FCC PART 15.407

TEST REPORT

For

Roku, Inc.

1155 Coleman Ave., San Jose, CA 95110, USA

FCC ID: TC2-R1037

Report Type:	Model:
Original Report	RC-EL2 & RC-EL3

Prepared By:	Zhao Zhao Test Engineer
Report Number:	R2005185-407
Report Date:	2020-06-22
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ACCREDITED
CERTIFICATE #3297.02

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2005185-407	Original Report	2020-06-22

1 General Description

1.1 Product Description for Equipment under Test (EUT)

This test report was prepared on behalf of Roku, Inc., and their product model: RC-EL3 and a similar model RC-EL2, FCC ID: TC2-R1037 or the "EUT" as referred to in this report. It is a remote control. The two models are electrically identical; RC-EL3 was selected for testing. Please refer to the declaration letter submitted by the manufacturer.

1.2 Mechanical Description of EUT

The Remote Control measures approximately 140 mm (L) x 43m (W) x 25 mm (H) and weighs approximately 0.05 kg.

The data gathered are from the typical production sample provided by Roku, Inc. with serial number: R2005185-1, assigned by BACL.

1.3 Objective

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

The objective was 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.

1.4 Related Submittal(s)/Grant(s)

Equipment Class: DTS, FCC ID: TC2-R1037

1.5 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 v02r01.

1.6 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 %

1.7 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.

1.8 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 3297.02),*** in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide

range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.03)*** 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 & Fixed Radio Services;
  - 4 All Scope 4-Licensed Maritime & 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 3297.01)*** 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 & 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: (Innovation, Science and Economic development Canada - ISED) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & 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 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
  - 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 & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
  - Nationally Recognized Test Laboratory (NRTL) – US OSHA
- Vietnam: APEC Tel MRA -Phase I;

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.10-2013 and FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.

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, peak power and PPSD across all data rates bandwidths, and modulations.

2.2 EUT Exercise Software

The test software used was UI_mptool, the EUT firmware is compliant with the standard requirements being tested against.

Please refer to the following power setting table.

Modulation	Channel	Frequency (MHz)	Power Setting
802.11a	36	5180	89
	40	5200	89
	48	5240	88
	149	5745	81
	157	5785	81
	165	5825	84
802.11n20/ac20	36	5180	90
	40	5200	89
	48	5240	89
	149	5745	82
	157	5785	82
	165	5825	85

*Data rates tested:
802.11a mode: 6Mbps
802.11n20/ac20: MCS0

2.3 Duty Cycle Correction Factor

According to KDB 789033 D02 General UNII Test Procedures New Rules v02r01 section B:

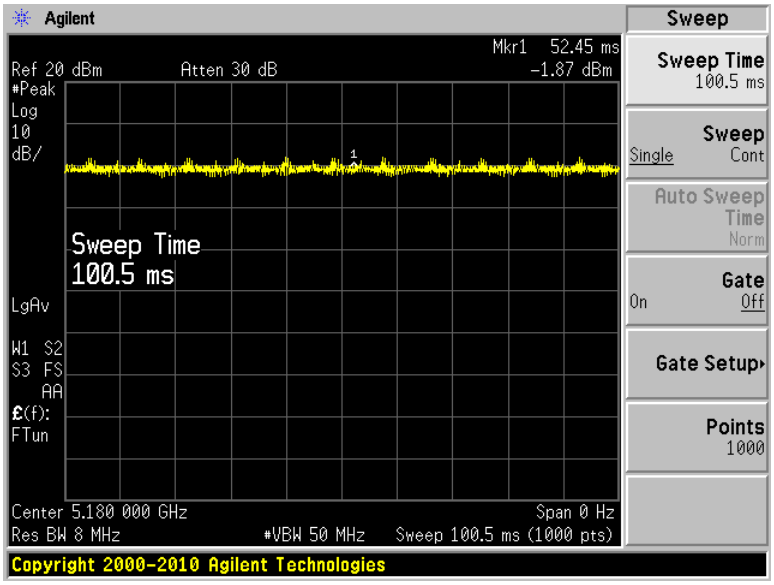
All measurements are to be performed with the EUT transmitting at 100% duty cycle at its maximum power control level; however, if 100% duty cycle cannot be achieved, measurements of duty cycle, x, and maximum-power transmission duration, T, are required for each tested mode of operation.

Frequency Band	Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
5 GHz	802.11a	100	100	100	0
	802.11n20	100	100	100	0

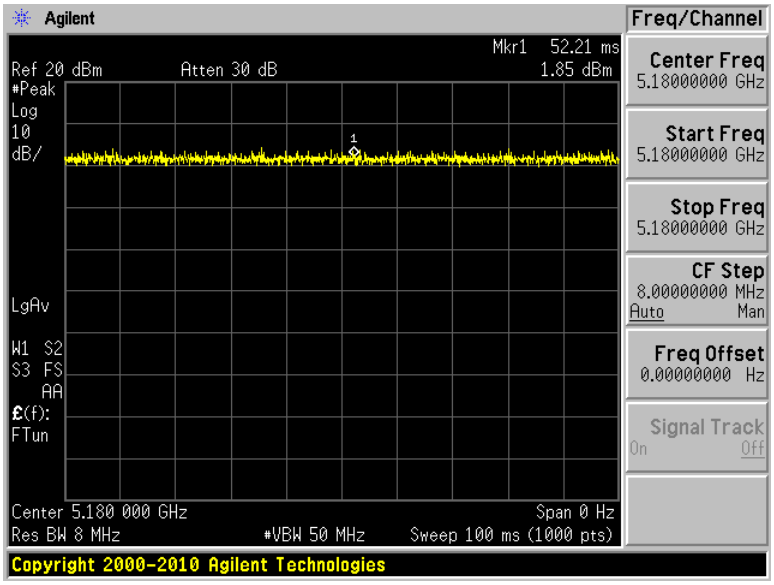
Note: Duty Cycle Correction Factor = 10*log(1/duty cycle)

Please refer to the following plots.

802.11a mode



802.11 n20/ac20 mode



2.4 Equipment Modifications

None

2.5 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E7450

2.6 Support Equipment

Manufacturer	Description	Model
Roku	Debug Board	-

2.7 Interface Ports and Cabling

Cable Description	Length (m)	To	From
RF Cable (WFL-SMA)	< 1 m	EUT	PSA
Standard USB Adapter (A-Male to B-Male)	< 1m	Laptop	EUT
Ribbon Cable	< 1m	EUT	Dubug/Programmer Board

3 Summary of Test Results

FCC Rules	Description of Test	Result
§2.1093, §15.407(f),	RF Exposure	Compliant
§15.203	Antenna Requirement	Compliant
§15.207	AC Power Line Conducted Emissions	N/A*
§2.1053, §15.205, §15.209, 15.407(b)	Spurious Radiated Emissions	Compliant
§15.407(e)	Emission Bandwidth	Compliant
§15.407(a)	Output Power	Compliant
§2.1051, §15.407(b)	Band Edges	Compliant
§15.407(a)	Power Spectral Density	Compliant
§2.1051, §15.407(b)	Spurious Emissions at Antenna Terminals	Compliant

Note: The EUT is powered by two AA batteries only, AC Power Line Conducted Emissions test does not apply.

4 FCC §2.1093 & §15.407(f) - RF Exposure

4.1 Applicable Standard

According to FCC KDB 447498 D01 General RF Exposure Guidance v05r02 Section 4.3.1, Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition, listed below, is satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The minimum test separation distance is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander (see 5) of section 4.1). To qualify for SAR test exclusion, the test separation distances applied must be fully explained and justified by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, typically in the SAR measurement or SAR analysis report, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting is required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for the SAR test exclusion. When required, the device specific conditions described in the other published RF exposure KDB procedures must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops & tablets etc.

1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

   [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

   • f(GHz) is the RF channel transmit frequency in GHz
   • Power and distance are rounded to the nearest mW and mm before calculation
   • The result is rounded to one decimal place for comparison
   • 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

   The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

2) At 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following, and as illustrated in Appendix B:

   a) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW, at 100 MHz to 1500 MHz
   b) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz

3) At frequencies below 100 MHz, the following may be considered for SAR test exclusion, and as illustrated in Appendix C:

   a) The power threshold at the corresponding test separation distance at 100 MHz in step 2) is multiplied by [1 + log(100/f(MHz))] for test separation distances > 50 mm and < 200 mm
   b) The power threshold determined by the equation in a) for 50 mm and 100 MHz is multiplied by ½ for test separation distances ≤ 50 mm

c) SAR measurement procedures are not established below 100 MHz. When SAR test exclusion cannot be applied, a KDB inquiry is required to determine SAR evaluation requirements for any test results to be acceptable.

4.2 RF Exposure Evaluation Results

Customer declares the separation distance between antenna and user's hand is 10mm.

The turn-up conducted power report was 6.01 dBm (3.99 mW).

According to KDB 447498D01, [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR.

(3.99/10)* √5.24=0.913 which is less than 7.5

SAR testing for this device is excluded.

5 FCC §15.203 - Antenna Requirements

5.1 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.

5.2 Antenna List

The antennas used by the EUT are permanent attached antennas.

	Antenna Usage	Frequency Range (MHz)	Antenna Type	Antenna Gain (dBi)
Antenna 1	Wi-Fi	5000-6000	Dual-band Chip Antenna	4.5
Antenna 2	Wi-Fi	5000-6000	Dual-band Chip Antenna	3.7

6 FCC §15.205, §15.209 & §15.407(b) - Spurious Radiated Emissions

6.1 Applicable Standard

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

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	960 – 1240	4. 5 – 5. 15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5. 35 – 5. 46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 –167.17	3.332 – 3.339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3 3458 – 3 358	23.6 – 24.0
12.29 – 12.293	240 – 285	3.600 – 4.400	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4		36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per FCC §15.209: 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.

(4) For transmitters operating in the 5.725-5.85 GHz band: All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall noet exceed an e.i.r.p. of -27 dBm/MHz.

(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.

6.2 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 limits.

The spacing between the peripherals was 10 centimeters.

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

6.3 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 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

6.4 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 A. The equation for margin calculation is as follows:

$$Margin = Corrected\ Amplitude - Limit$$

6.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2018-07-05	2 years
Agilent	Analyzer, Spectrum	E4446A	US44300386	2019-08-24	1 year
Sunol Sciences	System Controller	SC99V	011003-1	N/R	N/A
Sunol Sciences	Antenna, Biconi-Log	JB3	A020106-2	2019-11-20	2 years
ETS Lindgren	Horn Antenna	3117	00218973	2019-02-13	2 years
HP	Amplifier, Pre	8447D	2443A04374	2019-08-13	1 year
Agilent	Preamplifier	8449B	3147A00400	2020-02-17	1 year
Wisewave	Antenna, Horn	ARH-4223-02	10555-02	2020-02-05	2 years
Wisewave	Antenna, Horn	ARH-2823-02	10555-01	2020-02-05	2 years
AH Systems	Preamplifier	PAM 1840 VH	170	2019-09-24	1 year
IW Microwave	150 Series 2.92mm Cable	KPS1501AN-3780-KPS	DC 1925	2019-09-11	1 year
MDP Digital	Times Microwave LMR 400 UltraFex Coaxial Cable 35\'	LMR400UF	BACL1904161	2020-05-20	1 year
-	SMA cable	-	C0002	Each time[1]	N/A
-	N-Type Cable	-	C00012	Each time[1]	N/A
-	N-Type Cable	-	C00014	Each time[1]	N/A
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note[1]: cables and attenuators included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL *attests that all calibrations have been performed per the A2LA requirements, traceable to NIST.*

6.6 Test Environmental Conditions

Temperature:	20-22 ºC
Relative Humidity:	42-45 %
ATM Pressure:	101.5 kPa

The testing was performed by Zhao Zhao and Matthew Riego de Dios 2020-06-10 to 2020-06-12 in 5m chamber 3

6.7 Summary of Test Results

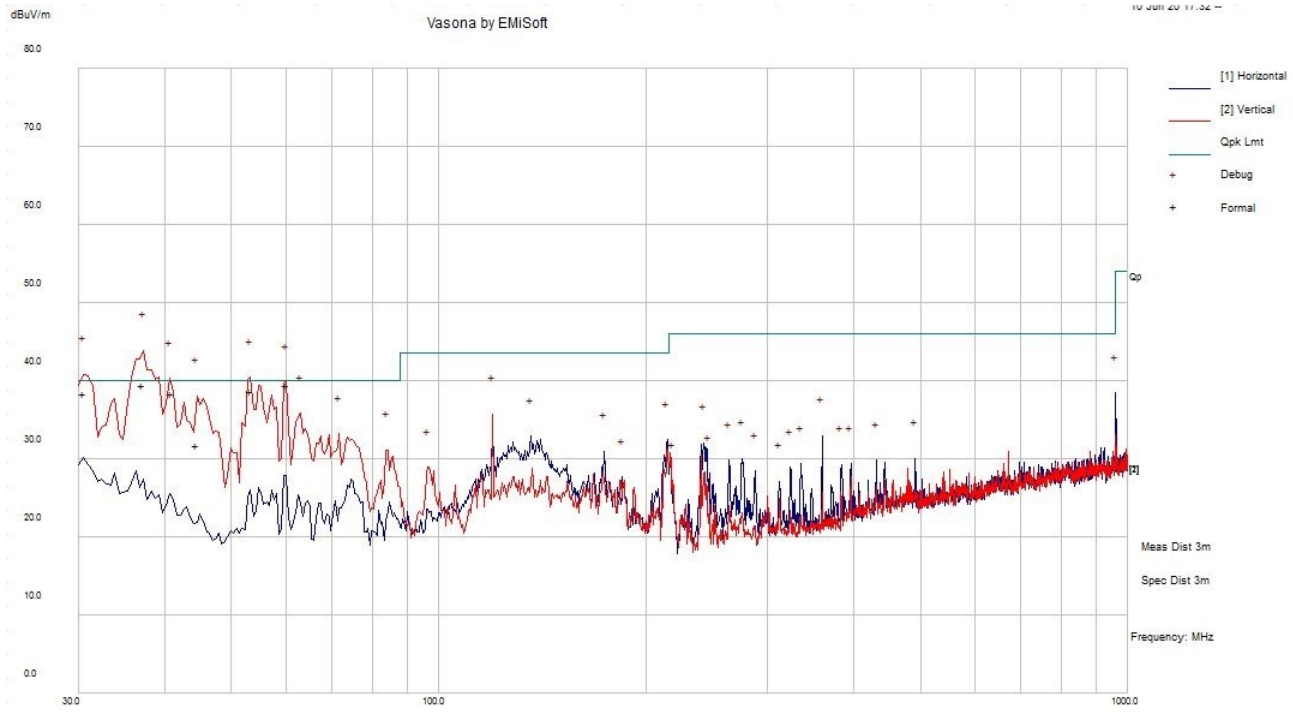
According to the data hereinafter, the EUT complied with the FCC Part 15.407 standards' radiated emissions limits, and had the worst margin of:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, Channel**
-0.14	5150	Horizontal	802.11a mode low channel

6.8 Radiated Emissions Test Result Data

1) 30 MHz – 1 GHz at 3m

Worst case



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
37.2185	39.6	103	V	105	40	-0.4	QP
30.5125	38.44	143	V	44	40	-1.56	QP
53.2725	38.7	134	V	316	40	-1.3	QP
40.8605	38.4	101	V	79	40	-1.6	QP
60	39.54	179	V	57	40	-0.46	QP
44.48875	31.72	159	V	214	40	-8.28	QP

2) 1–40 GHz

Band-edge emissions were measured at 3m, harmonic emissions were measured at 1m.

