Audix Technology Corp.
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New Taipei City244,Taiwan

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FCC 15.247
2.4GHz Test Report

for

FUTABA Corporation

1080 YabutsukaChosei-son Chosei-gun
Chiba, 299-4395 Japan.

Brand	**:**	**Futaba**
Product Name	**:**	**Radio Control**
Model Name	**:**	**T7PX**
FCC ID	**:**	**AZPT7PX-24G**

Prepared by: **:** **AUDIX Technology Corporation, EMC Department**

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TEST REPORT CERTIFICATION

Applicant	:	FUTABA Corporation
Manufacture	:	FUTABA Corporation
EUT Description		
(1) Product	:	Radio Control
(2) Model	:	T7PX
(3) Brand	:	Futaba

Applicable Standards:

47 CFR FCC Part 15 Subpart C
ANSI C63.10:2013

Audix Technology Corp. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.
Audix Technology Corp. does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens and samples.

Date of Report: 2017. 08. 16

Reviewed by: (Tina Huang/Administrator)

Approved by: (Ben Cheng/Manager)

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1. REVISION RECORD OF TEST REPORT

Edition No	Issued Data	Revision Summary	Report Number
0	2017. 08. 16	Original Report.	EM-F170498

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2. SUMMARY OF TEST RESULTS

Rule	Description	Results
15.207	Conducted Emission	**N/A, NOTE**
15.247(d)/15.205	Radiated Band Edge and Radiated Spurious Emission	**PASS**
15.247(a)(1)	20dB Bandwidth	**PASS**
15.247(a)(1)	Carrier Frequency Separation	**PASS**
15.247(a)(1)(iii)	Time of Occupancy	**PASS**
15.247(a)(1)(iii)	Number of Hopping Channels	**PASS**
15.247(b)(1)	Maximum Peak Output Power	**PASS**
15.247(d)	Conducted Band Edges and Conducted Spurious Emission	**PASS**
15.203	Antenna Requirement	**PASS**
Note: The EUT only employs battery power for operation, so it is unnecessary to test.		

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3. GENERAL INFORMATION

3.1. Description of Application

Applicant	FUTABA Corporation 1080 Yabutsuka Chosei-mura Chosei-gun Chiba-ken, 299-4395 Japan.
Manufacturer	FUTABA Corporation 1080 Yabutsuka Chosei-mura Chosei-gun Chiba-ken, 299-4395 Japan.
Product	Radio Control
Model	T7PX
Brand	Futaba

3.2. Description of Application

Test Model	T7PX
Serial Number	N/A
Power Rating	6.6Vdc
Firmware Version	N/A
RF Features	FHSS (S-FHSS, T-FHSS, T-FHSS SR) and DSSS (FASST)
Transmit Type	1T1R
Sample Status	Production
Date of Receipt	2017. 06. 22
Date of Test	2017. 06. 27 ~ 08. 16
I/O Ports List	None
Accessories Supplied	Battery: Futaba, M/N FT2F1700BV2

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3.3. Antenna Information

No.	Antenna Part Number	Manufacture	Antenna Type	Frequency (MHz)	Max Gain (dBi)
1	ANTB24-094A0	SANSEI ELECTRIC CO., LTD	1/2λ di-pole	2400 ~ 2500	1.48

3.4. EUT Specifications Assessed in Current Report

Mode	Fundamental Range (MHz)	Channel Number	Modulation	Data Rate (kbps)
FHSS	2403.250 to 2447.500	60	S-FHSS	128
FHSS	2407.500 to 2467.500	31	T-FHSS	384
FHSS	2407.500 to 2467.500	31	T-FHSS SR	384

Modulation: S-FHSS					
Channel List					
Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)
1	2403.25	21	2418.25	41	2433.25
2	2404.00	22	2419.00	42	2434.00
3	2404.75	23	2419.75	43	2434.75
4	2405.50	24	2420.50	44	2435.50
5	2406.25	25	2421.25	45	2436.25
6	2407.00	26	2422.00	46	2437.00
7	2407.75	27	2422.75	47	2437.75
8	2408.50	28	2423.50	48	2438.50
9	2409.25	29	2424.25	49	2439.25
10	2410.00	30	2425.00	50	2440.00
11	2410.75	31	2425.75	51	2440.75
12	2411.50	32	2426.50	52	2441.50
13	2412.25	33	2427.25	53	2442.25
14	2413.00	34	2428.00	54	2443.00
15	2413.75	35	2428.75	55	2443.75
16	2414.50	36	2429.50	56	2444.50
17	2415.25	37	2430.25	57	2445.25
18	2416.00	38	2431.00	58	2446.00
19	2416.75	39	2431.75	59	2446.75
20	2417.50	40	2432.50	60	2447.50

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Modulation: T-FHSS and T-FHSS SR			
Channel List			
Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)
1	2407.5	17	2439.5
2	2409.5	18	2441.5
3	2411.5	19	2443.5
4	2413.5	20	2445.5
5	2415.5	21	2447.5
6	2417.5	22	2449.5
7	2419.5	23	2451.5
8	2421.5	24	2453.5
9	2423.5	25	2455.5
10	2425.5	26	2457.5
11	2427.5	27	2459.5
12	2429.5	28	2461.5
13	2431.5	29	2463.5
14	2433.5	30	2465.5
15	2435.5	31	2467.5
16	2437.5		

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3.5. Test Configuration

Modulation	T_{on} (ms)	Duty Cycle Factor (dB)
S-FHSS	3.045	N/A
T-FHSS	0.418	N/A
T-FHSS SR	0.416	N/A

Item		Modulation	Test Channel
Radiated Test Case	Radiated Band Edge Note1	S-FHSS	1/60
		T-FHSS	1/31
	Radiated Spurious Emission Note1	S-FHSS	1/30/60
		T-FHSS	1/16/31
Conducted Test Case	20dB Bandwidth	S-FHSS	1/30/60
		T-FHSS	1/16/31
	Carrier Frequency Separation	S-FHSS	1/30/60
		T-FHSS	1/16/31
	Time of Occupancy	S-FHSS	1/30/60
		T-FHSS	1/16/31
		T-FHSS SR	1/16/31 Note A
	Number of Hopping Channels	S-FHSS	1/30/60
		T-FHSS	1/16/31
	Maximum Peak Output Power	S-FHSS	1/30/60
		T-FHSS	1/16/31
	Band Edges	S-FHSS	1/60
		T-FHSS	1/31
	Spurious Emission	S-FHSS	1/30/60
		T-FHSS	1/16/31
Note A: This system is similar to T-FHSS system, the difference is frame length from 3ms to 1.2ms.The purpose of this change is to get quick response. So this test item would be test.			

Note 1:

☐Mobile Device

■Portable Device, and 3 axis were assessed. The worst scenario for Radiated Spurious Emission as follow:

■ Lie

☐ Side

☐ Stand

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3.6. Tested Supporting System List

None.

3.7. Setup Configuration

3.7.1. EUT Configuration for Radiated Emission

3.7.2. EUT Configuration for RF Conducted Test Items

3.8. Operating Condition of EUT

Test program “Futaba Term” is used for enabling EUT RF function under continues transmitting and choosing data rate/ channel.

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3.9. Description of Test Facility

Name of Test Firm	Audix Technology Corporation / EMC Department No. 53-11, Dingfu, Linkou Dist., New Taipei City 244, Taiwan Tel: +886-2-26092133 Fax: +886-2-26099303 Website : www.audixtech.com Contact e-mail: sales@audixtech.com
Accreditations	The laboratory is accredited by following organizations under ISO/IEC 17025:2005 (1) NVLAP(USA) NVLAP Lab Code 200077-0 (2) TAF(Taiwan) No. 1724 (3) FCC OET Designation No. TW1004 & TW1090 & TW1724
Test Facilities	(1) Semi-Anechoic Chamber (IC Test Site Registration No.: 5183B-1)

3.10.Measurement Uncertainty

Test Item	Frequency Range	Uncertainty
Radiation Test (Distance: 3m)	30MHz~1000MHz	± 3.68dB
	Above 1GHz	± 5.82dB

Remark：Uncertainty = $ku_c(y)$

Test Item	Uncertainty
20dB Bandwidth	±0.2kHz
Carrier Frequency Separation	±0.2kHz
Time of Occupancy	±0.03sec
Maximum peak Output power	± 0.52dB
Conducted Emission Limitations	± 0.13dB

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4. MEASUREMENT EQUIPMENTLIST

4.1. Radiated Emission Measurement

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A-526	MY53400071	2016. 09. 19	1 Year
2.	Test Receiver	R & S	ESCS30	100338	2017. 06. 19	1 Year
3.	Amplifier	HP	8447D	2944A06305	2017. 02. 16	1 Year
4.	Amplifier	HP	8449B	3008A00529	2017. 02. 08	1 Year
5.	Bilog Antenna	CHASE	CBL6112D	33821	2017. 01. 21	1 Year
6.	HornAntenna	EMCO	3115	9609-4927	2017. 06. 27	1 Year
7.	Double-Ridged Waveguide Horn	ETS-Lindgren	3117	00135902	2017. 03. 08	1 Year
8.	2.4GHz Notch Filter	K&L	7NSL10-244 1.5E130.5-00	1	2017. 07. 27	1 Year
9.	3GHz Notch Filter	Microwave	H3G018G1	484798	2016. 08. 25	1 Year
10	Test Software	Audix	e3	V.6.110601	N.C.R.	N.C.R.

4.2. RF Conducted Measurement

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9030A-526	MY53310269	2017. 01. 03	1 Year

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5. CONDUCTED EMISSION MEASUREMET

【The EUT only employs battery power for operation, no conductive emission limits are required according to FCC 15.207】

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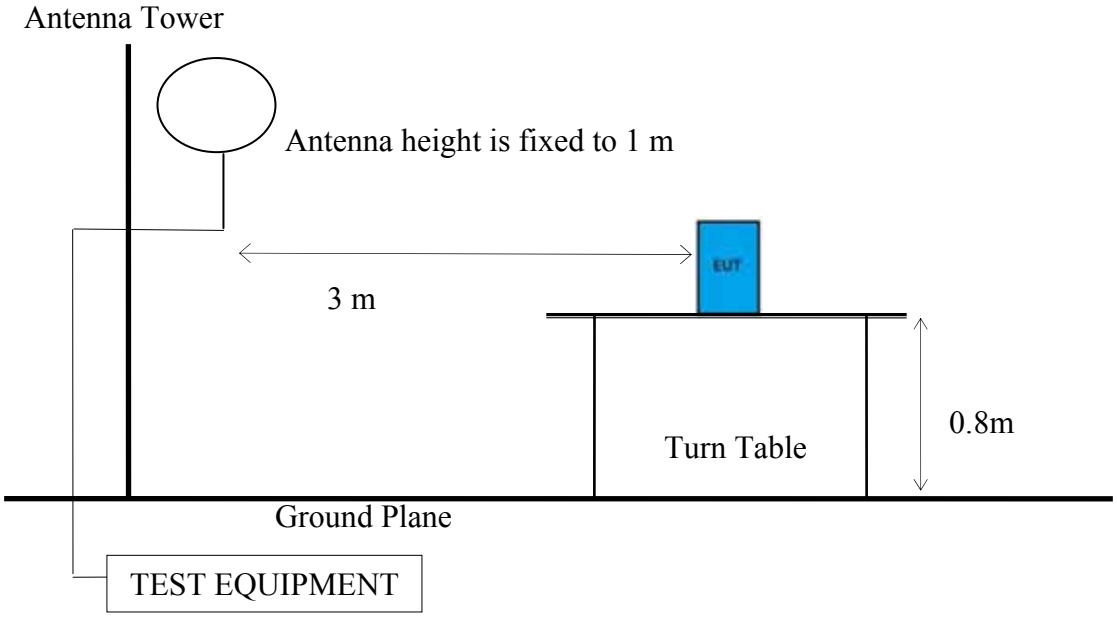
6. RADIATED EMISSION MEASUREMENT

6.1. Block Diagram of Test Setup

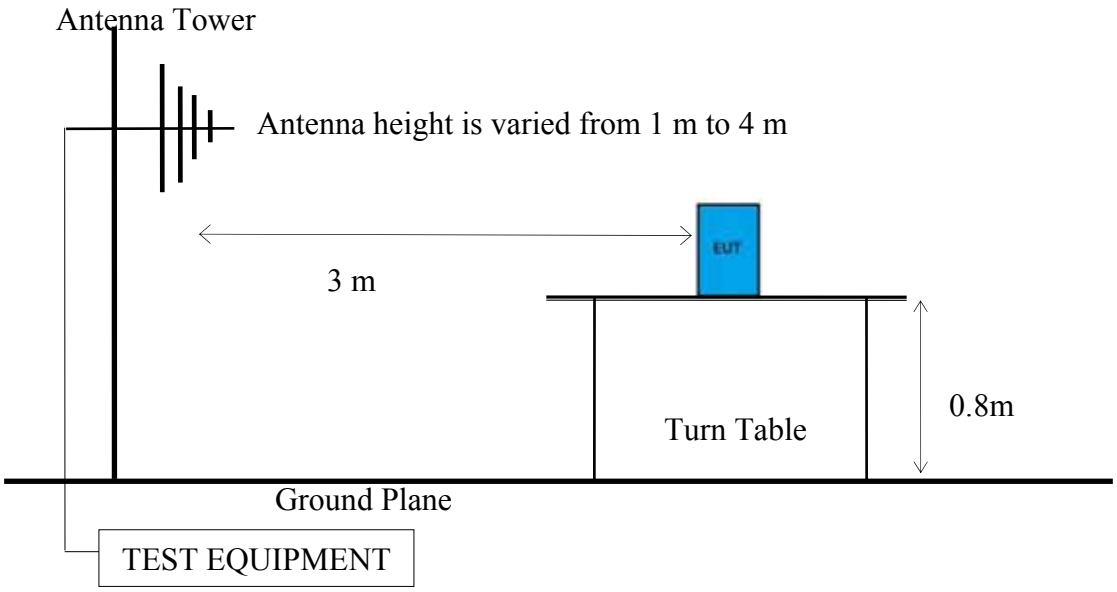
6.1.1. Block Diagram of connection between EUT and simulators

Indicated as section 3.7

6.1.2. Setup Diagram for 9kHz-30MHz



6.1.3. Setup Diagram for 30-1000 MHz



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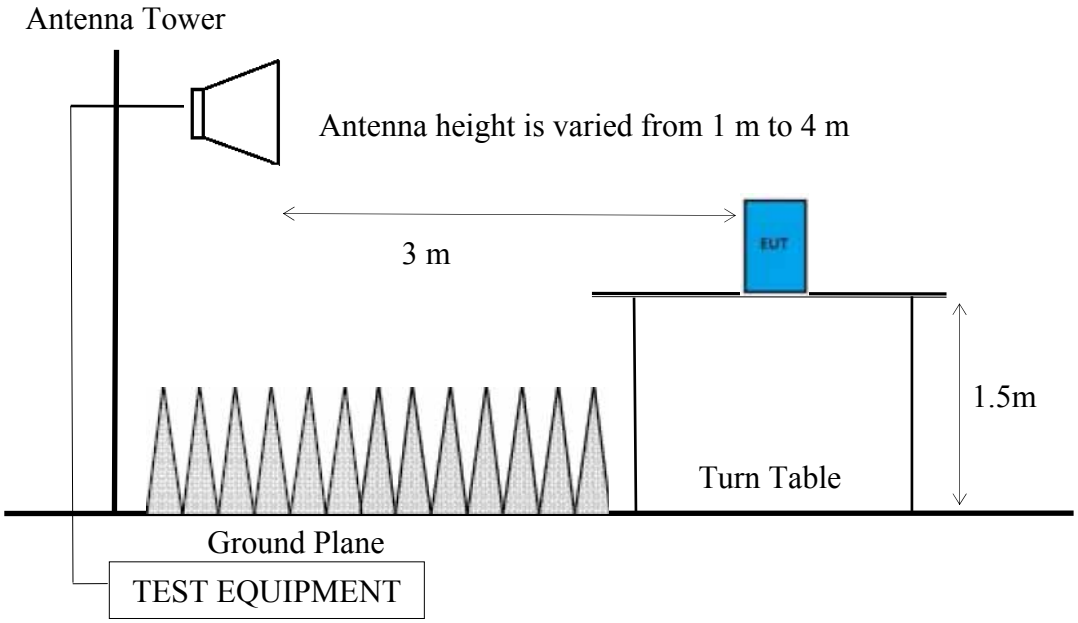
6.1.4. Setup Diagram for above 1GHz



6.2. Radiated Emission Limits

In any 100kHz bandwidth outside the frequency band, the radio frequency power produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level. In addition, radiated emissions which fall in restricted bands, as defined in Section 15.205/RSS-Gen Section 8.10 table 6, must also comply with the radiated emission limits specified as below.

