MEASUREMENT REPORT

FCC PART 15 Subpart C WLAN 802.11b/g/n

FCC ID:	2AD8UFZCWO4A1
APPLICANT:	Nokia Solutions and Networks
Application Type:	Certification
Product:	Wi-Fi AP 4x4 OD small omni antenna US
Model No.:	WO4C-AC400
Trademark:	Nokia
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 D01v03r05, KDB 662911 D01v02r01
Test Date:	July 16, 2016 ~ July 06, 2017

Reviewed : Paddy Chen
(Paddy Chen)

Approved By : Chenz Ker
(Chenz Ker)

Testing Laboratory
3261

The test results relate only to the samples tested.
This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in KDB 558074 D01v03r05. Test results reported herein relate only to the item(s) tested.
The test report shall not be reproduced except in full without the written approval of MRT Technology (Taiwan) Co., Ltd.

Revision History

Report No.	Version	Description	Issue Date	Note
1608TW0110-U10	Rev. 01	Draft report	07-06-2017	

Note: This report is prepared for FCC Class II permissive change and supplement to MRT Original "1608TW0110-U1" Report adding "Wi-Fi AP 4x4 OD small omni antenna US ant" and related data

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§2.1033 General Information

Applicant:	Nokia Solutions and Networks
Applicant Address:	Karaportti 3, FI-02610 Espoo, Finland
Manufacturer:	Nokia Solutions and Networks
Manufacturer Address:	Karaportti 3, FI-02610 Espoo, Finland
Test Site:	MRT Technology (Taiwan) Co., Ltd
Test Site Address:	No. 38, Fuxing Second Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C)
MRT Registration No.:	153292
FCC Rule Part(s):	Part 15 Subpart C (Section 15.247)
Model No.:	WO4C-AC400
FCC ID:	2AD8UFZCWO4A1
Test Device Serial No.:	N/A ☐ Production ☒ Pre-Production ☐ Engineering

Test Facility / Accreditations

Measurements were performed at MRT Laboratory located in Fuxing Rd., Taoyuan, Taiwan (R.O.C)

- **MRT facility is a FCC registered (Reg. No. 153292) test facility with the site description report on file and is designated by the FCC as an Accredited Test Film.**
- **MRT facility is an IC registered (MRT Reg. No. 21723-1) test laboratory with the site description on file at Industry Canada.**
- **MRT Lab is accredited to ISO 17025 by the American Association for Laboratory Accreditation (TAF) under the American Association for Laboratory Accreditation Program (TAF Cert. No. 3261) in EMC, Telecommunications and Radio testing for FCC, Industry Taiwan, EU and TELEC Rules.**

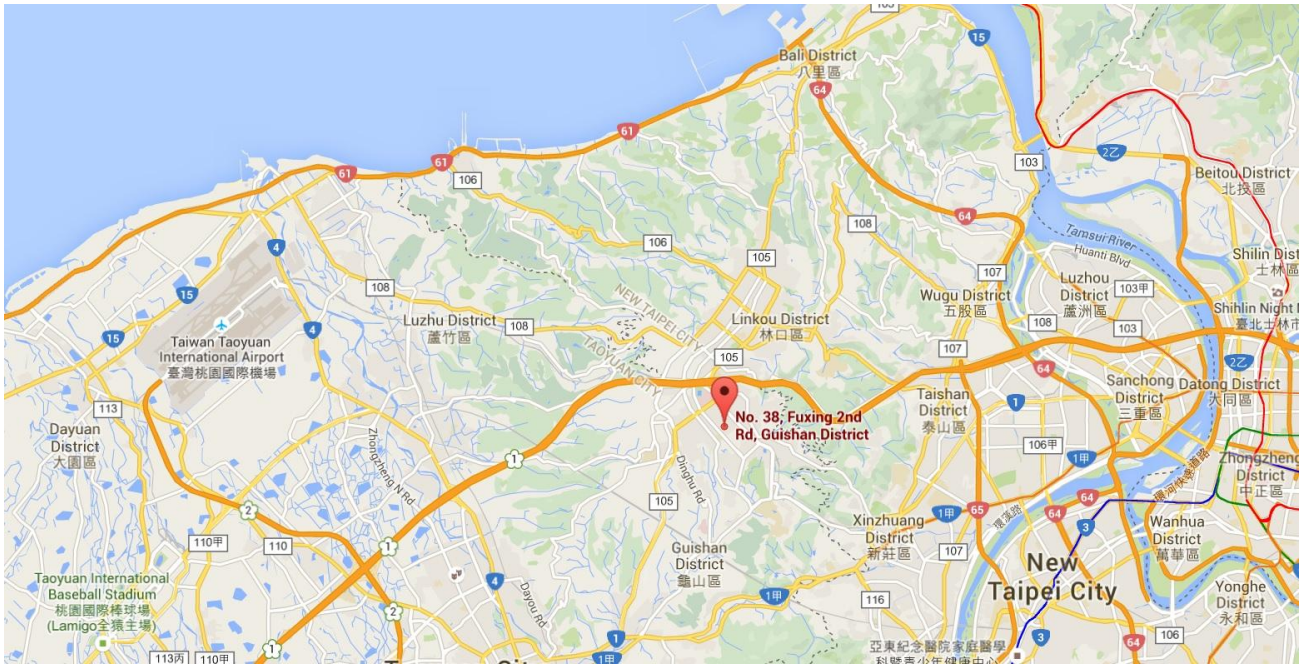
1. INTRODUCTION

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 Taoyuan City. These measurement tests were conducted at the MRT Technology (Taiwan) Co., Ltd. Facility located at No.38, Fuxing 2nd Rd., Guishan Dist., Taoyuan City 33377, Taiwan (R.O.C).



2. PRODUCT INFORMATION

2.1. Equipment Description

Product Name	Wi-Fi AP 4x4 OD small omni antenna US
Model No.	WO4C-AC400
Brand Name	Nokia
Hardware Version	v2.0
Wi-Fi Specification	802.11a/b/g/n/ac
Frequency Range	**2.4GHz:** For 802.11b/g/n-HT20: 2412 ~ 2462 MHz For 802.11n-HT40: 2422 ~ 2452 MHz **5GHz:** For 802.11a/n-HT20/ac-VHT20: 5180~5240MHz, 5745~5825MHz For 802.11n-HT40/ac-VHT40: 5190~5230MHz, 5755~5795MHz For 802.11ac-VHT80: 5210MHz, 5775MHz For 802.11ac-VHT80+80: 5210 MHz + 5775 MHz
2.4GHz Maximum Average Output Power	**CDD Mode:** 802.11b: 28.30dBm 802.11g: 28.65dBm **Beam-Forming Mode:** 802.11n-HT20: 26.40dBm 802.11n-HT40: 26.66dBm
Type of Modulation	802.11b: DSSS 802.11g/n: OFDM
Modulation Technology	CCK, DQPSK, DBPSK for DSSS 16QAM, 64QAM, QPSK, BPSK for OFDM

Note 1: We select the POE adapter (M/N: PoE35-54A) to perform all RF testing.

Note 2: The product name difference as below:

- when the device has been connected the Galtronics Small Omni antenna, the product name is “Wi-Fi AP 4x4 OD small omni antenna WW”;

2.2. Operating Frequencies and Channel List

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	--	--	--	--

2.3. Description of Available Antennas

Antenna	Manufacturer	Frequency Band (GHz)	Product Number	Tx Paths
	Galtronics	2.4	Galtronics Small Omni Antenna	2
		5		2

Product Number	Frequency Band (MHz)	Tx Paths	Per Chain Max Antenna Gain (dBi)				Beam Forming Directional Gain (dBi)	CDD Directional Gain (dBi)
			Ant 0	Ant 1	Ant 2	Ant 3		
Galtronics Small Omni Antenna	2412 ~2462	2	2.69	2.41	2.69	2.41	8.57	2.69
	5150 ~ 5250	2	3.27	3.85	3.27	3.85	9.59	3.85
	5150 ~ 5250 30°elevation angle	2	3.20	1.81	3.20	1.81	N/A	N/A
	5725 ~ 5850	2	4.35	4.30	4.35	4.30	10.35	4.35

Note

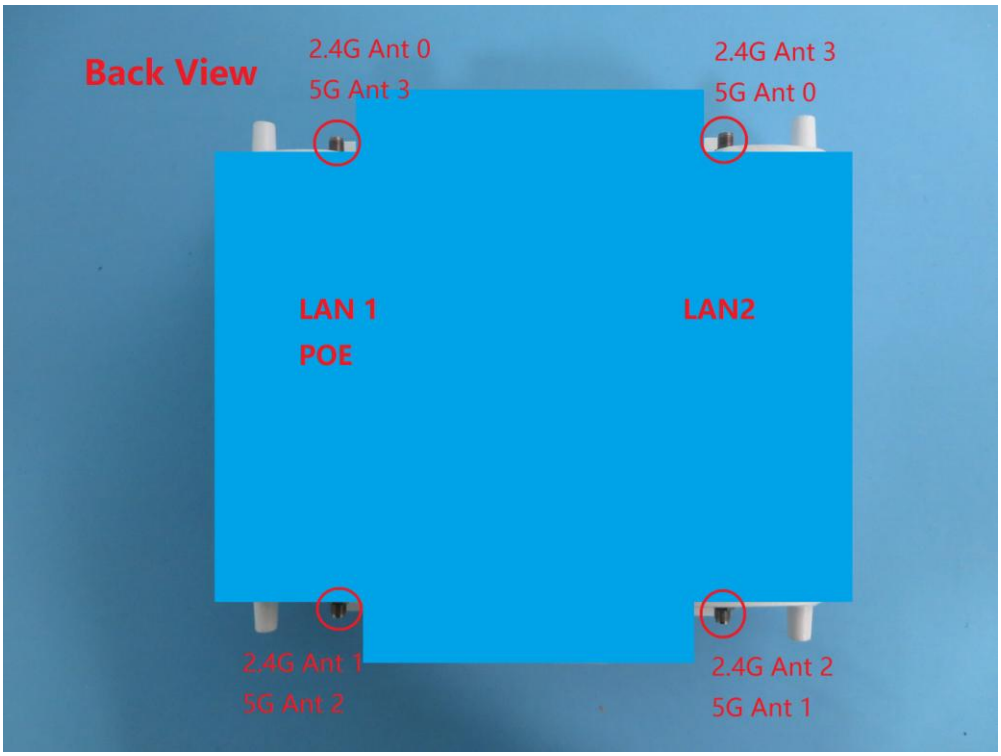
1. The EUT supports Cyclic Delay Diversity (CDD) technology for 802.11a/b/g mode, and CDD signals are correlated.
2. The EUT supports Beam Forming technology for 802.11n/ac mode, and exclude 802.11b/g mode. Correlated signals include, but are not limited to, signals transmitted in any of the following modes:

- Any transmit Beam Forming mode, whether fixed or adaptive (e.g., phased array modes, closed loop MIMO modes, Transmitter Adaptive Antenna modes, Maximum Ratio Transmission (MRT) modes, and Statistical Eigen Beam Forming (EBF) modes).
- CDD signals are correlated and create unintended array gain that varies with signal bandwidth, antenna geometry, and cyclic delay values. Consequently, depending on system parameters, it may be appropriate to use different values of array gain for compliance with power limits versus compliance with powerspectral density limits.

3. Unequal Antenna gains, with equal transmit powers. For Antenna gains given by G_1, G_2, …, G_N dBi transmit signals are correlated, then
   - Directional gain = $10*\log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2/N_{ANT}]$ dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]
   - For example (Galtronics Small Omni Antenna): 5150 ~ 5250MHz Directional Gain = $10*\log[(10^{3.27/20} + 10^{3.85/20} + 10^{3.27/20} + 10^{3.85/20})^2/4] = 9.59$ dBi

2.4. Description of Antenna RF Port

Antenna RF Port								
---	2.4GHz RF Port				5GHz RF Port			
Software Control Port	Ant 0	Ant 1	Ant 2	Ant 3	Ant 0	Ant 1	Ant 2	Ant 3



2.5. Test Mode

Test Mode	Mode 1: Transmit by 802.11b
	Mode 2: Transmit by 802.11g
	Mode 3: Transmit by 802.11n-HT20
	Mode 4: Transmit by 802.11n-HT40

2.6. Device Capabilities

This device contains the following capabilities:
2.4GHz WLAN (DTS) & 5GHz WLAN (UNII).
Note: 2.4GHz WLAN (DTS) operation is 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. 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 are as follows:

Test Mode	Duty Cycle
802.11b	99.20%
802.11g	96.04%
802.11n-HT20	98.16%
802.11n-HT40	97.11%

2.7. Test Configuration

The **FCC ID: 2AD8UFZCWO4A1** was tested per the guidance of KDB 558074 D01v03r05. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

2.8. EMI Suppression Device(s)/Modifications

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

2.9. 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 KDB 558074 D01v03r05 were used in the measurement of the **FCC ID: 2AD8UFZCWO4A1.**

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 150kHz to 30MHz. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 9kHz. 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 which 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 9kHz 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.