5150 - 5250 MHz

802.11a mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna Height (cm)	Test Antenna Polarity (H/V)	Test Antenna Factor (dB/m)	Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC Limit (dBµV/m)	FCC Margin (dB)	Comments (PK/Ave.)
Low Channel 5180 MHz											
5150	56.19	197	147	H	35.50	8.62	34.91	65.40	74.00	-8.61	PK
5150	41.37	197	147	H	35.50	8.62	34.91	50.58	54.00	-3.43	AV
5150	53.75	175	191	V	35.50	8.62	34.91	62.96	74.00	-11.05	PK
5150	40.77	175	191	V	35.50	8.62	34.91	49.98	54.00	-4.02	AV
10360	45.35	0	100	H	38.10	12.05	35.74	59.76	78.00	-18.24	PK
10360	45.52	0	100	V	38.10	12.05	35.74	59.93	78.00	-18.07	PK
15540	44.06	0	100	H	40.40	18.95	33.70	69.71	84.00	-14.29	PK
15540	32.24	0	100	H	40.40	18.95	33.70	57.89	64.00	-6.11	AV
15540	44.85	0	100	H	40.40	18.95	33.70	70.50	84.00	-13.50	PK
15540	33.09	0	100	H	40.40	18.95	33.70	58.74	64.00	-5.26	AV
Middle Channel 5200 MHz											
10400	45.35	0	100	H	38.10	12.05	35.49	60.01	78.00	-17.99	PK
10400	45.52	0	100	V	38.10	12.05	35.49	60.18	78.00	-17.82	PK
15600	44.06	0	100	H	40.40	18.95	33.70	69.71	84.00	-14.29	PK
15600	32.24	0	100	H	40.40	18.95	33.70	57.89	64.00	-6.11	AV
15600	43.38	0	100	V	40.40	18.95	33.70	69.03	84.00	-14.97	PK
15600	31.67	0	100	V	40.40	18.95	33.70	57.32	64.00	-6.68	AV
High Channel 5240 MHz											
10480	44.26	0	100	H	38.20	12.05	35.49	59.02	78.00	-18.98	PK
10480	43.61	0	100	V	38.20	12.05	35.49	58.37	78.00	-19.63	PK
15720	43.59	0	100	H	40.70	19.09	33.87	69.51	84.00	-14.49	PK
15720	32.14	0	100	H	40.70	19.09	33.87	58.06	64.00	-5.94	AV
15720	43.87	0	100	V	40.70	19.09	33.87	69.79	84.00	-14.21	PK
15720	32.38	0	100	V	40.70	19.09	33.87	58.30	64.00	-5.70	AV

802.11n20/ac20 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	64.65	197	147	H	35.50	8.62	34.91	73.86	74.00	**-0.14**	PK
5150	43.41	197	147	H	35.50	8.62	34.91	52.62	54.00	-1.39	AV
5150	59.02	175	191	V	35.50	8.62	34.91	68.23	74.00	-5.77	PK
5150	41.53	175	191	V	35.50	8.62	34.91	50.74	54.00	-3.27	AV
10360	45.88	0	100	H	38.10	12.05	35.74	60.29	78.00	-17.71	PK
10360	45.75	0	100	V	38.10	12.05	35.74	60.16	78.00	-17.84	PK
15540	45.59	0	100	H	40.40	18.95	33.70	71.24	84.00	-12.76	PK
15540	33.78	0	100	H	40.40	18.95	33.70	59.43	64.00	-4.57	AV
15540	45.58	0	100	V	40.40	18.95	33.70	71.23	84.00	-12.77	PK
15540	33.61	0	100	V	40.40	18.95	33.70	59.26	64.00	-4.74	AV
Middle Channel 5200 MHz											
10400	45.09	0	100	H	38.10	12.05	35.49	59.75	78.00	-18.25	PK
10400	44.72	0	100	V	38.10	12.05	35.49	59.38	78.00	-18.62	PK
15600	44.54	0	100	H	40.40	18.95	33.70	70.19	84.00	-13.81	PK
15600	32.50	0	100	H	40.40	18.95	33.70	58.15	64.00	-5.85	AV
15600	44.88	0	100	V	40.40	18.95	33.70	70.53	84.00	-13.47	PK
15600	32.33	0	100	V	40.40	18.95	33.70	57.98	64.00	-6.02	AV
High Channel 5240 MHz											
10480	44.33	0	100	H	38.20	12.05	35.49	59.09	78.00	-18.91	PK
10480	43.58	0	100	V	38.20	12.05	35.49	58.34	78.00	-19.66	PK
15720	44.91	0	100	H	40.70	19.09	33.87	70.83	84.00	-13.17	PK
15720	32.35	0	100	H	40.70	19.09	33.87	58.27	64.00	-5.73	AV
15720	43.65	0	100	V	40.70	19.09	33.87	69.57	84.00	-14.43	PK
15720	32.23	0	100	V	40.70	19.09	33.87	58.15	64.00	-5.85	AV

5725 - 5850 MHz

802.11a mode

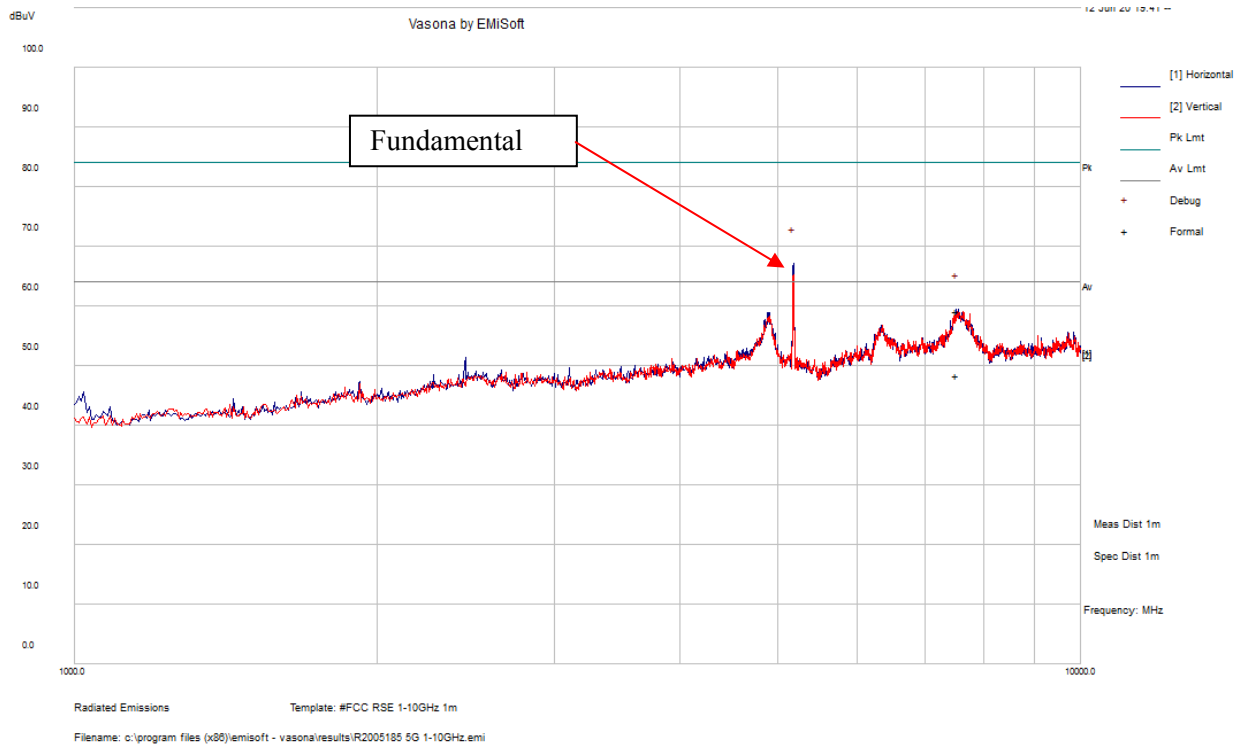
Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments (PK/Ave.)
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 5745 MHz											
11490	43.89	0	100	H	38.70	14.68	34.47	62.80	84.00	-21.20	PK
11490	33.52	0	100	H	38.70	14.68	34.47	52.43	64.00	-11.57	AV
11490	32.69	0	100	V	38.70	14.68	34.47	51.60	84.00	-32.40	PK
11490	43.48	0	100	V	38.70	14.68	34.47	62.39	64.00	-1.61	AV
17235	43.76	0	100	H	41.80	17.85	32.84	70.57	78.00	-7.43	PK
17235	43.88	0	100	H	41.80	17.85	32.84	70.69	78.00	-7.31	PK
Middle Channel 5785 MHz											
11570	43.96	0	100	H	38.90	14.77	34.47	63.16	84.00	-20.84	PK
11570	31.40	0	100	H	38.90	14.77	34.47	50.60	64.00	-13.40	AV
11570	44.39	0	100	V	38.90	14.77	34.47	63.59	84.00	-20.41	PK
11570	31.86	0	100	V	38.90	14.77	34.47	51.06	64.00	-12.94	AV
17355	42.94	0	100	H	41.90	19.83	32.84	71.83	78.00	-6.17	PK
17355	43.43	0	100	V	41.90	19.83	32.84	72.32	78.00	-5.68	PK
High Channel 5825 MHz											
11650	43.51	0	100	H	38.90	14.60	34.49	62.52	84.00	-21.48	PK
11650	31.98	0	100	H	38.90	14.60	34.49	50.99	64.00	-13.01	AV
11650	43.67	0	100	V	38.90	14.60	34.49	62.68	84.00	-21.32	PK
11650	32.06	0	100	V	38.90	14.60	34.49	51.07	64.00	-12.93	AV
17475	43.06	0	100	H	41.80	18.20	32.73	70.33	78.00	-7.67	PK
17475	42.24	0	100	V	41.80	18.20	32.73	69.51	78.00	-8.49	PK

802.11n20/ac20 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	44.21	0	100	H	38.70	14.68	34.47	63.12	84.00	-20.88	PK
11490	32.51	0	100	H	38.70	14.68	34.47	51.42	64.00	-12.58	AV
11490	44.67	0	100	V	38.70	14.68	34.47	63.58	84.00	-20.42	PK
11490	32.70	0	100	V	38.70	14.68	34.47	51.61	64.00	-12.39	AV
17235	43.80	0	100	H	41.80	17.85	32.84	70.61	78.00	-7.39	PK
17235	44.02	0	100	V	41.80	17.85	32.84	70.83	78.00	-7.17	PK
Middle Channel 5785 MHz											
11570	44.07	0	100	H	38.90	14.77	34.47	63.27	84.00	-20.73	PK
11570	32.32	0	100	H	38.90	14.77	34.47	51.52	64.00	-12.48	AV
11570	44.70	0	100	V	38.90	14.77	34.47	63.90	84.00	-20.10	PK
11570	31.58	0	100	V	38.90	14.77	34.47	50.78	64.00	-13.22	AV
17355	42.94	0	100	H	41.90	19.83	32.84	71.83	78.00	-6.17	PK
17355	43.43	0	100	V	41.90	19.83	32.84	72.32	78.00	-5.68	PK
High Channel 5825 MHz											
11650	44.62	0	100	H	38.90	14.60	34.49	63.63	84.00	-20.37	PK
11650	32.08	0	100	H	38.90	14.60	34.49	51.09	64.00	-12.91	AV
11650	43.06	0	100	V	38.90	14.60	34.49	62.07	84.00	-21.93	PK
11650	32.44	0	100	V	38.90	14.60	34.49	51.45	64.00	-12.55	AV
17475	42.26	0	100	H	41.80	18.20	32.73	69.53	78.00	-8.47	PK
17475	43.08	0	100	V	41.80	18.20	32.73	70.35	78.00	-7.65	PK

