3.5. Carrier Frequencies Separation

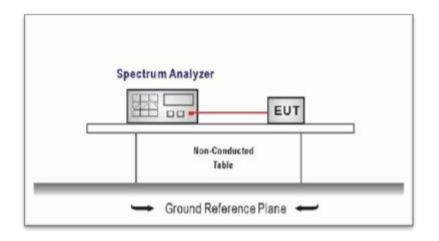
<u>LIMIT</u>

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

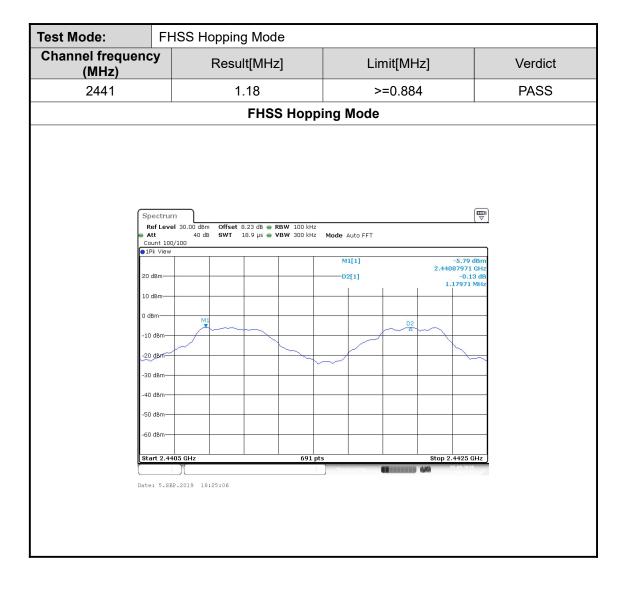
- 1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
- 2. Spectrum Setting:
 - (1) Set RBW = 100 kHz.
 - (2) Set the video bandwidth (VBW) \ge 3 RBW.
 - (3) Detector = Peak.
 - (4) Trace mode = Max hold.
 - (5) Sweep = Auto couple.

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

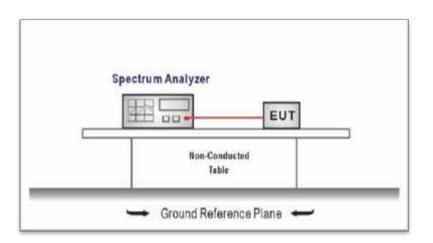


3.6. Number of Hopping Channel

<u>Limit</u>

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.

<u>Test Result</u>

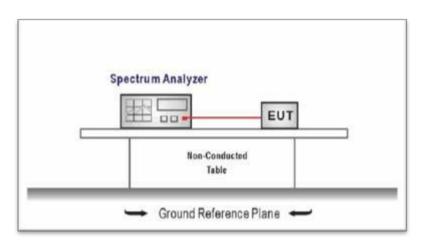
Test Mode:	ode: FHSS Hopping Mode									
Frequency Range		Test Mo	Quantity of Hopping Channel						Limit	
2402MHz~2483.5M	1Hz	Нор		79						>15
			FHSS	5 Нор	ping	Mode				
R A → A → A → → → → → → → → → → → → →	k View JBm JBm JBm JBm JBm JBm JBm JBm JBm JBm	40 dB SWT	8.23 dB • F	/BW 300 kH				Stop 2		

3.7. Dwell Time

<u>Limit</u>

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

<u>Test Result</u>

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

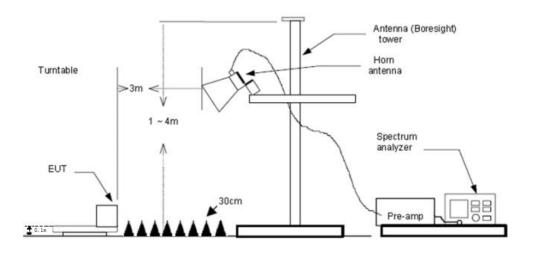
Test Mod	e:	FHS	SS Hopping N	lode									
Test Mode	Chann (MHz		Pulse Time (ms)	To	tal of (ms		Pe	riod Time (s)		mit ns)	Result		
1DH5	2480)	2.98		317.8	37		31.60	4	00	PASS		
1DH5 Total of	f Dwell= F	Pulse t	ime (ms) × (1600	÷6÷79	9) ×31.6	Second							
	FHSS Hopping Mode 1DH5												
	2480MHz												
		● Att SGL TR CI 20 dBm- 10 dBm- -10 dBm -20 dBm- -20 dBm-	2000 30.00 dBm 40 dB SWT G-VID TW TRG -16.500 dBm TRG -16.500 dBm TRG -16.500 dBm										

