

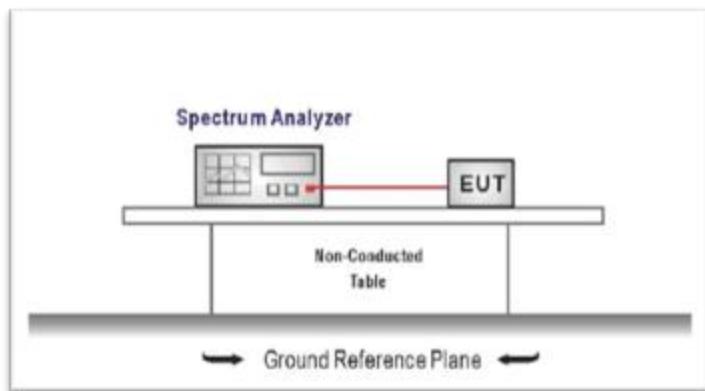
5.6. Hopping Channel Number

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, the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:
Span = the frequency band of operation
 $RBW \geq 1\%$ of the span, $VBW \geq RBW$
Sweep = auto, Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

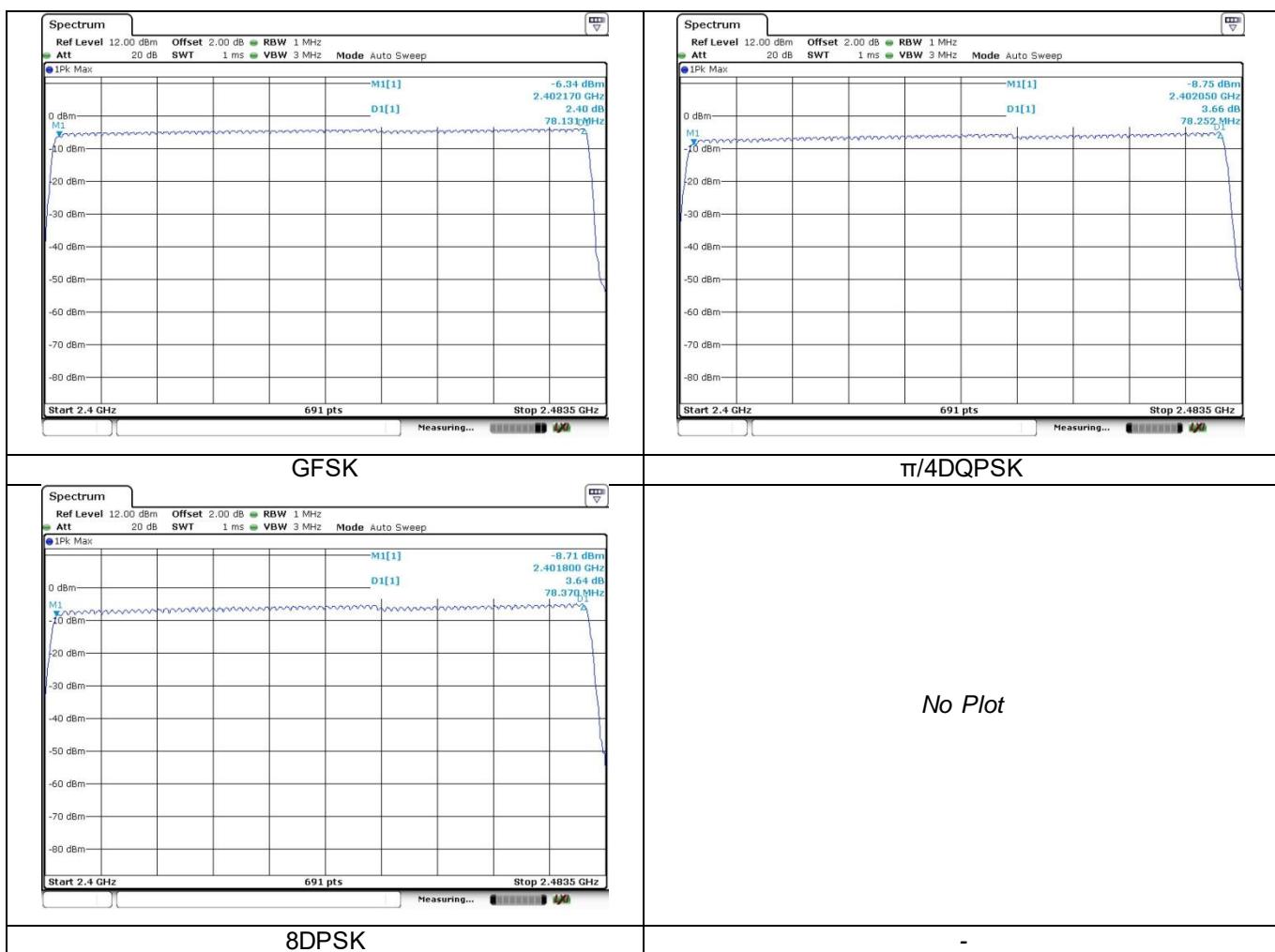
TEST MODE:

Please refer to the clause 3.3

TEST RESULTS

Passed Not Applicable

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



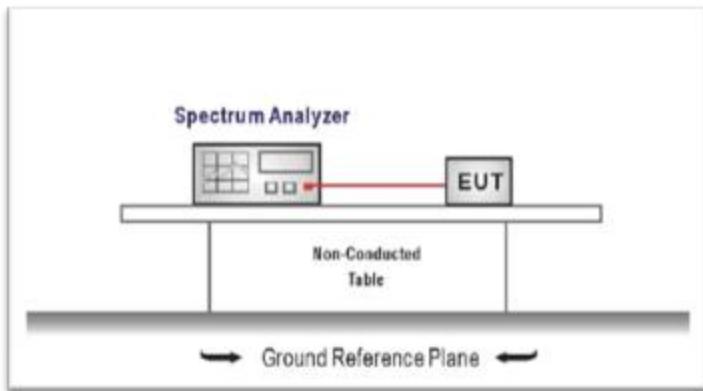
5.7. Dwell Time

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, the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:
Span = zero span, centered on a hopping channel, RBW= 1 MHz, VBW \geq RBW
Sweep = as necessary to capture the entire dwell time per hopping channel,
Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

TEST MODE:

Please refer to the clause 3.3

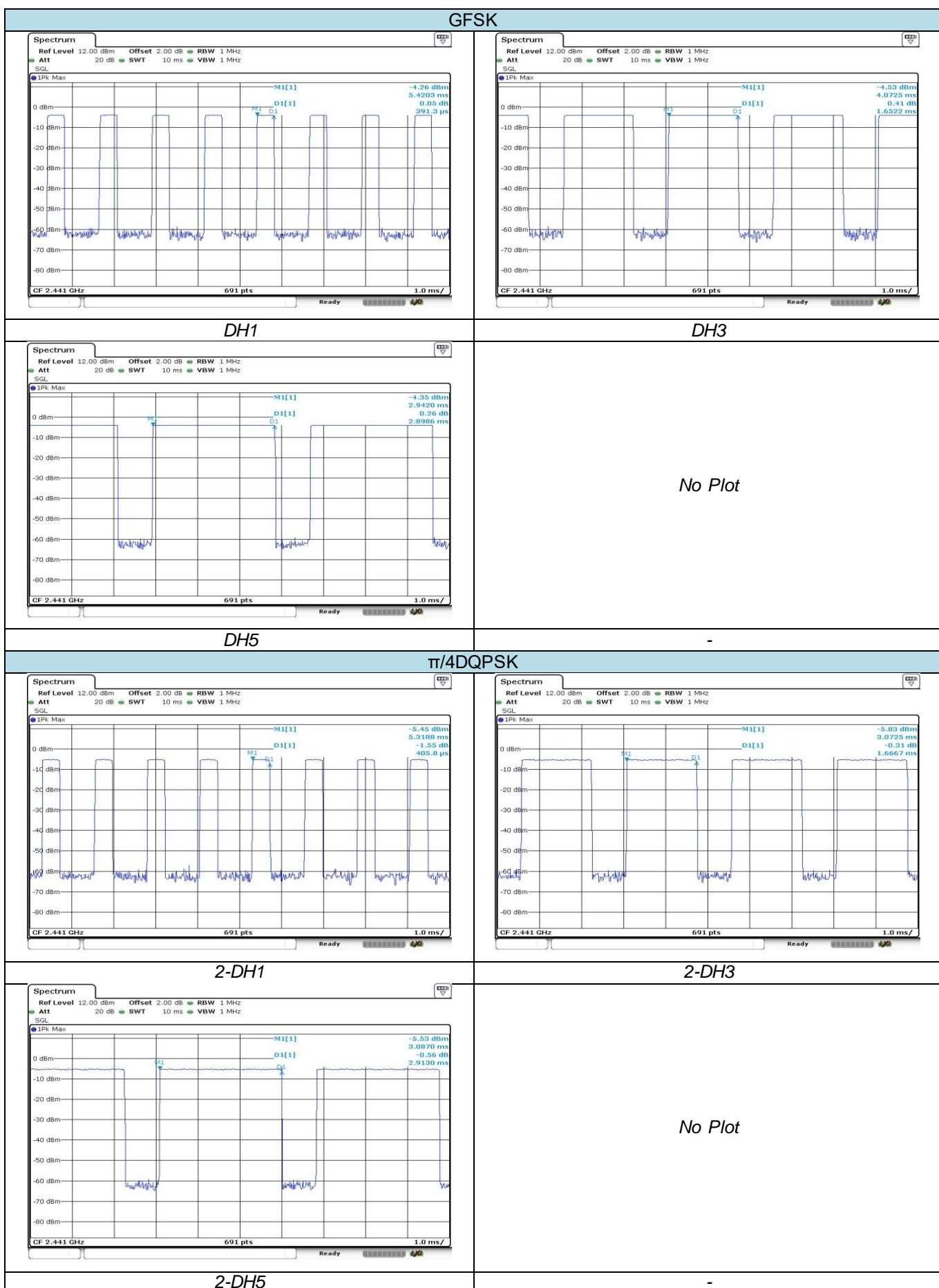
TEST RESULTS

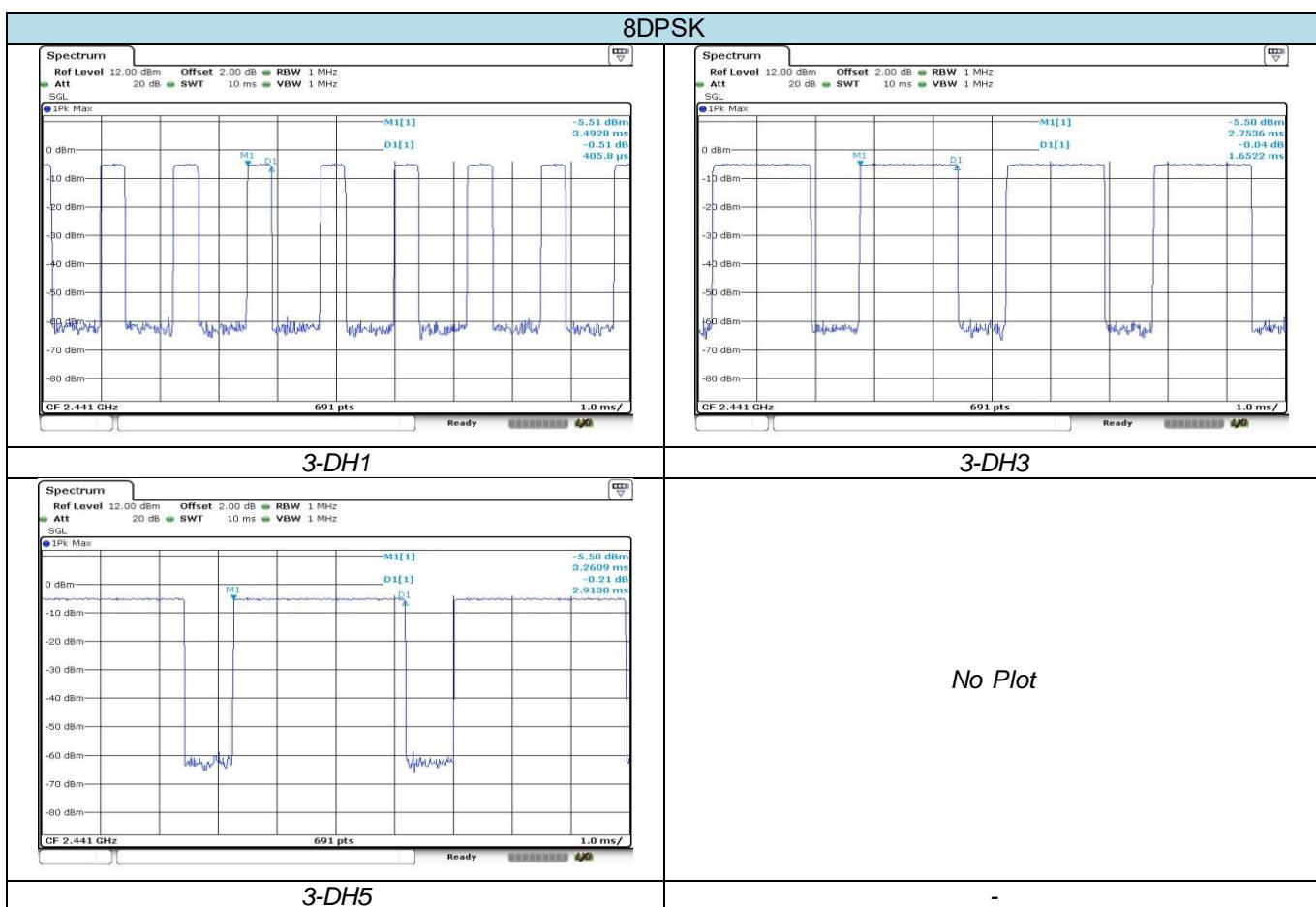
Passed Not Applicable

Modulation type	Channel	Dwell time (Second)	Limit (Second)	Result
GFSK	DH1	0.125	0.40	Pass
	DH3	0.264		
	DH5	0.309		
$\pi/4$ DQPSK	2-DH1	0.130	0.40	Pass
	2-DH3	0.267		
	2-DH5	0.311		
8DPSK	3-DH1	0.130	0.40	Pass
	3-DH3	0.264		
	3-DH5	0.311		

