ELEMENT WASHINGTON DC LLC
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MEASUREMENT REPORT

FCC PART 15.247/ ISED RSS-247 802.11ax/be (OFDMA)

Applicant Name:
Microsoft Corporation
One Microsoft Way
Redmond, WA 98052
United States

Date of Testing:
12/14/2023 - 03/05/2024
Test Report Issue Date:
03/20/2024
Test Site/Location:
Element lab., Columbia, MD, USA
Test Report Serial No.:
1M2312040120-18.C3K

FCC ID:	**C3K2077**
IC:	**3048A-2077**
APPLICANT:	**Microsoft Corporation**

Application Type:	Certification
Model/HVIN:	2077
EUT Type:	Portable Computing Device
Frequency Range:	2412 – 2472MHz
Modulation Type:	OFDMA
FCC Classification:	Digital Transmission System (DTS)
FCC Rule Part(s):	Part 15 Subpart C (15.247)
ISED Specification:	RSS-247 Issue 3
Test Procedure(s):	ANSI C63.10-2013

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. 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 #2041.01

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Channel Bandwidth [MHz]	IEEE Mode	Tones	Tx Frequency [MHz]	MIMO			
				Avg. Conducted		Peak Conducted	
				Max. Power [mW]	Max. Power [dBm]	Max. Power [mW]	Max. Power [dBm]
20	802.11ax/be OFDMA	26T	2412 - 2462	192.67	22.85	987.49	29.95
	802.11ax/be OFDMA	52T	2412 - 2462	191.13	22.81	977.51	29.90
	802.11be OFDMA	52+26T	2412 - 2462	192.03	22.83	963.90	29.84
	802.11ax/be OFDMA	106T	2412 - 2462	192.45	22.84	969.49	29.87
	802.11be OFDMA	106+26T	2412 - 2462	191.81	22.83	984.08	29.93
	802.11ax/be OFDMA	242T	2412 - 2462	168.25	22.26	954.95	29.80
40	802.11ax/be OFDMA	484T	2412 - 2462	67.45	18.29	400.30	26.02

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 Test Location

These measurement tests were conducted at the Element laboratory facility located at 7185 Oakland Mills Road, Columbia, MD 21046. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014.

1.3 Test Facility / Accreditations

Measurements were performed at Element lab located in Columbia, MD 21046, 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 2041.01 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 (2451B) test laboratory with the site description on file with ISED.

- Element Washington DC LLC is a Recognized U.S. Certification Assessment Body (CAB # US0110) for ISED Canada as designated by NIST under the U.S. and Canada Mutual Recognition Agreements (MRAs).

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Microsoft Corporation Portable Computing Device FCC ID: C3K2077**. The test data contained in this report pertains only to the emissions due to the EUT's WLAN (DTS) transmitter.

Test Device Serial No.: 7CCX2, 7CDJ2, B44G2, B44D2, B44T2

2.2 Device Capabilities

This device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, Multi-band 5G NR (FR1), 802.11b/g/n/ac/ax/be WLAN, 802.11a/n/ac/ax/be UNII (5GHz and 6GHz), Bluetooth (1x, EDR, LE)

Ch.	Frequency (MHz)	Ch.	Frequency (MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	12	2467
6	2437	13	2472
7	2442		

Table 2-1. Frequency/ Channel Operations

Notes:

1. 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 6.0 b) of ANSI C63.10-2013 and KDB 558074 D01 v05r02. 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:

Band	Bandwidth	Tone Type	Tone Size	MIMO (1+2)
				Duty Cycle [%]
2.4GHz	20MHz	RU	26T	99.28
			52T	99.28
			106T	99.23
			242T	98.68
		MRU	52+26T	99.28
			106+26T	98.62
	40MHz	RU	26T	99.28
			52T	99.28
			106T	99.23
			242T	98.68
			484T	97.59

Table 2-2. Measured Duty Cycles

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

WiFi Configurations		SDM		CDD	
		ANT1	ANT2	ANT1	ANT2
2.4GHz	11ax/be	✓	✓	✓	✓

Table 2-3. Antenna Configuration

✓= Support ; × = NOT Support
MIMO = Single Input Single Output
SDM = Spatial Diversity Multiplexing – MIMO function
CDD = Cyclic Delay Diversity - 2Tx Function

3. The device supports the following data rates (shown in Mbps):

MCS Index		Spatial Stream	OFDMA (802.11ax/be)											
			26T			52T			106T			242T		
HE	EHT		0.8µs GI	1.6µs GI	3.2µs GI	0.8µs GI	1.6µs GI	3.2µs GI	0.8µs GI	1.6µs GI	3.2µs GI	0.8µs GI	1.6µs GI	3.2µs GI
0	0	1	0.9	0.8	0.8	1.8	1.7	1.5	3.8	3.5	3.2	8.6	8.1	7.3
1	1	1	1.8	1.7	1.5	3.5	3.3	3	7.5	7.1	6.4	17.2	16.3	14.6
2	2	1	2.6	2.5	2.3	5.3	5	4.5	11.3	10.6	9.6	25.8	24.4	21.9
3	3	1	3.5	3.3	3	7.1	6.7	6	15	14.2	12.8	34.4	32.5	29.3
4	4	1	5.3	5	4.5	10.6	10	9	22.5	21.3	19.1	51.6	48.8	43.9
5	5	1	7.1	6.7	6	14.1	13.3	12	30	28.3	25.5	68.8	65	58.5
6	6	1	7.9	7.5	6.8	15.9	15	13.5	33.8	31.9	28.7	77.4	73.1	65.8
7	7	1	8.8	8.3	7.5	17.6	16.7	15	37.5	35.4	31.9	86	81.3	73.1
8	8	1	10.6	10	9	21.2	20	18	45	42.5	38.3	103.2	97.5	87.8
9	9	1	11.8	11.1	10	23.5	22.2	20	50	47.2	42.5	114.7	108.3	97.5
10	10	1	13.2	12.5	11.3	26.5	25	22.5	56.3	53.1	47.8	129	121.9	109.7
11	11	1	14.7	13.9	12.5	29.4	27.8	25	62.5	59	53.1	143.4	135.4	121.9
	12	1	15.9	15	13.5	31.8	30	27	67.5	63.8	57.4	154.9	146.3	131.6
	13	1	17.6	16.7	15	35.3	33.3	30	75	70.8	63.8	172.1	162.5	146.3
0	0	2	1.8	1.7	1.5	3.5	3.3	3	7.5	7.1	6.4	17.2	16.3	14.6
1	1	2	3.5	3.3	3	7.1	6.7	6	15	14.2	12.8	34.4	32.5	29.3
2	2	2	5.3	5	4.5	10.6	10	9	22.5	21.3	19.1	51.6	48.8	43.9
3	3	2	7.1	6.7	6	14.1	13.3	12	30	28.3	25.5	68.8	65	58.5
4	4	2	10.6	10	9	21.2	20	18	45	42.5	38.3	103.2	97.5	87.8
5	5	2	14.1	13.3	12	28.2	26.7	24	60	56.7	51	137.6	130	117
6	6	2	15.9	15	13.5	31.8	30	27	67.5	63.8	57.4	154.9	146.3	131.6
7	7	2	17.6	16.7	15	35.3	33.3	30	75	70.8	63.8	172.1	162.5	146.3
8	8	2	21.2	20	18	42.4	40	36	90	85	76.5	206.5	195	175.5
9	9	2	23.5	22.2	20	47.1	44.4	40	100	94.4	85	229.4	216.7	195
10	10	2	26.5	25	22.5	52.9	50	45	112.5	106.3	95.6	258.1	243.8	219.4
11	11	2	29.4	27.8	25	58.8	55.6	50	125	118.1	106.3	286.8	270.8	243.8
	12	2	31.8	30	27	63.5	60	54	135	127.5	114.8	309.7	292.5	263.3
	13	2	35.3	33.3	30	70.6	66.7	60	150	141.7	127.5	344.1	325	292.5

Table 2-4. Supported Data Rates

2.3 Test Configuration

ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing. See Sections 7.7 for radiated emissions test setups, and 7.2, 7.3, 7.4, 7.5, and 7.6 for antenna port conducted emissions test setups.

2.4 Antenna Description

The following antenna gains were used for the testing.

Frequency [GHz]	Antenna-1 Gain [dBi]	Antenna-2 Gain [dBi]	Directional Gain [dBi]
2.4	0.55	0.14	3.36

Table 2-5. Antenna Peak Gain

2.5 Software and Firmware

The test was conducted with software/firmware version 2024.111.46 installed on the EUT.

2.6 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) was used in the measurement of the EUT**.**

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

3.2 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.

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.

All radiated measurements are performed in a chamber that meets the site requirements per ANSI C63.4-2014. Additionally, radiated emissions below 30MHz are also validated on an Open Area Test Site to assert correlation with the chamber measurements per the requirements of KDB 414788 D01 v01r01.

3.3 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 connections to an external antenna.

Conclusion:

The EUT unit 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 C63.10-2013. 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	1.13
Line Conducted Disturbance	3.09
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

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
N/A	WL25-1	Conducted Cable Set (25GHz)	11/15/2023	Annual	11/15/2024	WL25-1
N/A	WL25-2	WLAN Cable Set (25GHz)	11/15/2023	Annual	11/15/2024	WL25-2
N/A	WL40-1	WLAN Cable Set (40GHz)	11/15/2023	Annual	11/15/2024	WL40-1
N/A	ETS-001	EMC Cable and Switch System	11/15/2023	Annual	11/15/2024	ETS-001
N/A	ETS-002	EMC Cable and Switch System	11/15/2023	Annual	11/15/2024	ETS-002
N/A	AP1-002	EMC Cable and Switch System	11/15/2023	Annual	11/15/2024	AP1-002
N/A	AP2-001	EMC Cable and Switch System	11/15/2023	Annual	11/15/2024	AP2-001
N/A	AP2-002	EMC Cable and Switch System	11/15/2023	Annual	11/15/2024	AP2-002
Anritsu	MA2411B	Pulse Power Sensor	11/8/2023	Annual	11/8/2024	1027293
Anritsu	MA2411B	Pulse Power Sensor	6/14/2023	Annual	6/14/2024	1911105
Com-Power	AL-130	9kHz - 30MHz Loop Antenna	4/13/2022	Biennial	4/13/2024	121034
Keysight Technologies	N9038A	MXE EMI Receiver	8/30/2023	Annual	8/30/2024	MY51210133
Keysight Technologies	N9030A	PXA Signal Analyzer	2/29/2024	Annual	3/1/2025	MY55410501
Keysight Technologies	N9020A	MXA Signal Analyzer	3/15/2023	Annual	3/15/2024	MY54500644
Pasternack	NMLC-2	Line Conducted Emissions Cable (NM)	11/15/2023	Annual	11/15/2024	NMLC-2
Rohde & Schwarz	ESU26	EMI Test Receiver (26.5GHz)	9/25/2023	Annual	9/25/2024	100342
Rohde & Schwarz	ESU40	EMI Test Receiver (40GHz)	9/11/2023	Annual	9/11/2024	100348
Rohde & Schwarz	FSW67	Signal / Spectrum Analyzer	2/15/2024	Annual	2/15/2025	103200
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	3/15/2023	Biennial	3/15/2025	102136
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	3/15/2023	Biennial	3/15/2025	102132
Rohde & Schwarz	SFUNIT-Rx	Shielded Filter Unit	1/11/2024	Annual	1/11/2025	102151
Sunol Sciences	DRH-118	Horn (Small)	2/21/2024	Biennial	2/21/2026	A050307
Sunol Sciences	JB5	Bi-Log Antenna (30M-5GHz)	8/30/2022	Biennial	8/30/2024	A051107

Table 6-1. Annual Test Equipment Calibration Schedule

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: Microsoft Corporation

FCC ID: C3K2077

FCC Classification: Digital Transmission System (DTS)

FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.247(a)(2)	RSS-247 [5.2(a)]	6dB Bandwidth	The minimum 6 dB bandwidth shall be at least 500 kHz.	CONDUCTED	PASS	Section 7.2
15.247(b)(3)	RSS-247 [5.4(b)]	Transmitter Output Power	shall not exceed 1 W		PASS	Section 7.3
N/A	RSS-247 [5.4(b)]	e.i.r.p	Shall not exceed 4 W		PASS	Section 7.3
15.247(e)	RSS-247 [5.2(b)]	Transmitter Power Spectral Density	shall not be greater than 8 dBm in any 3 kHz band		PASS	Section 7.4
15.247(d)	RSS-247 [5.5]	Band Edge / Out-of-Band Emissions	≥ 20dBc		PASS	Sections 7.5, 7.6
15.205 15.209	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])	RADIATED	PASS	Section 7.7

Table 7-1. Summary of Test Results

Notes:

1) All modes of operation and data rates were investigated. 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 Element "WLAN Automation," Version 3.5.
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 Element "Chamber Automation," Version 1.3.1.
6) 802.11be OFDMA testing was performed for all signal tone configurations as specified by the 802.11be standard. Worst case results are determined and reported per the guidance provided at the October 2018 TCB Workshop.

7.2 6dB Bandwidth Measurement

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 transmitter antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates were investigated and the worst-case configuration results are reported in this section.

The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure Used

ANSI C63.10-2013 – Section 11.8.2 Option 2

Test Settings

1. The signal analyzer's automatic bandwidth measurement capability was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 100kHz
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize

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. Based on preliminary measurements, it was determined that, of all the tone configurations, the 26T configuration produced the worst case 6dB Bandwidth measurement. Only the worst-case data is included in this section.

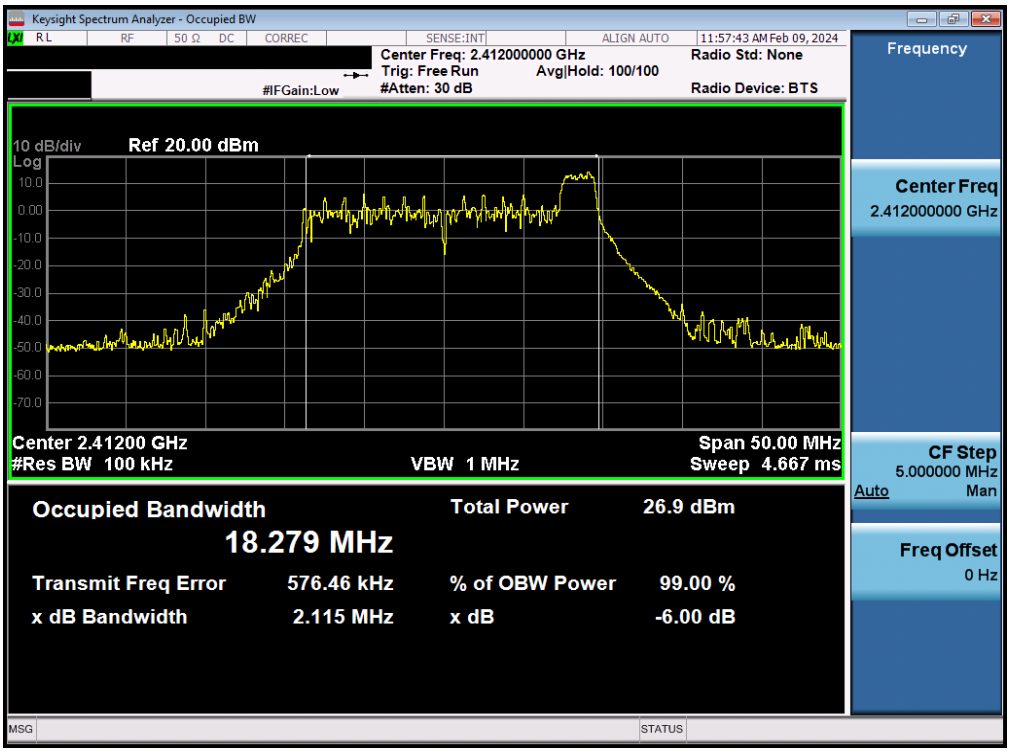
2. The 6dB bandwidth for each channel was measured with the RU index showing the highest conducted power.

6dB Bandwidth Measurements

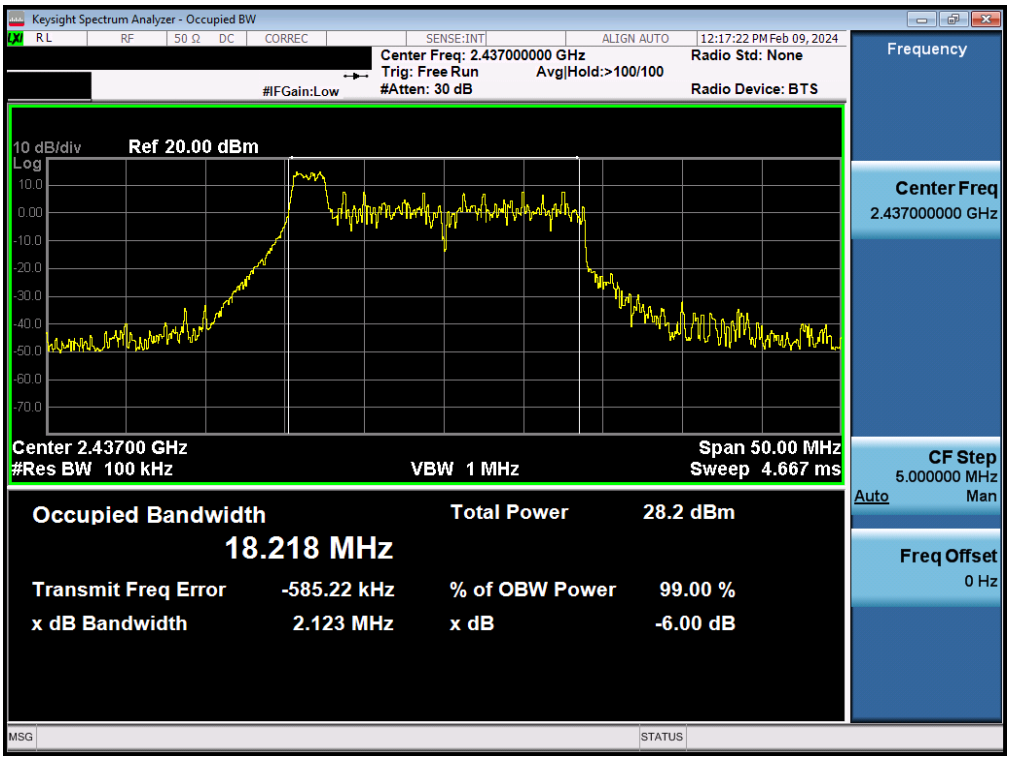
Frequency [MHz]	Channel No.	802.11 Mode	Tones	Data Rate [Mbps]	Antenna-1 6dB Bandwidth [MHz]	Antenna-2 6dB Bandwidth [MHz]	Minimum Bandwidth [MHz]
2412	1	be	26T	MCS0	2.12	2.11	0.500
2437	6	be	26T	MCS0	2.12	2.15	0.500
2462	11	be	26T	MCS0	2.10	2.06	0.500
2412	1	be	242T	MCS0	19.05	19.14	0.500
2437	6	be	242T	MCS0	19.10	19.06	0.500
2462	11	be	242T	MCS0	19.10	19.10	0.500
2422	3	be	484T	MCS0	38.13	38.08	0.500
2437	6	be	484T	MCS0	38.21	37.95	0.500
2462	11	be	484T	MCS0	38.13	38.18	0.500

Table 7-2. Conducted 6dB Bandwidth Measurements MIMO

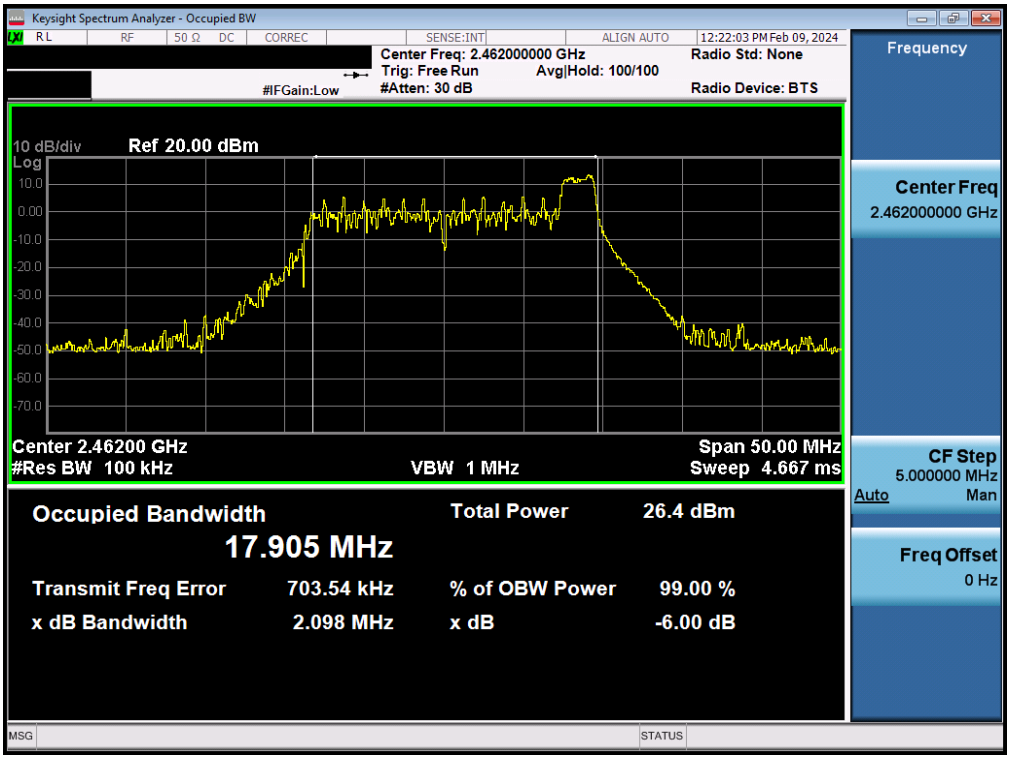
7.2.1 MIMO Antenna-1 6dB Bandwidth Measurements



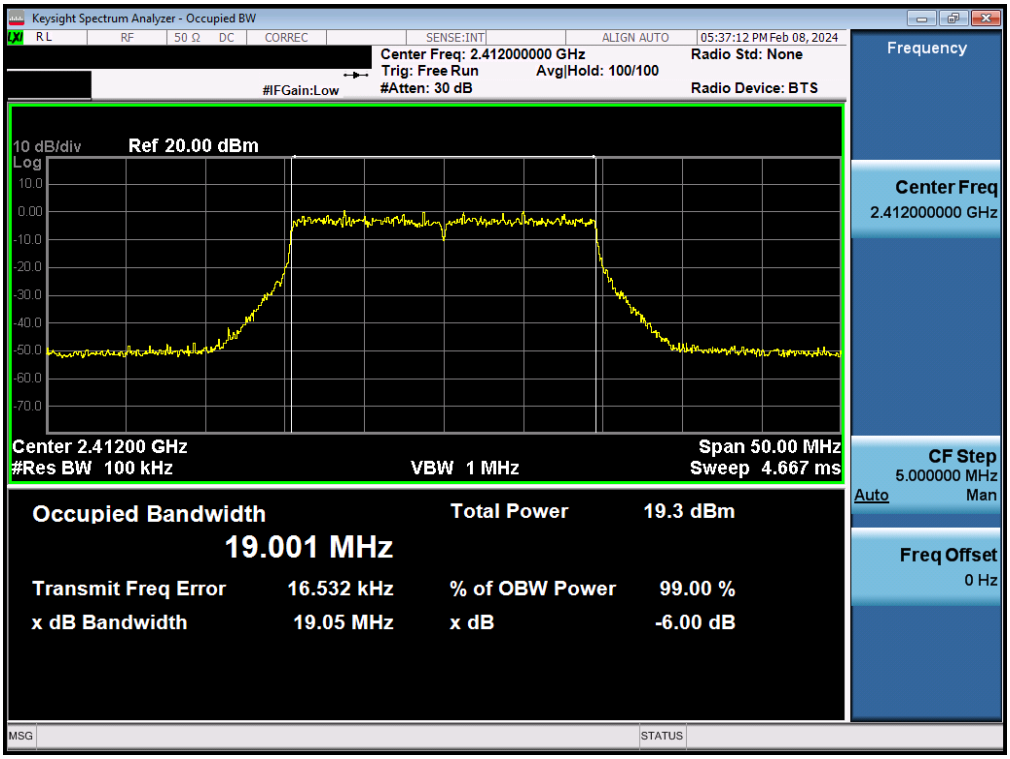
Plot 7-1. 6dB Bandwidth Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 1)



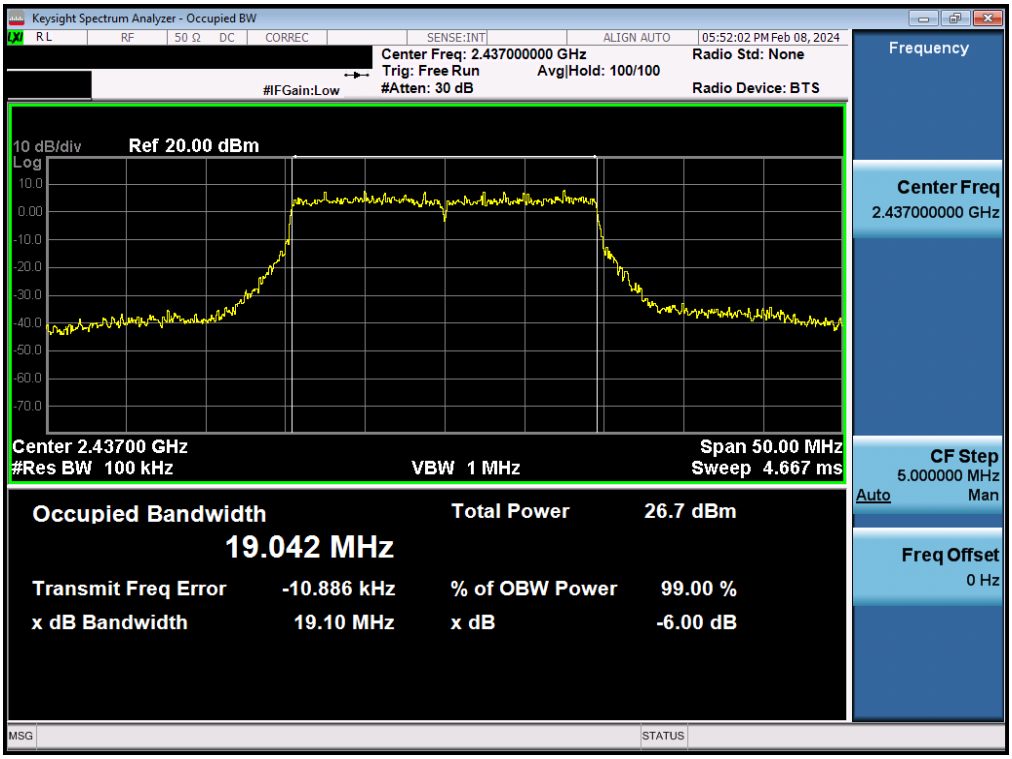
Plot 7-2. 6dB Bandwidth Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 6)



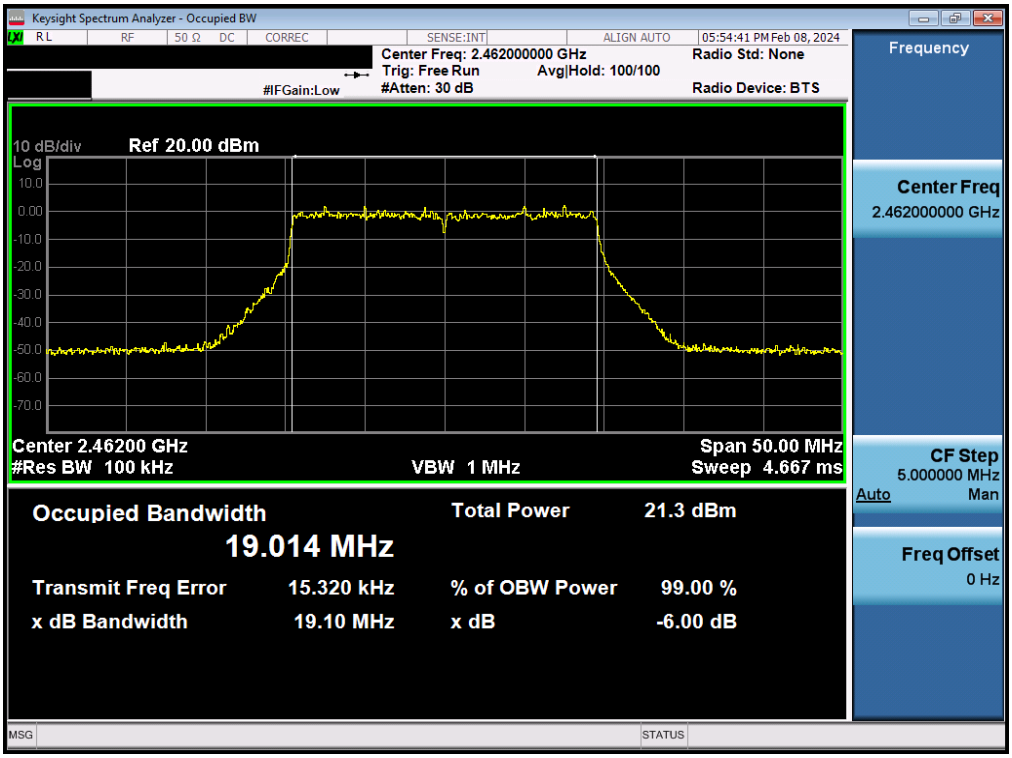
Plot 7-3. 6dB Bandwidth Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 11)



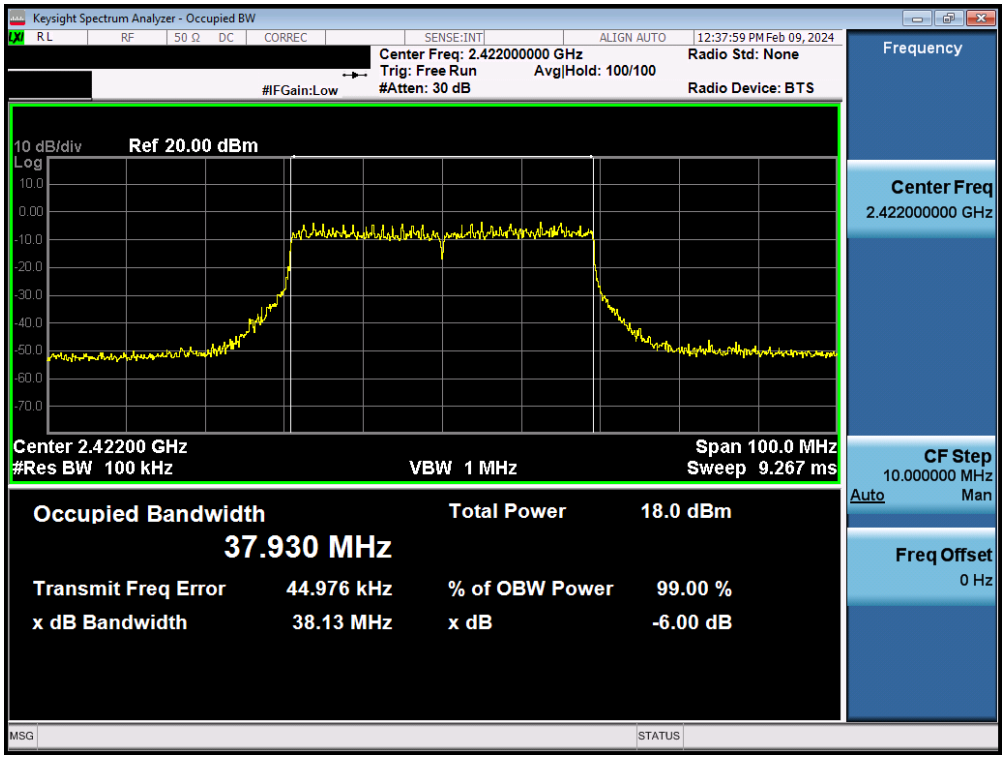
Plot 7-4. 6dB Bandwidth Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 1)



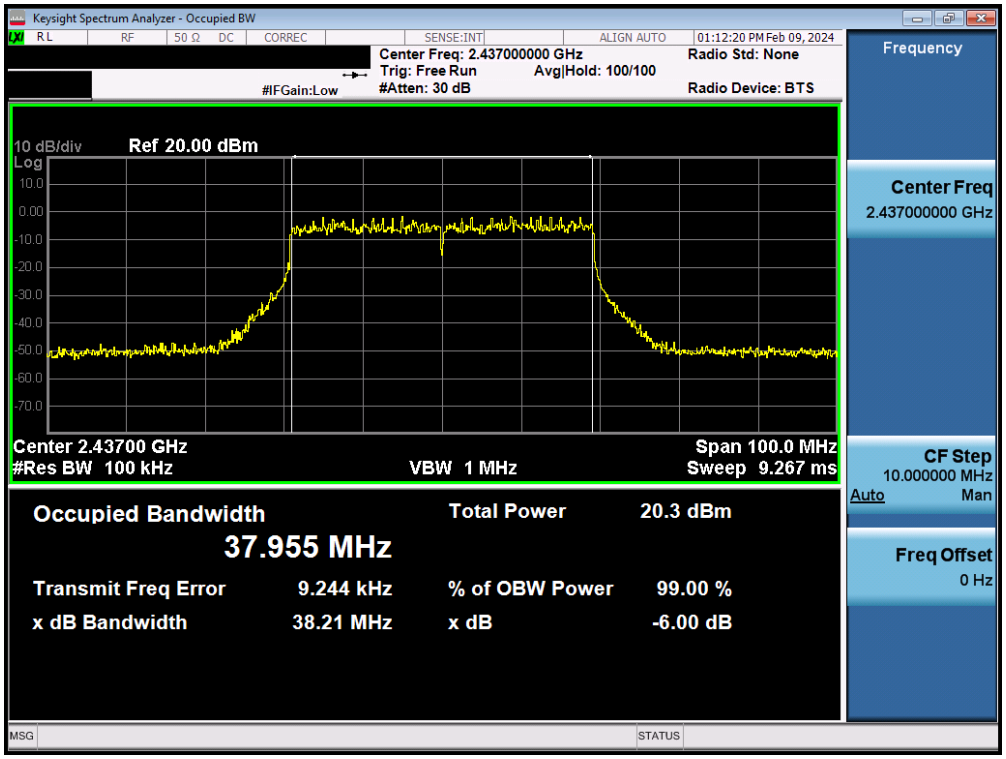
Plot 7-5. 6dB Bandwidth Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 6)



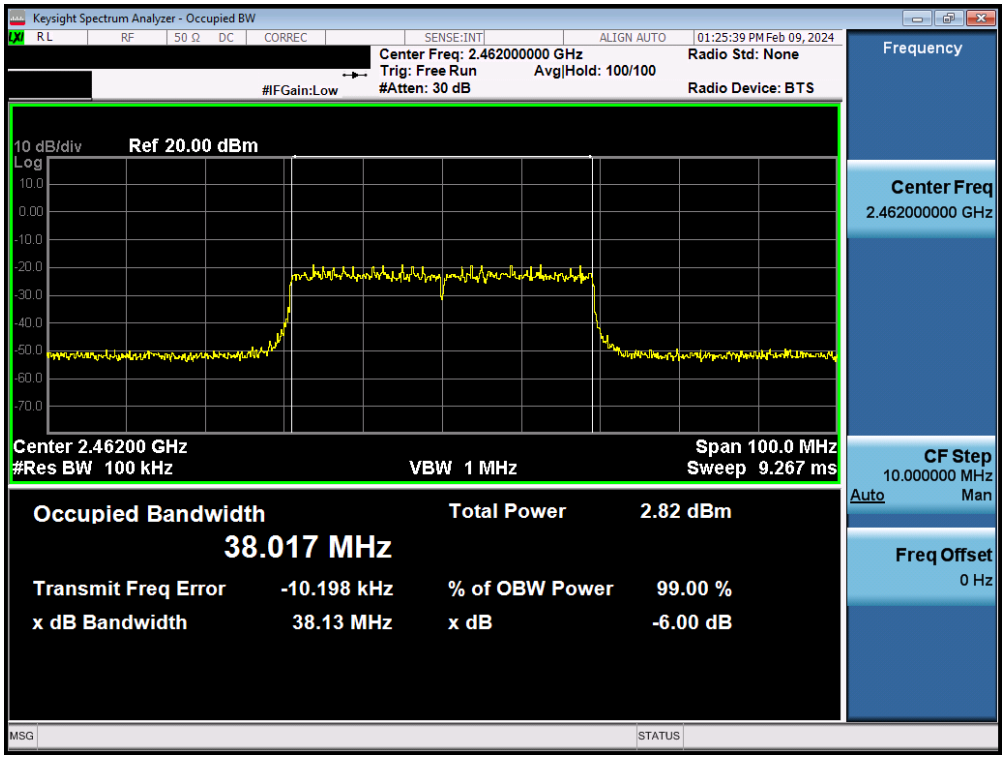
Plot 7-6. 6dB Bandwidth Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 11)



Plot 7-7. 6dB Bandwidth Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 3)

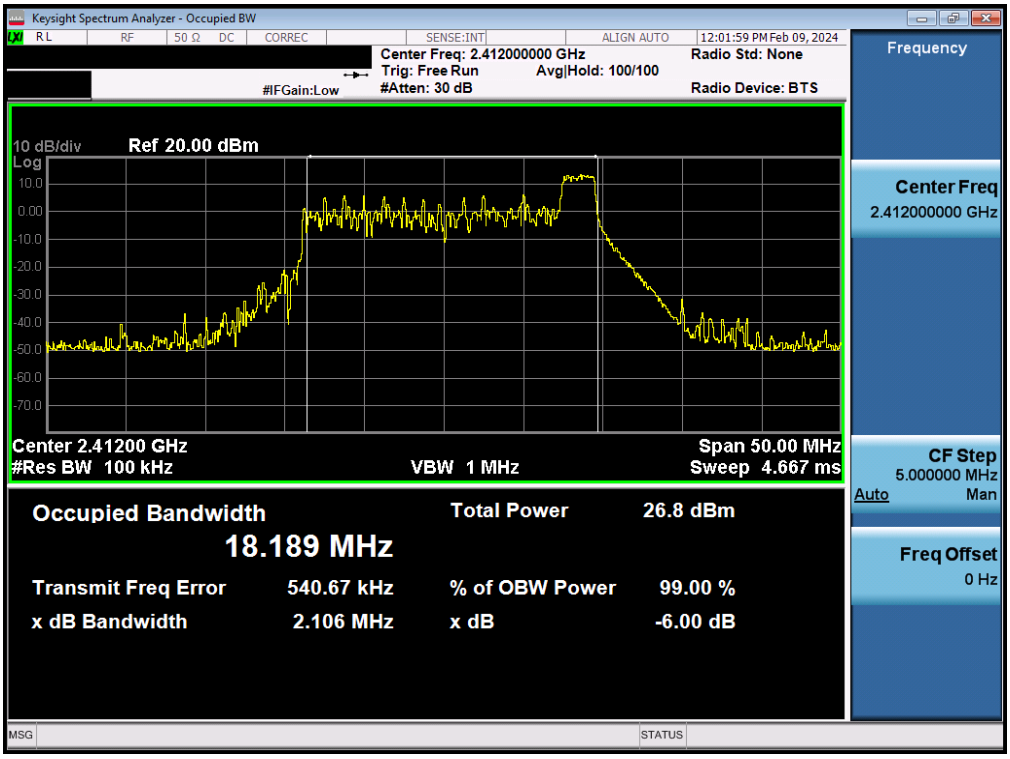


Plot 7-8. 6dB Bandwidth Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 6)