Line conducted emissions test results are shown in Section 7.8.

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 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, which 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."

- There are provisions for reverse connecter to an external antenna.
- Galtronics Small Omni Antenna: reverse SMA connecter.

Conclusion:

The **Wi-Fi AP 4x4 OD small omni antenna US FCC ID: 2AD8UFZCWO4A1** unit complies with the requirement of §15.203.

5. TEST EQUIPMENT CALIBRATION DATE

Conducted Emissions

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EMI Test Receiver	R&S	ESR3	MRTTWA00045	1 year	2018/03/17
Two-Line V-Network	R&S	ENV216	MRTTWA00019	1 year	2018/03/23
Two-Line V-Network	R&S	ENV216	MRTTWA00020	1 year	2018/03/23
Temperature/Humidity Meter	TFA	35.1078.10.IT	MRTTWA00033	1 year	2018/06/09

Radiated Emissions

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
Signal Analyzer	R&S	FSV40	MRTTWA00007	1 year	2018/03/02
EMI Test Receiver	R&S	ESR3	MRTTWA00009	1 year	2018/03/16
Broadband Preamplifier	SCHWARZBECK	BBV 9718	MRTTWA00005	1 year	2018/04/06
Broadband Amplifier	SCHWARZBECK	BBV 9721	MRTTWA00006	1 year	2018/04/06
Acitve Loop Antenna	SCHWARZBECK	FMZB 1519B	MRTTWA00002	1 year	2018/04/06
Broadband TRILOG Antenna	SCHWARZBECK	VULB 9162	MRTTWA00001	1 year	2018/04/06
Broadband Hornantenna	SCHWARZBECK	BBHA 9120D	MRTTWA00003	1 year	2018/04/06
Breitband Hornantenna	SCHWARZBECK	BBHA 9170	MRTTWA00004	1 year	2018/04/06
Temperature/Humidity Meter	TFA	35.1078.10.IT	MRTTWA00033	1 year	2018/06/09

Conducted Test Equipment

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EXA Signal Analyzer	KEYSIGHT	N9010A	MRTTWA00012	1 year	2017/07/11
PSA Series Spectrum Analyzer	Agilent	E4447A	MRTTWA00060	1 year	2017/12/11
X-Series USB Peak and Average Power Sensor	KEYSIGHT	U2021XA	MRTTWA00014	1 year	2018/03/18
X-Series USB Peak and Average Power Sensor	KEYSIGHT	U2021XA	MRTTWA00015	1 year	2018/03/18
Programmable Temperature & Humidity Chamber	TEN BILLION	TTH-B3UP	MRTTWA00036	1 year	2018/05/11
Temperature/Humidity Meter	TFA	35.1078.10.IT	MRTTWA00033	1 year	2018/06/09

Software	Version	Function
EMI Software	V3	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
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 150kHz~30MHz: 3.46dB
Radiated Emission Measurement
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 9kHz ~ 1GHz: 4.18dB 1GHz ~ 25GHz: 4.76dB
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

Product Name: **Nokia Solutions and Networks**
FCC ID: **2AD8UFZCWO4A1**
Model No.: **WO4C-AC400**
FCC Classification: **Digital Transmission System (DTS)**
Data Rate(s) Tested: **1Mbps ~ 11Mbps (b); 6Mbps ~ 54Mbps (g); 6.5/7.2Mbps ~ 260/288.8Mbps (n-HT20); 13.5/15Mbps ~ 540/600Mbps (n-HT40)**

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	Refer to Section 7.3		Pass	Section 7.3
15.247(e)	Power Spectral Density	Refer to Section 7.4		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) The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
2) Test Items “6dB Bandwidth” & “Band Edge / Out-of-Band Emissions” have been assessed single 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.

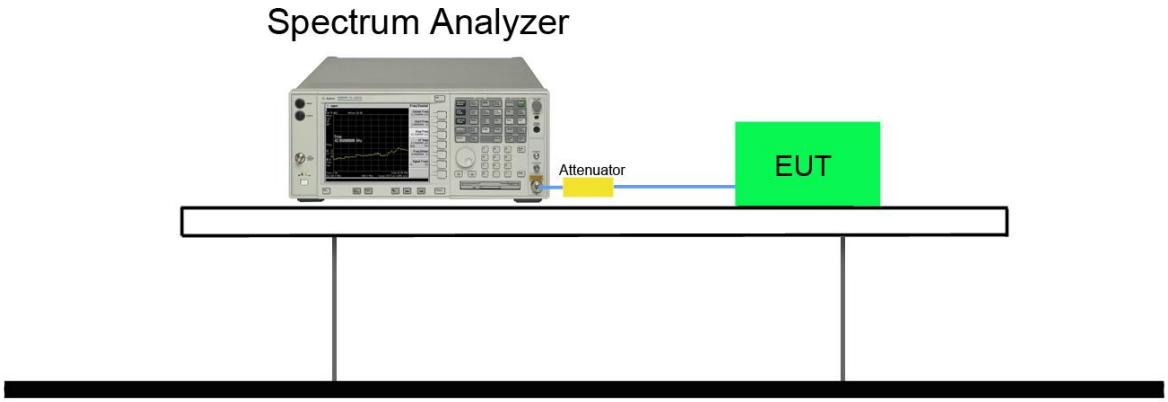
7.2.2.Test Procedure used

KDB 558074 D01v03r05 - Section 8.2 Option 2

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

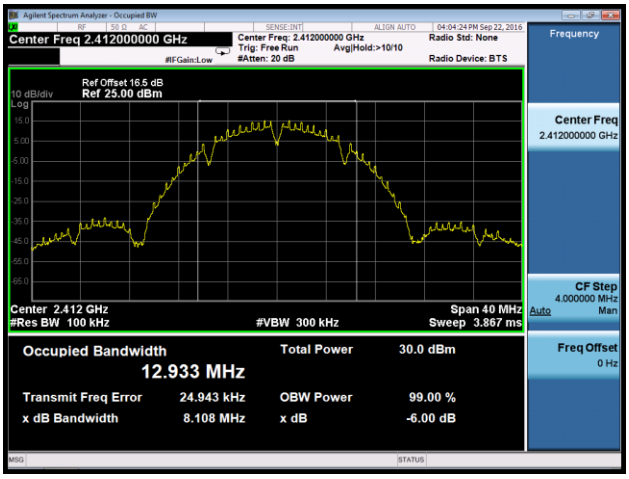
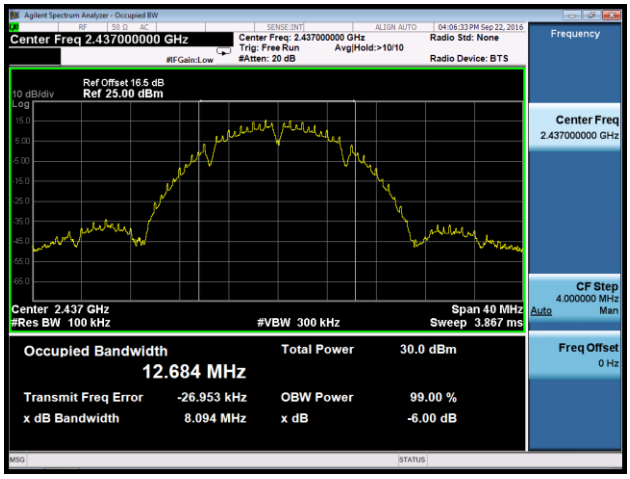


7.2.5.Test Result

Product	Wi-Fi AP 4x4 OD small omni antenna US	Temperature	25°C
Test Engineer	Johnson Liao	Relative Humidity	50 ~ 58%
Test Site	SR2	Test Date	2016/09/22
Test Item	6dB Bandwidth		

Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)	Result
Ant 0						
802.11b	1	01	2412	8.11	≥ 0.5	Pass
802.11b	1	06	2437	8.09	≥ 0.5	Pass
802.11b	1	11	2462	8.10	≥ 0.5	Pass
802.11g	6	01	2412	16.33	≥ 0.5	Pass
802.11g	6	06	2437	15.69	≥ 0.5	Pass
802.11g	6	11	2462	16.05	≥ 0.5	Pass
802.11n-HT20	6.5	01	2412	16.84	≥ 0.5	Pass
802.11n-HT20	6.5	06	2437	16.53	≥ 0.5	Pass
802.11n-HT20	6.5	11	2462	16.79	≥ 0.5	Pass
802.11n-HT40	13.5	03	2422	35.12	≥ 0.5	Pass
802.11n-HT40	13.5	06	2437	35.09	≥ 0.5	Pass
802.11n-HT40	13.5	09	2452	35.14	≥ 0.5	Pass
Ant 1						
802.11b	1	01	2412	8.10	≥ 0.5	Pass
802.11b	1	06	2437	8.09	≥ 0.5	Pass
802.11b	1	11	2462	8.10	≥ 0.5	Pass
802.11g	6	01	2412	15.93	≥ 0.5	Pass
802.11g	6	06	2437	16.32	≥ 0.5	Pass
802.11g	6	11	2462	15.92	≥ 0.5	Pass
802.11n-HT20	6.5	01	2412	15.75	≥ 0.5	Pass
802.11n-HT20	6.5	06	2437	17.18	≥ 0.5	Pass
802.11n-HT20	6.5	11	2462	16.91	≥ 0.5	Pass
802.11n-HT40	13.5	03	2422	35.14	≥ 0.5	Pass
802.11n-HT40	13.5	06	2437	35.16	≥ 0.5	Pass
802.11n-HT40	13.5	09	2452	35.08	≥ 0.5	Pass

Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)	Result
Ant 2						
802.11b	1	01	2412	8.10	≥ 0.5	Pass
802.11b	1	06	2437	8.09	≥ 0.5	Pass
802.11b	1	11	2462	8.10	≥ 0.5	Pass
802.11g	6	01	2412	16.29	≥ 0.5	Pass
802.11g	6	06	2437	15.95	≥ 0.5	Pass
802.11g	6	11	2462	16.07	≥ 0.5	Pass
802.11n-HT20	6.5	01	2412	16.95	≥ 0.5	Pass
802.11n-HT20	6.5	06	2437	16.24	≥ 0.5	Pass
802.11n-HT20	6.5	11	2462	16.59	≥ 0.5	Pass
802.11n-HT40	13.5	03	2422	35.14	≥ 0.5	Pass
802.11n-HT40	13.5	06	2437	35.17	≥ 0.5	Pass
802.11n-HT40	13.5	09	2452	35.11	≥ 0.5	Pass
Ant 3						
802.11b	1	01	2412	8.11	≥ 0.5	Pass
802.11b	1	06	2437	8.09	≥ 0.5	Pass
802.11b	1	11	2462	8.10	≥ 0.5	Pass
802.11g	6	01	2412	16.06	≥ 0.5	Pass
802.11g	6	06	2437	16.06	≥ 0.5	Pass
802.11g	6	11	2462	16.07	≥ 0.5	Pass
802.11n-HT20	6.5	01	2412	16.80	≥ 0.5	Pass
802.11n-HT20	6.5	06	2437	16.58	≥ 0.5	Pass
802.11n-HT20	6.5	11	2462	16.58	≥ 0.5	Pass
802.11n-HT40	13.5	03	2422	33.89	≥ 0.5	Pass
802.11n-HT40	13.5	06	2437	35.07	≥ 0.5	Pass
802.11n-HT40	13.5	09	2452	35.14	≥ 0.5	Pass

