



FCC PART 15, SUBPART C
ISED C RSS-247, ISSUE 2, FEBRUARY 2017

TEST REPORT

For

Roku, Inc.

150 Winchester Circle,
Los Gatos, CA 95032, USA

FCC ID: TC2-R1018
IC: 5959A-R1018

Report Type: Original Report	Model: 3810X
Prepared By: Troy Pandhumsoporn Test Engineer	
Report Number: R1706262-247	
Report Date: 2017-08-08	
Reviewed By: Jin Yang RF Engineer	
Bay Area Compliance Laboratories Corp. 1274 Anvilwood Avenue, Sunnyvale, CA 94089, USA Tel: (408) 732-9162 Fax: (408) 732-9164	

Note: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This report **must not** be used by the customer to claim product certification, approval, or endorsement by A2LA*, NIST, or any agency of the Federal Government.

* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk “*” (Rev. 0)

TABLE OF CONTENTS

1 General Description.....	5
1.1 Product Description for Equipment Under Test (EUT)	5
1.2 Objective.....	5
1.3 Related Submittal(s)/Grant(s)	5
1.4 Test Methodology	5
1.5 Measurement Uncertainty	5
1.6 Test Facility Registrations	6
1.7 Test Facility Accreditations	6
2 System Test Configuration.....	9
2.1 Justification.....	9
2.2 EUT Exercise Software.....	9
2.3 Duty Cycle Correction Factor	10
2.4 Equipment Modifications.....	13
2.5 Local Support Equipment	13
2.6 Support Equipment	13
2.7 Interface Ports and Cabling.....	13
3 Summary of Test Results	14
4 FCC §15.203& ISED RSS-Gen §8.3 - Antenna Requirements	15
4.1 Applicable Standards	15
4.2 Antenna Description	16
5 FCC §2.1091, §15.247(i) & ISED RSS-102 - RF Exposure.....	17
5.1 Applicable Standard.....	17
5.2 MPE Prediction.....	18
5.3 MPE Results	18
5.4 RF exposure evaluation exemption for ISED.....	18
6 FCC §15.207 & ISED RSS-Gen §8.8 - AC Line Conducted Emissions.....	19
6.1 Applicable Standards	19
6.2 Test Setup	19
6.3 Test Procedure	19
6.4 Corrected Amplitude and Margin Calculation.....	20
6.5 Test Setup Block Diagram.....	20
6.6 Test Equipment List and Details.....	21
6.7 Test Environmental Conditions	21
6.8 Summary of Test Results	21
6.9 Conducted Emissions Test Plots and Data.....	22
7 FCC §15.209, §15.247(d) & ISED RSS-247 §5.5, RSS-Gen §8.9, §8.10 - Spurious Radiated Emissions.....	24
7.1 Applicable Standards	24
7.2 Test Setup	26
7.3 Test Procedure	26
7.4 Corrected Amplitude and Margin Calculation.....	26
7.5 Test Equipment List and Details.....	27
7.6 Test Environmental Conditions	27
7.7 Summary of Test Results	28
7.8 Radiated Emissions Test Results	29
8 FCC §15.247(a) (2) & ISED RSS-247 §5.2 -Emission Bandwidth	36
8.1 Applicable Standards	36
8.2 Measurement Procedure.....	36
8.3 Test Equipment List and Details.....	36
8.4 Test Environmental Conditions	36
8.5 Test Results.....	37
9 FCC §15.247(b) (3) & ISED RSS-247 §5.4 (4) - Output Power Measurement	55
9.1 Applicable Standards	55

9.2	Measurement Procedure.....	55
9.3	Test Equipment List and Details.....	55
9.4	Test Environmental Conditions	55
9.5	Test Results.....	56
10	FCC §15.247(d) & ISERC RSS-247 §5.5 - 100 kHz Bandwidth of Band Edges.....	57
10.1	Applicable Standards	57
10.2	Measurement Procedure.....	57
10.3	Test Equipment List and Details.....	57
10.4	Test Environmental Conditions	57
10.5	Test Results.....	58
11	FCC §15.247(e) & ISERC RSS-247 §5.2(2) - Power Spectral Density	62
11.1	Applicable Standards	62
11.2	Measurement Procedure.....	62
11.3	Test Equipment List and Details.....	62
11.4	Test Environmental Conditions	62
11.5	Test Results.....	63
12	FCC §15.247(d) & ISERC RSS-247 §5.5, RSS-GEN §8.9 - Spurious Emissions at Antenna Terminals	72
12.1	Applicable Standards	72
12.2	Test Procedure	72
12.3	Test Equipment List and Details.....	72
12.4	Test Environmental Conditions	73
12.5	Test Results.....	73
13	Annex A (Informative) - A2LA Electrical Testing Certificate.....	89

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1706262-247	Original Report	2017-08-08

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Roku, Inc.*, and their product model: 3810X. FCC ID: TC2-R1018, IC: 5959A-R1018 or the “EUT” as referred to in this report.

1.2 Objective

This report is prepared on behalf of *Roku, Inc.*, in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission’s rules and ISEDC RSS-247 Issue 2, February 2017.

The objective is to determine compliance with FCC Part 15.247 and ISEDC RSS-247 rules for Output Power, Antenna Requirements, 99% and 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

1.3 Related Submittal(s)/Grant(s)

FCC Part 15, Subpart E, Equipment NII with FCC ID: TC2-R1018, IC: 5959A-R1018 Report: R1706262-407
FCC Part 15, Subpart E, Equipment NII with FCC ID: TC2-RCB14, IC: 5959A-RCB14 Report: R1706263-407
FCC Part 15, Subpart C, Equipment DTS with FCC ID: TC2-RCB14, IC: 5959A-RCB14 report: R1706263-247

1.4 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

1.5 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Parameter	Measurement uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.57 dB
Power Spectral Density, conducted	±1.48dB
Unwanted Emissions, conducted	±1.57dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 ° C
Humidity	±5 %
DC and low frequency voltages	±1.0 %
Time	±2 %
Duty Cycle	±3 %

1.6 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

1.7 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2005 by A2LA (Test Laboratory Accreditation Certificate Number 3279.02), in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3279.03) to certify

- For the USA (Federal Communications Commission):

- 1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
- 2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
- 3- All Telephone Terminal Equipment within FCC Scope C.

- For the Canada (Industry Canada):

- 1 All Scope 1-Licence-Exempt Radio Frequency Devices;
- 2 All Scope 2-Licensed Personal Mobile Radio Services;
- 3 All Scope 3-Licensed General Mobile and Fixed Radio Services;
- 4 All Scope 4-Licensed Maritime and Aviation Radio Services;
- 5 All Scope 5-Licensed Fixed Microwave Radio Services
- 6 All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.

- For Singapore (Info-Communications Development Authority (IDA)):

- 1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2

2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2
- For the Hong Kong Special Administrative Region:
 - 1 All Radio Equipment, per KHCA 10XX-series Specifications;
 - 2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
 - 3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
 - 1 MIC Telecommunication Business Law (Terminal Equipment):
 - All Scope A1 - Terminal Equipment for the Purpose of Calls;
 - All Scope A2 - Other Terminal Equipment
 - 2 Radio Law (Radio Equipment):
 - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
 - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
 - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

C- A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3279.01) to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:

- 1 Electronics and Office Equipment:
 - for Telephony (ver. 3.0)
 - for Audio/Video (ver. 3.0)
 - for Battery Charging Systems (ver. 1.1)
 - for Set-top Boxes and Cable Boxes (ver. 4.1)
 - for Televisions (ver. 6.1)
 - for Computers (ver. 6.0)
 - for Displays (ver. 6.0)
 - for Imaging Equipment (ver. 2.0)
 - for Computer Servers (ver. 2.0)
- 2 Commercial Food Service Equipment
 - for Commercial Dishwashers (ver. 2.0)
 - for Commercial Ice Machines (ver. 2.0)
 - for Commercial Ovens (ver. 2.1)
 - for Commercial Refrigerators and Freezers
- 3 Lighting Products
 - For Decorative Light Strings (ver. 1.5)
 - For Luminaires (including sub-components) and Lamps (ver. 1.2)
 - For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
 - For Integral LED Lamps (ver. 1.4)
- 4 Heating, Ventilation, and AC Products
 - for Residential Ceiling Fans (ver. 3.0)
 - for Residential Ventilating Fans (ver. 3.2)
- 5 Other
 - For Water Coolers (ver. 3.0)

D- A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (Industry Canada - ISED) Foreign Certification Body – FCB – APEC Tel MRA -Phase I and Phase II;

- Chinese Taipei (Republic of China – Taiwan):
 - o BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
 - o NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
 - o EMC Directive 2004/108/EC US-EU EMC and Telecom MRA CAB
 - o Radio and Teleterminal Equipment (RandTTE) Directive 1995/5/EC
US -EU EMC and Telecom MRA CAB
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA)
APEC Tel MRA -Phase I and Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Development Authority - IDA) APEC Tel MRA -Phase I and Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
 - o ENERGY STAR Recognized Test Laboratory – US EPA
 - o Telecommunications Certification Body (TCB) – US FCC;
- Vietnam: APEC Tel MRA -Phase I;

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.10-2013 and FCC KDB 558074 D01 DTS Meas Guidance v04.

The EUT was tested in a testing mode to represent worst-case results during the final qualification test.

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power, peak power and PPSS across all data rates bandwidths, and modulations.

2.2 EUT Exercise Software

The test firmware used was Putty provided by *Roku, Inc.*, the software is compliant with the standard requirements being tested against.

Modulation	Frequency (MHz)	Power Setting
b	2412	63
	2437	63
	2462	63
g	2412	59
	2437	63
	2462	56
n20	2412	59
	2437	63
	2462	56

Data Rates Tested:

802.11b mode: 1Mbps

802.11g mode: 6Mbps

802.11n HT20 mode: HTMCS0

2.3 Duty Cycle Correction Factor

According to KDB 558074 D01 DTS Meas Guidance v04 section 6.0:

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (T) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed T at any time that data is being acquired (i.e., no transmitter off-time is to be considered).

Radio Mode	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11b	100	0
802.11g	100	0
802.11n20	100	0
802.11n20 (MIMO)	100	0

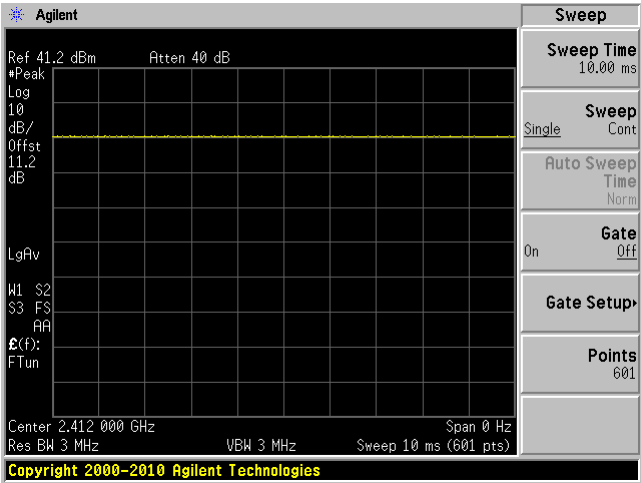
Duty Cycle = On Time (ms)/ Period (ms)

Duty Cycle Correction Factor (dB) = $10 \cdot \log(1/\text{Duty Cycle})$

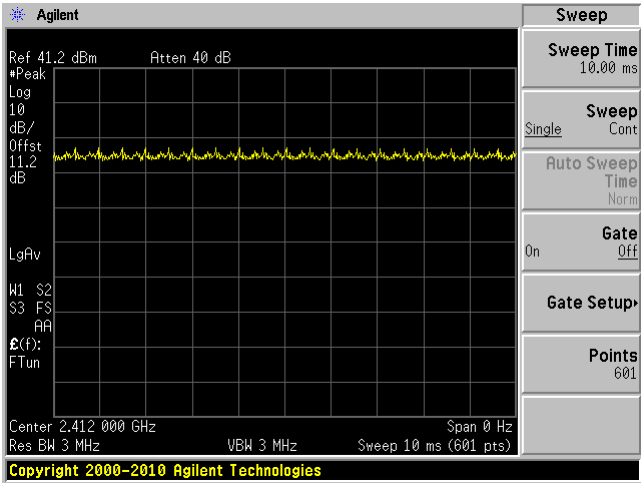
Please refer to the following plots.

Antenna Port 0

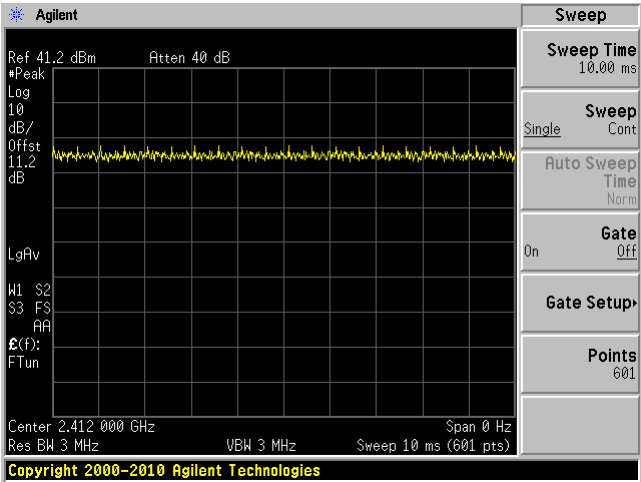
802.11b mode



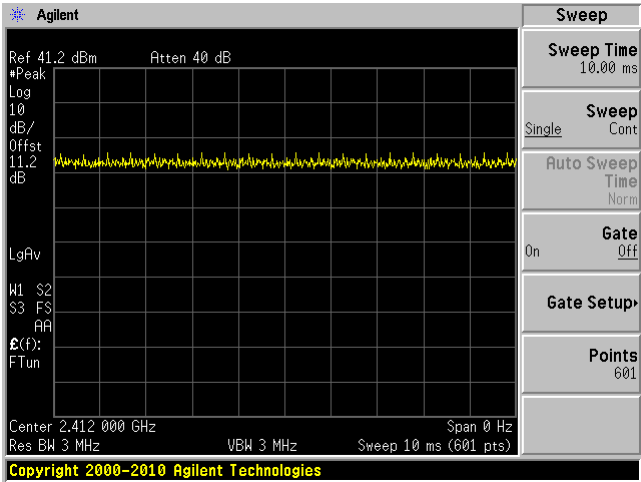
802.11g mode



802.11n20 mode

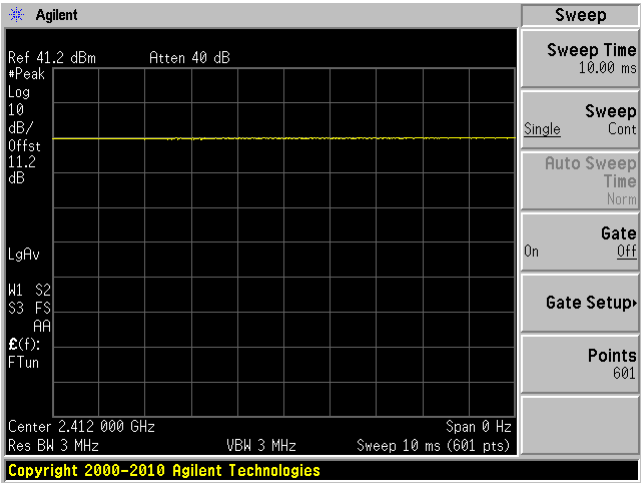


802.11 n20 mode MIMO

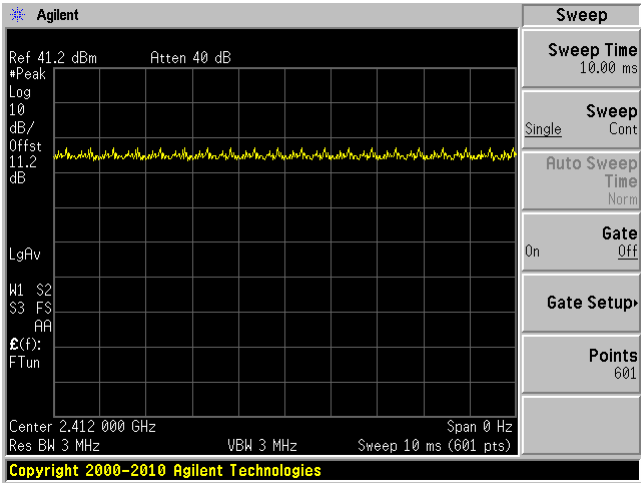


Antenna Port 1

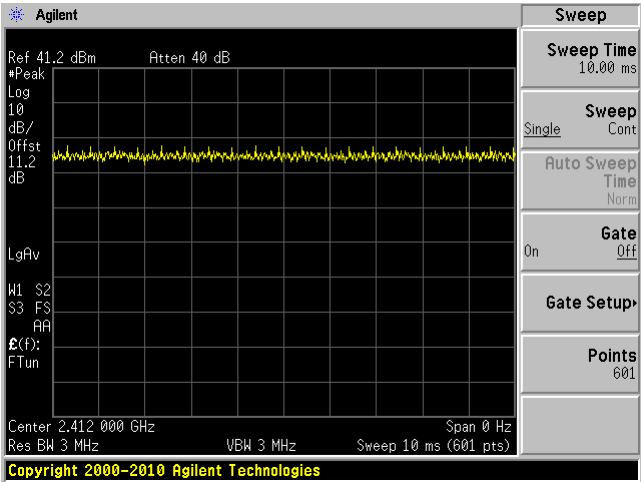
802.11b mode



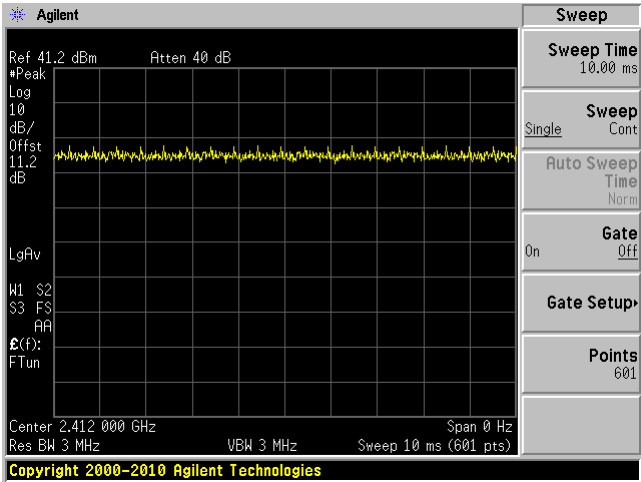
802.11g mode



802.11n20 mode



802.11 n20 mode MIMO



2.4 Equipment Modifications

N/A

2.5 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E6410

2.6 Support Equipment

Manufacturer	Description
Roku	Debug Board (Apollo)

2.7 Interface Ports and Cabling

Cable Description	Length (m)	To	From
USB 2.0 A-Male to B-Male	2 m	Laptop	EUT
RF Cable	< 1 m	EUT	PSA
Roku Switching (DC) Adapter	< 2 m	EUT	Power Outlet

3 Summary of Test Results

Results reported relate only to the product tested.

FCC and ISED Rules	Description of Test	Results
FCC §15.203 ISED RSS-Gen §8.3	Antenna Requirement	Compliant
FCC §15.207 ISED RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §2.1091, §15.247(i) ISED RSS-102	RF Exposure	Compliant ¹
FCC §2.1051, §15.247 (d) ISED RSS-247 §5.5	Spurious Emissions at Antenna Port	Compliant
FCC §2.1053, §15.205, §15.209, §15.247 (d) ISED RSS-247 §5.5 ISED RSS-Gen §8.9 and §8.10	Radiated Spurious Emissions	Compliant
FCC §15.247(a)(2) ISED RSS-247 §5.2 (1)	6 dB and 99% Emission Bandwidth	Compliant
FCC §15.247(b)(3) ISED RSS-247 §5.4 (4)	Maximum Peak Output Power	Compliant
FCC §15.247(d) ISED RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(e) ISED RSS-247 §5.2 (2)	Power Spectral Density	Compliant

4 FCC §15.203& ISEDC RSS-Gen §8.3 - Antenna Requirements

4.1 Applicable Standards

According to FCC §15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

And according to FCC §15.247 (b) (4), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to ISEDC RSS-Gen §8.3: Transmitter Antenna

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the license-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

License-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotopically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the license-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of license-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. ⁹ When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

4.2 Antenna Description

The antennas used by the EUT are permanent attached antennas.

Antenna usage	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
Wi-Fi	2400	-0.8
Wi-Fi	2442	-0.6
Wi-Fi	2485	-0.6

5 FCC §2.1091, §15.247(i) & ISEDC RSS-102 - RF Exposure

5.1 Applicable Standard

According to FCC §15.247(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* (100)	30
1.34-30	824/f	2.19/f	* (180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

According to ISEDC RSS-102 Issue 5:

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz⁶ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

5.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density

P = power input to antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

5.3 MPE Results

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>20.68</u>
<u>Maximum peak output power at antenna input terminal (mW):</u>	<u>116.95</u>
<u>Prediction distance (cm):</u>	<u>20</u>
<u>Prediction frequency (MHz):</u>	<u>2412</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>-0.8</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>0.83</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm²):</u>	<u>0.0193</u>
<u>MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.0193 mW/cm². Limit is 1.0 mW/cm².

5.4 RF exposure evaluation exemption for ISEDC

$$20.68 + (-0.8) \text{ dBi} = 19.88 \text{ dBm} < 1.31 \times 10^{-2} f^{0.6834} = 2.68 \text{ W} = 34.29 \text{ dBm}$$

Therefore the RF exposure is not required.

6 FCC §15.207 & ISEDC RSS-Gen §8.8 - AC Line Conducted Emissions

6.1 Applicable Standards

As per FCC §15.207 and ISEDC RSS-Gen §8.8 Conducted limits:

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 ^{Note1}	56 to 46 ^{Note2}
0.5-5	56	46
5-30	60	50

Note1: Decreases with the logarithm of the frequency.

Note2: A linear average detector is required

6.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.10-2013 measurement procedure. The specification used were FCC §15.207 and ISEDC RSS-Gen §8.8 limits.

External I/O cables were draped along the edge of the test table and bundle when necessary.

The AC/DC power adapter of the EUT was connected with LISN-1 which provided 120 V / 60 Hz AC power.

6.3 Test Procedure

During the conducted emissions test, the power cord of the EUT host system was connected to the mains outlet of the LISN-1 and the power cords of support equipment were connected to LISN-2.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data were recorded in the peak, quasi-peak, and average detection mode. Quasi-Peak readings are distinguished with a "QP." Average readings are distinguished with an "Ave".

6.4 Corrected Amplitude and Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Cable Loss (CL), the Attenuator Factor (Atten) to indicated Amplitude (Ai) reading. The basic equation is as follows:

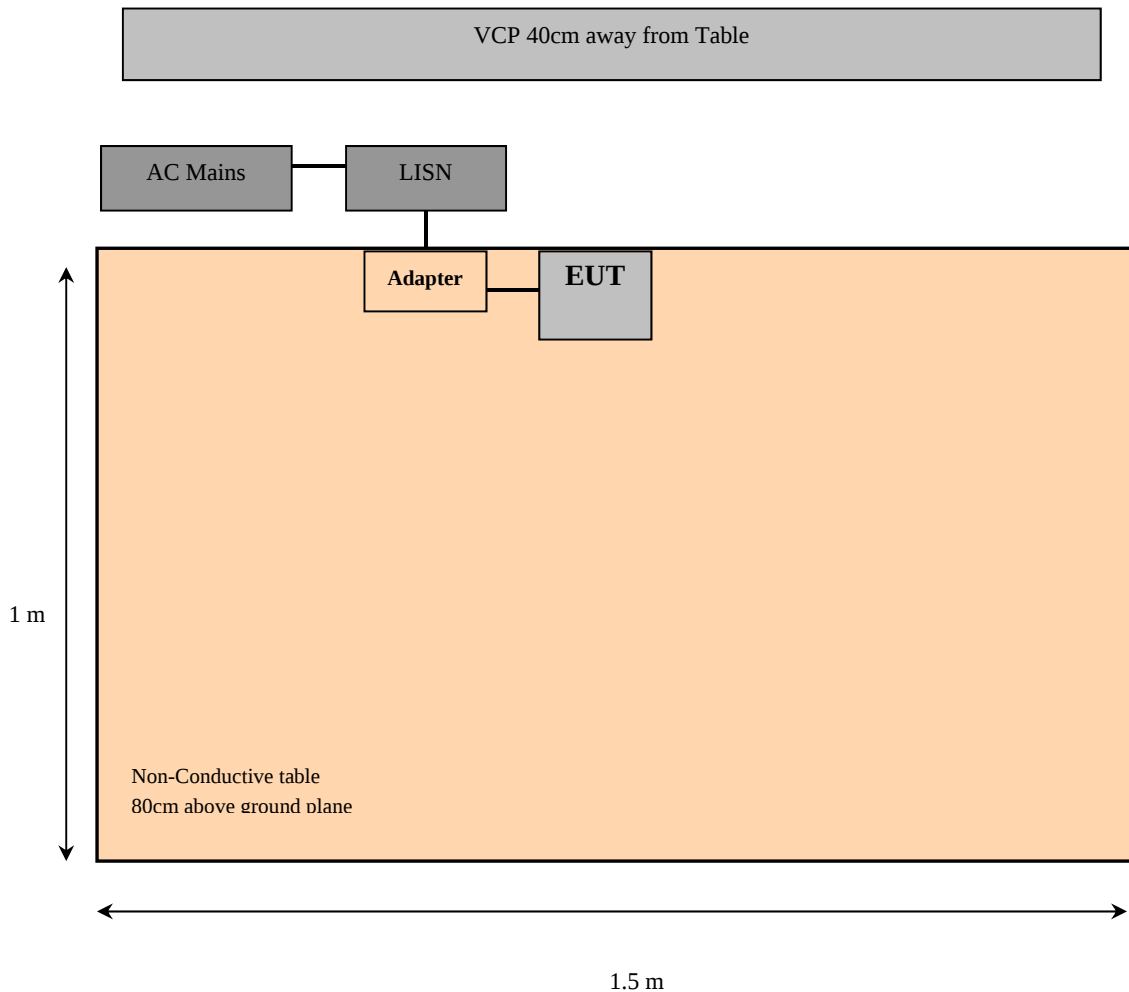
$$CA = A_i + CL + \text{Atten}$$

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Cable Loss (3.7 dB) + Attenuator (10 dB)

The “**Margin**” column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corrected Amplitude} - \text{Limit}$$

6.5 Test Setup Block Diagram



6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2016-02-04	2 years
Rohde and Schwarz	Impulse Limiter	ESH3-Z2	101964	2017-07-25	1 year
Keysight Technologies	RF Limiter	11867A	MY42242931	2017-01-12	1 year
Solar Electronics Company	High Pass Filter	Type 7930-100	7930150204	2017-03-13	1 year
Suirong	30 ft conductive emission cable	LMR 400	-	N/R	N/A
FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2017-04-24	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Statement of Traceability: *BACL Corp.* attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

6.7 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	101.31 kPa

The testing was performed by Troy Pandhumsoporn on 2017-08-02 in 5 chamber 3.

