3.5. Carrier Frequencies Separation

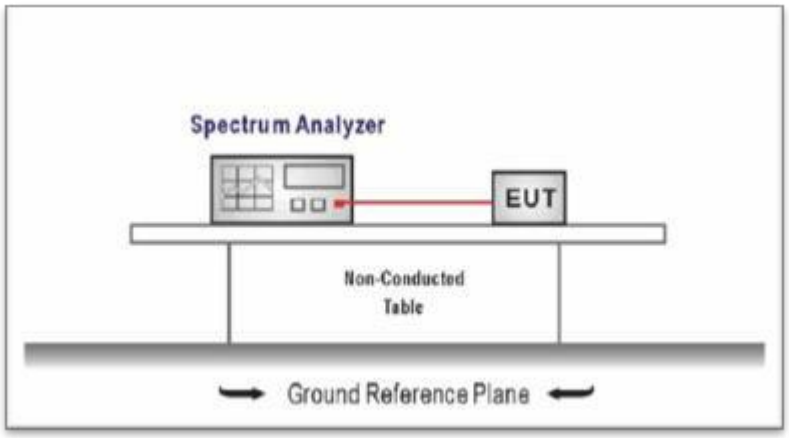
LIMIT

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

frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25kHz or the 2/3*20dB bandwidth of the hopping channel, whichever is greater.

Test Item	Limit	Frequency Range(MHz)
Channel Separation	>25KHz or >two-thirds of the 20 dB bandwidth Which is greater	2400~2483.5

Test Configuration



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:
   (1) Set RBW = 100 kHz.
   (2) Set the video bandwidth (VBW) ≥ 3 RBW.
   (3) Detector = Peak.
   (4) Trace mode = Max hold.
   (5) Sweep = Auto couple.

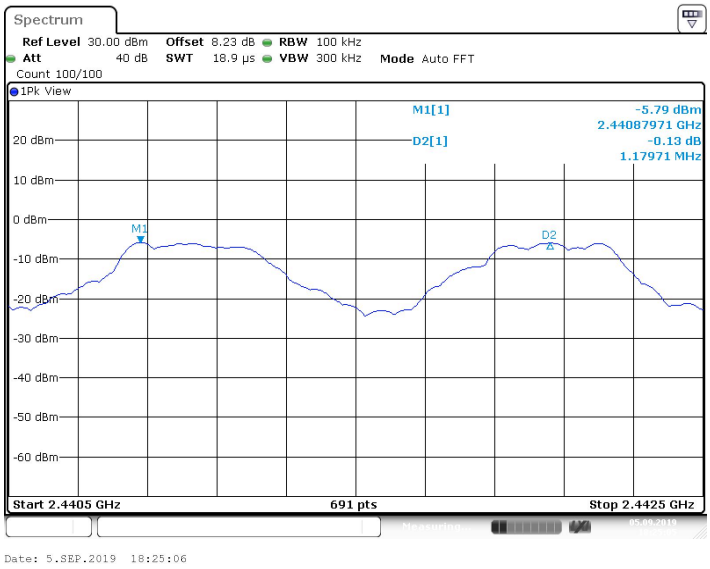
NOTE: The EUT was set to continuously transmitting in each mode and low, Middle and high channel for the test.

Test Mode

Please refer to the clause 2.3.

Test Results

Test Mode:	FHSS Hopping Mode		
Channel frequency (MHz)	Result[MHz]	Limit[MHz]	Verdict
2441	1.18	>=0.884	PASS
FHSS Hopping Mode			

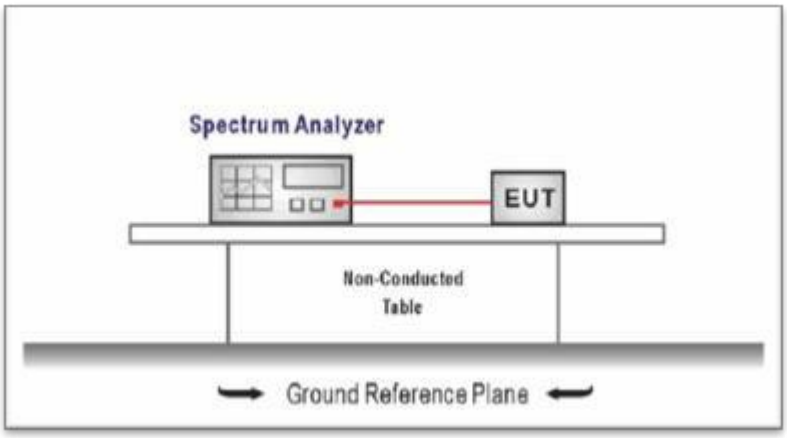


3.6. Number of Hopping Channel

Limit

Section	Test Item	Limit
15.247	Number of Hopping Channel	>15

Test Configuration



Test Procedure

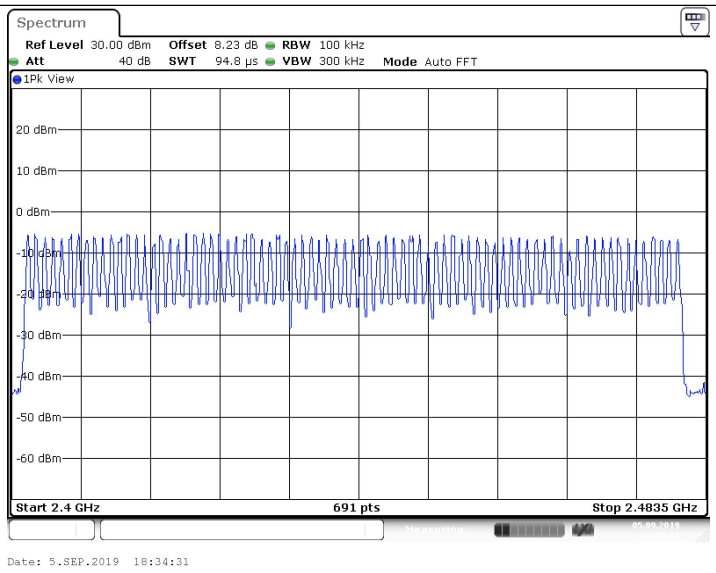
1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
2. Spectrum Setting:
   (1)Peak Detector: RBW=100 kHz, VBW≥RBW, Sweep time= Auto.

Test Mode

Please refer to the clause 2.3.

Test Result

Test Mode:	FHSS Hopping Mode		
Frequency Range	**Test Mode**	**Quantity of Hopping Channel**	**Limit**
2402MHz~2483.5MHz	Hop	79	**>15**
FHSS Hopping Mode			

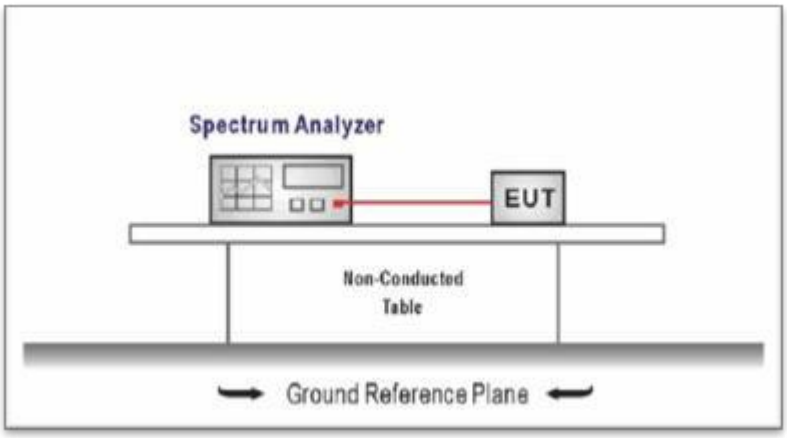


3.7. Dwell Time

Limit

Section	Test Item	Limit
15.247(a)(1)	Average Time of Occupancy	0.4 sec

Test Configuration



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:
   (1) Spectrum Setting: RBW=1MHz, VBW≥RBW.
   (2) Use video trigger with the trigger level set to enable triggering only on full pulses.
   (3) Sweep Time is more than once pulse time.
   (4) Set the center frequency on any frequency would be measure and set the frequency span to zero.
   (5) Measure the maximum time duration of one single pulse.
   (6) Set the EUT for packet transmitting.

