

FCC/IC REPORT

Applicant: Horizon Hobby, LLC

Address of Applicant(FCC): 2904 Research Rd., Champaign, IL 61822 USA

Address of Applicant(IC): 4105 Fieldstone Rd.Champaign IL 61822 United States Of America

Equipment Under Test (EUT)

Product Name: Waco RF Module

Model No.: Waco

FCC ID: BRWWACO1T

IC: 6157A-WACO1T

Applicable standards: FCC CFR Title 47 Part 15 Subpart C Section 15.249
RSS-210 Issue 9 August 2016 Annex B Section B10
RSS-Gen Issue 5 April 2018

Date of sample receipt: 24 Apr., 2019

Date of Test: 25 Apr., to 14 May., 2019

Date of report issued: 14 May., 2019

Test Result: PASS*

* In the configuration tested, the EUT complied with the standards specified above.

Authorized Signature:



Bruce Zhang
Laboratory Manager

This report details the results of the testing carried out on one sample. The results contained in this test report do not relate to other samples of the same product and does not permit the use of the CCIS product certification mark. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

This report may only be reproduced and distributed in full. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards.

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2 Version

Version No.	Date	Description
00	14 May, 2019	Original
01	31 May, 2019	Update page 1, 4~11, 25, 26, 28

Prepared By:

Mike.Ou

Date:

14 May, 2019

Project Engineer

Check By:

Wimer Zhang

Date:

14 May, 2019

Reviewer

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4 Test Summary

Test Item	Section in CFR 47		Result
	FCC	IC	
Antenna requirement	15.203	RSS-GEN Section 6.8	Pass
Conducted Emission	15.207	RSS-GEN Section 8.8	Pass
Field strength of the fundamental signal	15.249 (a)(e)	RSS-210 Annex B Section B.10(a)	Pass
Spurious emissions	15.249 (d)/15.209	RSS-210 Annex B Section B.10(b) / RSS- GEN Section 8.9	Pass
20dB Occupy Bandwidth	15.215	RSS-GEN Section 6.7	Pass
99% Occupy Bandwidth	N/A	RSS-GEN Section 6.7	Pass
Frequency stability	/	RSS-210 RSS-GEN Section 8.11	Pass

Pass: The EUT comply with the essential requirements in the standard.

5 General Information

5.1 Client Information

Applicant:	Horizon Hobby, LLC
Address of Applicant:	2904 Research Rd., Champaign, IL 61822 USA
Manufacturer:	Horizon Hobby, LLC
Address:	2904 Research Rd., Champaign, IL 61822 USA

5.2 General Description of E.U.T.

Product Name:	Waco RF Module
Model No.:	Waco
Operation Frequency:	2404MHz~2476MHz
Channel numbers:	23
Hardware version:	A
Software version:	1.0
Modulation type:	GFSK
Antenna Type:	Integral antenna
Antenna gain:	1.3 dBi
Power supply:	DC 3.3V
Test Sample Condition:	The test samples were provided in good working order with no visible defects.

Operation Frequency each of channel

Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2404MHz	9	2433MHz	18	2463MHz
1	2407MHz	10	2437MHz	19	2466MHz
2	2411MHz	11	2440MHz	20	2469MHz
3	2414MHz	12	2443MHz	21	2473MHz
4	2417MHz	13	2446MHz	22	2476 MHz
5	2420MHz	14	2450MHz		
6	2424MHz	15	2453MHz		
7	2427MHz	16	2456MHz		
8	2430MHz	17	2459MHz		

Note:

In section 15.31(m), regards to the operating frequency range over 10 MHz, the Lowest frequency, the middle frequency, and the highest frequency of channel were selected to perform the test. Channel No. 0, 11 & 22 were selected as Lowest, Middle and Highest channel.

5.3 Test mode

Transmitting mode:	Keep the EUT in transmitting mode with modulation.		
Pre-Test Mode: (highest channel=2404MHz)			
CCIS has verified the construction and function in typical operation, The EUT was placed on three different polar directions; i.e. X axis, Y axis, Z axis. which was shown in this test report and defined as follows:			
Axis	X	Y	Z
Field Strength(dBuV/m)	95.13	94.37	93.89
Final Test Mode:			
According to ANSI C63.4 standards, the test results are both the “worst case” and “worst setup”: Z axis (see the test setup photo)			

5.4 Description of Support Units

Manufacturer	Description	Model	S/N	FCC ID/DoC
LENOVO	Laptop	SL510	2847A65	DoC
ROKIT	Adapter	TPA-46B050055UU	N/A	N/A
Horizon Hobby, LCC	Test suite	WCAO DEV KIT X0	N/A	N/A

5.5 Laboratory Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **FCC - Registration No.: 727551**

Shenzhen Zhongjian Nanfang Testing Co., Ltd. has been accredited as a testing laboratory by FCC (Federal Communications Commission). The Registration No. is 727551.

- **IC - Registration No.: 10106A-1**

The 3m Semi-anechoic chamber of Shenzhen Zhongjian Nanfang Testing Co., Ltd. has been Registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 10106A-1.

- **CNAS - Registration No.: CNAS L6048**

Shenzhen Zhongjian Nanfang Testing Co., Ltd. is accredited to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration laboratories for the competence of testing. The Registration No. is CNAS L6048.

- **A2LA - Registration No.: 4346.01**

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories. The test scope can be found as below link: <https://portal.a2la.org/scopepdf/4346-01.pdf>

5.6 Laboratory Location

Shenzhen Zhongjian Nanfang Testing Co., Ltd.
Address: No. B-C, 1/F., Building 2, Laodong No.2 Industrial Park, Xixiang Road,
Bao'an District, Shenzhen, Guangdong, China
Tel: +86-755-23118282, Fax: +86-755-23116366
Email: info@ccis-cb.com, Website: <http://www.ccis-cb.com>