802.11b 6dB Bandwidth - Ant 0	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
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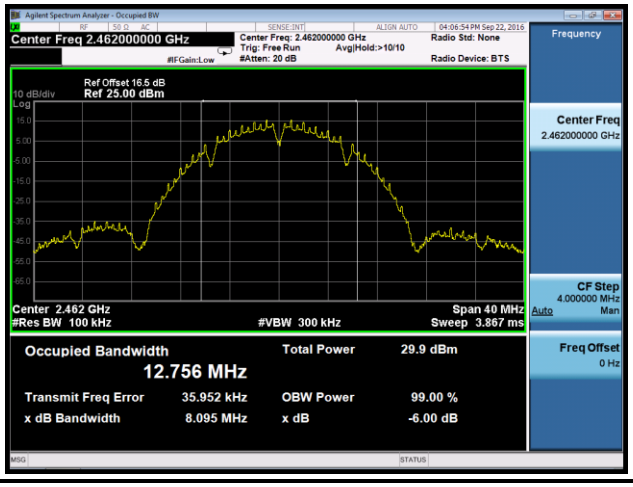
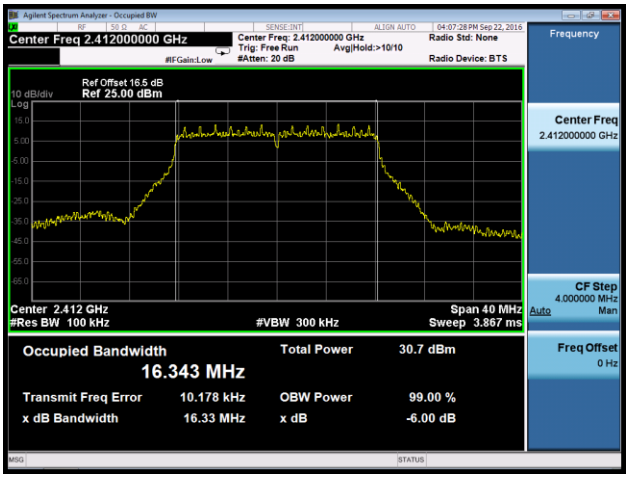
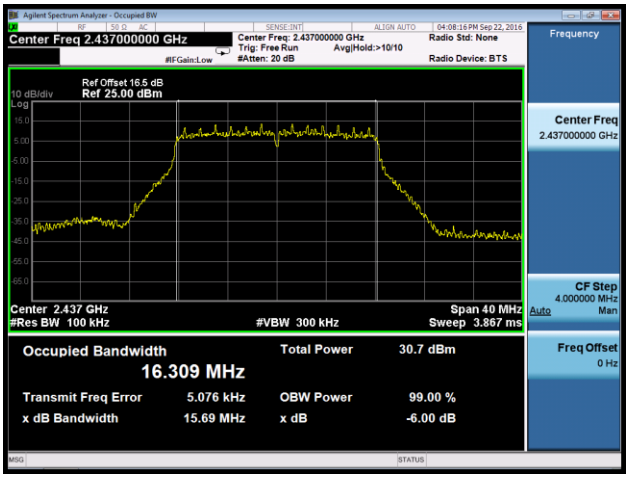
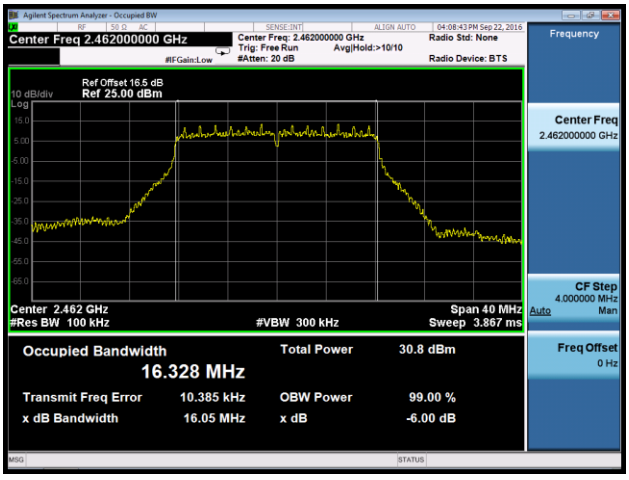
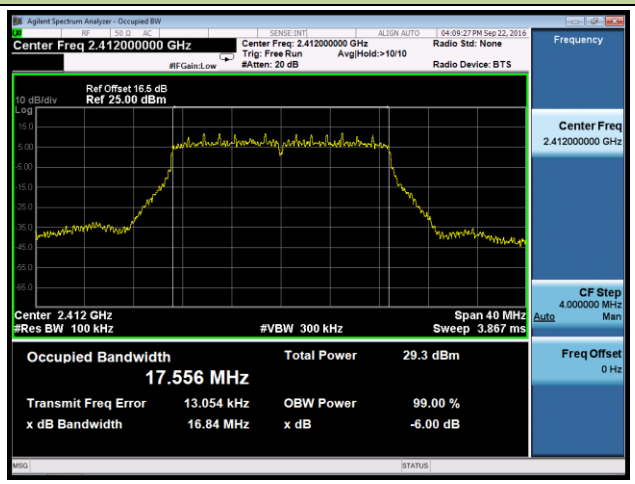
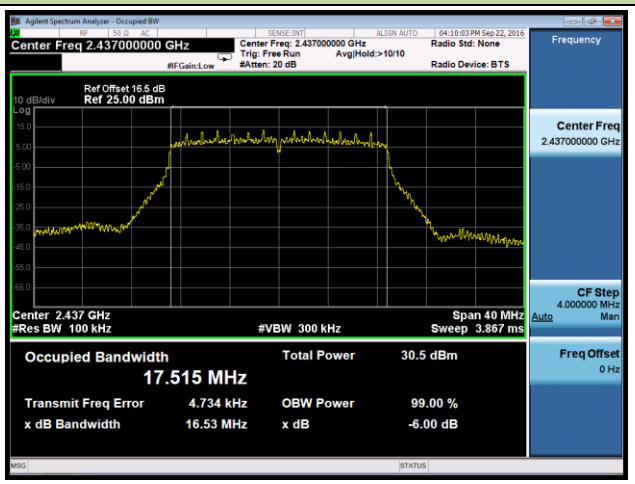
	

802.11g 6dB Bandwidth - Ant 0	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
Channel 11 (2462MHz)	
	

802.11n-HT20 6dB Bandwidth - Ant 0	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
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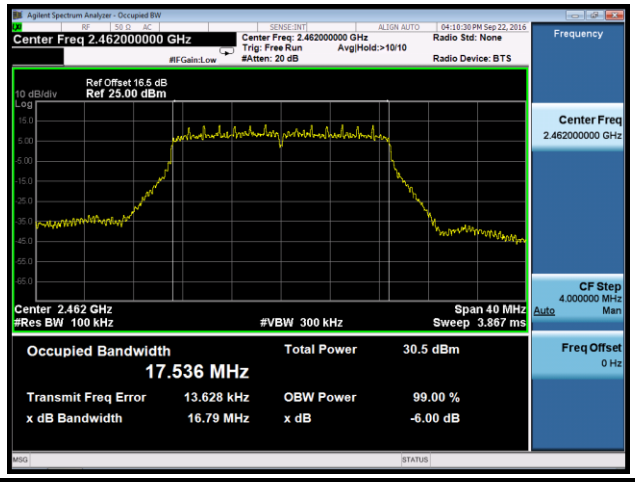
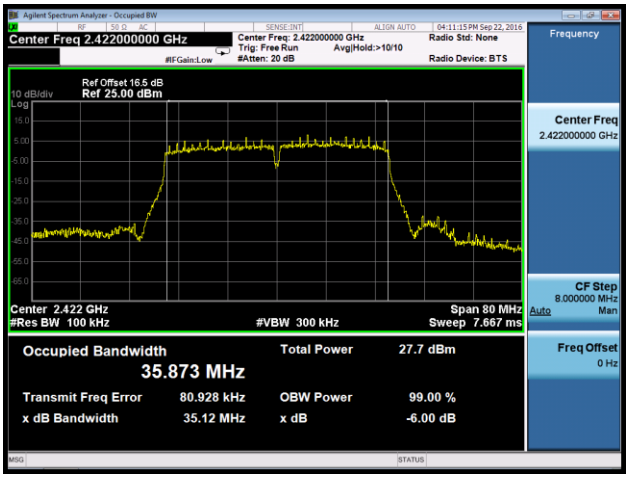
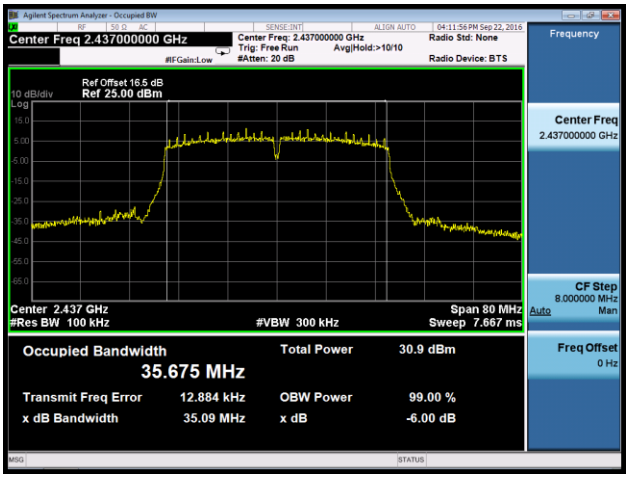
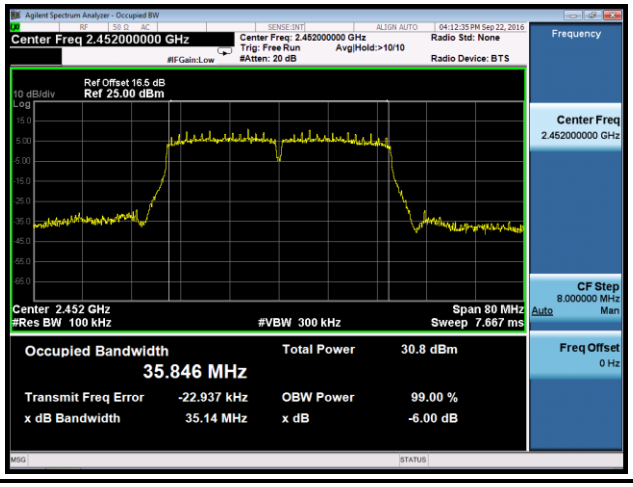
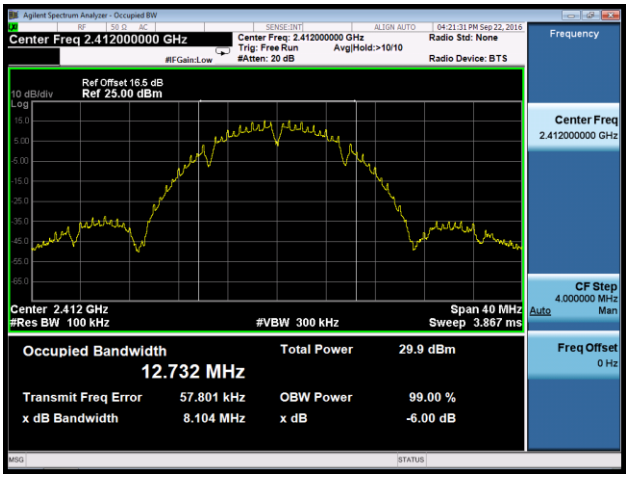
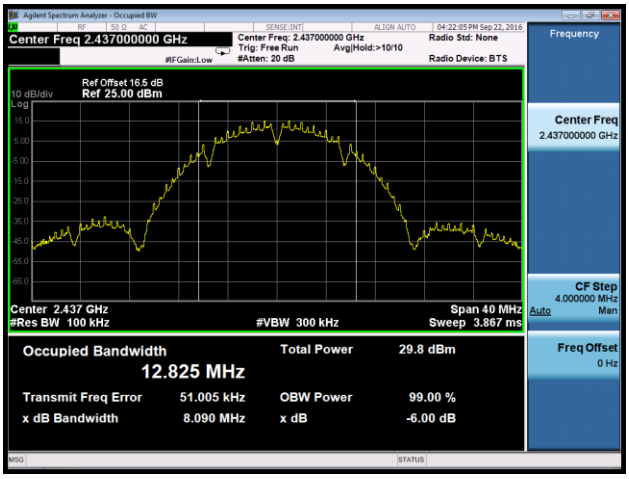
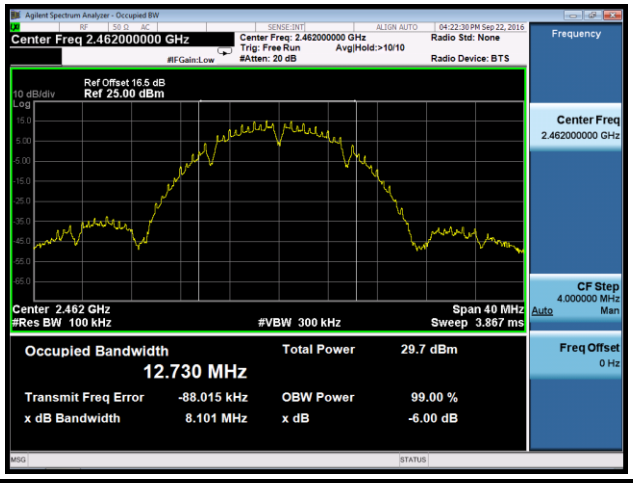
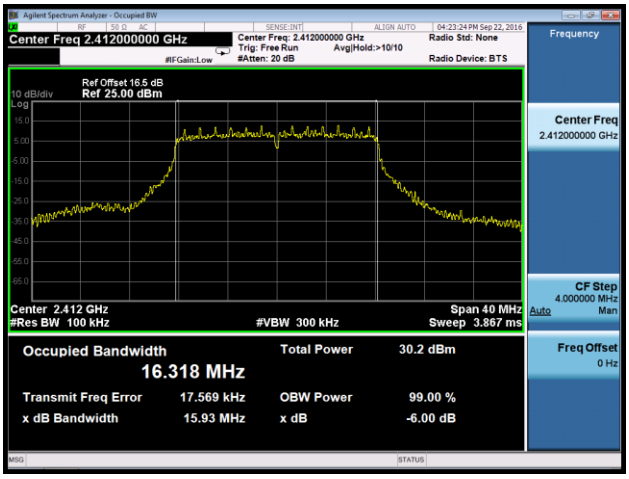
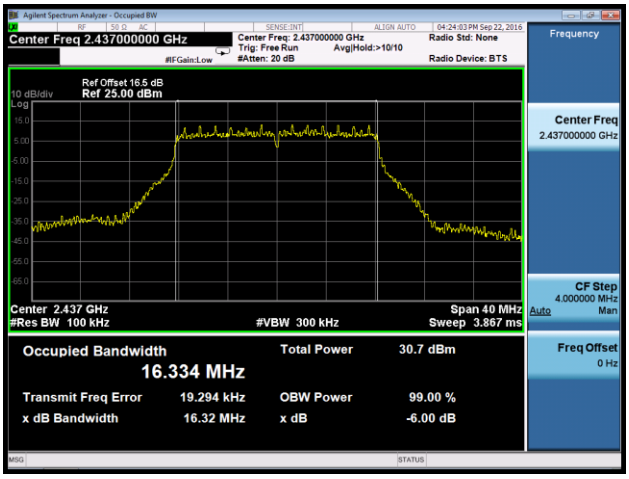
	

