FCC PART 15.407

TEST REPORT

For

Roku, Inc.

150 Winchester Cir

Los Gatos, CA 95032, USA

FCC ID: TC2-R1022

Report Type: Original Report	**Model:** 2200X
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Report Number:	R1903224-407
Report Date:	2019-04-20
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ACCREDITED
CERTIFICATE #3297.02

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

* This test report may contain data and test methods that are not covered by BACL's scope of accreditation as of the test report date shown above. These items are marked within the test report text with an asterisk "*"

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1903224-407	Original Report	2019-04-20

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

Manufacturer:	Roku, Inc.
EUT Model(s):	2200X
FCC ID:	TC2-R1022
Serial Number(s):	R1903244-1 and R1903244-2

1.2 Objective

This report is prepared on behalf of *Roku, Inc.*, Inc in accordance with FCC CFR47 §15.407.

The objective is to determine compliance with FCC Part 15.407 rules for Output Power, Antenna Requirements, AC Line Conducted Emissions, Emission Bandwidth, Power spectral density, Conducted and Radiated Spurious Emissions.

1.3 Related Submittal(s)/Grant(s)

R1903224-247

1.4 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz, and FCC KDB 789033 D02 General UNII Test Procedure New Rules v01r04.

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 Efficienct 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 EUT Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.10-2013 and FCC KDB 789033 D02 General UNII Test Procedures New Rules v01r04.

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 by measuring the average 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 Tera Term. The software is compliant with the standard requirements being tested against.

Radio 1

Band	Modulation	Frequency (MHz)	Power Setting
5.2 GHz	802.11a	5180	41
		5220	41
		5240	41
	802.11n20	5180	41
		5220	41
		5240	41
	802.11n40	5190	37
		5230	37
	802.11ac20	5180	42
		5220	42
		5240	42
	802.11ac40	5190	45
		5230	45

Band	Modulation	Frequency (MHz)	Power Setting
5.8 GHz	802.11a	5745	63
		5785	63
		5825	63
	802.11n20	5745	62
		5785	62
		5825	62
	802.11n40	5755	54
		5795	54
	802.11ac20	5745	63
		5785	63
		5825	63
	802.11ac40	5755	54
		5795	54

Radio 2

Band	Modulation	Frequency (MHz)	Power Setting
5.2 GHz	802.11a	5180	51
		5220	51
		5240	51
	802.11n20	5180	52
		5220	52
		5240	52
	802.11n40	5190	50
		5230	50
		5180	50
	802.11ac20	5220	50
		5240	50
		5190	50
	802.11ac40	5230	50
		5180	50
		5220	50

Band	Modulation	Frequency (MHz)	Power Setting
5.8 GHz	802.11a	5745	56
		5785	56
		5825	56
	802.11n20	5745	56
		5785	56
		5825	56
	802.11n40	5755	63
		5795	63
	802.11ac20	5745	58
		5785	58
		5825	58
	802.11ac40	5755	63
		5795	63

*Data rates tested:
802.11a mode: 6Mbps
802.11n: HTMCS0
802.11ac: VHT1MCS0

2.3 Duty Cycle Correction Factor

According to KDB 789033 D02 General UNII Test Procedures New Rules v01r04 section B:

All measurements are to be performed with the EUT transmitting at 100% duty cycle at its maximum power control level; however, if 100% duty cycle cannot be achieved, measurements of duty cycle, x, and maximum-power transmission duration, T, are required for each tested mode of operation.

Radio 1

Radio Mode	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11a	100	0
802.11n20	100	0
802.11n40	100	0
802.11ac20	100	0
802.11ac40	100	0

Radio 2

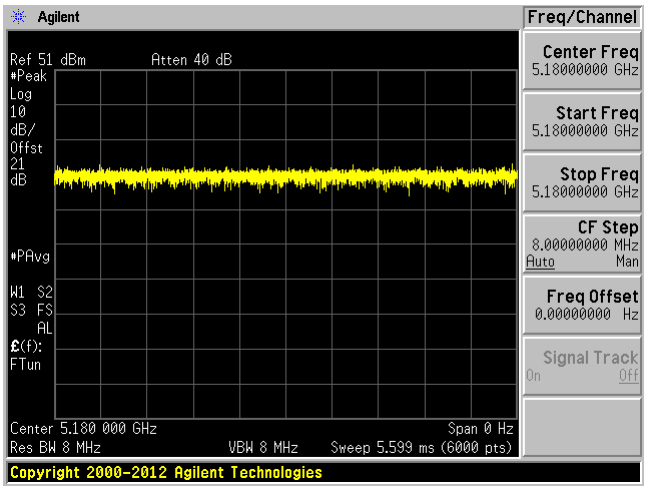
Radio Mode	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11a	100	0
802.11n20	100	0
802.11n40	100	0
802.11ac20	100	0
802.11ac40	100	0

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

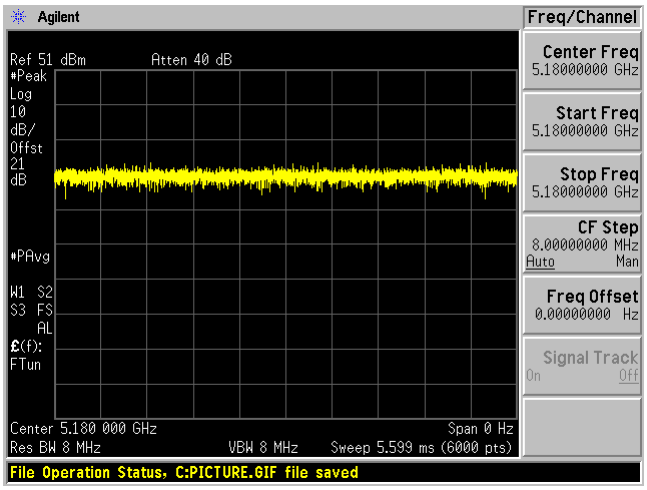
Please refer to the following plots.

Radio 1

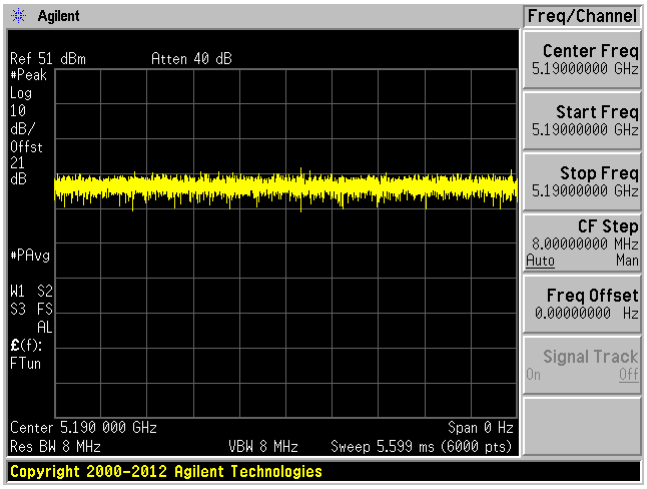
802.11a mode



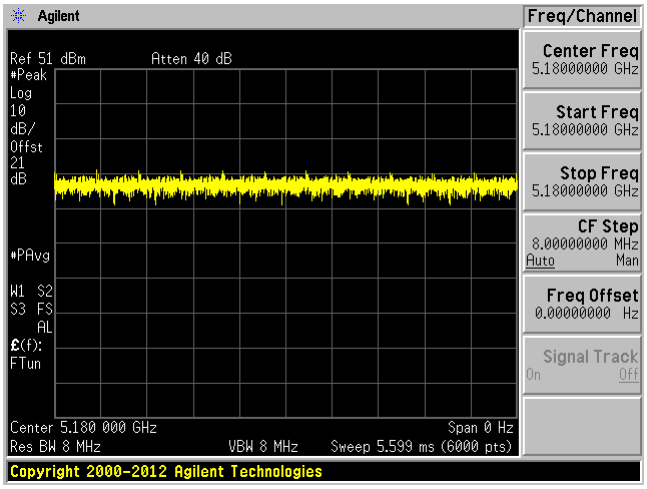
802.11n20 mode



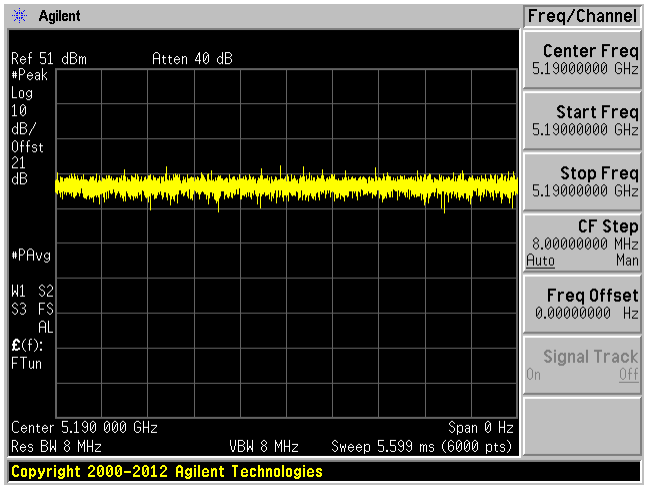
802.11n40



802.11ac20

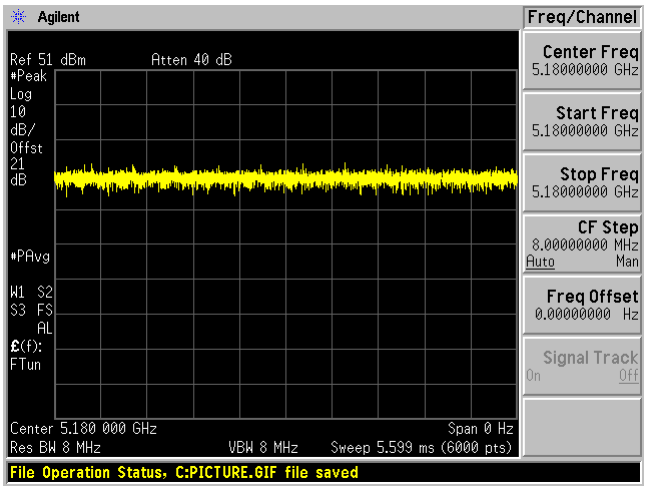


802.11ac40

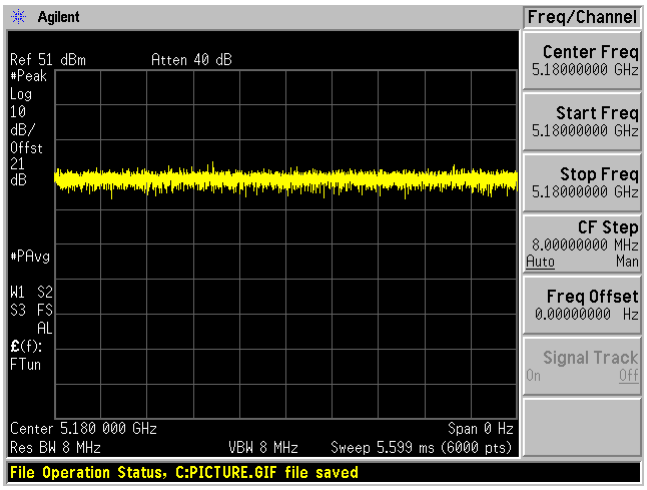

Agilent
Freq/Channel
Ref 51 dBm
Atten 40 dB
#Peak
Log
10
dB/
Offst
21
dB
#PAvg
W1 S2
S3 FS
AL
£(f):
FTun
Center 5.190 000 GHz
Span 0 Hz
Res BW 8 MHz
VBW 8 MHz
Sweep 5.599 ms (6000 pts)
Center Freq
5.19000000 GHz
Start Freq
5.19000000 GHz
Stop Freq
5.19000000 GHz
CF Step
8.00000000 MHz
Auto
Man
Freq Offset
0.00000000 Hz
Signal Track
On
Off
Copyright 2000-2012 Agilent Technologies

Radio 2

802.11a mode



802.11n20 mode



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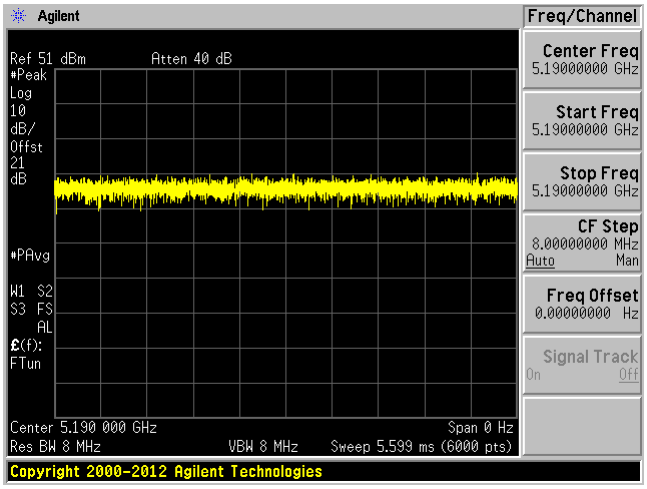

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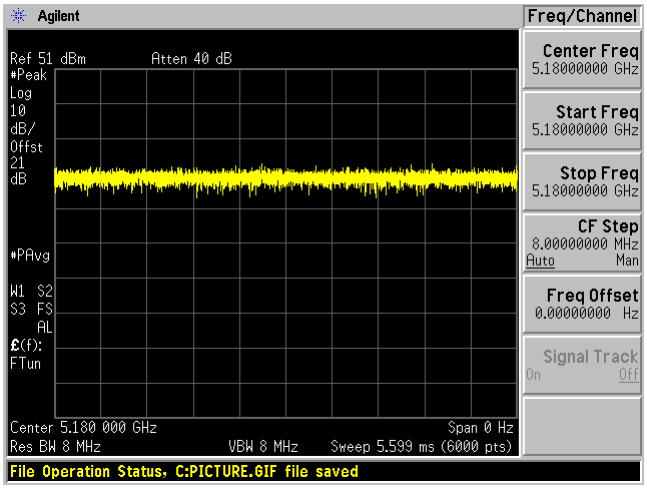

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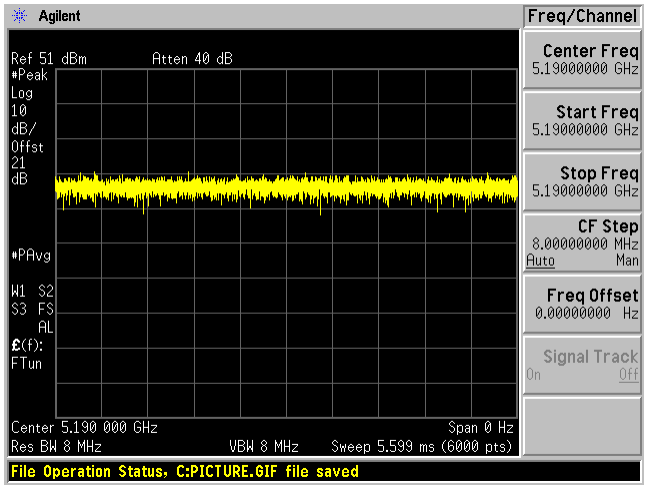


2.4 Equipment Modifications

Client added the conducted port in one of EUT for the conducted testing.

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	2000000093 Rev. D1

2.7 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

FCC Rules	Description of Test	Result
FCC §15.203	Antenna Requirement	Compliant
FCC §2.1091, §15.407(f),	RF Exposure	Compliant
FCC §15.207	AC Power Line Conducted Emissions	Compliant
FCC §2.1053, §15.205, §15.209, 15.407(b)	Spurious Radiated Emissions	Compliant
FCC §15.407(e)	Emission Bandwidth	Compliant
FCC §407(a)	Output Power	Compliant
FCC §2.1051, §15.407(b)	Band Edges	Compliant
FCC §15.407(a)	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.

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

4.2 Antenna List

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

Radio	Antenna Usage	Frequency Range (MHz)	Antenna Gain (dBi)
Radio 1	2.4 GHz Wi-Fi and 5 GHz Wi-Fi	2400-2483.5 5150-5250 & 5725-5850	1.5
Radio 2	5 GHz Wi-Fi and BLE	2400-2483.5 5150-5250 & 5725-5850	1.5

5 FCC §2.1091 & §15.407(f) - RF Exposure

5.1 Applicable Standards

According to FCC §15.407(f) 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

2.4 GHz Wi-Fi

Maximum output power at antenna input terminal (dBm):	26.0103
Maximum output power at antenna input terminal (mW):	399.052467
Tuned up output power at antenna input terminal (dBm):	27.0103
Tuned up output power at antenna input terminal (mW):	502.3772913
Prediction distance (cm):	20
Prediction frequency (MHz):	2412
Maximum Antenna Gain, typical (dBi):	1.5
Maximum Antenna Gain (numeric):	1.4125375
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.141247365
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 tuned up power density at the distance of 20 cm is 0.1412 mW/cm^2. Limit is 1.0 mW/cm^2.

2.4 GHz BLE

Maximum peak output power at antenna input terminal (dBm):	13.2
Maximum peak output power at antenna input terminal (mW):	20.892961
Tuned up output power at antenna input terminal (dBm):	14.2
Tuned up output power at antenna input terminal (mW):	26.30267992
Prediction distance (cm):	20
Prediction frequency (MHz):	2402
Maximum Antenna Gain, typical (dBi):	1.5
Maximum Antenna Gain (numeric):	1.4125375
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.007395207
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 tuned up power density at the distance of 20 cm is 0.0074 mW/cm^2. Limit is 1.0 mW/cm^2.

5 GHz Wi-Fi Radio 1

Maximum peak output power at antenna input terminal (dBm):	22.09899
Maximum peak output power at antenna input terminal (mW):	162.143297
Tuned up output power at antenna input terminal (dBm):	23.09899
Tuned up output power at antenna input terminal (mW):	204.1263171
Prediction distance (cm):	20
Prediction frequency (MHz):	5240
Maximum Antenna Gain, typical (dBi):	1.5
Maximum Antenna Gain (numeric):	1.4125375
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.057391735
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 tuned up power density at the distance of 20 cm is 0.0574 mW/cm^2. Limit is 1.0 mW/cm^2.

5 GHz Wi-Fi Radio 2

Maximum peak output power at antenna input terminal (dBm):	22.66065
Maximum peak output power at antenna input terminal (mW):	184.52916
Tuned up output power at antenna input terminal (dBm):	23.66065
Tuned up output power at antenna input terminal (mW):	232.3084462
Prediction distance (cm):	20
Prediction frequency (MHz):	5795
Maximum Antenna Gain, typical (dBi):	1.5
Maximum Antenna Gain (numeric):	1.4125375
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.065315365
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 tuned up power density at the distance of 20 cm is 0.0653 mW/cm^2. Limit is 1.0 mW/cm^2.

Worst case colocation

2.4 GHz Wi-Fi, b mode, 2412 MHz, Radio 1; and BLE, 2402 MHz, Radio 2

Sum of MPE Ratios: 0.1412/1+0.0074/1=0.1486<1

5.2 GHz Wi-Fi, a mode, 5240 MHz, Radio 1; and 5.8 GHz Wi-Fi, ac40 mode, 5795 MHz, Radio 2

Sum of MPE Ratios: 0.0574/1+0.0653/1=0.1227<1

5.2 GHz Wi-Fi, a mode, 5240 MHz, Radio 1; and BLE, 2402 MHz, Radio 2

Sum of MPE Ratios: : 0.0574/1+0.0074/1=0.0648<1

2.4 GHz Wi-Fi, b mode, 2412 MHz, Radio 1; and 5.8 GHz Wi-Fi, ac40 mode, 5795 MHz, Radio 2

Sum of MPE Ratios: 0.1412/1+0.0653/1=0.2065<1

6 FCC §15.207 - AC Power Line Conducted Emissions

6.1 Applicable Standards

As per FCC §15.207:

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

6.2 Test Setup

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

External I/O cables were draped along the edge of the test table and bundle when necessary.
The AC/DC power adapter of the EUT was connected with LISN-1 which provided 120 V / 60 Hz AC power.

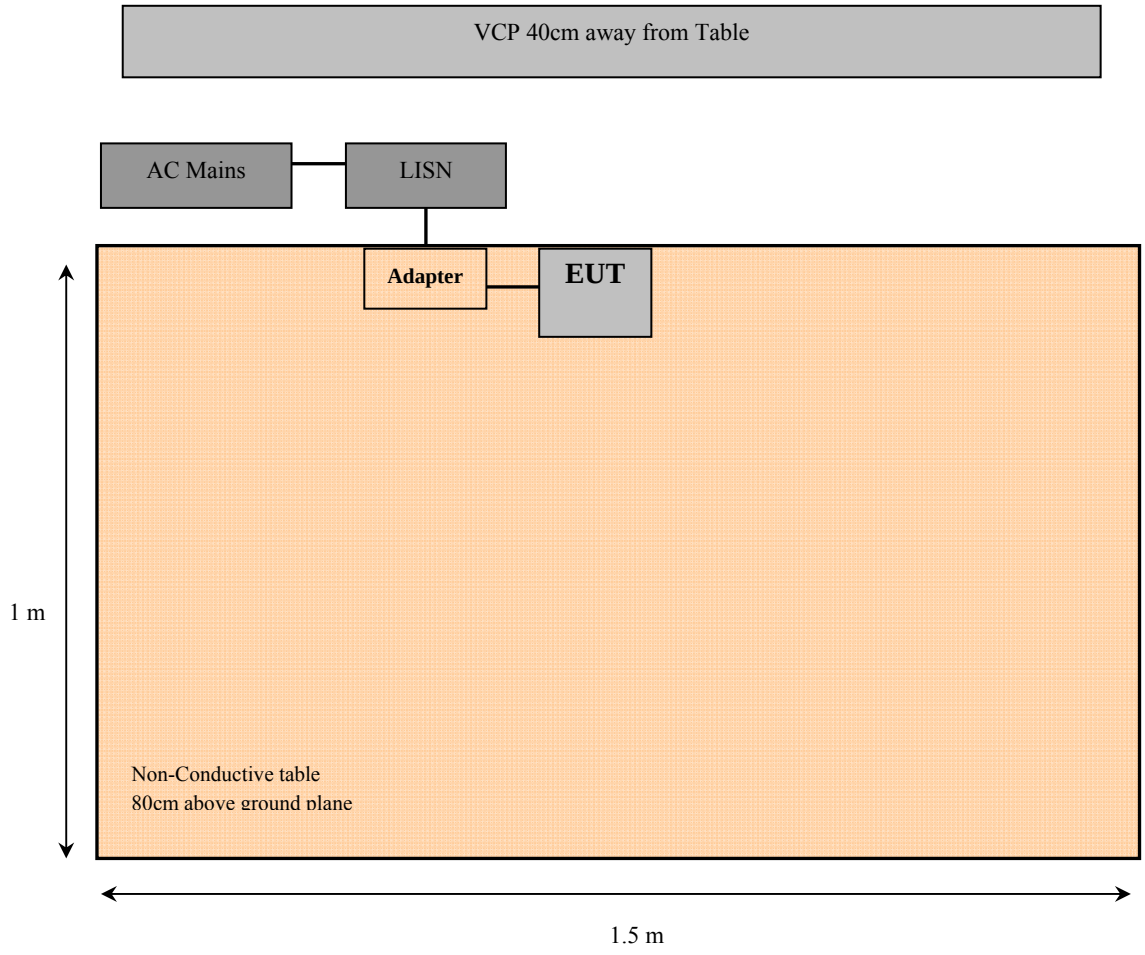
6.3 Test Procedure

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

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

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

6.4 Test Setup Block Diagram



6.5 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

6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2018-07-05	2 years
Rohde and Schwarz	Impulse Limiter	ESH3-Z2	101964	2018-07-27	1 year
Keysight Technologies	RF Limiter	11867A	MY42242931	2018-09-04	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	2019-04-04	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".

6.7 Test Environmental Conditions

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

The testing was performed by Alexandrae Duran on 2019-04-16 in 5 chamber 3.

6.8 Summary of Test Results

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

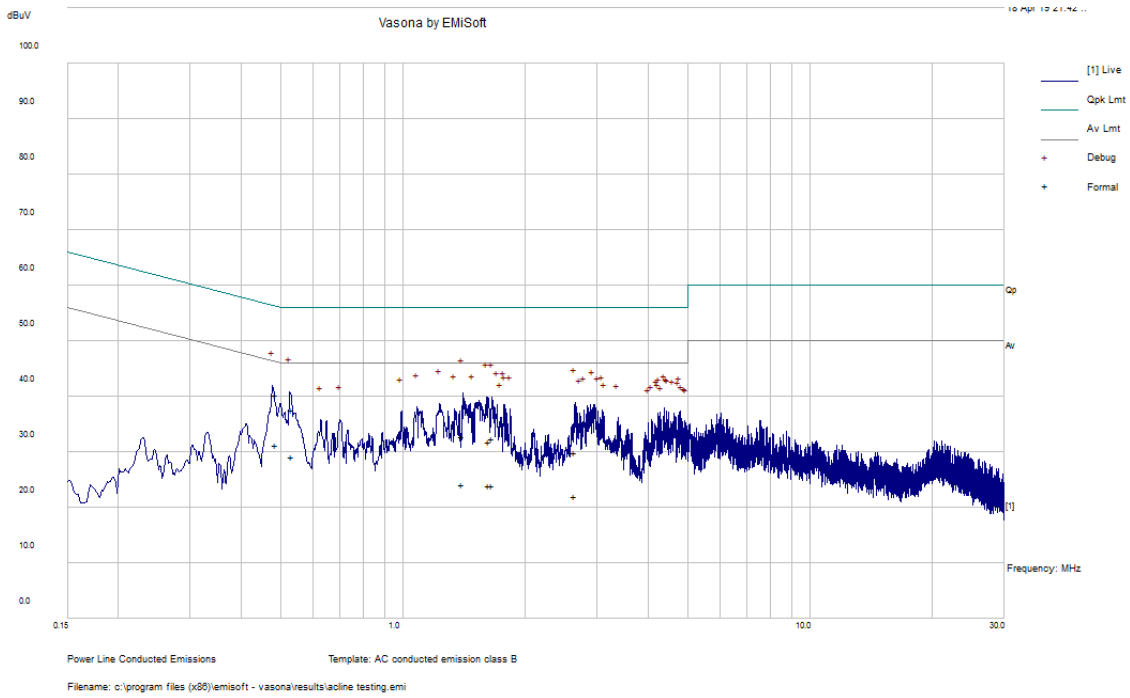
Transmitting simultaneously: 5.2 GHz Wi-Fi, a mode, 5240 MHz, Radio 1; and 5.8 GHz Wi-Fi, ac40 mode, 5795 MHz, Radio 2

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Line/Neutral)**	**Range (MHz)**
-12.01	0.495365	Neutral	0.15-30

6.9 Conducted Emissions Test Plots and Data

5.2 GHz Wi-Fi, a mode, 5240 MHz, Radio 1; and 5.8 GHz Wi-Fi, ac40 mode, 5795 MHz, Radio 2

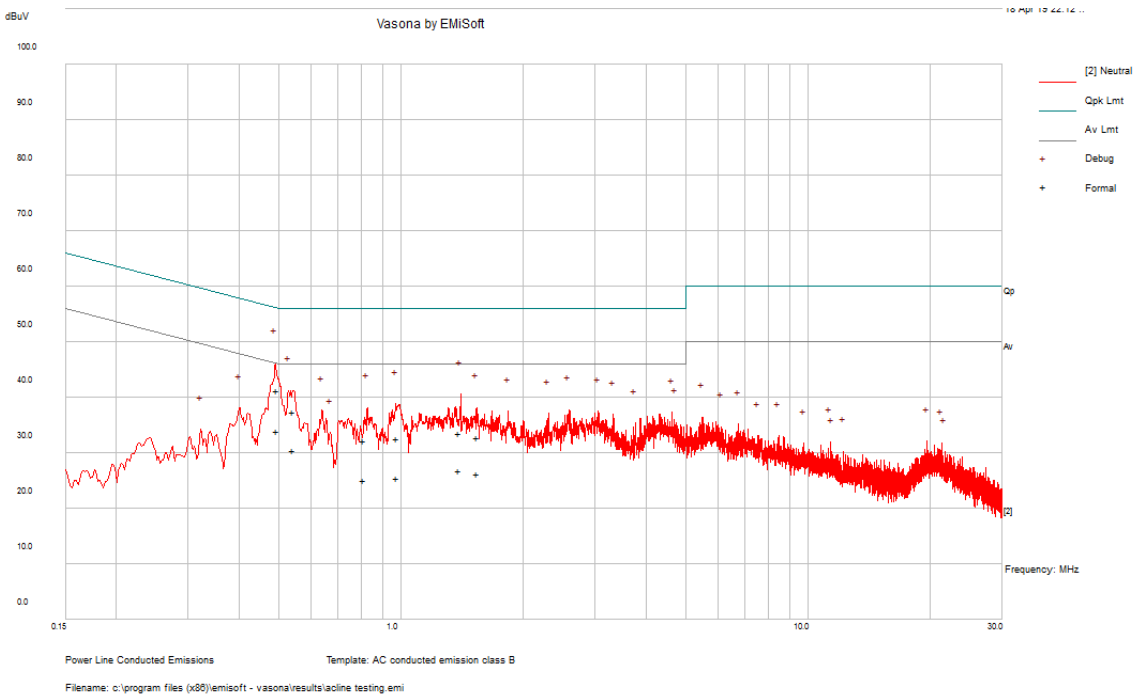
120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.486212	40.33	Line	56.23	-15.9	QP
0.532015	37.61	Line	56	-18.39	QP
1.401703	32.79	Line	56	-23.21	QP
1.624841	31.78	Line	56	-24.22	QP
1.652752	32.43	Line	56	-23.57	QP
2.641269	29.86	Line	56	-26.14	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.486212	31.22	Line	46.23	-15.01	Ave
0.532015	29.23	Line	46	-16.77	Ave
1.401703	24.26	Line	46	-21.74	Ave
1.624841	23.94	Line	46	-22.06	Ave
1.652752	23.97	Line	46	-22.03	Ave
2.641269	22.01	Line	46	-23.99	Ave

120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.495365	41.2	Neutral	56.08	-14.88	QP
0.544627	37.4	Neutral	56	-18.6	QP
1.389931	33.54	Neutral	56	-22.46	QP
0.980241	32.72	Neutral	56	-23.28	QP
0.812255	32.16	Neutral	56	-23.84	QP
1.535522	32.82	Neutral	56	-23.18	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.495365	34.07	Neutral	46.08	**-12.01**	Ave
0.544627	30.5	Neutral	46	-15.5	Ave
1.389931	26.89	Neutral	46	-19.11	Ave
0.980241	25.58	Neutral	46	-20.42	Ave
0.812255	25.04	Neutral	46	-20.96	Ave
1.535522	26.29	Neutral	46	-19.71	Ave

7 FCC §15.209 & §15.407(b) - Spurious Radiated Emissions

7.1 Applicable Standard

As Per FCC §15.205(a) §8.10 except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

As per FCC §15.209: 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 Note 1	3
88 - 216	150 Note 1	3
216 - 960	200 Note 1	3
Above 960	500	3

Note 1: 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 Part 15.407 (b)

(1) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(3) For transmitters operating in the 5.47 -5.725 GHz band: All emissions outside of the 5.47-5725 GHz band shall not exceed an ei.r.p. of -27 dBm/MHz.

(4) For transmitters operating in the 5.725-5.85 GHz band:

(i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

(5) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

(6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.

(7) The provisions of §15.205 apply to intentional radiators operating under this section.

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 15.407.

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 is set 1 or 3 meter away from the testing antenna, which is varied from 1-4 meter, and the EUT is placed on a turntable, which is 0.8 meter or 1.5 meter above ground plane, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal and vertical.

The spectrum analyzer or receiver is set as:

Below 1000 MHz:

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

Above 1000 MHz:

(1) Peak: RBW = 1MHz / VBW = 3MHz / Sweep = 100ms
(2) Average: RBW = 1MHz / VBW = 10Hz / 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 for Class B. 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	100338	2018-07-05	2 years
-	5GHz Notch Filter	-	-	N/R	N/A
Agilent	Analyzer, Spectrum	E4446A	US44300386	2018-06-01	1 year
Sunol Sciences	System Controller	SC99V	011003-1	N/R	N/A
UTiFLEX	High Frequency Cable	223458-002	223458-001	2019-02-13	1 year
UTiFLEX	High Frequency Cable	223458-002	223458-002	2018-09-05	1 year
Agilent	Amplifier, Pre	8447D	2443A04374	2018-08-09	1 year
HP/ Agilent	Pre Amplifier	8449B OPT HO2	3008A0113	2018-06-08	1 year
AH Systems	Pre-Amplifier 18-40GHz	PAM-1840VH	170	2018-09-10	1 year
Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2018-07-26	1 year
Sunol Sciences	Antenna, Horn	DRH-118	A052704	2019-04-02	2 years
Wisewave	Antenna, Horn 18-26.5GHz	ARH-4223-02	10555-02	2017-12-15	2 years
Wisewave	Antenna, Horn 26.5-40GHz	ARH-2823-02	10555-01	2017-09-18	28 Months
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 Alexandrae Duran 2019-03-26 to 2019-04-17 in 5m chamber 3.

7.7 Summary of Test Results

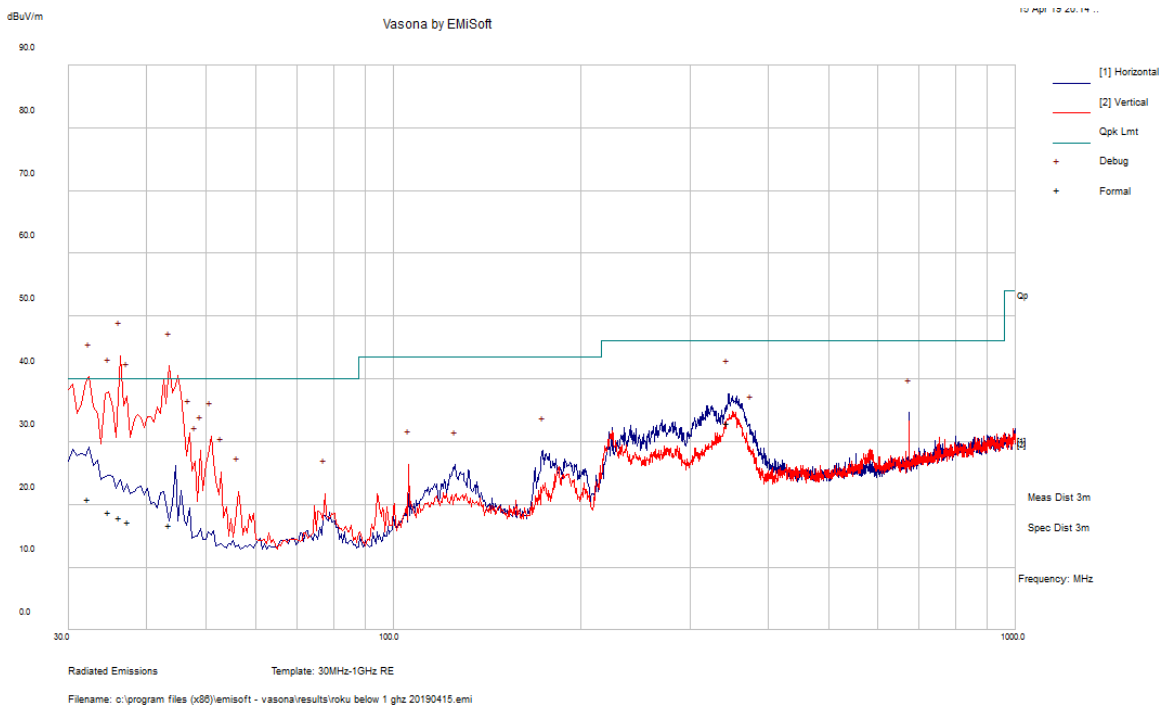
According to the data hereinafter, the EUT complied with the FCC Part 15.407 standards' radiated emissions limits, and had the worst margin of:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, Channel**
-0.60	5150	Horizontal	Ac40, 5190MHz

7.8 Radiated Emissions Test Result Data

1) 30 MHz – 1 GHz

5.2 GHz Wi-Fi, a mode, 5240 MHz, Radio 1; and 5.8 GHz Wi-Fi, ac40 mode, 5795 MHz, Radio 2



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
36.25775	17.92	242	V	242	40	-22.08	QP
43.6905	16.67	122	V	122	40	-23.33	QP
32.286	20.94	112	V	112	40	-19.06	QP
34.78275	18.89	217	V	217	40	-21.11	QP
37.40125	17.3	289	V	289	40	-22.7	QP
344.7178	33.03	107	H	107	46	-12.97	QP

2) 1–26.5 GHz

5150 - 5250 MHz

Radio 1, Measured at 1 meters

802.11a mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5180 MHz											
5150	69.70	0	100	H	33.99	11.90	38.51	77.07	84	-6.93	PK
5150	55.61	0	100	H	33.99	11.90	38.51	62.98	64	-1.02	AV
5150	73.40	43	166	V	33.99	11.90	38.51	80.77	84	-3.23	PK
5150	55.74	43	166	V	33.99	11.90	38.51	63.11	64	-0.89	AV
10360	45.10	0	100	H	39.24	17.54	38.41	63.47	78	-14.53	PK
10360	45.19	0	100	H	38.64	19.24	38.93	64.14	78	-13.86	PK
Middle Channel 5200 MHz											
10440	46.46	0	100	H	39.28	17.54	38.41	64.87	78	-13.13	PK
10440	45.09	0	100	V	39.28	17.54	38.41	63.50	78	-14.5	PK
High Channel 5240 MHz											
10480	46.72	0	100	H	39.31	17.54	38.07	65.50	78	-12.5	PK
10480	45.86	0	100	V	39.31	17.54	38.07	64.64	78	-13.36	PK

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 (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5180 MHz											
5150	73.02	0	100	H	33.99	11.90	38.51	80.39	84	-3.61	PK
5150	55.57	0	100	H	33.99	11.90	38.51	62.94	64	-1.06	AV
5150	76.01	0	100	V	33.99	11.90	38.51	83.38	84	-0.62	PK
5150	55.61	0	100	V	33.99	11.90	38.51	62.98	64	-1.02	AV
10360	46.86	0	100	H	39.24	17.54	38.41	65.23	78	-12.77	PK
10360	46.22	0	100	H	38.64	19.24	38.93	65.17	78	-12.83	PK
Middle Channel 5200 MHz											
10440	46.94	0	100	H	39.28	17.54	38.41	65.36	78	-12.64	PK
10440	46.96	0	100	V	39.28	17.54	38.41	65.37	78	-12.63	PK
High Channel 5240 MHz											
10480	46.08	0	100	H	39.31	17.54	38.07	64.87	78	-13.13	PK
10480	46.37	0	100	V	39.31	17.54	38.07	65.16	78	-12.84	PK

802.11n40 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5190 MHz											
5150	71.58	335	144	H	33.99	11.90	38.51	78.95	84	-5.05	PK
5150	55.28	335	144	H	33.99	11.90	38.51	62.65	64	-1.35	AV
5150	73.56	42	166	V	33.99	11.90	38.51	80.93	84	-3.07	PK
5150	55.59	42	166	V	33.99	11.90	38.51	62.96	64	-1.04	AV
10380	42.07	0	100	V	39.28	17.54	38.41	60.48	78	-17.52	PK
10380	41.19	0	100	H	38.63	19.24	38.96	60.10	78	-17.9	PK
High Channel 5230 MHz											
10480	42.55	0	100	H	39.31	17.54	38.07	61.33	78	-16.67	PK
10480	42.85	0	100	V	39.31	17.54	38.07	61.63	78	-16.37	PK

802.11ac20 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5180 MHz											
5150	73.49	335	145	H	33.99	11.90	38.51	80.86	84	-3.14	PK
5150	55.30	335	145	H	33.99	11.90	38.51	62.67	64	-1.33	AV
5150	75.68	42	166	V	33.99	11.90	38.51	83.05	84	-0.95	PK
5150	55.53	42	166	V	33.99	11.90	38.51	62.90	64	-1.10	AV
10360	46.95	0	100	H	39.24	17.54	38.41	65.32	78	-12.68	PK
10360	46.40	0	100	V	38.64	19.24	38.93	65.34	78	-12.66	PK
Middle Channel 5200 MHz											
10440	46.84	0	100	H	39.28	17.54	38.41	65.25	78	-12.75	PK
10440	46.79	0	100	V	39.28	17.54	38.41	65.20	78	-12.8	PK
High Channel 5240 MHz											
10480	46.81	0	100	H	39.31	17.54	38.07	65.59	78	-12.41	PK
10480	46.91	0	100	V	39.31	17.54	38.07	65.69	78	-12.31	PK

802.11ac40 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5190 MHz											
5150	72.66	335	144	H	33.99	11.90	38.51	80.03	84	-3.97	PK
5150	55.93	335	144	H	33.99	11.90	38.51	63.30	64	-0.70	AV
5150	71.22	42	166	V	33.99	11.90	38.51	78.59	84	-5.41	PK
5150	54.50	42	166	V	33.99	11.90	38.51	61.87	64	-2.13	AV
10380	41.05	0	100	H	39.28	17.54	38.41	59.46	78	-18.54	PK
10380	42.91	0	100	H	38.63	19.24	38.96	61.82	78	-16.18	PK
High Channel 5230 MHz											
10480	42.70	0	100	H	39.31	17.54	38.07	61.49	78	-16.51	PK
10480	42.66	0	100	V	39.31	17.54	38.07	61.44	78	-16.56	PK

Note: Testing was done in 1 meter, the distance factor will be added into the limit

Radio 2, Measured at 3 meters

802.11a mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5180 MHz											
5150	56.62	216	100	H	33.99	11.443	38.54	63.52	74	-10.49	PK
5150	42.08	216	100	H	33.99	11.443	38.54	48.98	54	-5.03	AV
5150	53.65	116	164	V	33.99	11.443	38.54	60.55	74	-13.46	PK
5150	38.93	116	164	V	33.99	11.443	38.54	45.83	54	-8.18	AV
10360	46.11	0	100	H	39.24	18.71	38.78	65.28	74	-8.72	PK
10360	46.64	0	100	V	39.24	18.71	38.78	65.81	74	-8.19	PK
Middle Channel 5200 MHz											
10440	45.93	0	100	H	39.27	19.54	38.41	66.32	74	-7.68	PK
10440	46.16	0	100	V	39.27	19.54	38.41	66.56	74	-7.44	PK
High Channel 5240 MHz											
10480	46.51	0	100	H	39.31	19.54	38.07	67.28	68	-0.72	PK
10480	45.61	0	100	V	39.31	19.54	38.07	66.38	68	-1.62	PK

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 (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5180 MHz											
5150	55.21	0	100	H	33.99	11.443	38.54	62.11	74	-11.90	PK
5150	41.08	0	100	H	33.99	11.443	38.54	47.98	54	-6.03	AV
5150	52.58	0	100	V	33.99	11.443	38.54	59.48	74	-14.53	PK
5150	37.50	0	100	V	33.99	11.443	38.54	44.40	54	-9.61	AV
10360	42.97	0	100	H	39.24	19.538	38.07	63.68	74	-10.32	PK
10360	43.38	0	100	V	39.24	19.538	38.07	64.09	74	-9.91	PK
Middle Channel 5200 MHz											
10440	43.70	0	100	H	39.27	19.538	38.07	64.44	74	-9.56	PK
10440	43.36	0	100	V	39.27	19.538	38.07	64.10	74	-9.90	PK
High Channel 5240 MHz											
10480	41.52	0	100	H	39.31	19.54	38.07	62.29	68	-5.71	PK
10480	41.15	0	100	V	39.31	19.54	38.07	61.92	68	-6.08	PK

802.11n40 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5190 MHz											
5150	59.52	139	167	H	33.99	11.46	38.37	66.61	74	-7.40	PK
5150	46.05	139	167	H	33.99	11.25	38.54	52.75	54	-1.25	AV
5150	52.98	84	239	V	33.99	11.25	38.54	59.68	74	-14.32	PK
5150	39.20	0	100	V	33.99	11.25	38.54	45.90	54	-8.10	AV
10380	42.92	0	100	H	39.28	20.538	38.41	64.33	74	-9.67	PK
10380	42.54	0	100	V	39.28	20.538	38.41	63.94	74	-10.06	PK
High Channel 5230 MHz											
10460	45.41	0	100	H	39.27	20.538	38.07	67.15	68	-0.85	PK
10460	45.47	0	100	V	39.27	20.538	38.07	67.21	68	-0.79	PK

802.11ac20 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5180 MHz											
5150	55.77	139	167	H	38.41	11.443	38.54	67.09	74	-6.91	PK
5150	38.86	139	167	H	38.41	11.443	38.54	50.18	54	-3.82	AV
5150	55.23	123	240	V	38.37	11.443	38.54	66.51	74	-7.49	PK
5150	38.15	123	240	V	38.37	11.443	38.54	49.43	54	-4.57	AV
10360	43.10	0	100	H	38.41	18.71	38.78	61.45	74	-12.55	PK
10360	42.60	0	100	V	38.37	18.71	38.78	60.91	74	-13.09	PK
Middle Channel 5200 MHz											
10440	43.81	0	100	H	39.27	19.54	38.41	64.21	74	-9.79	PK
10440	43.18	0	100	V	39.27	19.54	38.41	63.58	74	-10.42	PK
High Channel 5240 MHz											
10480	43.91	0	100	H	39.31	19.54	38.07	64.68	68	-3.32	PK
10480	43.39	0	100	V	39.31	19.54	38.07	64.16	68	-3.84	PK

802.11ac40 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5190 MHz											
5150	56.35	135	210	H	33.99	11.25	38.54	63.05	74	-10.95	PK
5150	46.70	135	210	H	33.99	11.25	38.54	53.40	54	-0.60	AV
5150	53.45	135	240	V	33.99	11.25	38.54	60.15	74	-13.85	PK
5150	40.61	135	240	V	33.99	11.25	38.54	47.31	54	-6.69	AV
10380	42.39	0	100	H	39.28	20.538	38.41	63.80	74	-10.20	PK
10380	42.84	0	100	V	39.28	20.538	38.41	64.24	74	-9.76	PK
High Channel 5230 MHz											
10460	42.71	0	100	H	39.27	20.538	38.07	64.45	68	-3.55	PK
10460	42.78	0	100	V	39.27	20.538	38.07	64.52	68	-3.48	PK

