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MEASUREMENT REPORT
FCC Part 15.407 UNII 802.11a/n/ac

Applicant Name:
Samsung Electronics Co., Ltd.
129, Samsung-ro,
Yeongtong-gu, Suwon-si
Gyeonggi-do, 16677, Korea

Date of Testing:
11/23/2016-02/17/2017
Test Site/Location:
PCTEST Lab, Columbia, MD, USA
Test Report Serial No.:
1M1705180171-03 .A3L

FCC ID: **A3LETWV531**

APPLICANT: **Samsung Electronics Co., Ltd.**

Application Type: Certification
Model: ET-WV531
EUT Type: Indoor Access Point
FCC Classification: Unlicensed National Information Infrastructure (UNII)
FCC Rule Part(s): Part 15.407
Test Procedure(s): KDB 789033 D02 v01r04, KDB 662911 D01 v02r01

UNII Band	Channel Bandwidth (MHz)	Tx Frequency (MHz)	ANT1		ANT2		ANT3		ANT4		MIMO	
			Max. Power (mW)	Max. Power (dBm)	Max. Power (mW)	Max. Power (dBm)	Max. Power (mW)	Max. Power (dBm)	Max. Power (mW)	Max. Power (dBm)	Max. Power (mW)	Max. Power (dBm)
1	20	5180 - 5240	125.314	20.98	121.339	20.84	107.647	20.32	122.744	20.89	112.916	20.53
3		5745 - 5825	124.165	20.94	121.899	20.86	121.339	20.84	117.761	20.71	113.170	20.54
1	40	5190 - 5230	99.083	19.96	103.514	20.15	106.660	20.28	95.719	19.81	100.481	20.02
3		5755 - 5795	110.917	20.45	104.954	20.21	104.713	20.20	99.541	19.98	102.556	20.11
1	80	5210	10.280	10.12	11.169	10.48	9.616	9.83	9.550	9.80	41.952	16.23
3		5775	74.817	18.74	79.068	18.98	74.989	18.75	85.310	19.31	79.096	18.98

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in KDB 789033 D02 v01r04. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Randy Ortanez
President

ACCREDITED
TESTING CERT#2041.01

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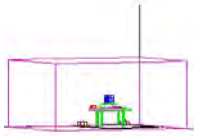
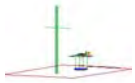


MEASUREMENT REPORT
FCC Part 15.407



§ 2.1033 General Information

APPLICANT:	Samsung Electronics Co., Ltd.
APPLICANT ADDRESS:	129, Samsung-ro,
	Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea
TEST SITE:	PCTEST ENGINEERING LABORATORY, INC.
TEST SITE ADDRESS:	7185 Oakland Mills Road, Columbia, MD 21046 USA
FCC RULE PART(S):	Part 15.407
BASE MODEL:	ET-WV531
FCC ID:	A3LETWV531
FCC CLASSIFICATION:	Unlicensed National Information Infrastructure (UNII)
Test Device Serial No.:	26APR-4, 26APR-6 ☐ Production ☒ Pre-Production ☐ Engineering
DATE(S) OF TEST:	11/23/2016-02/17/2017
TEST REPORT S/N:	1M1705180171-03 .A3L

Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Columbia, MD 21046, U.S.A.

- PCTEST facility is an FCC registered (PCTEST Reg. No. 159966) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules and Industry Canada (2451B-1).
- PCTEST Lab is accredited to ISO 17025 by U.S. National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP Lab code: 100431-0) in EMC, FCC and Telecommunications.
- PCTEST Lab is accredited to ISO 17025-2005 by the American Association for Laboratory Accreditation (A2LA) in Specific Absorption Rate (SAR) testing, Hearing Aid Compatibility (HAC) testing, CTIA Test Plans, and wireless testing for FCC and Industry Canada Rules.

- PCTEST Lab is a recognized U.S. Conformity Assessment Body (CAB) in EMC and R&TTE (n.b. 0982) under the U.S.-EU Mutual Recognition Agreement (MRA).
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC Guide 65 by the American National Standards Institute (ANSI) in all scopes of FCC Rules and Industry Canada Standards (RSS).
- PCTEST facility is an IC registered (2451B-1) test laboratory with the site description on file at Industry Canada.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for AMPS, CDMA, and EvDO wireless devices and for Over-the-Air (OTA) Antenna Performance testing for AMPS, CDMA, GSM, GPRS, EGPRS, UMTS (W-CDMA), CDMA 1xEVDO, and CDMA 1xRTT.

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1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Industry Canada Certification and Engineering Bureau.

1.2 PCTEST Test Location

The map below shows the location of the PCTEST LABORATORY, its proximity to the FCC Laboratory, the Columbia vicinity, the Baltimore-Washington Internt'l (BWI) airport, the city of Baltimore and the Washington, DC area. (*See Figure 1-1*).

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility located at 7185 Oakland Mills Road, Columbia, MD 21046. The site coordinates are 39º 10'23" N latitude and 76º 49'50" W longitude. The facility is 0.4 miles North of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4-2014 on January 22, 2015.

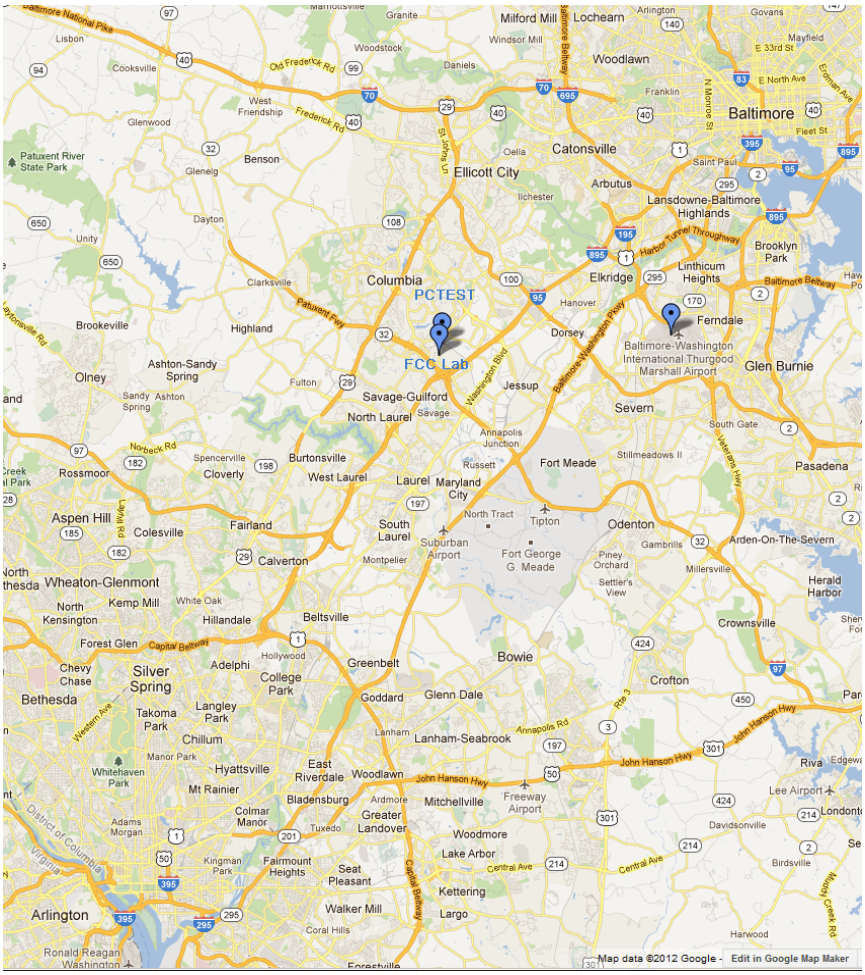

Figure 1-1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Samsung Indoor Access Point FCC ID: A3LETWV531**. The test data contained in this report pertains only to the emissions due to the EUT's UNII transmitter.

2.2 Device Capabilities

This device contains the following capabilities:

802.11b/g/n WLAN, 802.11a/n/ac UNII, BT (LE), Zigbee, Zwave

Band 1

Ch.	Frequency (MHz)
36	5180
:	:
42	5210
:	:
48	5240

Band 3

Ch.	Frequency (MHz)
149	5745
:	:
157	5785
:	:
165	5825

Table 2-1. 802.11a / 802.11n / 802.11ac (20MHz) Frequency / Channel Operations

Band 1

Ch.	Frequency (MHz)
38	5190
:	:
46	5230

Band 3

Ch.	Frequency (MHz)
151	5755
:	:
159	5795

Table 2-2. 802.11n / 802.11ac (40MHz BW) Frequency / Channel Operations

Band 1

Ch.	Frequency (MHz)
42	5210

Band 3

Ch.	Frequency (MHz)
155	5775

Table 2-3. 802.11ac (80MHz BW) Frequency / Channel Operations

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Notes:

1. This device can also operate in 80MHz + 80MHz mode in UNII Band 1 and 3.

2. 5GHz NII operation is possible in 20MHz, and 40MHz, and 80MHz channel bandwidths. The maximum achievable duty cycles for all modes were determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz, and detector = peak per the guidance of Section B)2)b) of KDB 789033 D02 v01r04. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

Maximum Achievable Duty Cycles						
802.11 Mode/Band		Duty Cycle [%]				
		ANT1	ANT2	ANT3	ANT4	MIMO
5GHz	a	97.1	96.7	97.1	97.1	97.2
	n (HT20)	95.7	96.6	97.2	97.2	97.1
	ac (HT20)	95.7	95.0	95.1	95.2	95.1
	n (HT40)	97.9	98.0	97.3	96.8	97.2
	ac (HT40)	96.6	98.0	96.0	95.5	96.1
	ac (HT80)	95.3	95.0	94.0	95.6	94.8

3. The device employs MIMO technology using four 2.4GHz outputs and 5GHz outputs. Below are the possible configurations.

WiFi Configurations		SISO				SDM				CDD			
		ANT1	ANT2	ANT3	ANT4	ANT1	ANT2	ANT3	ANT4	ANT1	ANT2	ANT3	ANT4
5GHz	11a	✓	✓	✓	✓	×	×	×	×	✓	✓	✓	✓
	11n (20MHz)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	11n (40MHz)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	11ac (80MHz)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 2-4. Frequency / Channel Operations

✓= Support ; × = NOT Support
SISO = Single Input Single Output
SDM = Spatial Diversity Multiplexing – MIMO function
CDD = Cyclic Delay Diversity

Data Rate(s) Tested: 6, 9, 12, 18, 24, 36, 48, 54Mbps (802.11a)

6.5/7.2, 13/14.4, 19.5/21.7, 26/28.9, 39/43.3, 52/57.8, 58.5/65, 65/72.2 (n – 20MHz)

13.5/15, 27/30, 40.5/45, 54/60, 81/90, 108/120, 121.5/135, 135/150 (n – 40MHz BW)

29.3/32.5, 58.5/65, 87.8/97.5, 117/130, 175.5/195, 234/260, 263.3/292.5, 292.5/325, 351/390, 390/433.3 (ac – 80MHz BW)
13/14.4, 26.28.9, 39/43.3, 52/57.8, 78/86.7, 104/115.6, 117/130, 130/144.4MBps (MIMO n/ac – 20MHz) 156/173Mbps (MIMO ac – 20MHz)
27/30, 54/60, 81/90, 108/120, 162/180, 216/240, 243,270, 270/300Mbps (MIMO n/ac – 40MHz) 324/360, 360/400Mbps (MIMO ac – 40MHz)
58.5/65, 117/130, 175.5/195, 234/260, 351/390, 468/520, 526.5/585, 585/650, 702/780, 780/866.7Mbps (MIMO ac – 80MHz)

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4. This device supports simultaneous transmission operation, which allows for multiple SISO channels to operate independent of one another in the 2.4GHz and 5GHz bands simultaneously. The following table shows the worst case configurations determined during testing. The data for these configurations is contained in this UNII report.

   All 2.4 GHz Antennas transmitting in 2.4GHz mode and All 5 GHz Antennas transmitting in 5GHz mode:

Description	2.4 GHz Emission	5 GHz Emisison
Antenna	ALL	ALL
Channel	6	36
Operating Frequency(MHz	2437	5180
Data Rate (Mbps)	1	6
Band	WLAN	UNII 1
Mode	802.11g	802.11a

Table 2-5. ALL 2.4GHz ANT & ALL 5GHz ANT

2.3 Test Configuration

The EUT was tested per the guidance of KDB 789033 D02 v01r04. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for AC line conducted emissions test setups, 3.3 for radiated emissions test setups, and 7.2, 7.3, 7.4, and 7.5 for antenna port conducted emissions test setups.

2.4 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

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3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 789033 D02 v01r04 were used in the measurement of the EUT.

Deviation from measurement procedure……..…….....None

3.2 AC Line Conducted Emissions

The line-conducted facility is located inside a 10'x16'x9' shielded enclosure. The shielded enclosure is manufactured by ETS Lindgren RF Enclosures. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-5. A 1m x 1.5m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50μH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. The external power line filter is an ETS Lindgren Model LPRX-4X30 (100dB Attenuation, 14kHz-18GHz) and the two EMI/RFI filters are ETS Lindgren Model LRW-2030-S1 (100dB Minimum Insertion Loss, 14kHz – 10GHz). These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply line(s) will be connected to the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference groundplane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The spectrum was scanned from 150kHz to 30MHz with a spectrum analyzer. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 10kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions is used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

Line conducted emissions test results are shown in Section 7.9. The EMI Receiver mode of the Agilent MXE was used to perform AC line conducted emissions testing.

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3.3 Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. A raised turntable is used for radiated measurement. It is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. A 72.4cm high PVC support structure is placed on top of the turntable. A 3" (~7.6cm) sheet of high density polystyrene is used as the table top and is placed on top of the PVC supports to bring the total height of the table to 80cm. For measurements above 1GHz, a high density expanded polystyrene block is placed on top of the test table to bring the total table height to 1.5m.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33(b)(1) depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

3.4 Environmental Conditions

The temperature is controlled within range of 15°C to 35°C. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

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4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antennas of the EUT are **permanently attached.**
- There are no provisions for connection to an external antenna.

Conclusion:

The EUT complies with the requirement of §15.203.

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5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
Conducted Bench Top Measurements	1.13
Line Conducted Disturbance	3.09
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

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6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2006.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	RE1	Radiated Emissions Cable Set (UHF/EHF)	7/11/2016	Annual	7/11/2017	RE1
-	WL25-1	Conducted Cable Set (25GHz)	4/11/2016	Annual	4/11/2017	WL25-1
Agilent	E4448A	PSA (3Hz-50GHz) Spectrum Analyzer	3/1/2016	Annual	3/1/2017	US42510244
Agilent	N9020A	MXA Signal Analyzer	10/28/2016	Annual	10/28/2017	US46470561
Agilent	N9038A	MXE EMI Receiver	4/21/2016	Annual	4/21/2017	MY51210133
Agilent	N9030A	PXA Signal Analyzer (44GHz)	3/1/2016	Annual	3/1/2017	MY52350166
Anritsu	ML2495A	Power Meter	10/16/2015	Biennial	10/16/2017	941001
Anritsu	MA2411B	Pulse Power Sensor	10/14/2015	Biennial	10/14/2017	846215
Com-Power	AL-130	9kHz - 30MHz Loop Antenna	7/30/2015	Biennial	7/30/2017	121034
Com-Power	PAM-118A	Pre-Amplifier	4/10/2016	Annual	4/10/2017	551042
Com-Power	PAM-103	Pre-Amplifier (1-1000MHz)	7/6/2016	Annual	7/6/2017	441119
Emco	3115	Horn Antenna (1-18GHz)	3/10/2016	Biennial	3/10/2018	9704-5182
EMCO	3160-09	Small Horn (18 - 26.5GHz)	8/23/2016	Biennial	8/23/2018	135427
EMCO	3160-10	Small Horn (26.5 - 40GHz)	8/23/2016	Biennial	8/23/2018	130993
Espec	ESX-2CA	Environmental Chamber	3/4/2016	Annual	3/4/2017	17620
ETS-Lindgren	3816/2NM	Line Impedance Stabilization Network	12/27/2016	Biennial	12/27/2018	114451
Huber+Suhner	Sucoflex 102A	40GHz Radiated Cable	4/26/2016	Annual	4/26/2017	251425001
K & L	11SH10-6000/T18000	High Pass Filter	7/11/2016	Annual	7/11/2017	11SH10-6000/T18000-1
Pasternack	NMLC-1	Line Conducted Emissions Cable (NM)	10/14/2016	Annual	10/14/2017	NMLC-1
PCTEST	-	EMC Switch System	7/11/2016	Annual	7/11/2017	NM1
PCTEST	-	EMC Switch System	7/6/2016	Annual	7/6/2017	NM2
Rohde & Schwarz	TS-PR26	18-26.5 GHz Pre-Amplifier	3/7/2016	Annual	3/7/2017	100040
Rohde & Schwarz	ESU26	EMI Test Receiver (26.5GHz)	5/16/2016	Annual	5/16/2017	100342
Rohde & Schwarz	TS-PR40	26.5-40 GHz Pre-Amplifier	3/7/2016	Annual	3/7/2017	100037
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	7/15/2016	Annual	7/15/2017	100348
Rohde & Schwarz	FSW67	Signal / Spectrum Analyzer	7/27/2016	Annual	7/27/2017	103200
Seekonk	NC-100	Torque Wrench 5/16", 8" lbs	3/2/2016	Biennial	3/2/2018	N/A
Sunol	DRH-118	Horn Antenna (1-18GHz)	7/30/2015	Biennial	7/30/2017	A050307
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	3/14/2016	Biennial	3/14/2018	A051107

Table 6-1. Annual Test Equipment Calibration Schedule

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7.0 TEST RESULTS

7.1 Summary

Company Name: Samsung Electronics Co., Ltd.
FCC ID: A3LETWV531
Method/System: Unlicensed National Information Infrastructure (UNII)

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
N/A	26dB Bandwidth	N/A	CONDUCTED	PASS	Section 7.2
15.407(e)	6dB Bandwidth	>500kHz(5725-5850MHz)		PASS	Section 7.3
15.407 (a.1.ii)	Maximum Conducted Output Power	Maximum conducted powers must meet the limits detailed in 15.407 (a)		PASS	Section 7.4
15.407 (a.1.ii)	Maximum Power Spectral Density	Maximum power spectral density must meet the limits detailed in 15.407 (a)		PASS	Section 7.5
15.407(g)	Frequency Stability	N/A		PASS	Section 7.6
15.407(h)	Dynamic Frequency Selection	See DFS Test Report		PASS	See DFS Test Report
15.407(b.1), (2), (3), (4)	Undesirable Emissions	Undesirable emissions must meet the limits detailed in 15.407(b)	RADIATED	PASS	Section 7.7
15.205, 15.407(b.1), (4), (5), (6)	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209		PASS	Section 7.7, 7.8
15.407	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits	LINE CONDUCTED	PASS	Section 7.9

Table 7-1. Summary of Test Results

Notes:

1) All channels, modes, and modulations/data rates were investigated among all UNII bands. The test results shown in the following sections represent the worst case emissions.
2) The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
3) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.
4) For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "UNII Automation," Version 4.5.
5) For radiated band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Chamber Automation," Version 1.1.5.

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7.2 26dB Bandwidth Measurement – 802.11a/n/ac

Test Overview and Limit

The bandwidth at 26dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating at its maximum duty cycle, at its maximum power control level, as defined in KDB 789033 D02 v01r04, and at the appropriate frequencies. The spectrum analyzer's bandwidth measurement function is configured to measure the 26dB bandwidth.

The 26dB bandwidth is used to determine the conducted power limits.

Test Procedure Used

KDB 789033 D02 v01r04 – Section C

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability was used to perform the 26dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 26. The automatic bandwidth measurement function also has the capability of simultaneously measuring the 99% occupied bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = approximately 1% of the emission bandwidth
3. VBW $\geq$ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

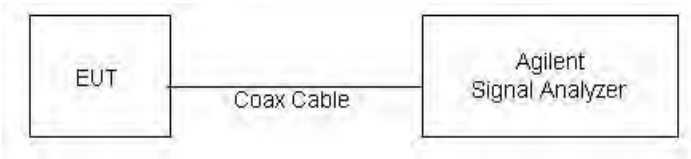

Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None.

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Antenna-1 26dB Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Antenna 1 Measured 26dB Bandwidth [MHz]
Band 1	5180	36	a	6	39.00
	5200	40	a	6	37.79
	5240	48	a	6	32.68
	5180	36	n (20MHz)	6.5/7.2 (MCS0)	40.23
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	39.08
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	35.91
	5190	38	n (40MHz)	13.5/15 (MCS0)	79.44
	5230	46	n (40MHz)	13.5/15 (MCS0)	78.51
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	99.96

Table 7-2. Conducted Bandwidth Measurements

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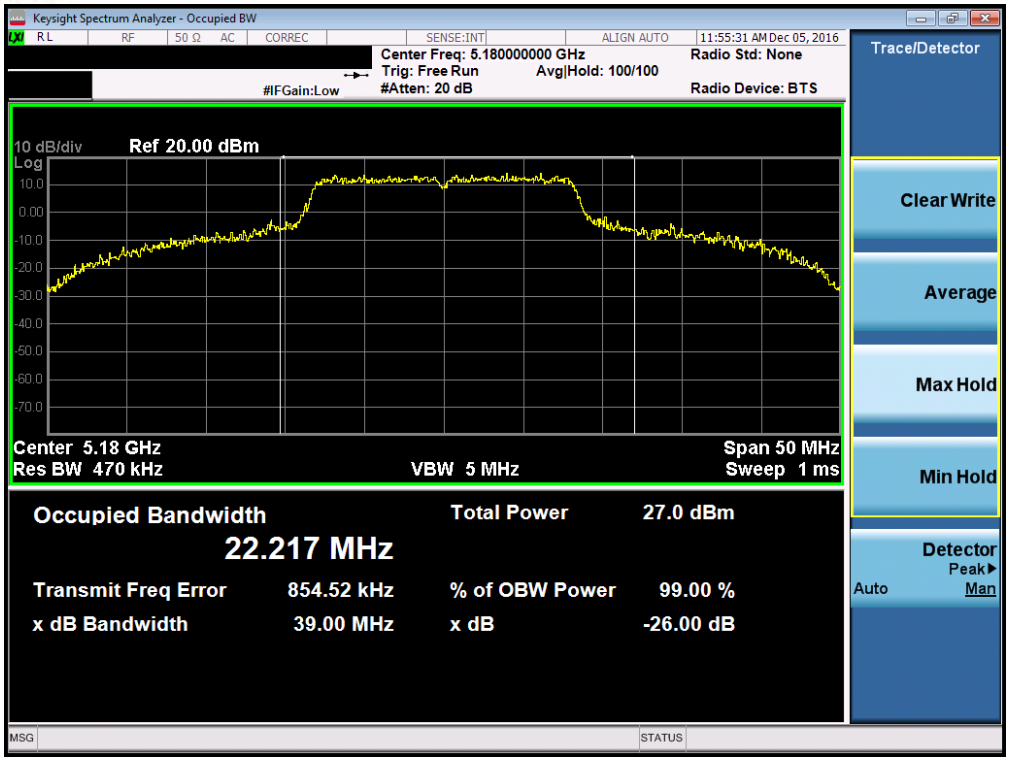
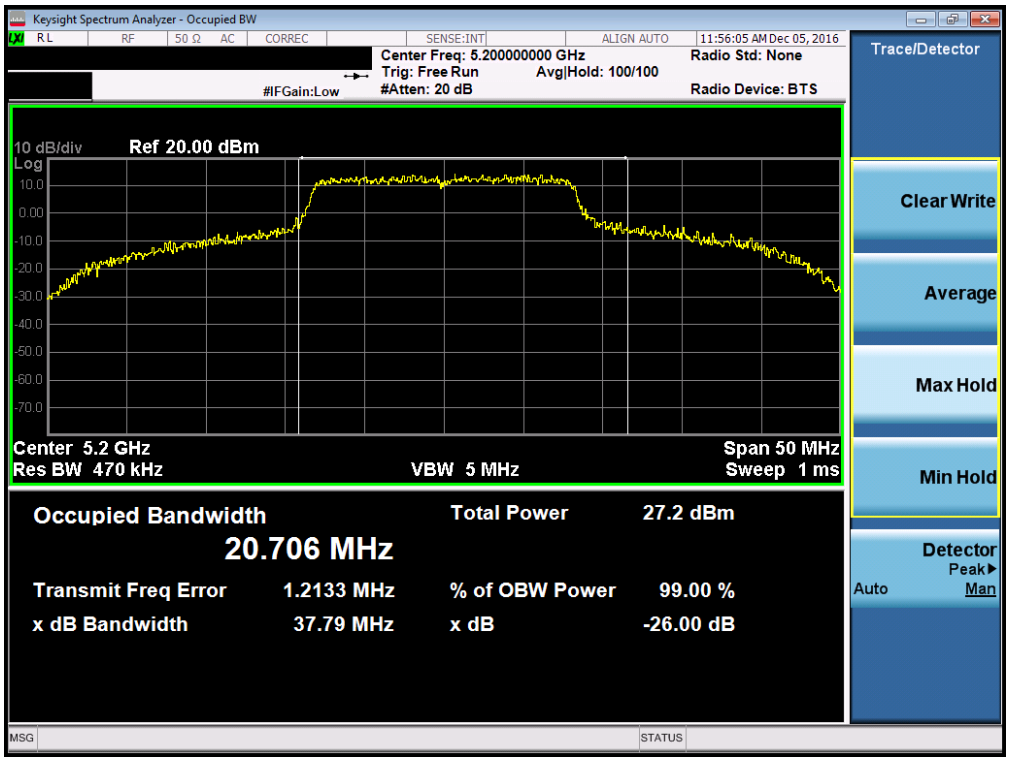


Plot 7-1. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 36)



Plot 7-2. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 40)

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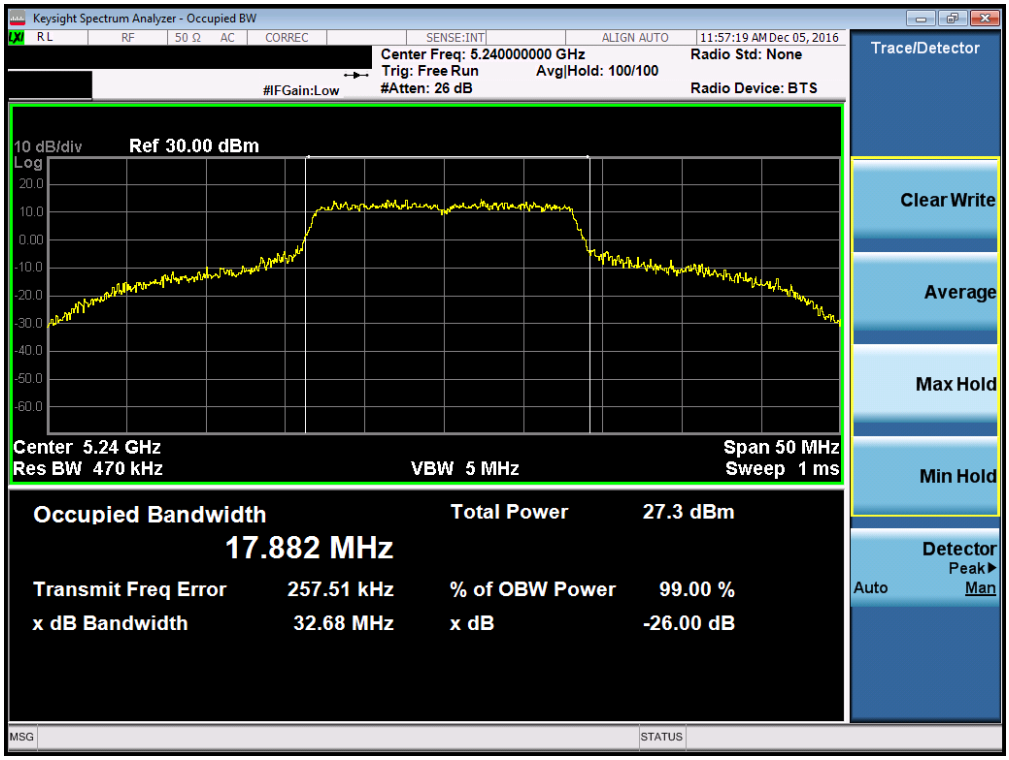
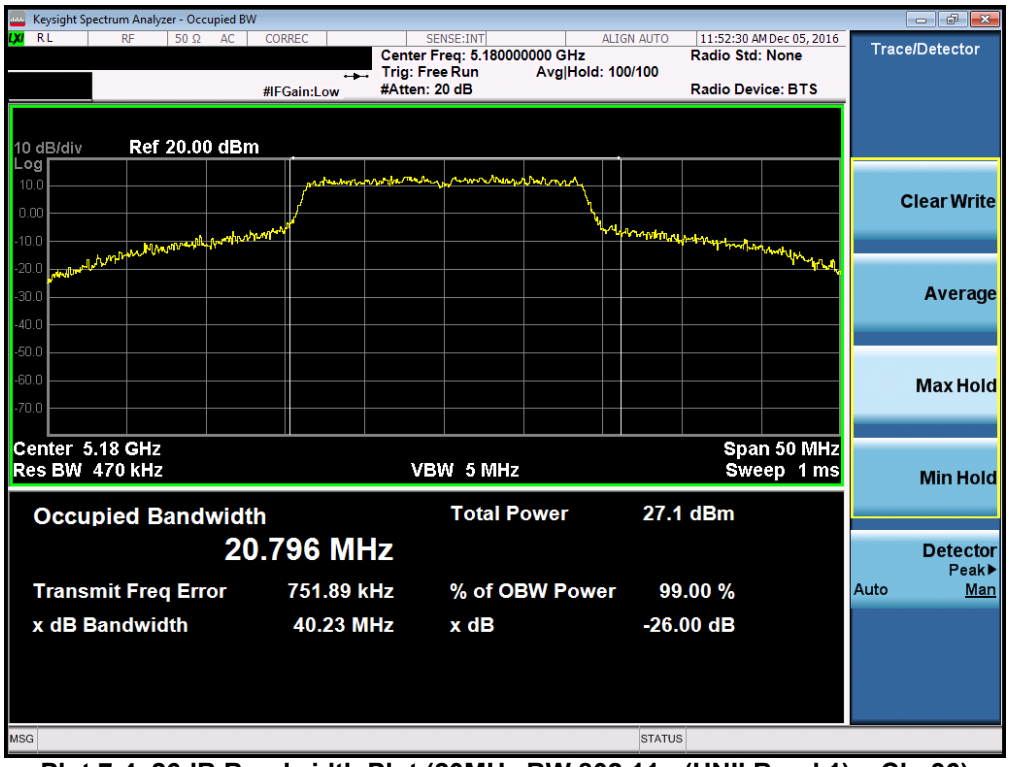


Plot 7-3. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 48)



Plot 7-4. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 36)

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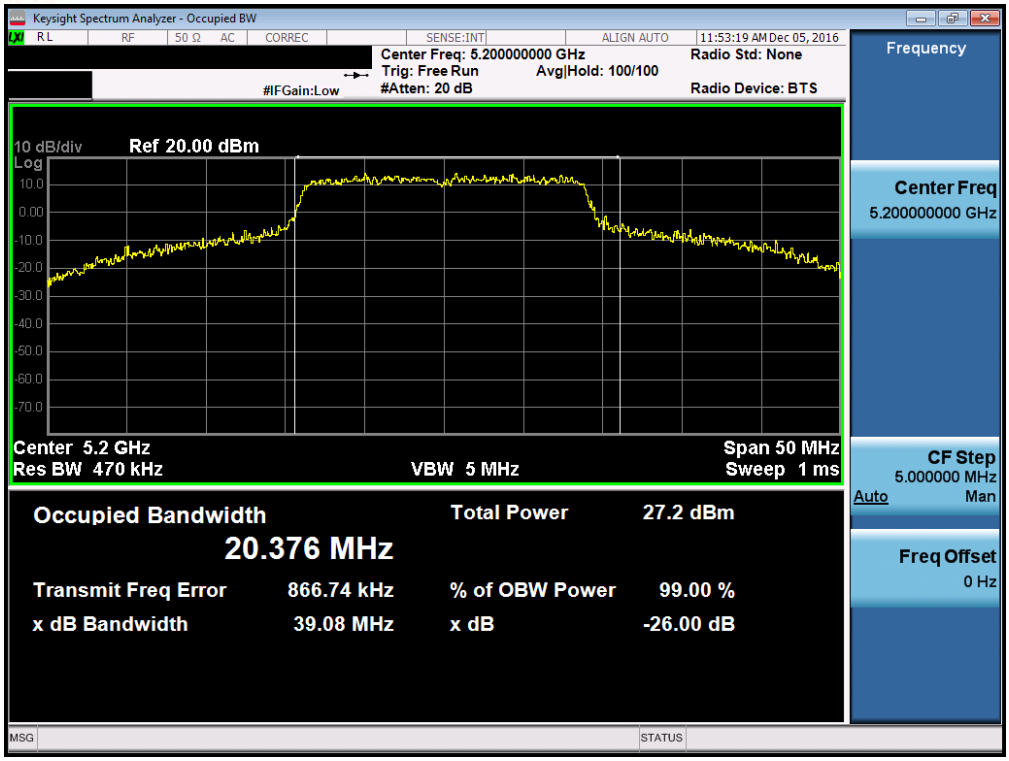
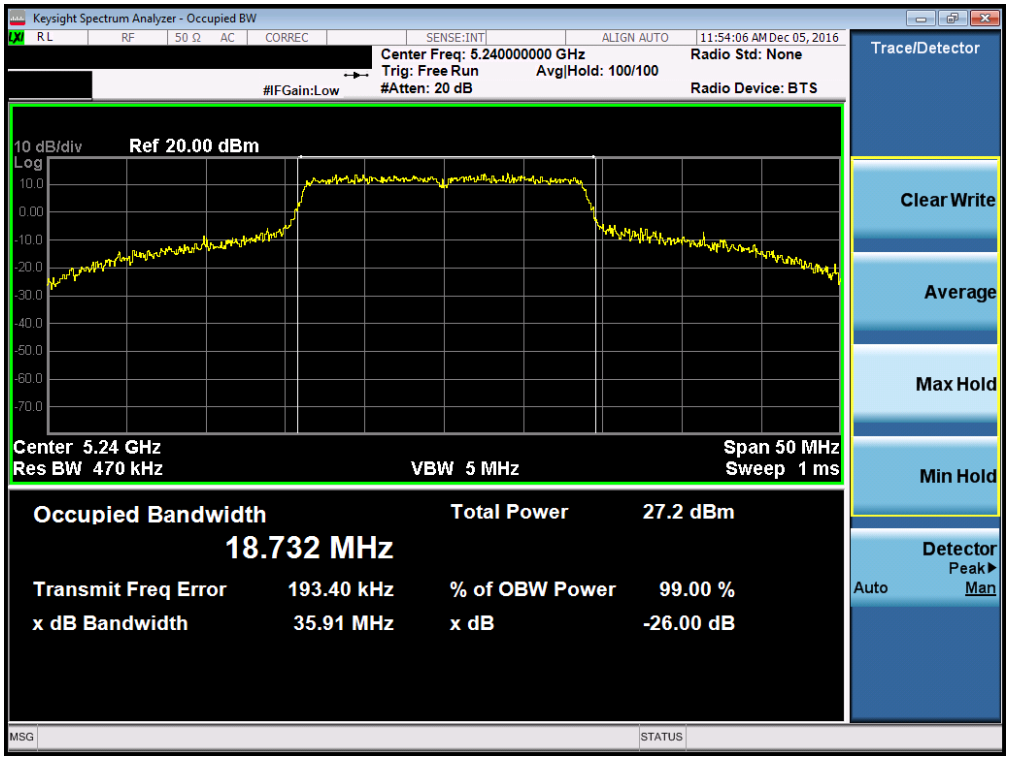


Plot 7-5. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 40)



Plot 7-6. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 48)

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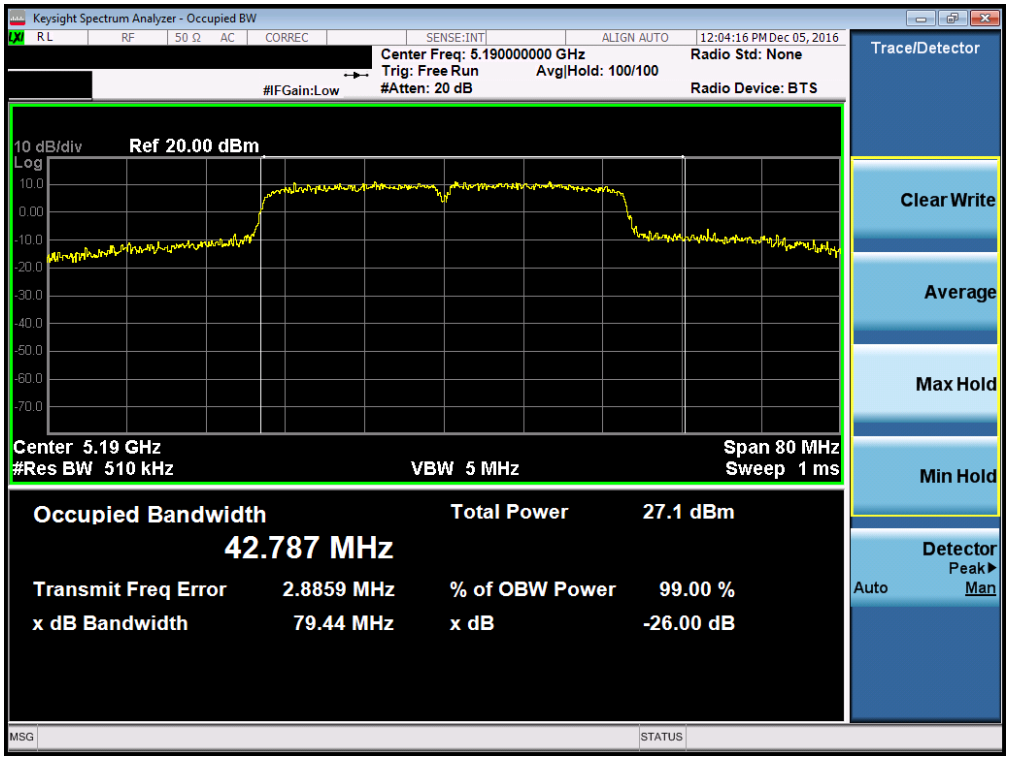
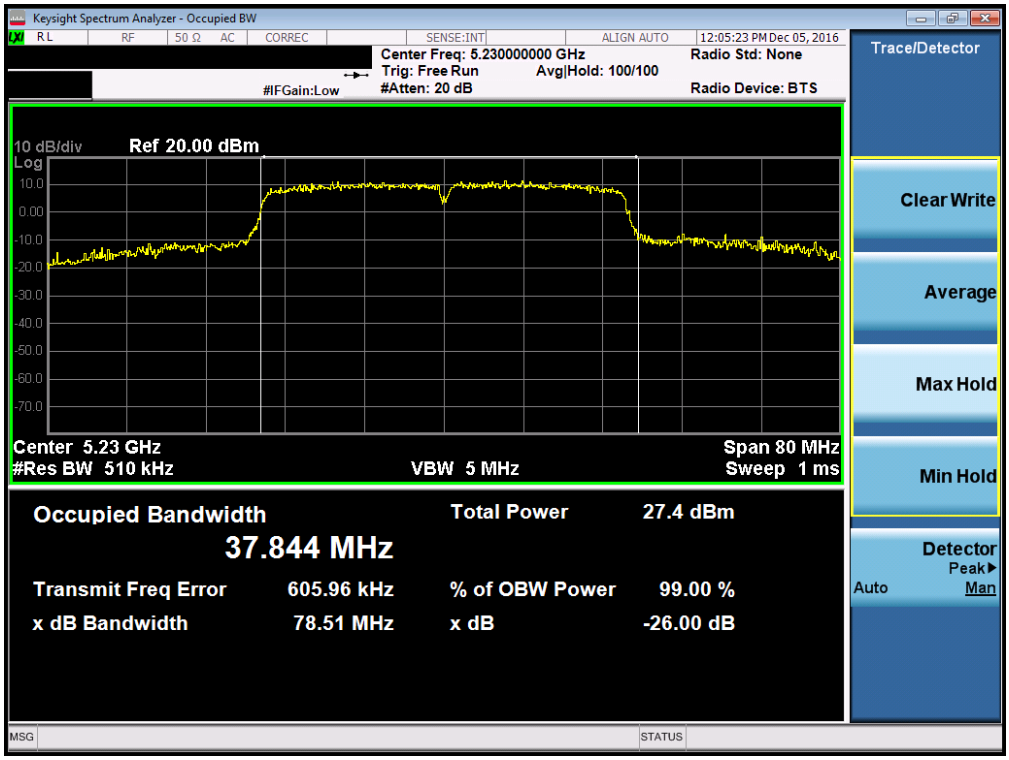


