FCC PART 15, SUBPART C

TEST REPORT

For

Roku, Inc.

150 Winchester Cir

Los Gatos, CA 95032, USA

FCC ID: TC2-R1031

Report Type: Original Report		**Model:** 9101X
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Report Number	R1907164-247 (DTS)	
Report Date	2019-08-21	
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ACCREDITED
CERTIFICATE #3297.02

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1907164-247 (DTS)	Original Report	2019-08-21

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of Roku Inc., FCC ID: TC2-R1031.

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.

The objective is to determine compliance with FCC Part 15.247 for Output Power, Antenna Requirements, 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 15.247 Report: R1907164-247 DSS, FCC ID: TC2-R1031
FCC 15.407 Report: R1907164-407 NII, FCC ID: TC2-R1031

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 v05r02: 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 º 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 - ISEDC) Foreign Certification Body – FCB – APEC Tel MRA -Phase I and Phase II;
- Chinese Taipei (Republic of China – Taiwan):
  - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - EMC Directive 2004/108/EC US-EU EMC and Telecom MRA CAB
  - Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
  - Low Voltage Directive (LVD) 2014/35/EU
- 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:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC
  - Nationally Recognized Test Laboratory (NRTL) – US OSHA
- 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 v05r02.

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 PPSD across all data rates bandwidths, and modulations.

2.2 EUT Exercise Software

The software used in testing to configure the EUT was Putty. The software is compliant with the standard requirements being tested against.

Modulation	Frequency (MHz)	Power Setting RADIO 2 Ant A &B	Power Setting RADIO 1 Ant A
802.11b	2412	63	50
	2437	63	58
	2462	63	52
8002.11g	2412	57	49
	2437	60	54
	2462	58	48
802.11n20	2412	54	50
	2437	61	50
	2462	59	48
Modulation	**Frequency (MHz)**	**Power Setting**	
BLE	2402	Max	
	2440	Max	
	2480	Max	

Note: Radio 2 is Roku Wifi 1 and Radio 1 is Roku Wifi 2 in the block diagram.

2.3 Duty Cycle Correction Factor

According to KDB 558074 D01 DTS Meas Guidance v05r02 section 6.0:

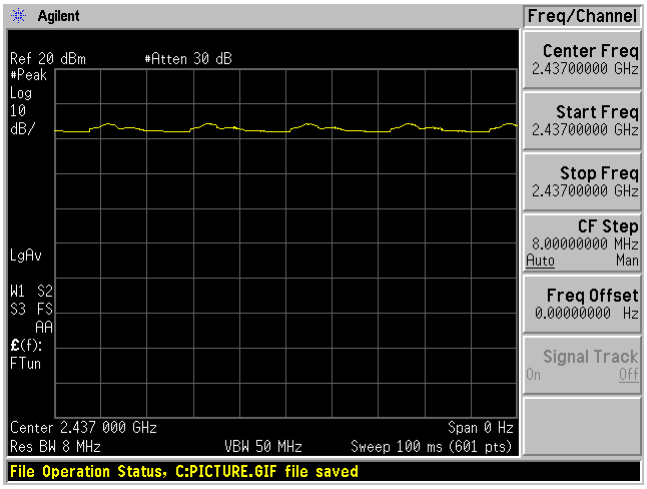
Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized 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
BLE	100	0

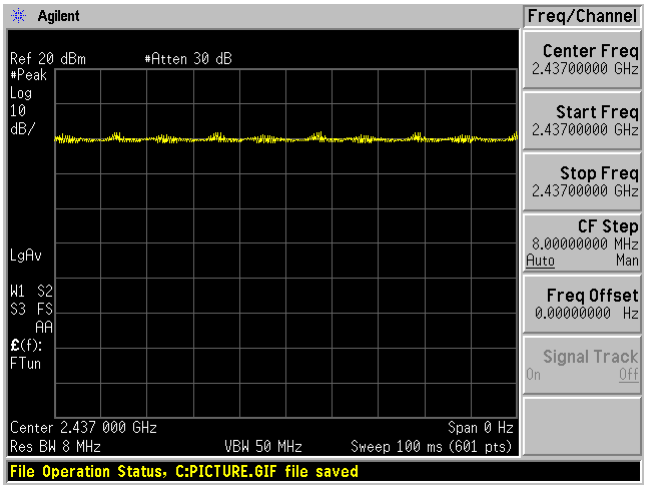
Duty Cycle = On Time (ms)/ Period (ms)
Duty Cycle Correction Factor (dB) = 10*log(1/Duty Cycle)

Please refer to the following plots.

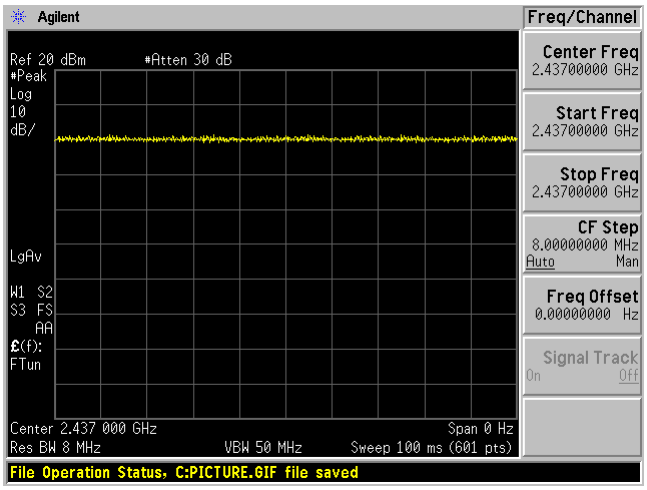
802.11 b mode



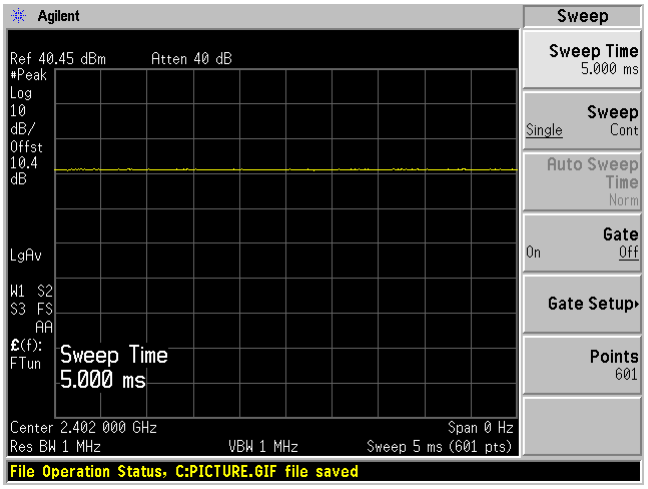
802.11 g mode



802.11 n20 mode



BLE



2.4 Equipment Modifications

No equipment modifications were made to the EUT.

2.5 Local Support Equipment

Manufacturer	Description	Model	Serial Number
Dell	Laptop	Latitude E6410	3CKRAQ1

2.6 Support Equipment

Manufacturer	Description	Model
Roku, Inc.	Debug Board	

2.7 Power Supply/Adapter

Eut was was powered by an extension cable for testing.

2.8 Interface Ports and Cabling

Cable Description	Length (m)	To	From
RF Cable	< 1m	EUT	PSA
Power Extension Cord	< 1m	EUT	Outlet
USB Type-A to USB Type B	< 1m	Laptop	Debug Board

3 Summary of Test Results

Results reported relate only to the product tested.

FCC Rules	Description of Test	Results
FCC §15.203	Antenna Requirement	Compliant
FCC §15.207	AC Line Conducted Emissions	Compliant
§2.1091, §15.247(i)	RF Exposure	Compliant
FCC §2.1051, §15.247 (d)	Spurious Emissions at Antenna Port	Compliant
FCC §2.1053, §15.205, §15.209, §15.247(d)	Radiated Spurious Emissions	Compliant
FCC §15.247(a)(2)	6 dB and 99% Emission Bandwidth	Compliant
FCC §15.247(b)(3)	Maximum Peak Output Power	Compliant
FCC §15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(e)	Power Spectral Density	Compliant

4 FCC §15.203 - 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.

4.2 Antenna Description

The antennas used by the EUT are permanent attached antennas. The following antenna specifications were provided by the applicant.

Radio	Antenna usage	Band of Operation (GHz)	Maximum Antenna Gain (dBi)
Radio 1	Wi-Fi	2400-2483.5	1.8
	Wi-Fi	5000-6000	2.6
Radio 2	Wi-Fi	2400-2483.5	1.8
	Wi-Fi	5000-6000	2.6

Antenna usage	Band of Operation (GHz)	Maximum Antenna Gain (dBi)
Bluetooth	2400-2483.5	1.8

5 FCC §2.1091, §15.247(i)– RF Exposure

5.1 Applicable Standards

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

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

Radio 1

5 GHz Wi-Fi

Maximum output power at antenna input terminal (dBm):	21.91
Maximum output power at antenna input terminal (mW):	155.2387
Prediction distance (cm):	20
Prediction frequency (MHz):	5745
Maximum Antenna Gain, typical (dBi):	2.6
Maximum Antenna Gain (numeric):	1.82
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.05620844
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.05620844mW/cm^2. Limit is 1.0 mW/cm^2.

2.4 GHz Wi-Fi

Maximum peak output power at antenna input terminal (dBm):	22.47
Maximum peak output power at antenna input terminal (mW):	176.6038
Prediction distance (cm):	20
Prediction frequency (MHz):	2437
Maximum Antenna Gain, typical (dBi):	1.8
Maximum Antenna Gain (numeric):	1.51
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.05305266
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.05305266mW/cm^2. Limit is 1.0 mW/cm^2.

Radio 2

5 GHz Wi-Fi

Maximum output power at antenna input terminal (dBm):	19.18
Maximum output power at antenna input terminal (mW):	82.7942
Prediction distance (cm):	20
Prediction frequency (MHz):	5745
Maximum Antenna Gain, typical (dBi):	2.6
Maximum Antenna Gain (numeric):	1.82
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.029959016
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.029959016mW/cm^2. Limit is 1.0 mW/cm^2.

2.4 GHz Wi-Fi

Maximum peak output power at antenna input terminal (dBm):	22.02
Maximum peak output power at antenna input terminal (mW):	159.2209
Prediction distance (cm):	20
Prediction frequency (MHz):	2412
Maximum Antenna Gain, typical (dBi):	1.8
Maximum Antenna Gain (numeric):	1.51
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.047830747
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.047830747mW/cm^2. Limit is 1.0 mW/cm^2.

2.4 GHz Classic Bluetooth

Maximum peak output power at antenna input terminal (dBm):	12.81
Maximum peak output power at antenna input terminal (mW):	19.09853
Prediction distance (cm):	20
Prediction frequency (MHz):	2402
Maximum Antenna Gain, typical (dBi):	1.8
Maximum Antenna Gain (numeric):	1.51
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.005737293
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.005737293mW/cm^2. Limit is 1.0 mW/cm^2.

Worst case colocation Radio 1 5 GHz Wi-Fi, Radio 2 2.4 GHz Wi-Fi and 2.4 GHz Classic Bluetooth:

Frequency Band	Max Conducted Power(dBm)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
Worst Case							
Radio 1 5 GHz WiFi	21.91	20	0.05620844	1.0	5.621%	10.978%	100%
Radio 2 2.4 GHz WiFi	22.02	20	0.047830747	1.0	4.783%		
2.4 GHz Classic BT	12.81	20	0.005737293	1.0	0.574%		

6 FCC §15.207 - AC Line Conducted Emissions

6.1 Applicable Standards

As per FCC §15.207 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 μH/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

6.1 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.

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.

6.2 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”.

6.3 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:

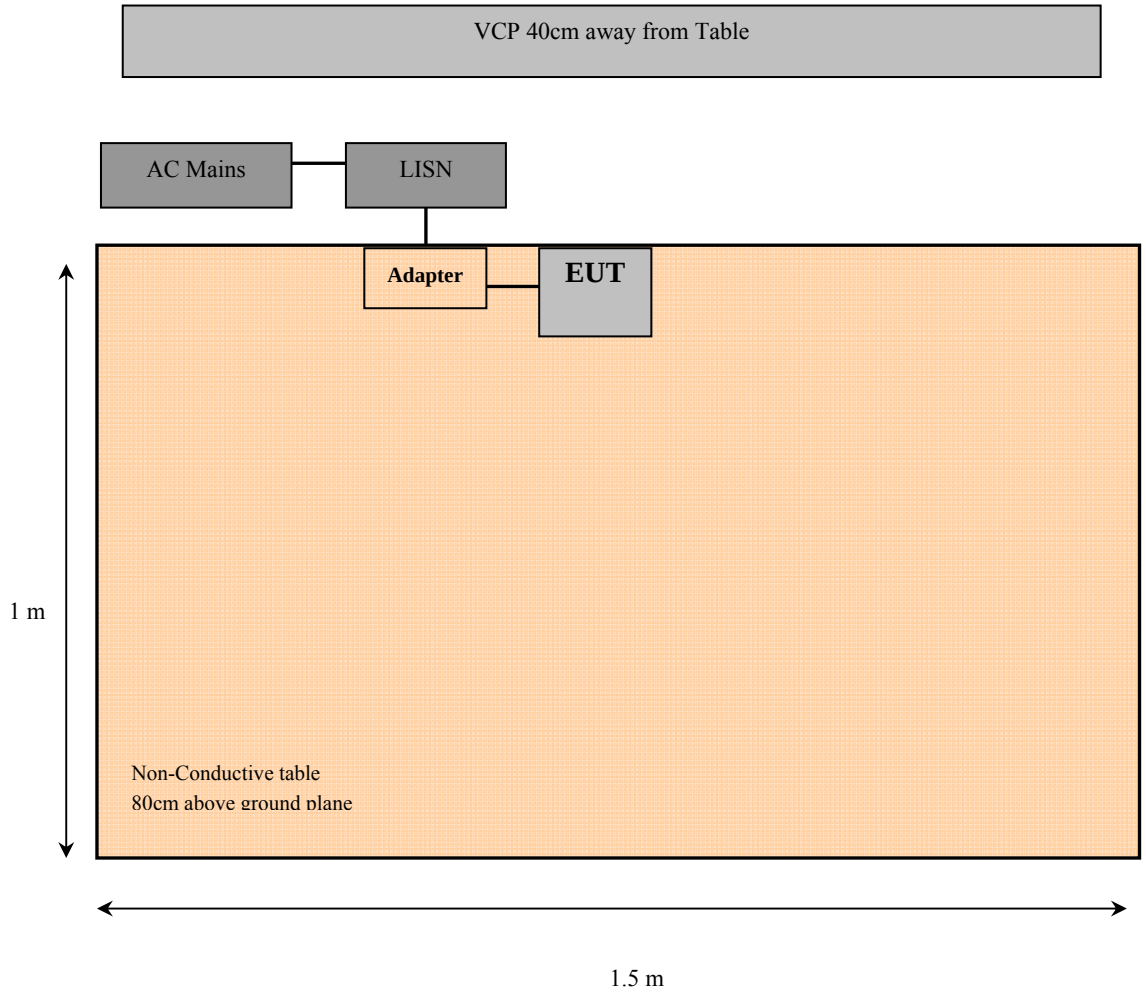
CA = Ai + CL + Atten

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:

Margin = Corrected Amplitude – Limit

6.4 Test Setup Block Diagram



6.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950.03	100338	2018-07-05	2 years
Rohde and Schwarz	Impulse Limiter	ESH3-Z2	101964	2019-07-31	1 year
Solar Electronics Company	High Pass Filter	Type 7930-100	7930150204	2019-02-25	1 year
Suirong	30 ft conductive emission cable	LMR 400	-	N/R	N/A
FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2019-04-11	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

***Statement of Traceability*:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) "A2LA Policy on Metrological Traceability".

6.6 Test Environmental Conditions

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

The testing was performed by Corey Phan on 2019-08-09 in the outside emission test site.

6.7 Summary of Test Results

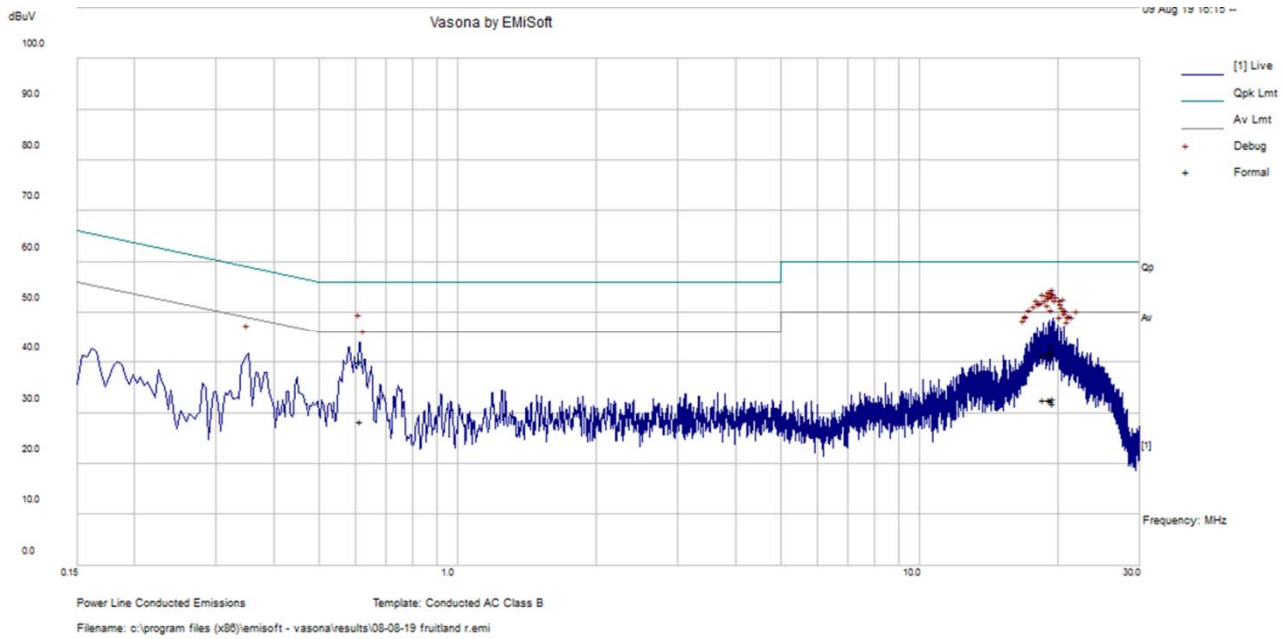
According to the recorded data in following table, the EUT complied with the FCC 15C's conducted emissions limits, with the margin reading of:

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Line/Neutral)**	**Range (MHz)**
-15.02	0.64088	Neutral	0.15-30

6.8 Conducted Emissions Test Plots and Data

2.4 GHz Wi-Fi Radio 1; 2.4GHz Wi-Fi Radio 2 and 2.4 GHz Classic Bluetooth

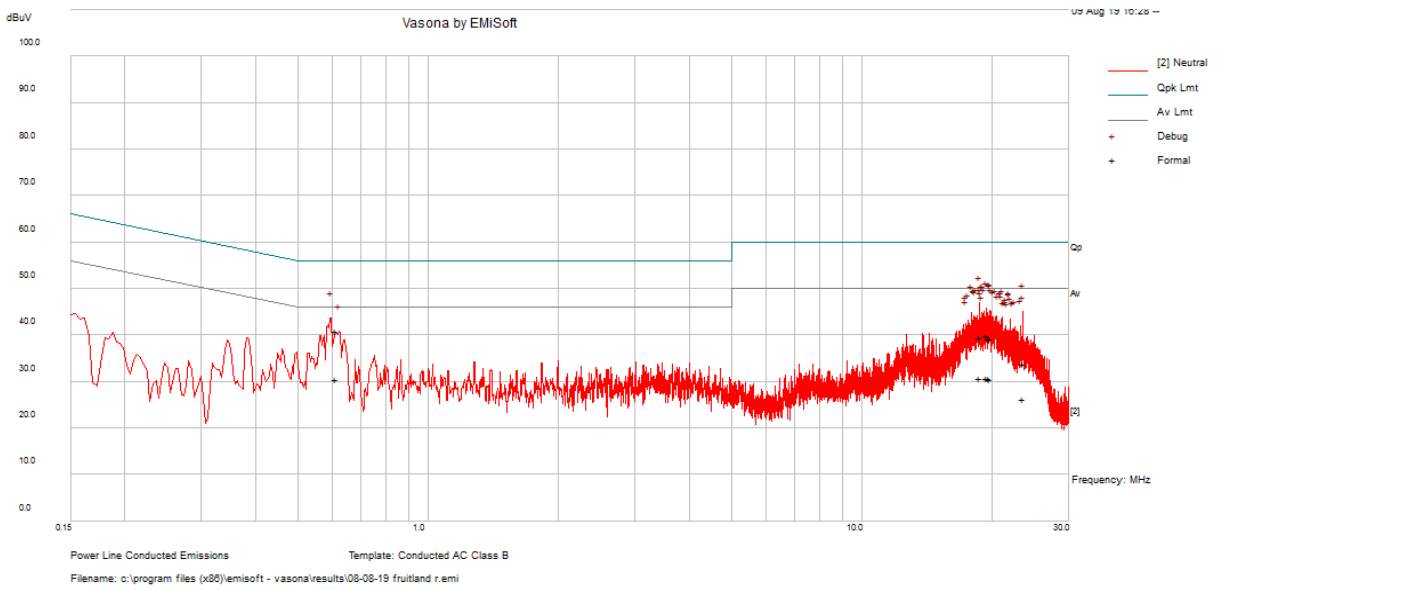
120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
19.505984	42.14	Line	60	-17.86	QP
19.168776	41.88	Line	60	-18.12	QP
19.551497	43.14	Line	60	-16.86	QP
19.380654	40.91	Line	60	-19.09	QP
0.617134	40.19	Line	56	-15.81	QP
18.545528	41.41	Line	60	-18.59	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	De tector (QP/Ave.)
19.505984	32.78	Line	50	-17.22	Ave
19.168776	32.54	Line	50	-17.46	Ave
19.551497	31.82	Line	50	-18.18	Ave
19.380654	32.3	Line	50	-17.7	Ave
0.617134	28.47	Line	46	-17.53	Ave
18.545528	32.58	Line	50	-17.42	Ave

120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.614088	**40.98**	**Neutral**	**56**	**-15.02**	**QP**
18.686649	39.47	Neutral	60	-20.53	QP
19.386126	39.93	Neutral	60	-20.07	QP
19.673742	39.28	Neutral	60	-20.72	QP
19.769735	39.33	Neutral	60	-20.67	QP
23.492635	33.69	Neutral	60	-26.31	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.614088	30.61	Neutral	46	-15.39	Ave
18.686649	30.69	Neutral	50	-19.31	Ave
19.386126	30.82	Neutral	50	-19.18	Ave
19.673742	30.66	Neutral	50	-19.34	Ave
19.769735	30.39	Neutral	50	-19.61	Ave
23.492635	26.17	Neutral	50	-23.83	Ave

7 FCC §15.209, §15.247(d) - 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) 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 0.495 – 0.505 2.1735 – 2.1905 4.125 – 4.128 4.17725 – 4.17775 4.20725 – 4.20775 6.215 – 6.218 6.26775 – 6.26825 6.31175 – 6.31225 8.291 – 8.294 8.362 – 8.366 8.37625 – 8.38675 8.41425 – 8.41475 12.29 – 12.293 12.51975 – 12.52025 12.57675 – 12.57725 13.36 – 13.41	16.42 – 16.423 16.69475 – 16.69525 25.5 – 25.67 37.5 – 38.25 73 – 74.6 74.8 – 75.2 108 – 121.94 123 – 138 149.9 – 150.05 156.52475 – 156.52525 156.7 – 156.9 162.0125 –167.17 167.72 – 173.2 240 – 285 322 – 335.4 399.9 – 410 608 – 614	960 – 1240 1300 – 1427 1435 – 1626.5 1645.5 – 1646.5 1660 – 1710 1718.8 – 1722.2 2200 – 2300 2310 – 2390 2483.5 – 2500 2690 – 2900 3260 – 3267 3.332 – 3.339 3 3458 – 3 358 3.600 – 4.400	4. 5 – 5. 15 5. 35 – 5. 46 7.25 – 7.75 8.025 – 8.5 9.0 – 9.2 9.3 – 9.5 10.6 – 12.7 13.25 – 13.4 14.47 – 14.5 15.35 – 16.2 17.7 – 21.4 22.01 – 23.12 23.6 – 24.0 31.2 – 31.8 36.43 – 36.5 Above 38.6

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).

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.

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:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

Above 1000 MHz:

(1) Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto
(2) Average: RBW = 1MHz / VBW = 10Hz or 1/T / Sweep = 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:

CA = Ai + AF + CL + Atten – 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:

Margin = Corrected Amplitude - 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	100044	2018-10-26	2 years
Agilent	Analyzer, Spectrum	E4440A	US45303156	2019-03-19	1 year
Sunol Sciences	System Controller	SC99V	011003-1	N/R	N/A
Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2018-02-26	2 years
EMCO	Antenna, Horn	3115	9511-4627	2018-03-28	2 years
Agilent	Amplifier, Pre	8447D	2443A04374	2018-08-09	1 year
Insulated Wire INC	157 Series 2.92 SM (x2) Armored 33 ft. Cable	KPS-1501AN-3960-KPS	DC 1807	2018-03-13	2 years
-	SMA cable	-	C0002	Each time[1]	N/A
HP/Agilent	Pre-Amplifier	8449B	3008A01978	2018-08-17	1 year
Wisewave	Antenna, Horn	ARH-4223-02	10555-01	2018-02-14	2 years
Sunol Sciences	Antenna, Horn	DRH-118	A052704	2019-04-13	2 years
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

***Statement of Traceability*:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) "A2LA Policy on Metrological Traceability".

7.6 Test Environmental Conditions

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

The testing was performed by Christian McCaig and Corey Phan from 2019-07-29 to 2019-08-07 in 5 m chamber 3.

7.7 Summary of Test Results

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

RADIO 2:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, channel**
-0.59	2390	Horizontal	g, 2412 MHz

RADIO 1:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, channel**
-0.50	2390	Vertical	b, 2412 MHz

BLE:

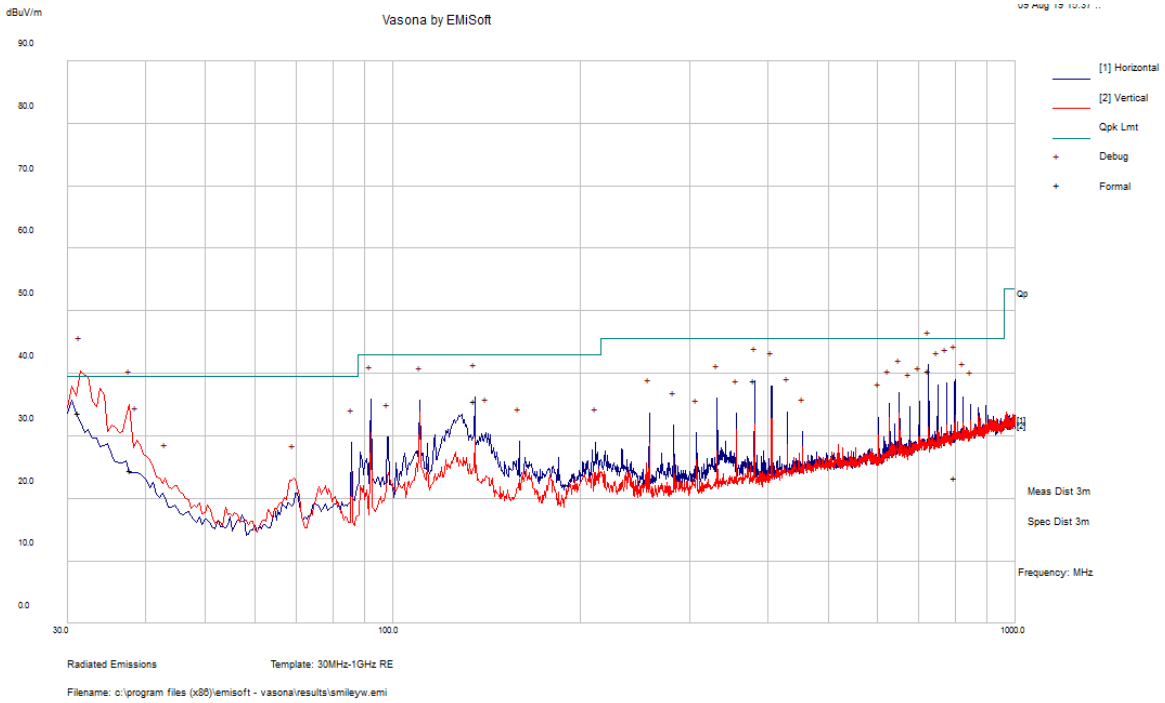
Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel**
-0.59	2483.5	Vertical	2480 MHz

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 Colocation, Radio 1-2.4 GHz Wi-Fi, Radio 2-2.4 GHz Wi-Fi and 2.4 GHz Classic Bluetooth



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
31.235	33.77	111	V	65	39.5	-5.73	QP
724.98975	40.43	103	H	291	45.5	-5.07	QP
37.88225	24.5	108	V	60	39.5	-15	QP
799.183	23.24	211	H	286	45.5	-22.26	QP
380.9265	38.82	103	H	39	45.5	-6.68	QP
135.157	35.62	190	H	13	43	-7.38	QP