802.11n-HT40 6dB Bandwidth - Ant 0	
Channel 03 (2422MHz)	**Channel 06 (2437MHz)**
	
Channel 09 (2452MHz)	
	

802.11b 6dB Bandwidth - Ant 1	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
Channel 11 (2462MHz)	
	

802.11g 6dB Bandwidth - Ant 1	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
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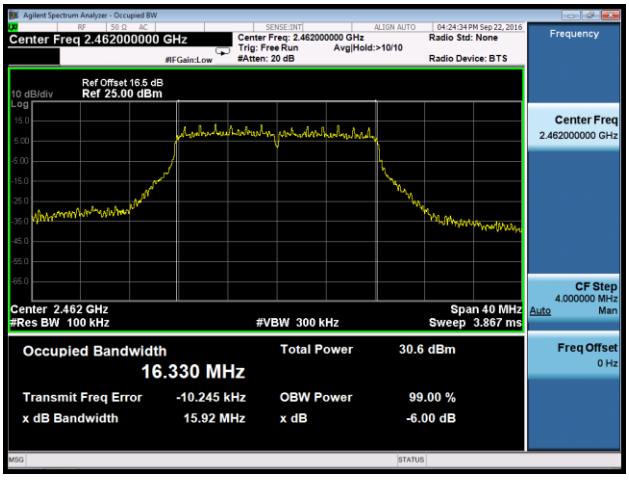
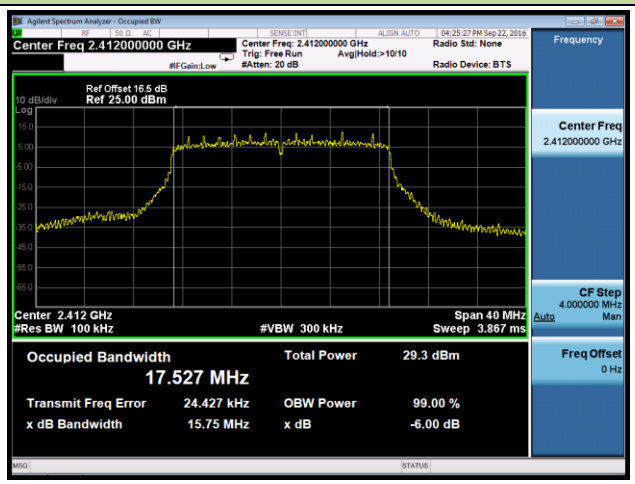
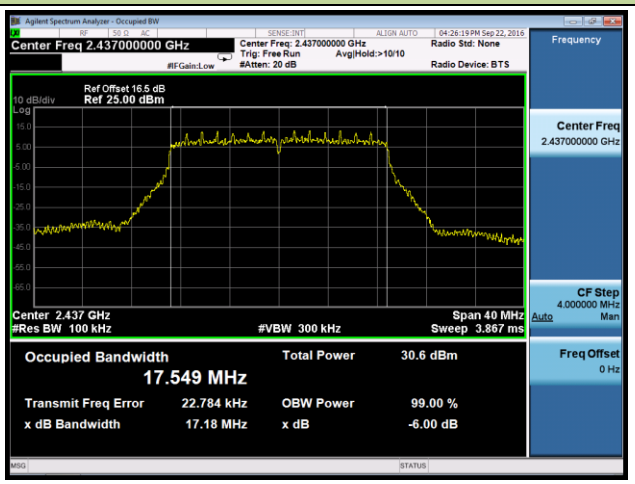
	

802.11n-HT20 6dB Bandwidth - Ant 1	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
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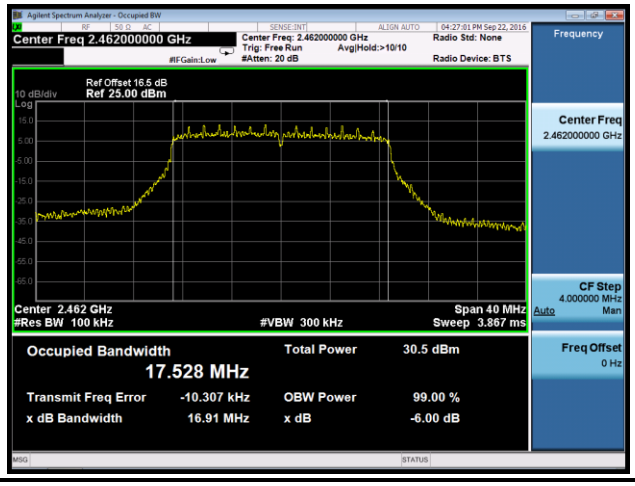
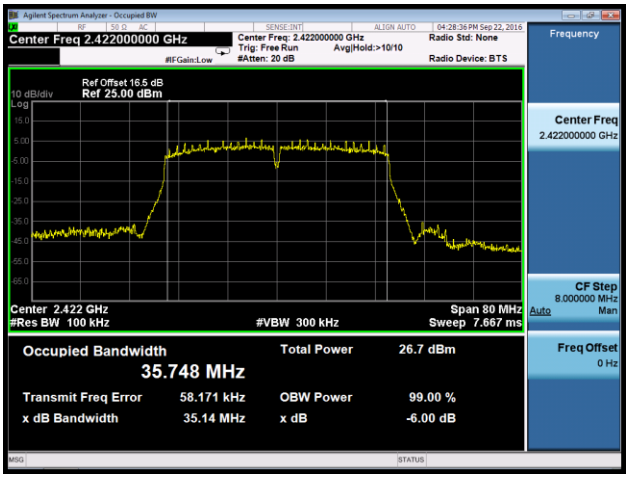
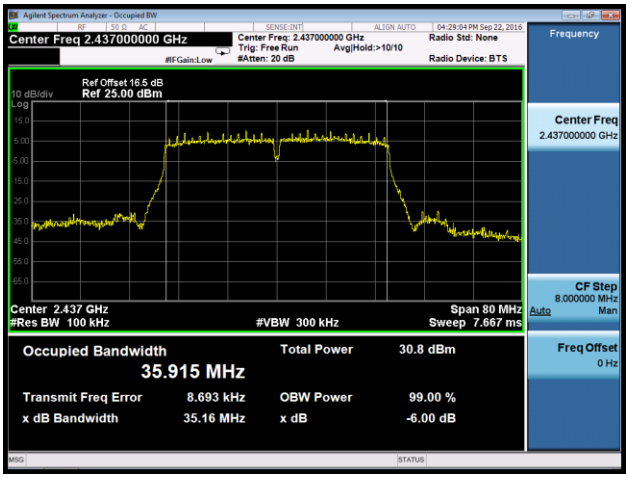
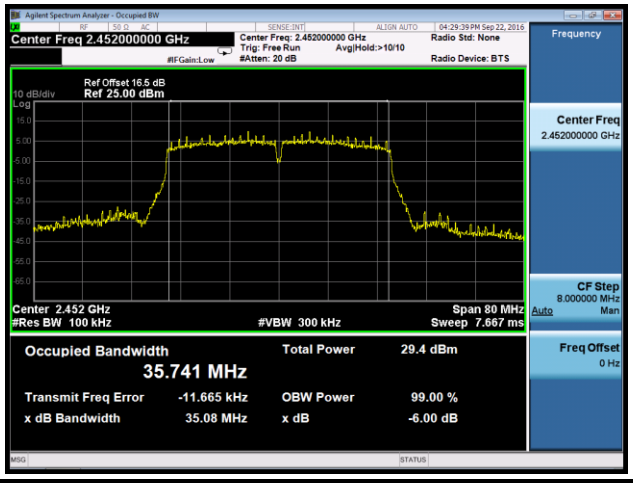
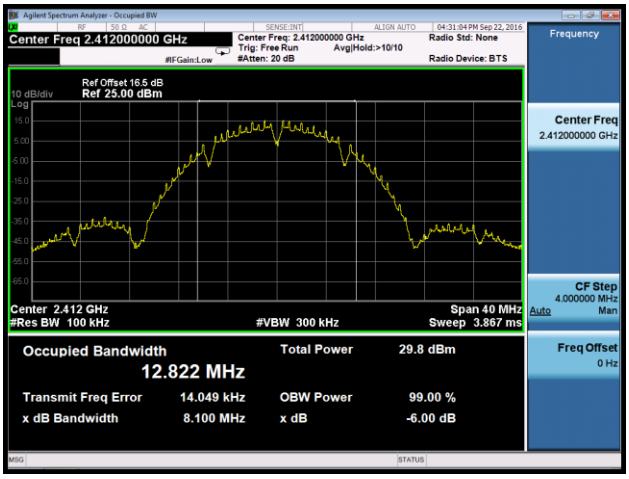
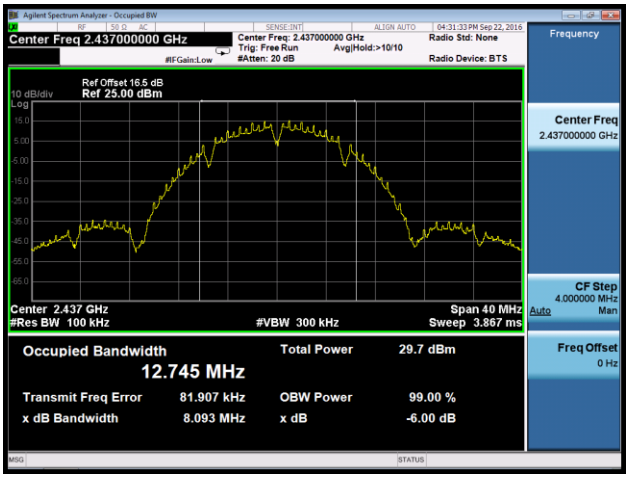
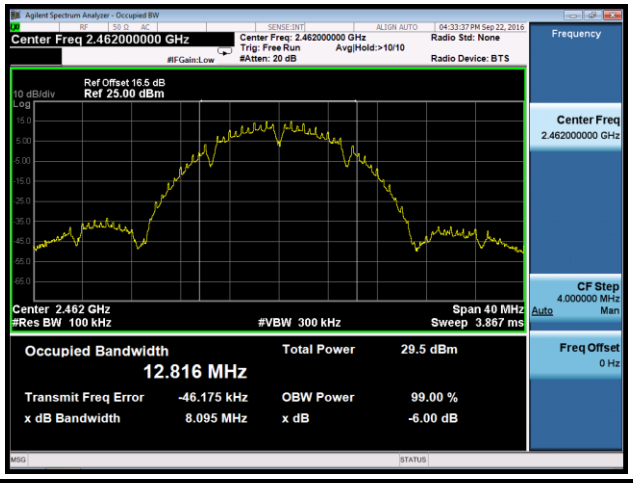
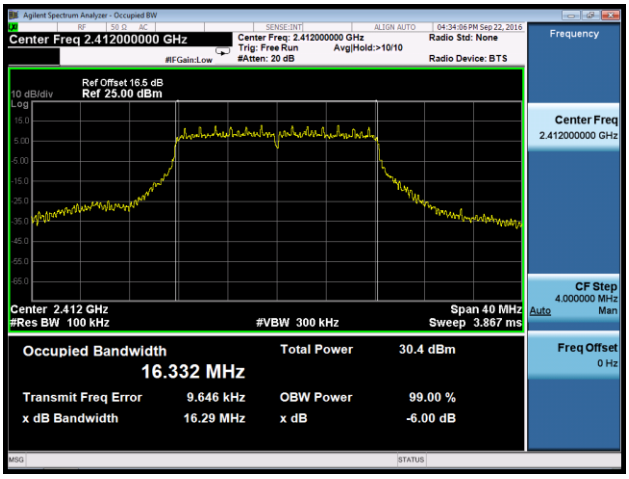
	