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





5.8. Pseudorandom Frequency Hopping Sequence

LIMIT

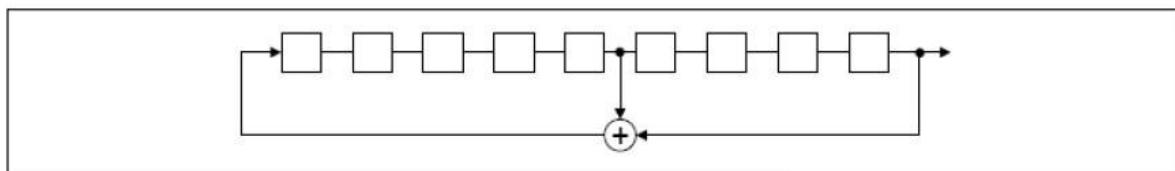
FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):

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

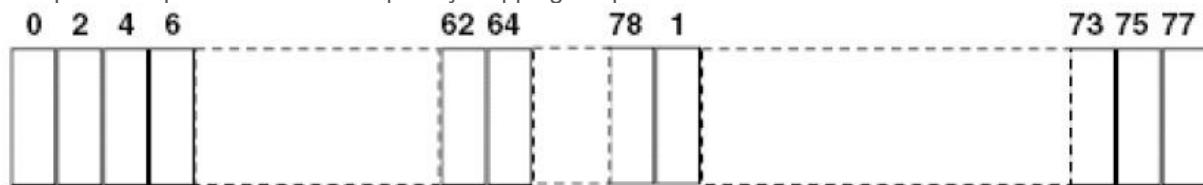
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: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

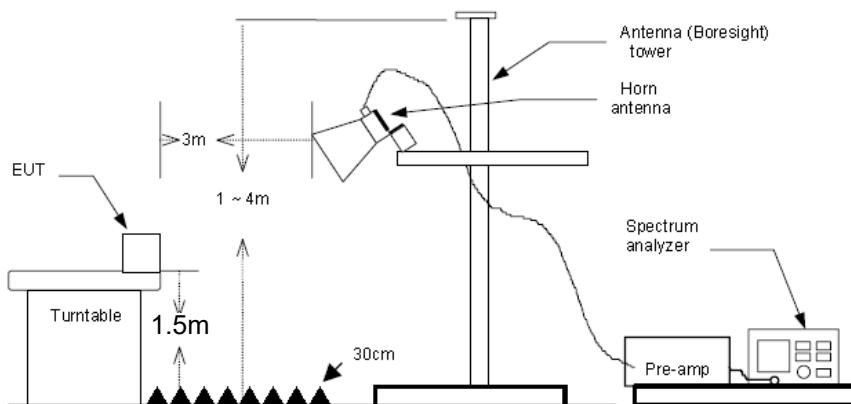
5.9. Restricted band (radiated)

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 or digitally modulated intentional radiator is operating, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

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 Peak detector for Peak value
RBW=1MHz, VBW=10Hz Peak detector for Average value.

TEST MODE:

Please refer to the clause 3.3

TEST RESULTS

Passed Not Applicable

Note:

- 1) Final level= Read level + Antenna Factor+ Cable Loss- Preamp Factor
- 2) 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.

CH00									
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Margin Limit (dB)	Polarization	Test value
2310.00	36.81	27.27	6.62	37.65	33.05	74.00	-40.95	Vertical	Peak
2390.00	43.53	27.53	6.75	37.87	39.94	74.00	-34.06	Vertical	
2310.00	37.10	27.27	6.62	37.65	33.34	74.00	-40.66	Horizontal	
2390.00	41.69	27.53	6.75	37.87	38.10	74.00	-35.90	Horizontal	
2310.00	24.94	27.27	6.62	37.65	21.18	54.00	-32.82	Vertical	Average
2390.00	27.05	27.53	6.75	37.87	23.46	54.00	-30.54	Vertical	
2310.00	24.62	27.27	6.62	37.65	20.86	54.00	-33.14	Horizontal	
2390.00	26.06	27.53	6.75	37.87	22.47	54.00	-31.53	Horizontal	

CH78									
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Margin Limit (dB)	Polarization	Test value
2483.50	50.77	27.85	6.83	37.87	47.58	74.00	-26.42	Vertical	Peak
2500.00	39.01	27.90	6.84	37.87	35.88	74.00	-38.12	Vertical	
2483.50	55.29	27.85	6.83	37.87	52.10	74.00	-21.90	Horizontal	
2500.00	37.98	27.90	6.84	37.87	34.85	74.00	-39.15	Horizontal	
2483.50	30.65	27.85	6.83	37.87	27.46	54.00	-26.54	Vertical	Average
2500.00	23.82	27.90	6.84	37.87	20.69	54.00	-33.31	Vertical	
2483.50	31.84	27.85	6.83	37.87	28.65	54.00	-25.35	Horizontal	
2500.00	23.87	27.90	6.84	37.87	20.74	54.00	-33.26	Horizontal	

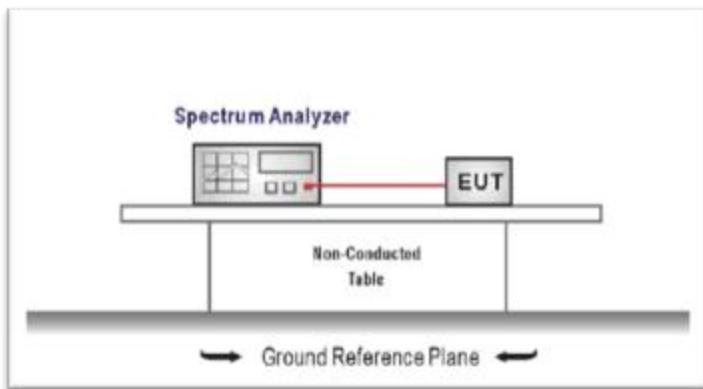
5.10. Bandedge and Spurious Emission (conducted)

