FCC and ISED Test Report

Apple Inc
Model: A3247

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

TUV SUD Limited

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Date: 2024.10.14 14:41:01 +01'00'

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FCC ID: BCGA3247 IC: 579C-A3247

COMMERCIAL-IN-CONFIDENCE

Document 75960488-15 Issue 01

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Matthew Russell	Chief Engineer	Authorised Signatory	12 August 2024

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	12 August 2024	

FCC Accreditation
553713/UK2026 Concorde Park, Fareham Test Laboratory

ISED Accreditation
28798//UK0003 Concorde Park, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2023, ISED RSS-247: Issue 3 (2023-08) and ISED RSS-GEN: Issue 5 (2018-04) + A2 (2021-02) for the tests detailed in section 1.3.

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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	12-Aug-2024

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
EUT/Sample Identification	Refer to section 1.6
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2023 ISED RSS-247: Issue 3 (2023-08) ISED RSS-GEN: Issue 5 (2018-04) + A2 (2021-02)
Start of Test	25-April-2024
Finish of Test	24-June-2024
Name of Engineer(s)	Colin Brain, Elliot Callender, Michael Evans, Vineeth Nagaraj, Mahmud Bari Chowdhury, Mustafa Murad, Akhil Rajendran Bhaskaran Nair, Ian Hart, Ioan-Alexandru Bogatu, James Woods, Manohar Thota and Thomas Randall
Related Document(s)	ANSI C63.4 (2014) ANSI C63.10 (2020) KDB 662911 D01 v02r01

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
	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	3.3	8.10	Restricted Band Edges	Pass	ANSI C63.10 (2020)
2.2	15.247 (a)(2)	5.2	6.7	Emission Bandwidth	Pass	ANSI C63.10 (2020)
2.3	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	ANSI C63.10 (2020) KDB 662911 D01 v02r01
2.4	15.247 (d)	5.5	-	Authorised Band Edges	Pass	ANSI C63.10 (2020)
2.5	15.209 and 15.247 (d)	3.3 and 5.5	6.13 and 8.9	Spurious Radiated Emissions	Pass	ANSI C63.4 (2014) ANSI C63.10 (2020)
2.6	15.247 (e)	5.2	6.12	Power Spectral Density	Pass	ANSI C63.10 (2020) KDB 662911 D01 v02r01

Table 2

1.4 Product Information

1.4.1 Technical Description

The equipment under test (EUT) was a desktop computer.

1.4.2 Test Modes

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

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 0):

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

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

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

*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 Setup

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. 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	2.60	1.32
Core 1	2400 to 2480	2.30	1.37

Table 3

1.5 Deviations from the Standard

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

1.6 Identification of the EUT

The table below details identification of the EUT(s) that have been used to carry out the testing within this report.

Model: A3247			
Serial Number	Hardware Version	Software Version	Firmware
KN47NTDQRY	REV1.0	24A81452a	23.30.16
CMVW5QCY3C	REV1.0	24A81452a	23.30.16

Table 4

1.7 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: A3247, Serial Number: KN47NTDQRY			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A3247, Serial Number: CMVW5QCY3C			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 5

1.8 Test Location

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		
Restricted Band Edges	Colin Brain, Elliot Callender, Michael Evans and Vineeth Nagaraj	UKAS
Emission Bandwidth	Mahmud Bari Chowdhury and Mustafa Murad	UKAS
Maximum Conducted Output Power	Mahmud Bari Chowdhury	UKAS
Authorised Band Edges	Colin Brain, Elliot Callender, Michael Evans and Vineeth Nagaraj	UKAS
Spurious Radiated Emissions	Akhil Rajendran Bhaskaran Nair, Elliot Callender, Ian Hart, Ioan-Alexandru Bogatu, James Woods, Manohar Thota, Thomas Randall and Vineeth Nagaraj	UKAS
Power Spectral Density	Mahmud Bari Chowdhury	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 3.3
ISED RSS-GEN, Clause 8.10

2.1.2 Equipment Under Test and Modification State

A3247, S/N: KN47NTDQRY - Modification State 0

2.1.3 Date of Test

25-April-2024 to 31-May-2024

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 dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

2.1.5 Environmental Conditions

Ambient Temperature	22.2 - 23.0 °C
Relative Humidity	38.3 - 41.5 %

2.1.6 Test Results

2.4 GHz WLAN

20 MHz Bandwidth - Core 0 (SISO)

Mode	Data Rate/ MCS	Resource Size	Resource Index	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBuV/m)
802.11b	1 Mbps	-	-	2412	2390	59.33	51.37
802.11b	1 Mbps	-	-	2417	2390	56.56	48.11
802.11g	54 Mbps	-	-	2412	2390	69.47	50.49
802.11g	54 Mbps	-	-	2417	2390	69.24	51.38
802.11g	24 Mbps	-	-	2422	2390	69.14	50.88
802.11g	54 Mbps	-	-	2427	2390	68.80	50.66
802.11n HT20	MCS 4	-	-	2412	2390	65.34	51.01
802.11n HT20	MCS 7	-	-	2417	2390	69.41	50.52
802.11n HT20	MCS 2	-	-	2422	2390	63.06	48.83
802.11n HT20	MCS 7	-	-	2427	2390	69.28	50.75
802.11ax HE20	MCS 2x1	SU	-	2412	2390	62.47	50.99
802.11ax HE20	MCS 9x1	106	53	2412	2390	68.87	47.39
802.11ax HE20	MCS 4x1	SU	-	2417	2390	64.83	51.14
802.11ax HE20	MCS 9x1	106	53	2417	2390	65.47	44.90
802.11ax HE20	MCS 9x1	SU	-	2422	2390	68.57	51.38
802.11ax HE20	MCS 9x1	SU	-	2427	2390	68.66	51.25
802.11ax HE20	MCS 9x1	SU	-	2432	2390	67.83	51.48
802.11b	1 Mbps	-	-	2462	2483.5	59.84	51.44
802.11b	1 Mbps	-	-	2467	2483.5	59.96	51.20
802.11b	1 Mbps	-	-	2472	2483.5	59.18	50.98
802.11g	24 Mbps	-	-	2452	2483.5	66.08	51.29
802.11g	24 Mbps	-	-	2457	2483.5	65.86	51.28
802.11g	24 Mbps	-	-	2462	2483.5	66.76	51.42
802.11g	24 Mbps	-	-	2467	2483.5	65.58	51.39
802.11g	54 Mbps	-	-	2472	2483.5	63.64	51.47
802.11n HT20	MCS 7	-	-	2447	2483.5	68.72	51.40
802.11n HT20	MCS 4	-	-	2452	2483.5	66.33	51.44
802.11n HT20	MCS 4	-	-	2457	2483.5	66.39	51.36
802.11n HT20	MCS 2	-	-	2462	2483.5	64.76	51.06
802.11n HT20	MCS 7	-	-	2467	2483.5	64.58	51.48
802.11n HT20	MCS 2	-	-	2472	2483.5	64.30	51.19
802.11ax HE20	MCS 9x1	SU	-	2447	2483.5	66.97	51.43
802.11ax HE20	MCS 9x1	SU	-	2452	2483.5	66.46	50.87
802.11ax HE20	MCS 2x1	SU	-	2457	2483.5	65.34	51.50
802.11ax HE20	MCS 9x1	106	54	2457	2483.5	67.51	47.05
802.11ax HE20	MCS 9x1	SU	-	2462	2483.5	66.36	51.01
802.11ax HE20	MCS 9x1	106	54	2462	2483.5	68.42	49.39
802.11ax HE20	MCS 4x1	SU	-	2467	2483.5	64.16	51.42
802.11ax HE20	MCS 9x1	106	53	2467	2483.5	69.07	51.22
802.11ax HE20	MCS 2x1	SU	-	2472	2483.5	64.95	51.47
802.11ax HE20	MCS 9x1	106	53	2472	2483.5	69.22	48.35

