FCC PART 15, SUBPART E
ISEDC RSS-247, ISSUE 2, FEBRUARY 2017

TEST REPORT

For

Roku, Inc.

1155 Coleman Avenue, San Jose, CA 95110, USA

FCC ID:TC2-R1042
IC: 5959A-R1039

Report Type:	**Model:**
Class II Permissive Change	WR002

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Report Number:	R2205317-407
Report Date:	2022-09-02
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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	R2205317-407	Class II Permissive Change	2022-09-02

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: *WR002*, *FCC ID: TC2-R1042, IC: 5959A-R1039*, or the "EUT" as referred to in this report. The EUT has 2.4 GHz/5 GHz Wi-Fi capabilities.

The EUT was evaluated as a complete unit, which consist of models 3820X2 and WR002. In order for the device to function, both sub-devices must be connected to each other (refer to the User Manual for more information) Similarity and differences between tested model 3820X2 and models 3820X2, 3821X, and 3820X2 are described by the Declaration of Similarity provided by the customer (Annex D)

1.2 Objective

This report was prepared on behalf of *Roku, Inc* in accordance with FCC CFR47 §15.407 and ISEDC RSS-247 Issue 2, February2017.

The objective was to determine compliance with FCC Part 15.407 and ISEDC RSS-247 rules for Output Power, Antenna Requirements, AC Line Conducted Emissions, Emission Bandwidth, Power spectral density, Conducted and Radiated Spurious Emissions.

This report was for a Permissive Change II submission for the purpose of enabling DFS bands.

1.3 Related Submittal(s)/Grant(s)

Equipment Class: DTS, FCC ID: TC2-R1042, IC: 5959A-R1039

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 v02r01.

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 17025:2017 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 17025:2017 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 17025:2017 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 - ISEDC) 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 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 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 TeraTerm. The software is compliant with the standard requirements being tested against.

Please refer to the following power setting table.

Modulation	Frequency (MHz)	Power Setting	
		Ant A	Ant B
802.11a	5260	105	105
	5280	105	105
	5320	105	105
802.11n/ac20	5260	85	85
	5280	85	85
	5320	85	85
802.11n/ac40	5270	85	85
	5310	85	85
802.11ac80	5290	85	85

Modulation	Frequency (MHz)	Power Setting	
		Ant A	Ant B
802.11a	5500	100	100
	5580	100	100
	5700	100	100
802.11n/ac20	5500	80	80
	5580	75	75
	5700	75	75
802.11n/ac40	5510	80	80
	5590	75	75
	5670	80	80
802.11n/ac80	5530	78	78
	5610	78	78

*Data rates tested:
802.11a mode: 6 Mbps
802.11n/ac20 HT20/VHT20: MCS0
802.11n/ac40 HT40/VHT40: MCS0
802.11ac80 VHT80: MCS0

2.3 Duty Cycle Correction Factor

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

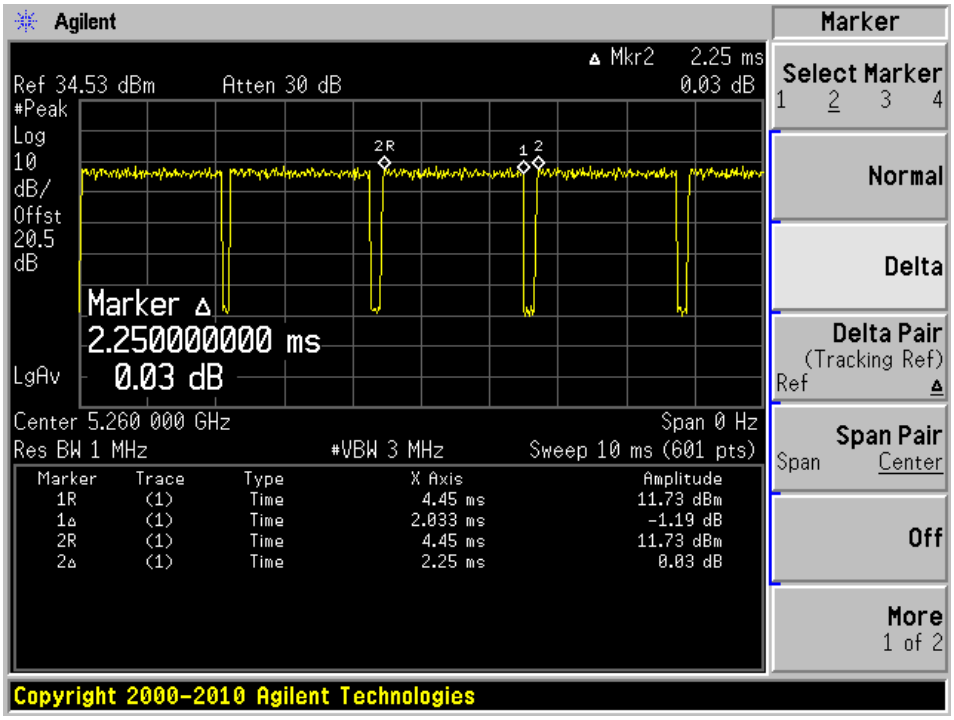
All measurements are to be performed with the EUT transmitting at 100% duty cycle at its maximum power control level; however, if 100% duty cycle cannot be achieved, measurements of duty cycle, x, and maximum-power transmission duration, T, are required for each tested mode of operation.

Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11a	2.033	2.25	90%	0.45
802.11n/ac20	1.9	2.117	89%	0.50
802.11n/ac40	.87	1.07	81%	0.91
802.11ac80	.425	.675	63%	2

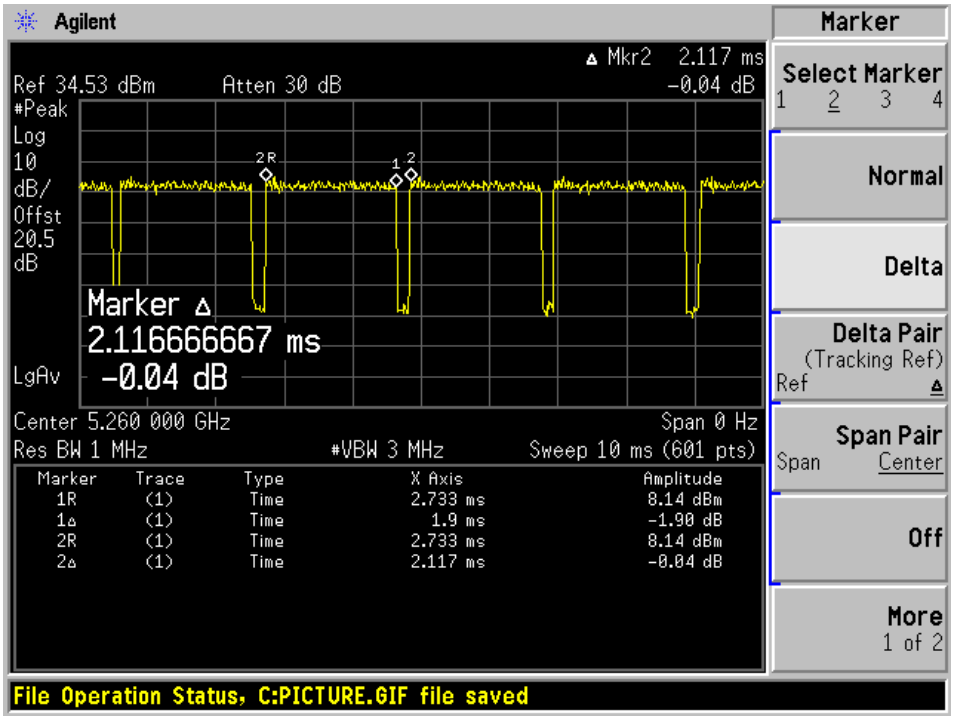
Note: Duty Cycle Correction Factor = 10*log(1/duty cycle)

Please refer to the following plots.

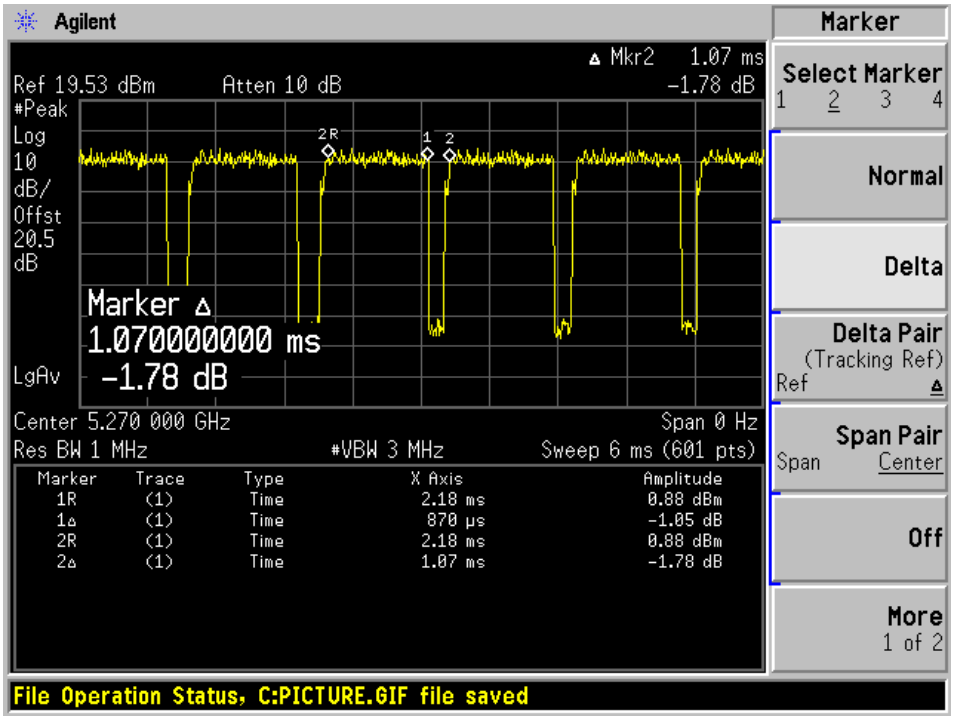
802.11a mode



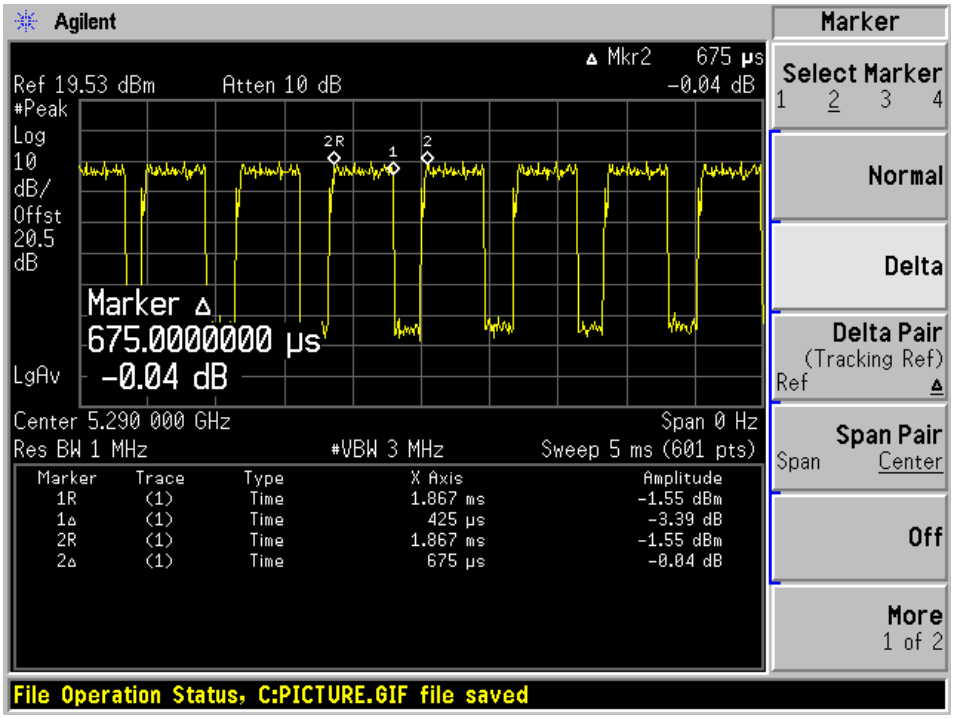
802.11n/ac20 mode



802.11n/ac40 mode



802.11ac80



2.4 Equipment Modifications

N/A

2.5 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E6410

2.6 Support Equipment

Manufacturer	Description	Model
Roku, Inc.	Debug Board	-

2.7 Interface Ports and Cabling

Cable Description	Length (m)	To	From
USB Cable	< 1 m	Laptop	EUT
RF Cable	< 1 m	EUT	PSA

3 Summary of Test Results

FCC/ISEDC Rules	Description of Test	Result
FCC §2.1091, §15.407(f), ISEDC RSS-102	RF Exposure	Compliant
FCC §15.203 ISEDC RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §15.207 ISEDC RSS-Gen §8.8	AC Power Line Conducted Emissions	Compliant
FCC §2.1053, §15.205, §15.209, 15.407(b) ISEDC RSS-247 §6.2	Spurious Radiated Emissions	Compliant
FCC §15.407(e) ISEDC RSS-Gen §6.2	Emission Bandwidth	Compliant
FCC §407(a) ISEDC RSS-247 §6.2	Output Power	Compliant
FCC §2.1051, §15.407(b) ISEDC RSS-247 §6.2	Band Edges	Compliant
FCC §15.407(a) ISEDC RSS-247 §6.2	Power Spectral Density	Compliant

BACL is responsible for all the information provided in this report, except when information is provided by the customer as identified in this report. Information provided by the customer, e.g., antenna gain, can affect the validity of results

4 FCC §2.1091, §15.407(f) & ISEDC RSS-102 - RF Exposure

4.1 Applicable Standards

According to FCC KDB 447498 D04 Interim General RF Exposure Guidance v01, Section 2.1 RF Exposure Test Exemptions for Single Source,

2.1.1 General RF Exposure Test Exemption Considerations

RF exposure test exemptions provide means to obtain certification without the need of showing data (measurements, or analytical/numerical modeling) to demonstrate compliance. Hereafter, in this context, an RF source is referred to as "*exempt RF device*" in the sense that it is not required to show data demonstrating compliance to RF exposure limits.

Test exemptions apply for devices used in general population/uncontrolled exposure environments, according to the SAR-based, or MPE-based exemption thresholds.[8] However, it is always possible, especially when the potential for exposure cannot be easily determined, that an RF exposure evaluation may become required according §§ 1.1307(c) and (d).

As detailed in Section 2.1.2, the 1 mW and SAR-based test exemption conditions are in terms of source-based available maximum time-averaged (matched conducted) output power for all operating configurations, adjusted for tune-up tolerance, and at the minimum *test separation distance* required for the particular RF exposure scenario under consideration. This 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. To qualify for SAR test exemption, the *test separation distances* applied must be fully explained and justified (typically in the SAR measurement, or SAR analysis report, according to KDB Pub. 865664) by showing the actual operating configurations and exposure conditions of the transmitter, and applicable host platform requirements (e.g., KDB Pubs. 648474, 616217, 941225)

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 SAR test exemption.

If RF exposure testing requirements for a specific device are covered in a KDB Publication, those requirements must be satisfied before applying any SAR test exemption provisions. For example, this is the case for handheld PTT two-way radios, handsets, laptops, and tablets, etc.[9]

Finally, when 10-g extremity SAR applies, SAR test exemption may be considered by applying a factor of 2.5 to the SAR-based exemption thresholds.

2.1.2 1-mW Test Exemption

Per §1.1307(b)(3)(i)(A), a single RF source is *exempt RF device* (from the requirement to show data demonstrating compliance to RF exposure limits, as previously mentioned) if the available maximum time-averaged power is no more than 1 mW, regardless of separation distance.

This exemption applies to all operating configurations and exposure conditions, for the frequency range 100 kHz to 100 GHz, regardless of fixed, mobile, or portable device exposure conditions. This is a standalone exemption, and it cannot be applied in conjunction with any other test exemption.

2.1.3 SAR-Based Exemption

A more comprehensive exemption, considering a variable power threshold that depends on both the *separation distance* and power, is provided in §1.1307(b)(3)(ii)(B). This exemption is applicable to the frequency range between 300 MHz and 6 GHz, with *test separation distances* between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions.

Accordingly, a RF source is considered an *RF exempt device* if its available maximum time-averaged (matched conducted) power or its effective radiated power (ERP), whichever is greater, are below a specified threshold. This exemption threshold was derived based on general population 1-g SAR requirements and is detailed in Appendix C.

2.1.4 MPE-Based Exemption

An alternative to the SAR-based exemption is provided in §1.1307(b)(3)(ii)(C), for a much wider frequency range, from 300 kHz to 100 GHz, applicable for separation distances greater or equal to $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. The MPE-based test exemption condition is in terms of ERP, defined as the

[8] Specific test exemption thresholds for operations under occupational/controlled limits are not established.
[9] When SAR evaluation is required by the hotspot mode or UMPC mini-tablet procedures, that is, where an antenna is ≤ 2.5 cm from a surface or edge, the *test separation distance* from the phantom to the antenna or device enclosure, as appropriate, should be applied to determine SAR test exemption for such configurations, according to the criteria in this document. For that case, the *test separation distance* cannot be determined from the distance of the antenna to the device surface or edge.

According to ISED RSS-102 Issue 5 Section 2.5.1 Exemption Limits for Routine Evaluation-SAR Evaluation:

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in table below,

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71	101	132	162	193
450	52	70	88	106	123
835	17	30	42	55	67
1900	7	10	18	34	60
2450	4	7	15	30	52
3500	2	6	16	32	55
5800	1	6	15	27	41

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223	254	284	315	345
450	141	159	177	195	213
835	80	92	105	117	130
1900	99	153	225	316	431
2450	83	123	173	235	309
3500	86	124	170	225	290
5800	56	71	85	97	106

4.2 FCC RF Exposure Exemption Evaluation Procedures

According to FCC KDB 447498 D04 Interim General RF Exposure Guidance v01, Annex B Exemptions for Single Source,

B.1 General

This appendix provides the exemption criteria and summarizes relevant parameters and usage considerations based on descriptions in FCC 19-126.

B.2 Blanket 1 mW Blanket Exemption

The 1 mW Blanket Exemption of § 1.1307(b)(3)(i)(A) applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power of no more than 1 mW, regardless of separation distance. The 1 mW blanket exemption applies at separation distances less than 0.5 cm, including where there is no separation. This exemption shall not be used in conjunction with other exemption criteria other than those for multiple RF sources in paragraph § 1.1307(b)(3)(ii)(A). The 1 mW exemption is independent of service type and covers the full range of 100 kHz to 100 GHz, but it shall not be used in conjunction with other exemption criteria or in devices with higher-power transmitters operating in the same time-averaging period. Exposure from such higher-power transmitters would invalidate the underlying assumption that exposure from the lower-power transmitter is the only contributor to SAR in the relevant volume of tissue.

B.3 MPE-based Exemption

General frequency and separation-distance dependent MPE-based effective radiated power (ERP) thresholds are in Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] to support an exemption from further evaluation from 300 kHz through 100 GHz.

Table B.1 – THRESHOLD FOR SINGLE RF SOURCE SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source			Minimum Distance			Threshold ERP
f_L MHz		f_H MHz	$\lambda_L/2\pi$		$\lambda_H/2\pi$	W
0.3	-	1.34	159 m	-	35.6 m	1,920 R^2
1.34	-	30	35.6 m	-	1.6 m	3,450 R^2/f^2
30	-	300	1.6 m	-	159 mm	3.83 R^2
300	-	1,500	159 mm	-	31.8 mm	0.0128 $R^2 f$
1,500	-	100,000	31.8 mm	-	0.5 mm	19.2 R^2
Subscripts L and H are low and high; λ is wavelength. From § 1.1307(b)(3)(i)(C), modified by adding Minimum Distance columns.						

The table applies to any RF source (i.e., single fixed, mobile, and portable transmitters) and specifies power and distance criteria for each of the five frequency ranges used for the MPE limits. These criteria apply at separation distances from any part of the radiating structure of at least λ/2π. The thresholds are based on the general population MPE limits with a single perfect reflection, outside of the reactive near-field, and in the main beam of the radiator.

For mobile devices that are not exempt per Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] at distances from 20 cm to 40 cm and in 0.3 GHz to 6 GHz, evaluation of compliance with the exposure limits in § 1.1310 is necessary if the ERP of the device is greater than ERP20cm in Formula (B.1) [repeated from § 2.1091(c)(1) and § 1.1307(b)(1)(i)(B)].

$$P_{th}\,(\text{mW}) = ERP_{20\,cm}\,(\text{mW}) = 2040f \quad 0.3\ \text{GHz} \le f < 1.5\ \text{GHz}$$
$$P_{th}\,(\text{mW}) = ERP_{20\,cm}\,(\text{mW}) = 3060 \quad 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \qquad \text{(B.1)}$$

If the ERP is not easily obtained, then the available maximum time-averaged power may be used (i.e., without consideration of ERP only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole.

SAR-based exemptions are constant at separation distances between 20 cm and 40 cm to avoid discontinuities in the threshold when transitioning between SAR-based and MPE-based exemption criteria at 40 cm, considering the importance of reflections.

B.4 SAR-based Exemption

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum time-averaged power or maximum time-averaged ERP, whichever is greater.

If the ERP of a device is not easily determined, such as for a portable device with a small form factor, the applicant may use the available maximum time-averaged power exclusively if the device antenna or radiating structure does not exceed an electrical length of λ/4.

As for devices with antennas of length greater than λ/4 where the gain is not well defined, but always less than that of a half-wave dipole (length λ/2), the available maximum time-averaged power generated by the device may be used in place of the maximum time-averaged ERP, where that value is not known.

The separation distance is the smallest distance from any part of the antenna or radiating structure for all persons, during operation at the applicable ERP. In the case of mobile or portable devices, the separation distance is from the outer housing of the device where it is closest to the antenna.

The SAR-based exemption formula of § 1.1307(b)(3)(i)(B), repeated here as Formula (B.2), applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold P_{th} (mW).

This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by Formula (B.2).

$$P_{th}\,(\text{mW}) = ERP_{20\,\text{cm}}\,(d/20\,\text{cm})^{x} \quad d \le 20\,\text{cm}$$
$$P_{th}\,(\text{mW}) = ERP_{20\,\text{cm}} \quad 20\,\text{cm} < d \le 40\,\text{cm} \qquad \text{(B.2)}$$

Where

$$x = -\log_{10}\,(60/(ERP_{20\,\text{cm}}\sqrt{f}))$$

and f is in GHz, d is the separation distance (cm), and EPR20cm is per Formula (B.1).

The example values shown in Table B.2 are for illustration only.

Table B.2 – Example Power Thresholds (mW)

Frequency (MHz)	**Distance (mm)**										
		5	10	15	20	25	30	35	40	45	50
	300	39	65	88	110	129	148	166	184	201	217
	450	22	44	67	89	112	135	158	180	203	226
	835	9	25	44	66	90	116	145	175	207	240
	1900	3	12	26	44	66	92	122	157	195	236
	2450	3	10	22	38	59	83	111	143	179	219
	3600	2	8	18	32	49	71	96	125	158	195
	5800	1	6	14	25	40	58	80	106	136	169

4.3 RF exposure evaluation exemption for FCC

Prediction frequency (GHz):			5.320	
Maximum output power (dBm):			19.71	
Maximum ERP (dBm):			22.86	
Maximum ERP (mW):			193.20	
Prediction distance (cm):			20	
Maximum antenna gain (dBi):			5.3	
0.3 GHz ≤ f < 1.5 GHz	$ERP_{20\,cm}$ (mW)	x	SAR-based Exemption Threshold	
	-	-	$d \leq 20$ cm	P_{th} (mW)
				-
			20 cm < $d \leq 40$ cm	P_{th} (mW)
				-
1.5 GHz ≤ f ≤ 6 GHz	$ERP_{20\,cm}$ (mW)	x	SAR-based Exemption Threshold	
	3060	-	$d \leq 20$ cm	P_{th} (mW)
				-
			20 cm < $d \leq 40$ cm	P_{th} (mW)
				3060

As shown in the table above, the EUT's Max ERP is lower than the SAR-based Exemption Threshold. SAR testing for this device is exempted.

4.4 RF exposure evaluation exemption for IC

Maximum EIRP = 19.71 dBm + 5.3dBi = 25.01 dBm (0.317 W), which is less $1.31\times10^{-2}f^{0.6834}$ = 4.61 W = 36.64 dBm. Therefore, ISED SAR testing is not required.

Note: Directional antenna gain (dBi) = 2.3 dBi + 10*log(2) = 5.3 dBi. Individual antenna gain was provided by customer

5 FCC §15.203 & ISEDC RSS-Gen §6.8 - 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.

According to ISEDC RSS-Gen §6.8: Transmitter Antenna

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

5.2 Antenna List

Antenna usage	Frequency Range (MHz)	Maximum Antenna Gain (dBi)	Antenna Type
5 GHz Wi-Fi	5250-5725	2.3	Chip

Note: The antennas used by the EUT are permanent attached antennas.
Note: Antenna info is information provided by customer.

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

6.1 Applicable Standards

As per FCC §15.207 and ISEDC RSS GEN §8.8

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 and and ISEDC RSS GEN §8.8.

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.

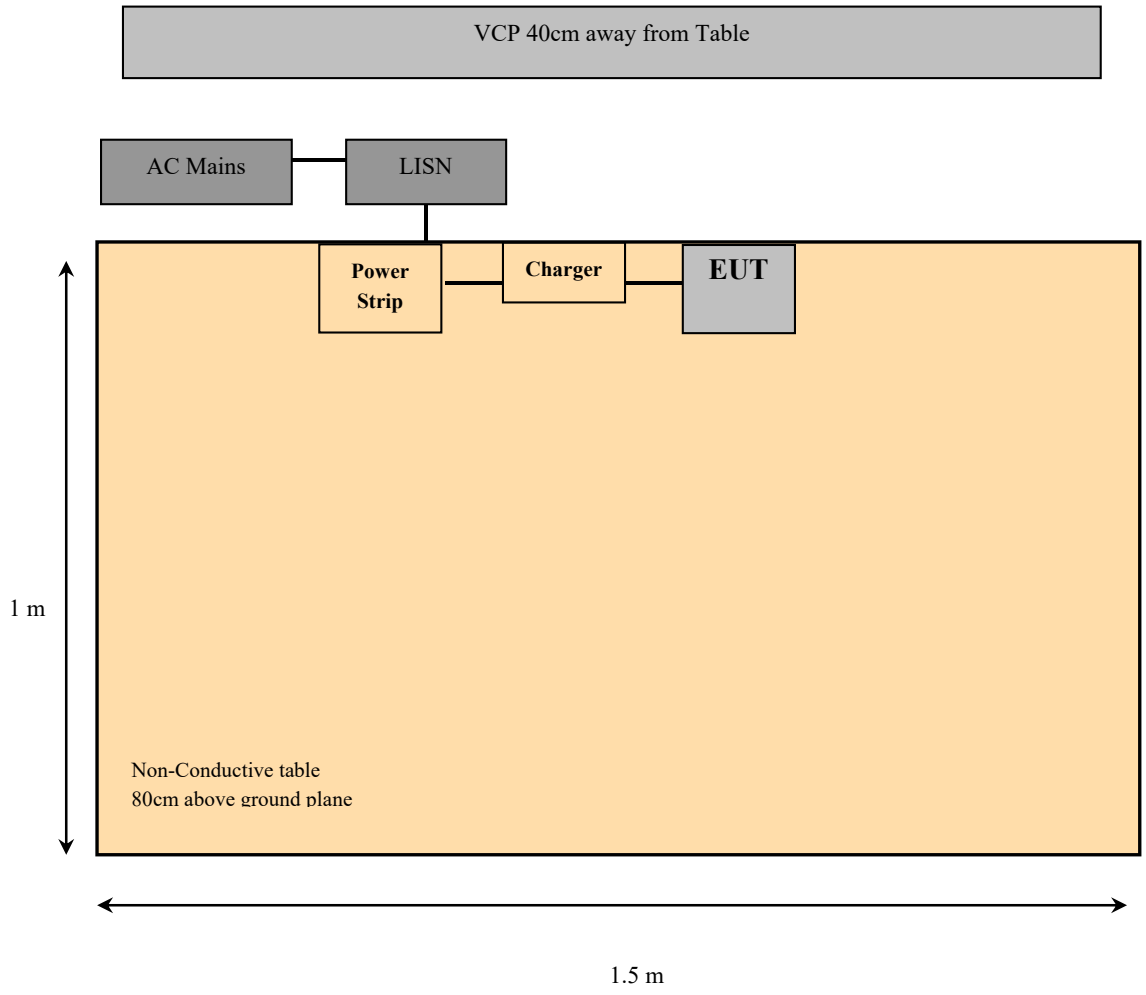
6.3 Test Procedure

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 Correction Factor (CF) to indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + CF

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Correction Factor (13.7 dB)

The Correction Factor is calculated by adding Cable loss (CL), LISN calibration factor, and attenuation of the impulse limiter and the high pass filter. The basic equation is as follows:

CF= CL + LISN calibration factor + Attenuation

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Cable Loss (3.5 dB) + LISN calibration factor (0.2 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

BACL No.	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
124	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100044	2021-05-14	2 years
681	Rohde & Schwarz	Impulse Limiter	ESH3-Z2	101962	2021-11-30	1 year
725	Solar Electronics Company	High Pass Filter	Type 7930-100	7930150203	2022-03-18	1 year
732	FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2021-11-24	1 year
1187	Fairview Microwave	Coaxial Cable	PE3C2220-1250CM	1	2021-09-08	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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

6.7 Test Environmental Conditions

Temperature:	20º C
Relative Humidity:	55 %
ATM Pressure:	102.1 kPa

The testing was performed by Weishan Zhang on 22-07-29 in the Ground Plane test site.

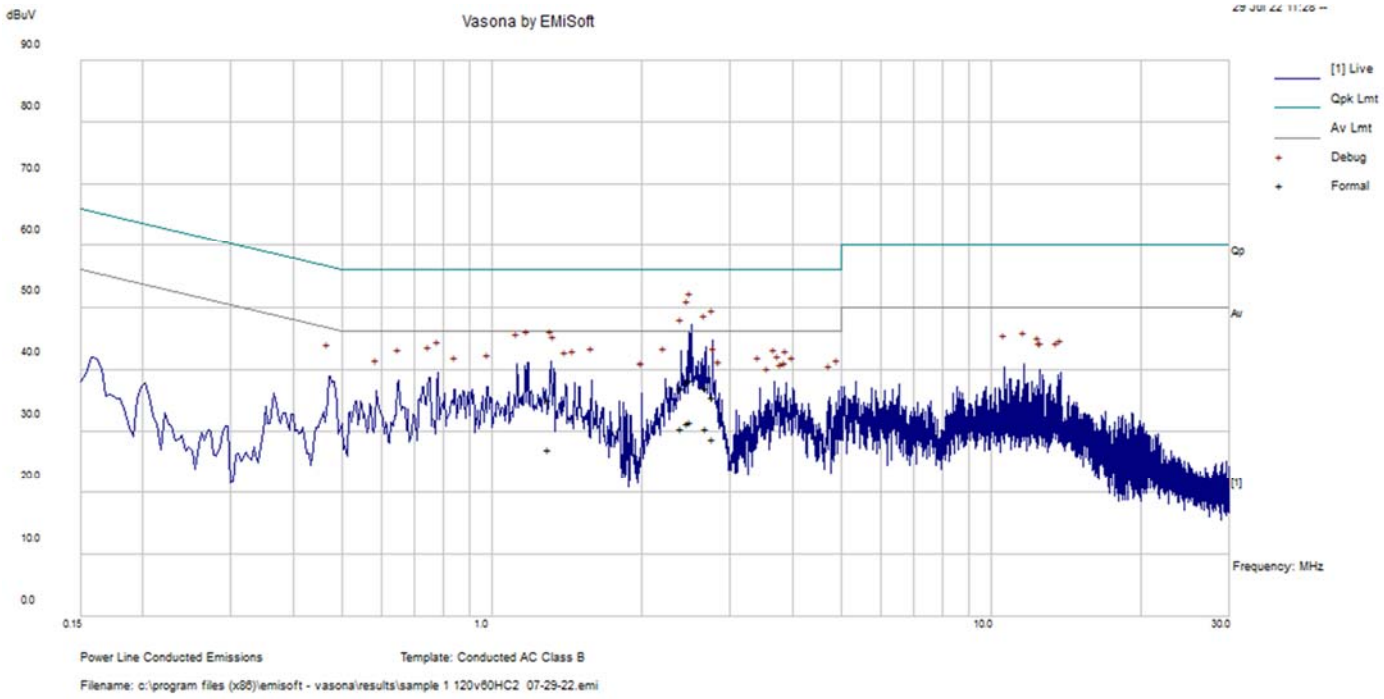
6.8 Summary of Test Results

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

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Line/Neutral)**	**Range (MHz)**
-14.48	2.507493	Neutral	0.15-30

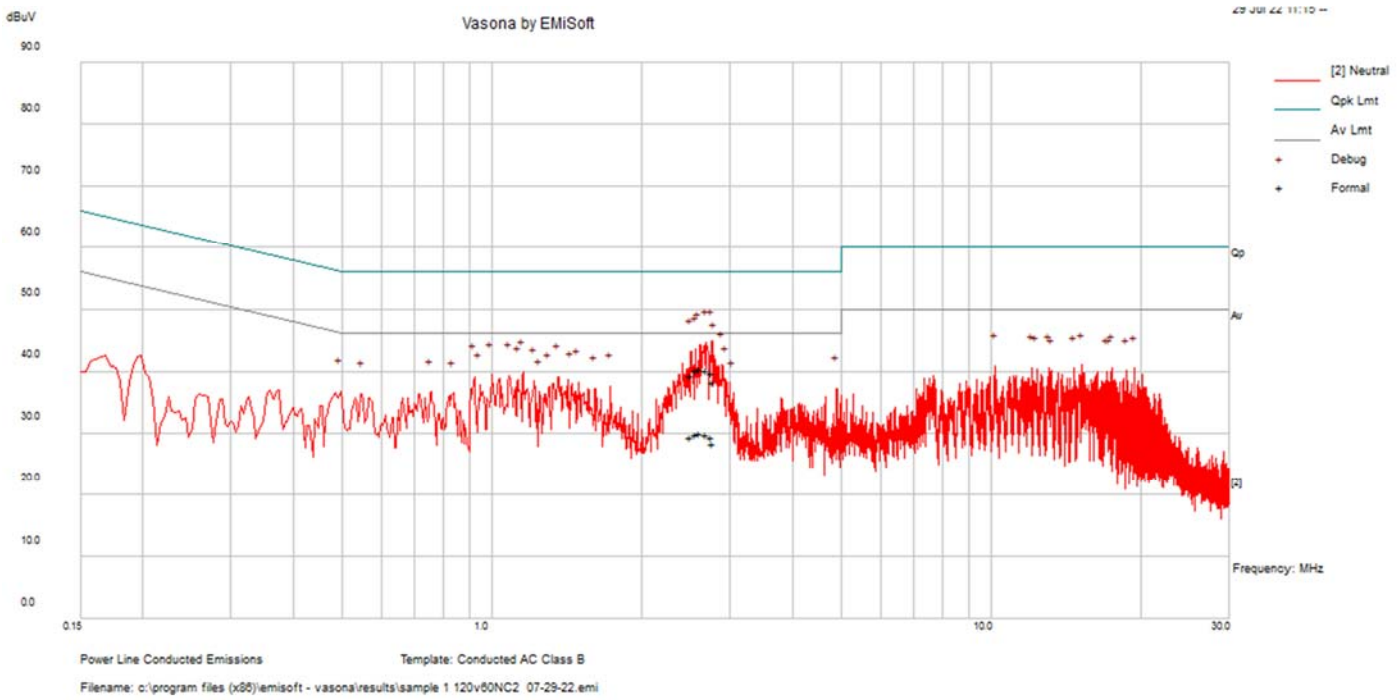
6.9 Conducted Emissions Test Plots and Data

120 V, 60 Hz – Line



Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
2.507493	28.1	10.11	38.21	56	-17.79	QP
2.475859	27.69	10.1	37.79	56	-18.21	QP
2.769999	25.42	10.1	35.52	56	-20.48	QP
2.693722	26.91	10.11	37.02	56	-18.98	QP
2.397078	26.93	10.11	37.04	56	-18.96	QP
1.296282	24.98	10.15	35.13	56	-20.87	QP
2.507493	21.41	10.11	31.52	46	-14.48	Ave
2.475859	21.19	10.1	31.29	46	-14.71	Ave
2.769999	18.62	10.11	28.73	46	-17.27	Ave
2.693722	20.4	10.11	30.51	46	-15.49	Ave
2.397078	20.34	10.1	30.44	46	-15.56	Ave
1.296282	16.87	10.15	27.02	46	-18.98	Ave

120 V, 60 Hz – Neutral



Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
2.748773	29.57	10.1	39.67	56	-16.33	QP
2.682704	30.16	10.11	40.27	56	-15.73	QP
2.613758	30.22	10.11	40.33	56	-15.67	QP
2.569796	30.19	10.1	40.29	56	-15.71	QP
2.501432	29.28	10.1	39.38	56	-16.62	QP
2.767681	28.25	10.11	38.36	56	-17.64	QP
2.748773	19.16	10.11	29.27	46	-16.73	Ave
2.682704	19.68	10.11	29.79	46	-16.21	Ave
2.613758	19.82	10.11	29.93	46	-16.07	Ave
2.569796	19.69	10.1	29.79	46	-16.21	Ave
2.501432	19.22	10.1	29.32	46	-16.68	Ave
2.767681	18.11	10.11	28.22	46	-17.78	Ave

7 FCC §15.209, §15.407(b) & ISEDC RSS-247 §6.2 - Spurious Radiated Emissions

7.1 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.

(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: 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.

As per ISEDC RSS-247 §6.2

For transmitters operating in the band 5150-5250 MHz, all emissions outside the band 5150-5350 MHz shall not exceed -27 dBm/MHz e.i.r.p. However, any unwanted emissions that fall into the band 5250- 5350 MHz must be 26 dBc, when measured using a resolution bandwidth between 1 and 5% of the occupied bandwidth, above 5.25 GHz. Otherwise, the transmission is considered as intentional and the devices shall implement dynamic frequency selection (DFS) and transmitter power control (TPC) as per the requirements for the band 5250-5350 MHz

For devices with both operating frequencies and channel bandwidths contained within the band 5250-5350 MHz, the device shall comply with the following:

1. All emissions outside the band 5250-5350 MHz shall not exceed -27 dBm/MHz e.i.r.p. if the equipment is intended for outdoor use; or
2. All emissions outside the band 5150-5350 MHz shall not exceed -27 dBm/MHz e.i.r.p. and any emissions within the band 5150-5250 MHz shall meet the power spectral density limits of Section 6.2.1. The device shall be labelled “for indoor use only.”

For devices with operating frequencies in the band 5250-5350 MHz but having a channel bandwidth that overlaps the band 5150-5250 MHz, the devices’ unwanted emission shall not exceed -27 dBm/MHz e.i.r.p. outside the band 5150-5350 MHz and its power shall comply with the spectral power density for operation within the band 5150-5250 MHz. The device shall be labelled “for indoor use only.”

For transmitters operating in the band 5470-5725 MHz, emissions outside the band shall not exceed -27 dBm/MHz e.i.r.p.

For the band 5725-5850 MHz, emissions at frequencies from the band edges to 10 MHz above or below the band edges shall not exceed -17 dBm/MHz e.i.r.p. For emissions at frequencies more than 10 MHz above or below the band edges, the emissions power shall not exceed -27 dBm/MHz.

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 and ISEDC RSS-247 limits.

The spacing between the peripherals was 10 centimeters.

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

7.3 Test Procedure

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

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

The EUT 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

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

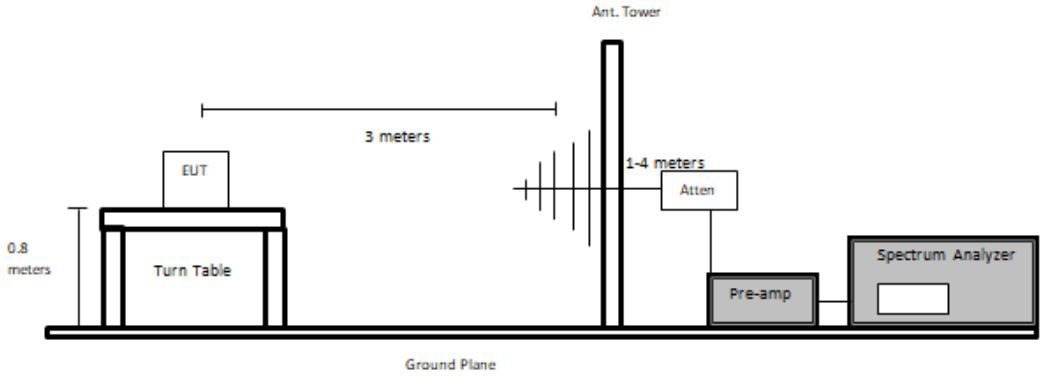
For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

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 A. The equation for margin calculation is as follows:

Margin = Corrected Amplitude – Limit

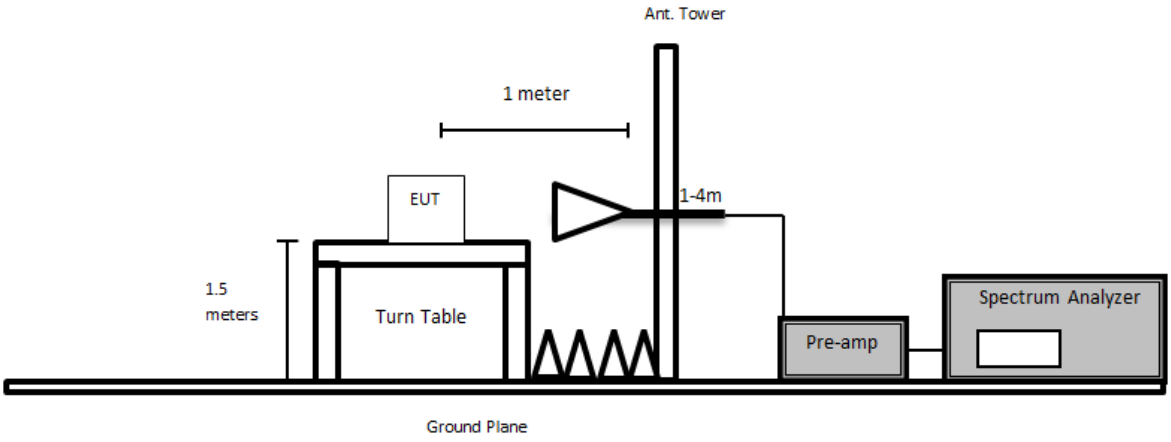
7.5 Test Setup Block Diagram

Below 1GHz:

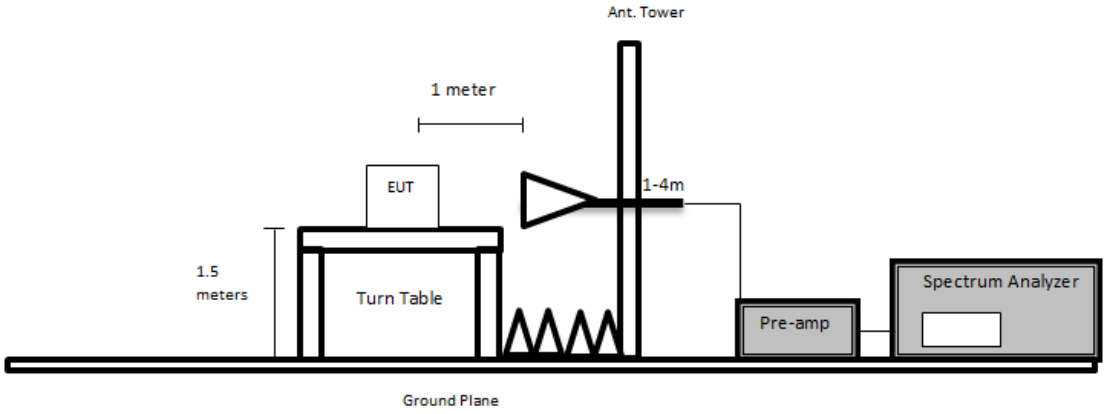


Above 1GHz:

Using Asset #1192



Using Asset #91,#92



7.6 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
655	Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2022-02-07	2 years
-	Sunol Science Corp	System Controller	SC110V	122303-1	N/R	N/A
310	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950.03	G132150CM 5351119	2021-04-05	2 years
658	HP	Pre-Amplifier	8449B	3008A01103	2022-07-22	1 year
459	HP	Pre Amplifier	8447D	2443A04374	2021-11-02	1 year
827	AH Systems	Preamplifier	PAM 1840 VH	170	2021-09-03	1 year
1192	ETS Lindgren	Horn Antenna	3117	00218973	2021-09-14	2 years
321	Sunol Sciences	Biconilog Antenna	JB3	A020106-2	2021-11-22	2 years
91	Wisewave	Antenna, Horn	ARH-4223-02	10555-02	2022-03-08	2 years
92	Wisewave	Antenna, Horn	ARH-2823-02	10555-01	2022-03-17	2 years
-	-	RF cable	-	-	Each time[1]	N/A
-	-	Notch Filter	-	-	Each time[1]	N/A
1077	Insulated Wire Corp.	157 Series 2.92 SM (x2) Armored 33 ft. Cable	KPS-1571AN-3960-KPS	DC 1917	2022-03-03	1 year
1228	Pasternack	Coaxial Cable, RG213	PE3496-800CM	2111301	2021-11-30	1 year
	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 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

7.7 Test Environmental Conditions

Temperature:	20-22 ºC
Relative Humidity:	42-50 %
ATM Pressure:	102.7 kPa

The testing was performed by Deepak Mishra from 2022-07-12 to 2022-07-18 in 5m chamber 3.

7.8 Summary of Test Results

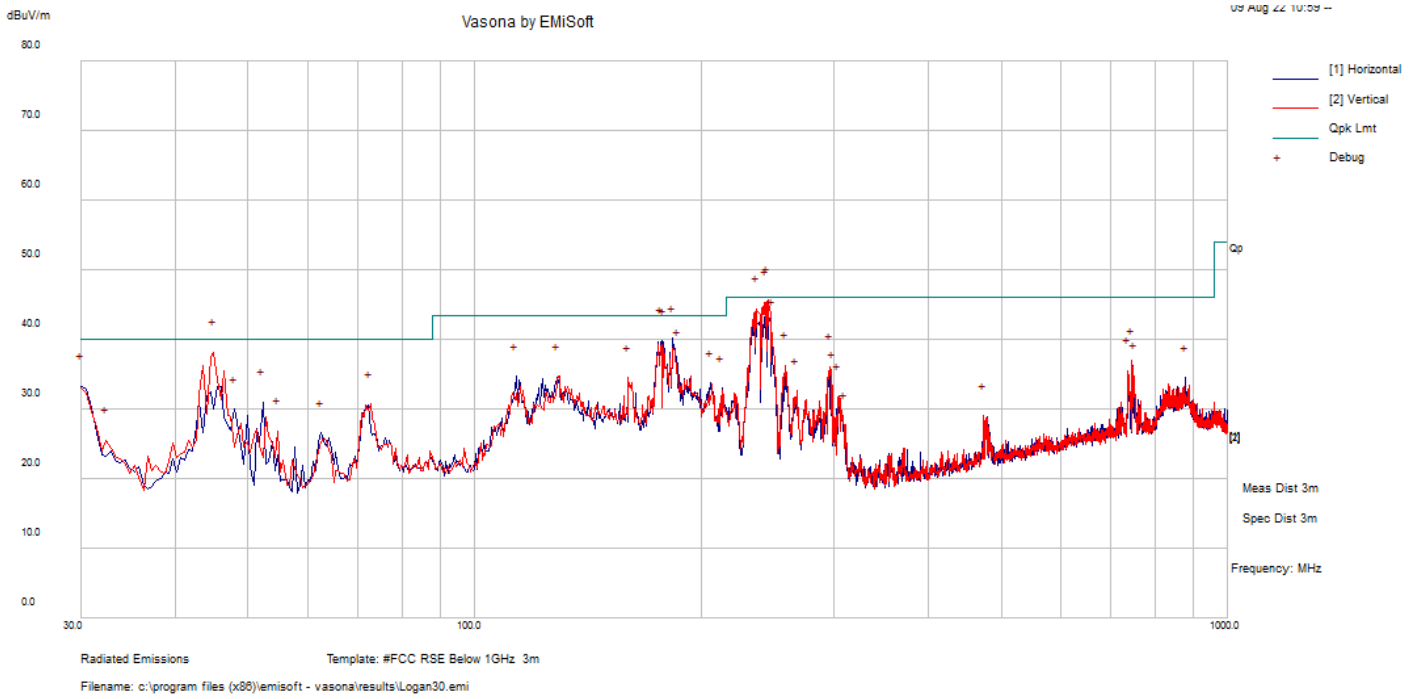
According to the data hereinafter, the EUT complied with the FCC Part 15.407 and RSS-247 standards' radiated emissions limits, and had the worst margin of:

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, Channel**
-0.105	5350	Horizontal	802.11n/ac20 mode, 5320 MHz

7.9 Radiated Emissions Test Result Data

1) 30 MHz – 1 GHz at 3 meters

Worst Case: 802.11n/ac20 mode, 5320 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
244.855	59.66	-0.24	45.76	100	V	142	46	-0.24	Pass
243.885	59.37	-0.58	45.42	100	V	124	46	-0.58	Pass
236.61	58.47	-1.66	44.34	100	V	35	46	-1.66	Pass
45.035	59.31	-1.82	38.18	100	V	333	40	-1.82	Pass
183.26	55.12	-3.33	40.17	100	H	101	43.5	-3.33	Pass
176.955	54.57	-3.7	39.8	100	H	76	43.5	-3.7	Pass

FCC/IC Limits for 1 GHz to 40 GHz				
Applicablity	**(dBm)**	**(uV/m at 3meters)**	**(dBuV/m at 3meters)**	**(dBuV/m at 1meter)[2]**
Restricted Band Average Limit	-	500	54	64
Restricted Band Peak Limit[1]	-	-	74	84
FCC §15.407(b) & ISEDC RSS-247 §6.2 Defined Unwanted Emissions Limit	-27	-	68	78

Note[1]: Restricted Band Peak Limit is defined to be 20dB higher than Average Limit.
Note[2]: Limits at 1 meter are determined by applying a Distance correction factor accounts for extrapolation from 1 meters to 3 meters. Formula used is as follows: 20*log(3meters/1meter) = 9.54 (According to ANSI C63.10-2013 Section 9.4)
Note[3]: Where Restricted Band Peak Limit is replaced with stricter 78 dBµV/m at 1 meter, compliance is being shown for unwmated emissions per FCC §15.407(b) & ISEDC RSS-247 §6.2

2) 1 – 18 GHz measured at 1 meter

5250 - 5350 MHz

802.11a mode Antenna A

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel: 5260 MHz											
10520	49.020	270	276	H	38.194	12.93	36.46	63.677	78	-14.323	Peak
10520	36.915	270	276	H	38.194	12.93	36.46	51.572	64	-12.428	Ave
Middle Channel: 5280 MHz											
10560	48.400	149	130	H	38.194	13.06	36.36	63.296	78	-14.704	Peak
10560	36.195	149	130	H	38.194	13.06	36.36	51.091	64	-12.909	Ave
High Channel: 5320 MHz											
5350	68.150	348	115	H	35.242	9.06	36.64	75.815	78	-2.185	Peak
5350	55.623	348	115	H	35.242	9.06	36.64	63.288	64	-0.712	Ave
10640	56.500	336	127	H	38.194	13.13	36.36	71.470	84	-12.530	Peak
10640	44.321	336	127	H	38.194	13.13	36.36	59.291	64	-4.709	Ave

5250 - 5350 MHz

802.11a mode Antenna B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel: 5260 MHz											
10520	48.374	270	276	H	38.194	12.932	36.469	63.031	78	-14.969	Peak
10520	36.334	270	276	H	38.194	12.932	36.469	50.991	64	-13.009	Ave
Middle Channel: 5280 MHz											
10560	47.648	149	130	H	38.194	13.065	36.363	62.544	78	-15.456	Peak
10560	35.534	149	130	H	38.194	13.065	36.363	50.430	64	-13.570	Ave
High Channel: 5320 MHz											
5350	48.510	360	174	H	35.242	9.068	36.64	56.175	78	-21.825	Peak
5350	37.307	360	174	H	35.242	9.068	36.64	44.972	64	-19.028	Ave
10640	48.150	60	162	H	38.194	13.139	36.36	63.120	84	-20.880	Peak
10640	38.244	60	162	H	38.194	13.139	36.36	53.214	64	-10.786	Ave

5250 - 5350 MHz

802.11ac20/n20 mode Antenna A+B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel: 5260 MHz											
10520	49.100	285	197	H	38.194	12.93	36.46	63.757	78	-14.243	Peak
10520	38.032	285	197	H	38.194	12.93	36.46	52.689	64	-11.311	Ave
15780	48.880	78	227	H	41.592	16.44	36.87	70.045	84	-13.955	Peak
15780	37.542	78	227	H	41.592	16.44	36.87	58.707	64	-5.293	Ave
Middle Channel: 5280 MHz											
10560	48.500	309	165	H	38.194	13.06	36.36	63.396	78	-14.604	Peak
10560	37.242	309	165	H	38.194	13.06	36.36	52.138	64	-11.862	Ave
High Channel: 5320 MHz											
5350	70.230	340	158	H	35.242	9.06	36.64	77.895	78	-0.105	Peak
5350	50.713	340	158	H	35.242	9.06	36.64	58.378	64	-5.622	Ave
10640	47.800	117	247	H	38.194	13.13	36.36	62.770	84	-21.230	Peak
10640	36.852	117	247	H	38.194	13.13	36.36	51.822	64	-12.178	Ave

5250 - 5350 MHz

802.11ac40/n40 mode Antenna A+B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel: 5270 MHz											
10540	48.200	220	193	H	38.194	12.98	36.46	62.911	78	-15.089	Peak
10540	38.315	220	193	H	38.194	12.98	36.46	53.026	64	-10.974	Ave
High Channel: 5310 MHz											
5350	68.720	346	145	H	35.242	9.06	36.64	76.385	78	-1.615	Peak
5350	53.257	346	145	H	35.242	9.06	36.64	60.922	64	-3.078	Ave
10620	48.540	163	178	H	38.194	13.16	36.36	63.537	84	-20.463	Peak
10620	38.995	163	178	H	38.194	13.16	36.36	53.992	64	-10.008	Ave

5250 - 5350 MHz

802.11ac80 mode Antenna A+B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
5280 MHz											
5350	69.610	341	143	H	35.242	9.068	36.718	77.202	78	-0.798	Peak
5350	50.875	341	143	H	35.242	9.068	36.718	58.467	64	-5.533	Ave
10580	47.220	129	210	H	38.194	13.12	36.363	62.171	84	-21.829	Peak
10580	37.107	129	210	H	38.194	13.12	36.363	52.058	64	-11.942	Ave

5470 - 5725 MHz

802.11a mode Antenna A

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel: 5500 MHz											
5470	67.390	330	150	H	35.213	9.185	36.57	75.214	78	-2.786	Peak
5470	49.097	330	150	H	35.213	9.185	36.57	56.921	64	-7.079	Ave
11000	47.810	260	155	H	38.631	13.528	36.15	63.817	84	-20.183	Peak
11000	36.407	260	155	H	38.631	13.528	36.15	52.414	64	-11.586	Ave
Middle Channel: 5580 MHz											
11160	47.850	345	270	H	38.631	13.36	36.09	63.749	84	-20.251	Peak
11160	35.737	345	270	H	38.631	13.36	36.09	51.635	64	-12.365	Ave
High Channel: 5700 MHz											
5725	69.610	330	150	H	35.242	9.412	36.61	77.651	78	-0.349	Peak
5725	52.237	330	150	H	35.242	9.412	36.61	60.278	64	-3.722	Ave
11400	47.320	43	195	H	38.631	13.75	36.03	63.666	84	-20.334	Peak
11400	35.377	43	195	H	38.631	13.75	36.03	51.723	64	-12.277	Ave

5470 - 5725 MHz

802.11a mode Antenna B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel: 5500 MHz											
5470	68.350	70	150	H	35.213	9.18	36.57	76.174	78	-1.826	Peak
5470	45.570	70	150	H	35.213	9.18	36.57	53.394	64	-10.606	Ave
11000	47.348	260	155	H	38.631	13.528	36.152	63.355	84	-20.645	Peak
11000	35.818	260	155	H	38.631	13.528	36.152	51.825	64	-12.175	Ave
Middle Channel: 5580 MHz											
11160	48.317	345	270	H	38.631	13.367	36.099	64.216	84	-19.784	Peak
11160	35.410	345	270	H	38.631	13.367	36.099	51.309	64	-12.691	Ave
High Channel: 5700 MHz											
5725	69.680	150	133	H	35.242	9.41	36.61	77.721	78	-0.279	Peak
5725	50.000	150	133	H	35.242	9.41	36.61	58.041	64	-5.959	Ave
11400	47.843	43	195	H	38.631	13.752	36.037	64.189	84	-19.811	Peak
11400	35.348	43	195	H	38.631	13.752	36.037	51.694	64	-12.306	Ave

5470 - 5725 MHz

802.11ac20/n20 mode Antenna A+B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel: 5500 MHz											
5470	69.900	340	150	H	35.213	9.185	36.57	77.724	78	-0.276	Peak
5470	49.049	340	150	H	35.213	9.185	36.57	56.873	64	-7.127	Ave
11000	45.940	183	128	H	38.631	13.52	36.15	61.947	84	-22.053	Peak
11000	34.469	183	128	H	38.631	13.52	36.15	50.476	64	-13.524	Ave
Middle Channel: 5580 MHz											
11160	47.320	135	240	H	38.631	13.36	36.09	63.219	84	-20.781	Peak
11160	35.219	135	240	H	38.631	13.36	36.09	51.118	64	-12.882	Ave
High Channel: 5700 MHz											
5725	60.450	150	150	H	35.242	9.412	36.61	68.491	78	-9.509	Peak
5725	41.779	150	150	H	35.242	9.412	36.61	49.820	64	-14.180	Ave
11400	47.680	340	132	H	38.631	13.752	36.03	64.026	84	-19.974	Peak
11400	36.579	340	132	H	38.631	13.752	36.03	52.925	64	-11.075	Ave

