

9. TIME OF OCCUPANCY (DWEELL TIME)

9.1 Measurement Procedure

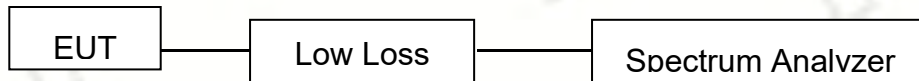
Average Channel Occupancy Time, FCC Ref:15.247(a)(1)(iii):

Connect EUT antenna terminal to the spectrum analyzer with a low loss cable. The spectrum analyzer center frequency was set to one of the known hopping channels. The Sweep was set to 10 ms, the SPAN was set to Zero SPAN. The time duration of the transmissions so captured was measured with the Marker Delta function

9.2 Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

9.3 Test SET-UP (Block Diagram of Configuration)



9.4 Measurement Results

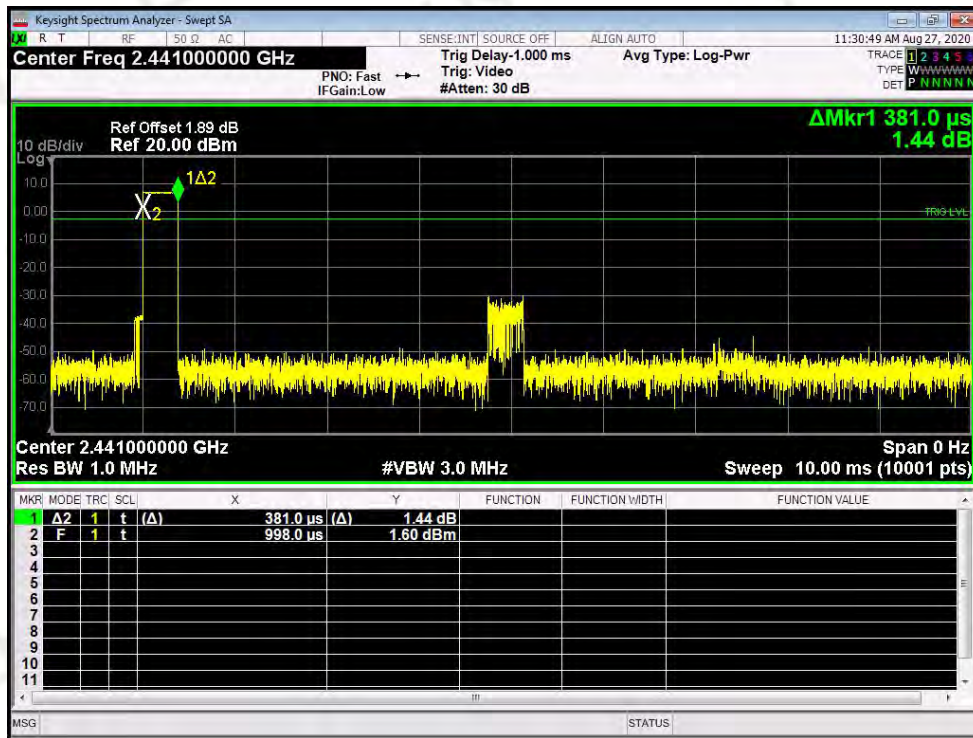
Refer to attached data chart.

The maximum number of hopping channels in 31.6s (0.4s/Channel x 79 Channel)

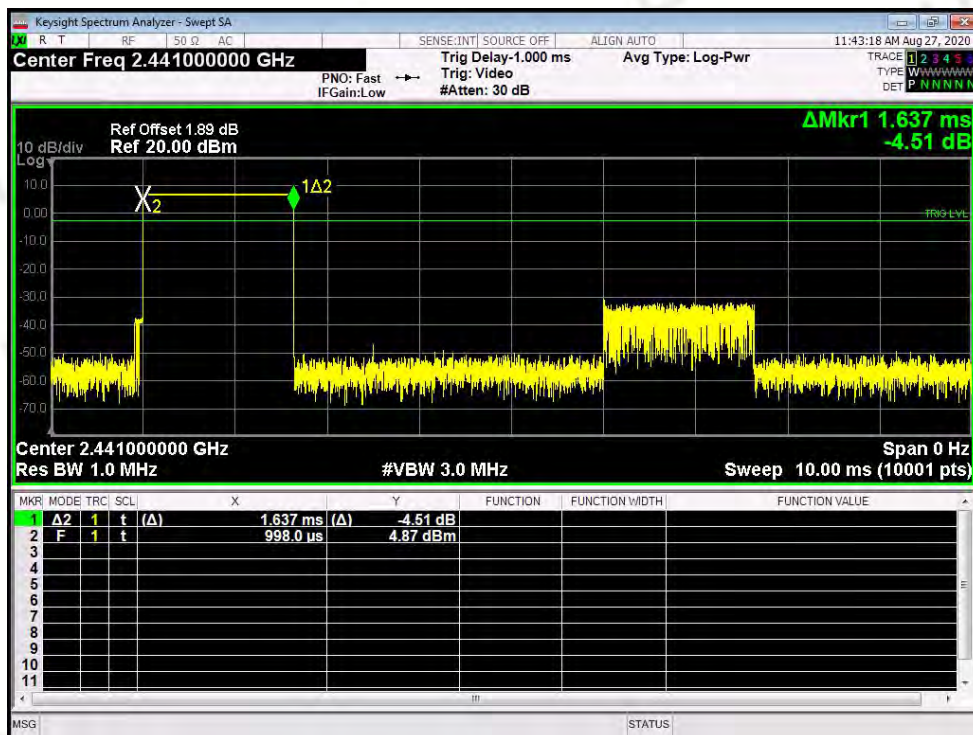
RBW:	1MHz	Temperature:	24 °C
VBW:	3MHz	Humidity:	50 %
Spectrum Detector:	PK	Test By:	PEI
Test Result:	PASS	Test Date:	August 27, 2020

Packet	Frequency (MHz)	Result (msec)		Limit (msec)
GFSK				
DH1	2441	0.380	$(ms) * (1600 / (2 * 79)) * 31.6 = 121.92$	400
DH3	2441	1.637	$(ms) * (1600 / (4 * 79)) * 31.6 = 261.92$	400
DH5	2441	3.077	$(ms) * (1600 / (6 * 79)) * 31.6 = 307.73$	400
$\pi/4$-DQPSK				
2-DH1	2441	0.389	$(ms) * (1600 / (2 * 79)) * 31.6 = 124.48$	400
2-DH3	2441	1.642	$(ms) * (1600 / (4 * 79)) * 31.6 = 262.72$	400
2-DH5	2441	2.889	$(ms) * (1600 / (6 * 79)) * 31.6 = 308.16$	400
8DPSK				
3-DH1	2441	0.390	$(ms) * (1600 / (2 * 79)) * 31.6 = 124.80$	400
3-DH3	2441	1.641	$(ms) * (1600 / (4 * 79)) * 31.6 = 262.56$	400
3-DH5	2441	2.892	$(ms) * (1600 / (6 * 79)) * 31.6 = 380.48$	400

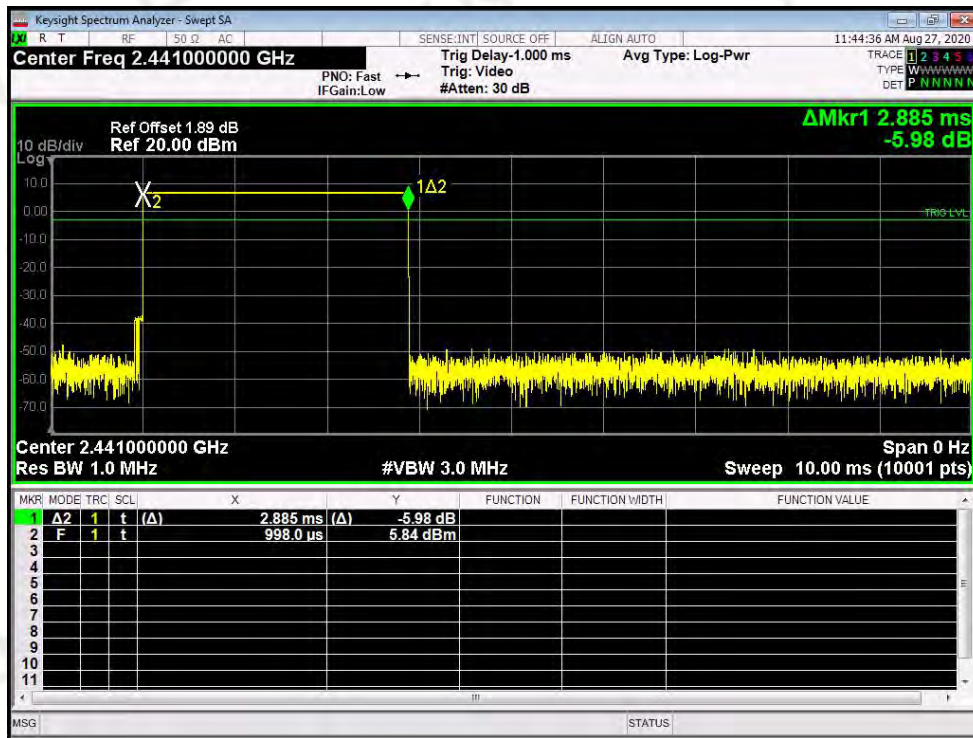
GFSK (DH1)



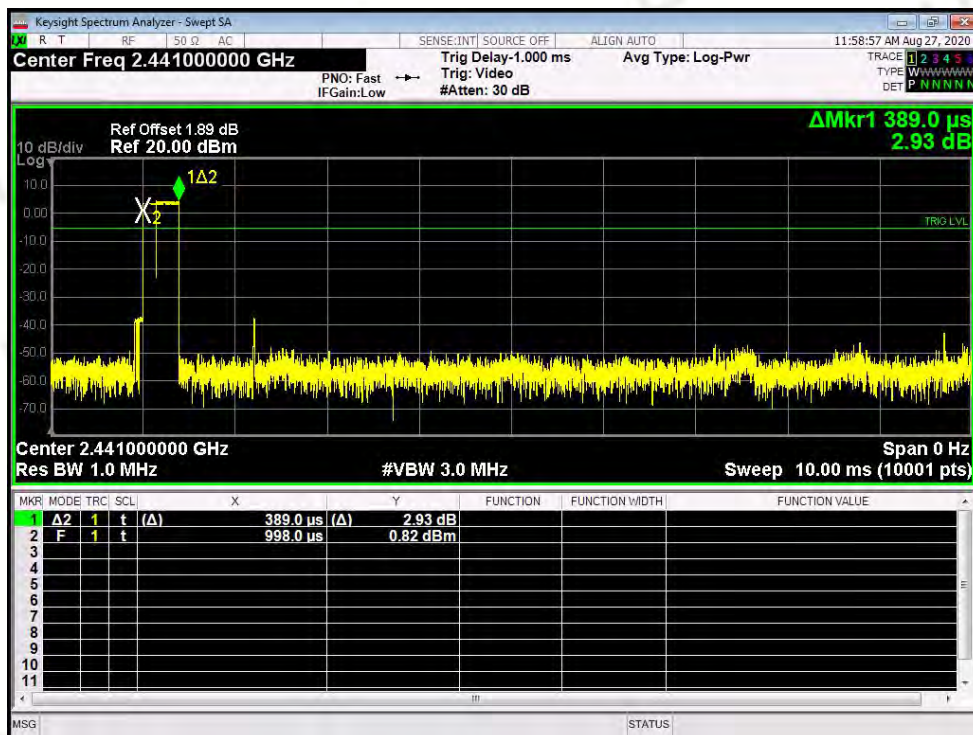
GFSK (DH3)



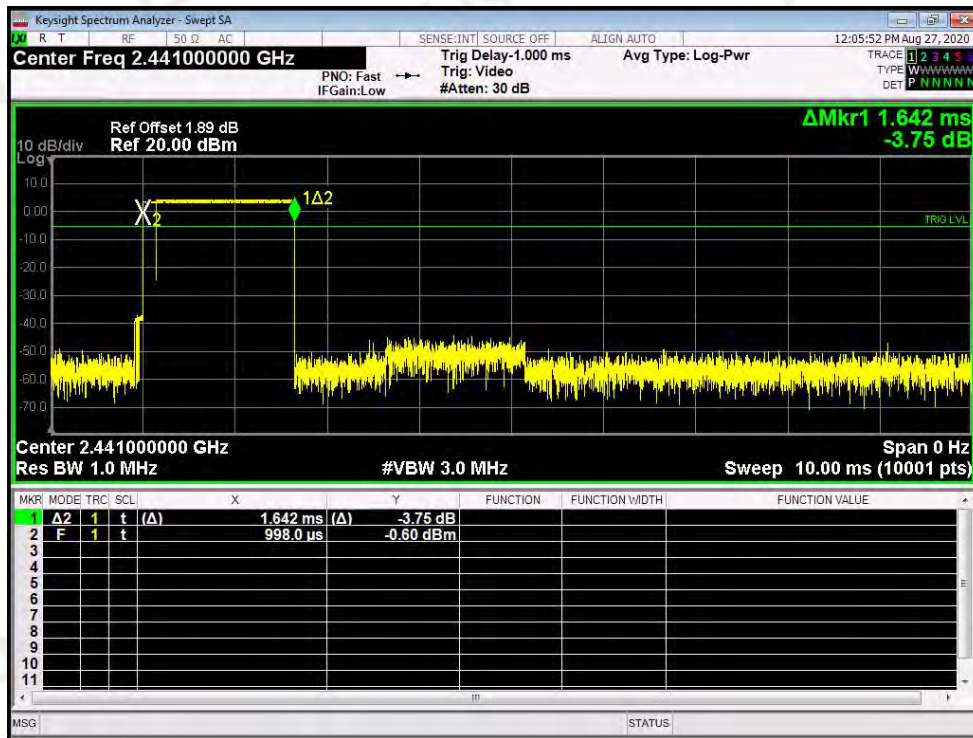
GFSK (DH5)