Test Mode

Please refer to the clause 2.3

Test Result

Note:

1.We have tested all mode at high,middle and low channel,and recoreded worst case at high channel.

2.Dwell time=Pulse time (ms) × (1600 ÷ 2 ÷ 79) ×31.6 Second for DH1, 2-DH1, 3-DH1

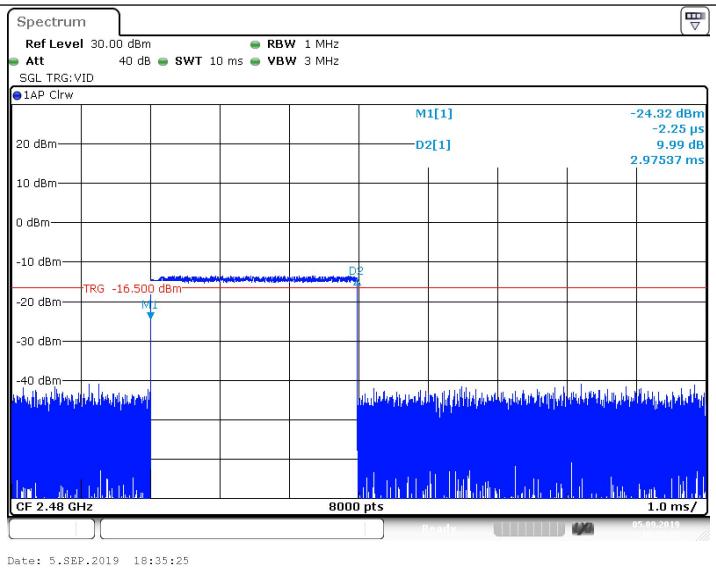
Dwell time=Pulse time (ms) × (1600 ÷ 4 ÷ 79) ×31.6 Second for DH3, 2-DH3, 3-DH3

Dwell time=Pulse time (ms) × (1600 ÷ 6 ÷ 79) ×31.6 Second for DH5, 2-DH5, 3-DH5

Test Mode:	FHSS Hopping Mode					
Test Mode	**Channel (MHz)**	**Pulse Time (ms)**	**Total of Dwell (ms)**	**Period Time (s)**	**Limit (ms)**	**Result**
1DH5	2480	2.98	317.87	31.60	**400**	**PASS**
1DH5 Total of Dwell= Pulse time (ms) × (1600 ÷ 6 ÷ 79) ×31.6 Second						

FHSS Hopping Mode 1DH5

2480MHz

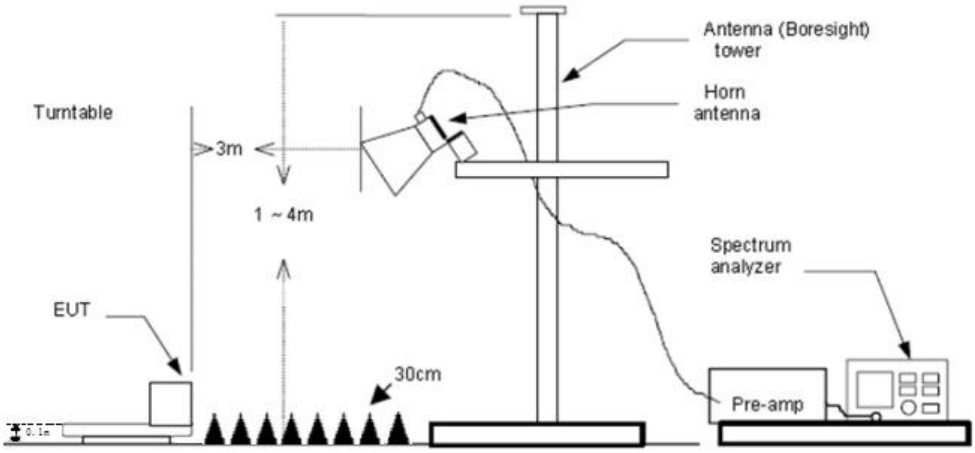


3.8. Band Edge Emissions (Radiated)

Limit

Restricted Frequency Band (MHz)	(dBuV/m)(at 3m)	
	Peak	Average
2310 ~2390	74	54
2483.5 ~2500	74	54
Note: All restriction bands have been tested, only the worst case is reported.		

Test Configuration



Test Procedure

1. The EUT was setup and tested according to ANSI C63.10:2013 requirements.
2. The EUT is placed on a turn table which is 0.1 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 with Average Detector for Average Value.

Test Mode

Please refer to the clause 2.3.

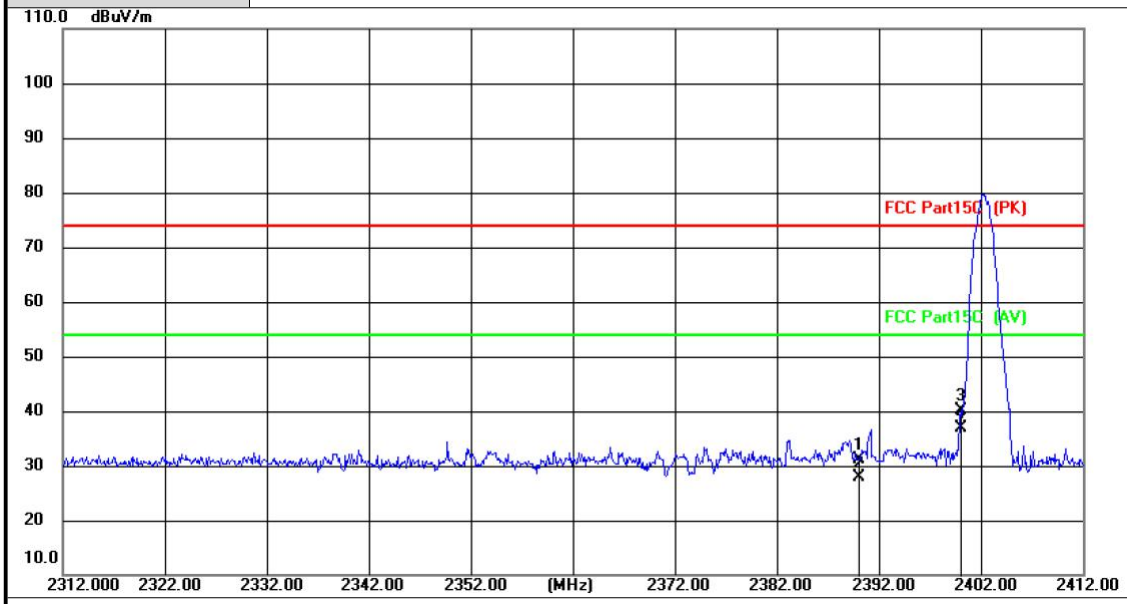
Test Results

Note:

Measurement = Reading level + Correct Factor

Correct Factor=Antenna Factor + Cable Loss -Preamplifier Factor

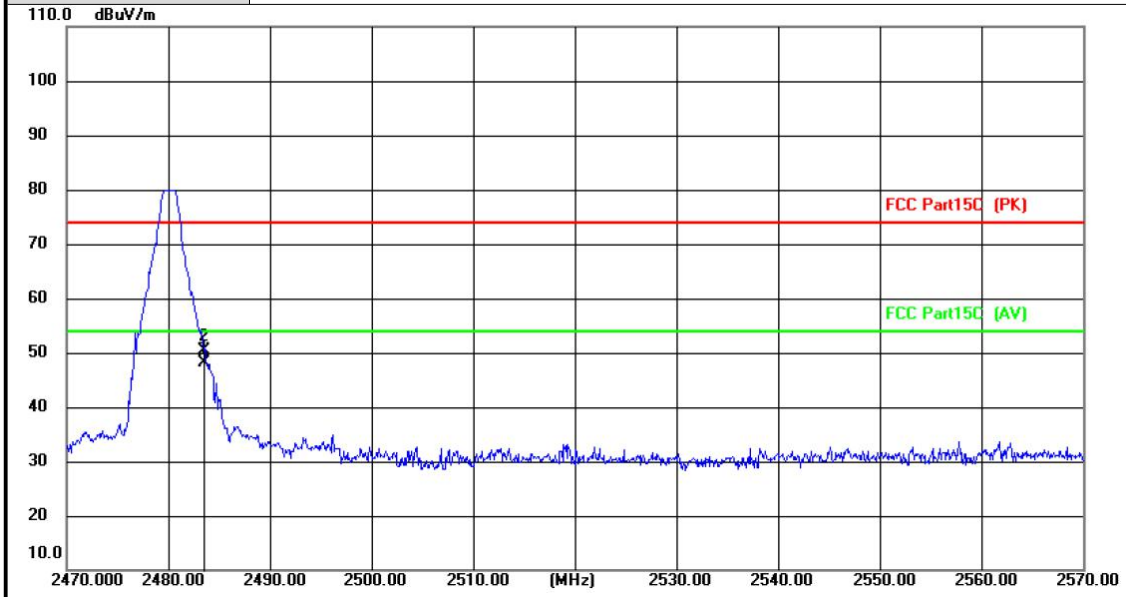
Ant. Pol.	Vertical
Test Mode:	FHSS Mode 2402 MHz



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		2390.000	44.54	-13.49	31.05	74.00	-42.95	peak
2		2390.000	41.26	-13.49	27.77	54.00	-26.23	AVG
3		2400.000	53.53	-13.48	40.05	74.00	-33.95	peak
4	*	2400.000	50.42	-13.48	36.94	54.00	-17.06	AVG

Measurement = Reading level + Correct Factor

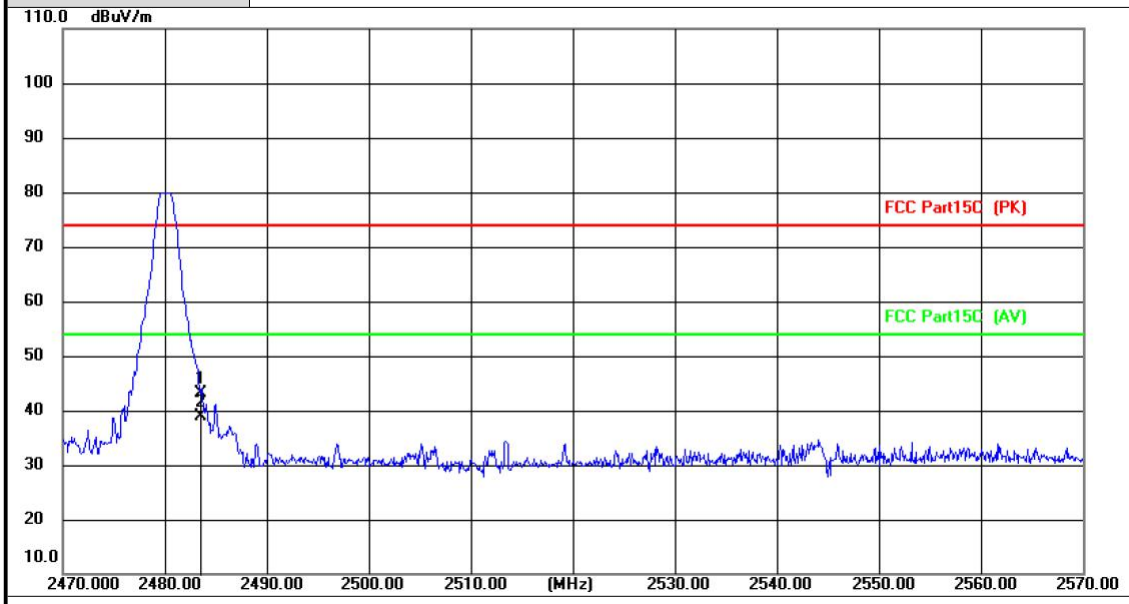
Ant. Pol.	Horizontal
Test Mode:	FHSS Mode 2480MHz



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		2483.500	61.45	-13.35	48.10	74.00	-25.90	peak
2	*	2483.500	63.80	-13.35	50.45	54.00	-3.55	AVG

Measurement = Reading level + Correct Factor

Ant. Pol.	Vertical
Test Mode:	FHSS Mode 2480 MHz



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		2483.500	56.42	-13.35	43.07	74.00	-30.93	peak
2	*	2483.500	52.19	-13.35	38.84	54.00	-15.16	AVG

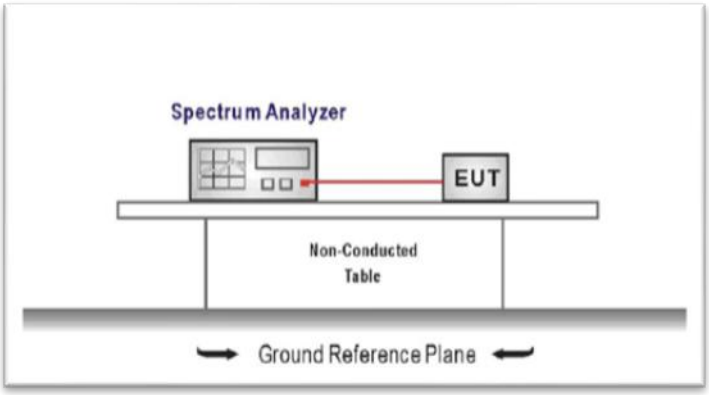
Measurement = Reading level + Correct Factor

3.9. Band Edge and Spurious Emission (conducted)

LIMIT

FCC CFR Title 47 Part 15 Subpart C Section15.247 (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 pathloss 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≥RBW
Sweep = auto, Detector function = peak, Trace = max hold

4.Measure and record the results in the test report.

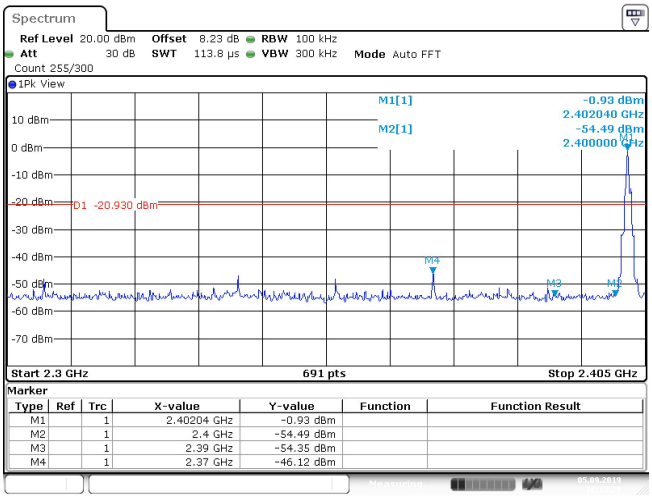
TEST MODE:

Please refer to the clause 2.3.