5725 - 5850 MHz

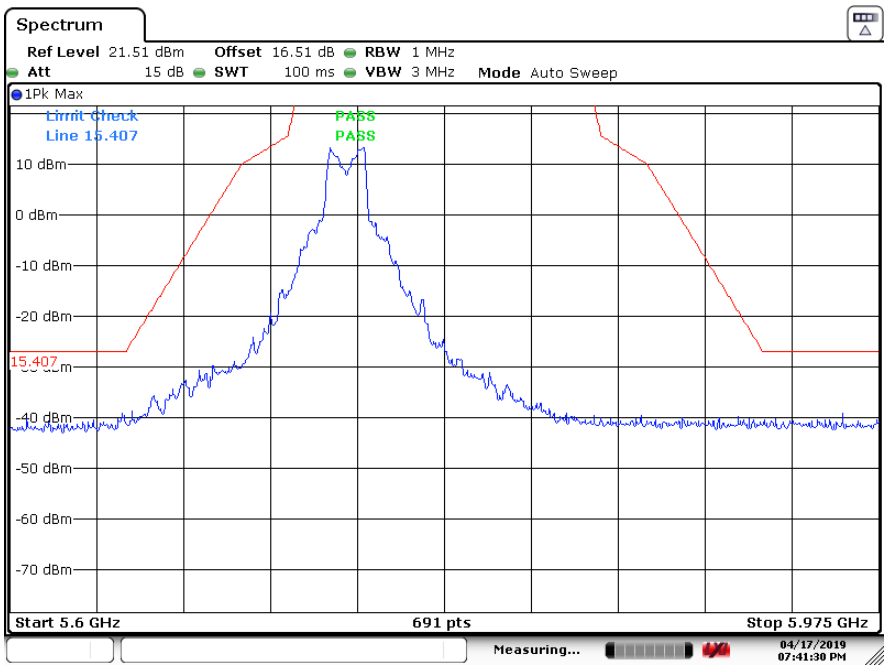
Radio 1, Measured at 3 Meter

802.11a mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5745 MHz											
11490	35.81	0	100	H	38.44	19.013	38.070	55.19	74.00	-18.81	PK
11490	21.21	0	100	H	38.44	19.013	38.070	40.59	54.00	-13.41	AV
11490	47.04	0	100	V	38.44	19.013	38.070	66.43	74.00	-7.57	PK
11490	22.53	0	100	V	38.44	19.013	38.070	41.91	54.00	-12.09	AV
Middle Channel 5785 MHz											
11570	35.26	0	100	H	38.585	19.013	37.97	54.88	74.00	-19.12	PK
11570	22.02	0	100	H	38.585	19.013	37.97	41.65	54.00	-12.36	AV
11570	35.69	0	100	V	38.585	19.013	37.97	55.32	74.00	-18.68	PK
11570	22.92	0	100	V	38.585	19.013	37.97	42.55	54.00	-11.45	AV
High Channel 5825 MHz											
11650	35.41	0	100	H	38.671	19.354	38.32	55.11	74.00	-18.89	PK
11650	22.79	0	100	H	38.671	19.354	38.32	42.49	54.00	-11.51	AV
11650	34.14	0	100	V	38.671	19.354	38.32	53.85	74.00	-20.15	PK
11650	22.38	0	100	V	38.671	19.354	38.32	42.09	54.00	-11.91	AV

802.11a mode, Low channel 5745 MHz

Horizontal



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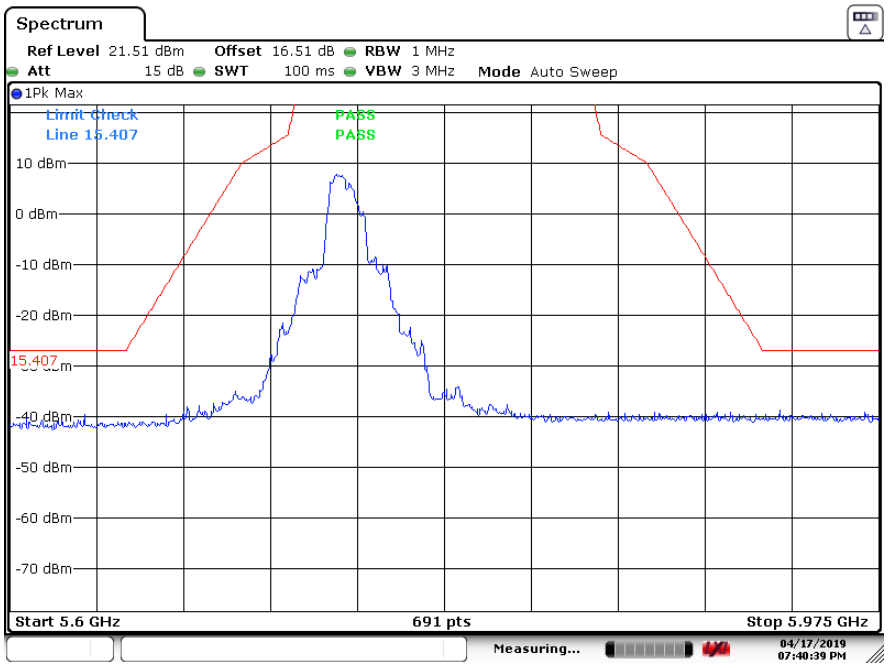
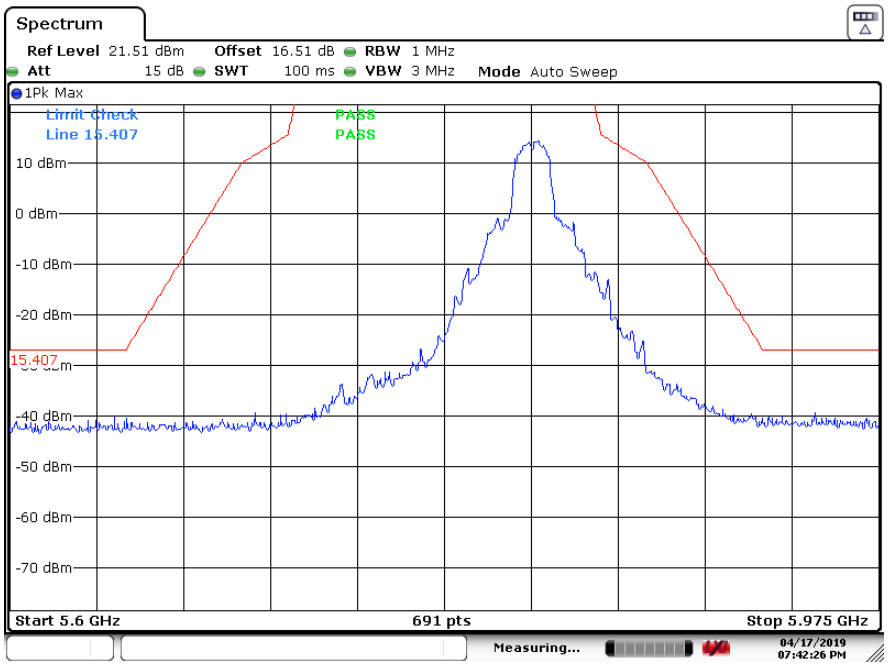


Date: 17 APR 2019 19:40:39

802.11a mode, high channel 5825 MHz

Horizontal



Date: 17 APR 2019 19:42:26

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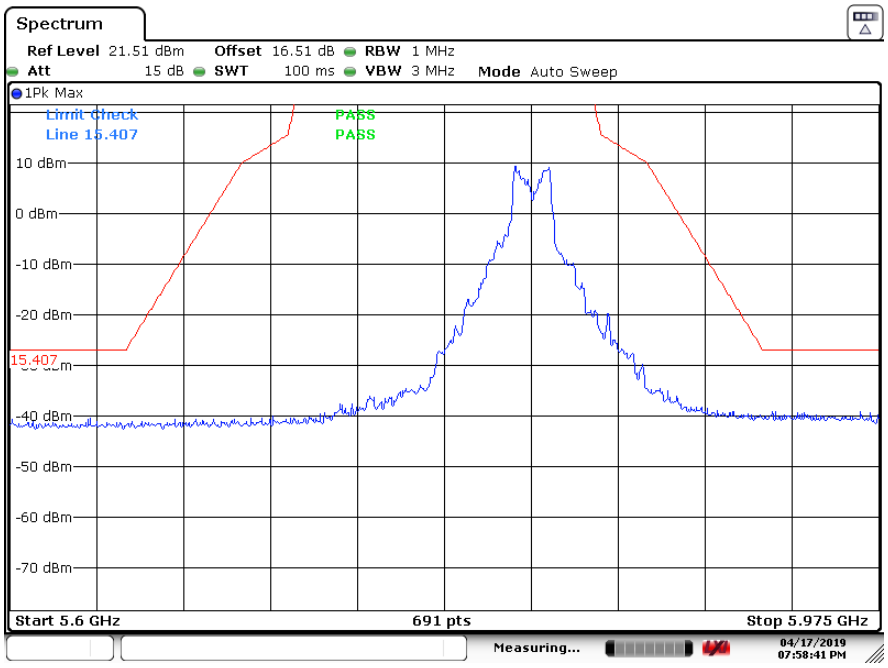

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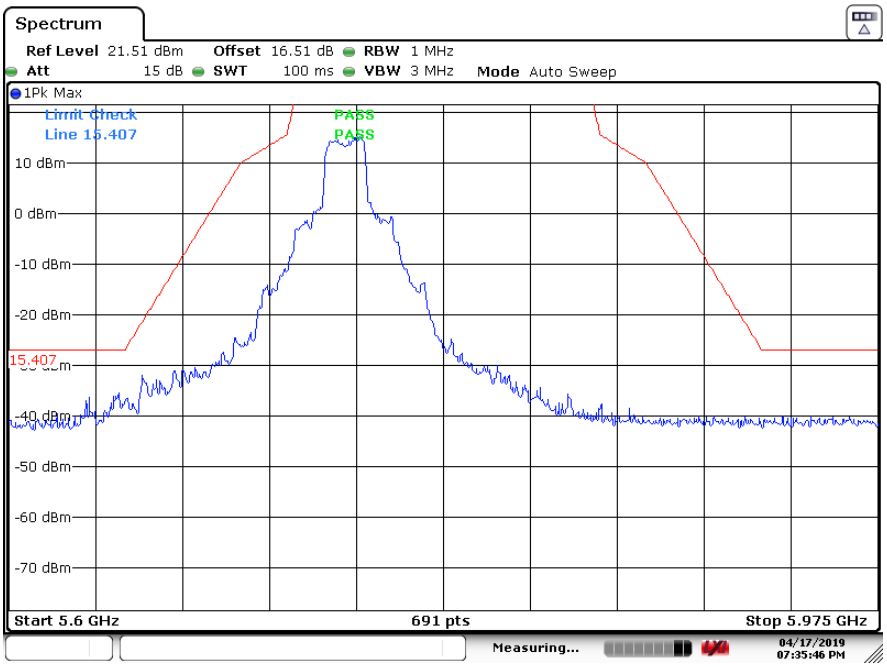
802.11n20 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5745 MHz											
11490	35.08	0	100	H	38.44	19.013	38.070	54.47	74.00	-19.53	PK
11490	22.51	0	100	H	38.44	19.013	38.070	41.90	54.00	-12.10	AV
11490	35.23	0	100	V	38.44	19.013	38.070	54.61	74.00	-19.39	PK
11490	22.46	0	100	V	38.44	19.013	38.070	41.85	54.00	-12.15	AV
Middle Channel 5785 MHz											
11570	34.64	0	100	H	38.585	19.013	37.97	54.27	74.00	-19.73	PK
11570	22.25	0	100	H	38.585	19.013	37.97	41.88	54.00	-12.12	AV
11570	35.03	0	100	V	38.585	19.013	37.97	54.66	74.00	-19.35	PK
11570	21.48	0	100	V	38.585	19.013	37.97	41.11	54.00	-12.90	AV
High Channel 5825 MHz											
11650	35.14	0	100	H	38.671	19.354	38.32	54.84	74.00	-19.16	PK
11650	22.55	0	100	H	38.671	19.354	38.32	42.25	54.00	-11.75	AV
11650	34.16	0	100	V	38.671	19.354	38.32	53.87	74.00	-20.14	PK
11650	21.06	0	100	V	38.671	19.354	38.32	40.77	54.00	-13.23	AV

802.11n20 mode, Low channel 5745 MHz

Horizontal



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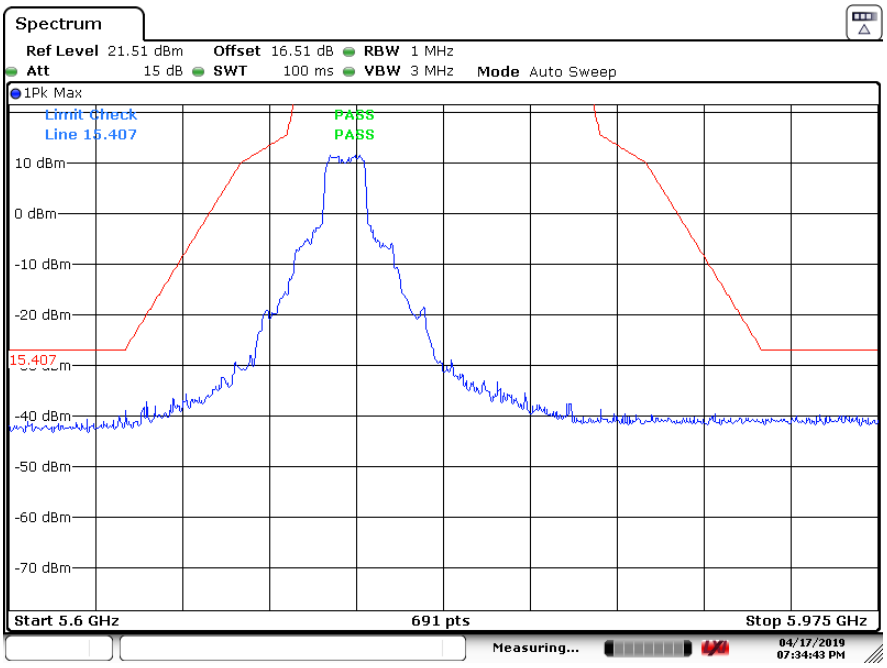
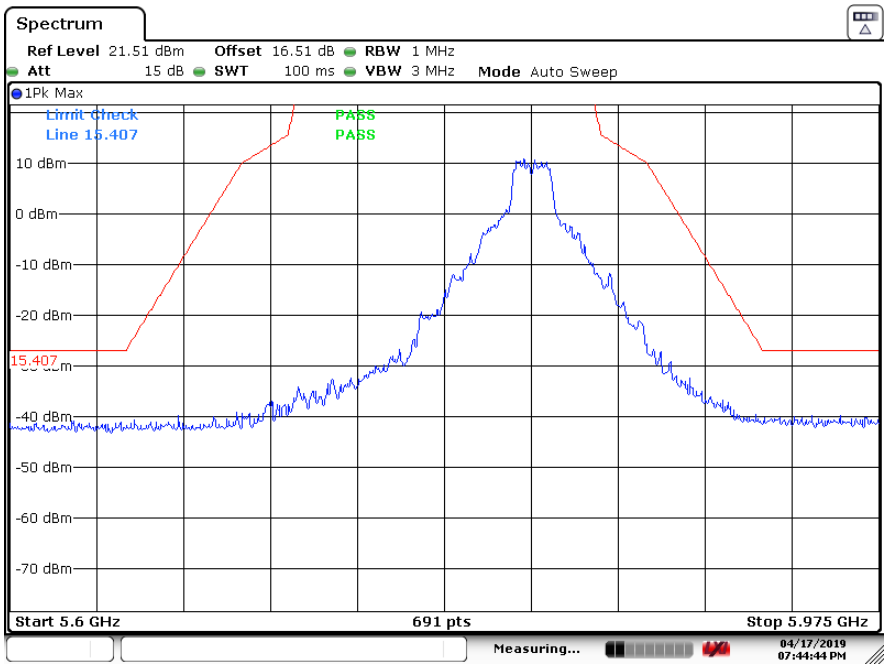


Date: 17 APR 2019 19:34:43

802.11n20 mode, high channel 5825 MHz

Horizontal



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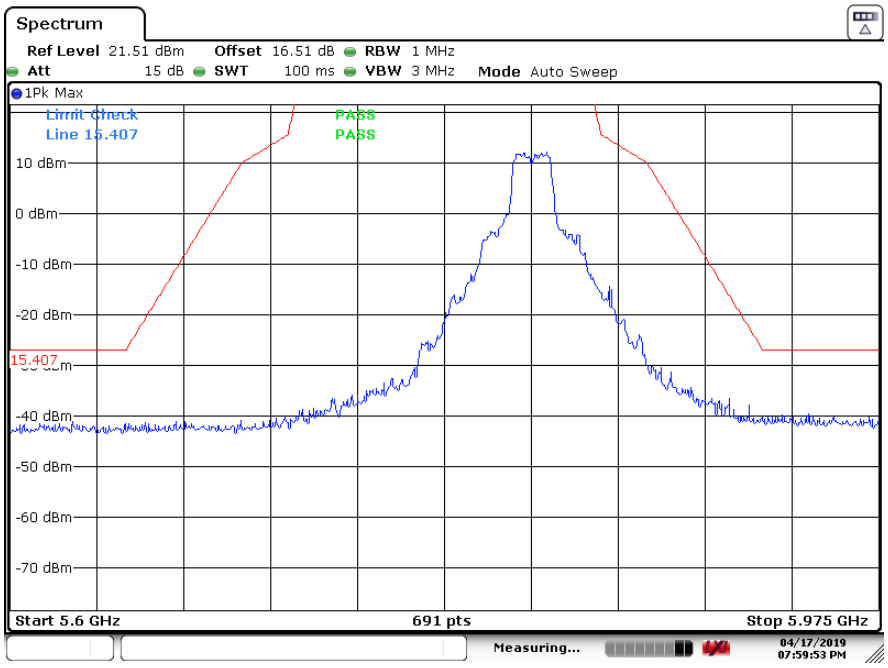
Vertical



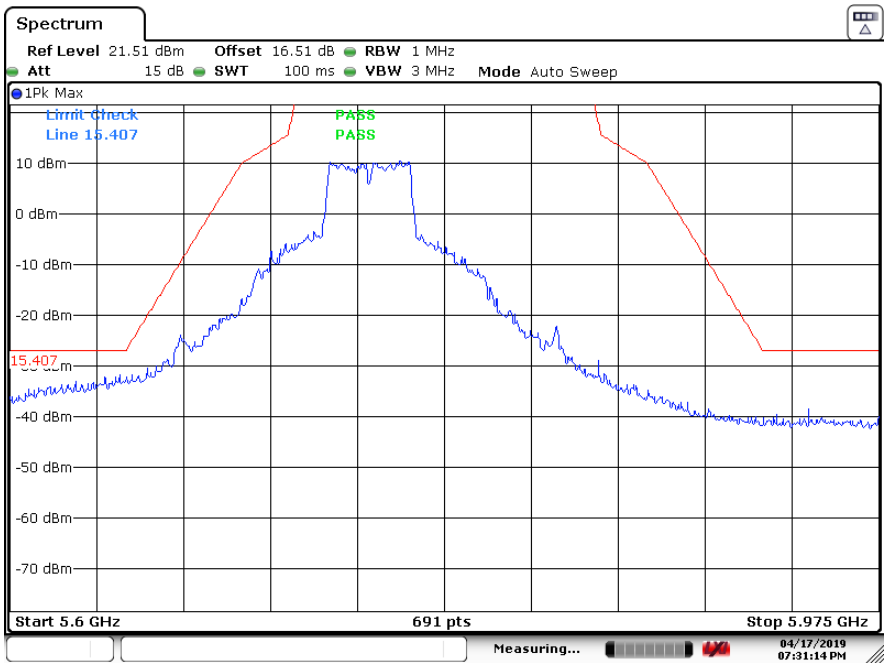
Date: 17.APR.2019 19:59:53

802.11n40 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5755 MHz											
11510	35.41	0	100	H	38.44	19.013	38.070	54.79	74.00	-19.21	PK
11510	22.64	0	100	H	38.44	19.013	38.070	42.02	54.00	-11.98	AV
11510	35.07	0	100	V	38.44	19.013	38.070	54.45	74.00	-19.55	PK
11510	22.82	0	100	V	38.44	19.013	38.070	42.20	54.00	-11.80	AV
High Channel 5795 MHz											
11590	35.92	0	100	H	38.671	19.354	38.32	55.62	74.00	-18.38	PK
11590	22.34	0	100	H	38.671	19.354	38.32	42.04	54.00	-11.96	AV
11590	35.33	0	100	V	38.671	19.354	38.32	55.04	74.00	-18.97	PK
11590	21.39	0	100	V	38.671	19.354	38.32	41.09	54.00	-12.91	AV

802.11n40 mode, Low channel 5755 MHz

Horizontal



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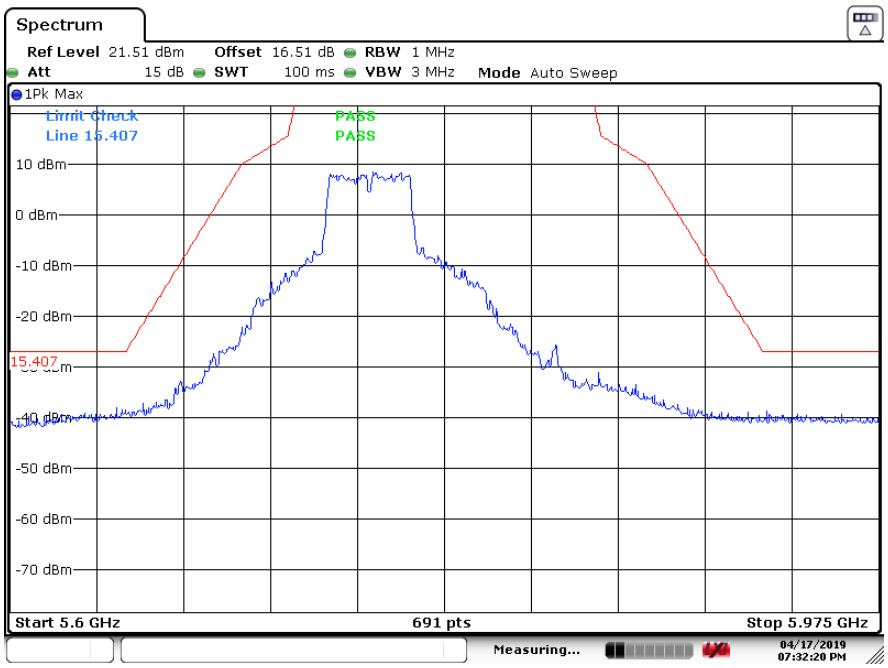
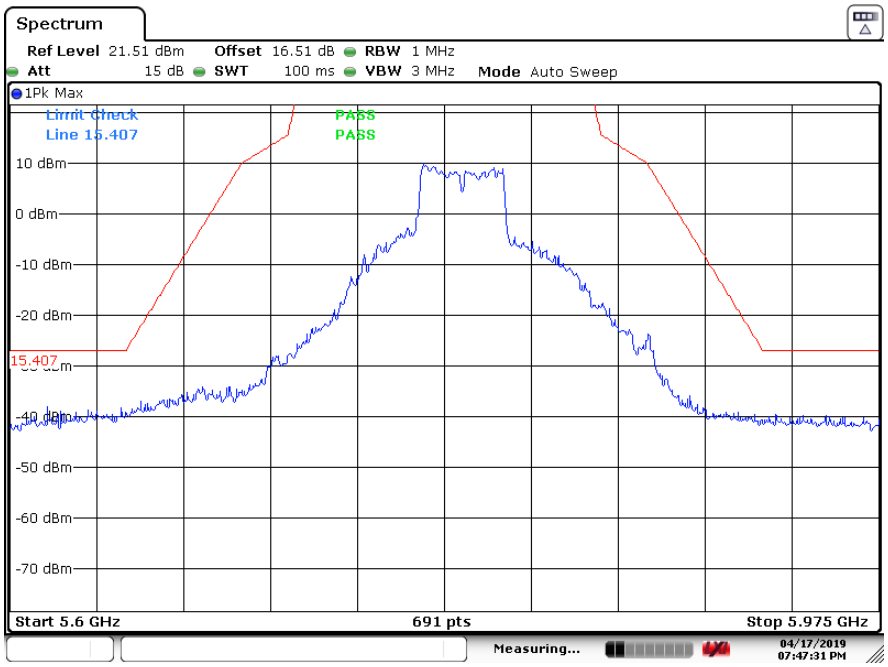


Date: 17.APR.2019 19:32:21

802.11n40 mode, high channel 5795 MHz

Horizontal



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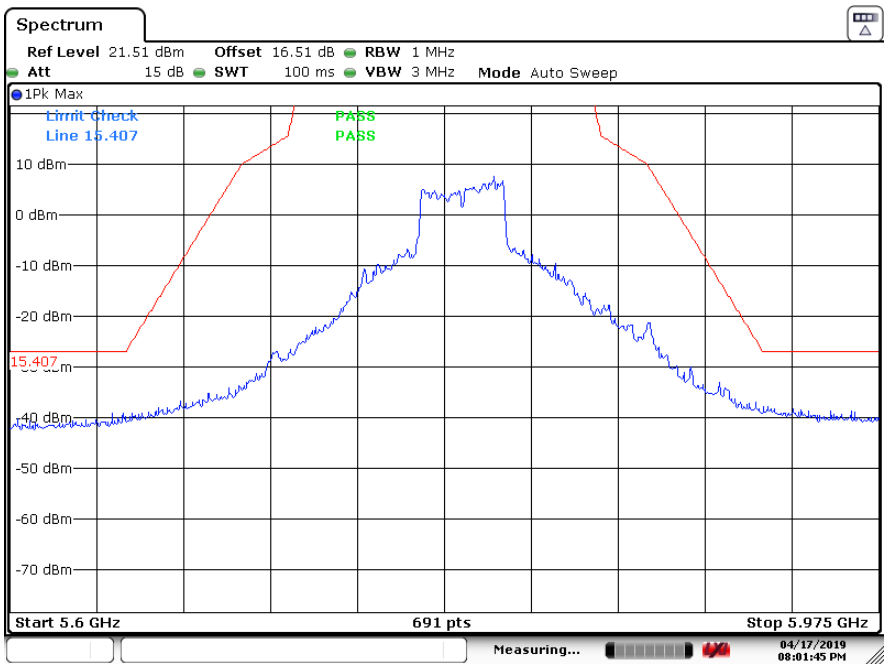

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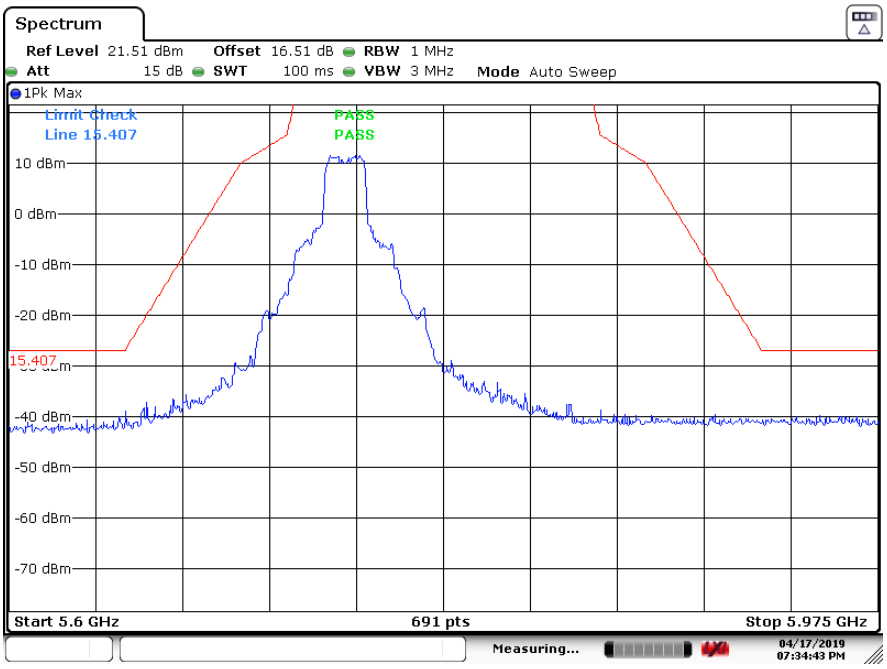
802.11ac20 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5745 MHz											
11490	35.12	0	100	H	38.44	19.013	38.070	54.51	74.00	-19.49	PK
11490	24.09	0	100	H	38.44	19.013	38.070	43.47	54.00	-10.53	AV
11490	35.37	0	100	V	38.44	19.013	38.070	54.76	74.00	-19.24	PK
11490	22.81	0	100	V	38.44	19.013	38.070	42.19	54.00	-11.81	AV
Middle Channel 5785 MHz											
11570	35.57	0	100	H	38.585	19.013	37.97	55.19	74.00	-18.81	PK
11570	22.72	0	100	H	38.585	19.013	37.97	42.35	54.00	-11.65	AV
11570	35.74	0	100	V	38.585	19.013	37.97	55.37	74.00	-18.63	PK
11570	21.57	0	100	V	38.585	19.013	37.97	41.20	54.00	-12.80	AV
High Channel 5825 MHz											
11650	35.82	0	100	H	38.671	19.354	38.32	55.53	74.00	-18.47	PK
11650	21.09	0	100	H	38.671	19.354	38.32	40.79	54.00	-13.21	AV
11650	35.17	0	100	V	38.671	19.354	38.32	54.88	74.00	-19.12	PK
11650	21.90	0	100	V	38.671	19.354	38.32	41.60	54.00	-12.40	AV

802.11ac20 mode, Low channel 5745 MHz

Horizontal



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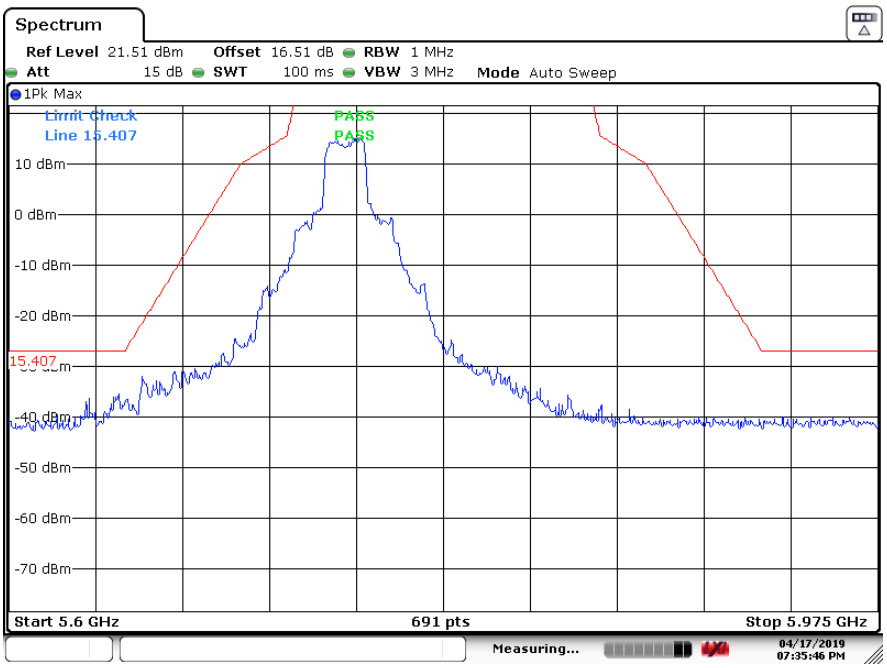
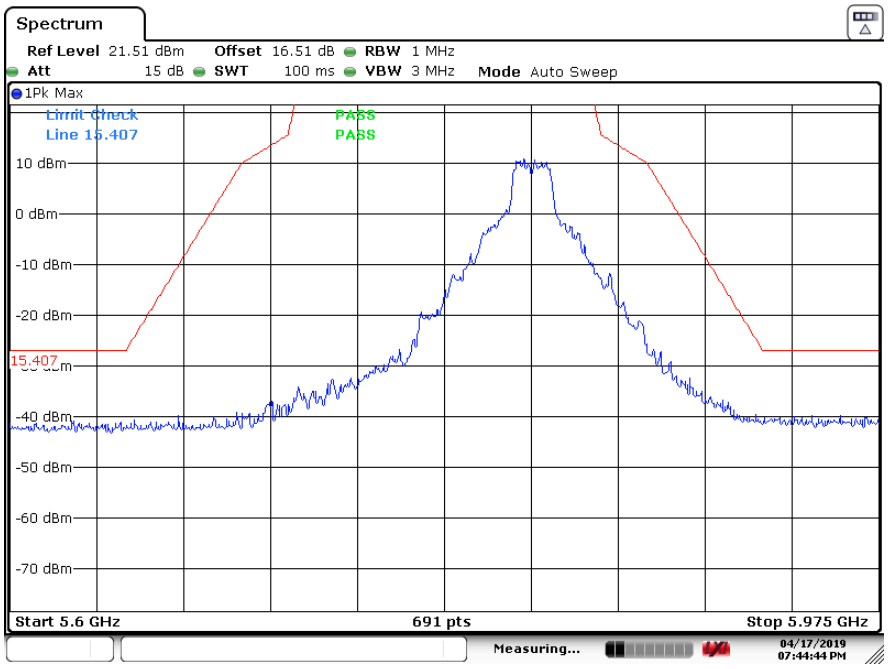


Date: 17 APR 2019 19:35:46

802.11ac20 mode, high channel 5825 MHz

Horizontal



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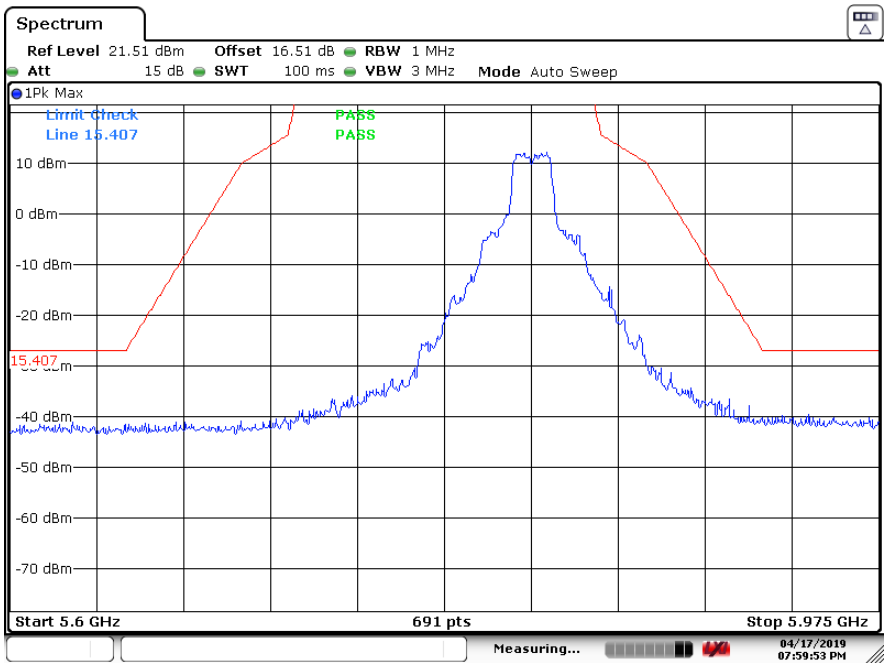
Vertical



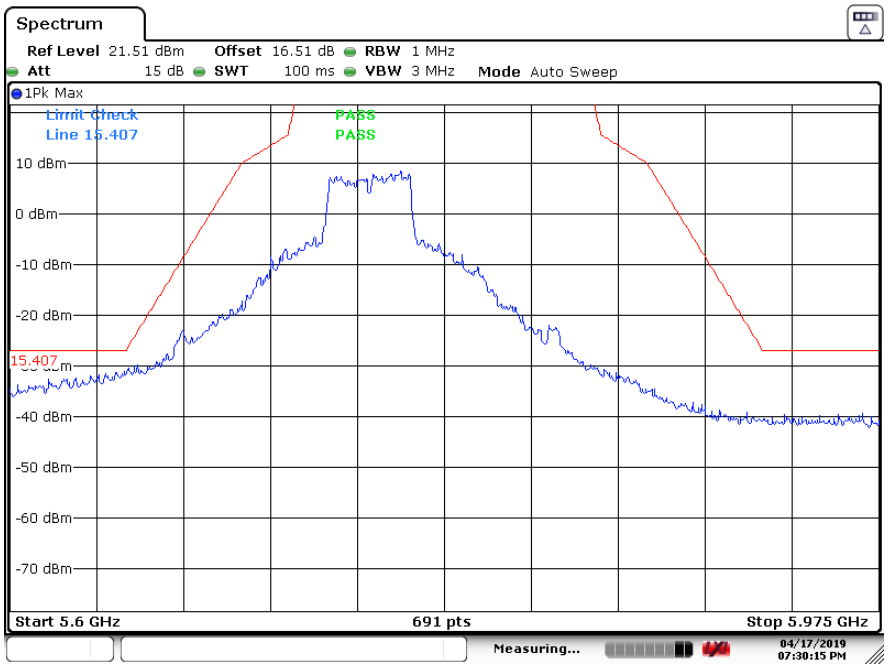
Date: 17.APR.2019 19:59:53

802.11ac40 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5755 MHz											
11510	35.62	0	100	H	38.44	19.013	38.070	55.01	74.00	-19.00	PK
11510	21.42	0	100	H	38.44	19.013	38.070	40.80	54.00	-13.20	AV
11510	35.31	0	100	V	38.44	19.013	38.070	54.69	74.00	-19.31	PK
11510	22.34	0	100	V	38.44	19.013	38.070	41.72	54.00	-12.28	AV
High Channel 5795 MHz											
11590	35.12	0	100	H	38.671	19.354	38.32	54.83	74.00	-19.18	PK
11590	21.99	0	100	H	38.671	19.354	38.32	41.69	54.00	-12.31	AV
11590	35.60	0	100	V	38.671	19.354	38.32	55.30	74.00	-18.70	PK
11590	22.89	0	100	V	38.671	19.354	38.32	42.60	54.00	-11.40	AV

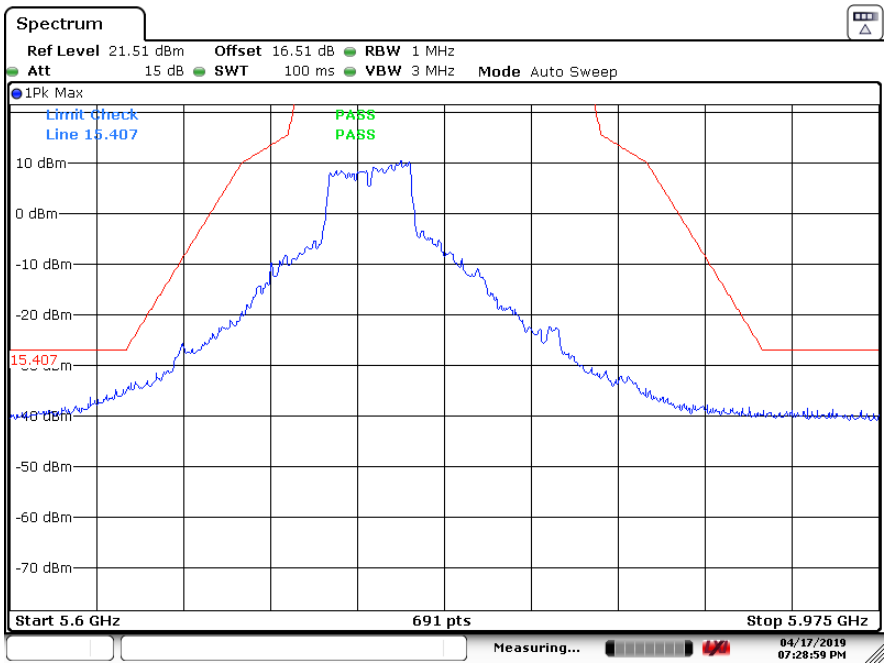
802.11ac40 mode, Low channel 5755 MHz

Horizontal



Date: 17 APR 2019 19:30:15

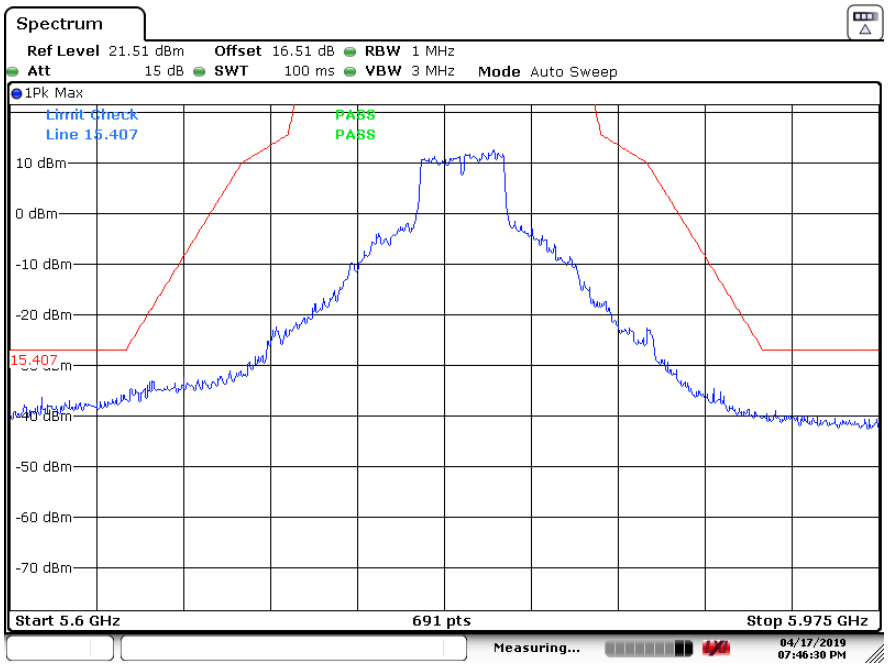
Vertical



Date: 17 APR 2019 19:28:59

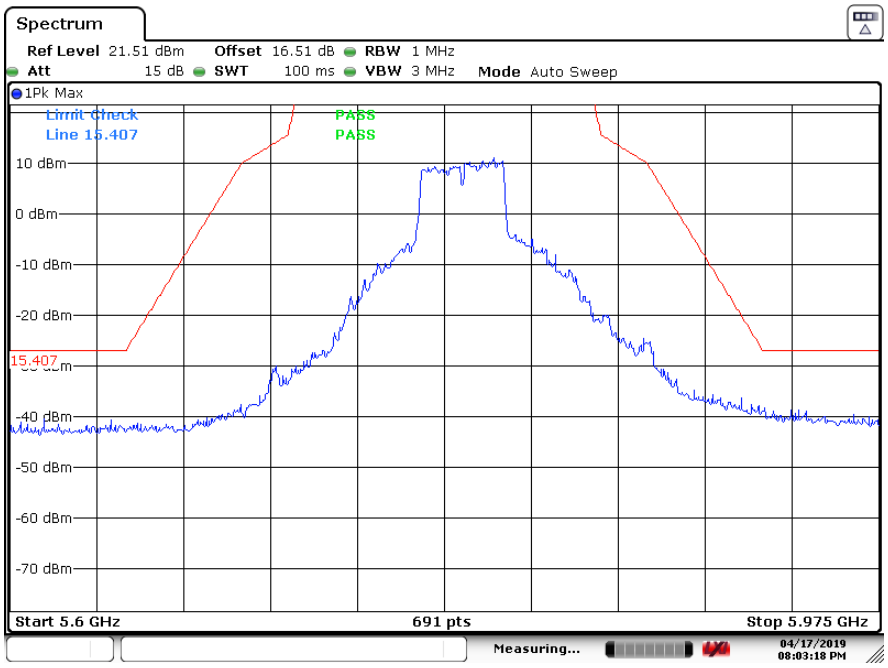
802.11ac40 mode, high channel 5795 MHz

Horizontal



Date: 17 APR 2019 19:46:30

Vertical



Date: 17 APR 2019 20:03:18

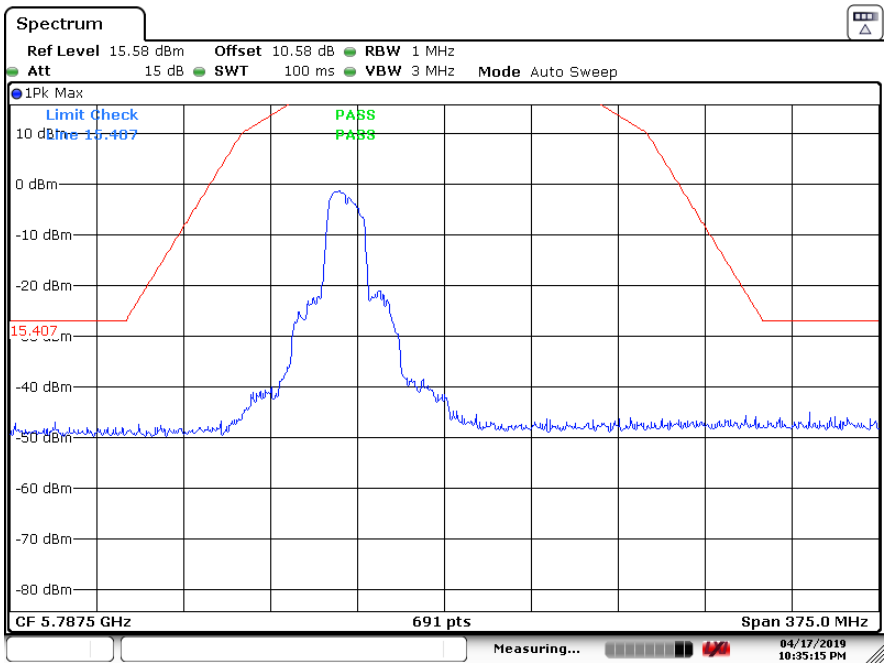
Radio 2

802.11a mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5745 MHz											
11490	35.11	0	100	H	38.44	19.013	38.070	54.50	74.00	-19.50	PK
11490	21.30	0	100	H	38.44	19.013	38.070	40.69	54.00	-13.31	AV
11490	35.65	0	100	V	38.44	19.013	38.070	55.03	74.00	-18.97	PK
11490	22.24	0	100	V	38.44	19.013	38.070	41.63	54.00	-12.37	AV
Middle Channel 5785 MHz											
11570	36.00	0	100	H	38.585	19.013	37.97	55.63	74.00	-18.37	PK
11570	21.74	0	100	H	38.585	19.013	37.97	41.37	54.00	-12.63	AV
11570	35.11	0	100	V	38.585	19.013	37.97	54.74	74.00	-19.27	PK
11570	24.74	0	100	V	38.585	19.013	37.97	44.37	54.00	-9.63	AV
High Channel 5825 MHz											
11650	35.82	0	100	H	38.671	19.354	38.32	55.53	74.00	-18.47	PK
11650	21.12	0	100	H	38.671	19.354	38.32	40.83	54.00	-13.17	AV
11650	35.62	0	100	V	38.671	19.354	38.32	55.33	74.00	-18.67	PK
11650	22.74	0	100	V	38.671	19.354	38.32	42.45	54.00	-11.55	AV

