MEASUREMENT REPORT

FCC PART 15.247 WLAN 802.11b/g/n

FCC ID:	TK4WLE1216V220
APPLICANT:	Compex Systems Pte Ltd
Application Type:	Class II Permissive Change
Product:	4x4 Wave-2 802.11BGN Mini PCIe WiFi Module
Model No.:	WLE1216V2-20, WLE1216V2-20-I
Brand Name:	COMPEX
FCC Classification:	Digital Transmission System (DTS)
FCC Rule Part(s):	Part 15 Subpart C (Section 15.247)
Test Procedure(s):	ANSI C63.10-2013, KDB 558074 D01v05r01
Test Date:	June 20 ~ August 14, 2018

Reviewed By: (Jame Yuan)

Approved By: (Robin Wu)

Revision History

Report No.	Version	Description	Issue Date	Note
1807RSU013-U8	Rev. 01	Initial Report	12-18-2018	Valid

CONTENTS

§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 ANSI C63.4-2014.**
- **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-20025, G-20034, C-20020, T-20020) 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, Radio and SAR testing.**

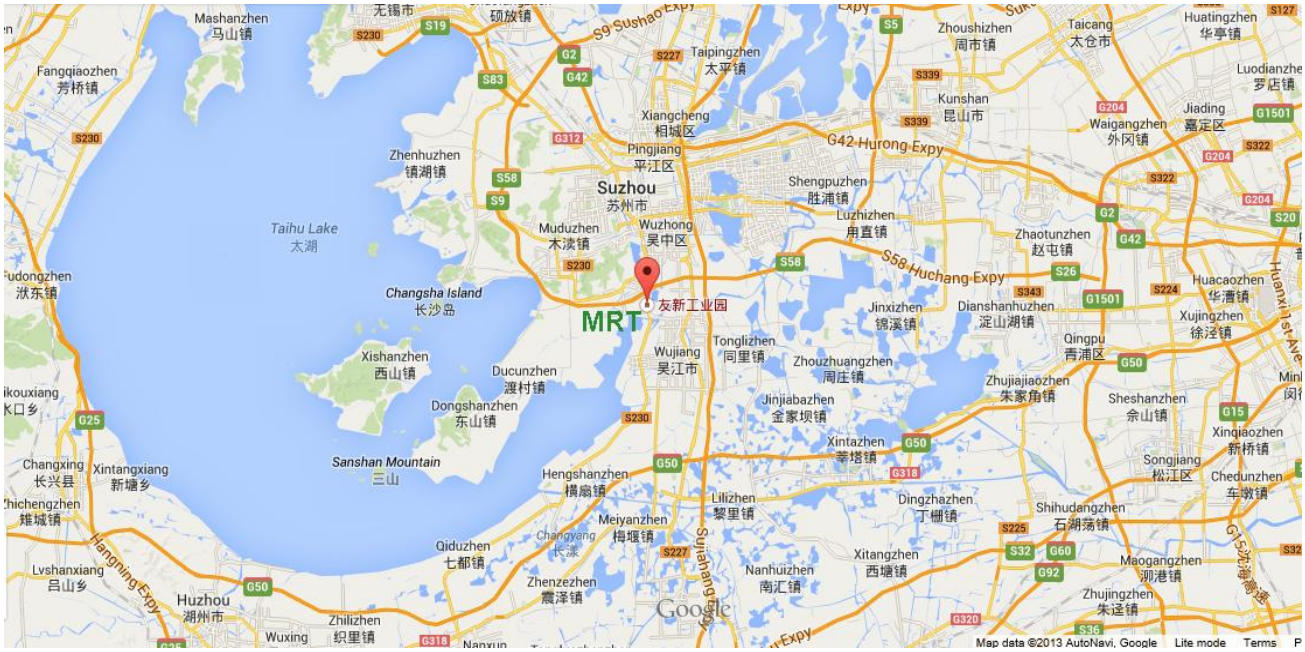
1. INTRODUCTION

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 measurement facility compliant with the test site requirements specified in ANSI C63.4-2014.



2. PRODUCT INFORMATION

2.1. Feature of Equipment under Test

Product Name	4x4 Wave-2 802.11BGN Mini PCIe WiFi Module
Model No.	WLE1216V2-20, WLE1216V2-20-I
Wi-Fi Specification	802.11b/g/n
Antenna Delivery	4*TX + 4*RX

Note: The difference of models is only for marketing different client.

2.2. Product Specification Subjective to this Report

Wi-Fi Specification	
Frequency Range	802.11b/g/n-HT20: 2412 ~ 2462 MHz 802.11n-HT40: 2422 ~ 2452 MHz
Type of Modulation	802.11b: DSSS 802.11g/n: OFDM
Data Rate	802.11b: 1/2/5.5/11Mbps 802.11g: 6/9/12/18/24/36/48/54Mbps 802.11n: up to 600Mbps

Note: For other features of this EUT, test report will be issued separately.

2.3. Working Frequencies for this Report

802.11b/g/n-HT20

Channel	Frequency	Channel	Frequency	Channel	Frequency
01	2412 MHz	02	2417 MHz	03	2422 MHz
04	2427 MHz	05	2432 MHz	06	2437 MHz
07	2442 MHz	08	2447 MHz	09	2452 MHz
10	2457 MHz	11	2462 MHz	--	--

802.11n-HT40

Channel	Frequency	Channel	Frequency	Channel	Frequency
03	2422 MHz	04	2427 MHz	05	2432 MHz
06	2437 MHz	07	2442 MHz	08	2447 MHz
09	2452 MHz	--	--	--	--

2.4. Description of Available Antennas

Antenna Type	Manufacturer	Frequency Band (GHz)	Max Peak Gain (dBi)	Directional Gain (dBi)
Directional Antenna	A*STAR Research	2400 ~ 2483.5	7.0	7.0
		5150 ~ 5850	7.1	7.1

Note: The device didn't support beam-forming technology and Cyclic Delay Diversity (CDD) technology, and the transmit signals are uncorrected, so directional gain = G_{ANT}.

2.5. Test Mode

Test Mode	Mode 1: Transmit by 802.11b (1Mbps)
	Mode 2: Transmit by 802.11g (6Mbps)
	Mode 3: Transmit by 802.11n-HT20 (MCS24)
	Mode 4: Transmit by 802.11n-HT40 (MCS24)

2.6. Description of Support Units

The EUT should be tested with associated equipment as below.

Product Name	Icomera SynAPse Rail Access Point
Model No.	AP01
Two Configurations	
Type 01#	Host board (BBD 0009) Three 5GHz WLAN modules (FCC ID: TK4WLE1216V520)
Type 02#	Host board (BBD 0009) Two 5GHz WLAN modules (FCC ID: TK4WLE1216V520) One 2.4GHz WLAN module (FCC ID: TK4WLE1216V220)

2.7. Description of Antenna RF Port

Antenna RF Port				
Software Control Port	2.4GHz RF Port			
	Ant 0	Ant 1	Ant 2	Ant 3

