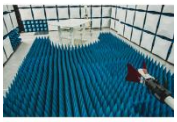
Element Washington DC LLC
18855 Adams Court, Morgan Hill, CA 95037 USA
Tel. 410.290.6652 / Fax 410.290.6654
http://www.element.com



DATA REFERENCE REPORT

FCC PART 15.407 / ISED RSS-247 UNII 802.11ax OFDMA

Applicant Name:
Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:
05/30/2022 - 09/12/2022
Test Site/Location:
Element Washington DC LLC, Morgan Hill, CA, USA
Test Report Serial No.:
1C2205090026-19.BCG

FCC ID:	**BCGA2761**
IC:	**579C-A2761**
APPLICANT:	**Apple Inc.**

Reference Model/HVIN:	A2435
Variant Model/HVIN:	A2761(A2762)
EUT Type:	Tablet Device
Frequency Range:	5180 – 5825MHz
Modulation Type:	OFDMA
FCC Classification:	Unlicensed National Information Infrastructure (UNII)
FCC Rule Part(s):	Part 15 Subpart E (15.407)
ISED Specification:	RSS-247 Issue 2
Test Procedure(s):	ANSI C63.10-2013, KDB 789033 D02 v02r01, KDB 662911 D01 v02r01

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 ANSI C63.10-2013 and KDB 789033 D02 v02r01. 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.

RJ Ortanez
Executive Vice President

ACCREDITED
CERT #2041.02

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1.0 INTRODUCTION

1.1 Scope

Per manufacturer declaration, there are two tablet device models, A2435 and A2761(A2762), with high degree of similarity, reference model FCC ID: BCGA2435 / IC: 579C-A2435 and variant model **FCC ID: BCGA2761 / IC: 579C-A2761**. The reference models support mmWave operations, while the variant models have the mmWave components/antennas removed. Both models share the same material, form factor, circuit design, and components, including antennas and their locations. The reference and variant models use the same power tables and have same tune-up tolerances.

Per FCC/ISED approved Data Referencing Test Plan, testing was done fully on the reference model FCC ID: BCGA2435 / IC: 579C-A2435, while radiated and conducted spot-check verification has been performed on variant model **FCC ID: BCGA2761 / IC: 579C-A2761**. Spot-check measurements were conducted, all measurements were investigated and found to be within acceptable tolerance.

Equipment Class	Reference Model FCC ID & IC	Reference Report	Report Title
NII	BCGA2435 579C-A2435	1C2205090025-20.BCG	RF UNII 802.11ax (OFDMA) Test Report

Table 1-1. Reference Model Details

Spot-check verification are not applicable to this test report; therefore, all data for variant model FCC ID: BCGA2761 / IC: 579C-A2761 can be full referenced from the reference model.

Reference model FCC ID: BCGA2435 / IC: 579C-A2435 test report has been included in Appendix A.

1.2 Element Washington DC LLC Test Location

These measurement tests were conducted at the Element Washington DC LLC facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at Element Washington DC LLC located in Morgan Hill, CA 95037, U.S.A.

- Element Washington DC LLC is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- Element Washington DC LLC TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- Element Washington DC LLC facility is a registered (22831) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID: BCGA2761** and **IC: 579C-A2761**.

Test Device Serial No.: DLX2254004Z21NF15, W7NCJD7FYQ, X3JD904MC6

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, 5G NR (FR1/FR2), 802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, 802.11a/ax WIFI 6E, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8), WPT, NB UNII (1x, HDR4, HDR8)

Band 1		Band 2A		Band 2C		Band 3	
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
36	5180	52	5260	100	5500	149	5745
:	:	:	:	:	:	:	:
42	5210	56	5280	116	5580	157	5785
:	:	:	:	:	:	:	:
48	5240	64	5320	144	5720	165	5825

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

Band 1		Band 2A		Band 2C		Band 3	
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
38	5190	54	5270	102	5510	151	5755
:	:	:	:	:	:	:	:
46	5230	62	5310	110	5550	159	5795
				:	:		
				142	5710		

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

Band 1		Band 2A		Band 2C		Band 3	
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
42	5210	58	5290	106	5530	155	5775
				:	:		
				138	5690		

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

Band 1		Band 2A		Band 2C	
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
50	5250	50	5250	114	5570

Table 2-4. 802.11ac / 802.11ax (160MHz BW) Frequency / Channel Operations

Notes:

1. TDWR channels are not supported for ISED.
2. 5GHz NII operation is possible in 20MHz, and 40MHz, 80MHz and 160MHz 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) KDB 789033 D02 v02r01 and ANSI C63.10-2013. 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:

Measure Duty Cycles				
802.11 Mode/Band		Duty Cyles [%]		
		Antenna WF5b	Antenna WF4a	CDD/SDM
5GHz	11ax(RU) 26T HE20	89.3	89.1	89.0
	11ax(RU) 52T HE20	88.6	88.8	88.6
	11ax(RU) 242T HE20	87.6	87.2	87.2
	11ax(RU) 26T HE40	90.5	90.4	89.6
	11ax(RU) 52T HE40	88.8	88.6	89.2
	11ax(RU) 484T HE40	86.8	86.3	88.0
	11ax(RU) 26T HE80	89.5	89.2	89.0
	11ax(RU) 52T HE80	88.5	88.8	88.8
	11ax(RU) 996T HE80	88.2	88.4	88.8
	11ax(RU) 52T HE160	88.8	89.1	89.0
	11ax(RU) 996x2T HE160	83.6	83.6	76.2

Table 2-5. Measured Duty Cycles

3. The device employs MIMO technology. Below are the possible configurations.

WiFi Configurations		SISO		CDD		SDM		STBC	
		Antenna WF5b	Antenna WF 4a	Antenna WF5b	Antenna WF 4a	Antenna WF5b	Antenna WF 4a	Antenna WF5b	Antenna WF 4a
5GHz	11ax (20MHz)	✓	✓	✓	✓	✓	✓	✓	✓
	11ax (40MHz)	✓	✓	✓	✓	✓	✓	✓	✓
	11ax (80MHz)	✓	✓	✓	✓	✓	✓	✓	✓
	11ax (160MHz)	✓	✓	✓	✓	✓	✓	✓	✓

Table 2-6. WIFI Configurations

✓= Support ; × = NOT Support
SISO = Single Input Single Output
SDM = Spatial Diversity Multiplexing – MIMO function
CDD = Cyclic Delay Diversity - 2Tx Function
STBC = Space-Time Block Coding – 2Tx Function

Data Rate(s) Tested: 8/8.6, 16/17.2, 24/25.8, 33/34.4, 49/51.6, 65/68.8, 73/77.4, 81/86.0, 98/103.2, 108/114.7, 122/129.0, 135/143.4 (ax – 20MHz)
16/17.2, 33/34.4, 49/51.6, 65/68.8, 98/103.2, 130/137.6, 146/154.9, 163/172.1, 195/206.5, 217/229.4, 244/258.1, 271/286.8 (ax – 40MHz BW)
34/36.0, 68/72.1, 102/108.1, 136/144.1, 204/216.2, 272/288.2, 306/324.4, 340/360.3, 408/432.4, 453/480.4, 510/540.4, 567/600.5 (ax – 80MHz BW)
34/36, 68.1/72.1, 102.1/108.1, 136.1/144.1, 204.2/216.2, 272.2/288.2, 306.3/324.3, 340.3/360.3, 408.3/432.4, 453.7/480.4, 510.4/540.4, 567.1/600.5 (ax – 160MHz BW)
16.3/17.2, 32.5/34.4, 48.8/51.6, 65/68.8, 97.5/103.2, 130/137.6, 146.3/154.9, 162.5/172.1, 195/206.5, 216.7/229.4, 243.8/258.1, 270.8/286.8 (ax – 20MHz MIMO)
32.5/34.4, 65/68.8, 97.5/103.2, 130/137.6, 195/206.5, 260/275.3, 292.5/309.7, 325/344.1, 390/412.9, 433.3/458.8, 487.5/516.2, 541.7/573.5 (ax – 40MHz MIMO)
68.1/72.1, 136.1/144.1, 204.2/216.2, 272.2/288.2, 408.3/432.4, 544.4/576.5, 612.5/648.5, 680.6/720.6, 816.7/864.7, 907.4/960.8, 1020.8/1080.9, 1134.3/1201 (ax – 80/160MHz MIMO)

This device supports simultaneous transmission operations, which allows for multiple transmitters to transmit simultaneously on the same antenna. The table below shows all configurations possible.

Antenna	Simultaneous Tx Config	WiFi 2.4GHz	Bluetooth	NB UNII	WiFi 5GHz	WiFi 6GHz	LTE / FR1 NR
		802.11 b/g/n/ax	BDR, EDR, HDR4/8, LE1/2M	BDR, HDR4/8	802.11 a/n/ac/ax	802.11 a/ax	Ultra High Band
2a	Config 1	✓	×	×	×	×	✓
2a	Config 2	×	✓	×	×	×	✓
4a	Config 3	✓	×	✓	×	×	×
4a	Config 4	×	✓	×	✓	×	×

Table 2-7. Simultaneous Transmission Configurations

✓ = Support; × = Not Support

Note:

All of the above simultaneous transmission configurations have been tested and the worst case configuration was found to be Config 2 and reported in the Bluetooth and Part 96 RF test report.

Wi-Fi 2.4GHz and Bluetooth 2.4 GHz can transmit simultaneously on separate antennas. For BT (2.4 GHz) in connected mode and Wi-Fi (2.4 GHz) – Wi-Fi max power will not exceed minimum of (13.5dBm, SAR max cap, Reg max cap) power. For BT (2.4 GHz) in disconnected mode and Wi-Fi (2.4 GHz) – BT will be using iPA only and Wi-Fi max power will not exceed minimum of (SAR max cap, Reg max cap) power.

2.3 Antenna Description

Following antenna gains provided by manufacturer were used for testing.

Frequency [GHz]	Antenna Gain (dBi)	
	Antenna WF5b	Antenna WF4a
5.150 – 5.250	3.7	2.4
5.250 – 5.350	3.6	2.8
5.470 – 5.725	3.5	0.7
5.725 – 5.850	4.0	0.3

Table 2-8. Highest Antenna Gain

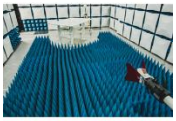
3.0 CONCLUSION

The spot-check data measured for variant model **FCC ID: BCGA2761 / IC: 579C-A2761** is in tolerance with reference model FCC ID: BCGA2435 / IC: 579C-A2435 per FCC/ISED Approved Data Referencing Test Plan.

4.0 APPENDIX A: REFERENCE MODEL TEST REPORT

Attached is the test report (1C2205090025-20.BCG) from reference model FCC ID: BCGA2435 / IC: 579C-A2435, which includes referenced data results.

Element Washington DC LLC
18855 Adams Court, Morgan Hill, CA 95037 USA
Tel. 410.290.6652 / Fax 410.290.6654
http://www.element.com



MEASUREMENT REPORT
FCC PART 15.407 / ISED RSS-247 UNII 802.11ax OFDMA

Applicant Name:
Apple Inc.
One Apple Park Way
Cupertino, CA 95014
United States

Date of Testing:
05/30/2022-09/12/2022
Test Site/Location:
Element Washington DC LLC Morgan Hill, CA, USA
Test Report Serial No.:
1C2205090025-20.BCG

FCC ID:	**BCGA2435**
IC:	**579C-A2435**
APPLICANT:	**Apple Inc.**

Application Type:	Certification
Model/HVIN:	A2435
EUT Type:	Tablet Device
Frequency Range:	5180 – 5825MHz
Modulation Type:	OFDMA
FCC Classification:	Unlicensed National Information Infrastructure (UNII)
FCC Rule Part(s):	Part 15 Subpart E (15.407)
ISED Specification:	RSS-247 Issue 2
Test Procedure(s):	ANSI C63.10-2013, KDB 789033 D02 v02r01, KDB 662911 D01 v02r01

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 ANSI C63.10-2013 and KDB 558074 D01 v05r02. 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.