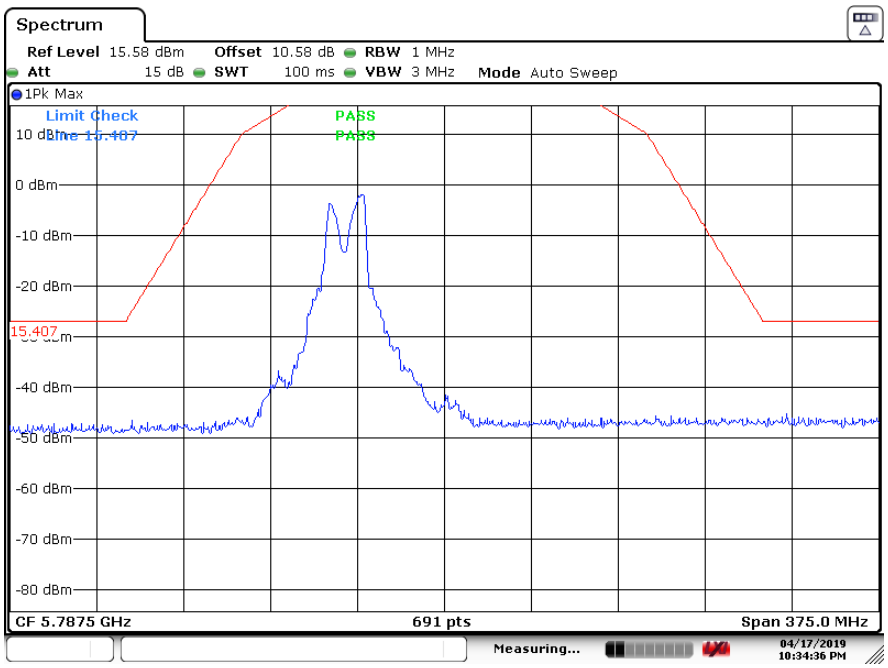
802.11a mode, Low channel 5745 MHz

Horizontal



Date: 17 APR 2019 22:35:15

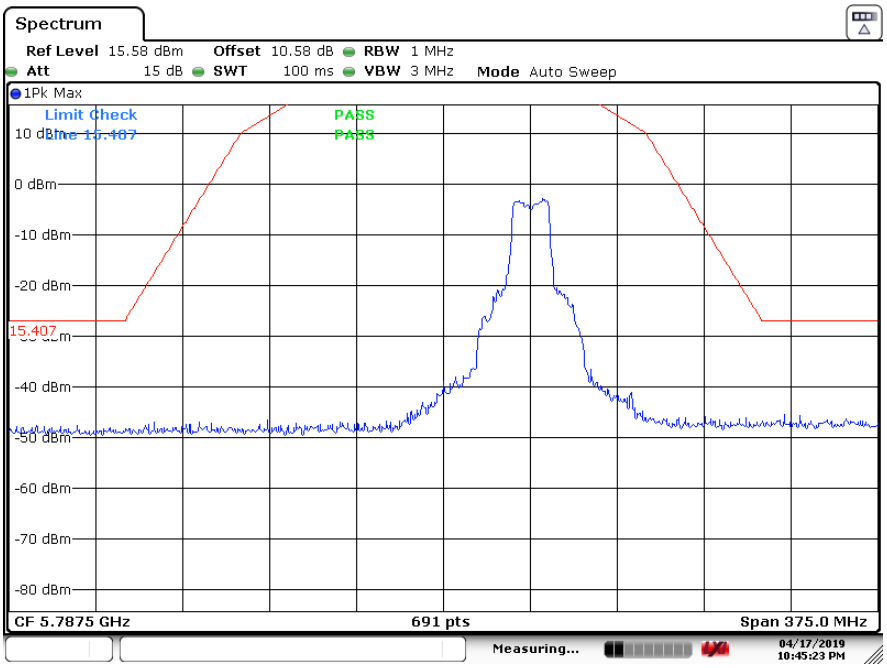
Vertical



Date: 17 APR 2019 22:34:37

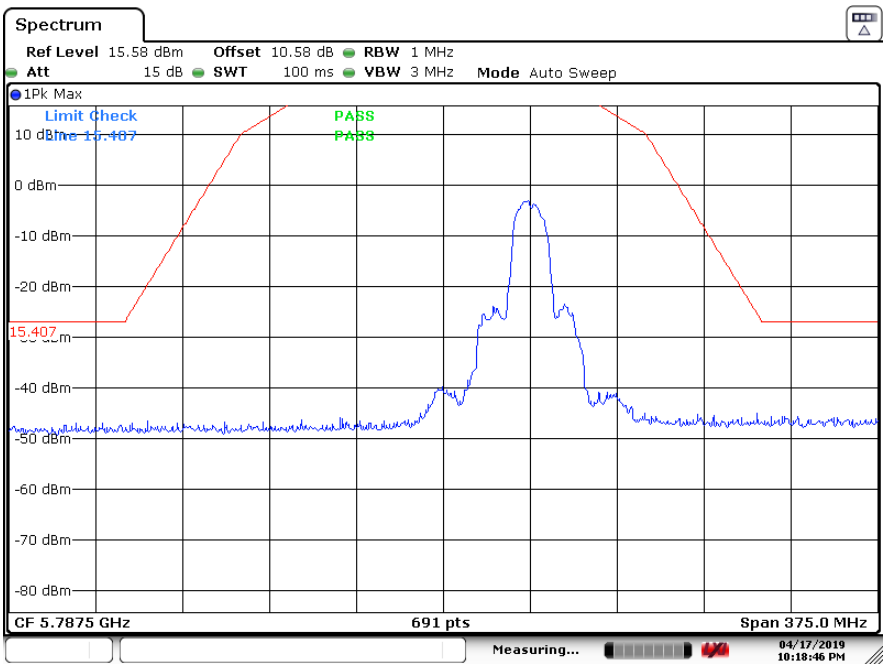
802.11a mode, high channel 5825 MHz

Horizontal



Date: 17 APR 2019 22:45:24

Vertical



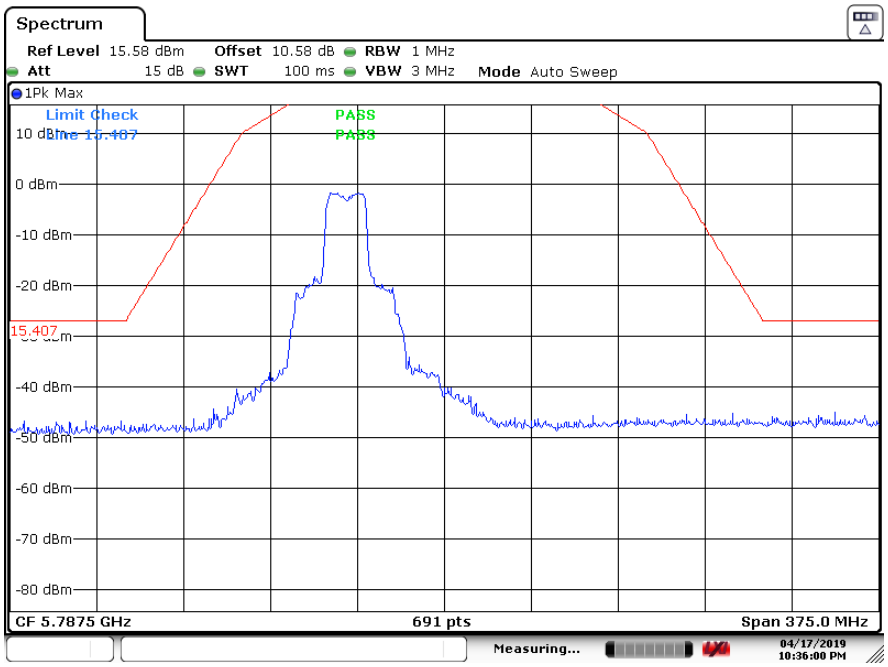
Date: 17 APR 2019 22:18:47

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 (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5745 MHz											
11490	35.61	0	100	H	38.44	19.013	38.070	54.99	74.00	-19.01	PK
11490	22.67	0	100	H	38.44	19.013	38.070	42.05	54.00	-11.95	AV
11490	35.26	0	100	V	38.44	19.013	38.070	54.65	74.00	-19.35	PK
11490	22.62	0	100	V	38.44	19.013	38.070	42.00	54.00	-12.00	AV
Middle Channel 5785 MHz											
11570	35.65	0	100	H	38.585	19.013	37.97	55.27	74.00	-18.73	PK
11570	21.18	0	100	H	38.585	19.013	37.97	40.81	54.00	-13.19	AV
11570	35.79	0	100	V	38.585	19.013	37.97	55.42	74.00	-18.59	PK
11570	22.00	0	100	V	38.585	19.013	37.97	41.62	54.00	-12.38	AV
High Channel 5825 MHz											
11650	35.12	0	100	H	38.671	19.354	38.32	54.82	74.00	-19.18	PK
11650	21.58	0	100	H	38.671	19.354	38.32	41.28	54.00	-12.72	AV
11650	34.12	0	100	V	38.671	19.354	38.32	53.82	74.00	-20.18	PK
11650	21.82	0	100	V	38.671	19.354	38.32	41.53	54.00	-12.47	AV

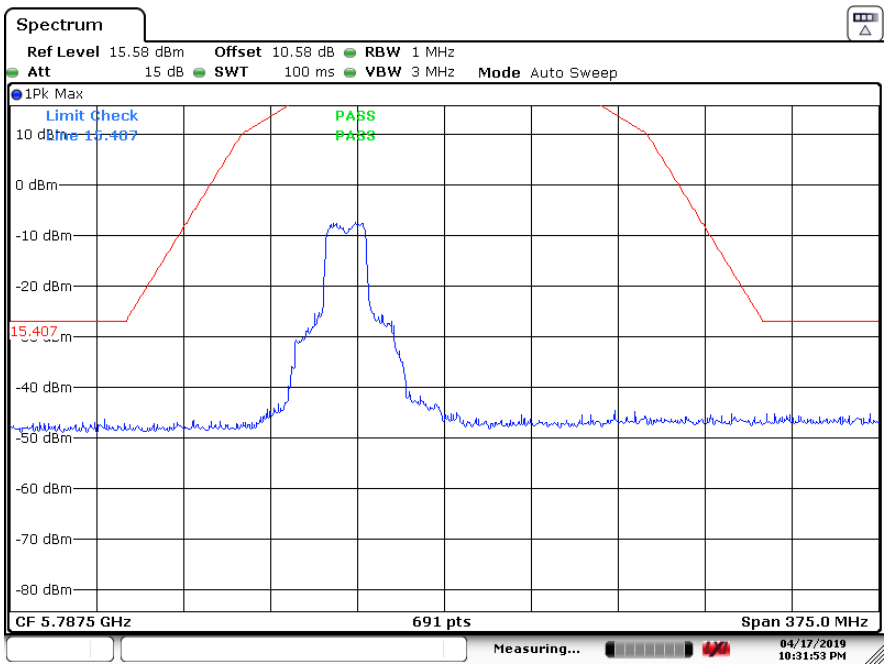
802.11n20 mode, Low channel 5745 MHz

Horizontal



Date: 17 APR 2019 22:36:00

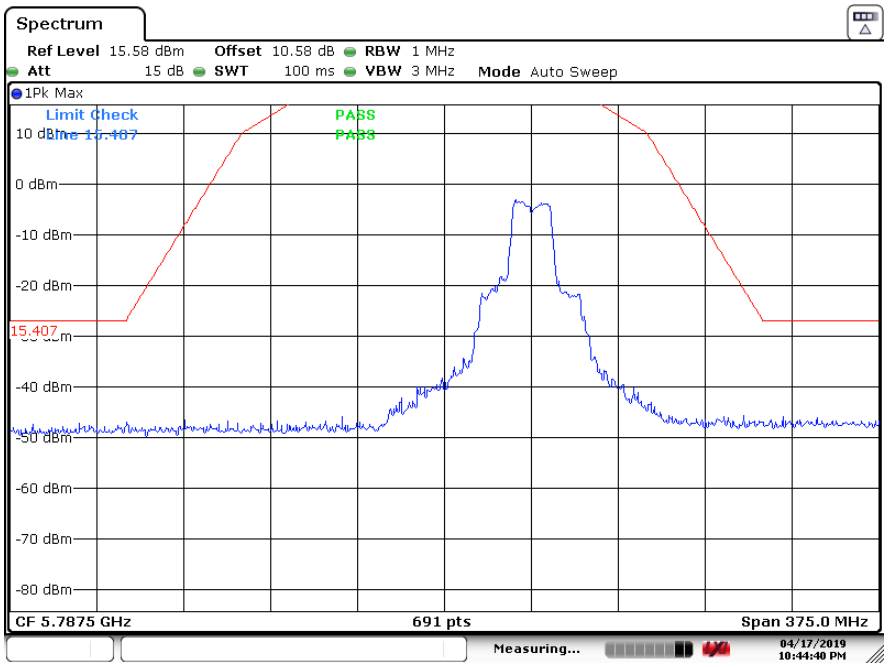
Vertical



Date: 17 APR 2019 22:31:53

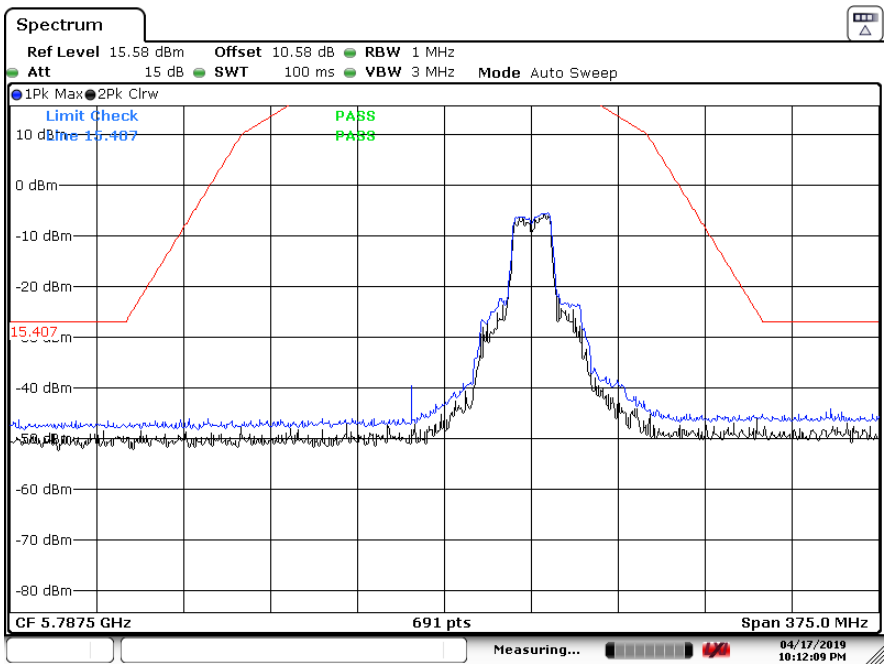
802.11n20 mode, high channel 5825 MHz

Horizontal



Date: 17 APR 2019 22:44:39

Vertical



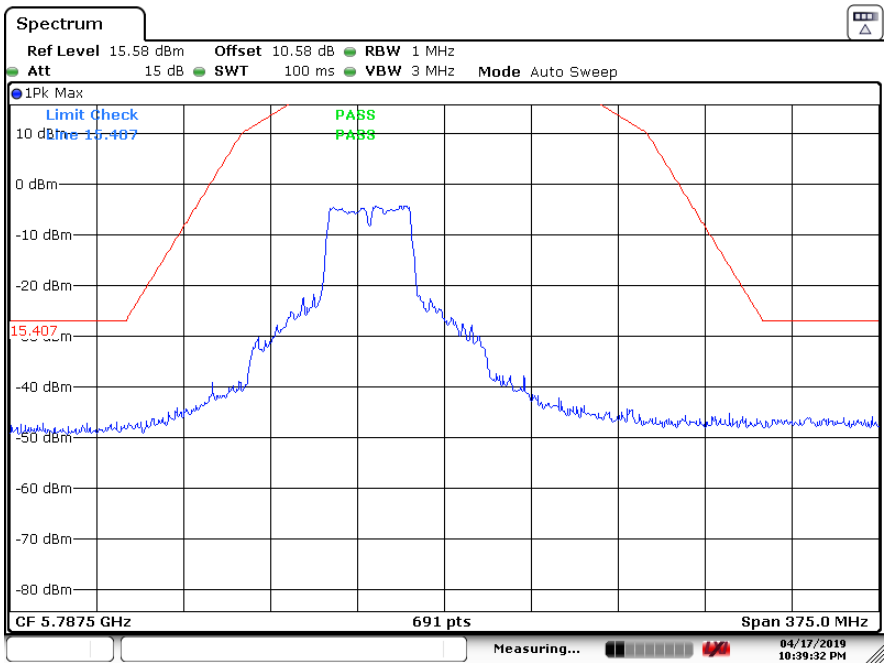
Date: 17 APR 2019 22:12:09

802.11n40 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5755 MHz											
11510	35.03	0	100	H	38.44	19.013	38.070	54.41	74.00	-19.59	PK
11510	22.65	0	100	H	38.44	19.013	38.070	42.03	54.00	-11.97	AV
11510	35.10	0	100	V	38.44	19.013	38.070	54.48	74.00	-19.52	PK
11510	21.74	0	100	V	38.44	19.013	38.070	41.12	54.00	-12.88	AV
High Channel 5795 MHz											
11590	35.72	0	100	H	38.671	19.354	38.32	55.43	74.00	-18.58	PK
11590	21.38	0	100	H	38.671	19.354	38.32	41.09	54.00	-12.91	AV
11590	35.42	0	100	V	38.671	19.354	38.32	55.13	74.00	-18.87	PK
11590	22.26	0	100	V	38.671	19.354	38.32	41.97	54.00	-12.04	AV

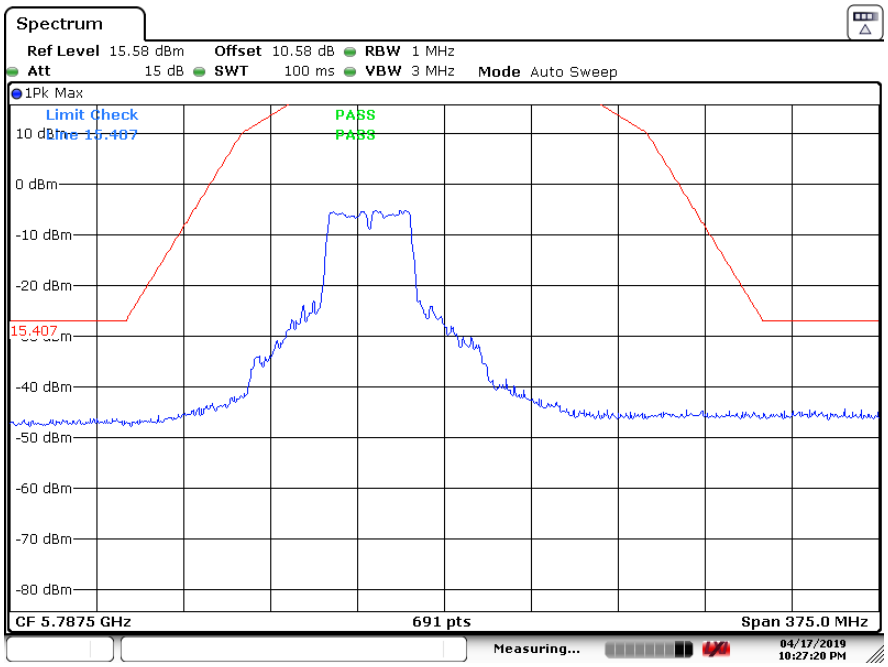
802.11n40 mode, Low channel 5755 MHz

Horizontal



Date: 17 APR 2019 22:39:33

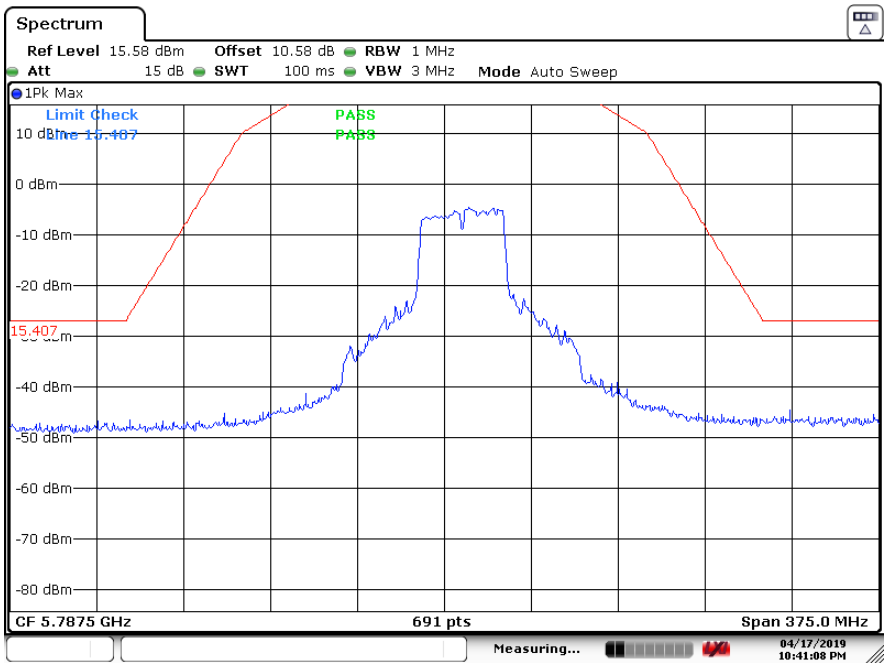
Vertical



Date: 17 APR 2019 22:27:21

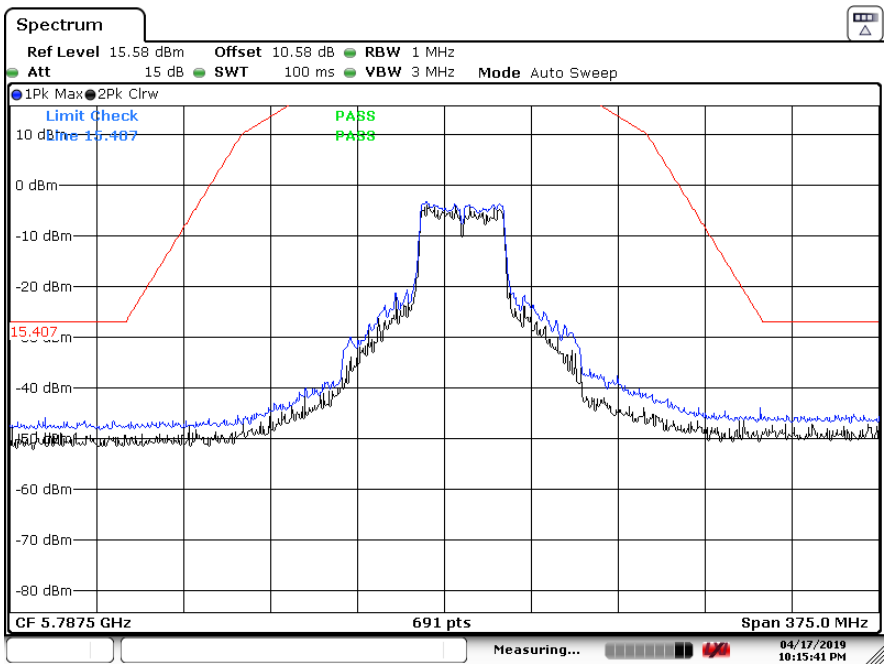
802.11n40 mode, high channel 5795 MHz

Horizontal



Date: 17 APR 2019 22:41:08

Vertical



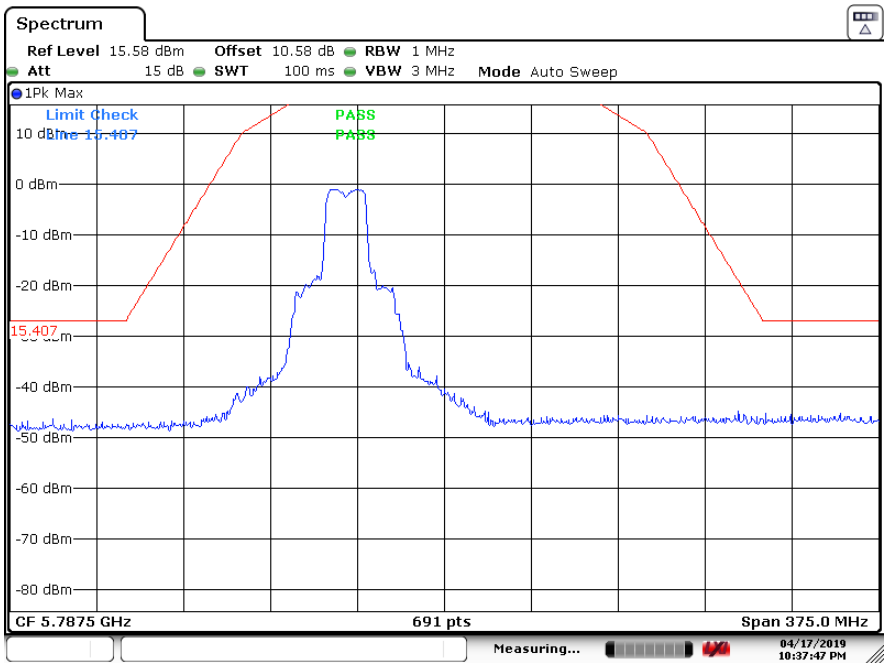
Date: 17 APR 2019 22:15:42

802.11ac20 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5745 MHz											
11490	35.68	0	100	H	38.44	19.013	38.070	55.06	74.00	-18.94	PK
11490	22.37	0	100	H	38.44	19.013	38.070	41.75	54.00	-12.25	AV
11490	35.05	0	100	V	38.44	19.013	38.070	54.43	74.00	-19.57	PK
11490	21.53	0	100	V	38.44	19.013	38.070	40.92	54.00	-13.09	AV
Middle Channel 5785 MHz											
11570	35.64	0	100	H	38.585	19.013	37.97	55.27	74.00	-18.73	PK
11570	21.66	0	100	H	38.585	19.013	37.97	41.29	54.00	-12.71	AV
11570	35.60	0	100	V	38.585	19.013	37.97	55.23	74.00	-18.77	PK
11570	21.22	0	100	V	38.585	19.013	37.97	40.85	54.00	-13.15	AV
High Channel 5825 MHz											
11650	35.41	0	100	H	38.671	19.354	38.32	55.12	74.00	-18.88	PK
11650	21.67	0	100	H	38.671	19.354	38.32	41.37	54.00	-12.63	AV
11650	35.35	0	100	V	38.671	19.354	38.32	55.05	74.00	-18.95	PK
11650	22.67	0	100	V	38.671	19.354	38.32	42.37	54.00	-11.63	AV

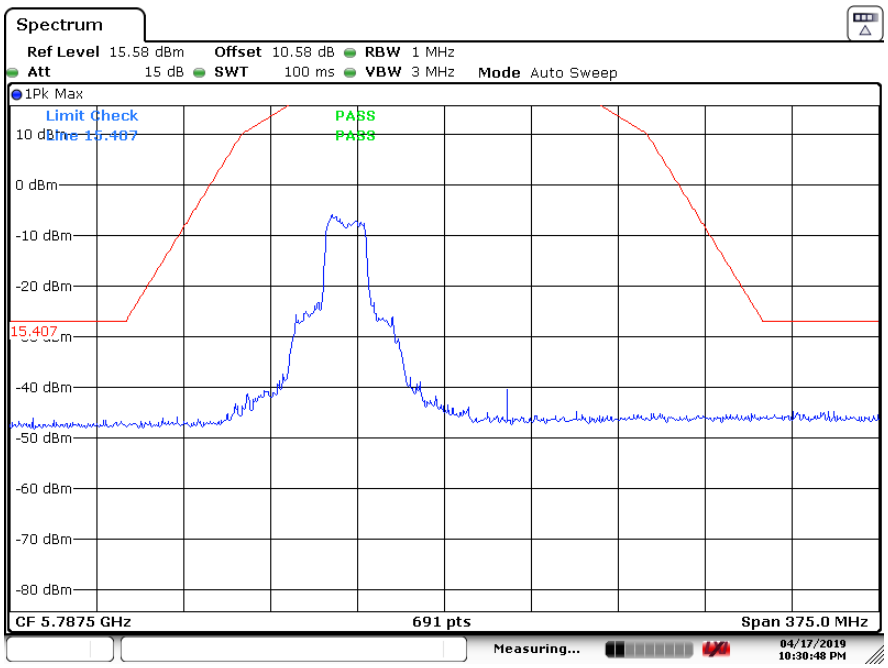
802.11ac20 mode, Low channel 5745 MHz

Horizontal



Date: 17 APR 2019 22:37:47

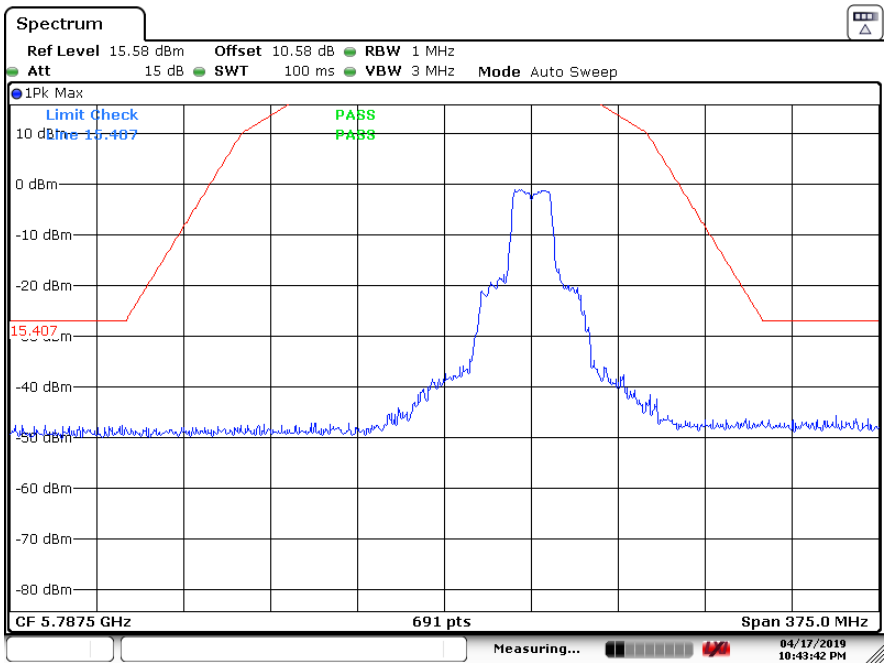
Vertical



Date: 17 APR 2019 22:30:48

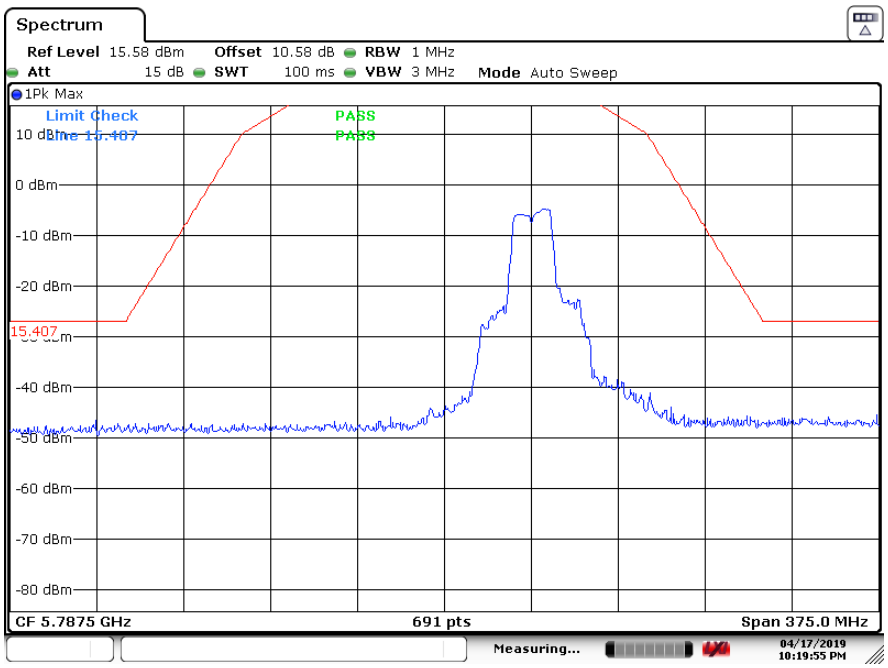
802.11ac20 mode, high channel 5825 MHz

Horizontal



Date: 17 APR 2019 22:43:42

Vertical



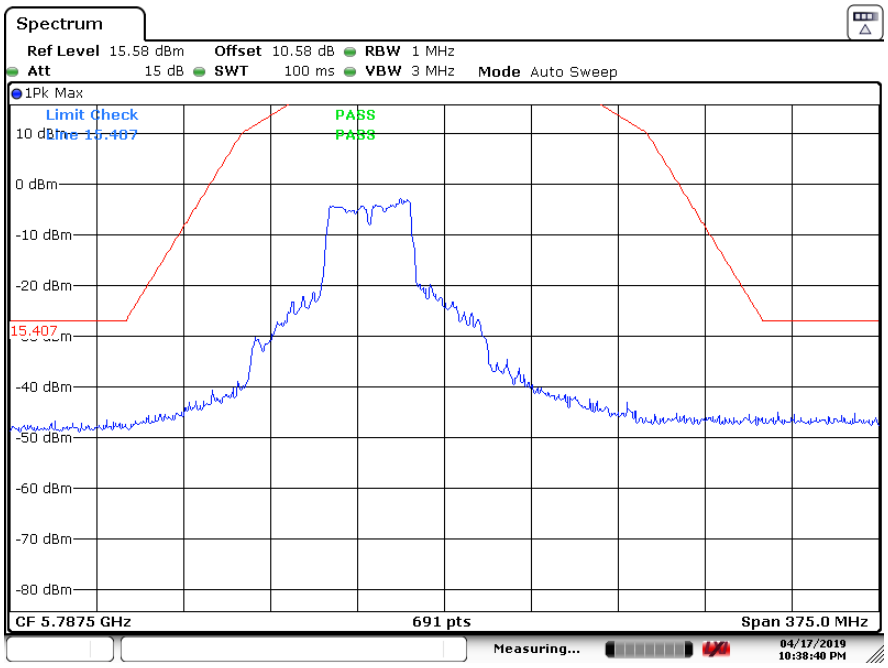
Date: 17 APR 2019 22:19:56

802.11ac40 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5755 MHz											
11510	34.37	0	100	H	38.44	19.013	38.070	53.75	74.00	-20.25	PK
11510	22.48	0	100	H	38.44	19.013	38.070	41.87	54.00	-12.13	AV
11510	35.06	0	100	V	38.44	19.013	38.070	54.45	74.00	-19.55	PK
11510	21.53	0	100	V	38.44	19.013	38.070	40.91	54.00	-13.09	AV
High Channel 5795 MHz											
11590	35.91	0	100	H	38.671	19.354	38.32	55.62	74.00	-18.38	PK
11590	21.18	0	100	H	38.671	19.354	38.32	40.88	54.00	-13.12	AV
11590	35.16	0	100	V	38.671	19.354	38.32	54.86	74.00	-19.14	PK
11590	21.99	0	100	V	38.671	19.354	38.32	41.70	54.00	-12.30	AV

802.11ac40 mode, Low channel 5755 MHz

Horizontal



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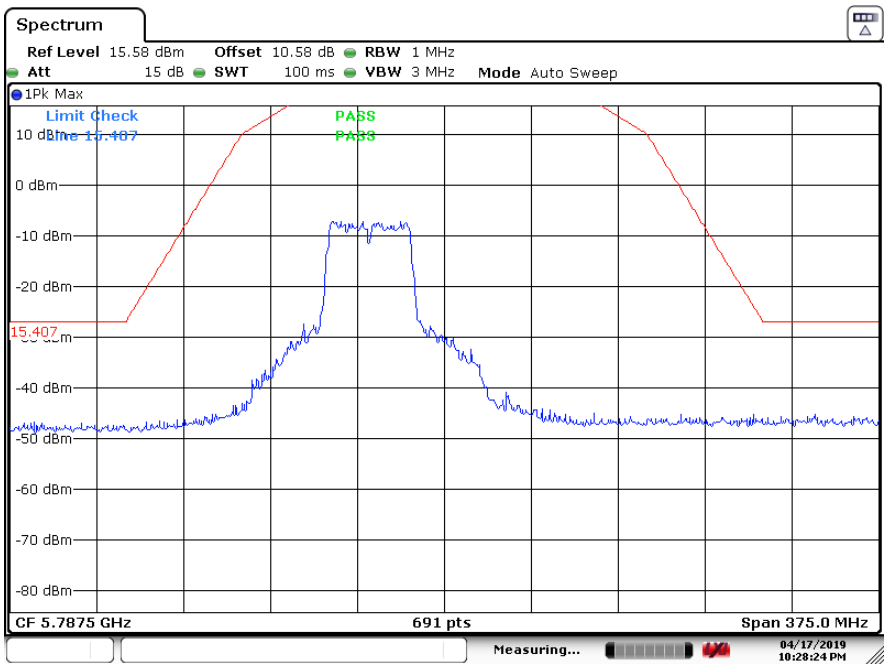
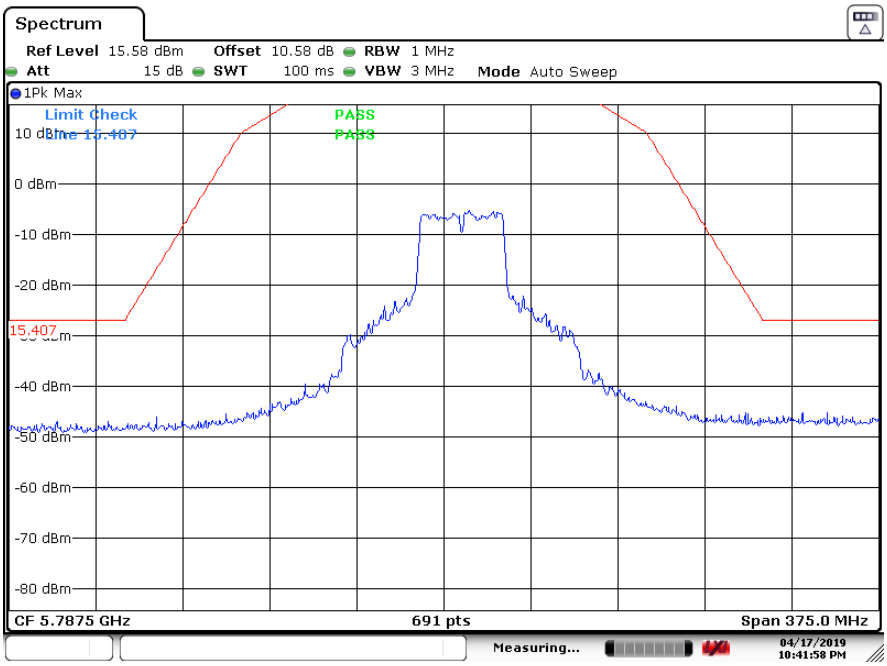
Vertical



Date: 17 APR 2019 22:28:24

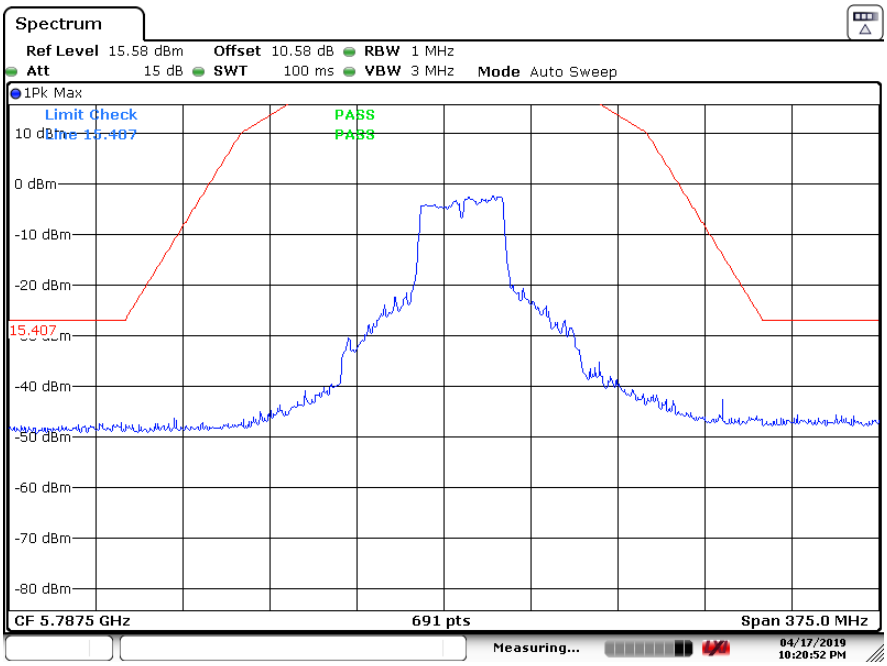
802.11ac40 mode, high channel 5795 MHz

Horizontal



Date: 17.APR.2019 22:41:58

Vertical



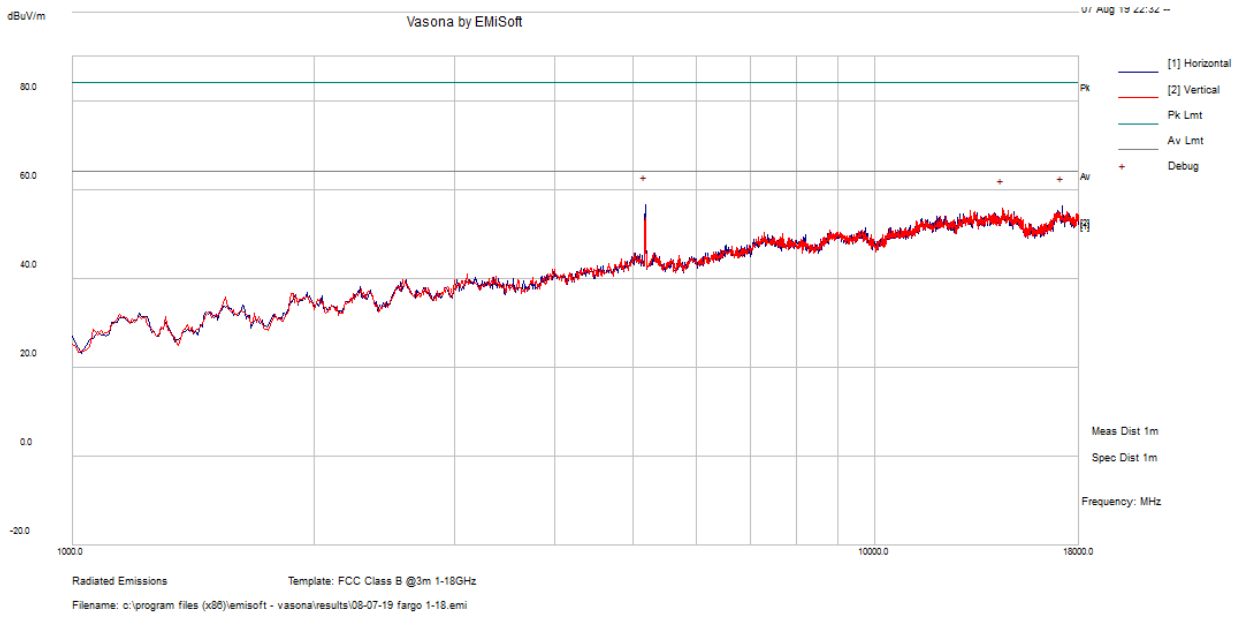
Date: 17.APR.2019 22:20:52

Note1: Spurious Emission above 10.5 GHz is nosie floor.
Note2: EIRP (dBµV/m) = dBm+Cable Loss+Antenna Factor-Amplifier Gain +11.76@ 3 Meter.
PSA offser = Cable Loss+Antenna Factor-Amplifier Gain +11.76

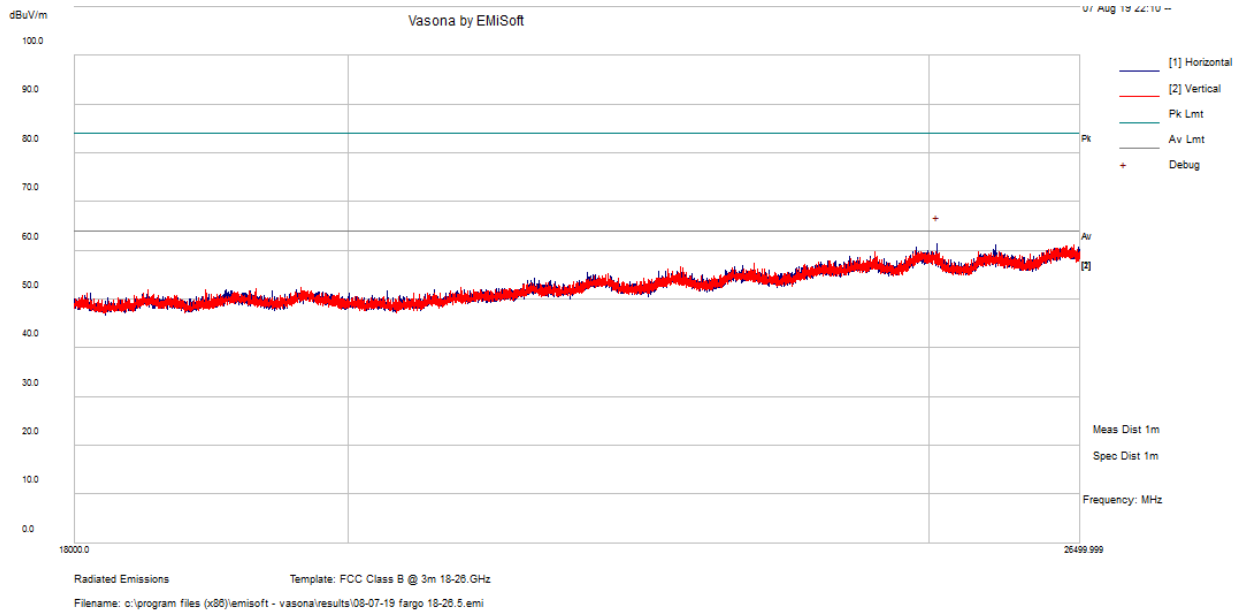
5.2 GHz Wi-Fi, a mode, 5240 MHz, Radio 1; and 5.8 GHz Wi-Fi, ac40 mode, 5795 MHz, Radio 2

1 GHz – 18 GHz Scan at 1 Meter

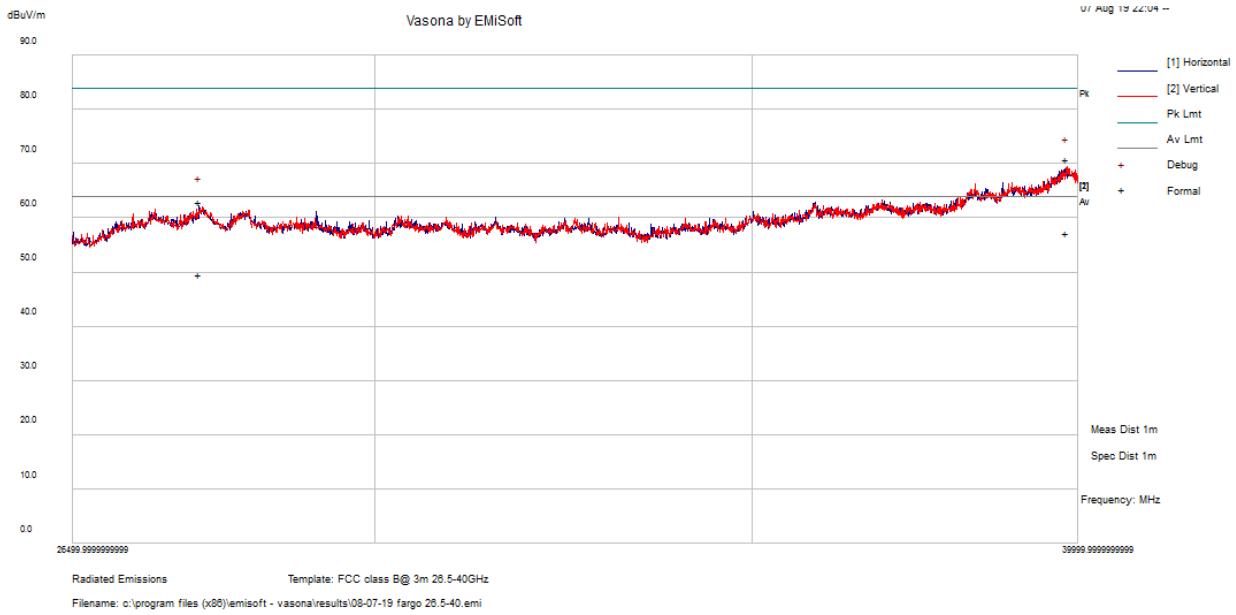
Notch Filter has been added



18 GHz – 26.5 GHz Scan at 1 Meter



26.5 GHz – 40 GHz Scan at 1 Meter



8 FCC §15.407(e) - Occupied Bandwidth

8.1 Applicable Standards

As per FCC §15.407(e): for equipment operating in the band 5725 – 5850 MHz, the minimum 6 dB bandwidth of U-NII devices shall be 500 kHz.