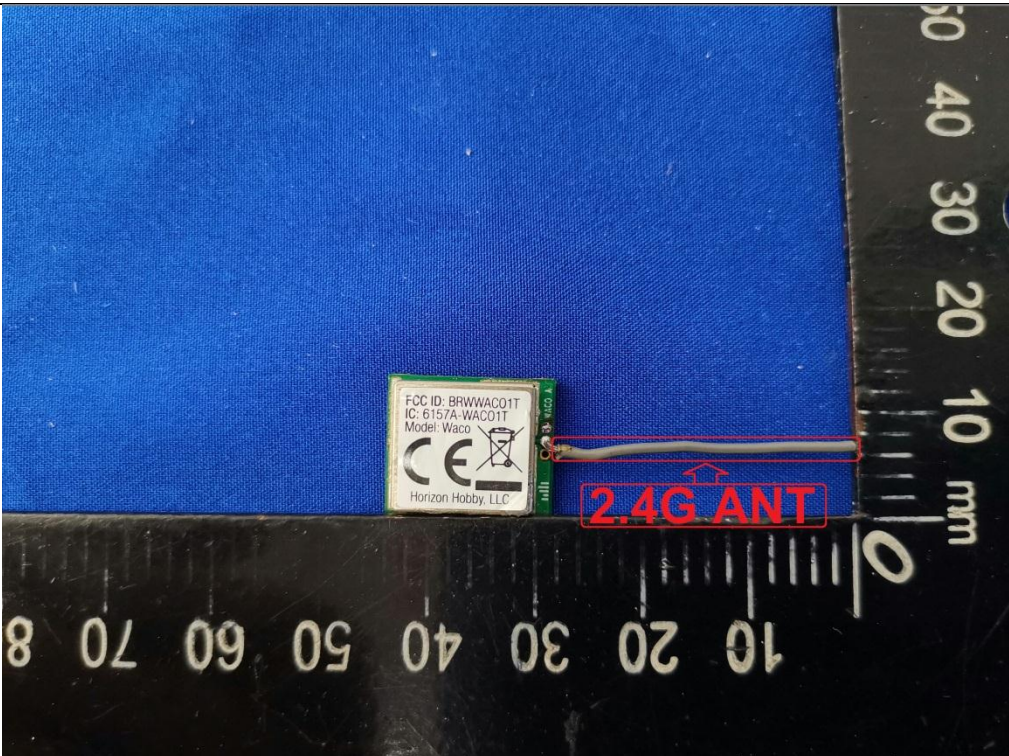
5.7 Test Instruments list

Radiated Emission:					
Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Date (mm-dd-yy)	Cal. Due date (mm-dd-yy)
3m SAC	SAEMC	9m*6m*6m	966	07-22-2017	07-21-2020
BiConiLog Antenna	SCHWARZBECK	VULB9163	497	03-18-2019	03-17-2020
Horn Antenna	SCHWARZBECK	BBHA9120D	916	03-18-2019	03-17-2020
Horn Antenna	SCHWARZBECK	BBHA9120D	1805	06-22-2017	06-21-2020
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170582	11-21-2018	11-20-2019
Loop Antenna	SCHWARZBECK	FMZB 1519 B	00044	03-18-2019	03-17-2020
EMI Test Software	AUDIX	E3	Version: 6.110919b		
Pre-amplifier	HP	8447D	2944A09358	03-18-2019	03-17-2020
Pre-amplifier	CD	PAP-1G18	11804	03-18-2019	03-17-2020
Spectrum analyzer	Rohde & Schwarz	FSP30	101454	03-18-2019	03-17-2020
Spectrum analyzer	Rohde & Schwarz	FSP40	100363	11-21-2018	11-20-2019
EMI Test Receiver	Rohde & Schwarz	ESRP7	101070	03-18-2019	03-17-2020
Simulated Station	Anritsu	MT8820C	6201026545	03-18-2019	03-17-2020
Cable	ZDECL	Z108-NJ-NJ-81	1608458	03-18-2019	03-17-2020
Cable	MICRO-COAX	MFR64639	K10742-5	03-18-2019	03-17-2020
Cable	SUHNER	SUCOFLEX100	58193/4PE	03-18-2019	03-17-2020

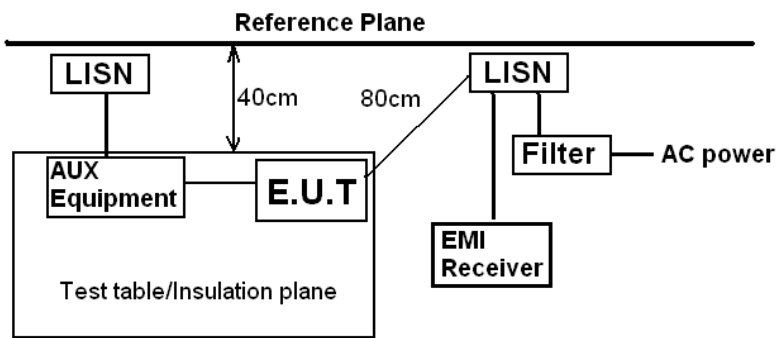
Conducted Emission:					
Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Date (mm-dd-yy)	Cal. Due date (mm-dd-yy)
EMI Test Receiver	Rohde & Schwarz	ESCI	101189	03-18-2019	03-17-2020
Pulse Limiter	SCHWARZBECK	OSRAM 2306	9731	03-18-2019	03-17-2020
LISN	CHASE	MN2050D	1447	03-18-2019	03-17-2020
LISN	Rohde & Schwarz	ESH3-Z5	8438621/010	07-21-2018	07-20-2019
Cable	HP	10503A	N/A	03-18-2019	03-17-2020
EMI Test Software	AUDIX	E3	Version: 6.110919b		

6 Test results and Measurement Data

6.1 Antenna requirement:

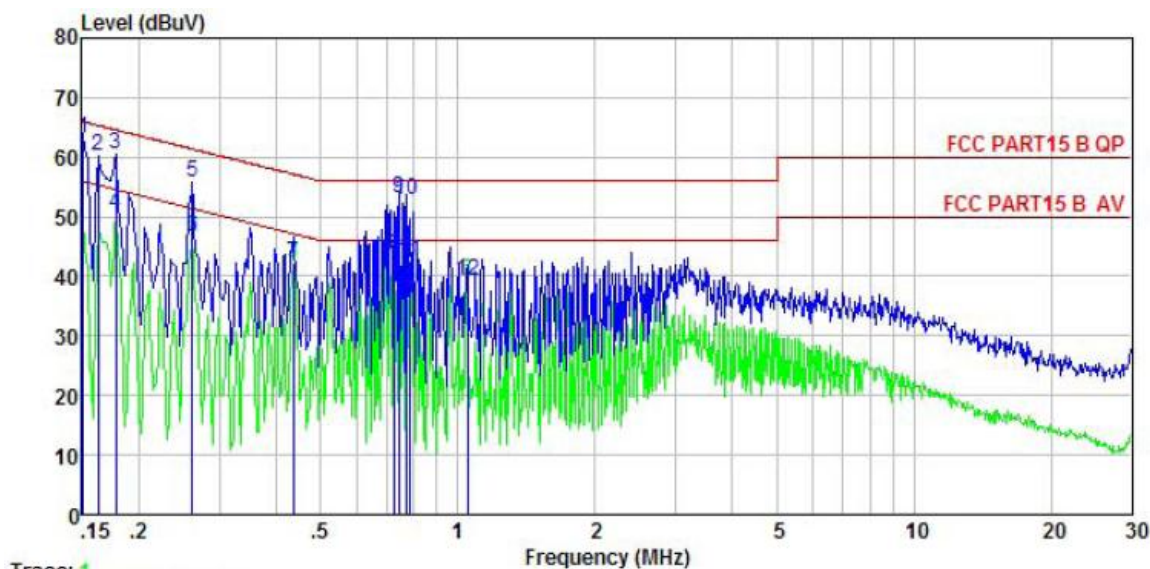
Standard requirement:	FCC Part15 C Section 15.203
15.203 requirement: <i>An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.</i>	
E.U.T Antenna:	
The antenna is Solder 1/4 Wave Antenna which cannot detachable . The best case gain of the antenna is 1.3 dBi.	
	

