0	-41.49	2.0	0	55.77	PEAK	74	PASS
	Off	2500.0	-52.77	2.0	0	44.49	AV	54	PASS
8DPSK	Off	2310.0	-42.99	2.0	0	54.27	PEAK	74	PASS
	Off	2310.0	-53.53	2.0	0	43.73	AV	54	PASS
	Off	2390.0	-41.34	2.0	0	55.92	PEAK	74	PASS
	Off	2390.0	-53.02	2.0	0	44.23	AV	54	PASS
	Off	2483.5	-41.15	2.0	0	56.11	PEAK	74	PASS
	Off	2483.5	-50.85	2.0	0	46.41	AV	54	PASS
	Off	2500.0	-43.14	2.0	0	54.12	PEAK	74	PASS
	Off	2500.0	-52.79	2.0	0	44.47	AV	54	PASS

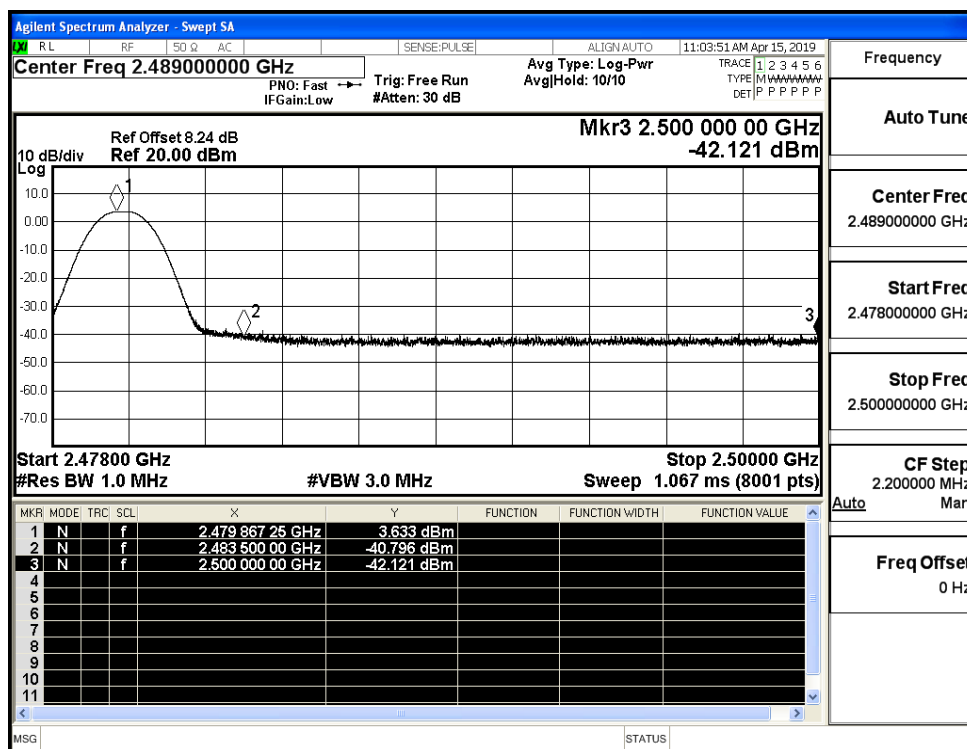
Restrict-band band-edge measurements_Hopping Off_GFSK_PEAK (Low Channel)



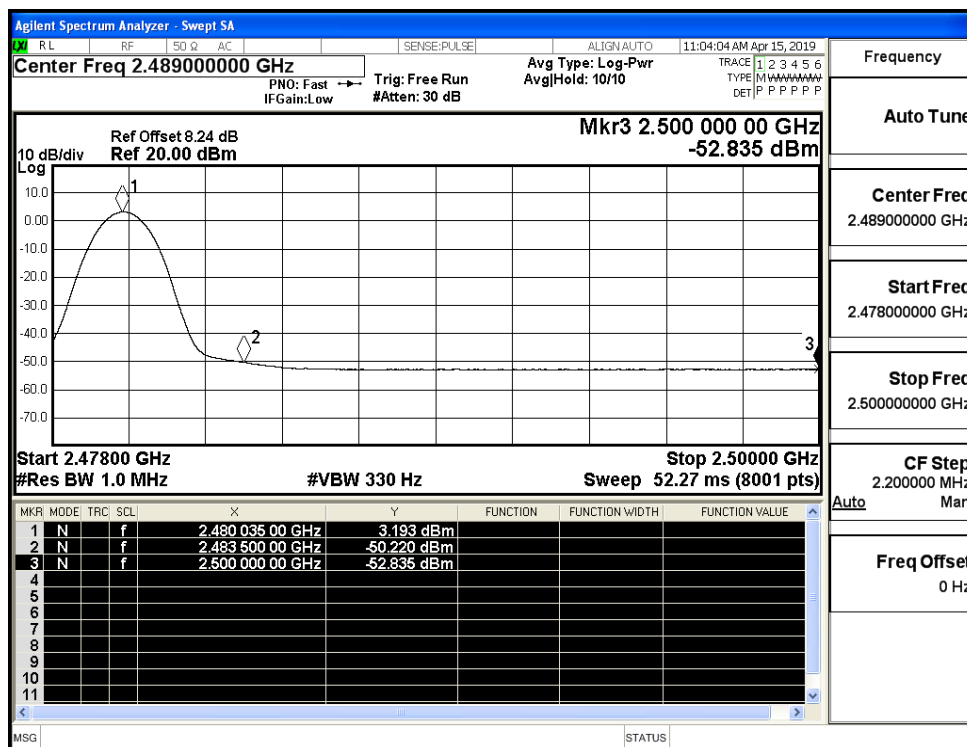
Restrict-band band-edge measurements_Hopping Off_GFSK_Average (Low Channel)