5470 - 5725 MHz

802.11ac40/n40 mode Antenna A+B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel: 5510 MHz											
5470	66.490	264	139	H	35.213	9.185	36.574	74.314	78	-3.686	Peak
5470	47.659	264	139	H	35.213	9.185	36.574	55.483	64	-8.517	Ave
11020	46.750	39	140	H	38.631	13.46	36.152	62.693	84	-21.307	Peak
11020	35.271	39	140	H	38.631	13.46	36.152	51.214	64	-12.786	Ave
Middle Channel: 5590 MHz											
11180	47.150	0	225	H	38.631	13.37	36.099	63.060	84	-20.940	Peak
11180	36.011	0	225	H	38.631	13.37	36.099	51.921	64	-12.079	Ave
High Channel: 5670 MHz											
5725	65.550	349	112	H	35.242	9.412	36.613	73.591	78	-4.409	Peak
5725	51.161	349	112	H	35.242	9.412	36.613	59.202	64	-4.798	Ave
11340	46.770	205	291	H	38.631	13.45	36.071	62.783	84	-21.217	Peak
11340	35.651	205	291	H	38.631	13.45	36.071	51.664	64	-12.336	Ave

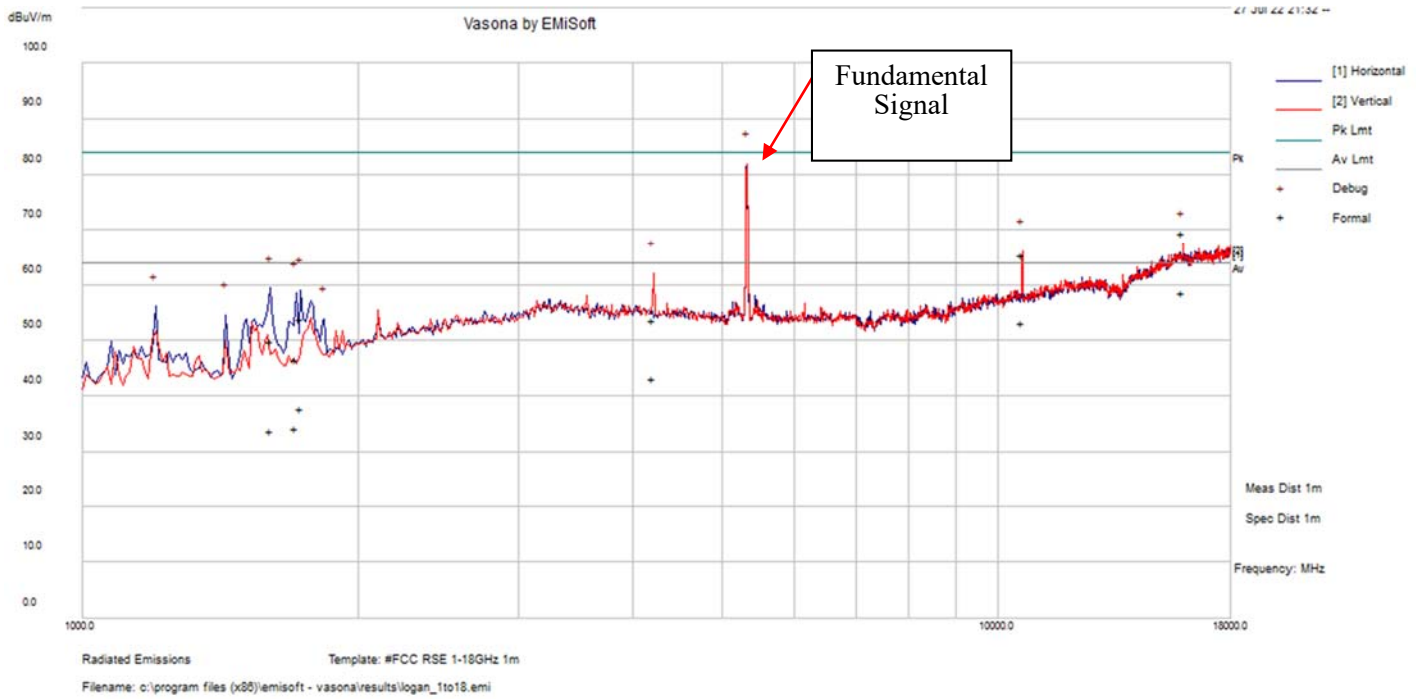
5470 - 5725 MHz

802.11ac80 mode Antenna A+B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
5530 MHz											
5470	69.350	268	150	H	35.213	9.185	36.57	77.174	78	-0.826	Peak
5470	46.899	268	150	H	35.213	9.185	36.57	54.723	64	-9.277	Ave
11060	46.380	120	225	H	38.631	13.238	36.13	62.118	84	-21.882	Peak
11060	34.469	120	225	H	38.631	13.238	36.13	50.207	64	-13.793	Ave
5610 MHz											
11220	45.185	120	225	H	38.631	16.380	37.918	62.278	84	-21.722	Peak
11220	35.615	120	225	H	38.631	16.380	37.918	52.708	64	-11.292	Ave

3) 1 to 18 GHz Vasona scan at 1 meter

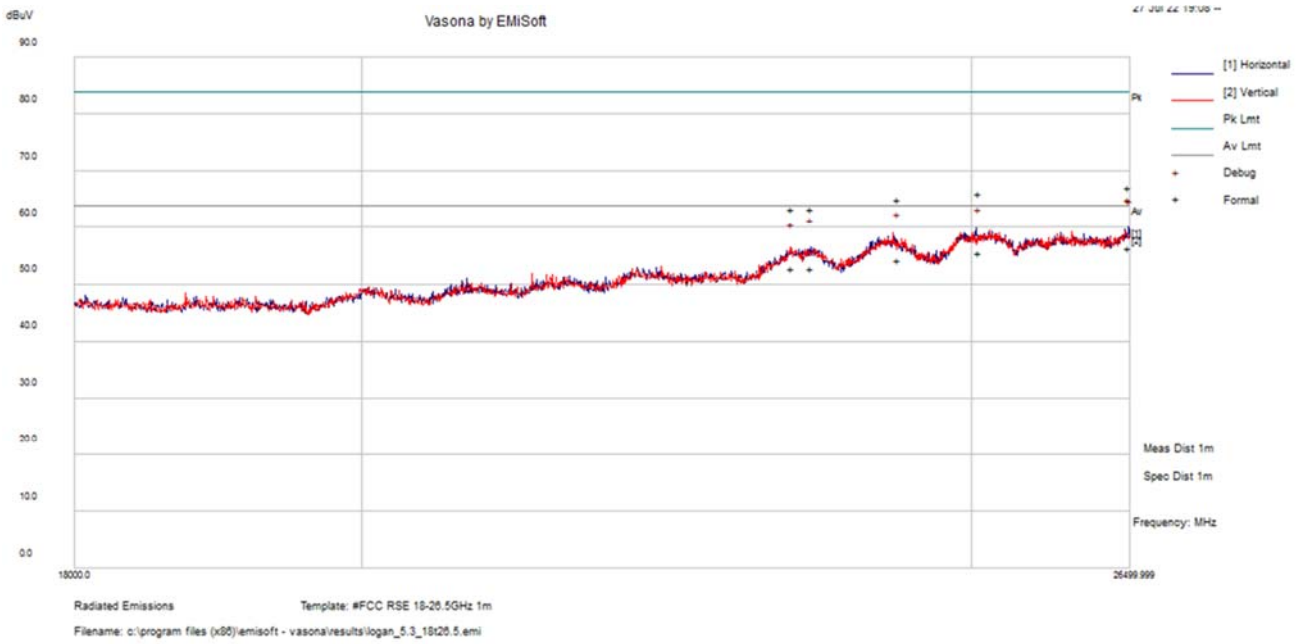
Worst Case: 802.11n/ac20 mode, 5320 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
15949.633	52.3	17.13	69.43	170	V	22	84	-14.57	Peak
10647.015	54.1	11.4	65.5	157	V	336	84	-18.5	Peak
15949.633	41.46	17.12	58.58	170	V	22	64	-5.42	Avg
10647.015	41.64	11.41	53.05	157	V	336	64	-10.95	Avg

4) 18 – 26.5 GHz Worst Case Scan at 1 Meter

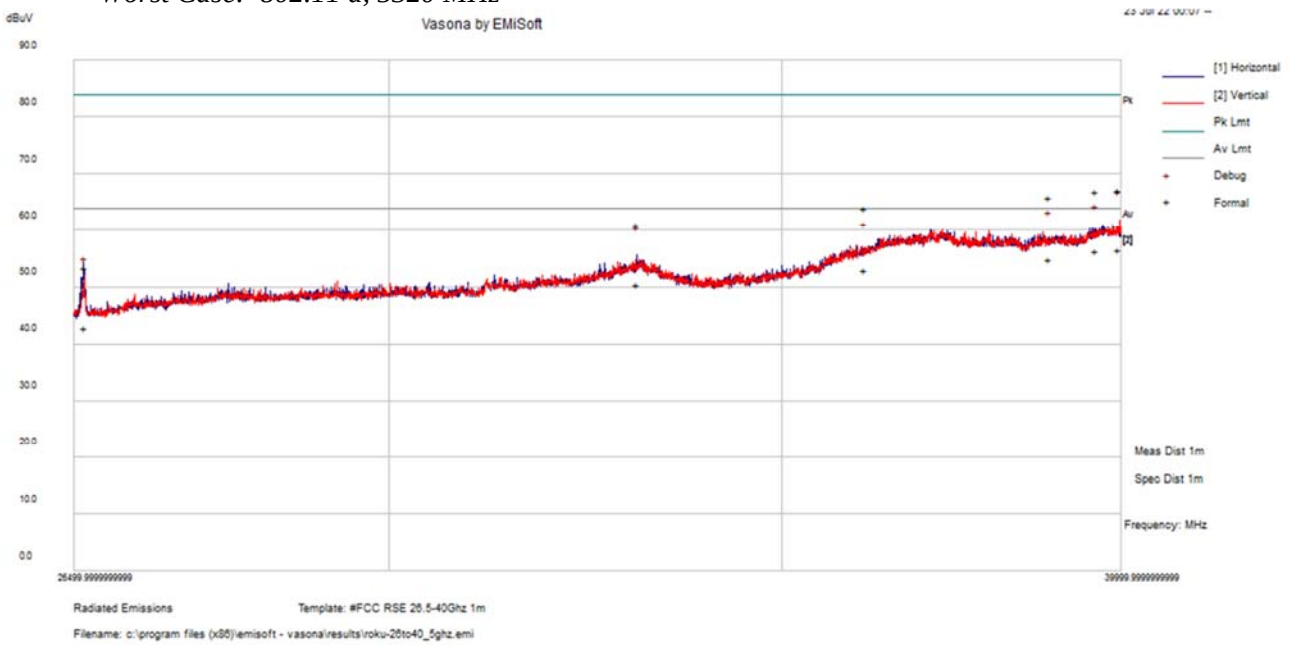
Worst Case: 802.11 a, 5320 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
26484.15	43.9	23.19	67.09	281	H	130	84	-16.91	Peak
26484.15	33.18	23.19	56.38	281	H	130	64	-7.62	Avg

5) 26.5 – 40 GHz Worst Case Scan at 1 Meter

Worst Case: 802.11 a, 5320 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
39968.07	51.02	16.26	67.27	266	V	300	84	-16.73	Peak
39968.07	40.39	16.26	56.64	266	V	300	64	-7.36	Avg

8 FCC §15.407(e) & ISEDC RSS-247 §6.2 - 6 dB, 26 dB, & 99% - Occupied Bandwidth

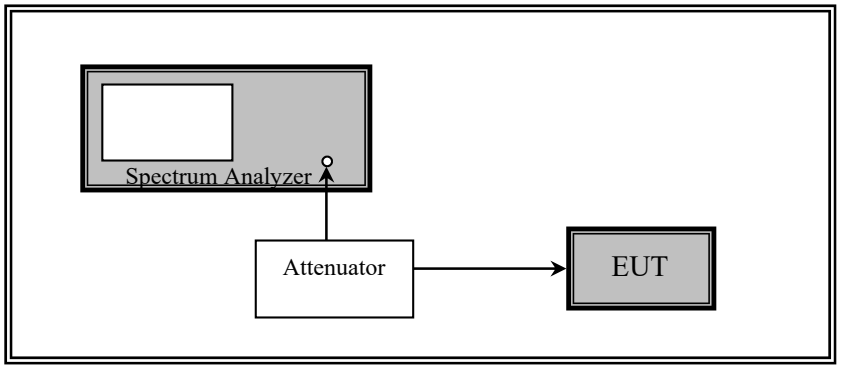
8.1 Applicable Standards

As per FCC §15.407(e) and ISEDC RSS-247 6.2.4(1): 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 Setup Block Diagram



8.4 Test Equipment List and Details

BACL Number	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
287	Agilent	Signal Analyzer	E4446A	US44300386	2022-05-05	1 year
-	-	10dB attenuator	-	-	Each time1	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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

8.5 Test Environmental Conditions

Temperature:	22-24 ºC
Relative Humidity:	40-41 %
ATM Pressure:	103.1-104.1 kPa

The testing was performed by Marc Jean from 2022-07-27 in RF site.

8.6 Test Results

Please refer to the following tables and plots.

5250 - 5350 MHz

Ant A

Channel	Frequency (MHz)	99% OBW (MHz)	26 dB OBW (MHz)
802.11a mode			
52	5260	16.3132	18.445
56	5280	16.3179	18.415
64	5320	16.3276	18.4339
802.11n/ac20 mode			
52	5260	17.4450	19.356
56	5280	17.4499	19.365
64	5320	17.4557	19.386
802.11n/ac40 mode			
54	5270	36.3955	42.264
62	5310	36.1938	41.921
802.11ac80 mode			
58	5290	75.1624	138.306

5250 - 5350 MHz

Ant B

Channel	Frequency (MHz)	99% OBW (MHz)	26 dB OBW (MHz)
802.11a mode			
52	5260	16.2953	18.527
56	5280	16.2830	18.524
64	5320	16.3178	19.353
802.11n/ac20 mode			
52	5260	17.4549	19.3432
56	5280	17.4567	19.527
64	5320	17.4616	19.395
802.11n/ac40 mode			
54	5270	36.400	42.541
62	5310	36.3476	43.3
802.11ac80 mode			
58	5290	75.6087	116.349

5470MHz - 5725 MHz

Ant A

Channel	Frequency (MHz)	99% OBW (MHz)	26 dB OBW (MHz)
802.11a mode			
100	5500	16.3247	18.419
116	5580	16.3191	18.315
140	5700	16.3142	18.386
802.11n/ac20 mode			
100	5500	17.4514	19.341
116	5580	17.4466	19.298
140	5700	17.4578	19.361
802.11n/ac40 mode			
102	5510	36.2460	58.929
118	5590	36.3651	50.266
134	5670	36.2459	42.180
802.11ac80 mode			
106	5530	76.0600	114.762
122	5610	75.0719	103.560

5470MHz - 5725 MHz

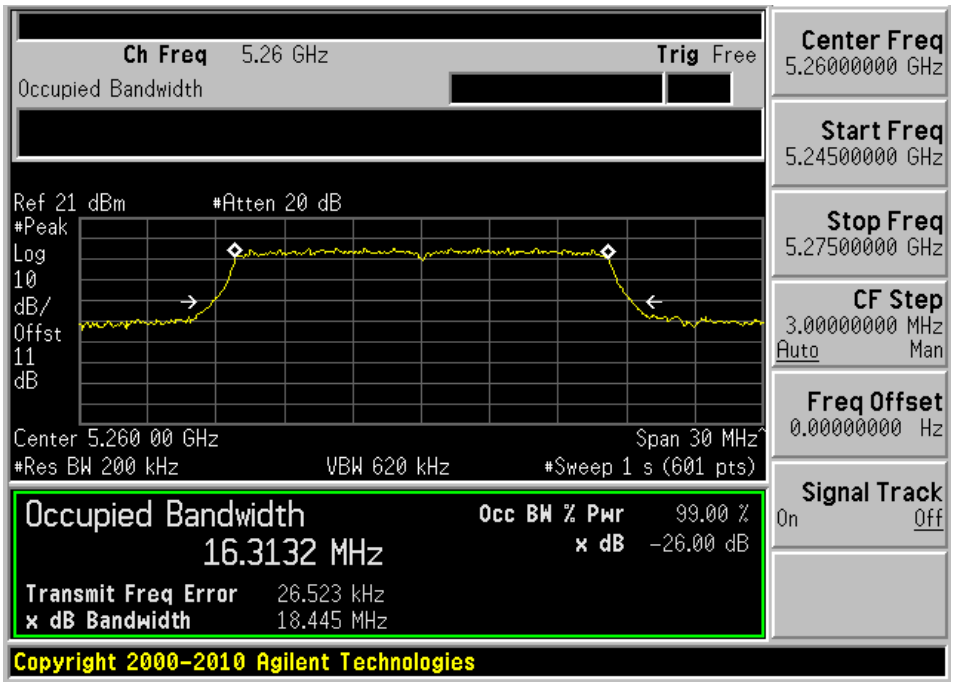
Ant B

Channel	Frequency (MHz)	99% OBW (MHz)	26 dB OBW (MHz)
802.11a mode			
100	5500	17.0271	30.722
116	5580	17.1174	32.596
140	5700	16.3070	18.589
802.11n/ac20 mode			
100	5500	17.4510	19.331
116	5580	17.7876	25.013
140	5700	17.4996	19.505
802.11n/ac40 mode			
102	5510	36.2249	42.384
118	5590	36.6125	55.252
134	5670	36.4158	51.747
802.11ac80 mode			
106	5530	75.1916	109.825
122	5610	75.7913	118.536

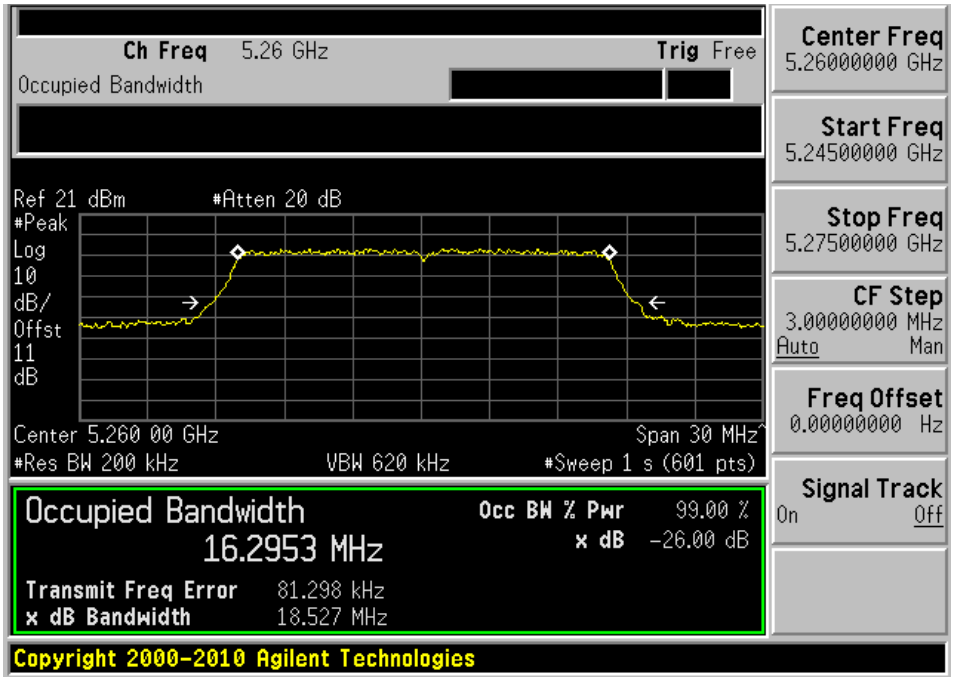
5250 - 5350 MHz

802.11a mode 26dB & 99% OBW

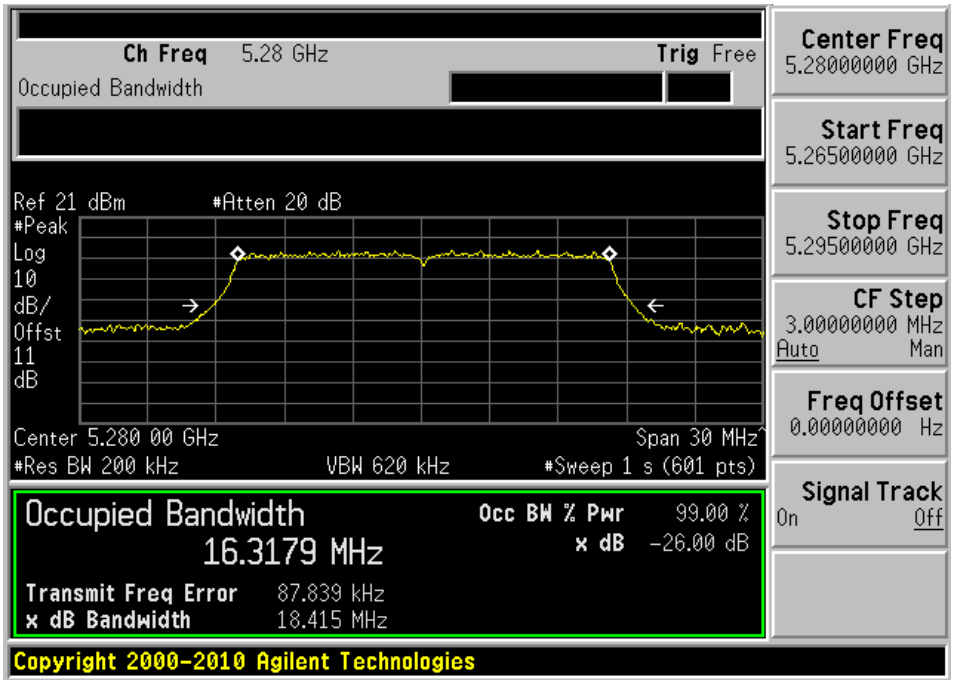
Low Channel Ant A



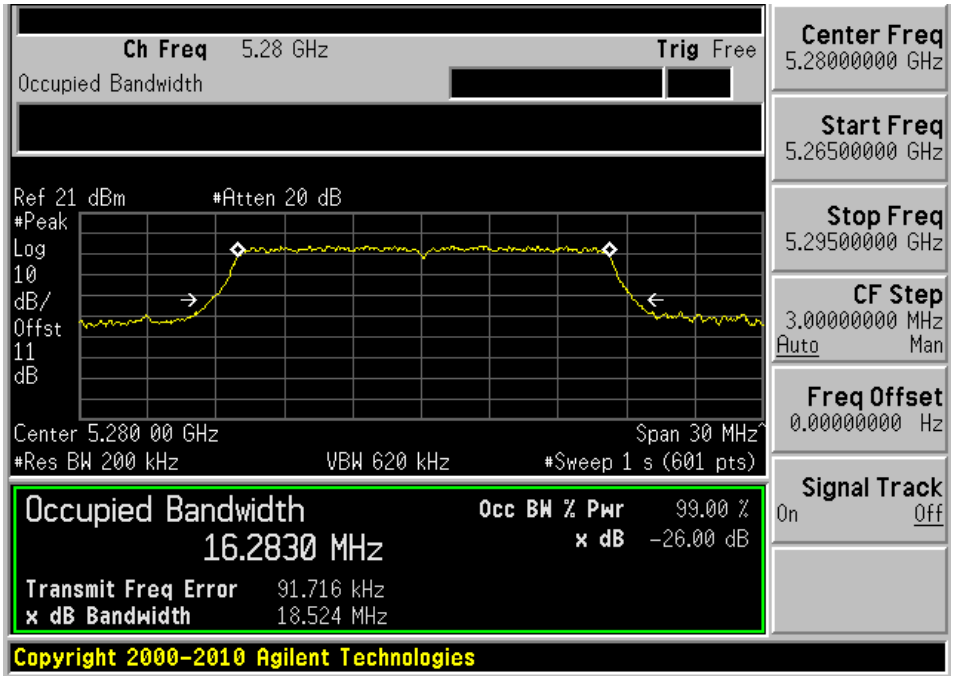
Low Channel Ant B



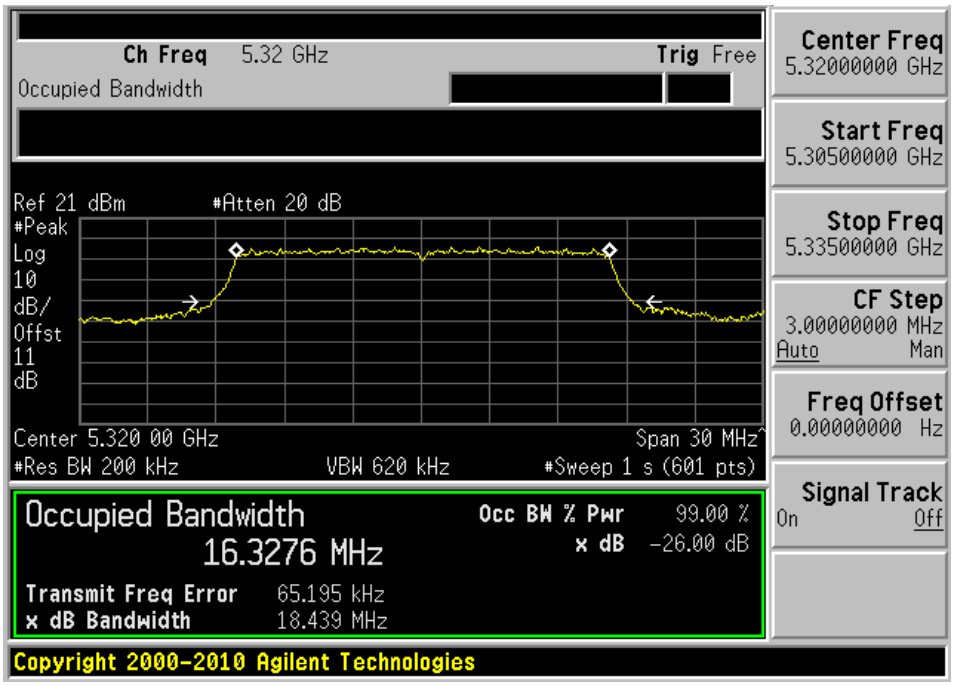
Mid Channel Ant A



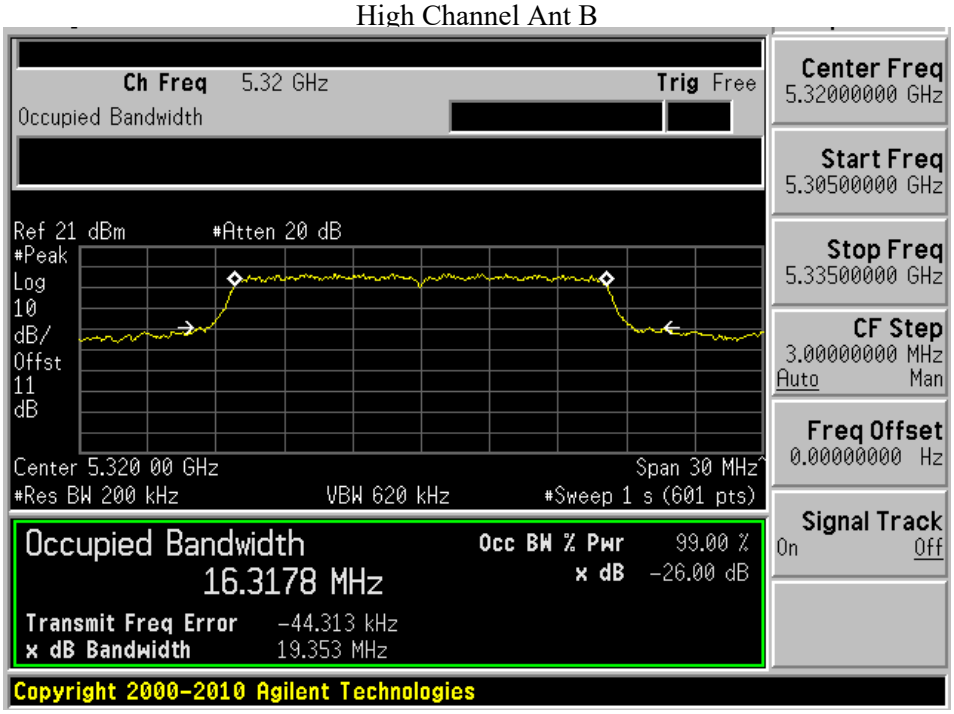
Mid Channel Ant B



High Channel Ant A

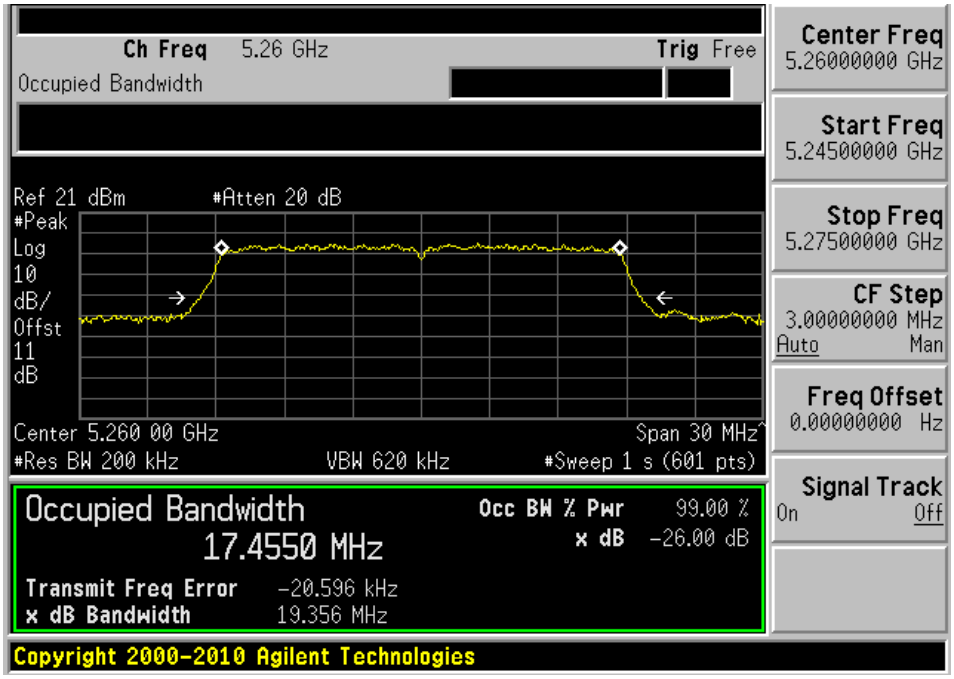


High Channel Ant B

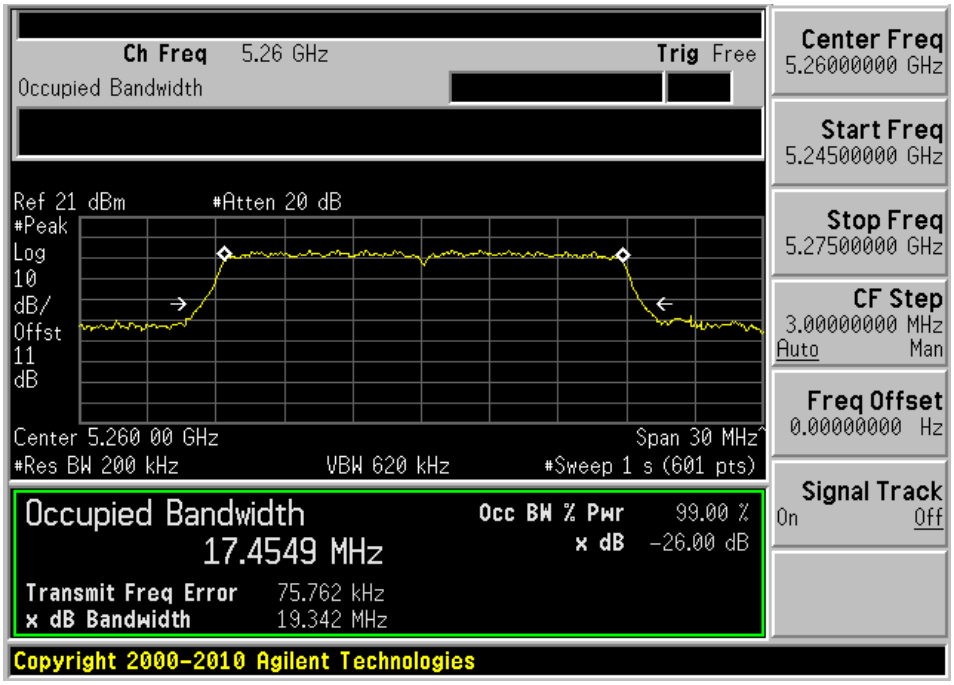


802.11n20 mode 26dB & 99% OBW

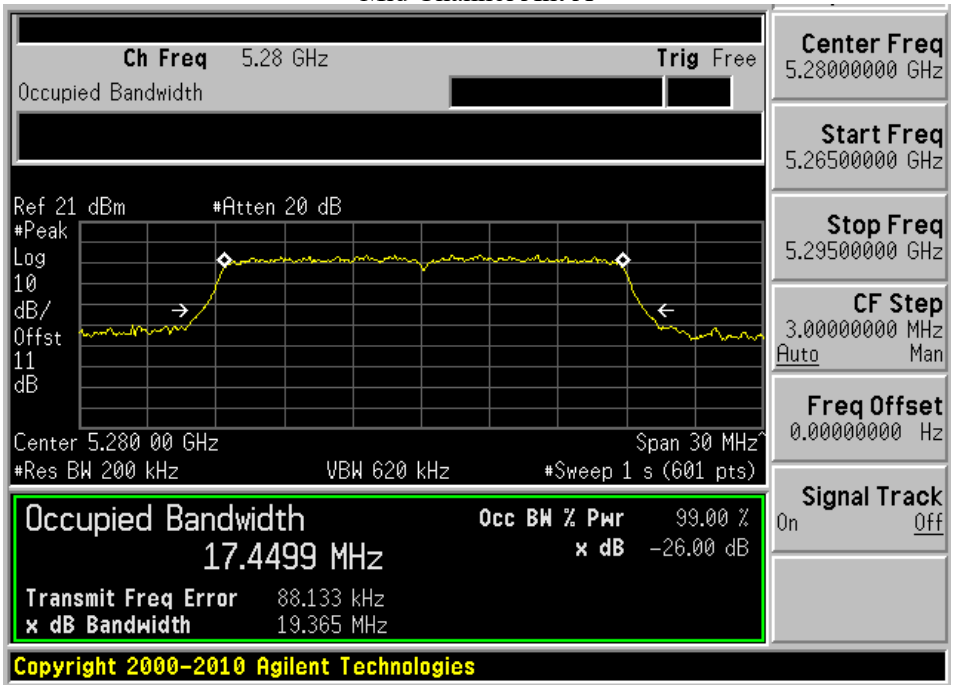
Low Channel Ant A



Low Channel Ant B



Mid Channel Ant A



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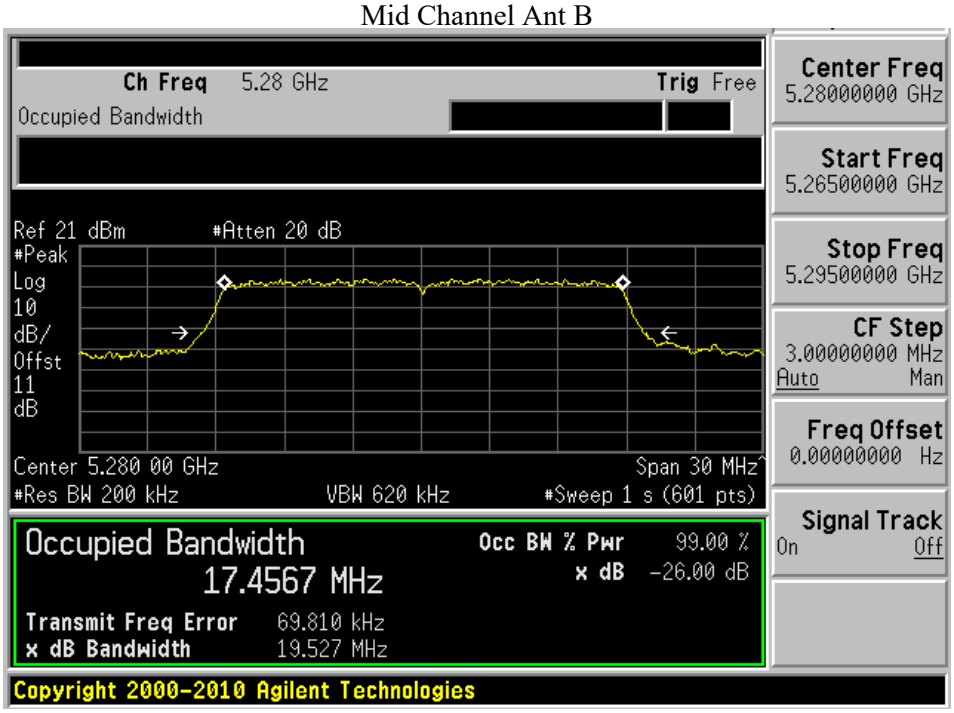

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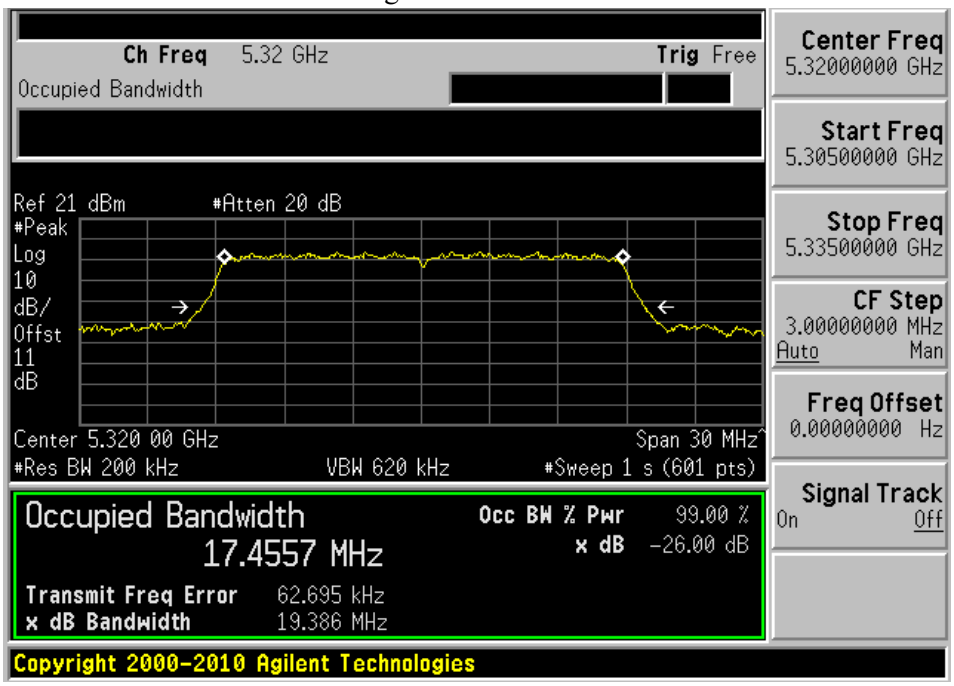

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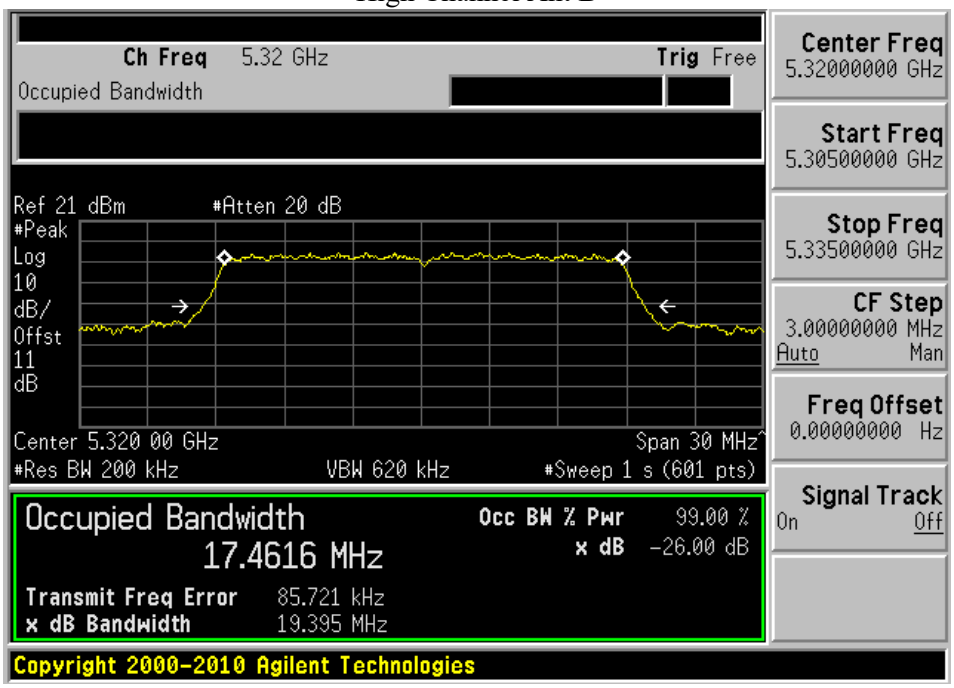
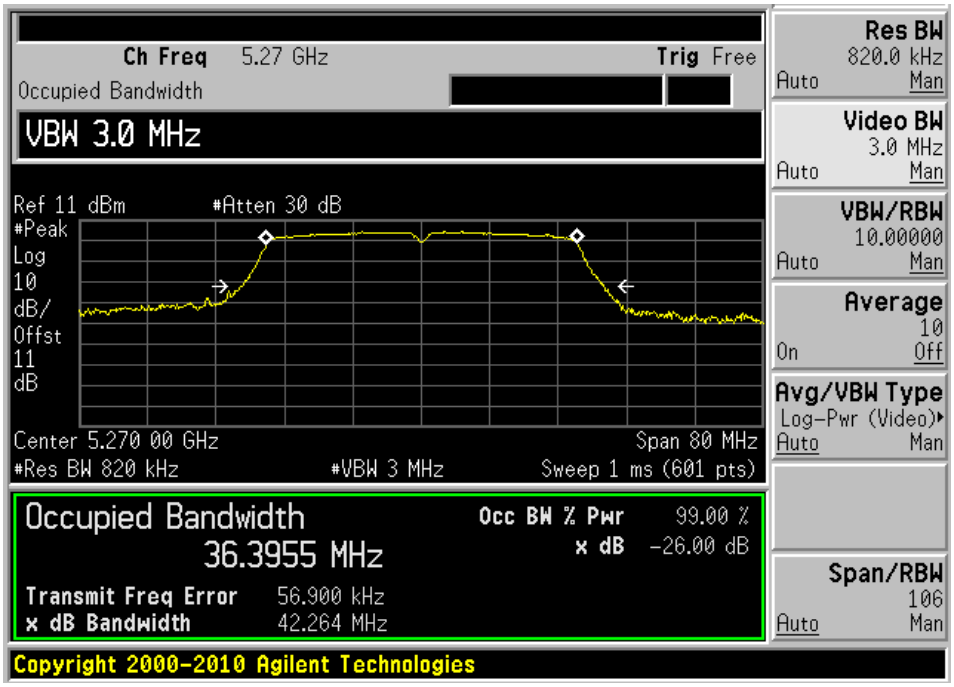


802.11n40 mode 26dB & 99% OBW

Low Channel Ant A



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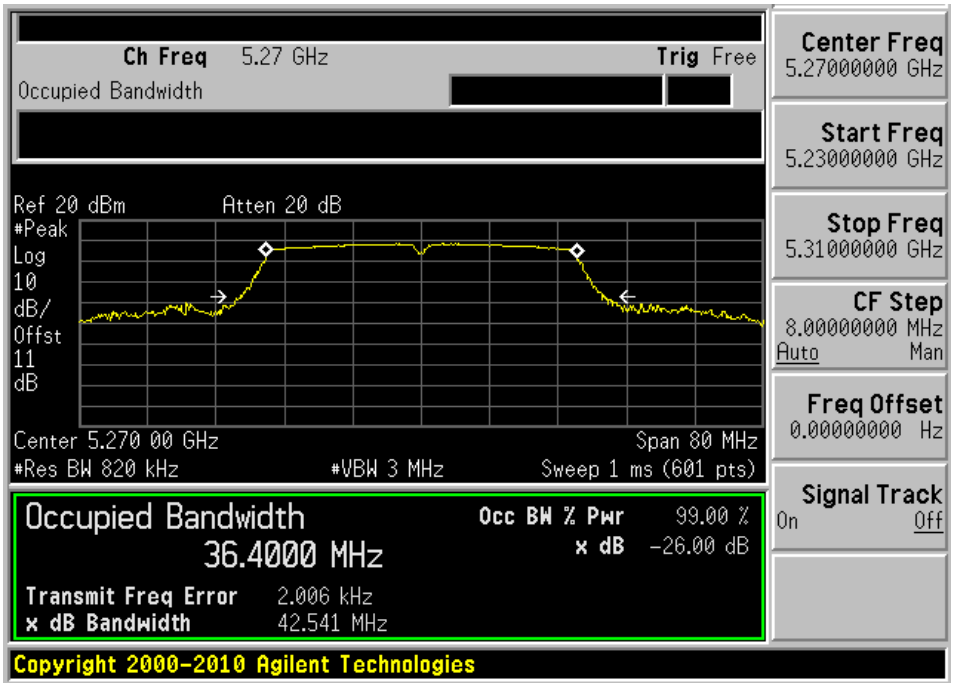

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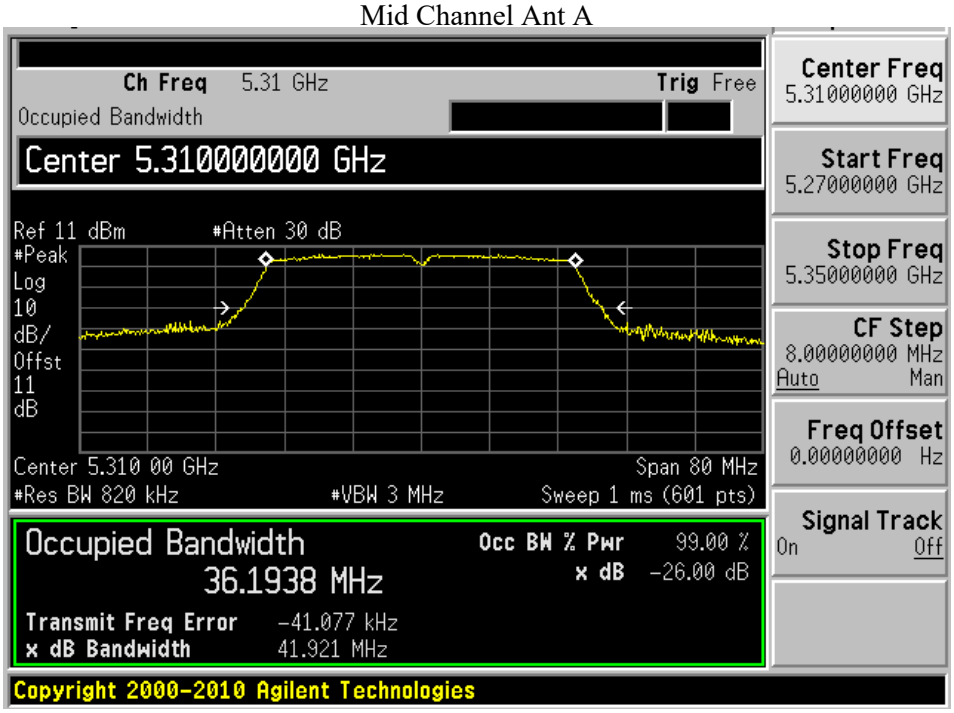

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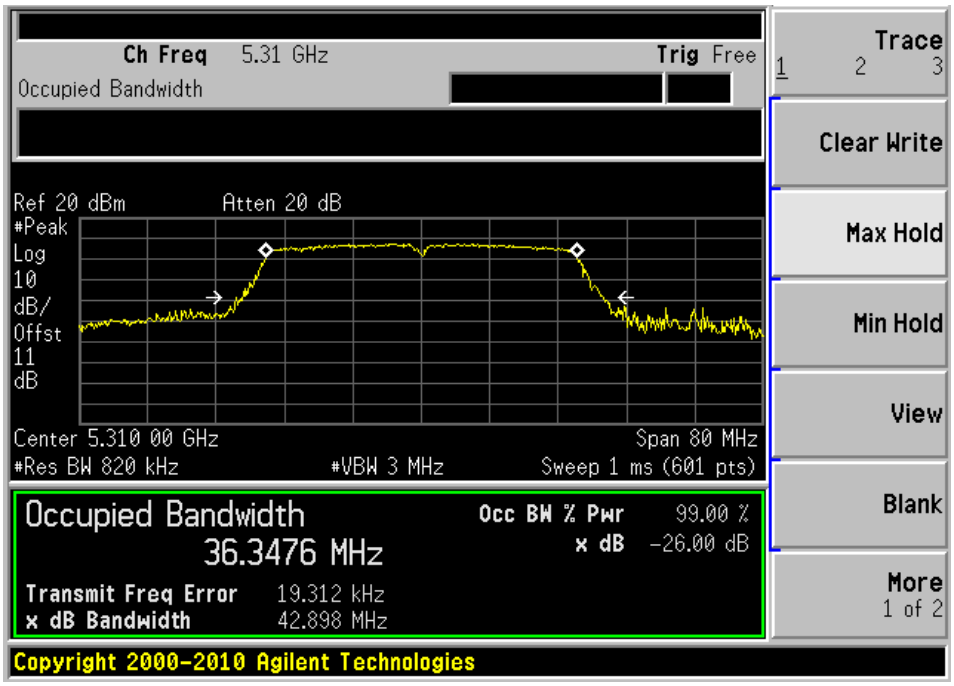
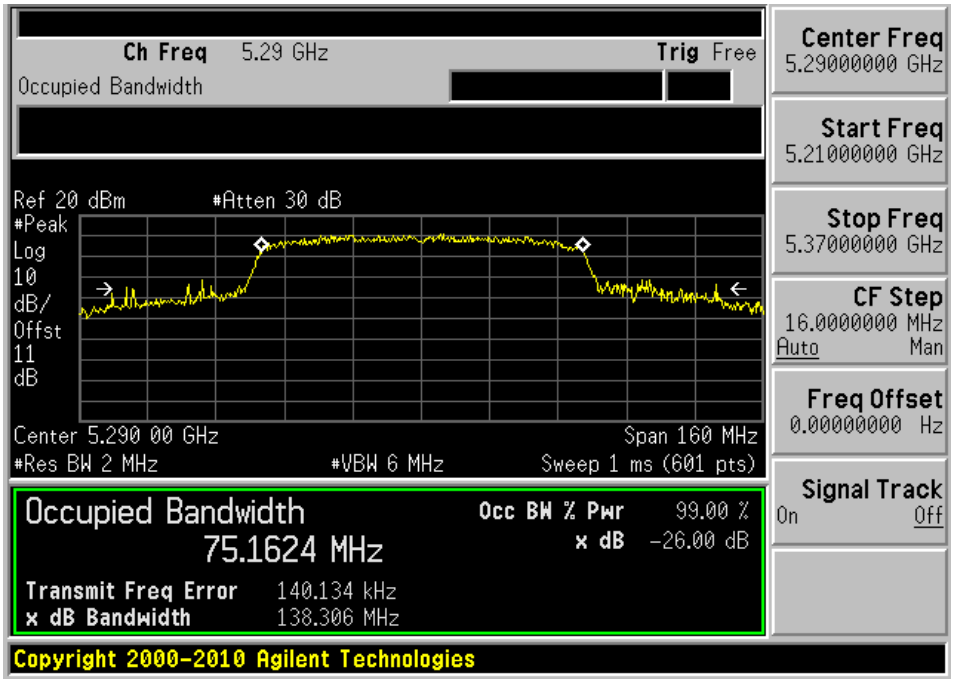


802.11ac80 mode 26dB & 99% OBW

Low Channel Ant A



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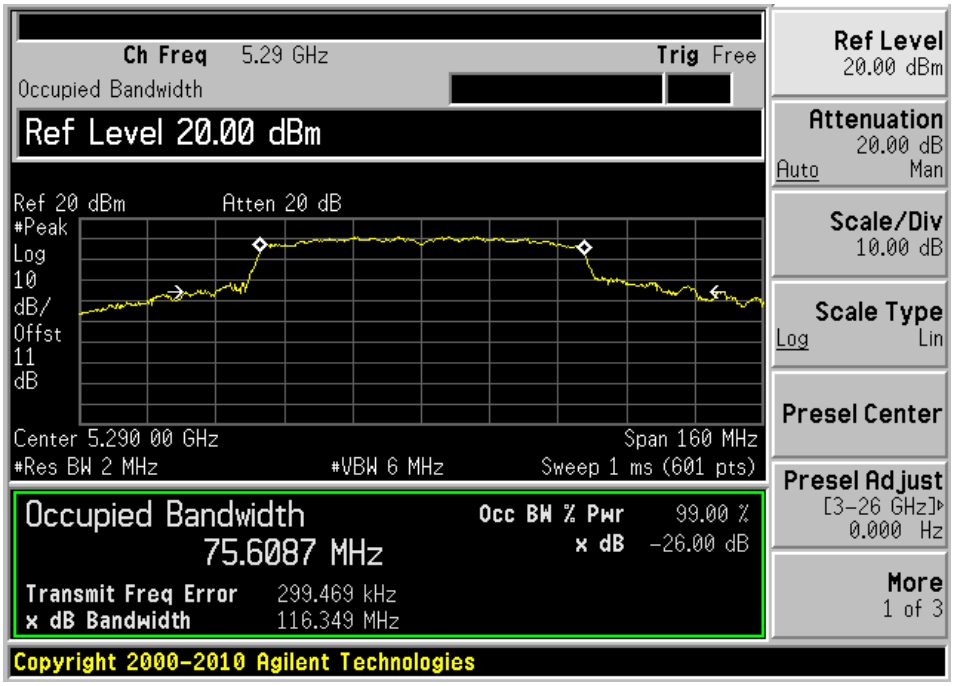
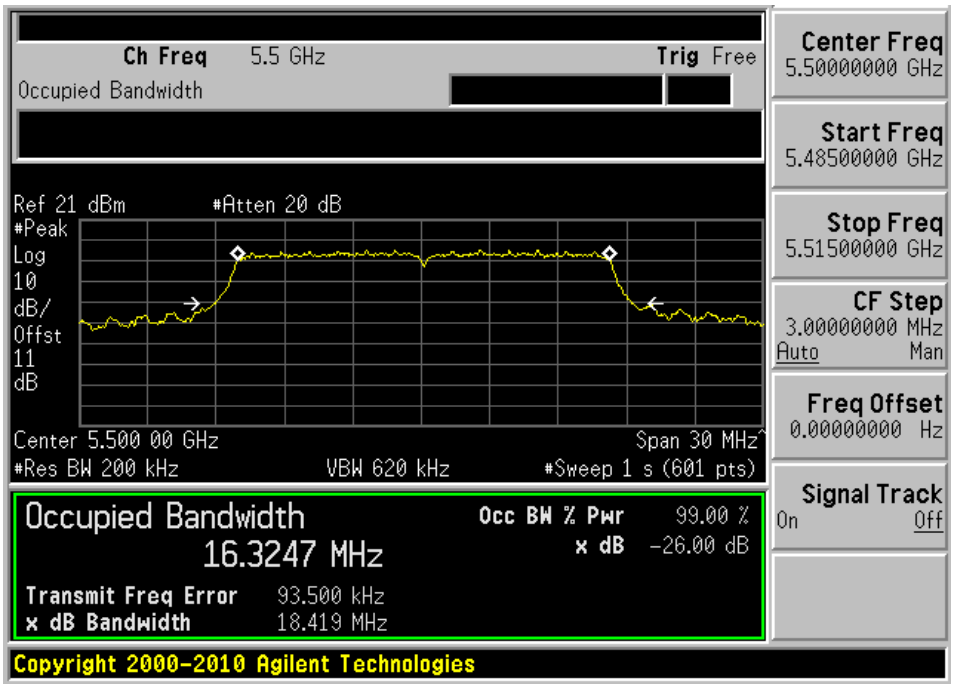


5470MHz - 5725 MHz

802.11a mode 26dB & 99% OBW

Low Channel Ant A



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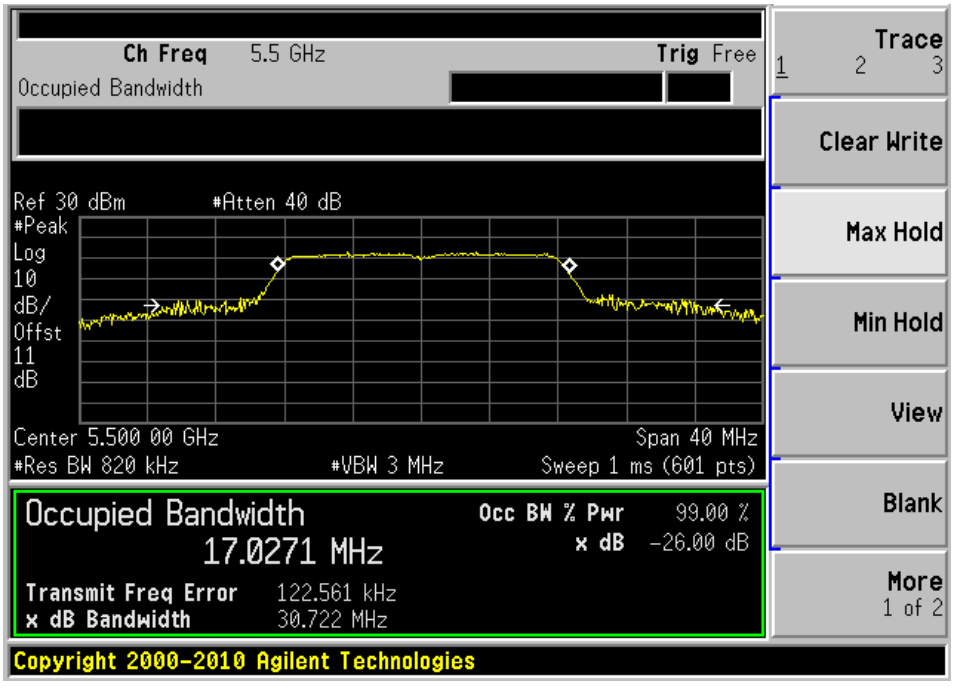