6.2 Conducted Emission

Test Requirement:	FCC Part 15 C Section 15.207		
Test Method:	ANSI C63.10: 2013		
Test Frequency Range:	150 kHz to 30 MHz		
Class / Severity:	Class B		
Receiver setup:	RBW=9kHz, VBW=30kHz		
Limit:	Frequency range (MHz)	Limit (dBuV)	
		Quasi-peak	Average
	0.15-0.5	66 to 56*	56 to 46*
	0.5-5	56	46
	5-30	60	50
* Decreases with the logarithm of the frequency.			
Test procedure	1. The E.U.T and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.), which provides a 50ohm/50uH coupling impedance for the measuring equipment. 2. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs). 3. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4: 2014 on conducted measurement.		
Test setup:	 Remark: E.U.T: Equipment Under Test LISN: Line Impedance Stabilization Network Test table height=0.8m		
Test Instruments:	Refer to section 5.8 for details		
Test mode:	Refer to section 5.3 for details		
Test results:	Passed		

Measurement Data:

Product name:	Waco RF Module	Product model:	Waco
Test by:	Mike	Test mode:	2.4G Tx mode
Test frequency:	150 kHz ~ 30 MHz	Phase:	Line
Test voltage:	AC 120 V/60 Hz	Environment:	Temp: 22.5°C Humi: 55%

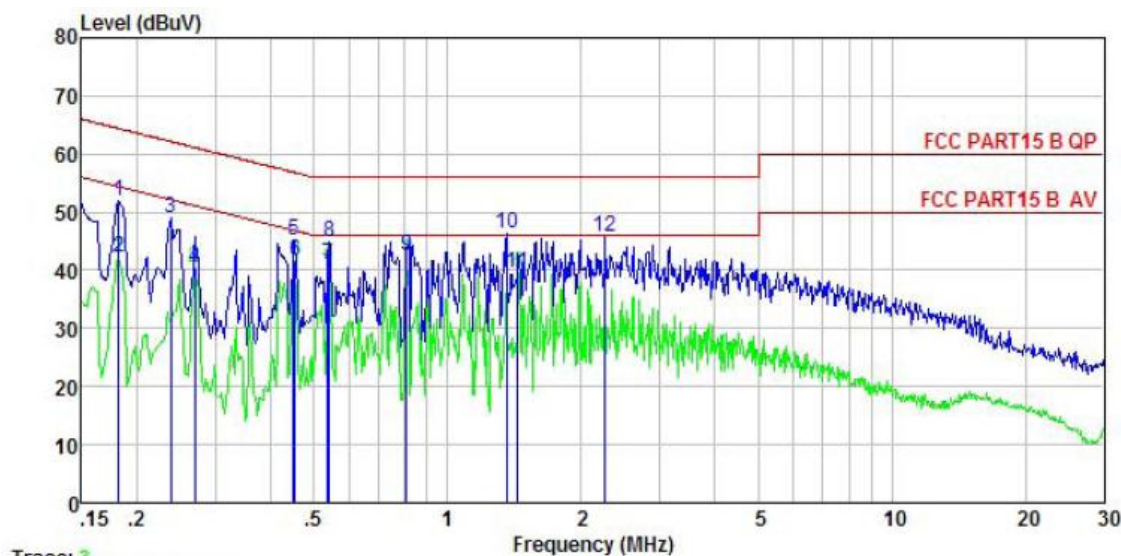


	Freq	Read	LISN	Cable	Level	Limit	Over	
	MHz	dBuV	Factor	Loss	dBuV	dBuV	Limit	Remark
			dB	dB			dB	
1	0.151	52.74	-0.45	10.78	63.07	65.96	-2.89	QP
2	0.162	49.86	-0.44	10.77	60.19	65.34	-5.15	QP
3	0.178	50.31	-0.43	10.77	60.65	64.59	-3.94	QP
4	0.178	40.14	-0.43	10.77	50.48	54.59	-4.11	Average
5	0.262	45.50	-0.39	10.75	55.86	61.38	-5.52	QP
6	0.262	36.38	-0.39	10.75	46.74	51.38	-4.64	Average
7	0.435	31.78	-0.38	10.73	42.13	47.15	-5.02	Average
8	0.727	32.94	-0.38	10.78	43.34	46.00	-2.66	Average
9	0.743	42.69	-0.38	10.79	53.10	56.00	-2.90	QP
10	0.771	42.43	-0.38	10.80	52.85	56.00	-3.15	QP
11	0.788	31.96	-0.38	10.81	42.39	46.00	-3.61	Average
12	1.049	28.89	-0.38	10.88	39.39	46.00	-6.61	Average

Notes:

1. An initial pre-scan was performed on the line and neutral lines with peak detector.
2. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.
3. Final Level = Receiver Read level + LISN Factor + Cable Loss.

Product name:	Waco RF Module	Product model:	Waco
Test by:	Mike	Test mode:	2.4G Tx mode
Test frequency:	150 kHz ~ 30 MHz	Phase:	Neutral
Test voltage:	AC 120 V/60 Hz	Environment:	Temp: 22.5℃ Humi: 55%



Trace: 3

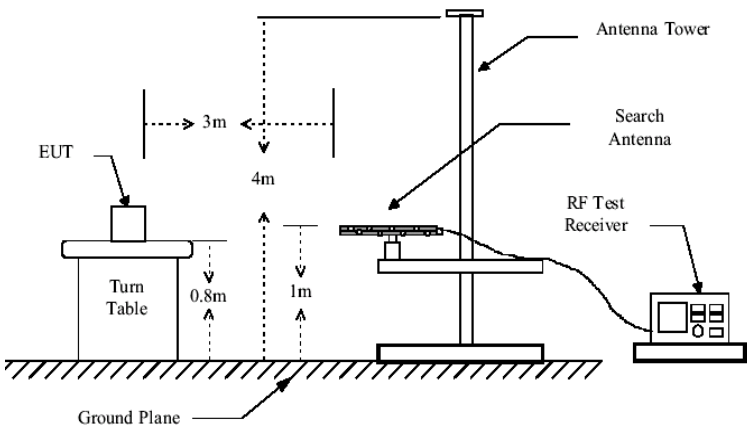
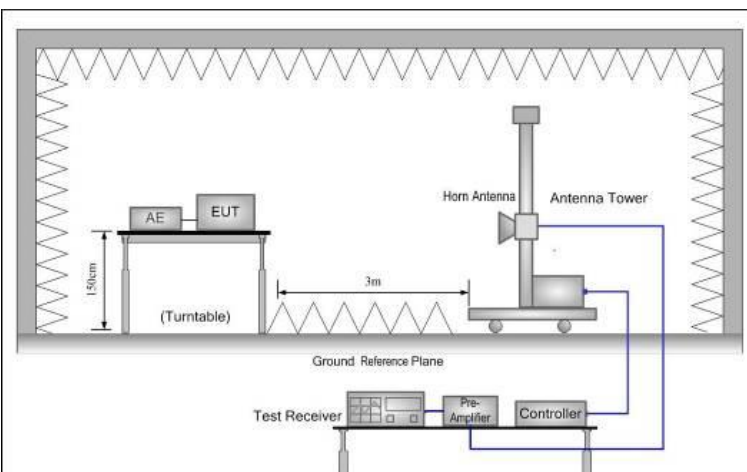
	Freq	Read Level	LISN Factor	Cable Loss	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dB	dBuV	dBuV	dB	
1	0.182	41.84	-0.69	10.77	51.92	64.42	-12.50	QP
2	0.182	32.24	-0.69	10.77	42.32	54.42	-12.10	Average
3	0.238	38.77	-0.66	10.75	48.86	62.17	-13.31	QP
4	0.270	30.46	-0.65	10.75	40.56	51.12	-10.56	Average
5	0.449	35.20	-0.65	10.74	45.29	56.89	-11.60	QP
6	0.454	31.43	-0.65	10.74	41.52	46.80	-5.28	Average
7	0.538	31.05	-0.65	10.76	41.16	46.00	-4.84	Average
8	0.541	34.88	-0.65	10.76	44.99	56.00	-11.01	QP
9	0.809	32.25	-0.64	10.81	42.42	46.00	-3.58	Average
10	1.359	36.00	-0.65	10.91	46.26	56.00	-9.74	QP
11	1.441	29.37	-0.65	10.92	39.64	46.00	-6.36	Average
12	2.261	35.55	-0.67	10.95	45.83	56.00	-10.17	QP