802.11n-HT40 6dB Bandwidth - Ant 1	
Channel 03 (2422MHz)	**Channel 06 (2437MHz)**
	
Channel 09 (2452MHz)	
	

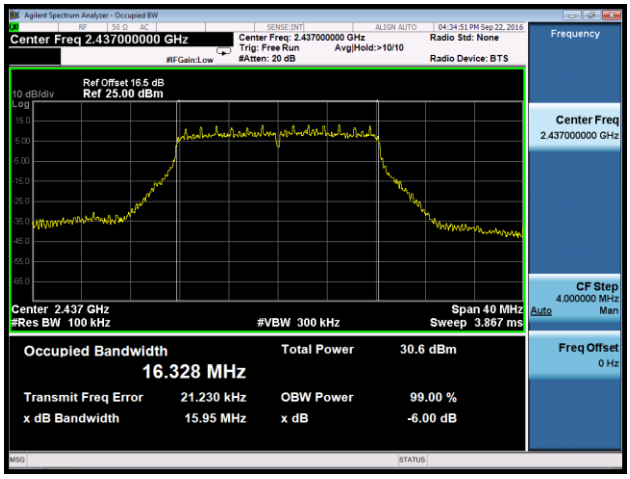
802.11b 6dB Bandwidth - Ant 2	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
Channel 11 (2462MHz)	
	

802.11g 6dB Bandwidth - Ant 2

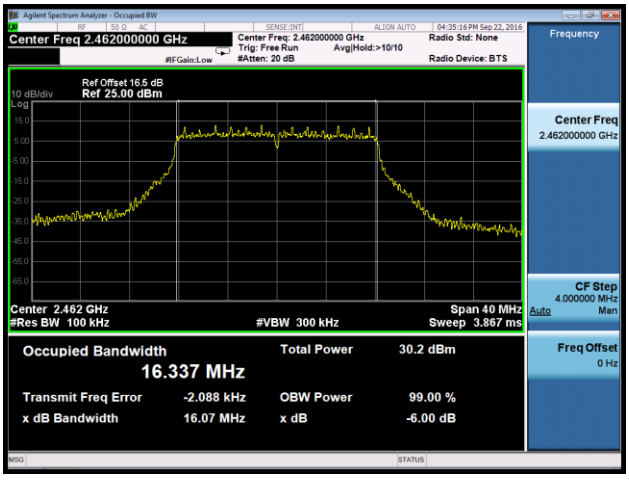
Channel 01 (2412MHz)

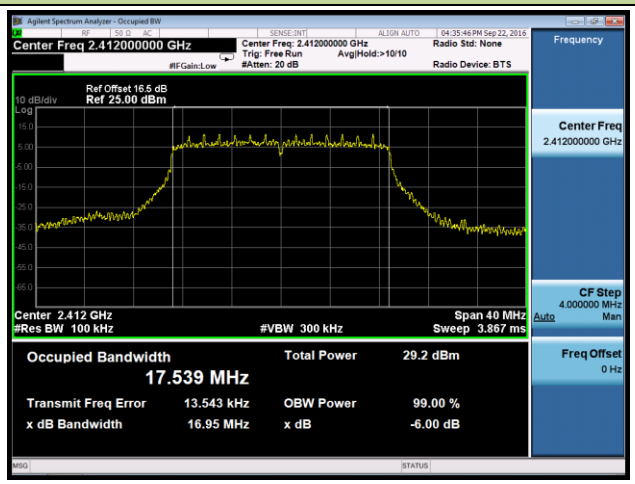
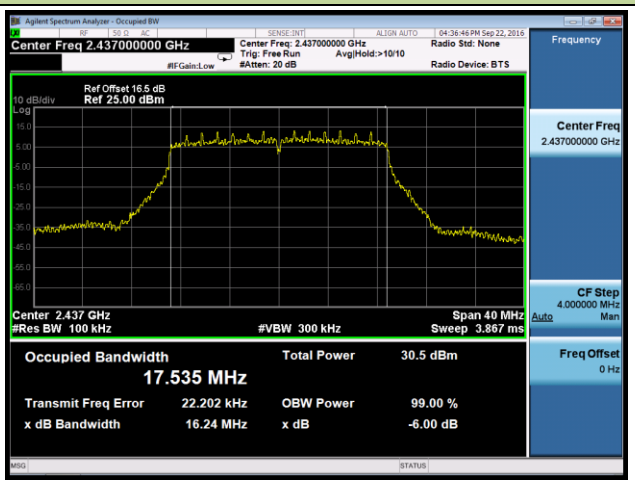
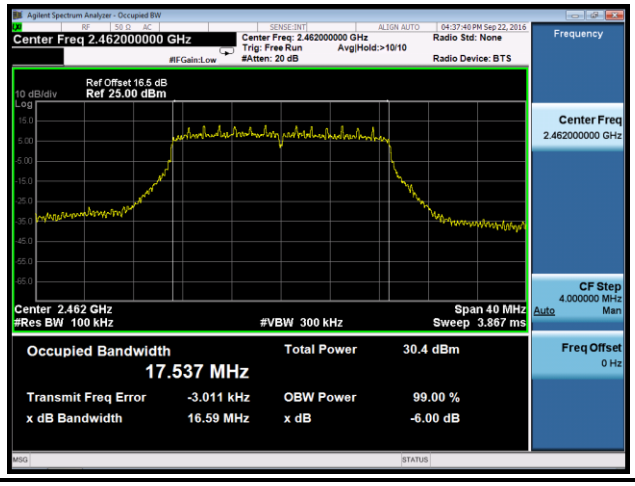


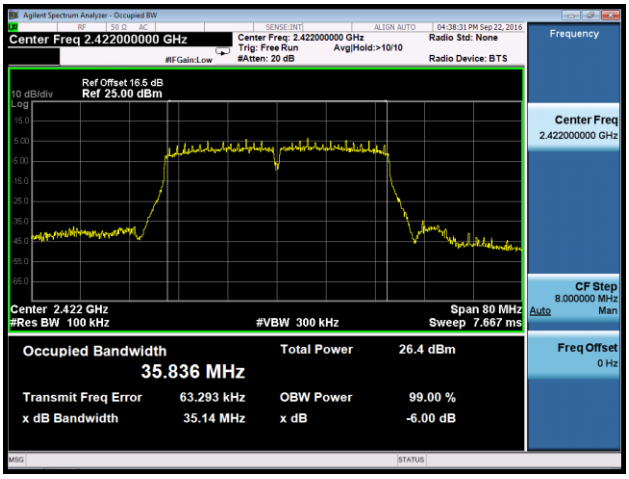
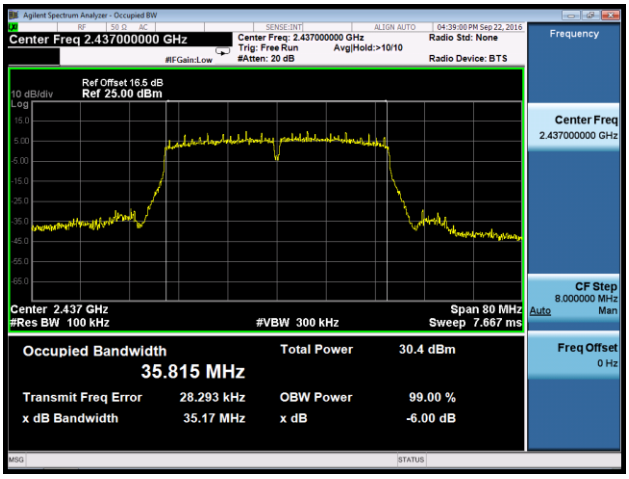
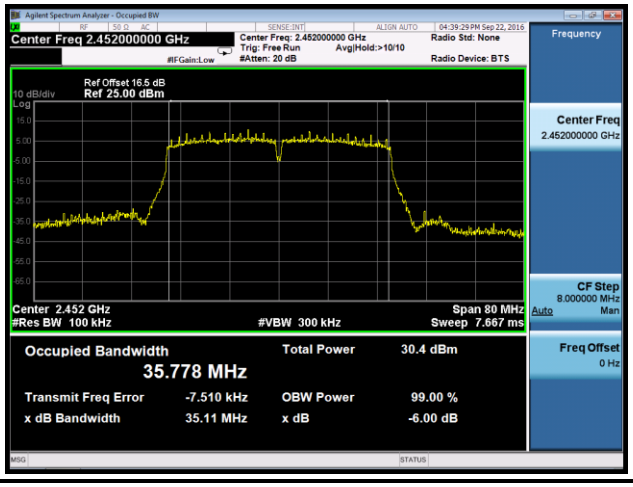
Channel 06 (2437MHz)

