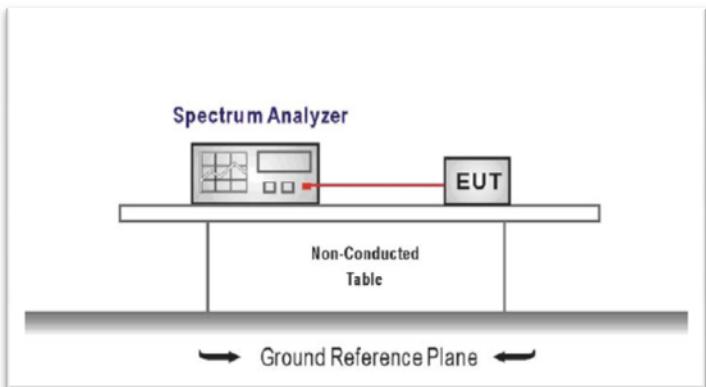


4.6. Hopping Channel Number

LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):
Frequency hopping systems in the 2400–2483.5 MHz band shall use at least **15** channels.

TEST CONFIGURATION



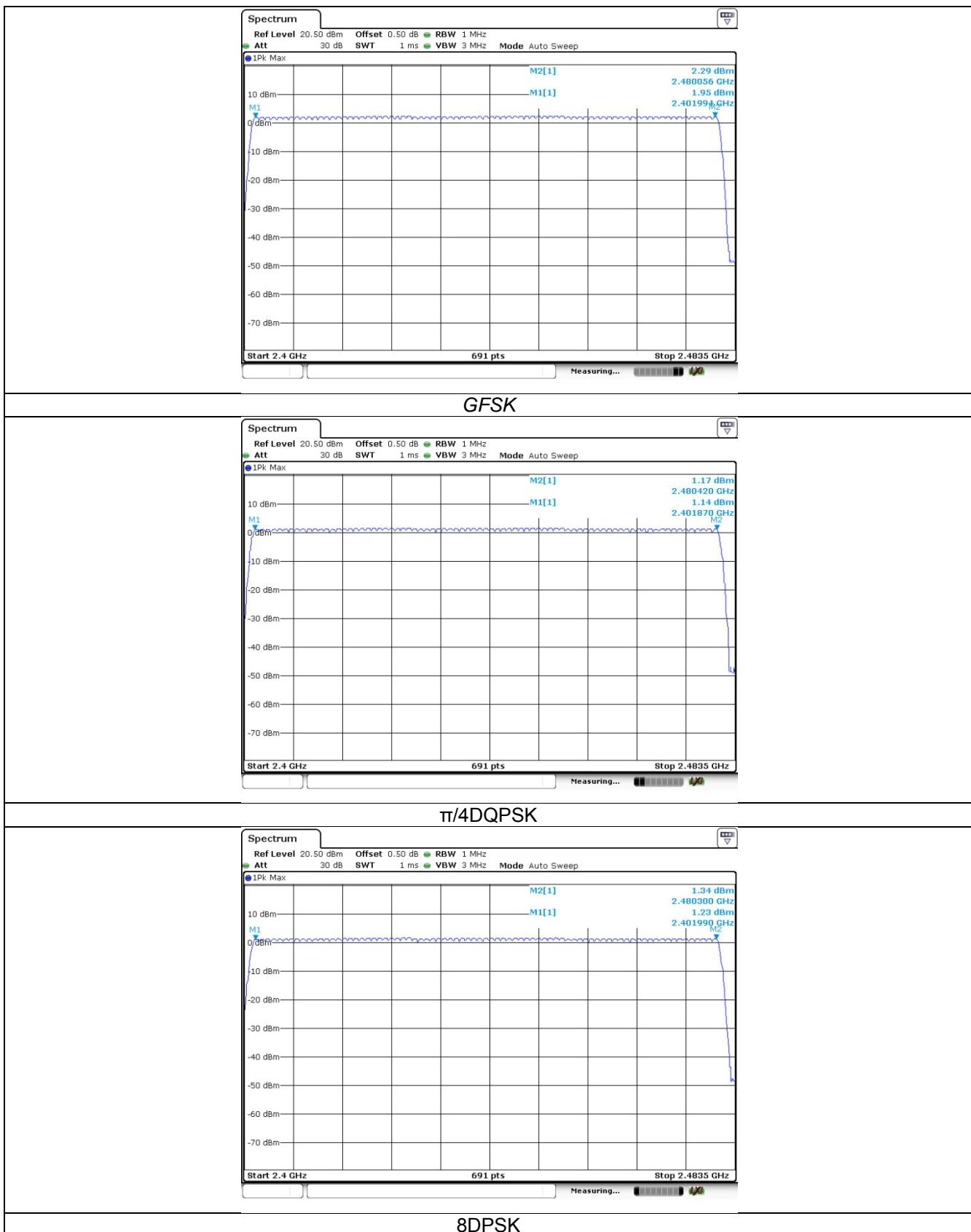
TEST PROCEDURE

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW=1MHz and VBW=3MHz.

TEST RESULTS

Modulation type	Channel number	Limit	Result
GFSK	79	15	Pass
$\pi/4$ DQPSK	79		
8DPSK	79		

Test plot as follows:



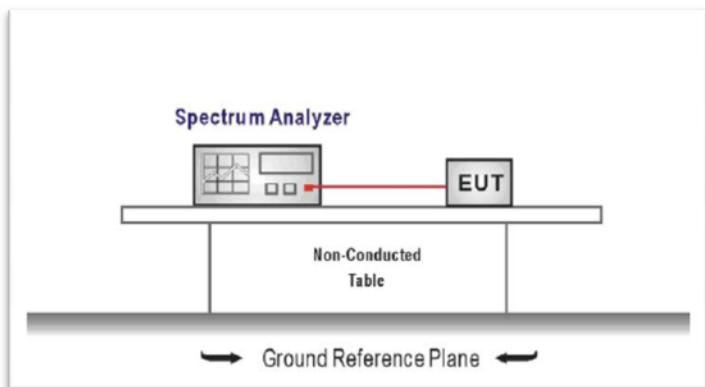
4.7. Dwell Time

LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):

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.

TEST CONFIGURATION



TEST PROCEDURE

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. Set center frequency of spectrum analyzer=operating frequency with RBW=1MHz and VBW=1MHz,Span=0Hz.