6.8 Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC 15C and ISEDC RSS-Gen standard's conducted emissions limits, with the margin reading of:

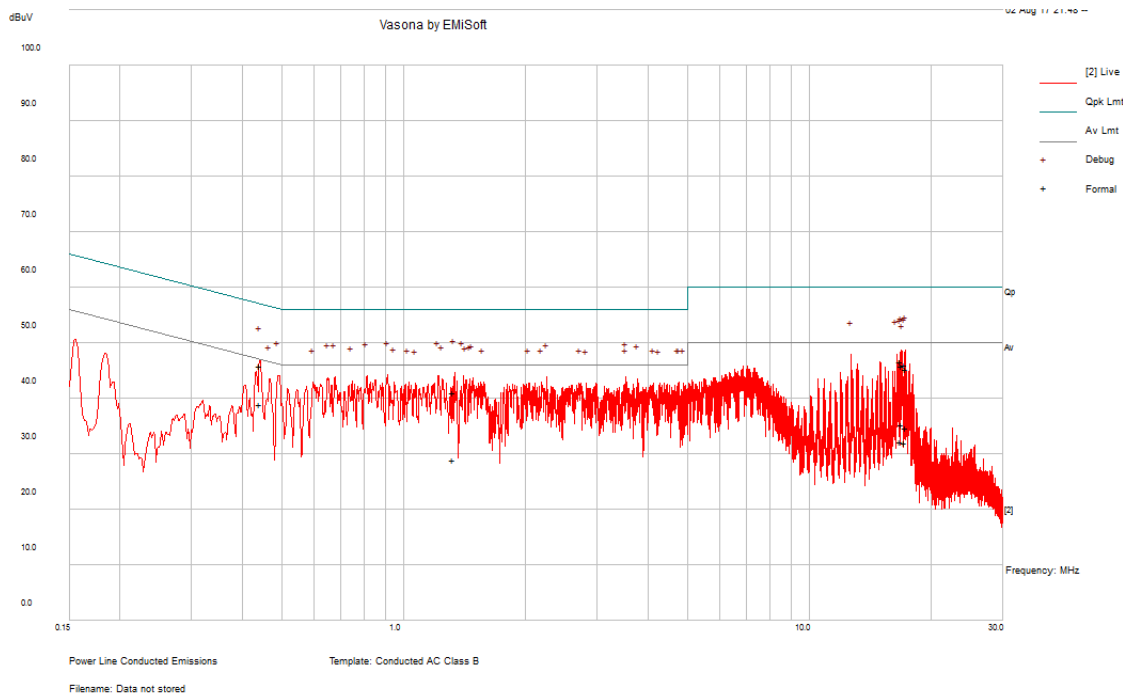
2.4 GHz Wi-Fi

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	Frequency (MHz)	Conductor Mode (Line/Neutral)	Range (MHz)
-8.13	0.442722	Line	30.97

6.9 Conducted Emissions Test Plots and Data

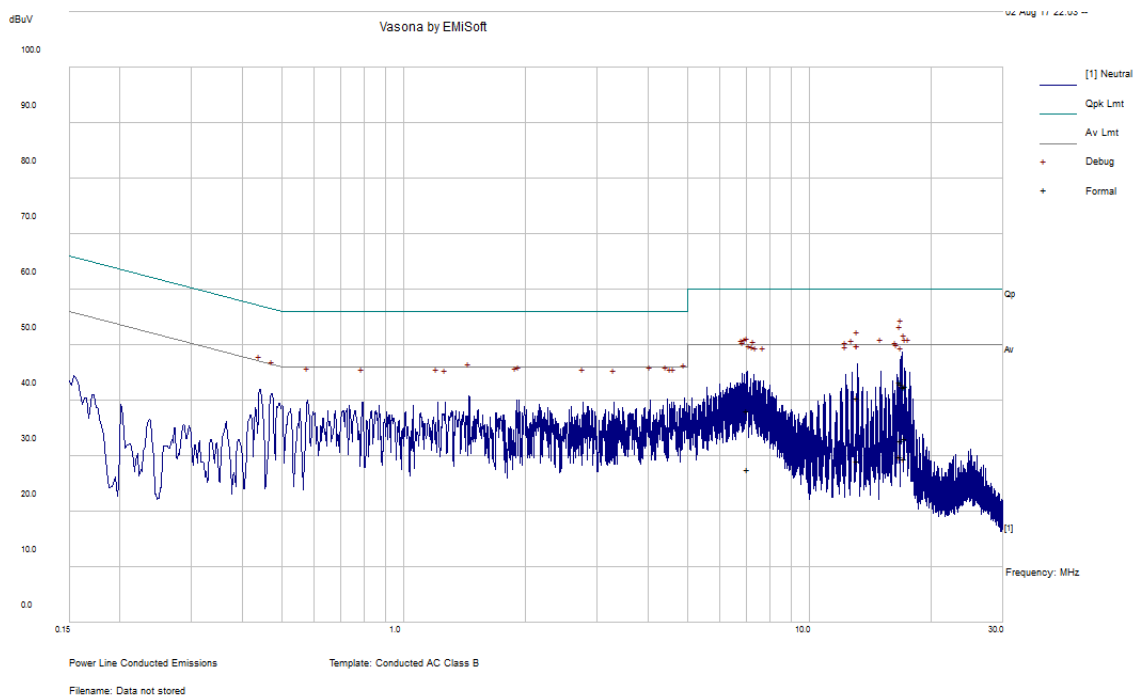
2.4 GHz Wi-Fi: B mode, 2412 MHz, Ant 0

120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.442722	45.86	Line	57.01	-11.15	QP
17.25081	46.05	Line	60	-13.95	QP
16.87579	46.15	Line	60	-13.85	QP
1.349575	41.06	Line	56	-14.94	QP
17.14277	45.9	Line	60	-14.1	QP
16.77364	46.65	Line	60	-13.35	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.442722	38.88	Line	47.01	-8.13	Ave.
17.25081	35.51	Line	50	-14.49	Ave.
16.87579	35.29	Line	50	-14.71	Ave.
1.349575	28.36	Line	46	-17.64	Ave.
17.14277	31.88	Line	50	-18.12	Ave.
16.77364	32.45	Line	50	-17.55	Ave.

120 V, 60 Hz – Neutral

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
16.87674	43.09	Neutral	60	-16.91	QP
16.77174	43.47	Neutral	60	-16.53	QP
13.12922	40.51	Neutral	60	-19.49	QP
17.14575	42.52	Neutral	60	-17.48	QP
7.042664	38.25	Neutral	60	-21.75	QP
17.24989	42.54	Neutral	60	-17.46	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
16.87674	32.82	Neutral	50	-17.18	Ave.
16.77174	30	Neutral	50	-20	Ave.
13.12922	29.08	Neutral	50	-20.92	Ave.
17.14575	29.64	Neutral	50	-20.36	Ave.
7.042664	27.59	Neutral	50	-22.41	Ave.
17.24989	33.21	Neutral	50	-16.79	Ave.

7 FCC §15.209, §15.247(d) & ISEDC RSS-247 §5.5, RSS-Gen §8.9, §8.10 - Spurious Radiated Emissions

7.1 Applicable Standards

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As Per FCC §15.205(a) and RSS-Gen except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	960 – 1240	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5.35 – 5.46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 – 167.17	3.332 – 3.339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3.3458 – 3.358	23.6 – 24.0
12.29 – 12.293	240 – 285	3.600 – 4.400	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4		36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz.

However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per FCC §15.247 (d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

As per ISED RSS-Gen 8.9,

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 or Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	Field Strength ($\mu\text{V/m}$ at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960*	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for license-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

As per ISED RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

7.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.10-2013. The specification used was the FCC 15 Subpart C and ISEDC RSS-247 limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

7.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords were connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT was set 3 meter away from the testing antenna, which was varied from 1-4 meter, and the EUT was placed on a turntable, which was 0.8 meter and 1.5 meter above the ground plane for below and above 1000 MHz measurements, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna's polarity should be changed between horizontal and vertical.

The spectrum analyzer or receiver was set as:

Below 1000 MHz:

$$\text{RBW} = 100 \text{ kHz} / \text{VBW} = 300 \text{ kHz} / \text{Sweep} = \text{Auto}$$

Above 1000 MHz:

(1) Peak: $\text{RBW} = 1\text{MHz} / \text{VBW} = 1\text{MHz} / \text{Sweep} = \text{Auto}$

(2) Average: $\text{RBW} = 1\text{MHz} / \text{VBW} = 10\text{Hz} / \text{Sweep} = \text{Auto}$

7.4 Corrected Amplitude and Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to indicated Amplitude (Ai) reading. The basic equation is as follows:

$$\text{CA} = \text{Ai} + \text{AF} + \text{CL} + \text{Atten} - \text{Ga}$$

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

The “**Margin**” column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corrected Amplitude} - \text{Limit}$$

7.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2016-02-04	2 years
Agilent	Analyzer, Spectrum	E4446A	US44300386	2017-04-20	1 year
Sunol Sciences	System Controller	SC99V	011003-1	N/R	N/A
Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2016-07-11	2 years
EMCO	Antenna, Horn	3115	9511-4627	2016-01-28	2 years
Agilent	Amplifier, Pre	8447D	2944A06639	2017-06-28	1 year
IW	AOBOR Hi frequency Co AX Cable	DC 1531	KPS- 1501A3960KPS	2016-08-05	1 year
-	SMA cable	-	C0002	Each time ¹	N/A
-	N-Type Cable	-	C00012	Each time ¹	N/A
-	N-Type Cable	-	C00014	Each time ¹	N/A
Agilent	Pre-Amplifier	8449B	3008A01978	2016-10-06	1 year
Sunol Sciences	Antenna, Horn	DRH-118	A052704	2017-03-27	2 years
A.R.A.	Antenna, Horn	DRG-118/A	1132	2015-09-21	2 years
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL attests that all calibrations have been performed per the A2LA requirements, traceable to NIST.*

7.6 Test Environmental Conditions

Temperature:	20-23 °C
Relative Humidity:	42-50 %
ATM Pressure:	102.7 kPa

The testing was performed by Frank Wang and Troy Pandhumsoporn on 2017-07-26 to 2017-08-02 in 5m chamber 3.

7.7 Summary of Test Results

According to the data hereinafter, the EUT complied with FCC Title 47, Part 15C and ISEDC RSS-247 standard's radiated emissions limits, and had the worst margin of:

2.4 GHz Wi-Fi

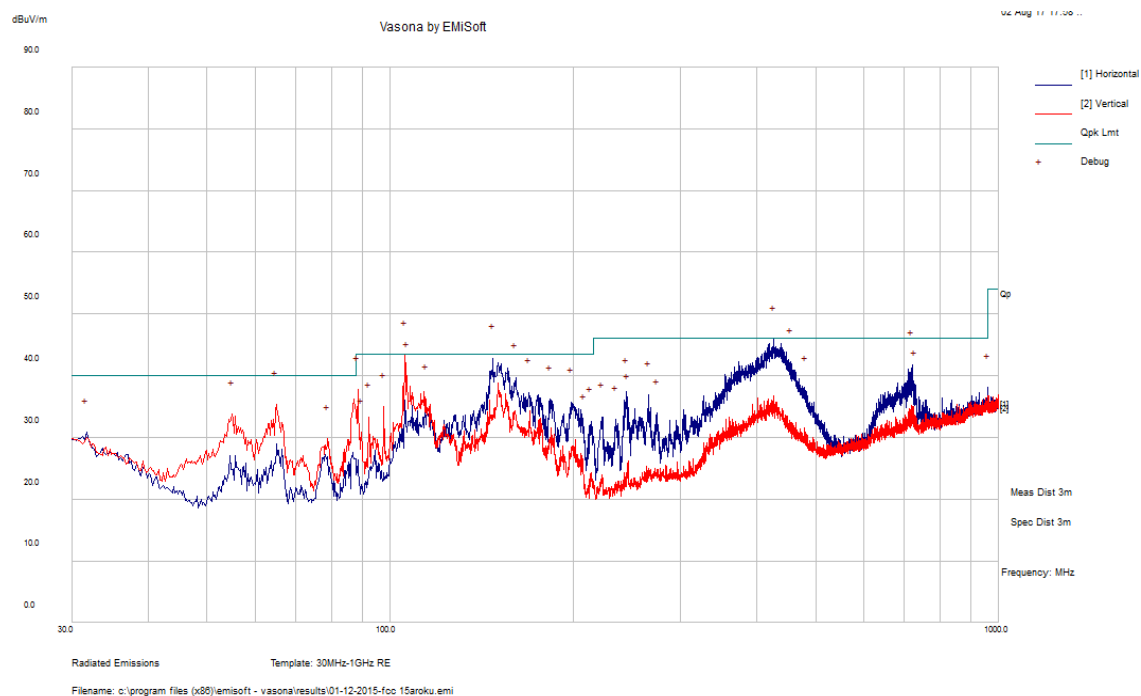
Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Mode, channel
-0.297	2483.5	Horizontal	n mode, high channel

Please refer to the following table and plots for specific test result details

7.8 Radiated Emissions Test Results

1) 30 MHz – 1 GHz Worst Case, Measured at 3 meters

2.4 GHz Wi-Fi



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comment
427.1825	40.53	101	H	27	46	-5.47	QP
105.744	40.85	125	V	255	43.5	-2.65	QP
147.3688	36.73	208	H	129	43.5	-6.77	QP
106.5453	36.32	111	V	181	43.5	-7.18	QP
160.591	34.12	144	H	119	43.5	-9.38	QP
455.366	36.89	239	H	29	46	-9.11	QP

Note 1: Only 6 emissions were present because the other emissions were 20 dB below the limit

2) 1–25 GHz Measured at 3 meters

After the pre-scan, the worst case for each mode has been selected for the formal tested as below,

802.11b mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISED		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2412	76.08	113	141	H	29.042	6.29	0	111.412	-	-	PK
2412	72.2	113	141	H	29.042	6.29	0	107.532	-	-	AV
2412	69.39	83	212	V	29.042	6.29	0	104.722	-	-	PK
2412	65.28	83	212	V	29.042	6.29	0	100.612	-	-	AV
2390	28.42	0	100	H	29.042	6.29	0	63.752	74	-10.248	PK
2390	12.47	0	100	H	29.042	6.29	0	47.802	54	-6.198	AV
2390	27.47	0	100	V	29.042	6.29	0	62.802	74	-11.198	PK
2390	13.07	0	100	V	29.042	6.29	0	48.402	54	-5.598	AV
4824	53.21	150	100	H	32.472	8.416	38.56	55.538	74	-18.462	PK
4824	47	150	100	H	32.472	8.416	38.56	49.328	54	-4.672	AV
7236	46.13	0	100	H	36.69	10.211	37.9	55.131	74	-18.869	PK
7236	31.29	0	100	H	36.39	10.211	37.9	39.991	54	-14.009	AV
9648	44.61	0	100	H	37.77	11.621	38.29	55.711	74	-18.289	PK
9648	30.25	0	100	H	37.77	11.621	38.29	41.351	54	-12.649	AV
Middle Channel 2437 MHz											
2437	68.55	142	106	H	29.042	6.29	0	103.882	-	-	PK
2437	64.46	142	106	H	29.042	6.29	0	99.792	-	-	AV
2437	60.34	83	100	V	29.042	6.29	0	95.672	-	-	PK
2437	56.1	83	100	V	29.042	6.29	0	91.432	-	-	AV
4874	46.49	0	100	H	32.64	8.416	38.54	49.006	74	-24.994	PK
4874	31.92	0	100	H	32.64	8.416	38.54	34.436	54	-19.564	AV
7311	45.97	0	100	H	37.148	10.211	37.9	55.429	74	-18.571	PK
7311	30.495	0	100	H	37.148	10.211	37.9	39.954	54	-14.046	AV
9748	44.41	0	100	H	37.92	11.621	38.29	55.661	74	-18.339	PK
9748	29.37	0	100	H	37.92	11.621	38.29	40.621	54	-13.379	AV

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/ISED		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
High Channel 2462 MHz											
2462	77.73	242	154	H	29.413	6.29	0	113.433	-	-	PK
2462	73.89	242	154	H	29.413	6.29	0	109.593	-	-	AV
2462	68.97	113	105	V	29.413	6.29	0	104.673	-	-	PK
2462	64.92	113	105	V	29.413	6.29	0	100.623	-	-	AV
2483.5	28.7	251	100	H	29.413	6.29	0	64.403	74	-9.597	PK
2483.5	14.546	251	100	H	29.413	6.29	0	50.249	54	-3.751	AV
2483.5	27.77	0	269	V	29.413	6.29	0	63.473	74	-10.527	PK
2483.5	13.21	0	269	V	29.413	6.29	0	48.913	54	-5.087	AV
4924	53.2	173	100	H	32.64	8.416	38.54	55.716	74	-18.284	PK
4924	49.44	173	100	H	32.64	8.416	38.54	51.956	54	-2.044	AV
7386	46.75	213	251	H	37.139	10.211	37.89	56.21	74	-17.79	PK
7386	33.22	213	251	H	37.139	10.211	37.89	42.68	54	-11.32	AV
9848	44.11	123	100	H	37.99	11.621	38.33	55.391	74	-18.609	PK
9848	29.35	123	100	H	37.99	11.621	38.33	40.631	54	-13.369	AV

802.11g mode

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/ISED		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel 2412 MHz											
2412	75.25	245	147	H	29.042	6.29	0	110.582	-	-	PK
2412	65.25	245	147	H	29.042	6.29	0	100.582	-	-	AV
2412	64.25	140	100	V	29.042	6.29	0	99.582	-	-	PK
2412	54.2	140	100	V	29.042	6.29	0	89.532	-	-	AV
2390	36.69	248	158	H	29.042	6.29	0	72.022	74	-1.978	PK
2390	17.82	248	158	H	29.042	6.29	0	53.152	54	-0.848	AV
2390	28.69	135	100	V	29.042	6.29	0	64.022	74	-9.978	PK
2390	12.91	135	100	V	29.042	6.29	0	48.242	54	-5.758	AV
4824	47.11	0	100	H	32.472	8.416	38.56	49.438	74	-24.562	PK
4824	31.29	0	100	H	32.472	8.416	38.56	33.618	54	-20.382	AV
7236	45.59	0	100	H	36.69	10.211	37.9	54.591	74	-19.409	PK
7236	30.4	0	100	H	36.39	10.211	37.9	39.101	54	-14.899	AV
9648	44.36	0	100	H	37.77	11.621	38.29	55.461	74	-18.539	PK
9648	29.63	0	100	H	37.77	11.621	38.29	40.731	54	-13.269	AV
Middle Channel 2437 MHz											
2437	75.58	143	270	H	29.042	6.29	0	110.912	-	-	PK
2437	65.47	143	270	H	29.042	6.29	0	100.802	-	-	AV
2437	72.79	112	300	V	29.042	6.29	0	108.122	-	-	PK
2437	62.84	112	300	V	29.042	6.29	0	98.172	-	-	AV
4874	47.69	62	100	H	32.64	8.416	38.54	50.206	74	-23.794	PK
4874	32.68	62	100	H	32.64	8.416	38.54	35.196	54	-18.804	AV
7311	45.28	0	100	H	37.148	10.211	37.9	54.739	74	-19.261	PK
7311	31.27	0	100	H	37.148	10.211	37.9	40.729	54	-13.271	AV
9748	44.27	0	100	H	37.92	11.621	38.29	55.521	74	-18.479	PK
9748	29.93	0	100	H	37.92	11.621	38.29	41.181	54	-12.819	AV

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/ISED		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
High Channel 2462 MHz											
2462	73.89	143	265	H	29.413	6.29	0	109.593	-	-	PK
2462	63.76	143	265	H	29.413	6.29	0	99.463	-	-	AV
2462	71.39	91	289	V	29.413	6.29	0	107.093	-	-	PK
2462	61.68	91	289	V	29.413	6.29	0	97.383	-	-	AV
2483.5	35.98	143	300	H	29.413	6.29	0	71.683	74	-2.317	PK
2483.5	17.96	143	300	H	29.413	6.29	0	53.663	54	-0.337	AV
2483.5	35.49	93	300	V	29.413	6.29	0	71.193	74	-2.807	PK
2483.5	16.84	93	300	V	29.413	6.29	0	52.543	54	-1.457	AV
4924	46.54	136	100	H	32.64	8.416	38.54	49.056	74	-24.944	PK
4924	31.56	136	100	H	32.64	8.416	38.54	34.076	54	-19.924	AV
7386	45.68	0	100	H	37.139	10.211	37.89	55.14	74	-18.86	PK
7386	30.93	0	100	H	37.139	10.211	37.89	40.39	54	-13.61	AV
9848	44.26	0	100	H	37.99	11.621	38.33	55.541	74	-18.459	PK
9848	28.91	0	100	H	37.99	11.621	38.33	40.191	54	-13.809	AV

802.11n20 mode

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/ISED		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel 2412 MHz											
2412	75.03	72	100	H	29.042	6.29	0	110.362	-	-	PK
2412	61.3	72	100	H	29.042	6.29	0	96.632	-	-	AV
2412	66.16	176	109	V	29.042	6.29	0	101.492	-	-	PK
2412	55.45	176	109	V	29.042	6.29	0	90.782	-	-	AV
2390	34.03	237	105	H	29.042	6.29	0	69.362	74	-4.638	PK
2390	15.79	237	105	H	29.042	6.29	0	51.122	54	-2.878	AV
2390	33.53	175	100	V	29.042	6.29	0	68.862	74	-5.138	PK
2390	15.14	175	100	V	29.042	6.29	0	50.472	54	-3.528	AV
4824	45.81	0	100	H	32.472	8.416	38.56	48.138	74	-25.862	PK
4824	30.31	0	100	H	32.472	8.416	38.56	32.638	54	-21.362	AV
7236	45.76	52	100	H	36.69	10.211	37.9	54.761	74	-19.239	PK
7236	30.4	52	100	H	36.39	10.211	37.9	39.101	54	-14.899	AV
9648	44.05	0	100	H	37.77	11.621	38.29	55.151	74	-18.849	PK
9648	29.41	0	100	H	37.77	11.621	38.29	40.511	54	-13.489	AV
Middle Channel 2437 MHz											
2437	75.78	72	100	H	29.042	6.29	0	111.112	-	-	PK
2437	63.77	72	100	H	29.042	6.29	0	99.102	-	-	AV
2437	68.48	174	100	V	29.042	6.29	0	103.812	-	-	PK
2437	57.35	174	100	V	29.042	6.29	0	92.682	-	-	AV
4874	45.87	0	100	H	32.64	8.416	38.54	48.386	74	-25.614	PK
4874	30.78	0	100	H	32.64	8.416	38.54	33.296	54	-20.704	AV
7311	45.55	0	100	H	37.148	10.211	37.9	55.009	74	-18.991	PK
7311	30.08	0	100	H	37.148	10.211	37.9	39.539	54	-14.461	AV
9748	44.3	0	100	H	37.92	11.621	38.29	55.551	74	-18.449	PK
9748	29.4	0	100	H	37.92	11.621	38.29	40.651	54	-13.349	AV

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/ISED		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
High Channel 2462 MHz											
2462	71.55	342	100	H	29.413	6.29	0	107.253	-	-	PK
2462	61.19	342	100	H	29.413	6.29	0	96.893	-	-	AV
2462	68.29	261	100	V	29.413	6.29	0	103.993	-	-	PK
2462	58.41	261	100	V	29.413	6.29	0	94.113	-	-	AV
2483.5	37.61	343	100	H	29.413	6.29	0	73.313	74	-0.687	PK
2483.5	18	343	100	H	29.413	6.29	0	53.703	54	-0.297	AV
2483.5	37.09	0	250	V	29.413	6.29	0	72.793	74	-1.207	PK
2483.5	16.25	0	250	V	29.413	6.29	0	51.953	54	-2.047	AV
4924	44.95	0	100	V	32.64	8.42	38.54	47.47	74.00	-26.53	PK
4924	29.64	0	100	V	32.64	8.42	38.54	32.16	54.00	-21.84	AV
7386	45.24	163	100	V	37.14	10.21	37.89	54.70	74.00	-19.30	PK
7386	30.58	163	100	V	37.14	10.21	37.89	40.04	54.00	-13.96	AV
9848	43.58	0	100	V	37.99	11.62	38.33	54.86	74.00	-19.14	PK
9848	28.87	0	100	V	37.99	11.62	38.33	40.15	54.00	-13.85	AV

8 FCC §15.247(a) (2) & ISEDC RSS-247 §5.2 -Emission Bandwidth

8.1 Applicable Standards

According to eCFR §15.247(a) (2) and ISEDC RSS-247 §5.2, systems using digital modulation techniques may operate in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz

8.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2017-04-20	1 year
-	U. FL to SMA pigtail	-	-	Each time ¹	N/A
-	10dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp.* attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

8.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Troy Pandhumsoporn and Frank Wang on 2017-07-24 to 2017-07-26 in RF site.