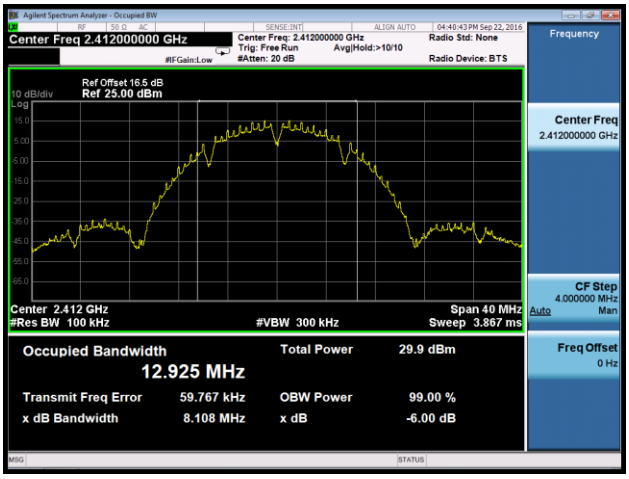
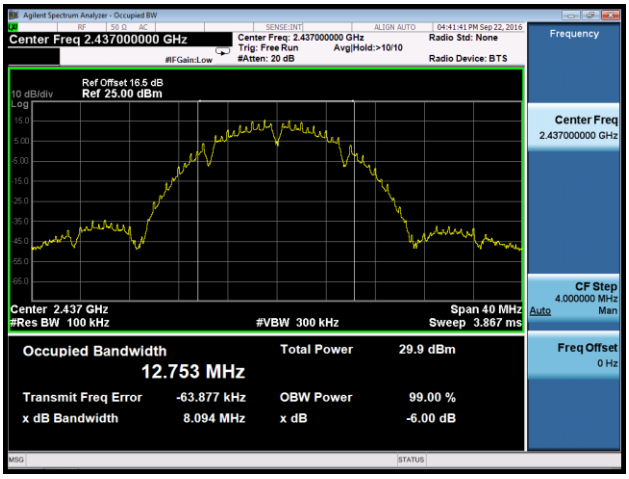
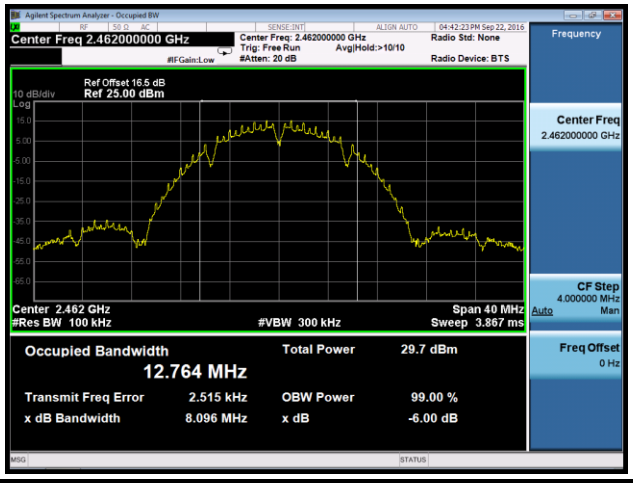


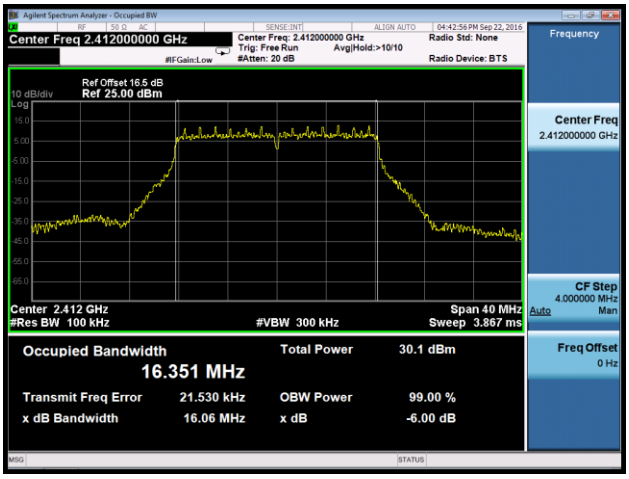
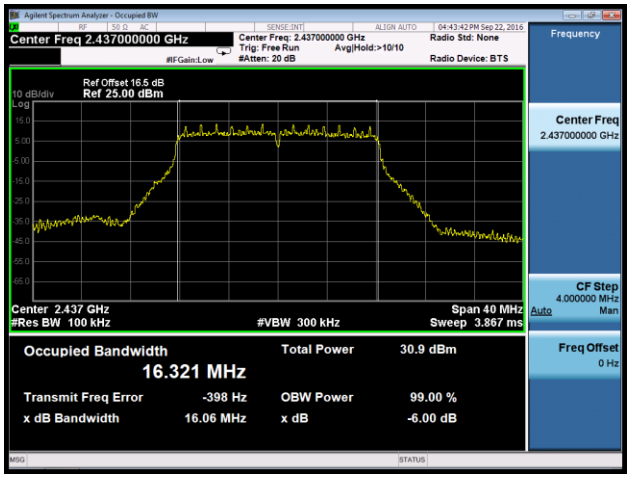
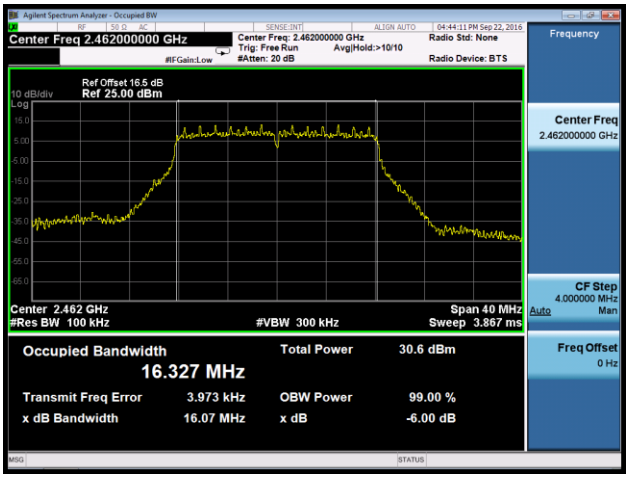
Channel 11 (2462MHz)

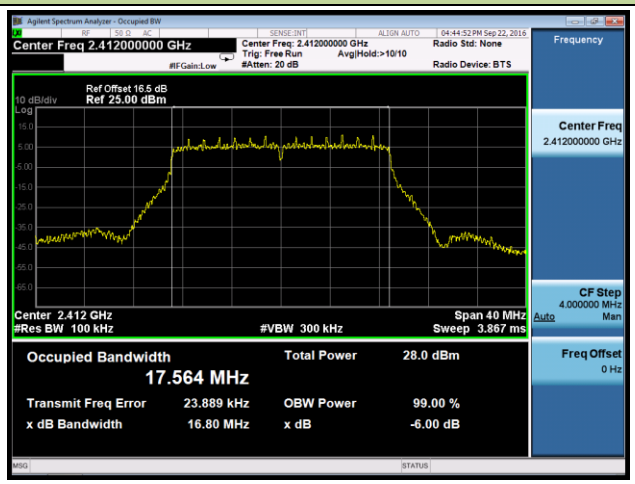
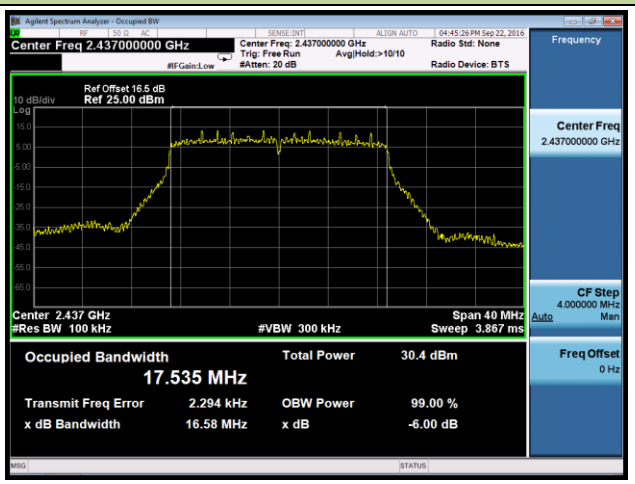
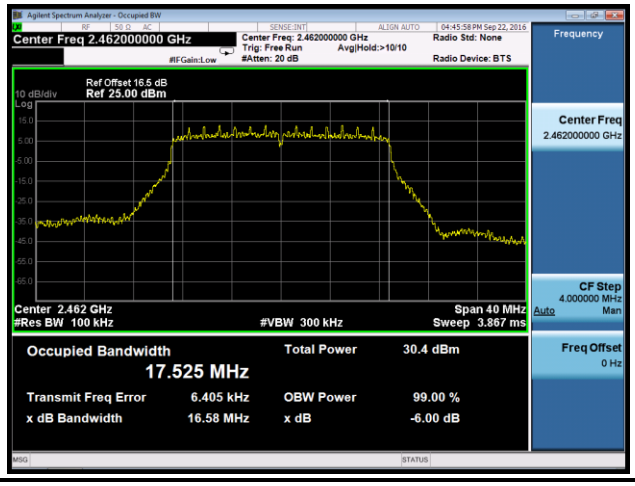


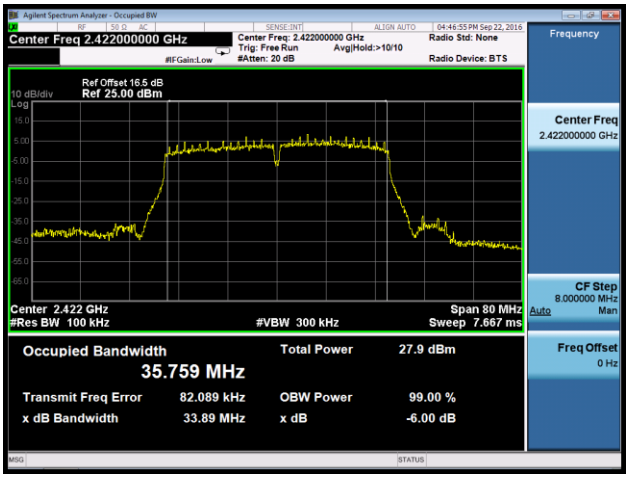
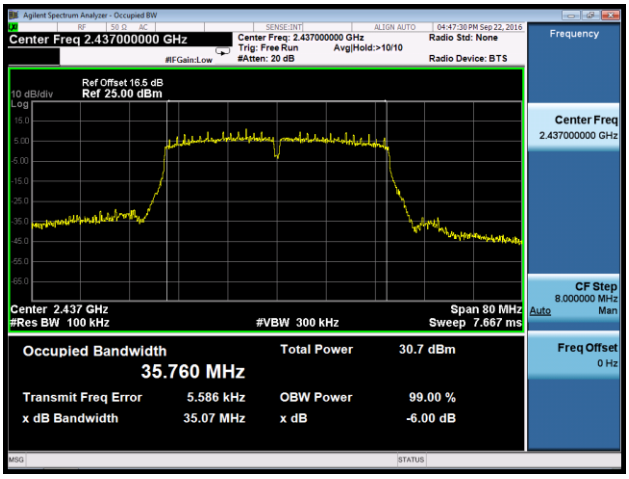
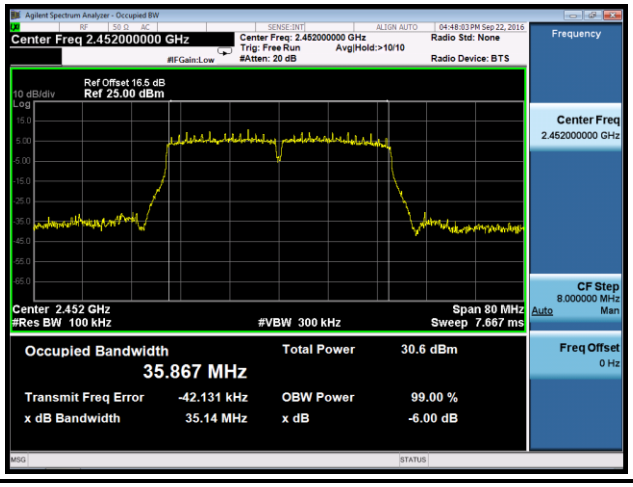
802.11n-HT20 6dB Bandwidth - Ant 2	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
Channel 11 (2462MHz)	
	

802.11n-HT40 6dB Bandwidth - Ant 2	
Channel 03 (2422MHz)	**Channel 06 (2437MHz)**
	
Channel 09 (2452MHz)	
	

802.11b 6dB Bandwidth - Ant 3	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
Channel 11 (2462MHz)	
	

802.11g 6dB Bandwidth - Ant 3	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
Channel 11 (2462MHz)	
	

802.11n-HT20 6dB Bandwidth - Ant 3	
Channel 01 (2412MHz)	**Channel 06 (2437MHz)**
	
Channel 11 (2462MHz)	
	

802.11n-HT40 6dB Bandwidth - Ant 3	
Channel 03 (2422MHz)	**Channel 06 (2437MHz)**
	
Channel 09 (2452MHz)	
	

7.3. Output Power Measurement

7.3.1.Test Limit

The maximum out power shall be less 1 Watt (30dBm).