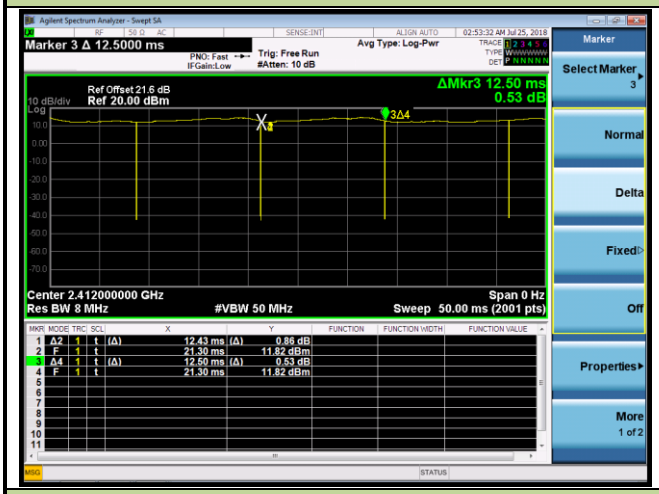
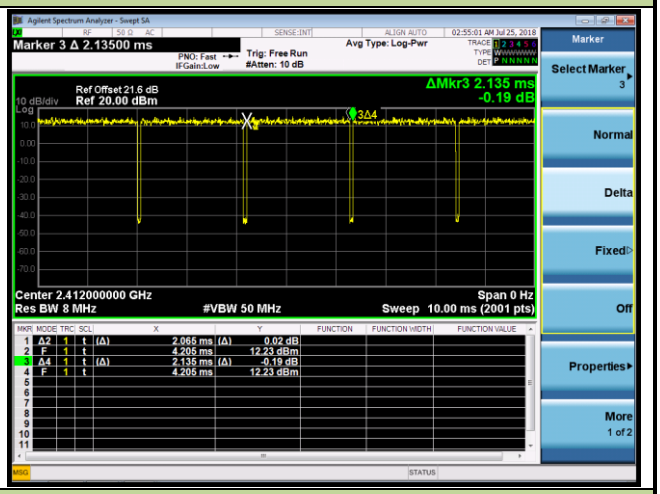
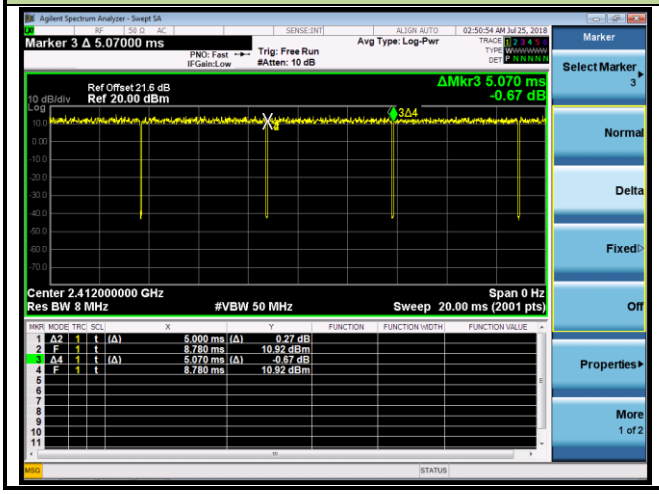
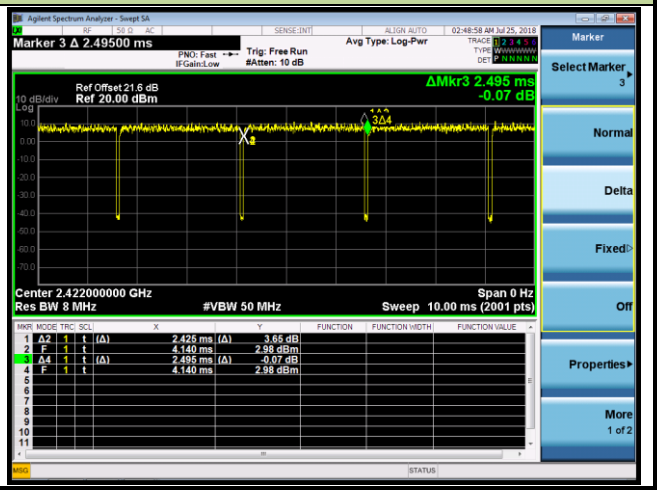
2.8. Device Capabilities

This device contains the following capabilities:

802.11b/g/n Wi-Fi Device

Note: 2.4GHz WLAN (DTS) operation was possible in 20MHz, and 40MHz channel bandwidths. The maximum achievable duty cycles for all modes were determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz, and detector = peak. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles were as follows:

Test Mode	Duty Cycle	Test Mode	Duty Cycle
802.11b	99.44 %	802.11g	96.72 %
802.11n-HT20	98.62 %	802.11n-HT40	97.19 %

Duty Cycle (T = Transmission Duration)	
802.11b (T = 12.430 ms)	802.11g (T = 2.065 ms)
	
802.11n-HT20 (T = 5.000 ms)	802.11n-HT40 (T = 2.425 ms)
	

2.9. Test Configuration

The **4x4 Wave-2 802.11BGN Mini PCIe WiFi Module** was tested per the guidance of ANSI C63.10-2013. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated emissions testing and AC line conducted testing.

2.10. EMI Suppression Device(s)/Modifications

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

2.11. Description of Test Software

The test utility software used during testing was “QRCT”, and the version was “3.0.268.0”.

2.12. Labeling Requirements

Per 2.1074 & 15.19; Docket 95-19

The label shall be permanently affixed at a conspicuous location on the device; instruction manual or pamphlet supplied to the user and be readily visible to the purchaser at the time of purchase. However, when the device is so small wherein placement of the label with specified statement is not practical, only the FCC ID must be displayed on the device per Section 15.19(a)(5). Please see attachment for FCC ID label and label location.

3. DESCRIPTION of TEST

3.1. Evaluation Procedure

The measurement procedures described in the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013), and the guidance provided in ANSI C63.10-2013 were used in the measurement.

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. 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 30MHz. 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 data exchange speed, 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. The analyzer is set to CISPR quasi-peak and average detectors with a 9 kHz resolution bandwidth for final measurements.

An extension cord was used to connect to a single LISN which powered by EUT. The extension cord was calibrated with LISN, the impedance and insertion loss are compliance with the requirements as stated in ANSI C63.10-2013.

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. A 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 30MHz 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 30MHz, 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 for frequencies below 1GHz was placed on top of the 0.8 meter high, 1 x 1.5 meter table; and test set-up for frequencies 1-40GHz was placed on top of the 1.5 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, clock speed, mode of operation or video resolution, 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. ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 shall be considered sufficient to comply with the provisions of this section."

- The antenna of the EUT uses **a unique (IPEX) connector**.

Conclusion:

The **4x4 Wave-2 802.11BGN Mini PCIe WiFi Module** unit complies with the requirement of §15.203.

5. TEST EQUIPMENT CALIBRATION DATE

Conducted Emissions - SR2

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EMI Test Receiver	R&S	ESR3	MRTSUE06185	1 year	2019/04/20
Two-Line V-Network	R&S	ENV216	MRTSUE06002	1 year	2019/06/15
Two-Line V-Network	R&S	ENV216	MRTSUE06003	1 year	2019/06/15
Thermohygrometer	testo	608-H1	MRTSUE06404	1 year	2018/08/14
Shielding Room	MIX-BEP	Chamber-SR2	MRTSUE06215	N/A	N/A

Radiated Disturbance - AC1

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EXA Signal Analyzer	Keysight	N9020A	MRTSUE06106	1 year	2019/04/20
EMI Test Receiver	R&S	ESR7	MRTSUE06001	1 year	2018/08/18
Loop Antenna	Schwarzbeck	FMZB 1519	MRTSUE06025	1 year	2018/11/20
Bilog Period Antenna	Schwarzbeck	VULB 9168	MRTSUE06172	1 year	2019/04/12
Broad Band Horn Antenna	Schwarzbeck	BBHA 9120D	MRTSUE06023	1 year	2018/10/21
Broad Band Horn Antenna	Schwarzbeck	BBHA 9170	MRTSUE06024	1 year	2018/12/14
Microwave System Amplifier	Agilent	83017A	MRTSUE06076	1 year	2018/11/17
Preamplifier	Schwarzbeck	BBV 9721	MRTSUE06121	1 year	2019/06/12
Thermohygrometer	testo	608-H1	MRTSUE06403	1 year	2018/08/14
Anechoic Chamber	TDK	Chamber-AC1	MRTSUE06212	1 year	2019/05/02

Radiated Emissions - AC2

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
MXE EMI Receiver	Agilent	N9038A	MRTSUE06125	1 year	2018/08/14
EXA Signal Analyzer	Keysight	N9010B	MRTSUE06452	1 year	2018/07/20
				1 year	2019/07/20
Loop Antenna	Schwarzbeck	FMZB 1519	MRTSUE06025	1 year	2018/11/20
Bilog Period Antenna	Schwarzbeck	VULB 9162	MRTSUE06022	1 year	2018/10/21
Broad Band Horn Antenna	Schwarzbeck	BBHA 9120D	MRTSUE06171	1 year	2018/11/18
Broad Band Horn Antenna	Schwarzbeck	BBHA 9170	MRTSUE06024	1 year	2018/12/14
Broadband Coaxial Preamplifier	Agilent	BBV 9718	MRTSUE06176	1 year	2018/11/17
Preamplifier	Schwarzbeck	BBV 9721	MRTSUE06121	1 year	2019/06/13
Digitial Thermometer & Hygrometer	MingGao	ETH529	MRTSUE06170	1 year	2018/12/12
Anechoic Chamber	RIKEN	Chamber-AC2	MRTSUE06213	1 year	2019/05/02

Conducted Test Equipment - TR3

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
Spectrum Analyzer	Agilent	N9020A	MRTSUE06106	1 year	2019/04/20
Power Meter	Agilent	U2021XA	MRTSUE06030	1 year	2018/12/06
Thermohygrometer	testo	608-H1	MRTSUE06401	1 year	2018/08/14

Software	Version	Function
e3	V8.3.5	EMI Test Software

6. 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: ± 3.46dB
Radiated Emission Measurement - AC1
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): Horizontal: 30MHz~300MHz: ±4.07dB 300MHz~1GHz: ±3.63dB 1GHz~18GHz: ±4.16dB Vertical: 30MHz~300MHz: ±4.18dB 300MHz~1GHz: ±3.60dB 1GHz~18GHz: ±4.76dB
Radiated Emission Measurement - AC2
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): Horizontal: 30MHz~300MHz: ±3.75dB 300MHz~1GHz: ±3.53 dB 1GHz~18GHz: ±4.28dB Vertical: 30MHz~300MHz: ±3.86 dB 300MHz~1GHz: ±3.53 dB 1GHz~18GHz: ±4.33 dB
Spurious Emissions, Conducted - TR3
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 0.78dB
Output Power - TR3
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 1.13dB
Power Spectrum Density - TR3
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 1.15dB
Occupied Bandwidth - TR3
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 0.28%