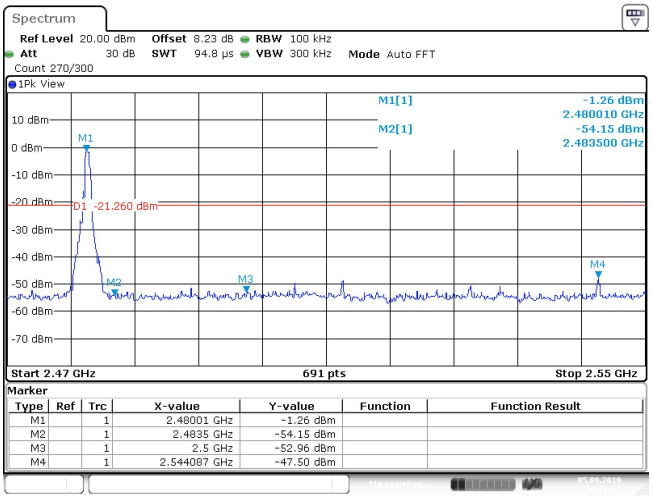
TEST RESULTS

FHSS

CH00-Bandedge

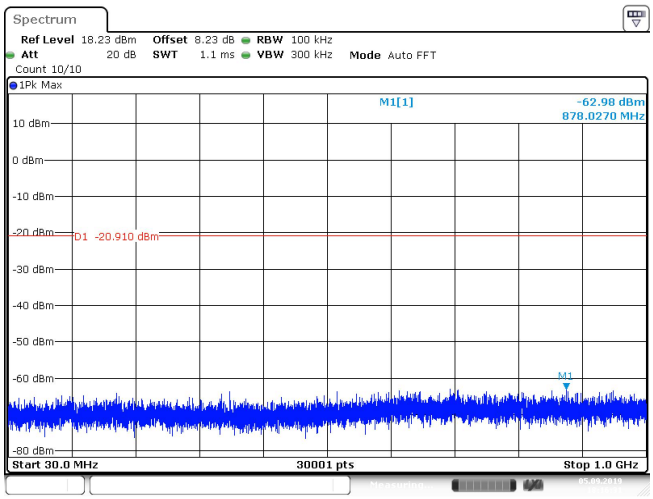


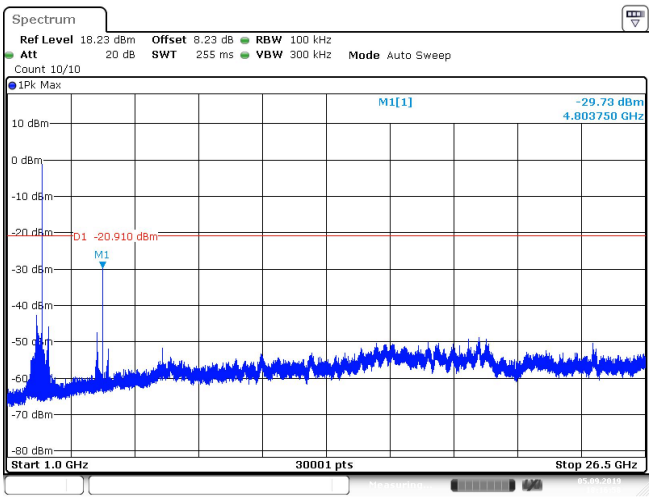
CH78-Bandedge



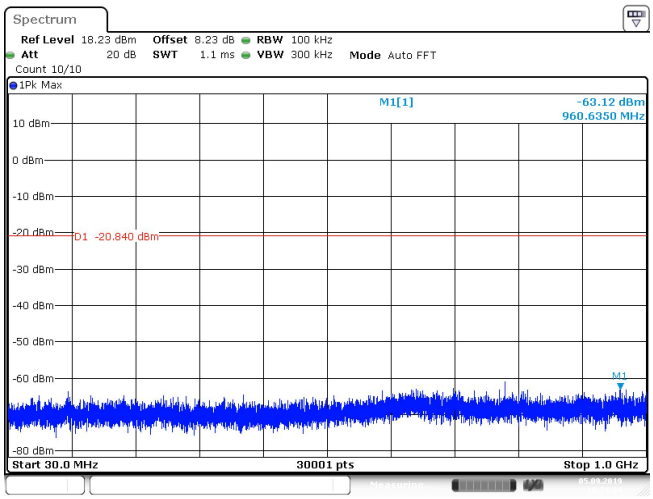
FHSS

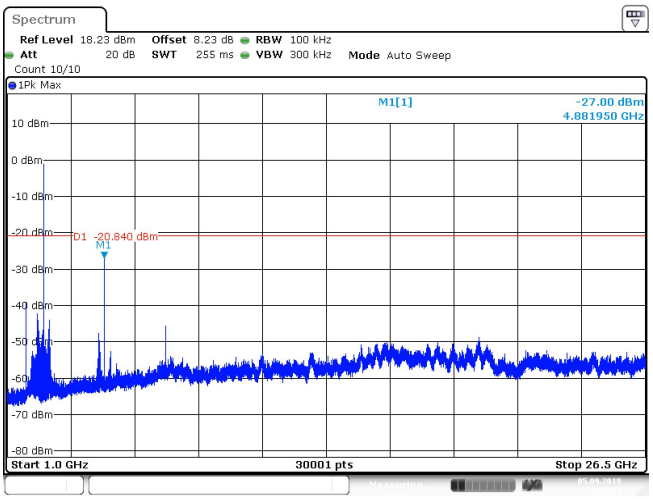
CH00-SE



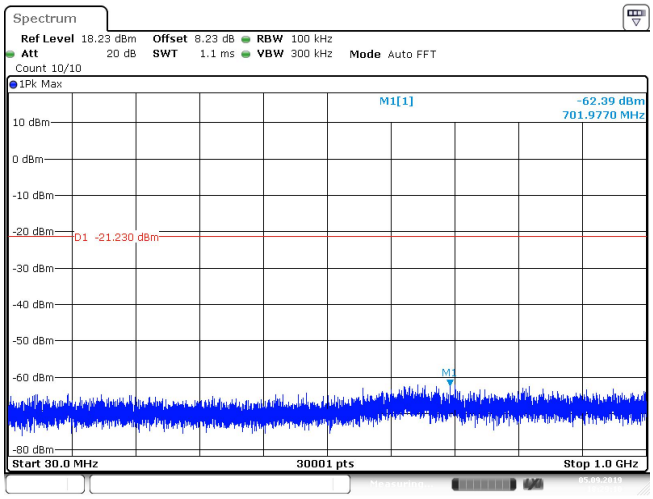


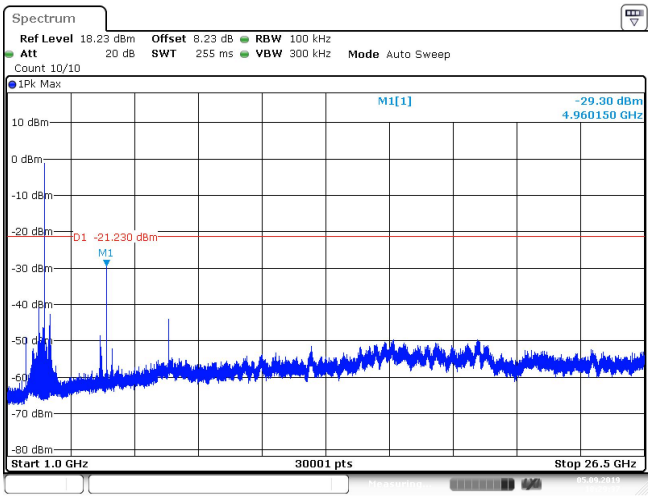
CH39-SE





CH78-SE





3.10. Radiated Spurious Emissions

Limit

Radiated Emission Limits (9 kHz~1000 MHz)

Frequency (MHz)	Field Strength (microvolt/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

Radiated Emission Limit (Above 1000MHz)

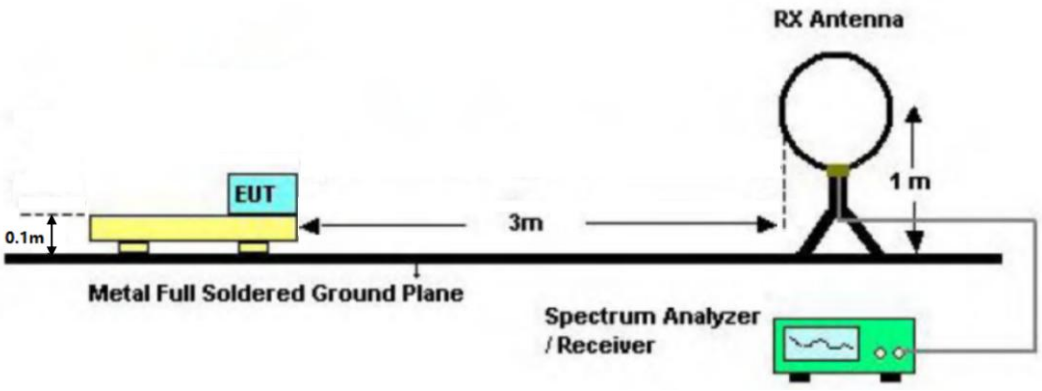
Frequency (MHz)	Distance Meters(at 3m)	
	Peak	Average
Above 1000	74	54

Note:

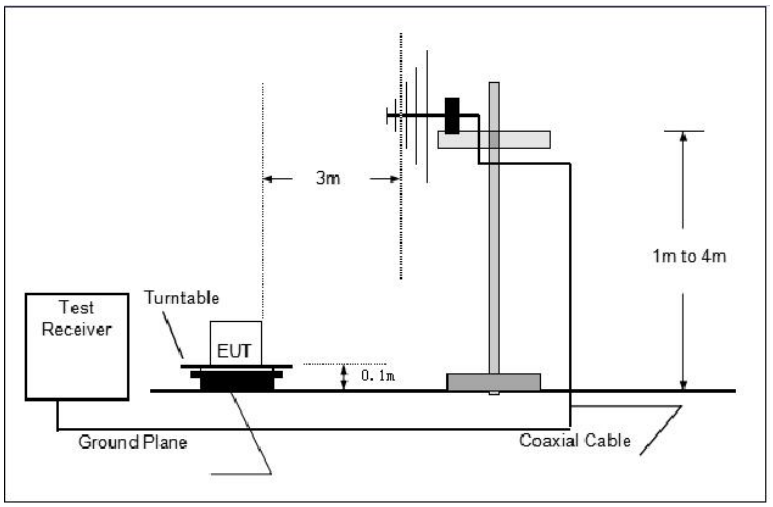
(1) The tighter limit applies at the band edges.

(2) Emission Level (dBuV/m)=20log Emission Level (uV/m).

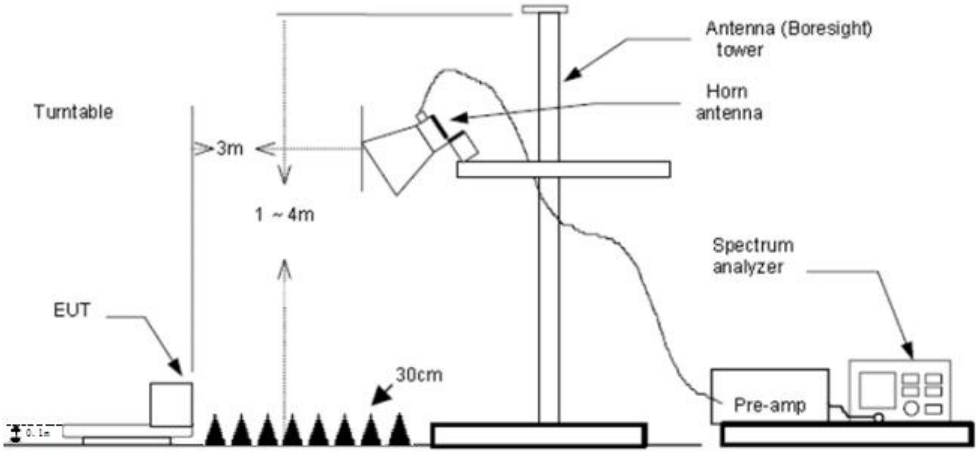
Test Configuration



Below 30MHz Test Setup



Below 1000MHz Test Setup



Above 1GHz Test Setup

Test Procedure

1. The EUT was setup and tested according to ANSI C63.10:2013
2. The EUT is placed on a turn table which is 0.1 meter above ground for below 1 GHz, and 0.1m for above 1 GHz. The turn table is rotated 360 degrees to determine the position of the maximum emission level.
3. The EUT was set 3 meters from the receiving antenna, which was mounted on the top of a variable height antenna tower.
4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
5. Set to the maximum power setting and enable the EUT transmit continuously.
6. Use the following spectrum analyzer settings
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Below 1 GHz:
   RBW=120 kHz, VBW=300 kHz, 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.
   (3) From 1 GHz to 10th harmonic:
   RBW=1MHz, VBW=1MHz Peak detector for Peak value.
   RBW=1MHz, VBW=10Hz RMS detector for Average value.

Test Mode

Please refer to the clause 2.3.

Test Result

9 KHz~30 MHz and 18GHz~25GHz

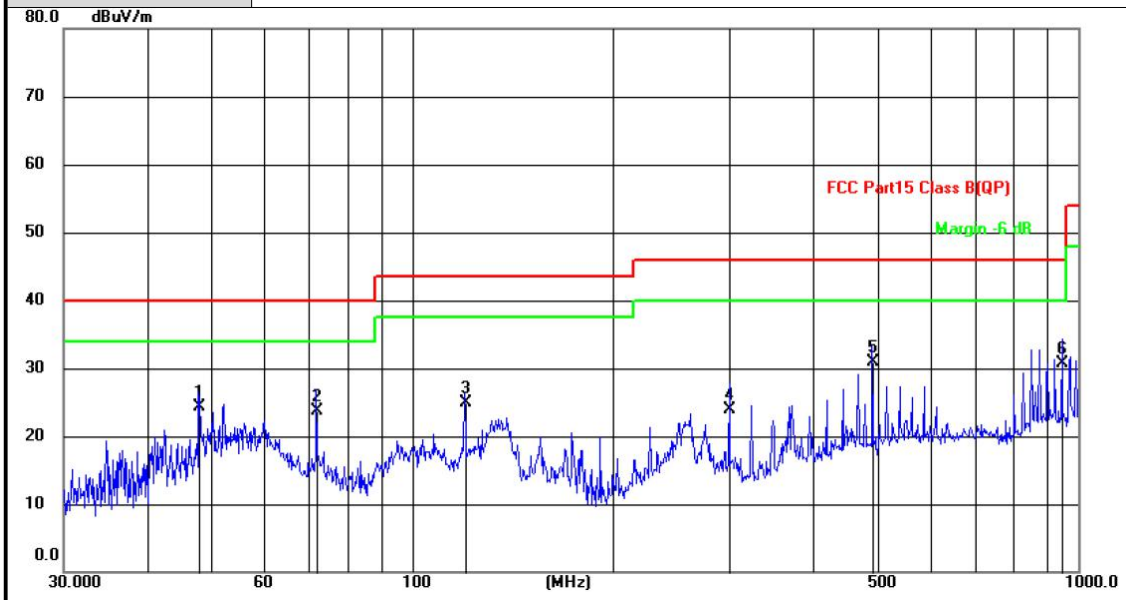
From 9 KHz~30 MHz and 18GHz~25GHz: Conclusion: PASS

Note:

1) Measurement = Reading level + Correct Factor
   Correct Factor=Antenna Factor + Cable Loss -Preamplifier Factor
2) The peak level is lower than average limit(54 dBuV/m), 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.
4) The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

30MHz-1GHz

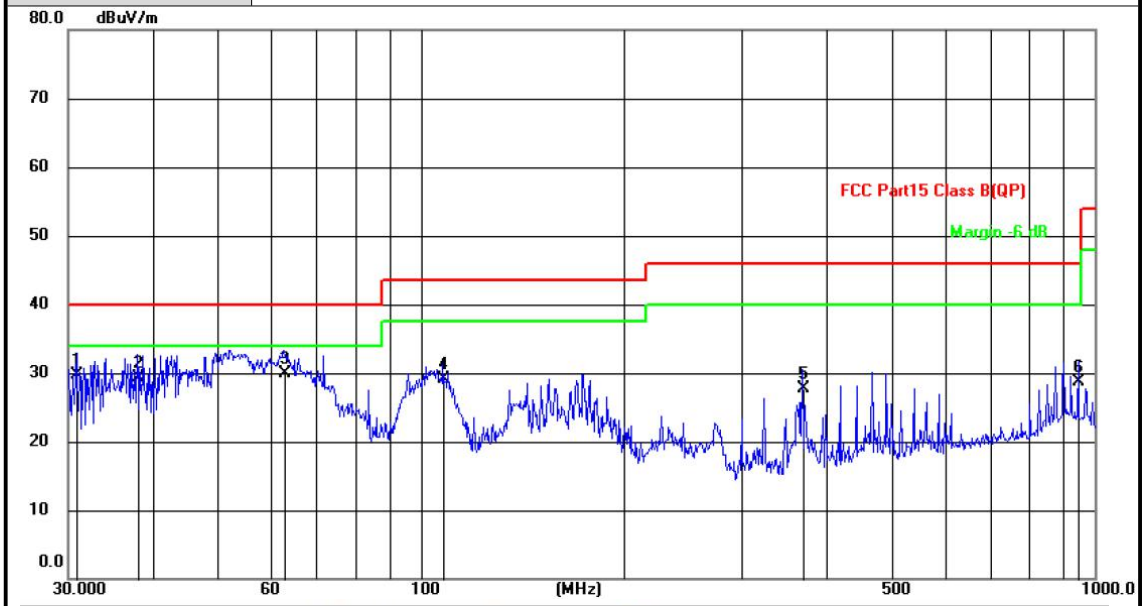
Ant. Pol.	Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		47.9772	38.97	-14.66	24.31	40.00	-15.69	QP
2		72.0085	42.21	-18.60	23.61	40.00	-16.39	QP
3		119.9818	42.27	-17.29	24.98	43.50	-18.52	QP
4		300.0514	38.17	-14.19	23.98	46.00	-22.02	QP
5	*	491.9508	40.89	-10.05	30.84	46.00	-15.16	QP
6		948.0958	35.22	-4.53	30.69	46.00	-15.31	QP