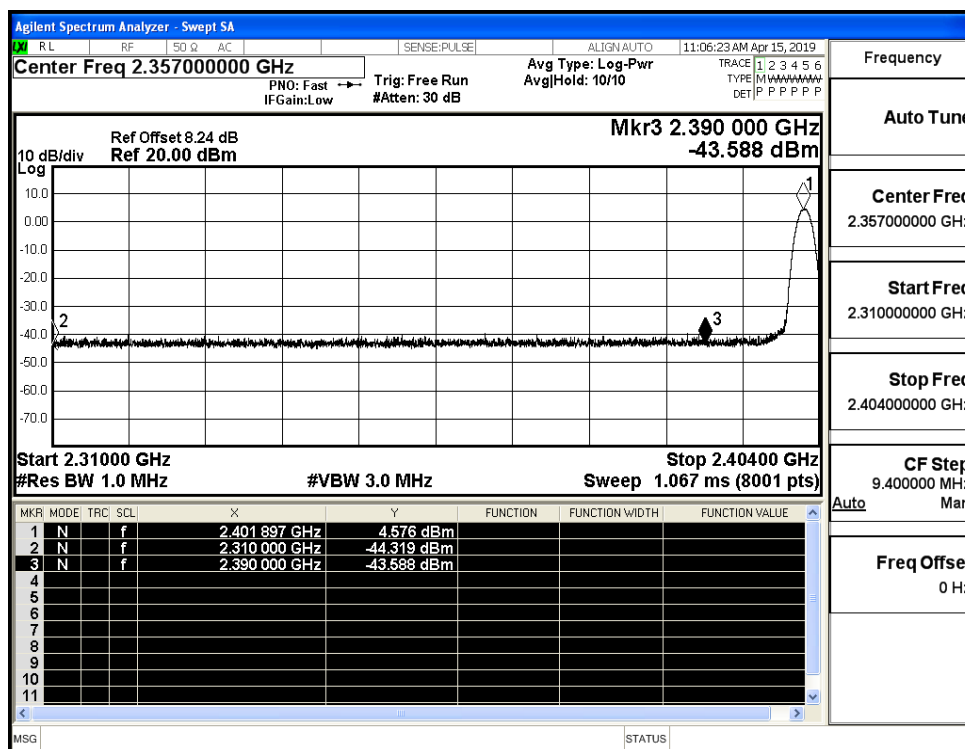
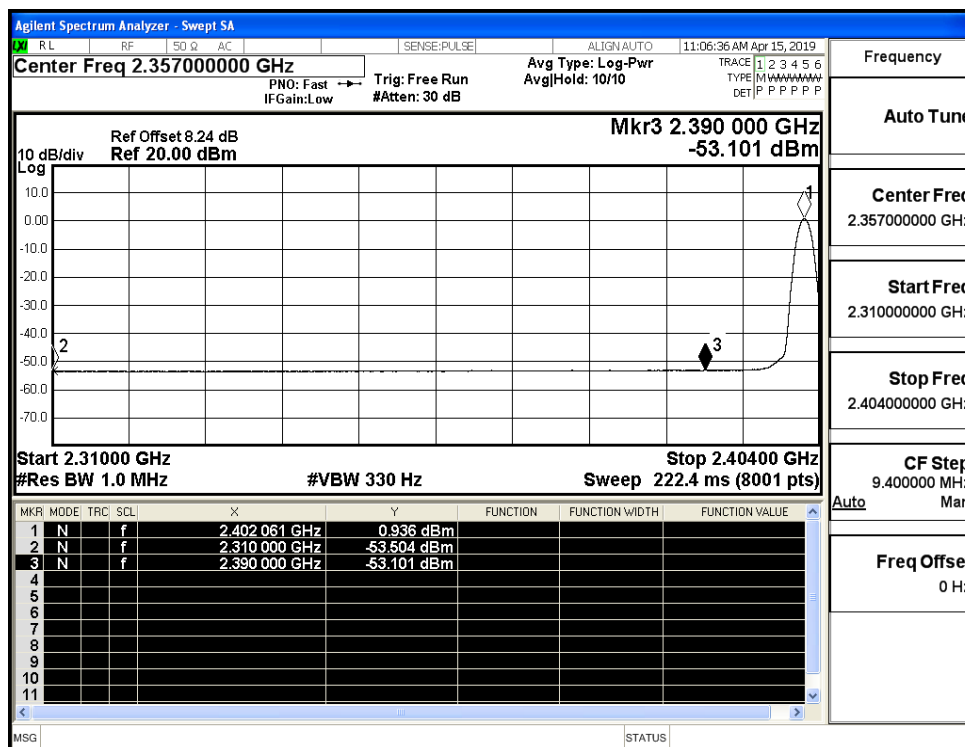