7. TEST RESULT

7.1. Summary

Company Name: **Compex Systems Pte Ltd**

FCC ID: **TK4WLE1216V220**

FCC Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.247(a)(2)	6dB Bandwidth	≥ 500kHz	Conducted	Pass	Section 7.2
15.247(b)(3)	Output Power	≤ 1 Watt		Pass	Section 7.3
15.247(e)	Power Spectral Density	≤ 8dBm/3kHz		Pass	Section 7.4
15.247(d)	Band Edge / Out-of-Band Emissions	≤ 30dBc(Average)		Pass	Section 7.5
15.205 15.209	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209	Radiated	Pass	Section 7.6 & 7.7
15.207	AC Conducted Emissions 150kHz - 30MHz	< FCC 15.207 limits	Line Conducted	Pass	Section 7.8

Notes:

1) All modes of operation and data rates were investigated. For radiated emission test, every axis (X, Y, Z) was also verified. The test results shown in the following sections represent the worst case emissions.
2) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.
3) Test Items “6dB Bandwidth” & “Band Edge / Out-of-Band Emissions” have been assessed SISO and MIMO transmission, and showed the worst test data in this report.

7.2. 6dB Bandwidth Measurement

7.2.1.Test Limit

The minimum 6dB bandwidth shall be at least 500 kHz.

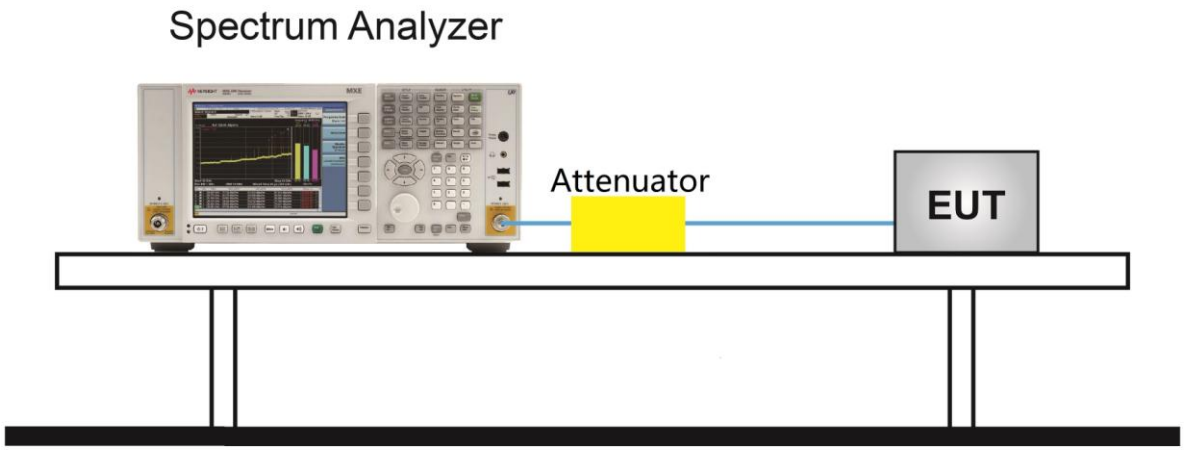
7.2.2.Test Procedure Used

ANSI C63.10-2013 Section 11.8

7.2.3.Test Setting

1. The Spectrum's automatic bandwidth measurement capability was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. Set RBW = 100 kHz
3. VBW ≥ 3 × RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. Allow the trace was allowed to stabilize

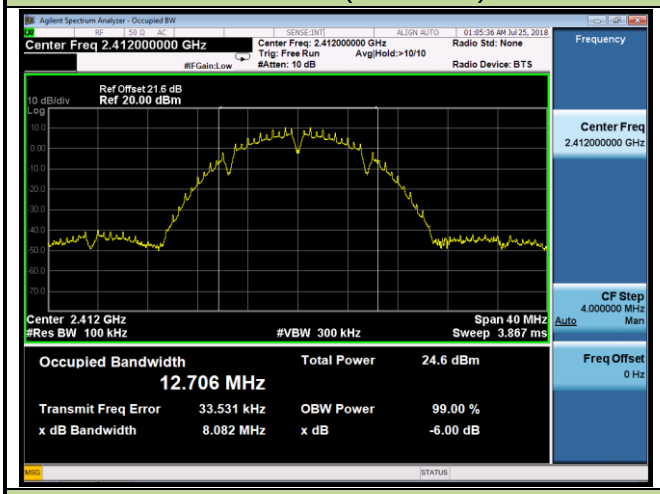
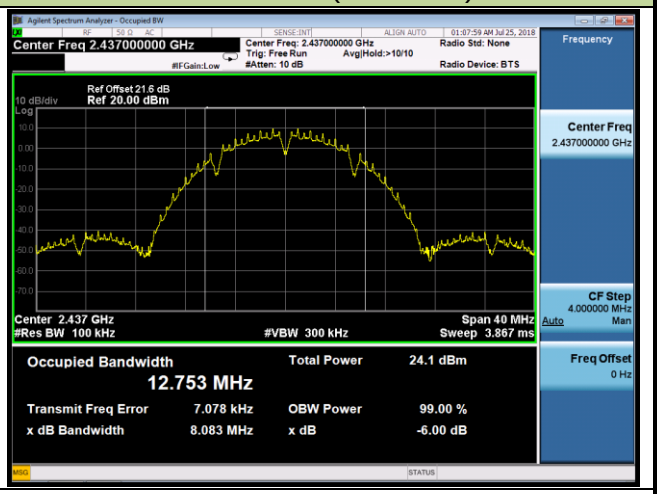
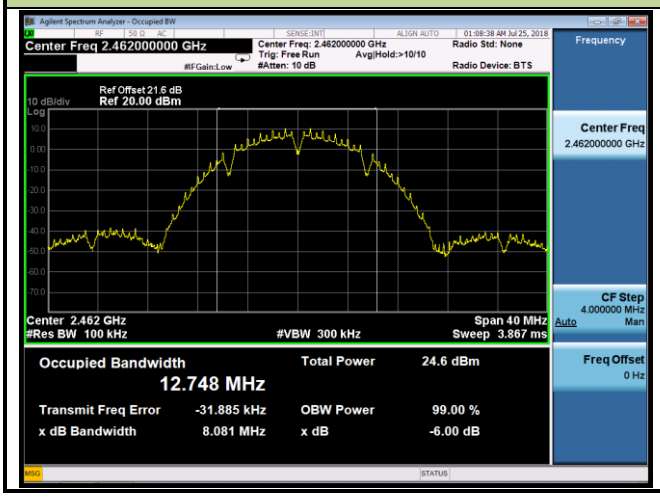
7.2.4.Test Setup

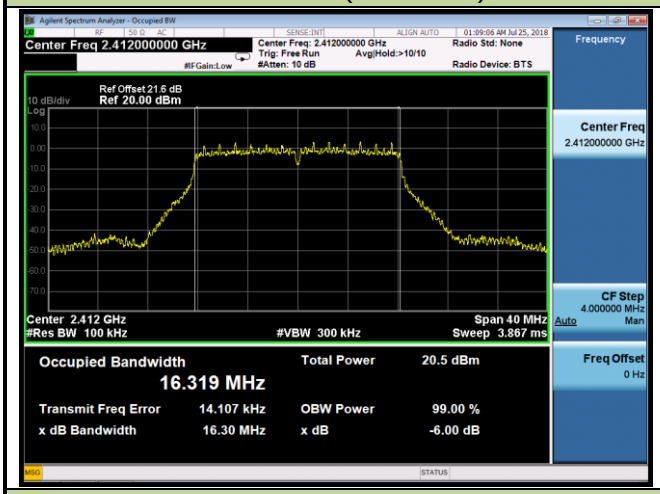
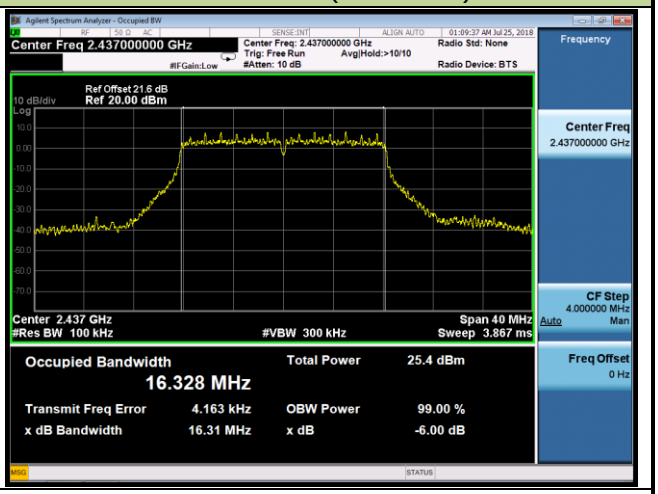
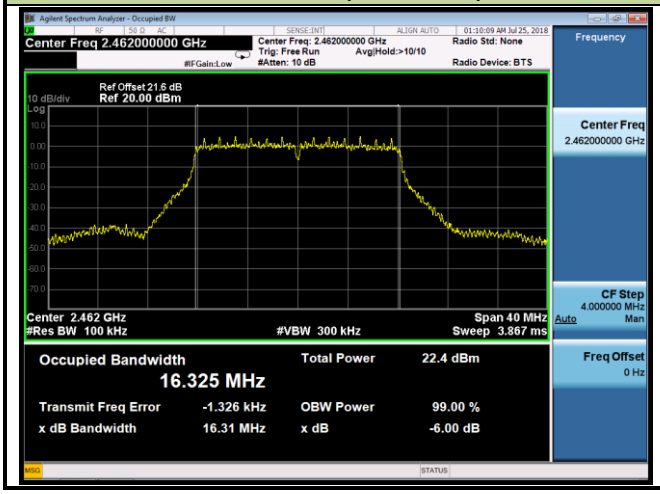