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

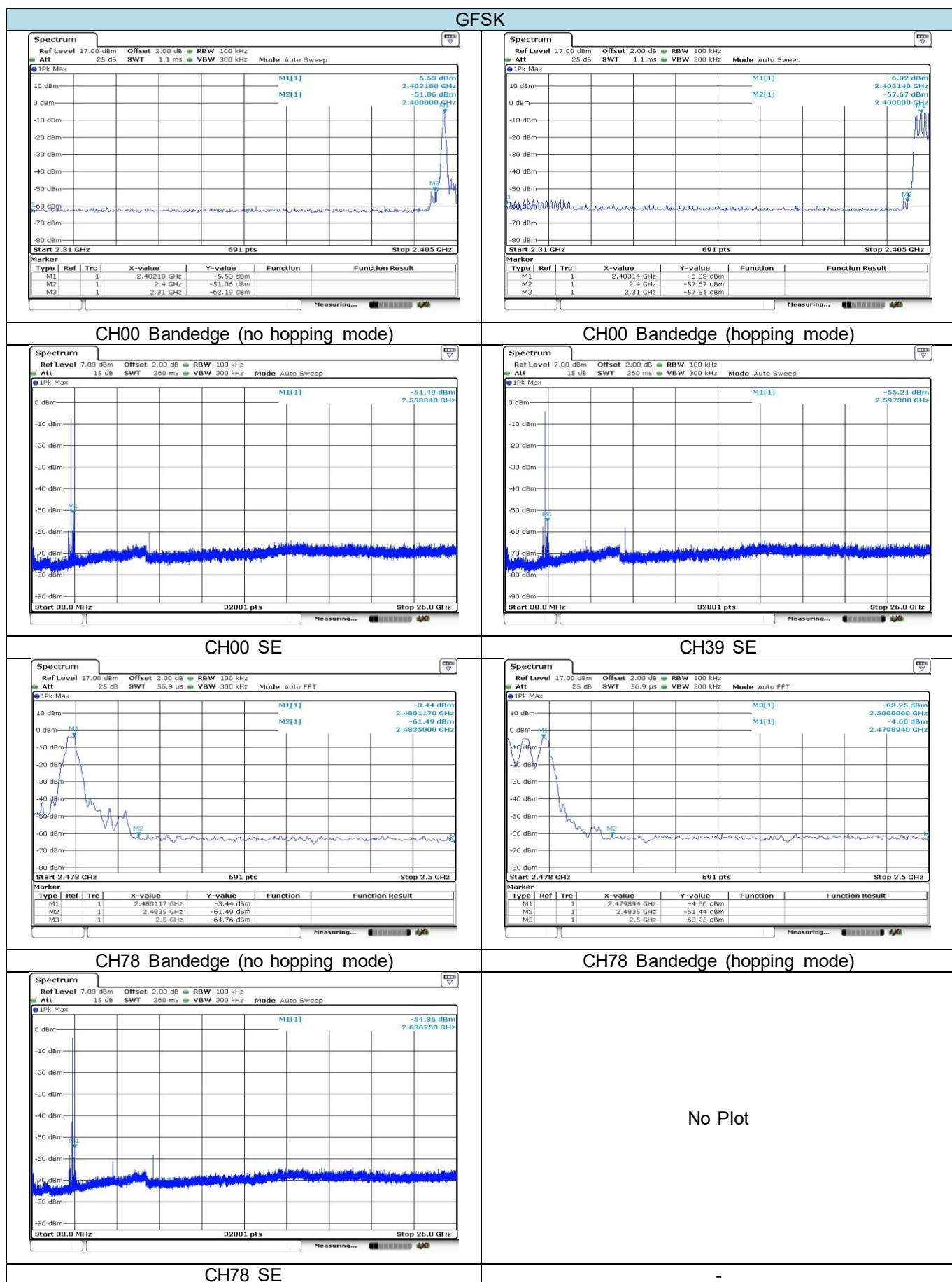
1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:
RBW= 100 KHz, VBW \geq RBW
Sweep = auto, Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

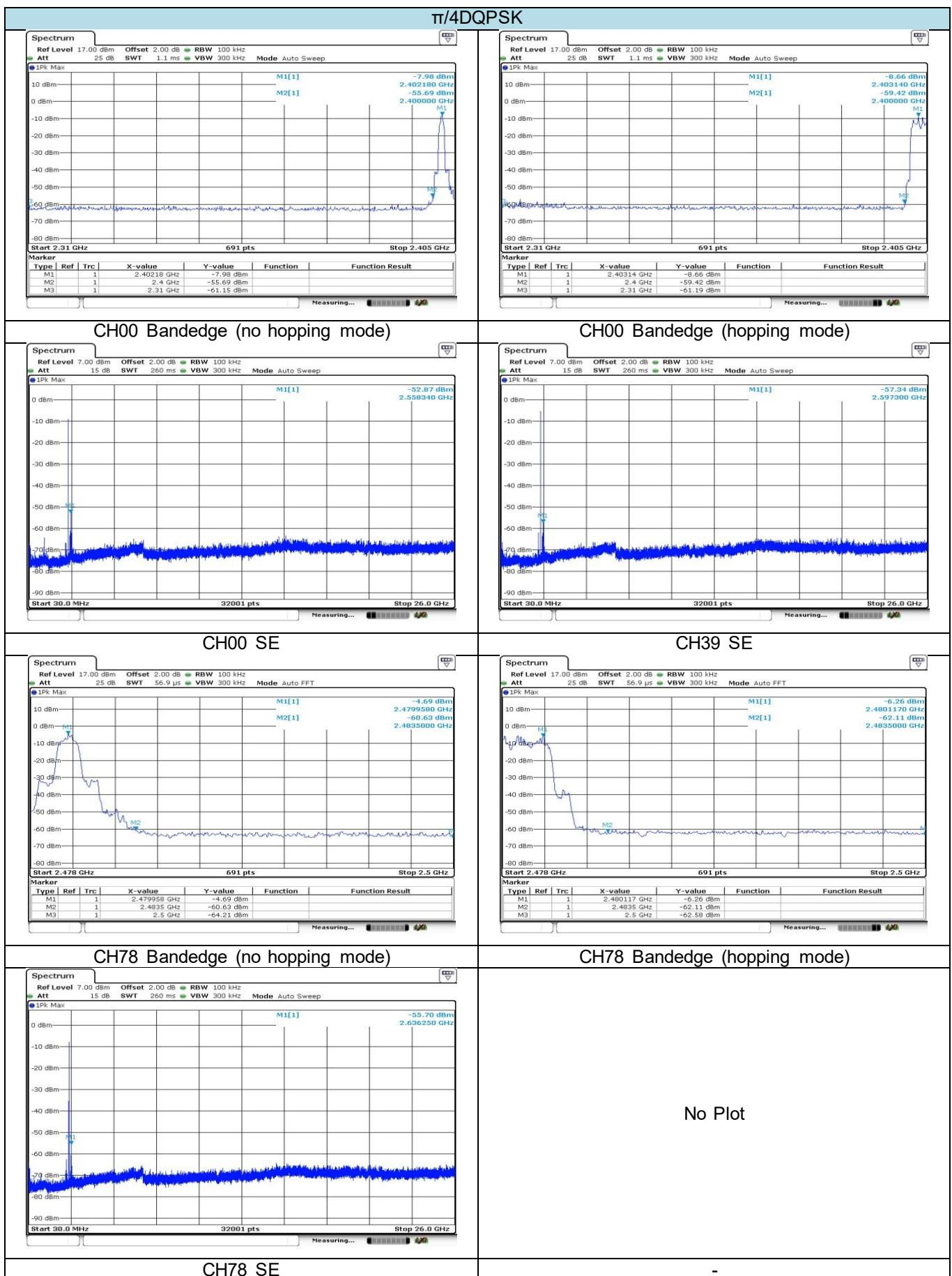
TEST MODE:

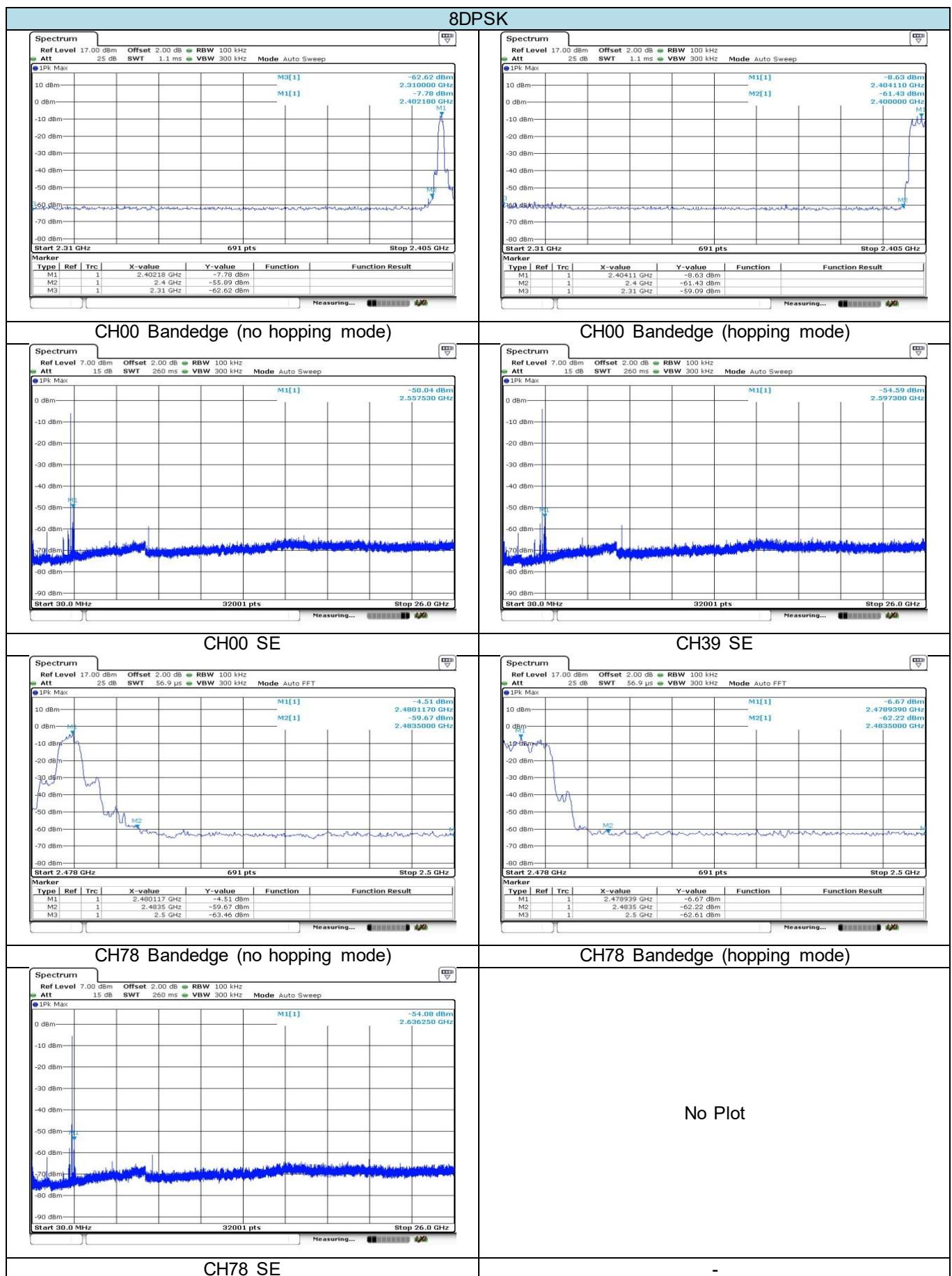
Please refer to the clause 3.3

TEST RESULTS

Passed Not Applicable







5.11. Spurious Emission (radiated)

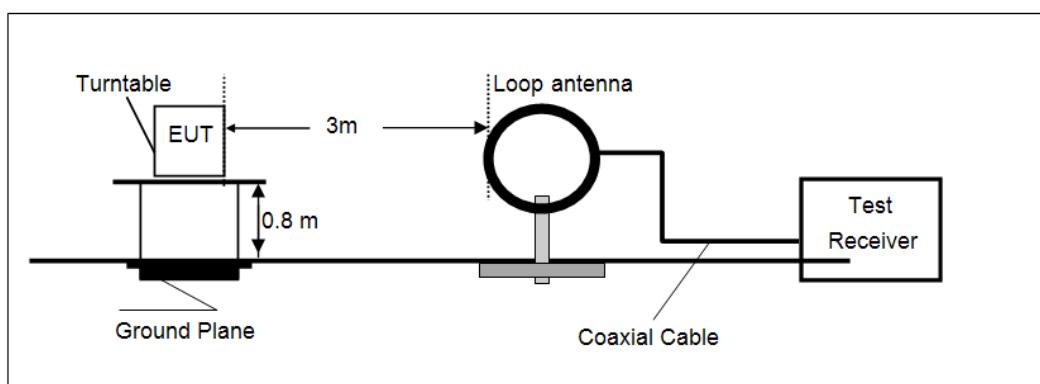
LIMIT

FCC CFR Title 47 Part 15 Subpart C Section 15.209

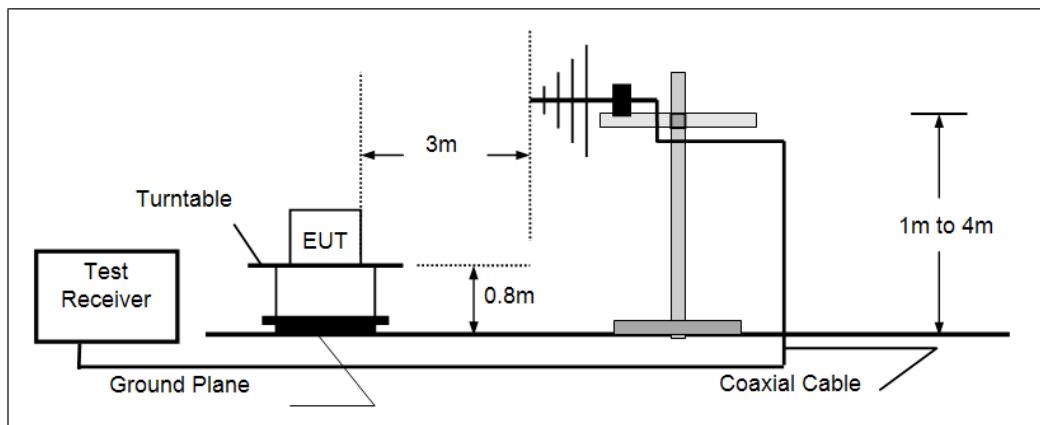
Frequency	Limit (dB _{uV/m} @3m)	Value
30MHz-88MHz	40.00	Quasi-peak
88MHz-216MHz	43.50	Quasi-peak
216MHz-960MHz	46.00	Quasi-peak
960MHz-1GHz	54.00	Quasi-peak
Above 1GHz	54.00	Average
	74.00	Peak