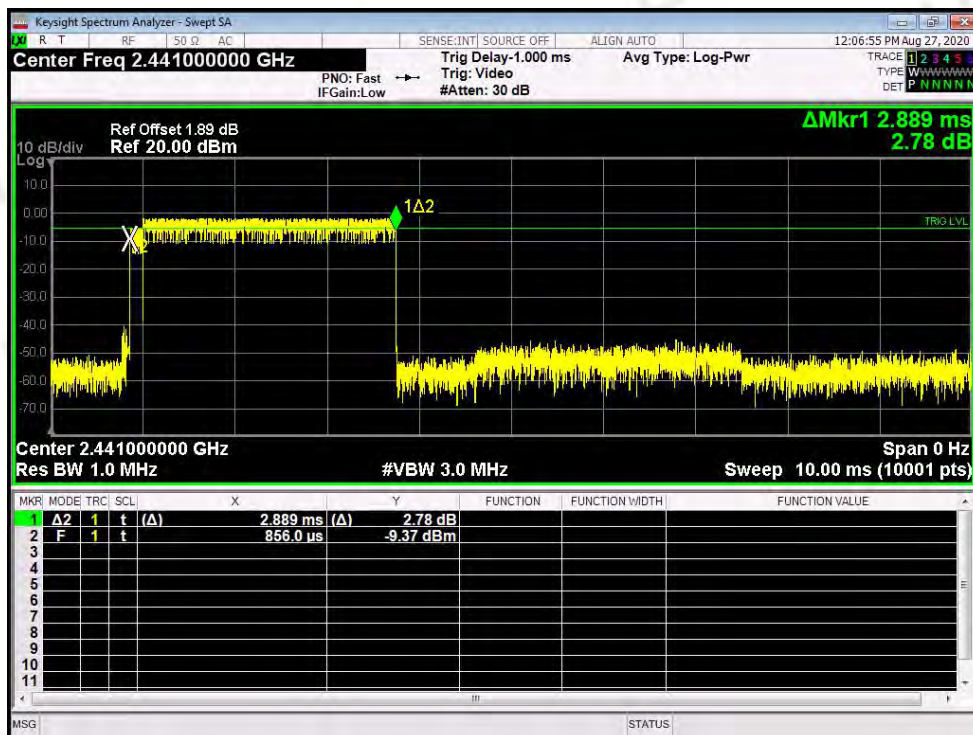
π/4-DQPSK (2-DH1)



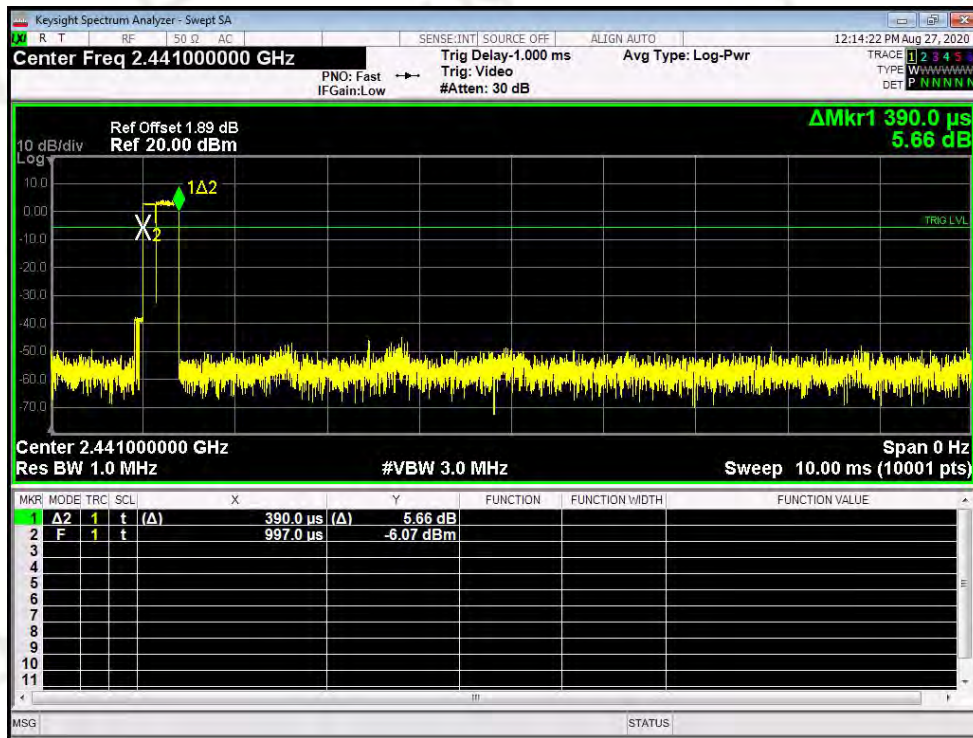
$\pi/4$ -DQPSK (2-DH3)



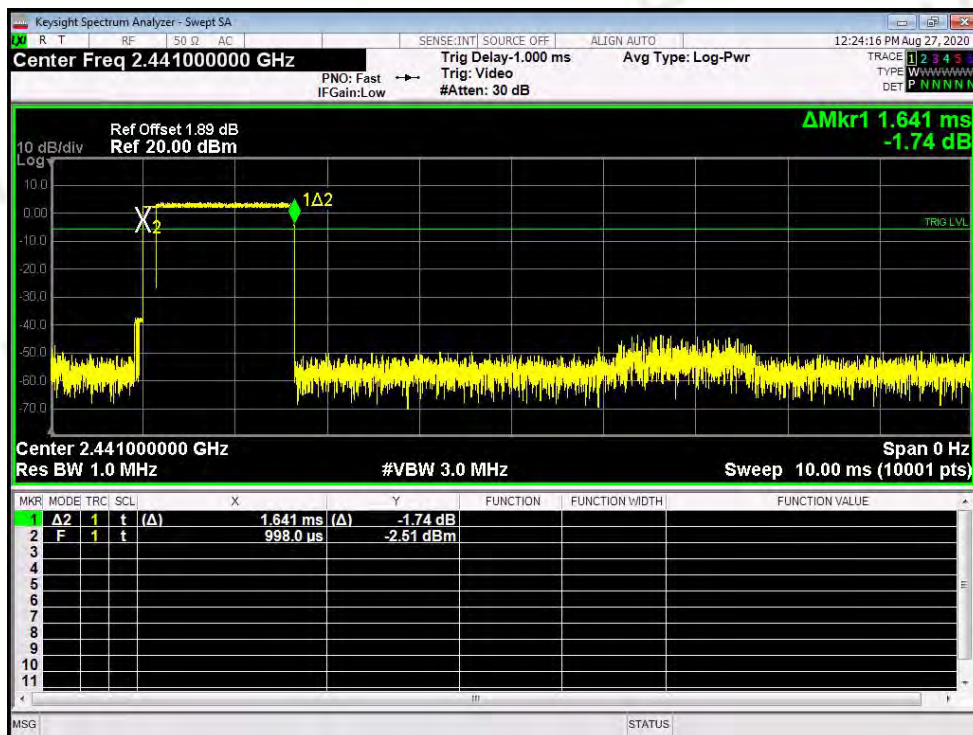
$\pi/4$ -DQPSK (2-DH5)



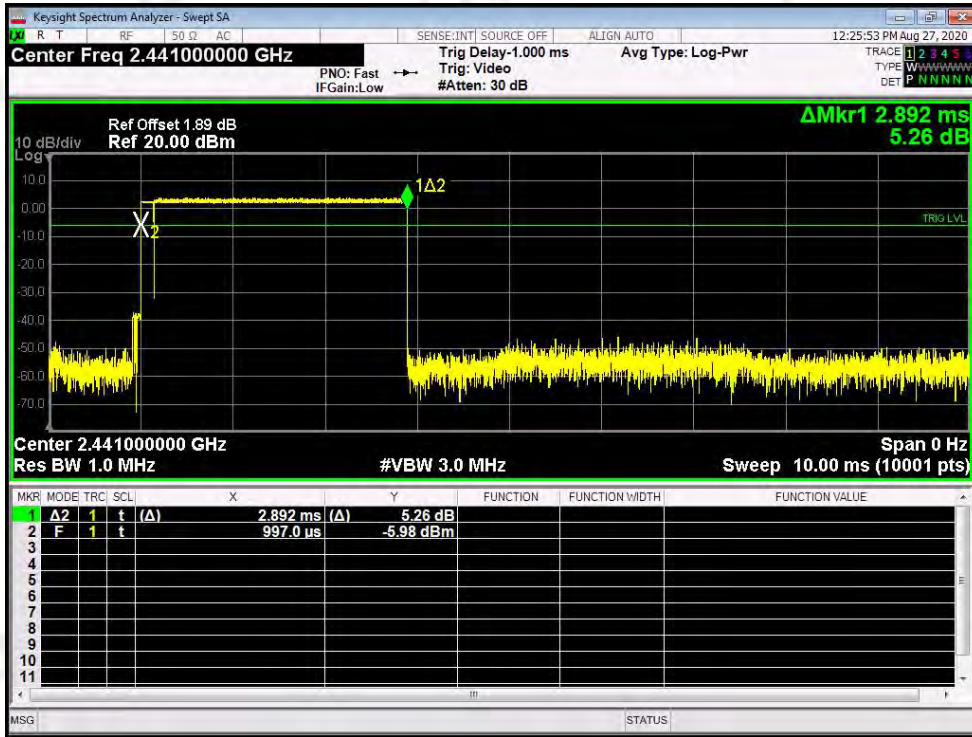
8DPSK (3-DH1)



8DPSK (3-DH3)



8DPSK (3-DH5)



10. MAXIMUM PEAK OUTPUT POWER

10.1 Measurement Procedure

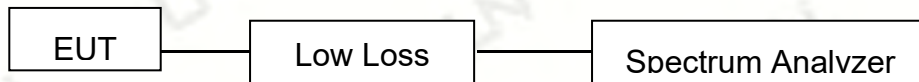
Maximum Conducted Output Power at Antenna Terminals, FCC Rules 15.247(b)(1):

Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum. The analyzer was set for RBW > 20dB bandwidth and power was read directly in dBm. Cable loss was considered during this measurement.

10.2 Limit

For all other frequency hopping systems in the 2400-2483.5MHz band: 0.125 watts.

10.3 Test SET-UP (Block Diagram of Configuration)

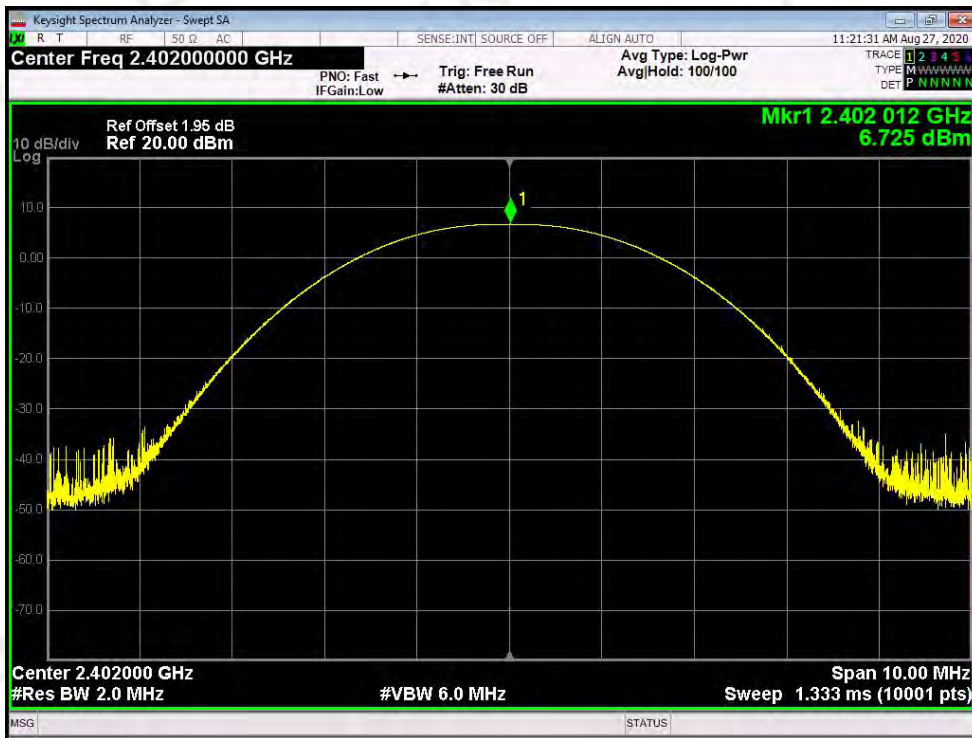


10.4 Measurement Results

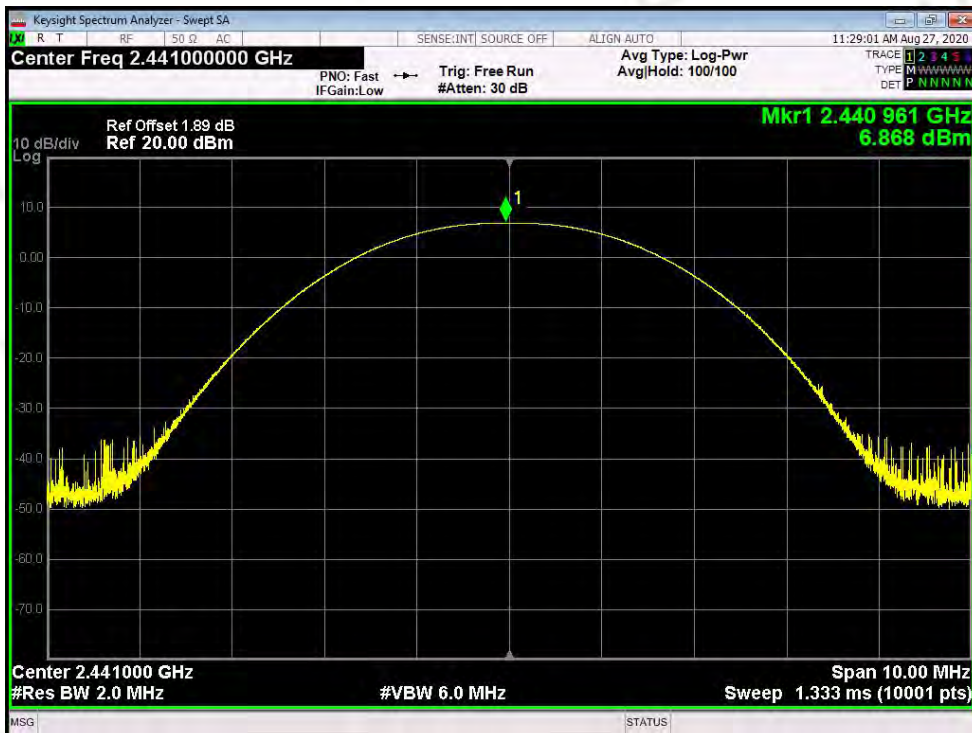
RBW:	3MHz	Temperature:	24 °C
VBW:	10MHz	Humidity:	50 %
Spectrum Detector:	PK	Test By:	PEI
Packet:	DH1, 2DH1, 3DH1(Worst case)	Test Date:	August 27, 2020