8.5 Test Results

Antenna Port 0

Channel	Frequency (MHz)	99% OBW (kHz)	6 dB OBW (kHz)	6 dB OBW limit (kHz)
802.11b mode				
Low	2412	13346.6	9574	500
Middle	2437	13994.4	9750	500
High	2462	14571.5	10012	500
802.11g mode				
Low	2412	16610.6	16528	500
Middle	2437	16732.1	16533	500
High	2462	16526.6	16514	500
802.11n-20 mode				
Low	2412	17572.9	17767	500
Middle	2437	17600.2	17718	500
High	2462	17626.7	17766	500
802.11n-20 mode MIMO				
Low	2412	17574.4	17679	500
Middle	2437	17597.0	17735	500
High	2462	17591.4	17745	500

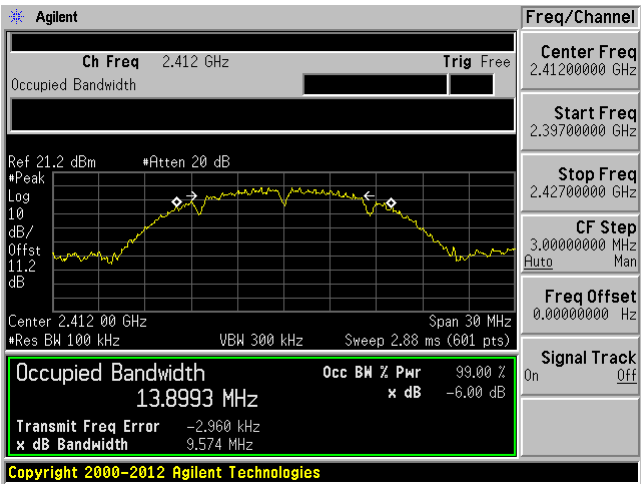
Antenna Port 1

Channel	Frequency (MHz)	99% OBW (kHz)	6 dB OBW (kHz)	6 dB OBW limit (kHz)
802.11b mode				
Low	2412	14476.9	9636	500
Middle	2437	14893.4	10083	500
High	2462	14716.9	10109	500
802.11g mode				
Low	2412	17709.8	16521	500
Middle	2437	17626.5	16476	500
High	2462	17589.3	16534	500
802.11n-20 mode				
Low	2412	17545.2	17708	500
Middle	2437	18691.6	17666	500
High	2462	17751.7	17731	500
802.11n-20 mode MIMO				
Low	2412	17674.3	17655	500
Middle	2437	17853.1	17660	500
High	2462	17703.6	17702	500

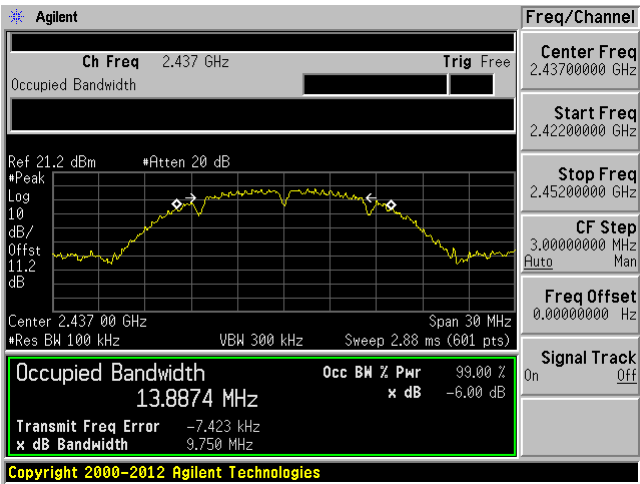
Please refer to the following plots for detailed test results.

802.11b mode (Ant 0)

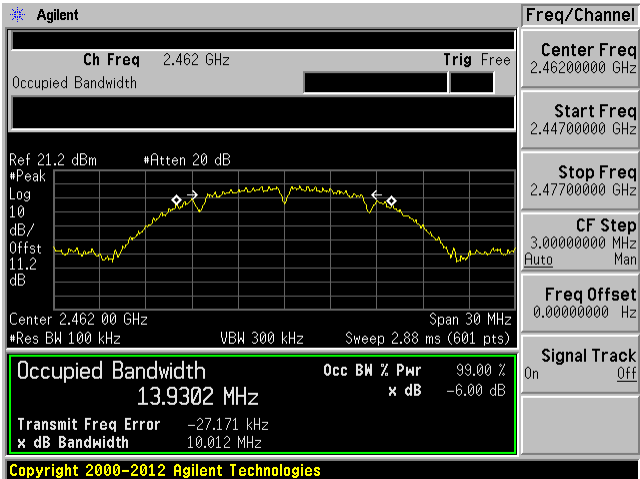
Low Channel 2412 MHz



Middle Channel 2437 MHz

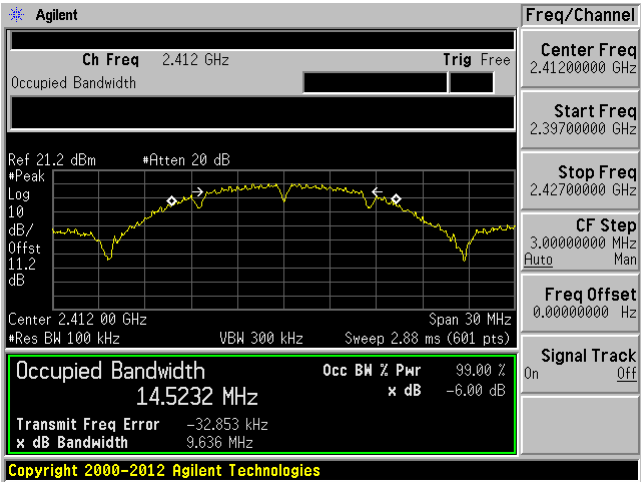


High Channel 2462 MHz

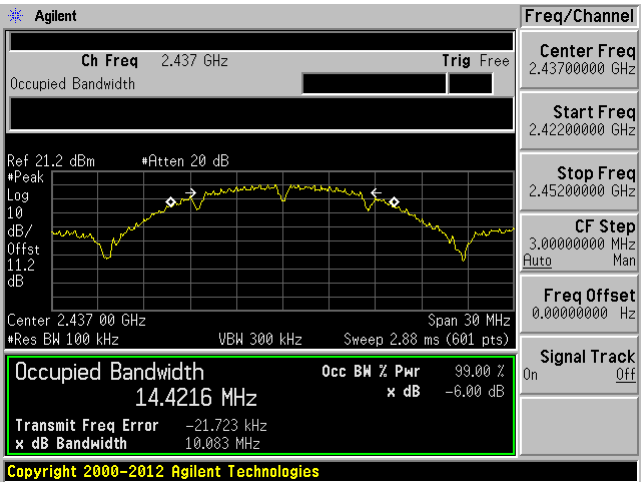


802.11b mode (Ant 1)

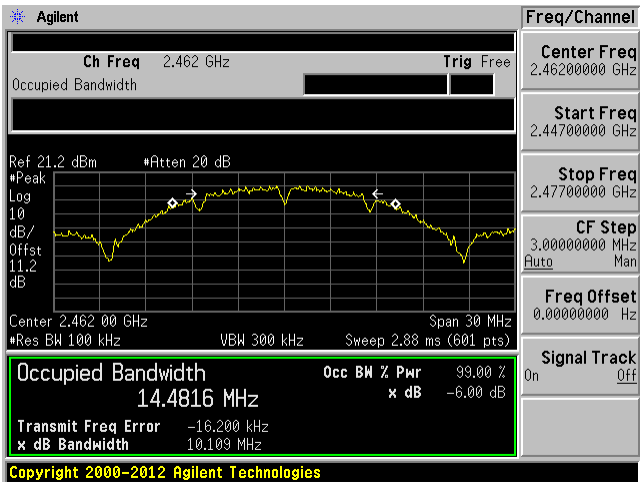
Low Channel 2412 MHz



Middle Channel 2437 MHz

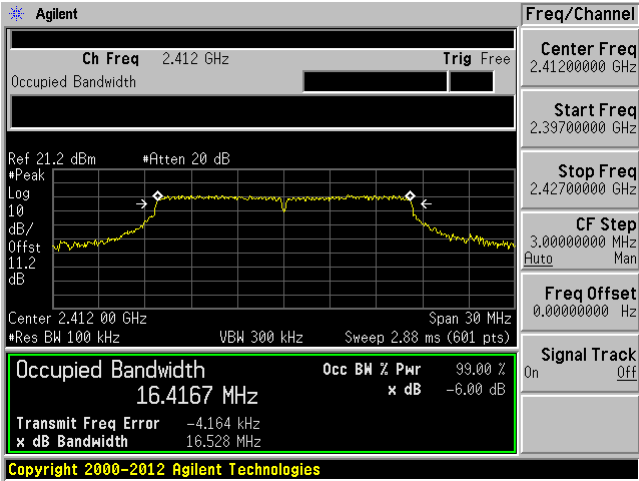


High Channel 2462 MHz

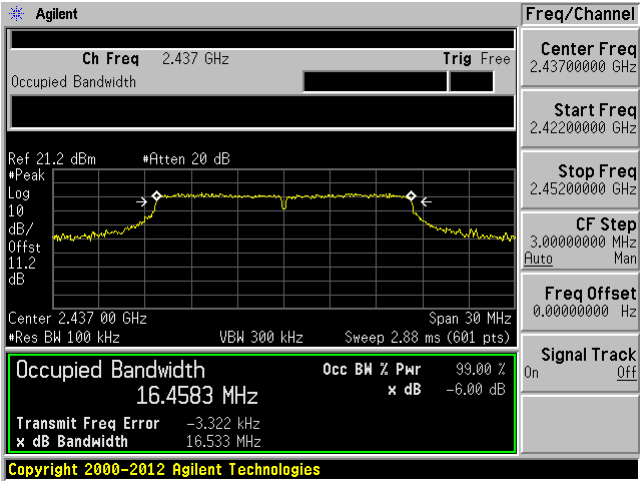


802.11g mode (Ant 0)

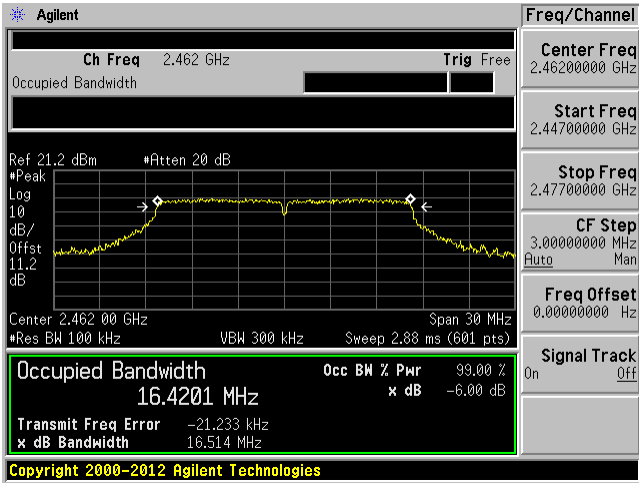
Low Channel 2412 MHz



Middle Channel 2437 MHz

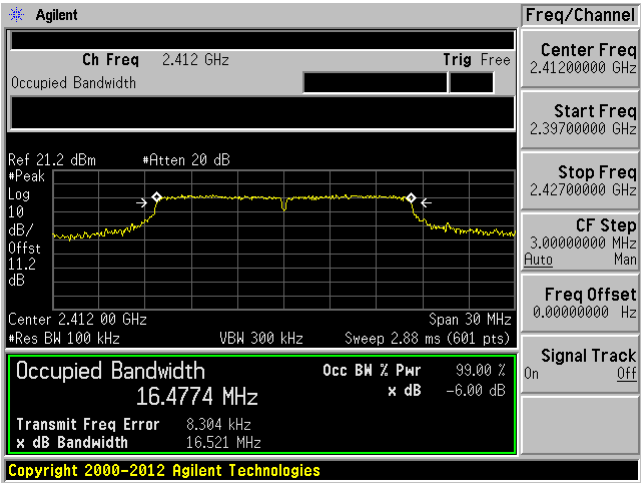


High Channel 2462 MHz

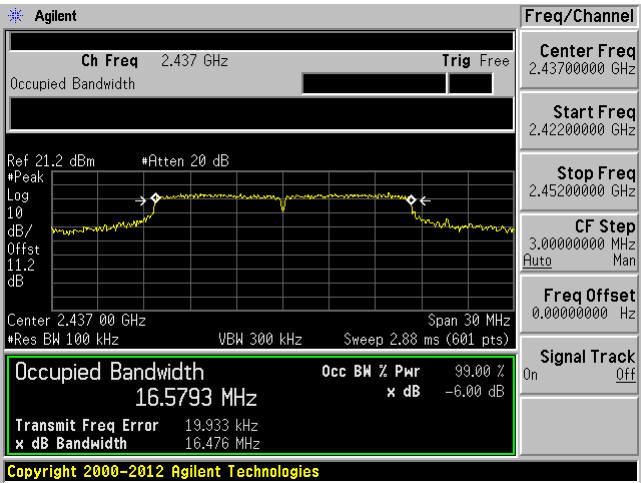


802.11g mode (Ant 1)

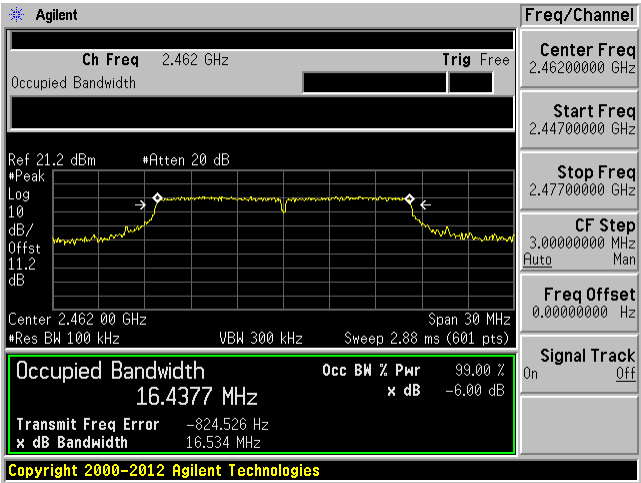
Low Channel 2412 MHz



Middle Channel 2437 MHz

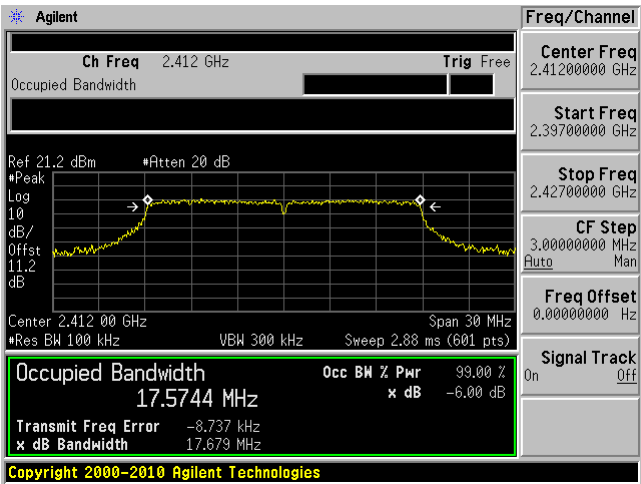


High Channel 2462 MHz

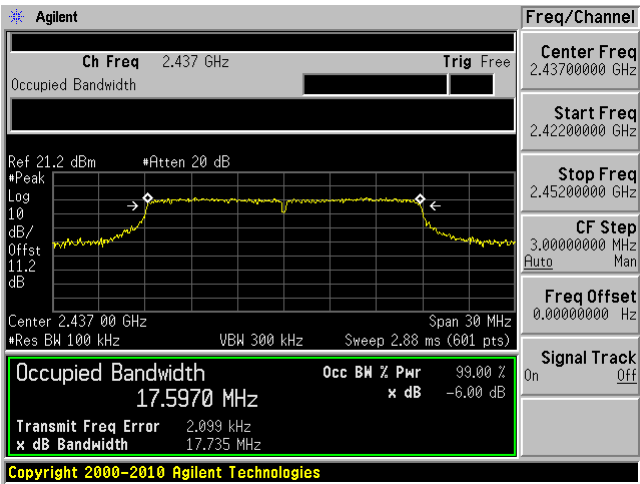


802.11n20 mode (Ant 0)

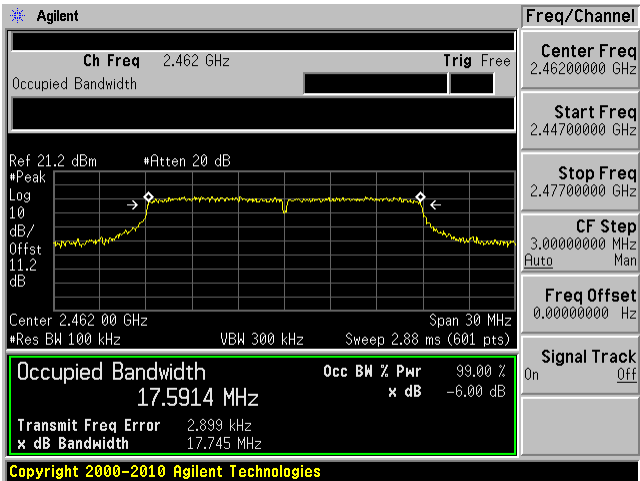
Low Channel 2412 MHz



Middle Channel 2437 MHz

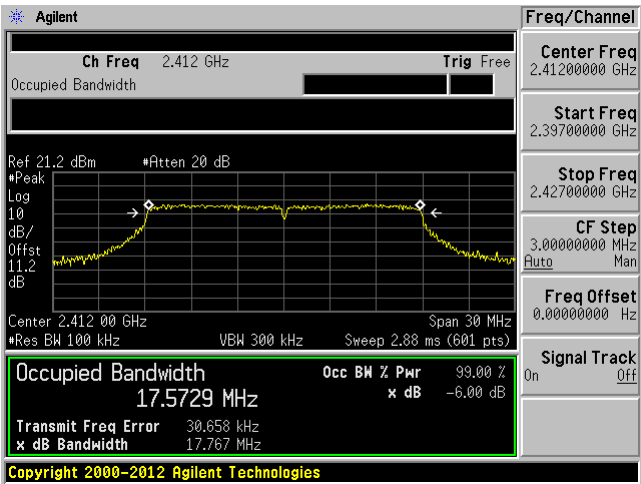


High Channel 2462 MHz

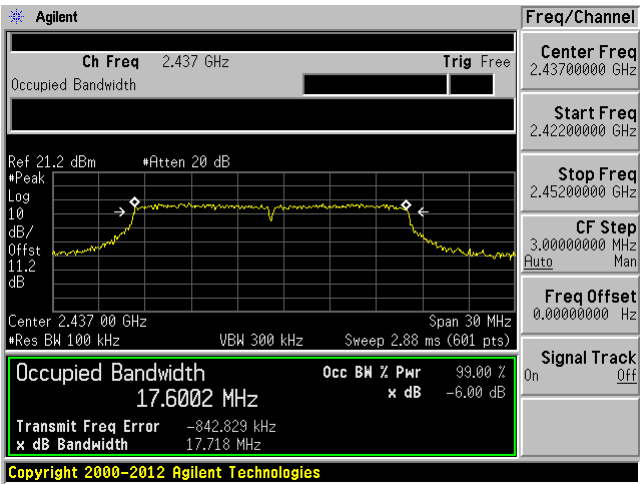


802.11n20 mode (Ant 0 MIMO)

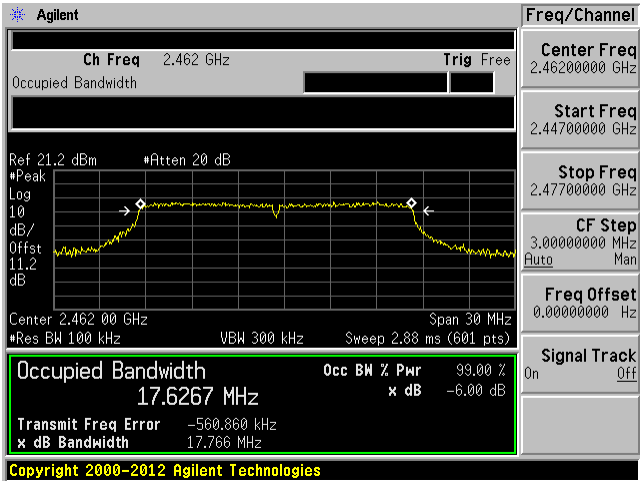
Low Channel 2412 MHz



Middle Channel 2437 MHz

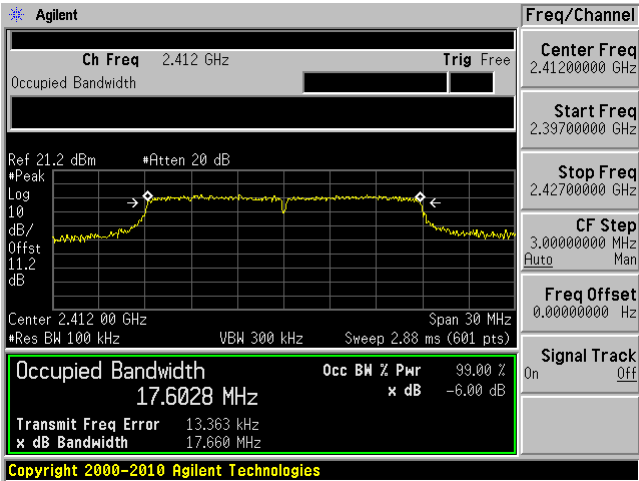


High Channel 2462 MHz

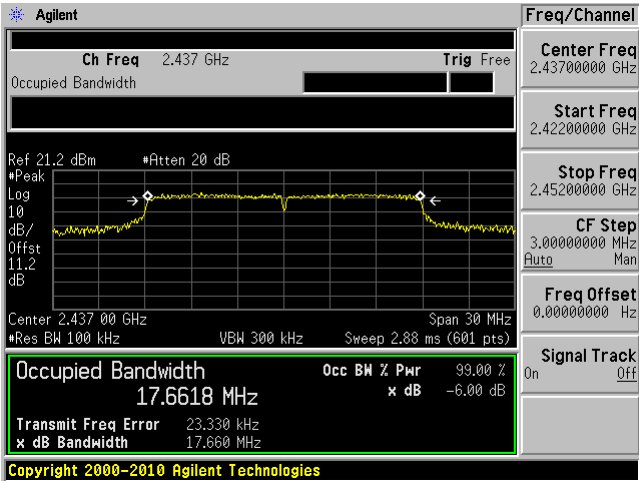


802.11n20 mode (Ant 1)

