10. Pseudorandom Frequency Hopping Sequence

10.1. Standard Requirement

10.1.1 Test Standard

FCC Part15 C Section 15.247 (a)(1)

10.1.2 Requirement

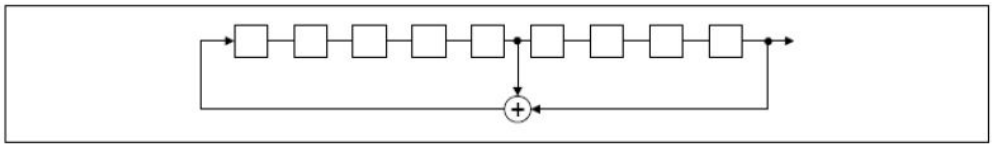
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

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 Pseudorandom 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.

10.2. EUT Pseudorandom Frequency Hopping Sequence

The pseudorandom 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; i.e. 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 follow:

Each frequency used equally on the average by each transmitter. The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

11. Band Edge Requirement (Conducted Emission Method)

11.1. Test Standard and Limit

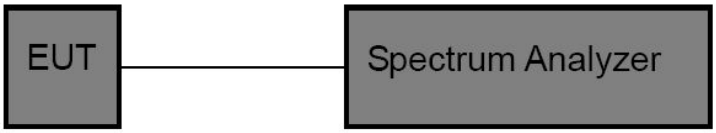
11.1.1 Test Standard

FCC Part15 C Section 15.247 (d)

11.1.2 Test 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.

11.2. Test Setup



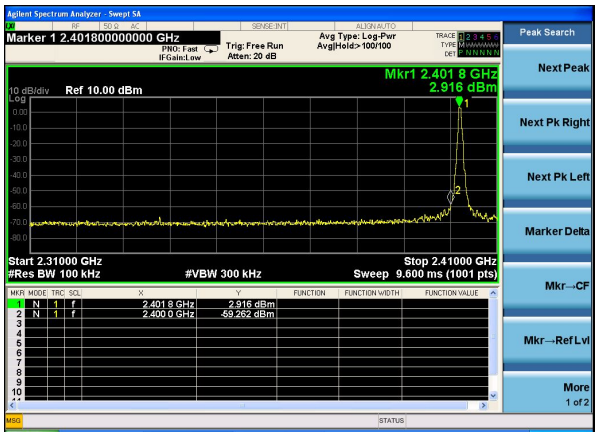
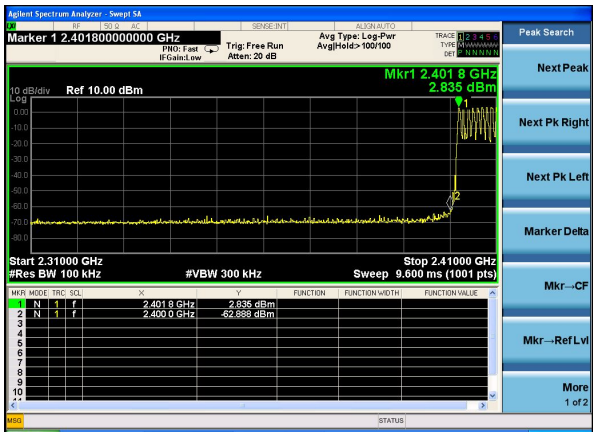
11.3. Test Procedure