Plot 7-7. 26dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 38)



Plot 7-8. 26dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 46)

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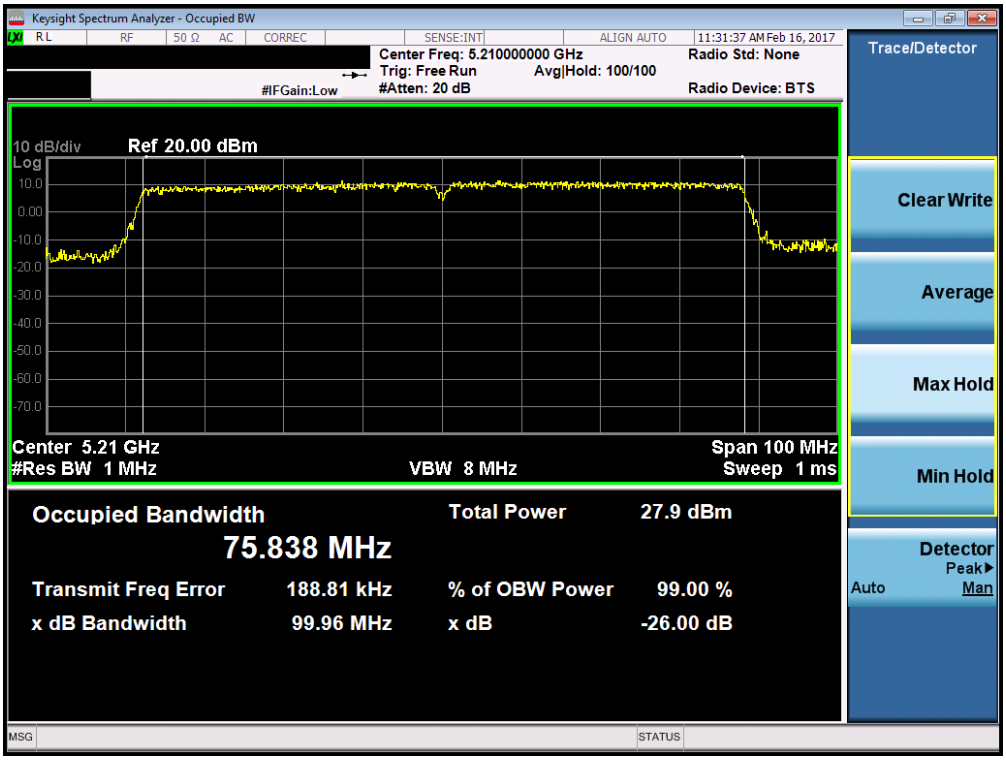

Plot 7-9. 26dB Bandwidth Plot (80MHz BW 802.11ac (UNII Band 1) – Ch. 42)

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Antenna-2 26dB Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Antenna 2 Measured 26dB Bandwidth [MHz]
Band 1	5180	36	a	6	24.81
	5200	40	a	6	24.39
	5240	48	a	6	22.05
	5180	36	n (20MHz)	6.5/7.2 (MCS0)	24.93
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	22.77
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	21.07
	5190	38	n (40MHz)	13.5/15 (MCS0)	43.89
	5230	46	n (40MHz)	13.5/15 (MCS0)	45.46
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	187.10

Table 7-3. Conducted Bandwidth Measurements

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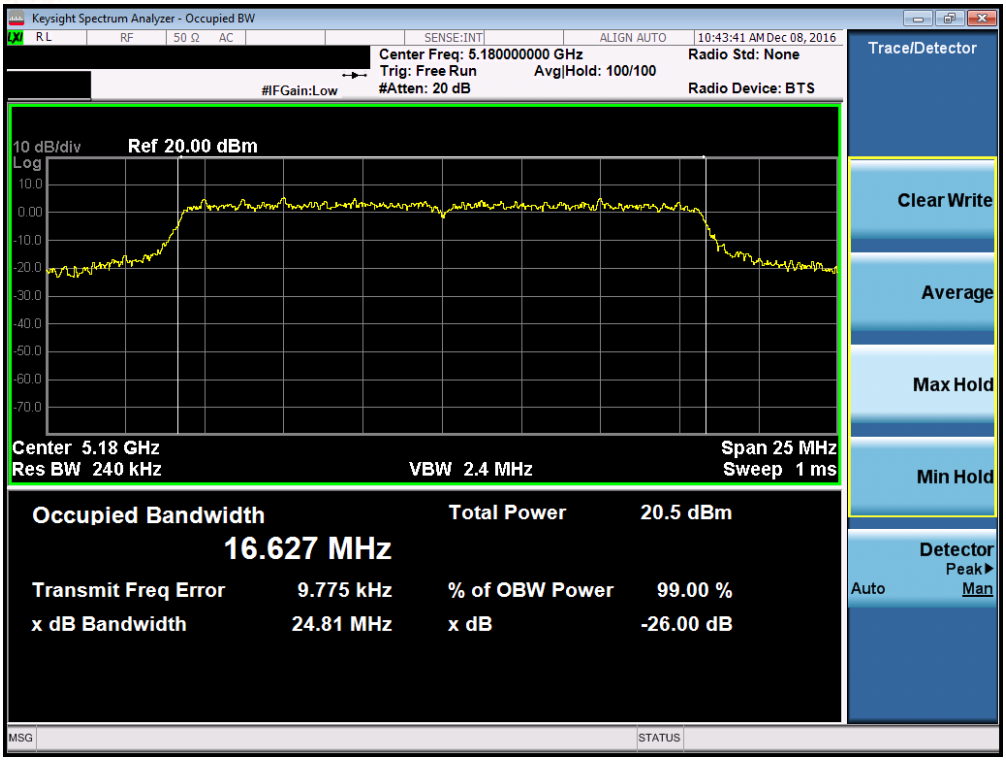
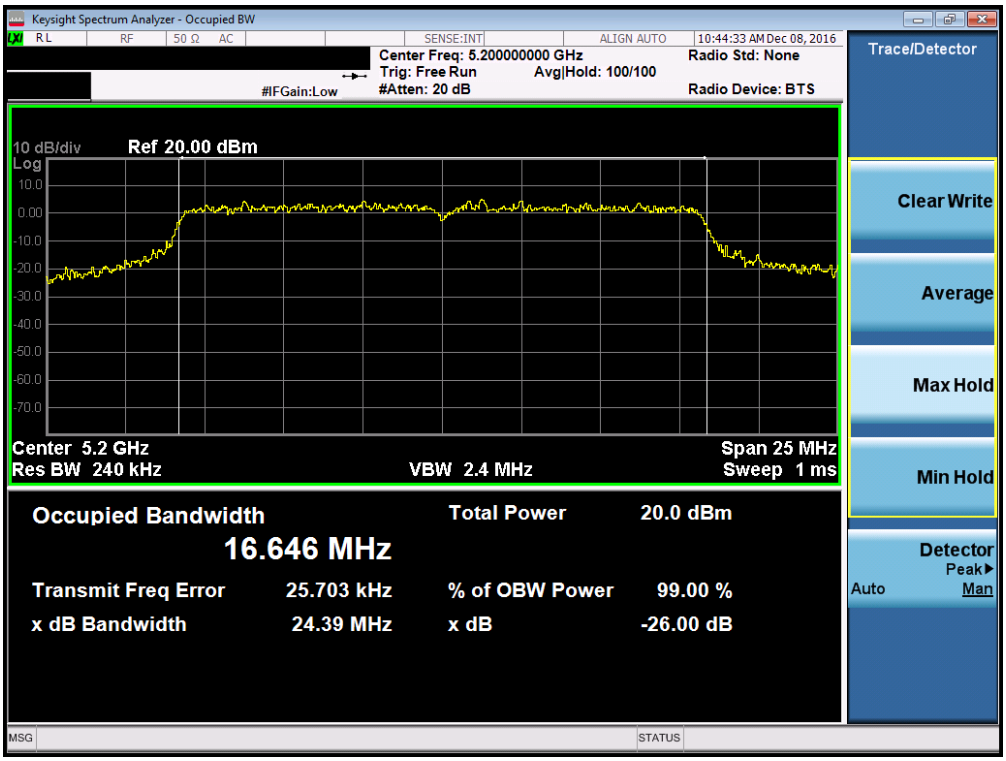


Plot 7-10. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 36)



Plot 7-11. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 40)

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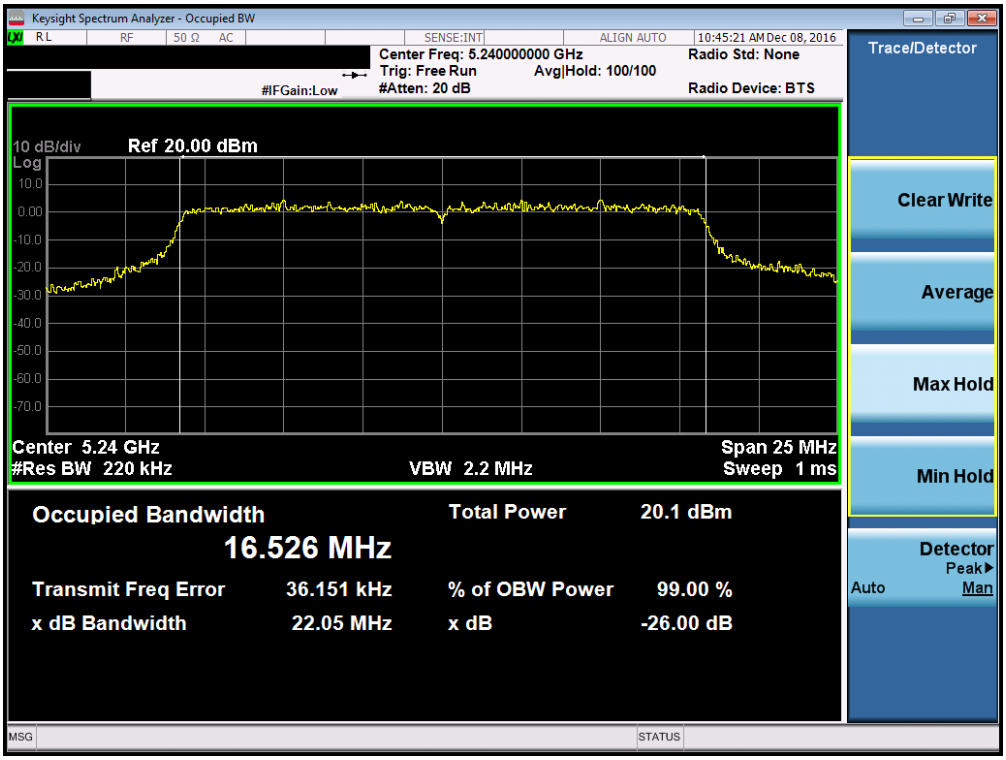
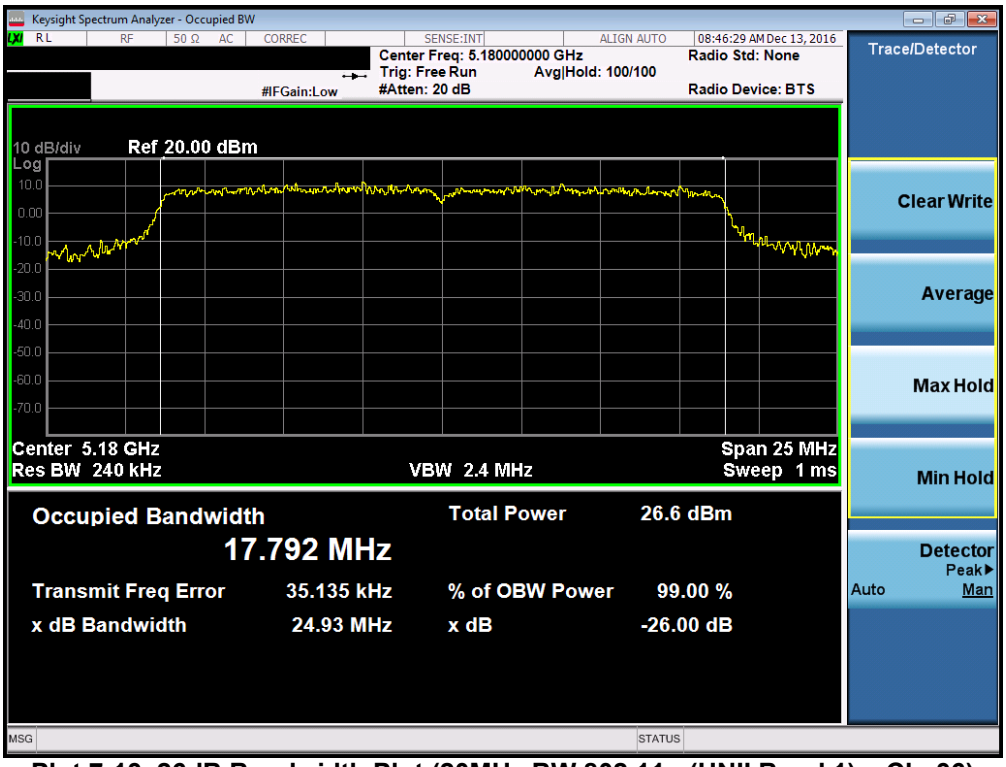


Plot 7-12. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 48)



Plot 7-13. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 36)

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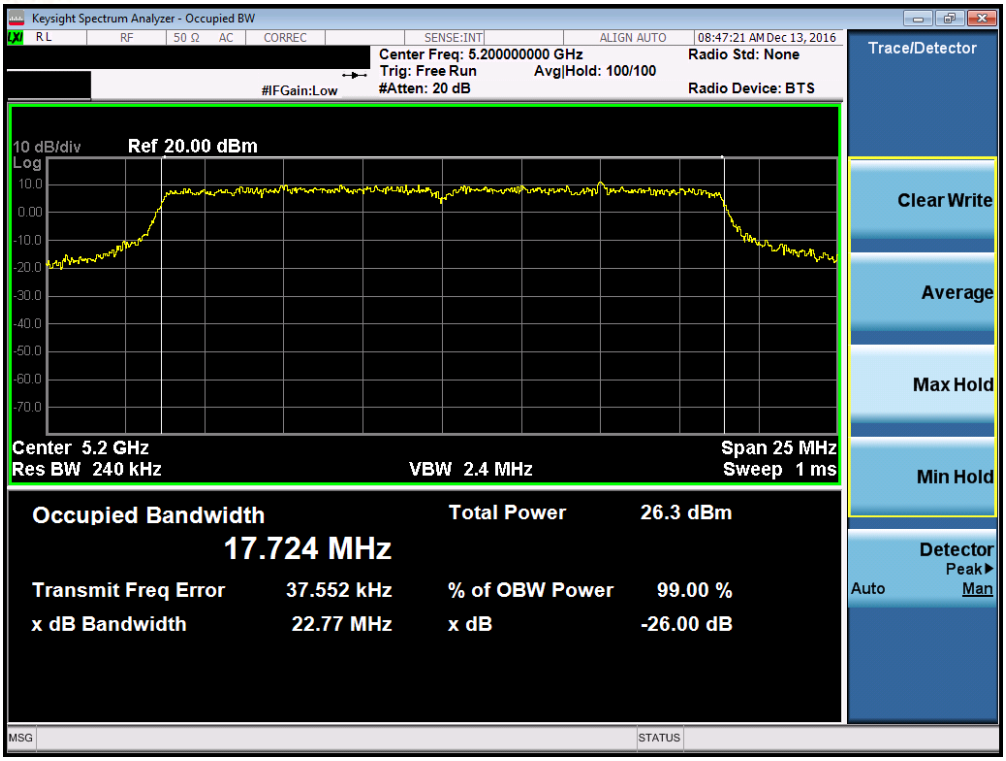
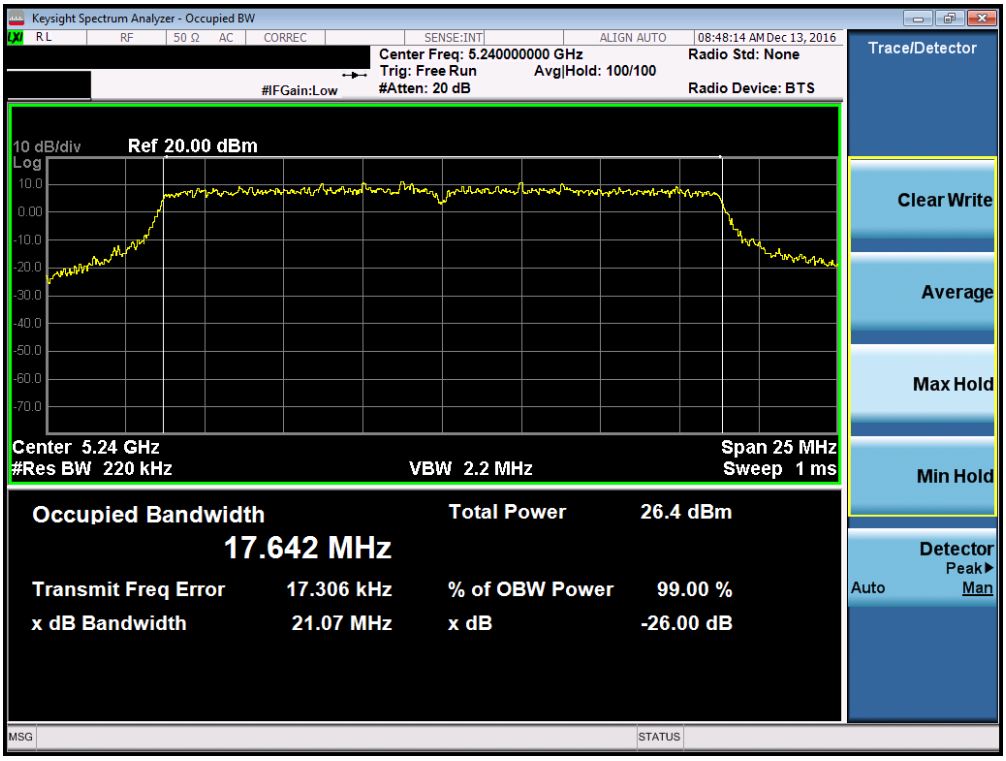


Plot 7-14. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 40)



Plot 7-15. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 48)

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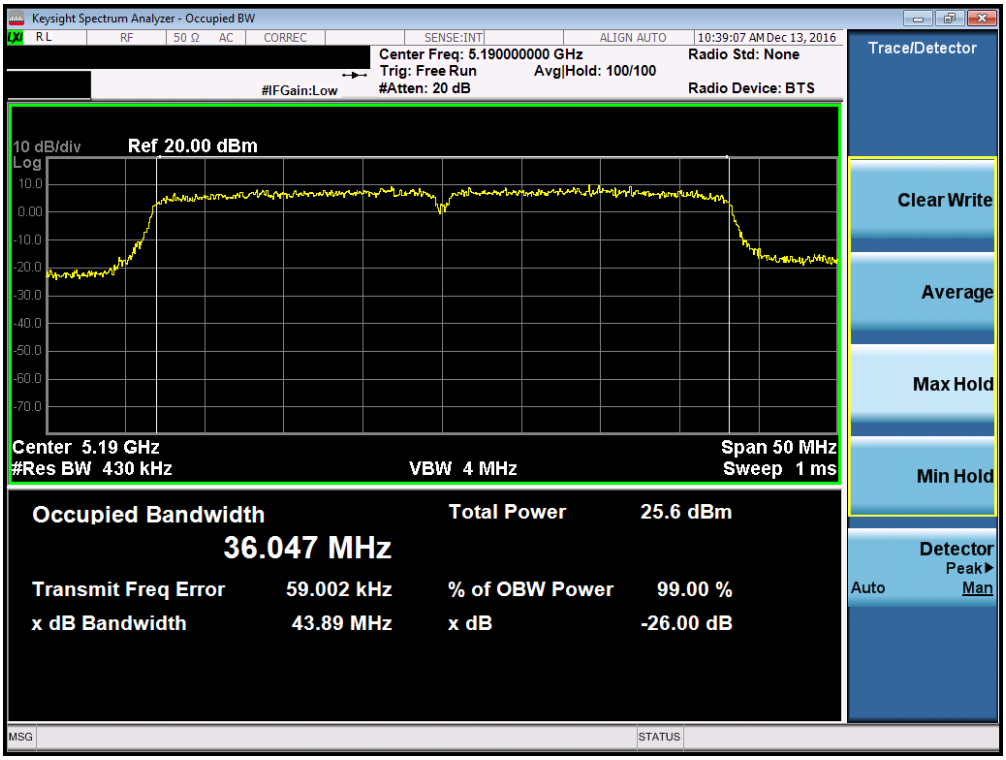
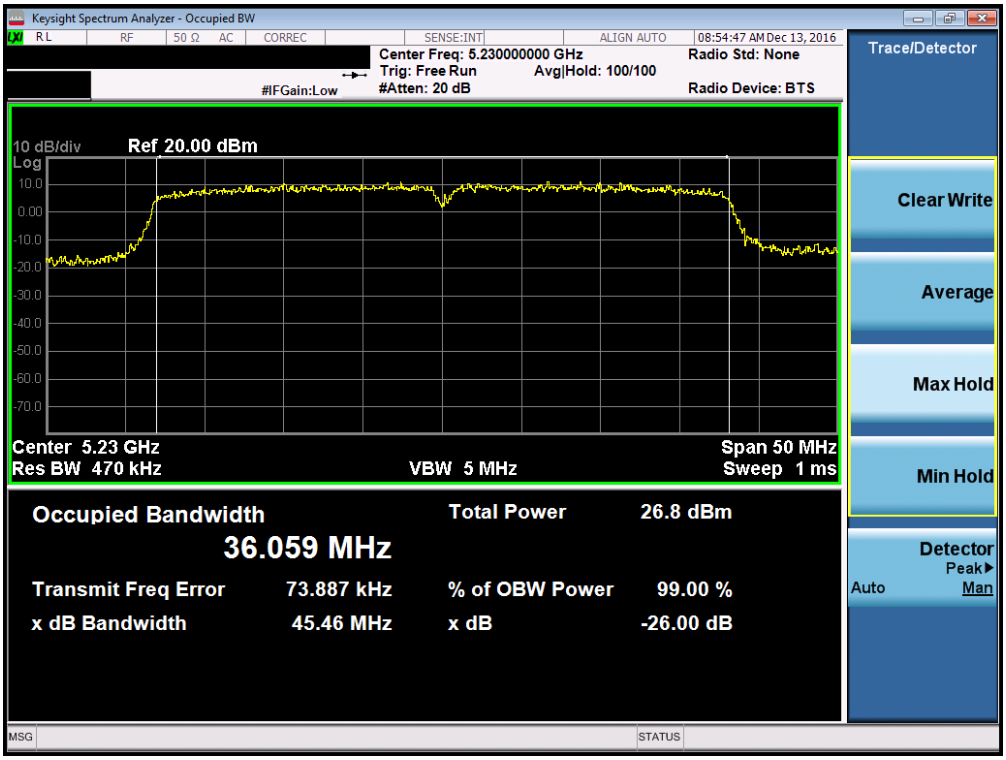


Plot 7-16. 26dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 38)



Plot 7-17. 26dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 46)

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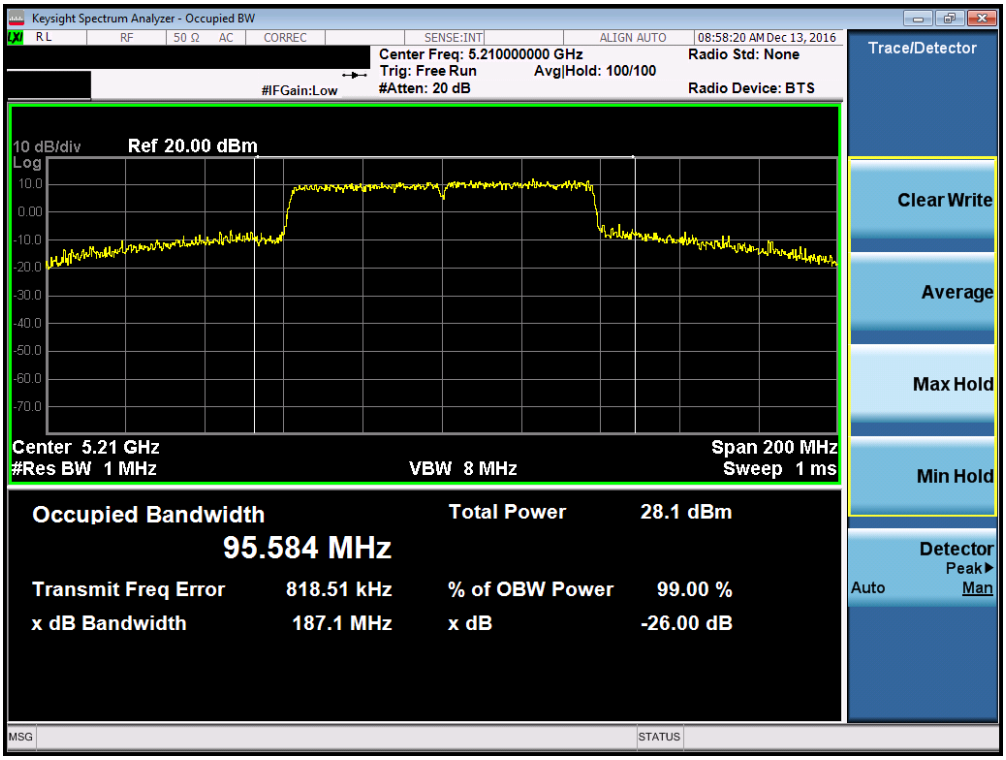

Plot 7-18. 26dB Bandwidth Plot (80MHz BW 802.11ac (UNII Band 1) – Ch. 42)

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Antenna-3 26dB Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Antenna 3 Measured 26dB Bandwidth [MHz]
Band 1	5180	36	a	6	22.70
	5200	40	a	6	22.45
	5240	48	a	6	20.74
	5180	36	n (20MHz)	6.5/7.2 (MCS0)	22.99
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	23.33
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	21.75
	5190	38	n (40MHz)	13.5/15 (MCS0)	45.87
	5230	46	n (40MHz)	13.5/15 (MCS0)	44.43
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	174.90

Table 7-4. Conducted Bandwidth Measurements

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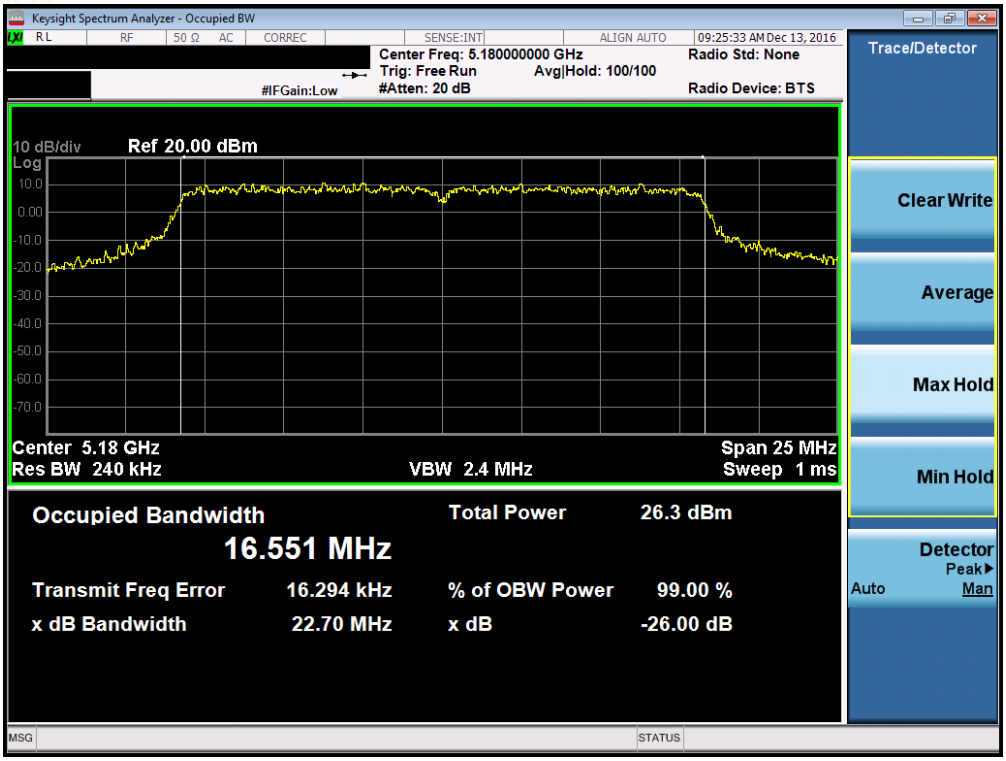
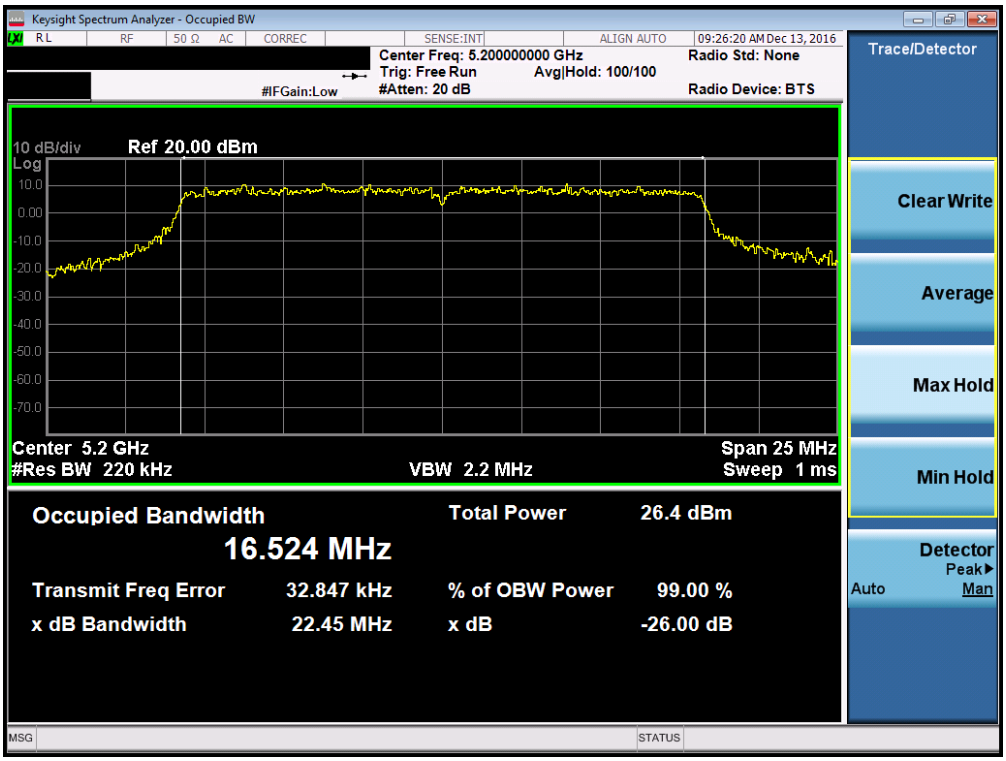


Plot 7-19. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 36)



Plot 7-20. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 40)

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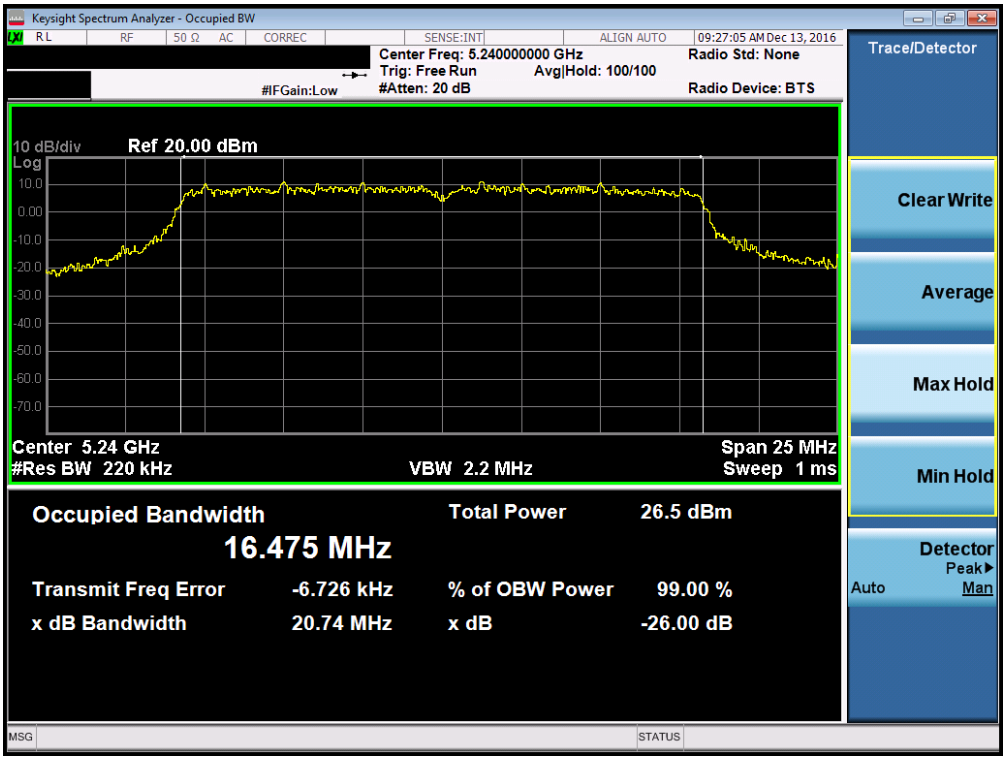
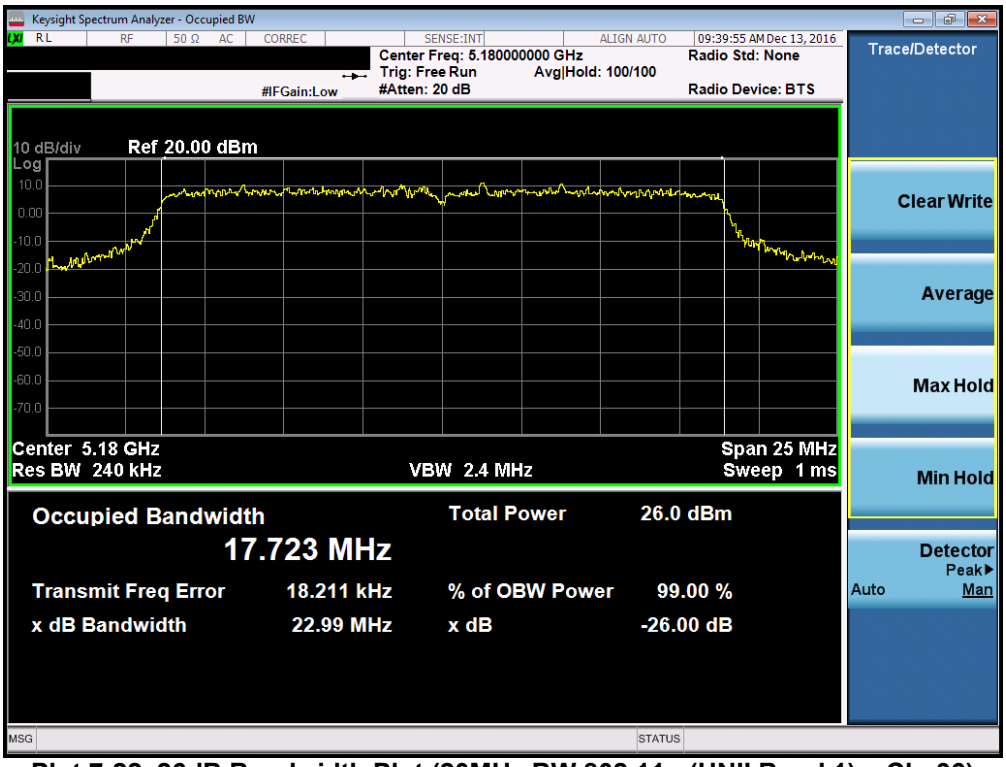


Plot 7-21. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 48)



Plot 7-22. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 36)