2) 1–18 GHz Measured at 3 meters

RADIO 2

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		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	60.72	69	212	H	28.07	5.72	36.16	58.34	74	-15.66	PK
2390	54.97	69	212	H	28.07	5.72	36.16	52.59	54	-1.41	AV
2390	60.33	194	284	V	28.89	5.72	36.16	58.78	74	-15.22	PK
2390	54.19	194	284	V	28.89	5.72	36.16	52.64	54	-1.36	AV
4824	46.12	110	105	H	33.14	7.31	35.90	50.66	74	-23.34	PK
4824	43.92	110	105	H	33.14	7.31	35.90	48.46	54	-5.54	AV
4824	44.47	119	151	V	33.14	7.31	35.90	49.01	74	-24.99	PK
4824	40.80	119	151	V	33.14	7.31	35.90	45.34	54	-8.66	AV
Mid Channel 2437 MHz											
4874	40.91	195	277	H	33.32	7.35	35.80	45.78	74	-28.22	PK
4874	34.06	195	277	H	33.32	7.35	35.80	38.93	54	-15.07	AV
4874	40.91	73	148	V	33.32	7.35	35.80	45.78	74	-28.22	PK
4874	36.06	73	148	V	33.32	7.35	35.80	40.93	54	-13.07	AV
7311	41.72	349	158	H	37.98	9.17	35.28	53.59	74	-20.41	PK
7311	36.72	349	158	H	37.98	9.17	35.28	48.59	54	-5.41	AV
7311	42.23	46	248	V	37.98	9.17	35.28	54.10	74	-19.90	PK
7311	37.40	46	248	V	37.98	9.17	35.28	49.27	54	-4.73	AV
High Channel 2462 MHz											
2483.5	58.35	160	136	H	29.17	5.85	36.15	57.22	74	-16.78	PK
2483.5	50.87	160	136	H	29.17	5.85	36.15	49.74	54	-4.26	AV
2483.5	55.99	143	285	V	29.10	5.85	36.15	54.79	74	-19.22	PK
2483.5	48.65	143	285	V	29.10	5.85	36.15	47.45	54	-6.56	AV
4924	45.28	15	232	H	33.35	7.54	35.80	50.37	74	-23.64	PK
4924	43.52	15	232	H	33.35	7.54	35.80	48.61	54	-5.40	AV
4924	40.97	117	271	V	33.35	7.54	35.80	46.06	74	-27.95	PK
4924	37.05	117	271	V	33.35	7.54	35.80	42.14	54	-11.87	AV
7386	42.80	350	176	H	37.98	9.35	35.33	54.80	74	-19.20	PK
7386	37.80	350	176	H	37.98	9.35	35.33	49.80	54	-4.20	AV
7386	43.05	37	285	V	37.98	9.35	35.33	55.05	74	-18.95	PK
7386	38.80	37	285	V	37.98	9.35	35.33	50.80	54	-3.20	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		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	72.63	158	150	H	28.068	5.72	36.16	70.25	74	-3.75	PK
2390	55.79	158	150	H	28.068	5.72	36.16	53.41	54	-0.59	AV
2390	69.52	75	200	V	28.89	5.72	36.16	67.97	74	-6.03	PK
2390	53.18	75	200	V	28.89	5.72	36.16	51.63	54	-2.37	AV
4824	37.18	0	100	H	33.14	7.31	35.90	41.72	74	-32.28	PK
4824	33.31	0	100	H	33.14	7.31	35.90	37.85	54	-16.15	AV
4824	37.08	0	100	V	33.14	7.31	35.90	41.62	74	-32.38	PK
4824	33.12	0	100	V	33.14	7.31	35.90	37.66	54	-16.34	AV
Mid Channel 2437 MHz											
4874	35.16	0	100	H	33.32	7.35	35.80	40.03	74	-33.97	PK
4874	33.17	0	100	H	33.32	7.35	35.80	38.04	54	-15.96	AV
4874	39.24	0	100	V	33.32	7.35	35.80	44.11	74	-29.89	PK
4874	32.98	0	100	V	33.32	7.35	35.80	37.85	54	-16.15	AV
7311	38.37	149	241	H	37.98	9.17	35.28	50.24	74	-23.76	PK
7311	33.08	149	241	H	37.98	9.17	35.28	44.95	54	-9.05	AV
7311	38.57	36	195	V	37.98	9.17	35.28	50.44	74	-23.56	PK
7311	34.48	36	195	V	37.98	9.17	35.28	46.35	54	-7.65	AV
High Channel 2462 MHz											
2483.5	74.01	157	133	H	29.169	5.85	36.15	72.88	74	-1.12	PK
2483.5	54.42	157	133	H	29.169	5.85	36.15	53.29	54	-0.71	AV
2483.5	69.03	58	200	V	29.095	5.85	36.15	67.83	74	-6.18	PK
2483.5	48.47	58	200	V	29.095	5.85	36.15	47.27	54	-6.74	AV
4924	36.70	0	100	H	33.35	7.54	35.80	41.79	74	-32.22	PK
4924	33.30	0	100	H	33.35	7.54	35.80	38.39	54	-15.62	AV
4924	37.33	0	100	V	33.35	7.54	35.80	42.42	74	-31.59	PK
4924	33.08	0	100	V	33.35	7.54	35.80	38.17	54	-15.84	AV
7386	37.54	0	100	H	37.98	9.35	35.33	49.54	74	-24.46	PK
7386	33.16	0	100	H	37.98	9.35	35.33	45.16	54	-8.84	AV
7386	37.31	0	100	V	37.98	9.35	35.33	49.31	74	-24.69	PK
7386	33.06	0	100	V	37.98	9.35	35.33	45.06	54	-8.94	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		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	74.48	160	145	H	28.07	5.72	36.16	72.10	74	-1.90	PK
2390	50.05	160	145	H	28.07	5.72	36.16	47.67	54	-6.33	AV
2390	73.26	71	170	V	28.89	5.72	36.16	71.71	74	-2.29	PK
2390	49.12	71	170	V	28.89	5.72	36.16	47.57	54	-6.43	AV
4824	36.93	0	100	H	33.14	7.31	35.90	41.47	74	-32.53	PK
4824	32.87	0	100	H	33.14	7.31	35.90	37.41	54	-16.59	AV
4824	37.03	0	100	V	33.14	7.31	35.90	41.57	74	-32.43	PK
4824	33.02	0	100	V	33.14	7.31	35.90	37.56	54	-16.44	AV
Mid Channel 2437 MHz											
4874	37.49	0	100	H	33.32	7.35	35.80	42.36	74	-31.64	PK
4874	33.68	0	100	H	33.32	7.35	35.80	38.55	54	-15.45	AV
4874	36.96	0	100	V	33.32	7.35	35.80	41.83	74	-32.17	PK
4874	32.92	0	100	V	33.32	7.35	35.80	37.79	54	-16.21	AV
7311	37.33	0	100	H	37.98	9.17	35.28	49.20	74	-24.80	PK
7311	33.27	0	100	H	37.98	9.17	35.28	45.14	54	-8.86	AV
7311	36.62	0	100	V	37.98	9.17	35.28	48.49	74	-25.51	PK
7311	33.96	0	100	V	37.98	9.17	35.28	45.83	54	-8.17	AV
High Channel 2462 MHz											
2483.5	73.80	123	152	H	29.17	5.85	36.15	72.67	74	-1.33	PK
2483.5	50.65	123	152	H	29.17	5.85	36.15	49.52	54	-4.48	AV
2483.5	69.60	267	293	V	29.10	5.85	36.15	68.40	74	-5.61	PK
2483.5	46.40	267	293	V	29.10	5.85	36.15	45.20	54	-8.81	AV
4924	38.13	0	100	H	33.35	7.54	35.80	43.22	74	-30.79	PK
4924	32.56	0	100	H	33.35	7.54	35.80	37.65	54	-16.36	AV
4924	38.10	0	100	V	33.35	7.54	35.80	43.19	74	-30.82	PK
4924	33.89	0	100	V	33.35	7.54	35.80	38.98	54	-15.03	AV
7386	36.78	0	100	H	37.98	9.35	35.33	48.78	74	-25.22	PK
7386	32.92	0	100	H	37.98	9.35	35.33	44.92	54	-9.08	AV
7386	37.89	0	100	V	37.98	9.35	35.33	49.89	74	-24.11	PK
7386	33.86	0	100	V	37.98	9.35	35.33	45.86	54	-8.14	AV

RADIO 1

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		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	62.53	185	247	H	28.07	5.72	36.16	60.15	74	-13.85	PK
2390	55.21	185	247	H	28.07	5.72	36.16	52.83	54	-1.17	AV
2390	61.18	252	300	V	28.89	5.72	36.16	59.63	74	-14.37	PK
2390	55.05	252	300	V	28.89	5.72	36.16	53.50	54	-0.50	AV
4824	46.35	55	300	H	33.14	7.31	35.90	50.89	74	-23.11	PK
4824	33.51	55	300	H	33.14	7.31	35.90	38.05	54	-15.95	AV
4824	46.37	230	300	V	33.14	7.31	35.90	50.91	74	-23.09	PK
4824	33.73	230	300	V	33.14	7.31	35.90	38.27	54	-15.73	AV
Mid Channel 2437 MHz											
4874	45.36	150	240	H	33.32	7.35	35.80	50.23	74	-23.77	PK
4874	32.03	150	240	H	33.32	7.35	35.80	36.90	54	-17.10	AV
4874	45.54	221	285	V	33.32	7.35	35.80	50.41	74	-23.59	PK
4874	32.09	221	285	V	33.32	7.35	35.80	36.96	54	-17.04	AV
7311	48.37	270	300	H	37.98	9.17	35.28	60.24	74	-13.76	PK
7311	37.61	270	300	H	37.98	9.17	35.28	49.48	54	-4.52	AV
7311	50.17	318	288	V	37.98	9.17	35.28	62.04	74	-11.96	PK
7311	41.09	318	288	V	37.98	9.17	35.28	52.96	54	-1.04	AV
High Channel 2462 MHz											
2483.5	51.88	205	270	H	29.17	5.85	36.15	50.75	74	-23.25	PK
2483.5	40.26	205	270	H	29.17	5.85	36.15	39.13	54	-14.87	AV
2483.5	52.19	250	277	V	29.10	5.85	36.15	50.99	74	-23.02	PK
2483.5	41.48	250	277	V	29.10	5.85	36.15	40.28	54	-13.73	AV
4924	44.66	0	100	H	33.35	7.54	35.80	49.75	74	-24.26	PK
4924	31.81	0	100	H	33.35	7.54	35.80	36.90	54	-17.11	AV
4924	45.08	0	100	V	33.35	7.54	35.80	50.17	74	-23.84	PK
4924	31.82	0	100	V	33.35	7.54	35.80	36.91	54	-17.10	AV
7386	45.34	0	100	H	37.98	9.35	35.33	57.34	74	-16.66	PK
7386	32.12	0	100	H	37.98	9.35	35.33	44.12	54	-9.88	AV
7386	45.35	0	100	V	37.98	9.35	35.33	57.35	74	-16.65	PK
7386	32.10	0	100	V	37.98	9.35	35.33	44.10	54	-9.90	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		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	71.98	201	228	H	28.068	5.72	36.16	69.60	74	-4.40	PK
2390	51.85	201	228	H	28.068	5.72	36.16	49.47	54	-4.53	AV
2390	73.70	238	280	V	28.89	5.72	36.16	72.15	74	-1.85	PK
2390	53.59	238	280	V	28.89	5.72	36.16	52.04	54	-1.96	AV
4824	46.03	0	100	H	33.14	7.31	35.90	50.57	74	-23.43	PK
4824	31.53	0	100	H	33.14	7.31	35.90	36.07	54	-17.93	AV
4824	45.32	0	100	V	33.14	7.31	35.90	49.86	74	-24.14	PK
4824	32.13	0	100	V	33.14	7.31	35.90	36.67	54	-17.33	AV
Mid Channel 2437 MHz											
4874	44.74	0	100	H	33.32	7.35	35.80	49.61	74	-24.39	PK
4874	31.07	0	100	H	33.32	7.35	35.80	35.94	54	-18.06	AV
4874	44.81	0	100	V	33.32	7.35	35.80	49.68	74	-24.32	PK
4874	31.23	0	100	V	33.32	7.35	35.80	36.10	54	-17.90	AV
7311	46.80	326	228	H	37.98	9.17	35.28	58.67	74	-15.33	PK
7311	32.49	326	228	H	37.98	9.17	35.28	44.36	54	-9.64	AV
7311	49.51	313	250	V	37.98	9.17	35.28	61.38	74	-12.62	PK
7311	34.21	313	250	V	37.98	9.17	35.28	46.08	54	-7.92	AV
High Channel 2462 MHz											
2483.5	68.31	194	191	H	29.169	5.85	36.15	67.18	74	-6.82	PK
2483.5	48.59	194	191	H	29.169	5.85	36.15	47.46	54	-6.54	AV
2483.5	70.33	237	249	V	29.095	5.85	36.15	69.13	74	-4.88	PK
2483.5	50.68	237	249	V	29.095	5.85	36.15	49.48	54	-4.53	AV
4924	45.07	0	100	H	33.35	7.54	35.80	50.16	74	-23.85	PK
4924	31.25	0	100	H	33.35	7.54	35.80	36.34	54	-17.67	AV
4924	45.36	0	100	V	33.35	7.54	35.80	50.45	74	-23.56	PK
4924	31.27	0	100	V	33.35	7.54	35.80	36.36	54	-17.65	AV
7386	46.22	275	275	H	37.98	9.35	35.33	58.22	74	-15.78	PK
7386	32.02	275	275	H	37.98	9.35	35.33	44.02	54	-9.98	AV
7386	48.47	319	249	V	37.98	9.35	35.33	60.47	74	-13.53	PK
7386	33.33	319	249	V	37.98	9.35	35.33	45.33	54	-8.67	AV

802.11n20 mode

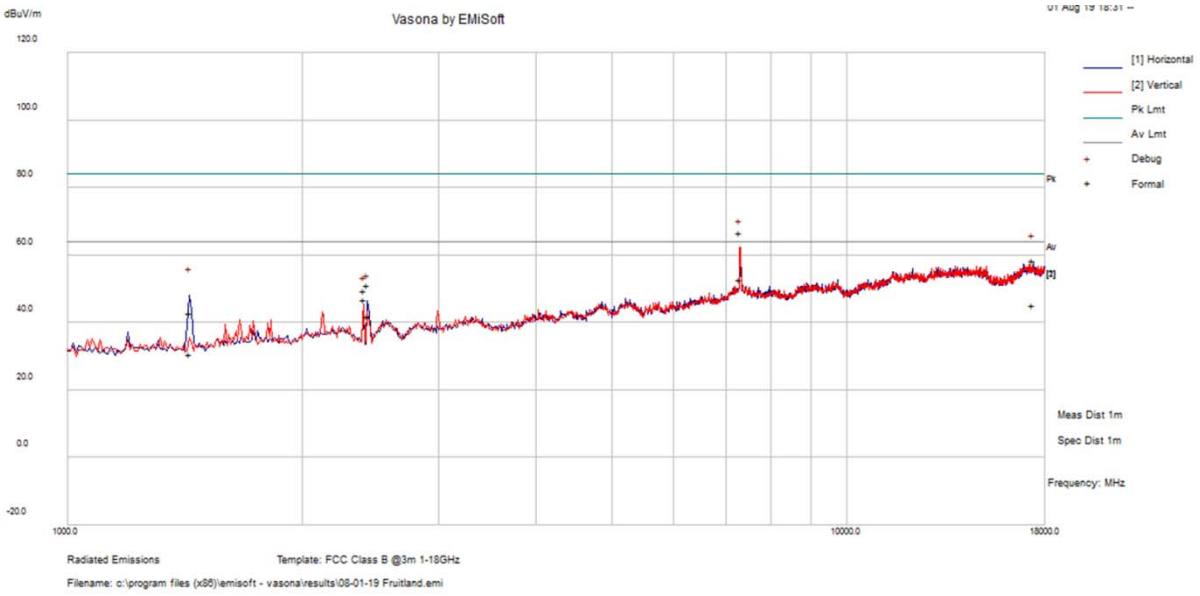
Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	70.48	199	230	H	28.07	5.72	36.16	68.10	74	-5.90	PK
2390	46.02	199	230	H	28.07	5.72	36.16	43.64	54	-10.36	AV
2390	71.71	250	300	V	28.89	5.72	36.16	70.16	74	-3.84	PK
2390	47.26	250	300	V	28.89	5.72	36.16	45.71	54	-8.29	AV
4824	45.70	0	100	H	33.14	7.31	35.90	50.24	74	-23.76	PK
4824	31.84	0	100	H	33.14	7.31	35.90	36.38	54	-17.62	AV
4824	47.27	0	100	V	33.14	7.31	35.90	51.81	74	-22.19	PK
4824	31.88	0	100	V	33.14	7.31	35.90	36.42	54	-17.58	AV
Mid Channel 2437 MHz											
4874	45.52	0	100	H	33.32	7.35	35.80	50.39	74	-23.61	PK
4874	31.13	0	100	H	33.32	7.35	35.80	36.00	54	-18.00	AV
4874	45.10	0	100	V	33.32	7.35	35.80	49.97	74	-24.03	PK
4874	31.12	0	100	V	33.32	7.35	35.80	35.99	54	-18.01	AV
7311	46.56	337	260	H	37.98	9.17	35.28	58.43	74	-15.57	PK
7311	31.80	337	260	H	37.98	9.17	35.28	43.67	54	-10.33	AV
7311	49.52	311	262	V	37.98	9.17	35.28	61.39	74	-12.61	PK
7311	33.48	311	262	V	37.98	9.17	35.28	45.35	54	-8.65	AV
High Channel 2462 MHz											
2483.5	73.57	178	132	H	29.17	5.85	36.15	72.44	74	-1.56	PK
2483.5	49.87	178	132	H	29.17	5.85	36.15	48.74	54	-5.26	AV
2483.5	73.78	236	244	V	29.10	5.85	36.15	72.58	74	-1.43	PK
2483.5	50.01	236	244	V	29.10	5.85	36.15	48.81	54	-5.20	AV
4924	45.43	0	100	H	33.35	7.54	35.80	50.52	74	-23.49	PK
4924	32.04	0	100	H	33.35	7.54	35.80	37.13	54	-16.88	AV
4924	45.93	0	100	V	33.35	7.54	35.80	51.02	74	-22.99	PK
4924	31.35	0	100	V	33.35	7.54	35.80	36.44	54	-17.57	AV
7386	46.79	0	100	H	37.98	9.35	35.33	58.79	74	-15.21	PK
7386	31.53	0	100	H	37.98	9.35	35.33	43.53	54	-10.47	AV
7386	47.84	0	100	V	37.98	9.35	35.33	59.84	74	-14.16	PK
7386	33.52	0	100	V	37.98	9.35	35.33	45.52	54	-8.48	AV

BLE mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2402 MHz											
2390	49.59	264	184	H	29.19	5.05	36.16	47.67	74	-26.33	PK
2390	36.15	264	184	H	29.19	5.05	36.16	34.23	54	-19.77	AV
2390	50.27	20	110	V	29.19	5.05	36.16	48.35	74	-25.65	PK
2390	36.77	20	110	V	29.19	5.05	36.16	34.85	54	-19.15	AV
4804	45.65	0	100	H	33.14	7.31	35.90	50.19	74	-23.81	PK
4804	32.78	0	100	H	33.14	7.31	35.90	37.32	54	-16.68	AV
4804	45.60	0	110	V	33.14	7.31	35.90	50.14	74	-23.86	PK
4804	33.25	0	110	V	33.14	7.31	35.90	37.79	54	-16.21	AV
7206	45.22	0	100	H	37.53	8.97	35.25	56.47	74	-17.53	PK
7206	31.11	0	100	H	37.53	8.97	35.25	42.36	54	-11.64	AV
7206	44.75	0	100	V	37.53	8.97	35.25	56.00	74	-18.00	PK
7206	31.08	0	100	V	37.53	8.97	35.25	42.33	54	-11.67	AV
Mid Channel 2440 MHz											
4880	45.26	0	100	H	33.32	7.35	35.80	50.13	74	-23.87	PK
4880	33.15	0	100	H	33.32	7.35	35.80	38.02	54	-15.98	AV
4880	45.01	0	100	V	33.32	7.35	35.80	49.88	74	-24.12	PK
4880	32.30	0	100	V	33.32	7.35	35.80	37.18	54	-16.82	AV
7320	45.23	0	100	H	37.98	9.17	35.28	57.10	74	-16.90	PK
7320	32.28	0	100	H	37.98	9.17	35.28	44.15	54	-9.85	AV
7320	45.13	0	100	V	37.98	9.17	35.28	57.00	74	-17.00	PK
7320	32.04	0	100	V	37.98	9.17	35.28	43.91	54	-10.09	AV
High Channel 2480 MHz											
2483.5	58.31	294	269	H	29.19	5.17	36.15	56.52	74	-17.48	PK
2483.5	54.90	294	269	H	29.19	5.17	36.15	53.11	54	-0.89	AV
2483.5	59.76	27	100	V	29.19	5.17	36.15	57.97	74	-16.03	PK
2483.5	55.20	27	100	V	29.19	5.17	36.15	53.41	54	-0.59	AV
4960	46.35	0	100	H	33.35	7.54	35.80	51.44	74	-22.57	PK
4960	32.52	0	100	H	33.35	7.54	35.80	37.61	54	-16.40	AV
4960	45.39	0	100	V	33.35	7.54	35.80	50.48	74	-23.53	PK
4960	33.24	0	100	V	33.35	7.54	35.80	38.33	54	-15.68	AV
7440	45.85	0	100	H	37.98	9.35	35.33	57.85	74	-16.15	PK
7440	33.05	0	100	H	37.98	9.35	35.33	45.05	54	-8.95	AV
7440	45.80	0	100	V	37.98	9.35	35.33	57.80	74	-16.20	PK
7440	33.01	0	100	V	37.98	9.35	35.33	45.01	54	-8.99	AV

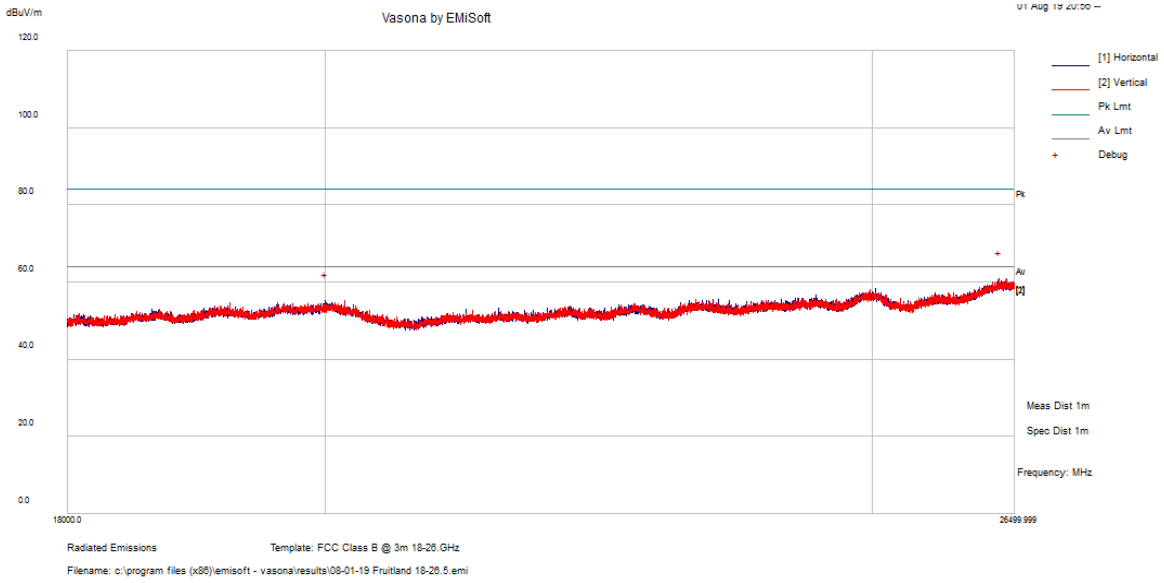
1 GHz – 18 GHz Worst Case Scan

Worst Case Colocation, Radio 1-2.4 GHz Wi-Fi, Radio 2-2.4 GHz Wi-Fi and 2.4 GHz Classic Bluetooth



18 GHz – 26.5 GHz Worst Case Scan

Worst Case Colocation, Radio 1-2.4 GHz Wi-Fi, Radio 2-2.4 GHz Wi-Fi and 2.4 GHz Classic Bluetooth



8 FCC §15.247(a)(2) -Emission Bandwidth

8.1 Applicable Standards

According to ECFR §15.247(a)(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 v05r02: 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	E4440A	US45303156	2019-03-06	1 year
-	RF cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A
-	10dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.

***Statement of Traceability*:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) "A2LA Policy on Metrological Traceability".

8.4 Test Environmental Conditions

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

The testing was performed by Zhao Zhao and Christian McCaig on 2019-07-09 and 2019-07-24 in RF site.

8.5 Test Results

RADIO 2:

Channel	Frequency (MHz)	6 dB OBW (MHz)		99% OBW (MHz)		6 dB OBW Limit (kHz)	Result
		Antenna A	Antenna B	Antenna A	Antenna B		
802.11b							
Low	2412	9.151	10.136	13.5534	15.7343	≥ 500	Pass
Middle	2437	9.153	9.150	13.5773	13.4334	≥ 500	Pass
High	2462	9.155	9.154	13.5771	13.4782	≥ 500	Pass
802.11g							
Low	2412	16.544	16.549	16.6091	16.5401	≥ 500	Pass
Middle	2437	16.549	16.547	16.5732	16.5684	≥ 500	Pass
High	2462	16.563	16.548	16.5694	16.5641	≥ 500	Pass
802.11n20							
Low	2412	17.667	17.683	17.6749	18.0698	≥ 500	Pass
Middle	2437	17.671	17.671	17.6749	17.6268	≥ 500	Pass
High	2462	17.667	17.665	17.7386	17.6211	≥ 500	Pass
BLE							
Low	2422	776.573	-	1.0429	-	≥ 500	Pass
Middle	2437	778.118	-	1.0449	-	≥ 500	Pass
High	2452	778.119	-	1.0480	-	≥ 500	Pass

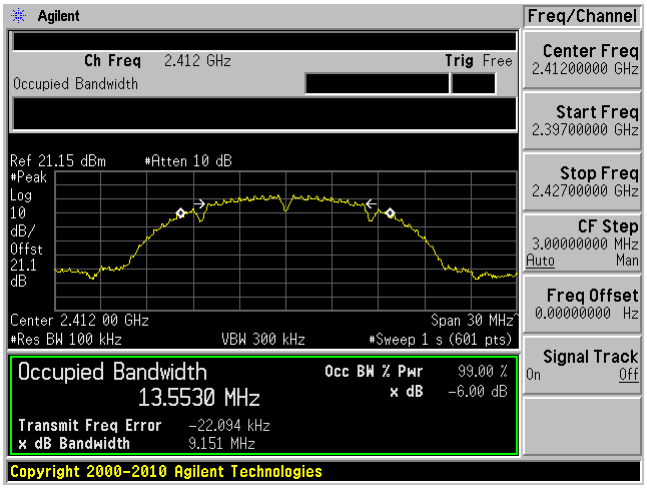
RADIO 1:

Channel	Frequency (MHz)	6 dB OBW (MHz)	99% OBW (MHz)	6 dB OBW Limit (kHz)	Result
802.11b					
Low	2412	10.162	16.2051	≥ 500	Pass
Middle	2437	10.163	16.2883	≥ 500	Pass
High	2462	10.154	15.7112	≥ 500	Pass
802.11g					
Low	2412	16.550	16.6669	≥ 500	Pass
Middle	2437	16.553	16.6626	≥ 500	Pass
High	2462	16.571	16.5604	≥ 500	Pass
802.11n20					
Low	2412	17.688	17.7721	≥ 500	Pass
Middle	2437	17.683	17.7231	≥ 500	Pass
High	2462	17.685	17.6886	≥ 500	Pass

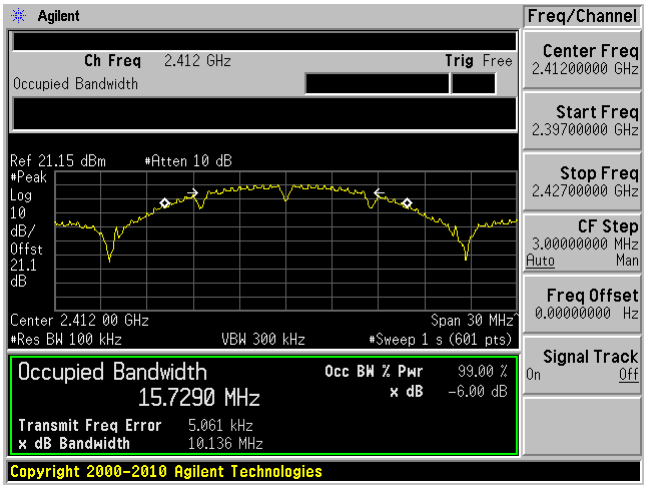
Please refer to the following plots for detailed test results.