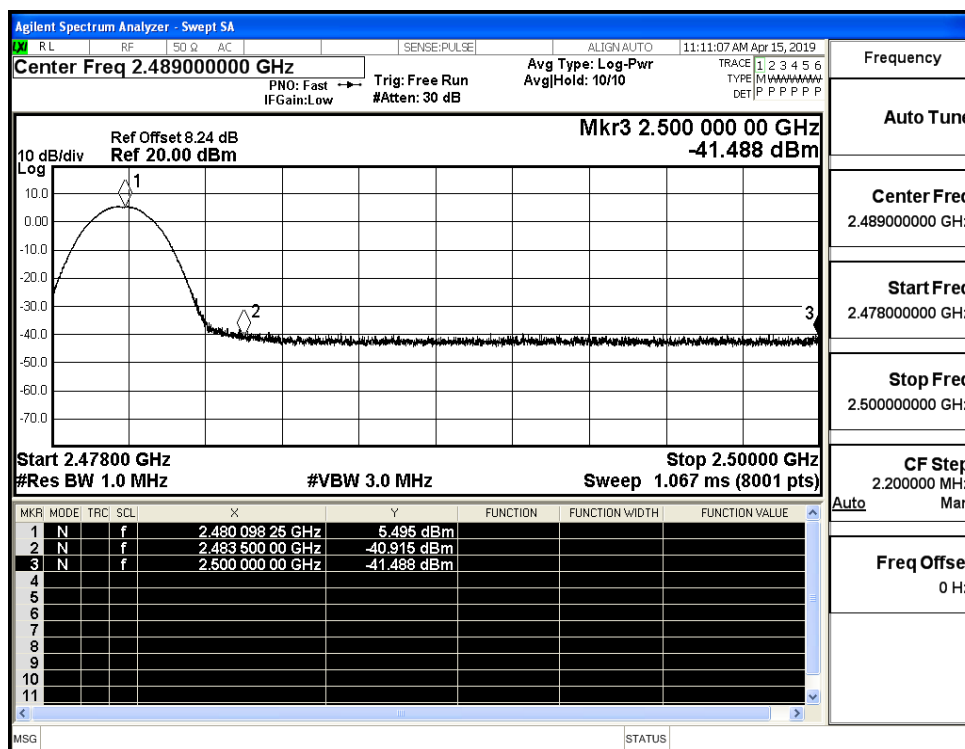
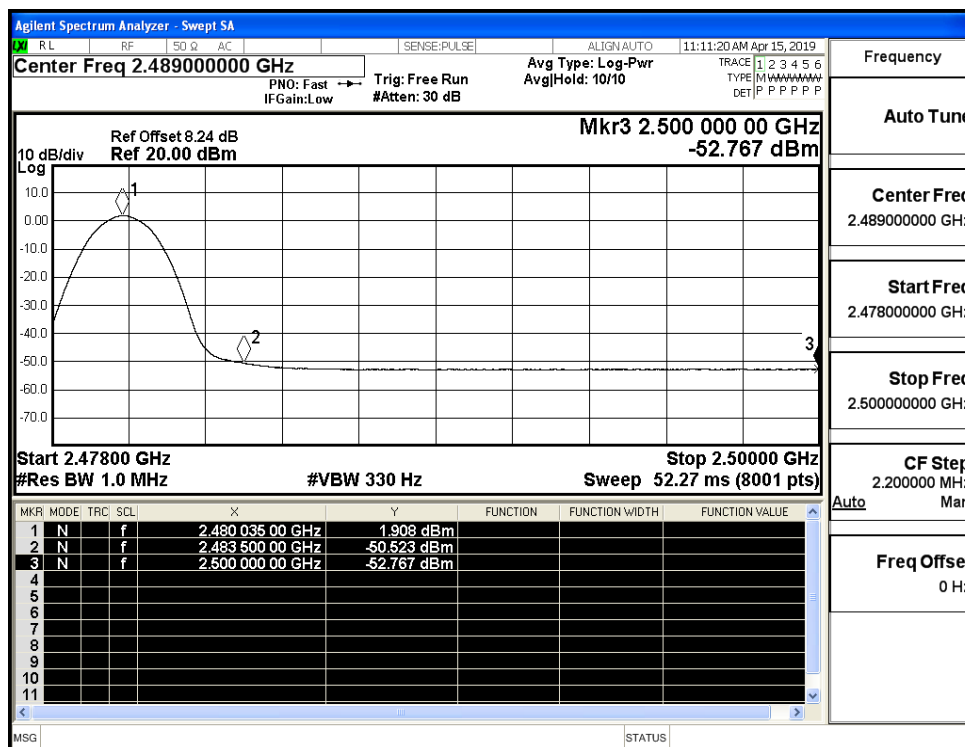
Restrict-band band-edge measurements_Hopping Off_GFSK_PEAK (High Channel)