RJ Ortanez
Executive Vice President

ACCREDITED
CERT #2041.02

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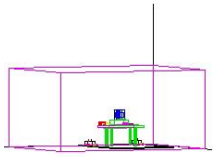
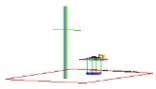


MEASUREMENT REPORT



UNII Band	Channel Bandwidth (MHz)	Tx Frequency (MHz)	SISO				CDD					
			Antenna WF5b		Antenna WF4a		Antenna WF5b		Antenna WF4a		Summed	
			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	87.096	19.40	85.704	19.33	49.317	16.93	49.204	16.92	98.628	19.94
2A		5260 - 5320	88.920	19.49	86.896	19.39	50.119	17.00	50.003	16.99	100.231	20.01
2C		5500 - 5720	86.497	19.37	89.125	19.50	50.003	16.99	49.888	16.98	99.770	19.99
3		5745 - 5825	89.125	19.50	85.507	19.32	88.920	19.49	88.308	19.46	172.982	22.38
1	40	5190 - 5230	70.795	18.50	70.795	18.50	70.795	18.50	69.663	18.43	140.605	21.48
2A		5270 - 5310	79.433	19.00	77.625	18.90	76.033	18.81	78.705	18.96	154.882	21.90
2C		5510 - 5710	87.700	19.43	86.896	19.39	87.498	19.42	88.512	19.47	176.198	22.46
3		5755 - 5795	88.105	19.45	88.105	19.45	87.498	19.42	88.716	19.48	175.388	22.44
1	80	5210	14.125	11.50	14.125	11.50	13.804	11.40	13.709	11.37	27.353	14.37
2A		5290	19.953	13.00	19.953	13.00	19.953	13.00	19.953	13.00	19.953	13.00
2C		5530 - 5690	88.920	19.49	83.176	19.20	88.308	19.46	87.096	19.40	175.388	22.44
3		5775	39.811	16.00	39.446	15.96	39.811	16.00	39.628	15.98	79.433	19.00
1/2A	160	5250	6.28	7.98	6.27	7.98	5.60	7.48	5.61	7.49	11.14	10.47
2C		5570	4.45	6.48	4.46	6.49	4.45	6.48	4.46	6.49	8.83	9.46

FCC EUT Overview

UNII Band	Channel Bandwidth (MHz)	Tx Frequency (MHz)	SISO				CDD					
			Antenna WF5b		Antenna WF4a		Antenna WF5b		Antenna WF4a		Summed	
			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	32.591	15.13	33.197	15.21	18.604	12.70	18.659	12.71	37.154	15.70
2A		5260 - 5320	88.920	19.49	86.896	19.39	50.119	17.00	50.003	16.99	100.231	20.01
2C		5500 - 5720	86.497	19.37	89.125	19.50	50.003	16.99	49.888	16.98	99.770	19.99
3		5745 - 5825	89.125	19.50	85.507	19.32	88.920	19.49	88.308	19.46	172.982	22.38
1	40	5190 - 5230	55.834	17.47	59.007	17.71	31.311	14.96	32.606	15.13	63.973	18.06
2A		5270 - 5310	79.433	19.00	77.625	18.90	76.033	18.81	78.705	18.96	154.882	21.90
2C		5510 - 5710	87.700	19.43	86.896	19.39	87.498	19.42	88.512	19.47	176.198	22.46
3		5755 - 5795	88.105	19.45	88.105	19.45	87.498	19.42	88.716	19.48	175.388	22.44
1	80	5210	14.083	11.49	14.002	11.46	13.935	11.44	13.903	11.43	27.669	14.42
2A		5290	19.953	13.00	19.953	13.00	19.953	13.00	19.953	13.00	19.953	13.00
2C		5530 - 5690	88.920	19.49	83.176	19.20	88.308	19.46	87.096	19.40	175.388	22.44
3		5775	39.811	16.00	39.446	15.96	39.811	16.00	39.628	15.98	79.433	19.00
1/2A	160	5250	6.28	7.98	6.27	7.98	5.60	7.48	5.61	7.49	11.14	10.47
2C		5570	4.45	6.48	4.46	6.49	4.45	6.48	4.46	6.49	8.83	9.46

ISED EUT Overview

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 Innovation, Science and Economic Development Canada.

1.2 Element Washington DC LLC Test Location

These measurement tests were conducted at the Element Washington DC LLC facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at Element Washington DC LLC located in Morgan Hill, CA 95037, U.S.A.

- Element Washington DC LLC is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- Element Washington DC LLC TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- Element Washington DC LLC facility is a registered (22831) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID: BCGA2435** and **IC: 579C-A2435**. The test data contained in this report pertains only to the emissions due to the EUT's UNII 802.11ax - RU transmitter.

Test Device Serial No.: Q994673JFG, N6FT9Q03C0, VRFY020797, DLX218300CD1JXQ1C, XYDYJQJ5Y7, TVDFT4T9CV, LXD9R9MDJG

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, 5G NR (FR1/FR2), 802.11b/g/n/ax WLAN, 802.11a/n/ac/ax UNII, 802.11a/ax WIFI 6E, Bluetooth (1x, EDR, LE1M, LE2M, HDR4, HDR8), WPT, NB UNII (1x, HDR4, HDR8).

This device supports BT Beamforming.

Band 1		Band 2A		Band 2C		Band 3	
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
36	5180	52	5260	100	5500	149	5745
:	:	:	:	:	:	:	:
42	5210	56	5280	116	5580	157	5785
:	:	:	:	:	:	:	:
48	5240	64	5320	144	5720	165	5825

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

Band 1		Band 2A		Band 2C		Band 3	
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
38	5190	54	5270	102	5510	151	5755
:	:	:	:	:	:	:	:
46	5230	62	5310	110	5550	159	5795
				:	:		
				142	5710		

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

Band 1		Band 2A		Band 2C		Band 3	
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
42	5210	58	5290	106	5530	155	5775
				:	:		
				138	5690		

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

Band 1		Band 2A		Band 2C	
Ch.	Frequency (MHz)	Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
50	5250	50	5250	114	5570

Table 2-4. 802.11ac / 802.11ax (160MHz BW) Frequency / Channel Operations

Notes:

1. TDWR channels are not supported for ISED.
2. 5GHz NII operation is possible in 20MHz, and 40MHz, 80MHz and 160MHz 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 v02r01 and ANSI C63.10-2013. 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:

Measure Duty Cycles				
802.11 Mode/Band		Duty Cyles [%]		
		Antenna WF5b	Antenna WF4a	CDD/SDM
5GHz	11ax(RU) 26T HE20	89.3	89.1	89.0
	11ax(RU) 52T HE20	88.6	88.8	88.6
	11ax(RU) 242T HE20	87.6	87.2	87.2
	11ax(RU) 26T HE40	90.5	90.4	89.6
	11ax(RU) 52T HE40	88.8	88.6	89.2
	11ax(RU) 484T HE40	86.8	86.3	88.0
	11ax(RU) 26T HE80	89.5	89.2	89.0
	11ax(RU) 52T HE80	88.5	88.8	88.8
	11ax(RU) 996T HE80	88.2	88.4	88.8
	11ax(RU) 52T HE160	88.8	89.1	89.0
	11ax(RU) 996x2T HE160	83.6	83.6	76.2

Table 2-5. Measured Duty Cycles

3. The device employs CDD/SDM technology. Below are the possible configurations.

WiFi Configurations		SISO		CDD		SDM		STBC	
		Antenna WF5b	Antenna WF 4a	Antenna WF5b	Antenna WF 4a	Antenna WF5b	Antenna WF 4a	Antenna WF5b	Antenna WF 4a
5GHz	11ax (20MHz)	✓	✓	✓	✓	✓	✓	✓	✓
	11ax (40MHz)	✓	✓	✓	✓	✓	✓	✓	✓
	11ax (80MHz)	✓	✓	✓	✓	✓	✓	✓	✓
	11ax (160MHz)	✓	✓	✓	✓	✓	✓	✓	✓

Table 2-6. WIFI Configurations

✓= Support ; × = NOT Support
SISO = Single Input Single Output
CDD = Cyclic Delay Diversity – 2Tx Function
SDM = Spatial Diversity Multiplexing – CDD/SDM function
STBC = Space-Time Block Coding – 2Tx Function

Data Rate(s) Tested:	8/8.6, 16/17.2, 24/25.8, 33/34.4, 49/51.6, 65/68.8, 73/77.4, 81/86.0, 98/103.2, 108/114.7, 122/129.0, 135/143.4 (ax – 20MHz) 16/17.2, 33/34.4, 49/51.6, 65/68.8, 98/103.2, 130/137.6, 146/154.9, 163/172.1, 195/206.5, 217/229.4, 244/258.1, 271/286.8 (ax – 40MHz BW) 34/36.0, 68/72.1, 102/108.1, 136/144.1, 204/216.2, 272/288.2, 306/324.4, 340/360.3, 408/432.4, 453/480.4, 510/540.4, 567/600.5 (ax – 80MHz BW) 34/36, 68.1/72.1, 102.1/108.1, 136.1/144.1, 204.2/216.2, 272.2/288.2, 306.3/324.3, 340.3/360.3, 408.3/432.4, 453.7/480.4, 510.4/540.4, 567.1/600.5 (ax – 160MHz BW) 16.3/17.2, 32.5/34.4, 48.8/51.6, 65/68.8, 97.5/103.2, 130/137.6, 146.3/154.9, 162.5/172.1, 195/206.5, 216.7/229.4, 243.8/258.1, 270.8/286.8 (ax – 20MHz MIMO) 32.5/34.4, 65/68.8, 97.5/103.2, 130/137.6, 195/206.5, 260/275.3, 292.5/309.7, 325/344.1, 390/412.9, 433.3/458.8, 487.5/516.2, 541.7/573.5 (ax – 40MHz MIMO) 68.1/72.1, 136.1/144.1, 204.2/216.2, 272.2/288.2, 408.3/432.4, 544.4/576.5, 612.5/648.5, 680.6/720.6, 816.7/864.7, 907.4/960.8, 1020.8/1080.9, 1134.3/1201 (ax – 80/160MHz MIMO) 136.2/144.2, 272.2/288.2, 408.4/432.4, 544.4/576.4, 816.6/864.8, 1088.8/1153, 1225/1297, 1361.2/1441.2, 1633.4/1729.4, 1814.8/1921.6, 2041.6/2161.8, 2268.6/2402 (ax – 160MHz MIMO)

This device supports simultaneous transmission operations, which allows for multiple transmitters to transmit simultaneously on the same antenna. The table below shows all configurations possible.

Antenna	Simultaneous Tx Config	WiFi 2.4GHz	Bluetooth	NB UNII	WiFi 5GHz	WiFi 6GHz	LTE / FR1 NR
		802.11 b/g/n/ax	BDR, EDR, HDR4/8, LE1/2M	BDR, HDR4/8	802.11 a/n/ac/ax	802.11 a/ax	Ultra High Band
2a	Config 1	✓	×	×	×	×	✓
2a	Config 2	×	✓	×	×	×	✓
4a	Config 3	✓	×	✓	×	×	×
4a	Config 4	×	✓	×	✓	×	×

Table 2-7. Simultaneous Transmission Configurations

✓ = Support; × = Not Support

Note:

All of the above simultaneous transmission configurations have been tested and the worst case configuration was found to be Config 2 and reported in the Bluetooth and Part 96 RF test report.

Wi-Fi 2.4GHz and Bluetooth 2.4 GHz can transmit simultaneously on separate antennas. For BT (2.4 GHz) in connected mode and Wi-Fi (2.4 GHz) – Wi-Fi max power will not exceed minimum of (13.5dBm, SAR max cap, Reg max cap) power. For BT (2.4 GHz) in disconnected mode and Wi-Fi (2.4 GHz) – BT will be using iPA only and Wi-Fi max power will not exceed minimum of (SAR max cap, Reg max cap) power.

2.3 Antenna Description

Following antenna gains provided by manufacturer were used for testing.

Frequency [GHz]	Antenna Gain (dBi)	
	Antenna WF5b	Antenna WF4a
5.150 – 5.250	3.7	2.4
5.250 – 5.350	3.6	2.8
5.470 – 5.725	3.5	0.7
5.725 – 5.850	4.0	0.3

Table 2-8. Highest Antenna Gain

Note: Antenna Specifications have been attached to Appendix A

2.4 Test Support Equipment

1	Apple MacBook Pro	Model:	A2141	S/N:	C02DV7VKMD6T
	w/AC/DC Adapter	Model:	A2166	S/N:	N/A
2	Apple USB-C Cable	Model:	Spartan	S/N:	000MKTR02U
3	USB-C Cable	Model:	A246	S/N:	N/A
	w/ AC Adapter	Model:	A2305	S/N:	N/A
4	Apple Pencil	Model:	N/A	S/N:	GQXGSXBJKM9
5	DC Power Supply	Model:	KPS3010D	S/N:	N/A

Table 2-9. Test Support Equipment List

2.5 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013 and KDB 789033 D02 v02r01. 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 0 for antenna port conducted emissions test setups.

There are two vendors of the WiFi/Bluetooth radio modules, variant 1 and variant 2. Both radio modules have the same mechanical outline, same on-board antenna matching circuit, identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances. The worst case configuration was found between the two variants. The EUT was also investigated with and without charger.