8.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 or 26 dB from the reference level. Record the frequency difference as the minimum emission or emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	MY48250238	2018-05-08	1 year
-	20dB attenuator	-	-	Each time[1]	N/A
-	10dB attenuator	-	-	Each time[1]	N/A
-	RF cable	-	-	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 Alexandrae Duran on 2019-03-28 in RF at RF site.

8.5 Test Results

Please refer to the following tables and plots.

5150 - 5250 MHz

Radio 1

Channel	Frequency (MHz)	99% OBW (MHz)	
		Chain 0	Chain 1
802.11a mode			
36	5180	22.7177	19.4899
44	5220	23.2191	16.5282
48	5240	24.6572	16.5310
802.11n20 mode			
36	5180	22.1371	18.6516
44	5220	23.2494	18.5384
48	5240	23.6480	17.6273
802.11n40 mode			
38	5190	37.9070	36.1534
46	5230	42.0045	36.3023
802.11ac20 mode			
36	5180	22.7177	17.6329
44	5220	24.7289	17.6320
48	5240	24.6572	17.6588
802.11ac40 mode			
38	5190	46.7572	36.1500
46	5230	50.9899	36.3843

Radio 2

Channel	Frequency (MHz)	99% OBW (MHz)	
		Chain 0	Chain 1
802.11a mode			
36	5180	18.1027	17.4805
44	5220	20.7687	18.4131
48	5240	22.9750	18.7388
802.11n20 mode			
36	5180	19.6685	19.6685
44	5220	20.6171	20.6171
48	5240	22.6364	22.6364
802.11n40 mode			
38	5190	40.7054	40.7054
46	5230	46.1536	46.1536
802.11ac20 mode			
36	5180	18.1438	18.1438
44	5220	18.2628	18.2628
48	5240	18.8281	18.8281
802.11ac40 mode			
38	5190	37.8898	37.8898
46	5230	43.2724	43.2724

5745 - 5785 MHz

Radio 1

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	
		Chain 0	Chain 1
802.11a mode			
36	5745	16.672	16.496
44	5785	16.389	16.434
48	5825	16.381	17.627
802.11n20 mode			
36	5745	17.660	17.630
44	5785	17.623	17.642
48	5825	17.601	17.627
802.11n40 mode			
38	5755	36.588	36.660
46	5795	36.517	36.532
802.11ac20 mode			
36	5745	17.669	17.581
44	5785	17.539	17.642
48	5825	17.668	17.627
802.11ac40 mode			
38	5755	36.443	36.414
46	5795	36.549	36.467

Radio 2

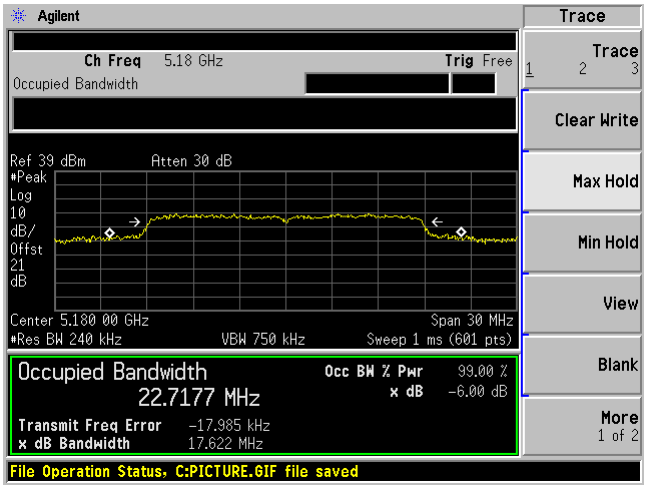
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	
		Chain 0	Chain 1
802.11a mode			
36	5745	16.455	16.496
44	5785	16.457	16.434
48	5825	16.467	17.646
802.11n20 mode			
36	5745	17.637	17.650
44	5785	17.429	17.685
48	5825	17.644	17.646
802.11n40 mode			
38	5755	36.446	36.288
46	5795	36.382	36.382
802.11ac20 mode			
36	5745	17.644	17.631
44	5785	17.635	17.593
48	5825	17.611	17.526
802.11ac40 mode			
38	5755	36.455	36.420
46	5795	36.312	36.525