RADIO 2 802.11b mode

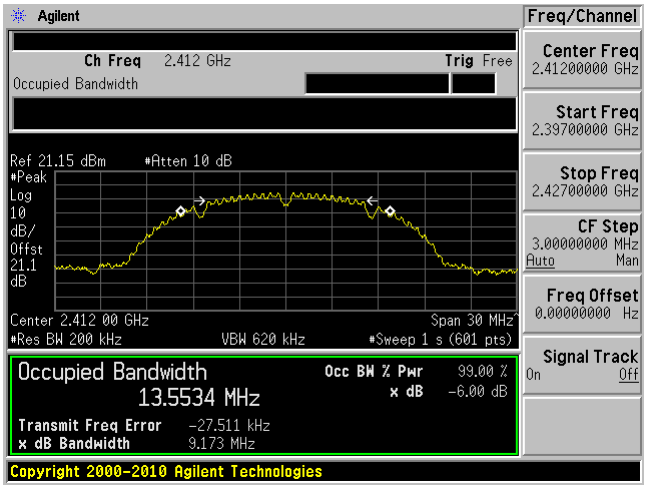
Low Channel 6 dB OBW Antenna A



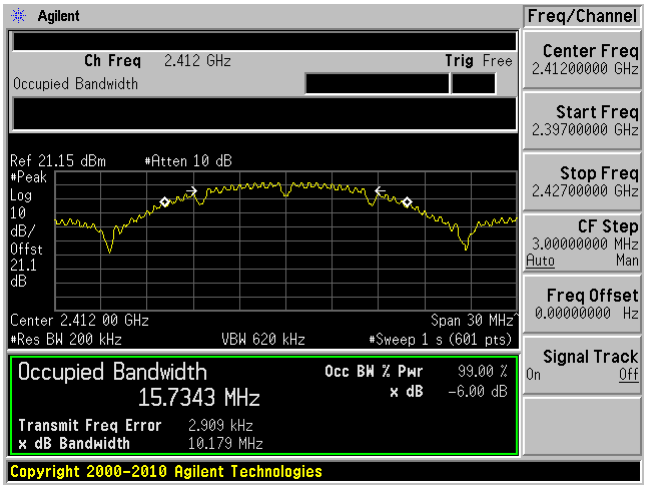
Low Channel 6 dB OBW Antenna B



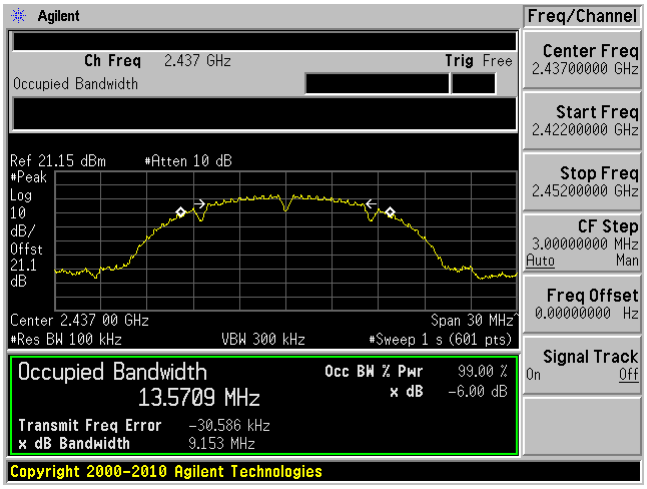
Low Channel 99% OBW Antenna A



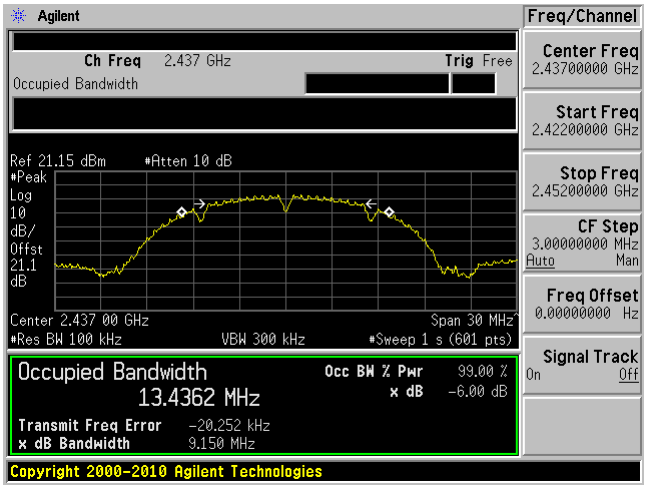
Low Channel 99% OBW Antenna B



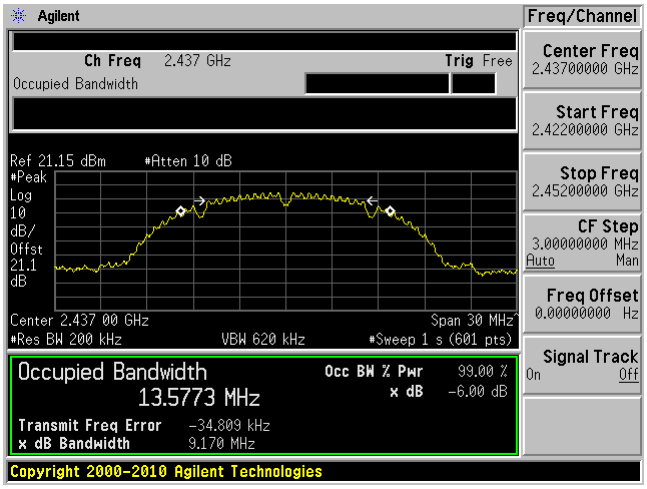
Mid Channel 6 dB OBW Antenna A



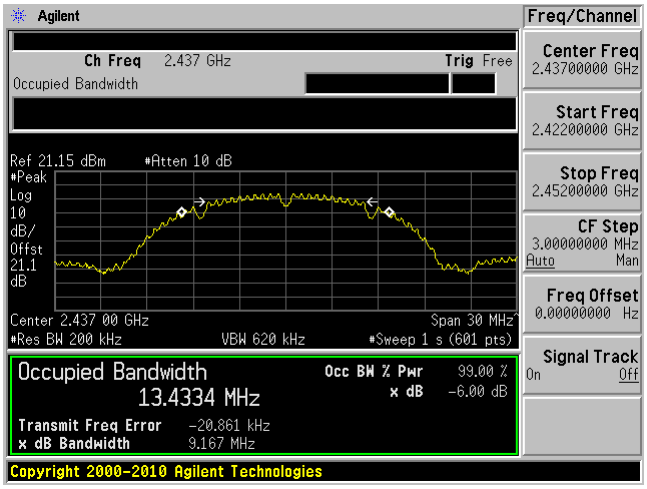
Mid Channel 6 dB OBW Antenna B



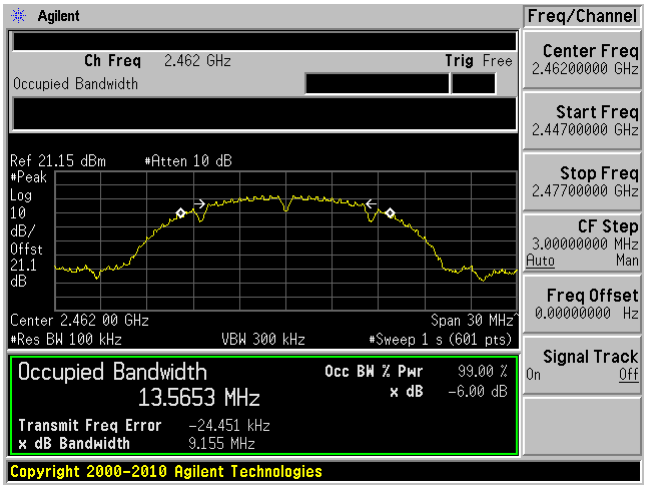
Mid Channel 99% OBW Antenna A



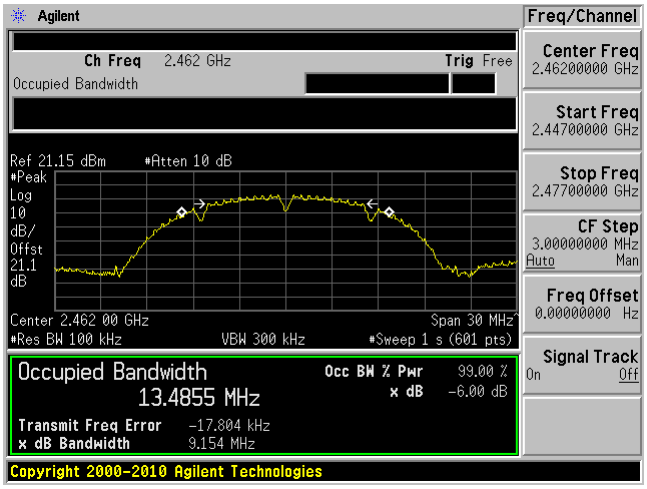
Mid Channel 99% OBW Antenna B



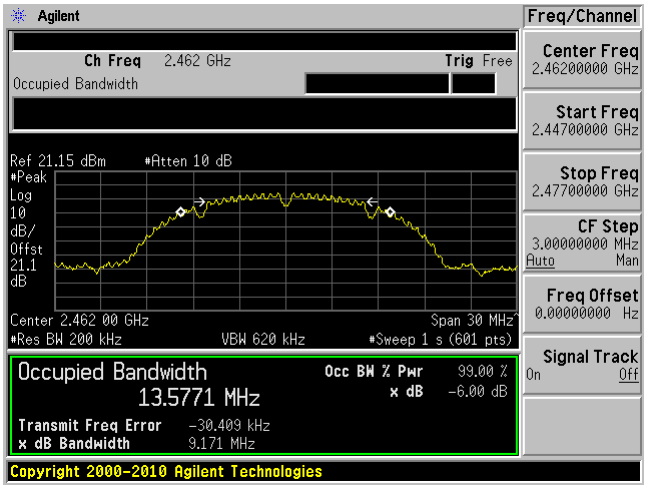
High Channel 6 dB OBW Antenna A



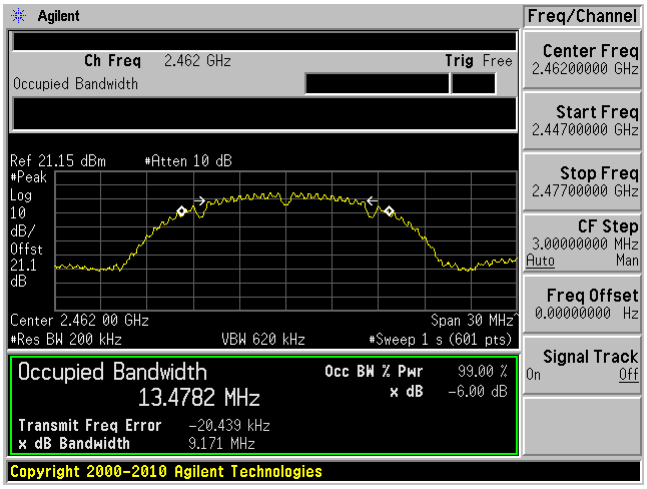
High Channel 6 dB OBW Antenna B



High Channel 99% OBW Antenna A

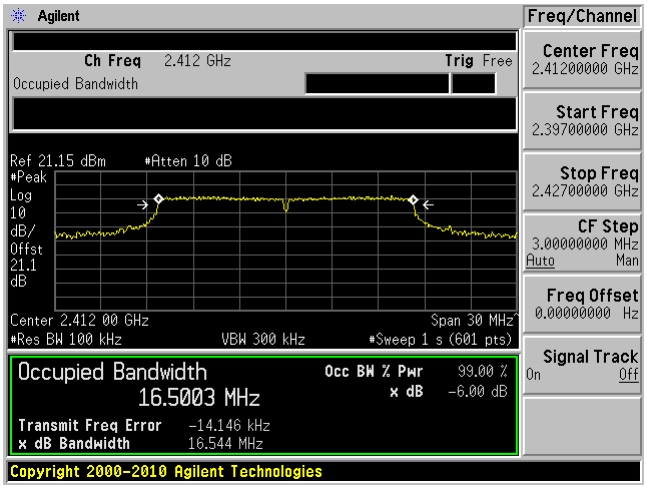


High Channel 99% OBW Antenna B

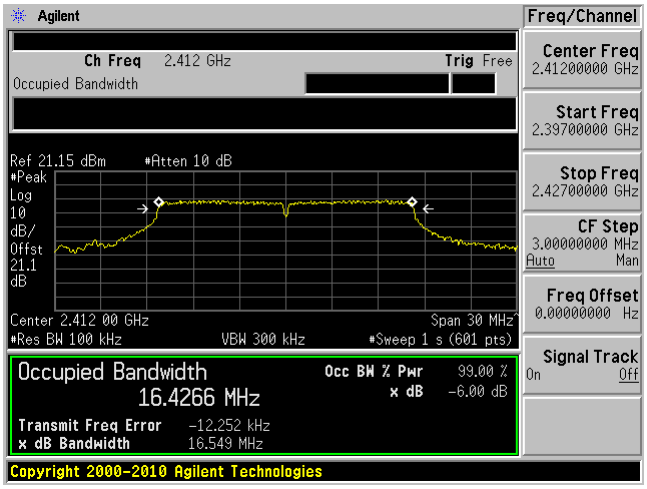


RADIO 2 802.11g mode

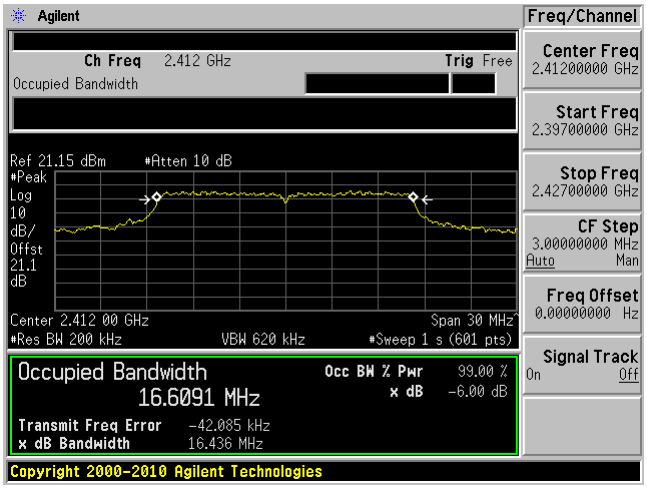
Low Channel 6 dB OBW Antenna A



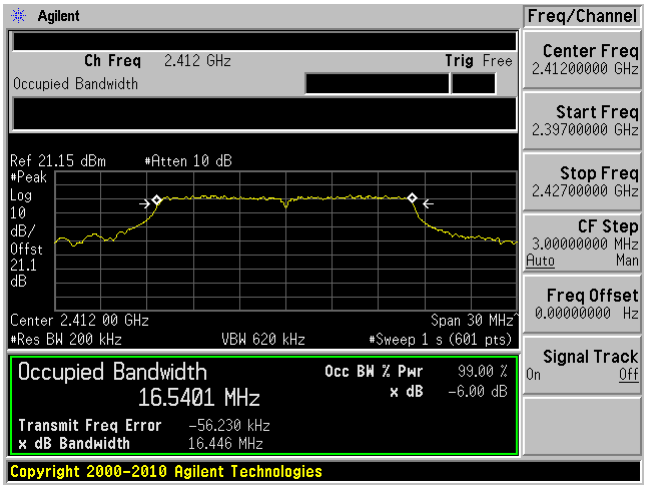
Low Channel 6 dB OBW Antenna B



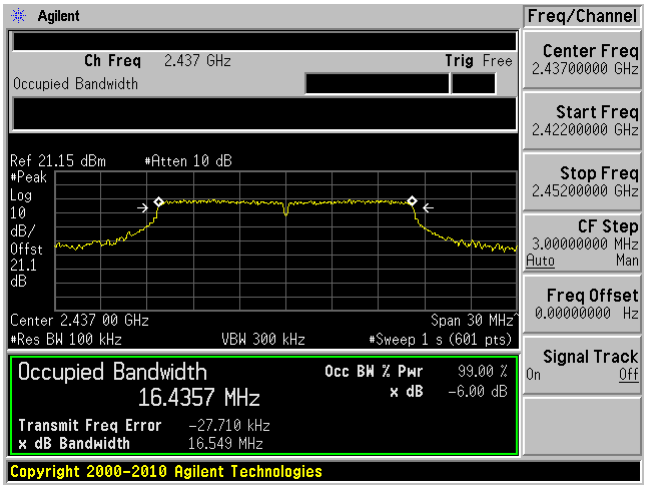
Low Channel 99% OBW Antenna A



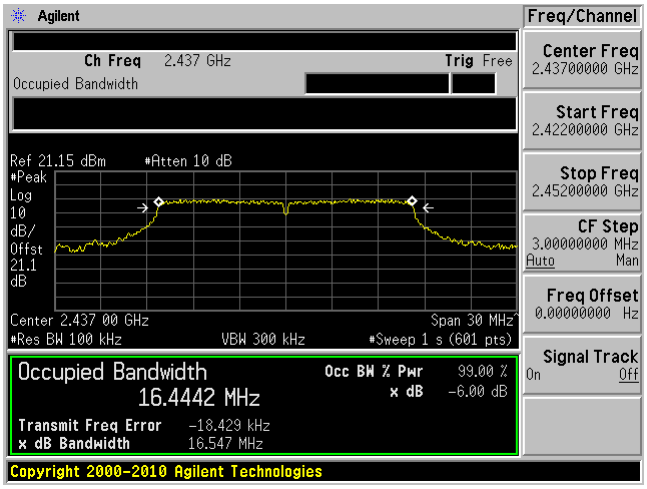
Low Channel 99% OBW Antenna B



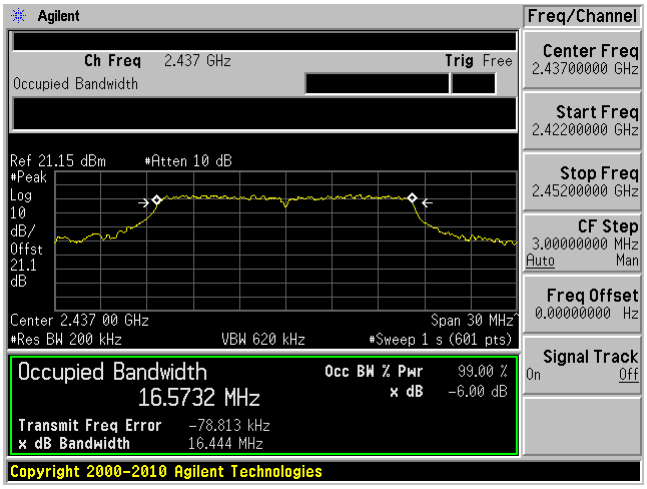
Mid Channel 6 dB OBW Antenna A



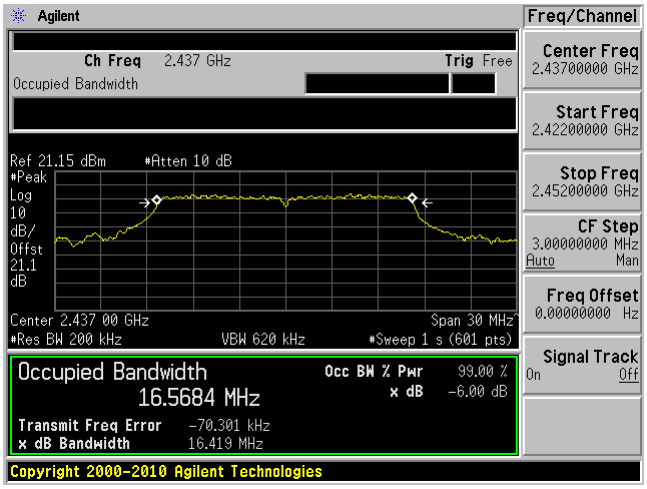
Mid Channel 6 dB OBW Antenna B



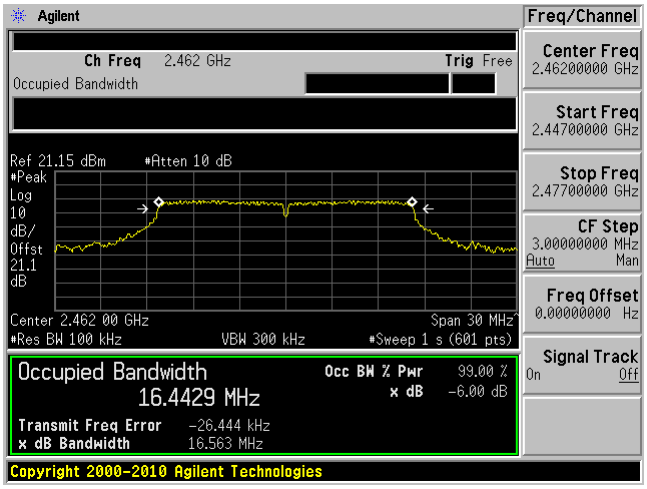
Mid Channel 99% OBW Antenna A



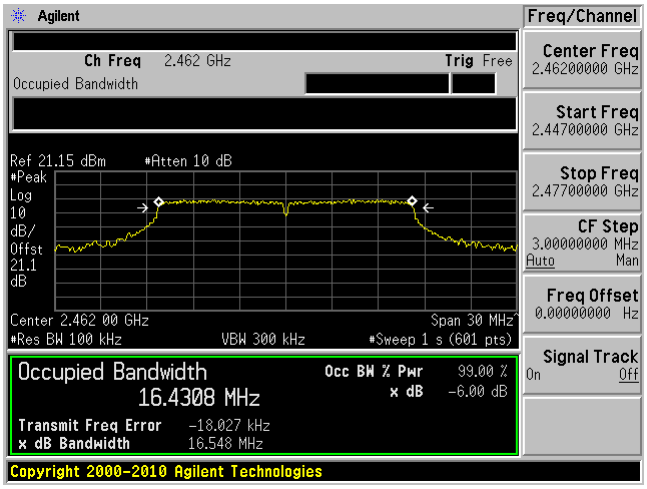
Mid Channel 99% OBW Antenna B



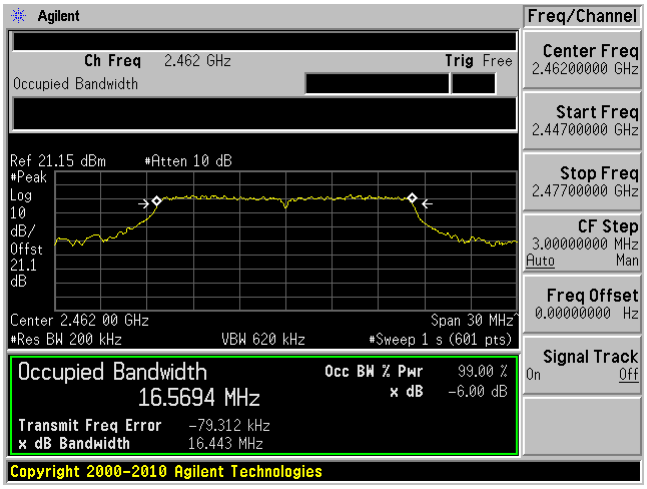
High Channel 6 dB OBW Antenna A



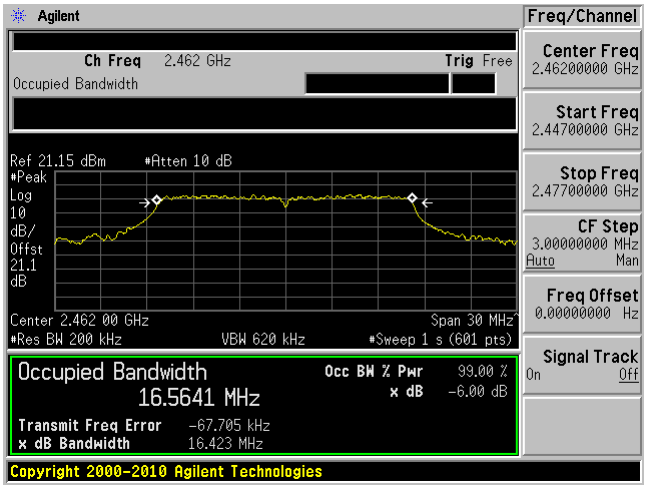
High Channel 6 dB OBW Antenna B



High Channel 99% OBW Antenna A

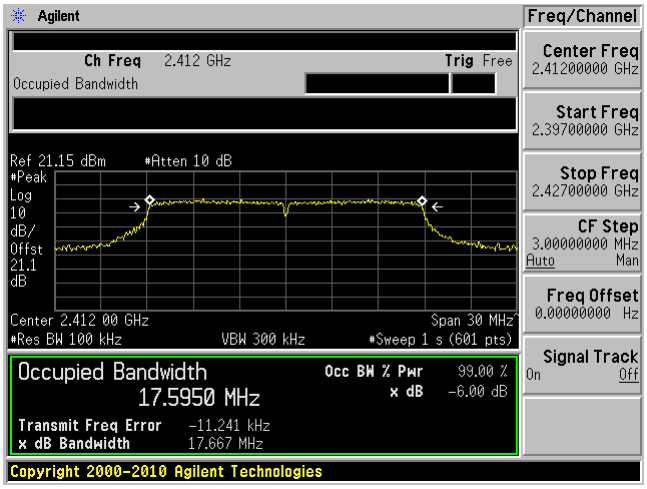


High Channel 99% OBW Antenna B

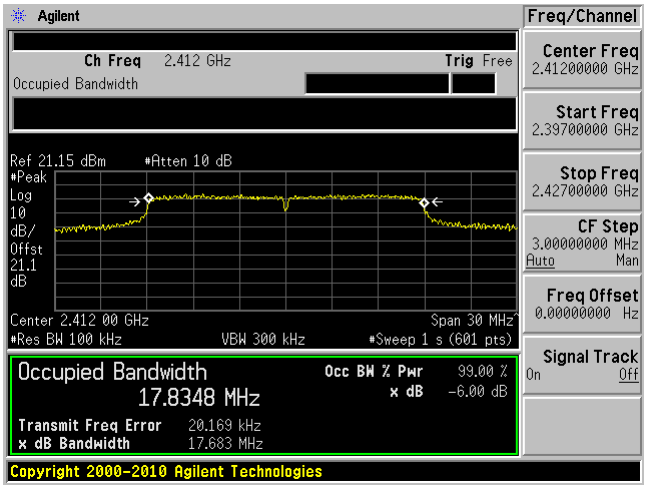


RADIO 2 802.11 n20 mode

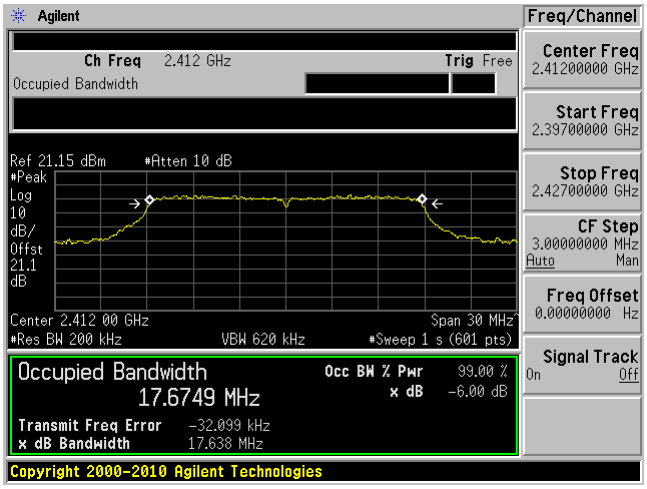
Low Channel 6 dB OBW Antenna A



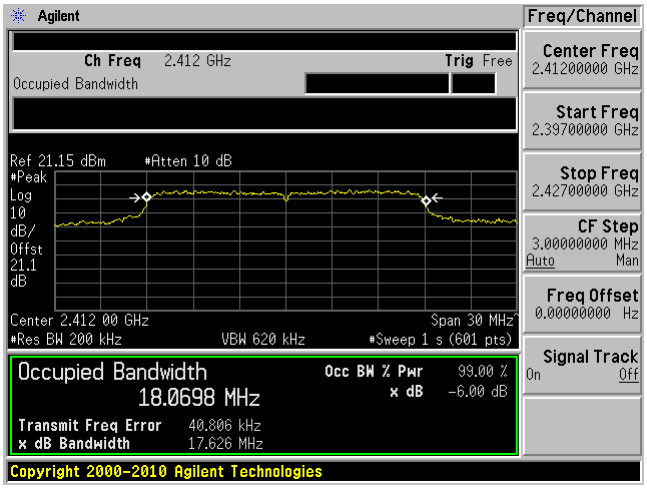
Low Channel 6 dB OBW Antenna B



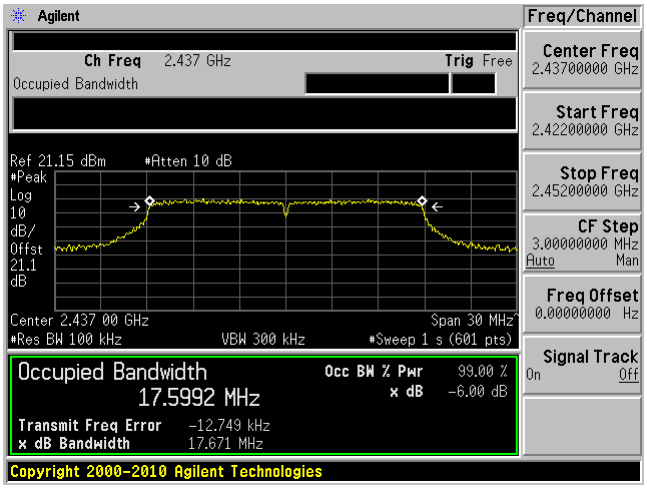
Low Channel 99% OBW Antenna A



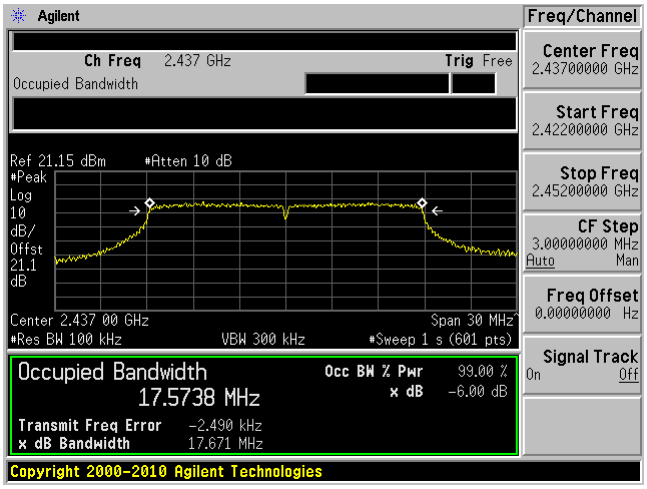
Low Channel 99% OBW Antenna B



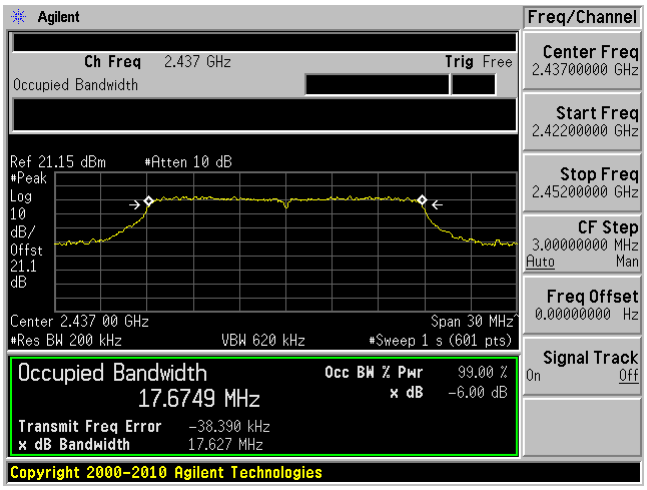
Mid Channel 6 dB OBW Antenna A



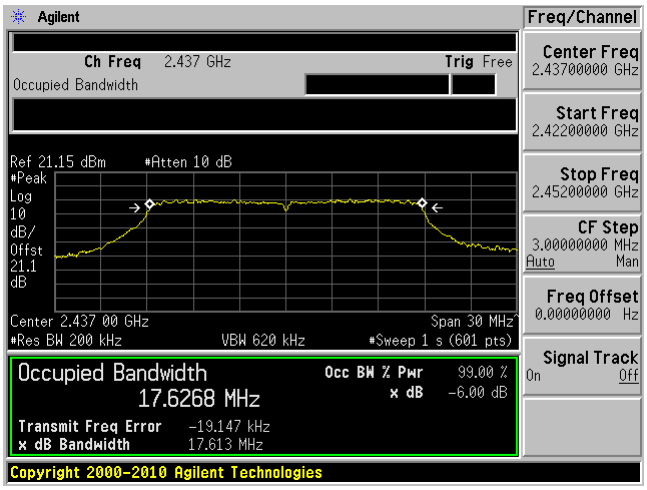
Mid Channel 6 dB OBW Antenna B



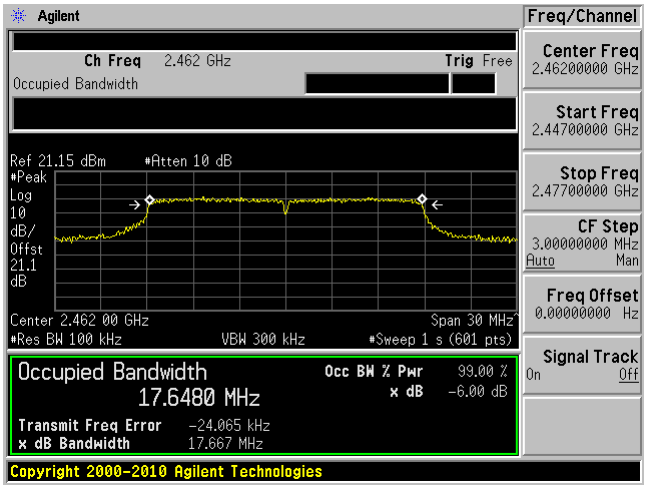