Table 7 - SISO Restricted Band Edge Results

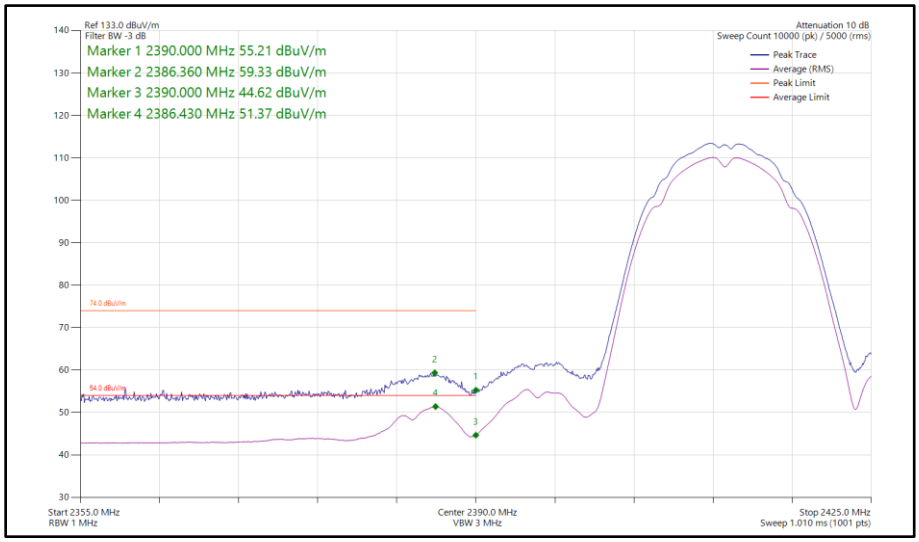

Figure 1 - 802.11b, SISO, Core 0 - 2412 MHz
Band Edge Frequency 2390 MHz

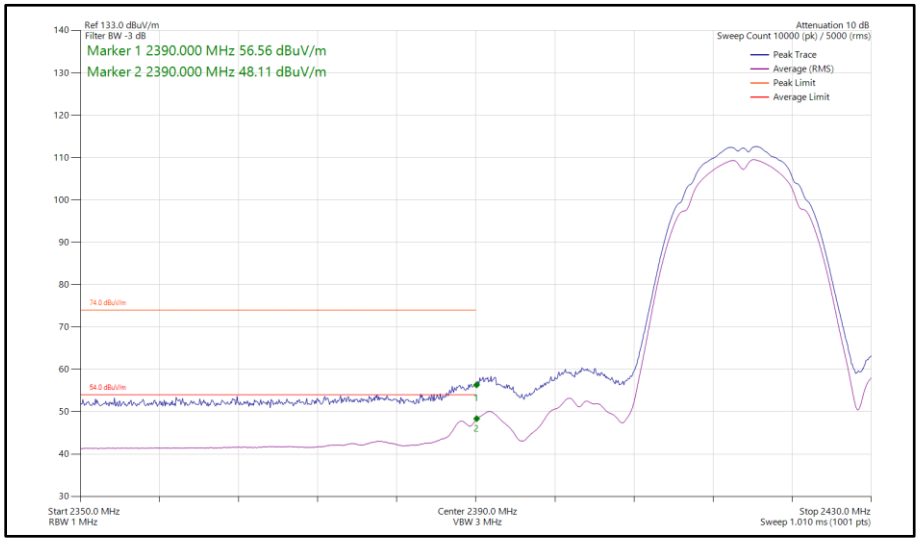

Figure 2 - 802.11b, SISO, Core 0 - 2417 MHz
Band Edge Frequency 2390 MHz

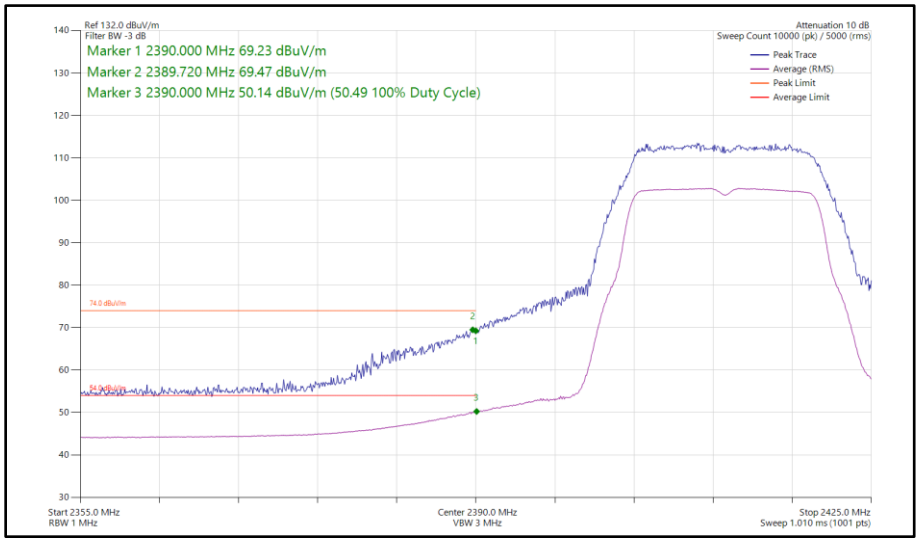

Figure 3 - 802.11g, SISO, Core 0 - 2412 MHz
Band Edge Frequency 2390 MHz

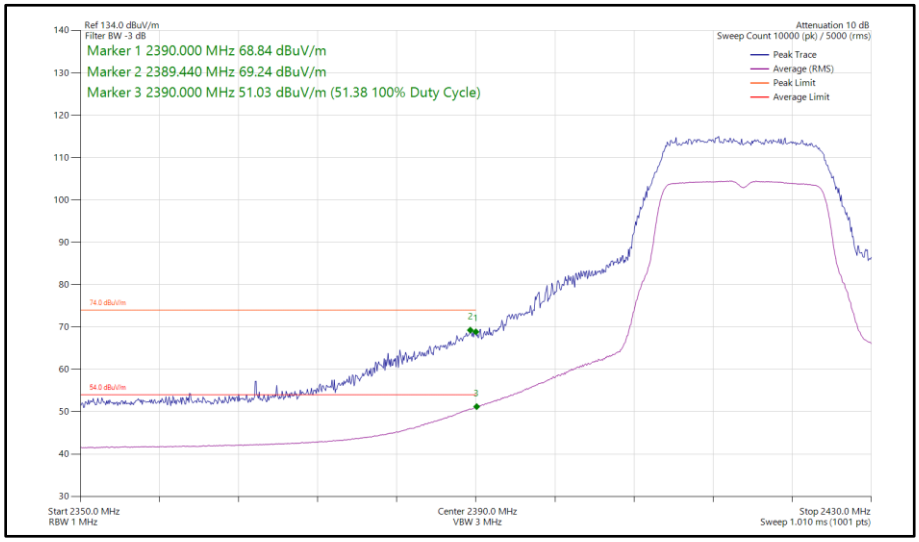

Figure 4 - 802.11g, SISO, Core 0 - 2417 MHz
Band Edge Frequency 2390 MHz

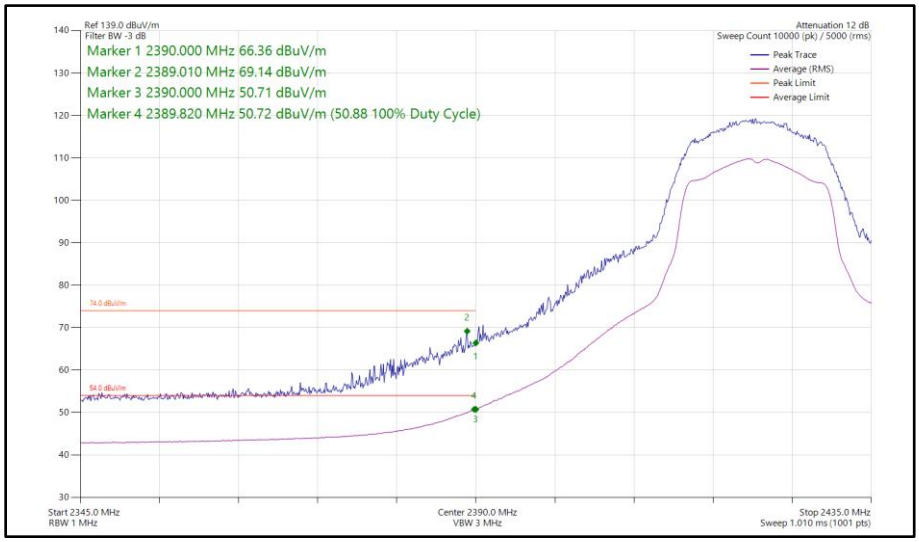

Figure 5 - 802.11g, SISO, Core 0 - 2422 MHz
Band Edge Frequency 2390 MHz

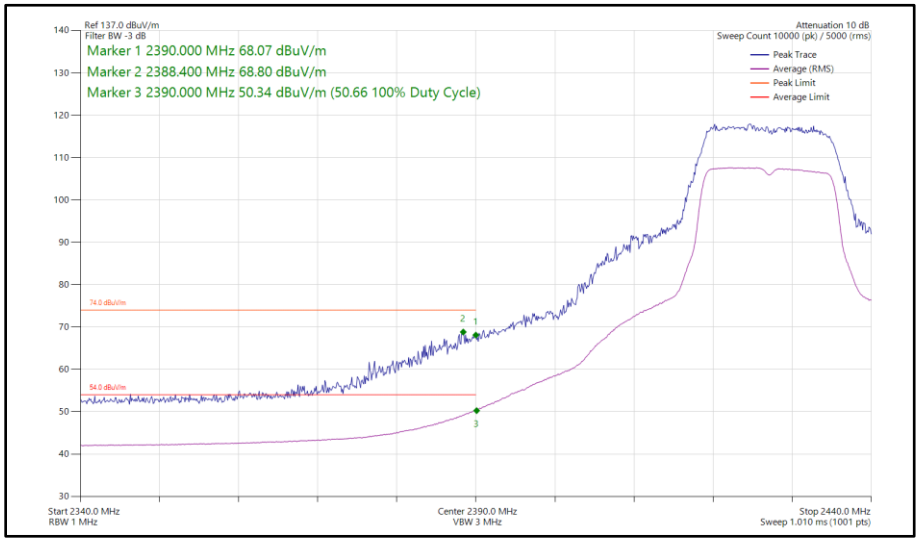

Figure 6 - 802.11g, SISO, Core 0 - 2427 MHz
Band Edge Frequency 2390 MHz

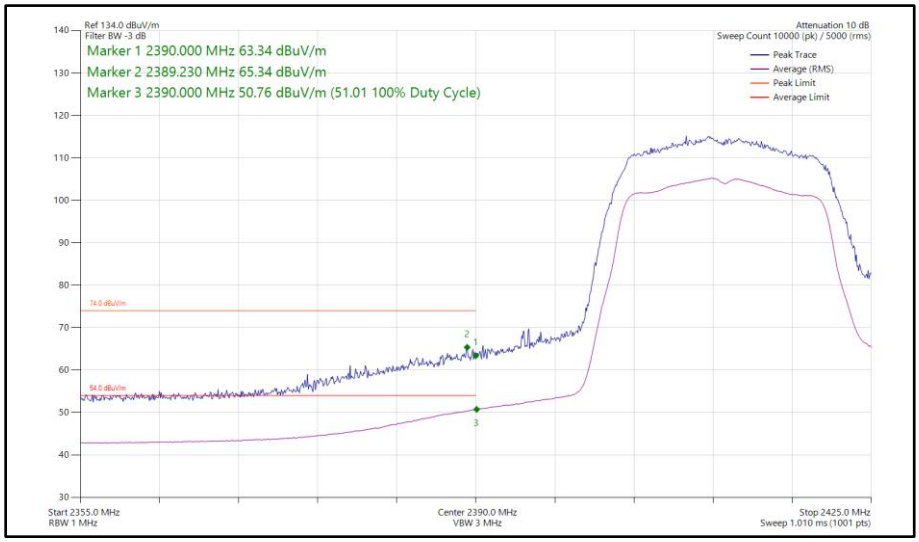

Figure 7 - 802.11n HT20, SISO, Core 0 - 2412 MHz
Band Edge Frequency 2390 MHz

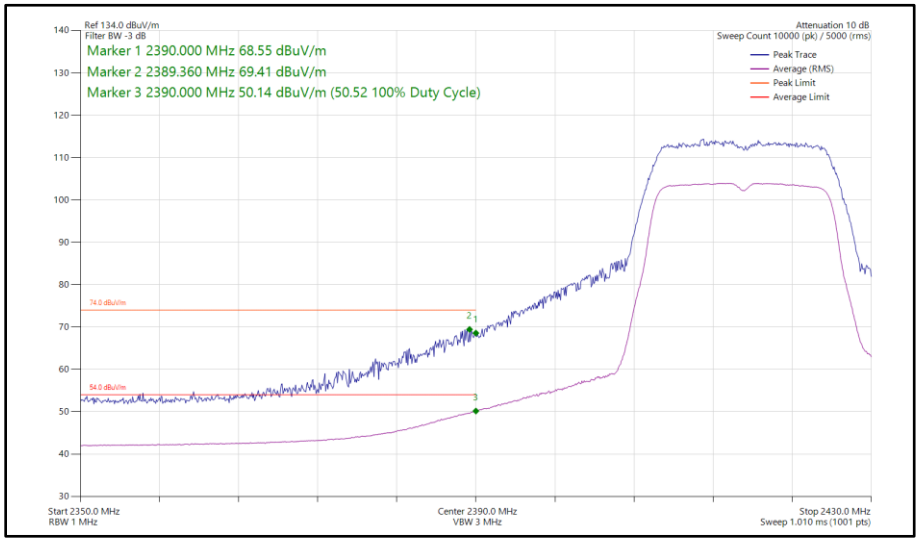

Figure 8 - 802.11n HT20, SISO, Core 0 - 2417 MHz
Band Edge Frequency 2390 MHz

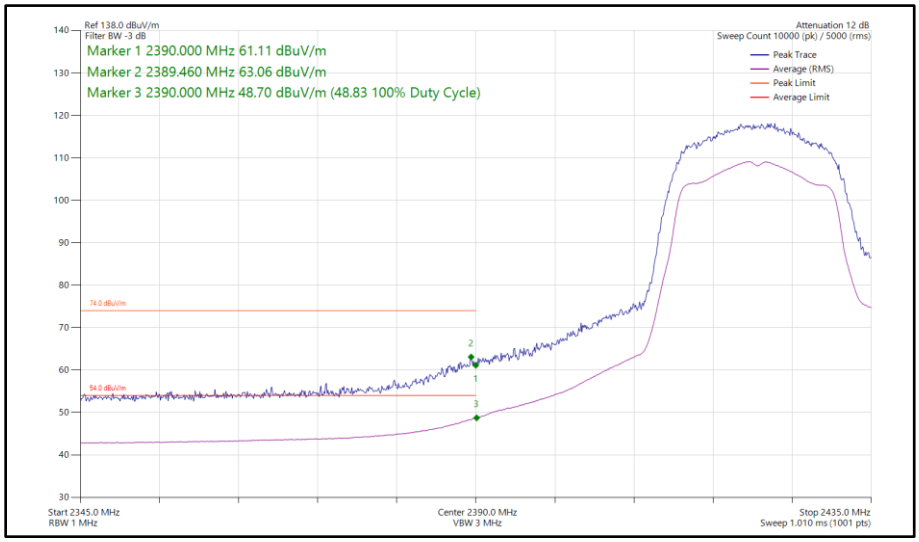

Figure 9 - 802.11n HT20, SISO, Core 0 - 2422 MHz
Band Edge Frequency 2390 MHz

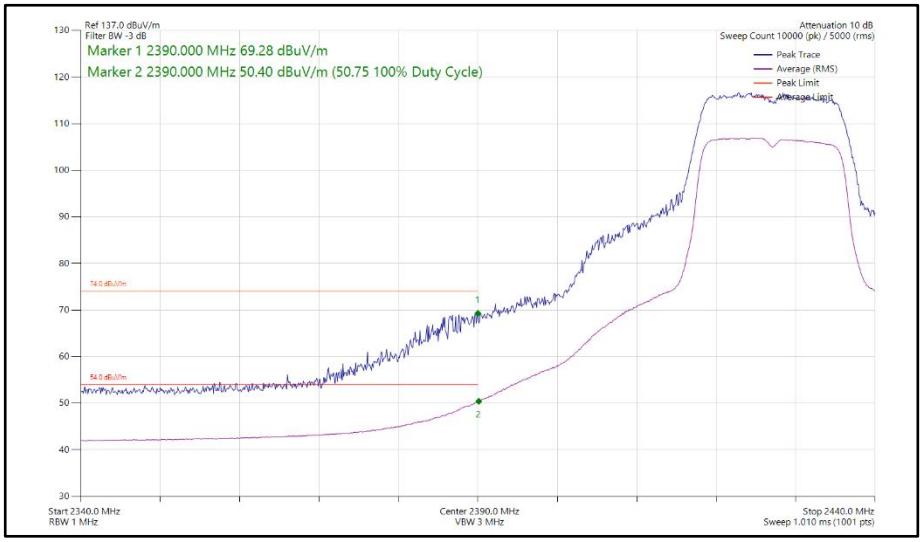

Figure 10 - 802.11n HT20, SISO, Core 0 - 2427 MHz
Band Edge Frequency 2390 MHz

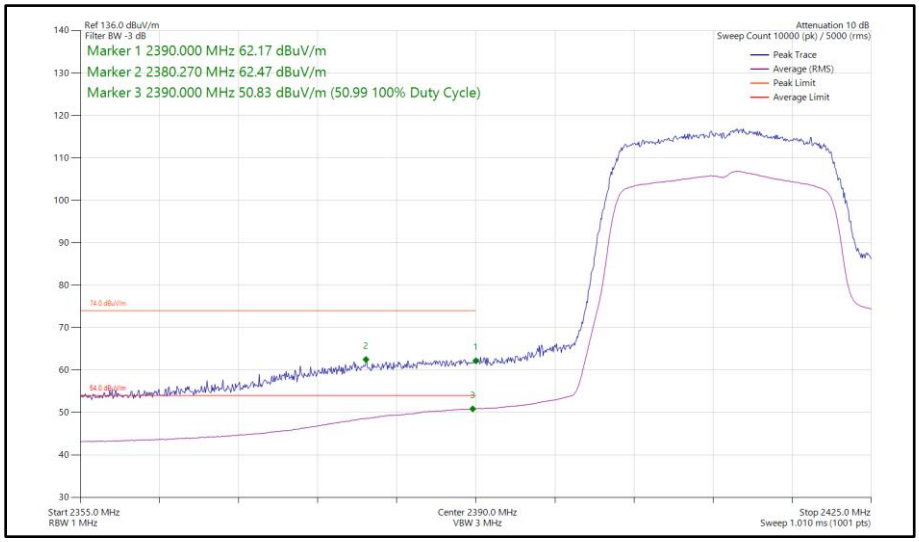

Figure 11 - 802.11ax HE20, SU, SISO, Core 0 - 2412 MHz
Band Edge Frequency 2390 MHz

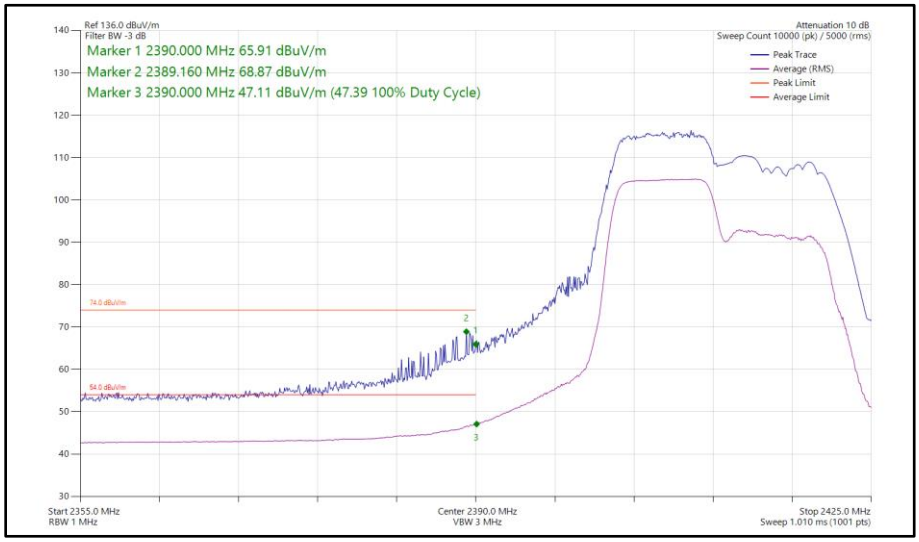

Figure 12 - 802.11ax HE20, RU 106-53, SISO, Core 0 - 2412 MHz
Band Edge Frequency 2390 MHz

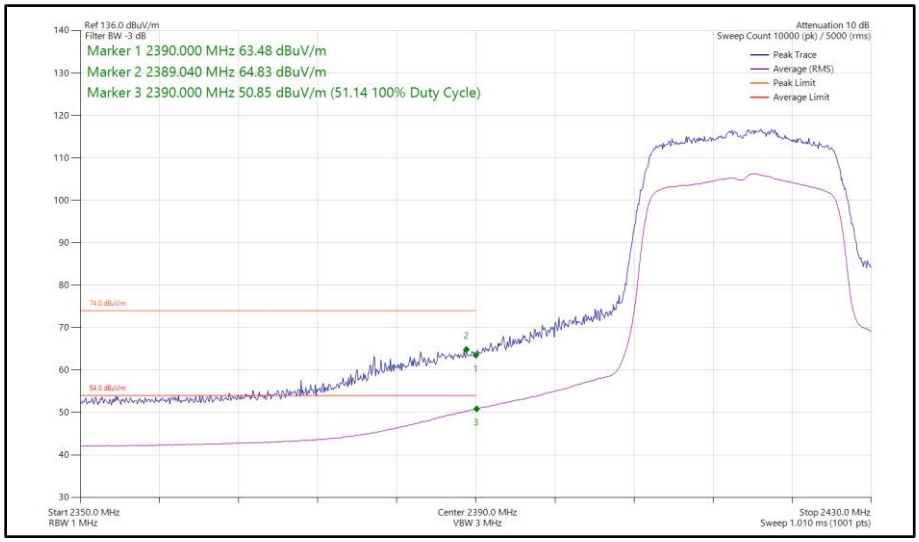

Figure 13 - 802.11ax HE20, SU, SISO, Core 0 - 2417 MHz
Band Edge Frequency 2390 MHz

