π/4-DQPSK mode

Test channel:	2441MHz

2DH1

2DH3

2DH5

8-DPSK

Test channel:	2441MHz

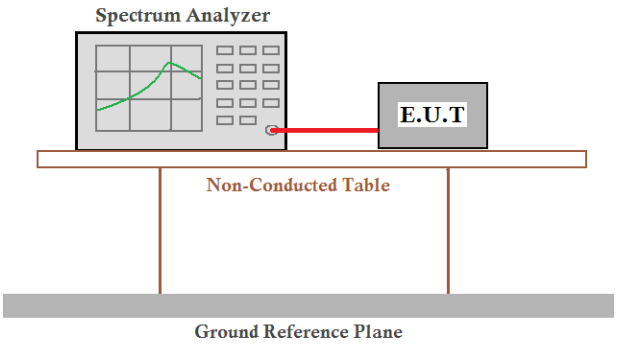
3DH1

3DH3

3DH5

4.8 Band Edge

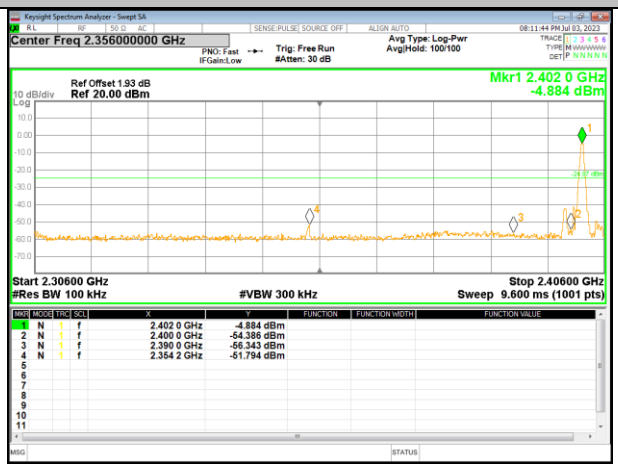
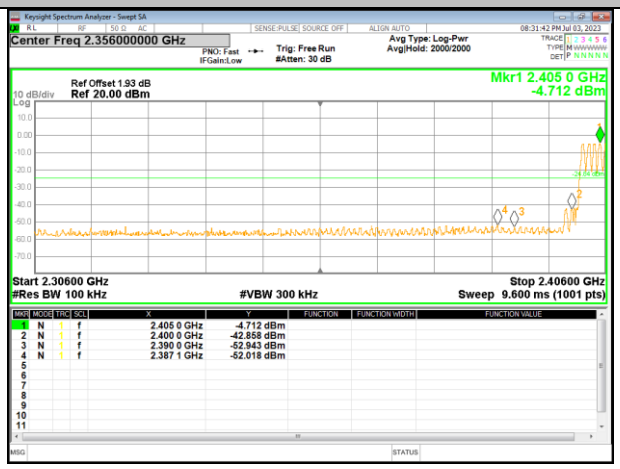
4.8.1 Conducted Emission Method

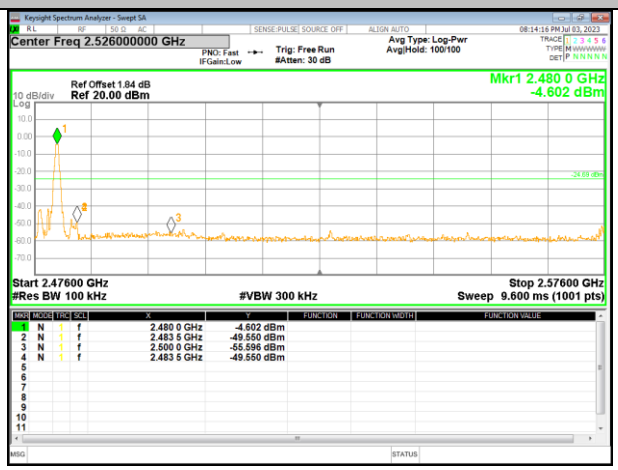
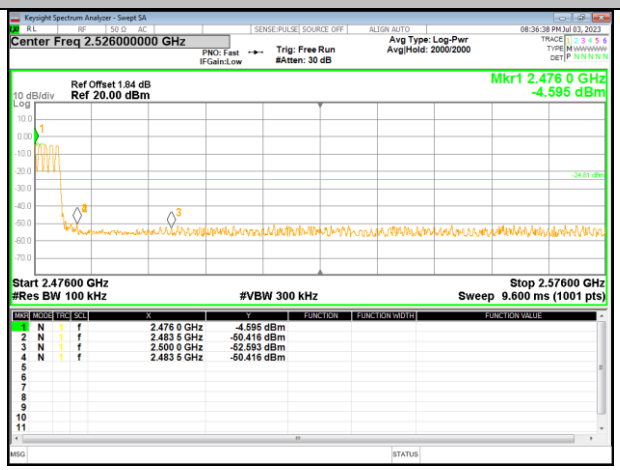
Test Requirement:	FCC Part15 C Section 15.247 (d)	
Test Method:	ANSI C63.10:2013	
Receiver setup:	RBW=100kHz, VBW=300kHz, Detector=Peak	
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.	
Test setup:		
Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.4°C	Humid.: 54%RH
Test voltage:	DC 3.7V	
Test results:	Pass	

Test plot as follows:

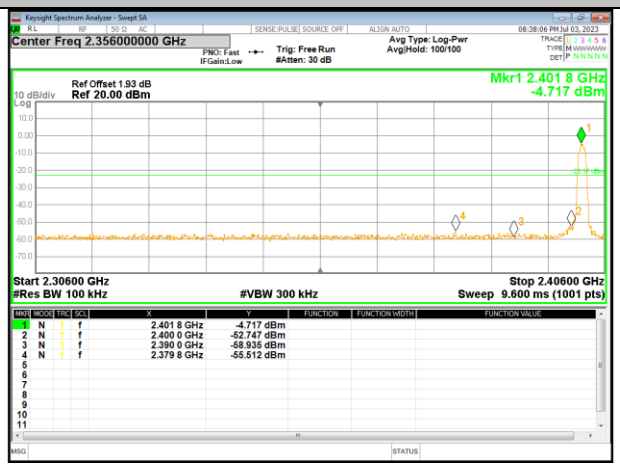
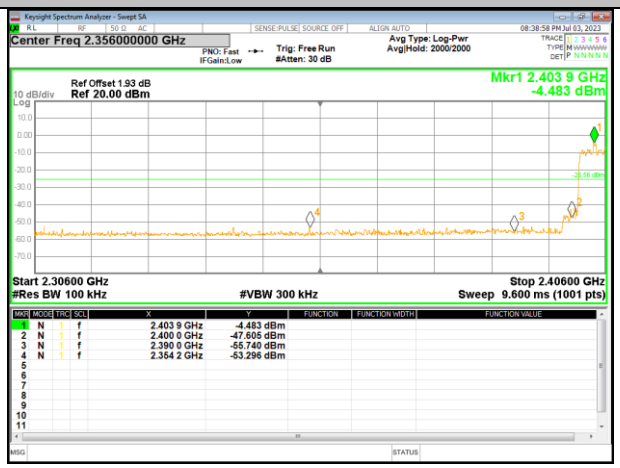
AC6976D Module

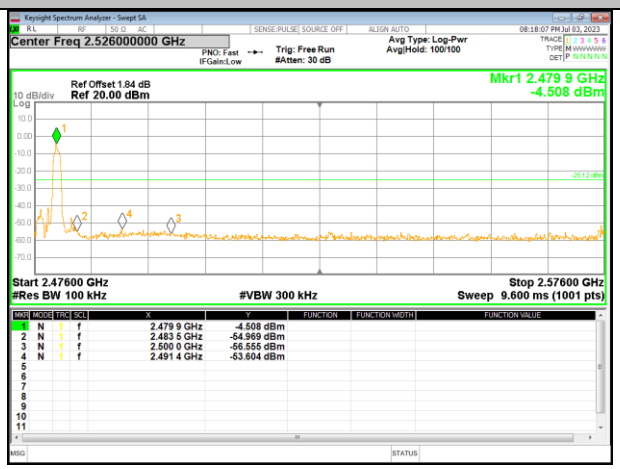
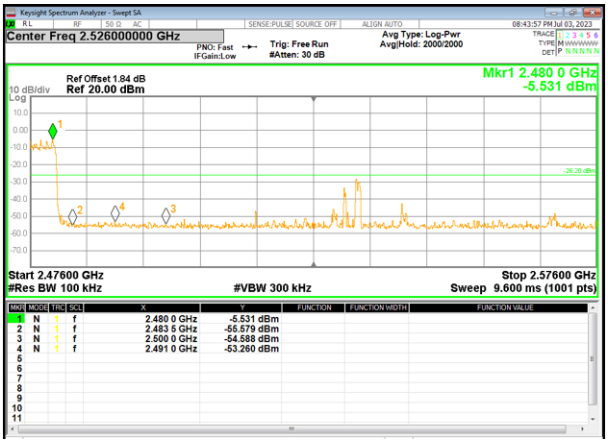
GFSK Mode:

Test channel:	Lowest channel
	
No-hopping mode	Hopping mode

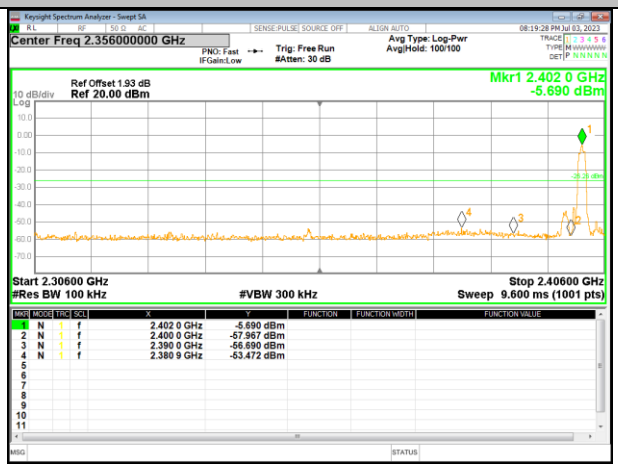
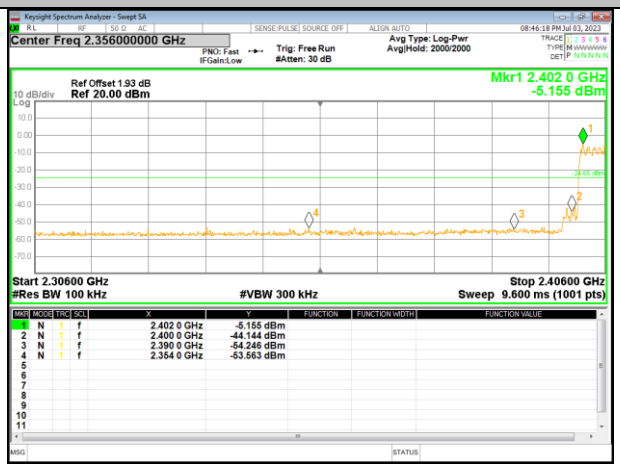
Test channel:	Highest channel
	
No-hopping mode	Hopping mode

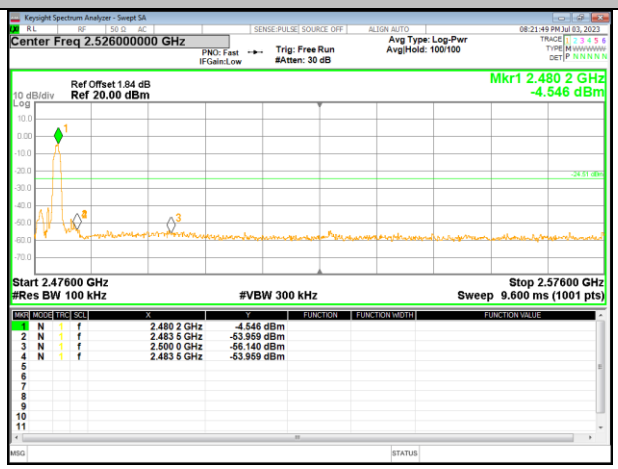
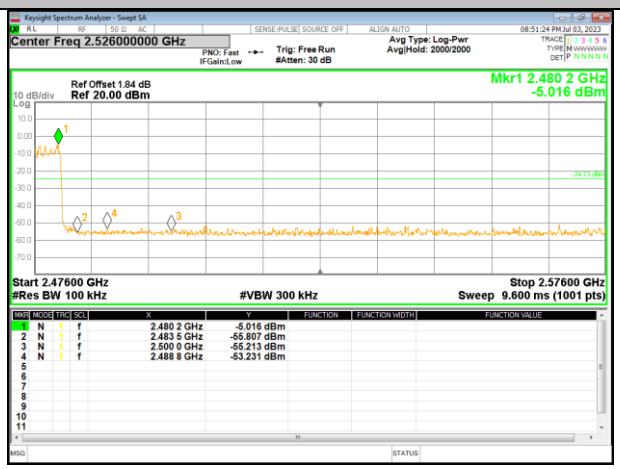
π/4-DQPSK Mode:

Test channel:	Lowest channel
	
No-hopping mode	Hopping mode

Test channel:	Highest channel
	
No-hopping mode	Hopping mode

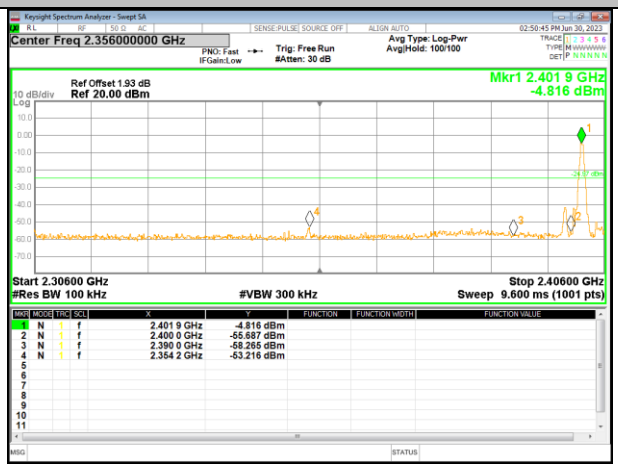
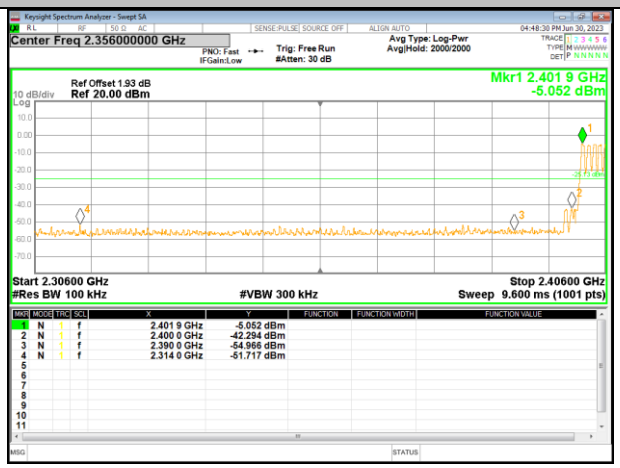
8-DPSK Mode:

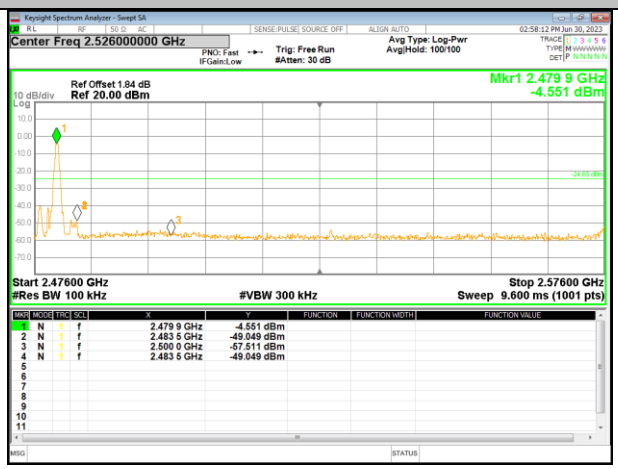
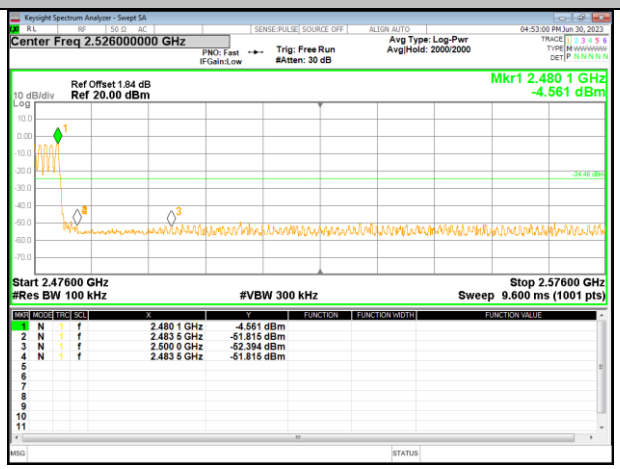
Test channel:	Lowest channel
	