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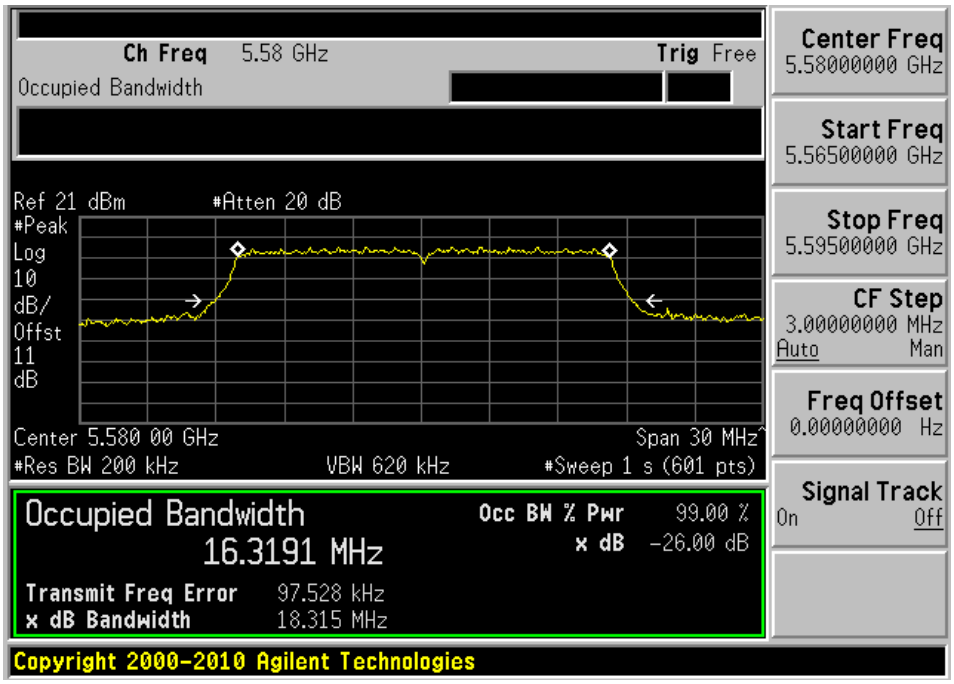

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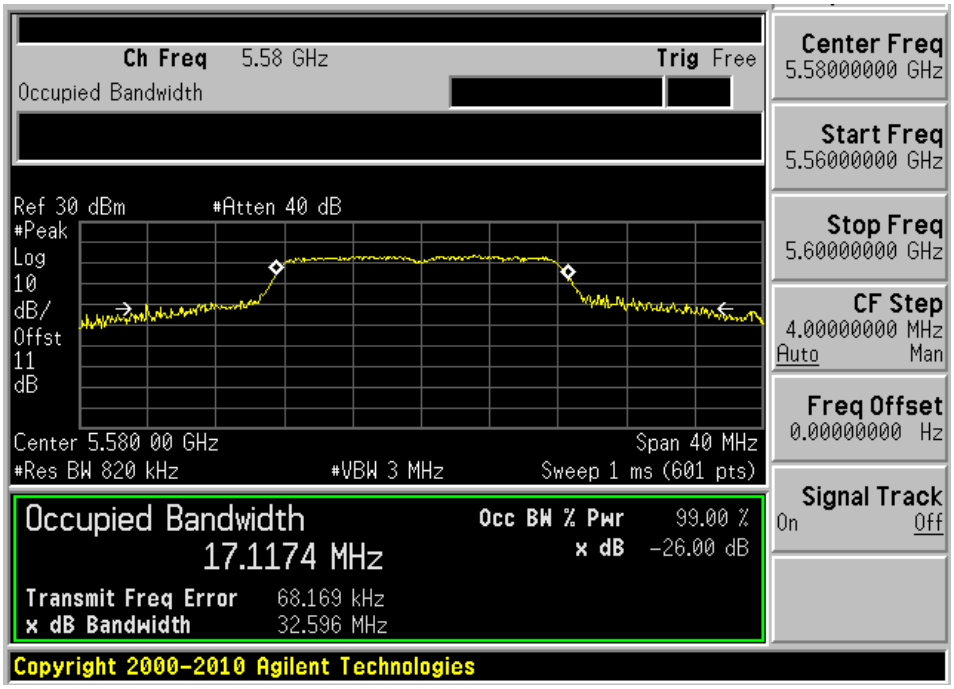

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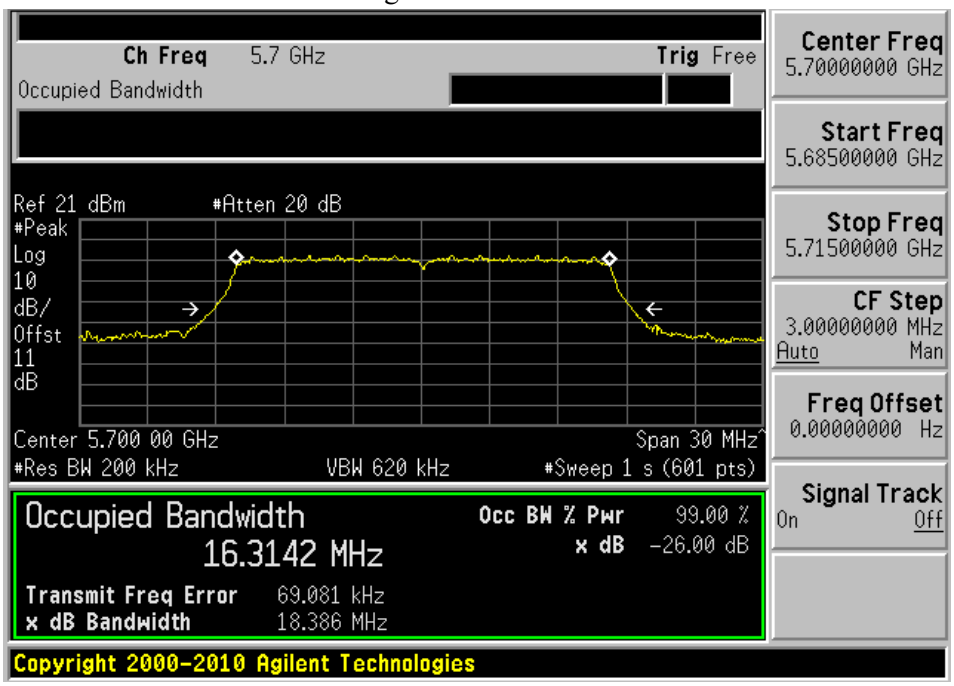
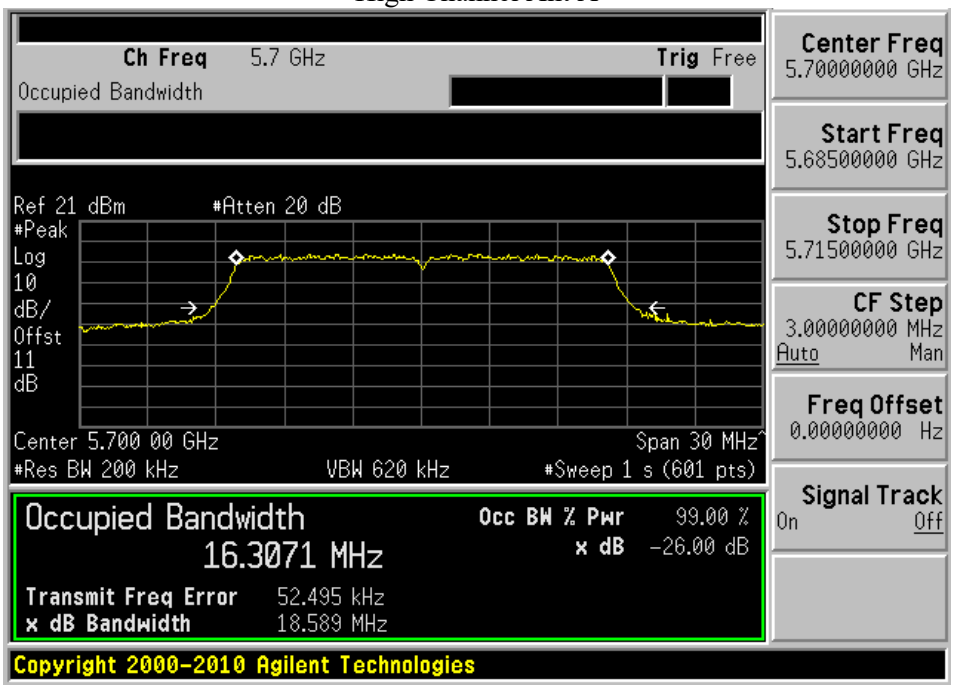
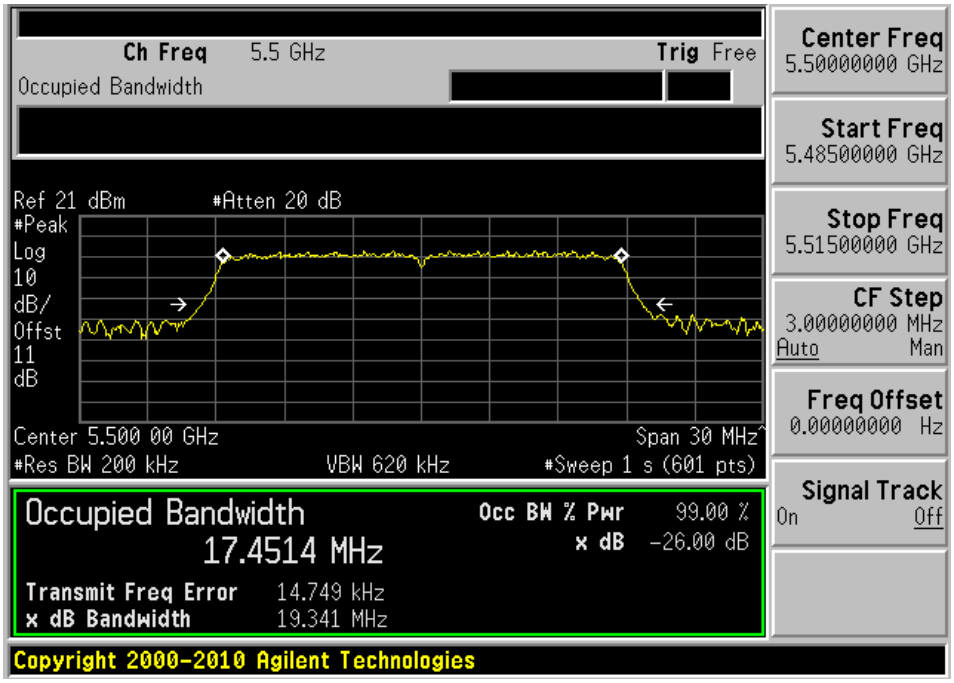


High Channel Ant A



802.11n20 mode 26dB & 99% OBW

Low Channel Ant A



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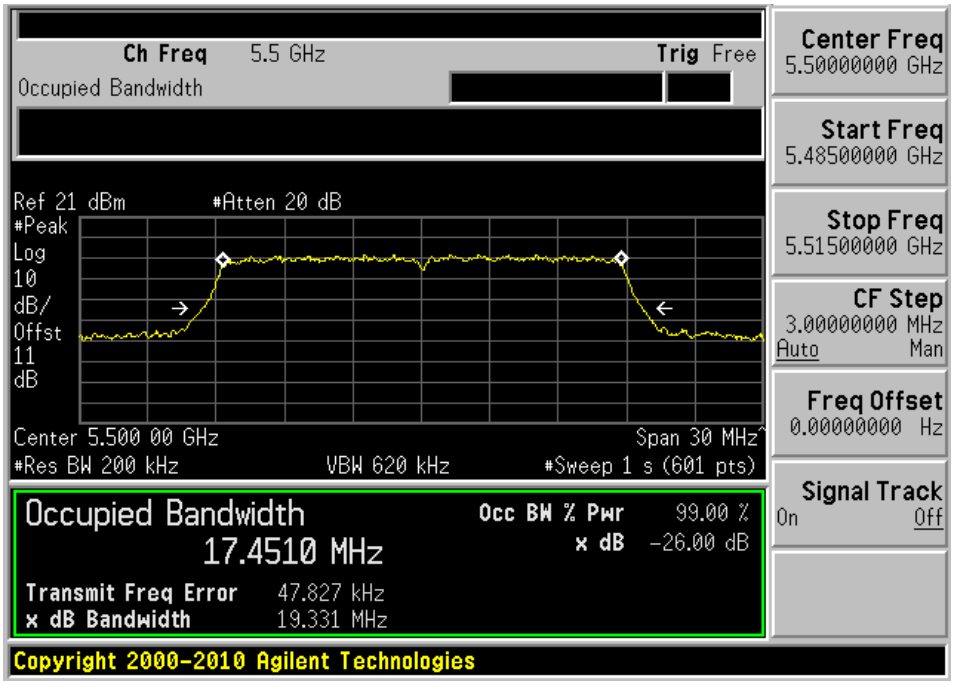

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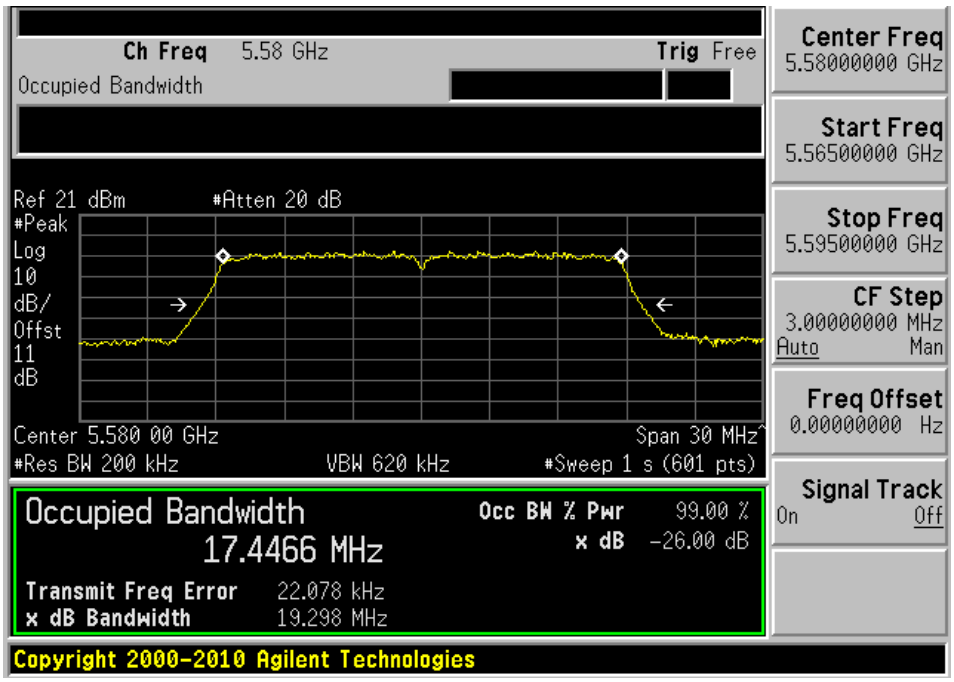

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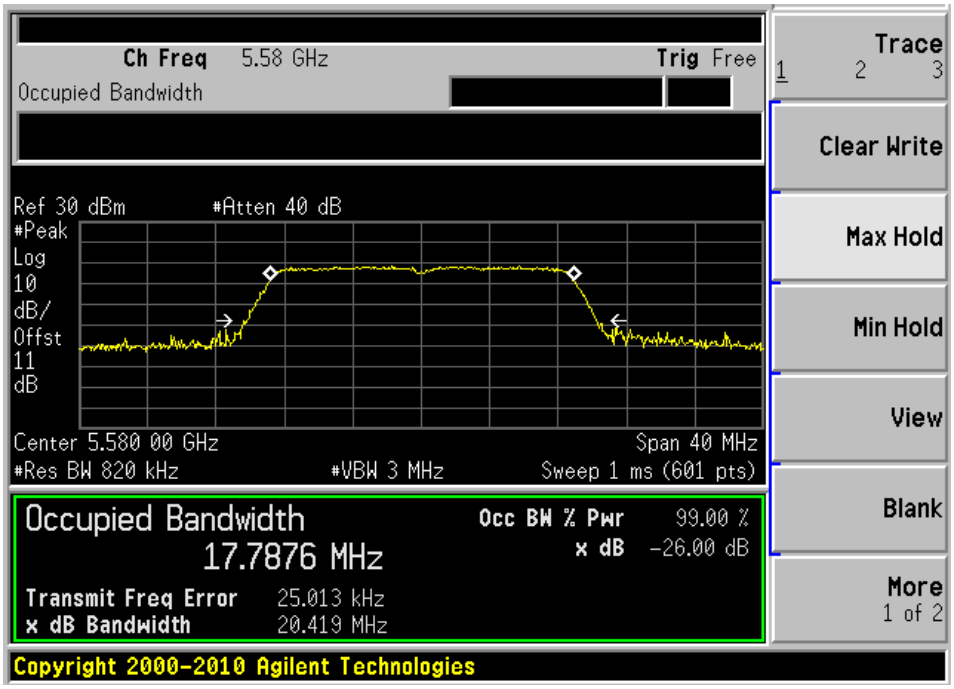

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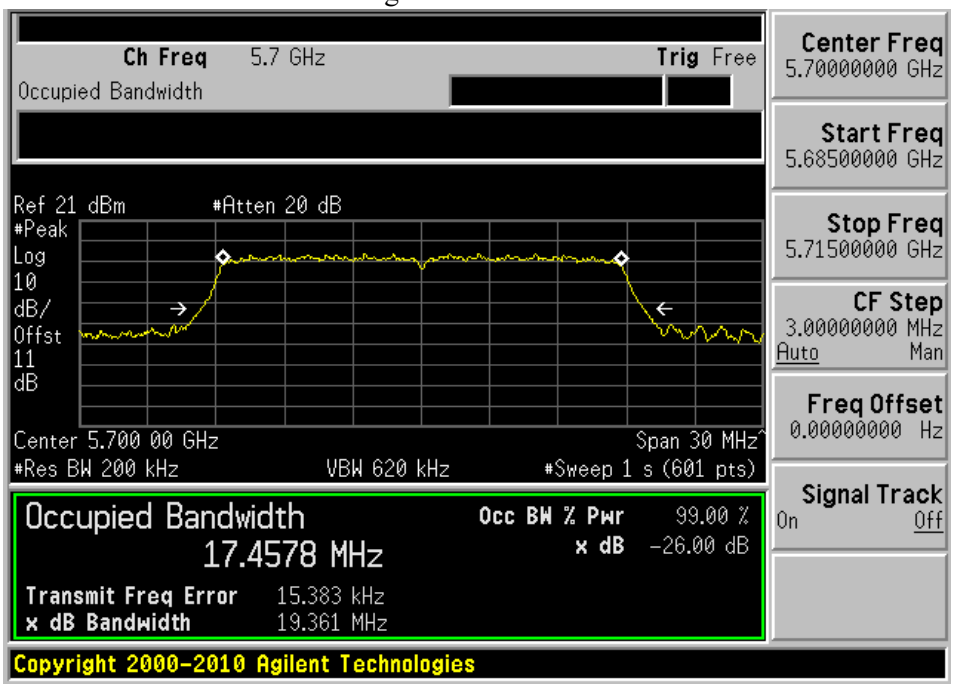

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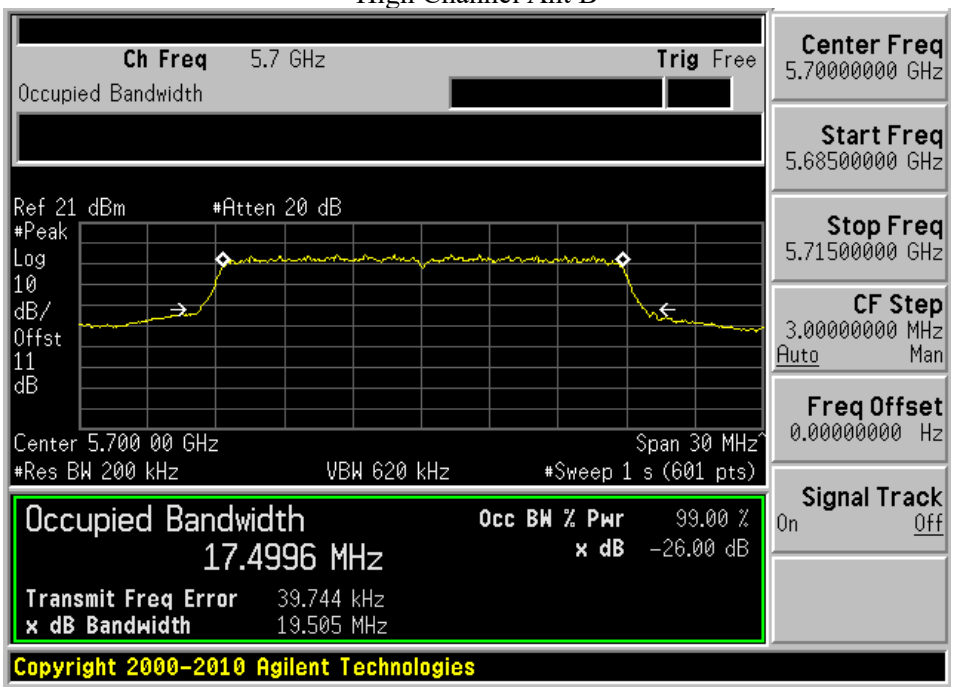
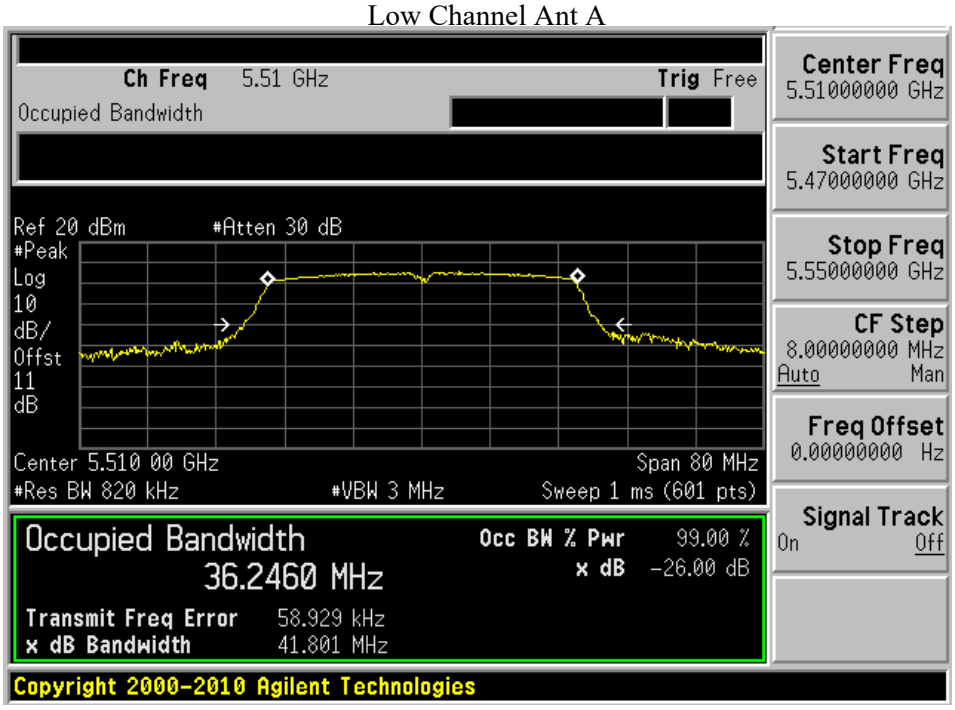


802.11n40 mode 26dB & 99% OBW

Low Channel Ant A



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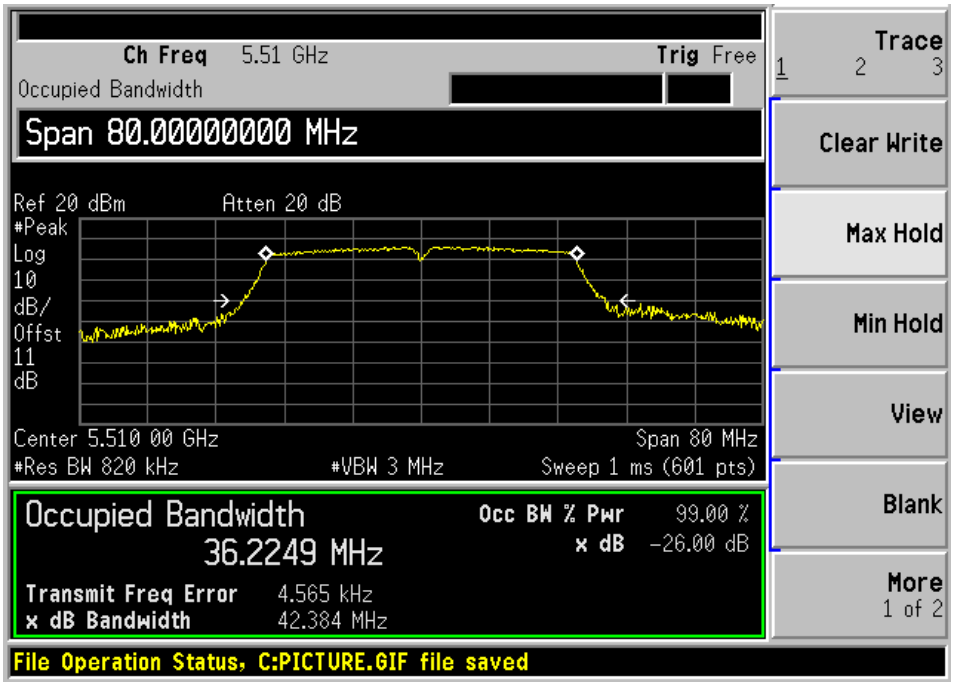

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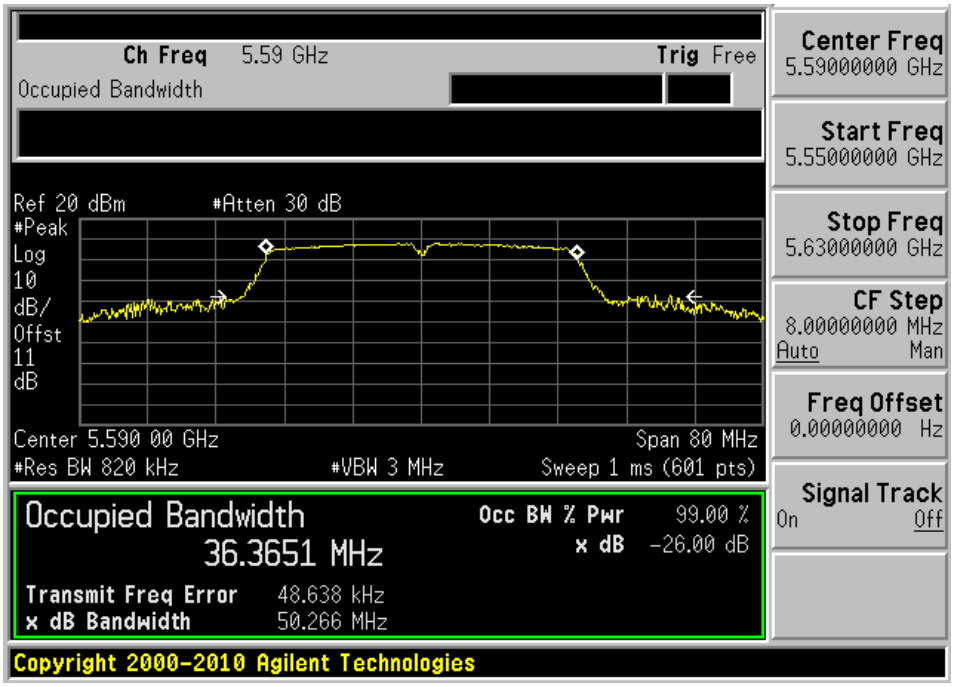

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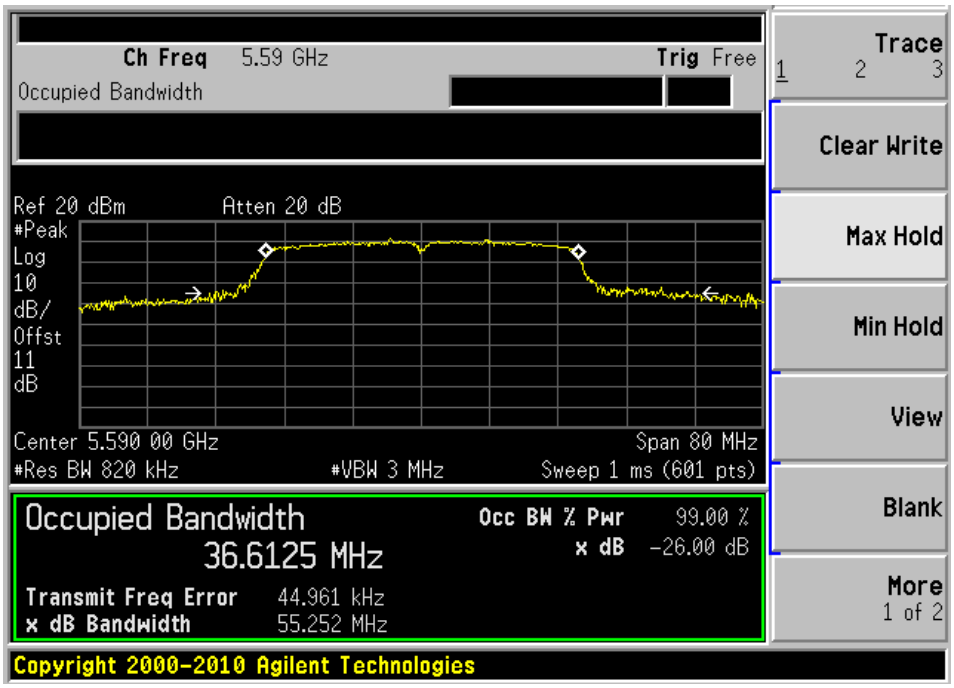

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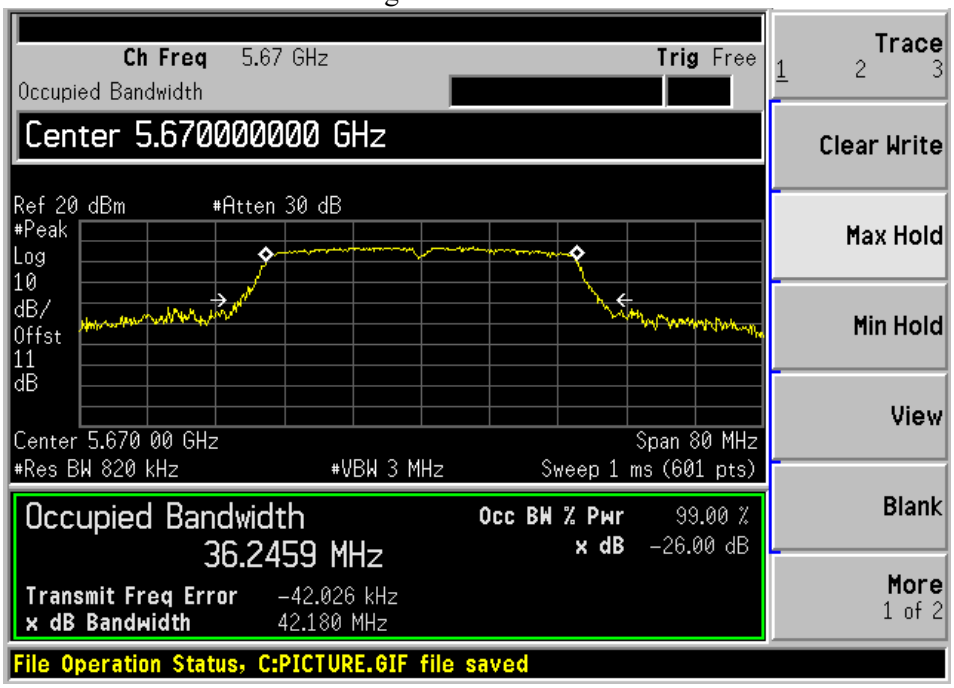

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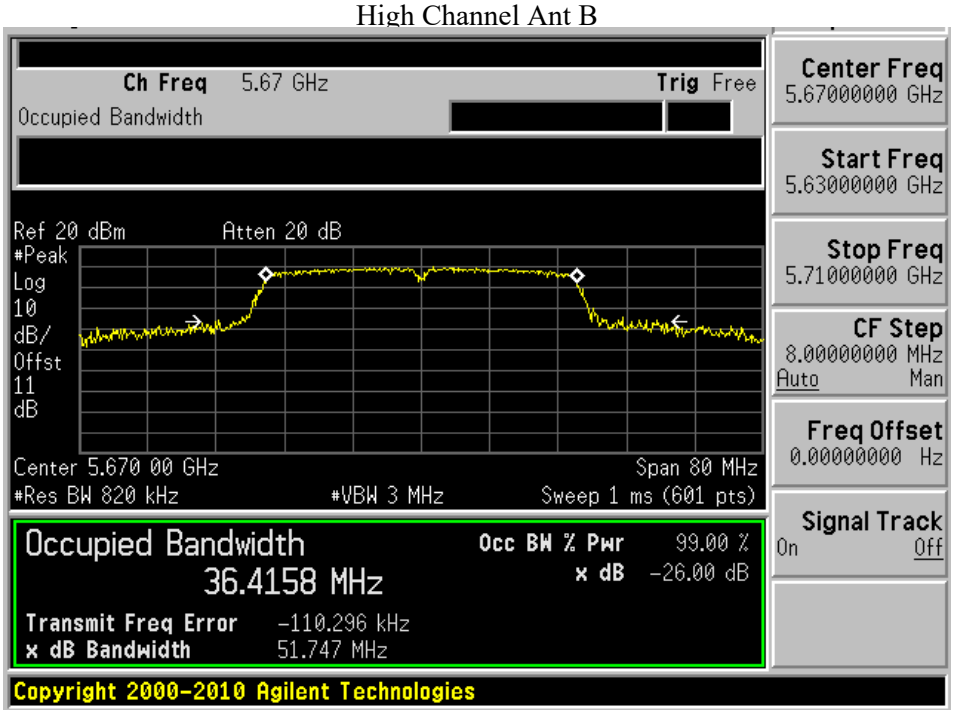
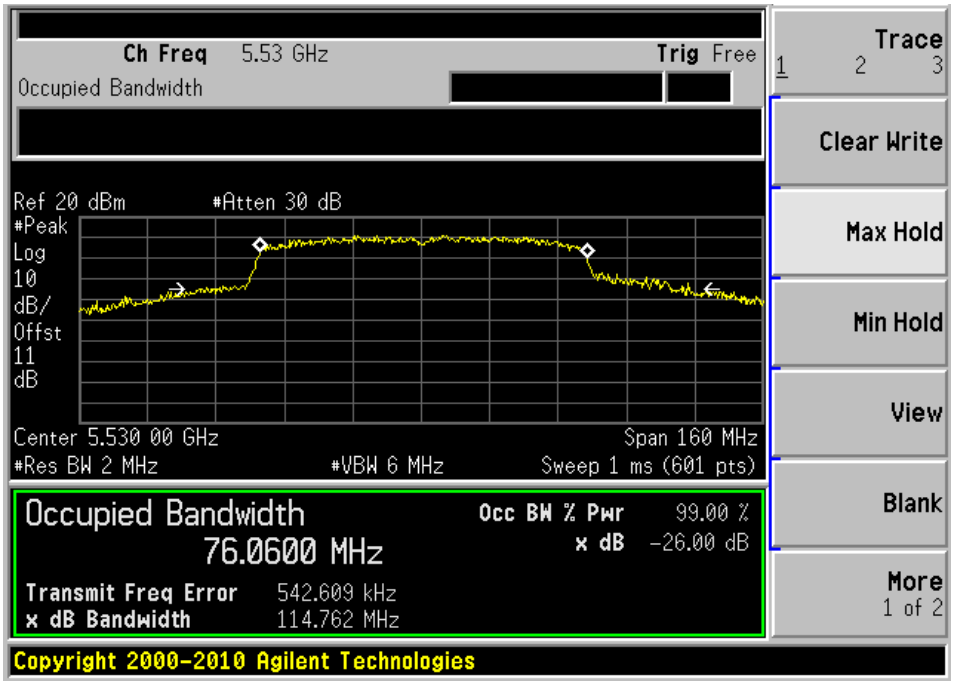


802.11ac80 mode 26dB & 99% OBW

Low Channel Ant A



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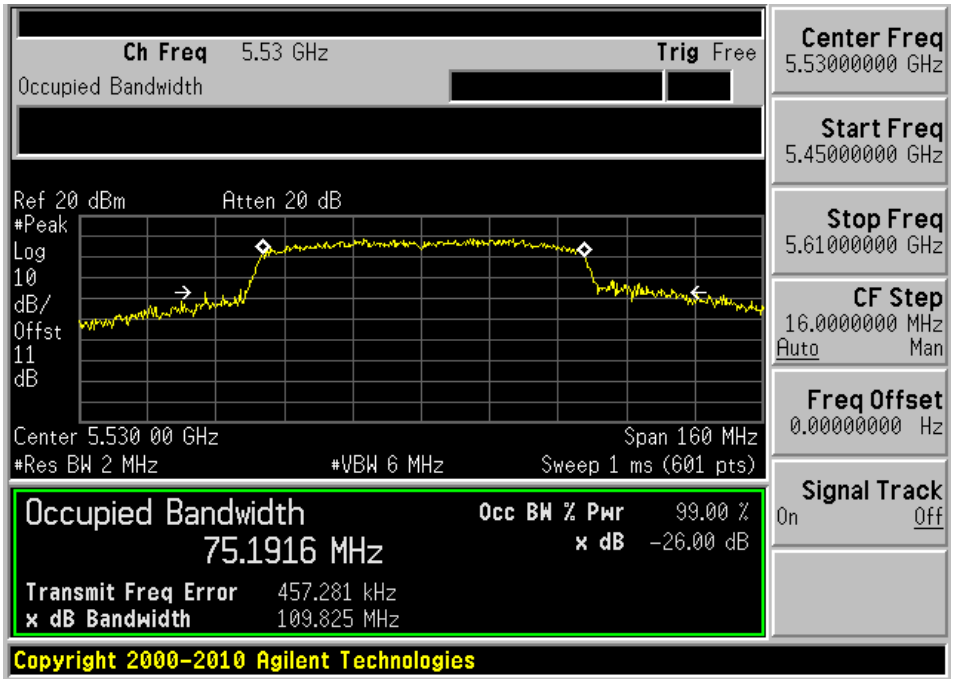

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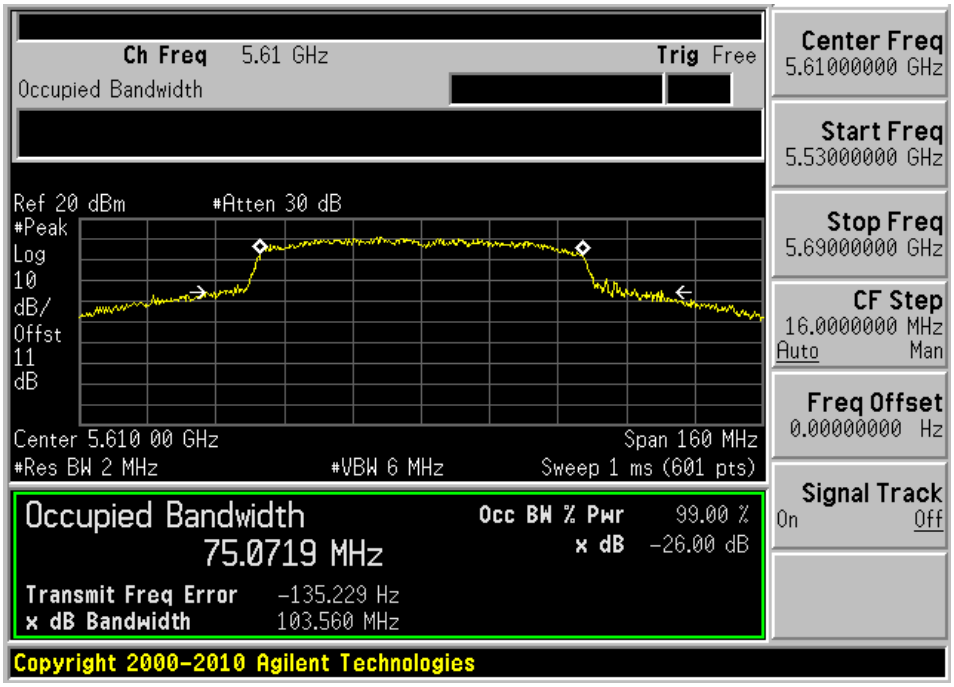
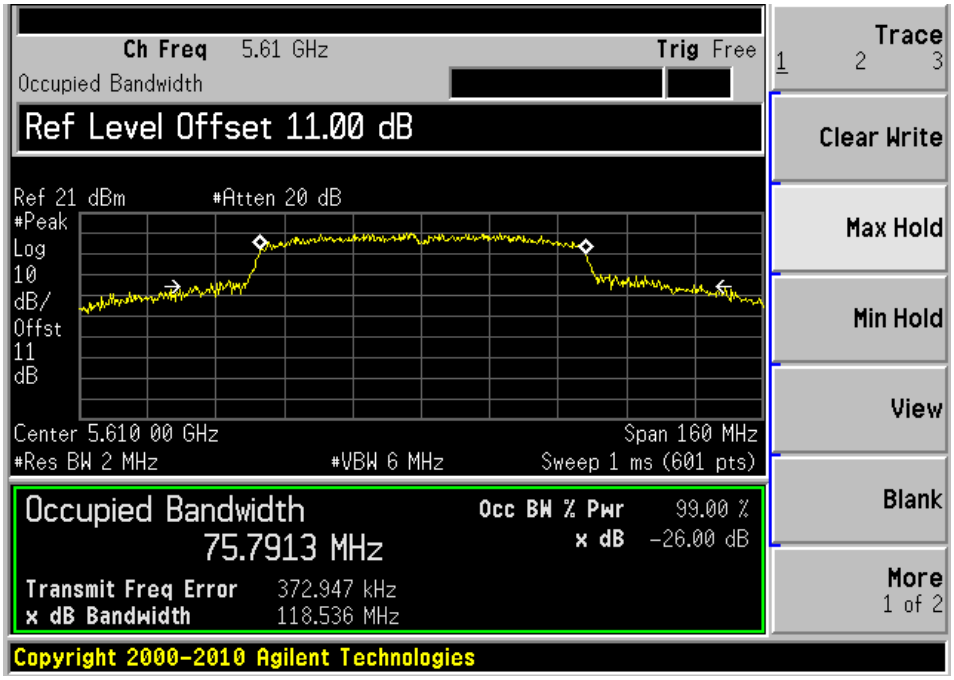


Mid Channel Ant B



9 FCC §407(a) & ISEDC RSS-247 §6.2 - Output Power

9.1 Applicable Standards

According to FCC §15.407(a):

For 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.

According to ISEDC RSS-247 §6.2.1 for frequency band 5150-5250 MHz:

The maximum e.i.r.p. shall not exceed 200 mW or $10 + 10 \log_{10}B$, dBm, whichever power is less. B is the 99% emission bandwidth in megahertz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

According to ISEDC RSS-247 §6.2.2 for frequency band 5250-5350 MHz:

The maximum conducted output power shall not exceed 250 mW or $11 + 10 \log_{10}B$, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

The maximum e.i.r.p. shall not exceed 1.0 W or $17 + 10 \log_{10}B$, 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.

According to ISEDC RSS-247 §6.2.3 for frequency band 5470-5600 MHz and 5650-5725 MHz:

The maximum conducted output power shall not exceed 250 mW or $11 + 10 \log_{10}B$, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

The maximum e.i.r.p. shall not exceed 1.0 W or $17 + 10 \log_{10}B$, 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.

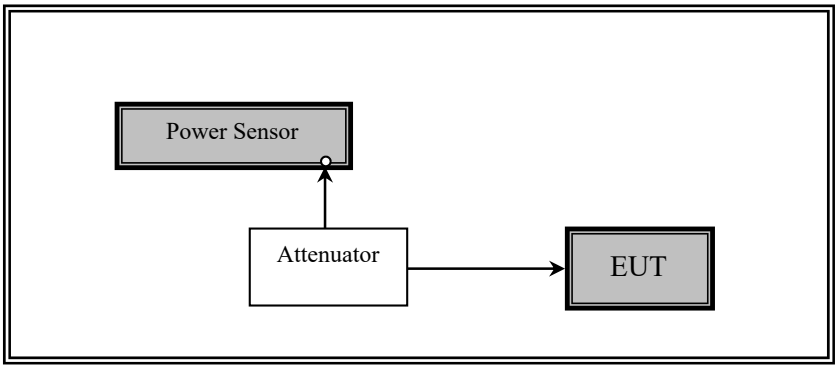
According to ISEDC RSS-247 §6.2.4 for frequency band 5725-5850 MHz:

The maximum conducted output power shall not exceed 1 W. The 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 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-multipoint systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

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 Setup Block Diagram



9.4 Test Equipment List and Details

BACL Number	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
-	-	20 dB attenuator	-	-	Each time1	N/A
-	-	RF cable	-	-	Each time[1]	N/A
697	ETS- Lindgren	Power Sensor	7002-006	160097	2021-02-12	2 years

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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

9.5 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	55 %
ATM Pressure:	102.2 KPa

The testing was performed by Christian Schwartz on 2022-07-15 in RF site.

9.6 Test Results

5250 - 5350 MHz

Channel	Frequency (MHz)	Conducted Output Power (dBm)		Total Power (dBm)	FCC/IC Limit (dBm)
		ANT A	ANT B		
802.11a mode					
52	5260	20.78	20.84	-	23
56	5280	20.55	20.65	-	23
64	5320	20.67	20.25	-	23
802.11n/ac20 mode					
52	5260	15.28	16.27	18.81	23
56	5280	16.3	16.73	19.53	23
64	5320	16.43	16.96	19.71	23
802.11n/ac40 mode					
54	5270	16.16	16.85	19.53	22
62	5310	16.12	16.63	19.39	22
802.11ac80 mode					
58	5290	16.03	16.59	19.33	22

5470MHz - 5725 MHz

Channel	Frequency (MHz)	Conducted Output Power (dBm)		Total Power (dBm)	FCC/IC Limit (dBm)
		ANT A	ANT B		
802.11a mode					
100	5500	20.98	21.79	-	23
116	5580	21.42	21.46	-	23
140	5700	20.13	20.7	-	23
802.11n/ac20 mode					
100	5500	16.05	16.96	19.54	23
116	5580	15.99	16.64	19.34	23
140	5700	15.3	15.14	18.23	23
802.11n/ac40 mode					
102	5510	16.57	16.66	19.63	22
118	5590	16.72	16.26	19.51	22
134	5670	16.45	16.99	19.74	22
802.11ac80 mode					
106	5530	16.03	16.74	19.41	22
122	5610	16.46	16.84	19.66	22

Note: Total power (dBm) =10*Log(Ant A(mw)+Ant B(mw))
Note: Duty cycle correction factor has already been added to the measurements
Note: For FCC: the maximum conducted output power shall not exceed 250 mW or 11 + 10 log10B, dBm, whichever is less. Here B is the 26dB bandwidth in megahertz. In this instance B was chosen to be the lowest measured BW rounded down to represent the worst case limit.
Note: For IC: the maximum conducted output power shall not exceed 250 mW or 11 + 10 log10B, dBm, whichever is less. Here B is the 99% emission bandwidth in megahertz. In this instance B was chosen to be the lowest measured BW rounded down to represent the worst case limit.

10 FCC §15.407(a) & ISEDC RSS-247 §6.2 - Power Spectral Density

10.1 Applicable Standards

According to FCC §15.407(a):

For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 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 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.

According to ISEDC RSS-247 §6.2.1 for frequency band 5150-5250 MHz:

The maximum e.i.r.p. shall not exceed 200 mW or 10 + 10 log10B, dBm, whichever power is less. B is the 99% emission bandwidth in megahertz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

According to ISEDC RSS-247 §6.2.2 for frequency band 5250-5350 MHz:

The maximum conducted output power shall not exceed 250 mW or 11 + 10 $\log_{10}$B, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 $\log_{10}$B, 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.

According to ISEDC RSS-247 §6.2.3 for frequency band 5470-5600 MHz and 5650-5725 MHz:

The maximum conducted output power shall not exceed 250 mW or $11 + 10 \log_{10}B$, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.
The maximum e.i.r.p. shall not exceed 1.0 W or $17 + 10 \log_{10}B$, 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.

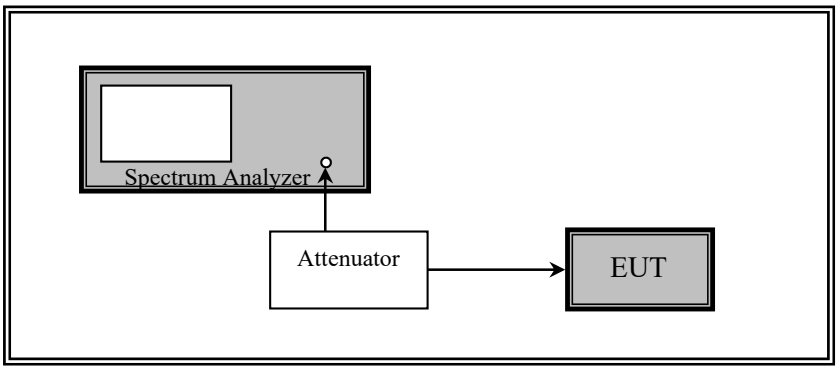
According to ISEDC RSS-247 §6.2.4 for frequency band 5725-5850 MHz:

The maximum conducted output power shall not exceed 1 W. The 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 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-multipoint systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

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 Setup Block Diagram



10.4 Test Equipment List and Details

BACL Number	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
287	Agilent	Signal Analyzer	E4446A	US44300386	2022-05-05	1 year
-	-	20 dB attenuator	-	-	Each time1	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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

10.5 Test Environmental Conditions

Temperature:	22-24 ºC
Relative Humidity:	50-55 %
ATM Pressure:	102.1-102.7 kPa

The testing was performed by Marc Jean and Christian Schwartz from 2022-07-27 to 2022-08-1 in RF site.