3.8. Band Edge Emissions (Radiated)

<u>Limit</u>

Restricted Frequency Band	(dBuV/m)(at 3m)								
(MHz)	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.
- 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.

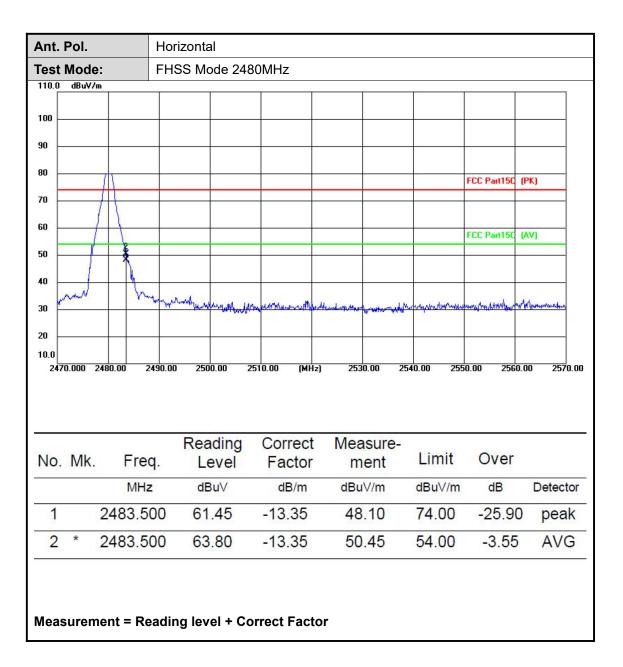
Test Results

Note:

Measurement = Reading level + Correct Factor

Correct Factor=Antenna Factor + Cable Loss -Preamplifier Factor

Ant	. Pol.		Verti	cal														
	t Mod		FHS	S Moo	de 240	02 MH	lz											
110.0	dBuVa	/m				Ĩ												1
100 -											e							
90			_															
80								-						FCC Pa	art15Q	(PK	r	
70						-									-	F		
60														FCC Pa	art15C	(AV)	
50																+		
40															THE REAL	+		
30 🎦	sprinkering	warderstand	Manner	mynny	whenny	my	month	Manualty	menty	July m	hallman	Munique	nyll X	mayness	May	h	Winnyth	6
20			_	_				-										
10.0 23	12.000	2322.00 2	332.00	2342.	00 2	2352.00	(MH	z)	237	2.00	238	2.00	239	2.00	240	2.00	24	2.00
				Rea	dina	Co	rrec	t	Me	asure	2_							
No	. <mark>M</mark> k	. Fre			vel		acto			nent		Lin	nit	0	ver	•		
		MH	z	dB	uV	C	dB/m		dB	uV/m		dBu	√/m		dB		Dete	ctor
1		2390.0	00	44.	54	-13	3.49)	31	1.05		74.	00	-4	12.9	5	pe	ak
2	2	2390.0	00	41.	26	-13	3. <mark>4</mark> 9		27	7.77		54.0	00	-2	26.2	3	A۱	/G
3	3	2400.0	00	53.	53	-13	3.48		40	0.05		74.	00	-3	33.9	5	pe	ak
4	*	2400.0	00	50.	42	-13	3. <mark>4</mark> 8		36	5.94		54.0	00	-1	7.0	6	A۱	/G
Меа	asurer	ment = Re	eading	g leve	l + Co	orrect	Fac	tor										