Measurement = Reading level + Correct Factor

Ant. Pol.	Vertical

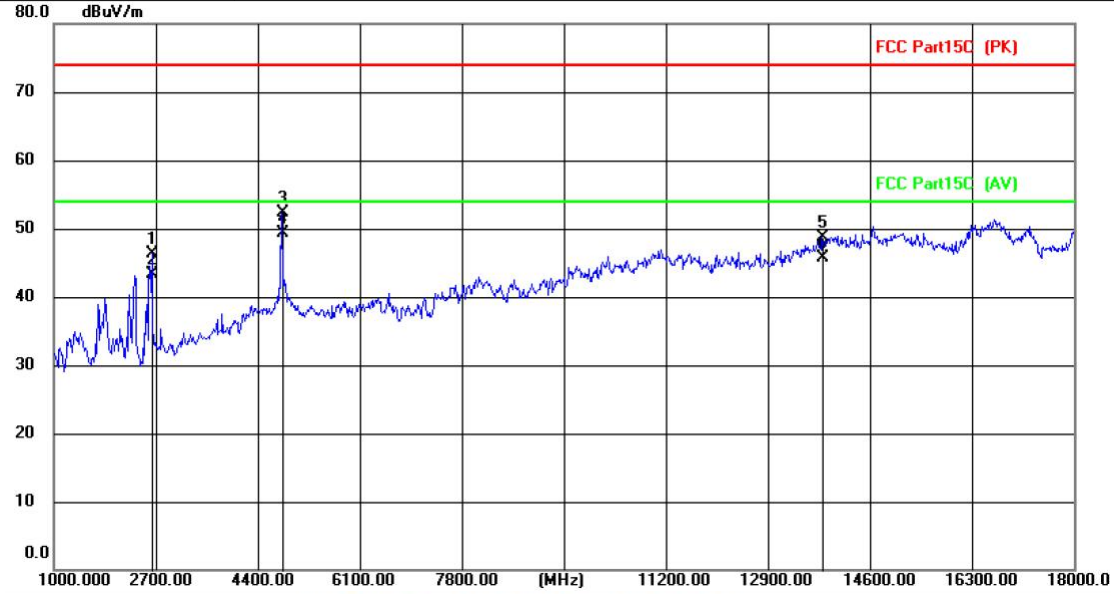


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		30.8967	46.52	-16.83	29.69	40.00	-10.31	QP
2		37.9982	45.39	-16.16	29.23	40.00	-10.77	QP
3	*	62.8266	46.25	-16.38	29.87	40.00	-10.13	QP
4		108.0012	45.29	-16.14	29.15	43.50	-14.35	QP
5		368.7576	39.26	-11.46	27.80	46.00	-18.20	QP
6		948.0958	33.22	-4.53	28.69	46.00	-17.31	QP

Measurement = Reading Level+ Correct Factor

Above 1GHz

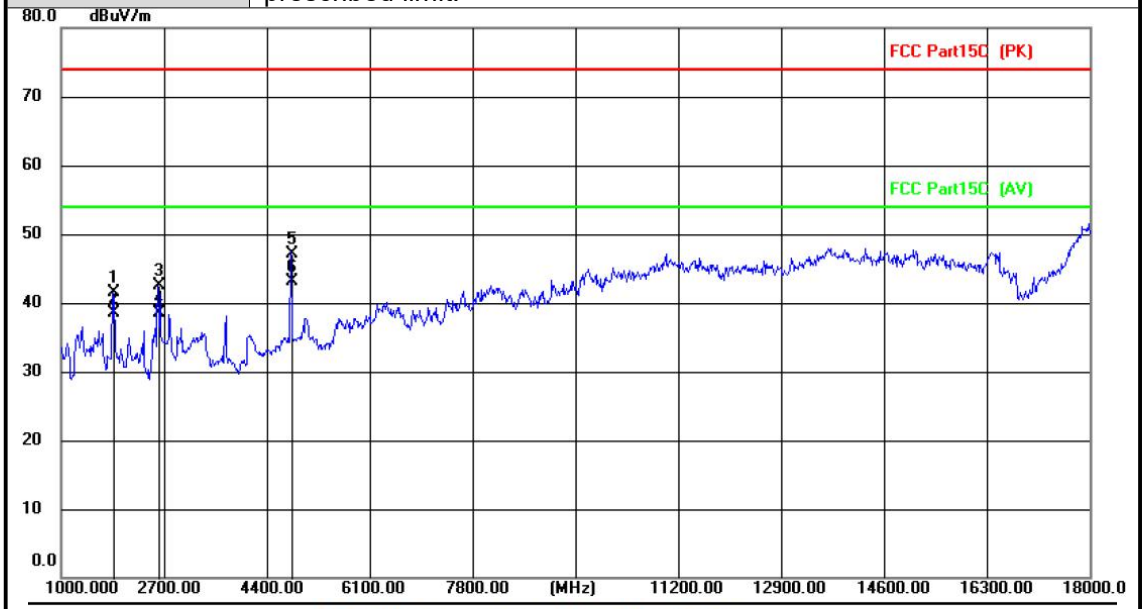
Ant. Pol.	Horizontal
Test Mode:	TX GFSK Mode 2402MHz
Remark:	No report for the emission which more than 10 dB below the prescribed limit.



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		2635.400	59.43	-13.13	46.30	74.00	-27.70	peak
2		2635.400	56.41	-13.13	43.28	54.00	-10.72	AVG
3		4804.600	60.02	-7.78	52.24	74.00	-21.76	peak
4	*	4804.600	57.08	-7.78	49.30	54.00	-4.70	AVG
5		13814.600	42.48	6.28	48.76	74.00	-25.24	peak
6		13814.600	39.48	6.28	45.76	54.00	-8.24	AVG

Measurement = Reading Level+ Correct Factor

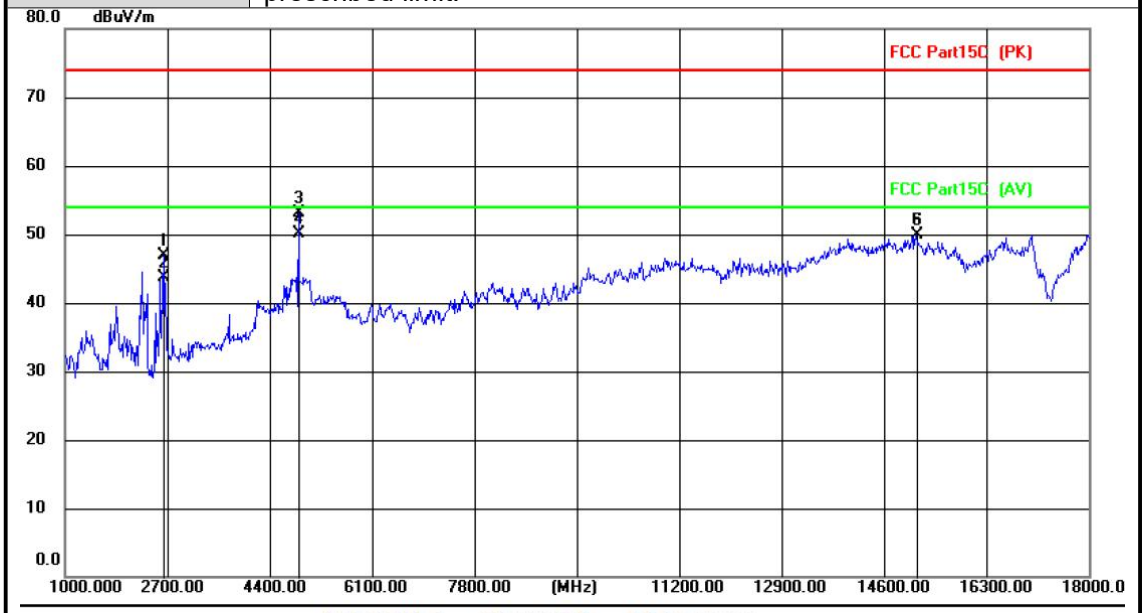
Ant. Pol.	Vertical
Test Mode:	TX GFSK Mode 2402MHz
Remark:	No report for the emission which more than 10 dB below the prescribed limit.