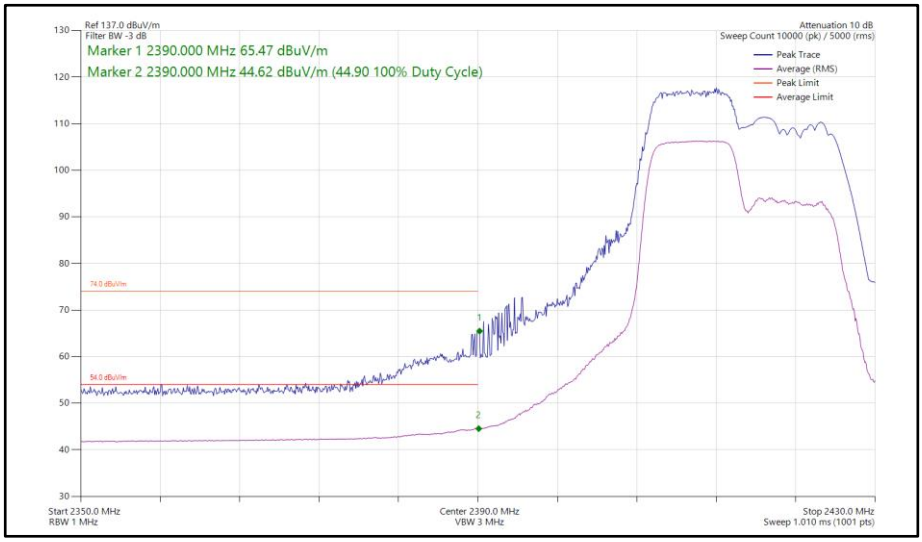

Figure 14 - 802.11ax HE20, RU 106-53, SISO, Core 0 - 2417 MHz
Band Edge Frequency 2390 MHz

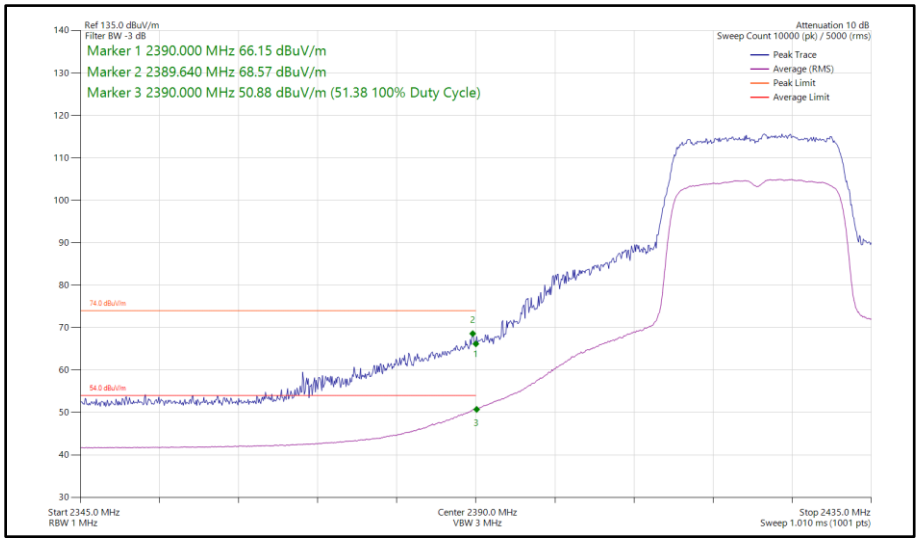

Figure 15 - 802.11ax HE20, SU, SISO, Core 0 - 2422 MHz
Band Edge Frequency 2390 MHz

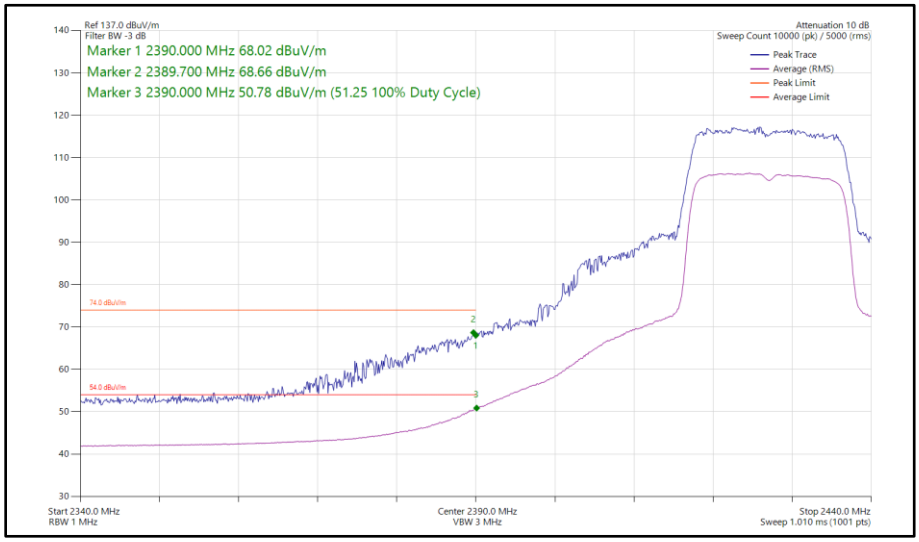

Figure 16 - 802.11ax HE20, SU, SISO, Core 0 - 2427 MHz
Band Edge Frequency 2390 MHz

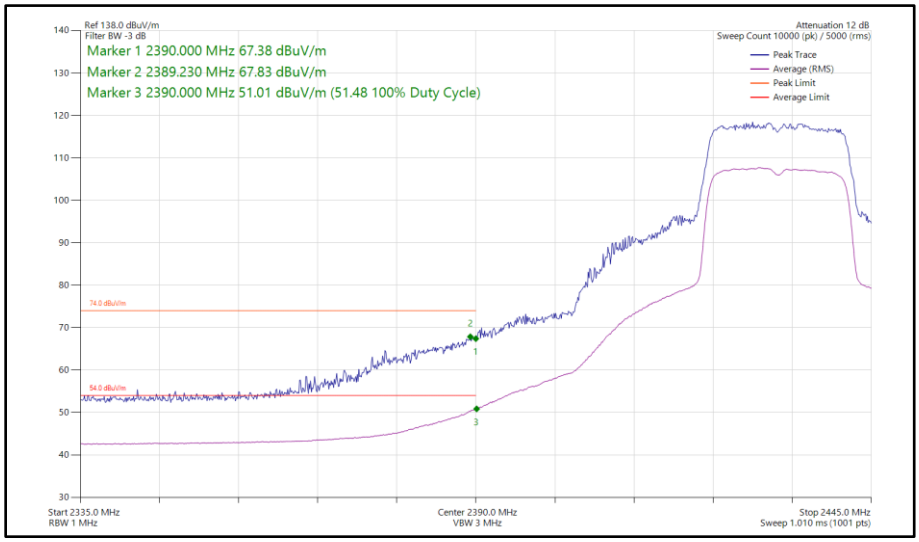

Figure 17 - 802.11ax HE20, SU, SISO, Core 0 - 2432 MHz
Band Edge Frequency 2390 MHz