10.6 Test Results

5250MHz - 5350 MHz

Channel	Frequency (MHz)	PSD (dBm/MHz)		Total PSD(dBm/MHz)	FCC/IC Limit (dBm/MHz)
		ANT A	ANT B		
802.11a mode					
52	5260	8.94	9.293	-	11
56	5280	8.183	9.238	-	11
64	5320	8.765	9.31	-	11
802.11n/ac20 mode					
52	5260	4.48	4.552	7.526	11
56	5280	4.217	4.92	7.593	11
64	5320	3.801	5.209	7.572	11
802.11n/ac40 mode					
54	5270	1.483	1.391	4.447	11
62	5310	0.747	1.923	4.384	11
802.11ac80 mode					
58	5290	2.422	1.545	5.015	11

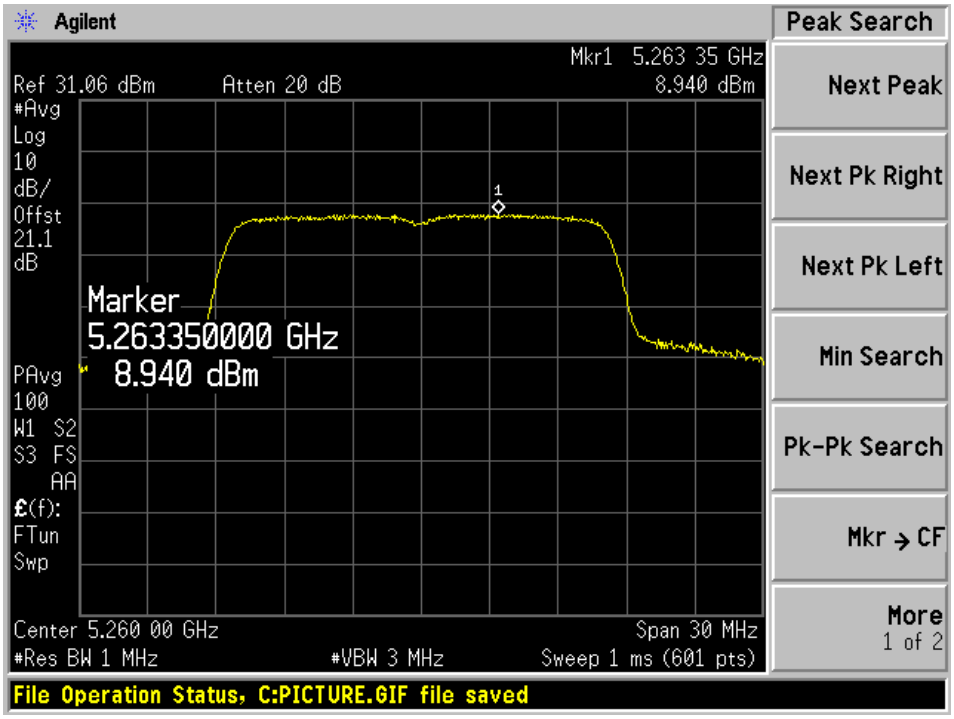
5470MHz - 5725 MHz

Channel	Frequency (MHz)	PSD (dBm/MHz)		Total PSD(dBm/MHz)	FCC/IC Limit (dBm/MHz)
		ANT A	ANT B		
802.11a mode					
100	5500	8.145	9.601	-	11
116	5580	8.722	9.68	-	11
140	5700	7.21	9.196	-	11
802.11n/ac20 mode					
100	5500	4.48	5.395	7.299	11
116	5580	4.217	4.708	7.225	11
140	5700	3.801	3.83	6.214	11
802.11n/ac40 mode					
102	5510	0.285	2.407	4.484	11
118	5590	0.234	1.287	3.802	11
134	5670	-.134	2.088	4.526	11
802.11ac80 mode					
106	5530	3.711	1.557	5.776	11
122	5610	2.835	1.637	5.287	11

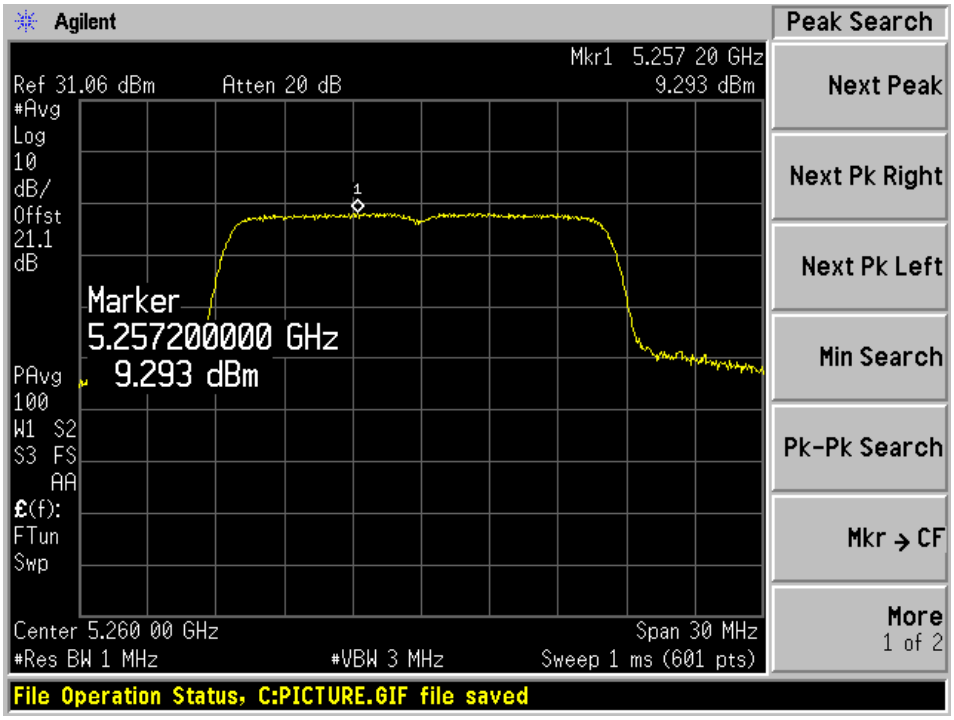
Note: Total PSD (dBm/MHz) =10*Log(Ant A(mw)+Ant B(mw))
Note: Duty cycle correction factor has already been added to the measurements

5250 - 5350 MHz 802.11a

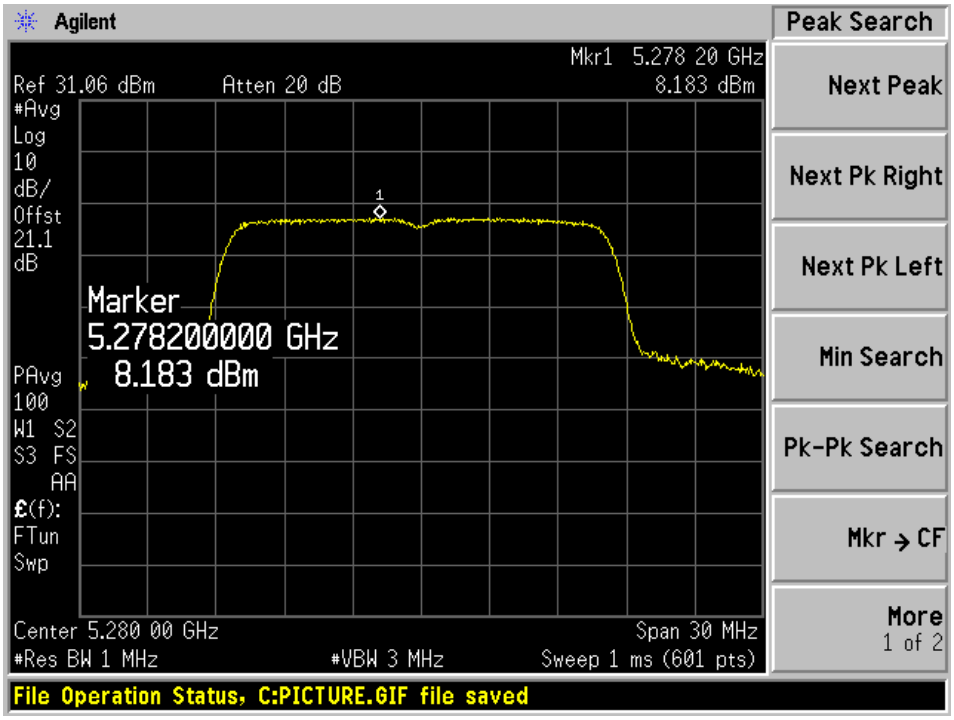
Low Channel Ant A



Low Channel Ant B



Mid Channel Ant A



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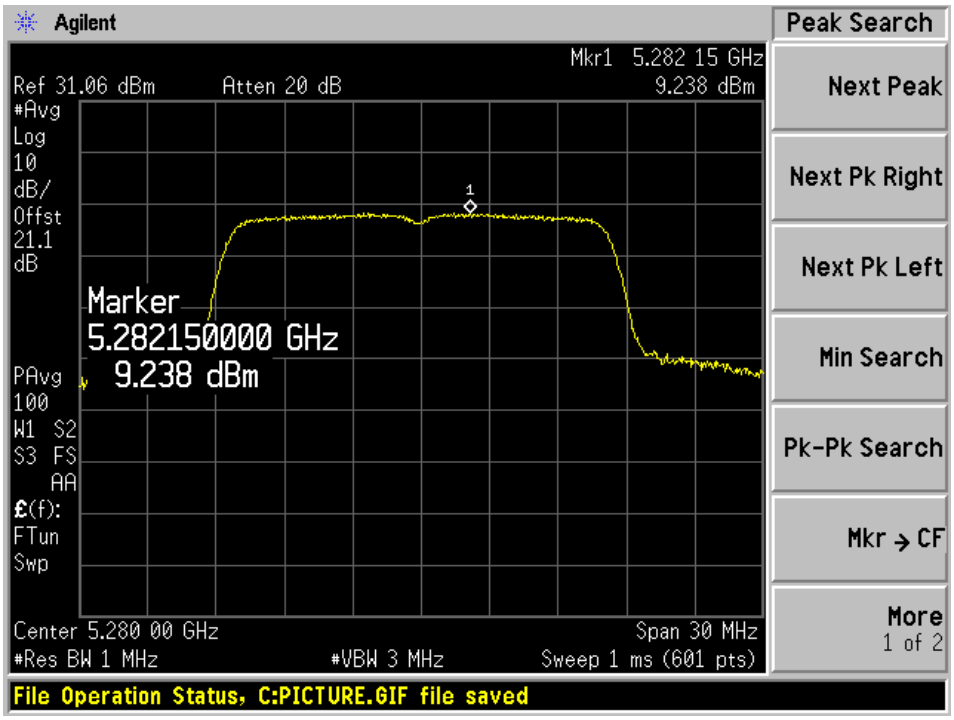

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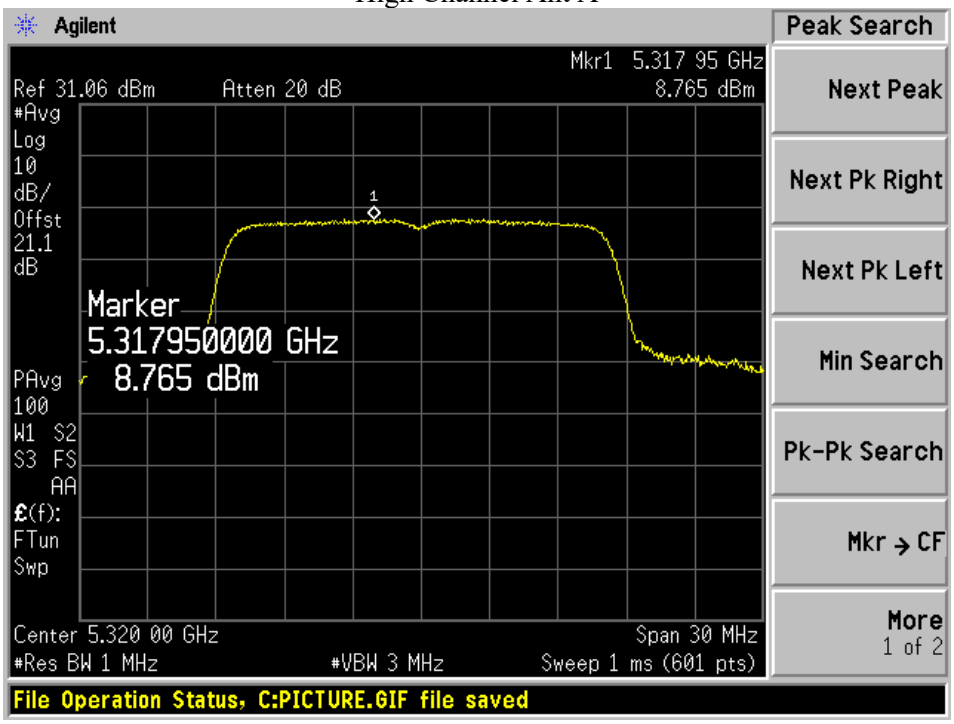

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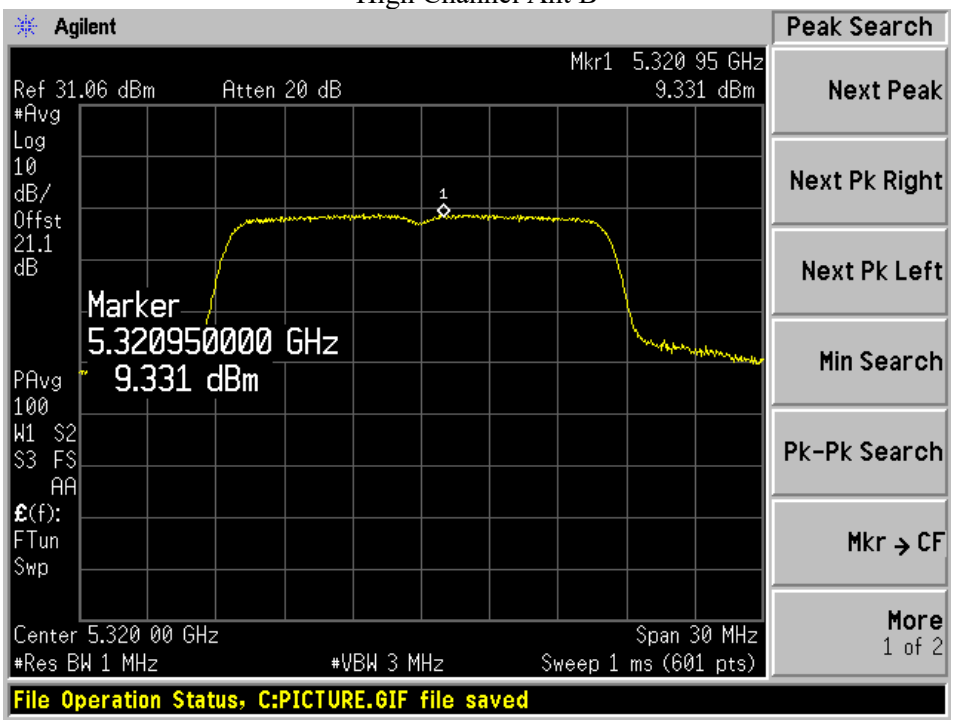
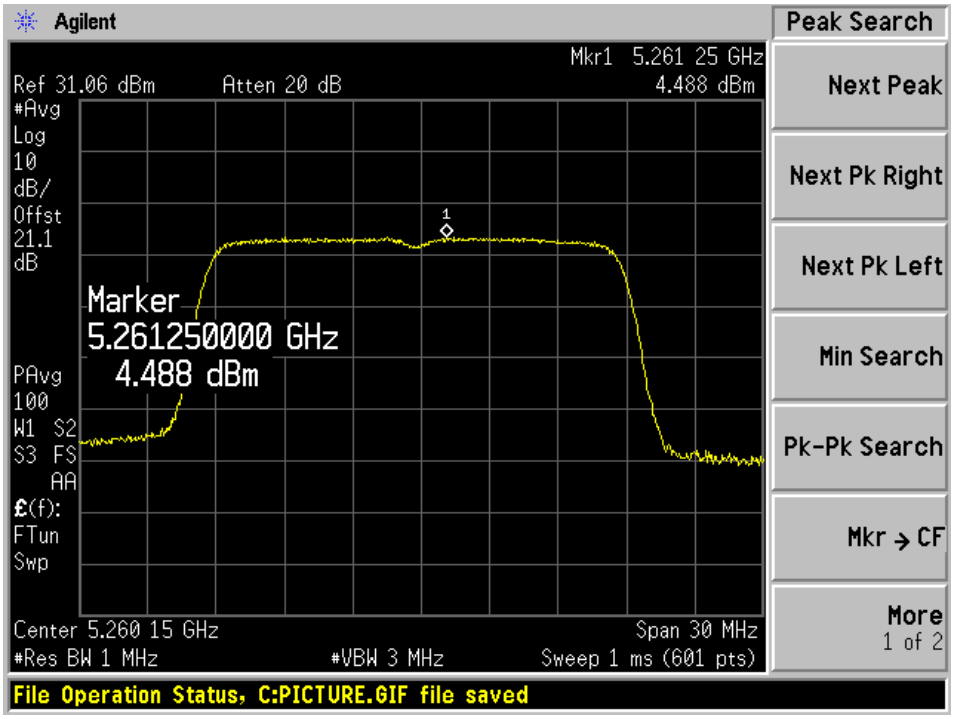


5250 - 5350 MHz 802.11n20

Low Channel Ant A



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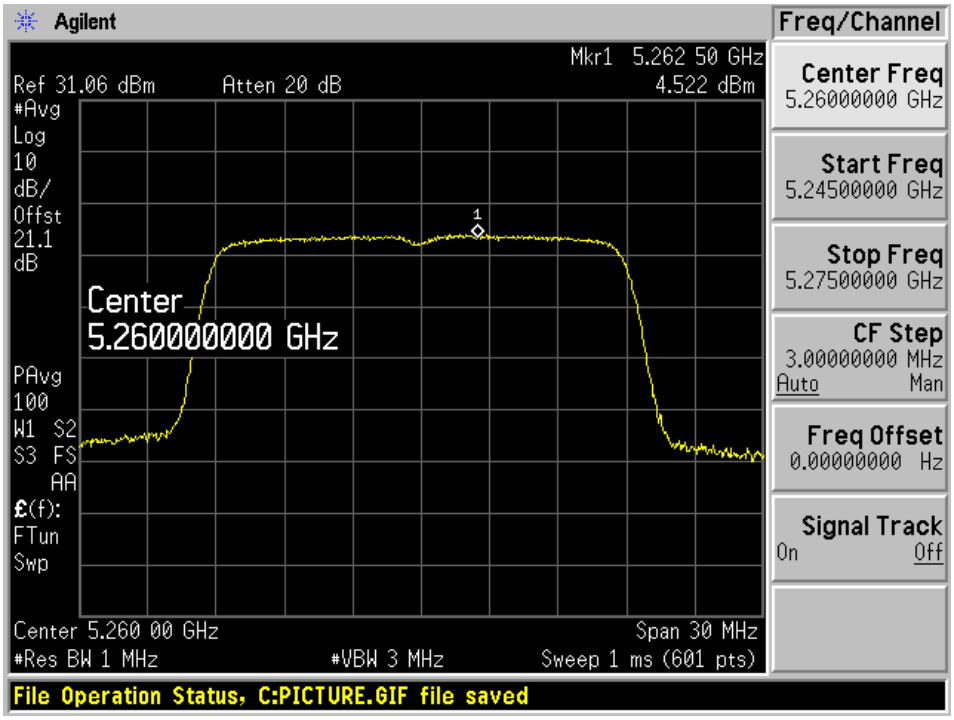

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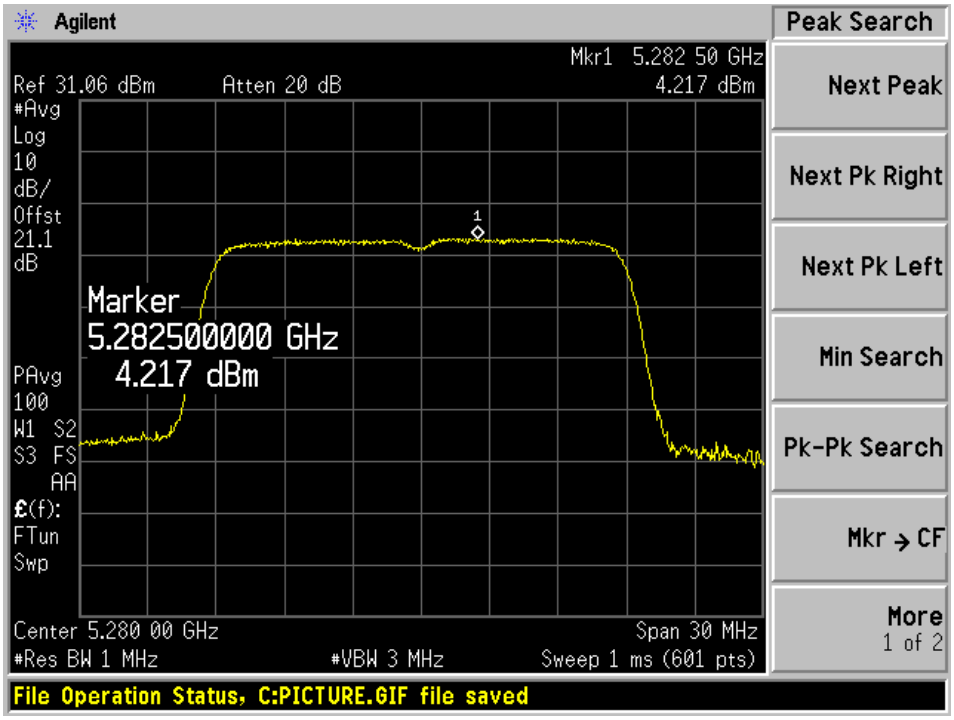

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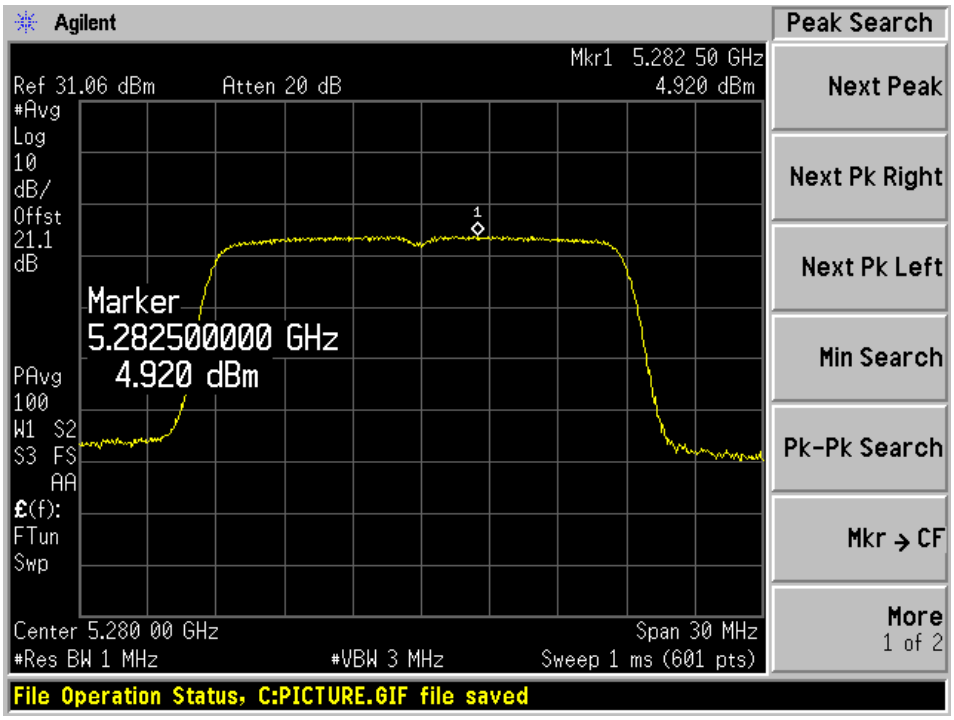

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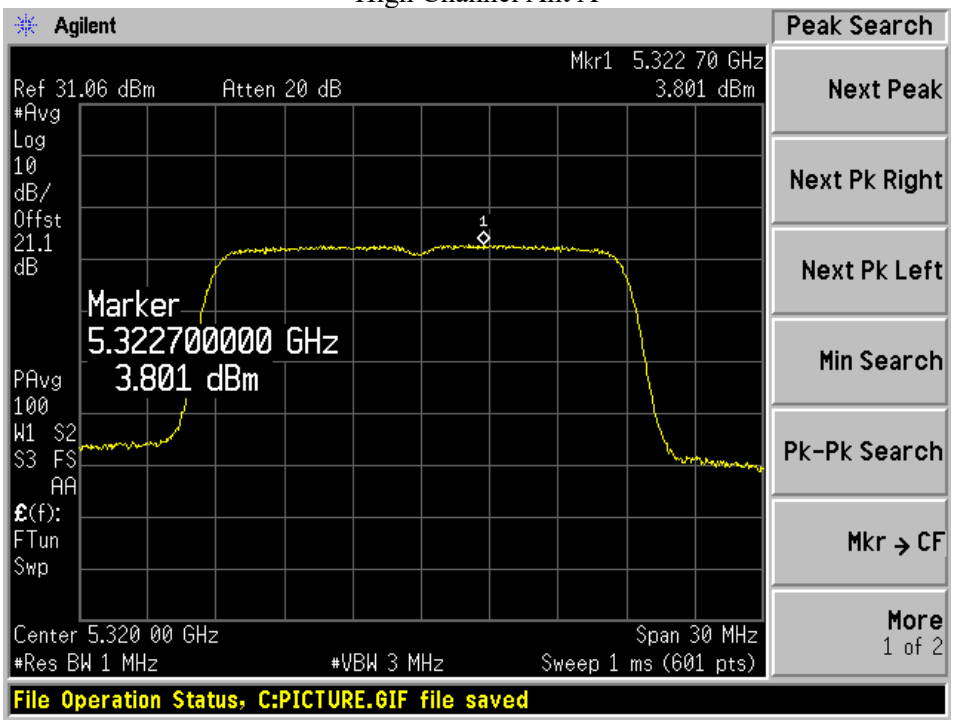

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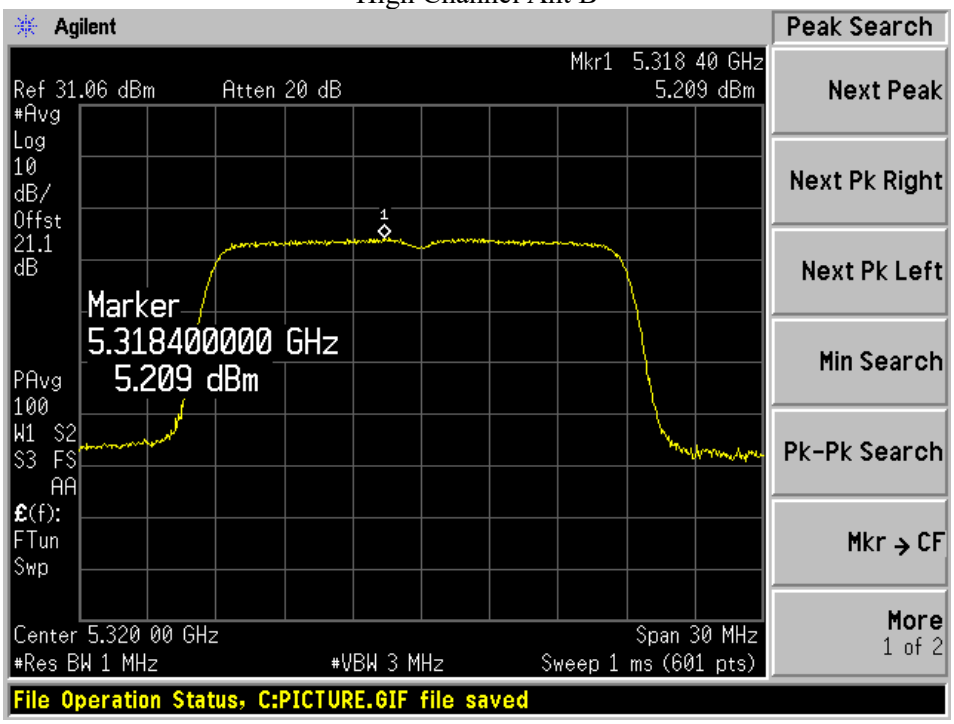
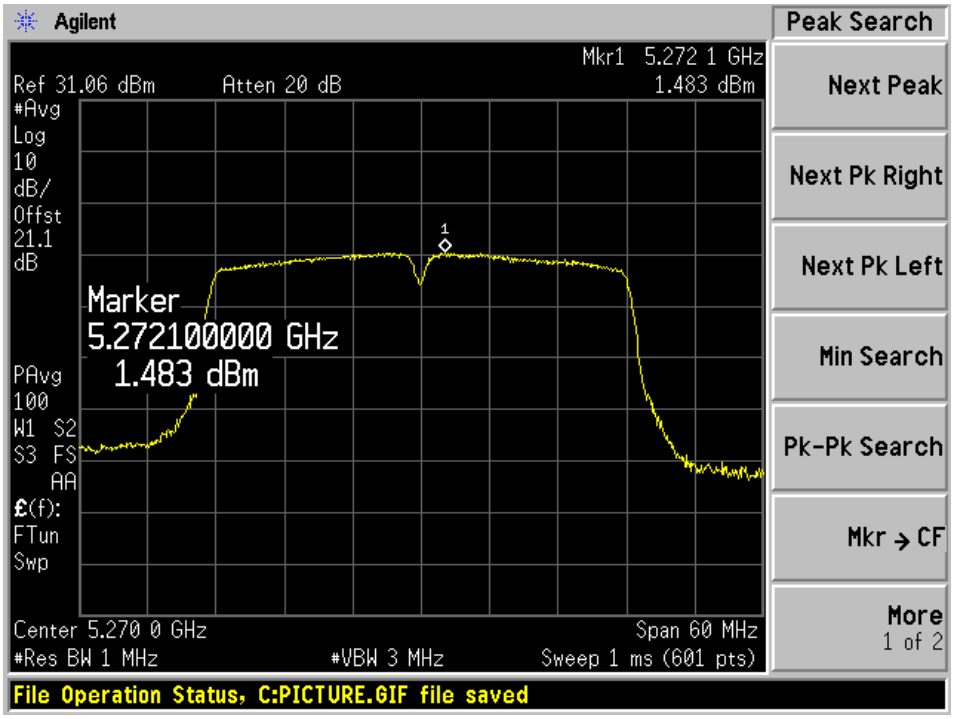


5250 - 5350 MHz 802.11n40

Low Channel Ant A



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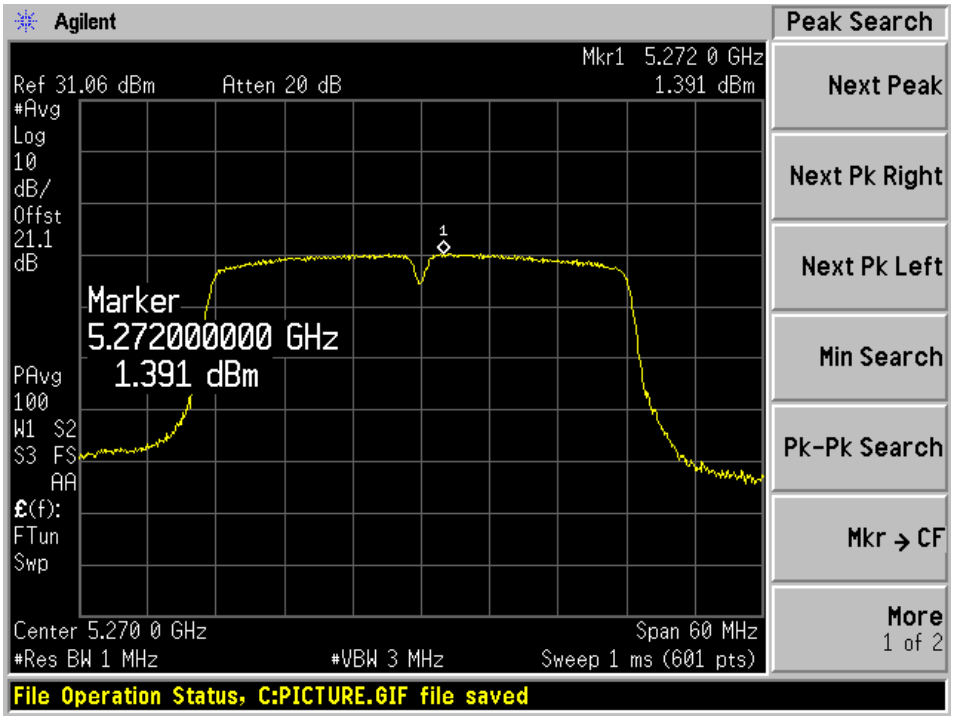

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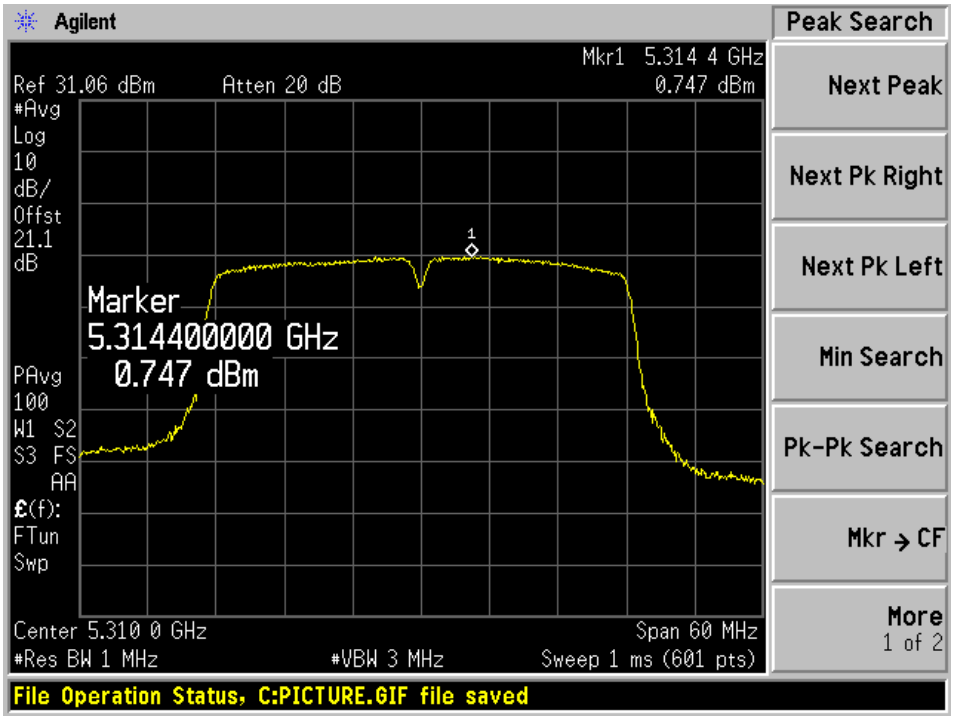

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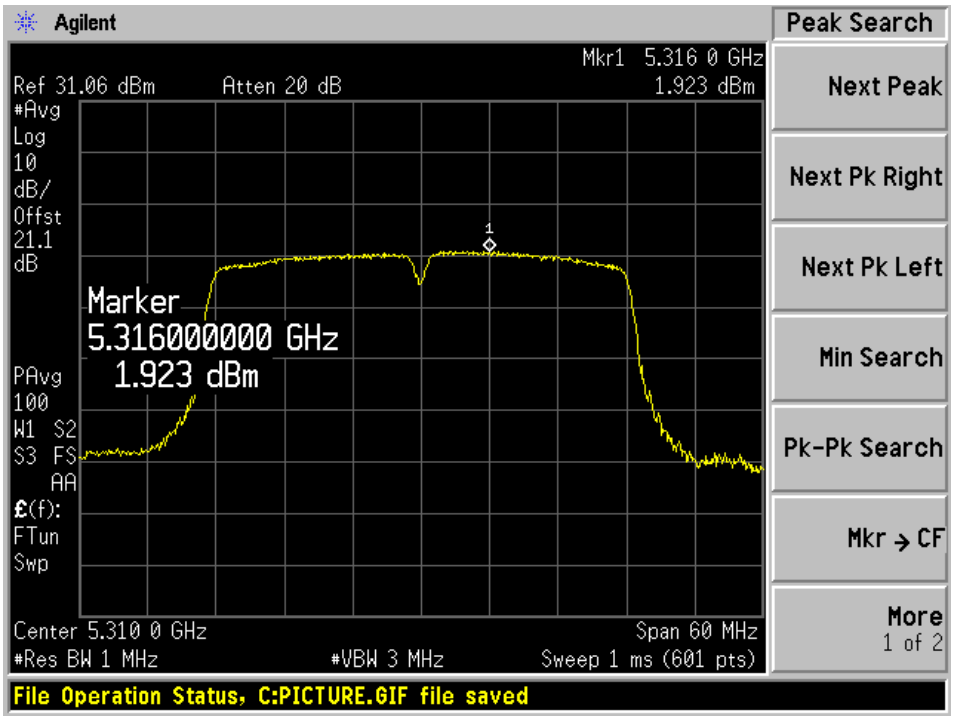
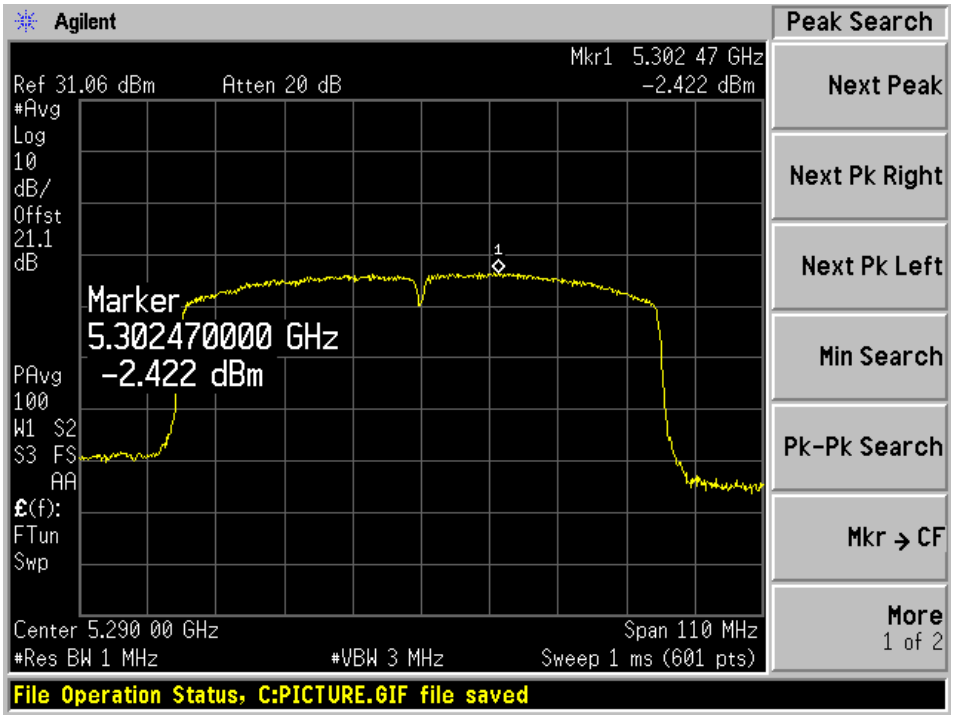


5250 - 5350 MHz 802.11ac80

Low Channel Ant A



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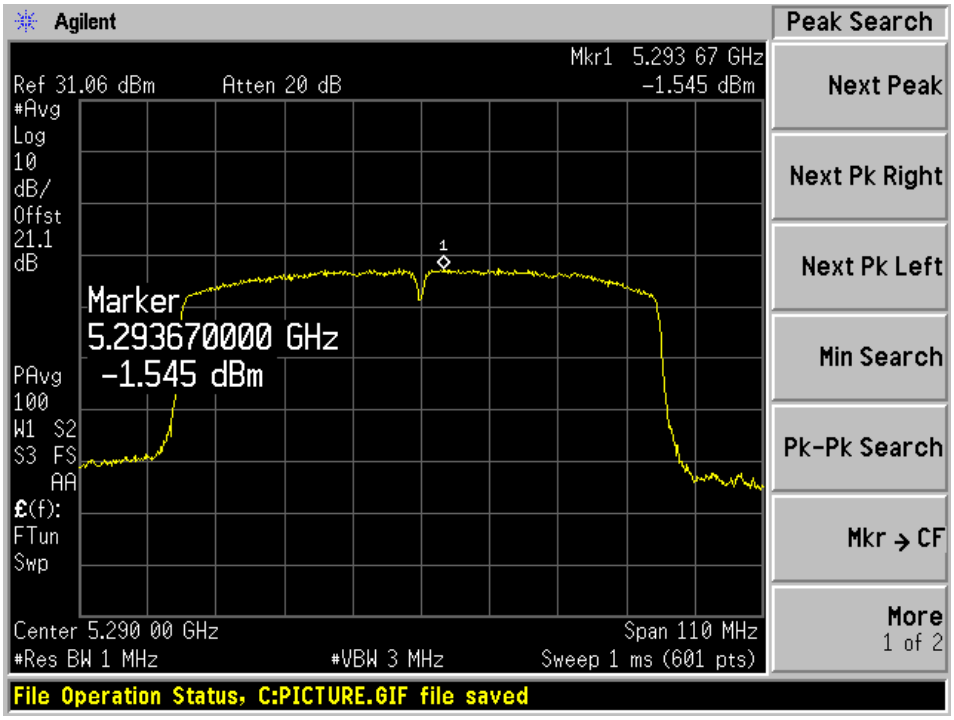
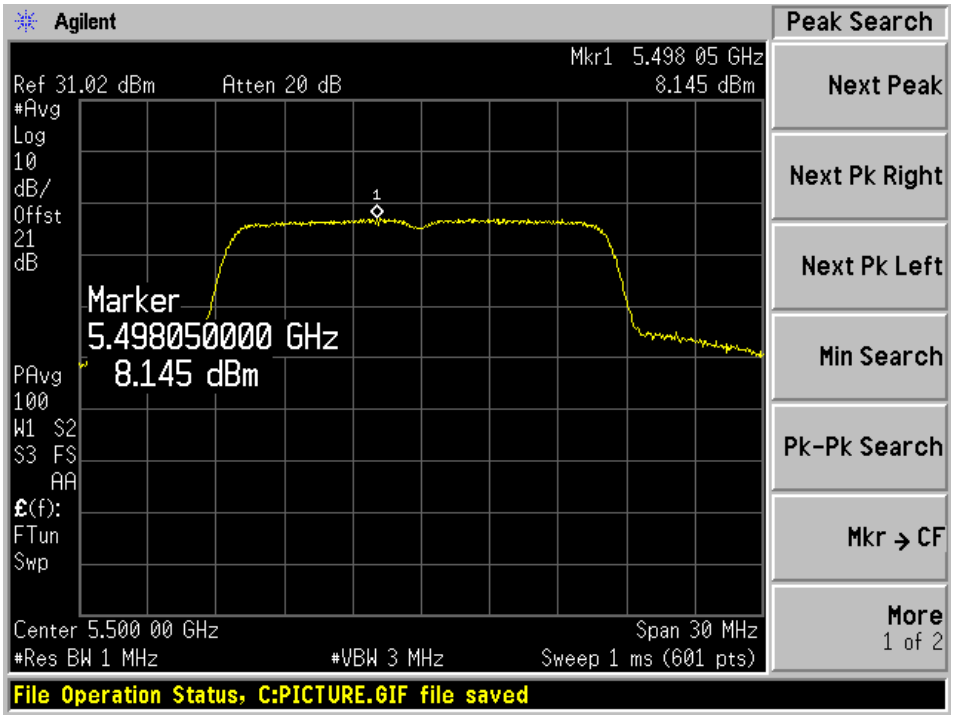


5470MHz-5725MHz 802.11a

Low Channel Ant A



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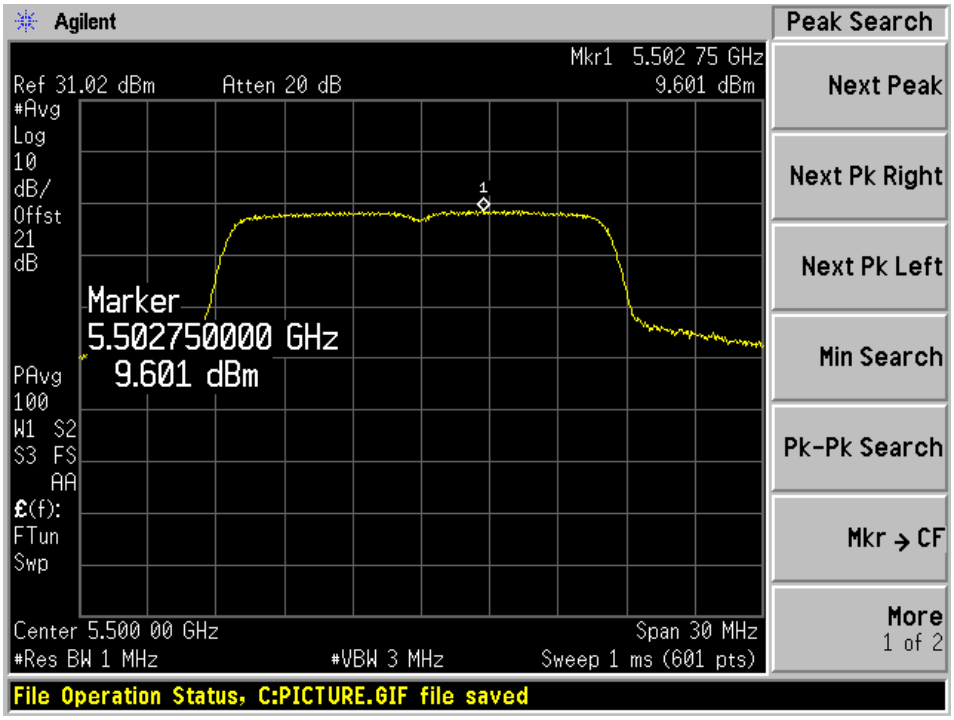
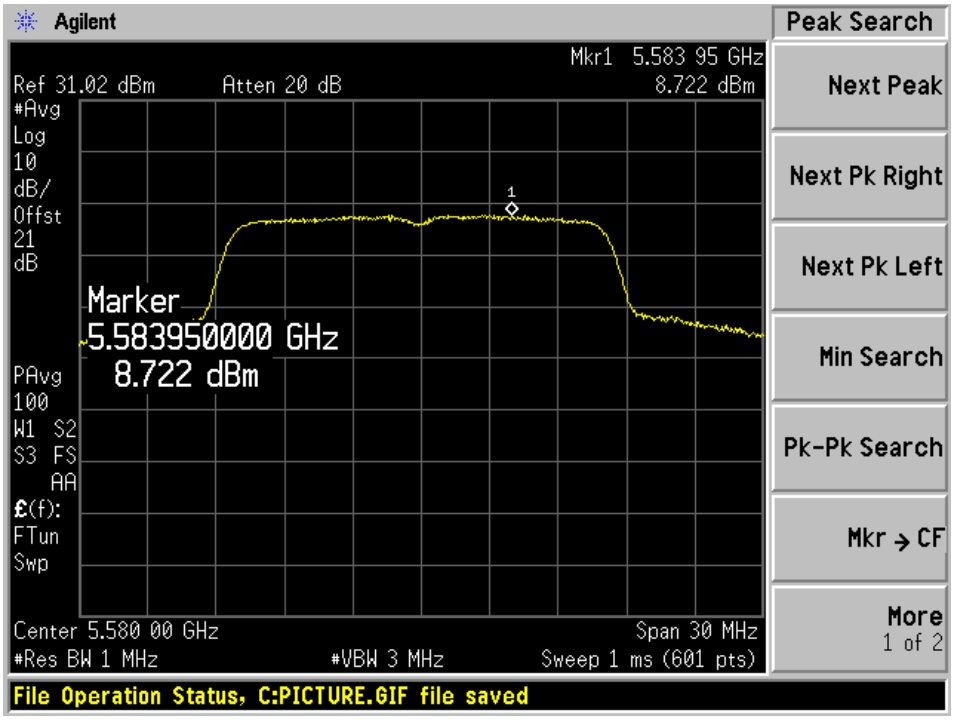
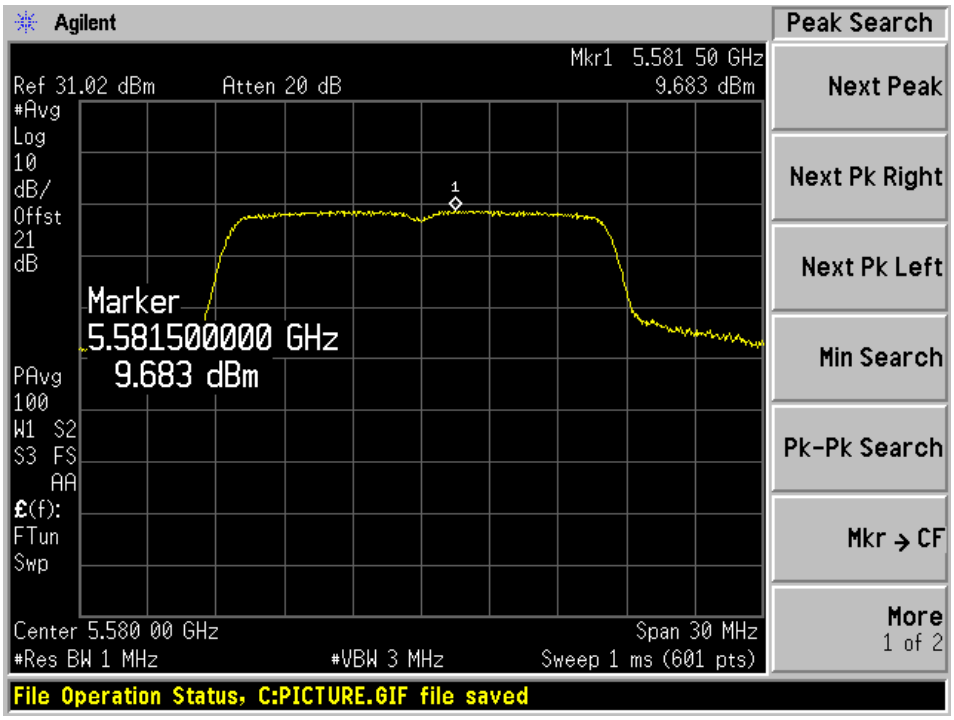


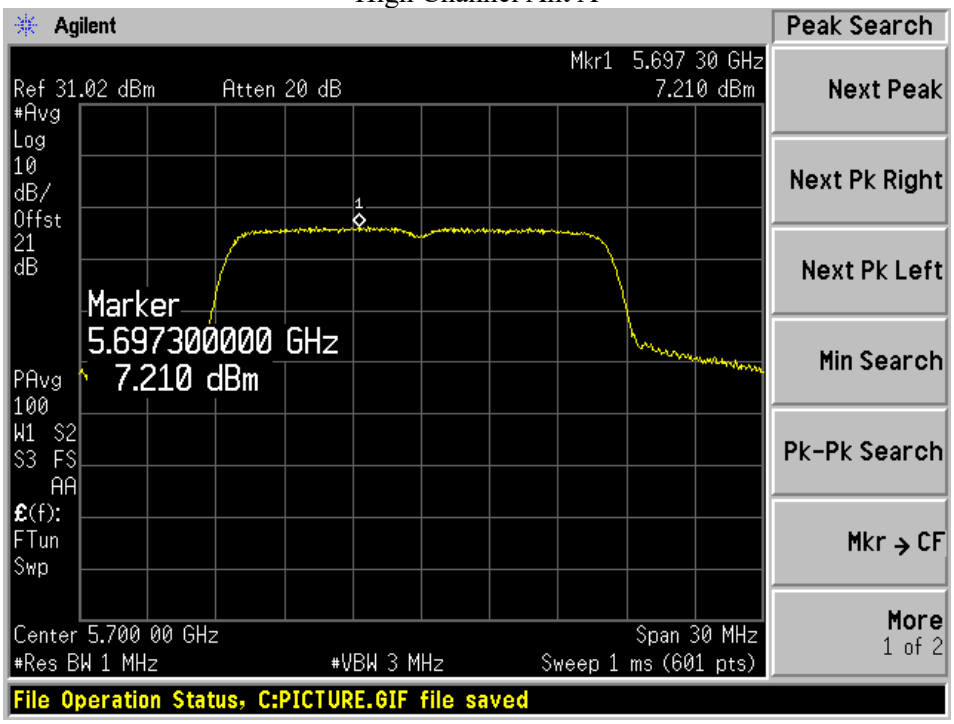
Mid Channel Ant A



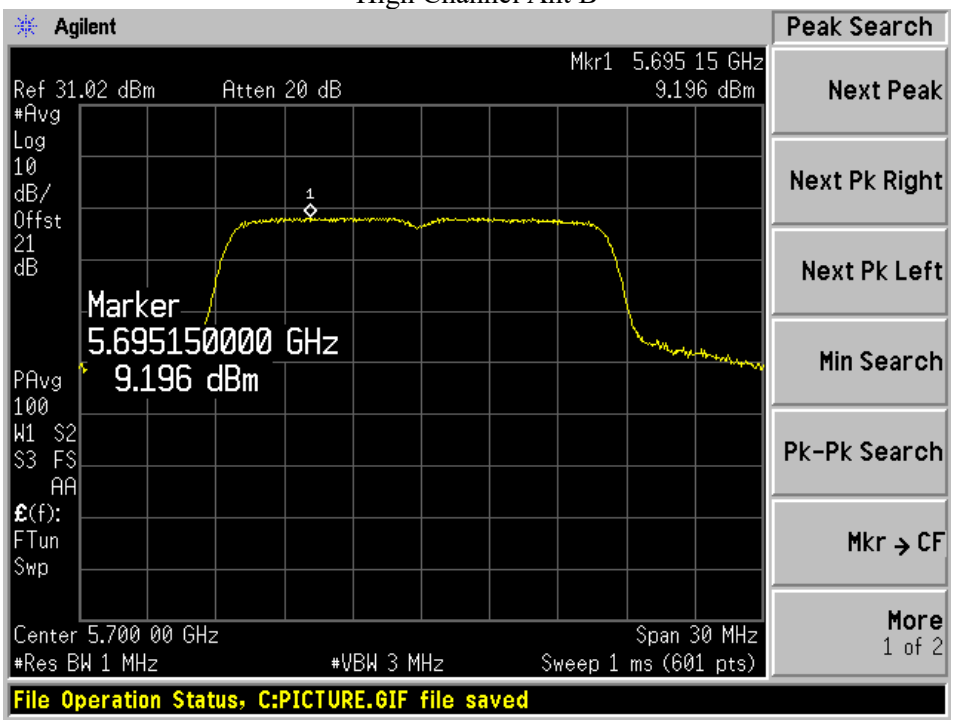
Mid Channel Ant B



High Channel Ant A

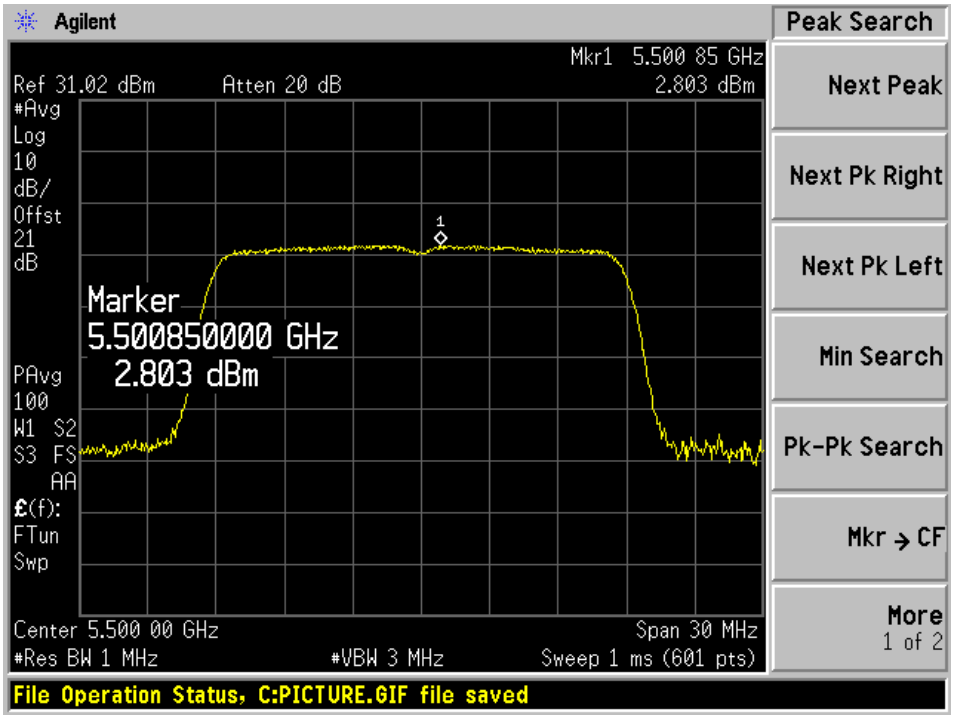


High Channel Ant B

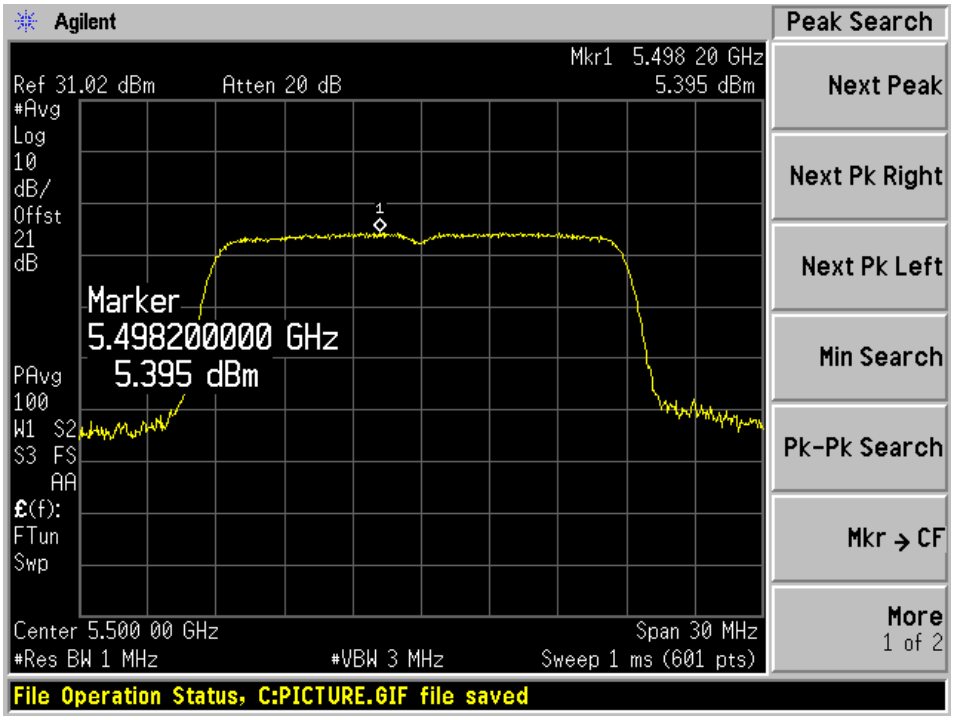


5470MHz-5725MHz 802.11n20

Low Channel Ant A



Low Channel Ant B



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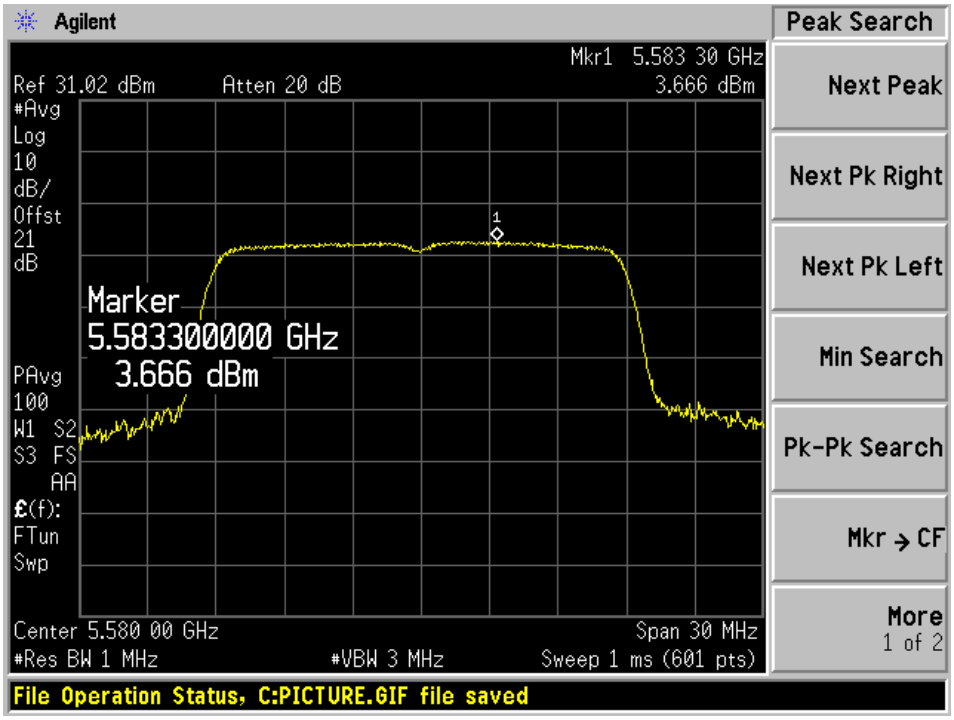
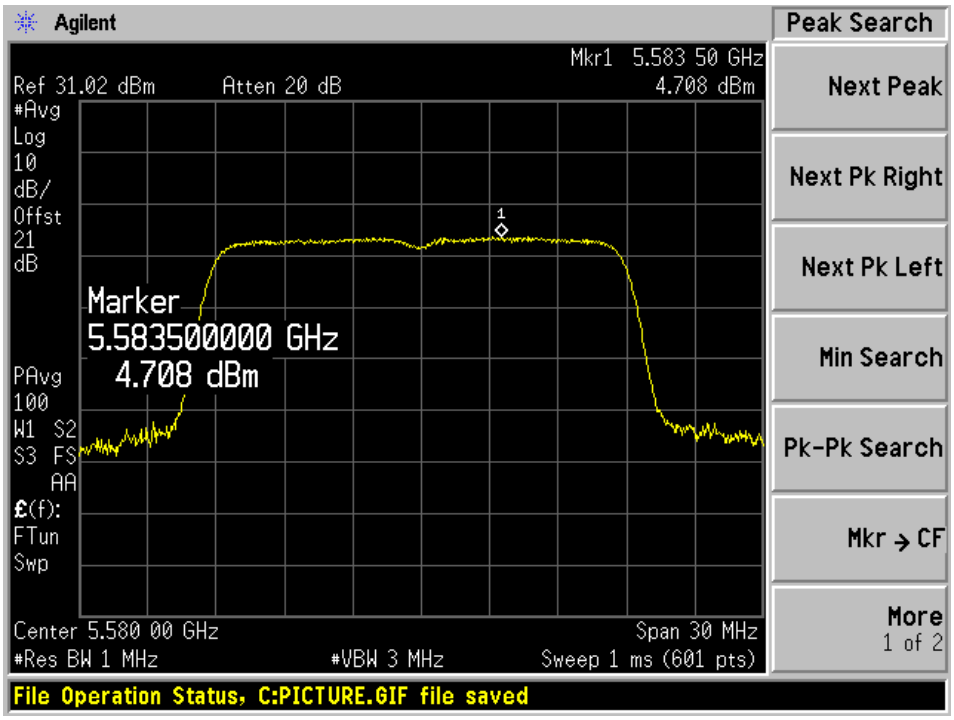