Radio 1, Chain 0

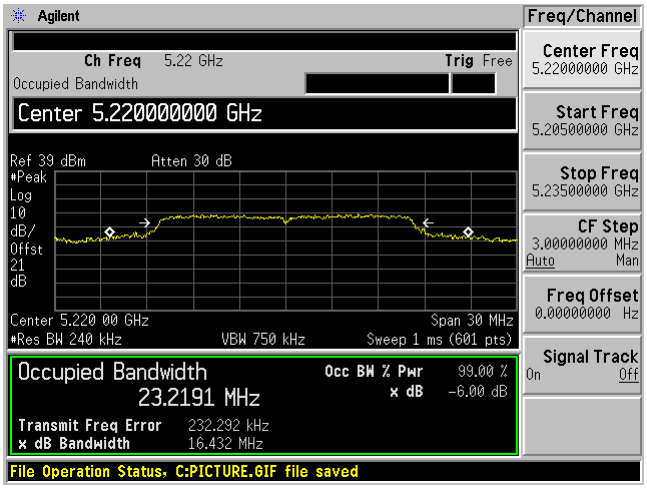
5150 – 5250 MHz

802.11a mode

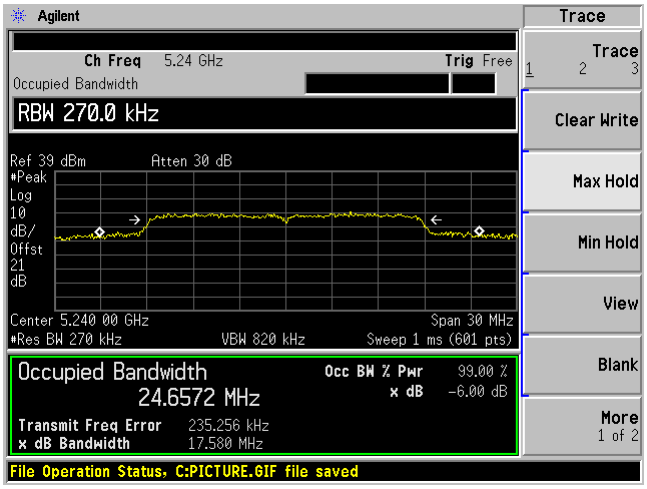
5180 MHz



5220 MHz

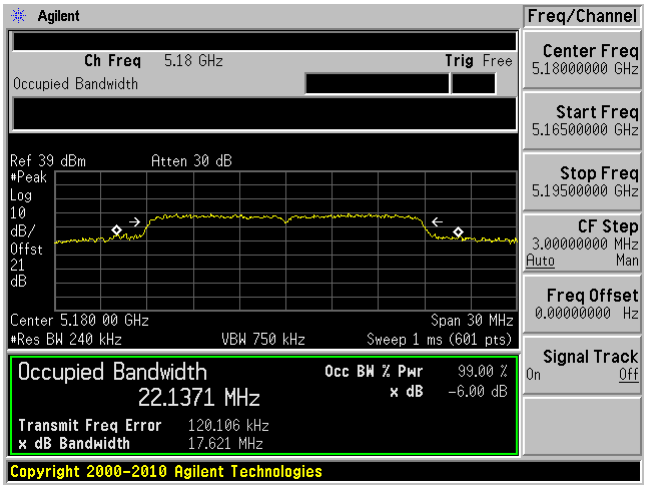


5240 MHz

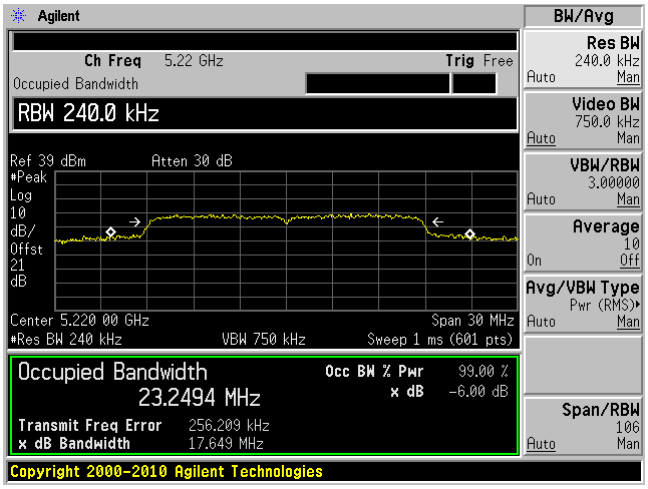


802.11n20 mode

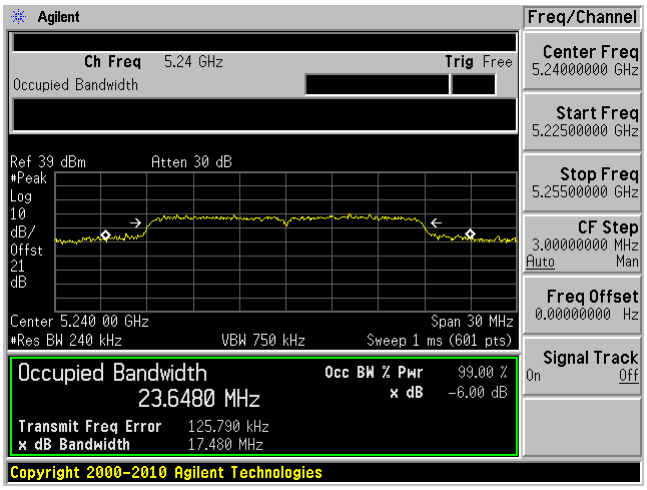
5180 MHz



5220 MHz

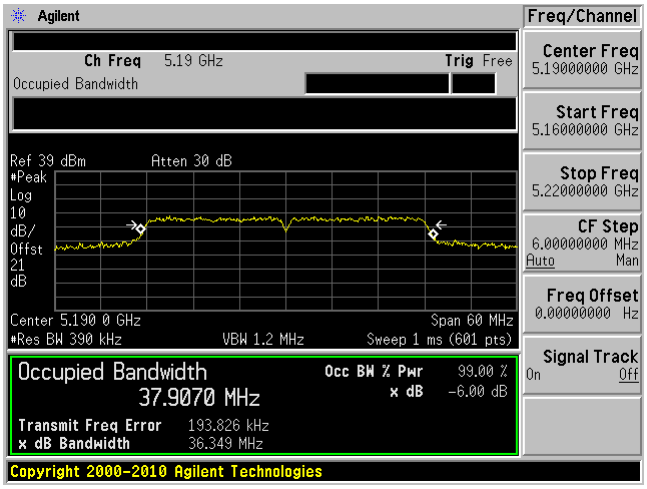


5240 MHz

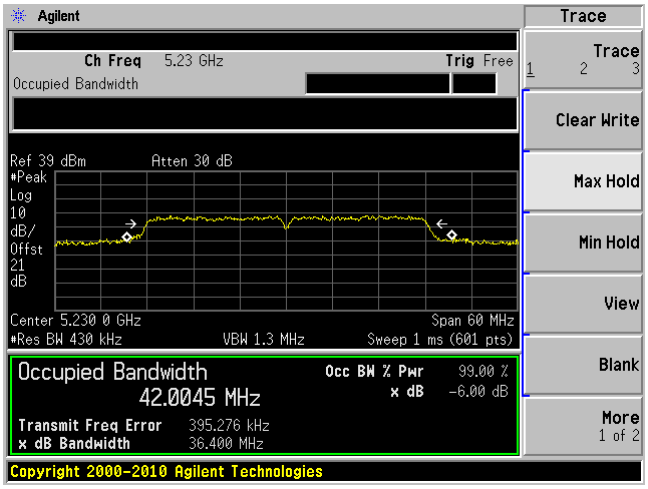


802.11n40 mode

5190 MHz

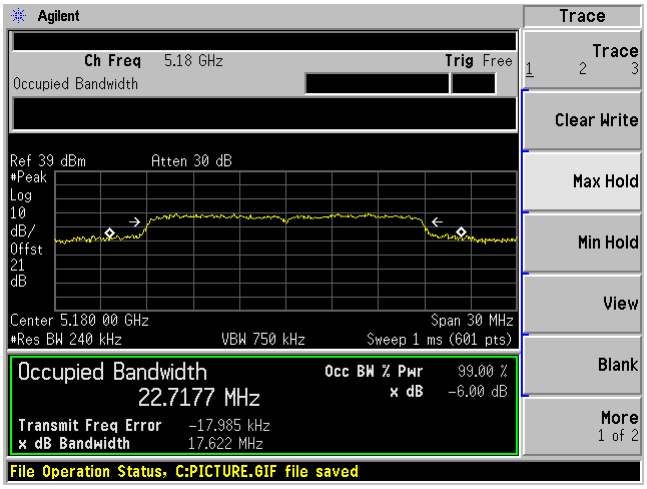


5230 MHz

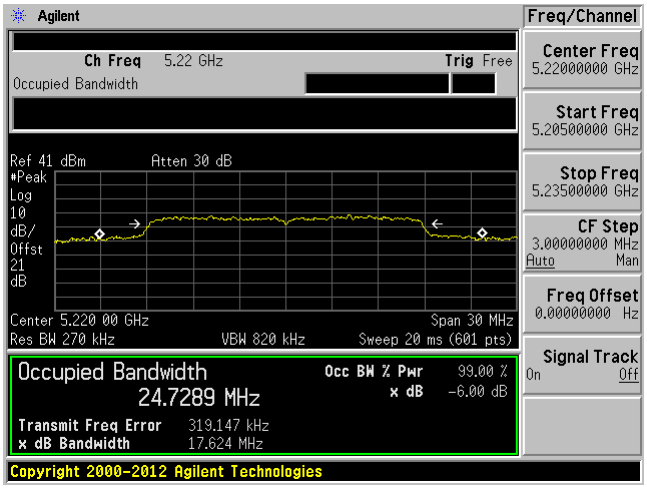


802.11ac20 mode

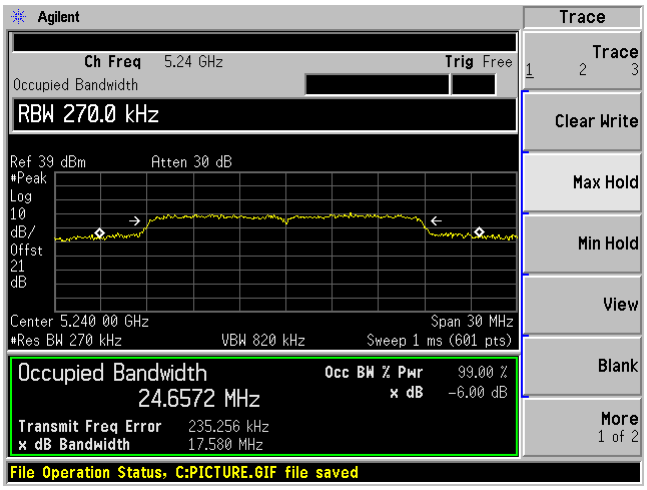
5180 MHz



5220 MHz

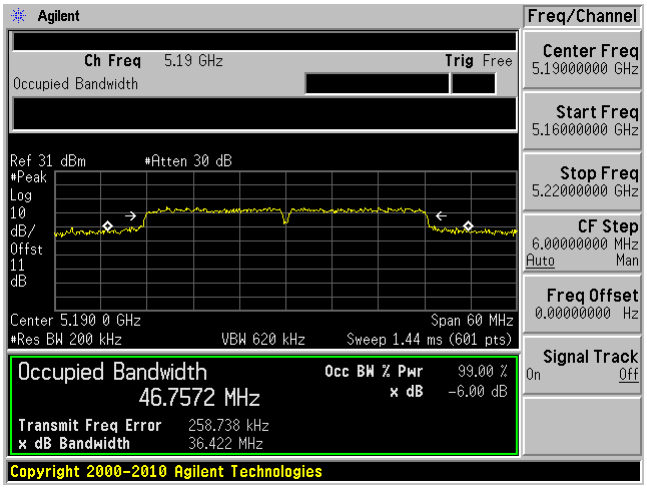


5240 MHz

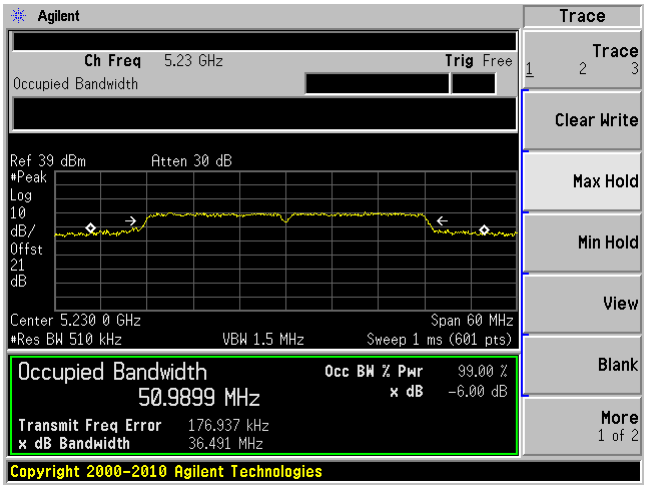


802.11ac40 mode

5190 MHz



5230 MHz

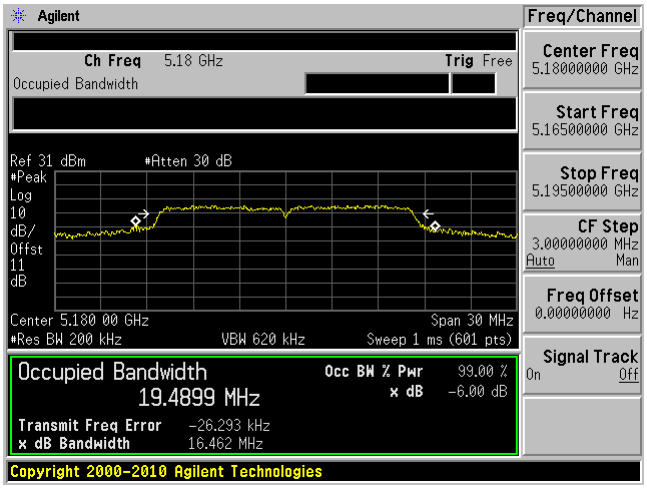


Radio 1, Chain 1

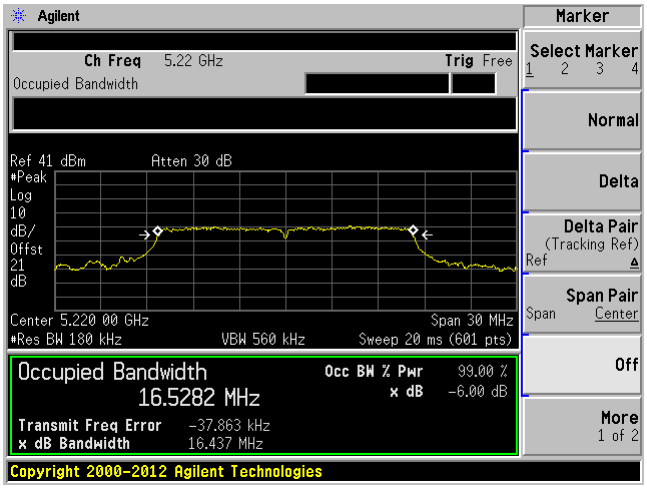
5150 – 5250 MHz

802.11a mode

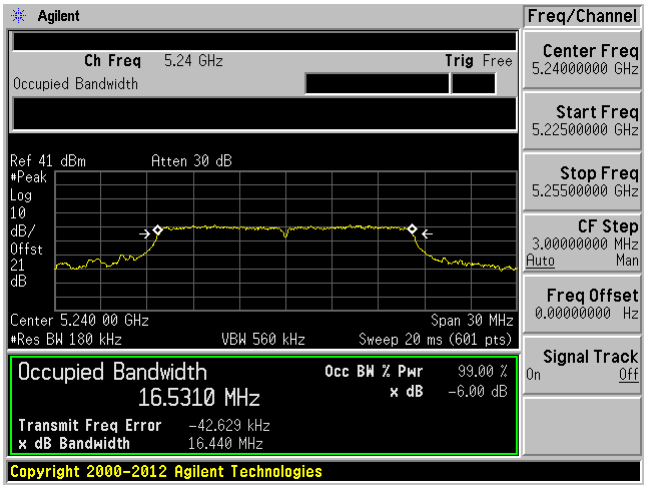
5180 MHz



5220 MHz

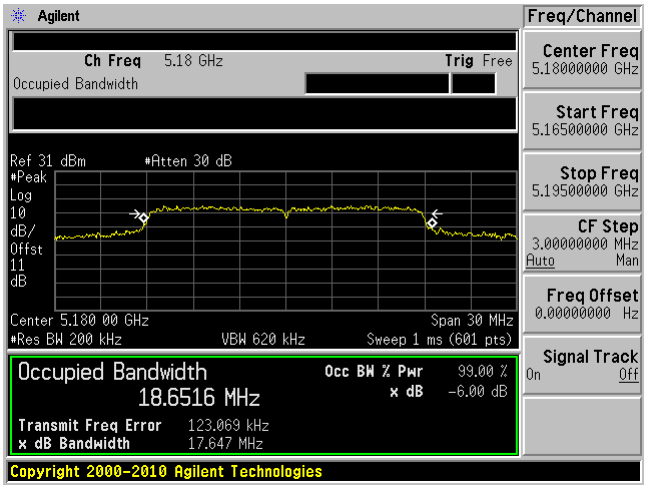


5240 MHz

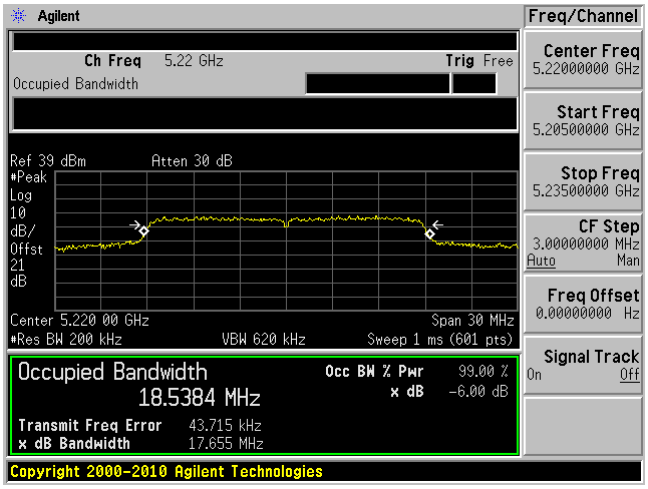


802.11n20 mode

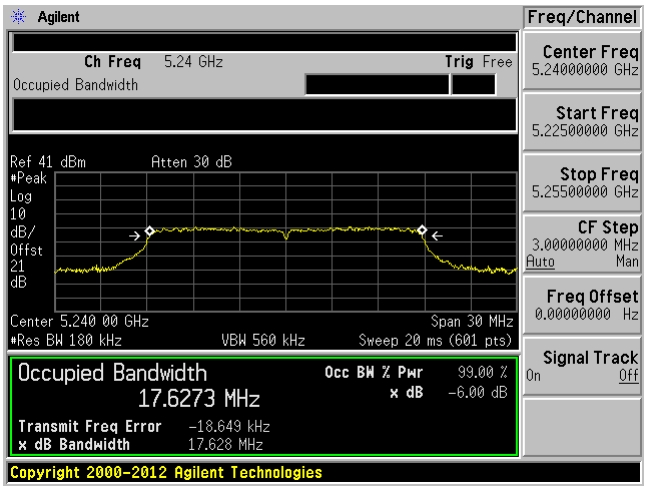
5180 MHz



5220 MHz

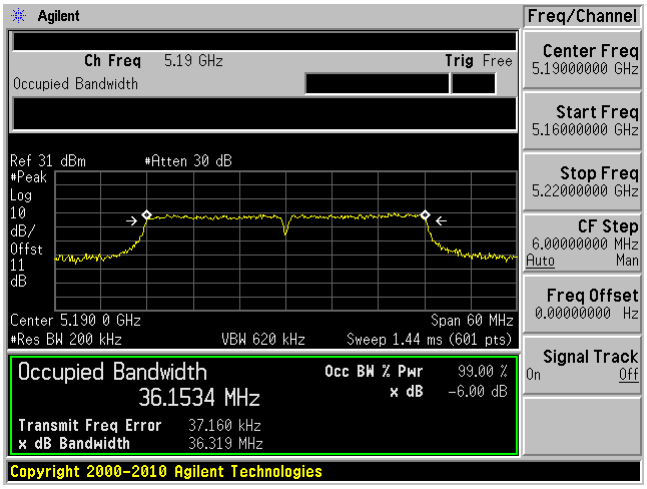


5240 MHz

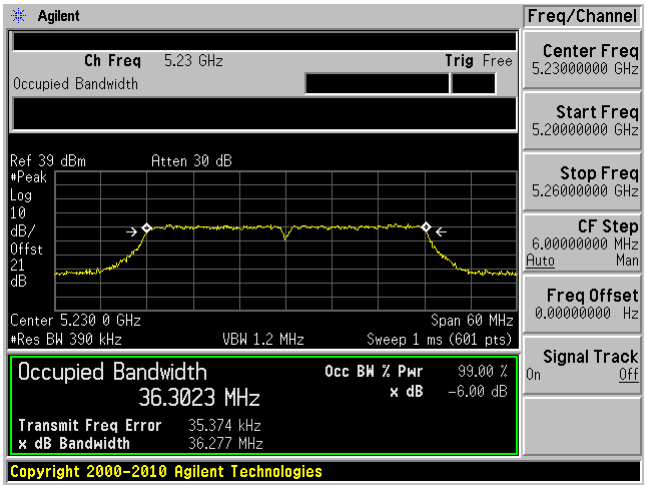


802.11n40 mode

5190 MHz

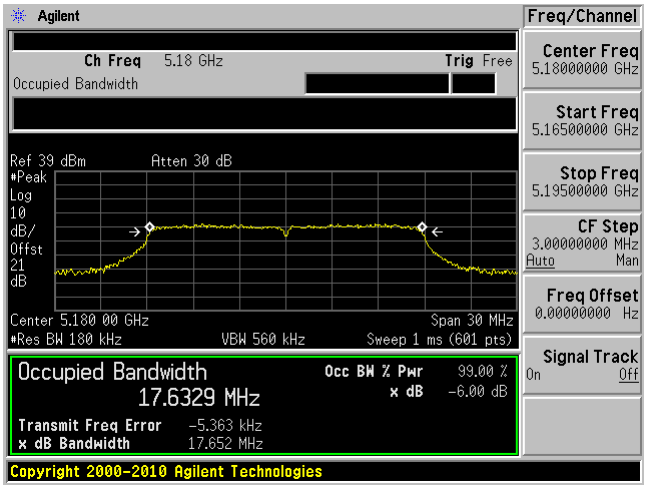


5230 MHz

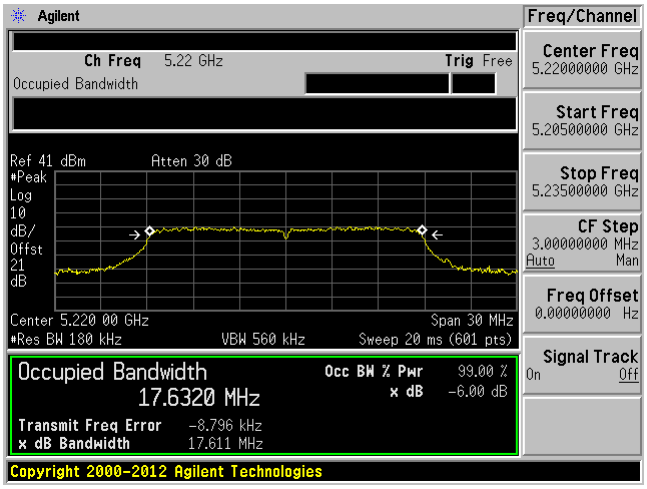


802.11ac20 mode

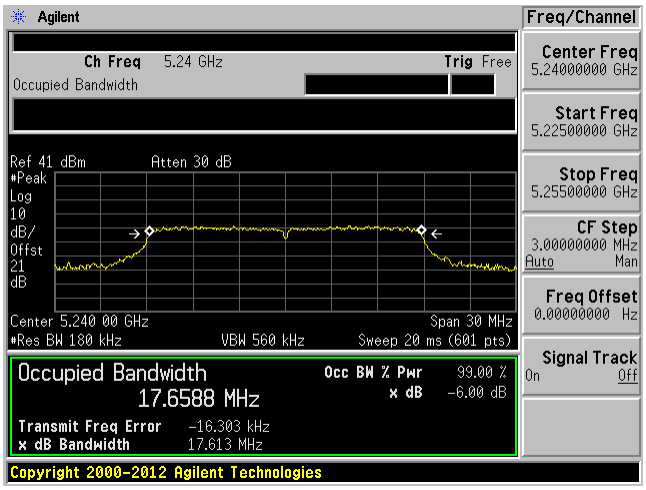
5180 MHz



5220 MHz

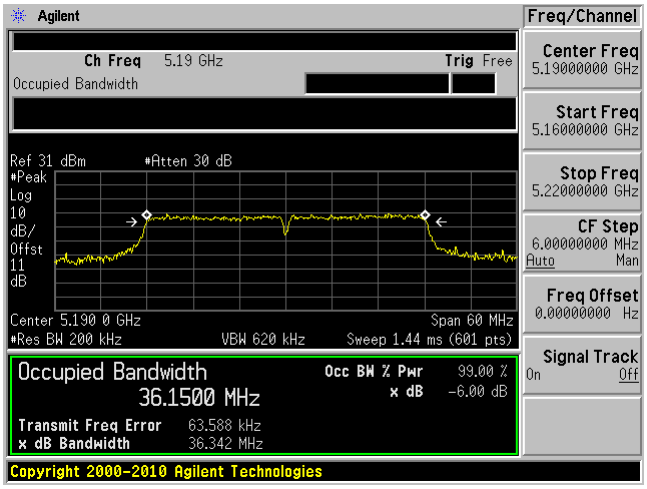


5240 MHz

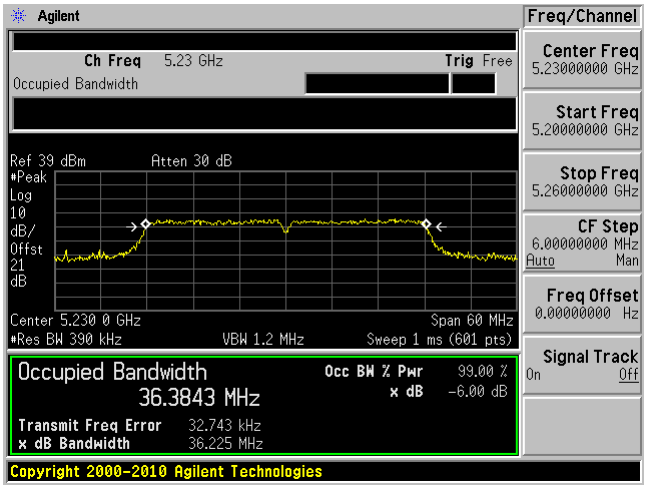


802.11ac40 mode

5190 MHz



5230 MHz

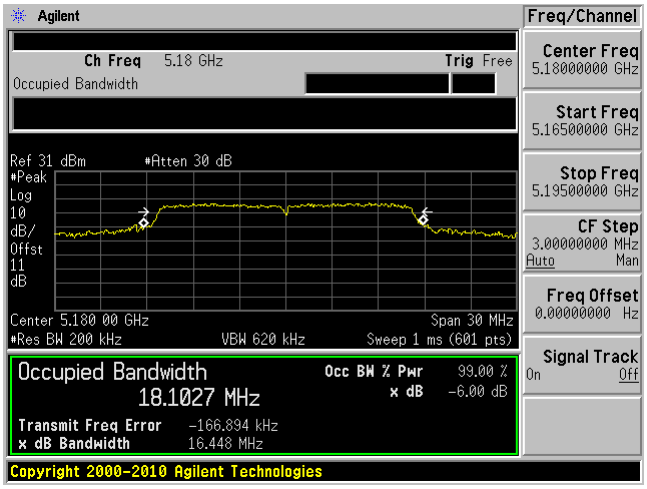


Radio 2, Chain 0

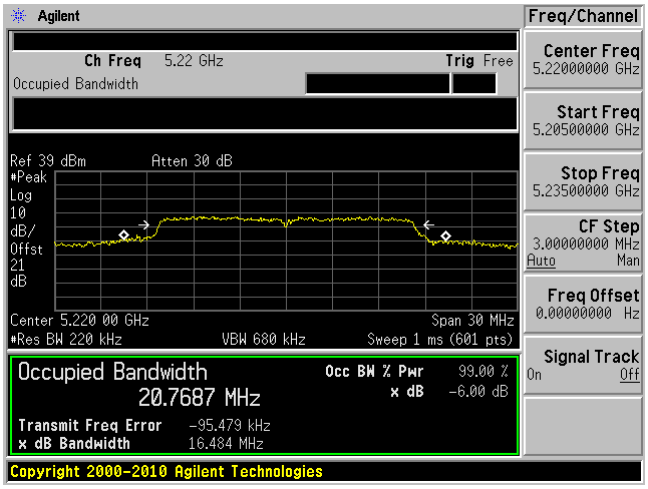
5150-5250 MHz

802.11a mode

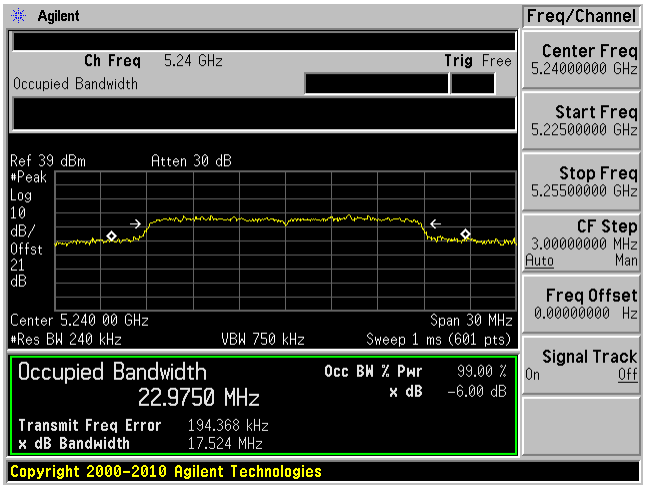
5180 MHz



5220 MHz

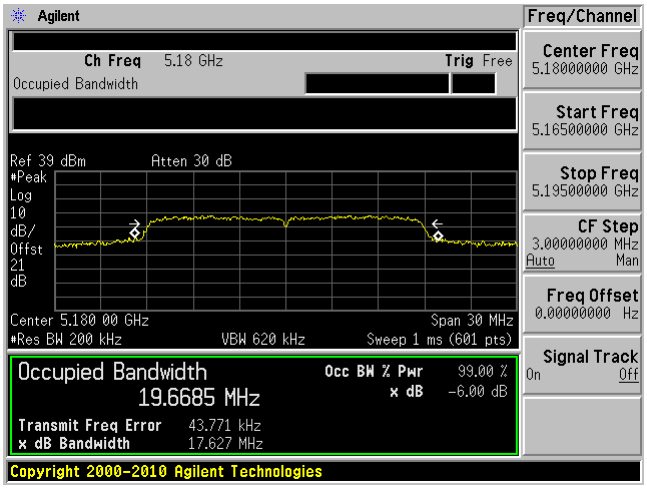


5240 MHz

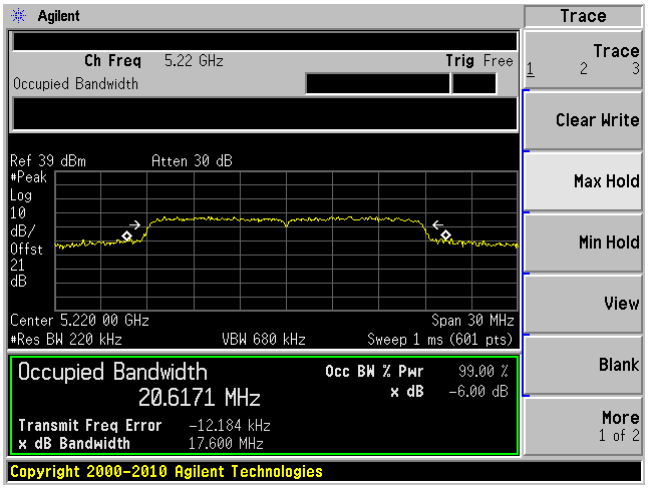


802.11n20 mode

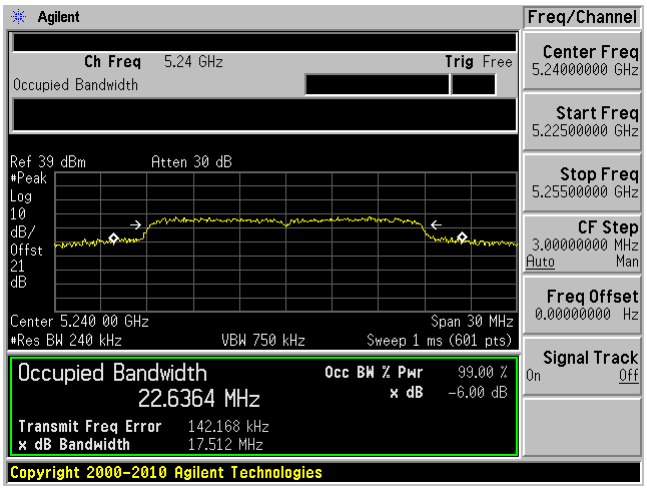
5180 MHz



5220 MHz

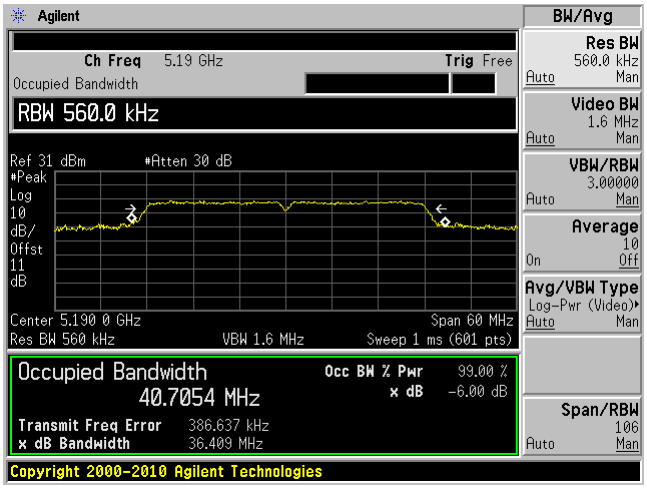


5240 MHz

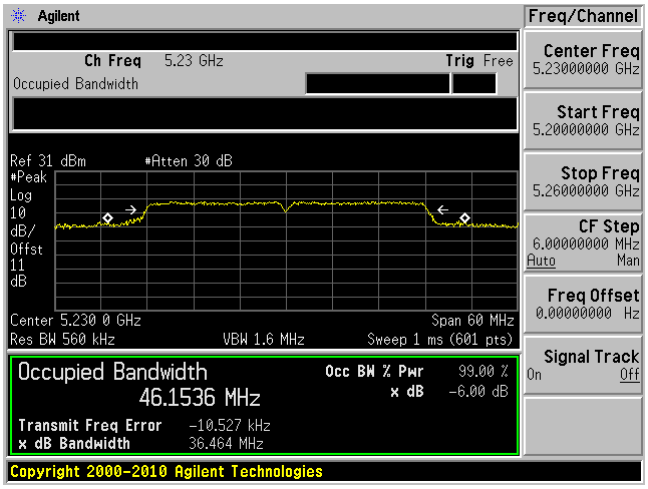


802.11n40 mode

5190 MHz

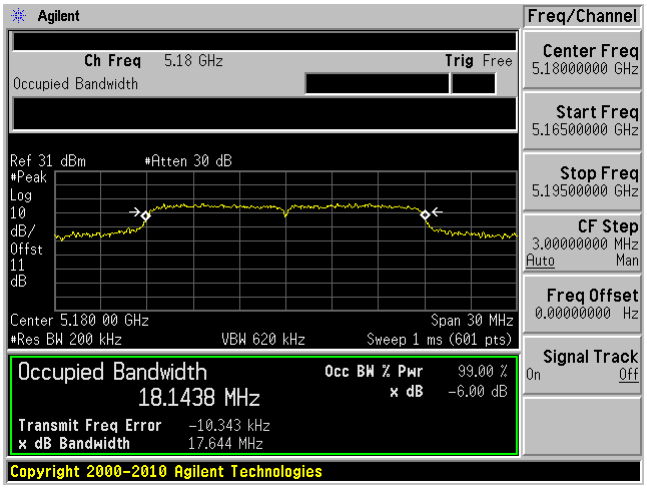


5230 MHz

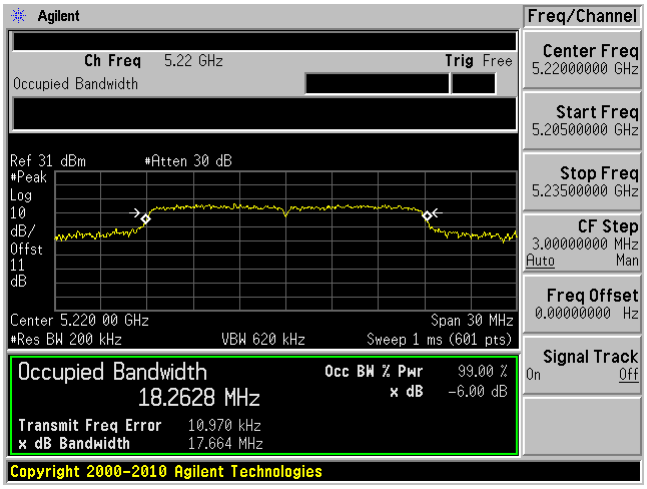


802.11ac20 mode

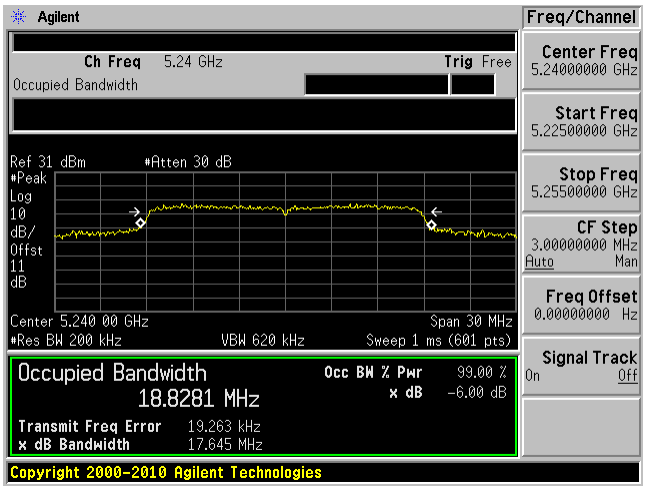
5180 MHz



5220 MHz

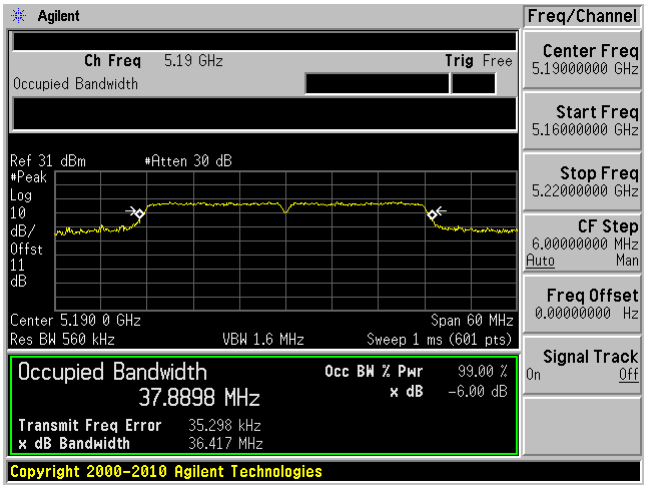


5240 MHz

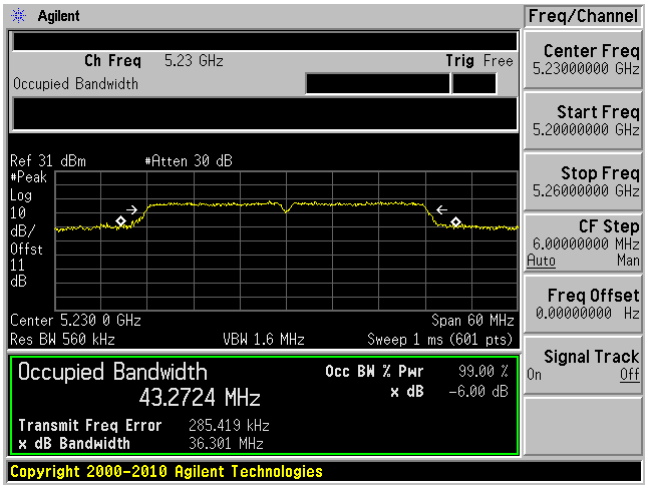


802.11ac40 mode

5190 MHz



5230 MHz

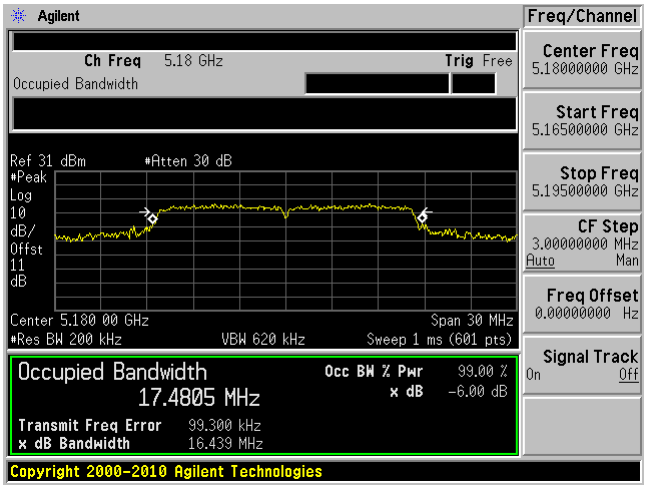


Radio 2, Chain 1

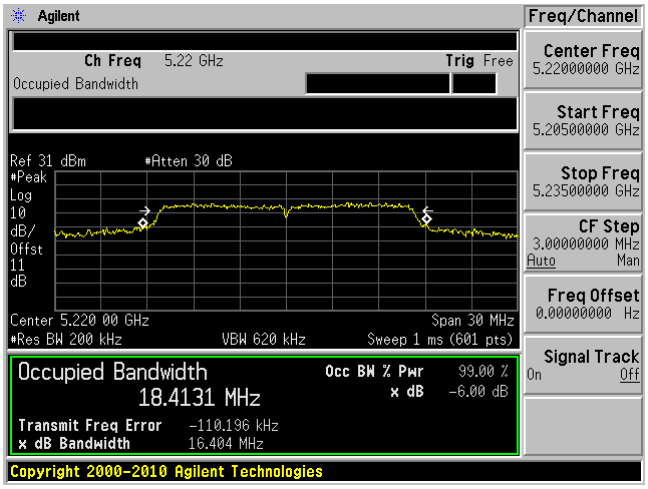
5150 – 5250 MHz

802.11a mode

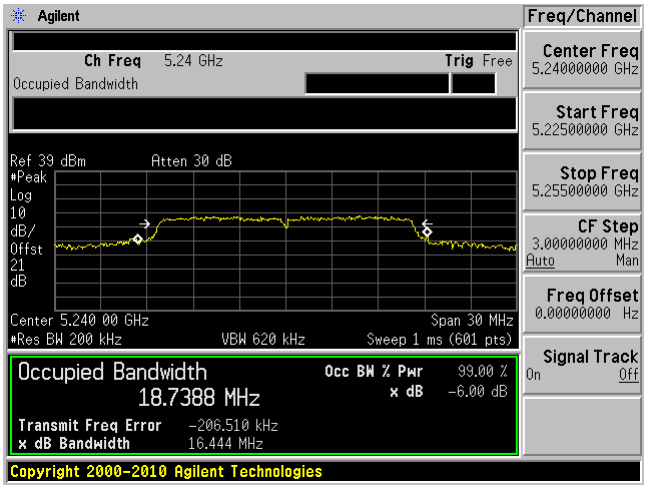
5180 MHz



5220 MHz

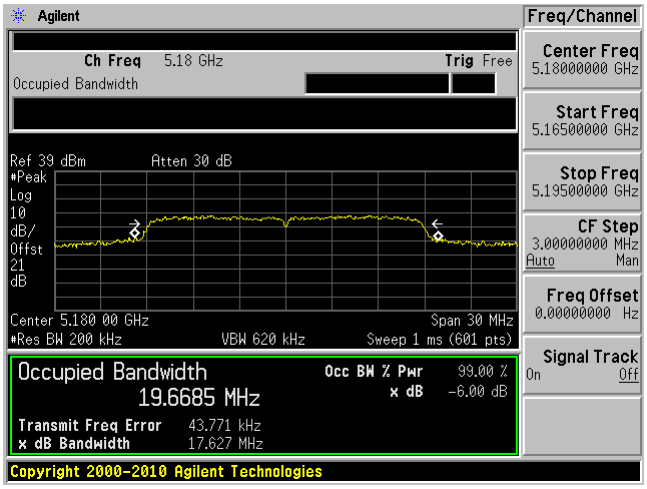


5240 MHz

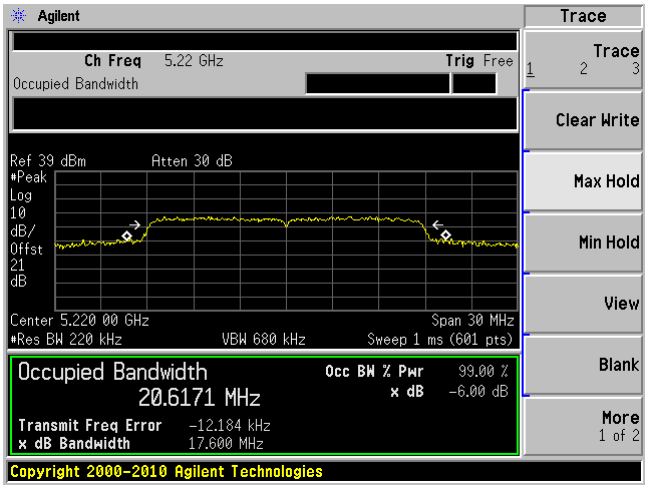


802.11n20 mode

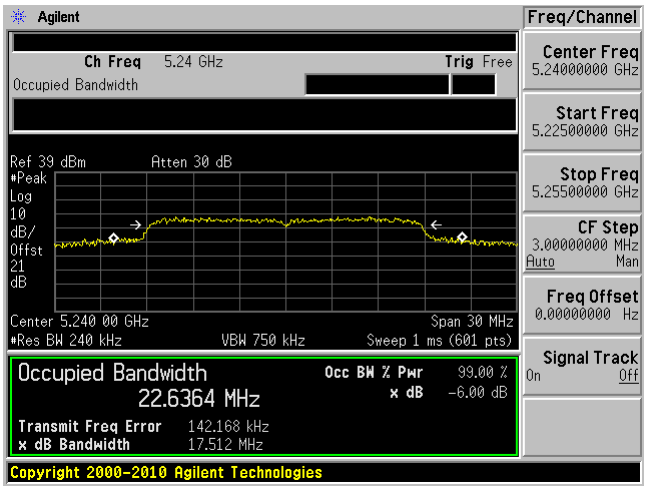
5180 MHz



5220 MHz

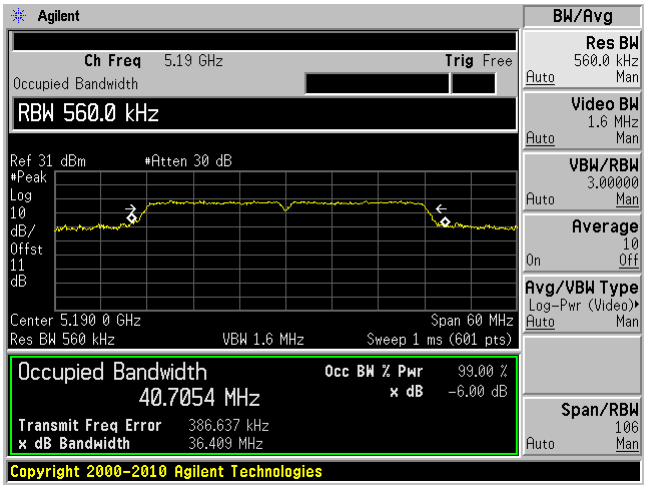


5240 MHz

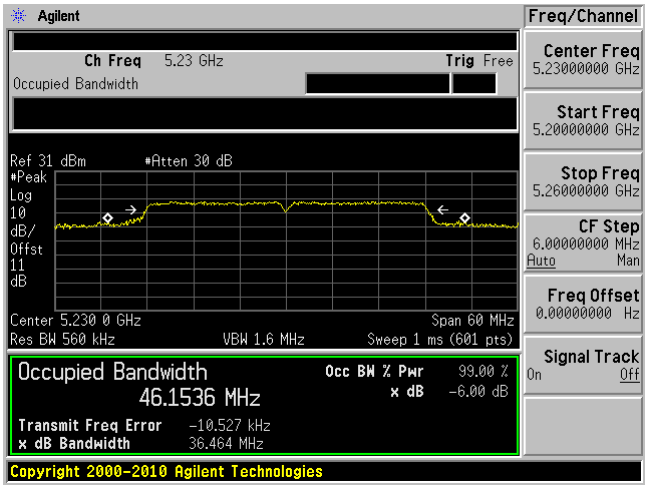


802.11n40 mode

5190 MHz

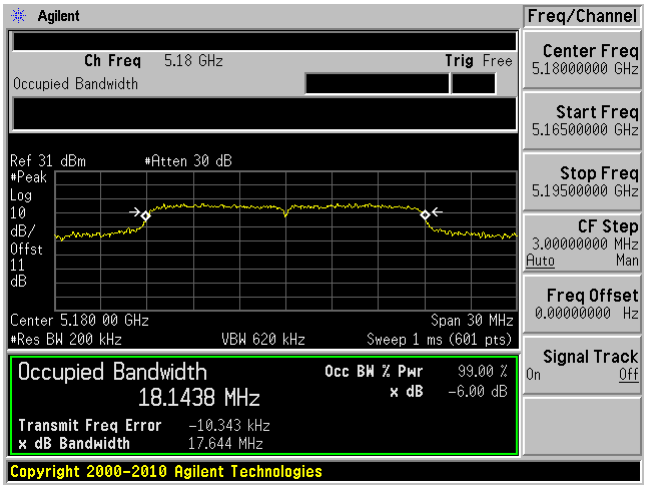


5230 MHz

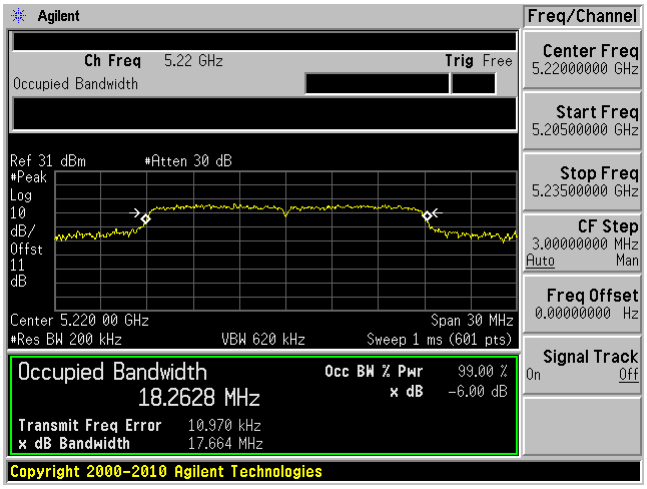


802.11ac20 mode

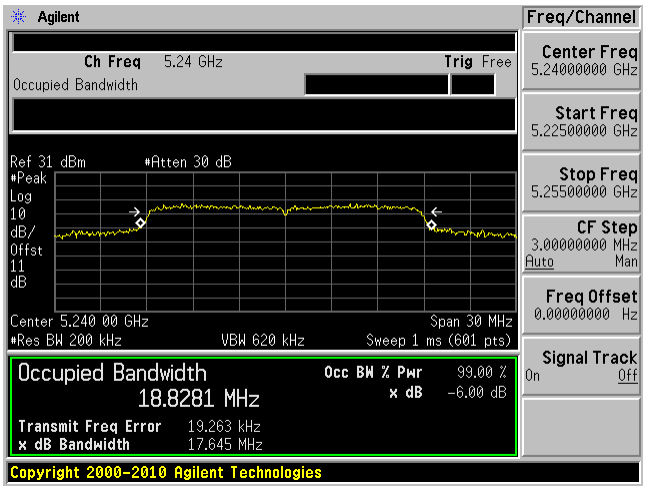
5180 MHz



5220 MHz

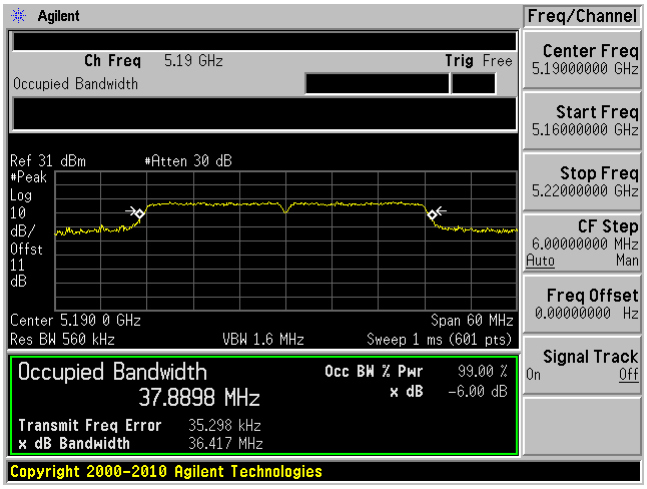


5240 MHz

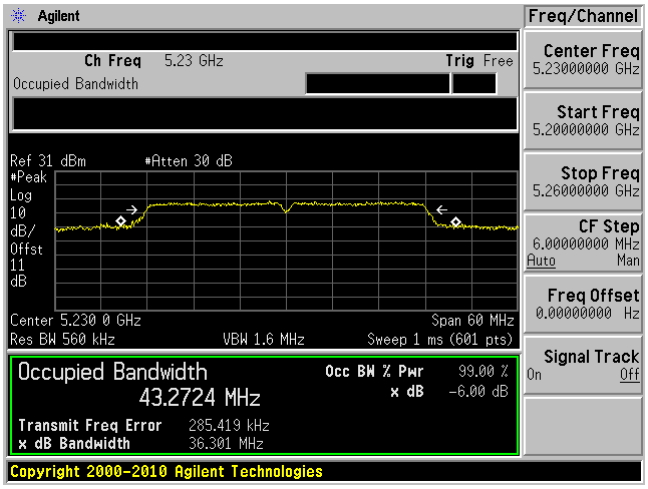


802.11ac40 mode

5190 MHz



5230 MHz

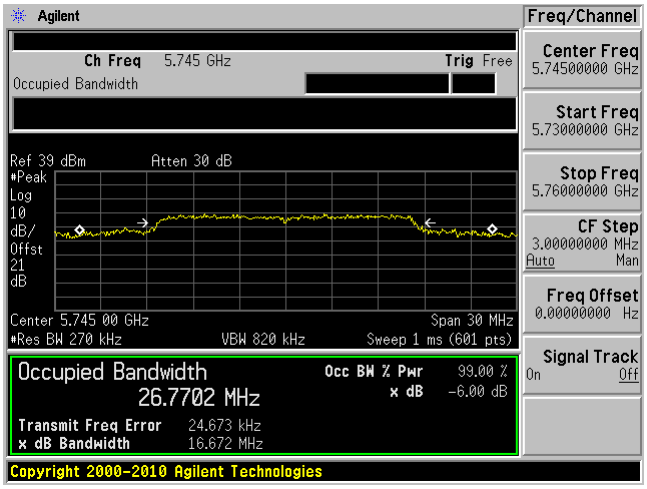


Radio 1, Chain 0

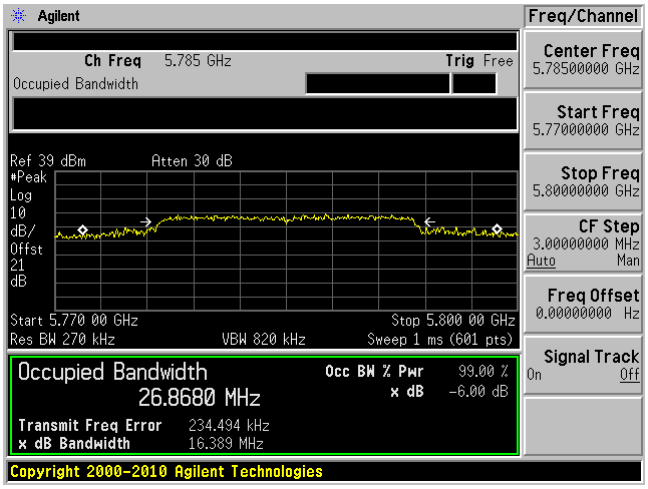
5725 – 5850 MHz

802.11a mode

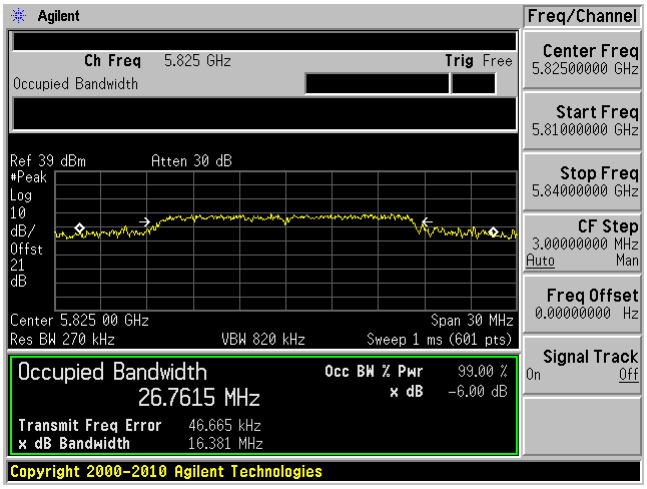
5745 MHz



5785 MHz

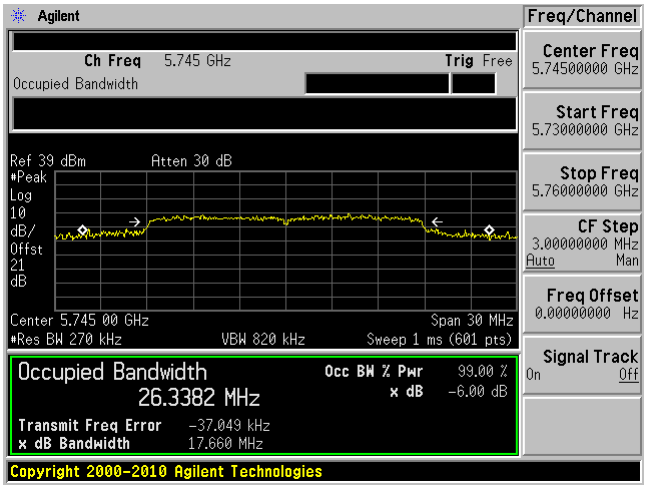


5825 MHz

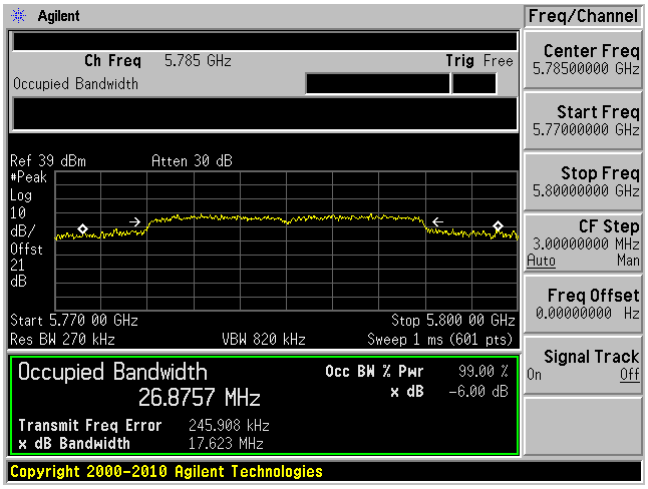


802.11n20 mode

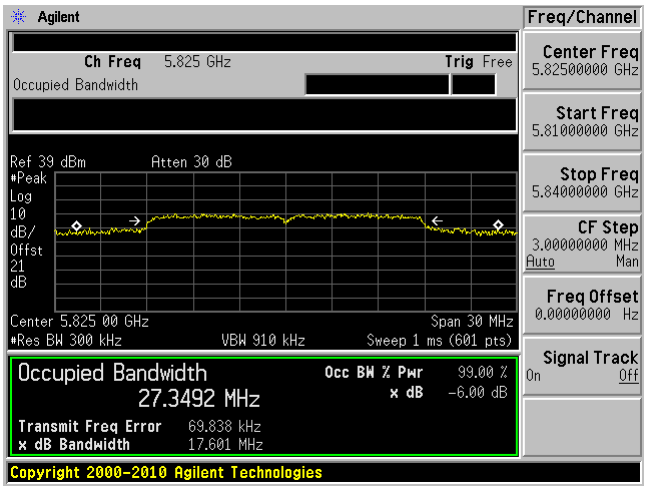
5745 MHz



5785 MHz

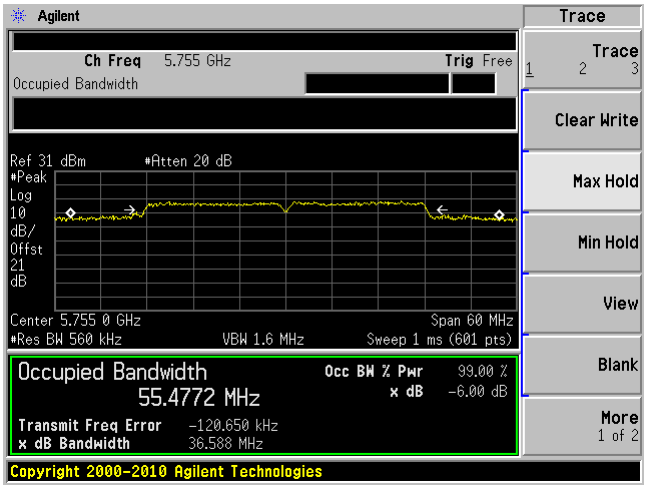


5825 MHz

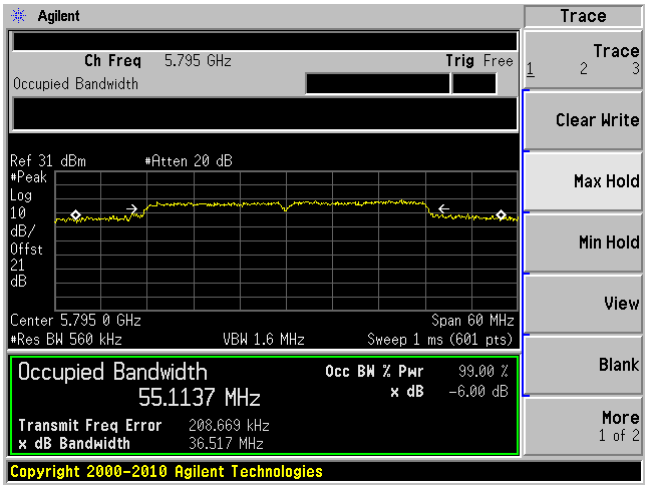


802.11n40 mode

5755 MHz

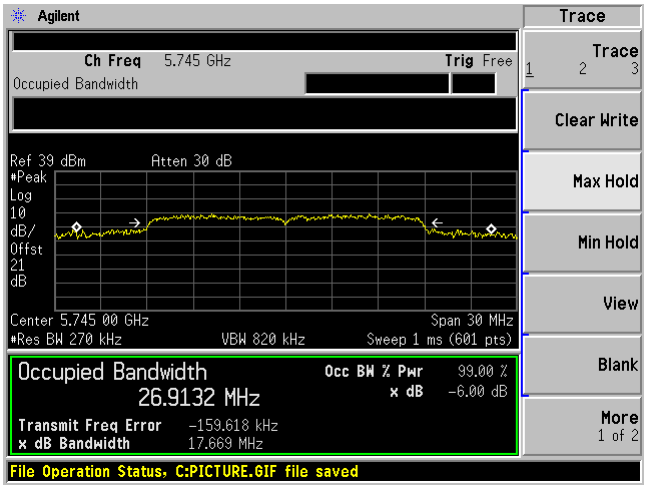


5795 MHz

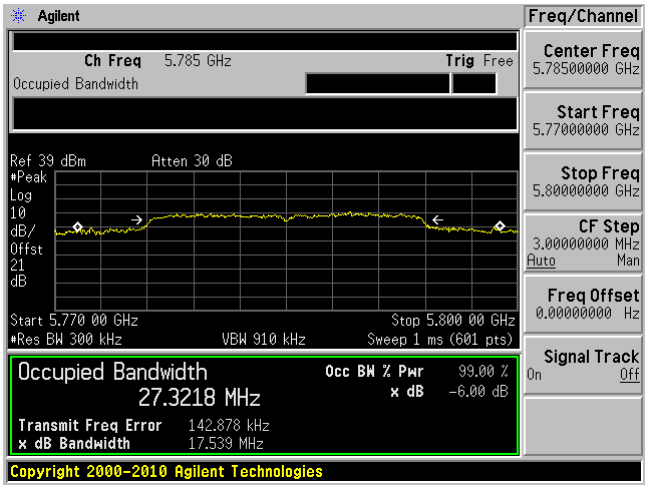


802.11ac20 mode

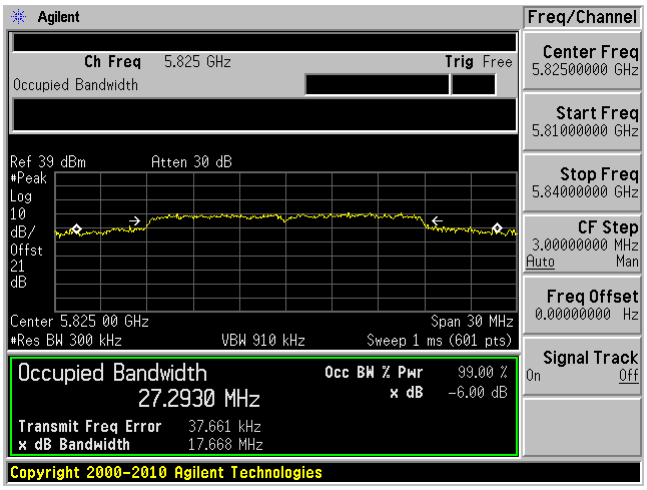
5745 MHz



5785 MHz

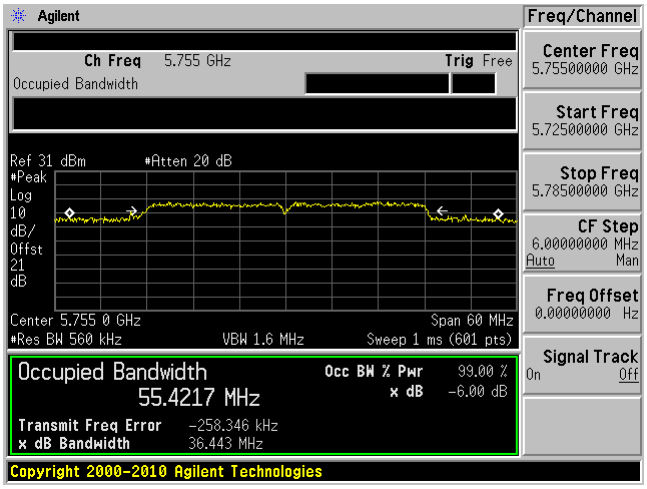


5825 MHz

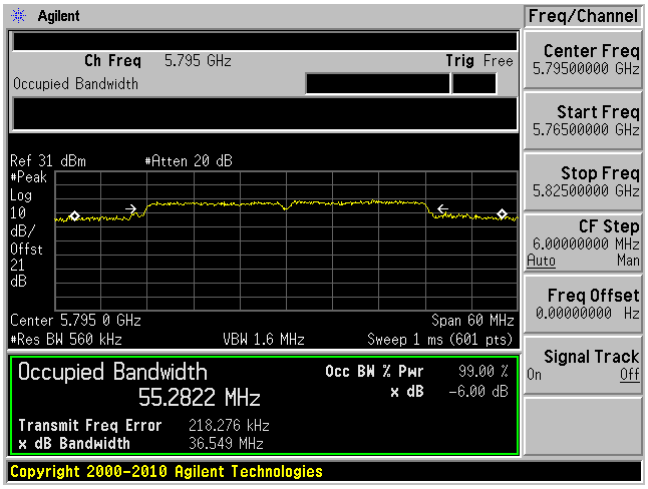


802.11ac40 mode

5755 MHz



5795 MHz

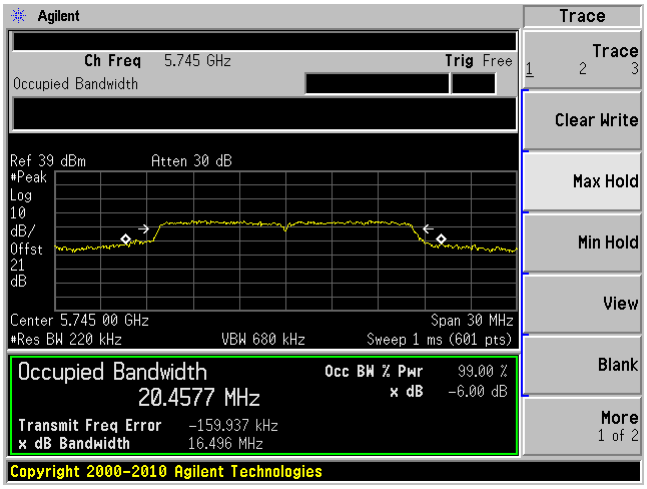


Radio 1, Chain 1

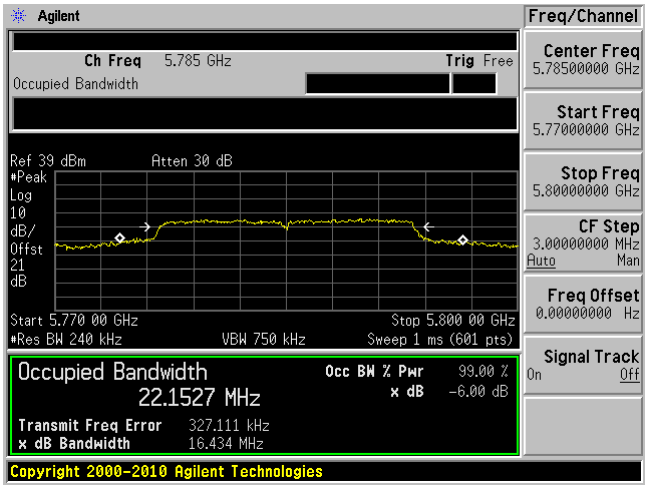
5725 – 5850 MHz

802.11a mode

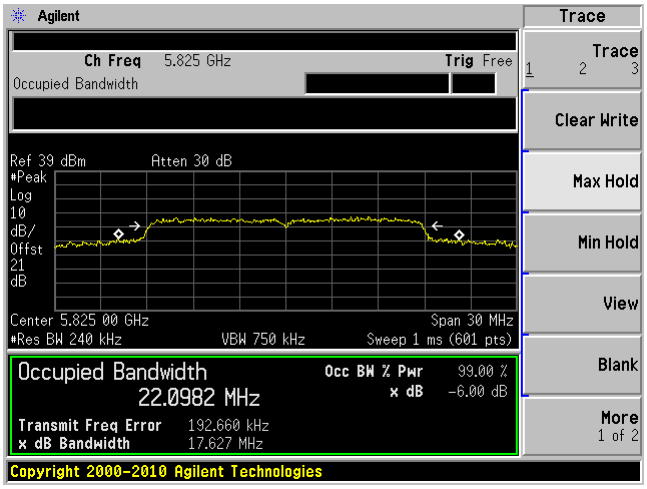
5745 MHz



5785 MHz

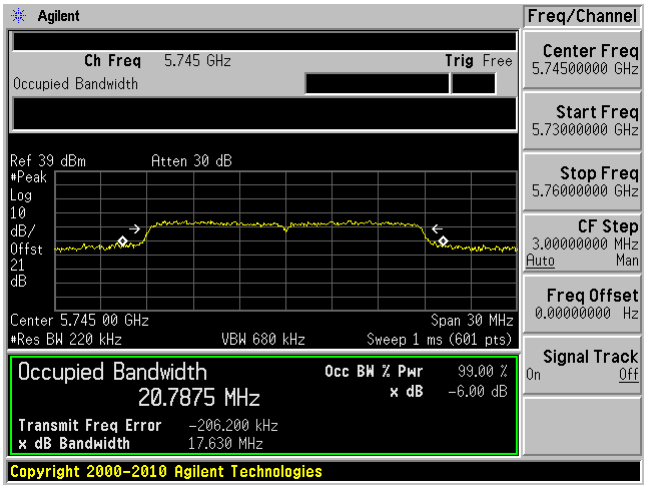


5825 MHz

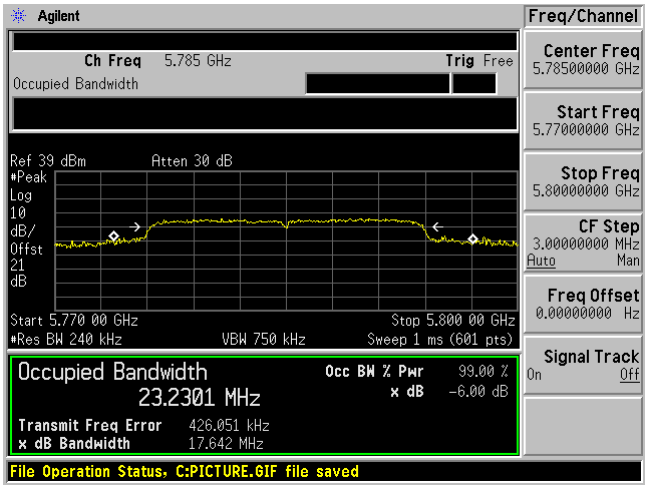


802.11n20 mode

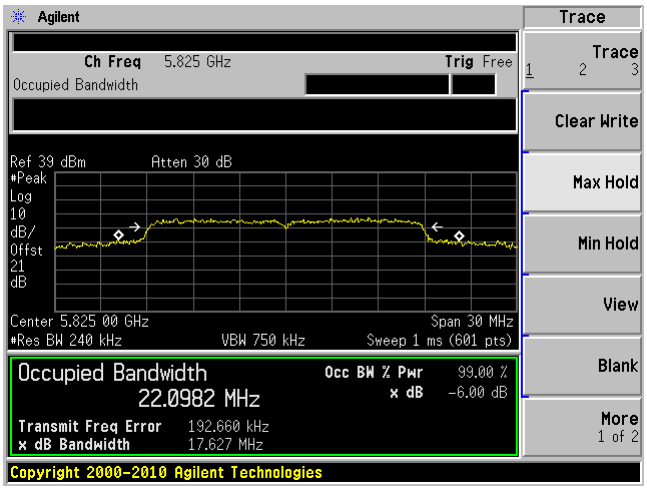
5745 MHz



5785 MHz

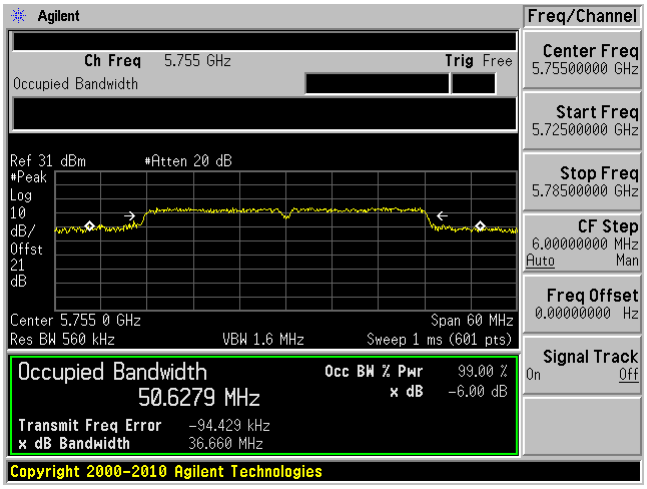


5825 MHz

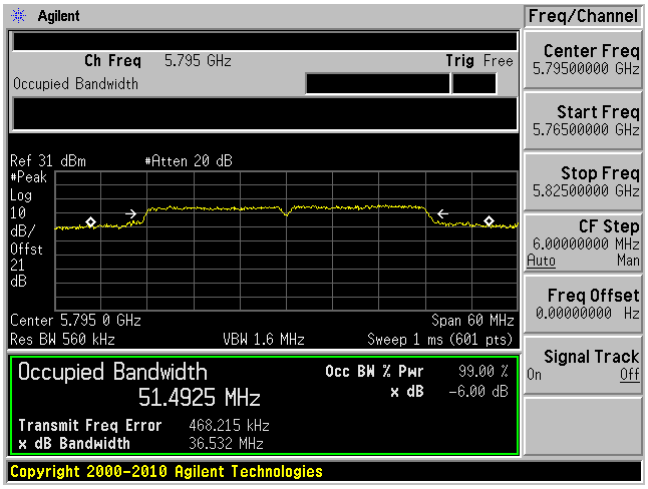


802.11n40 mode

5755 MHz

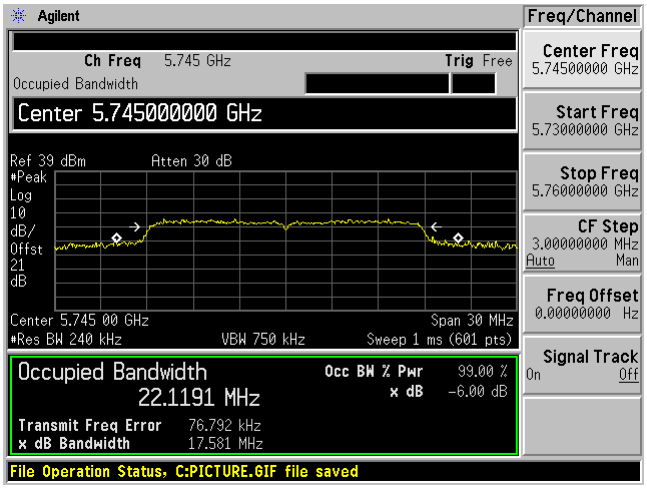


5795 MHz

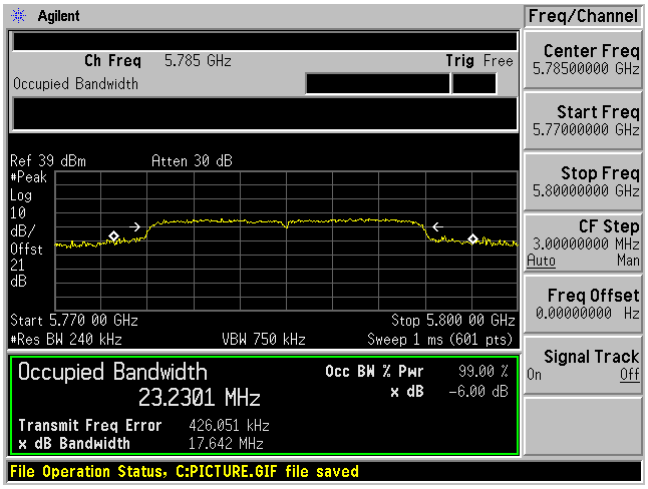


802.11ac20 mode

5745 MHz



5785 MHz



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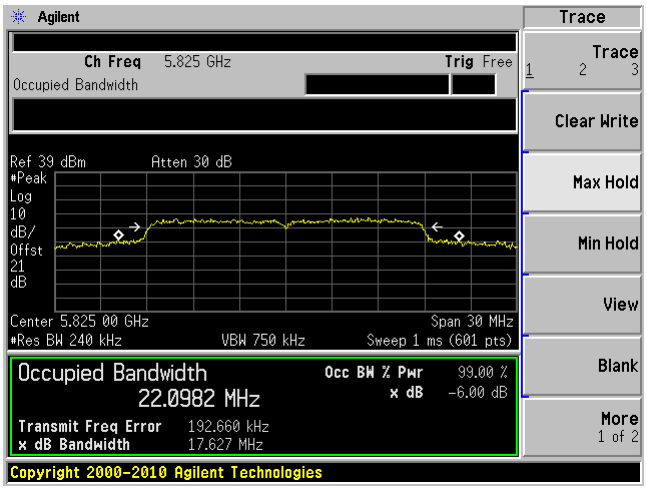
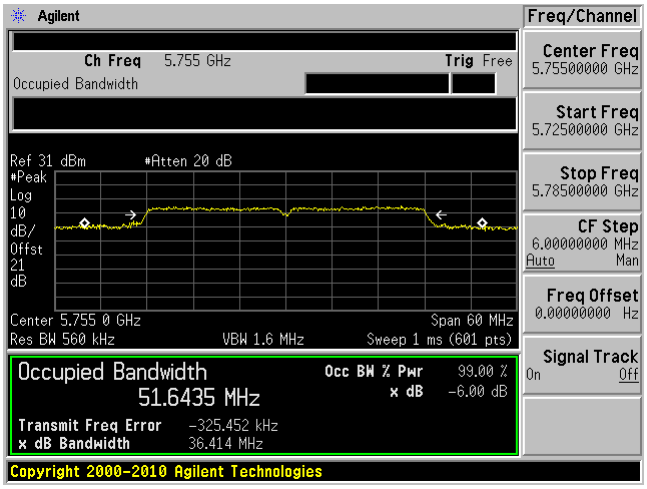


802.11ac40 mode

5755 MHz



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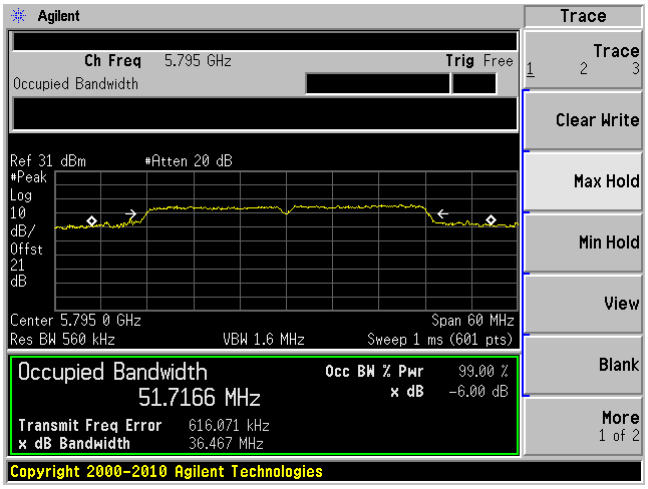
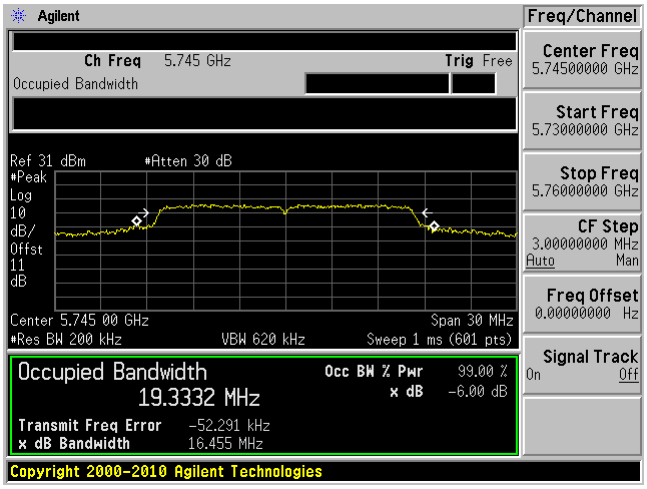