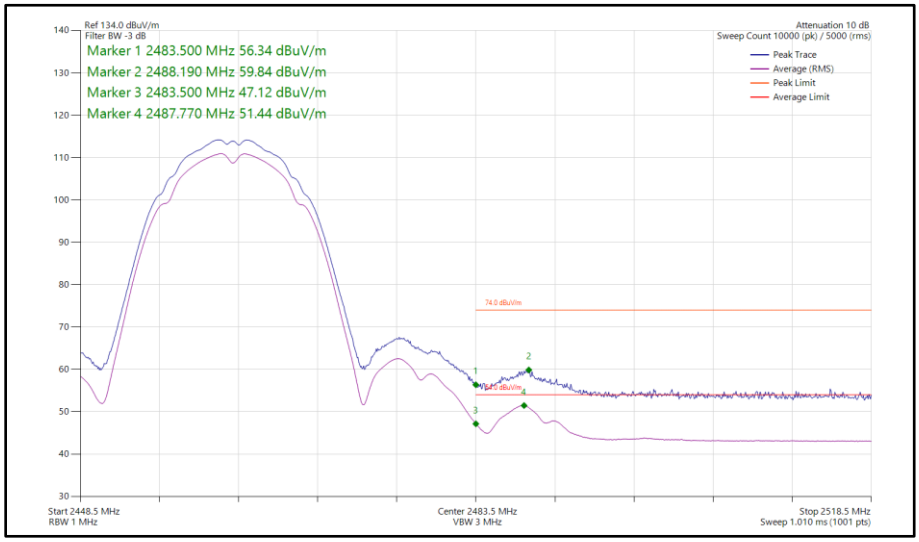

Figure 18 - 802.11b, SISO, Core 0 - 2462 MHz
Band Edge Frequency 2483.5 MHz

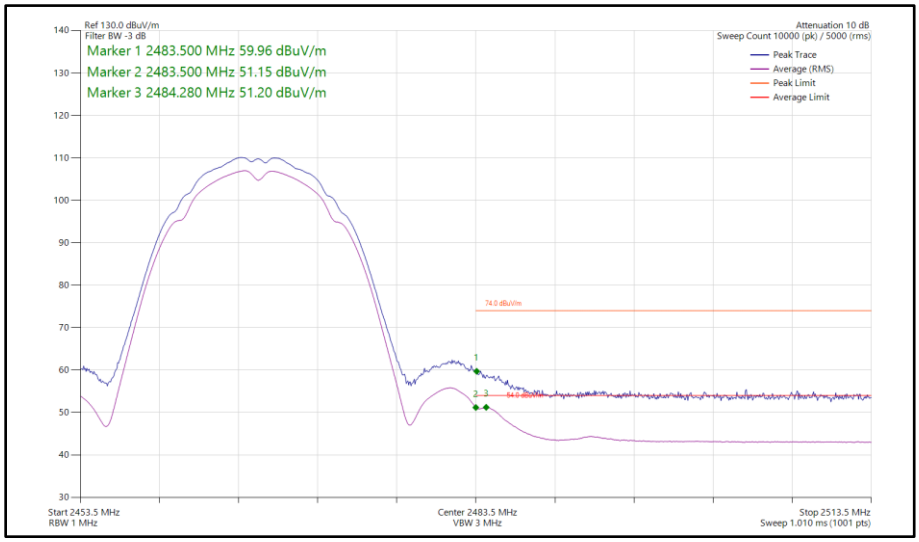

Figure 19 - 802.11b, SISO, Core 0 - 2467 MHz
Band Edge Frequency 2483.5 MHz

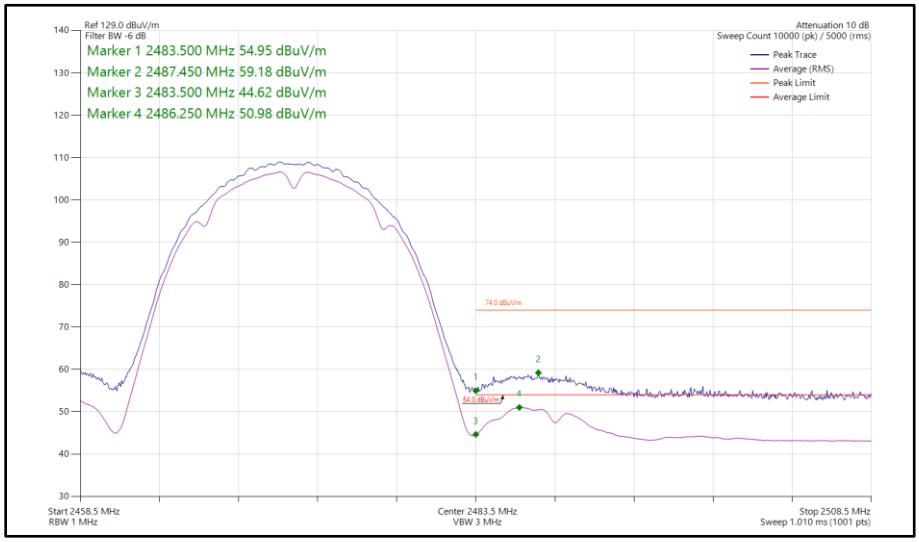

Figure 20 - 802.11b, SISO, Core 0 - 2472 MHz
Band Edge Frequency 2483.5 MHz

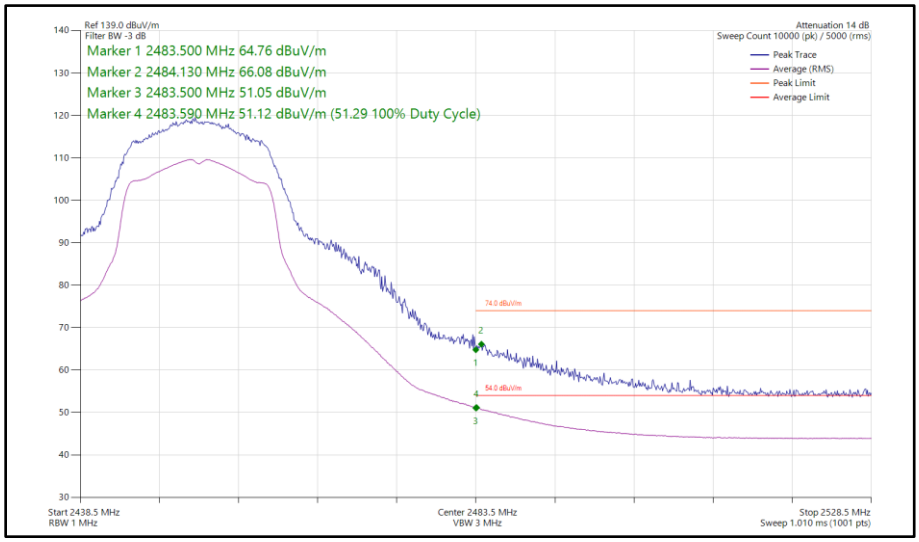

Figure 21 - 802.11g, SISO, Core 0 - 2452 MHz
Band Edge Frequency 2483.5 MHz

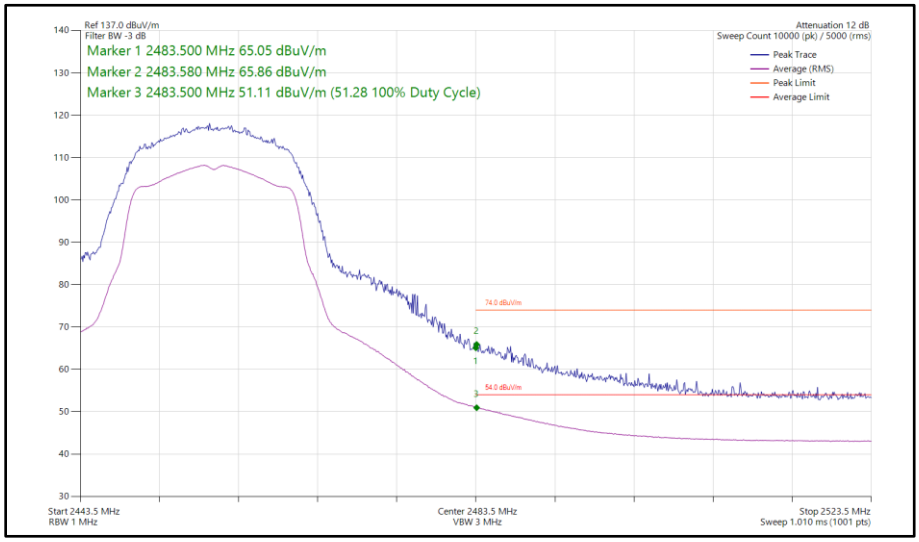

Figure 22 - 802.11g, SISO, Core 0 - 2457 MHz
Band Edge Frequency 2483.5 MHz

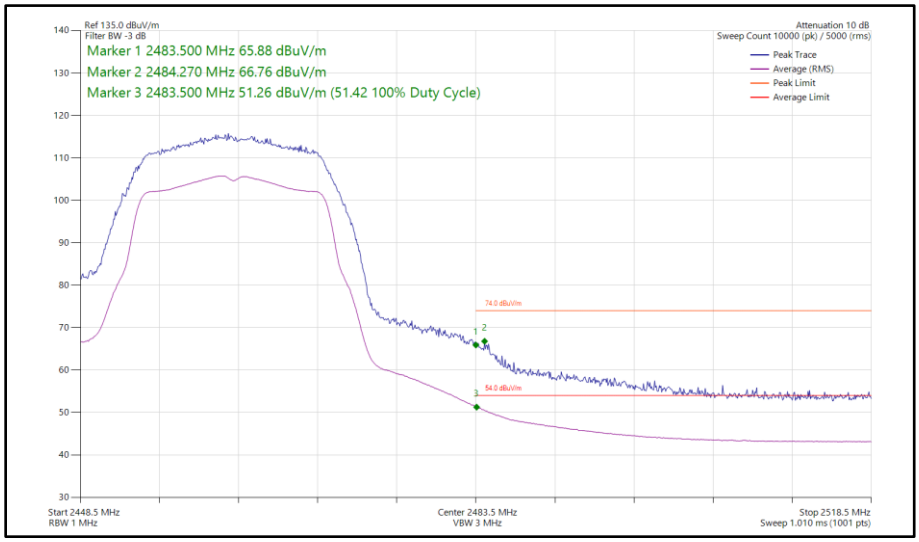

Figure 23 - 802.11g, SISO, Core 0 - 2462 MHz
Band Edge Frequency 2483.5 MHz

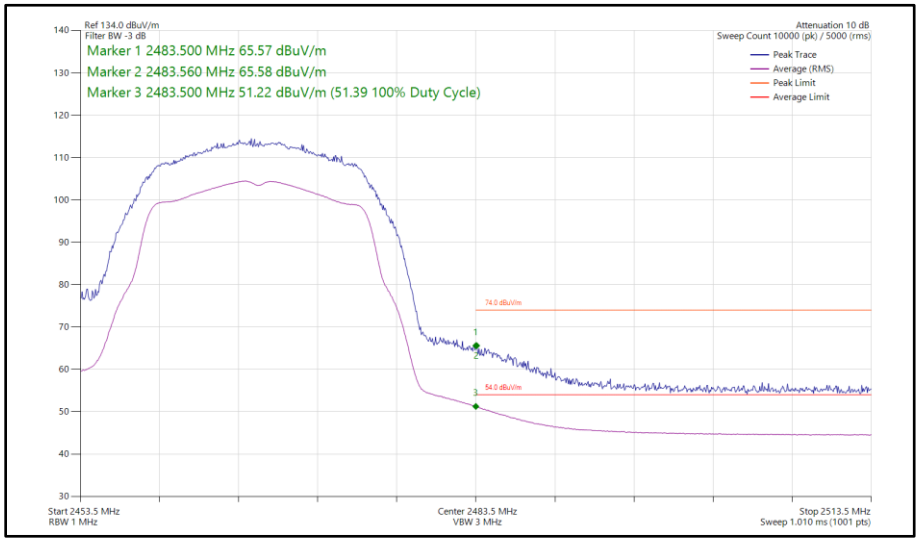

Figure 24 - 802.11g, SISO, Core 0 - 2467 MHz
Band Edge Frequency 2483.5 MHz

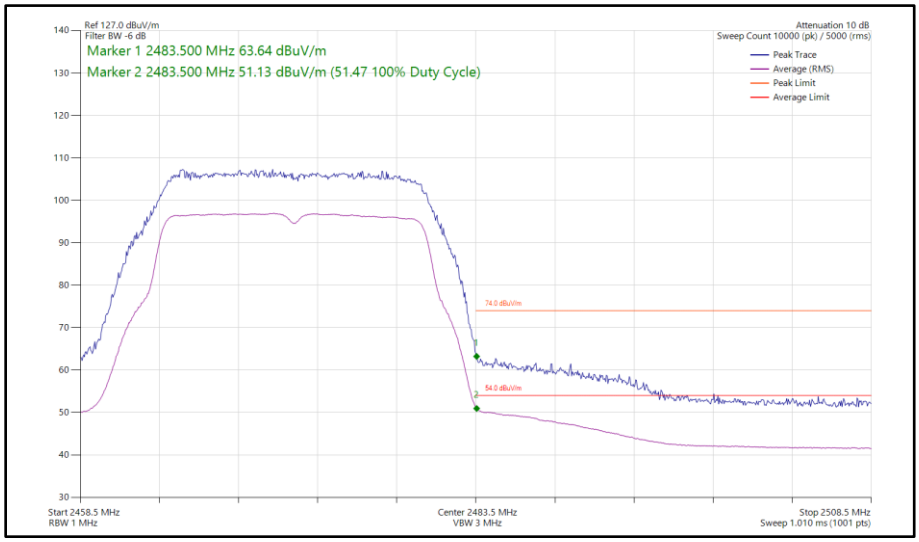

Figure 25 - 802.11g, SISO, Core 0 - 2472 MHz
Band Edge Frequency 2483.5 MHz

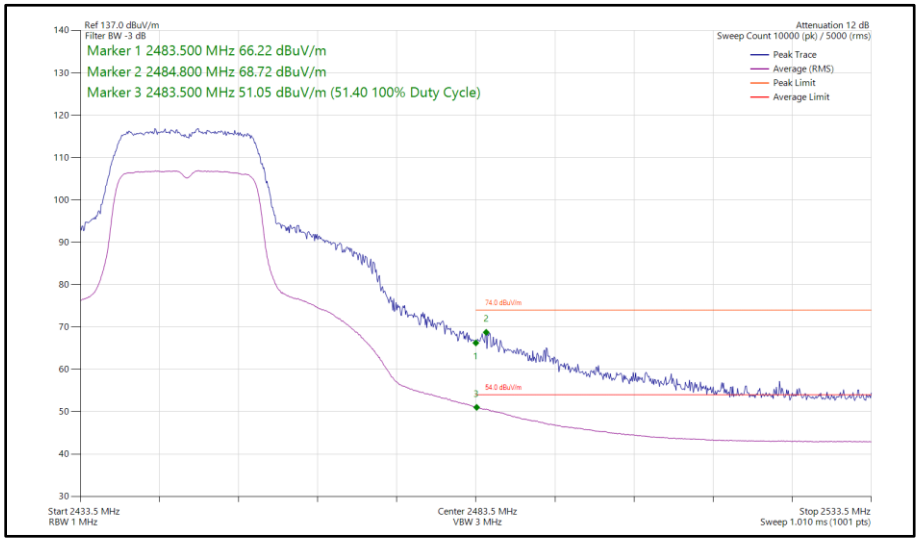

Figure 26 - 802.11n HT20, SISO, Core 0 - 2447 MHz
Band Edge Frequency 2483.5 MHz

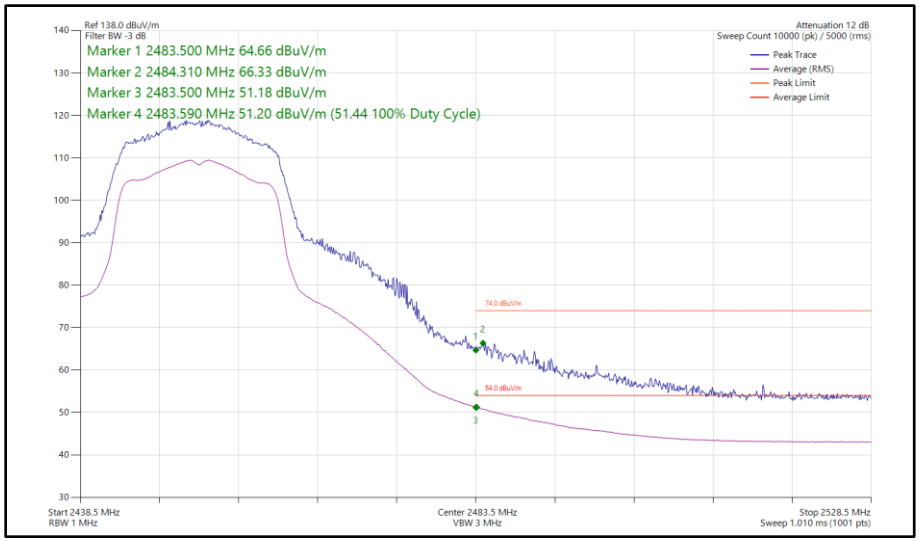

Figure 27 - 802.11n HT20, SISO, Core 0 - 2452 MHz
Band Edge Frequency 2483.5 MHz

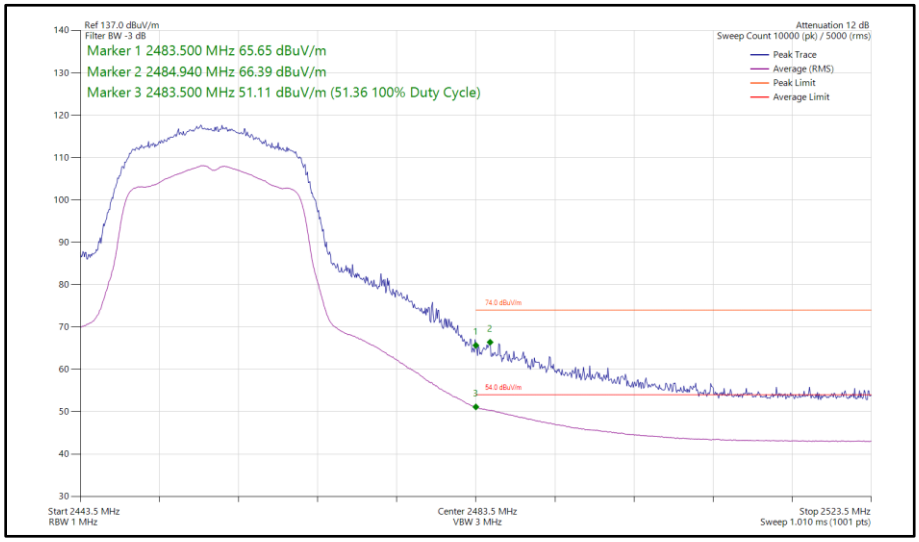

Figure 28 - 802.11n HT20, SISO, Core 0 - 2457 MHz
Band Edge Frequency 2483.5 MHz

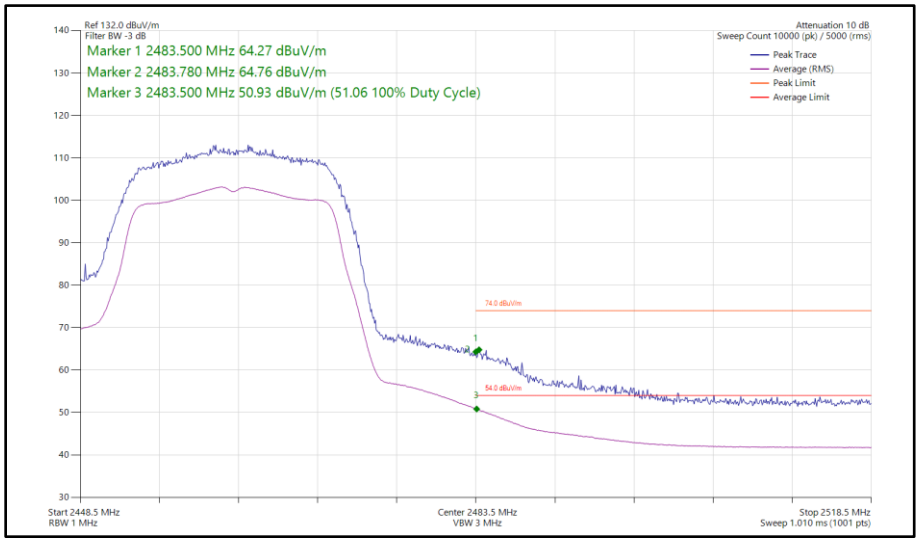