Frequency (MHz)	Distance (m)	Limits	
		dBμV/m	μV/m
0.009 - 0.490	300	67.6	2400/kHz
0.490 - 1.705	30	87.6	24000/kHz
1.705 - 30	30	29.5	30
30 - 88	3	40.0	100
88- 216	3	43.5	150
216- 960	3	46.0	200
Above 960	3	54.0	500
Above 1000	3	74.0 dBμV/m (Peak) 54.0 dBμV/m (Average)	

Remark：(1) dBμV/m = 20 log (μV/m)
(2) The tighter limit applies to the edge between two frequency bands.
(3) Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.
(4) Fundamental and emission fall within operation band are exempted from this section.
(5) Pursuant to ANSI C63.10: 6.6.4.3, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement

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6.3. Test Procedure

Frequency Range 9kHz~30MHz:
The EUT setup on the turn table which has 0.8 m height to the ground. The turn table rotated 360 degrees and antenna fixed to 1 m to find the maximum emission level.
In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10-2013 regulation.

(1) RBW = 9kHz with peak and average detector.
(2) Detector: average and peak (9kHz-490kHz)
Q.P. (490kHz-30MHz)

Frequency Range 30MHz ~ 25GHz:
The EUT setup on the turn find table which has 80 cm (for 30-1000 MHz) and 1.5m (for above 1GHz) height to the ground. The turn table rotated 360 degrees and antenna varied from 1 m to 4 m to find the maximum emission level. Both horizontal and vertical polarization are required. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10-2013 regulation.

Frequency below 1GHz:
Spectrum Analyzer is used for pre-testing with following setting:

(1) RBW = 120KHz
(2) VBW ≥ 3 x RBW.
(3) Detector = Peak.
(4) Sweep time = auto.
(5) Trace mode = max hold.
(6) Allow sweeps to continue until the trace stabilizes.
(7) When peak-detected value is lower than limit that the measurement using the Q.P. detector is not required. Otherwise using Q.P. for finally measurement.

Frequency above 1GHz to 10th harmonic:

Peak Measurement:

(1) RBW = 1 MHz
(2) VBW ≥ 3 x RBW.
(3) Detector = Peak.
(4) Sweep time = auto.
(5) Trace mode = max hold.
(6) Allow sweeps to continue until the trace stabilizes.
(7) When peak-detected value is lower than limit that the measurement using the average detector is not required. Otherwise using average for finally measurement.

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Average Measurement:

■**Option 1:**

(1) RBW = 1 MHz
(2) VBW =1/T, where T is Tx-on presented in Appendix A.4.
(3) Detector = Peak.
(4) Sweep time = auto.
(5) Trace mode = max hold.
(6) Allow sweeps to continue until the trace stabilizes.

☐**Option 2:**

Average Emission Level= Peak Emission Level+ D.C.C.F.

6.4. Measurement Result Explanation

■Peak Emission Level=Antenna Factor + Cable Loss + Meter Reading

■Average Emission Level l=Antenna Factor + Cable Loss + Meter Reading

☐Average Emission Level= Peak Emission Level+ DCCF

Duty Cycle Correction Factor (DCCF)= 20log (TX_{on}/100ms) presented in section 3.5

☐ERP= Peak Emission Level-95.2dB-2.14dB

6.5. Test Results

Please refer to Appendix A.

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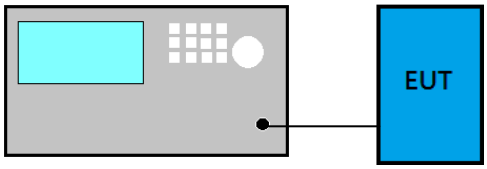
7. 20DB BANDWIDTH MEASUREMENT

7.1. Block Diagram of Test Setup



7.2. Specification Limits

Alternatively, frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater.

7.3. Test Procedure

Following measurement procedure is reference to ANSI C63.10-2013:

(1) Set RBW close to1% of OBW.
(2) Set VBW≧RBW.
(3) Detector = Peak.
(4) Trace mode = max hold.
(5) Sweep = auto couple.
(6) Allow the trace to stabilize.
(7) Setting channel bandwidth function x dB to -20 dB to record the final bandwidth.

7.4. Test Results

Please refer to Appendix A

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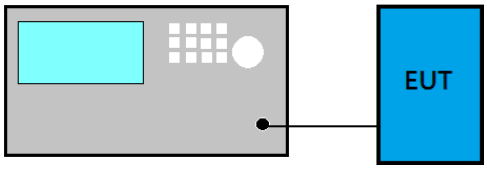
8. CARRIER FREQUENCY SEPARATION MEASUREMENT

8.1. Block Diagram of Test Setup



8.2. Specification Limits

Alternatively, frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output no greater than 125mW.

8.3. Test Procedure

Following measurement procedure is reference to ANSI C63.10-2013:

(1) Span = wide enough to capture the peaks of two adjacent channels
(2) RBW ≥ 1% of the span
(3) VBW≥ RBW
(4) Sweep = auto
(5) Detector function = peak
(6) Trace = max hold

8.4. Test Results

Please refer to Appendix A

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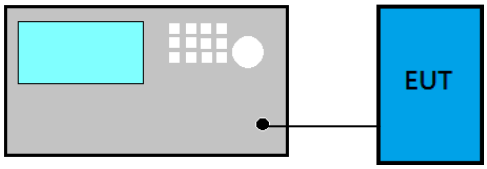
9. TIME OF OCCUPANCY MEASUREMENT

9.1. Block Diagram of Test Setup



9.2. Specification Limits

Frequency hopping systems in the 2400-2483.5MHz shall use at least 15 non-overlapping channels. 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 number of hopping channels employed.

9.3. Test Procedure

Following measurement procedure is reference to ANSI C63.10-2013:

(1) Span = zero span, centered on a hopping channel
(2) RBW = 1 MHz
(3) VBW ≥ RBW
(4) Sweep = as necessary to capture the entire dwell time per hopping channel
(5) Detector function = peak
(6) Trace = max hold

9.4. Test Results

Please refer to Appendix A

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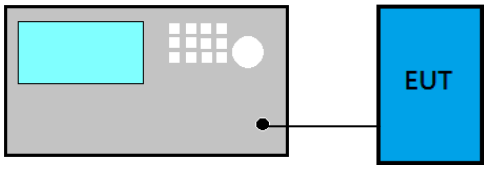
10. NUMBER OF HOPPING CHANNELS MEASUREMENT

10.1. Block Diagram of Test Setup



10.2. Specification Limits

Frequency hopping systems which use fewer than 20 hopping frequencies may employ intelligent hopping techniques to avoid interference to other transmissions. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels.

10.3. Test Procedure

Following measurement procedure is reference to ANSI C63.10-2013:

(1) Span = the frequency band of operation
(2) RBW ≥ 1% of the span
(3) VBW ≥ RBW
(4) Sweep = auto
(5) Detector function = peak
(6) Trace = max hold

10.4. Test Results

Please refer to Appendix A

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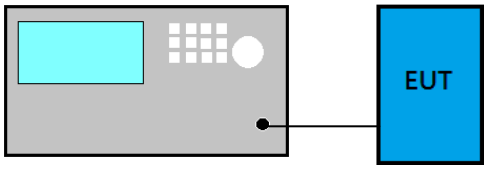
11. MAXIMUM PEAK OUTPUT POWER MEASUREMENT

11.1. Block Diagram of Test Setup



11.2. Specification Limits

The Limits of maximum Peak Output Power for frequency hopping systems in 2400-2483.5MHz is: 0.125Watt. (21dBm)

11.3. Test Procedure

Following measurement procedure is reference to ANSI C63.10-2013:

(1) Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
(2) RBW ≥ 1% of the span
(3) VBW ≥ RBW
(4) Sweep = auto
(5) Detector function = peak
(6) Trace = max hold

11.4. Test Results

Please refer to Appendix A

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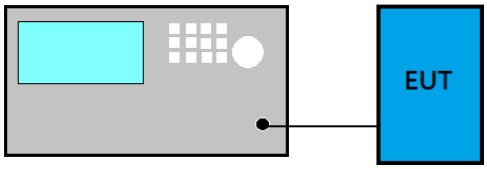
12. EMISSION LIMITATIONS MEASUREMENT

12.1. Block Diagram of Test Setup



12.2. Specification Limits

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (See Section 15.205(c)).(※This test result attaching to §3.6.3)

12.3. Test Procedure

Following measurement procedure is reference to ANSI C63.10-2013:

(1) Set span wide enough to capture the peak level of the in-band emission and all spurious emissions; up to 10th harmonic.
(2) RBW = 100 kHz
(3) VBW ≥ RBW
(4) Sweep = auto
(5) Detector function = peak
(6) Trace = max hold

12.4. Test Results

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13. DEVIATION TO TEST SPECIFICATIONS

【NONE】

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APPDNDIX A

TEST DATA AND PLOTS

(Model: T7PX)

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A.1 RADIATED EMISSION

Test Date	2017/08/04	Temp./Hum.	25℃/51%
Test Voltage	DC 6.6V (Via Battery)		

A.1.1 Emissions within Restricted Frequency Bands

A.2.1.1 Frequency 9kHz~30MHz

The emissions (9kHz~30MHz) not reported for there is no emission be found.

A.2.1.2 Frequency Below 1 GHz

Mode	S-FHSS	Frequency	TX 2447.5MHz

Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
101.78	17.38	2.29	6.67	26.34	43.50	17.16	Peak
187.14	15.45	3.21	7.48	26.14	43.50	17.36	Peak
246.31	18.66	3.77	6.82	29.25	46.00	16.75	Peak
320.03	20.44	4.58	7.87	32.89	46.00	13.11	Peak
359.80	21.63	5.09	10.25	36.97	46.00	9.03	Peak
421.88	22.99	5.76	15.03	43.78	46.00	2.22	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
147.37	17.17	2.80	12.85	32.82	43.50	10.68	Peak
195.87	15.67	3.30	18.60	37.57	43.50	5.93	Peak
256.01	19.01	3.87	11.09	33.97	46.00	12.03	Peak
421.88	22.99	5.76	10.41	39.16	46.00	6.84	Peak
480.08	23.58	6.27	8.25	38.10	46.00	7.90	Peak
500.45	23.77	6.43	7.42	37.62	46.00	8.38	Peak

Remark: The TX 2447.5MHz is a worst mode of S-FHSS modulation.

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Mode	T-FHSS	Frequency	TX 2437.500MHz

Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
101.78	17.38	2.29	7.10	26.77	43.50	16.73	Peak
194.90	15.65	3.29	7.20	26.14	43.50	17.36	Peak
244.37	18.57	3.76	6.71	29.04	46.00	16.96	Peak
359.80	21.63	5.09	10.69	37.41	46.00	8.59	Peak
421.88	22.99	5.76	14.66	43.41	46.00	2.59	Peak
635.28	25.09	6.88	3.98	35.95	46.00	10.05	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
134.76	18.01	2.66	11.52	32.19	43.50	11.31	Peak
194.90	15.65	3.29	18.55	37.49	43.50	6.01	Peak
247.28	18.76	3.79	11.92	34.47	46.00	11.53	Peak
421.88	22.99	5.76	9.94	38.69	46.00	7.31	Peak
480.08	23.58	6.27	10.36	40.21	46.00	5.79	Peak
500.45	23.77	6.43	7.01	37.21	46.00	8.79	Peak

Remark: The TX 2435.5MHz is a worst mode for T-FHSS modulation.

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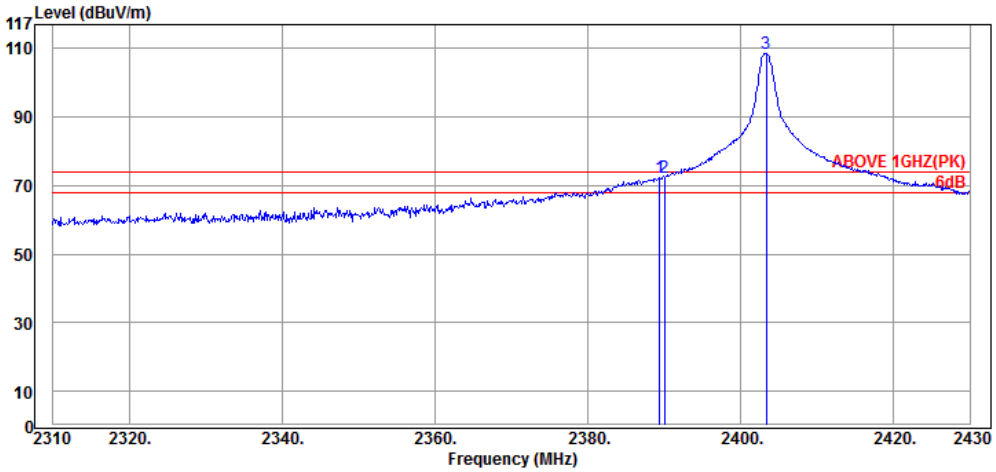
A.2.1.3 Frequency Above 1 GHz to 10th harmonics

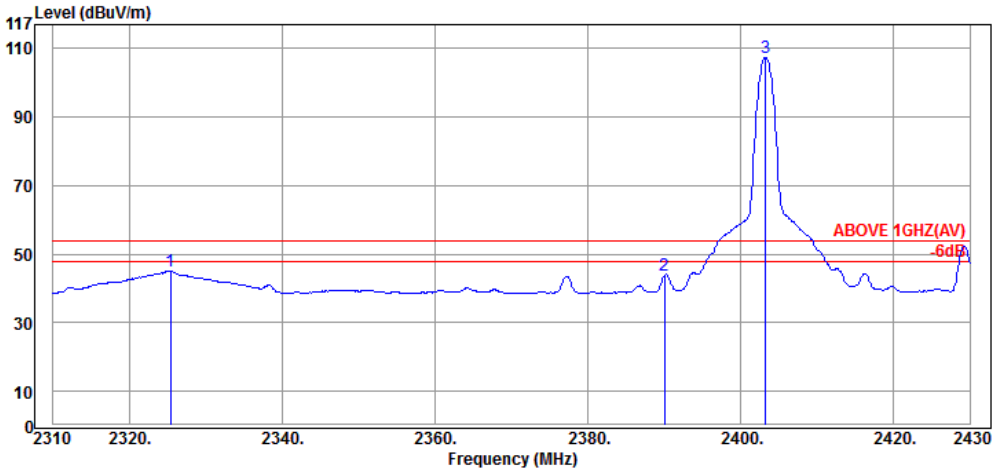
Band Edge:

Mode	S-FHSS	Frequency	TX 2403.250MHz



Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2389.44	28.17	5.24	39.00	72.41	74.00	1.59	Peak
2390.04	28.17	5.24	39.00	72.41	74.00	1.59	Peak
2403.36	28.14	5.25	75.27	108.66	---	---	Peak



Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2325.36	28.28	5.19	11.65	45.12	54.00	8.88	Average
2390.04	28.17	5.24	10.35	43.76	54.00	10.24	Average
2403.24	28.14	5.25	74.00	107.39	---	---	Average

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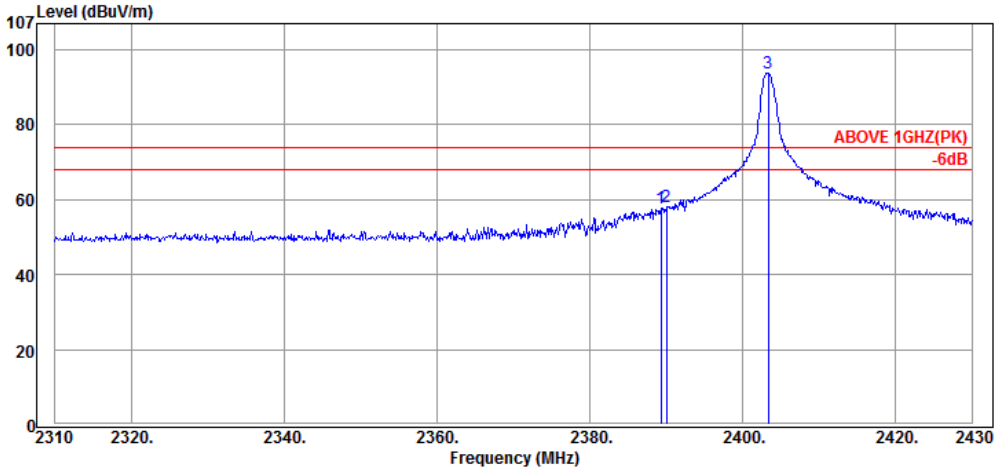
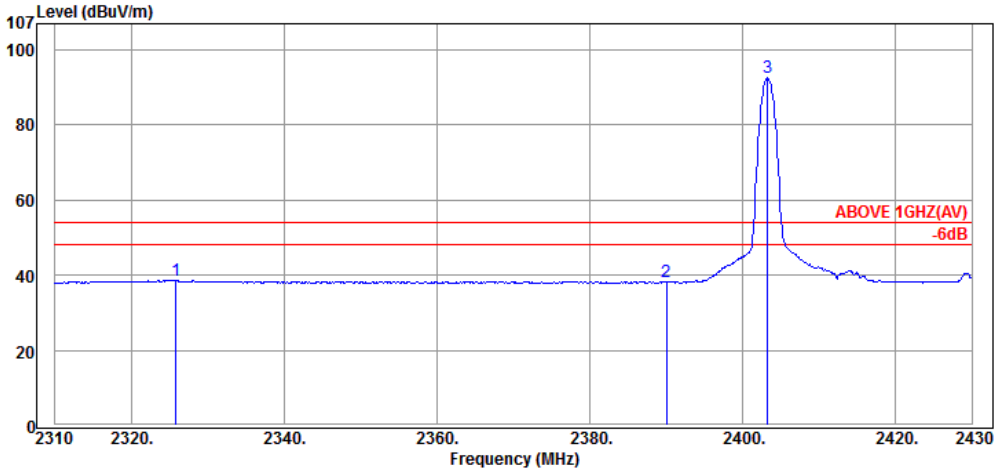
Mode	S-FHSS	Frequency	TX 2403.250MHz



Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2389.32	28.17	5.24	24.34	57.75	74.00	16.25	Peak
2390.04	28.17	5.24	24.68	58.09	74.00	15.91	Peak
2403.36	28.14	5.25	60.55	93.94	---	---	Peak



Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2325.84	28.28	5.19	5.21	38.68	54.00	15.32	Average
2390.04	28.17	5.24	4.87	38.28	54.00	15.72	Average
2403.24	28.14	5.25	59.10	92.49	---	---	Average

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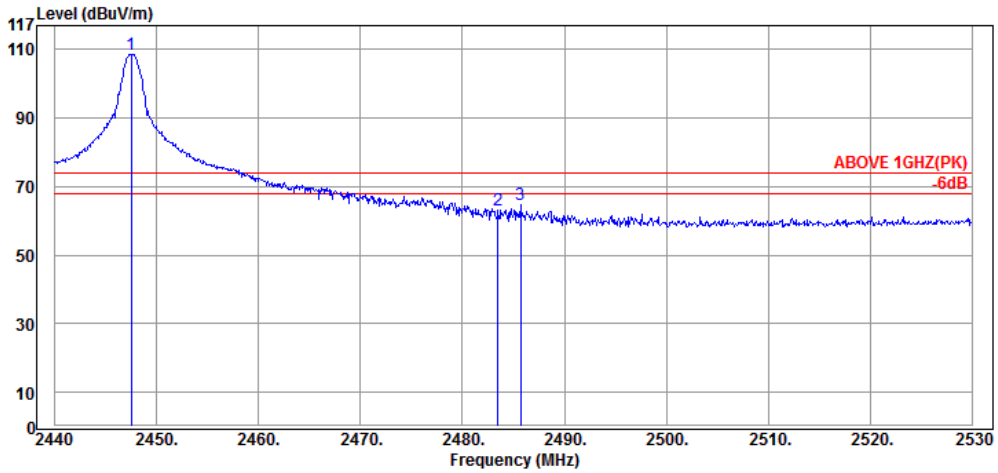
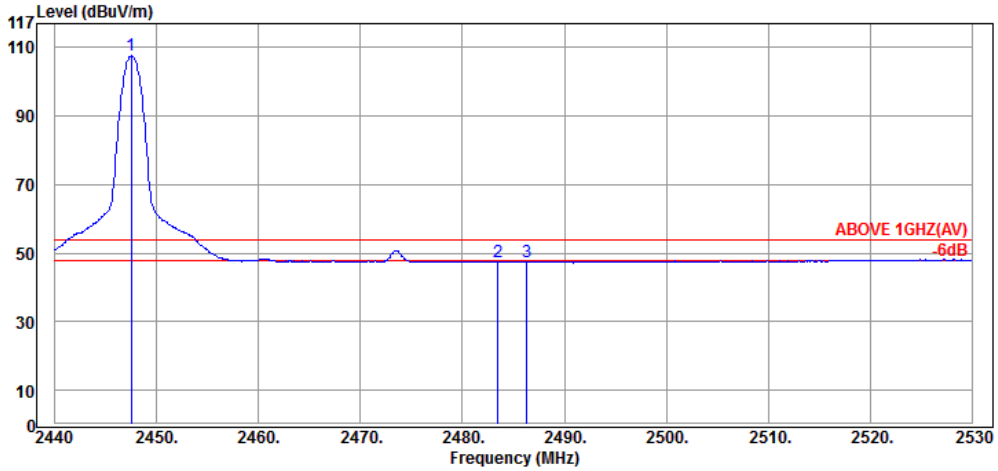
Mode	S-FHSS	Frequency	TX 2447.500MHz



Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2447.47	28.08	5.28	75.30	108.66	---	---	Peak
2483.47	28.03	5.31	29.59	62.93	74.00	11.07	Peak
2485.72	28.03	5.31	31.40	64.74	74.00	9.26	Peak



Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2447.47	28.08	5.28	74.31	107.67	---	---	Average
2483.47	28.03	5.31	14.01	47.35	54.00	6.65	Average
2486.35	28.03	5.31	14.29	47.63	54.00	6.37	Average

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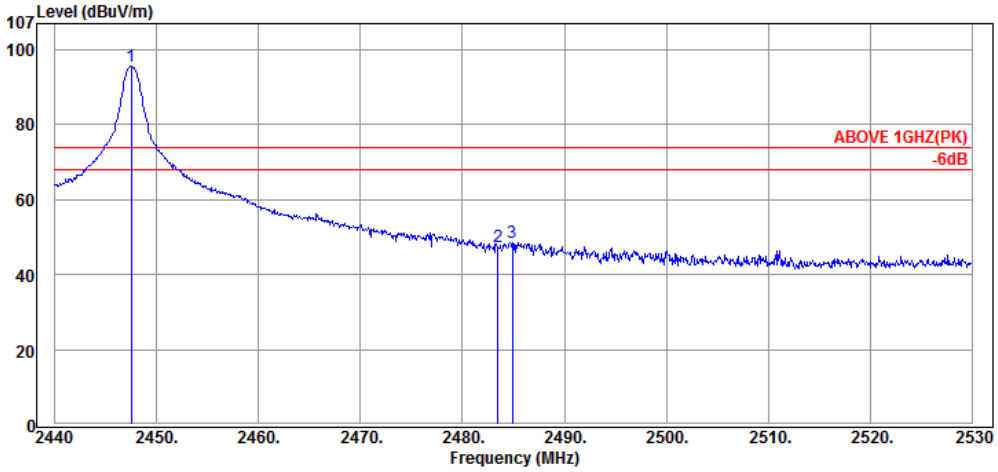
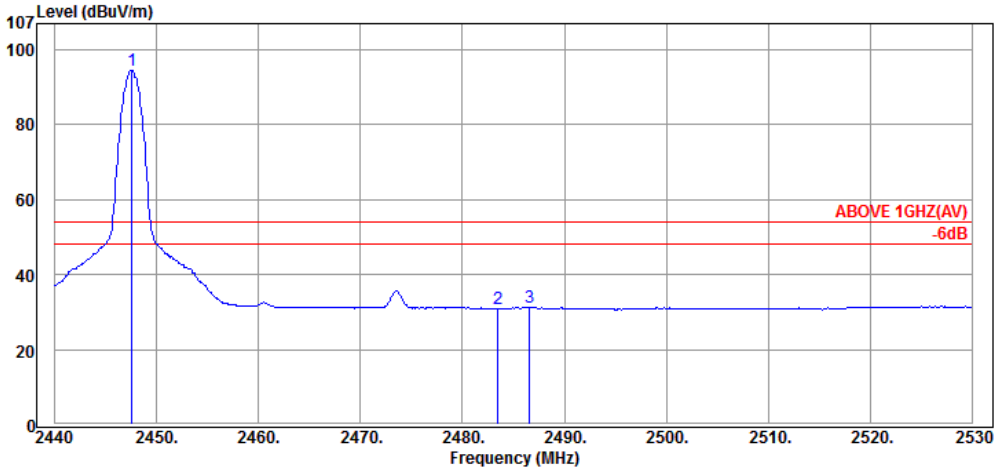
Mode	S-FHSS	Frequency	TX 2447.500MHz



Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2447.47	28.08	5.28	62.08	95.44	---	---	Peak
2483.47	28.03	5.31	13.95	47.29	74.00	26.71	Peak
2484.91	28.03	5.31	15.32	48.66	74.00	25.34	Peak



Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2447.56	28.08	5.28	61.21	94.57	---	---	Average
2483.47	28.03	5.31	-2.46	30.88	54.00	23.12	Average
2486.62	28.03	5.31	-1.98	31.36	54.00	22.64	Average

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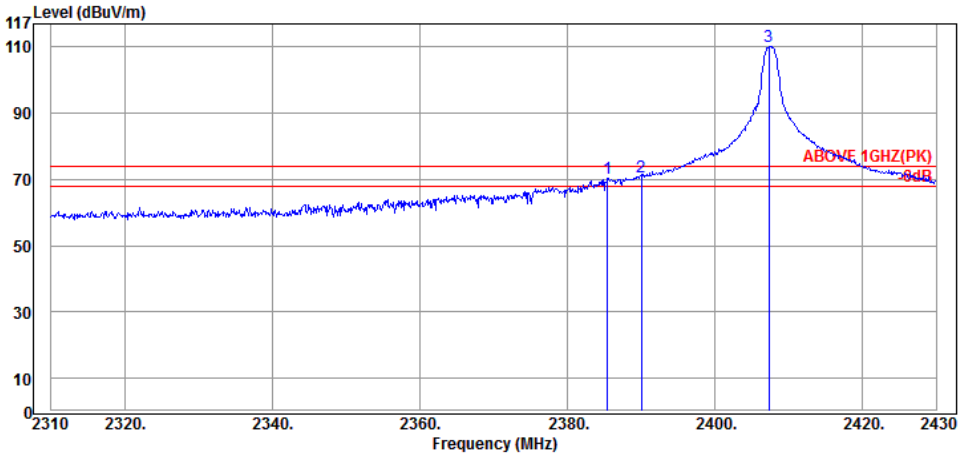
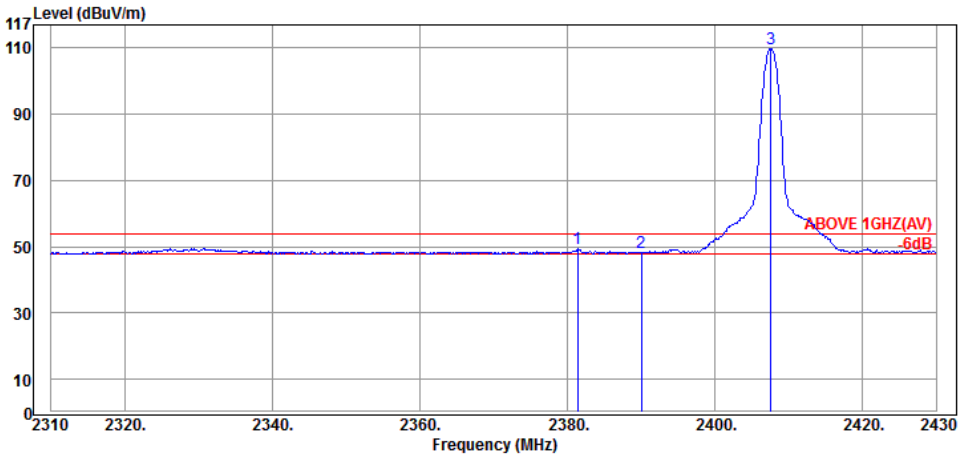
Mode	T-FHSS	Frequency	TX 2407.500MHz



Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2385.48	28.19	5.23	36.95	70.37	74.00	3.63	Peak
2390.04	28.17	5.24	37.53	70.94	74.00	3.06	Peak
2407.32	28.14	5.25	76.63	110.02	---	---	Peak



Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2381.40	28.19	5.23	16.19	49.61	54.00	4.39	Average
2390.04	28.17	5.24	14.85	48.26	54.00	5.74	Average
2407.56	28.14	5.25	76.36	109.75	---	---	Average