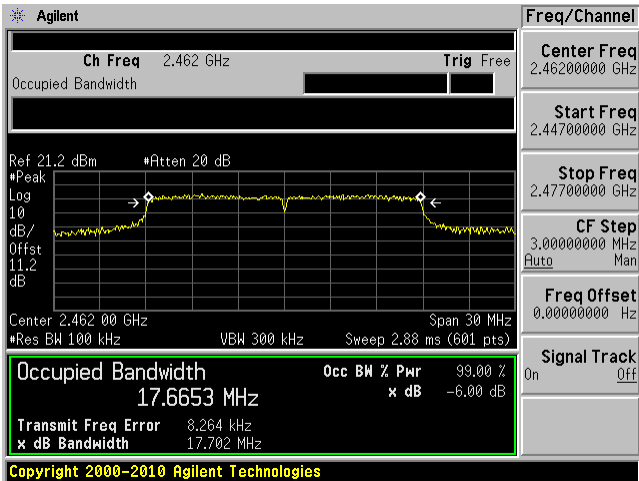
Low Channel 2412 MHz



Middle Channel 2437 MHz

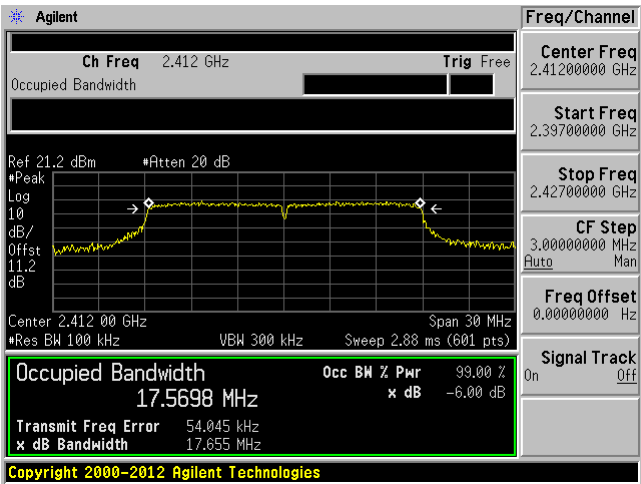


High Channel 2462 MHz

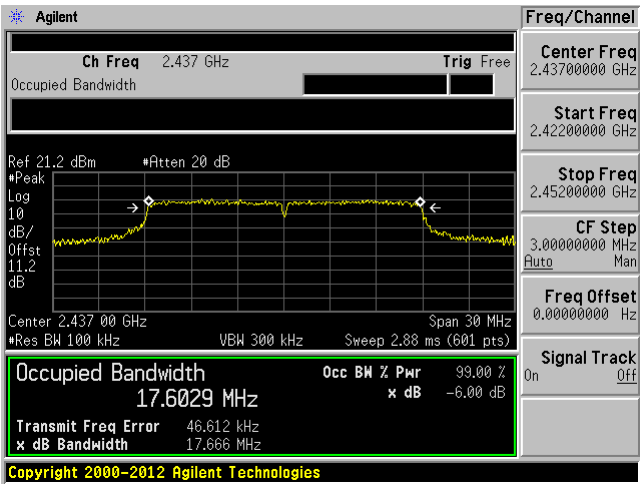


802.11n20 mode (Ant 1 MIMO)

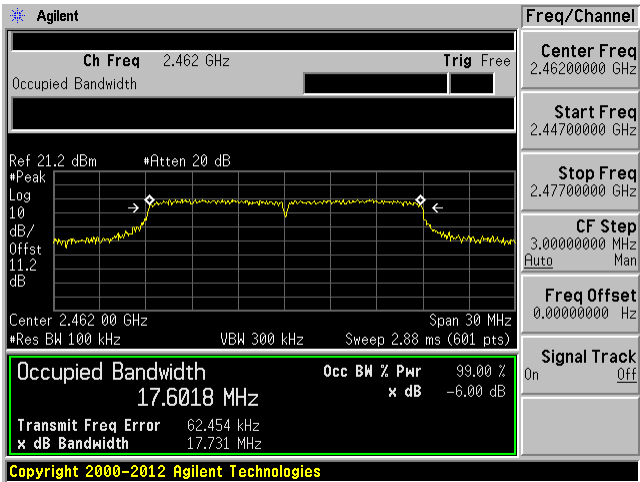
Low Channel 2412 MHz



Middle Channel 2437 MHz



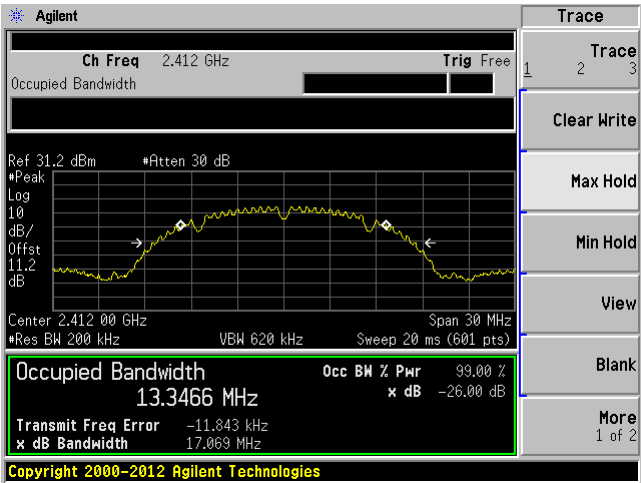
High Channel 2462 MHz



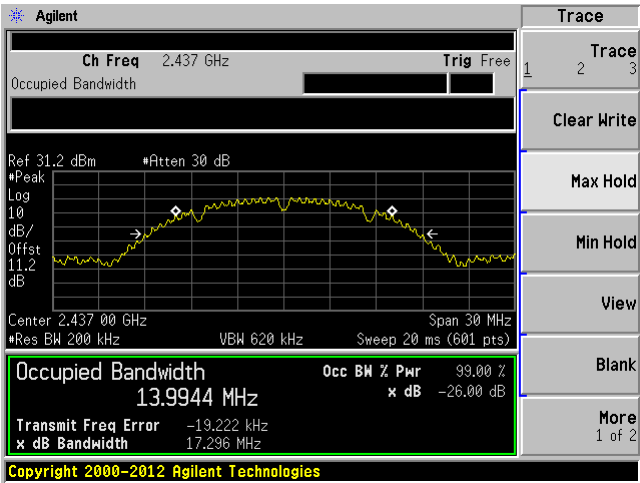
ISED: 99% Occupied Bandwidth

802.11b mode (Ant 0)

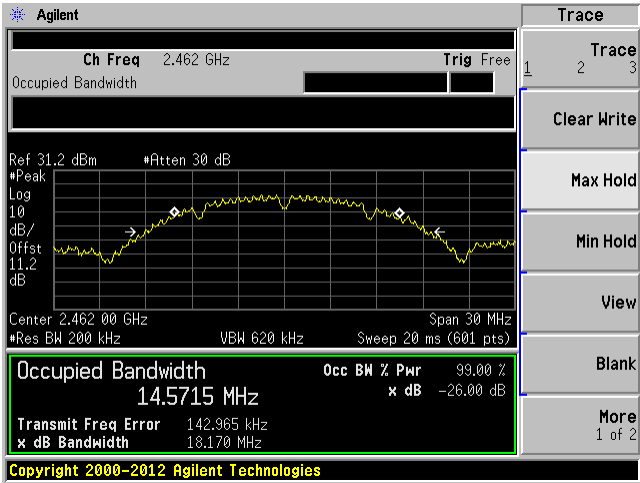
Low Channel 2412 MHz



Middle Channel 2437 MHz

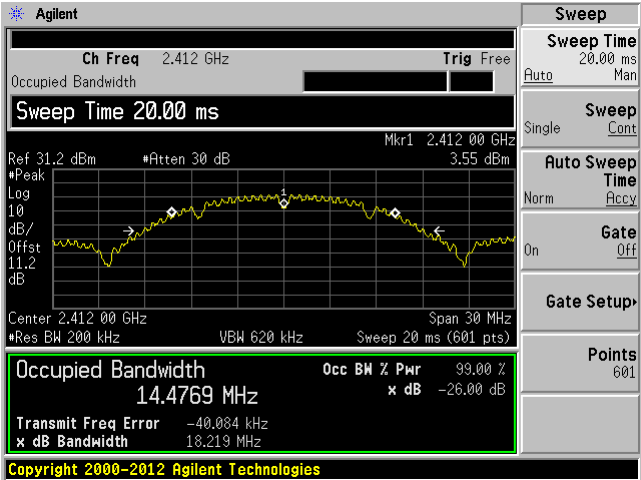


High Channel 2462 MHz

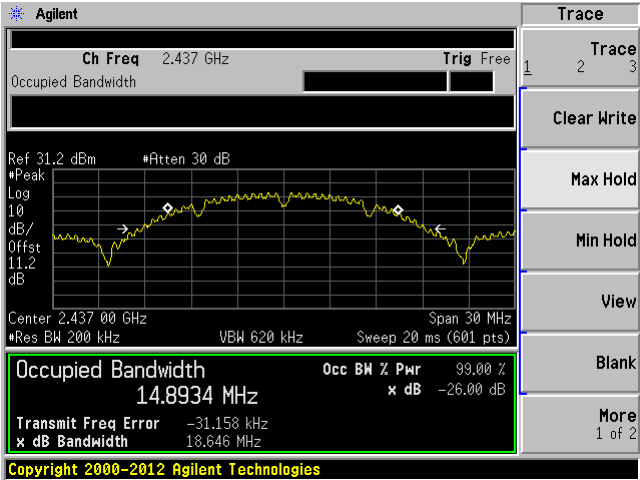


802.11b mode (Ant 1)

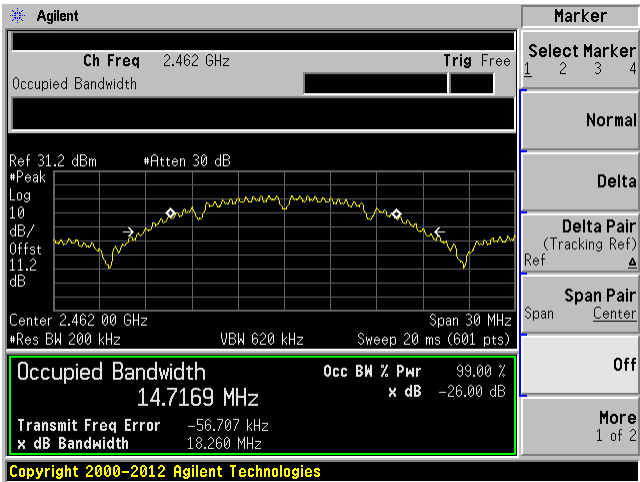
Low Channel 2412 MHz



Middle Channel 2437 MHz



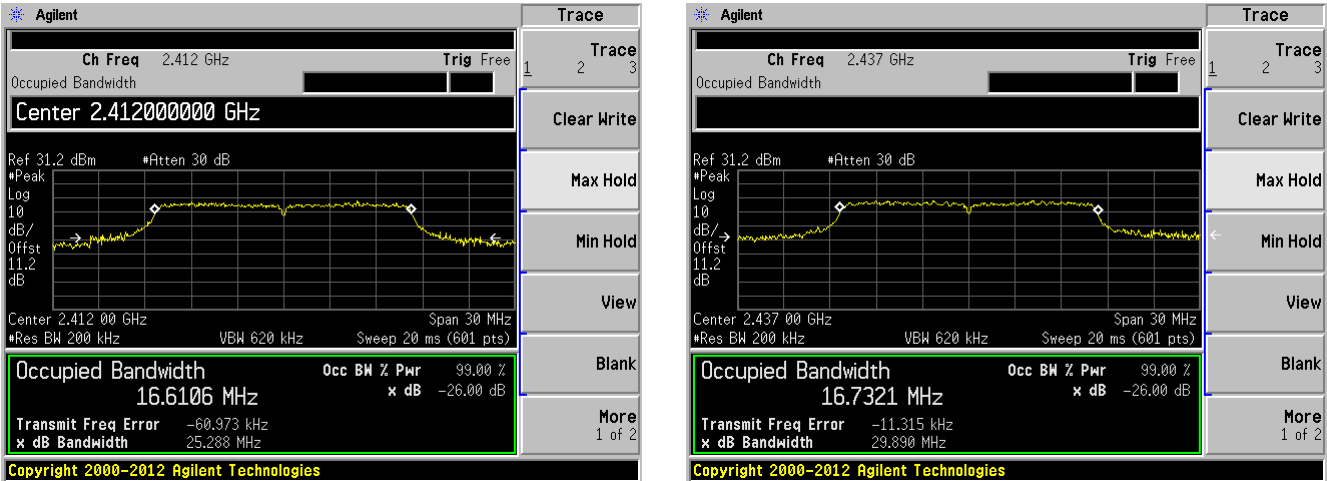
High Channel 2462 MHz



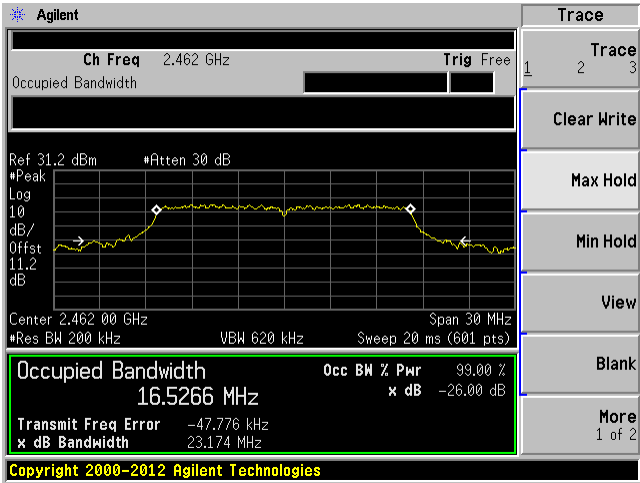
802.11g mode (Ant 0)

Low Channel 2412 MHz

Middle Channel 2437 MHz

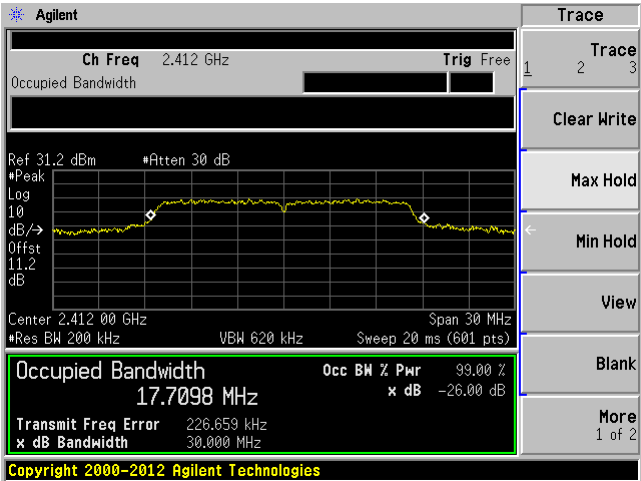


High Channel 2462 MHz

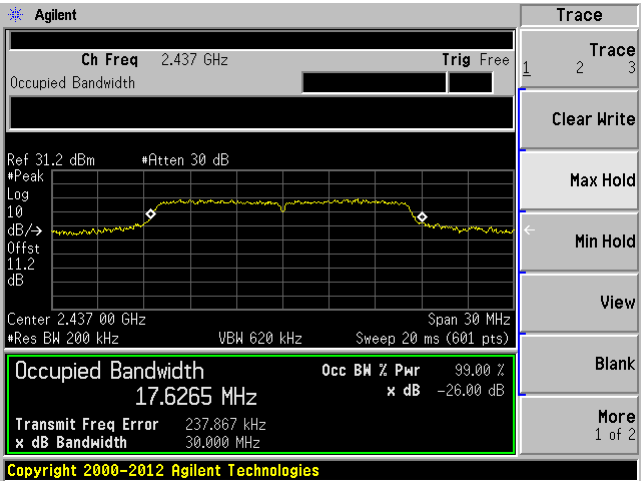


802.11g mode (Ant 1)

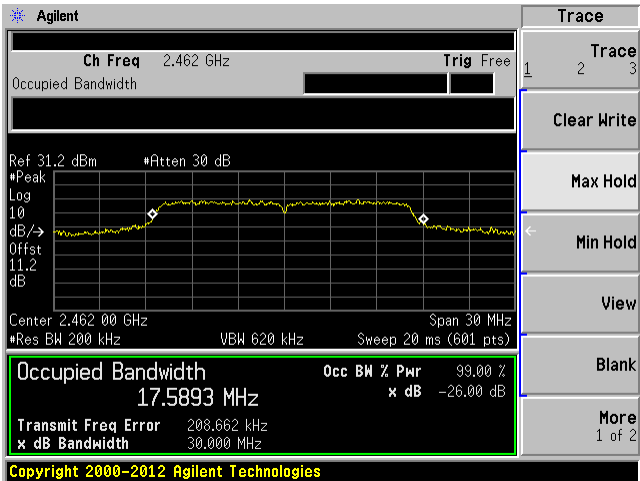
Low Channel 2412 MHz



Middle Channel 2437 MHz

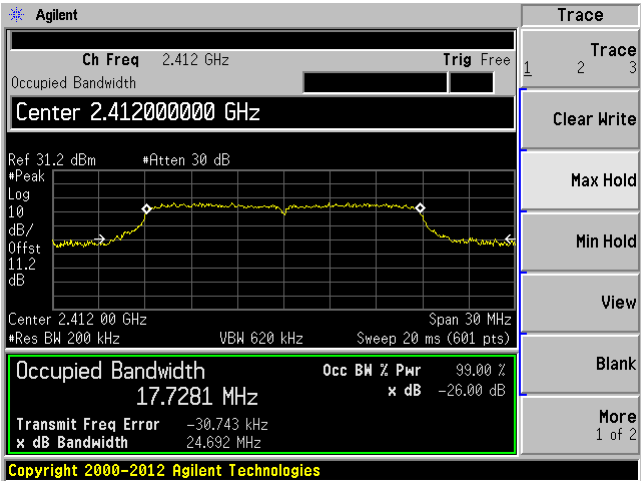


High Channel 2462 MHz

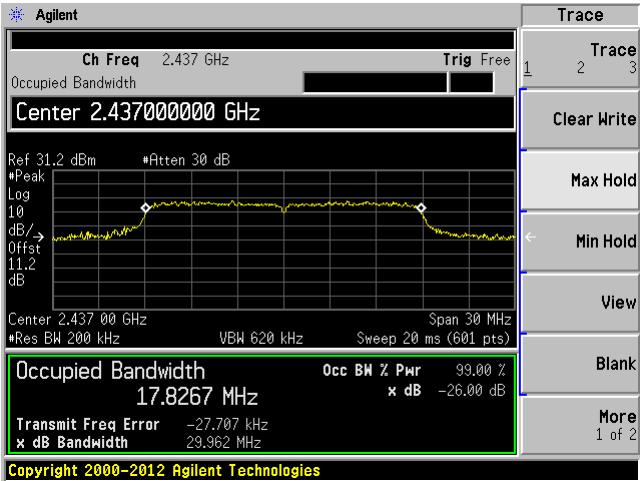


802.11n20 mode (Ant 0)

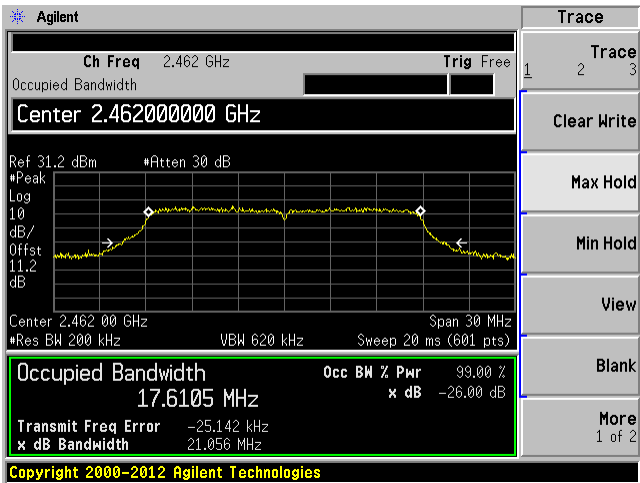
Low Channel 2412 MHz



Middle Channel 2437 MHz

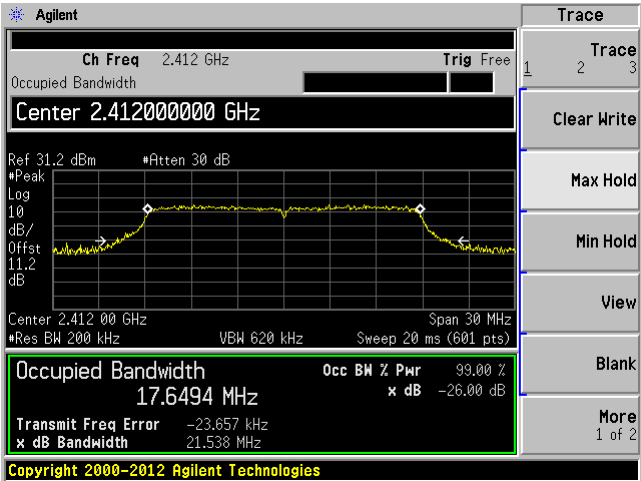


High Channel 2462 MHz

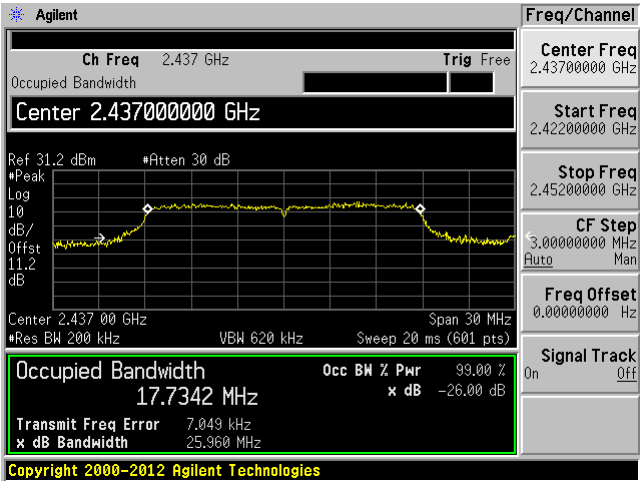


802.11n20 mode (Ant 0 MIMO)

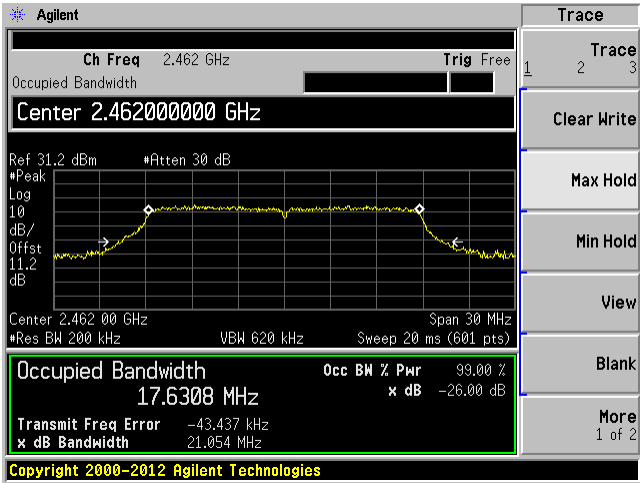
Low Channel 2412 MHz



Middle Channel 2437 MHz

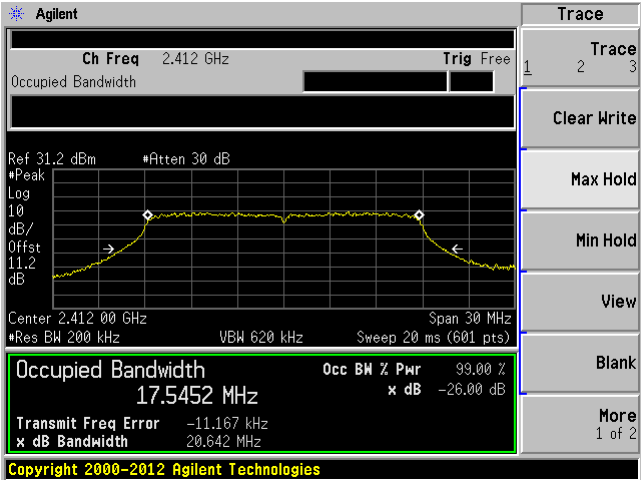


High Channel 2462 MHz

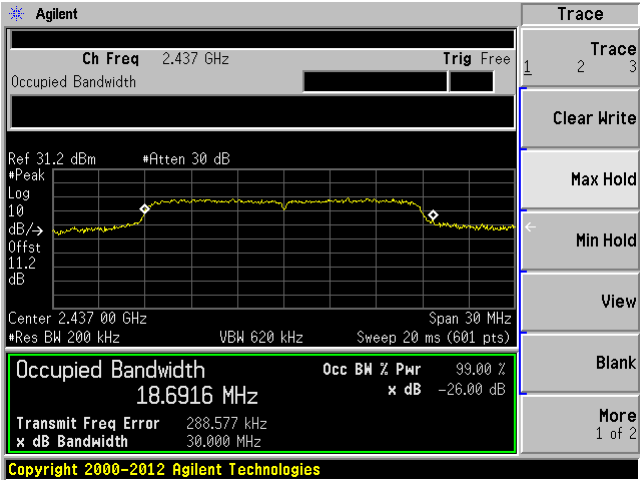


802.11n20 mode (Ant 1)

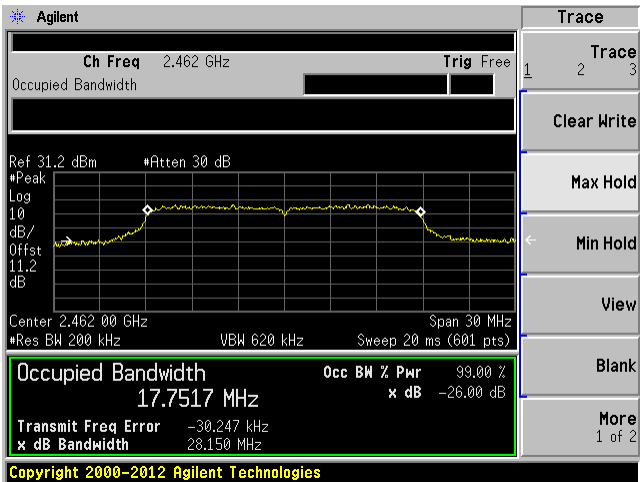
Low Channel 2412 MHz



Middle Channel 2437 MHz

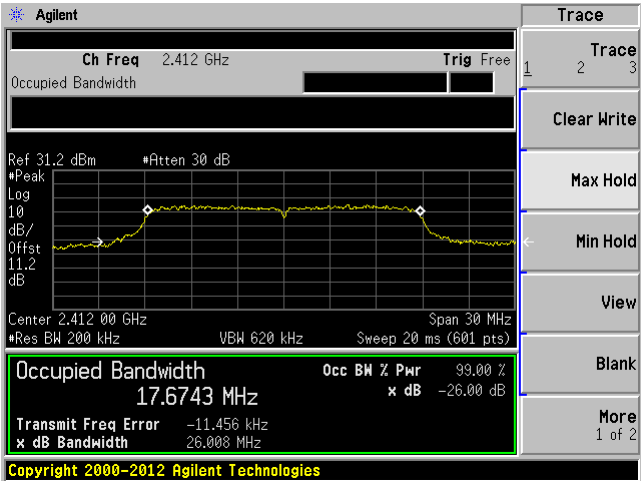


High Channel 2462 MHz

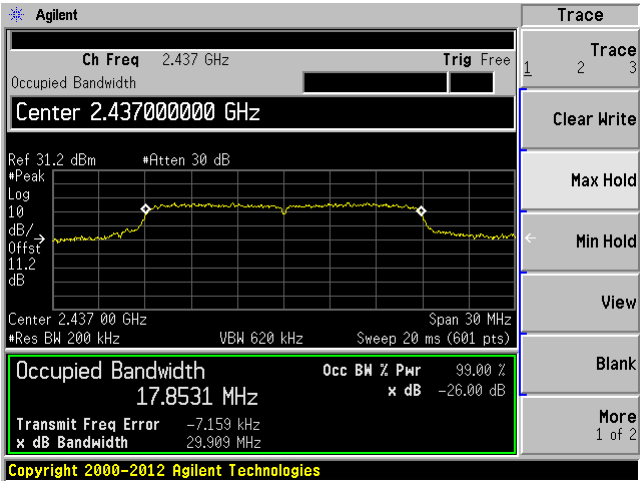


802.11n20 mode (Ant 1 MIMO)

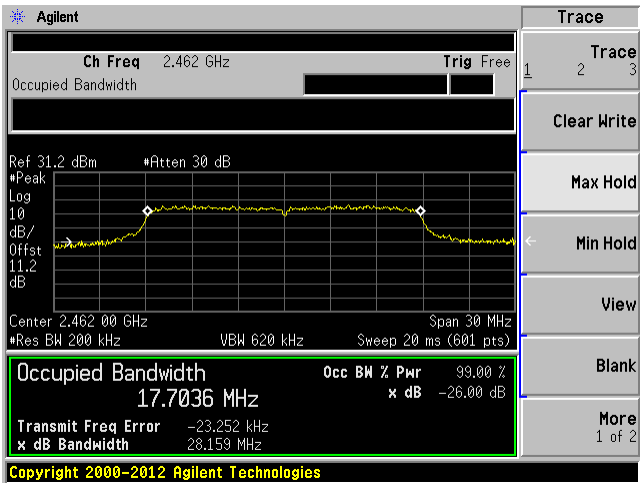
Low Channel 2412 MHz



Middle Channel 2437 MHz



High Channel 2462 MHz



9 FCC §15.247(b) (3) & ISEDC RSS-247 §5.4 (4) - Output Power Measurement

9.1 Applicable Standards

According to ECFR §15.247(b) (3) and ISEDC RSS-247 §5.4 (4) for systems using digital modulation in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands: 1 Watt.