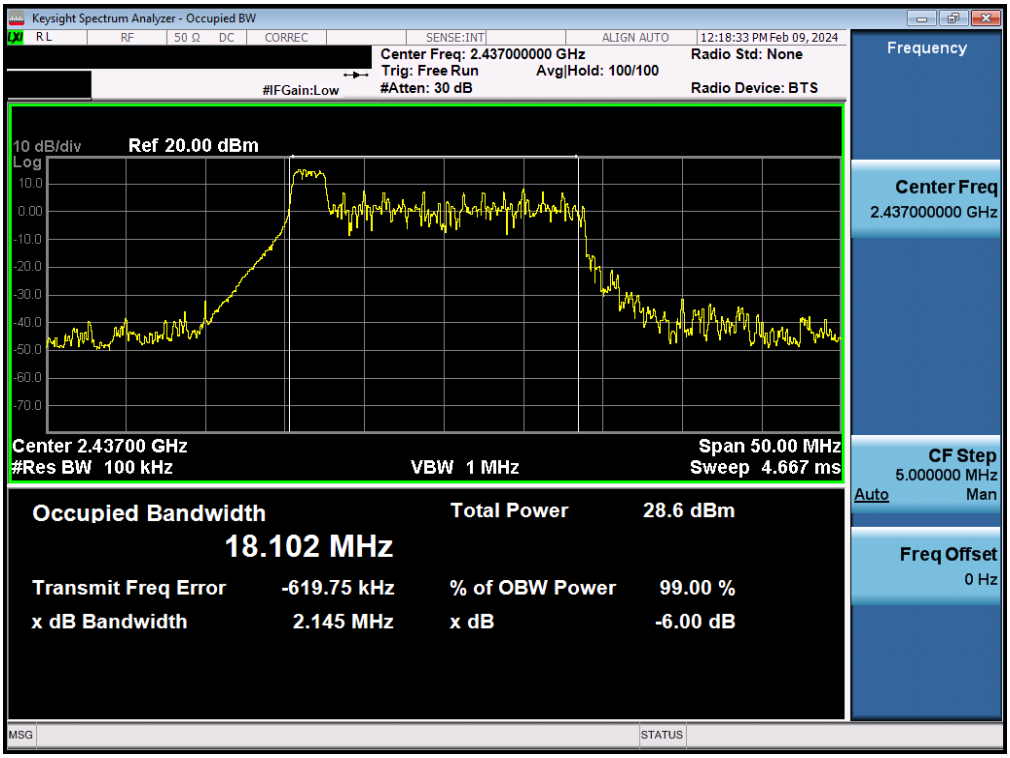


Plot 7-9. 6dB Bandwidth Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 11)

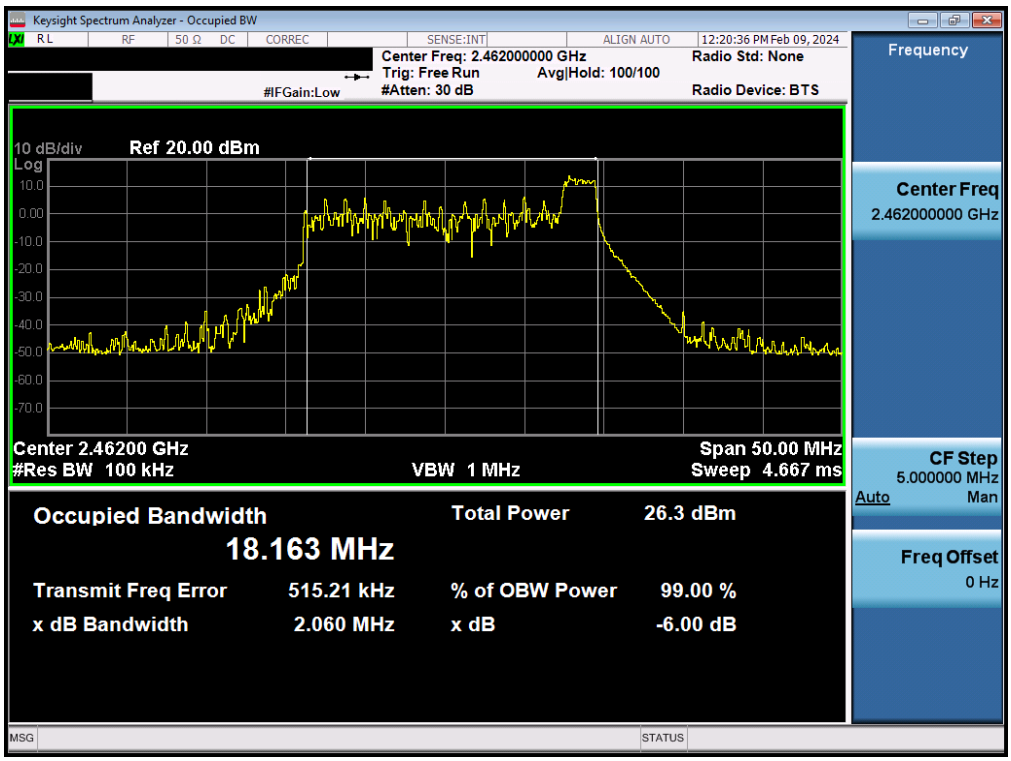
7.2.2 MIMO Antenna-2 6 dB Bandwidth Measurements



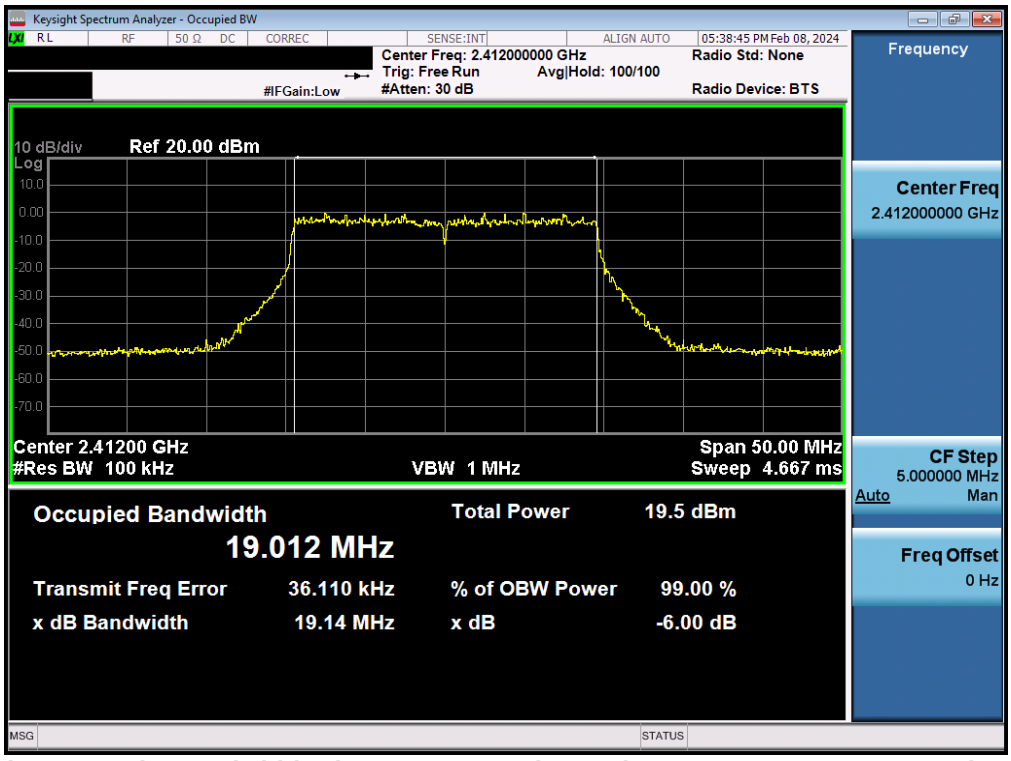
Plot 7-10. 6dB Bandwidth Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 1)



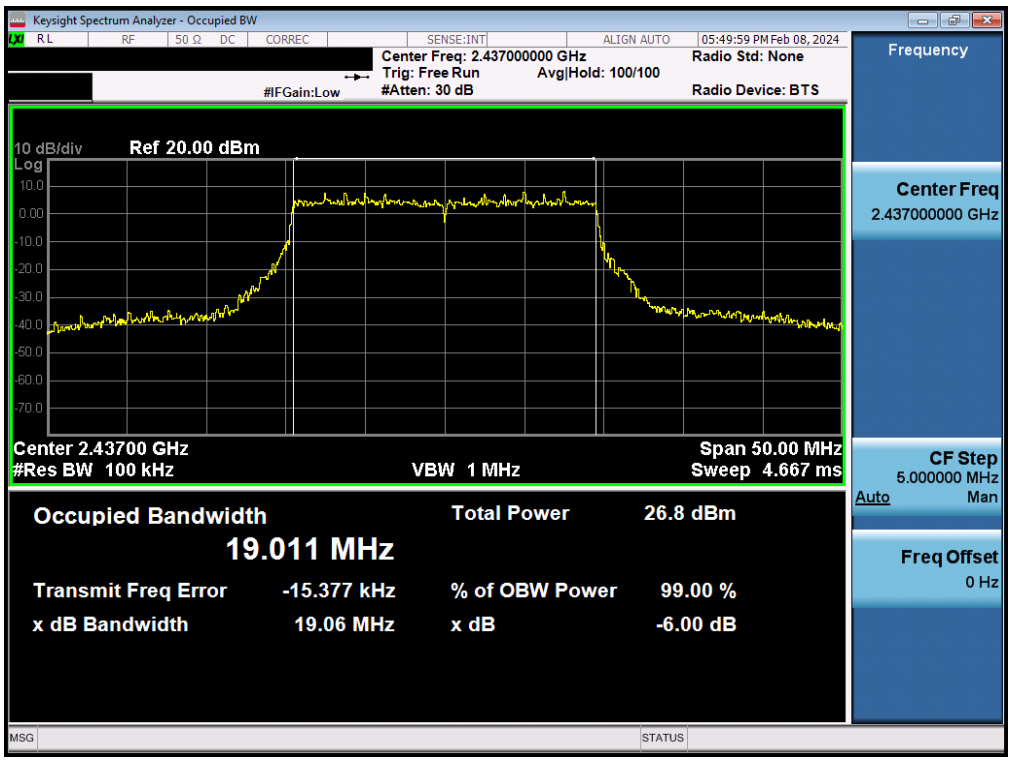
Plot 7-11. 6dB Bandwidth Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 6)



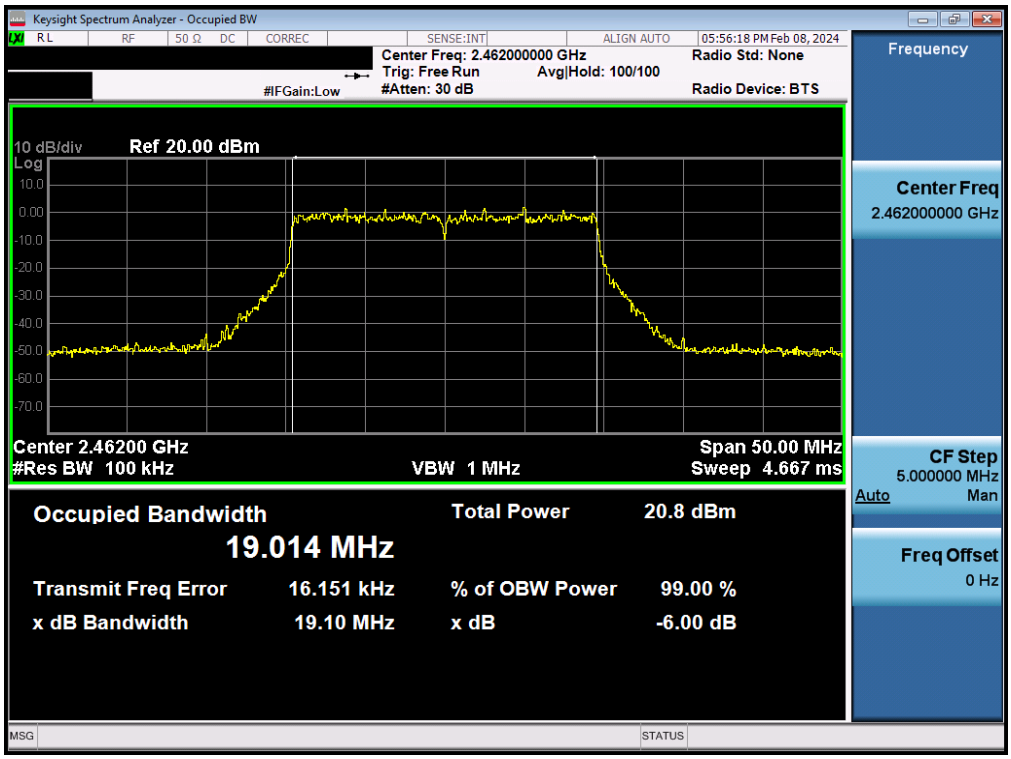
Plot 7-12. 6dB Bandwidth Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 11)



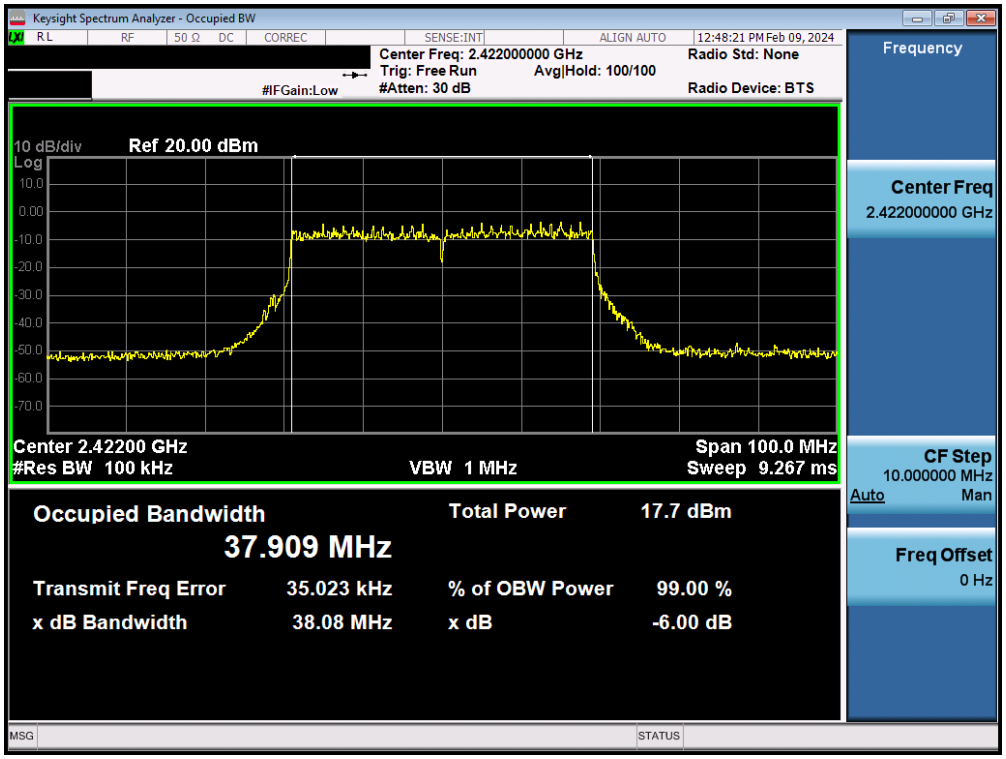
Plot 7-13. 6dB Bandwidth Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 1)



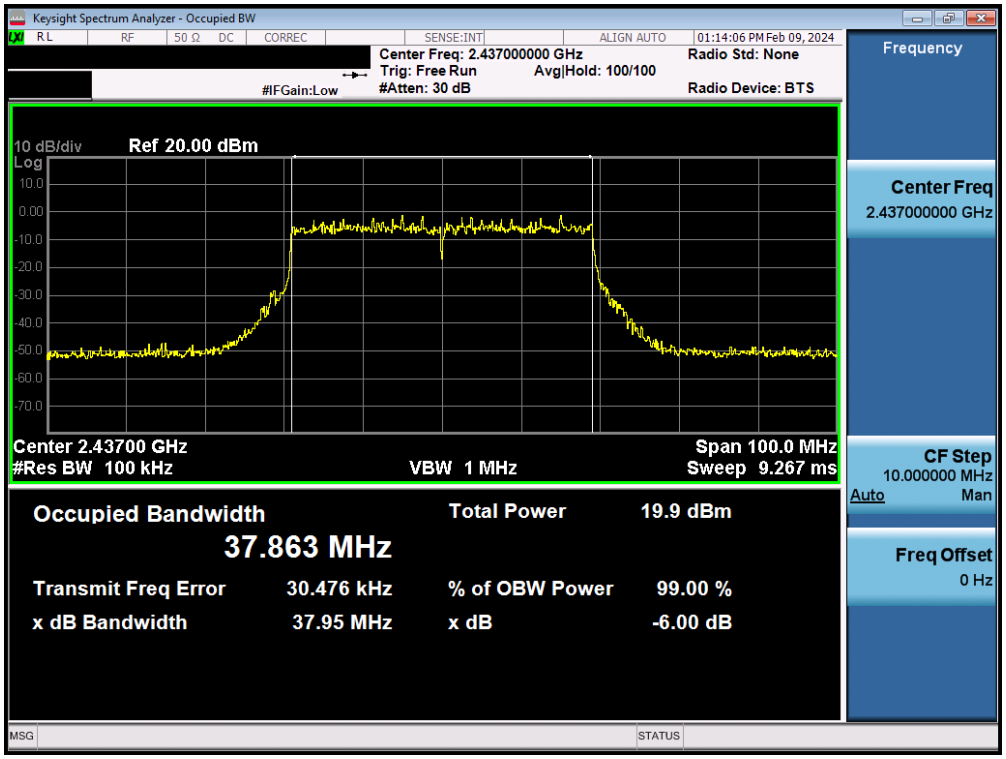
Plot 7-14. 6dB Bandwidth Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 6)



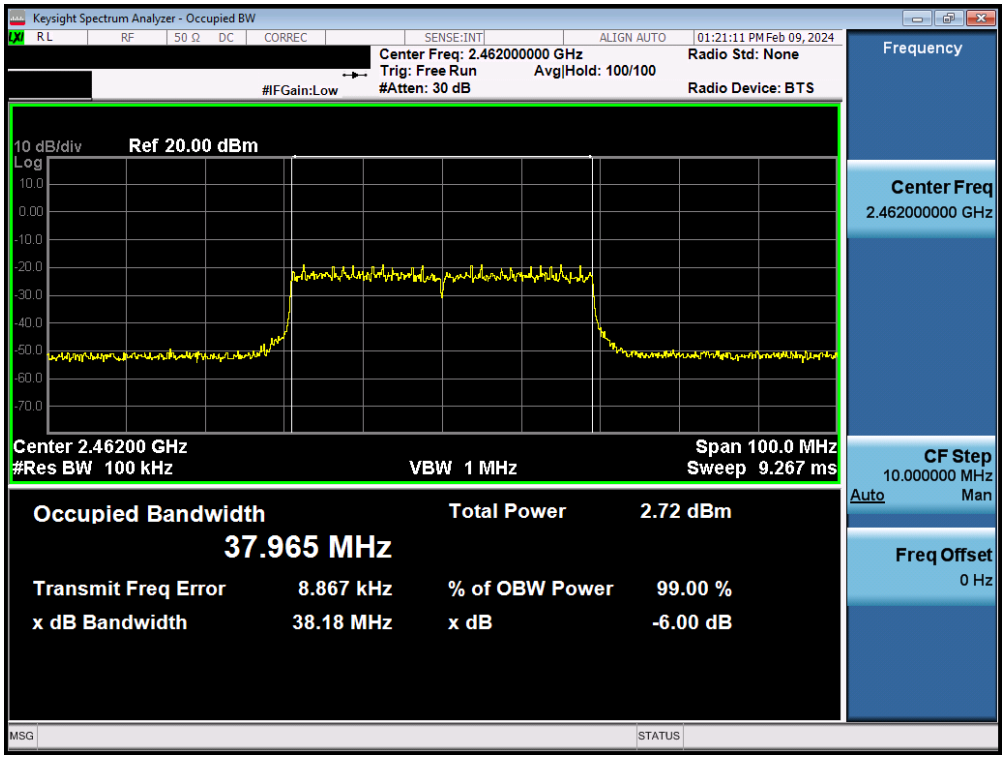
Plot 7-15. 6dB Bandwidth Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 11)



Plot 7-16. 6dB Bandwidth Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 3)



Plot 7-17. 6dB Bandwidth Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 6)



Plot 7-18. 6dB Bandwidth Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 11)

7.3 Output Power Measurement

Test Overview and Limits

A transmitter antenna terminal of EUT is connected to the input of an RF power sensor. Measurement is made using a broadband power meter capable of making peak and average measurements while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies.

The maximum permissible conducted output power is 1 Watt per 15.247 and RSS-247. The e.i.r.p. shall not exceed 4 W per RSS-247.

Test Procedure Used

ANSI C63.10-2013 – Section 11.9.1.3 PKPM1 Peak Power Method
ANSI C63.10-2013 – Section 11.9.2.3.2 Method AVGPM-G
ANSI C63.10-2013 – Section 14.2 Measure-and-Sum Technique

Test Settings

Method PKPM1 (Peak Power Measurement)

Peak 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 pulse sensor employs a VBW = 50MHz so this method was only used for signals whose DTS bandwidth was less than or equal to 50MHz.

Method AVGPM-G (Average Power Measurement)

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 diagrams below.

Figure 7-2. Test Instrument & Measurement Setup for Power Meter Measurements

Test Notes

None.

Freq [MHz]	Channel	Tones	RU Index	Conducted Power [dBm]						Conducted Power Limit [dBm]	Avg Conducted Power Margin [dB]	Peak Conducted Power Margin [dB]	Ant. Gain [dBi]	Max e.i.r.p [dBm]	e.i.r.p Limit [dBm]	e.i.r.p Margin [dB]
				Antenna-1		Antenna-2		MIMO								
				AVG	PEAK	AVG	PEAK	AVG	PEAK							
2412	1	26T	0	17.84	25.04	17.38	24.67	20.63	27.87	30.00	-9.37	-2.13	3.36	23.98	36.02	-12.04
			4	17.49	25.01	16.93	24.68	20.23	27.86	30.00	-9.77	-2.14	3.36	23.59	36.02	-12.43
			8	17.86	24.95	17.55	24.84	20.72	27.91	30.00	-9.28	-2.09	3.36	24.08	36.02	-11.94
2417	2	26T	0	19.43	26.75	19.35	26.65	22.40	29.71	30.00	-7.60	-0.29	3.36	25.76	36.02	-10.26
			4	19.65	26.81	19.51	26.73	22.59	29.78	30.00	-7.41	-0.22	3.36	25.95	36.02	-10.07
			8	19.74	26.95	19.70	26.92	22.73	29.95	30.00	-7.27	-0.05	3.36	26.09	36.02	-9.93
2437	6	26T	0	19.64	26.43	19.96	26.79	22.81	29.62	30.00	-7.19	-0.38	3.36	26.17	36.02	-9.85
			4	19.43	26.46	19.77	26.91	22.61	29.70	30.00	-7.39	-0.30	3.36	25.97	36.02	-10.05
			8	19.45	25.66	19.85	25.99	22.66	28.84	30.00	-7.34	-1.16	3.36	26.02	36.02	-10.00
2457	10	26T	0	19.68	26.28	19.99	26.65	22.85	29.48	30.00	-7.15	-0.52	3.36	26.21	36.02	-9.81
			4	19.25	26.33	19.63	26.81	22.45	29.59	30.00	-7.55	-0.41	3.36	25.81	36.02	-10.21
			8	19.65	26.44	19.81	26.87	22.74	29.67	30.00	-7.26	-0.33	3.36	26.10	36.02	-9.92
2462	11	26T	0	17.15	24.98	17.73	25.11	20.46	28.06	30.00	-9.54	-1.94	3.36	23.82	36.02	-12.20
			4	17.25	25.37	17.53	25.97	20.40	28.69	30.00	-9.60	-1.31	3.36	23.76	36.02	-12.26
			8	17.54	25.28	17.78	25.72	20.67	28.52	30.00	-9.33	-1.48	3.36	24.03	36.02	-11.99
2467	12	26T	0	-5.10	2.86	-4.82	2.55	-1.95	5.72	30.00	-31.95	-24.28	3.36	1.41	36.02	-34.61
			4	-4.92	3.29	-4.94	3.21	-1.92	6.26	30.00	-31.92	-23.74	3.36	1.44	36.02	-34.58
			8	-5.24	2.54	-4.83	2.99	-2.02	5.78	30.00	-32.02	-24.22	3.36	1.34	36.02	-34.68
2472	13	26T	0	-6.59	1.04	-6.55	0.99	-3.56	4.02	30.00	-33.56	-25.98	3.36	-0.20	36.02	-36.22
			4	-6.48	1.57	-6.54	1.48	-3.50	4.53	30.00	-33.50	-25.47	3.36	-0.14	36.02	-36.16
			8	-6.58	1.53	-6.56	1.44	-3.56	4.49	30.00	-33.56	-25.51	3.36	-0.21	36.02	-36.23

Table 7-3. Conducted Output Power Measurements MIMO (26 Tones)

Freq [MHz]	Channel	Tones	RU Index	Conducted Power [dBm]						Conducted Power Limit [dBm]	Avg Conducted Power Margin [dB]	Peak Conducted Power Margin [dB]	Ant. Gain [dBi]	Max e.i.r.p [dBm]	e.i.r.p Limit [dBm]	e.i.r.p Margin [dB]
				Antenna-1		Antenna-2		MIMO								
				AVG	PEAK	AVG	PEAK	AVG	PEAK							
2412	1	52T	37	18.32	25.36	18.16	25.28	21.25	28.33	30.00	-8.75	-1.67	3.36	24.61	36.02	-11.41
			38	18.11	25.35	17.98	25.28	21.06	28.33	30.00	-8.94	-1.67	3.36	24.41	36.02	-11.61
			40	18.27	25.36	18.31	25.27	21.30	28.33	30.00	-8.70	-1.67	3.36	24.66	36.02	-11.36
2417	2	52T	37	19.39	26.71	19.31	26.76	22.36	29.75	30.00	-7.64	-0.25	3.36	25.72	36.02	-10.30
			38	19.32	26.81	19.26	26.73	22.30	29.78	30.00	-7.70	-0.22	3.36	25.66	36.02	-10.36
			40	19.62	26.98	19.62	26.80	22.63	29.90	30.00	-7.37	-0.10	3.36	25.99	36.02	-10.03
2437	6	52T	37	19.64	26.34	19.96	26.84	22.81	29.61	30.00	-7.19	-0.39	3.36	26.17	36.02	-9.85
			38	19.56	26.49	19.96	26.96	22.77	29.74	30.00	-7.23	-0.26	3.36	26.13	36.02	-9.89
			40	19.28	26.05	19.67	26.49	22.49	29.29	30.00	-7.51	-0.71	3.36	25.85	36.02	-10.17
2457	10	52T	37	19.15	26.02	19.60	26.33	22.39	29.19	30.00	-7.61	-0.81	3.36	25.75	36.02	-10.27
			38	19.46	26.39	19.71	26.99	22.60	29.71	30.00	-7.40	-0.29	3.36	25.95	36.02	-10.07
			40	19.27	26.08	19.68	26.49	22.49	29.30	30.00	-7.51	-0.70	3.36	25.85	36.02	-10.17
2462	11	52T	37	17.34	25.51	17.56	25.91	20.46	28.72	30.00	-9.54	-1.28	3.36	23.82	36.02	-12.20
			38	17.35	25.61	17.54	25.97	20.46	28.80	30.00	-9.54	-1.20	3.36	23.81	36.02	-12.21
			40	17.51	25.56	17.74	25.93	20.64	28.76	30.00	-9.36	-1.24	3.36	23.99	36.02	-12.03
2467	12	52T	37	-1.07	6.81	-0.91	6.82	2.02	9.83	30.00	-27.98	-20.17	3.36	5.38	36.02	-30.64
			38	-0.71	7.47	-0.78	7.35	2.27	10.42	30.00	-27.73	-19.58	3.36	5.62	36.02	-30.40
			40	-0.79	7.28	-0.54	7.33	2.35	10.32	30.00	-27.65	-19.68	3.36	5.70	36.02	-30.32
2472	13	52T	37	-4.71	3.12	-4.67	3.06	-1.68	6.10	30.00	-31.68	-23.90	3.36	1.68	36.02	-34.34
			38	-4.88	3.09	-4.96	3.01	-1.91	6.06	30.00	-31.91	-23.94	3.36	1.45	36.02	-34.57
			40	-4.98	3.16	-5.00	3.01	-1.98	6.10	30.00	-31.98	-23.90	3.36	1.38	36.02	-34.64

Table 7-4. Conducted Output Power Measurements MIMO (52 Tones)

Freq [MHz]	Channel	Tones	MRU Index	Conducted Power [dBm]						Conducted Power Limit [dBm]	Avg Conducted Power Margin [dB]	Peak Conducted Power Margin [dB]	Ant. Gain [dBi]	Max e.i.r.p [dBm]	e.i.r.p Limit [dBm]	e.i.r.p Margin [dB]
				Antenna-1		Antenna-2		MIMO								
				AVG	PEAK	AVG	PEAK	AVG	PEAK							
2412	1	52+26T	70	18.05	24.93	18.29	25.46	21.18	28.21	30.00	-8.82	-1.79	3.36	24.54	36.02	-11.48
			71	17.91	24.78	18.22	25.27	21.08	28.04	30.00	-8.92	-1.96	3.36	24.44	36.02	-11.58
			72	18.06	24.92	17.23	25.26	20.68	28.10	30.00	-9.32	-1.90	3.36	24.03	36.02	-11.99
2417	2	52+26T	70	19.44	26.80	19.33	26.58	22.40	29.70	30.00	-7.60	-0.30	3.36	25.76	36.02	-10.26
			71	19.18	26.82	19.10	26.84	22.15	29.84	30.00	-7.85	-0.16	3.36	25.51	36.02	-10.51
			72	19.36	26.73	19.35	26.74	22.37	29.75	30.00	-7.63	-0.25	3.36	25.72	36.02	-10.30
2437	6	52+26T	70	19.64	26.32	19.86	26.83	22.76	29.59	30.00	-7.24	-0.41	3.36	26.12	36.02	-9.90
			71	19.58	26.41	19.81	26.82	22.71	29.63	30.00	-7.29	-0.37	3.36	26.06	36.02	-9.96
			72	19.65	26.42	19.99	26.82	22.83	29.63	30.00	-7.17	-0.37	3.36	26.19	36.02	-9.83
2457	10	52+26T	70	19.52	26.12	19.99	26.81	22.77	29.49	30.00	-7.23	-0.51	3.36	26.13	36.02	-9.89
			71	19.43	26.33	19.89	26.85	22.68	29.61	30.00	-7.32	-0.39	3.36	26.03	36.02	-9.99
			72	19.49	26.15	19.78	26.83	22.65	29.51	30.00	-7.35	-0.49	3.36	26.01	36.02	-10.01
2462	11	52+26T	70	17.44	25.32	17.93	25.67	20.70	28.51	30.00	-9.30	-1.49	3.36	24.06	36.02	-11.96
			71	17.33	25.41	17.71	25.76	20.53	28.60	30.00	-9.47	-1.40	3.36	23.89	36.02	-12.13
			72	17.41	25.34	17.67	25.69	20.55	28.53	30.00	-9.45	-1.47	3.36	23.91	36.02	-12.11
2467	12	52+26T	70	-0.65	7.08	-0.65	7.15	2.36	10.13	30.00	-27.64	-19.87	3.36	5.72	36.02	-30.30
			71	-0.74	7.03	-0.81	7.15	2.24	10.10	30.00	-27.76	-19.90	3.36	5.59	36.02	-30.43
			72	-0.69	7.07	-0.61	7.18	2.36	10.14	30.00	-27.64	-19.86	3.36	5.72	36.02	-30.30
2472	13	52+26T	70	-4.85	2.75	-4.93	2.82	-1.88	5.80	30.00	-31.88	-24.20	3.36	1.48	36.02	-34.54
			71	-4.98	2.17	-5.00	2.98	-1.98	5.60	30.00	-31.98	-24.40	3.36	1.38	36.02	-34.64
			72	-5.26	1.58	-4.89	2.74	-2.06	5.21	30.00	-32.06	-24.79	3.36	1.30	36.02	-34.72

Table 7-5. Conducted Output Power Measurements MIMO (52 + 26 Tones)

Freq [MHz]	Channel	Tones	RU Index	Conducted Power [dBm]						Conducted Power Limit [dBm]	Avg Conducted Power Margin [dB]	Peak Conducted Power Margin [dB]	Ant. Gain [dBi]	Max e.i.r.p [dBm]	e.i.r.p Limit [dBm]	e.i.r.p Margin [dB]
				Antenna-1		Antenna-2		MIMO								
				AVG	PEAK	AVG	PEAK	AVG	PEAK							
2412	1	106T	53	17.24	25.03	16.63	24.69	19.96	27.87	30.00	-10.04	-2.13	3.36	23.31	36.02	-12.71
			54	17.16	24.95	16.73	24.84	19.96	27.91	30.00	-10.04	-2.09	3.36	23.32	36.02	-12.70
2417	2	106T	53	19.28	26.80	19.19	26.61	22.24	29.72	30.00	-7.76	-0.28	3.36	25.60	36.02	-10.42
			54	19.42	26.89	19.38	26.82	22.41	29.87	30.00	-7.59	-0.13	3.36	25.77	36.02	-10.25
2437	6	106T	53	19.62	26.51	19.86	26.71	22.75	29.62	30.00	-7.25	-0.38	3.36	26.11	36.02	-9.91
			54	19.67	26.46	19.99	26.79	22.84	29.64	30.00	-7.16	-0.36	3.36	26.20	36.02	-9.82
2457	10	106T	53	19.56	26.31	19.99	26.82	22.79	29.58	30.00	-7.21	-0.42	3.36	26.15	36.02	-9.87
			54	19.54	26.38	19.76	26.88	22.66	29.65	30.00	-7.34	-0.35	3.36	26.02	36.02	-10.00
2462	11	106T	53	17.42	25.57	17.61	25.79	20.53	28.69	30.00	-9.47	-1.31	3.36	23.88	36.02	-12.14
			54	17.44	25.58	17.64	25.78	20.55	28.69	30.00	-9.45	-1.31	3.36	23.91	36.02	-12.11
2467	12	106T	53	-0.20	7.98	-0.08	7.92	2.87	10.96	30.00	-27.13	-19.04	3.36	6.23	36.02	-29.79
			54	-0.18	7.94	-0.08	7.88	2.88	10.92	30.00	-27.12	-19.08	3.36	6.24	36.02	-29.78
2472	13	106T	53	-2.32	5.71	-2.27	5.64	0.71	8.69	30.00	-29.29	-21.31	3.36	4.07	36.02	-31.95
			54	-2.42	5.82	-2.50	5.67	0.55	8.75	30.00	-29.45	-21.25	3.36	3.91	36.02	-32.11

Table 7-6. Conducted Output Power Measurements MIMO (106 Tones)

Freq [MHz]	Channel	Tones	MRU Index	Conducted Power [dBm]						Conducted Power Limit [dBm]	Avg Conducted Power Margin [dB]	Peak Conducted Power Margin [dB]	Ant. Gain [dBi]	Max e.i.r.p [dBm]	e.i.r.p Limit [dBm]	e.i.r.p Margin [dB]
				Antenna-1		Antenna-2		MIMO								
				AVG	PEAK	AVG	PEAK	AVG	PEAK							
2412	1	106+26T	82	16.96	23.99	17.22	24.41	20.10	27.22	30.00	-9.90	-2.78	3.36	23.46	36.02	-12.56
			83	17.01	23.81	17.28	24.55	20.16	27.21	30.00	-9.84	-2.79	3.36	23.52	36.02	-12.50
2417	2	106+26T	82	19.38	26.66	19.34	26.67	22.37	29.68	30.00	-7.63	-0.32	3.36	25.73	36.02	-10.29
			83	19.35	26.91	19.32	26.93	22.35	29.93	30.00	-7.65	-0.07	3.36	25.71	36.02	-10.31
2437	6	106+26T	82	19.64	26.58	19.99	26.99	22.83	29.80	30.00	-7.17	-0.20	3.36	26.19	36.02	-9.83
			83	19.64	26.53	19.99	26.91	22.83	29.73	30.00	-7.17	-0.27	3.36	26.19	36.02	-9.83
2457	10	106+26T	82	19.45	26.61	19.98	27.00	22.73	29.82	30.00	-7.27	-0.18	3.36	26.09	36.02	-9.93
			83	19.46	26.46	19.74	26.82	22.61	29.65	30.00	-7.39	-0.35	3.36	25.97	36.02	-10.05
2462	11	106+26T	82	17.38	25.71	17.81	25.76	20.61	28.75	30.00	-9.39	-1.25	3.36	23.97	36.02	-12.05
			83	17.40	25.66	17.59	25.99	20.51	28.84	30.00	-9.49	-1.16	3.36	23.86	36.02	-12.16
2467	12	106+26T	82	-0.33	7.88	-0.26	7.84	2.72	10.87	30.00	-27.28	-19.13	3.36	6.07	36.02	-29.95
			83	-0.27	7.99	-0.19	7.98	2.78	11.00	30.00	-27.22	-19.00	3.36	6.14	36.02	-29.88
2472	13	106+26T	82	-2.51	5.54	-2.56	5.49	0.48	8.53	30.00	-29.52	-21.47	3.36	3.83	36.02	-32.19
			83	-2.78	5.68	-2.44	5.79	0.40	8.75	30.00	-29.60	-21.25	3.36	3.76	36.02	-32.26

Table 7-7. Conducted Output Power Measurements MIMO (106 + 26 Tones)

Freq [MHz]	Channel	Tones	RU Index	Conducted Power [dBm]						Conducted Power Limit [dBm]	Avg Conducted Power Margin [dB]	Peak Conducted Power Margin [dB]	Ant. Gain [dBi]	Max e.i.r.p [dBm]	e.i.r.p Limit [dBm]	e.i.r.p Margin [dB]
				Antenna-1		Antenna-2		MIMO								
				AVG	PEAK	AVG	PEAK	AVG	PEAK							
2412	1	242T	61	11.53	20.43	11.10	20.33	14.33	23.39	30.00	-15.67	-6.61	3.36	17.69	36.02	-18.33
2417	2	242T	61	15.32	23.53	15.11	23.49	18.23	26.52	30.00	-11.77	-3.48	3.36	21.58	36.02	-14.44
2422	3	242T	61	19.07	26.35	18.88	26.55	21.99	29.46	30.00	-8.01	-0.54	3.36	25.34	36.02	-10.68
2437	6	242T	61	19.00	26.29	19.31	26.61	22.17	29.46	30.00	-7.83	-0.54	3.36	25.53	36.02	-10.49
2447	8	242T	61	19.05	26.42	19.44	27.13	22.26	29.80	30.00	-7.74	-0.20	3.36	25.62	36.02	-10.40
2452	9	242T	61	17.34	25.75	17.66	25.43	20.51	28.60	30.00	-9.49	-1.40	3.36	23.87	36.02	-12.15
2457	10	242T	61	17.28	25.89	17.55	26.09	20.43	29.00	30.00	-9.57	-1.00	3.36	23.79	36.02	-12.23
2462	11	242T	61	13.80	22.42	13.99	22.70	16.91	25.57	30.00	-13.09	-4.43	3.36	20.26	36.02	-15.76
2467	12	242T	61	10.33	19.15	10.44	19.21	13.40	22.19	30.00	-16.60	-7.81	3.36	16.75	36.02	-19.27
2472	13	242T	61	-2.52	6.21	-2.52	6.08	0.49	9.15	30.00	-29.51	-20.85	3.36	3.85	36.02	-32.17

Table 7-8. Conducted Output Power Measurements MIMO (242 Tones)

Freq [MHz]	Channel	Tones	RU Index	Conducted Power [dBm]						Conducted Power Limit [dBm]	Avg Conducted Power Margin [dB]	Peak Conducted Power Margin [dB]	Ant. Gain [dBi]	Max e.i.r.p [dBm]	e.i.r.p Limit [dBm]	e.i.r.p Margin [dB]
				Antenna-1		Antenna-2		MIMO								
				AVG	PEAK	AVG	PEAK	AVG	PEAK							
2422	3	484T	65	12.12	19.19	12.05	19.18	15.10	22.20	30.00	-14.90	-7.80	3.36	18.46	36.02	-17.56
2427	4	484T	65	13.35	20.73	13.51	20.54	16.44	23.65	30.00	-13.56	-6.35	3.36	19.80	36.02	-16.22
2432	5	484T	65	13.65	20.71	13.45	20.55	16.56	23.64	30.00	-13.44	-6.36	3.36	19.92	36.02	-16.10
2437	6	484T	65	15.26	22.26	15.10	22.12	18.19	25.20	30.00	-11.81	-4.80	3.36	21.55	36.02	-14.47
2447	8	484T	65	15.37	23.04	15.18	22.98	18.29	26.02	30.00	-11.71	-3.98	3.36	21.65	36.02	-14.37
2452	9	484T	65	13.86	21.13	13.87	21.15	16.88	24.15	30.00	-13.12	-5.85	3.36	20.23	36.02	-15.79
2457	10	484T	65	13.07	23.31	13.13	20.44	16.11	25.12	30.00	-13.89	-4.88	3.36	19.47	36.02	-16.55
2462	11	484T	65	-0.91	6.44	-0.85	6.34	2.13	9.40	30.00	-27.87	-20.60	3.36	5.49	36.02	-30.53

Table 7-9. Conducted Output Power Measurements MIMO (484 Tones)

Note:

Per ANSI C63.10-2013 Section 14.2, 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 2412MHz the average conducted output power was measured to be 17.84 dBm for Antenna 1 and 17.38 dBm for Antenna 2.