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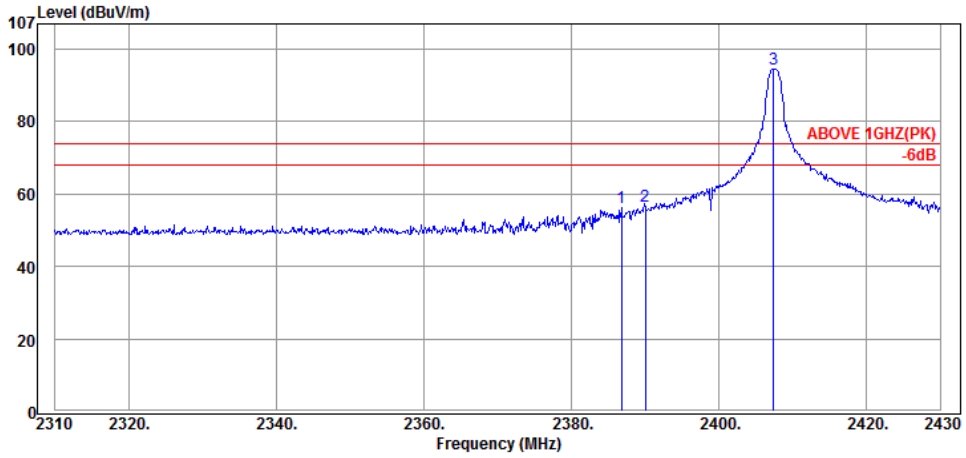
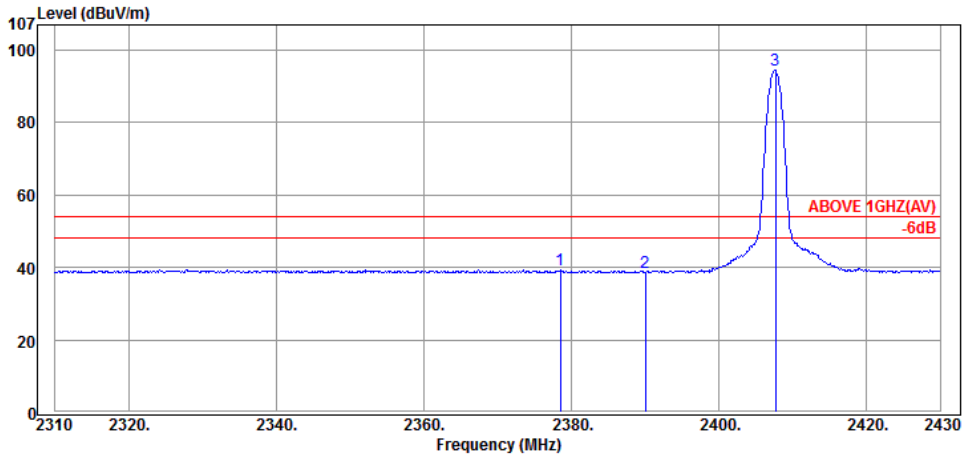
Mode	T-FHSS	Frequency	TX 2407.500MHz



Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2386.80	28.17	5.23	22.74	56.14	74.00	17.86	Peak
2390.04	28.17	5.24	23.39	56.80	74.00	17.20	Peak
2407.44	28.14	5.25	61.14	94.53	---	---	Peak



Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2378.52	28.19	5.23	5.87	39.29	54.00	14.71	Average
2390.04	28.17	5.24	5.35	38.76	54.00	15.24	Average
2407.68	28.14	5.25	60.98	94.37	---	---	Average

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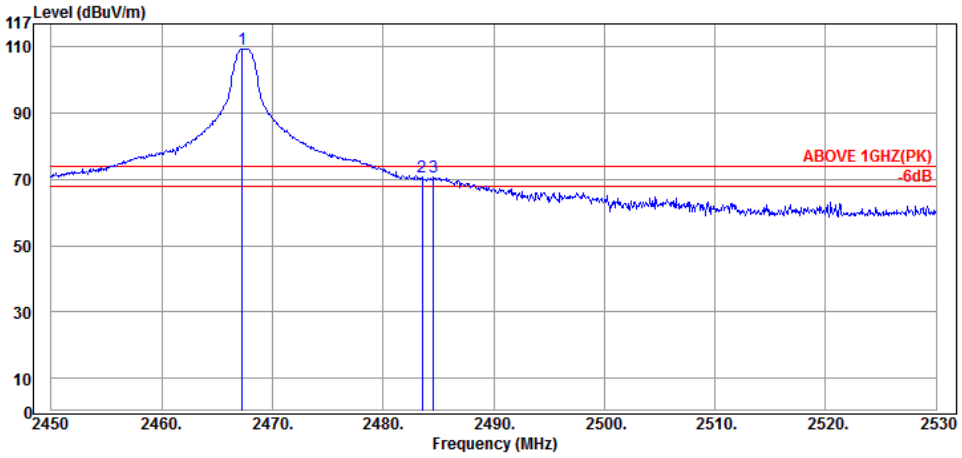
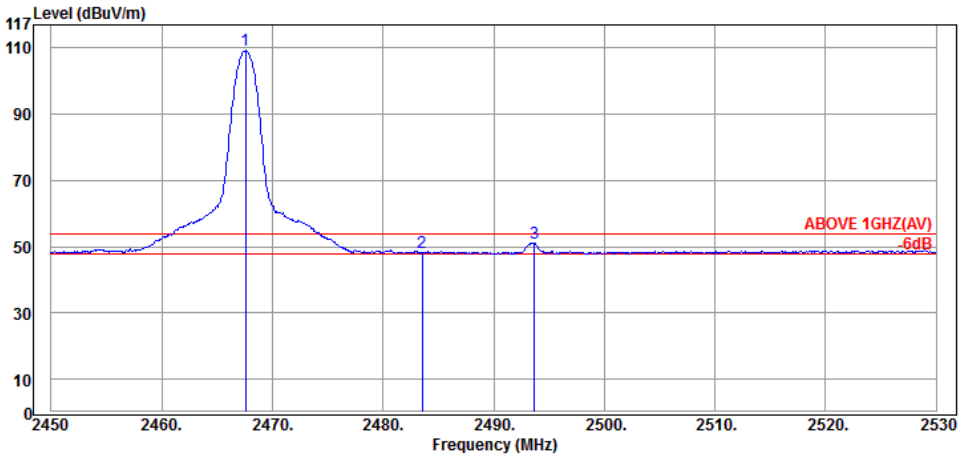
Mode	T-FHSS	Frequency	TX 2467.500MHz



Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2467.28	28.06	5.29	76.12	109.47	---	---	Peak
2483.52	28.03	5.31	37.33	70.67	74.00	3.33	Peak
2484.56	28.03	5.31	37.32	70.66	74.00	3.34	Peak



Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2467.60	28.06	5.30	75.80	109.16	---	---	Average
2483.52	28.03	5.31	14.91	48.25	54.00	5.75	Average
2493.68	28.00	5.31	17.88	51.19	54.00	2.81	Average

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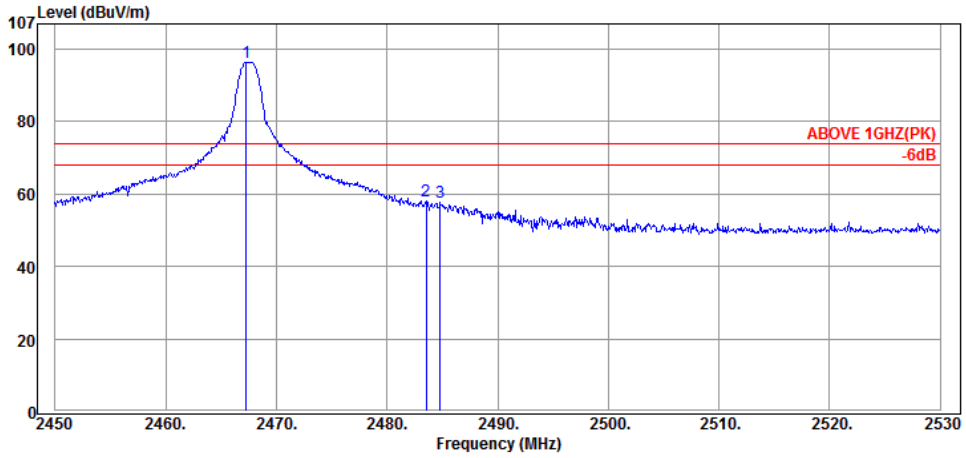
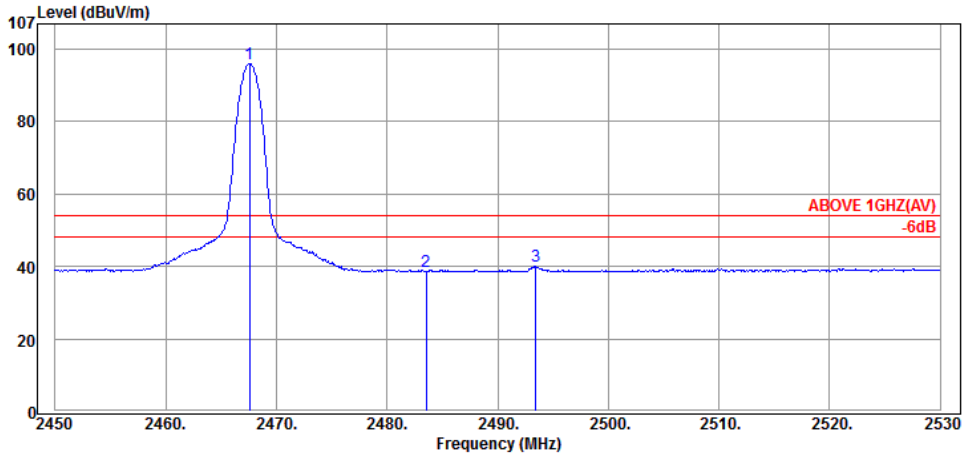
Mode	T-FHSS	Frequency	TX 2467.500MHz



Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2467.28	28.06	5.29	63.15	96.50	---	---	Peak
2483.52	28.03	5.31	24.66	58.00	74.00	16.00	Peak
2484.80	28.03	5.31	24.43	57.77	74.00	16.23	Peak



Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
2467.60	28.06	5.30	62.61	95.97	---	---	Average
2483.52	28.03	5.31	5.26	38.60	54.00	15.40	Average
2493.44	28.00	5.31	6.61	39.92	54.00	14.08	Average

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A.1.2 Emissions outside the frequency band:

The emissions (up to 25GHz) not reported for there is no emission be found.

Mode	S-FHSS	Frequency	TX 2403.250MHz

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4805.00	32.54	8.98	8.83	50.35	54.00	3.65	Peak

Mode	S-FHSS	Frequency	TX 2425.000MHz

Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4850.00	32.63	9.04	10.38	52.05	54.00	1.95	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4850.00	32.63	9.04	10.96	52.63	54.00	1.37	Peak

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Mode	S-FHSS	Frequency	TX 2447.500MHz

Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4895.00	32.75	9.10	9.04	50.89	54.00	3.11	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4895.00	32.75	9.10	10.29	52.14	54.00	1.86	Peak

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Mode	T-FHSS	Frequency	TX 2407.500MHz

Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4815.00	32.54	9.00	11.08	52.62	54.00	1.38	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4815.00	32.54	9.00	11.76	53.30	54.00	0.70	Peak

Mode	T-FHSS	Frequency	TX 2437.500MHz

Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4875.00	32.71	9.08	8.91	50.70	54.00	3.30	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4875.00	32.71	9.08	9.81	51.60	54.00	2.40	Peak

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Mode	T-FHSS	Frequency	TX 2467.500MHz

Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4935.00	32.83	9.16	9.71	51.70	54.00	2.30	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
4935.00	32.83	9.16	11.06	53.05	54.00	0.95	Peak

A.1.3 Emissions in Non-restricted Frequency Bands:

All emission levels below the 15.209 general radiated emissions limits is not required.

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A.2 20dB BANDWIDTH MEASUREMENT

Test Date	2017/06/27, 08/16	Temp./Hum.	22~23℃/50~52%
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

A.2.1 20dB Bandwidth Result

Modulation	Centre Frequency (MHz)	20 dB Bandwidth (MHz)	Limit 2/3 (20dB Bandwidth)
S-FHSS	2403.250	0.2636	0.176
	2425.000	0.2593	0.173
	2447.500	0.2606	0.174

Remark: The maximum two-thirds of the 20dB bandwidth shall be at maximum 0.176MHz.

Modulation	Centre Frequency (MHz)	20 dB Bandwidth (MHz)	Limit 2/3 (20dB Bandwidth)
T-FHSS	2407.5	0.8712	0.581
	2437.5	0.8868	0.591
	2467.5	0.7700	0.513

Remark: The maximum two-thirds of the 20dB bandwidth shall be at maximum 0.581MHz.