For emissions from 1GHz – 18GHz, low, mid, and high channels were tested with highest power and worst case configuration. The emissions below 1GHz and above 18GHz were tested with the highest transmitting power and the worst case channel.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst case emissions were reported in this test report.

For AC line conducted and radiated test below 1GHz, following configuration were investigated and EUT powered by AC/DC was the worst case.

- EUT powered by AC/DC adaptor via USB-C cable with wire charger
- EUT powered by host PC via USB-C cable with wire charger

802.11ax-RU HE20/40/80/160 2TX CDD/SDM mode test data provided in this report covers 802.11ax-RU HE20/40/80/160 2TX STBC mode.

For 802.11a/n/ac/ax-SU test results, see separate UNII report, 1C2205090025-19.BCG.

2.6 Software and Firmware

The test was conducted with firmware version 20A8359 installed on the EUT.

2.7 EMI Suppression Device(s)/Modifications

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

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 v02r01 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 7m x 3.66m x 2.7m shielded enclosure. The shielded enclosure is manufactured by AP Americas. The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-6. 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 EPCOS 2X60A Power Line Filter (100dB Attenuation, 14kHz-18GHz) and the two EPCOs 2X48A filters (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 ground plane. 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 7.8. Automated test software was used to perform the AC line conducted emissions testing. Automated measurement software utilized is Rohde & Schwarz EMC32, Version 10.50.40.

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. 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. An 80cm tall test table made of Styrodur is placed on top of the turn table. For measurements above 1GHz, an additional Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

Per KDB 414788 D01 v01r01, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30MHz if characterized so that the measurements correspond to those obtained at an open-field test site. To determine test site equivalency, a reference sample transmitting at 149kHz was measured on an open field test site (asphalt with no ground plane) and then measured in the 3m semi-anechoic chamber. A calibrated 60cm loop antenna was used while the reference device was rotated through the X, Y and Z axis in order to capture the worst case level. A maximum deviation of 2.77dB at 149kHz was measured when comparing the 3 meter semi-anechoic chamber to the open field site.

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

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.

5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.23-2012. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below 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	1.77
Line Conducted Disturbance	2.70
Radiated Disturbance (<30MHz)	4.38
Radiated Disturbance (30MHz - 1GHz)	4.75
Radiated Disturbance (1 - 18GHz)	5.20
Radiated Disturbance (>18GHz)	4.72

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 C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	6/10/2022	Annual	6/10/2023	MY49430244
Agilent Technologies	N9020A	MXA Signal Analyzer	4/26/2022	Annual	4/26/2023	MY56470202
Anritsu	ML2496A	Power Meter	11/29/2021	Annual	11/29/2022	1840005
Anritsu	MA2411B	Pulse Power Sensor	11/30/2021	Annual	11/30/2022	1726261
Anritsu	MA2411B	Pulse Power Sensor	11/30/2021	Annual	11/30/2022	1726262
ATM	180-442A-KF	20dB Nominal Gain Horn Antenna	1/19/2022	Annual	1/19/2023	T058701-02
Com-Power Corporation	LIN-120A	Line Impedance Stabilization Network (LISN)	3/7/2022	Annual	3/7/2023	241296
ETS-Lindgren	3142E	Biconilog Antenna (26-6000MHz)	10/21/2021	Annual	10/21/2022	208204
ETS-Lindgren	3117	Double Ridged Guide Horn Antenna (1-18GHz)	10/25/2021	Annual	10/25/2022	227597
Keysight Technology	N9040B	UXA Signal Analyzer	2/8/2022	Annual	2/8/2023	MY57212015
Rohde & Schwarz	TS-PR8	Pre-Amplifier (30MHz-6GHz)	1/6/2022	Annual	1/6/2023	102328
Rohde & Schwarz	ESW26	EMI Test Receiver	5/19/2022	Annual	5/19/2023	101299
Rohde & Schwarz	ESW44	EMI Test Receiver	12/2/2021	Annual	12/2/2022	101570
Rohde & Schwarz	FSV40	Signal Analyzer (10Hz-40GHz)	3/4/2022	Annual	3/4/2023	101619
Rohde & Schwarz	FSVA3044	Signal Analyzer (up to 44 GHz)	5/12/2022	Annual	5/12/2023	101098
Rohde & Schwarz	HFH2-Z2	Loop Antenna	4/3/2022	Annual	4/3/2023	100546
Rohde & Schwarz	TC-TA18	Cross-Polarized Antenna 400MHz-18GHz	1/25/2022	Annual	1/25/2023	101063
Rohde & Schwarz	TS-PR18	Pre-Amplifier (1GHz-18GHz)	1/6/2022	Annual	1/6/2023	101639
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz-40GHz)	4/18/2022	Annual	4/18/2023	100050

Table 6-1. Test Equipment List

Note:

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.
FCC ID: BCGA2435
IC: 579C-A2435
FCC Classification: Unlicensed National Information Infrastructure (UNII)

FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.407	RSS-Gen [6.7]	26dB Bandwidth	N/A	CONDUCTED	N/A	Section 7.2
15.407(e)	RSS-Gen [6.7]	6dB Bandwidth	>500kHz(5725-5850MHz)		PASS	Section 7.3
2.1049	RSS-Gen [6.7]	Occupied Bandwidth	N/A		N/A	Section7.2, 7.3
15.407 (a.1.iv), (a.2), (a.3)	RSS-247 [6.2]	Maximum Conducted Output Power	Maximum conducted powers must meet the limits detailed in 15.407 (a) (RSS-247 [6.2])		PASS	Section 7.4
15.407 (a.1.iv), (a.2), (a.3)	RSS-247 [6.2]	Maximum Power Spectral Density	Maximum power spectral density must meet the limits detailed in 15.407 (a) (RSS-247 [6.2])		PASS	Section 7.5
15.407(h)	RSS-247 [6.3]	Dynamic Frequency Selection	See DFS Test Report	RADIATED	PASS	See DFS Test Report (1C2205090 025-18.BCG)
15.407(b.1), (2), (3), (4)	RSS-247 [6.2]	Undesirable Emissions	Undesirable emissions must meet the limits detailed in 15.407(b) (RSS-247 [6.2])		PASS	Section 7.6
15.205, 15.407(b.1), (4), (5), (6)	RSS-Gen [8.9]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209 (RSS-Gen [8.9])		PASS	Section 7.6, 7.7
15.207	RSS-Gen [8.8]	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 (RSS-Gen [8.8]) limits	AC LINE CONDUCTED	PASS	Section 7.8

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 are Element "UNII Automation ax," Version 7.0 and Element EMC Software Tool v1.2.
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 Element "Chamber Automation," Version 1.3.2.
6. Per RSS-247 Section 6.2.3, transmission on channels which overlap the 5600-5650 MHz is prohibited. This device operates under these frequencies only under the control of a certified master device and does not support active scanning on these channels. This device does not transmit any beacons or initiate any transmissions in UNII Bands 2A or 2C.
7. 802.11ax OFDMA testing was performed for all signal tone configurations as specified by the 802.11ax standard. Worst case results are determined and reported per the guidance provided at the October 2018 TCB Workshop.
8. Only one RU index could be selected at a time so no contiguous or non-contiguous RU's were considered for testing.

7.2 26dB & 99% Bandwidth Measurement – 802.11ax OFDMA

§2.1049; §15.407; RSS-Gen [6.7]

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 ANSI C63.10-2013 and KDB 789033 D02 v02r01, 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

ANSI C63.10-2013 – Subclause 12.4
KDB 789033 D02 v02r01 – 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 ≥ 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

1. All antenna configs were investigated and only the worst case is reported.
2. All RU's were investigated and only worst case partially-loaded and fully-loaded RU's were reported
3. Low, mid, and high channels were tested and tabular data has been reported. Only mid channel bandwidth plots have been reported.

Antenna WF5b 26dB & 99% Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	RU Size	RU Index	Data Rate [Mbps]	Measured 99% Occupied Bandwidth [MHz]	Measured 26dB Bandwidth [MHz]
Band 1	5180	36	ax (20MHz)	26	0	12.5/14.7 (MCS11)	18.30	19.61
				26	4	12.5/14.7 (MCS11)	17.33	18.59
				26	8	12.5/14.7 (MCS11)	18.49	20.29
	5200	40	ax (20MHz)	26	0	12.5/14.7 (MCS11)	18.31	19.47
				26	4	12.5/14.7 (MCS11)	17.38	18.78
				26	8	12.5/14.7 (MCS11)	18.46	19.94
	5240	48	ax (20MHz)	26	0	12.5/14.7 (MCS11)	18.29	19.60
				26	4	12.5/14.7 (MCS11)	17.33	18.68
				26	8	12.5/14.7 (MCS11)	18.53	20.32
	5190	38	ax (40MHz)	26	0	12.5/14.7 (MCS11)	18.37	20.58
				26	8	12.5/14.7 (MCS11)	19.61	21.51
				26	17	12.5/14.7 (MCS11)	18.35	20.12
	5230	46	ax (40MHz)	26	0	12.5/14.7 (MCS11)	18.40	20.36
				26	8	12.5/14.7 (MCS11)	19.68	21.79
				26	17	12.5/14.7 (MCS11)	18.30	19.72
	5210	42	ax (80MHz)	26	0	12.5/14.7 (MCS11)	17.98	19.50
				26	18	12.5/14.7 (MCS11)	37.74	40.42
				26	36	12.5/14.7 (MCS11)	18.48	20.47

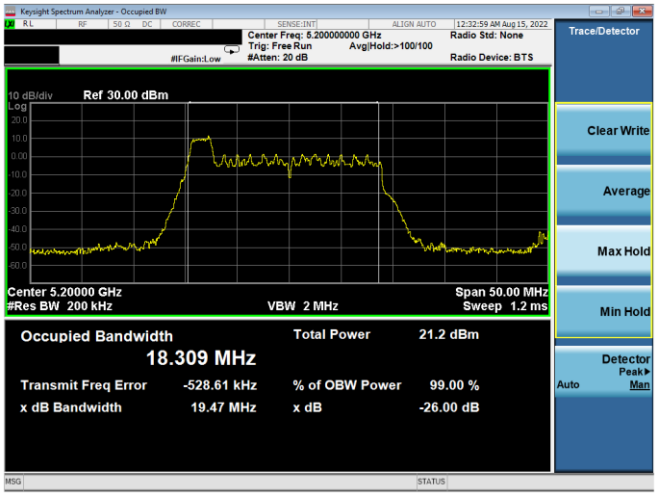
Table 7-2. Conducted BW Measurements Antenna WF5b (RU26)

	Frequency [MHz]	Channel No.	802.11 Mode	RU Size	RU Index	Data Rate [Mbps]	Measured 99% Occupied Bandwidth [MHz]	Measured 26dB Bandwidth [MHz]
Band 1/2A	5250	50 (L)	ax (160MHz)	52	37	25/29.4 (MCS11)	18.20	20.33
				52	52	25/29.4 (MCS11)	19.01	23.00
		50 (U)		52	52	25/29.4 (MCS11)	20.22	23.02
Band 2A	5260	52	ax (20MHz)	52	37	25/29.4 (MCS11)	18.22	20.36
				52	38	25/29.4 (MCS11)	17.43	19.86
				52	40	25/29.4 (MCS11)	18.57	20.73
	5300	60	ax (20MHz)	52	37	25/29.4 (MCS11)	18.26	20.17
				52	38	25/29.4 (MCS11)	17.41	19.90
				52	40	25/29.4 (MCS11)	18.49	20.74
	5320	64	ax (20MHz)	52	37	25/29.4 (MCS11)	18.24	20.32
				52	38	25/29.4 (MCS11)	17.43	19.85
				52	40	25/29.4 (MCS11)	18.51	20.79
	5270	54	ax (40MHz)	52	37	25/29.4 (MCS11)	18.09	20.75
				52	40	25/29.4 (MCS11)	19.26	22.76
				52	44	25/29.4 (MCS11)	18.14	21.26
	5310	62	ax (40MHz)	52	37	25/29.4 (MCS11)	19.01	22.64
				52	40	25/29.4 (MCS11)	20.05	24.49
				52	44	25/29.4 (MCS11)	19.57	23.85
	5290	58	ax (80MHz)	52	37	25/29.4 (MCS11)	17.93	19.90
				52	44	25/29.4 (MCS11)	18.35	22.48
				52	52	25/29.4 (MCS11)	18.60	21.96
Band 2C	5500	100	ax (20MHz)	52	37	25/29.4 (MCS11)	18.22	20.08
				52	38	25/29.4 (MCS11)	17.43	19.50
				52	40	25/29.4 (MCS11)	18.39	20.61
	5580	116	ax (20MHz)	52	37	25/29.4 (MCS11)	18.21	19.97
				52	38	25/29.4 (MCS11)	17.31	19.79
				52	40	25/29.4 (MCS11)	18.48	20.45
	5720	144	ax (20MHz)	52	37	25/29.4 (MCS11)	18.24	20.18
				52	38	25/29.4 (MCS11)	17.34	20.07
				52	40	25/29.4 (MCS11)	18.53	20.61
	5510	102	ax (40MHz)	52	37	25/29.4 (MCS11)	18.26	21.23
				52	40	25/29.4 (MCS11)	19.13	22.36
				52	44	25/29.4 (MCS11)	18.16	21.13
	5550	110	ax (40MHz)	52	37	25/29.4 (MCS11)	18.25	20.91
				52	40	25/29.4 (MCS11)	18.98	22.23
				52	44	25/29.4 (MCS11)	18.26	21.00
	5710	142	ax (40MHz)	52	37	25/29.4 (MCS11)	18.25	21.02
				52	40	25/29.4 (MCS11)	19.27	22.97
				52	44	25/29.4 (MCS11)	18.20	21.25
	5530	106	ax (80MHz)	52	37	25/29.4 (MCS11)	17.92	19.95
				52	44	25/29.4 (MCS11)	18.44	22.19
				52	52	25/29.4 (MCS11)	18.90	22.12
	5690	138	ax (80MHz)	52	37	25/29.4 (MCS11)	17.89	19.85
				52	44	25/29.4 (MCS11)	18.49	23.01
				52	52	25/29.4 (MCS11)	18.41	21.65
	5570*	114 (L)	ax (160MHz)	52	37	25/29.4 (MCS11)	18.18	20.28
				52	52	25/29.4 (MCS11)	18.82	23.19
		114 (U)		52	52	25/29.4 (MCS11)	21.34	23.97