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		1861.900	56.10	-14.51	41.59	74.00	-32.41	peak
2		1861.900	53.10	-14.51	38.59	54.00	-15.41	AVG
3		2609.900	55.64	-13.16	42.48	74.00	-31.52	peak
4		2609.900	51.63	-13.16	38.47	54.00	-15.53	AVG
5		4804.600	54.98	-7.78	47.20	74.00	-26.80	peak
6	*	4804.600	50.86	-7.78	43.08	54.00	-10.92	AVG

Measurement = Reading Level+ Correct Factor

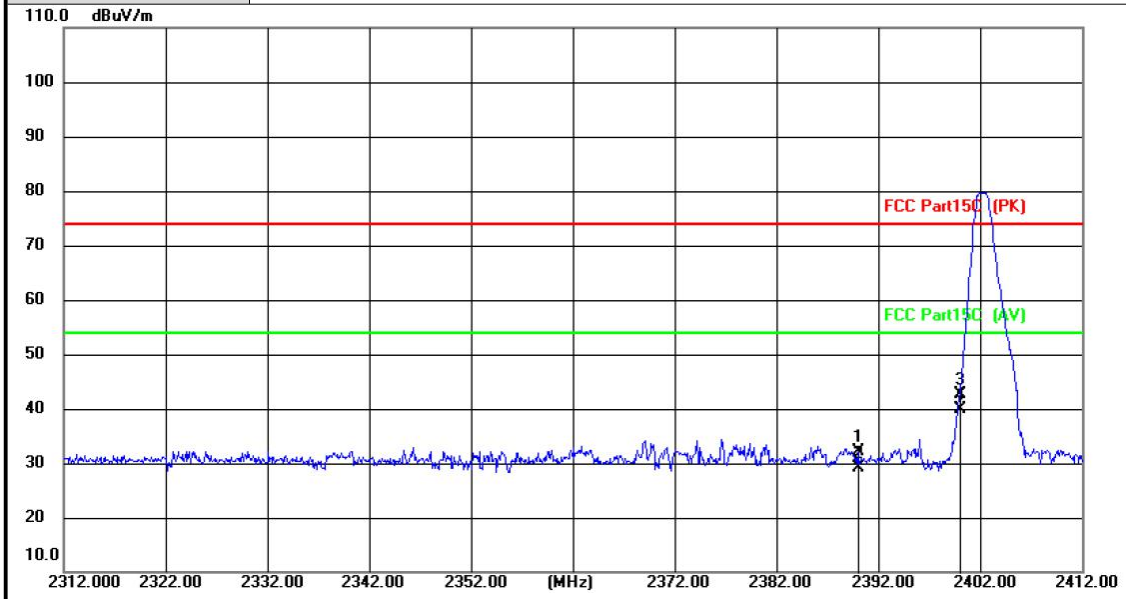
Ant. Pol.	Horizontal
Test Mode:	TX GFSK Mode 2441MHz
Remark:	No report for the emission which more than 10 dB below the prescribed limit.



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		2647.300	59.95	-13.11	46.84	74.00	-27.16	peak
2		2647.300	56.91	-13.11	43.80	54.00	-10.20	AVG
3		4877.700	60.74	-7.64	53.10	74.00	-20.90	peak
4	*	4877.700	57.72	-7.64	50.08	54.00	-3.92	AVG
5		15130.400	42.86	7.06	49.92	74.00	-24.08	peak
6		15130.400	42.86	7.06	49.92	54.00	-4.08	AVG

Measurement = Reading Level+ Correct Factor

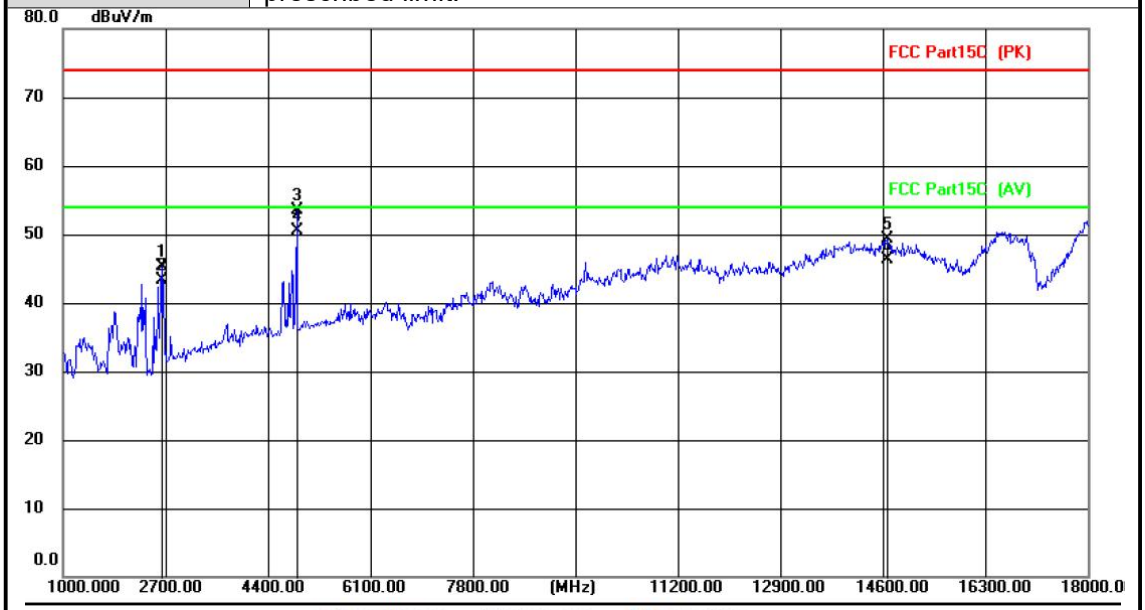
Ant. Pol.	Horizontal
Test Mode:	FHSS Mode 2402MHz



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		2390.000	45.56	-13.49	32.07	74.00	-41.93	peak
2		2390.000	42.56	-13.49	29.07	54.00	-24.93	AVG
3		2400.000	56.07	-13.48	42.59	74.00	-31.41	peak
4	*	2400.000	53.26	-13.48	39.78	54.00	-14.22	AVG