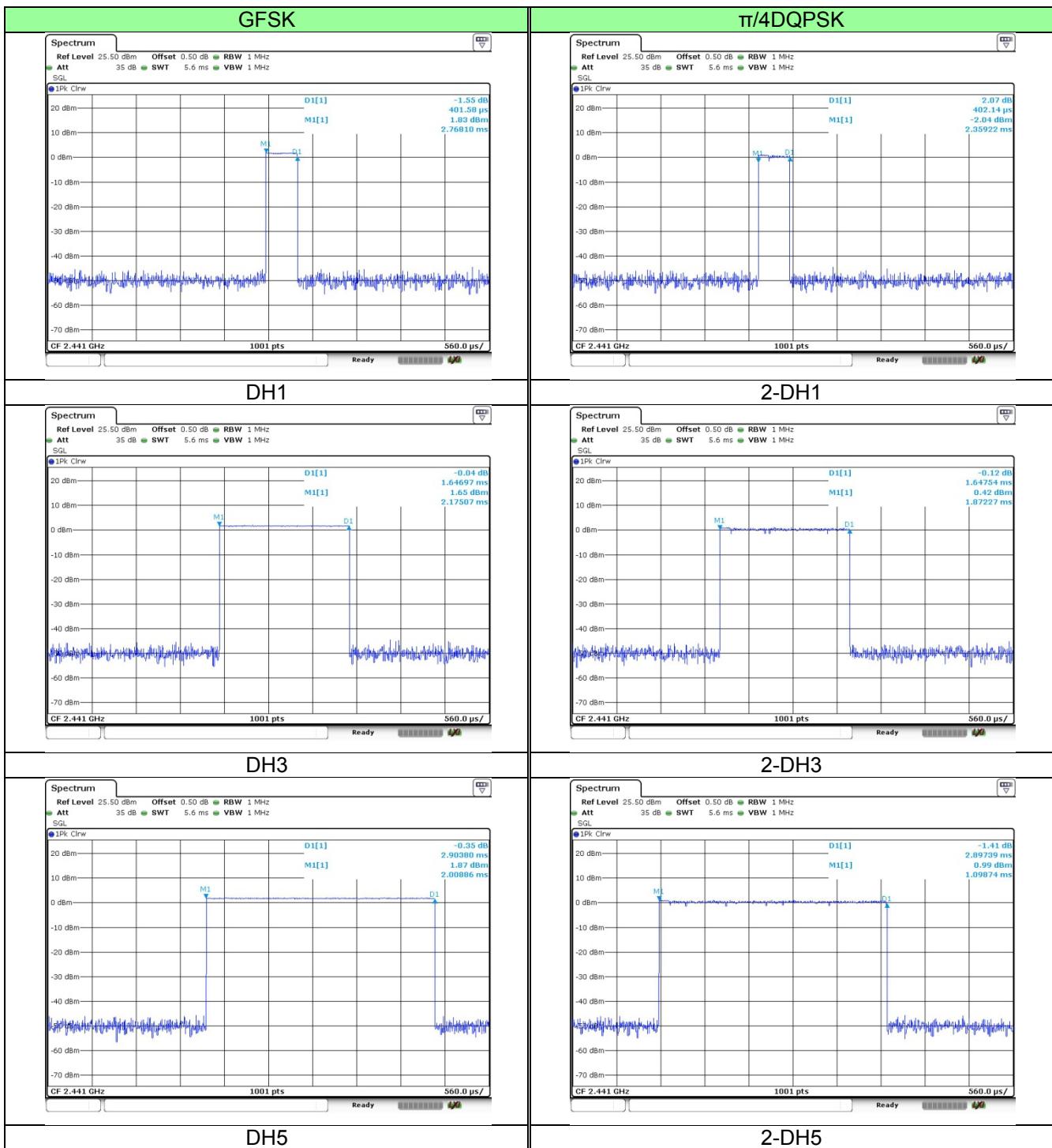
TEST RESULTS

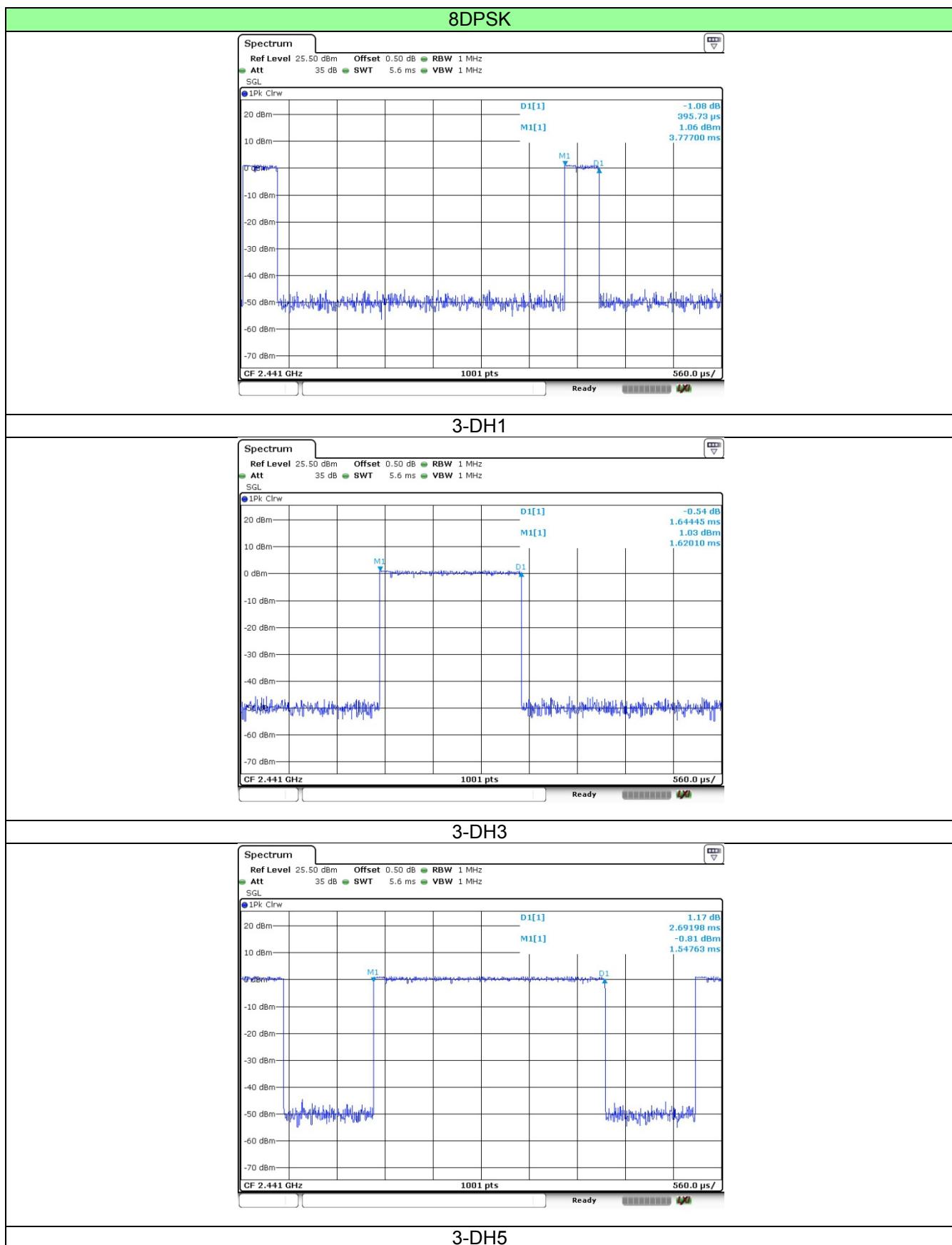
Modulation type	Channel	Dwell time (Second)	Limit (Second)	Result
GFSK	DH1	0.129	0.40	Pass
	DH3	0.264		
	DH5	0.310		
$\pi/4$ DQPSK	2-DH1	0.129	0.40	Pass
	2-DH3	0.264		
	2-DH5	0.309		
8DPSK	3-DH1	0.127	0.40	Pass
	3-DH3	0.263		
	3-DH5	0.287		

Note:

1. We have tested all mode at high,middle and low channel,and recorded worst case at middle channel.
2. Dwell time=Pulse time (ms) \times (1600 \div 2 \div 79) \times 31.6 Second for DH1, 2-DH1, 3-DH1
Dwell time=Pulse time (ms) \times (1600 \div 4 \div 79) \times 31.6 Second for DH3, 2-DH3, 3-DH3
Dwell time=Pulse time (ms) \times (1600 \div 6 \div 79) \times 31.6 Second for DH5, 2-DH5, 3-DH5

Test plot as follows:





4.8. Pseudorandom Frequency Hopping Sequence

LIMIT

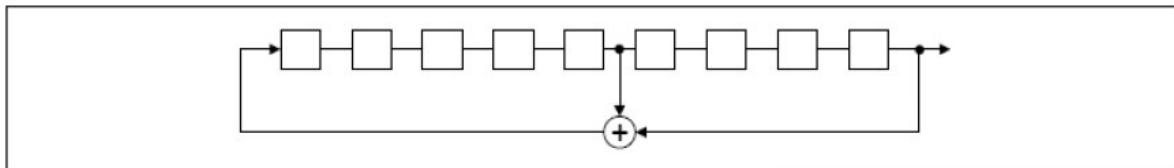
FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

TEST RESULTS

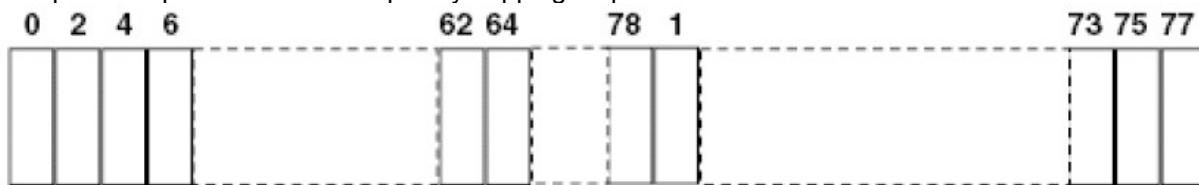
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: $2^9 - 1 = 511$ bits
- Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of pseudorandom frequency hopping sequence as follows:



Each frequency used equally one the average by each transmitter.

The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shift frequencies in synchronization with the transmitted signals.