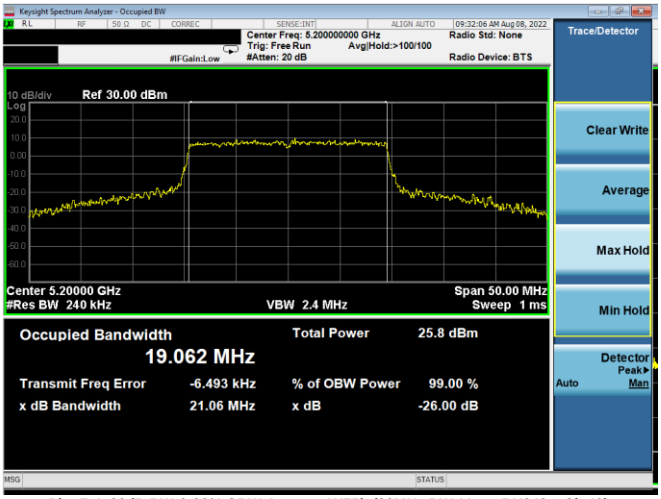
Table 7-3. Conducted BW Measurements Antenna WF5b (RU52)

	Frequency [MHz]	Channel No.	802.11 Mode	RU Size	RU Index	Data Rate [Mbps]	Measured 99% Occupied Bandwidth [MHz]	Measured 26dB Bandwidth [MHz]
Band 1	5180	36	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.02	21.20
	5200	40	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.06	21.06
	5240	48	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.05	23.82
	5190	38	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.04	42.43
	5230	46	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.43	60.09
	5210	42	ax (80MHz)	996	67	510.4/600.5 (MCS11)	77.11	81.91
Band 1/2A	5250	50	ax (160MHz)	996x2	68	510.4/600.5 (MCS11)	156.31	164.90
Band 2A	5260	52	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.01	21.43
	5300	60	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.02	21.37
	5320	64	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.04	21.24
	5270	54	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.29	67.71
	5310	62	ax (40MHz)	484	65	243.8/286.8 (MCS11)	37.94	41.99
	5290	58	ax (80MHz)	996	67	510.4/600.5 (MCS11)	77.09	81.84
Band 2C	5500	100	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.01	21.11
	5580	116	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.02	21.42
	5720	144	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.01	21.47
	5510	102	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.03	42.32
	5550	110	ax (40MHz)	484	65	243.8/286.8 (MCS11)	37.96	41.98
	5710	142	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.25	67.62
	5530	106	ax (80MHz)	996	67	510.4/600.5 (MCS11)	77.23	80.97
	5690	138	ax (80MHz)	996	67	510.4/600.5 (MCS11)	77.44	99.33
	5570*	114	ax (160MHz)	996x2	68	510.4/600.5 (MCS11)	156.27	165.30

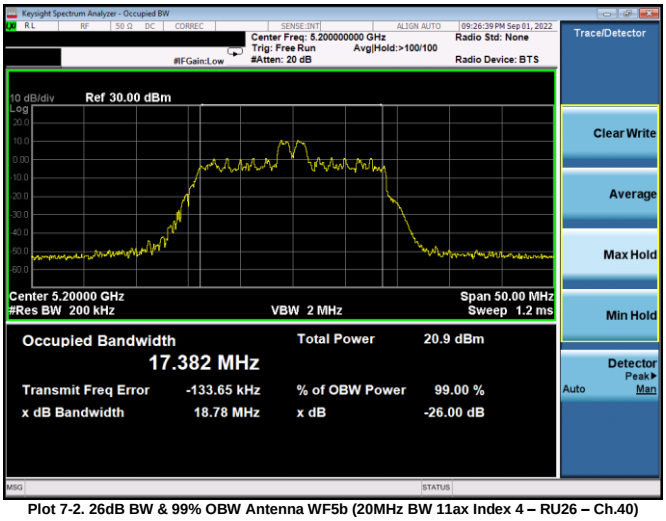
Table 7-4. Conducted BW Measurements Antenna WF5b (Fully – loaded RU)



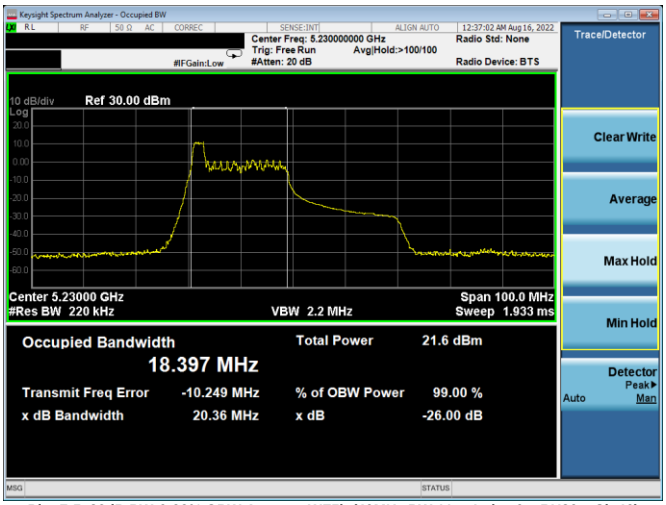
Plot 7-1. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax Index 0 – RU26 – Ch.40)



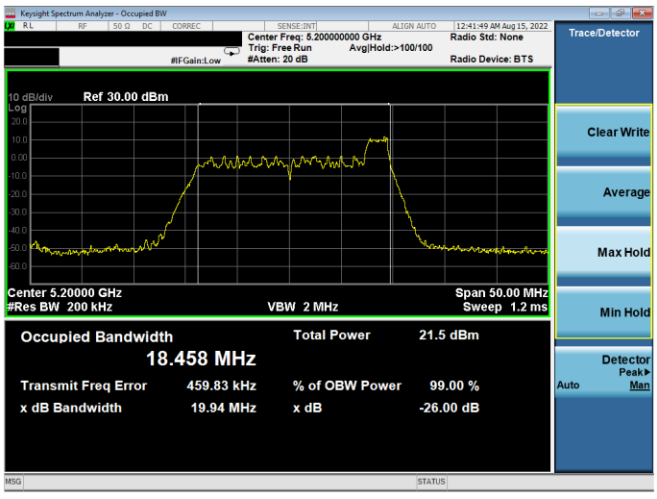
Plot 7-4. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax– RU242 – Ch.40)



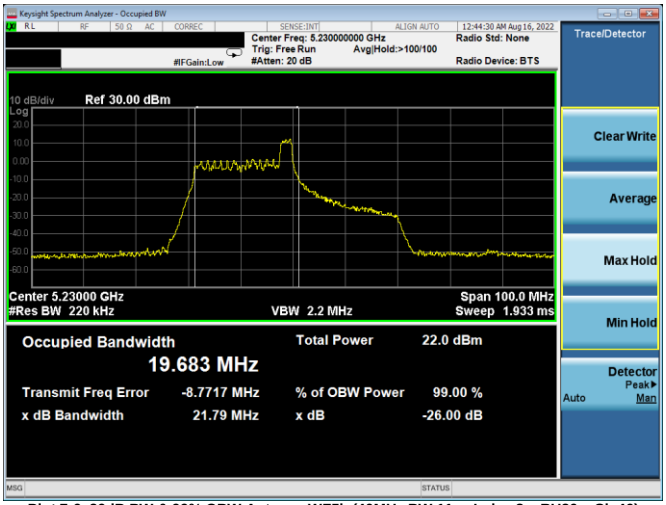
Plot 7-2. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax Index 4 – RU26 – Ch.40)



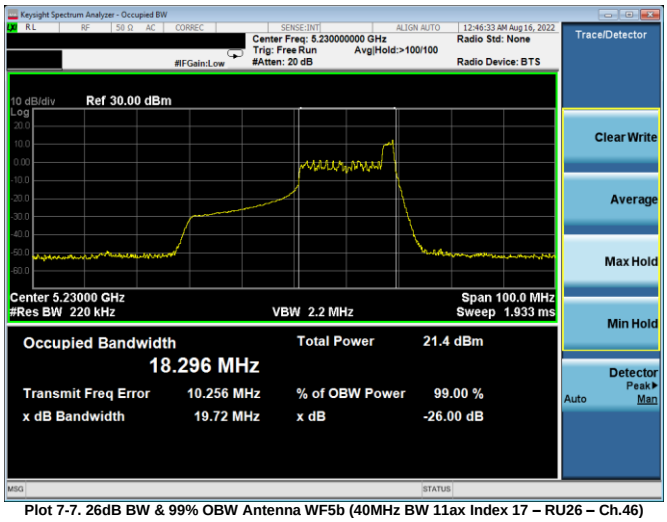
Plot 7-5. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax Index 0 – RU26 – Ch.46)



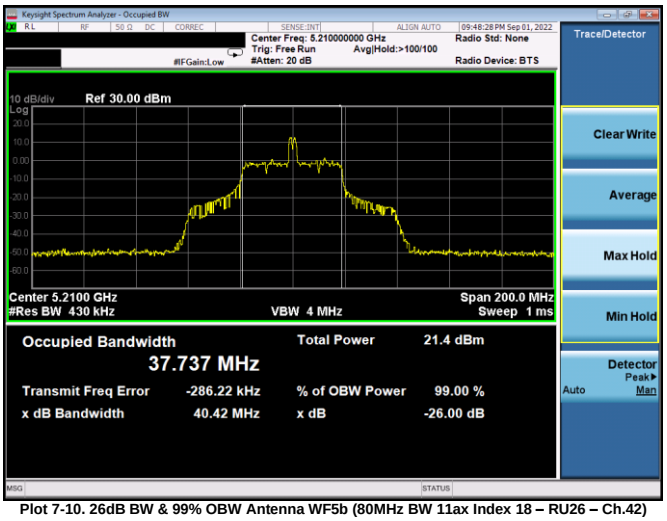
Plot 7-3. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax Index 8– RU26 – Ch.40)



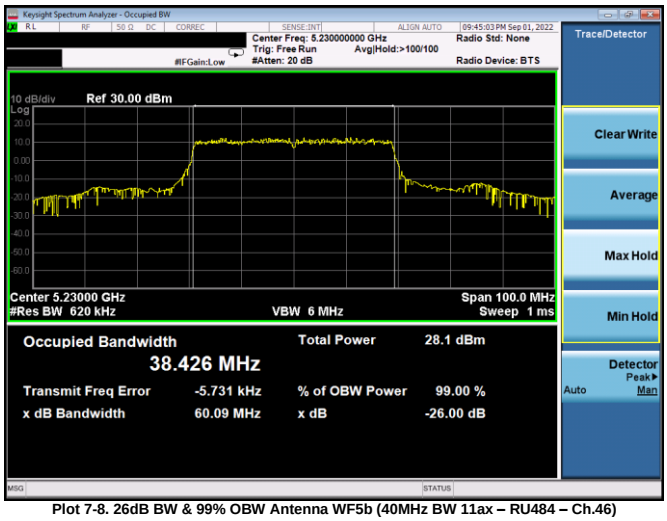
Plot 7-6. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax Index 8 – RU26 – Ch.46)