Figure 29 - 802.11n HT20, SISO, Core 0 - 2462 MHz
Band Edge Frequency 2483.5 MHz

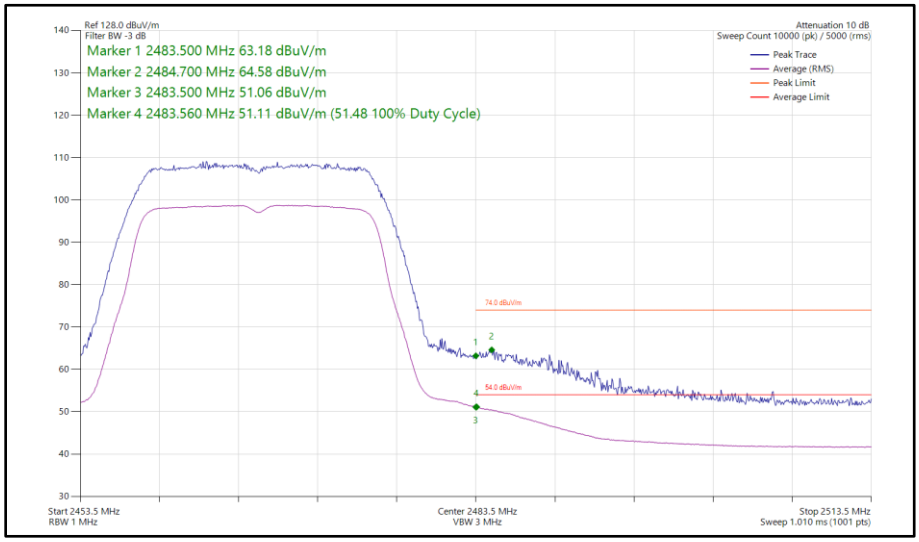

Figure 30 - 802.11n HT20, SISO, Core 0 - 2467 MHz
Band Edge Frequency 2483.5 MHz

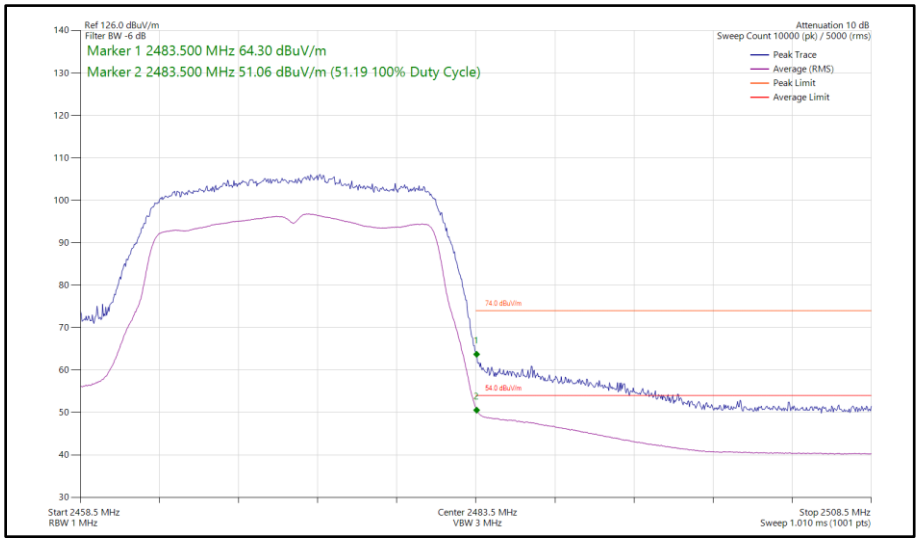

Figure 31 - 802.11n HT20, SISO, Core 0 - 2472 MHz
Band Edge Frequency 2483.5 MHz

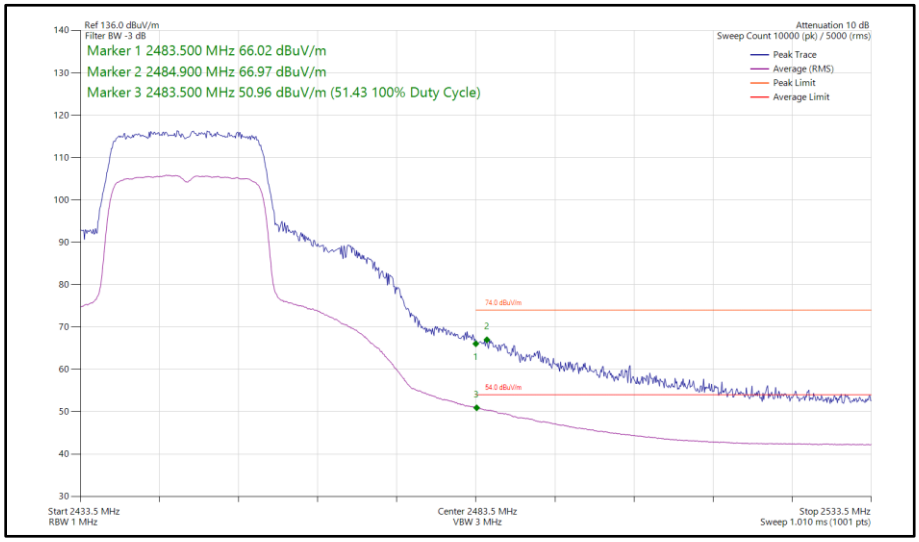

Figure 32 - 802.11ax HE20, SU, SISO, Core 0 - 2447 MHz
Band Edge Frequency 2483.5 MHz

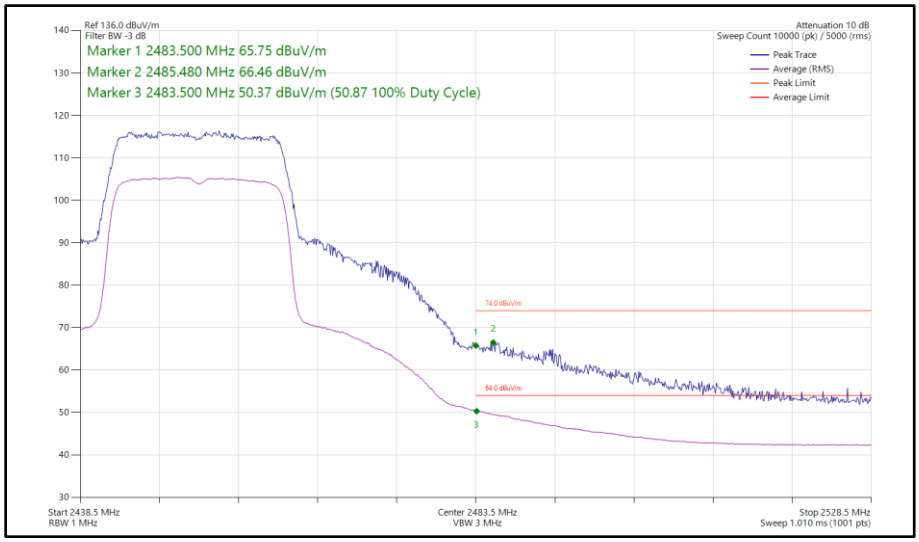

Figure 33 - 802.11ax HE20, SU, SISO, Core 0 - 2452 MHz
Band Edge Frequency 2483.5 MHz

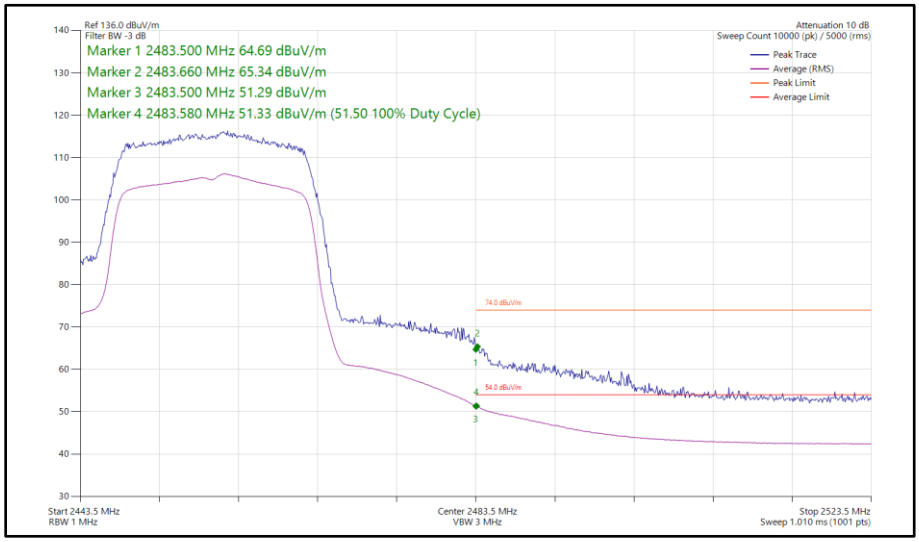

Figure 34 - 802.11ax HE20, SU, SISO, Core 0 - 2457 MHz
Band Edge Frequency 2483.5 MHz

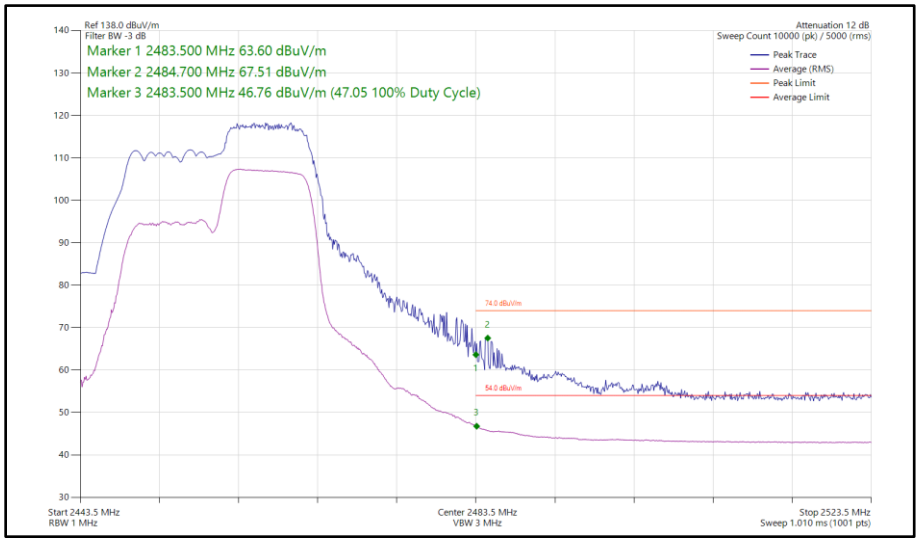

Figure 35 - 802.11ax HE20, RU 106-54, SISO, Core 0 - 2457 MHz
Band Edge Frequency 2483.5 MHz

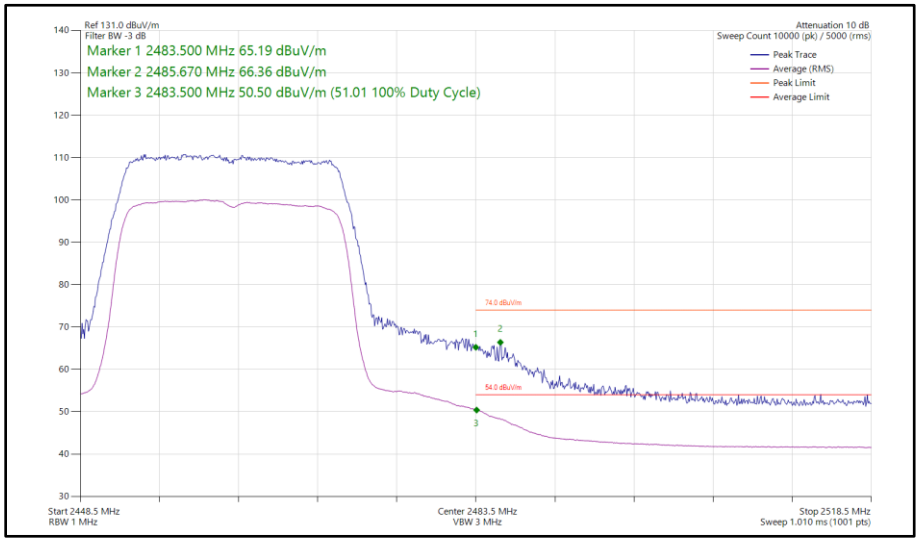

Figure 36 - 802.11ax HE20, SU, SISO, Core 0 - 2462 MHz
Band Edge Frequency 2483.5 MHz

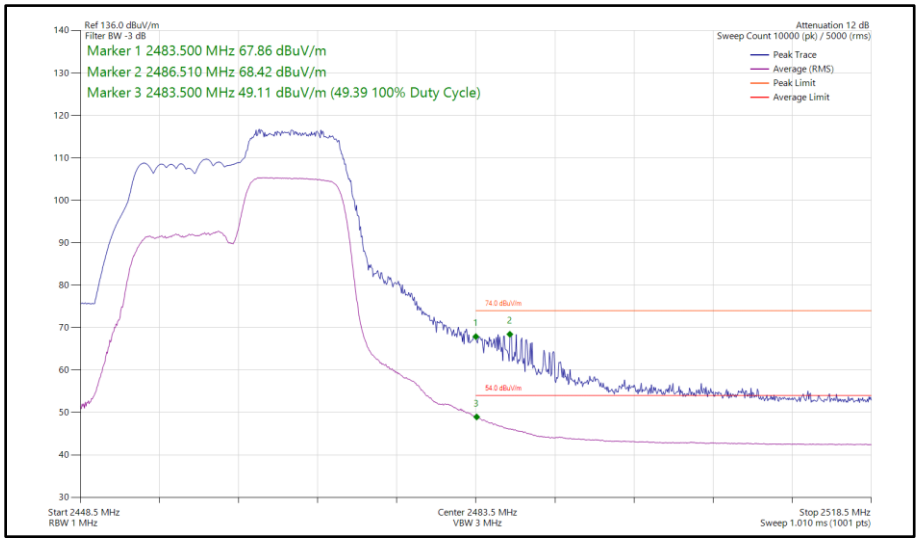

Figure 37 - 802.11ax HE20, RU 106-54, SISO, Core 0 - 2462 MHz
Band Edge Frequency 2483.5 MHz

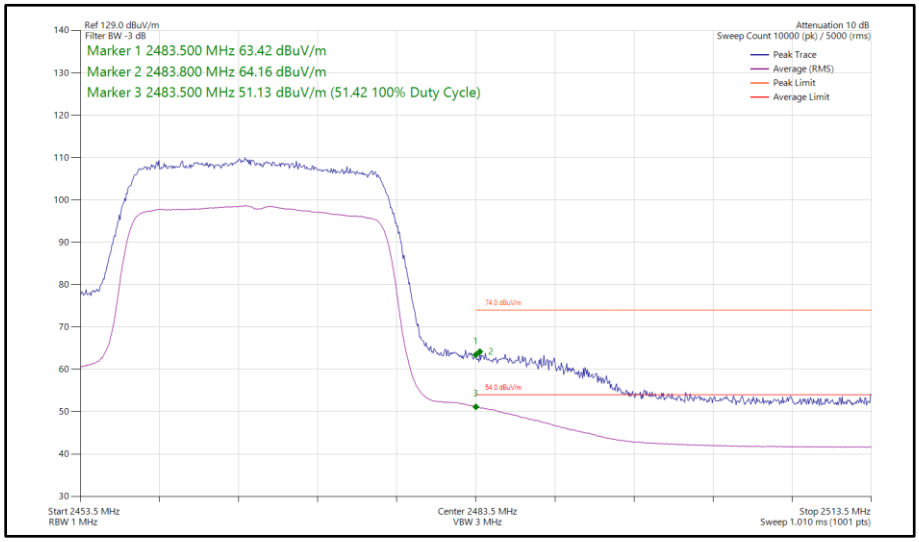

Figure 38 - 802.11ax HE20, SU, SISO, Core 0 - 2467 MHz
Band Edge Frequency 2483.5 MHz

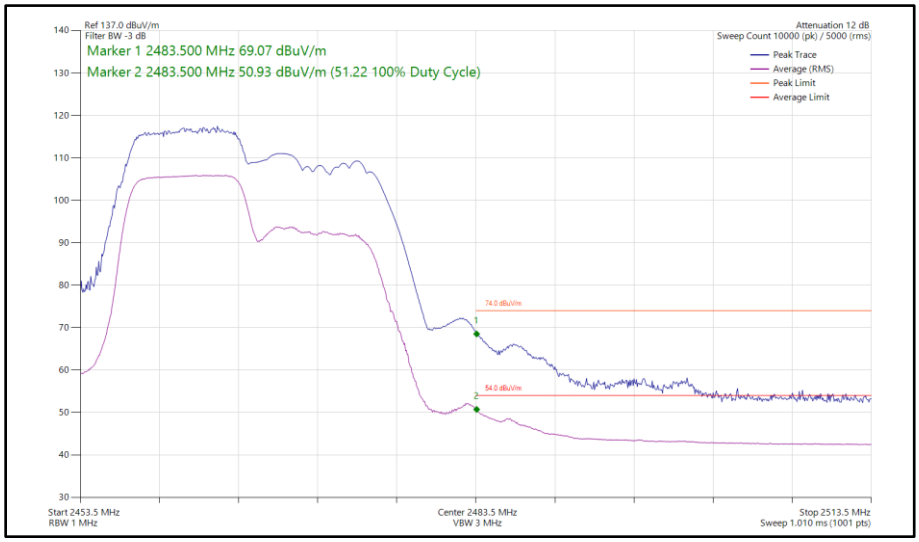

Figure 39 - 802.11ax HE20, RU 106-53, SISO, Core 0 - 2467 MHz Band Edge Frequency 2483.5 MHz