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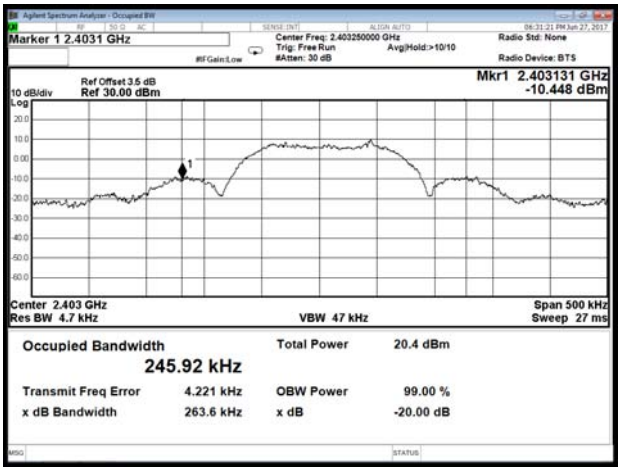
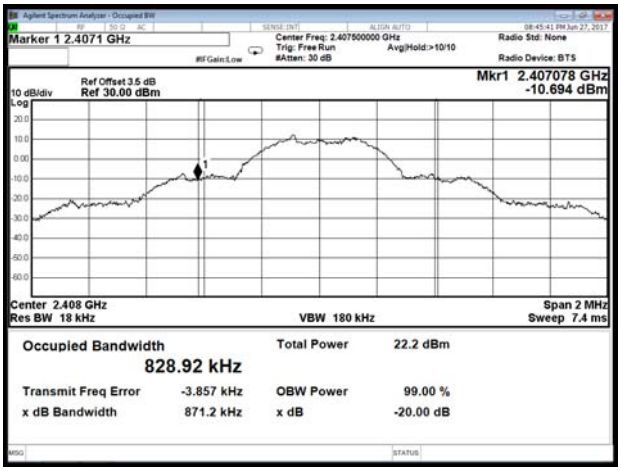
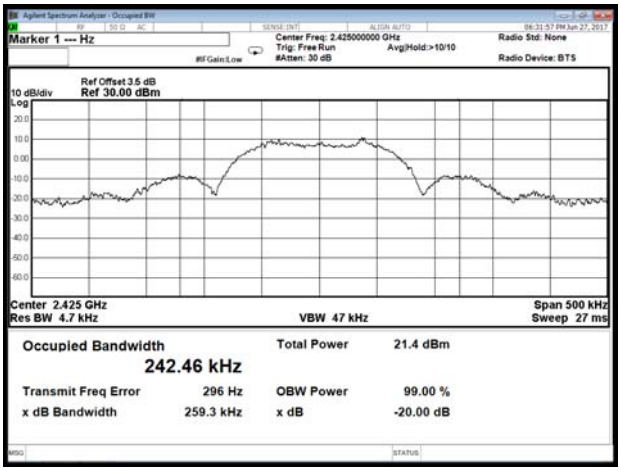
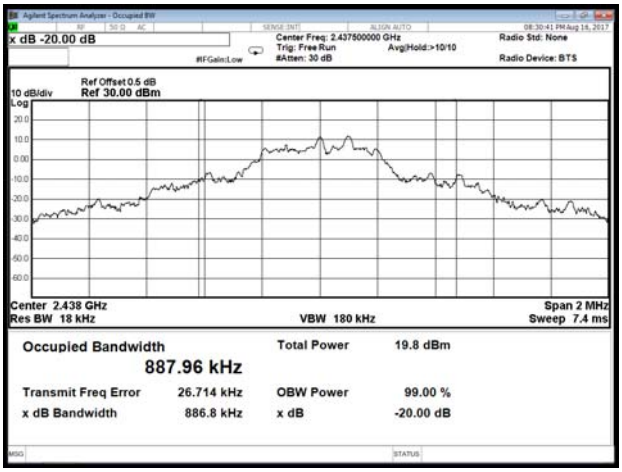
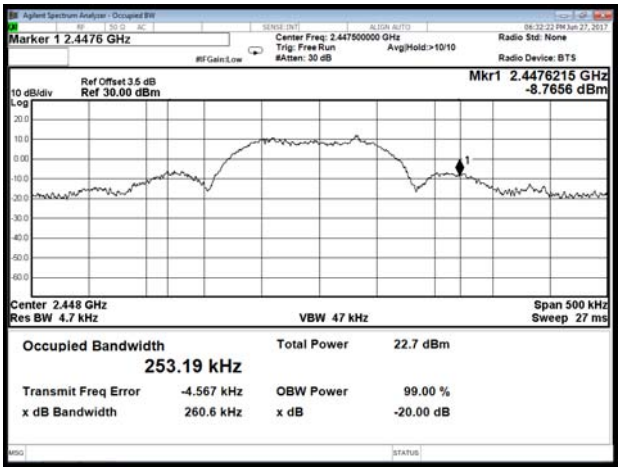
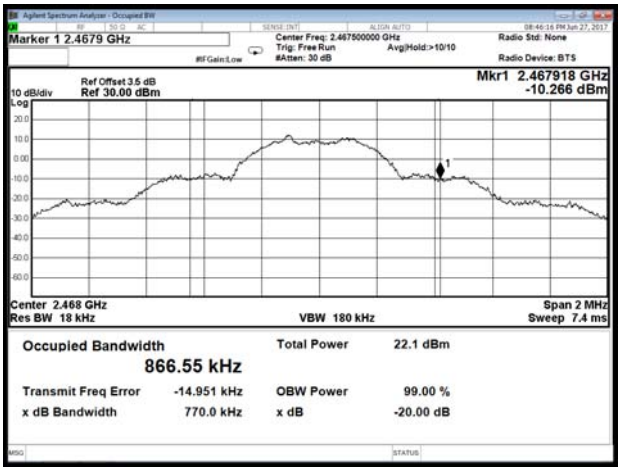
A.2.2 Measurement Plots

S-FHSS	T-FHSS
	
	
	

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A.3 CARRIER FREQUENCY SEPARATION MEASUREMENT

Test Date	2017/06/27, 08/16	Temp./Hum.	22~23℃/50~52%
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

A.3.1 Measurement Plots

Modulation: S-FHSS		
2403.250MHz	2425.000MHz adjacent channel of right carrier frequency	
2425.000MHz adjacent channel of left carrier frequency		2447.500MHz

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Modulation: T-FHSS	
2407.500MHz	2437.500MHz adjacent channel of right carrier frequency
2437.500MHz adjacent channel of left carrier frequency	2467.500MHz

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A.4 TIME OF OCCUPANCY MEASUREMENT

Test Date	2017/06/26 ~ 30, 08/16	Temp./Hum.	22~23℃/50~52%
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

A.4.1 Time of Occupancy

Modulation	Centre Frequency (MHz)	Time of Occupancy (ms)	Maximum accumulated Time of Occupancy (ms)	Limit (ms)
S-FHSS	2403.250	3.025	363.000	<400
	2425.000	3.045	365.400	<400
	2447.500	3.045	365.400	<400

Duty cycle: 60 channels*0.4 seconds = 24 seconds

Test Frequency: 2403.250MHz

For each 1 second of 5 channel appearance, the longest time of occupancy for each of 24 seconds is:
5 channels*24 seconds/1* 3.025ms = 363.000ms

Test Frequency: 2425.000MHz

For each 1 second of 5 channel appearance, the longest time of occupancy for each of 24 seconds is:
5 channel*24 seconds/1* 3.045ms = 365.400ms

Test Frequency: 2447.500MHz

For each 1 second of 5 channel appearance, the longest time of occupancy for each of 24 seconds is:
5 channel*24 seconds/1* 3.045ms = 365.400ms

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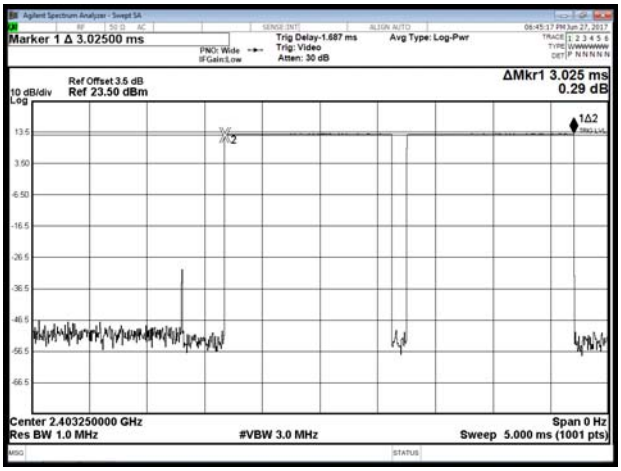
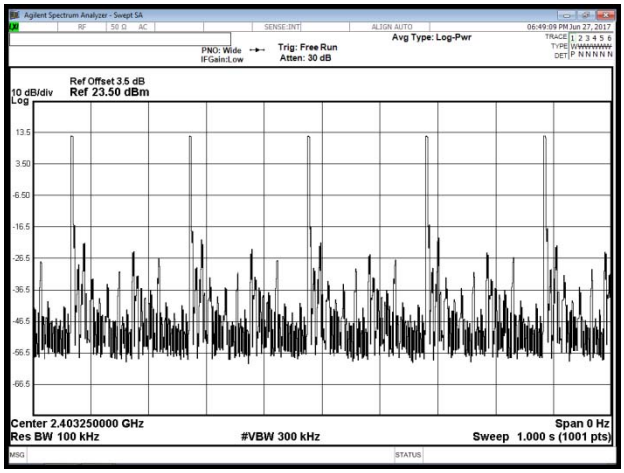
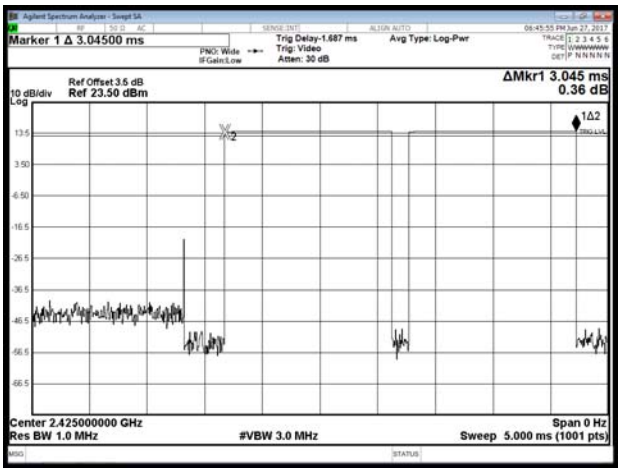
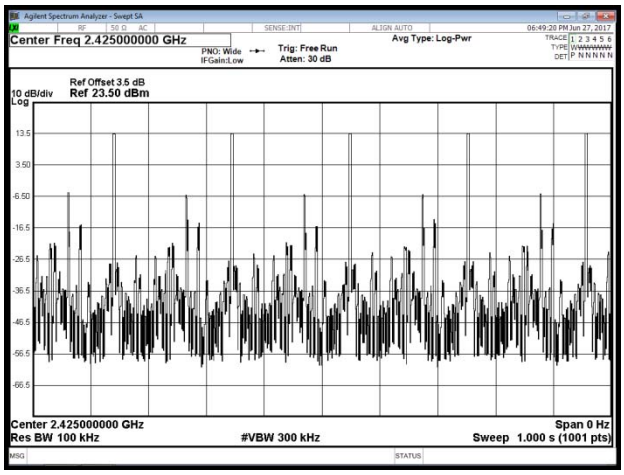
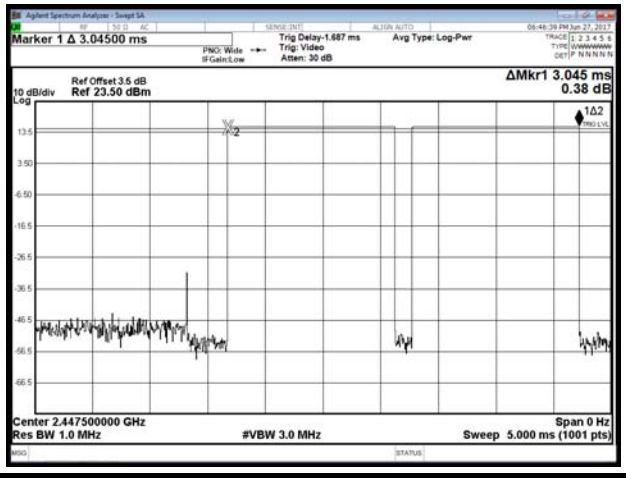
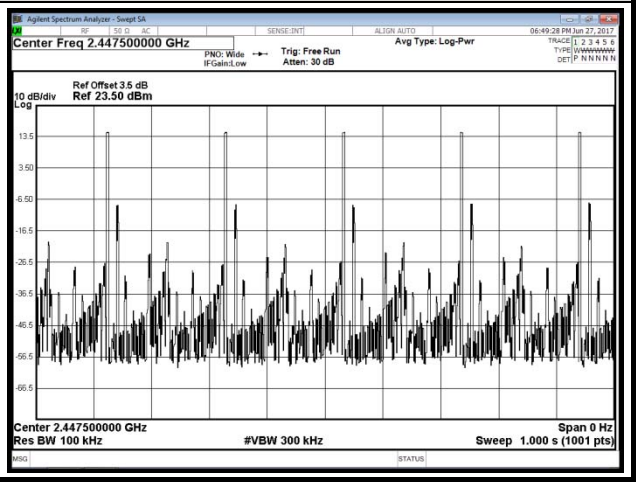
- Measurement Plots

Modulation: S-FHSS	
2403.250MHz	
	
2425.000MHz	
	
2447.500MHz	
	

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Modulation	Centre Frequency (MHz)	Time of Occupancy (ms)	Maximum accumulated Time of Occupancy (ms)	Limit (ms)
T-FHSS	2407.500	0.418	51.832	<400
	2437.500	0.418	57.015	<400
	2467.500	0.418	57.015	<400

Duty cycle: 31 channels*0.4 seconds = 12.4 seconds

Test Frequency: 2407.500MHz

For each 1 second of 10 channel appearance, the longest time of occupancy for each of 12.4 seconds is:

10 channels*12.4 seconds/1*0.418ms = 51.832ms

Test Frequency: 2437.500MHz

For each 1 second of 11 channel appearance, the longest time of occupancy for each of 12.4 seconds is:

11 channel*12.4 seconds/1* 0.418ms = 57.015ms

Test Frequency: 2467.500MHz

For each 1 second of 11 channel appearance, the longest time of occupancy for each of 12.4 seconds is:

11 channel*12.4 seconds/1* 0.418ms = 57.015ms

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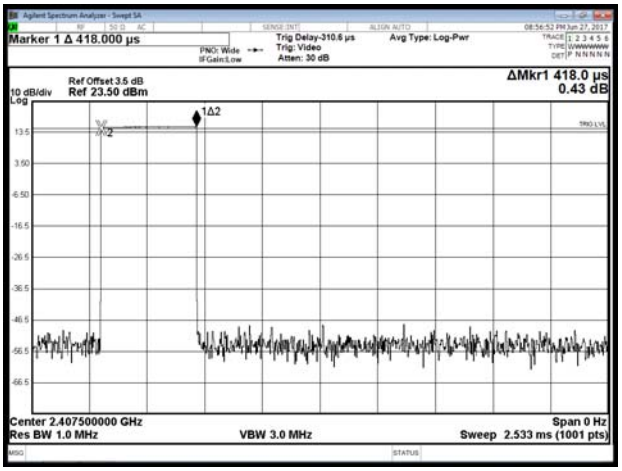
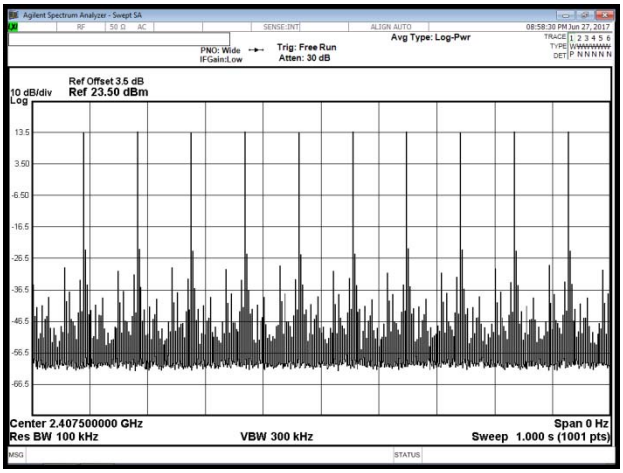
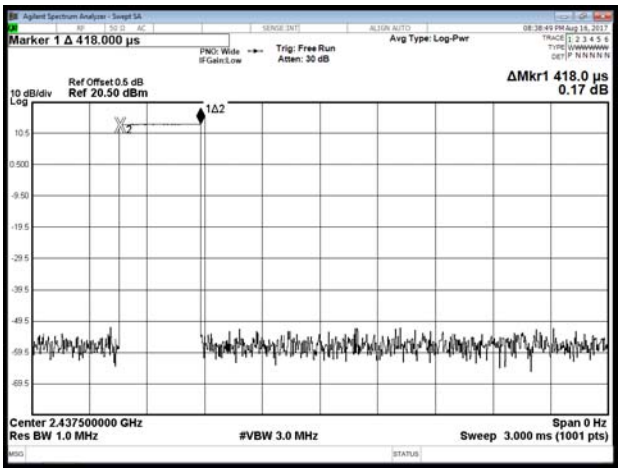
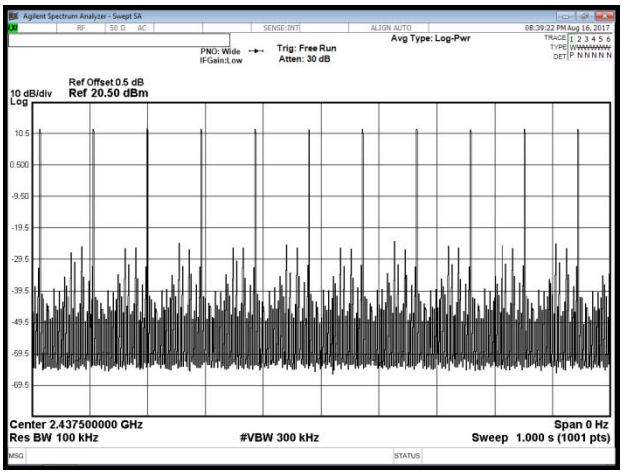
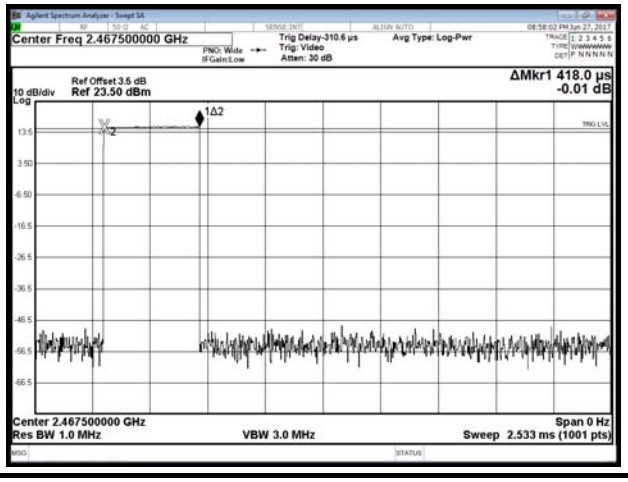
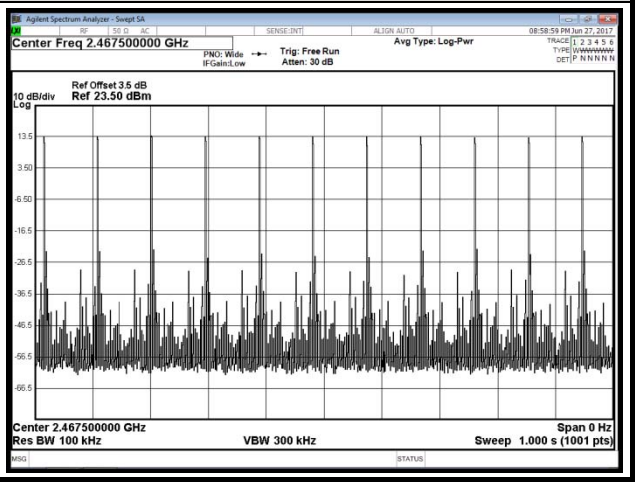
- Measurement Plots