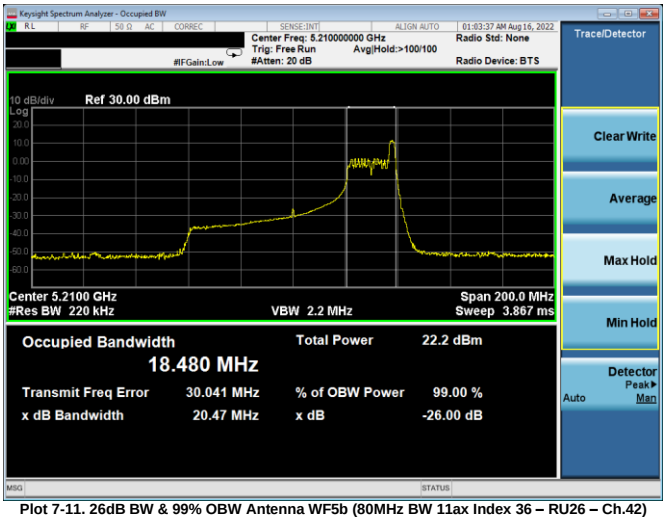
Plot 7-7. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax Index 17 – RU26 – Ch.46)



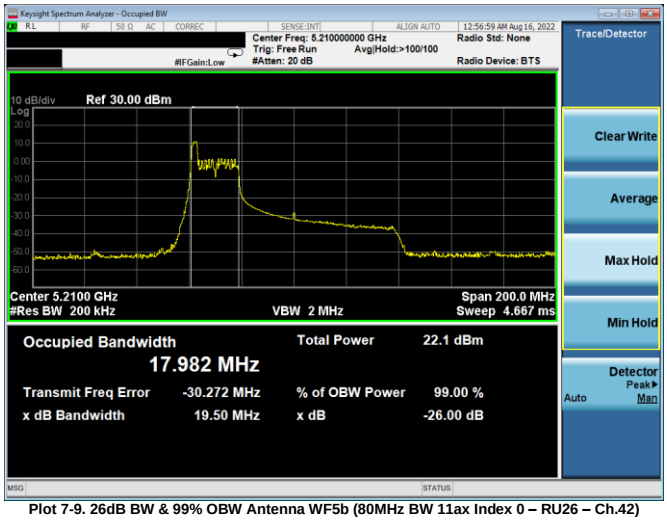
Plot 7-10. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax Index 18 – RU26 – Ch.42)



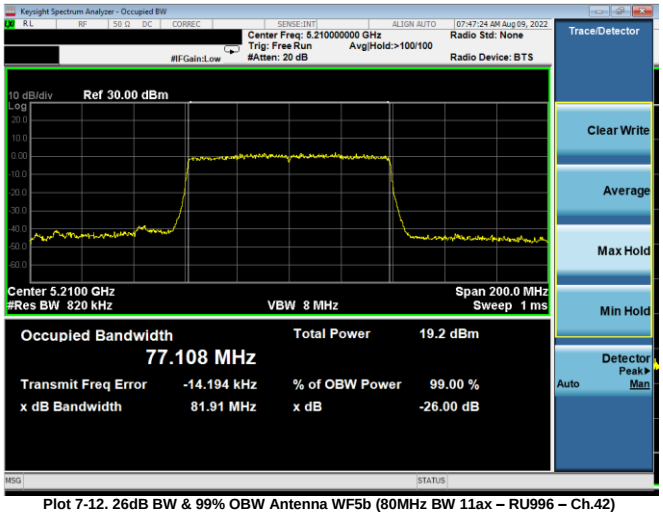
Plot 7-8. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax – RU484 – Ch.46)



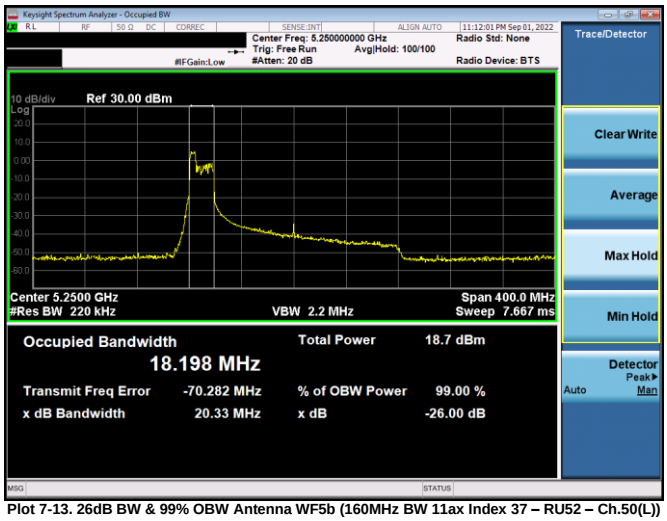
Plot 7-11. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax Index 36 – RU26 – Ch.42)



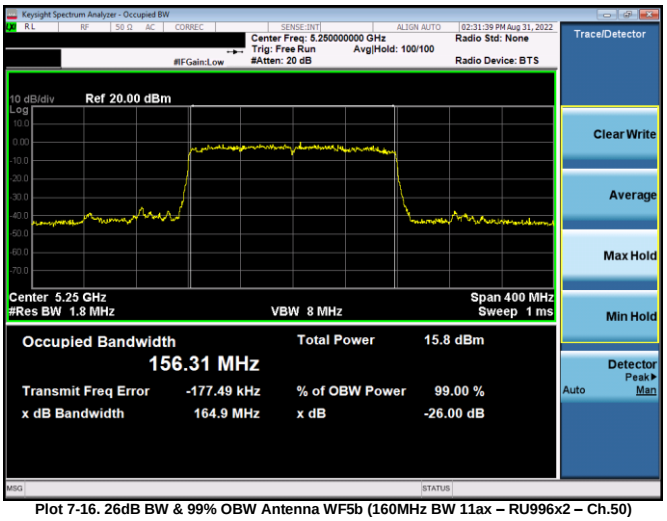
Plot 7-9. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax Index 0 – RU26 – Ch.42)



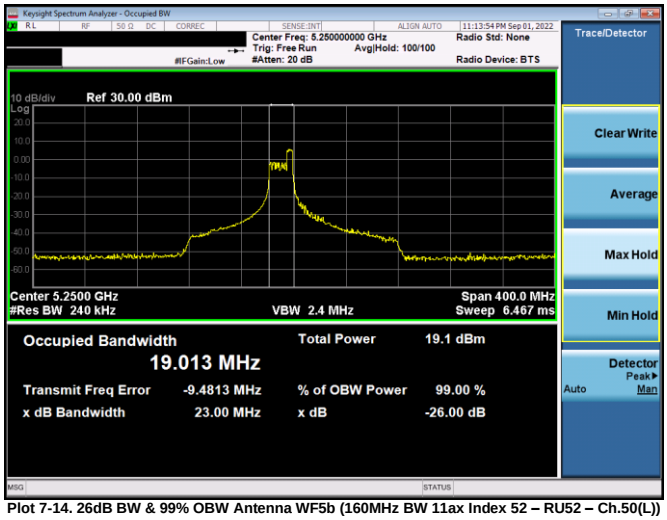
Plot 7-12. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax – RU996 – Ch.42)



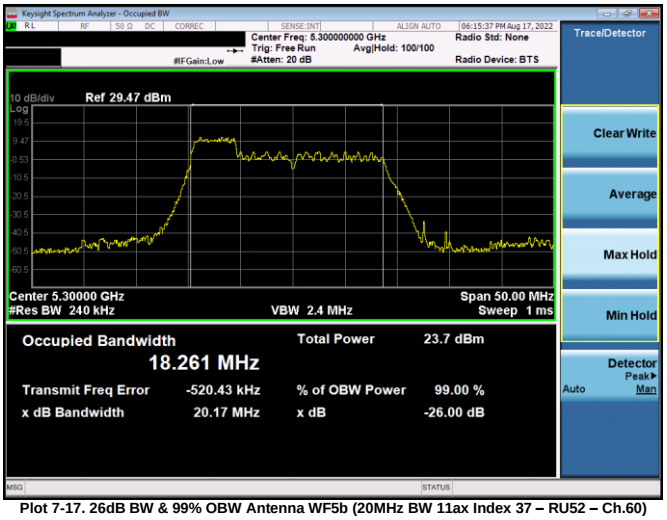
Plot 7-13. 26dB BW & 99% OBW Antenna WF5b (160MHz BW 11ax Index 37 – RU52 – Ch.50(L))



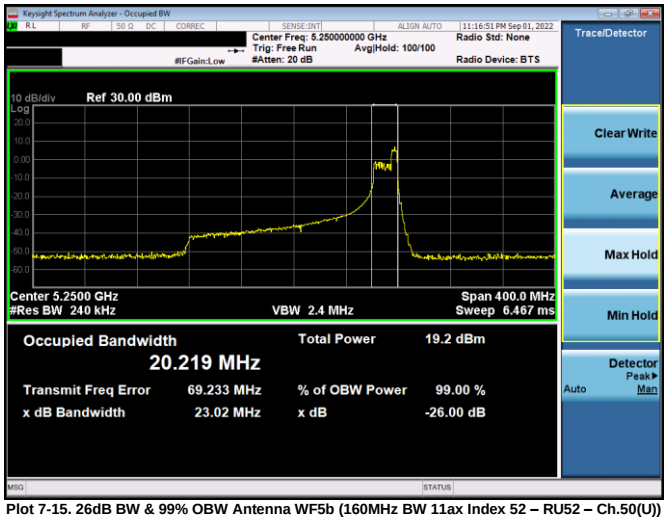
Plot 7-16. 26dB BW & 99% OBW Antenna WF5b (160MHz BW 11ax – RU996x2 – Ch.50)



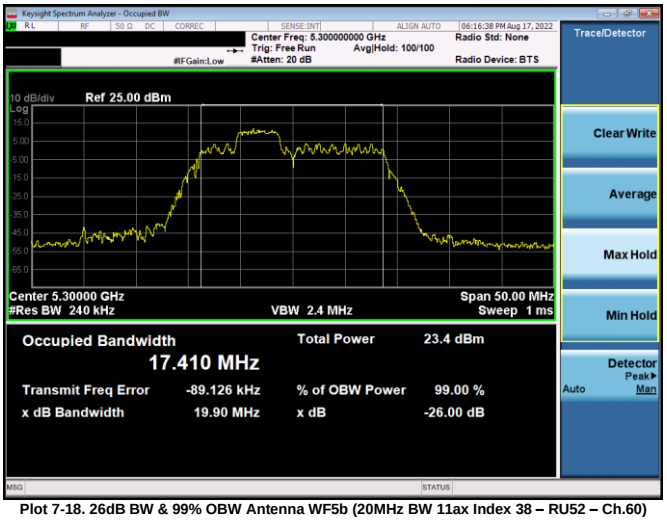
Plot 7-14. 26dB BW & 99% OBW Antenna WF5b (160MHz BW 11ax Index 52 – RU52 – Ch.50(L))



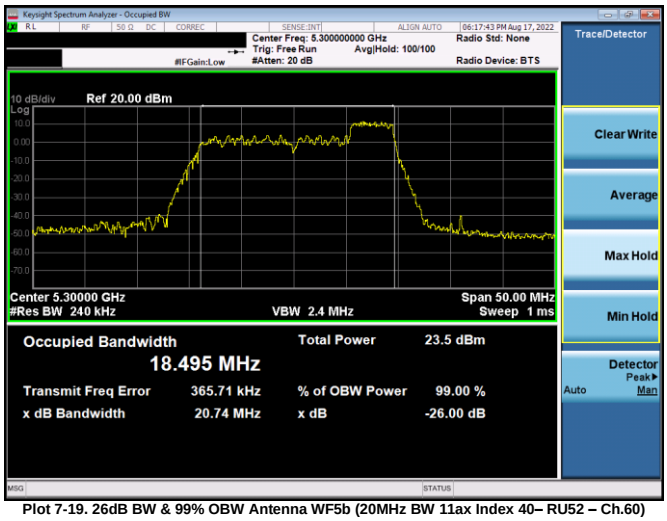
Plot 7-17. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax Index 37 – RU52 – Ch.60)