Mid Channel 99% OBW Antenna A



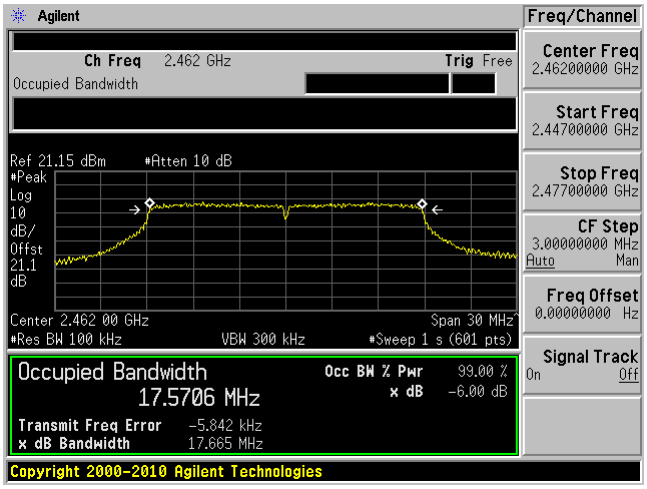
Mid Channel 99% OBW Antenna B



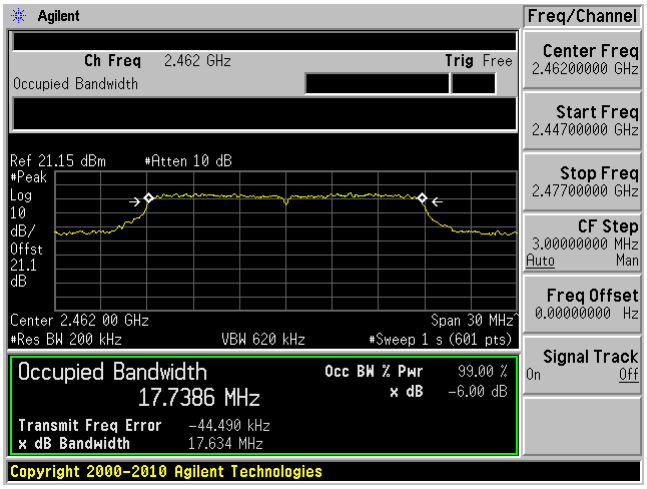
High Channel 6 dB OBW Antenna A



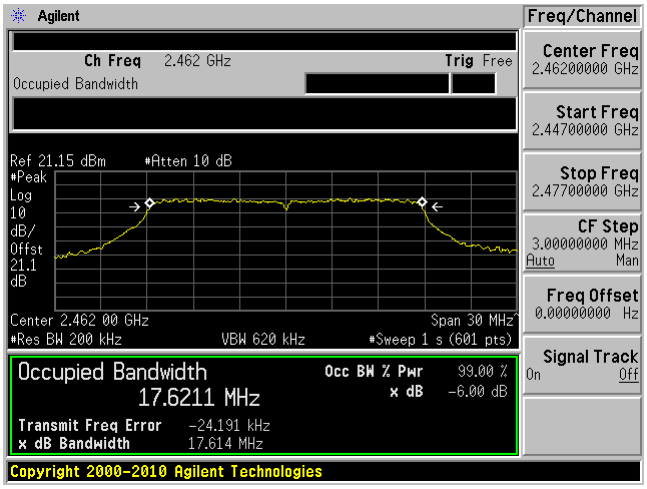
High Channel 6 dB OBW Antenna B



High Channel 99% OBW Antenna A

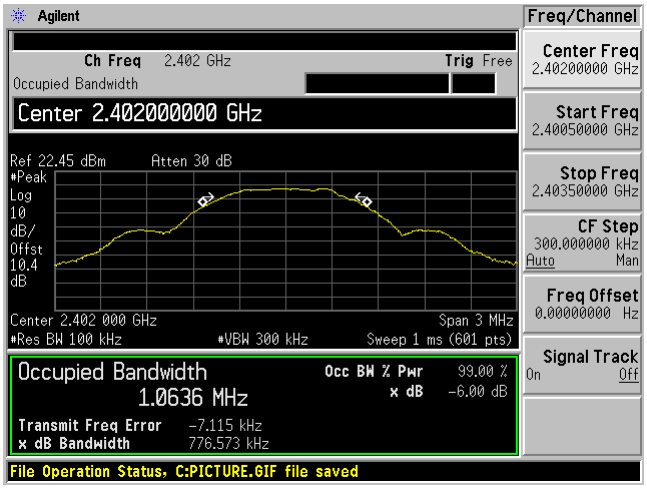


High Channel 99% OBW Antenna B

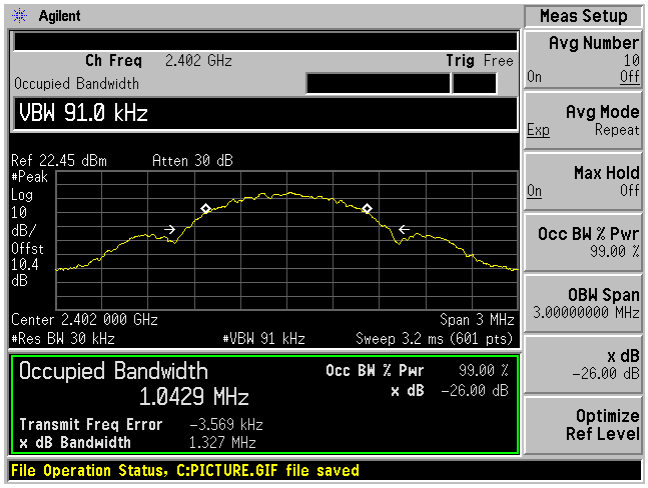


RADIO 2 BLE

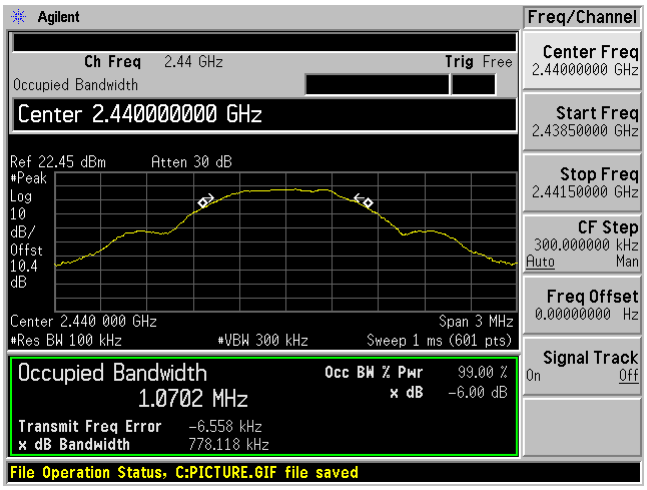
Low Channel 6 dB OBW



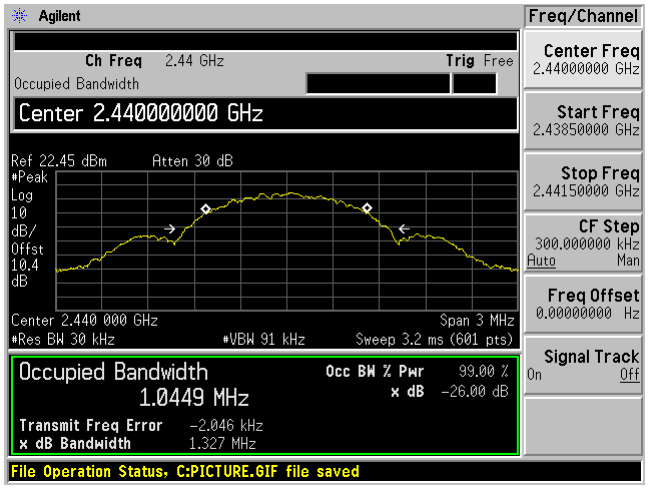
Low Channel 99% OBW



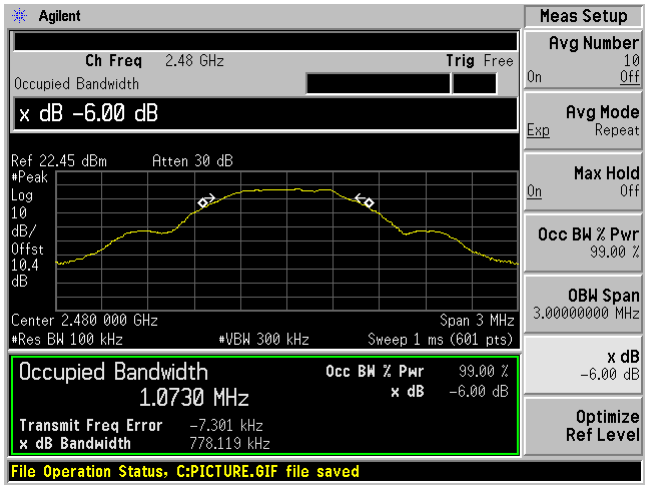
Mid Channel 6 dB OBW



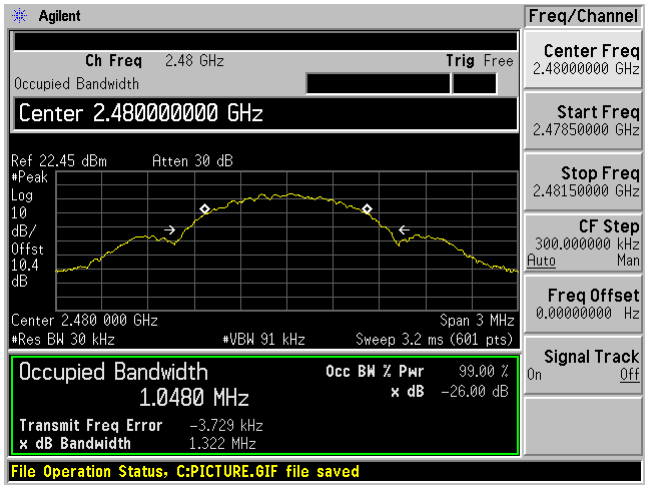
Mid Channel 99% OBW



High Channel 6 dB OBW

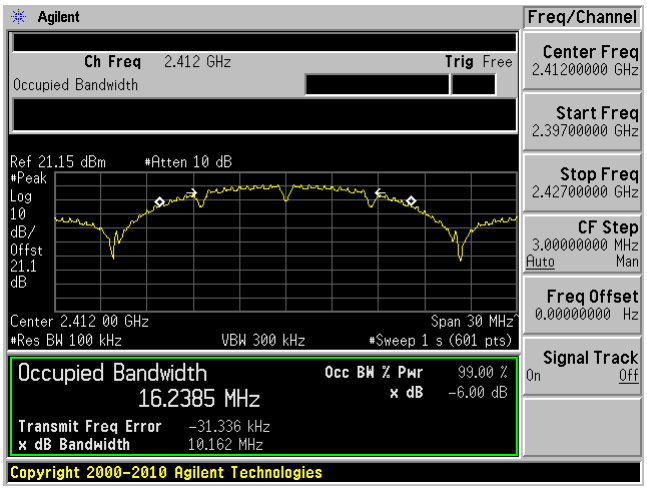


High Channel 99% OBW

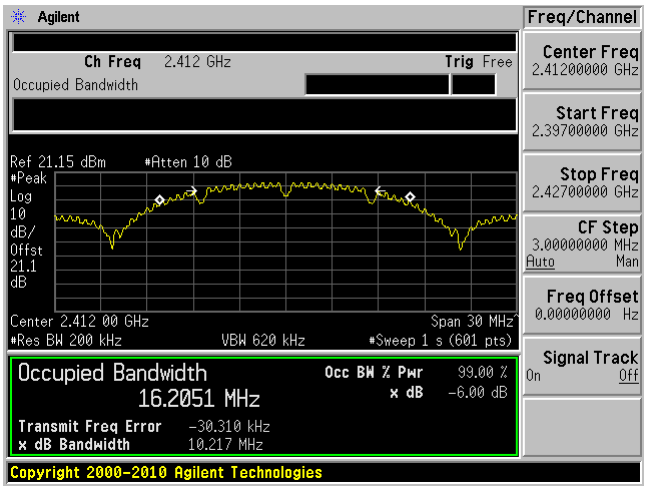


RADIO 1 802.11b mode

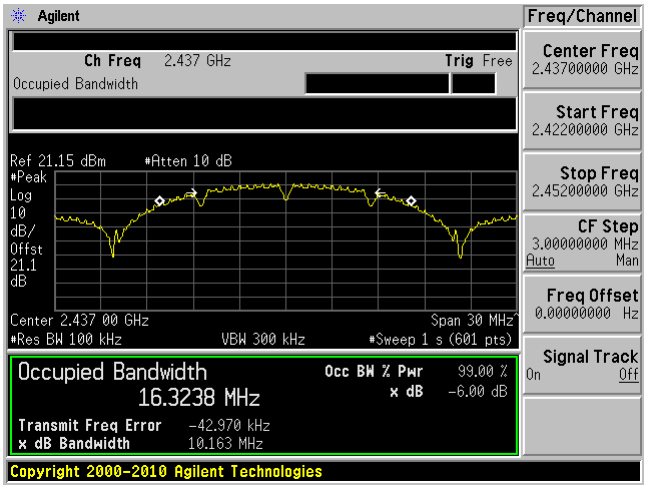
Low Channel 6 dB OBW



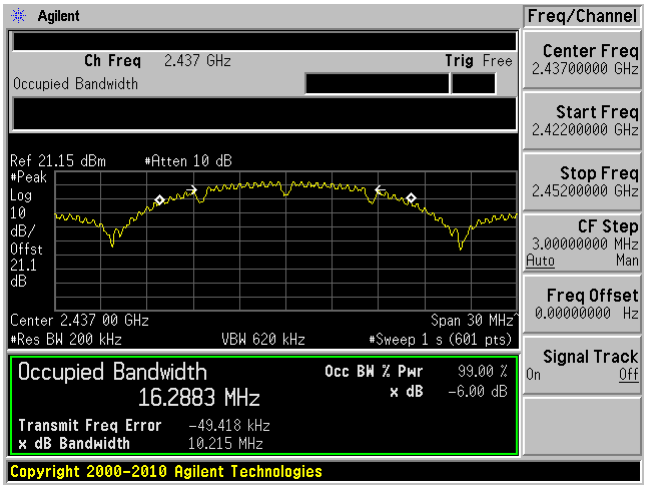
Low Channel 99% OBW



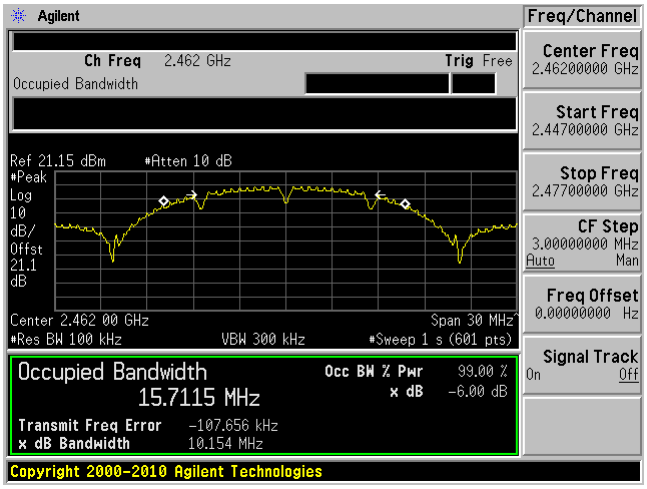
Mid Channel 6 dB OBW



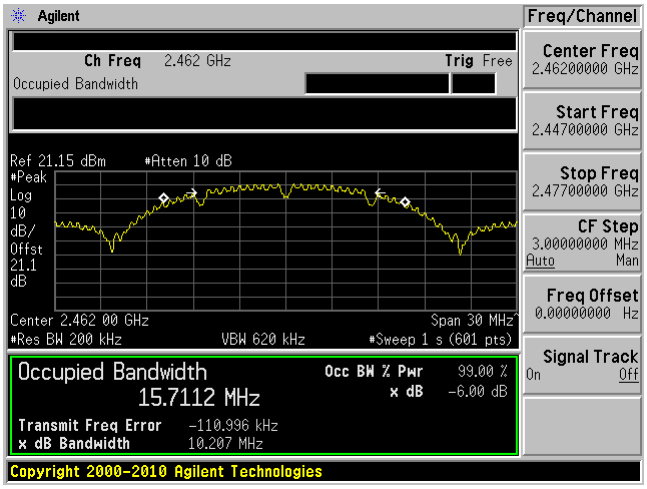
Mid Channel 99% OBW



High Channel 6 dB OBW

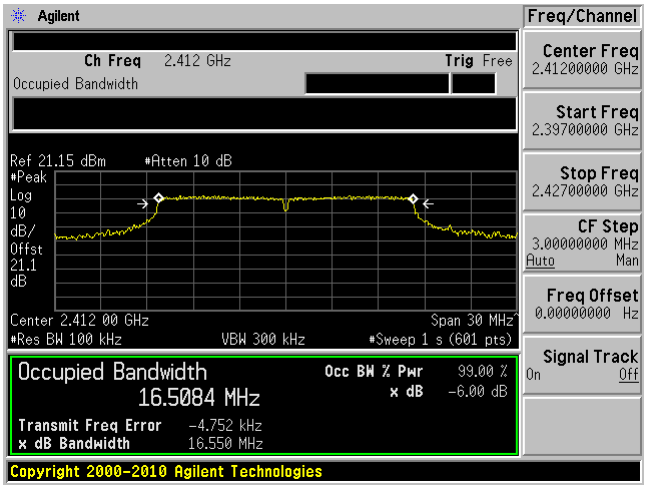


High Channel 99% OBW

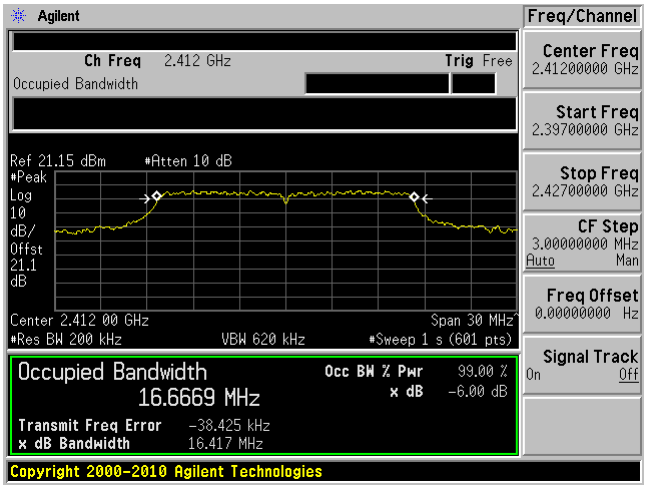


RADIO 1 802.11g mode

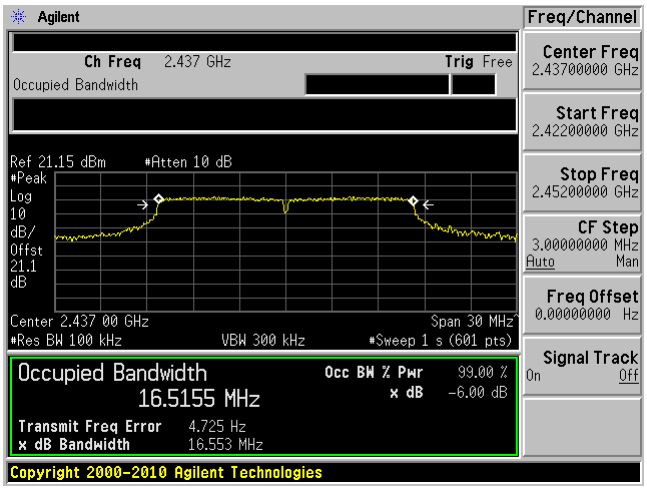
Low Channel 6 dB OBW



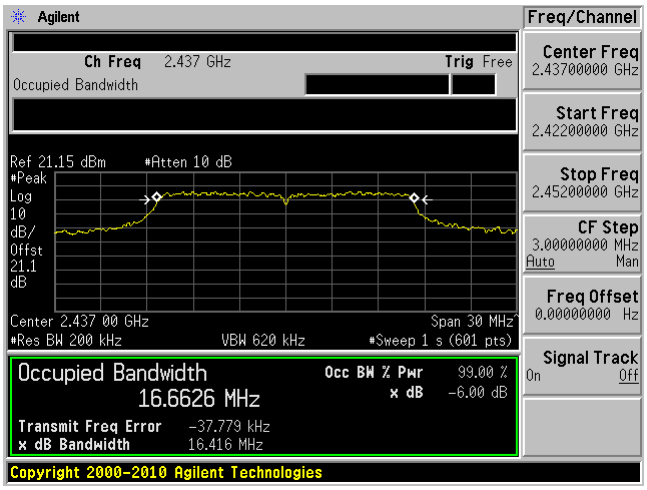
Low Channel 99% OBW



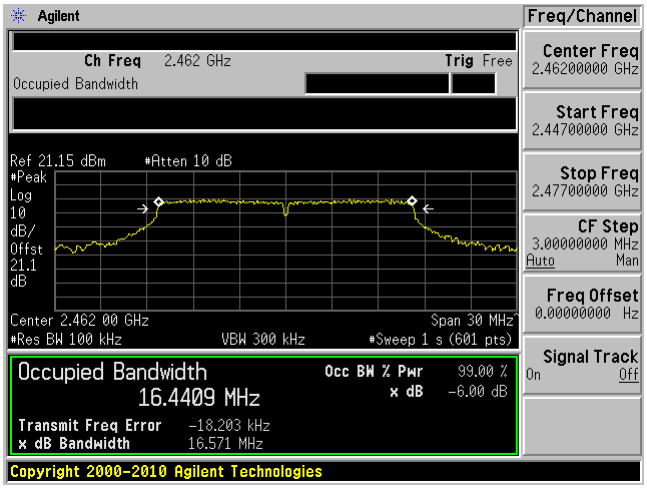
Mid Channel 6 dB OBW



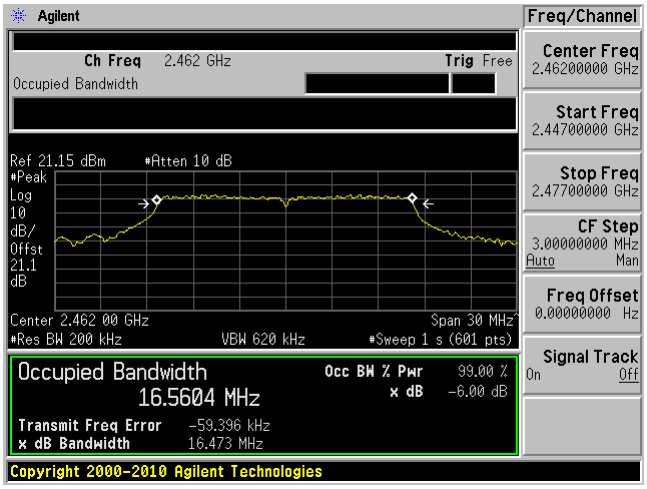
Mid Channel 99% OBW



High Channel 6 dB OBW

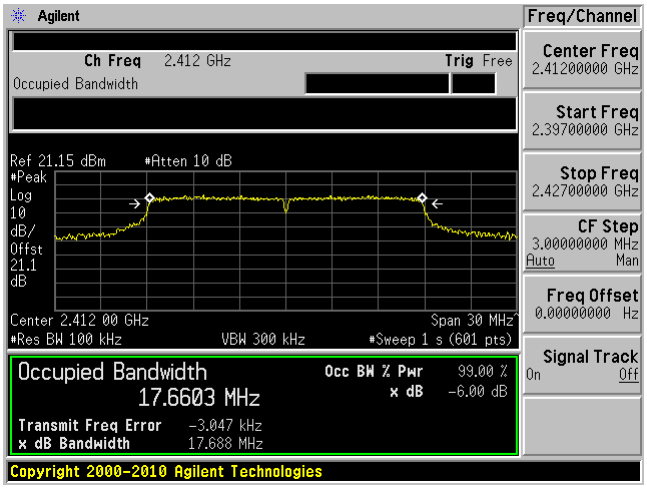


High Channel 99% OBW

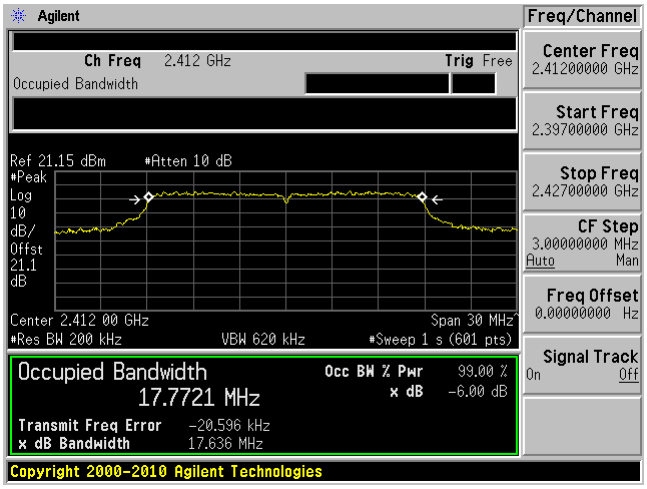


RADIO 1 802.11 n20 mode

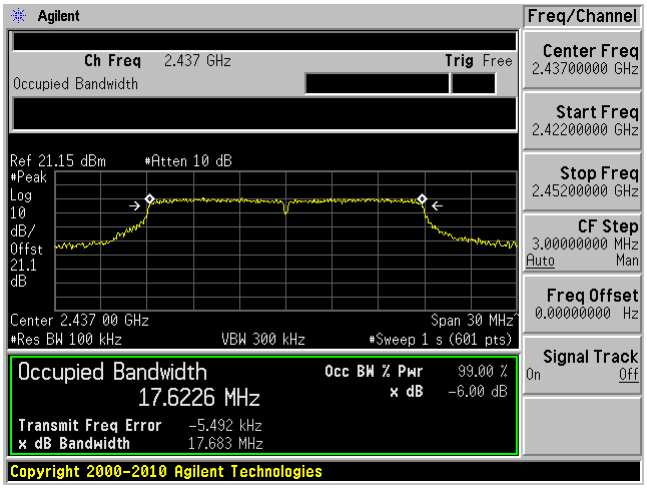
Low Channel 6 dB OBW



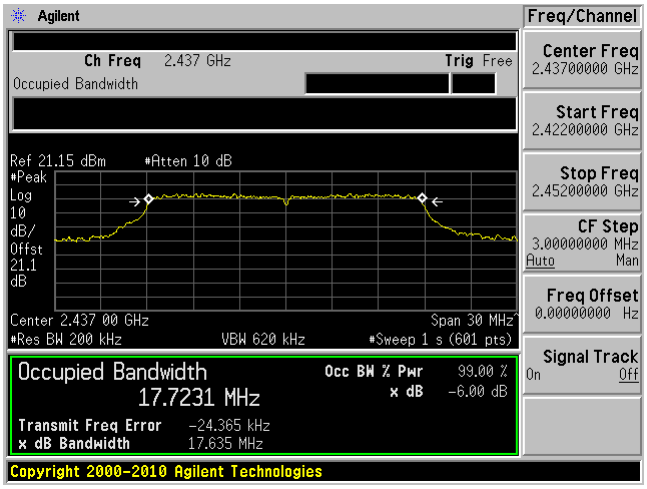
Low Channel 99% OBW



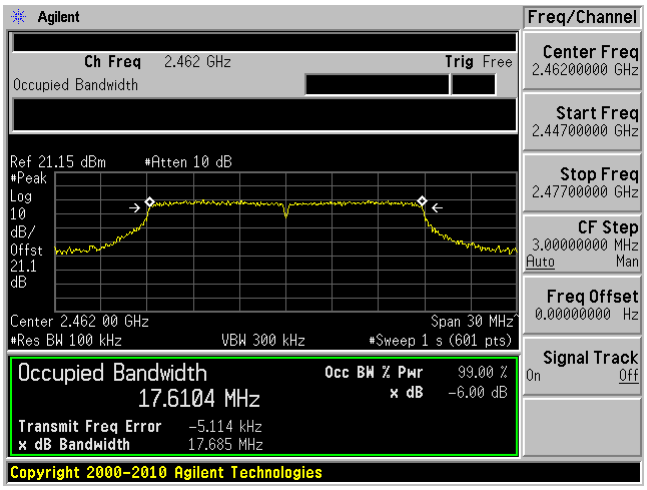
Mid Channel 6 dB OBW



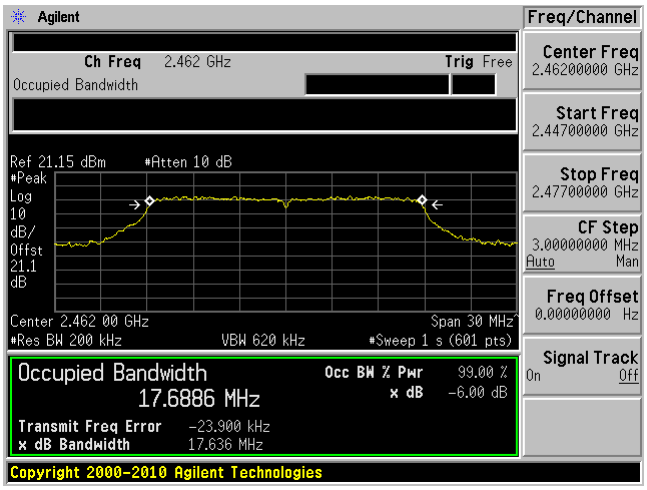
Mid Channel 99% OBW



High Channel 6 dB OBW



High Channel 99% OBW



9 FCC §15.247(b)(3) - Output Power Measurement

9.1 Applicable Standards

According to ECFR §15.247(b)(3) 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 v05r02: 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	2018-12-31	2 years
Agilent	Analyzer, Spectrum	E4440A	US45303156	2019-03-06	1 year
-	RF Cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.