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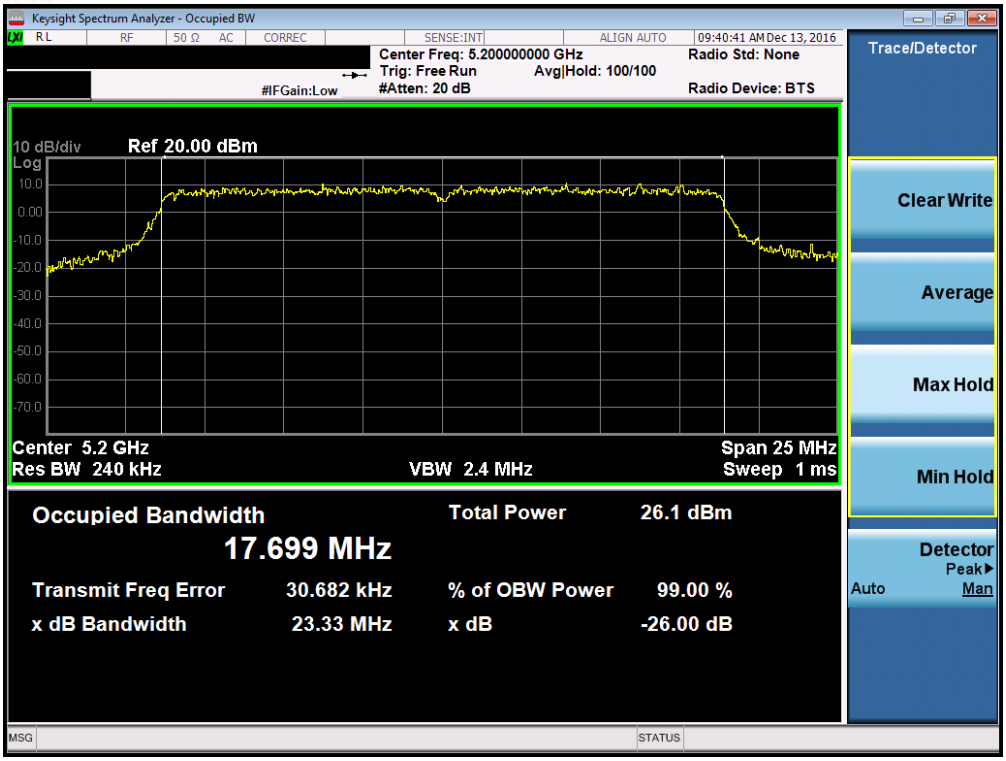
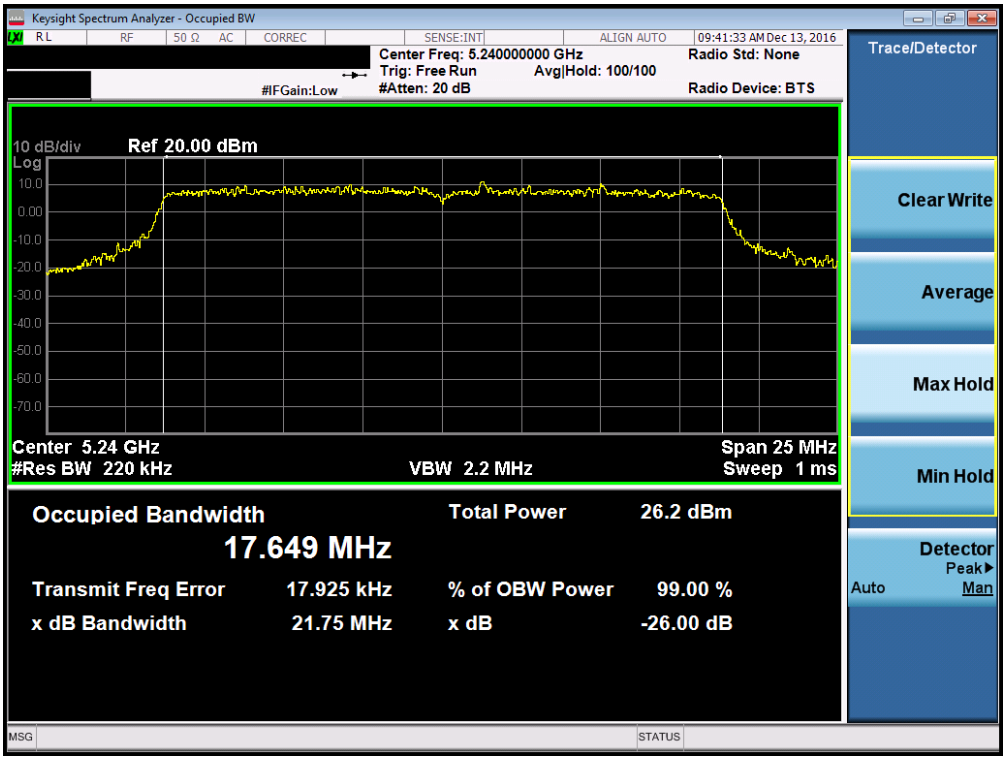


Plot 7-23. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 40)



Plot 7-24. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 48)

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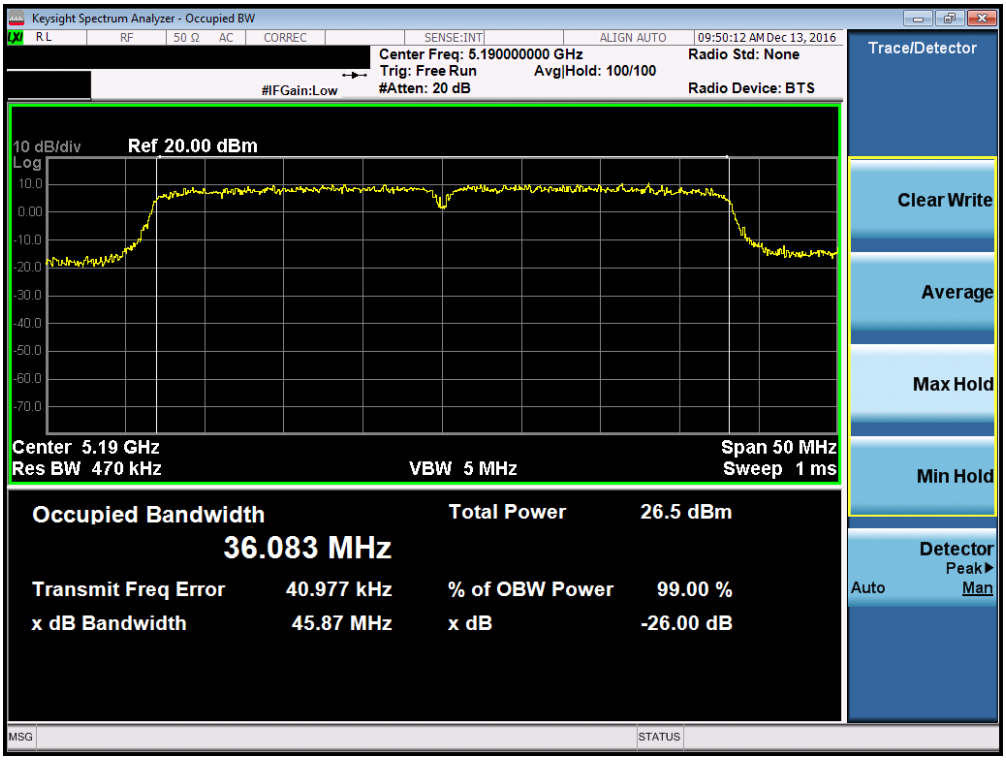
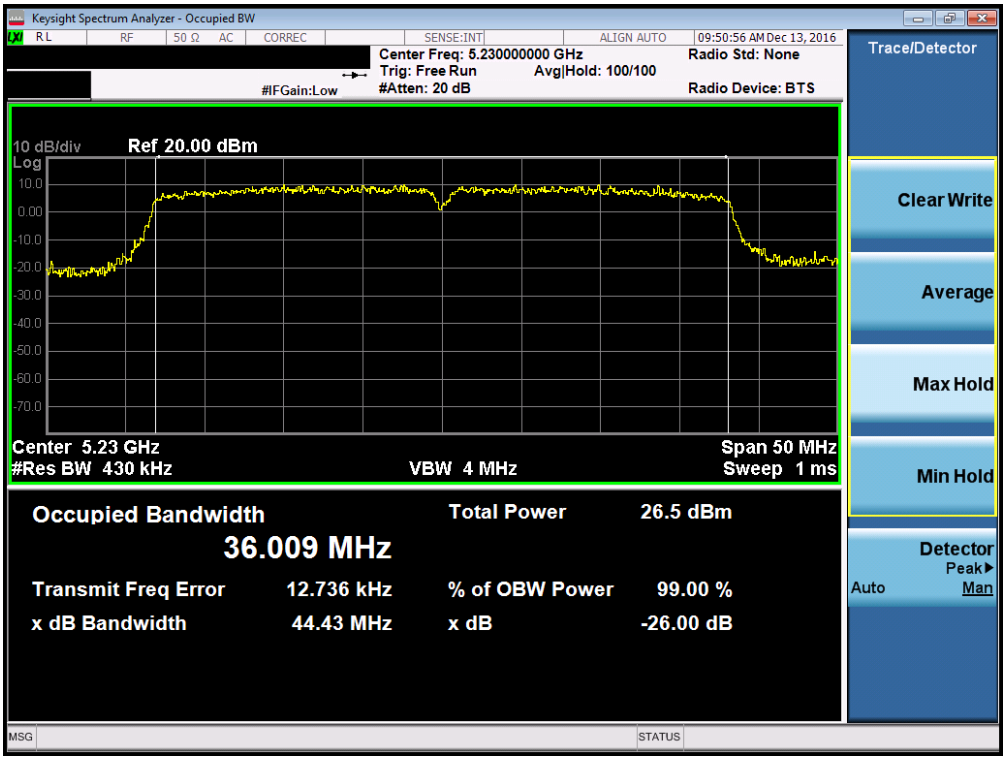


Plot 7-25. 26dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 38)



Plot 7-26. 26dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 46)

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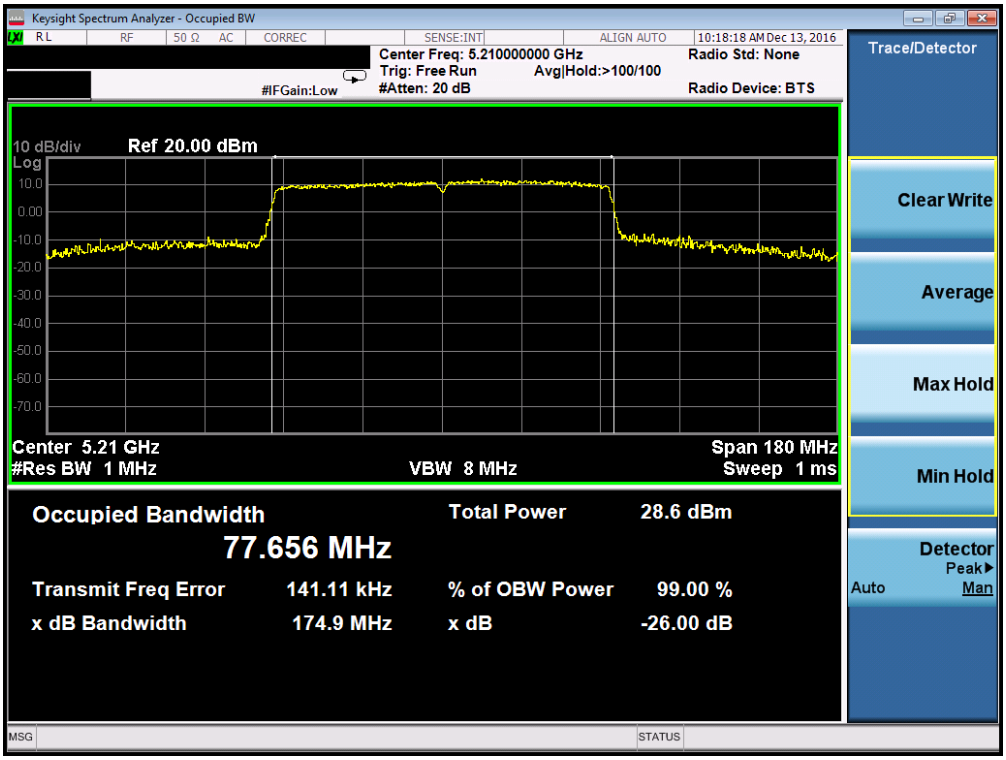

Plot 7-27. 26dB Bandwidth Plot (80MHz BW 802.11ac (UNII Band 1) – Ch. 42)

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Antenna-4 26dB Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Antenna 4 Measured 26dB Bandwidth [MHz]
Band 1	5180	36	a	6	24.41
	5200	40	a	6	22.03
	5240	48	a	6	22.81
	5180	36	n (20MHz)	6.5/7.2 (MCS0)	24.95
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	23.33
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	23.07
	5190	38	n (40MHz)	13.5/15 (MCS0)	43.89
	5230	46	n (40MHz)	13.5/15 (MCS0)	45.18
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	99.26

Table 7-5. Conducted Bandwidth Measurements

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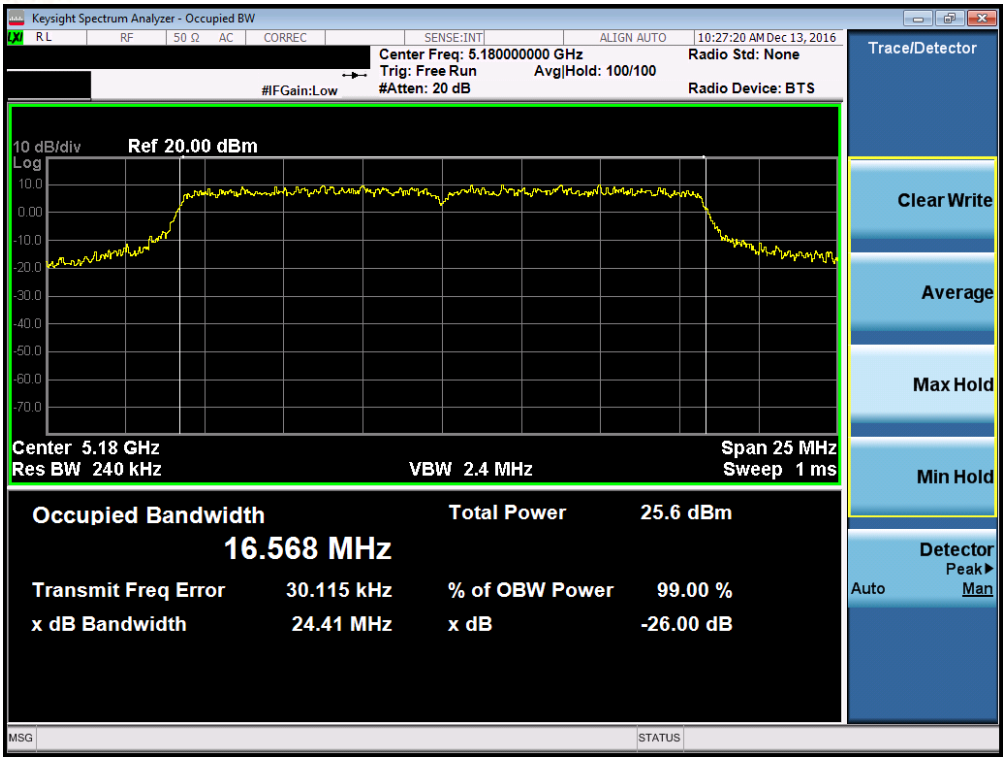
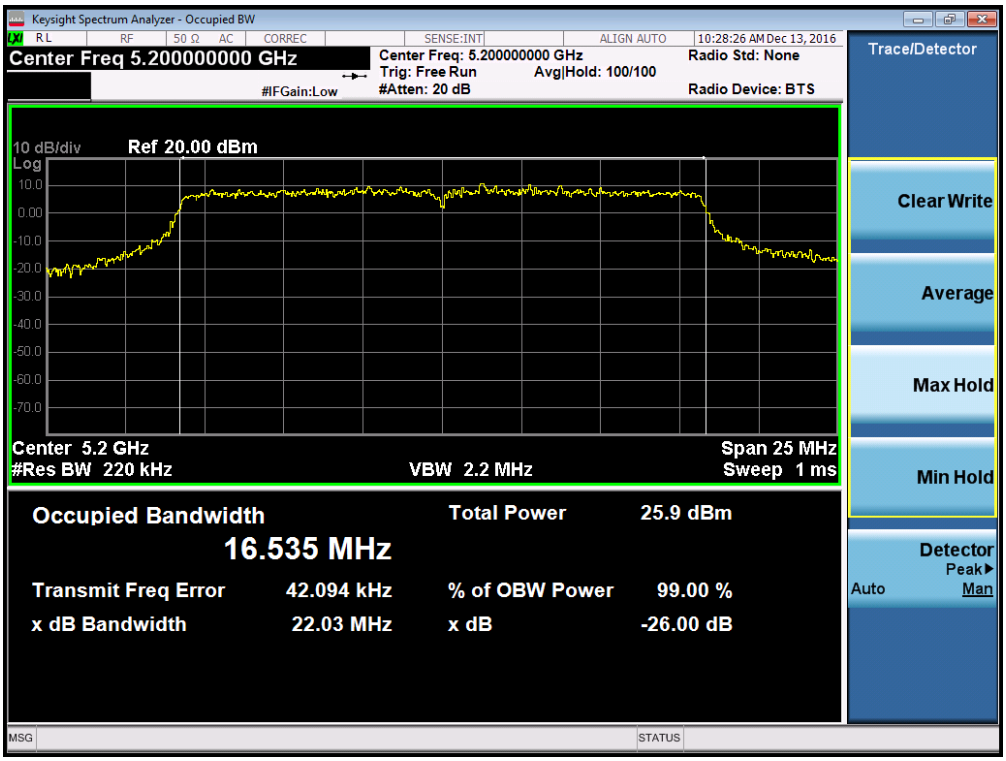


Plot 7-28. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 36)



Plot 7-29. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 40)

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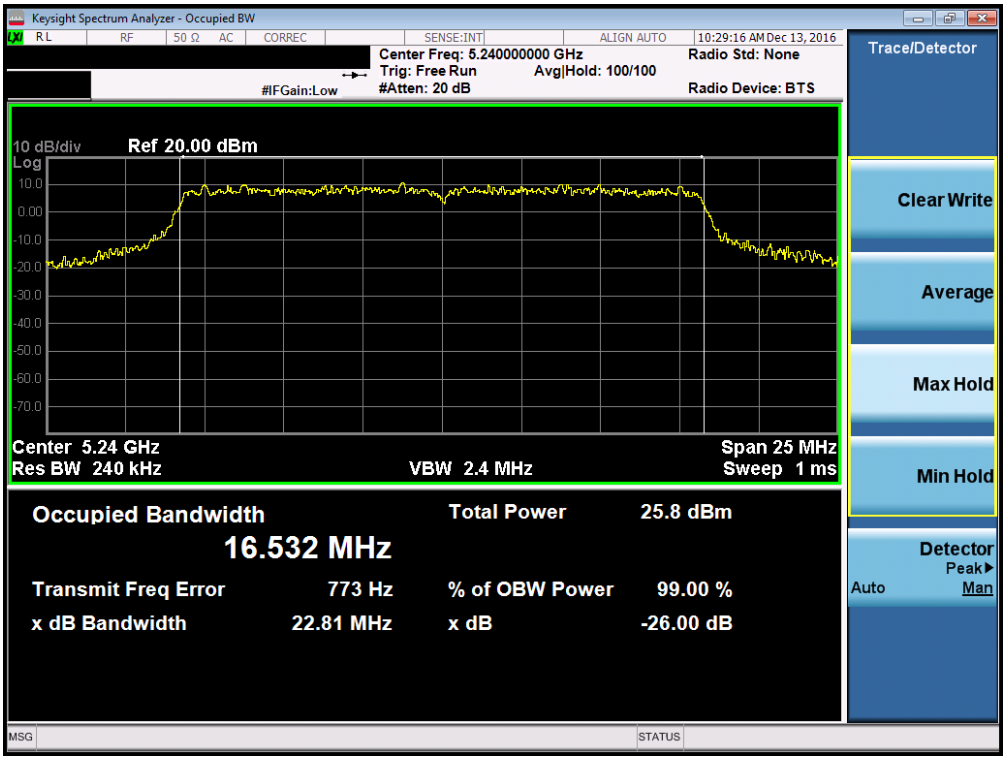
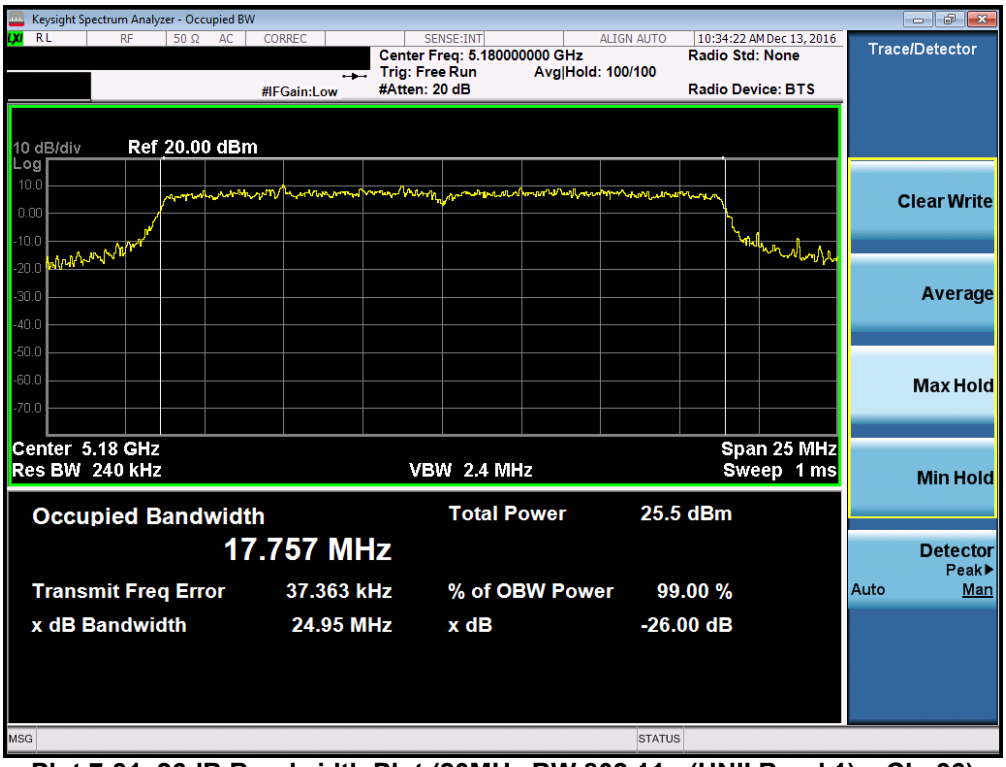


Plot 7-30. 26dB Bandwidth Plot (802.11a (UNII Band 1) – Ch. 48)



Plot 7-31. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 36)

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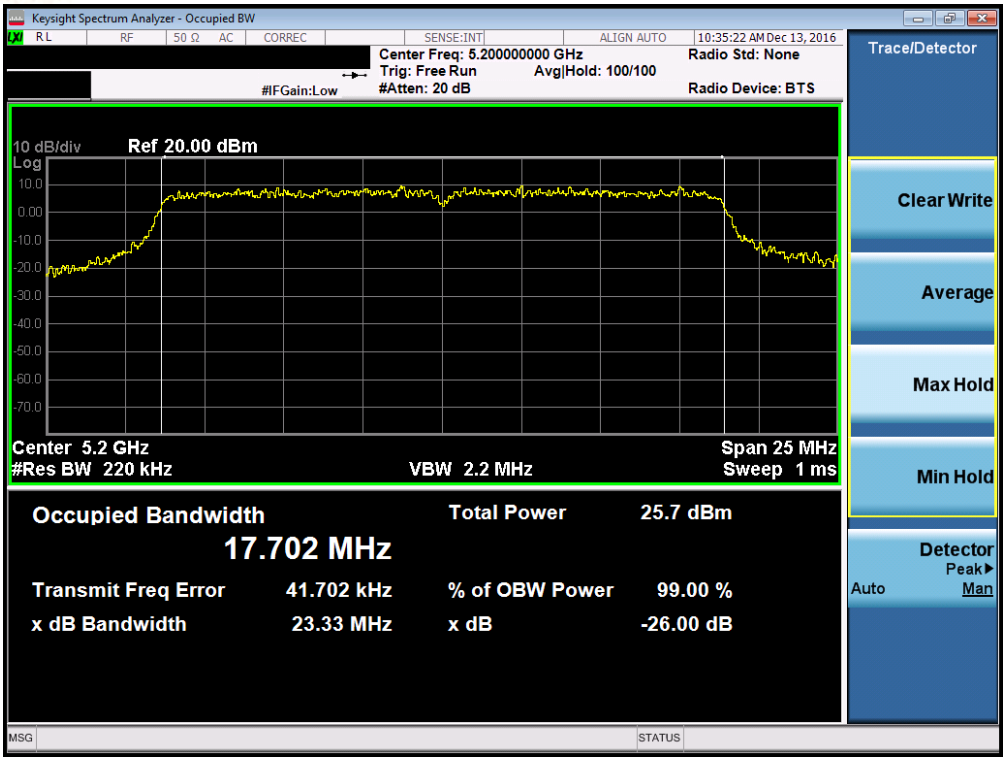
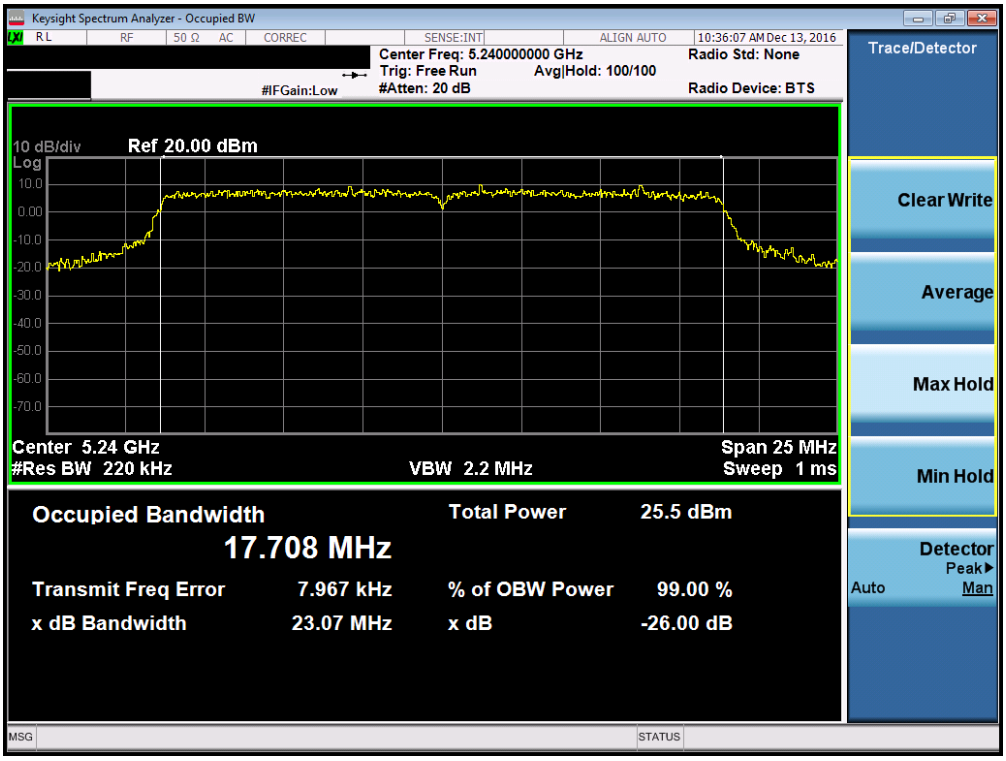


Plot 7-32. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 40)



Plot 7-33. 26dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 48)

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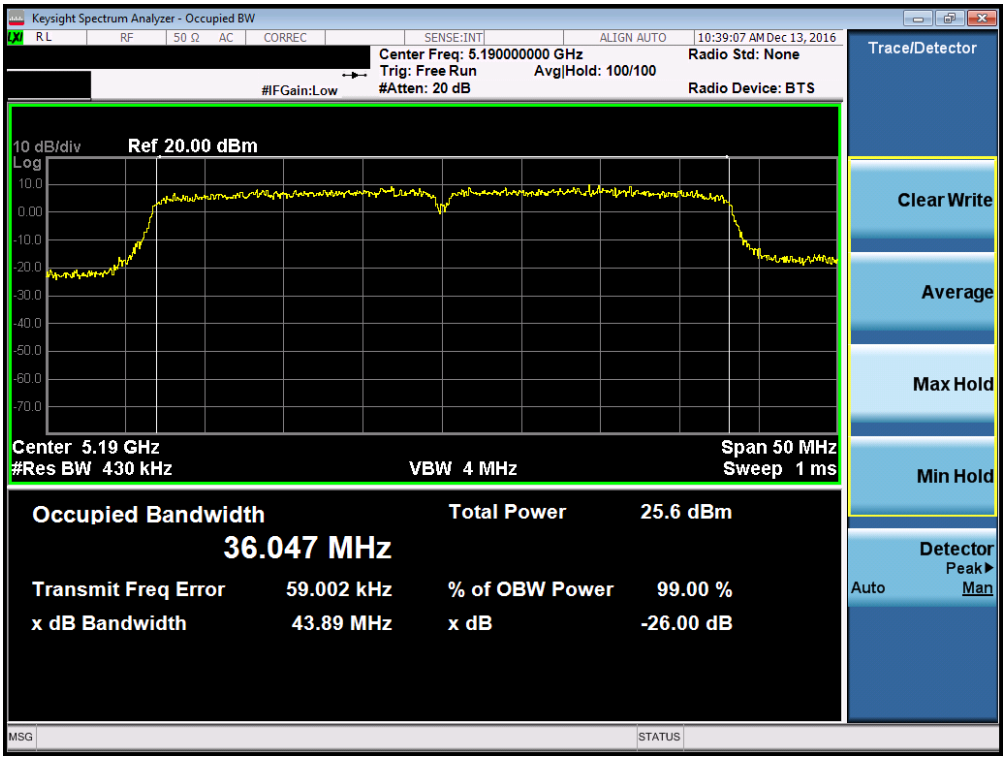
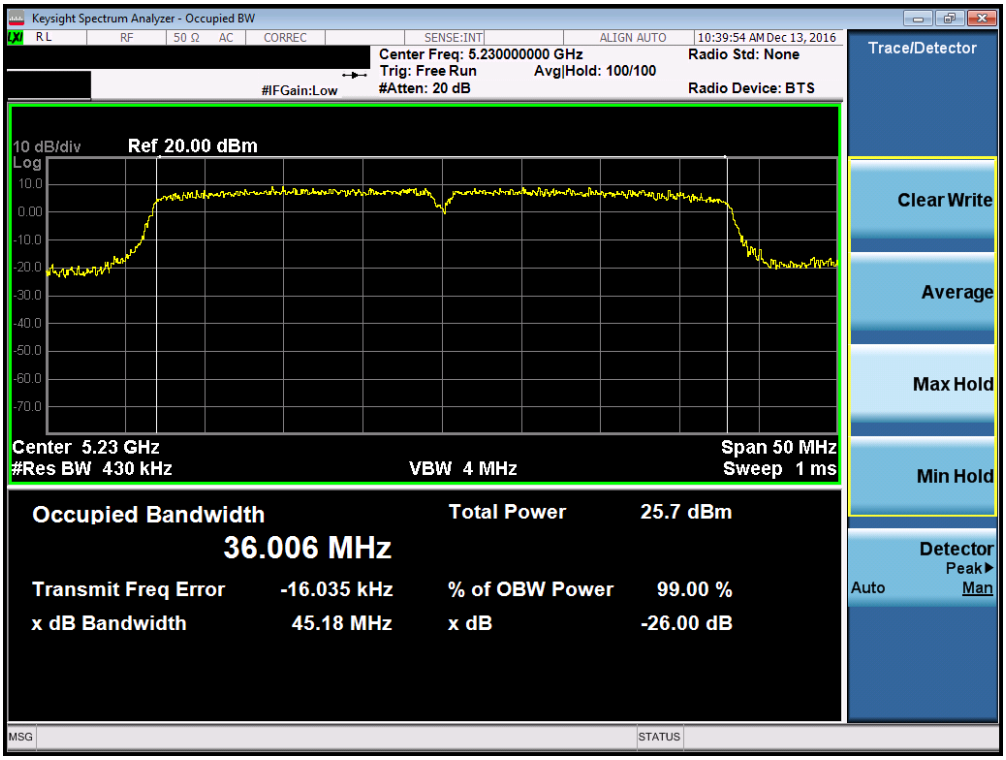


Plot 7-34. 26dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 38)



Plot 7-35. 26dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 46)

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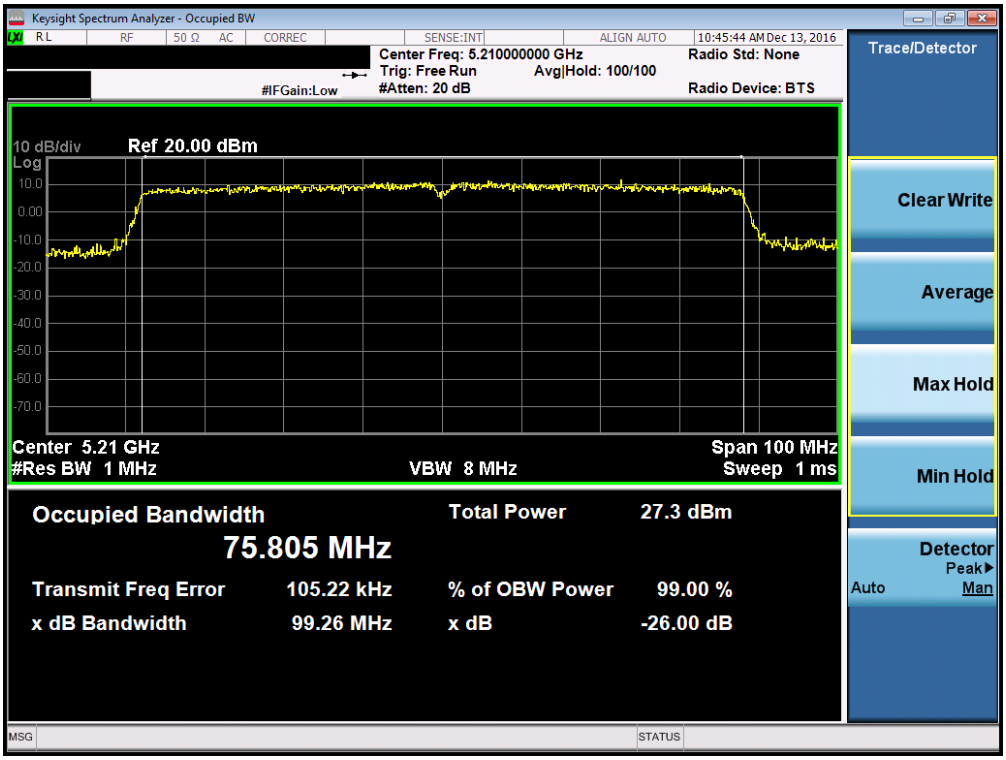

Plot 7-36. 26dB Bandwidth Plot (80MHz BW 802.11ac (UNII Band 1) – Ch. 42)

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7.3 6dB Bandwidth Measurement – 802.11a/n/ac

§15.407 (e)

Test Overview and Limit

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating at its maximum duty cycle, at its maximum power control level, as defined in KDB 789033 D02 v01r04, and at the appropriate frequencies. The spectrum analyzer's bandwidth measurement function is configured to measure the 6dB bandwidth.

In the 5.725 – 5.850GHz band, the 6dB bandwidth must be ≥ 500 kHz.

Test Procedure Used

KDB 789033 D02 v01r04 – Section C

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The automatic bandwidth measurement function also has the capability of simultaneously measuring the 99% occupied bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 100 kHz
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

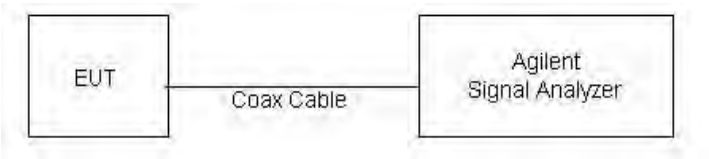

Figure 7-2. Test Instrument & Measurement Setup

Test Notes

None.