Ant. Pol.	Vertical							
Test Mode:	FHSS M	ode 248	0 MHz					
110.0 dBuV/m		1	1			T		
100	_							
90								
80							FCC Part150	(PK)
70		-					2	
60								
50							FCC Part150	
30								
40								
30 MM M	heldownway Ano	moneramental	Marina Marina	antipetholyth	an with the stand wit	Malither Johnson	mathematication	white where when
20								
10.0								
2470.000 2480.00	2490.00 25	00.00 25	10.00 (MH	lz) 25	30.00 25	40.00 255	0.00 256	0.00 2570.00
	Re	ading	Correc	t Me	easure-			
No. Mk. Fre		evel	Facto	r I	ment	Limit	Over	3 I
MF	lz d	Bu∨	dB/m	dE	8uV/m	<mark>d</mark> Bu∀/m	dB	Detector
1 2483.	5 <mark>00</mark> 5	6.42	-13.35	4	3.07	74.00	-30.9	3 peak
2 * 2483.	500 5	2.19	-13.35	3	8.84	54.00	-15.1	6 AVG
Measurement = R	eading lev	vel + Co	rrect Fac	tor				
	-							

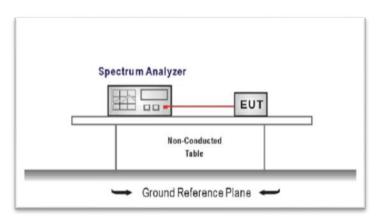
3.9. Band Edge and Spurious Emission (conducted)

<u>LIMIT</u>

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

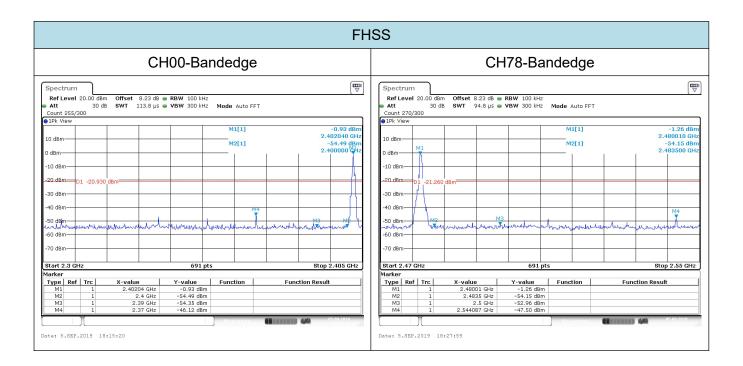
Sweep = auto, Detector function = peak, Trace = max hold

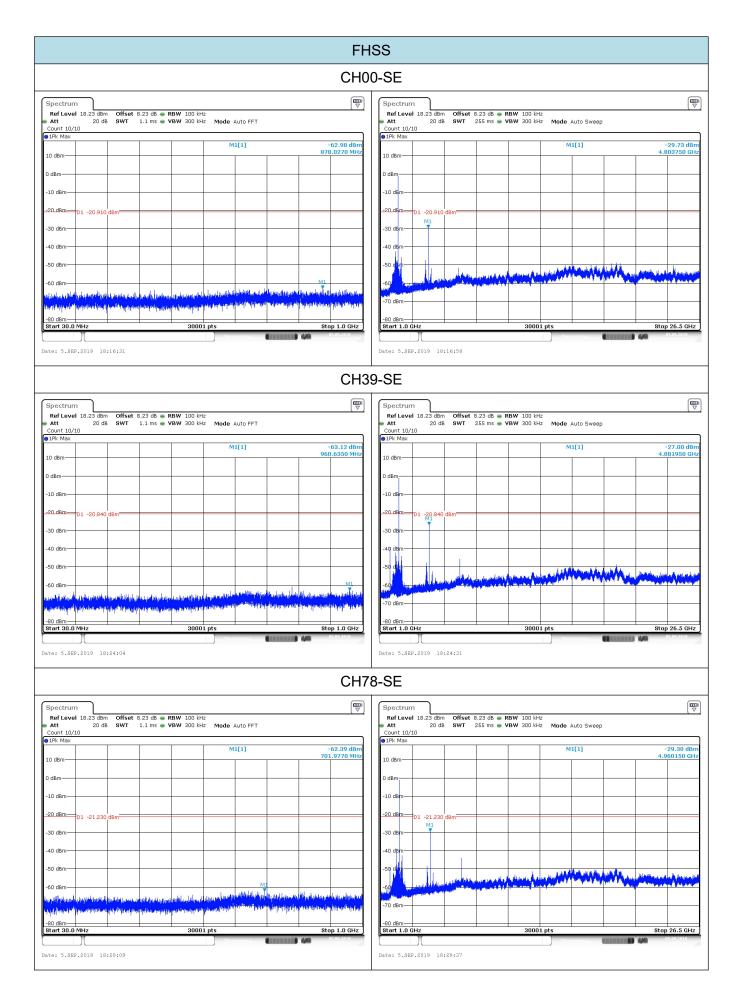
4.Measure and record the results in the test report.