Notes:

1. An initial pre-scan was performed on the line and neutral lines with peak detector.
2. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.
3. Final Level = Receiver Read level + LISN Factor + Cable Loss.

6.3 Radiated Emission

Test Requirement:	FCC Part15 C Section 15.249 and 15.209 RSS-210 Annex B Section B.10 and RSS-GEN Section 8.9				
Test Method:	ANSI C63.10:2013				
Test Frequency Range:	30MHz to 25000MHz				
Test site:	Measurement Distance: 3m				
Receiver setup:	Frequency	Detector	RBW	VBW	Remark
	30MHz-1GHz	Quasi-peak	120kHz	300kHz	Quasi-peak Value
	Above 1GHz	Peak	1MHz	3MHz	Peak Value
		RMS	1MHz	3MHz	Average Value
Limit: (Field strength of the fundamental signal)	Frequency		Limit (dBuV/m @3m)		Remark
	2400-2483.5MHz		94.00		Average Value
			114.00		Peak Value
Limit: (Spurious Emissions)	Frequency		Limit (dBuV/m @3m)		Remark
	30MHz-88MHz		40.00		Quasi-peak Value
	88MHz-216MHz		43.50		Quasi-peak Value
	216MHz-960MHz		46.00		Quasi-peak Value
	960MHz-1GHz		54.00		Quasi-peak Value
	Above 1GHz		54.00		Average Value
			74.00		Peak Value
Limit: (outside of the specified frequency band)	Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209, whichever is the lesser attenuation.				
Test Procedure:	1. The EUT was placed on the top of a rotating table 0.8m(below 1GHz)/1.5m(above 1GHz) above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation. 2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. 3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement. 4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. 5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. 6. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.				

Test setup:	Below 1GHz  Above 1GHz 
Test Instruments:	Refer to section 5.7
Test mode:	Refer to section 5.3
Test results:	Passed

6.3.1 Field Strength Of The Fundamental Signal

Peak value							
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2404	55.00	27.11	4.70	86.81	114.00	-27.19	Vertical
	62.77	27.56	4.80	95.13	114.00	-18.87	Horizontal
2440	55.33	27.22	4.75	87.3	114.00	-26.70	Vertical
	61.71	27.22	4.75	93.68	114.00	-20.32	Horizontal
2476	54.59	27.33	4.80	86.72	114.00	-27.28	Vertical
	59.48	27.33	4.80	91.61	114.00	-22.39	Horizontal
Average value							
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2404	54.26	27.11	4.7	86.07	94.00	-7.93	Vertical
	61.37	27.11	4.7	93.18	94.00	-0.82	Horizontal
2440	52.31	27.22	4.75	84.28	94.00	-9.72	Vertical
	61.4	27.22	4.75	93.37	94.00	-0.63	Horizontal
2476	53.39	27.33	4.8	85.52	94.00	-8.48	Vertical
	58.93	27.33	4.8	91.06	94.00	-2.94	Horizontal

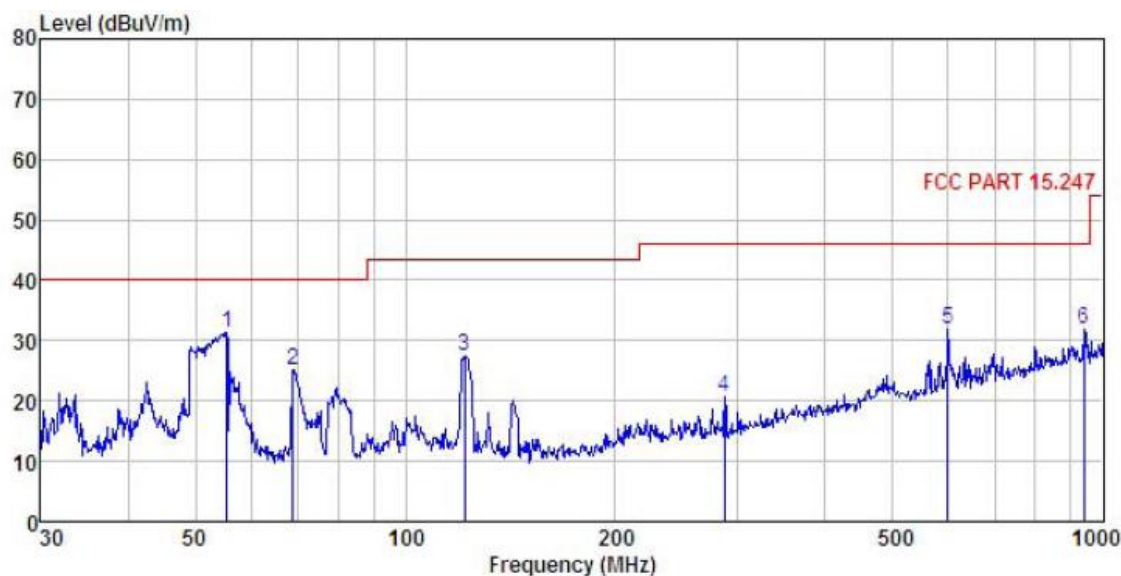
NOTE: Field strength of the fundamental signal test, RBW >20dB BW, VBW>=3XRBW.