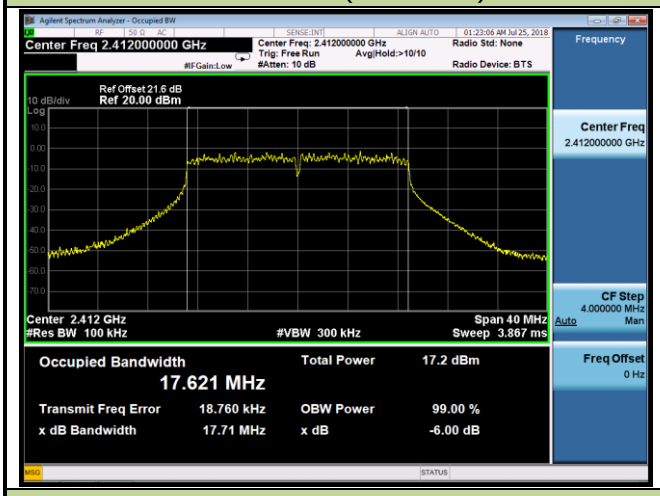
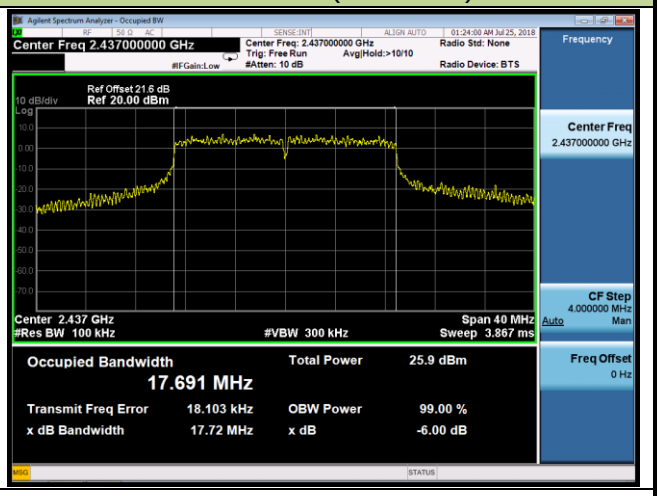
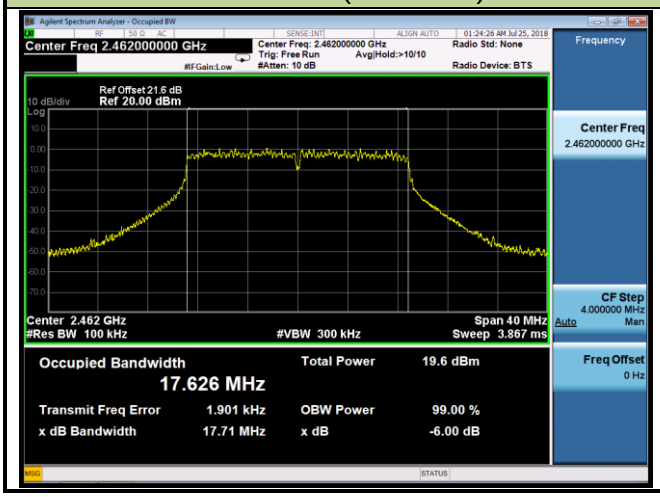
7.2.5.Test Result

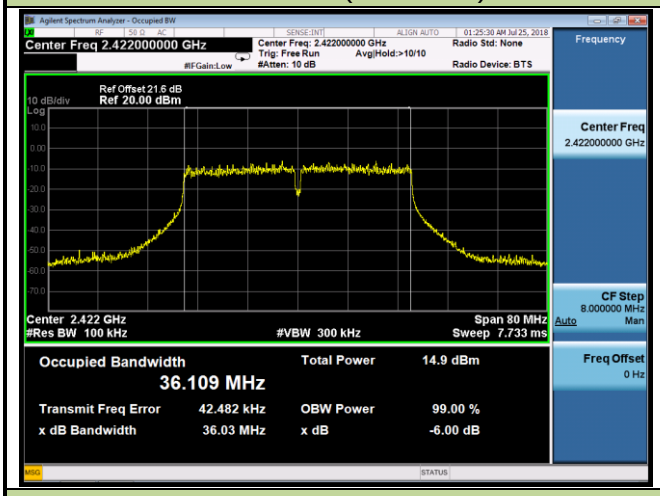
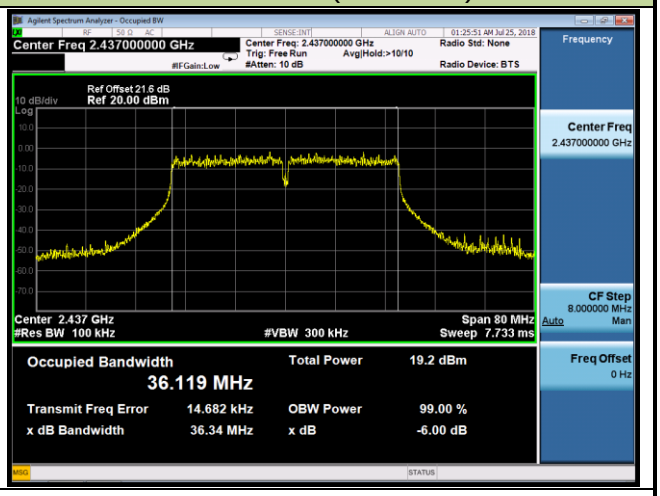
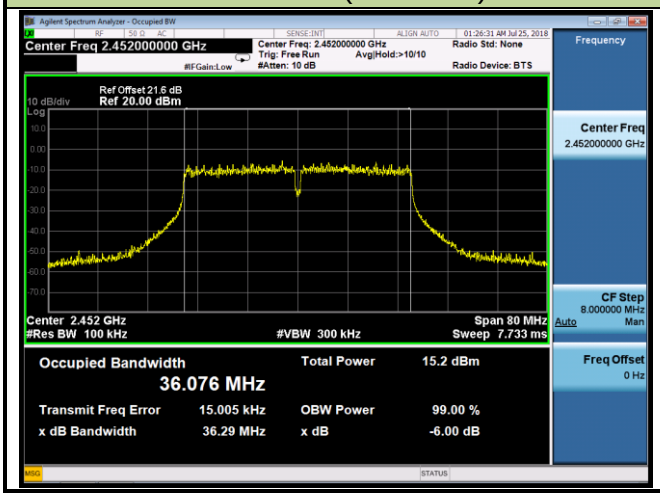
Product	4x4 Wave-2 802.11BGN Mini PCIe WiFi Module	Temperature	25℃
Test Engineer	Snake Ni	Relative Humidity	52%
Test Site	TR3	Test Date	2018/07/25

Test Mode	Data Rate /MCS	Channel No.	Frequency (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	Limit (MHz)	Result
Ant 2							
11b	1Mbps	01	2412	8.08	12.71	≥ 0.5	Pass
11b	1Mbps	06	2437	8.08	12.75	≥ 0.5	Pass
11b	1Mbps	11	2462	8.08	12.75	≥ 0.5	Pass
11g	6Mbps	01	2412	16.30	16.32	≥ 0.5	Pass
11g	6Mbps	06	2437	16.31	16.33	≥ 0.5	Pass
11g	6Mbps	11	2462	16.31	16.33	≥ 0.5	Pass
Ant 2 / Ant 0 + 1 + 2 + 3							
11n-HT20	MCS24	01	2412	17.71	17.62	≥ 0.5	Pass
11n-HT20	MCS24	06	2437	17.72	17.69	≥ 0.5	Pass
11n-HT20	MCS24	11	2462	17.71	17.63	≥ 0.5	Pass
11n-HT40	MCS24	03	2422	36.03	36.11	≥ 0.5	Pass
11n-HT40	MCS24	06	2437	36.34	36.12	≥ 0.5	Pass
11n-HT40	MCS24	09	2452	36.29	36.08	≥ 0.5	Pass

802.11b 6dB Bandwidth - Ant 2	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

802.11g 6dB Bandwidth - Ant 2	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

802.11n-HT20 6dB Bandwidth - Ant 2 / Ant 0 + 1 + 2 + 3	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

802.11n-HT40 6dB Bandwidth - Ant 2 / Ant 0 + 1 + 2 + 3	
Channel 03 (2422MHz)	Channel 06 (2437MHz)
	
Channel 09 (2452MHz)	
	

7.3. Output Power Measurement

7.3.1.Test Limit

The maximum conducted output power shall be not exceed 1 Watt (30dBm).