Channel Frequency (MHz)	Peak Power output (dBm)	Peak Power output (W)	Peak Power Limit (dBm/W)	Results
GFSK				
2402.00	6.725	0.0047	21 / 0.125	PASS
2441.00	6.868	0.0048	21 / 0.125	PASS
2480.00	5.953	0.0039	21 / 0.125	PASS
$\pi/4$ -DQPSK				
2402.00	4.829	0.0030	21 / 0.125	PASS
2441.00	4.837	0.0030	21 / 0.125	PASS
2480.00	3.888	0.0024	21 / 0.125	PASS
8DPSK				
2402.00	4.221	0.0026	21 / 0.125	PASS
2441.00	4.236	0.0026	21 / 0.125	PASS
2480.00	3.307	0.0021	21 / 0.125	PASS

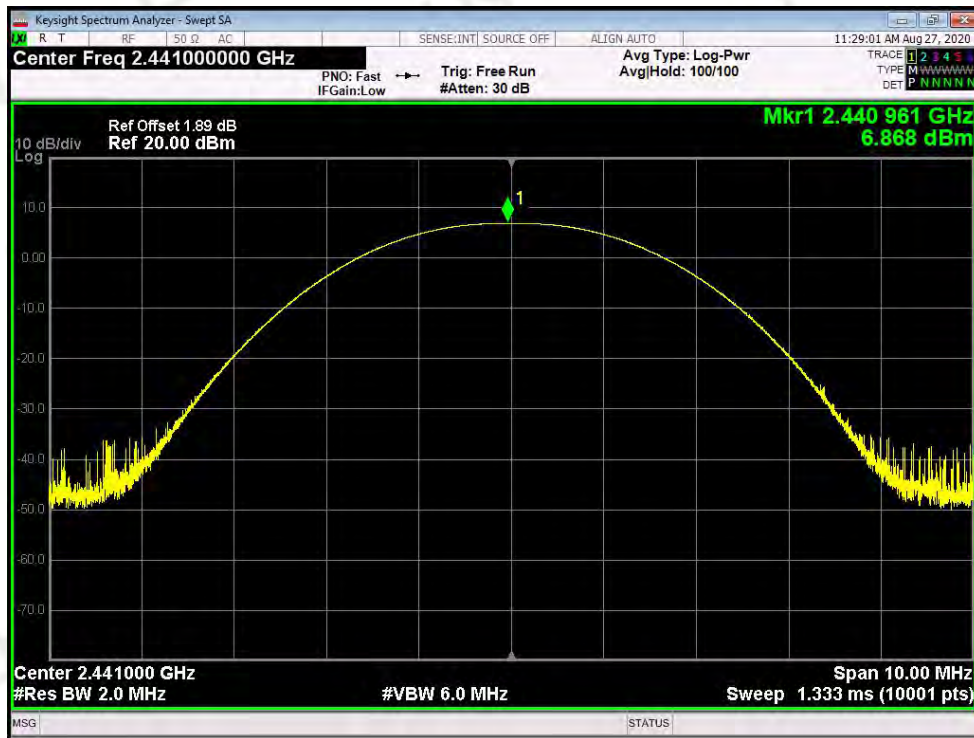
GFSK Lowest Channel



GFSK Middle Channel



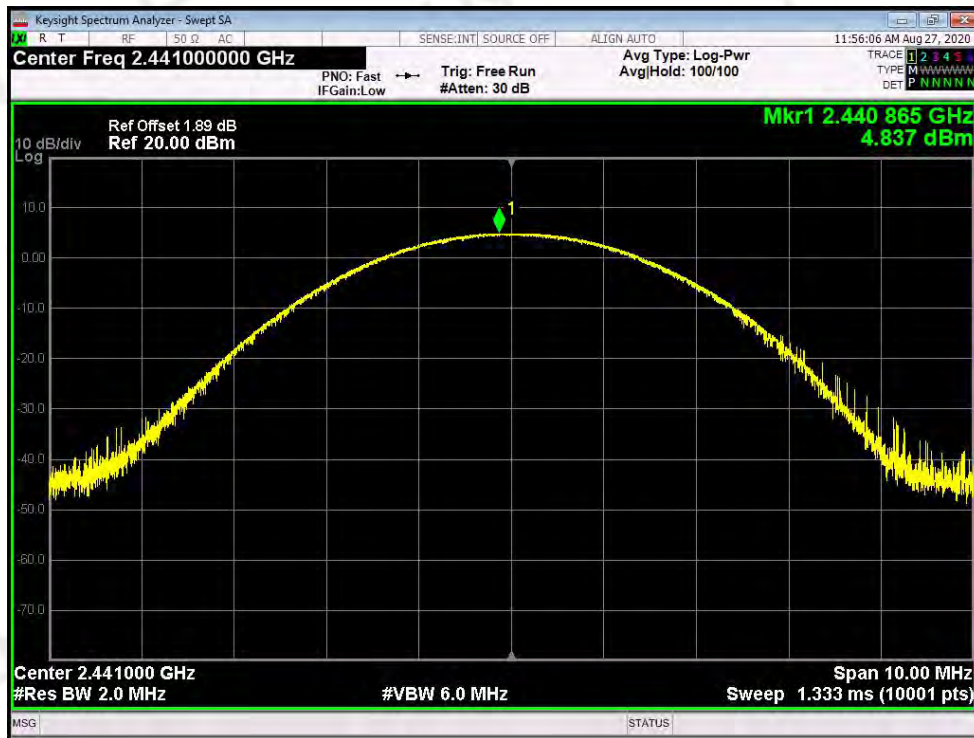
GFSK Highest Channel



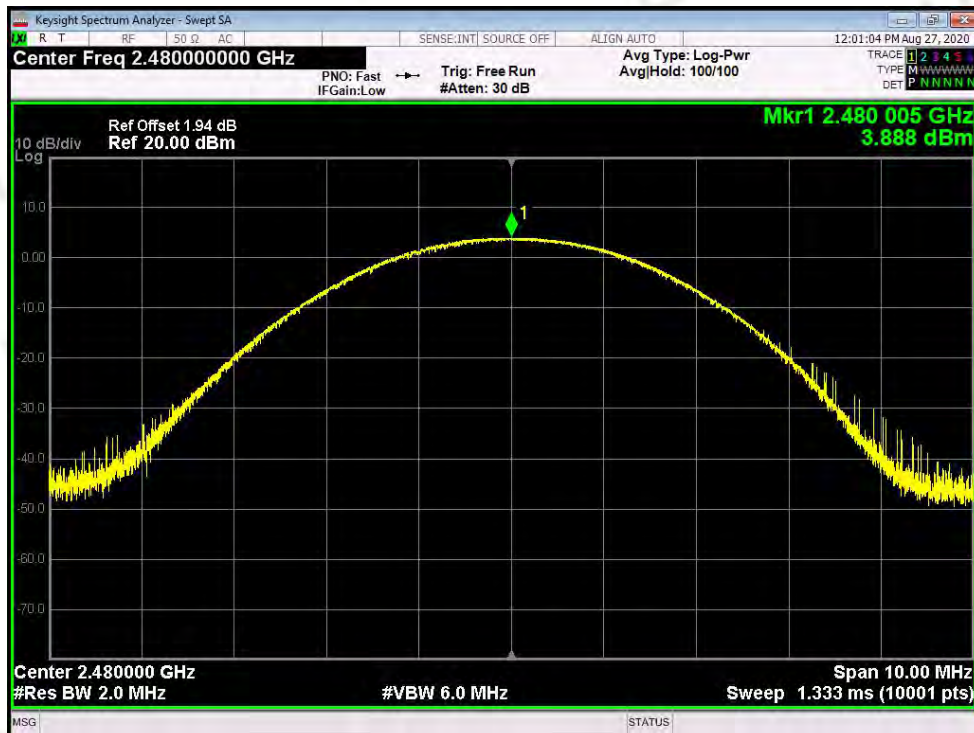
$\pi/4$ -DQPSK Lowest Channel



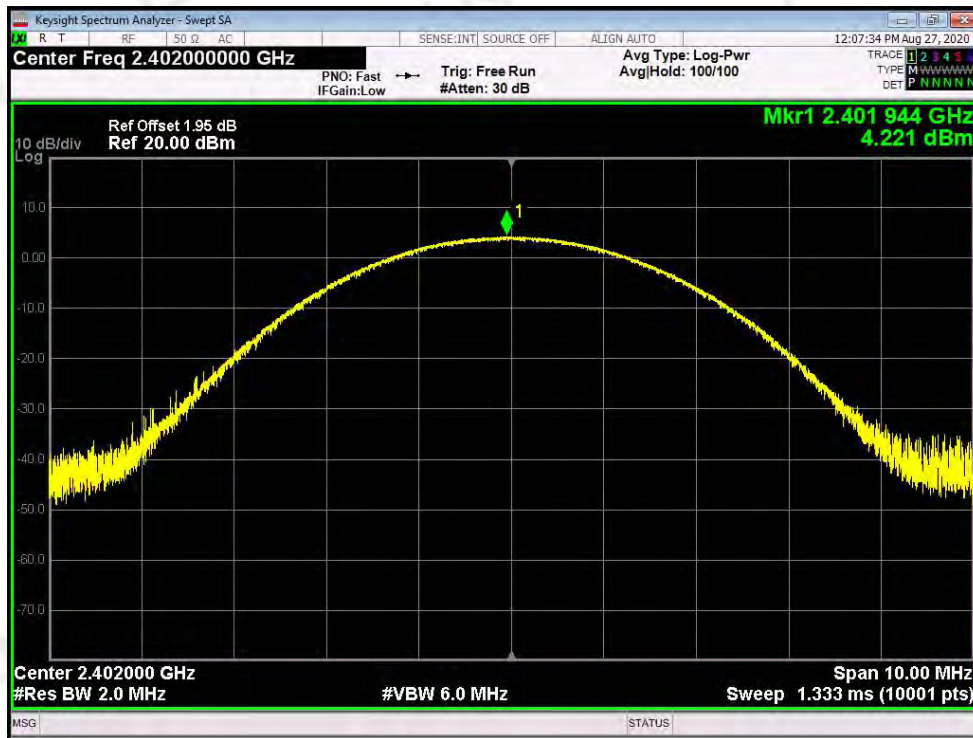
$\pi/4$ -DQPSK Middle Channel



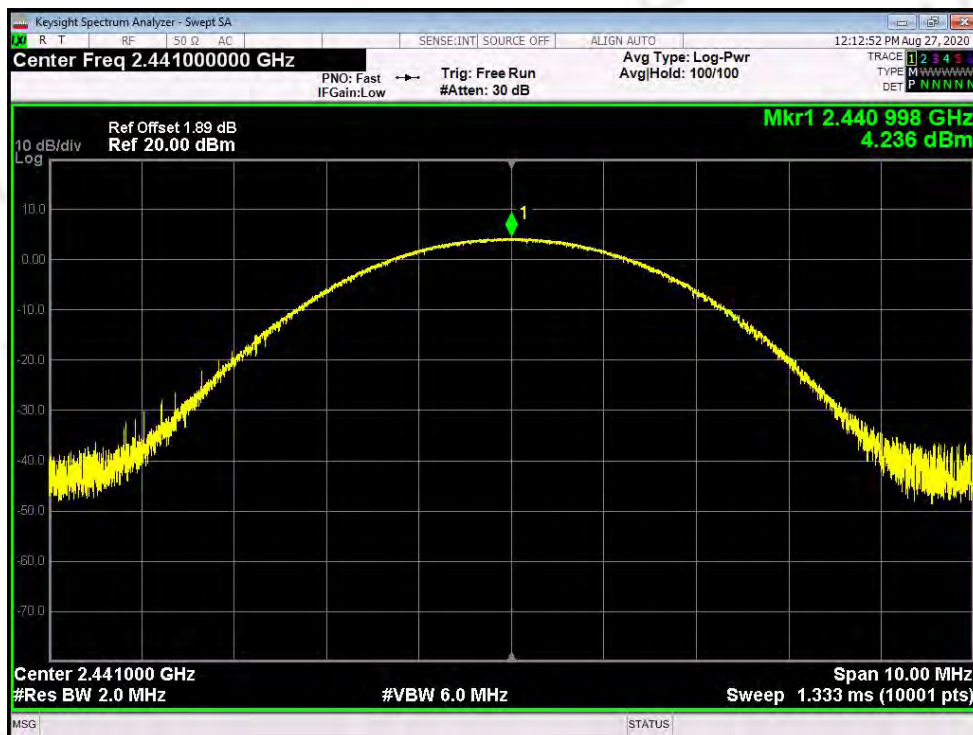
$\pi/4$ -DQPSK Highest Channel



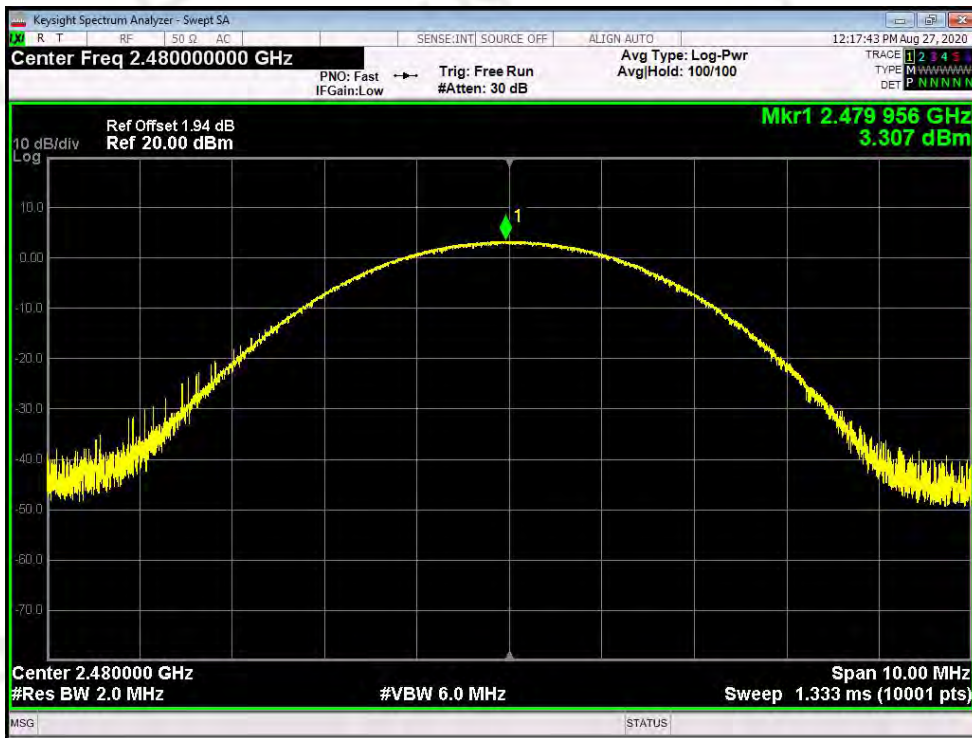
8DPSK Lowest Channel



8DPSK Middle Channel



8DPSK Highest Channel



11. BAND EDGE

11.1 Measurement Procedure

Out of Band Emissions, FCC Rule 15.247(d):

During the radiated emission test, the spectrum analyzer was set with the following configurations:

- 1.The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz for peak measurement with peak detector at frequency above 1GHz.
- 2.The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 10Hz for Average measurement with peak detection at frequency above 1GHz.

During the conducted emission test, the spectrum analyzer was set with the following configurations:

The transmitter output is connected to spectrum analyzer. The resolution bandwidth is set to 100KHz, and the video bandwidth set to 300kHz.

11.2 Limit

15.247(d) In any 100KHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

11.3 Measurement Results

Please see below test table and plots.

Note: All modes of operation were investigated and the worst case (GFSK Mode) emissions are reported.

