MEASUREMENT REPORT

FCC Part 15 Subpart B

Applicant:	Compex Systems Pte Ltd
Address:	No:9 Harrison Road, Harrison Industrial Building, #05-01, Singapore 369651
Application Type:	Declaration of Conformity
Product:	4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module
Model No.:	WLE1216V5-20, WLE1216V5-20-I
Brand Name:	COMPEX
FCC Rule Part(s):	FCC Part 15 Subpart B: 2016
Test Procedure(s):	ANSI C63.4: 2014
Result:	Complies
Test Date:	October 25 ~ November 20, 2017

Reviewed By : Jame Yuan
(Jame Yuan)

Approved By : Marlin Chen
(Marlin Chen)

Revision History

Report No.	Version	Description	Issue Date	Note
1710RSU02004	Rev. 01	Initial Report	11-20-2017	Valid

CONTENTS

Description Page

§2.1033 General Information

Applicant:	Compex Systems Pte Ltd
Applicant Address:	No:9 Harrison Road, Harrison Industrial Building, #05-01, Singapore 369651
Manufacturer:	Compex Systems Pte Ltd
Manufacturer Address:	No:9 Harrison Road, Harrison Industrial Building, #05-01, Singapore 369651
Test Site:	MRT Technology (Suzhou) Co., Ltd
Test Site Address:	D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China
FCC Registration No.:	893164
Test Device Serial No.:	N/A ☐ Production ☒ Pre-Production ☐ Engineering

Test Facility / Accreditations

Measurements were performed at MRT Laboratory located in Tian'edang Rd., Suzhou, China.

- **MRT facility is a FCC registered (MRT Reg. No. 893164) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules.**
- **MRT facility is an IC registered (MRT Reg. No. 11384A-1) test laboratory with the site description on file at Industry Canada.**
- **MRT facility is a VCCI registered (R-4179, G-814, C-4664, T-2206) test laboratory with the site description on file at VCCI Council.**
- **MRT Lab is accredited to ISO 17025 by the American Association for Laboratory Accreditation (A2LA) under the American Association for Laboratory Accreditation Program (A2LA Cert. No. 3628.01) in EMC, Telecommunications and Radio testing for FCC, Industry Canada, EU and TELEC Rules.**

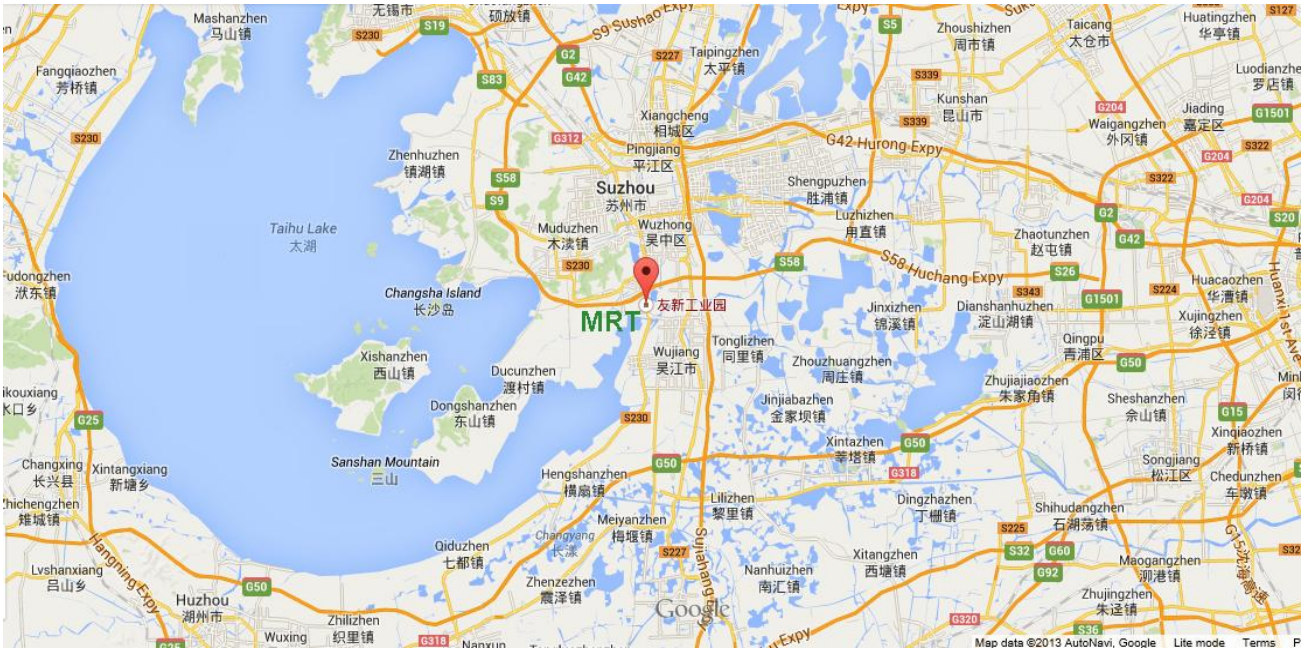
1. INTRODUCTION

1.1. Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Industry Canada Certification and Engineering Bureau.