The conducted output power limit is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

7.3.2.Test Procedure Used

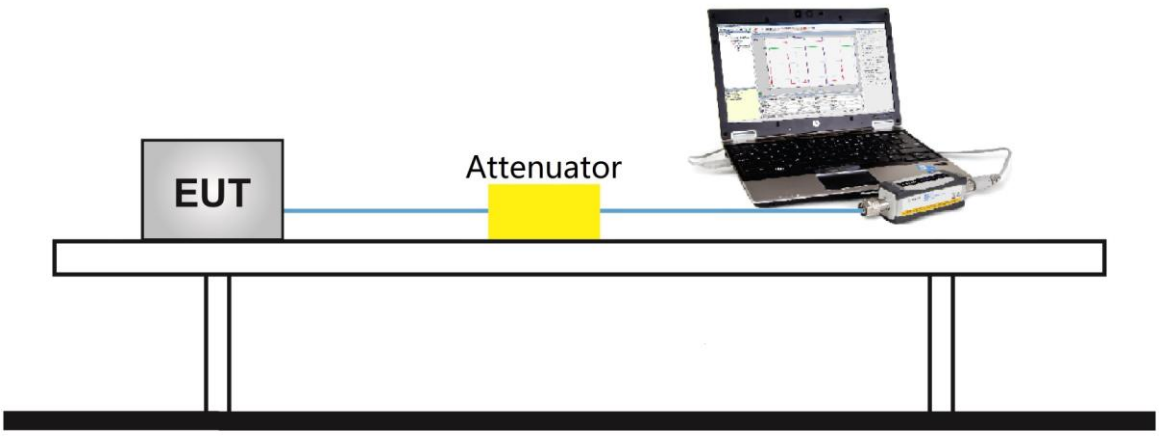
ANSI C63.10 Section 11.9.2.3

7.3.3.Test Setting

Method AVGPM-G (Measurement using a gated RF average-reading power meter)

Measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

7.3.4.Test Setup



7.3.5.Test Result of Output Power

Output power test was verified over all data rates of each mode shown as below, and then choose the maximum output power (Gray marker) for final test of each channel.

Output power at various data rates:

Test Mode	Bandwidth (MHz)	Channel No.	Frequency (MHz)	Data Rate /MCS	Average Power (dBm)
Ant 0					
802.11b	20	6	2437	1Mbps	17.58
				5.5Mbps	17.31
				11Mbps	17.13
802.11g	20	6	2437	6Mbps	12.87
				24Mbps	12.62
				54Mbps	12.43
Ant 0 / Ant 0 + 1 + 2 + 3					
802.11n	20	6	2437	MCS24	8.66
				MCS28	8.35
				MCS31	8.11
802.11n	40	6	2437	MCS24	6.12
				MCS28	5.98
				MCS31	5.76

Product	4x4 Wave-2 802.11BGN Mini PCIe WiFi Module	Temperature	23°C
Test Engineer	Snake Ni	Relative Humidity	51%
Test Site	TR3	Test Date	2018/07/25

Test Mode	Data Rate/ MCS	Channel No.	Freq. (MHz)	Ant 0 Average Power (dBm)	Ant 1 Average Power (dBm)	Ant 2 Average Power (dBm)	Ant 3 Average Power (dBm)	Limit (dBm)	Result
SISO Mode									
11b	1Mbps	1	2412	17.58	18.60	17.42	17.65	≤ 29.00	Pass
11b	1Mbps	6	2437	17.03	18.67	20.93	20.61	≤ 29.00	Pass
11b	1Mbps	11	2462	17.60	20.90	20.82	20.69	≤ 29.00	Pass
11g	6Mbps	1	2412	12.87	12.73	11.97	11.66	≤ 29.00	Pass
11g	6Mbps	6	2437	18.15	19.64	20.88	19.34	≤ 29.00	Pass
11g	6Mbps	11	2462	14.97	15.31	15.53	16.98	≤ 29.00	Pass

Note: Limit (dBm) = 30 dBm - (7 dBi - 6 dBi) = 29 dBm.

Test Mode	Data Rate/ MCS	Channel No.	Freq. (MHz)	Ant 0 Average Power (dBm)	Ant 1 Average Power (dBm)	Ant 2 Average Power (dBm)	Ant 3 Average Power (dBm)	Total Average Power (dBm)	Limit (dBm)	Result
MIMO Mode										
11n-HT20	MCS24	1	2412	8.66	8.86	8.99	8.56	14.79	≤ 29.00	Pass
11n-HT20	MCS24	6	2437	17.70	17.72	17.75	17.34	23.65	≤ 29.00	Pass
11n-HT20	MCS24	11	2462	11.25	11.57	11.51	11.25	17.42	≤ 29.00	Pass
11n-HT40	MCS24	3	2422	6.12	6.42	6.58	6.25	12.37	≤ 29.00	Pass
11n-HT40	MCS24	6	2437	10.45	10.96	11.01	10.92	16.86	≤ 29.00	Pass
11n-HT40	MCS24	9	2452	6.71	6.81	6.89	6.79	12.82	≤ 29.00	Pass

Note 1: Total Average Power (dBm) = $10*\log\{10^{(\text{Ant 0 Average Power }/10)} + 10^{(\text{Ant 1 Average Power }/10)} + 10^{(\text{Ant 2 Average Power }/10)} + 10^{(\text{Ant 3 Average Power }/10)}\}$ (dBm)

Note 2: Limit (dBm) = 30 dBm - (7 dBi - 6 dBi) = 29 dBm.

7.4. Power Spectral Density Measurement

7.4.1.Test Limit

The maximum permissible power spectral density is 8dBm in any 3 kHz band.

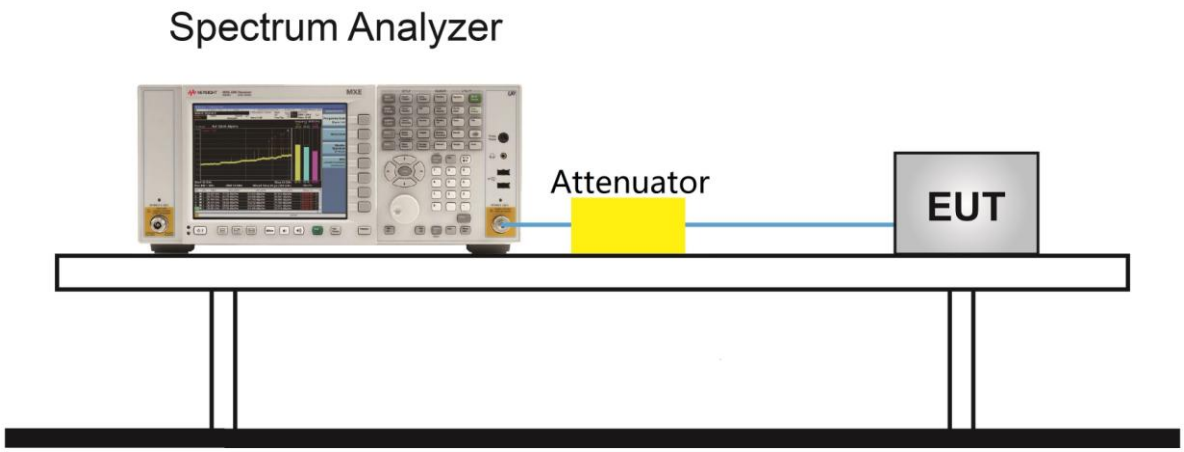
7.4.2.Test Procedure Used

ANSI C63.10 Section 11.10.6

7.4.3.Test Setting

1. Measure the duty cycle (x) of the transmitter output signal
2. Analyzer was set to the center frequency of the DTS channel under investigation
3. Span = 1.5 times the DTS channel bandwidth
4. RBW = 10kHz
5. VBW = 30kHz
6. Detector = RMS
7. Ensure that the number of measurement points in the sweep ≥ 2 * span / RBW
8. Sweep time = auto couple
9. Employ trace averaging (RMS) mode over a minimum of 100 traces
10. Use the peak marker function to determine the maximum amplitude level
11. If duty cycle < 98 %, add 10 log (1/x), where x is the duty cycle measured in step (a, to the measured PSD to compute the average PSD during the actual transmission time.
12. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).