TEST MODE:

Please refer to the clause 2.3.

TEST RESULTS





Zhejiang Kezheng Electronic Product Inspection

3.10. Radiated Spurious Emissions

<u>Limit</u>

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		

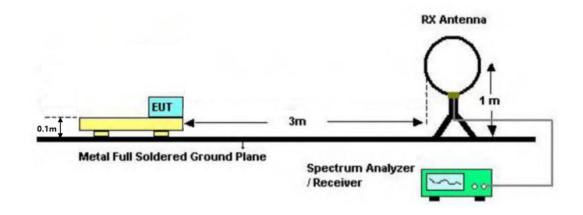
Radiated Emission Limit (Above 1000MHz)

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

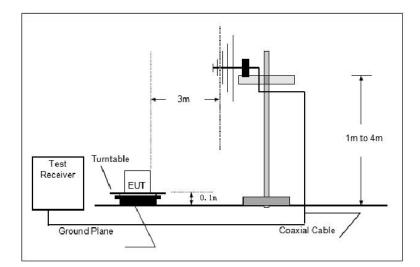
Note:

- (1) The tighter limit applies at the band edges.
- (2) Emission Level (dBuV/m)=20log Emission Level (uV/m).

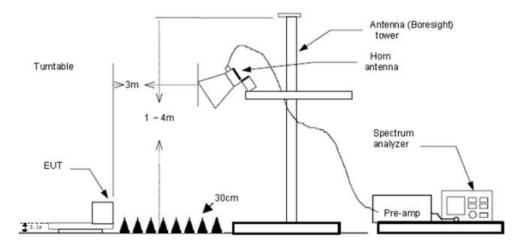
Test Configuration



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.

<u>Test Mode</u>

Please refer to the clause 2.3.

<u>Test Result</u>

9 KHz~30 MHz and 18GHz~25GHz

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

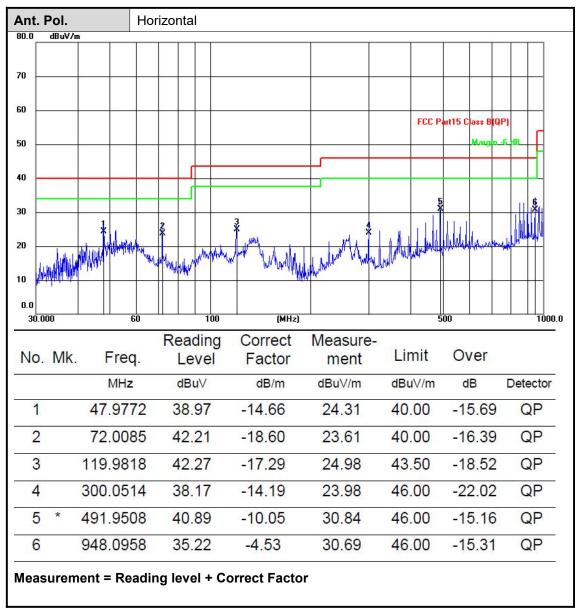
Note:

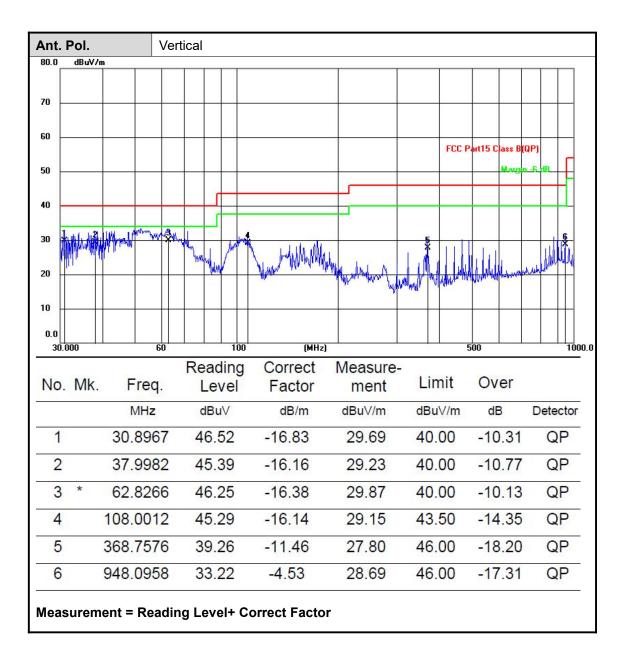
1) Measurement = Reading level + Correct Factor

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

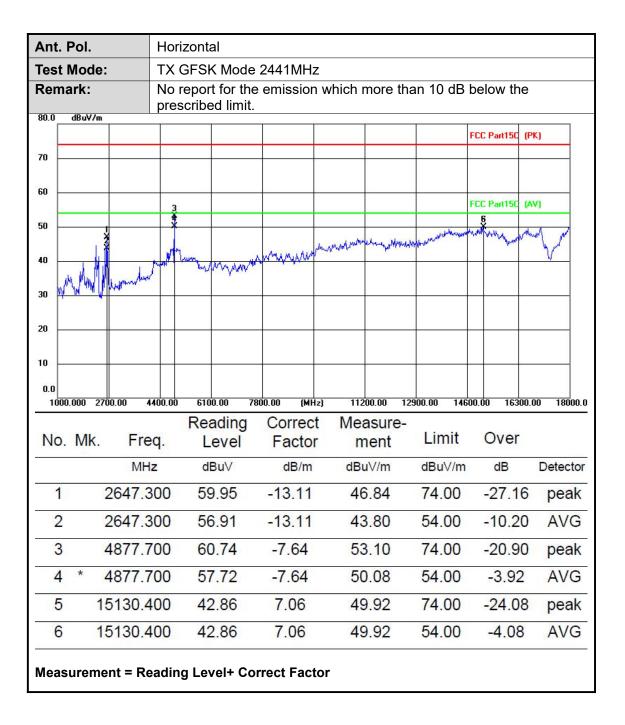




Above 1GHz

Ant	. Pol.		Но	rizontal					
Tes	t Mod	e:	ΤХ	GFSK Mode	e 2402MHz				
	nark:			report for th scribed limit		which more tha	an 10 dB	below the	
80.0	dBu¥	/m							1000
					_		-	FCC Part15C (PK)
70									
60								FCC Part15C (AV)
50		-	X				5		ALL C
		X			the second the	who was many maker the	hopen	howwelling	In from
40	. M.	Munut	Waterow	human	WWW. WOWN				
30	Mun A. Mu	ry www							
20					_				
10									
0.0									
1(000.000	2700.00	4400.0		7800.00 (MHz)		900.00 146	00.00 16300	.00 18000.0
No	. Mk	. Fre	q.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MH	z	dBu∨	dB/m	dBuV/m	dBuV/m	dB	Detector
1		2635.4	00	59.43	-13.13	46.30	74.00	-27.70	peak
2		2635.4	00	56.41	-13.13	43.28	54.00	-10.72	AVG
3	}	4804.6	00	60.02	-7.78	52.24	74.00	-21.76	peak
4	*	4804.6	600	57.08	-7.78	49.30	54.00	-4.70	AVG
5	;	13814.6	00	42.48	6.28	48.76	74.00	-25.24	peak
6	;	13814.6	600	39.48	6.28	45.76	54.00	-8.24	AVG
Mea	surer	nent = R	eadiı	ng Level+ Co	orrect Facto	r			