Radio 2, Chain 0

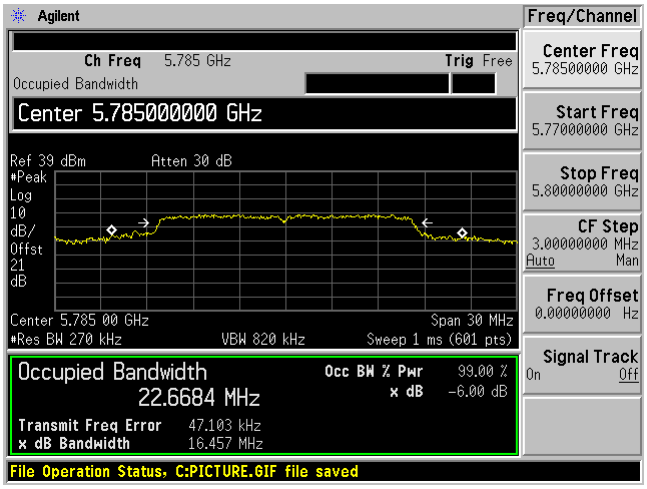
5725 – 5850 MHz

802.11a mode

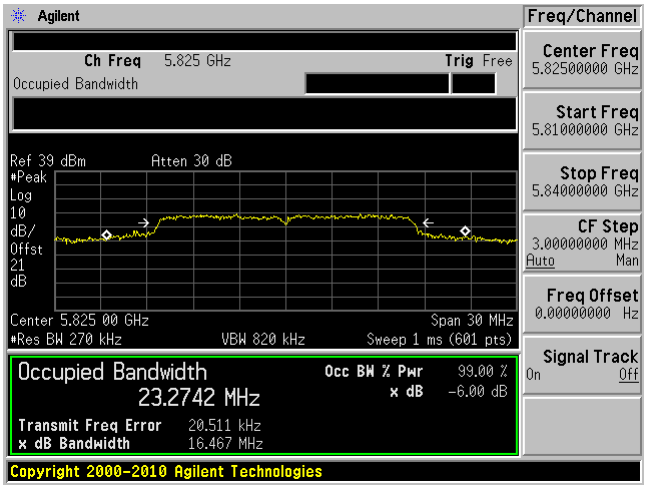
5745 MHz



5785 MHz

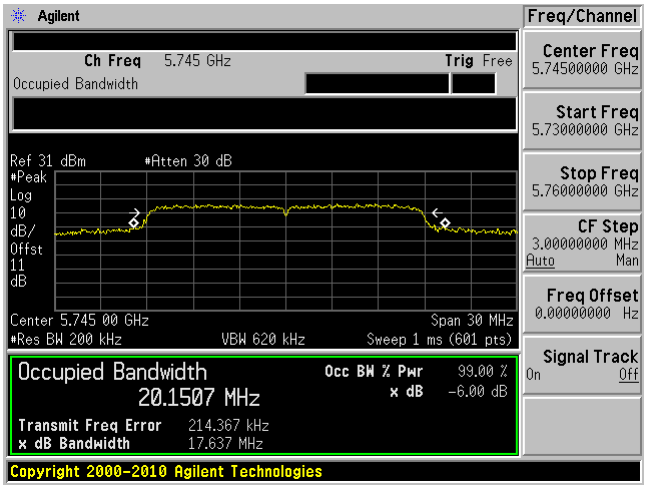


5825 MHz

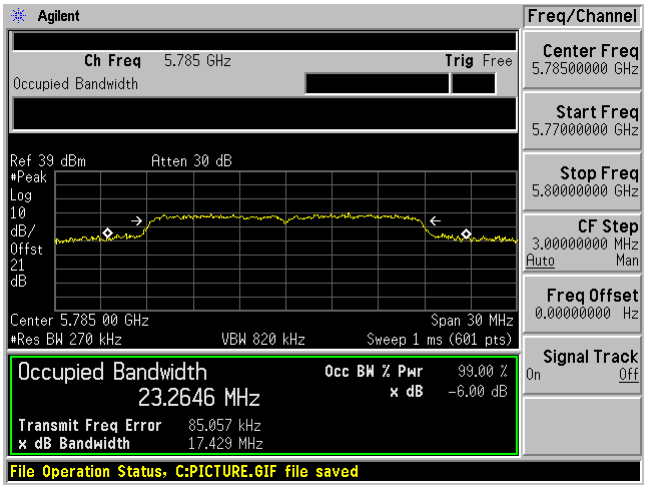


802.11n20 mode

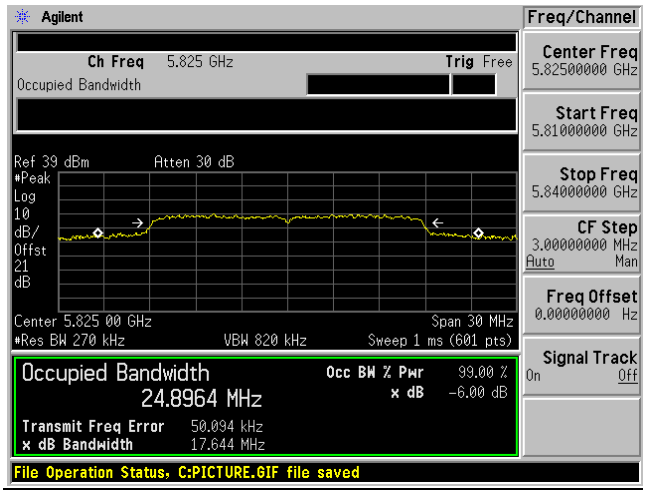
5745 MHz



5785 MHz

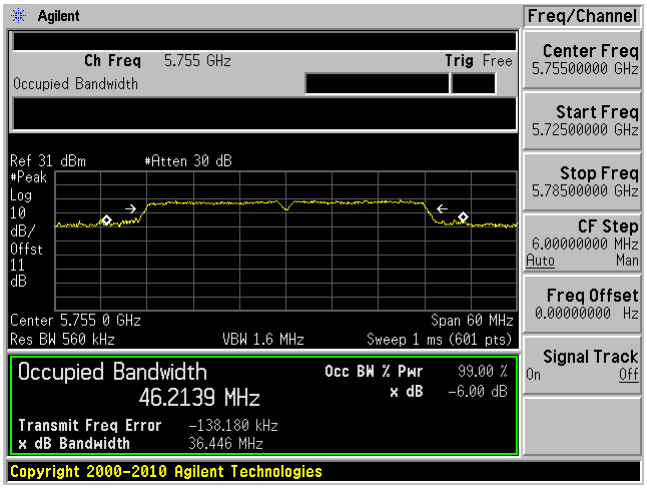


5825 MHz

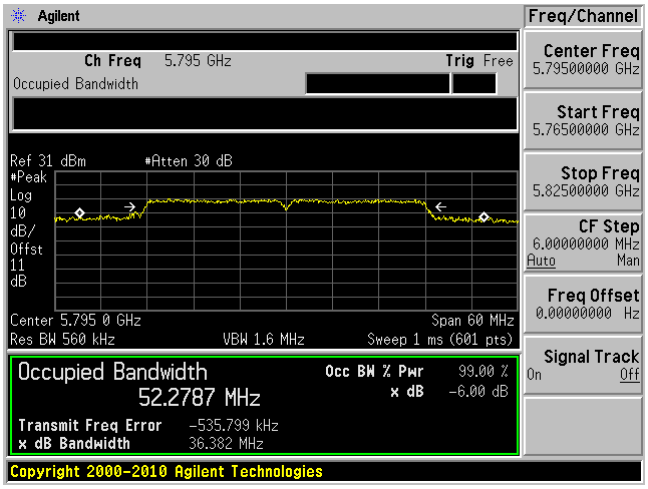


802.11n40 mode

5755 MHz

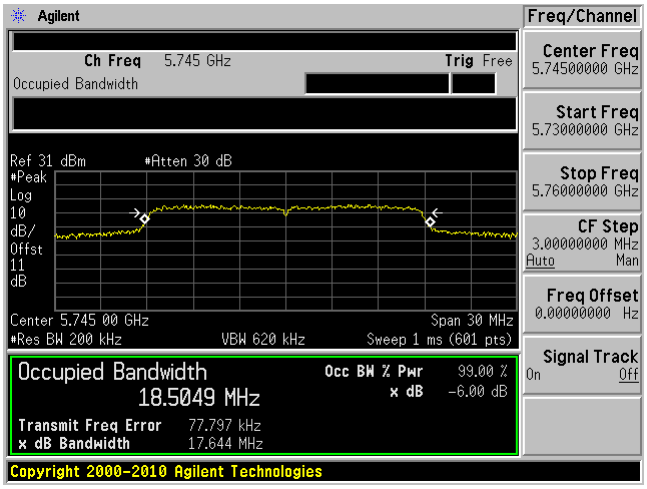


5795 MHz

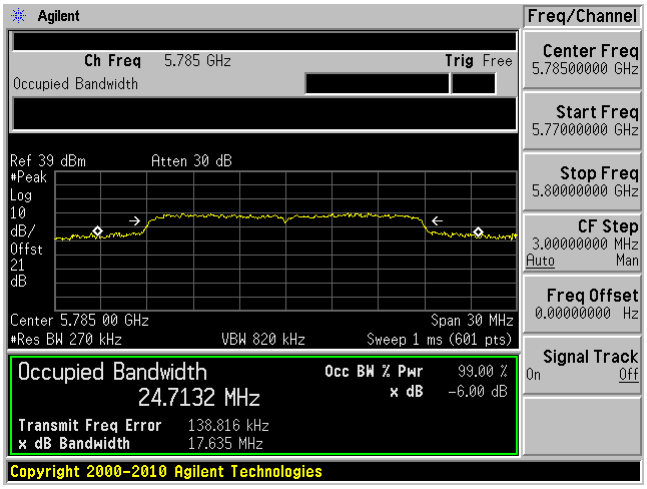


802.11ac20 mode

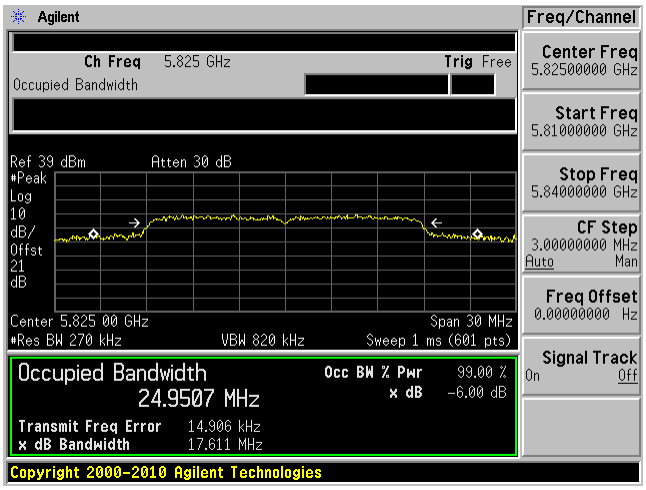
5745 MHz



5785 MHz

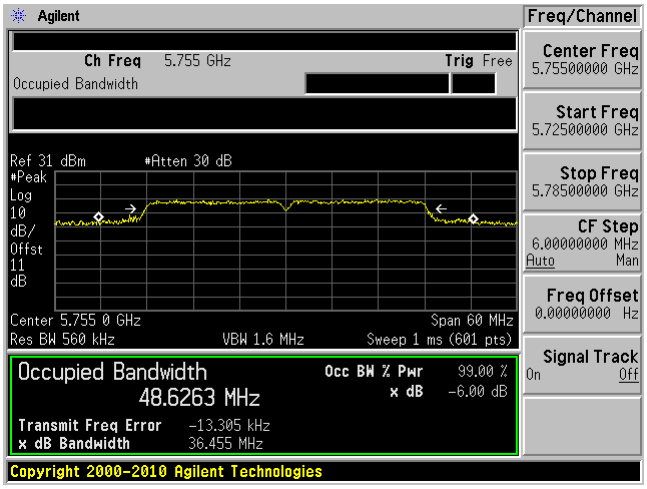


5825 MHz

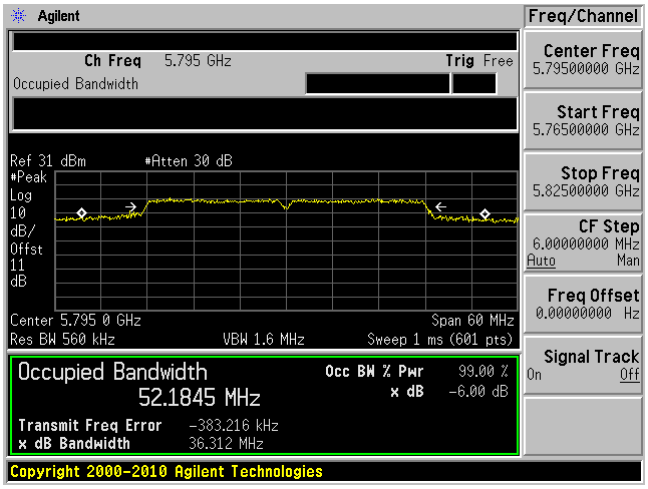


802.11ac40 mode

5755 MHz



5795 MHz

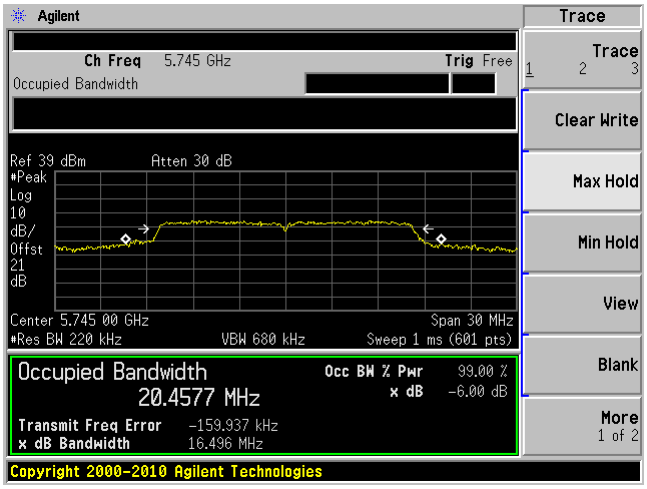


Radio 2, Chain 1

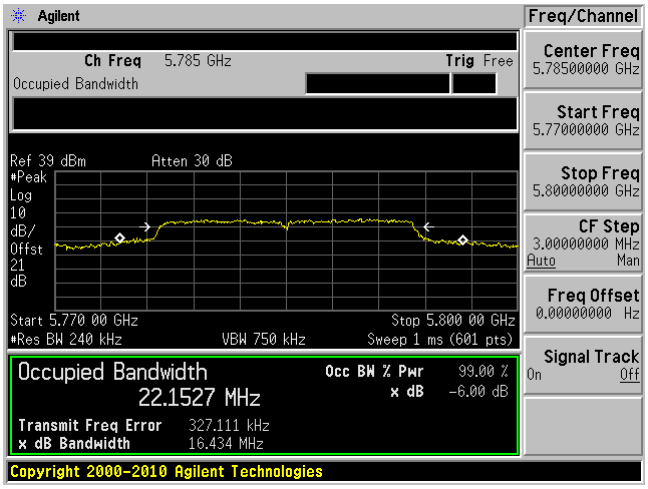
5725 – 5850 MHz

802.11a mode

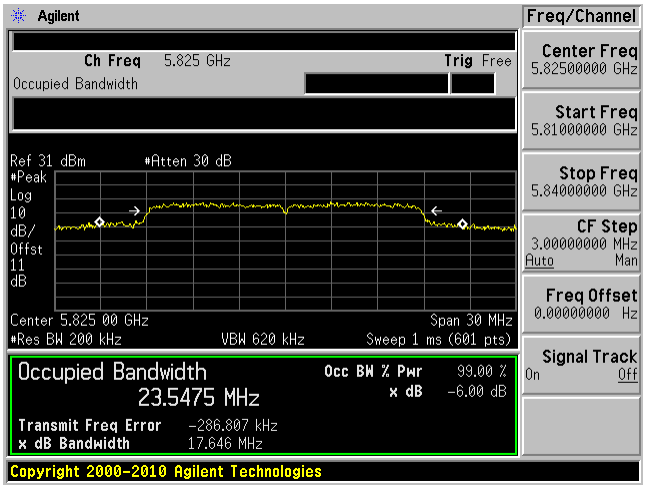
5745 MHz



5785 MHz

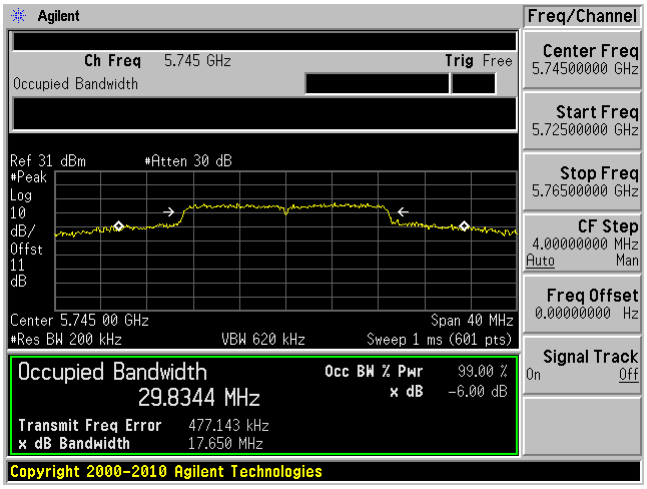


5825 MHz



802.11n20 mode

5745 MHz



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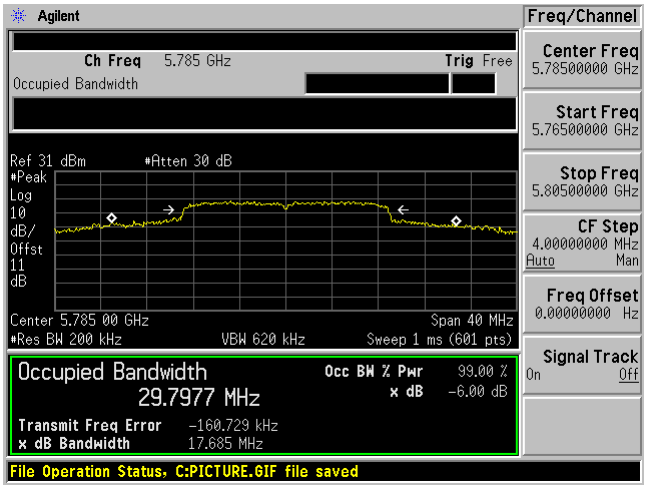

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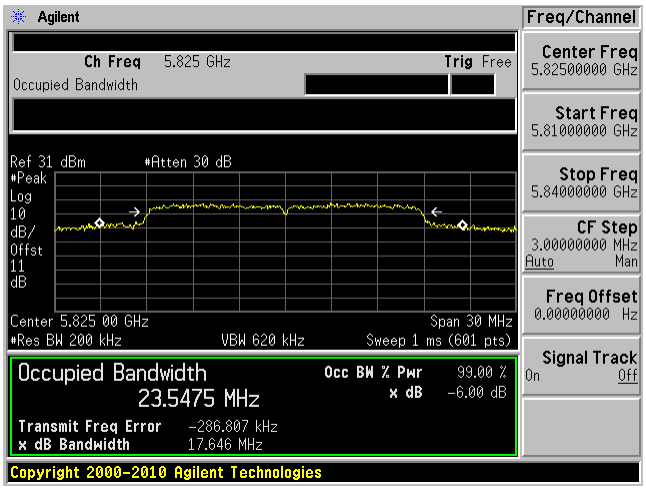
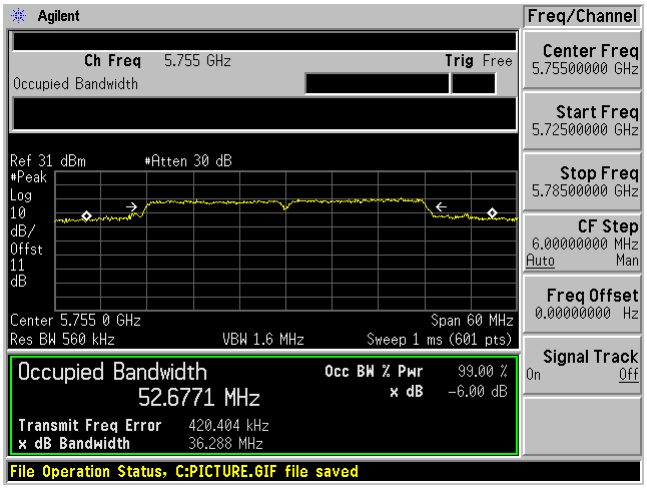
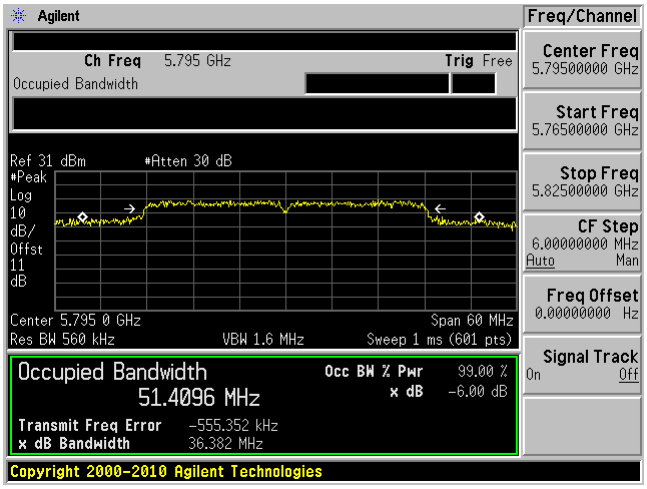


802.11n40 mode

5755 MHz

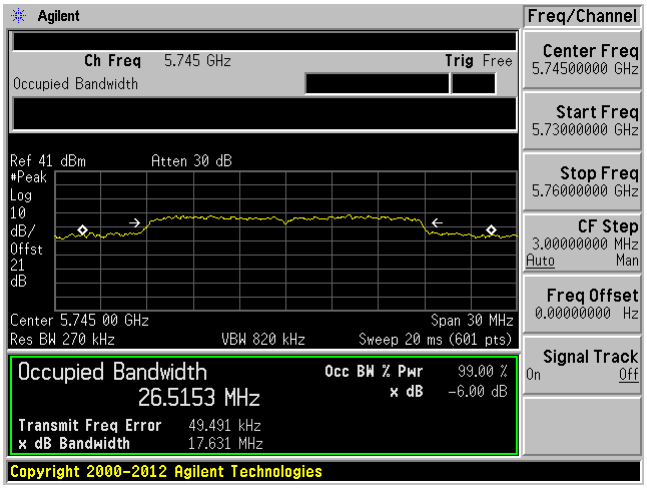


5795 MHz

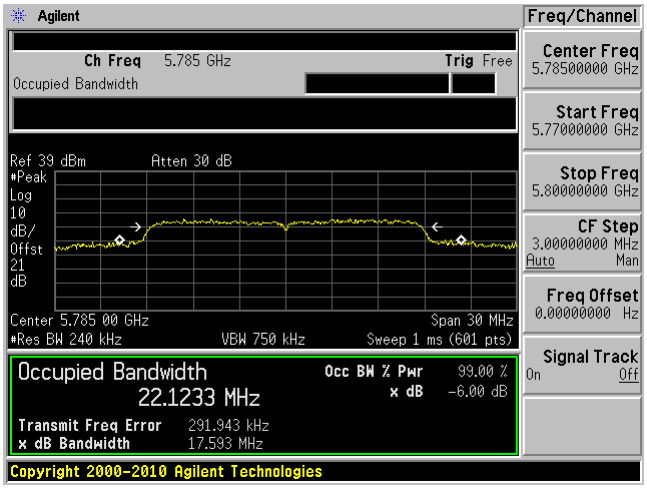


802.11ac20 mode

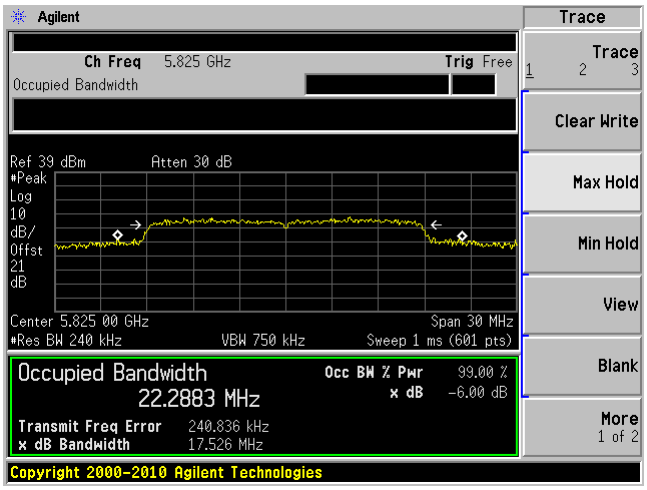
5745 MHz



5785 MHz

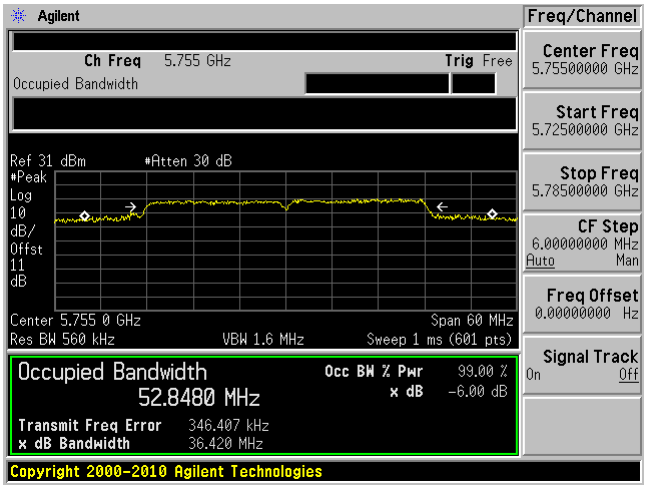


5825 MHz

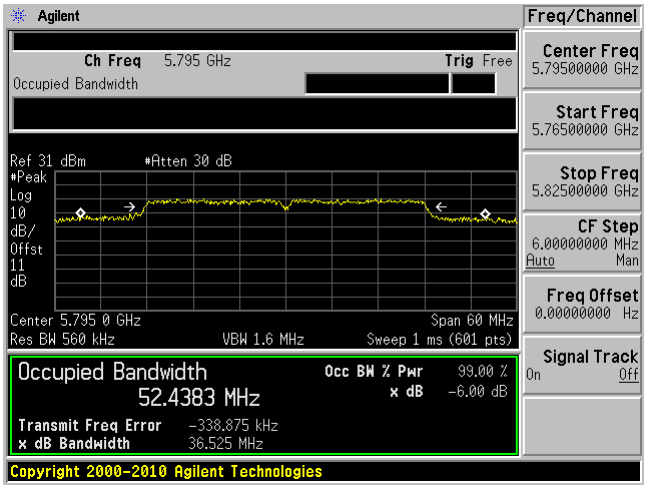


802.11ac40 mode

5755 MHz



5795 MHz



9 FCC §15407(a) - Output Power

9.1 Applicable Standards

According to FCC §15.407(a):

For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

9.2 Measurement Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to a power meter.

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
-	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

Testing was performed by Alexandrae Duran on 2019-03-29 and 2019-04-15 in RF site.

9.5 Test Results

5150 - 5250 MHz

Radio 1

Channel	Frequency (MHz)	Conducted Output Power (dBm)			Output Power Limit (dBm)	Result
		Chain 0	Chain 1	Total		
802.11a						
Low	5180	19.35	18.73	22.06135	24	Pass
Middle	5220	18.61	15.45	20.32158	24	Pass
High	5240	19.42	18.73	22.09899	24	Pass
802.11n20						
Low	5180	19.16	18.45	21.82979	24	Pass
Middle	5220	18.61	15.48	20.33138	24	Pass
High	5240	19.37	18.45	21.94462	24	Pass
802.11n40						
Low	5190	14.94	15.94	18.47902	24	Pass
High	5230	19.23	17.36	21.40518	24	Pass
802.11ac20						
Low	5180	19.58	18.48	22.07503	24	Pass
Middle	5220	18.84	15.49	20.49061	24	Pass
High	5240	19.38	18.48	21.96357	24	Pass
802.11ac40						
Low	5190	15.02	15.96	18.52568	24	Pass
High	5230	19.19	17.75	21.53971	24	Pass

Radio 2

Channel	Frequency (MHz)	Conducted Output Power (dBm)			Output Power Limit (dBm)	Result
		Chain 0	Chain 1	Total		
802.11a						
Low	5180	18.07	17.38	20.74899	24	Pass
Middle	5220	17.42	18.06	20.76208	24	Pass
High	5240	17.45	17.99	20.73869	24	Pass
802.11n20						
Low	5180	17.86	17.82	20.85035	24	Pass
Middle	5220	17.56	18.32	20.9669	24	Pass
High	5240	17.7	18.45	21.10147	24	Pass
802.11n40						
Low	5190	17.71	17.63	20.68048	24	Pass
High	5230	17.64	18.53	21.11806	24	Pass
802.11ac20						
Low	5180	17.63	17.24	20.44968	24	Pass
Middle	5220	17.12	17.74	20.45135	24	Pass
High	5240	17.25	18.47	20.913	24	Pass
802.11ac40						
Low	5190	17.68	17.56	20.63071	24	Pass
High	5230	17.37	18.09	20.7552	24	Pass

5745 - 5825 MHz

Radio 1

Channel	Frequency (MHz)	Chain 0 (dBm)	Chain 1 (dBm)	Total Power (dBm)	Limit (dBm)	Result
802.11a mode						
Low	5745	18.36	15.91	20.31582	30	Pass
Middle	5785	18.52	15.45	20.2611	30	Pass
High	5825	18.60	17.07	20.91233	30	Pass
802.11n20 mode						
Low	5745	18.39	15.86	20.31699	30	Pass
Middle	5785	18.56	15.48	20.2978	30	Pass
High	5825	18.71	16.93	20.92086	30	Pass
802.11n40 mode						
Low	5755	18.45	16.07	20.43133	30	Pass
High	5795	18.63	16.04	20.53558	30	Pass
802.11ac20 mode						
Low	5745	18.4	16.04	20.38867	30	Pass
Middle	5785	18.84	15.49	20.49061	30	Pass
High	5825	18.82	17.03	21.02688	30	Pass
802.11ac40 mode						
Low	5755	18.48	15.99	20.42136	30	Pass
High	5795	18.79	16.03	20.63596	30	Pass

Radio 2

Channel	Frequency (MHz)	Chain 0 (dBm)	Chain 1 (dBm)	Total Power (dBm)	Limit (dBm)	Result
802.11a mode						
Low	5745	19.20	18.05	21.67325	30	Pass
Middle	5785	19.23	19.11	22.18071	30	Pass
High	5825	18.53	19.23	21.90439	30	Pass
802.11n20 mode						
Low	5745	19.13	18.08	21.64696	30	Pass
Middle	5785	19.27	19.12	22.20595	30	Pass
High	5825	18.64	19.17	21.92338	30	Pass
802.11n40 mode						
Low	5755	19.25	18.41	21.86058	30	Pass
High	5795	19.97	19.02	22.53122	30	Pass
802.11ac20 mode						
Low	5745	19.12	18.07	21.63696	30	Pass
Middle	5785	19.18	19.14	22.17035	30	Pass
High	5825	18.53	19.17	21.87208	30	Pass
802.11ac40 mode						
Low	5755	19.28	18.41	21.87705	30	Pass
High	5795	19.94	19.34	22.66065	30	Pass

10 FCC §15.407(a) §6.2 - Power Spectral Density

10.1 Applicable Standards

According to FCC §15.407(a):

For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipointFootnote 3 systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

However, remote stations of point-to-multipoint systems shall be permitted to operate at e.i.r.p. greater than 4 W under the same conditions as for point-to-point systems.

10.2 Measurement Procedure

(i) Set span to encompass the entire emission bandwidth (EBW) of the signal.
(ii) Set RBW = 1 MHz.
(iii) Set VBW ≥ 3 MHz.
(iv) Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)

(v) Sweep time = auto.
(vi) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
(vii) If transmit duty cycle < 98 percent, use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 percent, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run".
(viii) Trace average at least 100 traces in power averaging (i.e., RMS) mode.
(ix) Compute power by integrating the spectrum across the 26 dB EBW of the signal using the spectrum analyzer's band power measurement function with band limits set equal to the EBW band edges. If the spectrum analyzer does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the 26 dB EBW of the spectrum.

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	MY48250238	2018-05-08	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 TraceabilityTest Environmental Conditions

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

The testing was performed by Alexandrae Duran on 2019-03-29 and 2019-04-15 at RF site.

10.4 Test Results

5150 - 5250 MHz

Radio 1

Channel	Frequency (MHz)	Chain 0 (dBm/MHz)	Chain 1 (dBm/MHz)	Total (dBm/MHz)	Limit (dBm/MHz)
802.11a mode					
Low	5180	6.482	5.947	9.233	11.00
Middle	5220	8.635	7.097	10.944	11.00
High	5240	7.674	7.171	10.440	11.00
802.11n20 mode					
Low	5180	8.449	6.180	10.471	11.00
Middle	5220	8.441	6.651	10.648	11.00
High	5240	8.350	6.619	10.580	11.00
802.11n40 mode					
Low	5190	4.214	4.369	7.302	11.00
High	5230	4.669	3.016	6.931	11.00
802.11ac20 mode					
Low	5180	8.486	5.899	10.393	11.00
Middle	5220	8.406	6.769	10.674	11.00
High	5240	8.852	6.534	10.856	11.00
802.11ac40 mode					
Low	5190	4.214	3.316	6.798	11.00
High	5230	4.361	4.153	7.269	11.00

Radio 2

Channel	Frequency (MHz)	Chain 0 (dBm/MHz)	Chain 1 (dBm/MHz)	Total (dBm/MHz)	Limit (dBm/MHz)
802.11a mode					
Low	5180	7.717	7.632	10.685	11.00
Middle	5220	7.229	8.512	10.928	11.00
High	5240	7.674	5.775	9.838	11.00
802.11n20 mode					
Low	5180	7.586	7.721	10.664	11.00
Middle	5220	7.321	8.297	10.847	11.00
High	5240	7.450	8.402	10.962	11.00
802.11n40 mode					
Low	5190	4.892	4.934	7.923	11.00
High	5230	4.537	5.265	7.927	11.00
802.11ac20 mode					
Low	5180	7.001	6.980	10.001	11.00
Middle	5220	6.595	7.451	10.054	11.00
High	5240	7.193	7.826	10.531	11.00
802.11ac40 mode					
Low	5190	4.537	4.514	7.536	11.00
High	5230	4.211	4.782	7.516	11.00

5745 - 5825 MHz

Radio 1

Channel	Frequency (MHz)	Chain 0 (dBm/500 kHz)	Chain 1 (dBm/500 kHz)	Total (dBm/500 kHz)	Limit (dBm/500 kHz)
802.11a mode					
Low	5745	4.294	1.357	6.079	30
Middle	5785	4.698	1.327	6.342	30
High	5825	4.794	2.704	6.884	30
802.11n20 mode					
Low	5745	4.058	1.006	5.805	30
Middle	5785	4.282	1.555	6.139	30
High	5825	4.915	2.905	7.036	30
802.11n40 mode					
Low	5755	0.957	-2.225	2.661	30
High	5795	1.400	-1.468	3.209	30
802.11ac20 mode					
Low	5745	4.057	0.903	5.771	30
Middle	5785	4.852	1.165	6.399	30
High	5825	5.151	2.773	7.133	30
802.11ac40 mode					
Low	5755	0.689	-2.225	2.482	30
High	5795	1.739	-1.188	3.528	30

Radio 2

Channel	Frequency (MHz)	Chain 0 (dBm/500 kHz)	Chain 1 (dBm/500 kHz)	Total (dBm/500 kHz)	Limit (dBm/500 kHz)
802.11a mode					
Low	5745	5.834	4.367	8.172	30
Middle	5785	5.950	6.681	9.341	30
High	5825	5.066	6.745	8.996	30
802.11n20 mode					
Low	5745	5.975	5.713	8.856	30
Middle	5785	5.852	4.884	8.405	30
High	5825	4.860	6.379	8.696	30
802.11n40 mode					
Low	5755	2.665	3.161	5.930	30
High	5795	2.200	3.228	5.755	30
802.11ac20 mode					
Low	5745	4.382	5.417	7.941	30
Middle	5785	5.616	8.063	10.020	30
High	5825	4.839	6.430	8.717	30
802.11ac40 mode					
Low	5755	2.804	3.402	6.124	30
High	5795	2.395	2.099	5.260	30

Please refer to the following plots.

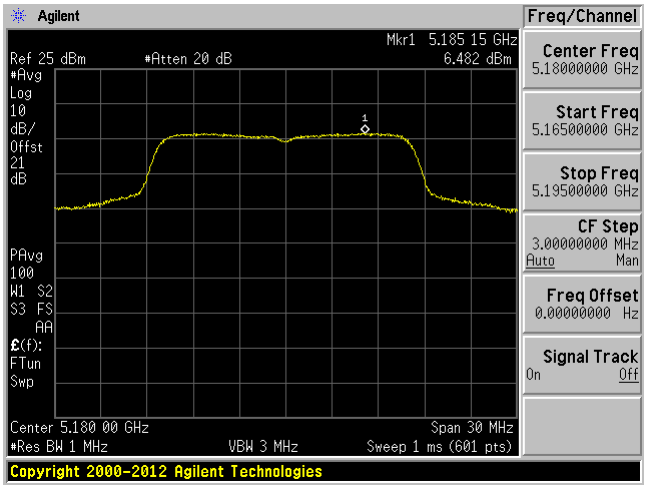
5150 – 5250 MHz

Radio 1

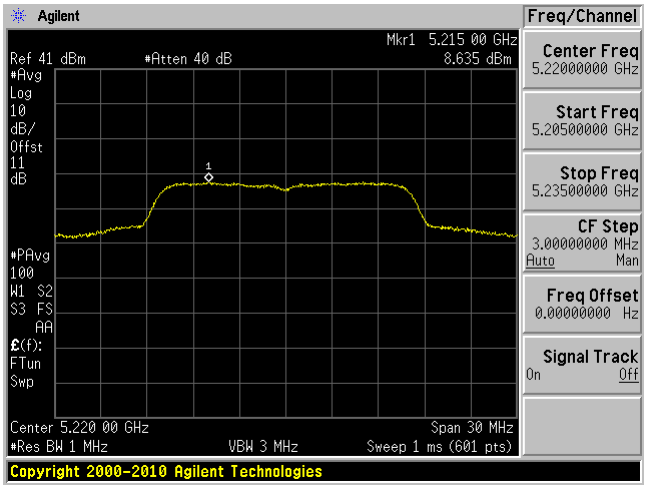
Chain 0

802.11a mode

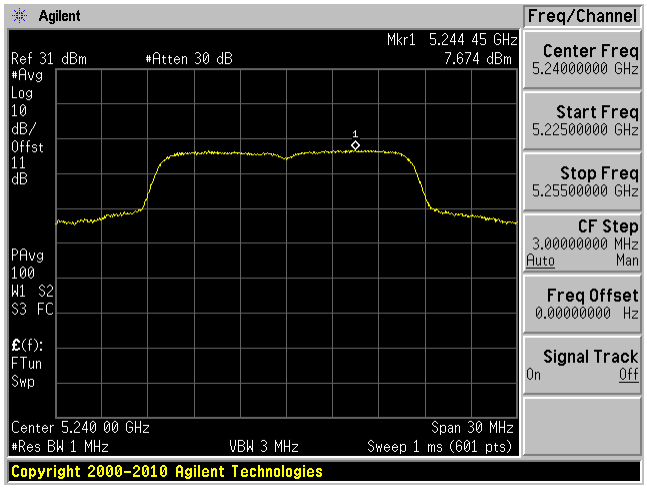
5180 MHz



5220 MHz

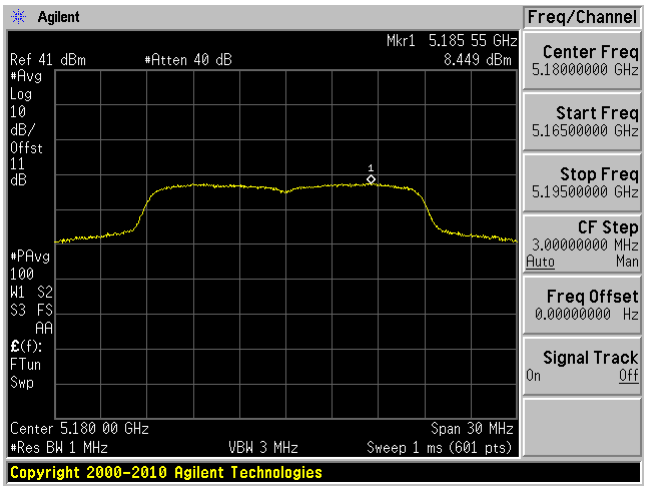


5240 MHz

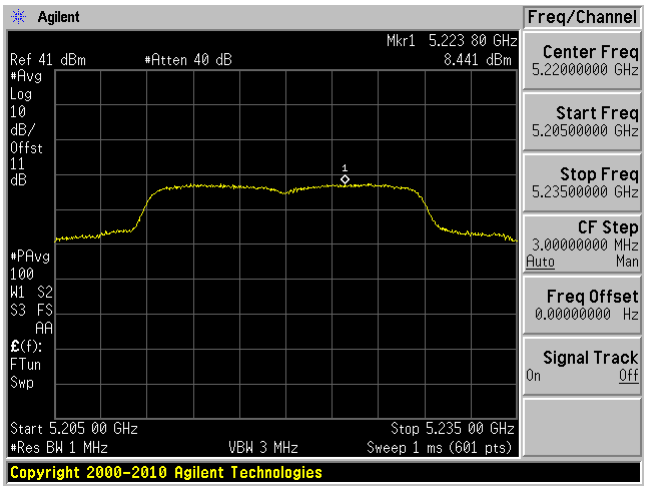


802.11n20 mode

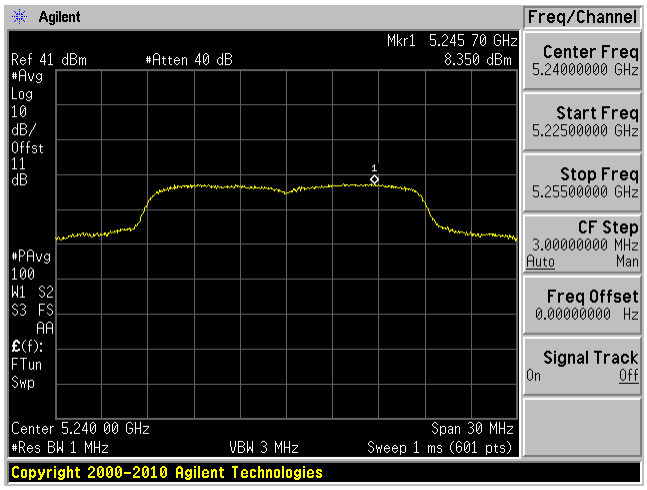
5180 MHz



5220 MHz

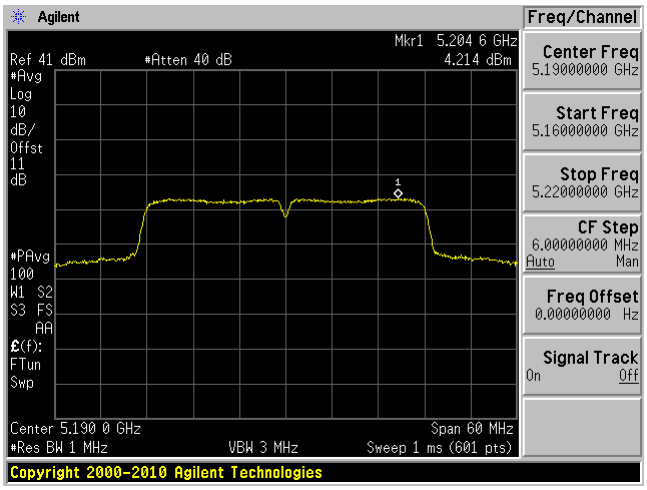


5240 MHz

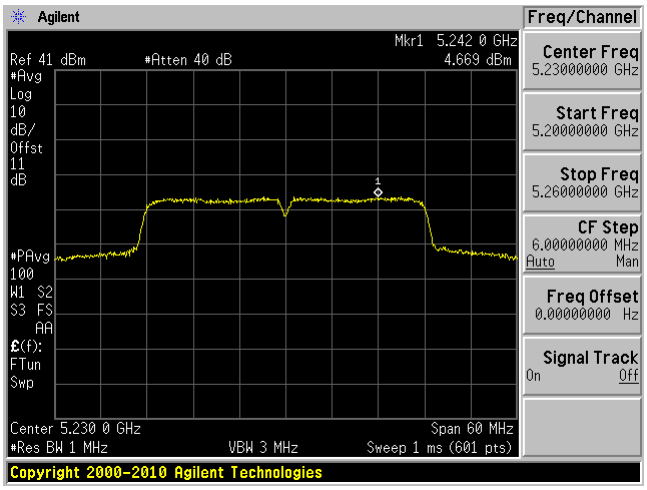


802.11n40 mode

5190 MHz

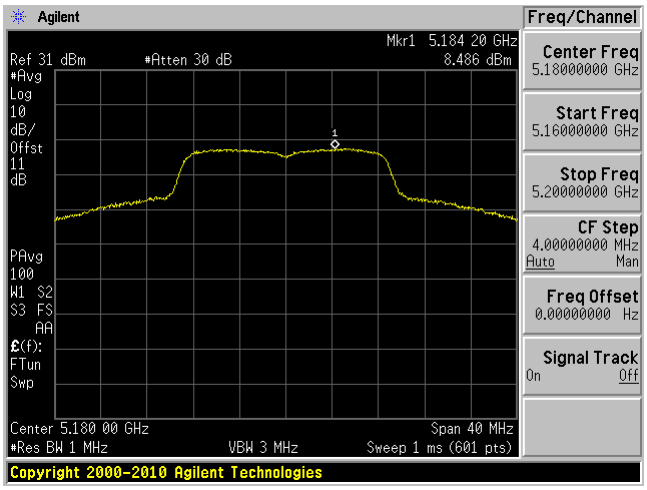


5230 MHz

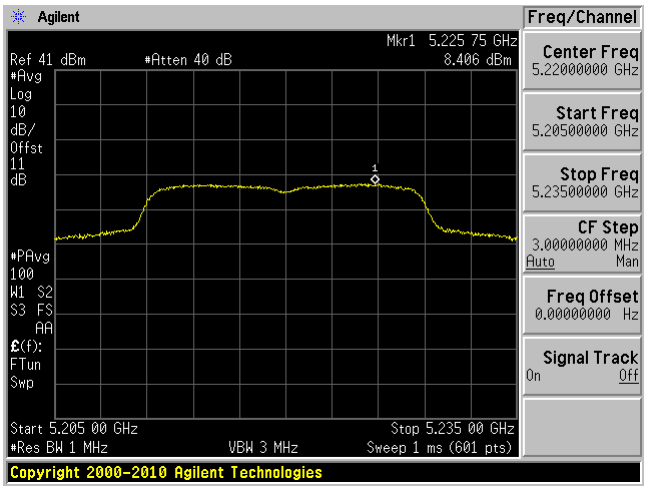


802.11ac20 mode

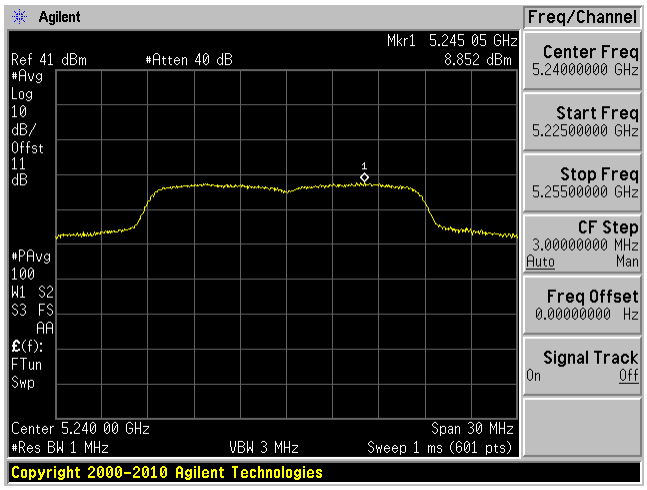
5180 MHz



5200 MHz

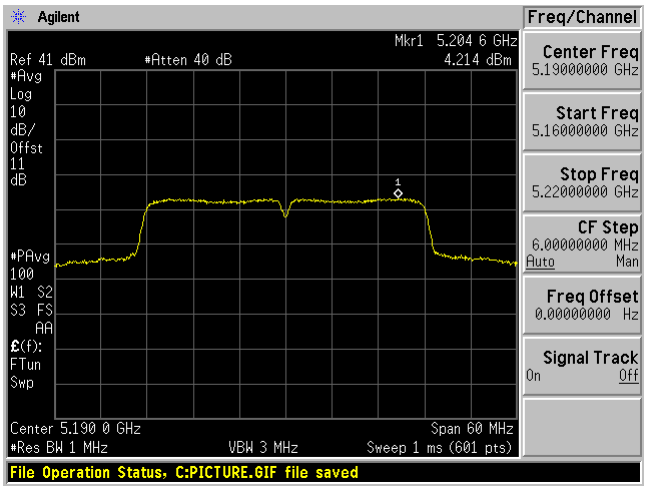


5240 MHz

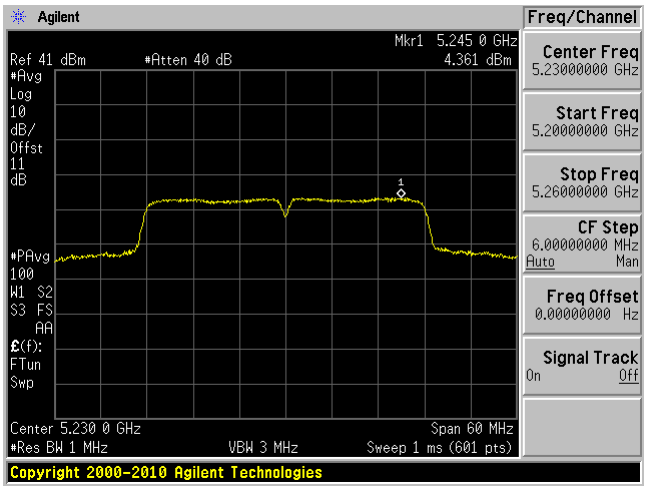


802.11ac40 mode

5190 MHz



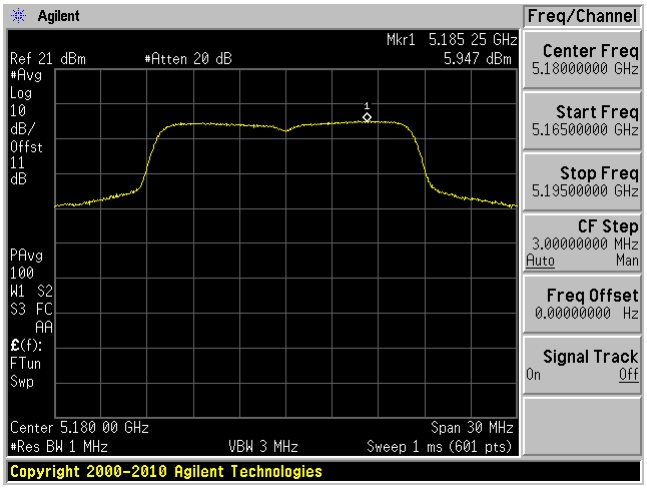
5230 MHz



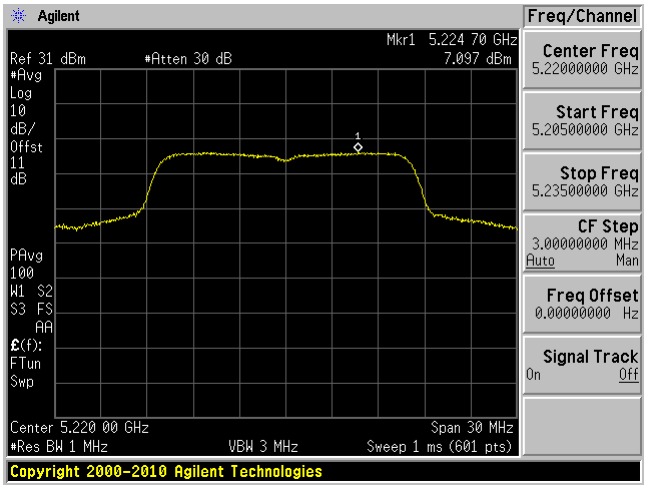
Chain 1

802.11a mode

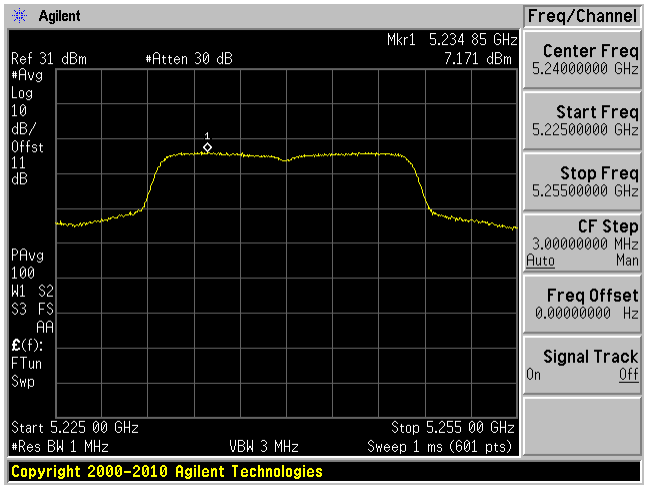
5180 MHz



5200 MHz

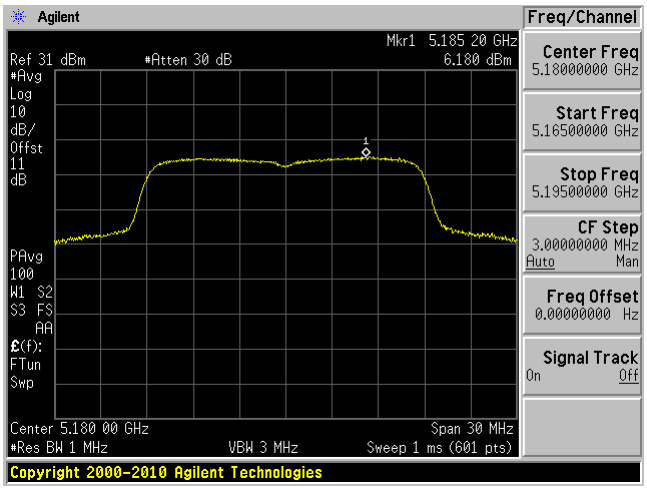


5240 MHz



802.11n20 mode

5180 MHz



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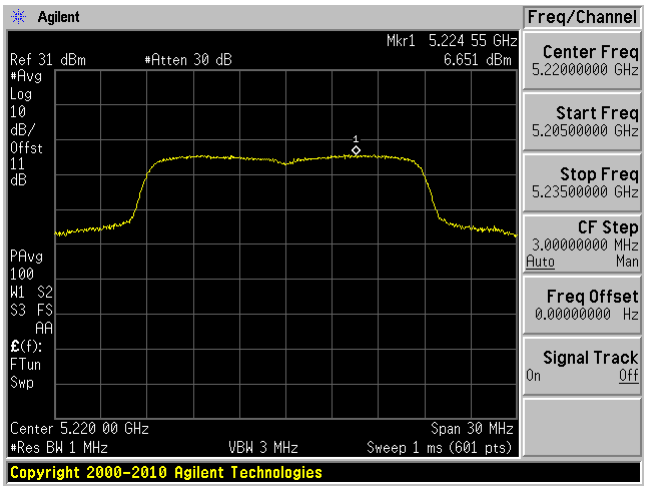