6.3.2 Spurious Emissions

Measurement Data (worst case):

Below 1GHz:

Product Name:	Waco RF Module	Product Model:	WACO
Test By:	Mike	Test mode:	2.4G Tx mode
Test Frequency:	30 MHz ~ 1 GHz	Polarization:	Vertical
Test Voltage:	DC 3.3V	Environment:	Temp: 24℃ Humi: 57%

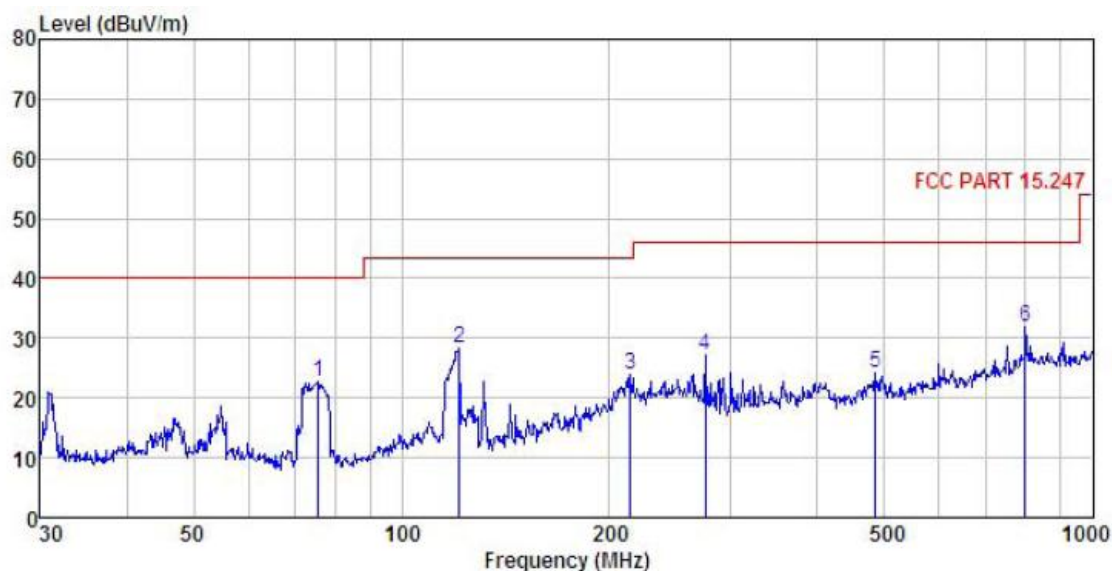


	Freq	ReadAntenna	Cable	Preamp	Level	Limit	Over	
	MHz	Level	Factor	Loss	Factor	Level	Line	Limit
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB
1	55.415	48.13	11.58	1.36	29.80	31.27	40.00	-8.73 QP
2	68.872	44.64	8.74	1.49	29.73	25.14	40.00	-14.86 QP
3	121.549	44.02	10.77	2.19	29.38	27.60	43.50	-15.90 QP
4	286.982	32.89	13.39	2.90	28.47	20.71	46.00	-25.29 QP
5	599.321	37.47	19.50	3.94	28.94	31.97	46.00	-14.03 QP
6	938.833	33.00	22.65	4.10	27.76	31.99	46.00	-14.01 QP

Remark:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamp Factor.
2. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product Name:	Waco RF Module	Product Model:	WACO
Test By:	Mike	Test mode:	2.4G Tx mode
Test Frequency:	30 MHz ~ 1 GHz	Polarization:	Horizontal
Test Voltage:	DC 3.3V	Environment:	Temp: 24℃ Humi: 57%



	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	75.711	42.99	7.78	1.63	29.67	22.73	40.00	-17.27	QP
2	121.123	44.74	10.81	2.18	29.38	28.35	43.50	-15.15	QP
3	214.514	38.60	11.23	2.85	28.74	23.94	43.50	-19.56	QP
4	275.157	39.66	13.18	2.87	28.49	27.22	46.00	-18.78	QP
5	485.609	31.97	17.72	3.50	28.93	24.26	46.00	-21.74	QP
6	798.980	34.17	21.50	4.35	28.20	31.82	46.00	-14.18	QP

Remark:

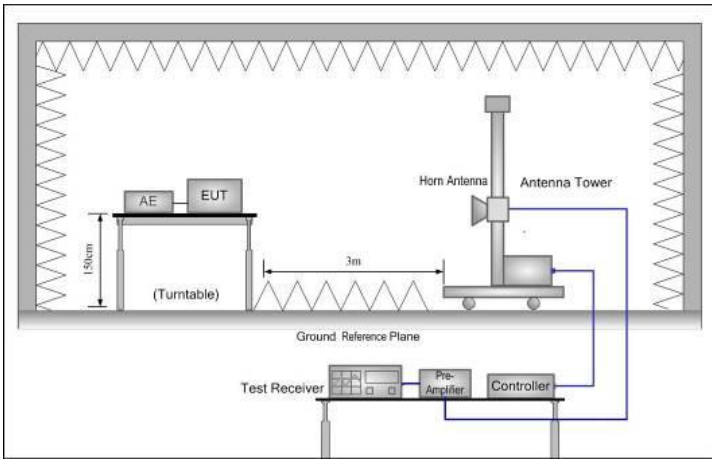
1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
2. The emission levels of other frequencies are very lower than the limit and not show in test report.

Above 1GHz

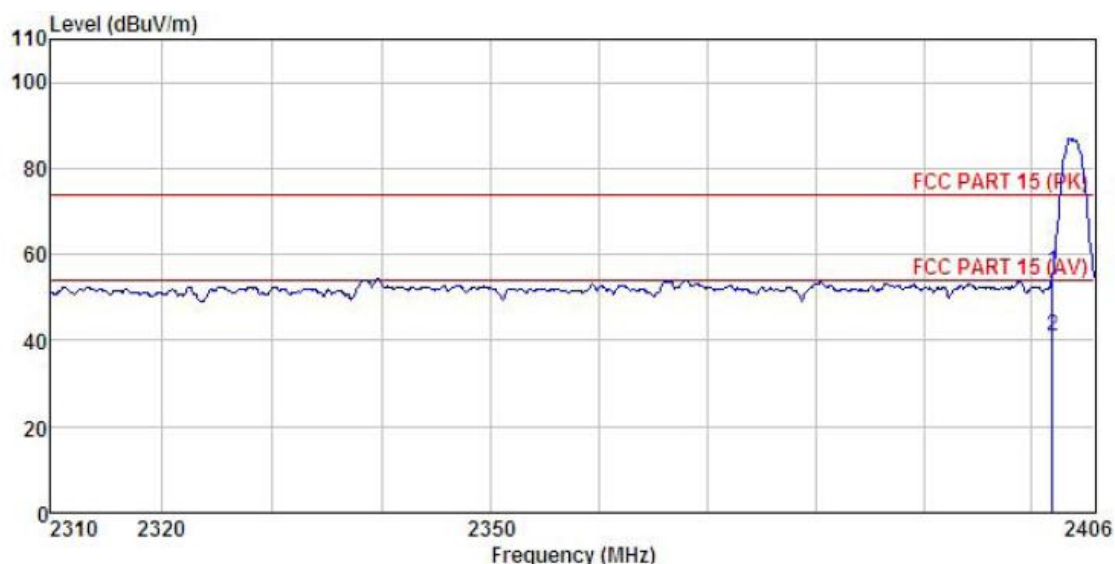
Test channel: Lowest channel								
Detector: Peak Value								
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamplifier Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4808.00	46.72	31.62	6.81	41.82	43.33	74.00	-30.67	Vertical
4808.00	49.96	31.62	6.81	41.82	46.57	74.00	-27.43	Horizontal
Detector: Average Value								
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamplifier Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4808.00	38.54	31.62	6.81	41.82	35.15	54.00	-18.85	Vertical
4808.00	39.75	31.62	6.81	41.82	36.36	54.00	-17.64	Horizontal
Test channel: Middle channel								
Detector: Peak Value								
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamplifier Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4880.00	47.26	31.72	6.86	41.84	44.00	74.00	-30.00	Vertical
4880.00	48.83	31.72	6.86	41.84	45.57	74.00	-28.43	Horizontal
Detector: Average Value								
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamplifier Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4880.00	38.67	31.72	6.86	41.84	35.41	54.00	-18.59	Vertical
4880.00	38.91	31.72	6.86	41.84	35.65	54.00	-18.35	Horizontal
Test channel: Highest channel								
Detector: Peak Value								
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamplifier Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4952.00	46.86	31.84	6.91	41.87	43.74	74.00	-30.26	Vertical
4952.00	47.49	31.84	6.91	41.87	44.37	74.00	-29.63	Horizontal
Detector: Average Value								
Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamplifier Factor (dB)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4952.00	38.44	31.84	6.91	41.87	35.32	54.00	-18.68	Vertical
4952.00	38.62	31.84	6.91	41.87	35.50	54.00	-18.50	Horizontal
Remark:								
1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.								
2. The emission levels of other frequencies are very lower than the limit and not show in test report.								