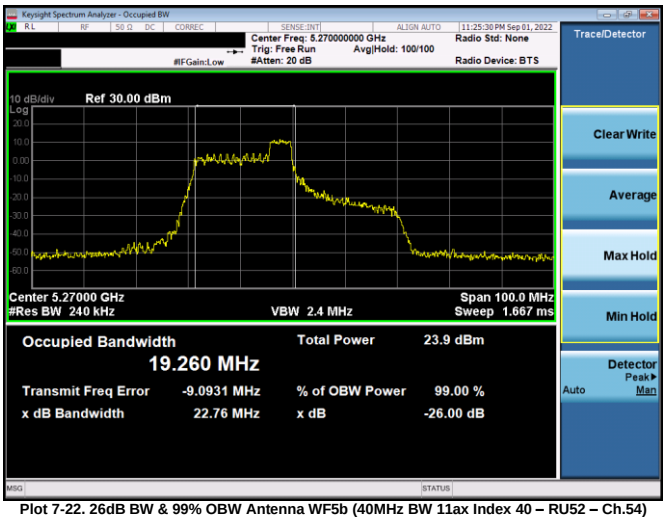
Plot 7-15. 26dB BW & 99% OBW Antenna WF5b (160MHz BW 11ax Index 52 – RU52 – Ch.50(U))



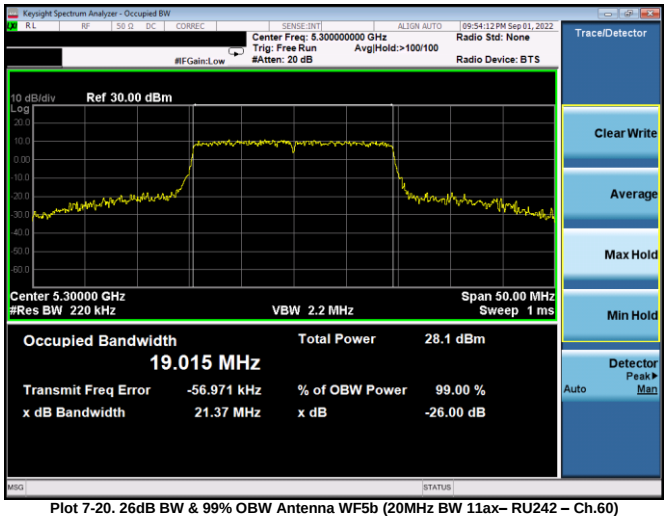
Plot 7-18. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax Index 38 – RU52 – Ch.60)



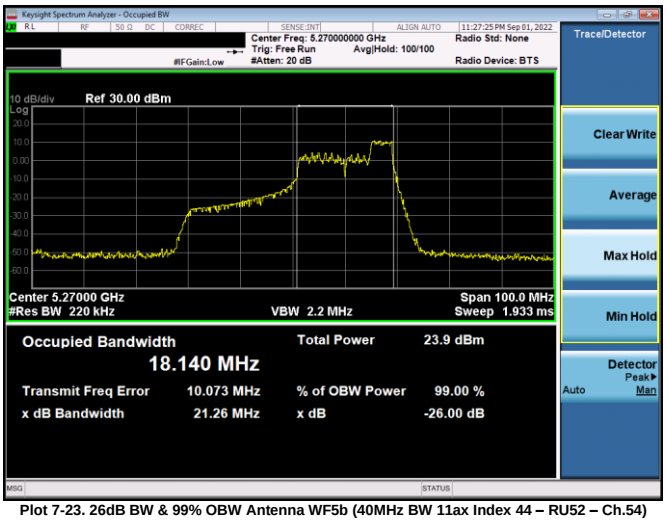
Plot 7-19. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax Index 40– RU52 – Ch.60)



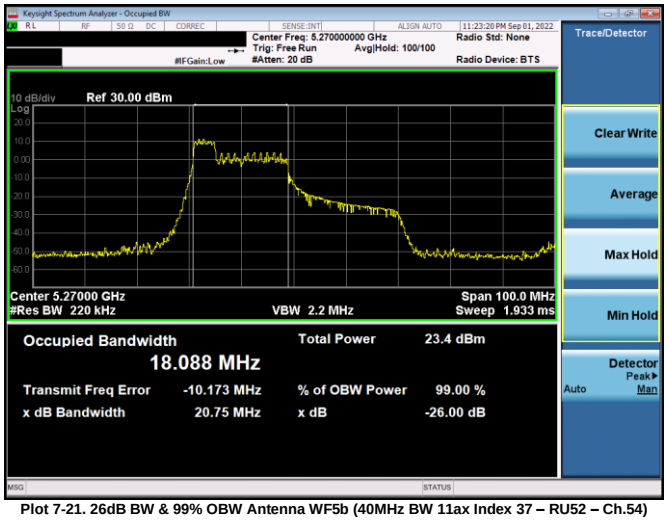
Plot 7-22. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax Index 40 – RU52 – Ch.54)



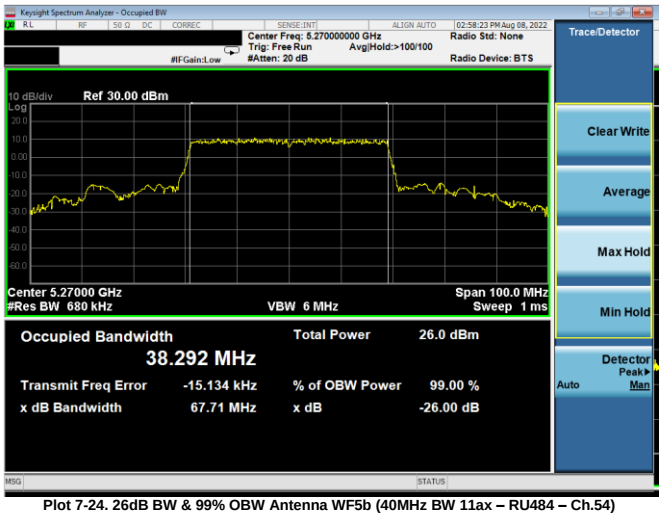
Plot 7-20. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax– RU242 – Ch.60)



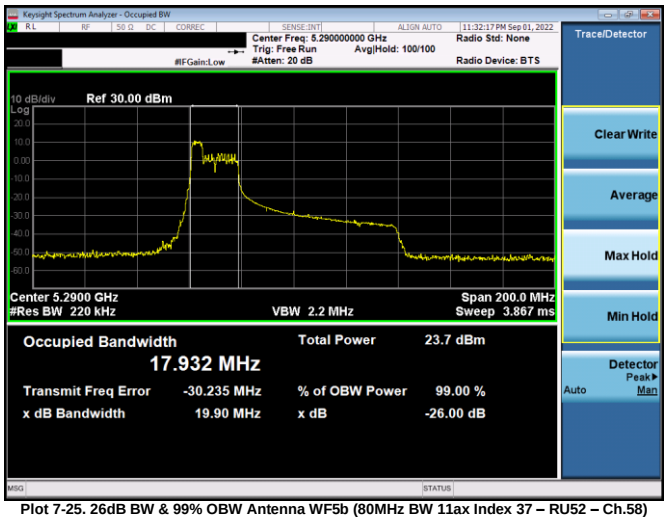
Plot 7-23. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax Index 44 – RU52 – Ch.54)



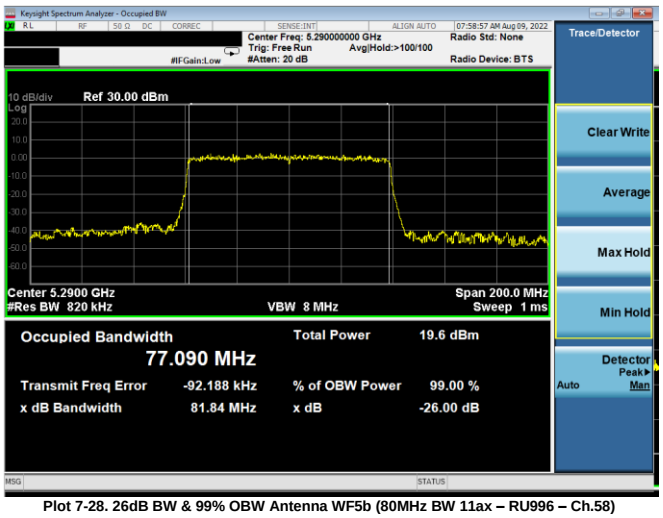
Plot 7-21. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax Index 37 – RU52 – Ch.54)



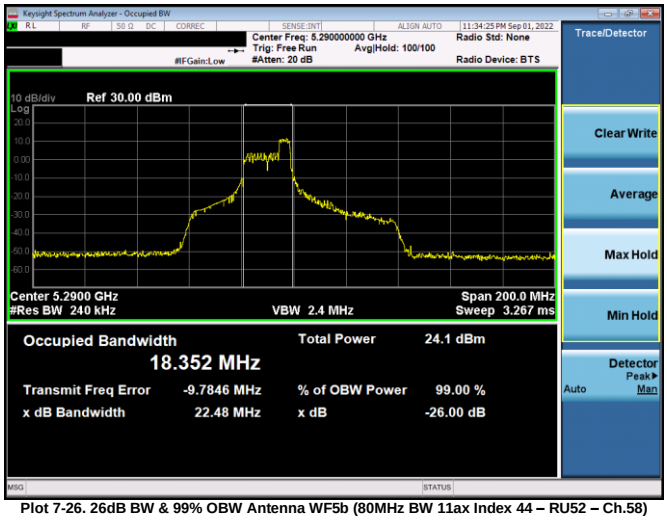
Plot 7-24. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax – RU484 – Ch.54)



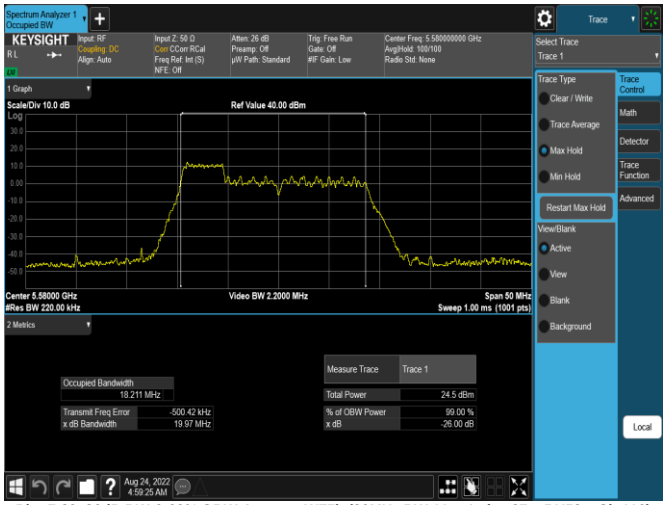
Plot 7-25. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax Index 37 – RU52 – Ch.58)



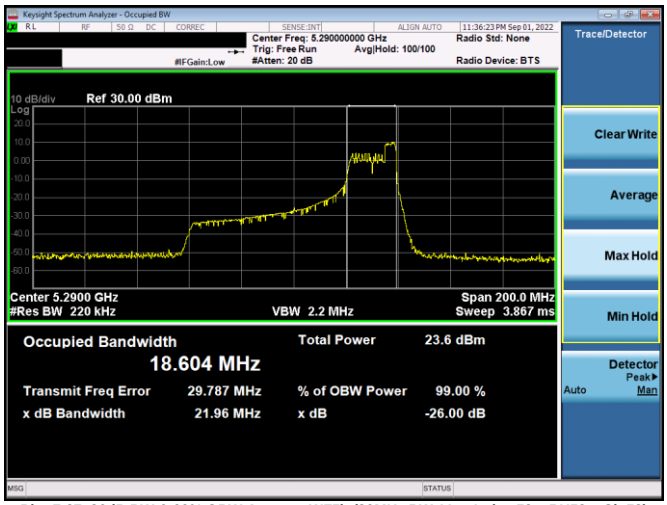
Plot 7-28. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax – RU996 – Ch.58)



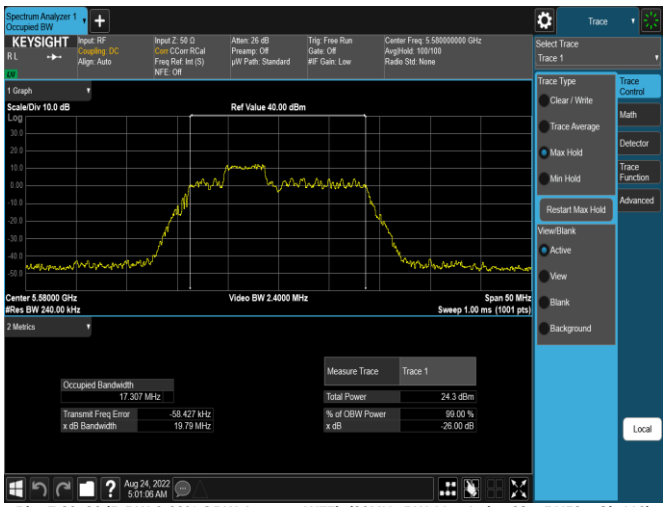
Plot 7-26. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax Index 44 – RU52 – Ch.58)