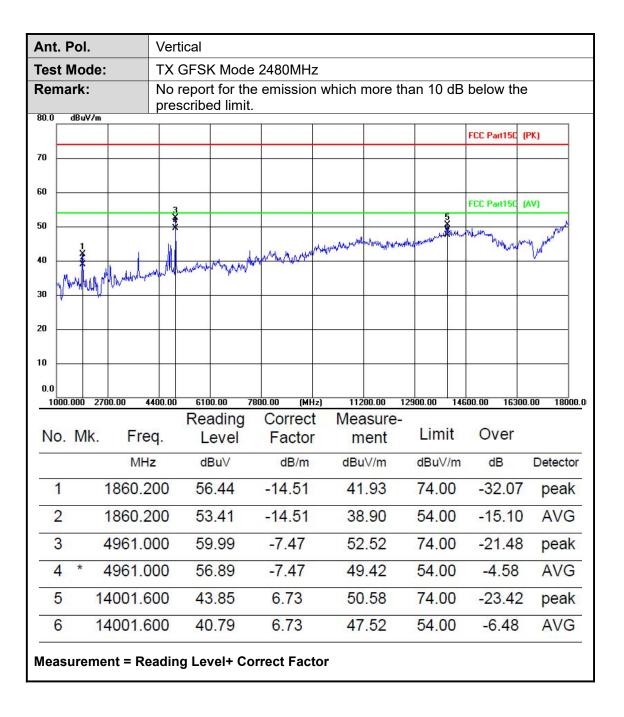
An	t. P	ol.		Ve	rtical										
Tes	st N	lode	:	TX GFSK Mode 2402MHz											
Rei					No report for the emission which more than 10 dB below the prescribed limit.										
80.0	d	lBu¥/m		T					1						
	_			-			-				FCC Part150	(PK)			
70						j.									
60											FCC Part150				
50															
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40		*	X	Ť	1 NW	MANNA	warman and	Mana				Muka			
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20				+							-				
10															
0.0	000.0	00 27	00.00 4	400.00	C10	0.00 7	/800.00 (M	Hz) 11	200.00	12900.00 14	600.00 163	00.00 18000.0			
	JUU. U	100 27	00.00 4	400.00		ading	Correc		asure-	12300.00 14	600.00 163	0.00 1000.0			
N	0.	Mk.	Fre	q.		evel	Facto		nent	Limit	Over				
			MH	z	dE	B <mark>u</mark> ∨	dB/m	dBu	uV/m	dBuV/m	dB	Detector			
	1		1861.9	00	56	.10	-14.51	41	.59	74.00	-32.41	peak			
	2		1861.9	00	53	.10	<mark>-14</mark> .51	38	8.59	54.00	-15.41	AVG			
5	3		2609.9	00	55	.64	-13.16	42	2.48	74.00	-31.52	peak			
	4		2609.9	00	51	.63	-13.16	38	3.47	54.00	-15.53	AVG			
	5		4804.6	00	54	.98	-7.78	47	.20	74.00	-26.80	peak			
)	6	*	4804.6	00	50	.86	-7.78	43	8. <mark>08</mark>	54.00	-10.92	AVG			
Me	asu	irem	ent = Re	adir	ng Lev	vel+ Co	orrect Fac	tor							



Ant.	Pol.		Horiz	zonta	al													
	Mode		FHS	S Mo	ode 24	02M	Hz											
110.0	dBu∀/r	n																1
100 -						_										-		-
90 -										3						š		_
80																1		
														FCC Pa	art150	(PK)	
70 -						+												
60 -						+								FCC Pa	art15C	idv)	-
50 -						-										1		
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20 -																9		
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		-	atosu		ading		orrea			asure	e-			0				
No.	Mk.	Fre	q.	L	evel	F	Facto	or	n	nent		Lim	lit	C	ve			
		MH	z	d	BuV		dB/m	۱	dBu	uV/m		dBu\	//m	j is	dB		Dete	ctor
1	1 2390.0		00	45	5.56	-	-13.49		32.07			74.00		-41.93		93	pe	ak
2		2390.000		42.56		-	-13.49		29.07			54.00		- <mark>24</mark> .93		93	AV	/G
3		2400.0	00	56	5.07	-	13.48	3	42	2.59		74.0	00	-3	31.4	1	pe	ak
4	*	2400.0	00	53	8.26	-	13.48	3	39	9.78		54.0	00	-1	14.2	22	AV	/G
Meas	surem	ient = Re	eadin	g lev	rel + C	orre	ct Fac	ctor	,									