6.3.3 Band Edge

Radiated Emission Method

Test Requirement:	FCC Part 15 C Section 15.205 and 15.209 RSS-GEN Section 8.9 and RSS-GEN Section 8.10				
Test Method:	ANSI C63.10:2013				
Test Frequency Range:	2.3GHz to 2.5GHz				
Test Distance:	3m				
Receiver setup:	Frequency	Detector	RBW	VBW	Remark
	Above 1GHz	Peak RMS	1MHz 1MHz	3MHz 3MHz	Peak Value Average Value
Limit:	Frequency		Limit (dBuV/m @3m)		Remark
	Above 1GHz		54.00		Average Value
			74.00		Peak Value
Test Procedure:	7. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation. 8. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. 9. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement. 10. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rota table was turned from 0 degrees to 360 degrees to find the maximum reading. 11. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. 12. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.				
Test setup:					
Test Instruments:	Refer to section 5.7 for details				
Test mode:	Refer to section 5.3 for details				
Test results:	Passed				

Product Name:	Waco RF Module	Product Model:	WACO
Test By:	Mike	Test mode:	2.4G-Tx mode
Test Channel:	Lowest channel	Polarization:	Vertical
Test Voltage:	DC 3.3V	Environment:	Temp: 24°C Humi: 57%

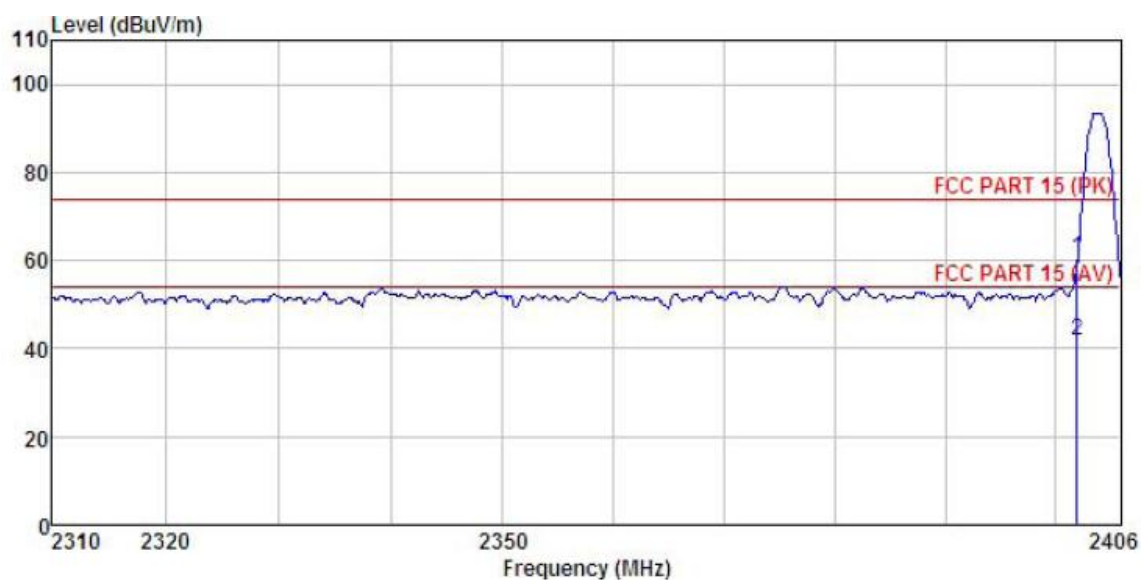


	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2402.000	24.30	27.11	4.70	0.00	56.11	74.00	-17.89	Peak
2	2402.000	9.24	27.11	4.70	0.00	41.05	54.00	-12.95	Average

Remark:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
2. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product Name:	Waco RF Module	Product Model:	WACO
Test By:	Mike	Test mode:	2.4G-Tx mode
Test Channel:	Lowest channel	Polarization:	Horizontal
Test Voltage:	DC 3.3V	Environment:	Temp: 24°C Humi: 57%

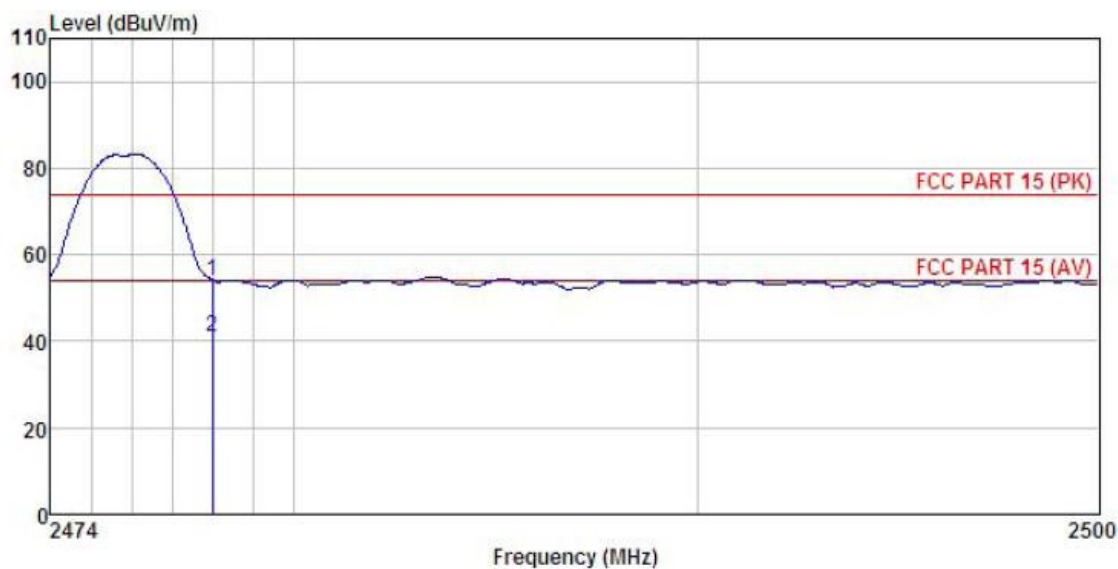


	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2402.000	28.60	27.11	4.70	0.00	60.41	74.00	-13.59	Peak
2	2402.000	10.09	27.11	4.70	0.00	41.90	54.00	-12.10	Average