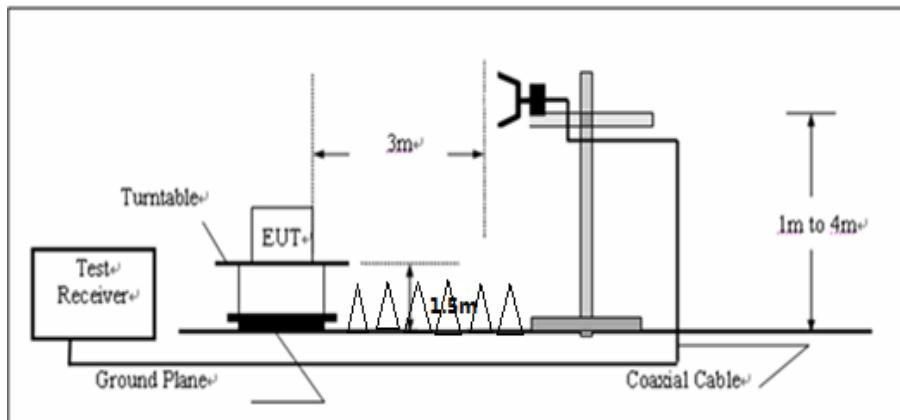
4.9. Restricted band (radiated)

LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.209

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

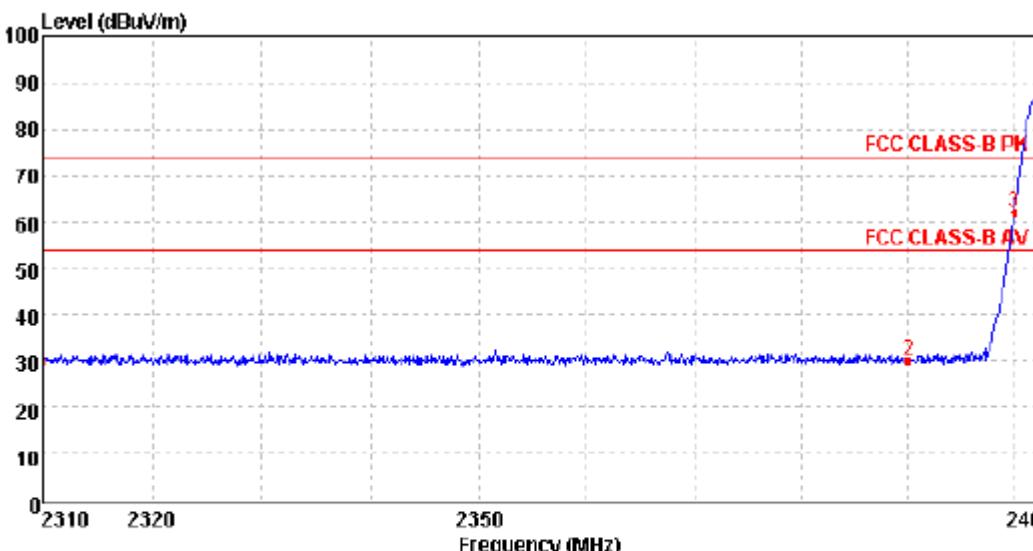
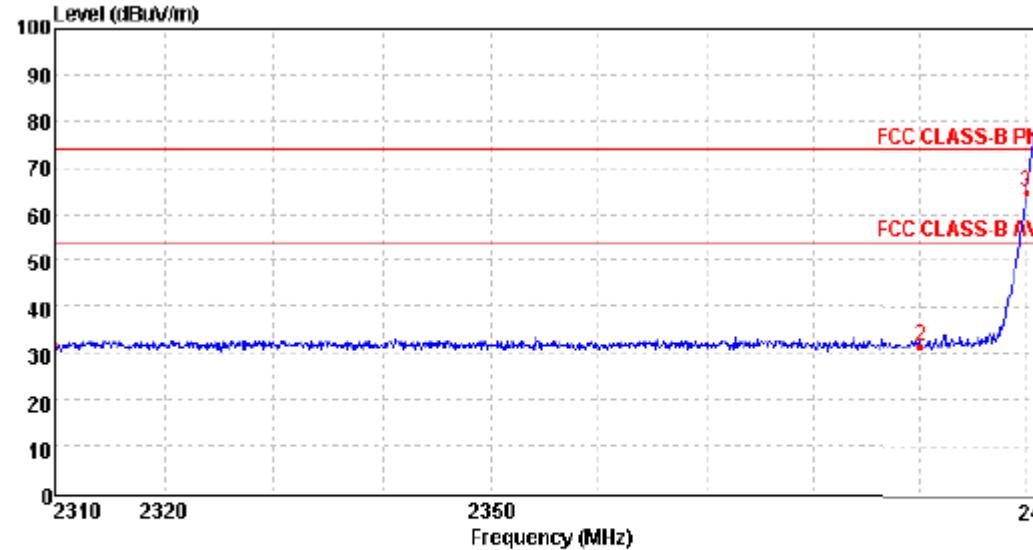
TEST CONFIGURATION



TEST PROCEDURE

1. The EUT was setup and tested according to ANSI C63.10:2013 for compliance to FCC 47CFR 15.247 requirements.
2. The EUT is placed on a turn table which is 1.5 meter above ground. The turn table is rotated 360 degrees to determine the position of the maximum emission level.
3. The EUT was positioned such that the distance from antenna to the EUT was 3 meters.
4. The antenna is scanned from 1 meter to 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10:2013 on radiated measurement.
5. The receiver set as follow:
RBW=1MHz, VBW=3MHz for Peak value
RBW=1MHz, VBW=10Hz for Average value.
6. The frequency range from 2310MHz to 2483.5MHz harmonic is checked.

TEST RESULTS

Test mode:		GFSK CH00		Polarization		Horizontal											
																	
<hr/>																	
Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark								
	MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit									
1	2310.00	33.52	27.27	6.68	37.51	29.96	74.00	-44.04	Peak								
2	2390.02	33.44	27.53	6.81	37.57	30.21	74.00	-43.79	Peak								
3	2400.03	65.32	27.57	6.83	37.58	62.14	74.00	-11.86	Peak								
																	
<hr/>																	
Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark								
	MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit									
1	2310.00	35.16	27.27	6.68	37.51	31.60	74.00	-42.40	Peak								
2	2390.02	34.98	27.53	6.81	37.57	31.67	74.00	-42.33	Peak								
3	2400.03	67.75	27.57	6.83	37.58	64.57	74.00	-9.43	Peak								

Test mode:	GFSK CH78	Polarization	Horizontal																																								
Level (dBuV/m)																																											
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Mark</th> <th>Frequency</th> <th>Reading</th> <th>Antenna</th> <th>Cable</th> <th>Preamp</th> <th>Level</th> <th>Limit</th> <th>Over</th> <th>Remark</th> </tr> <tr> <th></th> <th>MHz</th> <th>dBuV/m</th> <th>dB</th> <th>dB</th> <th>dB</th> <th>dBuV/m</th> <th>dBuV/m</th> <th>limit</th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>2483.51</td> <td>53.13</td> <td>27.85</td> <td>6.96</td> <td>37.65</td> <td>50.29</td> <td>74.00</td> <td>-23.71</td> <td>Peak</td> </tr> <tr> <td>2</td> <td>2500.00</td> <td>35.16</td> <td>27.90</td> <td>6.98</td> <td>37.66</td> <td>32.38</td> <td>74.00</td> <td>-41.62</td> <td>Peak</td> </tr> </tbody> </table>				Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark		MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit		1	2483.51	53.13	27.85	6.96	37.65	50.29	74.00	-23.71	Peak	2	2500.00	35.16	27.90	6.98	37.66	32.38	74.00	-41.62	Peak
Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark																																		
	MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit																																			
1	2483.51	53.13	27.85	6.96	37.65	50.29	74.00	-23.71	Peak																																		
2	2500.00	35.16	27.90	6.98	37.66	32.38	74.00	-41.62	Peak																																		
Level (dBuV/m)																																											
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Mark</th> <th>Frequency</th> <th>Reading</th> <th>Antenna</th> <th>Cable</th> <th>Preamp</th> <th>Level</th> <th>Limit</th> <th>Over</th> <th>Remark</th> </tr> <tr> <th></th> <th>MHz</th> <th>dBuV/m</th> <th>dB</th> <th>dB</th> <th>dB</th> <th>dBuV/m</th> <th>dBuV/m</th> <th>limit</th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>2483.51</td> <td>53.41</td> <td>27.85</td> <td>6.96</td> <td>37.65</td> <td>50.57</td> <td>74.00</td> <td>-23.43</td> <td>Peak</td> </tr> <tr> <td>2</td> <td>2500.00</td> <td>35.38</td> <td>27.90</td> <td>6.98</td> <td>37.66</td> <td>32.60</td> <td>74.00</td> <td>-41.40</td> <td>Peak</td> </tr> </tbody> </table>				Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark		MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit		1	2483.51	53.41	27.85	6.96	37.65	50.57	74.00	-23.43	Peak	2	2500.00	35.38	27.90	6.98	37.66	32.60	74.00	-41.40	Peak
Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark																																		
	MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit																																			
1	2483.51	53.41	27.85	6.96	37.65	50.57	74.00	-23.43	Peak																																		
2	2500.00	35.38	27.90	6.98	37.66	32.60	74.00	-41.40	Peak																																		

Note: 1. Level=Read+Antenna Factor+Cable Loss+Preamp Factor

2. The measurement result of peak value is smaller than the AVG Limit, so the AVG value is not show in the test report.

3. Have pre-scan all modulation mode, found the GFSK modulation which it was worst case, so only the worst case's data on the test report.