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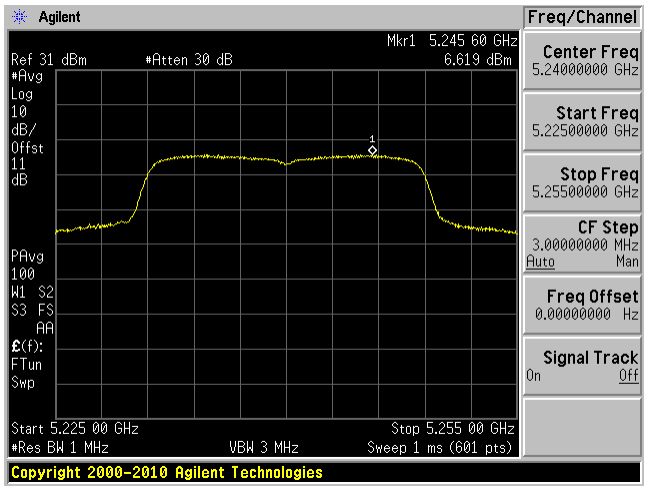
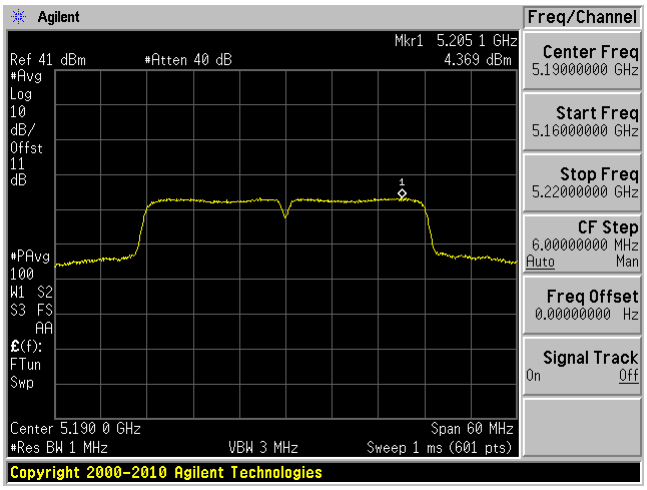


802.11n40 mode

5190 MHz



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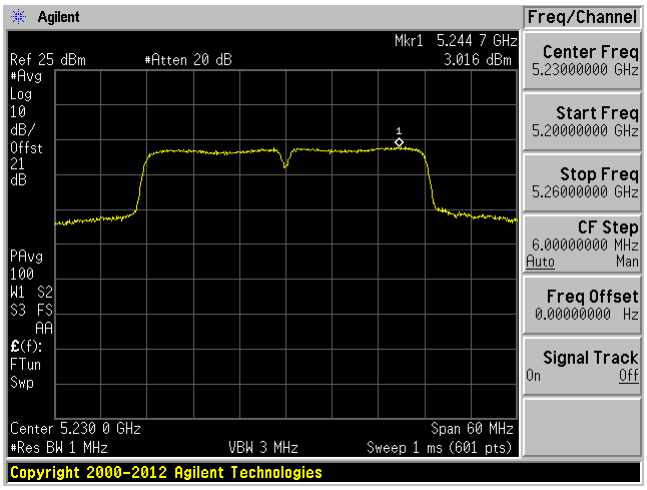
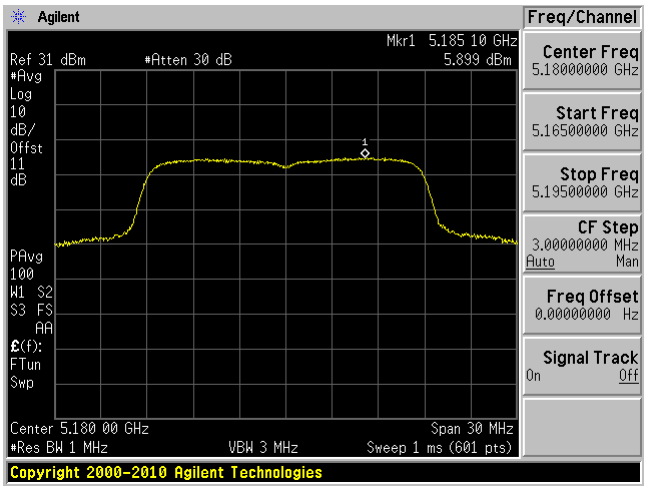


802.11ac20 mode

5180 MHz



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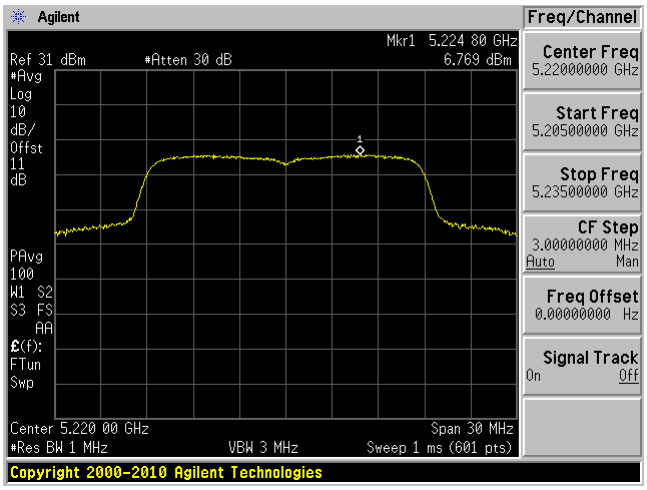

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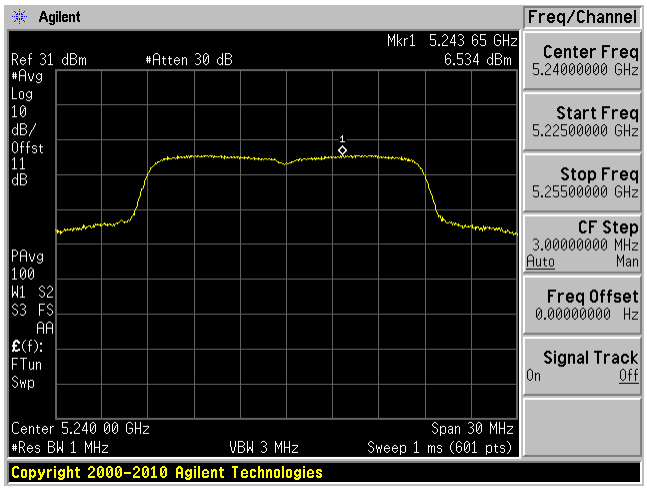

802.11ac40 mode

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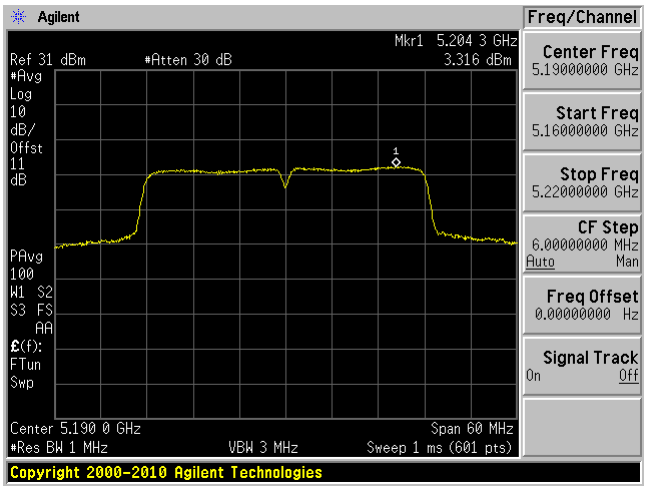
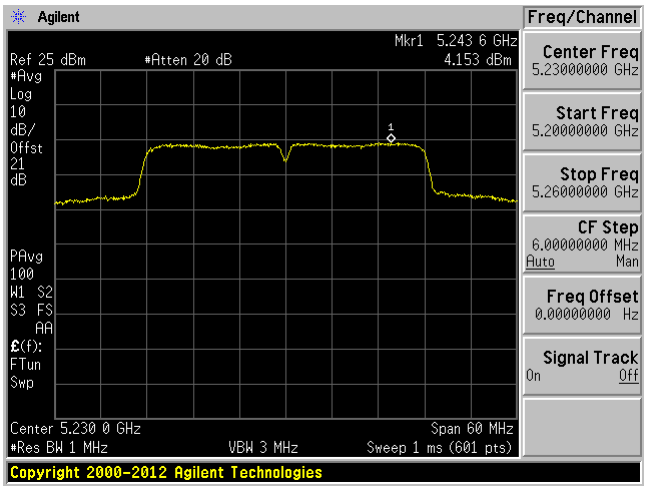


5230 MHz

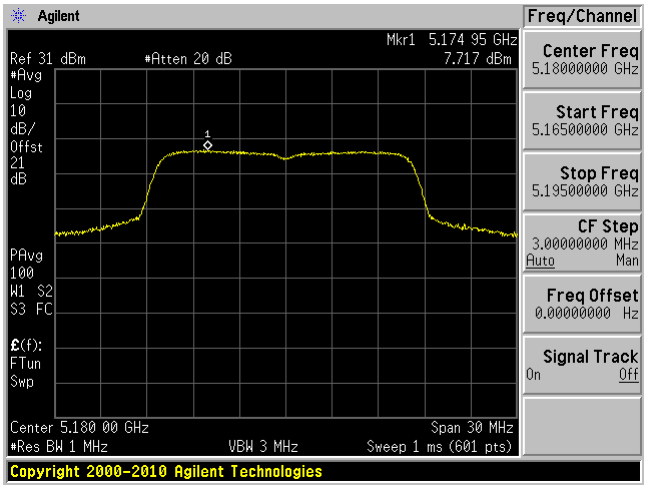


Radio 2

Chain 0

802.11a mode

5180 MHz



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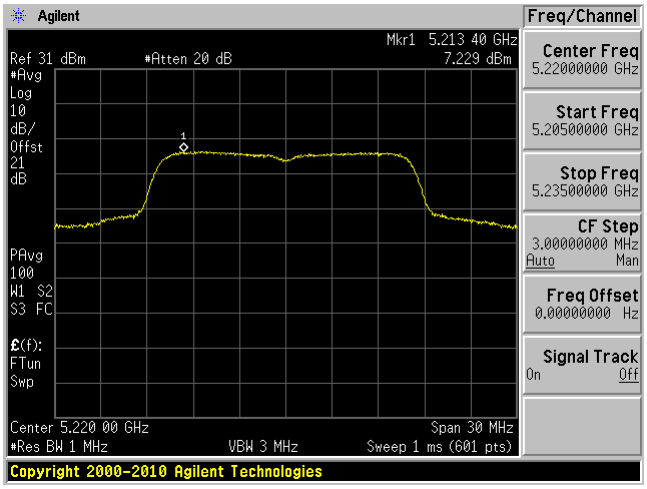

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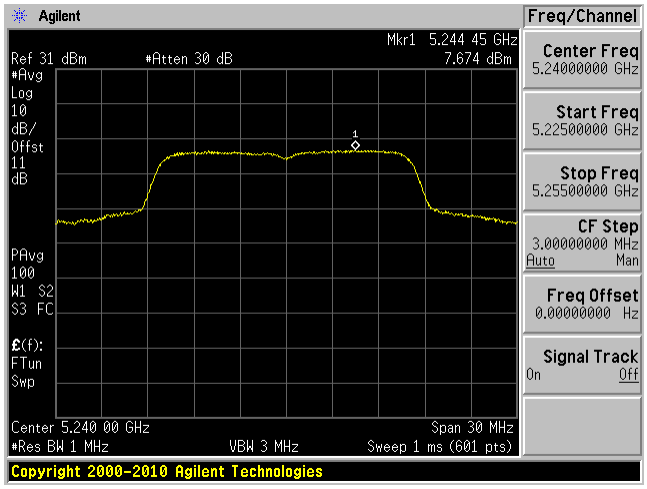

802.11n20 mode

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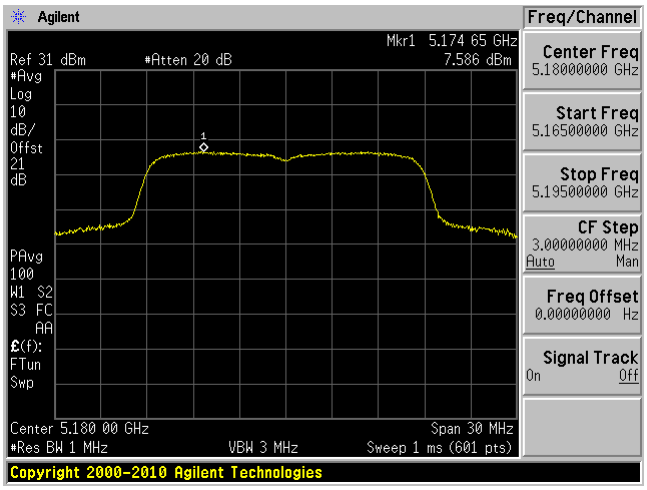

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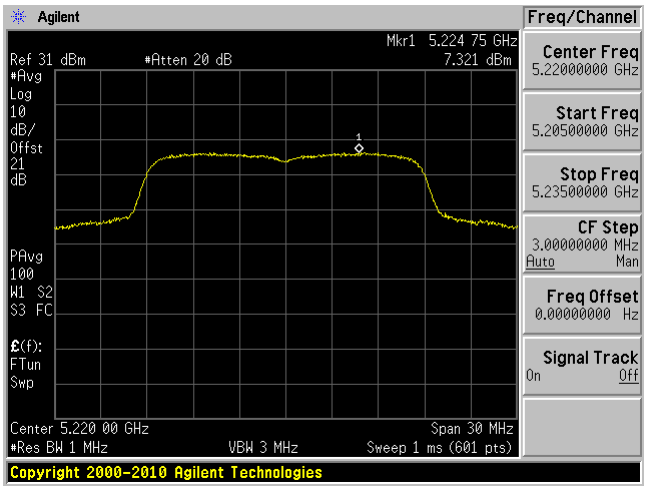

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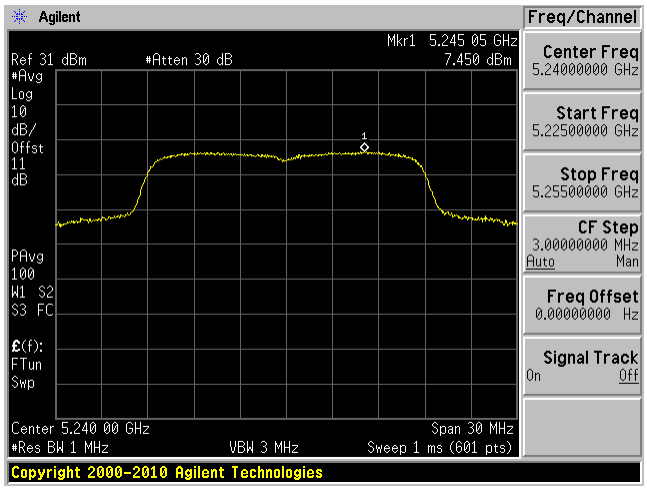
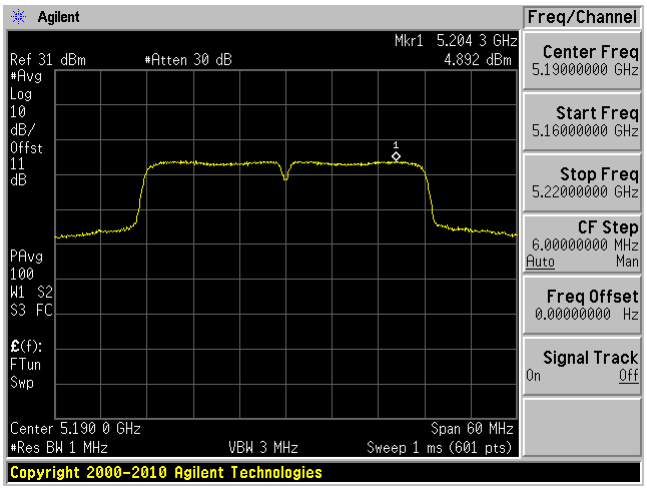
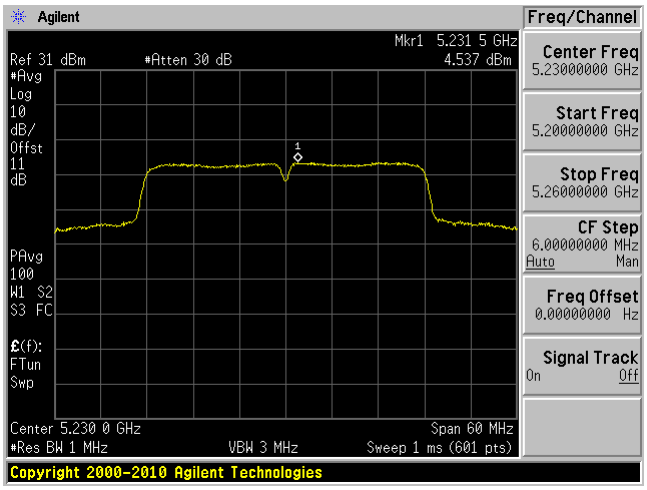


802.11n40 mode

5190 MHz

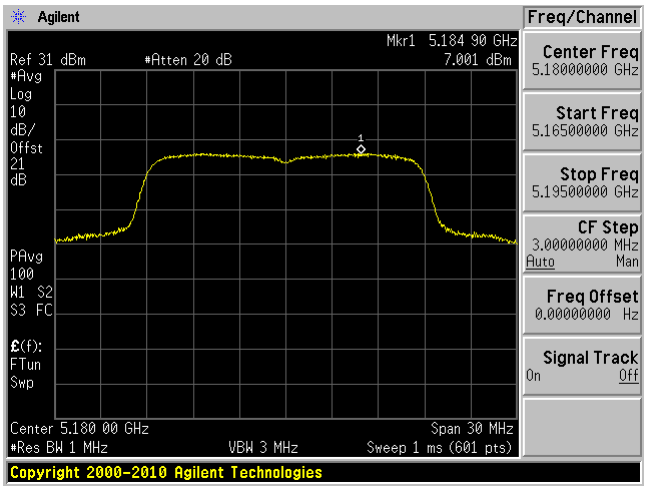


5230 MHz

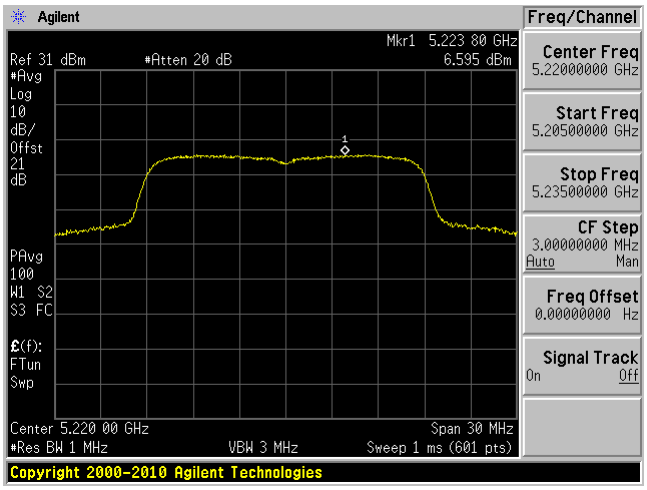


802.11ac20 mode

5180 MHz



5200 MHz



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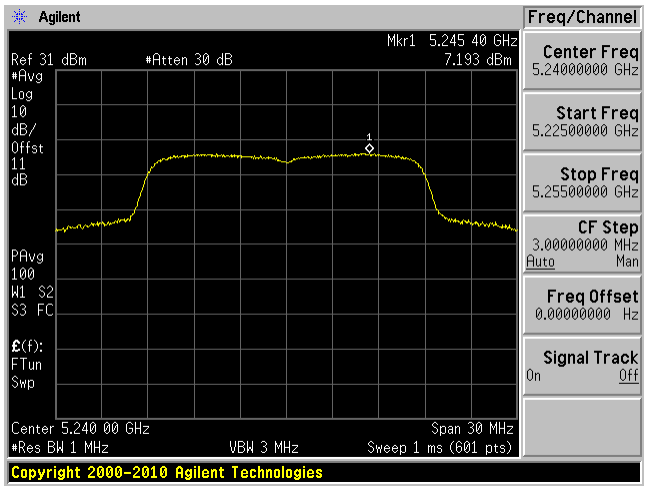
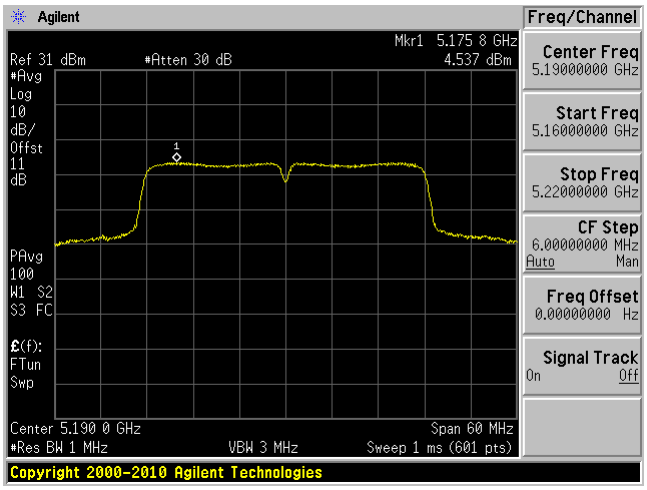


802.11ac40 mode

5190 MHz



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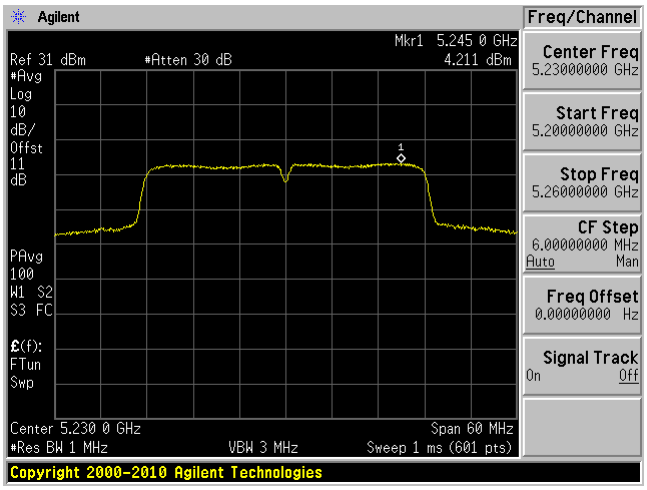
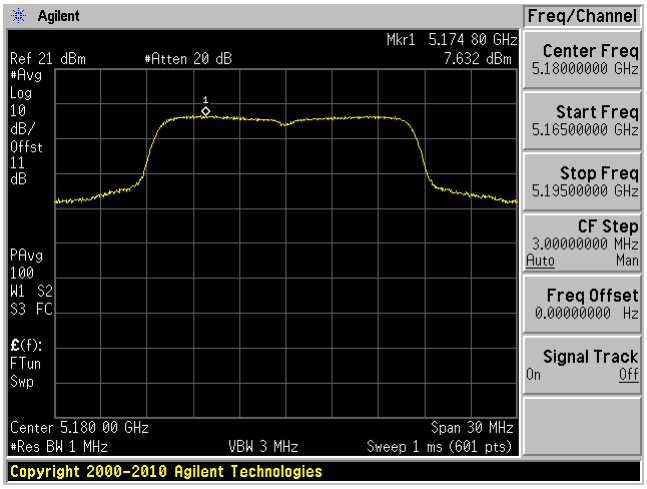


Chain 1

802.11a mode

5180 MHz



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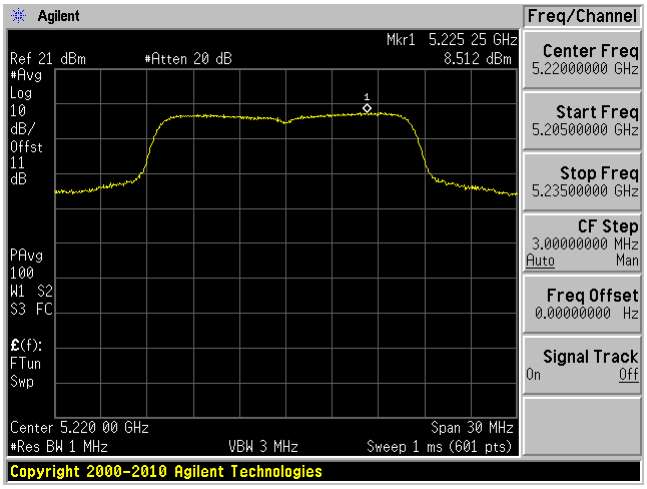

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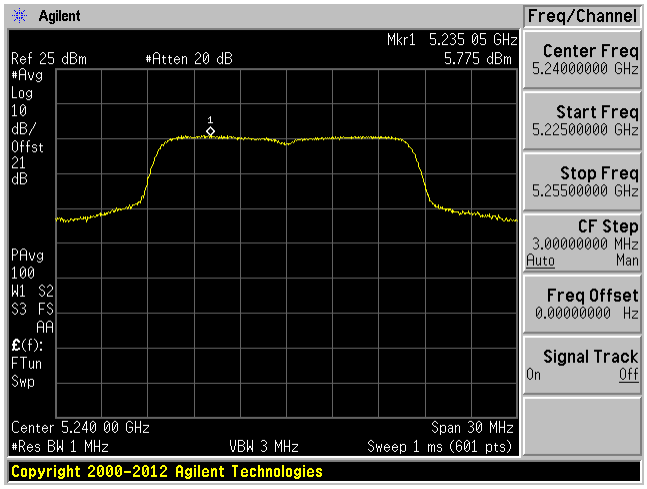
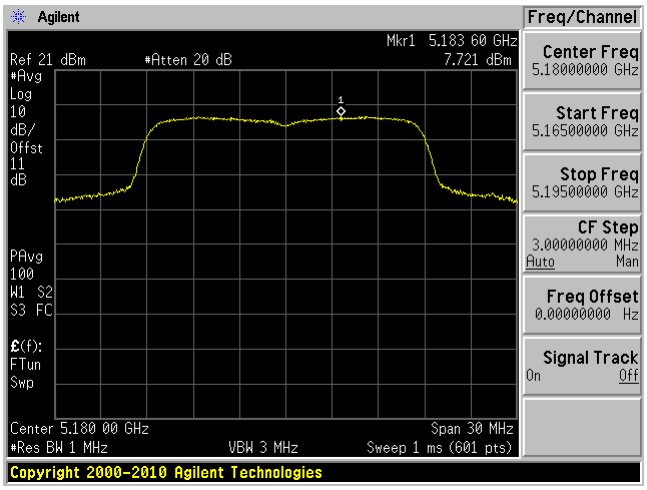


802.11n20 mode

5180 MHz



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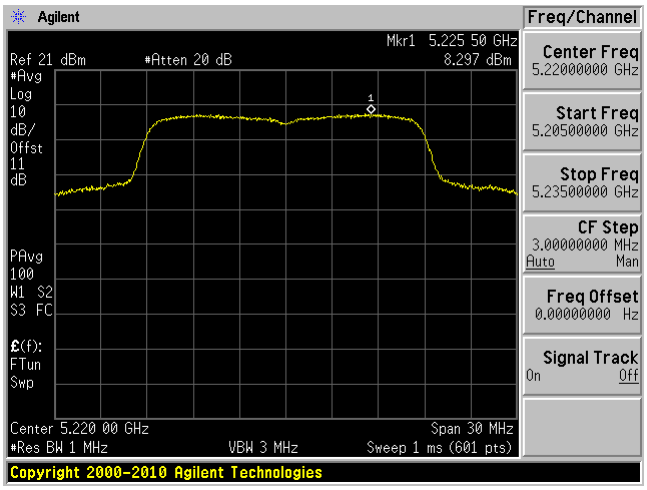

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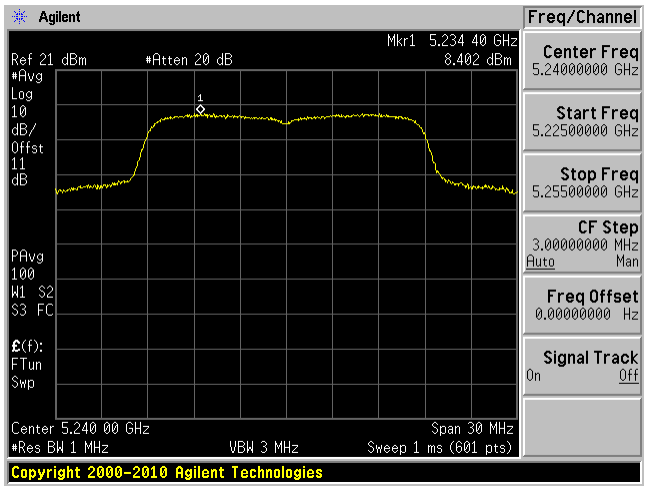
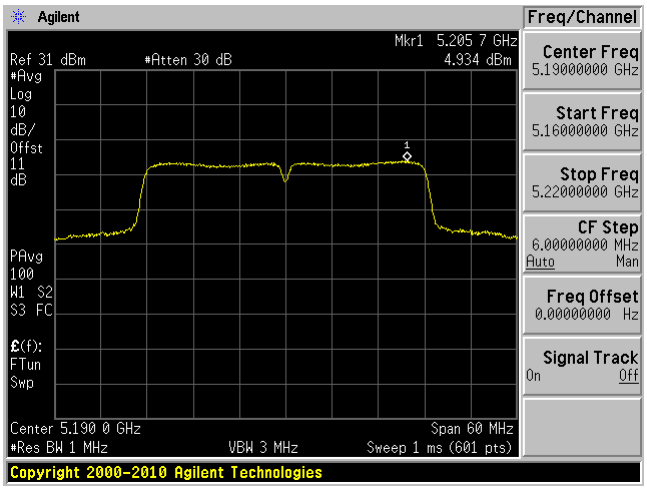
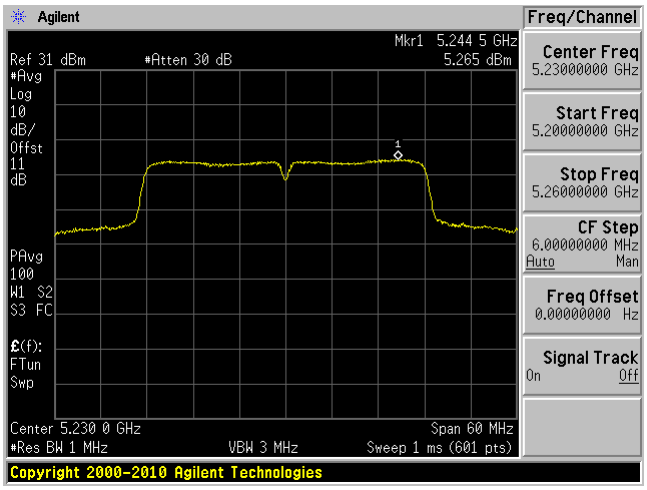


802.11n40 mode

5190 MHz

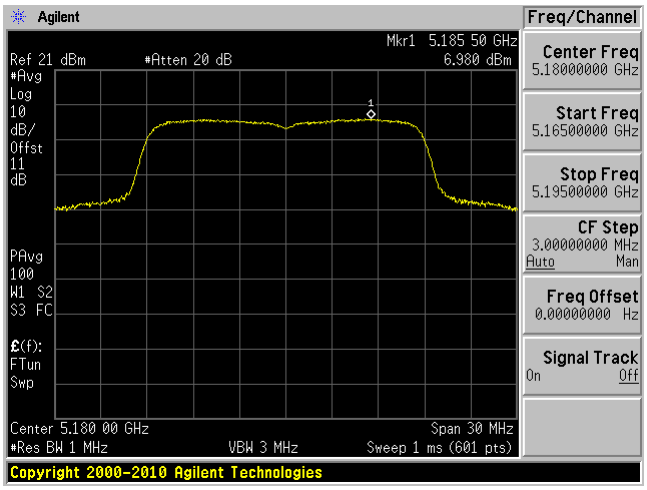


5230 MHz

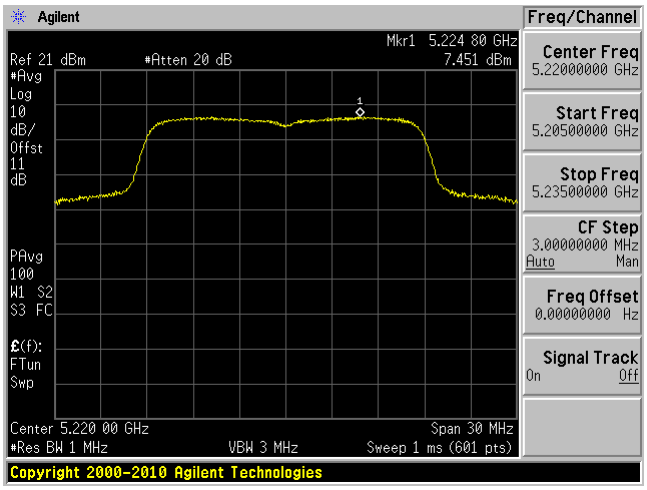


802.11ac20 mode

5180 MHz



5200 MHz



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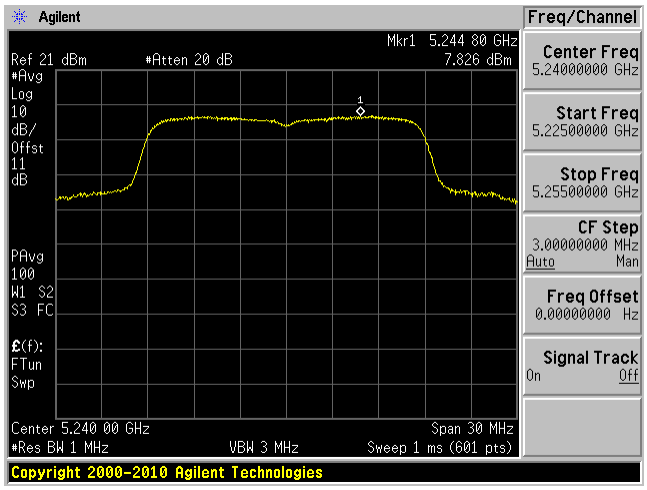
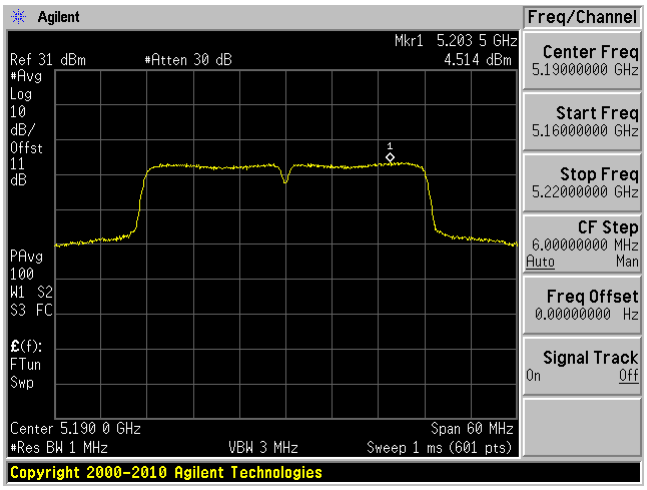


802.11ac40 mode

5190 MHz



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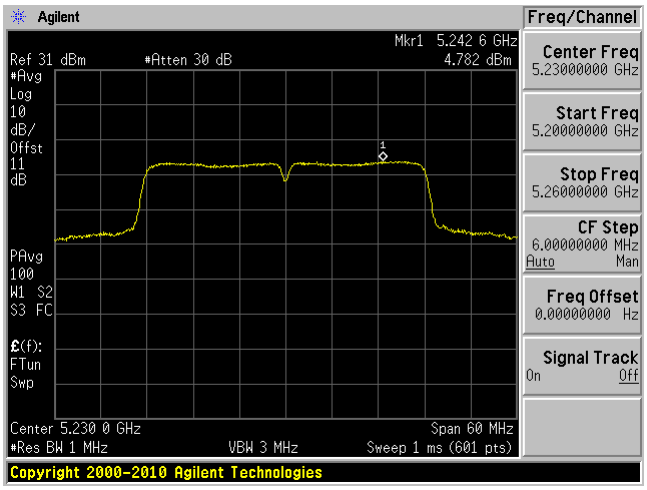


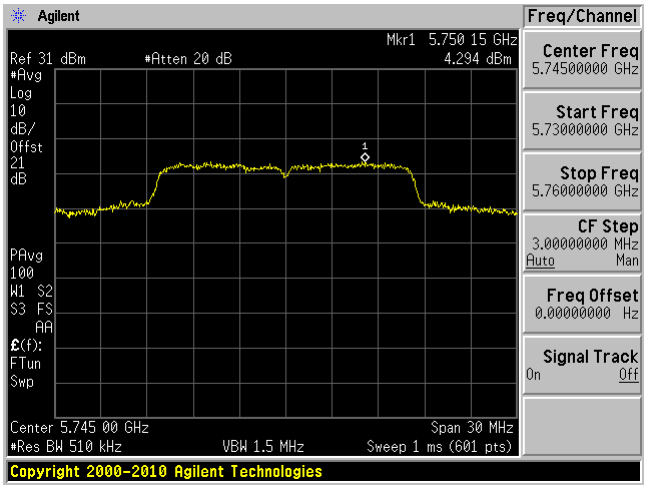
5725 – 5850 MHz

Radio 1

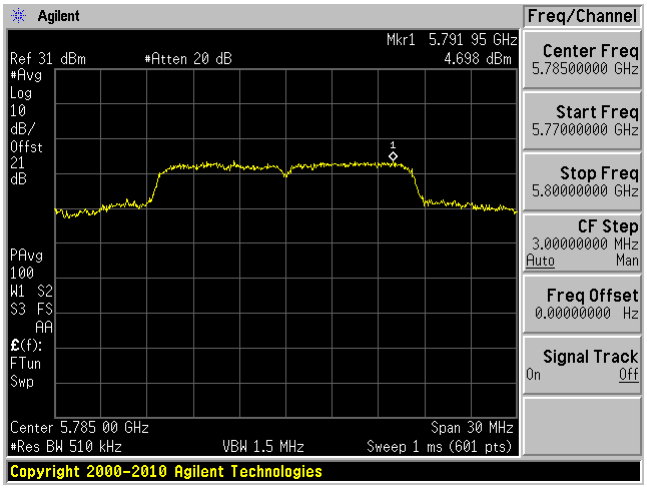
Chain 0

802.11a mode

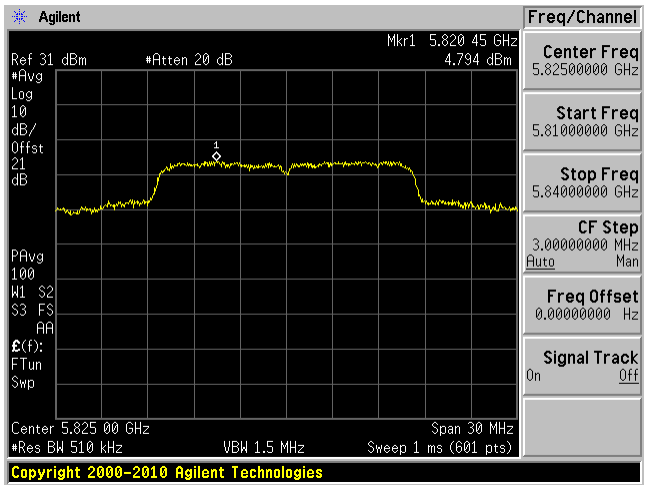
5745 MHz



5785 MHz

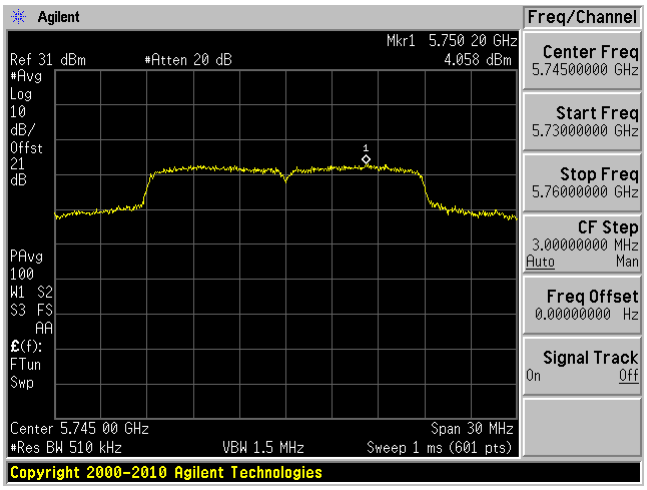


5825 MHz

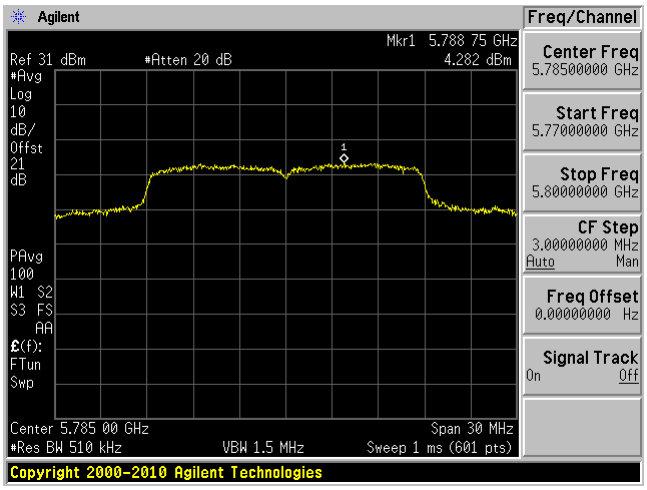


802.11n20 mode

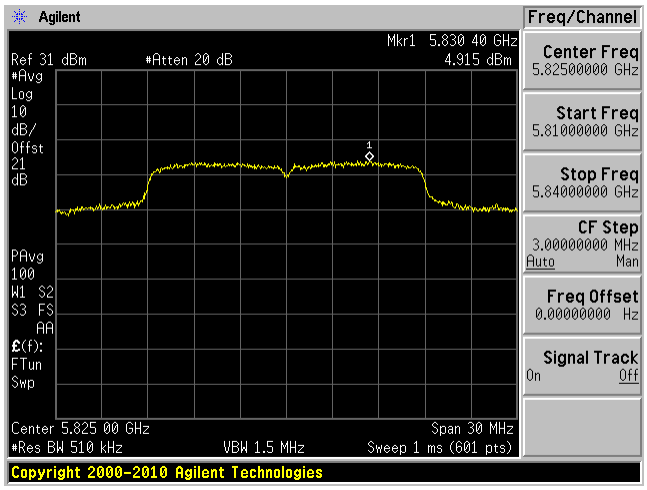
5745 MHz



5785 MHz

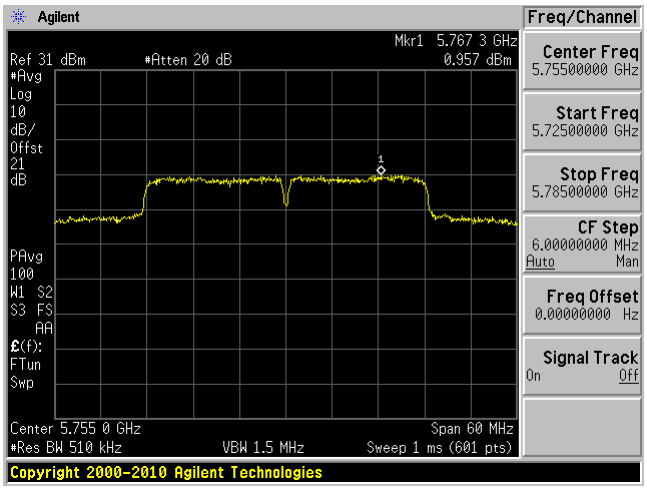


5825 MHz

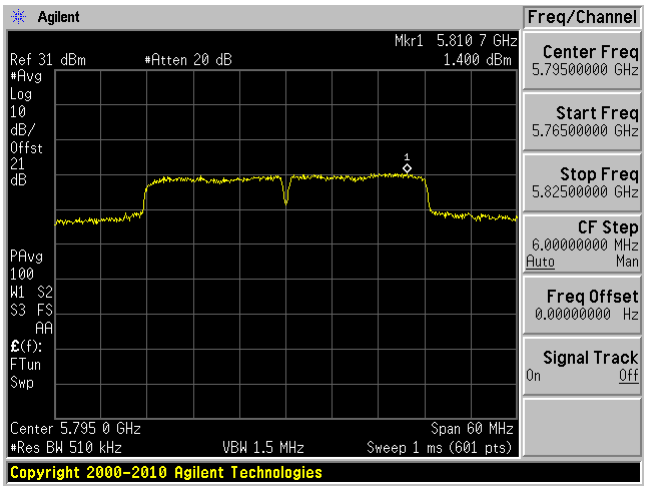


802.11n40 mode

5755 MHz

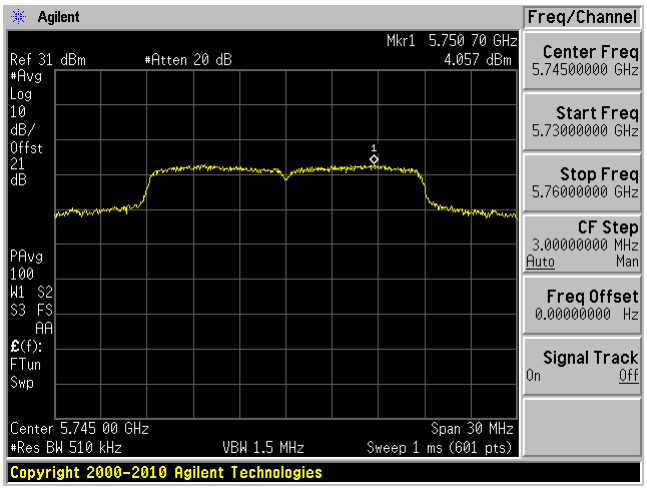


5795 MHz



802.11ac20 mode

5745 MHz



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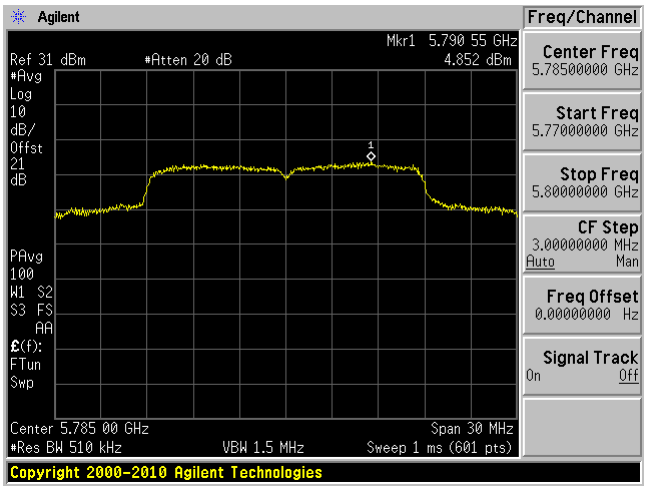