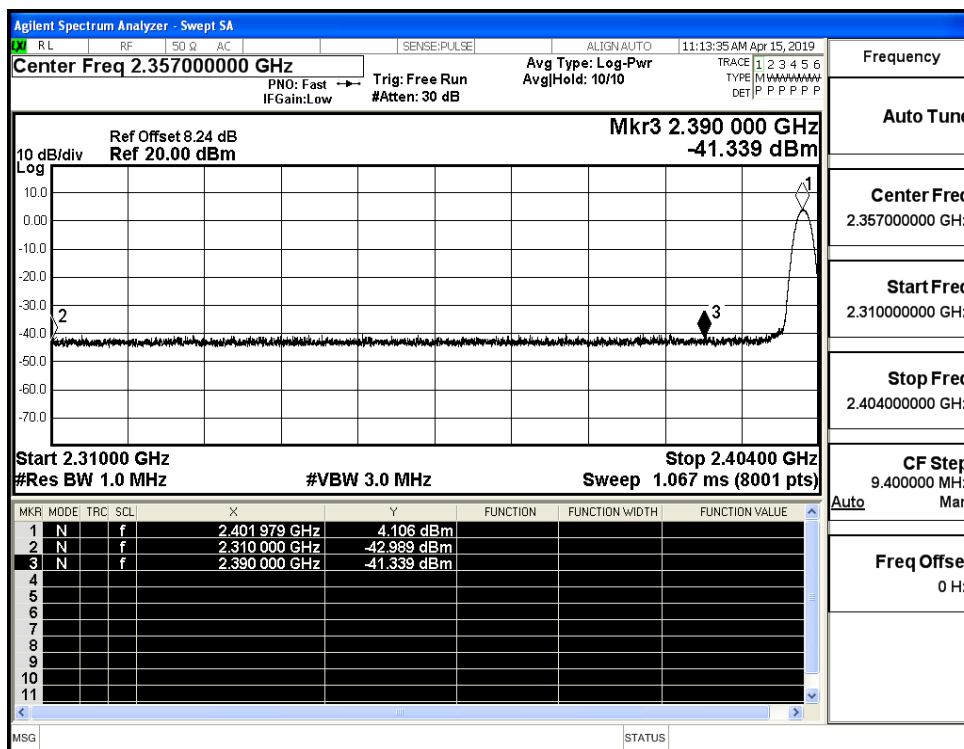
Restrict-band band-edge measurements_Hopping Off_GFSK_Average (High Channel)