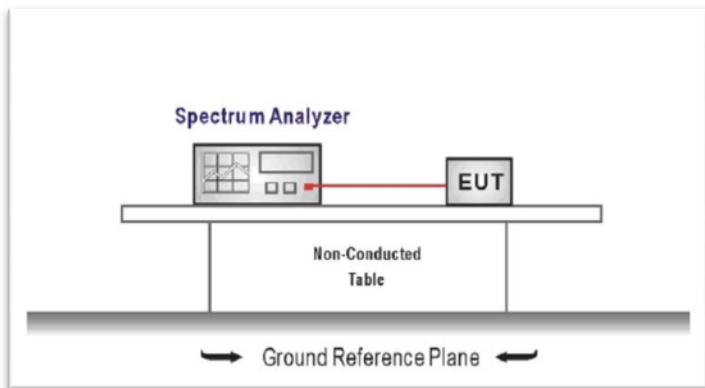
4.10. Bandedge and Spurious Emission (conducted)

LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (d):

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 CONFIGURATION

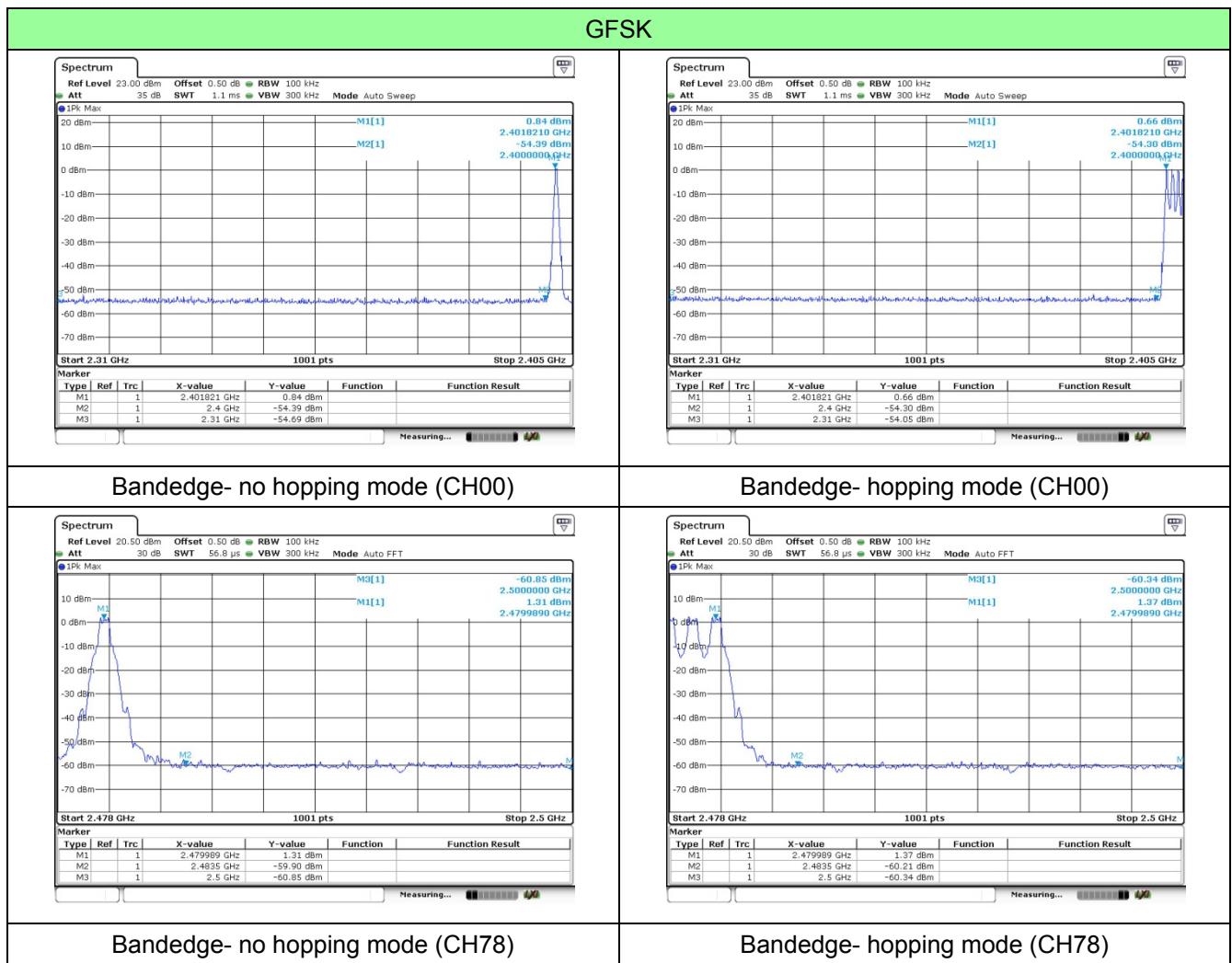


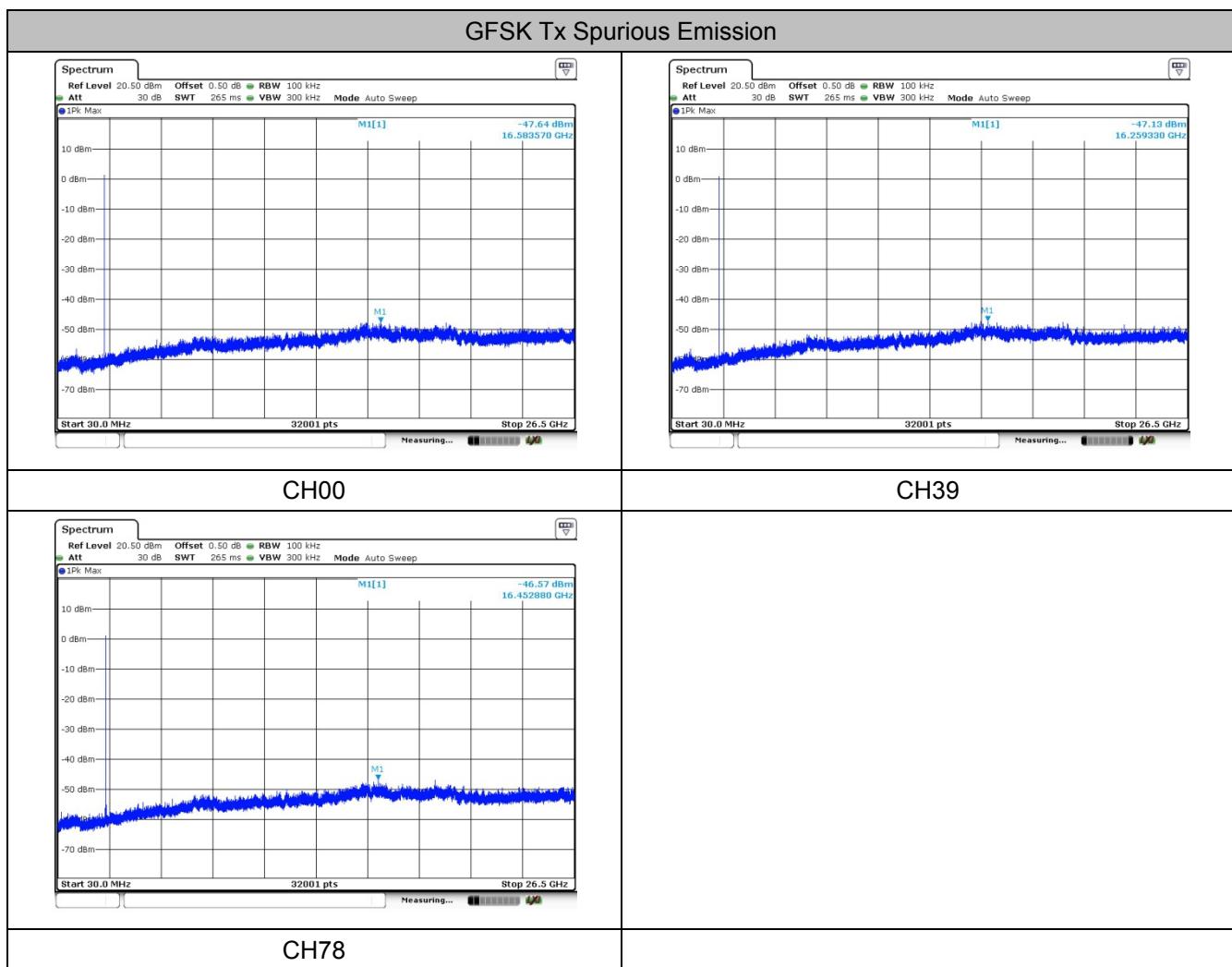
TEST PROCEDURE

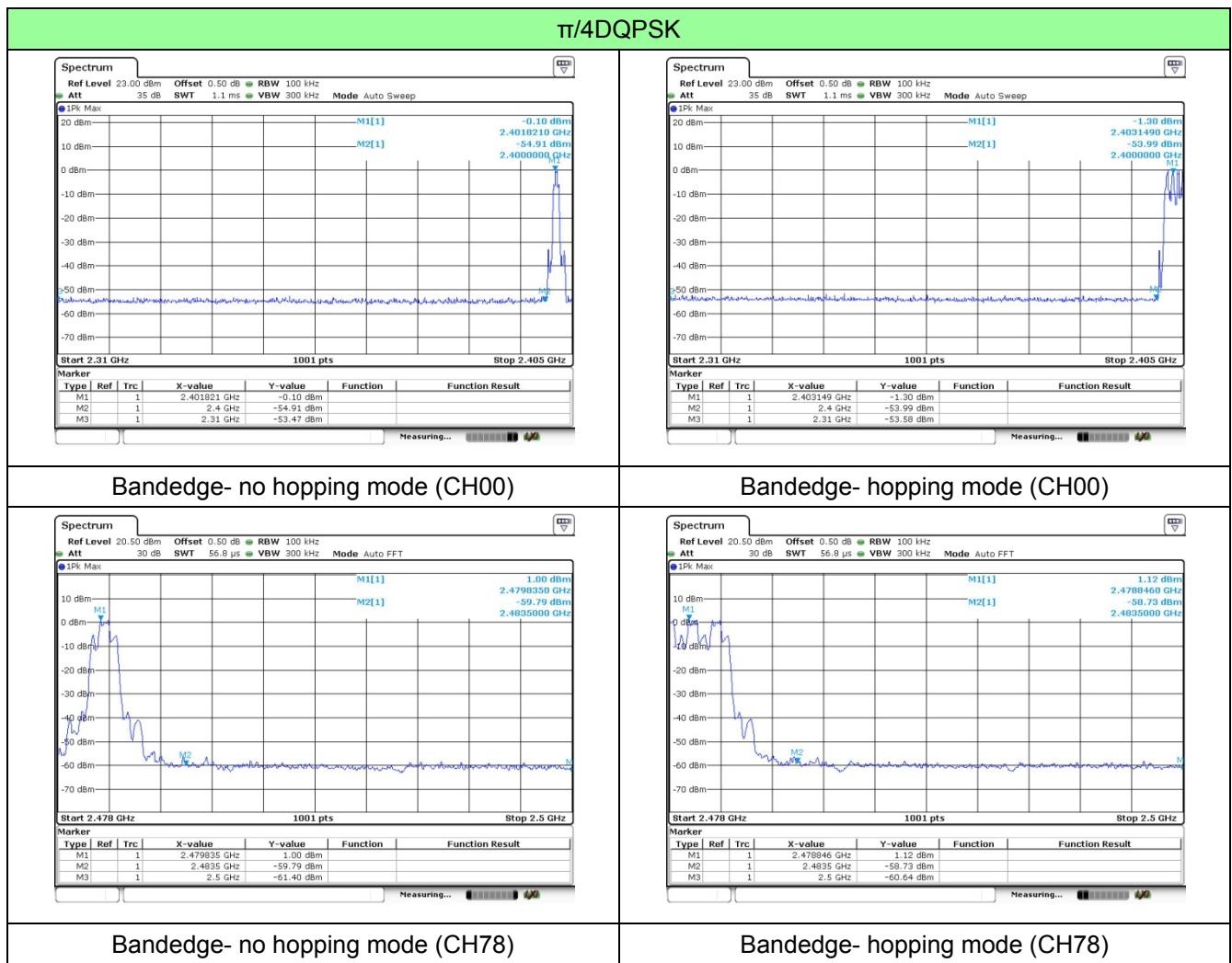
1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. Conducted spurious emission the bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW=100 KHz and VBW=300KHz.
3. Below -20dB of the highest emission level in operating band.