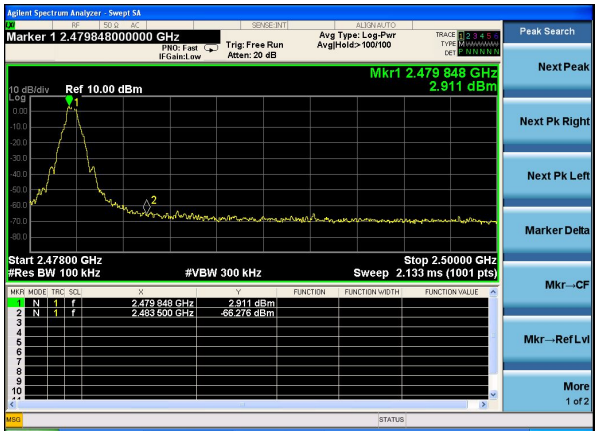
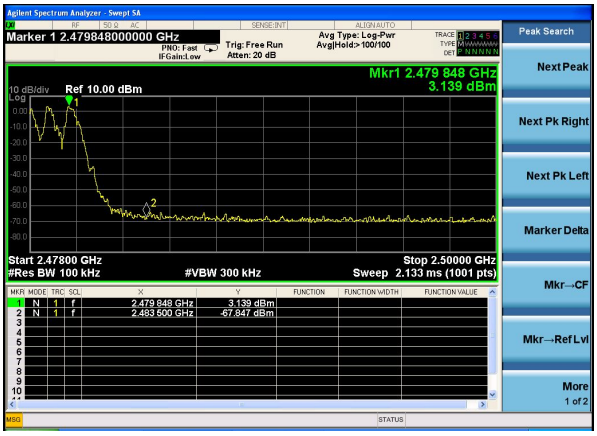
(1) The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

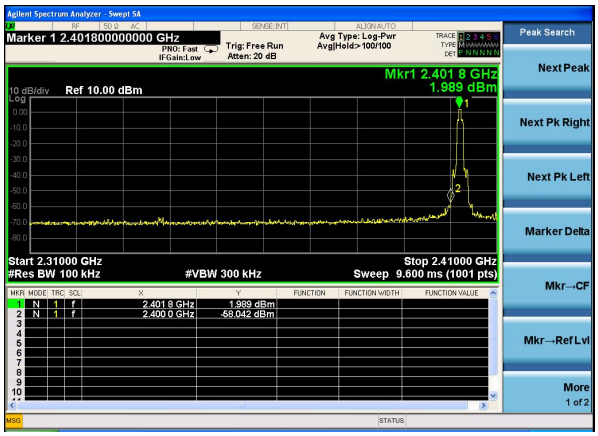
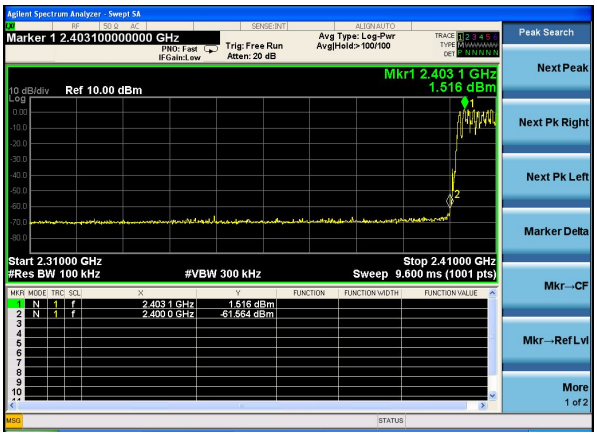
(2) Spectrum Setting: RBW=100 kHz, VBW=300 kHz, Detector=Peak

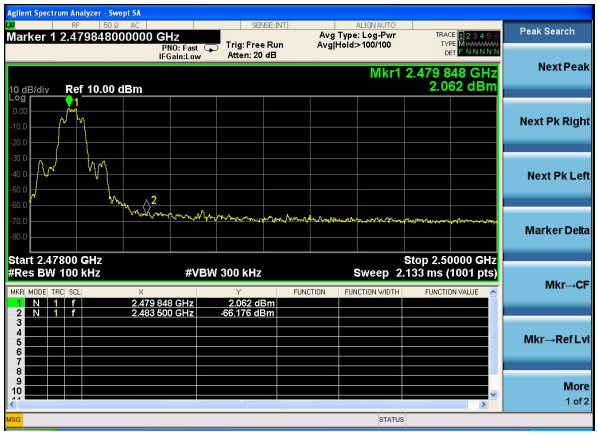
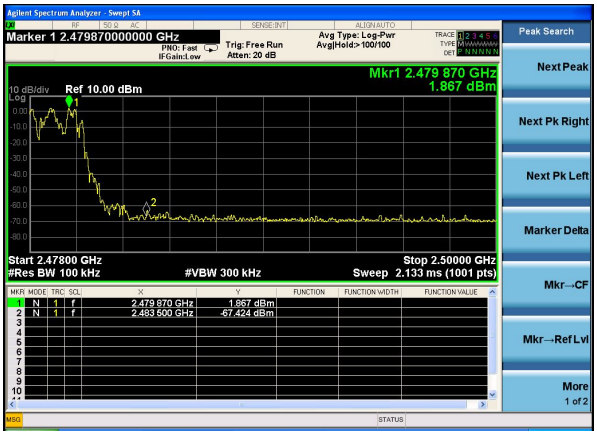
11.4. Test Data