Antenna 1 + Antenna 2 = MIMO

(17.84 dBm + 17.38 dBm) = (60.81 mW + 54.70 mW) = 115.52 mW = 20.63 dBm

Sample e.i.r.p. Calculation:

At 2412MHz the average MIMO conducted output power was calculated to be 20.63 dBm with directional gain of 3.36 dBi.

e.i.r.p. (dBm) = Conducted Power (dBm) + Ant gain (dBi)

20.63 dBm + 3.36 dBi = 23.99

7.4 Power Spectral Density

Test Overview and Limit

The peak power density is measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates, tones configurations, and RU indices were investigated and the worst-case configuration results are reported in this section.

The maximum permissible power spectral density shall not be greater than 8 dBm in any 3 kHz band.

Test Procedure Used

ANSI C63.10-2013 – Section 11.10.2 Method PKPSD
ANSI C63.10-2013 – Section 14.3.1 Measure-and-Sum Technique

Test Settings

1. Analyzer was set to the center frequency of the DTS channel under investigation
2. Span = 1.5 times the DTS channel bandwidth
3. RBW = 3kHz
4. VBW = 1MHz
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Trace was allowed to stabilize

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

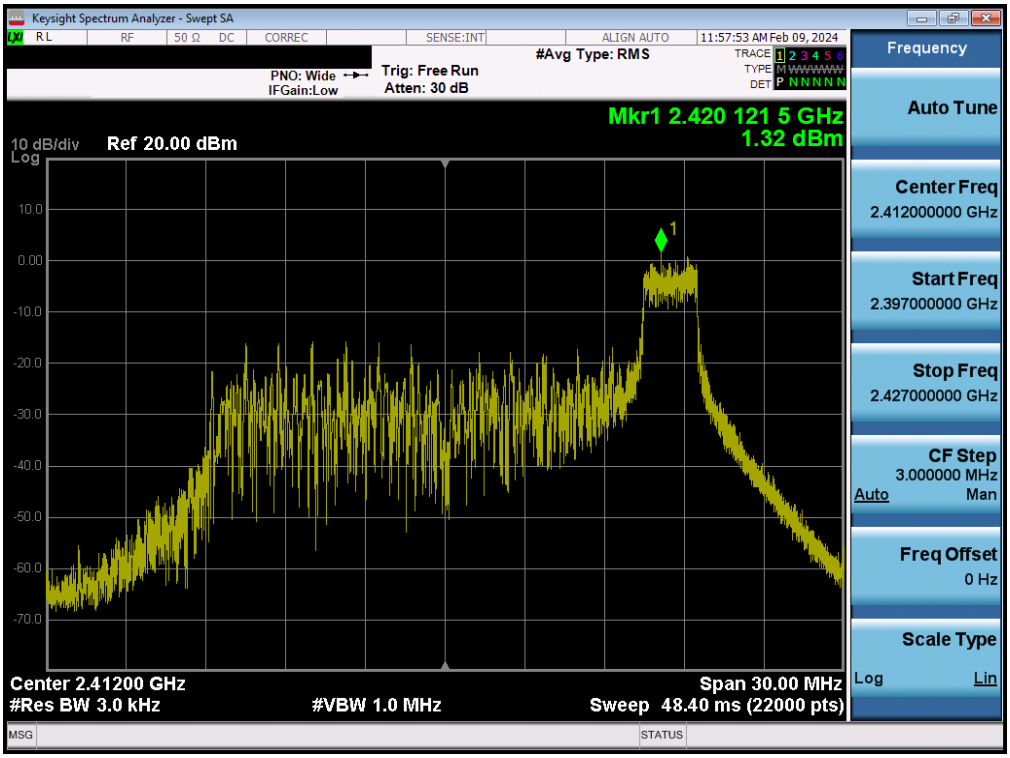
1. Based on preliminary measurements, it was determined that, of all of the tone configurations, the 26T configuration produced the worst case power spectral density measurement for partial loaded case. Therefore, only the 26 Tone configuration and 242 Tone data is included in this section.
2. The power spectral density for each channel was measured with the RU index showing the highest conducted power.

Power Spectral Density Measurements

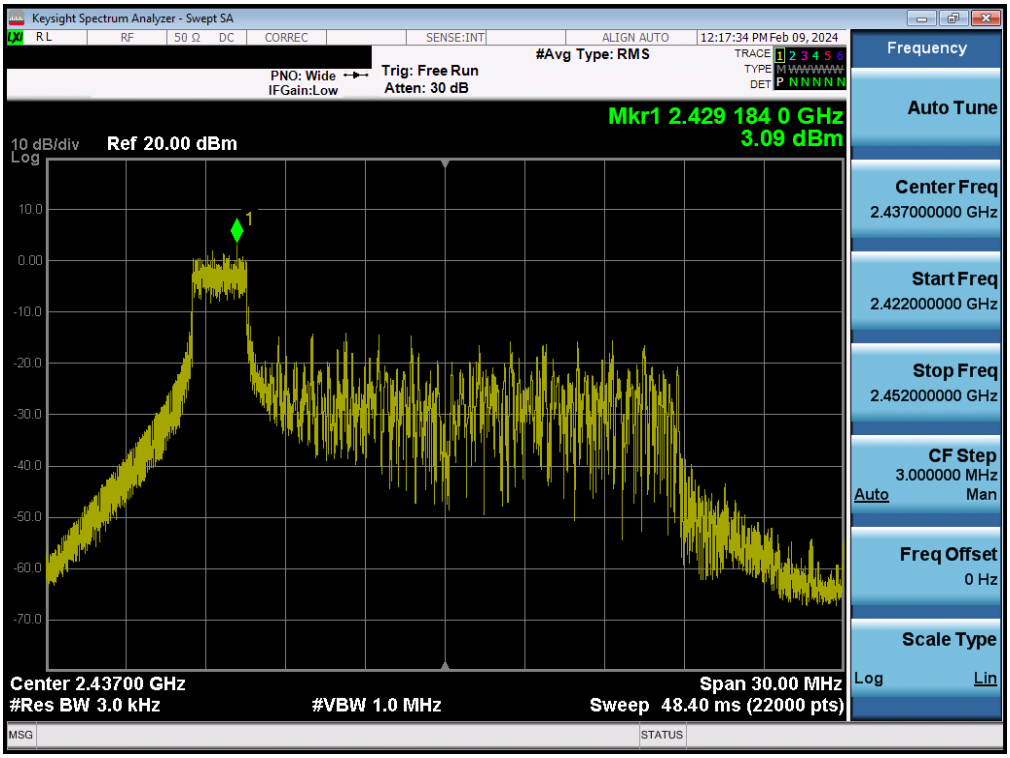
Frequency [MHz]	Channel No.	802.11 Mode	Tones	Data Rate [Mbps]	ANT 1 Power Spectral Density [dBm]	ANT 2 Power Spectral Density [dBm]	Summed MIMO Power Spectral Density [dBm]	Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]	Pass / Fail
2412	1	be	26T	MCS0	1.32	0.44	3.91	8.00	-4.09	Pass
2437	6	be	26T	MCS0	3.09	2.11	5.64	8.00	-2.36	Pass
2462	11	be	26T	MCS0	0.08	-0.17	2.97	8.00	-5.03	Pass
2412	1	be	242T	MCS0	-13.45	-13.50	-10.46	8.00	-18.46	Pass
2437	6	be	242T	MCS0	-5.95	-6.12	-3.02	8.00	-11.02	Pass
2462	11	be	242T	MCS0	-12.48	-12.48	-9.47	8.00	-17.47	Pass
2422	3	be	484T	MCS0	-18.68	-24.11	-17.59	8.00	-25.59	Pass
2437	6	be	484T	MCS0	-16.45	-15.35	-12.85	8.00	-20.85	Pass
2462	11	be	484T	MCS0	-32.86	-31.97	-29.38	8.00	-37.38	Pass

Table 7-10. Conducted Power Spectral Density Measurements MIMO

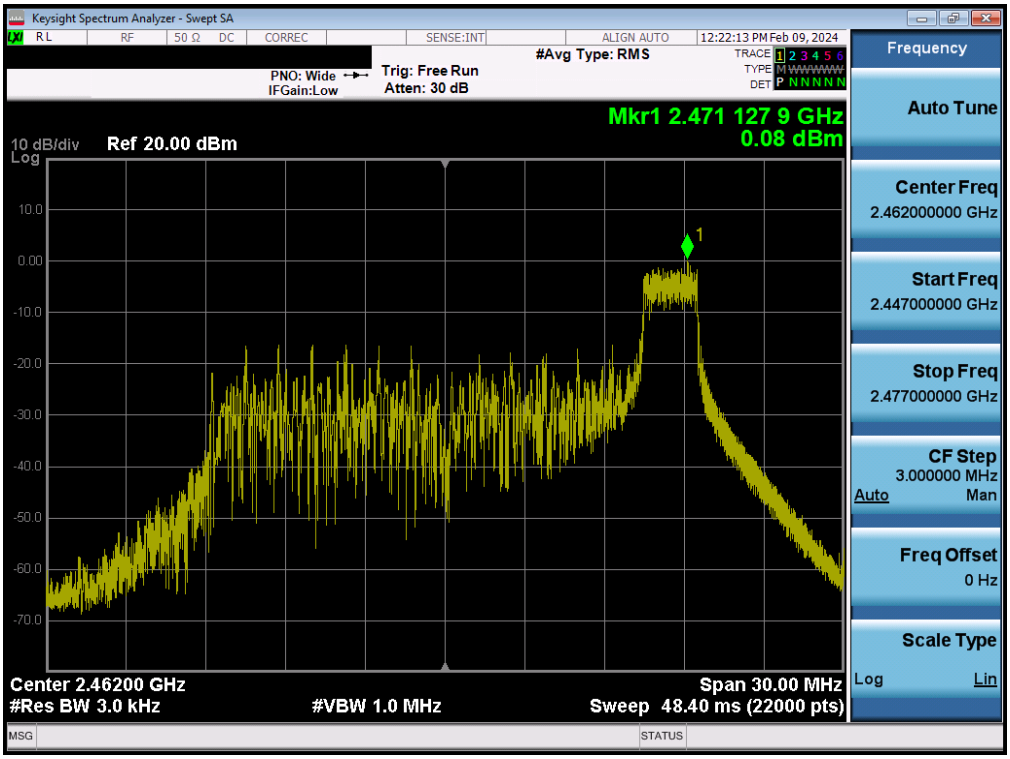
7.4.1 MIMO Antenna-1 Power Spectral Density Measurements



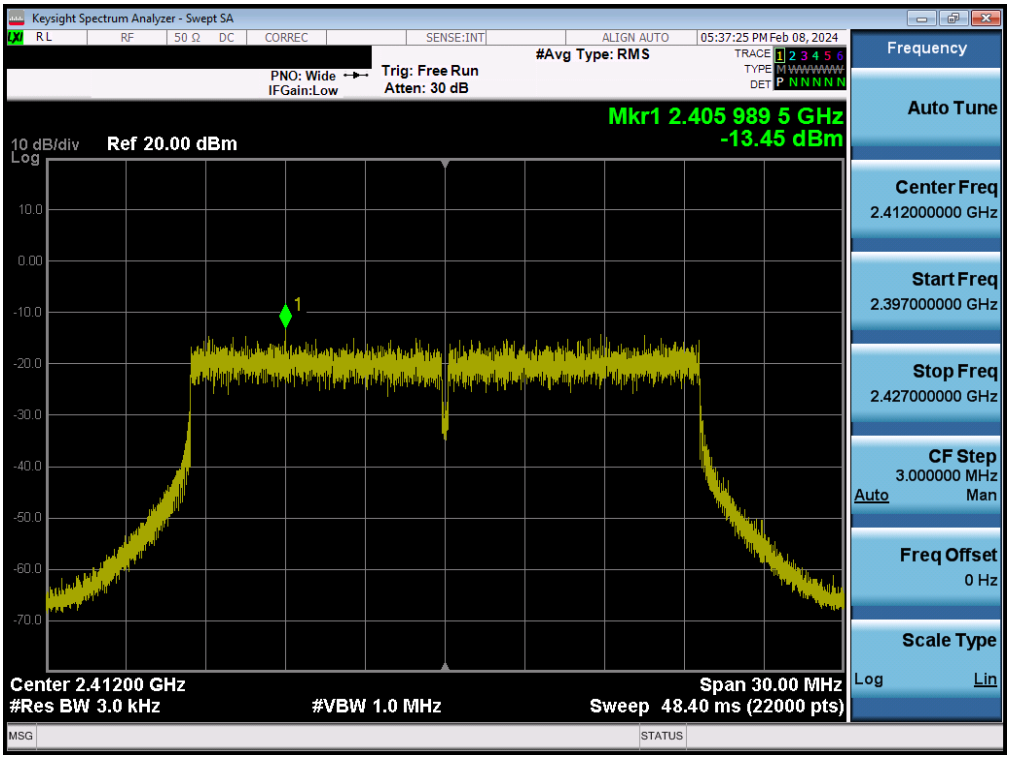
Plot 7-19. Power Spectral Density Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 1)



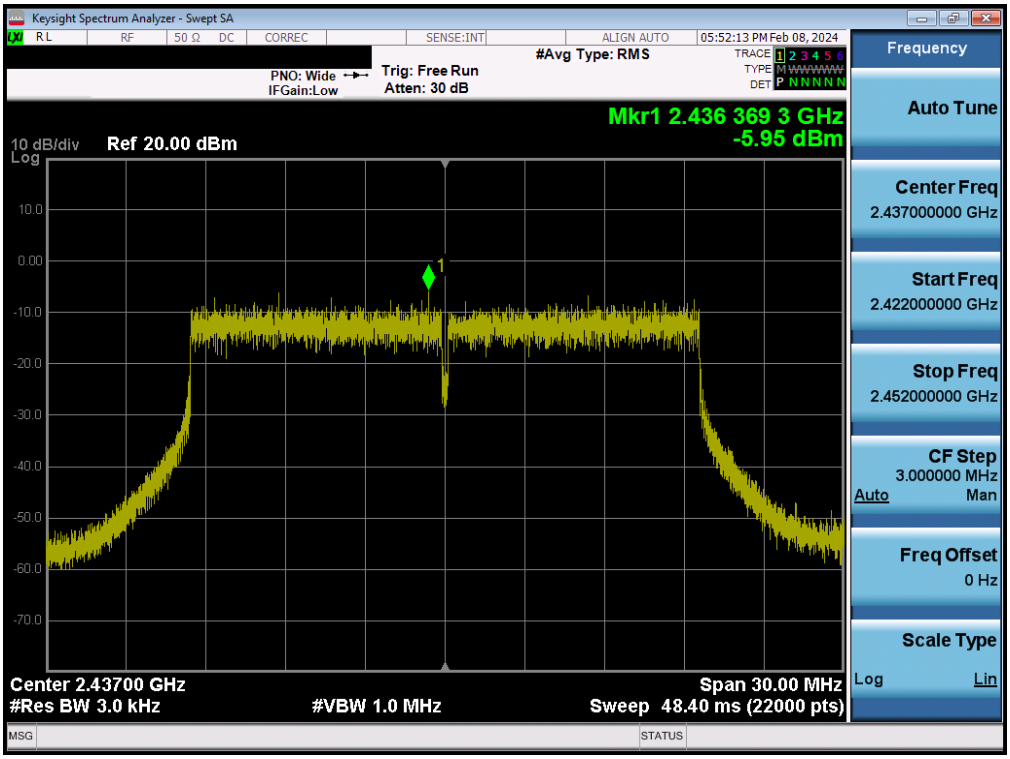
Plot 7-20. Power Spectral Density Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 6)



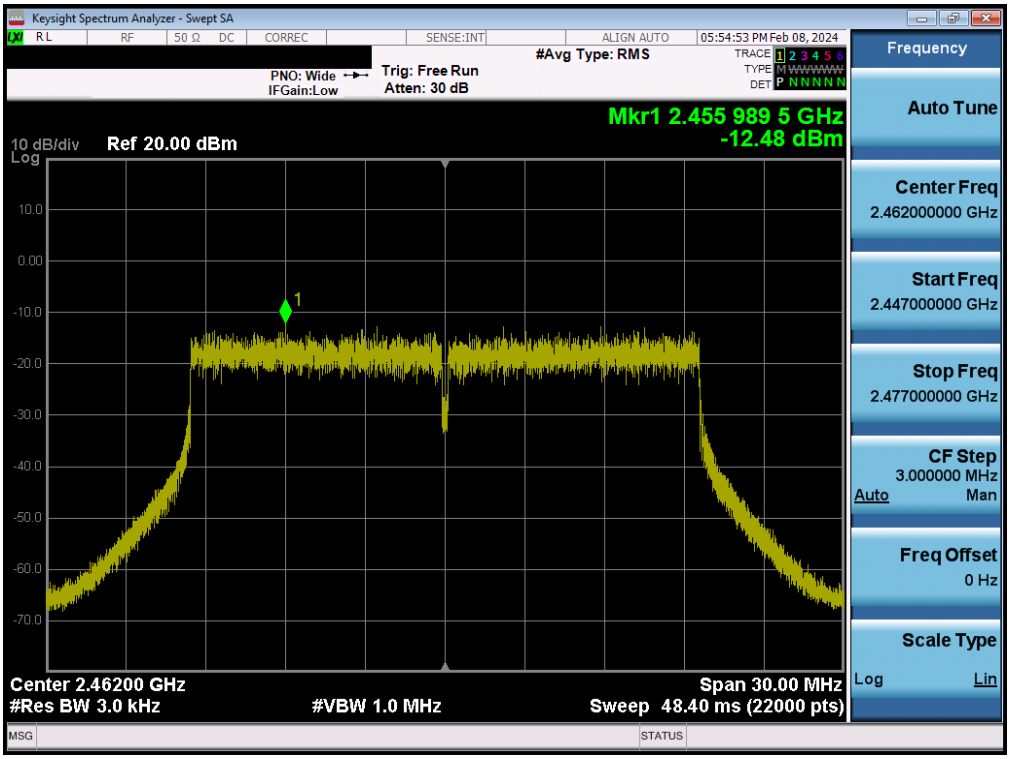
Plot 7-21. Power Spectral Density Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 11)



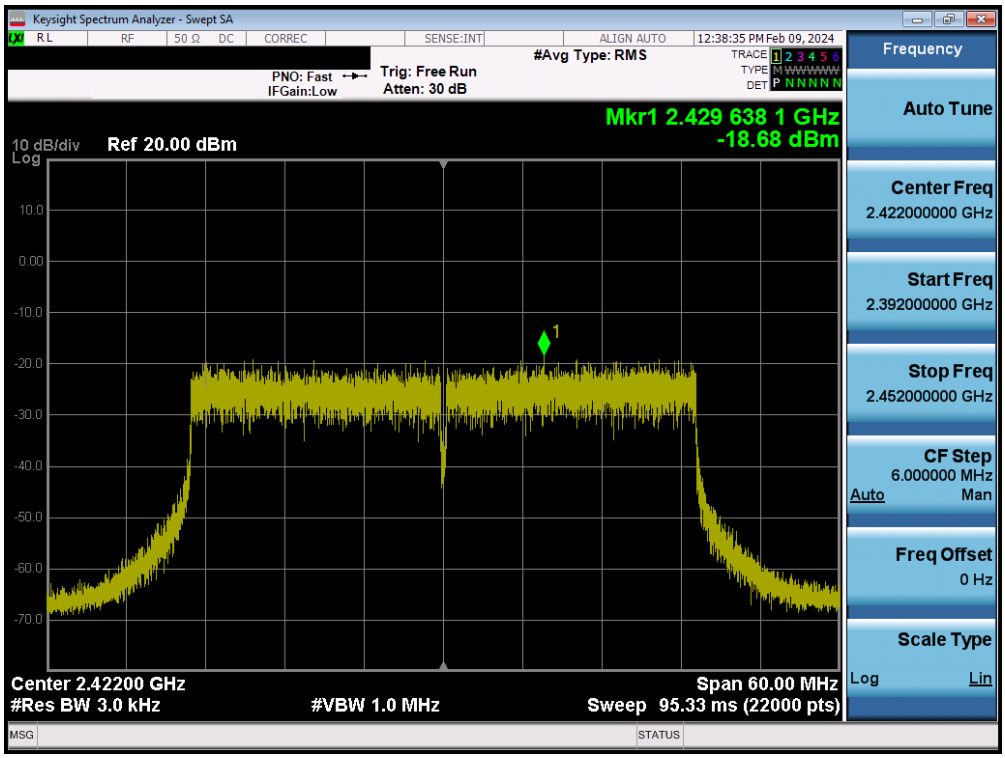
Plot 7-22. Power Spectral Density Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 1)



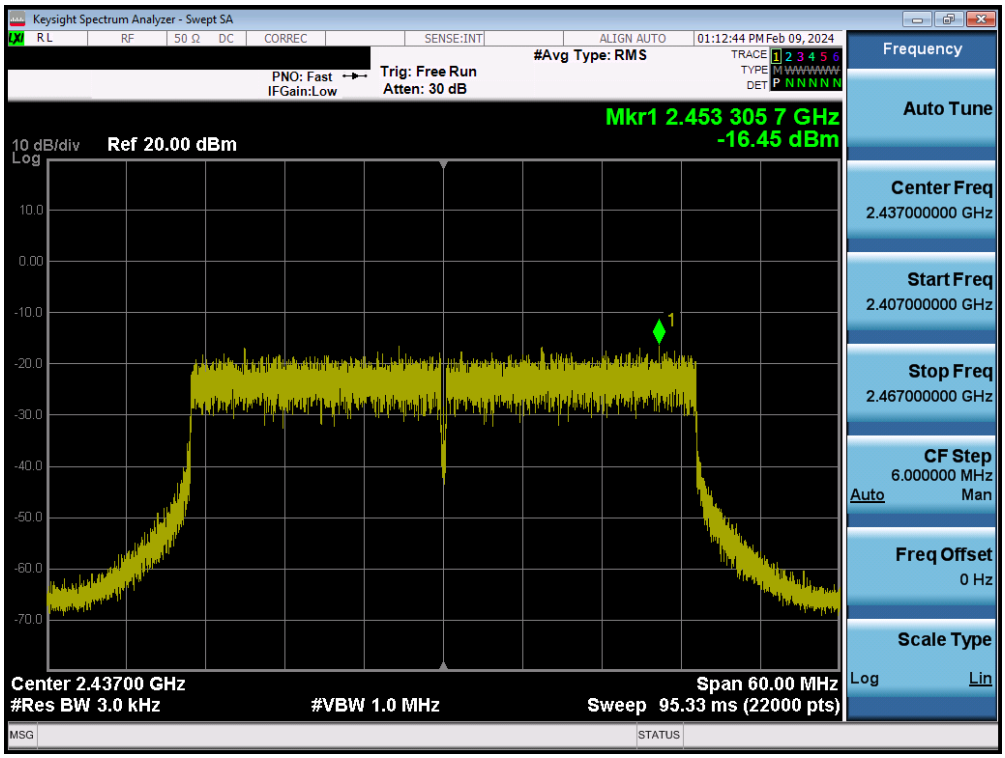
Plot 7-23. Power Spectral Density Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 6)



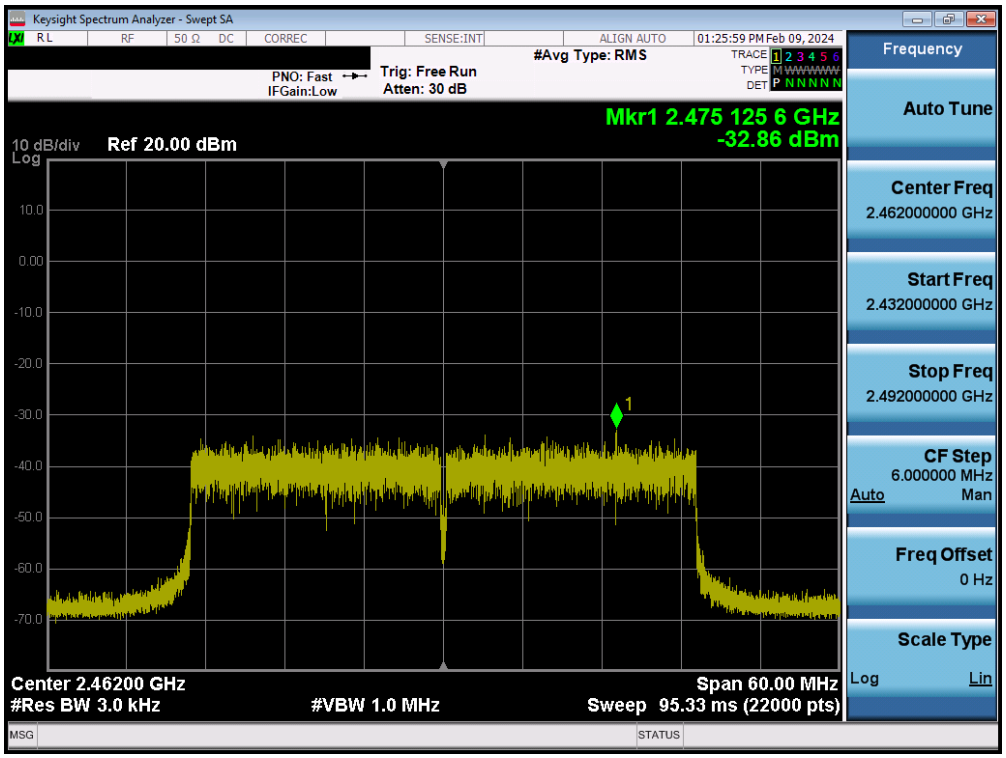
Plot 7-24. Power Spectral Density Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 11)



Plot 7-25. Power Spectral Density Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 3)

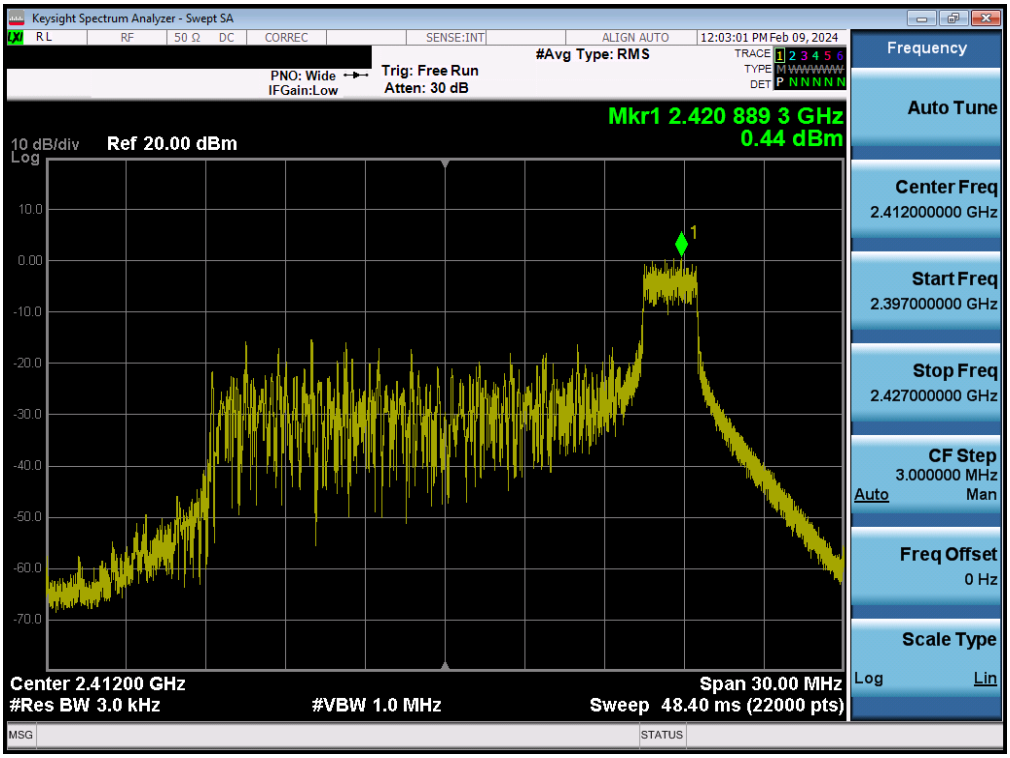


Plot 7-26. Power Spectral Density Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 6)

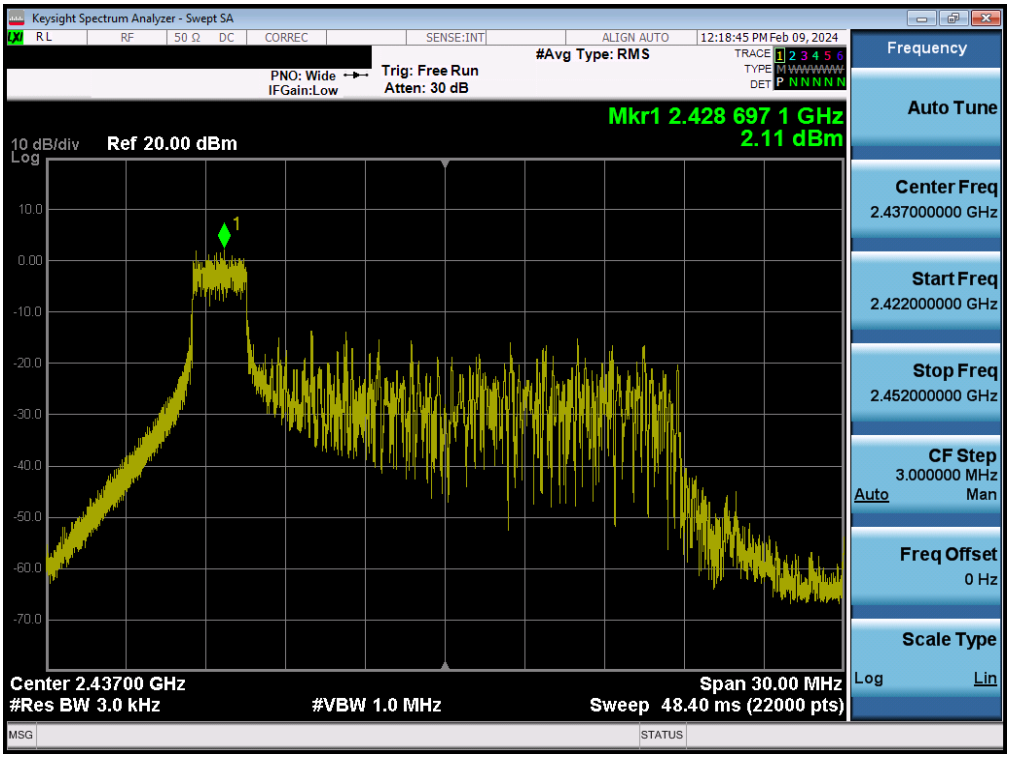


Plot 7-27. Power Spectral Density Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 11)

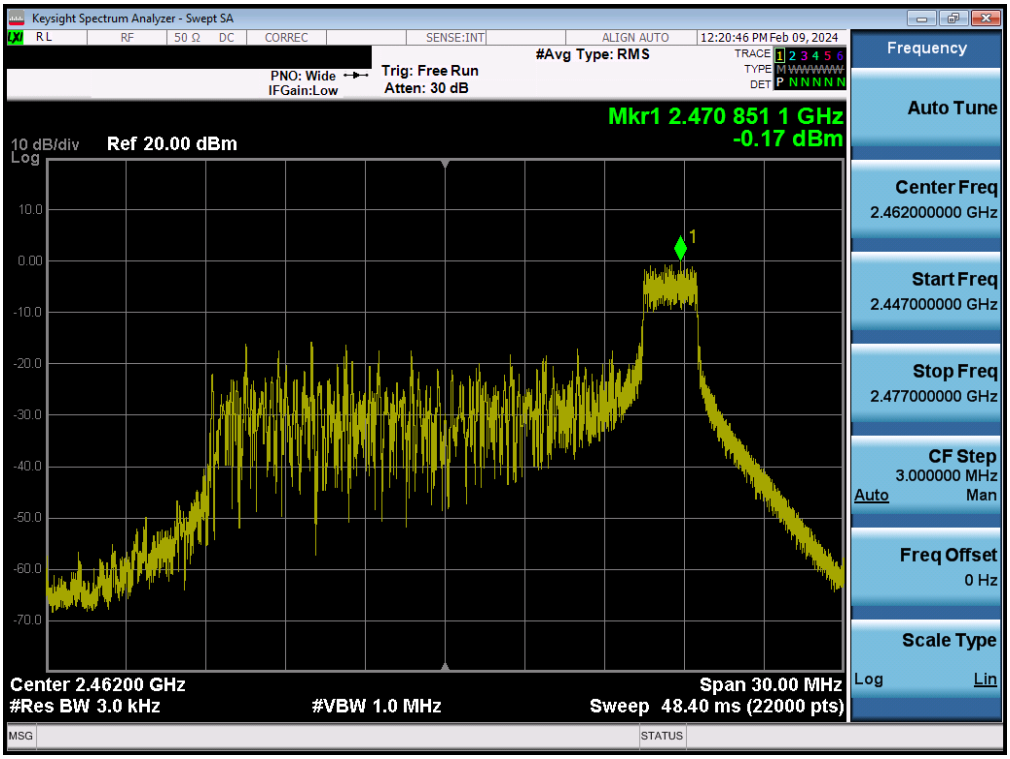
7.4.2 MIMO Antenna-2 Power Spectral Density Measurements