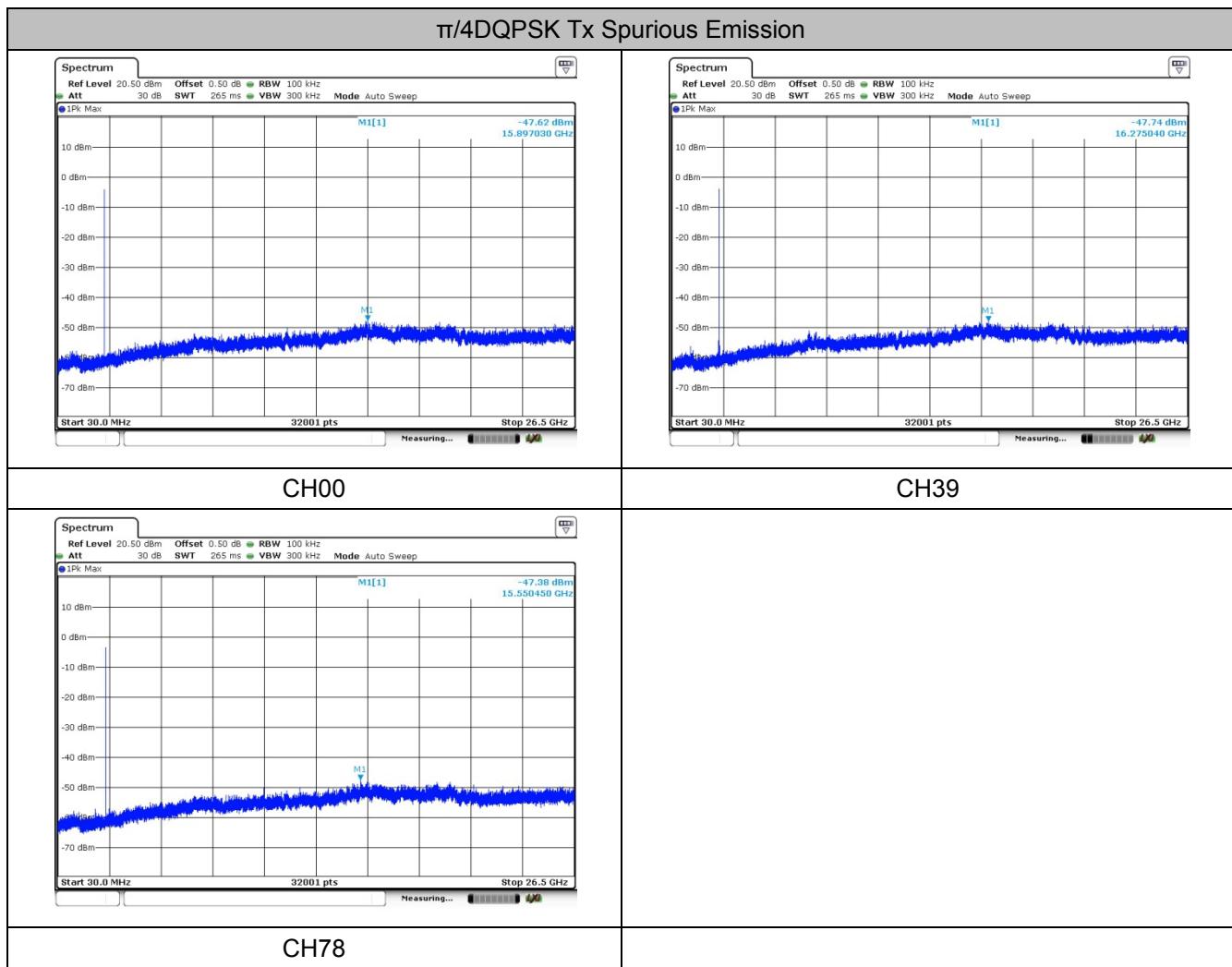
TEST RESULTS

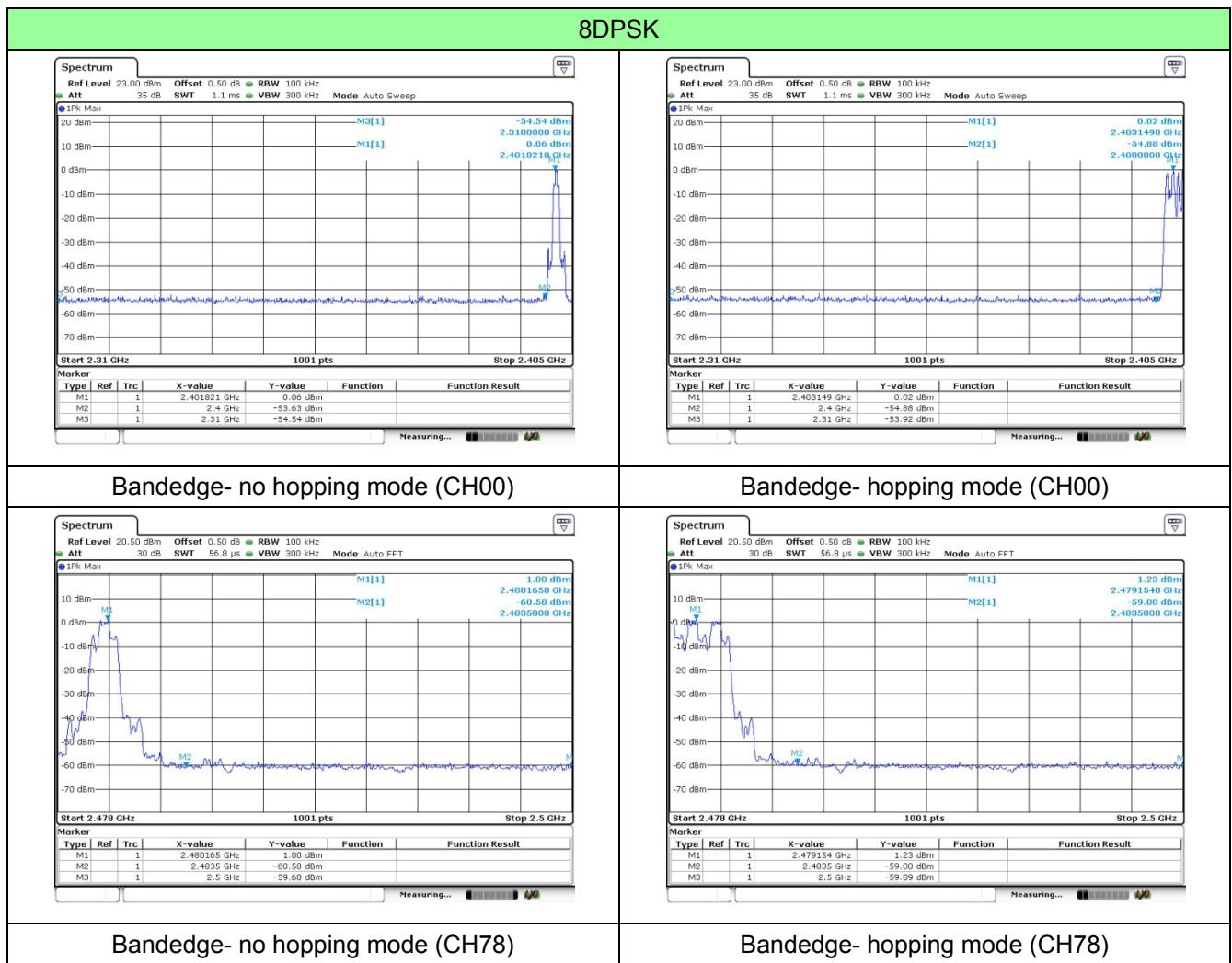
Test plot as follows:

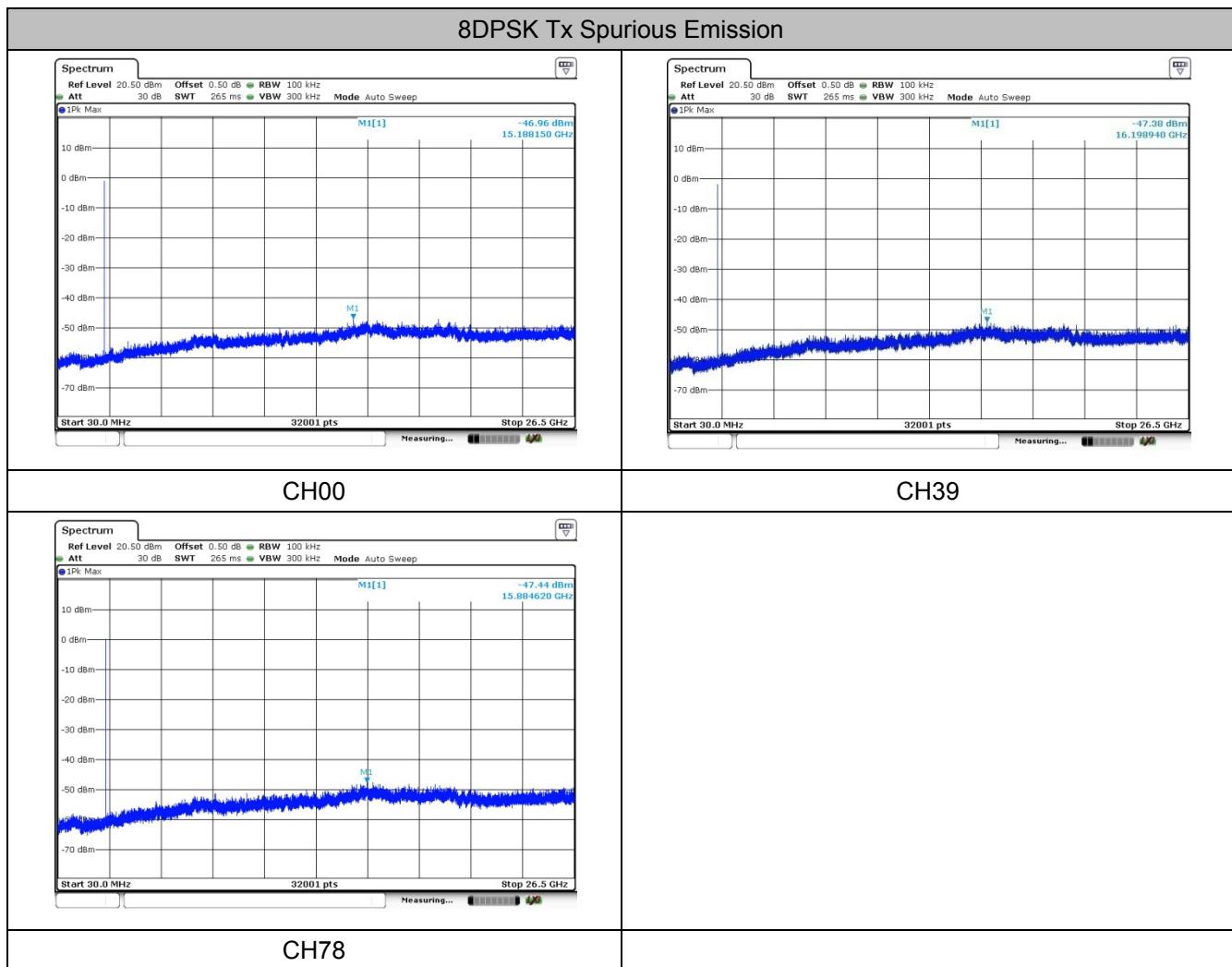