7.4.4.Test Setup



7.4.5.Test Result

Product	4x4 Wave-2 802.11BGN Mini PCIe WiFi Module	Temperature	23℃
Test Engineer	Vince Yu	Relative Humidity	52%
Test Site	TR3	Test Date	2018/07/25

Test Mode	Data Rate /MCS	Channel No.	Freq. (MHz)	AVGPSD (dBm/10kHz)	Duty Cycle (%)	Final AVGPSD (dBm/10kHz)	Limit (dBm/3kHz)	Result
SISO Mode - Ant 0								
11b	1Mbps	1	2412	-8.26	99.44	-8.26	≤ 7.00	Pass
11b	1Mbps	6	2437	-7.91	99.44	-7.91	≤ 7.00	Pass
11b	1Mbps	11	2462	-4.71	99.44	-4.71	≤ 7.00	Pass
11g	6Mbps	1	2412	-15.08	96.72	-14.94	≤ 7.00	Pass
11g	6Mbps	6	2437	-10.28	96.72	-10.14	≤ 7.00	Pass
11g	6Mbps	11	2462	-13.32	96.72	-13.18	≤ 7.00	Pass
SISO Mode - Ant 1								
11b	1Mbps	1	2412	-4.30	99.44	-4.30	≤ 7.00	Pass
11b	1Mbps	6	2437	-4.10	99.44	-4.10	≤ 7.00	Pass
11b	1Mbps	11	2462	-4.43	99.44	-4.43	≤ 7.00	Pass
11g	6Mbps	1	2412	-15.40	96.72	-15.26	≤ 7.00	Pass
11g	6Mbps	6	2437	-8.71	96.72	-8.57	≤ 7.00	Pass
11g	6Mbps	11	2462	-13.22	96.72	-13.08	≤ 7.00	Pass
SISO Mode - Ant 2								
11b	1Mbps	1	2412	-6.78	99.44	-6.78	≤ 7.00	Pass
11b	1Mbps	6	2437	-5.03	99.44	-5.03	≤ 7.00	Pass
11b	1Mbps	11	2462	-5.20	99.44	-5.20	≤ 7.00	Pass
11g	6Mbps	1	2412	-16.37	96.72	-16.23	≤ 7.00	Pass
11g	6Mbps	6	2437	-7.45	96.72	-7.31	≤ 7.00	Pass
11g	6Mbps	11	2462	-13.04	96.72	-12.90	≤ 7.00	Pass

SISO Mode - Ant 3								
11b	1Mbps	1	2412	-6.61	99.44	-6.61	≤ 7.00	Pass
11b	1Mbps	6	2437	-5.39	99.44	-5.39	≤ 7.00	Pass
11b	1Mbps	11	2462	-3.54	99.44	-3.54	≤ 7.00	Pass
11g	6Mbps	1	2412	-16.81	96.72	-16.67	≤ 7.00	Pass
11g	6Mbps	6	2437	-9.16	96.72	-9.02	≤ 7.00	Pass
11g	6Mbps	11	2462	-11.30	96.72	-11.16	≤ 7.00	Pass

Test Mode	Data Rate/ MCS	Channel No.	Freq. (MHz)	Ant 0 AVGPSD (dBm/ 10kHz)	Ant 1 AVGPSD (dBm/ 10kHz)	Ant 2 AVGPSD (dBm/ 10kHz)	Ant 3 AVGPSD (dBm/ 10kHz)	Duty Cycle (%)	Final AVGPSD (dBm/ 10kHz)	Limit (dBm/ 3kHz)	Result
MIMO Mode											
11n-HT20	MCS24	1	2412	-18.27	-19.02	-18.14	-18.44	98.42	-12.43	≤ 7.00	Pass
11n-HT20	MCS24	6	2437	-9.77	-9.72	-10.35	-10.69	98.42	-4.09	≤ 7.00	Pass
11n-HT20	MCS24	11	2462	-15.96	-16.08	-16.07	-16.41	98.42	-10.11	≤ 7.00	Pass
11n-HT40	MCS24	3	2422	-22.58	-22.64	-21.84	-22.36	97.15	-16.20	≤ 7.00	Pass
11n-HT40	MCS24	6	2437	-18.16	-18.12	-17.17	-18.07	97.15	-11.71	≤ 7.00	Pass
11n-HT40	MCS24	9	2452	-21.44	-21.59	-21.35	-22.08	97.15	-15.46	≤ 7.00	Pass

Note 1: For 802.11b/g

When EUT duty cycle < 98%, Each AVGPSD (dBm/10kHz) = AVGPSD (dBm/10kHz) + 10*log (1/Duty Cycle).

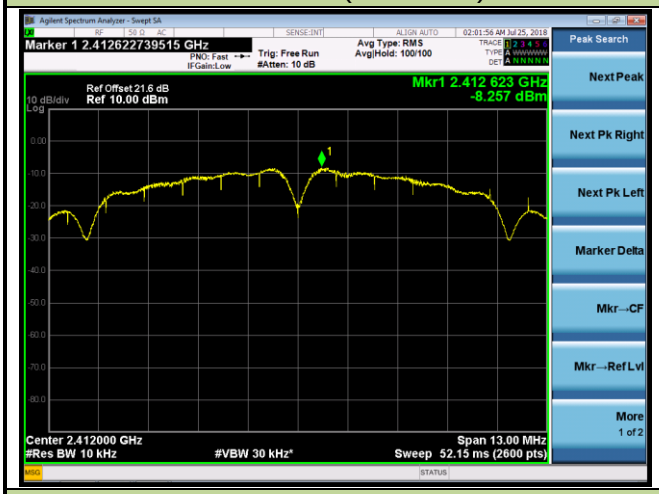
When EUT duty cycle ≥ 98%, Each AVGPSD (dBm/10kHz) = AVGPSD (dBm/10kHz).

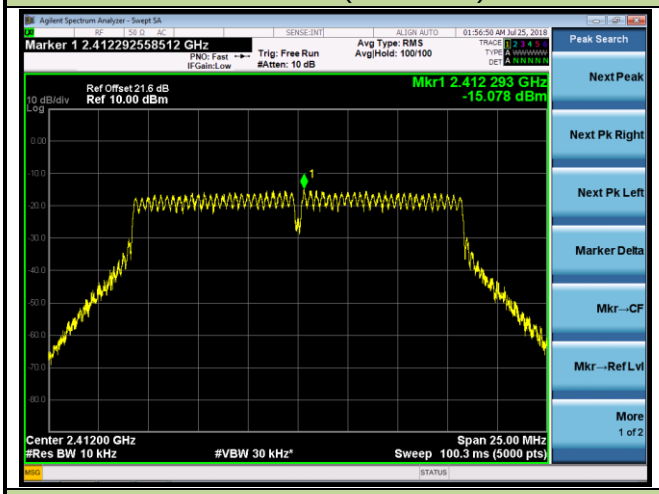
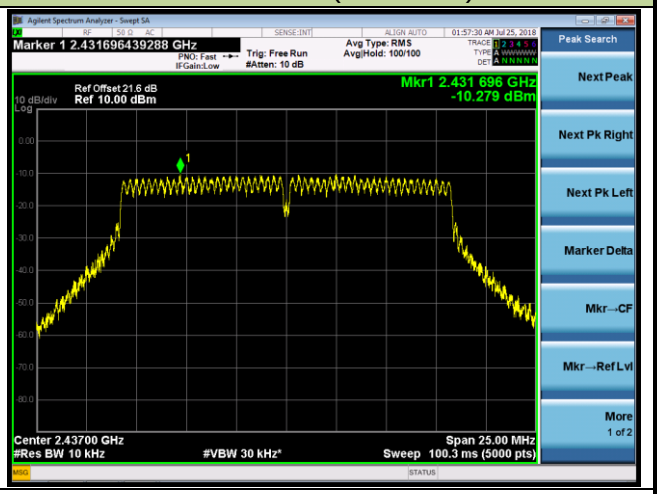
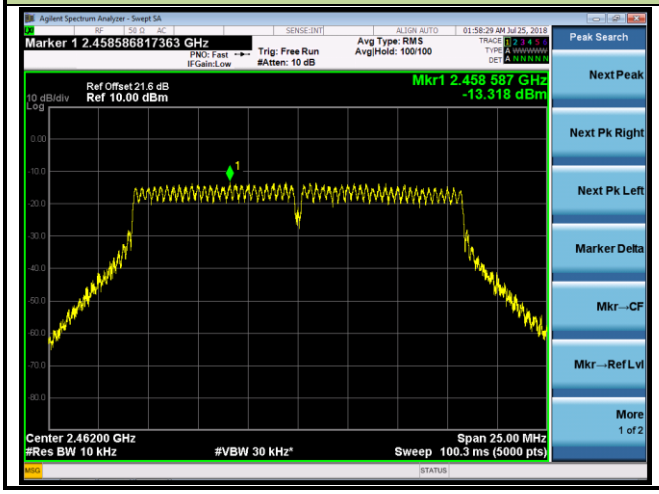
Note 2: For 802.11n

When EUT duty cycle < 98%, Final AVGPSD (dBm/10kHz) = 10*log $\{10^{(\text{Ant 0 PSD}/10)} + 10^{(\text{Ant 1 PSD}/10)} + 10^{(\text{Ant 2 PSD}/10)} + 10^{(\text{Ant 3 PSD}/10)}\}$ + 10*log (1/Duty Cycle).