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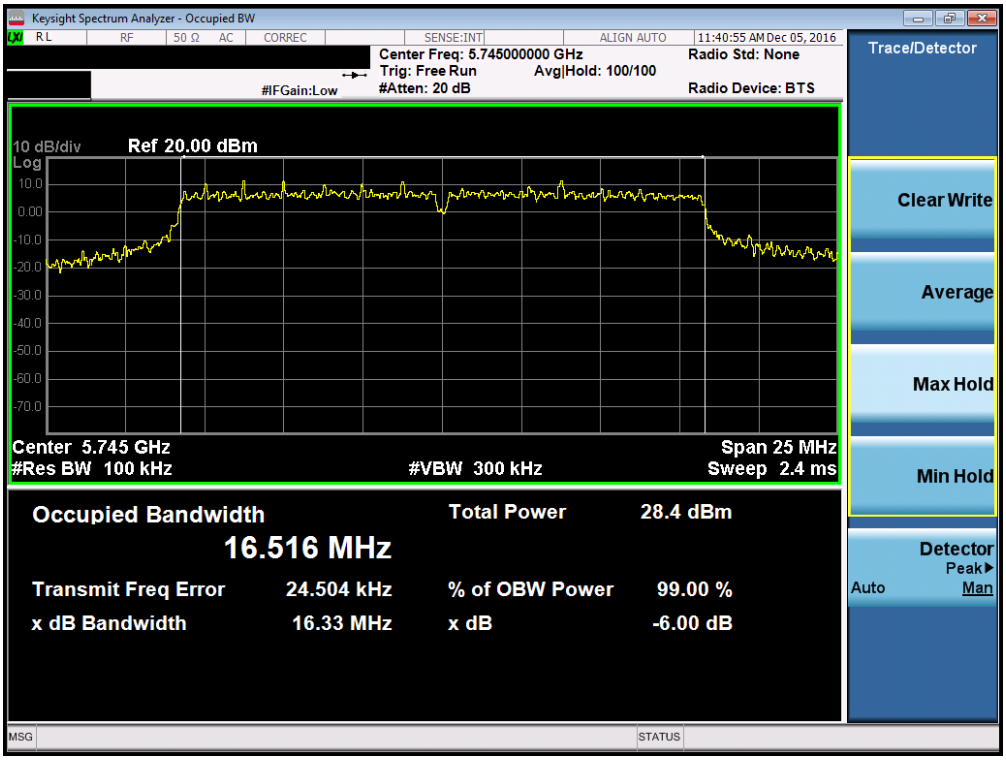
Antenna-1 6 dB Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Antenna 1 Measured 6dB Bandwidth [MHz]
Band 3	5745	149	a	6	16.33
	5785	157	a	6	16.35
	5825	165	a	6	16.38
	5745	149	n (20MHz)	6.5/7.2 (MCS0)	17.60
	5785	157	n (20MHz)	6.5/7.2 (MCS0)	16.95
	5825	165	n (20MHz)	6.5/7.2 (MCS0)	17.62
	5755	151	n (40MHz)	13.5/15 (MCS0)	31.93
	5795	159	n (40MHz)	13.5/15 (MCS0)	35.11
	5775	155	ac (80MHz)	29.3/32.5 (MCS0)	73.91

Table 7-6. Conducted Bandwidth Measurements



Plot 7-37. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 149)

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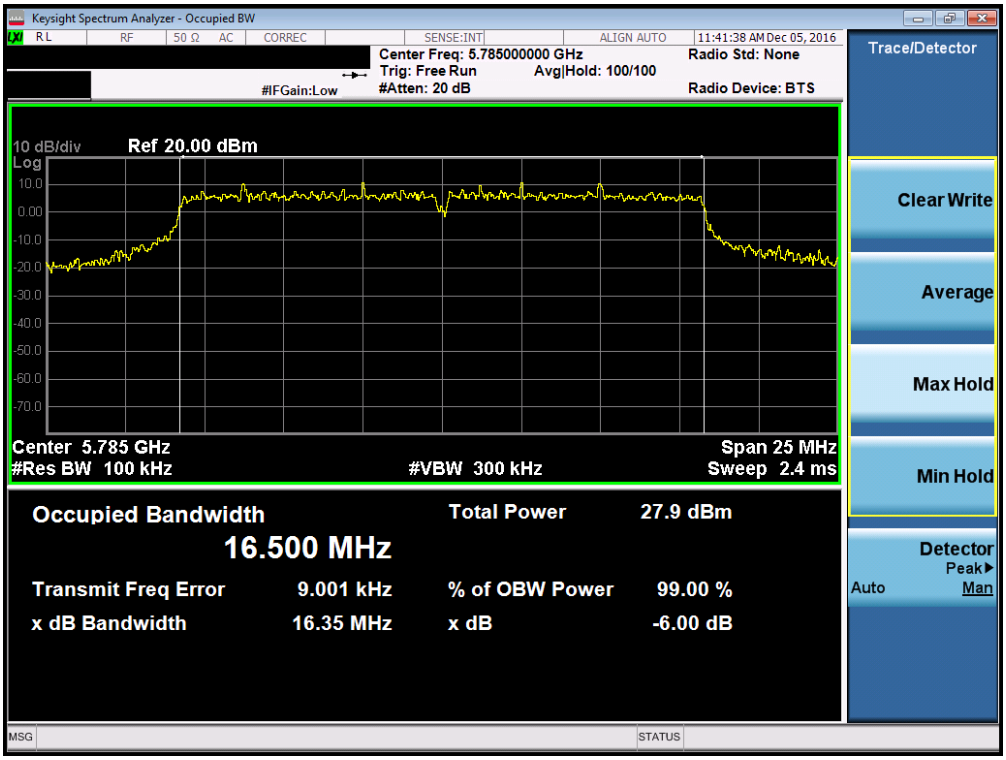
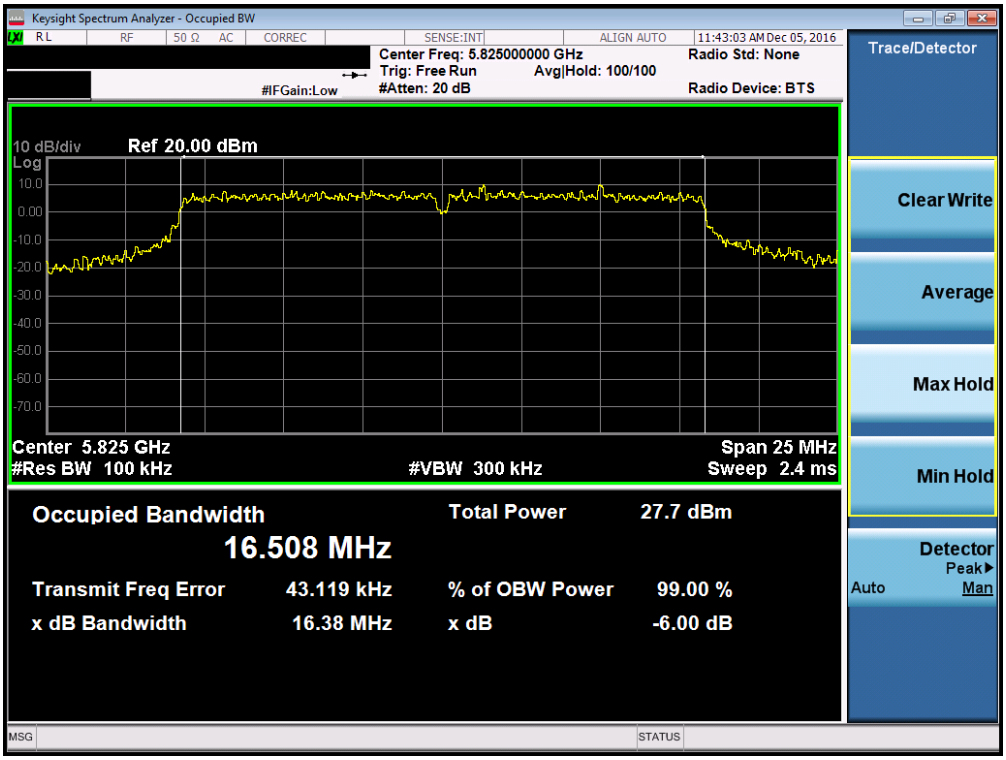


Plot 7-38. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 157)



Plot 7-39. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 165)

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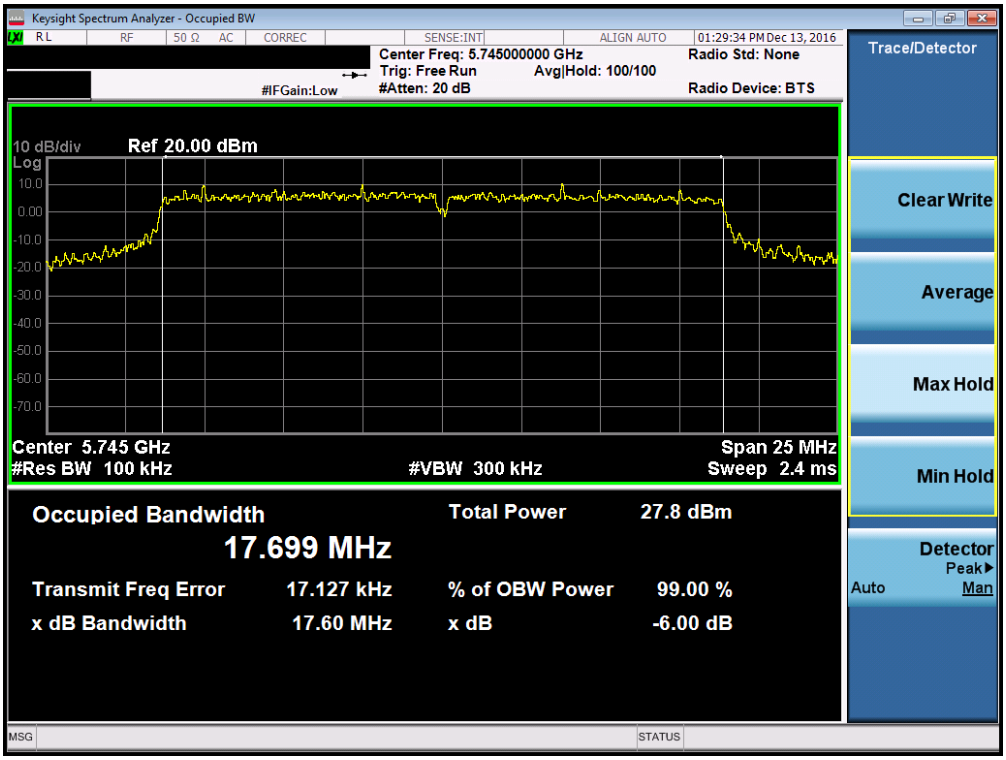
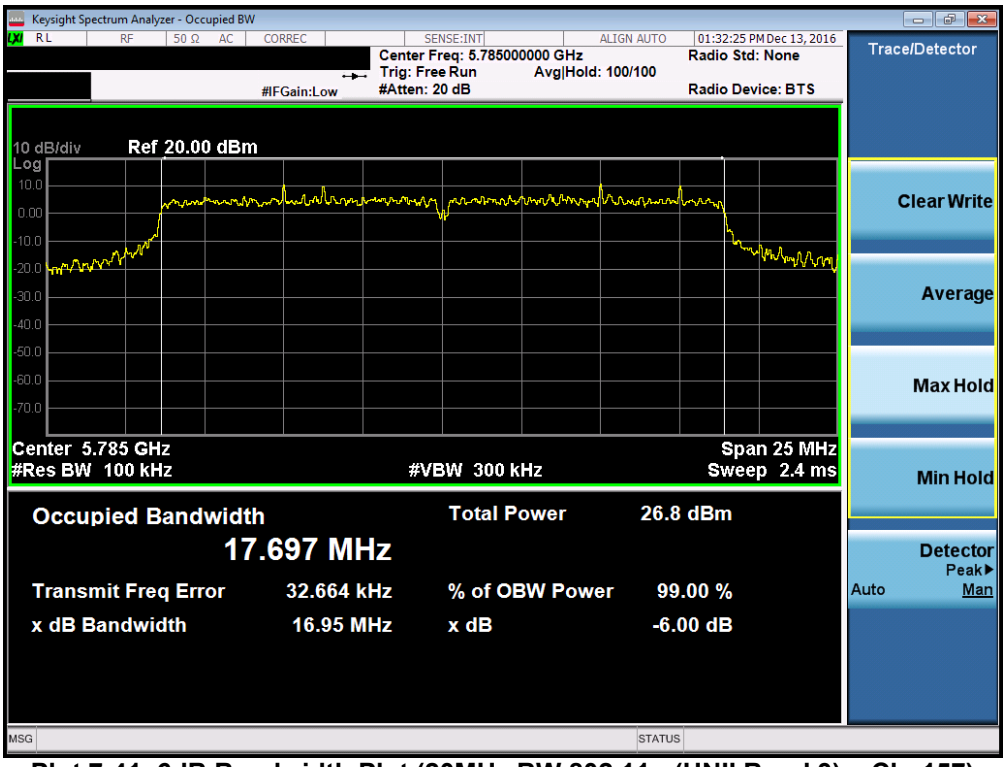


Plot 7-40. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 149)



Plot 7-41. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 157)

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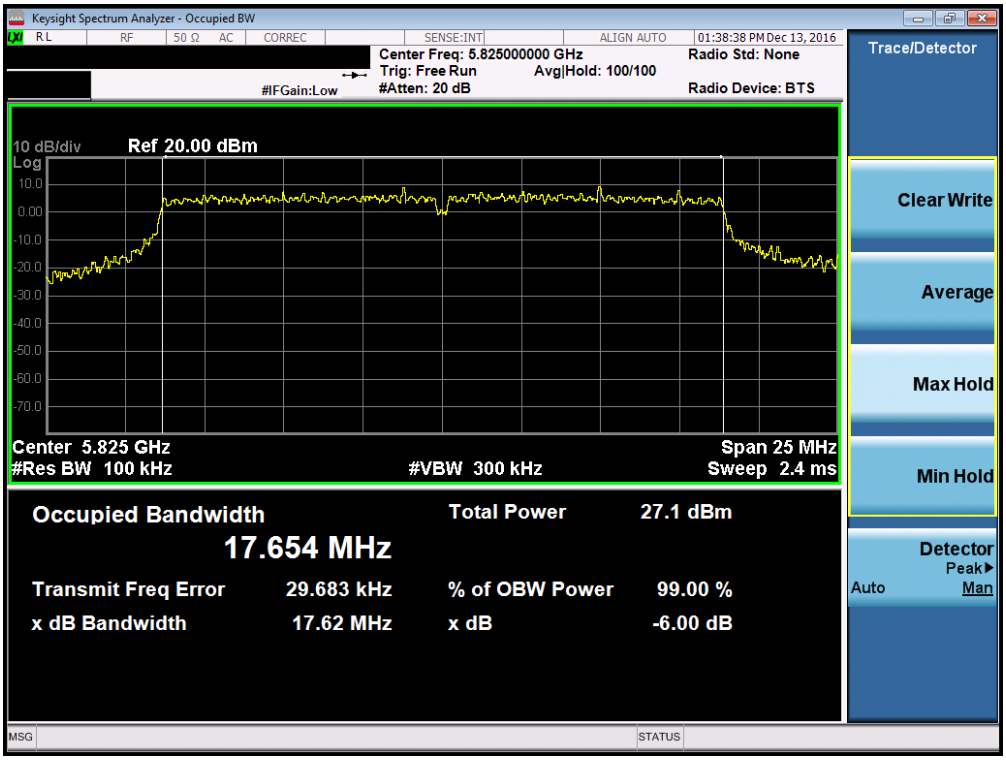
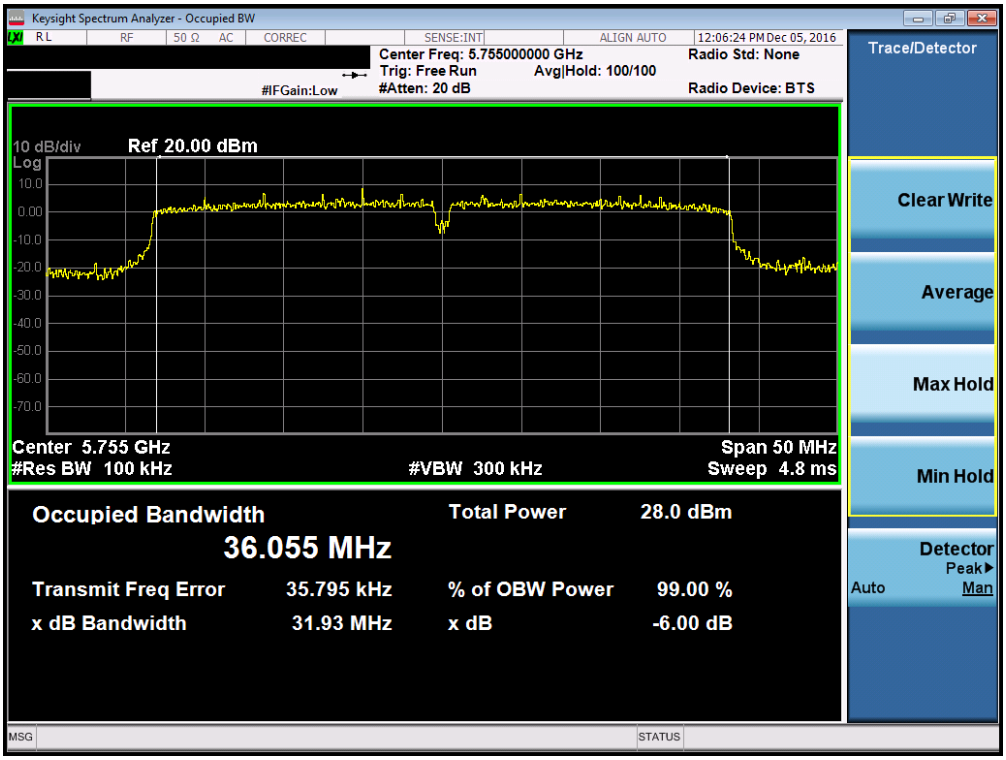


Plot 7-42. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 165)



Plot 7-43. 6dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 3) – Ch. 151)

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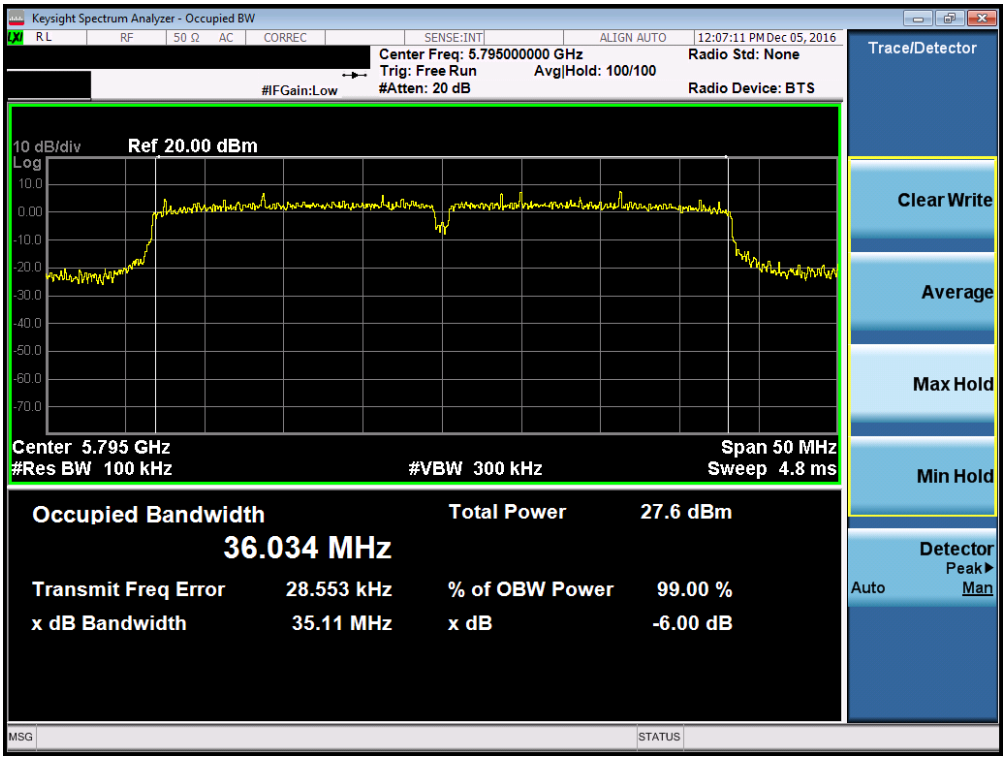
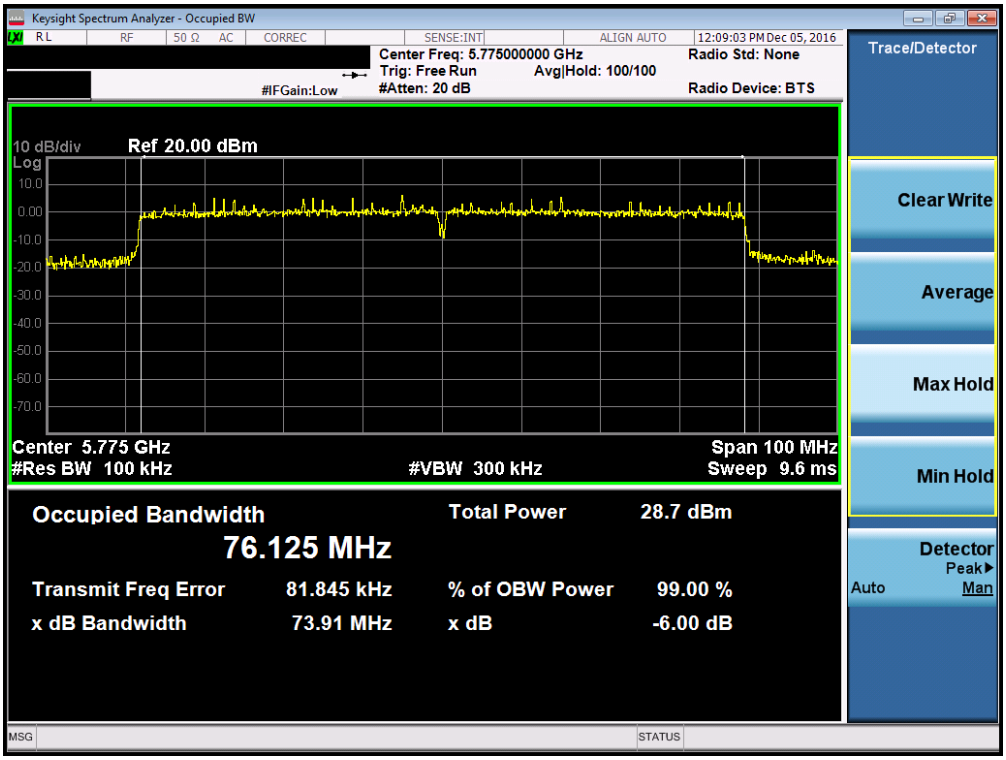


Plot 7-44. 6dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 3) – Ch. 159)



Plot 7-45. 6dB Bandwidth Plot (80MHz BW 802.11ac (UNII Band 3) – Ch. 155)

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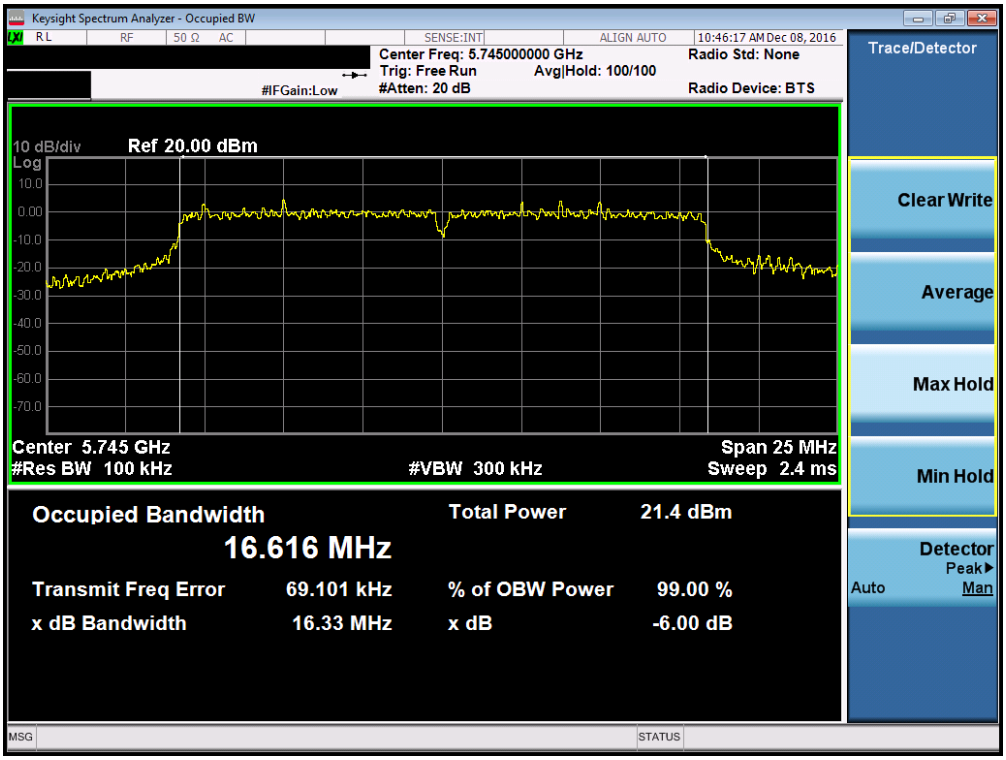
Antenna-2 6dB Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Antenna 2 Measured 6dB Bandwidth [MHz]
Band 3	5745	149	a	6	16.33
	5785	157	a	6	16.34
	5825	165	a	6	16.36
	5745	149	n (20MHz)	6.5/7.2 (MCS0)	17.39
	5785	157	n (20MHz)	6.5/7.2 (MCS0)	17.57
	5825	165	n (20MHz)	6.5/7.2 (MCS0)	17.65
	5755	151	n (40MHz)	13.5/15 (MCS0)	34.93
	5795	159	n (40MHz)	13.5/15 (MCS0)	35.68
	5775	155	ac (80MHz)	29.3/32.5 (MCS0)	75.46

Table 7-7. Conducted Bandwidth Measurements



Plot 7-46. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 149)

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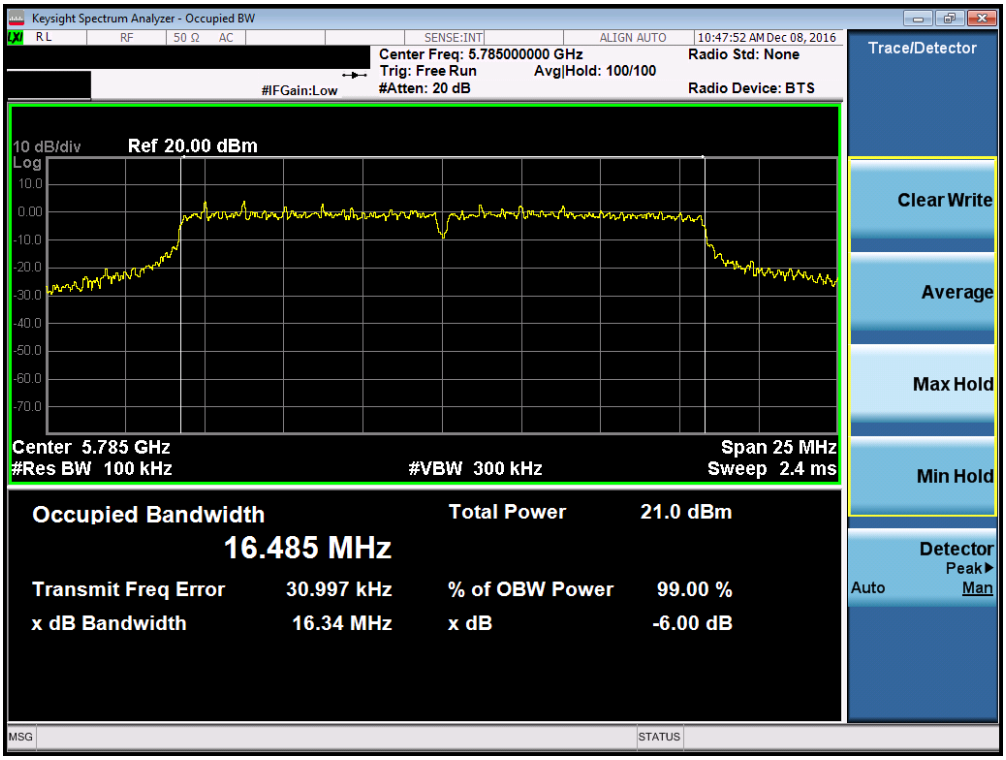
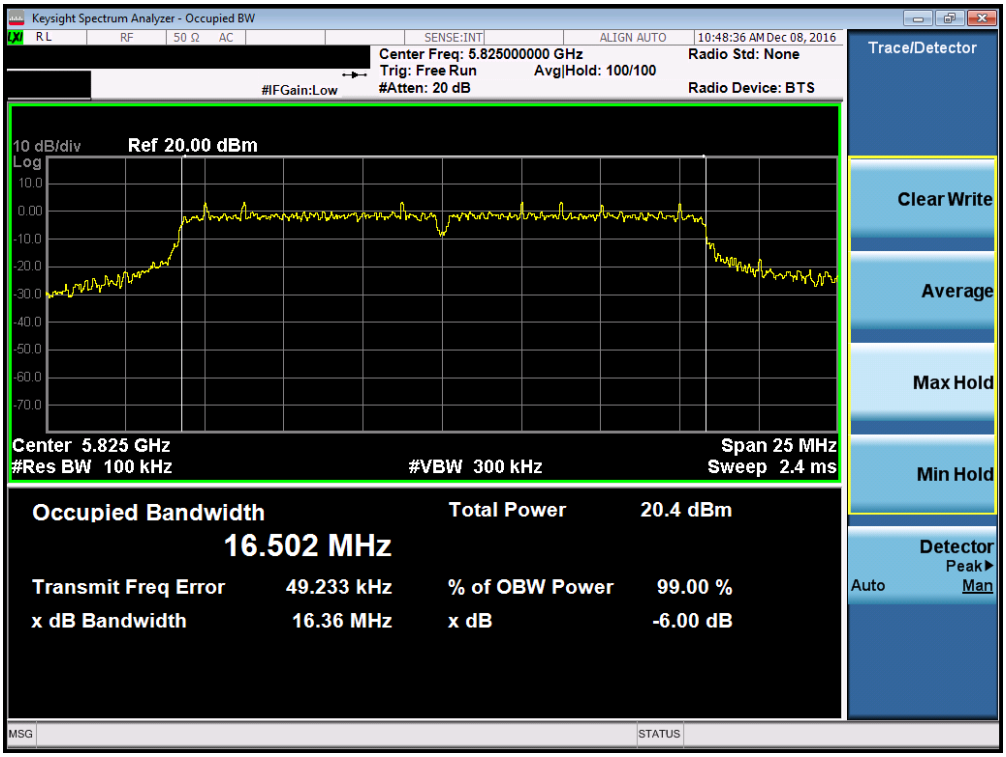


Plot 7-47. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 157)



Plot 7-48. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 165)

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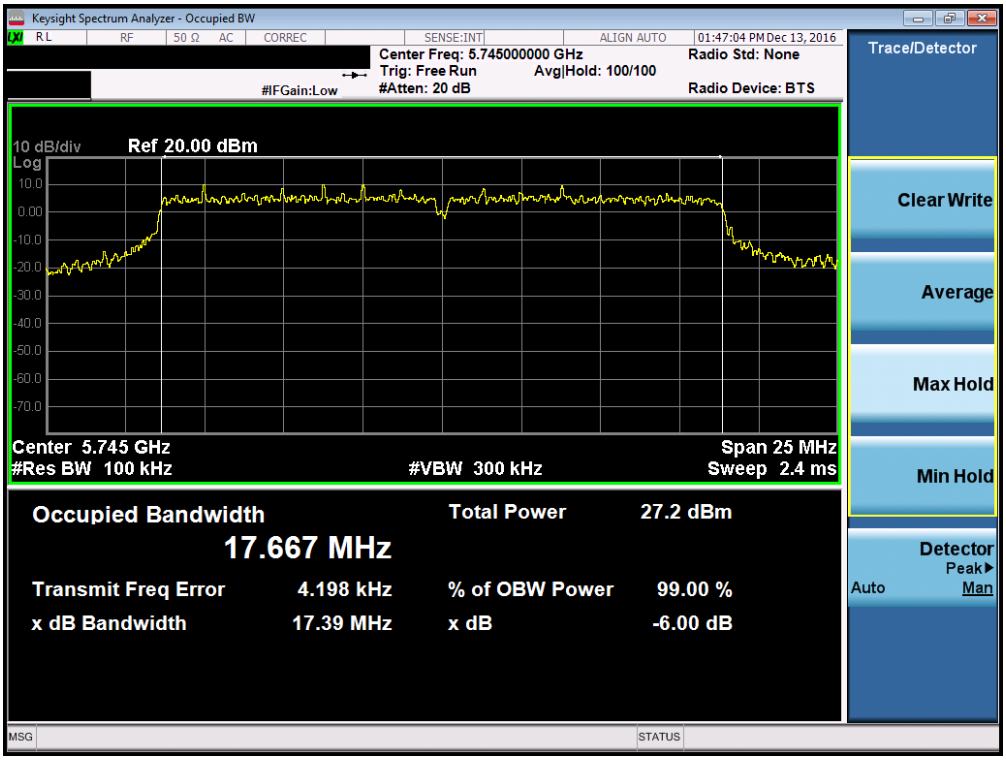
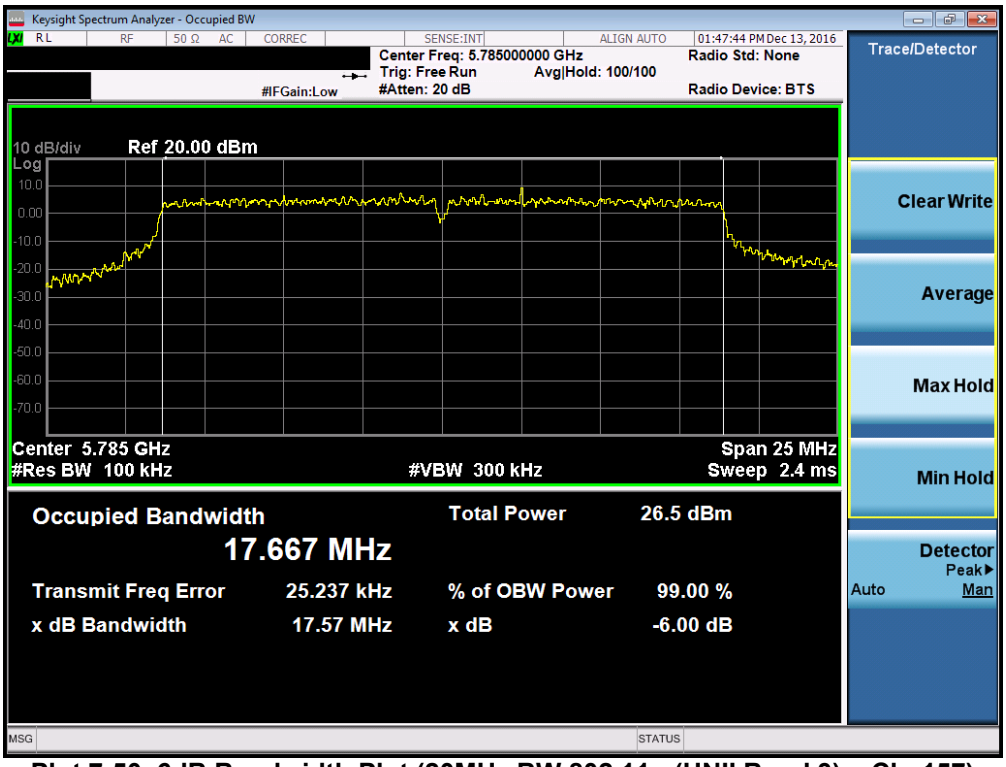


Plot 7-49. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 149)



Plot 7-50. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 157)

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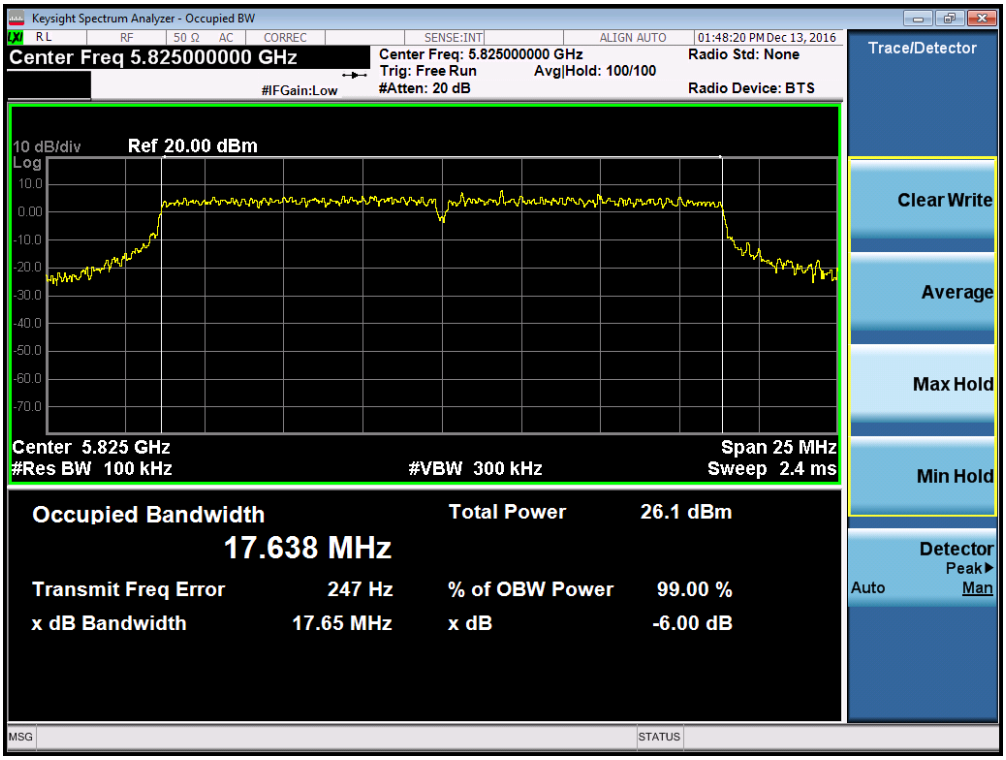
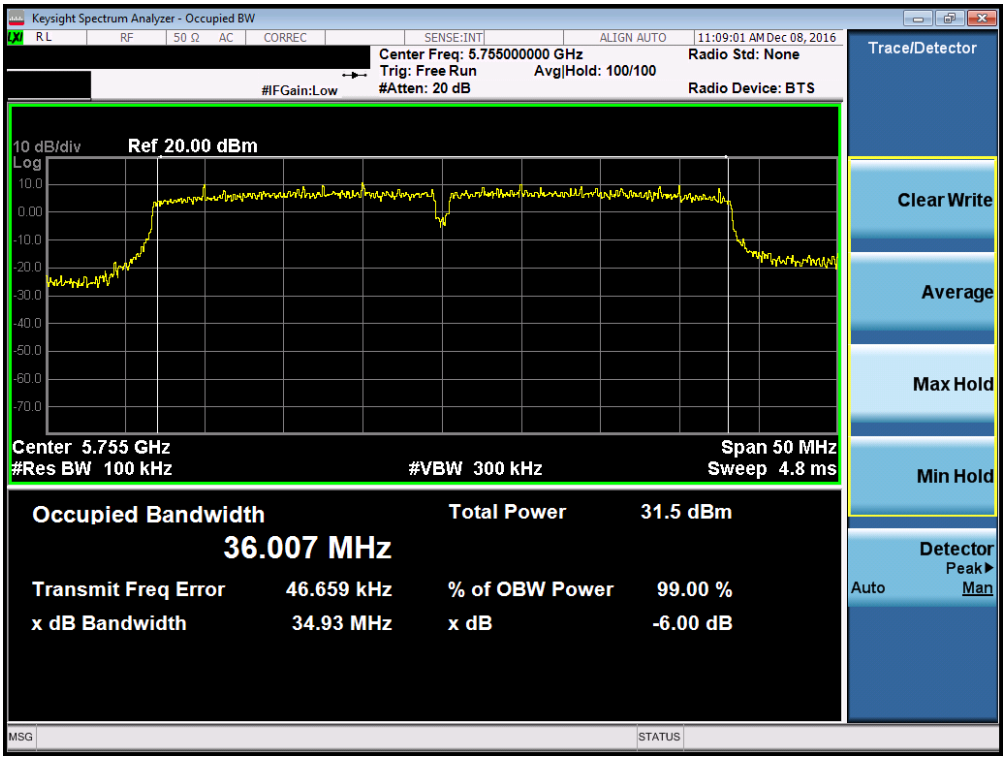


Plot 7-51. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 165)



Plot 7-52. 6dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 3) – Ch. 151)