7.3.2.Test Procedure Used

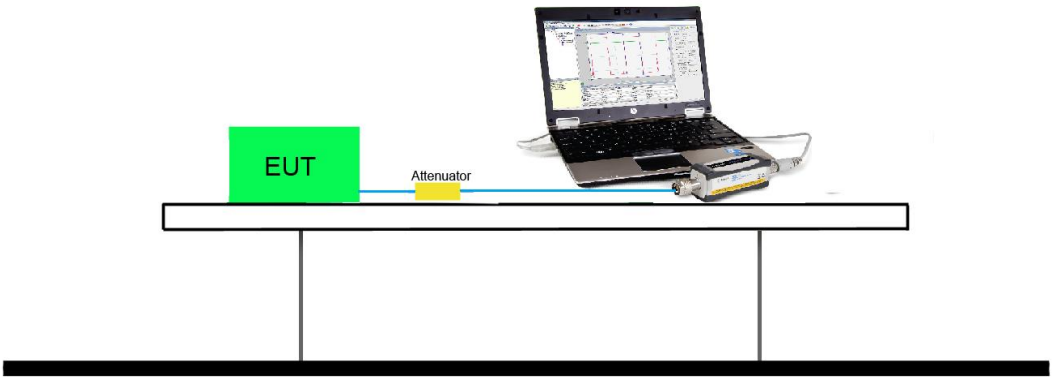
KDB 558074 D01v03r05 - Section 9.2.3.2 AVGPM-G Average Power Method

7.3.3.Test Setting

Average Power Measurement

Average power measurements were perform only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The power meter implemented triggering and gating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter. The trace was averaged over 100 traces to obtain the final measured average power.

7.3.4.Test Setup



7.3.5.Test Rate Assessment

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

N_{TX}	Data Rate (Mbps)						
	802.11b	802.11g	MCS Index for 802.11n	20MHz Bandwidth		40MHz Bandwidth	
				800ns GI	400ns GI	800ns GI	400ns GI
1	1	6	0	6.5	7.2	13.5	15.0
1	2	9	1	13.0	14.4	27.0	30.0
1	5.5	12	2	19.5	21.7	40.5	45.0
1	11	18	3	26.0	28.9	54.0	60.0
1	--	24	4	39.0	43.3	81.0	90.0
1	--	36	5	52.0	57.8	108.0	120.0
1	--	48	6	58.5	65.0	121.5	135.0
1	--	54	7	65.0	72.2	135.0	150.0
4	--	--	24	26.0	28.8	54.0	60.0
4	--	--	25	52.0	57.8	108.0	120.0
4	--	--	26	78.0	86.6	162.0	180.0
4	--	--	27	104.0	115.6	216.0	240.0
4	--	--	28	156.0	173.4	324.0	360.0
4	--	--	29	208.0	231.2	432.0	480.0
4	--	--	30	234.0	260.0	486.0	540.0
4	--	--	31	260.0	288.0	540.0	600.0

Output power at various data rates for Ant 0:

Test Mode	Bandwidth (MHz)	Channel No.	Frequency (MHz)	Data Rate (Mbps)	Average Power (dBm)
802.11b	20	6	2437	1	22.87
				5.5	22.62
				11	22.45
802.11g	20	6	2437	6	23.18
				24	22.88
				54	22.69
802.11n	20	6	2437	6.5	22.89
				52	22.60
				65	22.51
802.11n	40	6	2437	13.5	23.16
				54	22.87
				135	22.64

7.3.6.Test Result

Product	Wi-Fi AP 4x4 small omni antenna US	Temperature	25°C
Test Engineer	Johnson Liao	Relative Humidity	50 ~ 58%
Test Site	SR2	Test Date	2017/07/27
Test Item	Output Power		

Test Mode	Data Rate (Mbps)	Channel No.	Freq. (MHz)	Average Power (dBm)	Limit (dBm)	Result
Ant 0						
11b	1	1	2412	22.68	≤ 30.00	Pass
11b	1	6	2437	22.87	≤ 30.00	Pass
11b	1	11	2462	22.67	≤ 30.00	Pass
11g	6	1	2412	23.14	≤ 30.00	Pass
11g	6	6	2437	23.18	≤ 30.00	Pass
11g	6	11	2462	23.11	≤ 30.00	Pass
11n-HT20	6.5	1	2412	22.87	≤ 30.00	Pass
11n-HT20	6.5	6	2437	22.89	≤ 30.00	Pass
11n-HT20	6.5	11	2462	22.78	≤ 30.00	Pass
11n-HT40	13.5	3	2422	20.12	≤ 30.00	Pass
11n-HT40	13.5	6	2437	23.16	≤ 30.00	Pass
11n-HT40	13.5	9	2452	22.42	≤ 30.00	Pass
Ant 1						
11b	1	1	2412	23.11	≤ 30.00	Pass
11b	1	6	2437	22.72	≤ 30.00	Pass
11b	1	11	2462	22.91	≤ 30.00	Pass
11g	6	1	2412	22.93	≤ 30.00	Pass
11g	6	6	2437	22.89	≤ 30.00	Pass
11g	6	11	2462	23.02	≤ 30.00	Pass
11n-HT20	6.5	1	2412	22.30	≤ 30.00	Pass
11n-HT20	6.5	6	2437	22.66	≤ 30.00	Pass
11n-HT20	6.5	11	2462	22.75	≤ 30.00	Pass
11n-HT40	13.5	3	2422	21.54	≤ 30.00	Pass
11n-HT40	13.5	6	2437	23.02	≤ 30.00	Pass
11n-HT40	13.5	9	2452	22.99	≤ 30.00	Pass

Test Mode	Data Rate (Mbps)	Channel No.	Freq. (MHz)	Average Power (dBm)	Limit (dBm)	Result
Ant 2						
11b	1	1	2412	22.76	≤ 30.00	Pass
11b	1	6	2437	22.73	≤ 30.00	Pass
11b	1	11	2462	22.56	≤ 30.00	Pass
11g	6	1	2412	21.83	≤ 30.00	Pass
11g	6	6	2437	22.93	≤ 30.00	Pass
11g	6	11	2462	22.75	≤ 30.00	Pass
11n-HT20	6.5	1	2412	21.11	≤ 30.00	Pass
11n-HT20	6.5	6	2437	22.82	≤ 30.00	Pass
11n-HT20	6.5	11	2462	22.57	≤ 30.00	Pass
11n-HT40	13.5	3	2422	19.91	≤ 30.00	Pass
11n-HT40	13.5	6	2437	23.03	≤ 30.00	Pass
11n-HT40	13.5	9	2452	22.79	≤ 30.00	Pass
Ant 3						
11b	1	1	2412	23.03	≤ 30.00	Pass
11b	1	6	2437	23.08	≤ 30.00	Pass
11b	1	11	2462	22.86	≤ 30.00	Pass
11g	6	1	2412	23.26	≤ 30.00	Pass
11g	6	6	2437	23.32	≤ 30.00	Pass
11g	6	11	2462	23.28	≤ 30.00	Pass
11n-HT20	6.5	1	2412	23.03	≤ 30.00	Pass
11n-HT20	6.5	6	2437	23.01	≤ 30.00	Pass
11n-HT20	6.5	11	2462	22.99	≤ 30.00	Pass
11n-HT40	13.5	3	2422	20.96	≤ 30.00	Pass
11n-HT40	13.5	6	2437	23.44	≤ 30.00	Pass
11n-HT40	13.5	9	2452	23.25	≤ 30.00	Pass

Test Mode	Data Rate (Mbps)	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
Ant 0 + 1 + 2 + 3										
11b	1	1	2412	20.14	20.35	20.12	20.69	26.35	≤ 30.00	Pass
11b	1	6	2437	20.28	20.31	20.31	20.52	26.38	≤ 30.00	Pass
11b	1	11	2462	20.21	19.92	19.96	20.55	26.19	≤ 30.00	Pass
11g	6	1	2412	19.51	19.55	19.47	20.01	25.66	≤ 30.00	Pass
11g	6	6	2437	20.54	20.56	20.61	20.76	26.64	≤ 30.00	Pass
11g	6	11	2462	20.55	20.55	20.31	20.76	26.57	≤ 30.00	Pass
11n-HT20	26	1	2412	17.78	17.68	17.64	18.18	23.85	≤ 27.43	Pass
11n-HT20	26	6	2437	20.28	20.29	20.39	20.56	26.40	≤ 27.43	Pass
11n-HT20	26	11	2462	20.21	20.23	20.11	20.59	26.31	≤ 27.43	Pass
11n-HT40	54	3	2422	15.96	15.65	15.91	16.26	21.97	≤ 27.43	Pass
11n-HT40	54	6	2437	20.66	20.41	20.51	20.97	26.66	≤ 27.43	Pass
11n-HT40	54	9	2452	17.98	17.76	17.78	18.19	23.95	≤ 27.43	Pass

Note: 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).

7.4. Power Spectral Density Measurement

7.4.1.Test Limit

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

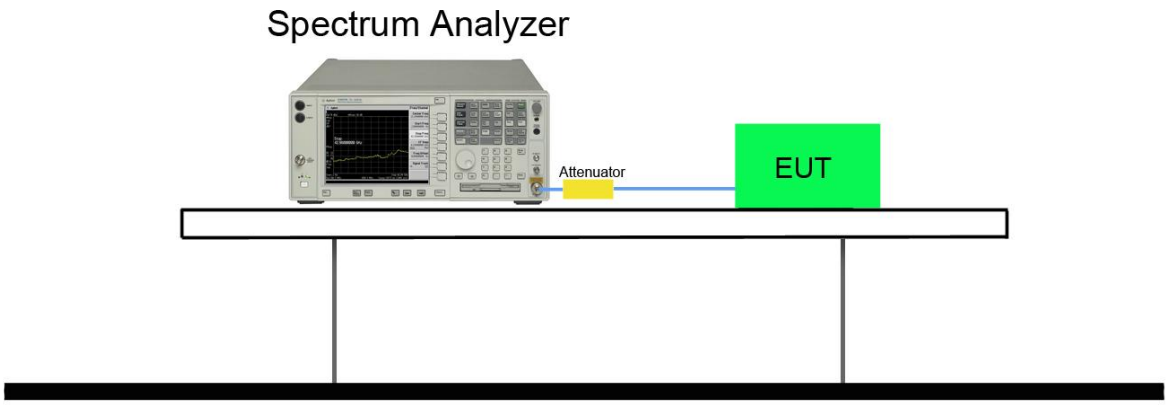
7.4.2.Test Procedure Used

KDB 558074 D01v03r05 - Section 10.5 Method AVGPSD

7.4.3.Test Setting

1. Measure the duty cycle (x) of the transmitter output signal
2. Set instrument center frequency to DTS channel center frequency.
3. Set span to at least 1.5 times the OBW.
4. RBW = 10kHz
5. VBW = 30kHz
6. Detector = RMS
7. Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW.
8. Sweep time = auto couple
9. Don’t use sweep triggering. Allow sweep to “free run”.
10. Employ trace averaging (RMS) mode over a minimum of 100 traces.
11. Use the peak marker function to determine the maximum amplitude level.
12. 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.
13. Add Constant Factor = 10*log(3kHz / 10kHz) = -5.23

7.4.4.Test Setup



7.4.5.Test Result

Product	Wi-Fi AP 4x4 OD small omni antenna US	Temperature	25°C
Test Engineer	Johnson Liao	Relative Humidity	50 ~ 58%
Test Site	SR2	Test Date	2016/12/13
Test Item	Power Spectral Density		