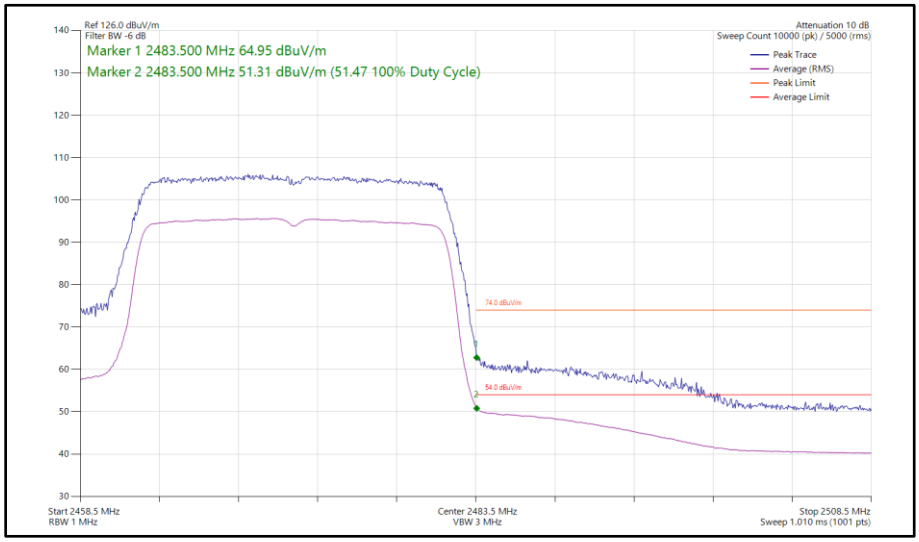

Figure 40 - 802.11ax HE20, SU, SISO, Core 0 - 2472 MHz Band Edge Frequency 2483.5 MHz

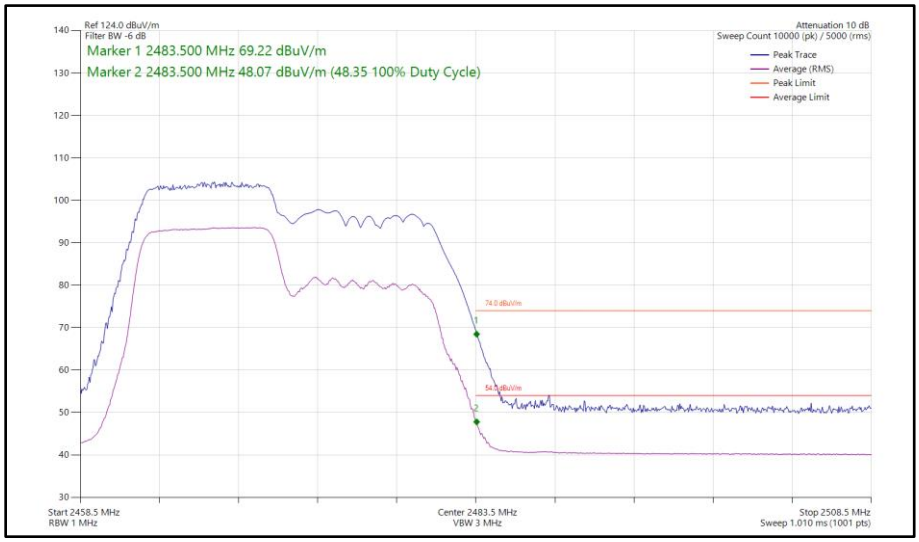

Figure 41 - 802.11ax HE20, RU 106-53, SISO, Core 0 - 2472 MHz Band Edge Frequency 2483.5 MHz

20 MHz Bandwidth - Core 1 (SISO)

Mode	Data Rate/ MCS	Resource Size	Resource Index	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBuV/m)
802.11b	1 Mbps	-	-	2412	2390	59.53	51.40
802.11b	1 Mbps	-	-	2417	2390	57.52	49.23
802.11g	54 Mbps	-	-	2412	2390	69.33	50.65
802.11g	54 Mbps	-	-	2417	2390	69.35	51.41
802.11g	54 Mbps	-	-	2422	2390	69.33	50.89
802.11g	54 Mbps	-	-	2427	2390	68.97	50.39
802.11n HT20	MCS 2	-	-	2412	2390	63.61	51.22
802.11n HT20	MCS 7	-	-	2417	2390	69.38	50.00
802.11n HT20	MCS 7	-	-	2422	2390	69.48	50.43
802.11n HT20	MCS 7	-	-	2427	2390	69.25	48.92
802.11ax HE20	MCS 2x1	SU	-	2412	2390	64.56	51.19
802.11ax HE20	MCS 9x1	106	53	2412	2390	68.24	46.41
802.11ax HE20	MCS 9x1	SU	-	2417	2390	69.31	48.92
802.11ax HE20	MCS 9x1	106	53	2417	2390	64.87	45.35
802.11ax HE20	MCS 9x1	SU	-	2422	2390	69.32	51.20
802.11ax HE20	MCS 2x1	SU	-	2427	2390	69.47	50.51
802.11ax HE20	MCS 9x1	SU	-	2432	2390	69.36	51.09
802.11b	1 Mbps	-	-	2462	2483.5	57.92	49.00
802.11b	1 Mbps	-	-	2467	2483.5	60.19	51.28
802.11b	1 Mbps	-	-	2472	2483.5	58.12	51.38
802.11g	54 Mbps	-	-	2452	2483.5	68.22	51.11
802.11g	54 Mbps	-	-	2457	2483.5	68.69	51.03
802.11g	54 Mbps	-	-	2462	2483.5	69.44	50.82
802.11g	54 Mbps	-	-	2467	2483.5	65.68	51.47
802.11g	12 Mbps	-	-	2472	2483.5	62.84	51.27
802.11n HT20	MCS 7	-	-	2447	2483.5	69.38	51.10
802.11n HT20	MCS 7	-	-	2452	2483.5	69.12	50.39
802.11n HT20	MCS 7	-	-	2457	2483.5	69.39	49.40
802.11n HT20	MCS 4	-	-	2462	2483.5	67.23	51.37
802.11n HT20	MCS 2	-	-	2467	2483.5	64.23	51.50
802.11n HT20	MCS 2	-	-	2472	2483.5	64.42	51.32
802.11ax HE20	MCS 9x1	SU	-	2447	2483.5	67.68	50.95
802.11ax HE20	MCS 4x1	SU	-	2452	2483.5	65.61	50.77
802.11ax HE20	MCS 4x1	SU	-	2457	2483.5	66.80	51.28
802.11ax HE20	MCS 9x1	106	54	2457	2483.5	63.42	45.46
802.11ax HE20	MCS 2x1	SU	-	2462	2483.5	65.36	51.15
802.11ax HE20	MCS 9x1	106	54	2462	2483.5	69.38	49.46
802.11ax HE20	MCS 9x1	SU	-	2467	2483.5	65.88	51.29
802.11ax HE20	MCS 9x1	106	53	2467	2483.5	69.48	51.30
802.11ax HE20	MCS 2x1	SU	-	2472	2483.5	66.63	51.49
802.11ax HE20	MCS 9x1	26	8	2472	2483.5	69.12	48.96