1.2. MRT Test Location

The map below shows the location of the MRT LABORATORY, its proximity to the Taihu Lake. These measurement tests were conducted at the MRT Technology (Suzhou) Co., Ltd. Facility located at D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4-2009 on September 30, 2013.



2. PRODUCT INFORMATION

2.1. Equipment Description

Product Name	4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module
Model No.	WLE1216V5-20, WLE1216V5-20-I
Brand Name:	COMPEX
Operating Temperature:	-20 ~ 55 °C

Note: The difference between models is for different market sale.

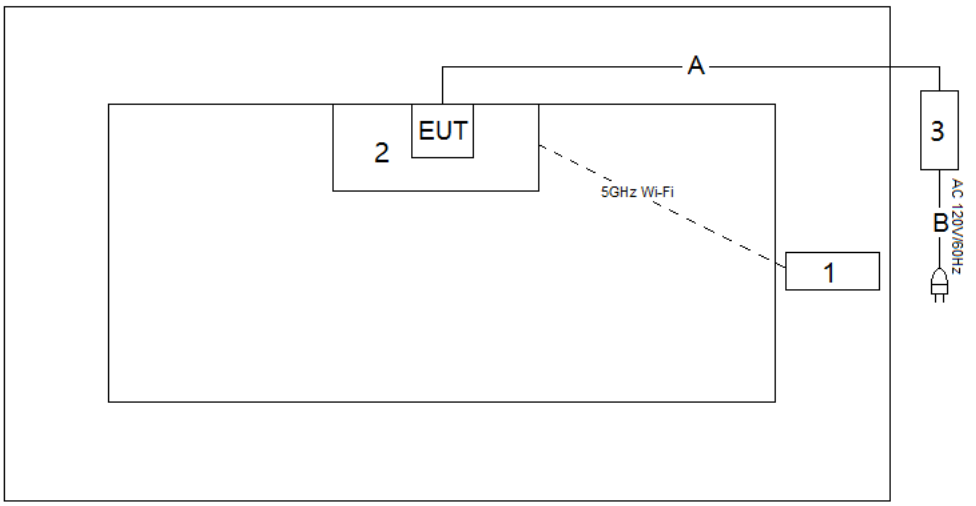
2.2. Test Mode

EMI Mode	Mode 1: Make the EUT communicate with notebook by Wi-Fi.

2.3. Configuration of Tested System

The **4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module** was tested per the guidance FCC Part 15 Subpart B: 2016, and ANSI C63.4: 2014 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

Connection Diagram (Mode 1)



Signal Cable Type		Signal Cable Description
A	LAN Cable	Non-Shielding, >10m
B	Power Cable	Non-Shielding, >2m

2.4. Test System Details

The types for all equipments, plus descriptions of all cables used in the tested system (including inserted cards) are:

Product		Manufacturer	Model No.	Serial No.	Power Cord
1	Notebook	Lenovo	X201	N/A	N/A
2	PCB Board	Compex	WPQ864HV	N/A	N/A
3	POE Adapter	MRT	GRT-560110A-AT	N/A	N/A

2.5. Test Software

1	Setup the EUT and simulators as shown on above.
2	Make the EUT communicate with notebook by wireless.
3	Begin to test.

2.6. EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

3. DESCRIPTION OF TEST

3.1. Evaluation Procedure

The measurement procedures described in the American National Standard for Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical Equipment in the Range of 9kHz to 18GHz (ANSI C63.4-2014) was used in the measurement of the **4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module.**

Deviation from measurement procedure…….....None

3.2. AC Line Conducted Emissions

The line-conducted facility is located inside an 8'x4'x4' shielded enclosure. A 1m x 2m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50uH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference ground-plane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the receiver and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The receiver was scanned from 150 kHz to 30 MHz. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Each emission was also maximized by varying: power lines, the mode of operation or resolution, clock or data exchange speed, scrolling H pattern to the EUT and/or support equipment whichever determined the worst-case emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions are used for final measurements on the same test site.

Line conducted emissions test results are shown in Section 6.2.

3.3. Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. For measurements above 1GHz absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1GHz, the absorbers are removed. An MF Model 210SS turntable is used for radiated measurement. It is a continuously rotatable, remote controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm high PVC support structure is placed on top of the turntable.
For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30 MHz up to the upper frequency shown in 15.33(b)(1) depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30 MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 0.8 meter high, 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, if applicable, turntable azimuth, and receive antenna height was noted for each frequency found.
Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions. According to 3dB beam-width of horn antenna, the horn antenna should be always directed to the EUT when rising height.