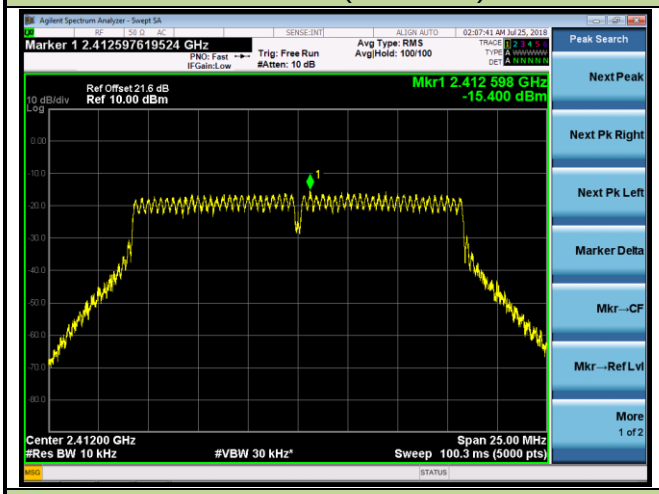
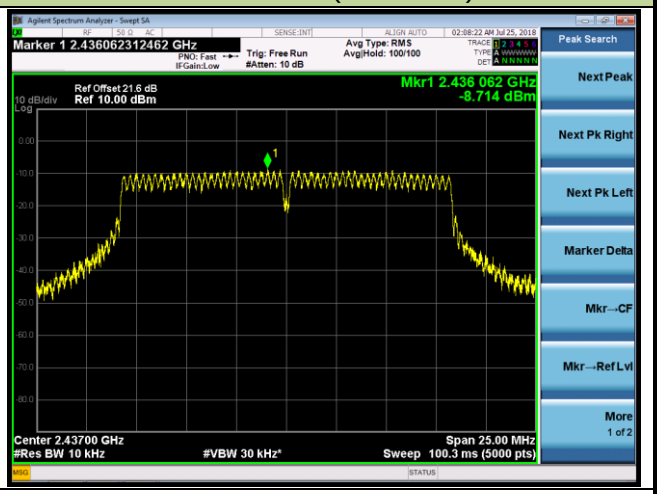
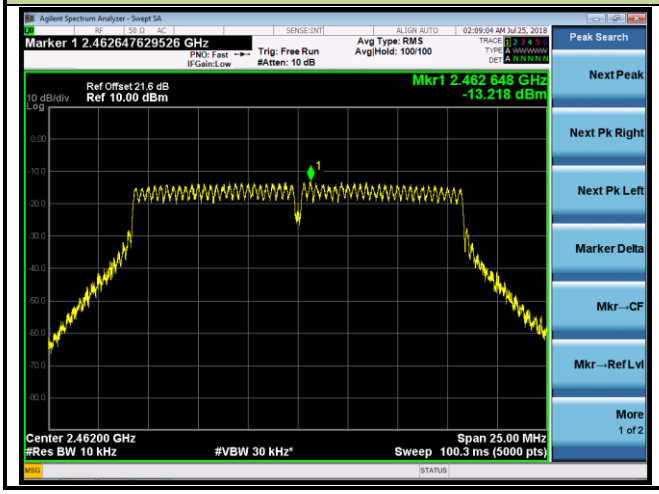
When EUT duty cycle ≥ 98%, Final AVGPSD (dBm/10kHz) = 10*log $\{10^{(\text{Ant 0 PSD}/10)} + 10^{(\text{Ant 1 PSD}/10)} + 10^{(\text{Ant 2 PSD}/10)} + 10^{(\text{Ant 3 PSD}/10)}\}$.

Note 3: Limit (dBm/3kHz) = 8 (dBm/3kHz) - (7 dBi - 6 dBi) = 7 (dBm/3kHz).

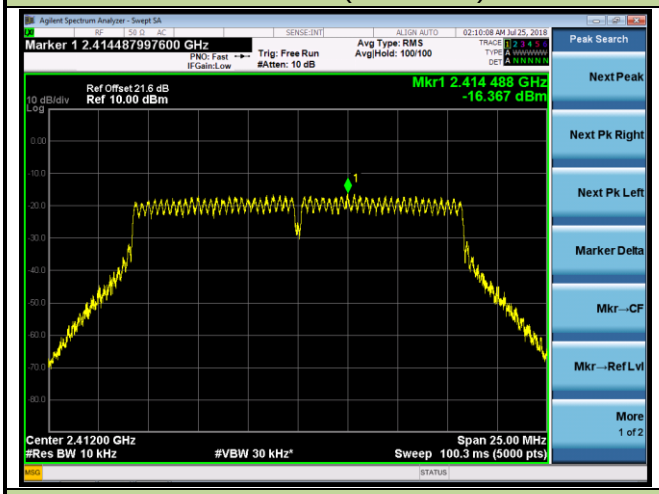
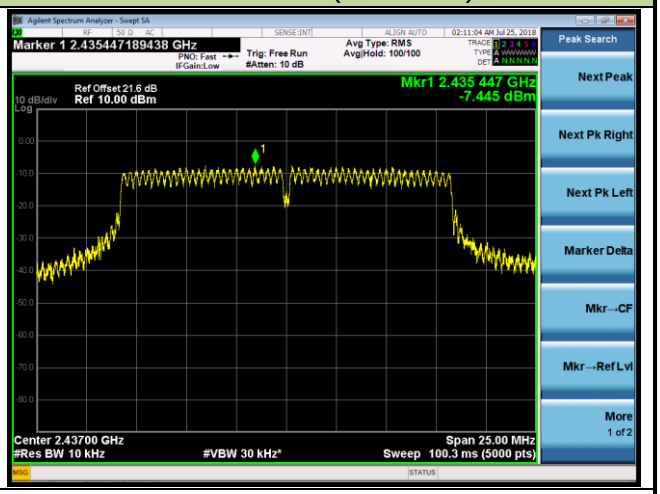
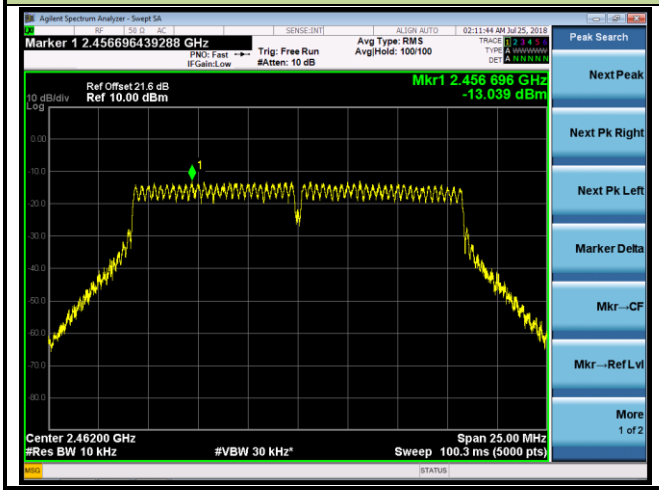
802.11b AVGPSD - Ant 0	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