4.11. Spurious Emission (radiated)

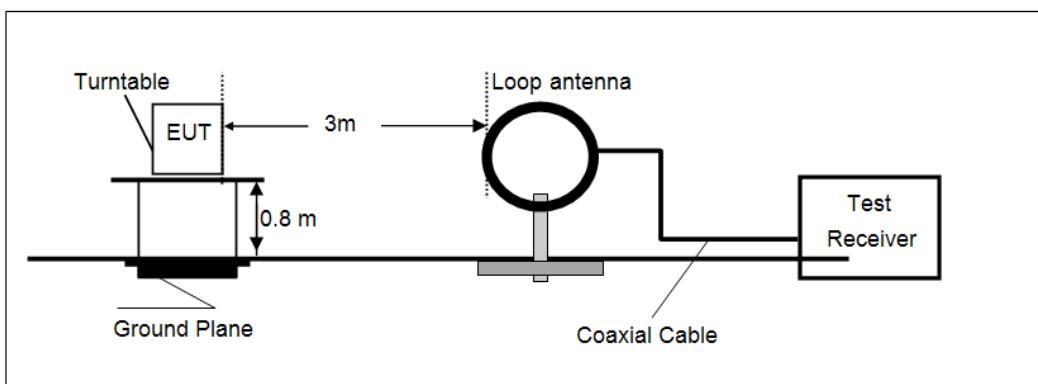
LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.209