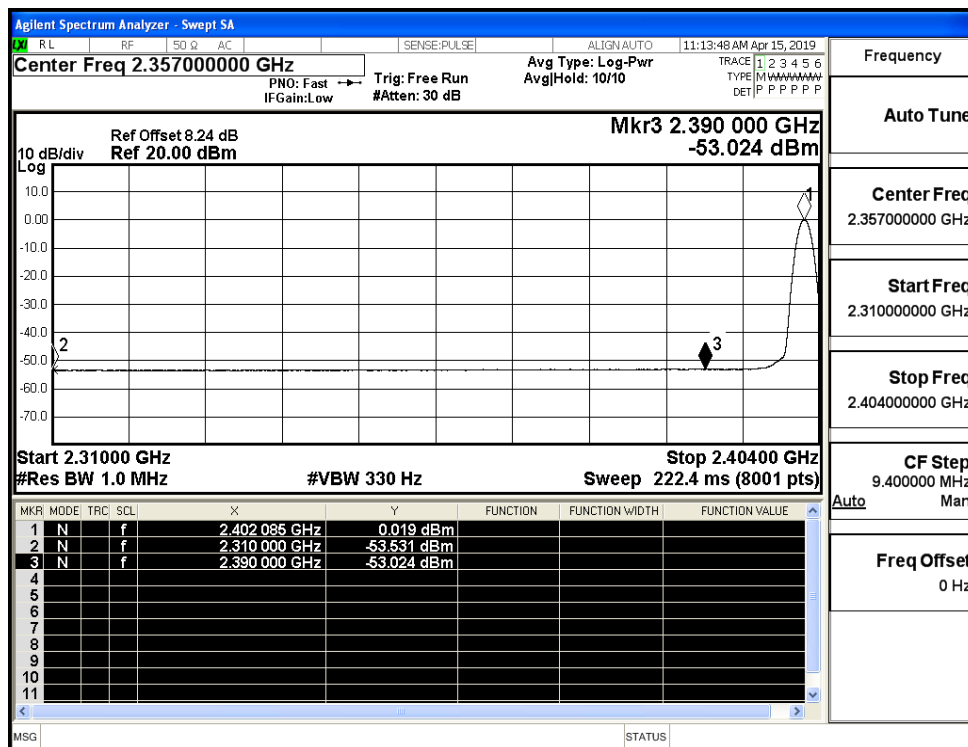
Restrict-band band-edge measurements_Hopping Off $\pi/4$ -DQPSK_PEAK (Low Channel)Restrict-band band-edge measurements_Hopping Off $\pi/4$ -DQPSK_Average (Low Channel)

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)

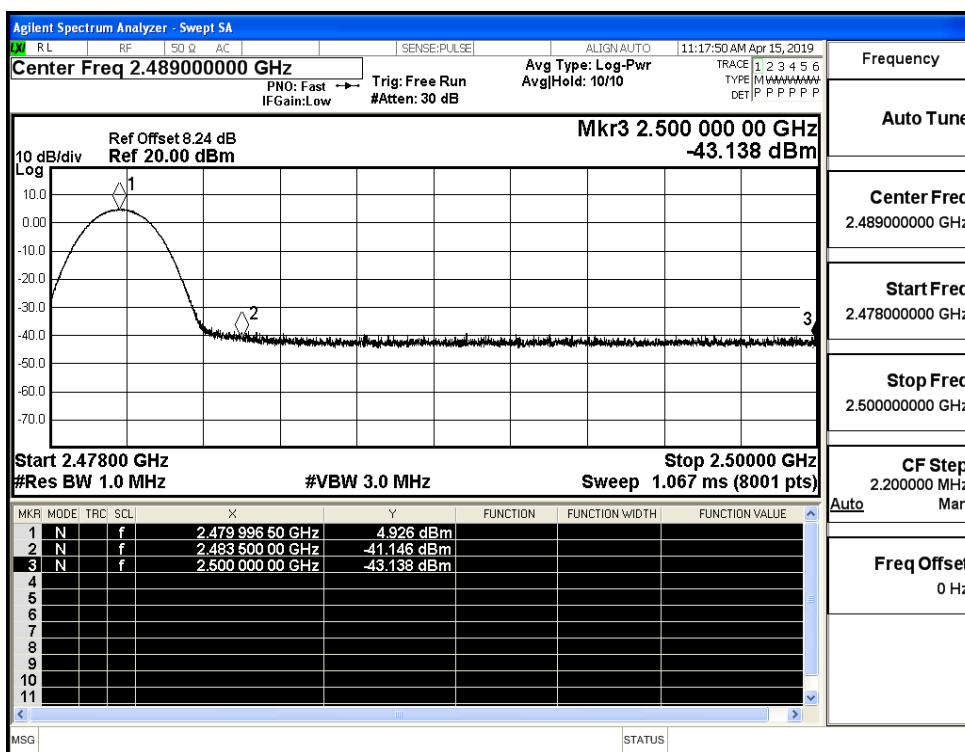
Restrict-band band-edge measurements_Hopping Off_8DPSK_PEAK (Low Channel)



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)