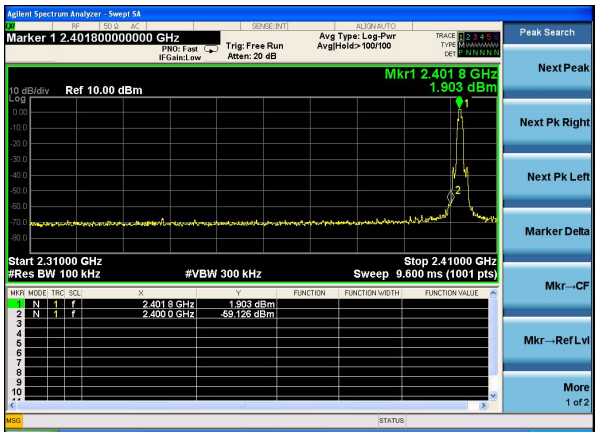
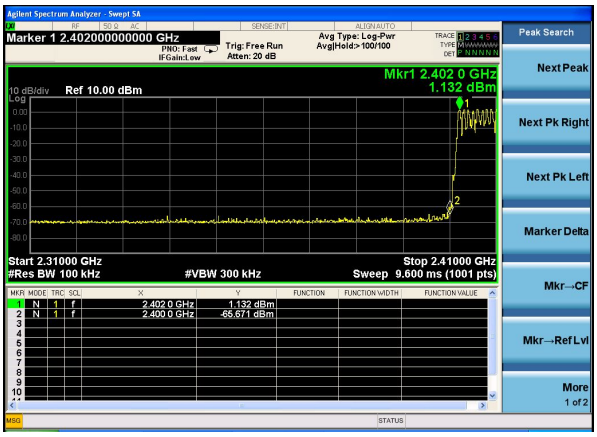
Test plot as follows

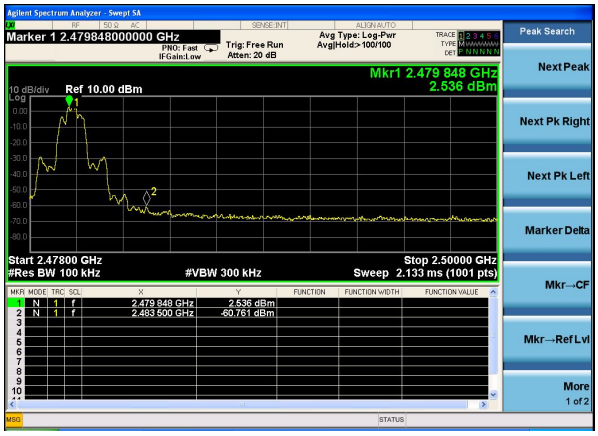
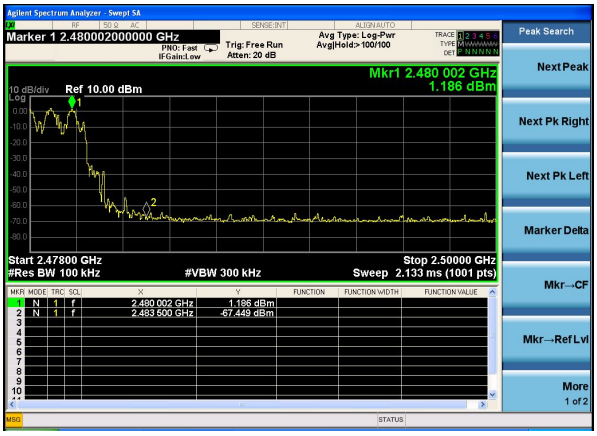
Modulation mode	GFSK	Test channel	Lowest
			
No-hopping mode		Hopping mode	

Modulation mode	GFSK	Test channel	Highest
			
No-hopping mode		Hopping mode	

Modulation mode	π/4-DQPSK	Test channel	Lowest
			
No-hopping mode		Hopping mode	

Modulation mode	π/4-DQPSK	Test channel	Highest
			
No-hopping mode		Hopping mode	

Modulation mode	8DPSK	Test channel	Lowest
			
No-hopping mode		Hopping mode	

Modulation mode	8DPSK	Test channel	Highest
			
No-hopping mode		Hopping mode	

12. Band Edge Requirement (Radiated Emission Method)

12.1. Test Standard and Limit

12.1.1 Test Standard

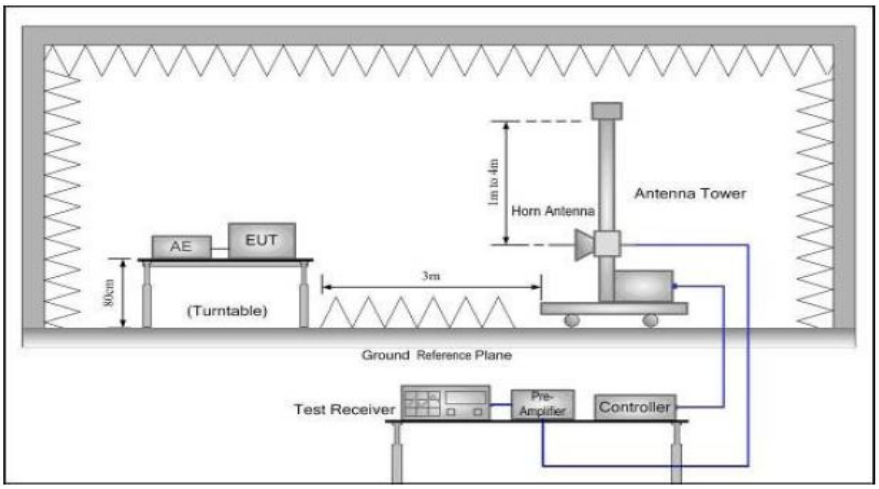
FCC Part15 C Section 15.209 and 15.205

12.1.2 Test Limit

Radiated Emission Test Limit

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

12.2. Test Setup



12.3. Test Procedure

1) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic 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 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. Peak Value: RBW=1MHz, VBW=3MHz; Average value: RBW=1MHz, VBW=10Hz

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.

12.4. Test Data

Remark:

1. During the test, pre-scan the GFSK, π/4-DQPSK, 8DPSK, and all data were shown in the report.
2. Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the Y-axis is the worst case.

Test mode: GFSK					Test channel: Lowest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2400.00	22.14	27.58	5.67	0	55.39	74.00	-18.61	H	PEAK
2400.00	21.69	27.58	5.67	0	54.94	74.00	-19.06	V	PEAK
2400.00	10.12	27.58	5.67	0	43.37	54.00	-10.63	H	AVG.
2400.00	10.54	27.58	5.67	0	43.79	54.00	-10.21	V	AVG.
Test mode: GFSK					Test channel: Highest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2483.50	22.74	27.52	5.7	0	55.96	74.00	-18.04	H	PEAK
2483.50	22.17	27.52	5.7	0	55.39	74.00	-18.61	V	PEAK
2483.50	10.54	27.52	5.7	0	43.76	54.00	-10.24	H	AVG.
2483.50	10.88	27.52	5.7	0	44.1	54.00	-9.9	V	AVG.

Remark:

1. Final Level = 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.

Test mode: π/4-DQPSK					Test channel: Lowest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2400.00	20.9	27.58	5.67	0	54.15	74.00	-19.85	H	PEAK
2400.00	21.32	27.58	5.67	0	54.57	74.00	-19.43	V	PEAK
2400.00	10.33	27.58	5.67	0	43.58	54.00	-10.42	H	AVG.
2400.00	10.79	27.58	5.67	0	44.04	54.00	-9.96	V	AVG.
Test mode: π/4-DQPSK					Test channel: Highest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2483.50	21.12	27.52	5.7	0	54.34	74.00	-19.66	H	PEAK
2483.50	22.01	27.52	5.7	0	55.23	74.00	-18.77	V	PEAK
2483.50	9.79	27.52	5.7	0	43.01	54.00	-10.99	H	AVG.
2483.50	10.13	27.52	5.7	0	43.35	54.00	-10.65	V	AVG.

Remark:

1. Final Level = 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.

Test mode: 8DPSK					Test channel: Lowest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2400.00	22.23	27.58	5.67	0	55.48	74.00	-19.11	H	PEAK
2400.00	22.37	27.58	5.67	0	55.62	74.00	-18.97	V	PEAK
2400.00	10.15	27.58	5.67	0	43.4	54.00	-11.19	H	AVG.
2400.00	10.33	27.58	5.67	0	43.58	54.00	-11.01	V	AVG.
Test mode: 8DPSK					Test channel: Highest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
2483.50	20.85	27.52	5.7	0	54.07	74.00	-19.93	H	PEAK
2483.50	21.99	27.52	5.7	0	55.21	74.00	-18.79	V	PEAK
2483.50	10.1	27.52	5.7	0	43.32	54.00	-10.68	H	AVG.
2483.50	10.35	27.52	5.7	0	43.57	54.00	-10.43	V	AVG.

Remark:

1. Final Level = 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.

13. Spurious Emission (Radiated Emission Method)

13.1. Test Standard and Limit

13.1.1 Test Standard

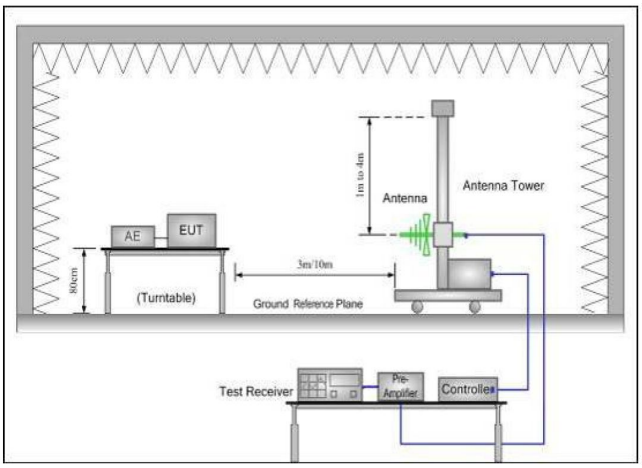
FCC Part15 C Section 15.209

13.1.2 Test Limit

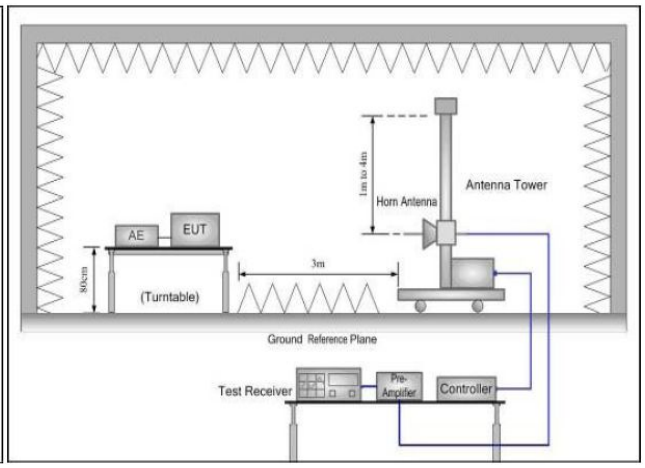
Frequency (MHz)	Limit (dBμV/m) At 3m Distance	
30MHz~88MHz	40	Quasi-peak
88MHz~216MHz	43.5	Quasi-peak
216MHz~960MHz	46	Quasi-peak
960MHz~1000MHz	54	Quasi-peak
Above 1000MHz	54	Average
	74	Peak
Remark: 1. The lower limit shall apply at the transition frequency.		

13.2. Test Setup

Below 1GHz



Above 1GHz



13.3. Test Procedure

1) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic 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 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.

   Peak value: RBW=1MHz, VBW=3MHz;

   Average value: RBW=1MHz, VBW=10Hz;

   QP Value: RBW=120kHz, VBW=300kHz

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.

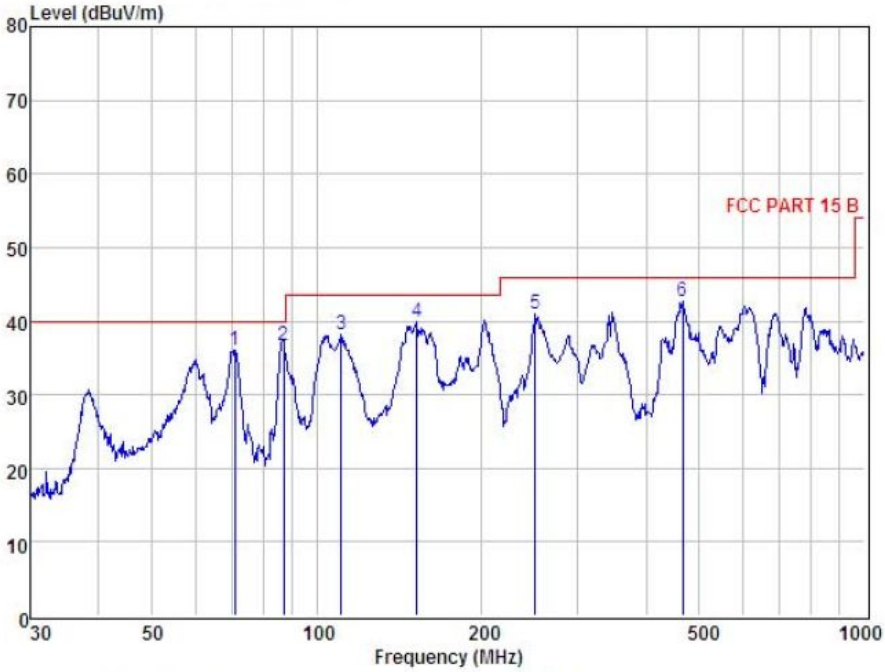
13.4. Test Data

Remark:

1. During the test, pre-scan the GFSK, π/4-DQPSK, 8-DPSK modulation, and found the GFSK modulation is the worst case.
2. Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the Y-axis is the worst case.
3. 9 kHz to 30 MHz is noise floor, so only shows the data of above 30MHz in this report.

Radiated Emission Test Data (Below 1GHz)

EUT:	Bluetooth Speaker	M/N: KTS-88
Operating Condition:	Bluetooth TX mode	
Test Site:	3m chamber	
Operator:	Jason	
Test Specification:	AC120V/60Hz	
Polarization:	Horizontal	
Note	Tem:23℃ Hum:50%	



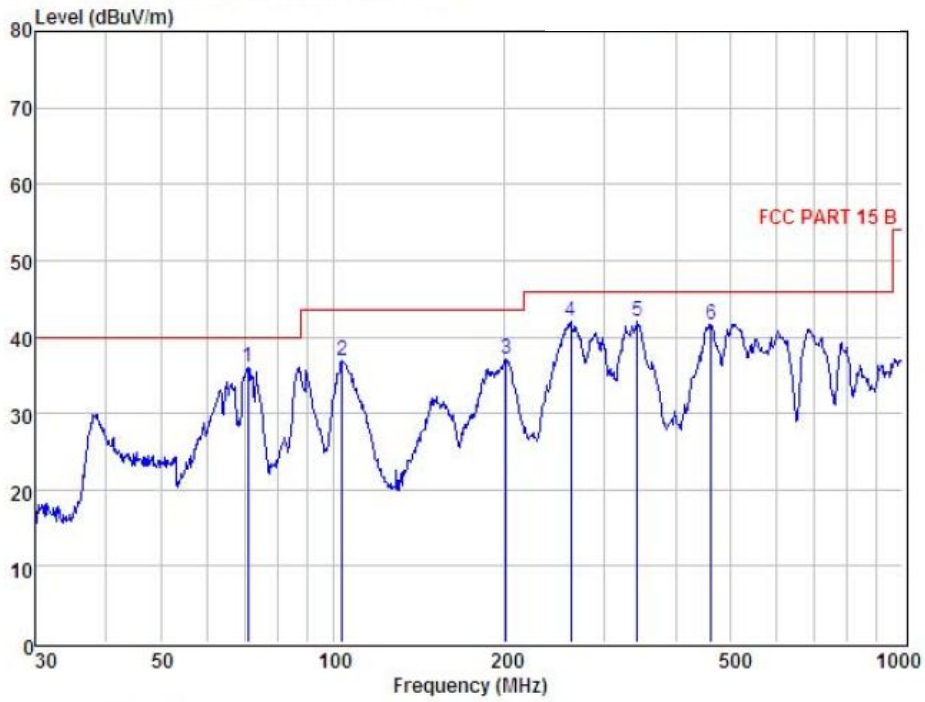
Condition : FCC PART 15 B 3m POL: HORIZONTAL

Item	Freq MHz	Read Level dBuV	Antenna Factor dB	Preamp Factor dB	Cable Loss dB	Level dBuV	Limit dBuV	Margin dBuV	Remark
1	70.83	57.94	10.65	32.64	0.17	36.12	40.00	-3.88	QP
2	87.11	59.22	9.61	32.57	0.32	36.58	40.00	-3.42	QP
3	110.96	60.25	10.22	32.76	0.41	38.12	43.50	-5.38	QP
4	152.66	59.44	12.84	32.82	0.41	39.87	43.50	-3.63	QP
5	250.30	61.00	12.17	32.74	0.48	40.91	46.00	-5.09	QP
6	465.60	56.35	17.49	31.93	0.88	42.79	46.00	-3.21	QP

Remark: Level = Read Level + Antenna Factor - Preamp Factor + Cable Loss

Radiated Emission Test Data (Below 1GHz)

EUT:	Bluetooth Speaker	M/N: KTS-88
Operating Condition:	Bluetooth TX mode	
Test Site:	3m chamber	
Operator:	Jason	
Test Specification:	AC120V/60Hz	
Polarization:	Vertical	
Note	Tem:23℃ Hum:50%	



Condition : FCC PART 15 B 3m POL: VERTICAL

Item	Freq MHz	Read Level dBuV	Antenna Factor dB	Preamp Factor dB	Cable Loss dB	Level dBuV	Limit dBuV	Margin dBuV	Remark
1	70.83	57.79	10.65	32.64	0.17	35.97	40.00	-4.03	QP
2	103.81	59.58	9.82	32.75	0.32	36.97	43.50	-6.53	QP
3	201.39	58.90	10.43	32.73	0.44	37.04	43.50	-6.46	QP
4	261.98	61.55	12.52	32.73	0.65	41.99	46.00	-4.01	QP
5	341.98	59.16	14.70	32.61	0.78	42.03	46.00	-3.97	QP
6	460.73	55.12	17.40	31.99	1.02	41.55	46.00	-4.45	QP

Remark: Level = Read Level + Antenna Factor - Preamp Factor + Cable Loss

Radiated Emission Test Data (Above 1GHz)

Test mode: GFSK					Test channel: Lowest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4804.00	41.94	31.53	8.9	40.24	42.13	74.00	-31.87	V	PEAK
7206.00	*					74.00		V	PEAK
9608.00	*					74.00		V	PEAK
12010.00	*					74.00		V	PEAK
14412.00	*					74.00		V	PEAK
16814.00	*					74.00		V	PEAK
4804.00	42.74	36.47	10.59	41.24	48.56	74.00	-25.44	H	PEAK
7206.00	*					74.00		H	PEAK
9608.00	*					74.00		H	PEAK
12010.00	*					74.00		H	PEAK
14412.00	*					74.00		H	PEAK
16814.00	*					74.00		H	PEAK
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4804.00	30.94	31.53	8.9	40.24	31.13	54.00	-22.87	V	AVG.
7206.00	*					54.00		V	AVG.
9608.00	*					54.00		V	AVG.
12010.00	*					54.00		V	AVG.
14412.00	*					54.00		V	AVG.
16814.00	*					54.00		V	AVG.
4804.00	31.35	36.47	10.59	41.24	37.17	54.00	-16.83	H	AVG.
7206.00	*					54.00		H	AVG.
9608.00	*					54.00		H	AVG.
12010.00	*					54.00		H	AVG.
14412.00	*					54.00		H	AVG.
16814.00	*					54.00		H	AVG.

Remark:

1. Final Level = 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.

Radiated Emission Test Data (Above 1GHz)

Test mode: GFSK					Test channel: Middle				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4882.00	41.94	31.58	8.98	40.15	42.35	74.00	-31.65	V	PEAK
7323.00	*					74.00		V	PEAK
9764.00	*					74.00		V	PEAK
12205.00	*					74.00		V	PEAK
14646.00	*					74.00		V	PEAK
17087.00	*					74.00		V	PEAK
4882.00	42.74	36.48	10.69	41.15	48.76	74.00	-25.83	H	PEAK
7323.00	*					74.00		H	PEAK
9764.00	*					74.00		H	PEAK
12205.00	*					74.00		H	PEAK
14646.00	*					74.00		H	PEAK
17087.00	*					74.00		H	PEAK
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4882.00	31.5	31.58	8.98	40.15	31.91	54.00	-22.68	V	AVG.
7323.00	*					54.00		V	AVG.
9764.00	*					54.00		V	AVG.
12205.00	*					54.00		V	AVG.
14646.00	*					54.00		V	AVG.
17087.00	*					54.00		V	AVG.
4882.00	32.16	36.48	10.69	41.15	38.18	54.00	-16.41	H	AVG.
7323.00	*					54.00		H	AVG.
9764.00	*					54.00		H	AVG.
12205.00	*					54.00		H	AVG.
14646.00	*					54.00		H	AVG.
17087.00	*					54.00		H	AVG.

Remark:

1. Final Level = 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.

Radiated Emission Test Data (Above 1GHz)

Test mode: GFSK					Test channel: Highest				
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4960.00	42.56	31.69	9.08	40.03	43.3	74.00	-31.29	V	PEAK
7440.00	*					74.00		V	PEAK
9920.00	*					74.00		V	PEAK
12400.00	*					74.00		V	PEAK
14880.00	*					74.00		V	PEAK
17360.00	*					74.00		V	PEAK
4960.00	42.85	36.6	10.8	41.05	49.2	74.00	-25.39	H	PEAK
7440.00	*					74.00		H	PEAK
9920.00	*					74.00		H	PEAK
12400.00	*					74.00		H	PEAK
14880.00	*					74.00		H	PEAK
17360.00	*					74.00		H	PEAK
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Level
4960.00	31.83	31.69	9.08	40.03	32.57	54.00	-22.02	V	AVG.
7440.00	*					54.00		V	AVG.
9920.00	*					54.00		V	AVG.
12400.00	*					54.00		V	AVG.
14880.00	*					54.00		V	AVG.
17360.00	*					54.00		V	AVG.
4960.00	32.36	36.6	10.8	41.05	38.71	54.00	-15.88	H	AVG.
7440.00	*					54.00		H	AVG.
9920.00	*					54.00		H	AVG.
12400.00	*					54.00		H	AVG.
14880.00	*					54.00		H	AVG.
17360.00	*					54.00		H	AVG.

Remark:

1. Final Level = 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.