Remark:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
2. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product Name:	Waco RF Module	Product Model:	WACO
Test By:	Mike	Test mode:	2.4G-Tx mode
Test Channel:	Highest channel	Polarization:	Vertical
Test Voltage:	DC 3.3V	Environment:	Temp: 24℃ Humi: 57%

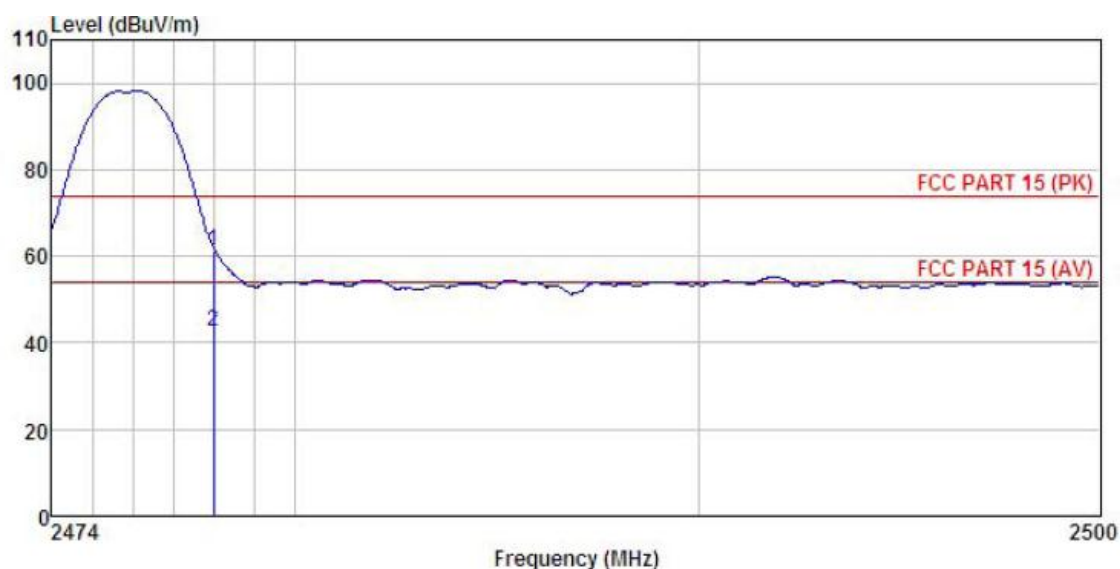


	Freq	Read	Antenna	Cable	Preamp	Level	Limit	Over	Remark
	MHz	Level	Factor	Loss	Factor	Level	Line	Limit	
		dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2478.000	21.88	27.34	4.80	0.00	54.02	74.00	-19.98	Peak
2	2478.000	9.04	27.34	4.80	0.00	41.18	54.00	-12.82	Average

Remark:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
2. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product Name:	Waco RF Module	Product Model:	WACO
Test By:	Mike	Test mode:	2.4G-Tx mode
Test Channel:	Highest channel	Polarization:	Horizontal
Test Voltage:	DC 3.3V	Environment:	Temp: 24°C Humi: 57%

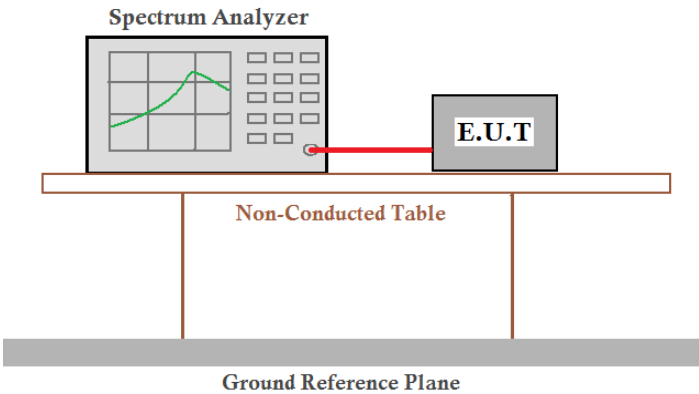


	Read	Antenna	Cable	Preamp	Limit	Over	
Freq	Level	Factor	Loss	Factor	Line	Limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB
1	2478.000	29.20	27.34	4.80	0.00	61.34	74.00 -12.66 Peak
2	2478.000	10.57	27.34	4.80	0.00	42.71	54.00 -11.29 Average

Remark:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor.
2. The emission levels of other frequencies are very lower than the limit and not show in test report.

6.4 Occupy Bandwidth

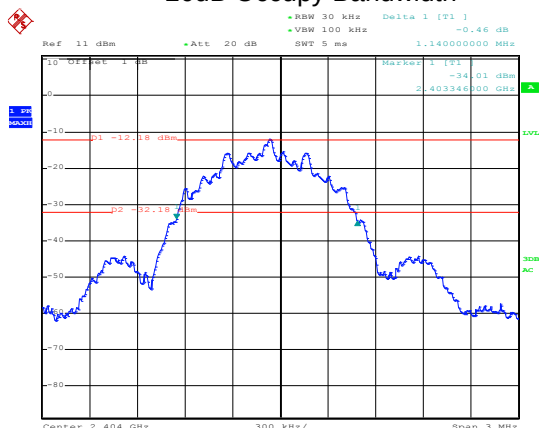
Test Requirement:	FCC Part 15 C Section 15.215 RSS-GEN Section 6.7
Test Method:	ANSI C63.10:2013
Receiver setup:	RBW=30 kHz, VBW=100 kHz, detector=Peak
Limit:	N/A
Test setup:	 The diagram illustrates the test setup. A Spectrum Analyzer is connected to an E.U.T. (Equipment Under Test) via a red cable. Both the Spectrum Analyzer and the E.U.T. are placed on a Non-Conducted Table. Below the table is a Ground Reference Plane.
Test Instruments:	Refer to section 5.7 for details
Test mode:	Transmitting mode
Test results:	Pass

Measurement Data:

20dB Occupy Bandwidth (MHz)		
Lowest channel	Middle channel	Highest Highest
1.140	1.188	1.176
99% Occupy Bandwidth (MHz)		
Lowest channel	Middle channel	Highest Highest
1.038	1.056	1.050