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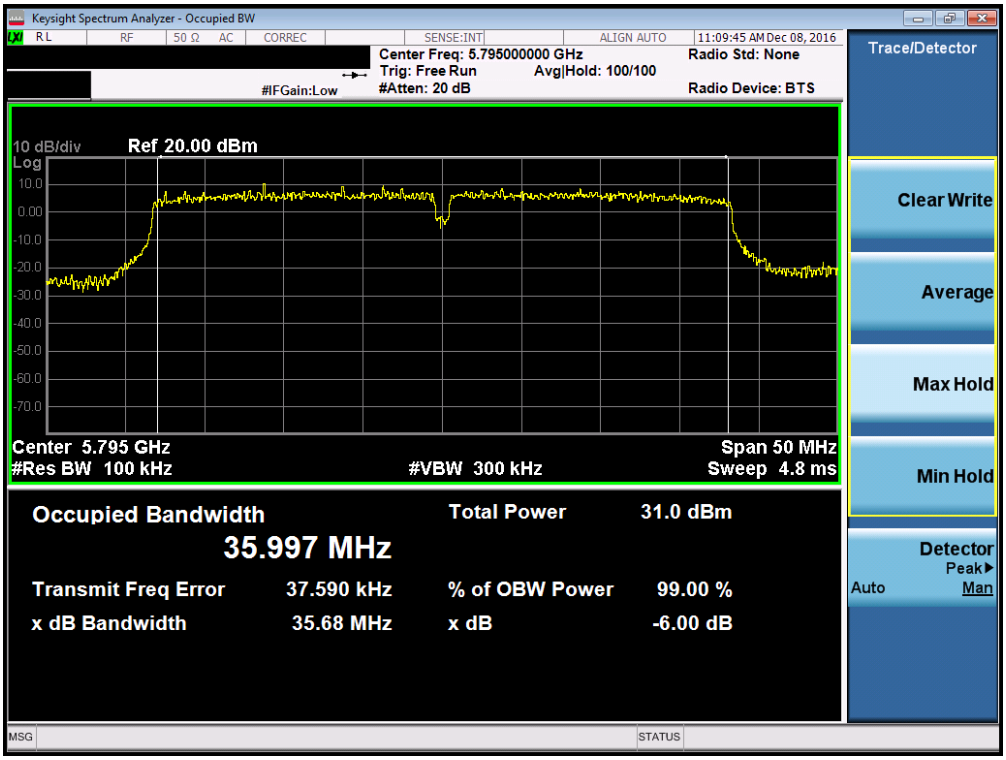
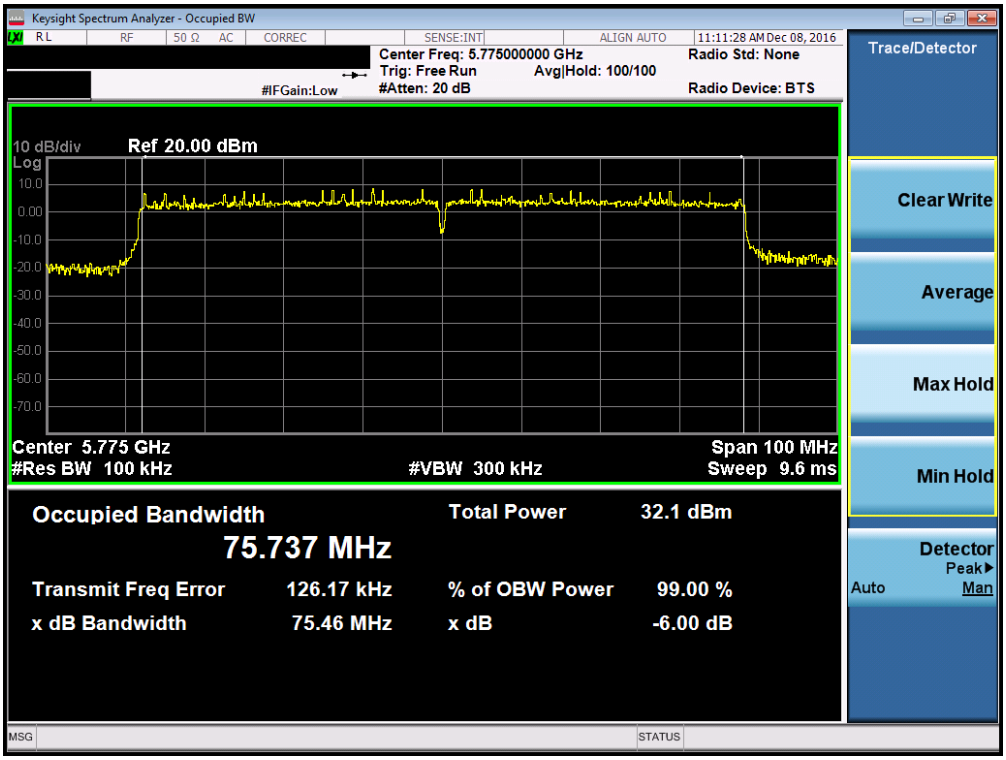


Plot 7-53. 6dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 3) – Ch. 159)



Plot 7-54. 6dB Bandwidth Plot (80MHz BW 802.11ac (UNII Band 3) – Ch. 155)

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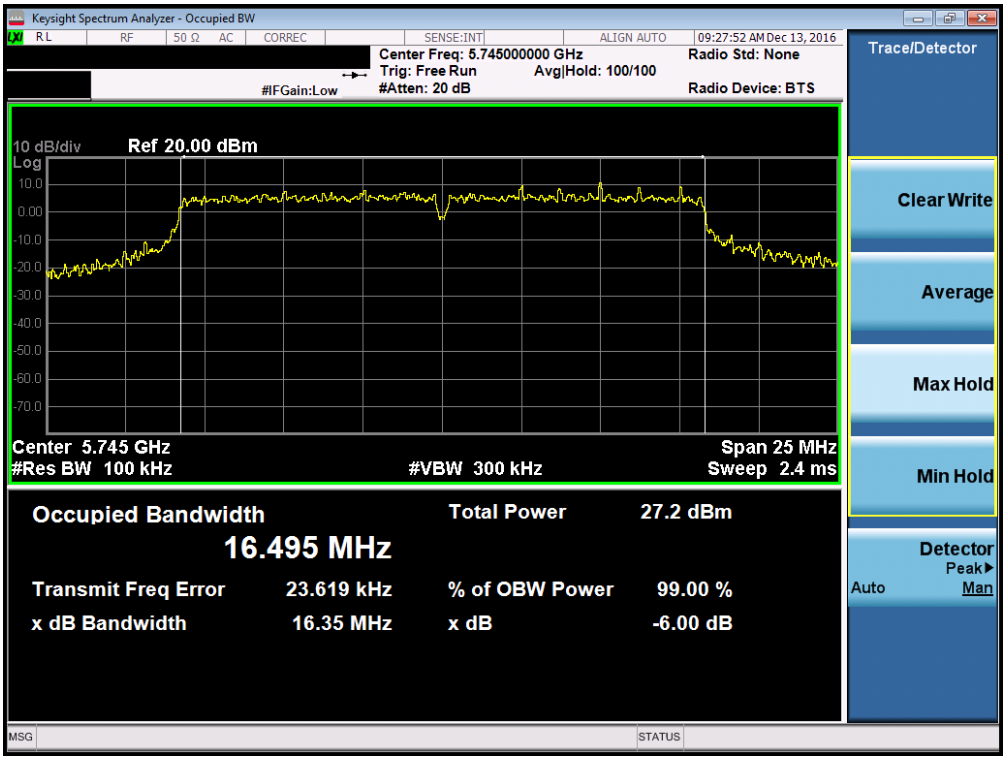
Antenna-3 6dB Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Antenna 3 Measured 6dB Bandwidth [MHz]
Band 3	5745	149	a	6	16.35
	5785	157	a	6	16.34
	5825	165	a	6	16.34
	5745	149	n (20MHz)	6.5/7.2 (MCS0)	16.96
	5785	157	n (20MHz)	6.5/7.2 (MCS0)	17.59
	5825	165	n (20MHz)	6.5/7.2 (MCS0)	17.58
	5755	151	n (40MHz)	13.5/15 (MCS0)	35.00
	5795	159	n (40MHz)	13.5/15 (MCS0)	34.02
	5775	155	ac (80MHz)	29.3/32.5 (MCS0)	75.07

Table 7-8. Conducted Bandwidth Measurements



Plot 7-55. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 149)

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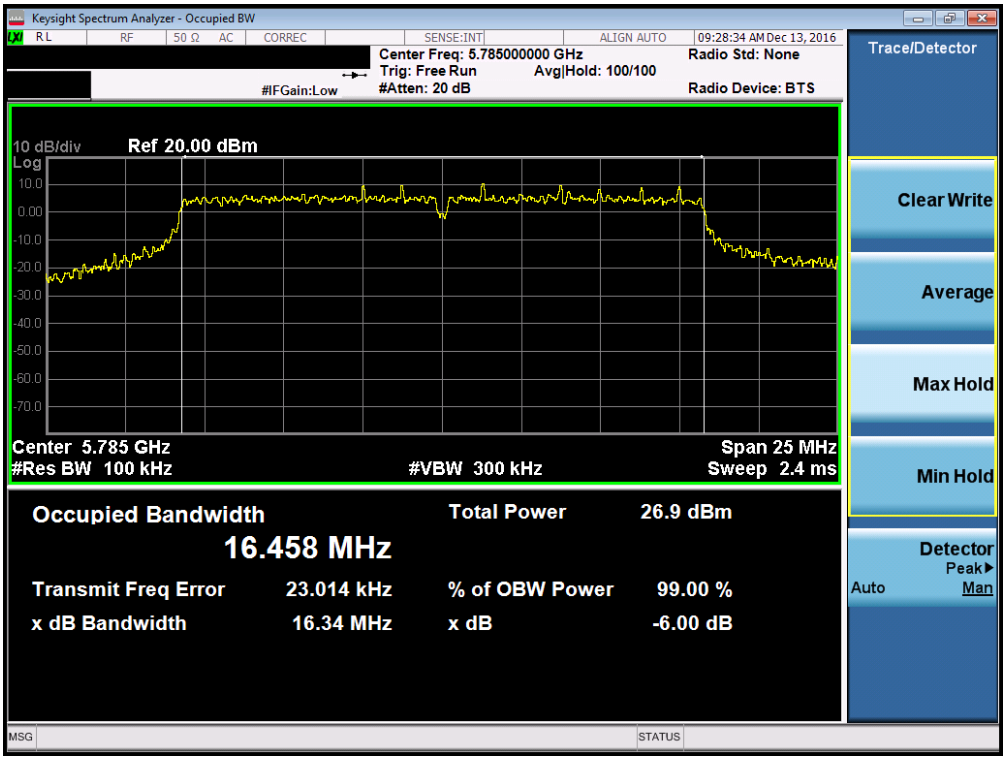
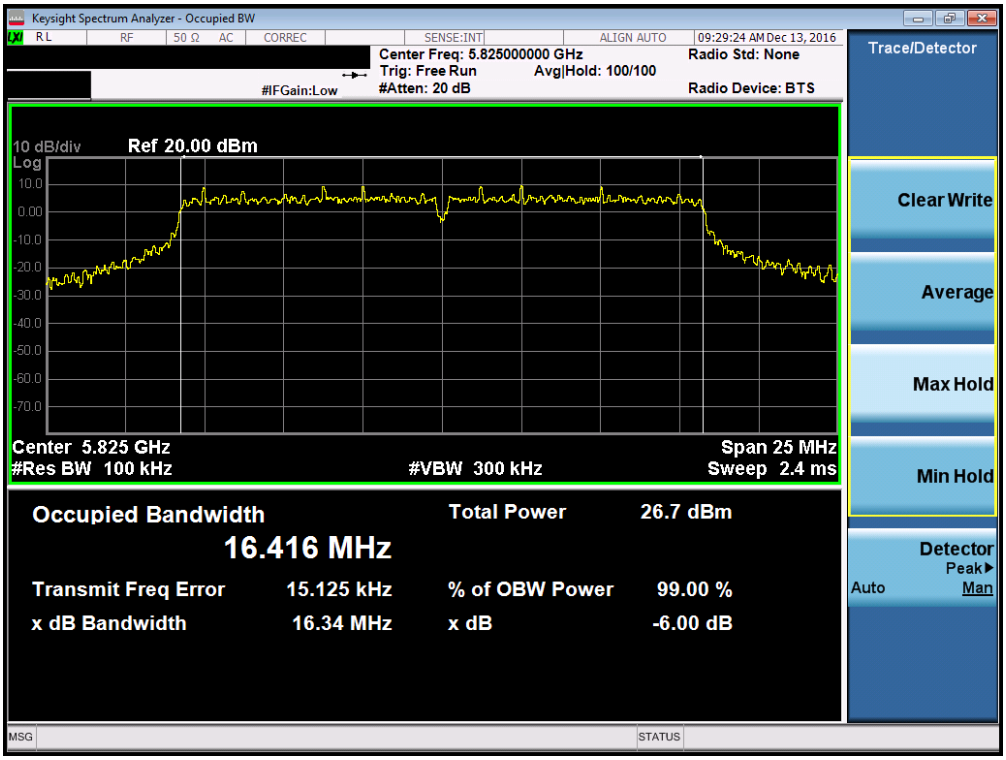


Plot 7-56. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 157)



Plot 7-57. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 165)

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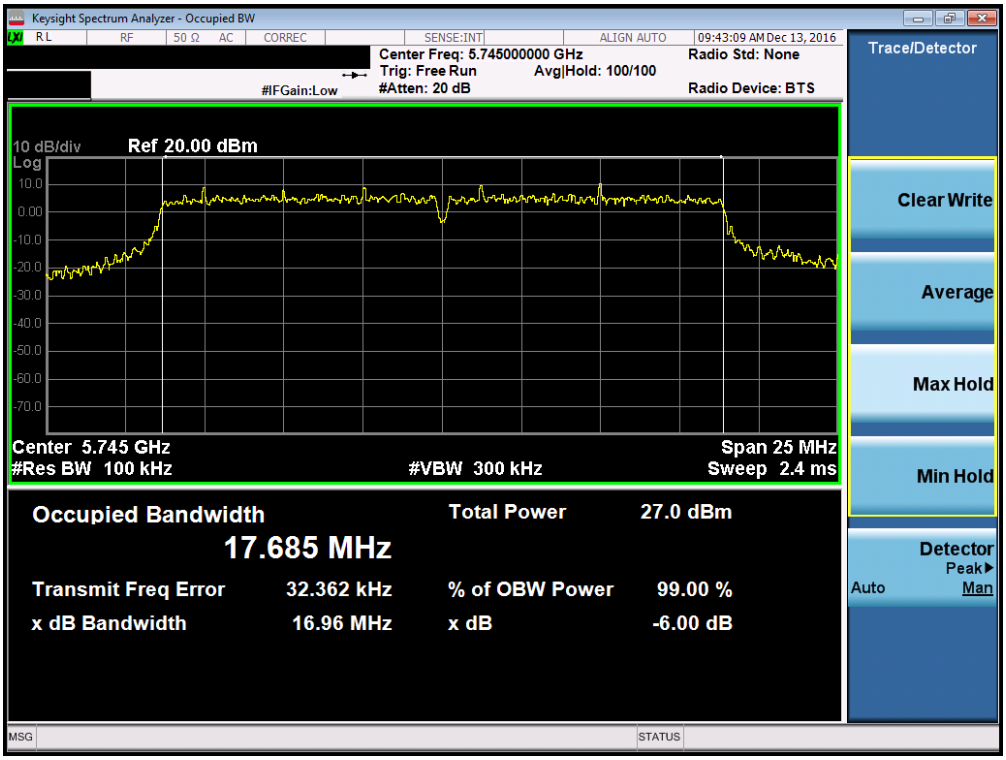
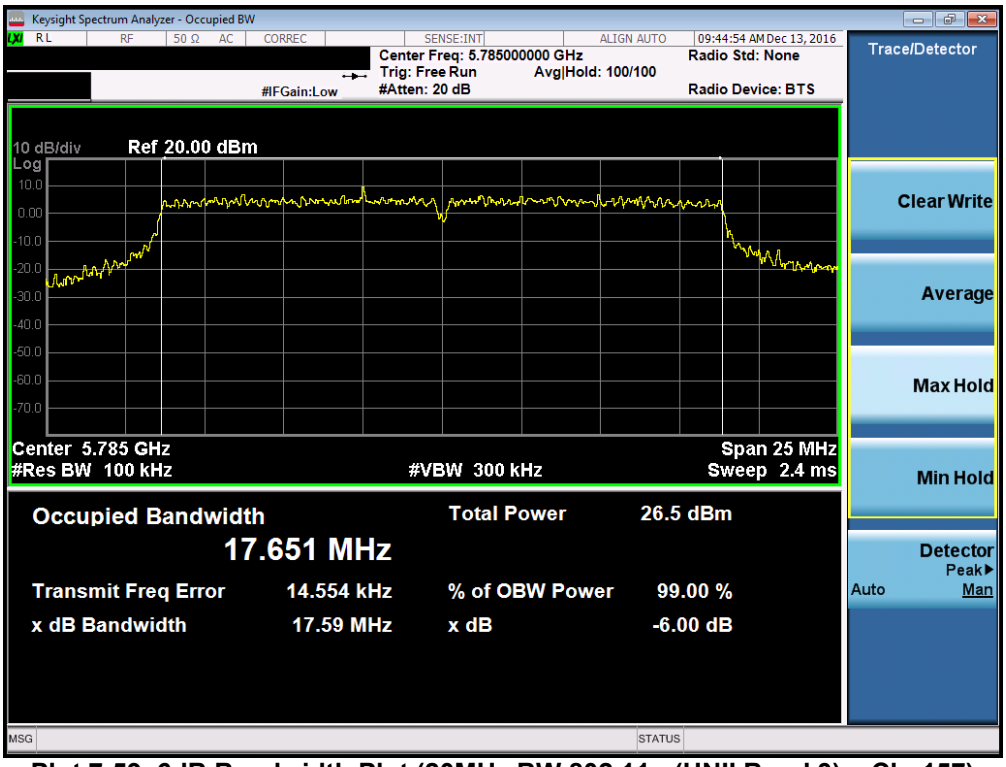


Plot 7-58. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 149)



Plot 7-59. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 157)

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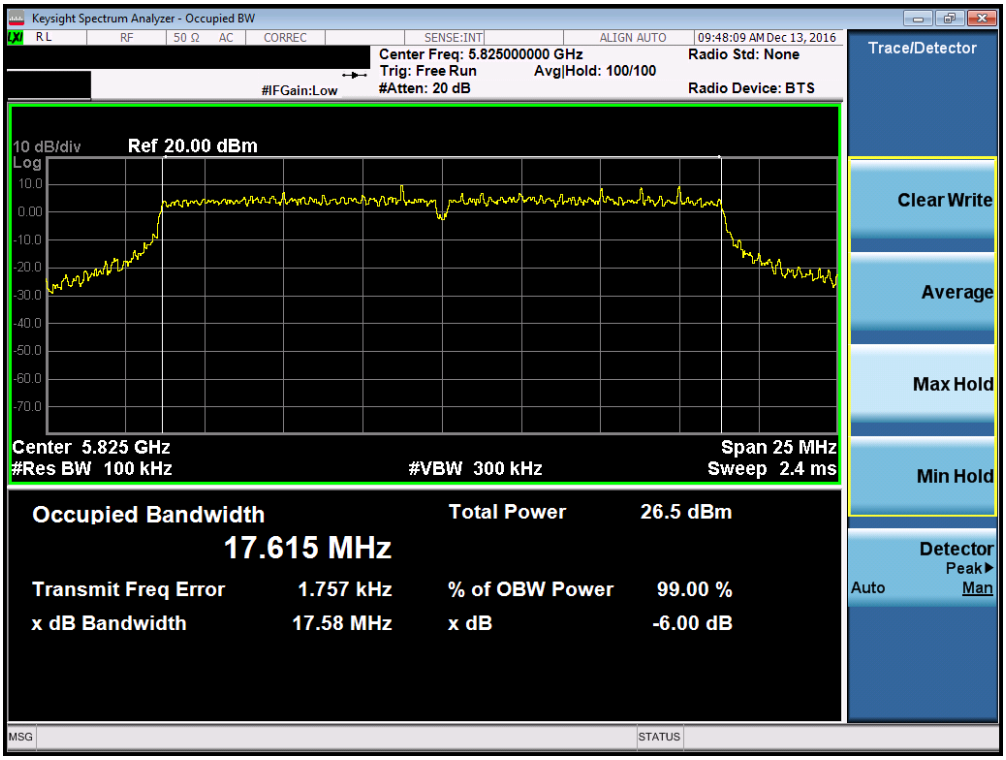
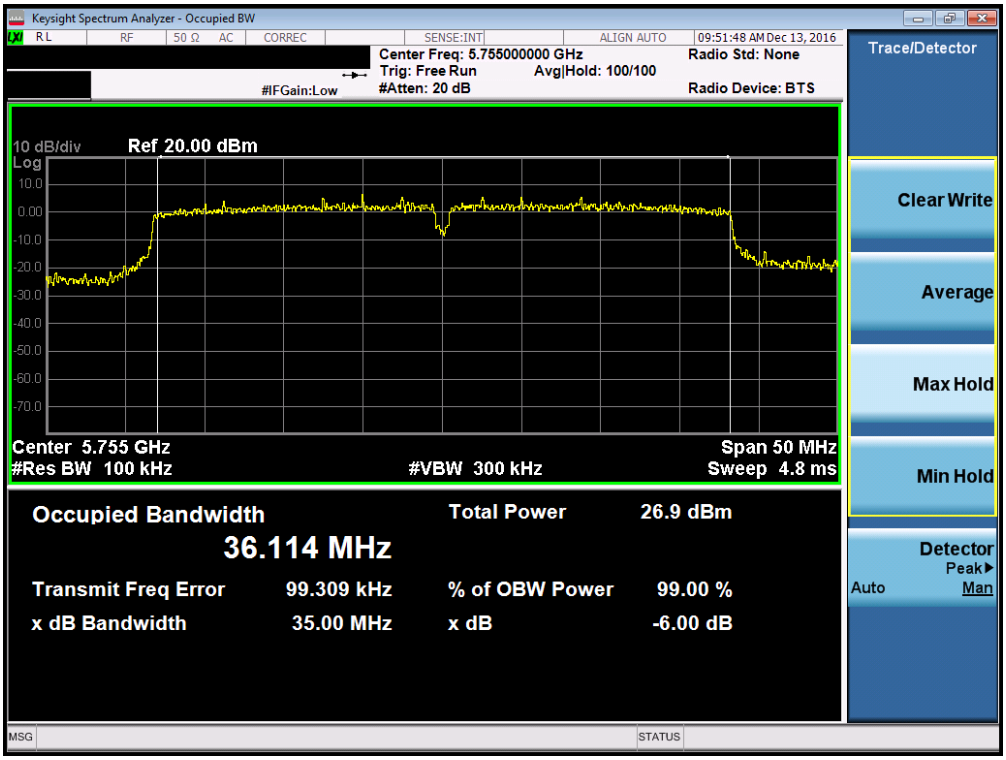


Plot 7-60. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 165)



Plot 7-61. 6dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 3) – Ch. 151)

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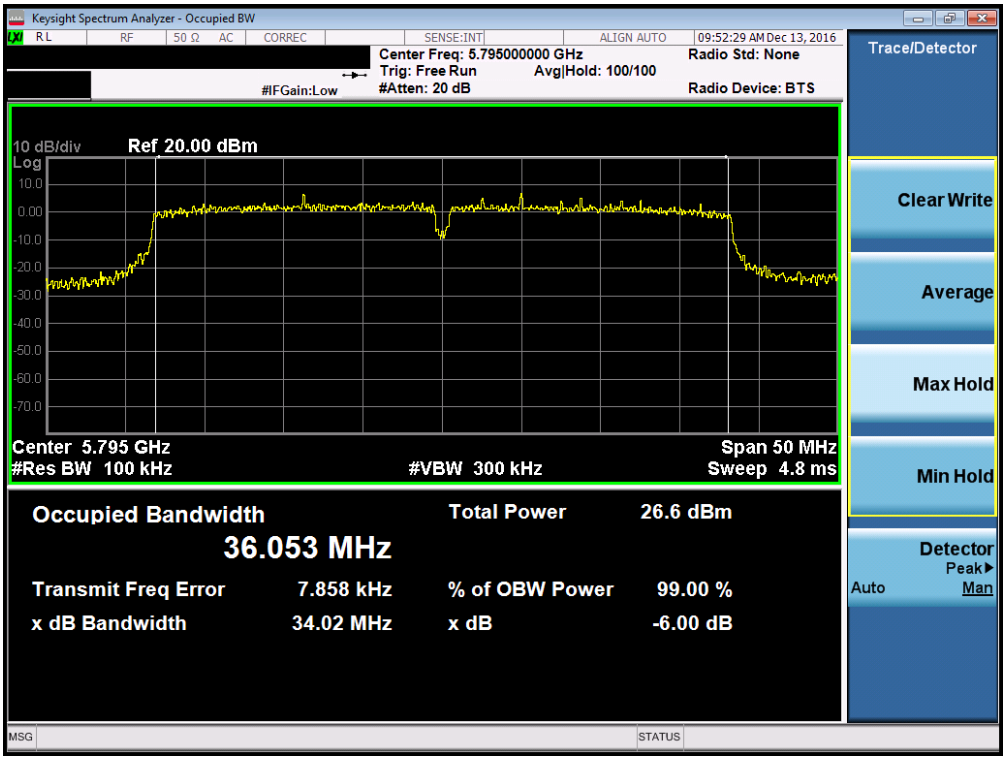
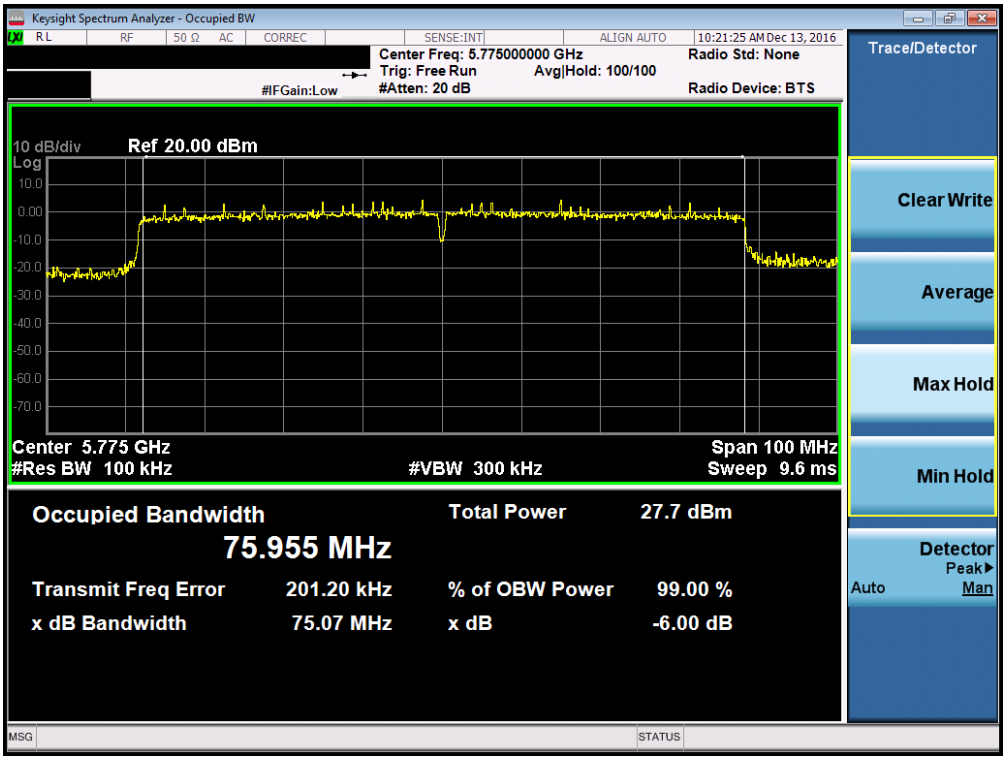


Plot 7-62. 6dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 3) – Ch. 159)



Plot 7-63. 6dB Bandwidth Plot (80MHz BW 802.11ac (UNII Band 3) – Ch. 155)

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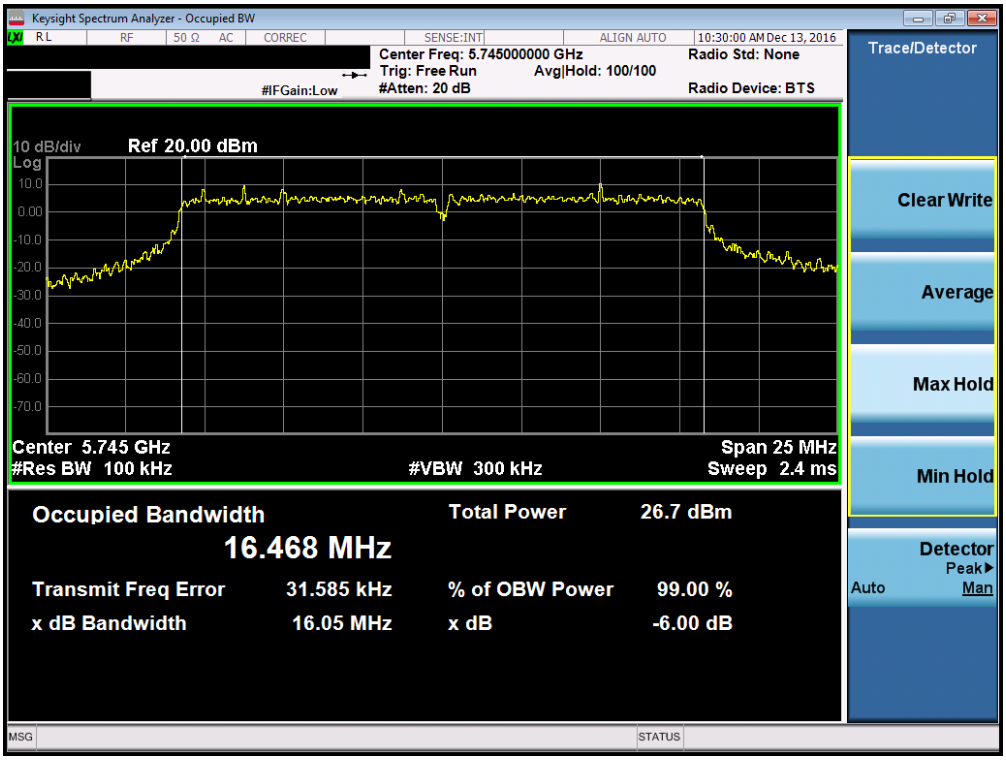
Antenna-4 6dB Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Antenna 4 Measured 6dB Bandwidth [MHz]
Band 3	5745	149	a	6	16.05
	5785	157	a	6	16.34
	5825	165	a	6	16.34
	5745	149	n (20MHz)	6.5/7.2 (MCS0)	17.60
	5785	157	n (20MHz)	6.5/7.2 (MCS0)	17.19
	5825	165	n (20MHz)	6.5/7.2 (MCS0)	17.59
	5755	151	n (40MHz)	13.5/15 (MCS0)	32.96
	5795	159	n (40MHz)	13.5/15 (MCS0)	35.06
	5775	155	ac (80MHz)	29.3/32.5 (MCS0)	74.02

Table 7-9. Conducted Bandwidth Measurements



Plot 7-64. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 149)

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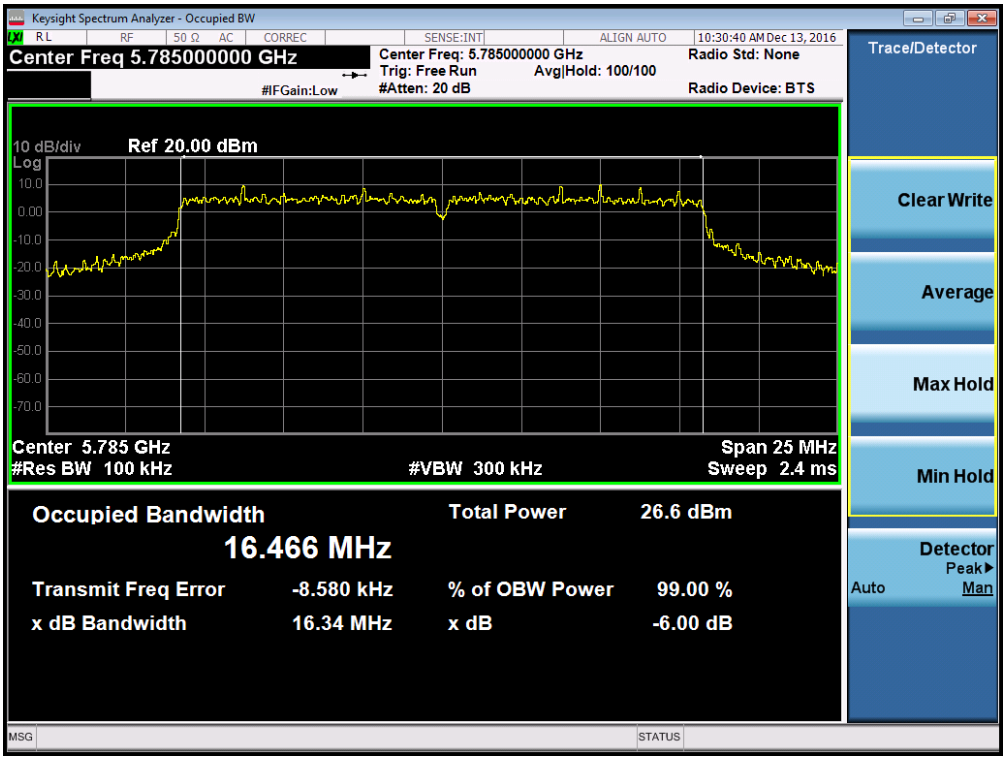
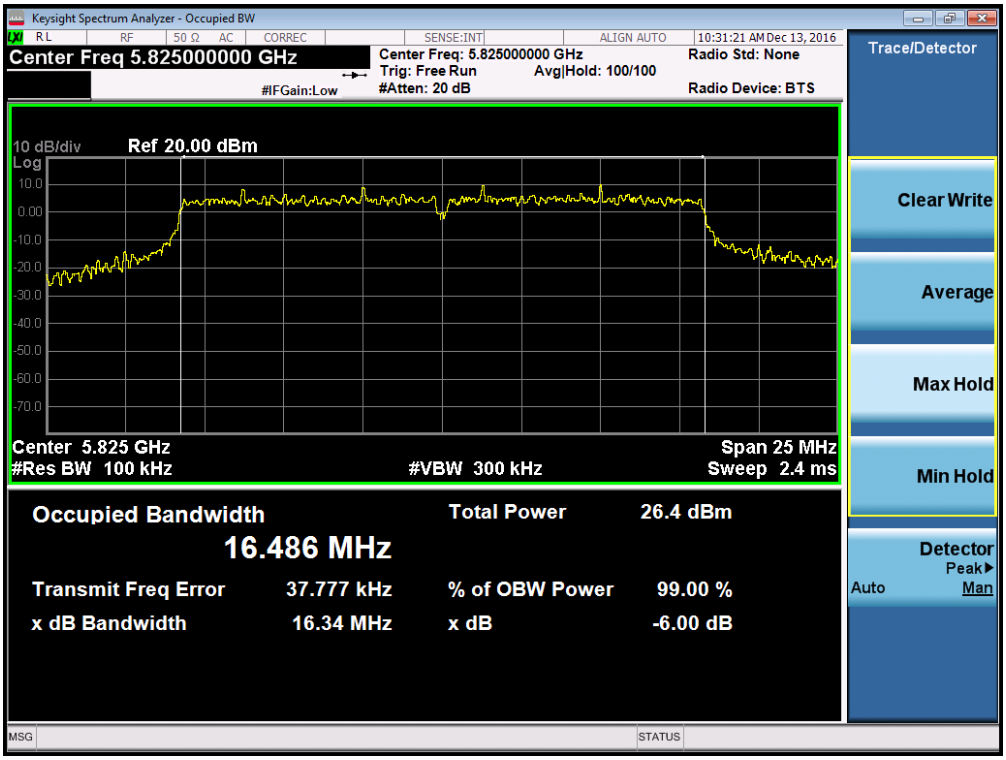


Plot 7-65. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 157)



Plot 7-66. 6dB Bandwidth Plot (802.11a (UNII Band 3) – Ch. 165)

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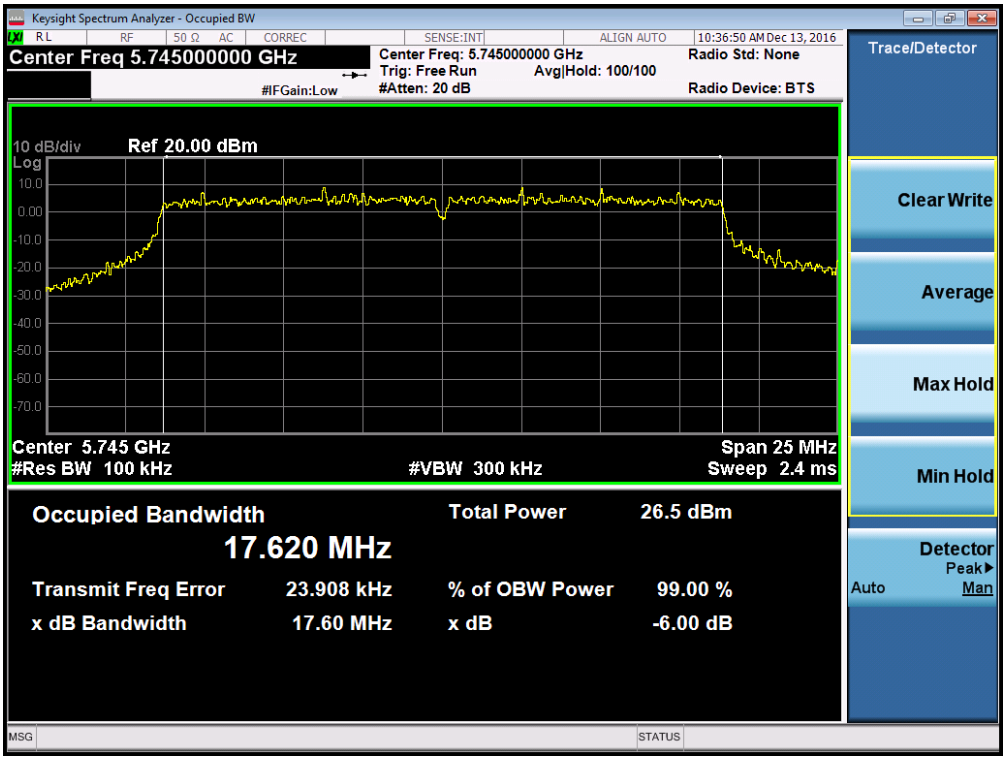
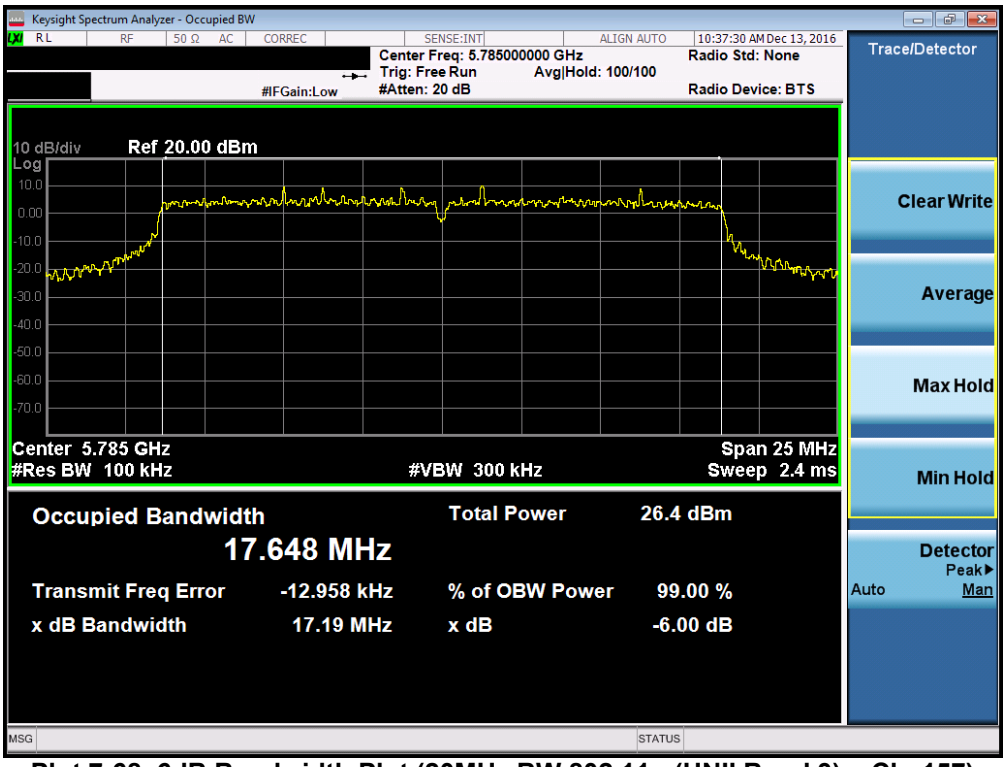