9.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 9: Fundamental emission output power

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
ETS- Lingerin	Power Sensor	7002-006	160097	2016-12-05	2 years
-	RF Cable	-	-	Each time ¹	N/A
-	10dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp.* attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

9.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Frank Wang and Troy Pandhumsoporn on 2017-07-26 to 2017-07-28 in RF site.

9.5 Test Results

Conducted Average Output Power

Mode	TX Paths	Port-0 (dBm)	Port-1 (dBm)	Total (dBm)	Limit (dBm)	Margin (dB)
2412 MHz						
802.11b	1	19.43	-	19.43	30.00	-10.57
802.11b	1	-	20.68	20.68	30.00	-9.32
802.11g	1	15.94	-	15.94	30.00	-14.06
802.11g	1	-	17.35	17.35	30.00	-12.65
802.11n20	1	15.98	-	15.98	30.00	-14.02
802.11n20	1	-	17.34	17.34	30.00	-12.66
802.11n20	2	10.68	12.55	14.73	30.00	-15.27
2437 MHz						
802.11b	1	19.33	-	19.33	30.00	-10.67
802.11b	1	-	20.55	20.55	30.00	-9.45
802.11g	1	16.93	-	16.93	30.00	-13.07
802.11g	1	-	18.55	18.55	30.00	-11.45
802.11n20	1	17.14	-	17.14	30.00	-12.86
802.11n20	1	-	18.8	18.80	30.00	-11.20
802.11n20	2	11.76	14.3	16.22	30.00	-13.78
2462 MHz						
802.11b	1	19.31	-	19.31	30.00	-10.69
802.11b	1	-	20.32	20.32	30.00	-9.68
802.11g	1	14.09	-	14.09	30.00	-15.91
802.11g	1	-	15.91	15.91	30.00	-14.09
802.11n20	1	14.5	-	14.50	30.00	-15.50
802.11n20	1	-	16.2	16.20	30.00	-13.80
802.11n20	2	9.8	12.31	14.24	30.00	-15.76

10 FCC §15.247(d) & ISEDC RSS-247 §5.5 - 100 kHz Bandwidth of Band Edges

10.1 Applicable Standards

According to ECFR §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) see §15.205(c).

According to ISEDC RSS-247 §5.5. In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

10.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 13: Band-edge measurements

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2017-04-20	1 year
-	U. FL to SMA pigtail	-	-	Each time ¹	N/A
-	10dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp.* attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

10.4 Test Environmental Conditions

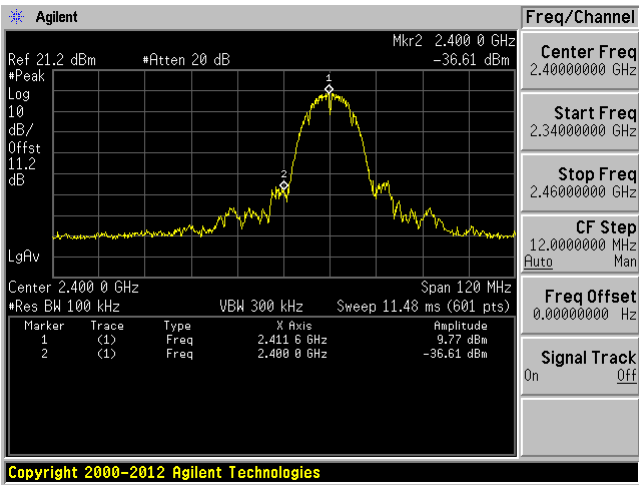
Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Troy Pandhumsoporn on 2017-07-24 to 2017-07-26 in RF site.

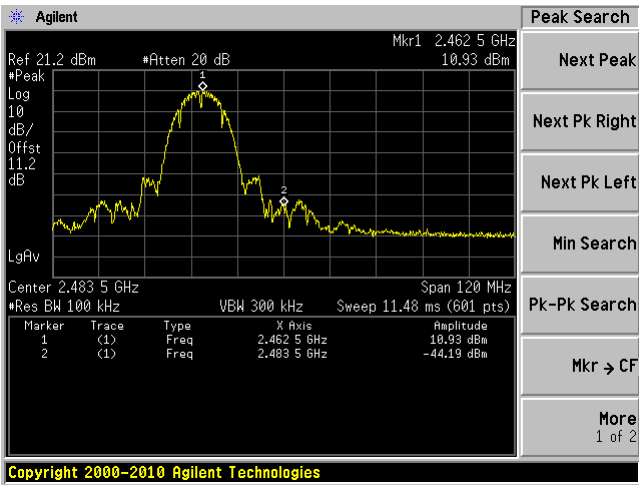
10.5 Test Results

802.11b mode (Ant 0)

Low Channel 2412 MHz

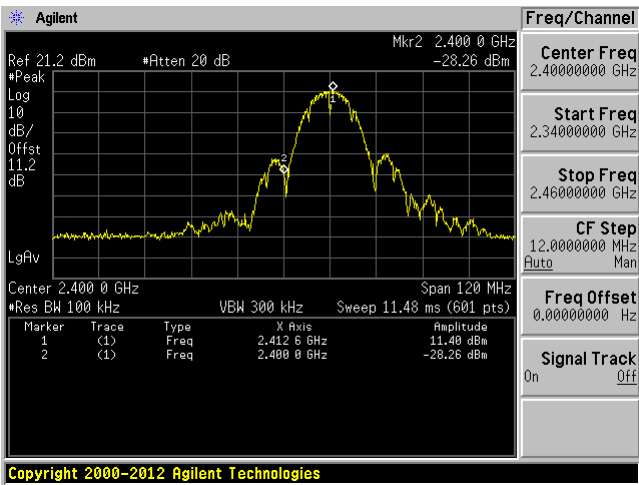


High Channel 2462 MHz

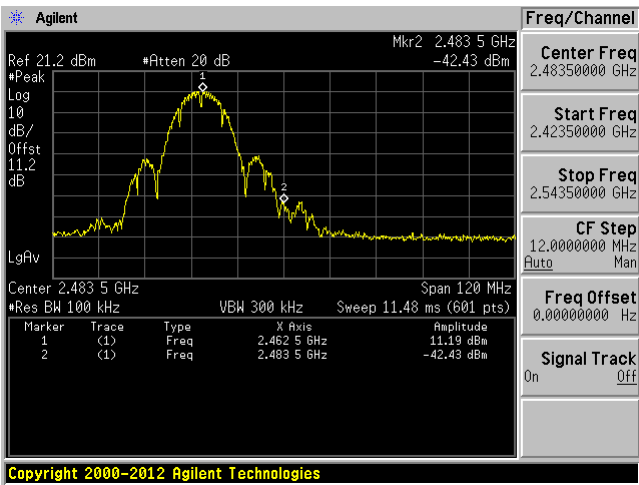


802.11b mode (Ant 1)

Low Channel 2412 MHz

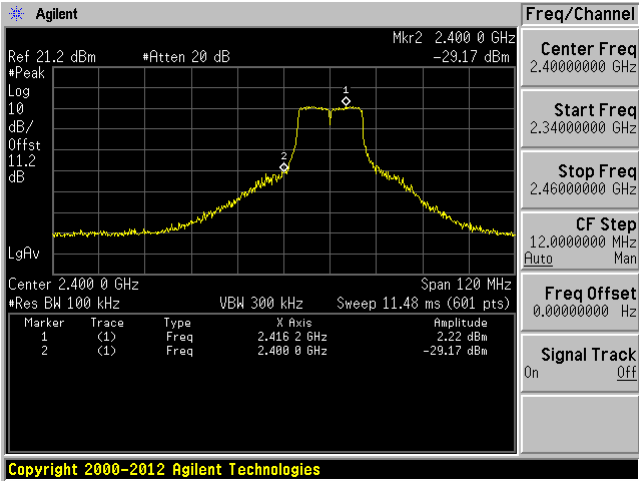


High Channel 2462 MHz

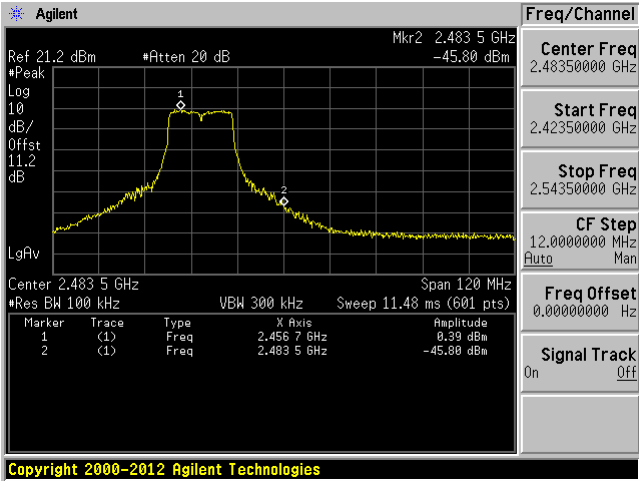


802.11g mode (Ant 0)

Low Channel 2412 MHz

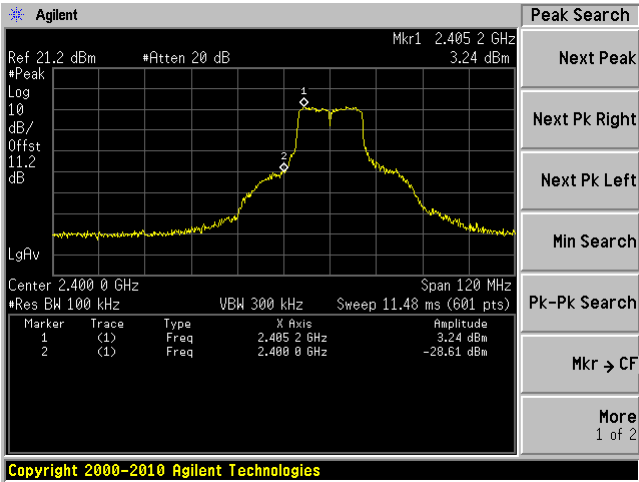


High Channel 2462 MHz

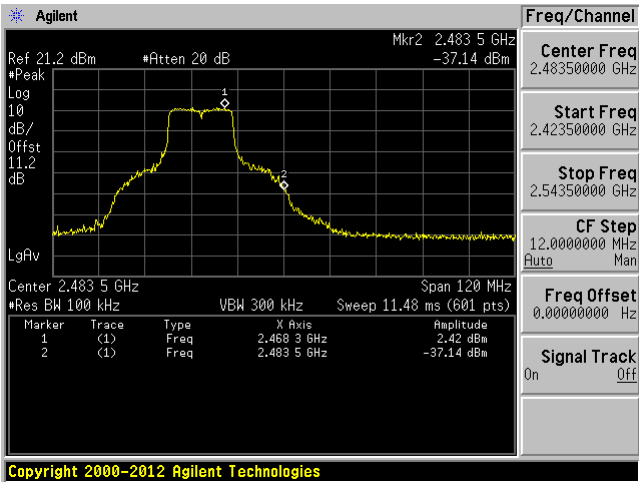


802.11g mode (Ant 1)

Low Channel 2412 MHz

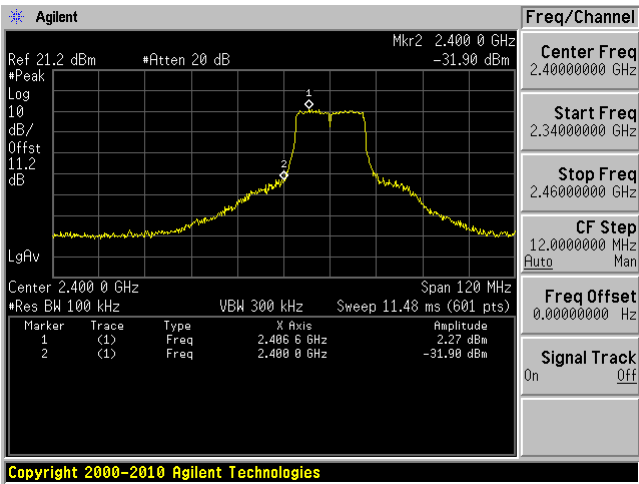


High Channel 2462 MHz

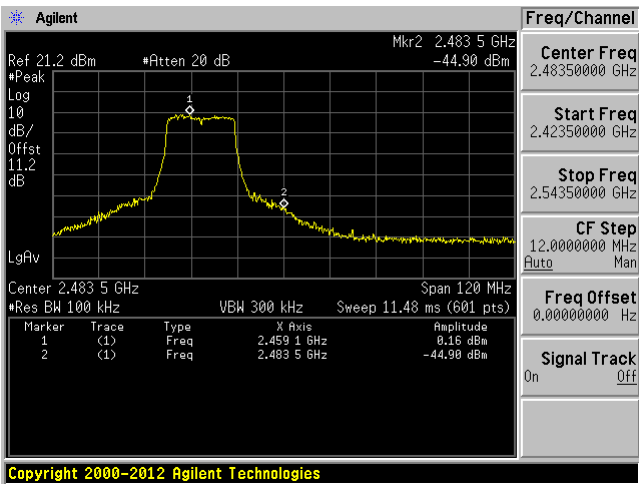


802.11n20 mode (Ant 0)

Low Channel 2412 MHz

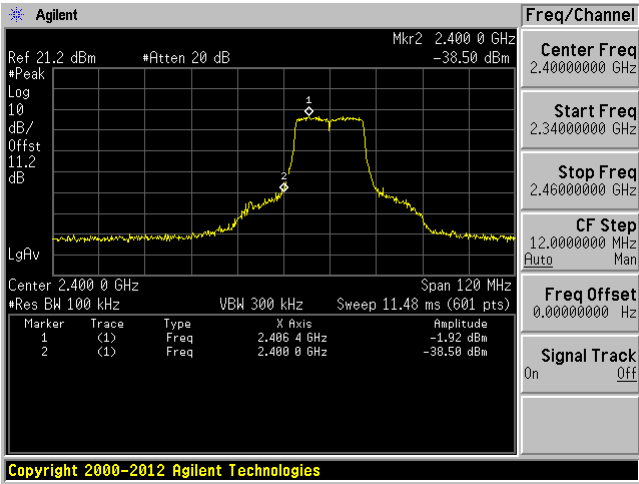


High Channel 2462 MHz

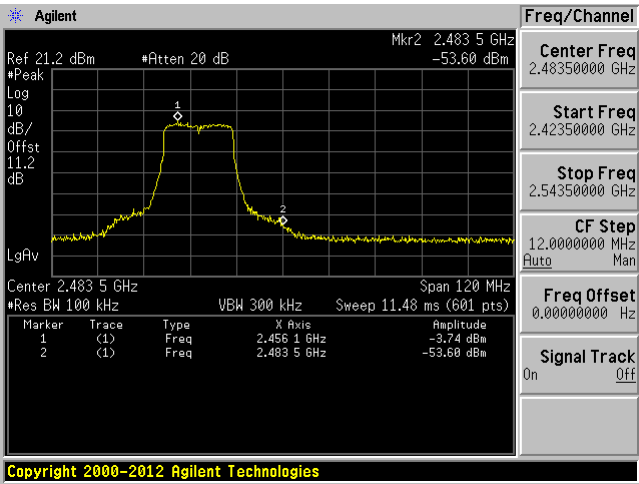


802.11n20 mode (MIMO Ant 0)

Low Channel 2412 MHz

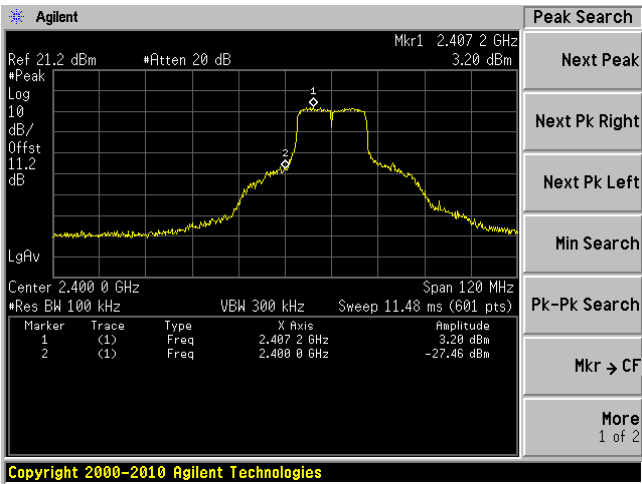


High Channel 2462 MHz

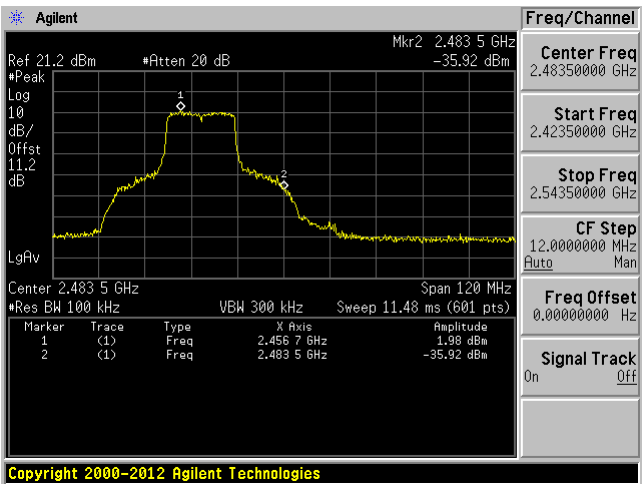


802.11n20 mode (Ant 1)

Low Channel 2412 MHz

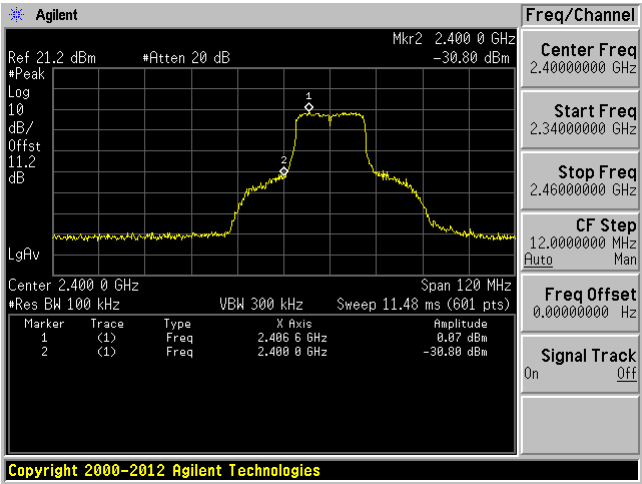


High Channel 2462 MHz

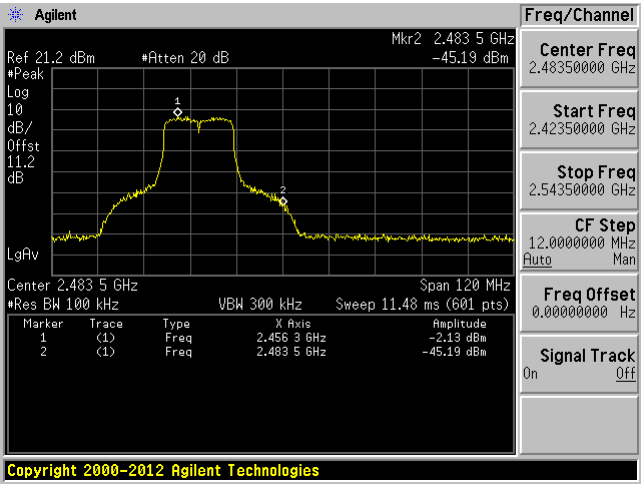


802.11n20 mode (MIMO Ant 1)

Low Channel 2412 MHz



High Channel 2462 MHz



11 FCC §15.247(e) & ISEDC RSS-247 §5.2(2) - Power Spectral Density

11.1 Applicable Standards

According to ECFR §15.247(e) and RSS-247 §5.2 (2) , for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

11.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v04: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 10: Maximum power spectral density level in the fundamental emission.

11.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2017-02-24	1 year
-	RF Cable	-	-	Each time ¹	N/A
-	10dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

11.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Frank Wang and Troy Pandhumsoporn on 2017-07-21 to 2017-07-23 in RF site.