Mid Channel Ant B



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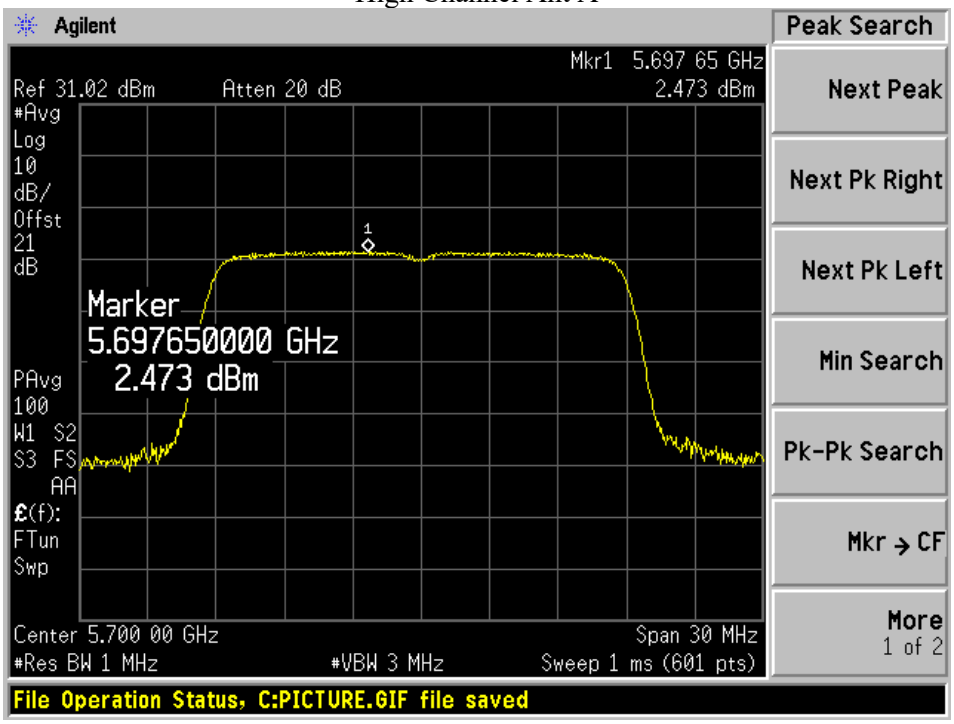
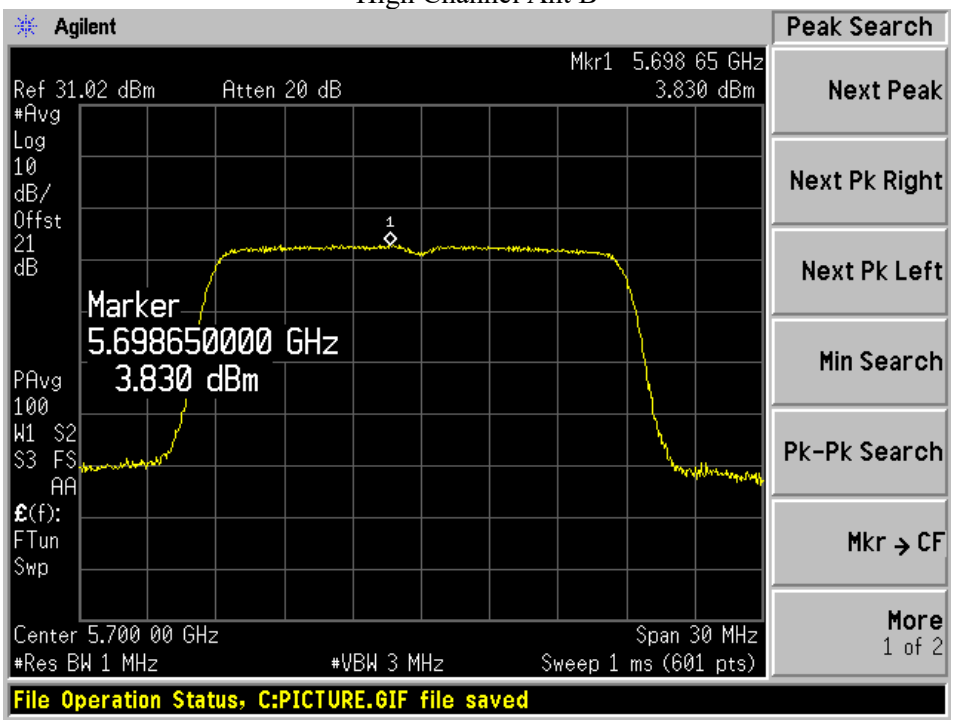
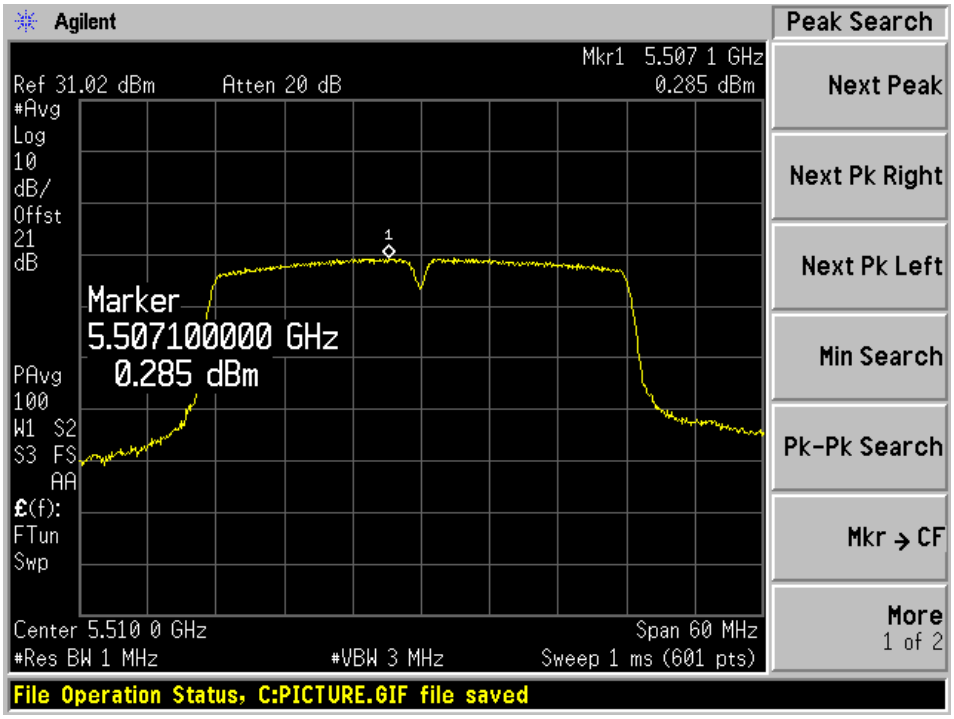


High Channel Ant B

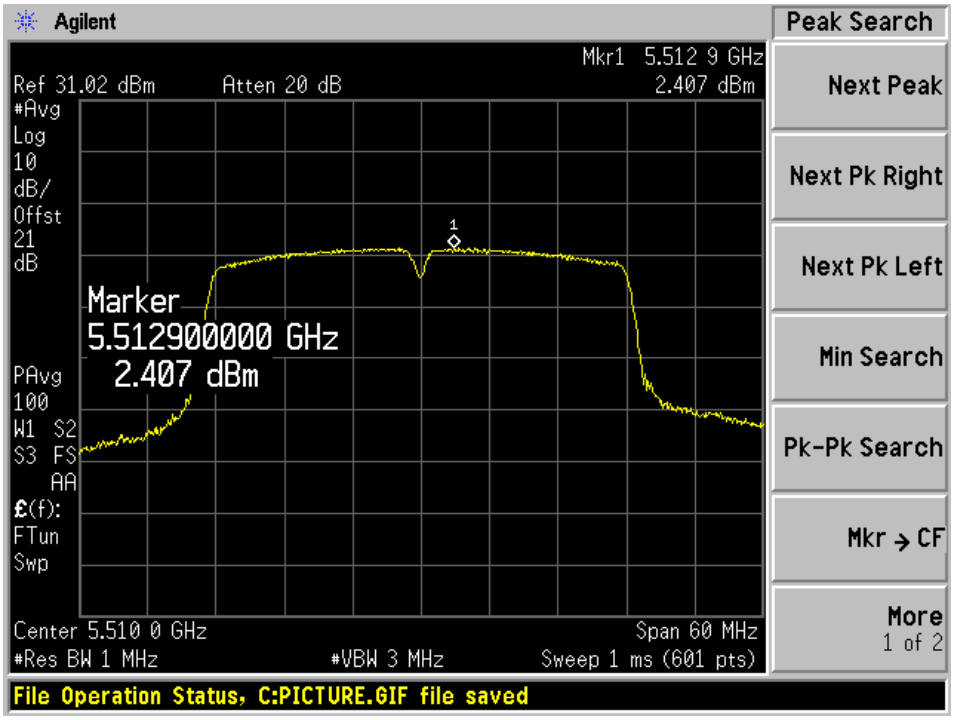


5470MHz-5725MHz 802.11n40

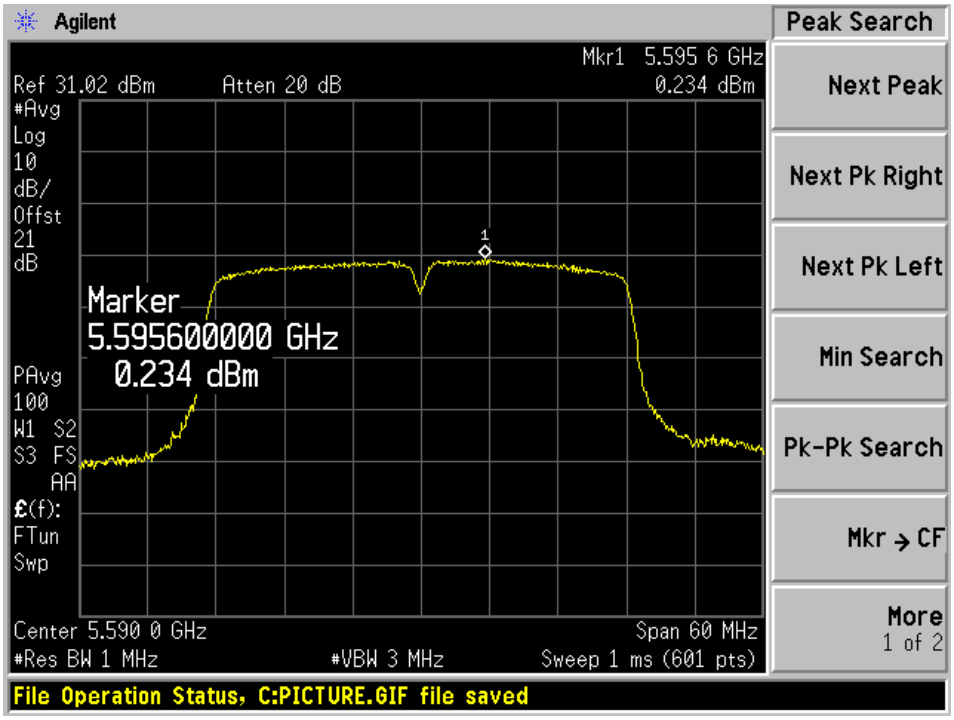
Low Channel Ant A



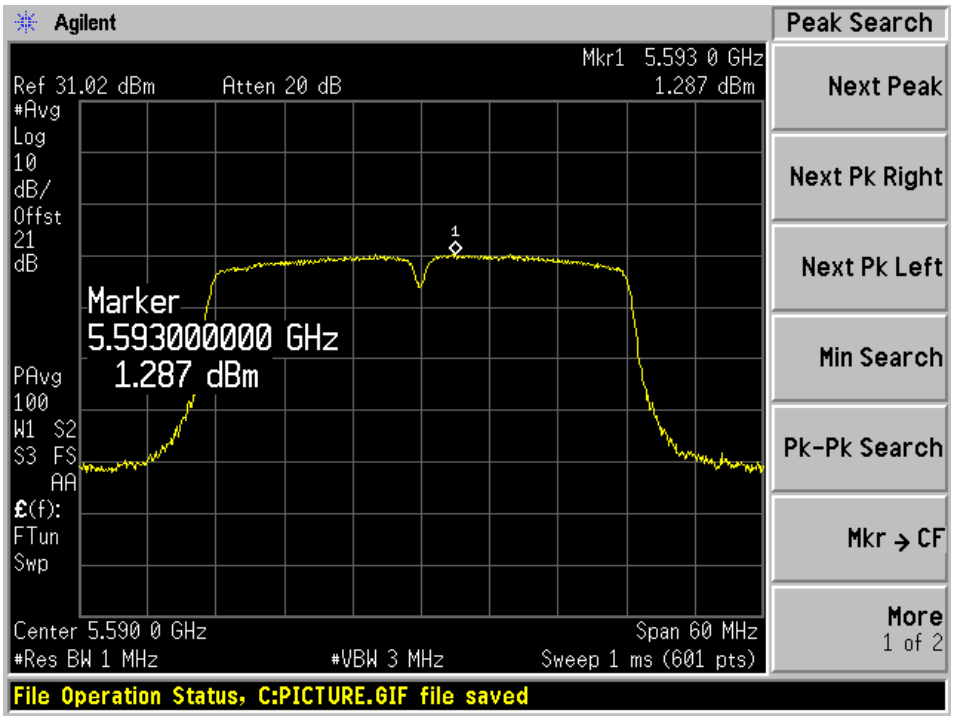
Low Channel Ant B



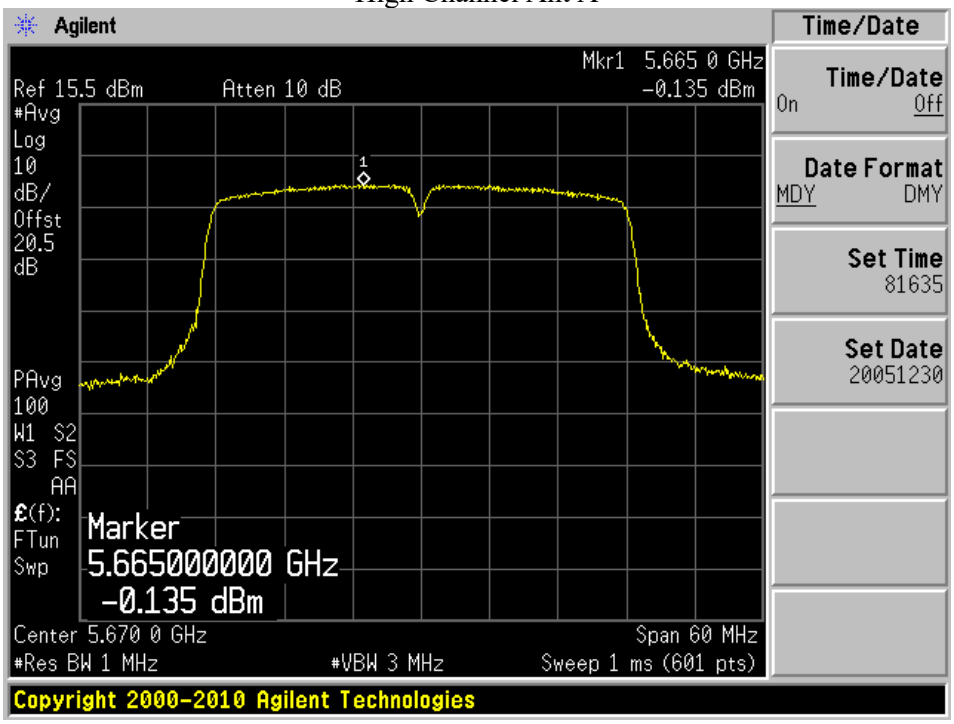
Mid Channel Ant A



Mid Channel Ant B



High Channel Ant A



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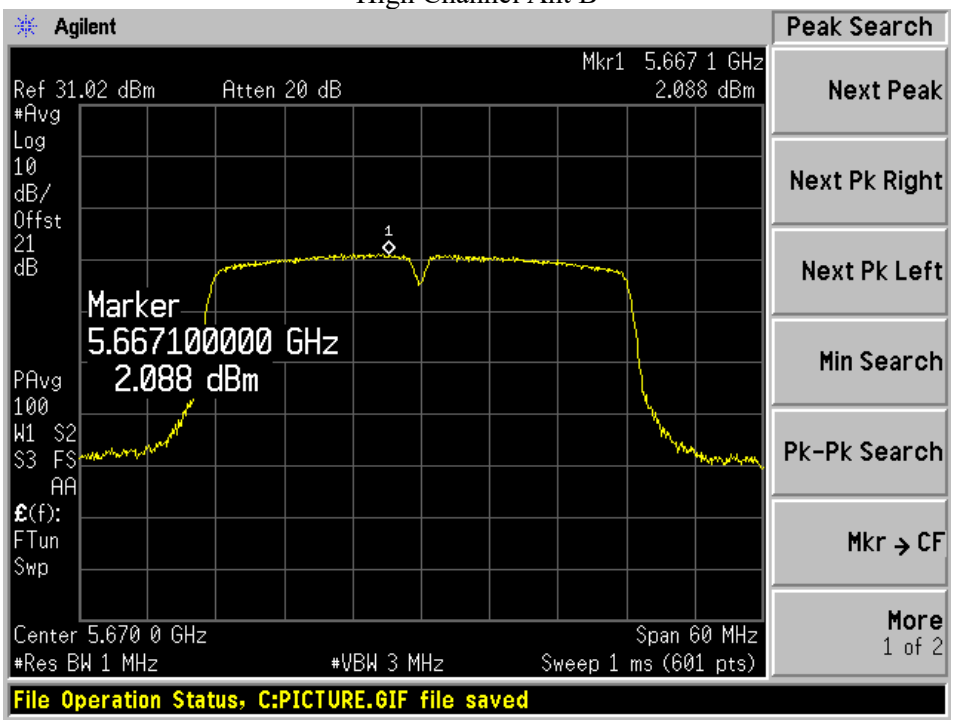
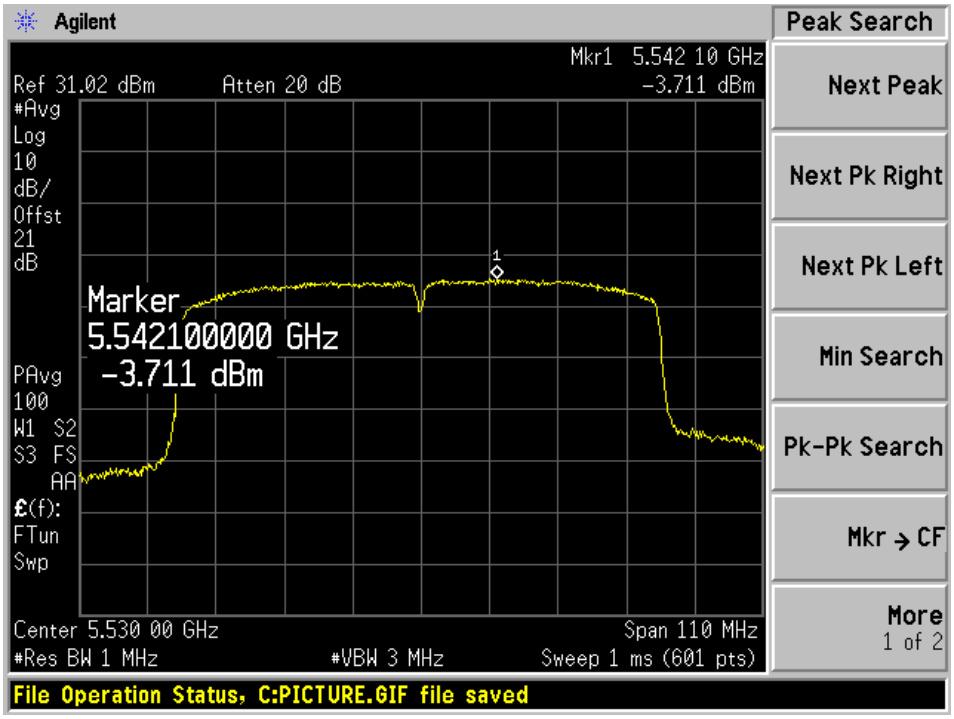


5470MHz-5725MHz 802.11ac80

Low Channel Ant A



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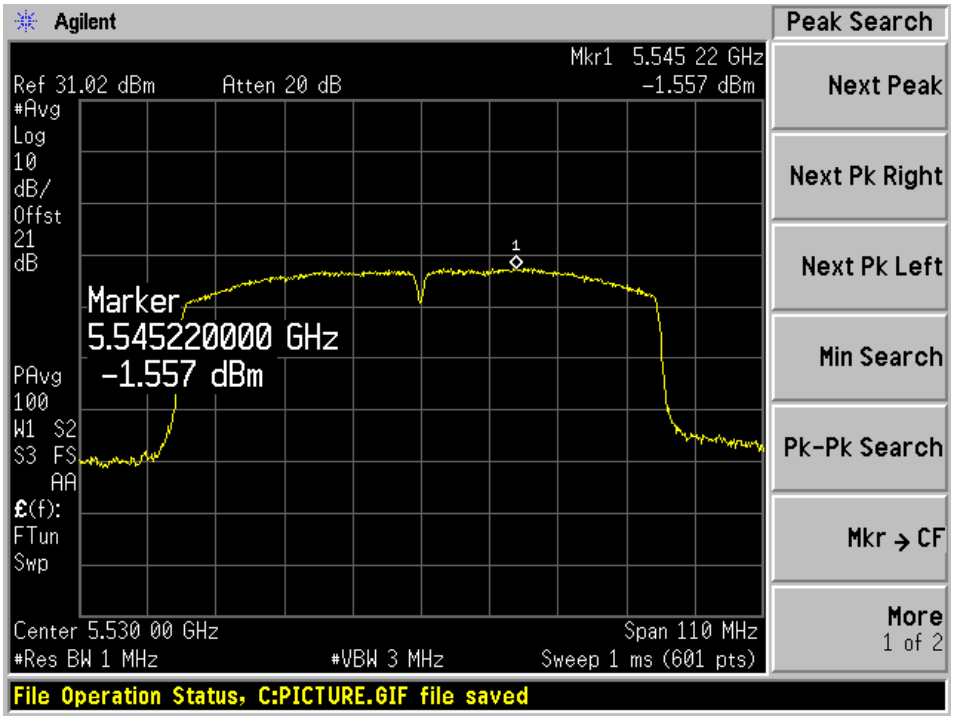
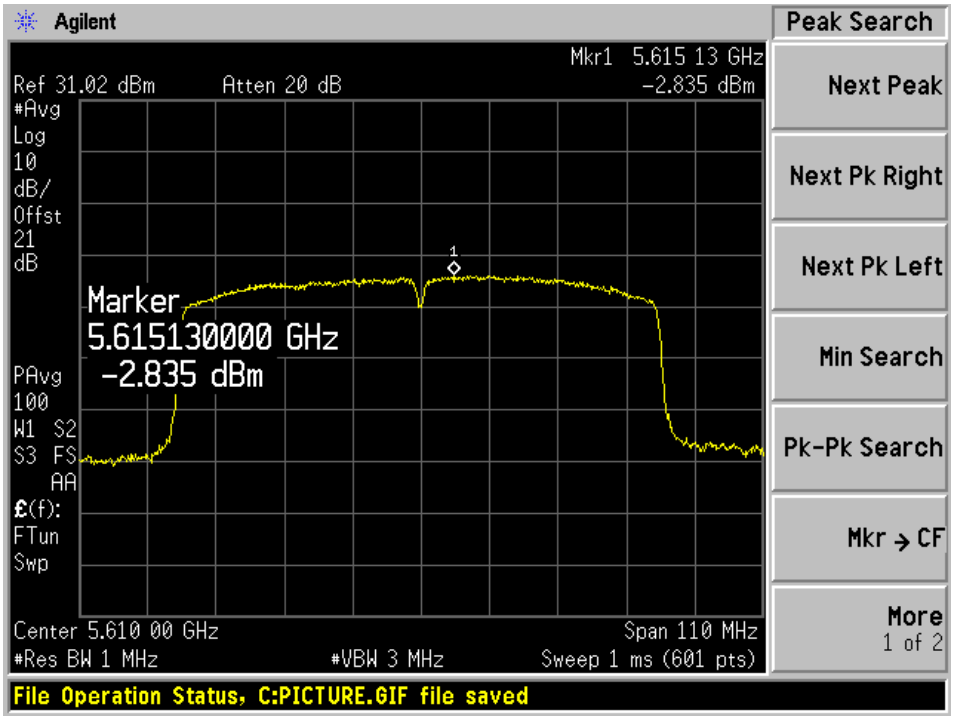


Mid Channel Ant A



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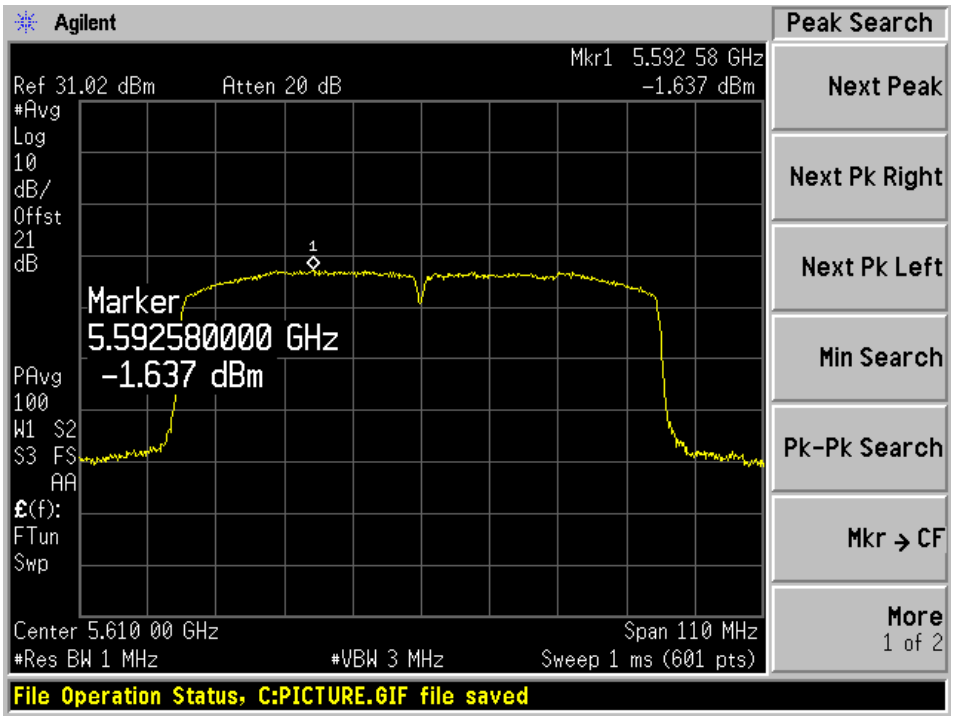


11 FCC §15.407(b) & ISEDC RSS-247 §6.2 - Out of Band Emissions

11.1 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.

According to ISEDC RSS-247 §6.2.1 for devices operatinging in the frequency band 5150-5250 MHz:

For transmitters operating in the band 5150-5250 MHz, all emissions outside the band 5150-5350 MHz shall not exceed -27 dBm/MHz e.i.r.p. However, any unwanted emissions that fall into the band 5250-5350 MHz must be 26 dBc, when measured using a resolution bandwidth between 1 and 5% of the occupied bandwidth, above 5.25 GHz. Otherwise, the transmission is considered as intentional and the devices shall implement dynamic frequency selection (DFS) and transmitter power control (TPC) as per the requirements for the band 5250-5350 MHz.

According to ISEDC RSS-247 §6.2.2 for devices operatinging in the frequency band 5250-5350 MHz:

For devices with both operating frequencies and channel bandwidths contained within the band 5250-5350 MHz, the device shall comply with the following:

1. All emissions outside the band 5250-5350 MHz shall not exceed -27 dBm/MHz e.i.r.p. if the equipment is intended for outdoor use; or
2. All emissions outside the band 5150-5350 MHz shall not exceed -27 dBm/MHz e.i.r.p. and any emissions within the band 5150-5250 MHz shall meet the power spectral density limits of Section 6.2.1. The device shall be labelled “for indoor use only.”

For devices with operating frequencies in the band 5250-5350 MHz but having a channel bandwidth that overlaps the band 5150-5250 MHz, the devices’ unwanted emission shall not exceed -27 dBm/MHz e.i.r.p. outside the band 5150-5350 MHz and its power shall comply with the spectral power density for operation within the band 5150-5250 MHz. The device shall be labelled “for indoor use only.”
According to ISEDC RSS-247 §6.2.3 for devices operatinging in the frequency band 5470-5600 MHz and 5650-5725 MHz. Emissions outside the band 5470-5725 MHz shall not exceed -27 dBm/MHz e.i.r.p.

According to ISEDC RSS-247 §6.2.4 for devices operatinging in the frequency band 5725-5850 MHz:
For the band 5725-5850 MHz, emissions at frequencies from the band edges to 10 MHz above or below the band edges shall not exceed -17 dBm/MHz e.i.r.p.
For emissions at frequencies more than 10 MHz above or below the band edges, the emissions power shall not exceed -27 dBm/MHz.

11.2 Measurement Procedure

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

Unwanted Emission Measurement:

Maximum emission levels are measured by setting the analyzer as follows:

i. RBW = 1 MHz
ii. VBW ≥ 3 MHz
iii. Detector = Peak
iv. Sweep time = auto
v. Trace mode = max hold

Integration Method:

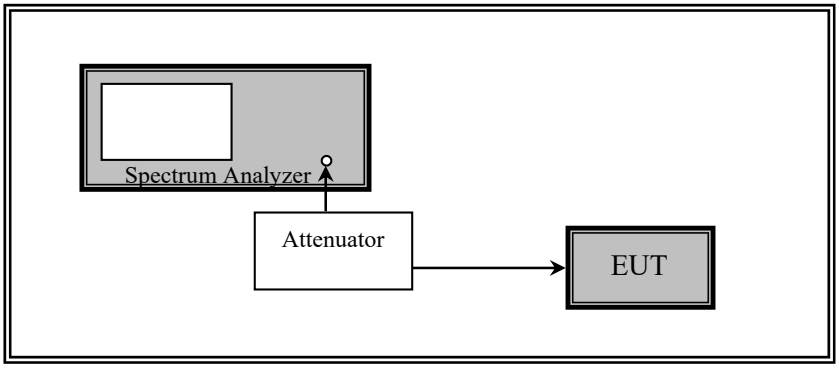
1. For peak emissions measurements, follow the procedures described in section H)5), "Procedures for Peak Unwanted Emissions Measurements above 1000 MHz", except for the following changes:

- 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.

11.3 Test Setup Block Diagram



11.4 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
287	Agilent	Spectrum Analyzer	E4446A	US44300386	2022-05-05	1 year
-	-	RF cable	-	-	Each time[1]	N/A
-	-	10 dB 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

11.5 Test Environmental Conditions

Temperature:	22-24º C
Relative Humidity:	40-41 %
ATM Pressure:	103.1-104.1 kPa

Testing was performed by Christian Schwartz from 2022-07-08 to 2022-07-28 at the RF site.