Modulation: T-FHSS	
2407.500MHz	
	
2437.500MHz	
	
2467.500MHz	
	

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Modulation	Centre Frequency (MHz)	Time of Occupancy (ms)	Maximum accumulated Time of Occupancy (ms)	Limit (ms)
T-FHSS SR	2407.500	0.416	134.118	<400
	2437.500	0.416	139.277	<400
	2467.500	0.418	139.946	<400

Duty cycle: 31 channels*0.4 seconds = 12.4 seconds

Test Frequency: 2407.500MHz

For each 1 second of 26 channel appearance, the longest time of occupancy for each of 12.4 seconds is:

26 channels*12.4 seconds/1* 0.416ms = 134.118ms

Test Frequency: 2435.500MHz

For each 1 second of 27 channel appearance, the longest time of occupancy for each of 12.4 seconds is:

27 channel*12.4 seconds/1* 0.416ms = 139.277ms

Test Frequency: 2467.500MHz

For each 1 second of 27 channel appearance, the longest time of occupancy for each of 12.4 seconds is:

27 channel*12.4 seconds/1* 0.418ms = 139.946ms

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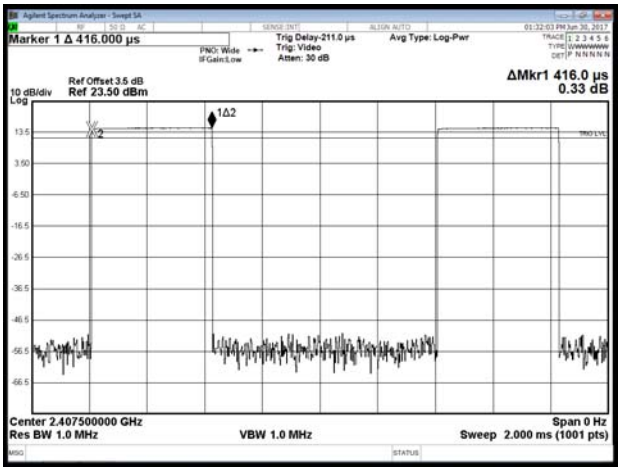
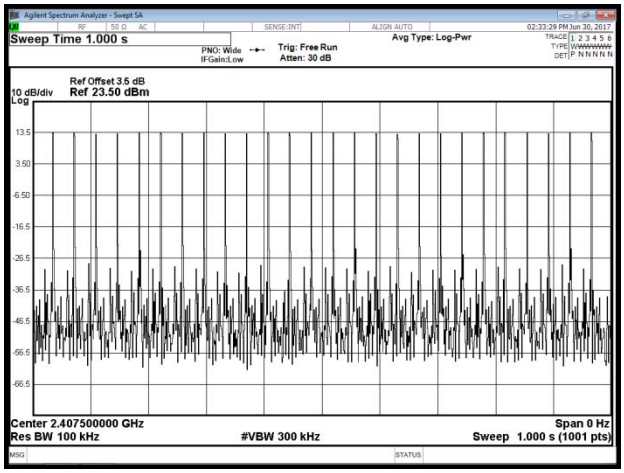
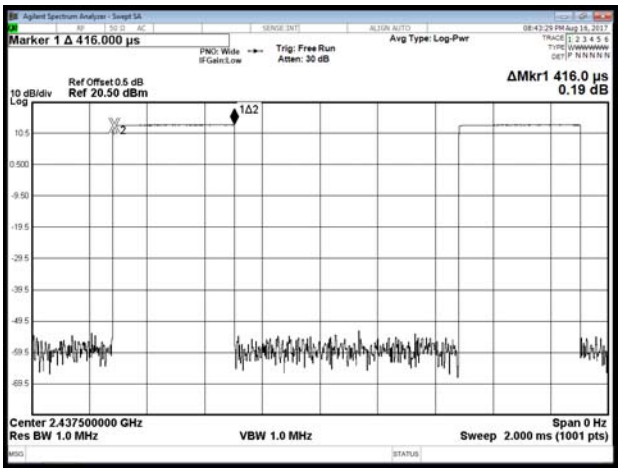
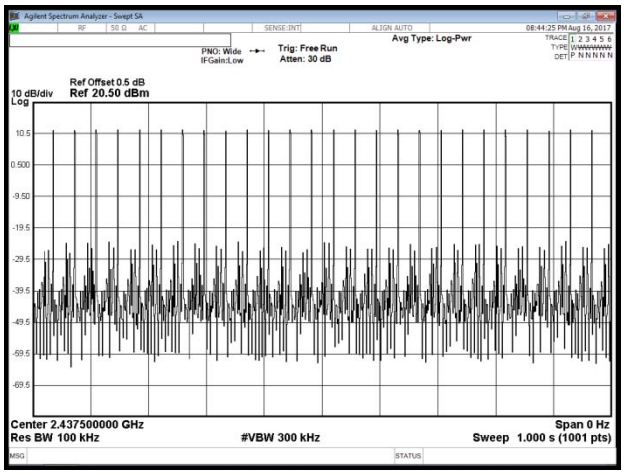
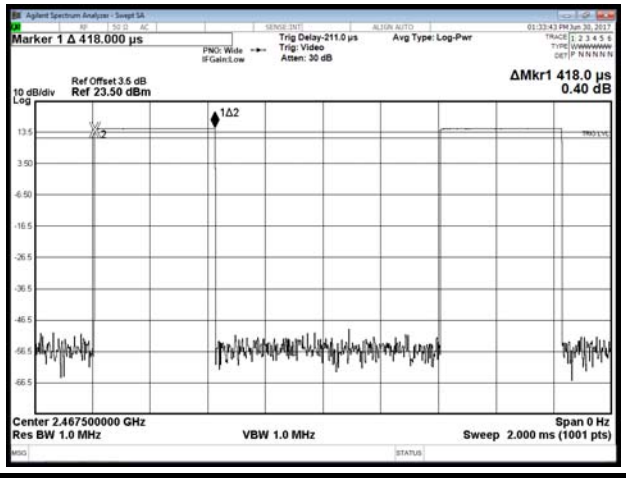
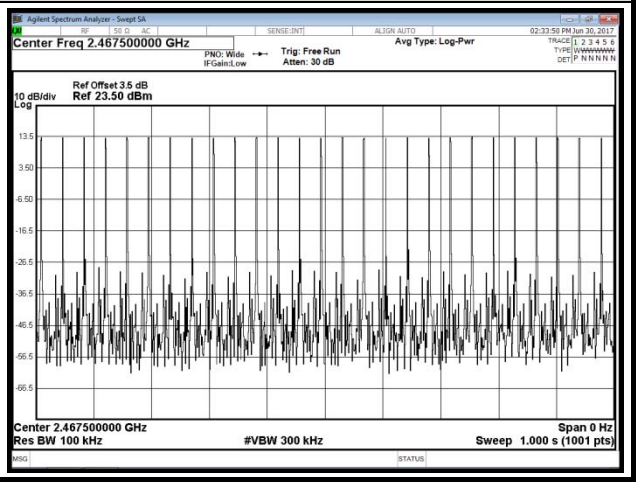
- Measurement Plots

Modulation: T-FHSS SR	
2407.500MHz	
	
2437.500MHz	
	
2467.500MHz	
	

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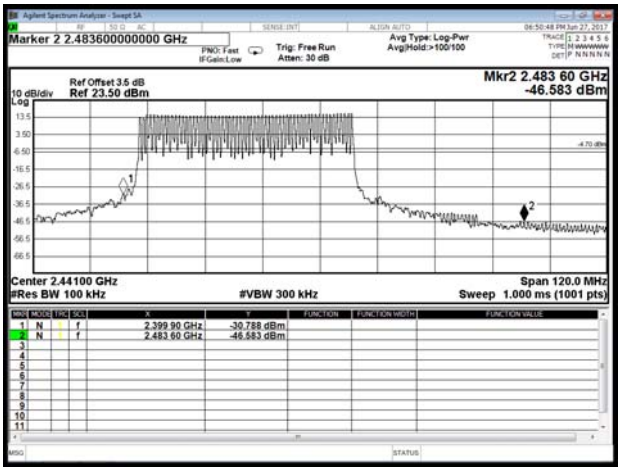
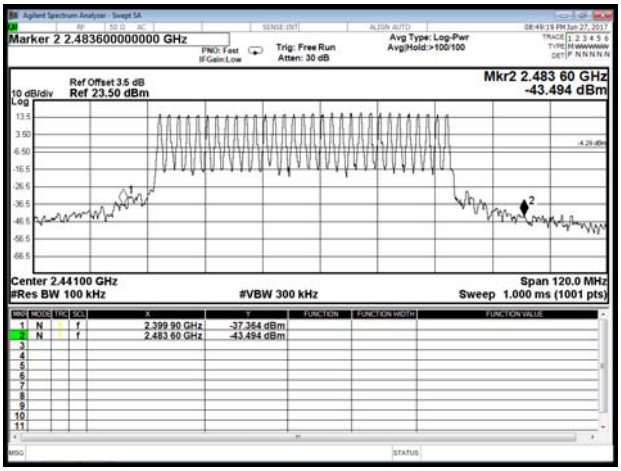
A.5 NUMBER OF HOPPING CHANNELS MEASUREMENT

Test Date	2017/06/27	Temp./Hum.	22℃/50%
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

A.5.1 Measurement Plots

Modulation: S-FHSS	Modulation: T-FHSS
	
The number hopping channel is 60.	The number hopping channel is 31.

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A.6 MAXIMUM PEAK OUTPUT POWER MEASUREMENT

Test Date	2017/06/30, 08/16	Temp./Hum.	23℃/52%
Cable Loss	3.5dB	Test Voltage	DC 6.6V

Modulation	Centre Frequency (MHz)	Peak Output Power		Limit
		dBm	W	
S-FHSS	2403.250	13.191	0.020850	21dBm (0.125W)
	2425.000	14.188	0.026230	
	2447.500	15.353	0.034300	

Modulation	Centre Frequency (MHz)	Peak Output Power		Limit
		dBm	W	
T-FHSS	2407.50	14.932	0.031131	21dBm (0.125W)
	2437.50	13.416	0.021958	
	2467.50	14.946	0.031232	

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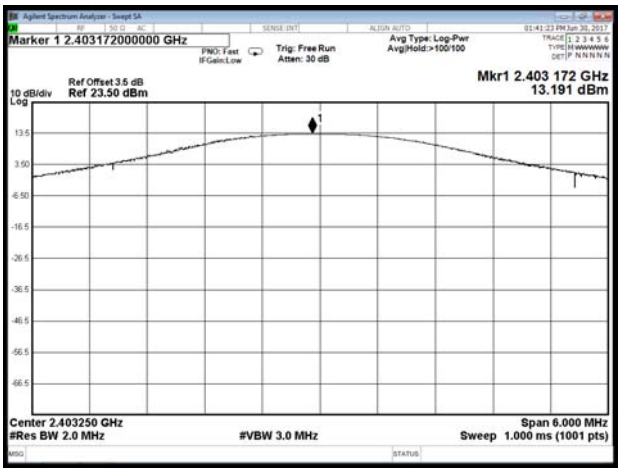
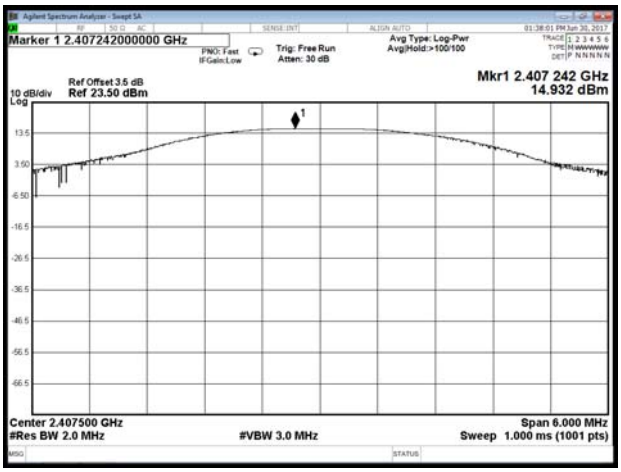
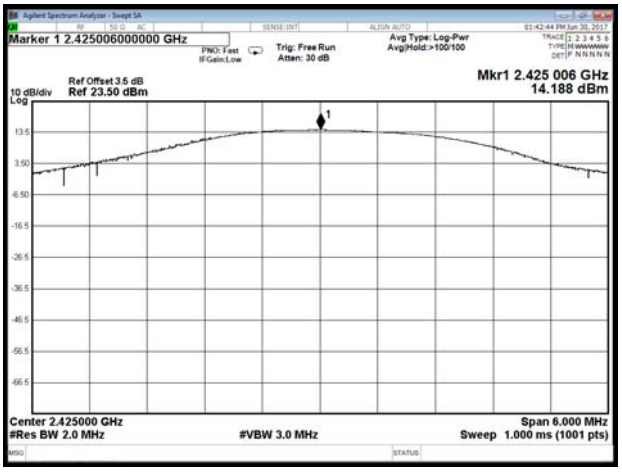
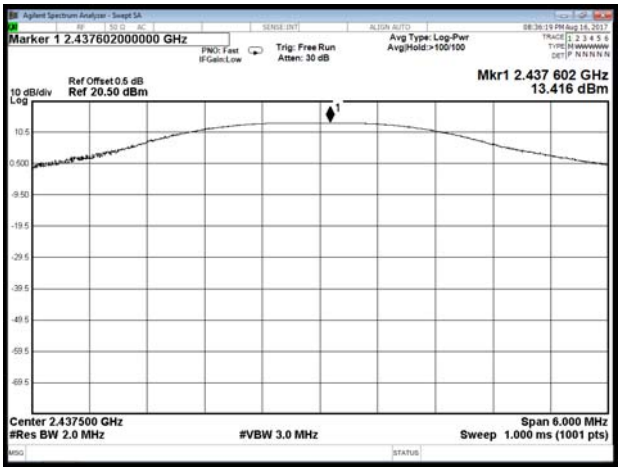
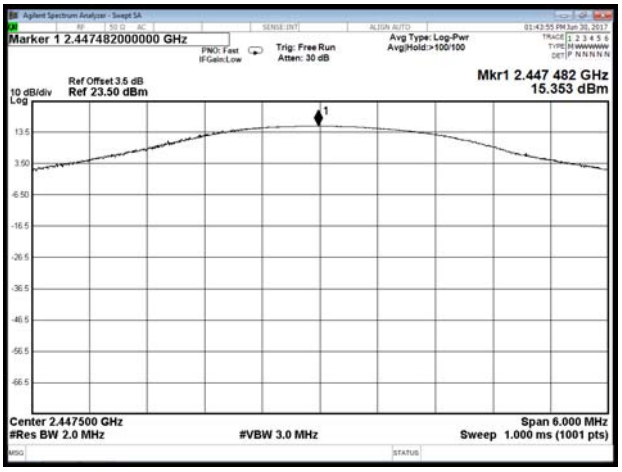
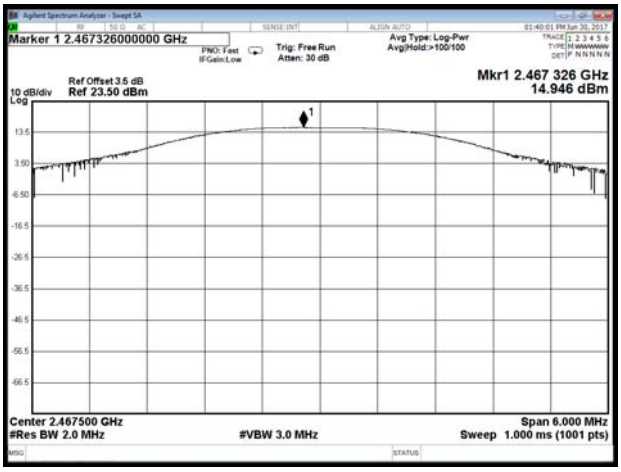
A.6.1 Measurement Plots