Plot 7-67. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 149)



Plot 7-68. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 157)

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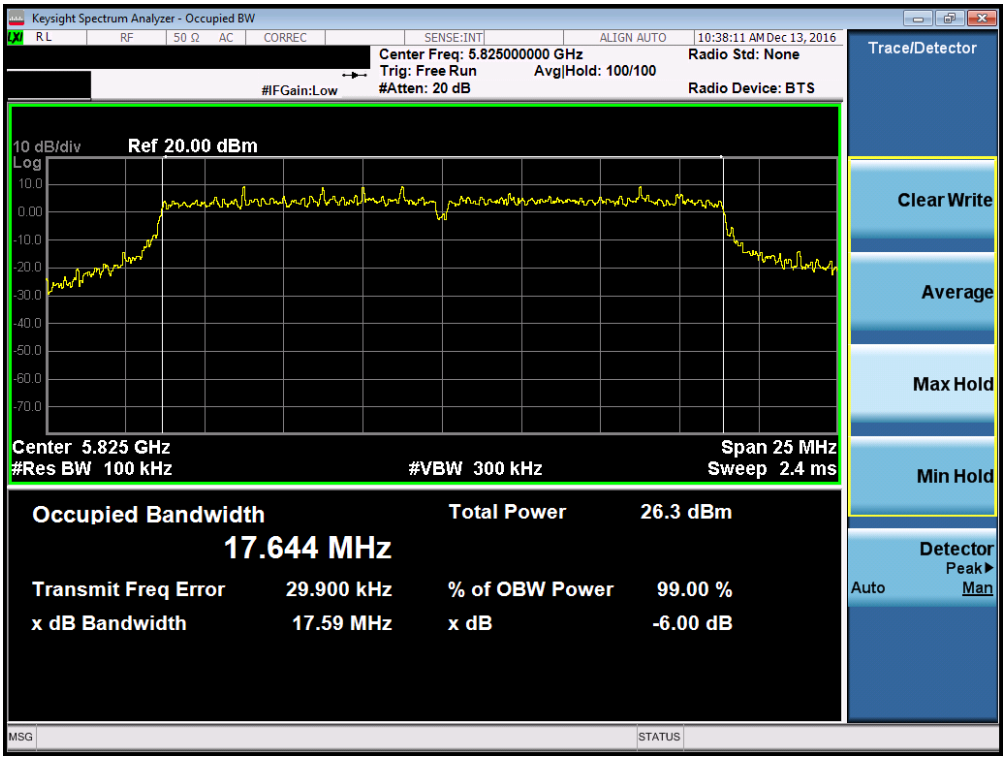
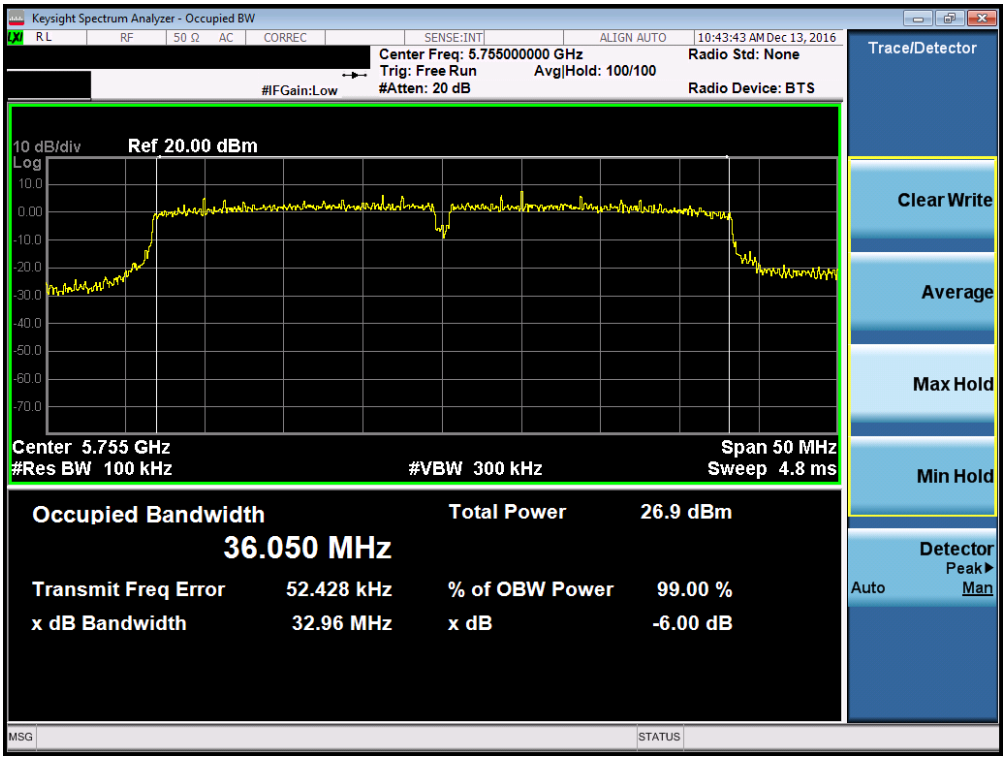


Plot 7-69. 6dB Bandwidth Plot (20MHz BW 802.11n (UNII Band 3) – Ch. 165)



Plot 7-70. 6dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 3) – Ch. 151)

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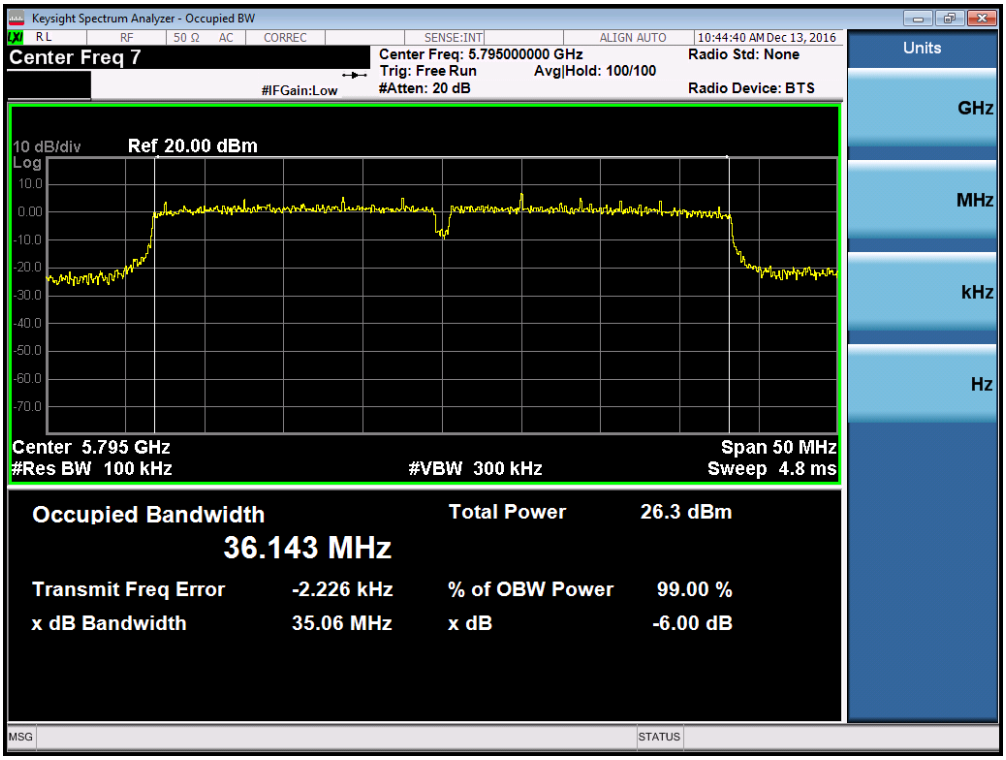
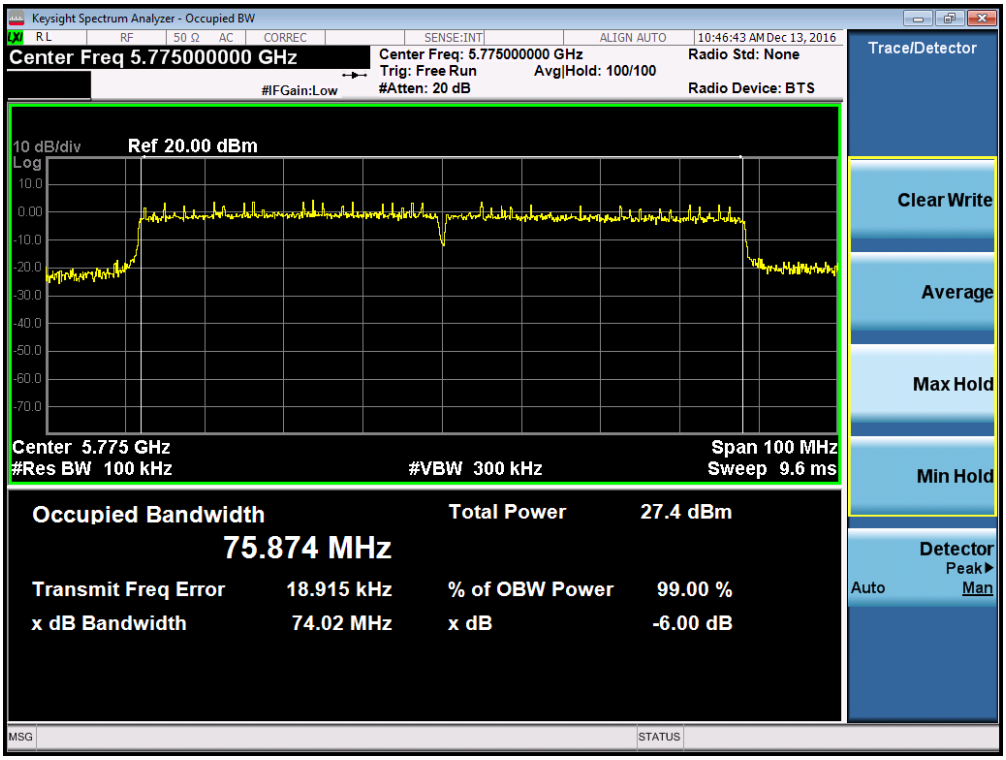


Plot 7-71. 6dB Bandwidth Plot (40MHz BW 802.11n (UNII Band 3) – Ch. 159)



Plot 7-72. 6dB Bandwidth Plot (80MHz BW 802.11ac (UNII Band 3) – Ch. 155)

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7.4 UNII Output Power Measurement – 802.11a/n/ac

§15.407(a.1.ii)

Test Overview and Limits

A transmitter antenna terminal of the EUT is connected to the input of an RF pulse power sensor. Measurement is made using a broadband average power meter while the EUT is operating at its maximum duty cycle, at its maximum power control level, as defined in KDB 789033 D02 v01r04, and at the appropriate frequencies.

In the 5.15 – 5.25GHz band and 5.725 – 5.850GHz band, the maximum permissible conducted output power is 1W (30dBm).

Test Procedure Used

KDB 789033 D02 v01r04 – Section E)3)b) Method PM-G
KDB 662911 v02r01 – Section E)1) Measure-and-Sum Technique

Test Settings

Average power measurements were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The power meter implemented triggering and gating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter. The trace was averaged over 100 traces to obtain the final measured average power.

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

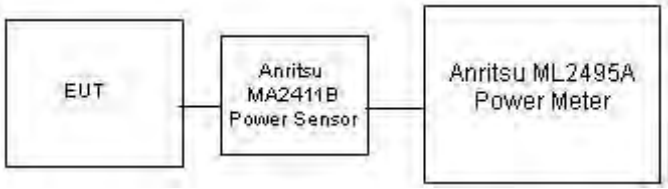

Figure 7-3. Test Instrument & Measurement Setup

Test Notes

Since the output of each of the four antennas transmit simultaneously and the signals are correlated, a directional gain is determined based on the guidance from KDB 662911 for systems with equal transmit powers and unequal antenna gains. The directional gain is applied to the summed simultaneous output power and is equal to $10\log[(10^{G1/20} + 10^{G2/20} + 10^{G3/20} + 10^{G4/20})^2 / N_{ANT}]$ dB, where the gains are specified in units of dBi.

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Antenna-1 Conducted Output Power Measurements

Freq [MHz]	Channel	Detector	5GHz (20MHz) Conducted Power [dBm]		
			IEEE Transmission Mode		
			802.11a	802.11n	802.11ac
5180	36	AVG	16.13	16.01	15.94
5200	40	AVG	20.77	20.14	20.19
5220	44	AVG	20.69	20.16	20.26
5240	48	AVG	20.98	20.84	20.13
5745	149	AVG	20.94	20.92	20.16
5785	157	AVG	20.35	20.51	20.88
5825	165	AVG	20.01	20.22	20.74

Table 7-10. 20MHz BW (UNII) Maximum Conducted Output Power

Freq [MHz]	Channel	Detector	5GHz (40MHz) Conducted Power [dBm]	
			IEEE Transmission Mode	
			802.11n	802.11ac
5190	38	AVG	13.99	13.99
5230	46	AVG	19.74	19.96
5755	151	AVG	20.45	19.54
5795	159	AVG	20.14	20.31

Table 7-11. 40MHz BW (UNII) Maximum Conducted Output Power

5GHz (80MHz) Conducted Power [dBm]			
Freq [MHz]	Channel	Detector	IEEE Transmission Mode
			802.11ac
5210	42	AVG	10.12
5775	155	AVG	18.74

Table 7-12. 80MHz BW (UNII) Maximum Conducted Output Power

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Antenna-2 Conducted Output Power Measurements

Freq [MHz]	Channel	Detector	5GHz (20MHz) Conducted Power [dBm]		
			IEEE Transmission Mode		
			802.11a	802.11n	802.11ac
5180	36	AVG	15.90	16.13	15.91
5200	40	AVG	20.84	20.38	20.71
5220	44	AVG	20.60	20.41	20.53
5240	48	AVG	20.37	20.22	20.16
5745	149	AVG	20.45	20.27	20.77
5785	157	AVG	20.22	20.78	20.38
5825	165	AVG	20.86	20.50	20.85

Table 7-13. 20MHz BW (UNII) Maximum Conducted Output Power

Freq [MHz]	Channel	Detector	5GHz (40MHz) Conducted Power [dBm]	
			IEEE Transmission Mode	
			802.11n	802.11ac
5190	38	AVG	13.87	13.88
5230	46	AVG	20.02	20.15
5755	151	AVG	19.69	19.64
5795	159	AVG	20.21	20.19

Table 7-14. 40MHz BW (UNII) Maximum Conducted Output Power

5GHz (80MHz) Conducted Power [dBm]			
Freq [MHz]	Channel	Detector	IEEE Transmission Mode
			802.11ac
5210	42	AVG	10.48
5775	155	AVG	18.98

Table 7-15. 80MHz BW (UNII) Maximum Conducted Output Power

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Antenna-3 Conducted Output Power Measurements

Freq [MHz]	Channel	Detector	5GHz (20MHz) Conducted Power [dBm]		
			IEEE Transmission Mode		
			802.11a	802.11n	802.11ac
5180	36	AVG	16.18	16.21	16.07
5200	40	AVG	20.16	20.18	20.04
5220	44	AVG	20.18	20.02	20.07
5240	48	AVG	20.32	20.11	20.03
5745	149	AVG	20.77	20.45	20.34
5785	157	AVG	20.62	20.35	20.80
5825	165	AVG	20.84	20.74	20.83

Table 7-16. 20MHz BW (UNII) Maximum Conducted Output Power

Freq [MHz]	Channel	Detector	5GHz (40MHz) Conducted Power [dBm]	
			IEEE Transmission Mode	
			802.11n	802.11ac
5190	38	AVG	13.75	13.96
5230	46	AVG	20.28	19.81
5755	151	AVG	20.20	19.66
5795	159	AVG	19.77	19.58

Table 7-17. 40MHz BW (UNII) Maximum Conducted Output Power

5GHz (80MHz) Conducted Power [dBm]			
Freq [MHz]	Channel	Detector	IEEE Transmission Mode
			802.11ac
5210	42	AVG	9.83
5775	155	AVG	18.75

Table 7-18. 80MHz BW (UNII) Maximum Conducted Output Power

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Antenna-4 Conducted Output Power Measurements

Freq [MHz]	Channel	Detector	5GHz (20MHz) Conducted Power [dBm]		
			IEEE Transmission Mode		
			802.11a	802.11n	802.11ac
5180	36	AVG	16.34	16.40	16.48
5200	40	AVG	20.73	20.54	20.74
5220	44	AVG	20.68	20.73	20.89
5240	48	AVG	20.27	20.65	20.09
5745	149	AVG	20.46	20.31	20.13
5785	157	AVG	20.71	20.45	20.22
5825	165	AVG	20.46	20.25	20.02

Table 7-19. 20MHz BW (UNII) Maximum Conducted Output Power

Freq [MHz]	Channel	Detector	5GHz (40MHz) Conducted Power [dBm]	
			IEEE Transmission Mode	
			802.11n	802.11ac
5190	38	AVG	14.12	13.76
5230	46	AVG	19.81	19.80
5755	151	AVG	19.98	19.87
5795	159	AVG	19.94	19.81

Table 7-20. 40MHz BW (UNII) Maximum Conducted Output Power

5GHz (80MHz) Conducted Power [dBm]			
Freq [MHz]	Channel	Detector	IEEE Transmission Mode
			802.11ac
5210	42	AVG	9.80
5775	155	AVG	19.31

Table 7-21. 80MHz BW (UNII) Maximum Conducted Output Power

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MIMO Maximum Conducted Output Power Measurements

Freq [MHz]	Channel	Detector	Directional Gain [dBi]	5GHz (20MHz) Conducted Power [dBm] IEEE Transmission Mode					Max Permissible Conducted Power [dBm]	Adjusted Limit [dBm]	Margin [dB]
				ANT1	ANT2	ANT3	ANT4	MIMO			
5180	36	AVG	9.18	14.99	14.11	14.22	14.38	20.46	30.00	26.82	-6.36
5200	40	AVG	9.18	15.12	14.33	14.11	14.40	20.53	30.00	26.82	-6.29
5220	44	AVG	9.18	15.11	14.44	14.01	13.77	20.38	30.00	26.82	-6.44
5240	48	AVG	9.19	14.86	14.26	14.26	13.66	20.30	30.00	26.81	-6.51
5745	149	AVG	9.48	14.91	14.27	14.44	14.30	20.51	30.00	26.52	-6.01
5785	157	AVG	9.48	14.55	14.23	14.36	14.44	20.42	30.00	26.52	-6.10
5825	165	AVG	9.87	14.67	14.26	13.76	14.26	20.27	30.00	26.13	-5.86

Table 7-22. MIMO 20MHz BW 802.11n (UNII) Maximum Conducted Output Power

Freq [MHz]	Channel	Detector	Directional Gain [dBi]	5GHz (20MHz) Conducted Power [dBm] IEEE Transmission Mode					Max Permissible Conducted Power [dBm]	Adjusted Limit [dBm]	Margin [dB]
				ANT1	ANT2	ANT3	ANT4	MIMO			
5180	36	AVG	9.18	14.92	13.98	14.33	13.39	20.21	30.00	26.82	-6.61
5200	40	AVG	9.18	15.18	13.88	14.42	13.77	20.37	30.00	26.82	-6.45
5220	44	AVG	9.18	15.22	13.99	14.24	13.87	20.38	30.00	26.82	-6.44
5240	48	AVG	9.19	15.11	14.26	14.03	13.84	20.36	30.00	26.81	-6.45
5745	149	AVG	9.48	15.35	14.27	14.33	13.99	20.54	30.00	26.52	-5.98
5785	157	AVG	9.48	15.25	14.32	13.88	13.99	20.42	30.00	26.52	-6.10
5825	165	AVG	9.87	15.33	14.22	13.87	14.24	20.47	30.00	26.13	-5.66

Table 7-23. MIMO 20MHz BW 802.11ac (UNII) Maximum Conducted Output Power

Freq [MHz]	Channel	Detector	Directional Gain [dBi]	5GHz (40MHz) Conducted Power [dBm] IEEE Transmission Mode					Max Permissible Conducted Power [dBm]	Adjusted Limit [dBm]	Margin [dB]
				ANT1	ANT2	ANT3	ANT4	MIMO			
5190	38	AVG	9.18	11.97	11.98	12.01	12.22	18.07	30.00	26.82	-8.75
5230	46	AVG	9.18	13.74	13.98	13.27	13.25	19.59	30.00	26.82	-7.23
5755	151	AVG	9.48	14.44	13.68	14.21	13.99	20.11	30.00	26.52	-6.41
5795	159	AVG	9.48	14.26	14.21	13.78	13.99	20.08	30.00	26.52	-6.44

Table 7-24. MIMO 40MHz BW 802.11n (UNII) Maximum Conducted Output Power

Freq [MHz]	Channel	Detector	Directional Gain [dBi]	5GHz (40MHz) Conducted Power [dBm] IEEE Transmission Mode					Max Permissible Conducted Power [dBm]	Adjusted Limit [dBm]	Margin [dB]
				ANT1	ANT2	ANT3	ANT4	MIMO			
5190	38	AVG	9.18	11.24	11.85	12.35	12.34	17.99	30.00	26.82	-8.83
5230	46	AVG	9.18	13.99	14.25	13.86	13.89	20.02	30.00	26.82	-6.80
5755	151	AVG	9.48	14.26	14.41	13.66	13.88	20.08	30.00	26.52	-6.44
5795	159	AVG	9.48	14.25	14.19	13.59	13.81	19.99	30.00	26.52	-6.53

Table 7-25. MIMO 40MHz BW 802.11ac (UNII) Maximum Conducted Output Power

Freq [MHz]	Channel	Detector	Directional Gain [dBi]	5GHz (80MHz) Conducted Power [dBm] IEEE Transmission Mode					Max Permissible Conducted Power [dBm]	Adjusted Limit [dBm]	Margin [dB]
				ANT1	ANT2	ANT3	ANT4	MIMO			
5210	42	AVG	9.19	9.99	10.33	10.24	10.26	16.23	30.00	26.81	-10.58
5775	155	AVG	9.87	12.77	12.99	12.75	13.31	18.98	30.00	26.13	-7.15

Table 7-26. MIMO 80MHz BW 802.11ac (UNII) Maximum Conducted Output Power

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Note:

Per KDB 662911 v02r01 Section E)1), the conducted powers at Antenna 1 and Antenna 2 were first measured separately during MIMO transmission as shown in the section above. The measured values were then summed in linear power units then converted back to dBm.

Sample MIMO Calculation:

At 5180MHz in 802.11n (20MHz BW), the average conducted output power was measured to be N/A dBm for Antenna-1, 14.11 dBm for Antenna-2, 14.22 dBm for Antenna-3, and N/A dBm for Antenna-4.

Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 = MIMO power (mW)

(N/A dBm + 14.11 dBm + 14.22 dBm + 14.38 dBm) = (N/A mW + 25.76 mW + 26.42 mW + 27.42 mW) = 111.15 mW = N/A dBm

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7.5 Maximum Power Spectral Density – 802.11a/n/ac

§15.407(a.1.ii)

Test Overview and Limit

The spectrum analyzer was connected to the antenna terminal while the EUT was operating at its maximum duty cycle, at its maximum power control level, as defined in KDB 789033 D02 v01r04, and at the appropriate frequencies. Method SA-1, as defined in KDB 789033 D02 v01r04, was used to measure the power spectral density.

In the 5.15 – 5.25GHz band, the maximum permissible power spectral density is 17dBm/MHz.

In the 5.725 – 5.850GHz band, the maximum permissible power spectral density is 30dBm/500kHz.

Test Procedure Used

KDB 789033 D02 v01r04 – Section F
KDB 662911 v02r01 – Section E)2) Measure-and-Sum Technique

Test Settings

1. Analyzer was set to the center frequency of the UNII channel under investigation
2. Span was set to encompass the entire emission bandwidth of the signal
3. RBW = 1MHz
4. VBW = 3MHz
5. Number of sweep points $\geq$ 2 x (span/RBW)
6. Sweep time = auto
7. Detector = power averaging (RMS)
8. Trigger was set to free run for all modes
9. Trace was averaged over 100 sweeps
10. The peak search function of the spectrum analyzer was used to find the peak of the spectrum.

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

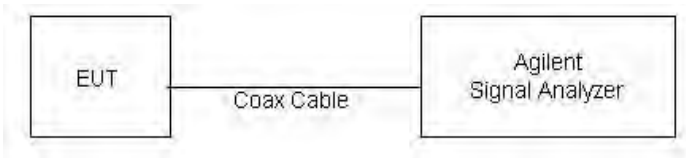

Figure 7-4. Test Instrument & Measurement Setup

Test Notes

Since the output of each of the four antennas transmit simultaneously and the signals are correlated, a directional gain is determined based on the guidance from KDB 662911 for systems with equal transmit powers and unequal antenna gains. The directional gain is applied to the summed simultaneous output power and is equal to $10\log[(10^{G1/20} + 10^{G2/20} + 10^{G3/20} + 10^{G4/20})^2 / N_{ANT}]$ dB, where the gains are specified in units of dBi.

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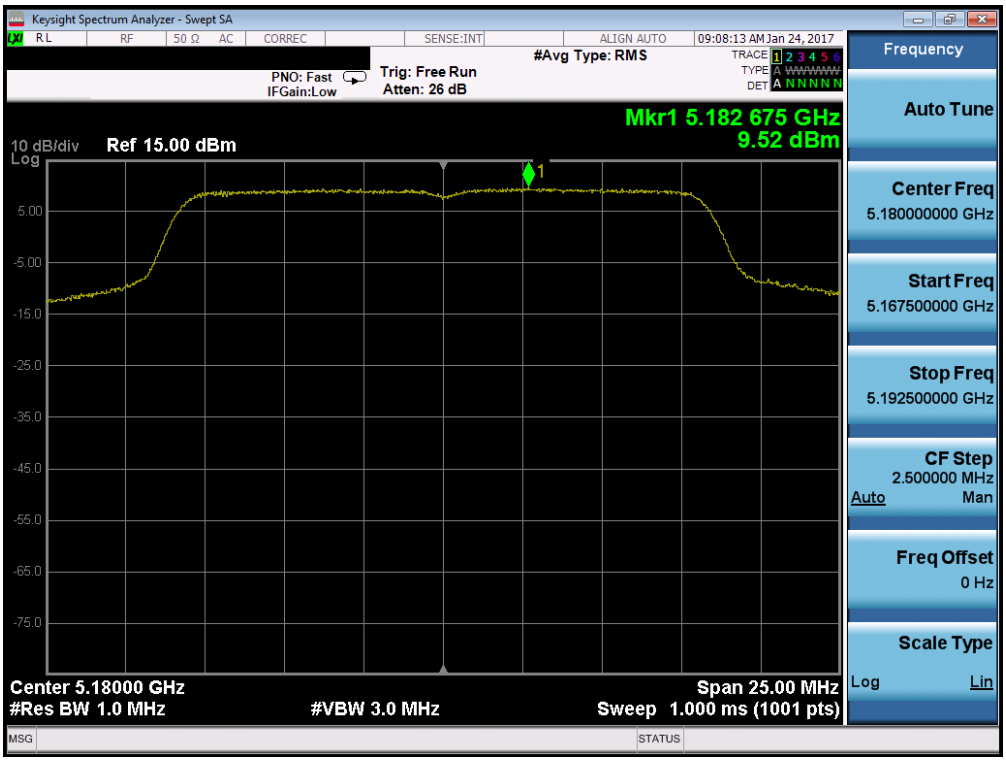
Antenna-1 Power Spectral Density Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Measured Power Density [dBm]	Max Permissible Power Density [dBm/MHz]	Margin [dB]	Pass / Fail
Band 1	5180	36	a	6	9.52	17.0	-7.48	Pass
	5200	40	a	6	9.25	17.0	-7.75	Pass
	5240	48	a	6	8.69	17.0	-8.31	Pass
	5180	36	n (20MHz)	6.5/7.2 (MCS0)	9.15	17.0	-7.85	Pass
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	8.63	17.0	-8.37	Pass
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	7.27	17.0	-9.73	Pass
	5190	38	n (40MHz)	13.5/15 (MCS0)	6.79	17.0	-10.21	Pass
	5230	46	n (40MHz)	13.5/15 (MCS0)	7.05	17.0	-9.95	Pass
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	3.28	17.0	-13.72	Pass

Table 7-27. Band 1 Conducted Power Spectral Density Measurements



Plot 7-73. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 36)

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Plot 7-74. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 40)

Plot 7-75. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 48)

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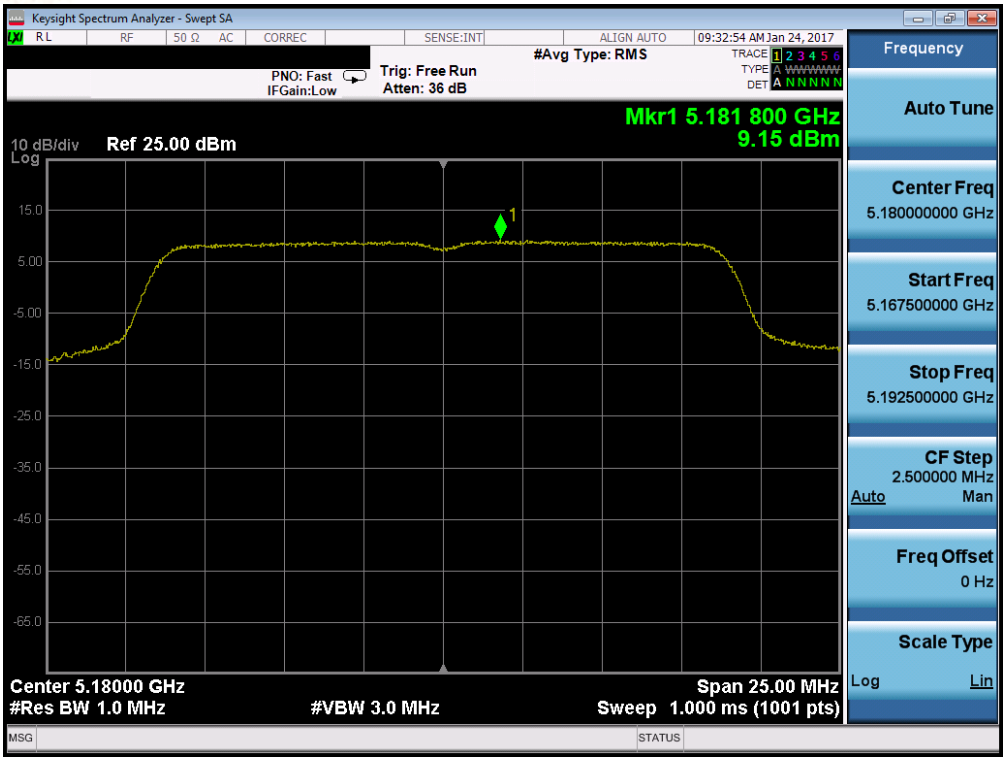
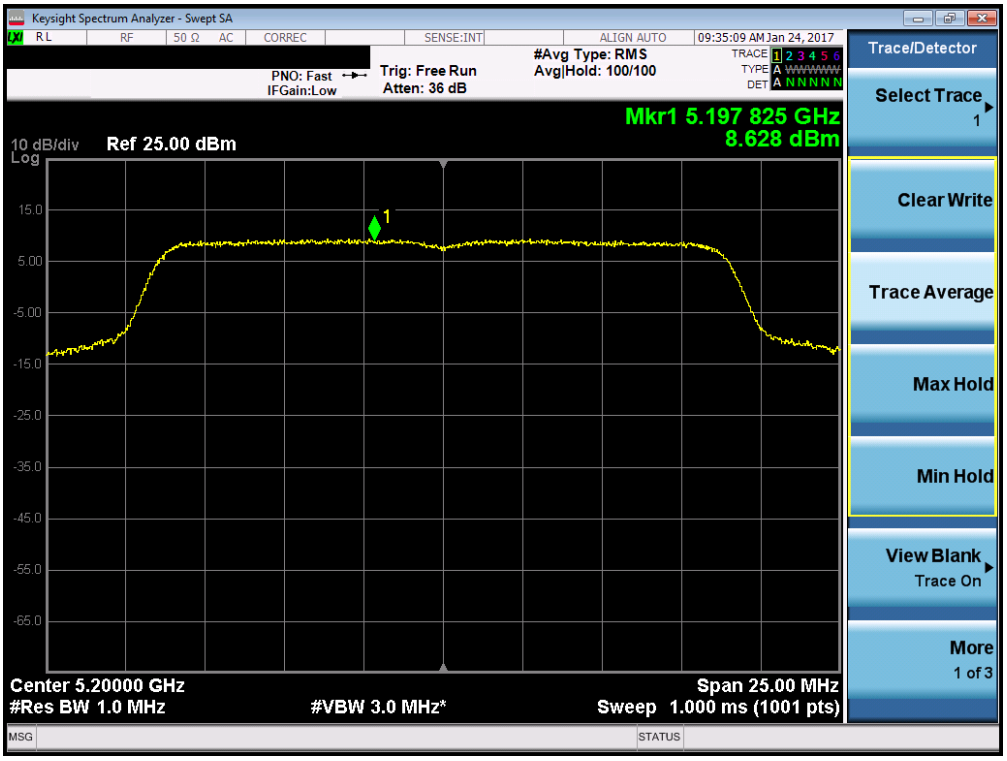


Plot 7-76. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 36)



Plot 7-77. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 40)

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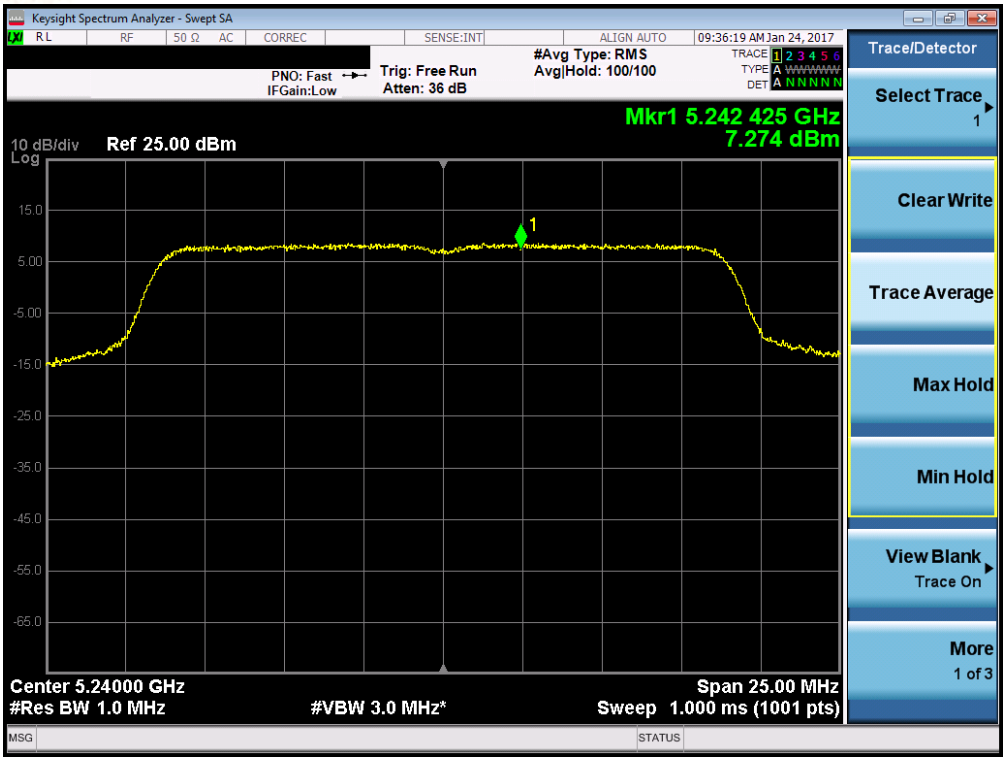
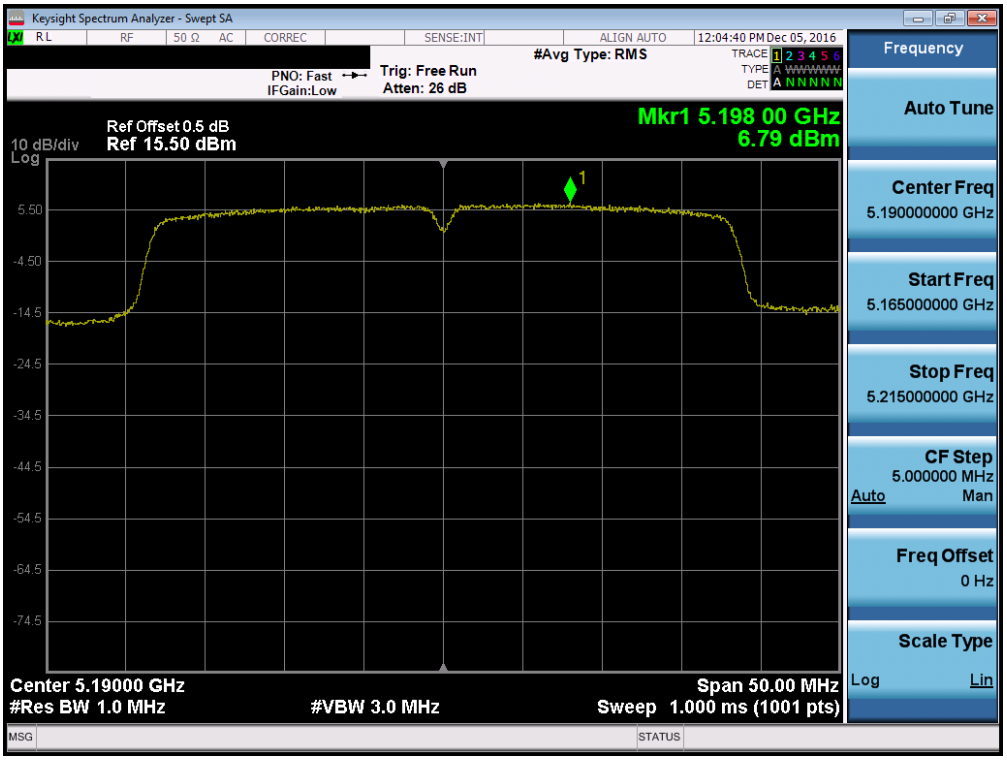