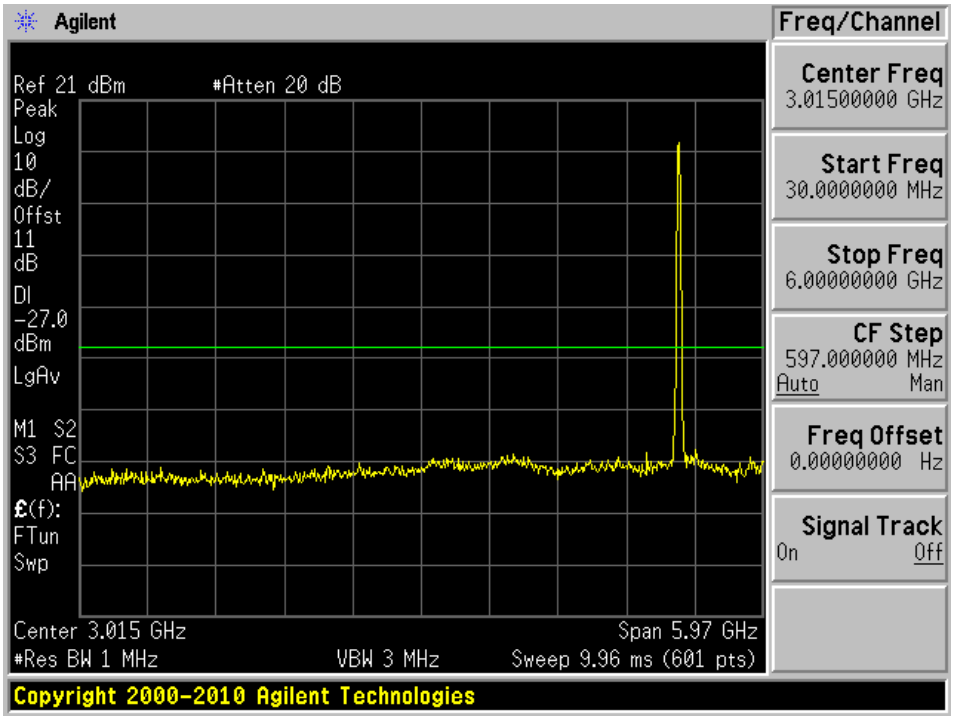
11.6 Test Results

Please refer to the following plots

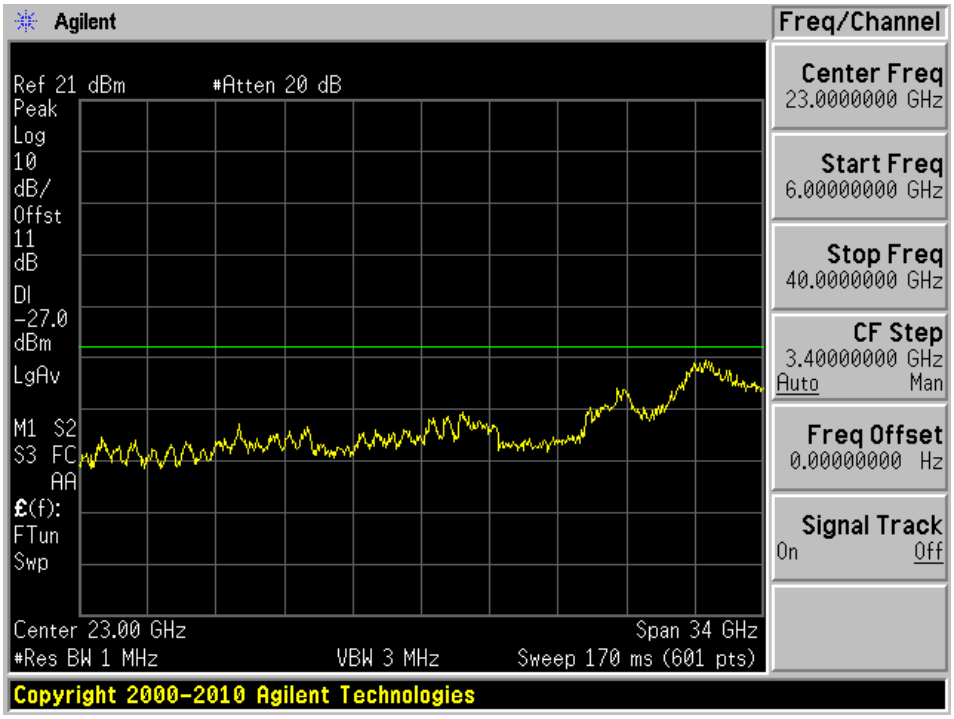
Spurious Emissions

5250 - 5350 MHz 802.11a

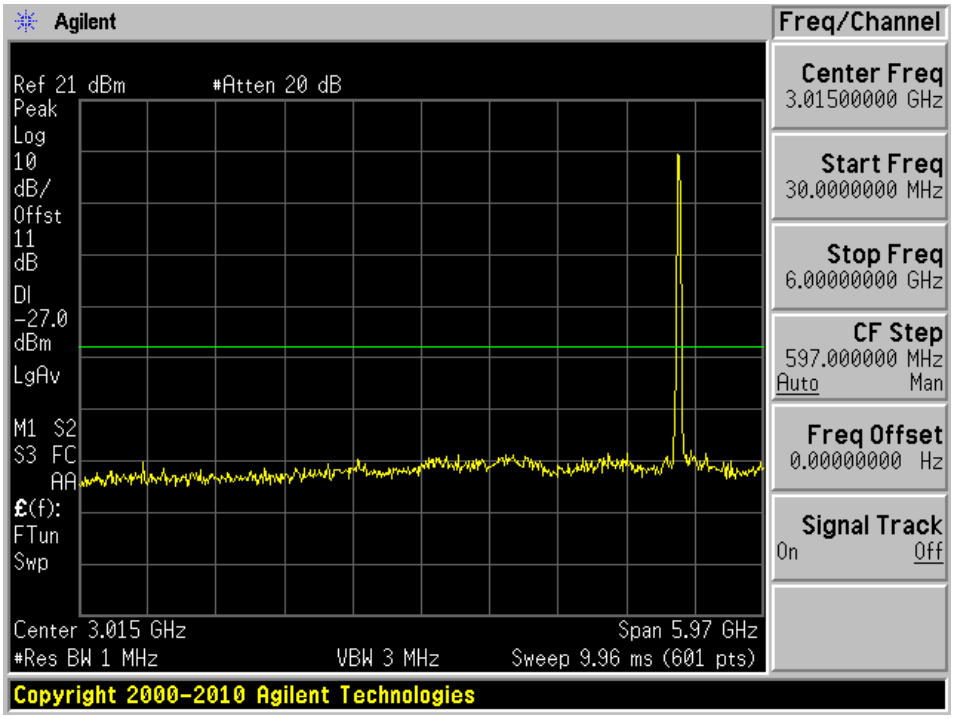
Low Channel Ant A 30MHz-6GHz



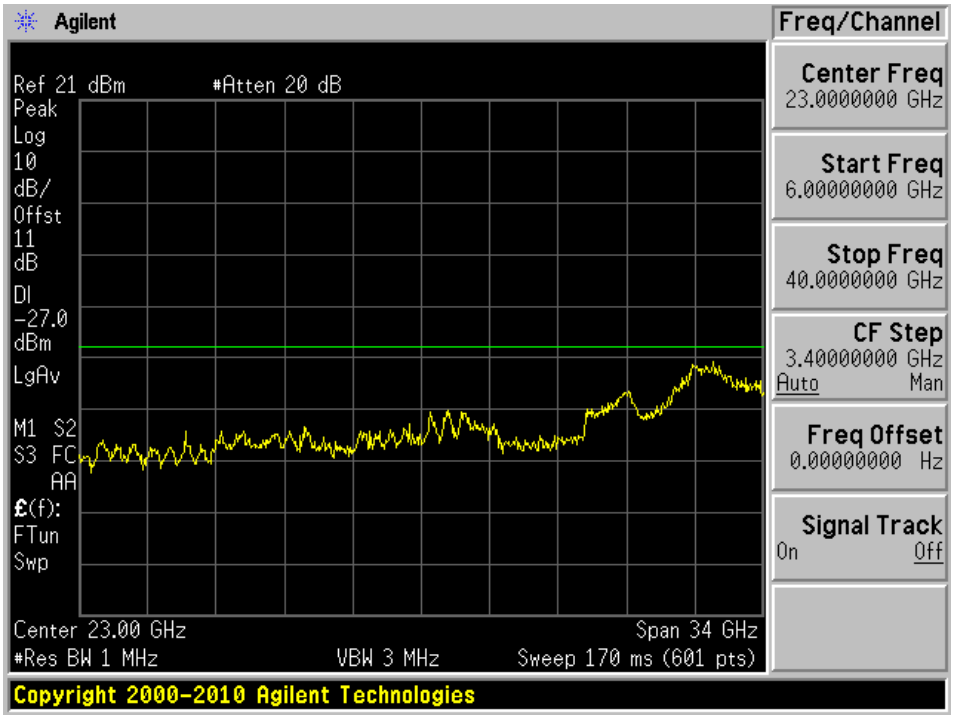
Low Channel Ant A 6GHz-40GHz



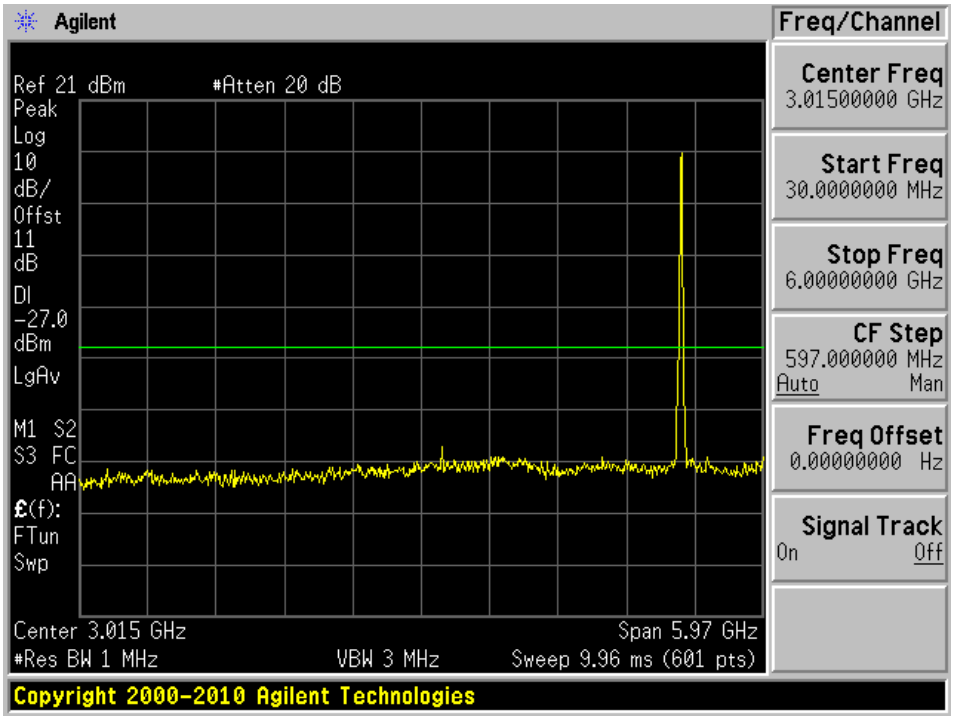
Low Channel Ant B 30MHz-6GHz



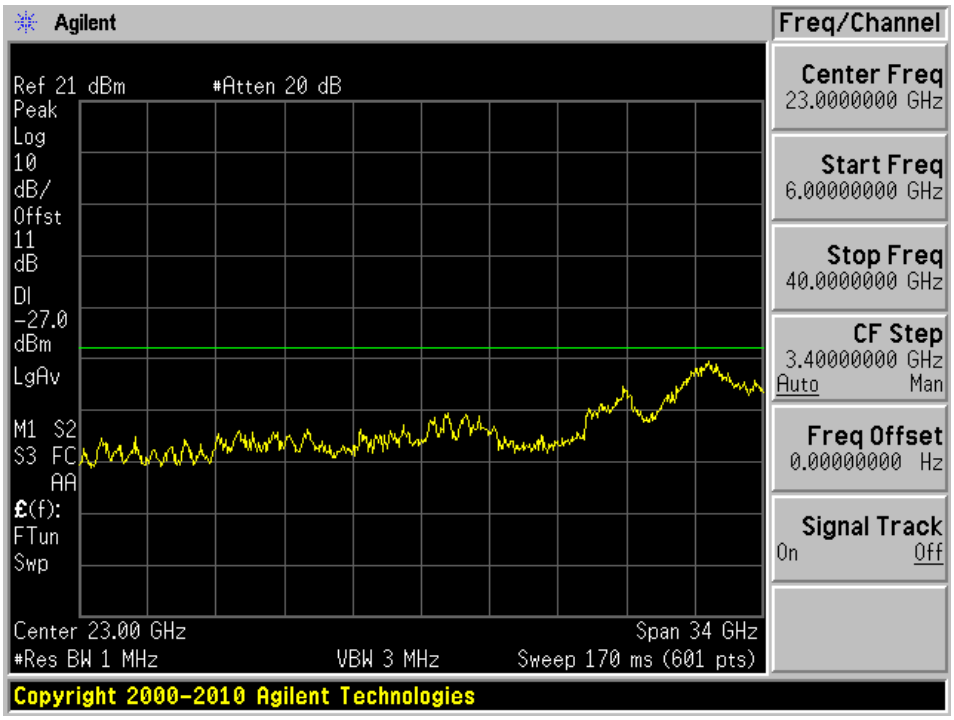
Low Channel Ant B 6GHz-40GHz



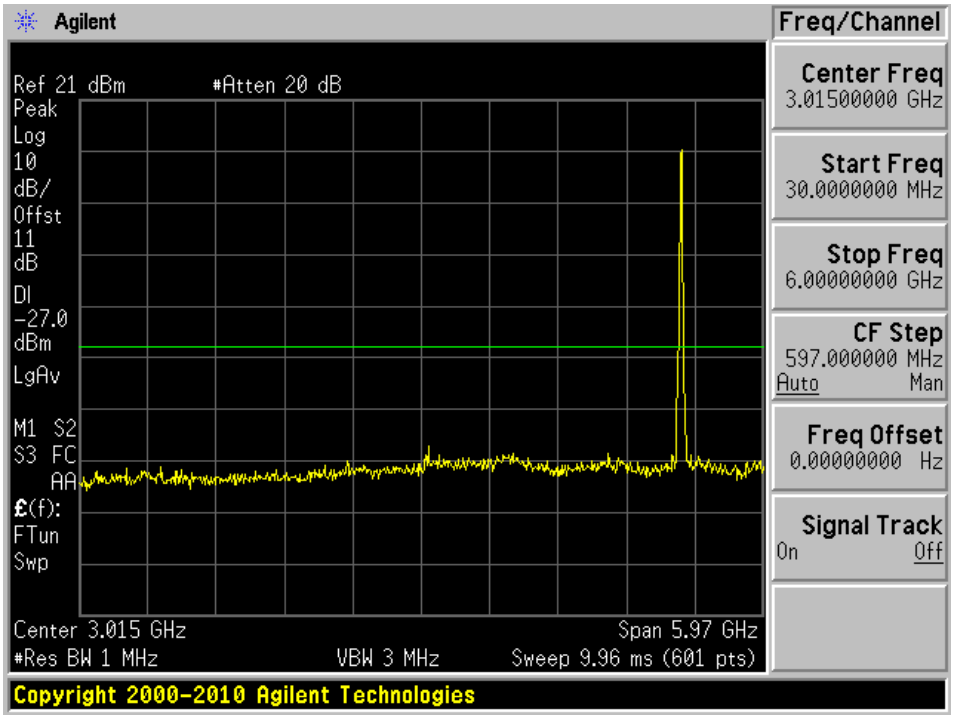
Mid Channel Ant A 30MHz-6GHz



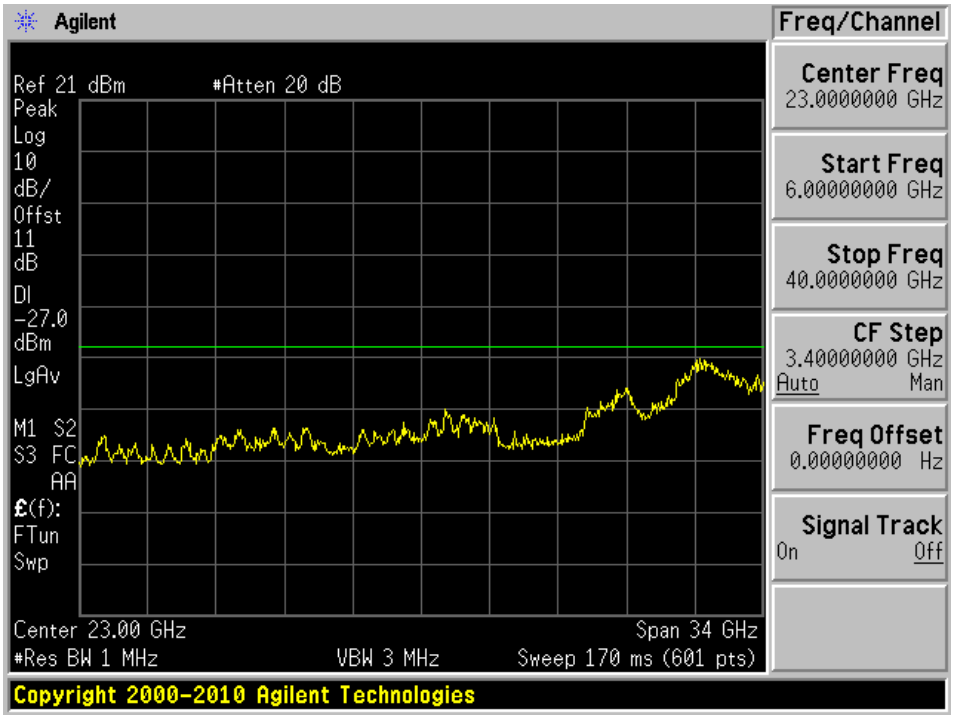
Mid Channel Ant A 6GHz-40GHz



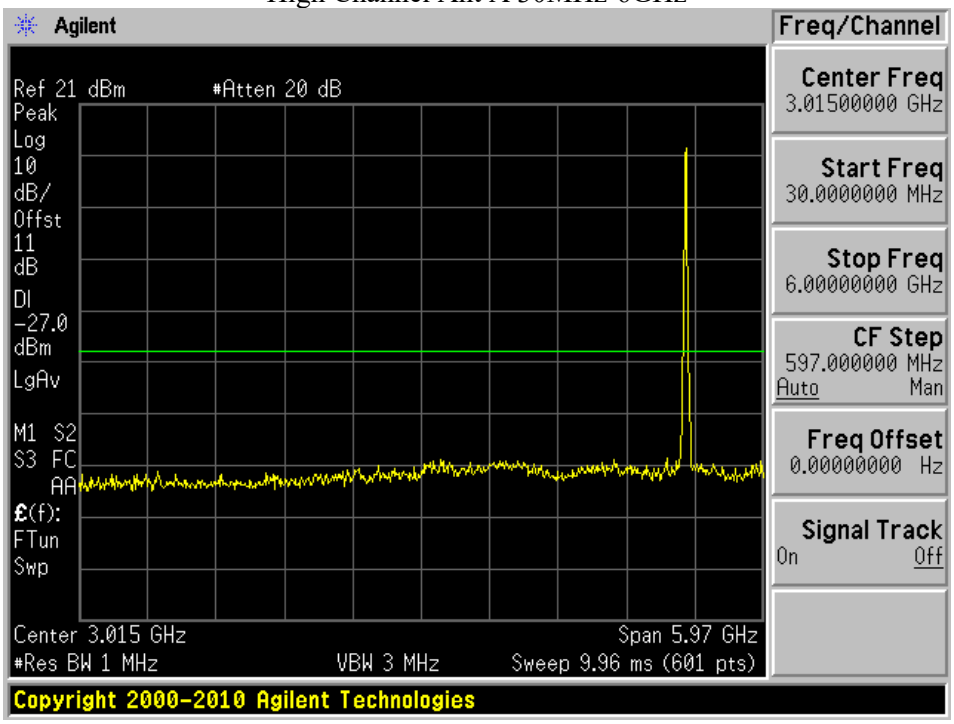
Mid Channel Ant B 30MHz-6GHz



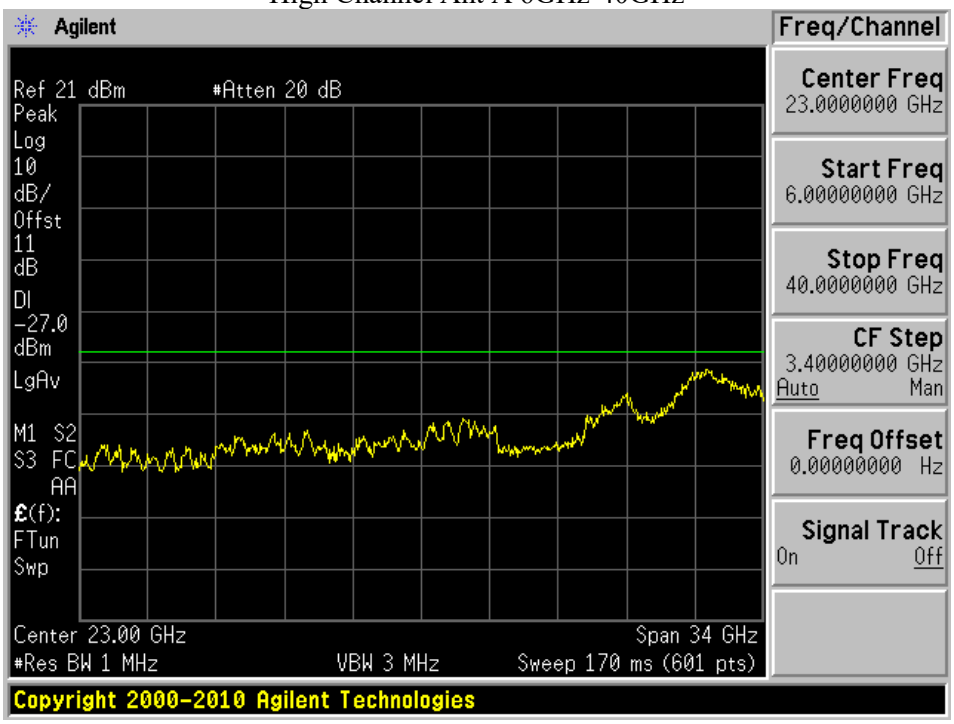
Mid Channel Ant B 6GHz-40GHz



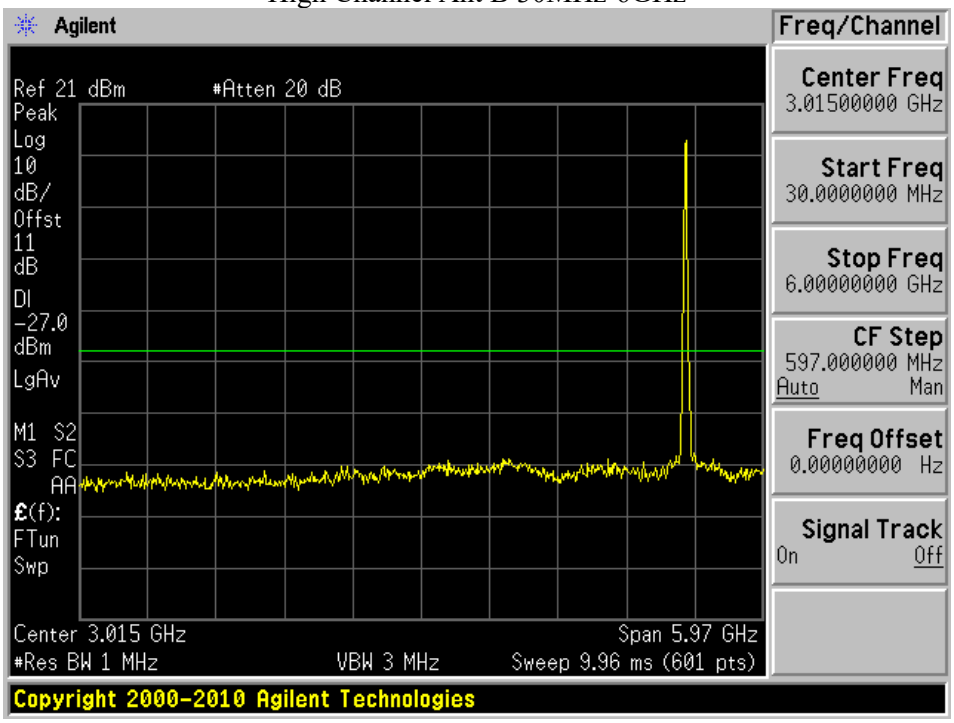
High Channel Ant A 30MHz-6GHz



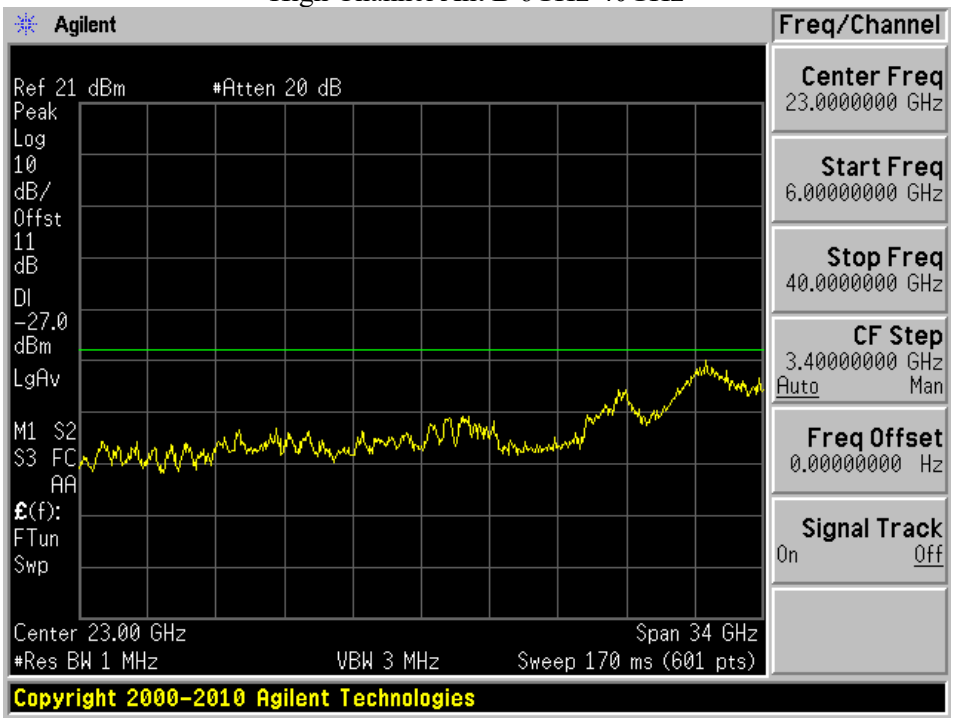
High Channel Ant A 6GHz-40GHz



High Channel Ant B 30MHz-6GHz

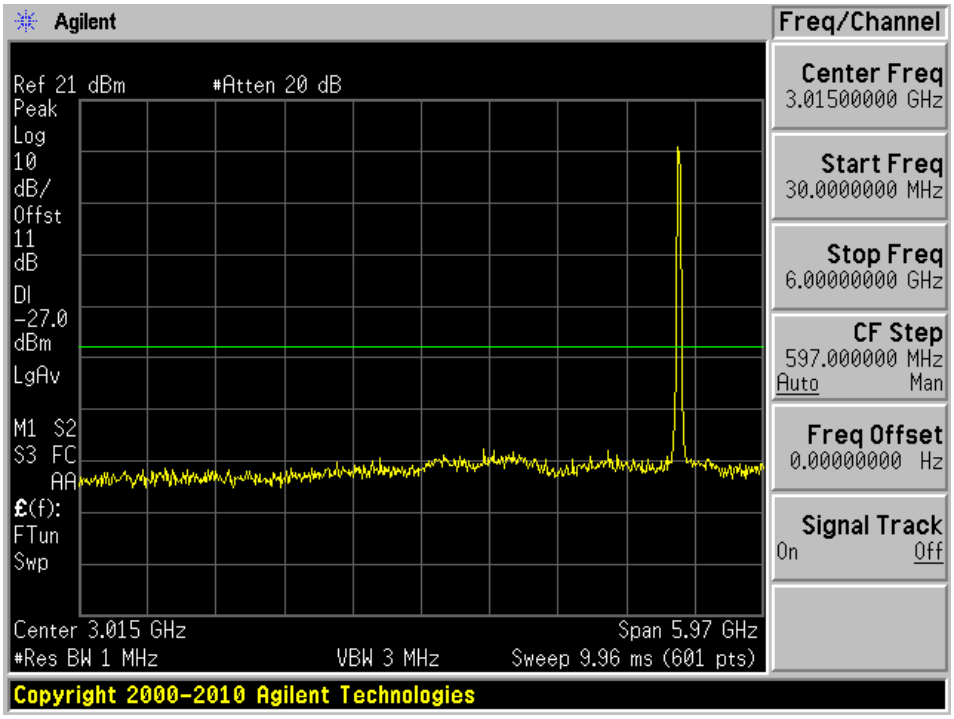


High Channel Ant B 6GHz-40GHz

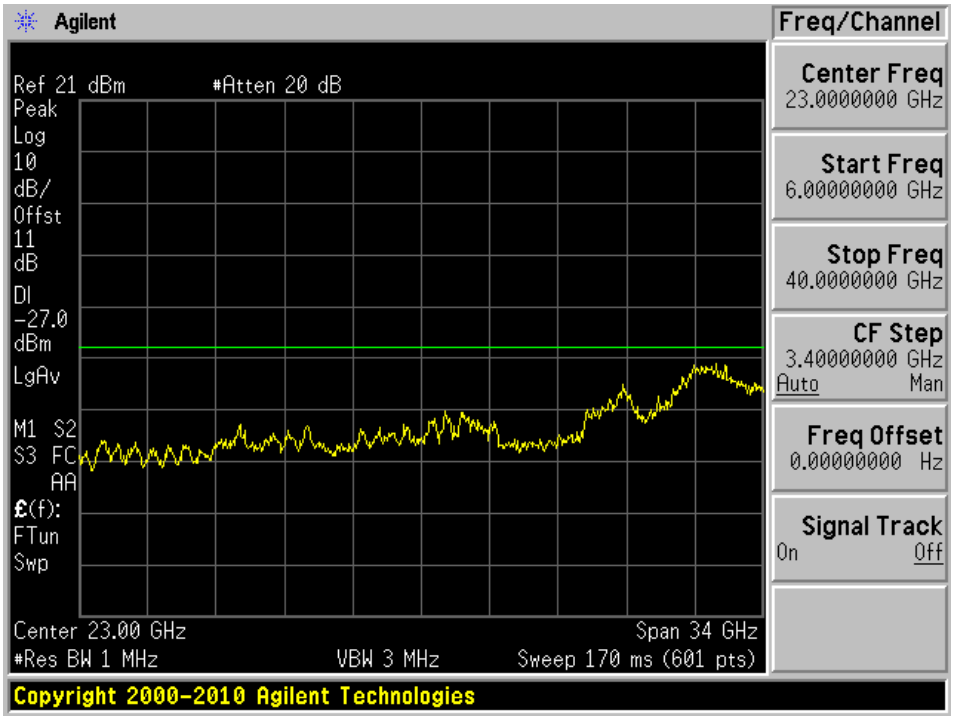


5250 - 5350 MHz 802.11n20

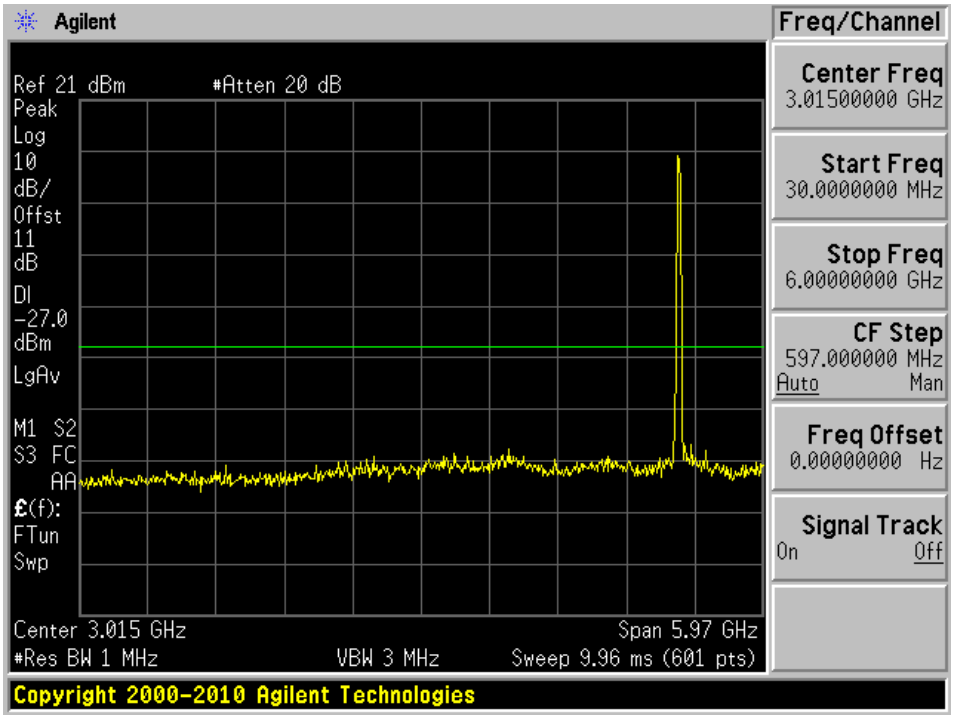
Low Channel Ant A 30MHz-6GHz



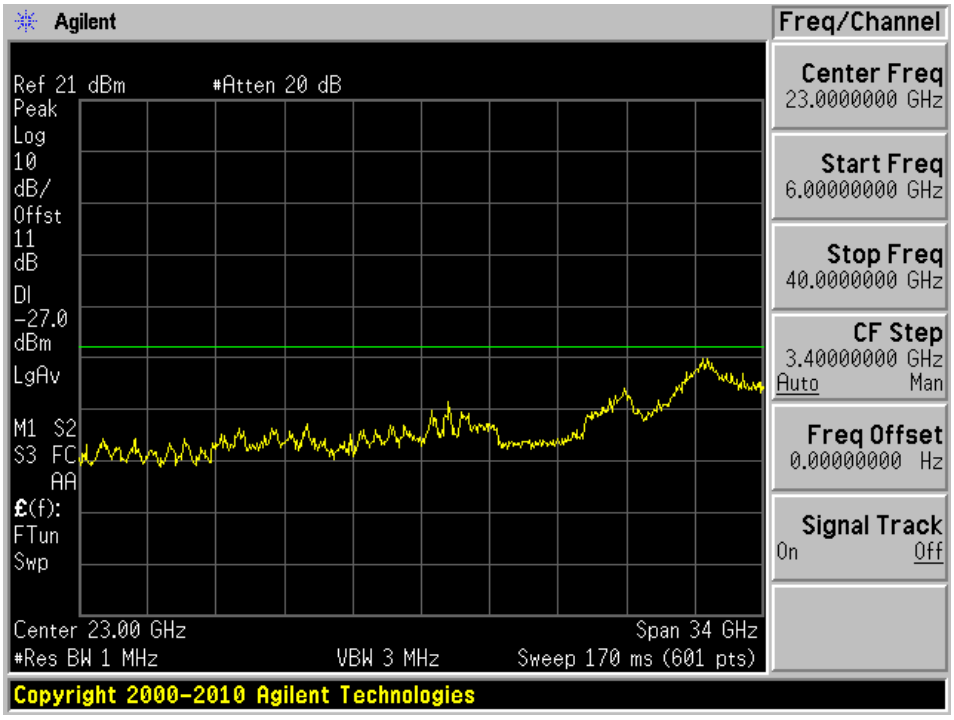
Low Channel Ant A 6GHz-40GHz



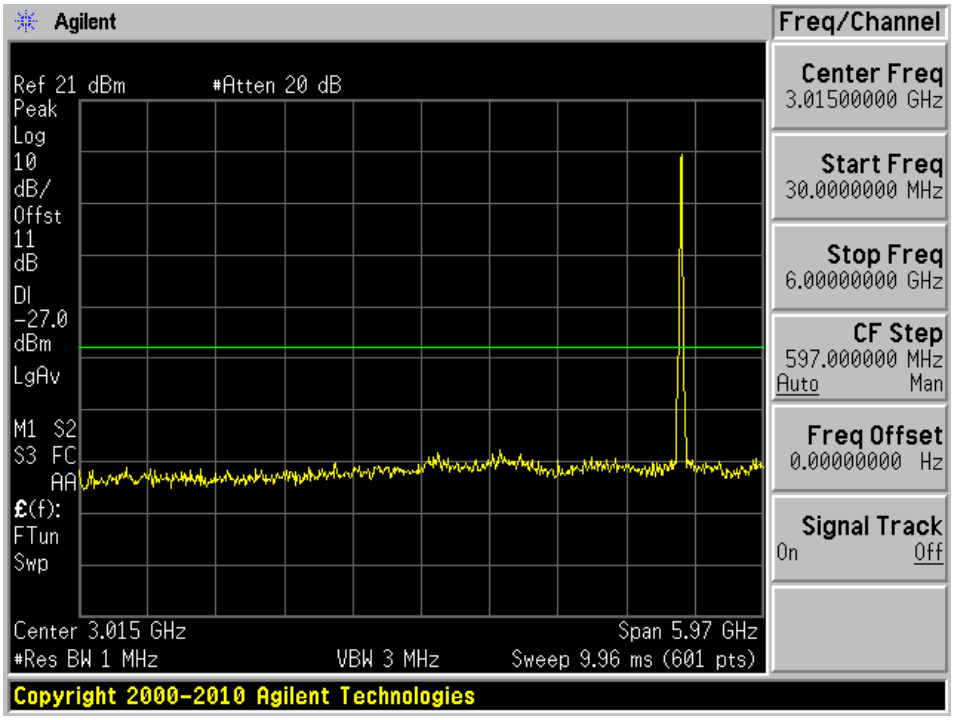
Low Channel Ant B 30MHz-6GHz



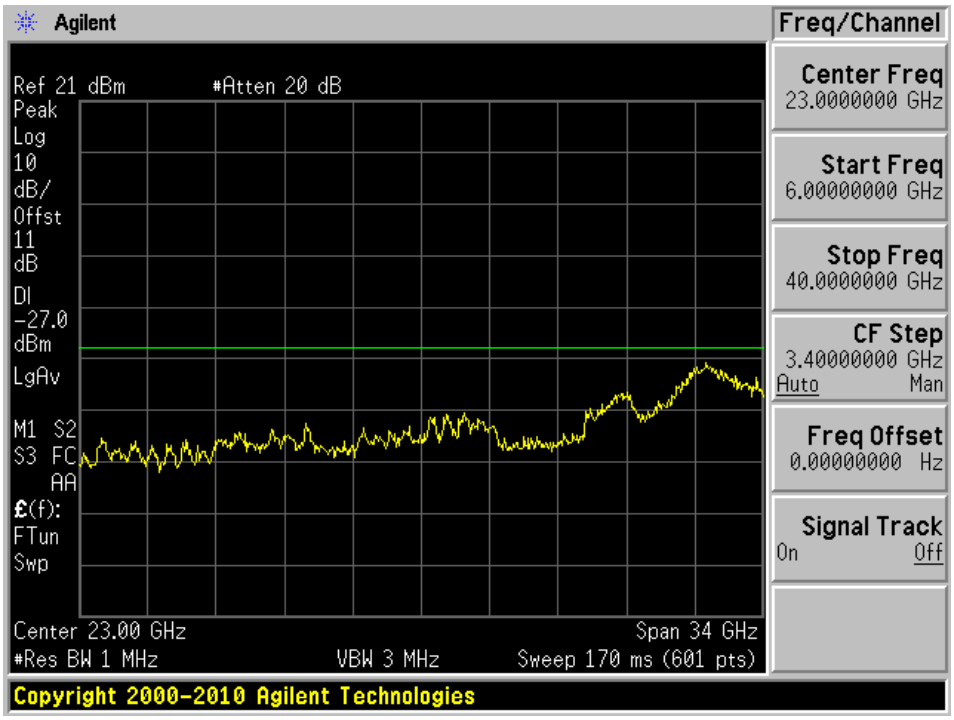
Low Channel Ant B 6GHz-40GHz



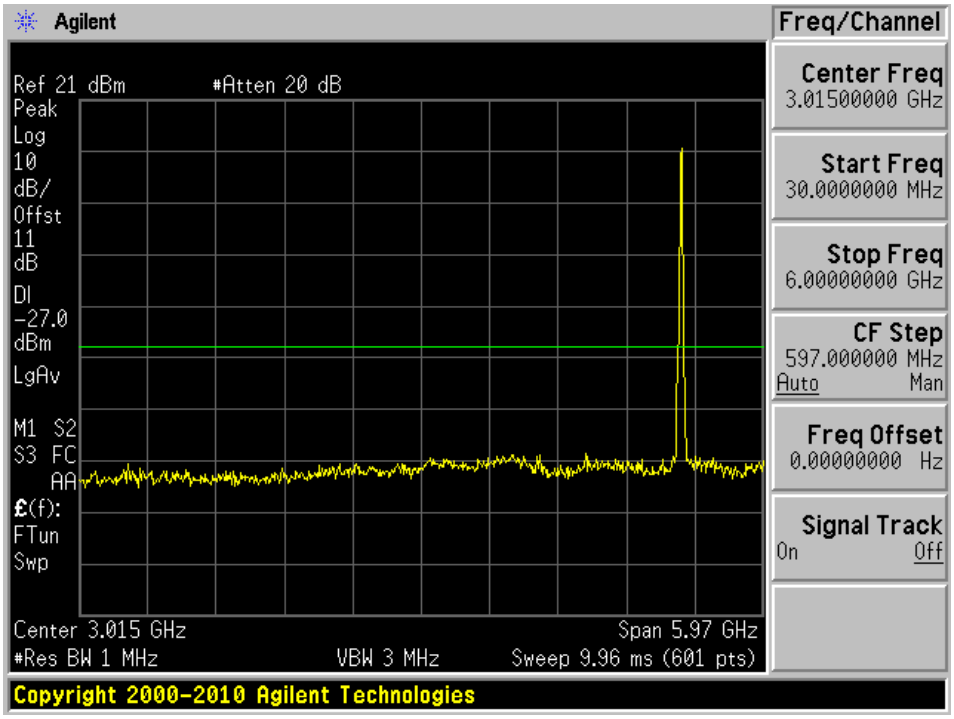
Mid Channel Ant A 30MHz-6GHz



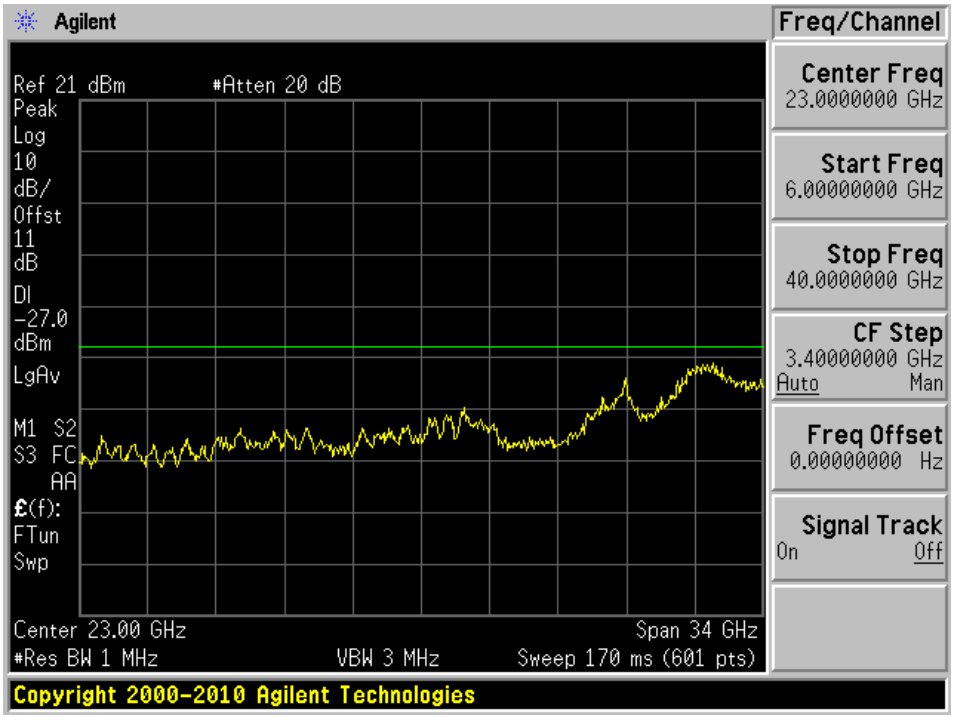
Mid Channel Ant A 6GHz-40GHz



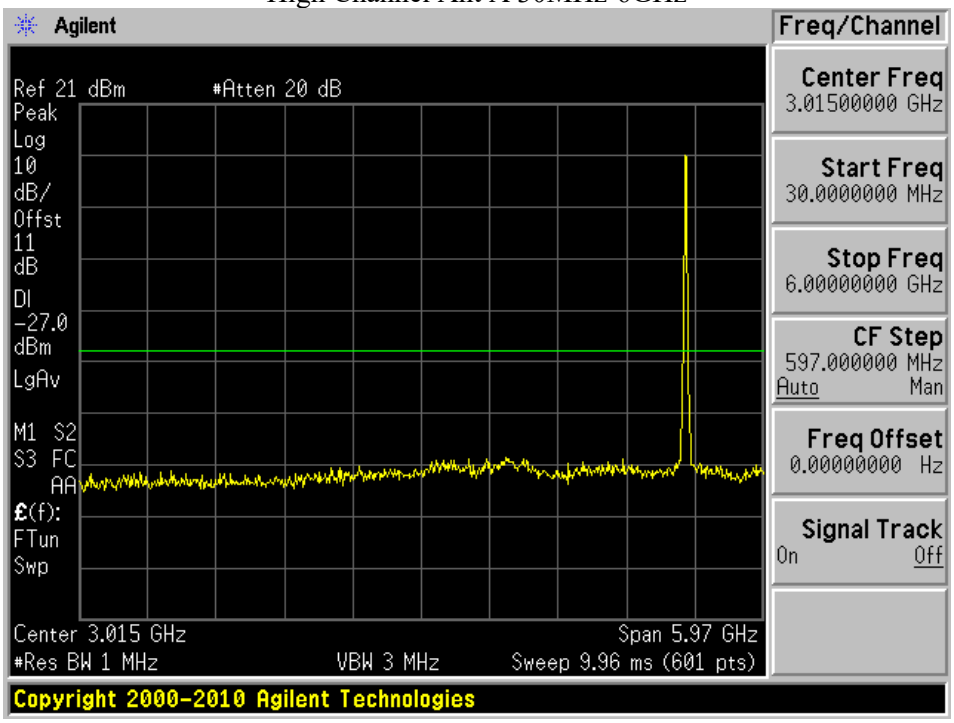
Mid Channel Ant B 30MHz-6GHz



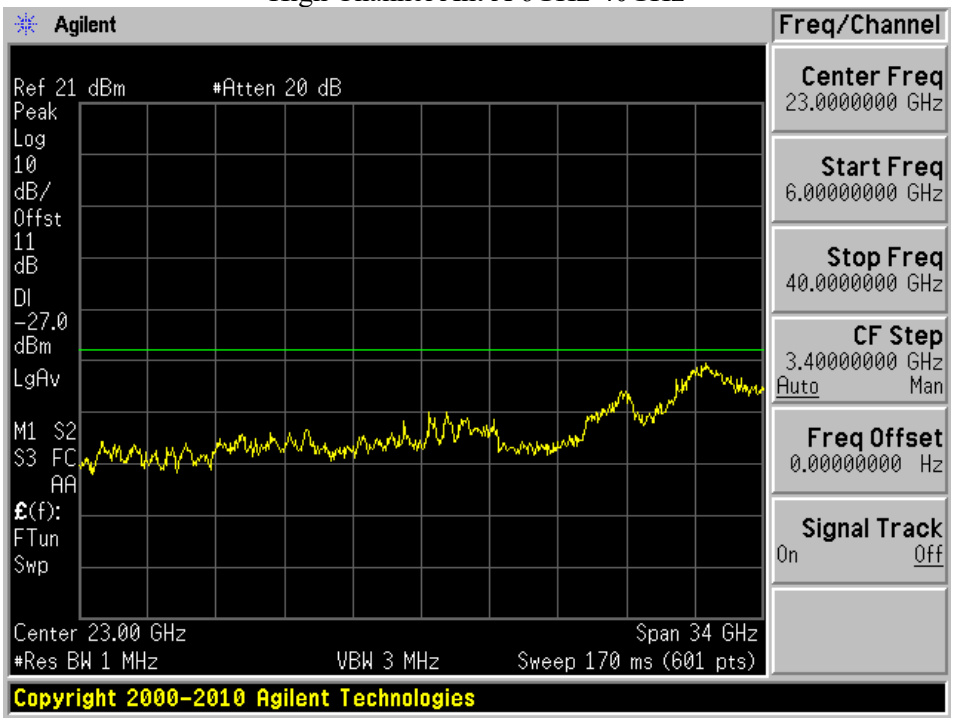
Mid Channel Ant B 6GHz-40GHz



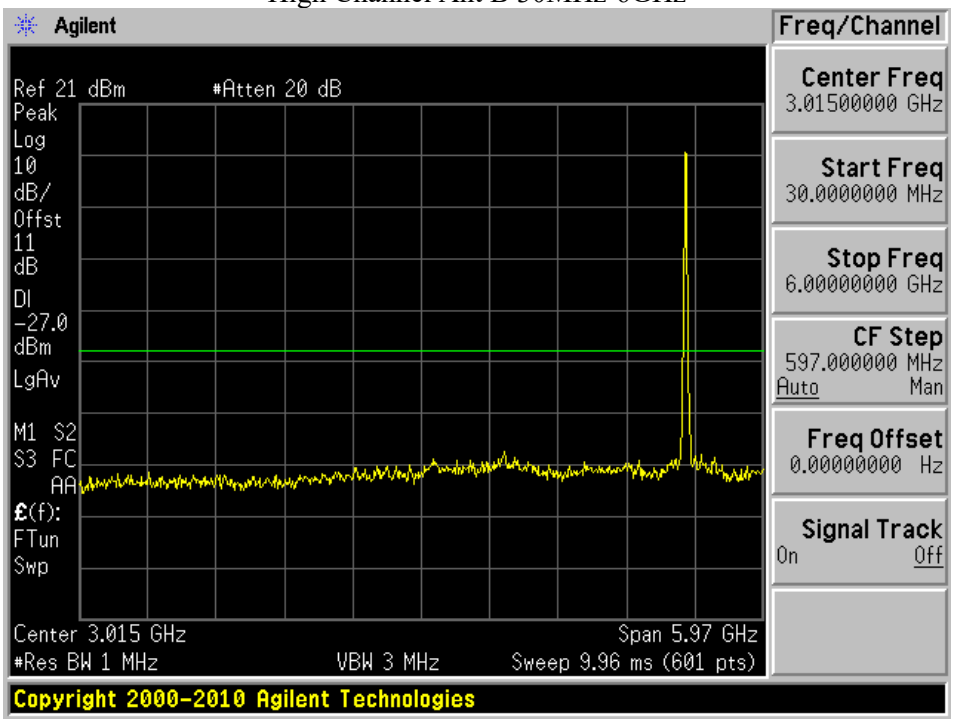
High Channel Ant A 30MHz-6GHz



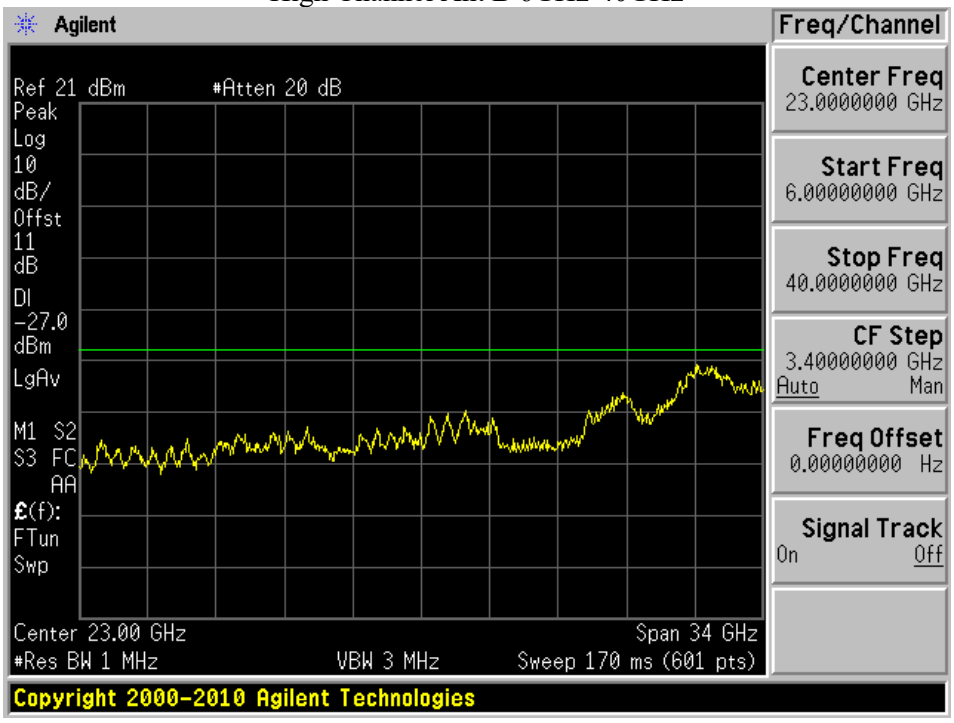
High Channel Ant A 6GHz-40GHz



High Channel Ant B 30MHz-6GHz

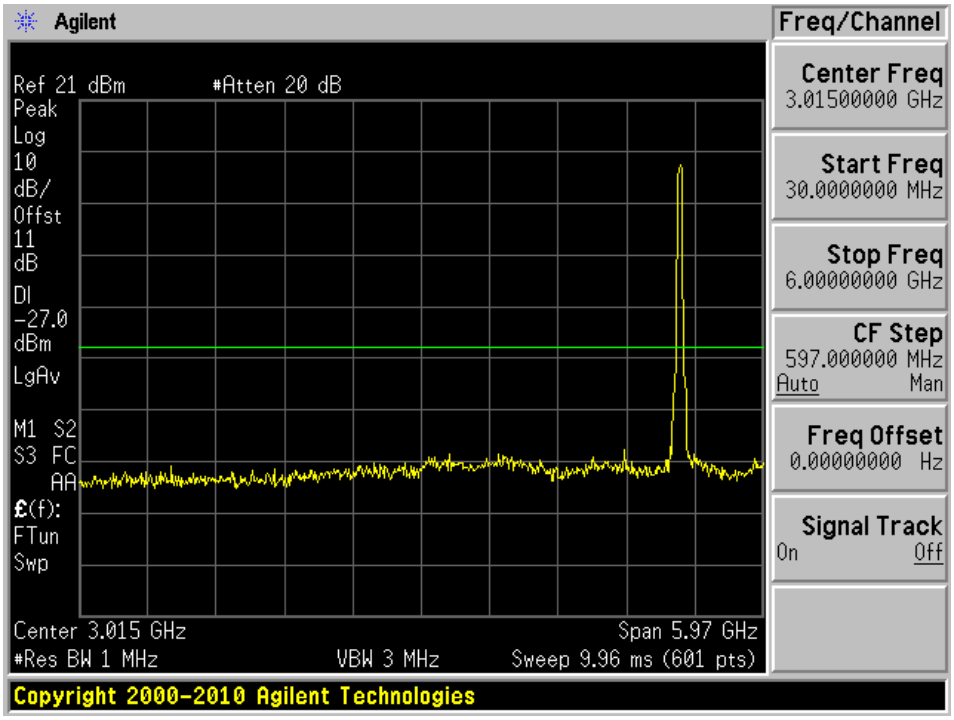


High Channel Ant B 6GHz-40GHz

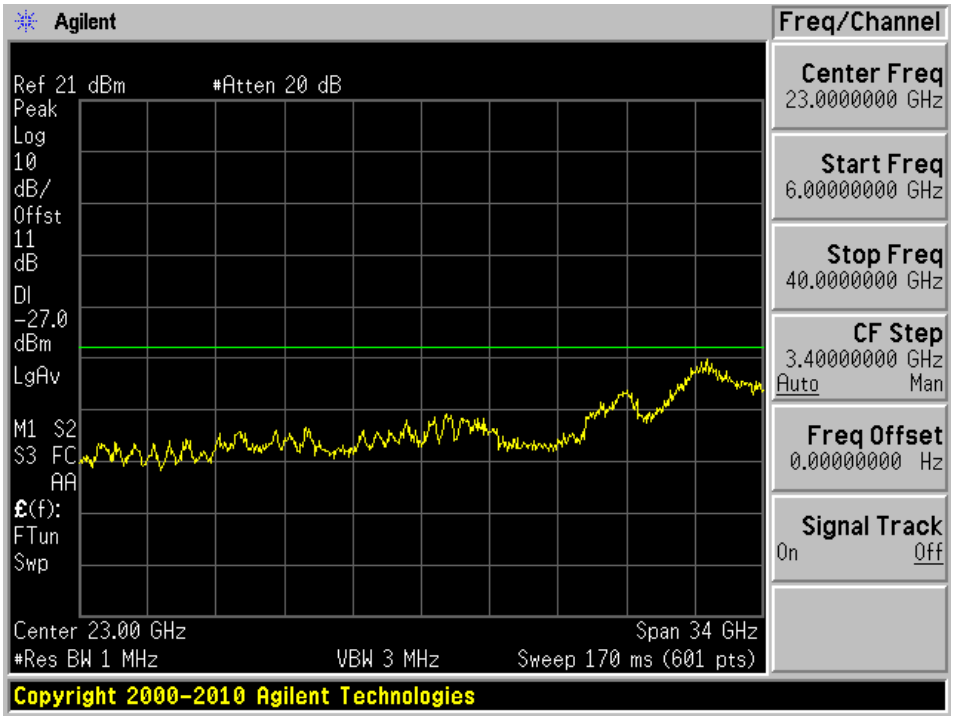


5250 - 5350 MHz 802.11n40

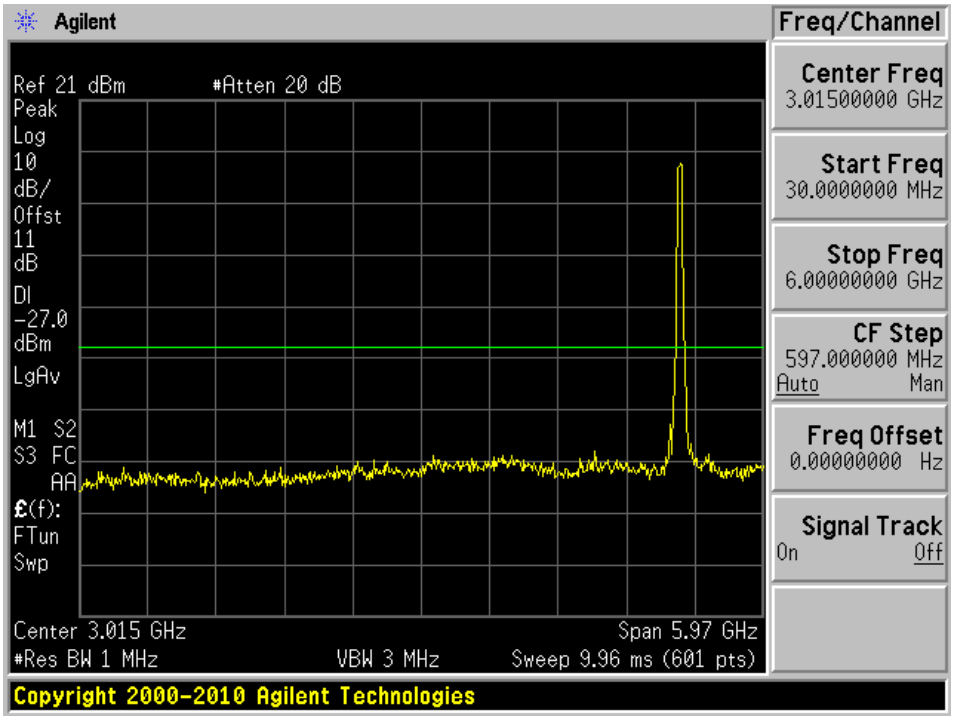
Low Channel Ant A 30MHz-6GHz



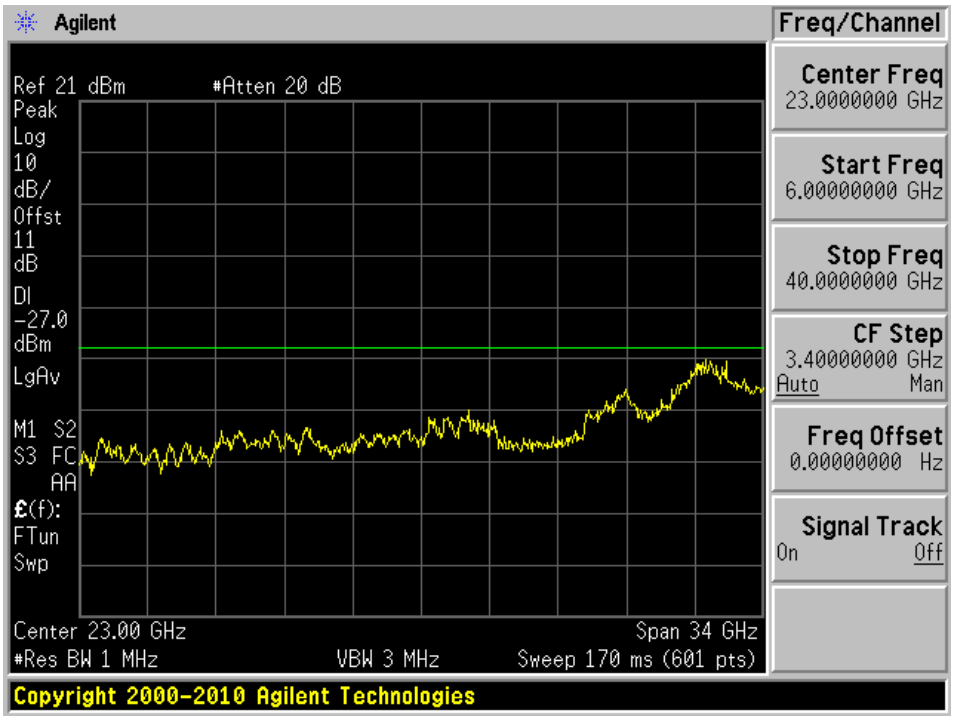
Low Channel Ant A 6GHz-40GHz



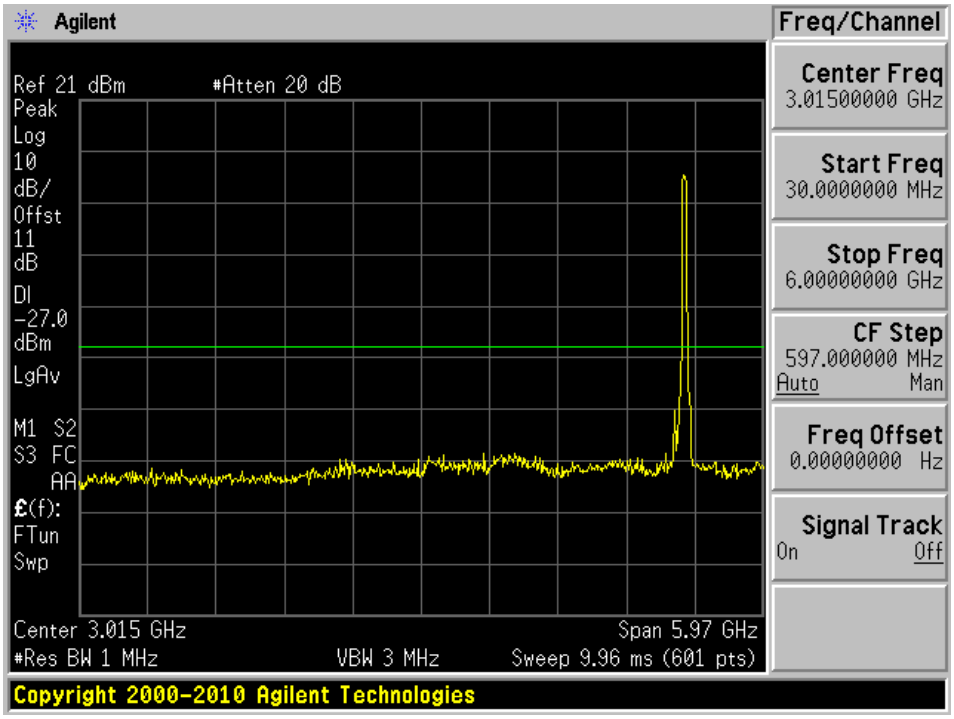
Low Channel Ant B 30MHz-6GHz



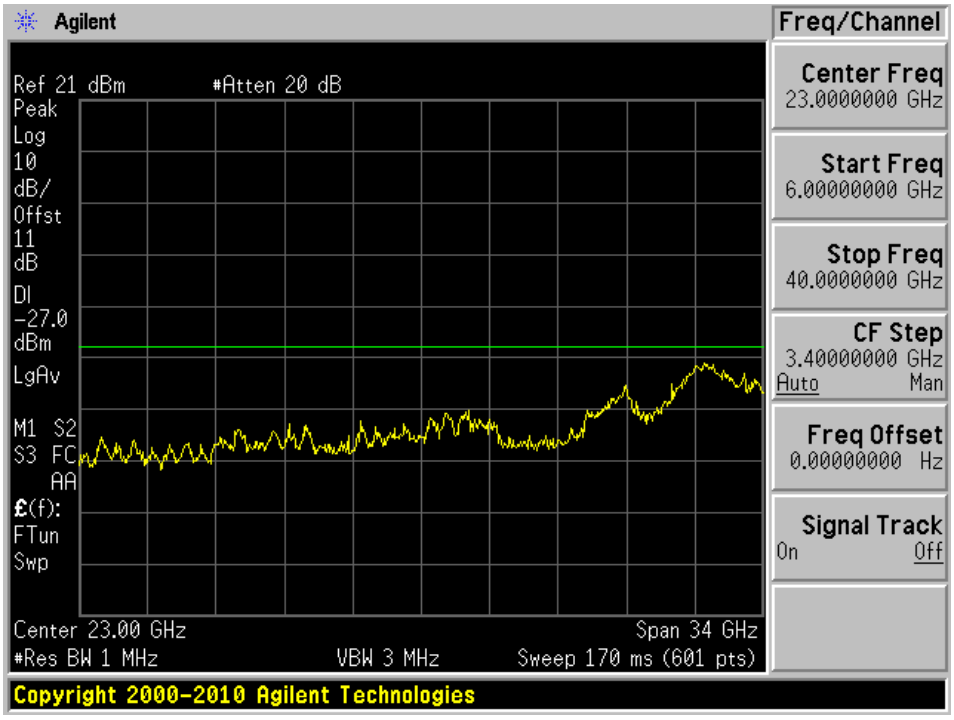
Low Channel Ant B 6GHz-40GHz



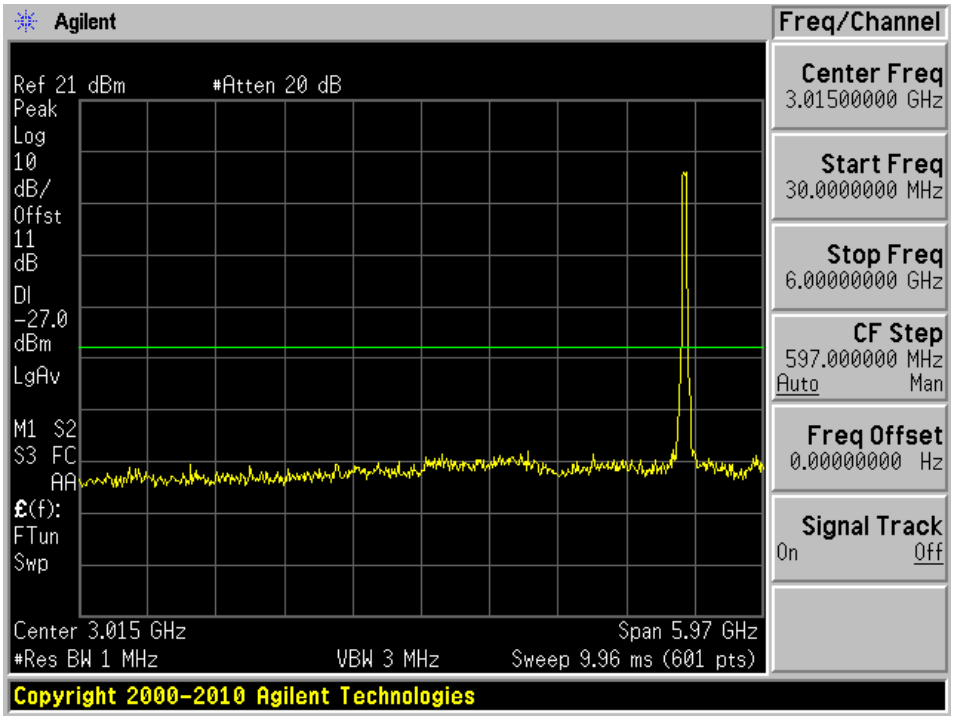
Mid Channel Ant A 30MHz-6GHz



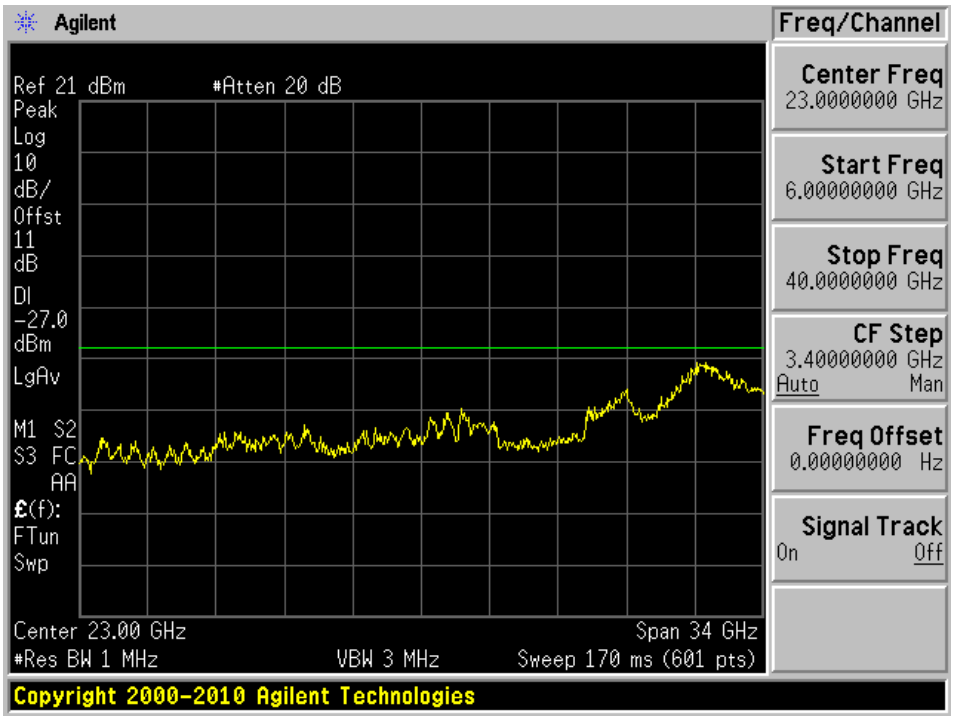
Mid Channel Ant A 6GHz-40GHz



Mid Channel Ant B 30MHz-6GHz

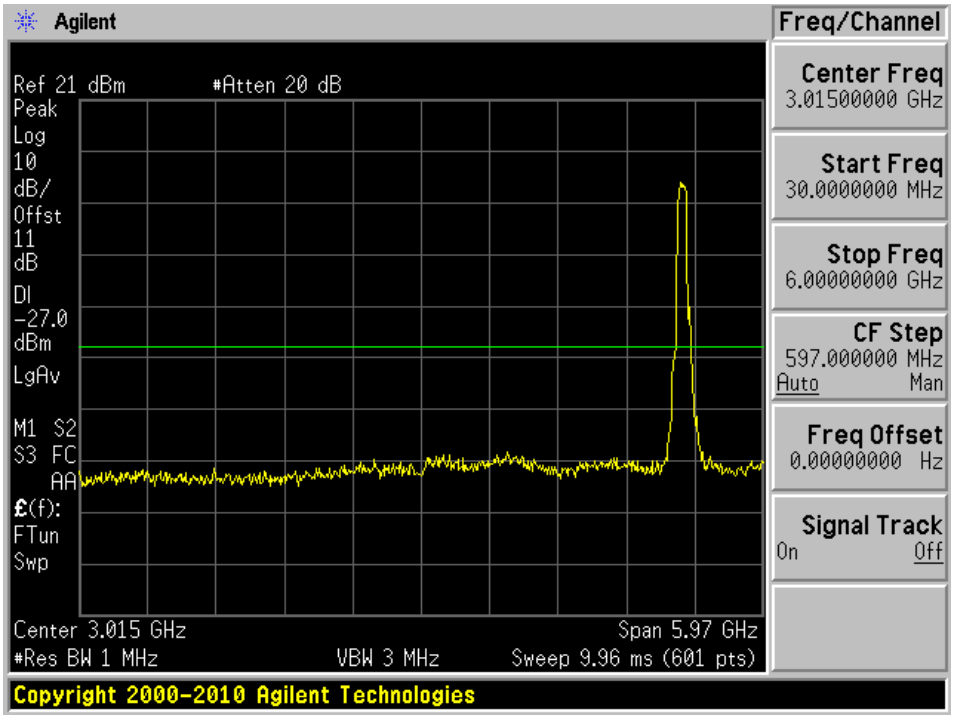


Mid Channel Ant B 6GHz-40GHz

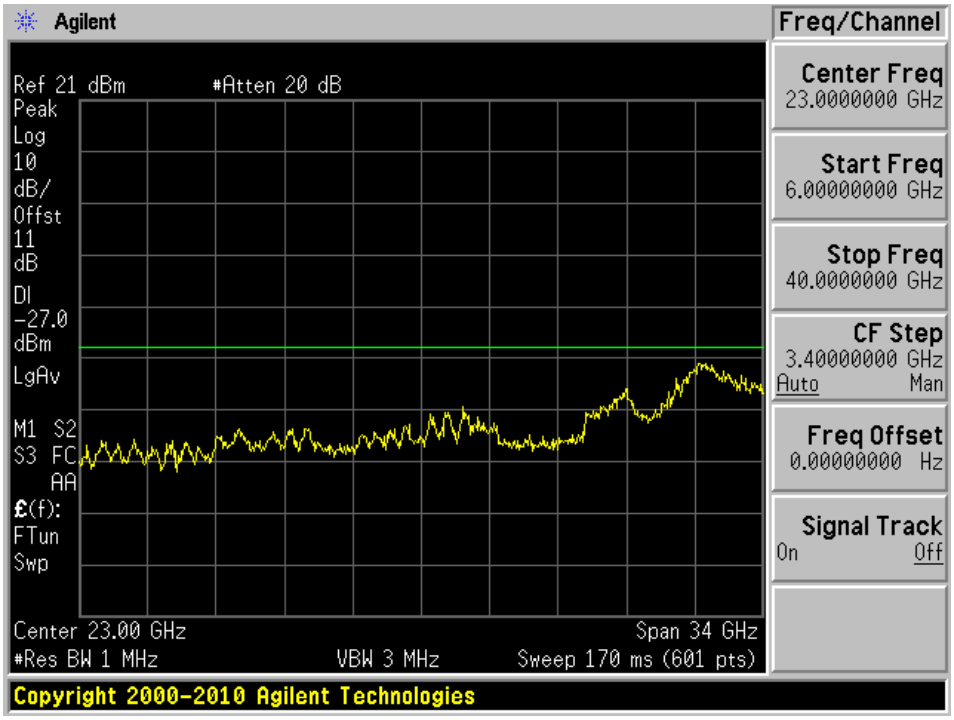


5250 - 5350 MHz 802.11ac80

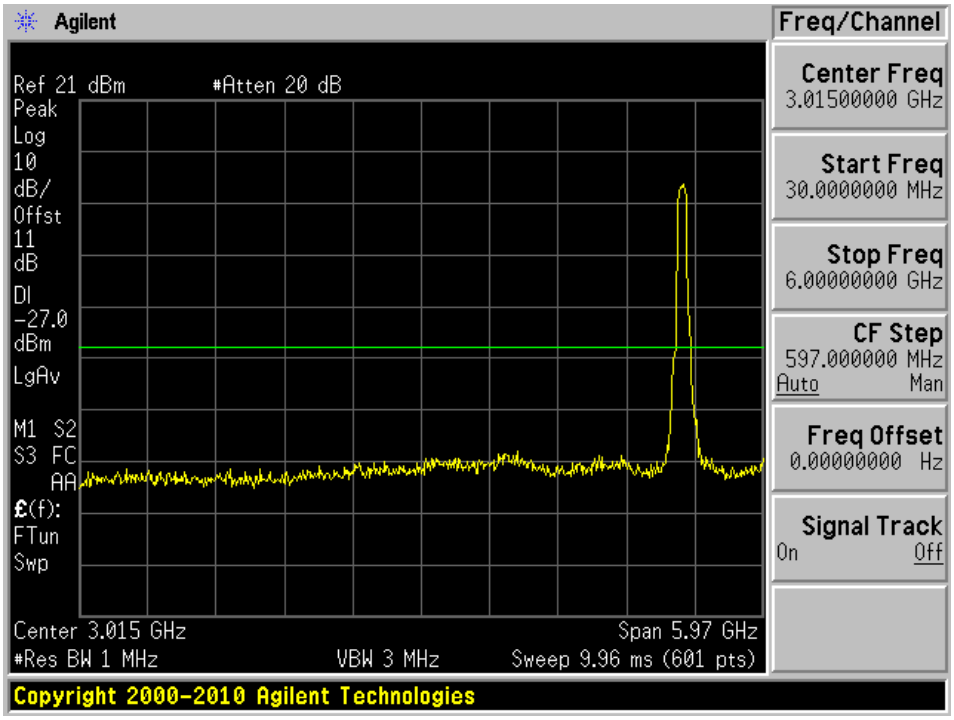
Low Channel Ant A 30MHz-6GHz



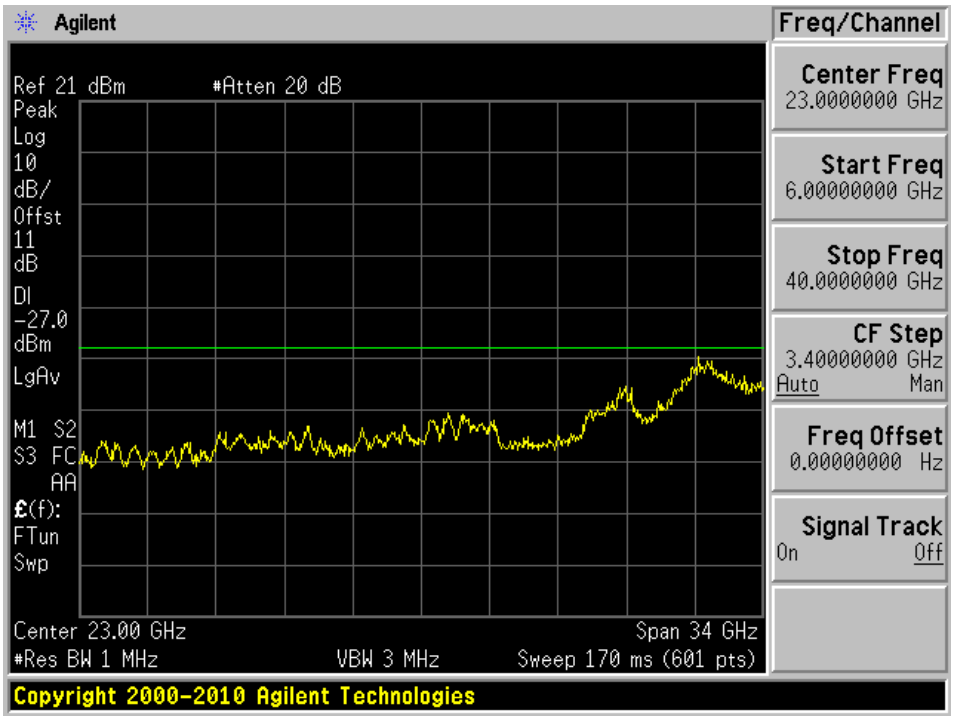
Low Channel Ant A 6GHz-40GHz



Low Channel Ant B 30MHz-6GHz

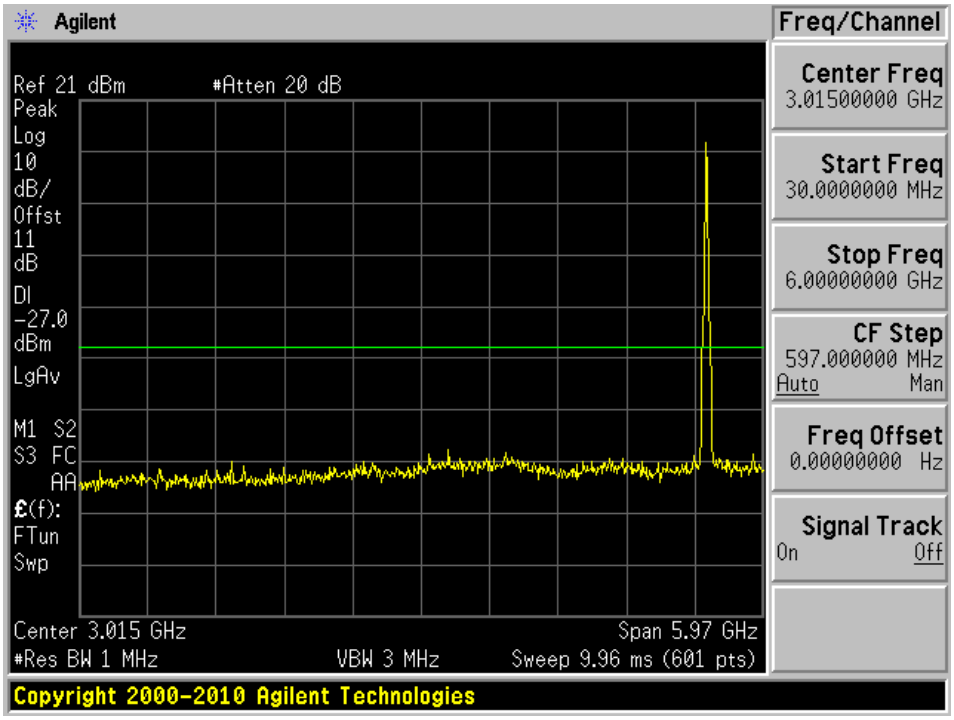


Low Channel Ant B 6GHz-40GHz

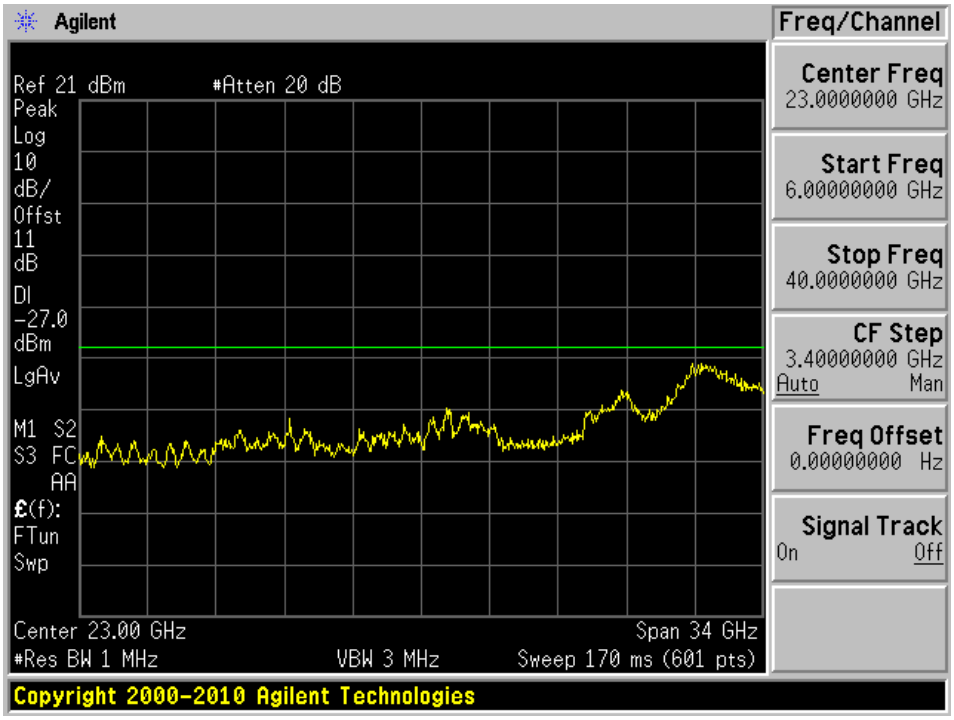


5470 - 5725 MHz 802.11a

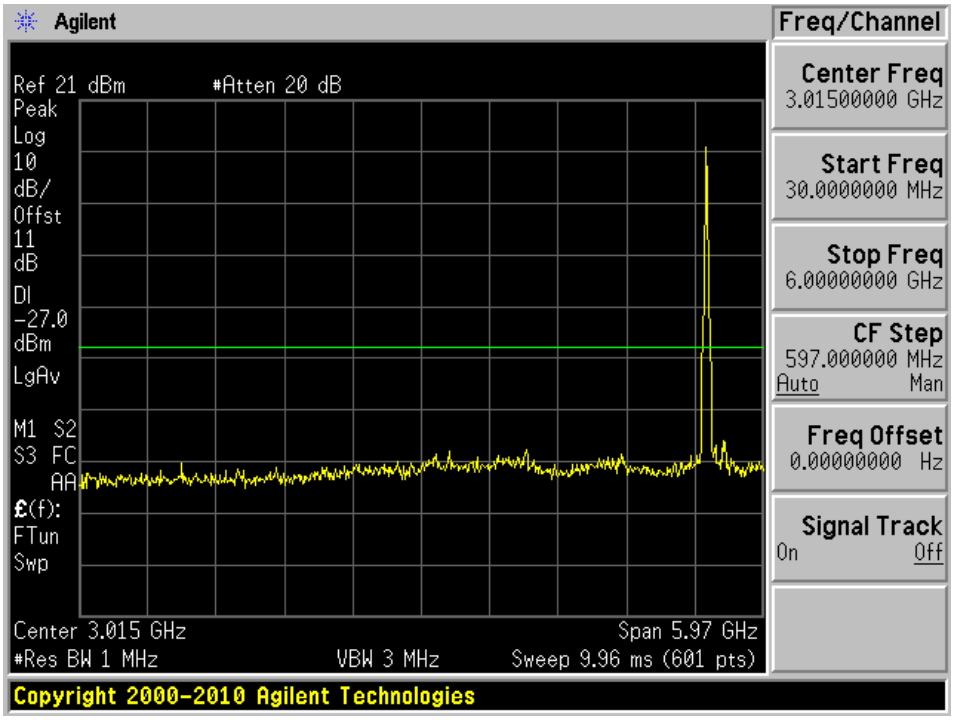
Low Channel Ant A 30MHz-6GHz



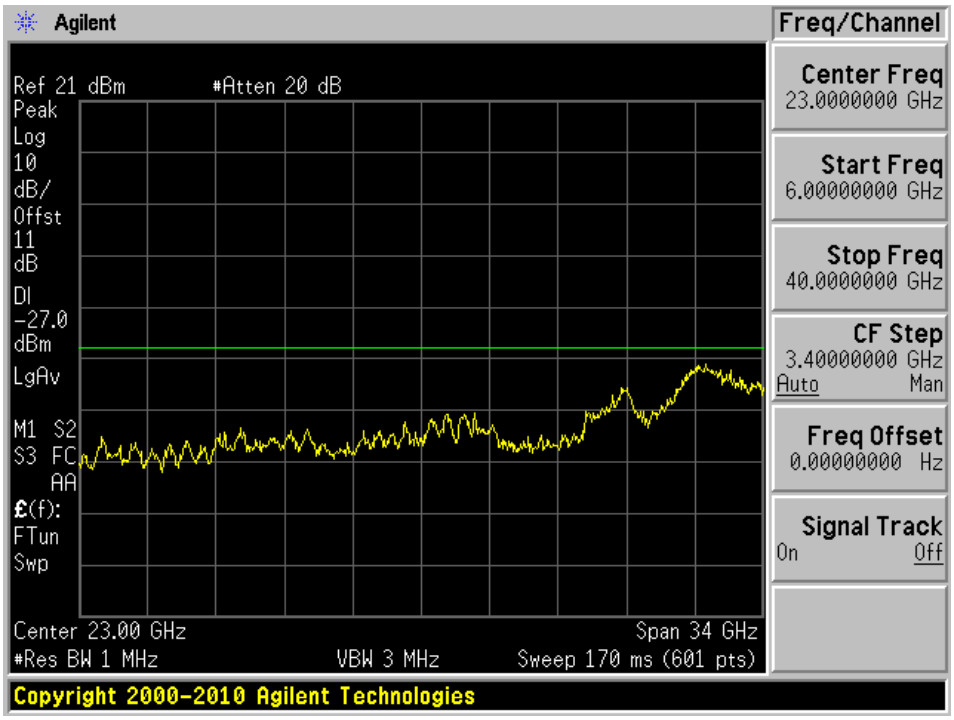
Low Channel Ant A 6GHz-40GHz



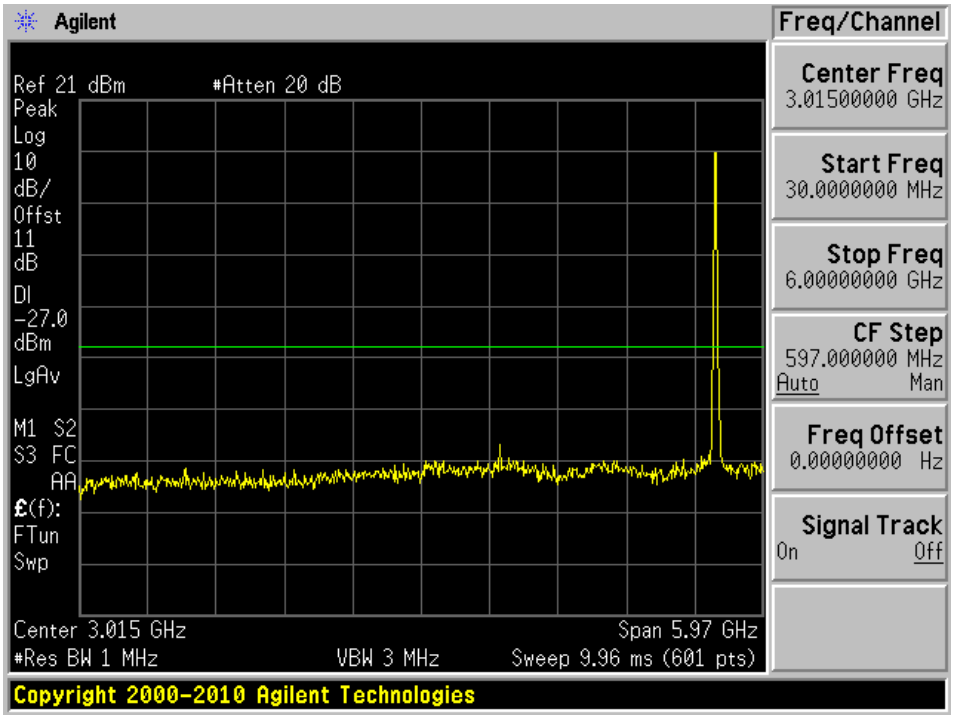
Low Channel Ant B 30MHz-6GHz



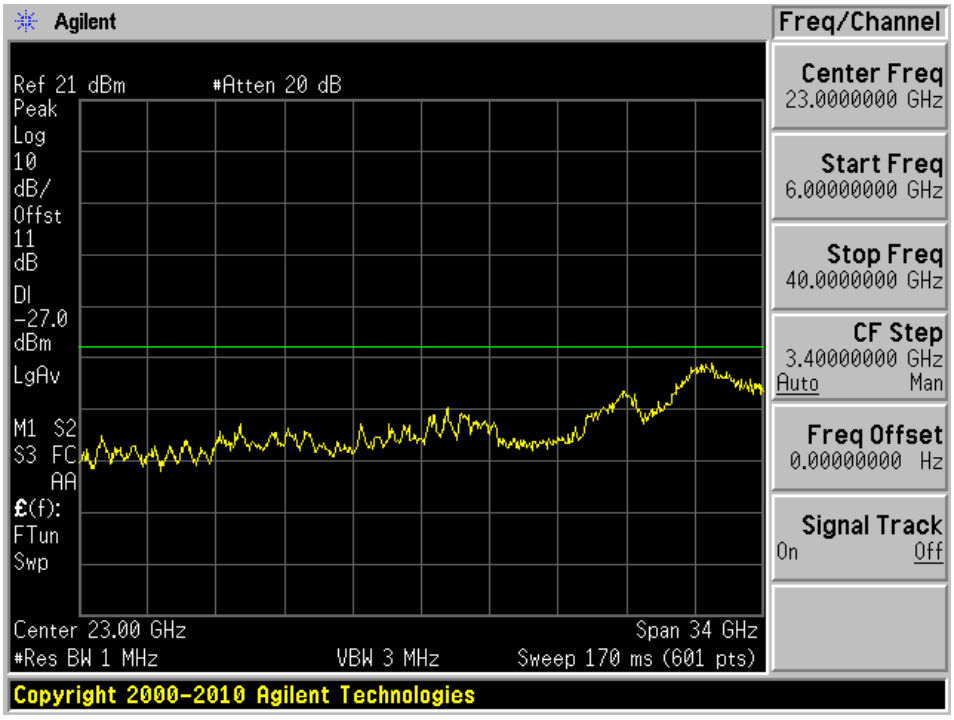
Low Channel Ant B 6GHz-40GHz



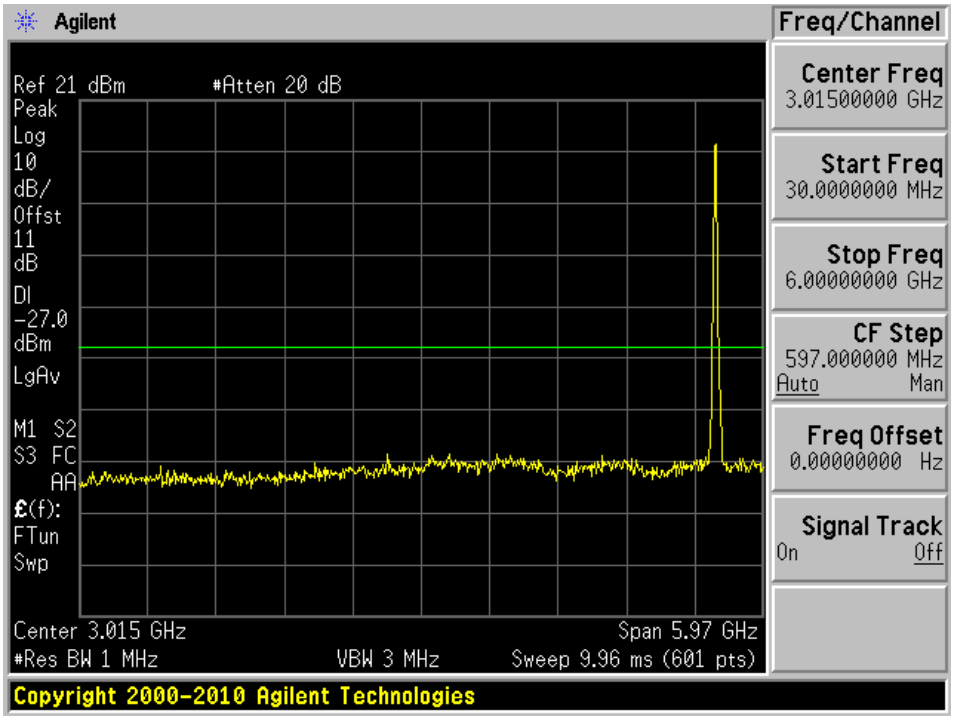
Mid Channel Ant A 30MHz-6GHz



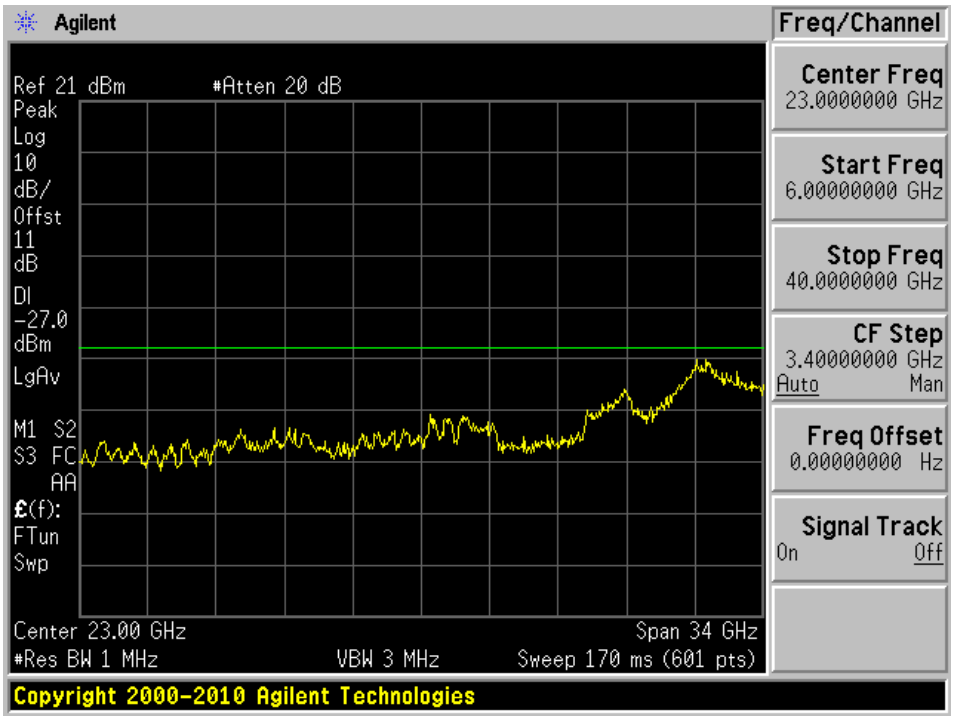
Mid Channel Ant A 6GHz-40GHz



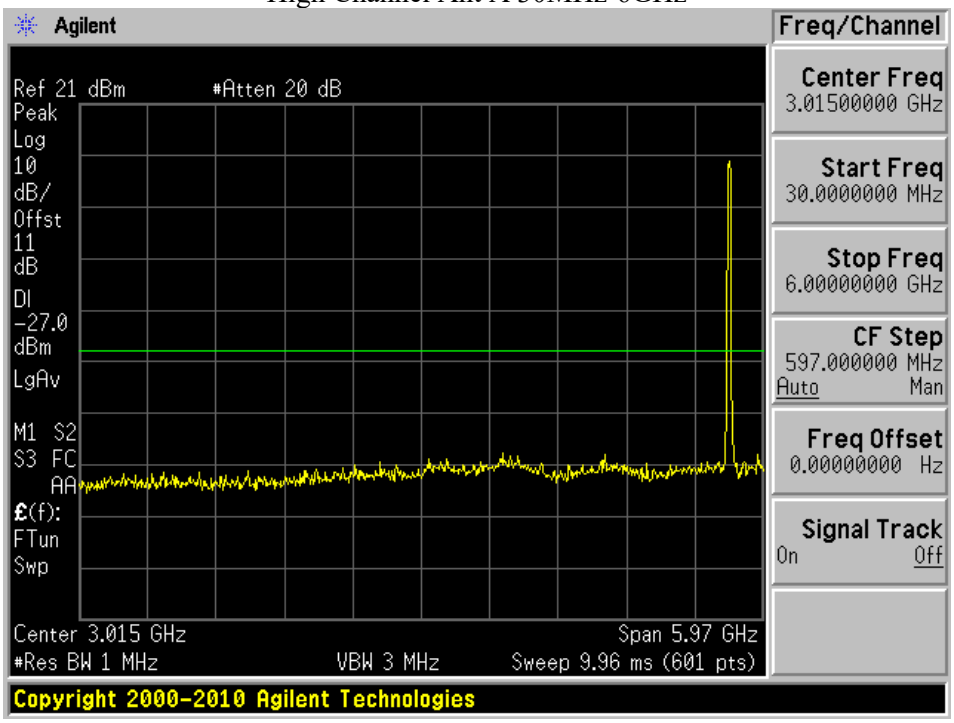
Mid Channel Ant B 30MHz-6GHz



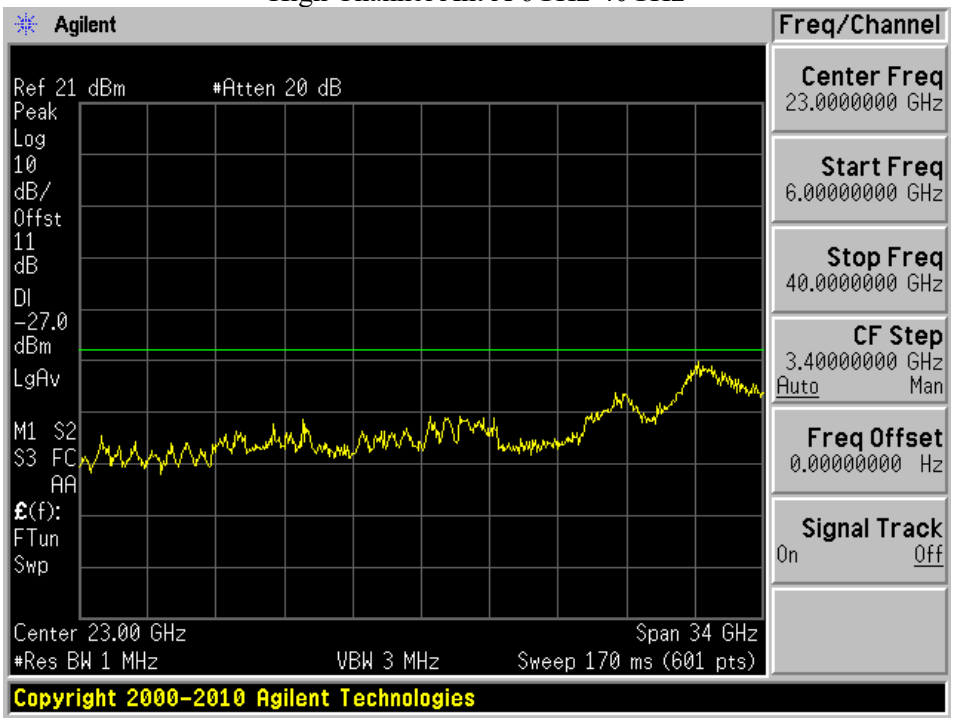
Mid Channel Ant B 6GHz-40GHz



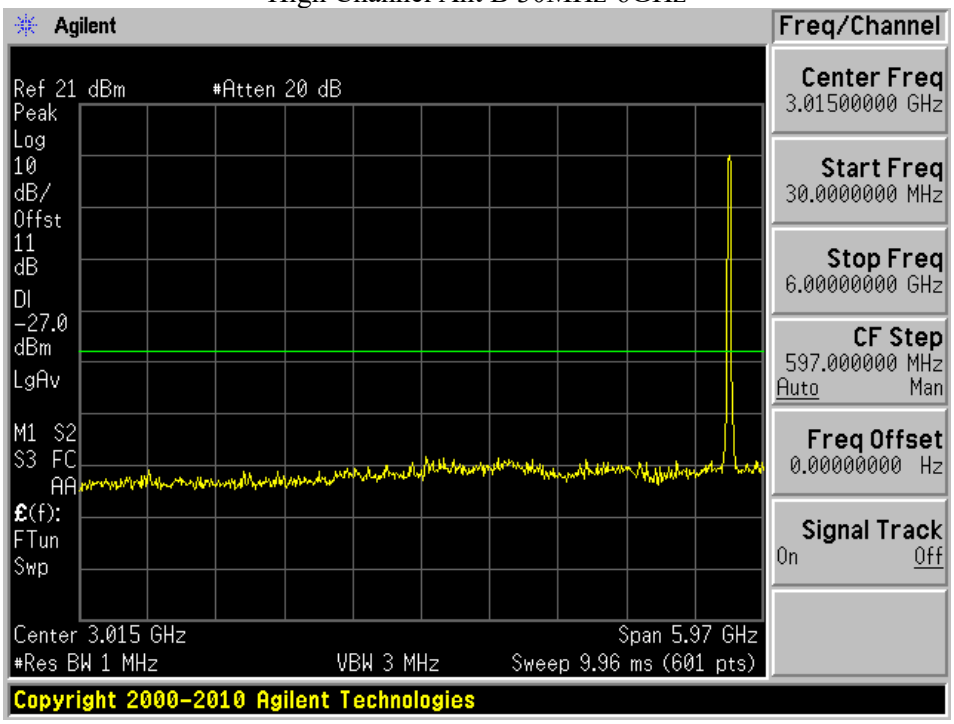
High Channel Ant A 30MHz-6GHz



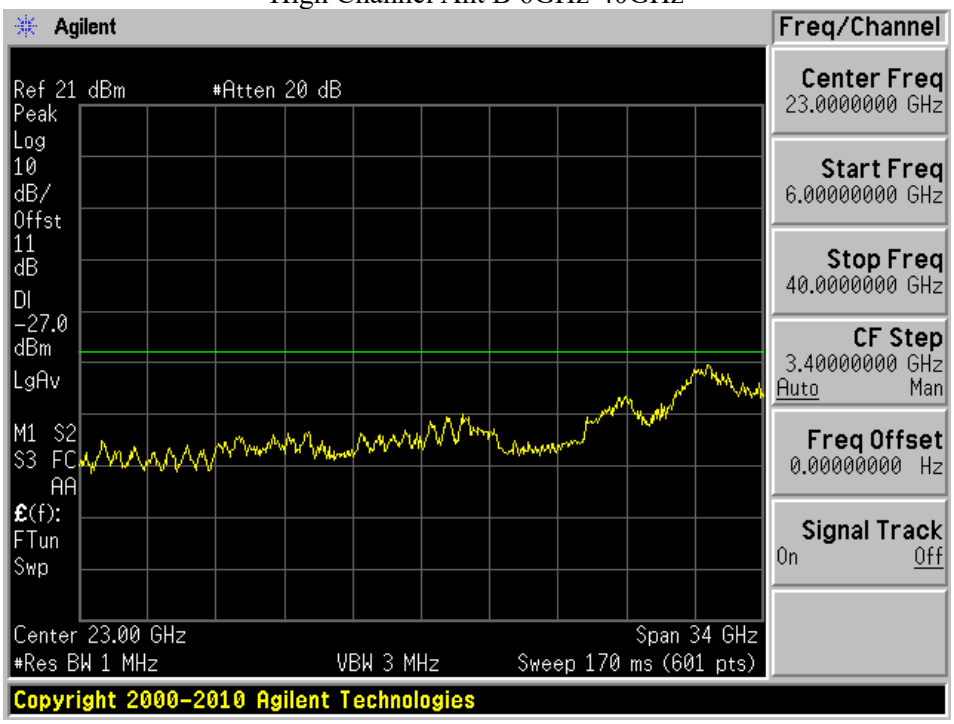
High Channel Ant A 6GHz-40GHz



High Channel Ant B 30MHz-6GHz

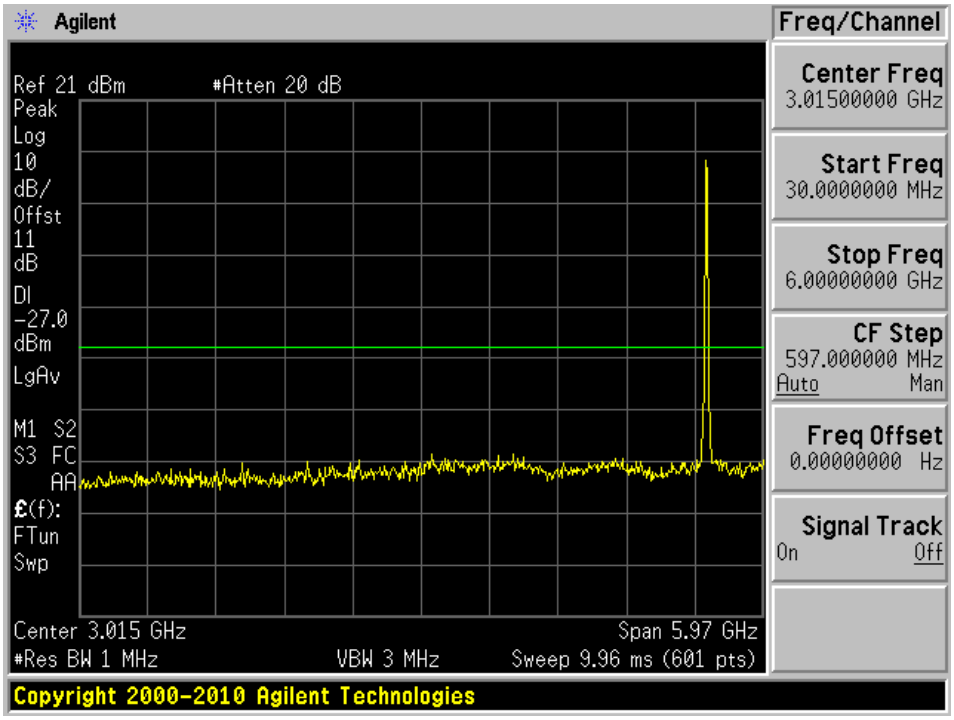


High Channel Ant B 6GHz-40GHz

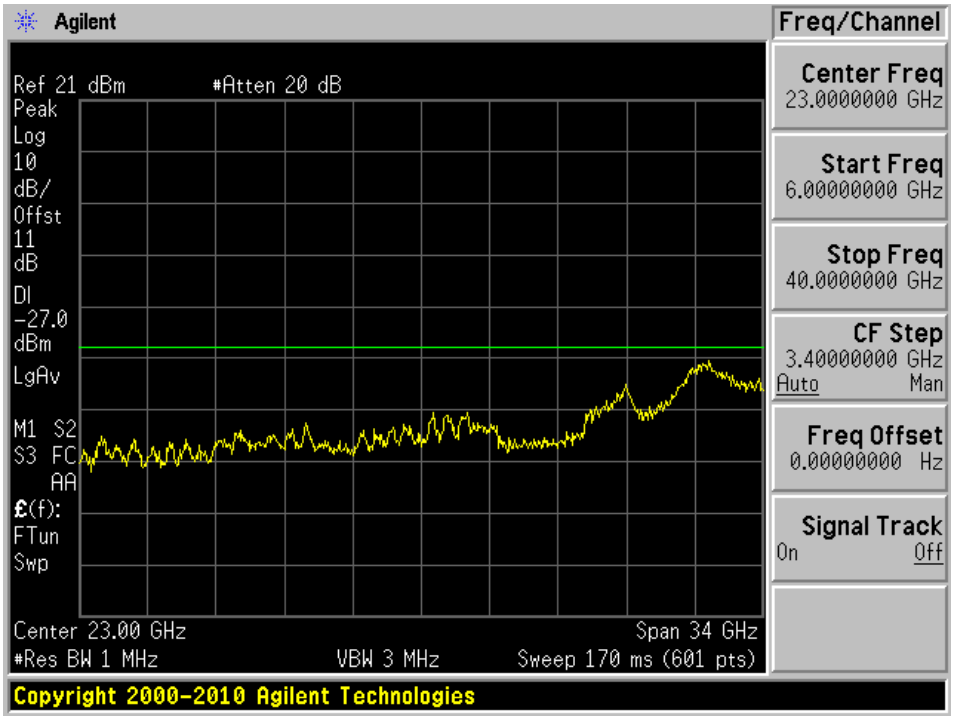


5470 - 5725 MHz 802.11n20

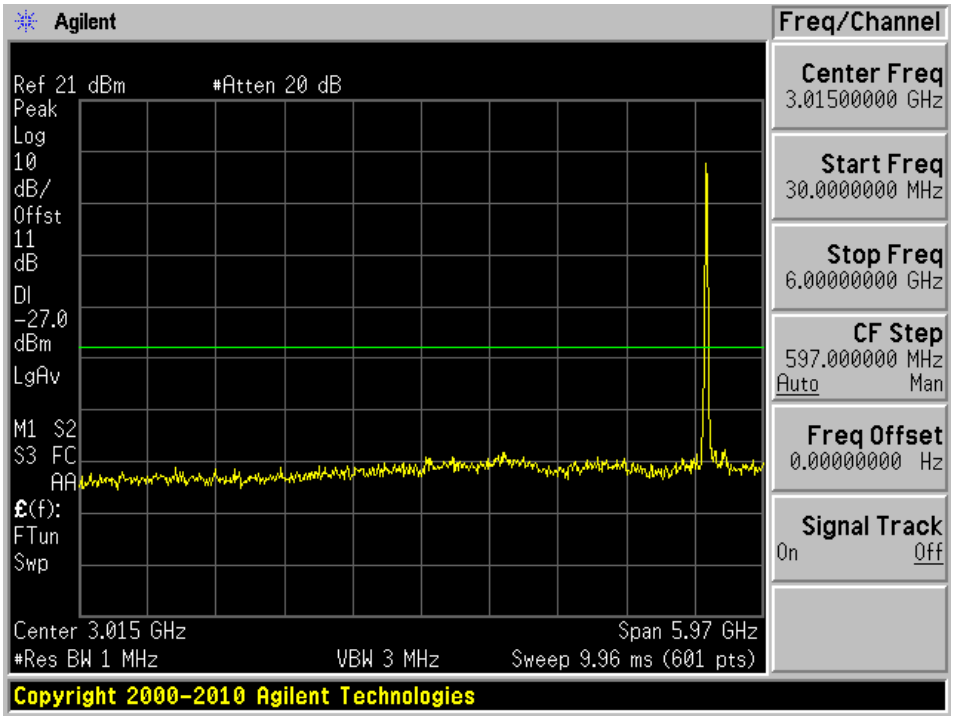
Low Channel Ant A 30MHz-6GHz



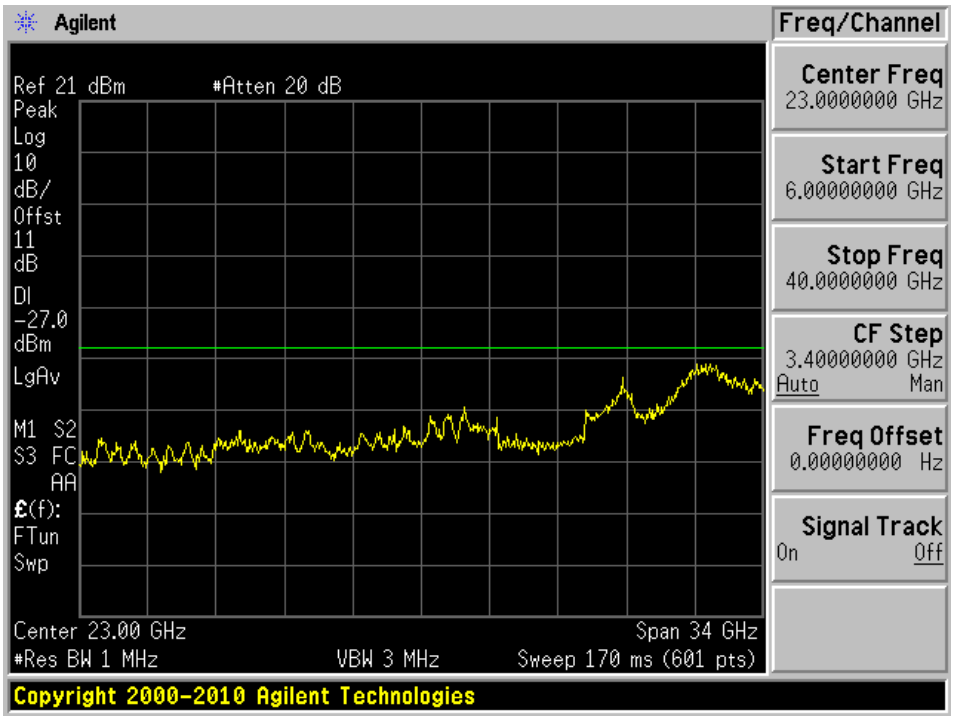
Low Channel Ant A 6GHz-40GHz



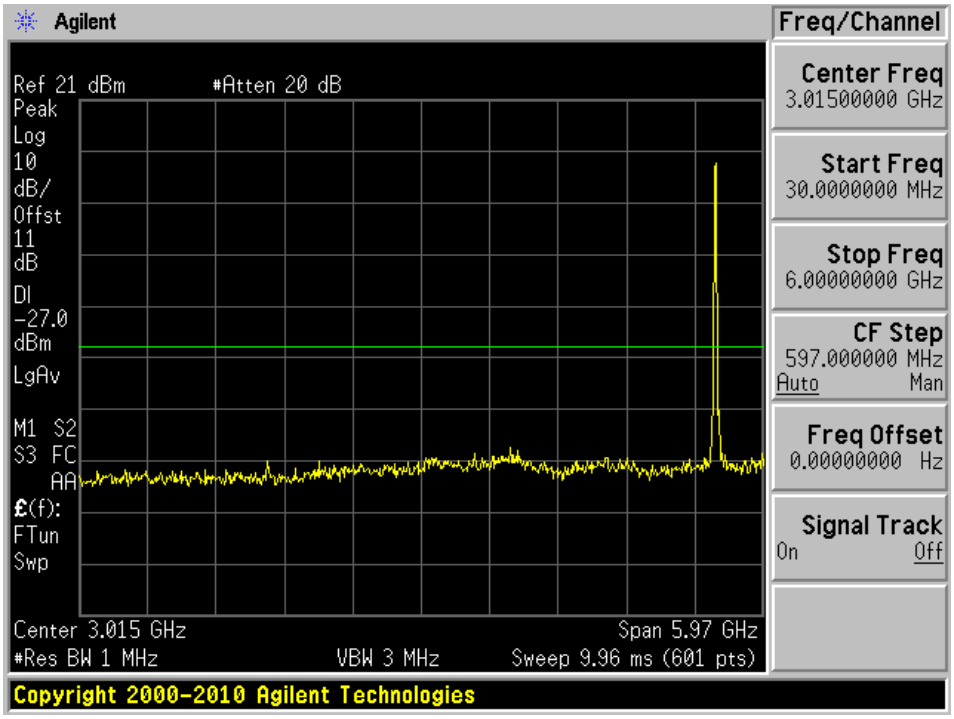
Low Channel Ant B 30MHz-6GHz



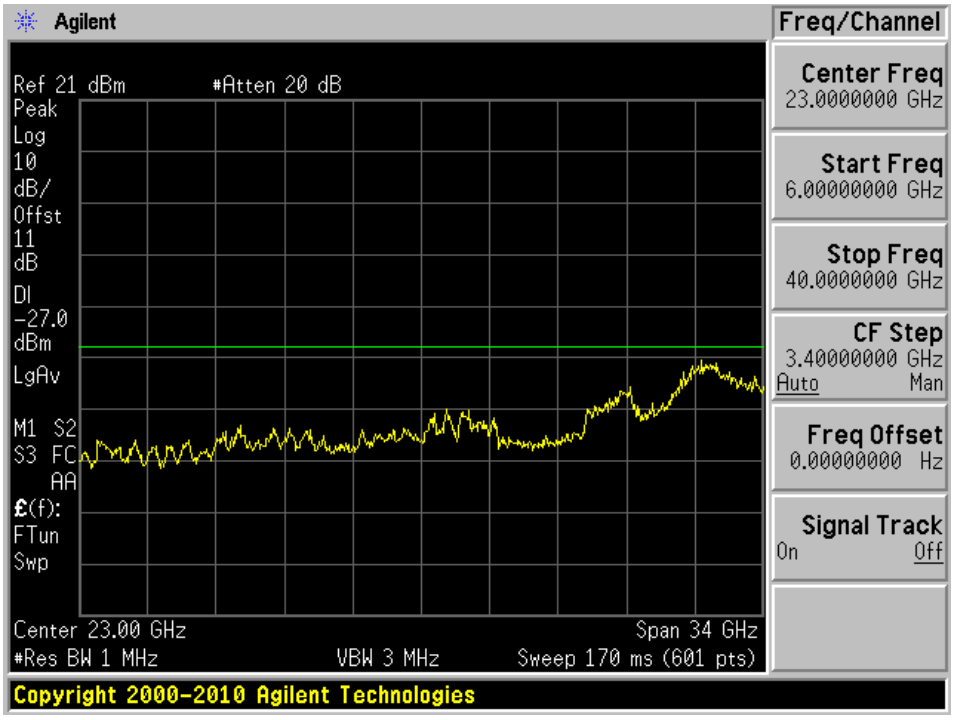
Low Channel Ant B 6GHz-40GHz



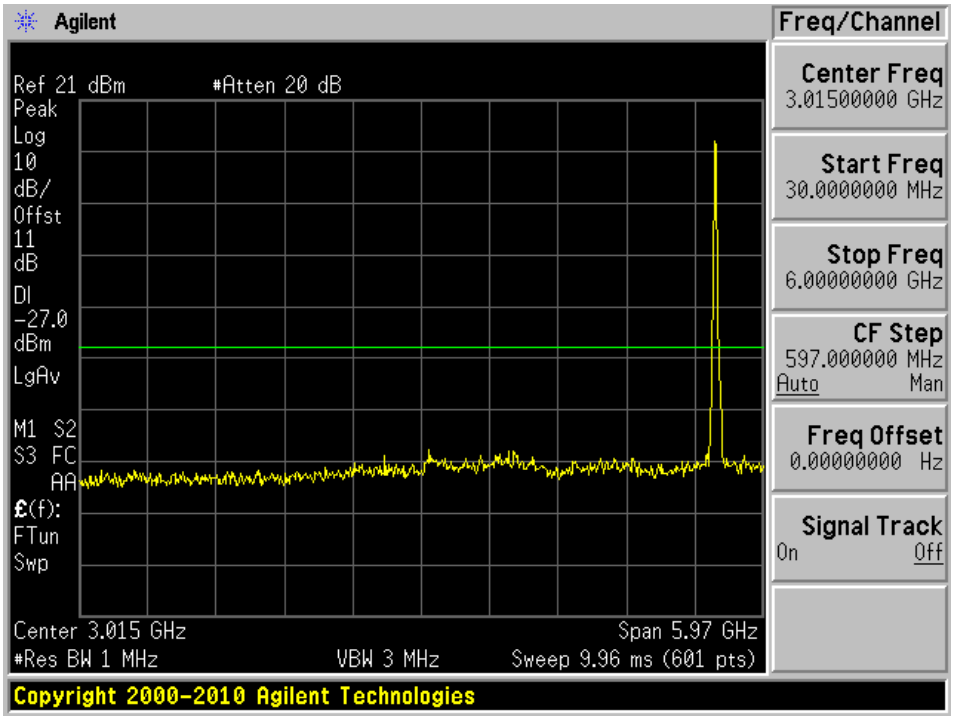
Mid Channel Ant A 30MHz-6GHz



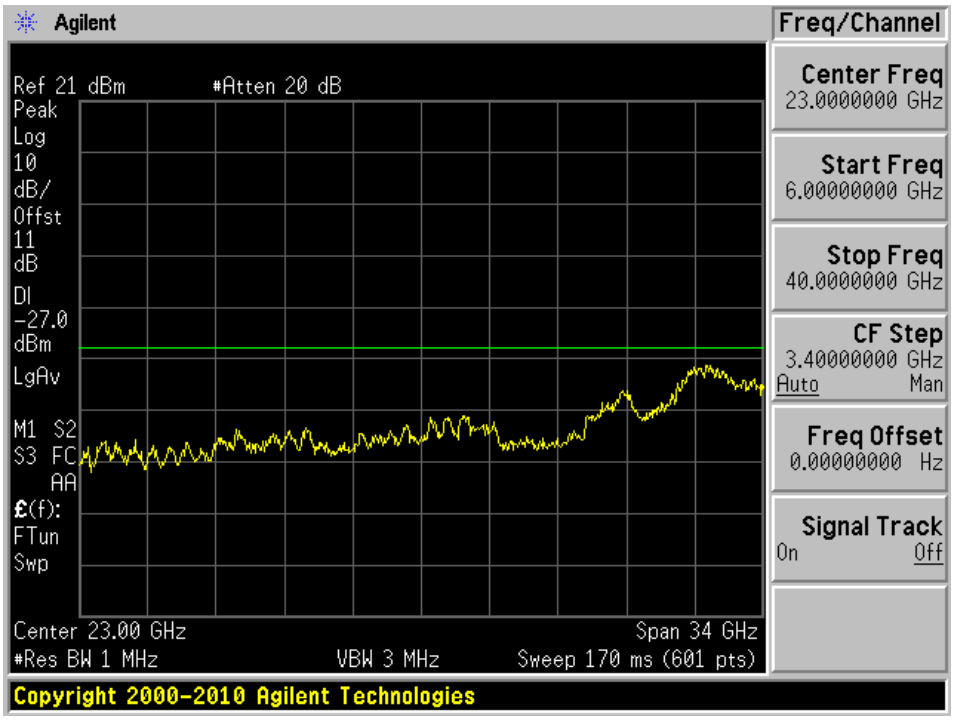
Mid Channel Ant A 6GHz-40GHz



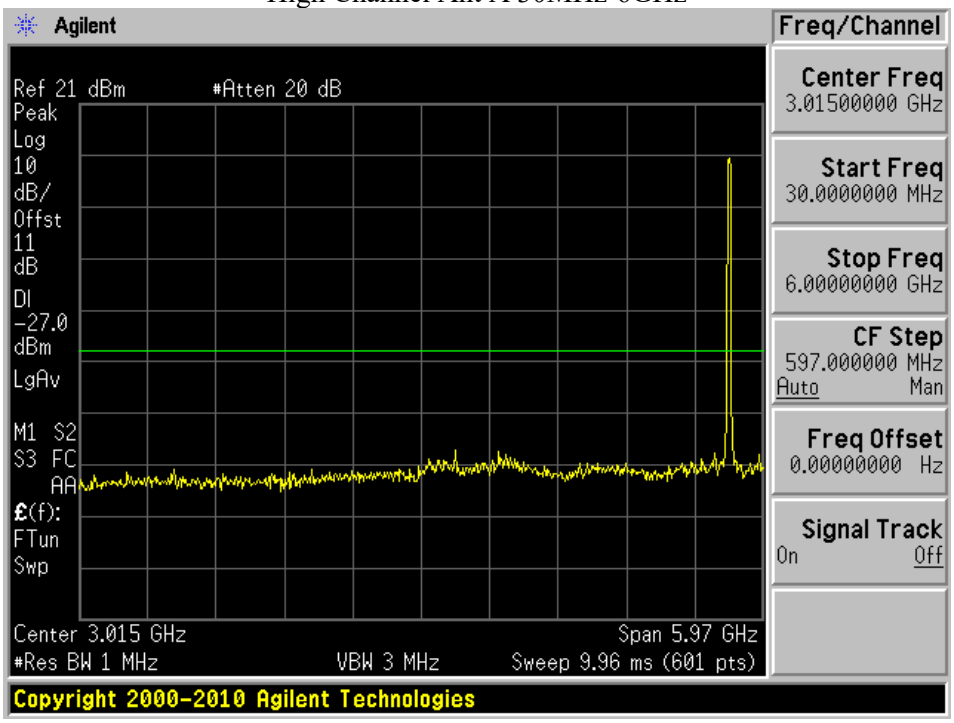
Mid Channel Ant B 30MHz-6GHz



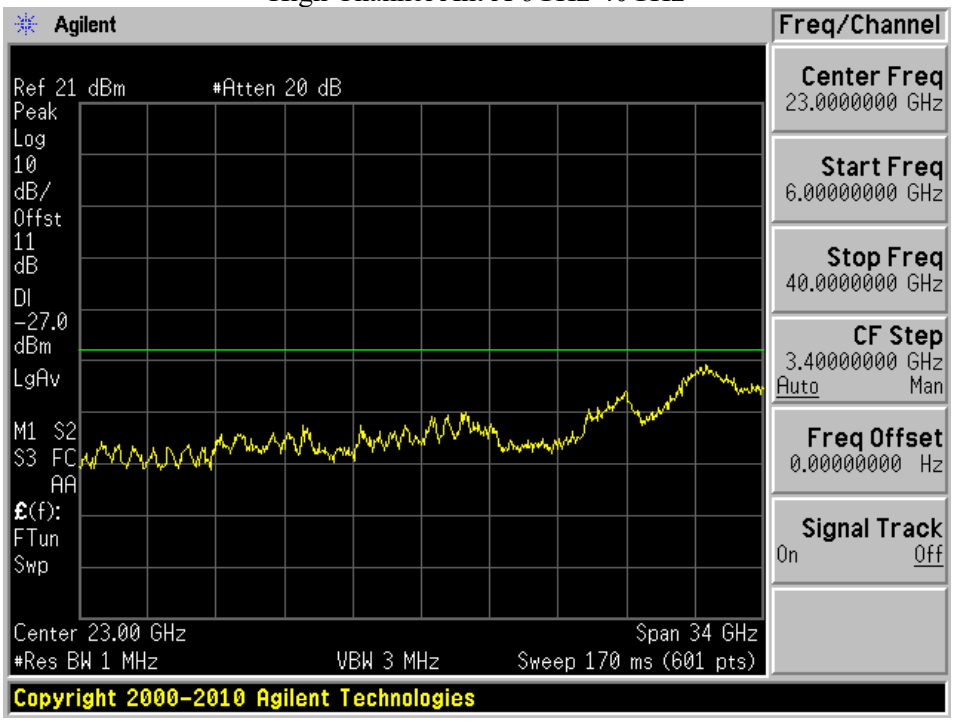
Mid Channel Ant B 6GHz-40GHz



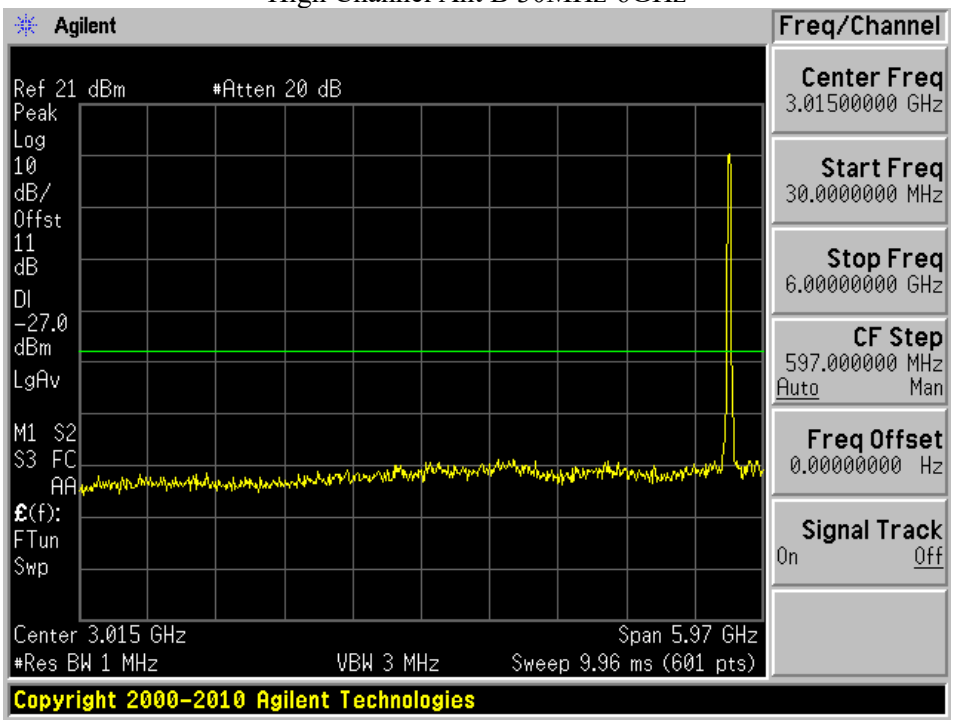
High Channel Ant A 30MHz-6GHz



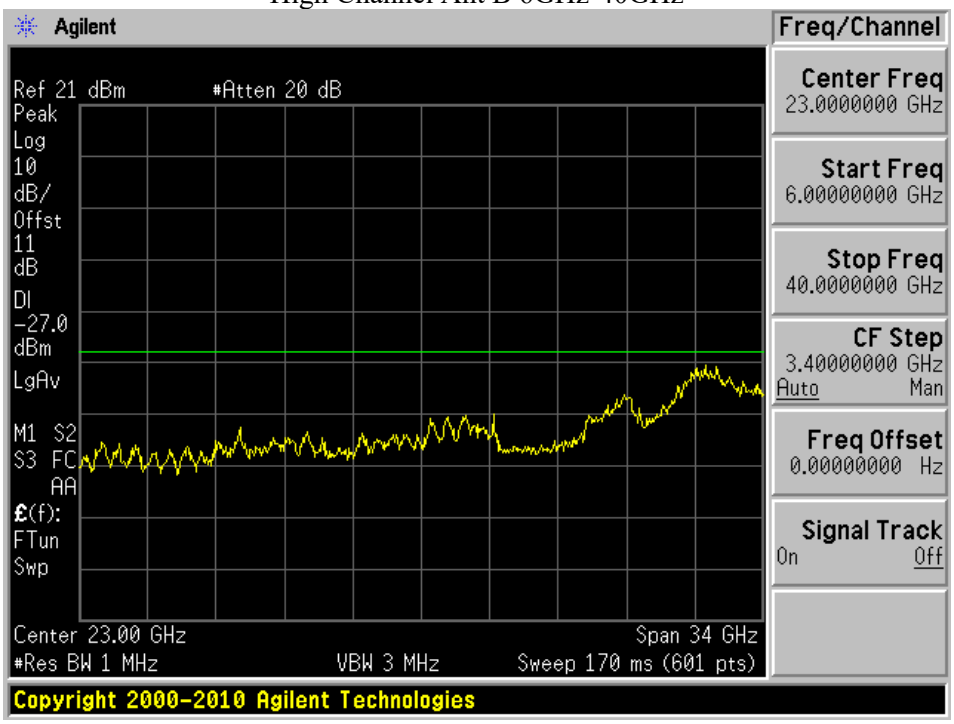
High Channel Ant A 6GHz-40GHz