4. TEST EQUIPMENT CALIBRATION DATE

Conducted Emissions - SR2

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EMI Test Receiver	R&S	ESR7	MRTSUE06001	1 year	2018/06/20
Two-Line V-Network	R&S	ENV216	MRTSUE06002	1 year	2018/06/20
Two-Line V-Network	R&S	ENV216	MRTSUE06003	1 year	2018/06/20
Temperature/Humidity Meter	Yuhuaze	HTC-2	MRTSUE06181	1 year	2017/12/20
Shielding Anechoic Chamber	Mikebang	Chamber-SR2	MRTSUE06214	1 year	2018/05/10

Radiated Emissions - AC1

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
MXE EMI Receiver	Agilent	N9038A	MRTSUE06125	1 year	2018/08/03
Microwave System Amplifier	Agilent	83017A	MRTSUE06076	1 year	2018/03/28
Loop Antenna	Schwarzbeck	FMZB1519	MRTSUE06025	1 year	2017/11/21
Bilog Period Antenna	Schwarzbeck	VULB 9168	MRTSUE06172	1 year	2017/11/19
Horn Antenna	Schwarzbeck	BBHA9120D	MRTSUE06023	1 year	2018/10/21
Broadband Horn Antenna	Schwarzbeck	BBHA9170	MRTSUE06024	1 year	2018/01/04
Temperature/Humidity Meter	Yuhuaze	HTC-2	MRTSUE06183	1 year	2017/12/20
Anechoic Chamber	TDK	Chamber-AC1	MRTSUE06212	1 year	2018/05/10

Software	Version	Function
e3	V8.3.5	EMI Test Software

5. MEASUREMENT UNCERTAINTY

Where relevant, the following test uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k = 2.

AC Conducted Emission Measurement - SR2
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 150kHz~30MHz: 2.42dB
Radiated Emission Measurement - AC1
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 9kHz ~ 1GHz: 4.18dB 1GHz ~ 25GHz: 4.76dB

6. TEST RESULT

6.1. Summary

Product Name: **4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module**

Applicant: **Compex Systems Pte Ltd**

Test Mode: **Mode 1**

Normative References	Test Description	Test Result (Pass/Fail)
15.107	Conducted Emission	Pass
15.109	Radiated Emission	Pass

6.2. Conducted Emission Measurement

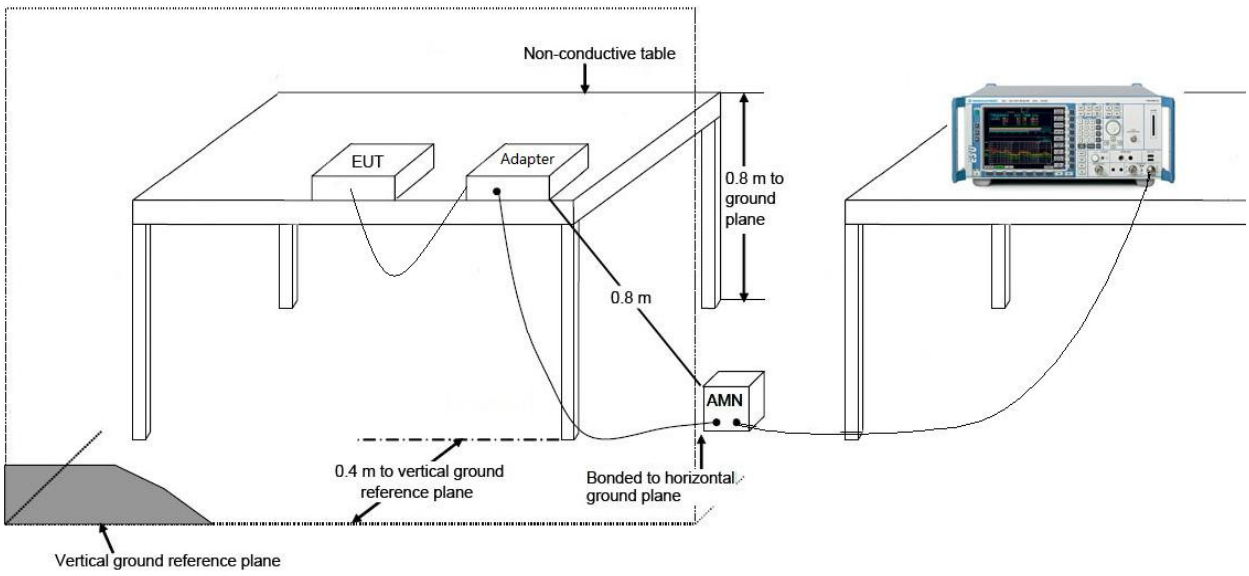
6.2.1.Test Limit

FCC Part 15.107 Limits		
Frequency (MHz)	QP (dBμV)	AV (dBμV)
0.15 - 0.50	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30	60	50

Note 1: The lower limit shall apply at the transition frequencies.