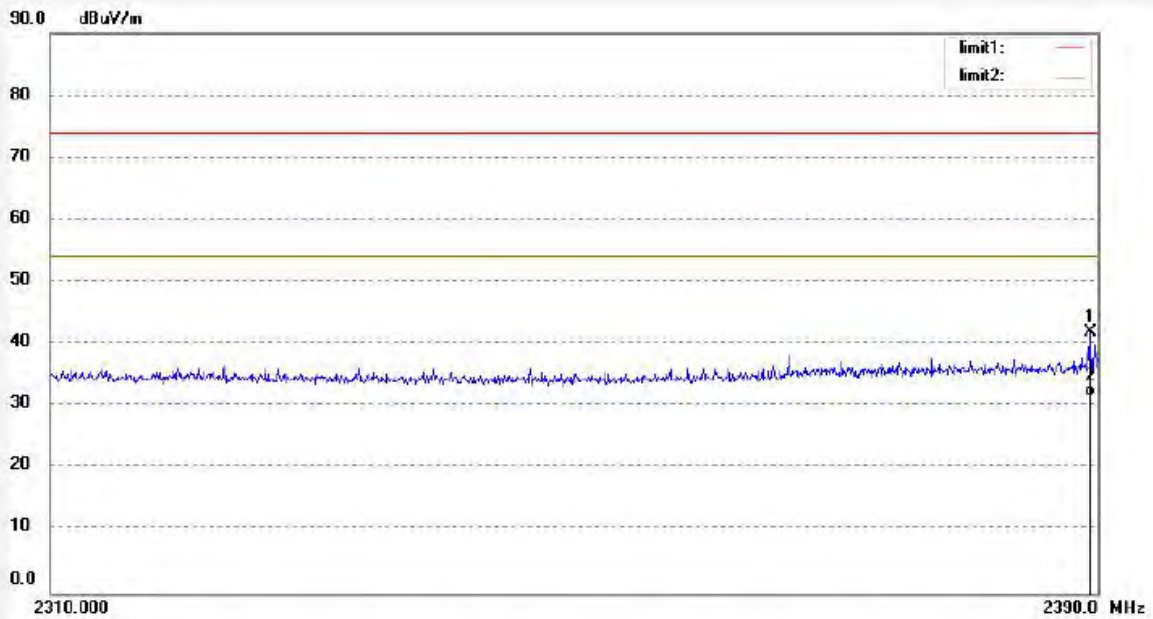


For Radiated restricted band:

E.U.T:	MDK-100	Polarization:	Horizontal
Model No.:	MDK-100	Temperature:	23 °C
Test Mode:	TX 2402MHz (GFSK)	Humidity:	48 %
Test Distance:	3m	Test By:	PEI
Test Results:	PASS	Test Voltage	DC 11.1V

Job No.: Data 2020 #71	Polarization: Horizontal
Standard: FCC (Band Edge)	Power Source: DC 11.1V
Test item: Radiation Test	Date: 2020/09/07
Temp.(C)/Hum.(%) 23 C / 48 %	Time:
EUT: MDK-100	Engineer Signature: WADE
Mode: TX 2402MHz	Distance: 3m
Model: MDK-100	
Manufacturer: Estone	

Note:

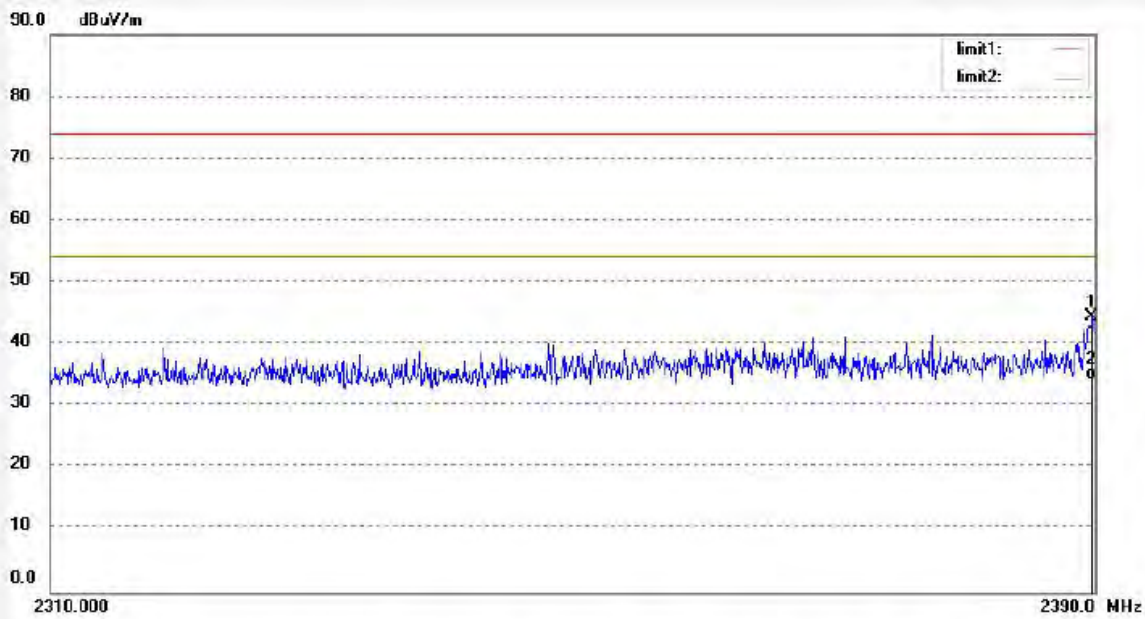


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2389.360	41.16	0.79	41.95	74.00	-32.05	peak			
2	2389.360	30.75	0.79	31.54	54.00	-22.46	AVG			

E.U.T:	MDK-100	Polarization:	Vertical
Model No.:	MDK-100	Temperature:	23 °C
Test Mode:	TX 2402MHz (GFSK)	Humidity:	48 %
Test Distance:	3m	Test By:	PEI
Test Results:	PASS	Test Voltage	DC 11.1V

Job No.: Data 2020 #72	Polarization: Vertical
Standard: FCC (Band Edge)	Power Source: DC 11.1V
Test item: Radiation Test	Date: 2020/09/07
Temp.(C)/Hum.(%) 23 C / 48 %	Time:
EUT: MDK-100	Engineer Signature: WADE
Mode: TX 2402MHz	Distance: 3m
Model: MDK-100	
Manufacturer: Estone	

Note:

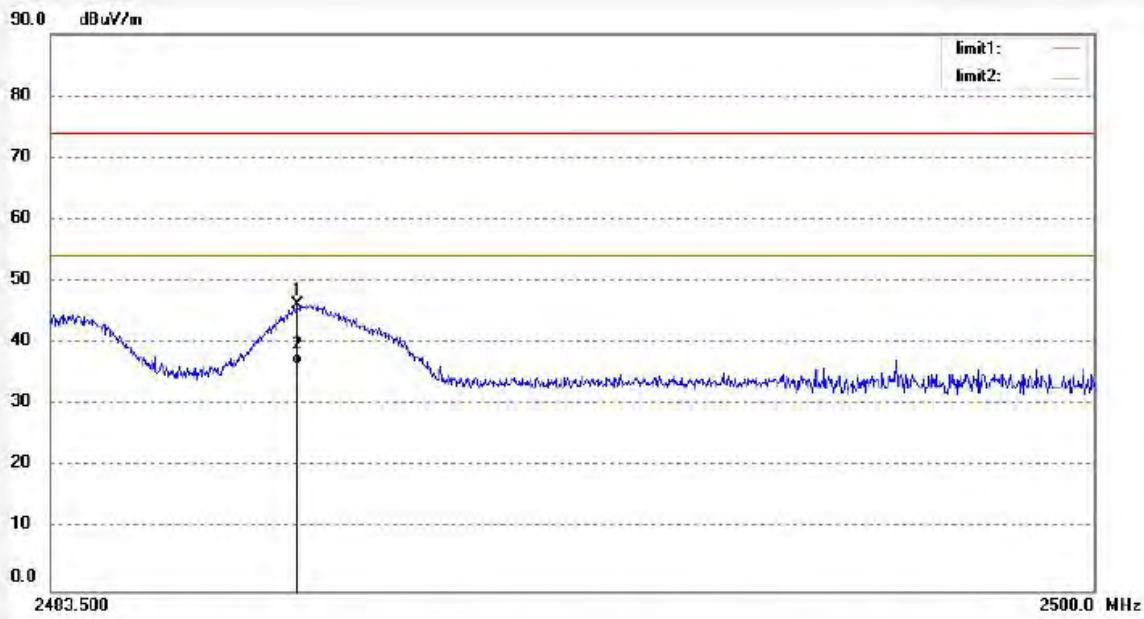


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2389.760	43.72	0.79	44.51	74.00	-29.49	peak			
2	2389.760	33.45	0.79	34.24	54.00	-19.76	AVG			

E.U.T:	MDK-100	Polarization:	Horizontal
Model No.:	MDK-100	Temperature:	23 °C
Test Mode:	TX 2480MHz (GFSK)	Humidity:	48 %
Test Distance:	3m	Test By:	PEI
Test Results:	PASS	Test Voltage	DC 11.1V

Job No.: Data 2020 #74 Standard: FCC (Band Edge) Test item: Radiation Test Temp.(C)/Hum.(%) 23 C / 48 % EUT: MDK-100 Mode: TX 2480MHz Model: MDK-100 Manufacturer: Estone	Polarization: Horizontal Power Source: DC 11.1V Date: 2020/09/07 Time: Engineer Signature: WADE Distance: 3m
---	---

Note:

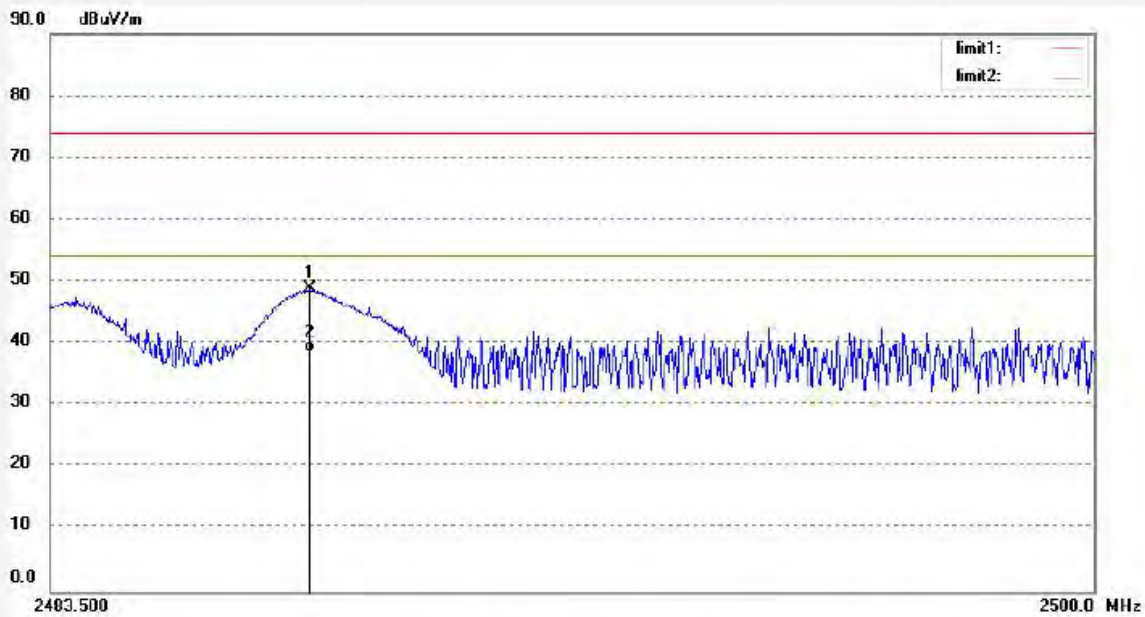


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2487.394	45.10	1.10	46.20	74.00	-27.80	peak			
2	2487.394	35.45	1.10	36.55	54.00	-17.45	AVG			

E.U.T:	MDK-100	Polarization:	Vertical
Model No.:	MDK-100	Temperature:	25 °C
Test Mode:	TX 2480MHz (GFSK)	Humidity:	50 %
Test Distance:	3m	Test By:	PEI
Test Results:	PASS	Test Voltage	DC 11.1V

Job No.: Data 2020 #73	Polarization: Vertical
Standard: FCC (Band Edge)	Power Source: DC 11.1V
Test item: Radiation Test	Date: 2020/09/07
Temp.(C)/Hum.(%) 23 C / 48 %	Time:
EUT: MDK-100	Engineer Signature: WADE
Mode: TX 2480MHz	Distance: 3m
Model: MDK-100	
Manufacturer: Estone	

Note:



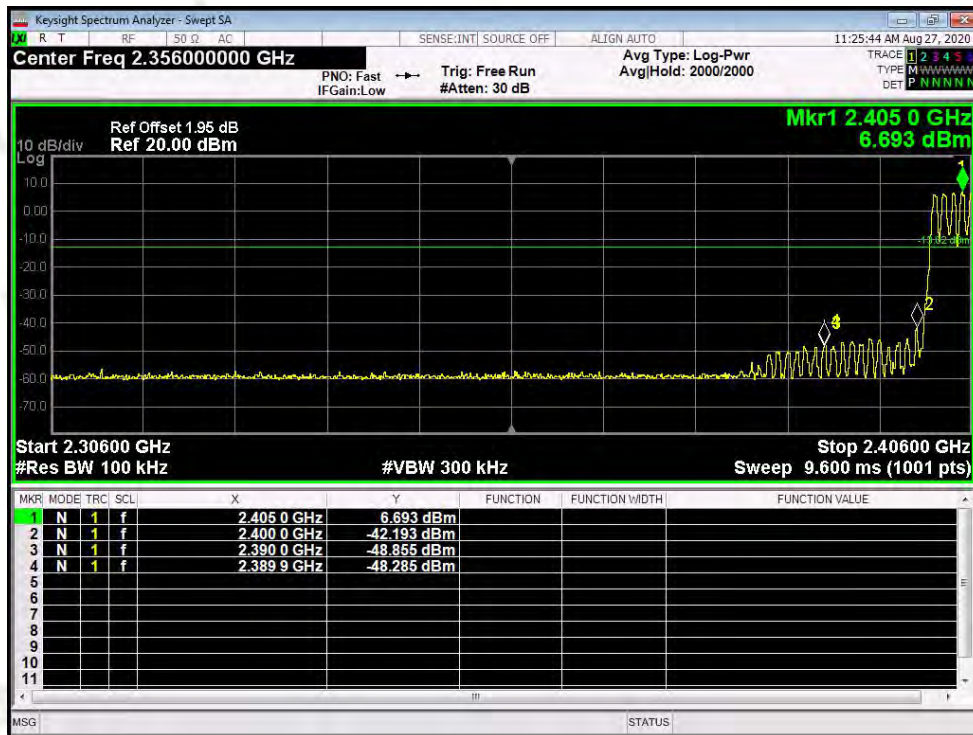
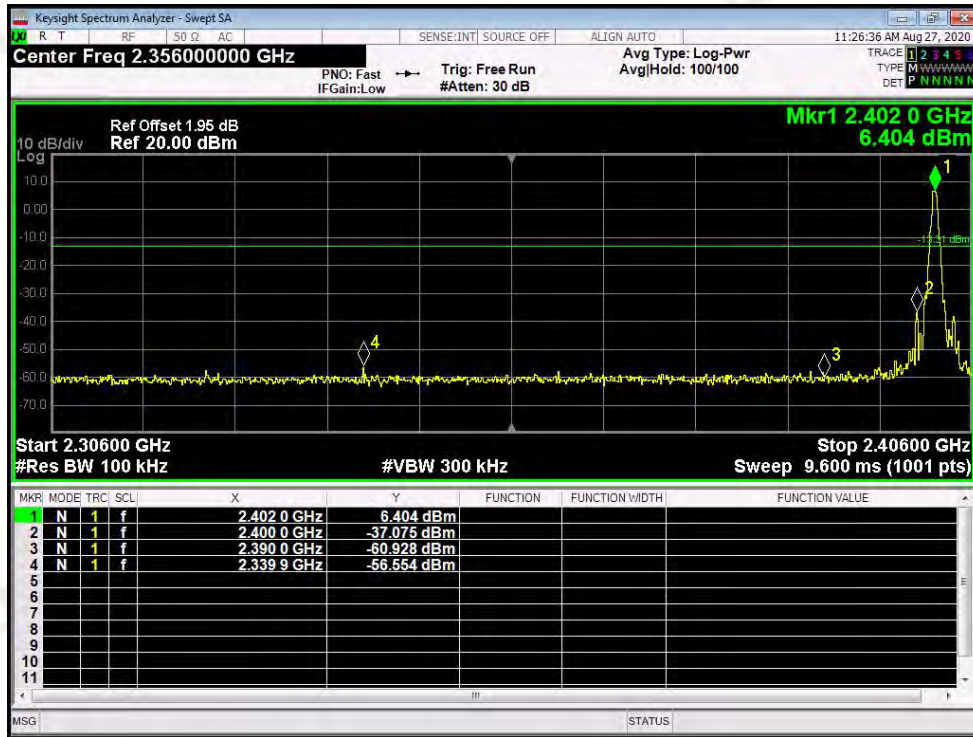
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2487.608	47.75	1.10	48.85	74.00	-25.15	peak			
2	2487.608	37.46	1.10	38.56	54.00	-15.44	AVG			

- Note:**
- (1) Result= Reading + Factor
 - (2) Factor= Antenna Gain + Cable Loss – Amplifier Gain
 - (3) Horn antenna used for the emission over 1000MHz.

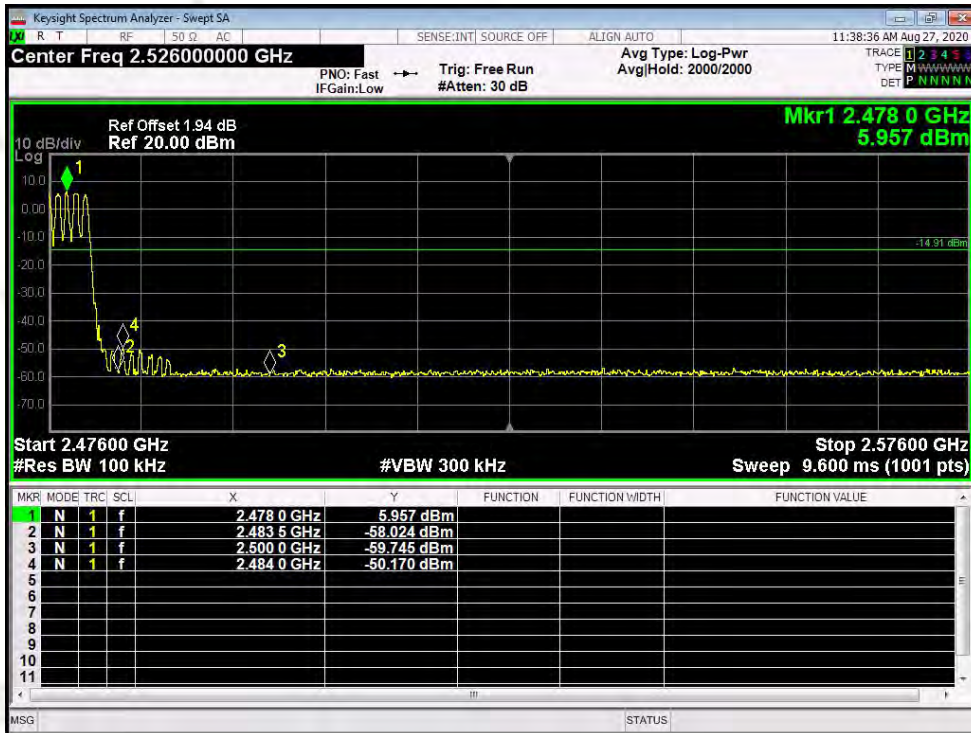
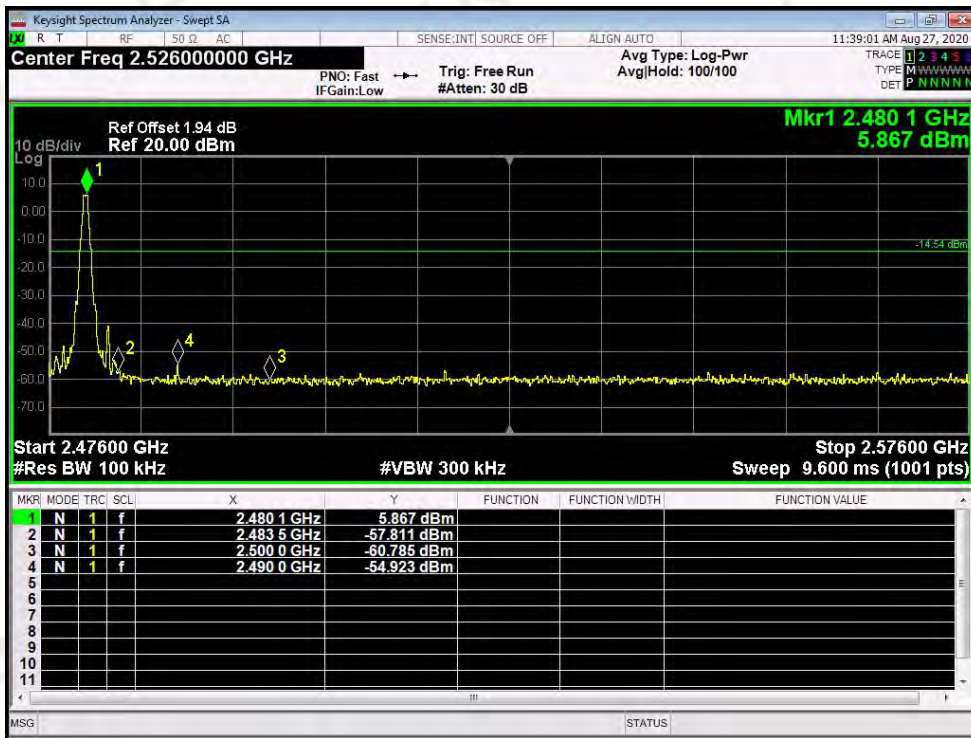


For RF Conducted restricted band:

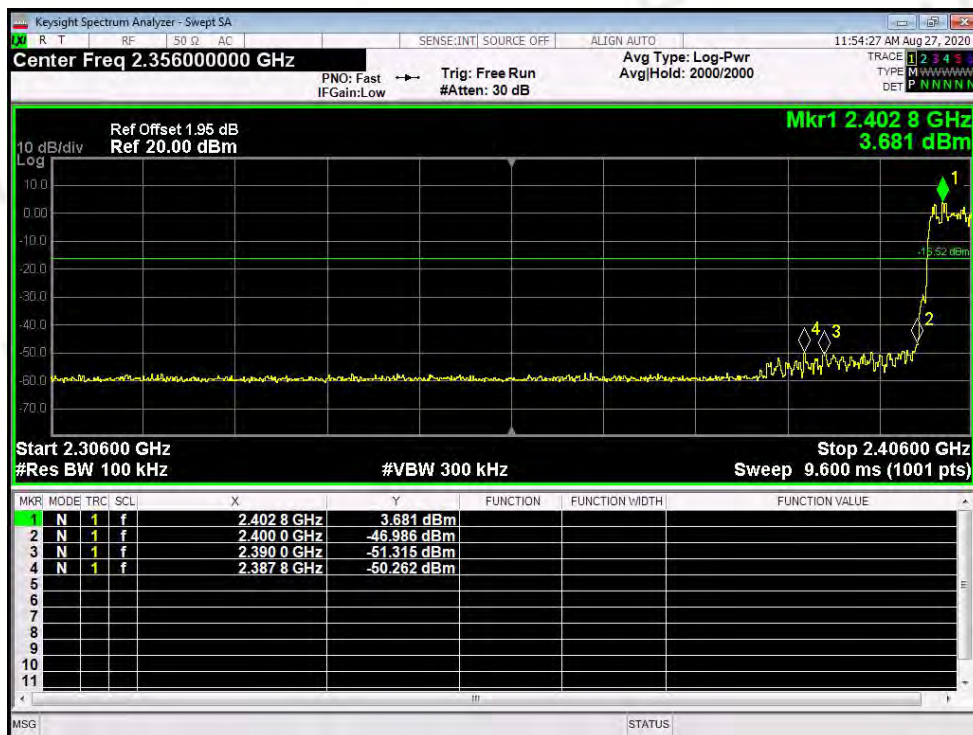
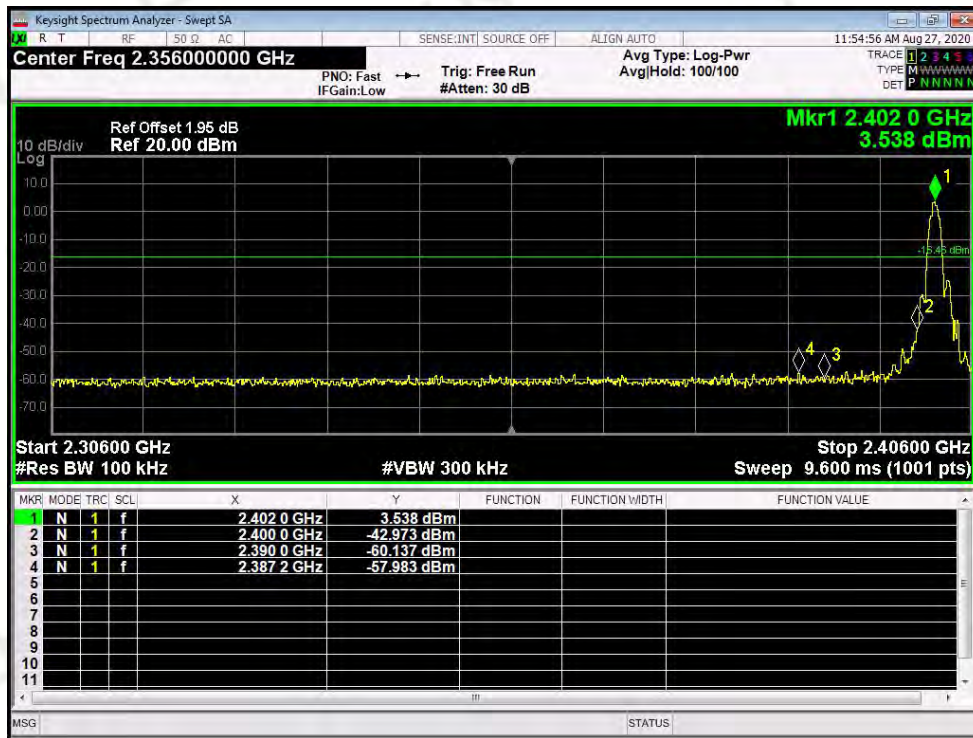
GFSK Lowest Channel



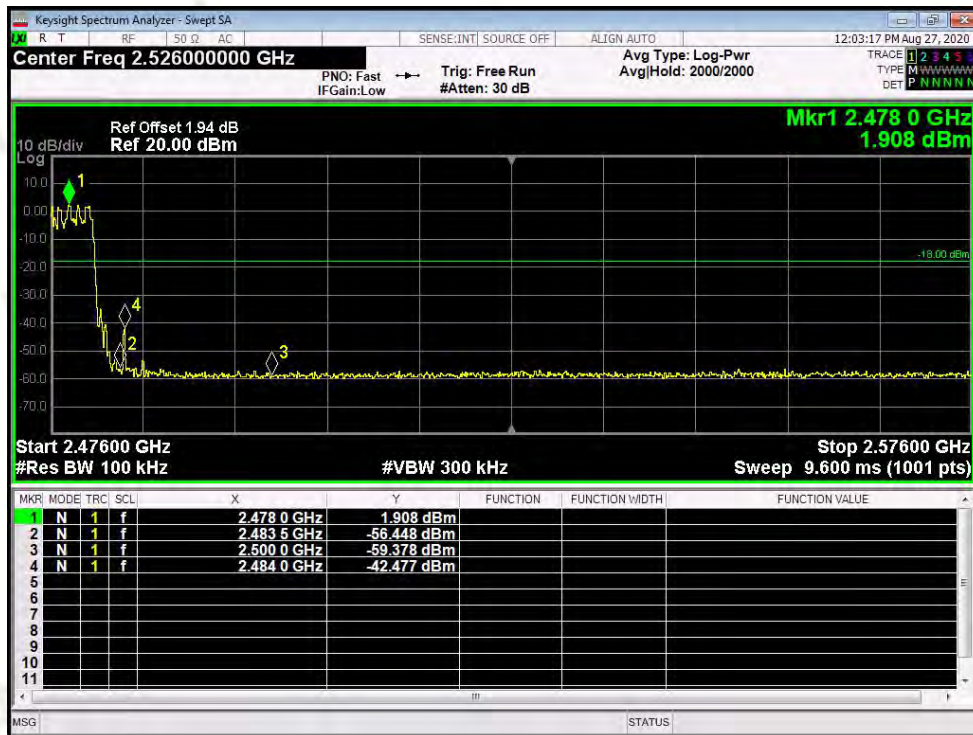
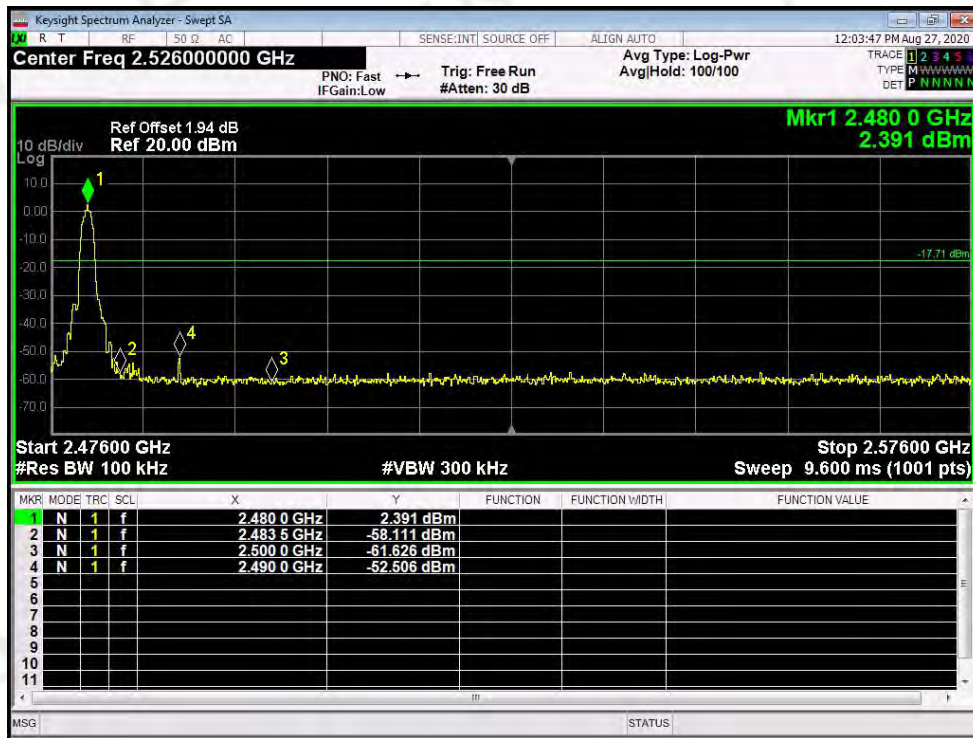
GFSK Highest Channel



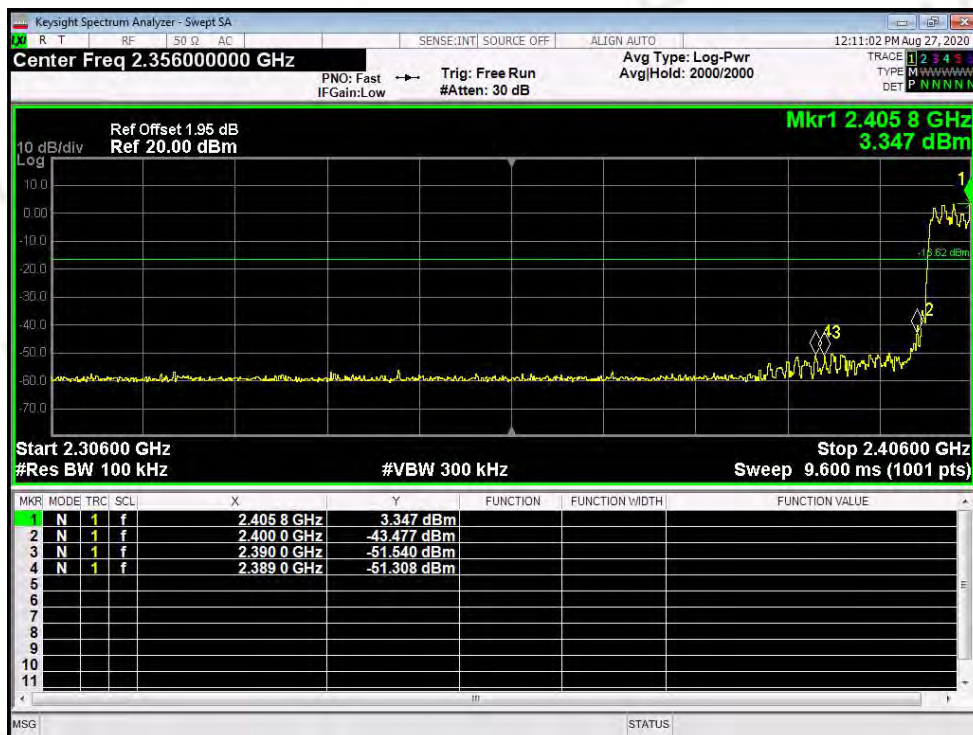
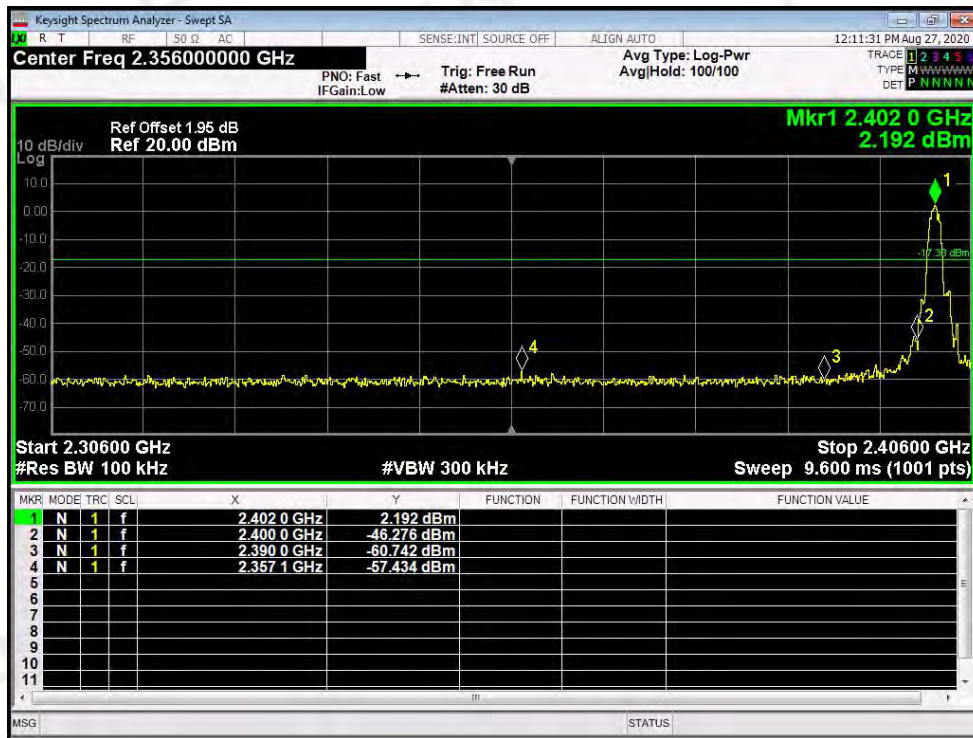
π/4-DQPSK Lowest Channel