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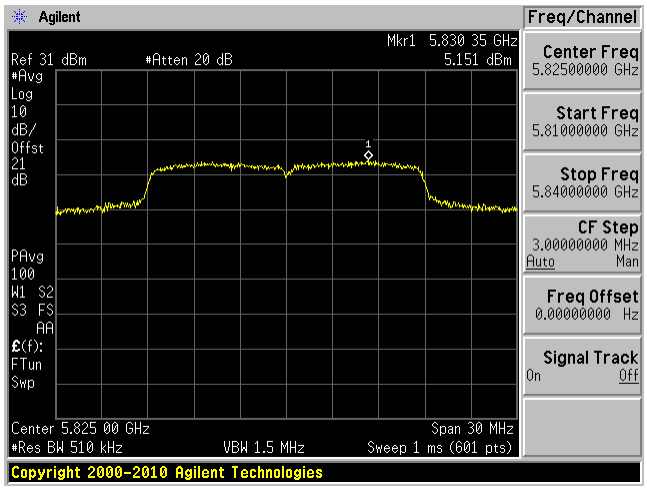
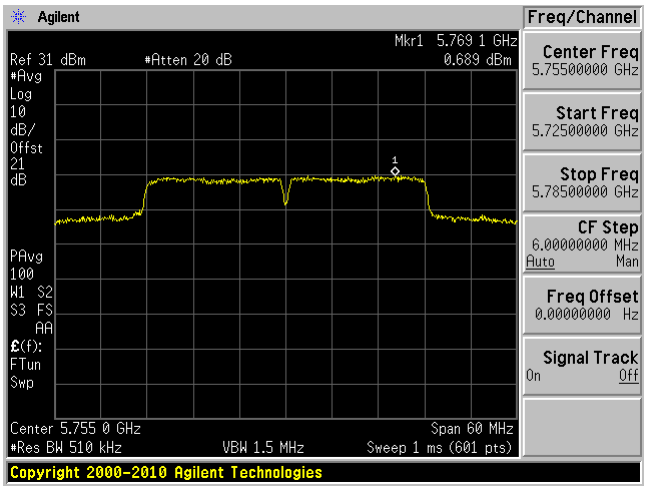
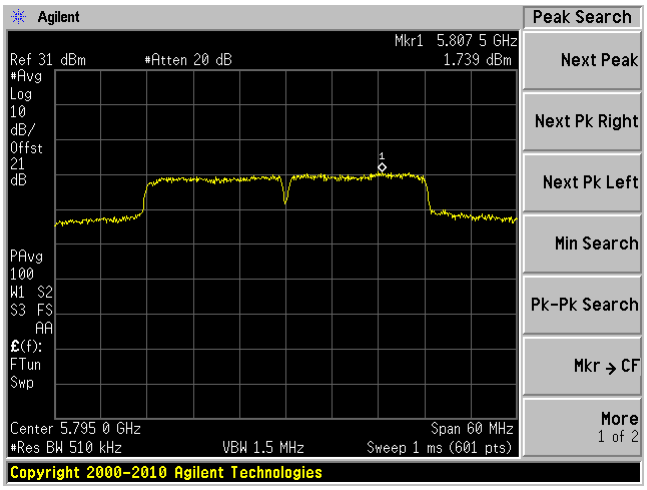


802.11ac40 mode

5755 MHz



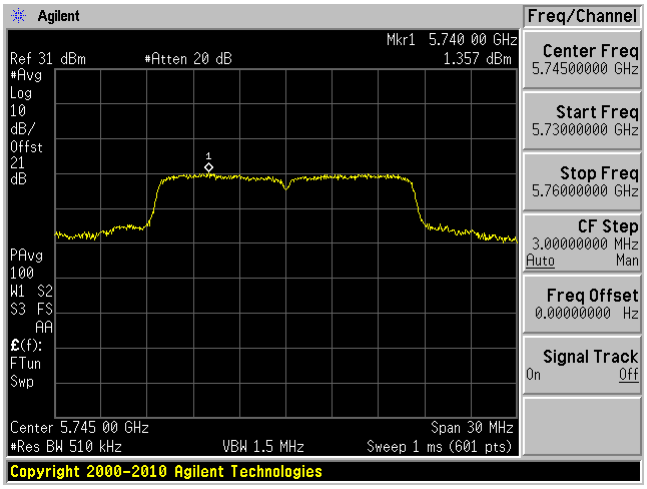
5795 MHz



Chain 1

802.11a mode

5745 MHz



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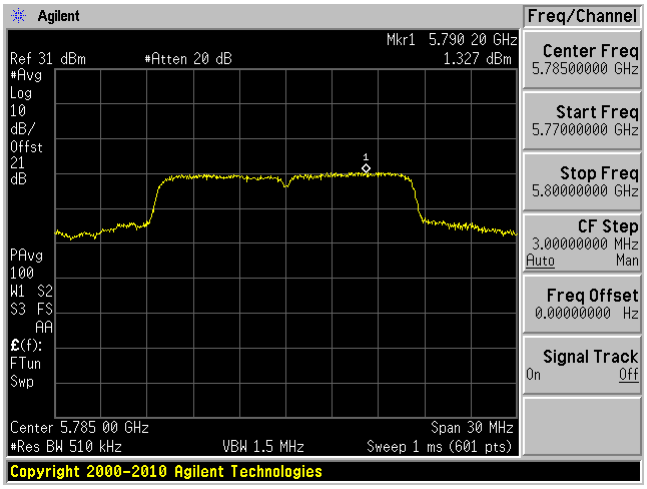

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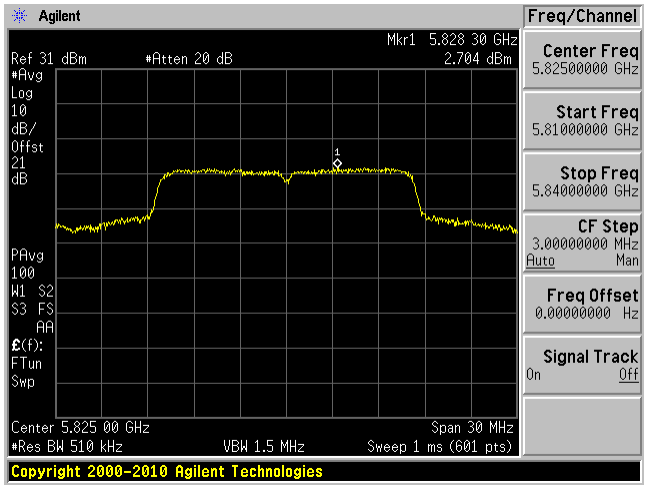
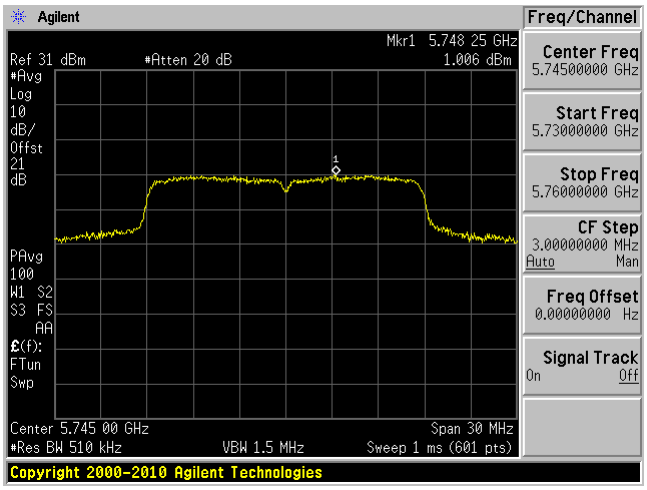


802.11n20 mode

5745 MHz



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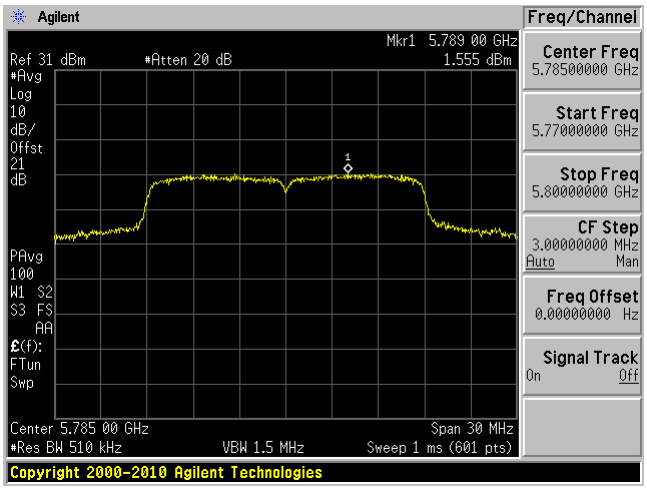

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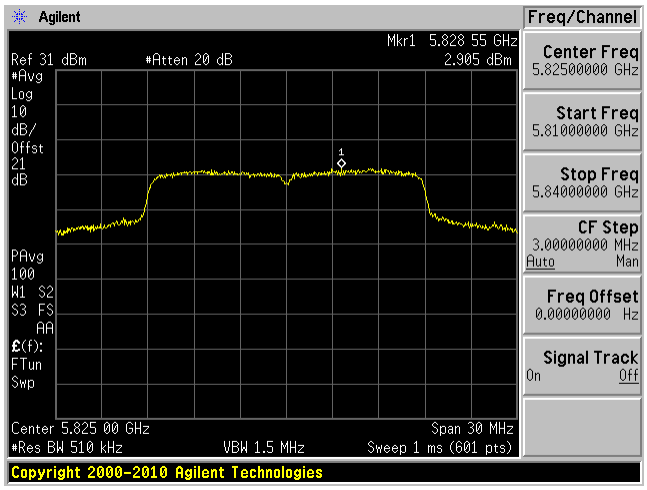
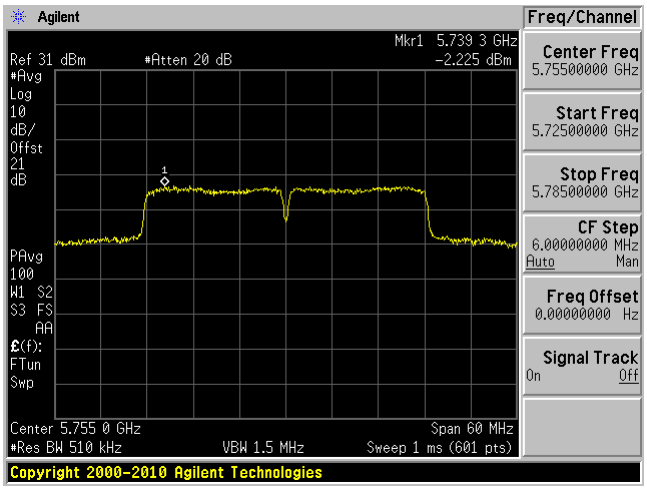


802.11n40 mode

5755 MHz



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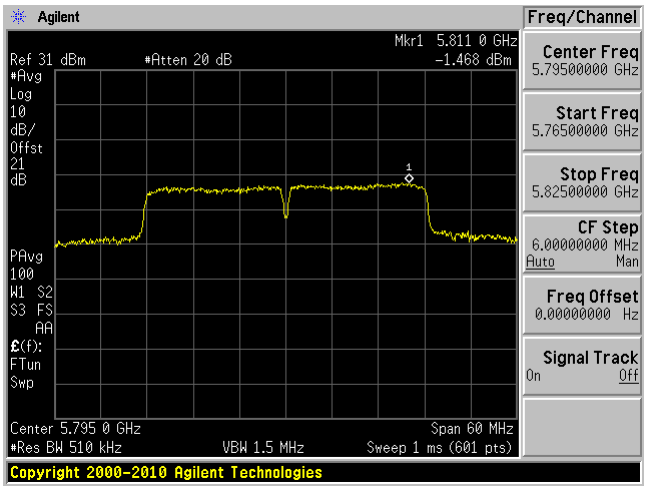

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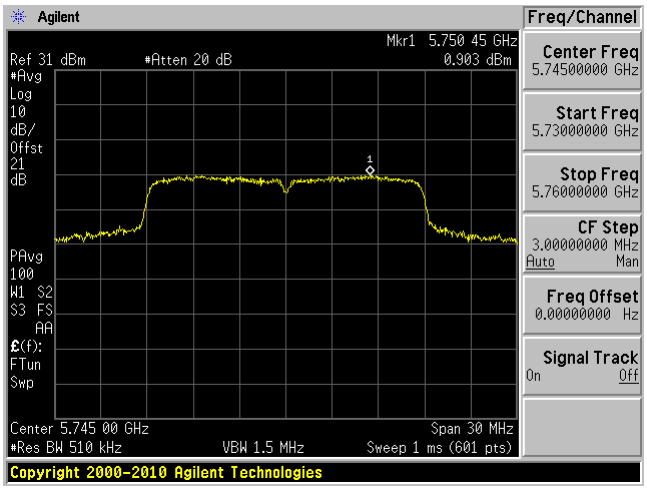

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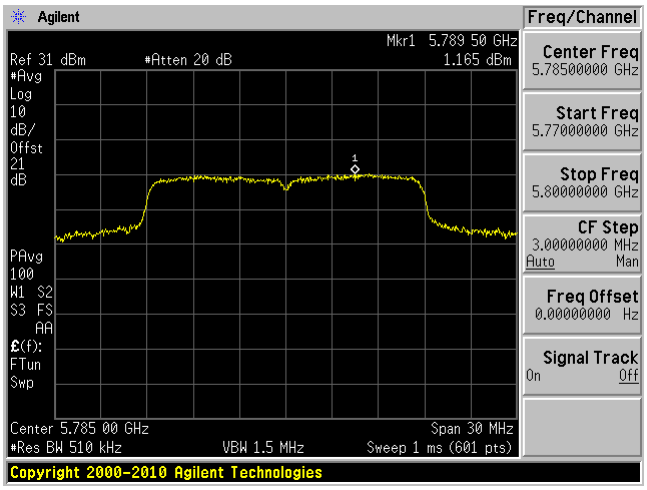

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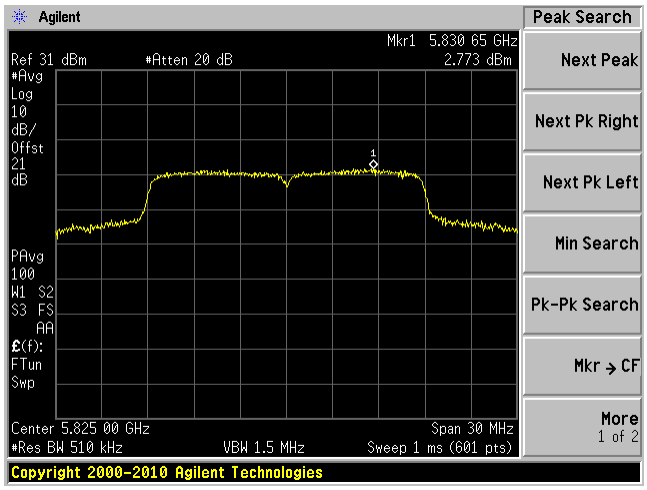

802.11ac40 mode

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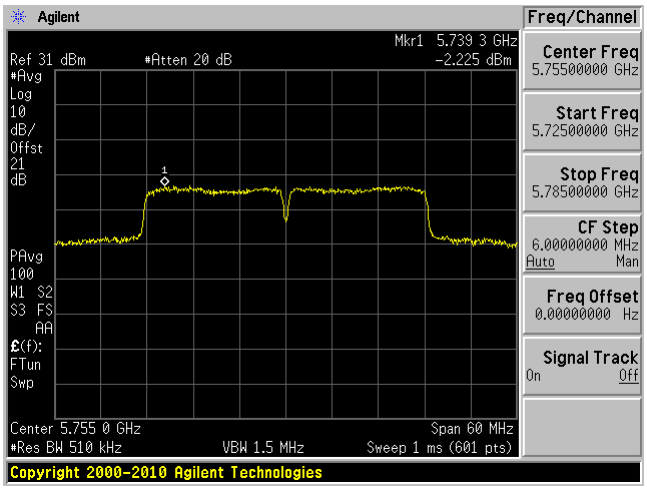

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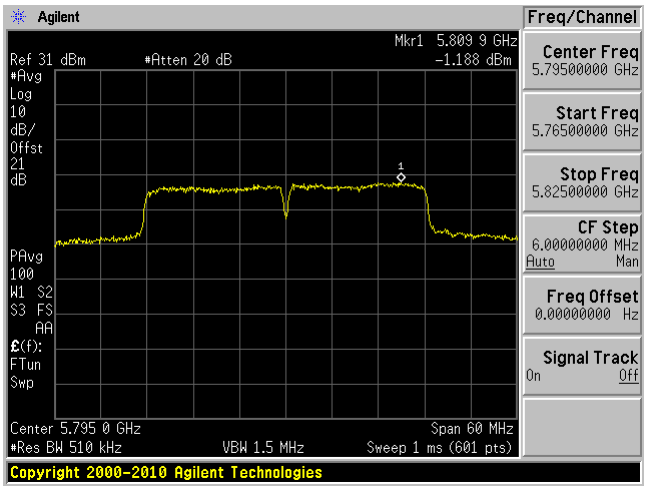
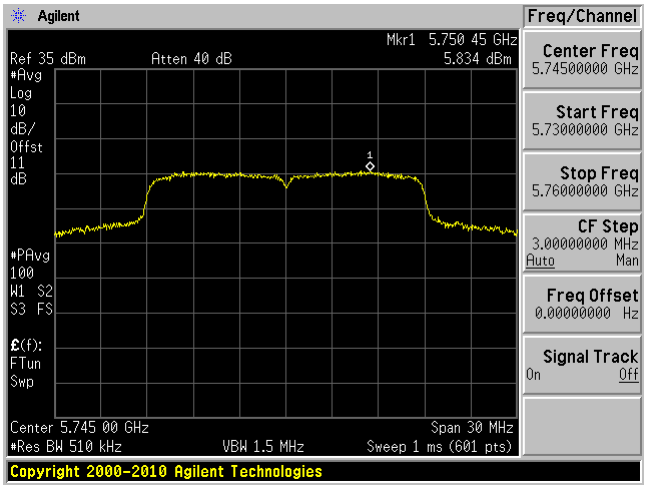


Radio 2

Chain 1

802.11a mode

5745 MHz



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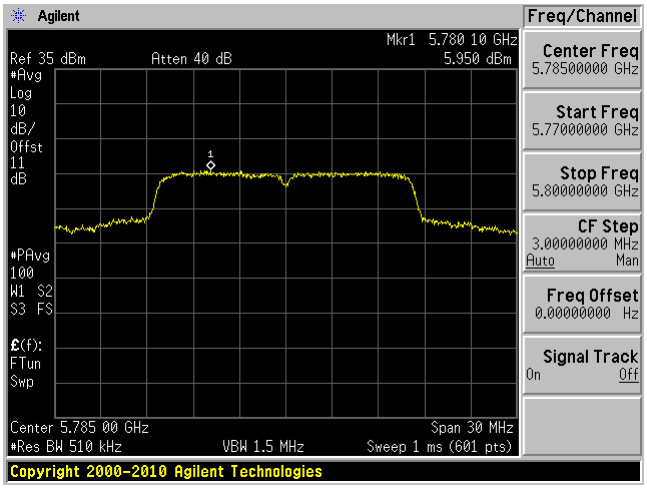

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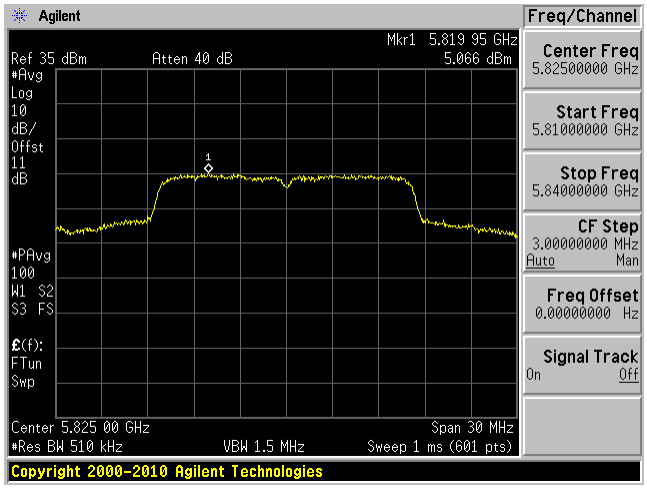
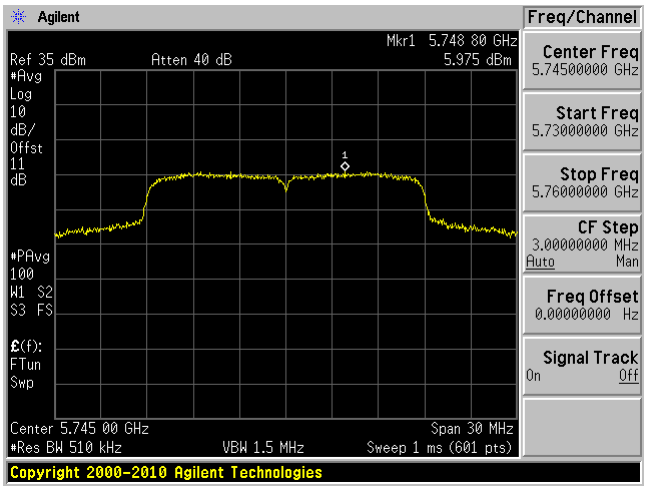


802.11n20 mode

5745 MHz



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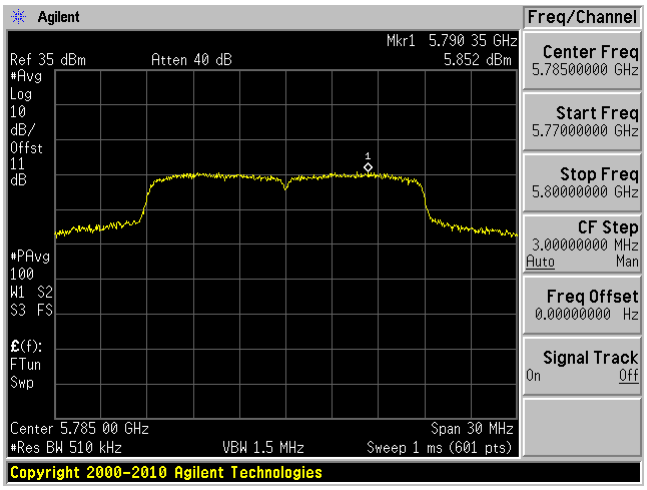

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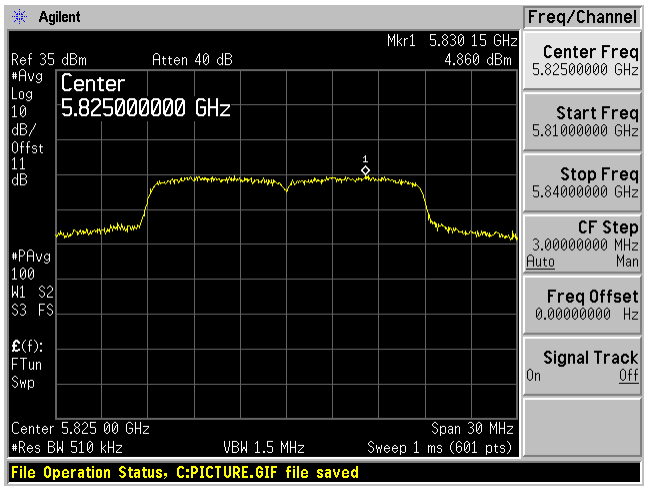

802.11n40 mode

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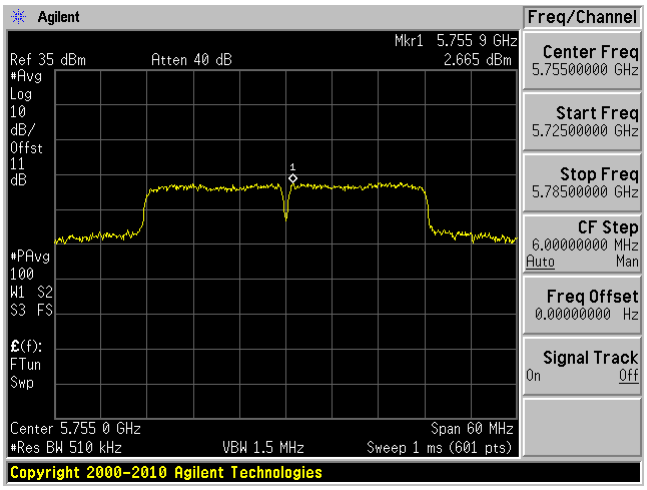

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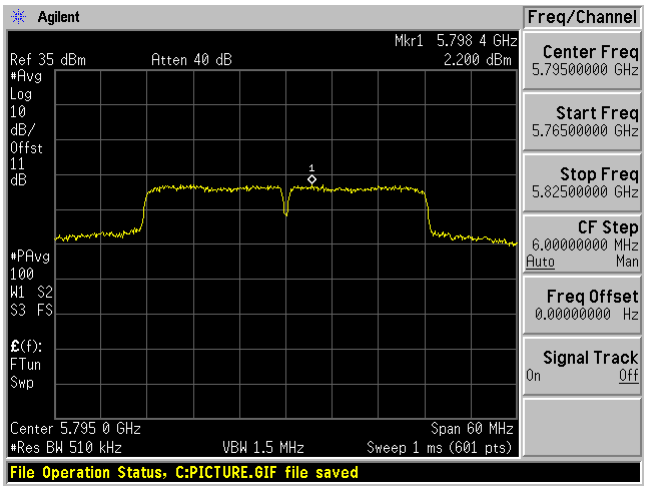

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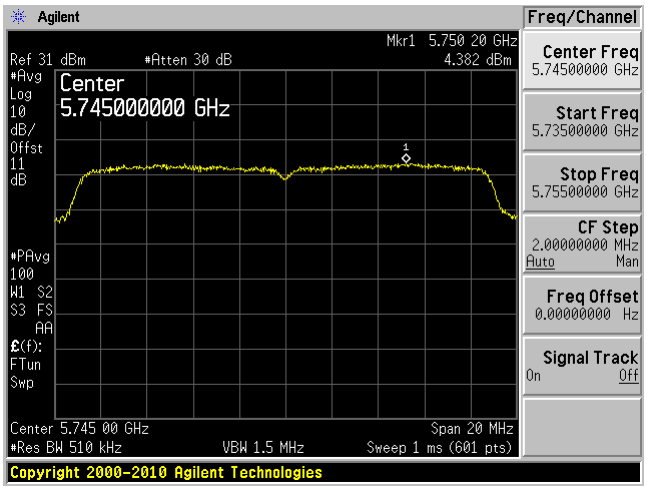
5745 MHz



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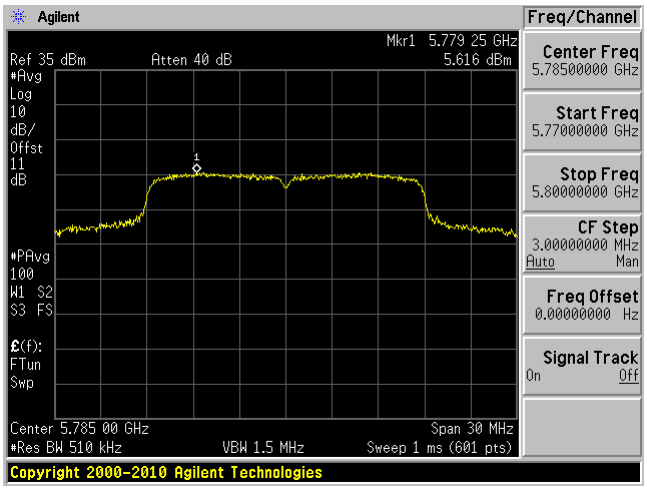

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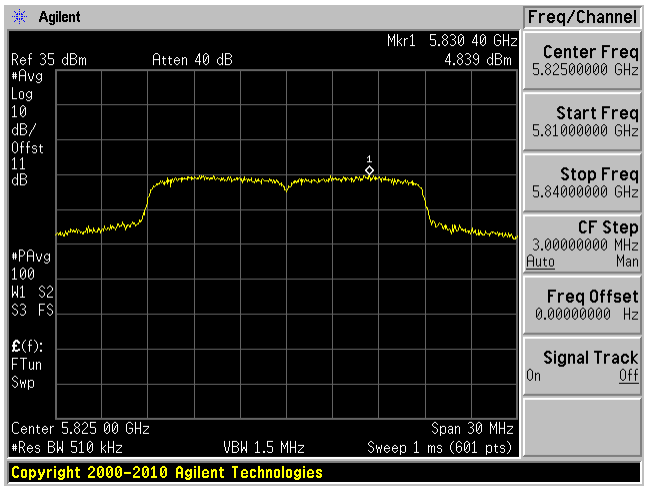
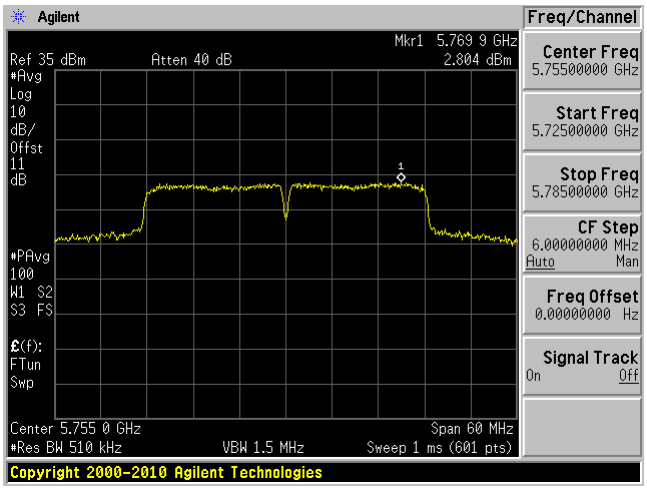


802.11ac40 mode

5755 MHz



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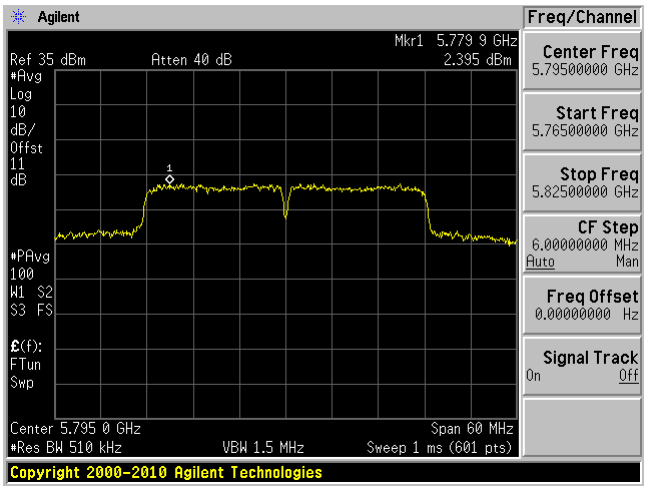
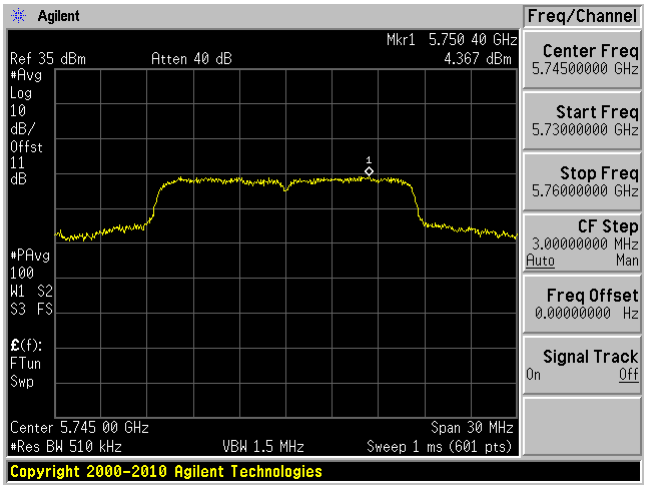


Chain 1

802.11a mode

5745 MHz



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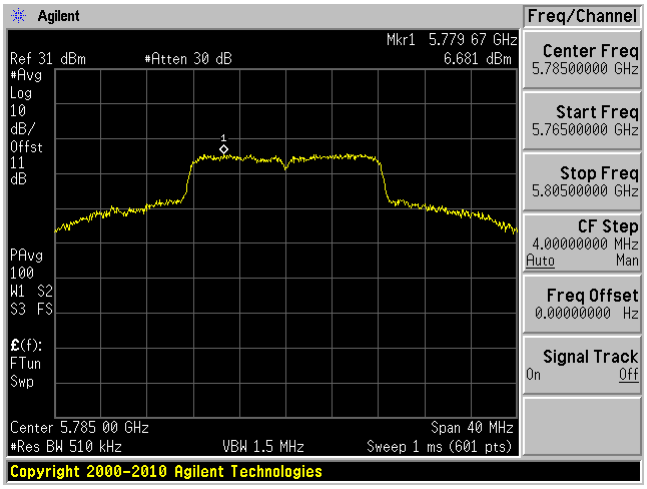

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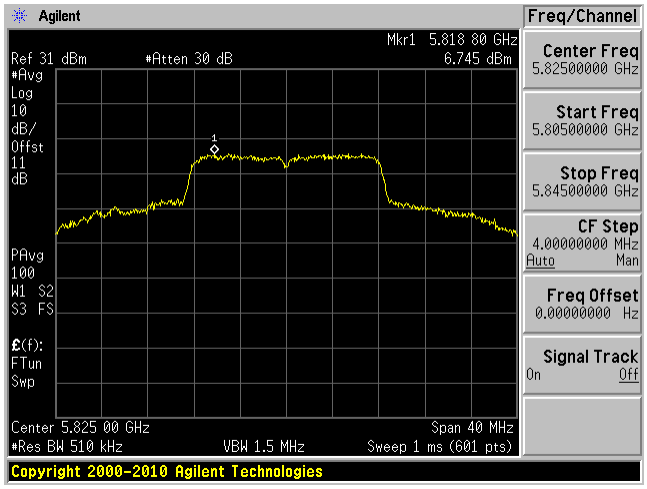
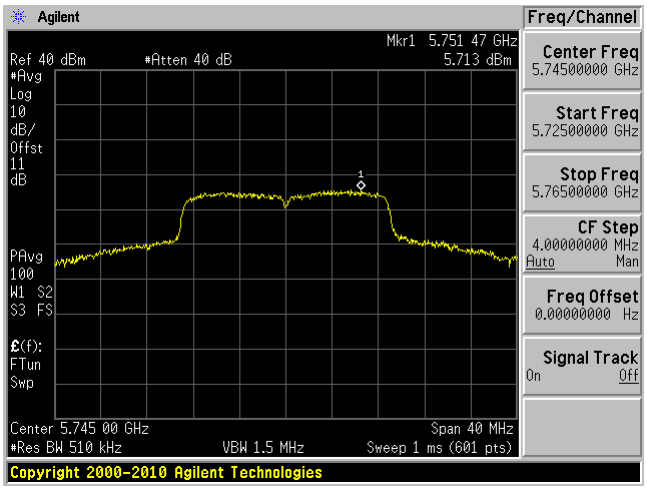


802.11n20 mode

5745 MHz



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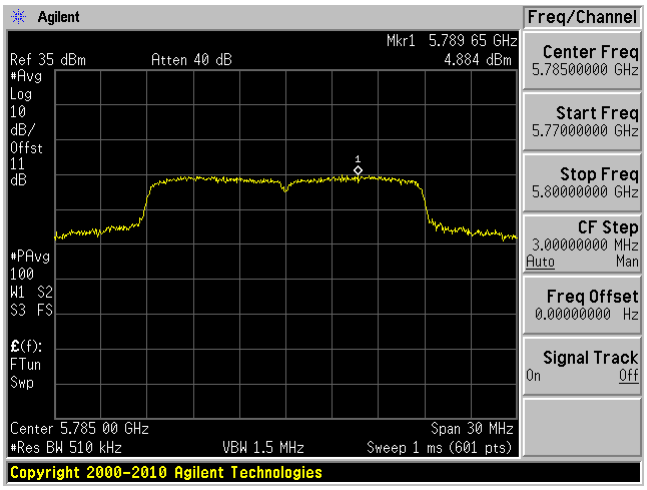

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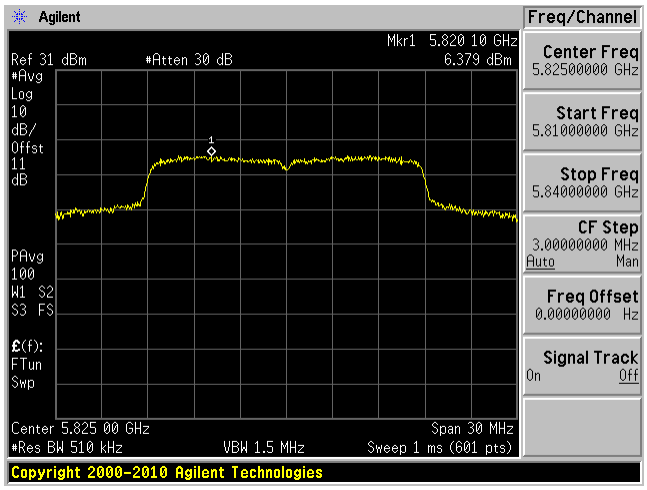
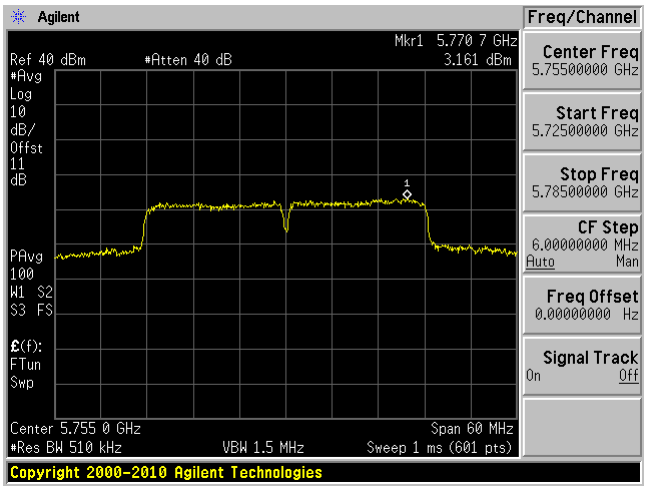


802.11n40 mode

5755 MHz



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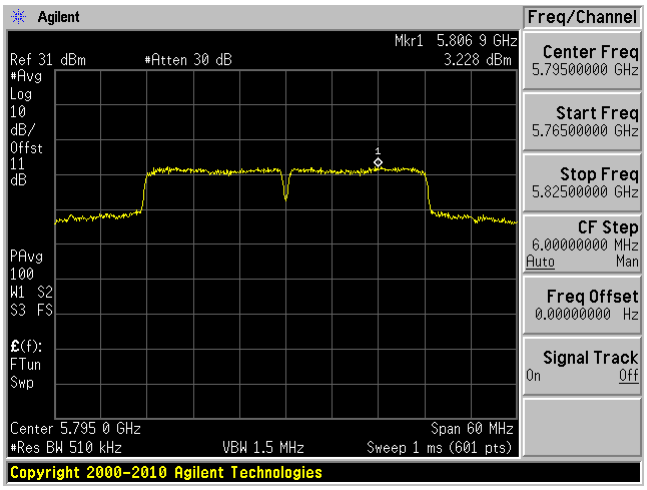
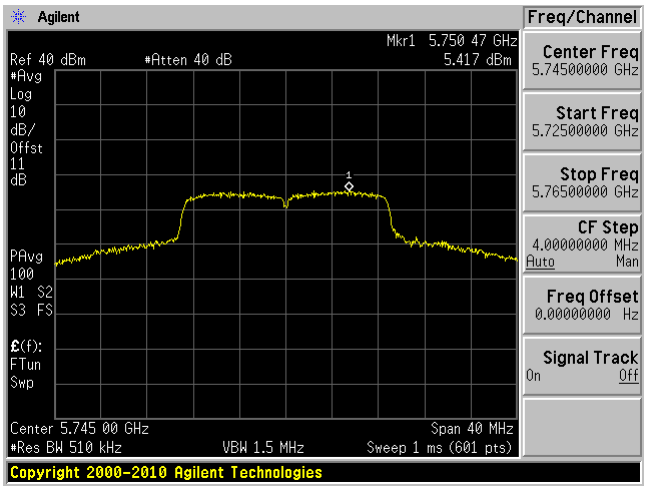


802.11ac20 mode

5745 MHz



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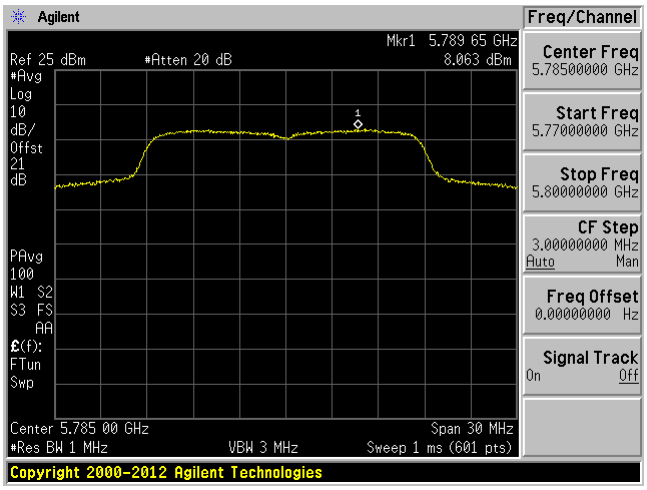

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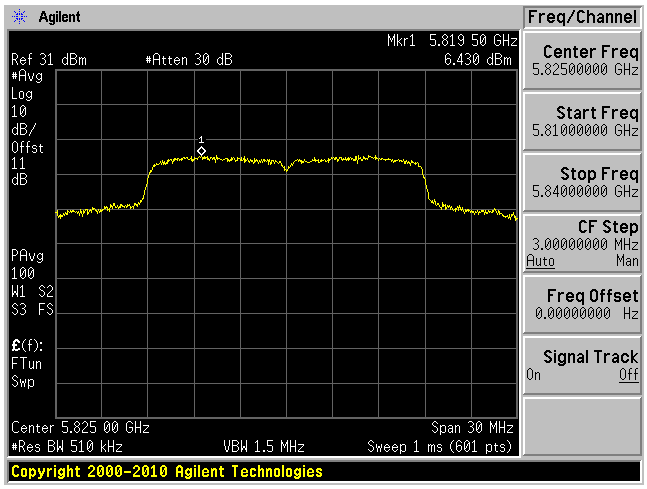
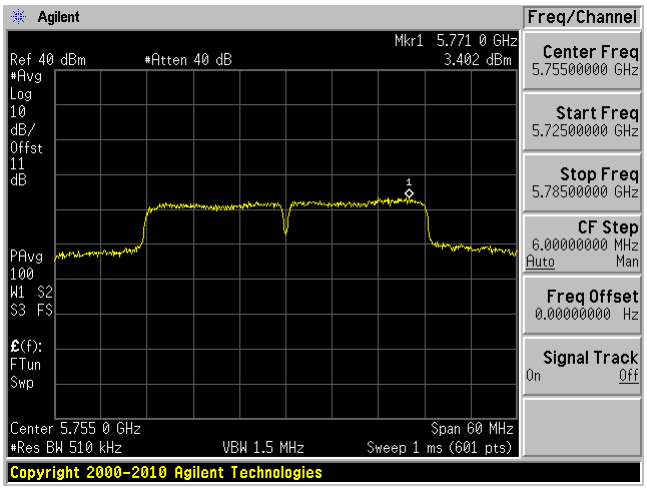


802.11ac40 mode

5755 MHz



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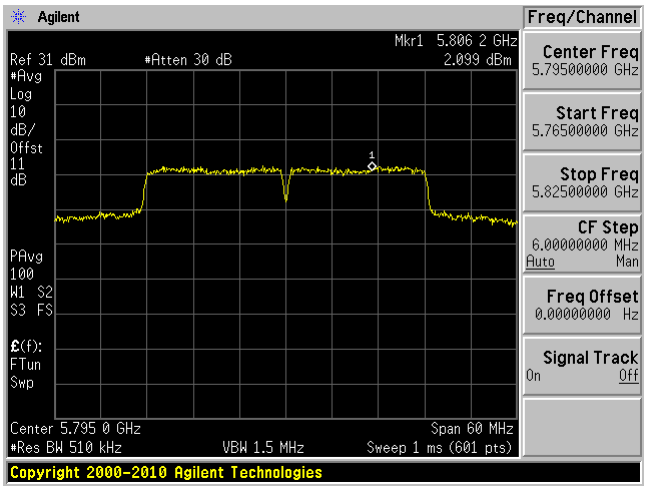

11 Annex A (Normative) – EUT Test Setup Photographs

Please refer to the attachment

12 Annex B (Normative) – EUT External Photographs

Please refer to the attachment

13 Annex C (Normative) – EUT Internal Photographs

Please refer to the attachment

14 Annex D (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 June 5, 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

--- END OF REPORT ---