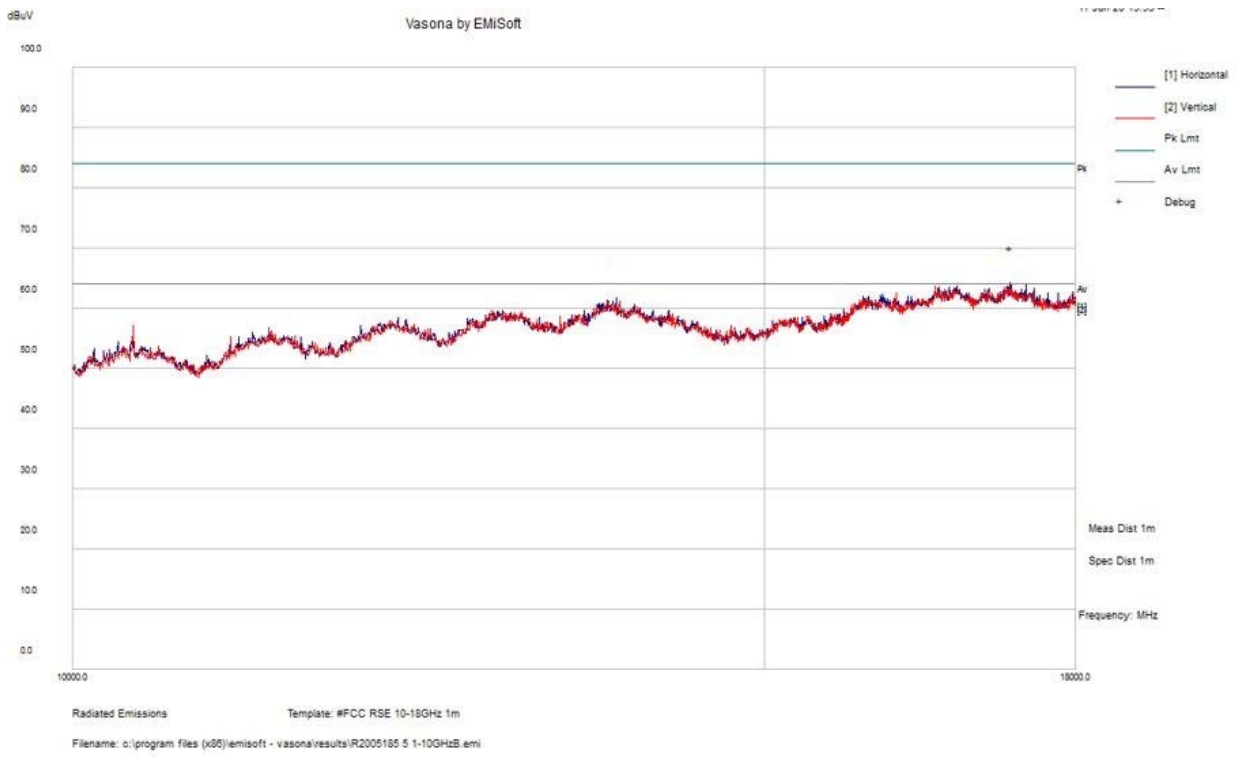
Note: pre-scanned each antenna, and the final testing was done on the worst case antenna.

3) 1–10 GHz Graph at 1m



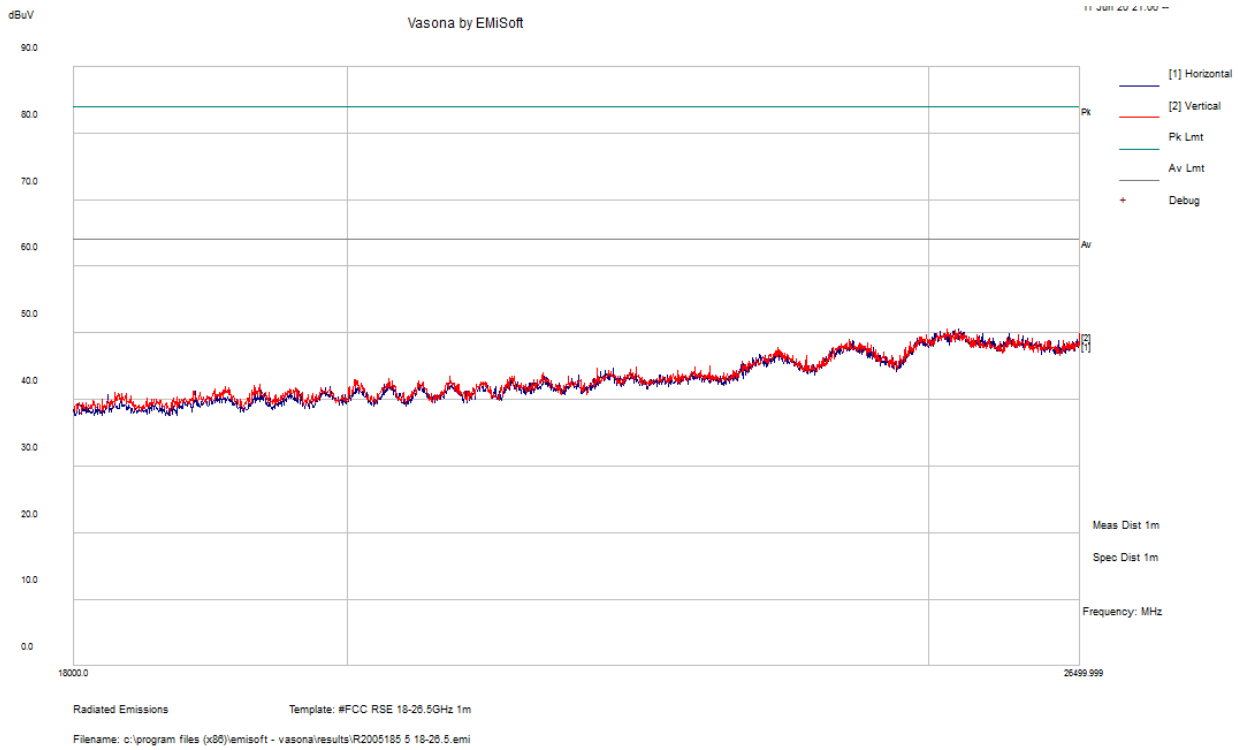
Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
7517.375	59.22	258	H	333	84	-24.78	PK
7517.375	48.39	258	H	333	64	-15.61	AV

4) 10–18 GHz Graph at 1m

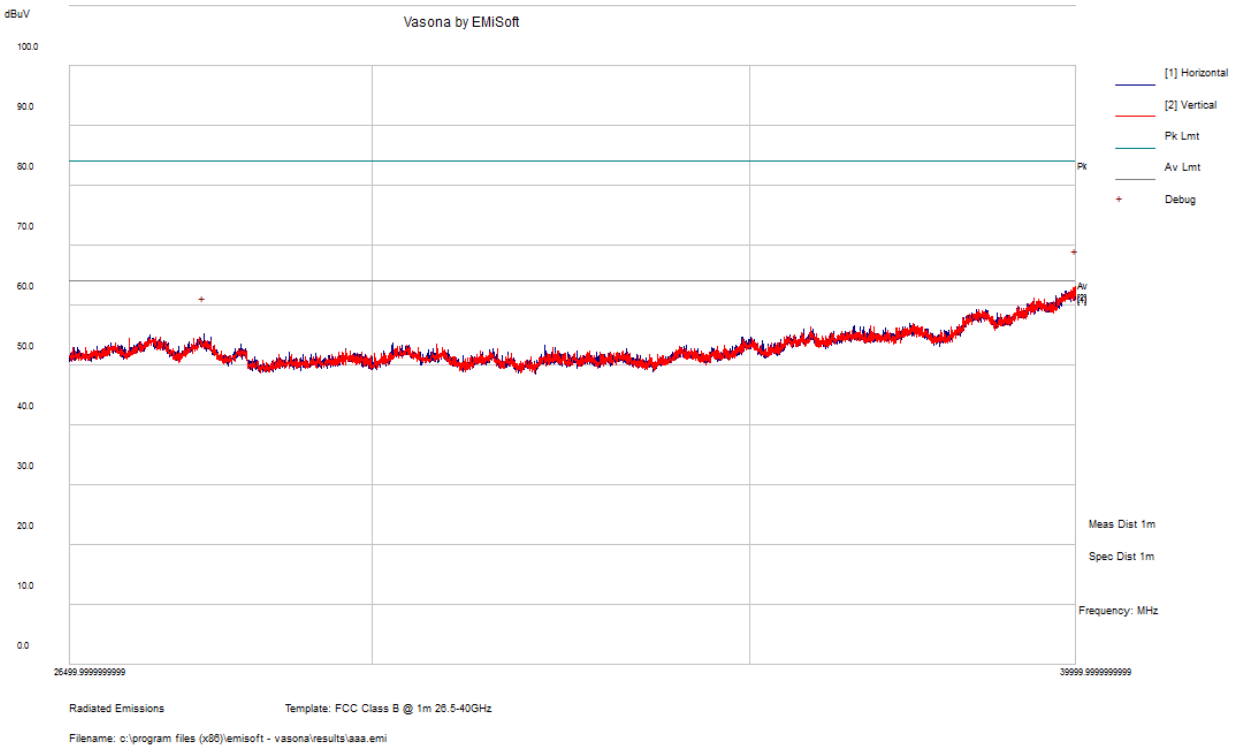


Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
17318.31	67.88	274	H	352	84	-16.12	PK
17318.31	56.86	183	V	225	64	-7.14	AV

5) 18–26.5 GHz Graph at 1m



6) 26.5–40 GHz Graph at 1m



7 FCC §15.407(e) - 6 dB, 26 dB & 99% Occupied Bandwidth

7.1 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.

7.2 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.

7.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2020-04-29	1 year
-	RF Cable	-	-	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 calibrations have been performed per the A2LA requirements, traceable to the NIST.*

7.4 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	101.5 KPa

The testing was performed by Zhao Zhao on 2020-06-02 in RF site.

7.5 Test Results

5150 - 5250 MHz

Channel	Frequency (MHz)	99% OBW (kHz)	26 dB OBW (kHz)
802.11 a mode			
36	5180	16549.2	20776
40	5200	16547.1	20701
48	5240	16550.3	20790
802.11 n20/ac20 mode			
36	5180	17654.7	21595
40	5200	17653.4	21621
48	5240	17638.2	21555

5725 - 5850 MHz

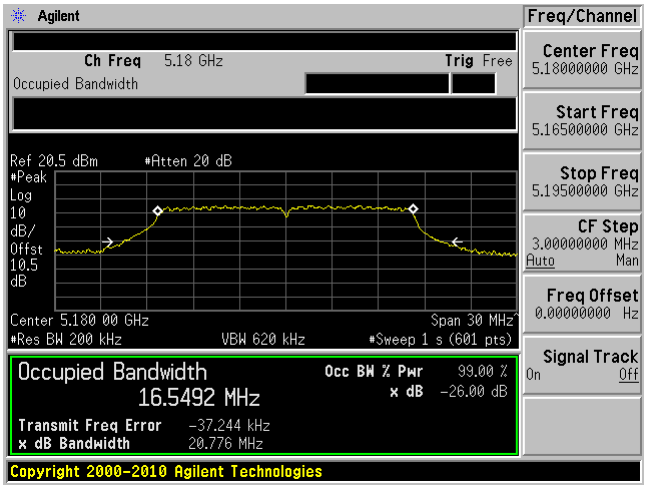
Channel	Frequency (MHz)	99% OBW (kHz)	6 dB OBW (kHz)	6 dB OBW limit (kHz)
802.11 a mode				
149	5745	16528.6	16520	≥ 500
157	5785	16529.8	16519	≥ 500
165	5825	16528.6	16500	≥ 500
802.11 n20/ac20 mode				
149	5745	17629.5	17664	≥ 500
157	5785	17631.0	17668	≥ 500
165	5825	17630.9	17669	≥ 500