Table 8 - SISO Restricted Band Edge Results

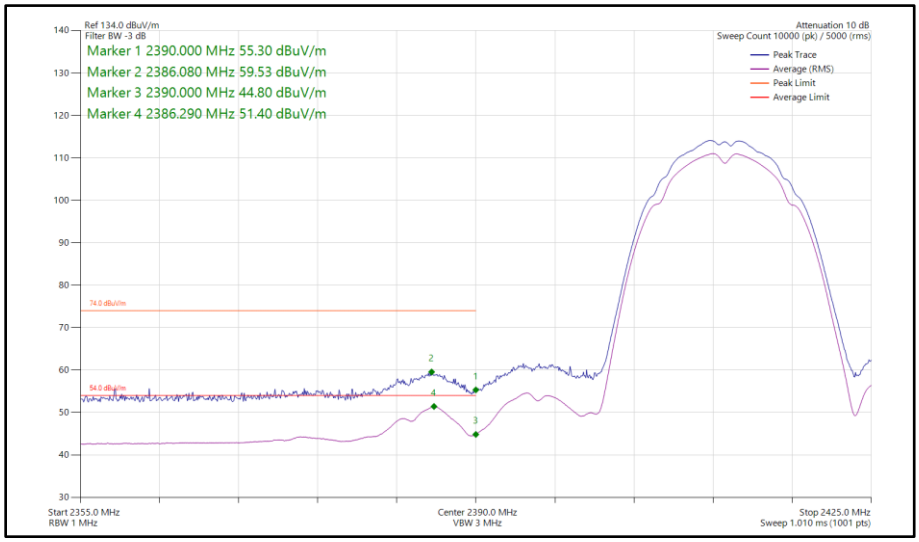

Figure 42 - 802.11b, SISO, Core 1 - 2412 MHz
Band Edge Frequency 2390 MHz

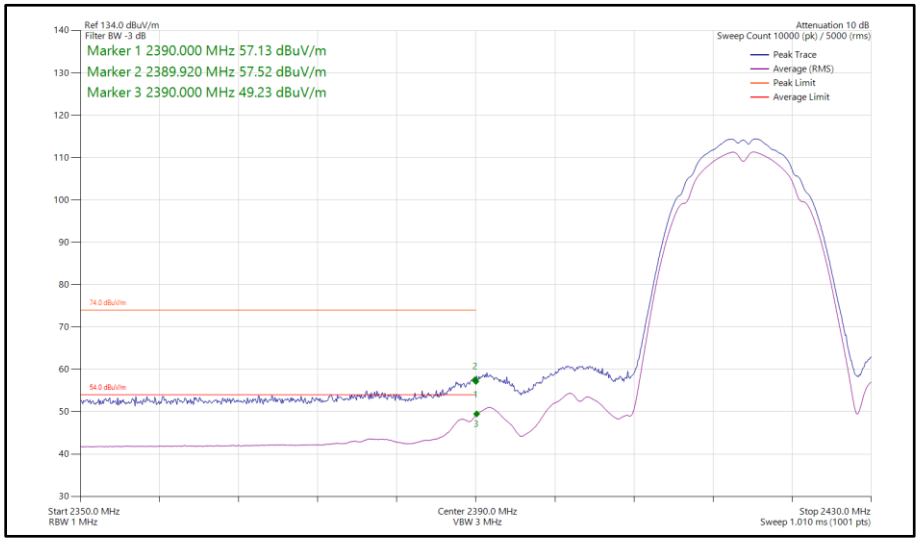

Figure 43 - 802.11b, SISO, Core 1 - 2417 MHz
Band Edge Frequency 2390 MHz

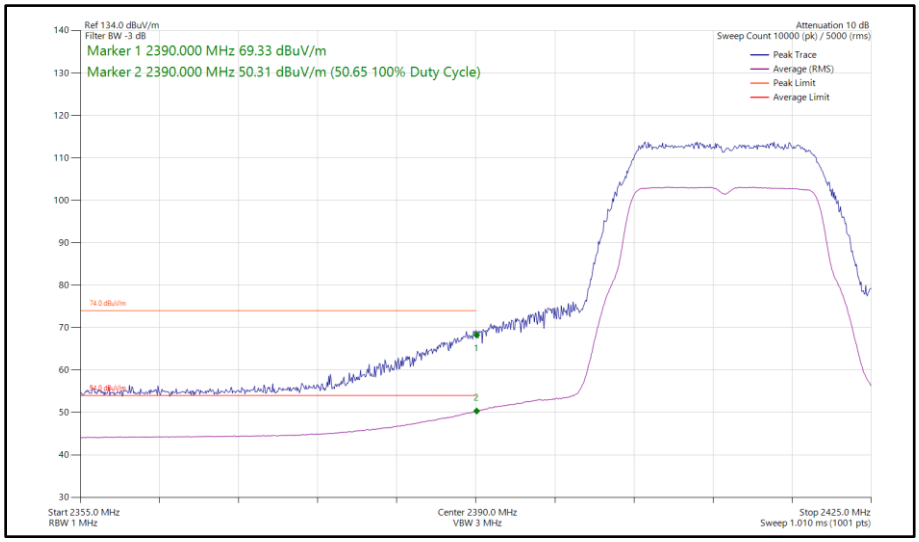

Figure 44 - 802.11g, SISO, Core 1 - 2412 MHz
Band Edge Frequency 2390 MHz

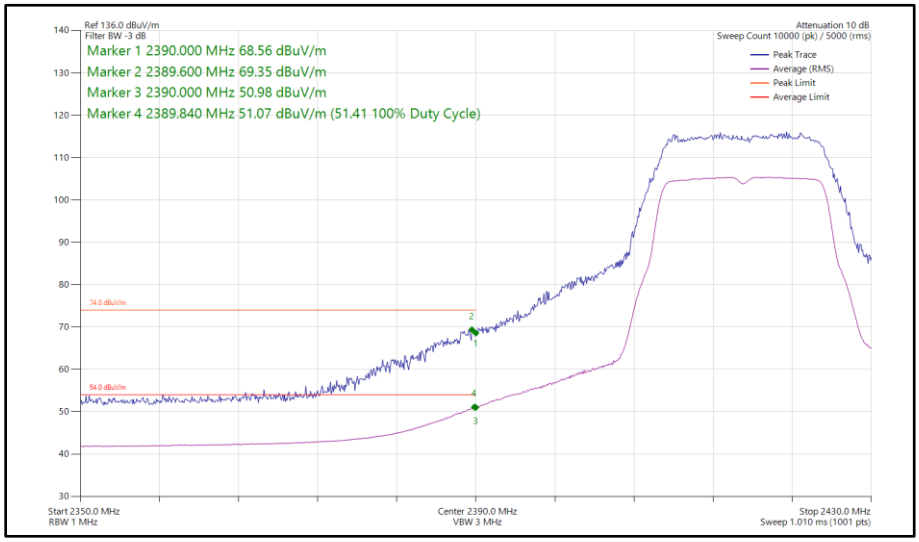

Figure 45 - 802.11g, SISO, Core 1 - 2417 MHz
Band Edge Frequency 2390 MHz

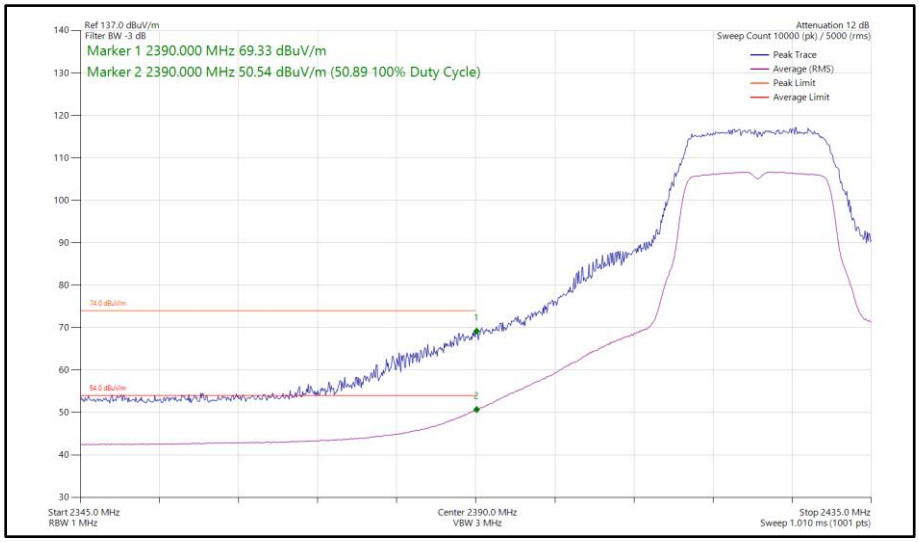

Figure 46 - 802.11g, SISO, Core 1 - 2422 MHz
Band Edge Frequency 2390 MHz

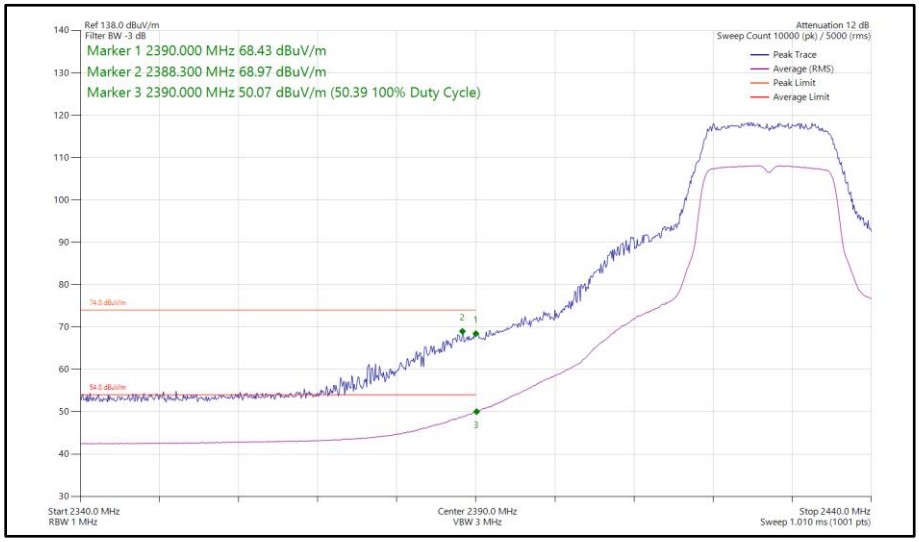

Figure 47 - 802.11g, SISO, Core 1 - 2427 MHz
Band Edge Frequency 2390 MHz

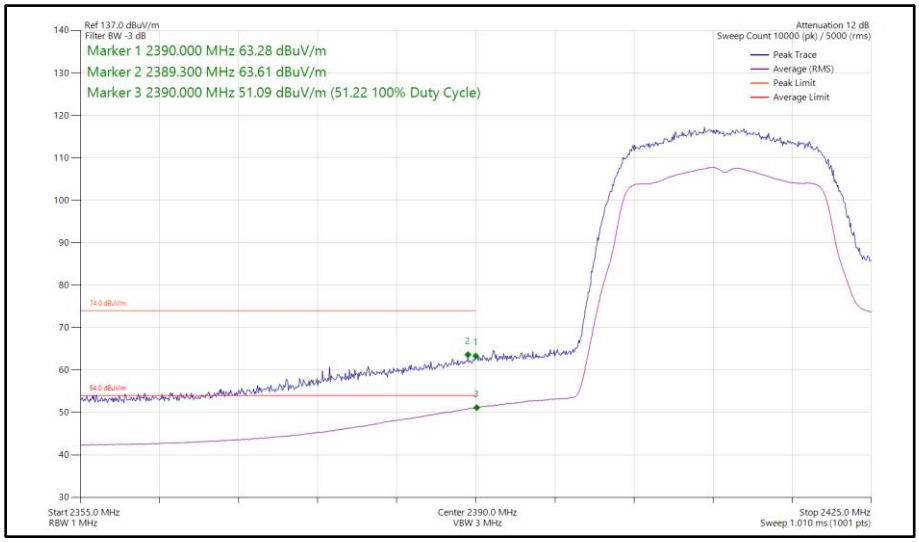

Figure 48 - 802.11n HT20, SISO, Core 1 - 2412 MHz
Band Edge Frequency 2390 MHz

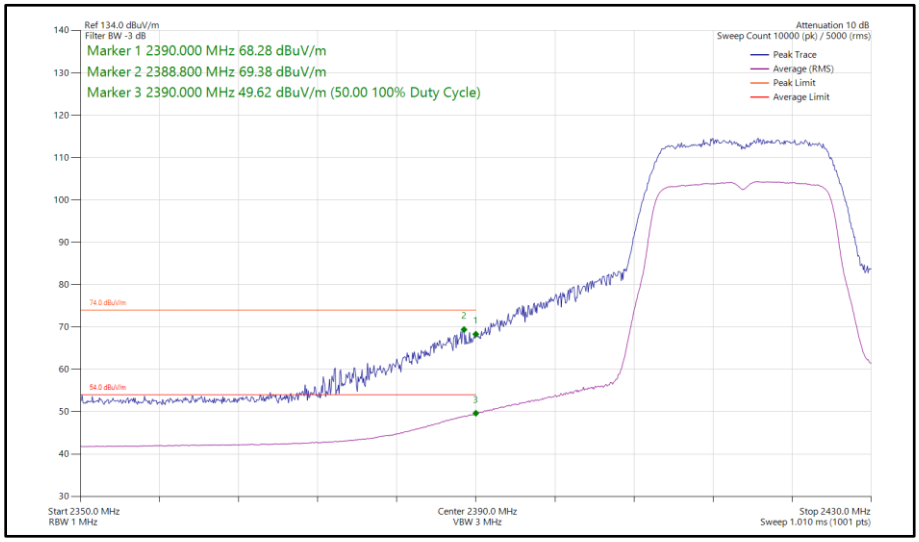

Figure 49 - 802.11n HT20, SISO, Core 1 - 2417 MHz
Band Edge Frequency 2390 MHz

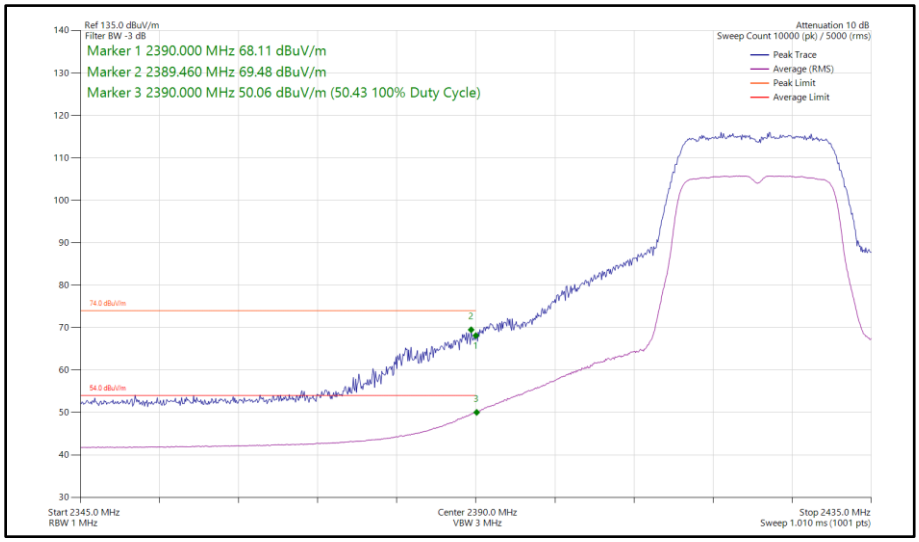

Figure 50 - 802.11n HT20, SISO, Core 1 - 2422 MHz
Band Edge Frequency 2390 MHz

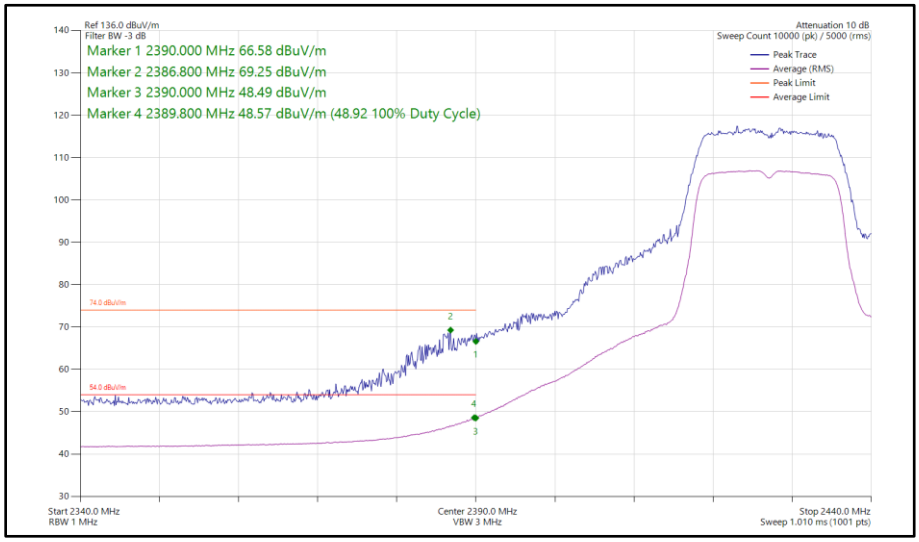

Figure 51 - 802.11n HT20, SISO, Core 1 - 2427 MHz
Band Edge Frequency 2390 MHz

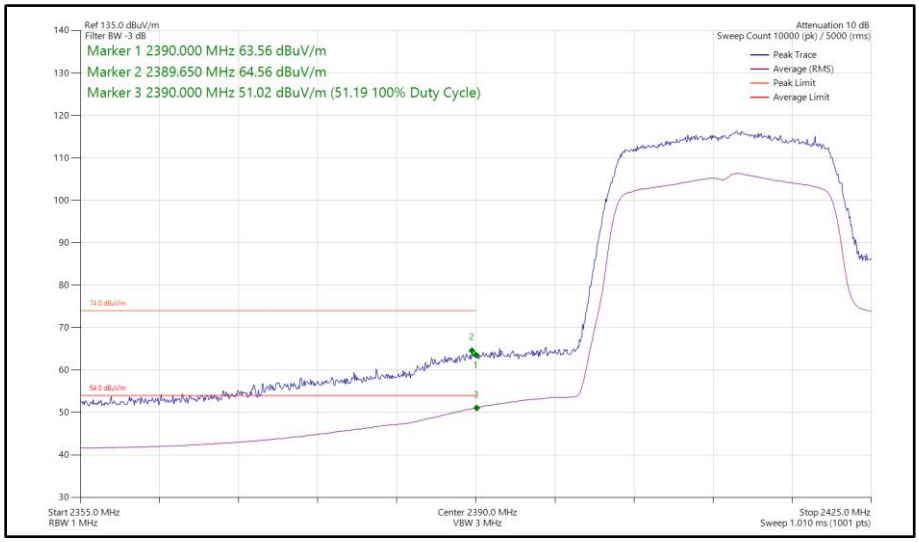

Figure 52 - 802.11ax HE20, SU, SISO, Core 1 - 2412 MHz
Band Edge Frequency 2390 MHz

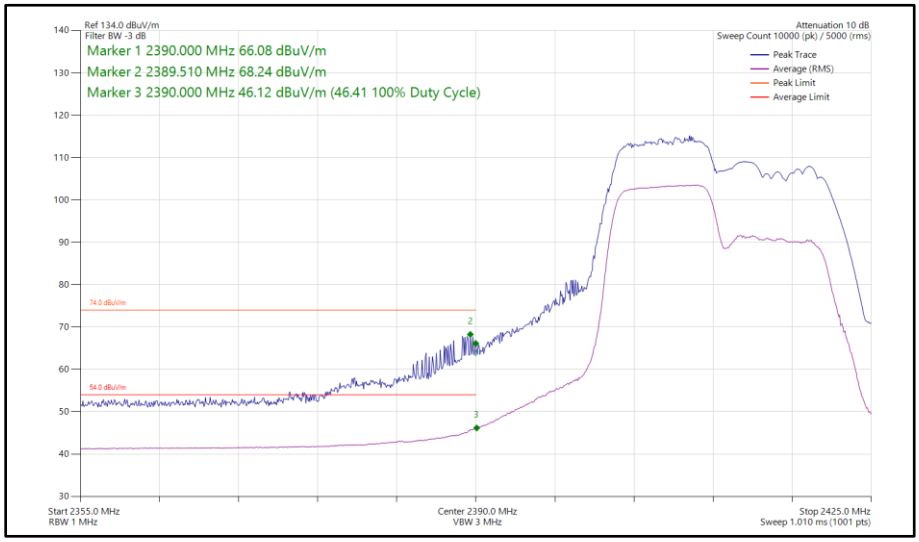

Figure 53 - 802.11ax HE20, RU 106-53, SISO, Core 1 - 2412 MHz
Band Edge Frequency 2390 MHz

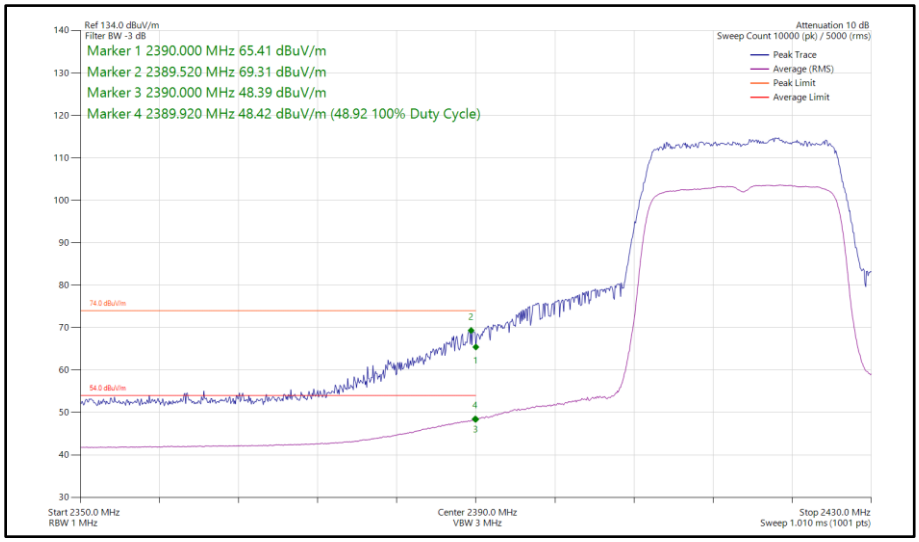

Figure 54 - 802.11ax HE20, SU, SISO, Core 1 - 2417 MHz
Band Edge Frequency 2390 MHz