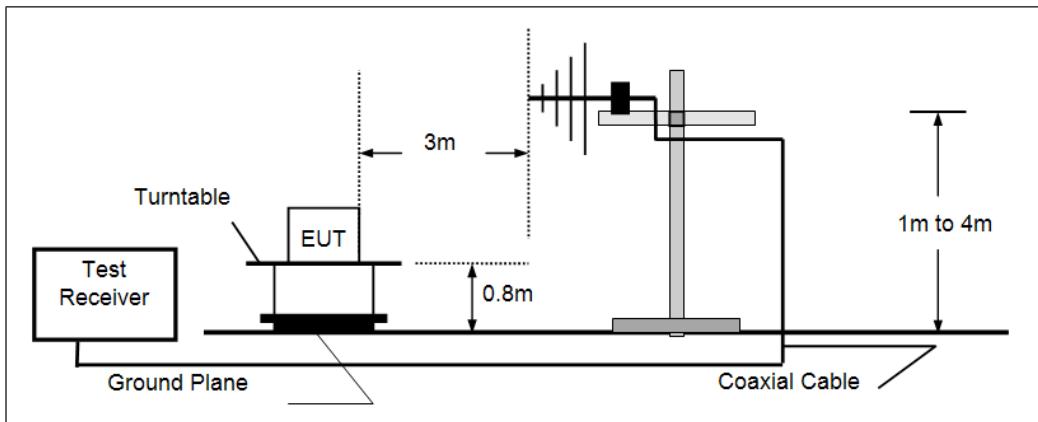
Frequency	Limit (dBuV/m @3m)	Value
30MHz-88MHz	40.00	Quasi-peak
88MHz-216MHz	43.50	Quasi-peak
216MHz-960MHz	46.00	Quasi-peak
960MHz-1GHz	54.00	Quasi-peak
Above 1GHz	54.00	Average
	74.00	Peak

TEST CONFIGURATION

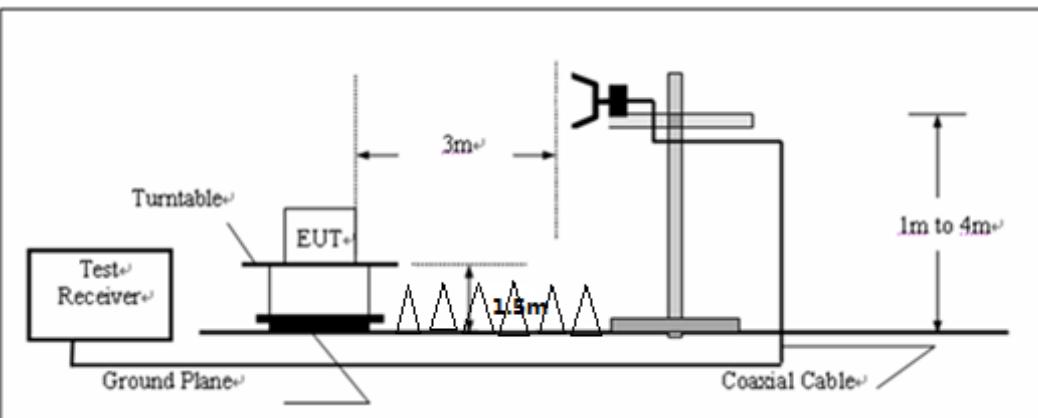
- ◆ Below 30MHz



- ◆ 30MHz~1000MHz



- ◆ Above 1GHz



TEST PROCEDURE

1. The EUT was placed on the top of a rotating table 0.8 meter above ground for below 1GHz, and 1.5m for above 1GHz 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 rotatable was turned from 0 degrees to 360 degrees to find the maximum reading.
5. Use the following spectrum analyzer settings
 - a) Span shall be wide enough to fully capture the emission being measured;
 - b) Below 1GHz, RBW=120KHz, VBW=300KHz, Sweep=auto, Detector function=peak, Trace=max hold;
If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
 - c) Above 1GHz, RBW=1MHz, VBW=3MHz for Peak value
RBW=1MHz, VBW=10Hz for Average value.

TEST RESULTS

Noted:

Below 1GHz

Have pre-scan all modulation mode, found the GFSK modulation CH39 which it was worst case, so only the worst case's data on the test report.

Above 1GHz

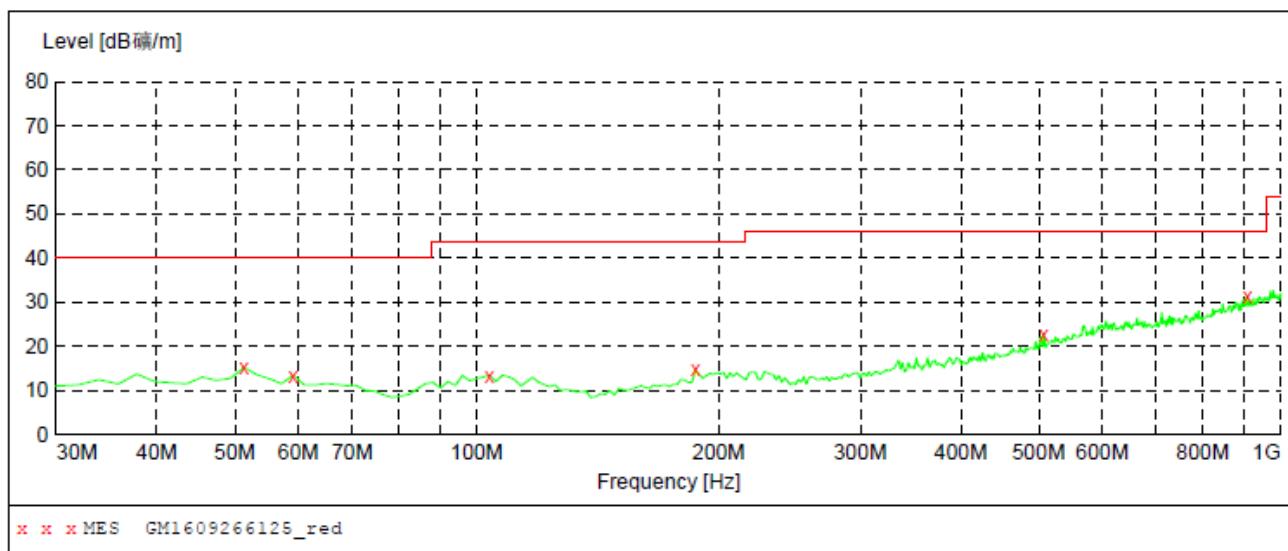
Have pre-scan all modulation mode, found the GFSK modulation which it was worst case, so only the worst case's data on the test report.

Measurement data:

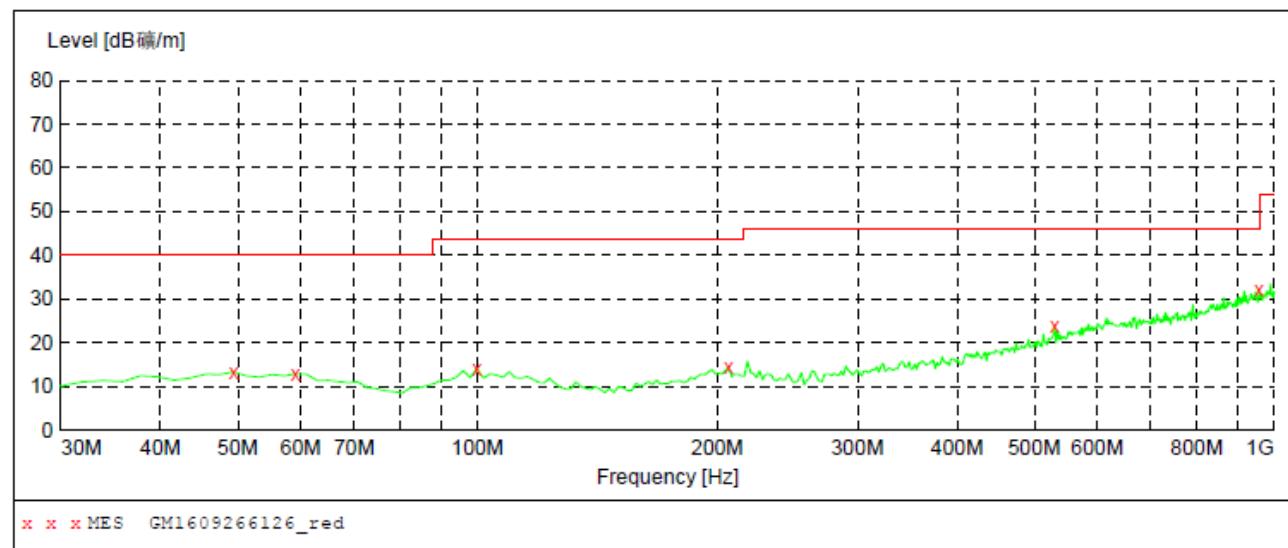
■ 9kHz ~ 30MHz

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

■ 30MHz ~ 1GHz



Frequency MHz	Level dB μ V/m	Transd dB	Limit dB μ V/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
51.340000	15.20	-14.4	40.0	24.8	QP	100.0	119.00	HORIZONTAL
59.100000	13.40	-14.8	40.0	26.6	QP	100.0	6.00	HORIZONTAL
103.720000	13.40	-14.6	43.5	30.1	QP	300.0	158.00	HORIZONTAL
187.140000	14.60	-15.0	43.5	28.9	QP	300.0	204.00	HORIZONTAL
507.240000	22.80	-6.9	46.0	23.2	QP	300.0	65.00	HORIZONTAL
908.820000	31.20	2.9	46.0	14.8	QP	300.0	354.00	HORIZONTAL