5150 – 5250 MHz

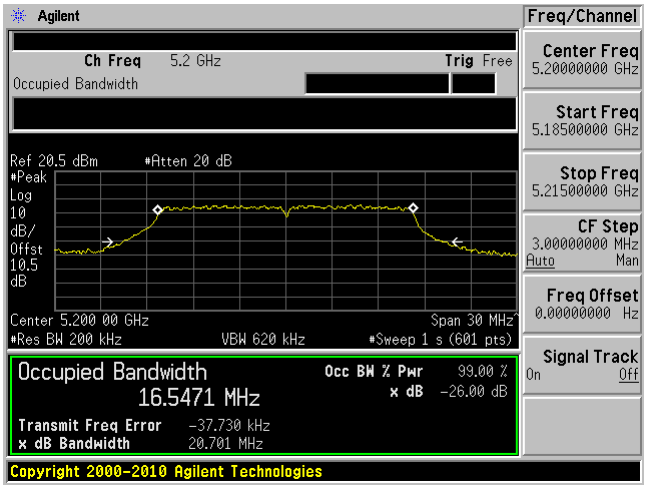
99% OBW & 26 dB OBW

802.11a mode

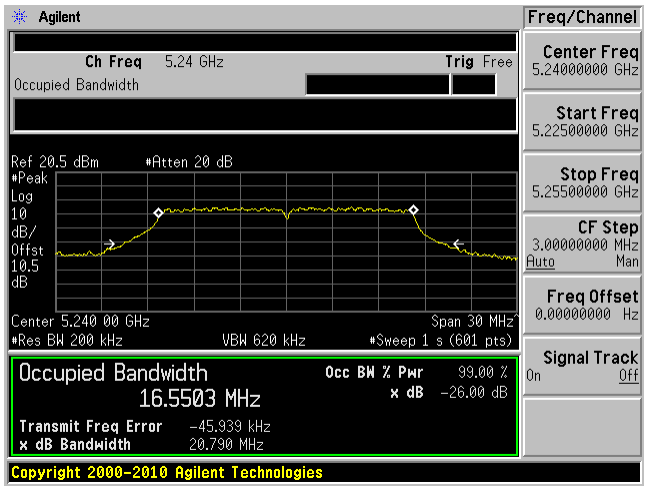
5180 MHz



5200 MHz

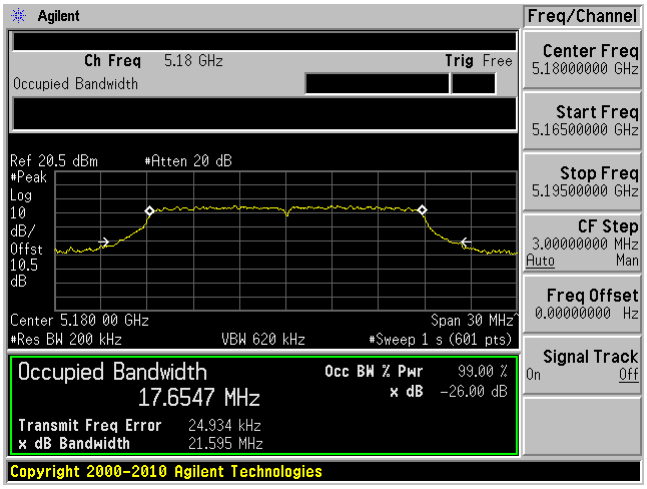


5240 MHz

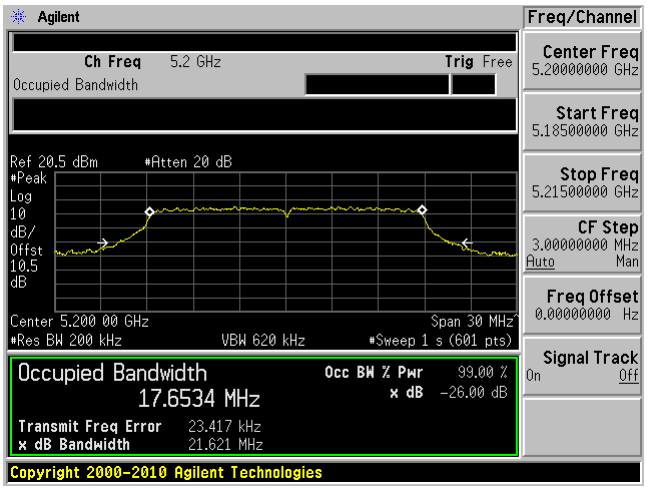


802.11n20/ac20 mode

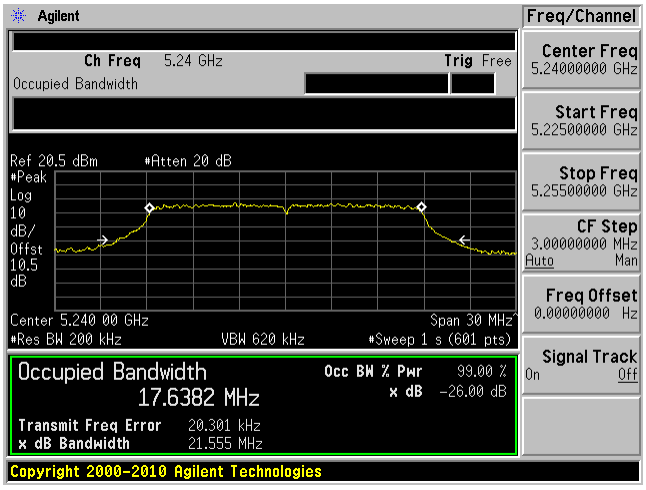
5180 MHz



5200 MHz



5240 MHz

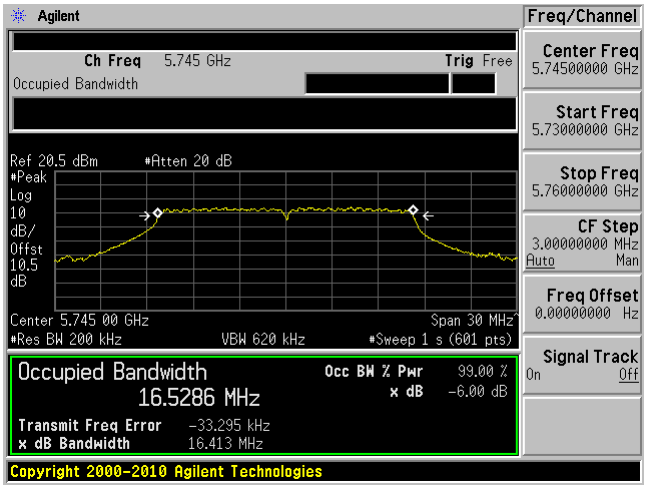


5725 – 5850 MHz

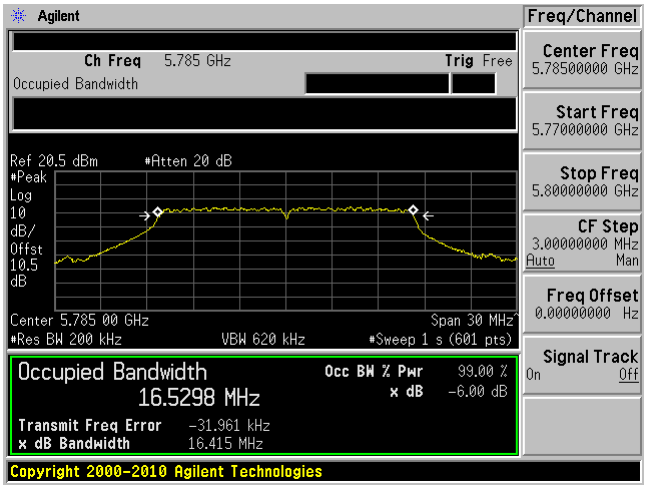
99% OBW

802.11a mode

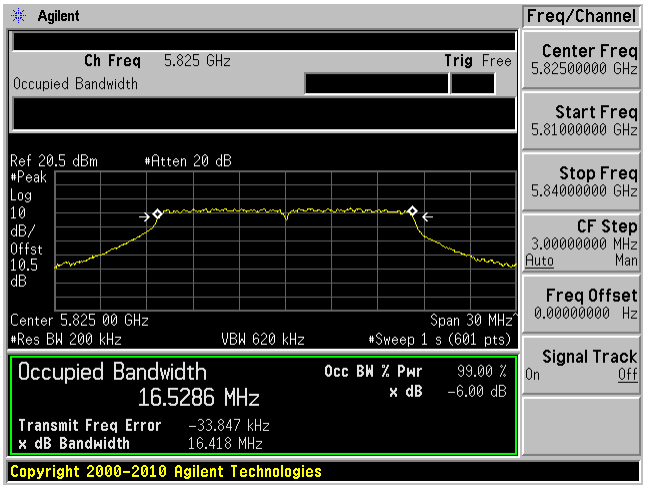
5745 MHz



5785 MHz

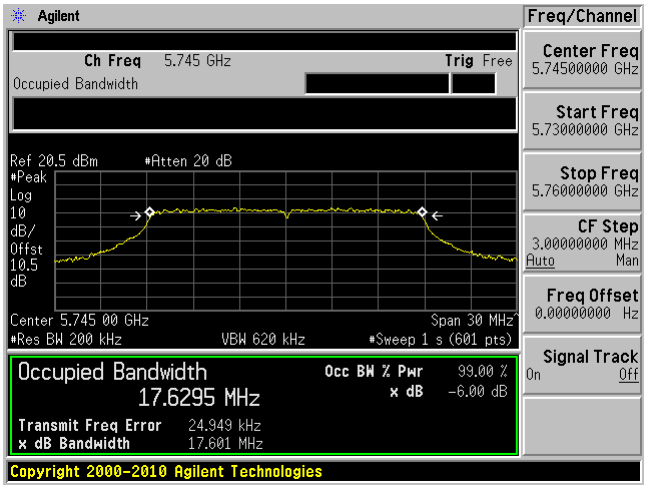


5825 MHz

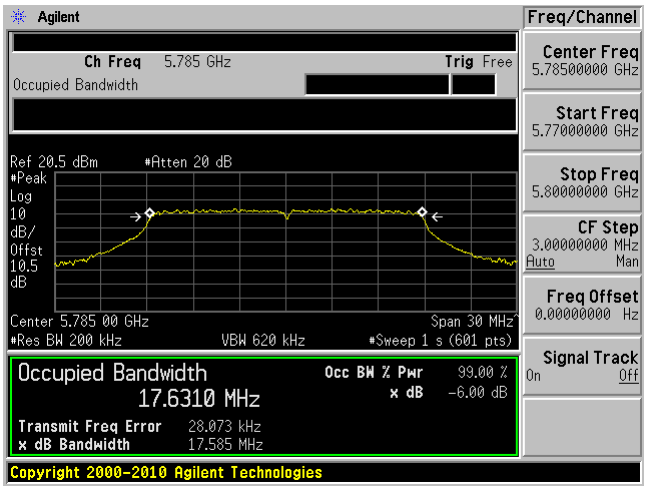


802.11n20/ac20 mode

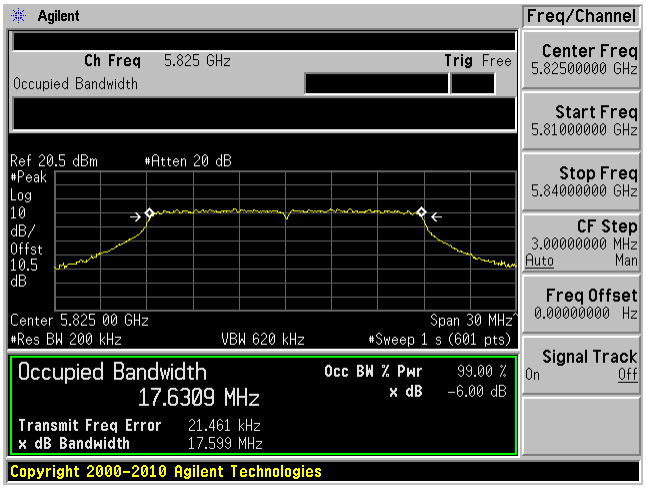
5745 MHz



5785 MHz



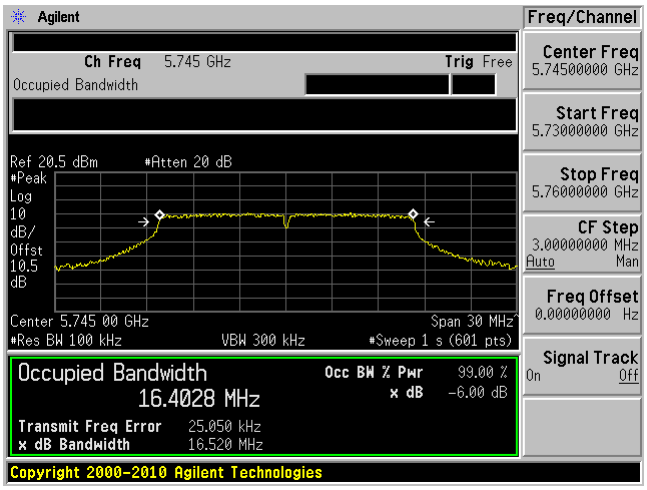
5825 MHz



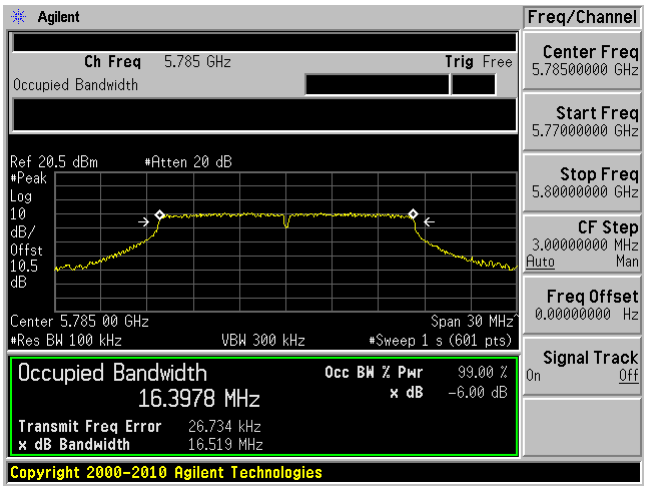
6 dB OBW

802.11a mode

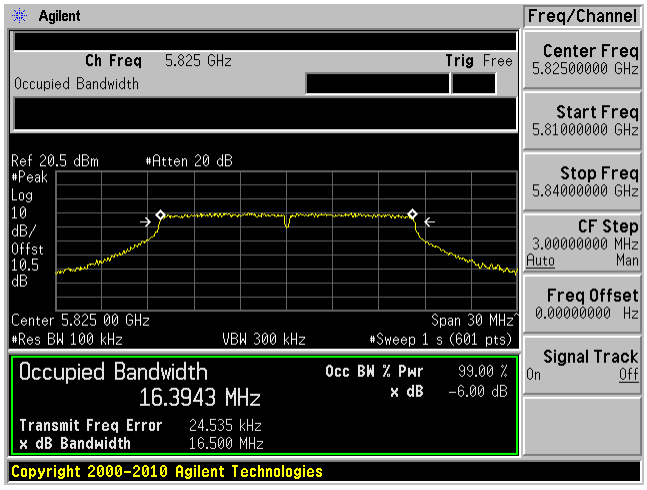
5745 MHz



5785 MHz

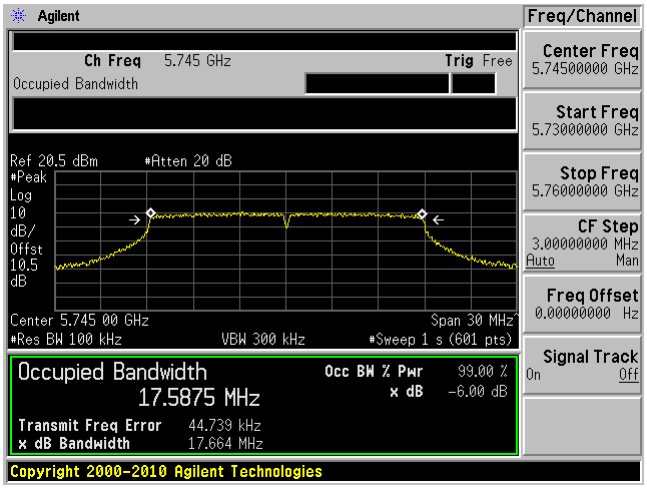


5825 MHz

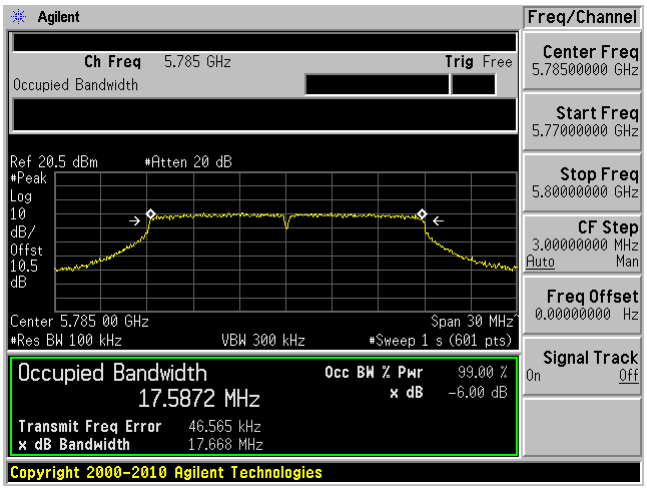


802.11n20/ac20 mode

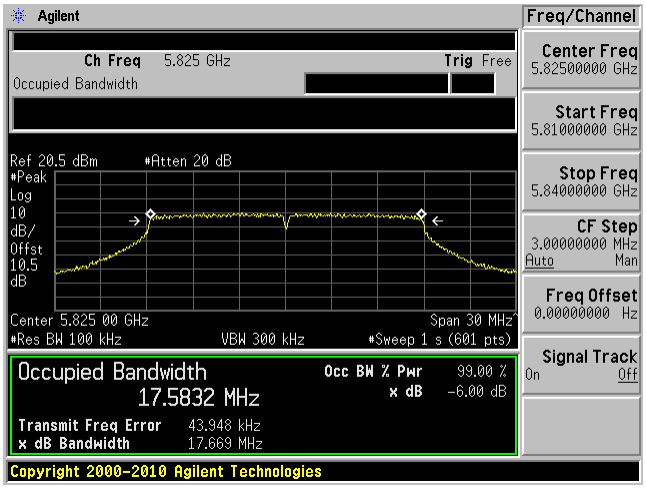
5745 MHz



5785 MHz



5825 MHz



8 FCC §407(a) - Output Power

8.1 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 e.i.r.p. shall not exceed 1.0 W or 17 + 10 log10B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

8.2 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.