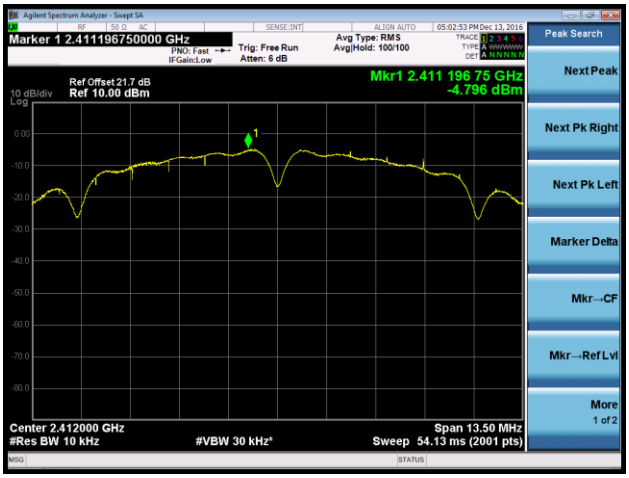
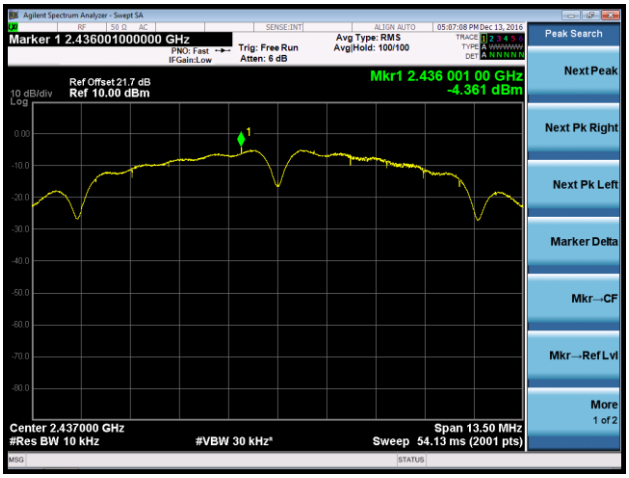
Test Mode	Data Rate (Mbps)	Channel No.	Freq. (MHz)	AVGPSD (dBm / 10kHz)	Duty Cycle (%)	Constant Factor	Total AVGPSD (dBm / 3kHz)	Limit (dBm / 3kHz)	Result
Ant 0									
11b	1	1	2412	-4.80	99.20	-5.23	-10.03	≤ 8.0	Pass
11b	1	6	2437	-4.36	99.20	-5.23	-9.59	≤ 8.0	Pass
11b	1	11	2462	-4.44	99.20	-5.23	-9.67	≤ 8.0	Pass
11g	6	1	2412	-7.46	96.04	-5.23	-12.51	≤ 8.0	Pass
11g	6	6	2437	-6.96	96.04	-5.23	-12.01	≤ 8.0	Pass
11g	6	11	2462	-7.10	96.04	-5.23	-12.15	≤ 8.0	Pass
11n-HT20	6.5	1	2412	-7.29	98.16	-5.23	-12.52	≤ 8.0	Pass
11n-HT20	6.5	6	2437	-6.78	98.16	-5.23	-12.01	≤ 8.0	Pass
11n-HT20	6.5	11	2462	-7.35	98.16	-5.23	-12.58	≤ 8.0	Pass
11n-HT40	13.5	3	2422	-13.47	97.11	-5.23	-18.57	≤ 8.0	Pass
11n-HT40	13.5	6	2437	-10.17	97.11	-5.23	-15.27	≤ 8.0	Pass
11n-HT40	13.5	9	2452	-10.91	97.11	-5.23	-16.01	≤ 8.0	Pass
Ant 1									
11b	1	1	2412	-3.34	99.20	-5.23	-8.57	≤ 8.0	Pass
11b	1	6	2437	-3.89	99.20	-5.23	-9.12	≤ 8.0	Pass
11b	1	11	2462	-4.04	99.20	-5.23	-9.27	≤ 8.0	Pass
11g	6	1	2412	-6.24	96.04	-5.23	-11.29	≤ 8.0	Pass
11g	6	6	2437	-6.39	96.04	-5.23	-11.44	≤ 8.0	Pass
11g	6	11	2462	-6.16	96.04	-5.23	-11.21	≤ 8.0	Pass
11n-HT20	6.5	1	2412	-6.54	98.16	-5.23	-11.77	≤ 8.0	Pass
11n-HT20	6.5	6	2437	-6.40	98.16	-5.23	-11.63	≤ 8.0	Pass
11n-HT20	6.5	11	2462	-6.16	98.16	-5.23	-11.39	≤ 8.0	Pass
11n-HT40	13.5	3	2422	-10.74	97.11	-5.23	-15.84	≤ 8.0	Pass
11n-HT40	13.5	6	2437	-9.56	97.11	-5.23	-14.66	≤ 8.0	Pass
11n-HT40	13.5	9	2452	-9.28	97.11	-5.23	-14.38	≤ 8.0	Pass

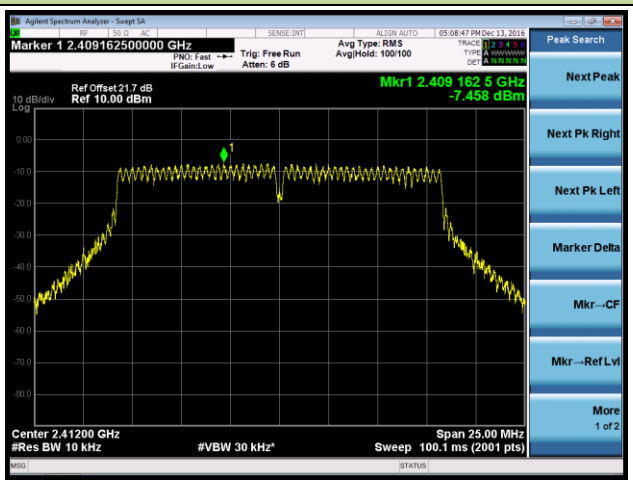
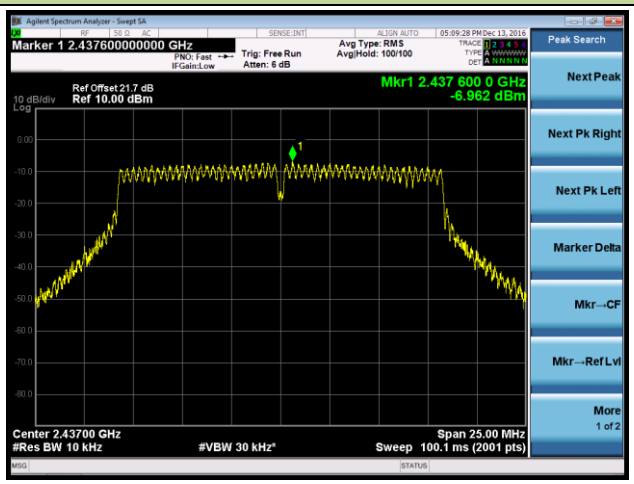
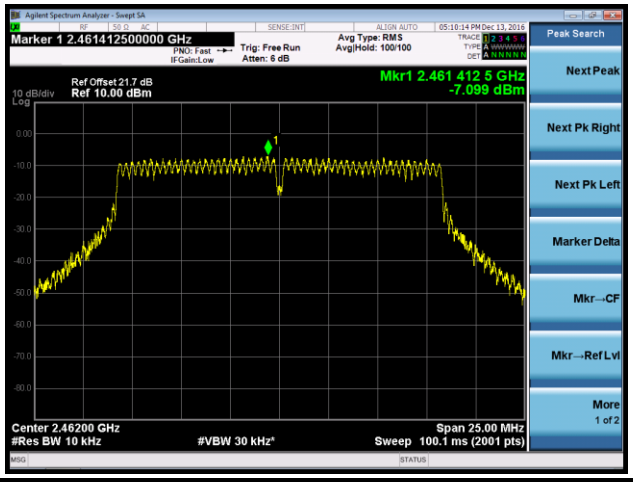
Test Mode	Data Rate (Mbps)	Channel No.	Freq. (MHz)	AVGPSD (dBm / 10kHz)	Duty Cycle (%)	Constant Factor	Total AVGPSD (dBm / 3kHz)	Limit (dBm / 3kHz)	Result
Ant 2									
11b	1	1	2412	-4.07	99.20	-5.23	-9.30	≤ 8.0	Pass
11b	1	6	2437	-3.79	99.20	-5.23	-9.02	≤ 8.0	Pass
11b	1	11	2462	-4.28	99.20	-5.23	-9.51	≤ 8.0	Pass
11g	6	1	2412	-7.16	96.04	-5.23	-12.21	≤ 8.0	Pass
11g	6	6	2437	-6.03	96.04	-5.23	-11.08	≤ 8.0	Pass
11g	6	11	2462	-6.38	96.04	-5.23	-11.43	≤ 8.0	Pass
11n-HT20	6.5	1	2412	-7.75	98.16	-5.23	-12.98	≤ 8.0	Pass
11n-HT20	6.5	6	2437	-5.98	98.16	-5.23	-11.21	≤ 8.0	Pass
11n-HT20	6.5	11	2462	-6.65	98.16	-5.23	-11.88	≤ 8.0	Pass
11n-HT40	13.5	3	2422	-12.51	97.11	-5.23	-17.61	≤ 8.0	Pass
11n-HT40	13.5	6	2437	-9.34	97.11	-5.23	-14.44	≤ 8.0	Pass
11n-HT40	13.5	9	2452	-9.59	97.11	-5.23	-14.69	≤ 8.0	Pass
Ant 3									
11b	1	1	2412	-3.57	99.20	-5.23	-8.80	≤ 8.0	Pass
11b	1	6	2437	-3.64	99.20	-5.23	-8.87	≤ 8.0	Pass
11b	1	11	2462	-3.88	99.20	-5.23	-9.11	≤ 8.0	Pass
11g	6	1	2412	-6.18	96.04	-5.23	-11.23	≤ 8.0	Pass
11g	6	6	2437	-5.98	96.04	-5.23	-11.03	≤ 8.0	Pass
11g	6	11	2462	-5.89	96.04	-5.23	-10.94	≤ 8.0	Pass
11n-HT20	6.5	1	2412	-6.25	98.16	-5.23	-11.48	≤ 8.0	Pass
11n-HT20	6.5	6	2437	-6.32	98.16	-5.23	-11.55	≤ 8.0	Pass
11n-HT20	6.5	11	2462	-5.78	98.16	-5.23	-11.01	≤ 8.0	Pass
11n-HT40	13.5	3	2422	-11.18	97.11	-5.23	-16.28	≤ 8.0	Pass
11n-HT40	13.5	6	2437	-8.80	97.11	-5.23	-13.90	≤ 8.0	Pass
11n-HT40	13.5	9	2452	-9.38	97.11	-5.23	-14.48	≤ 8.0	Pass

Test Mode	Data Rate (Mbps)	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 (%)	Constant Factor	Total AVGPSD (dBm / 3kHz)	Limit (dBm / 3kHz)	Result
Ant 0 + 1 + 2 + 3												
11b	1	1	2412	-6.68	-6.49	-6.55	-6.06	99.20	-5.23	-5.65	≤ 5.43	Pass
11b	1	6	2437	-6.18	-6.42	-6.21	-6.34	99.20	-5.23	-5.50	≤ 5.43	Pass
11b	1	11	2462	-6.59	-7.14	-6.66	-6.40	99.20	-5.23	-5.90	≤ 5.43	Pass
11g	6	1	2412	-9.76	-9.75	-9.67	-9.38	96.04	-5.23	-8.67	≤ 5.43	Pass
11g	6	6	2437	-8.39	-8.36	-8.66	-8.22	96.04	-5.23	-7.44	≤ 5.43	Pass
11g	6	11	2462	-8.67	-8.49	-8.84	-7.99	96.04	-5.23	-7.52	≤ 5.43	Pass
11n-HT20	26	1	2412	-11.69	-11.34	-11.02	-10.53	98.16	-5.23	-10.33	≤ 5.43	Pass
11n-HT20	26	6	2437	-8.58	-8.34	-8.49	-8.28	98.16	-5.23	-7.63	≤ 5.43	Pass
11n-HT20	26	11	2462	-9.00	-8.05	-8.37	-8.62	98.16	-5.23	-7.71	≤ 5.43	Pass
11n-HT40	54	3	2422	-16.60	-16.80	-16.63	-15.80	97.11	-5.23	-15.52	≤ 5.43	Pass
11n-HT40	54	6	2437	-11.67	-11.88	-11.44	-11.28	97.11	-5.23	-10.64	≤ 5.43	Pass
11n-HT40	54	9	2452	-14.84	-14.39	-14.56	-14.24	97.11	-5.23	-13.58	≤ 5.43	Pass

Note 1: When EUT duty cycle < 98%, the total AVGPSD = $10*\log\{10^{(\text{Ant 0 AVGPSD}/10)} + 10^{(\text{Ant 1 AVGPSD}/10)} + 10^{(\text{Ant 2 AVGPSD}/10)} + 10^{(\text{Ant 3 AVGPSD}/10)}\}$ + 10*log(1/duty cycle) + Constant Factor.

Note 2: When EUT duty cycle > 98%, the total AVGPSD = $10*\log\{10^{(\text{Ant 0 AVGPSD}/10)} + 10^{(\text{Ant 1 AVGPSD}/10)} + 10^{(\text{Ant 2 AVGPSD}/10)} + 10^{(\text{Ant 3 AVGPSD}/10)}\}$ + Constant Factor.

Galtronics Omni Antenna	
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)