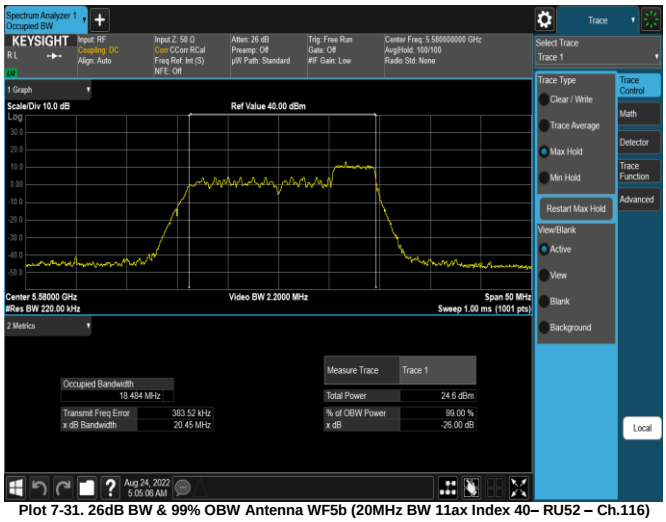
Plot 7-29. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax Index 37 – RU52 – Ch.116)



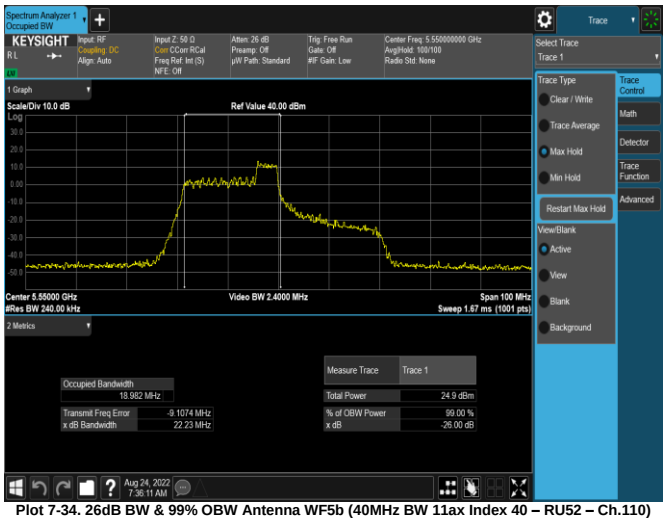
Plot 7-27. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax Index 52 – RU52 – Ch.58)



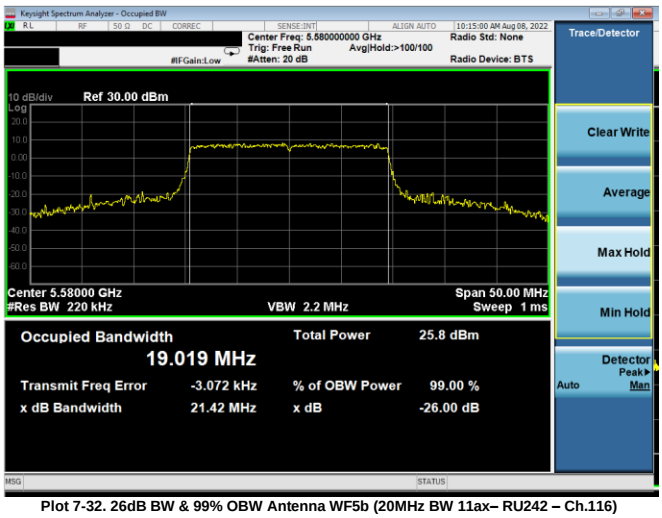
Plot 7-30. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax Index 38 – RU52 – Ch.116)



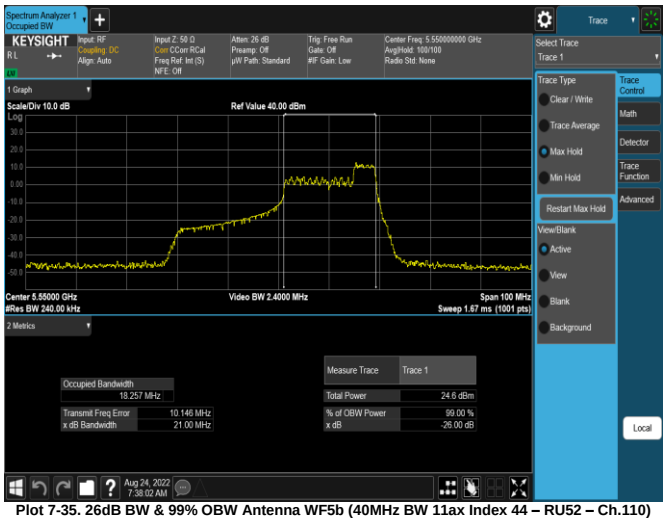
Plot 7-31. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax Index 40– RU52 – Ch.116)



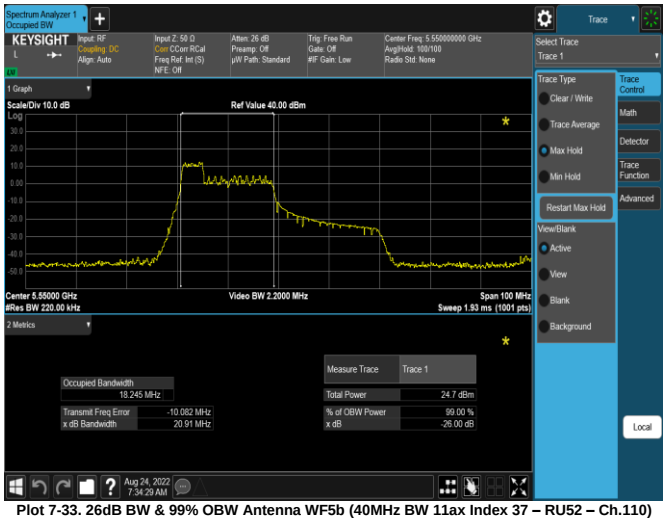
Plot 7-34. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax Index 40 – RU52 – Ch.110)



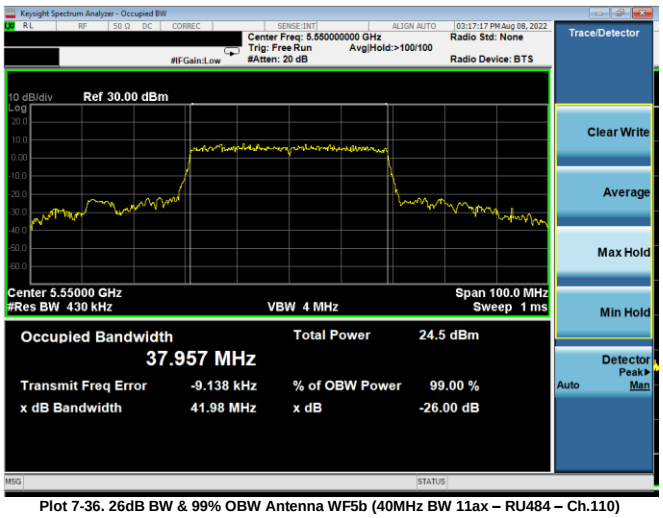
Plot 7-32. 26dB BW & 99% OBW Antenna WF5b (20MHz BW 11ax– RU242 – Ch.116)



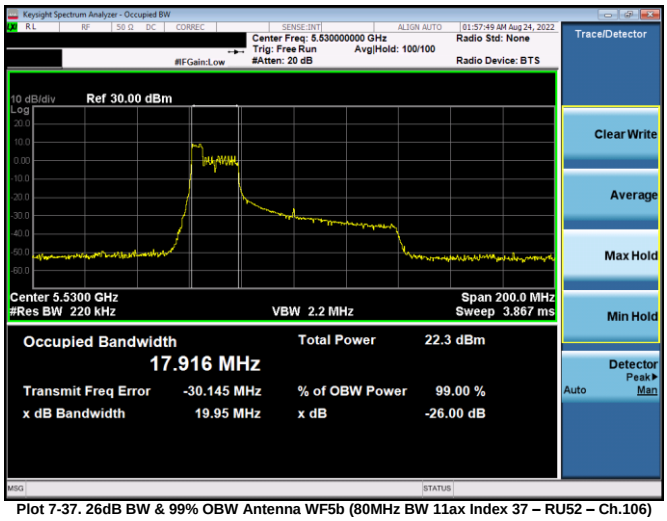
Plot 7-35. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax Index 44 – RU52 – Ch.110)



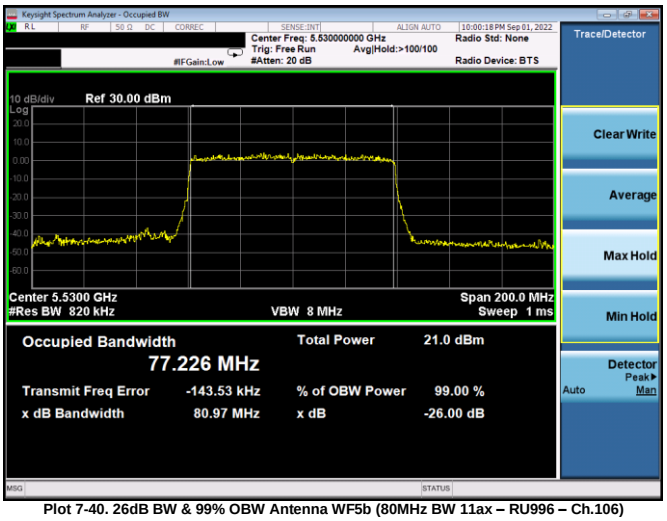
Plot 7-33. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax Index 37 – RU52 – Ch.110)



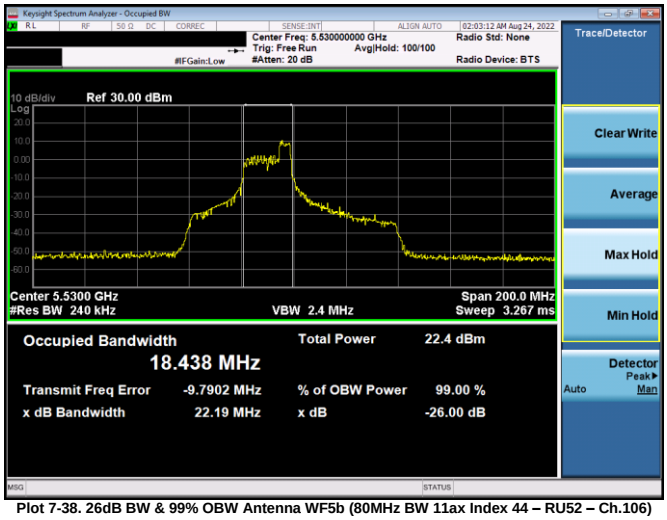
Plot 7-36. 26dB BW & 99% OBW Antenna WF5b (40MHz BW 11ax – RU484 – Ch.110)



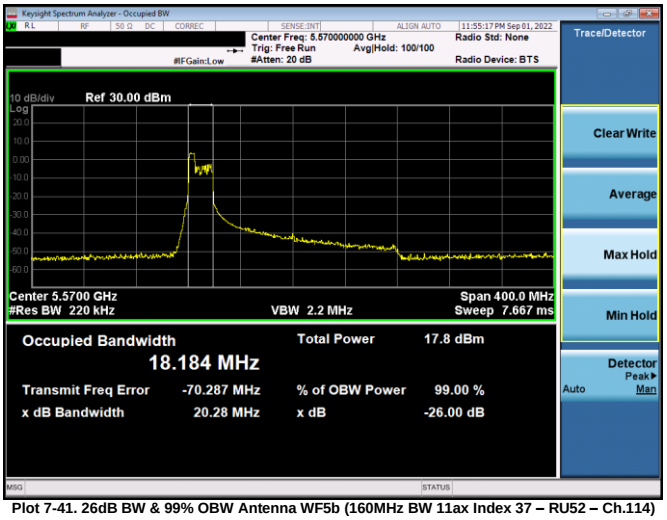
Plot 7-37. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax Index 37 – RU52 – Ch.106)