Ant	t. Pol		Vertica	al									
Tes	st Mo	de:	TX GFSK Mode 2441MHz										
-	mark		No report for the emission which more than 10 dB below the prescribed limit.										
80.0	dBu\	//m	1	1	T T		T						
13								FCC Part15C (PK)				
70	<u> </u>												
60			-					FCC Part15C	AVI				
			33					A second second second second					
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0.0													
1(000.000	2700.00 4	400.00	6100.00 78	00.00 (MHz)	11200.00 12	900.00 146	00.00 16300).00 18000.0				
				Reading	Correct	Measure-							
N	o. M	k. Fre	q.	Level	Factor	ment	Limit	Over					
		MH	z	dBu∨	dB/m	dBuV/m	dBuV/m	dB	Detector				
	1	2647.3	00	58.40	-13.11	45.29	74.00	-28.71	peak				
2	2	2647.3	00	56.38	-13.11	43.27	54.00	-10.73	AVG				
	3	4877.7	00	61.16	-7.64	53.52	74.00	-20.48	peak				
2	4 *	4877.7	00	58.22	-7.64	50.58	54.00	-3.42	AVG				
	5	14679.9	00	42.70	6.56	49.26	74.00	-24.74	peak				
(6	14679.9	00	39.70	6.56	46.26	54.00	-7.74	AVG				
Меа	asure	ment = Re	ading	Level+ Co	rrect Facto	or							

Ant	. Po	I.		H	orizor	ntal												
Test Mode:					TX GFSK Mode 2480MHz													
Remark:					No report for the emission which more than 10 dB below the prescribed limit.													
80.0	dBu	ı¥/m		Ť		1		1										٦
						_			_			_		_	FCC Part1	5C (F	РК)	
70				-				-	-			_	-					-
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20																		
20																		1
10		_																
0.0 1(00.000) 270	0.00	4400.	.00 E	5100.00	78	DO. 00	(MHz)	112	200.00	129	00.00	146	00.00 1	6300.	00 18	3000.0
					R	eadin	a	Corre	ect	Mea	asure)-						
No). M	lk.	Fre	eq.		Leve	-	Fac			nent		Lim	nit	Ove	r		
			MH	lz		dBu∨		dB	/ <mark>m</mark>	dBu	IV/m		dBu\	//m	dB		Dete	ctor
	1	2	2324.3	300) {	57.90		-13.5	8	44	.32		74.0	00	-29.	68	pe	ak
2	2	2	2324.3	300) 5	5 <mark>3.80</mark>		-13.5	58	40).22		54.0	00	-13.	78	A۱	/G
3	3	4	1961.0	000) 5	56.88		-7.4	7	49) <mark>.4</mark> 1		74.0	00	-24.	59	pe	ak
4	1	4	1961.0	000) 5	52.86	1	-7.4	7	45	5.39		54.0	00	-8.6	51	A۱	/G
Ę	5	13	8882.6	600) 2	12.23		6.44	4	48	8. <mark>67</mark>	1	74.0	00	-25.	33	pe	ak
6	ð *	13	3 <mark>882.6</mark>	600) (39.21		6.44	1	45	6. <mark>6</mark> 5		54.0	00	-8.3	35	A٧	/G
Меа	sure	eme	nt = Re	ead	ing L	evel+	Cor	rect Fa	actor	,								



3.11. Pseudorandom Frequency Hopping Sequence

<u>LIMIT</u>

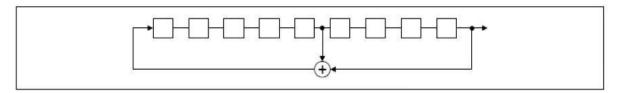
FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):

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:

0	2	4	6	62 64	78	1	73 75 77

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.