Frequency MHz	Level dB μ V/m	Transd dB	Limit dB μ V/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
49.400000	13.30	-14.4	40.0	26.7	QP	100.0	119.00	VERTICAL
59.100000	12.80	-14.8	40.0	27.2	QP	100.0	85.00	VERTICAL
99.840000	14.00	-14.3	43.5	29.5	QP	100.0	257.00	VERTICAL
206.540000	14.30	-13.9	43.5	29.2	QP	100.0	257.00	VERTICAL
530.520000	23.80	-5.8	46.0	22.2	QP	100.0	211.00	VERTICAL
957.320000	32.00	3.8	46.0	14.0	QP	100.0	211.00	VERTICAL

Remark: Transd=Cable loss+Antenna factor-Pre-amplifier; Margin=Limit-Level

■ Above 1GHz

Test mode:	GFSK CH00			Polarization	Horizontal				
Level (dBuV/m)									
100	90	80	70	60	50	40	30		
1000	1500	2000	5000	10000	25000	FCC CLASS-B PK			
Frequency (MHz)	1274.80	1916.18	3598.20	4804.11	8440.95	9585.68	FCC CLASS-B AV		
Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark
	MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit	
1	1274.80	37.80	24.50	4.70	36.60	30.40	74.00	-43.60	Peak
2	1916.18	36.24	25.89	6.01	37.19	30.95	74.00	-43.05	Peak
3	3598.20	36.26	28.87	8.76	37.99	35.90	74.00	-38.10	Peak
4	4804.11	46.37	31.09	9.21	38.53	48.14	74.00	-25.86	Peak
5	8440.95	32.12	37.15	11.25	38.11	42.41	74.00	-31.59	Peak
6	9585.68	32.77	38.15	12.08	38.06	44.94	74.00	-29.06	Peak
Test mode:	GFSK CH00			Polarization	Vertical				
Level (dBuV/m)									
100	90	80	70	60	50	40	30		
1000	1500	2000	5000	10000	25000	FCC CLASS-B PK			
Frequency (MHz)	1431.05	1772.33	4039.21	4804.11	7875.25	9312.59	FCC CLASS-B AV		
Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark
	MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit	
1	1431.05	37.42	24.64	5.04	36.77	30.33	74.00	-43.67	Peak
2	1772.33	36.95	25.51	5.75	37.08	31.13	74.00	-42.87	Peak
3	4039.21	36.16	29.60	8.64	38.02	36.38	74.00	-37.62	Peak
4	4804.11	41.91	31.09	9.21	38.53	43.68	74.00	-30.32	Peak
5	7875.25	32.87	36.59	11.17	38.23	42.40	74.00	-31.60	Peak
6	9312.59	33.42	38.03	11.88	38.01	45.32	74.00	-28.68	Peak

Test mode:		GFSK CH39			Polarization			Horizontal		
<p>Level (dBuV/m)</p> <p>FCC CLASS-B PK</p> <p>FCC CLASS-B AV</p> <p>Frequency (MHz)</p>										
Mark	Frequency MHz	Reading dBuV/m	Antenna dB	Cable dB	Preamp dB	Level dBuV/m	Limit dBuV/m	Over limit	Remark	
1	1155.48	38.08	24.38	4.42	36.46	30.42	74.00	-43.58	Peak	
2	1629.83	37.87	25.11	5.46	36.95	31.49	74.00	-42.51	Peak	
3	3376.52	36.92	28.65	8.66	37.99	36.24	74.00	-37.76	Peak	
4	4888.15	41.81	31.14	9.26	38.58	43.63	74.00	-30.37	Peak	
5	7326.27	32.41	36.07	10.90	38.13	41.25	74.00	-32.75	Peak	
6	9475.50	32.99	38.09	11.99	38.04	45.03	74.00	-28.97	Peak	
Test mode:		GFSK CH39			Polarization			Vertical		
<p>Level (dBuV/m)</p> <p>FCC CLASS-B PK</p> <p>FCC CLASS-B AV</p> <p>Frequency (MHz)</p>										
Mark	Frequency MHz	Reading dBuV/m	Antenna dB	Cable dB	Preamp dB	Level dBuV/m	Limit dBuV/m	Over limit	Remark	
1	1050.36	38.00	24.26	4.14	36.32	30.08	74.00	-43.92	Peak	
2	1672.78	36.41	25.23	5.55	36.99	30.20	74.00	-43.80	Peak	
3	3834.44	35.43	29.24	8.67	37.99	35.35	74.00	-38.65	Peak	
4	4888.15	40.50	31.14	9.26	38.58	42.32	74.00	-31.68	Peak	
5	8514.46	32.23	37.24	11.25	38.09	42.63	74.00	-31.37	Peak	
6	9697.15	32.72	38.22	12.20	38.08	45.06	74.00	-28.94	Peak	

Test mode:		GFSK CH78		Polarization		Horizontal			
Level (dBuV/m)									
100	90	80	70	60	50	40	30		
FCC CLASS-B PK									
1000	1500	2000	5000	10000	25000				
Frequency (MHz)									
Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark
	MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit	
1	1185.94	38.12	24.41	4.50	36.50	30.53	74.00	-43.47	Peak
2	1677.62	37.22	25.25	5.56	37.00	31.03	74.00	-42.97	Peak
3	2279.84	36.12	27.15	6.64	37.49	32.42	74.00	-41.58	Peak
4	4456.32	34.74	30.80	8.95	38.31	36.18	74.00	-37.82	Peak
5	4959.31	45.87	31.18	9.31	38.62	47.74	74.00	-26.26	Peak
6	9099.72	32.84	37.94	11.75	37.97	44.56	74.00	-29.44	Peak
Test mode:		GFSK CH78		Polarization		Vertical			
Level (dBuV/m)									
100	90	80	70	60	50	40	30		
FCC CLASS-B PK									
1000	1500	2000	5000	10000	25000				
Frequency (MHz)									
Mark	Frequency	Reading	Antenna	Cable	Preamp	Level	Limit	Over	Remark
	MHz	dBuV/m	dB	dB	dB	dBuV/m	dBuV/m	limit	
1	1331.29	37.33	24.55	4.83	36.66	30.05	74.00	-43.95	Peak
2	1944.07	36.83	25.96	6.06	37.21	31.64	74.00	-42.36	Peak
3	3714.44	37.15	29.06	8.71	37.99	36.93	74.00	-37.07	Peak
4	4959.31	42.79	31.18	9.31	38.62	44.66	74.00	-29.34	Peak
5	7097.00	32.24	35.88	10.81	38.08	40.85	74.00	-33.15	Peak
6	9448.15	32.46	38.08	11.97	38.04	44.47	74.00	-29.53	Peak

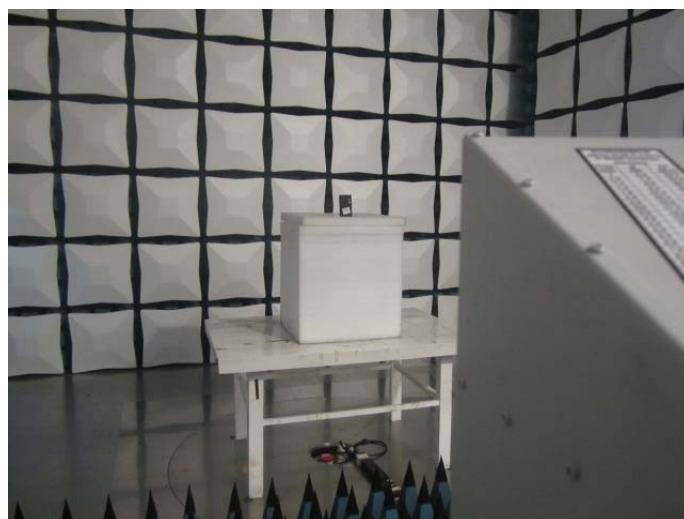
Remark:

- Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor

2. The measurement result of peak value is smaller than the AVG Limit, so the AVG value is not show in the test report.
3. The emission levels of other frequencies are very lower than the limit and not show in test report.

5. Test Setup Photos of the EUT

Radiated Emission



Conducted Emission (PC Charge)



6. External and Internal Photos of the EUT

Reference to Test Report No.: TRE1611003501.

.....End of Report.....