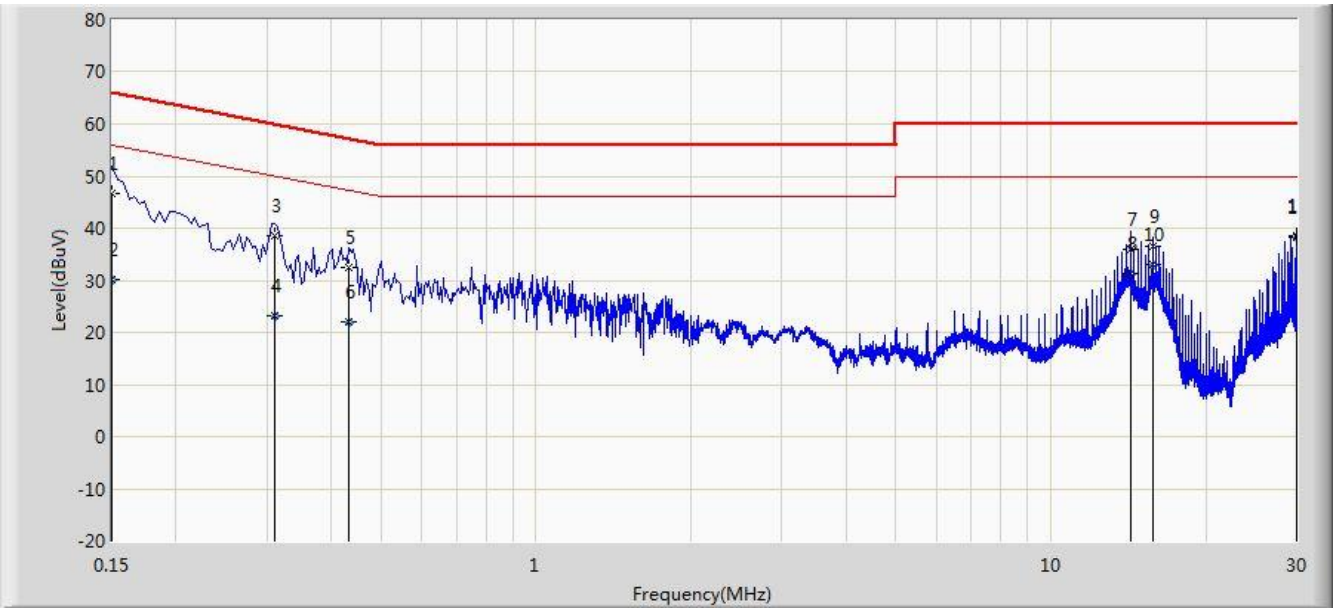
Note 2: The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.

6.2.2.Test Setup



6.2.3.Test Result

Site: SR2	Time: 2017/11/16 - 00:20
Limit: FCC_Part15.107_CE_AC Power_Class B	Engineer: Milo Li
Probe: ENV216_101683_Filter On	Polarity: Line
EUT: 4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module	Power: AC 120V/60Hz
Test Mode 1	

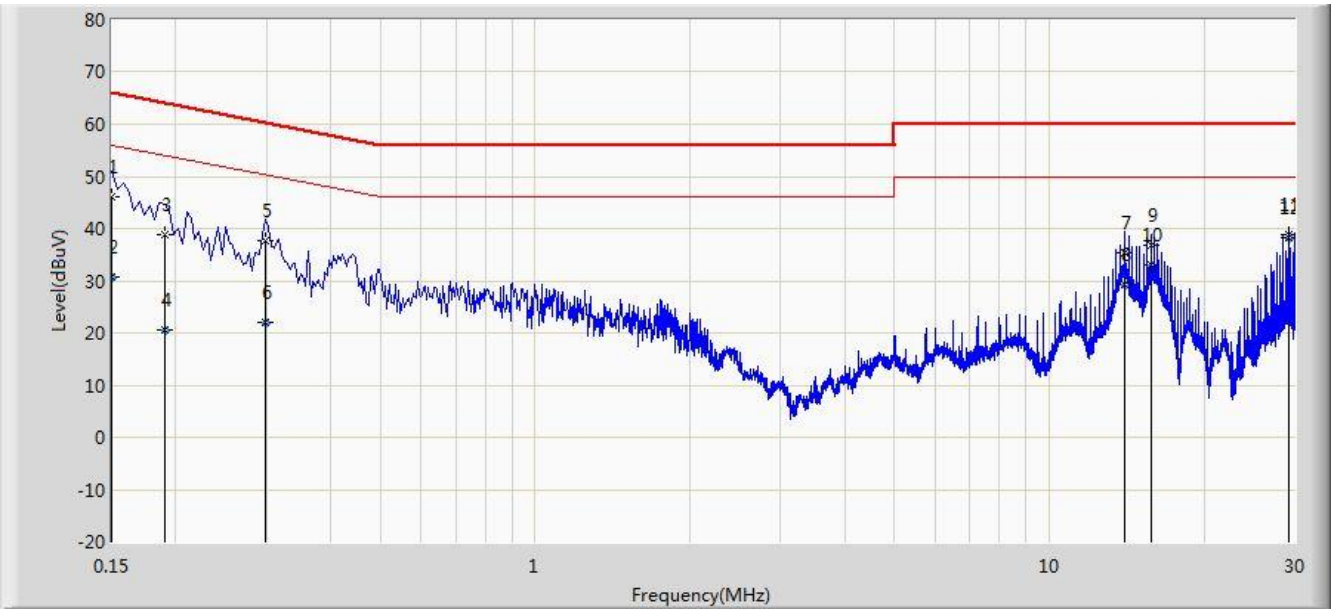


No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV)	Factor (dB)	Type
1			0.150	46.694	35.526	-19.306	66.000	11.168	QP
2			0.150	30.250	19.082	-25.750	56.000	11.168	AV
3			0.310	38.606	28.594	-21.365	59.970	10.012	QP
4			0.310	23.123	13.111	-26.847	49.970	10.012	AV
5			0.434	32.531	22.417	-24.645	57.176	10.113	QP
6			0.434	21.906	11.793	-25.269	47.176	10.113	AV
7			14.250	35.920	25.848	-24.080	60.000	10.072	QP
8			14.250	31.257	21.185	-18.743	50.000	10.072	AV
9			15.750	36.503	26.434	-23.497	60.000	10.070	QP
10		*	15.750	32.903	22.834	-17.097	50.000	10.070	AV
11			30.002	38.419	28.149	NaN	NaN	10.270	QP
12			30.002	38.121	27.851	NaN	NaN	10.270	AV

Note: Measure Level (dBμV) = Reading Level (dBμV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + LISN Factor (dB).