***Statement of Traceability*:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) "A2LA Policy on Metrological Traceability".

9.4 Test Environmental Conditions

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

The testing was performed by Zhao Zhao and Christian McCaig on 2019-07-09 and 2019-07-24 in RF site.

9.5 Test Results

RADIO 2 Average Output Power

Channel	Frequency (MHz)	Conducted Output Power (dBm)			Output Power Limit (dBm)	Result
		Antenna A	Antenna B	Total		
802.11b						
Low	2412	17.63	20.06	22.02	30	Pass
Middle	2437	17.26	19.94	21.81	30	Pass
High	2462	16.83	19.88	21.63	30	Pass
802.11g						
Low	2412	14.01	16.43	18.40	30	Pass
Middle	2437	13.27	16.85	18.43	30	Pass
High	2462	12.6	16.14	17.73	30	Pass
802.11 n20						
Low	2422	12.98	15.57	17.48	30	Pass
Middle	2437	14.95	17.71	19.56	30	Pass
High	2462	13.84	15.91	18.01	30	Pass

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Output Power Limit (dBm)	Result
BLE				
Low	2402	11.84	30	Pass
Middle	2440	11.83	30	Pass
High	2480	11.24	30	Pass

RADIO 1 Average Output Power

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Output Power Limit (dBm)	Result
802.11b				
Low	2412	20.28	30	Pass
Middle	2437	22.47	30	Pass
High	2462	20.67	30	Pass
802.11g				
Low	2412	15.54	30	Pass
Middle	2437	17.68	30	Pass
High	2462	15.03	30	Pass
802.11n20				
Low	2412	15.92	30	Pass
Middle	2437	15.97	30	Pass
High	2462	14.97	30	Pass

Note: the directional gain is less than 6dBi, thus no reduction to the limit.

10 FCC §15.247(d) - 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).

10.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: 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	E4440A	US45303156	2019-03-06	1 year
-	RF Cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A
-	10dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.

***Statement of Traceability*:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) "A2LA Policy on Metrological Traceability".

10.4 Test Environmental Conditions

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

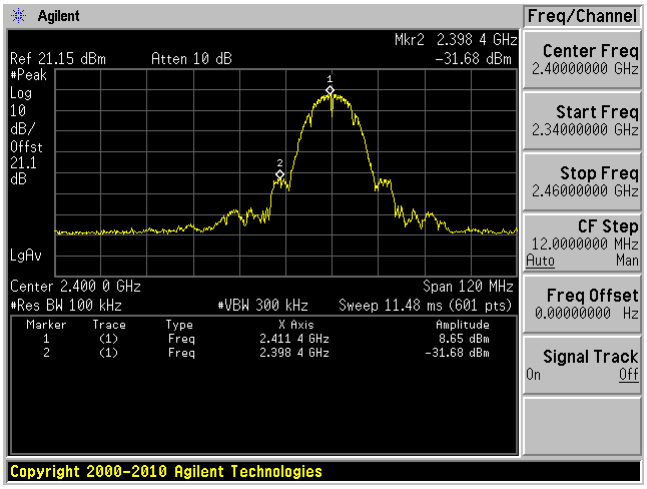
The testing was performed by Zhao Zhao and Christian McCaig on 2019-07-03, 2019-07-05 and 2019-07-24 in RF site.

10.5 Test Results

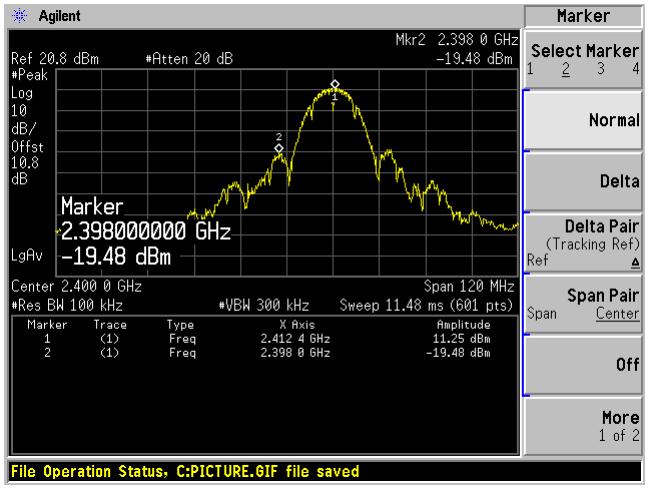
Radio 2

802.11 b mode

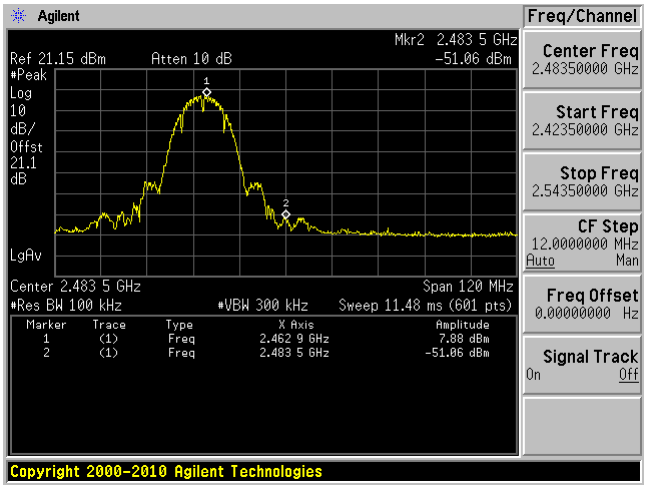
Low Channel Antenna A



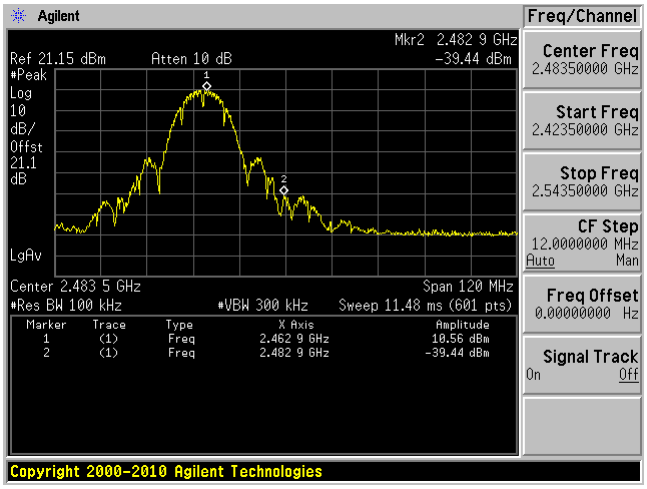
Low Channel Antenna B



High Channel Antenna A

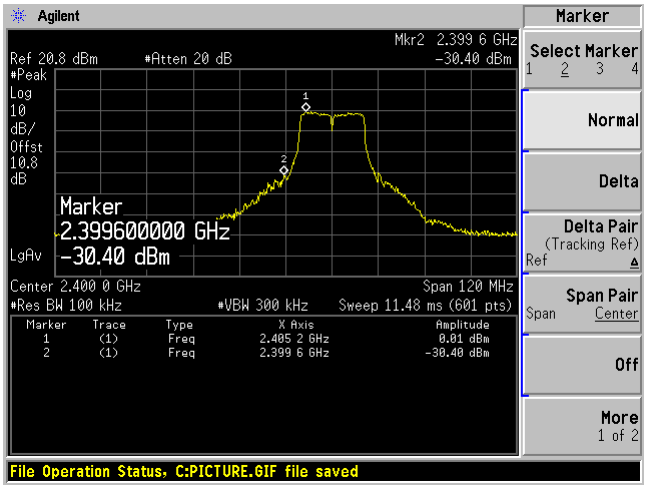


High Channel Antenna B

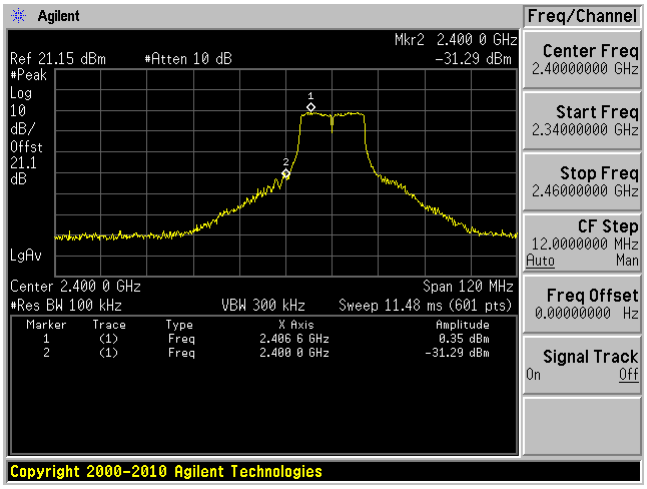


802.11 g mode

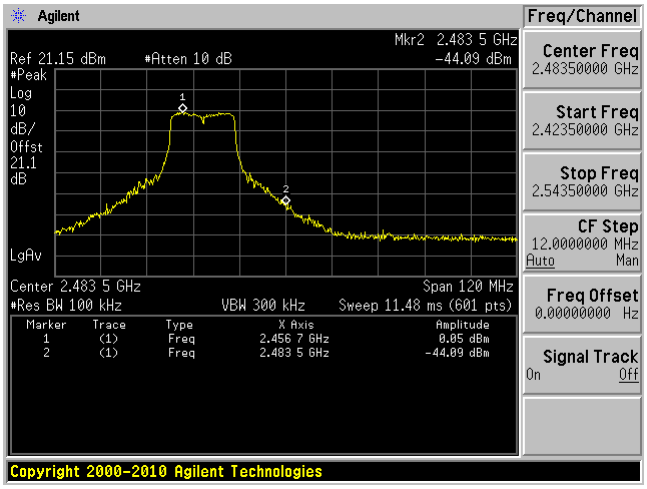
Low Channel Antenna A



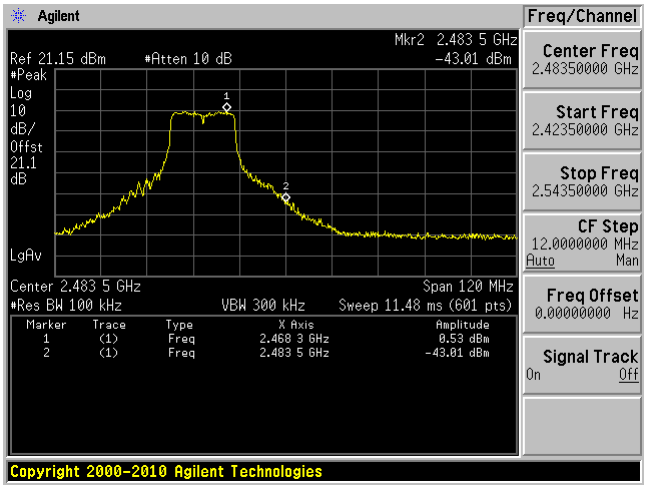
Low Channel Antenna B



High Channel Antenna A

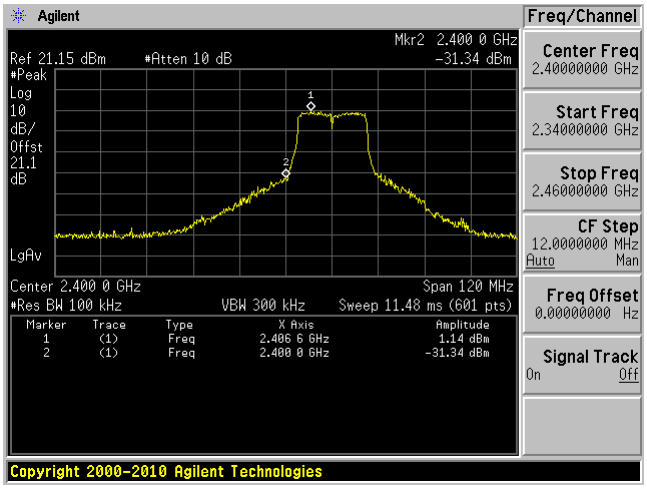


High Channel Antenna B

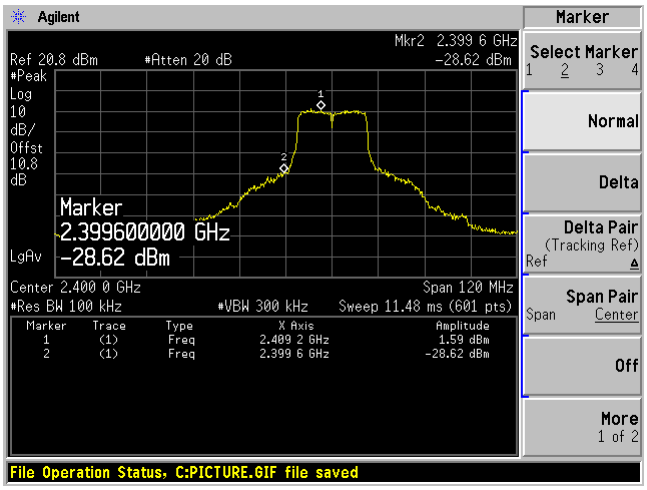


802.11 n20 mode

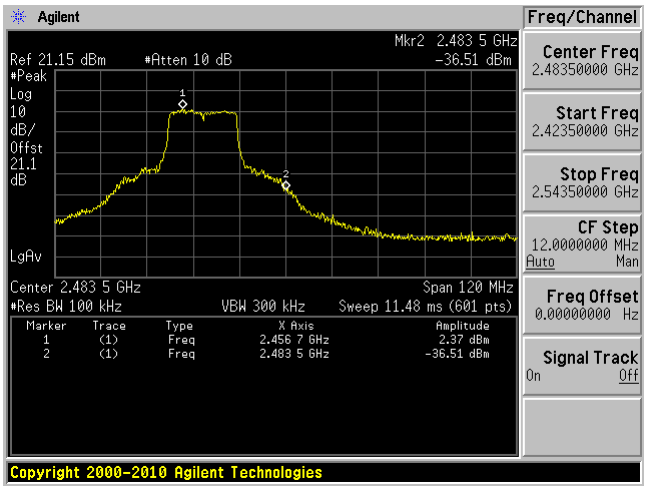
Low Channel Antenna A



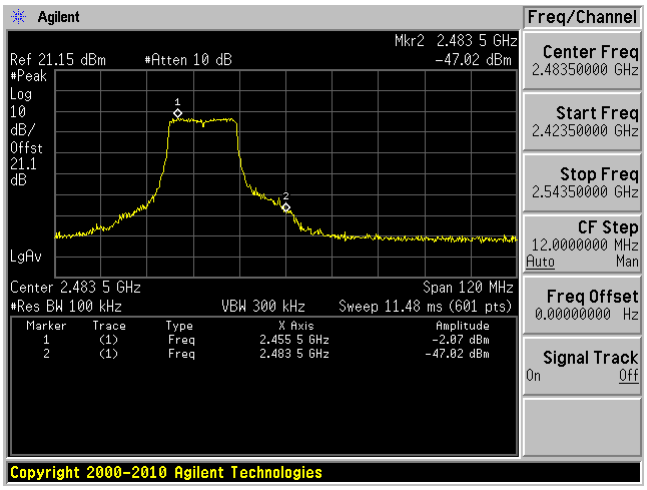
Low Channel Antenna B



High Channel Antenna A

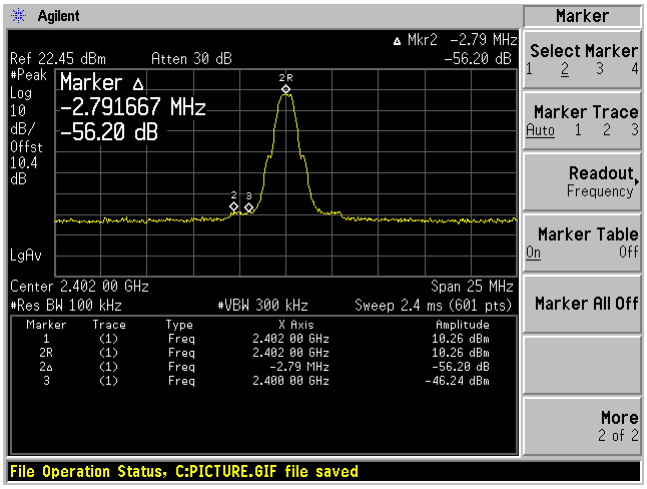


High Channel Antenna B

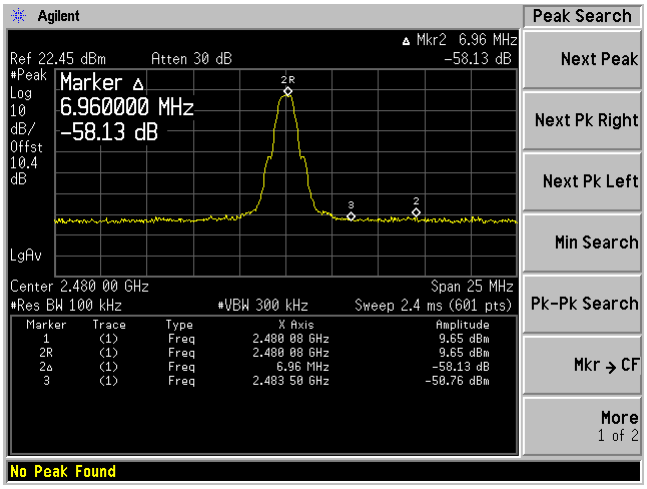


BLE mode

Low Channel

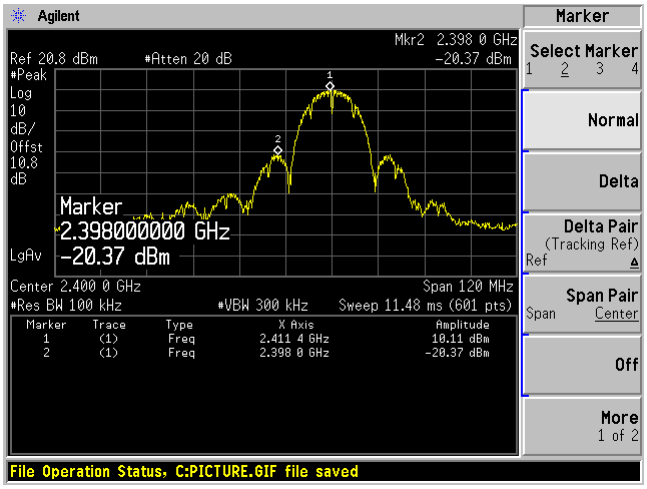


High Channel

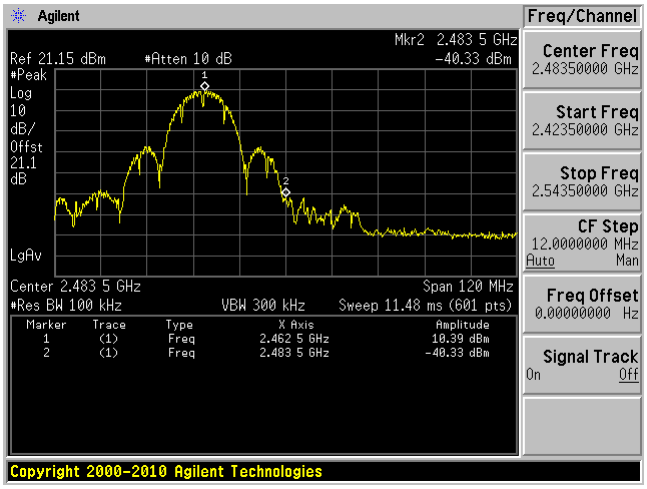


Radio 1
802.11 b mode

Low Channel

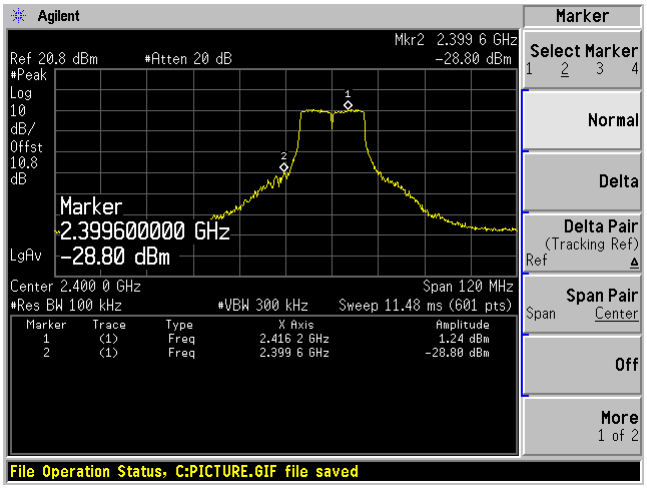


High Channel

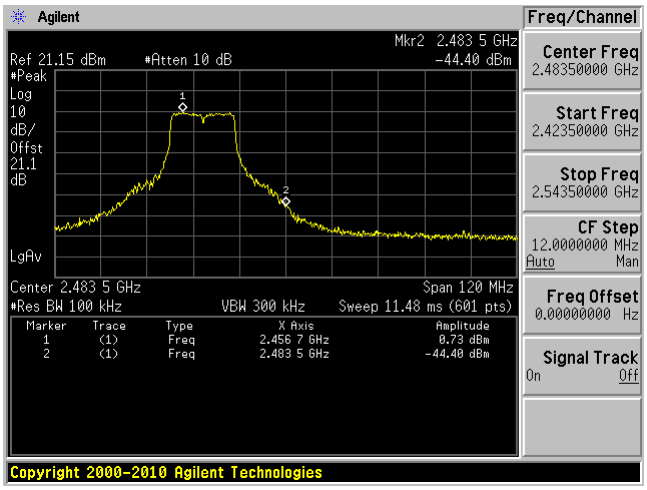


802.11 g mode

Low Channel

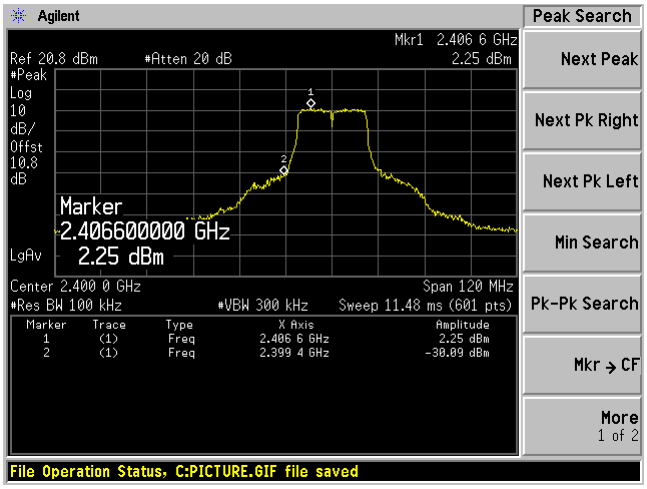


High Channel

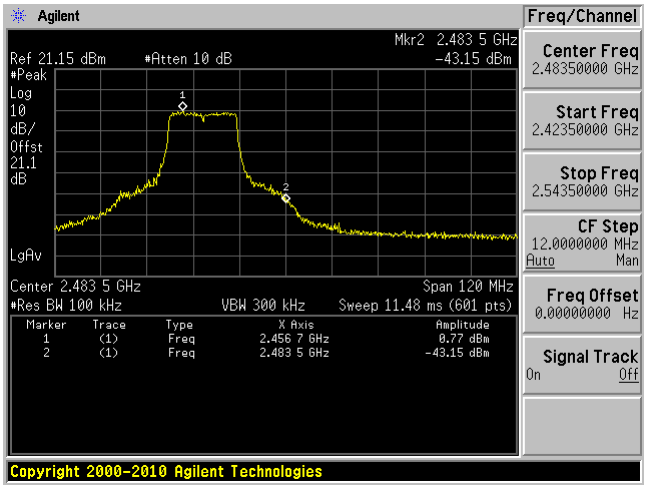


802.11 n20 mode

Low Channel



High Channel



11 FCC §15.247(e) - Power Spectral Density

11.1 Applicable Standards

According to ECFR §15.247(e), 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 v05r02: 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	E4440A	US45303156	2019-03-06	1 year
-	RF Cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A
-	10dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.

***Statement of Traceability*:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) "A2LA Policy on Metrological Traceability".

11.4 Test Environmental Conditions

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

The testing was performed by Zhao Zhao and Christian McCaig on 2019-07-05 and 2019-07-24 in RF site.

11.5 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3kHz)			Limit (dBm/3kHz)
		Antenna A	Antenna B	Total	
802.11b					
Low	2412	-11.16	-8.40	-6.55	8
Middle	2437	-15.61	-16.04	-12.81	8
High	2462	-16.11	-15.63	-12.85	8
802.11g					
Low	2412	-13.50	-11.13	-9.14	8
Middle	2437	-14.00	-13.34	-10.65	8
High	2462	-14.23	-13.63	-10.91	8
802.11n20					
Low	2412	-14.04	-11.59	-9.63	8
Middle	2437	-13.27	-13.49	-10.37	8
High	2462	-12.06	-16.00	-10.59	8

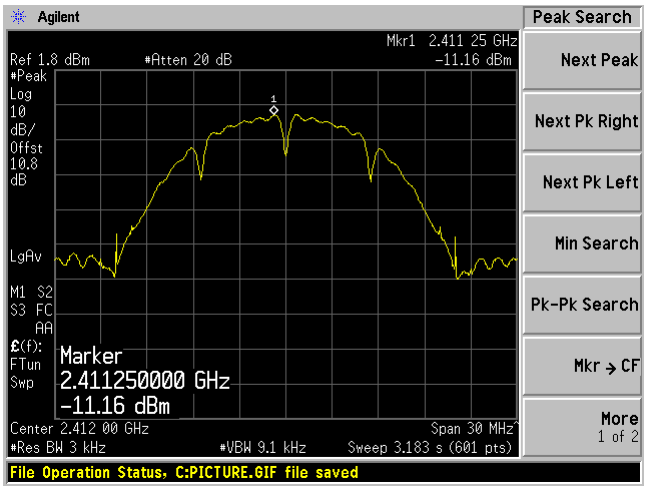
Channel	Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
BLE				
Low	2402	-4.89	8	Pass
Middle	2440	-4.55	8	Pass
High	2480	-4.74	8	Pass

Channel	Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
802.11b				
Low	2412	-9.59	8	Pass
Middle	2437	-7.91	8	Pass
High	2462	-9.46	8	Pass
802.11g				
Low	2412	-13.12	8	Pass
Middle	2437	-10.85	8	Pass
High	2462	-13.41	8	Pass
802.11n20				
Low	2412	-11.41	8	Pass
Middle	2437	-12.53	8	Pass
High	2462	-12.50	8	Pass

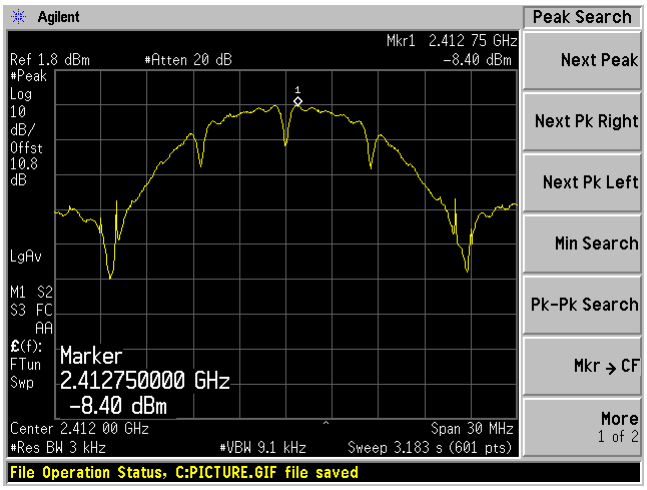
Note: the directional gain is less than 6dBi, thus no reduction to the limit.
Please refer to the following plots for detailed test results