802.11g AVGPSD - Ant 0	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

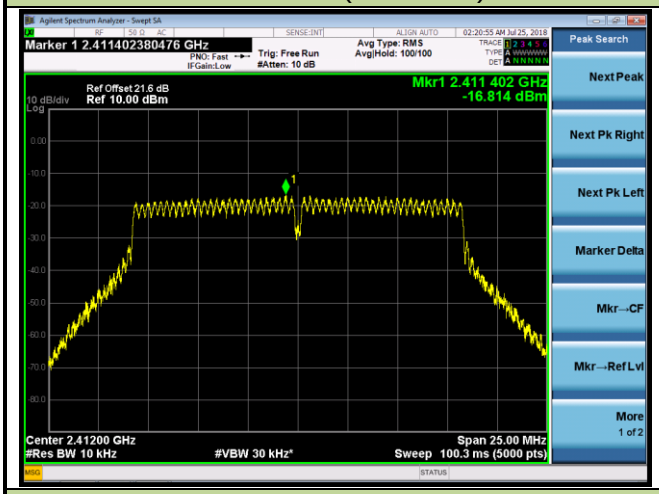
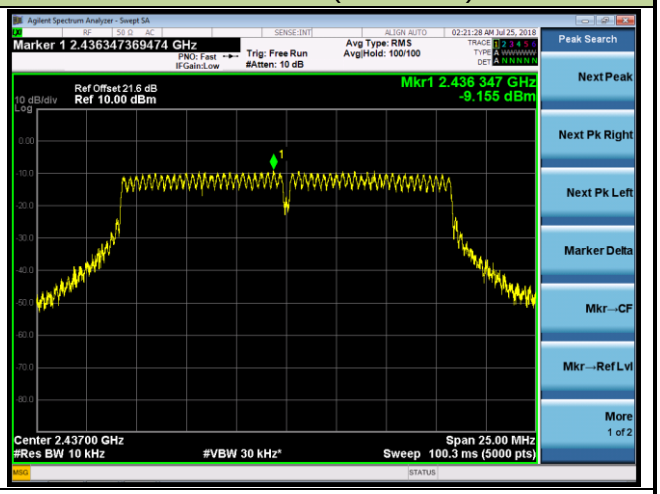
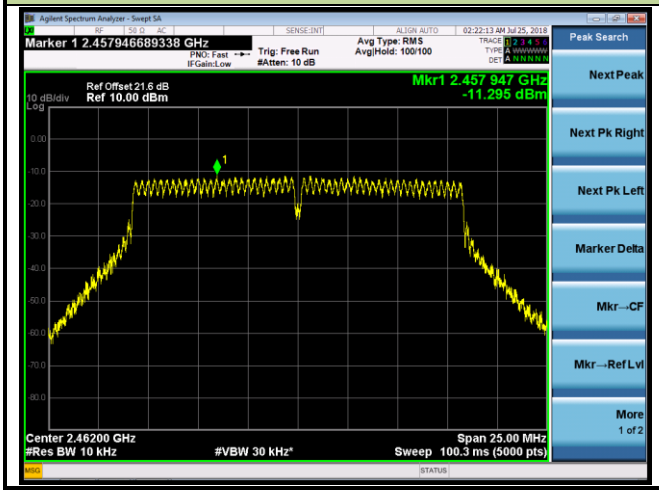
802.11b AVGPSD - Ant 1	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

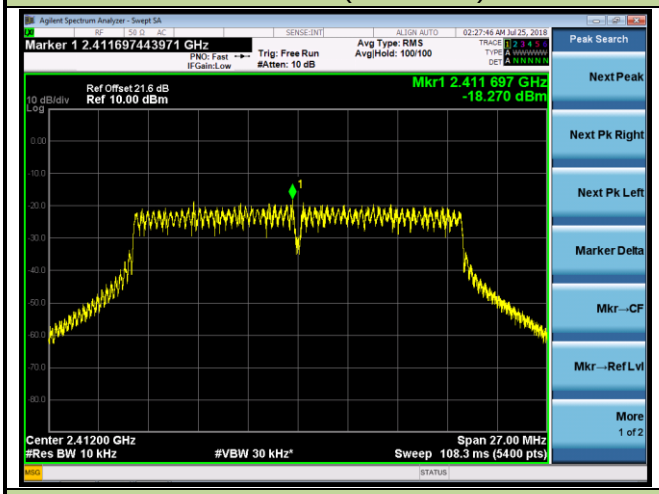
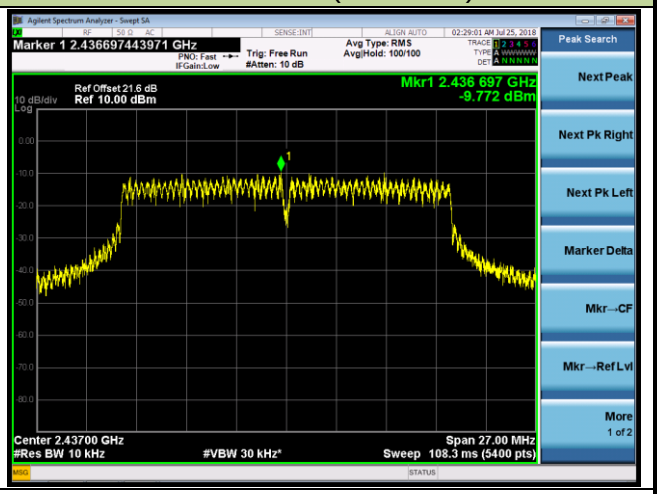
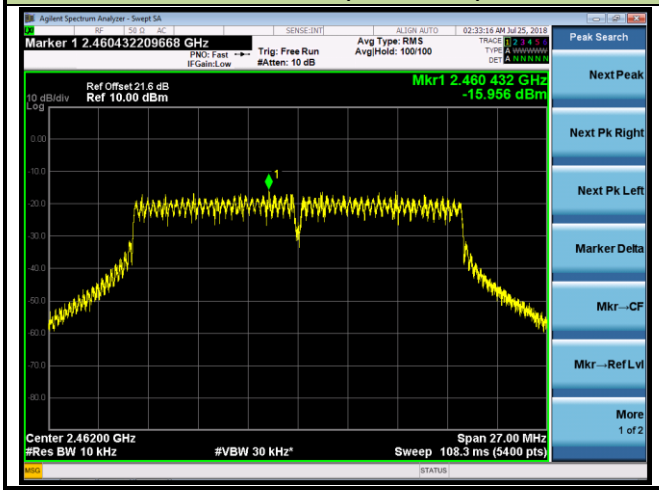
802.11g AVGPSD - Ant 1	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

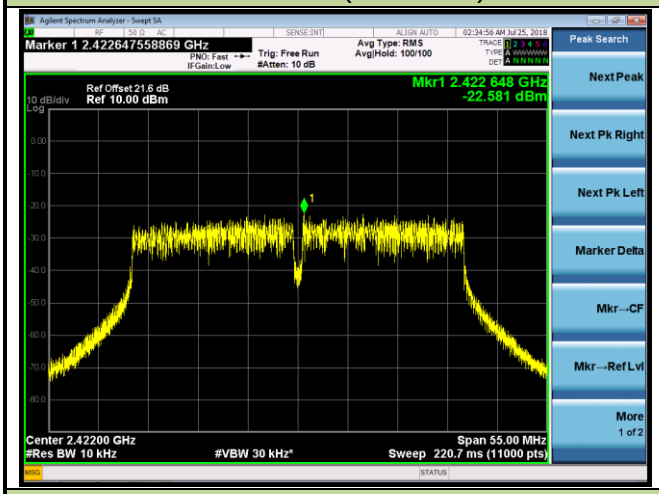
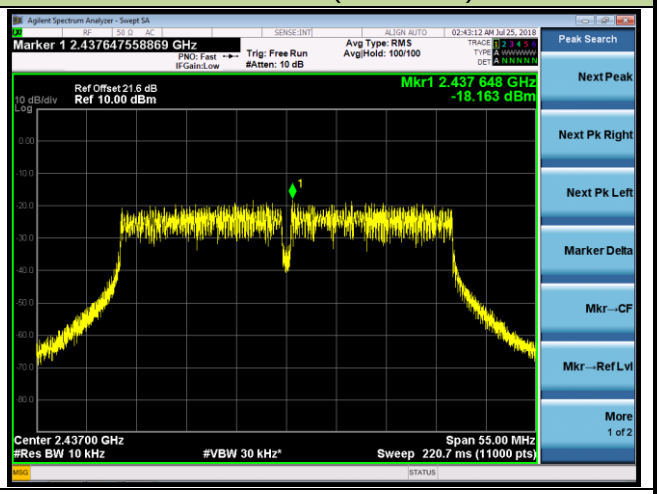
802.11b AVGPSD - Ant 2	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

802.11g AVGPSD - Ant 2	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

802.11b AVGPSD - Ant 3	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

802.11g AVGPSD - Ant 3	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

802.11n-HT20 AVGPSD - Ant 0 / Ant 0 + 1 + 2 + 3	
Channel 01 (2412MHz)	Channel 06 (2437MHz)
	
Channel 11 (2462MHz)	
	

802.11n-HT40 AVGPSD - Ant 0 / Ant 0 + 1 + 2 + 3	
Channel 03 (2422MHz)	Channel 06 (2437MHz)
	
Channel 09 (2452MHz)