Site: SR2	Time: 2017/11/16 - 00:24
Limit: FCC_Part15.107_CE_AC Power_Class B	Engineer: Milo Li
Probe: ENV216_101683_Filter On	Polarity: Neutral
EUT: 4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module	Power: AC 120V/60Hz
Test Mode 1	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV)	Factor (dB)	Type
1			0.150	46.075	34.933	-19.925	66.000	11.142	QP
2			0.150	30.841	19.699	-25.159	56.000	11.142	AV
3			0.190	38.773	28.745	-25.263	64.037	10.028	QP
4			0.190	20.547	10.520	-33.489	54.037	10.028	AV
5			0.298	37.626	27.590	-22.673	60.298	10.036	QP
6			0.298	22.067	12.030	-28.232	50.298	10.036	AV
7			14.002	35.270	25.158	-24.730	60.000	10.112	QP
8			14.002	29.165	19.053	-20.835	50.000	10.112	AV
9			15.750	36.912	26.795	-23.088	60.000	10.117	QP
10			15.750	33.076	22.960	-16.924	50.000	10.117	AV
11			29.254	38.819	28.387	-21.181	60.000	10.432	QP
12		*	29.254	38.349	27.916	-11.651	50.000	10.432	AV

Note: Measure Level (dBμV) = Reading Level (dBμV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + LISN Factor (dB).

6.3. Radiated Emission Measurement

6.3.1.Test Limit

FCC Part 15.109 Limits		
Frequency (MHz)	Distance (m)	Level (dBμV/m)
30 - 88	3	40
88 - 216	3	43.5
216 - 960	3	46
Above 960	3	54

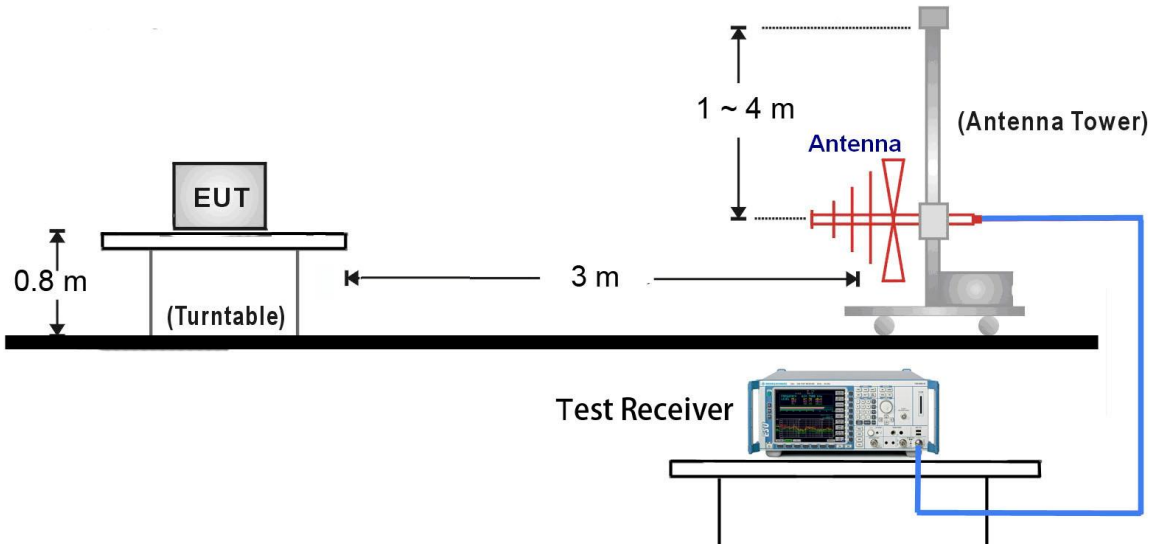
Note 1: The lower limit shall apply at the transition frequency.

Note 2: Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.