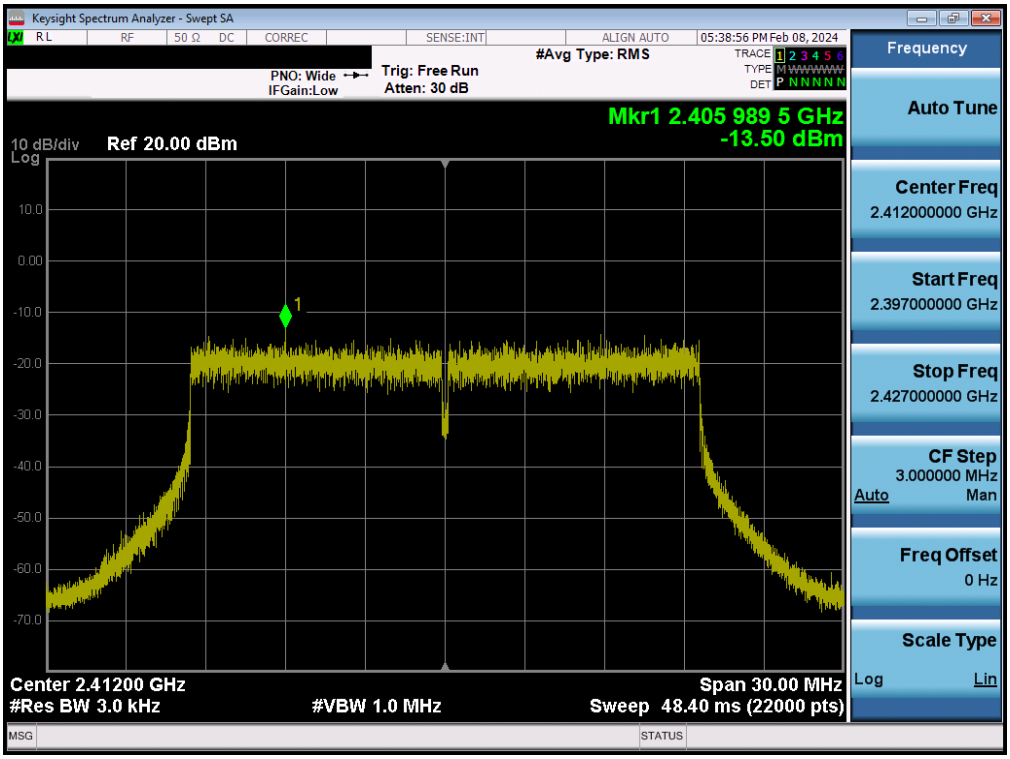
Plot 7-28. Power Spectral Density Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 1)



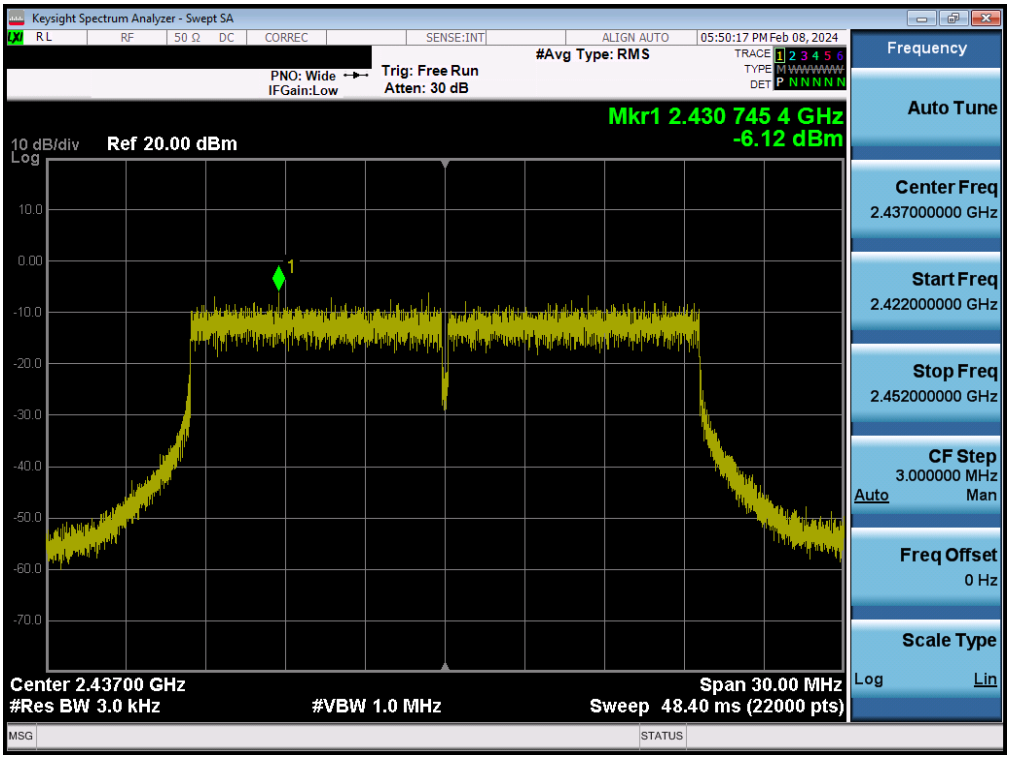
Plot 7-29. Power Spectral Density Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 6)



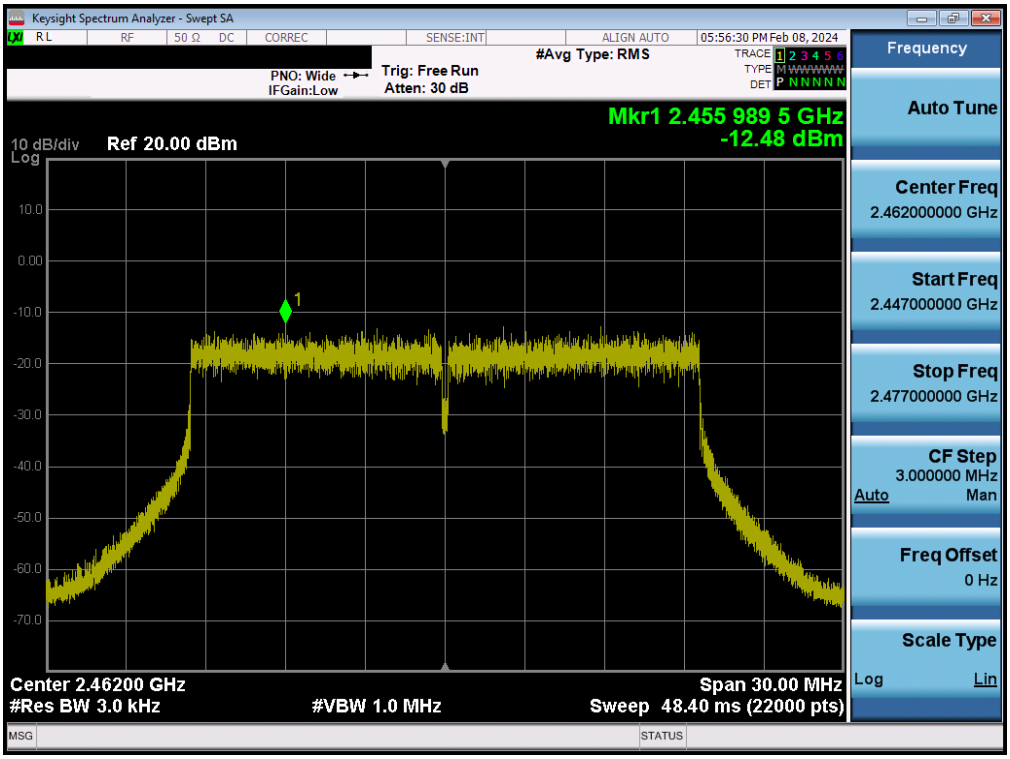
Plot 7-30. Power Spectral Density Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 11)



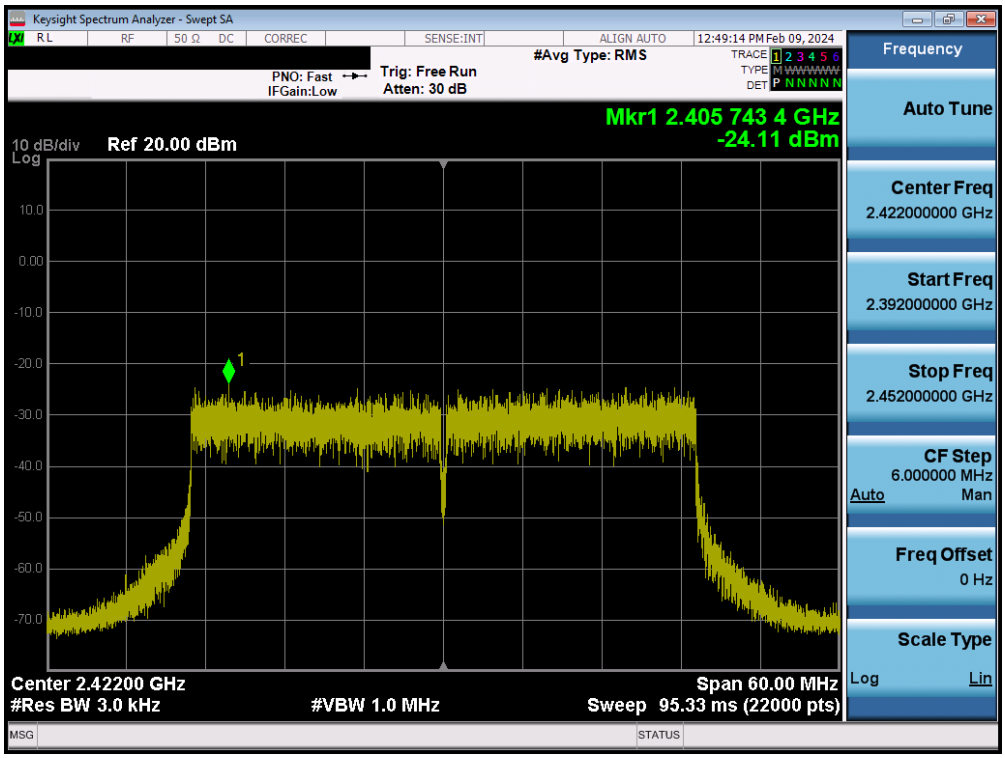
Plot 7-31. Power Spectral Density Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 1)



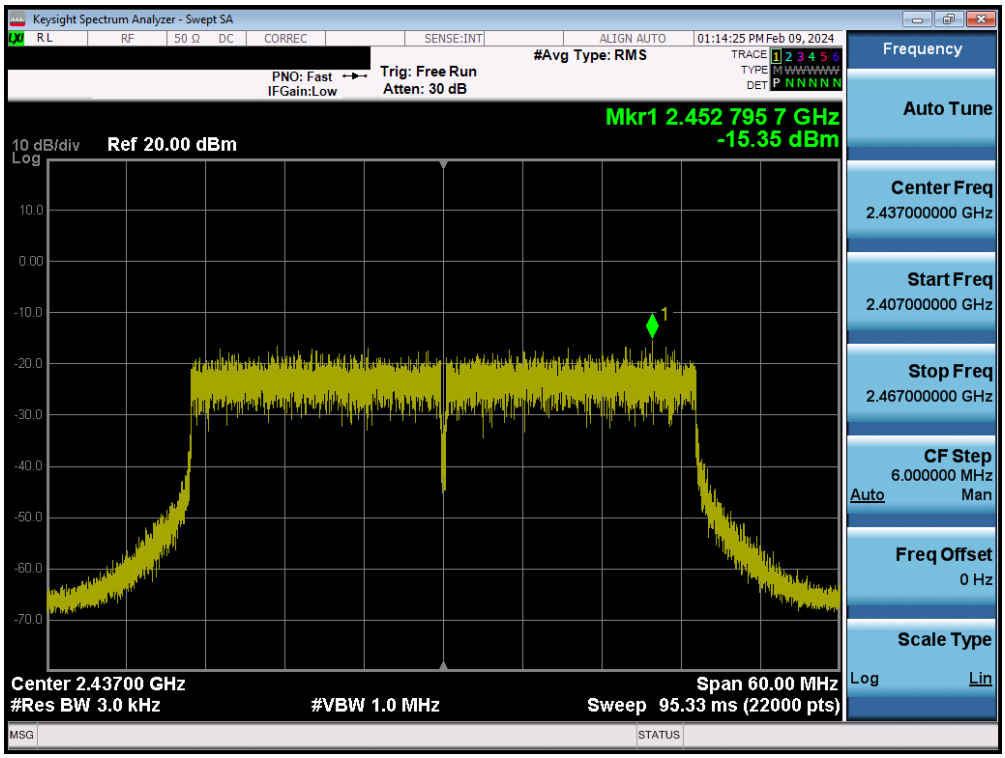
Plot 7-32. Power Spectral Density Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 6)



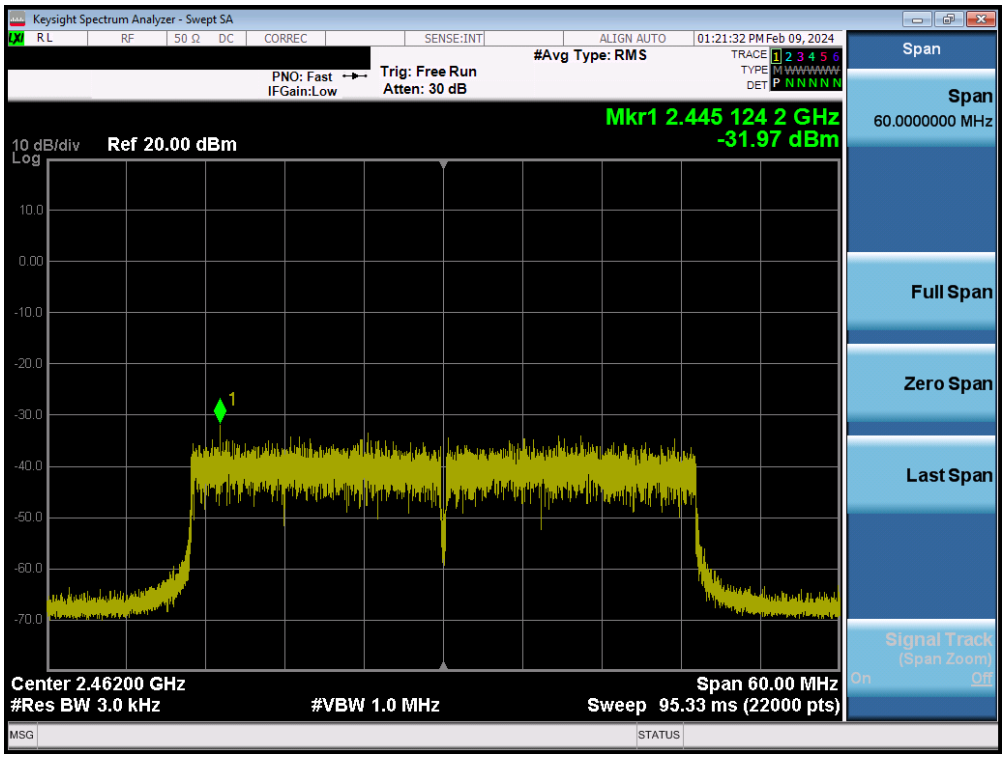
Plot 7-33. Power Spectral Density Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 11)



Plot 7-34. Power Spectral Density Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 3)



Plot 7-35. Power Spectral Density Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 6)



Plot 7-36. Power Spectral Density Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 11)

Note:

Per ANSI C63.10-2013 Section 14.3.1, the power spectral density at Antenna 1 and Antenna 2 were first measured separately 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 2412MHz the average conducted power spectral density was measured to be 1.32 dBm for Antenna 1 and 0.44 dBm for Antenna 2.

Antenna 1 + Antenna 2 = MIMO

(1.32 dBm + 0.44 dBm) = (1.36 mW + 1.11 mW) = 2.46 mW = 3.91 dBm

7.5 Conducted Band Edge Emissions

Test Overview and Limit

All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates, tone configurations, and RU indices were investigated to determine the worst-case configuration. For the following out of band conducted emissions plots at the band edge, the EUT was set to a data rate of MCS0 in 802.11be mode as this setting produced the worst-case emissions.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the PSD procedure (Section 7.4).

Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3

Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW = 100kHz
4. VBW = 1MHz
5. Detector = Peak
6. Number of sweep points ≥ 2 x Span/RBW
7. Trace mode = max hold
8. Sweep time = auto couple
9. The trace was allowed to stabilize

Test Setup

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

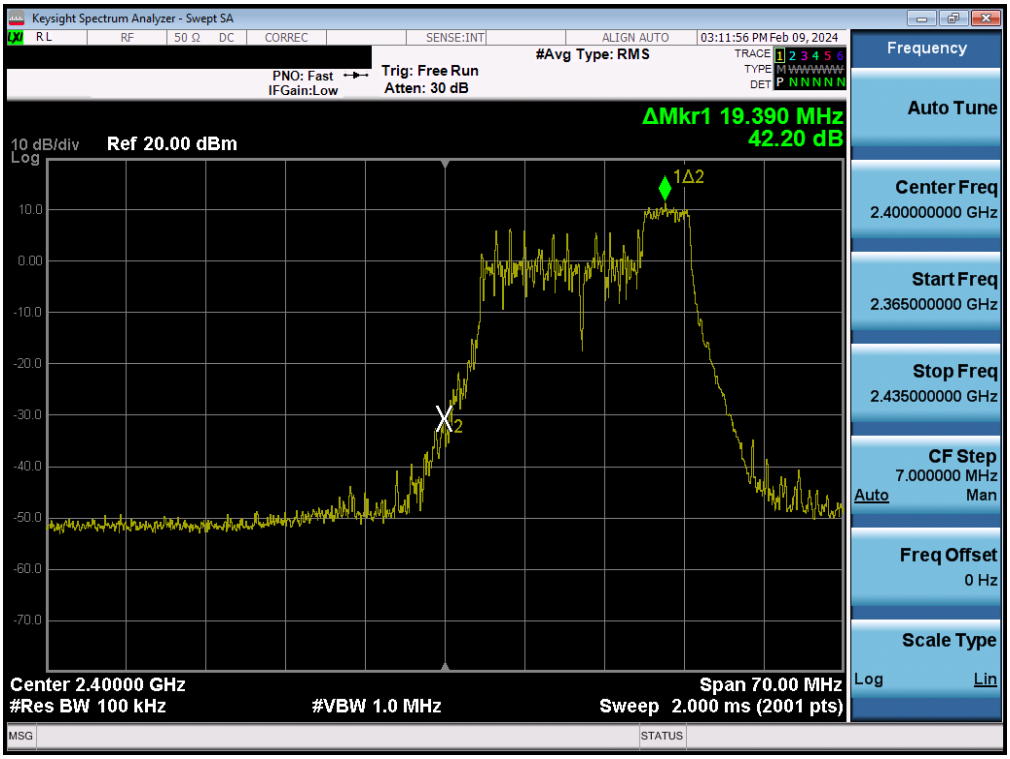
Figure 7-4. Test Instrument & Measurement Setup

Test Notes

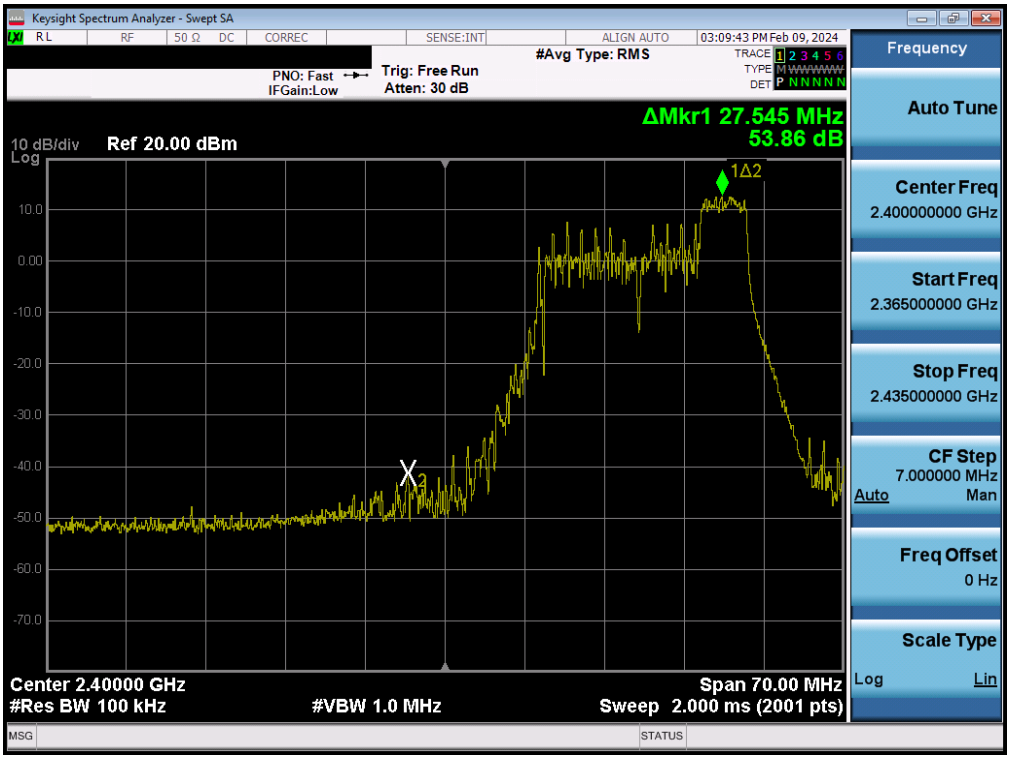
None.

7.5.1 MIMO Antenna-1 Conducted Band Edge Emissions

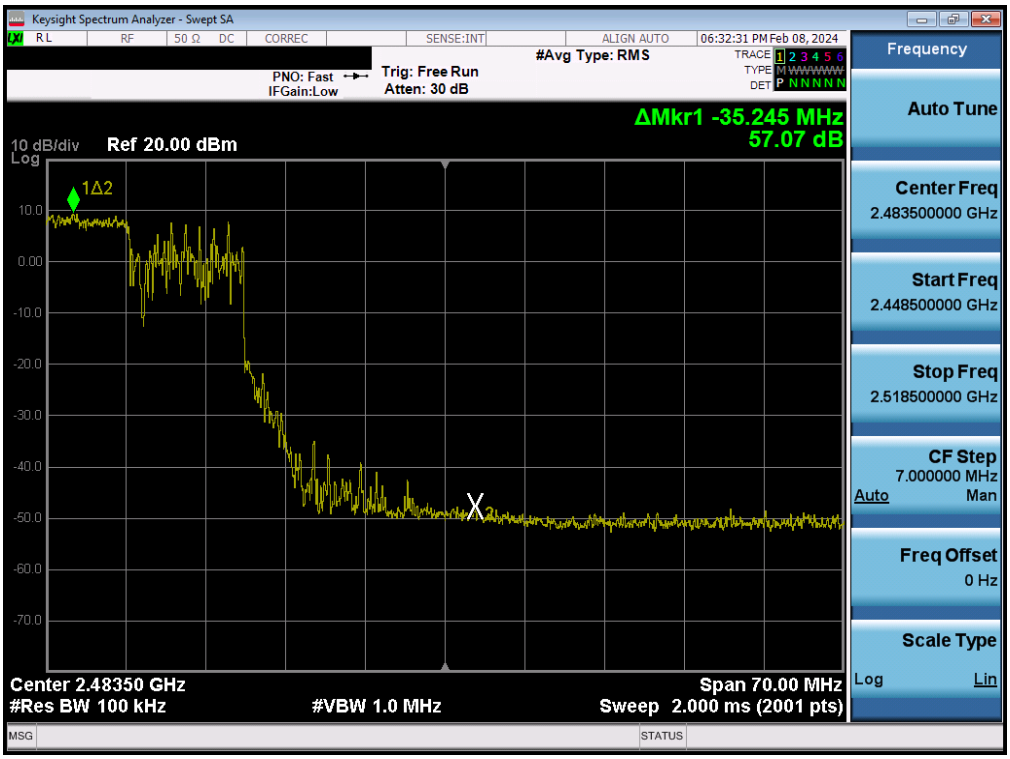
106T



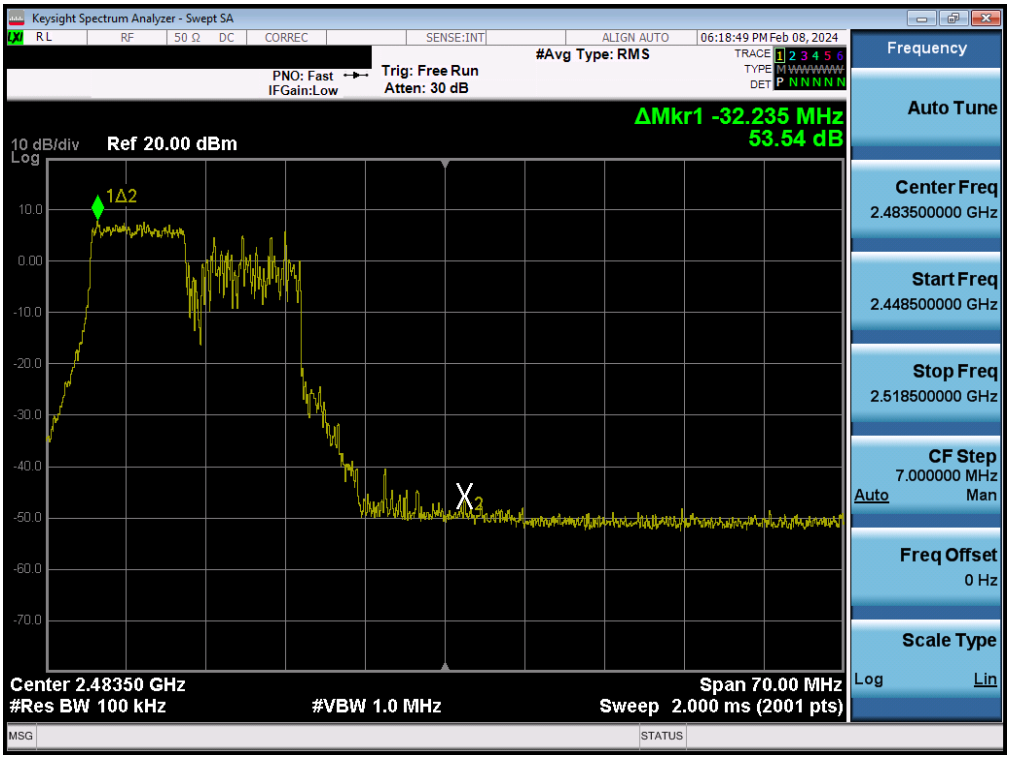
Plot 7-37. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 106 Tones – Ch. 1)



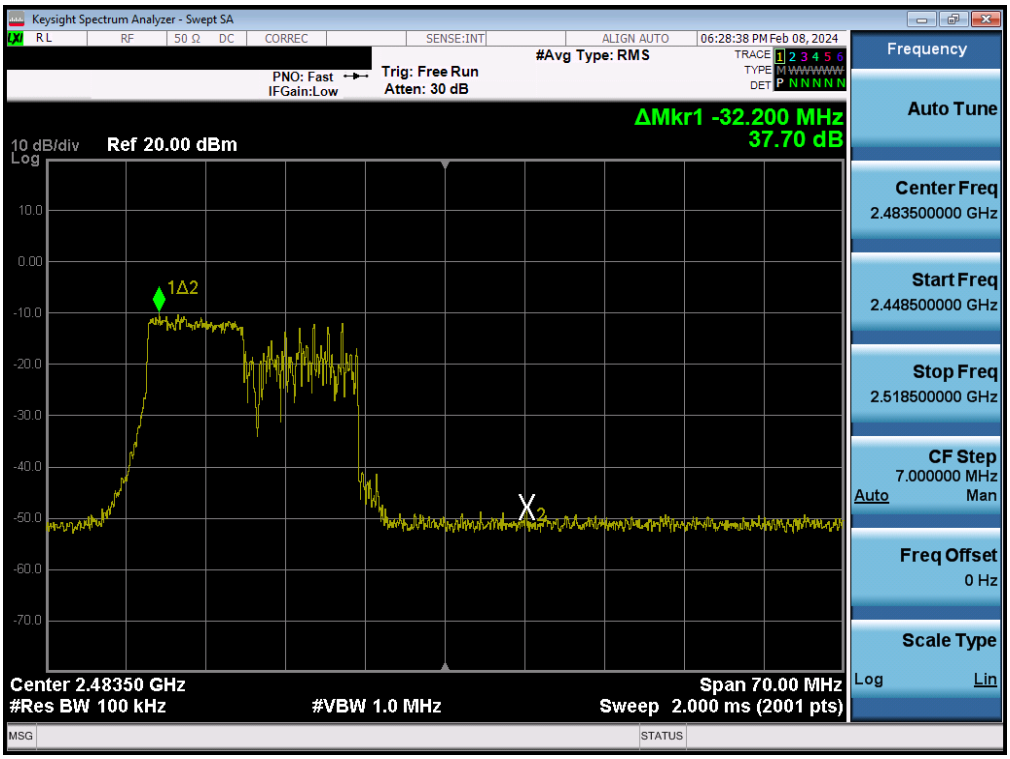
Plot 7-38. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 106 Tones – Ch. 2)



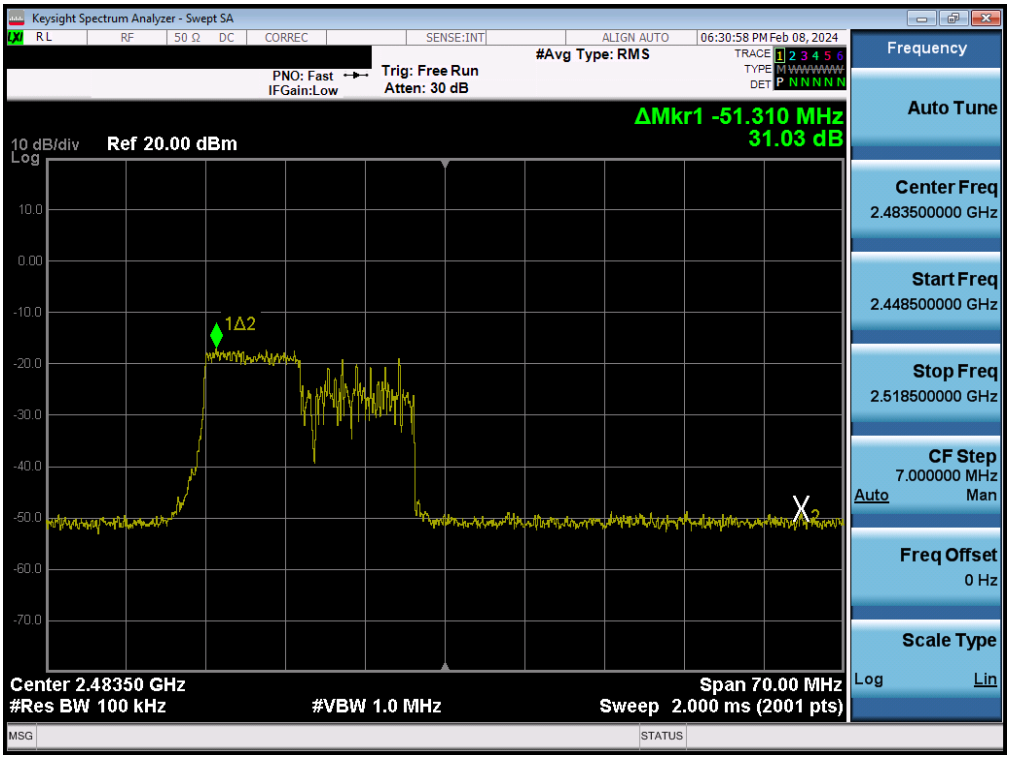
Plot 7-39. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 106 Tones – Ch. 10)



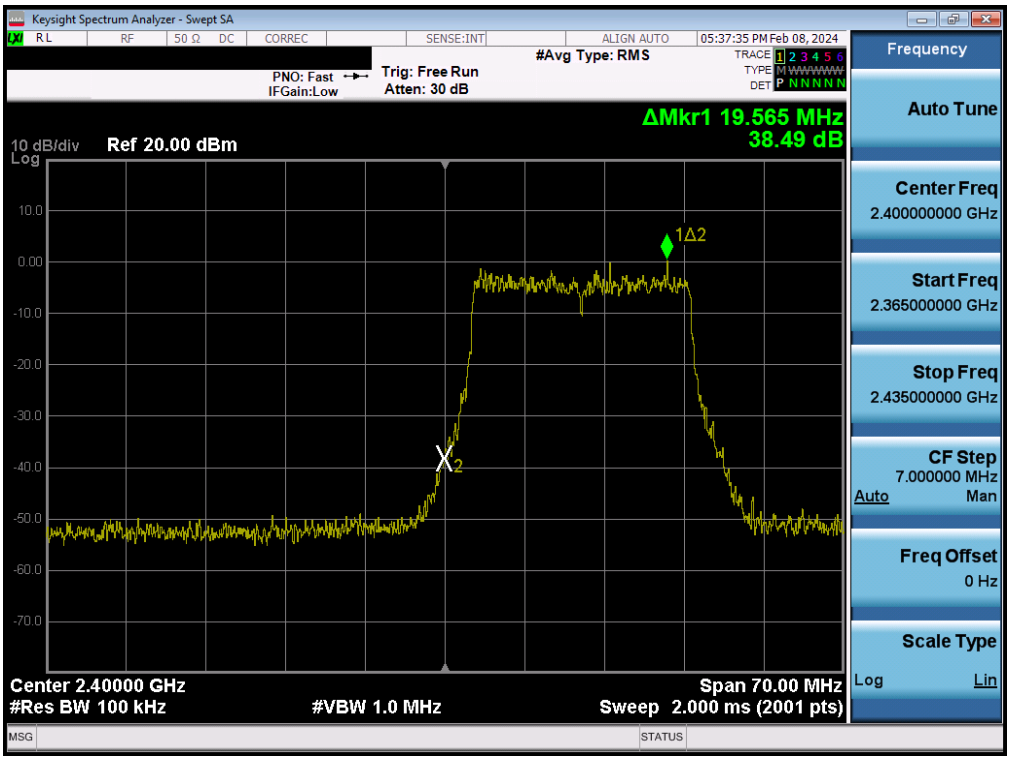
Plot 7-40. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 106 Tones – Ch. 11)



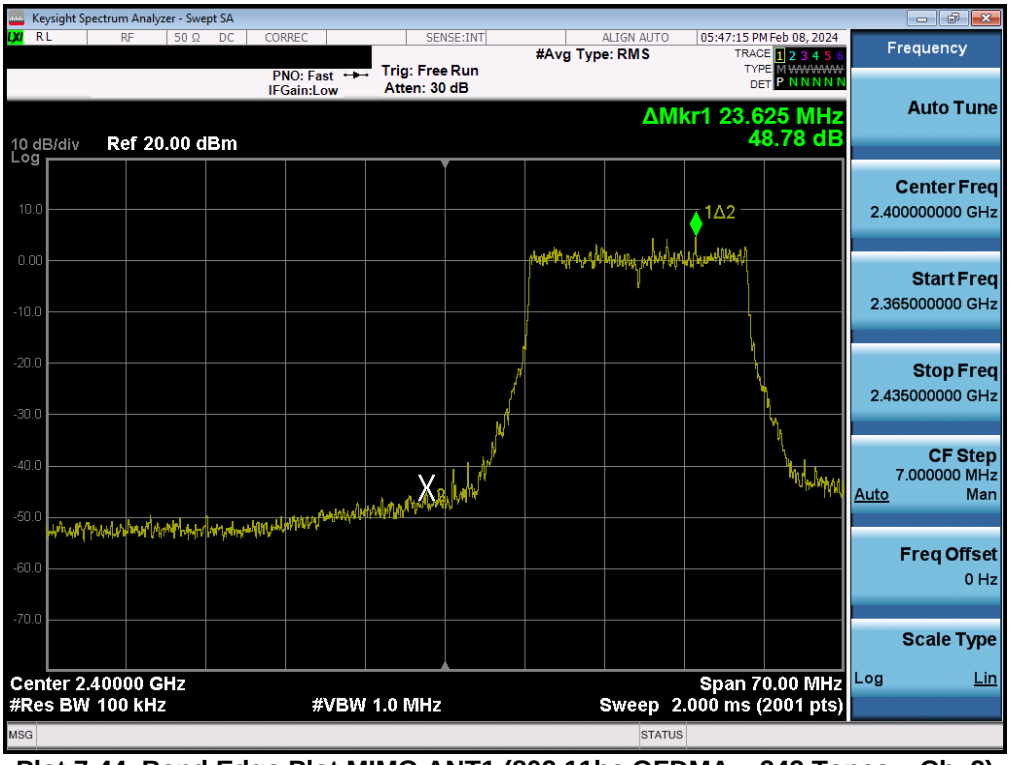
Plot 7-41. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 106 Tones – Ch. 12)



Plot 7-42. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 106 Tones – Ch. 13)

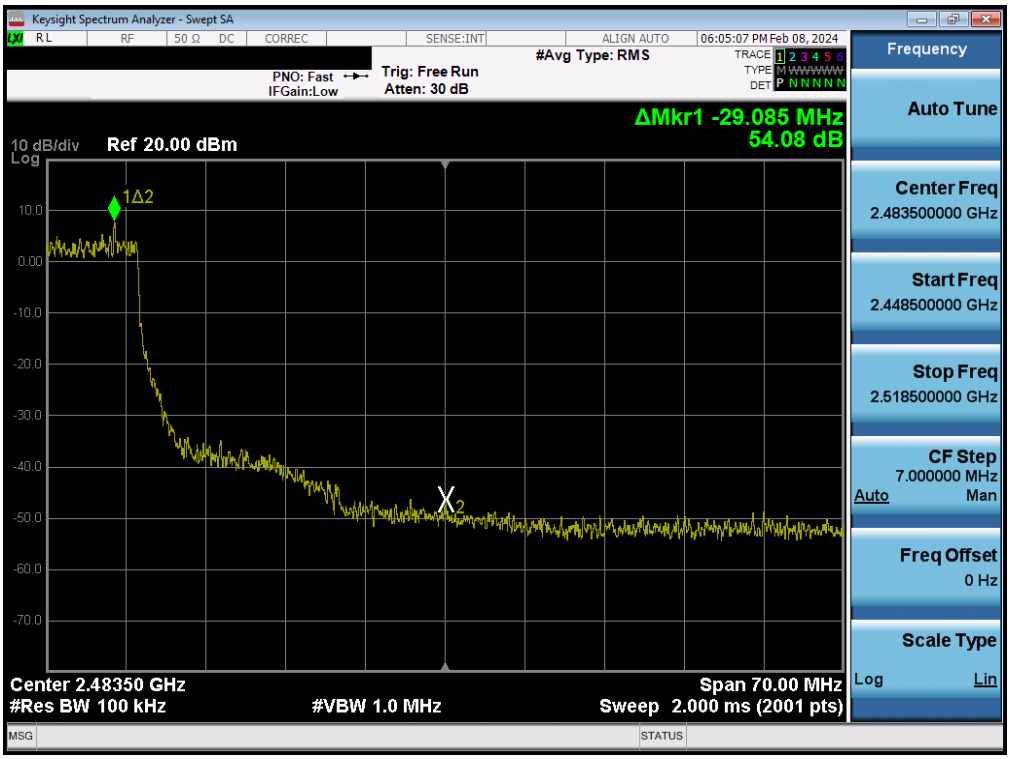


Plot 7-43. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 1)