TEST CONFIGURATION

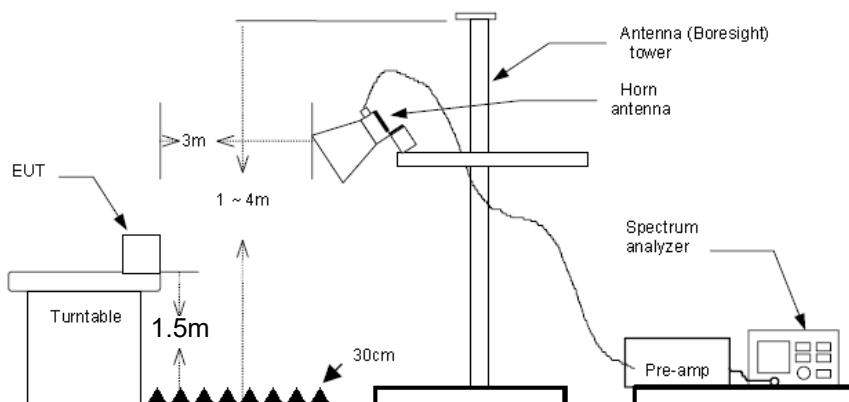
- Below 30MHz



- 30MHz~1000MHz



- Above 1GHz



TEST PROCEDURE

1. The EUT was 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 0.8 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.
5. Use the following spectrum analyzer settings
 - (1) Span shall be wide enough to fully capture the emission being measured;
 - (2) Below 1GHz, RBW=120KHz, VBW=300KHz, Sweep=auto, Detector function=QP, 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.
 - (3) Above 1GHz, RBW=1MHz, VBW=3MHz Peak detector for Peak value
RBW=1MHz, VBW=10Hz Peak detector for Average value.

TEST MODE:

Please refer to the clause 3.3

TEST RESULTS

Passed **Not Applicable**

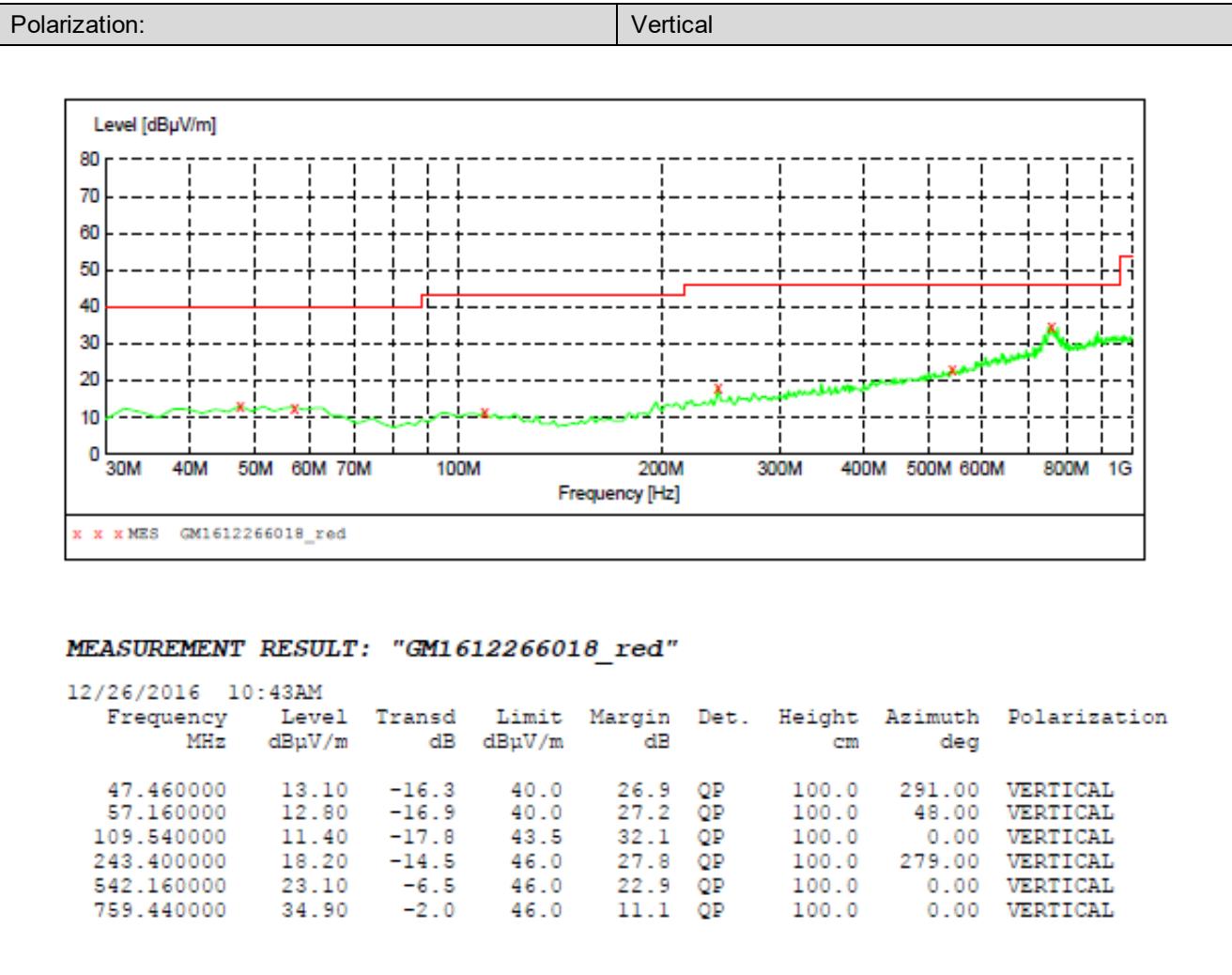
Note:

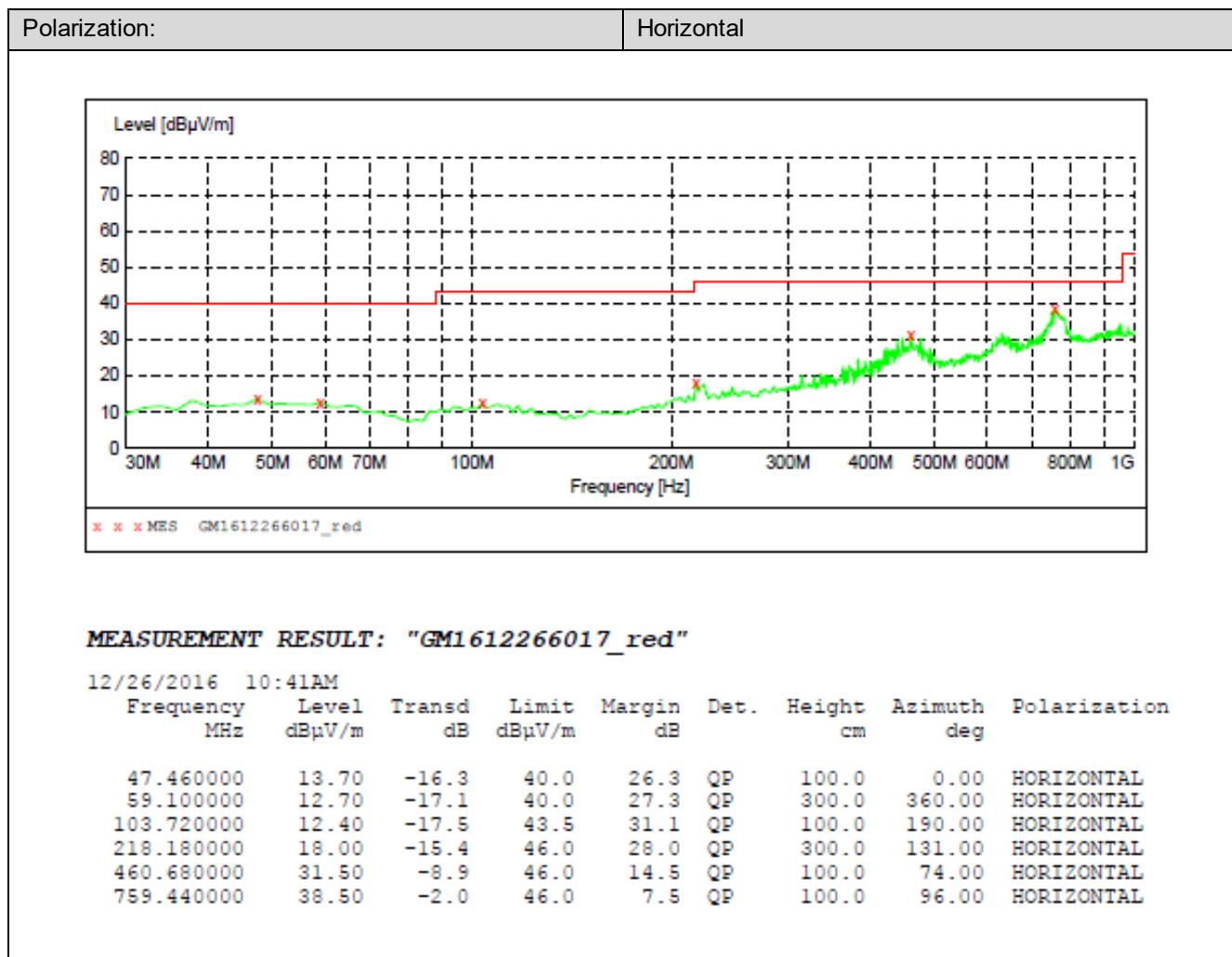
- 1) *Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor*
- 2) *The emission levels of other frequencies are very lower than the limit and not shown in test report.*
- 3) *Below 1GHz, Have pre-scan all modulation mode, found the GFSK modulation High channel which it was worst case, so only the worst case's data on the test report.*
- 4) *Above 1GHz, Have pre-scan all modulation mode, found the 8DPSK modulation which it was worst case, so only the worst case's data on the test report*

➤ **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





➤ Above 1GHz

CH00 for 8DPSK									
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Margin Limit (dB)	Polarization	Test value
1589.29	46.46	24.98	5.54	36.71	40.27	74.00	-33.73	Vertical	Peak
3184.25	40.90	28.58	7.70	38.20	38.98	74.00	-35.02	Vertical	
4809.50	43.08	31.09	9.55	36.93	46.79	74.00	-27.21	Vertical	
7981.72	33.48	36.70	12.39	34.58	47.99	74.00	-26.01	Vertical	
1689.41	49.92	25.27	5.74	36.91	44.02	74.00	-29.98	Horizontal	Peak
3184.25	42.08	28.58	7.70	38.20	40.16	74.00	-33.84	Horizontal	
4809.50	54.31	31.09	9.55	36.93	58.02	74.00	-15.98	Horizontal	
8292.38	32.89	37.01	12.81	34.42	48.29	74.00	-25.71	Horizontal	
4809.50	38.16	31.09	9.55	36.93	41.87	54.00	-12.13	Horizontal	Average

CH39 for 8DPSK									
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Margin Limit (dB)	Polarization	Test value
1593.34	46.27	24.99	5.55	36.71	40.10	74.00	-33.90	Vertical	Peak
3200.50	39.84	28.58	7.72	38.20	37.94	74.00	-36.06	Vertical	
4883.52	44.13	31.14	9.59	36.73	48.13	74.00	-25.87	Vertical	
7227.39	31.54	35.98	11.89	35.04	44.37	74.00	-29.63	Vertical	
1860.99	46.92	25.75	6.05	37.19	41.53	74.00	-32.47	Horizontal	Peak
3192.37	40.36	28.58	7.71	38.20	38.45	74.00	-35.55	Horizontal	
4883.52	50.56	31.14	9.59	36.73	54.56	74.00	-19.44	Horizontal	
7319.96	33.16	36.07	11.99	34.92	46.30	74.00	-27.70	Horizontal	
4883.52	32.39	31.14	9.59	36.73	36.39	54.00	-17.61	Horizontal	Average

CH78 for 8DPSK									
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Margin Limit (dB)	Polarization	Test value
1593.34	45.65	24.99	5.55	36.71	39.48	74.00	-34.52	Vertical	Peak
3184.25	41.36	28.58	7.70	38.20	39.44	74.00	-34.56	Vertical	
4958.68	43.77	31.18	9.64	36.52	48.07	74.00	-25.93	Vertical	
7432.62	31.83	36.15	12.18	34.85	45.31	74.00	-28.69	Vertical	
1860.99	45.38	25.75	6.05	37.19	39.99	74.00	-34.01	Horizontal	Peak
3192.37	41.94	28.58	7.71	38.20	40.03	74.00	-33.97	Horizontal	
4958.68	49.02	31.18	9.64	36.52	53.32	74.00	-20.68	Horizontal	
7451.57	35.82	36.17	12.24	34.86	49.37	74.00	-24.63	Horizontal	

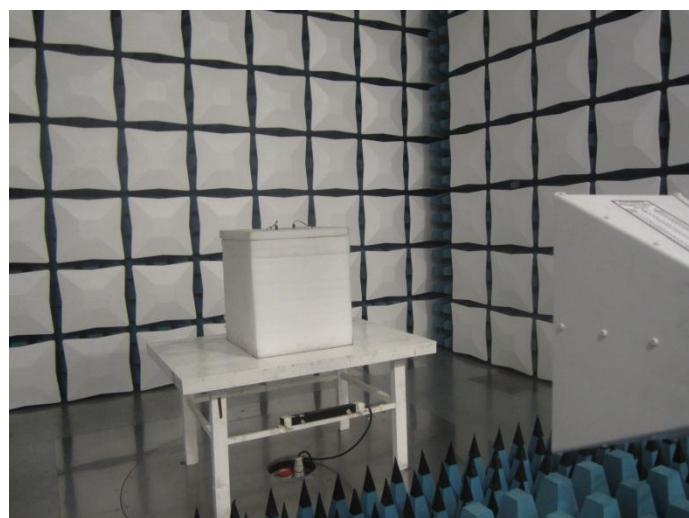
6. Test Setup Photos of the EUT

Conducted Emission (AC Mains)