RADIO 2 802.11b mode

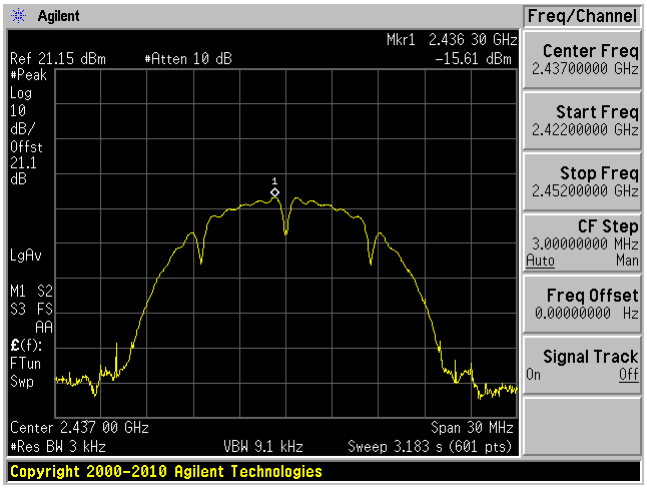
Low Channel Antenna A



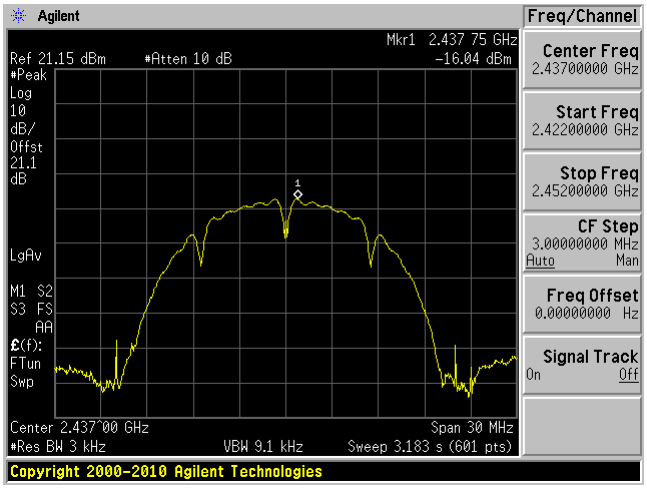
Low Channel Antenna B



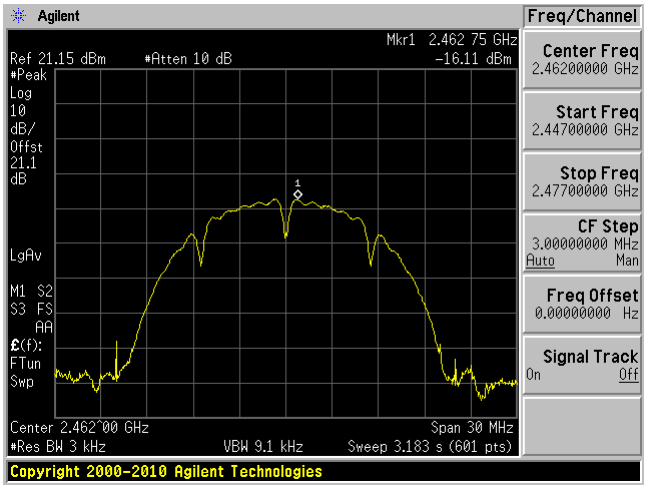
Mid Channel Antenna A



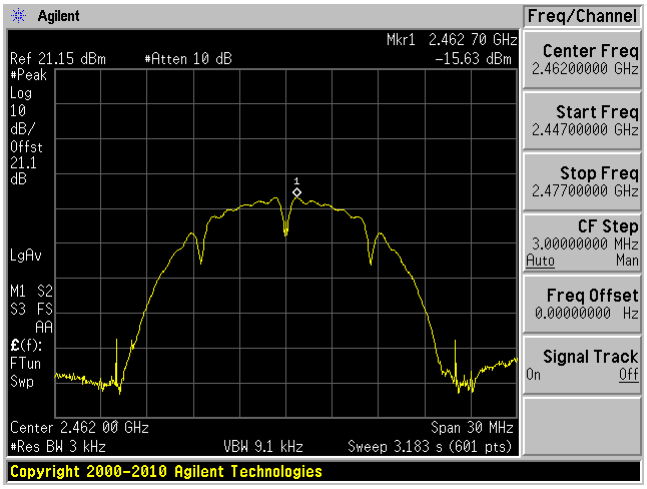
Mid Channel Antenna B



High Channel Antenna A

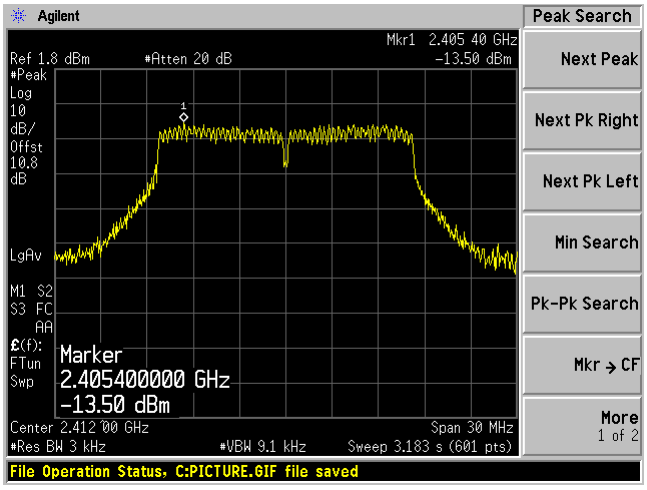


High Channel Antenna B

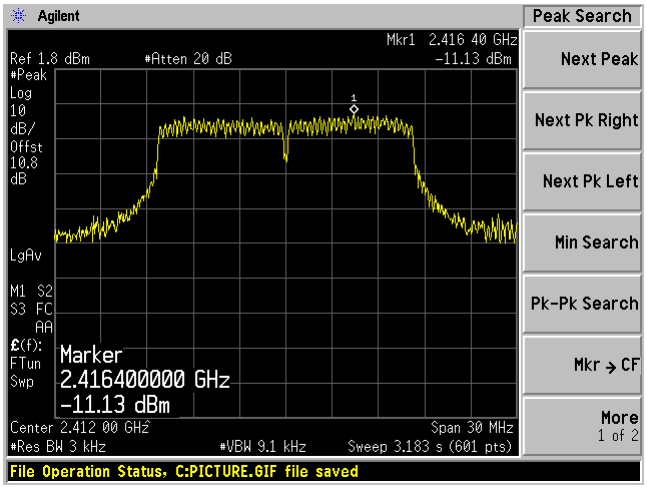


RADIO 2 802.11g mode

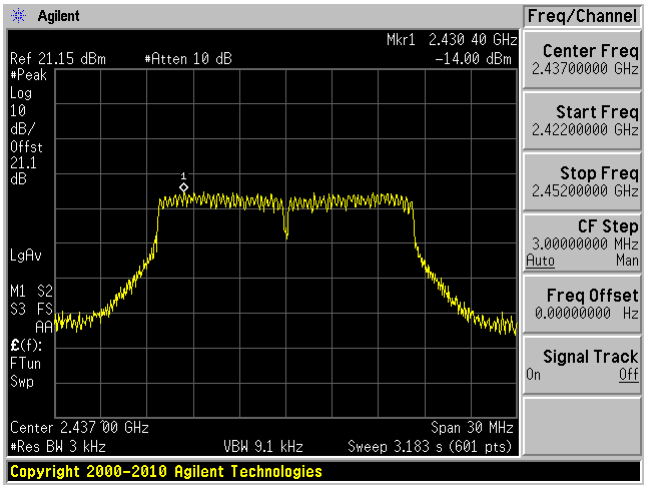
Low Channel Antenna A



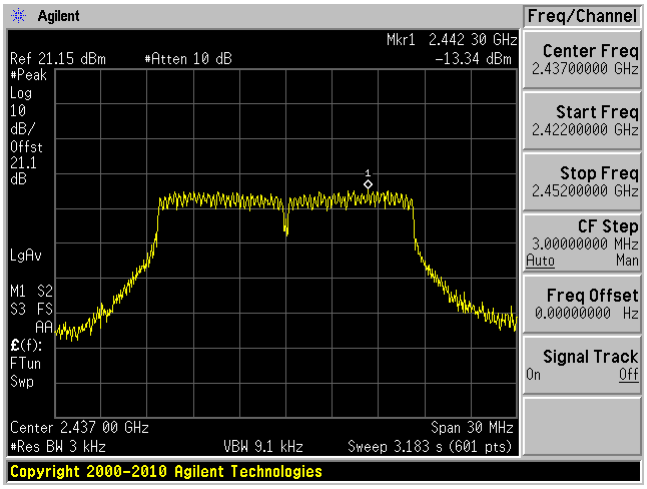
Low Channel Antenna B



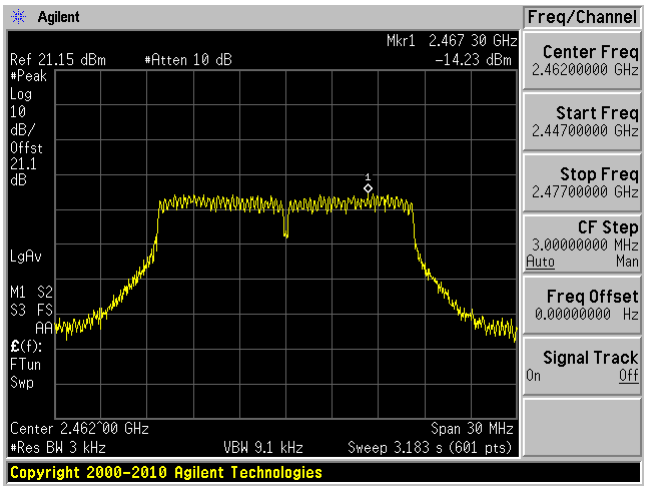
Mid Channel Antenna A



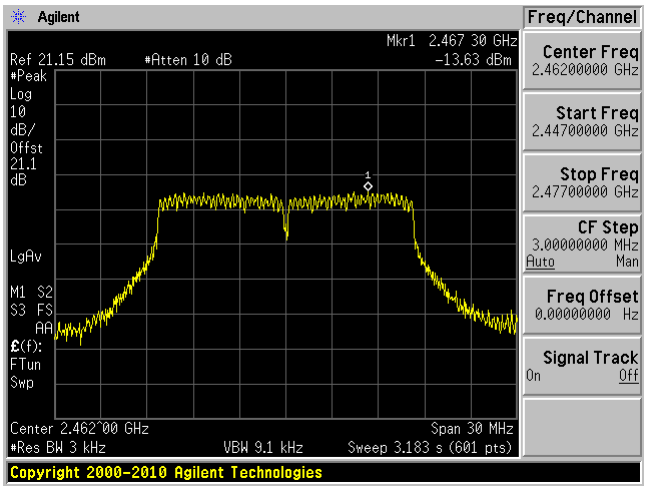
Mid Channel Antenna B



High Channel Antenna A

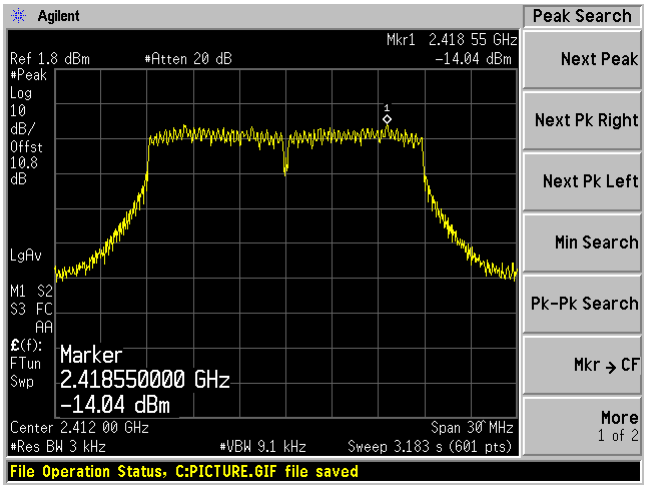


High Channel Antenna B

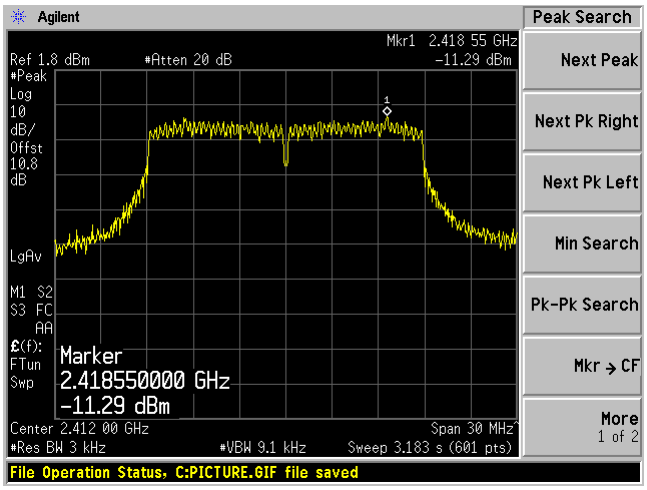


RADIO 2 802.11 n20 mode

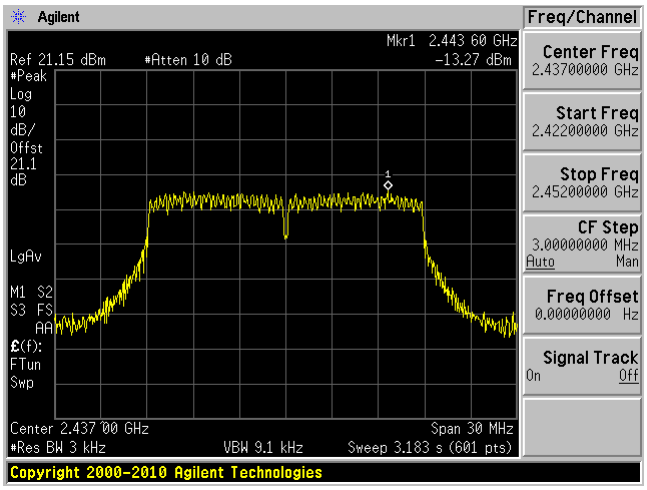
Low Channel Antenna A



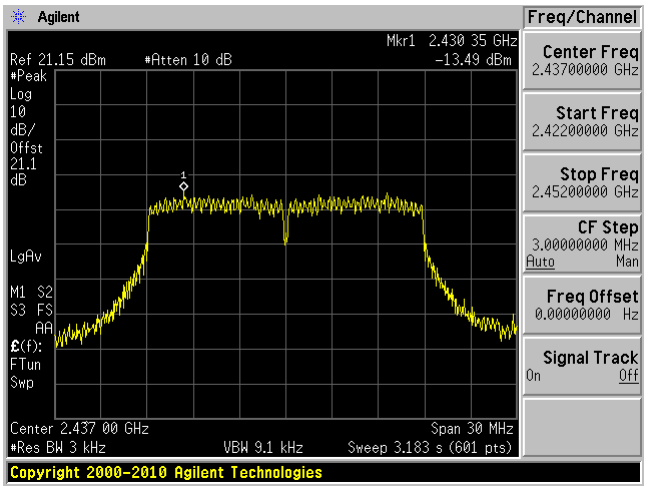
Low Channel Antenna B



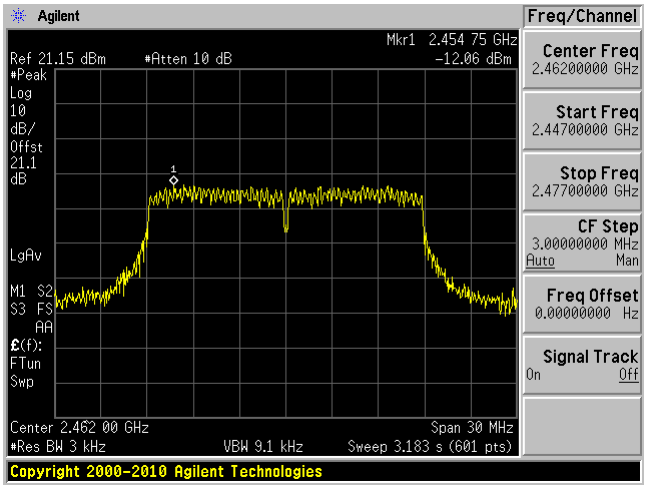
Mid Channel Antenna A



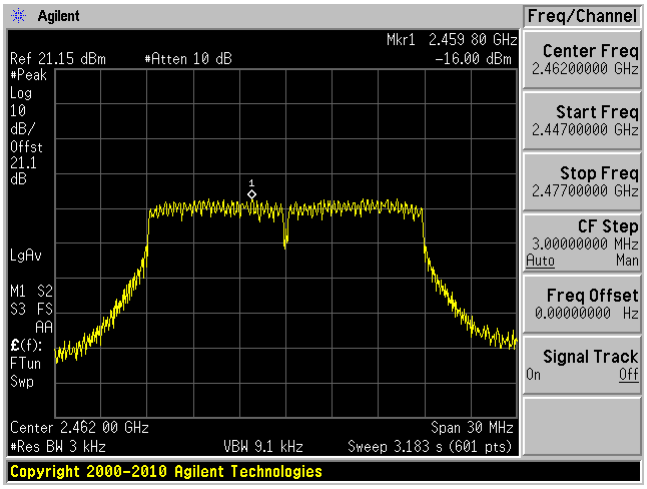
Mid Channel Antenna B



High Channel Antenna A

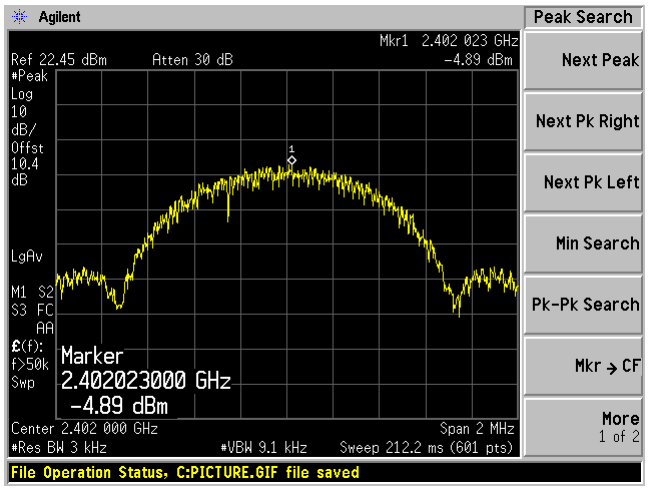


High Channel Antenna B

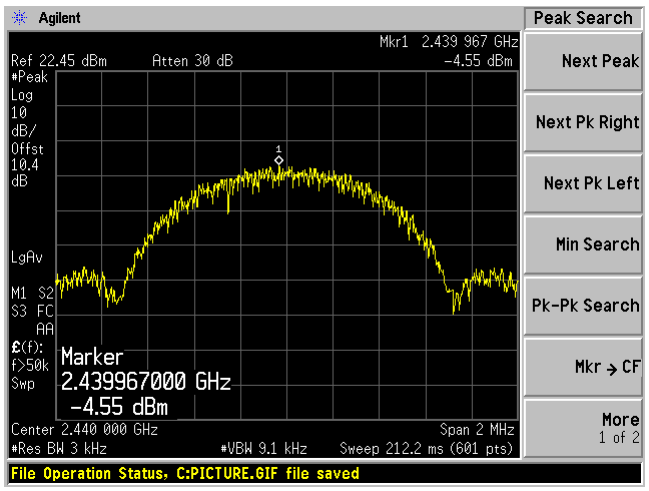


RADIO 2 BLE mode

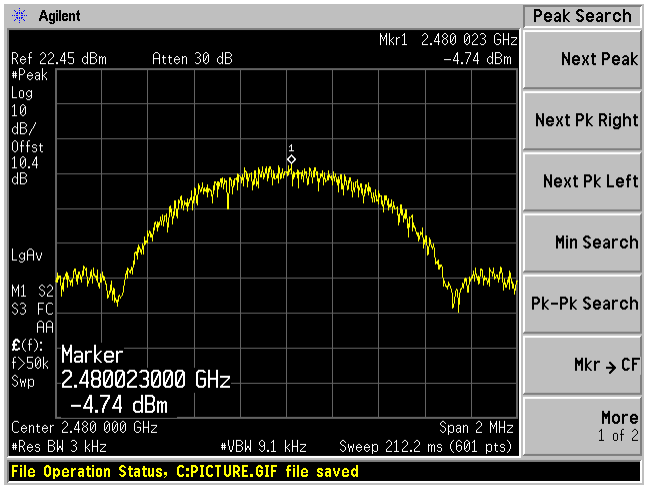
Low Channel



Mid Channel

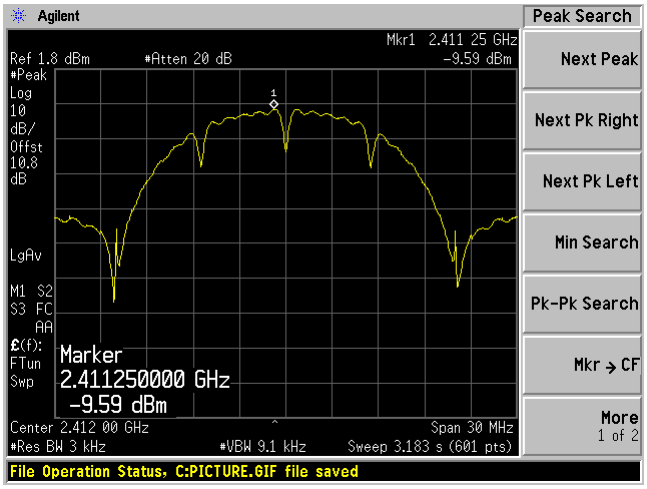


High Channel

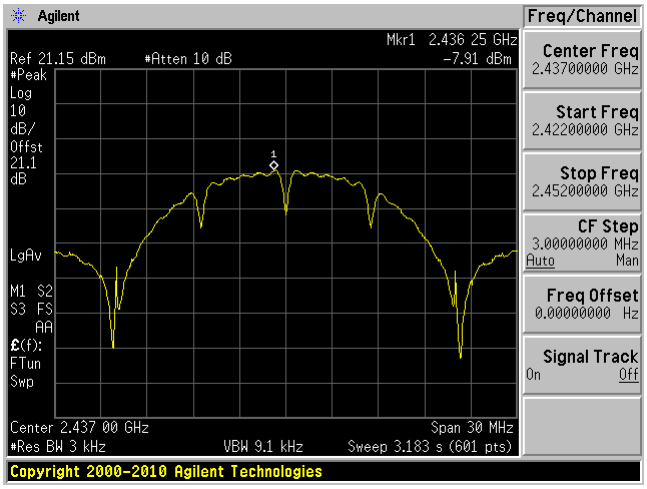


RADIO 1 802.11b mode

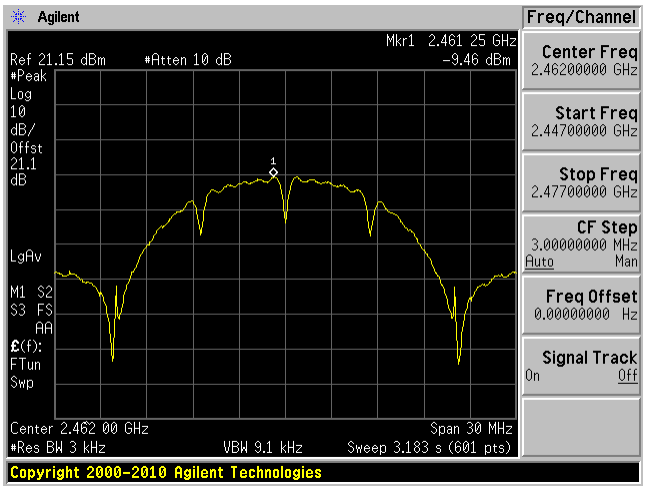
Low Channel



Mid Channel

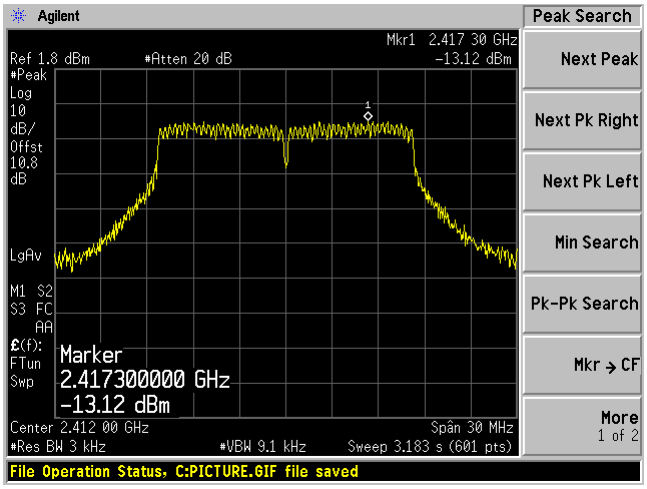


High Channel

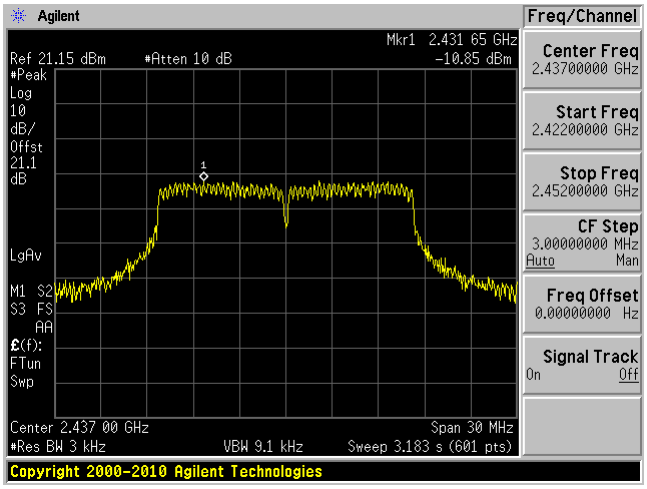


RADIO 1 802.11g mode

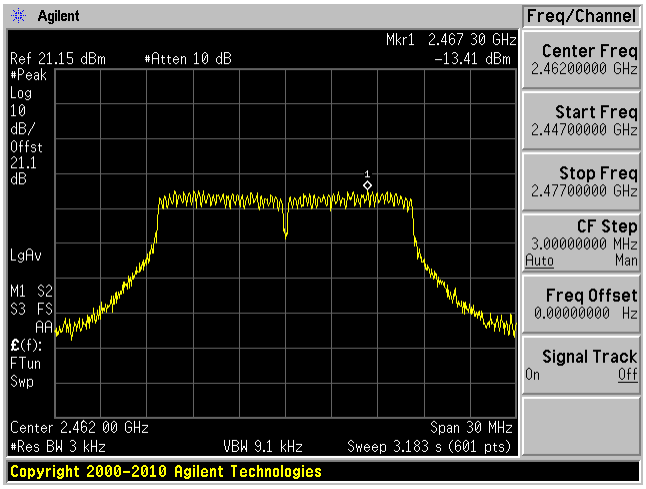
Low Channel



Mid Channel

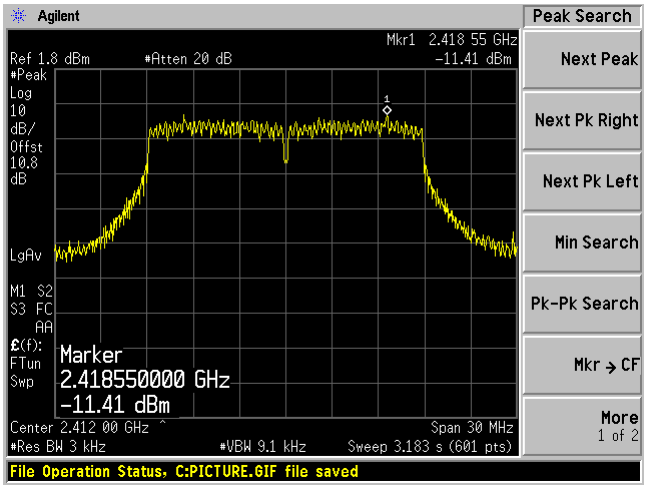


High Channel

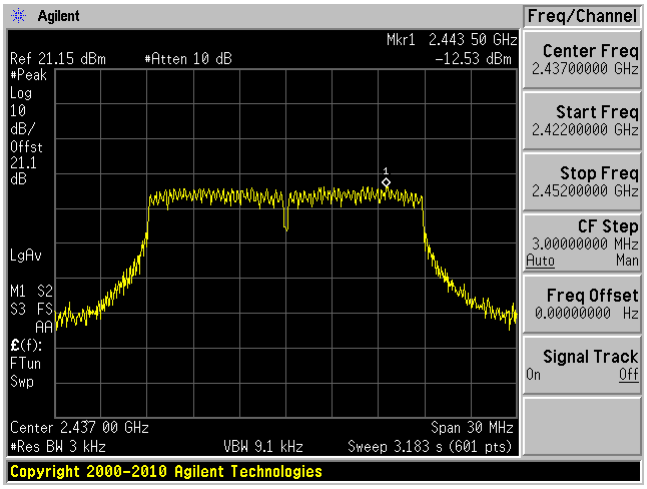


RADIO 1 802.11 n20 mode

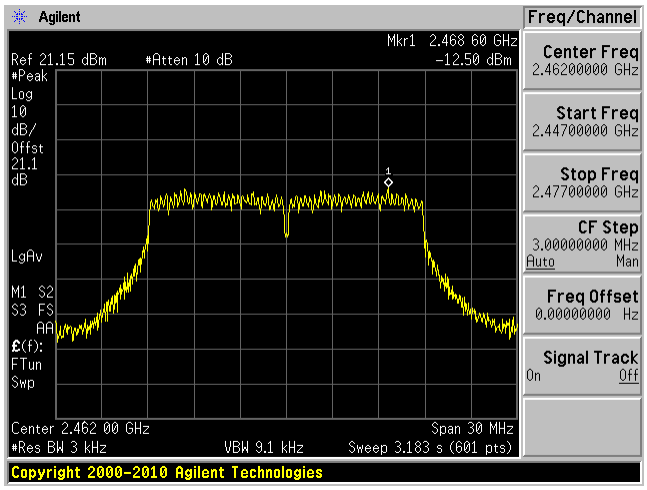
Low Channel



Mid Channel



High Channel



12 FCC §15.247(d) - Spurious Emissions at Antenna Terminals

12.1 Applicable Standards

For 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)).

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	E4440A	US45303156	2019-03-06	1 year
-	RF cable	-	-	Each time[1]	N/A
-	20dB attenuator	-	-	Each time[1]	N/A
-	10dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.

***Statement of Traceability*:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 9 June 2016) "A2LA Policy on Metrological Traceability".

12.4 Test Environmental Conditions

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

The testing was performed by Zhao Zhao and Christian McCaig on 2019-07-09 and 2019-07-24 in RF site.

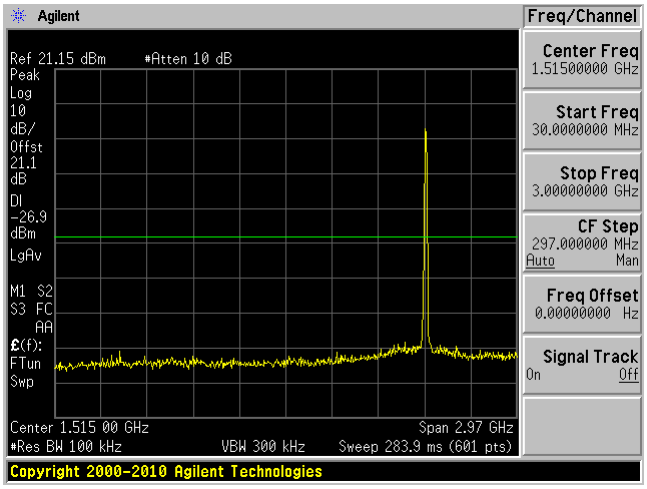
12.5 Test Results

Please refer to following plots.

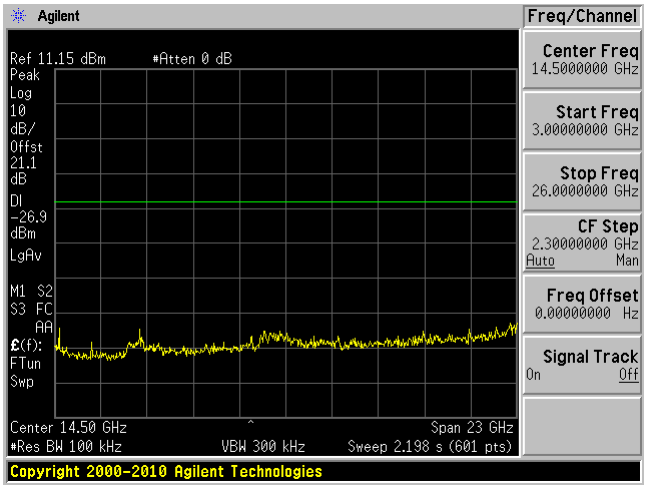
RADIO 2 802.11b mode

Antenna A Low Channel 2412MHz

30MHz – 3GHz

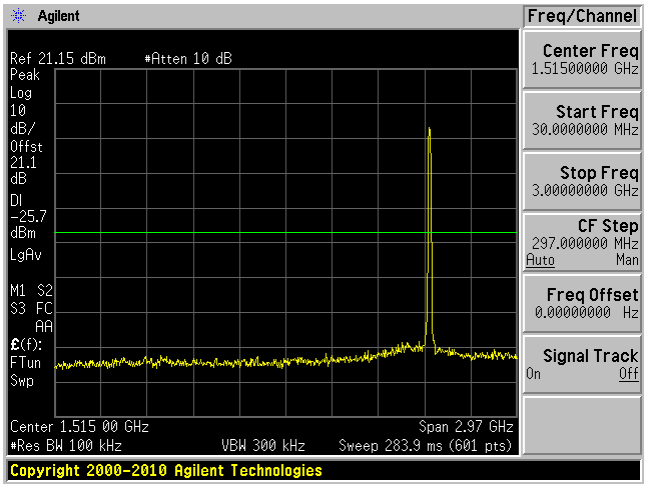


3GHz – 26GHz

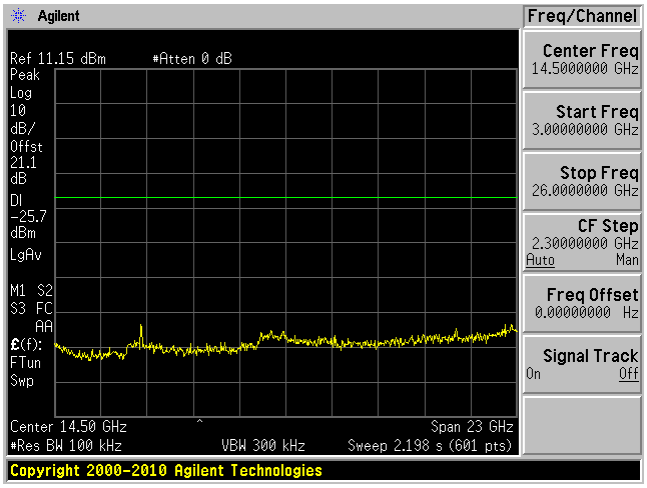


Antenna A Mid Channel 2437MHz

30MHz – 3GHz

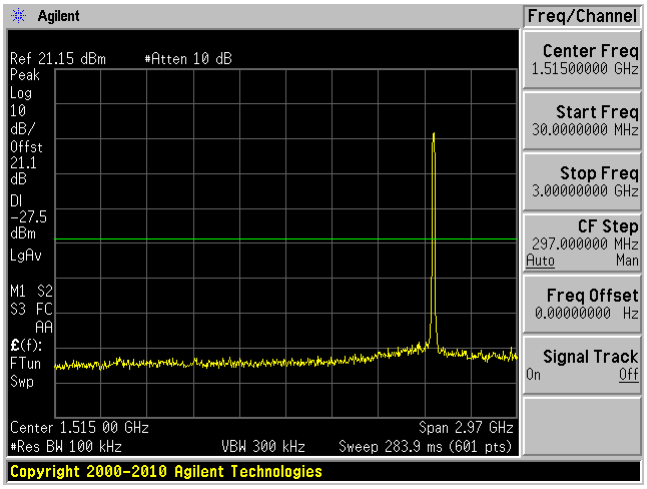


3GHz – 26GHz

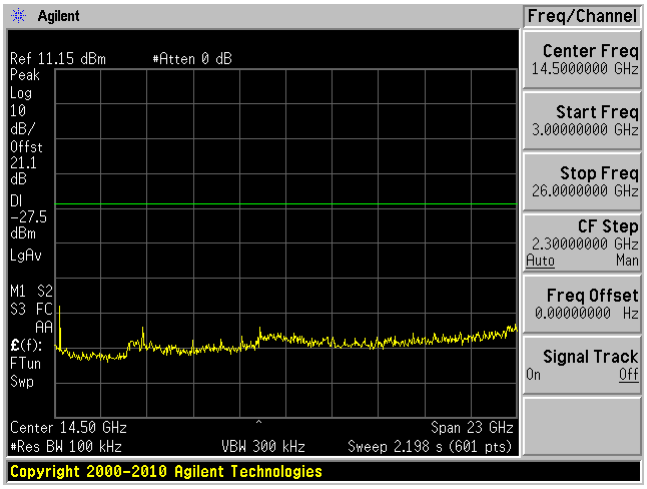


Antenna A High Channel 2462MHz

30MHz – 3GHz

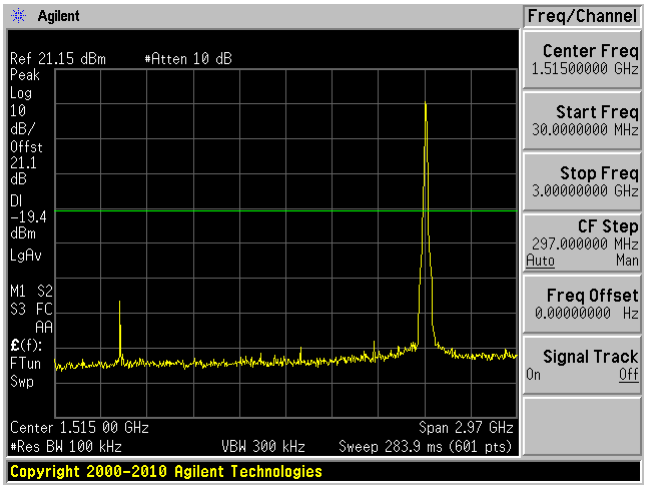


3GHz – 26GHz

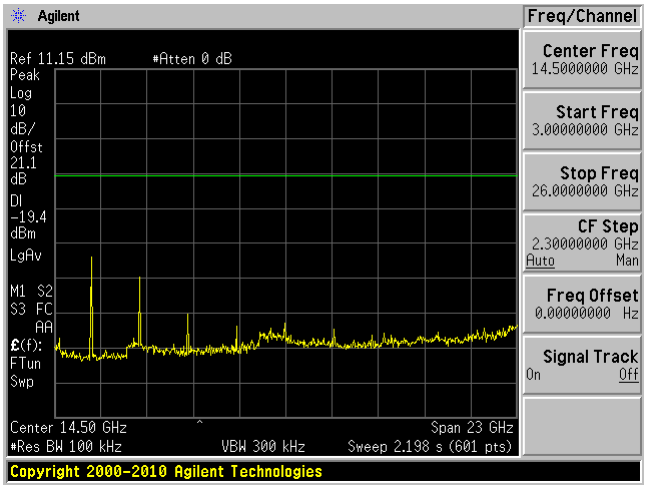


Antenna B Low Channel 2412MHz

30MHz – 3GHz

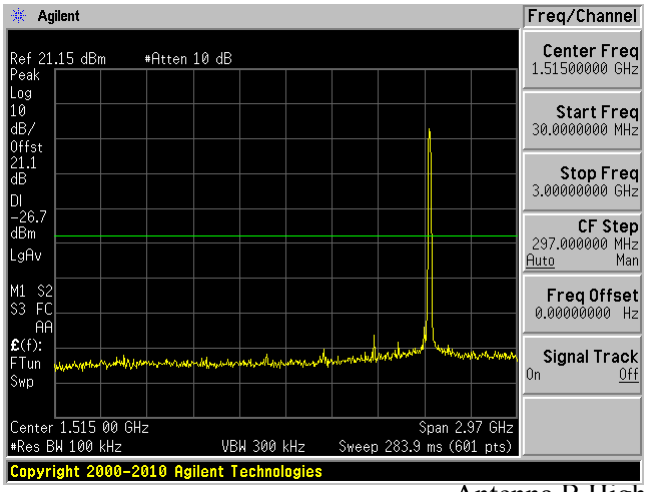


3GHz – 26GHz

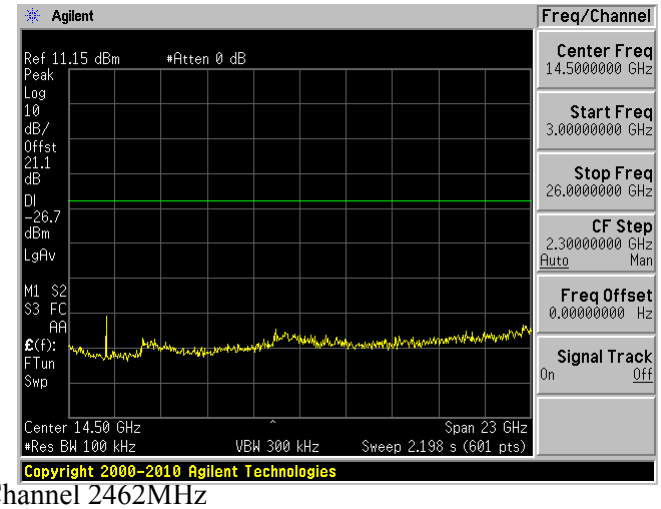


Antenna B Mid Channel 2437MHz

30MHz – 3GHz

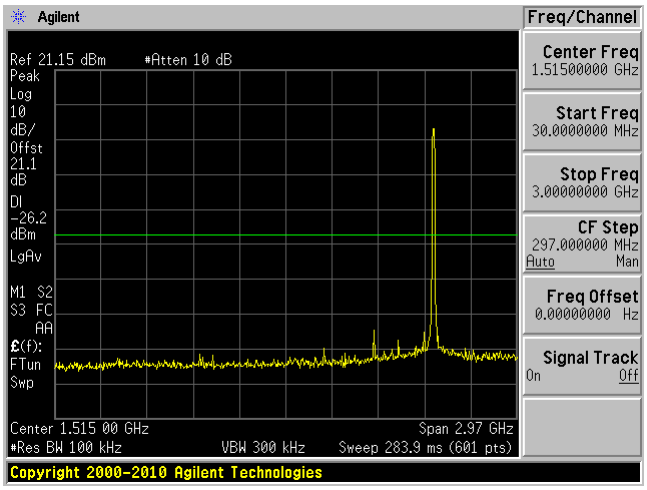


3GHz – 26GHz

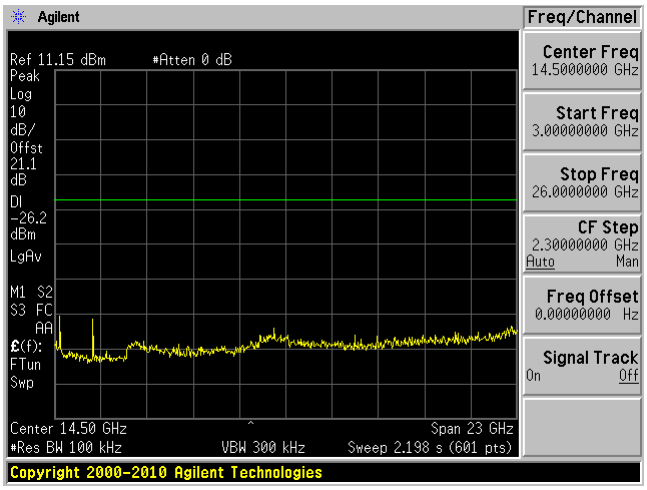


Antenna B High Channel 2462MHz

30MHz – 3GHz



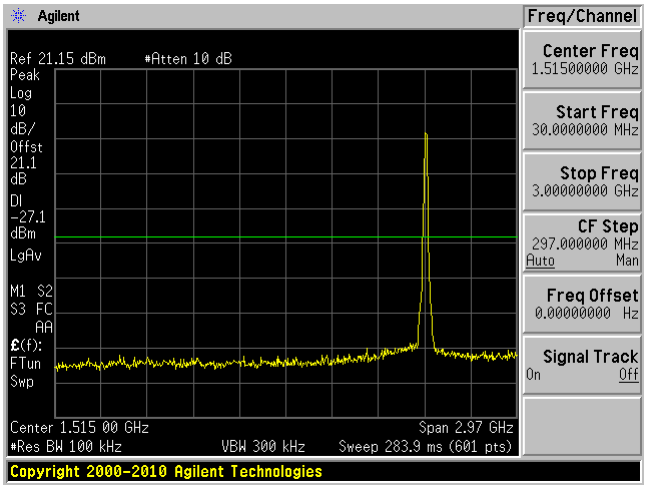
3GHz – 26GHz



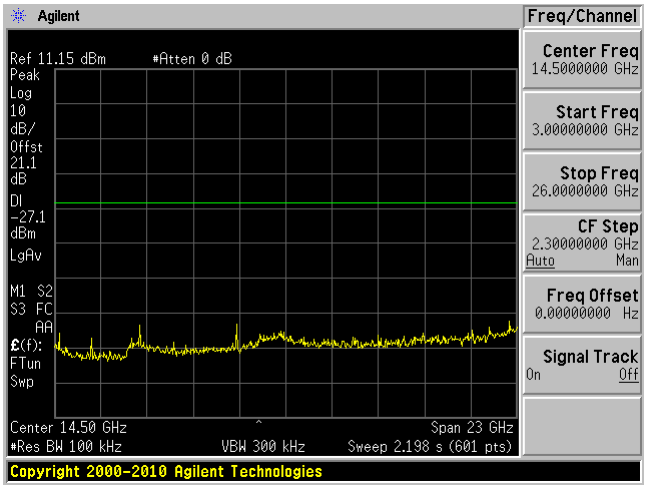
RADIO 2 802.11g mode

Antenna A Low Channel 2412MHz

30MHz – 3GHz

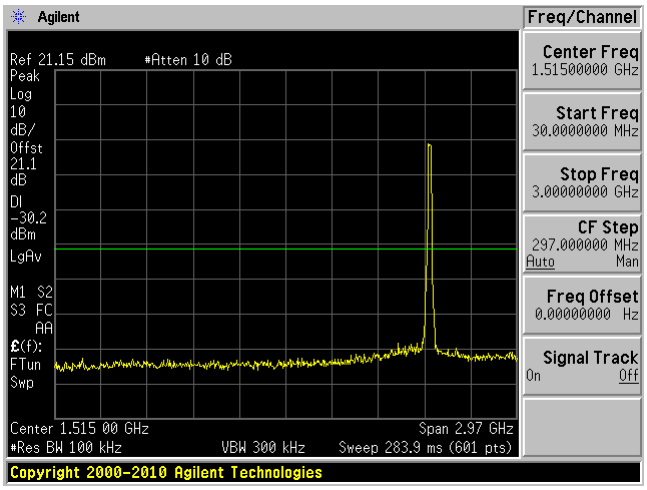


3GHz – 26GHz

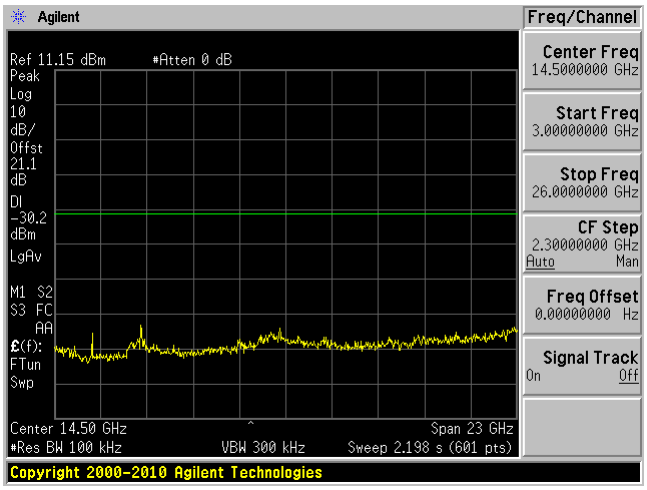


Antenna A Mid Channel 2437MHz

30MHz – 3GHz

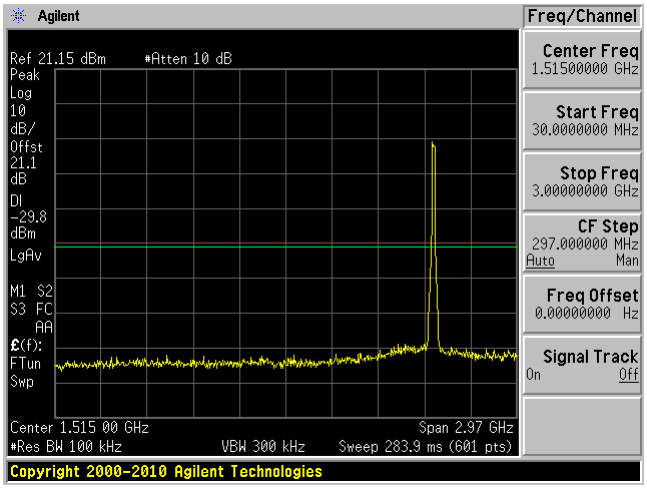


3GHz – 26GHz

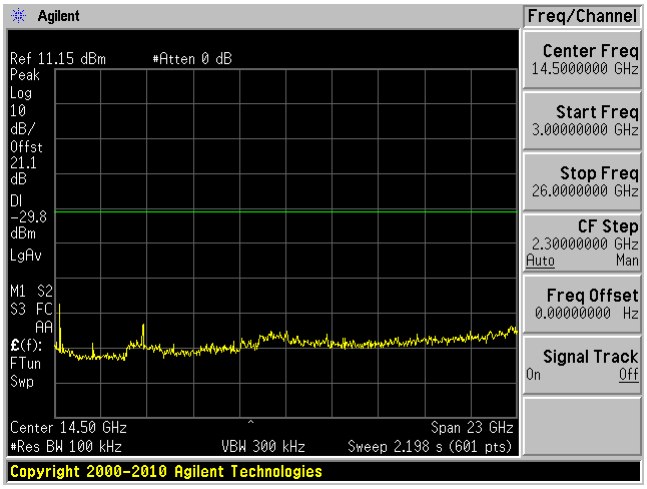


Antenna A High Channel 2462MHz

30MHz – 3GHz

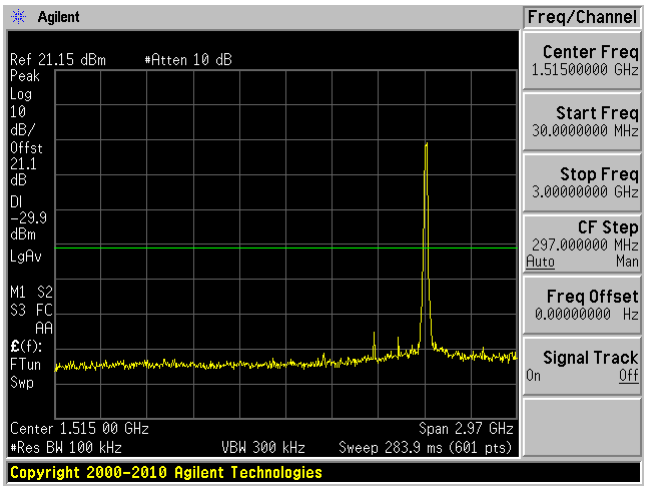


3GHz – 26GHz

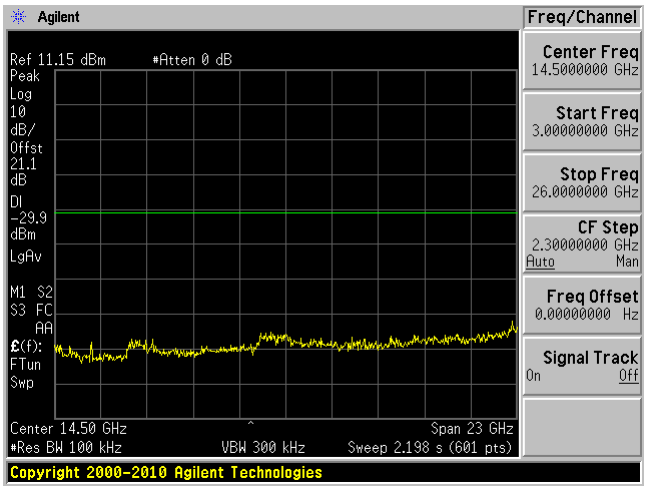


Antenna B Low Channel 2412MHz

30MHz – 3GHz

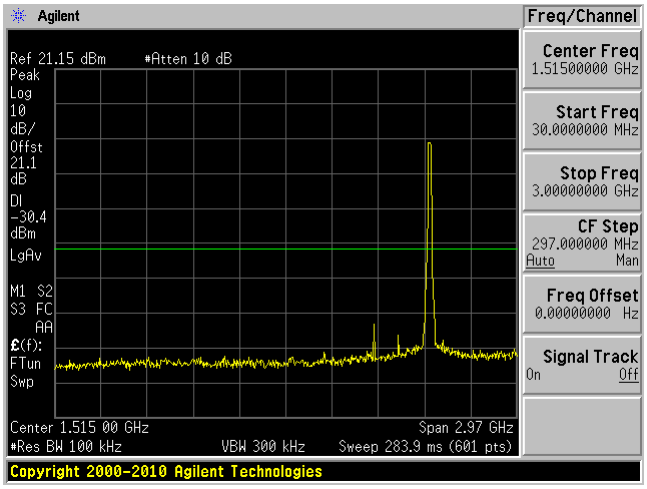


3GHz – 26GHz

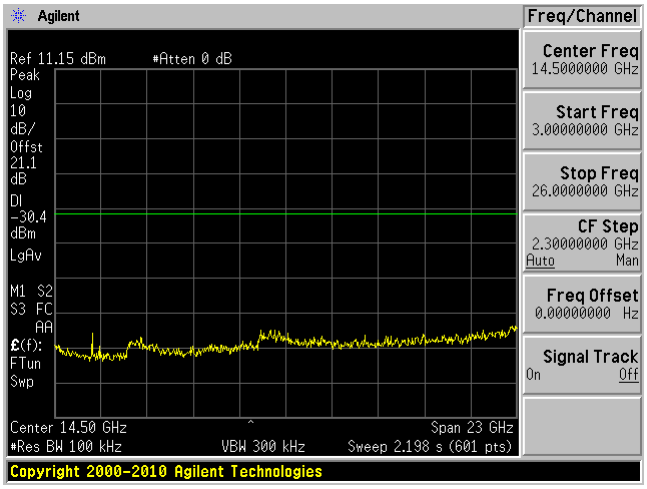


Antenna B Mid Channel 2437MHz

30MHz – 3GHz

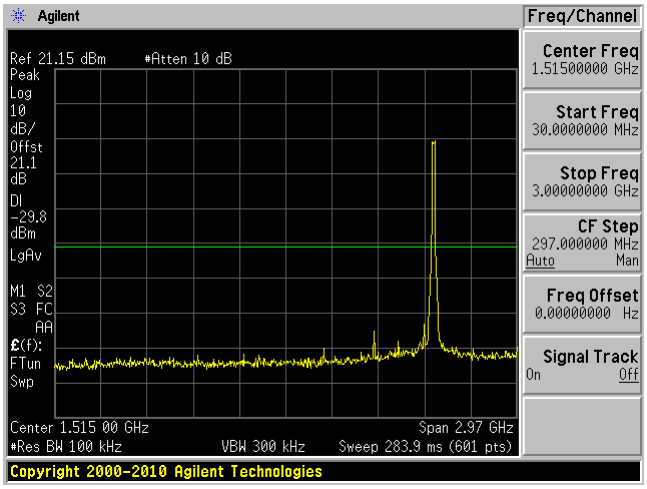


3GHz – 26GHz

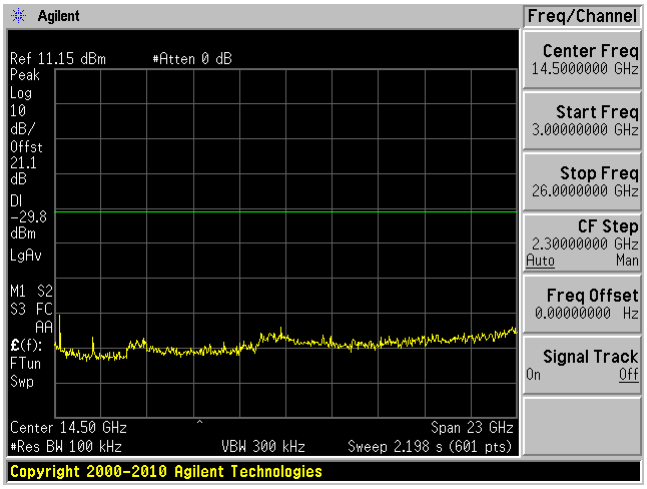


Antenna B High Channel 2462MHz

30MHz – 3GHz



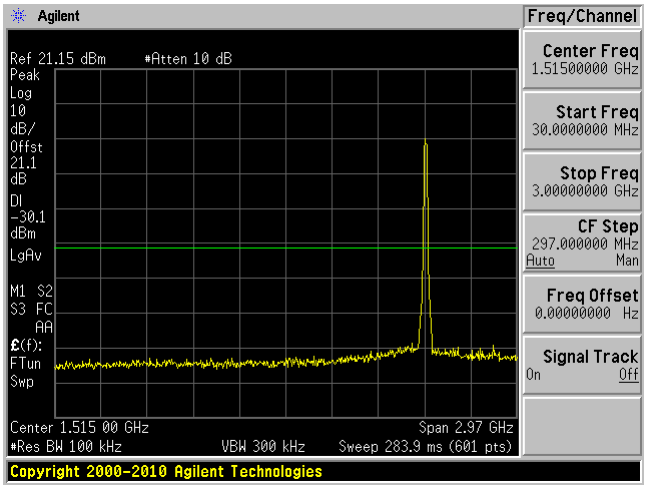
3GHz – 26GHz



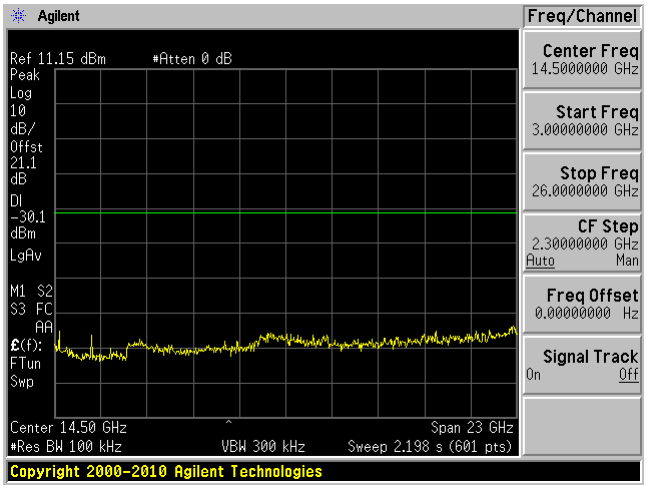
RADIO 2 802.11 n20 mode

Antenna A Low Channel 2412MHz

30MHz – 3GHz

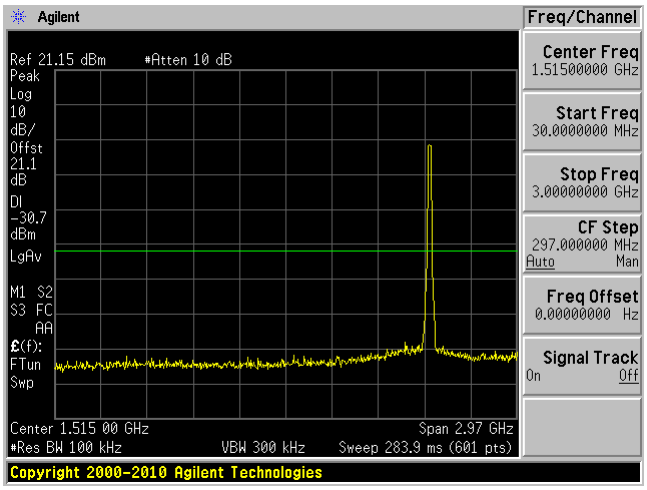


3GHz – 26GHz

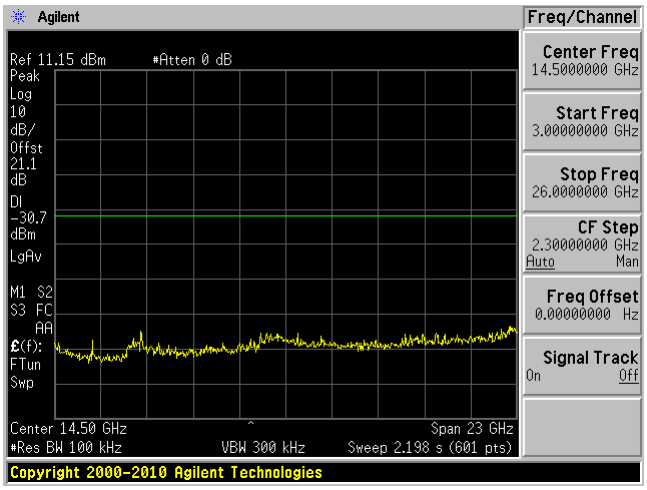


Antenna A Mid Channel 2437MHz

30MHz – 3GHz

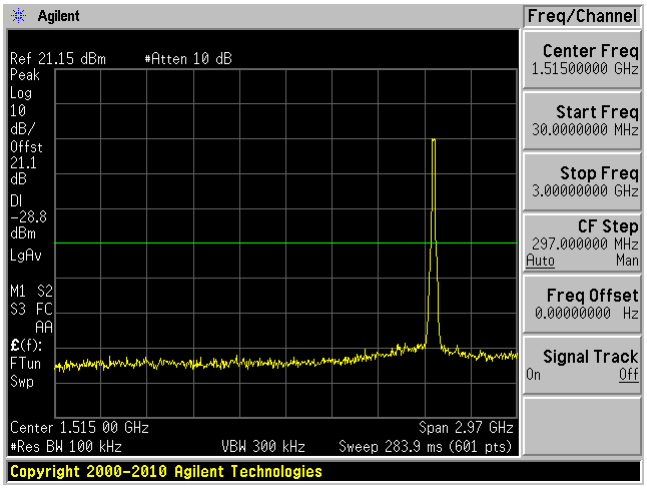


3GHz – 26GHz

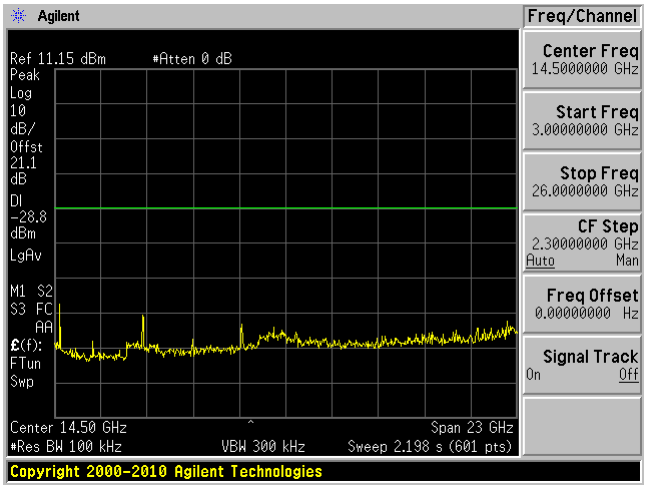


Antenna A High Channel 2462MHz

30MHz – 3GHz

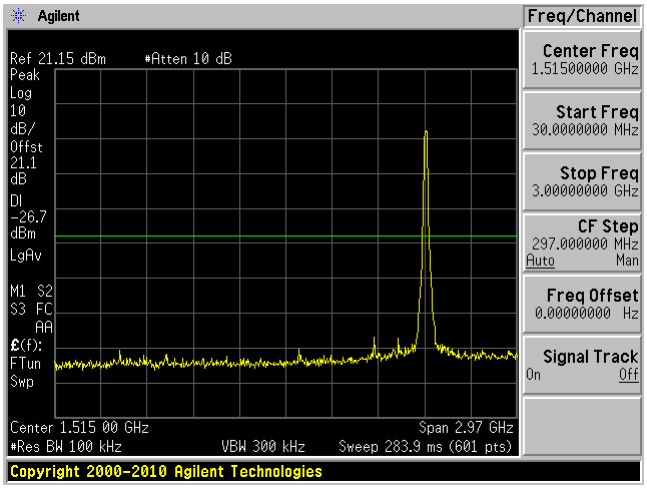


3GHz – 26GHz

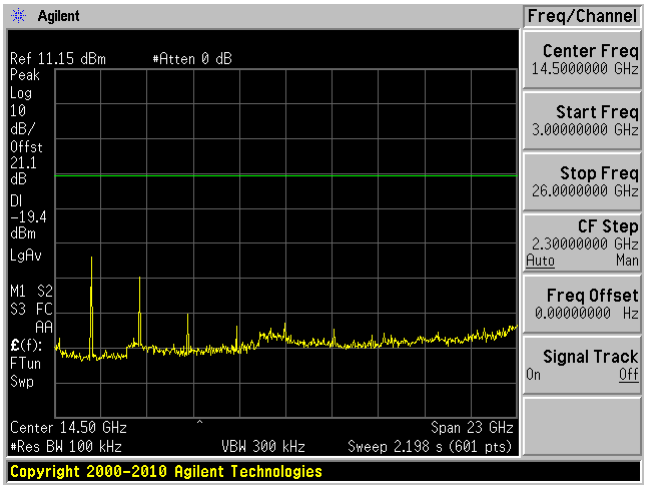


Antenna B Low Channel 2412MHz

30MHz – 3GHz

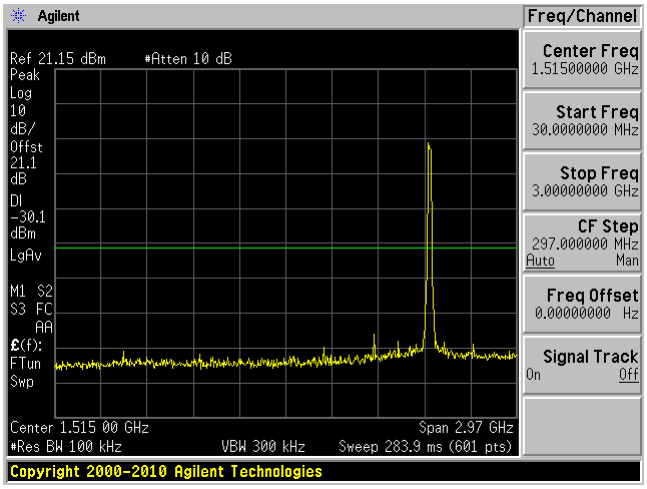


3GHz – 26GHz

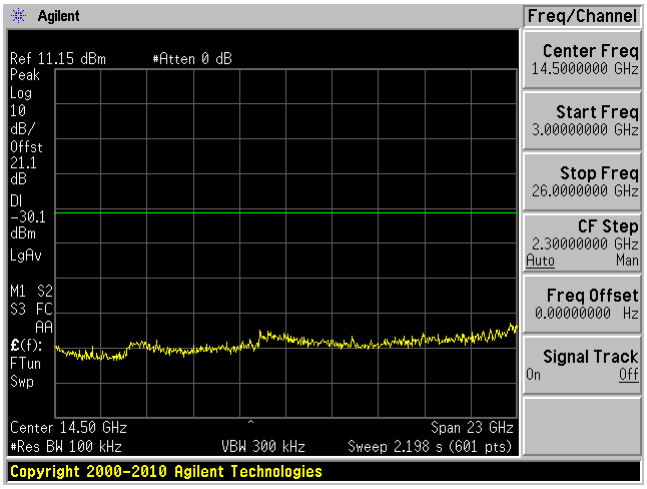


Antenna B Mid Channel 2437MHz