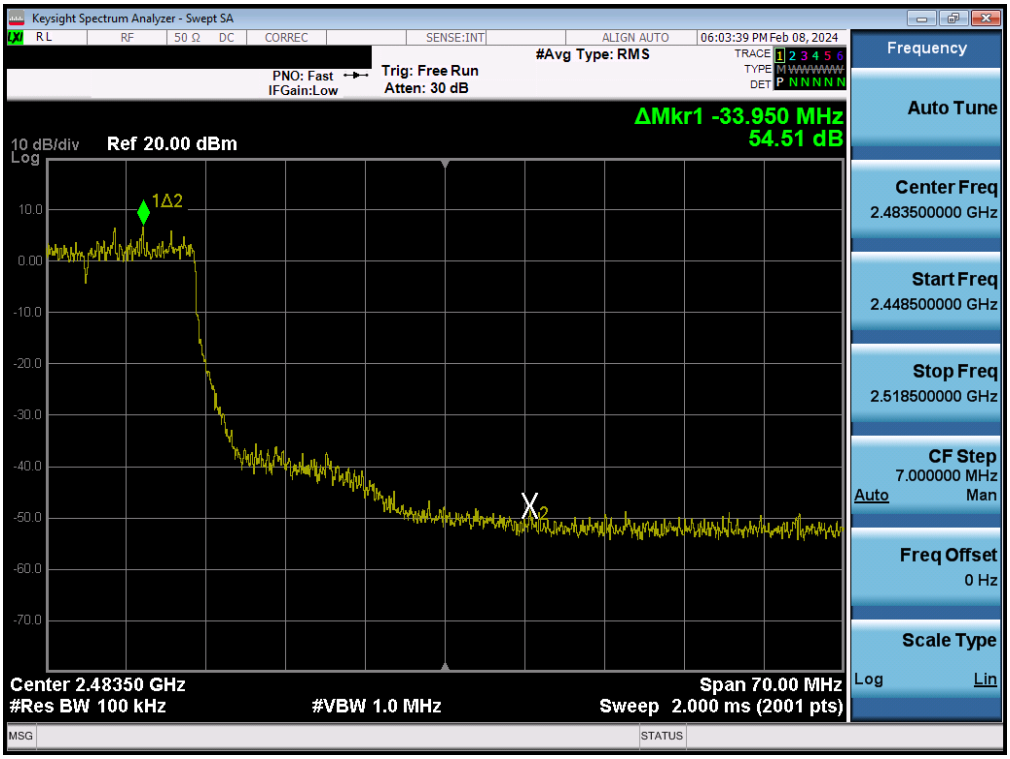


Plot 7-44. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 2)

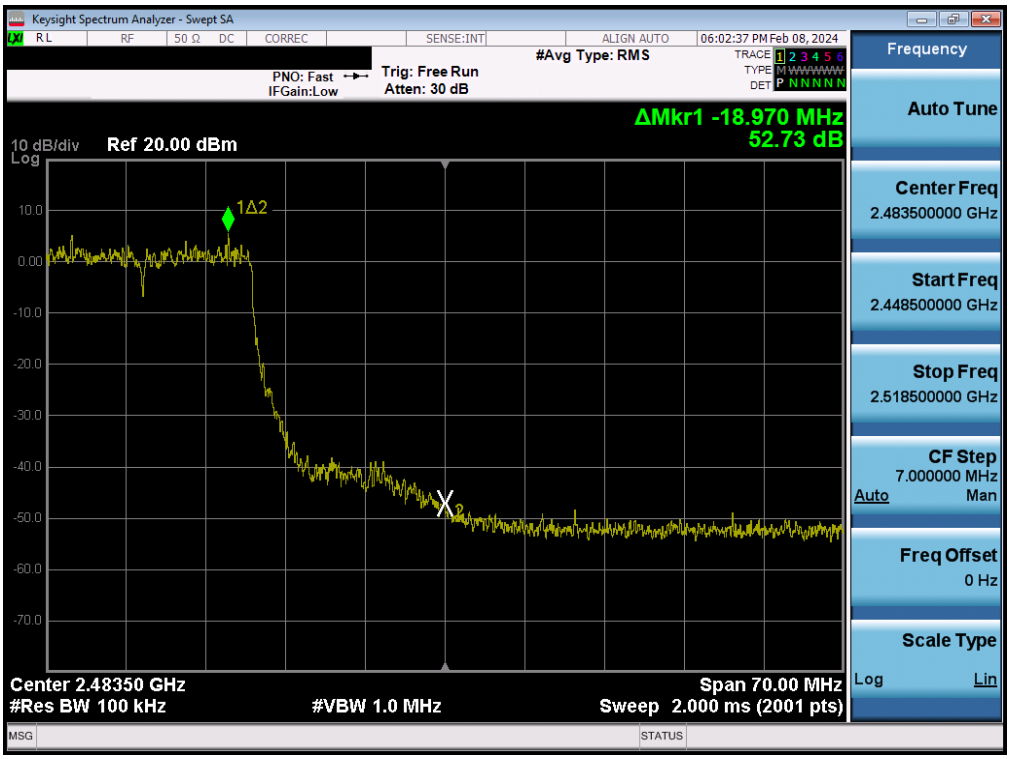
Plot 7-45. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 3)



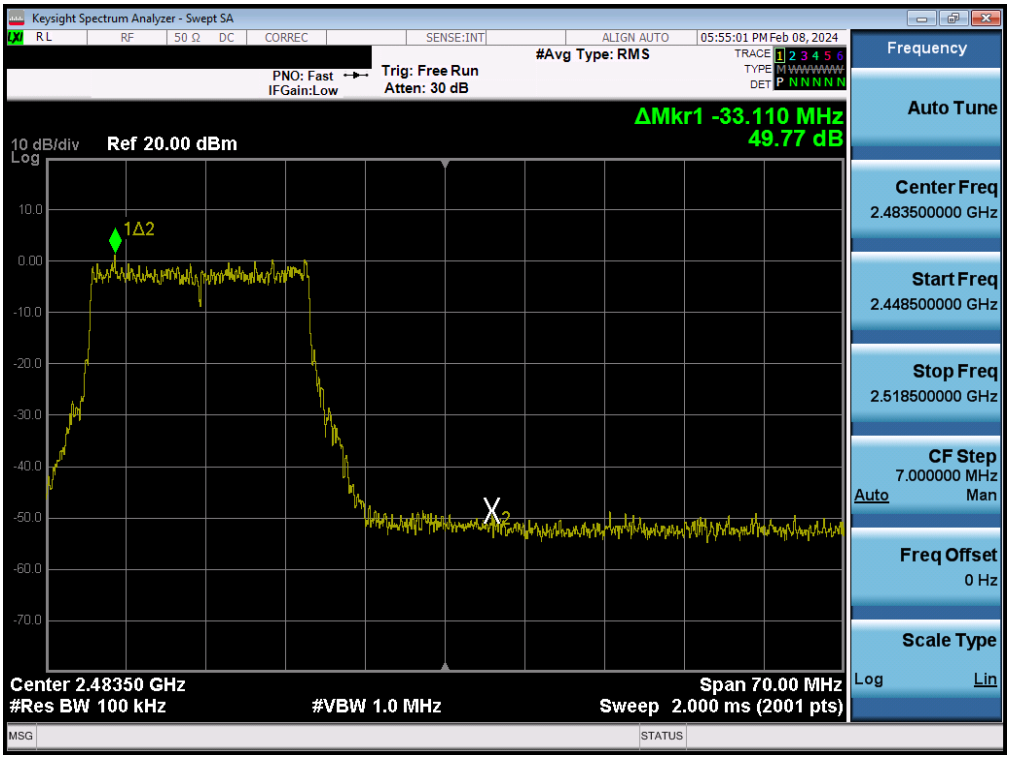
Plot 7-46. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 8)



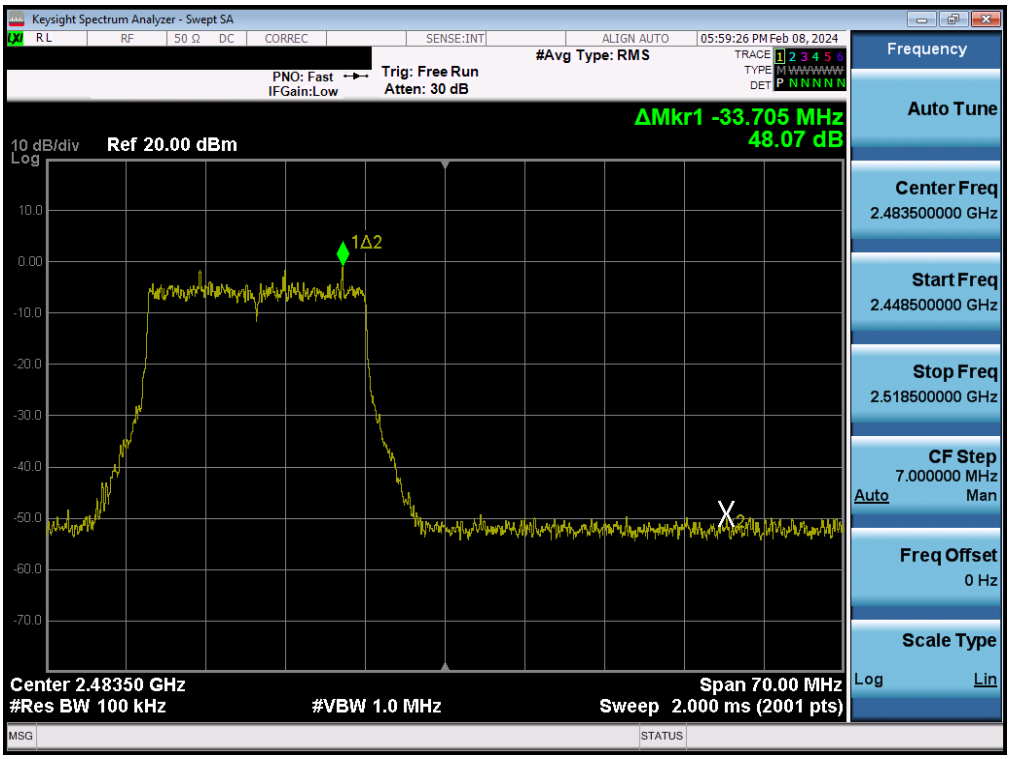
Plot 7-47. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 9)



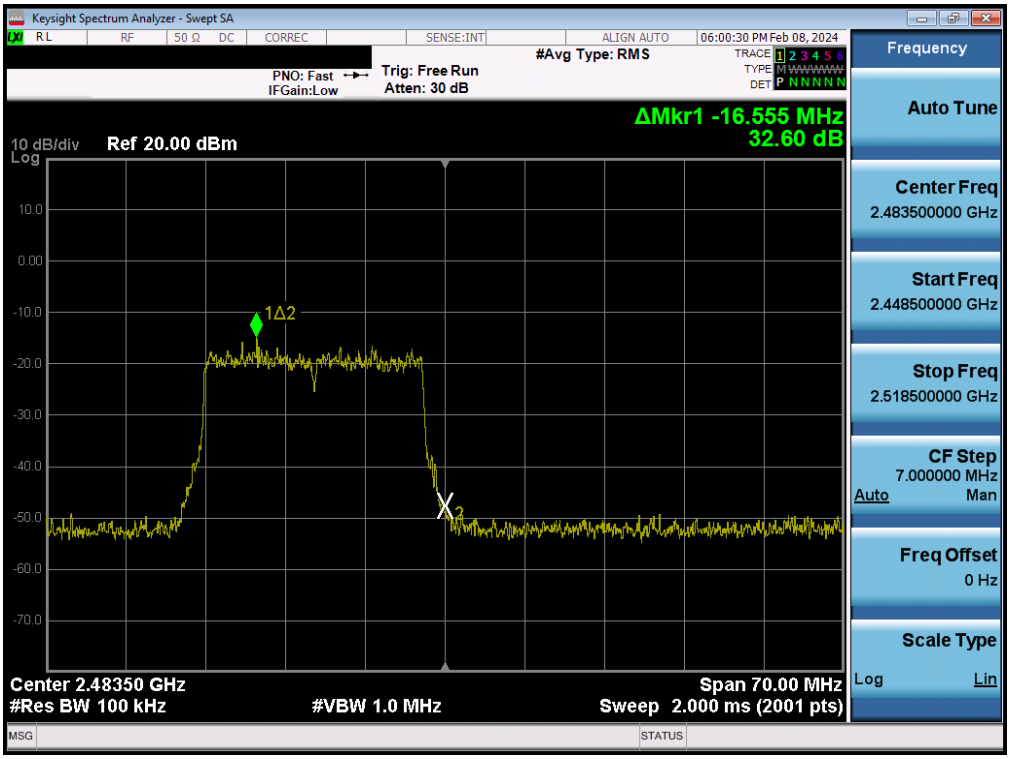
Plot 7-48. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 10)



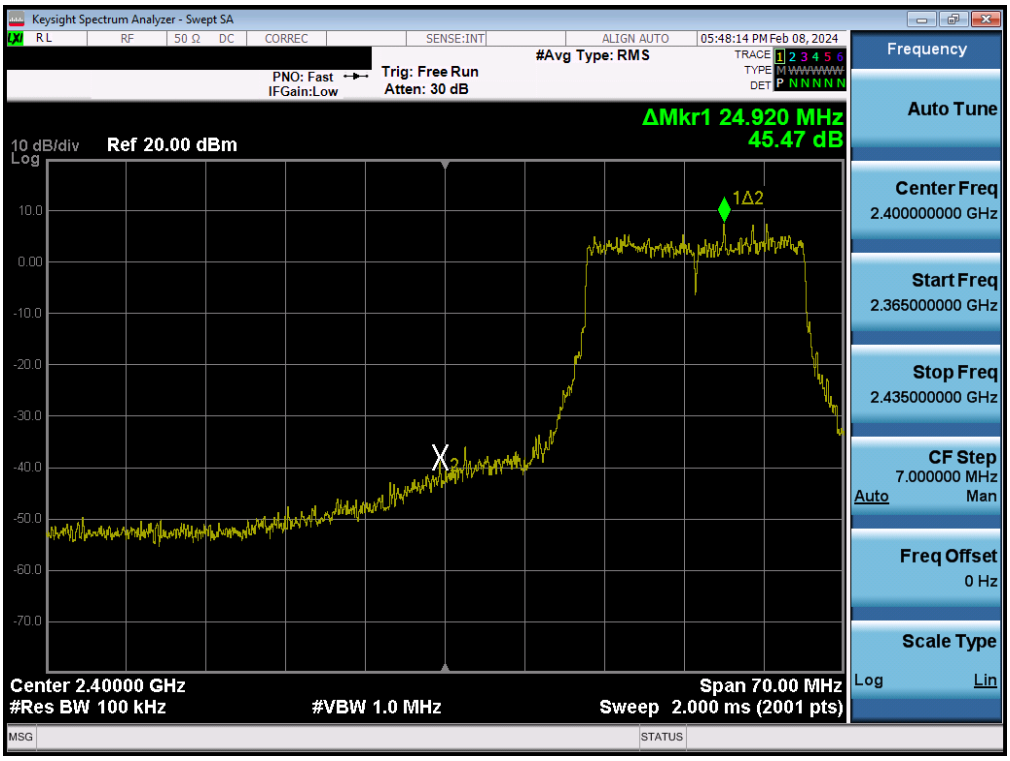
Plot 7-49. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 11)



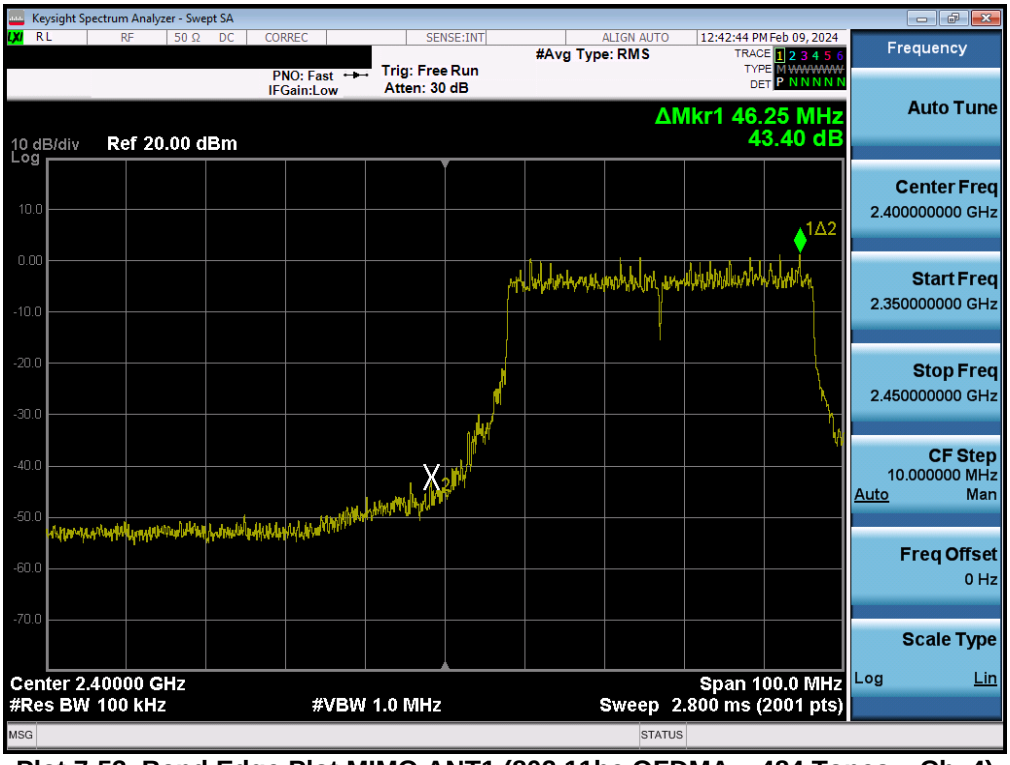
Plot 7-50. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 12)



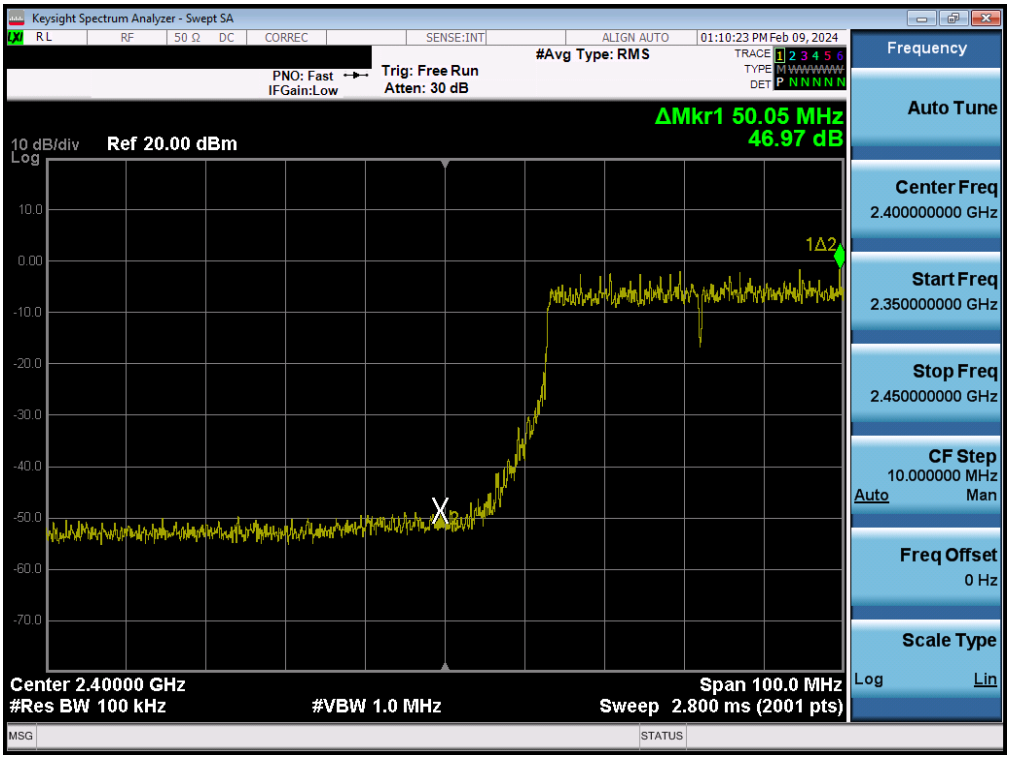
Plot 7-51. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 13)



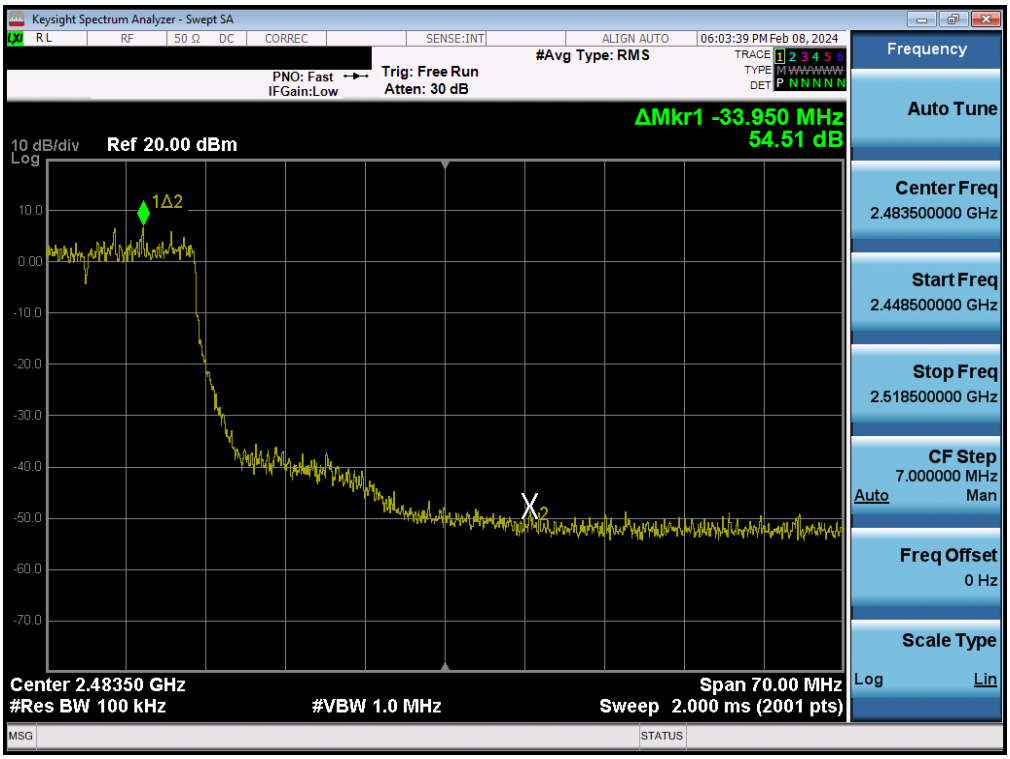
Plot 7-52. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 3)



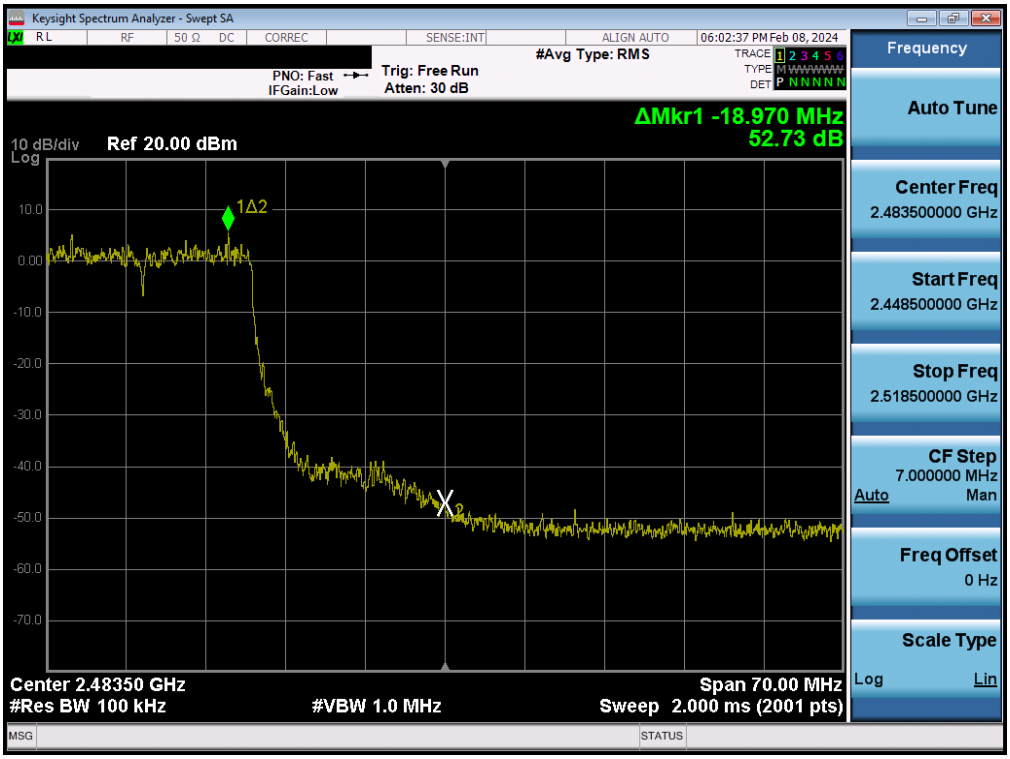
Plot 7-53. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 4)



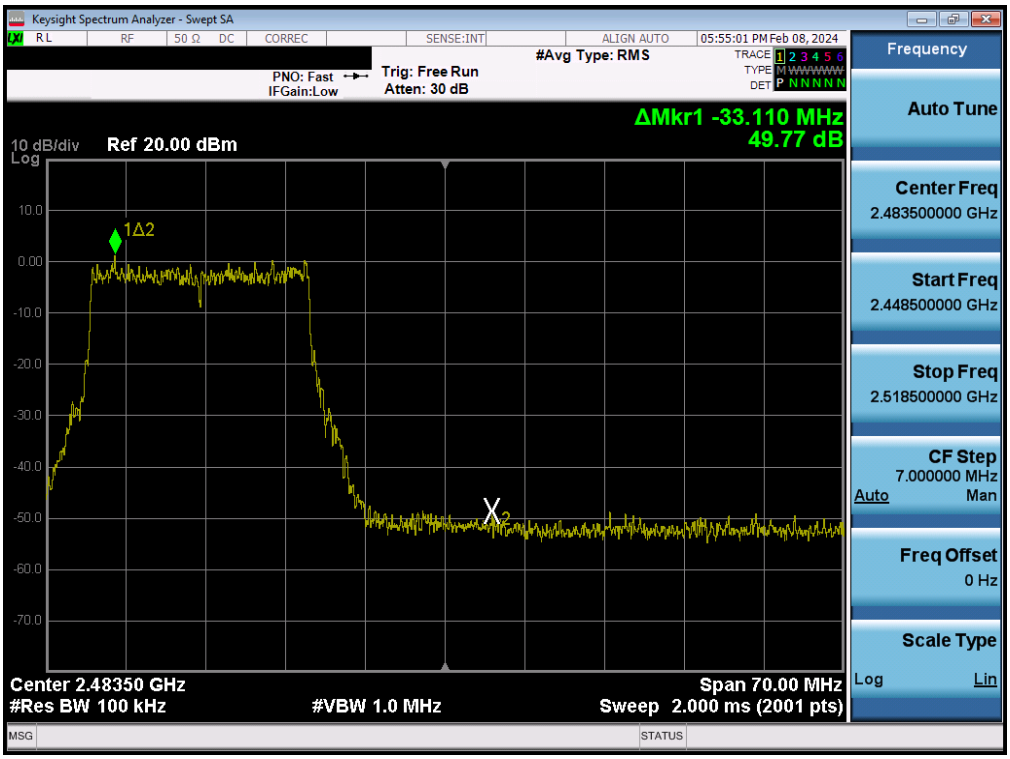
Plot 7-54. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 5)



Plot 7-55. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 9)



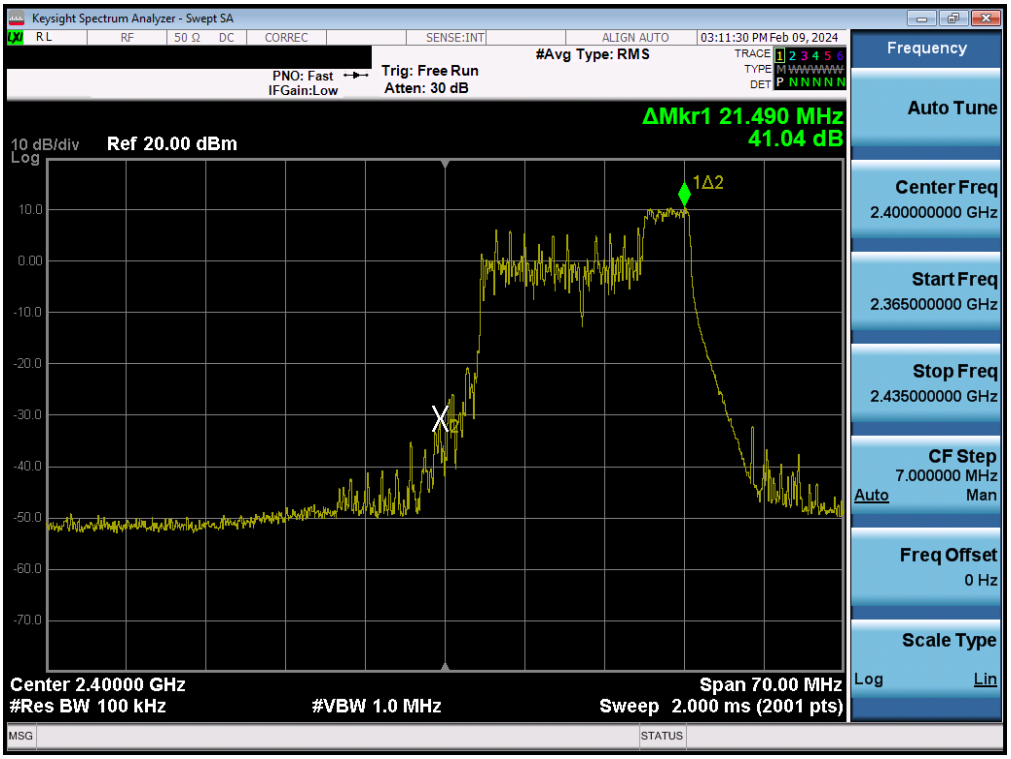
Plot 7-56. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 10)



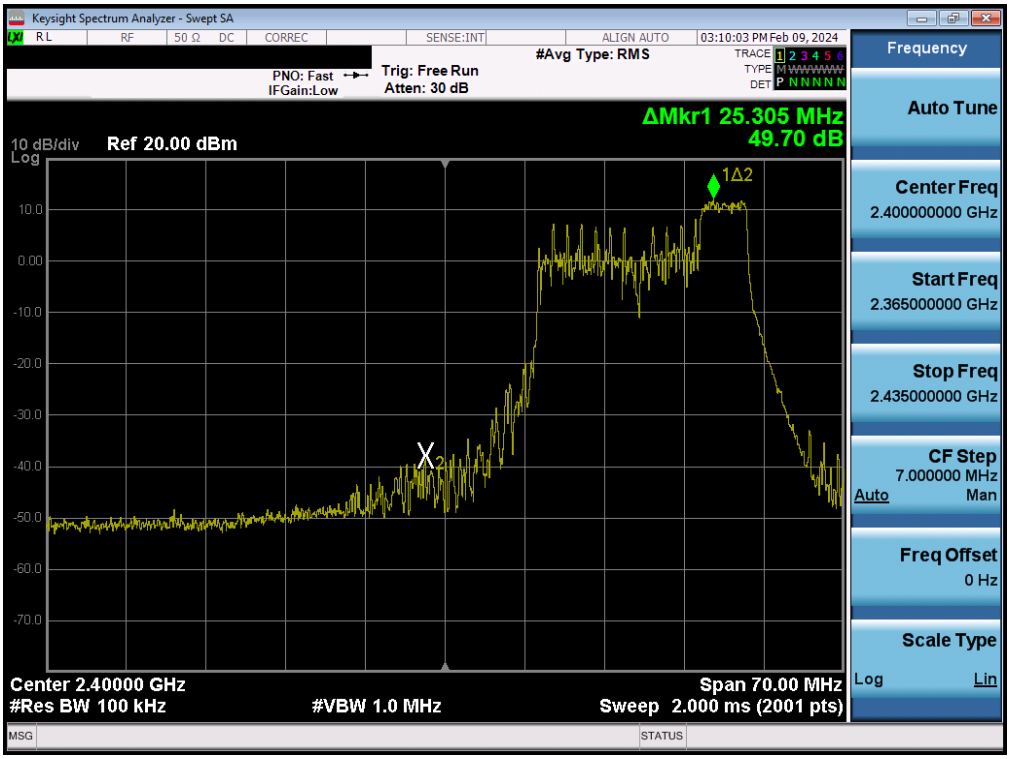
Plot 7-57. Band Edge Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 11)

7.5.2 MIMO Antenna-2 Conducted Band Edge Emissions

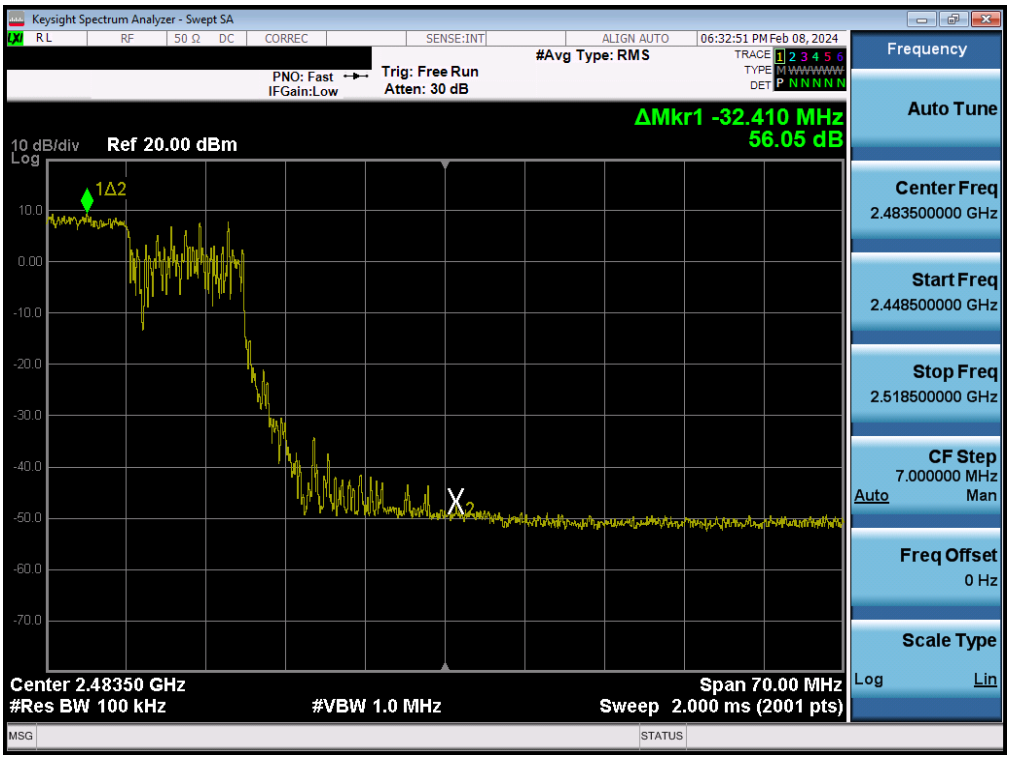
106T



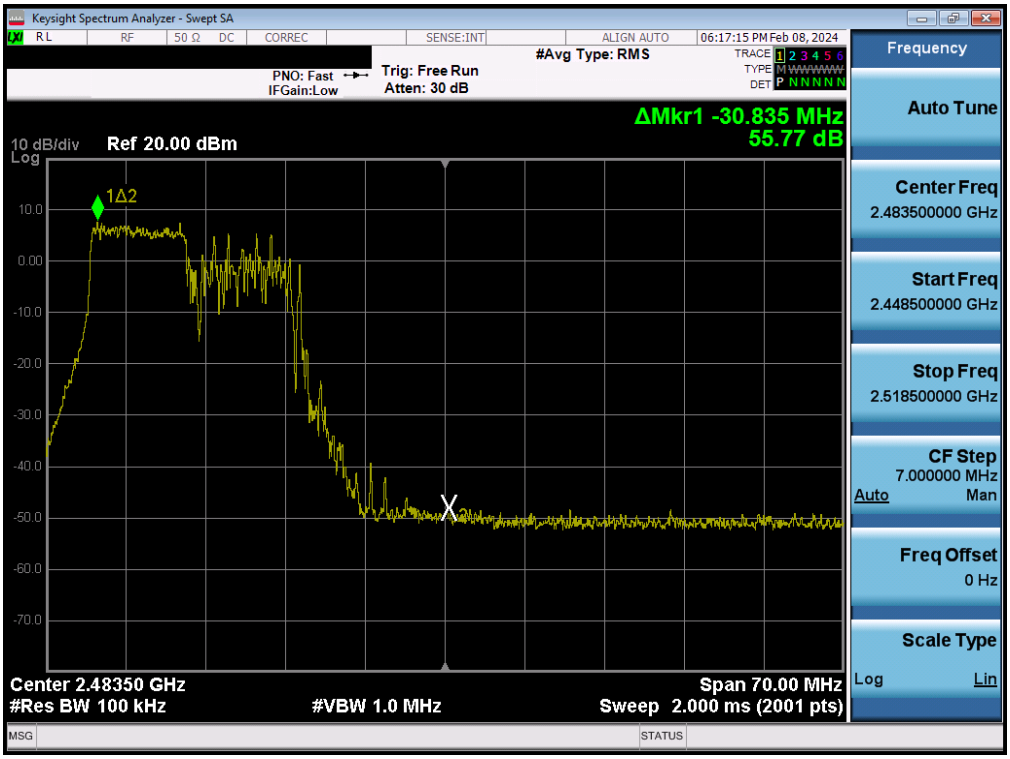
Plot 7-58. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 106 Tones – Ch. 1)



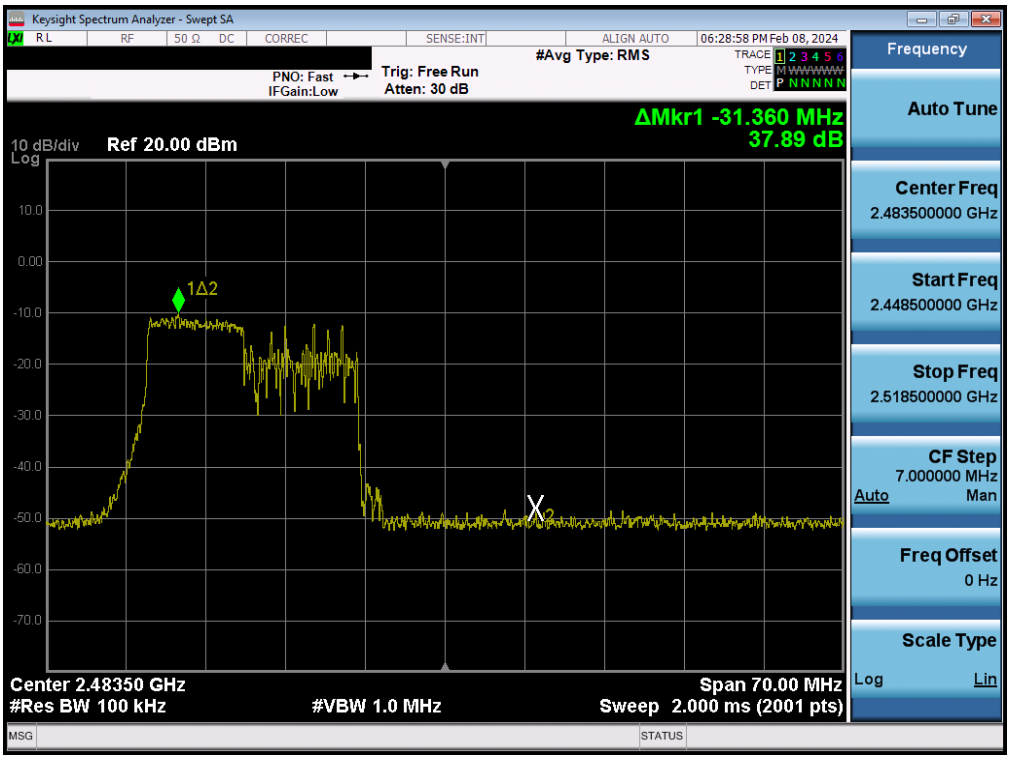
Plot 7-59. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 106 Tones – Ch. 2)



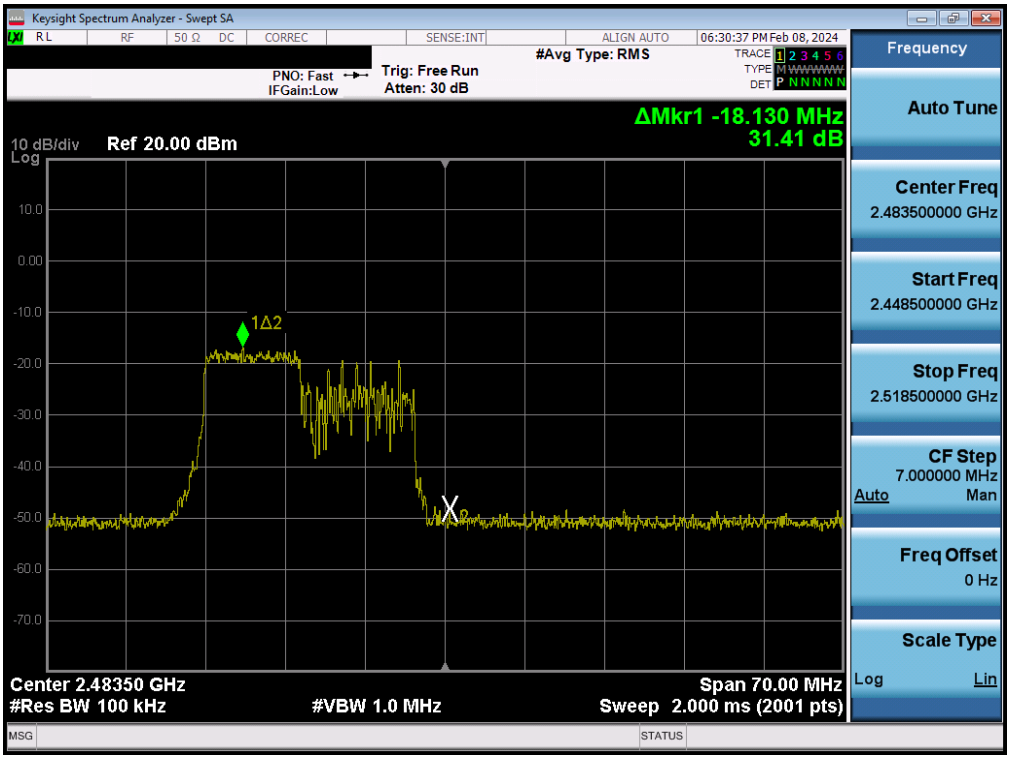
Plot 7-60. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 106 Tones – Ch. 10)



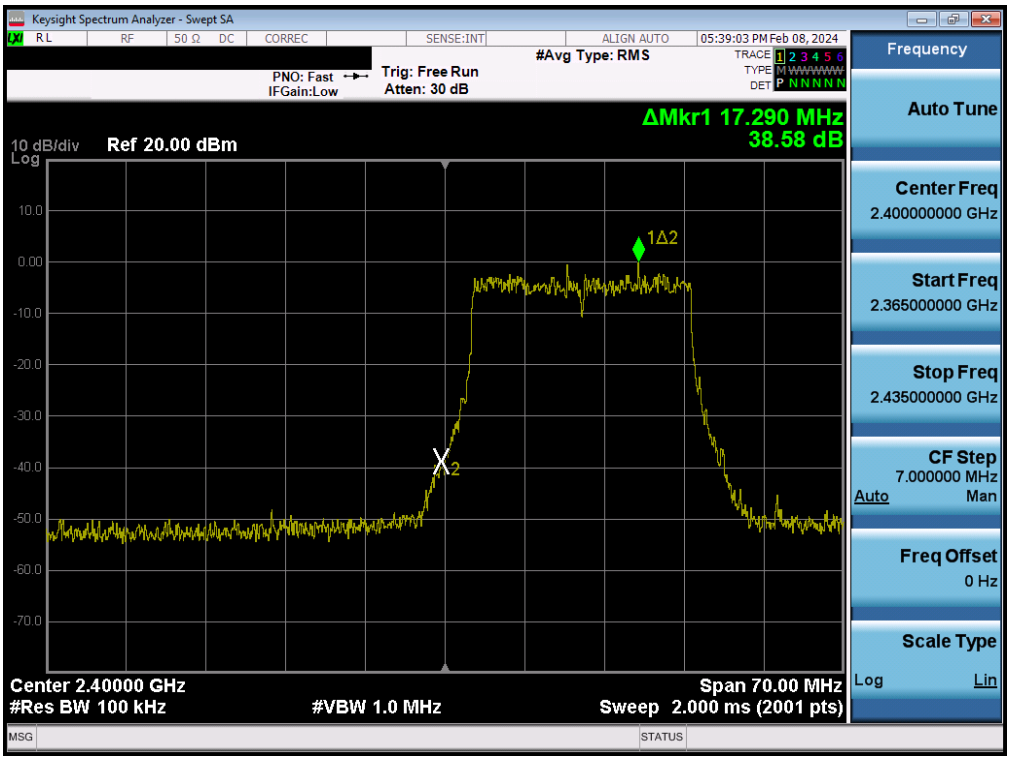
Plot 7-61. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 106 Tones – Ch. 11)



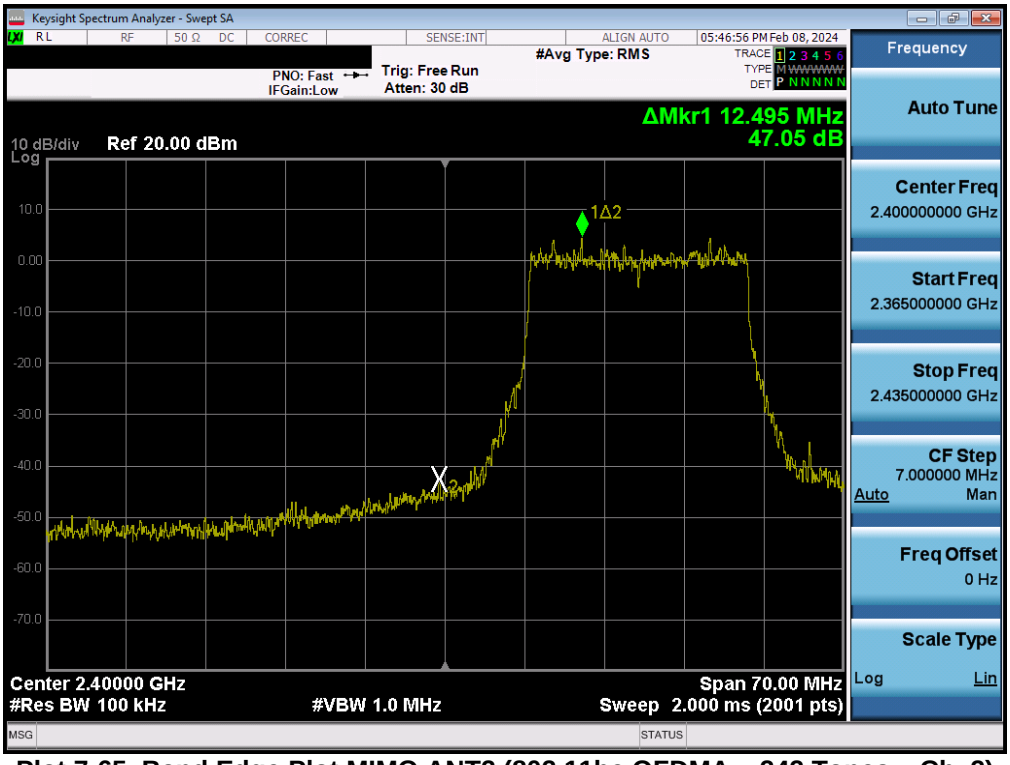
Plot 7-62. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 106 Tones – Ch. 12)



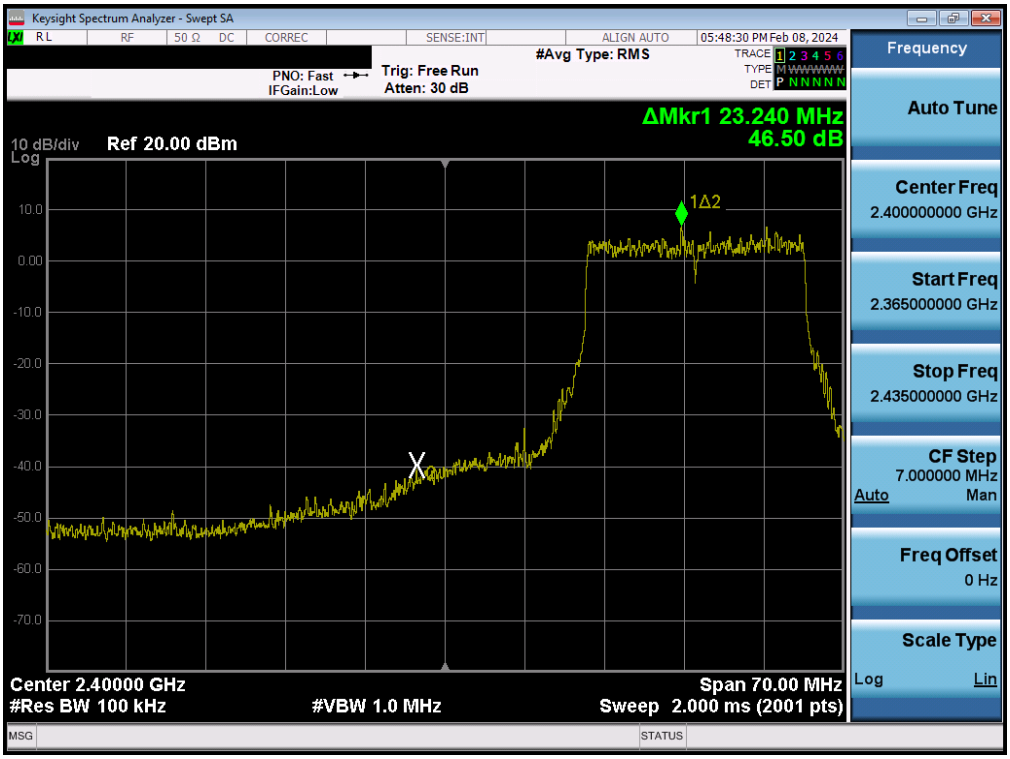
Plot 7-63. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 106 Tones – Ch. 13)



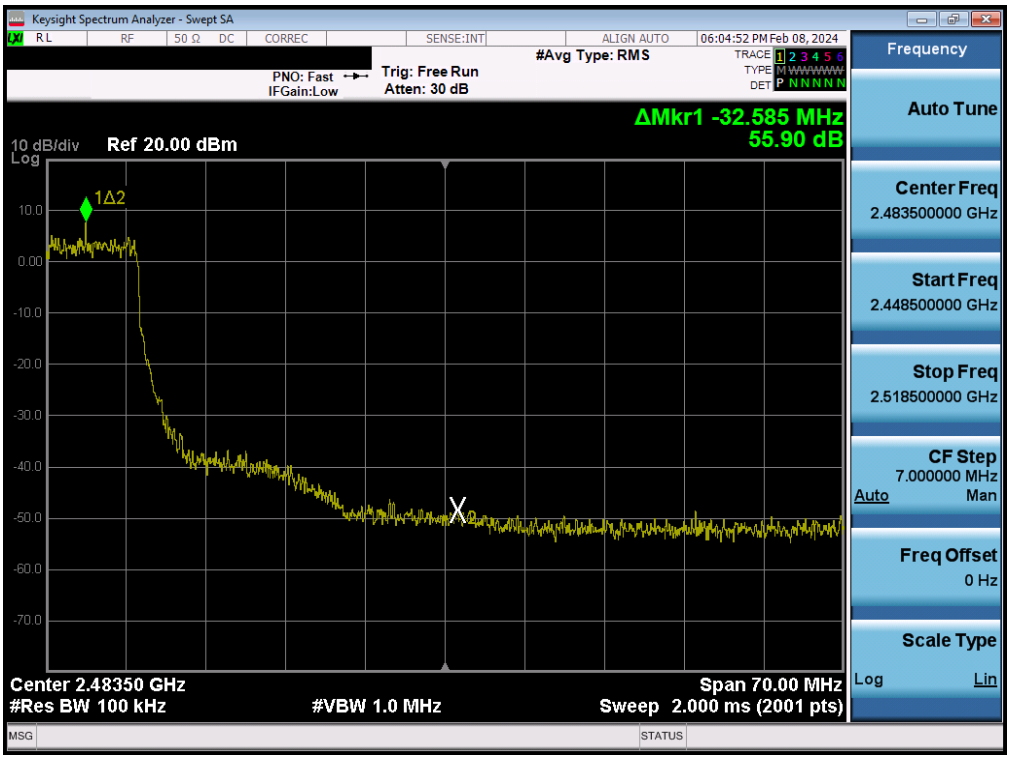
Plot 7-64. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 1)



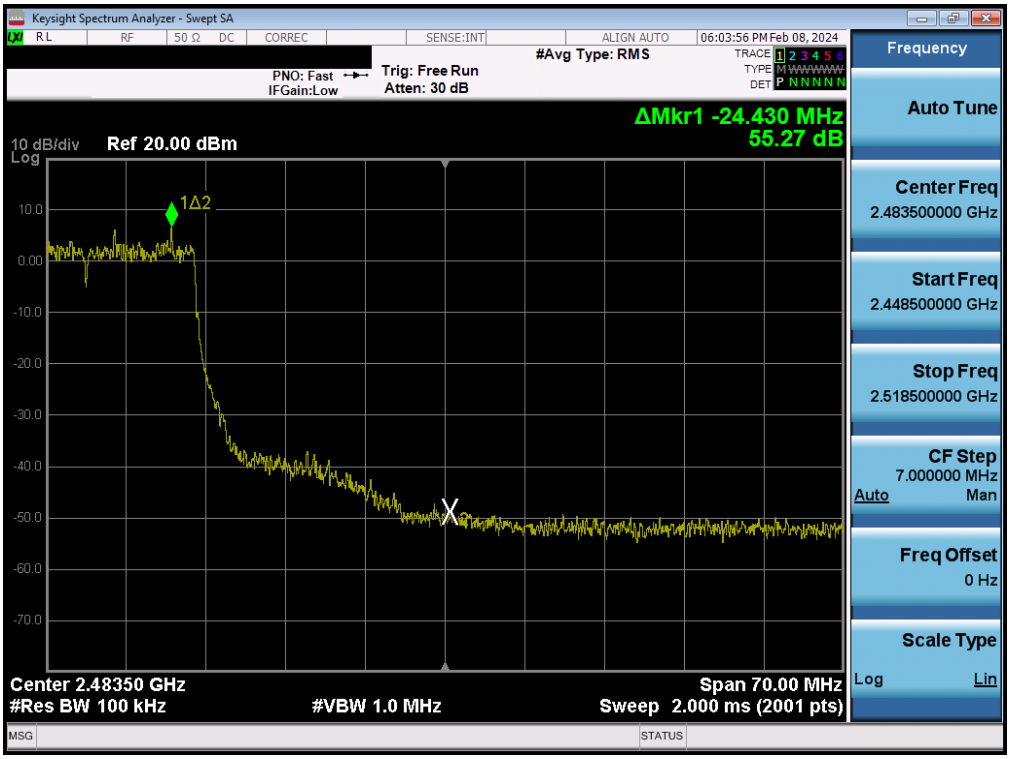
Plot 7-65. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 2)



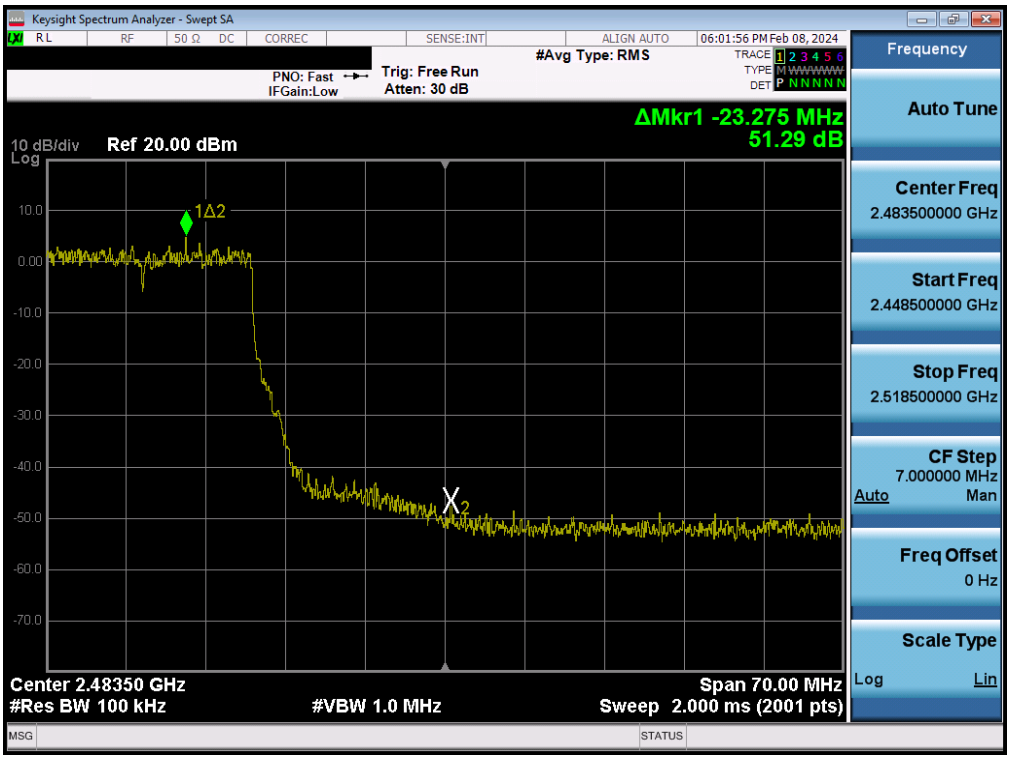
Plot 7-66. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 3)



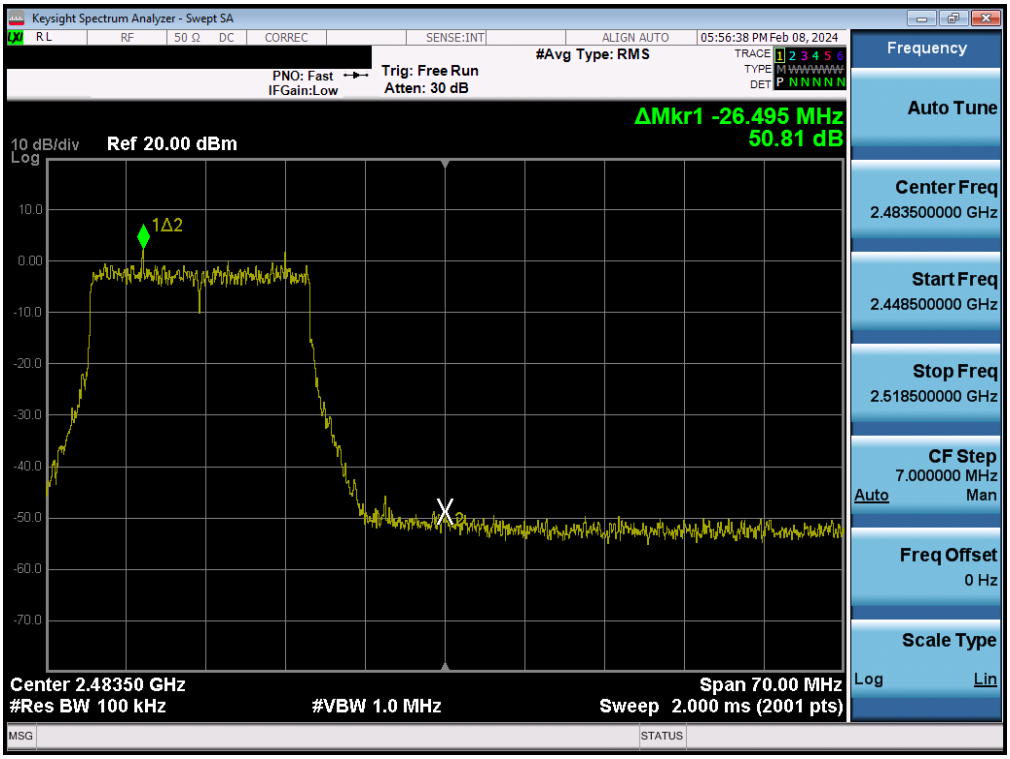
Plot 7-67. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 8)



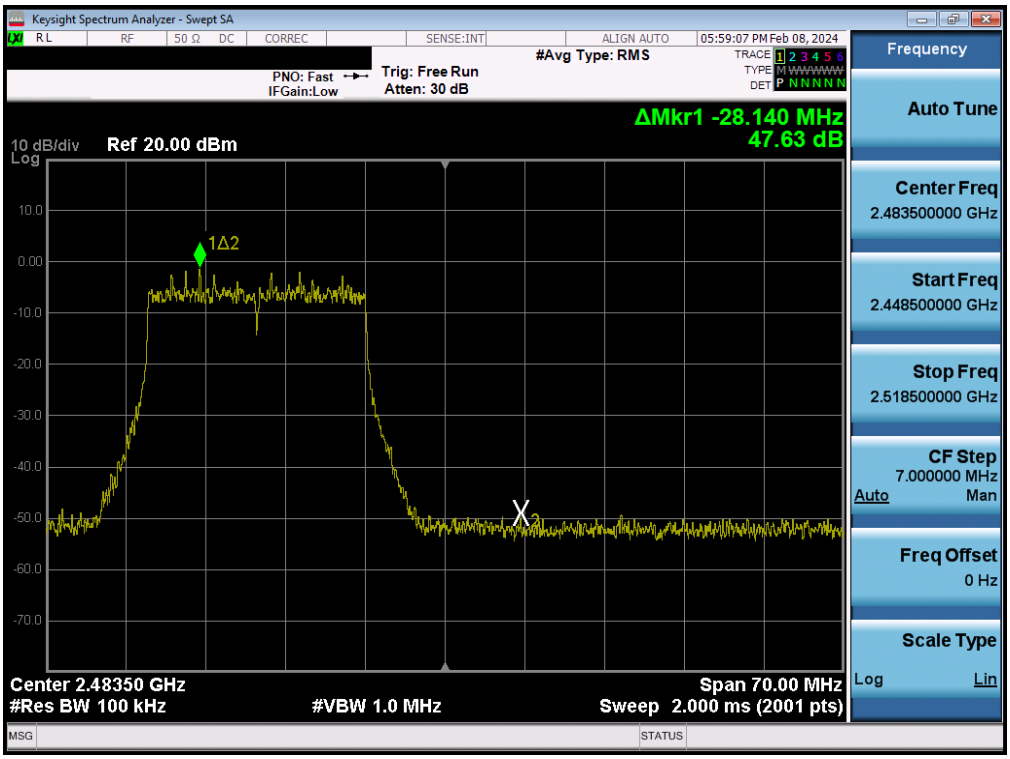
Plot 7-68. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 9)



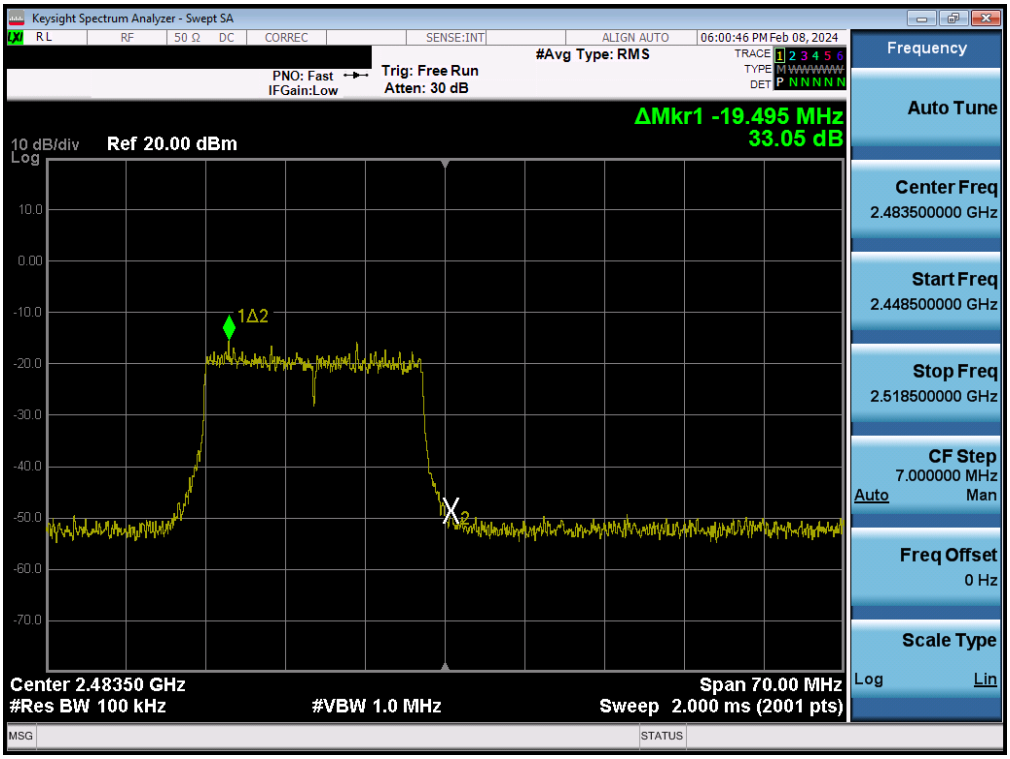
Plot 7-69. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 10)



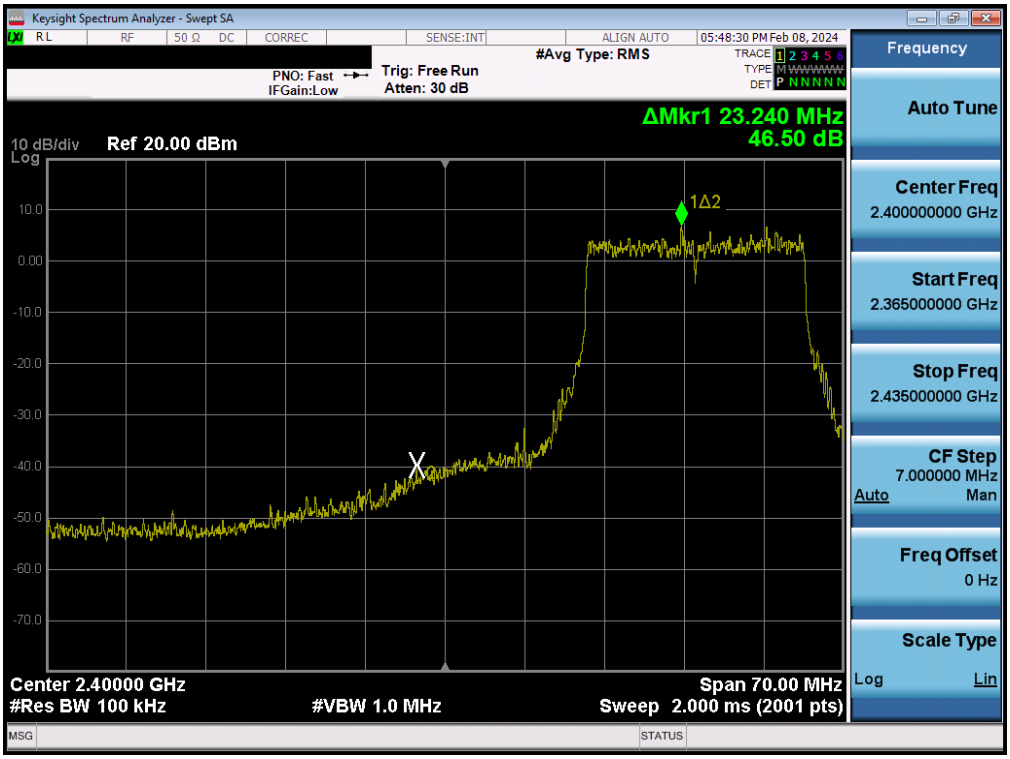
Plot 7-70. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 11)



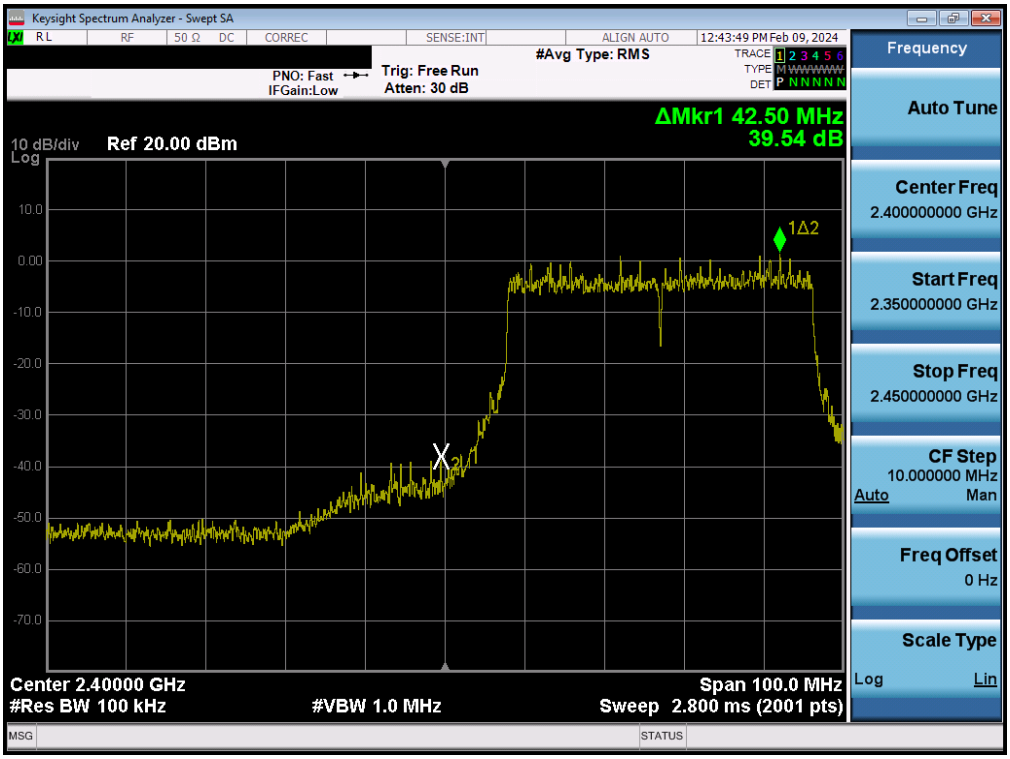
Plot 7-71. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 12)



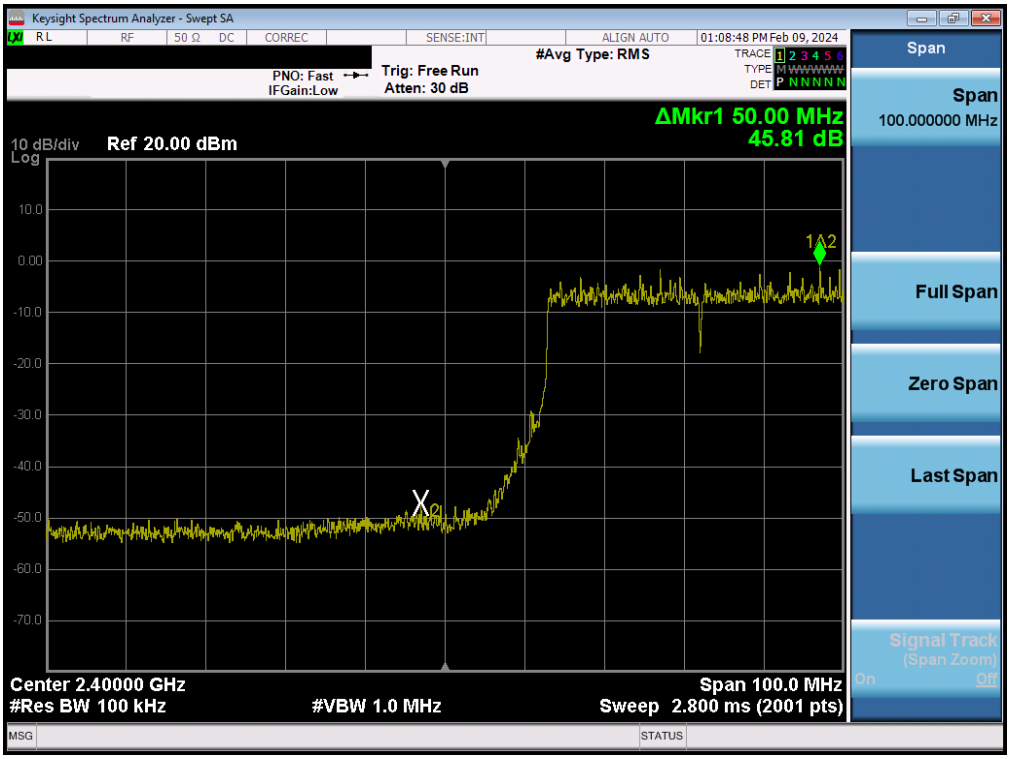
Plot 7-72. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 13)



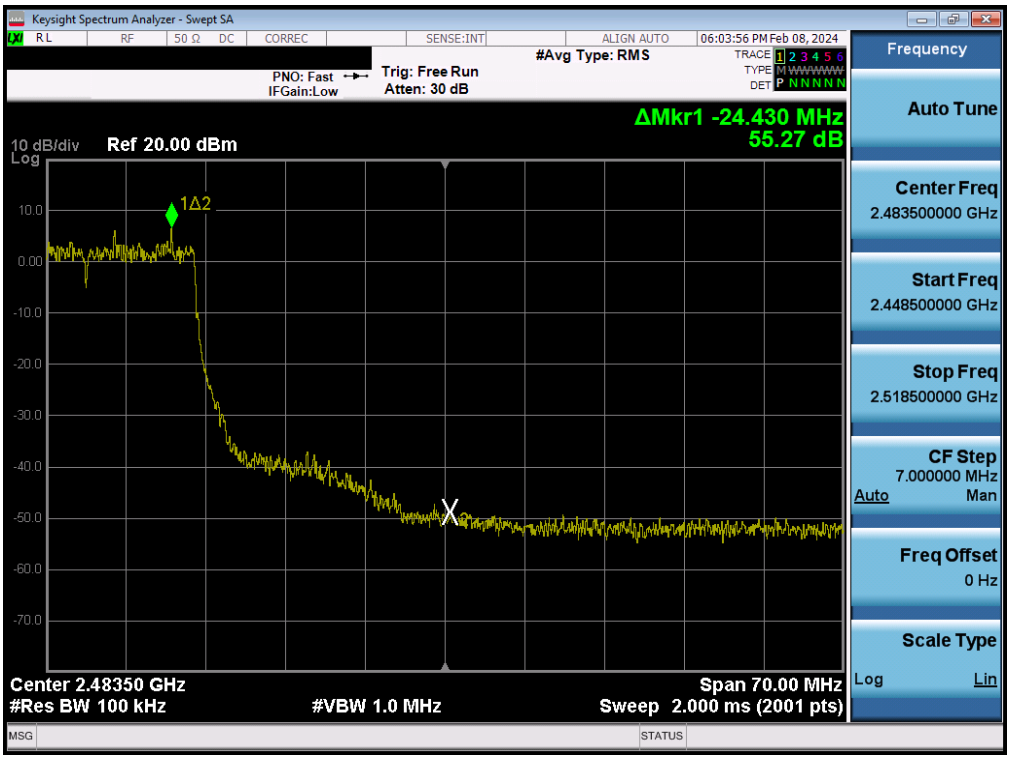
Plot 7-73. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 3)



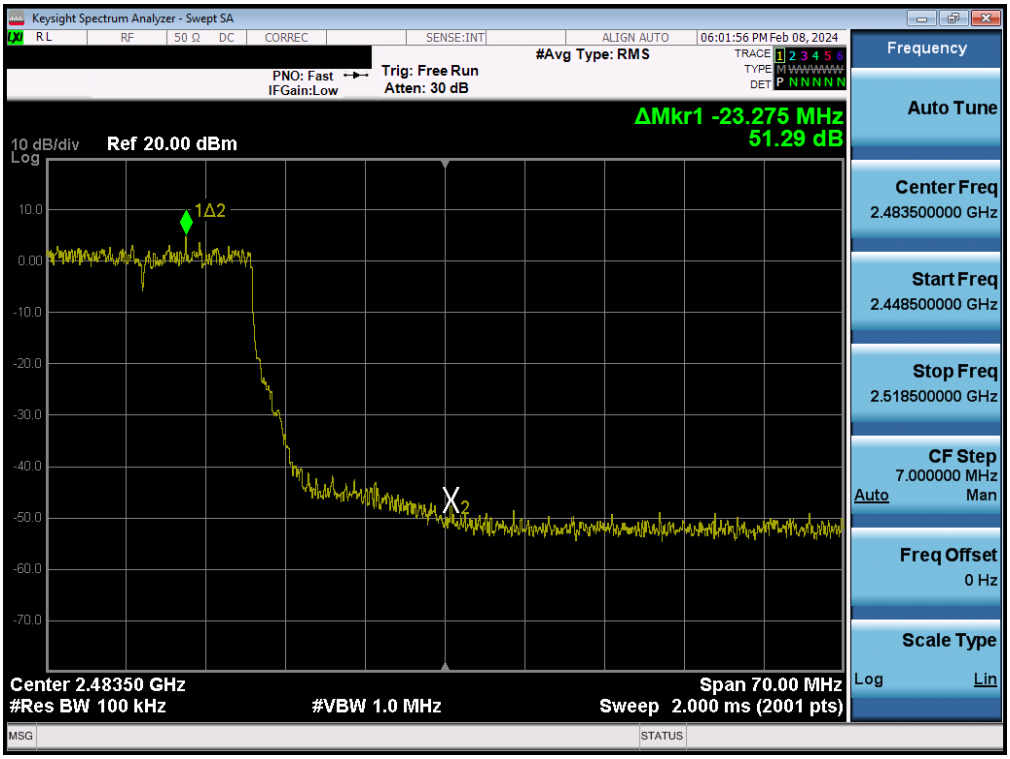
Plot 7-74. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 4)



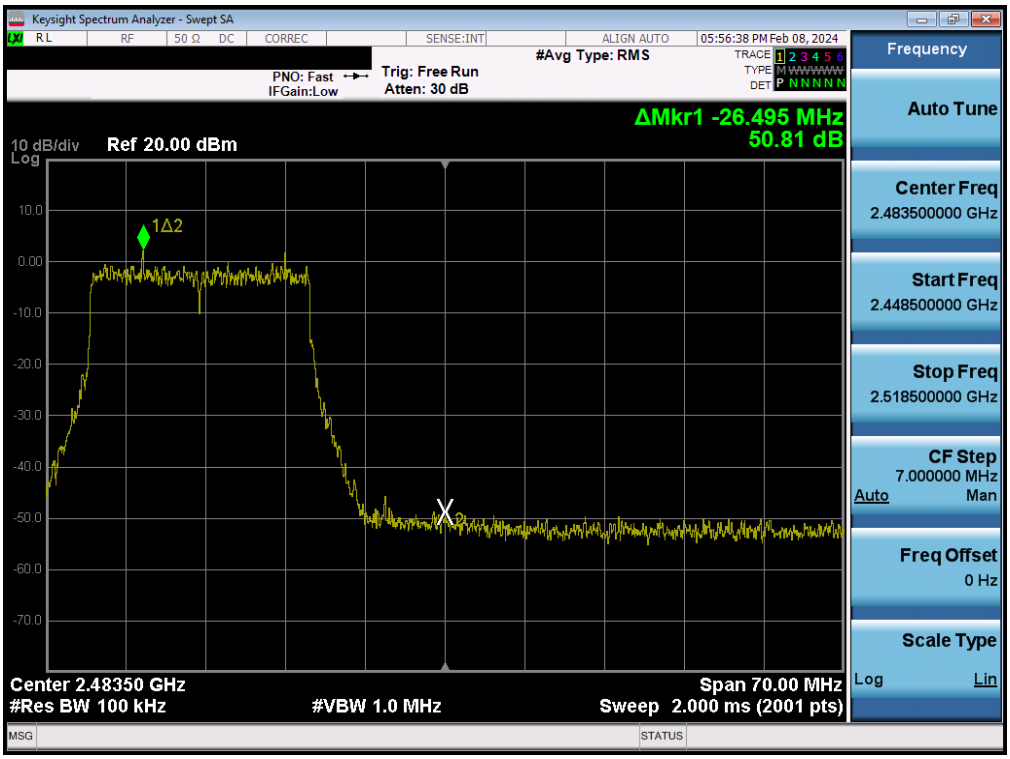
Plot 7-75. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 5)



Plot 7-76. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 9)



Plot 7-77. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 10)



Plot 7-78. Band Edge Plot MIMO ANT2 (802.11be OFDMA – 484 Tones – Ch. 11)

7.6 Conducted Spurious Emissions

Test Overview and Limit

All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates, tone configurations, and RU indices were investigated to determine the worst-case configuration. For the following out of band conducted emissions plots, the EUT was set to a data rate of MCS0 in 802.11be mode as this setting produced the worst-case emissions.

The limit for out-of-band spurious emissions at the band edge is 30dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the procedure in Section 11.11.3 of ANSI C63.10-2013.

Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3
ANSI C63.10-2013 – Section 14.3.3

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 25GHz (separated into two plots per channel)
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

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

Figure 7-5. Test Instrument & Measurement Setup

Test Notes

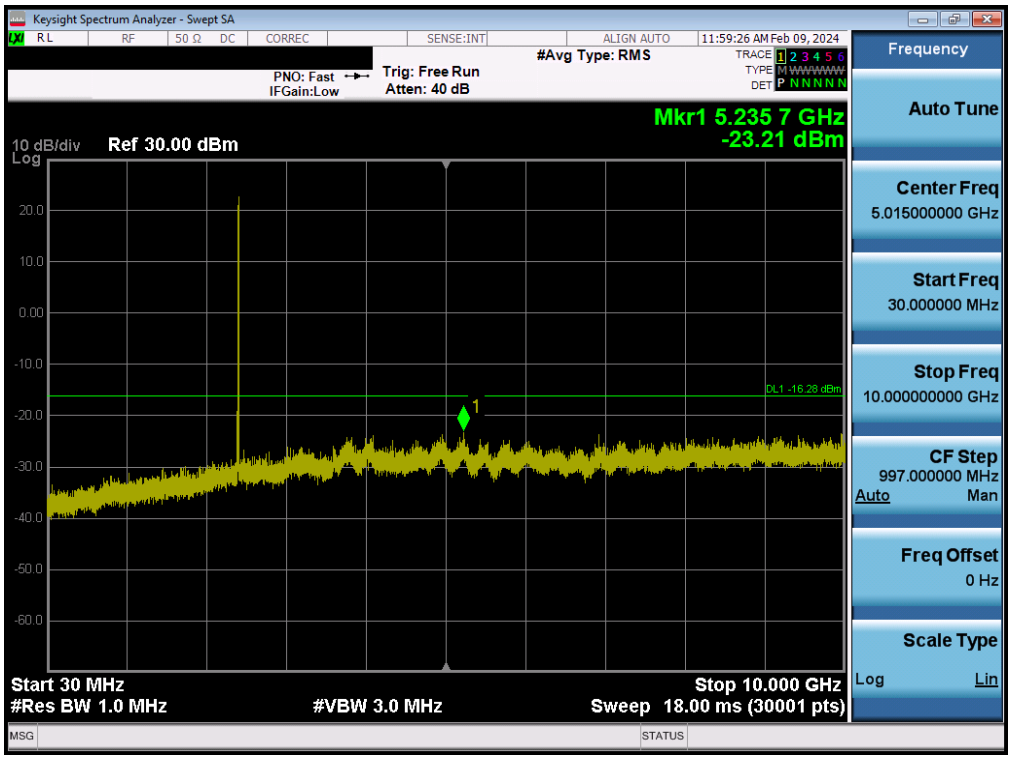
1. RBW was set to 1MHz rather than 100kHz in order to increase the measurement speed.

2. The display line shown in the following plots denotes the limit at 30dB below the fundamental emission level measured in a 100kHz bandwidth. However, since the traces in the following plots are measured with a 1MHz RBW, the display line may not necessarily appear to be 30dB below the level of the fundamental in a 1MHz bandwidth.

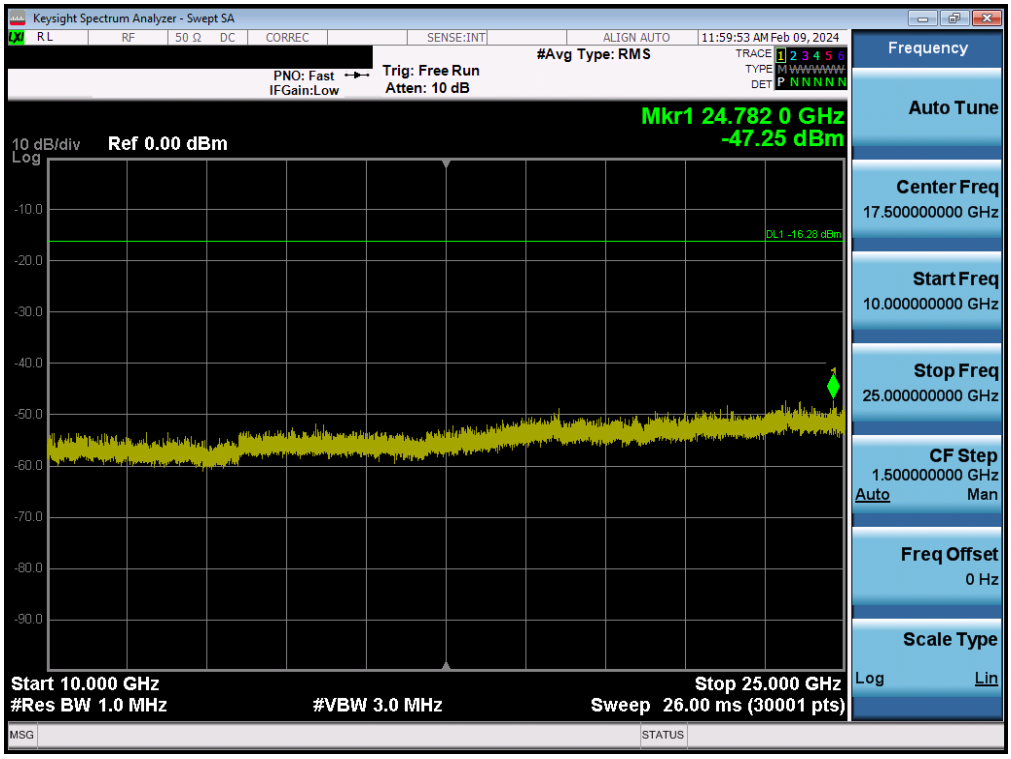
3. For plots showing conducted spurious emissions near the limit, the frequencies were investigated with a reduced RBW to ensure that no emissions were present.

4. The conducted spurious emissions were measured to relative limits. Therefore, in accordance with ANSI C63.10-2013 Section 14.3.3, it was unnecessary to show compliance through the summation of test results of the individual outputs.

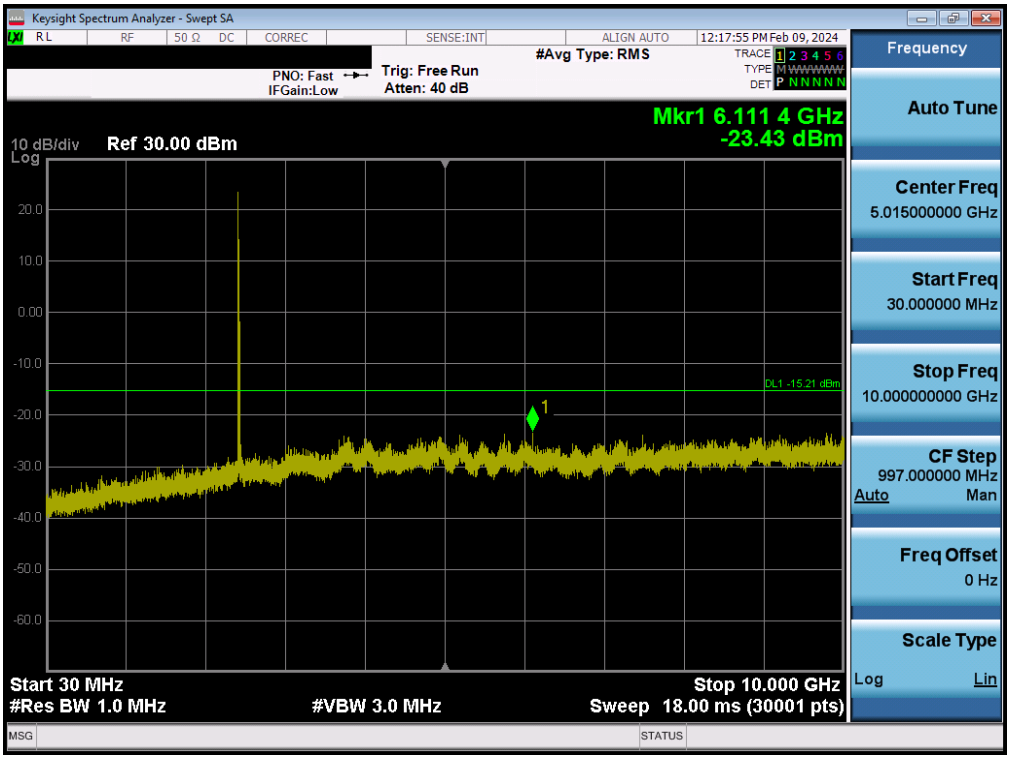
7.6.1 MIMO Antenna-1 Conducted Spurious Emission



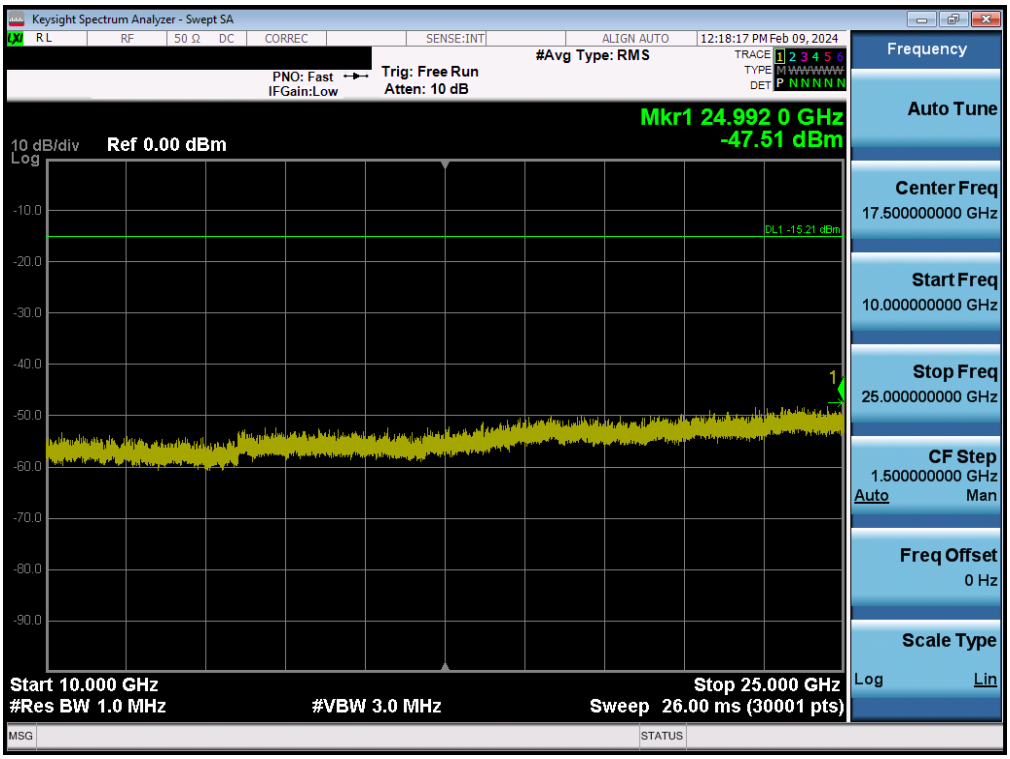
Plot 7-79. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 1)



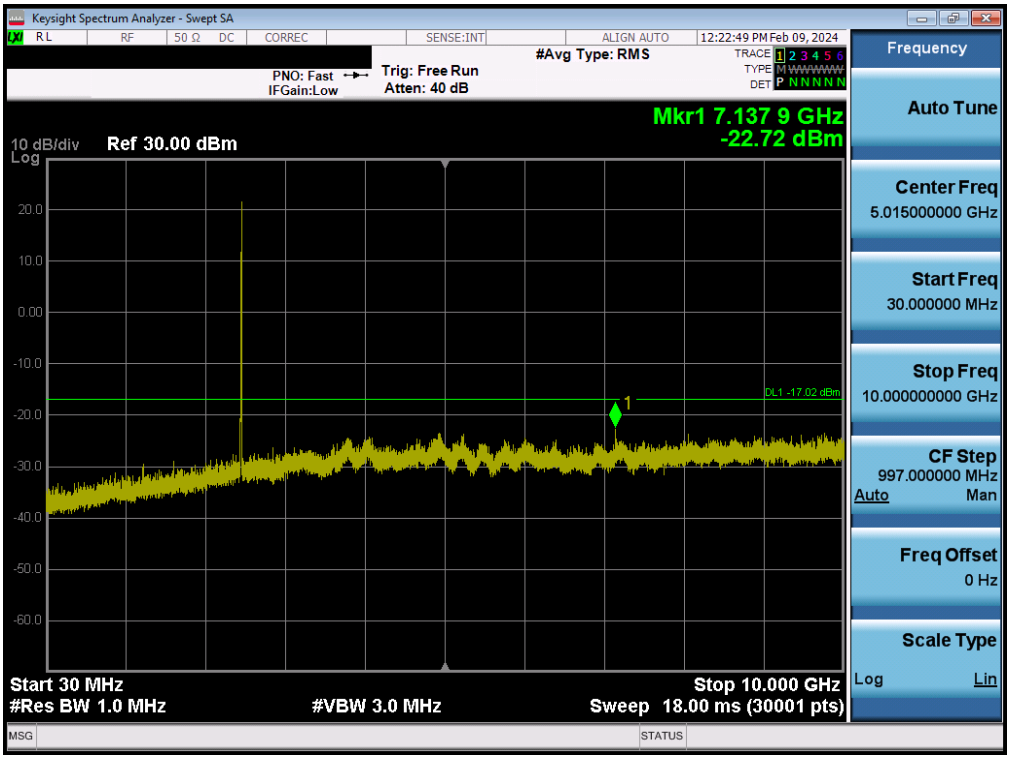
Plot 7-80. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 1)



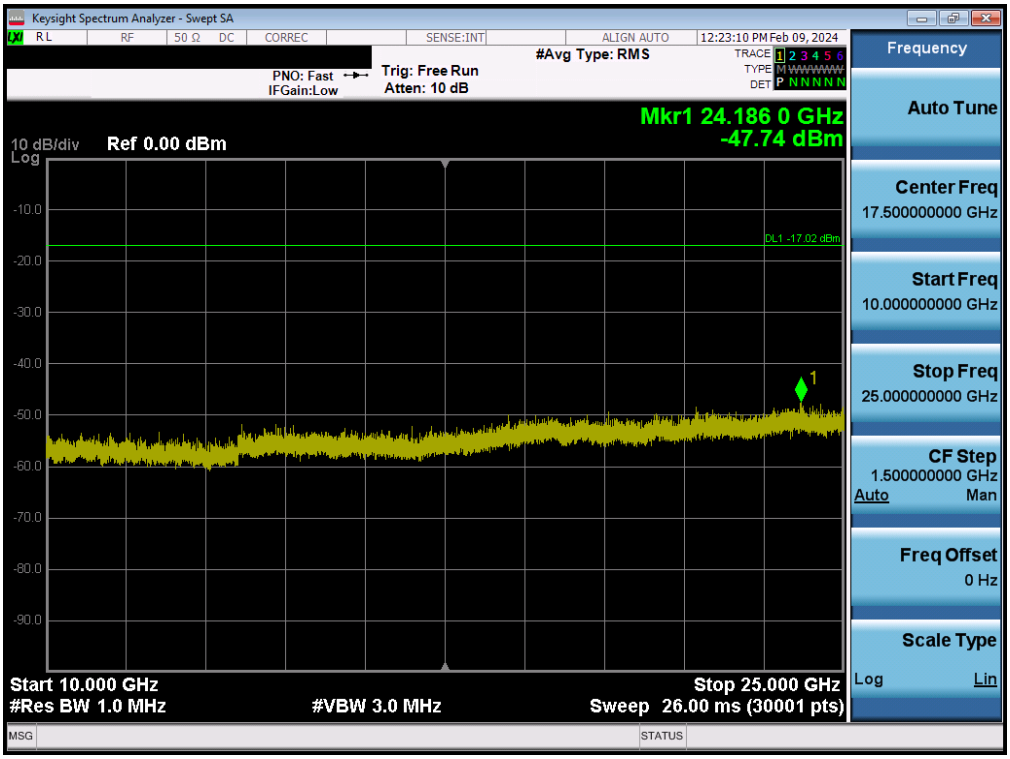
Plot 7-81. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 6)



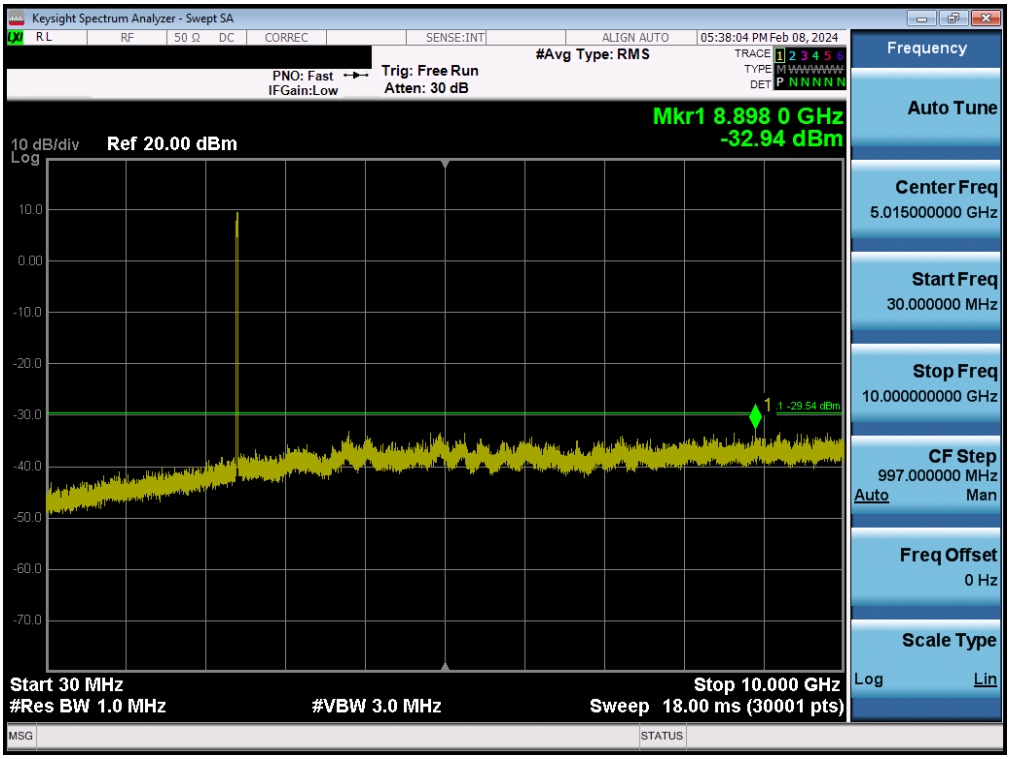
Plot 7-82. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 6)



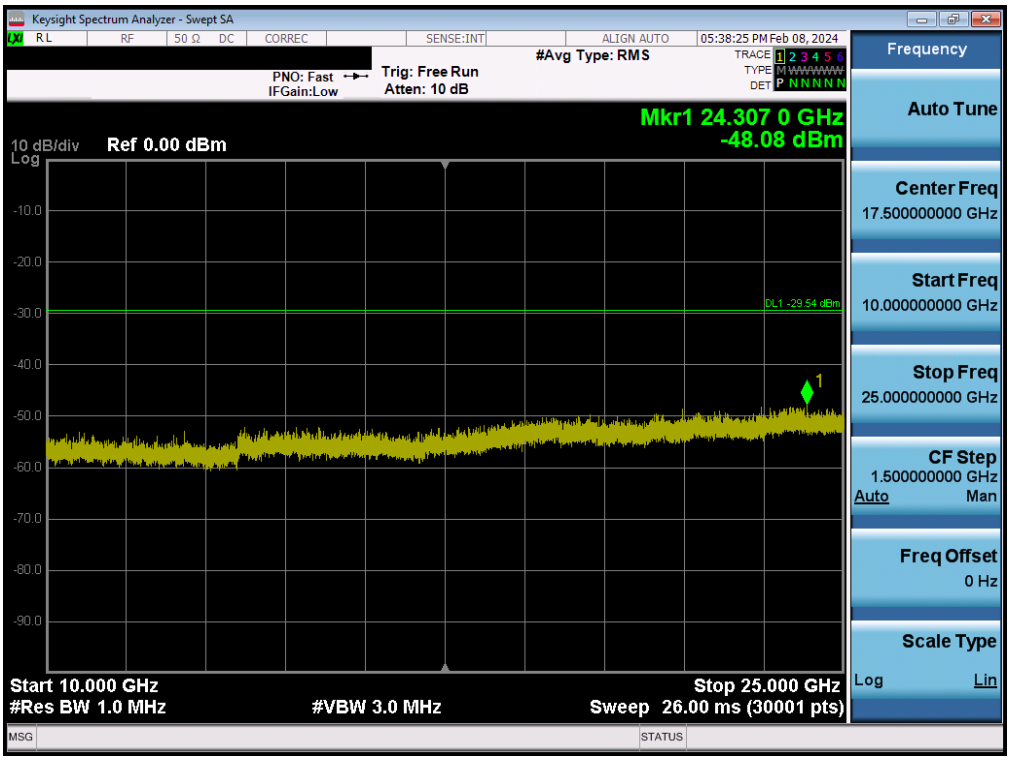
Plot 7-83. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 11)



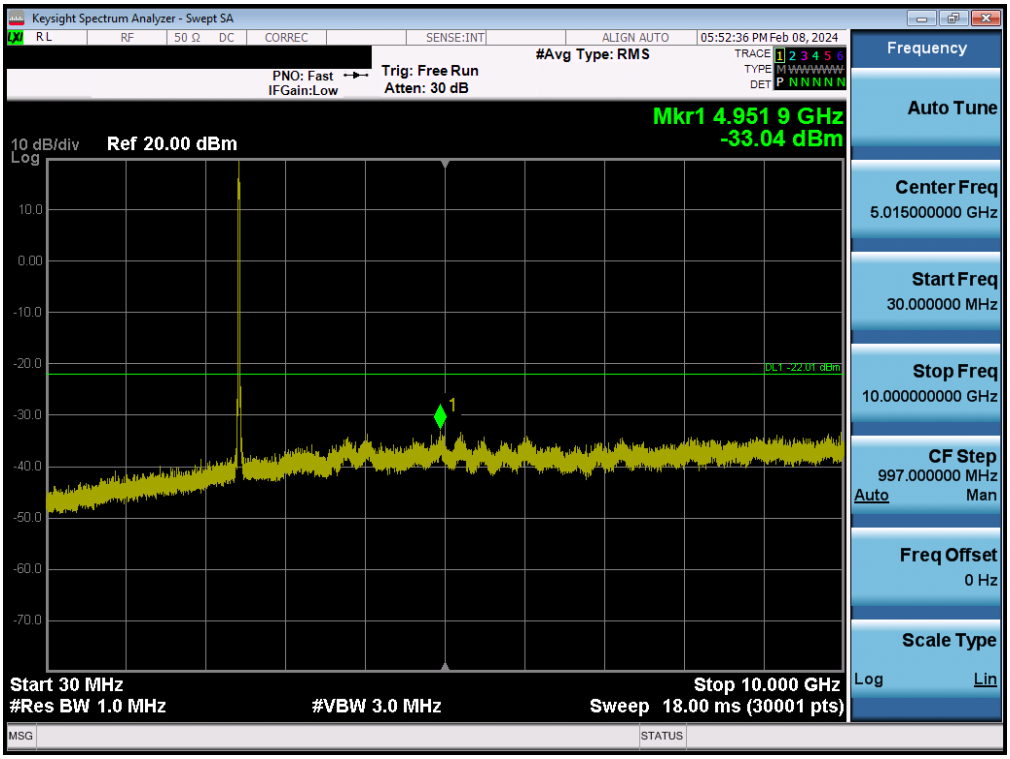
Plot 7-84. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 26 Tones – Ch. 11)



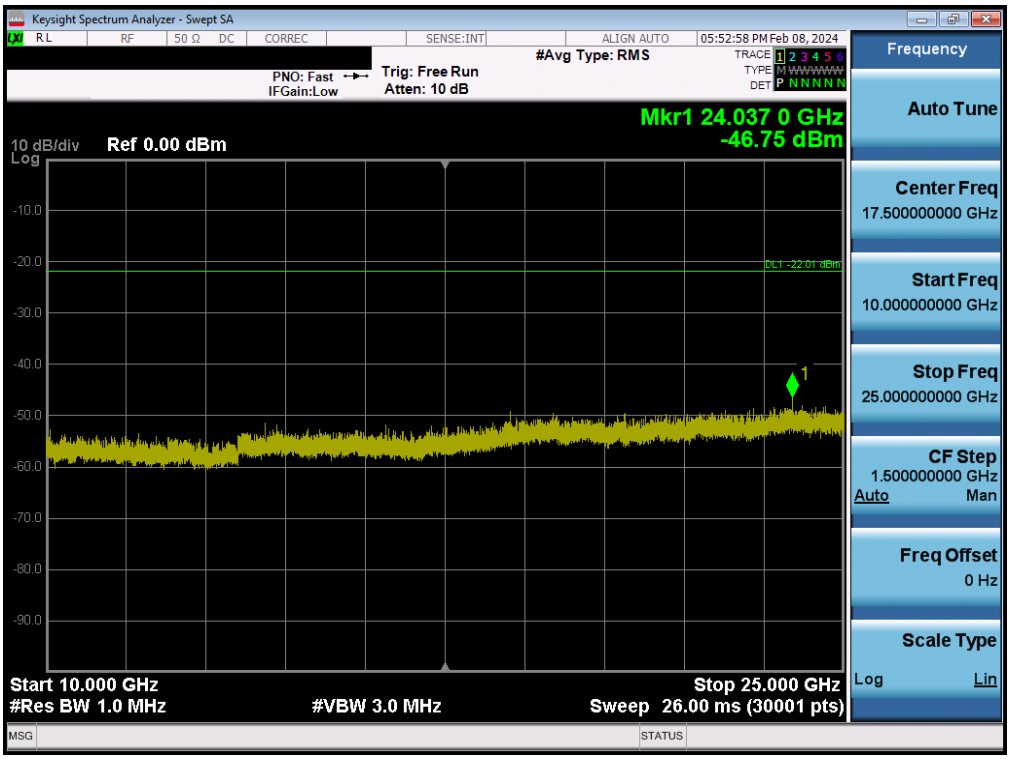
Plot 7-85. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 1)



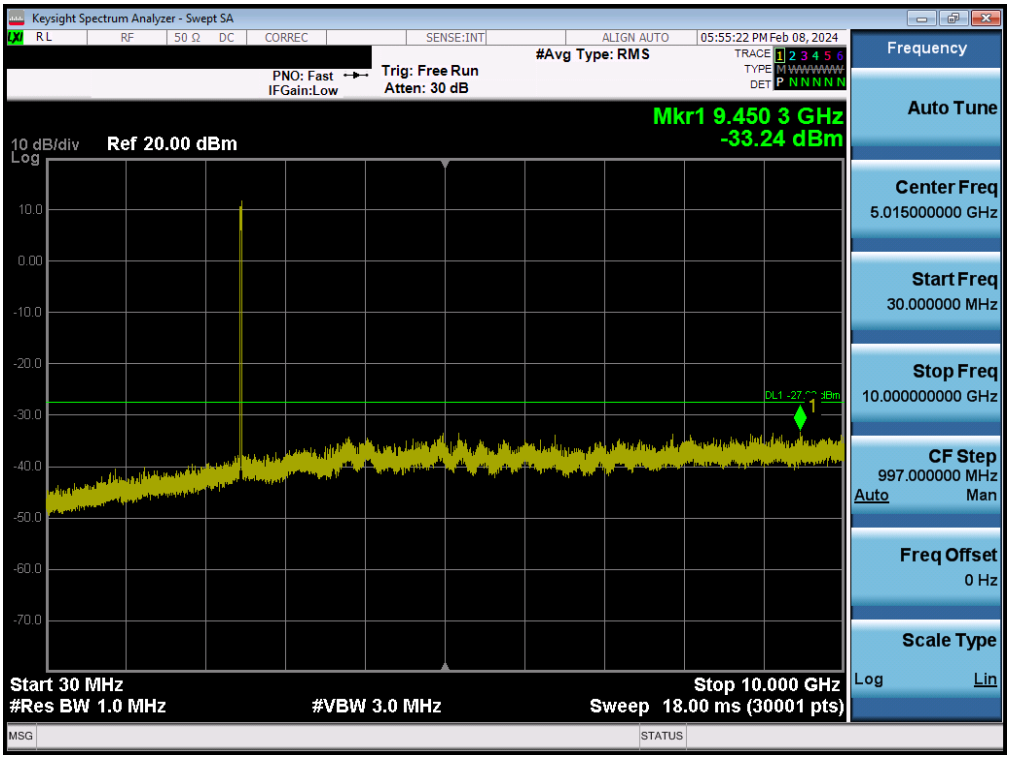
Plot 7-86. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 1)



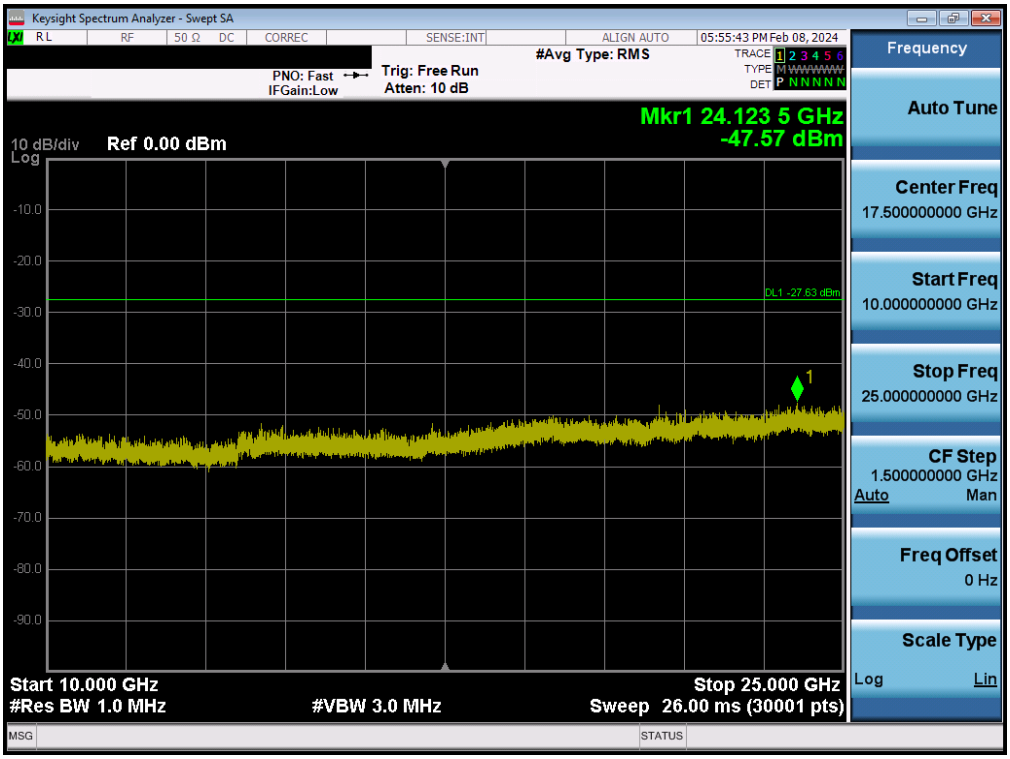
Plot 7-87. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 6)



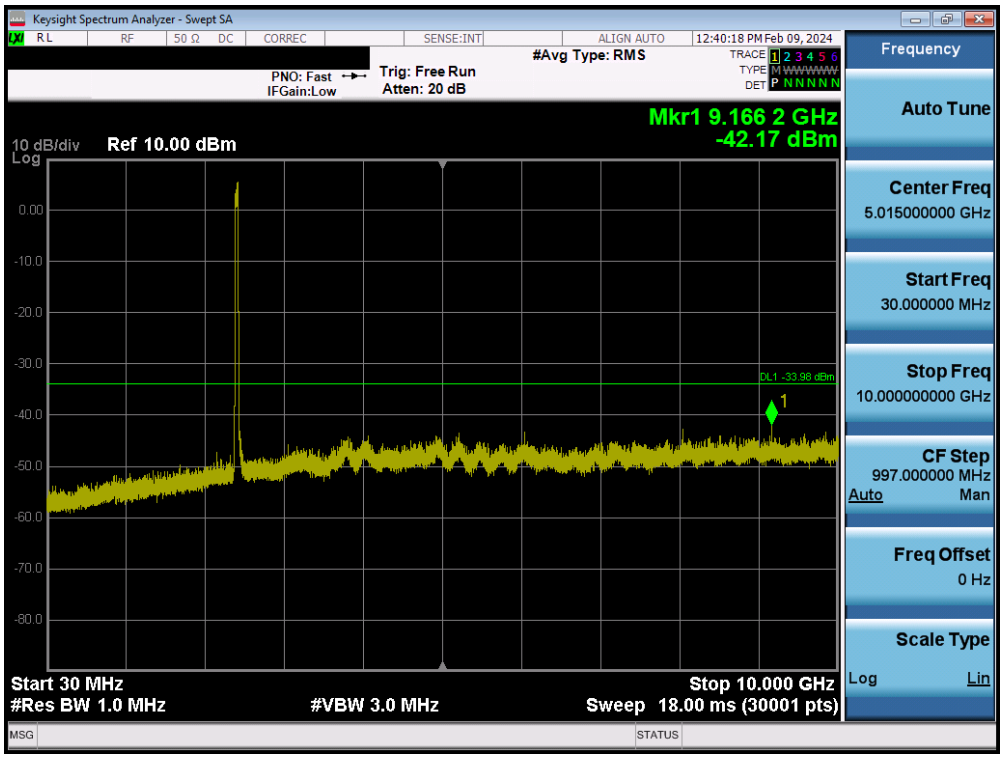
Plot 7-88. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 6)



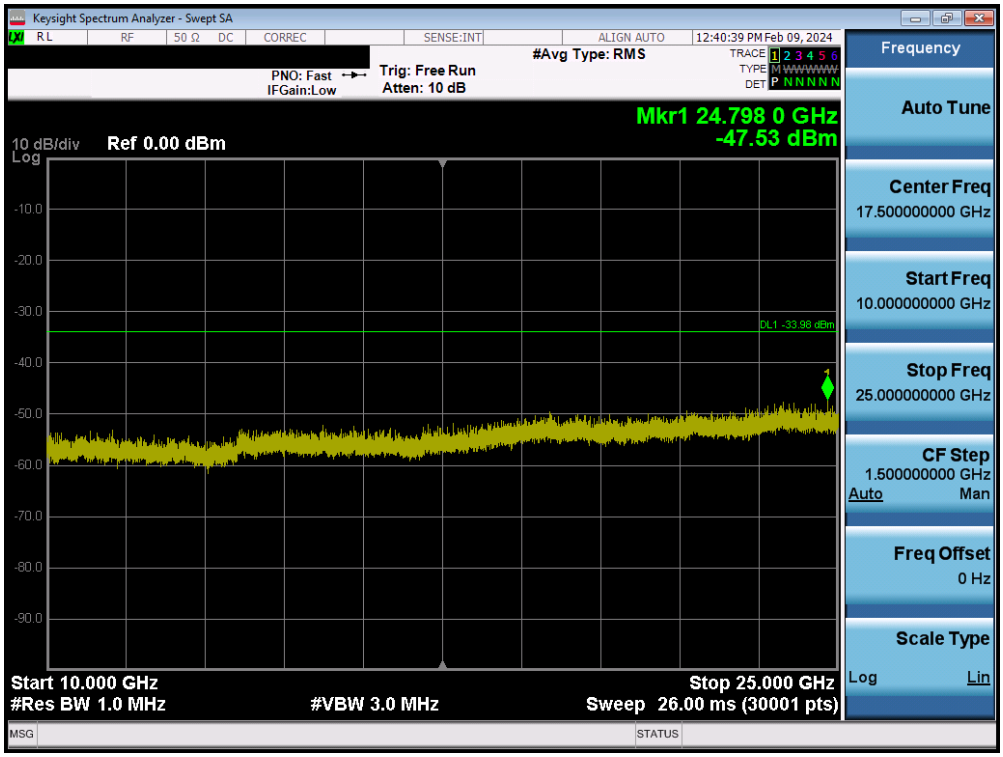
Plot 7-89. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 11)



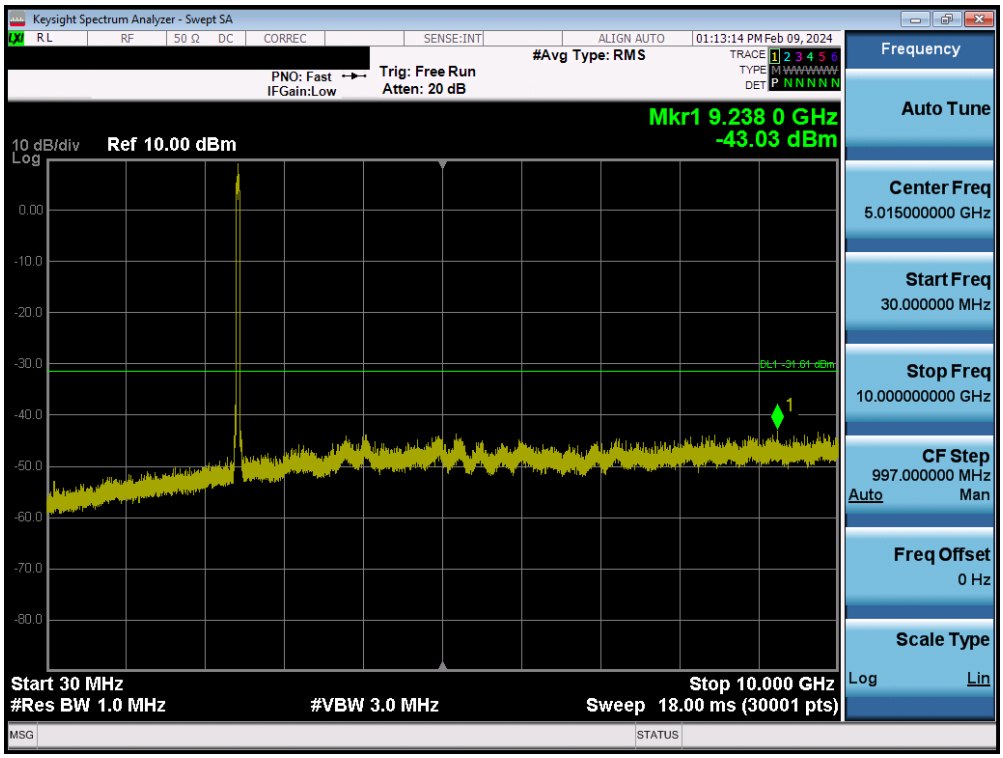
Plot 7-90. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 242 Tones – Ch. 11)



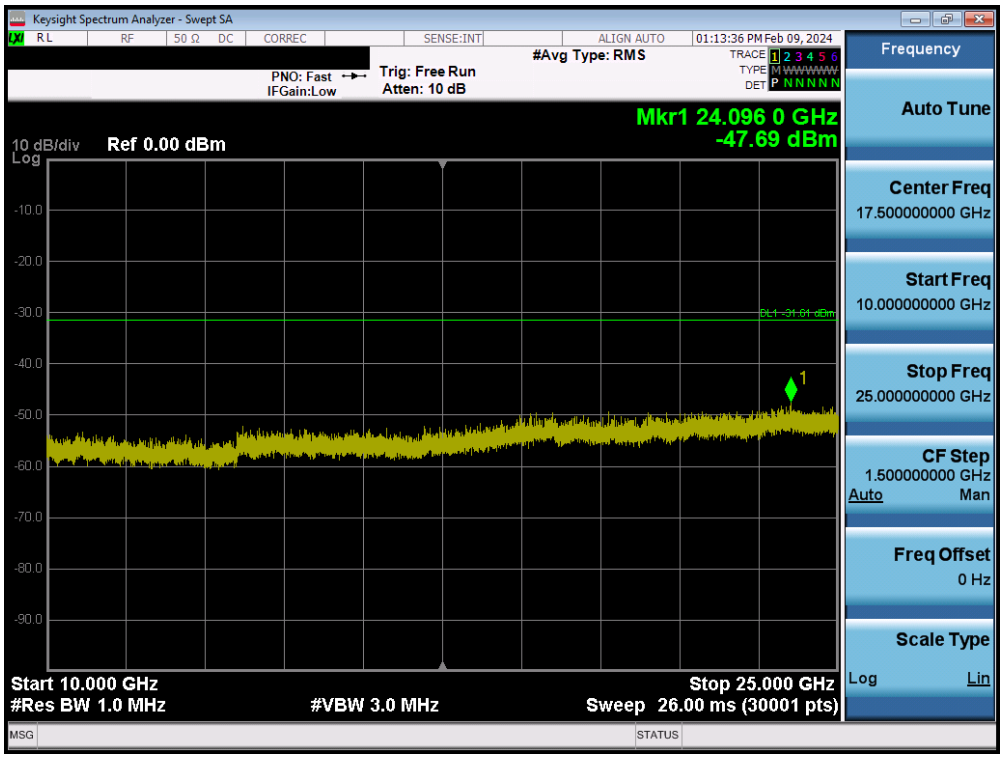
Plot 7-91. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 3)



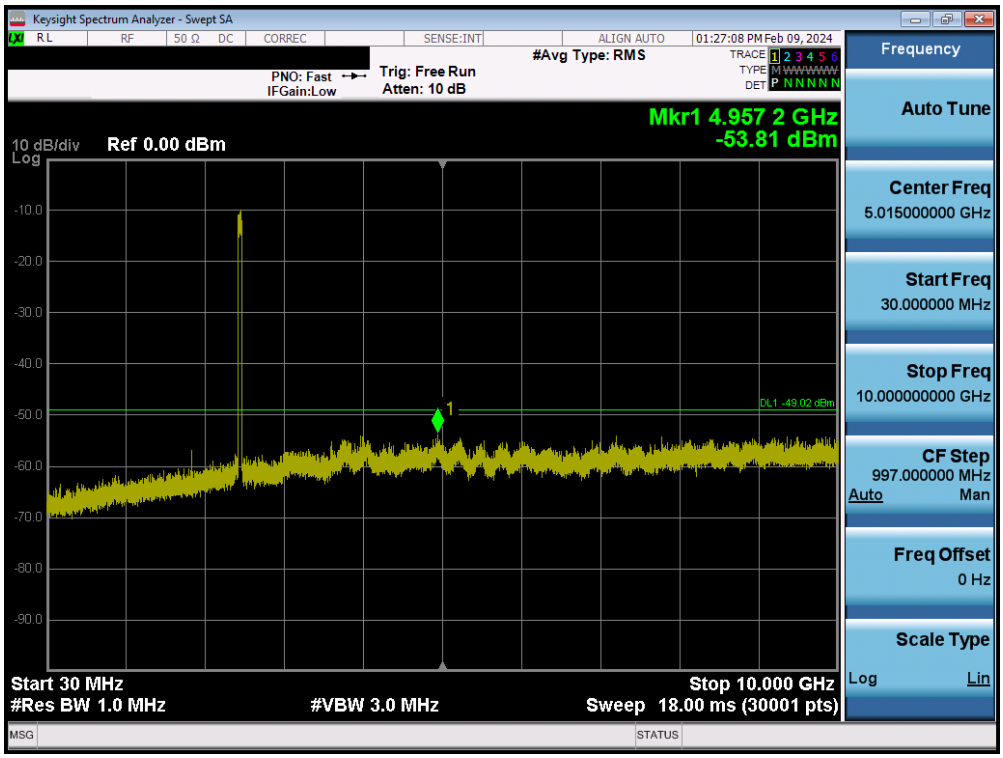
Plot 7-92. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 3)



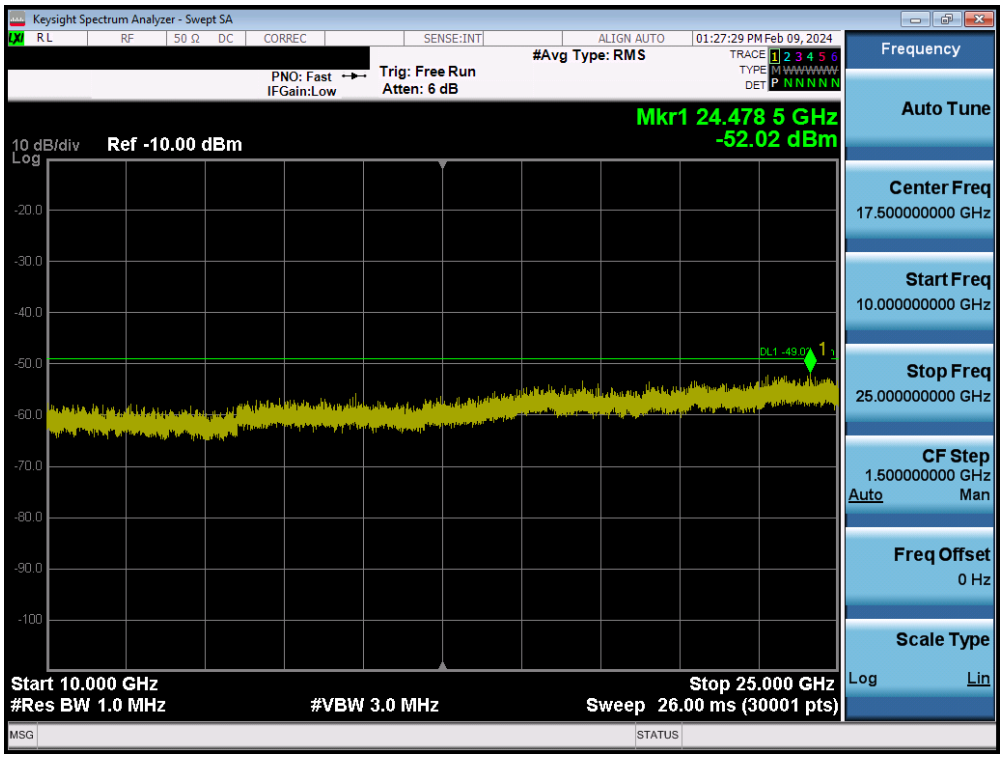
Plot 7-93. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 6)



Plot 7-94. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 6)

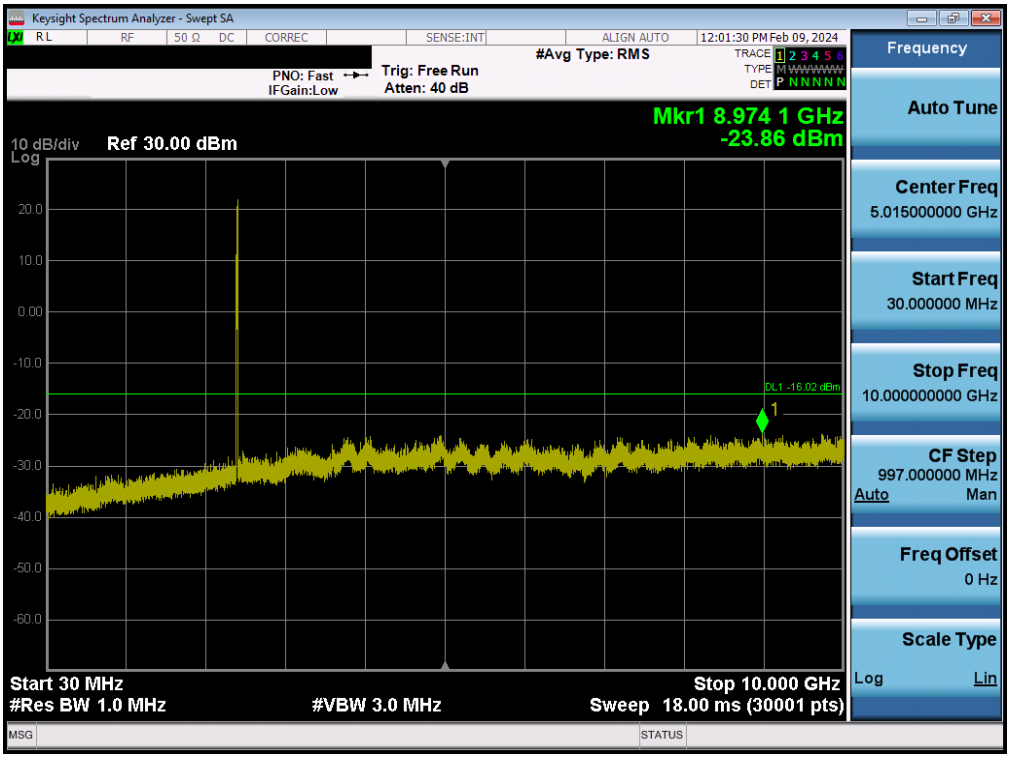


Plot 7-95. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 11)

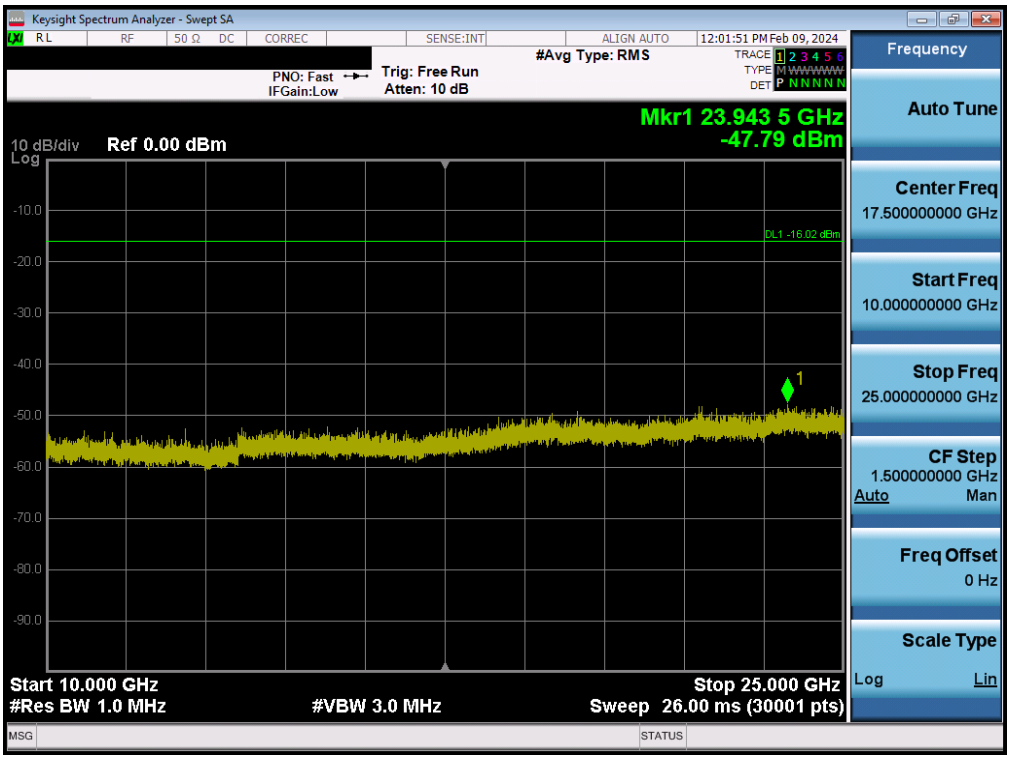


Plot 7-96. Conducted Spurious Plot MIMO ANT1 (802.11be OFDMA – 484 Tones – Ch. 11)

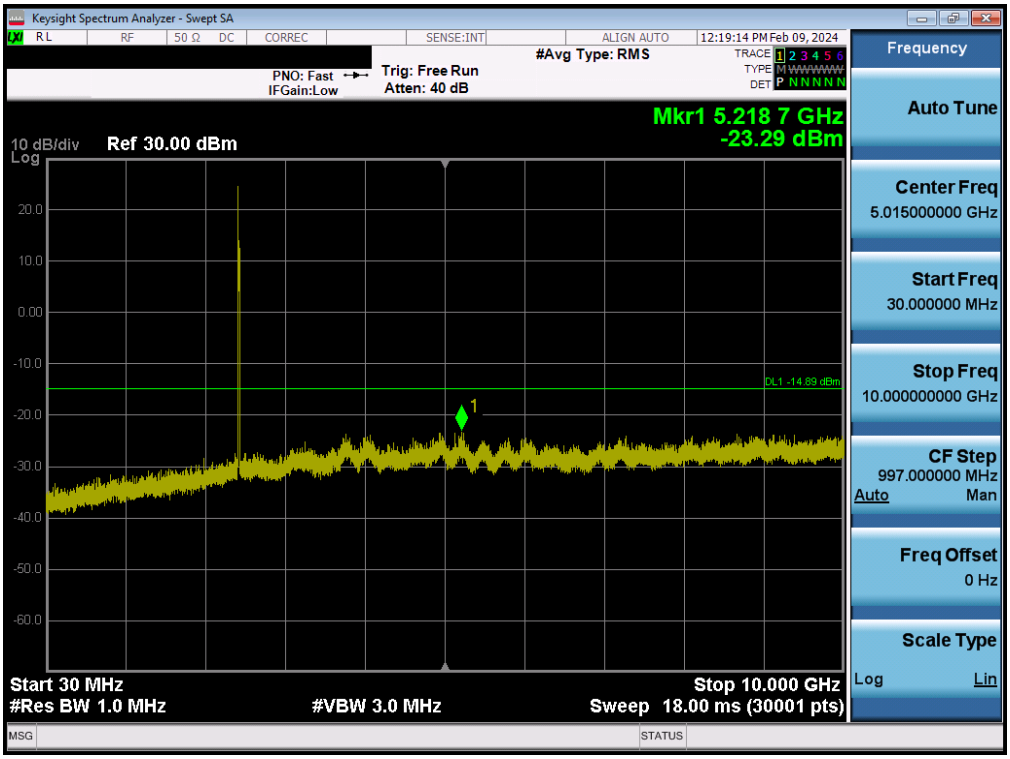
7.6.2 MIMO Antenna-2 Conducted Spurious Emissions



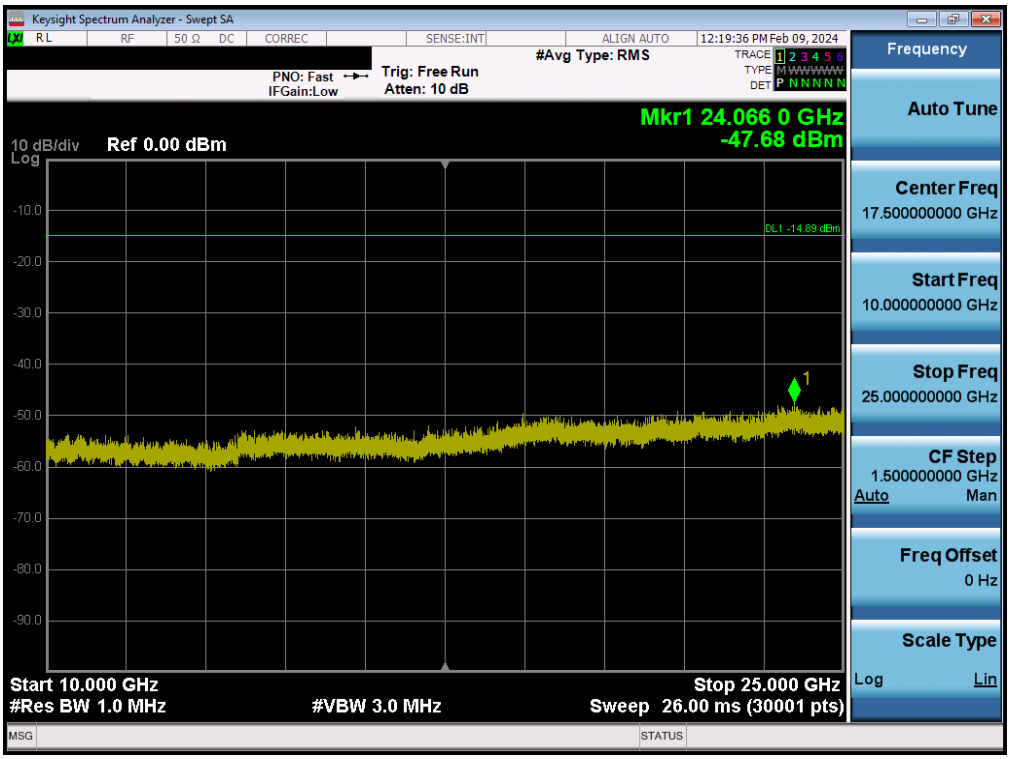
Plot 7-97. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 1)



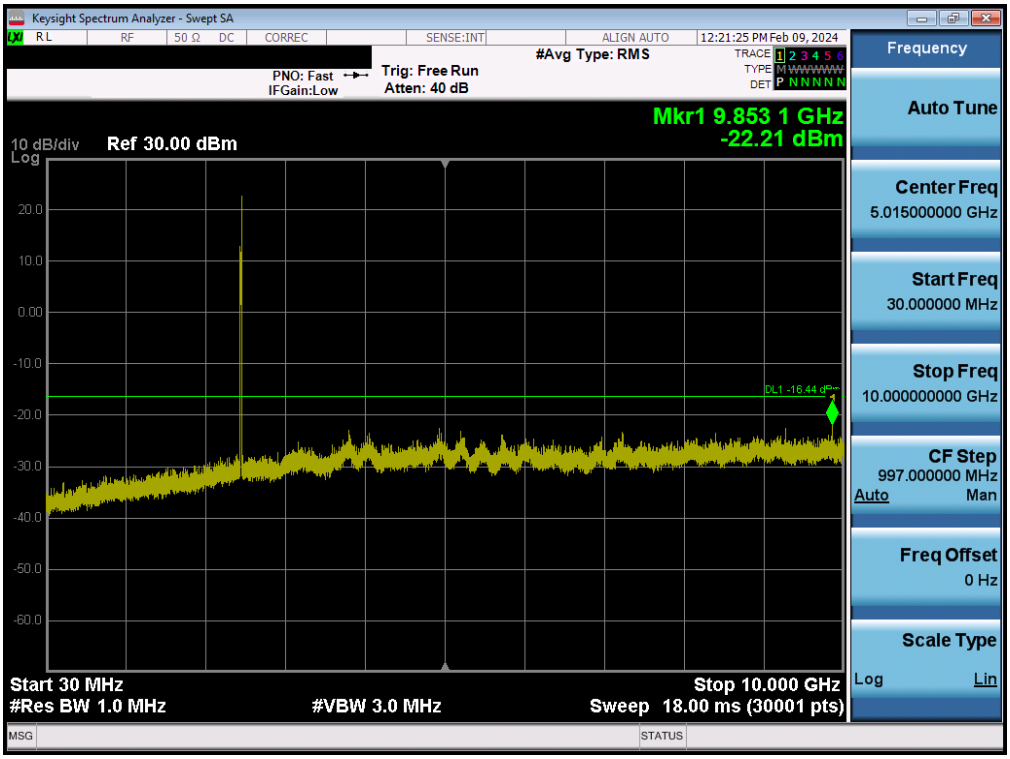
Plot 7-98. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 1)



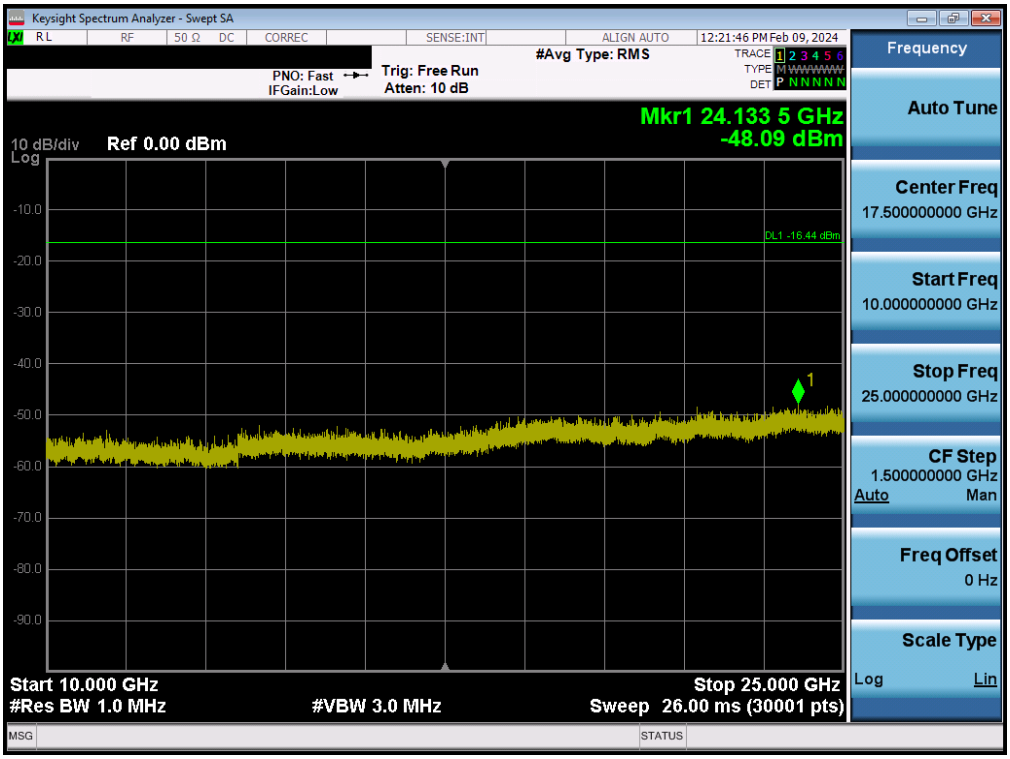
Plot 7-99. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 6)



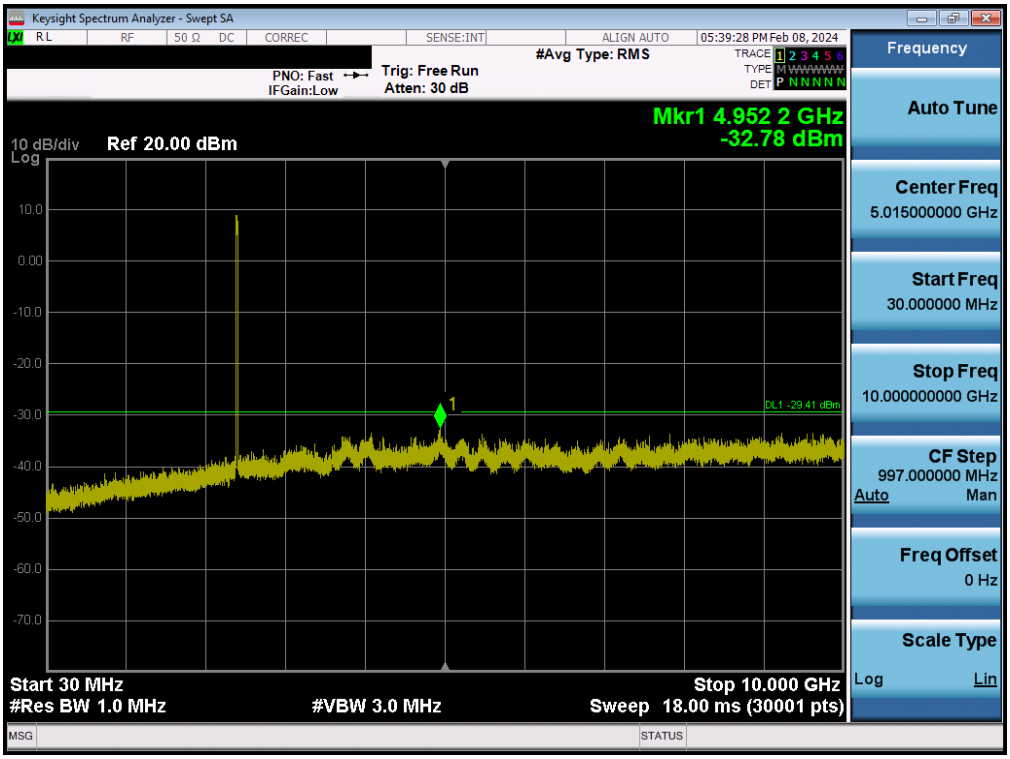
Plot 7-100. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 6)



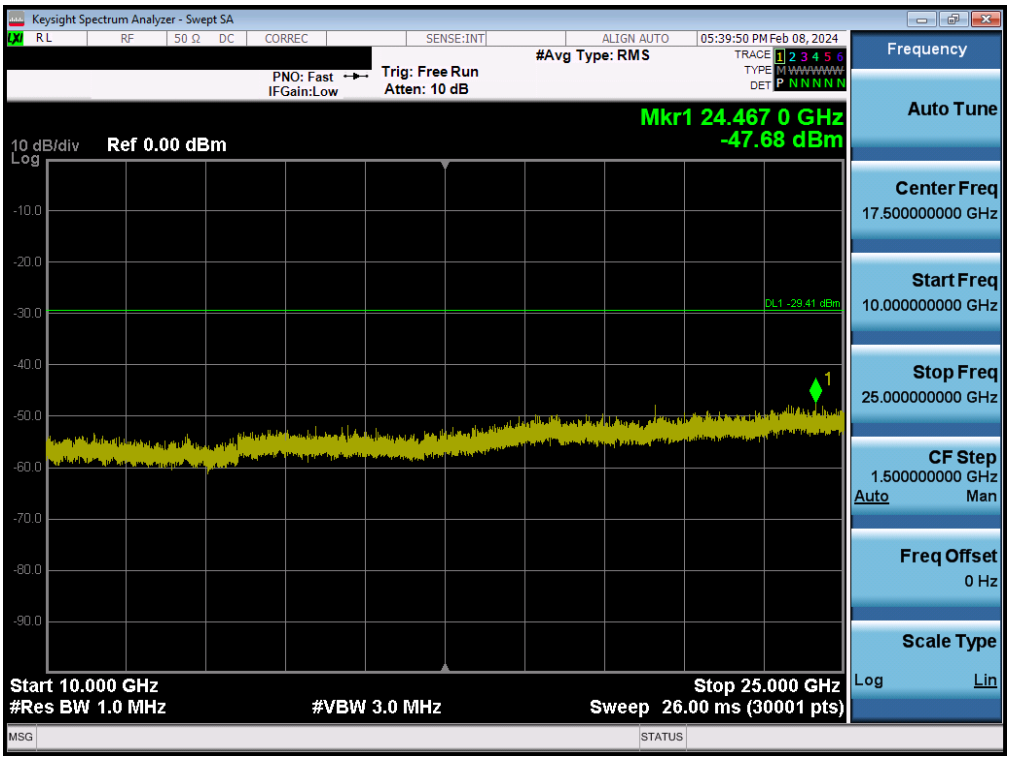
Plot 7-101. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 11)



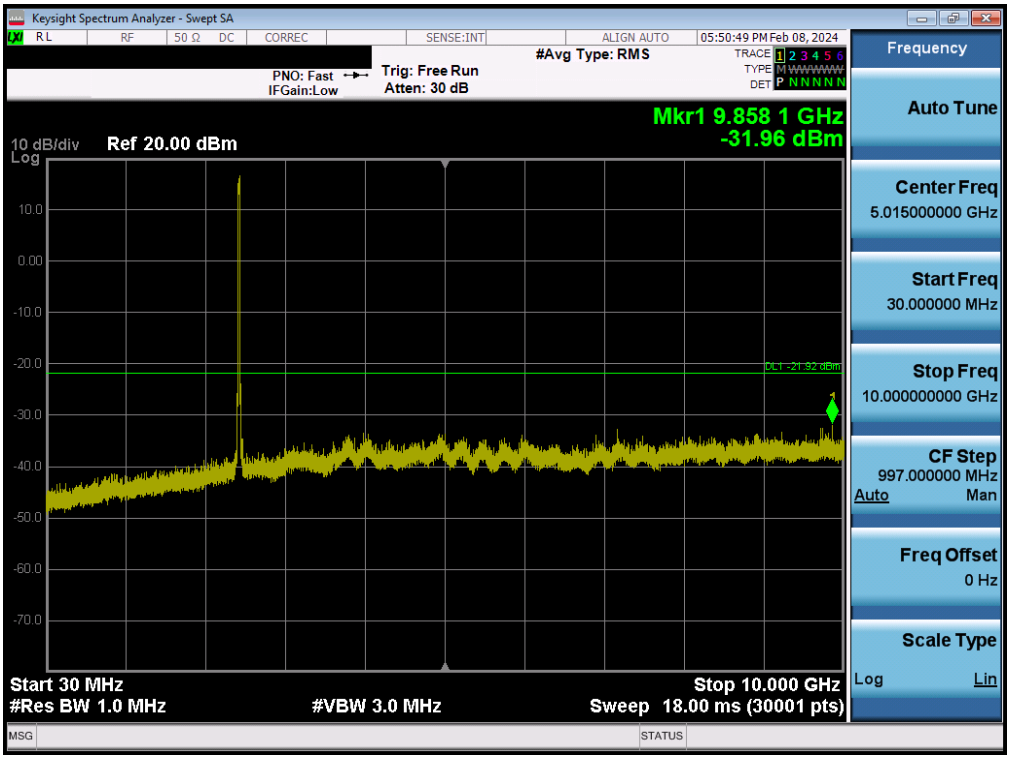
Plot 7-102. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 26 Tones – Ch. 11)



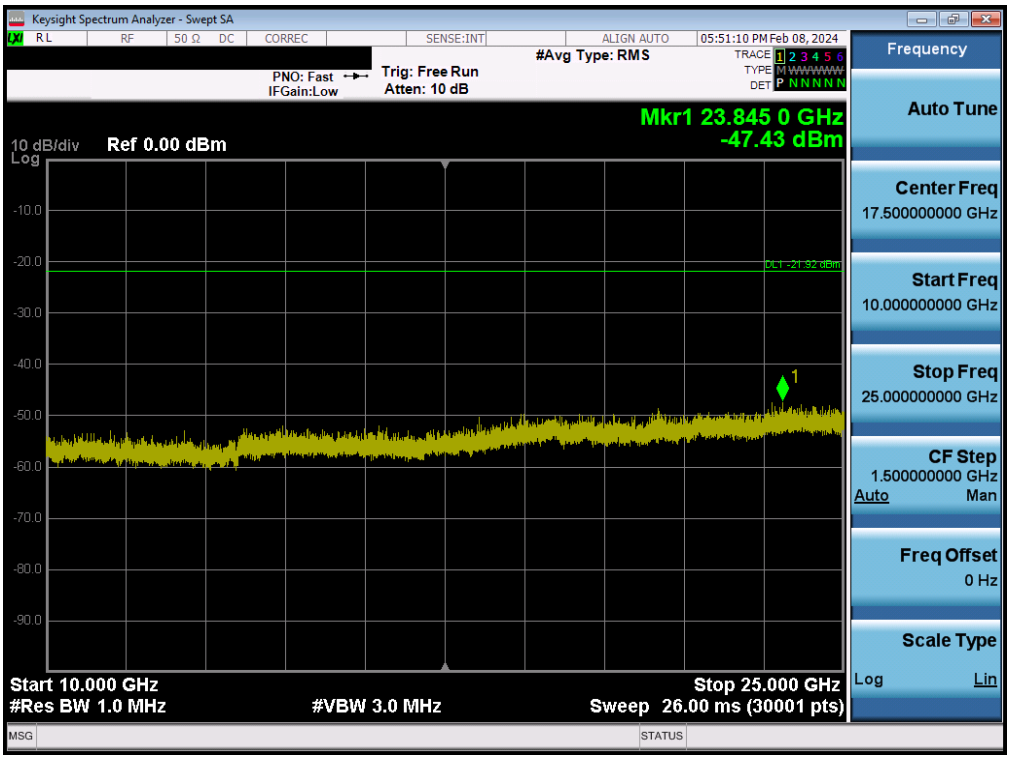
Plot 7-103. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 1)



Plot 7-104. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 1)



Plot 7-105. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 6)



Plot 7-106. Conducted Spurious Plot MIMO ANT2 (802.11be OFDMA – 242 Tones – Ch. 6)