No-hopping mode	Hopping mode

Test channel:	Highest channel
	
No-hopping mode	Hopping mode

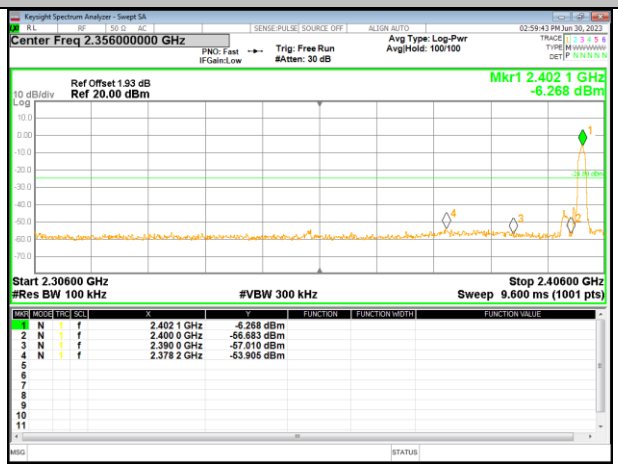
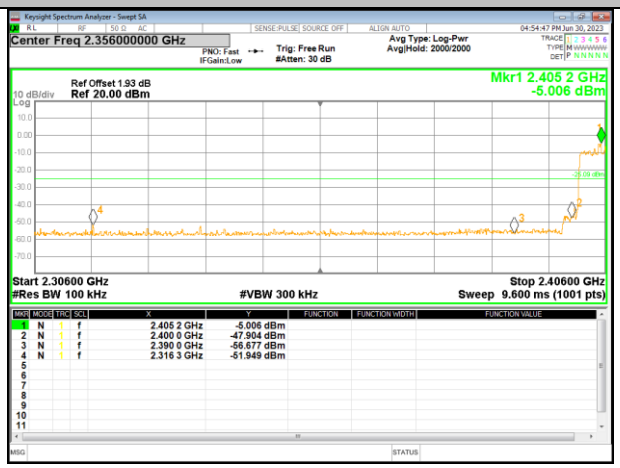
AC6956C Module

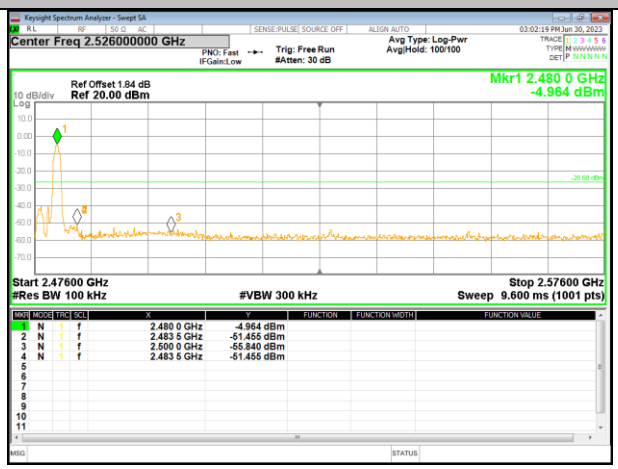
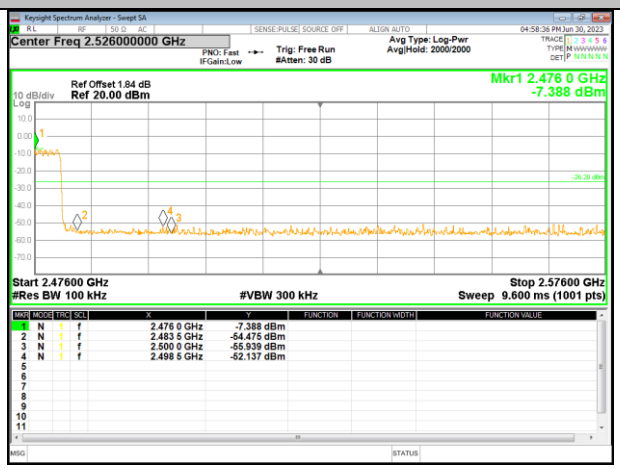
GFSK Mode:

Test channel:	Lowest channel
	
No-hopping mode	Hopping mode

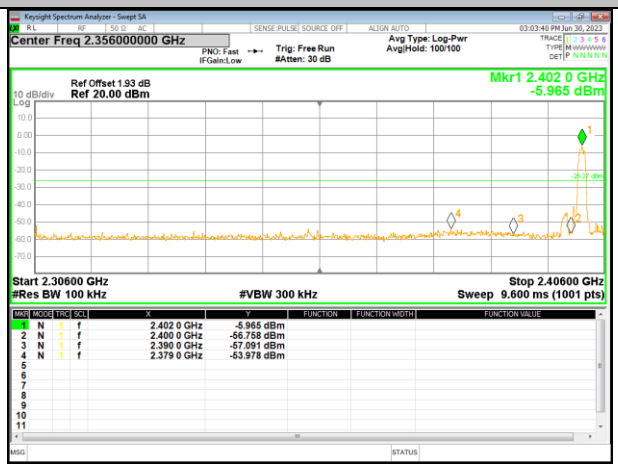
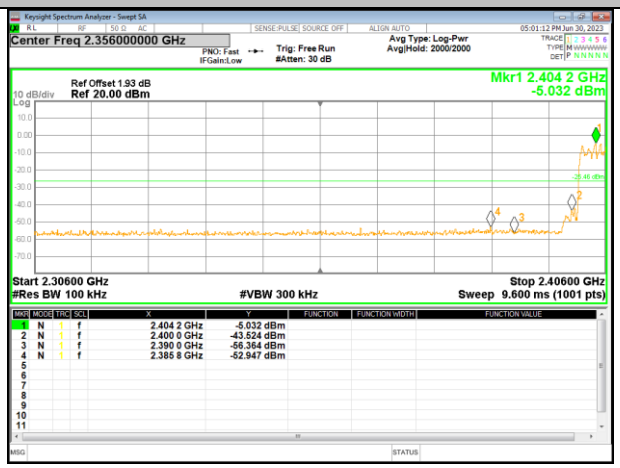
Test channel:	Highest channel
	
No-hopping mode	Hopping mode

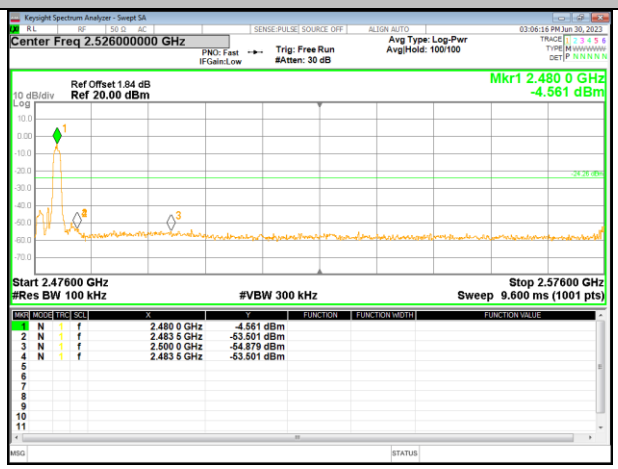
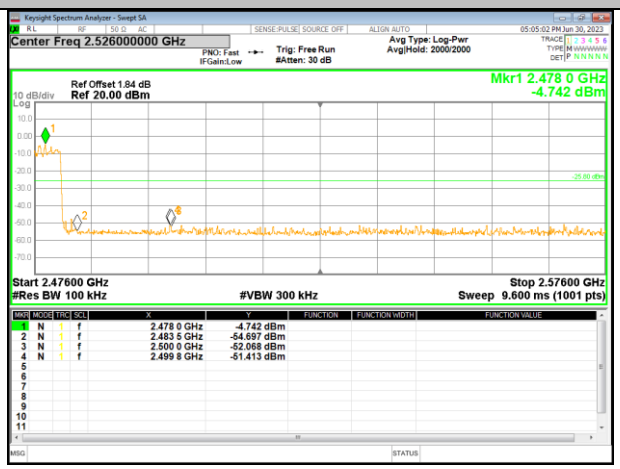
π/4-DQPSK Mode:

Test channel:	Lowest channel
	
No-hopping mode	Hopping mode

Test channel:	Highest channel
	
No-hopping mode	Hopping mode

8-DPSK Mode:

Test channel:	Lowest channel
	
No-hopping mode	Hopping mode

Test channel:	Highest channel
	
No-hopping mode	Hopping mode

4.8.2 Radiated Emission Method

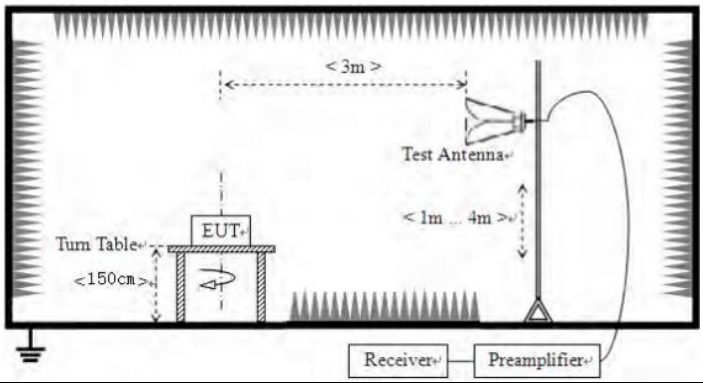
Test Requirement:	FCC Part15 C Section 15.209 and 15.205
Test Method:	ANSI C63.10:2013
Test Frequency Range:	All of the restrict bands were tested, only the worst band's (2310MHz to 2500MHz) data was showed.
Test site:	Measurement Distance: 3m
Receiver setup:	

Frequency	Detector	RBW	VBW	Remark
Above 1GHz	Peak	1MHz	3MHz	Peak Value
	Peak	1MHz	10Hz	Average Value

Limit:

Frequency	Limit (dBuV/m @3m)	Remark
Above 1GHz	54.00	Average Value
	74.00	Peak Value

Test setup:



Test Procedure:

1. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rota table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.4°C	Humid.: 54%RH
Test voltage:	DC 3.7V	
Test results:	Pass	

Remark:
During the test, pre-scan the GFSK, π/4-DQPSK, 8-DPSK modulation, and found the 8-DPSK modulation (two module operate simultaneously)which it is worse case.

Measurement Data

Test channel:	Lowest

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2310.00	69.17	27.40	3.41	45.40	54.58	74.00	-19.42	Horizontal
2390.00	69.80	27.10	3.43	45.40	54.93	74.00	-19.07	Horizontal
2400.00	73.14	27.10	3.43	45.40	58.27	74.00	-15.73	Horizontal
2310.00	69.87	27.40	3.41	45.40	55.28	74.00	-18.72	Vertical
2390.00	72.06	27.10	3.43	45.40	57.19	74.00	-16.81	Vertical
2400.00	72.84	27.10	3.43	45.40	57.97	74.00	-16.03	Vertical

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2310.00	49.95	27.40	3.41	45.40	35.36	54.00	-18.64	Horizontal
2390.00	50.95	27.10	3.43	45.40	36.08	54.00	-17.92	Horizontal
2400.00	53.47	27.10	3.43	45.40	38.60	54.00	-15.40	Horizontal
2310.00	49.32	27.40	3.41	45.40	34.73	54.00	-19.27	Vertical
2390.00	51.93	27.10	3.43	45.40	37.06	54.00	-16.94	Vertical
2400.00	55.42	27.10	3.43	45.40	40.55	54.00	-13.45	Vertical

Test channel:	Highest

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2483.50	62.32	27.80	3.56	45.40	48.28	74.00	-25.72	Horizontal
2500.00	61.30	27.80	3.56	45.40	47.26	74.00	-26.74	Horizontal
2483.50	63.84	27.80	3.56	45.40	49.80	74.00	-24.20	Vertical
2500.00	60.22	27.80	3.56	45.40	46.18	74.00	-27.82	Vertical

Average value:

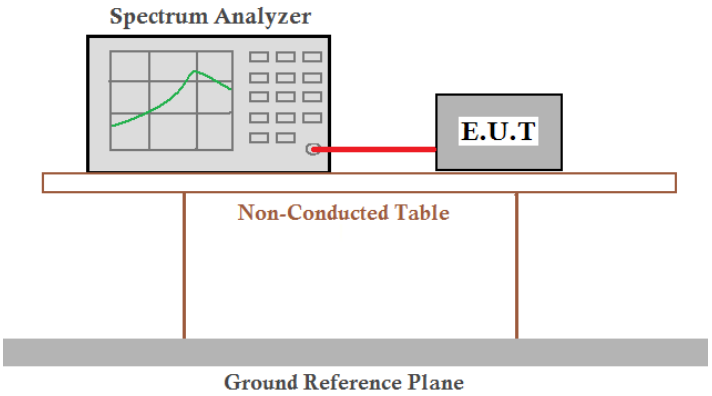
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2483.50	53.71	27.80	3.56	45.40	39.67	54.00	-14.33	Horizontal
2500.00	51.51	27.80	3.56	45.40	37.47	54.00	-16.53	Horizontal
2483.50	53.79	27.80	3.56	45.40	39.75	54.00	-14.25	Vertical
2500.00	50.92	27.80	3.56	45.40	36.88	54.00	-17.12	Vertical

Remarks:

1. *Final Level =Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor*
2. *The emission levels of other frequencies are very lower than the limit and not show in test report.*
3. *The pre-test were performed on lowest, middle and highest frequencies, only the worst case's (lowest and highest frequencies) data was showed.*

4.9 Spurious Emission

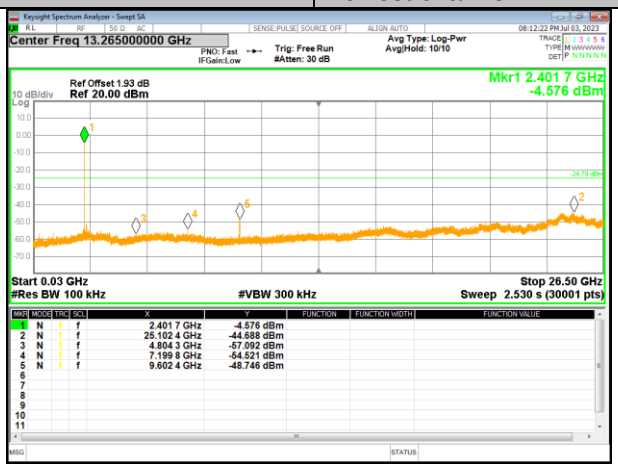
4.9.1 Conducted Emission Method

Test Requirement:	FCC Part15 C Section 15.247 (d)	
Test Method:	ANSI C63.10:2013	
Limit:	In any 100 kHz 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 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.	
Test setup:		
Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.4°C	Humid.: 54%RH
Test voltage:	DC 3.7V	
Test results:	Pass	

AC6976D Module

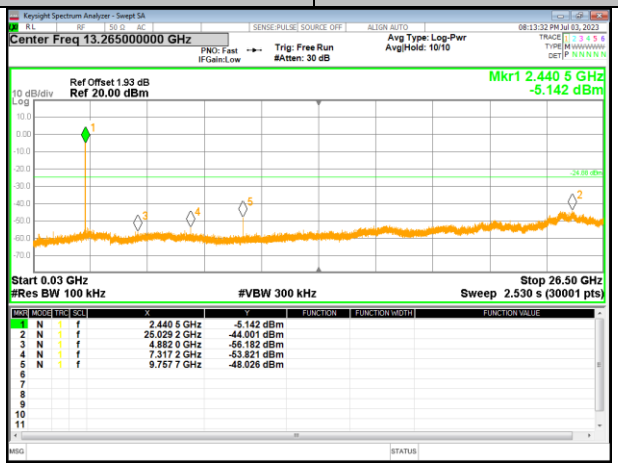
GFSK mode:

Test channel:	Lowest channel



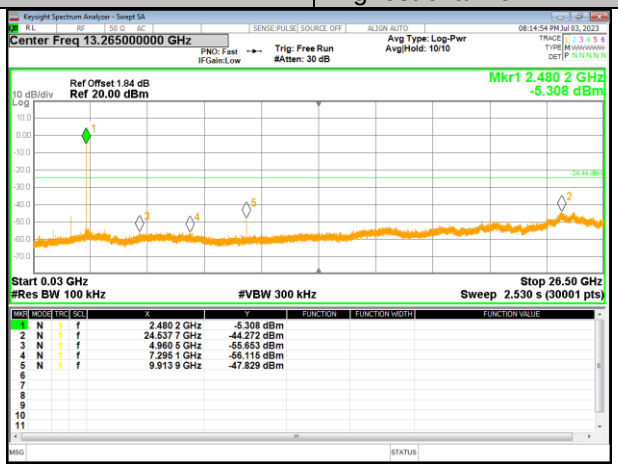
30MHz~25GHz

Test channel:	Middle channel



30MHz~25GHz

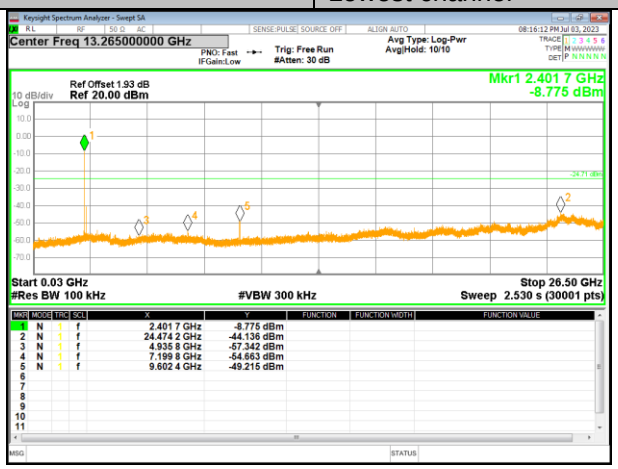
Test channel:	Highest channel



30MHz~25GHz

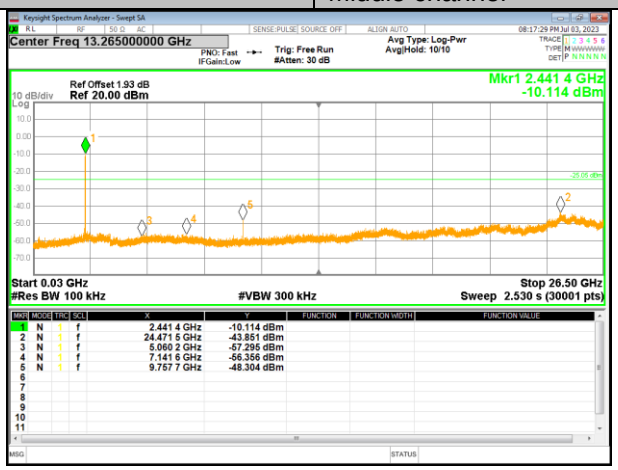
π/4-DQPSK mode:

Test channel:	Lowest channel



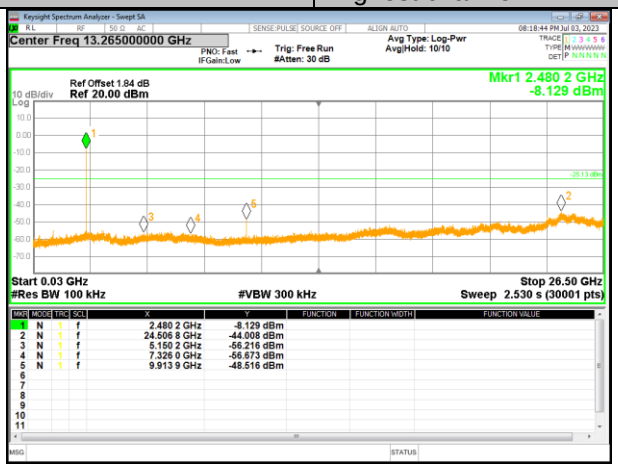
30MHz~25GHz

Test channel:	Middle channel



30MHz~25GHz

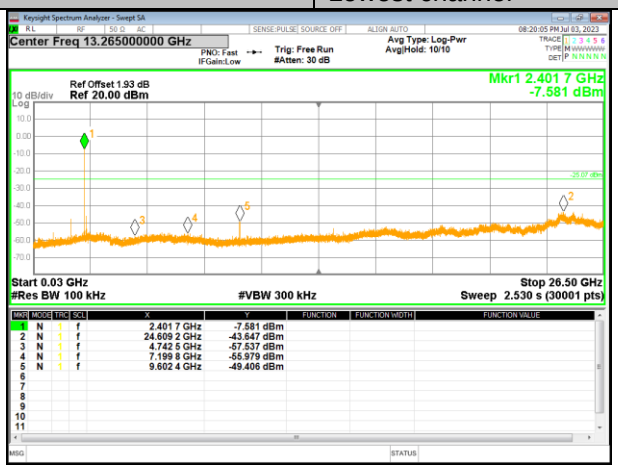
Test channel:	Highest channel



30MHz~25GHz

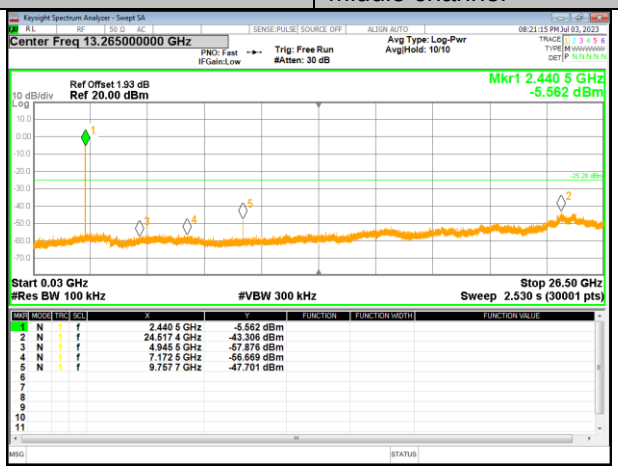
8-DPSK mode:

Test channel:	Lowest channel



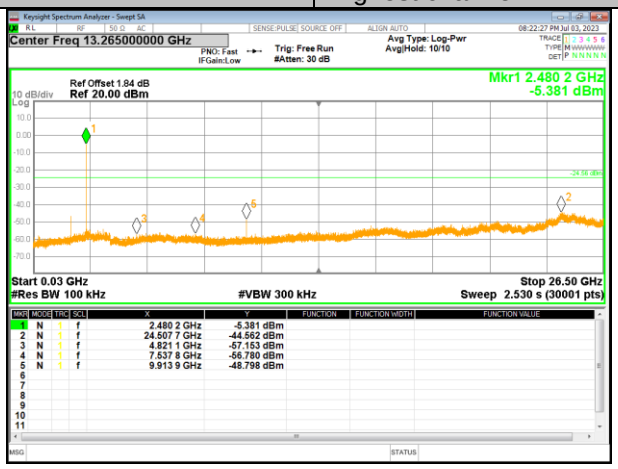
30MHz~25GHz

Test channel:	Middle channel



30MHz~25GHz

Test channel:	Highest channel

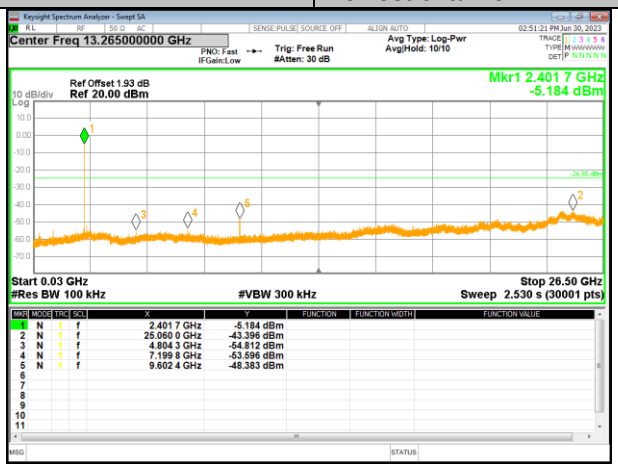


30MHz~25GHz

AC6956C Module

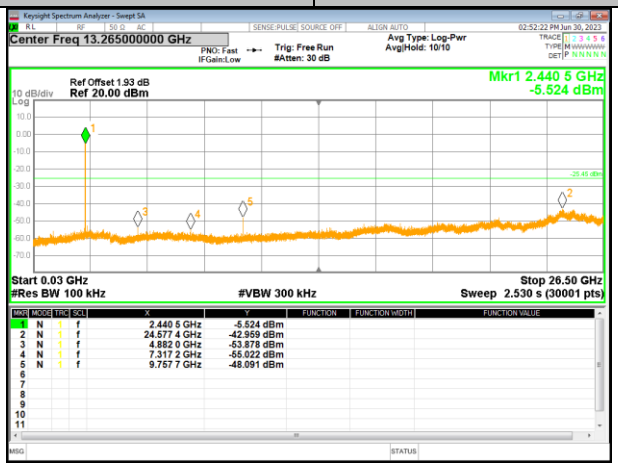
GFSK mode:

Test channel:	Lowest channel



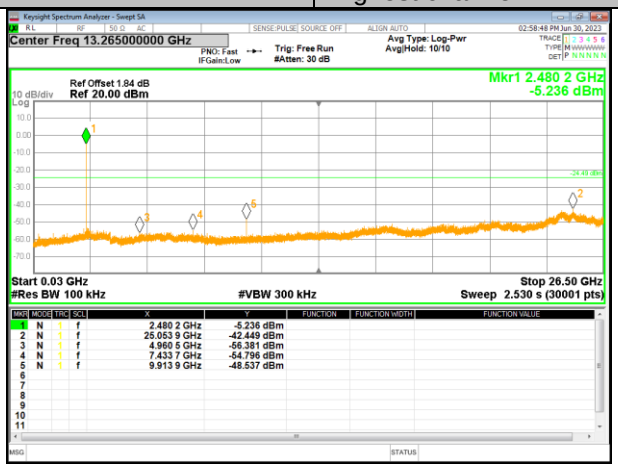
30MHz~25GHz

Test channel:	Middle channel



30MHz~25GHz

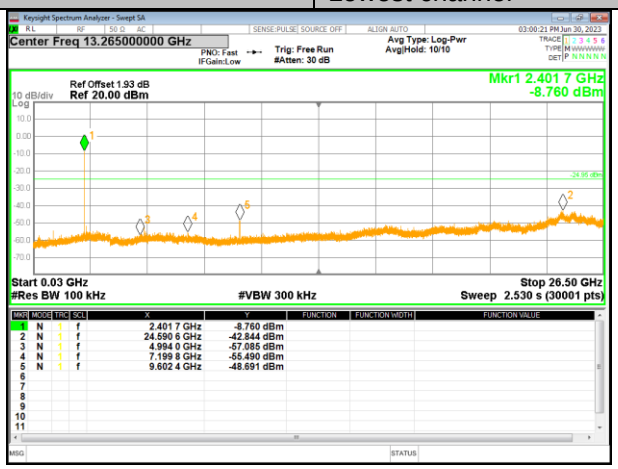
Test channel:	Highest channel



30MHz~25GHz

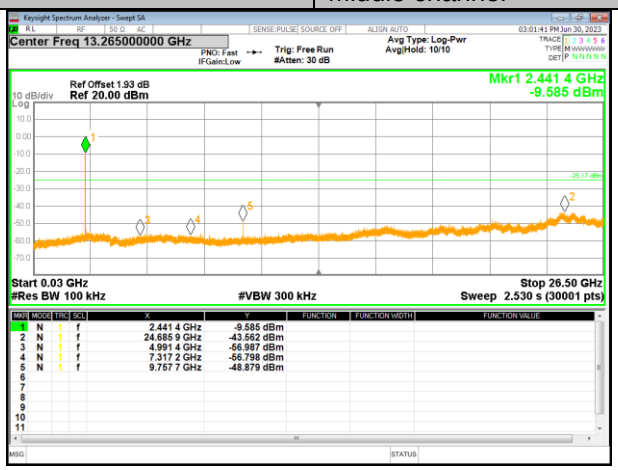
π/4-DQPSK mode:

Test channel:	Lowest channel



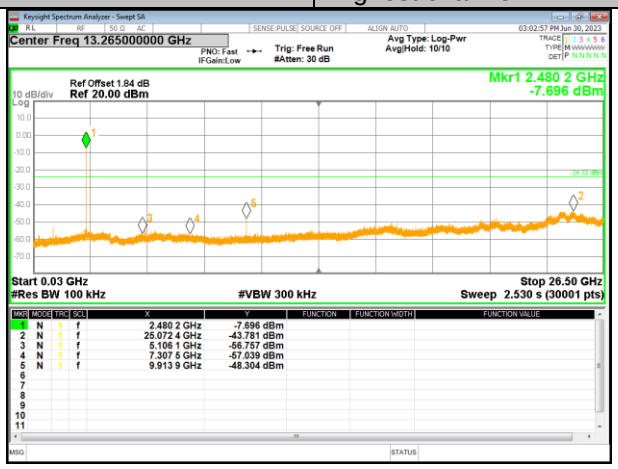
30MHz~25GHz

Test channel:	Middle channel



30MHz~25GHz

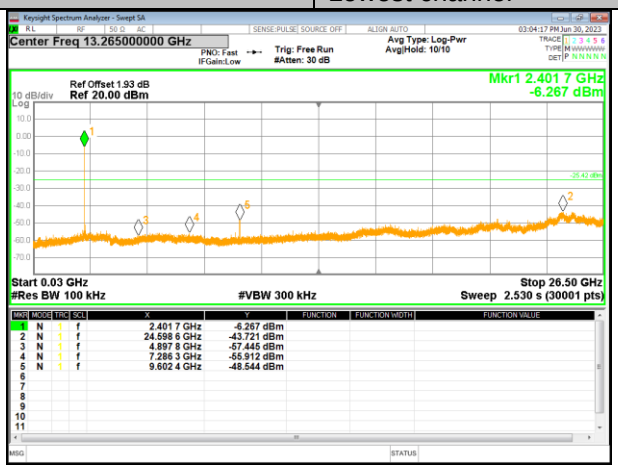
Test channel:	Highest channel



30MHz~25GHz

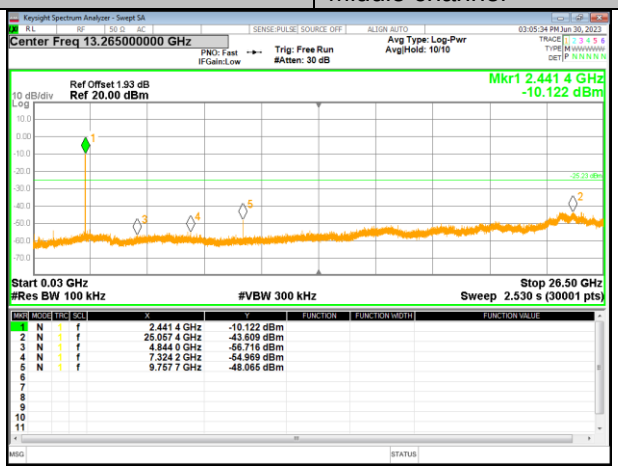
8-DPSK mode:

Test channel:	Lowest channel



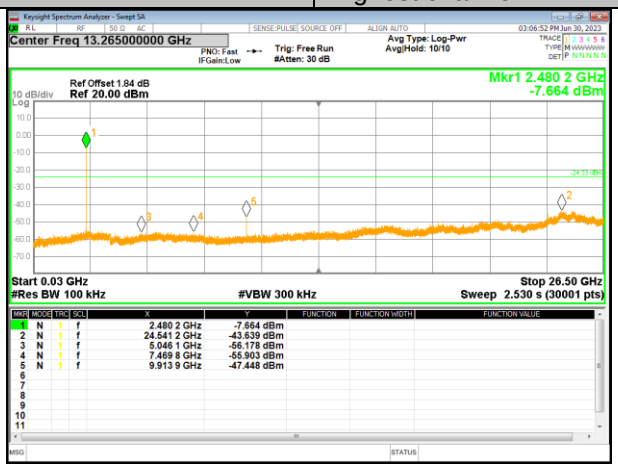
30MHz~25GHz

Test channel:	Middle channel



30MHz~25GHz

Test channel:	Highest channel



30MHz~25GHz

4.9.2 Radiated Emission Method

Test Requirement:	FCC Part15 C Section 15.209
Test Method:	ANSI C63.10:2013
Test Frequency Range:	9kHz to 25GHz
Test site:	Measurement Distance: 3m

Receiver setup:

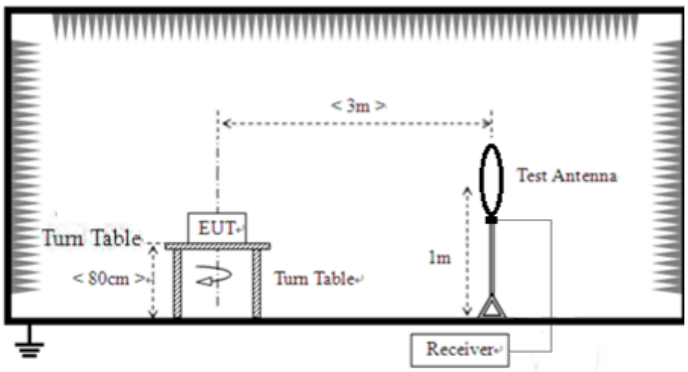
Frequency	Detector	RBW	VBW	Value
9KHz-150KHz	Quasi-peak	200Hz	600Hz	Quasi-peak
150KHz-30MHz	Quasi-peak	9KHz	30KHz	Quasi-peak
30MHz-1GHz	Quasi-peak	120KHz	300KHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

Limit:

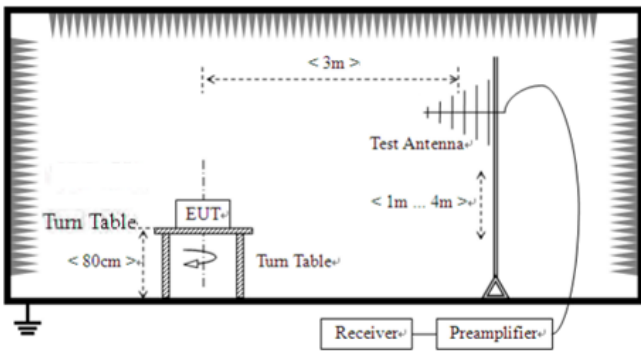
Frequency	Limit (uV/m)	Value	Measurement Distance
0.009MHz-0.490MHz	2400/F(KHz)	QP	300m
0.490MHz-1.705MHz	24000/F(KHz)	QP	30m
1.705MHz-30MHz	30	QP	30m
30MHz-88MHz	100	QP	3m
88MHz-216MHz	150	QP	
216MHz-960MHz	200	QP	
960MHz-1GHz	500	QP	
Above 1GHz	500	Average	
	5000	Peak	

Test setup:

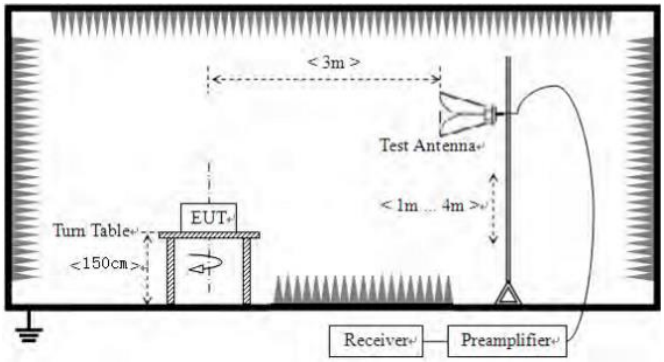
For radiated emissions from 9kHz to 30MHz



For radiated emissions from 30MHz to1GHz



For radiated emissions above 1GHz



Test Procedure:

1. The EUT was placed on the top of a rotating table (0.8m for below 1G and 1.5m for above 1G) above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rota table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Test Instruments:	Refer to section 3.0 for details					
Test mode:	Refer to section 2.2 for details					
Test environment:	Temp.:	23.8 °C	Humid.:	51%	Press.:	1012mbar
Test voltage:	DC 3.7V From battery					
Test results:	Pass					

Measurement data:

Remarks:

1. *During the test, pre-scan the GFSK, π/4-DQPSK, 8-DPSK modulation, and found the 8-DPSK modulation (two module operate simultaneously) which it is worse case.*
2. *Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the Y-axis which it is worse case.*

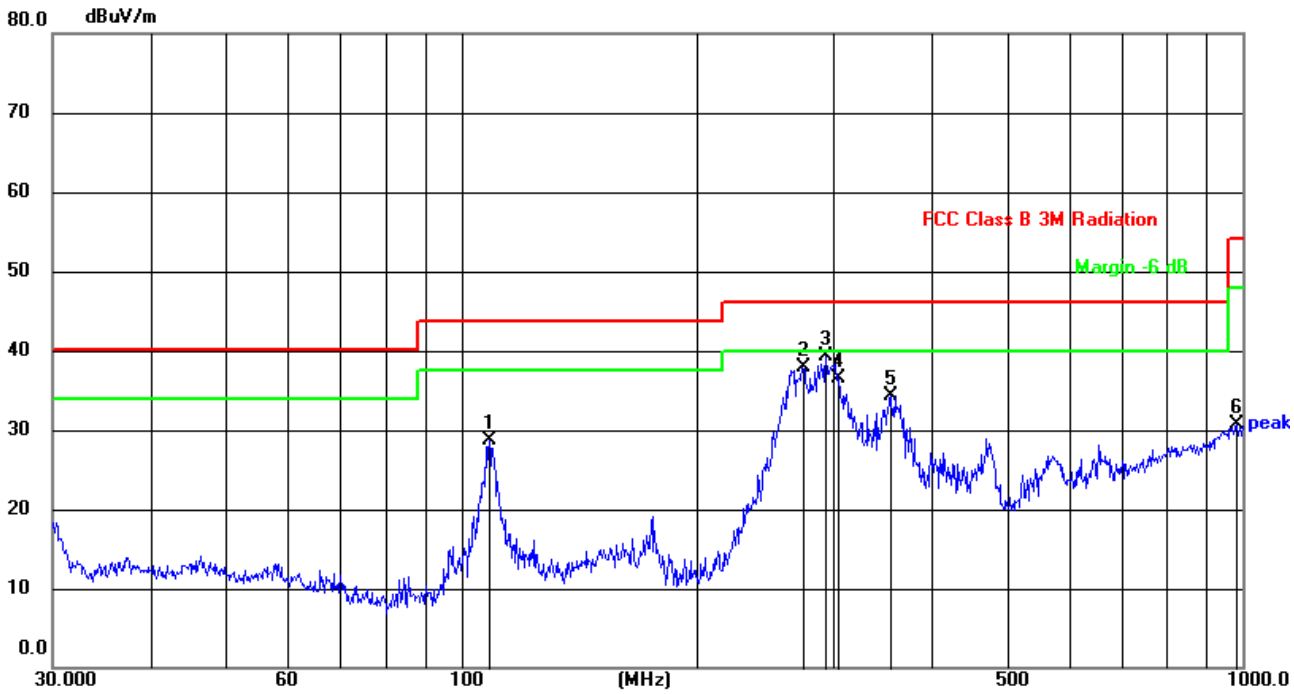
■ **9kHz~30MHz**

The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

■ **Below 1GHz**

Pre-scan all test modes, the report only shows the worst mode data, and the worst mode is two module operate simultaneously on 8-DPSK (2480MHz).

Vertical:

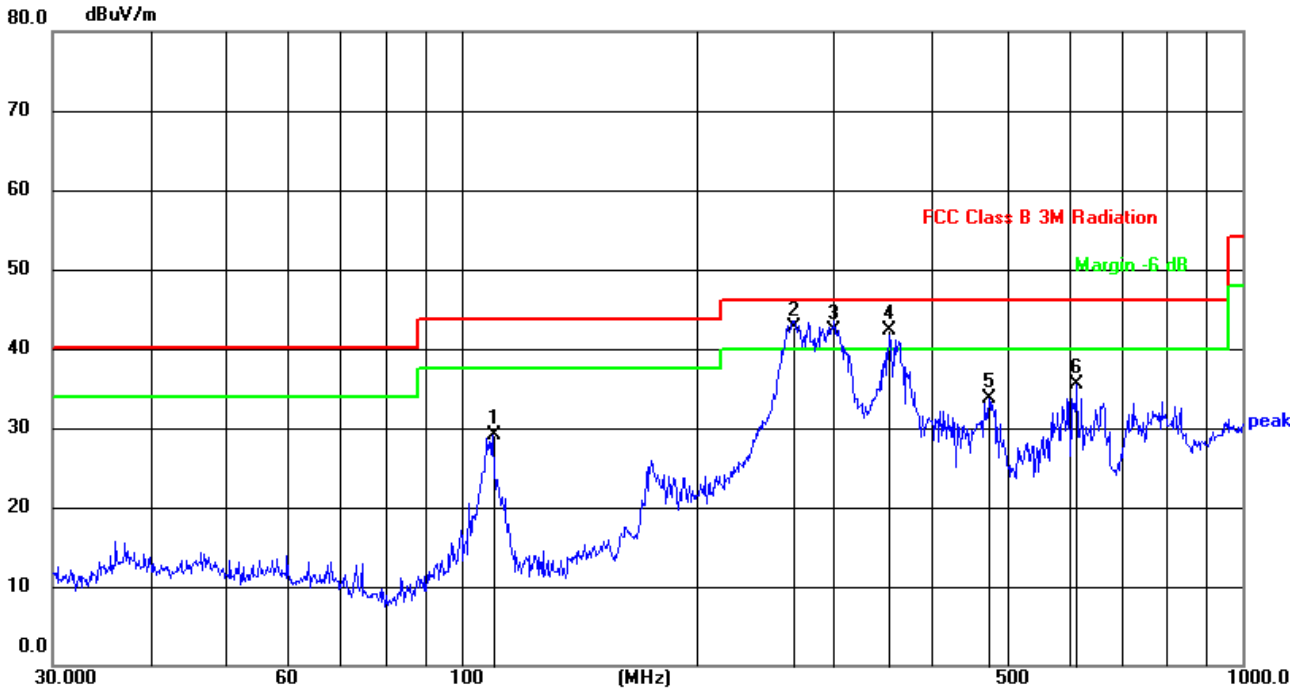


No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	108.6470	53.01	-24.25	28.76	43.50	-14.74	QP
2	273.2341	59.41	-21.60	37.81	46.00	-8.19	QP
3	293.0842	59.93	-20.63	39.30	46.00	-6.70	QP
4	304.6099	56.60	-20.07	36.53	46.00	-9.47	QP
5	354.1831	53.47	-19.22	34.25	46.00	-11.75	QP
6	982.6200	34.22	-3.51	30.71	54.00	-23.29	QP

Level = Reading + Factor, Margin=level-Limit

Factor= Antenna Factor + Cable Loss – Preamplifier Factor

Horizontal:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	109.7960	53.16	-24.12	29.04	43.50	-14.46	QP
2	266.6089	64.53	-21.83	42.70	46.00	-3.30	QP
3	300.3672	62.64	-20.24	42.40	46.00	-3.60	QP
4	352.9433	61.56	-19.27	42.29	46.00	-3.71	QP
5	473.8346	49.15	-15.53	33.62	46.00	-12.38	QP
6	614.2142	46.72	-11.15	35.57	46.00	-10.43	QP

Level = Reading + Factor, Margin=level-Limit
Factor= Antenna Factor + Cable Loss – Preamplifier Factor

■ **Above 1GHz**

Test channel:	Lowest

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4804.00	55.04	32.10	5.96	45.70	47.40	74.00	-26.60	Vertical
7206.00	51.07	36.10	6.86	45.50	48.53	74.00	-25.47	Vertical
9608.00	50.44	38.30	8.25	46.20	50.79	74.00	-23.21	Vertical
12010.00	*	--	--	--	--	74.00	--	Vertical
14412.00	*	--	--	--	--	74.00	--	Vertical
4804.00	57.66	32.10	5.96	45.70	50.02	74.00	-23.98	Horizontal
7206.00	52.67	36.10	6.86	45.50	50.13	74.00	-23.87	Horizontal
9608.00	52.10	38.30	8.25	46.20	52.45	74.00	-21.55	Horizontal
12010.00	*	--	--	--	--	74.00	--	Horizontal
14412.00	*	--	--	--	--	74.00	--	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4804.00	47.94	32.10	5.96	45.70	40.30	54.00	-13.70	Vertical
7206.00	42.12	36.10	6.86	45.50	39.58	54.00	-14.42	Vertical
9608.00	41.10	38.30	8.25	46.20	41.45	54.00	-12.55	Vertical
12010.00	*	--	--	--	--	54.00	--	Vertical
14412.00	*	--	--	--	--	54.00	--	Vertical
4804.00	48.53	32.10	5.96	45.70	40.89	54.00	-13.11	Horizontal
7206.00	42.23	36.10	6.86	45.50	39.69	54.00	-14.31	Horizontal
9608.00	40.49	38.30	8.25	46.20	40.84	54.00	-13.16	Horizontal
12010.00	*	--	--	--	--	54.00	--	Horizontal
14412.00	*	--	--	--	--	54.00	--	Horizontal

Test channel:	Middle

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4882.00	55.38	32.10	5.96	45.70	47.74	74.00	-26.26	Vertical
7323.00	50.44	36.80	6.86	45.50	48.60	74.00	-25.40	Vertical
9764.00	49.04	38.40	8.25	46.20	49.49	74.00	-24.51	Vertical
12205.00	*	--	--	--	--	74.00	--	Vertical
14646.00	*	--	--	--	--	74.00	--	Vertical
4882.00	56.52	32.10	5.96	45.70	48.88	74.00	-25.12	Horizontal
7323.00	52.72	36.80	6.86	45.50	50.88	74.00	-23.12	Horizontal
9764.00	49.99	38.40	8.25	46.20	50.44	74.00	-23.56	Horizontal
12205.00	*	--	--	--	--	74.00	--	Horizontal
14646.00	*	--	--	--	--	74.00	--	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4882.00	43.70	32.10	5.96	45.70	36.06	54.00	-17.94	Vertical
7323.00	42.22	36.80	6.86	45.50	40.38	54.00	-13.62	Vertical
9764.00	40.67	38.40	8.25	46.20	41.12	54.00	-12.88	Vertical
12205.00	*	--	--	--	--	54.00	--	Vertical
14646.00	*	--	--	--	--	54.00	--	Vertical
4882.00	44.12	32.10	5.96	45.70	36.48	54.00	-17.52	Horizontal
7323.00	41.00	36.80	6.86	45.50	39.16	54.00	-14.84	Horizontal
9764.00	40.18	38.40	8.25	46.20	40.63	54.00	-13.37	Horizontal
12205.00	*	--	--	--	--	54.00	--	Horizontal
14646.00	*	--	--	--	--	54.00	--	Horizontal

Test channel:	Highest

Peak value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4960.00	55.79	32.70	5.96	45.70	48.75	74.00	-25.25	Vertical
7440.00	49.20	36.40	6.86	45.50	46.96	74.00	-27.04	Vertical
9920.00	48.84	38.00	8.25	46.20	48.89	74.00	-25.11	Vertical
12400.00	*	--	--	--	--	74.00	--	Vertical
14880.00	*	--	--	--	--	74.00	--	Vertical
4960.00	55.80	32.70	5.96	45.70	48.76	74.00	-25.24	Horizontal
7440.00	51.61	36.40	6.86	45.50	49.37	74.00	-24.63	Horizontal
9920.00	50.82	38.00	8.25	46.20	50.87	74.00	-23.13	Horizontal
12400.00	*	--	--	--	--	74.00	--	Horizontal
14880.00	*	--	--	--	--	74.00	--	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4960.00	41.96	32.70	5.96	45.70	34.92	54.00	-19.08	Vertical
7440.00	38.09	36.40	6.86	45.50	35.85	54.00	-18.15	Vertical
9920.00	38.97	38.00	8.25	46.20	39.02	54.00	-14.98	Vertical
12400.00	*	--	--	--	--	54.00	--	Vertical
14880.00	*	--	--	--	--	54.00	--	Vertical
4960.00	43.10	32.70	5.96	45.70	36.06	54.00	-17.94	Horizontal
7440.00	38.13	36.40	6.86	45.50	35.89	54.00	-18.11	Horizontal
9920.00	38.29	38.00	8.25	46.20	38.34	54.00	-15.66	Horizontal
12400.00	*	--	--	--	--	54.00		Horizontal
14880.00	*	--	--	--	--	54.00		Horizontal

Remarks:

1. *Final Level =Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor*
2. *"*", means this data is the too weak instrument of signal is unable to test.*
3. *The emission levels of other frequencies are very lower than the limit and not show in test report.*

5 Test Setup Photo

Reference to the **appendix I** for details.

6 EUT Constructional Details

Reference to the **appendix II** for details.

------End------