

FCC and ISED Test Report

Apple Inc
Model: A2780

In accordance with FCC 47 CFR Part 15C, ISED
RSS-247 and ISED RSS-GEN
(2.4 GHz WLAN)

Prepared for: Apple Inc
One Apple Park Way
Cupertino, California
95014, USA



Add value.
Inspire trust.

FCC ID: BCGA2780

IC: 579C-A2780

COMMERCIAL-IN-CONFIDENCE

Document 75955429-14 Issue 01

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
S Bennett	Head Of New Service Development	Authorised Signatory	17 November 2022

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Report Generation	Hollie Marshall	17 November 2022	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

ISED Accreditation
12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2020, ISED RSS-247: Issue 2 (02-2017) and ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021) for the tests detailed in section 1.3.



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is a trading name of TÜV SÜD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TÜV SÜD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuvsud.com/en

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom



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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	17 November 2022

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A2780
Serial Number(s)	FWC3JLYYHC and NW3J007K67
Hardware Version(s)	REV 1.0
Software Version(s)	22A42770m and 22A31991j
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2020 ISED RSS-247: Issue 2 (02-2017) ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021)
Order Number	0540246998
Start of Test	12-July-2022
Finish of Test	20-October-2022
Name of Engineer(s)	Elliot Callender, Taha Shafique, Nicolae Mihailiuc, Danial Shafique, Ioan-Alexandru Bogatu and Thomas Biddlecombe
Related Document(s)	KDB 662911 D01 v02r01 ANSI C63.10 (2013) ANSI C63.10 (2020)



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	FCC Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: 2.4 GHz WLAN						
-	15.203	-	-	Antenna Requirement	N/T	The device complies with the provisions of this section, as it uses permanently attached integral antennas.
2.1	15.205	3.1	8.10	Restricted Band Edges	Pass	
2.2	15.247 (a)(2)	5.2	6.7	Emission Bandwidth	Pass	
2.3	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	
2.4	15.209 and 15.247 (d)	3.3 and 5.5	6.13 and 8.9	Spurious Radiated Emissions	Pass	
2.5	15.247 (d)	5.5	-	Authorised Band Edges	Pass	
2.6	15.247 (e)	5.2	6.12	Power Spectral Density	Pass	

Table 2



1.4 Product Information

1.4.1 Technical Description

The equipment under test was an Apple laptop computer with Bluetooth® and IEEE 802.11 a/b/g/n/ac/ax Wi-Fi capabilities in the 2.4GHz, 5GHz and 6GHz bands.

1.4.2 Test Modes

The EUT's 2.4 GHz 802.11 radio supports Single Input/Single Output (SISO) and 2x2 MIMO (Multiple Input/Multiple Output). It supports 802.11b and g for SISO and 802.11n and ax at 20 MHz channel bandwidths for SISO and MIMO. 802.11ax supports RU 26/52/106/242.

The EUT uses different output powers per core dependent on how many cores are used. It uses the same conducted power across all cores in any given mode, but due to the different antenna gains the radiated powers per core differs.

After preliminary investigations were performed, the EUT was therefore tested in the following worst-case modes:

SISO Modes (Core 1):

- 802.11b 1 Mbps
- 802.11g 12 Mbps
- 802.11n HT20 MCS2
- 802.11ax HE20 MCS2x1 SU, RU26/52/106*

2x2 MIMO Modes (Core 0 + Core 1):

- 802.11n HT20 MCS2 – CDD
- 802.11ax HE20 MCS2x1 CDD SU, RU26/52/106*

*Note: The RU offset for bottom and middle channels were placed in the lowest position and on the top channel, the offset was placed in the upper most position.

1.4.3 Test Set-up

For conducted tests the EUT antennas were disconnected and replaced with U.FL to SMA test cables to enable conducted testing on each core. The loss of these test cables were known and compensated for in any conducted measurements.

For all tests, the EUT was put into a continuous transmit test mode with the chipset manufacturer's test commands via a script running in the EUTs terminal application. The EUT then transmitted the required type of packeted 802.11 data frames of fixed length, containing the standard headers and with pseudo-random data content, ensuring the measured signals were representative and contained all the symbols at the highest power control level.

All testing was performed with the EUT powered via a 120 V AC, 60 Hz source.

1.4.4 Antenna Gain Table

Antenna Port	Frequency Range (MHz)	Peak Gain (dBi)	Conducted Cable Loss (dB)
Core 0	2400 to 2480	4.60	0.70
Core 1	2400 to 2480	6.13	0.70

Table 3



1.5 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.6 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Model: A2780, Serial Number: NW3J007K67			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A2780, Serial Number: FWC3JLYYHC			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 4



1.7 Test Location

TÜV SÜD conducted the following tests at our Octagon House Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: 2.4 GHz WLAN		
Restricted Band Edges	Elliot Callender, Taha Shafique, Nicolae Mihailiuc and Danial Shafique	UKAS
Emission Bandwidth	Thomas Biddlecombe	UKAS
Maximum Conducted Output Power	Thomas Biddlecombe	UKAS
Authorised Band Edges	Elliot Callender, Taha Shafique, Nicolae Mihailiuc and Danial Shafique	UKAS
Power Spectral Density	Thomas Biddlecombe	UKAS

Table 5

Office Address:

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire
PO15 5RL
United Kingdom

TÜV SÜD conducted the following tests at our Concorde Park Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: 2.4 GHz WLAN		
Spurious Radiated Emissions	Ioan-Alexandru Bogatu and Nicolae Mihailiuc	UKAS

Table 6

Office Address:

TÜV SÜD
Concorde Park
Concorde Way
Fareham
Hampshire
PO15 5FG
United Kingdom



2 Test Details

2.1 Restricted Band Edges

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.205
ISED RSS-247, Clause 3.1
ISED RSS-GEN, Clause 8.10

2.1.2 Equipment Under Test and Modification State

A2780, S/N: FWC3JLYYHC - Modification State 0

2.1.3 Date of Test

12-July-2022 to 23-July-2022

2.1.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.10.5 and 11.12.1.

Plots for average measurements were taken in accordance with ANSI C63.10, clause 11.12.2.5.2.

The following conversion can be applied to convert from dB μ V/m to μ V/m:
 $10^{(\text{Field Strength in dB}\mu\text{V/m}/20)}$.

2.1.5 Environmental Conditions

Ambient Temperature	20.0 - 24.5 °C
Relative Humidity	41.2 - 64.8 %



2.1.6 Test Results

2.4 GHz WLAN

SISO

Mode	Data Rate /MCS	Resource Size	Resource Index	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBμV/m)	Average Level (dBμV/m)
802.11b, Core 1	1 Mbps	-	-	2412	2390.0	59.14	51.22
802.11b, Core 1	1 Mbps	-	-	2462	2483.5	58.52	50.11
802.11b, Core 1	1 Mbps	-	-	2467	2483.5	59.58	51.02
802.11b, Core 1	1 Mbps	-	-	2472	2483.5	58.75	51.39
802.11g, Core 1	24 Mbps	-	-	2412	2390.0	66.31	51.21
802.11g, Core 1	24 Mbps	-	-	2462	2483.5	67.38	51.38
802.11g, Core 1	54 Mbps	-	-	2467	2483.5	67.91	51.35
802.11g, Core 1	24 Mbps	-	-	2472	2483.5	65.81	51.36
802.11n HT20, Core 1	MCS4	-	-	2412	2390.0	67.22	51.06
802.11n HT20, Core 1	MCS4	-	-	2462	2483.5	67.42	51.17
802.11n HT20, Core 1	MCS7	-	-	2467	2483.5	67.47	51.44
802.11n HT20, Core 1	MCS2	-	-	2472	2483.5	65.17	51.40
802.11ax HE20, Core 1	MCS2	SU	-	2412	2390.0	66.40	51.35
802.11ax HE20, Core 1	MCS9	26	0	2412	2390.0	58.32	43.88
802.11ax HE20, Core 1	MCS4	SU	-	2462	2483.5	68.44	51.36
802.11ax HE20, Core 1	MCS9	SU	-	2467	2483.5	66.46	51.01
802.11ax HE20, Core 1	MCS9	26	8	2467	2483.5	63.05	45.37
802.11ax HE20, Core 1	MCS2	SU	-	2472	2483.5	66.83	51.44
802.11ax HE20, Core 1	MCS9	26	8	2472	2483.5	69.17	48.06

Table 7 - SISO Restricted Band Edge Results

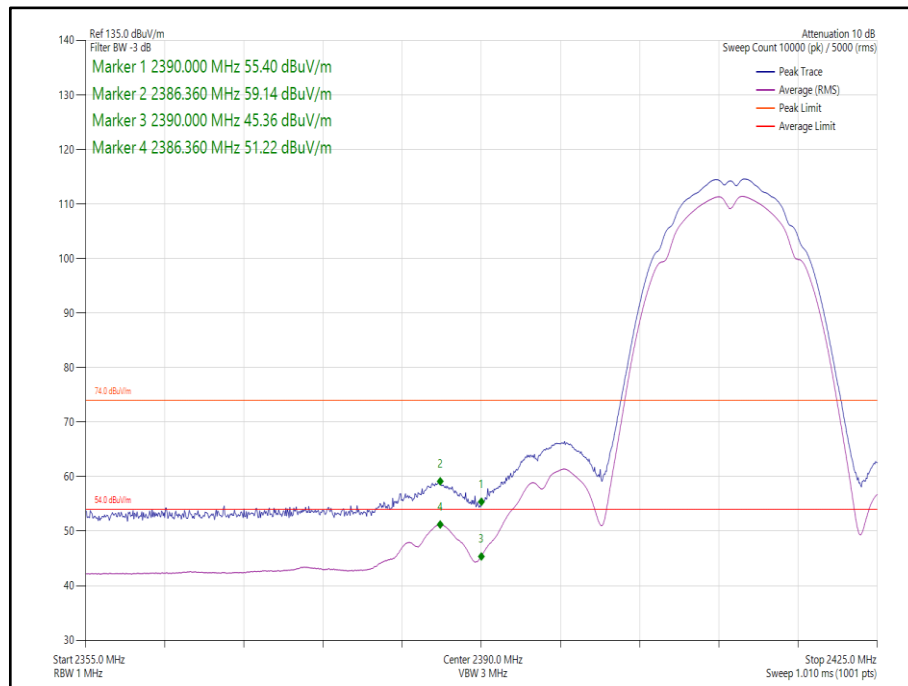


Figure 1 - 802.11b, Core 1 - 2412 MHz, Band Edge Frequency 2390.0 MHz

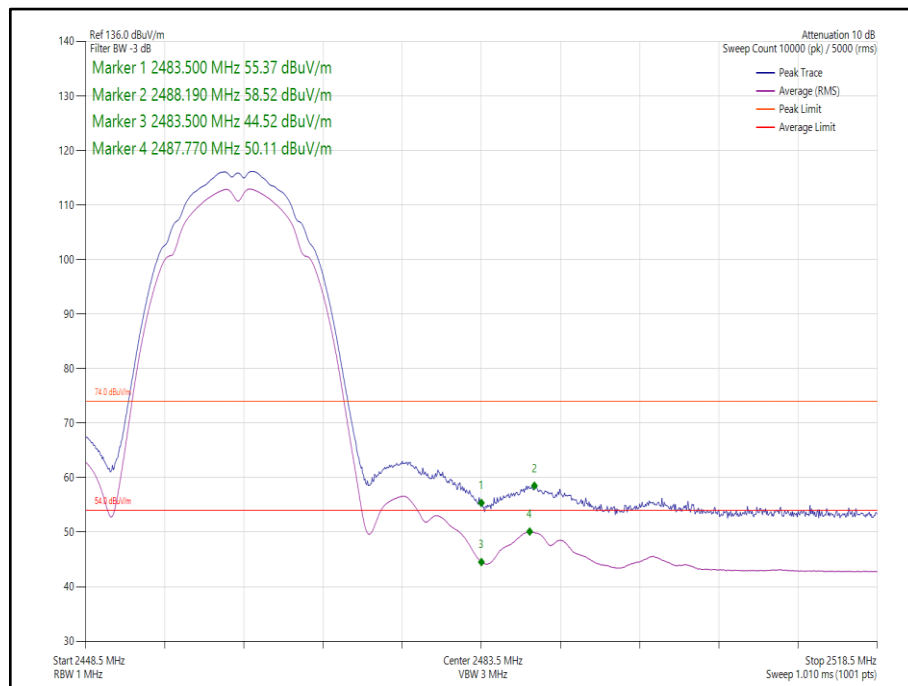


Figure 2 - 802.11b, Core 1 - 2462 MHz, Band Edge Frequency 2483.5 MHz

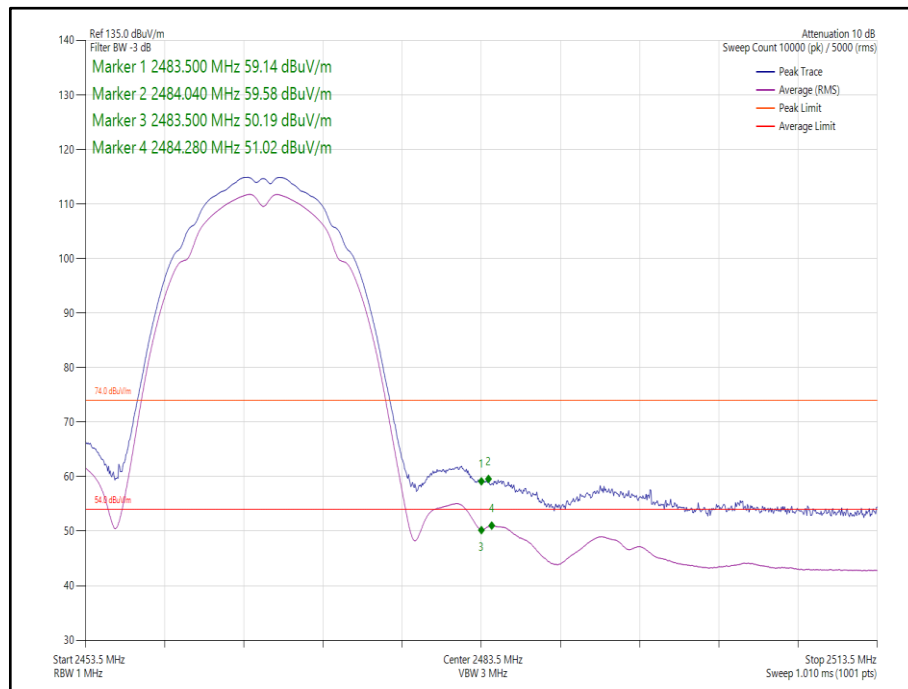


Figure 3 - 802.11b, Core 1 - 2467 MHz, Band Edge Frequency 2483.5 MHz

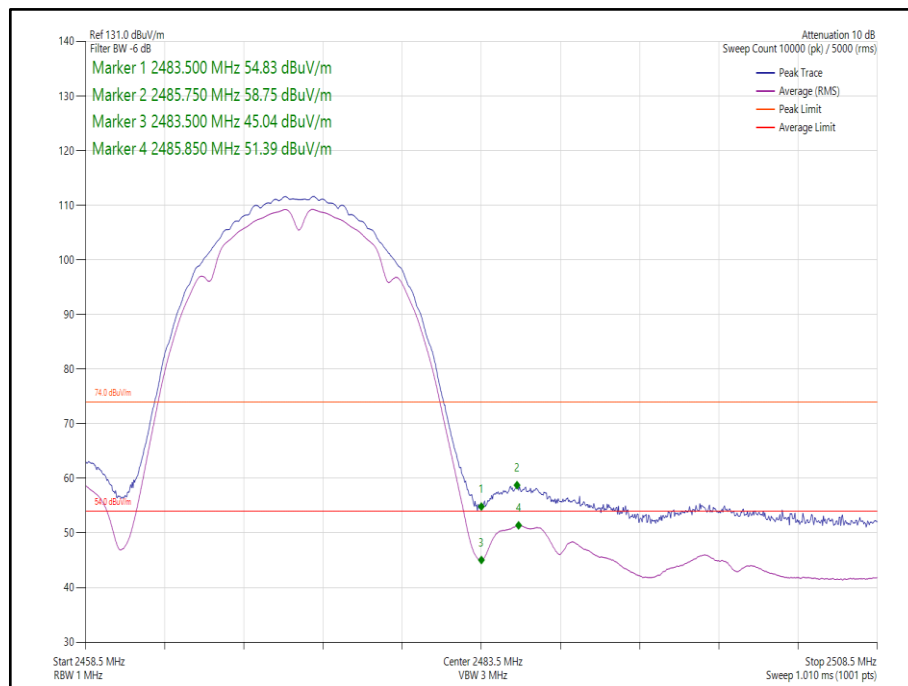


Figure 4 - 802.11b, Core 1 - 2472 MHz, Band Edge Frequency 2483.5 MHz

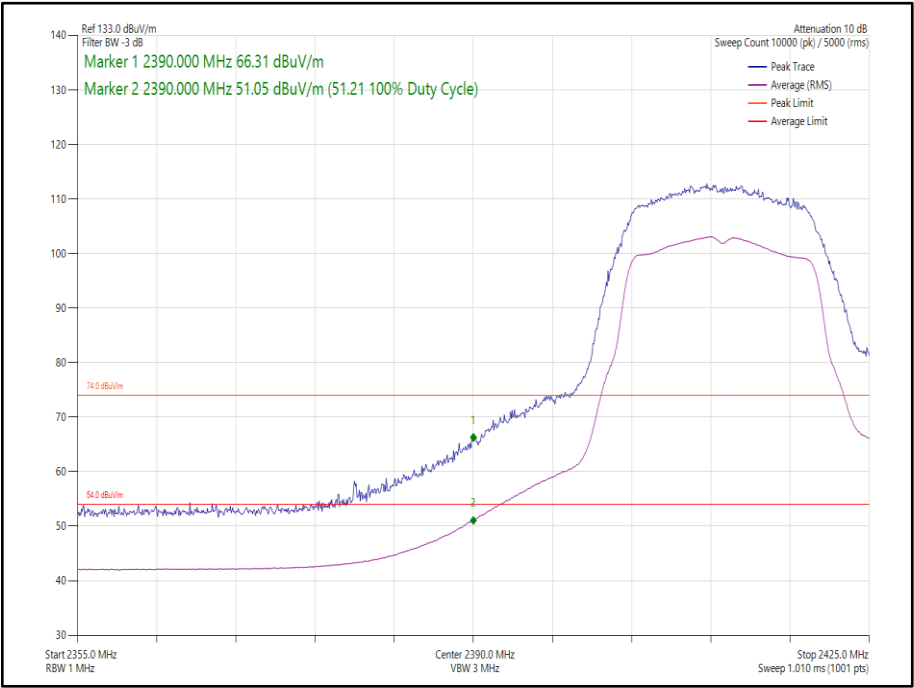


Figure 5 - 802.11g, Core 1 - 2412 MHz, Band Edge Frequency 2390.0 MHz

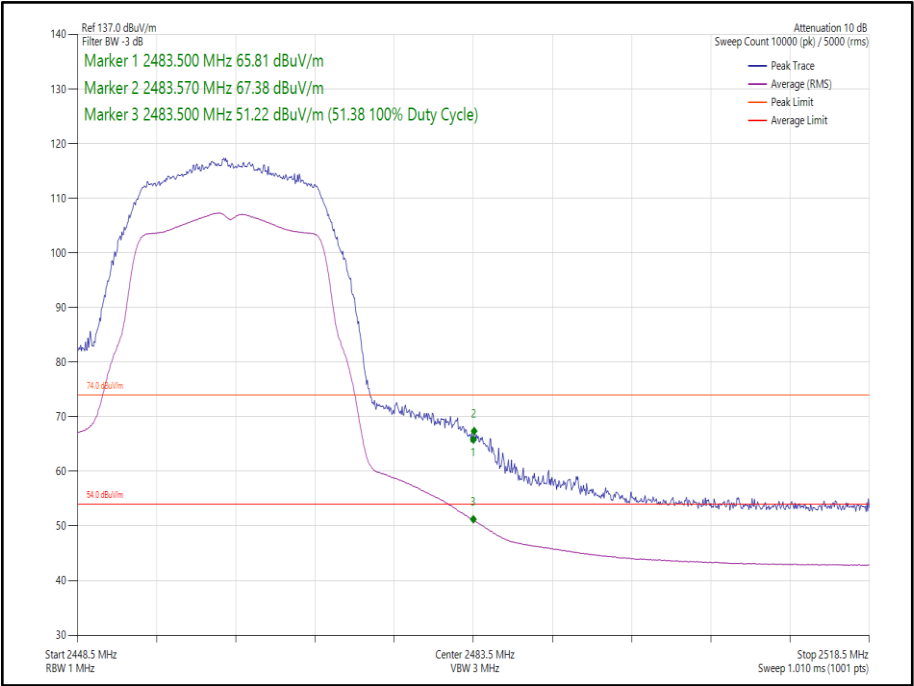


Figure 6 - 802.11g, Core 1 - 2462 MHz, Band Edge Frequency 2483.5 MHz

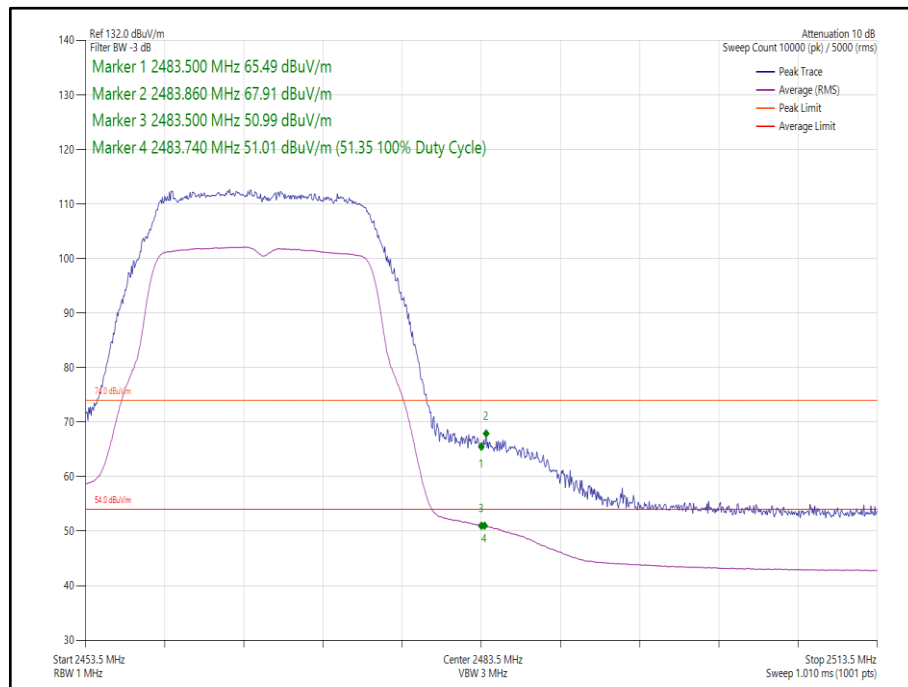


Figure 7 - 802.11g, Core 1 - 2467 MHz, Band Edge Frequency 2483.5 MHz

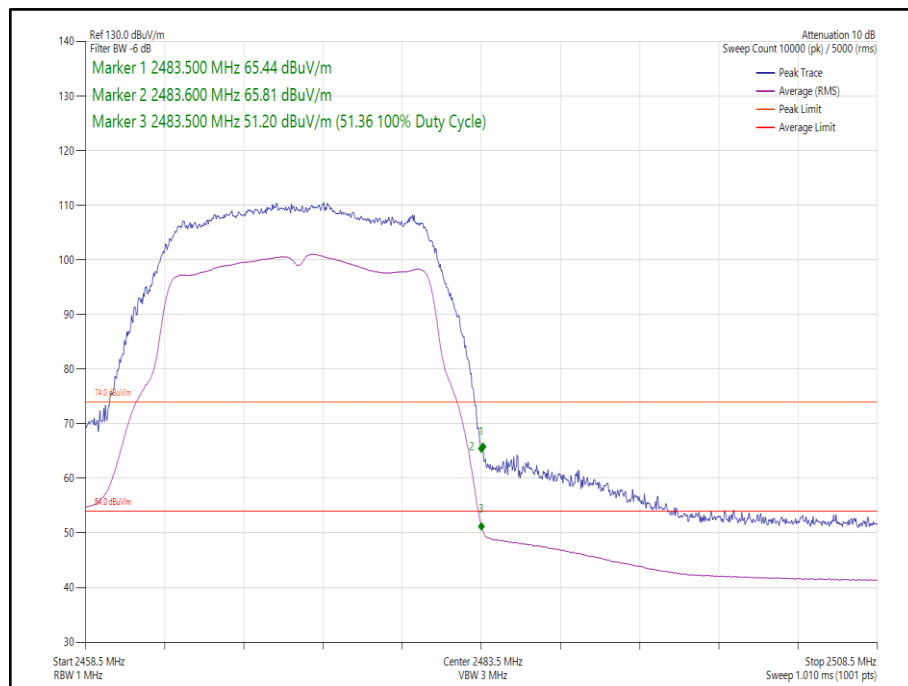


Figure 8 - 802.11g, Core 1 - 2472 MHz, Band Edge Frequency 2483.5 MHz

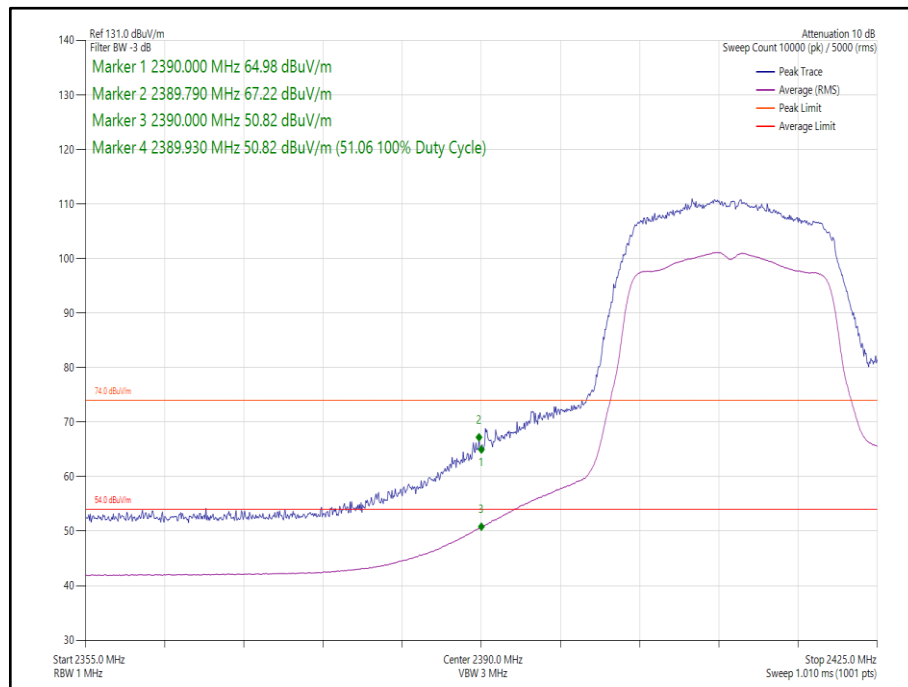


Figure 9 - 802.11n, HT20, Core 1 - 2412 MHz, Band Edge Frequency 2390 MHz

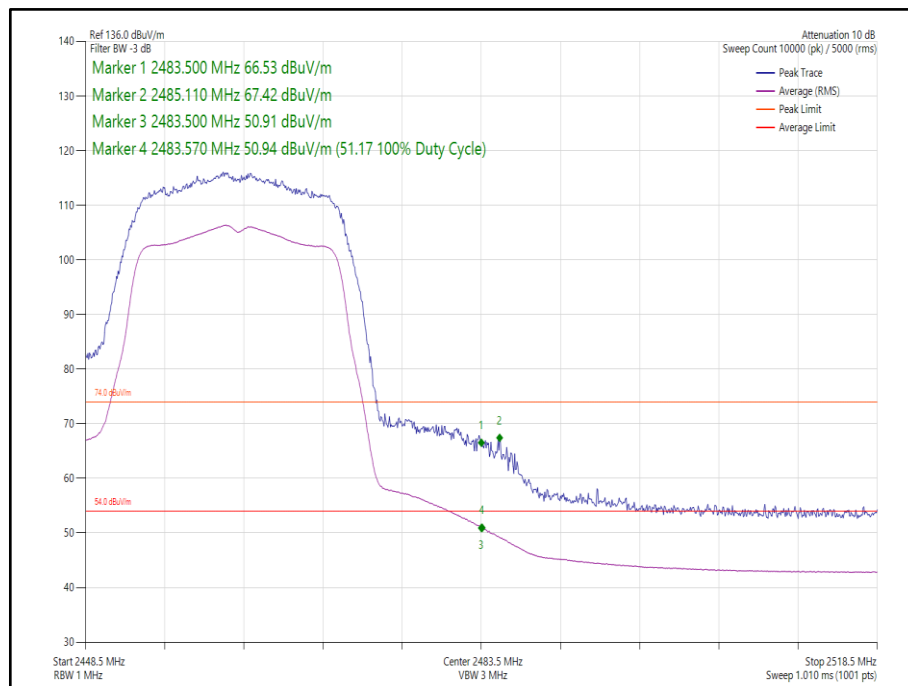


Figure 10 - 802.11n HT20, Core 1 - 2462 MHz, Band Edge Frequency 2483.5 MHz

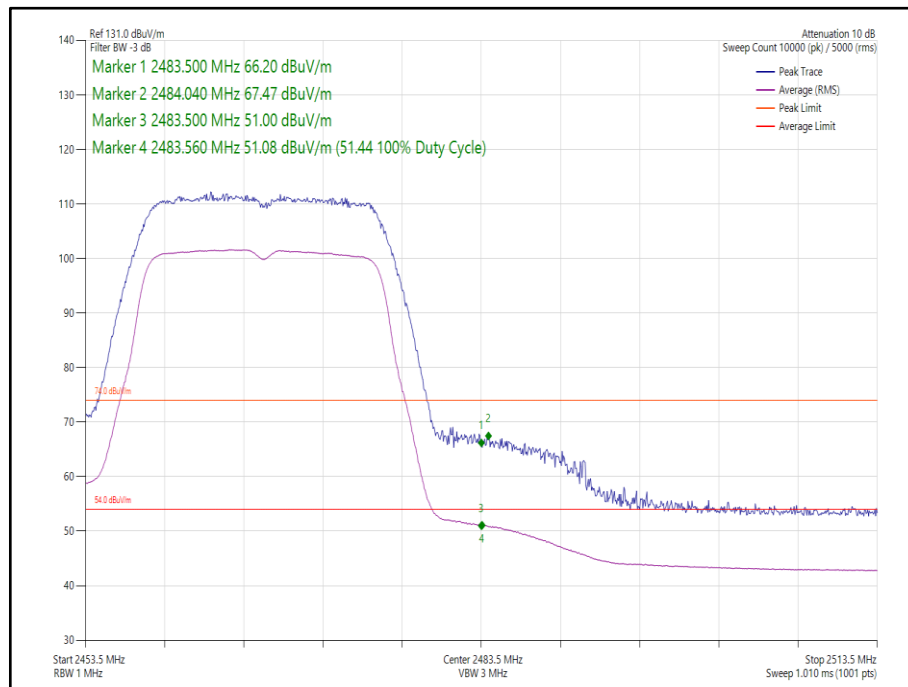


Figure 11 - 802.11n HT20, Core 1 - 2467 MHz, Band Edge Frequency 2483.5 MHz

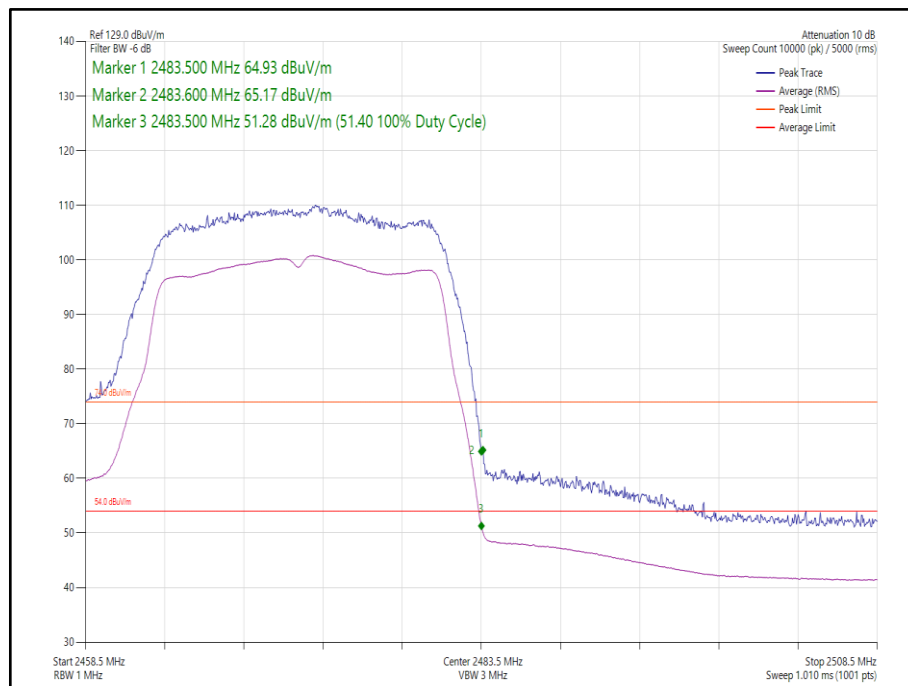


Figure 12 - 802.11n HT20, Core 1 - 2472 MHz, Band Edge Frequency 2483.5 MHz

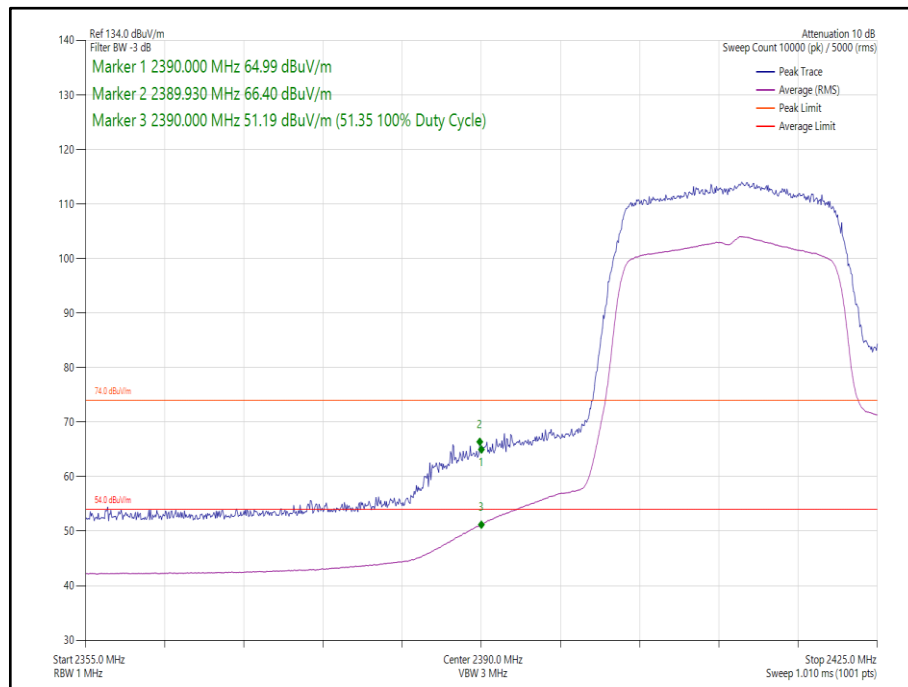


Figure 13 - 802.11ax HE20, Core 1, SU - 2412 MHz, Band Edge Frequency 2390 MHz

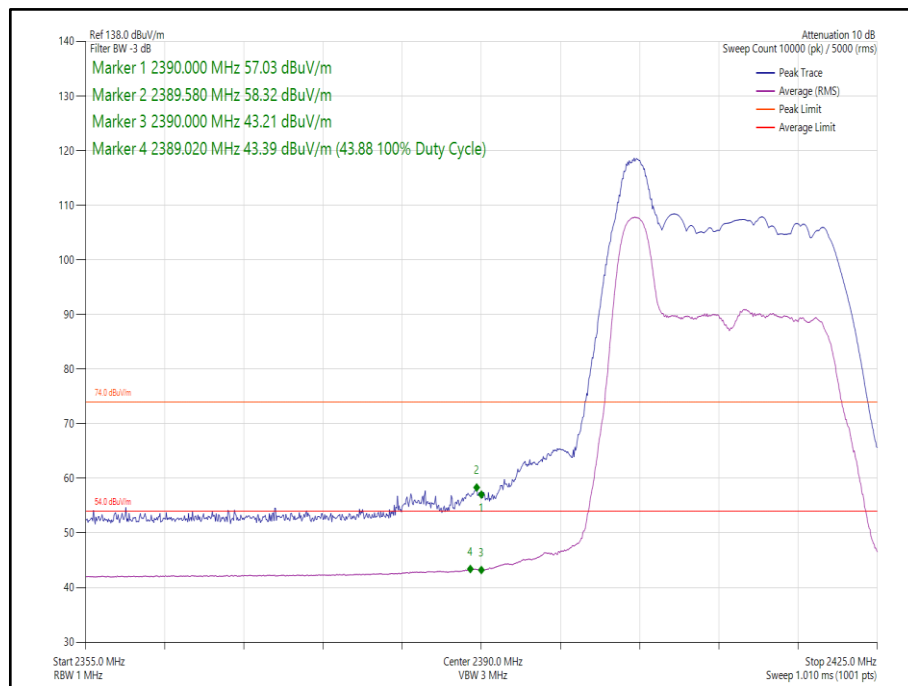


Figure 14 - 802.11ax HE20, Core 1, 26-0 - 2412 MHz, Band Edge Frequency 2390 MHz

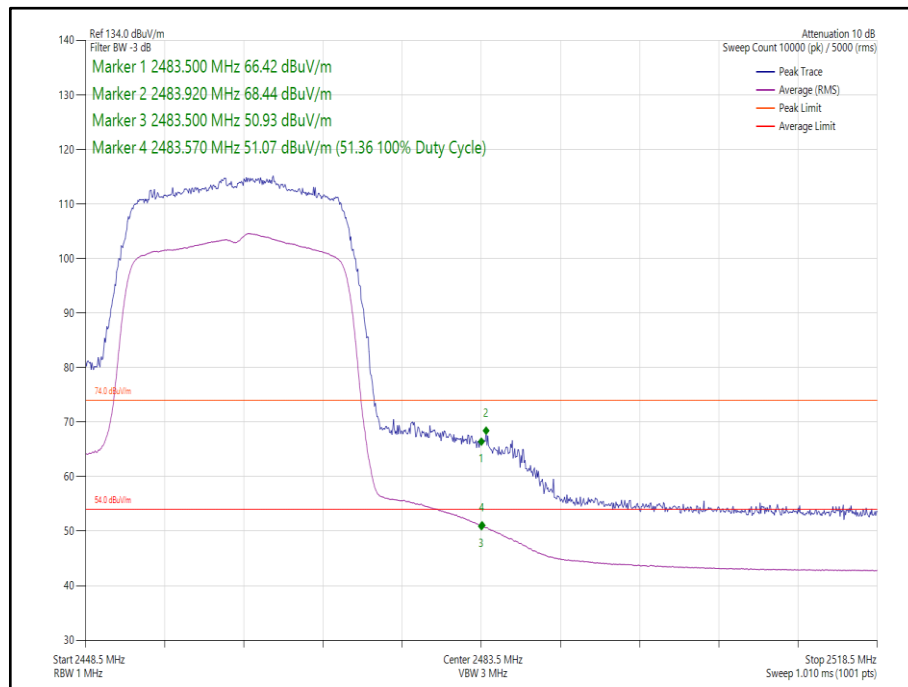


Figure 15 - 802.11ax HE20, Core 1, SU - 2462 MHz, Band Edge Frequency 2483.5 MHz

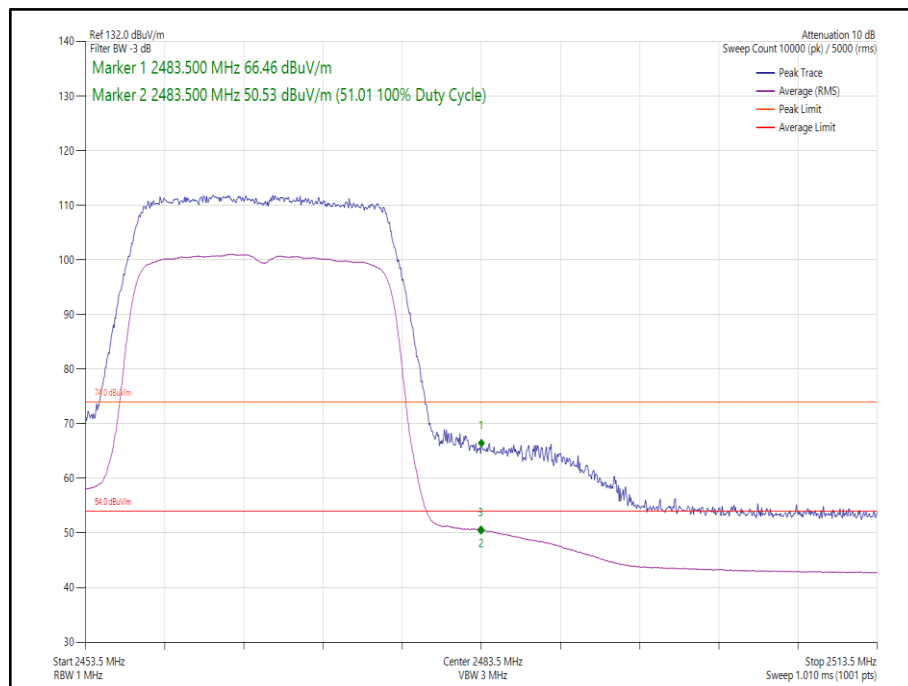


Figure 16 - 802.11ax HE20, Core 1, SU - 2467 MHz, Band Edge Frequency 2483.5 MHz

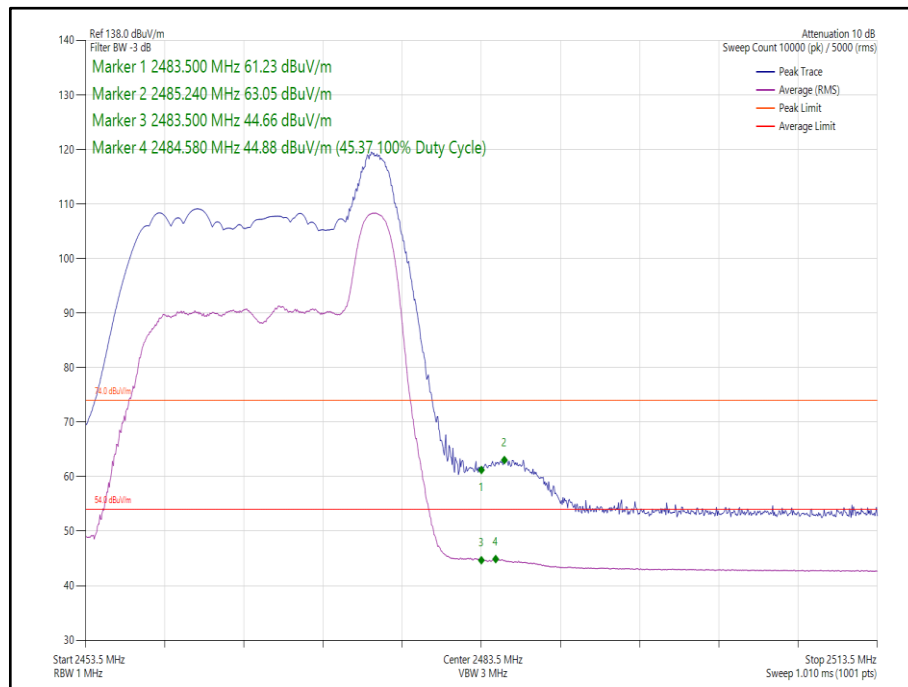


Figure 17 - 802.11ax HE20, Core 1, 26-8 - 2467 MHz, Band Edge Frequency 2483.5 MHz

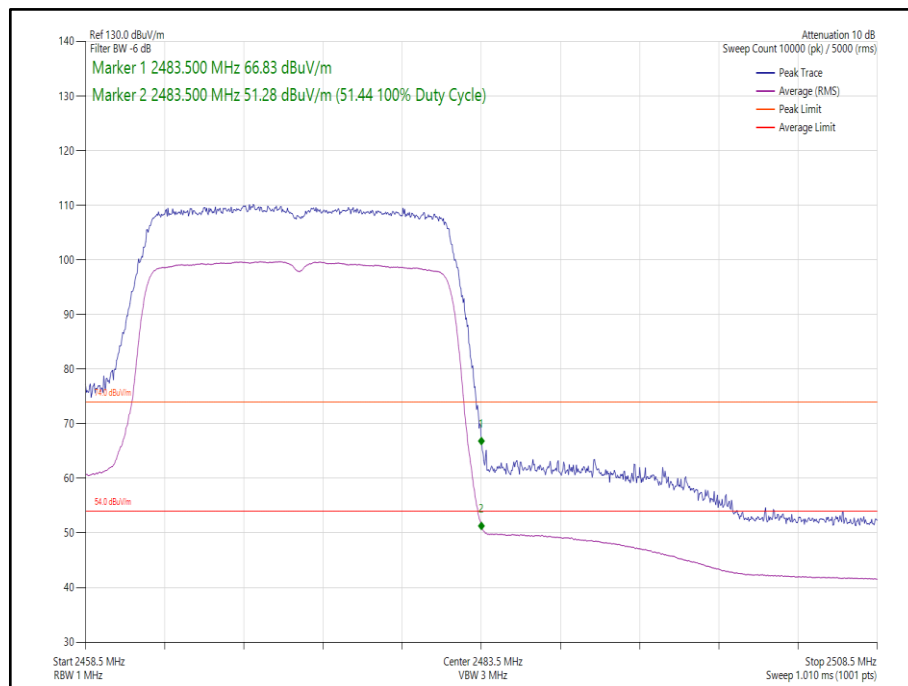


Figure 18 - 802.11ax HE20, Core 1, SU - 2472 MHz, Band Edge Frequency 2483.5 MHz

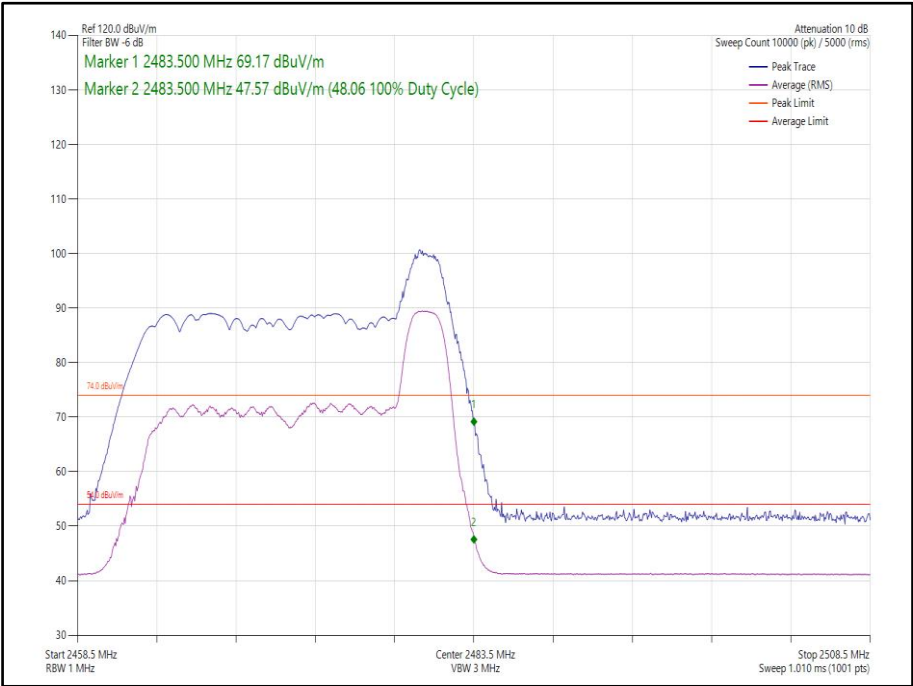


Figure 19 - 802.11ax HE20, Core 1, 26-8 - 2472 MHz, Band Edge Frequency 2483.5 MHz

2TX MIMO

Mode	Data Rate/MCS	Resource Size	Resource Index	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBμV/m)	Average Level (dBμV/m)
802.11n HT20, Core 0-1	MCS2	-	-	2412	2390.0	64.30	51.46
802.11n HT20, Core 0-1	MCS4	-	-	2462	2483.5	67.08	51.44
802.11n HT20, Core 0-1	MCS4	-	-	2467	2483.5	64.73	51.31
802.11n HT20, Core 0-1	MCS4	-	-	2472	2483.5	66.26	51.48
802.11ax HE20, Core 0-1	MCS4	SU	-	2412	2390.0	67.67	51.12
802.11ax HE20, Core 0-1	MCS9	26	0	2412	2390.0	61.34	45.72
802.11ax HE20, Core 0-1	MCS2	SU	-	2462	2483.5	64.52	51.26
802.11ax HE20, Core 0-1	MCS9	SU	-	2467	2483.5	67.47	51.29
802.11ax HE20, Core 0-1	MCS9	26	8	2467	2483.5	67.58	48.23
802.11ax HE20, Core 0-1	MCS4	SU	-	2472	2483.5	66.79	51.44
802.11ax HE20, Core 0-1	MCS9	26	8	2472	2483.5	69.41	49.06

Table 8 – MIMO 2TX Restricted Band Edge Results

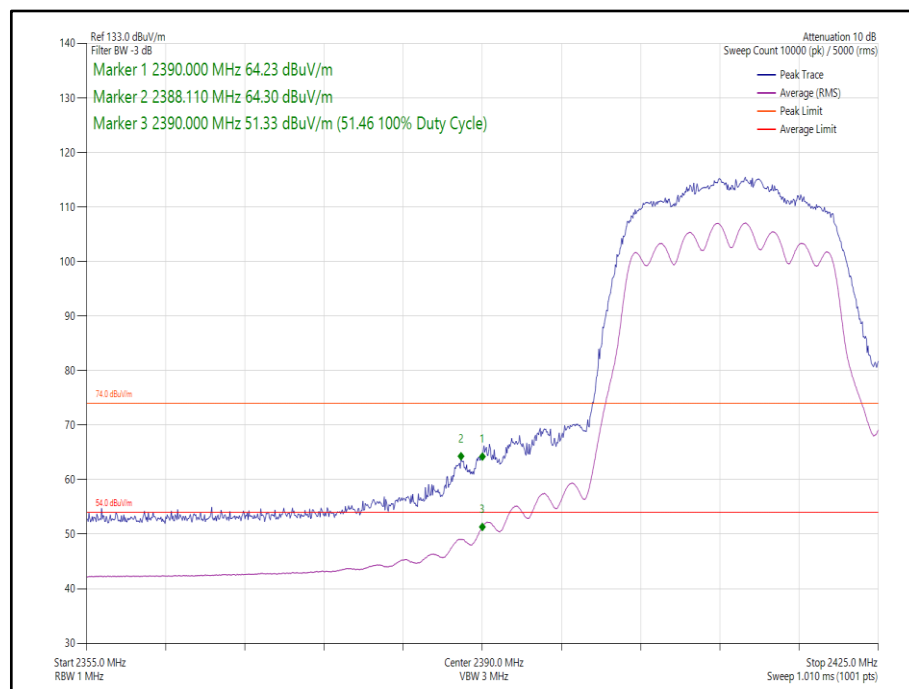


Figure 20 - 802.11n HT20, Core 0-1 - 2412 MHz, Band Edge Frequency 2390 MHz

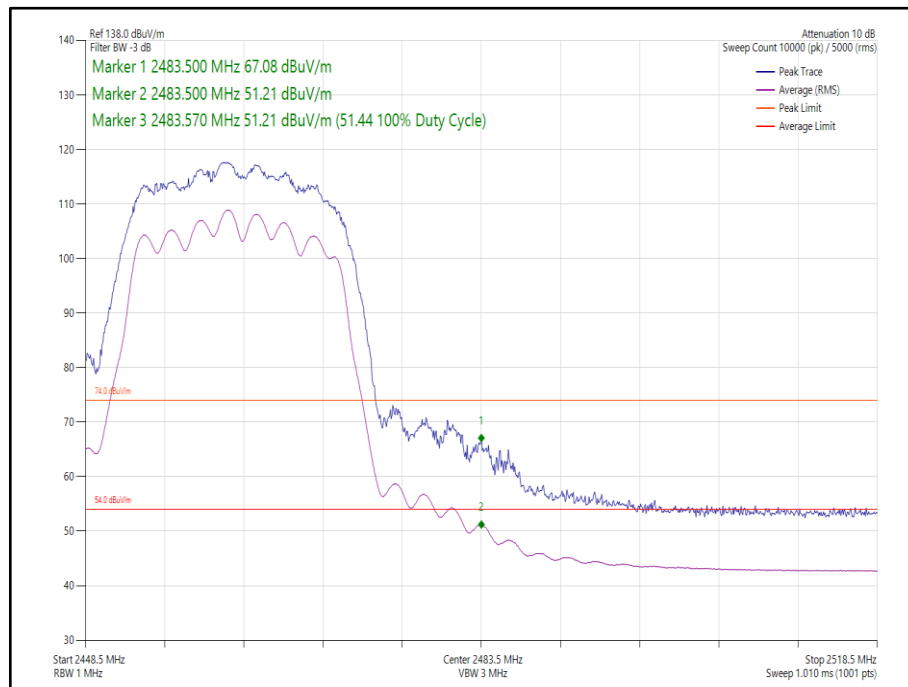


Figure 21 - 802.11n HT20, Core 0-1 - 2462 MHz, Band Edge Frequency 2483.5 MHz

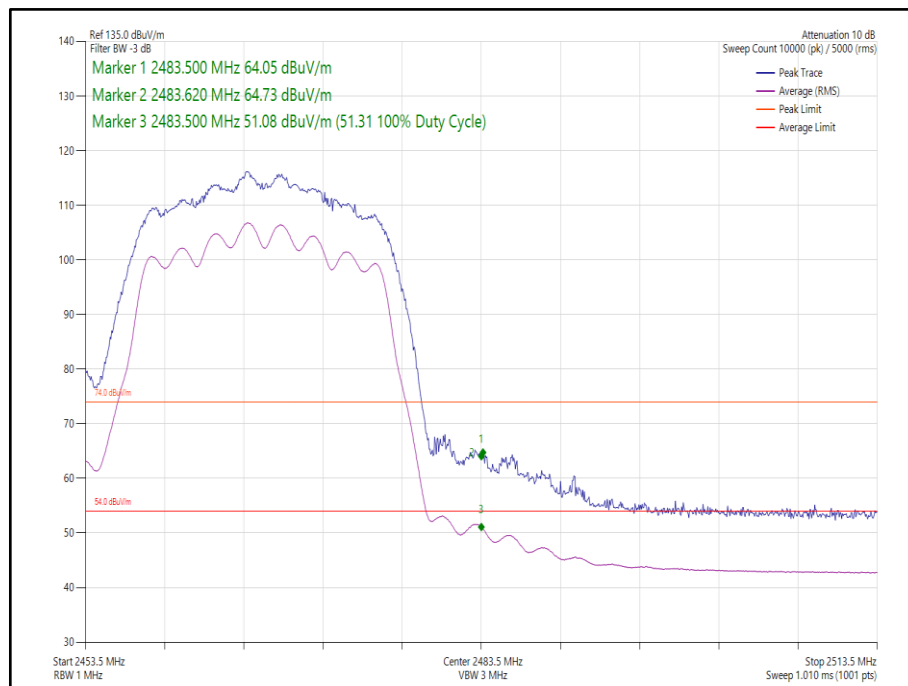


Figure 22 - 802.11n HT20, Core 0-1 - 2467 MHz, Band Edge Frequency 2483.5 MHz

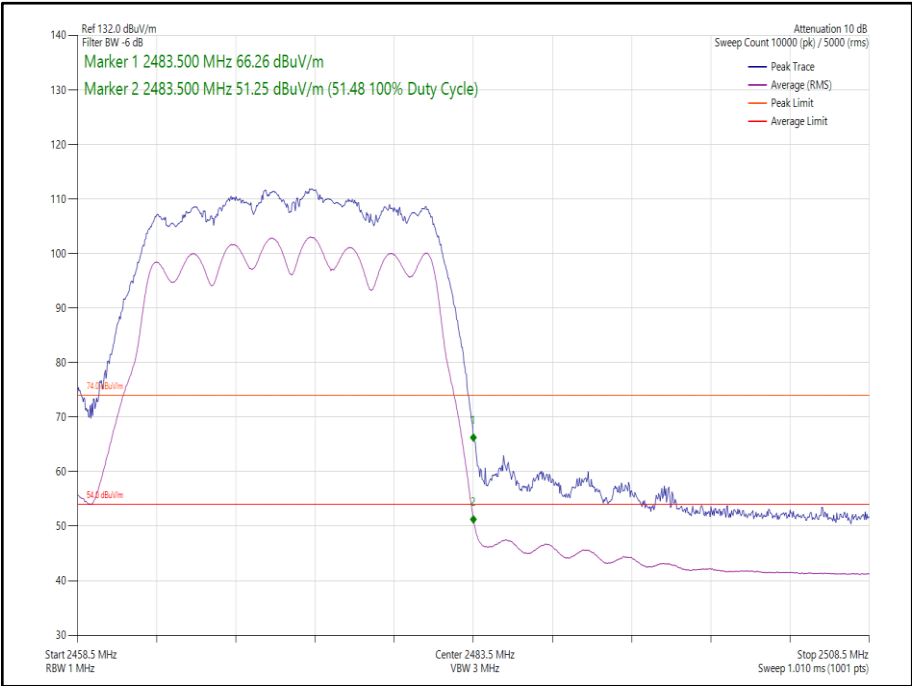


Figure 23 - 802.11n HT20, Core 0-1 - 2472 MHz, Band Edge Frequency 2483.5 MHz

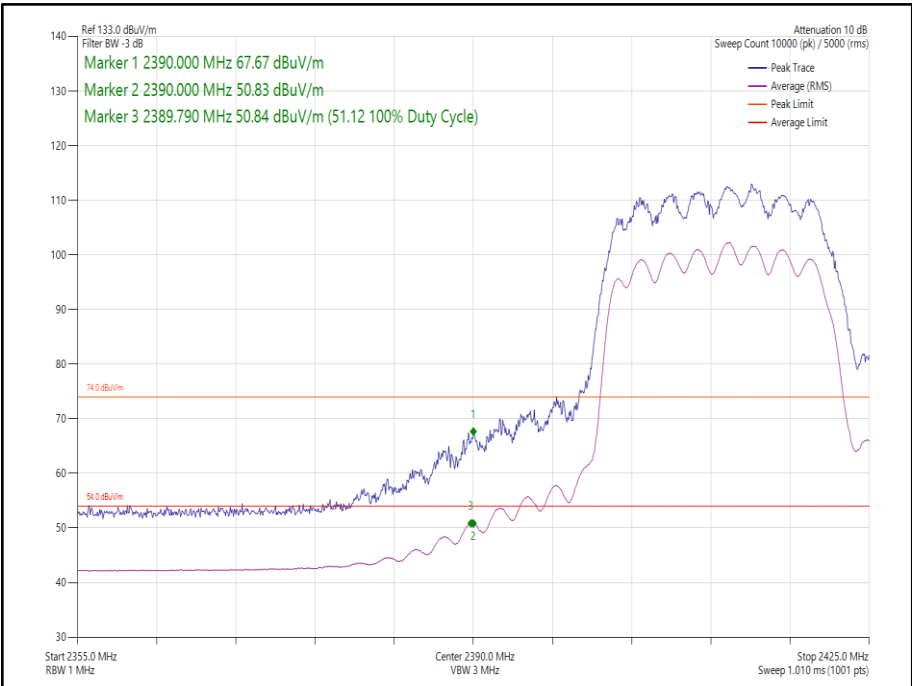


Figure 24 - 802.11ax HE20, Core 0-1, SU - 2412 MHz, Band Edge Frequency 2390 MHz

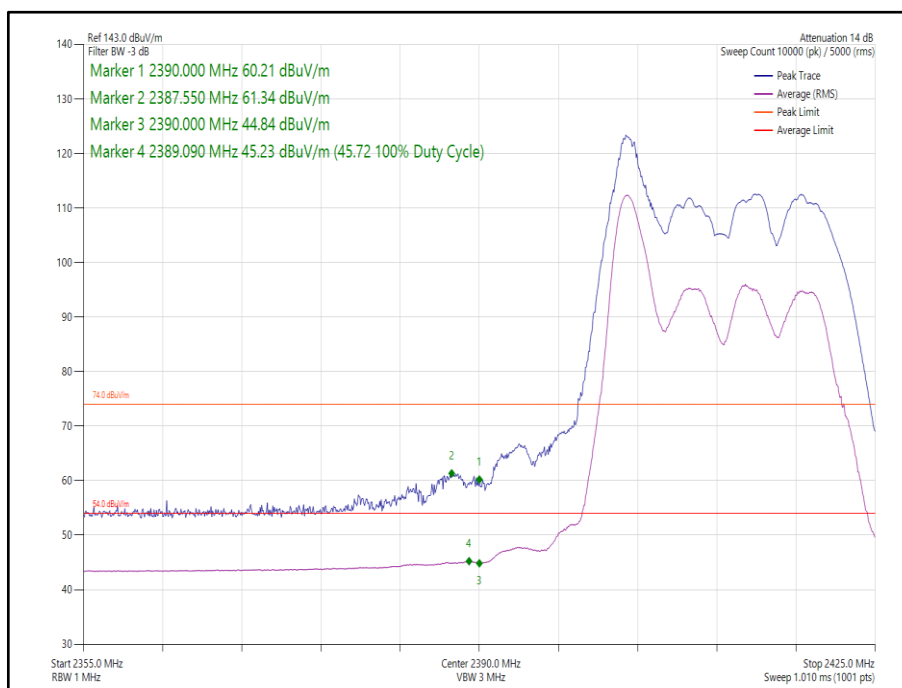


Figure 25 - 802.11ax HE20, Core 0-1, 26-0 - 2412 MHz, Band Edge Frequency 2390 MHz

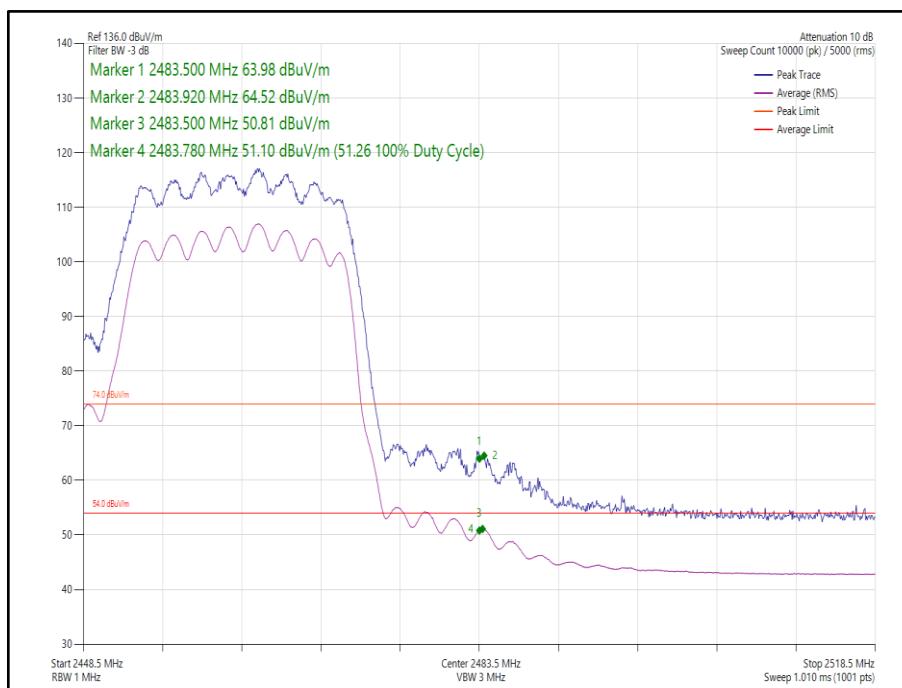


Figure 26 - 802.11ax HE20, Core 0-1, SU - 2462 MHz, Band Edge Frequency 2483.5 MHz

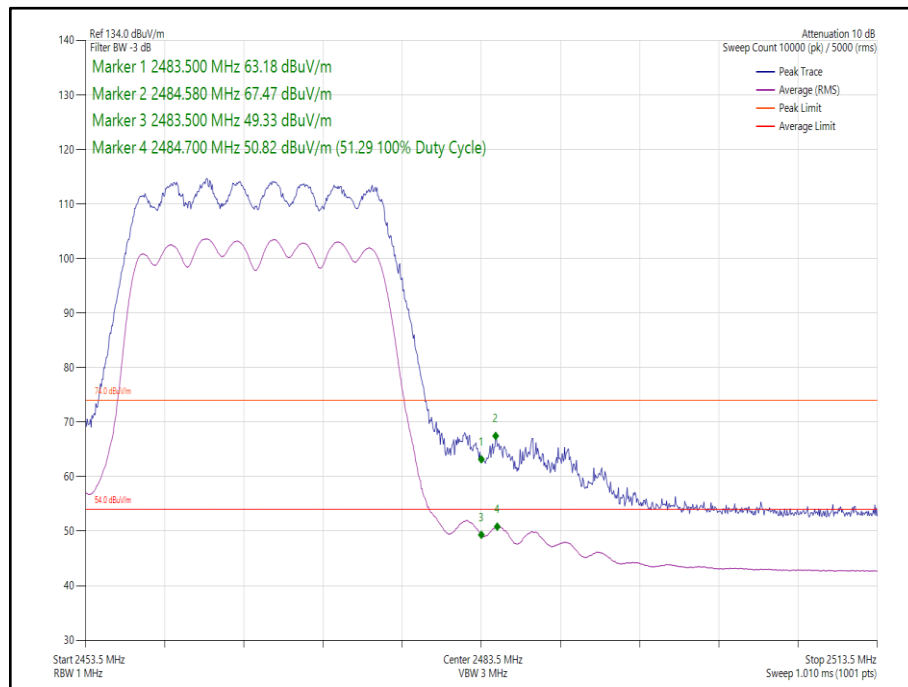


Figure 27 - 802.11ax HE20, Core 0-1, SU - 2467 MHz, Band Edge Frequency 2483.5 MHz

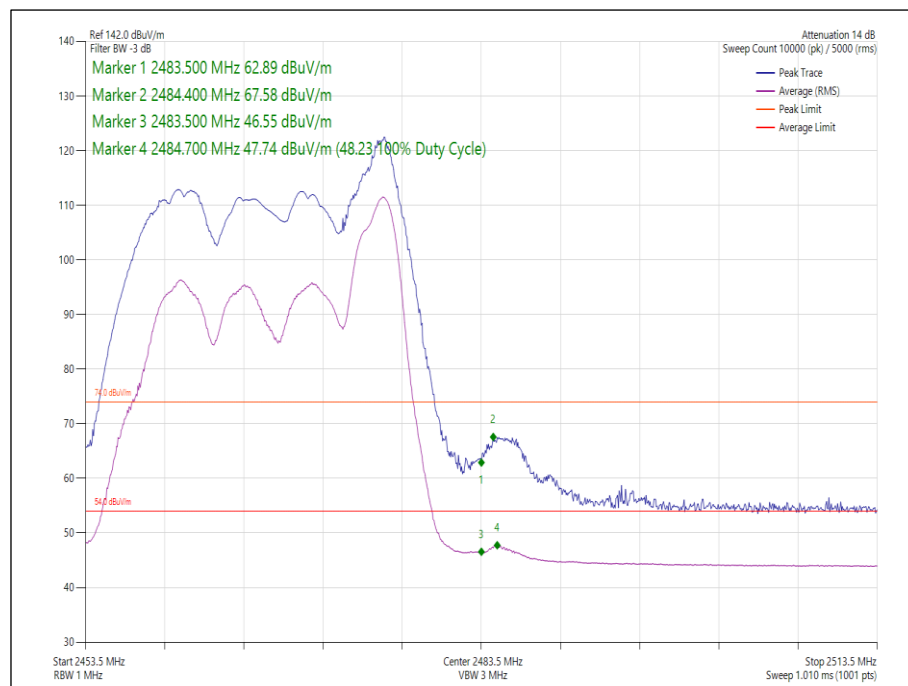


Figure 28 - 802.11ax HE20, Core 0-1, 26-8 - 2467 MHz, Band Edge Frequency 2483.5 MHz

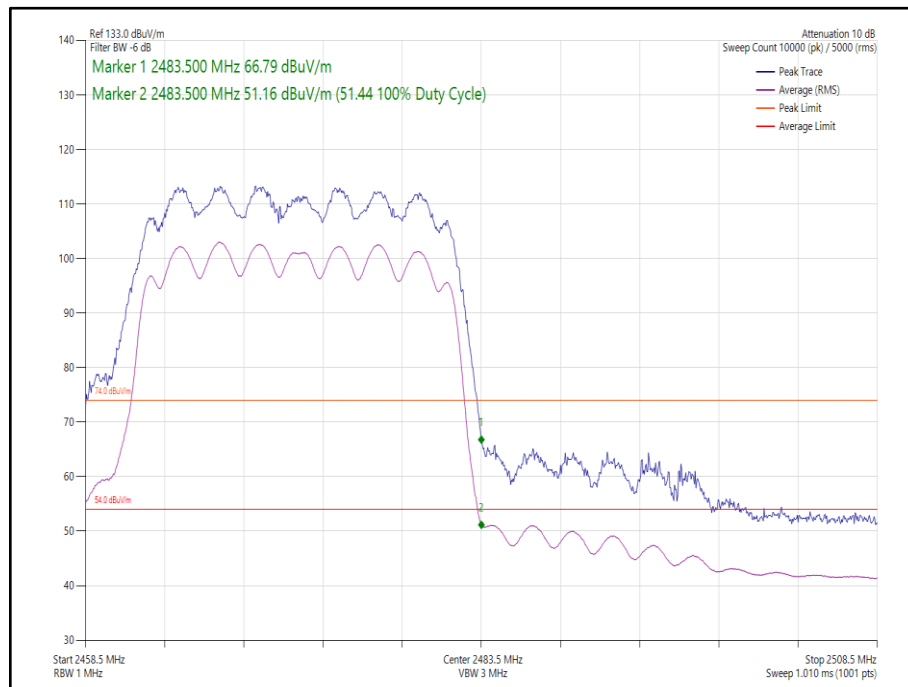


Figure 29 - 802.11ax HE20, Core 0-1, SU - 2472 MHz, Band Edge Frequency 2483.5 MHz

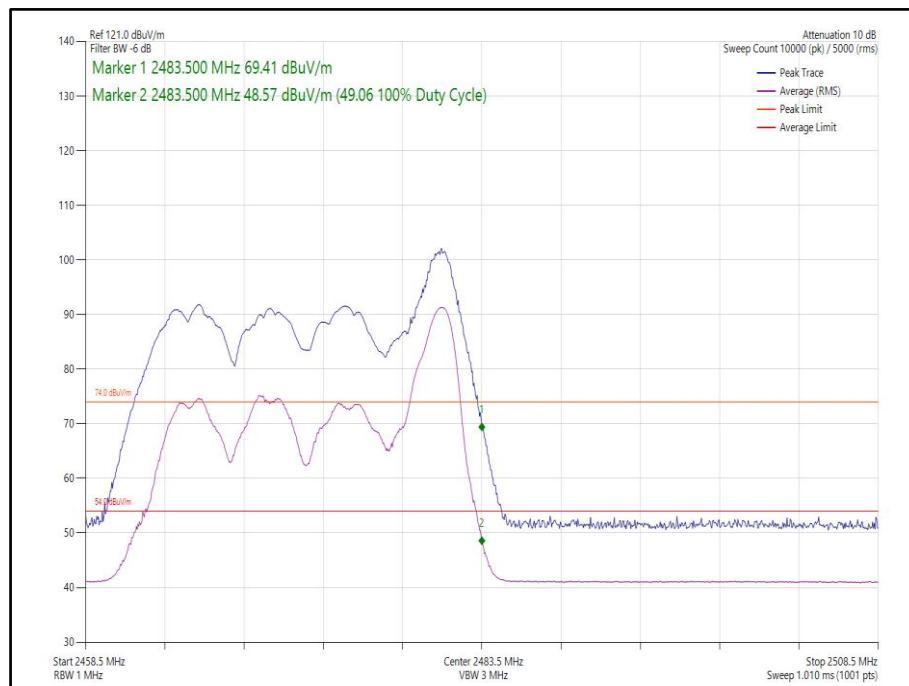


Figure 30 - 802.11ax HE20, Core 0-1, 26-8 - 2472 MHz, Band Edge Frequency 2483.5 MHz



FCC 47 CFR Part 15, Limit Clause 15.209

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

Table 9

ISED RSS-GEN, Limit Clause 8.9

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960*	500

Table 10

*Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.



2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Chamber 11.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
EMI Test Receiver	Rohde & Schwarz	ESW44	5084	12	17-May-2023
Screened Room (11)	Rainford	Rainford	5136	36	24-Nov-2024
Mast	Maturo	TAM 4.0-P	5158	-	TU
Mast and Turntable Controller	Maturo	Maturo NCD	5159	-	TU
Turntable	Maturo	TT 15WF	5160	-	TU
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	5215	12	28-May-2023
2m SMA Cable	Junkosha	MWX221-02000AMSAMS/A	5518	12	12-Apr-2023
8m N Type Cable	Junkosha	MWX221-08000NMSNMS/B	5522	12	24-Mar-2023
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5604	12	22-Sep-2022

Table 11

TU – Traceability Unscheduled



2.2 Emission Bandwidth

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(2)
ISED RSS-247, Clause 5.2
ISED RSS-GEN, Clause 6.7

2.2.2 Equipment Under Test and Modification State

A2780, S/N: NW3J007K67 - Modification State 0

2.2.3 Date of Test

20-October-2022

2.2.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.8.1 for 6 dB BW and 6.9.3 for 99% occupied bandwidth measurements.

2.2.5 Environmental Conditions

Ambient Temperature	22.7 °C
Relative Humidity	52.3 %

2.2.6 Test Results

2.4 GHz WLAN

Protocol	6 dB Bandwidth (MHz)	
	Minimum	Maximum
802.11b	8.640	9.120
802.11g	15.240	16.440
802.11n HT20	15.240	17.700
802.11ax HE20 SU	18.360	19.020

Table 12 - 6 dB Bandwidth Summary Results

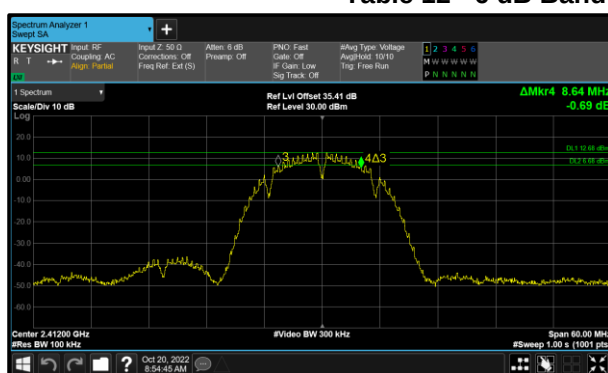


Figure 31 - 802.11b Minimum 6 dB EBW

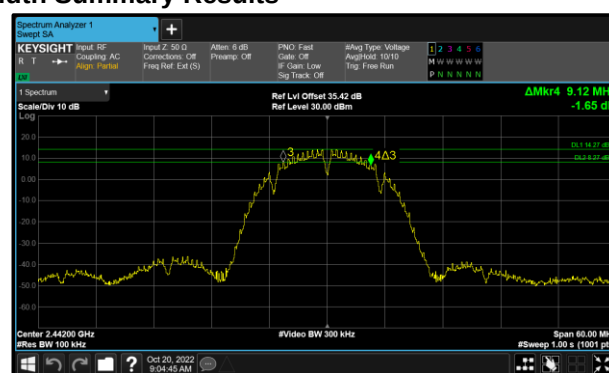


Figure 32 - 802.11b Maximum 6 dB EBW

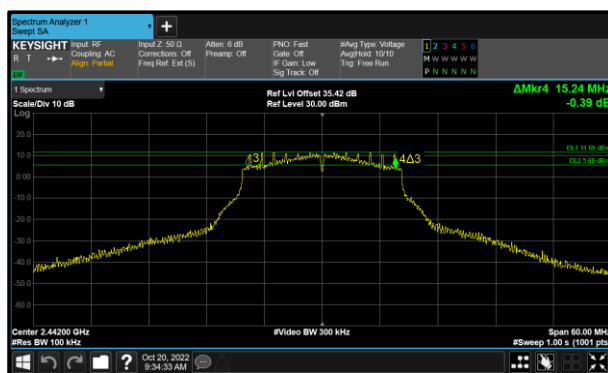


Figure 33 - 802.11g Minimum 6 dB EBW

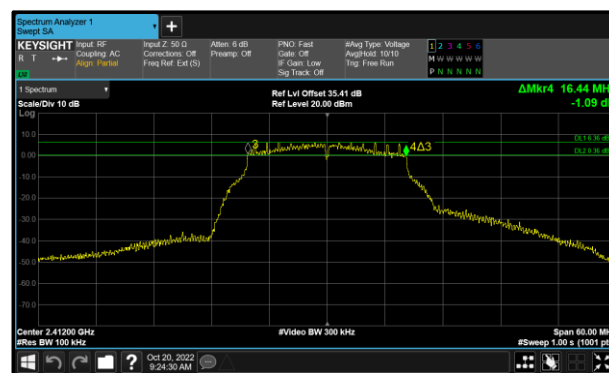
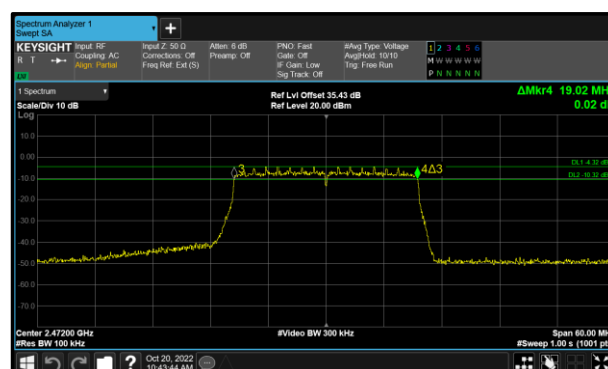
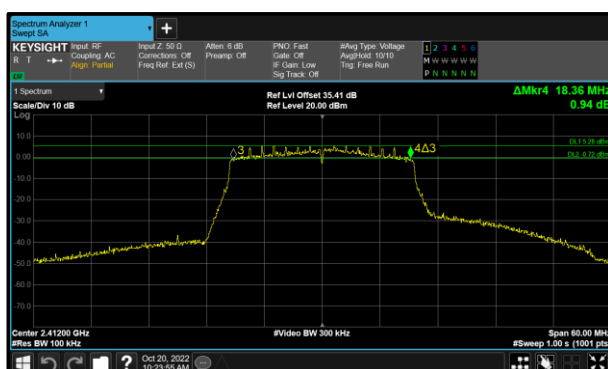
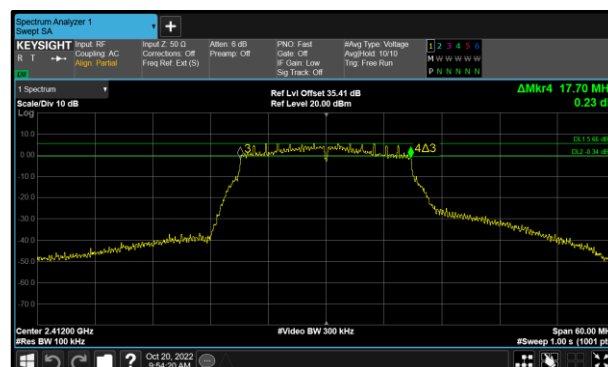
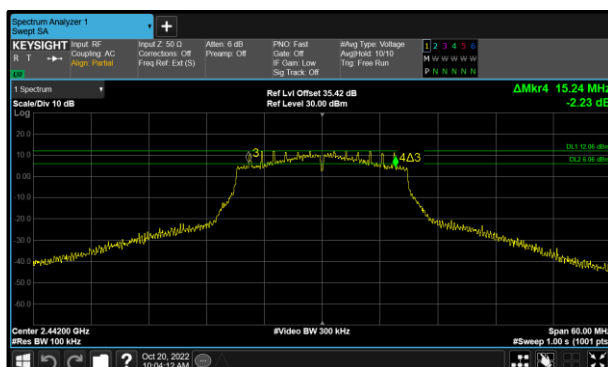


Figure 34 - 802.11g Maximum 6 dB EBW



Protocol	99% Bandwidth (MHz)	
	Minimum	Maximum
802.11b	12.900	12.960
802.11g	16.380	16.800
802.11n HT20	17.580	17.820
802.11ax HE20 SU	18.960	18.960

Table 13 - 99% Bandwidth Summary Results

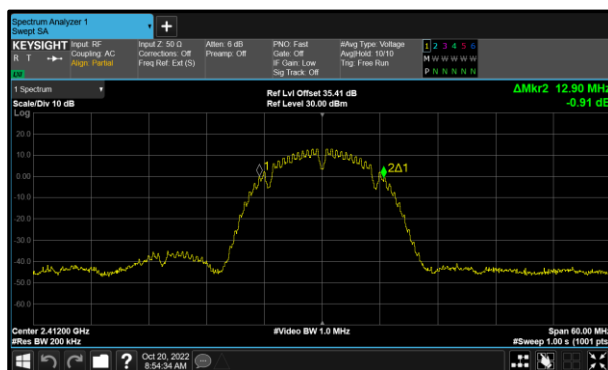


Figure 39 - 802.11b Minimum 99% OBW

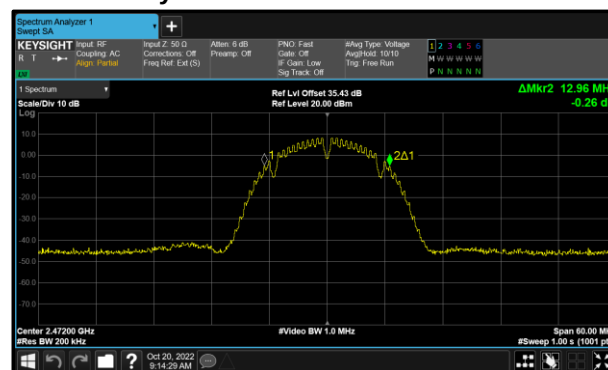


Figure 40 - 802.11b Maximum 99% OBW

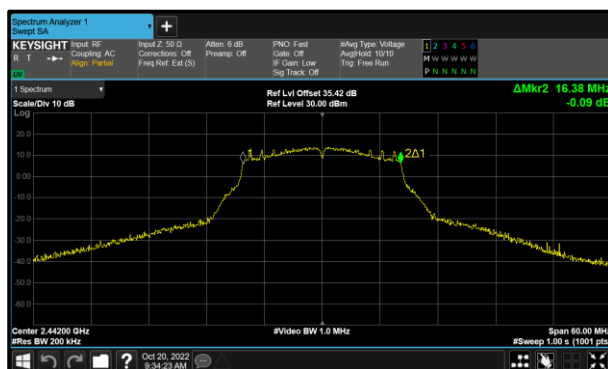


Figure 41 - 802.11g Minimum 99% OBW

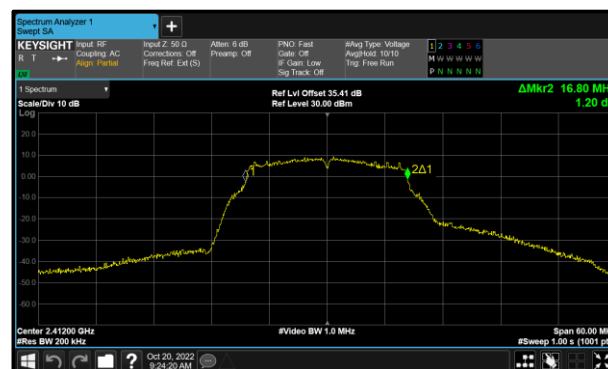


Figure 42 - 802.11g Maximum 99% OBW

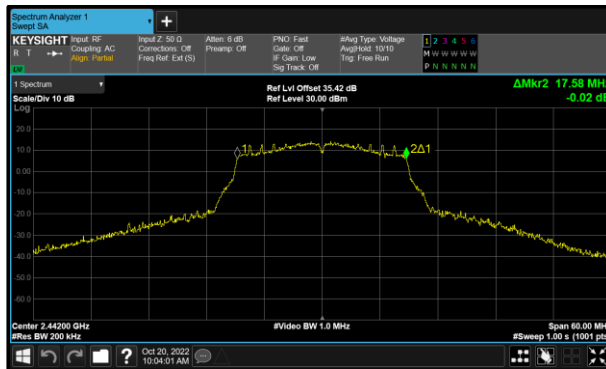


Figure 43 - 802.11n HT20 Minimum 99% OBW

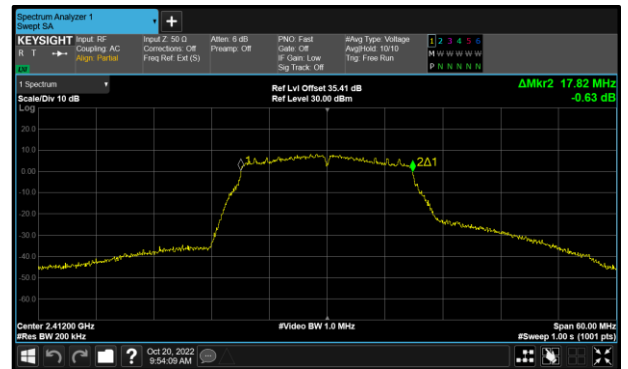


Figure 44 - 802.11n HT20 Maximum 99% OBW

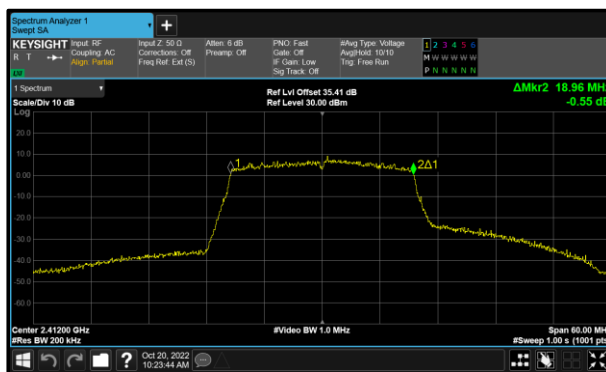


Figure 45 - 802.11ax HE20 SU Minimum 99% OBW

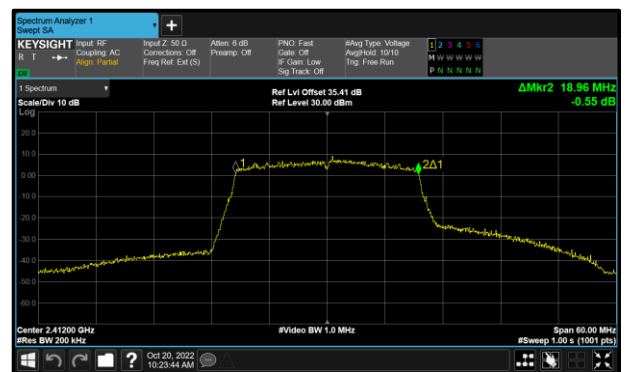


Figure 46 - 802.11ax HE20 SU Maximum 99% OBW



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (a)(2) RSS-247 5.2 a)	Test Method(s):	C63.10 6.9.3 C63.10 11.8.1
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11b	Duty Cycle (%):	-
Data Rate:	1 Mbps	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	-
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	8.640	-	-	≥500.0
2442	-	9.120	-	-	≥500.0
2472	-	8.640	-	-	≥500.0

Table 14 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	12.900	-	-	-
2442	-	12.900	-	-	-
2472	-	12.960	-	-	-

Table 15 - 99% Bandwidth Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (a)(2) RSS-247 5.2 a)	Test Method(s):	C63.10 6.9.3 C63.10 11.8.1
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11g	Duty Cycle (%):	-
Data Rate:	12 Mbps	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	-
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	16.440	-	-	≥500.0
2442	-	15.240	-	-	≥500.0
2472	-	16.200	-	-	≥500.0

Table 16 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	16.800	-	-	-
2442	-	16.380	-	-	-
2472	-	16.560	-	-	-

Table 17 - 99% Bandwidth Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (a)(2) RSS-247 5.2 a)	Test Method(s):	C63.10 6.9.3 C63.10 11.8.1
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11n HT20	Duty Cycle (%):	-
Modulation Coding Scheme:	MCS2	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	-
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	17.700	-	-	≥500.0
2442	-	15.240	-	-	≥500.0
2472	-	17.400	-	-	≥500.0

Table 18 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	17.820	-	-	-
2442	-	17.580	-	-	-
2472	-	17.700	-	-	-

Table 19 - 99% Bandwidth Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (a)(2) RSS-247 5.2 a)	Test Method(s):	C63.10 6.9.3 C63.10 11.8.1
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11ax HE20 SU	Duty Cycle (%):	-
Modulation Coding Scheme:	MCS2x1	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	-
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	18.360	-	-	≥500.0
2442	-	18.960	-	-	≥500.0
2472	-	19.020	-	-	≥500.0

Table 20 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	18.960	-	-	-
2442	-	18.960	-	-	-
2472	-	18.960	-	-	-

Table 21 - 99% Bandwidth Results



Protocol	6 dB Bandwidth (MHz)	
	Minimum	Maximum
802.11n HT20	15.300	17.520
802.11ax HE20 SU	18.600	19.080

Table 22 - 6 dB Bandwidth Summary Results

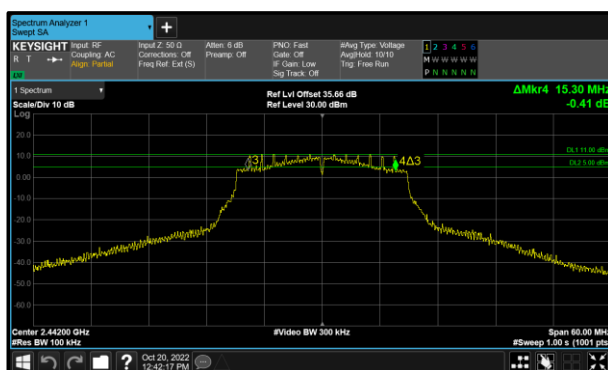


Figure 47 - 802.11n HT20 Minimum 6 dB EBW

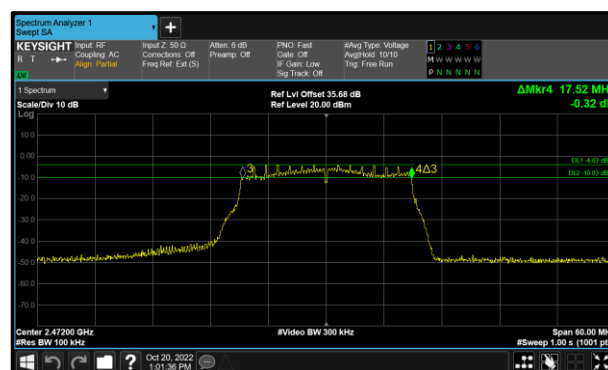


Figure 48 - 802.11n HT20 Maximum 6 dB EBW

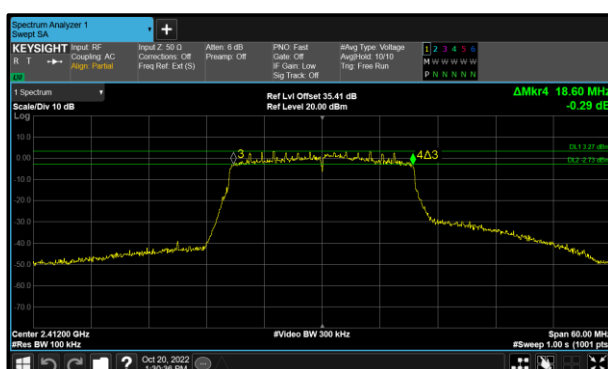


Figure 49 - 802.11ax HE20 SU Minimum 6 dB EBW

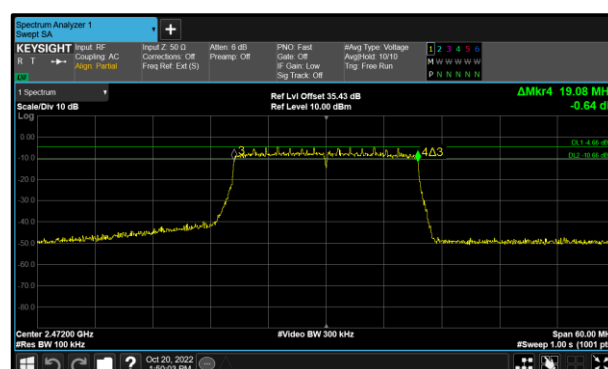


Figure 50 - 802.11ax HE20 SU Maximum 6 dB EBW



Protocol	99% Bandwidth (MHz)	
	Minimum	Maximum
802.11n HT20	17.580	17.820
802.11ax HE20 SU	18.960	18.960

Table 23 - 99% Bandwidth Summary Results

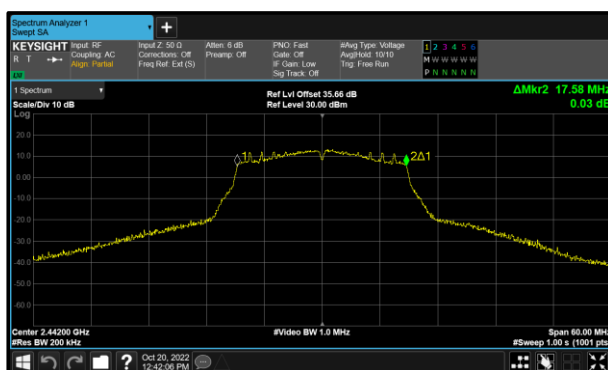


Figure 51 - 802.11n HT20 Minimum 99% OBW

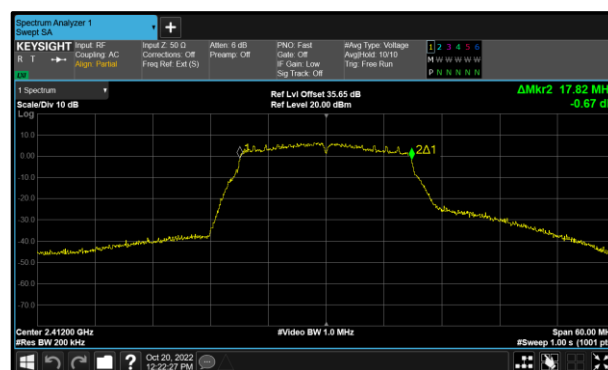


Figure 52 - 802.11n HT20 Maximum 99% OBW

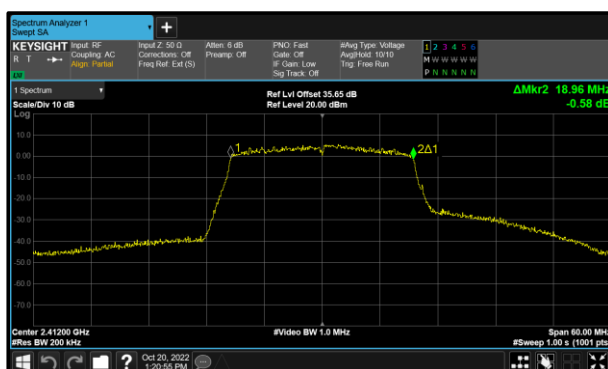


Figure 53 - 802.11ax HE20 SU Minimum 99% OBW

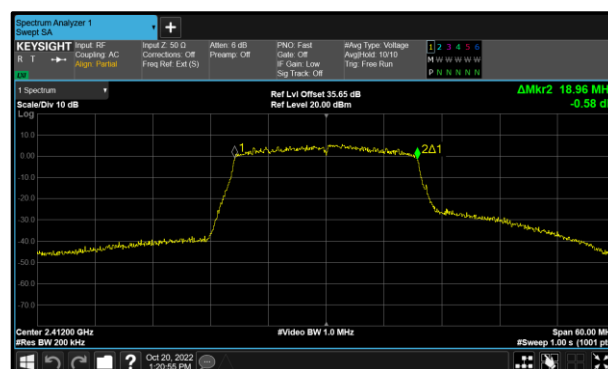


Figure 54 - 802.11ax HE20 SU Maximum 99% OBW



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (a)(2) RSS-247 5.2 a)	Test Method(s):	C63.10 6.9.3 C63.10 11.8.1
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11n HT20	Duty Cycle (%):	-
Modulation Coding Scheme:	MCS2	DCCF (dB):	-
Antenna Configuration:	MIMO CDD	Peak Antenna Gain (dBi):	-
Active Port(s):	A+B (Core 0 + Core 1)	Active Chain(s):	0+1

Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	17.100	17.400	-	-	≥500.0
2442	15.300	15.300	-	-	≥500.0
2472	17.520	17.460	-	-	≥500.0

Table 24 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	17.820	17.820	-	-	-
2442	17.580	17.580	-	-	-
2472	17.700	17.700	-	-	-

Table 25 - 99% Bandwidth Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (a)(2) RSS-247 5.2 a)	Test Method(s):	C63.10 6.9.3 C63.10 11.8.1
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11ax HE20 SU	Duty Cycle (%):	-
Modulation Coding Scheme:	MCS2x1	DCCF (dB):	-
Antenna Configuration:	MIMO CDD	Peak Antenna Gain (dBi):	-
Active Port(s):	A+B (Core 0 + Core 1)	Active Chain(s):	0+1

Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	18.900	18.600	-	-	≥500.0
2437	19.020	18.900	-	-	≥500.0
2472	19.020	19.080	-	-	≥500.0

Table 26 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	18.960	18.960	-	-	-
2437	18.960	18.960	-	-	-
2472	18.960	18.960	-	-	-

Table 27 - 99% Bandwidth Results

FCC 47 CFR Part 15, Limit Clause 15.247(a)(2) and ISSED RSS-247, Clause 5.2(a)

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



2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Multimeter	Fluke	79 Series III	611	12	21-Dec-2022
Hygrometer	Rotronic	I-1000	3220	12	5-Nov-2022
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	01-Feb-2023
AC Programmable Power Supply	iTech	IT7324	5226	-	O/P Mon
MXA Signal Analyser	Keysight Technologies	N9020B	5529	24	13-Sep-2024
Signal Conditioning Unit	TUV SUD	SPECTRUM SCU002	5759	12	05-Jul-2023

Table 28

O/P Mon – Output Monitored using calibrated equipment



2.3 Maximum Conducted Output Power

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (b)
ISED RSS-247, Clause 5.4
ISED RSS-GEN, Clause 6.12

2.3.2 Equipment Under Test and Modification State

A2780, S/N: NW3J007K67 - Modification State 0

2.3.3 Date of Test

20-October-2022

2.3.4 Test Method

The test was performed in accordance with ANSI C63.10 clause 11.9.2.3.2 Method AVGPM-G.

MIMO output port summing was performed in accordance with KDB 662911 D01. For the CDD results, the Directional Gain was calculated in accordance with clause F)2)f)(ii) using the calculations from F)2)f)(i) with worst-case individual gain and an array gain of zero.

2.3.5 Environmental Conditions

Ambient Temperature	22.7 °C
Relative Humidity	52.3 %



2.3.6 Test Results

2.4 GHz WLAN

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(3) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.2.3.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11b	Duty Cycle (%):	99.4
Data Rate:	1 Mbps	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	6.13
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2412	-	20.67	-	-	-	29.87	-9.20
2442	-	22.37	-	-	-	29.87	-7.50
2472	-	15.69	-	-	-	29.87	-14.18

Table 29 - FCC Maximum Conducted (average) Output Power Results

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2412	-	20.67	-	-	-	30.00	-9.33	26.80	36.00	-9.20
2442	-	22.37	-	-	-	30.00	-7.63	28.50	36.00	-7.50
2472	-	15.69	-	-	-	30.00	-14.31	21.82	36.00	-14.18

Table 30 - ISSED Maximum Conducted (average) Output Power Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(3) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.2.3.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11g	Duty Cycle (%):	97.6
Data Rate:	12 Mbps	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	6.13
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2412	-	17.47	-	-	-	29.87	-12.40
2442	-	22.37	-	-	-	29.87	-7.50
2472	-	7.82	-	-	-	29.87	-22.05

Table 31 - FCC Maximum Conducted (average) Output Power Results

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2412	-	17.47	-	-	-	30.00	-12.53	23.60	36.00	-12.40
2442	-	22.37	-	-	-	30.00	-7.63	28.50	36.00	-7.50
2472	-	7.82	-	-	-	30.00	-22.18	13.95	36.00	-22.05

Table 32 - ISSED Maximum Conducted (average) Output Power Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(3) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.2.3.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11n HT20	Duty Cycle (%):	96.5
Modulation Coding Scheme:	MCS2	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	6.13
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2412	-	16.65	-	-	-	29.87	-13.22
2442	-	22.15	-	-	-	29.87	-7.72
2472	-	7.46	-	-	-	29.87	-22.41

Table 33 - FCC Maximum Conducted (average) Output Power Results

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2412	-	16.65	-	-	-	30.00	-13.35	22.78	36.00	-13.22
2442	-	22.15	-	-	-	30.00	-7.85	28.28	36.00	-7.72
2472	-	7.46	-	-	-	30.00	-22.54	13.59	36.00	-22.41

Table 34 - ISSED Maximum Conducted (average) Output Power Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(3) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.2.3.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11ax HE20 SU	Duty Cycle (%):	95.8
Modulation Coding Scheme:	MCS2x1	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	6.13
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2412	-	15.82	-	-	-	29.87	-14.05
2442	-	22.22	-	-	-	29.87	-7.65
2472	-	6.57	-	-	-	29.87	-23.30

Table 35 - FCC Maximum Conducted (average) Output Power Results

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2412	-	15.82	-	-	-	30.00	-14.18	21.95	36.00	-14.05
2442	-	22.22	-	-	-	30.00	-7.78	28.35	36.00	-7.65
2472	-	6.57	-	-	-	30.00	-23.43	12.70	36.00	-23.30

Table 36 - ISSED Maximum Conducted (average) Output Power Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(3) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.2.3.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11ax HE20 RU26	Duty Cycle (%):	96.5
Modulation Coding Scheme:	MCS2x1	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	6.13
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2412	-	14.26	-	-	-	29.87	-15.61
2442	-	14.47	-	-	-	29.87	-15.40
2472	-	-3.28	-	-	-	29.87	-33.15

Table 37 - FCC Maximum Conducted (average) Output Power Results

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2412	-	14.26	-	-	-	30.00	-15.74	20.39	36.00	-15.61
2442	-	14.47	-	-	-	30.00	-15.53	20.60	36.00	-15.40
2472	-	-3.28	-	-	-	30.00	-33.28	2.85	36.00	-33.15

Table 38 - ISSED Maximum Conducted (average) Output Power Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(3) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.2.3.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11ax HE20 RU52	Duty Cycle (%):	96.4
Modulation Coding Scheme:	MCS2x1	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	6.13
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2412	-	17.15	-	-	-	29.87	-12.72
2442	-	17.18	-	-	-	29.87	-12.69
2472	-	-0.18	-	-	-	29.87	-30.05

Table 39 - FCC Maximum Conducted (average) Output Power Results

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2412	-	17.15	-	-	-	30.00	-12.85	23.28	36.00	-12.72
2442	-	17.18	-	-	-	30.00	-12.82	23.31	36.00	-12.69
2472	-	-0.18	-	-	-	30.00	-30.18	5.95	36.00	-30.05

Table 40 - ISSED Maximum Conducted (average) Output Power Results



Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(3) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.2.3.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	802.11ax HE20 RU106	Duty Cycle (%):	97.8
Modulation Coding Scheme:	MCS2x1	DCCF (dB):	-
Antenna Configuration:	SISO	Peak Antenna Gain (dBi):	6.13
Active Port(s):	B (Core 1)	Active Chain(s):	1

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2412	-	16.79	-	-	-	29.87	-13.08
2442	-	20.16	-	-	-	29.87	-9.71
2472	-	0.73	-	-	-	29.87	-29.14

Table 41 - FCC Maximum Conducted (average) Output Power Results

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2412	-	16.79	-	-	-	30.00	-13.21	22.92	36.00	-13.08
2442	-	20.16	-	-	-	30.00	-9.84	26.29	36.00	-9.71
2472	-	0.73	-	-	-	30.00	-29.27	6.86	36.00	-29.14

Table 42 - ISD Maximum Conducted (average) Output Power Results