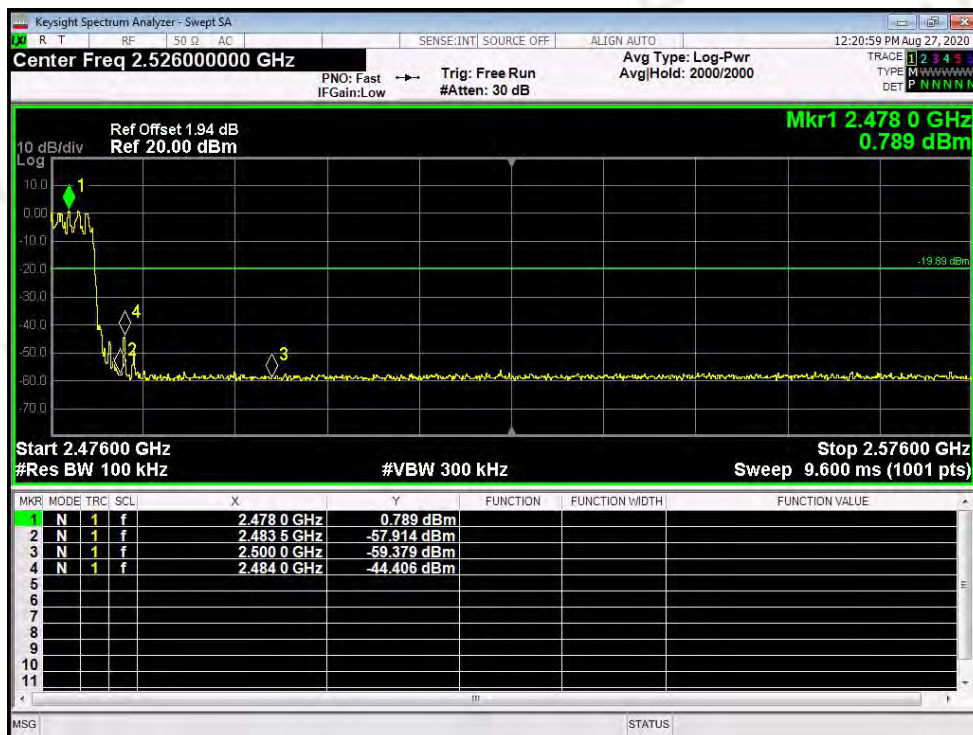
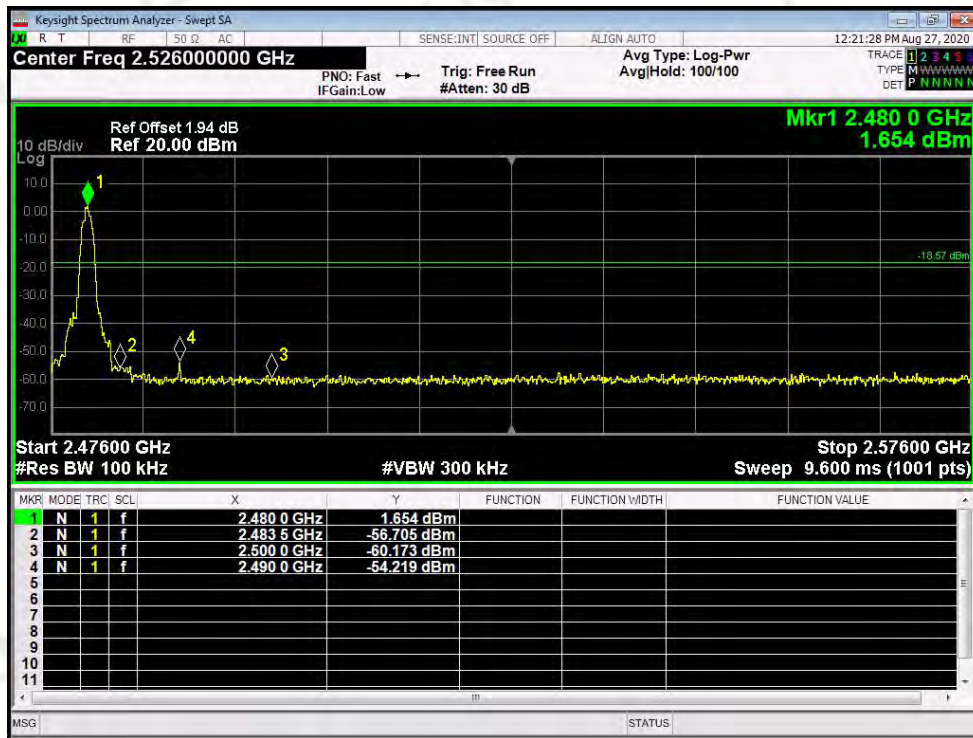
$\pi/4$ -DQPSK Highest Channel



8DPSK Lowest Channel



8DPSK Highest Channel



12. ANTENNA APPLICATION

12.1 Antenna requirement

According to of FCC part 15C section 15.203 and 15.240:

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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. Systems operating in the 2400-2483.5MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

12.2 Measurement Results

The EUT antenna is PIFA antenna. It comply with the standard requirement.

13. CONDUCTED SPURIOUS EMISSIONS

13.1 Measurement Procedure

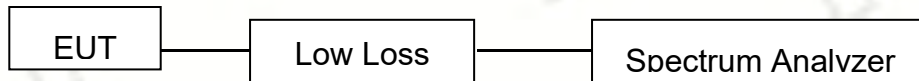
Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

The transmitter output is connected to spectrum analyzer. All spurious emission and up to the tenth harmonic was measured and they were found to be at least 20dB below the highest level of the desired power in the passband.

13.2 Limit

In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

13.3 Test SET-UP (Block Diagram of Configuration)

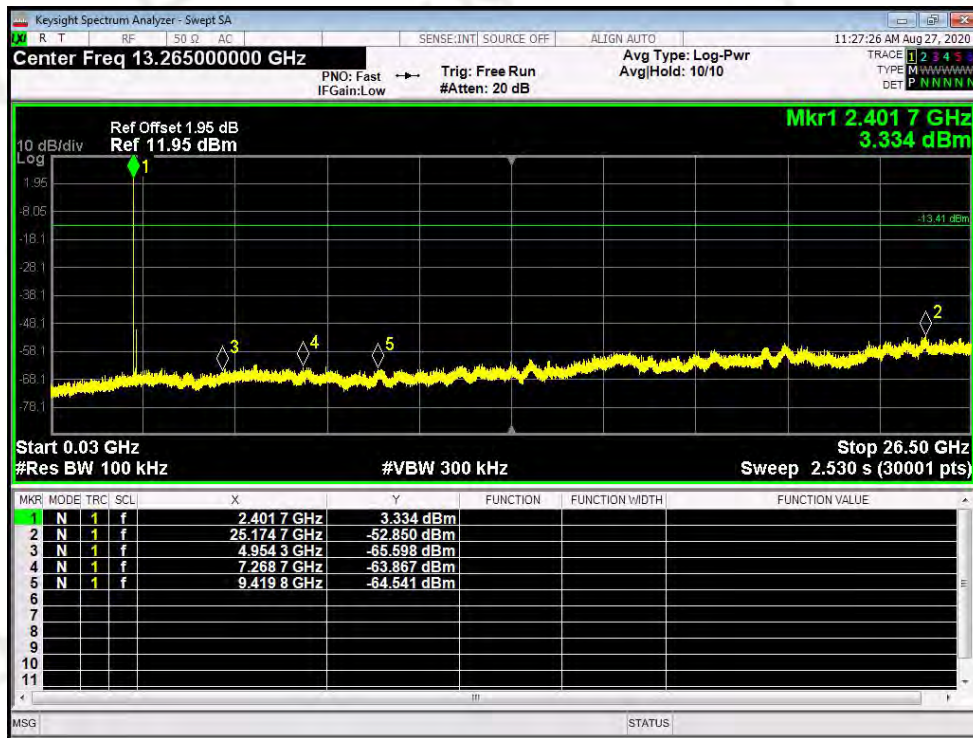


13.4 Measurement Results

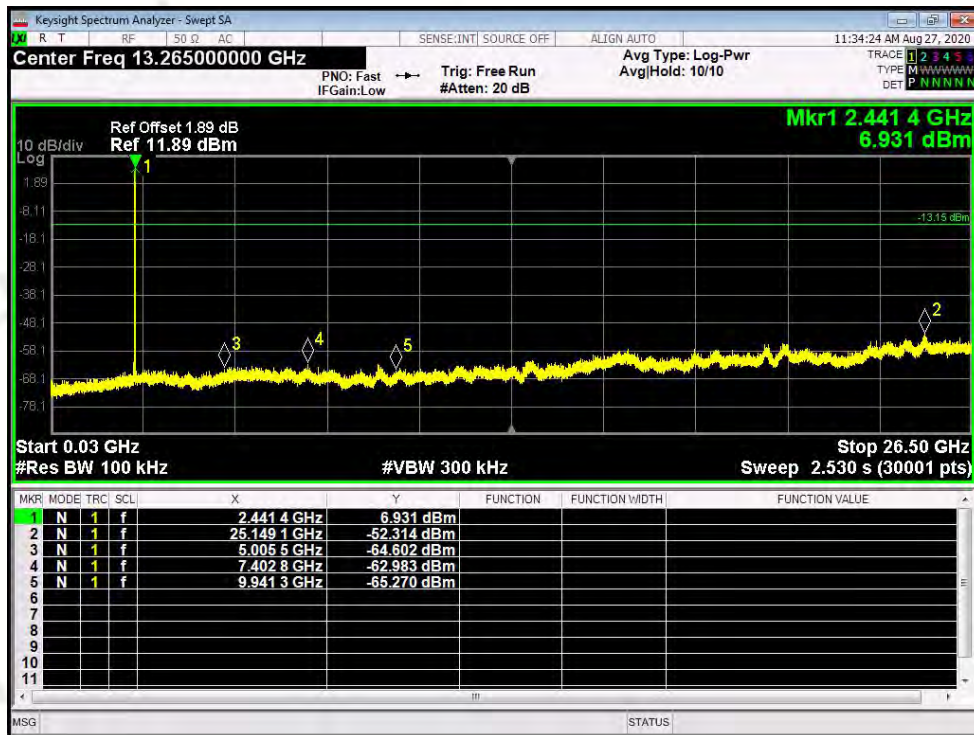
Pass

Please refer to following plots.