Modulation: S-FHSS	Modulation: T-FHSS
	
	
	

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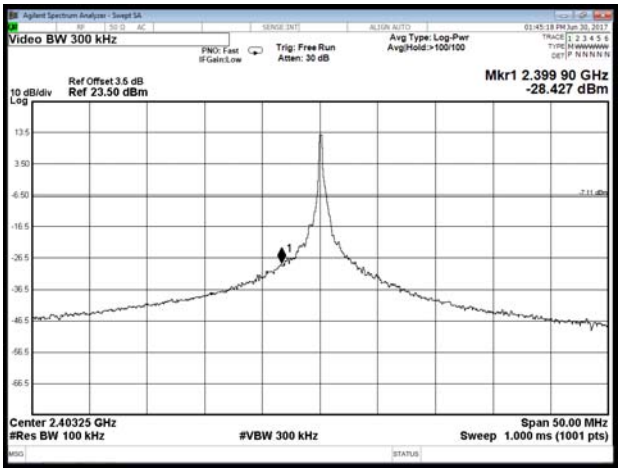
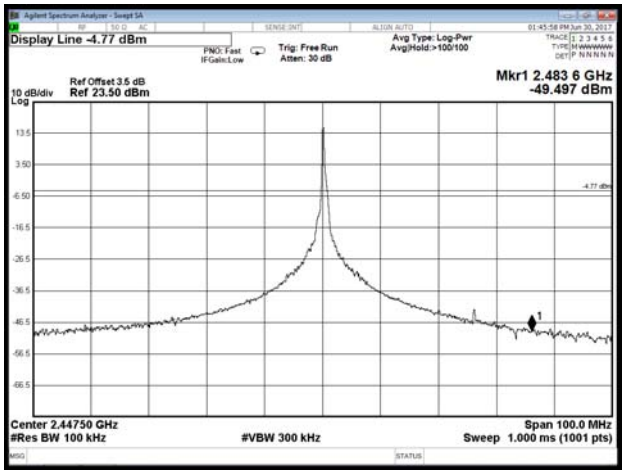
A.7 EMISSION LIMITATIONS MEASUREMENT

A.7.1 Band Edge

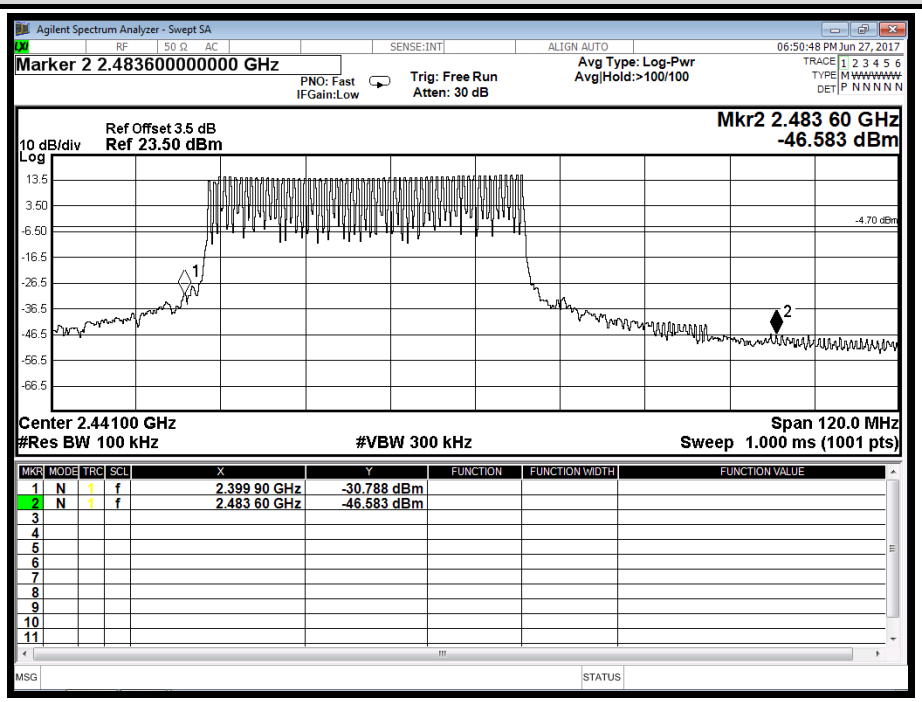
Test Date	2017/06/27 ~ 30	Temp./Hum.	22~23℃/50~52%
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

Modulation: S-FHSS

Single Channel

Low channel	High channel
	

Hopping Mode



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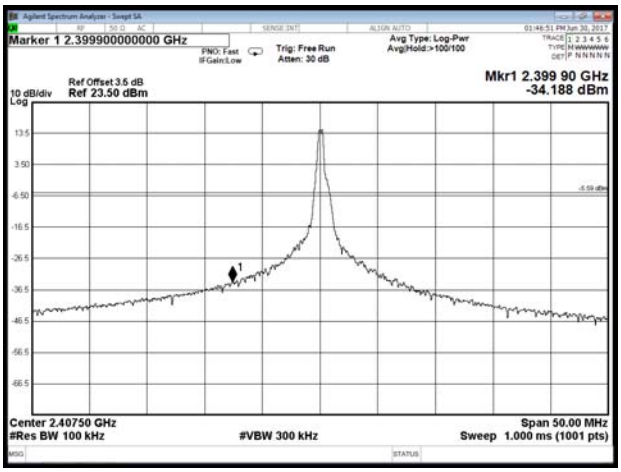
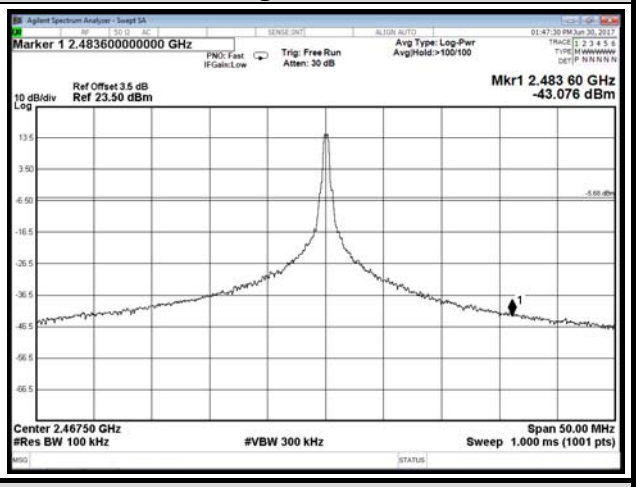
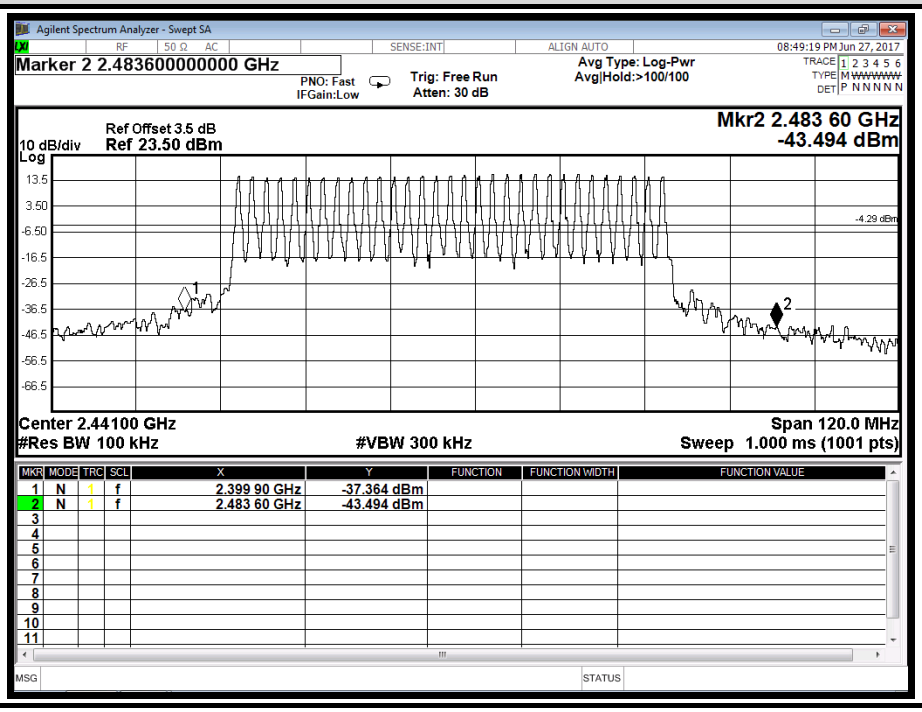
Modulation: T-FHSS	
Single Channel	
Low channel	High channel
	
Hopping Mode	
	

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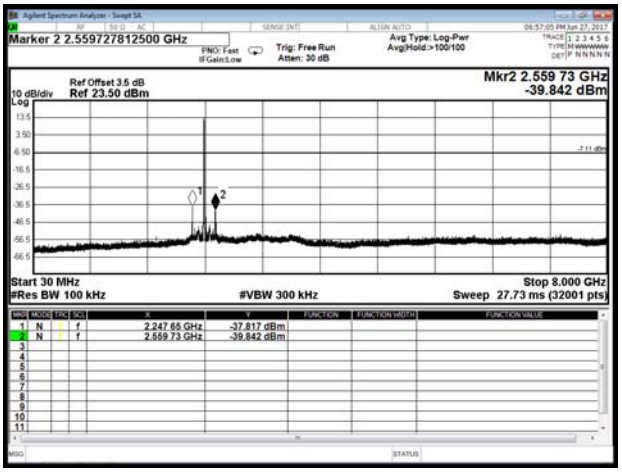
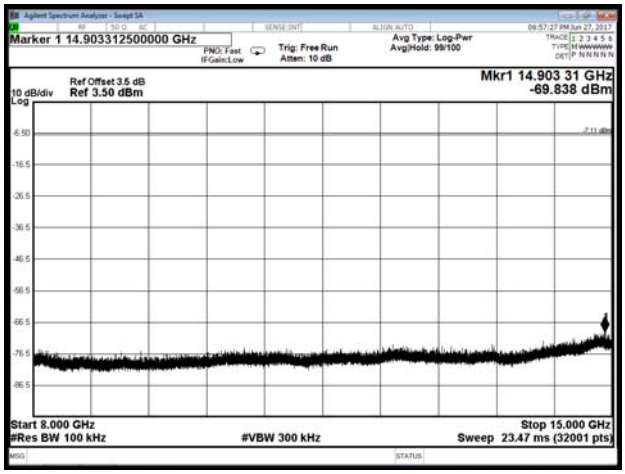
A.7.2 Spurious Emission

Test Date	2017/06/27	Temp./Hum.	22℃/50%
Mode	TX	Modulation	S-FHSS
		Frequency	2403.250MHz
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

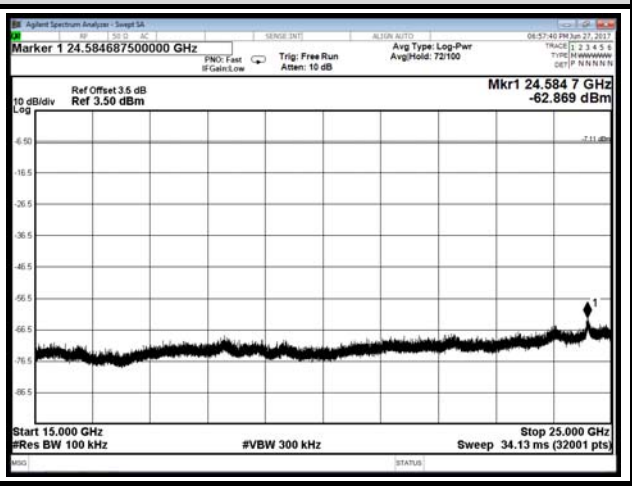
30MHz – 8GHz



8GHz – 15GHz



15GHz – 25GHz



Note: All results have been included cable loss and simultaneous factor.