High Channel Ant B 30MHz-6GHz

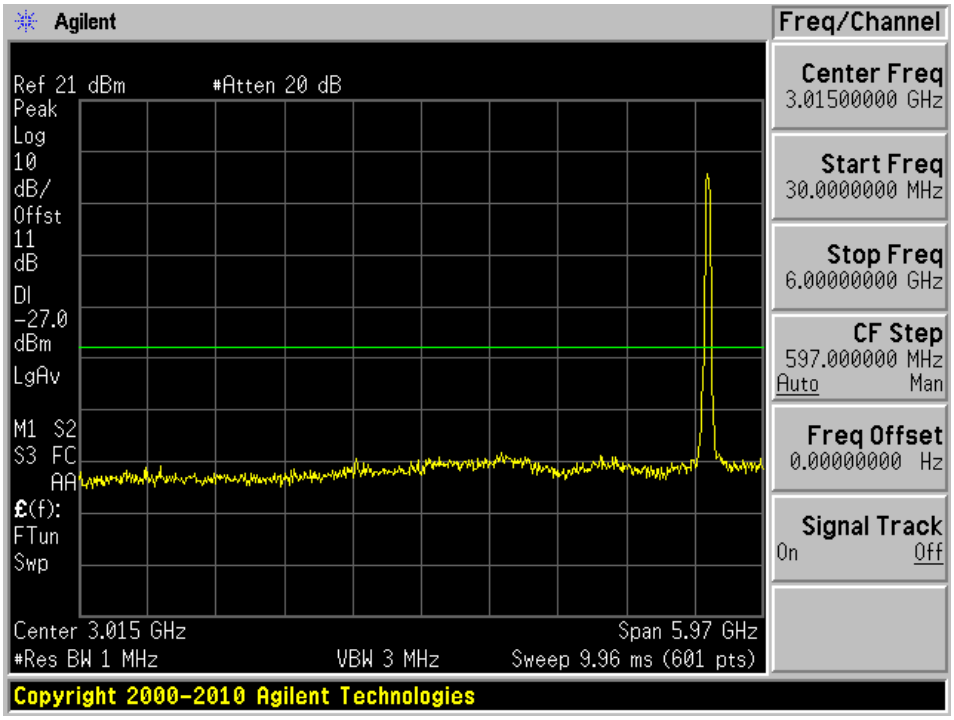


High Channel Ant B 6GHz-40GHz

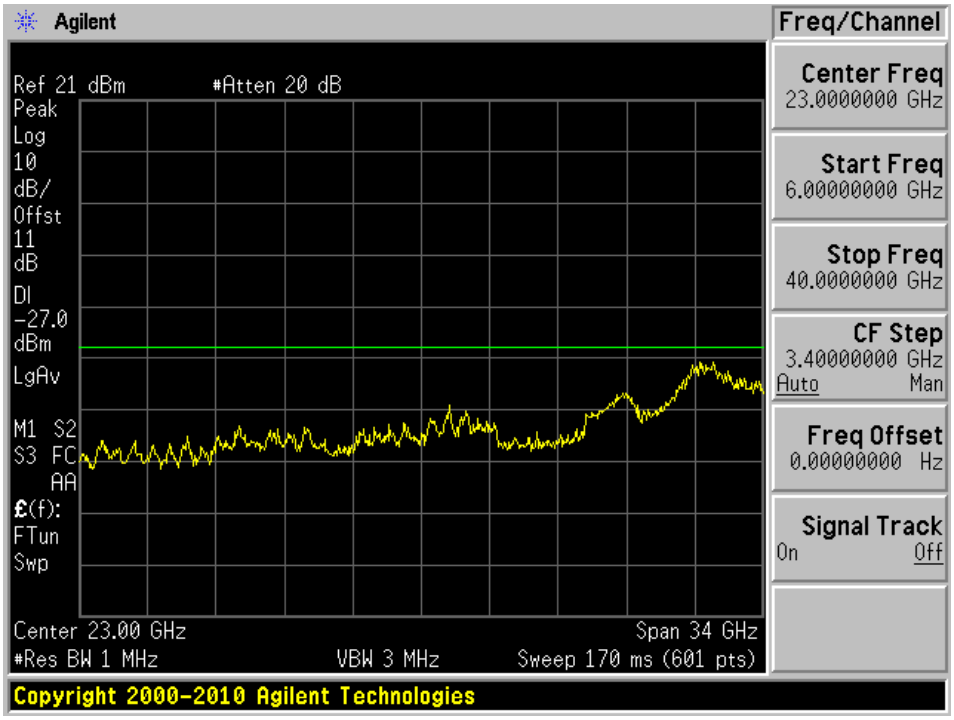


5470 - 5725 MHz 802.11n40

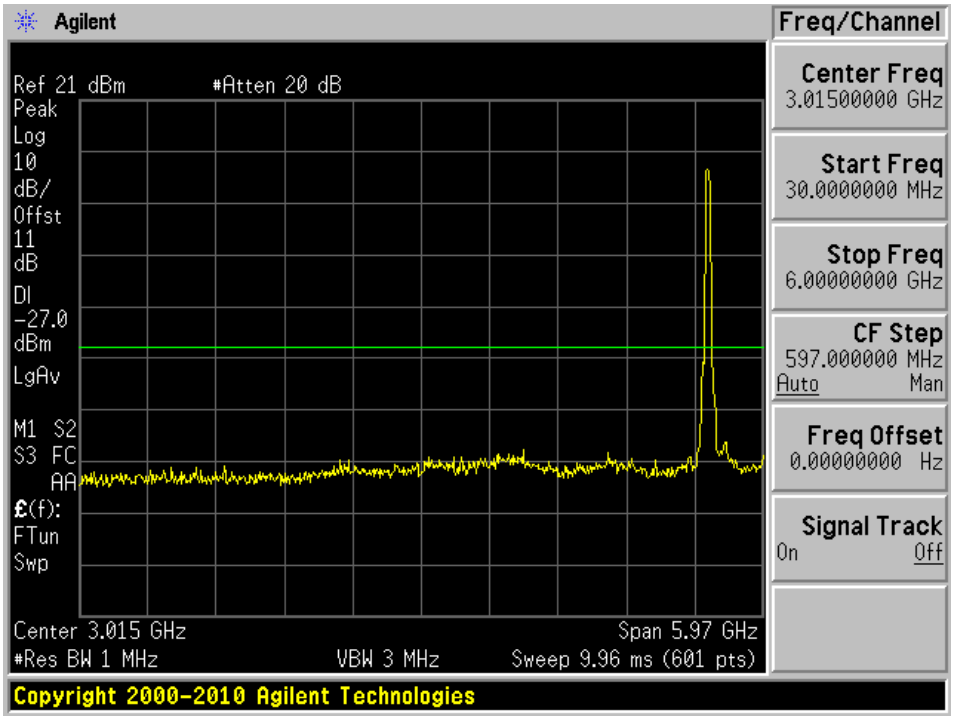
Low Channel Ant A 30MHz-6GHz



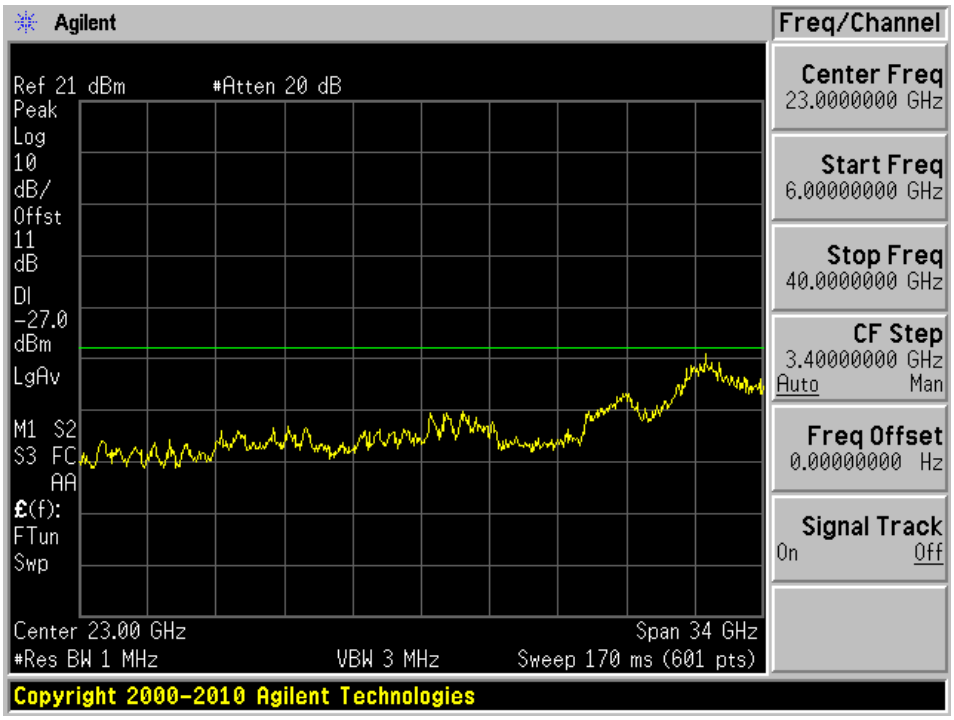
Low Channel Ant A 6GHz-40GHz



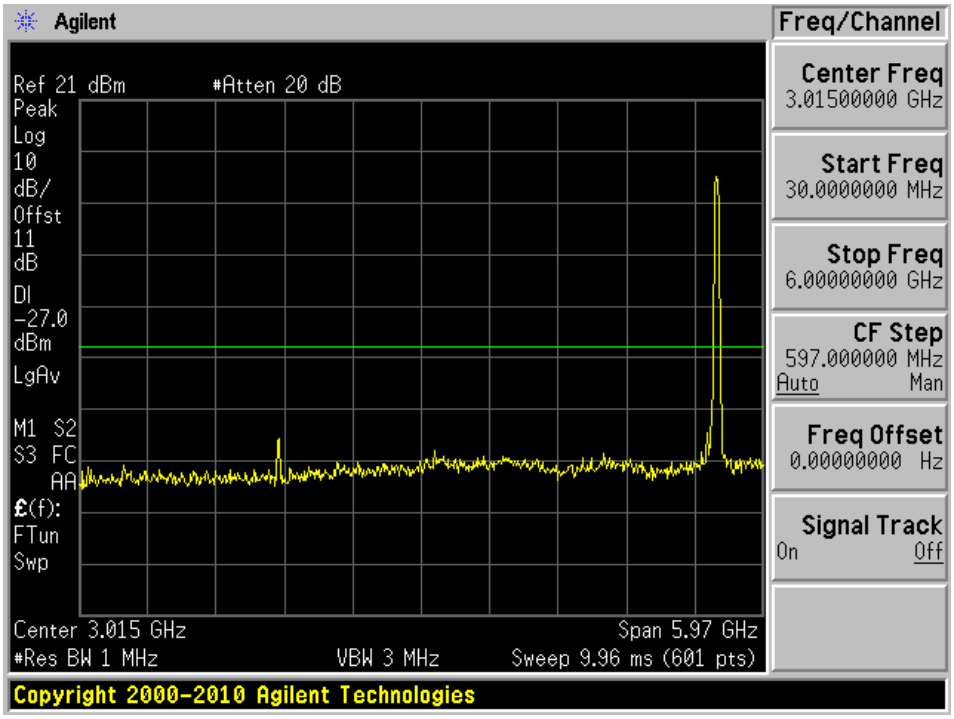
Low Channel Ant B 30MHz-6GHz



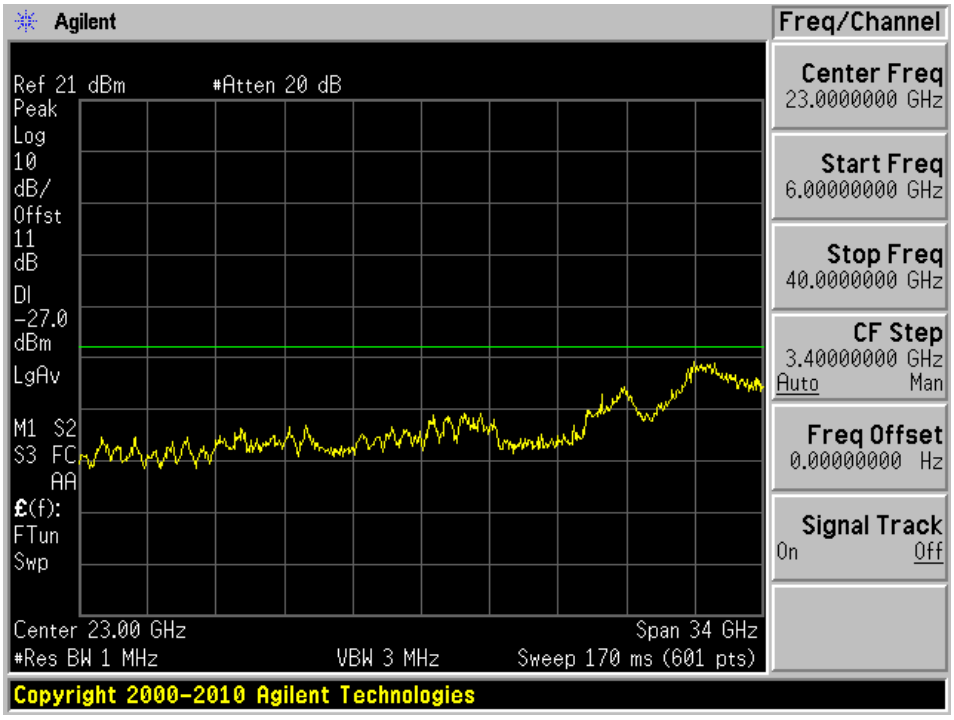
Low Channel Ant B 6GHz-40GHz



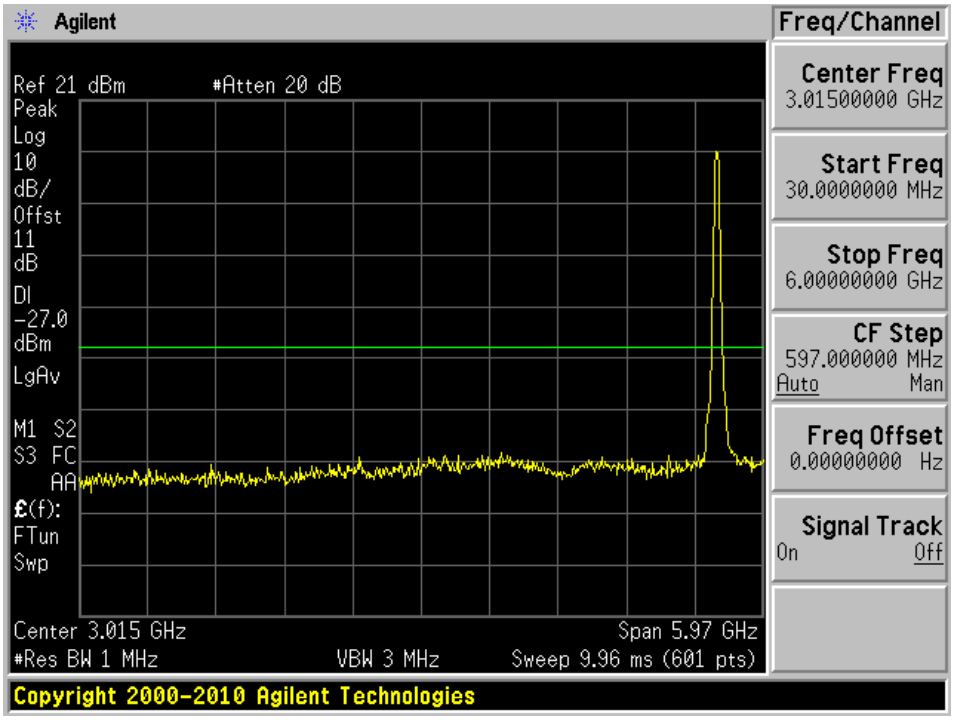
Mid Channel Ant A 30MHz-6GHz



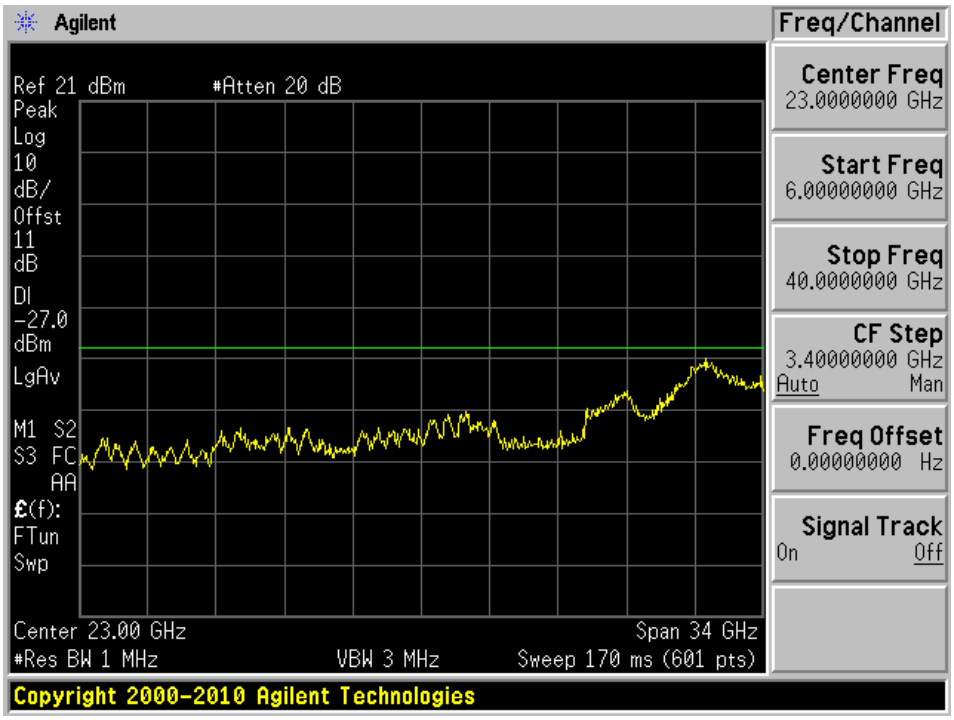
Mid Channel Ant A 6GHz-40GHz



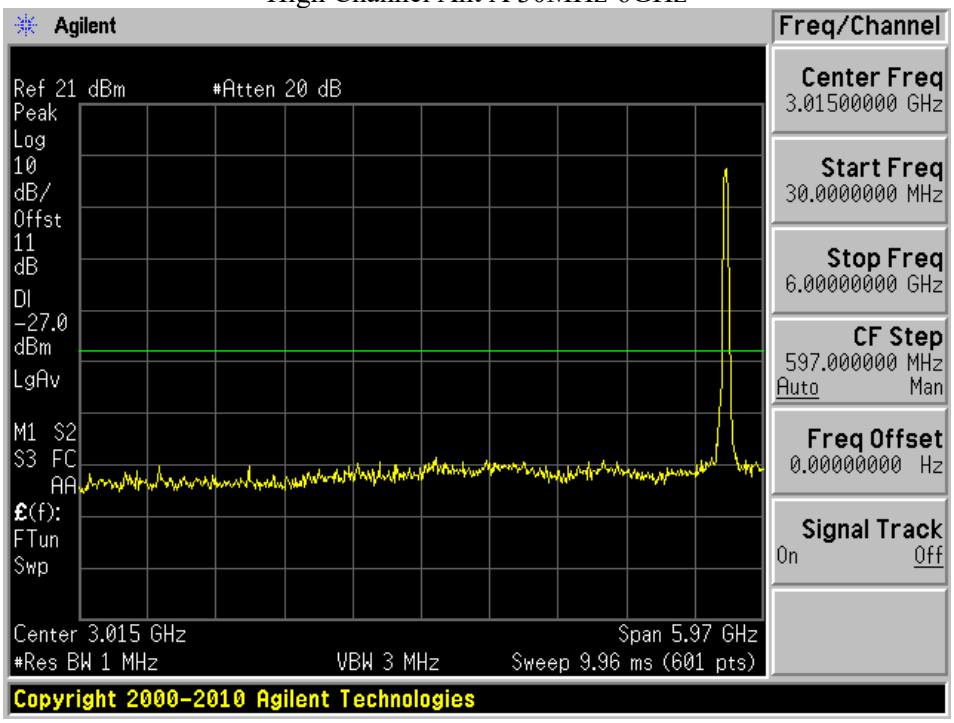
Mid Channel Ant B 30MHz-6GHz



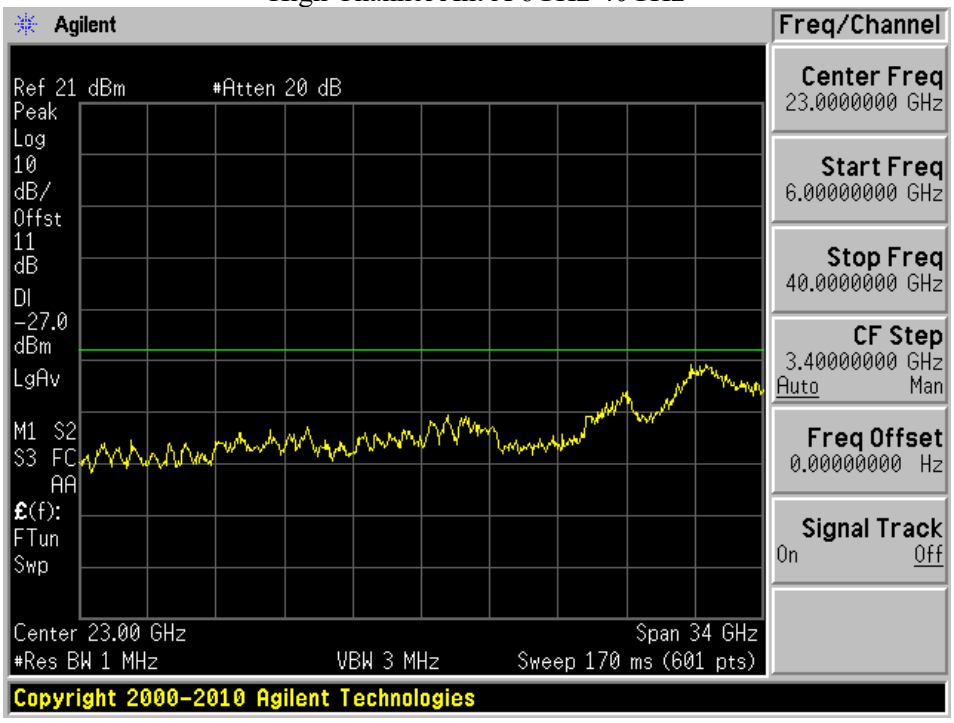
Mid Channel Ant B 6GHz-40GHz



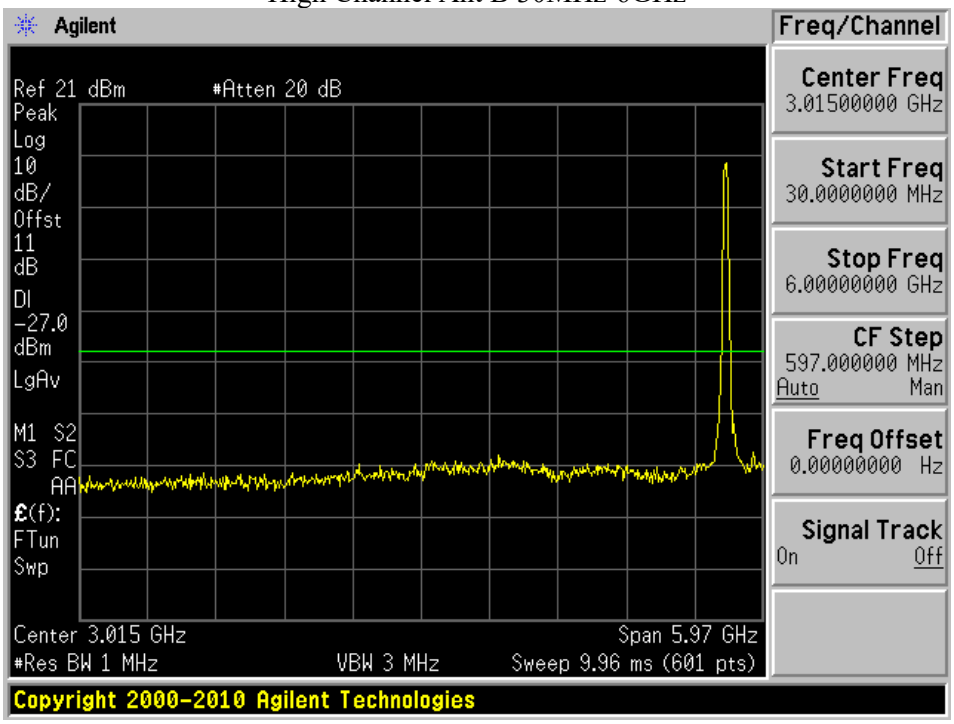
High Channel Ant A 30MHz-6GHz



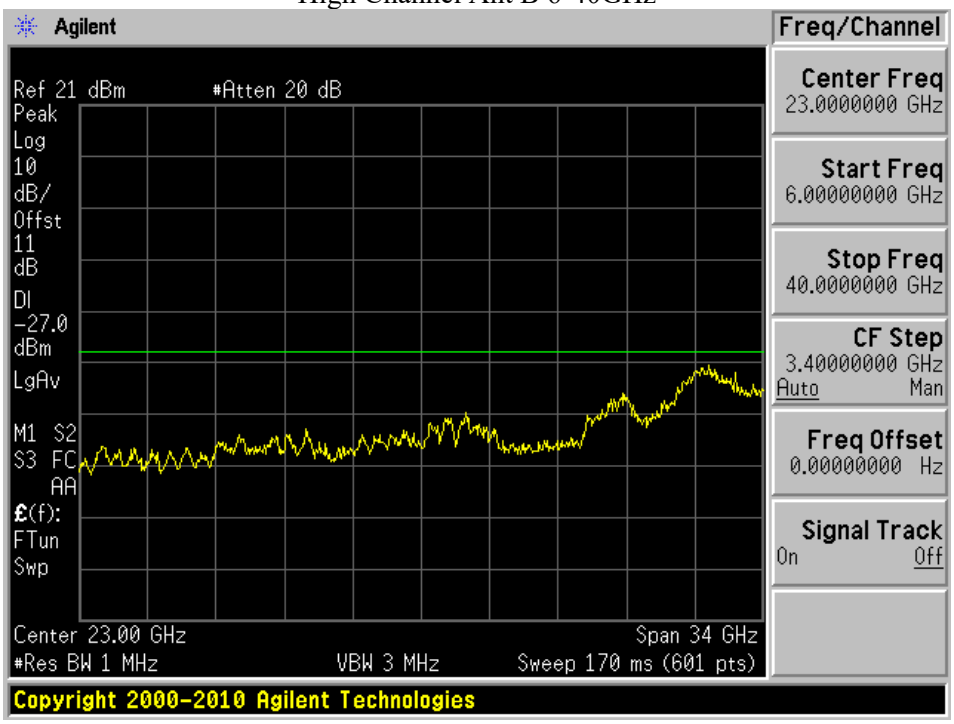
High Channel Ant A 6GHz-40GHz



High Channel Ant B 30MHz-6GHz

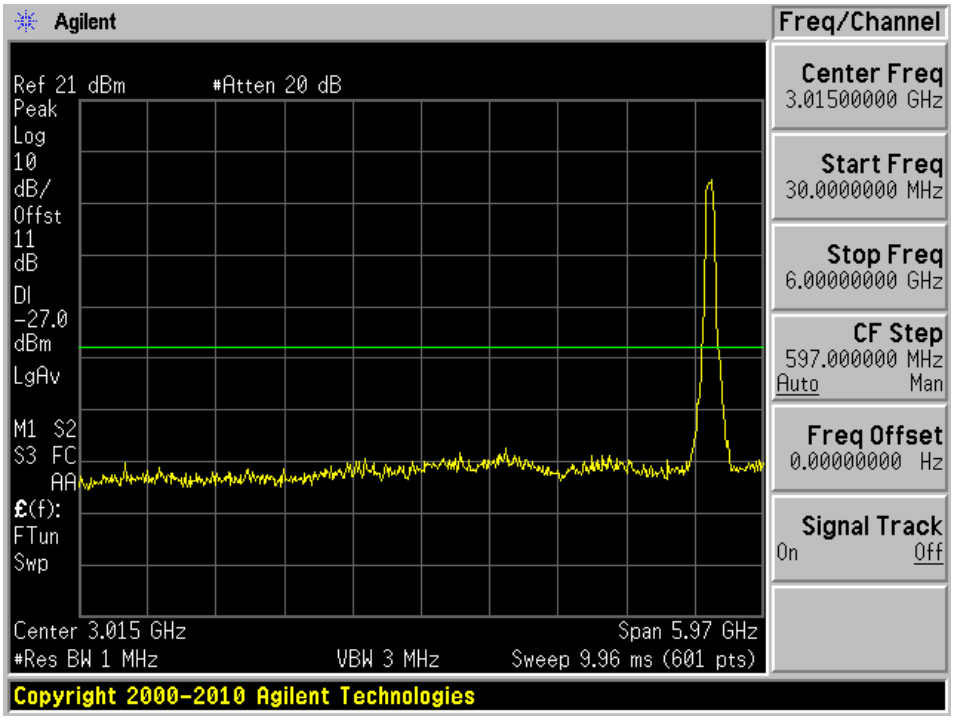


High Channel Ant B 6-40GHz

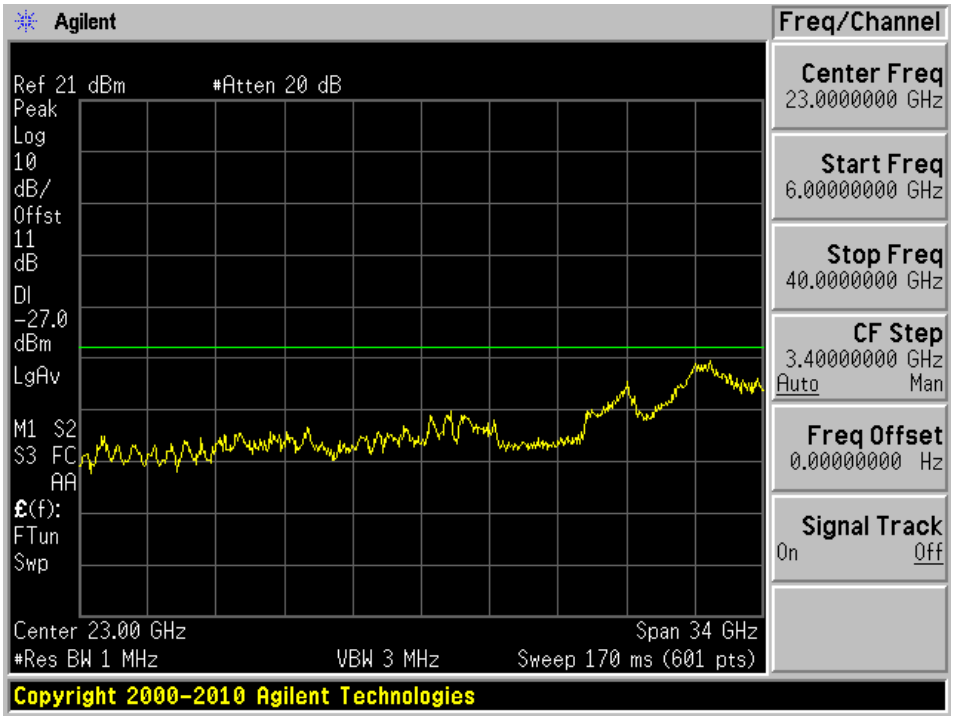


5470 - 5725 MHz 802.11ac80

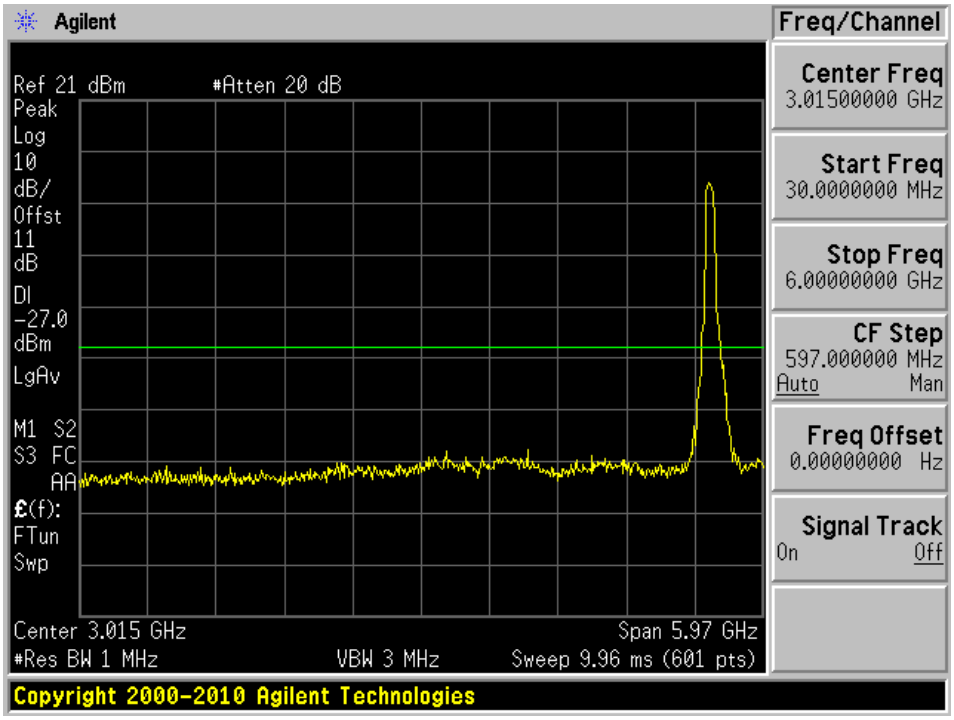
Low Channel Ant A 30MHz-6GHz



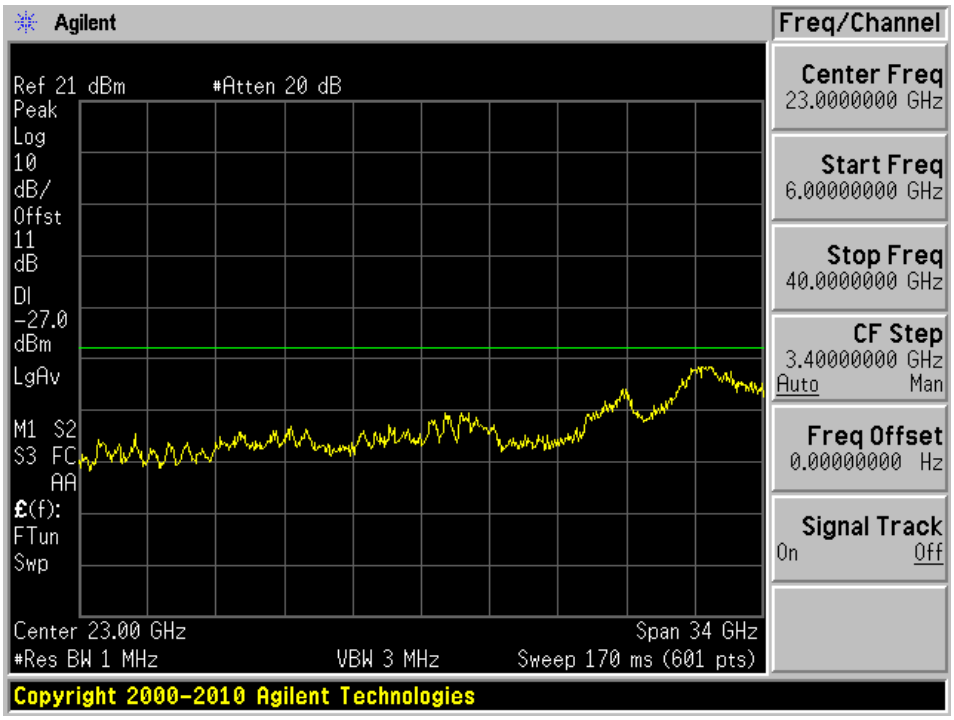
Low Channel Ant A 6GHz-40GHz



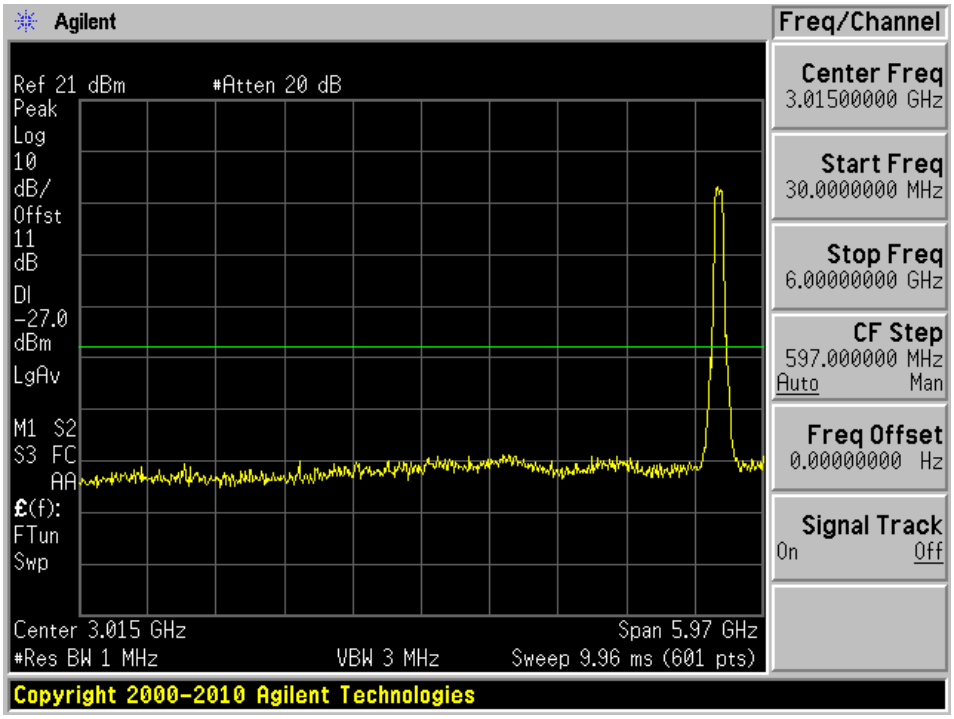
Low Channel Ant B 30MHz-6GHz



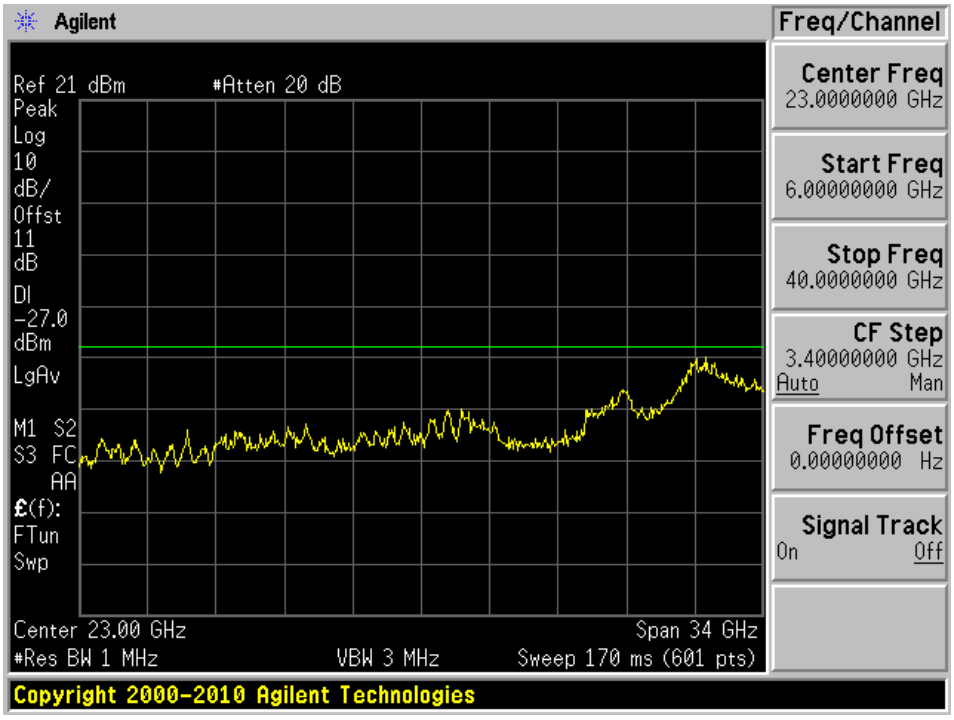
Low Channel Ant B 6GHz-40GHz



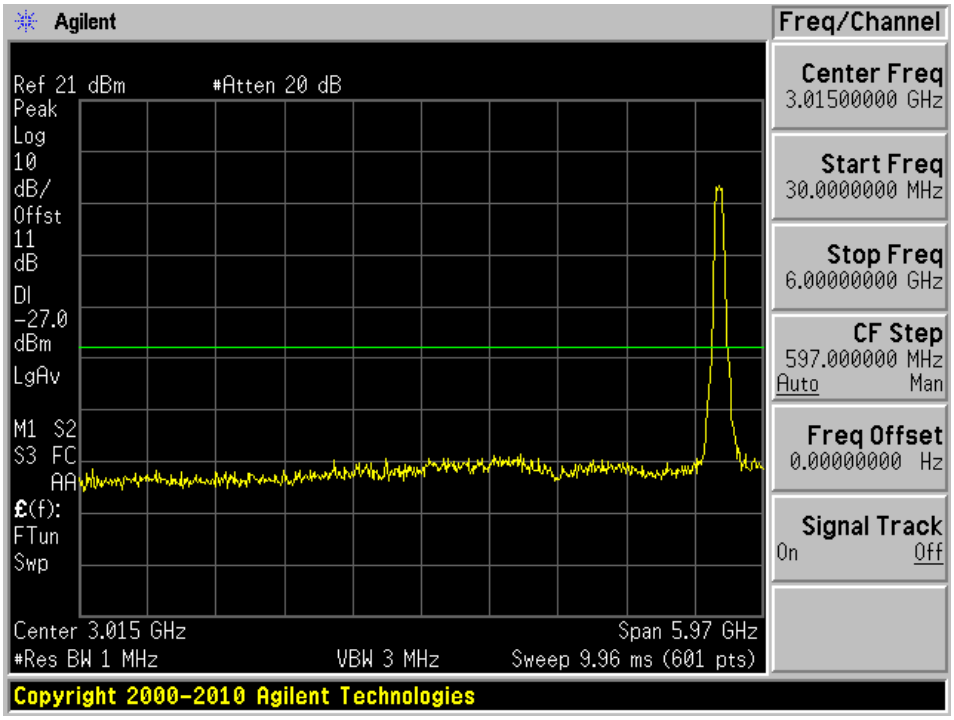
Mid Channel Ant A 30MHz-6GHz



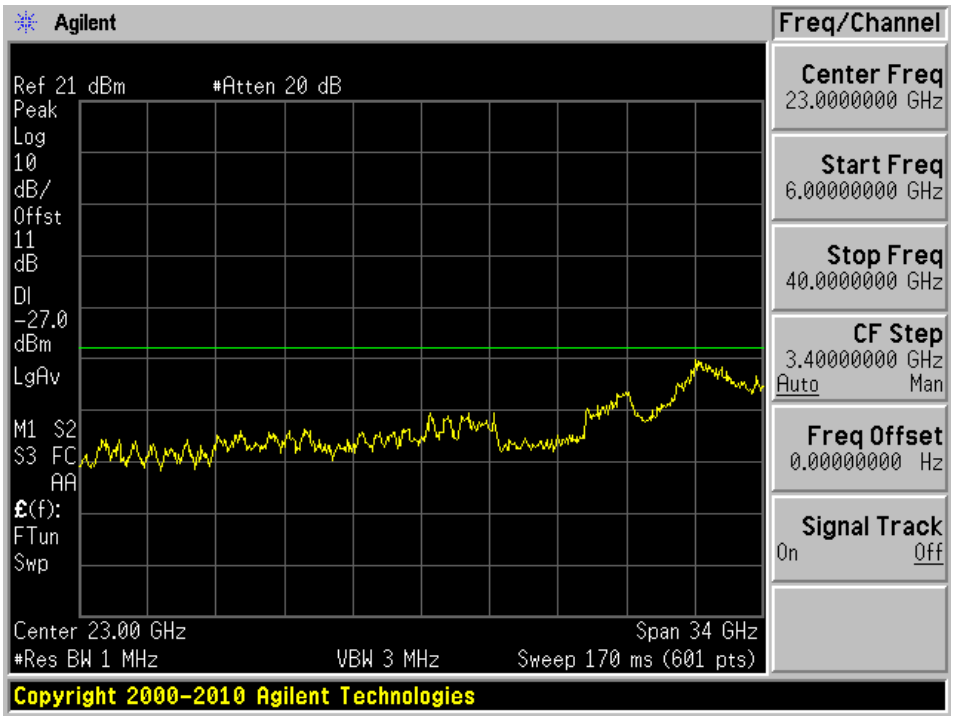
Mid Channel Ant A 6GHz-40GHz



Mid Channel Ant B 30MHz-6GHz



Mid Channel Ant B 6GHz-40GHz



Note: Antenna Gain is considered into offset.

12 FCC §15.407(h) & ISEDC RSS-247 §6.3 – Dynamic Frequency Selection

12.1 Applicable Standards

FCC CFR47 §15.407 (h), RSS-247 Issue 2 and KDB: 905462 D02 UNII DFS Compliance Procedures New Rules v02.

Table 1: Applicability of DFS requirements prior to use of a channel

Requirement	Operational Mode		
	Master	Client (Without radar detection)	Client (With radar detection)
Non-Occupancy Period	Yes	Not Required	Yes
DFS Detection Threshold	Yes	Not Required	Yes
Channel Availability Check Time	Yes	Not Required	Not Required
U-NII Detection Bandwidth	Yes	Not Required	Yes

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	Client Without Radar Detection
DFS Detection Threshold	Yes	Not Required
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not Required

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar Detection	Client Without Radar Detection
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note: Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.		

Table 3: Interference Threshold for Master and Client with Radar Detection

Maximum Transmit Power	Value (See Notes 1, 2 and 3)
EIRP≥ 200 milliwatt	-64 dBm
EIRP< 200 milliwatt and power spectral density < 10dBm/MHz	-62 dBm
EIRP< 200 milliwatt that do not meet the power spectral density requirement	-64 dBm

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.
Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.
Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.

Table 4: DFS Response Requirement Values

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds ***See Note 1***.
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. ***See Notes 1 and 2***.
U-NII Detection Bandwidth	Minimum 100% of the UNII 99% transmission power bandwidth. ***See Note 3***.

Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.

Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Note 3: During the U-NII Detection Bandwidth detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

Table 5: Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (Microseconds)	PRI (Microseconds)	Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a Test B: 15 unique PRI values randomly selected within the range of 518-3066 µsec, with a minimum increment of 1 µsec, excluding PRI values selected in Test A	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{PRI_{\mu sec}}\right)\right\}$	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120
Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

Table 6: Long Pulse Radar Test Signal

Radar Type	Bursts	Chirp Width (MHz)	PRI (usec)	Number of Pulses per Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

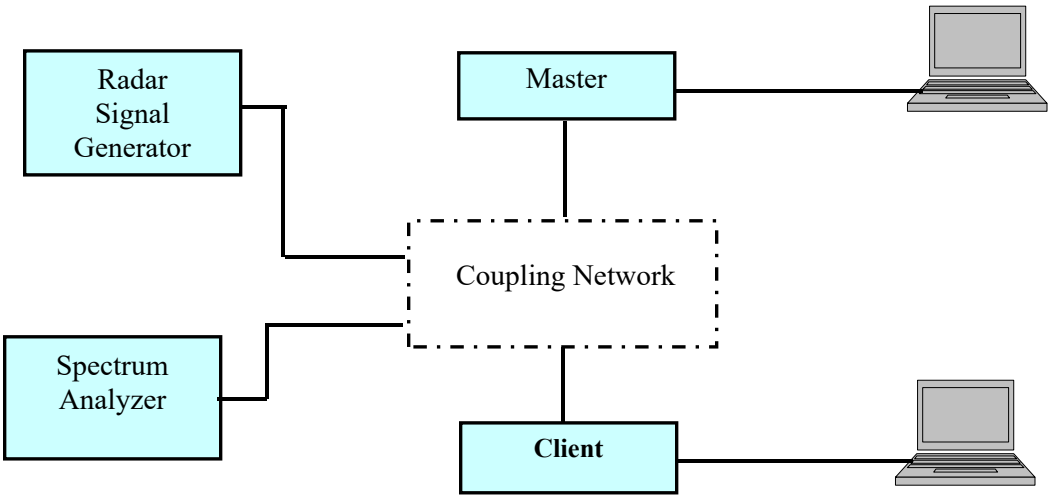
Table 7: Frequency Hopping Radar Test Signal

Radar Type	Pulse Width (usec)	PRI (usec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

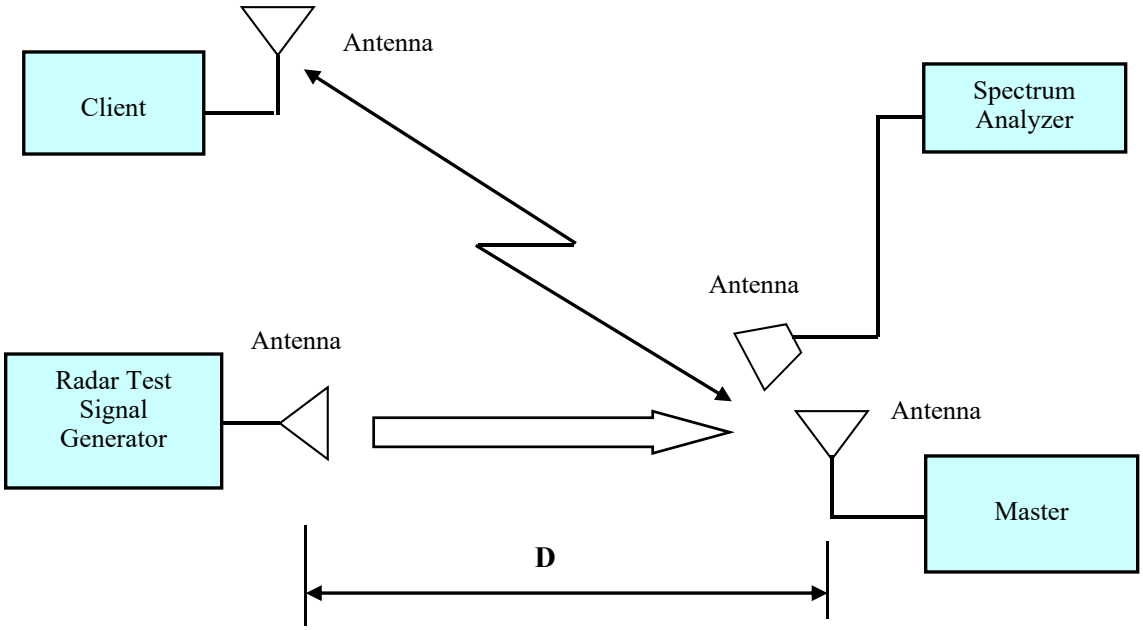
12.2 DFS Measurement System