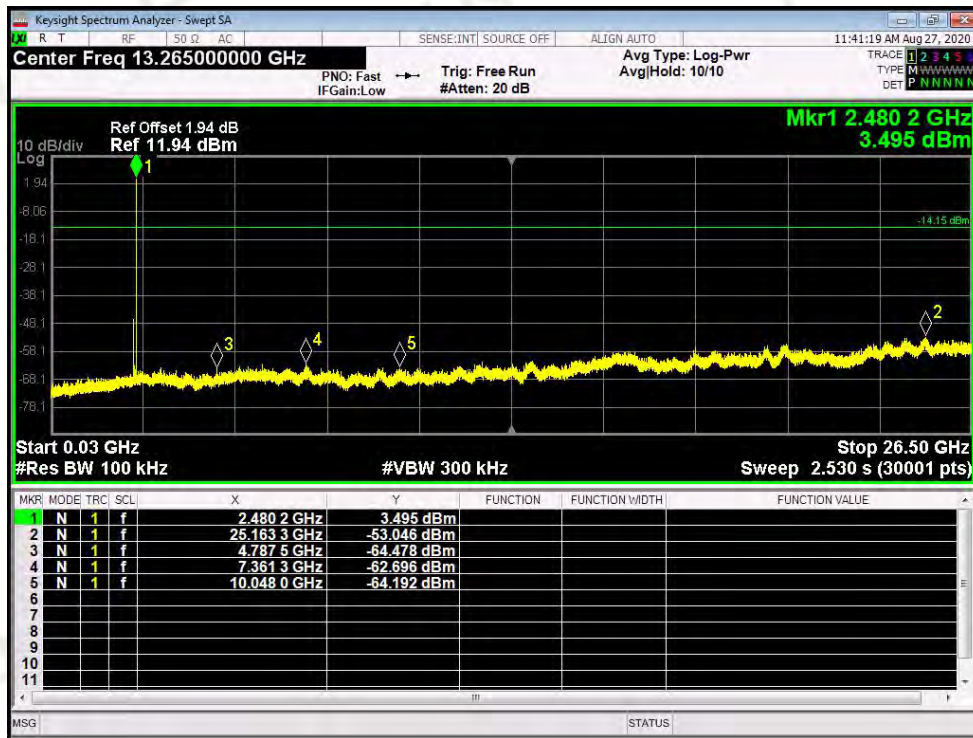
GFSK Lowest Channel



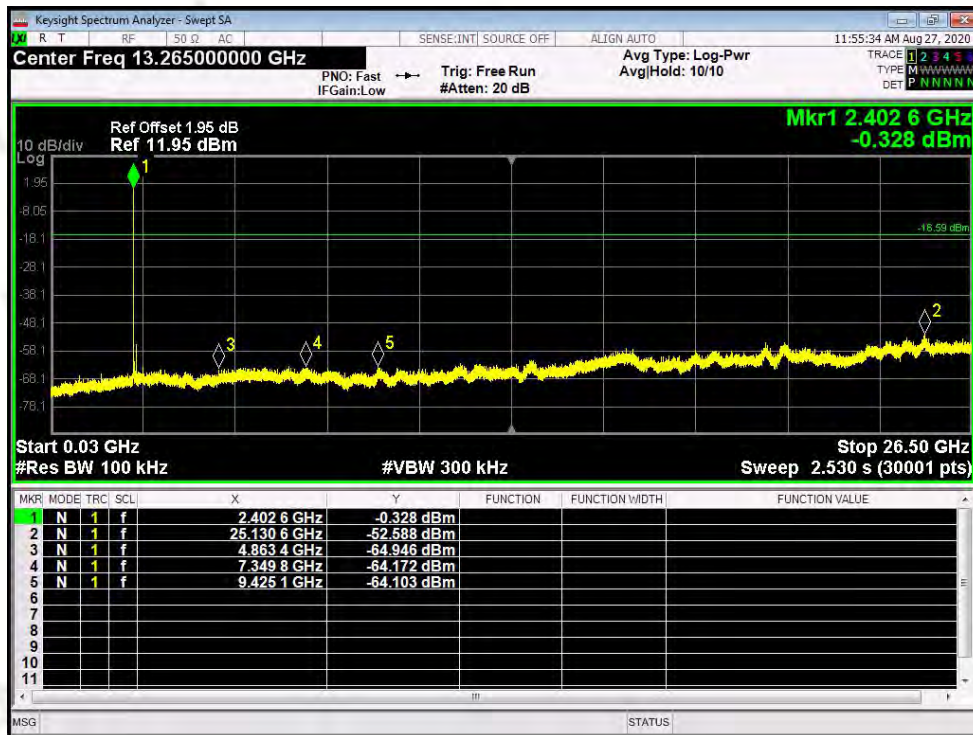
GFSK Middle Channel



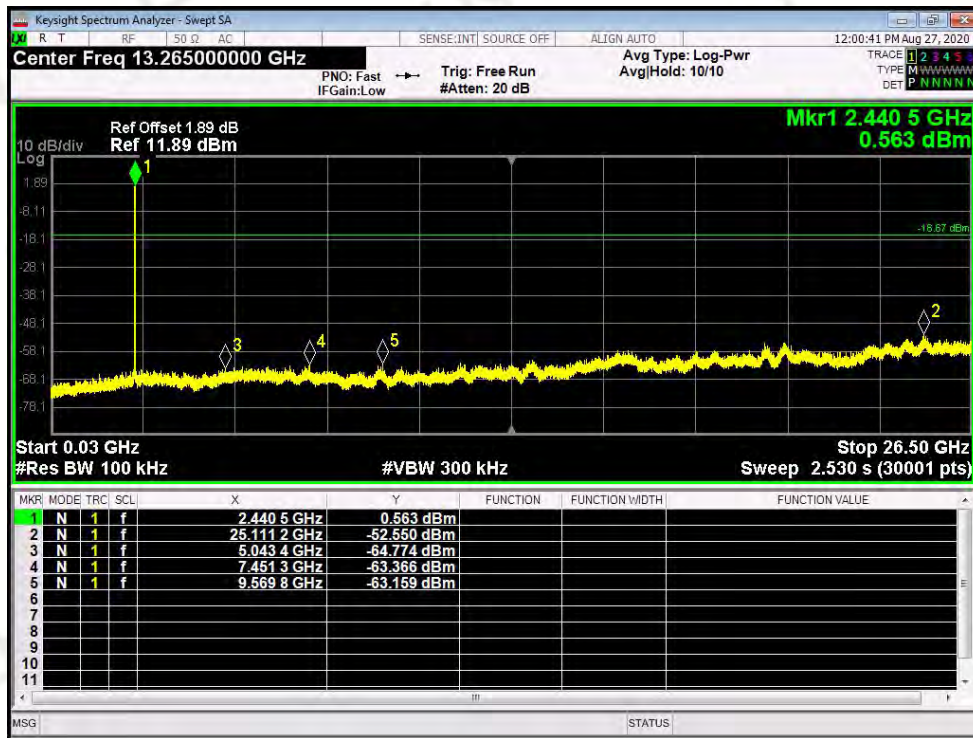
GFSK Highest Channel



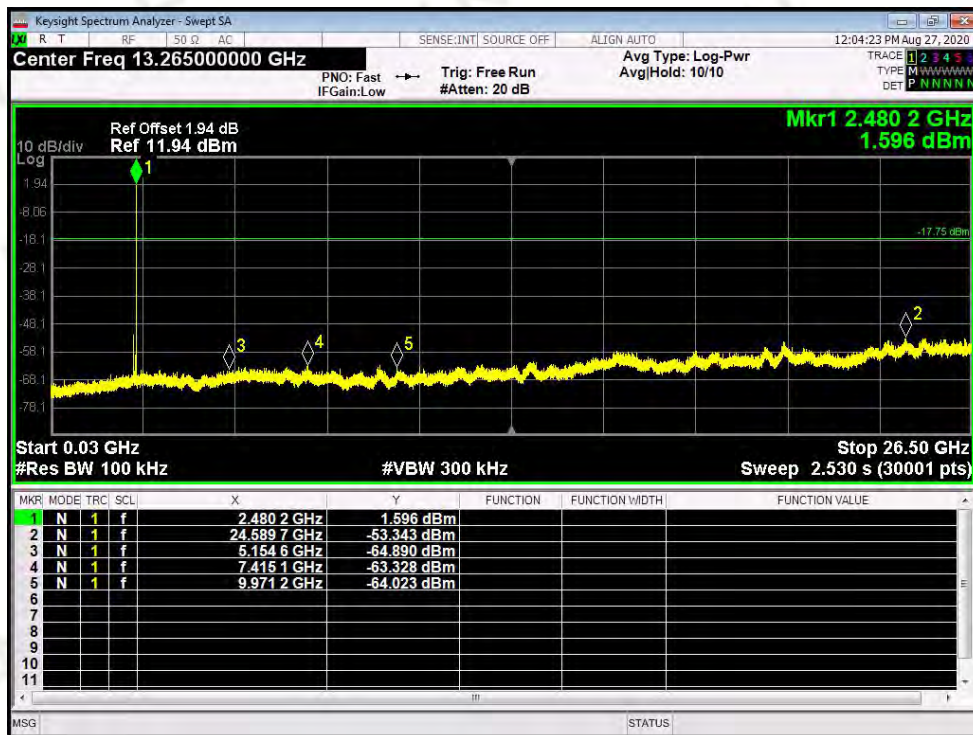
$\pi/4$ -DQPSK Lowest Channel



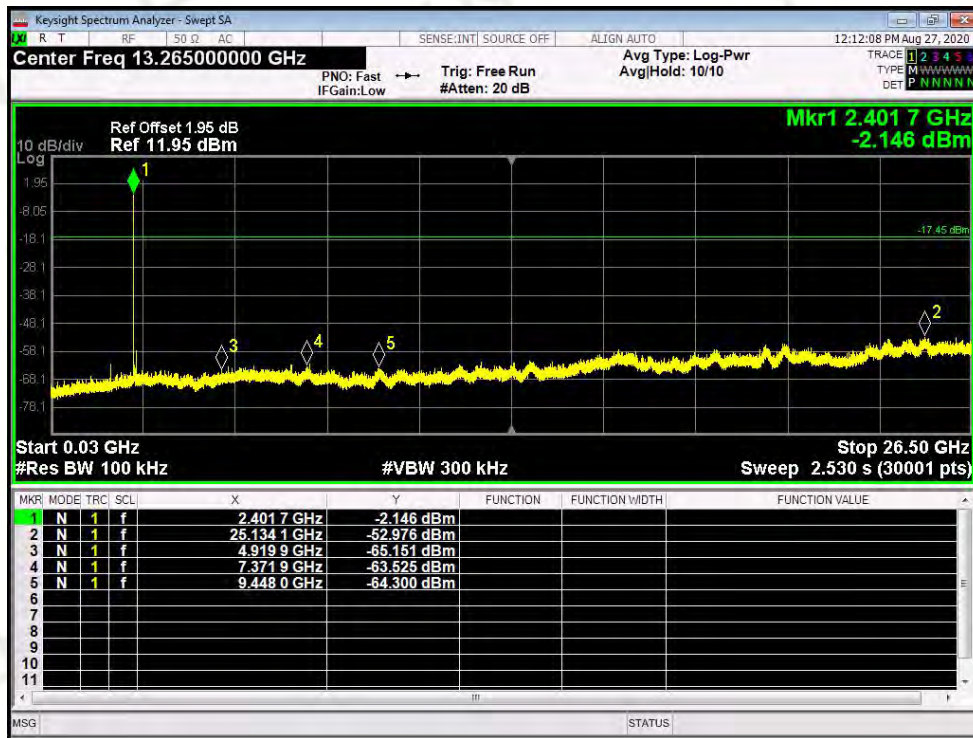
$\pi/4$ -DQPSK Middle Channel



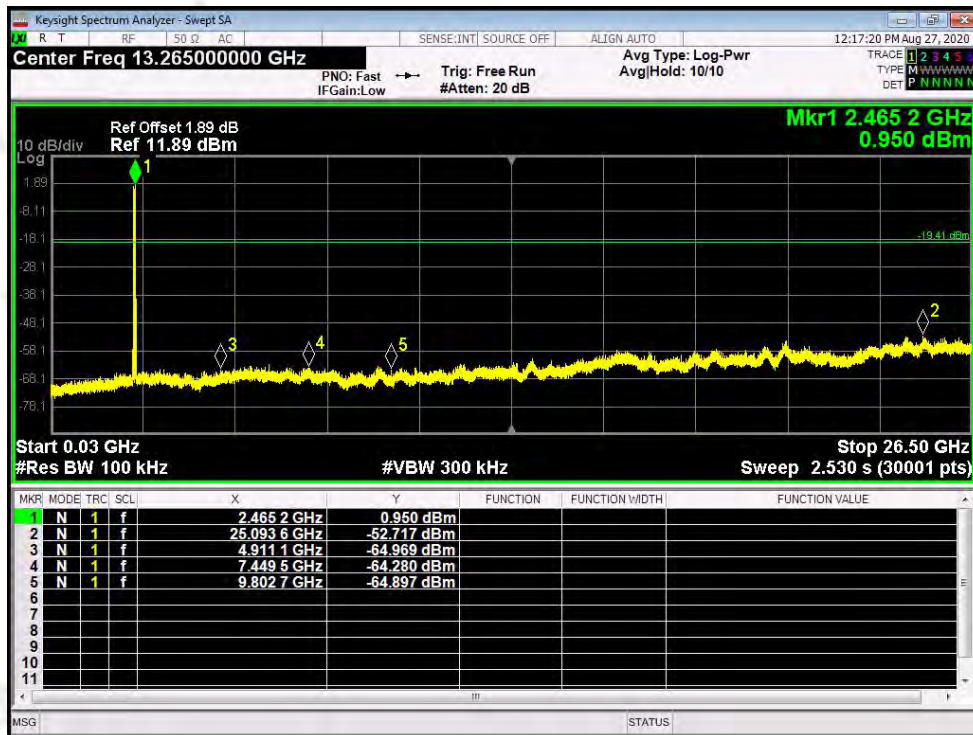
$\pi/4$ -DQPSK Highest Channel



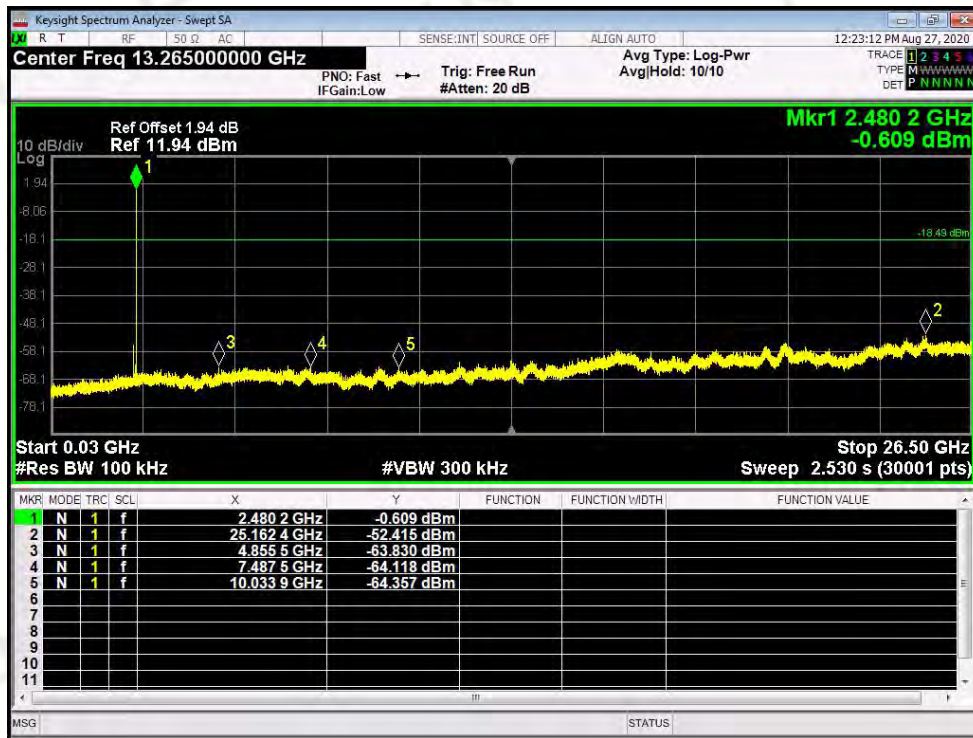
8DPSK Lowest Channel



8DPSK Middle Channel



8DPSK Highest Channel



14. TEST EQUIPMENT LIST

Item	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	Conducted Emission Test Software	EZ-EMC	Ver.CCS-3A1-CE	N/A	N/A
2	AMN	Schwarzbeck	NNLK8121	8121370	2021.10.15
3	AMN	ETS	3810/2	00020199	2021.10.15
4	AAN	TESEQ	T8-Cat6	38888	2021.10.15
5	Pulse Limiter	CYBRTEK	EM5010	E115010056	2021.05.25
6	EMI Test Receiver	Rohde&Schwarz	ESCI	101210	2020.10.15
1	Radiated Emission Test Software	EZ-EMC	Ver.CCS-03A1	N/A	N/A
2	Horn Antenna	Sunol	DRH-118	A101415	2021.10.08
3	Broadband Hybrid Antenna	Sunol	JB1	A090215	2022.03.01
4	PREAMP	HP	8449B	3008A00160	2020.10.21
5	PREAMP	HP	8447D	2944A07999	2021.05.25
6	EMI TEST RECEIVER	Rohde&Schwarz	ESR3	101891	2021.10.15
7	VECTOR Signal Generator	Rohde&Schwarz	SMU200A	101521	2021.10.15
8	Signal Generator	Agilent	E4421B	MY4335105	2021.10.15
9	MXA Signal Analyzer	Agilent	N9020A	MY50510140	2021.10.15
10	MXA Signal Analyzer	Keysight	N9020A	MY51110104	2021.10.15
11	RF Power sensor	DARE	RPR3006W	15I00041SNO88	2021.05.25
12	RF Power sensor	DARE	RPR3006W	15I00041SNO89	2021.05.25
13	RF power divider	Anritsu	K241B	992289	2020.10.28
14	Wideband radio communication tester	Rohde&Schwarz	CMW500	154987	2020.11.19
15	Active Loop Antenna	Com-Power	AL-130R	10160009	2021.05.25
16	Broadband Hybrid Antennas	Schwarzbeck	VULB9163	VULB9163#958	2021.05.25
17	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1680	2021.05.25
18	Horn Antenna	A-INFOMW	LB-180400-KF	J211060660	2020.10.23
19	Microwave Broadband Preamplifier	Schwarzbeck	BBV 9721	100472	2021.05.25
20	Signal Generator	Agilent	N5183A	MY47420153	2021.05.25
21	Spectrum Analyzer	Rohde&Schwarz	FSP 40	100501	2021.05.25
22	Power Meter	KEYSIGHT	N1911A	MY50520168	2021.05.25
23	Frequency Meter	VICTOR	VC2000	997406086	2021.05.25
24	DC Power Source	HYELEC	HY5020E	055161818	2021.05.25

APPENDIX-PHOTOS OF TEST SETUP

Note: See test photos in setup photo document for the actual connections between Product and support equipment.

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