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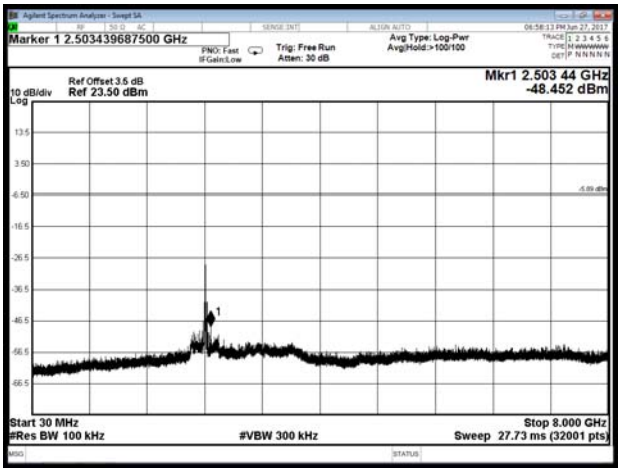
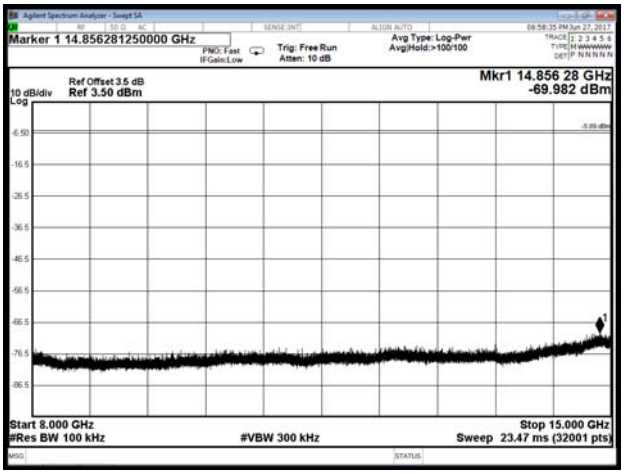
Test Date	2017/06/27	Temp./Hum.	22℃/50%
Mode	TX	Modulation	S-FHSS
		Frequency	2425.000MHz
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

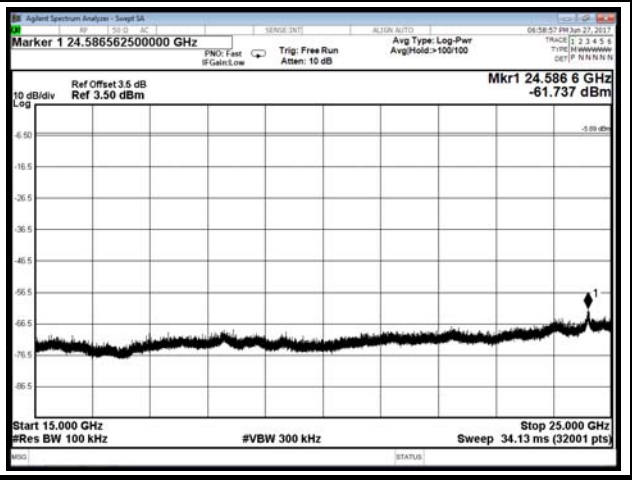
30MHz – 8GHz



8GHz – 15GHz



15GHz – 25GHz



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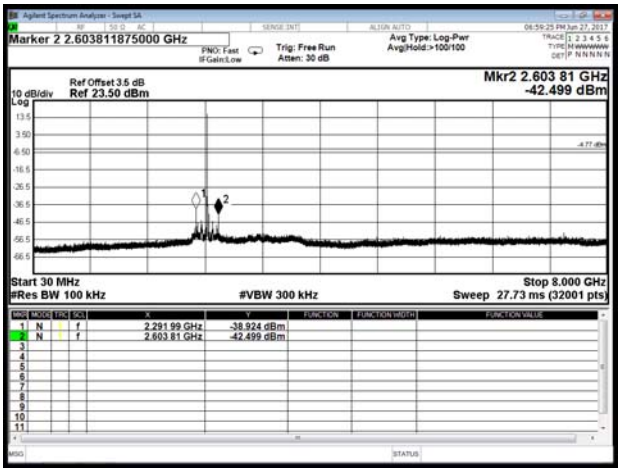
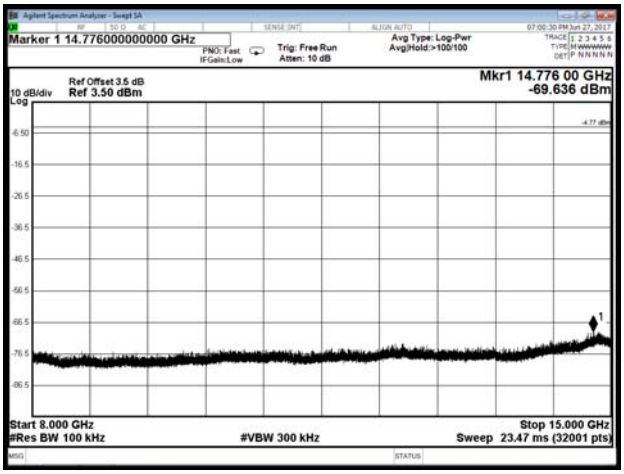
Test Date	2017/06/27	Temp./Hum.	22℃/50%
Mode	TX	Modulation	S-FHSS
		Frequency	2447.500MHz
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

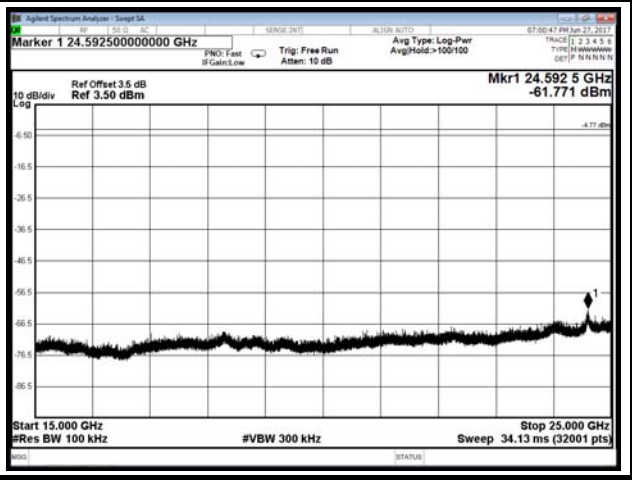
30MHz – 8GHz



8GHz – 15GHz



15GHz – 25GHz



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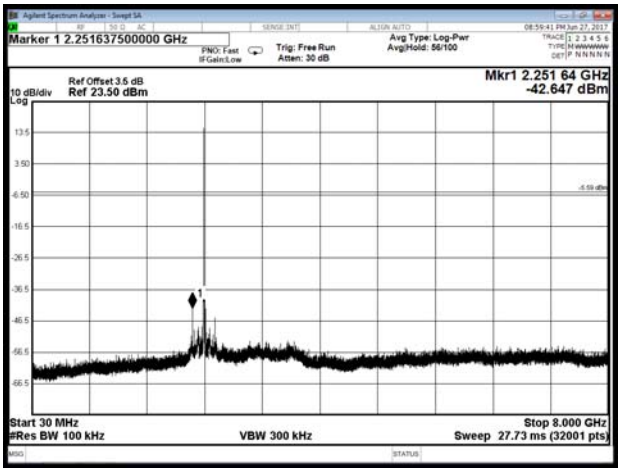
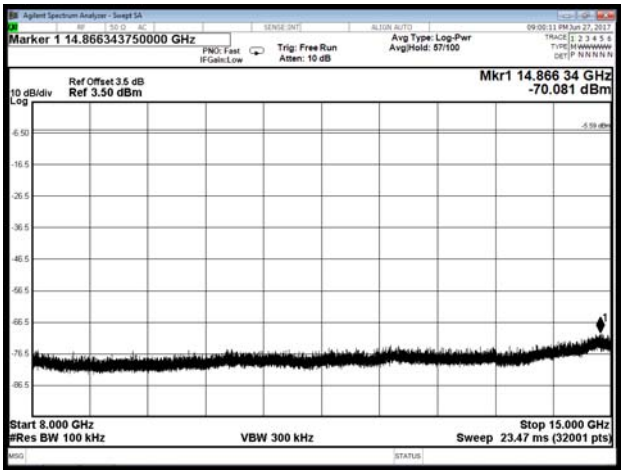
Test Date	2017/06/27	Temp./Hum.	22℃/50%
Mode	TX	Modulation	T-FHSS
		Frequency	2407.500MHz
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

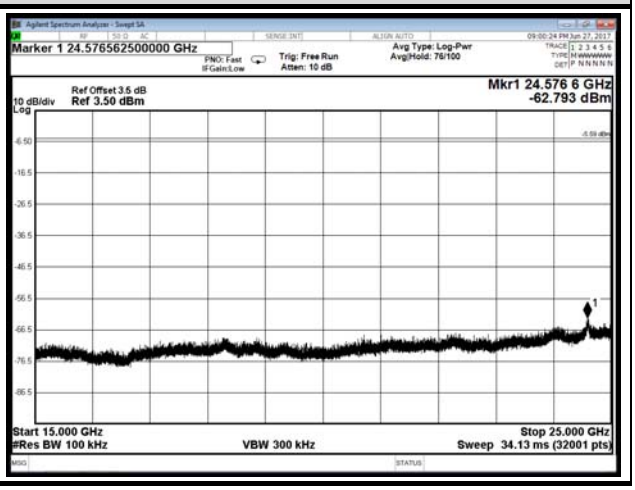
30MHz – 8GHz



8GHz – 15GHz



15GHz – 25GHz



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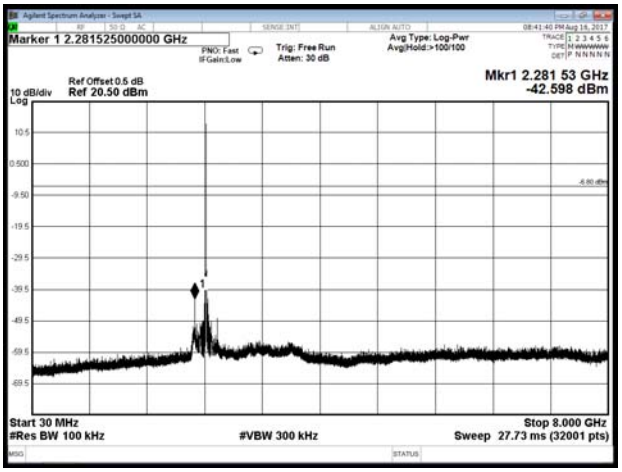
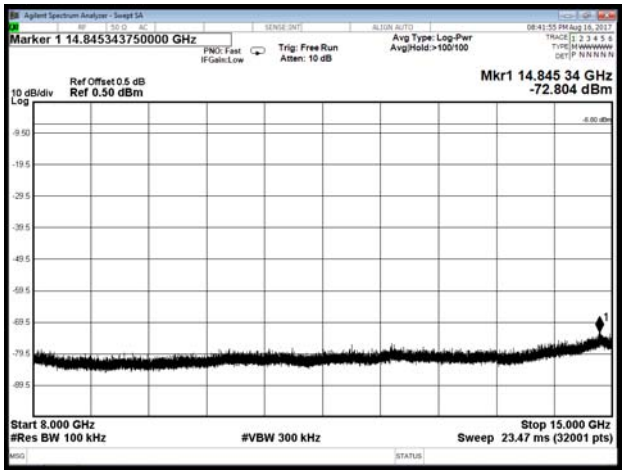
Test Date	2017/08/16	Temp./Hum.	23℃/52%
Mode	TX	Modulation	T-FHSS
		Frequency	2437.500MHz
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

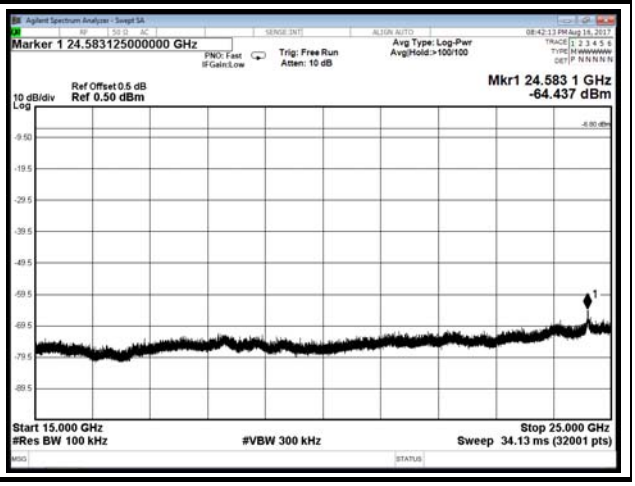
30MHz – 8GHz



8GHz – 15GHz



15GHz – 25GHz



Note: All results have been included cable loss and simultaneous factor.

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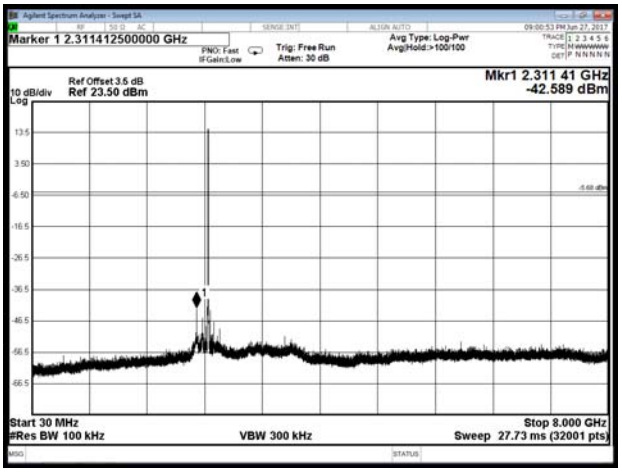
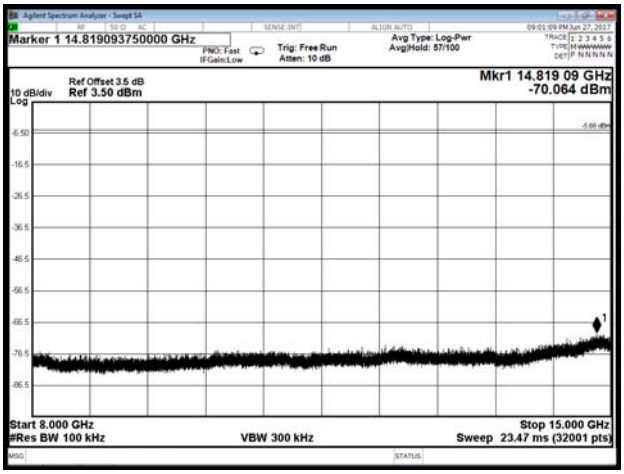
Test Date	2017/06/27	Temp./Hum.	22℃/50%
Mode	TX	Modulation	T-FHSS
		Frequency	2467.500MHz
Cable Loss	3.5dB	Test Voltage	DC 6.6V (Via Battery)

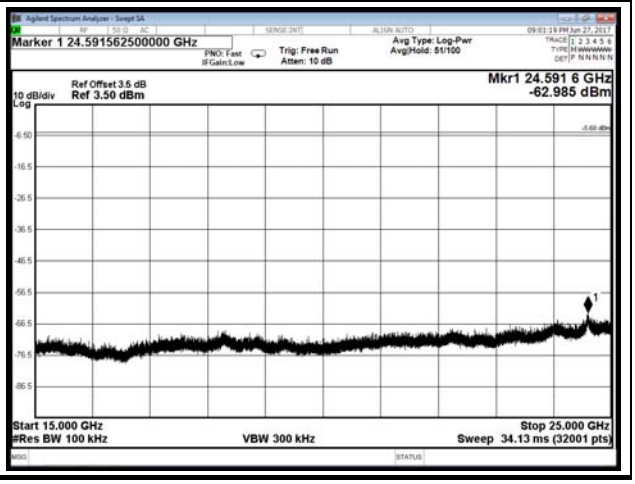
30MHz – 8GHz



8GHz – 15GHz



15GHz – 25GHz



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APPDNDIX B

TEST PHOTOGRAPHS

(Model: T7PX)

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