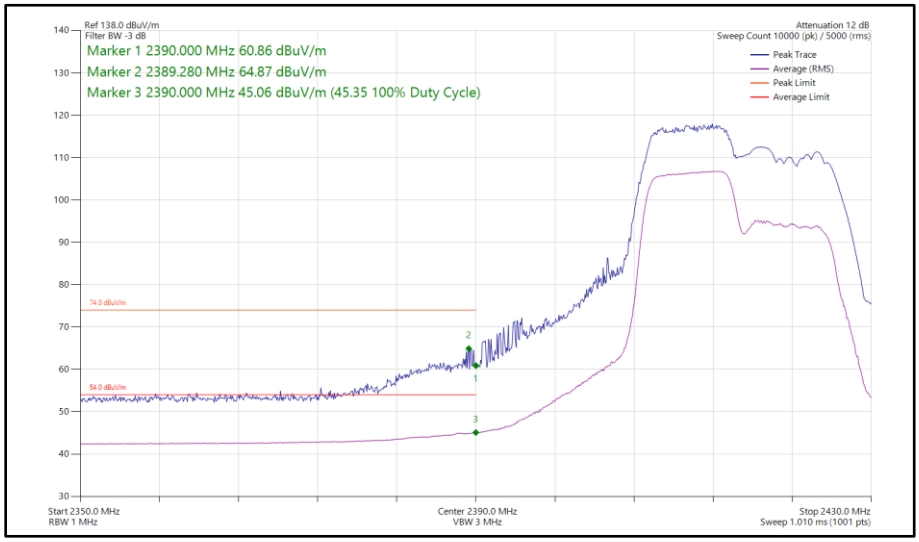

Figure 55 - 802.11ax HE20, RU 106-53, SISO, Core 1 - 2417 MHz
Band Edge Frequency 2390 MHz

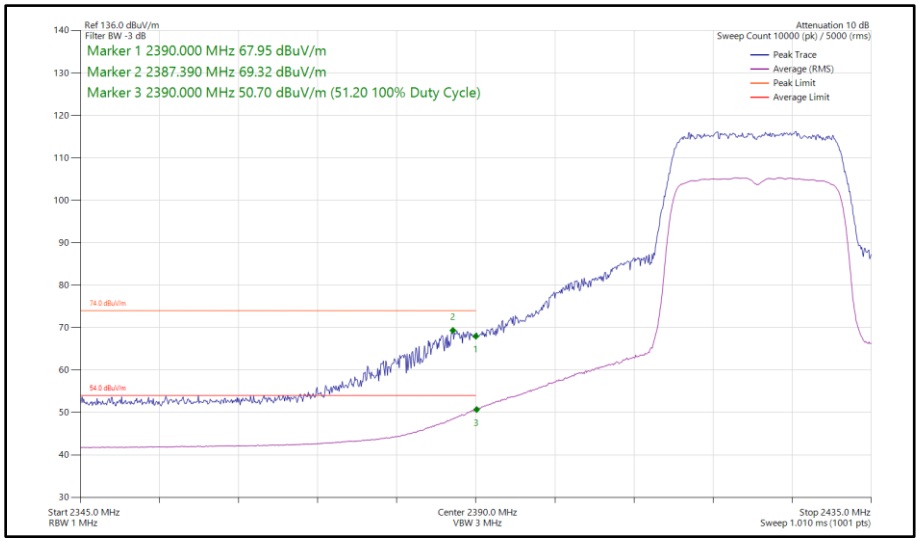

Figure 56 - 802.11ax HE20, SU, SISO, Core 1 - 2422 MHz
Band Edge Frequency 2390 MHz

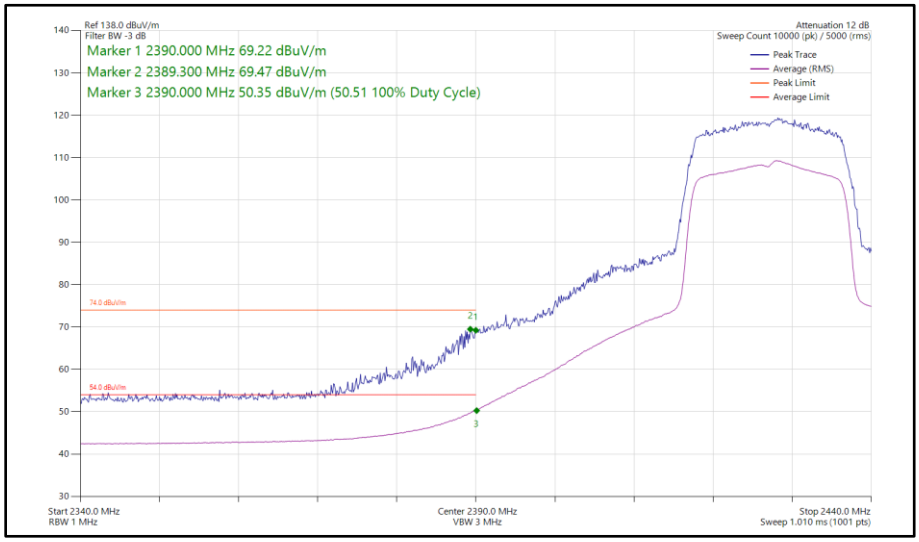

Figure 57 - 802.11ax HE20, SU, SISO, Core 1 - 2427 MHz
Band Edge Frequency 2390 MHz

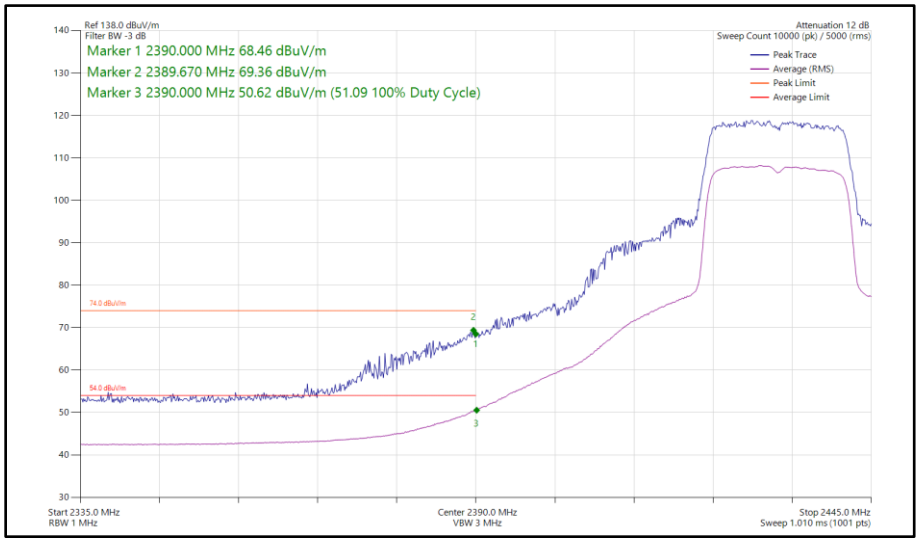

Figure 58 - 802.11ax HE20, SU, SISO, Core 1 - 2432 MHz
Band Edge Frequency 2390 MHz

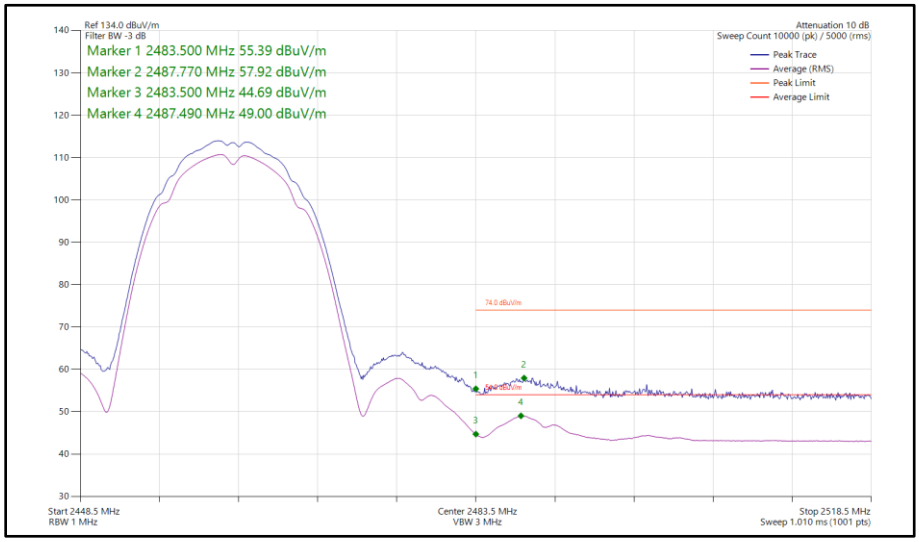

Figure 59 - 802.11b, SISO, Core 1 - 2462 MHz
Band Edge Frequency 2483.5 MHz

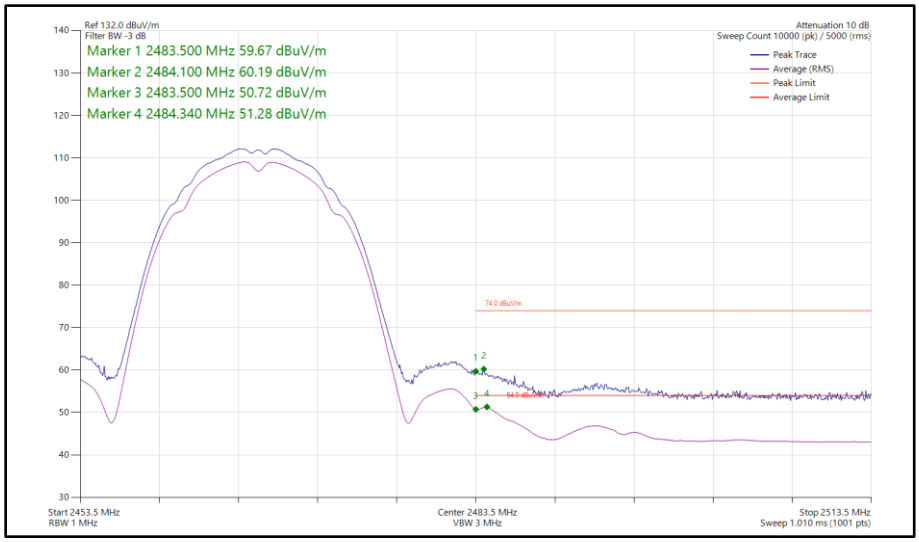

Figure 60 - 802.11b, SISO, Core 1 - 2467 MHz
Band Edge Frequency 2483.5 MHz

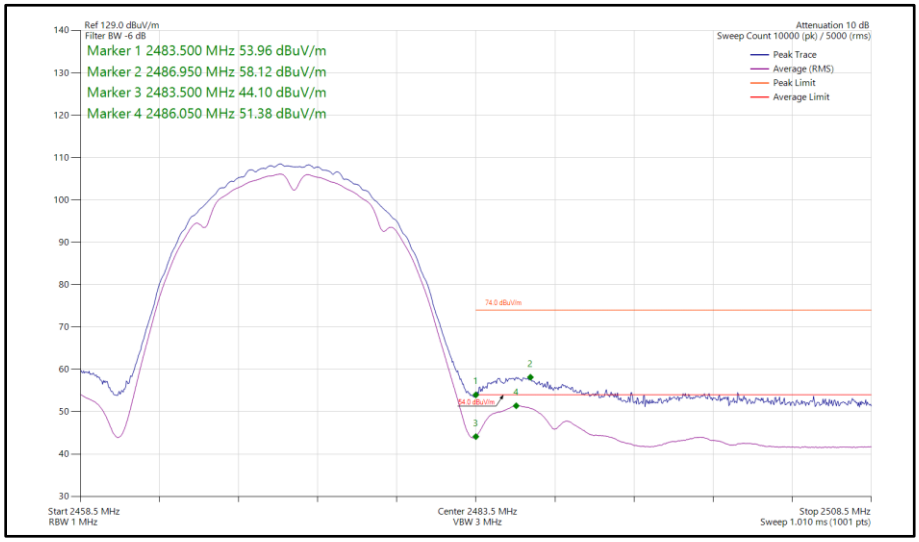

Figure 61 - 802.11b, SISO, Core 1 - 2472 MHz
Band Edge Frequency 2483.5 MHz

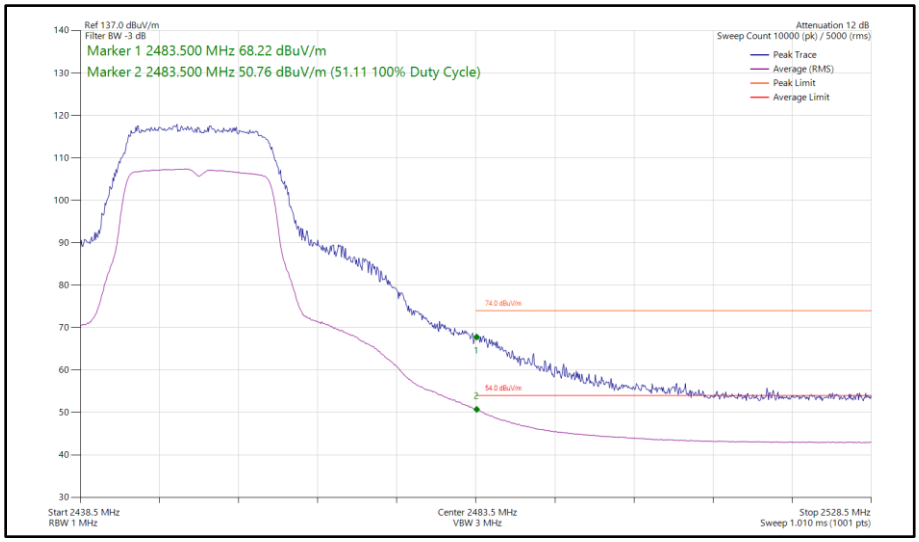

Figure 62 - 802.11g, SISO, Core 1 - 2452 MHz
Band Edge Frequency 2483.5 MHz

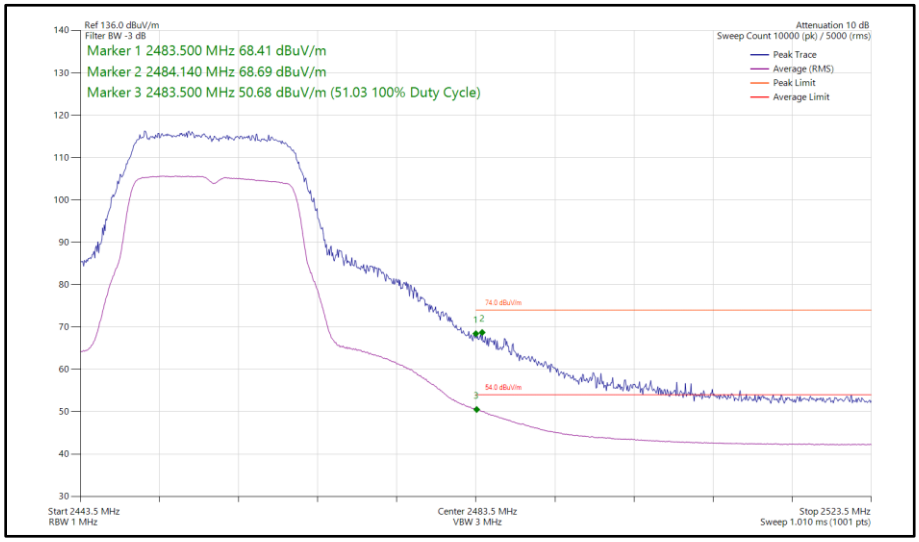

Figure 63 - 802.11g, SISO, Core 1 - 2457 MHz
Band Edge Frequency 2483.5 MHz