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
ETS-LINDGREN	Power Sensor	7002-006	160097	2018-12-31	2 years
-	RF Cable	-	-	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 calibrations have been performed per the A2LA requirements, traceable to the NIST.*

8.4 Test Environmental Conditions

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

The testing was performed by Christopher Casteel on 2020-06-17 in RF site.

8.5 Test Results

5150 - 5250 MHz

Modulation	Frequency (MHz)	Conducted Average Power (dBm)	Limit (dBm)
802.11a	5180	5.85	24
	5200	5.74	24
	5240	5.94	24
802.11n20/ac20	5180	5.82	24
	5200	5.84	24
	5240	6.01	24

5725 - 5850 MHz

Modulation	Frequency (MHz)	Conducted Average Power (dBm)	Limit (dBm)
802.11a	5745	3.96	30
	5785	3.86	30
	5825	3.89	30
802.11n20/ac20	5745	3.99	30
	5785	3.98	30
	5825	3.98	30

9 FCC §15.407(a) - Power Spectral Density

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

(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.

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2020-04-29	1 year
-	RF Cable	-	-	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 calibrations have been performed per the A2LA requirements, traceable to the NIST.*
.

9.4 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	101.5 KPa

The testing was performed by Zhao Zhao on 2020-06-02 in RF site.

9.5 Test Results

5150 – 5250 MHz

Frequency (MHz)	Measured PSD (dBm/MHz)	Limit (dBm/MHz)
802.11a mode		
5180	-4.674	11
5200	-4.284	11
5240	-4.488	11
802.11n20/ac20 mode		
5180	-4.500	11
5200	-4.442	11
5240	-2.820	11

5725 - 5850 MHz

Frequency (MHz)	Measured PSD (dBm/100 kHz)	Corrected PSD (dBm/500 kHz)	Limit (dBm/500 kHz)
802.11a mode			
5745	-14.887	-7.887	30
5785	-14.568	-7.568	30
5825	-15.500	-8.500	30
802.11n20/ac20 mode			
5745	-15.110	-8.110	30
5785	-15.040	-8.040	30
5825	-15.853	-8.853	30

Corrected PSD (dBm/MHz) = PSD (dBm/MHz) + Duty Cycle Correction (dB)

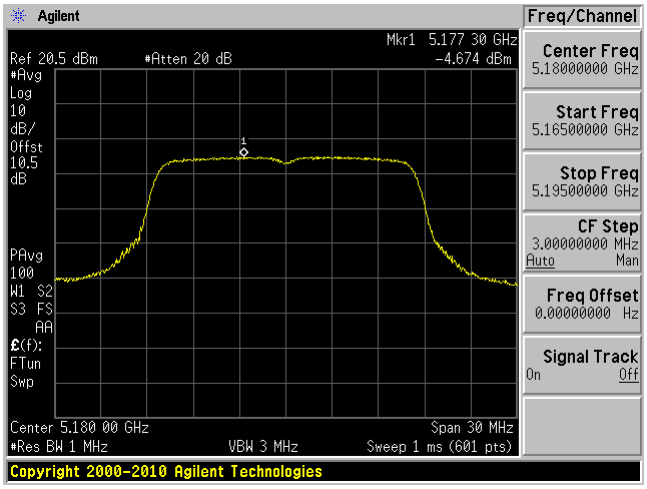
Note: For the 5725-5850 MHz band, the Corrected PSD (dBm/500 kHz) is equal to:
Correct PSD (dBm/500 kHz) = PSD (dBm/100 kHz) + Duty Cycle Correction (dB) + 10*log(500 kHz/100 kHz)

Please refer to the following plots.

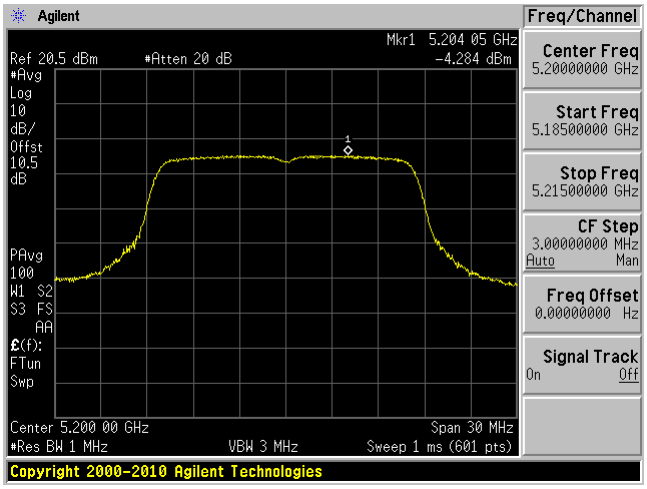
5150 – 5250 MHz

802.11a mode

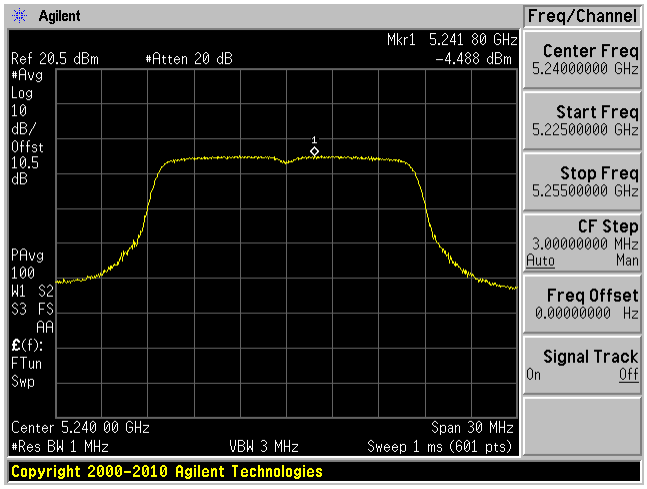
5180 MHz



5200 MHz

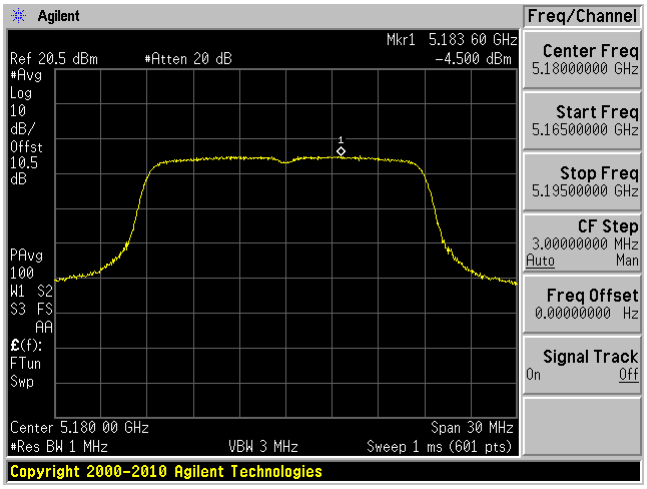


5240 MHz

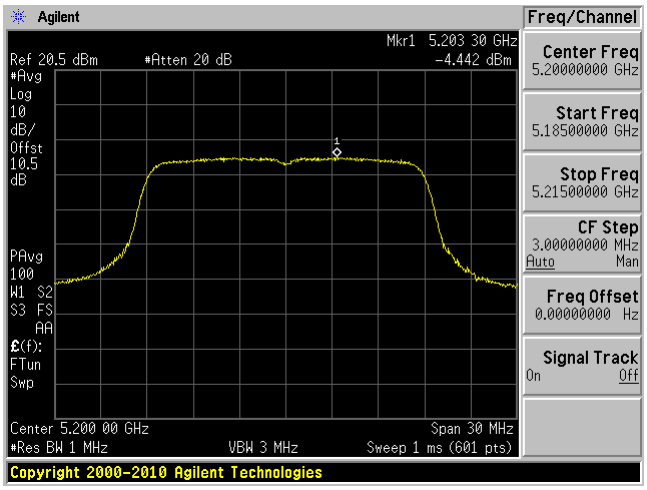


802.11n20/ac20 mode

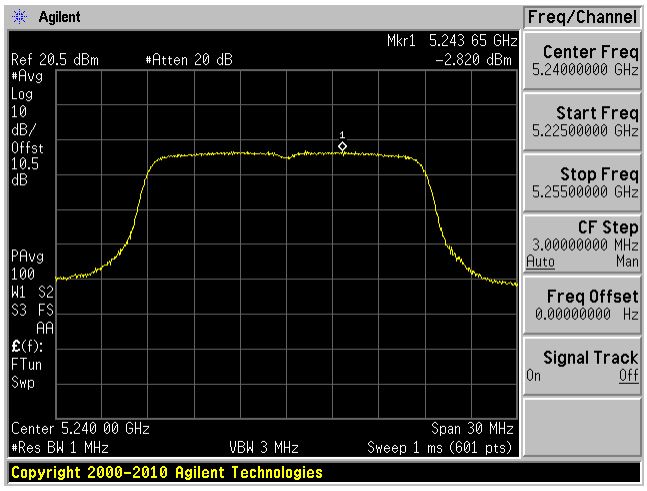
5180 MHz



5200 MHz



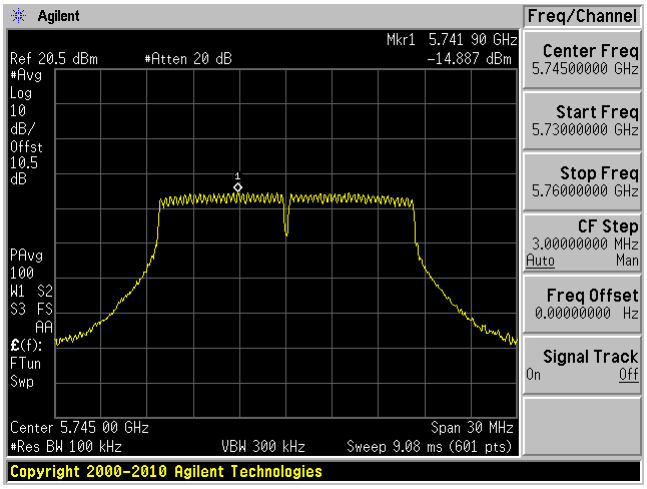
5240 MHz



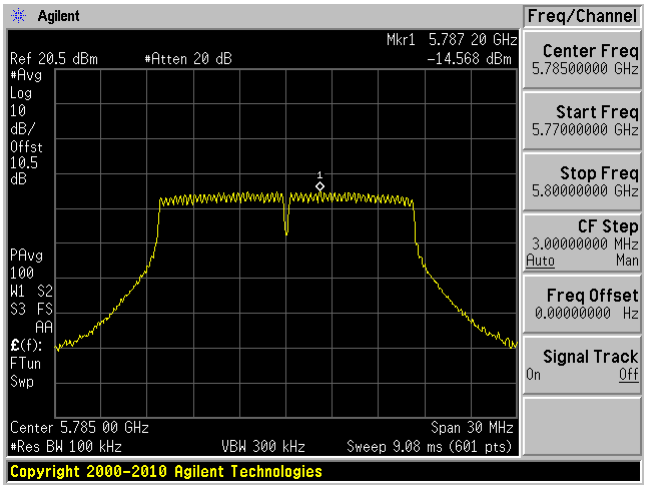
5725 – 5850 MHz

802.11a mode

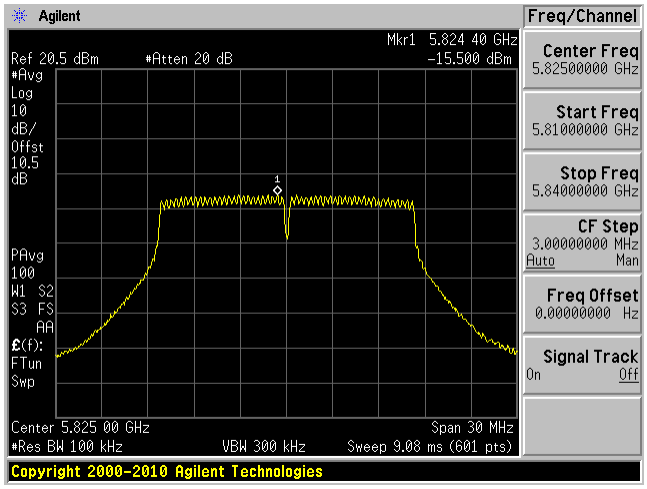
5745 MHz



5785 MHz

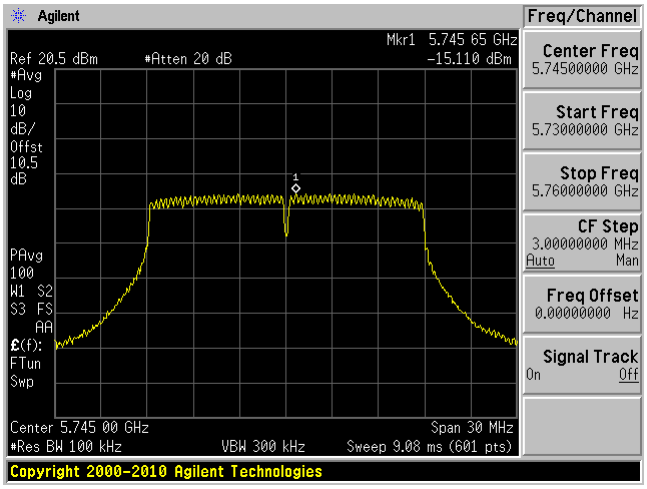


5825 MHz

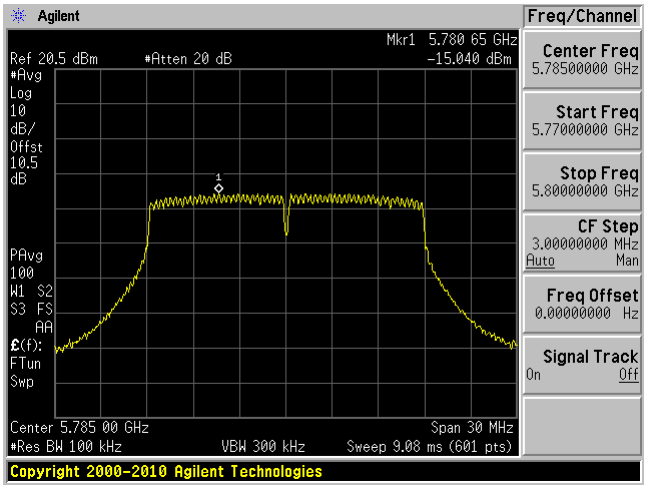


802.11n20/ac20 mode

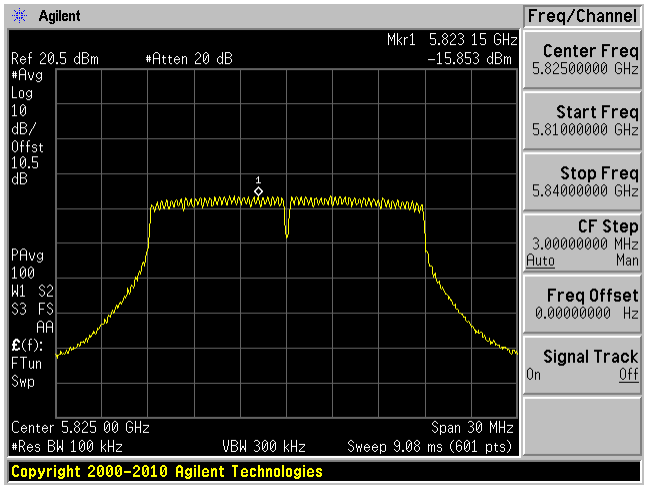
5745 MHz



5785 MHz



5825 MHz



10 FCC §15.407(b) - Out of Band Emissions

10.1 Applicable Standards

According to FCC §15.407(b):

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.

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.

For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

For transmitters operating in the 5.725-5.85 GHz band: 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.

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.

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

10.2 Measurement Procedure

Add a correction factor (antenna gain+ Attenuator loss+cable loss) to the offset of the spectrum analyzer.
Integration Method

1. For peak emissions measurements, follow the procedures described in section H)5), “Procedures for Peak Unwanted Emissions Measurements above 1000 MHz”, except for the following changes:

- Set RBW = 100 kHz
- Set VBW = 3RBW
- Perform a band-power integration across the 1 MHz bandwidth in which the band-edge emission level is to be measured. CAUTION: You must ensure that the spectrum analyzer or EMI receiver is set for peak-detection and max-hold for this measurement.

2. For average emissions measurements, follow the procedures described in section H)6), “Procedures for Average Unwanted Emissions Measurements above 1000 MHz”, except for the following changes:

- Set RBW = 100 kHz
- Set VBW = 3RBW
- Perform a band-power integration across the 1 MHz bandwidth in which the band-edge emission level is to be measured.

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4440A	US45303156	2020-04-29	1 year
Rhode & Schwarz	Signal Analyzer	FSV40	1321.3008K39-101203-UW	2019-08-06	1 year
-	RF Cable	-	-	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 calibrations have been performed per the A2LA requirements, traceable to the NIST.*
.

10.4 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	101.5 KPa

The testing was performed by Zhao Zhao on 2020-06-02 and 2020-06-17in RF site.

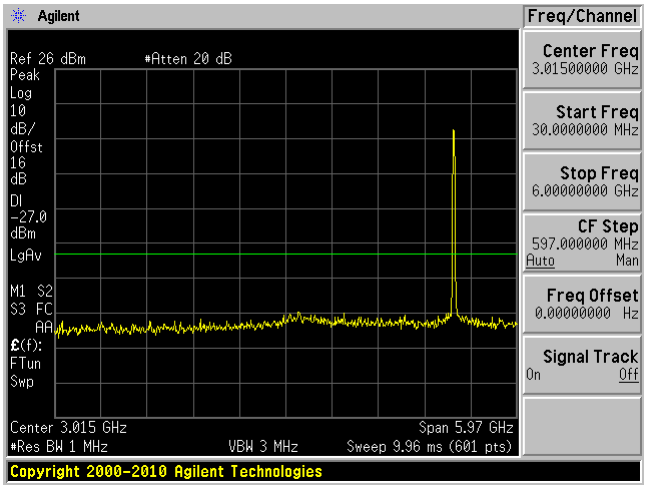
10.5 Test Results

Please refer to the following plots.

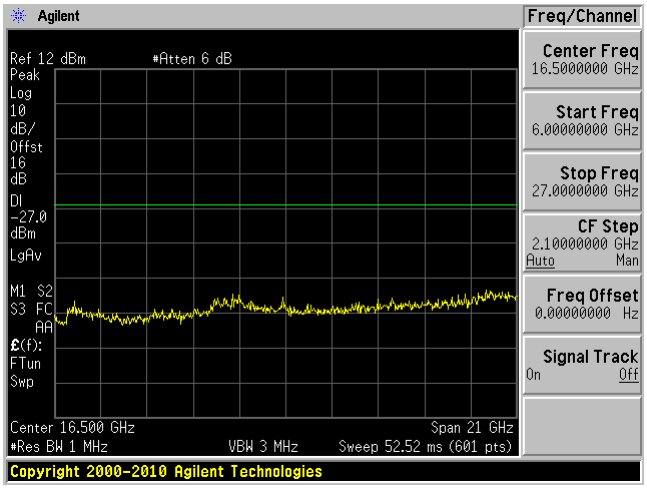
5150 - 5250 MHz

802.11a mode

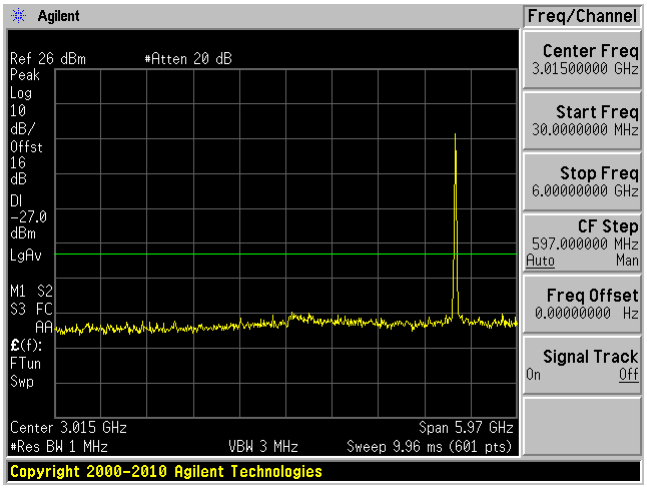
Low Channel 5180 MHz (30MHz-6GHz)



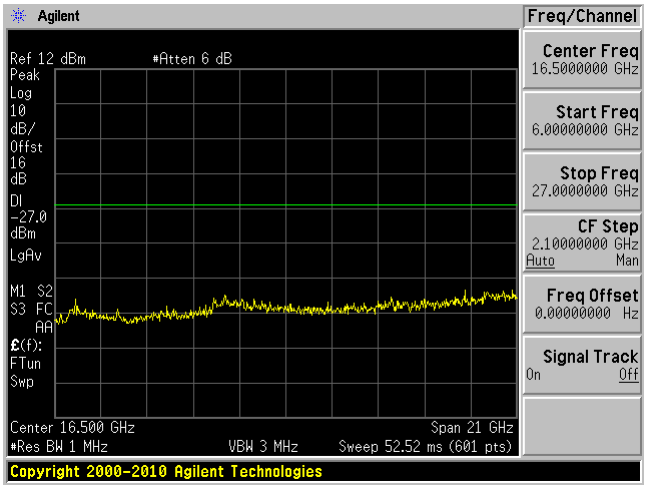
Low Channel 5180 MHz (6-40GHz)



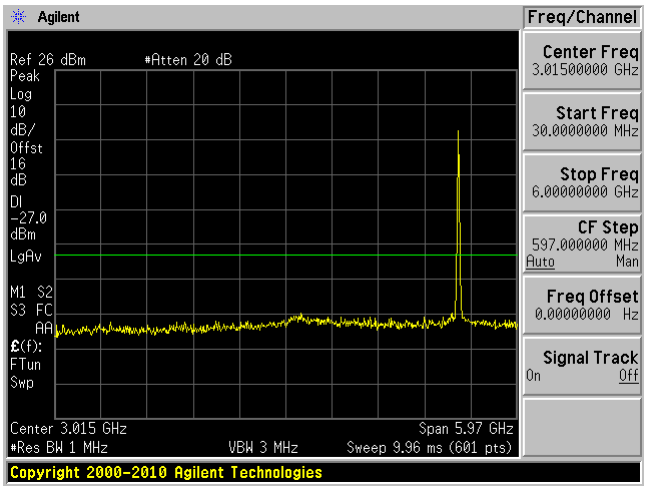
Middle Channel 5200 MHz (30MHz-6GHz)



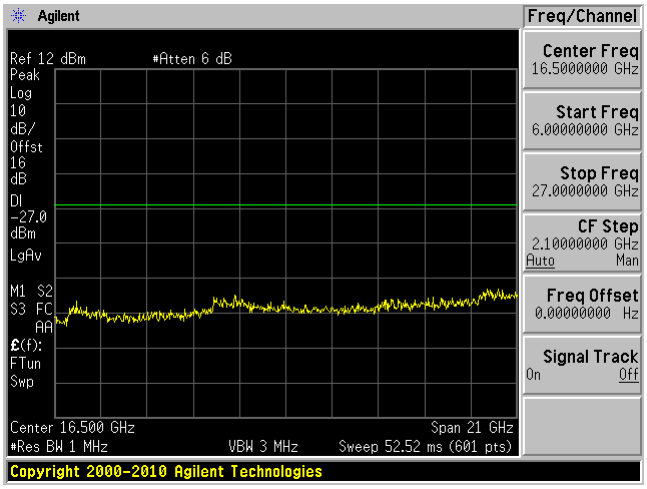
Middle Channel 5200 MHz (6-40GHz)



High Channel 5240 MHz (30MHz-6GHz)

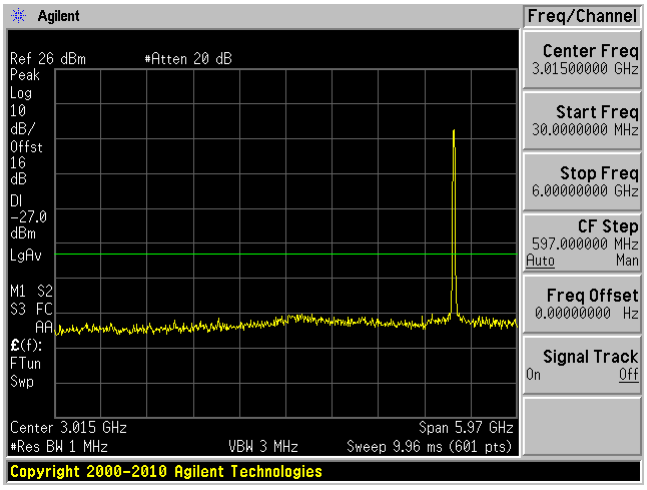


High Channel 5240 MHz (6-40GHz)

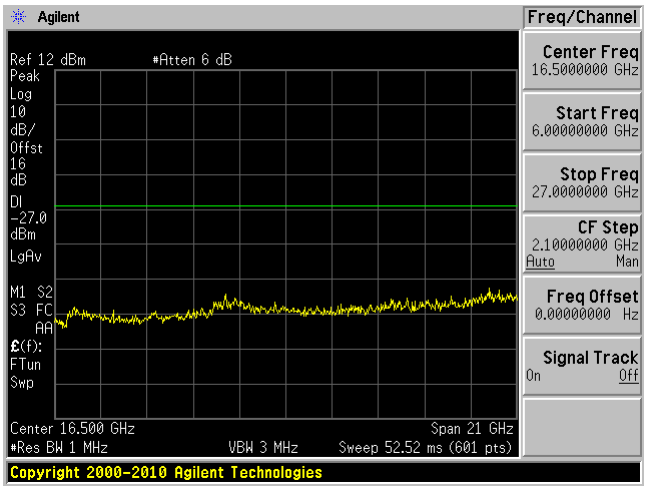


802.11n20/ac20 mode

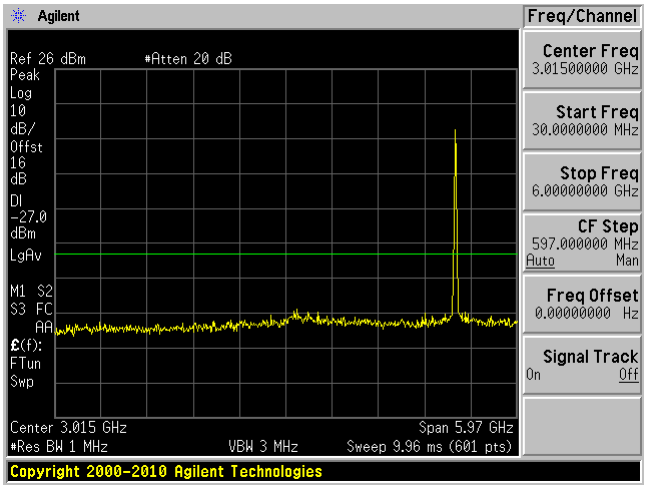
Low Channel 5180 MHz (30MHz-6GHz)



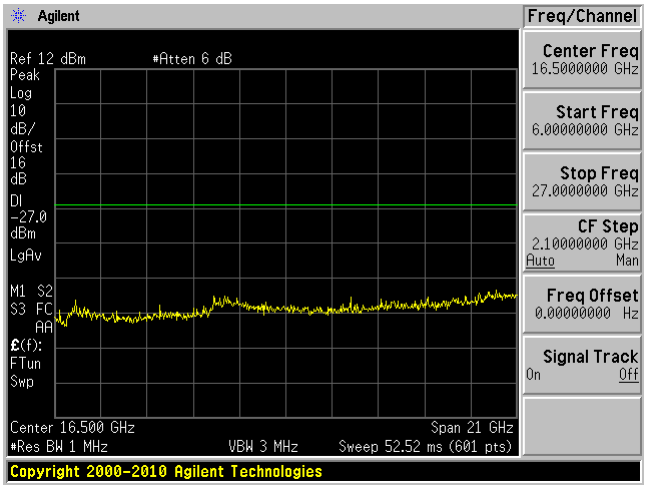
Low Channel 5180 MHz (6-40GHz)



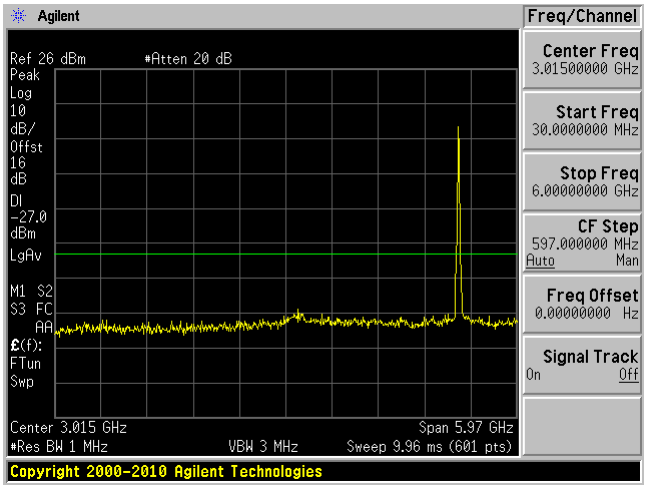
Middle Channel 5200 MHz (30MHz-6GHz)



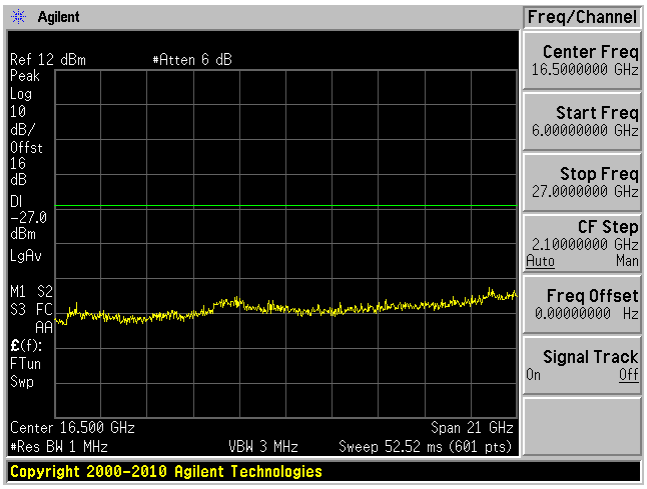
Middle Channel 5200 MHz (6-40GHz)



High Channel 5240 MHz (30MHz-6GHz)



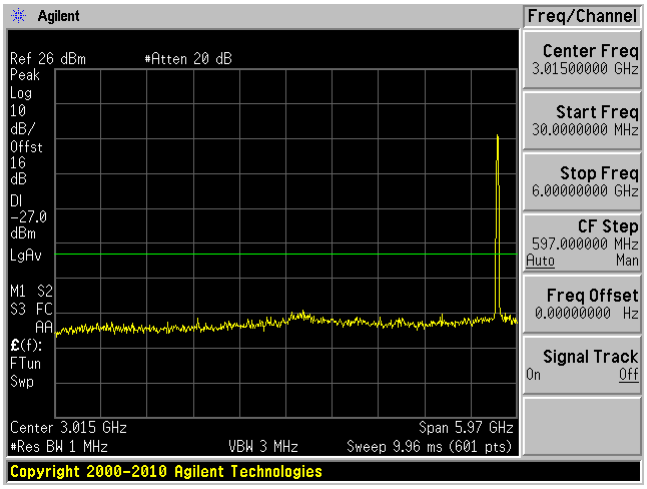
High Channel 5240 MHz (6-40GHz)



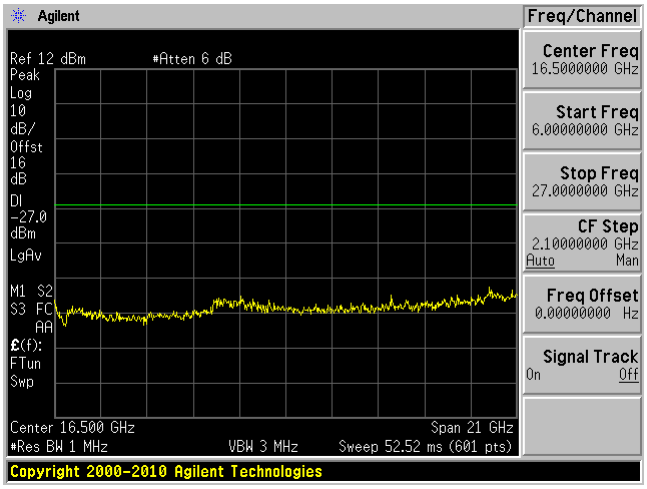
5725 – 5850 MHz

802.11a mode

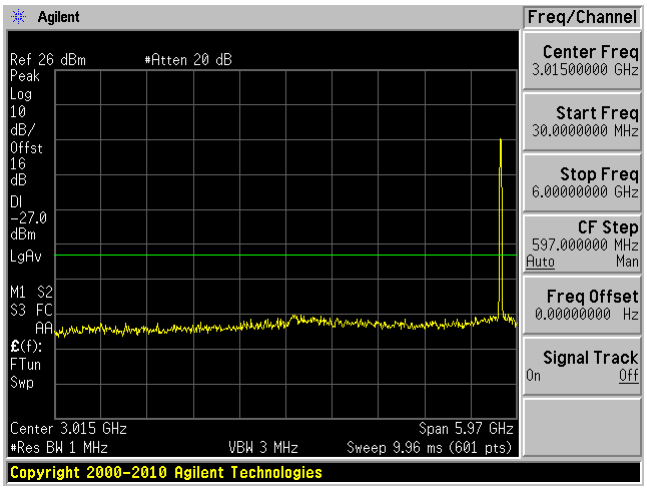
Low Channel 5745 MHz (30MHz-6GHz)



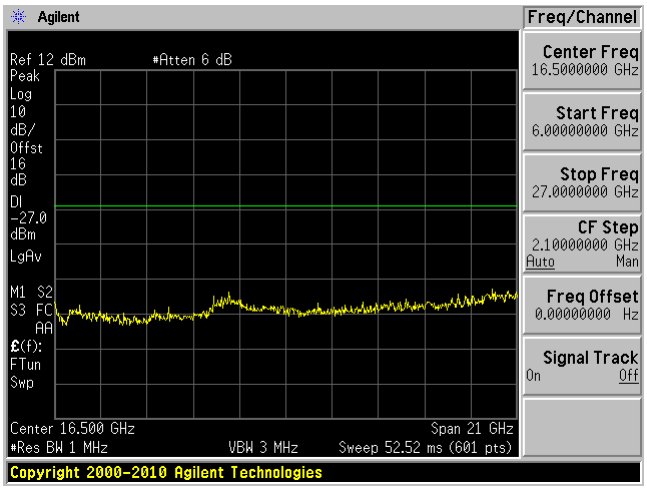
Low Channel 5745 MHz (6-40GHz)



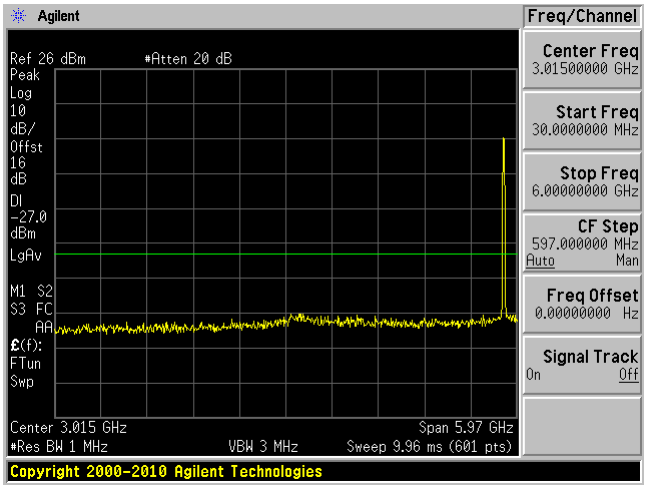
Middle Channel 5785 MHz (30MHz-6GHz)



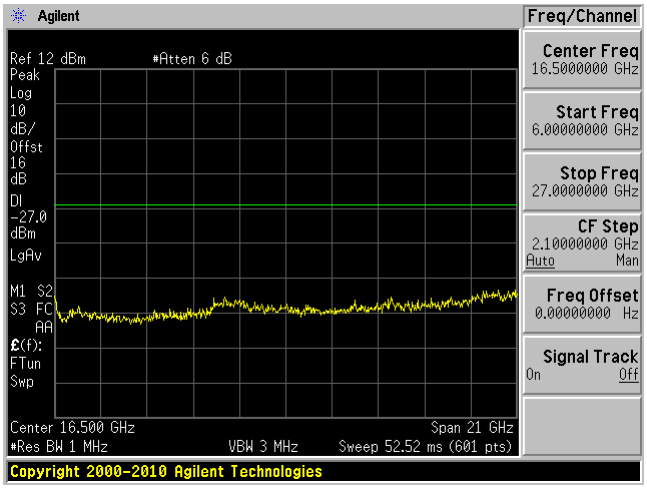
Middle Channel 5785 MHz (6-40GHz)



High Channel 5825 MHz (30MHz-6GHz)

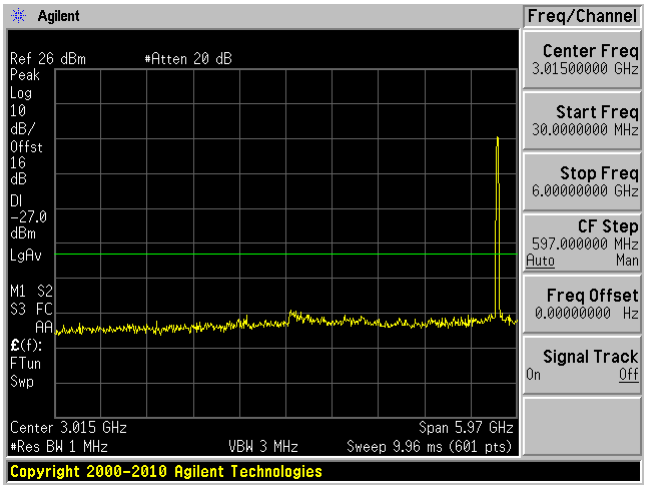


High Channel 5825 MHz (6-40GHz)

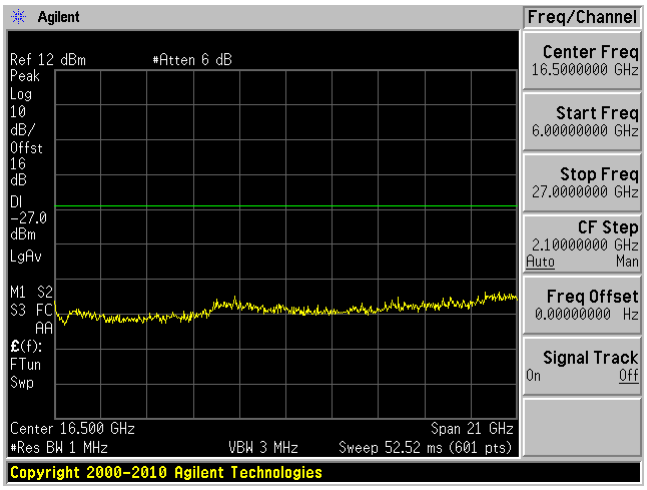


802.11n20/ac20 mode

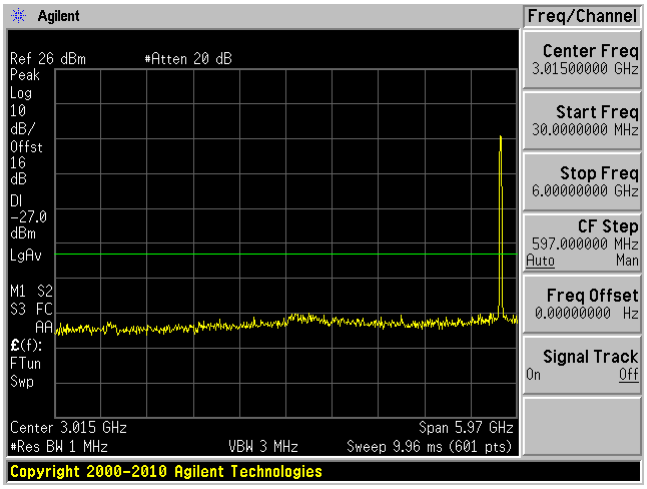
Low Channel 5745 MHz (30MHz-6GHz)



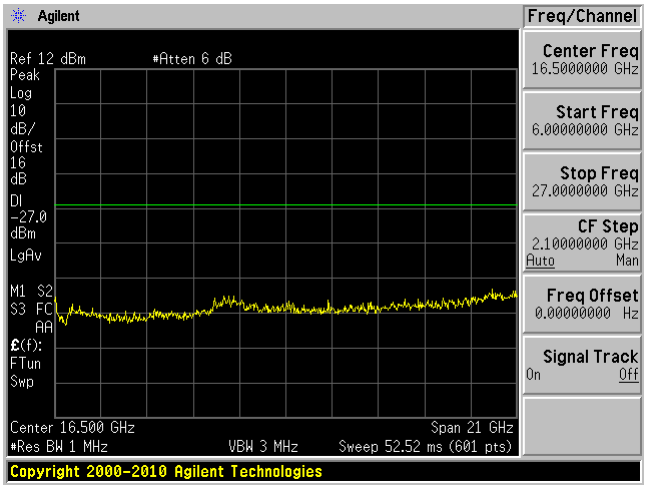
Low Channel 5745 MHz (6-40GHz)



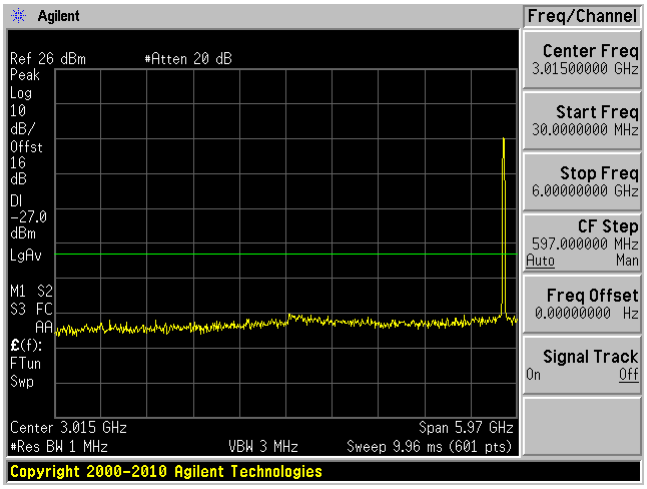
Middle Channel 5785 MHz (30MHz-6GHz)



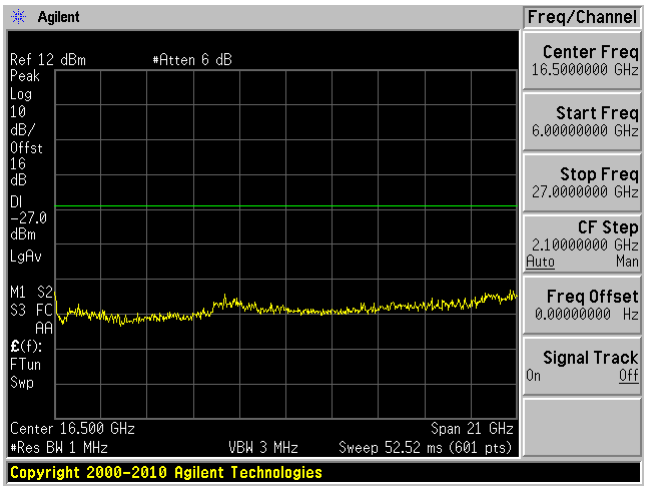
Middle Channel 5785 MHz (6-40GHz)



High Channel 5825 MHz (30MHz-6GHz)



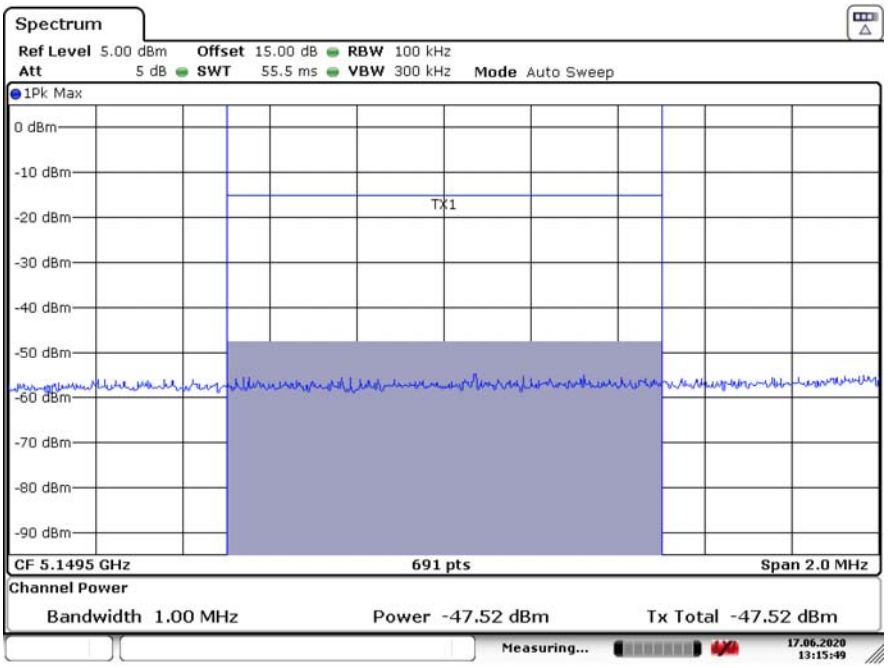
High Channel 5825 MHz (6-40GHz)



Band Edge Emissions

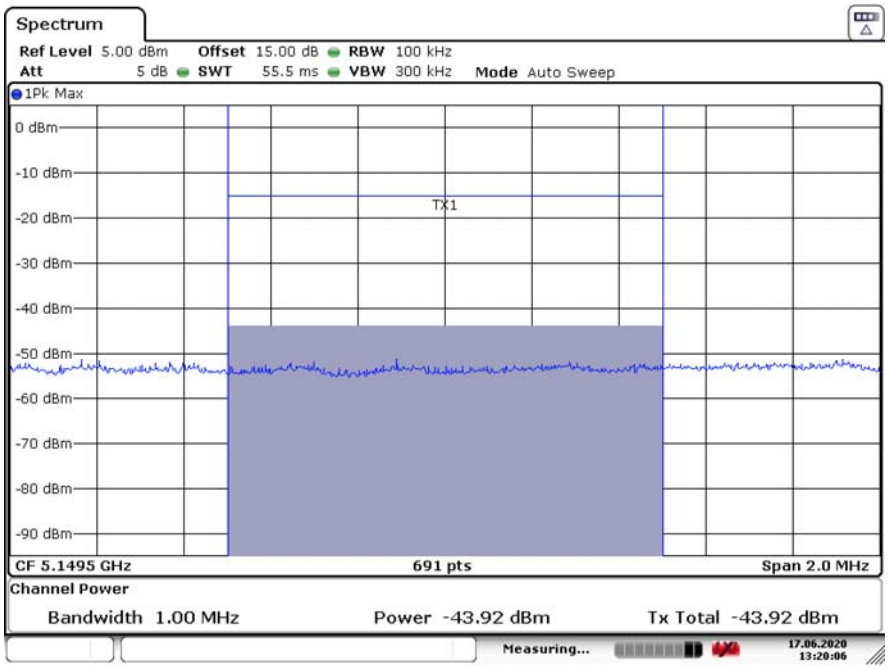
5150 - 5250 MHz

802.11a mode, Low Channel: 5180 MHz



Date: 17.JUN.2020 13:15:49

802.11n20/ac20 mode Low Channel: 5180 MHz



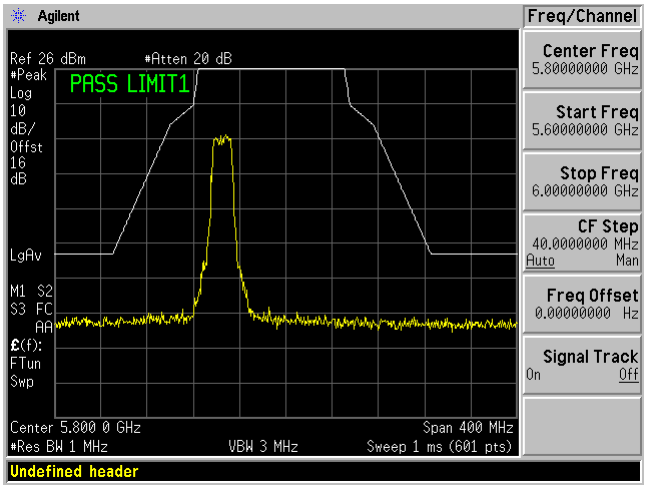
Date: 17.JUN.2020 13:20:07

5725 – 5850 MHz

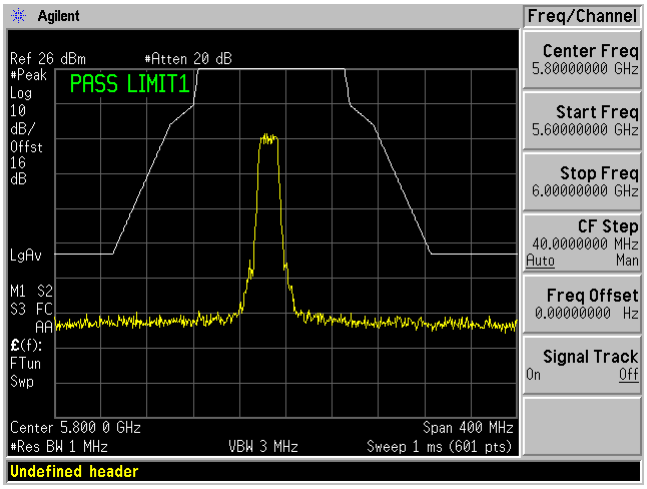
Emission Mask

802.11a mode

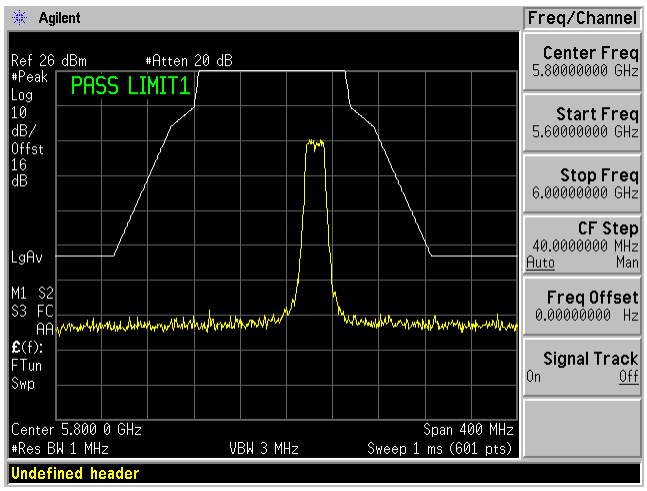
Low Channel: 5745 MHz



Middle Channel: 5785 MHz

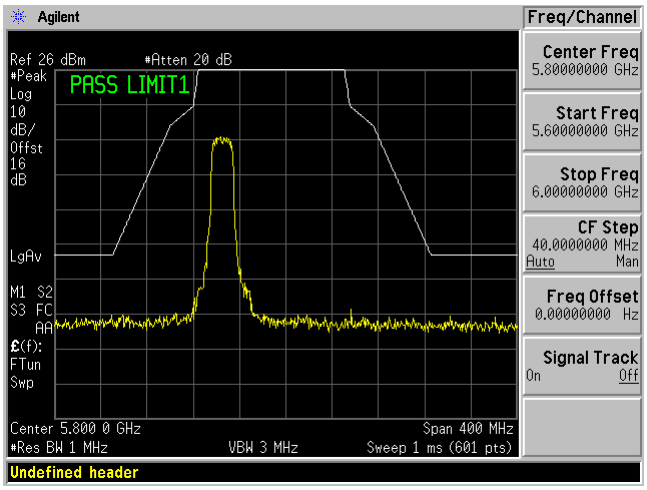


High Channel: 5825 MHz

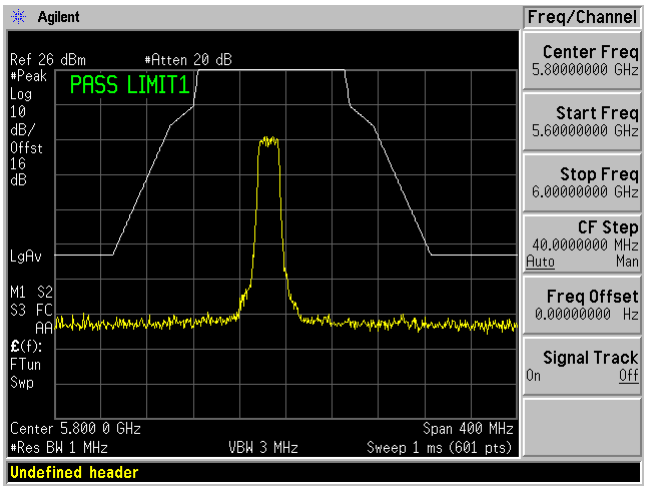


802.11n20/ac20 mode

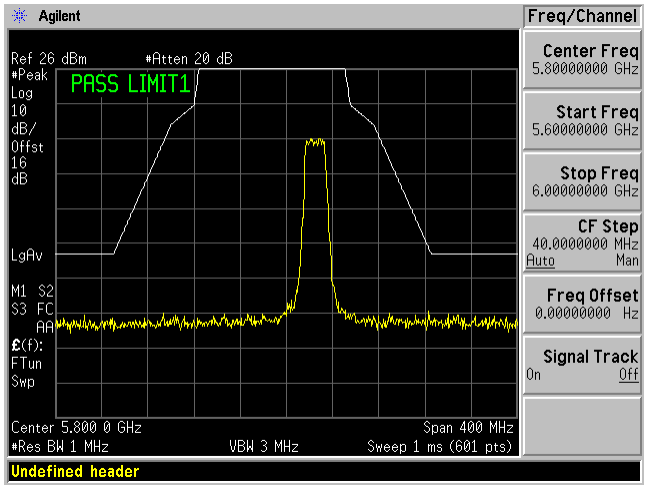
Low Channel: 5745 MHz



Middle Channel: 5785 MHz



High Channel: 5825 MHz



Note: The result is e.i.r.p; antenna gain has been added in the measurement offset during the testing.

11 Annex A - EUT Test Setup Photographs

Please refer to the attachment.

12 Annex B - EUT External Photographs

Please refer to the attachment.

13 Annex C - 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 ---