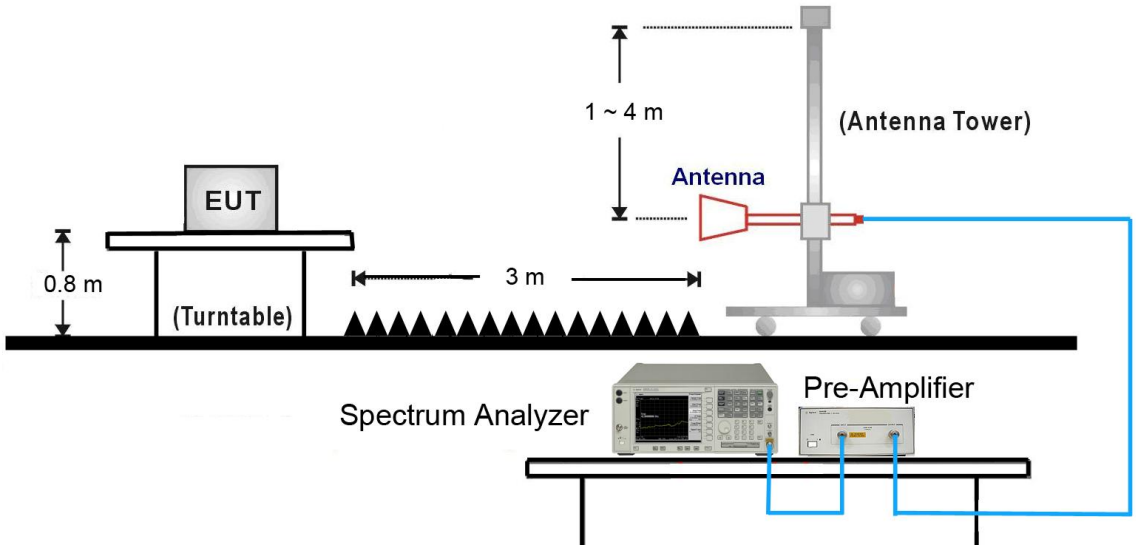
Note 3: E field strength (dBμV/m) = 20 log E field strength (uV/m)

6.3.2.Test Setup

30MHz ~ 1GHz Test Setup:

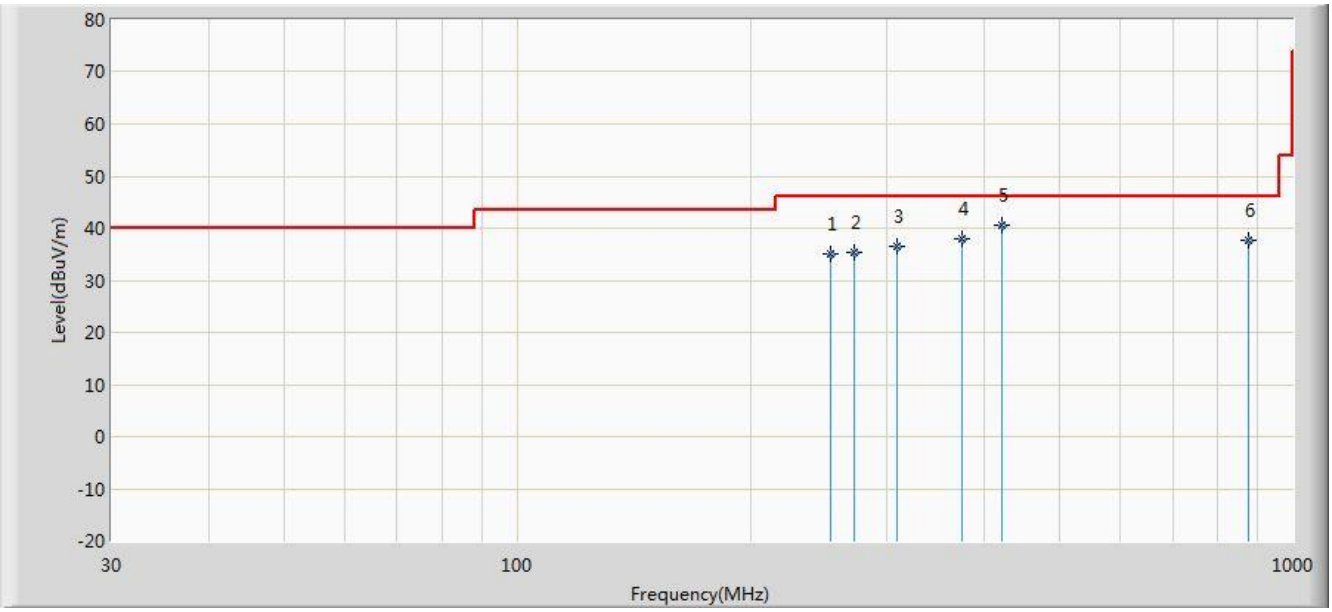


1GHz ~18GHz Test Setup:



6.3.3.Test Result

Site: AC1	Time: 2017/11/16 - 00:36
Limit: FCC_Part15.109_RE(3m)_Class B	Engineer: Alex Ma
Probe: VULB 9168 _20-2000MHz	Polarity: Horizontal
EUT: 4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module	Power: AC 120V/60Hz
Test Mode 1	