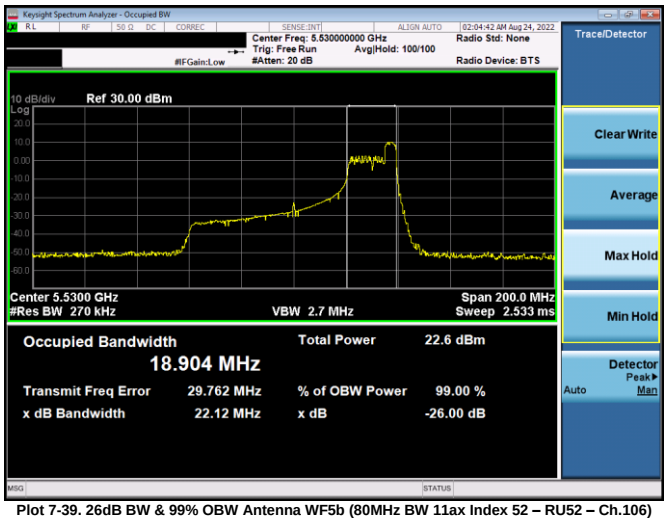
Plot 7-40. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax – RU996 – Ch.106)



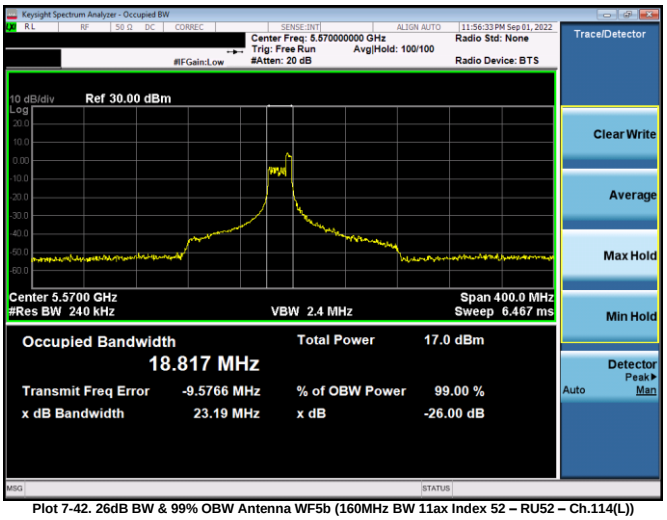
Plot 7-38. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax Index 44 – RU52 – Ch.106)



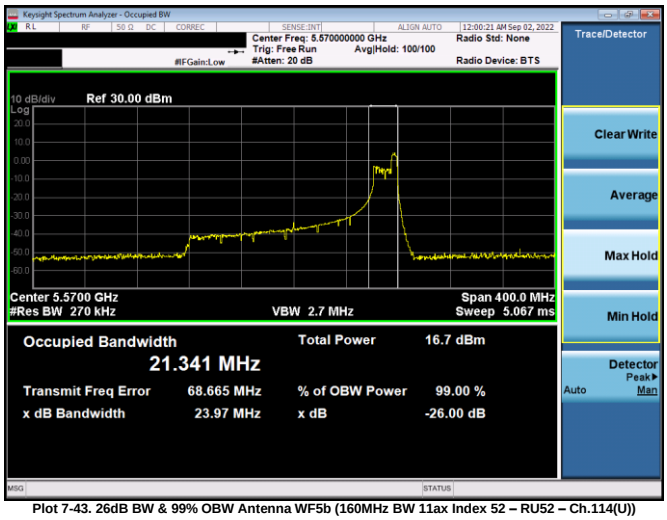
Plot 7-41. 26dB BW & 99% OBW Antenna WF5b (160MHz BW 11ax Index 37 – RU52 – Ch.114)



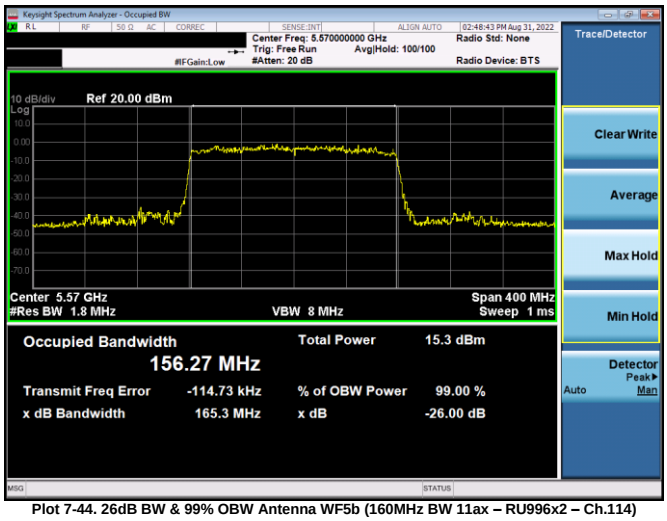
Plot 7-39. 26dB BW & 99% OBW Antenna WF5b (80MHz BW 11ax Index 52 – RU52 – Ch.106)



Plot 7-42. 26dB BW & 99% OBW Antenna WF5b (160MHz BW 11ax Index 52 – RU52 – Ch.114(L))



Plot 7-43. 26dB BW & 99% OBW Antenna WF5b (160MHz BW 11ax Index 52 – RU52 – Ch.114(U))



Plot 7-44. 26dB BW & 99% OBW Antenna WF5b (160MHz BW 11ax – RU996x2 – Ch.114)

Antenna WF4a 26dB & 99% Bandwidth Measurements

	Frequency [MHz]	Channel No.	802.11 Mode	RU Size	RU Index	Data Rate [Mbps]	Measured 99% Occupied Bandwidth [MHz]	Measured 26dB Bandwidth [MHz]
Band 1	5180	36	ax (20MHz)	26	0	12.5/14.7 (MCS11)	18.32	19.38
				26	4	12.5/14.7 (MCS11)	17.43	19.30
				26	8	12.5/14.7 (MCS11)	18.56	20.46
	5200	40	ax (20MHz)	26	0	12.5/14.7 (MCS11)	18.26	19.77
				26	4	12.5/14.7 (MCS11)	17.39	19.03
				26	8	12.5/14.7 (MCS11)	18.43	20.23
	5240	48	ax (20MHz)	26	0	12.5/14.7 (MCS11)	18.27	19.76
				26	4	12.5/14.7 (MCS11)	17.30	19.11
				26	8	12.5/14.7 (MCS11)	18.52	20.34
	5190	38	ax (40MHz)	26	0	12.5/14.7 (MCS11)	18.44	20.59
				26	8	12.5/14.7 (MCS11)	19.81	21.57
				26	17	12.5/14.7 (MCS11)	18.82	20.59
	5230	46	ax (40MHz)	26	0	12.5/14.7 (MCS11)	18.42	20.26
				26	8	12.5/14.7 (MCS11)	19.85	21.54
				26	17	12.5/14.7 (MCS11)	18.27	19.99
	5210	42	ax (80MHz)	26	0	12.5/14.7 (MCS11)	17.98	19.44
				26	18	12.5/14.7 (MCS11)	37.59	39.32
				26	36	12.5/14.7 (MCS11)	18.52	20.50

Table 7-5. Conducted Bandwidth Measurements Antenna WF4a (RU26)

	Frequency [MHz]	Channel No.	802.11 Mode	RU Size	RU Index	Data Rate [Mbps]	Measured 99% Occupied Bandwidth [MHz]	Measured 26dB Bandwidth [MHz]
Band 1/2A	5250	50 (L)	ax (160MHz)	52	37	25/29.4 (MCS11)	18.17	20.45
				52	52	25/29.4 (MCS11)	19.17	23.55
		50 (U)		52	52	25/29.4 (MCS11)	20.12	23.24
Band 2A	5260	52	ax (20MHz)	52	37	25/29.4 (MCS11)	18.23	20.15
				52	38	25/29.4 (MCS11)	17.52	20.11
				52	40	25/29.4 (MCS11)	18.52	20.79
	5300	60	ax (20MHz)	52	37	25/29.4 (MCS11)	18.19	20.05
				52	38	25/29.4 (MCS11)	17.48	19.82
				52	40	25/29.4 (MCS11)	18.49	20.75
	5320	64	ax (20MHz)	52	37	25/29.4 (MCS11)	18.11	19.98
				52	38	25/29.4 (MCS11)	17.38	19.87
				52	40	25/29.4 (MCS11)	18.42	20.28
	5270	54	ax (40MHz)	52	37	25/29.4 (MCS11)	18.07	21.18
				52	40	25/29.4 (MCS11)	19.21	23.24
				52	44	25/29.4 (MCS11)	18.29	21.85
	5310	62	ax (40MHz)	52	37	25/29.4 (MCS11)	18.07	21.18
				52	40	25/29.4 (MCS11)	19.21	23.24
				52	44	25/29.4 (MCS11)	18.29	21.85
	5290	58	ax (80MHz)	52	37	25/29.4 (MCS11)	17.99	20.15
				52	44	25/29.4 (MCS11)	18.52	23.52
				52	52	25/29.4 (MCS11)	18.58	21.65
Band 2C	5500	100	ax (20MHz)	52	37	25/29.4 (MCS11)	18.19	20.22
				52	38	25/29.4 (MCS11)	17.38	19.20
				52	40	25/29.4 (MCS11)	18.28	20.66
	5580	116	ax (20MHz)	52	37	25/29.4 (MCS11)	18.19	20.22
				52	38	25/29.4 (MCS11)	17.37	19.47
				52	40	25/29.4 (MCS11)	18.46	20.49
	5720	144	ax (20MHz)	52	37	25/29.4 (MCS11)	18.18	19.98
				52	38	25/29.4 (MCS11)	17.34	19.47
				52	40	25/29.4 (MCS11)	18.40	20.54
	5510	102	ax (40MHz)	52	37	25/29.4 (MCS11)	19.47	23.85
				52	40	25/29.4 (MCS11)	19.25	22.68
				52	44	25/29.4 (MCS11)	18.60	22.50
	5550	110	ax (40MHz)	52	37	25/29.4 (MCS11)	18.25	21.36
				52	40	25/29.4 (MCS11)	19.09	23.92
				52	44	25/29.4 (MCS11)	18.14	21.43
	5710	142	ax (40MHz)	52	37	25/29.4 (MCS11)	18.26	20.68
				52	40	25/29.4 (MCS11)	19.18	23.29
				52	44	25/29.4 (MCS11)	18.13	21.36
	5530	106	ax (80MHz)	52	37	25/29.4 (MCS11)	17.89	19.85
				52	44	25/29.4 (MCS11)	18.50	22.63
				52	52	25/29.4 (MCS11)	18.60	21.64
	5690	138	ax (80MHz)	52	37	25/29.4 (MCS11)	18.03	20.36
				52	44	25/29.4 (MCS11)	18.84	23.22
				52	52	25/29.4 (MCS11)	18.72	22.28
	5570	114 (L)	ax (160MHz)	52	37	25/29.4 (MCS11)	18.65	22.52
				52	52	25/29.4 (MCS11)	20.09	24.60
		114 (U)		52	52	25/29.4 (MCS11)	19.86	23.61

Table 7-6. Conducted Bandwidth Measurements Antenna WF4a (RU52)

	Frequency [MHz]	Channel No.	802.11 Mode	RU Size	RU Index	Data Rate [Mbps]	Measured 99% Occupied Bandwidth [MHz]	Measured 26dB Bandwidth [MHz]
Band 1	5180	36	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.00	21.06
	5200	40	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.12	25.02
	5240	48	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.12	25.62
	5190	38	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.01	42.64
	5230	46	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.68	74.86
	5210	42	ax (80MHz)	996	67	510.4/600.5 (MCS11)	77.27	81.72
Band 1/2A	5250	50	ax (160MHz)	996x2	68	510.4/600.5 (MCS11)	156.28	165.10
Band 2A	5260	52	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.06	21.42
	5300	60	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.13	25.41
	5320	64	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.03	21.26
	5270	54	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.51	74.76
	5310	62	ax (40MHz)	484	65	243.8/286.8 (MCS11)	37.98	42.06
	5290	58	ax (80MHz)	996	67	510.4/600.5 (MCS11)	77.15	81.97
Band 2C	5500	100	ax (20MHz)	242	61	121.9/143.4 (MCS11)	18.98	21.12
	5580	116	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.09	21.21
	5720	144	ax (20MHz)	242	61	121.9/143.4 (MCS11)	19.04	20.99
	5510	102	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.12	42.72
	5550	110	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.33	74.88
	5710	142	ax (40MHz)	484	65	243.8/286.8 (MCS11)	38.28	68.11
	5530	106	ax (80MHz)	996	67	510.4/600.5 (MCS11)	77.02	81.78
	5690	138	ax (80MHz)	996	67	510.4/600.5 (MCS11)	77.27	99.01
	5570*	114	ax (160MHz)	996x2	68	510.4/600.5 (MCS11)	156.50	166.50

Table 7-7. Conducted Bandwidth Measurements Antenna WF4a (Fully- loaded RU)