30MHz – 3GHz

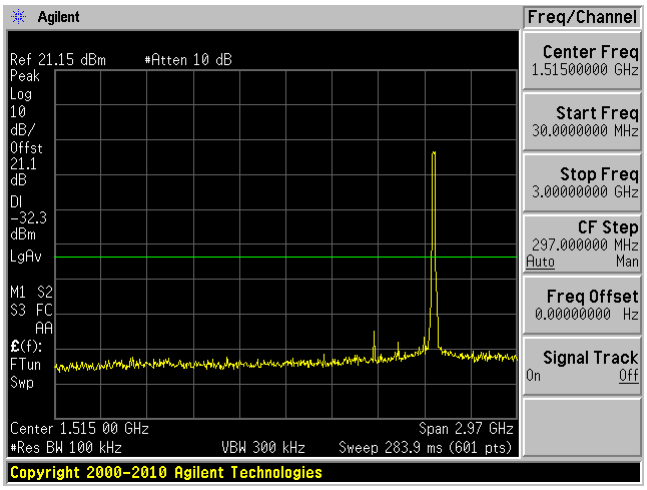


3GHz – 26GHz

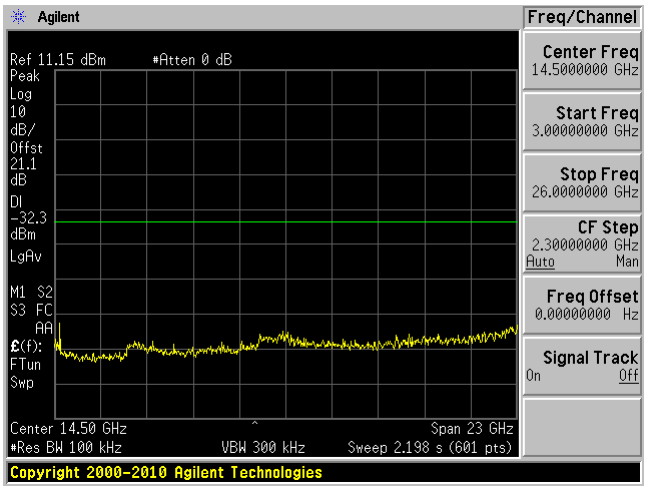


Antenna B High Channel 2462MHz

30MHz – 3GHz



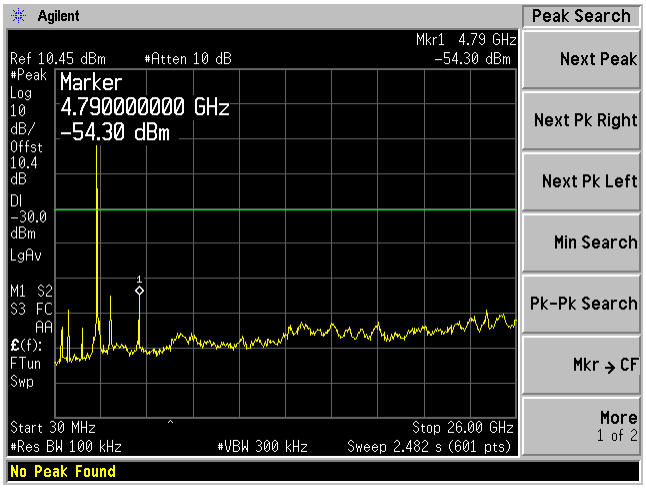
3GHz – 26GHz



RADIO 2 BLE mode

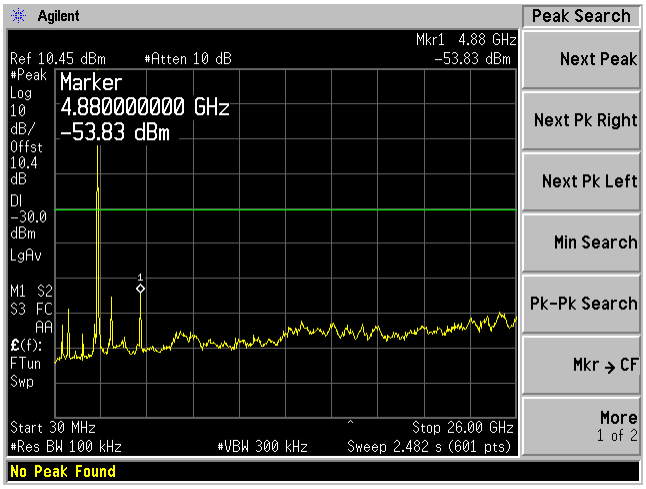
Low Channel 2402MHz

30MHz – 26GHz



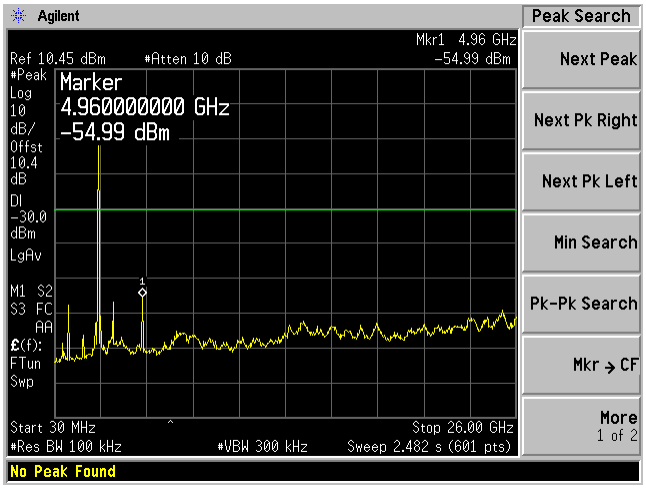
Mid Channel 2440MHz

30MHz – 26GHz



High Channel 2480MHz

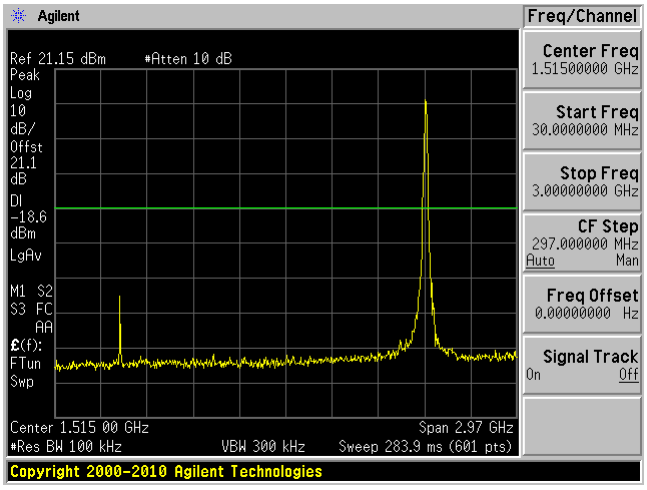
30MHz – 26GHz



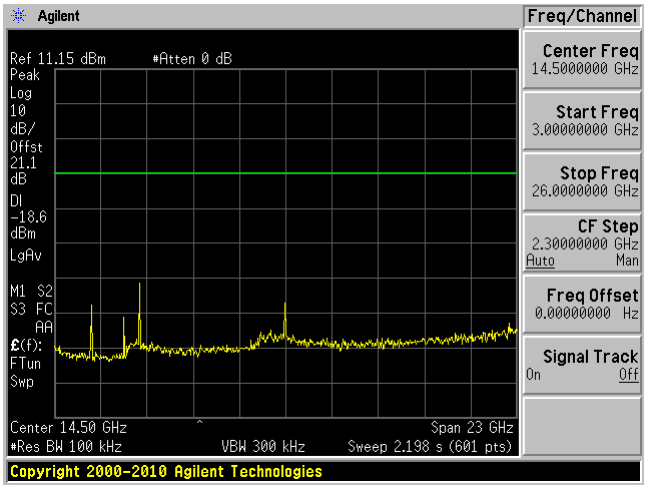
RADIO 1 802.11 b mode

Low Channel 2412MHz

30MHz – 3GHz

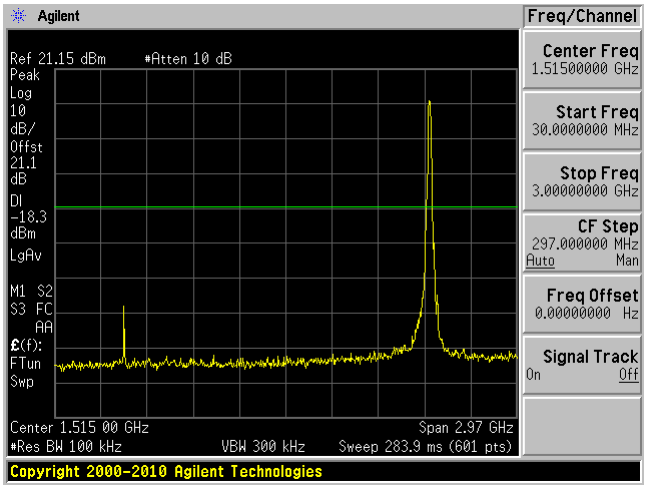


3GHz – 26GHz

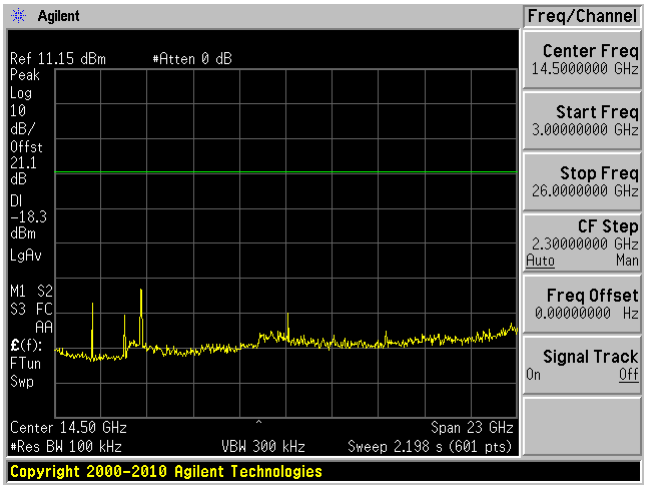


Mid Channel 2437MHz

30MHz – 3GHz

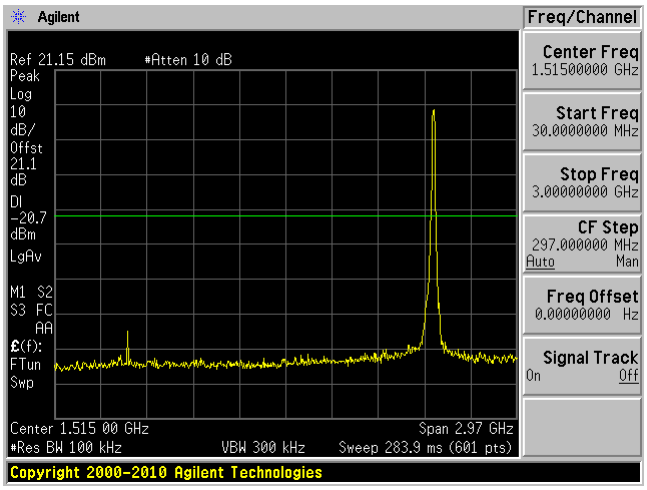


3GHz – 26GHz

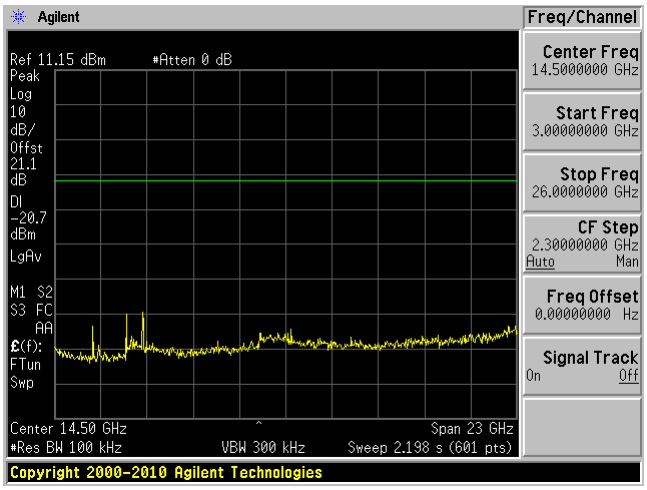


High Channel 2462MHz

30MHz – 3GHz



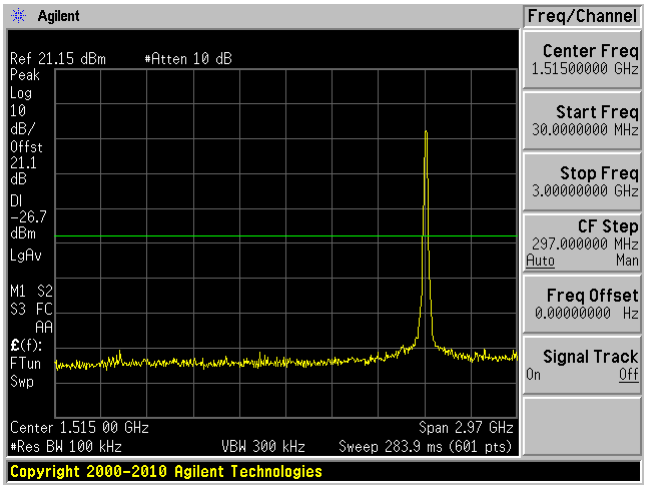
3GHz – 26GHz



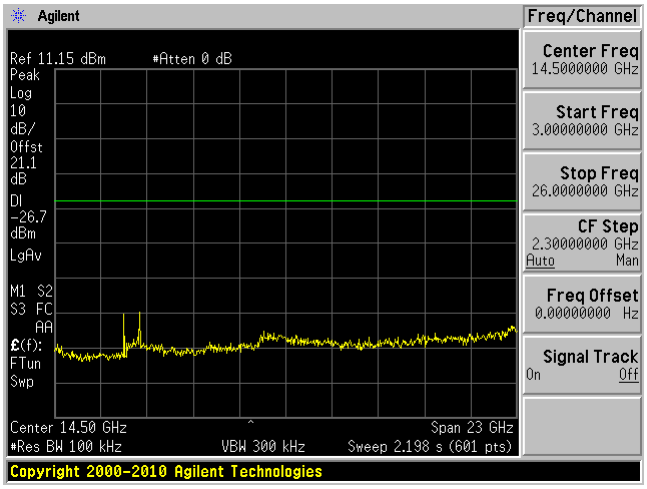
RADIO 1 802.11 g mode

Low Channel 2412MHz

30MHz – 3GHz

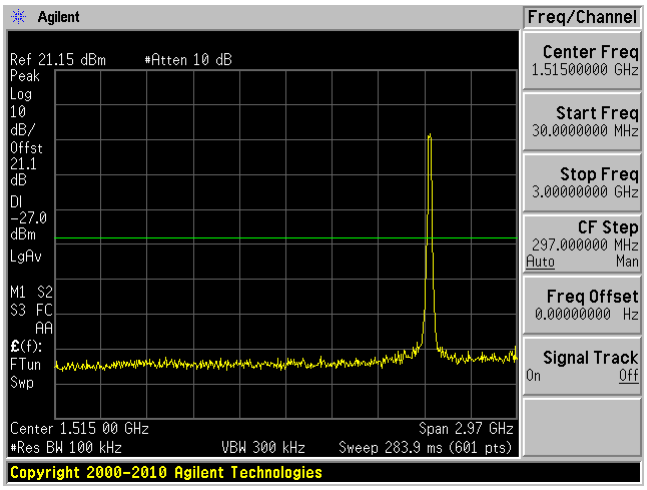


3GHz – 26GHz

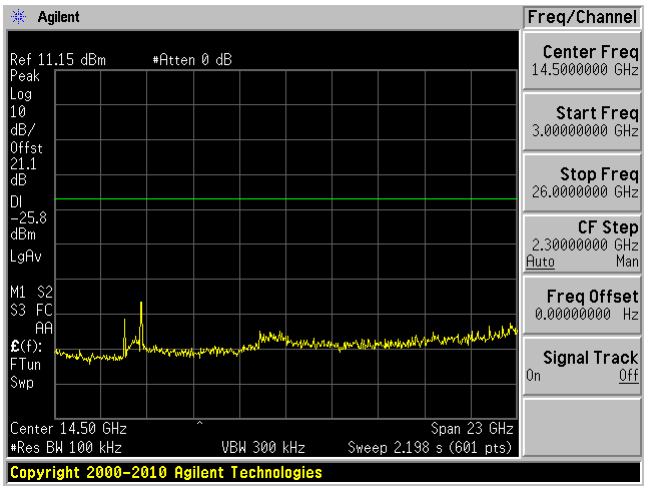


Mid Channel 2437MHz

30MHz – 3GHz

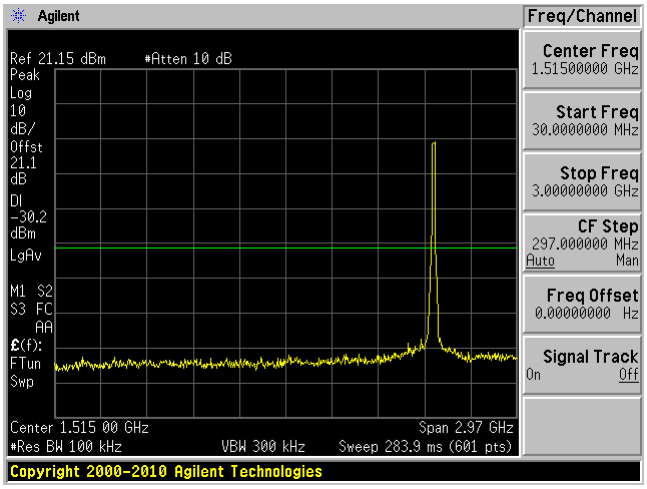


3GHz – 26GHz

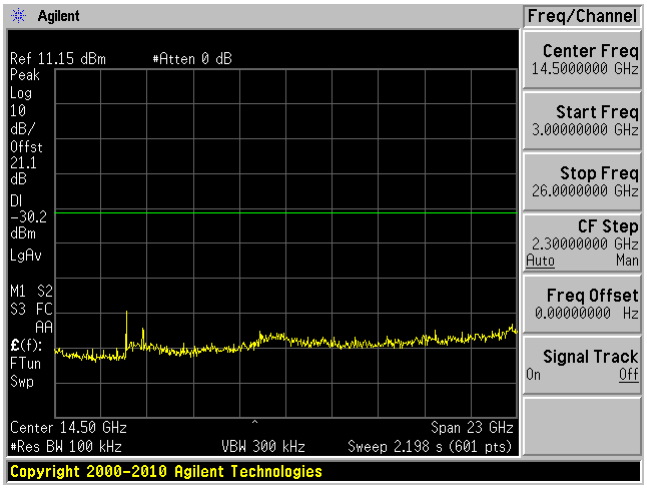


High Channel 2462MHz

30MHz – 3GHz



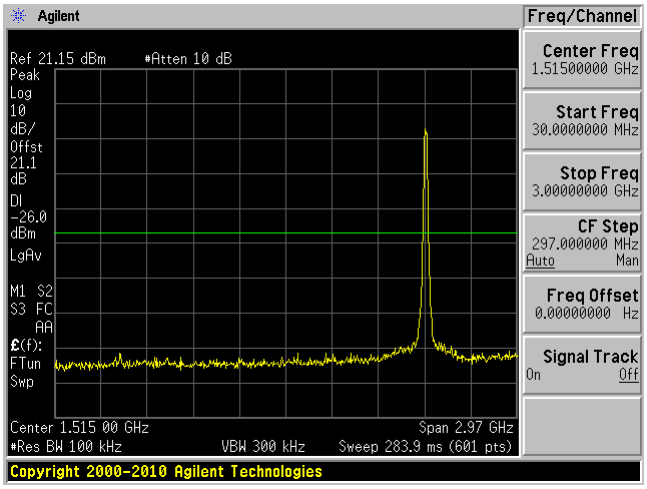
3GHz – 26GHz



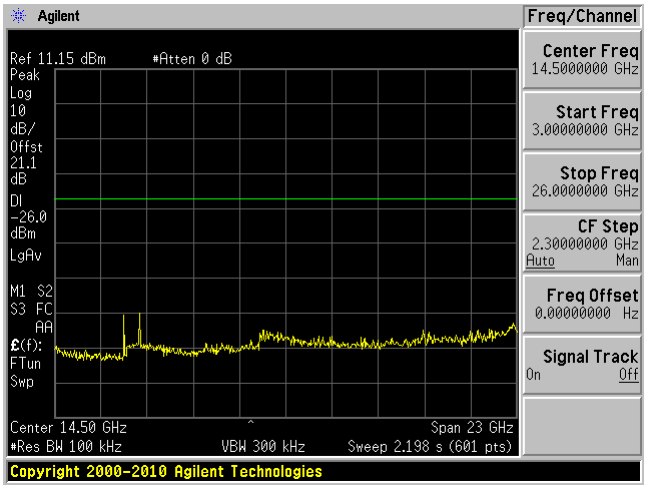
RADIO 1 802.11 n20 mode

Low Channel 2412MHz

30MHz – 3GHz

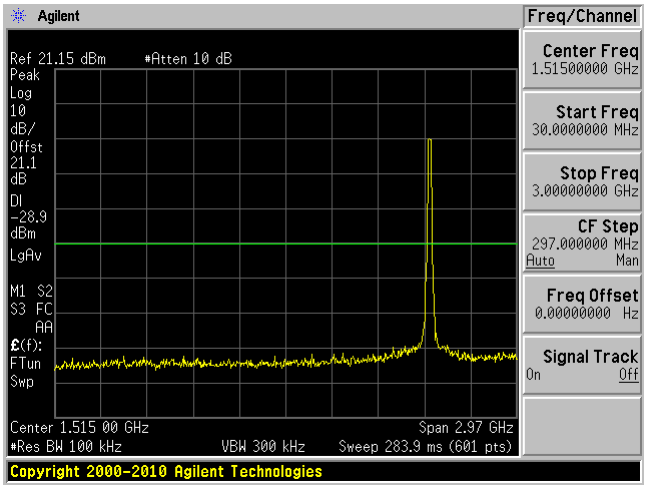


3GHz – 26GHz

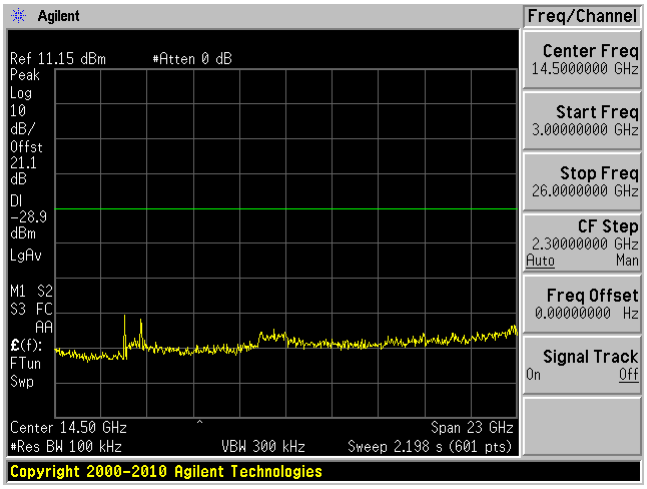


Mid Channel 2437MHz

30MHz – 3GHz

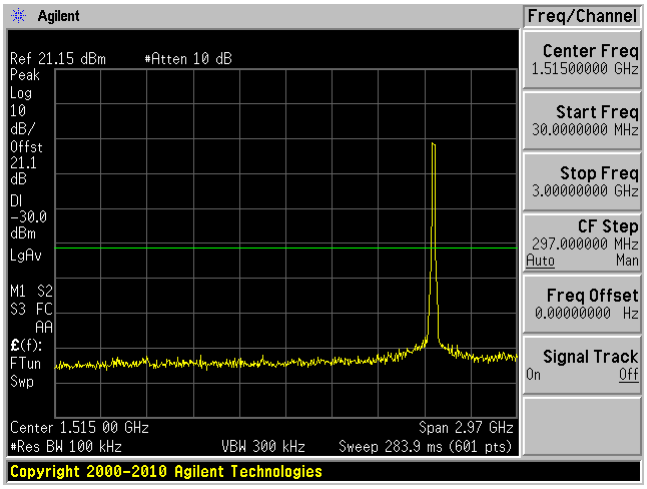


3GHz – 26GHz

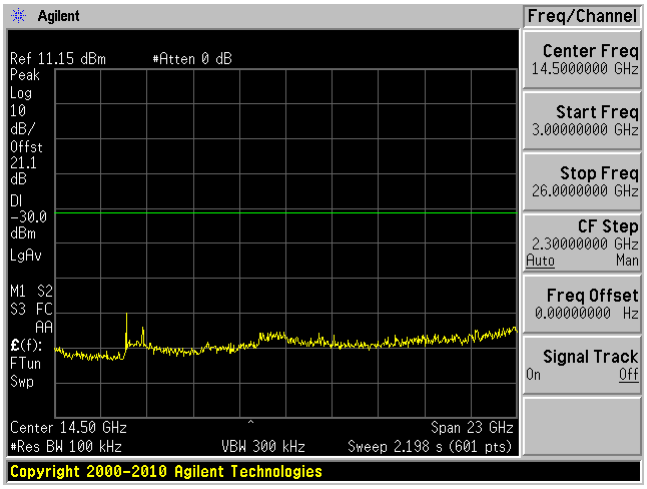


High Channel 2462MHz

30MHz – 3GHz



3GHz – 26GHz



13 Annex A (Normative)- EUT Test Setup Photographs

Please refer to the attachment

14 Annex B (Normative) – EUT External Photographs

Please refer to the attachment

15 Annex C (Normative) – EUT Internal Photographs

Please refer to the attachment

16 Annex E (Normative) – 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 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 April 2017*).

Presented this 2nd day of October 2018.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2020
Revised February 21, 2019

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

Please follow the web link below for a full ISO 17025 scope

https://www.a2la.org/scopepdf/3297-02.pdf

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