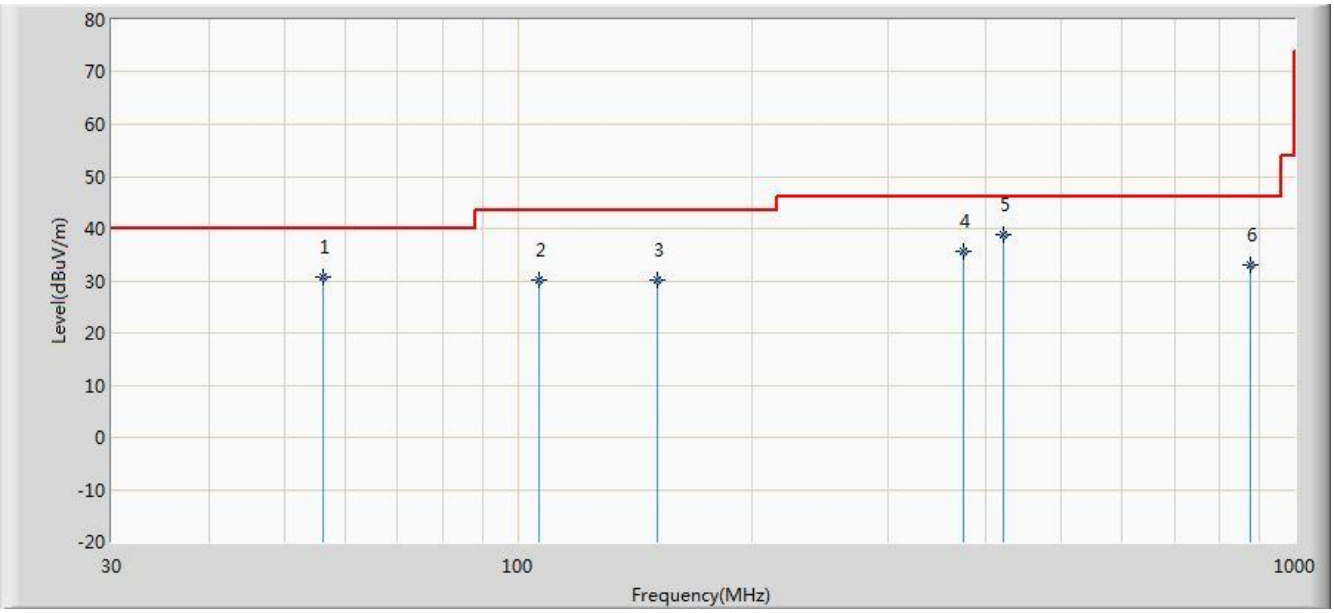


No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1			253.100	35.121	22.119	-10.879	46.000	13.002	QP
2			272.015	35.446	21.884	-10.554	46.000	13.562	QP
3			309.360	36.504	21.955	-9.496	46.000	14.549	QP
4			374.835	37.878	21.878	-8.122	46.000	16.000	QP
5			421.880	40.592	23.495	-5.408	46.000	17.097	QP
6			875.355	37.647	13.637	-8.353	46.000	24.010	QP

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m).

Site: AC1	Time: 2017/11/16 - 00:36
Limit: FCC_Part15.109_RE(3m)_Class B	Engineer: Alex Ma
Probe: VULB 9168 _20-2000MHz	Polarity: Vertical
EUT: 4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module	Power: AC 120V/60Hz
Test Mode 1	

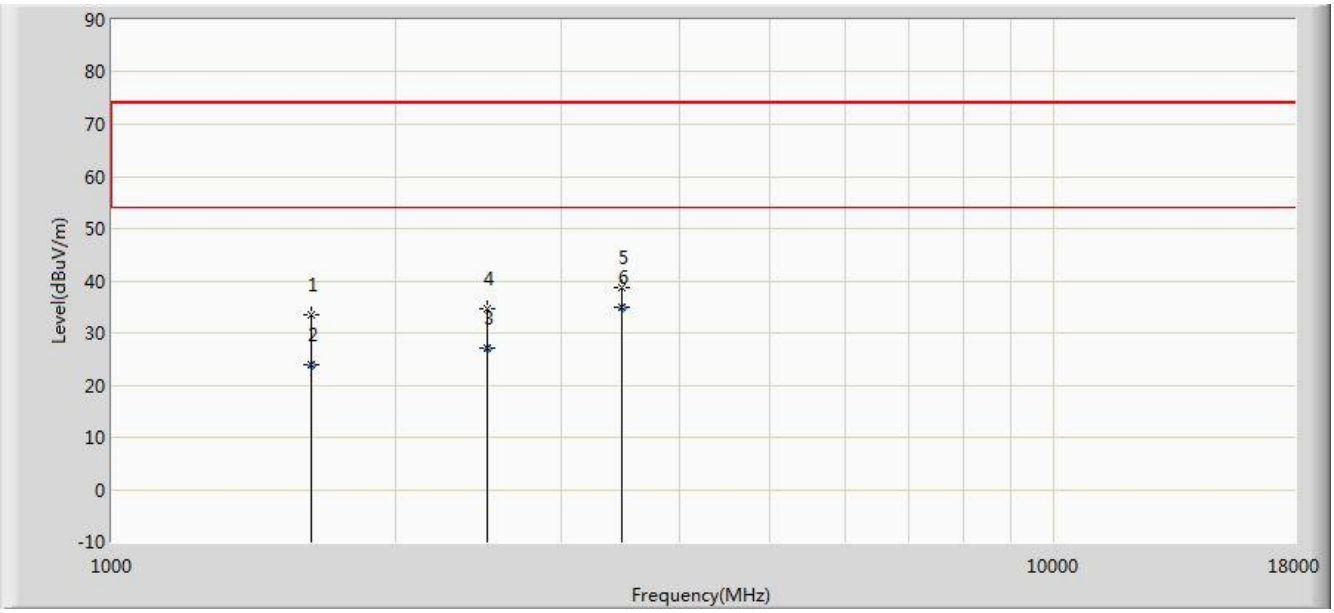


No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1			56.190	30.756	17.123	-9.244	40.000	13.633	QP
2			106.630	30.139	18.495	-13.361	43.500	11.644	QP
3			151.250	30.146	14.962	-13.354	43.500	15.184	QP
4			374.835	35.778	19.778	-10.222	46.000	16.000	QP
5			420.910	38.847	21.778	-7.153	46.000	17.069	QP
6			875.355	32.971	8.961	-13.029	46.000	24.010	QP

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m).