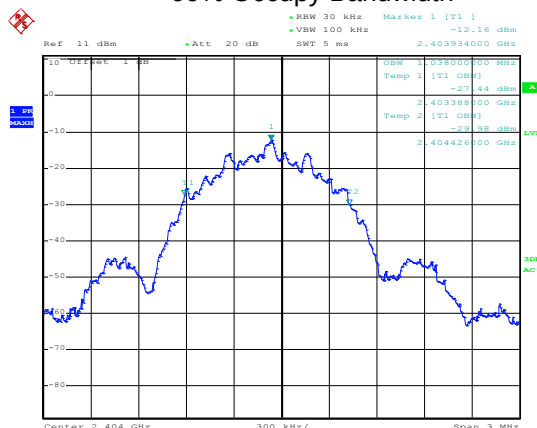
Test plot as follows:

20dB Occupy Bandwidth



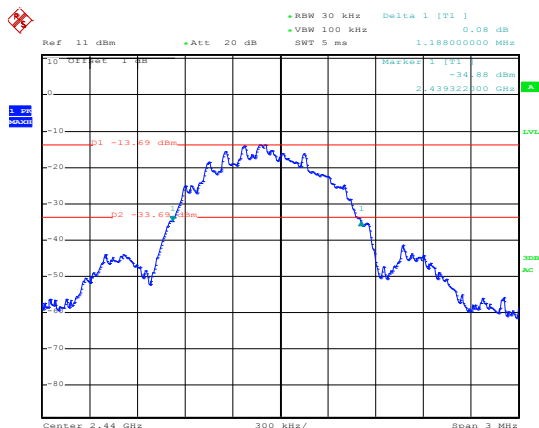
Date: 13.MAY.2019 16:04:02

99% Occupy Bandwidth



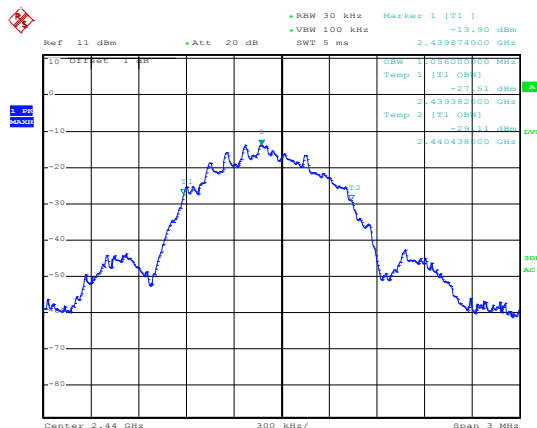
Date: 13.MAY.2019 16:02:36

Lowest channel



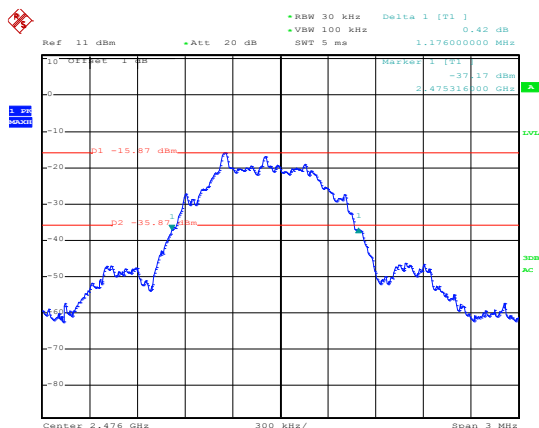
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Lowest channel



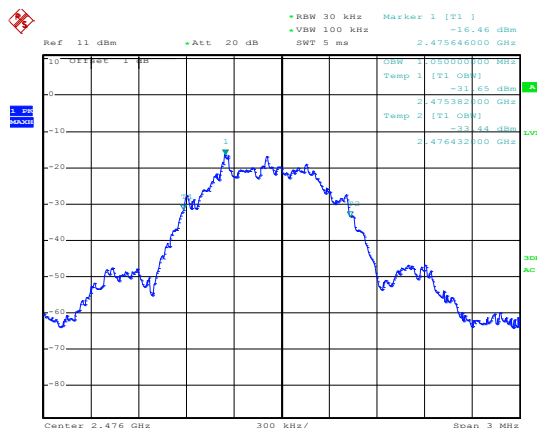
Date: 13.MAY.2019 16:00:59

Middle channel



Date: 13.MAY.2019 16:17:47

Middle channel

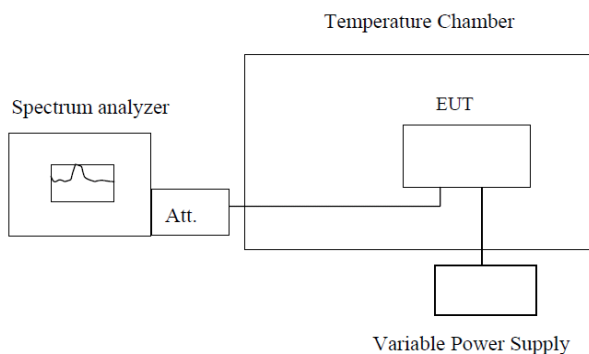


Date: 13.MAY.2019 16:18:42

Highest channel

Highest channel

6.5 Frequency stability

Test Requirement:	RSS-GEN Section 8.11
Test Method:	RSS-GEN Section 6.11
Limit:	2400MHz~2483.5MHz
Test setup:	 Note : Measurement setup for testing on Antenna connector
Test procedure:	1. The EUT is installed in an environment test chamber with external power source. 2. Set the chamber to operate at 50 centigrade and external power source to output at nominal voltage of EUT. 3. A sufficient stabilization period at each temperature is used prior to each frequency measurement. 4. When temperature is stabled, measure the frequency stability. 5. The test shall be performed under -20 to 50 centigrade and 85 to 115 percent of the nominal voltage. Change setting of chamber and external power source to complete all conditions.
Test Instruments:	Refer to section 5.7 for details
Test mode:	Refer to section 5.3 for details
Test results:	Passed

Measurement Data (worst case):**Voltage vs. Frequency Stability**

Test conditions		Measurement Frequency (MHz)		Limit (MHz)
Temp(°C)	Voltage(ac)	Lowest channel	Highest Highest	
20	5.0V	2403.946	2475.942	2400MHz~2483.5
	3.3V	2403.947	2475.943	
	3.0V	2403.945	2475.940	

Note: EUT stops working when the supply voltage is lower than DC 3V.

Temperature vs. Frequency Stability

Test conditions		Frequency(MHz)		Limit (MHz)
Voltage(dc)	Temp(°C)	Lowest channel	Highest channel	
3.3 V	-20	2403.945	2475.947	2400MHz~2483.5
	-10	2403.946	2475.946	
	0	2403.947	2475.948	
	10	2403.945	2475.945	
	20	2403.946	2475.944	
	30	2403.944	2475.942	
	40	2403.947	2475.943	
	50	2403.945	2475.9449	

Test plot as follows: