

FCC and ISED Test Report

Apple Inc
Model: A2816

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: BCGA2816

IC: 579C-A2816

COMMERCIAL-IN-CONFIDENCE

Document 75954420-05 Issue 01

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Ryan Henley	Sales Manager	Authorised Signatory	05 December 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	Lauren Walters	05 December 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: 2021, 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.



DISCLAIMER AND COPYRIGHT

This non-binding report has been prepared by TÜV SÜD with all reasonable skill and care. The document is confidential to the potential Client and TÜV SÜD. No part of this document may be reproduced without the prior written approval of TÜV SÜD. © 2022 TÜV SÜD. This report relates only to the actual item/items tested.

ACCREDITATION

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation. Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

TÜV SÜD
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



Contents

1	Report Summary	2
1.1	Report Modification Record.....	2
1.2	Introduction.....	2
1.3	Brief Summary of Results	3
1.4	Product Information	4
1.5	Deviations from the Standard.....	5
1.6	EUT Modification Record	5
1.7	Test Location	5
2	Test Details	6
2.1	Restricted Band Edges.....	6
2.2	Emission Bandwidth	25
2.3	Maximum Conducted Output Power	39
2.4	Spurious Radiated Emissions	53
2.5	Authorised Band Edges	81
2.6	Power Spectral Density.....	88
3	Measurement Uncertainty	96



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	05 December 2022

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A2816
Serial Number(s)	V712HT2WFF and H12J4GXMVX
Hardware Version(s)	REV 1.0
Software Version(s)	22A12320r
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2021 ISED RSS-247: Issue 2 (02-2017) ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021)
Order Number	0540246998
Start of Test	17-June-2022
Finish of Test	11-November-2022
Name of Engineer(s)	Daniel Cameron, Thomas Biddlecombe, Ahmad Javid, Colin Brain, Thomas Randall, Mohammad Malik and Ian Hart
Related Document(s)	ANSI C63.10 (2020) KDB 662911 D01 v02r01 ANSI C63.10 (2013)



1.3 Brief Summary of Results

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

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	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	15.247 (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 desktop computer with Bluetooth® and IEEE 802.11 a/b/g/n/ac/ax Wi-Fi 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 was 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	2.58	0.70
Core 1	2400 to 2480	6.24	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: A2816, Serial Number: H12J4GXMVX			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A2816, Serial Number: V712HT2WFF			
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	Colin Brain, Thomas Randall, Mohammad Malik and Ian Hart	UKAS
Emission Bandwidth	Daniel Cameron	UKAS
Maximum Conducted Output Power	Daniel Cameron	UKAS
Spurious Radiated Emissions	Ahmad Javid	UKAS
Authorised Band Edges	Colin Brain, Thomas Randall, Mohammad Malik and Ian Hart	UKAS
Power Spectral Density	Thomas Biddlecombe	UKAS

Table 5

Office Address:

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire
PO15 5RL
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

A2816, S/N: V712HT2WFF - Modification State 0

2.1.3 Date of Test

17-June-2022 to 27-June-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	22.2 - 25.1 °C
Relative Humidity	38.8 - 49.1 %



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	59.41	51.24
802.11b, Core 1	1 Mbps	-	-	2462	2483.5	56.83	46.10
802.11b, Core 1	1 Mbps	-	-	2467	2483.5	59.83	50.62
802.11b, Core 1	1 Mbps	-	-	2472	2483.5	58.03	50.82
802.11g, Core 1	54 Mbps	-	-	2412	2390.0	67.46	51.38
802.11g, Core 1	12 Mbps	-	-	2462	2483.5	65.53	51.14
802.11g, Core 1	54 Mbps	-	-	2467	2483.5	64.86	51.48
802.11g, Core 1	24 Mbps	-	-	2472	2483.5	63.89	51.41
802.11n HT20, Core 1	MCS4	-	-	2412	2390.0	66.51	51.40
802.11n HT20, Core 1	MCS2	-	-	2462	2483.5	65.23	51.39
802.11n HT20, Core 1	MCS2	-	-	2467	2483.5	63.45	51.23
802.11n HT20, Core 1	MCS4	-	-	2472	2483.5	65.18	51.32
802.11ax HE20, Core 1	MCS4x1	SU	-	2412	2400	67.61	51.05
802.11ax HE20, Core 1	MCS9x1	26	0	2412	2400	61.64	44.78
802.11ax HE20, Core 1	MCS4x1	SU	-	2462	2483.5	66.51	51.40
802.11ax HE20, Core 1	MCS2x1	SU	-	2467	2483.5	63.28	51.34
802.11ax HE20, Core 1	MCS9x1	26	8	2467	2483.5	60.82	44.47
802.11ax HE20, Core 1	MCS9x1	SU	-	2472	2483.5	66.43	51.24
802.11ax HE20, Core 1	MCS9x1	26	8	2472	2483.5	69.05	48.27

Table 6 - SISO Restricted Band Edge Results

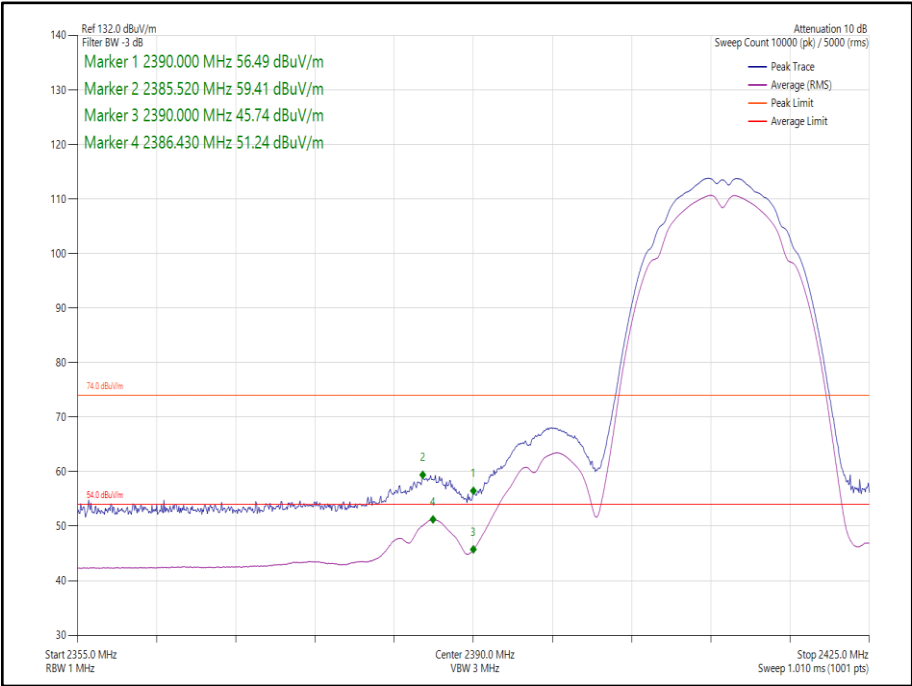


Figure 1 - 802.11b, Core 1 - 2412 MHz, Band Edge Frequency 2390.0 MHz

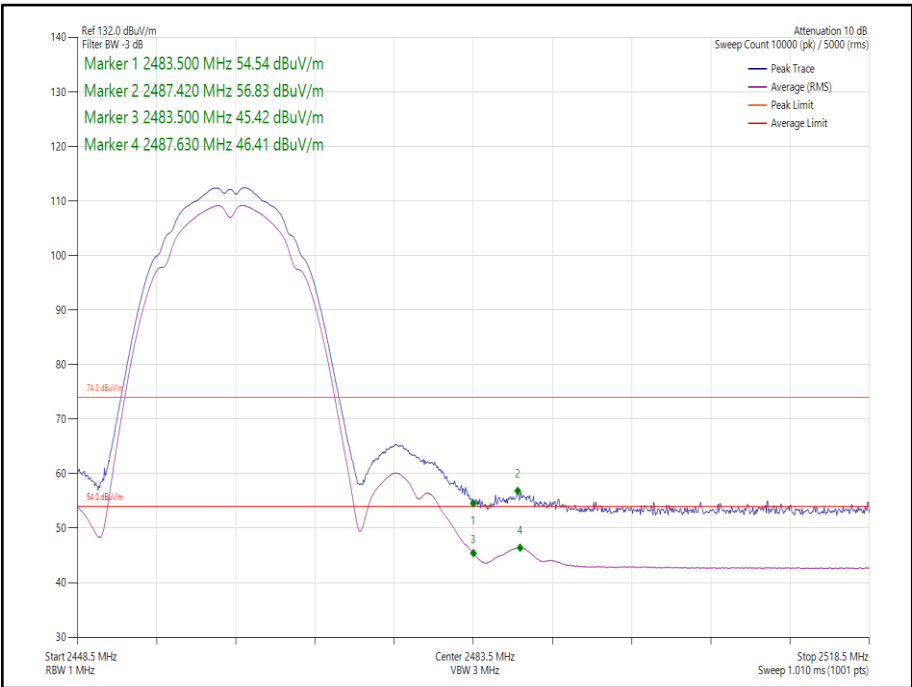


Figure 2 - 802.11b, Core 1 - 2462 MHz, Band Edge Frequency 2483.5 MHz

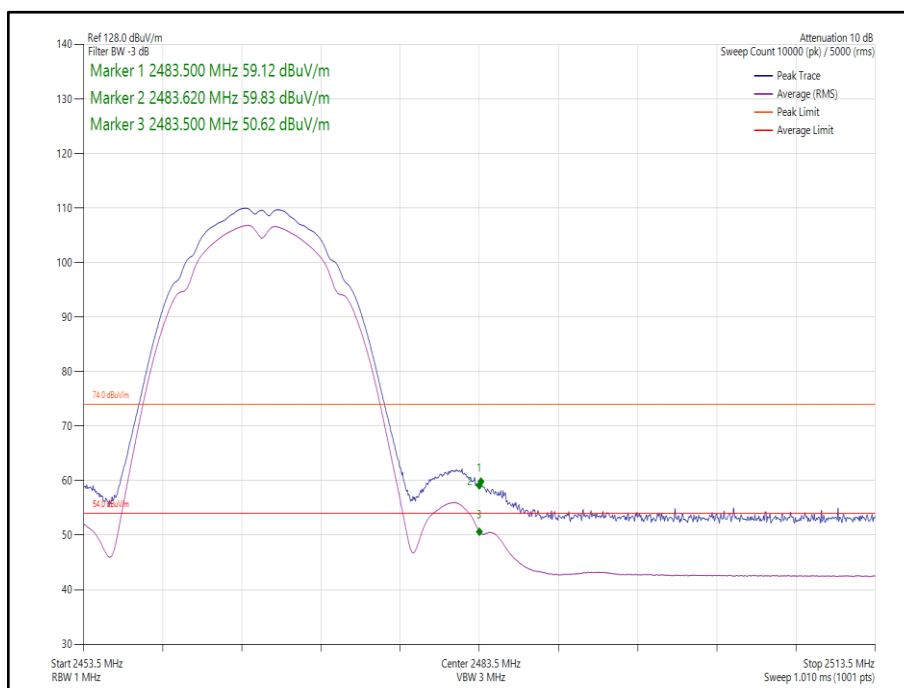


Figure 3 - 802.11b, Core 1 - 2467 MHz, Band Edge Frequency 2483.5 MHz

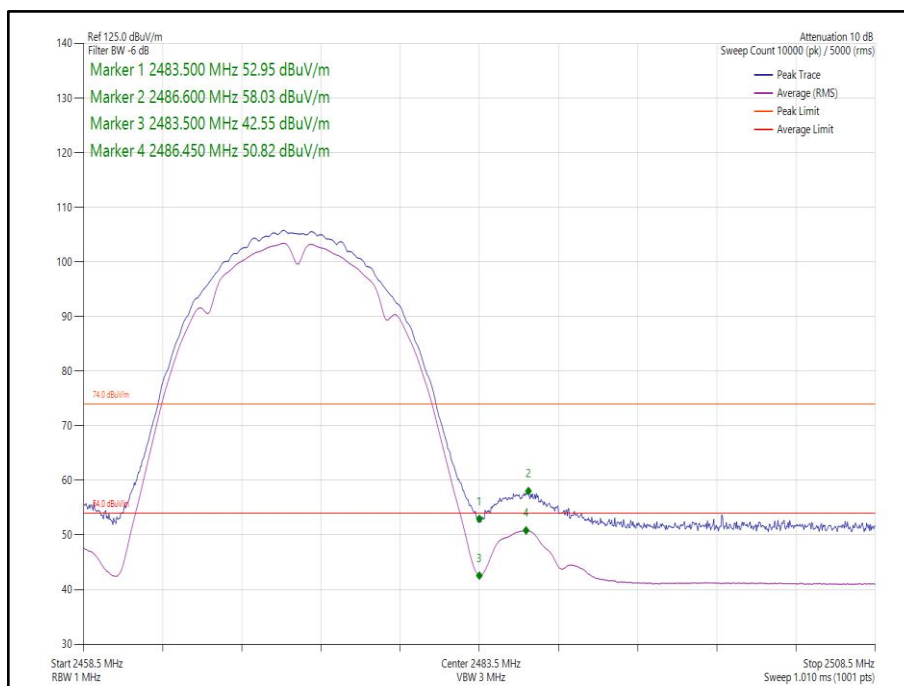


Figure 4 - 802.11b, Core 1 - 2472 MHz, Band Edge Frequency 2483.5 MHz

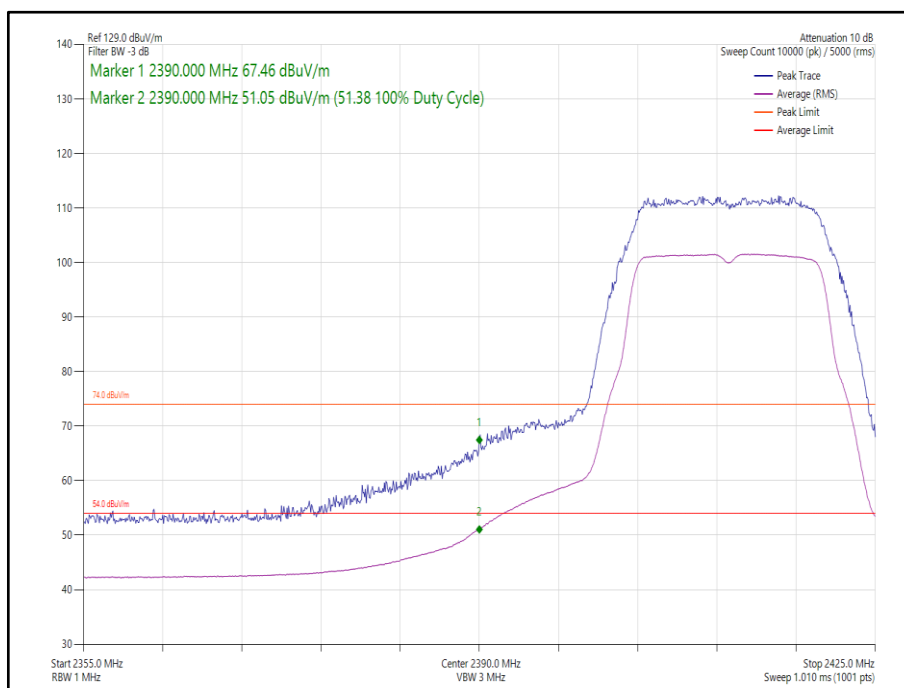


Figure 5 - 802.11g, Core 1 - 2412 MHz, Band Edge Frequency 2390.0 MHz

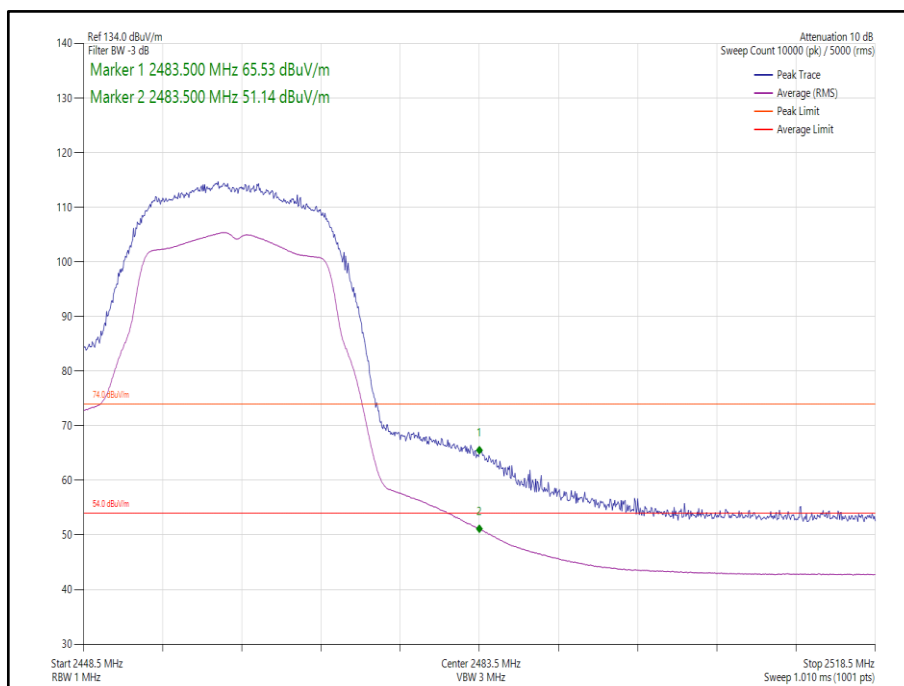


Figure 6 - 802.11g, Core 1 - 2462 MHz, Band Edge Frequency 2483.5 MHz

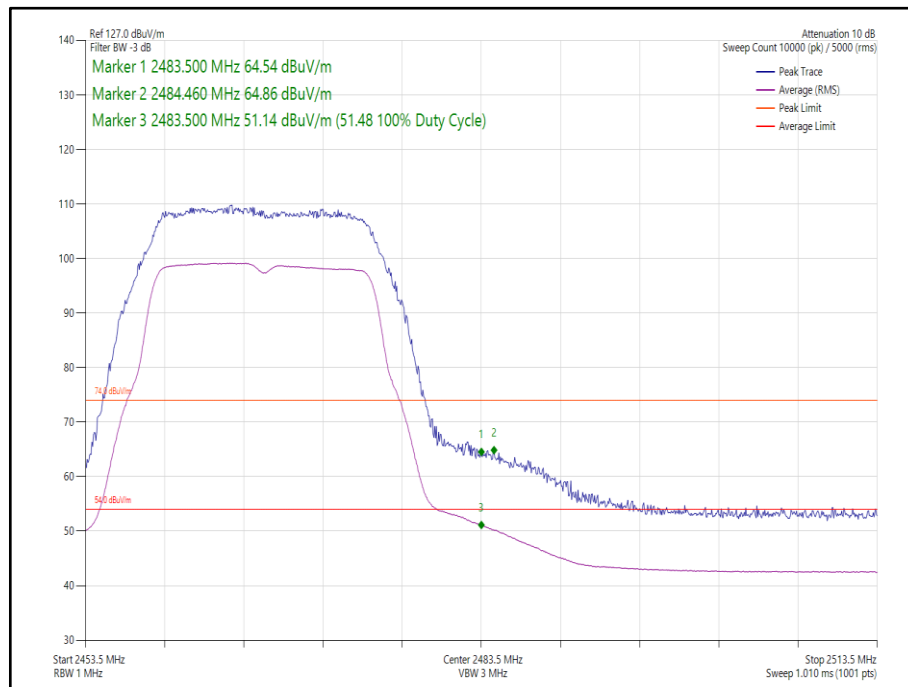


Figure 7 - 802.11g, Core 1 - 2467 MHz, Band Edge Frequency 2483.5 MHz

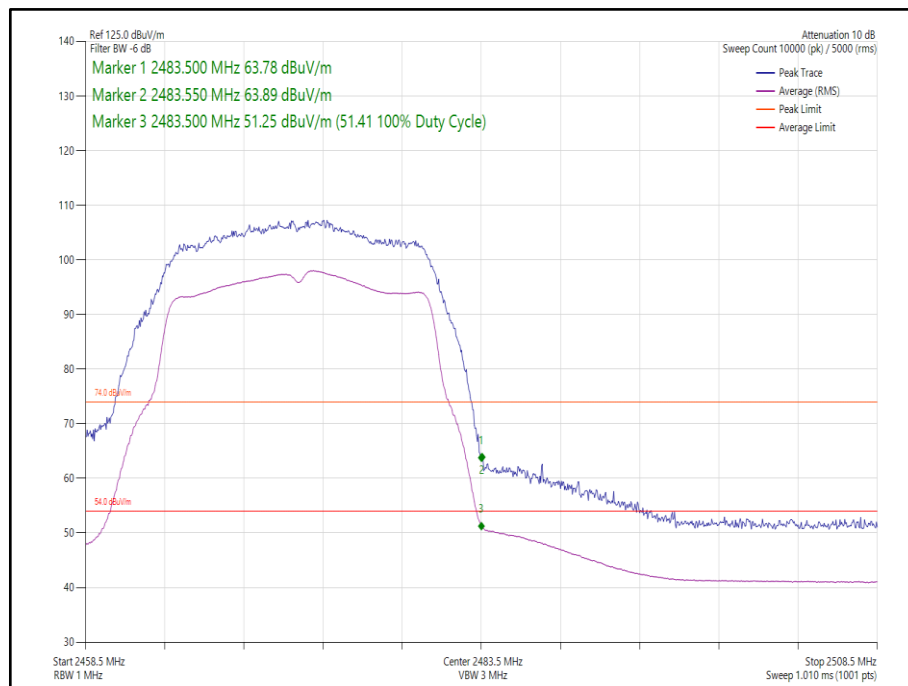


Figure 8 - 802.11g, Core 1 - 2472 MHz, Band Edge Frequency 2483.5 MHz

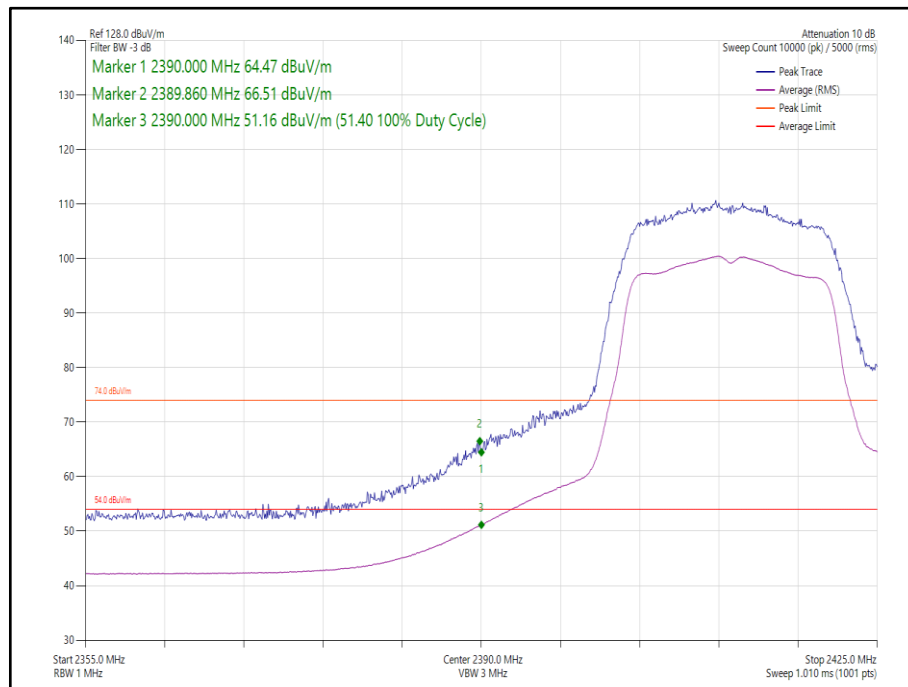


Figure 9 - 802.11n, HT20, Core 1 - 2412 MHz, Band Edge Frequency 2390 MHz

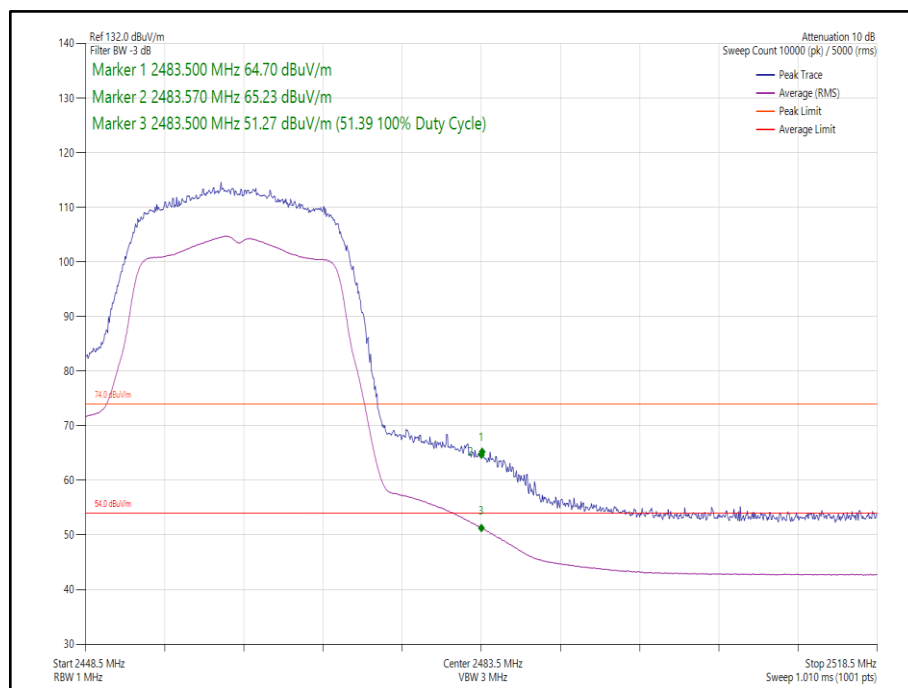


Figure 10 - 802.11n HT20, Core 1 - 2462 MHz, Band Edge Frequency 2483.5 MHz

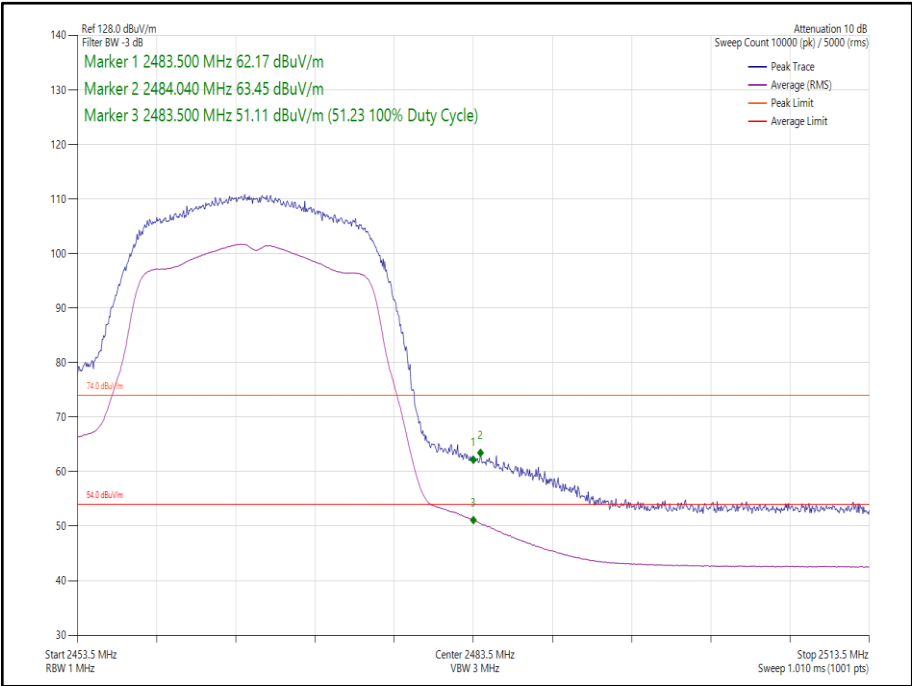


Figure 11 - 802.11n HT20, Core 1 - 2467 MHz, Band Edge Frequency 2483.5 MHz

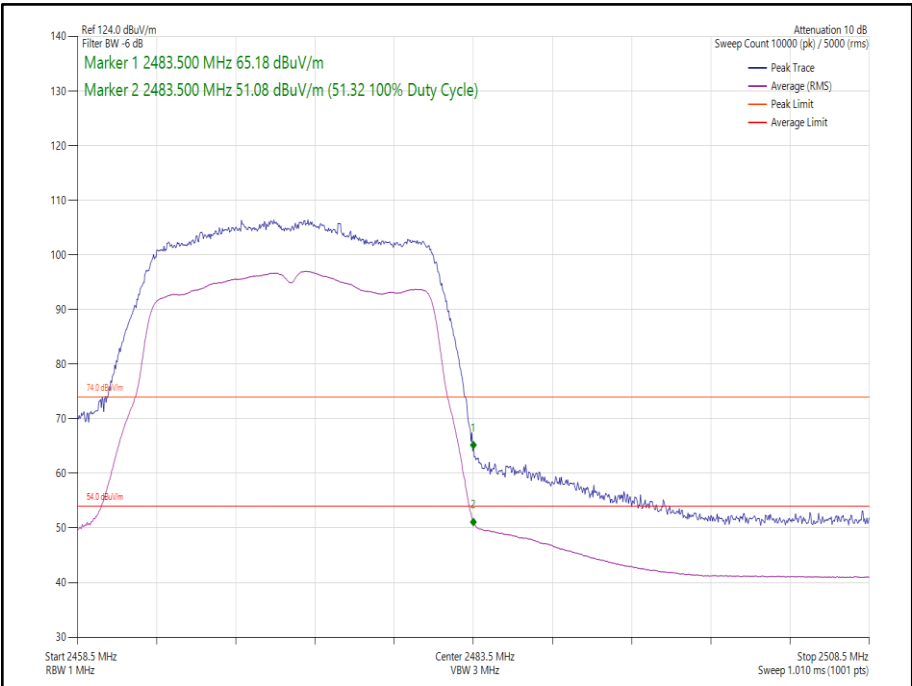


Figure 12 - 802.11n HT20, Core 1 - 2472 MHz, Band Edge Frequency 2483.5 MHz

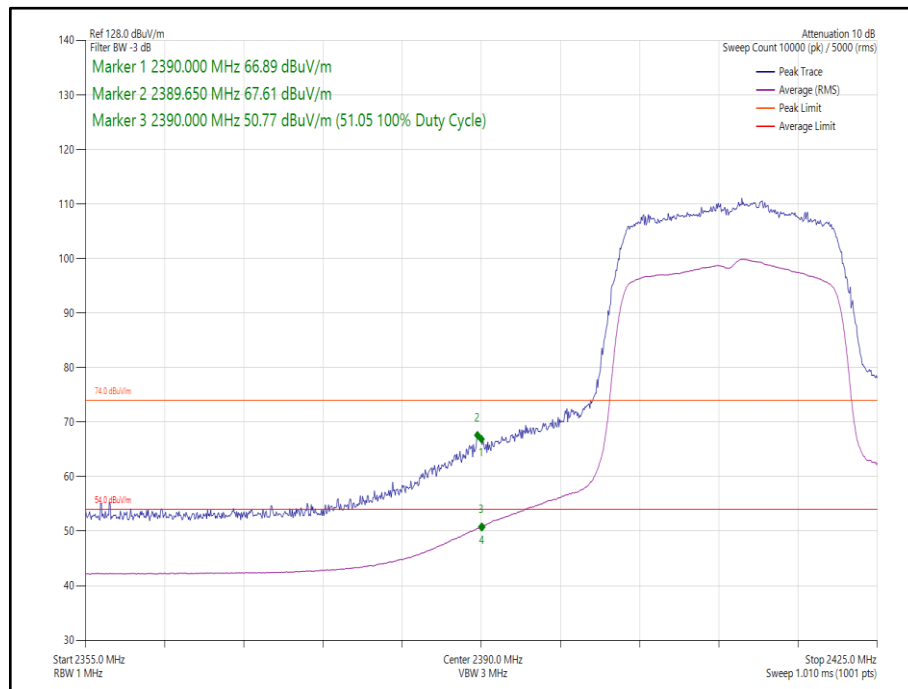


Figure 13 - 802.11ax HE20, Core 1, SU - 2412 MHz, Band Edge Frequency 2390 MHz

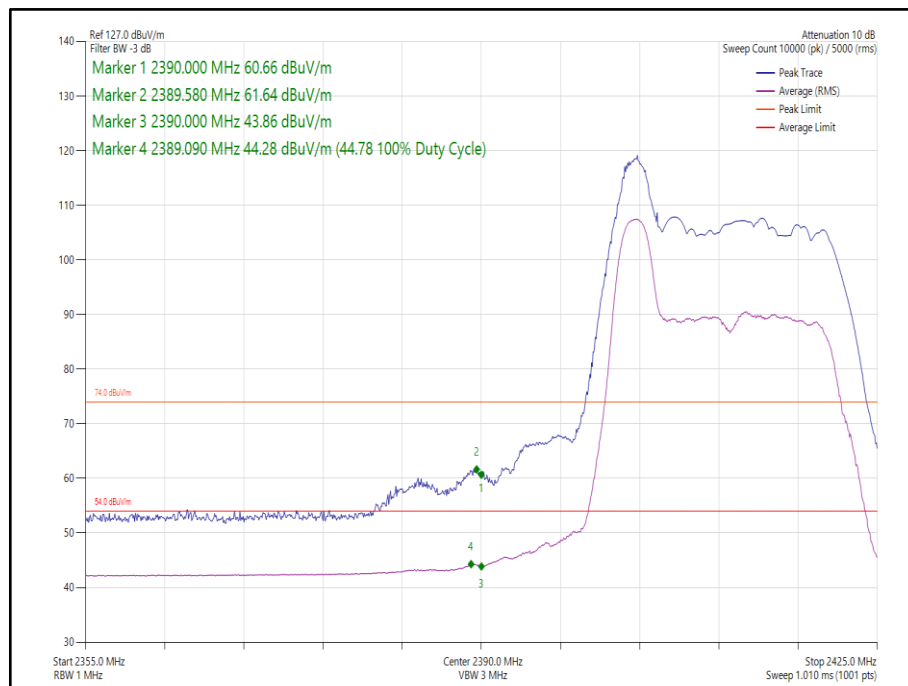


Figure 14 - 802.11ax HE20, Core 1, 26-0 - 2412 MHz, Band Edge Frequency 2390 MHz

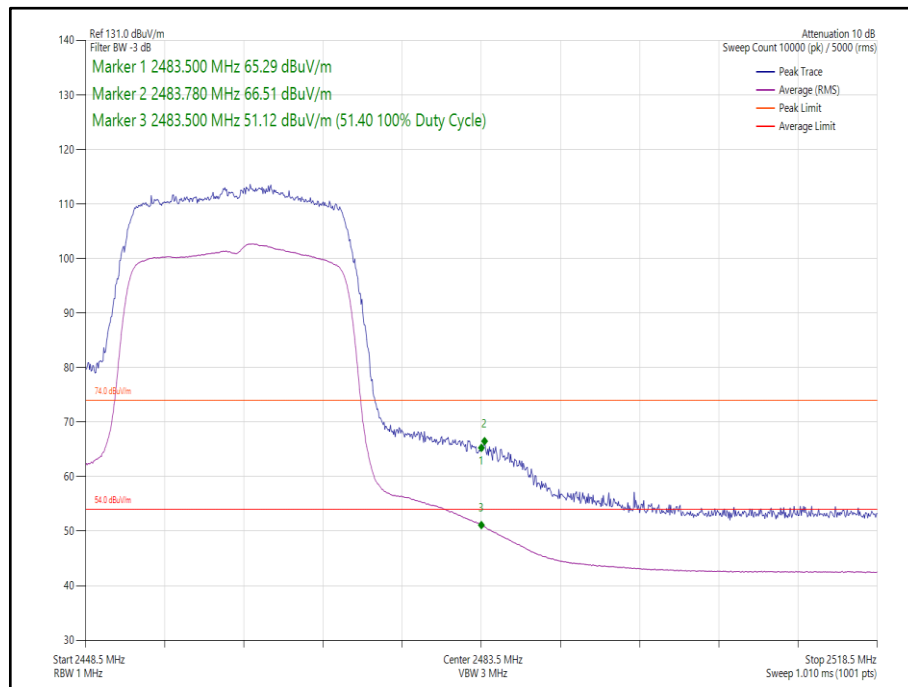


Figure 15 - 802.11ax HE20, Core 1, SU - 2462 MHz, Band Edge Frequency 2483.5 MHz

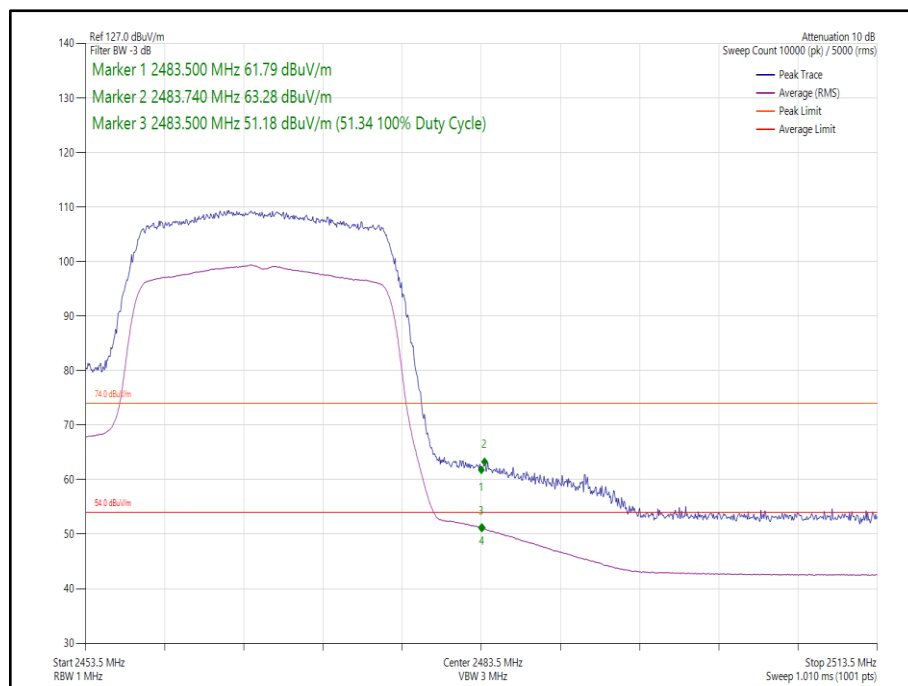


Figure 16 - 802.11ax HE20, Core 1, SU - 2467 MHz, Band Edge Frequency 2483.5 MHz

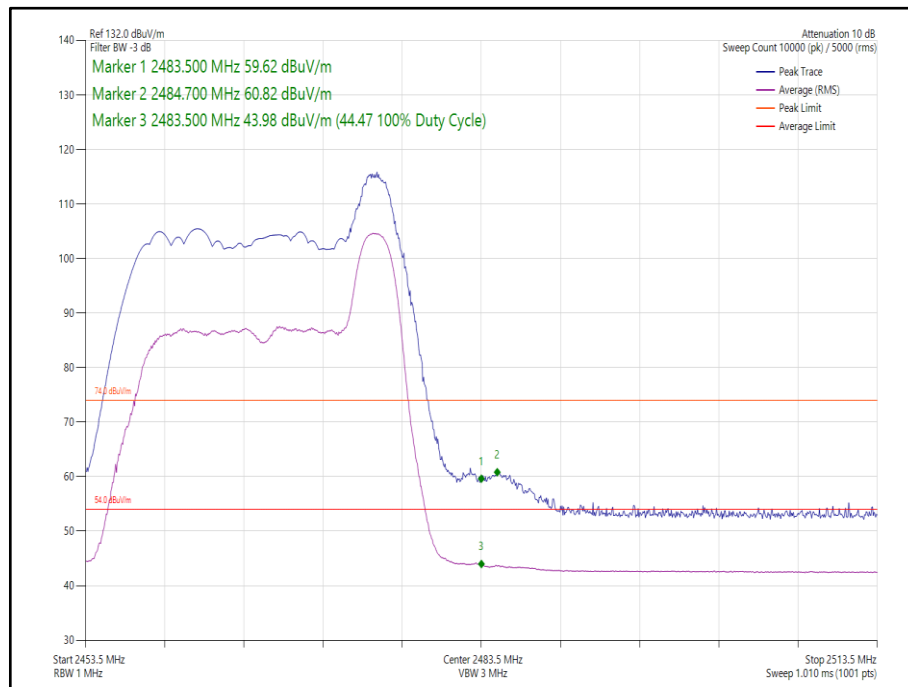


Figure 17 - 802.11ax HE20, Core 1, 26-8 - 2467 MHz, Band Edge Frequency 2483.5 MHz

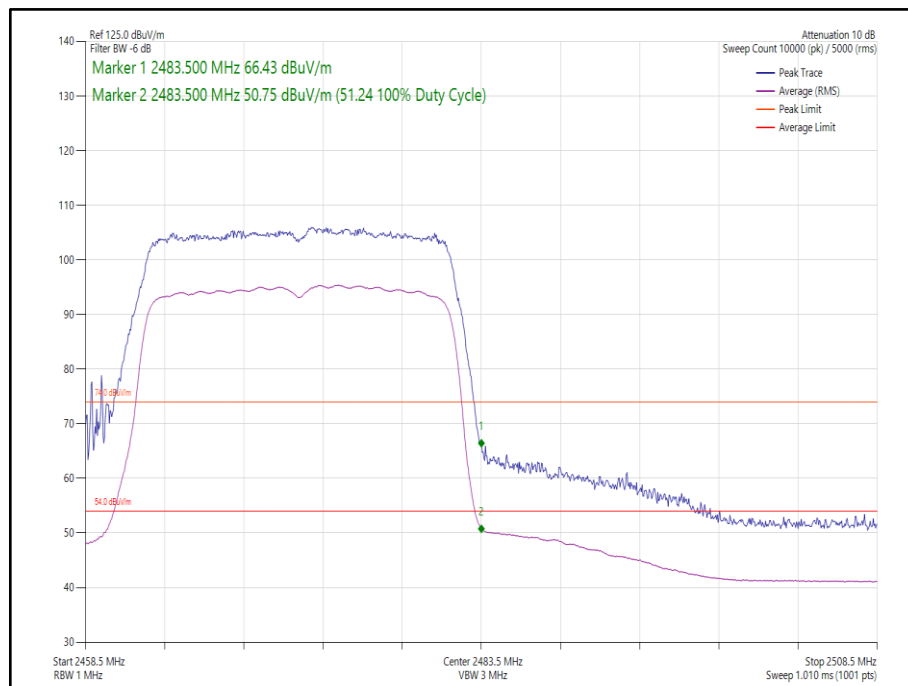


Figure 18 - 802.11ax HE20, Core 1, SU - 2472 MHz, Band Edge Frequency 2483.5 MHz

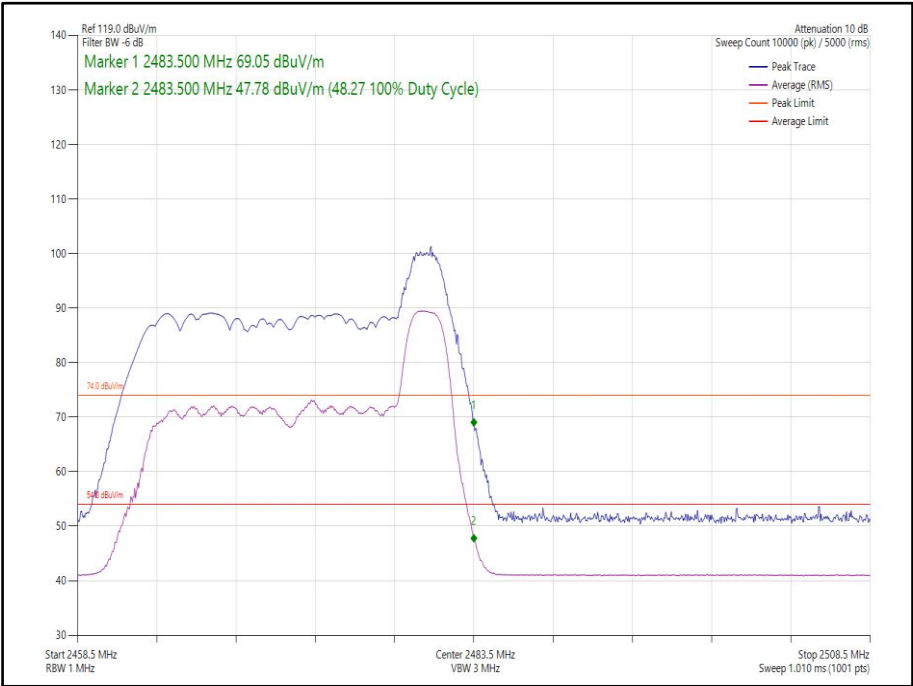


Figure 19 - 802.11ax HE20, Core 1, 26-8 - 2472 MHz, Band Edge Frequency 2483.5 MHz

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	66.03	51.09
802.11n HT20, Core 0-1	MCS4	-	-	2462	2483.5	65.53	51.42
802.11n HT20, Core 0-1	MCS2	-	-	2467	2483.5	63.35	51.44
802.11n HT20, Core 0-1	MCS7	-	-	2472	2483.5	64.03	51.07
802.11ax HE20, Core 0-1	MCS2x1	SU	-	2412	2400	64.58	51.43
802.11ax HE20, Core 0-1	MCS9x1	26	0	2412	2400	62.59	45.10
802.11ax HE20, Core 0-1	MCS4x1	SU	-	2462	2483.5	66.85	51.45
802.11ax HE20, Core 0-1	MCS4x1	SU	-	2467	2483.5	64.59	51.26
802.11ax HE20, Core 0-1	MCS9x1	26	8	2467	2483.5	64.33	46.45
802.11ax HE20, Core 0-1	MCS2x1	SU	-	2472	2483.5	64.41	51.22
802.11ax HE20, Core 0-1	MCS9x1	26	8	2472	2483.5	68.94	48.21

Table 7 – MIMO 2TX Restricted Band Edge Results

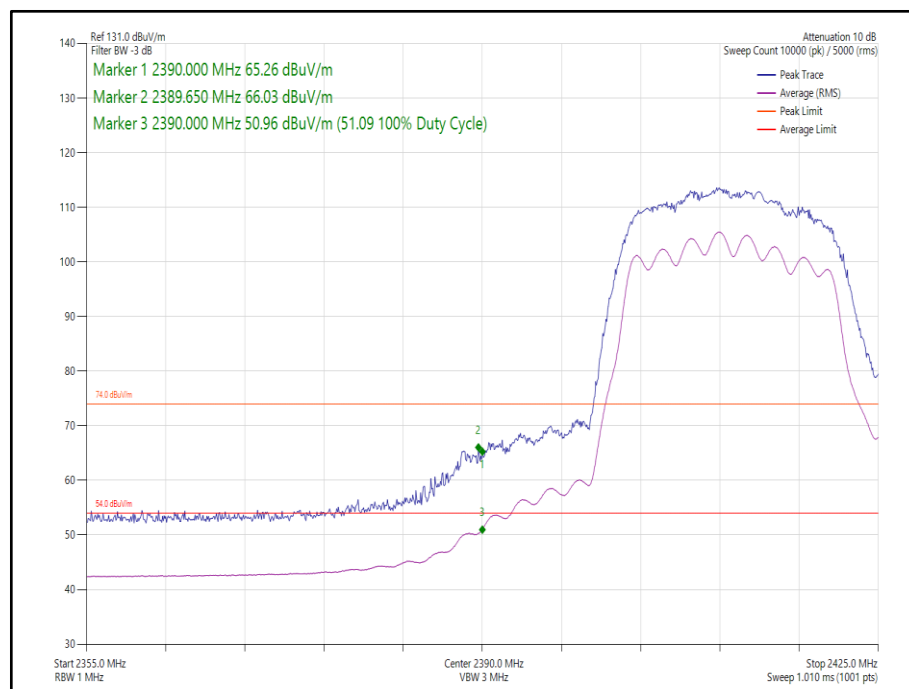


Figure 20 - 802.11n HT20, Core 0-1 - 2412 MHz, Band Edge Frequency 2390 MHz

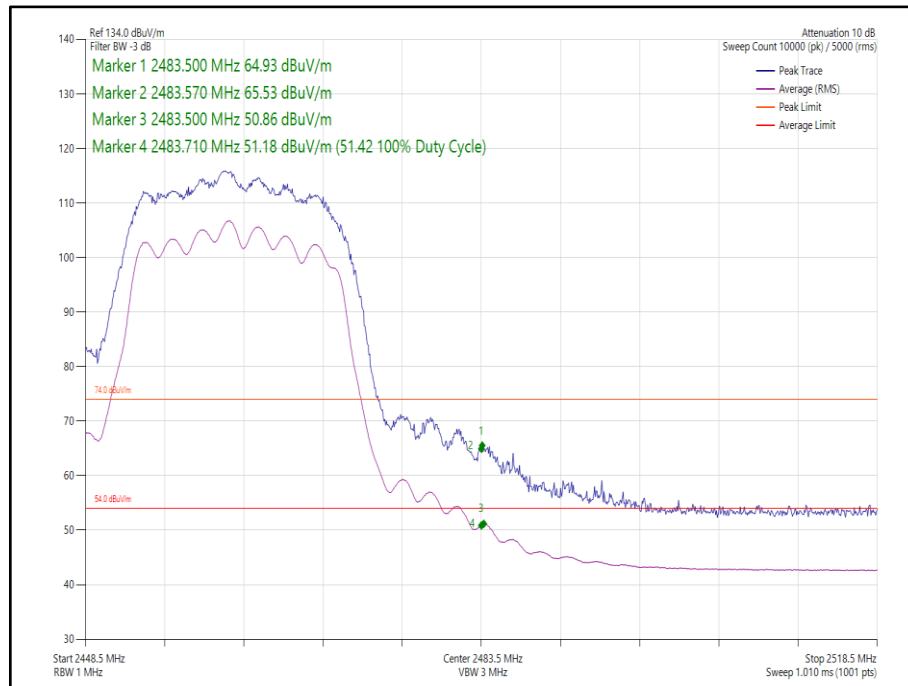


Figure 21 - 802.11n HT20, Core 0-1 - 2462 MHz, Band Edge Frequency 2483.5 MHz

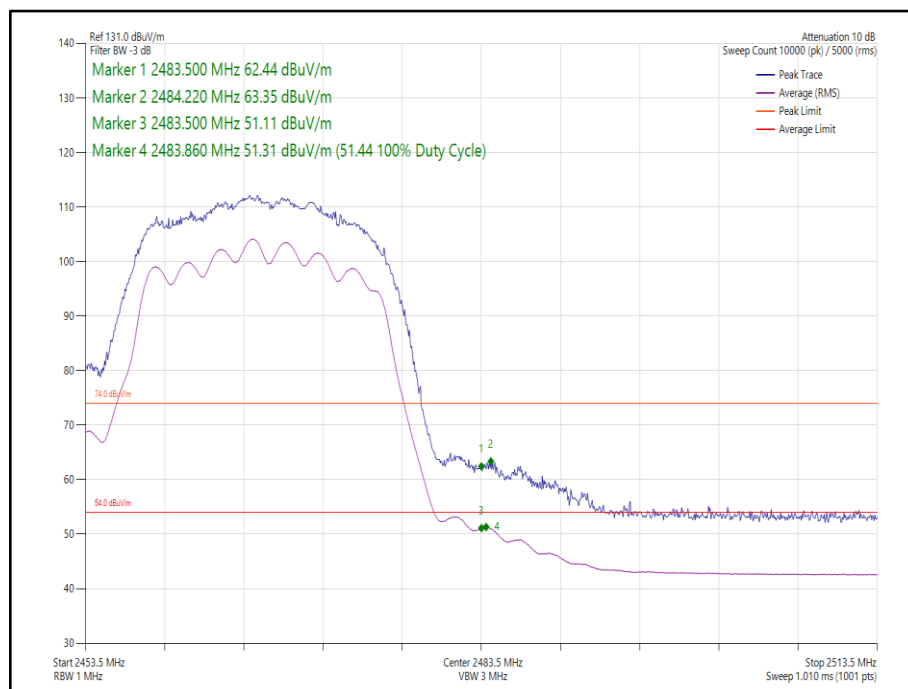


Figure 22 - 802.11n HT20, Core 0-1 - 2467 MHz, Band Edge Frequency 2483.5 MHz

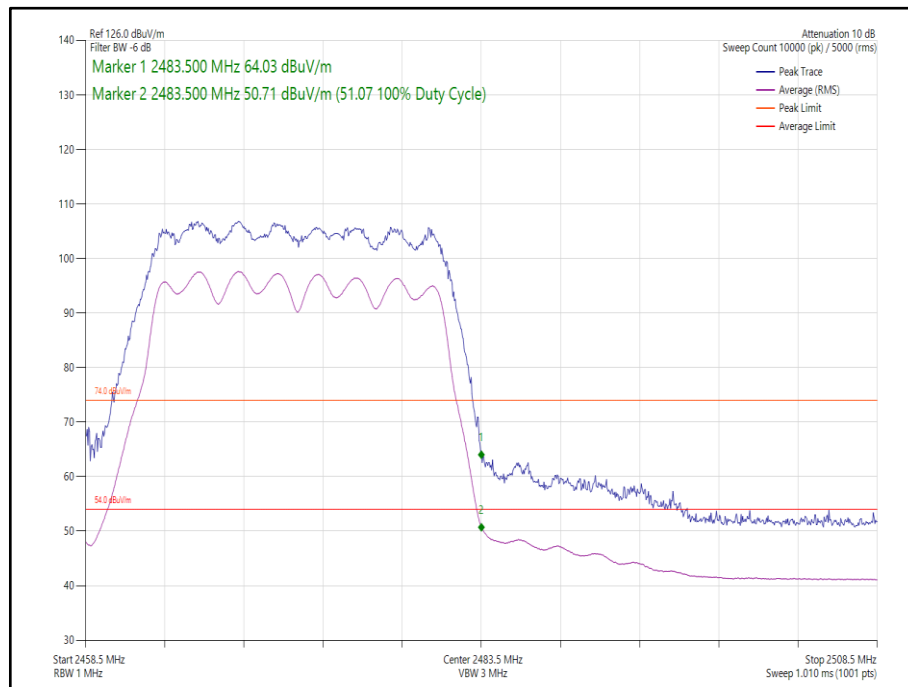


Figure 23 - 802.11n HT20, Core 0-1 - 2472 MHz, Band Edge Frequency 2483.5 MHz

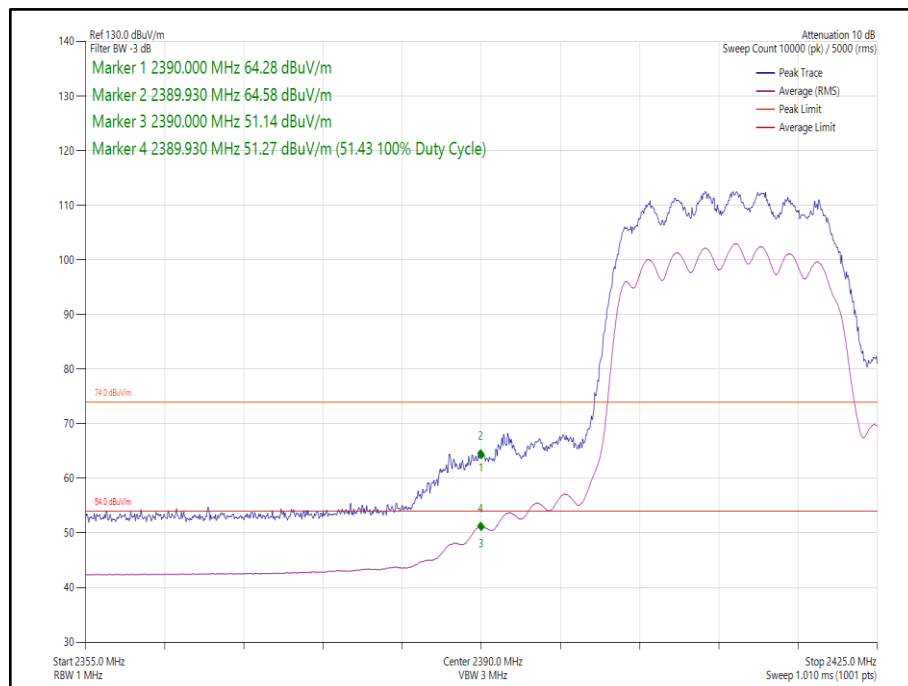
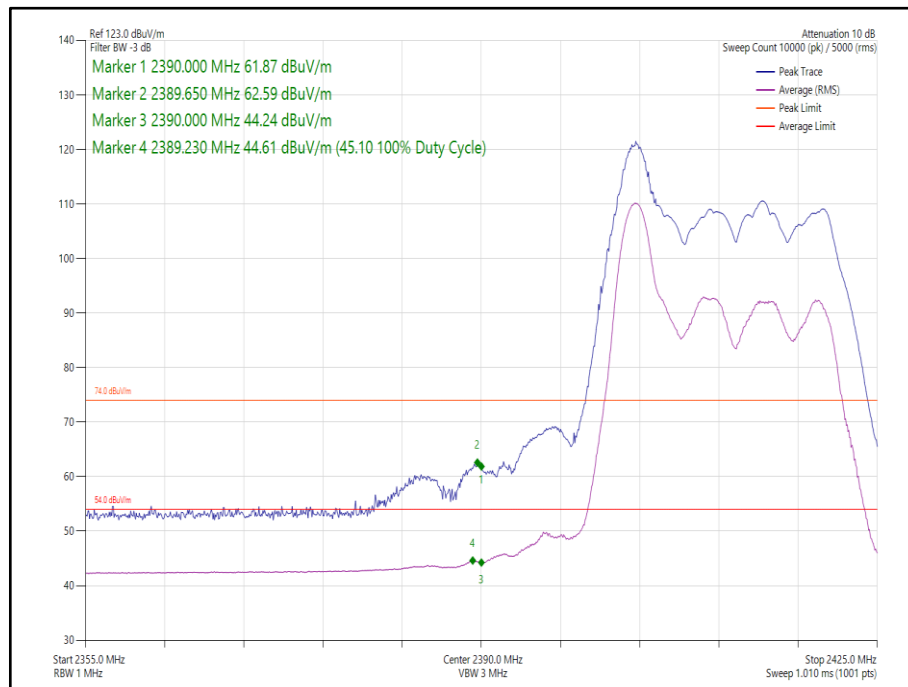
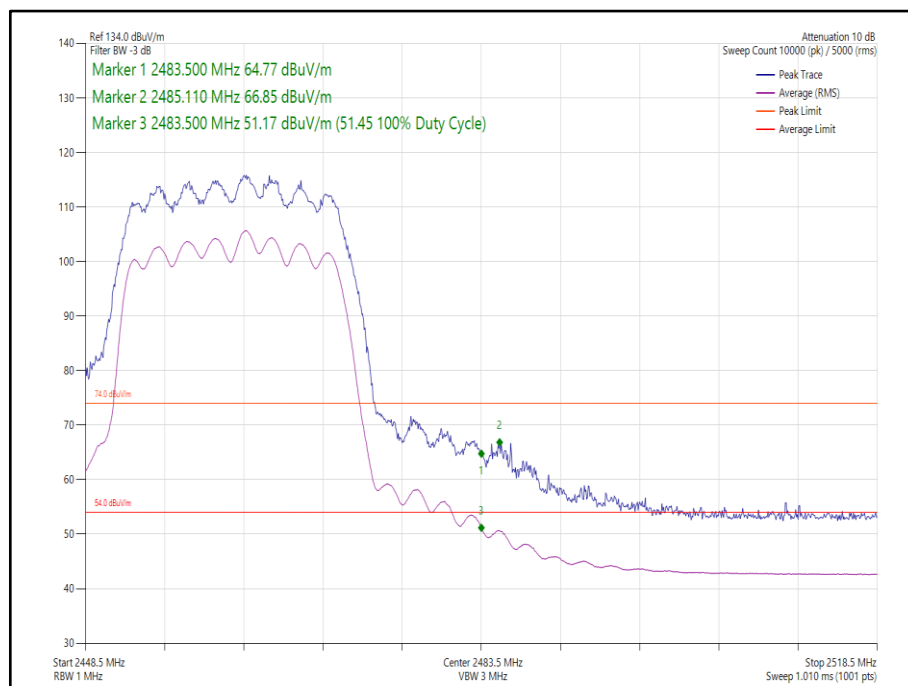


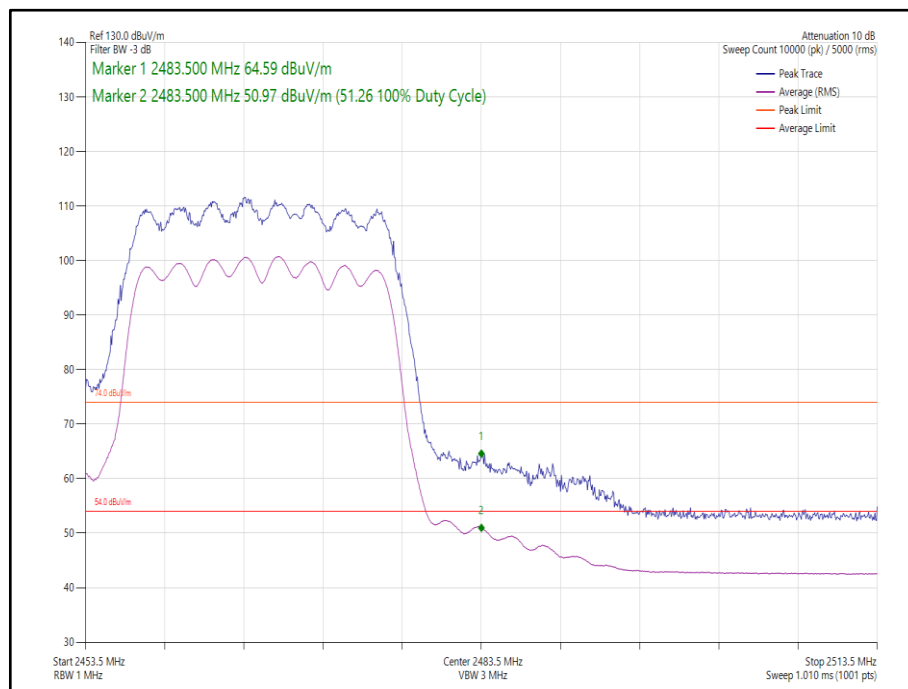
Figure 24 - 802.11ax HE20, Core 0-1, SU - 2412 MHz, Band Edge Frequency 2390 MHz



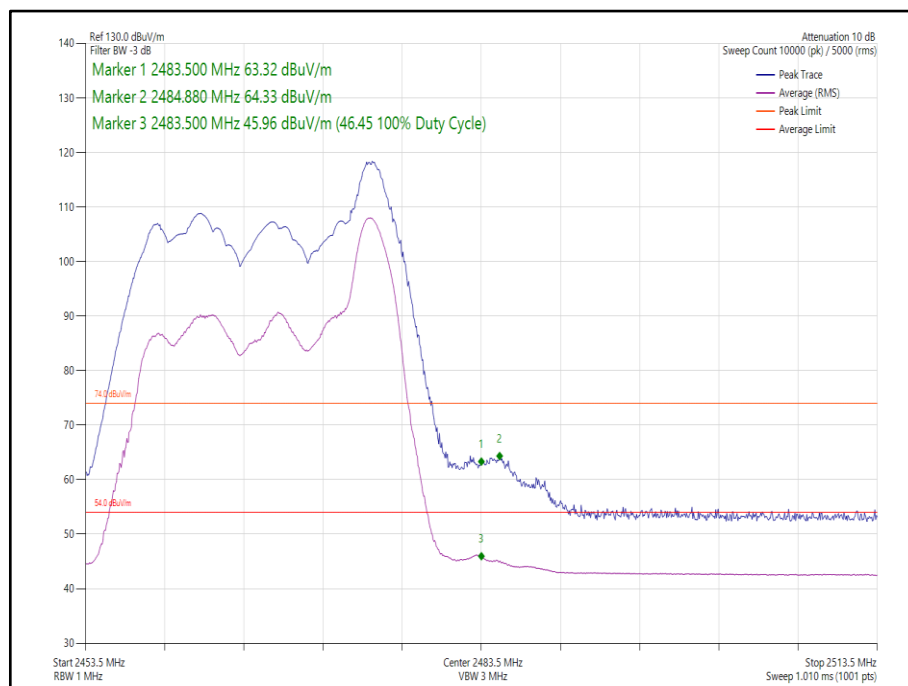
**Figure 25 - 802.11ax HE20, Core 0-1, 26-0 - 2412 MHz,
Band Edge Frequency 2390 MHz**



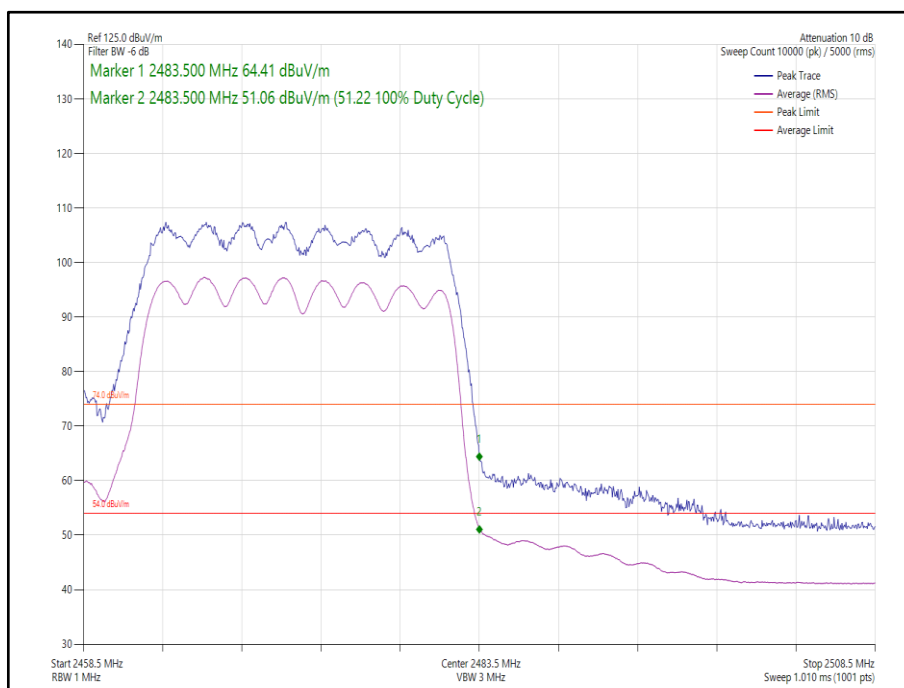
**Figure 26 - 802.11ax HE20, Core 0-1, SU - 2462 MHz,
Band Edge Frequency 2483.5 MHz**



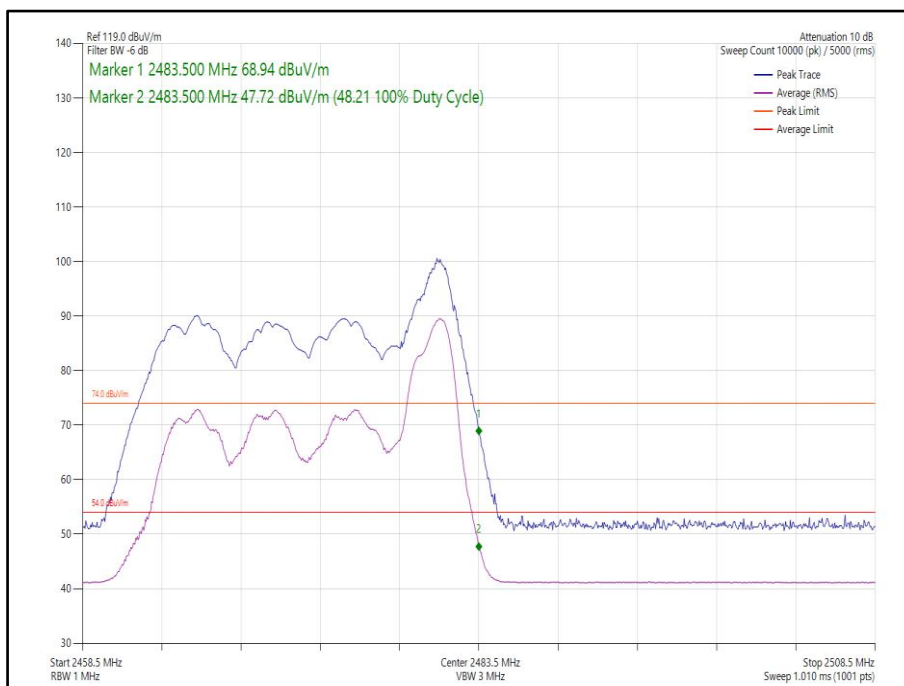
**Figure 27 - 802.11ax HE20, Core 0-1, SU - 2467 MHz,
Band Edge Frequency 2483.5 MHz**



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

Table 8

ISED RSS-GEN, Limit Clause 8.9

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

Table 9

*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 EMC Chamber 5.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Expiry Date
Screened Room (5)	Rainford	Rainford	1545	36	15-Apr-2024
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Mast Controller	Maturo GmbH	NCD	4810	-	TU
Tilt Antenna Mast	Maturo GmbH	TAM 4.0-P	4811	-	TU
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	4848	12	28-May-2023
Cable (SMA to SMA, 2 m)	Junkosha	MWX221-02000AMSAMS/A	5517	12	12-Apr-2023
EMI Test Receiver	Rohde & Schwarz	ESW44	5527	12	28-Apr-2023
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5604	12	22-Sep-2022

Table 10

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

A2816, S/N: H12J4GXMVX - Modification State 0

2.2.3 Date of Test

11-November-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	23.4 °C
Relative Humidity	46.5 %

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	16.200
802.11n HT20	15.300	17.400
802.11ax HE20 SU	18.240	19.080

Table 11 - 6 dB Bandwidth Summary Results

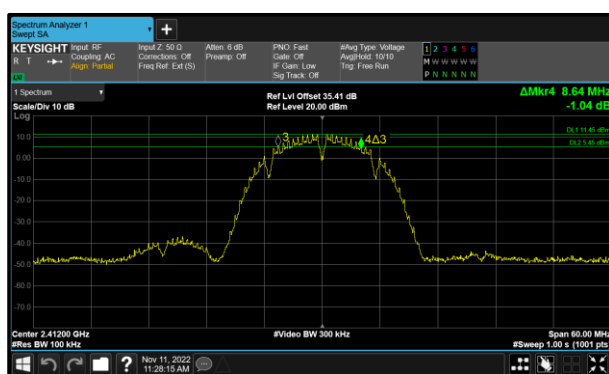


Figure 31 - 802.11b Minimum 6 dB EBW

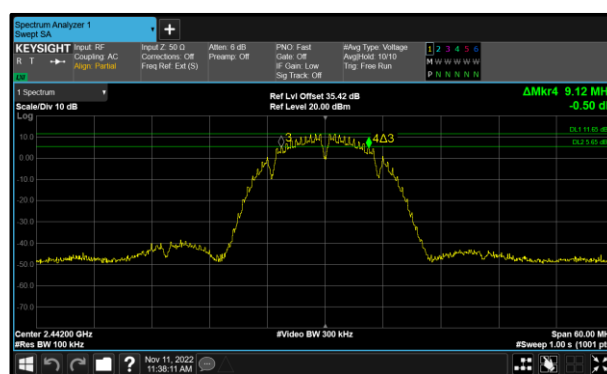


Figure 32 - 802.11b Maximum 6 dB EBW

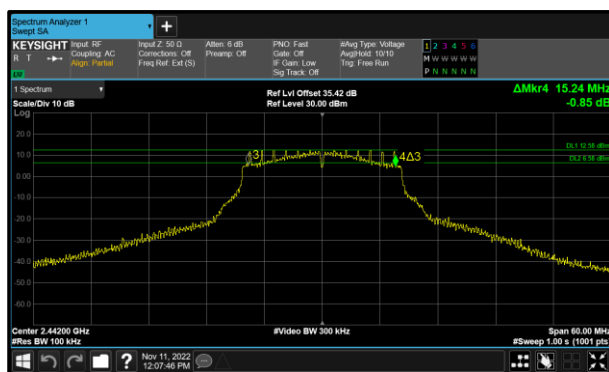


Figure 33 - 802.11g Minimum 6 dB EBW

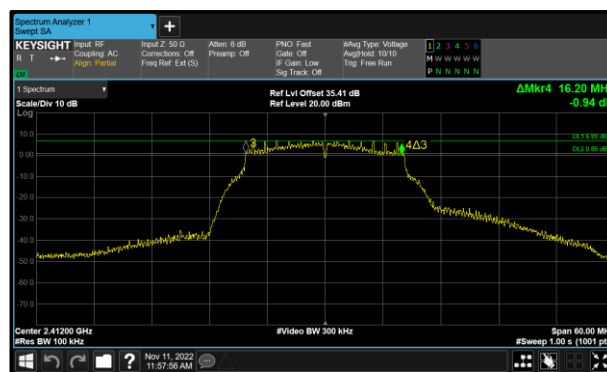


Figure 34 - 802.11g Maximum 6 dB EBW

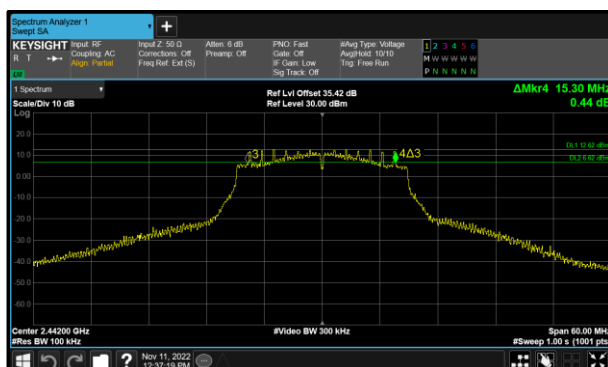


Figure 35 - 802.11n HT20 Minimum 6 dB EBW

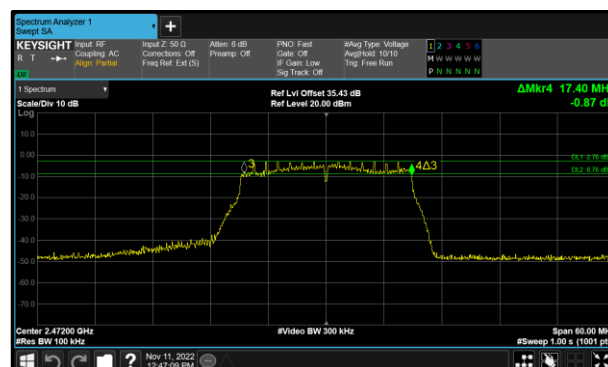


Figure 36 - 802.11n HT20 Maximum 6 dB EBW

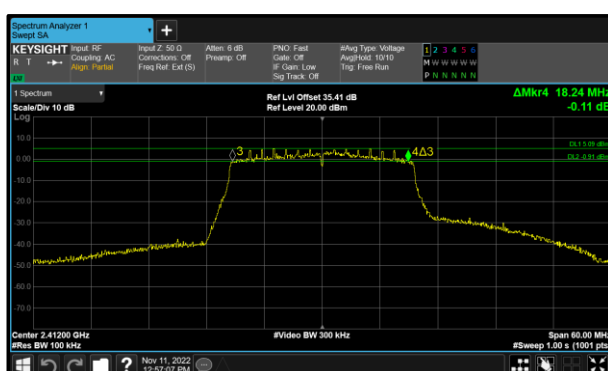


Figure 37 - 802.11ax HE20 SU Minimum 6 dB
EBW

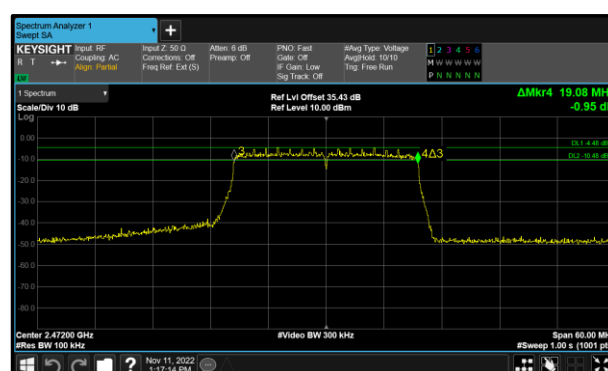


Figure 38 - 802.11ax HE20 SU Maximum 6 dB
EBW

Protocol	99% Bandwidth (MHz)	
	Minimum	Maximum
802.11b	12.900	12.960
802.11g	16.440	16.860
802.11n HT20	17.580	17.820
802.11ax HE20 SU	18.960	19.020

Table 12 - 99% Bandwidth Summary Results

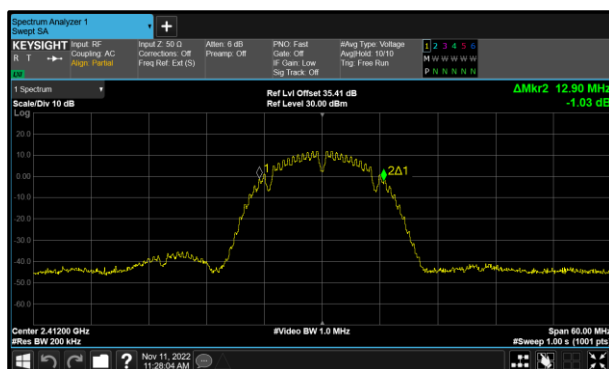


Figure 39 - 802.11b Minimum 99% OBW

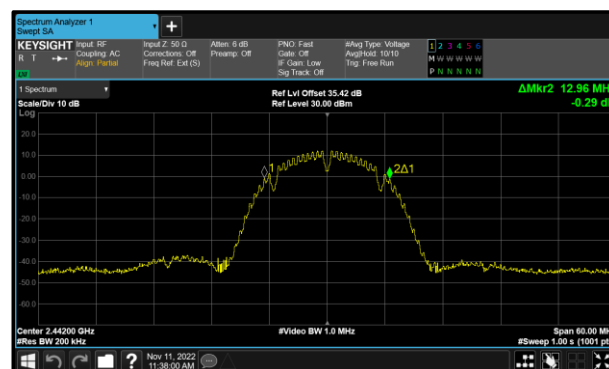


Figure 40 - 802.11b Maximum 99% OBW

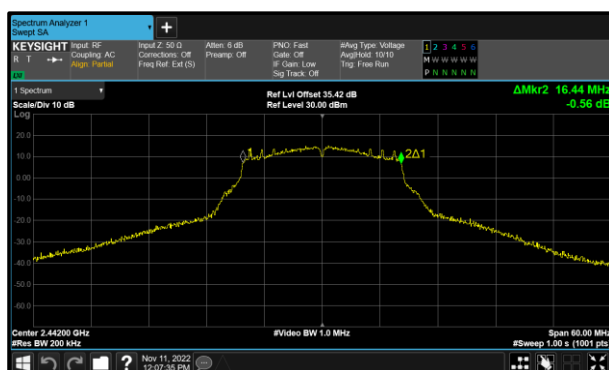


Figure 41 - 802.11g Minimum 99% OBW

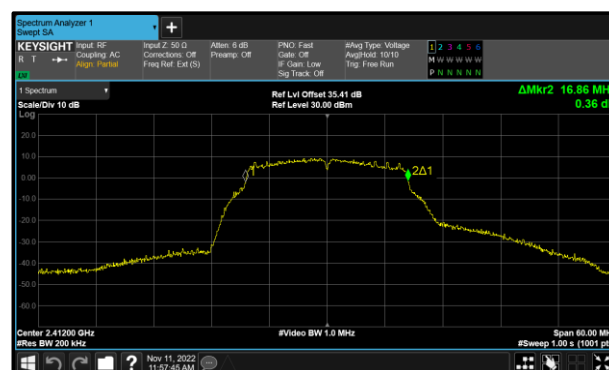


Figure 42 - 802.11g Maximum 99% OBW

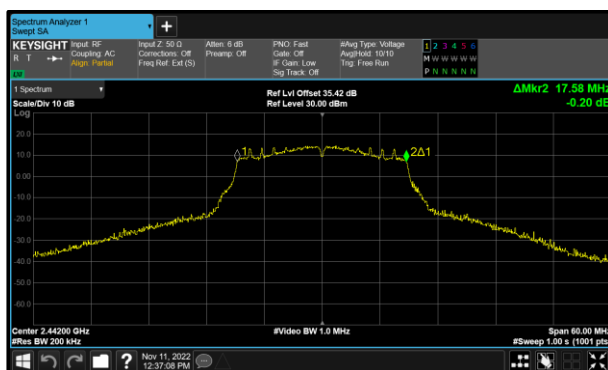


Figure 43 - 802.11n HT20 Minimum 99% OBW

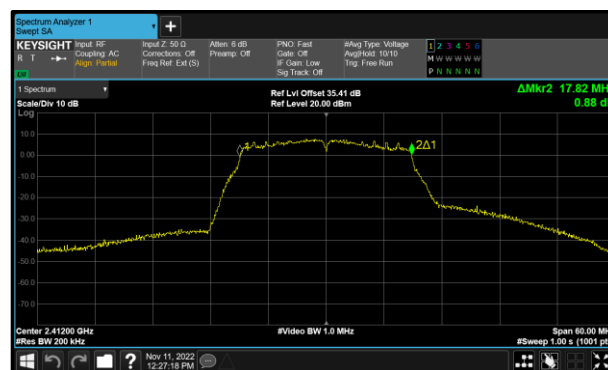


Figure 44 - 802.11n HT20 Maximum 99% OBW

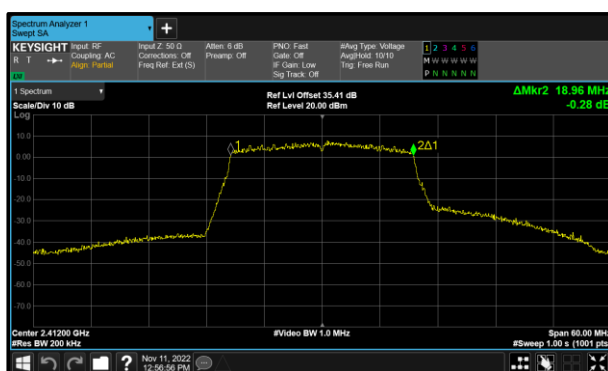


Figure 45 - 802.11ax HE20 SU Minimum 99% OBW

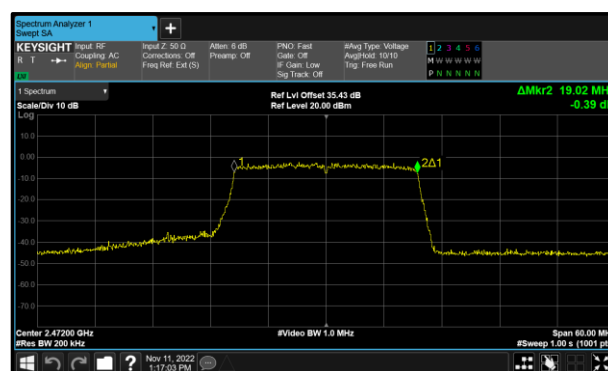


Figure 46 - 802.11ax HE20 SU Maximum 99% OBW



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	-	9.120	-	-	≥500.0

Table 13 - 6 dB Bandwidth Results

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

Table 14 - 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	-	16.200	-	-	≥500.0
2442	-	15.240	-	-	≥500.0
2472	-	16.200	-	-	≥500.0

Table 15 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	16.860	-	-	-
2442	-	16.440	-	-	-
2472	-	16.560	-	-	-

Table 16 - 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	-	17.340	-	-	≥500.0
2442	-	15.300	-	-	≥500.0
2472	-	17.400	-	-	≥500.0

Table 17 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	17.820	-	-	-
2442	-	17.580	-	-	-
2472	-	17.760	-	-	-

Table 18 - 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	-	18.240	-	-	≥500.0
2442	-	18.900	-	-	≥500.0
2472	-	19.080	-	-	≥500.0

Table 19 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	-	18.960	-	-	-
2442	-	18.960	-	-	-
2472	-	19.020	-	-	-

Table 20 - 99% Bandwidth Results

Protocol	6 dB Bandwidth (MHz)	
	Minimum	Maximum
802.11n HT20	15.240	17.400
802.11ax HE20 SU	18.060	19.080

Table 21 - 6 dB Bandwidth Summary Results

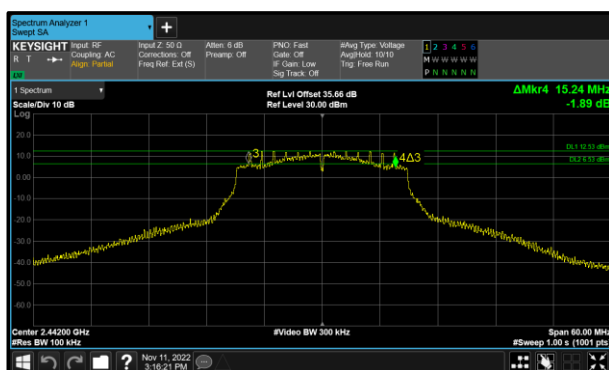


Figure 47 - 802.11n HT20 Minimum 6 dB EBW

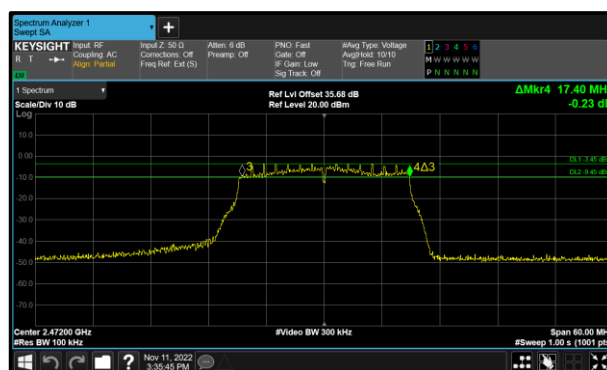


Figure 48 - 802.11n HT20 Maximum 6 dB EBW

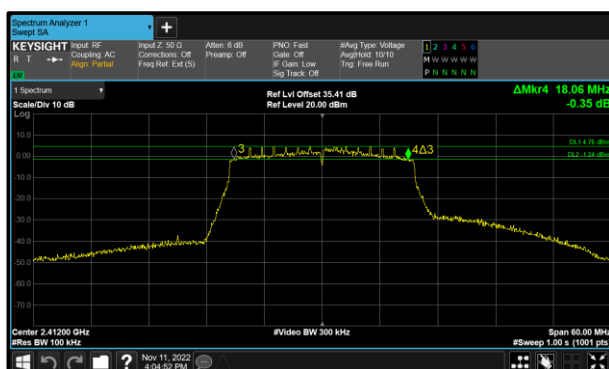


Figure 49 - 802.11ax HE20 SU Minimum 6 dB EBW

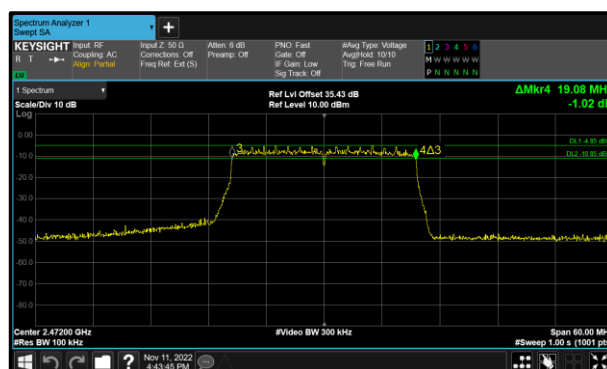


Figure 50 - 802.11ax HE20 SU Maximum 6 dB EBW

Protocol	99% Bandwidth (MHz)	
	Minimum	Maximum
802.11n HT20	17.580	17.820
802.11ax HE20 SU	18.960	19.020

Table 22 - 99% Bandwidth Summary Results

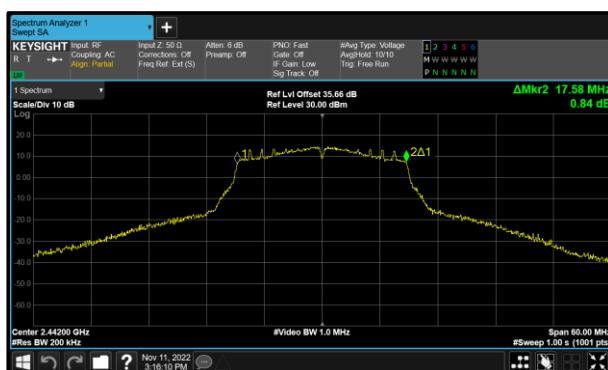


Figure 51 - 802.11n HT20 Minimum 99% OBW

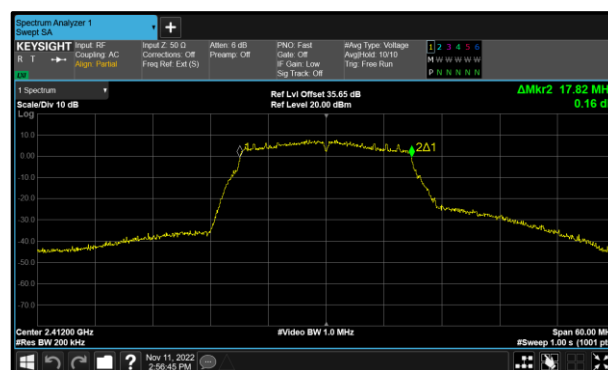


Figure 52 - 802.11n HT20 Maximum 99% OBW

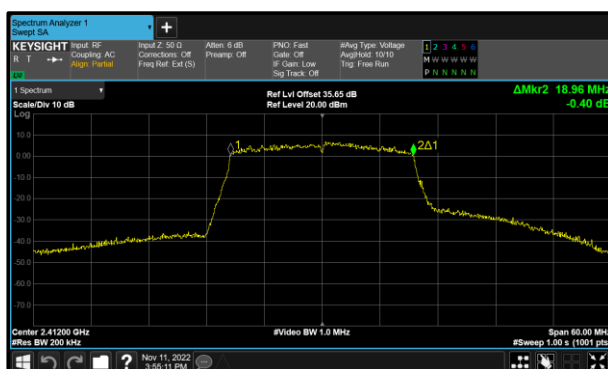


Figure 53 - 802.11ax HE20 SU Minimum 99% OBW

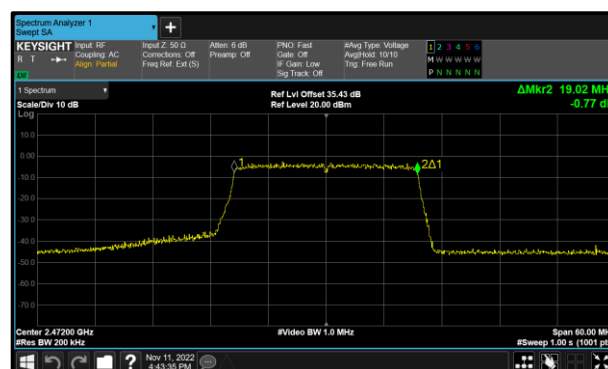


Figure 54 - 802.11ax HE20 SU Maximum 99% OBW



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	17.280	17.340	-	-	≥500.0
2442	15.240	15.300	-	-	≥500.0
2472	17.400	17.400	-	-	≥500.0

Table 23 - 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	17.760	-	-	-

Table 24 - 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	18.600	18.060	-	-	≥500.0
2442	18.840	18.720	-	-	≥500.0
2472	19.020	19.080	-	-	≥500.0

Table 25 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2412	18.960	18.960	-	-	-
2442	18.960	18.960	-	-	-
2472	18.960	19.020	-	-	-

Table 26 - 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 Expiry Date
Multimeter	Fluke	79 Series III	611	12	21-Dec-2022
Hygrometer	Rotronic	I-1000	3068	12	21-Sep-2023
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 27

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

A2816, S/N: H12J4GXMVX - Modification State 0

2.3.3 Date of Test

11-November-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	23.1 °C
Relative Humidity	45.4 %



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):	6.24
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	-	18.86	-	-	-	29.76	-10.90
2442	-	18.87	-	-	-	29.76	-10.89
2472	-	11.77	-	-	-	29.76	-17.99

Table 28 - 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	-	18.86	-	-	-	30.00	-11.14	25.10	36.00	-10.90
2442	-	18.87	-	-	-	30.00	-11.13	25.11	36.00	-10.89
2472	-	11.77	-	-	-	30.00	-18.23	18.01	36.00	-17.99

Table 29 - ISED 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):	6.24
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	-	17.19	-	-	-	29.76	-12.57
2442	-	22.49	-	-	-	29.76	-7.27
2472	-	7.29	-	-	-	29.76	-22.47

Table 30 - 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	-	17.19	-	-	-	30.00	-12.81	23.43	36.00	-12.57
2442	-	22.49	-	-	-	30.00	-7.51	28.73	36.00	-7.27
2472	-	7.29	-	-	-	30.00	-22.71	13.53	36.00	-22.47

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