Measurement = Reading level + Correct Factor

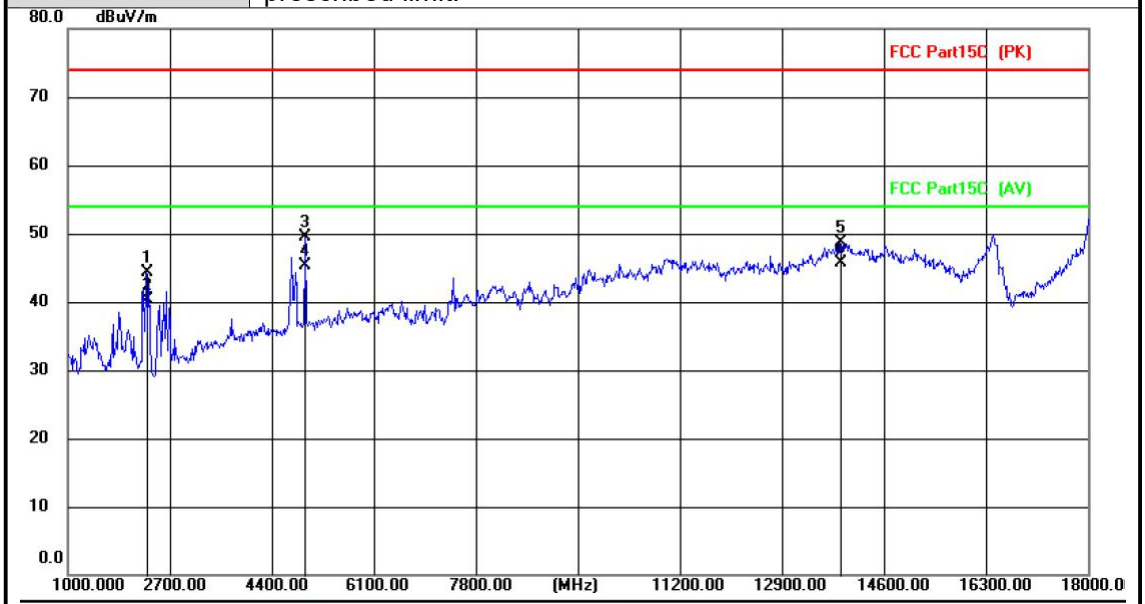
Ant. Pol.	Vertical
Test Mode:	TX GFSK Mode 2441MHz
Remark:	No report for the emission which more than 10 dB below the prescribed limit.



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		2647.300	58.40	-13.11	45.29	74.00	-28.71	peak
2		2647.300	56.38	-13.11	43.27	54.00	-10.73	AVG
3		4877.700	61.16	-7.64	53.52	74.00	-20.48	peak
4	*	4877.700	58.22	-7.64	50.58	54.00	-3.42	AVG
5		14679.900	42.70	6.56	49.26	74.00	-24.74	peak
6		14679.900	39.70	6.56	46.26	54.00	-7.74	AVG

Measurement = Reading Level+ Correct Factor

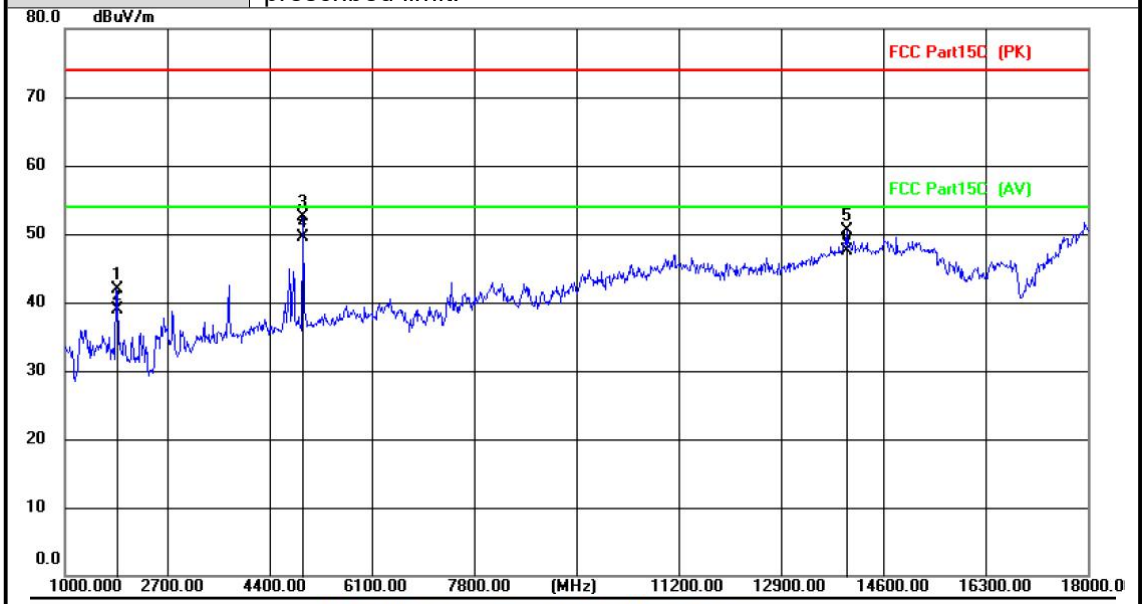
Ant. Pol.	Horizontal
Test Mode:	TX GFSK Mode 2480MHz
Remark:	No report for the emission which more than 10 dB below the prescribed limit.



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		2324.300	57.90	-13.58	44.32	74.00	-29.68	peak
2		2324.300	53.80	-13.58	40.22	54.00	-13.78	AVG
3		4961.000	56.88	-7.47	49.41	74.00	-24.59	peak
4		4961.000	52.86	-7.47	45.39	54.00	-8.61	AVG
5		13882.600	42.23	6.44	48.67	74.00	-25.33	peak
6	*	13882.600	39.21	6.44	45.65	54.00	-8.35	AVG

Measurement = Reading Level+ Correct Factor

Ant. Pol.	Vertical
Test Mode:	TX GFSK Mode 2480MHz
Remark:	No report for the emission which more than 10 dB below the prescribed limit.



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		1860.200	56.44	-14.51	41.93	74.00	-32.07	peak
2		1860.200	53.41	-14.51	38.90	54.00	-15.10	AVG
3		4961.000	59.99	-7.47	52.52	74.00	-21.48	peak
4	*	4961.000	56.89	-7.47	49.42	54.00	-4.58	AVG
5		14001.600	43.85	6.73	50.58	74.00	-23.42	peak
6		14001.600	40.79	6.73	47.52	54.00	-6.48	AVG

Measurement = Reading Level+ Correct Factor

3.11. Pseudorandom Frequency Hopping Sequence

LIMIT

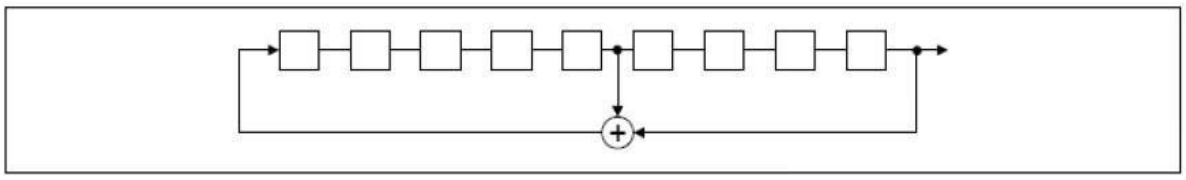
FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hop-ping channel, whichever is greater. Al-ternatively, 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 hop-ping channel bandwidths of their cor-responding transmitters and shall shift frequencies in synchronization with the transmitted signals.

TEST RESULTS

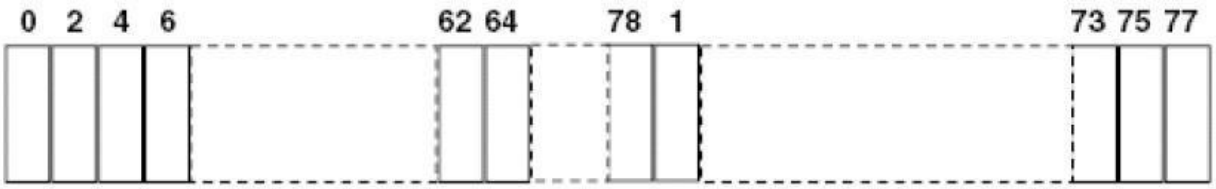
The pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5^{th} and 9^{th} stage outputs are added in a modulo-two addition stage.And the result is fed back to the input of the friststage.The sequence begins with the frist one of 9 consecutive ones, for example: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

- Number of shift register stages: 9
- Length of pseudo-random sequence:29-1=511 bits
- Longest sequence of zeros:8(non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An explame 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. EUT TEST PHOTOS

Reference to the document No.: Test Photos.

5. PHOTOGRAPHS OF EUT CONSTRUCTIONAL

Reference to the document No.: External Photos and Internal Photos.

*************************THE END**************************