BACL DFS measurement system consists of two subsystems: (1) The radar signal generating subsystem and (2) the traffic monitoring subsystem.

12.3 System Block Diagram



12.4 Radiated Method



12.5 Test Procedure

The EUT was connected to a certified master device (FCC ID: S9GH350, IC: 5912A-H350). A spectrum analyzer was used as a monitor that verifies the EUT's status, which includes the Channel Closing Transmission Time and the Channel Move Time.

BACL use type 0 radar signal to test the channel move time and channel closing transmission time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time = N * Dwell Time

N is the number of spectrum analyzer bins showing a device transmission
Dwell Time is the dwell time per bin (i.e. Dwell Time = S/B, S is the sweep time and B is the number of bin, i.e. 8192)

12.6 Test Equipment List and Details

Bacl No.	Manufacturer	Equipment Description	Model	S/N	Calibration Date	Calibration Interval
547	National Instruments	NI PXI-1042 8-Slot chassis	PXI-1042	V08X01EE1	N/A	N/A
-	National Instruments	Arbitrary Waveform Generator	PXI-5421	N/A	N/A	N/A
-	National Instruments	RF Upconverter	PXI-5610	N/A	N/A	N/A
-	ASCOR	Upconverter	AS-7206	N/A	N/A	N/A
424	Agilent	Analyzer, Spectrum	E4440A	US45303156	2021-12-06	1 year
187	A.R.A	Horn Antenna	DRG-118/A	1132	2022-03-17	2 years
473	EMCO	Horn Antenna	3115	9511-4627	2020-10-12	2 years
-	-	RF Cable	-	-	Each Time	Each Time

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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

12.7 Test Environmental Conditions

Temperature:	22° C
Relative Humidity:	43 %
ATM Pressure:	101.9 kPa

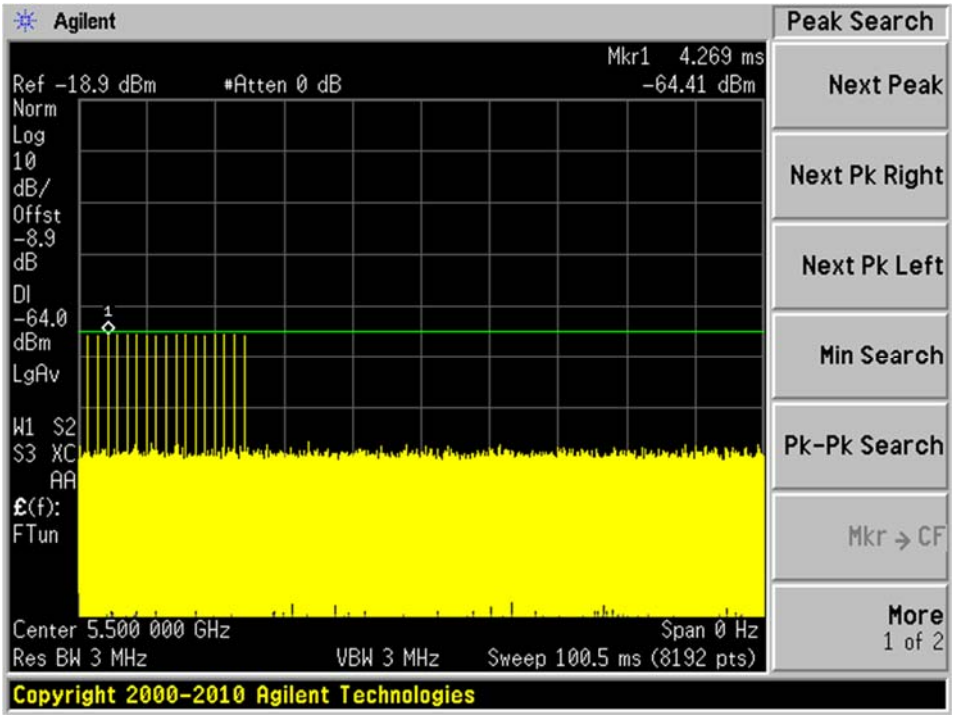
Testing was performed by Simon Ma on 2022-08-18 at the DFS testing site.

12.8 Test Results

Plots of Radar Waveforms

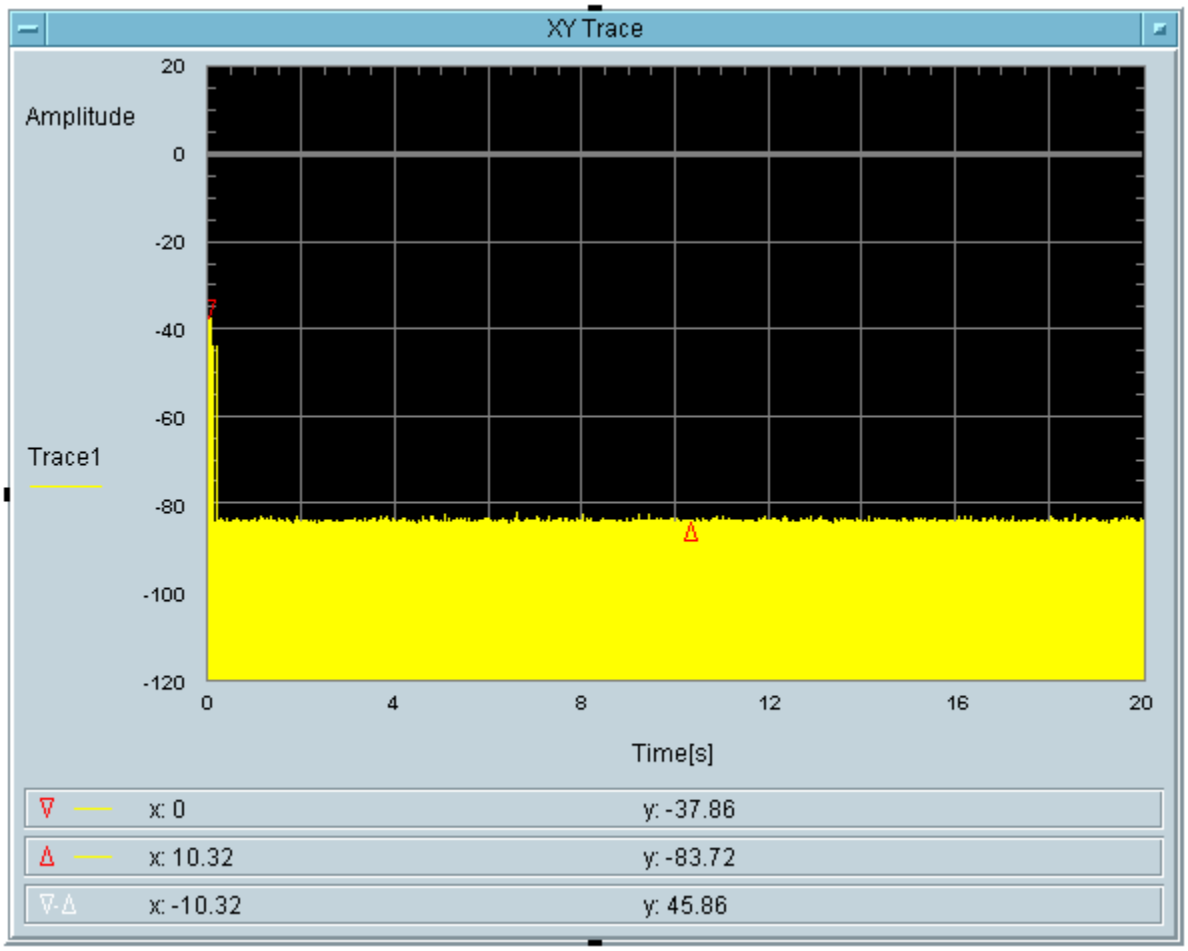
Radar Type 0

5500 MHz



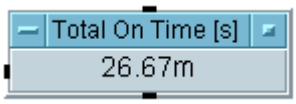
Frequency (MHz)	Bandwidth (MHz)	Radar Type	Results
5500	20	Type 0	Compliant

Type 0 radar channel move time less than 10s result:



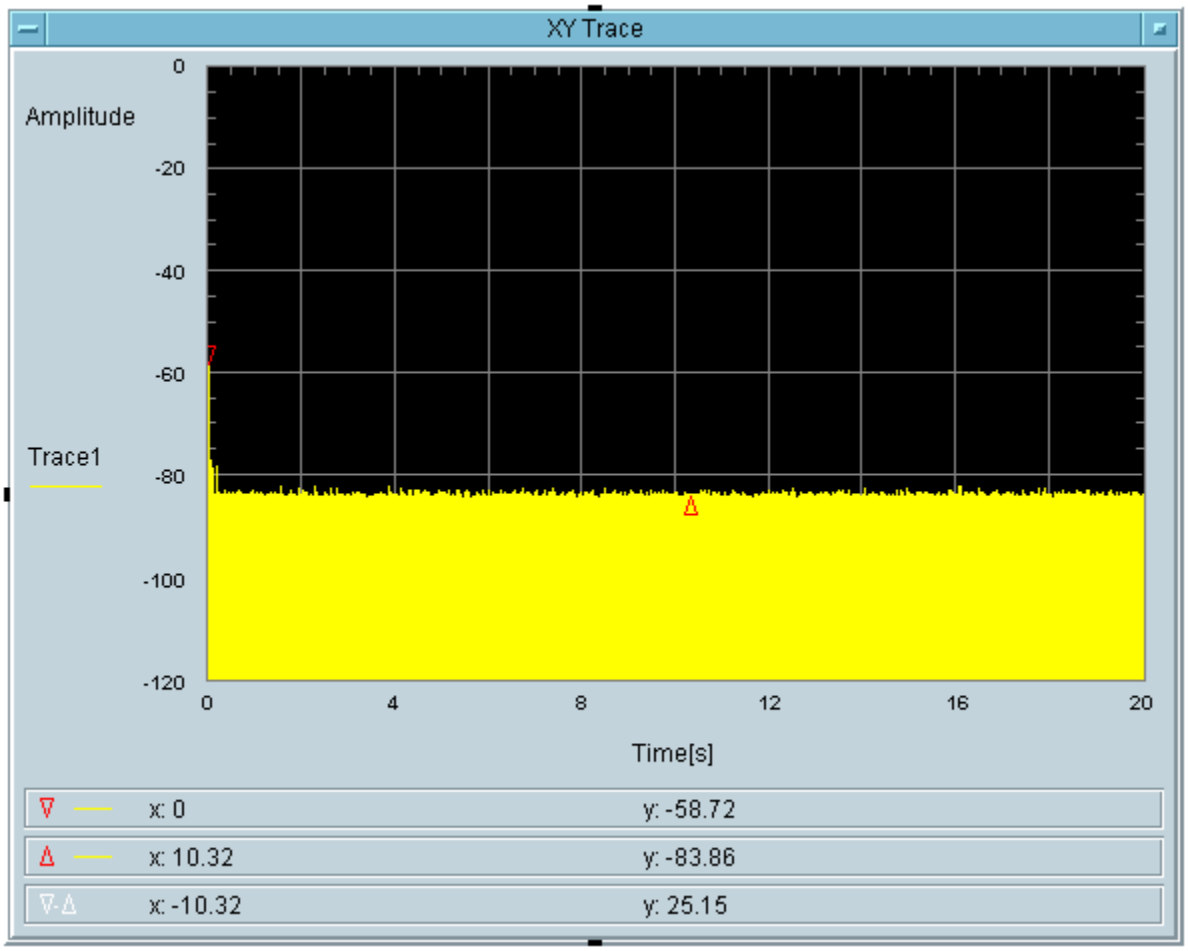
Type 0 radar channel closing transmission time result:

Channel closing transmitting time (ms)	Limit (ms)	Result
26.67+0	200	Pass



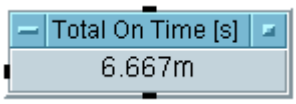
Frequency (MHz)	Bandwidth (MHz)	Radar Type	Results
5530	80	Type 0	Compliant

Type 0 radar channel move time less than 10s result:

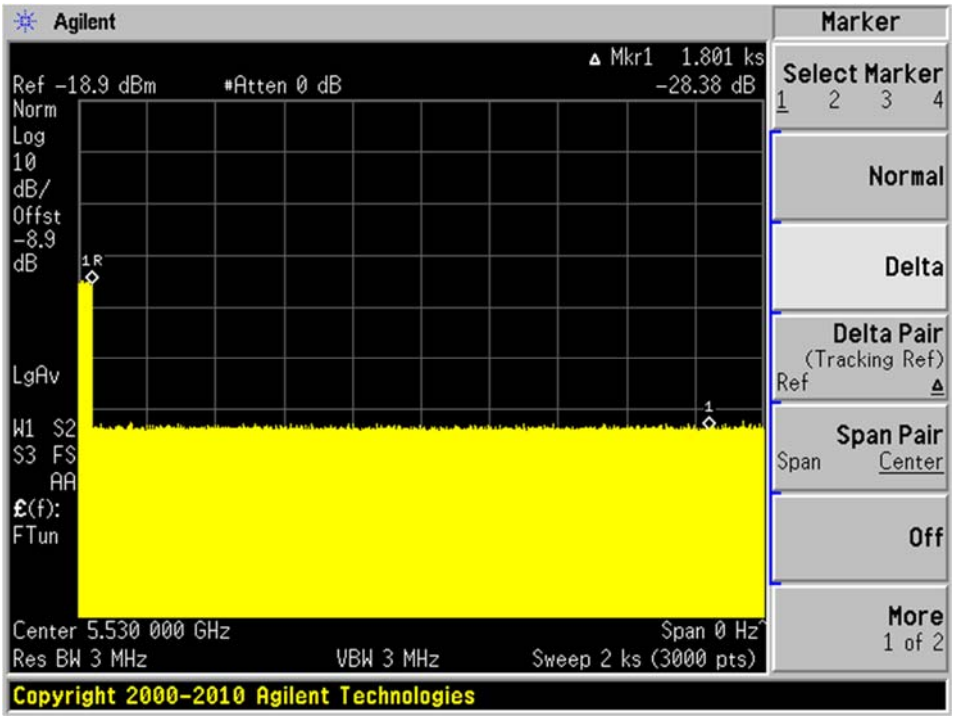


Type 0 radar channel closing transmission time result:

Channel closing transmitting time (ms)	Limit (ms)	Result
6.667+0	200	Pass



Non-occupancy Time



13 Annex A (Normative) – EUT Test Setup Photographs

Please refer to the attachment.

14 Annex B (Normative) – EUT External Photographs

Please refer to the attachment.

15 Annex C (Normative) – EUT Internal Photographs

Please refer to the attachment.

16 Annex D – Delcartion of Similarity

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

DECLARATION OF SIMILARITY

August 10, 2022

To:
Bay Area Compliance Laboratories Corp.
1274 Anvilwood Ave.
Sunnyvale, CA 94089
Phone: 408-732-9162, Fax: 408-732-9164
http://www.baclcorp.com

Dear Sir or Madam:

We *Roku, Inc.* hereby declare the following hardware similarities between the product: *Streaming player*, models 3820X, 3821X, 3820X2, and 3821X2.

Model	Hardware Similarities	BACL Project Reference
3820X	Original	R2106181 R2108088 R2108244
3821X	Identical to 3820X. The only different between the model names is to represent a different remote-control unit bundled with the end-product. The remote-control units have been separately certified under FCC ID: TC2-R1041 (bundled with 3820X) and FCC ID: TC2-R1039 (bundled with 3821X)	
3820X2	Identical to 3820X only in enclosure design. Ships with identical wireless receiver model WR002 as 3820X.	R2205317
3821X2	Identical to 3820X2. The only difference between the model names is to represent a different remote-control unit bundled with the end-product. The remote-control units have been separately certified under FCC ID: TC2-R1047 (bundled with 3820X2) and FCC ID: TC2-R1039 (bundled with 3821X2)	

Please contact me should there be need for any additional clarification or information.

Best Regards,

Robert Curtis, Sr. Director, SW Engineering
1155 Coleman Ave. San Jose, CA 95110 USA
RCurtis@roku.com

QA-FR-227-A 11/05/2013

17 Annex E (Normative) - A2LA Electrical Testing Certificate

Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *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 10th day of March 2021.

Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2022

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 ---