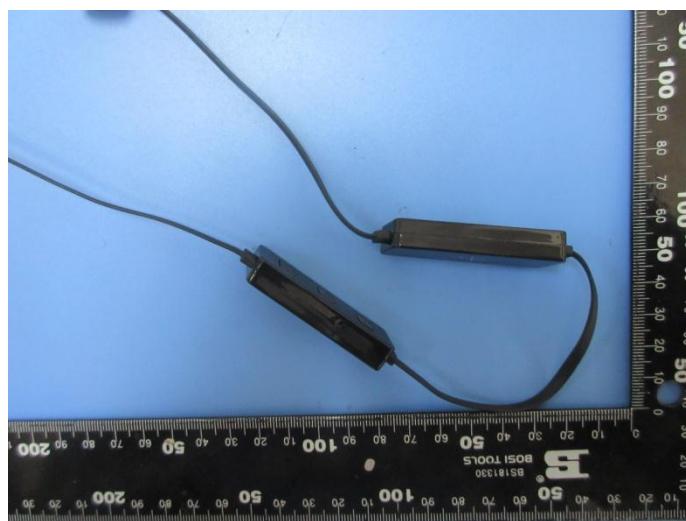
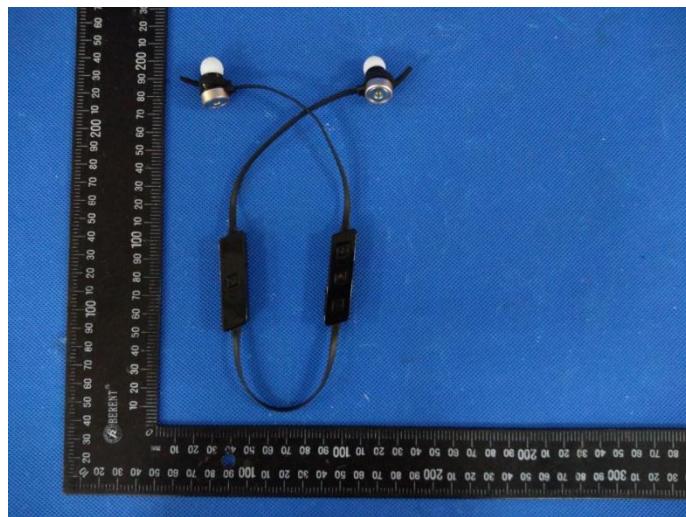
Radiated Emission



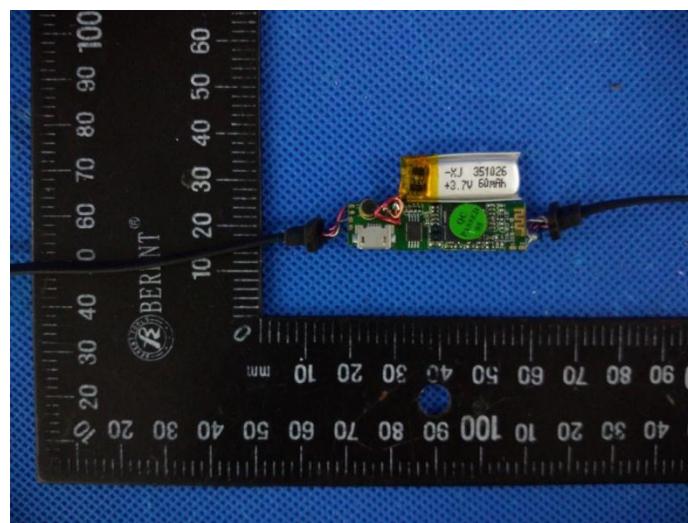
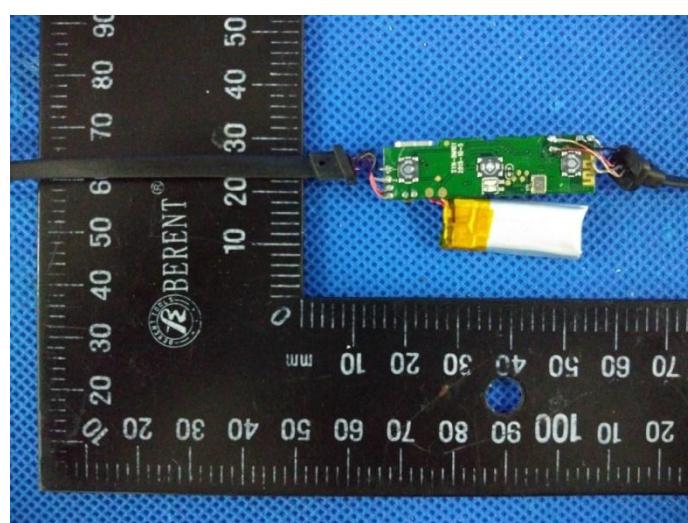


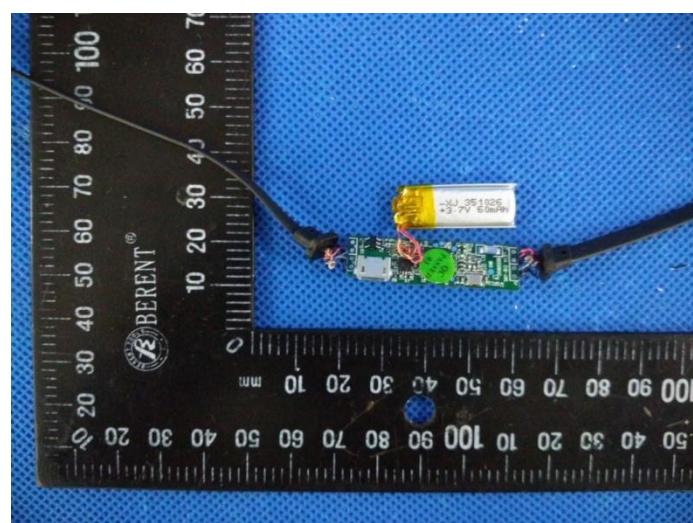
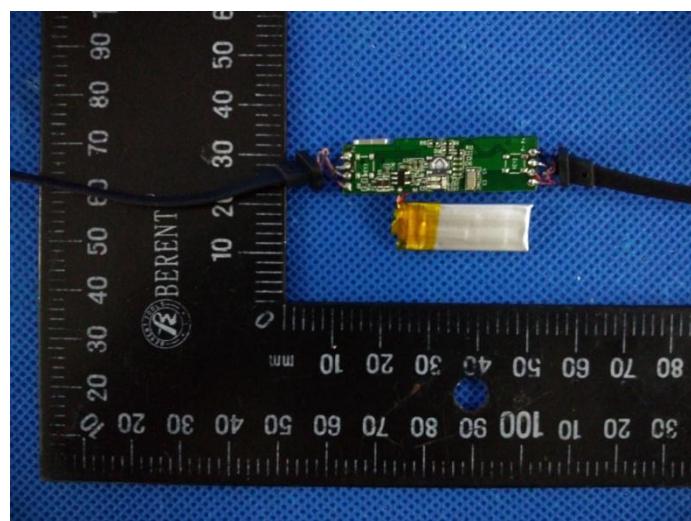
7. External and Internal Photos of the EUT

External Photos





Internal Photos



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