Plot 7-78. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 48)



Plot 7-79. Power Spectral Density Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 38)

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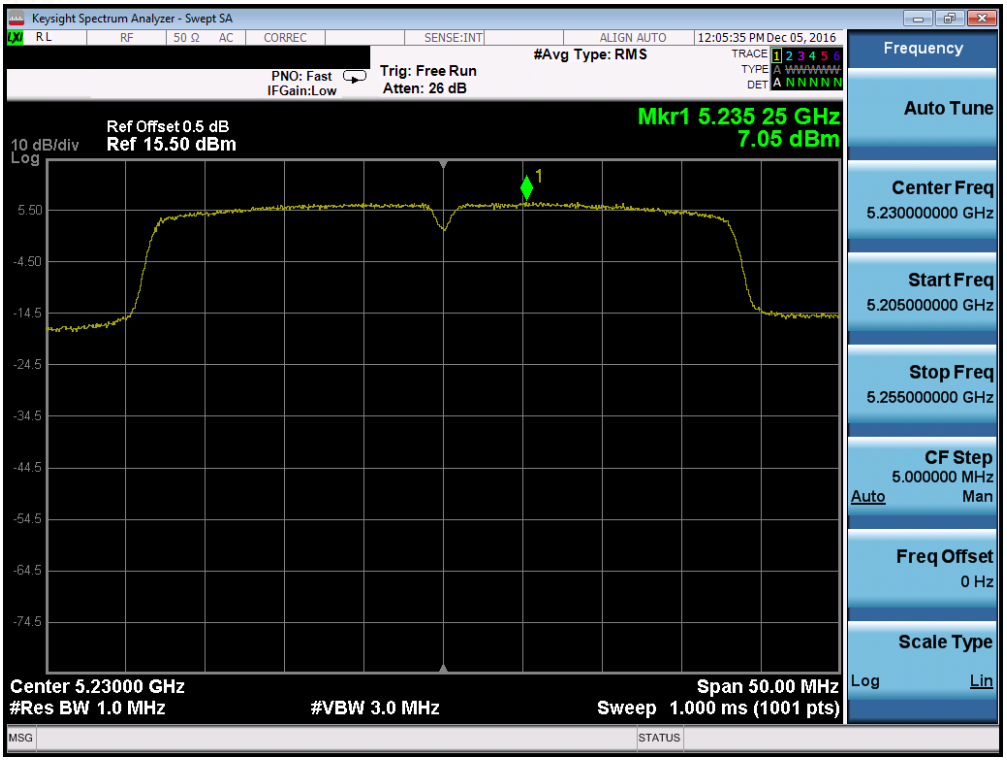
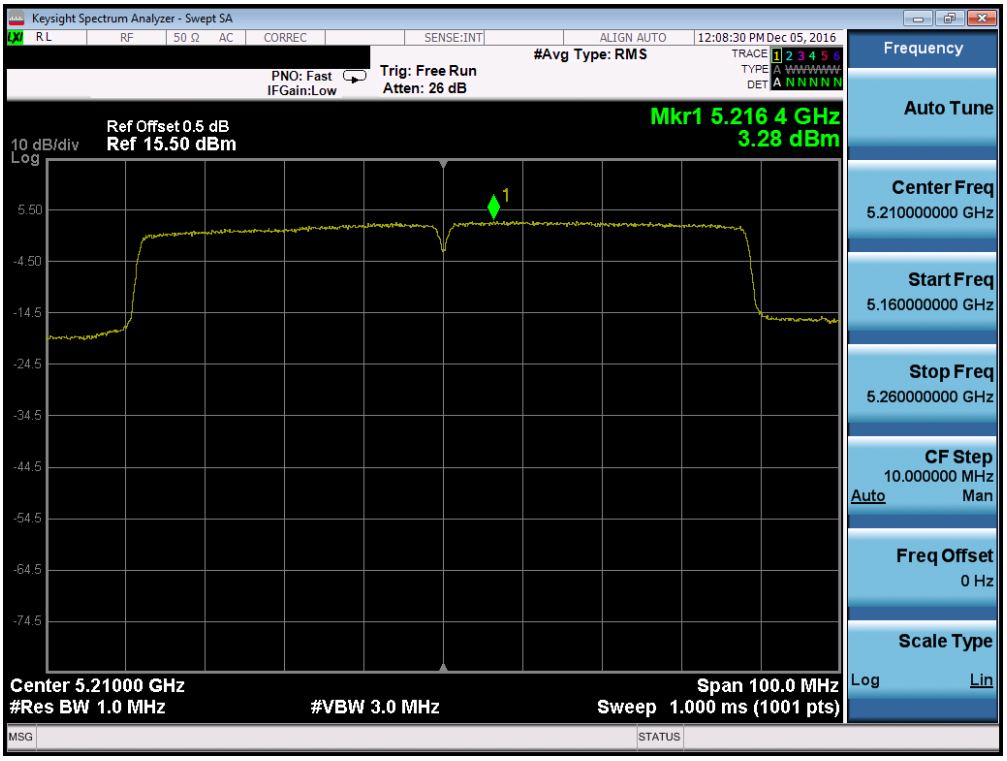


Plot 7-80. Power Spectral Density Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 46)



Plot 7-81. Power Spectral Density Plot (80MHz BW 802.11ac (UNII Band 1) – Ch. 42)

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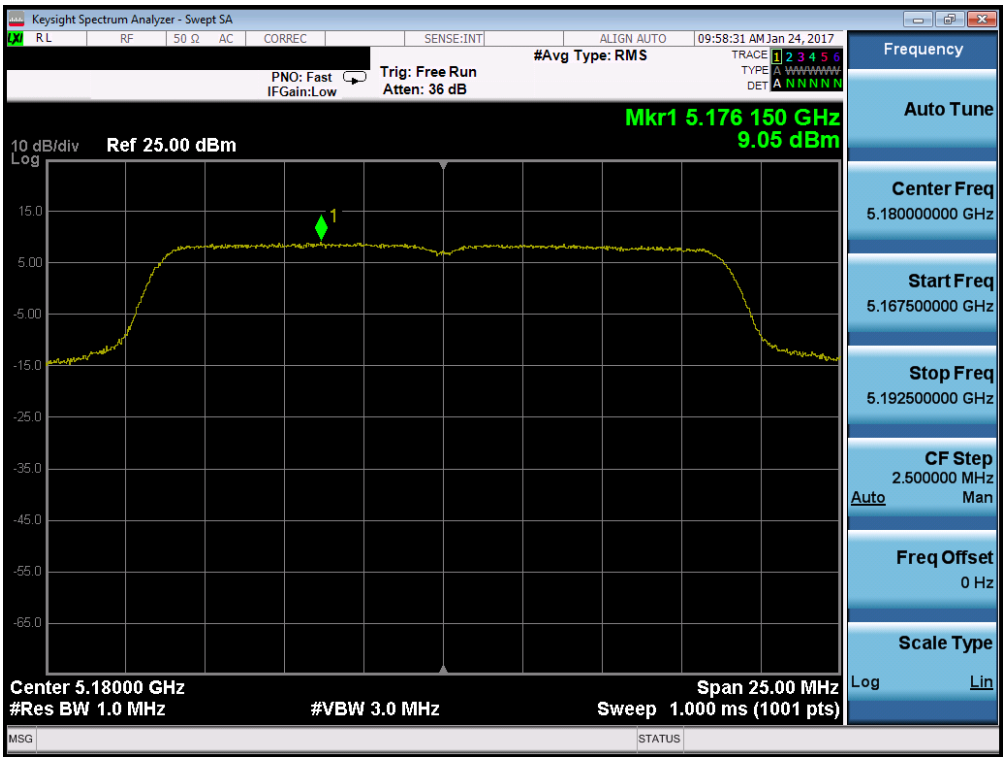
Antenna-2 Power Spectral Density Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Measured Power Density [dBm]	Max Permissible Power Density [dBm/MHz]	Margin [dB]	Pass / Fail
Band 1	5180	36	a	6	9.05	17.0	-7.95	Pass
	5200	40	a	6	8.44	17.0	-8.56	Pass
	5240	48	a	6	8.57	17.0	-8.43	Pass
	5180	36	n (20MHz)	6.5/7.2 (MCS0)	9.26	17.0	-7.74	Pass
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	8.84	17.0	-8.16	Pass
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	8.96	17.0	-8.04	Pass
	5190	38	n (40MHz)	13.5/15 (MCS0)	6.96	17.0	-10.04	Pass
	5230	46	n (40MHz)	13.5/15 (MCS0)	6.92	17.0	-10.08	Pass
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	3.67	17.0	-13.33	Pass

Table 7-28. Band 1 Conducted Power Spectral Density Measurements



Plot 7-82. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 36)

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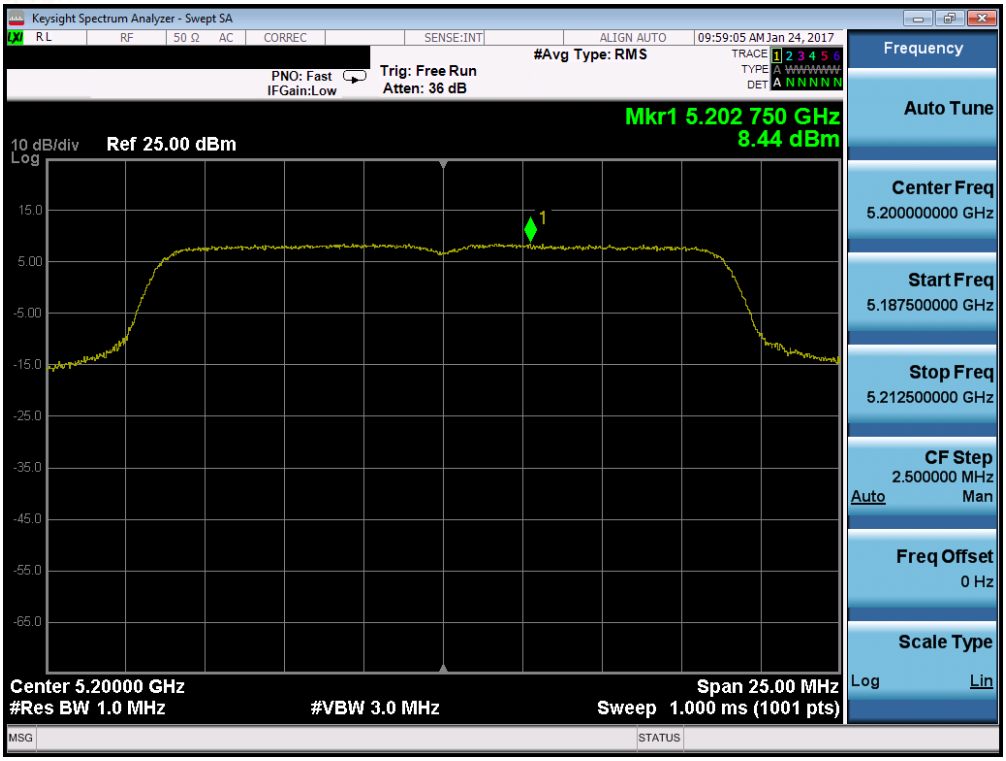
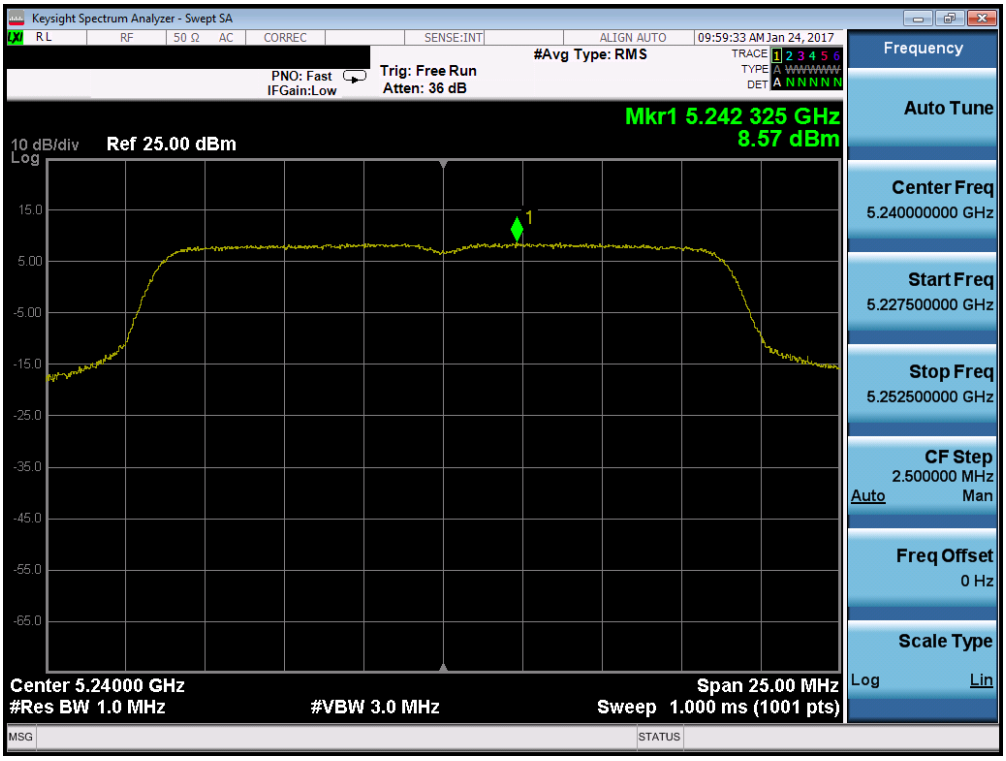


Plot 7-83. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 40)



Plot 7-84. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 48)

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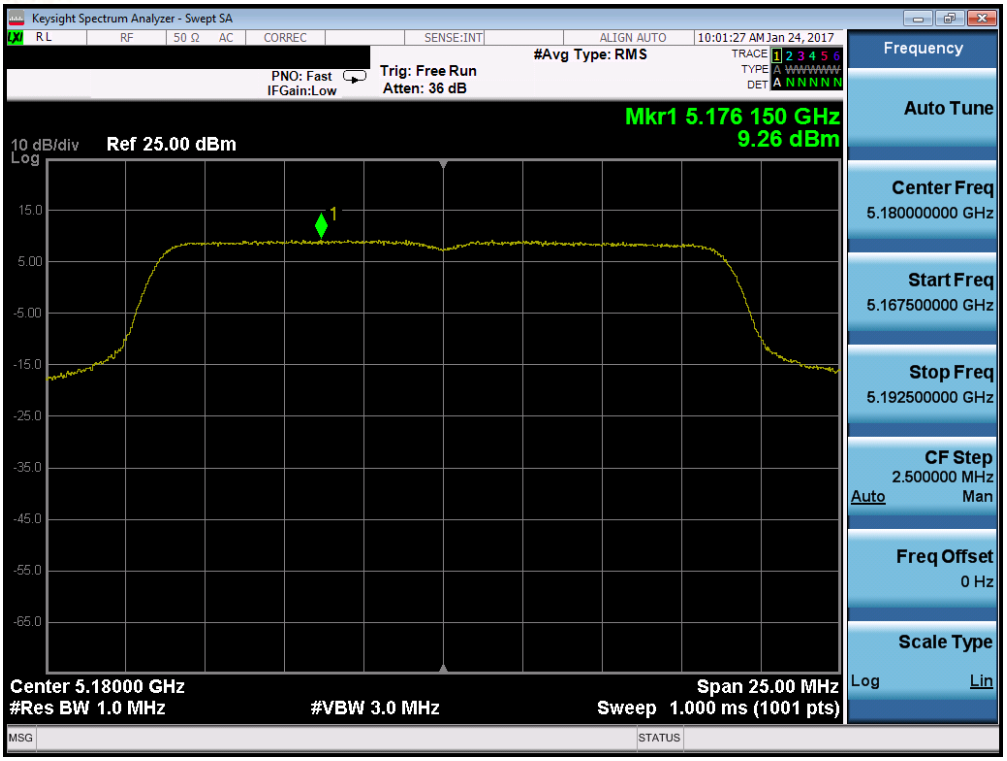
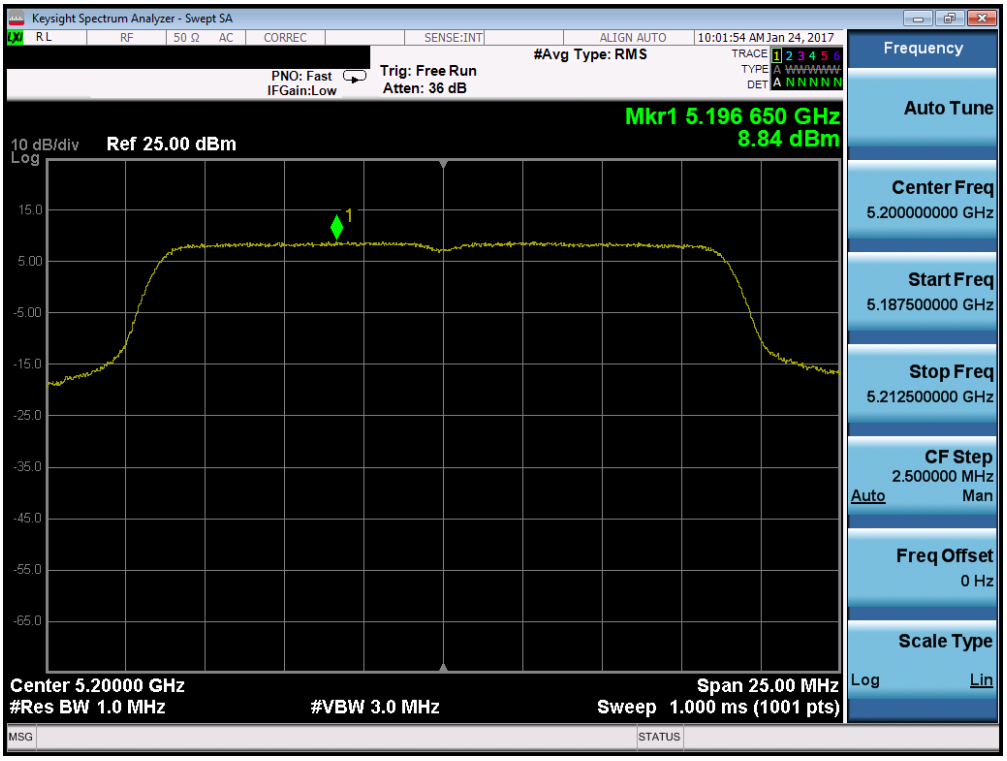


Plot 7-85. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 36)



Plot 7-86. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 40)

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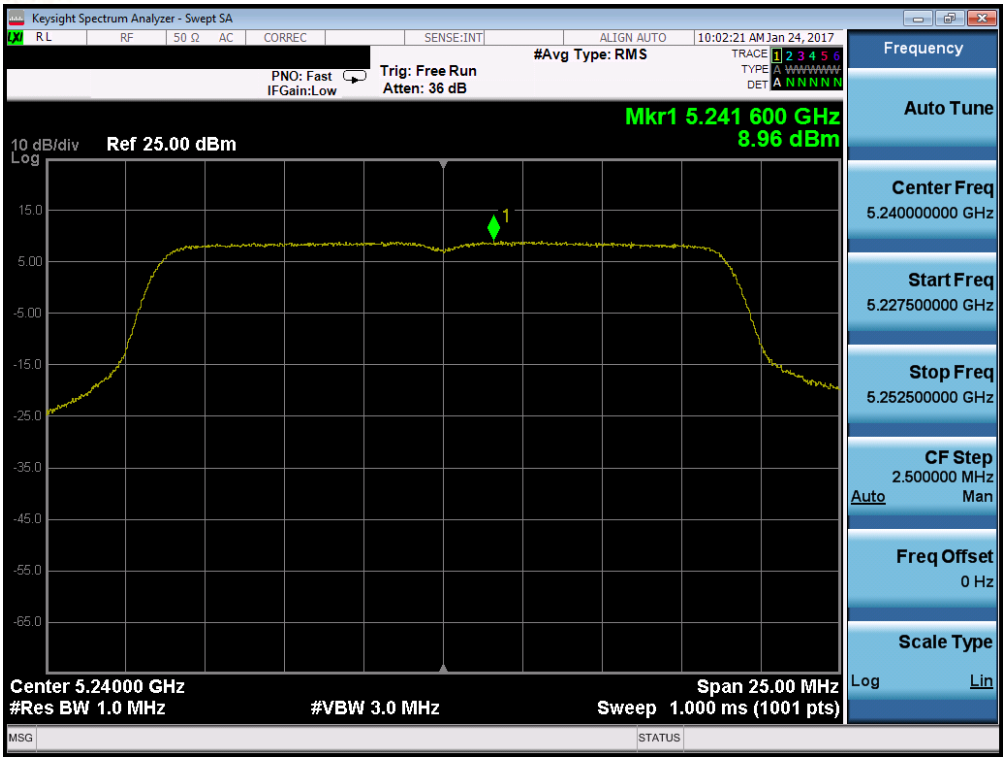
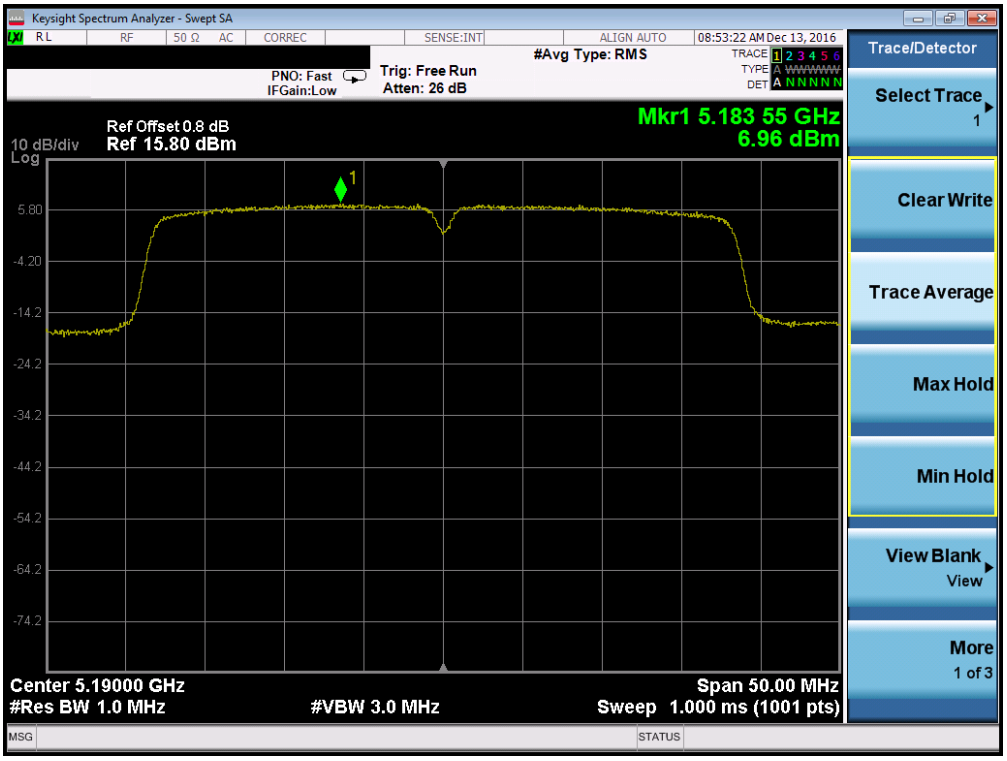


Plot 7-87. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 48)



Plot 7-88. Power Spectral Density Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 38)

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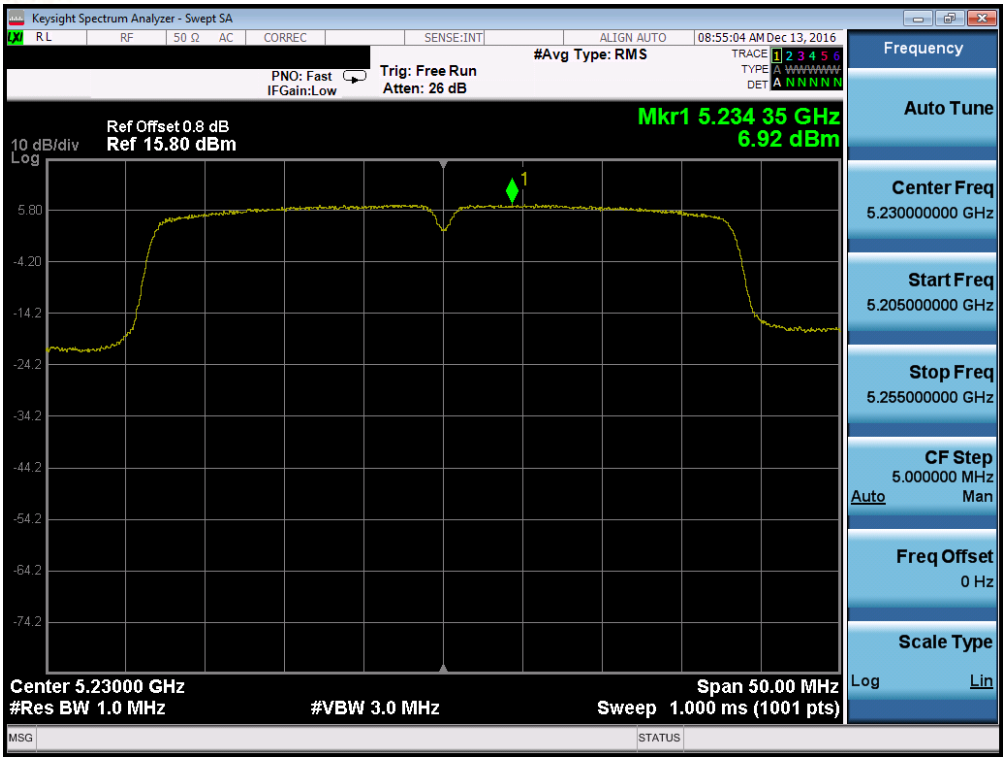
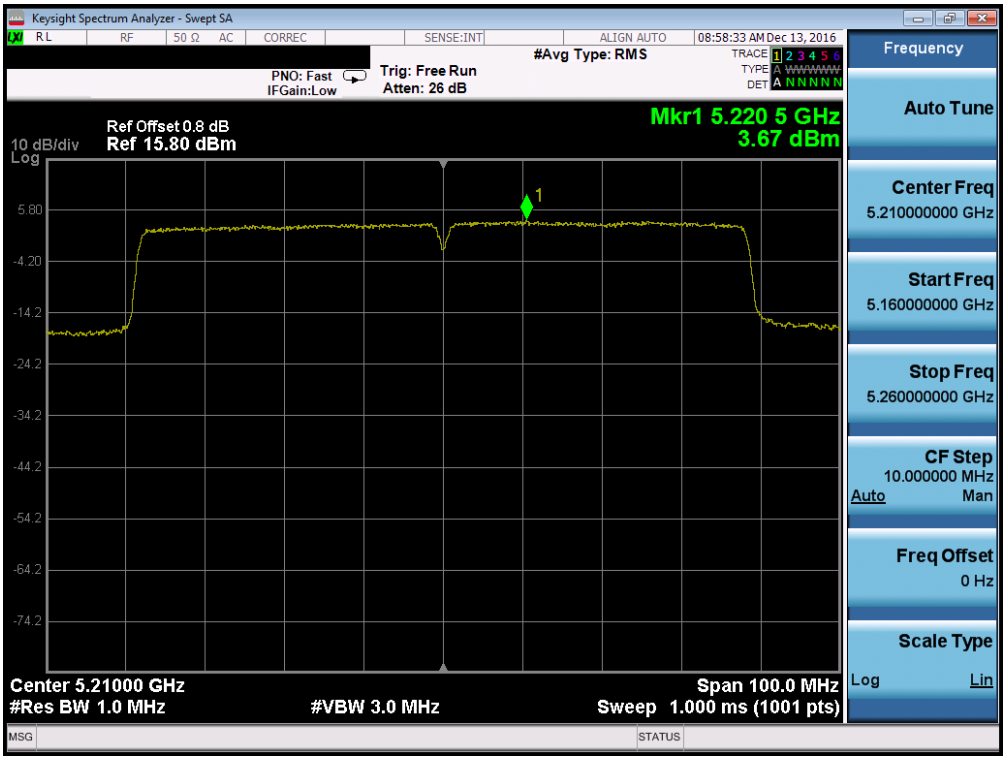


Plot 7-89. Power Spectral Density Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 46)



Plot 7-90. Power Spectral Density Plot (80MHz BW 802.11ac (UNII Band 1) – Ch. 42)

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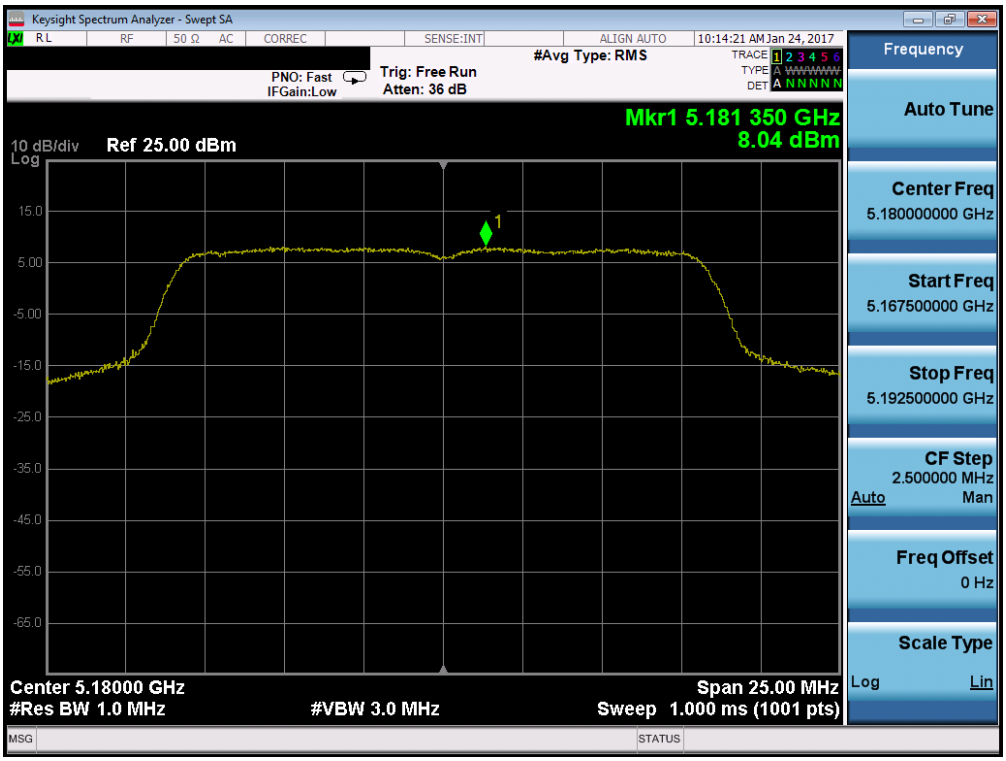
Antenna-3 Power Spectral Density Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Measured Power Density [dBm]	Max Permissible Power Density [dBm/MHz]	Margin [dB]	Pass / Fail
Band 1	5180	36	a	6	8.04	17.0	-8.96	Pass
	5200	40	a	6	8.14	17.0	-8.86	Pass
	5240	48	a	6	8.22	17.0	-8.78	Pass
	5180	36	n (20MHz)	6.5/7.2 (MCS0)	8.73	17.0	-8.27	Pass
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	8.69	17.0	-8.31	Pass
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	8.72	17.0	-8.28	Pass
	5190	38	n (40MHz)	13.5/15 (MCS0)	5.75	17.0	-11.25	Pass
	5230	46	n (40MHz)	13.5/15 (MCS0)	6.10	17.0	-10.90	Pass
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	3.62	17.0	-13.38	Pass

Table 7-29. Band 1 Conducted Power Spectral Density Measurements



Plot 7-91. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 36)

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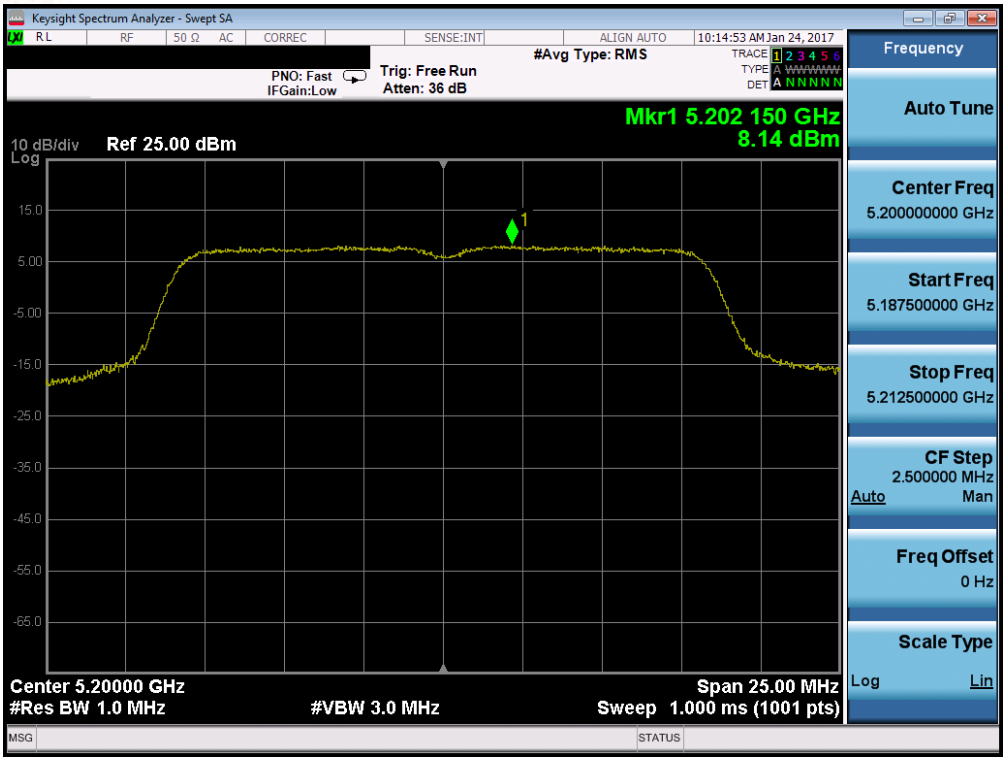
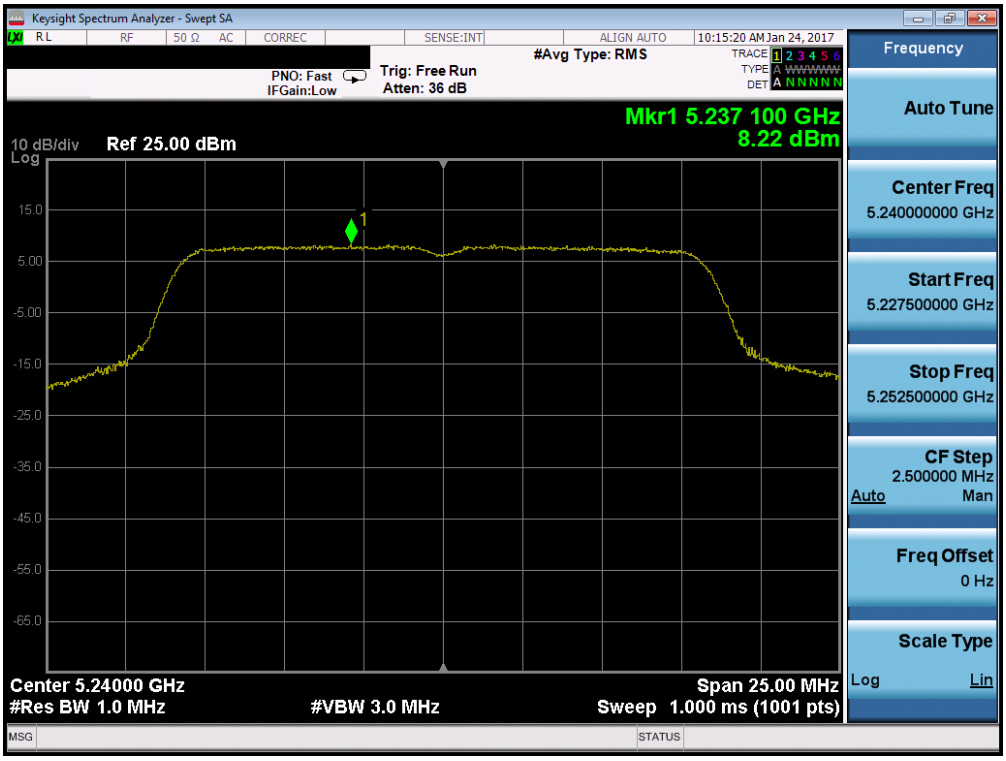


Plot 7-92. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 40)



Plot 7-93. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 48)