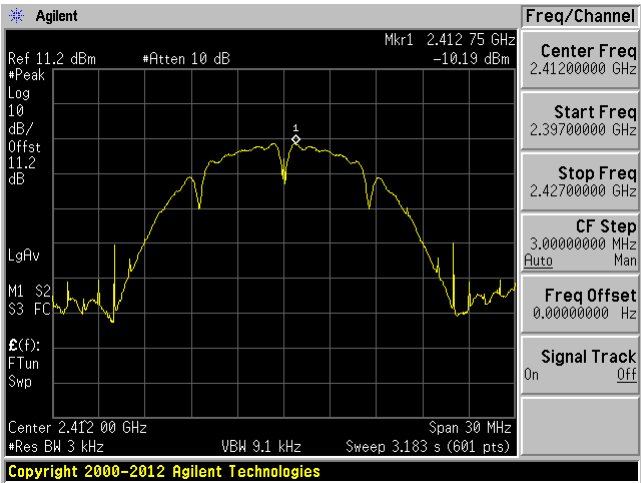
11.5 Test Results

Antenna Port	Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
802.11b mode				
0	Low	2412	-10.19	8
	Middle	2437	-10.36	8
	High	2462	-10.05	8
1	Low	2412	-8.38	8
	Middle	2437	-8.63	8
	High	2462	-8.58	8
802.11g mode				
0	Low	2412	-12.07	8
	Middle	2437	-10.00	8
	High	2462	-13.82	8
1	Low	2412	-10.83	8
	Middle	2437	-9.00	8
	High	2462	-12.13	8
802.11n20 mode				
0	Low	2412	-11.39	8
	Middle	2437	-10.08	8
	High	2462	-12.99	8
0 MIMO	Low	2412	-15.28	8
	Middle	2437	-14.81	8
	High	2462	-16.60	8
1	Low	2412	-10.27	8
	Middle	2437	-8.82	8
	High	2462	-11.78	8
1 MIMO	Low	2412	-13.81	8
	Middle	2437	-10.18	8
	High	2462	-14.68	8

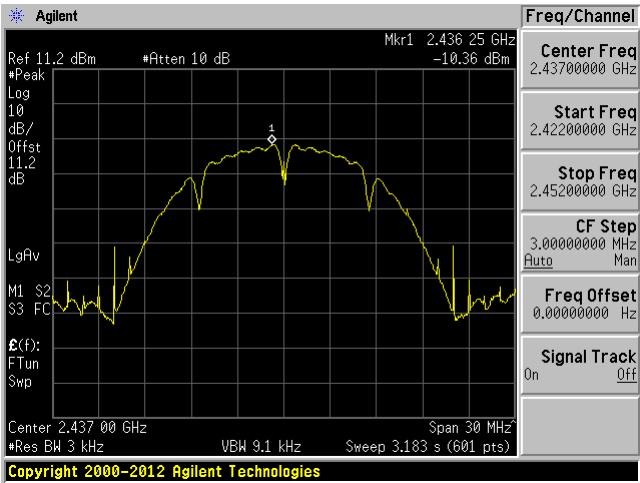
Please refer to the following plots for detailed test results

802.11b mode (Ant 0)

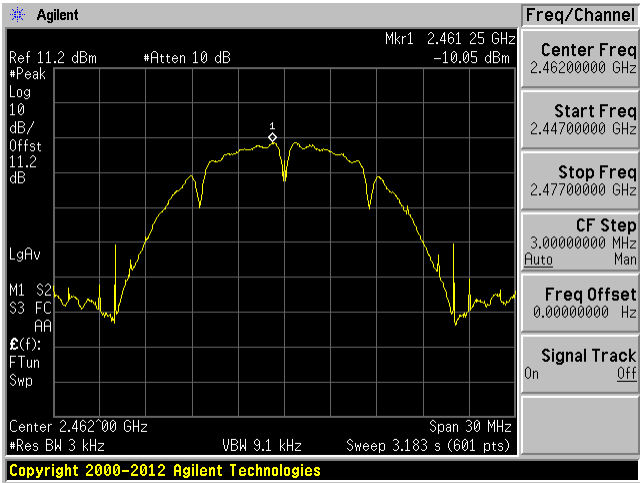
Low Channel 2412 MHz



Middle Channel 2437 MHz

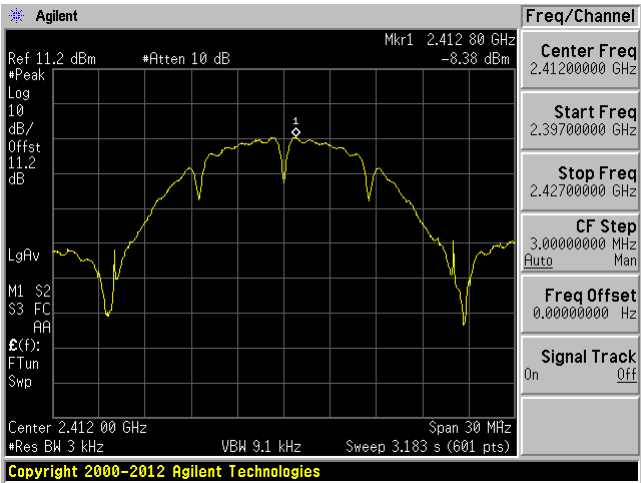


High Channel 2462 MHz

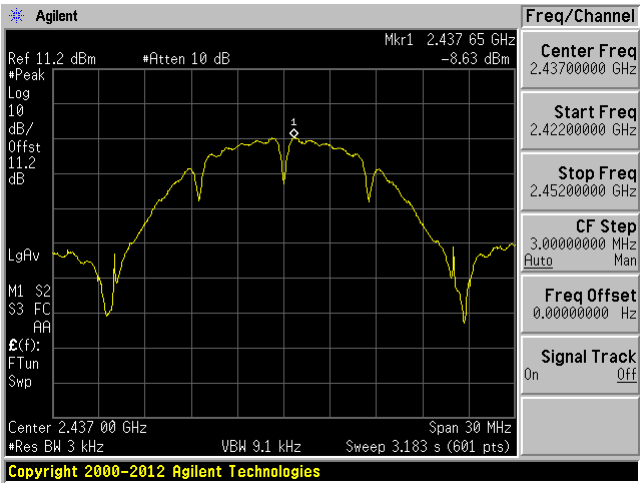


802.11b mode (Ant 1)

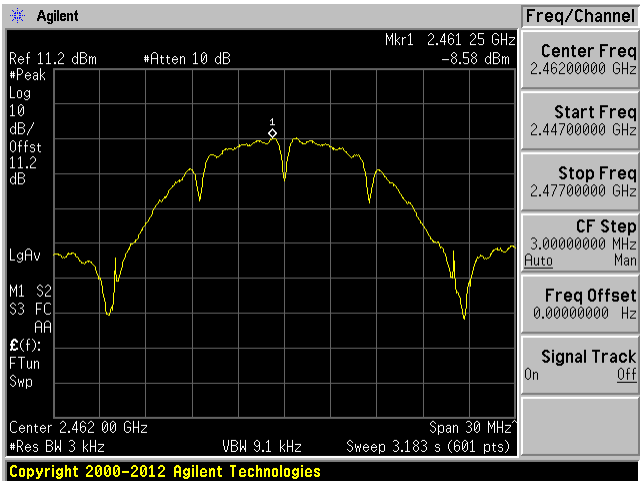
Low Channel 2412 MHz



Middle Channel 2437 MHz

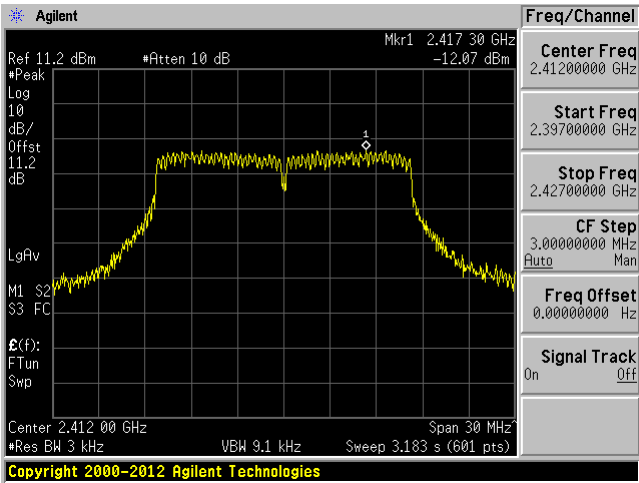


High Channel 2462 MHz

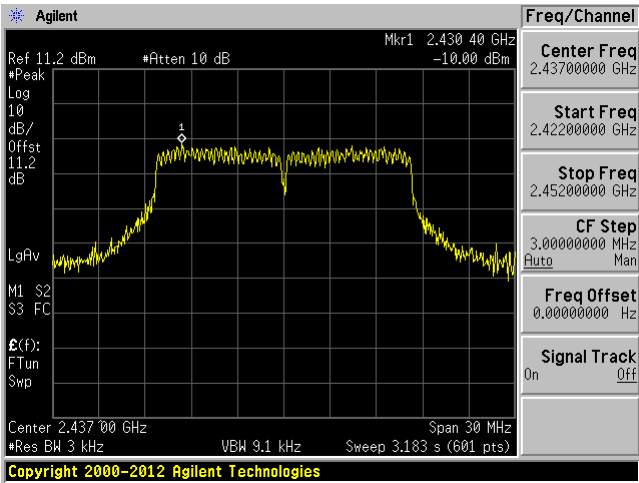


802.11g mode (Ant 0)

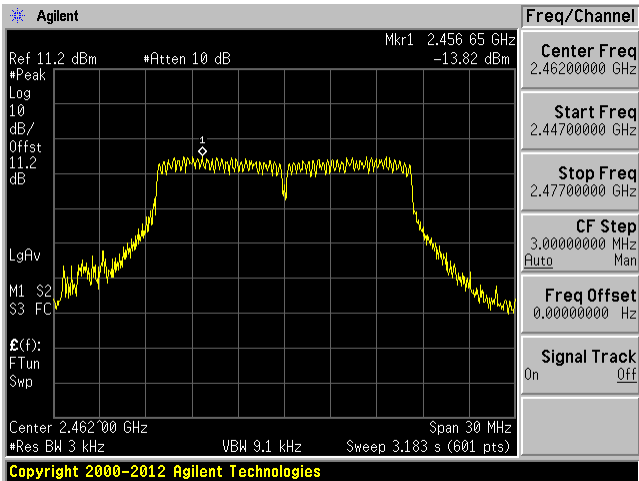
Low Channel 2412 MHz



Middle Channel 2437 MHz

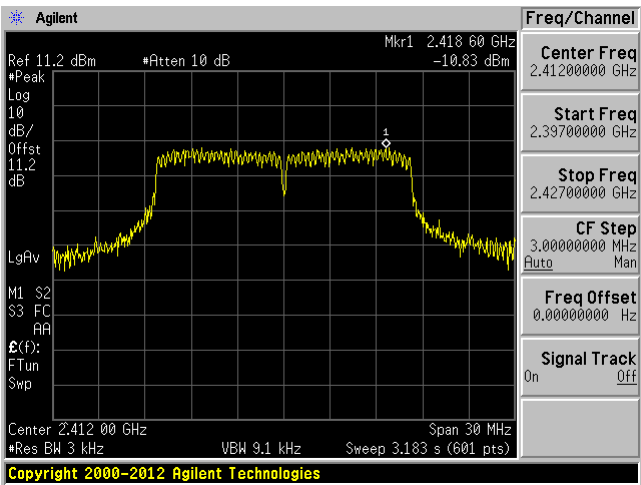


High Channel 2462 MHz

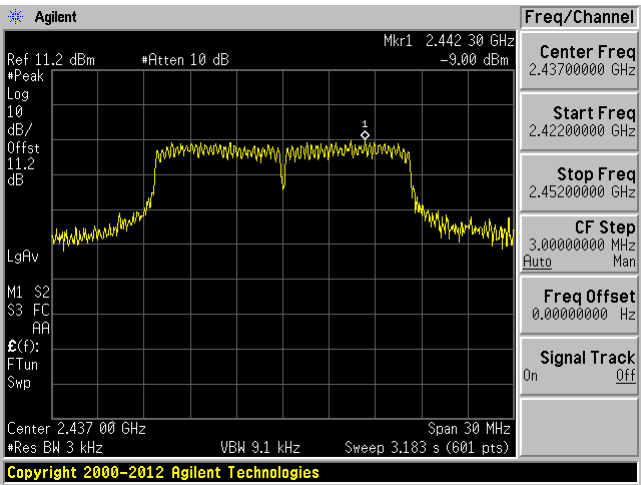


802.11g mode (Ant 1)

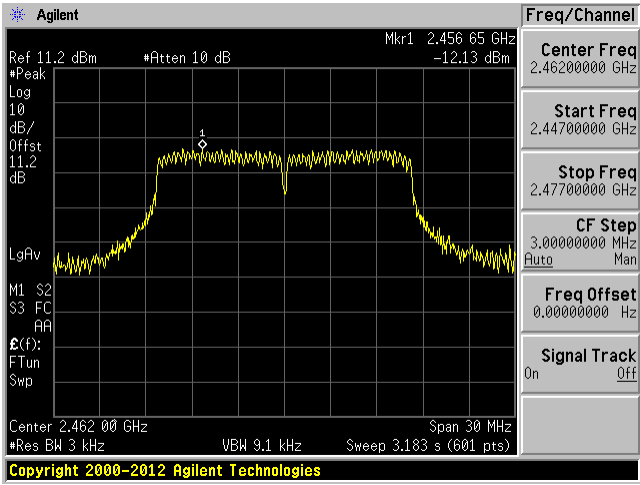
Low Channel 2412 MHz



Middle Channel 2437 MHz

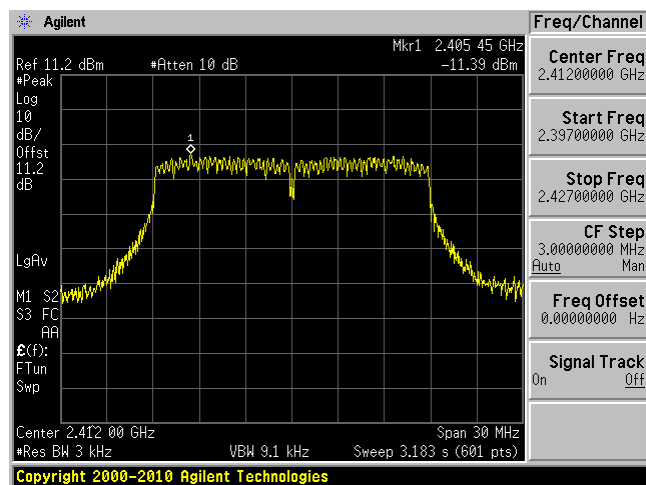


High Channel 2462 MHz

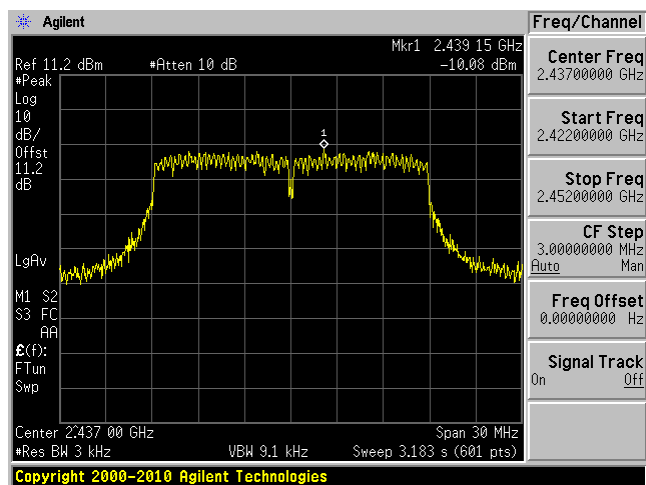


802.11n20 mode (Ant 0)

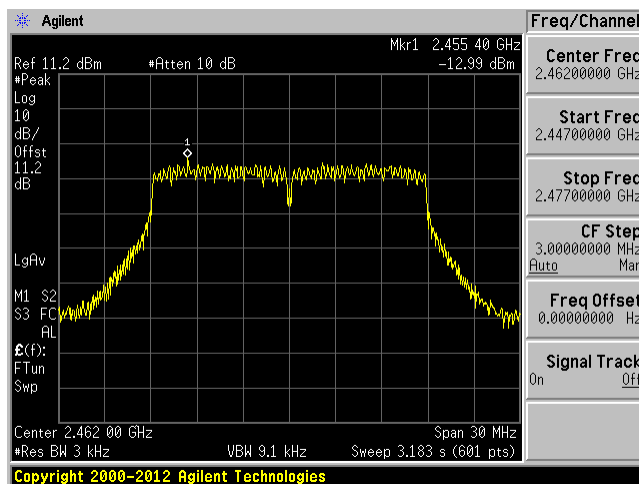
Low Channel 2412 MHz



Middle Channel 2437 MHz

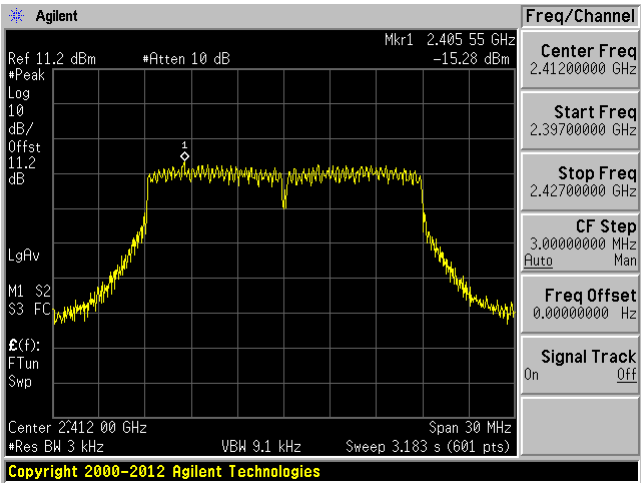


High Channel 2462 MHz

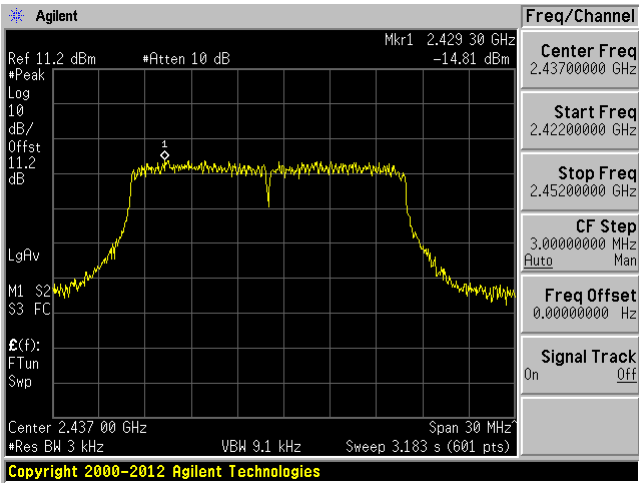


802.11n20 mode (Ant 0 MIMO)

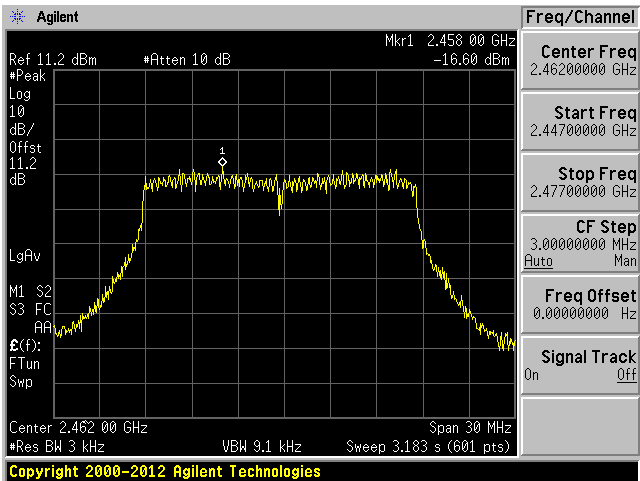
Low Channel 2412 MHz



Middle Channel 2437 MHz

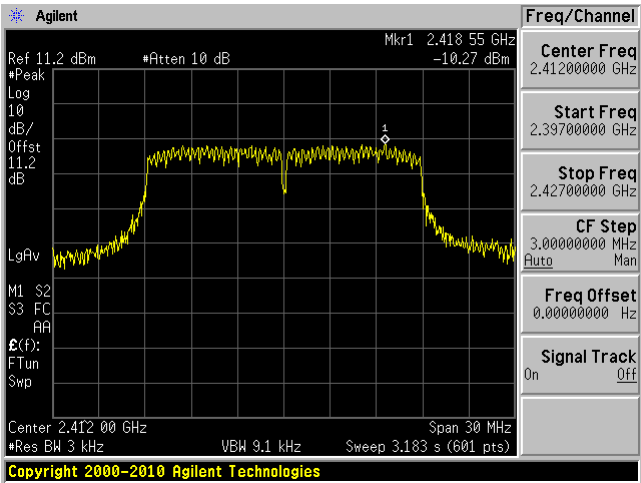


High Channel 2462 MHz

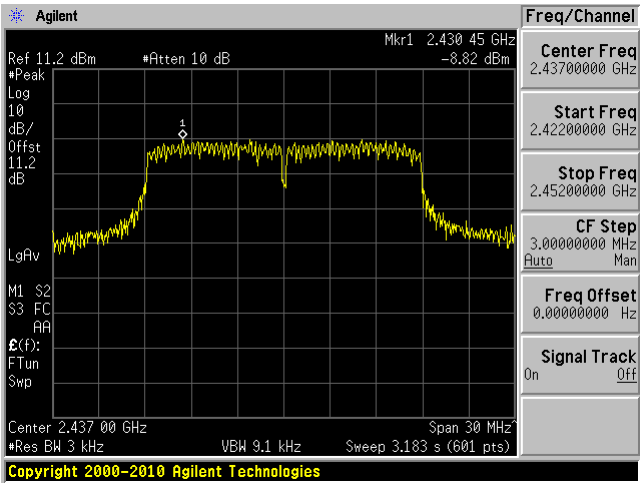


802.11n20 mode (Ant 1)

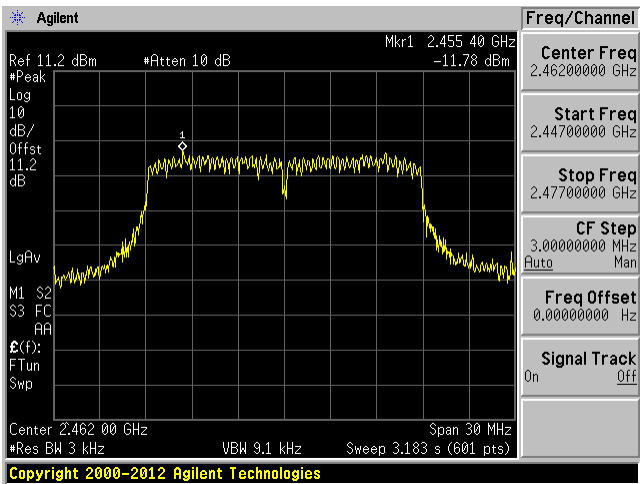
Low Channel 2412 MHz



Middle Channel 2437 MHz

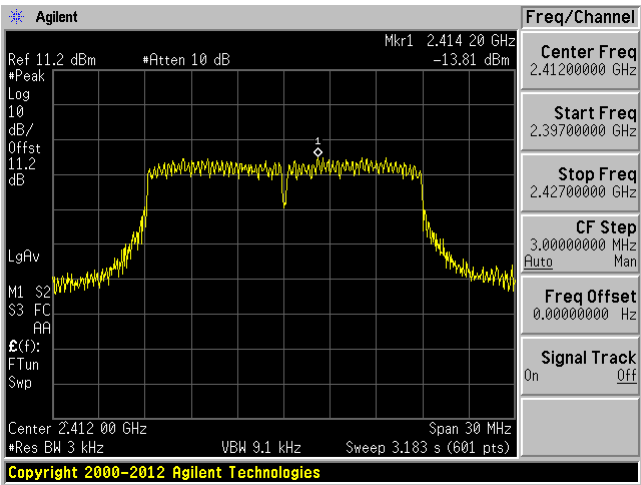


High Channel 2462 MHz

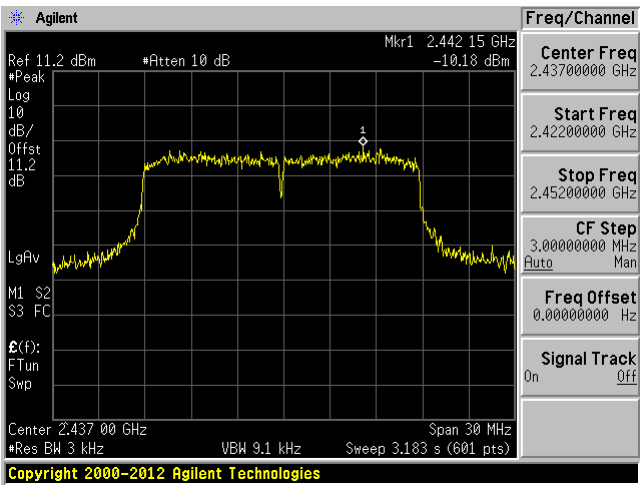


802.11n20 mode (Ant 1 MIMO)

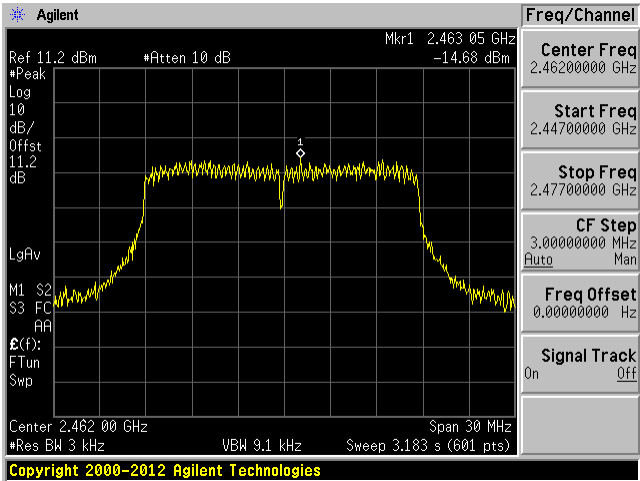
Low Channel 2412 MHz



Middle Channel 2437 MHz



High Channel 2462 MHz



12 FCC §15.247(d) & ISEDC RSS-247 §5.5, RSS-GEN §8.9 - Spurious Emissions at Antenna Terminals

12.1 Applicable Standards

For ECFR §15.247(d) in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

As per ISEDC RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

12.2 Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

12.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2017-04-20	1 year
-	U. FL to SMA pigtail	-	-	Each time ¹	N/A
-	10dB attenuator	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

12.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

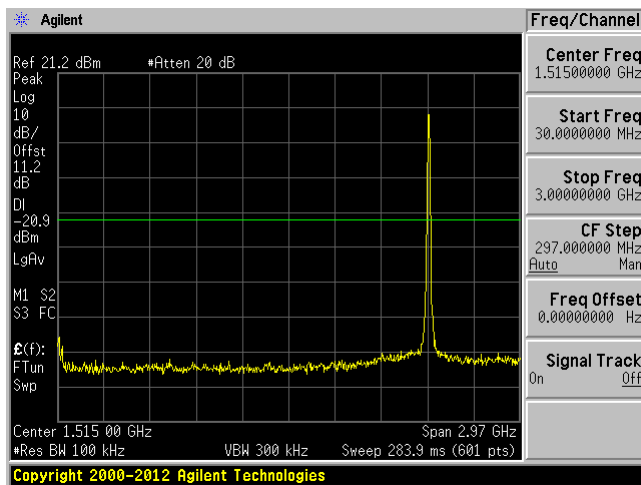
The testing was performed by Troy Pandhumsoporn on 2017-07-24 to 2017-07-26 in RF site.

12.5 Test Results

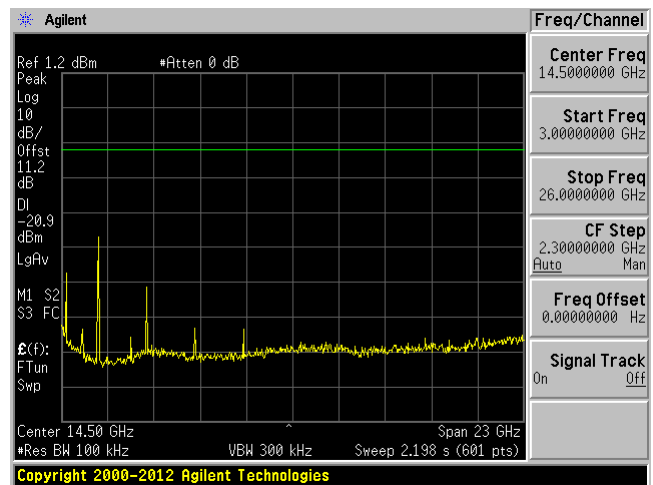
Please refer to following plots.

802.11b mode (Ant 0)

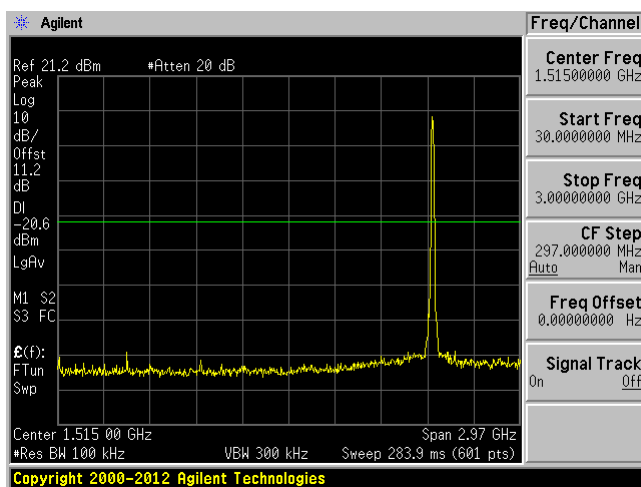
Low Channel 30MHz – 3 GHz



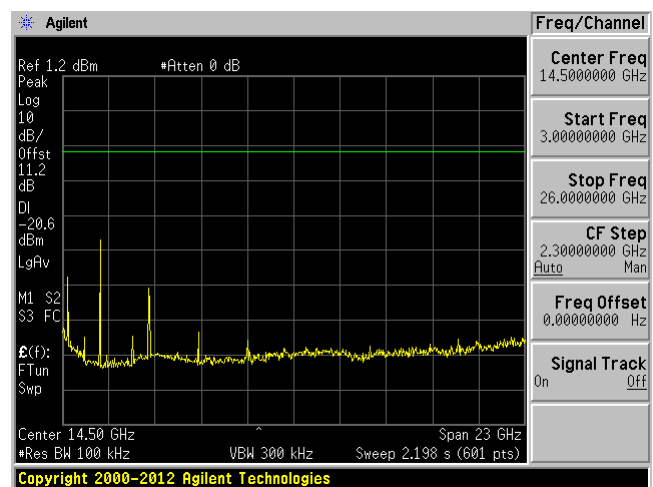
Low Channel 3 GHz – 26 GHz



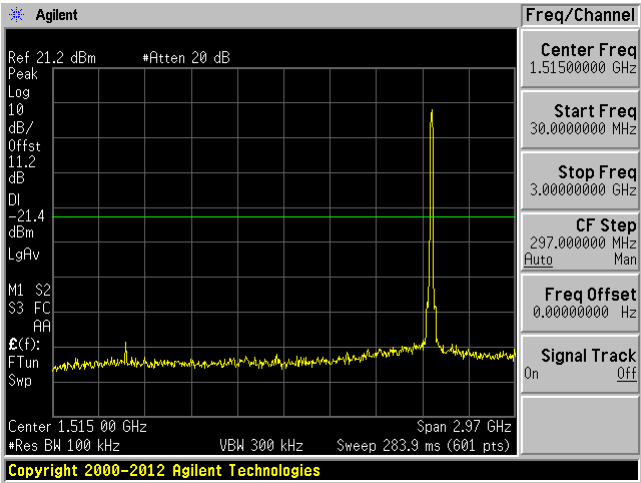
Middle Channel 30 MHz – 3 GHz



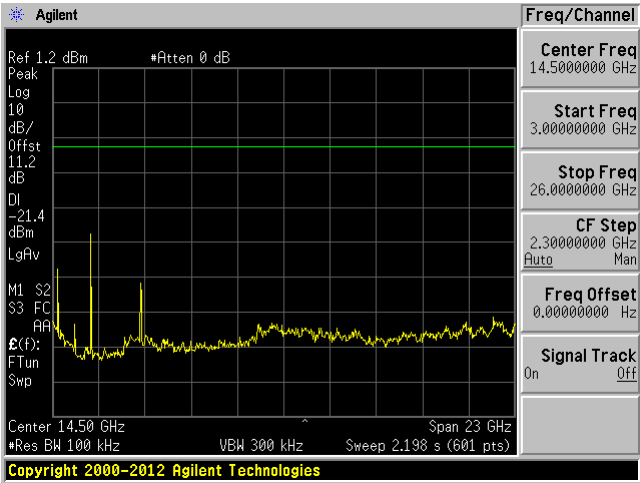
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz

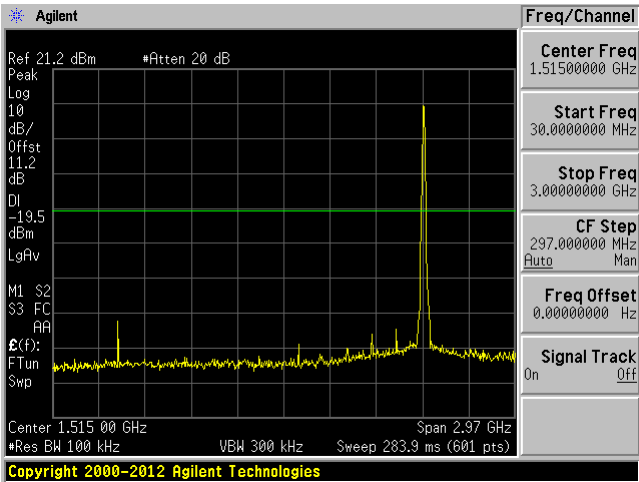


High Channel 3 GHz – 26 GHz

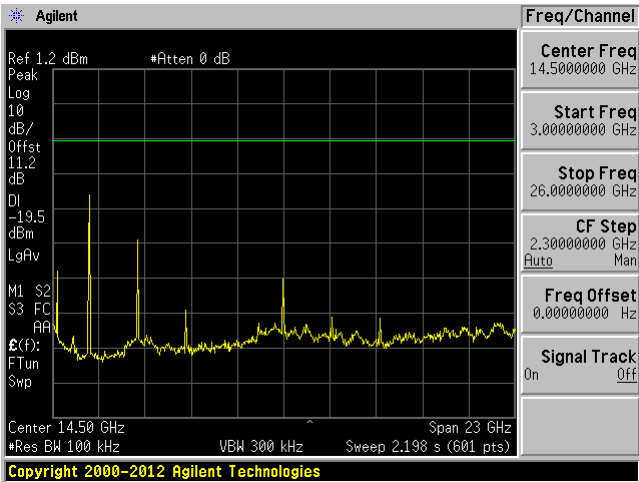


802.11b mode (Ant 1)

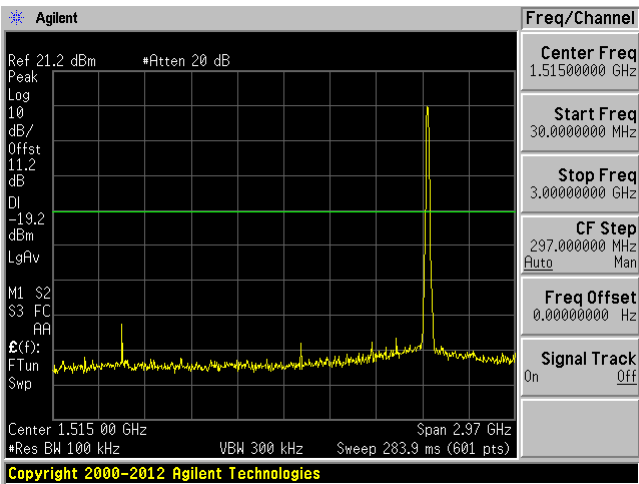
Low Channel 30 MHz – 3 GHz



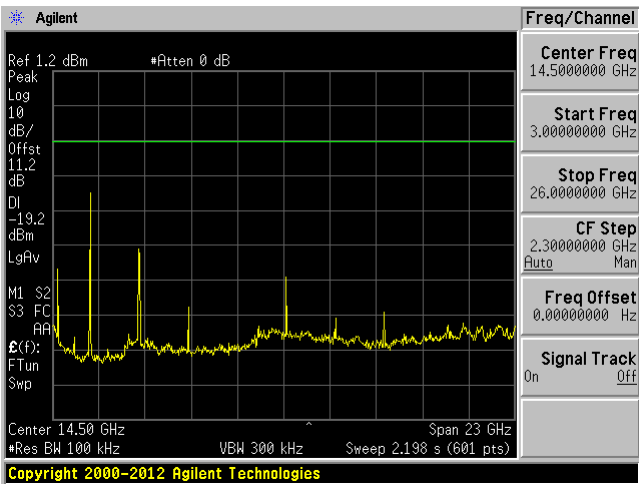
Low Channel 3 GHz – 26 GHz



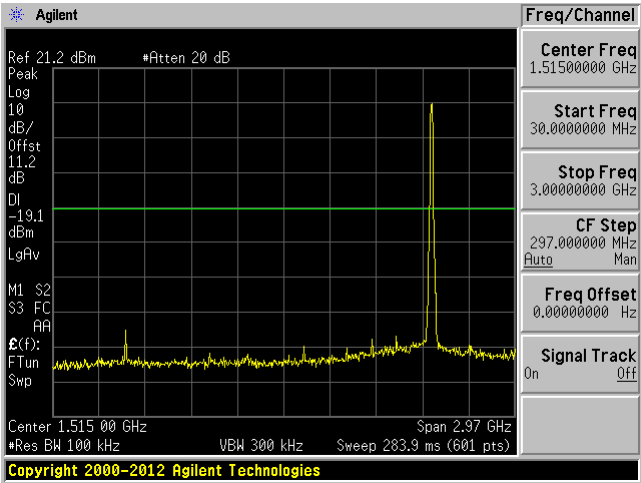
Middle Channel 30 MHz – 3 GHz



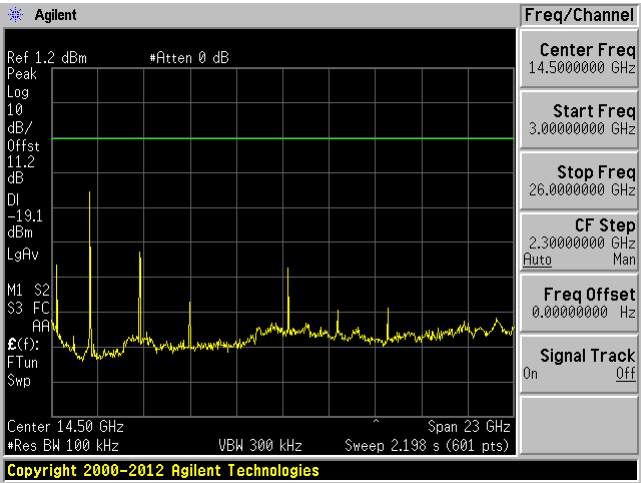
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz

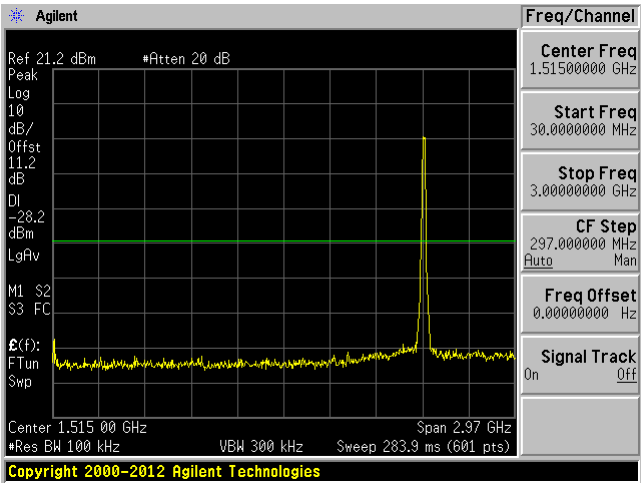


High Channel 3 GHz – 26 GHz

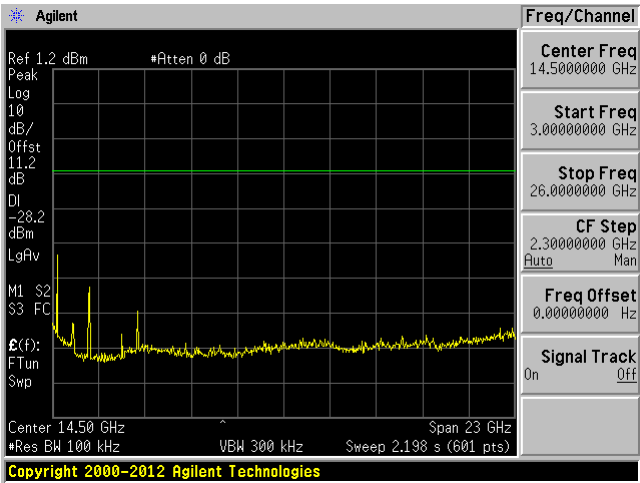


802.11g mode (Ant 0)

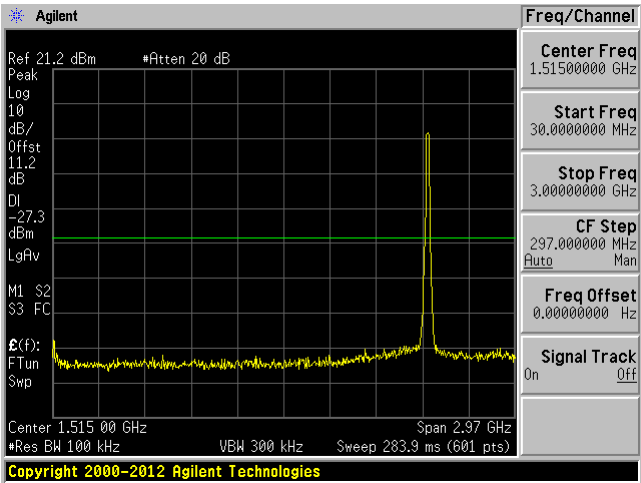
Low Channel 30 MHz – 3 GHz



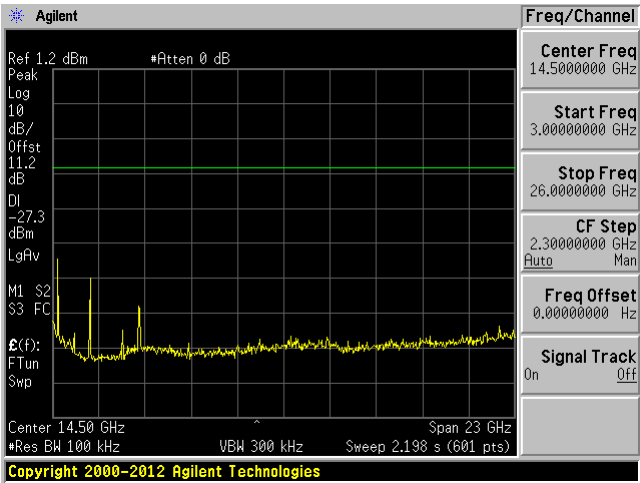
Low Channel 3 GHz – 26 GHz



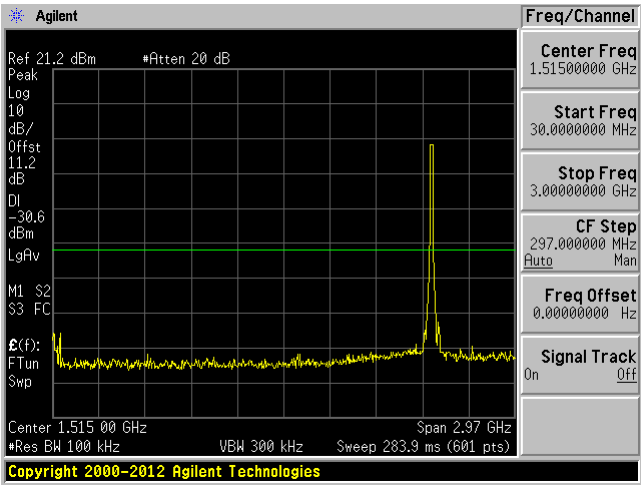
Middle Channel 30 MHz – 3 GHz



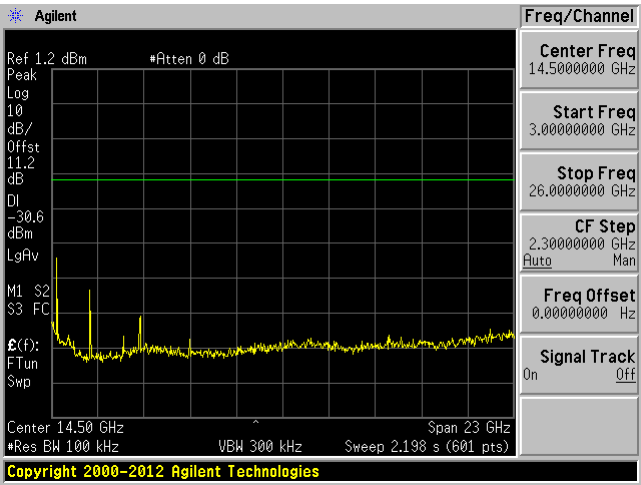
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz

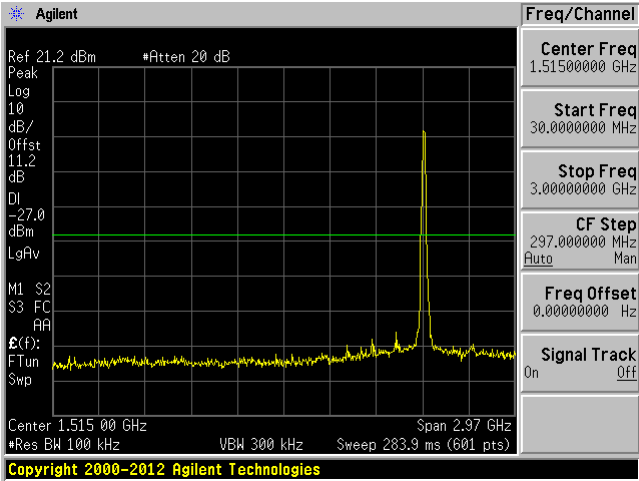


High Channel 3 GHz – 26 GHz

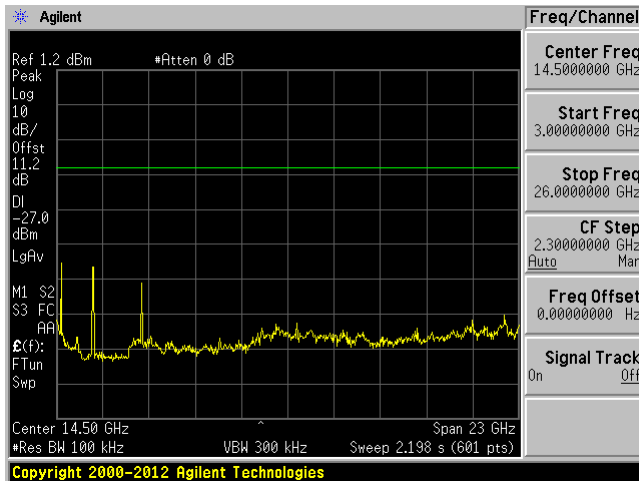


802.11g mode (Ant 1)

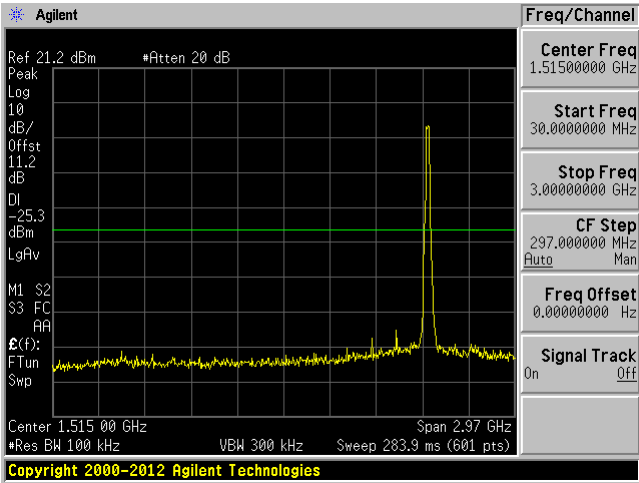
Low Channel 30 MHz – 3 GHz



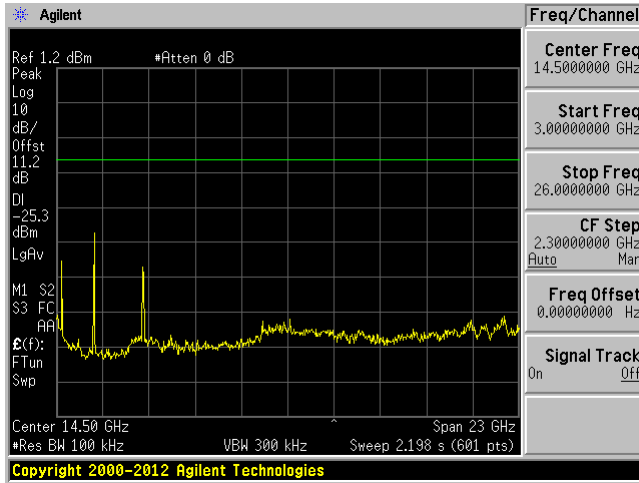
Low Channel 3 GHz – 26 GHz



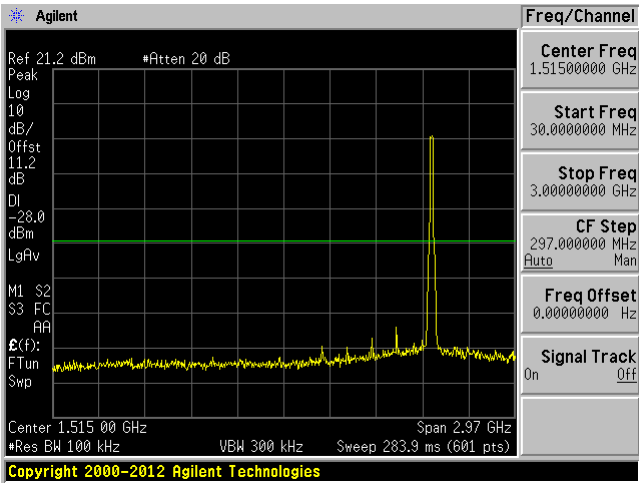
Middle Channel 30 MHz – 3 GHz



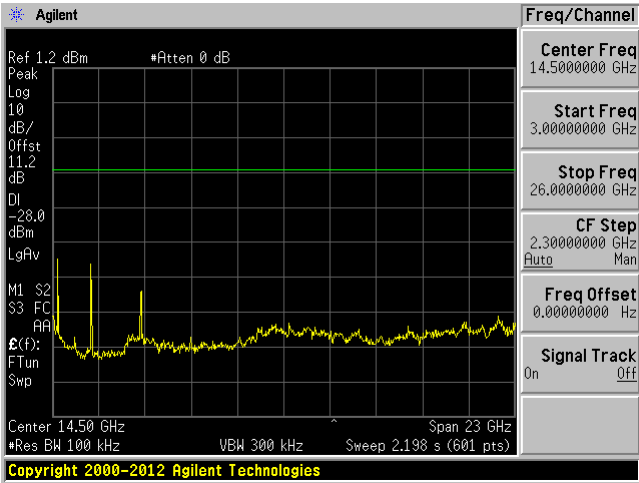
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz

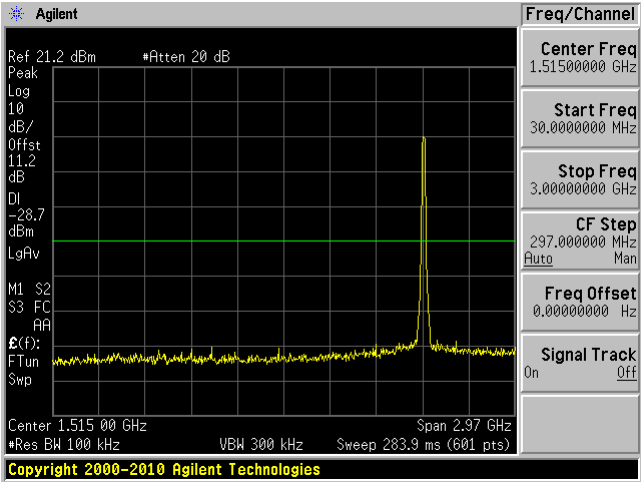


High Channel 3 GHz – 26 GHz

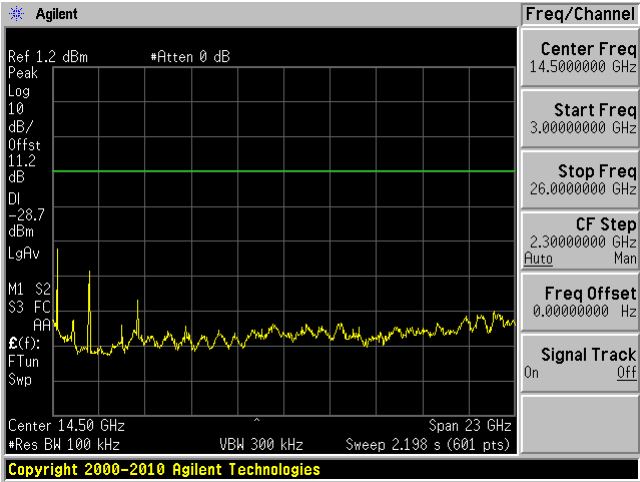


802.11n20 mode (Ant 0)

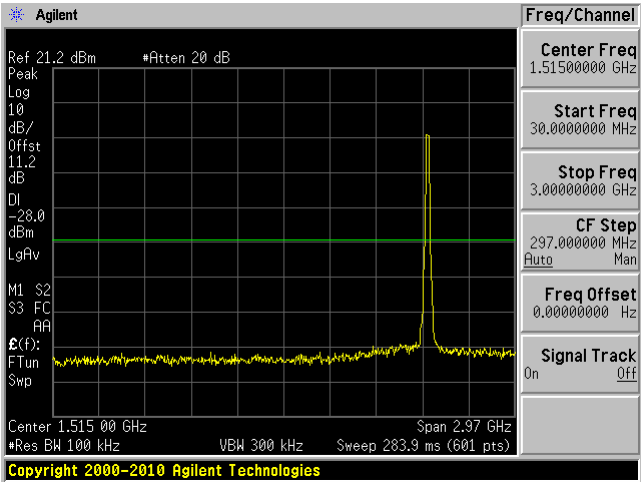
Low Channel 30 MHz – 3 GHz



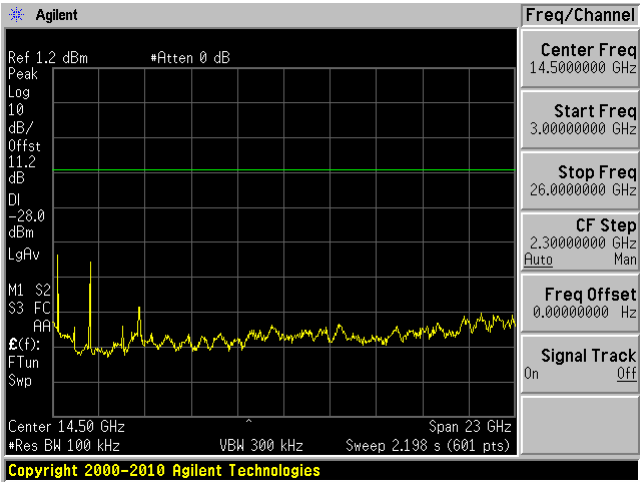
Low Channel 3 GHz – 26 GHz



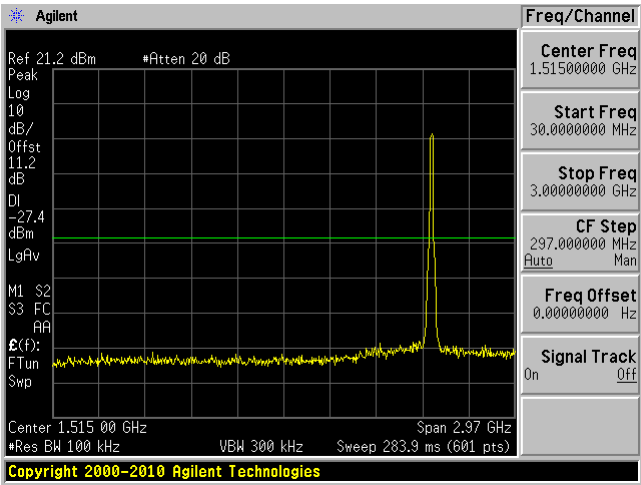
Middle Channel 30 MHz – 3 GHz



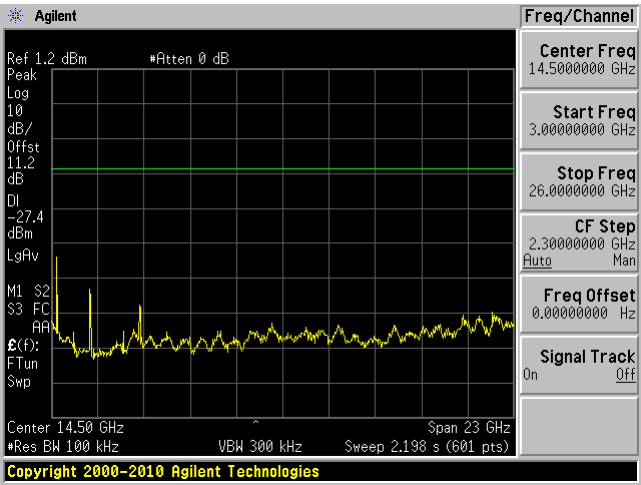
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz

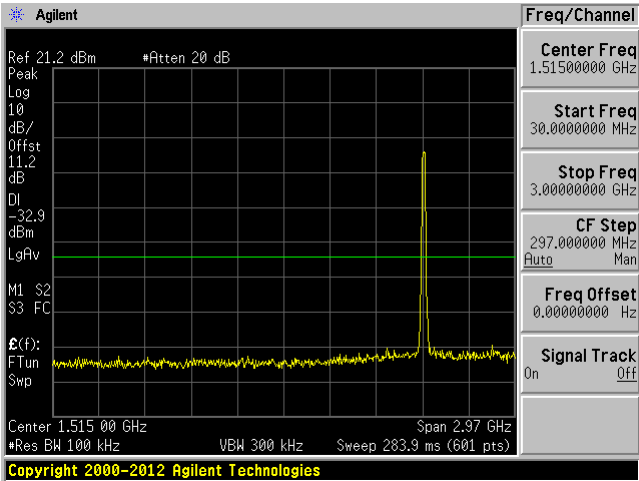


High Channel 3 GHz – 26 GHz

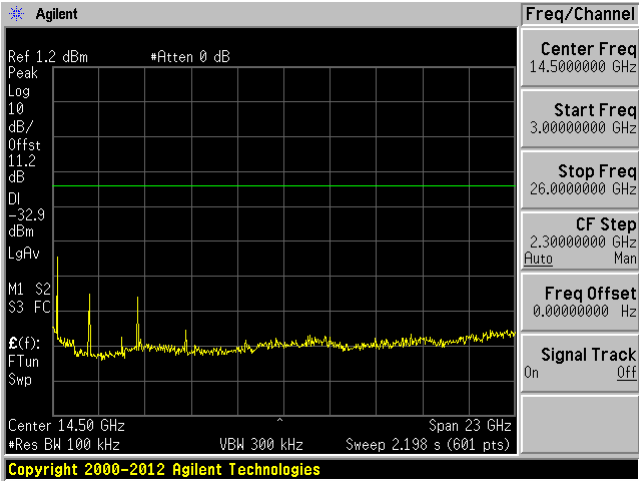


802.11n20 mode (Ant 0 MIMO)

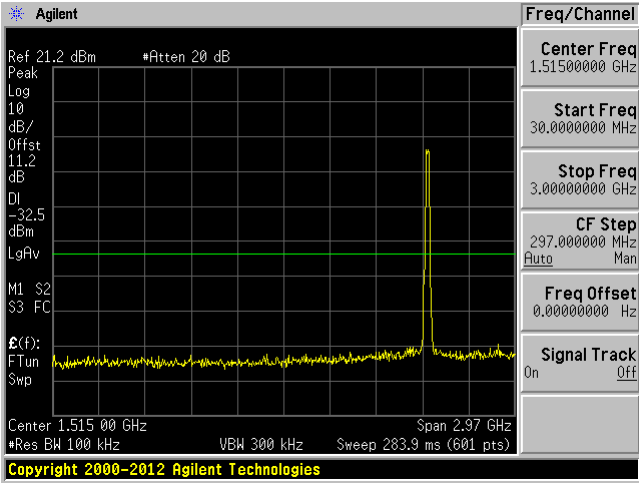
Low Channel 30 MHz – 3 GHz



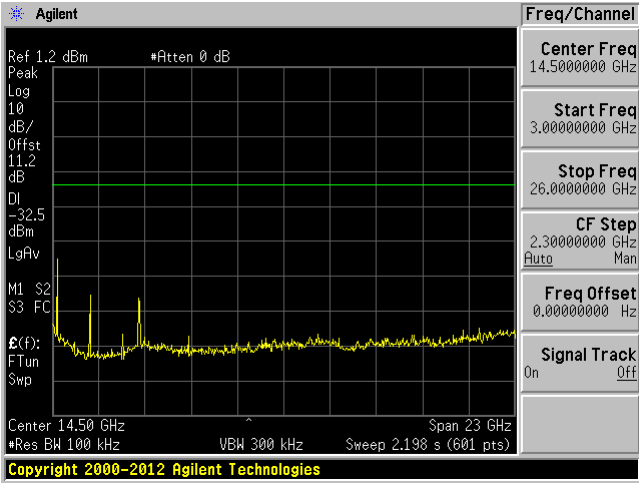
Low Channel 3 GHz – 26 GHz



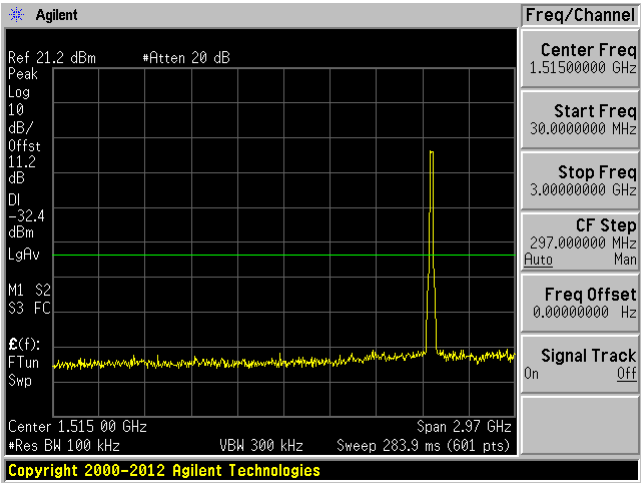
Middle Channel 30 MHz – 3 GHz



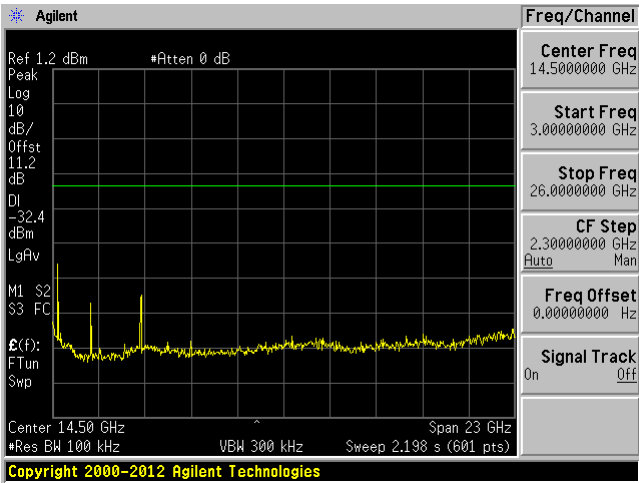
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz

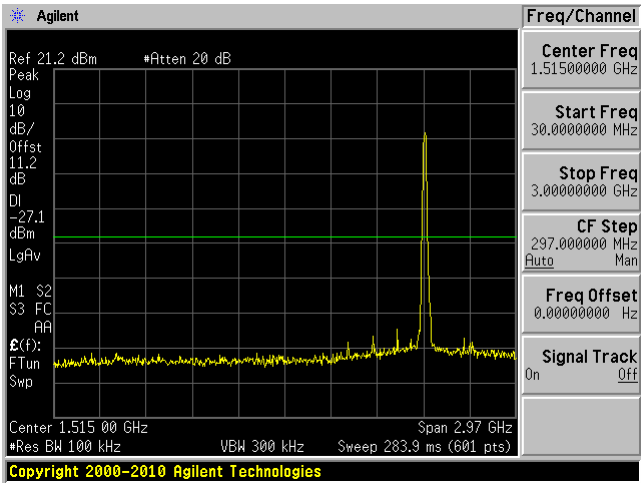


High Channel 3 GHz – 26 GHz

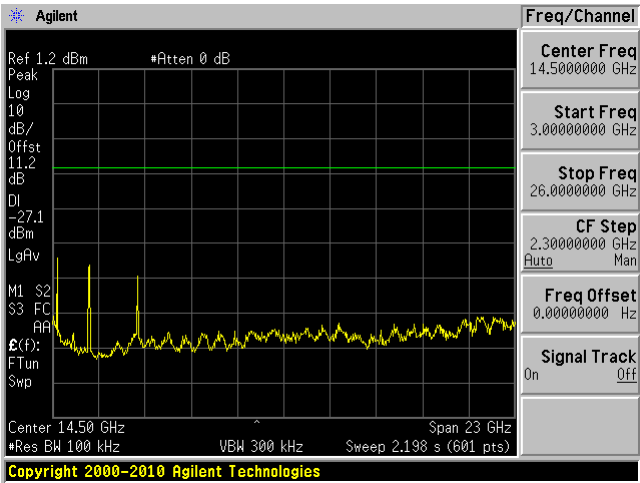


802.11n20 mode (Ant 1)

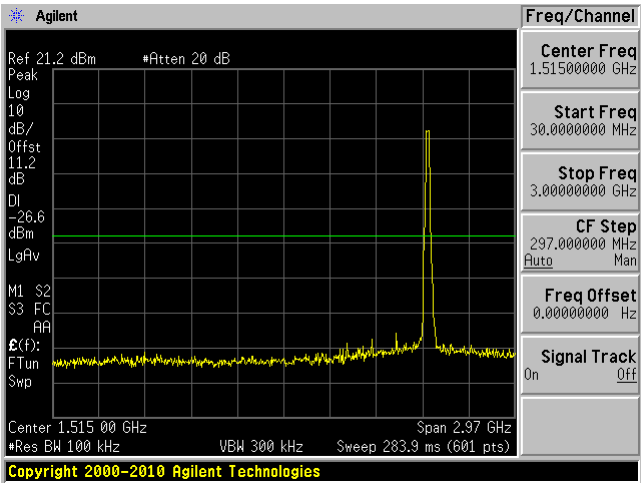
Low Channel 30 MHz – 3 GHz



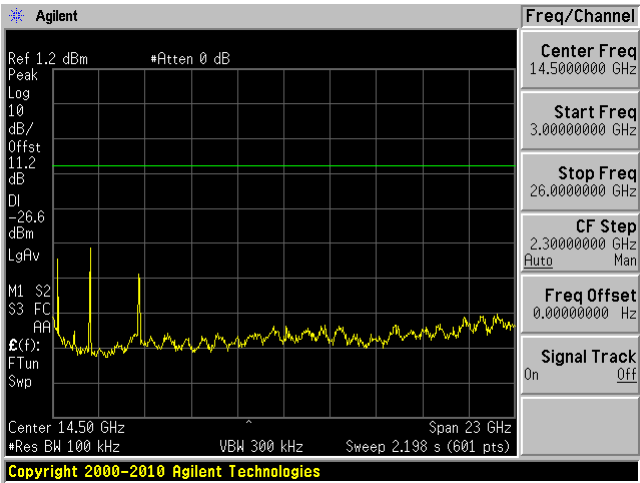
Low Channel 3 GHz – 26 GHz



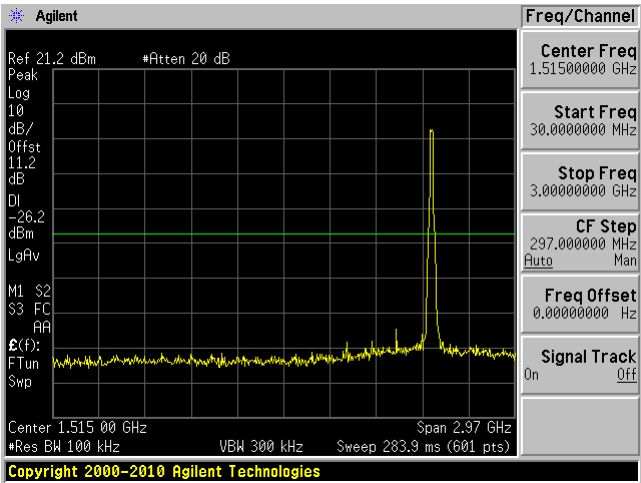
Middle Channel 30 MHz – 3 GHz



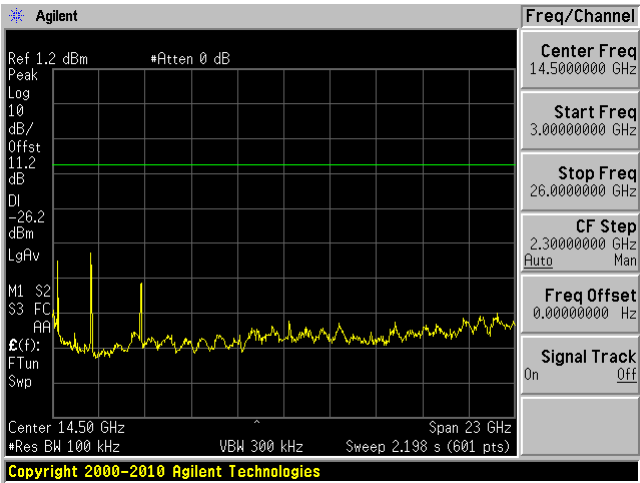
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz

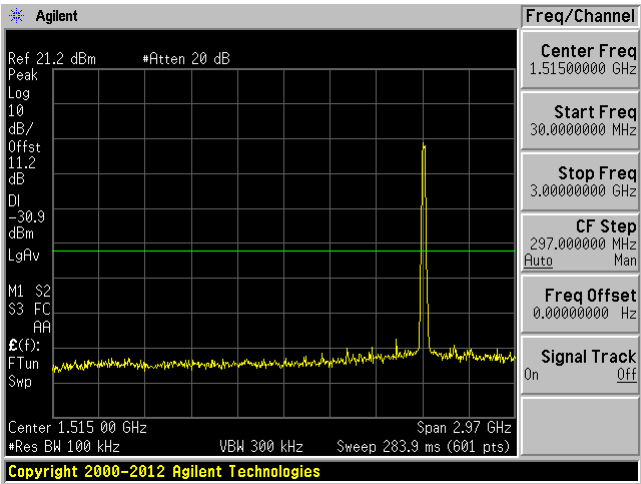


High Channel 3 GHz – 26 GHz

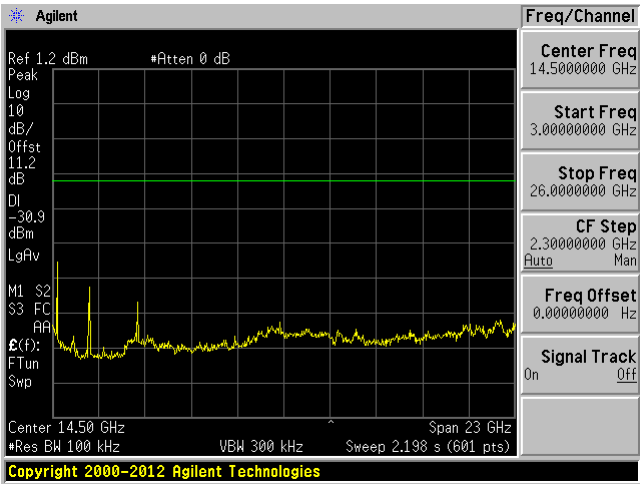


802.11n20 mode (Ant 1 MIMO)

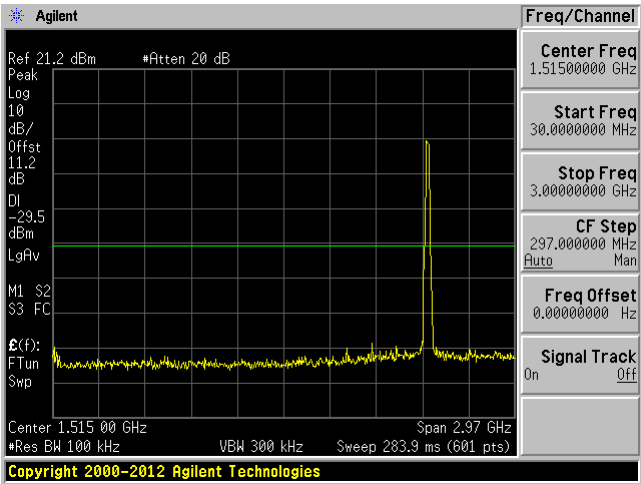
Low Channel 30 MHz – 3 GHz



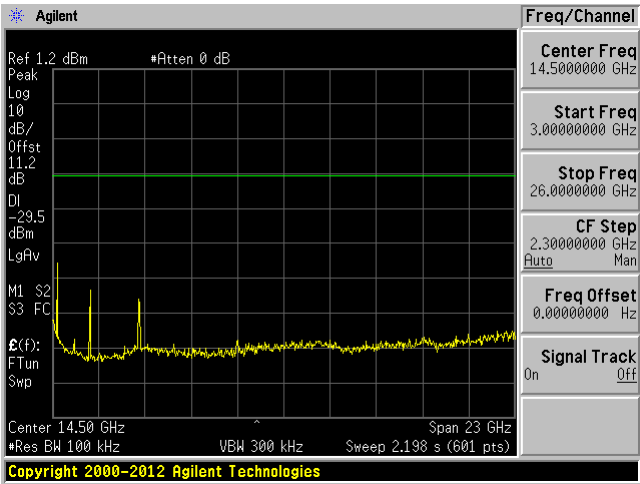
Low Channel 3 GHz – 26 GHz



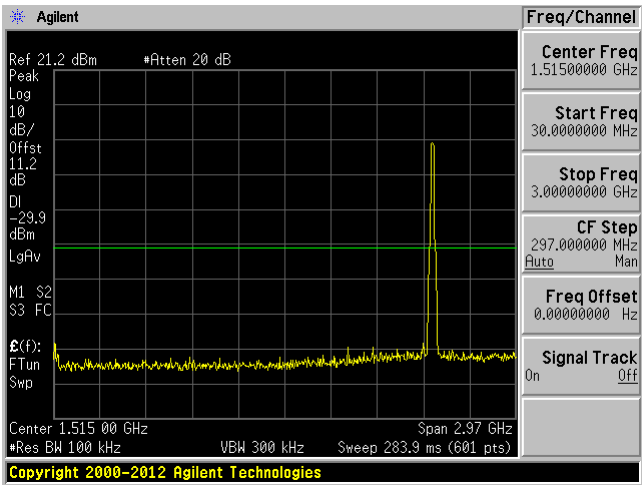
Middle Channel 30 MHz – 3 GHz



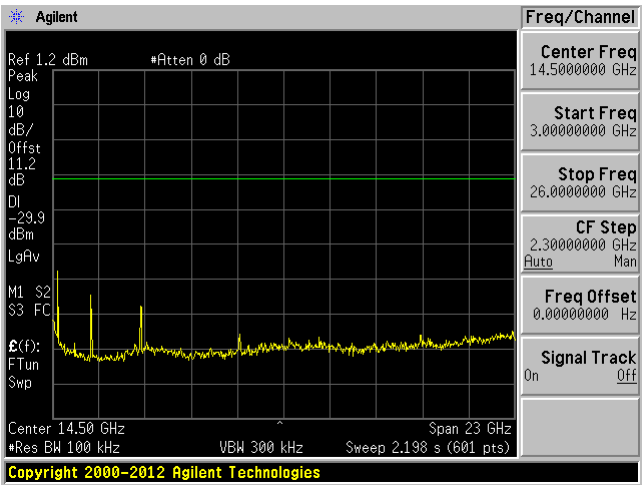
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz



High Channel 3 GHz – 26 GHz



13 Annex A (Informative) - A2LA Electrical Testing Certificate



Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories. This laboratory also meets the requirements of A2LA R222 - Specific Requirements - EPA ENERGY STAR Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).



Presented this 30th day of August 2016.

Senior Director of Quality & Communications
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2018

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

--- END OF REPORT ---