Site: AC1	Time: 2017/11/16 - 00:36
Limit: FCC_Part15.109_RE(3m)_Class B	Engineer: Alex Ma
Probe: BBHA9120D_1-18GHz	Polarity: Horizontal
EUT: 4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module	Power: AC 120V/60Hz
Test Mode 1	

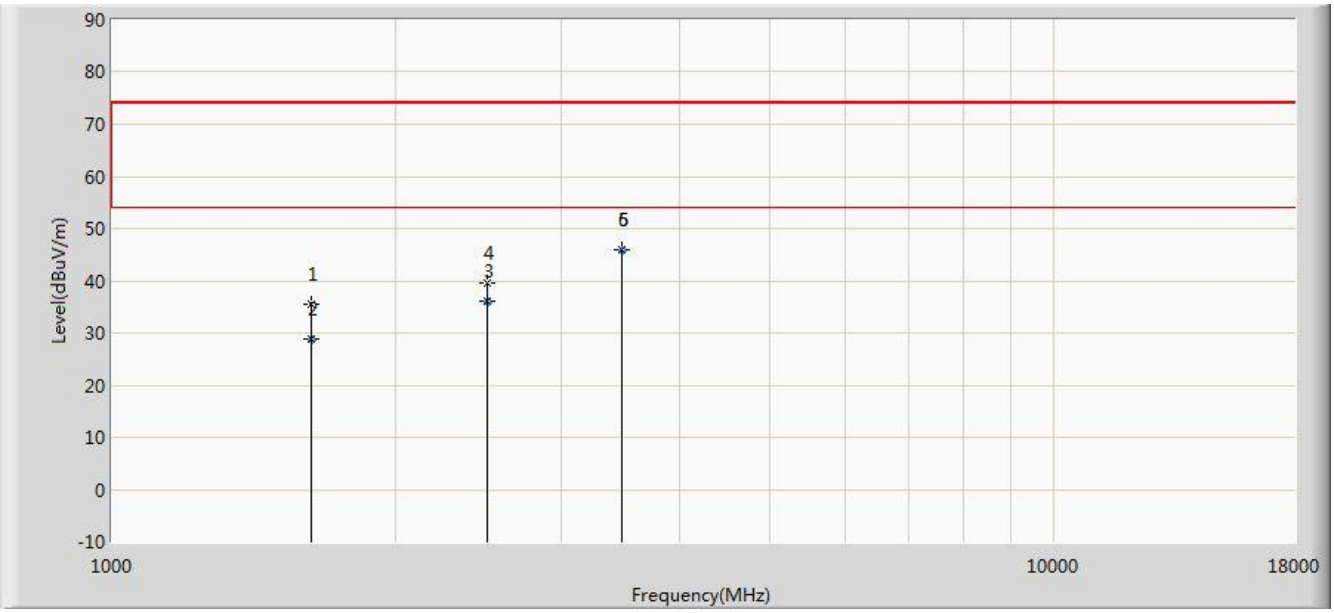


No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1			1629.000	33.565	41.268	-40.435	74.000	-7.703	PK
2			1629.500	23.887	31.590	-30.113	54.000	-7.703	AV
3			2504.300	26.963	30.590	-27.037	54.000	-3.628	AV
4			2504.500	34.591	38.218	-39.409	74.000	-3.628	PK
5			3473.500	38.647	39.925	-35.353	74.000	-1.278	PK
6			3473.500	34.878	36.156	-19.122	54.000	-1.278	AV

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m) - Pre_Amplifier Gain (dB).

Site: AC1	Time: 2017/11/16 - 00:37
Limit: FCC_Part15.109_RE(3m)_Class B	Engineer: Alex Ma
Probe: BBHA9120D_1-18GHz	Polarity: Vertical
EUT: 4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module	Power: AC 120V/60Hz
Test Mode 1	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1			1629.000	35.488	43.191	-38.512	74.000	-7.703	PK
2			1629.300	28.947	36.650	-25.053	54.000	-7.704	AV
3			2504.100	36.028	39.656	-17.972	54.000	-3.628	AV
4			2504.500	39.461	43.088	-34.539	74.000	-3.628	PK
5			3472.500	46.026	47.310	-7.974	54.000	-1.284	AV
6			3473.500	45.877	47.155	-28.123	74.000	-1.278	PK

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m) - Pre_Amplifier Gain (dB).

7. CONCLUSION

The data collected relate only the item(s) tested and show that the **4x4 Wave-2 802.11ac/a/n Mini PCIe WiFi Module** has been tested to comply with the requirements specified in §15.107 and §15.109 of the FCC Rules.

The End