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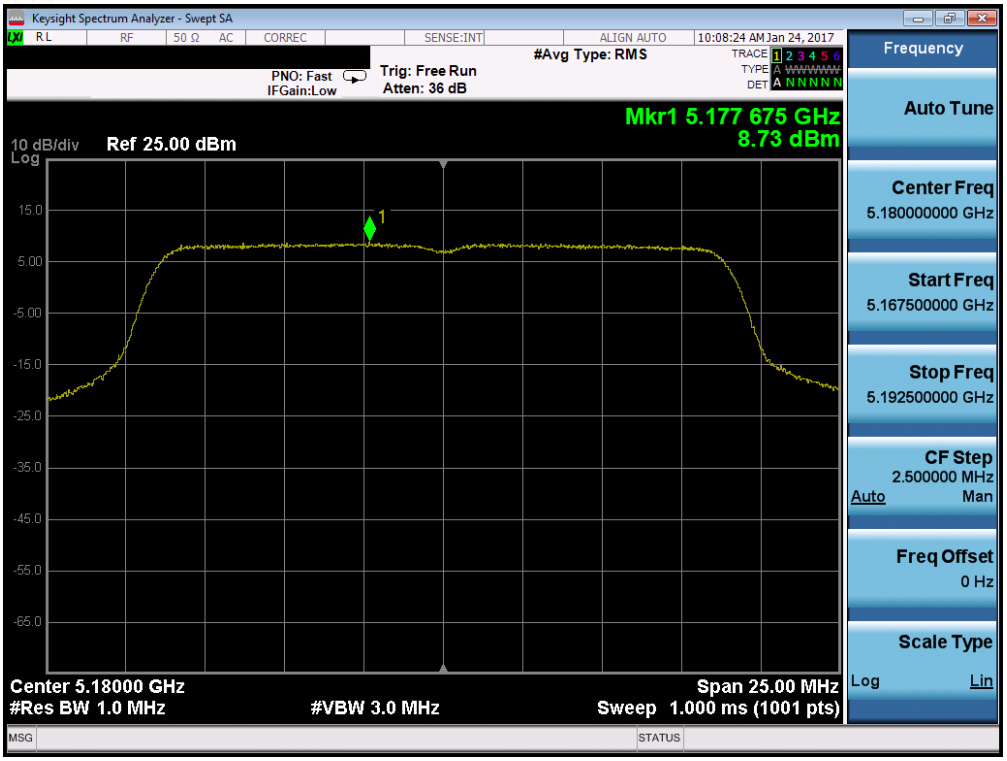
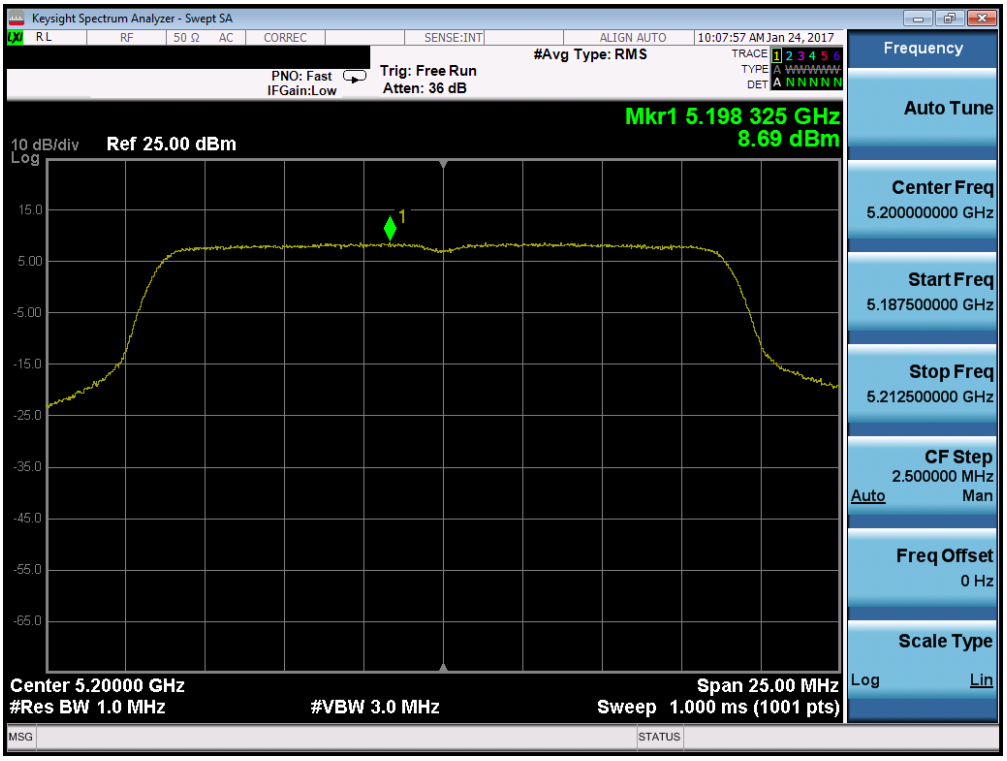


Plot 7-94. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 36)



Plot 7-95. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 40)

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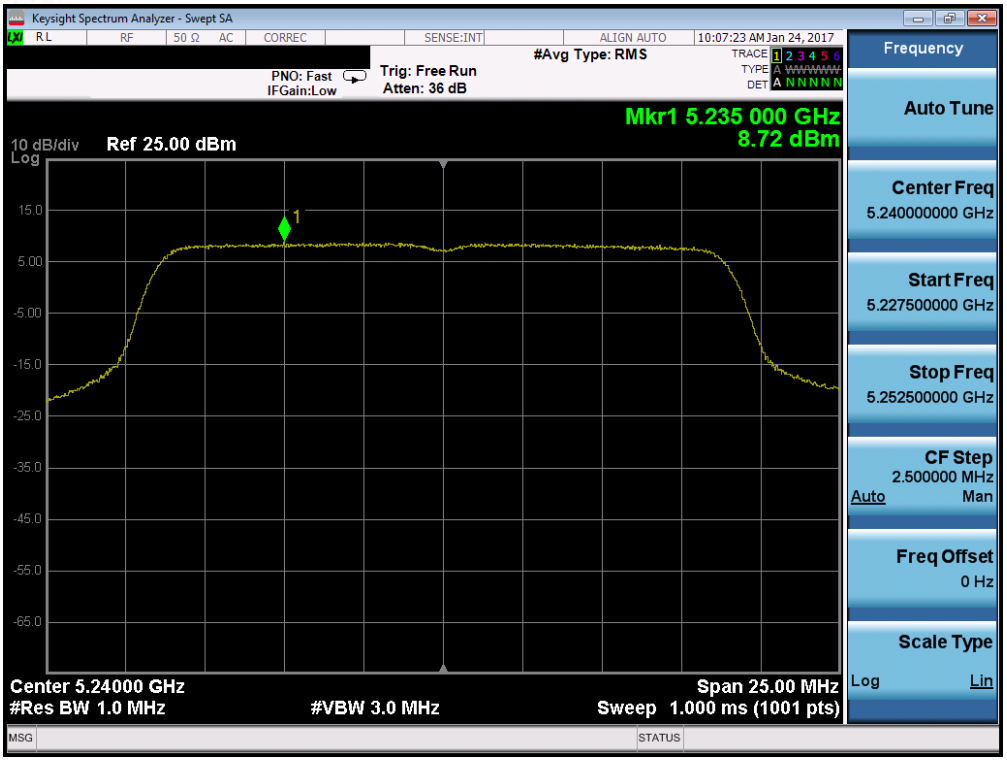
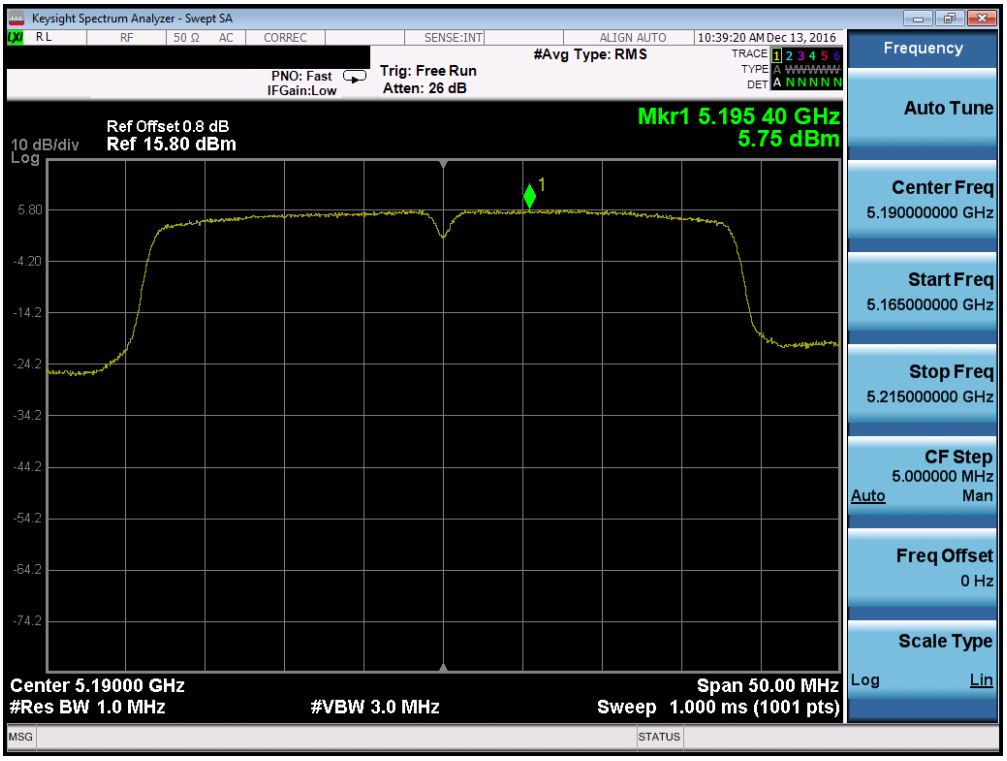


Plot 7-96. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 48)



Plot 7-97. Power Spectral Density Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 38)

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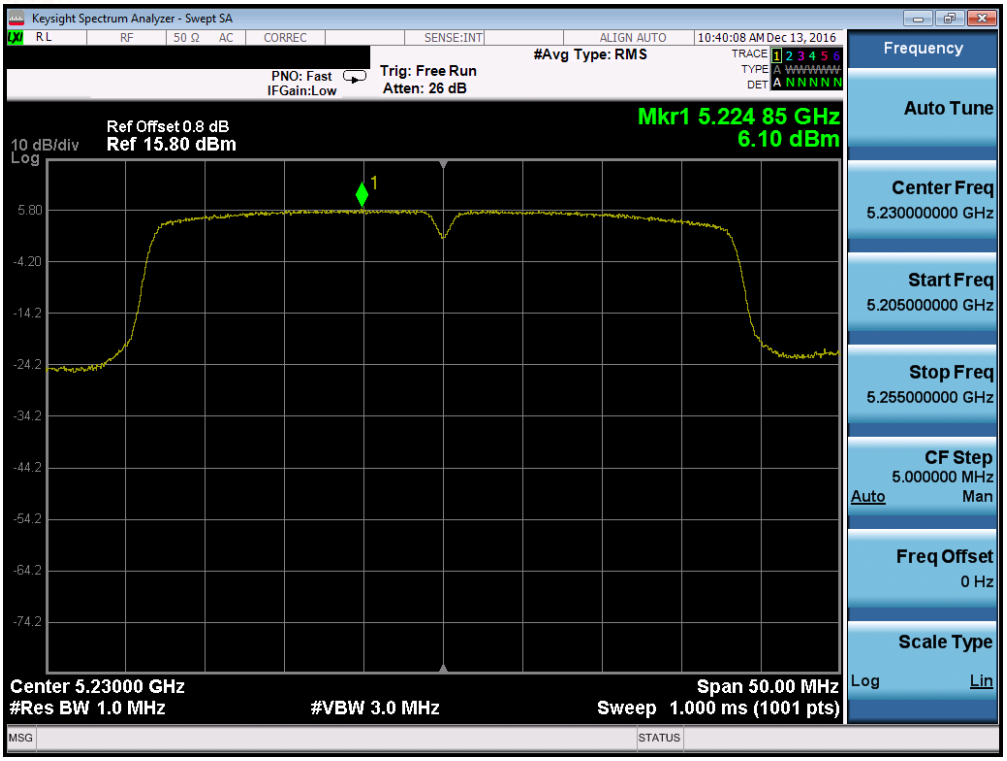
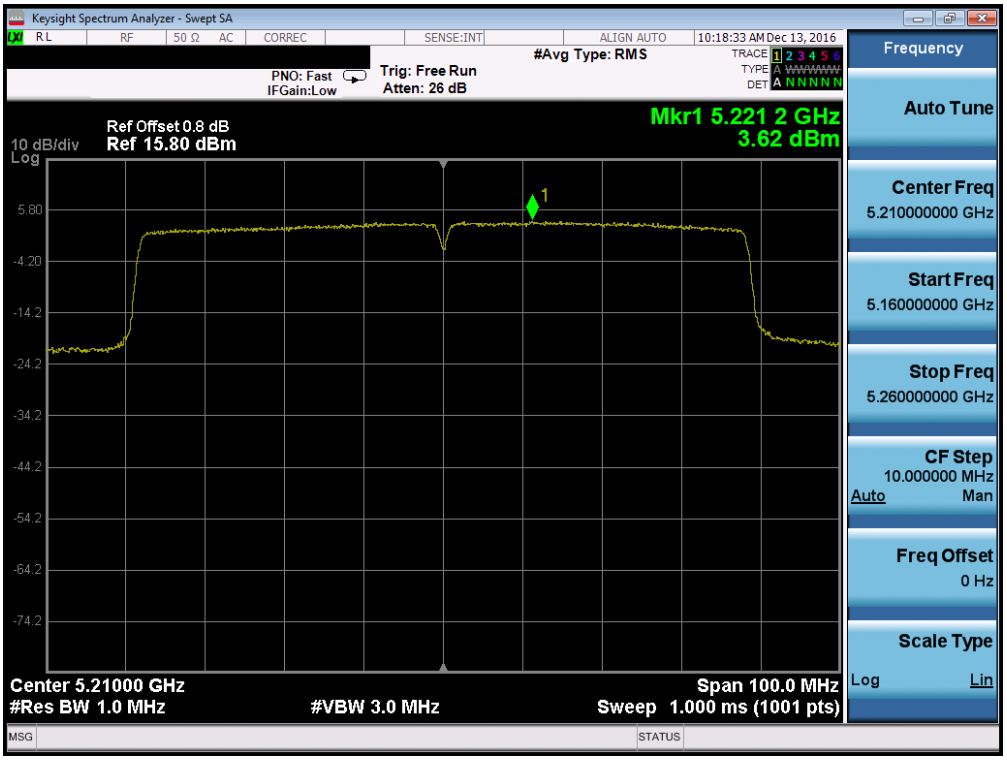


Plot 7-98. Power Spectral Density Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 46)



Plot 7-99. Power Spectral Density Plot (80MHz BW 802.11ac (UNII Band 1) – Ch. 42)

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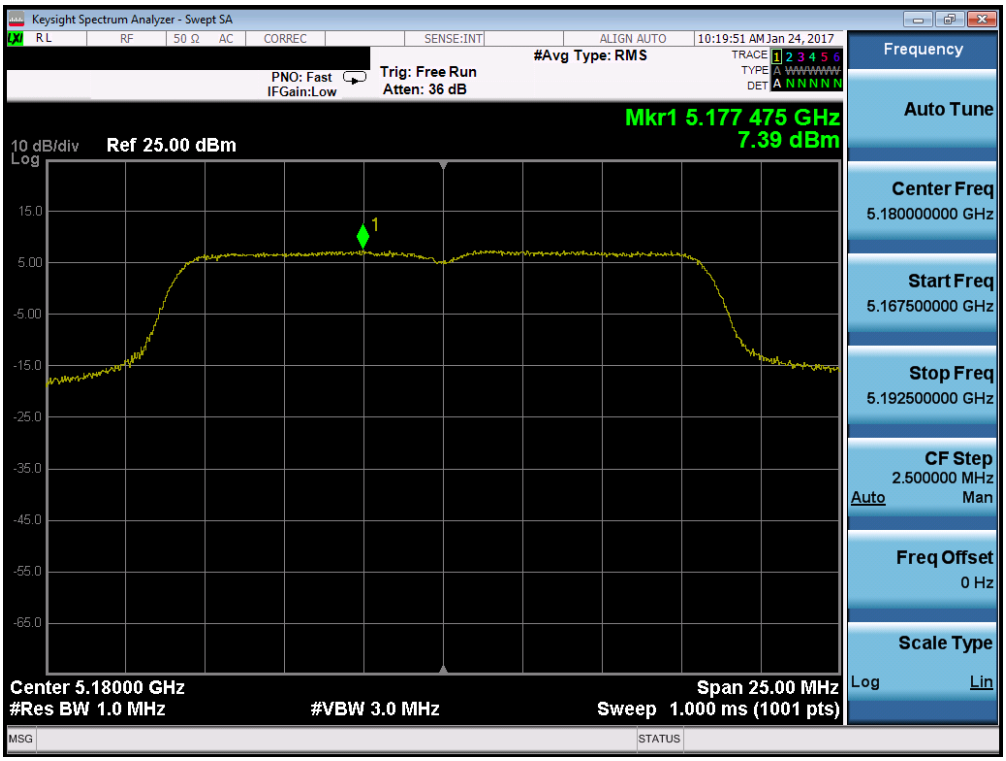
Antenna-4 Power Spectral Density Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	Data Rate [Mbps]	Measured Power Density [dBm]	Max Permissible Power Density [dBm/MHz]	Margin [dB]	Pass / Fail
Band 1	5180	36	a	6	7.39	17.0	-9.61	Pass
	5200	40	a	6	9.42	17.0	-7.58	Pass
	5240	48	a	6	9.25	17.0	-7.75	Pass
	5180	36	n (20MHz)	6.5/7.2 (MCS0)	8.61	17.0	-8.39	Pass
	5200	40	n (20MHz)	6.5/7.2 (MCS0)	8.93	17.0	-8.07	Pass
	5240	48	n (20MHz)	6.5/7.2 (MCS0)	8.81	17.0	-8.19	Pass
	5190	38	n (40MHz)	13.5/15 (MCS0)	6.48	17.0	-10.52	Pass
	5230	46	n (40MHz)	13.5/15 (MCS0)	6.83	17.0	-10.17	Pass
	5210	42	ac (80MHz)	29.3/32.5 (MCS0)	3.62	17.0	-13.38	Pass

Table 7-30. Band 1 Conducted Power Spectral Density Measurements



Plot 7-100. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 36)

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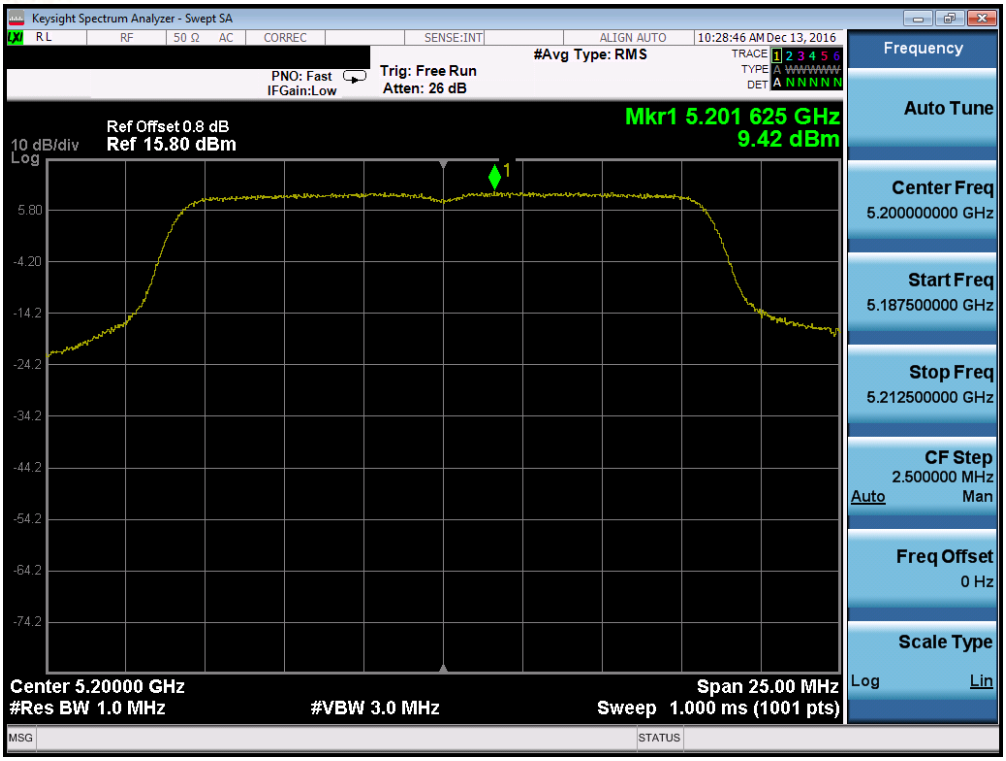
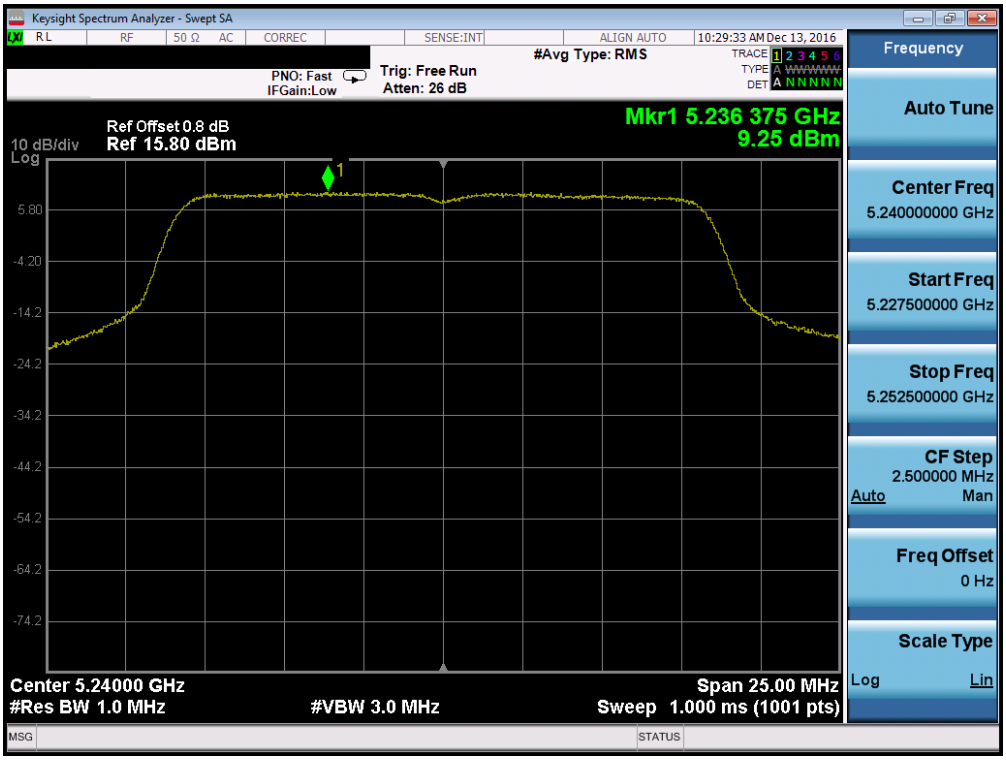


Plot 7-101. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 40)



Plot 7-102. Power Spectral Density Plot (802.11a (UNII Band 1) – Ch. 48)

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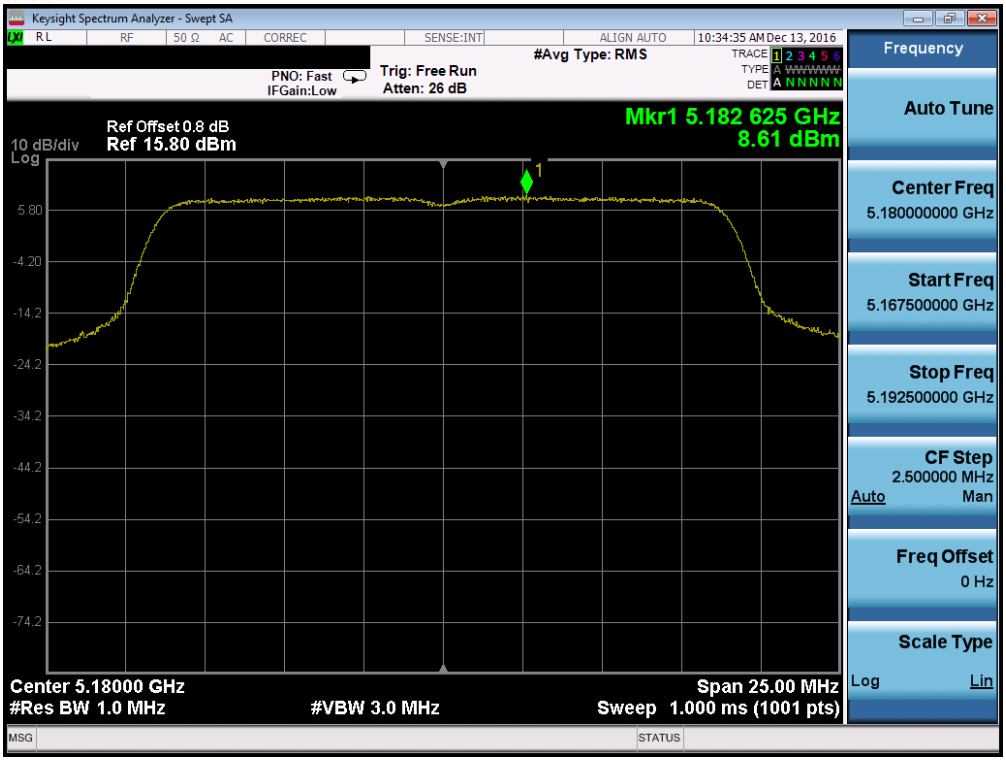
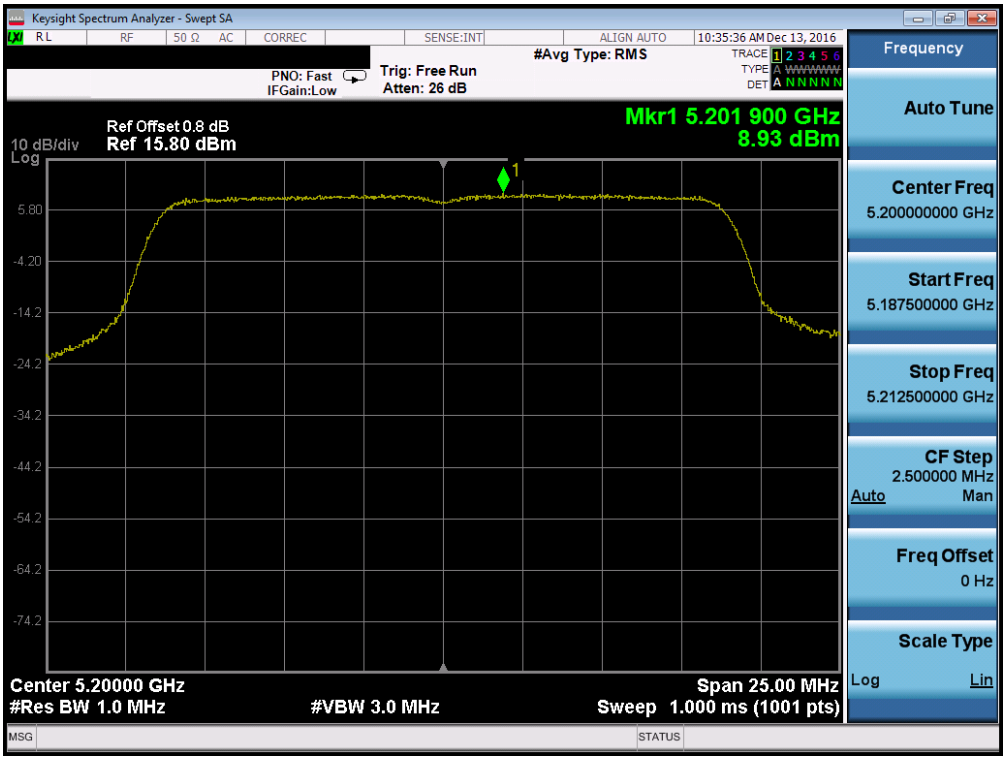


Plot 7-103. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 36)



Plot 7-104. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 40)

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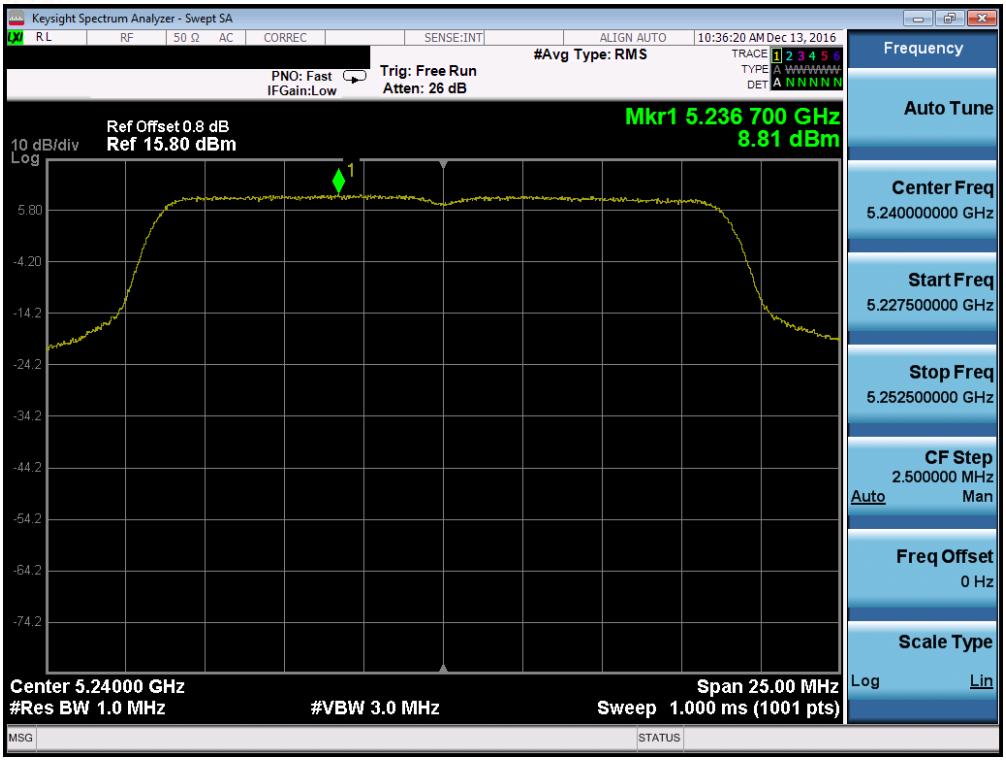
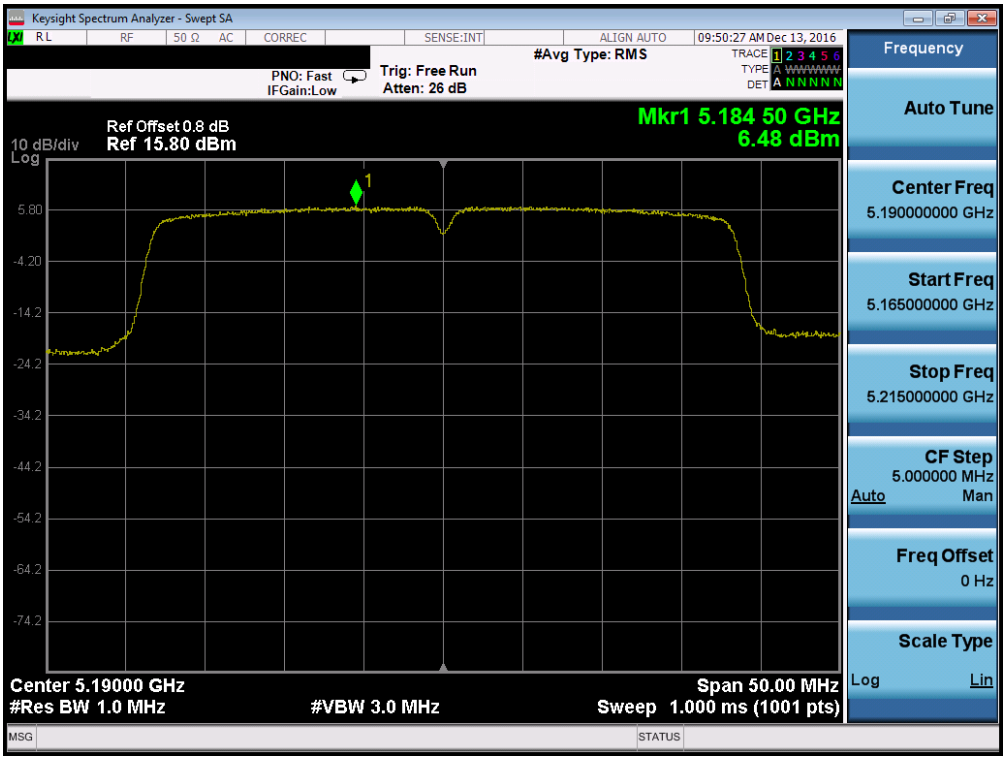


Plot 7-105. Power Spectral Density Plot (20MHz BW 802.11n (UNII Band 1) – Ch. 48)



Plot 7-106. Power Spectral Density Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 38)

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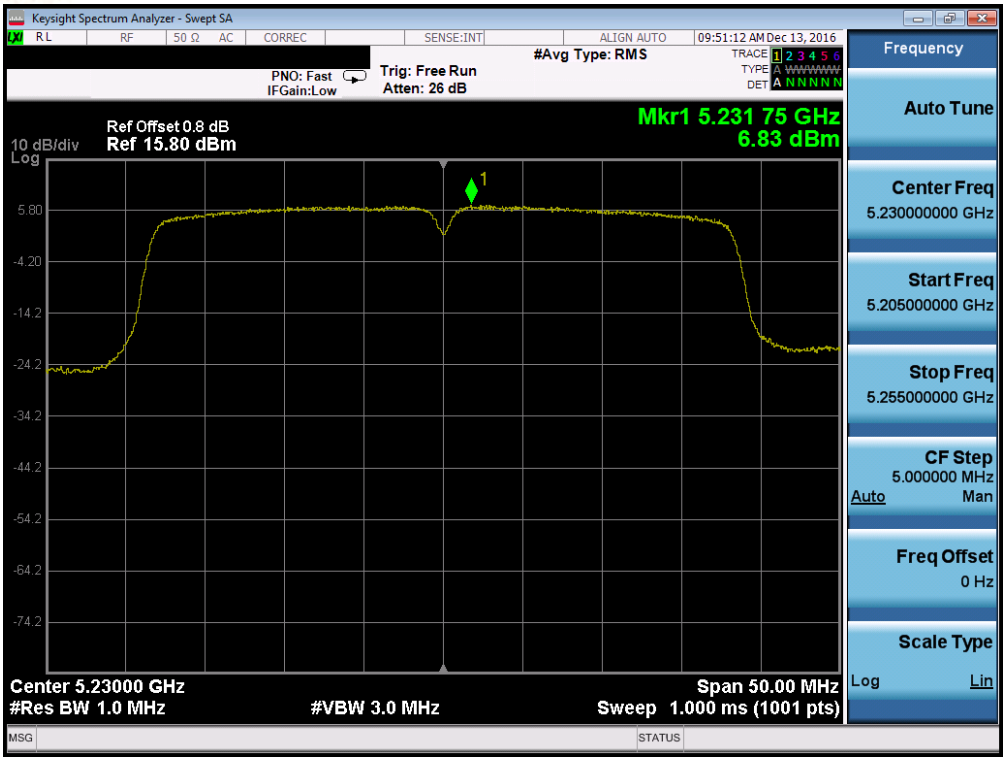
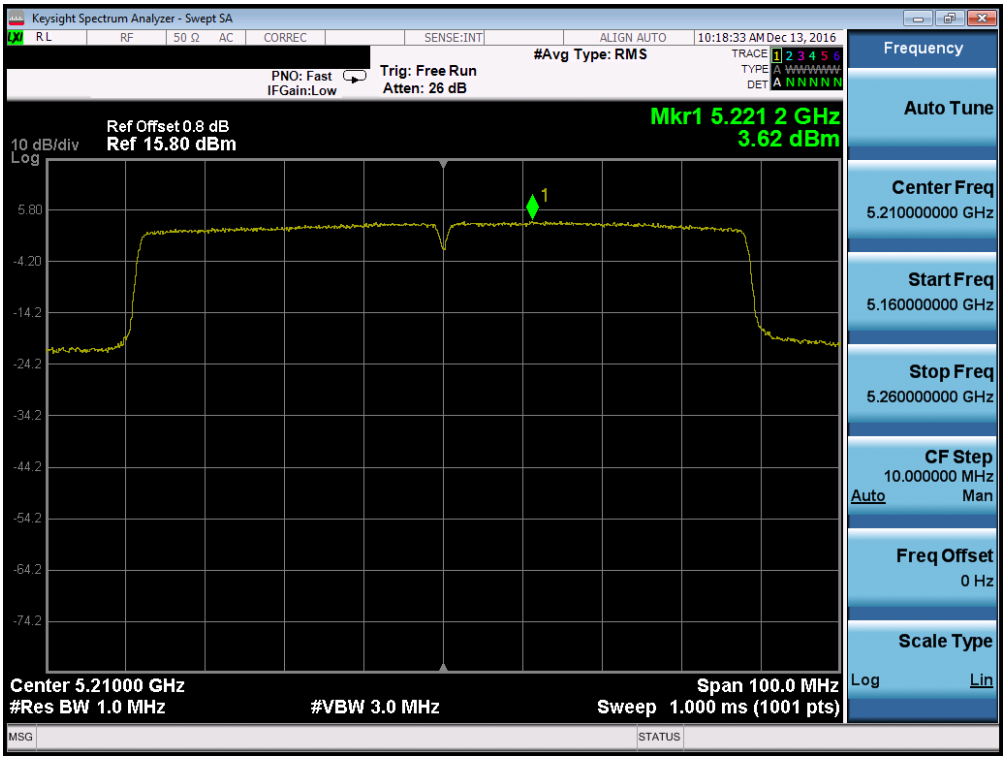


Plot 7-107. Power Spectral Density Plot (40MHz BW 802.11n (UNII Band 1) – Ch. 46)



Plot 7-108. Power Spectral Density Plot (80MHz BW 802.11ac (UNII Band 1) – Ch. 42)

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