RF Test Report

Standard(s): FCC Part 15 Subpart 15.247,
RSS-247 Issue 3:2023
Unlicensed Intentional Radiators

Issued To: Ecobee Inc
207 Queens Quay Suite 600
Toronto, ON M5J 1A7
Canada

Product Name: Smart Thermostat Lite and Smart Thermostat Essential
Model: ECB701
FCC ID: WR9202428847PR
IC: 7981A-202428847PR

Report No. ML301244B-RF01 (DTS – WIFI)
Date of Issue: August 9, 2024

Report Prepared By:

Min Xie, Sr. EMC/RF Project Engineer

Reviewed By:

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1. Revision History

Project No. & Revision	Report Date	Initials	Description
ML301244B-RF00 (DTS – WIFI)	July 26, 2024	MX	Initial Release
ML301244B-RF00 (DTS – WIFI)	August 9, 2024	MX	Updated product name.

NOTE:

- Latest reports marked as a revision replace any previous report and/or report revision issued under the same project number.

2. Summary of Test Results

2.1 Test Verdict

Unless otherwise stated, the test data and results in this test report relate only to the sample(s) tested.

Requirement		Test Type	Result	Remark
FCC	ISED			
15.203 15.247(b)(4)	RSS-247 5.4(d)	Antenna Gain and Requirement	Pass	PCB Trace Antenna 2.5 dBi
15.247(a)(2)	RSS-247 5.2(a)	Emission Bandwidth	Pass	6dB Bandwidth > 500kHz
15.247(b)(3)	RSS-247 5.4(d)	Average Conducted Output Power	Pass	< 1 Watt
15.247(d)	RSS-247 5.5	Spurious Out of Band Emissions	Pass	< 30dBc
15.247(d) 15.209	RSS-GEN 8.9 (Table 5 & 6)	Transmitter Spurious Radiated Emissions	Pass	---
15.205 15.209	RSS-GEN 8.10 (Table 7)	Lower and Upper Band Edges	Pass	Transmitter spurious radiated emissions which fall in the restricted bands
15.247(e)	RSS-247 5.2(b)	Power Spectral Density	Pass	< 8 dBm in 3kHz BW
15.207	RSS-GEN (Table 4)	Power Line Conducted Emissions	Pass	--

2.1.1 Test Verdict Notes and Justifications

The DUT was mounted as in normal usage. See the Test Setup Photos for details.

Antenna details obtained from Antenna Manufacturer's Datasheet.

2.2 Test Standards

Standard	Description
47 CFR FCC Part 15 Subpart C	Code of Federal Regulations – Radio Frequency Devices, Intentional Radiators
FCC KDB 558074:2019	Digital Transmission Systems, measurements and procedures
RSS-247 Issue 3:2023	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-GEN Issue 5:2021	General Requirements for Compliance of Radio Apparatus
ANSI C63.4:2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ISO 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories

2.3 Test Facility

All tests were performed at Megalab Group Inc., located at 150 Addison Hall Circle, Aurora, ON, L4G 3X8, Canada.
The 10-meter semi-anechoic chamber for radiated emission and radiated immunity is designed to handle weights of up to 10,000lb and has power capability of over 100A. The turntable is capable of supporting test devices or systems either floor standing or table top of up to 4 meters wide and 3m tall. Conducted emissions, unless otherwise specified, are performed on a 2.44m x 2.48m ground plane and using a 2.44m x 2.48m vertical ground plane if applicable.

2.3.1 Accreditations

This report does not indicate any product endorsement by any government, accreditation agency, or Megalab Group Inc. Megalab Group Inc. shall have no liability for any deductions, interpretations or generalizations drawn by the client or others from the issued reports. If any opinions or interpretations are expressed in this report, they are outside Megalab Group Inc.'s scope of accreditation and do not necessarily reflect the opinions of Megalab Group Inc., unless otherwise specified.

A2LA (Certificate #5179.02)
Megalab Group Inc. is accredited to ISO/IEC 17025:2017 by the American Association for Laboratory Accreditation (A2LA) with Testing Certificate #5179.02. The laboratories current scope of accreditation can be found as listed on A2LA's website.

ISED
Megalab Group Inc. is registered with and recognized by Innovation, Science and Economic Development Canada (ISED) as an accredited testing laboratory.
Company Number: 28697

FCC
Megalab Group Inc. is registered with and recognized by the Federal Communications Commission (FCC) as an accredited testing laboratory.
Registration No. 200040

VCCI
The Semi-anechoic chamber of Megalab Group Inc. is registered with the Regulations for Voluntary Control Council for Interference (VCCI). Registration No.: R-20173, G-20174, C-20132, T-20133.

2.3.2 Measurement Uncertainty

As per ISO/IEC 17025 requirements, an evaluation of the measurement uncertainties associated with the emission test results should be included in the test report.

Where relevant, the following measurement uncertainty levels have been estimated for the tests performed on the DUT as specified in CISPR 16-4-2. The measurement uncertainties given below are based on a coverage factor k = 2 which yields approximately a 95% level of confidence for the near-normal distribution typical of most measurement results.

Measurement	Frequency Range	Uncertainty
Conducted Emissions at AC Mains Power Port	150kHz to 30MHz	2.27 dB
Radiated Emissions	30MHz to 1GHz	5.22 dB
	1GHz to 18GHz	4.76 dB

2.3.3 Sample Calculations

Conducted Emissions

Emission Level (dBµV) =	Read Level (dBµV)	+	LISN Factor (dB)	+	Attenuation Factor (dB)	+	Cable Loss (dB)
=	34.8	+	0.1	+	10.0	+	0.2
=	45.1						

Margin (dB) =	Limit (dBµV)	-	Emission Level (dBµV)
=	60.0	-	45.1
=	14.9		

Radiated Emissions

Emission Level (dBµV/m) =	Read Level (dBµV)	+	Antenna Factor (dB/m)	+	Cable Loss (dB)	-	Pre-Amp Gain (dB)
=	52.4	+	9.4	+	1.3	-	29.2
=	33.9						

Margin (dB) =	Limit (dBµV/m)	-	Emission Level (dBµV/m)
=	50.0	-	33.9
=	16.1		

2.3.4 Terms, Definitions and Abbreviations

AE	Auxiliary Equipment
DUT	Device Under Test
DTS	Digital Transmission System
EMC	Electro-Magnetic Compatibility
FHSS	Frequency Hopping Spread Spectrum
ISM	Industrial, Scientific and Medical
LISN	Line Impedance Stabilization Network
N/A	Not Applicable
NCR	No Calibration Required
RF	Radio Frequency
RBW	Resolution Bandwidth
VBW	Video Bandwidth

Auxiliary Equipment/Support Equipment
Equipment needed to exercise and/or monitor the operation of the DUT.

Artificial Mains Network
Network that provides a defined impedance to the DUT at radio frequencies, couples the disturbance voltage to the measuring receiver and decouples the test circuit from the supply mains.

Class A Equipment
Equipment suitable for use in all locations other than those allocated in residential environments and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

Class B Equipment
Equipment suitable for use in all locations, including in residential environments and in establishments directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

Device Under Test
Device or system being evaluated for compliance with the requirements of the Test Standards listed in this report.

Electro-Magnetic Compatibility
Ability of equipment or system to function satisfactorily in its EM environment without introducing intolerable electromagnetic disturbances to anything in that environment.

Electromagnetic Disturbance
Any electromagnetic phenomenon which may degrade the performance of a device, equipment or system.

3. General Information

3.1 Client Information

Company	Ecobee Inc
Address	207 Queens Quay Suite 600 Toronto, ON M5J 1A7 Canada
Contact	John Russomanno
Email	john@ecobee.com

3.2 Device Under Test (DUT)

3.2.1 DUT Information

DUT Name	Smart Thermostat Lite and Smart Thermostat Essential
DUT Model(s)	ECB701
Serial Number	Production samples
Power Source (AC / DC / Battery)	AC
Input Voltage (V) or Range	24Vac
Frequency (Hz) or Range	60Hz
Mode(s) of Operation	Continuous transmission, > 98% Duty Cycle
Connectors Available on DUT	Standard thermostat connections
Transmitter Information	
FCC ID	WR9202428847PR
IC	7981A-202428847PR
Technology Used	802.11 b/g/n
Operating Frequency	2412 MHz to 2462 MHz
Modulation Type	DSSS, OFDM
Number of Channels	40
Antenna Manufacturer	Custom – PCB trace
Antenna Model	N/A
Antenna Type	Monopole
Antenna Gain	2.5 dBi

Note: Above antenna information is provided by the client. The characteristics and gain are obtained from the Antenna Manufacturer's Data Sheet.

3.2.2 DUT Description

EUT is a smart thermostat that have a 2400 – 2483.5 MHz DTS (802.11 b/g/n) and BLE transmitters on one chip, and a 920 – 928 MHz FHSS/Hybrid transmitter on second chip.

This report documents the compliance of the WIFI transmitter.

3.3 Test Setup of DUT

3.3.1 Configuration

The DUT was configured in a direct test mode with the following parameters

- For all the tests, the DUT was set to transmit continuously with maximum duty cycle
- Output Power: +20 dBm
- Channels:
  - low, 2412MHz
  - Mid, 2437MHz
  - High, 2462MHz

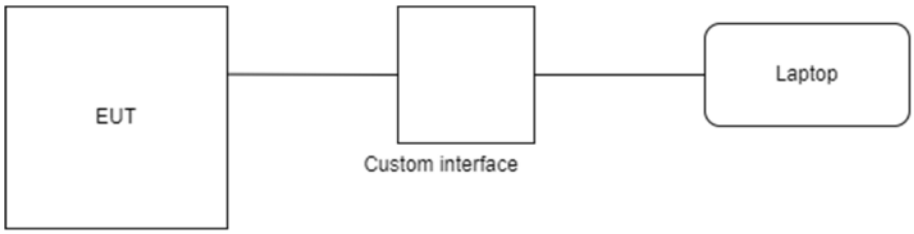


Figure 1 – Configuration Block Diagram

Description of I/O Cables			
Cable Function	**Length of Cable (m)**	**Shielded (Y/N)**	**Outdoor Use (Y/N)**
Thermostat control	>3	N	N

3.3.2 Support Equipment

Device	Manufacturer	Model	S/N
Custom USB Interface	Ecobee	--	---

3.4 Modifications for Compliance

No modifications were made to the device under test to comply with the testing requirements.

4. Test Results

4.1 Emission Bandwidth

Test Date:	May 13, 2024	Initials:	MX
Temperature (°C)	21.1		
Relative Humidity (%)	54.7		
Barometric Pressure (kPa)	100.8		

4.1.1 Limits

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

4.1.2 Test Procedure

Tested according to ANSI C63.10 Section 11.8 and 6.9.3.

For the 6dB (DTS) Bandwidth:

a) Set RBW = 100kHz and VBW ≥ [3 × RBW].
b) Detector = Peak and Trace Mode = Max Hold.
c) Sweep = Auto Couple.
d) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6dB relative to the maximum level measured in the fundamental emission.

For the 99% Bandwidth:

a) Set RBW in the range of 1% to 5% of the actual occupied bandwidth.
b) Set VBW ≥ [3 × RBW].
c) Span set to 1.5 to 5 times the occupied bandwidth.
d) Use the 99% power bandwidth function of the instrument to measure bandwidth.

4.1.3 Test Results

The EUT passed. All of the protocols had a minimum measured 6 dB BW of more than 500 kHz.

The 99% of bandwidth of the transmitters for informational purposes. There is no limit specified for 99% bandwidth.

The EUT supports 802.11 b/g/n protocols for 2.4 GHz WIFI. For every protocol, three channels were measured. The 6 dB and 99% bandwidth are documented in the following tables

802.11 b				
6dB (DTS) & 99% Bandwidth				
Frequency (MHz)	**6dB DTS Bandwidth (MHz)**	**99% Occupied Bandwidth (MHz)**	**6dB Bandwidth Limit (MHz)**	**Test Result**
2412.0	8.72	11.27	> 0.50	Pass
2437.0	8.58	11.36	> 0.50	Pass
2462.0	8.54	11.33	> 0.50	Pass

802.11 g				
6dB (DTS) & 99% Bandwidth				
Frequency (MHz)	**6dB DTS Bandwidth (MHz)**	**99% Occupied Bandwidth (MHz)**	**6dB Bandwidth Limit (MHz)**	**Test Result**
2412.0	15.20	16.29	> 0.50	Pass
2437.0	15.21	16.32	> 0.50	Pass
2462.0	15.21	16.29	> 0.50	Pass

802.11 n				
6dB (DTS) & 99% Bandwidth				
Frequency (MHz)	**6dB DTS Bandwidth (MHz)**	**99% Occupied Bandwidth (MHz)**	**6dB Bandwidth Limit (MHz)**	**Test Result**
2412.0	15.21	17.40	> 0.50	Pass
2437.0	15.21	17.40	> 0.50	Pass
2462.0	15.40	17.40	> 0.50	Pass

4.1.3.1. 802.11 b Plots

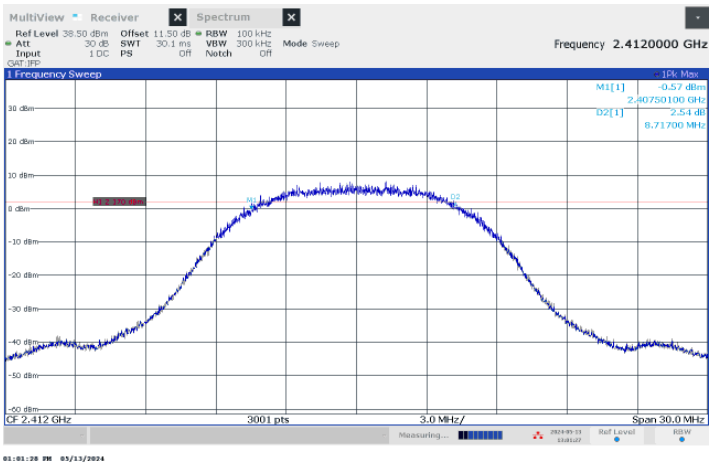


Figure 2 – 6dB Bandwidth – 2412 MHz

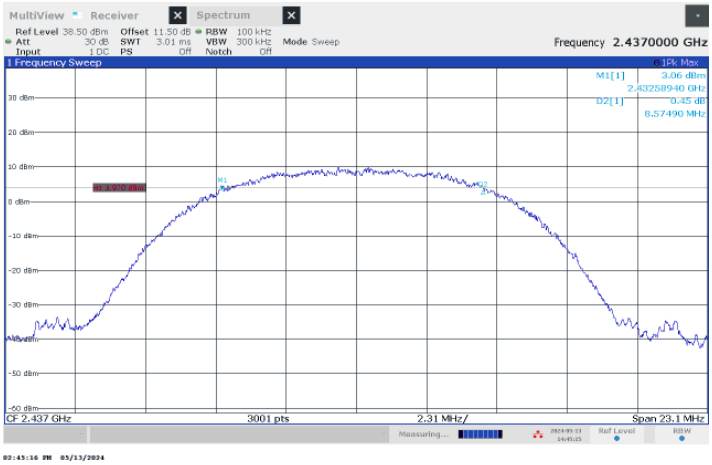


Figure 3 – 6dB Bandwidth – 2437 MHz

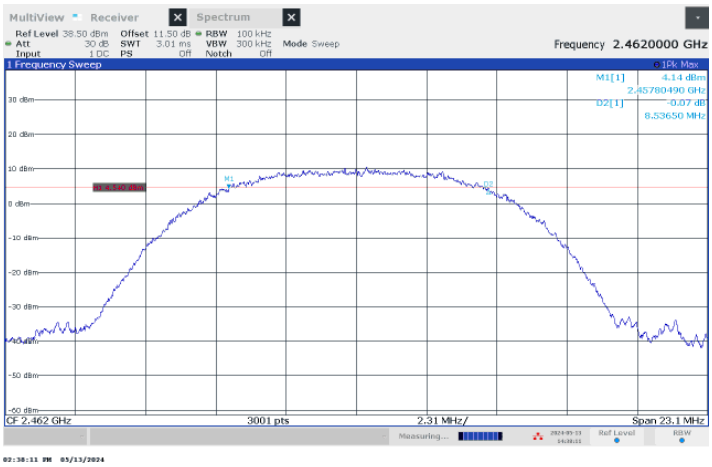


Figure 4 – 6dB Bandwidth – 2462 MHz

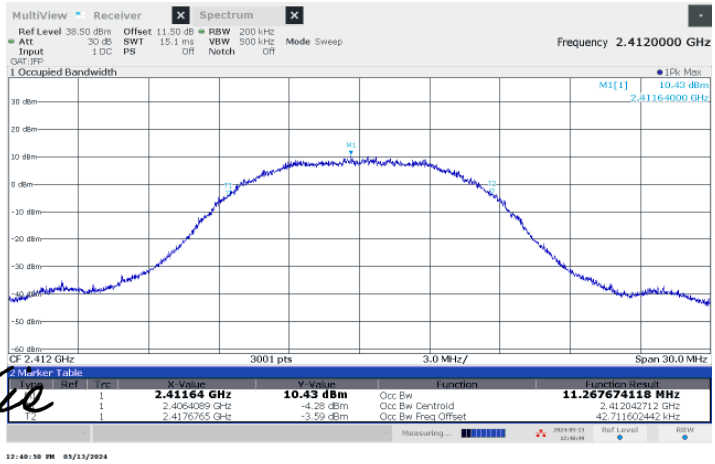


Figure 5 – 99% Bandwidth – 2412 MHz

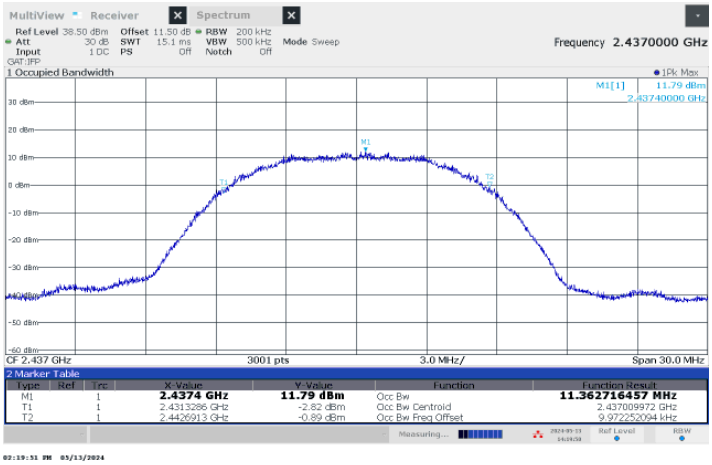


Figure 6 – 99% Bandwidth – 2437 MHz

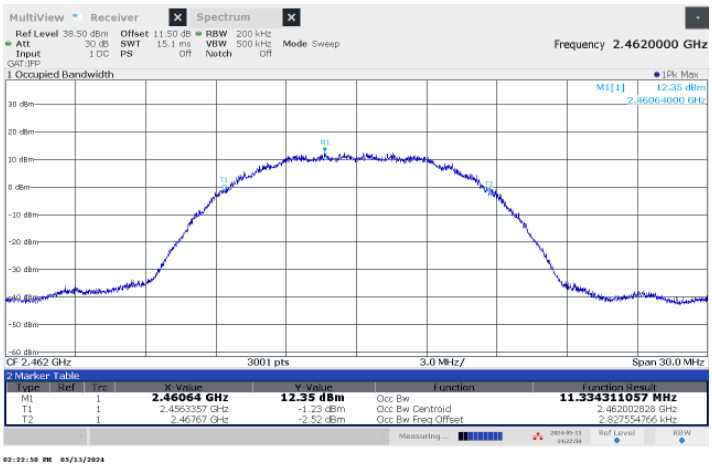


Figure 7 – 99% Bandwidth – 2462 MHz

4.1.3.2. 802.11 g Plots

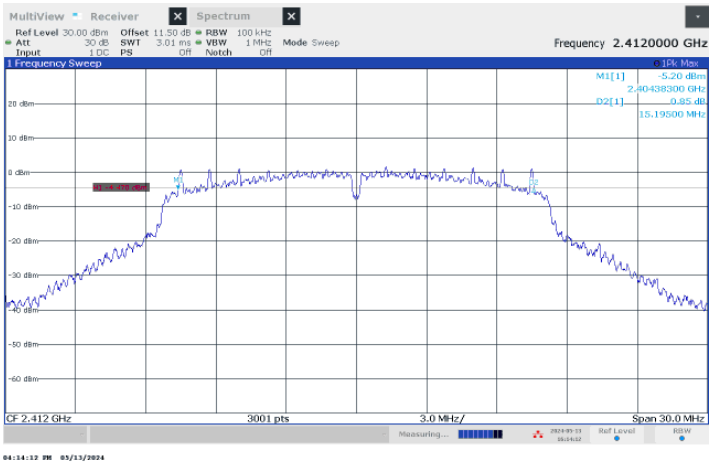


Figure 8 – 6dB Bandwidth – 2412 MHz

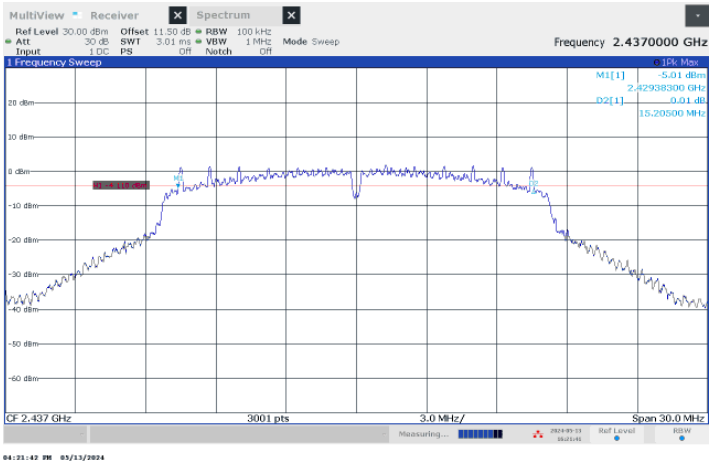


Figure 9 – 6dB Bandwidth – 2437 MHz

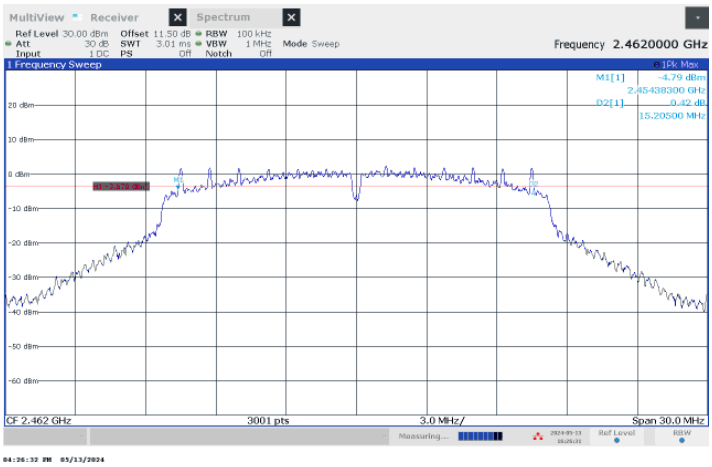


Figure 10 – 6dB Bandwidth – 2462 MHz

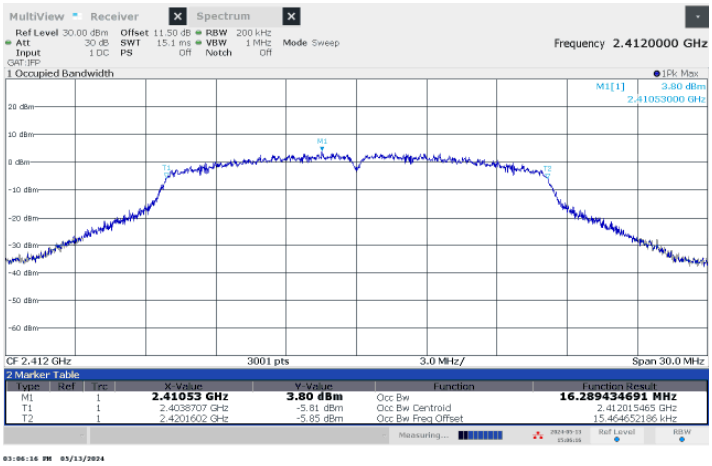


Figure 11 – 99% Bandwidth – 2412 MHz

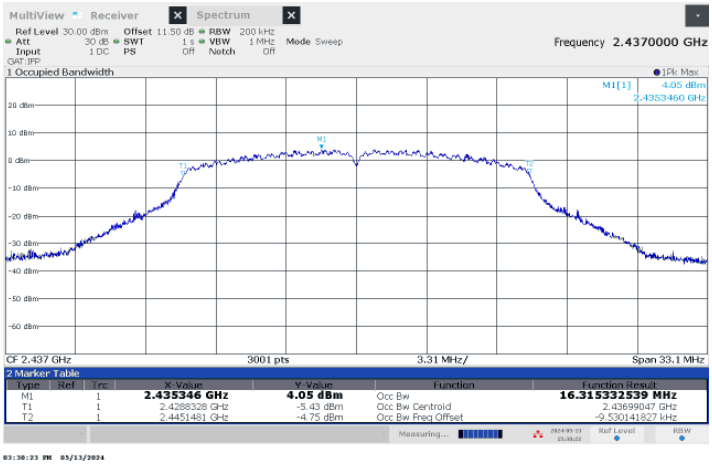


Figure 12 – 99% Bandwidth – 2437 MHz

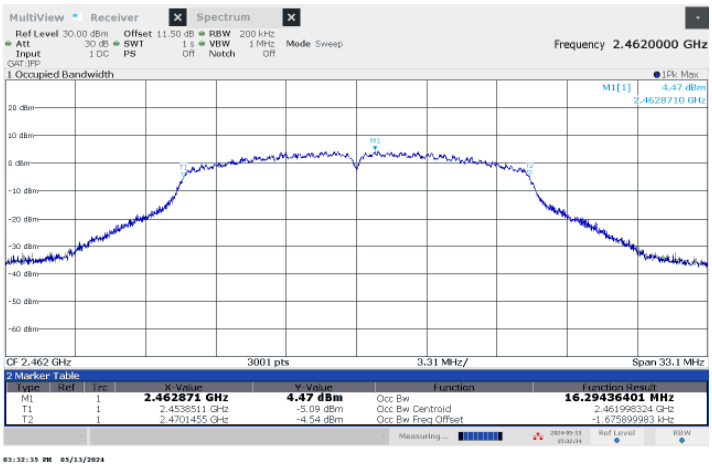


Figure 13 – 99% Bandwidth – 2462 MHz

4.1.3.3. 802.11 n Plots

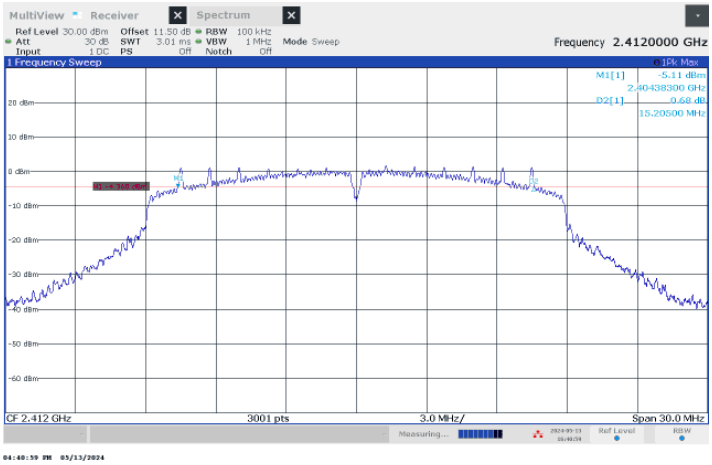


Figure 14 – 6dB Bandwidth – 2412 MHz

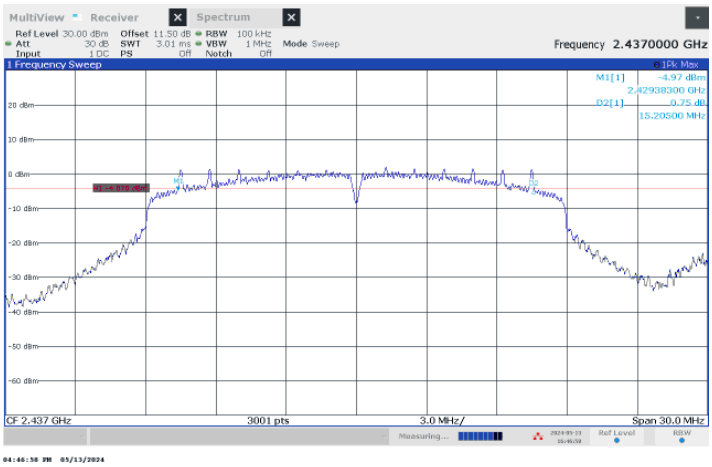


Figure 15 – 6dB Bandwidth – 2437 MHz

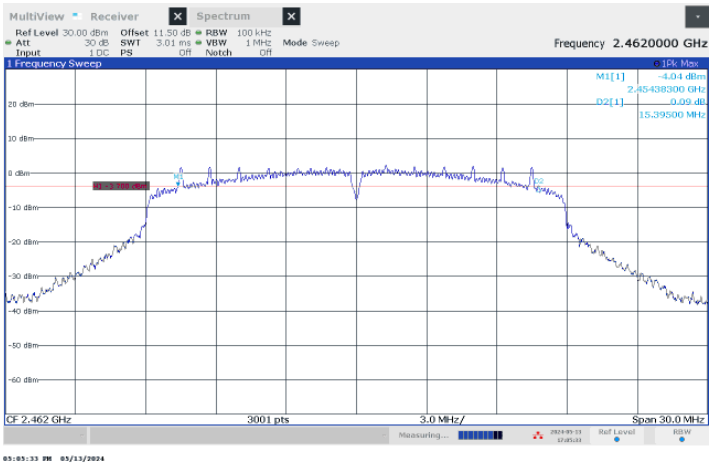


Figure 16 – 6dB Bandwidth – 2462 MHz

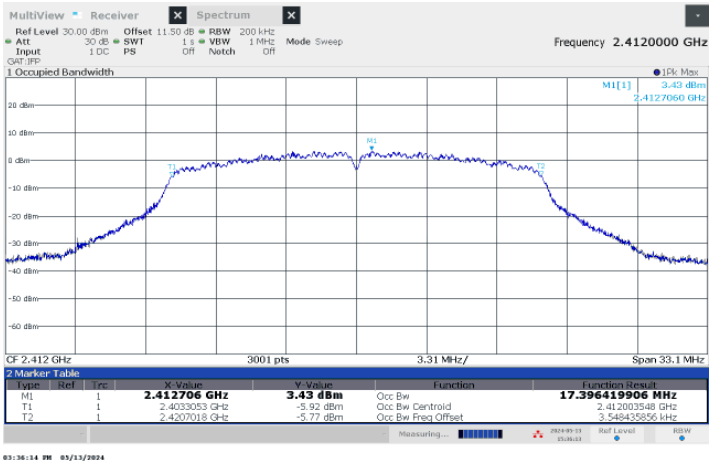


Figure 17 – 99% Bandwidth – 2412 MHz

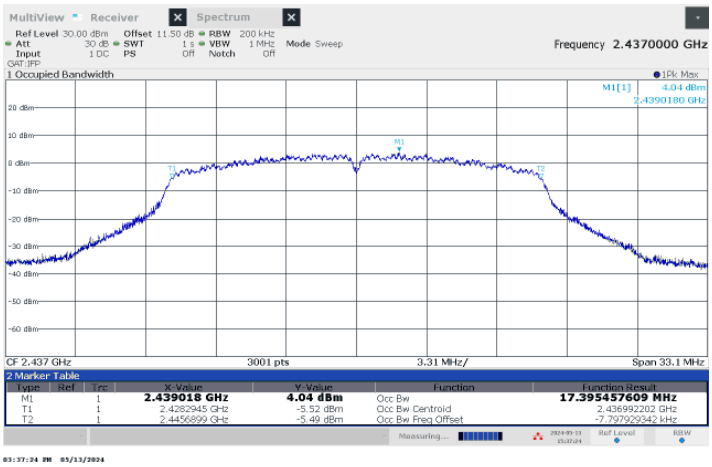


Figure 18 – 99% Bandwidth – 2437 MHz

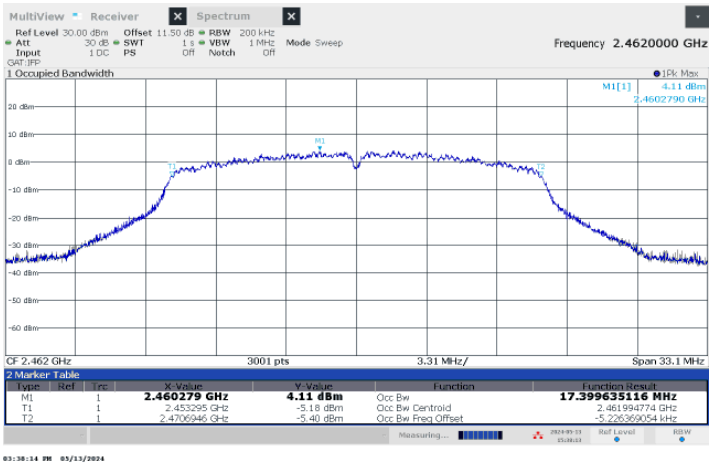


Figure 19 – 99% Bandwidth – 2462 MHz

4.1.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

4.2 Maximum Conducted Output Power

Test Date:	May 13, 2024	Initials:	MX
Temperature (°C)	21.1		
Relative Humidity (%)	54.7		
Barometric Pressure (kPa)	100.8		

4.2.1 Limits

The maximum conducted output power of the intentional radiator shall not exceed 1 Watt (+30dBm) for systems using digital modulation in the 902–928MHz, 2400–2483.5MHz, and 5725–5850MHz bands.

Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

4.2.2 Test Procedure

Tested according to ANSI C63.10 Section 11.9.2.

The RF output of the DUT was connected to the spectrum analyzer with sufficient attenuation in front. The total path loss was set as reference offset to correct the final reading.

For Maximum Conducted Output (Average) Power

a) Set RBW = 1% to 5% of OBW, not exceeding 1 MHz
b) Set VBW ≥ 3 x RBW
c) Detector: RMS
d) Span: At least 1.5 times the OBW
e) Trace: Average
f) Average Sweep Count: At least 100 times
g) Trace Mode: Single
h) Use instrument's band power measurement function to computer power by integrating the spectrum across the OBW.

4.2.3 Test Results

The EUT maximum conducted power is below 30 dBm (1 W).

The EUT supports 802.11 b/g/n protocols for 2.4 GHz WIFI. For each protocol, three channels were measured. The maximum conducted power are documented in the following tables

802.11 b					
Channel	**Frequency (MHz)**	**Average Power (dBm)**	**Average Power (mW)**	**Limit (dBm)**	**Test Result**
Low	2412	17.65	58.21	30	Pass
Mid	2437	17.74	59.43	30	Pass
High	2462	18.19	65.92	30	Pass

802.11 g					
Channel	**Frequency (MHz)**	**Average Power (dBm)**	**Average Power (mW)**	**Limit (dBm)**	**Test Result**
Low	2412	13.25	21.13	30	Pass
Mid	2437	13.42	21.98	30	Pass
High	2462	13.92	24.66	30	Pass

802.11 n					
Channel	**Frequency (MHz)**	**Average Power (dBm)**	**Average Power (mW)**	**Limit (dBm)**	**Test Result**
Low	2412	13.30	21.38	30	Pass
Mid	2437	13.33	21.53	30	Pass
High	2462	13.77	23.82	30	Pass

4.2.3.1. 802.11 b Plots

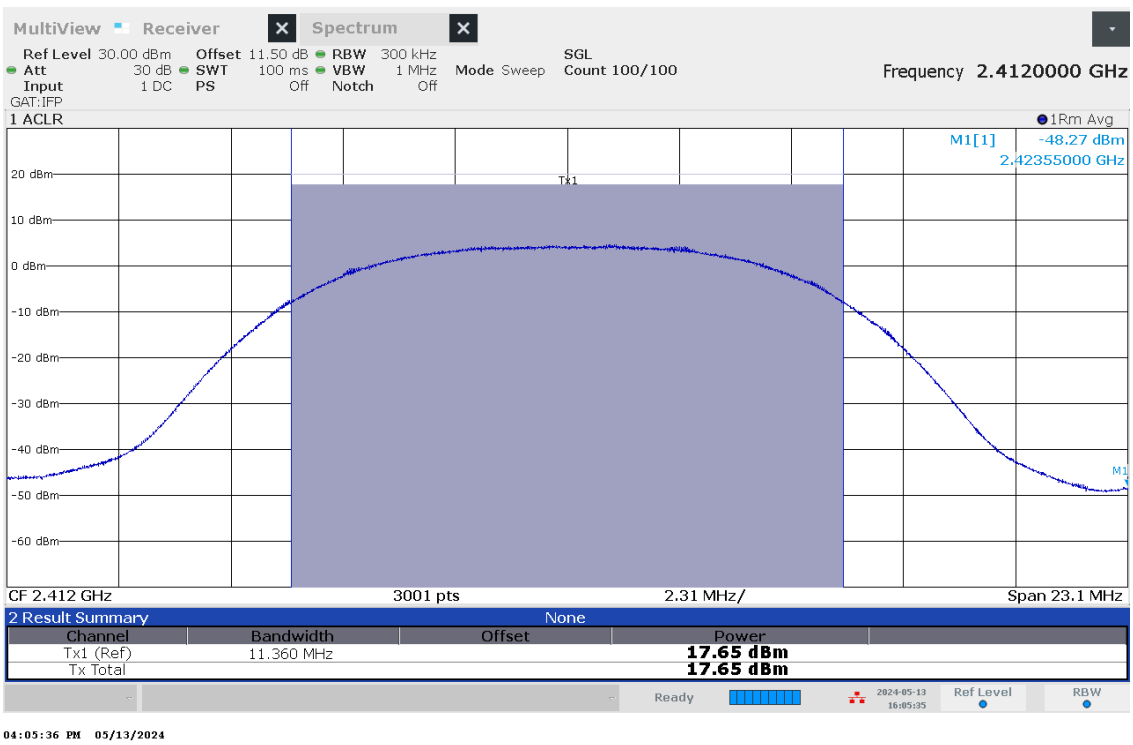


Figure 20 – Average Power - Low Channel

M.Xie

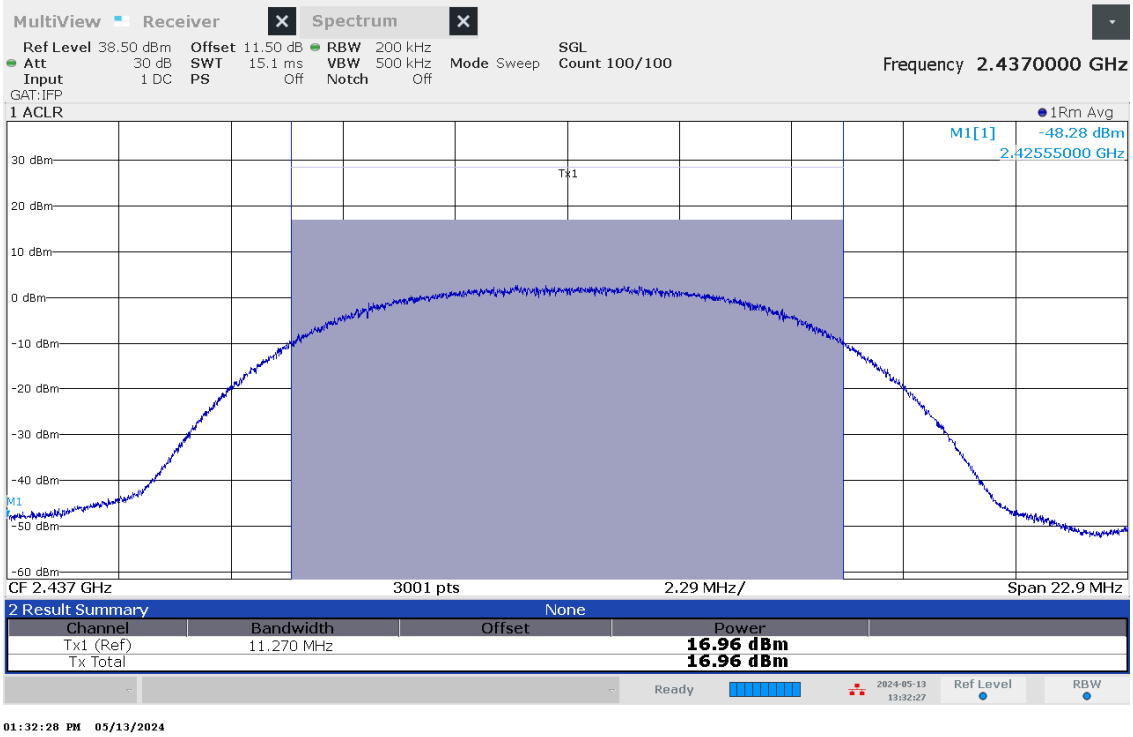


Figure 21 – Average Power - Mid Channel

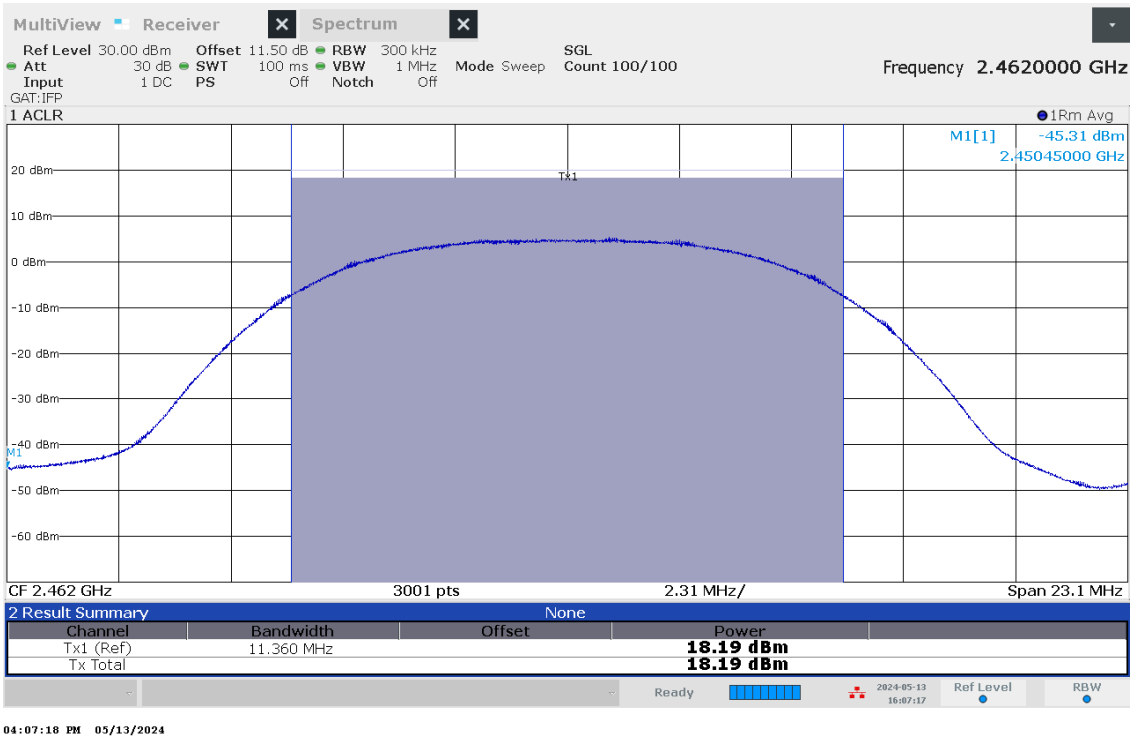


Figure 22 – Average Power - High Channel

4.2.3.2. 802.11 g Plots

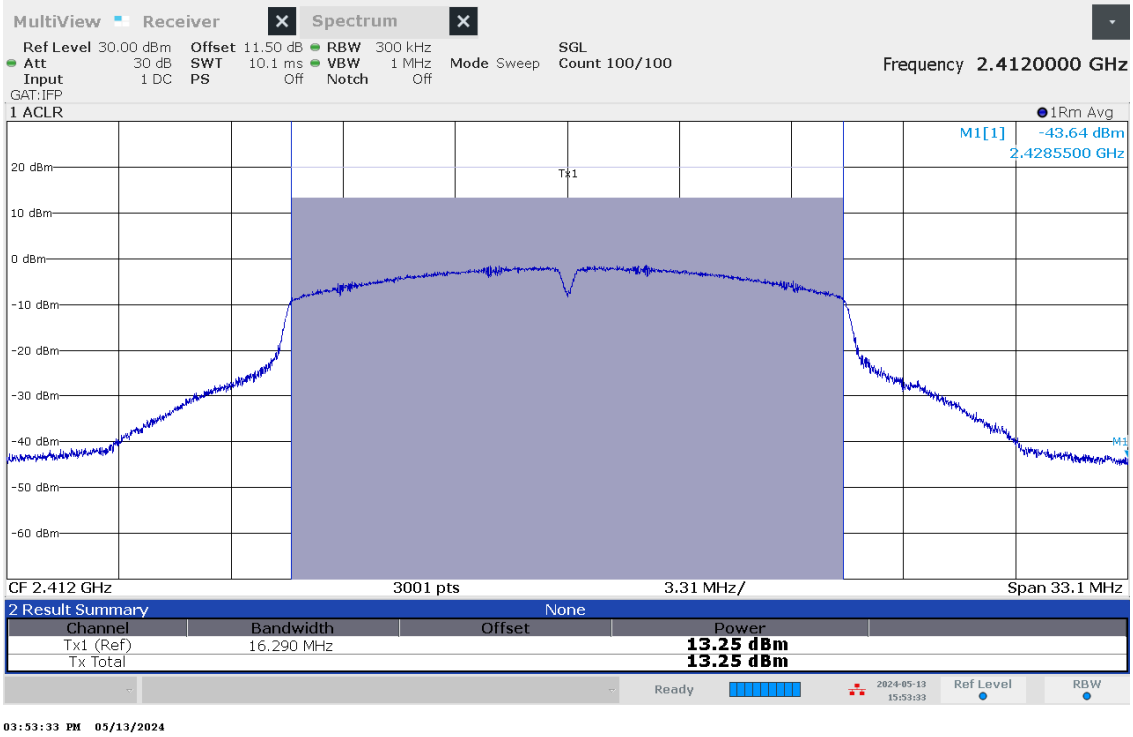


Figure 23 – Average Power - Low Channel

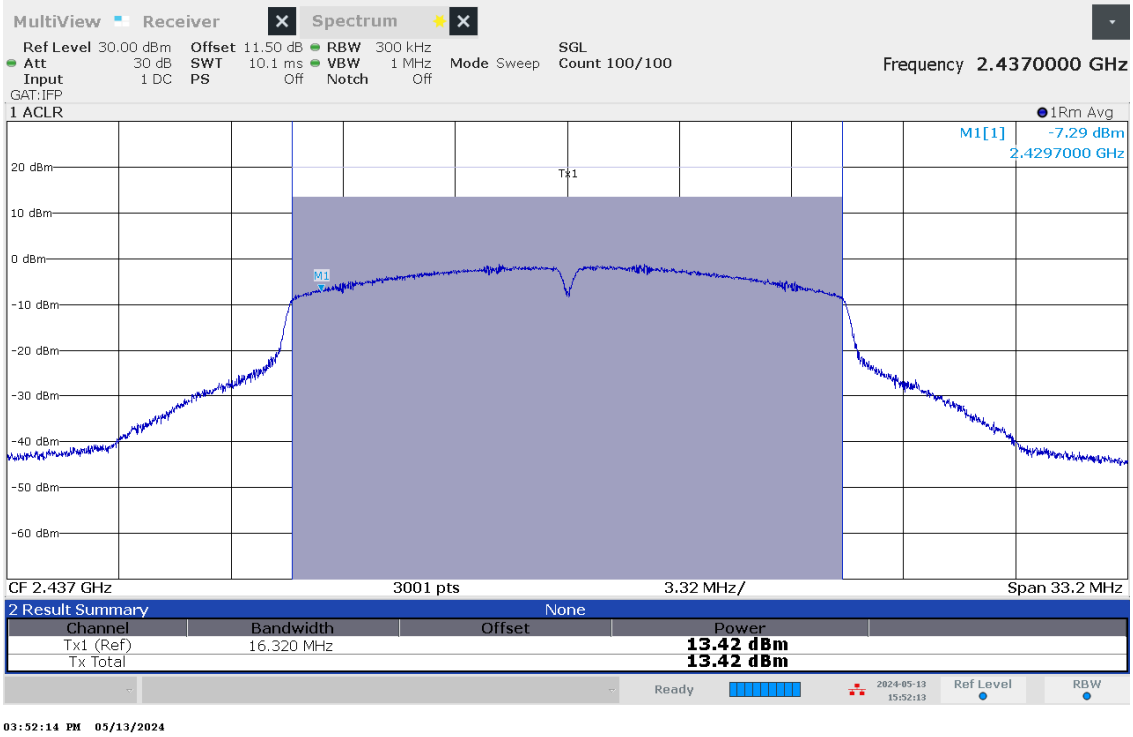


Figure 24 – Average Power - Mid Channel

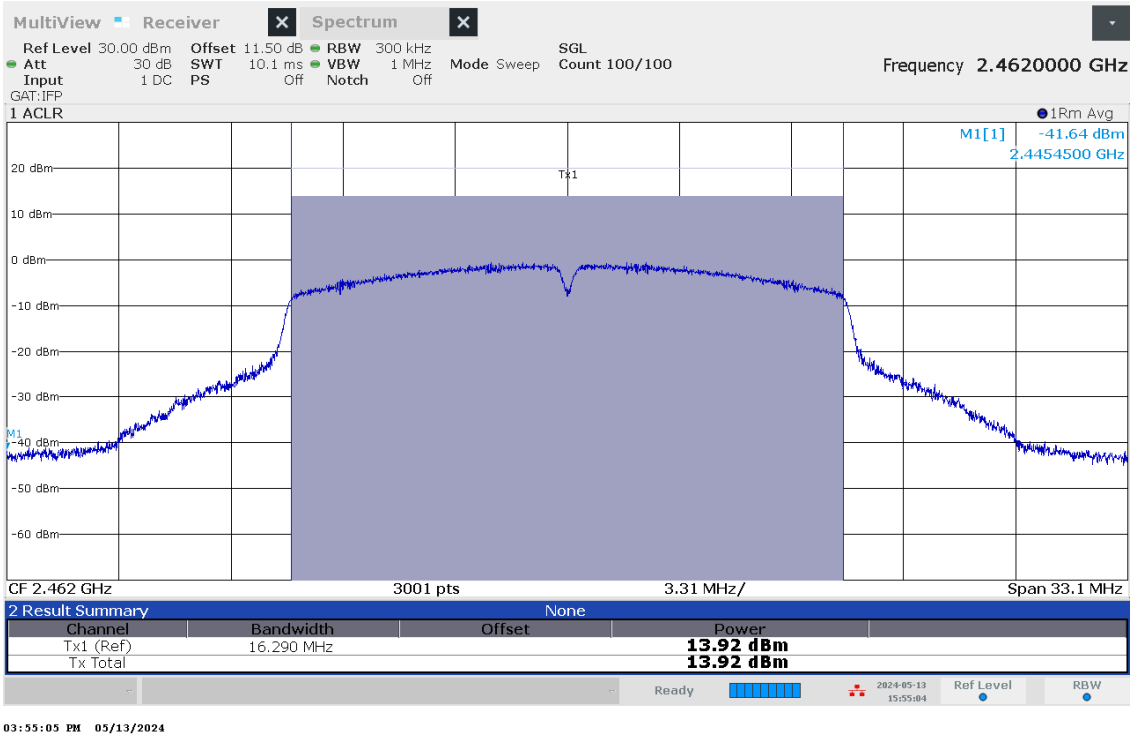


Figure 25 – Average Power - High Channel

4.2.3.3. 802.11 n Plots

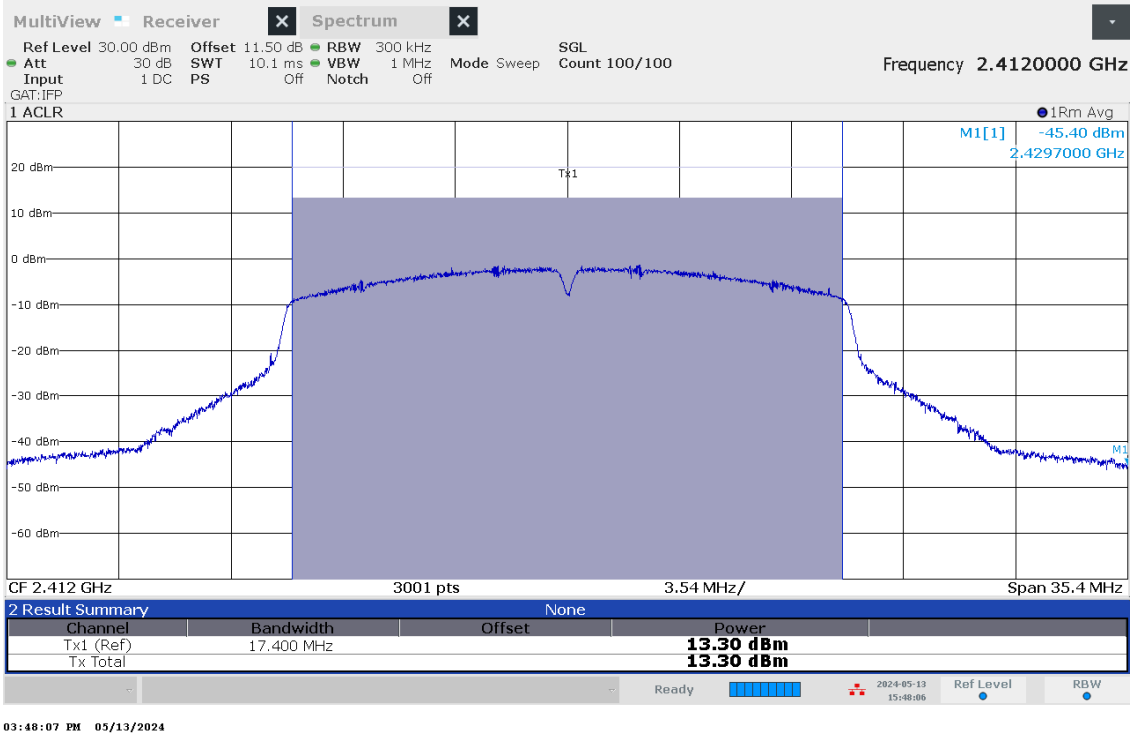


Figure 26 – Average Power - Low Channel

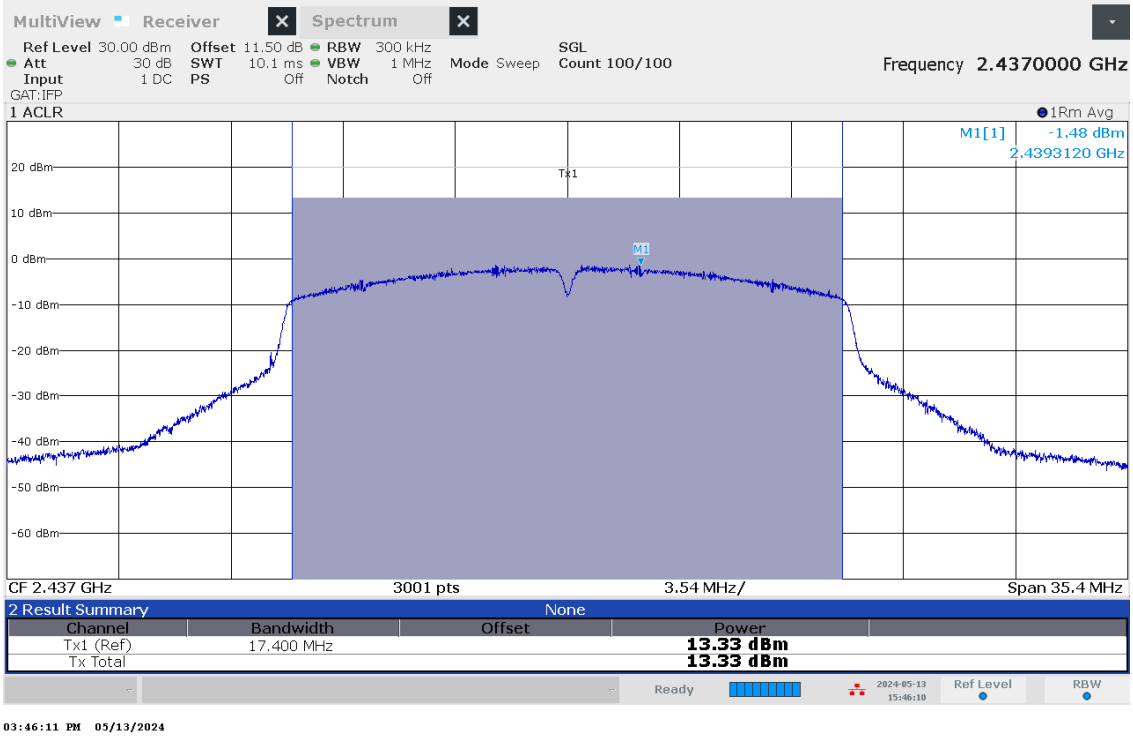


Figure 27 – Average Power - Mid Channel

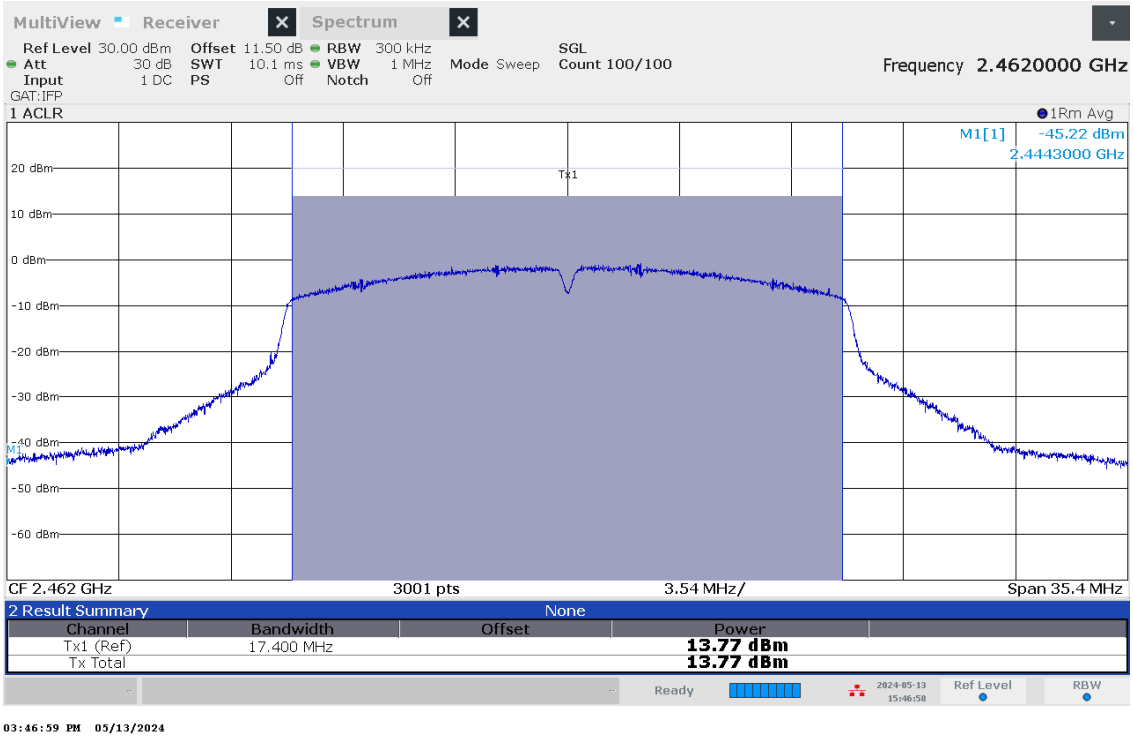


Figure 28 – Average Power - High Channel

4.2.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

4.3 Power Spectral Density

Test Date:	May 14, 2024	Initials:	MX
Temperature (°C)	21.8		
Relative Humidity (%)	53.6		
Barometric Pressure (kPa)	101.0		

4.3.1 Limits

For digitally modulated systems, the power spectral density (PSD) conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

4.3.2 Test Procedure

Tested according to ANSI C63.10 Section 11.10

a) Set RBW = 3kHz and VBW ≥ [3 × RBW].
b) Set Span to 1.5 times the DTS Bandwidth.
c) Detector = Peak and Trace Mode = Max Hold.
d) Sweep = Auto Couple.
e) Use the peak marker function to determine the maximum level.

The RF output of the DUT was connected to the spectrum analyzer with sufficient attenuation in front and the total path loss was set as reference offset to correct the final reading.

4.3.3 Test Results

The DUT meet the 8 dBm/3kHz power spectral density limit.

The DUT was set to transmit at maximum tuned power. The DUT supports 802.11 b/g/n. Three Channels for each mode were measured.

External attenuator and cable loss were accounted for as reference offset in the spectrum analyzer.

The following tables show the peak power spectral density:

802.11 b				
Channel	**Frequency (MHz)**	**PSD (dBm)**	**Limit (dBm)**	**Test Result**
Low	2412	-5.45	8	Pass
Mid	2437	-5.70	8	Pass
High	2462	-4.38	8	Pass

802.11 g				
Channel	**Frequency (MHz)**	**PSD (dBm)**	**Limit (dBm)**	**Test Result**
Low	2412	-10.75	8	Pass
Mid	2437	-12.07	8	Pass
High	2462	-11.15	8	Pass

802.11 n				
Channel	**Frequency (MHz)**	**PSD (dBm)**	**Limit (dBm)**	**Test Result**
Low	2412	-11.32	8	Pass
Mid	2437	-10.84	8	Pass
High	2462	-10.48	8	Pass

4.3.3.1. 802.11 b

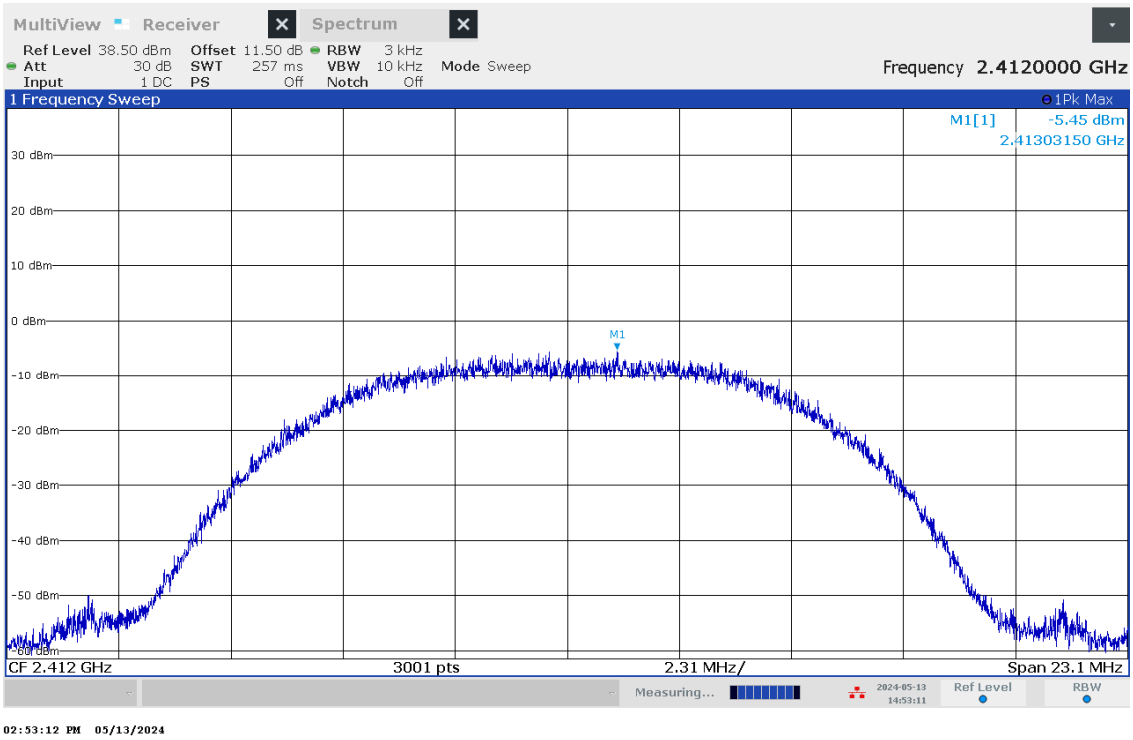


Figure 29 – PSD - Low Channel

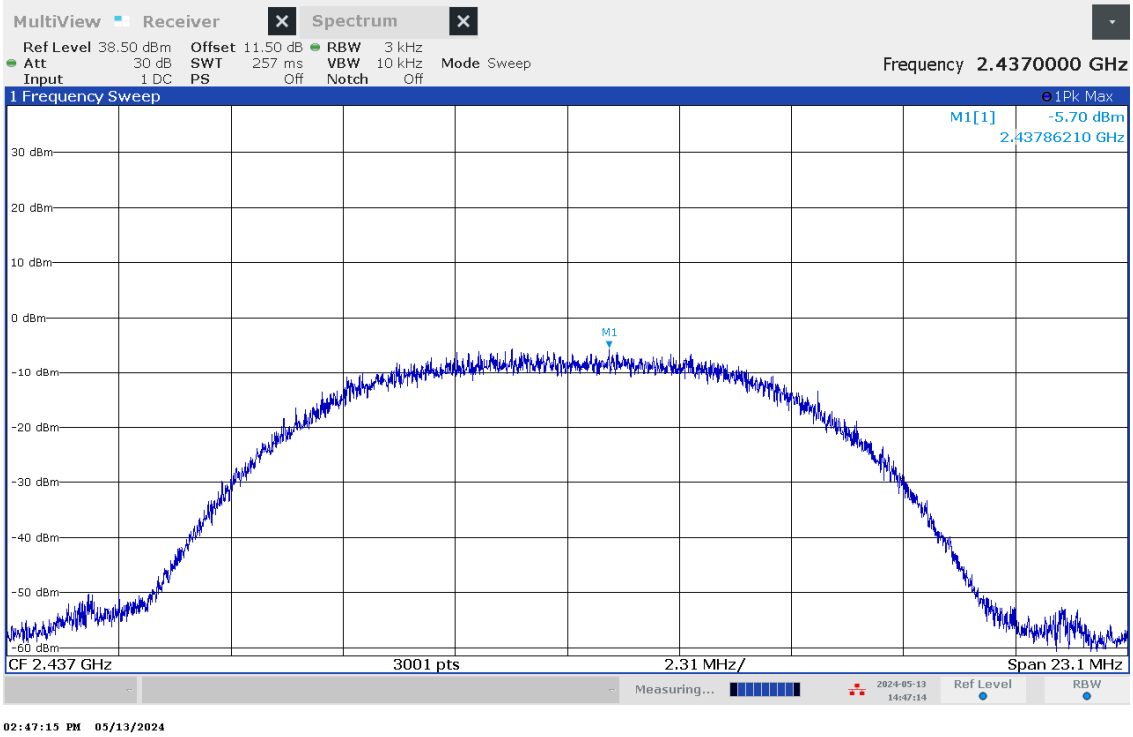


Figure 30 – PSD - Mid Channel

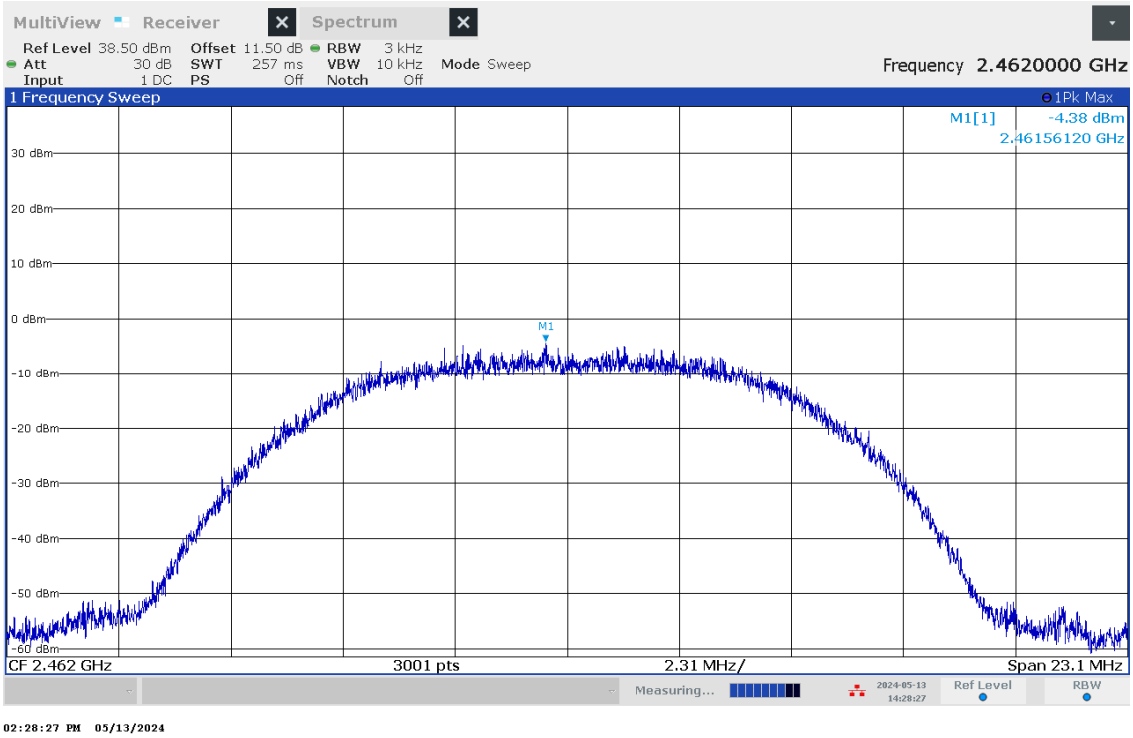


Figure 31 – PSD - High Channel

4.3.3.2. 802.11 g

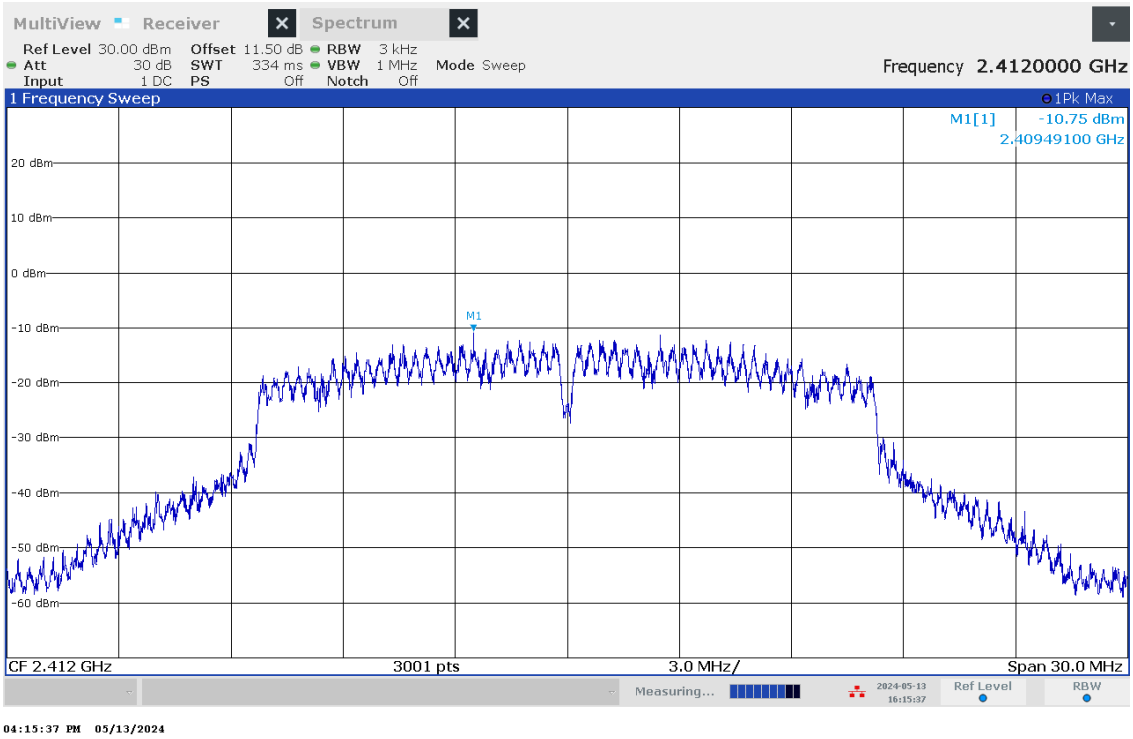


Figure 32 – PSD - Low Channel

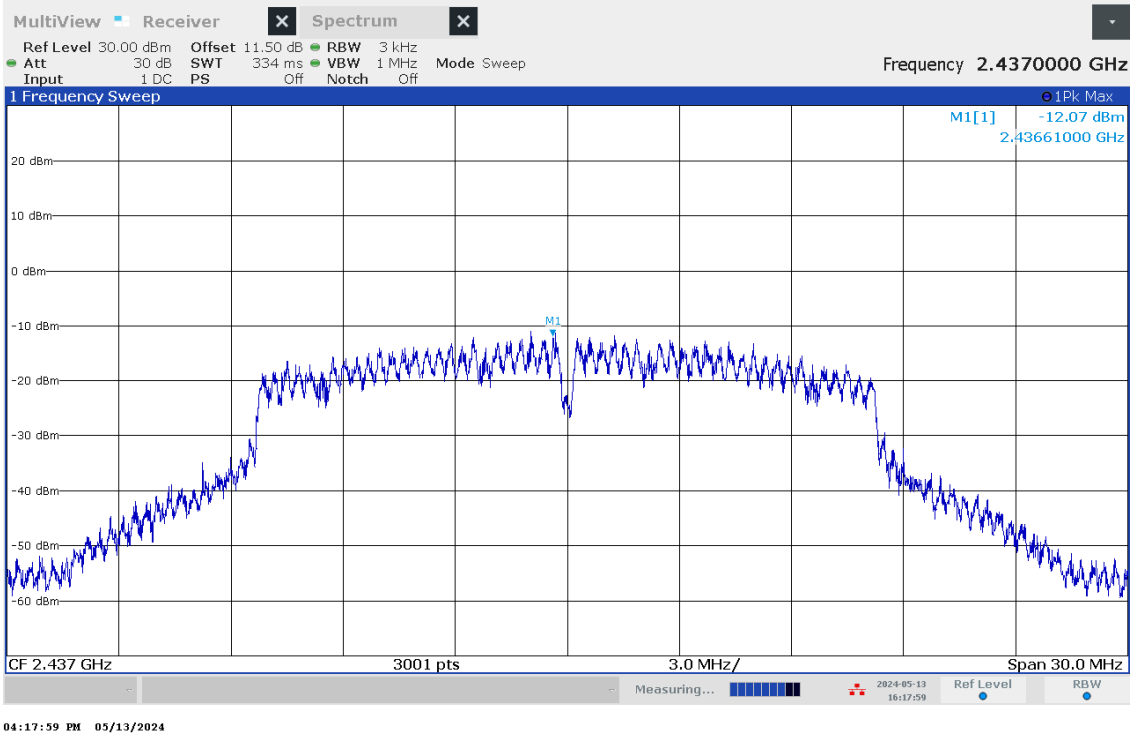


Figure 33 – PSD - Mid Channel

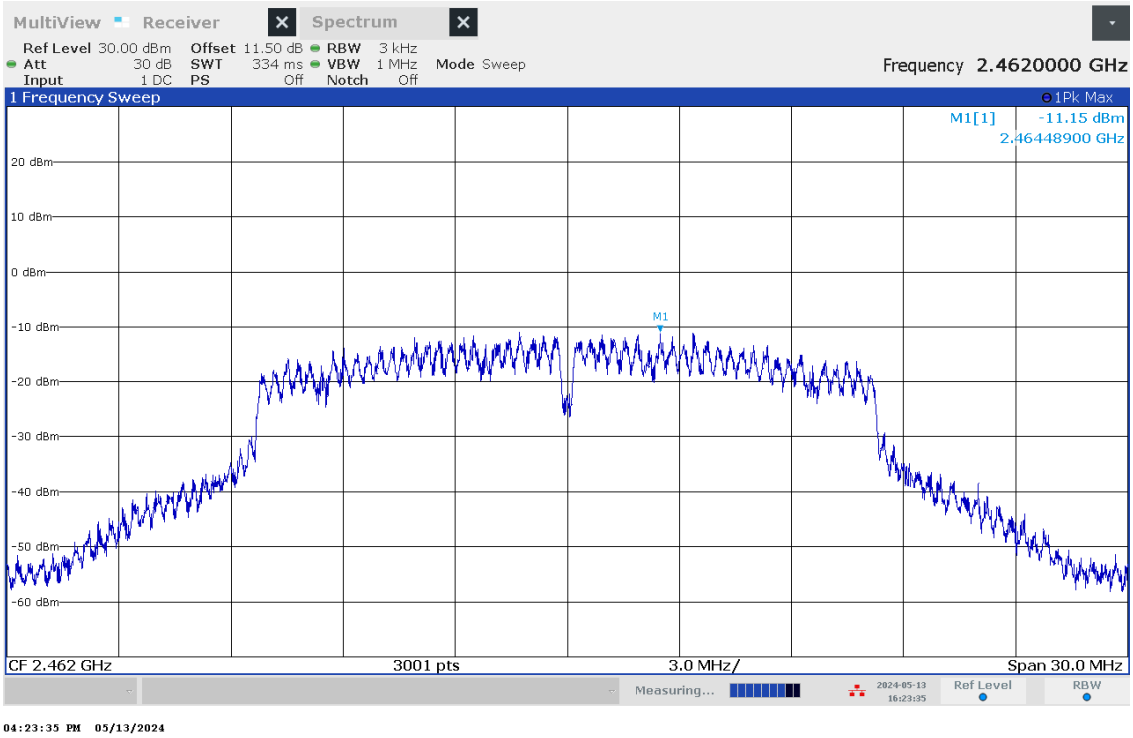


Figure 34 – PSD - High Channel

4.3.3.3. 802.11 n

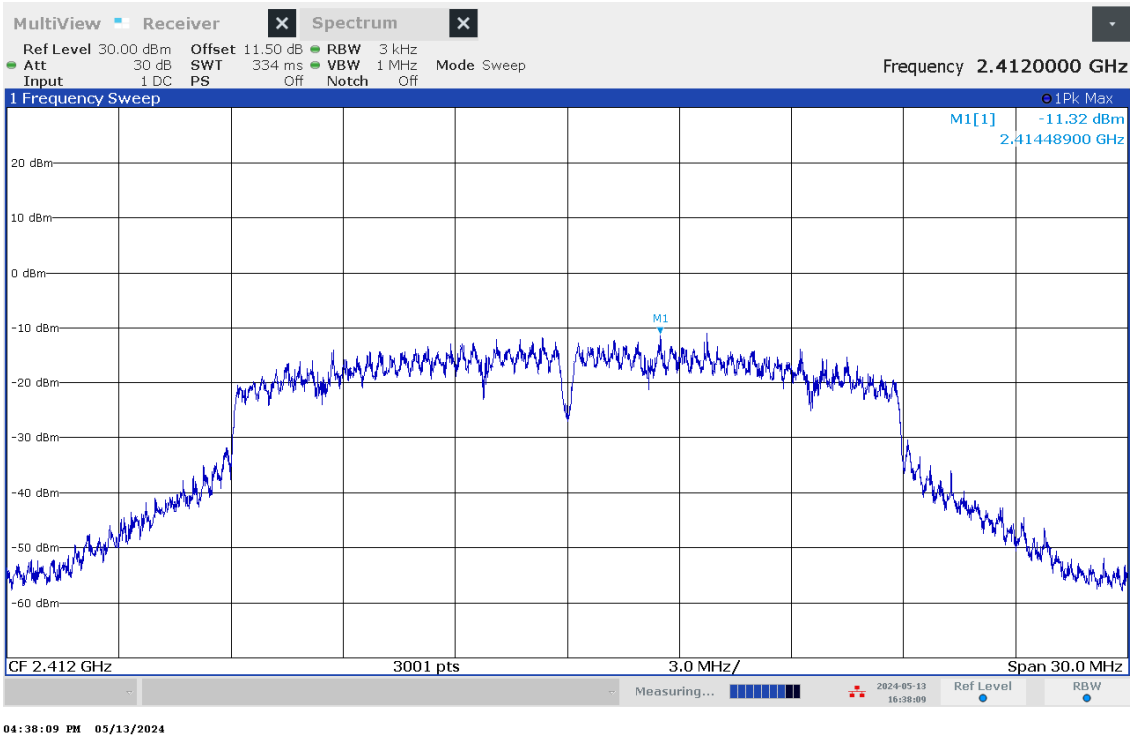


Figure 35 – PSD - Low Channel

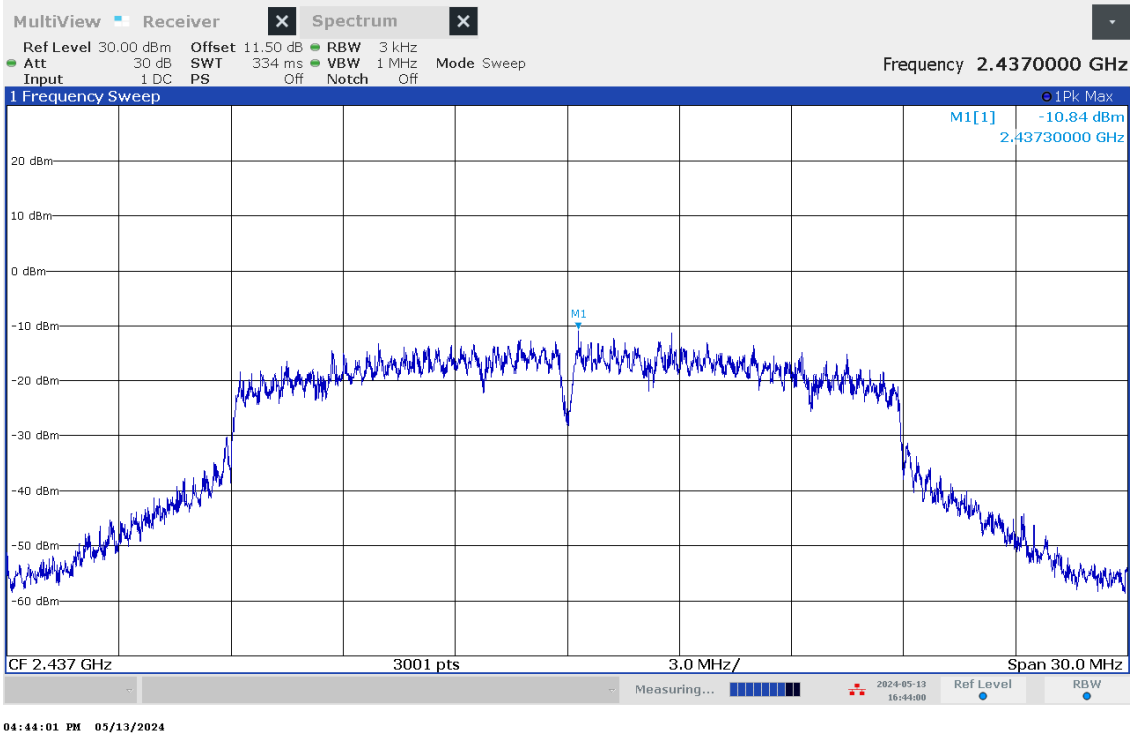


Figure 36 – PSD - Mid Channel

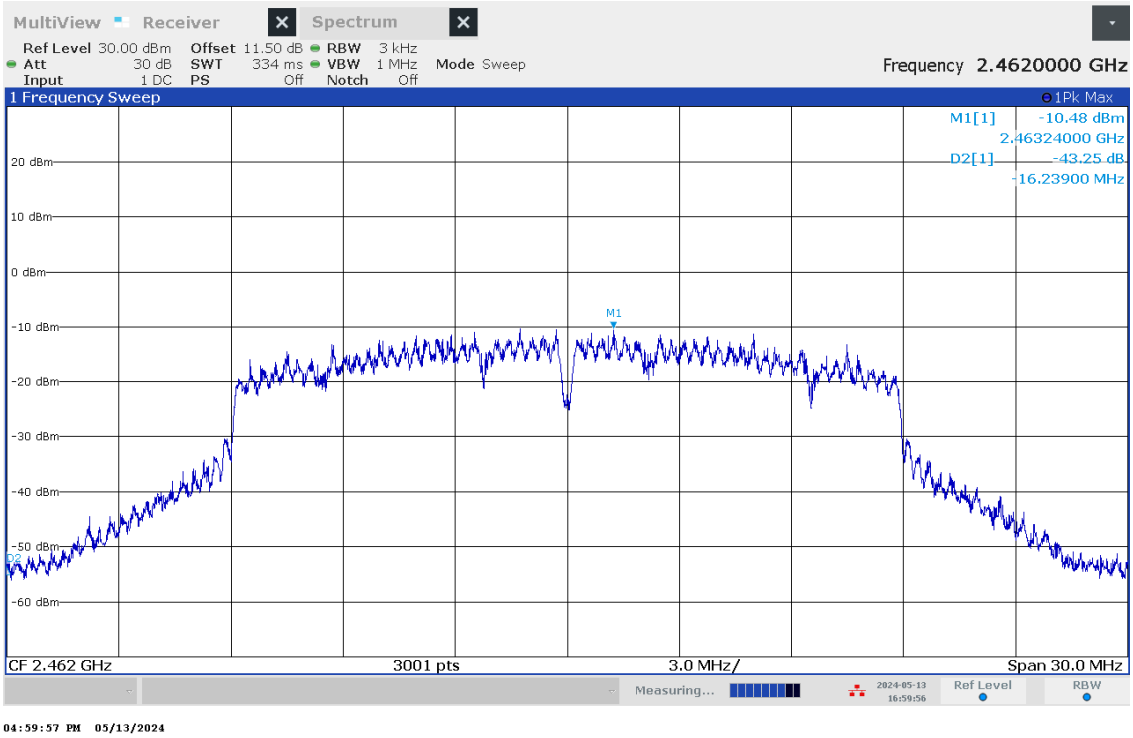


Figure 37 – PSD - High Channel

4.3.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

4.4 Spurious Antenna Conducted Emissions

Test Date:	May 14, 2024	Initials:	MX
Temperature (°C)	21.8		
Relative Humidity (%)	53.6		
Barometric Pressure (kPa)	101.0		

4.4.1 Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30dB instead of 20dB.

4.4.2 Test Procedure

Tested according to ANSI C63.10 Section 11.11

For the reference level measurement:

a) Set RBW = 100kHz and VBW ≥ [3 × RBW].
b) Detector = Peak and Trace Mode = Max Hold.
c) Sweep = Auto Couple.
d) Span set to ≥1.5 DTS bandwidth.
e) Use the peak marker function to determine the maximum level.

For the out of band emission measurement

a) Set the start and stop frequency to encompass the frequency range to be measured.
b) Set RBW = 100kHz and VBW ≥ [3 × RBW].
c) Detector = Peak and Trace Mode = Max Hold.
d) Sweep = Auto Couple.
e) Use the peak marker function to determine the maximum level.

The RF output of the DUT was connected to the spectrum analyzer with sufficient attenuation in front and the total path loss was set as reference offset to correct the final reading.

4.4.3 Test Results

The DUT met the 30dB below carrier requirement for out of band emissions.

The EUT supports 802.11 b/g/n protocols for 2.4 GHz WIFI. For every protocol, three channels were measured. The -30 dBc requirement is shown for the lower band edge at 2.4 GHz in the low band and for the higher band edge at 2.4835 GHz in the high band.

4.4.3.1. 802.11 b

802.11 b			
Channel	**Frequency (MHz)**	**Peak PSD w/ RBW=100 kHz (dBm)**	**30 dBc Limit (dBm)**
Low	2412	9.32	-20.68
Mid	2437	9.97	-20.03
High	2462	10.54	-19.46

The highest peak power in 100 kHz is 10.54 dBm; therefore, the 30 dBc limit is -19.46 dBm.

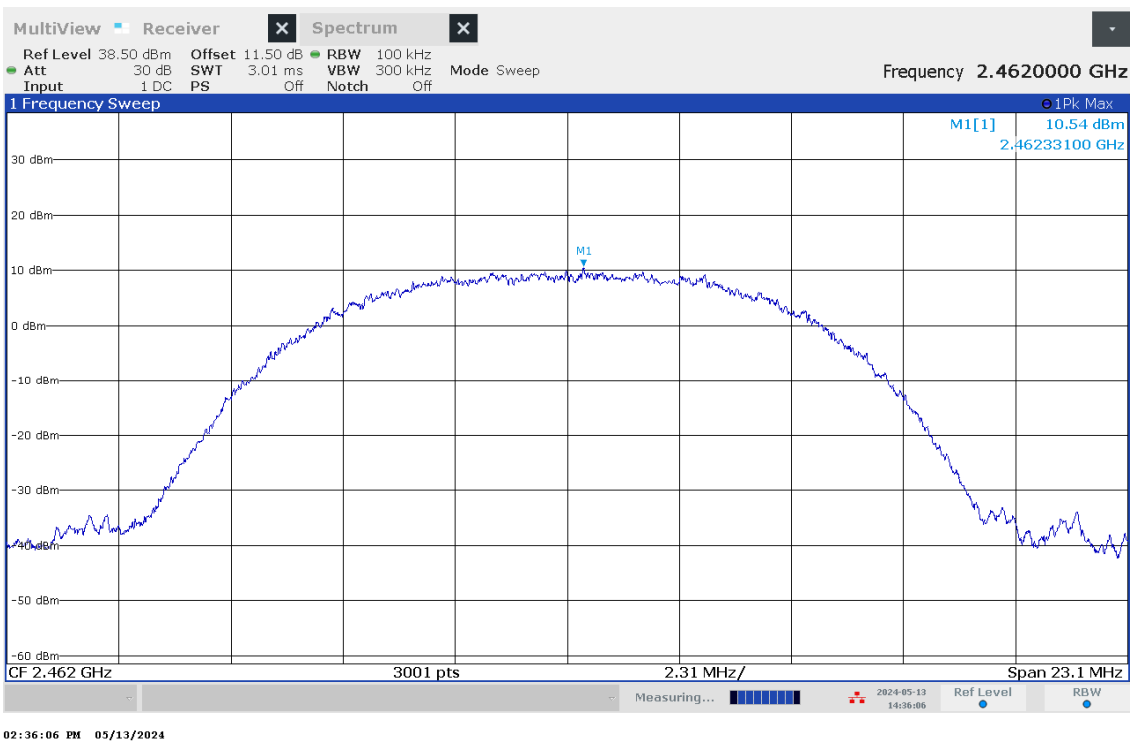


Figure 38 – -30dBc Reference Level - High Channel

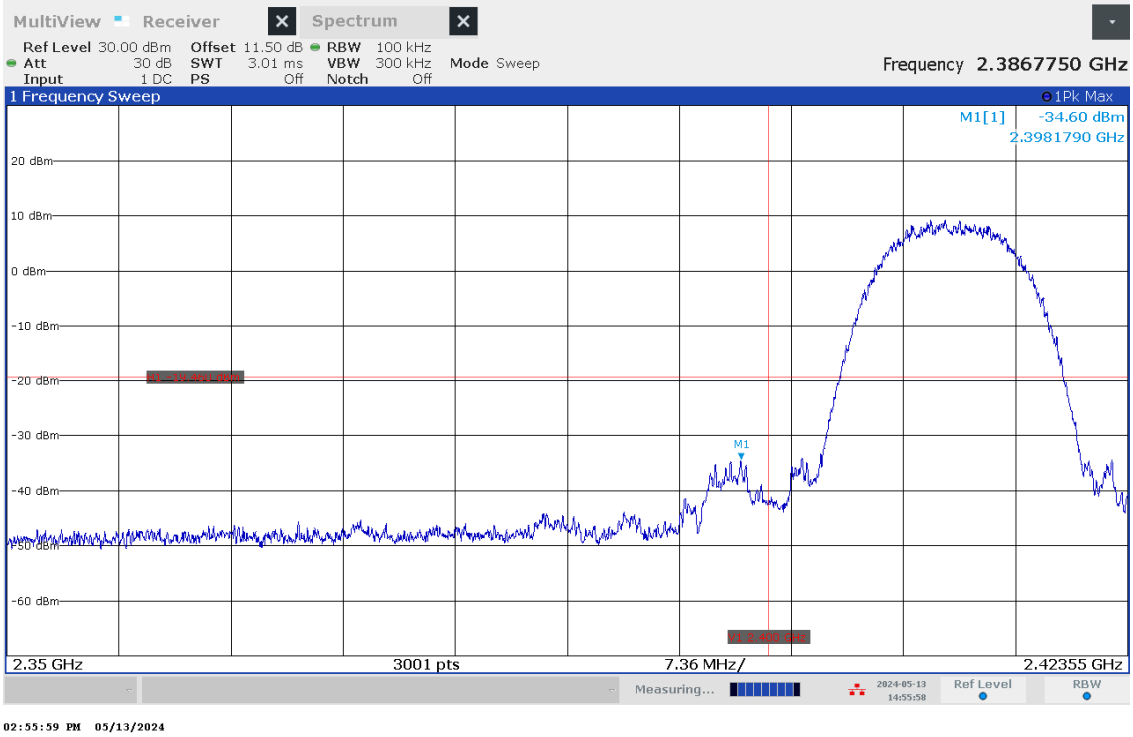


Figure 39 – -30dBc Band Edge - Low Channel

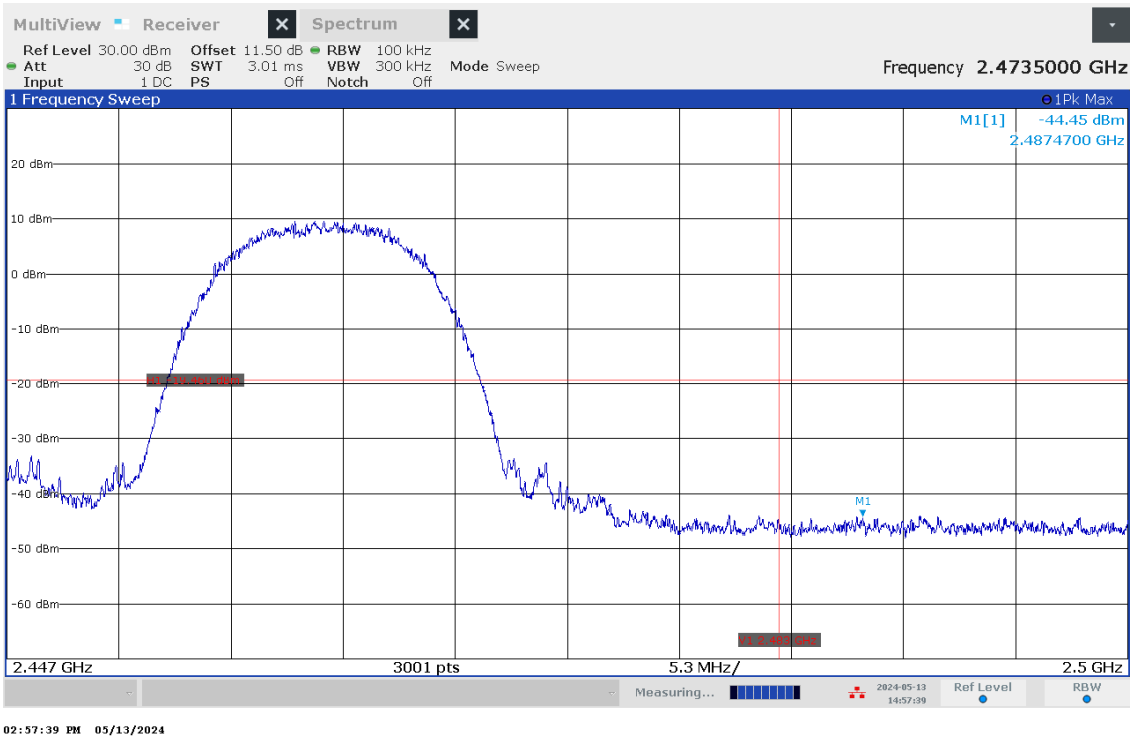


Figure 40 – -30dBc Band Edge - Low Channel

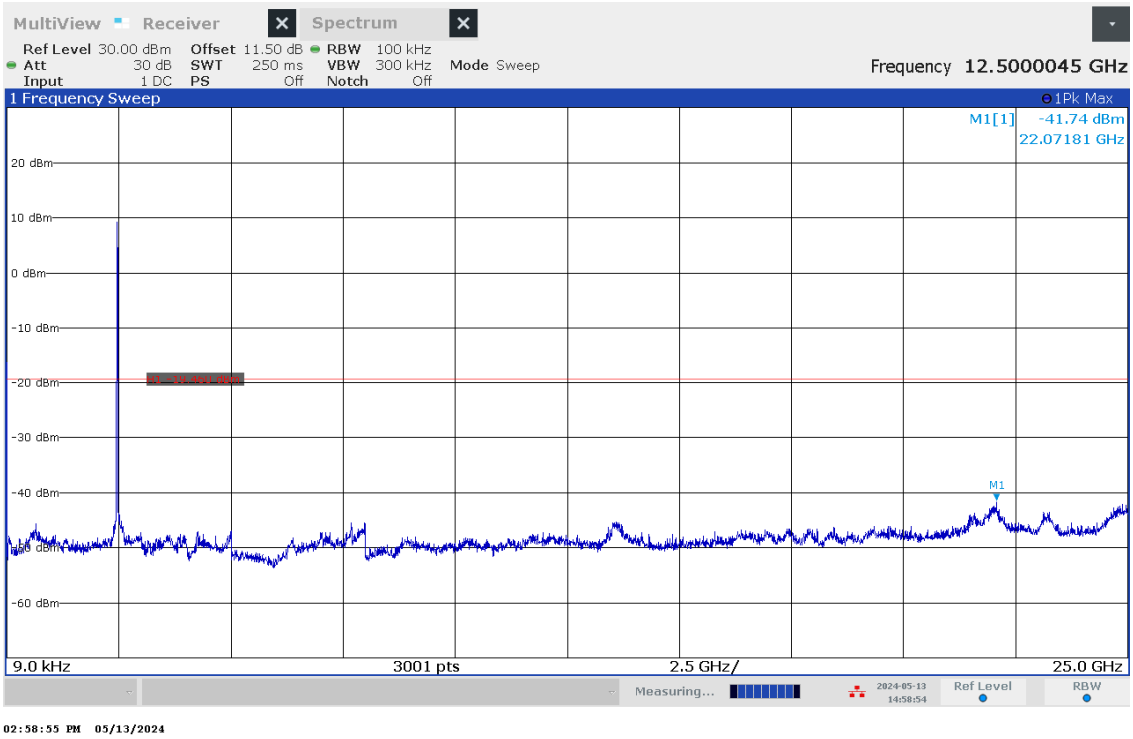


Figure 41 – -30dBc High Channel 9kHz – 25 GHz

4.4.3.2. 802.11 g

802.11 g			
Channel	**Frequency (MHz)**	**Peak PSD w/ RBW=100 kHz (dBm)**	**30 dBc Limit (dBm)**
Low	2412	1.53	-28.47
Mid	2437	1.84	-28.16
High	2462	2.33	-27.67

The highest peak power in 100 kHz is 2.33 dBm; therefore, the 30 dBc limit is -27.67 dBm.

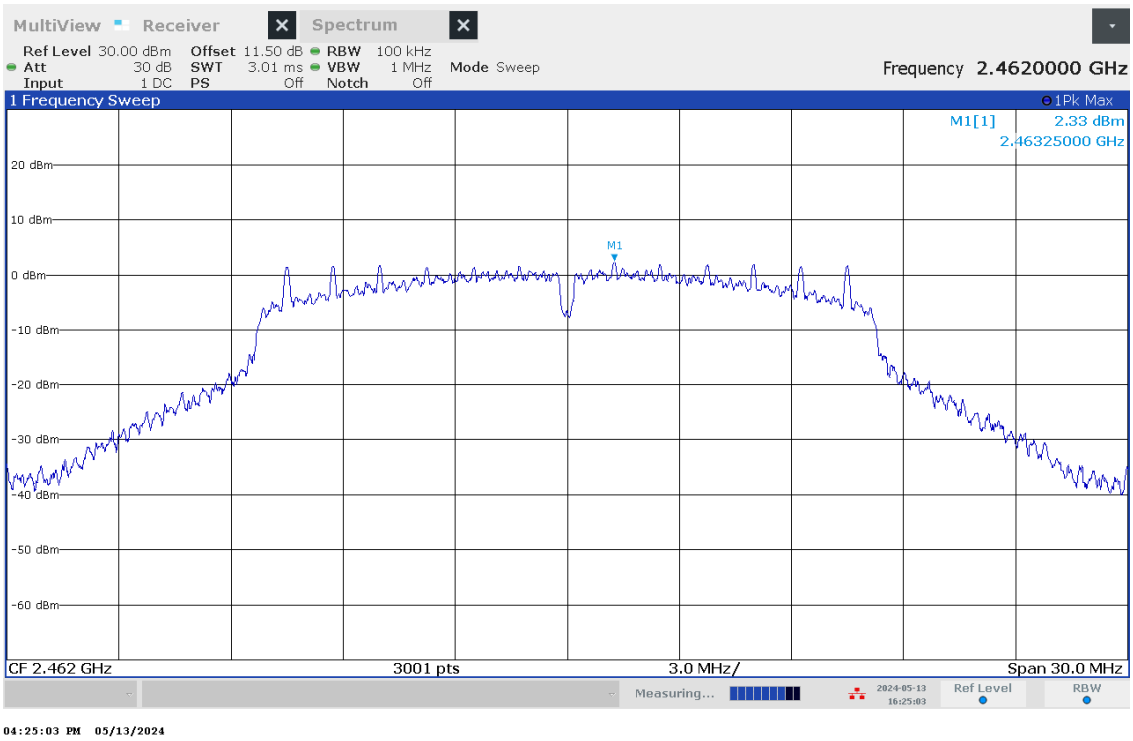


Figure 42 – -30dBc Reference Level - High Channel

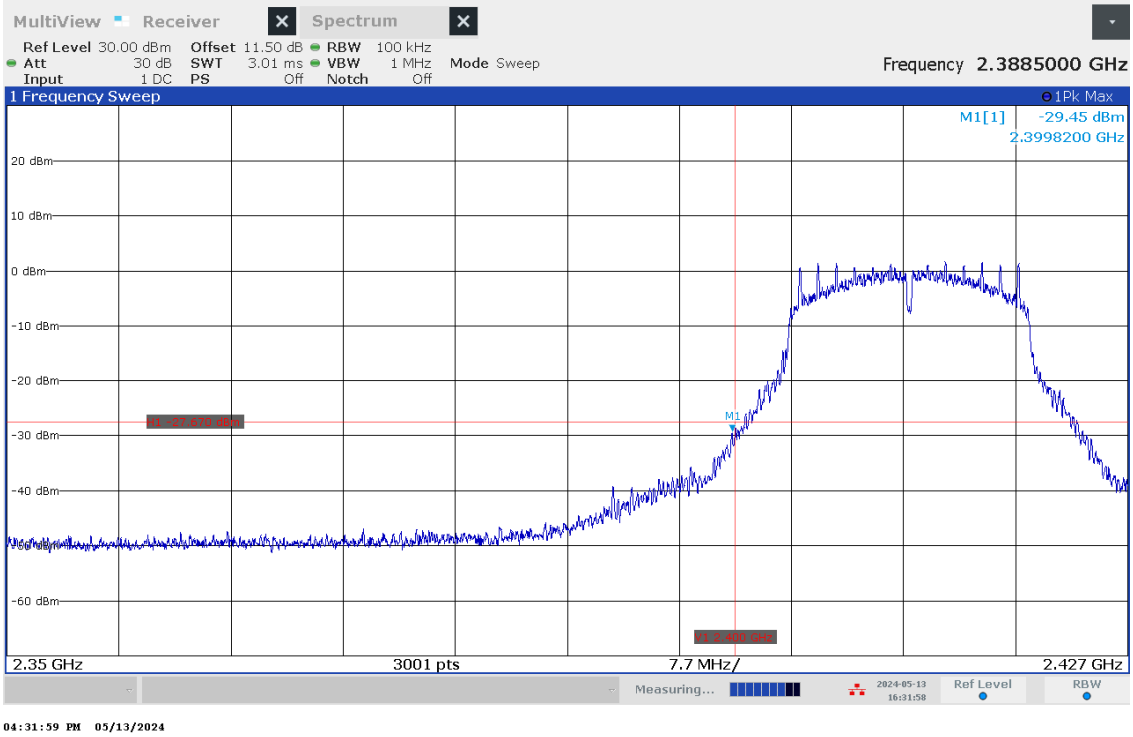


Figure 43 – -30dBc Band Edge - Low Channel

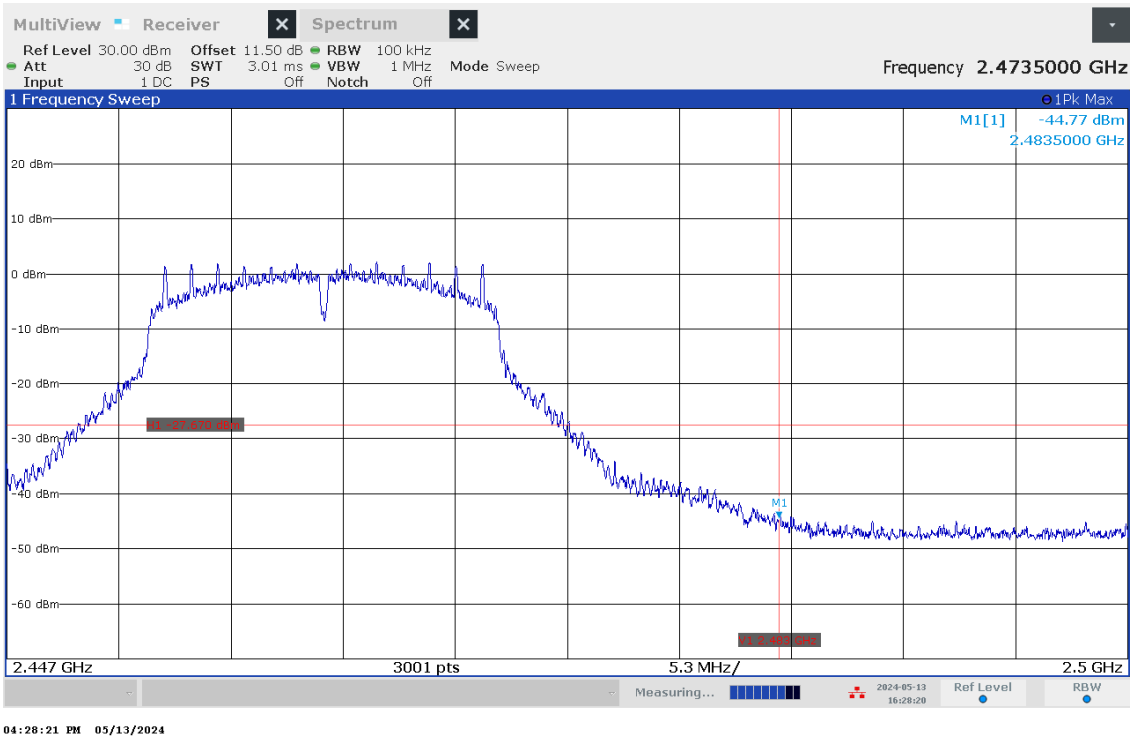


Figure 44 – -30dBc Band Edge - Low Channel

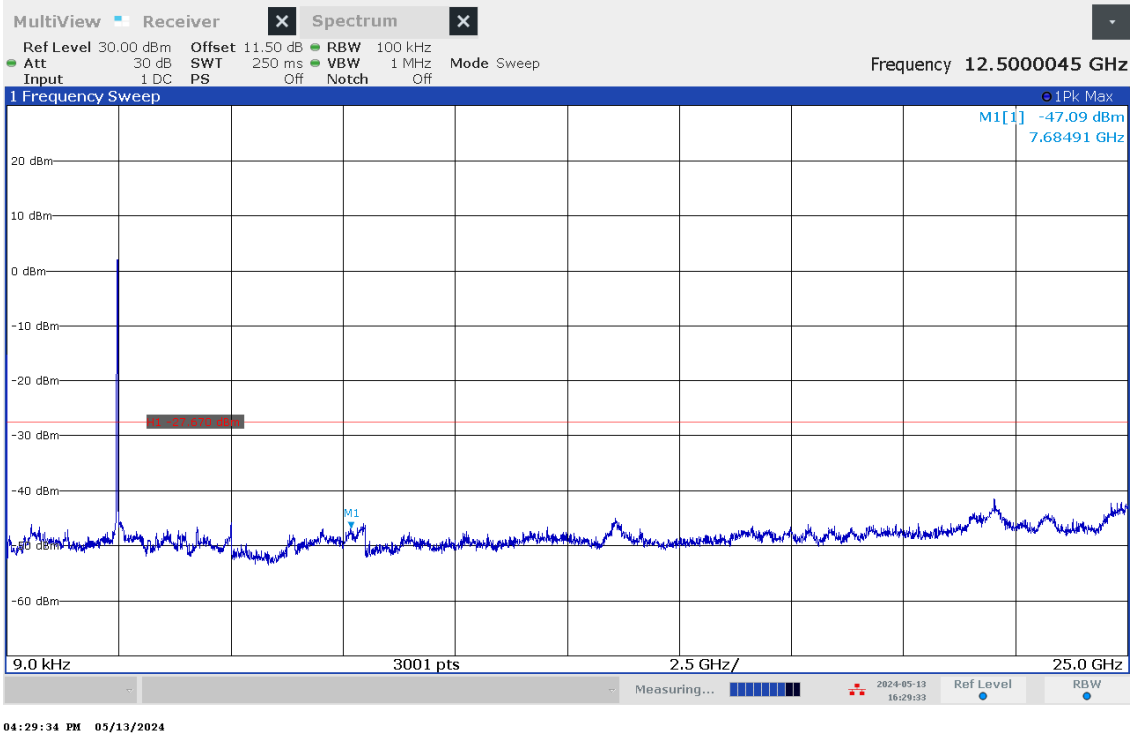


Figure 45 – -30dBc High Channel 9kHz – 25 GHz

4.4.3.3. 802.11 n

802.11 g			
Channel	**Frequency (MHz)**	**Peak PSD w/ RBW=100 kHz (dBm)**	**30 dBc Limit (dBm)**
Low	2412	1.64	-28.36
Mid	2437	1.93	-28.07
High	2462	2.30	-27.70

The highest peak power in 100 kHz is 2.30 dBm; therefore, the 30 dBc limit is -27.70 dBm.

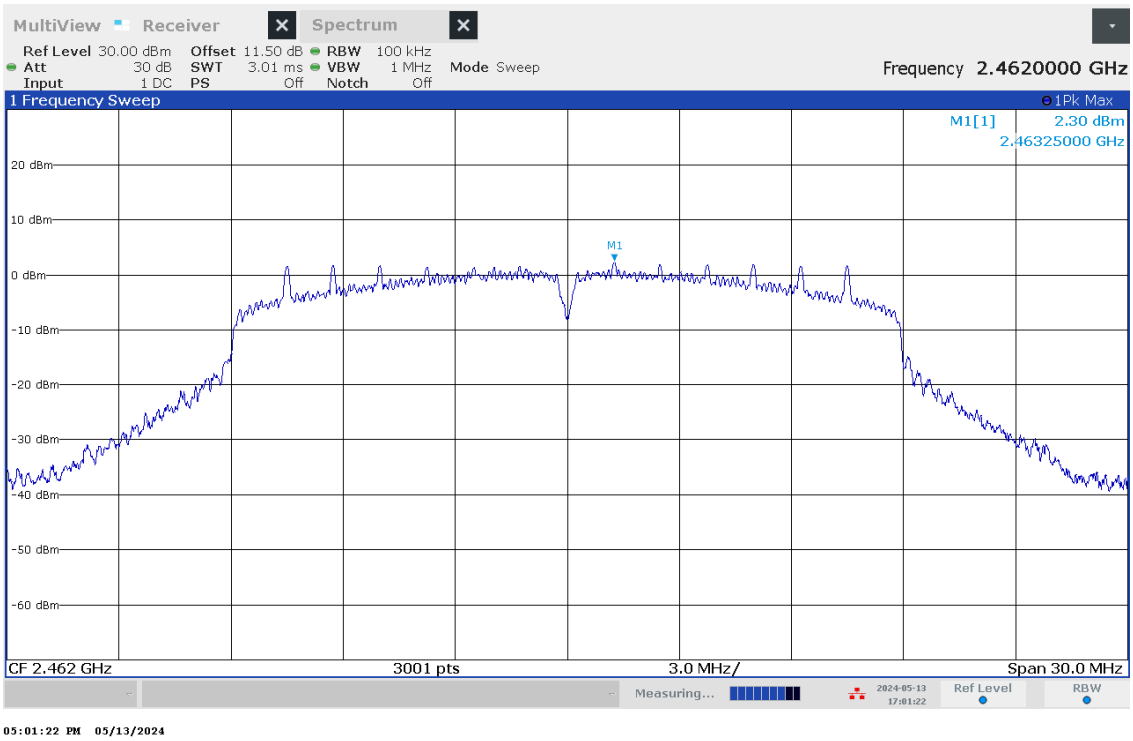


Figure 46 – -30dBc Reference Level - High Channel

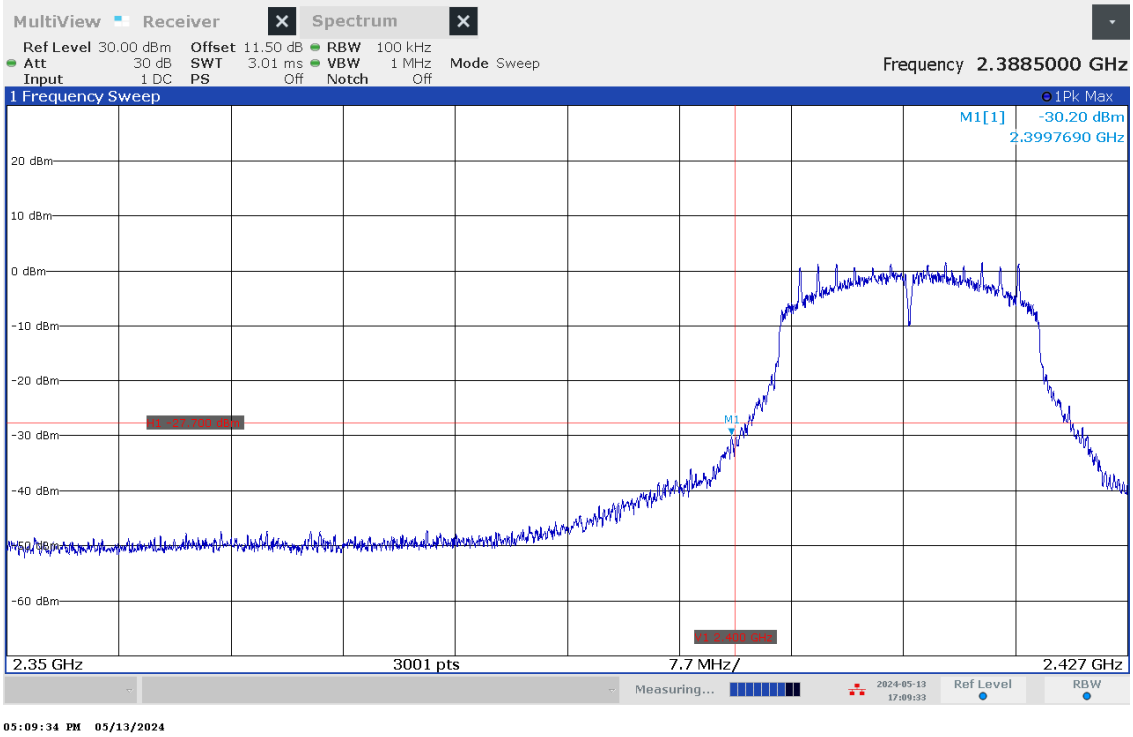


Figure 47 – -30dBc Band Edge - Low Channel

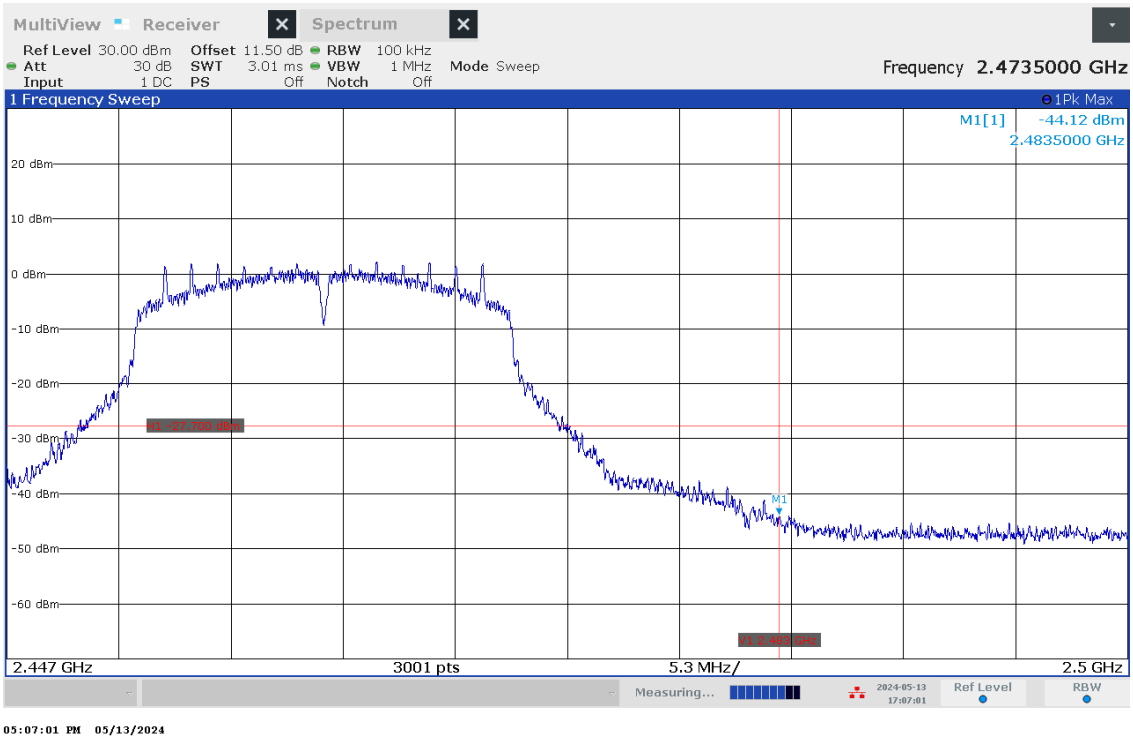


Figure 48 – -30dBc Band Edge - Low Channel

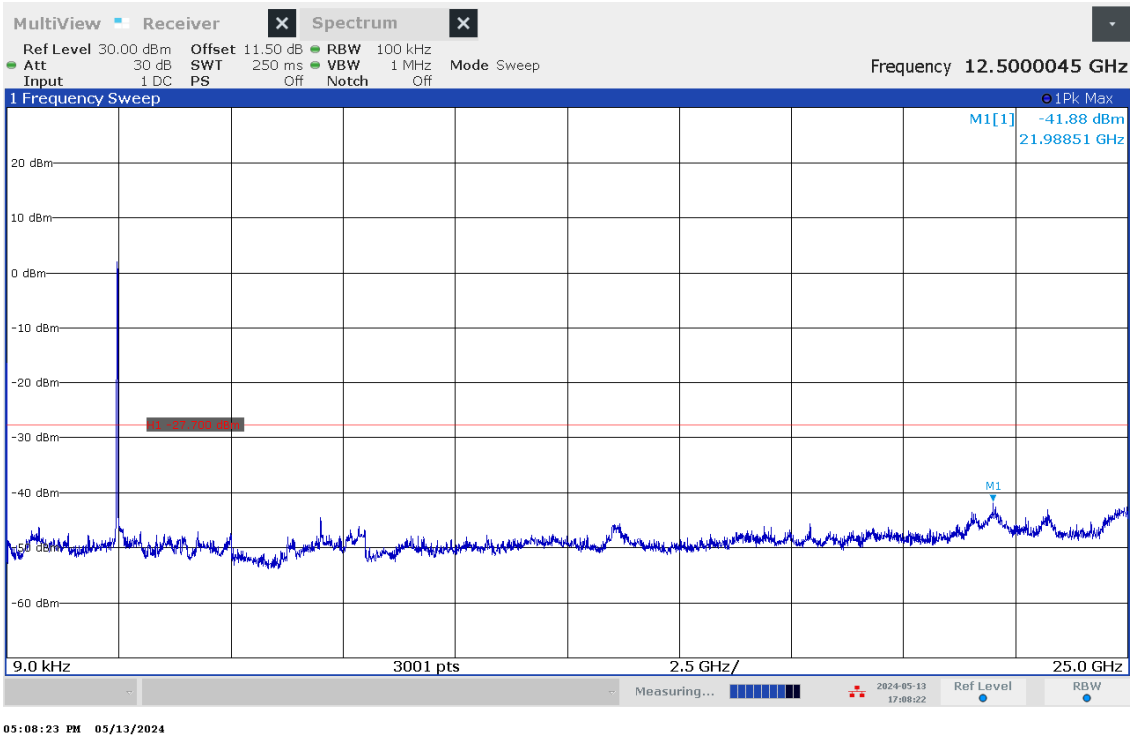


Figure 49 – -30dBc High Channel 9kHz – 25 GHz

4.4.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_115	10dB Attenuator	Fairview Microwave	SA18E-10	NCR	NCR

4.5 Transmitter Spurious Radiated Emissions

Test Date:	May 6 – 13, 2024	Initials:	MX
Temperature (°C)	20.8 - 21.7		
Relative Humidity (%)	42.8 - 54.7		
Barometric Pressure (kPa)	100.4 - 54.7		

4.5.1 Limits

Any radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a), must comply with the general radiated emission limits specified in FCC 15.209(a). Other emissions shall be at least 20dB below the highest level of the intentional transmitter.

Base Standard(s): FCC Subpart C 15.209 and RSS-Gen Section 8.9.

Frequency Range (MHz)	Field Strength Limit		Field Strength at 3m (dBµV/m)	Detector Type / Measurement Bandwidth
	µV/m	Distance		
0.009 – 0.150	2400/F(kHz)	300	128.5 – 104.1	Quasi-Peak‡ / 200Hz
0.150 – 0.490	2400/F(kHz)	300	104.1 – 93.8	Quasi-Peak‡ / 9kHz
0.490 – 1.705	24000/F(kHz)	30	73.8 – 63.0	Quasi-Peak / 9kHz
1.705 – 30	30	30	69.5	Quasi-Peak / 9kHz
30 – 88	100	3	40.0	Quasi-Peak / 120kHz
88 – 216	150	3	43.5	Quasi-Peak / 120kHz
216 – 960	200	3	46.0	Quasi-Peak / 120kHz
960 – 1000	500	3	54.0	Quasi-Peak / 120kHz
Above 1000	500	3	54.0	Average / 1MHz
Above 1000	5000	3	74.0	Peak / 1MHz

‡The emission limits below 1GHz shown in the above table are based on measurements employing a CISPR Quasi-Peak detector except for the frequency bands 9-90 kHz and 110-490 kHz. Radiated emission limits in these two bands are based on measurements employing an average detector.

As per ANSI C63.10 Section 4.1, if the Peak detector measurements do not exceed the Quasi-Peak limits, or Average limits where defined, then the DUT is considered to have passed the requirements.

4.5.2 Test Procedure

Tested according to ANSI C63.10 Section 6.3.

The device under test was setup inside a semi-anechoic chamber with remotely controlled turntable and antenna positioner at a 3m test distance. The DUT was placed on top of a 0.8m high non-conductive table above the reference ground plane for frequencies below 1GHz and 1.5m high for frequencies above 1GHz.

To determine the emission characteristics of the DUT, exploratory radiated emission scans were made while rotating the turntable 0° to 360° and using a Peak detector. The results were recorded in graphical form.

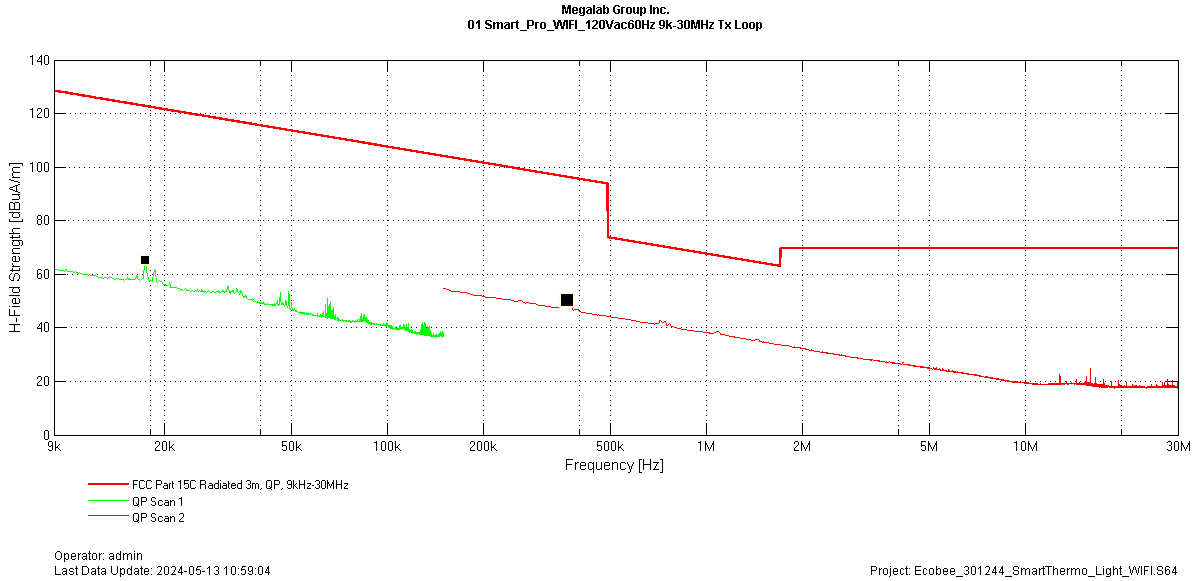
For each suspected emission, final measurements of the DUT radiated emissions with the Quasi-Peak, Average or Peak detector, as defined in the limit tables above, were made with the turntable azimuth rotated 0° to 360° and antenna height varied from 1m to 4m. The antenna was positioned to receive emissions in the vertical and horizontal polarizations such that the maximum radiated emission levels were detected.

As per FCC Part 15.33(a), the DUT was scanned to the 10th harmonic of the highest fundamental frequency.

Testing for 9 kHz – 30 MHz was performed with 3 orthogonal antenna polarities. The worst case results were present in this report.

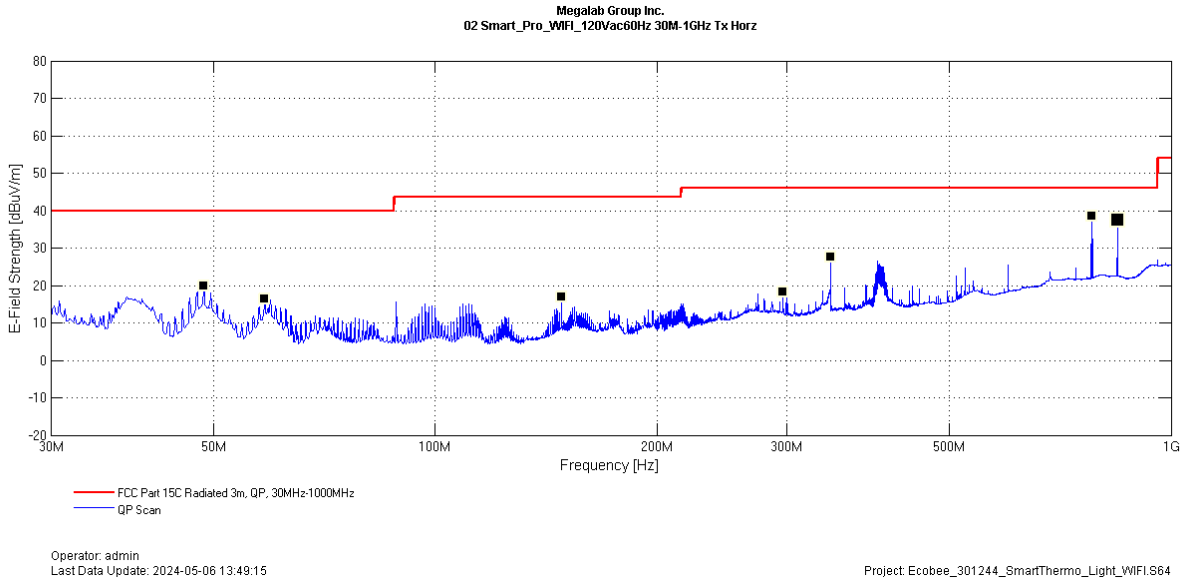
4.5.3 Test Results

Range:	9kHz to 30 MHz	**Tx Frequency**	2462 MHz
Test Voltage:	24Vac 60Hz	**Antenna Polarization**	XZ-Plane



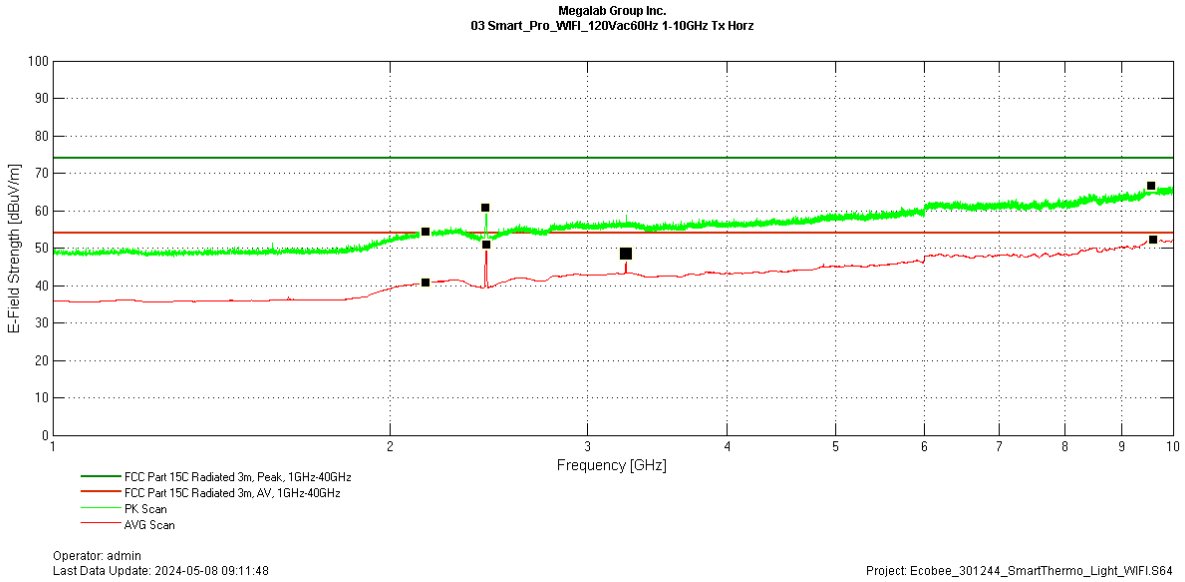
Remark: Quasi-Peak Emission Plot

Range:	30MHz to 1GHz	**Tx Frequency**	2462 MHz
Test Voltage:	24Vac 60Hz	**Antenna Polarization**	Horizontal



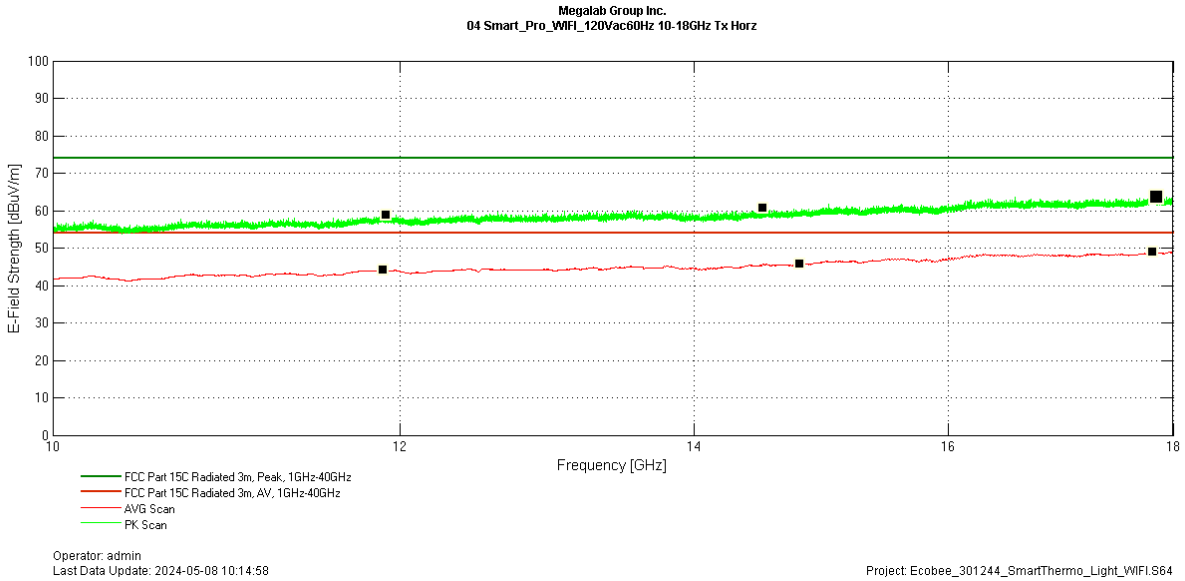
Remark: - Quasi-Peak Emission Plot
- A Notch filter was used to filter out the fundamental

Range:	1GHz to 10GHz	**Tx Frequency**	2462 MHz
Test Voltage:	24Vac 60Hz	**Antenna Polarization**	Horizontal



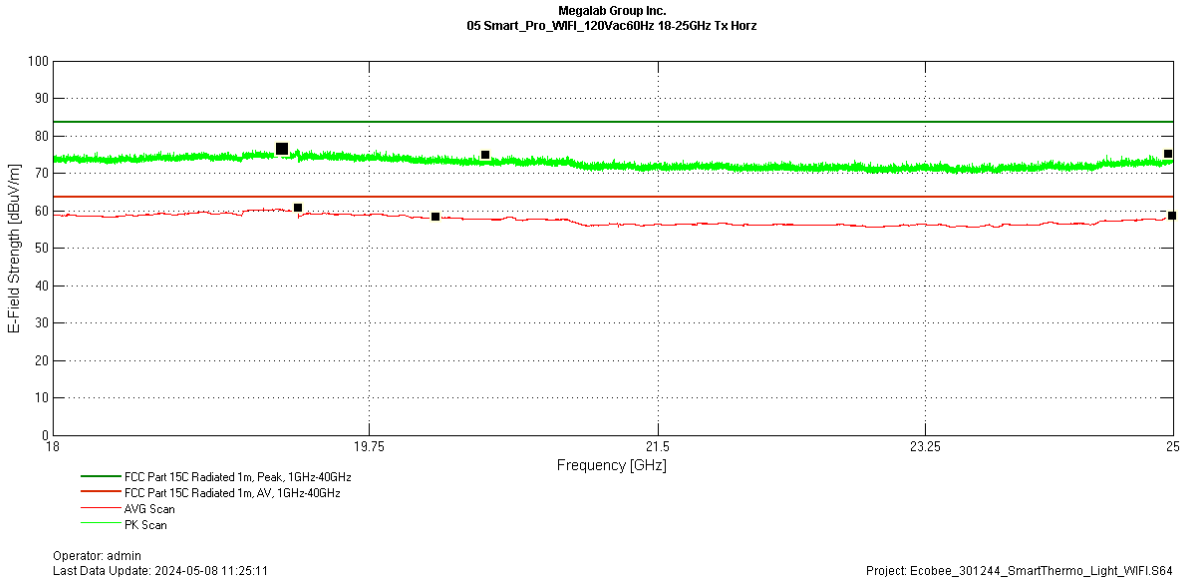
Remark: - Peak and Average Emission Plot
- A Notch filter was used to filter out the fundamental

Range:	10GHz to 18GHz	**Tx Frequency**	2462 MHz
Test Voltage:	24Vac 60Hz	**Antenna Polarization**	Horizontal



Remark: - Peak and Average Emission Plot
- A Notch filter was used to filter out the fundamental

Range:	18GHz to 25GHz	Tx Frequency	2462 MHz
Test Voltage:	24Vac 60Hz	Antenna Polarization	Horizontal



Remark: - Peak and Average Emission Plot

Horizontal Antenna Polarization							
Frequency (MHz)	Detector	Reading (dBµV)	Correction Factor (dB)	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Test Result
781.45	QP	36.8	1.9	38.7	46.0	7.3	Pass
845.20	QP	35.1	2.5	37.5	8.5	8.5	Pass
344.25	QP	34.3	-6.6	27.7	46.0	18.3	Pass
48.50	QP	35.5	-15.8	19.8	40.0	20.2	Pass

4.5.3.1. 802.11 b (Horizontal Antenna Polarization)

Horizontal Antenna Polarization – Harmonic Emissions							
Frequency (MHz)	**Detector**	**Reading (dBµV)**	**Correction Factor (dB)**	**Emission Level (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Test Result**
Low Channel							
4824	PEAK	48.8	0.9	49.7	74.0	24.3	Pass
4824	AVG	43.3	0.9	44.1	54.0	9.9	Pass
7236	PEAK	44.7	4.4	49.0	74.0	25.0	Pass
7236	AVG	33.2	4.4	37.6	54.0	16.4	Pass
Mid Channel							
4874	PEAK	49.2	1.1	50.2	74.0	23.8	Pass
4874	AVG	42.5	1.1	43.5	54.0	10.5	Pass
7311	PEAK	45.5	4.4	49.9	74.0	24.1	Pass
7311	AVG	33.6	4.4	38.0	54.0	16.0	Pass
High Channel							
4924	PEAK	47.1	1.2	48.4	74.0	25.6	Pass
4924	AVG	38.3	1.2	39.6	54.0	14.4	Pass
7386	PEAK	44.6	4.2	48.8	74.0	25.2	Pass
7386	AVG	33.6	4.2	37.7	54.0	16.3	Pass

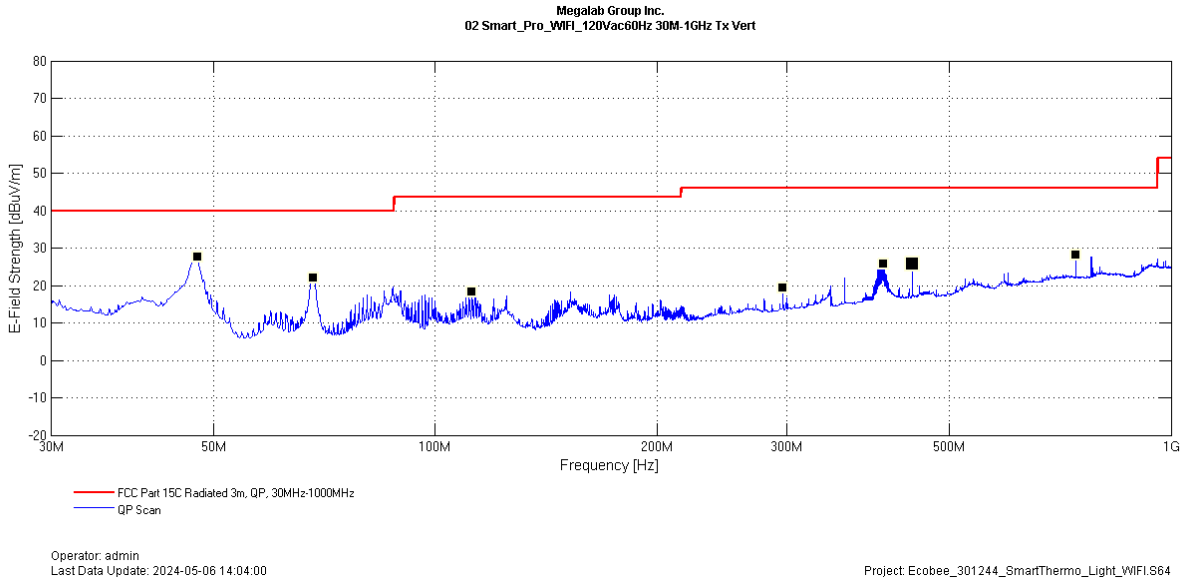
4.5.3.2. 802.11 g (Horizontal Antenna Polarization)

Horizontal Antenna Polarization – Harmonic Emissions							
Frequency (MHz)	**Detector**	**Reading (dBµV)**	**Correction Factor (dB)**	**Emission Level (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Test Result**
Low Channel							
4824	PEAK	46.9	0.9	47.8	74.0	26.2	Pass
4824	AVG	34.3	0.9	35.2	54.0	18.8	Pass
7236	PEAK	44.5	4.4	48.9	74.0	25.1	Pass
7236	AVG	33.0	4.4	37.4	54.0	16.6	Pass
Mid Channel							
4874	PEAK	46.8	1.1	47.9	74.0	26.1	Pass
4874	AVG	34.9	1.1	36.0	54.0	18.0	Pass
7311	PEAK	44.7	4.4	49.1	74.0	24.9	Pass
7311	AVG	33.5	4.4	37.9	54.0	16.1	Pass
High Channel							
4924	PEAK	46.8	1.2	48.0	74.0	26.0	Pass
4924	AVG	34.9	1.2	36.1	54.0	17.9	Pass
7386	PEAK	44.7	4.2	48.8	74.0	25.2	Pass
7386	AVG	33.4	4.2	37.5	54.0	16.5	Pass

4.5.3.3. 802.11 n (Horizontal Antenna Polarization)

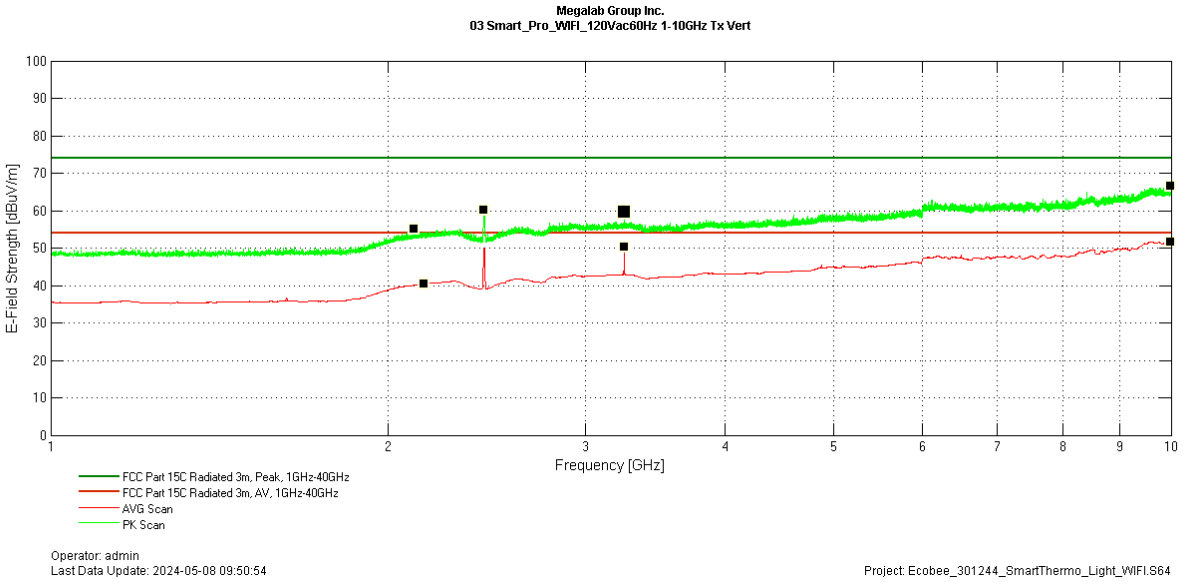
Horizontal Antenna Polarization – Harmonic Emissions							
Frequency (MHz)	**Detector**	**Reading (dBµV)**	**Correction Factor (dB)**	**Emission Level (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Test Result**
Low Channel							
4824	PEAK	46.9	0.9	47.8	74.0	26.2	Pass
4824	AVG	34.3	0.9	35.2	54.0	18.8	Pass
7236	PEAK	44.5	4.4	48.9	74.0	25.1	Pass
7236	AVG	33.0	4.4	37.4	54.0	16.6	Pass
Mid Channel							
4874	PEAK	46.9	1.1	48.0	74.0	26.0	Pass
4874	AVG	34.3	1.1	35.4	54.0	18.6	Pass
7311	PEAK	44.6	4.4	49.0	74.0	25.0	Pass
7311	AVG	33.1	4.4	37.5	54.0	16.5	Pass
High Channel							
4924	PEAK	46.8	1.2	48.0	74.0	26.0	Pass
4924	AVG	34.9	1.2	36.1	54.0	17.9	Pass
7386	PEAK	44.7	4.2	48.8	74.0	25.2	Pass
7386	AVG	33.4	4.2	37.5	54.0	16.5	Pass

Range:	30MHz to 1GHz	**Tx Frequency**	2462 MHz
Test Voltage:	24Vac 60Hz	**Antenna Polarization**	Vertical



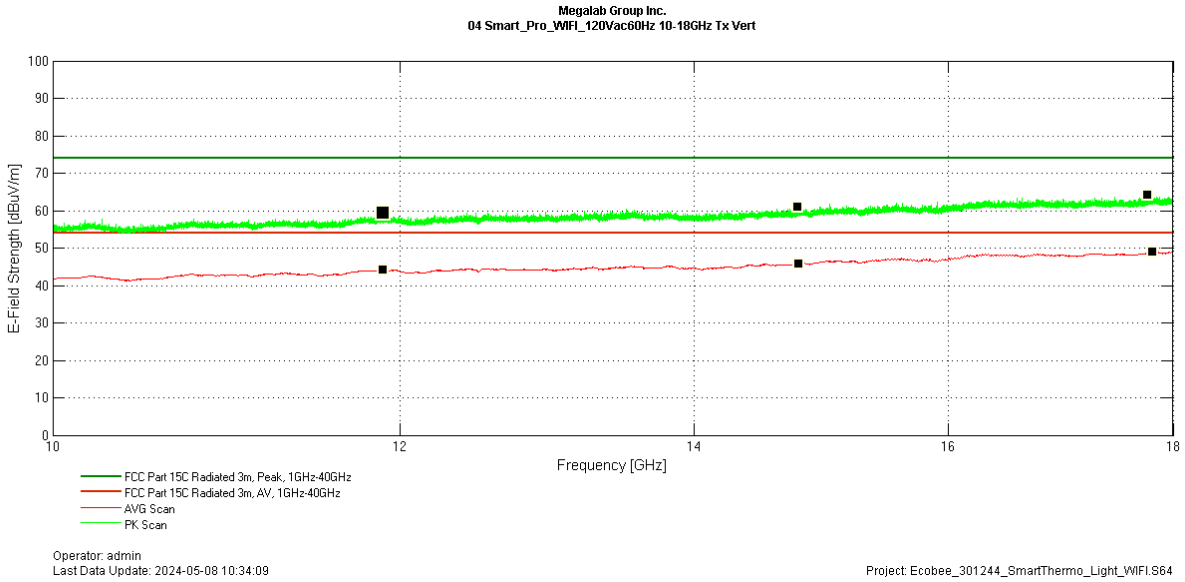
Remark: - Quasi-Peak Emission Plot
- A Notch filter was used to filter out the fundamental

Range:	1GHz to 10GHz	**Tx Frequency**	2462 MHz
Test Voltage:	24Vac 60Hz	**Antenna Polarization**	Vertical



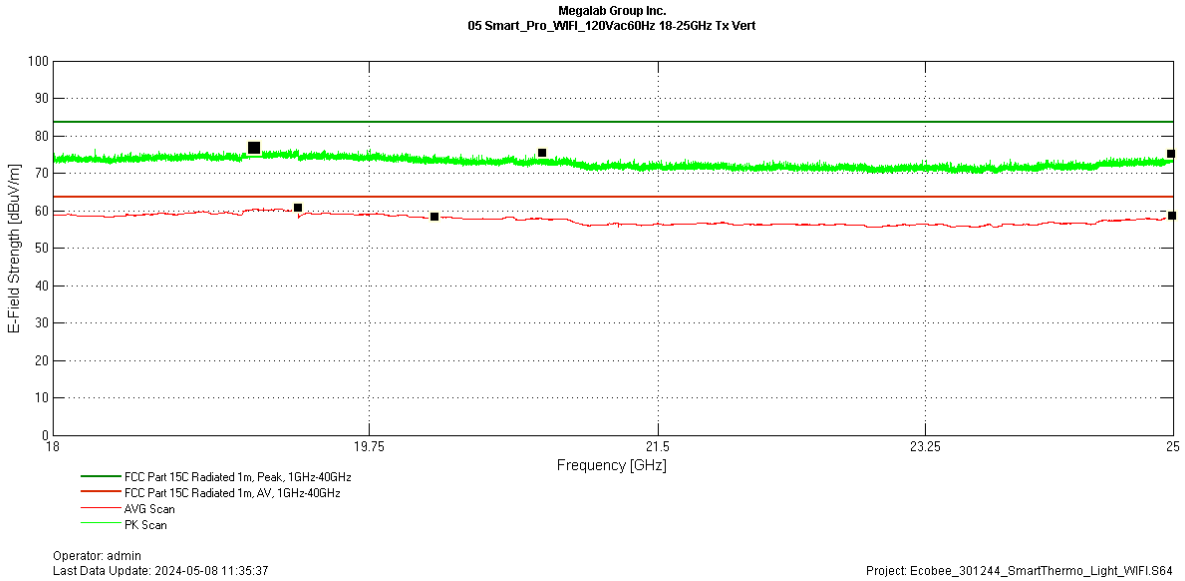
Remark: - Peak and Average Emission Plot
- A Notch filter was used to filter out the fundamental

Range:	10GHz to 18GHz	**Tx Frequency**	2462 MHz
Test Voltage:	24Vac 60Hz	**Antenna Polarization**	Vertical



Remark: - Peak and Average Emission Plot
- A Notch filter was used to filter out the fundamental

Range:	18GHz to 25GHz	**Tx Frequency**	2462 MHz
Test Voltage:	24Vac 60Hz	**Antenna Polarization**	Vertical



Remark: Peak and Average Emission Plot

Vertical Antenna Polarization							
Frequency (MHz)	Detector	Reading (dBµV)	Correction Factor (dB)	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Test Result
47.50	QP	43.0	-15.4	27.5	40.0	12.5	Pass
741.60	QP	26.7	1.5	28.2	46.0	17.8	Pass
68.35	QP	37.5	-15.4	22.1	40.0	17.9	Pass
406.10	QP	29.5	-3.7	25.8	46.0	20.3	Pass

4.5.3.4. 802.11 b (Vertical Antenna Polarization)

Vertical Antenna Polarization – Harmonic Emissions							
Frequency (MHz)	Detector	Reading (dBµV)	Correction Factor (dB)	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Test Result
Low Channel							
4824	PEAK	49.5	0.9	50.4	74.0	23.6	Pass
4824	AVG	42.7	0.9	43.6	54.0	10.4	Pass
7236	PEAK	46.5	4.4	50.8	74.0	23.2	Pass
7236	AVG	35.5	4.4	39.9	54.0	14.1	Pass
Mid Channel							
4874	PEAK	49.3	1.1	50.4	74.0	23.6	Pass
4874	AVG	42.8	1.1	43.9	54.0	10.1	Pass
7311	PEAK	46.5	4.4	50.9	74.0	23.1	Pass
7311	AVG	35.3	4.4	39.7	54.0	14.3	Pass
High Channel							
4924	PEAK	48.5	1.2	49.7	74.0	24.3	Pass
4924	AVG	40.3	1.2	41.5	54.0	12.5	Pass
7386	PEAK	47.2	4.2	51.4	74.0	22.6	Pass
7386	AVG	36.5	4.2	40.7	54.0	13.3	Pass

4.5.3.5. 802.11 g (Vertical Antenna Polarization)

Vertical Antenna Polarization – Harmonic Emissions							
Frequency (MHz)	**Detector**	**Reading (dBµV)**	**Correction Factor (dB)**	**Emission Level (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Test Result**
Low Channel							
4824	PEAK	46.3	0.9	47.2	74.0	26.8	Pass
4824	AVG	35.0	0.9	35.9	54.0	18.1	Pass
7236	PEAK	44.7	4.4	49.0	74.0	25.0	Pass
7236	AVG	33.2	4.4	37.6	54.0	16.4	Pass
Mid Channel							
4874	PEAK	46.8	1.1	47.9	74.0	26.1	Pass
4874	AVG	35.3	1.1	36.4	54.0	17.6	Pass
7311	PEAK	44.5	4.4	48.9	74.0	25.1	Pass
7311	AVG	33.5	4.4	37.8	54.0	16.2	Pass
High Channel							
4924	PEAK	46.8	1.2	48.1	74.0	25.9	Pass
4924	AVG	35.3	1.2	36.5	54.0	17.5	Pass
7386	PEAK	44.5	4.2	48.7	74.0	25.3	Pass
7386	AVG	33.5	4.2	37.6	54.0	16.4	Pass

4.5.3.6. 802.11 n (Vertical Antenna Polarization)

Vertical Antenna Polarization – Harmonic Emissions							
Frequency (MHz)	**Detector**	**Reading (dBµV)**	**Correction Factor (dB)**	**Emission Level (dBµV/m)**	**Limit (dBµV/m)**	**Margin (dB)**	**Test Result**
Low Channel							
4824	PEAK	46.8	0.9	47.7	74.0	26.3	Pass
4824	AVG	34.9	0.9	35.8	54.0	18.2	Pass
7236	PEAK	45.0	4.4	49.4	74.0	24.6	Pass
7236	AVG	33.3	4.4	37.7	54.0	16.3	Pass
Mid Channel							
4874	PEAK	46.4	1.1	47.5	74.0	26.5	Pass
4874	AVG	35.1	1.1	36.2	54.0	17.8	Pass
7311	PEAK	44.8	4.4	49.2	74.0	24.8	Pass
7311	AVG	33.3	4.4	37.7	54.0	16.3	Pass
High Channel							
4924	PEAK	46.8	1.2	48.1	74.0	25.9	Pass
4924	AVG	35.3	1.2	36.5	54.0	17.5	Pass
7386	PEAK	44.5	4.2	48.7	74.0	25.3	Pass
7386	AVG	33.5	4.2	37.6	54.0	16.4	Pass

4.5.4 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_132	EMI Test Receiver (v6.91.2)	Gauss Instruments	TDEMI X40	Nov 29, 2023	Nov 29, 2025
EQ_EMC_48	Loop Antenna	Com-Power	AL-130R	Apr 9, 2024	Apr 9, 2026
EQ_EMC_59	BiLog Antenna	ETS Lindgren	3142E	Apr 19, 2024	Apr 19, 2026
EQ_EMC_60	Horn Antenna	ETS Lindgren	3117	Apr 9, 2024	Apr 9, 2026
EQ_EMC_56	DRG Horn Antenna 18GHz-40GHz	A.H Systems	SAS-574	Apr 8, 2024	Apr 8, 2026
EQ_EMC_68	6dB Attenuator	Fairview Microwave	SA3NS-06	Apr 19, 2024	Apr 19, 2026
EQ_EMC_85	RF Cable <1GHz	Times Microwave	LMR-400	NCR	NCR
EQ_EMC_75	RF Cable >1GHz	MegaPhase	EMC2	NCR	NCR
EQ_EMC_123	Preamplifier 30MHz-9GHz	RF Bay	EPA-250T	Jan 23, 2024	Jan 23, 2026
EQ_EMC_42	Preamplifier 1GHz-18GHz	Com-Power	PAM-118A	Jan 17, 2024	Jan 17, 2026
EQ_EMC_43	Preamplifier 18GHz-40GHz	Com-Power	PAM-840A	Jan 31, 2024	Jan 31, 2026
EQ_EMC_108	2400 - 2500MHz Notch Filter	Micro-Tronics	BRM50702	NCR	NCR
EQ_EMC_149	Emission Software RE/CE	Gauss Instruments	EMI64k v6.31.2	NCR	NCR

4.6 Lower and Upper Band Edges

Test Date:	January 18/30, 2024	Initials:	MX
Temperature (°C)	20.7/ 20.4		
Relative Humidity (%)	9.1 / 20.9		
Barometric Pressure (kPa)	97.5 / 98.1		

4.6.1 Limits

Any radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a), must comply with the general radiated emission limits specified in FCC 15.209(a).

4.6.2 Test Procedure

Tested according to ANSI C63.10 Section 11.12

The device under test was setup inside a semi-anechoic chamber with remotely controlled turntable and antenna positioner at a 3m test distance. The DUT was placed on top of a 0.8m high non-conductive table above the reference ground plane for frequencies below 1GHz and 1.5m high for frequencies above 1GHz.

For both the lower and upper radiated band edges, the radiated emission was first maximized on the center frequency of the low and high channels with the turntable azimuth rotated 0° to 360° and antenna height varied from 1m to 4m. Once maximized, the start and stop frequency were adjusted to capture that channel's lower and upper band edges inside the restricted bands.

The antenna was positioned to receive emissions in the vertical and horizontal polarizations such that the maximum radiated emission levels were detected.

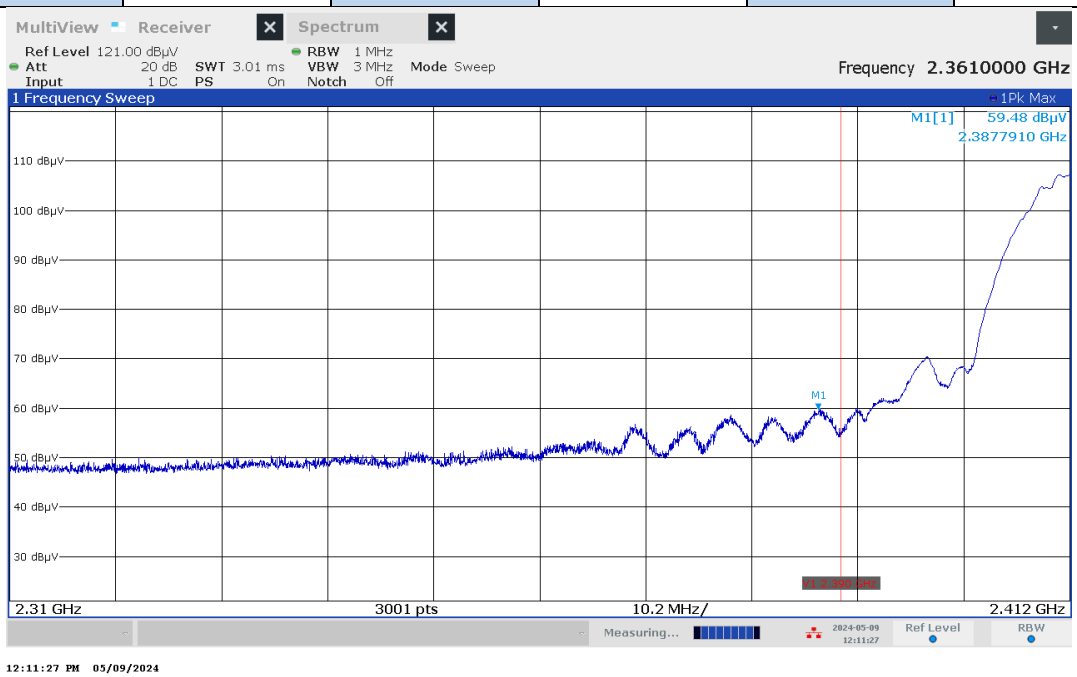
The radiated band edge measurements were made with the DUT in normal operation position.

4.6.3 Test Results – 802.11 b

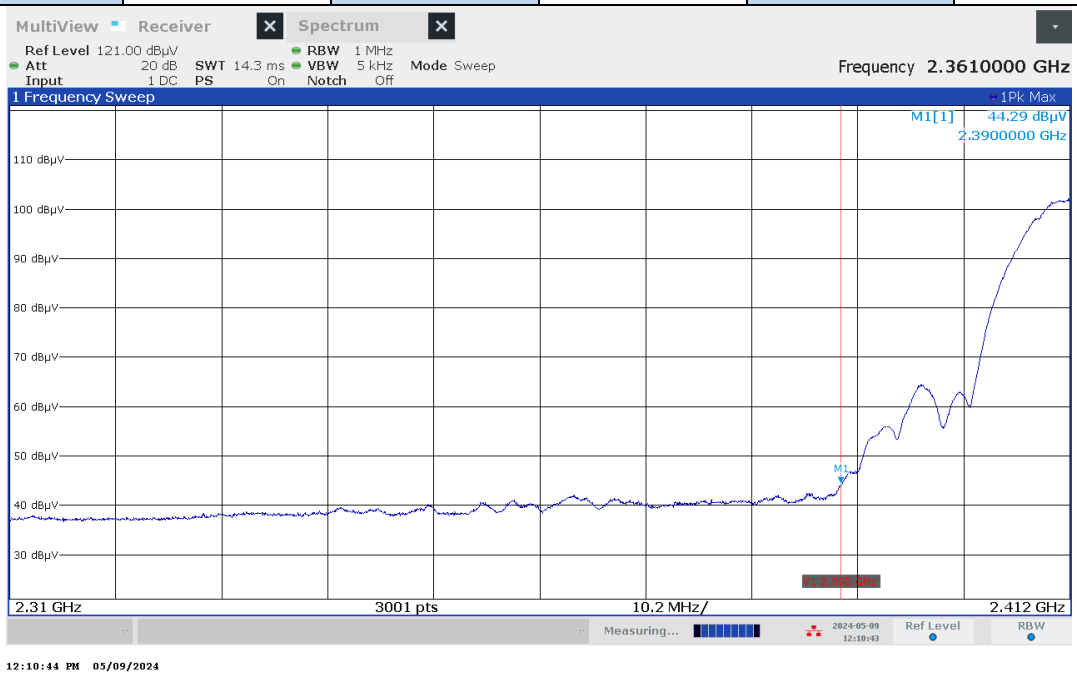
The DUT met the band edge requirements. Peak output power for low, mid and high channels were measured and the Plots Section below contains the maximum radiated emission levels captured on the spectrum analyzer at the band edges. The Final Measurements Section contains the final results with the correction factors added in.

4.6.3.1. Plots

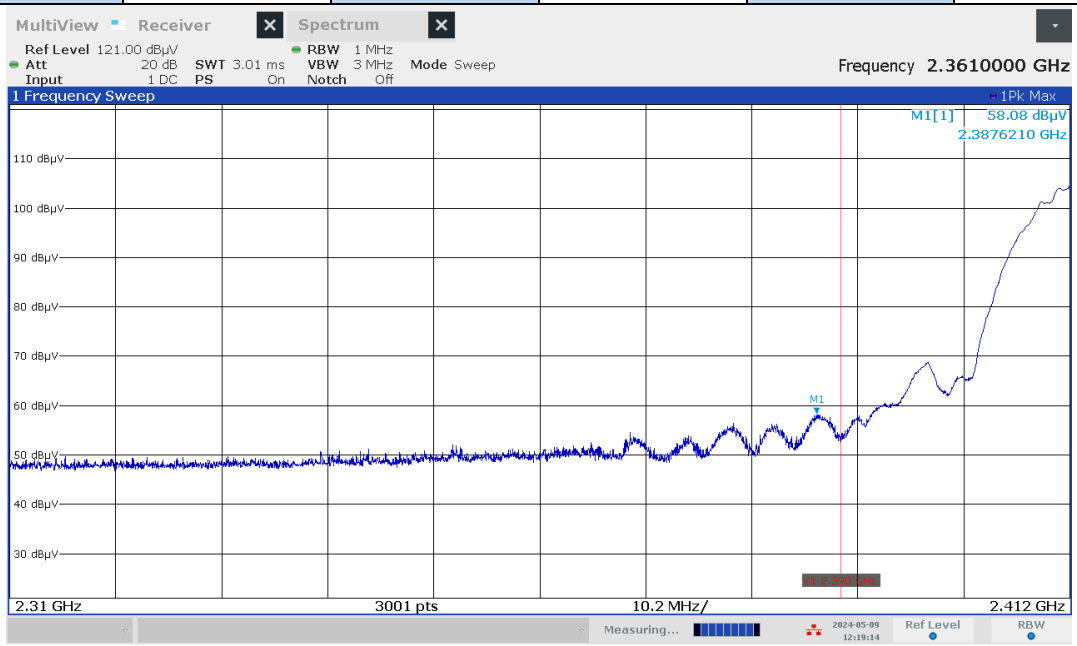
Tx Frequency	Low Channel	**Antenna Polarization**	Horizontal	**Emission**	Peak



Tx Frequency	Low Channel	**Antenna Polarization**	Horizontal	**Emission**	Average



Tx Frequency	Low Channel	**Antenna Polarization**	Vertical	**Emission**	Peak

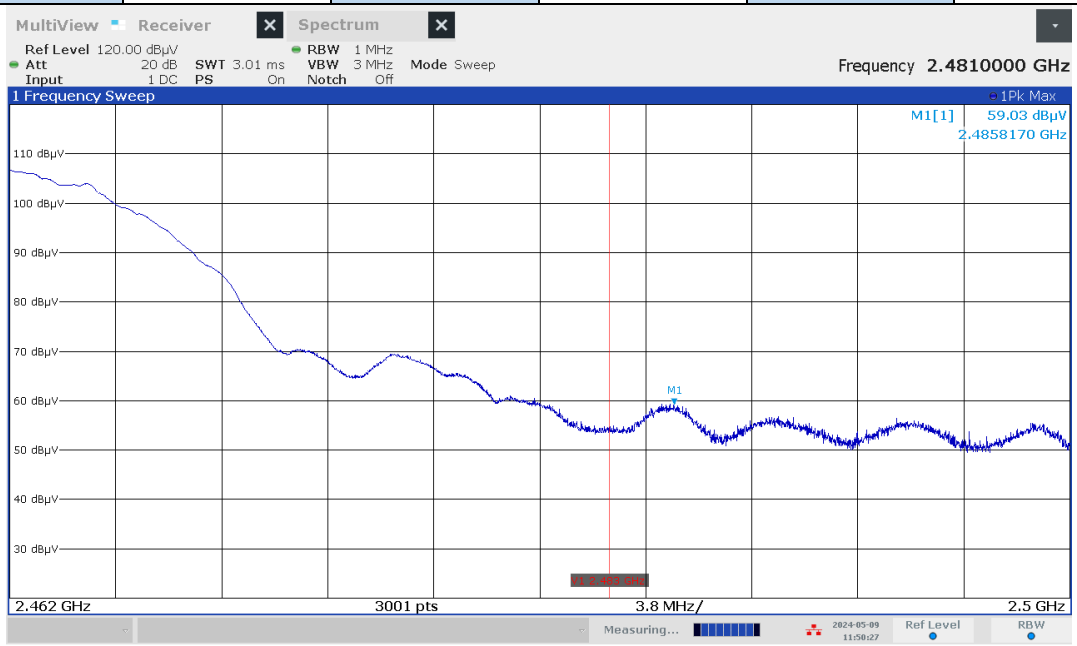


12:19:15 PM 05/09/2024

Tx Frequency	Low Channel	**Antenna Polarization**	Vertical	**Emission**	Average

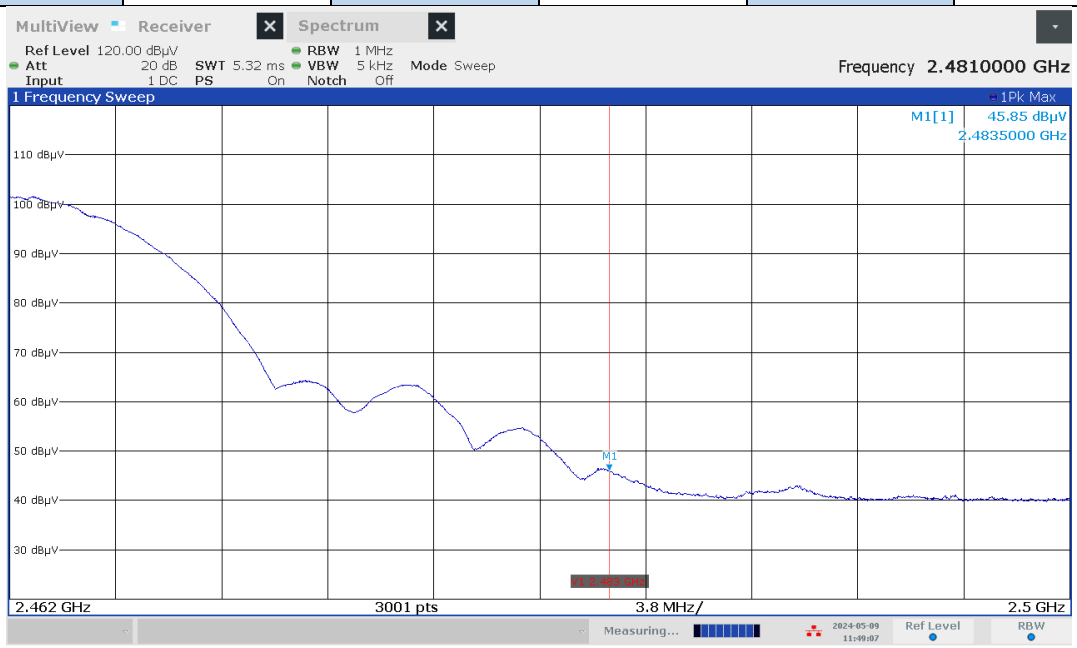
12:18:18 PM 05/09/2024

Tx Frequency	High Channel	**Antenna Polarization**	Horizontal	**Emission**	Peak



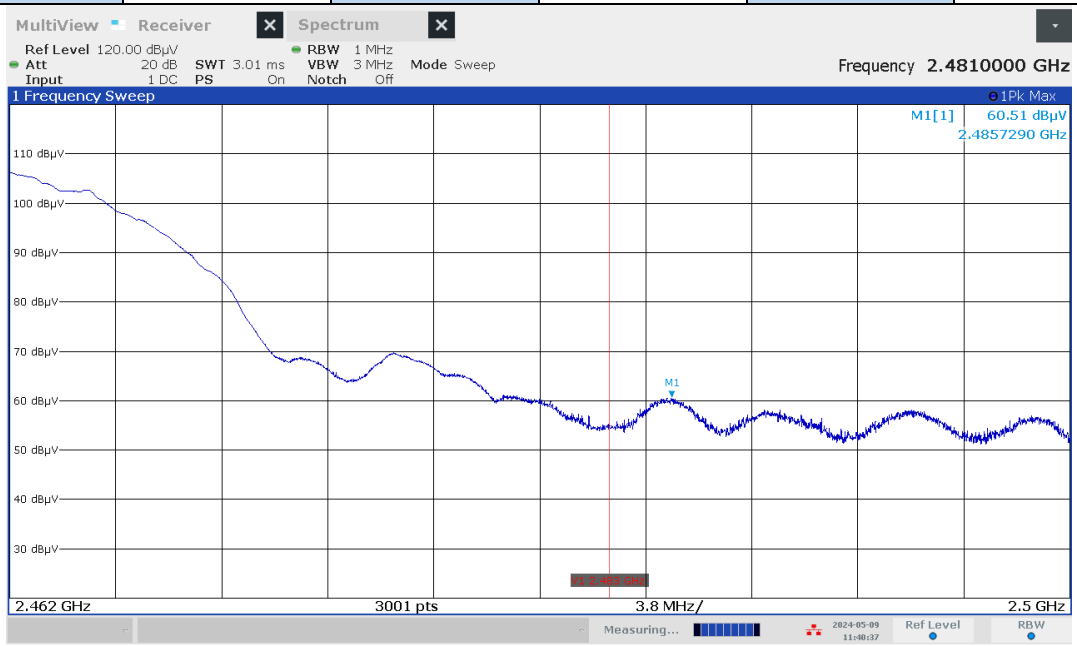
11:50:27 AM 05/09/2024

Tx Frequency	High Channel	**Antenna Polarization**	Horizontal	**Emission**	Average



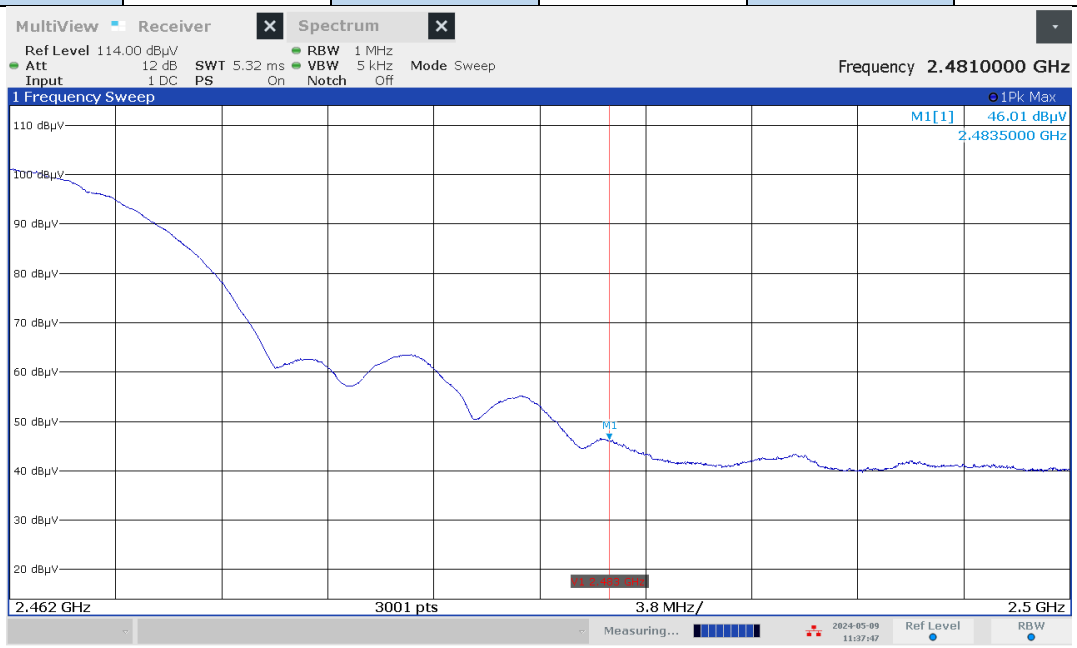
11:49:07 AM 05/09/2024

Tx Frequency	High Channel	**Antenna Polarization**	Vertical	**Emission**	Peak



11:40:37 AM 05/09/2024

Tx Frequency	High Channel	**Antenna Polarization**	Vertical	**Emission**	Average



11:37:47 AM 05/09/2024

4.6.3.2. Final Measurements

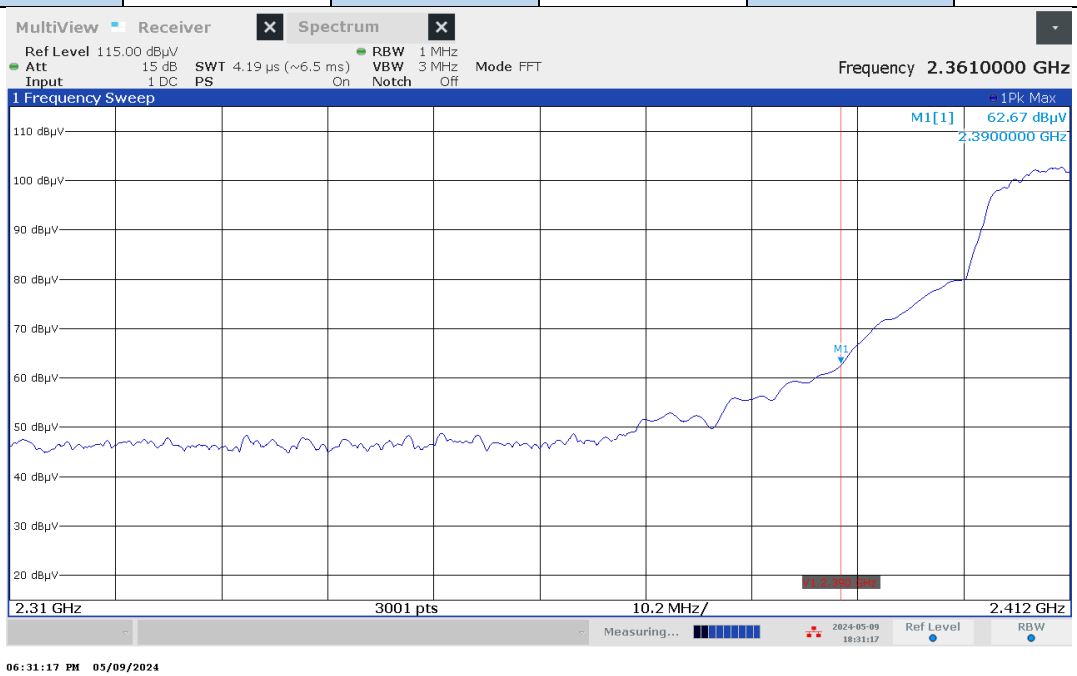
Frequency (MHz)	Detector	Antenna Polarity	Reading (dBµV)	Antenna Factor (dB/m)	Cable Factor (dB)	Attenuator (dB)	Pre-Amp Gain (dB)	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Test Result
Low Channel B-Mode											
2412	PEAK	Horz	107.1	32.5	6.8	10.0	-41.6	114.7			Pass
2412	AVG	Horz	101.8	32.5	6.8	10.0	-41.6	109.4			Pass
2412	PEAK	Vert	104.3	32.5	6.8	10.0	-41.6	112.0			Pass
2412	AVG	Vert	98.9	32.5	6.8	10.0	-41.6	106.6			Pass
2387.79	PEAK	Horz	59.5	32.4	6.8	10.0	-41.6	67.1	74.0	6.9	Pass
2390	AVG	Horz	44.3	32.4	6.8	10.0	-41.6	52.0	54.0	2.0	Pass
2387.6	PEAK	Vert	57.6	32.4	6.8	10.0	-41.6	65.3	74.0	8.7	Pass
2390	AVG	Vert	42.4	32.4	6.8	10.0	-41.6	50.0	54.0	4.0	Pass
High Channel B-Mode											
2462	PEAK	Horz	106.6	32.5	6.9	10.0	-41.7	114.3			Pass
2462	AVG	Horz	101.4	32.5	6.9	10.0	-41.7	109.1			Pass
2462	PEAK	Vert	106.4	32.5	6.9	10.0	-41.7	114.2			Pass
2462	AVG	Vert	101.2	32.5	6.9	10.0	-41.7	109.0			Pass
2483.6	PEAK	Horz	59.0	32.6	6.9	10.0	-41.7	66.8	74.0	7.2	Pass
2483.5	AVG	Horz	45.9	32.6	6.9	10.0	-41.7	53.6	54.0	0.4	Pass
2483.6	PEAK	Vert	60.5	32.6	6.9	10.0	-41.7	68.3	74.0	5.7	Pass
2483.5	AVG	Vert	45.8	32.6	6.9	10.0	-41.7	53.6	54.0	0.4	Pass

4.6.4 Test Results – 802.11 g

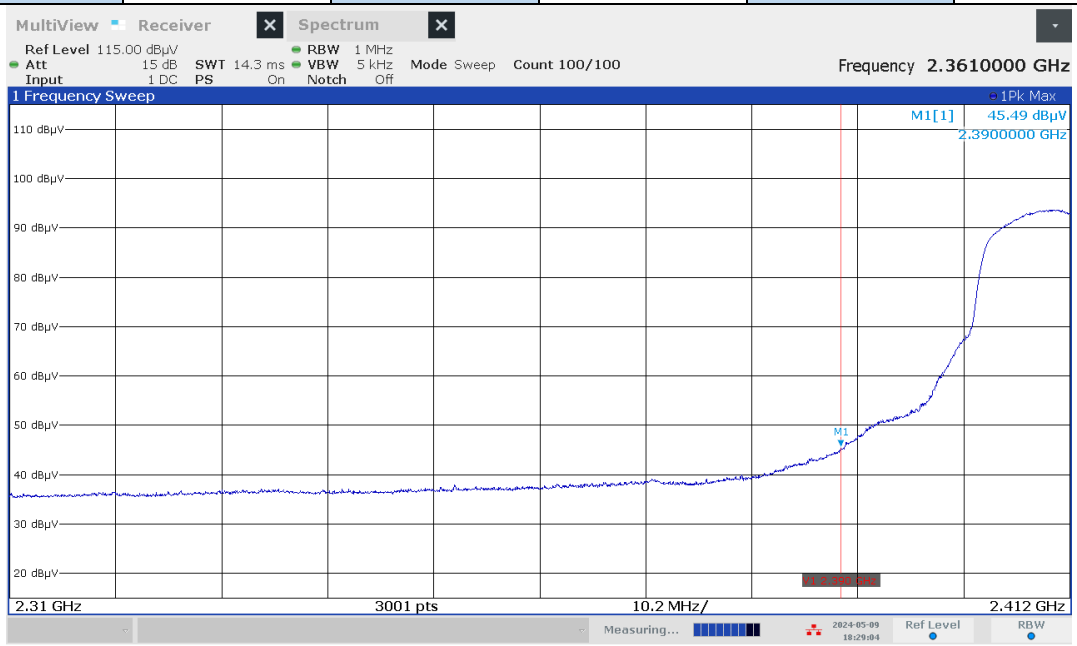
The DUT met the band edge requirements. Peak output power for low, mid and high channels were measured and the Plots Section below contains the maximum radiated emission levels captured on the spectrum analyzer at the band edges. The Final Measurements Section contains the final results with the correction factors added in.

4.6.4.1. Plots

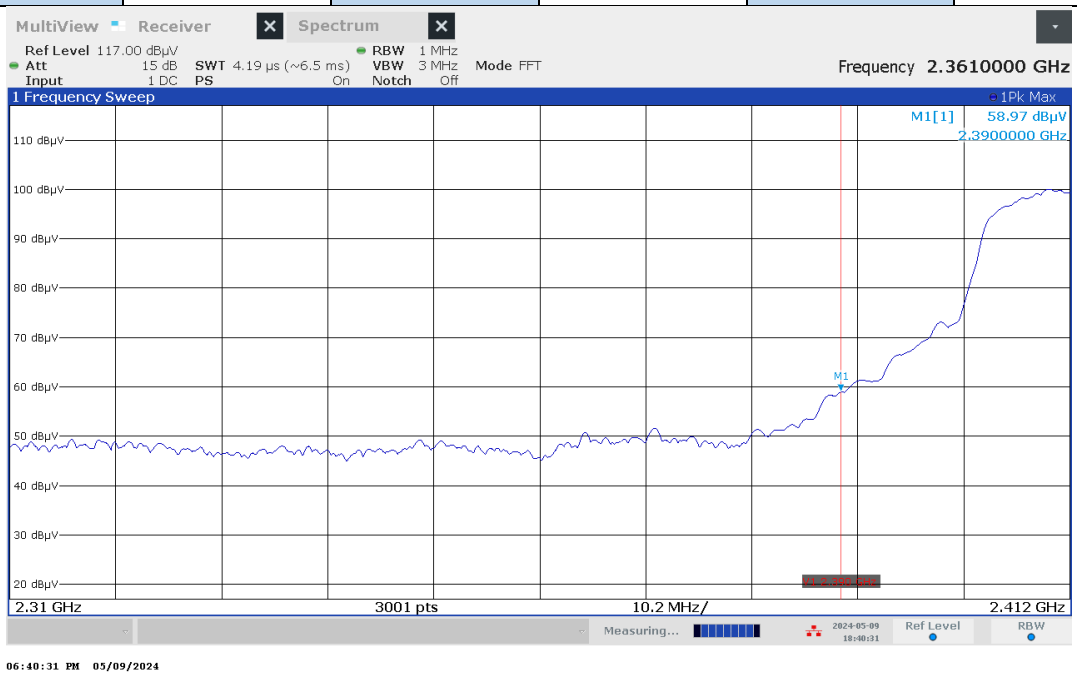
Tx Frequency	Low Channel	**Antenna Polarization**	Horizontal	**Emission**	Peak



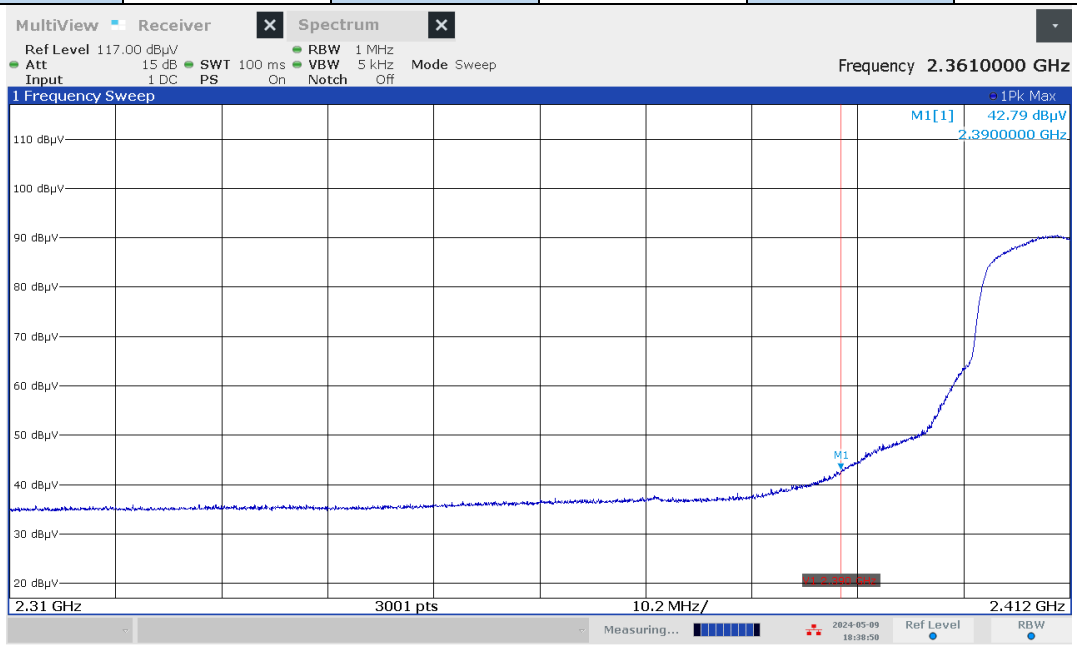
Tx Frequency	Low Channel	**Antenna Polarization**	Horizontal	**Emission**	Average



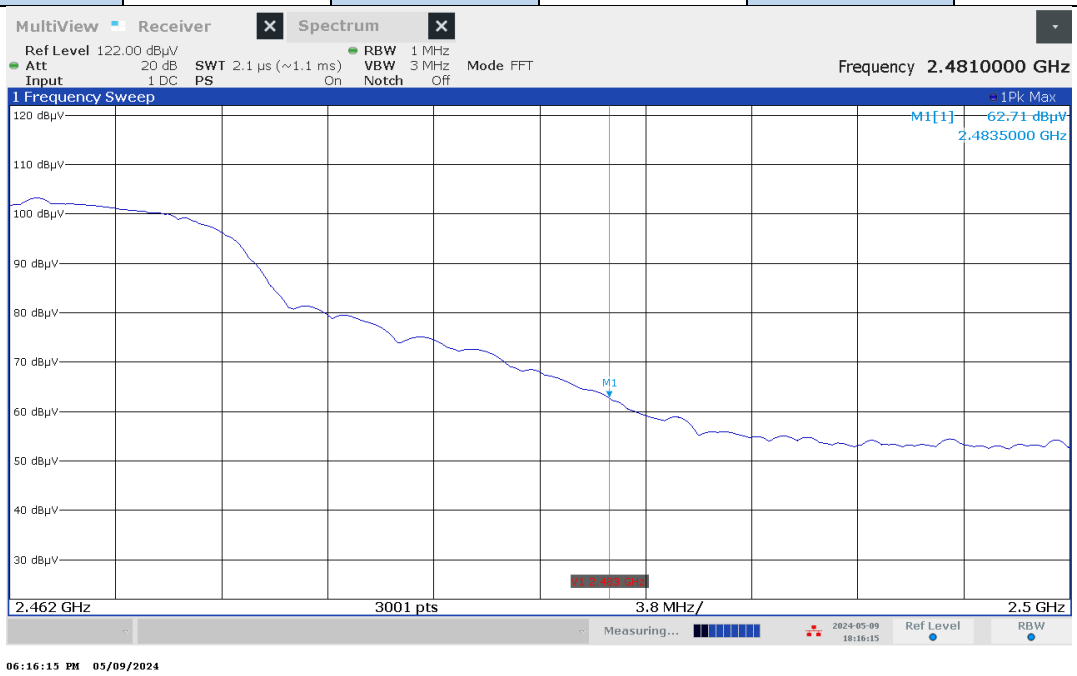
Tx Frequency	Low Channel	**Antenna Polarization**	Vertical	**Emission**	Peak



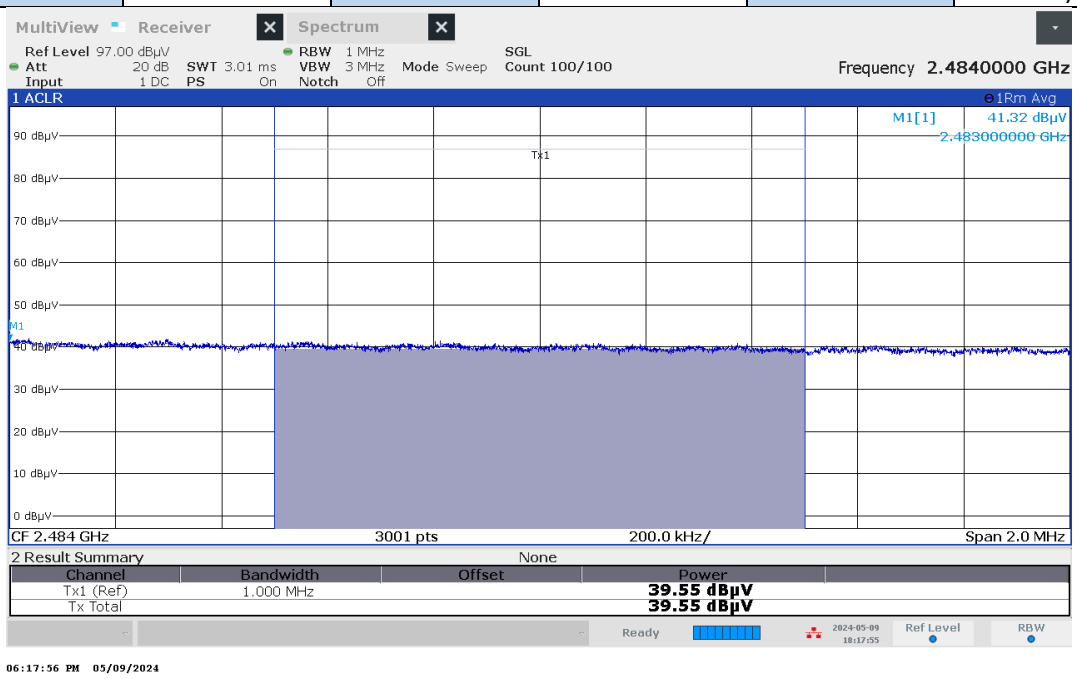
Tx Frequency	Low Channel	**Antenna Polarization**	Vertical	**Emission**	Average



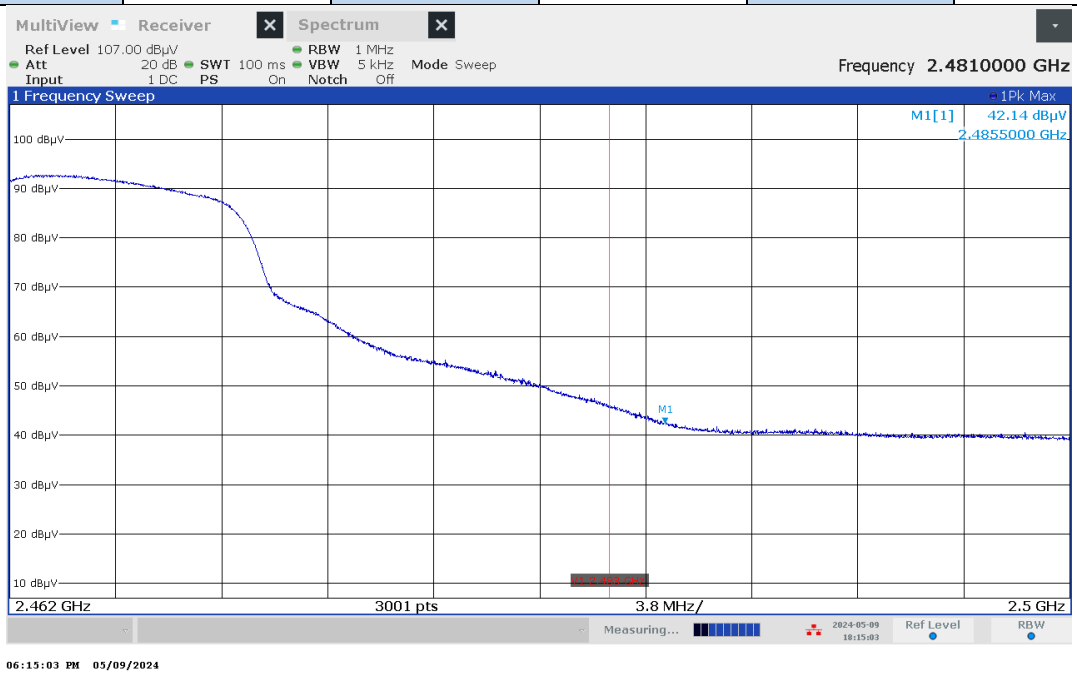
Tx Frequency	High Channel	**Antenna Polarization**	Horizontal	**Emission**	Peak



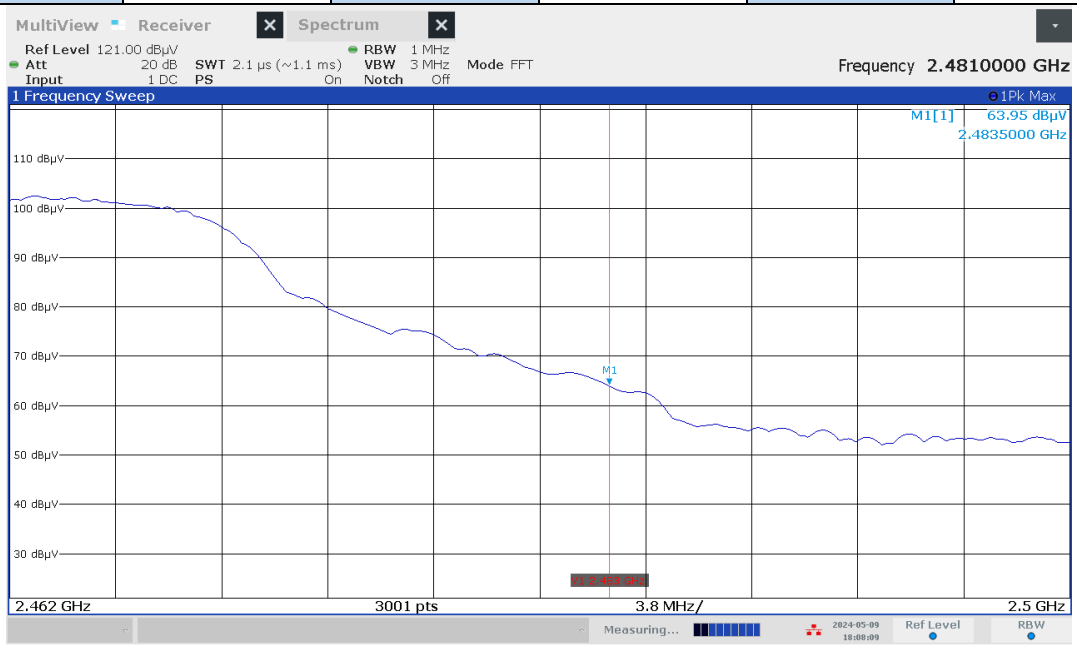
Tx Frequency	High Channel	**Antenna Polarization**	Horizontal	**Emission**	Average (Integration Method)



Tx Frequency	High Channel	**Antenna Polarization**	Horizontal	**Emission**	Average



Tx Frequency	High Channel	**Antenna Polarization**	Vertical	**Emission**	Peak



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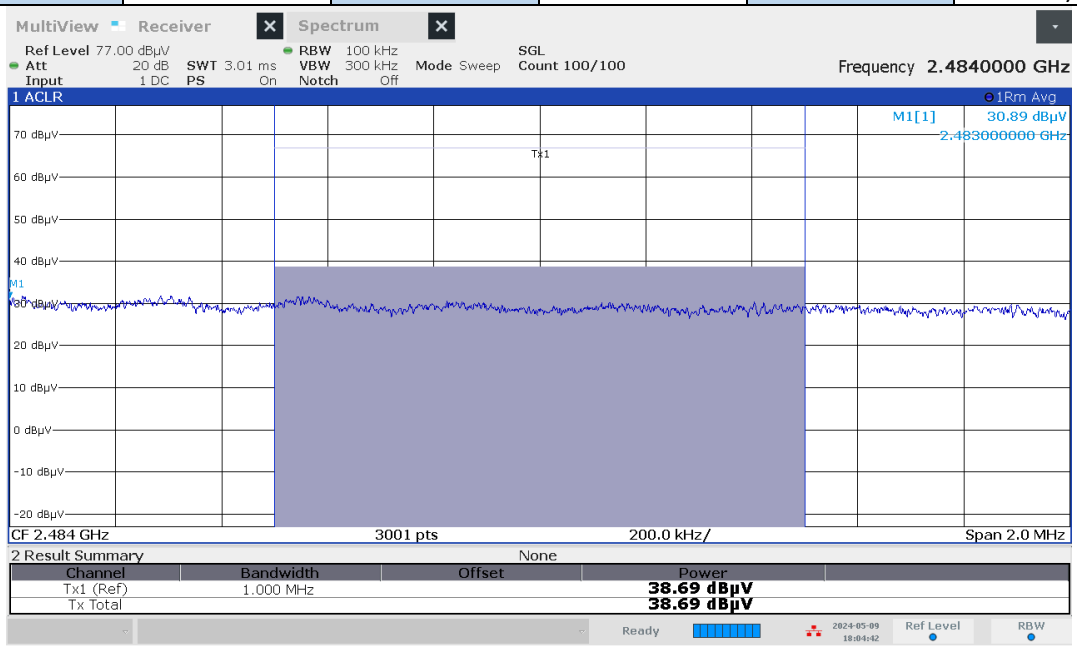
Tx Frequency	High Channel	**Antenna Polarization**	Vertical	**Emission**	Average (Integration Method)



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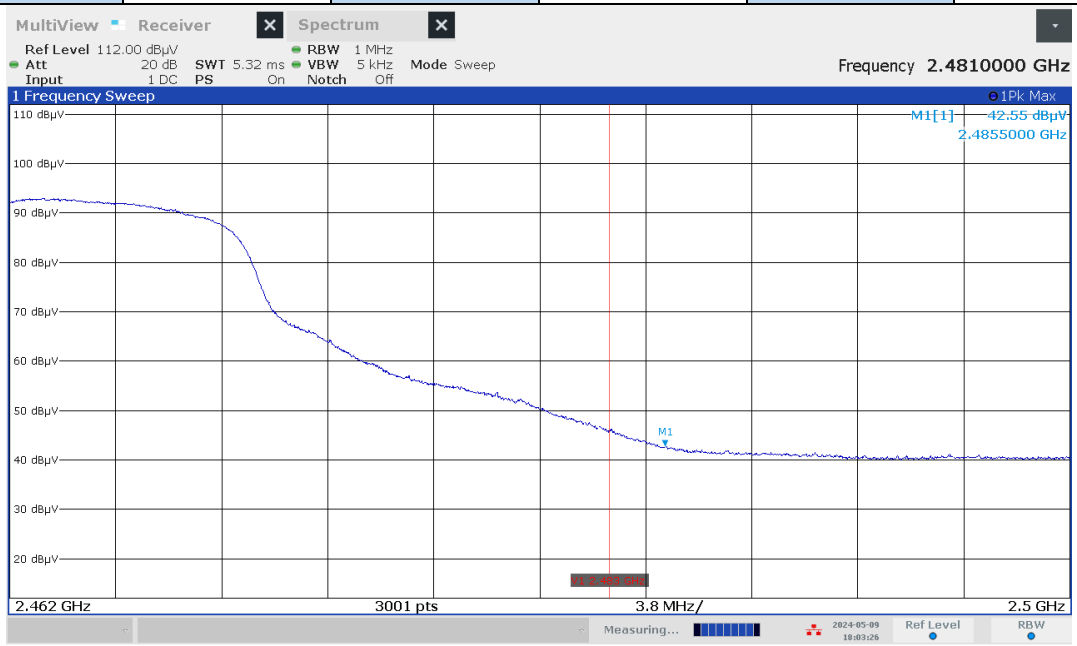
Tx Frequency	High Channel	**Antenna Polarization**	Vertical	**Emission**	Average



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4.6.4.2. Final Measurements

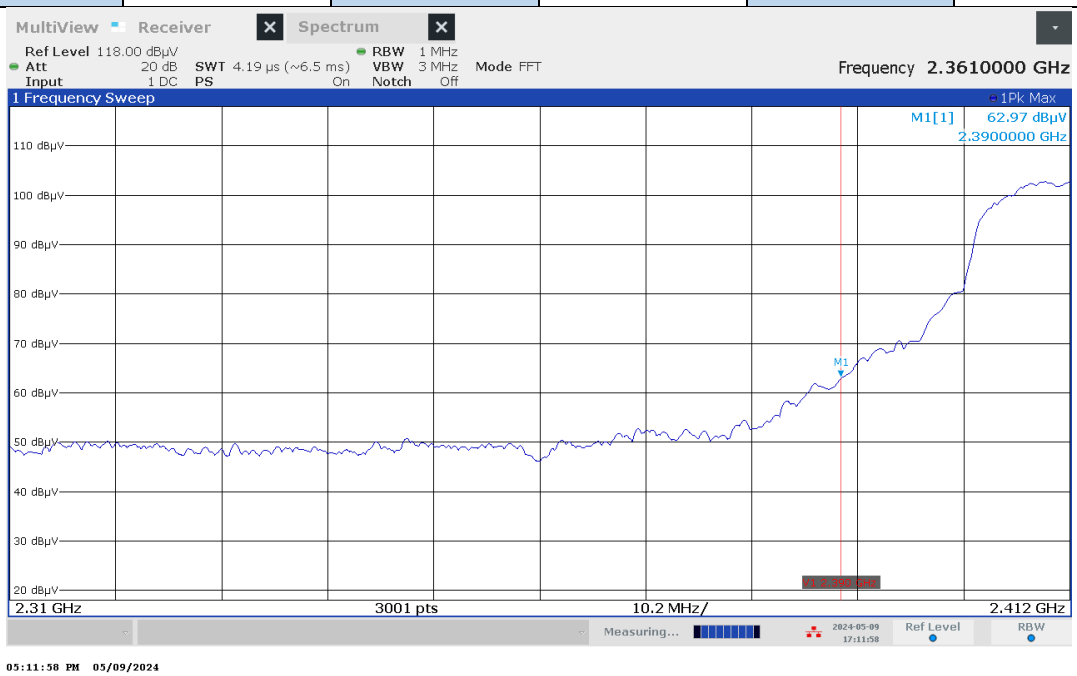
Frequency (MHz)	Detector	Antenna Polarity	Reading (dBµV)	Antenna Factor (dB/m)	Cable Factor (dB)	Attenuator (dB)	Pre-Amp Gain (dB)	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Test Result
Low Channel G-Mode											
2412	PEAK	Horz	103.3	32.5	6.8	10.0	-41.6	110.9			Pass
2412	AVG	Horz	96.6	32.5	6.8	10.0	-41.6	104.3			Pass
2412	PEAK	Vert	101.2	32.5	6.8	10.0	-41.6	108.8			Pass
2412	AVG	Vert	90.6	32.5	6.8	10.0	-41.6	98.3			Pass
2390	PEAK	Horz	62.7	32.4	6.8	10.0	-41.6	70.3	74.0	3.7	Pass
2390	AVG	Horz	45.5	32.4	6.8	10.0	-41.6	53.2	54.0	0.8	Pass
2390	PEAK	Vert	59.0	32.4	6.8	10.0	-41.6	66.6	74.0	7.4	Pass
2390	AVG	Vert	42.8	32.4	6.8	10.0	-41.6	50.5	54.0	3.5	Pass
High Channel G-Mode											
2462	PEAK	Horz	103.1	32.5	6.9	10.0	-41.7	110.8			Pass
2462	AVG	Horz	92.5	32.5	6.9	10.0	-41.7	100.3			Pass
2462	PEAK	Vert	102.6	32.5	6.9	10.0	-41.7	110.3			Pass
2462	AVG	Vert	92.9	32.5	6.9	10.0	-41.7	100.7			Pass
2483.5	PEAK	Horz	62.7	32.6	6.9	10.0	-41.7	70.5	74.0	3.5	Pass
2484	AVG	Horz	39.6	32.6	6.9	10.0	-41.7	47.3	54.0	6.7	Pass
2483.5	PEAK	Vert	64.0	32.6	6.9	10.0	-41.7	71.7	74.0	2.3	Pass
2484	AVG	Vert	38.9	32.6	6.9	10.0	-41.7	46.6	54.0	7.4	Pass
2485.5	AVG	Horz	42.1	32.6	6.9	0.0	-41.7	39.9	54.0	14.1	Pass
2485.5	AVG	Vert	42.6	32.6	6.9	0.0	-41.7	40.3	54.0	13.7	Pass

4.6.5 Test Results – 802.11 n

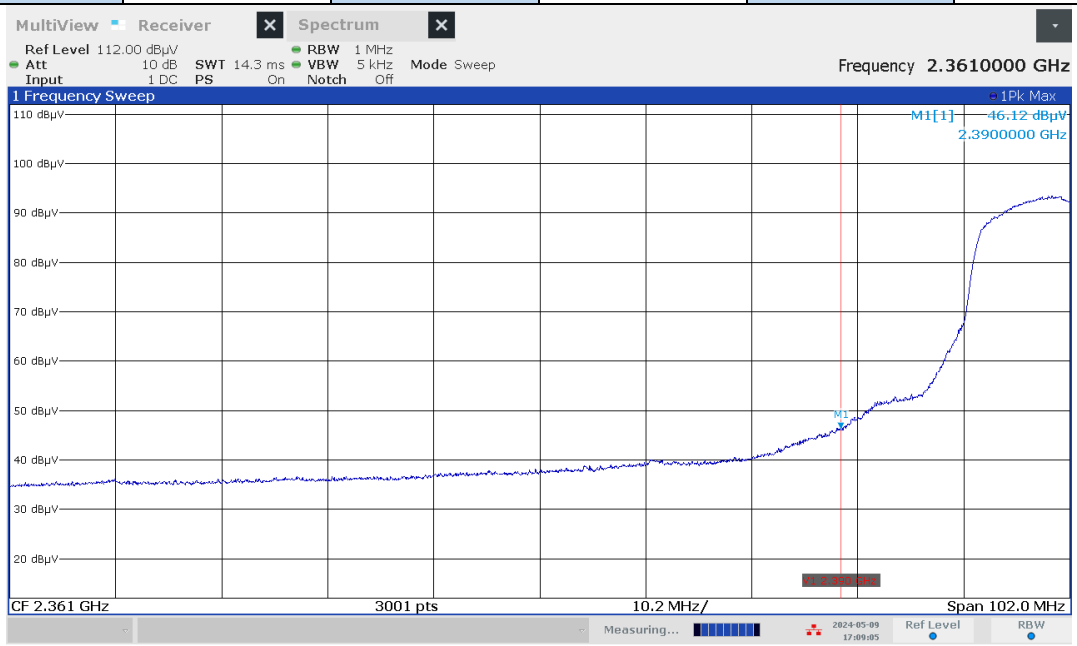
The DUT met the band edge requirements. Peak output power for low, mid and high channels were measured and the Plots Section below contains the maximum radiated emission levels captured on the spectrum analyzer at the band edges. The Final Measurements Section contains the final results with the correction factors added in.

4.6.5.1. Plots

Tx Frequency	Low Channel	**Antenna Polarization**	Horizontal	**Emission**	Peak



Tx Frequency	Low Channel	**Antenna Polarization**	Horizontal	**Emission**	Average



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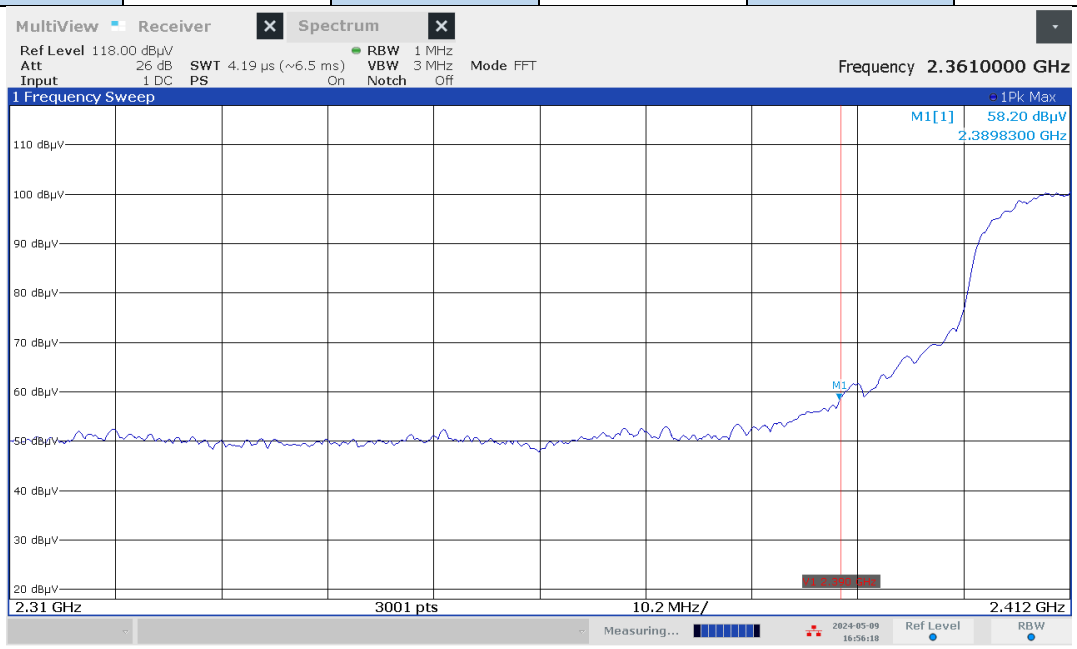
Tx Frequency	Low Channel	**Antenna Polarization**	Vertical	**Emission**	Peak



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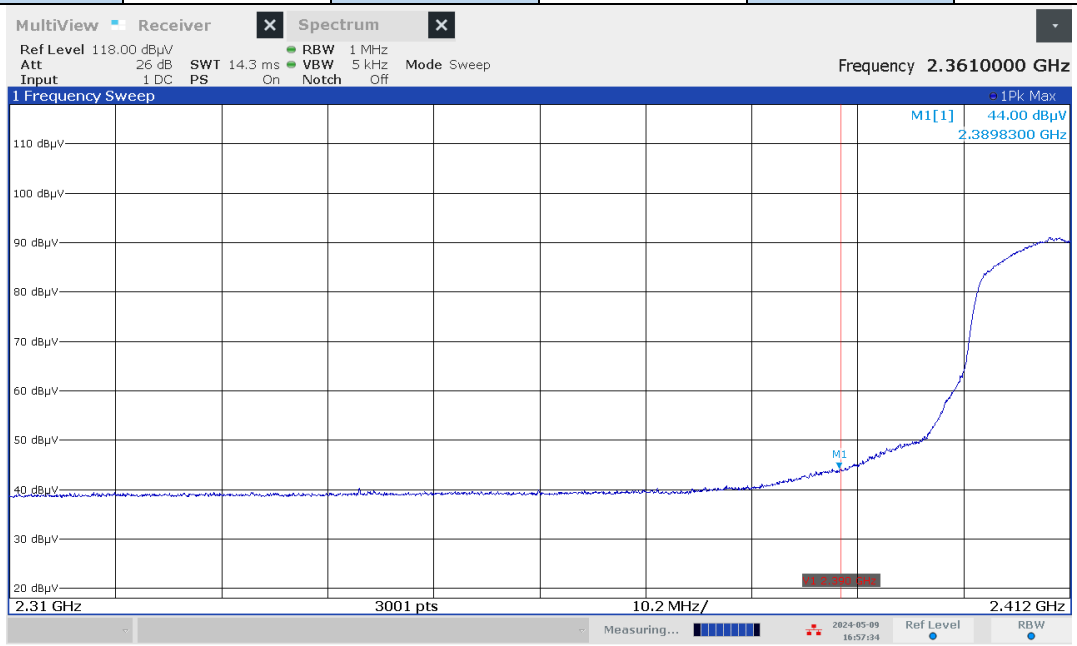
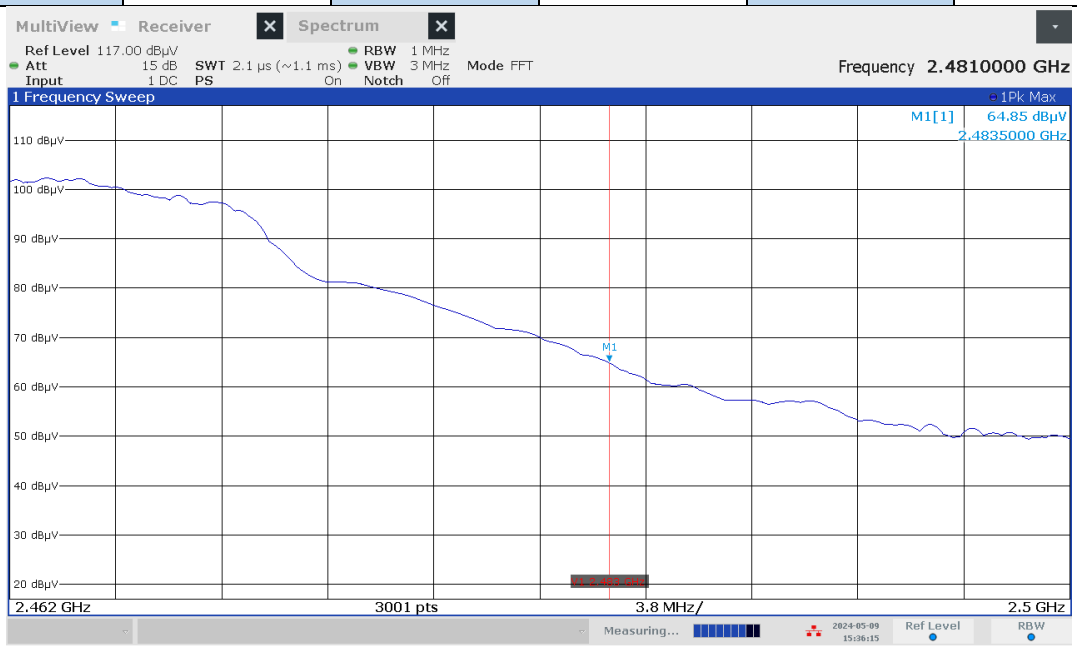
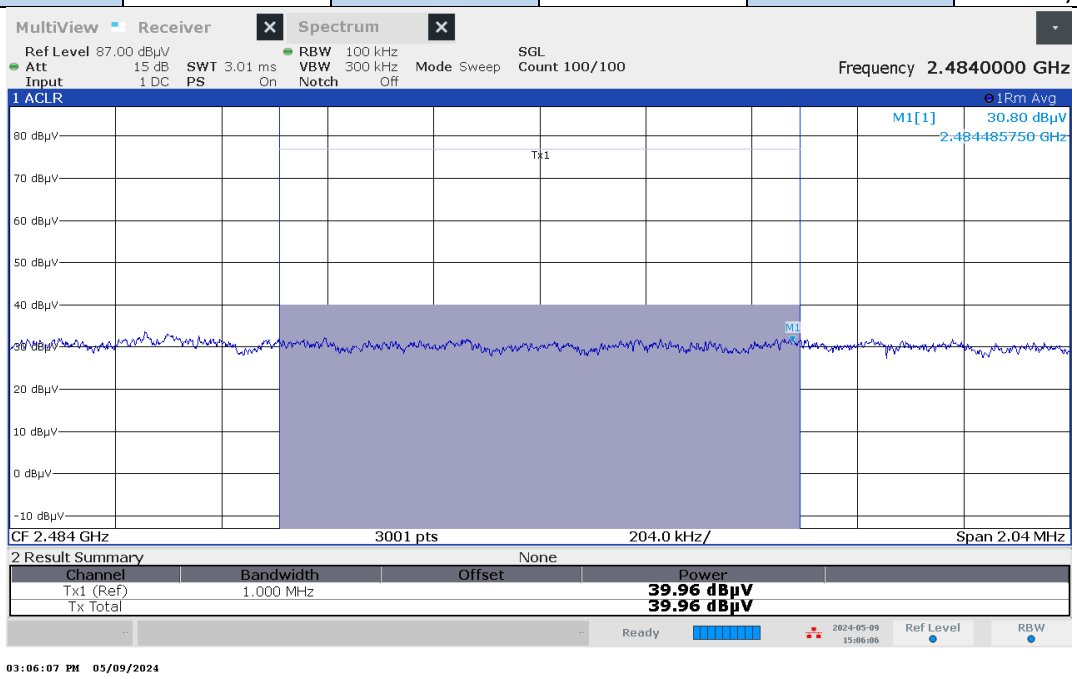
Tx Frequency	Low Channel	**Antenna Polarization**	Vertical	**Emission**	Average



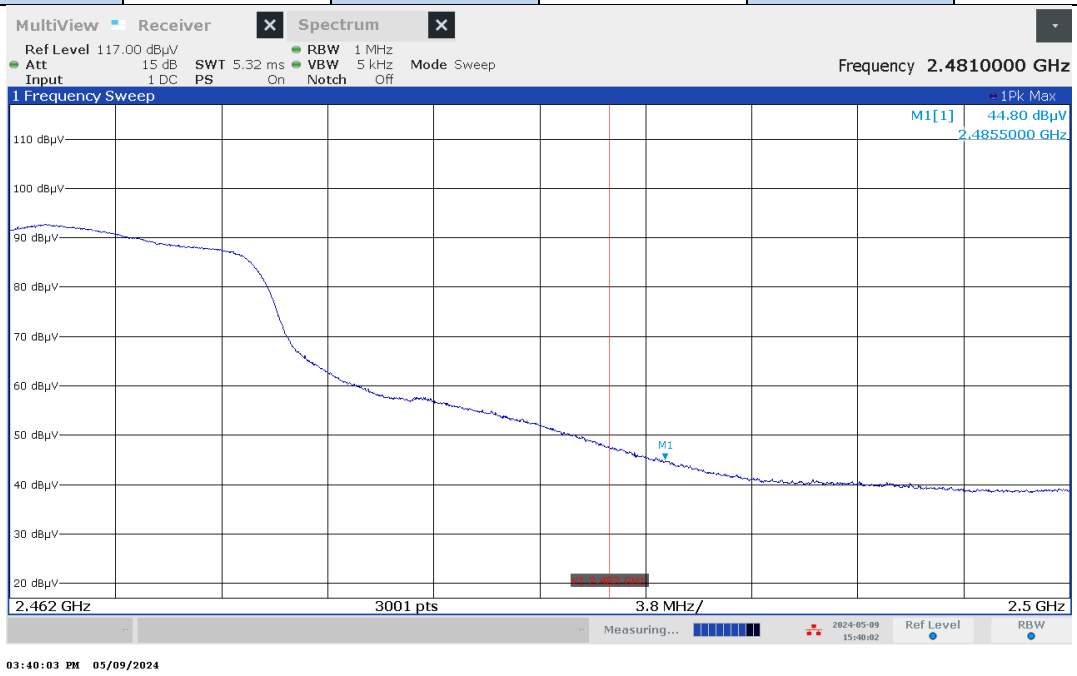
Tx Frequency	High Channel	**Antenna Polarization**	Horizontal	**Emission**	Peak



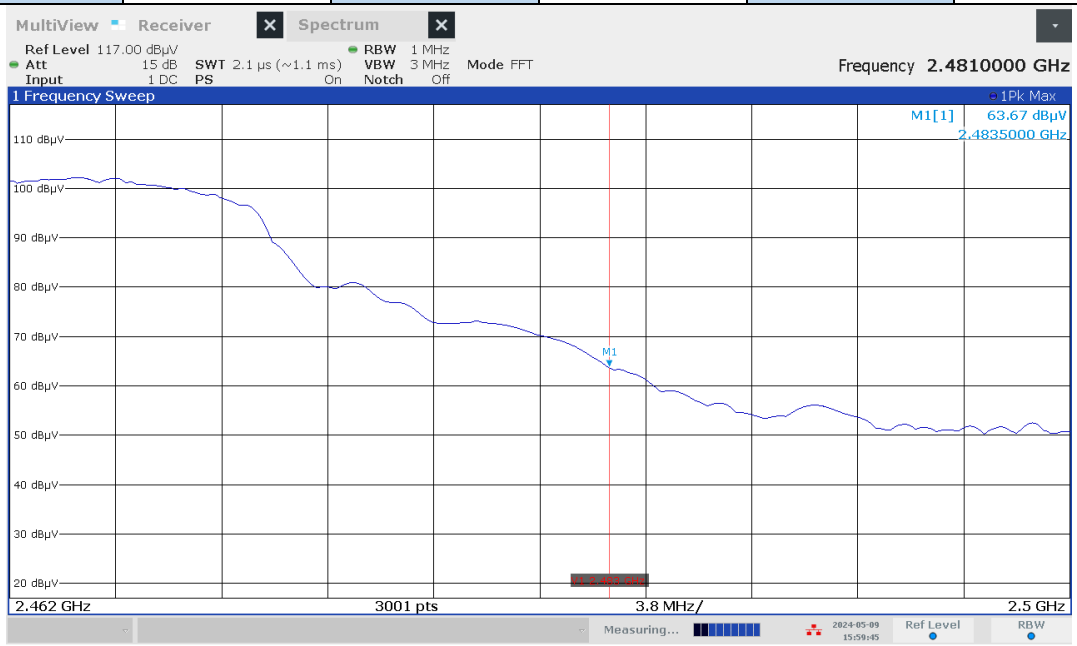
Tx Frequency	High Channel	**Antenna Polarization**	Horizontal	**Emission**	Average (Integration Method)



Tx Frequency	High Channel	**Antenna Polarization**	Horizontal	**Emission**	Average



Tx Frequency	High Channel	Antenna Polarization	Vertical	Emission	Peak



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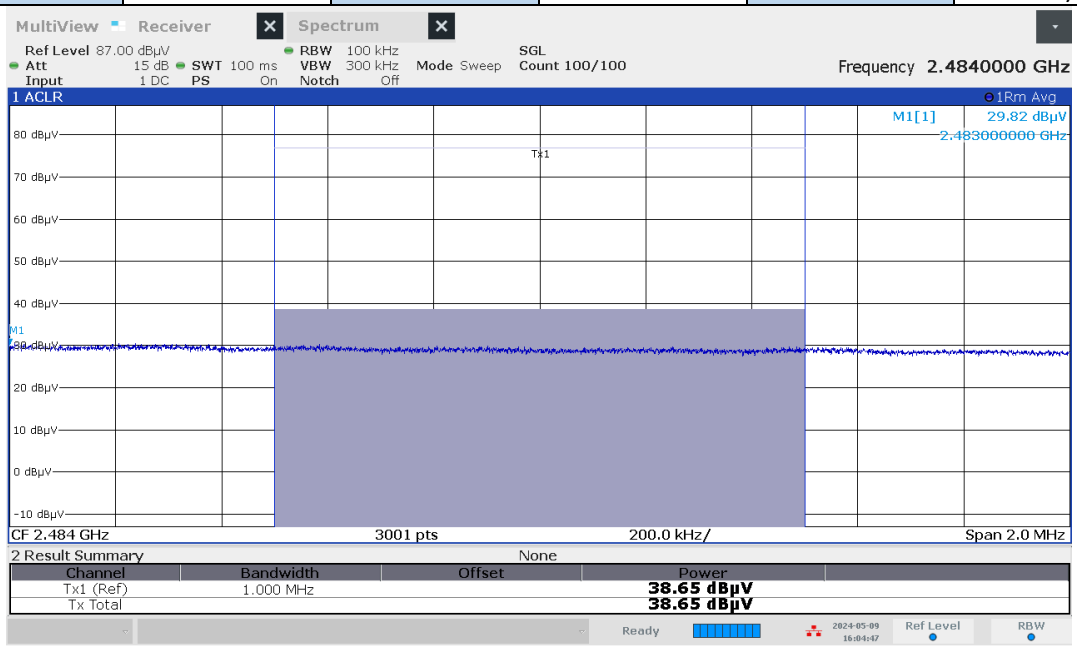
Tx Frequency	High Channel	Antenna Polarization	Vertical	Emission	Average (Integration Method)



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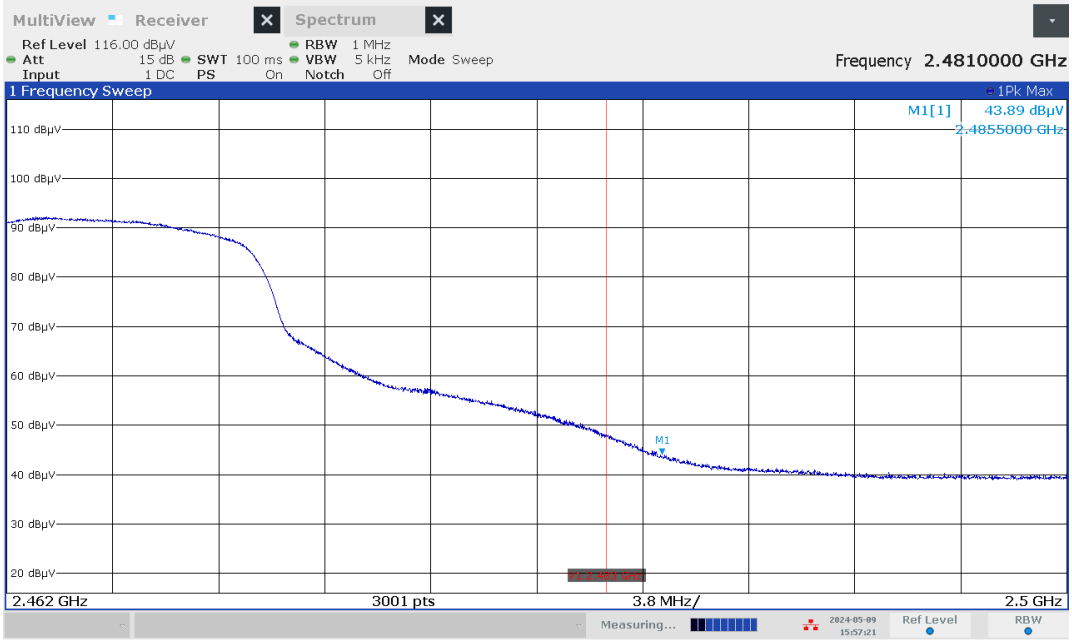
Tx Frequency	High Channel	**Antenna Polarization**	Vertical	**Emission**	Average



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4.6.5.2. Final Measurements

Frequency (MHz)	Detector	Antenna Polarity	Reading (dBµV)	Antenna Factor (dB/m)	Cable Factor (dB)	Attenuator (dB)	Pre-Amp Gain (dB)	Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Test Result
Low Channel N-Mode/20MHz											
2412	PEAK	Horz	103.3	32.5	6.8	10.0	-41.6	111.0			Pass
2412	AVG	Horz	93.8	32.5	6.8	10.0	-41.6	101.5			Pass
2412	PEAK	Vert	101.1	32.5	6.8	10.0	-41.6	108.8			Pass
2412	AVG	Vert	91.1	32.5	6.8	10.0	-41.6	98.8			Pass
2390	PEAK	Horz	63.0	32.4	6.8	10.0	-41.6	70.6	74.0	3.4	Pass
2390	AVG	Horz	46.1	32.4	6.8	10.0	-41.6	53.8	54.0	0.2	Pass
2390	PEAK	Vert	58.2	32.4	6.8	10.0	-41.6	65.9	74.0	8.1	Pass
2390	AVG	Vert	44.0	32.4	6.8	10.0	-41.6	51.7	54.0	2.3	Pass
High Channel N-Mode/20MHz BW											
2462	PEAK	Horz	103.3	32.5	6.9	10.0	-41.7	111.0			Pass
2462	AVG	Horz	92.2	32.5	6.9	10.0	-41.7	100.0			Pass
2462	PEAK	Vert	103.4	32.5	6.9	10.0	-41.7	111.1			Pass
2462	AVG	Vert	92.0	32.5	6.9	10.0	-41.7	99.8			Pass
2483.5	PEAK	Horz	64.9	32.6	6.9	10.0	-41.7	72.6	74.0	1.4	Pass
2484	AVG	Horz	36.3	32.6	6.9	10.0	-41.7	44.1	54.0	9.9	Pass
2484	PEAK	Vert	63.7	32.6	6.9	10.0	-41.7	71.4	74.0	2.6	Pass
2484	AVG	Vert	38.7	32.6	6.9	10.0	-41.7	46.4	54.0	7.6	Pass
2485.5	AVG	Horz	44.2	32.6	6.9	10.0	-41.7	52.0	54.0	2.0	Pass
2485.5	AVG	Vert	43.9	32.6	6.9	10.0	-41.7	51.6	54.0	2.4	Pass

4.6.6 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_58	EMI Receiver	Rohde & Schwarz	ESW 44	Mar 1, 2024	Mar 1, 2026
EQ_EMC_60	Horn Antenna	ETS Lindgren	3117	Apr 9, 2024	Apr 9, 2026
EQ_EMC_75	RF Cable >1GHz	MegaPhase	EMC2	NCR	NCR
EQ_EMC_115	10 dB Attenuator SMA	Fairview Microwave	SA18E-10	NCR	NCR
EQ_EMC_42	Preamplifier 1GHz-18GHz	Com-Power	PAM-118A	Jan 17, 2024	Jan 17, 2026

4.7 Power Line Conducted Emissions

Test Date:	May 13, 2024	Initials:	MX
Temperature (°C)	21.1		
Relative Humidity (%)	54.7		
Barometric Pressure (kPa)	100.8		

The conducted emission test is to measure radio-frequency (RF) signals and noise emitted from electrical and electronic devices in the frequency range of 150kHz to 30MHz.

4.7.1 Limits

Base Standard(s): FCC Subpart B 15.207 and RSS-GEN Section 8.8.

Frequency Range (MHz)	Coupling Device	Detector Type / Bandwidth	Limit (dBµV)
0.15 to 0.50	LISN	Quasi-Peak / 9kHz	66 to 56*
0.50 to 5			56
5 to 30			60
0.15 to 0.50	LISN	Average / 9kHz	56 to 46*
0.50 to 5			46
5 to 30			50

* Decreases linearly with the logarithm of the frequency

As per ANSI C63.4 Section 4.2, if the Peak or Quasi-Peak detector measurements do not exceed the Average limits, then the DUT is considered to have passed the requirements.

4.7.2 Test Procedure

Tested according to ANSI C63.10 Section 6.2.

Conducted emissions were measured on the DUT's power port via an Artificial Mains Network (AMN), also known as Line Impedance Stabilization Network (LISN), and maximum conducted emissions are checked on all the DUT's AC lines in the frequency range of 150kHz to 30MHz. All other support equipment were powered via another LISN. The LISNs provide 50Ω/50µH of coupling impedance for the measuring receiver.

To determine the emission characteristics of the DUT, the conducted emission scans were made using a Peak detector and the results were recorded in graphical form.

For each suspected emission, final measurements of the DUT conducted emissions were made with the Quasi-Peak or Average detector as defined in the limits table above.

For Table-Top Equipment, the device under test is configured on a 0.8m high non-conductive table above the reference ground plane and 0.4m away from the vertical reference ground plane.

4.7.3 Setup Diagram

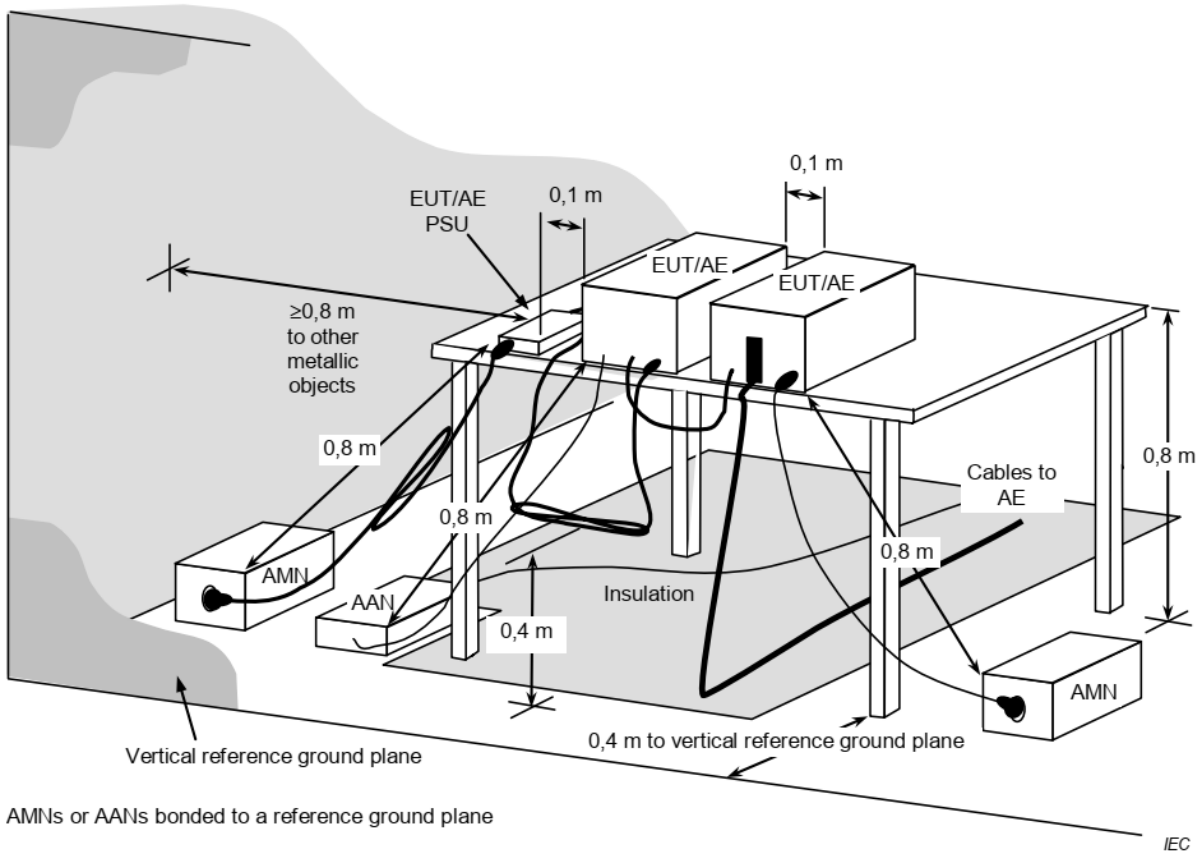
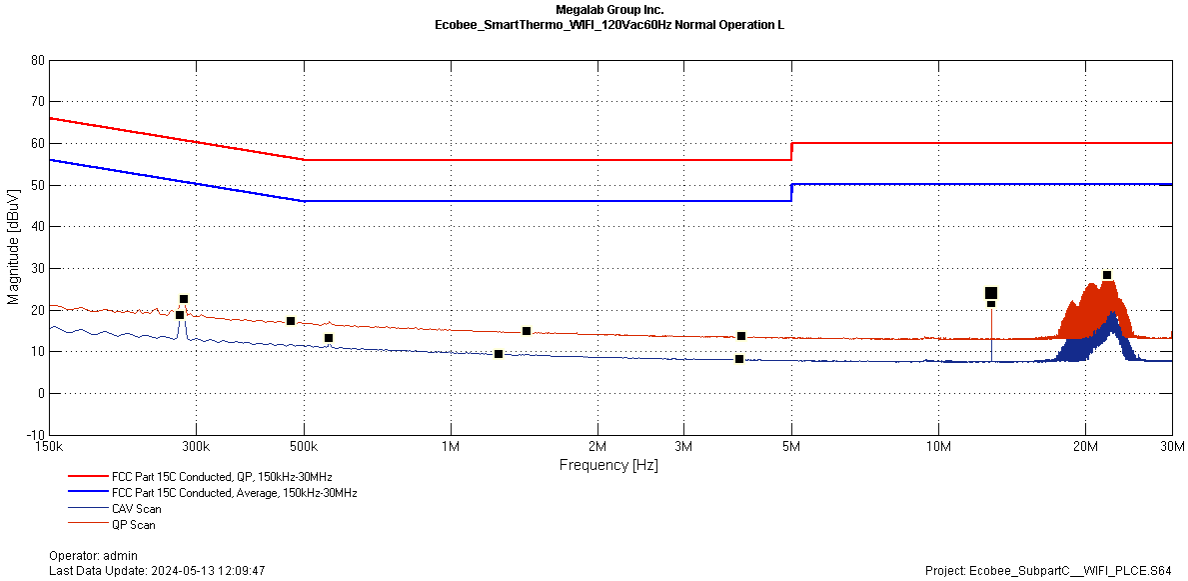


Figure 50 – Sample Measurement Arrangement for DUT

4.7.4 Test Results

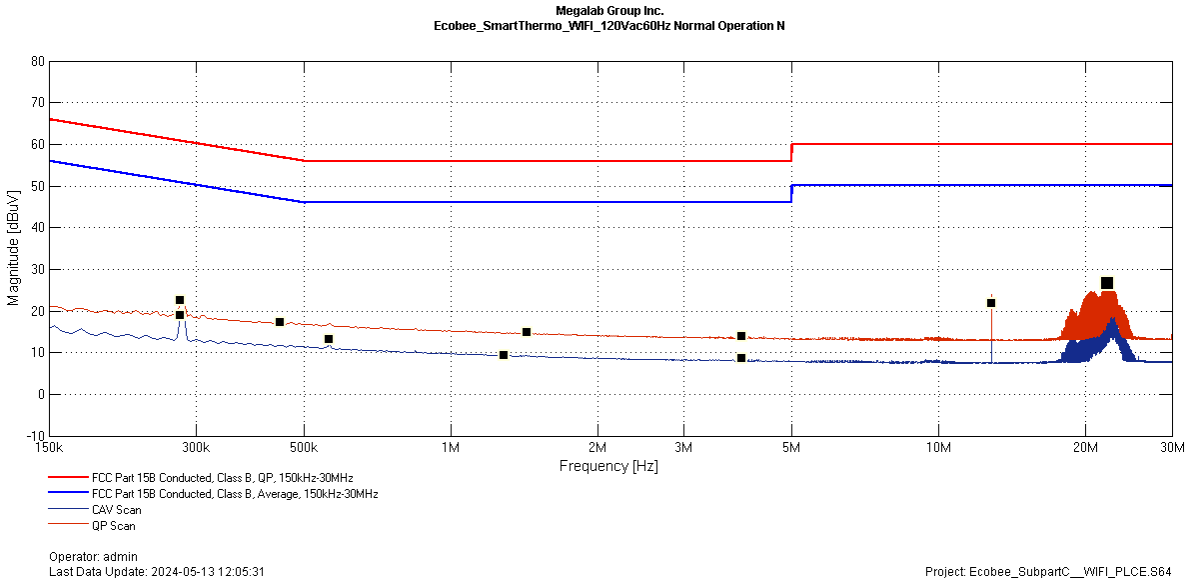
Range:	150kHz to 30MHz	**DUT**	ECB701/WIFI
Test Voltage:	120Vac 60Hz	**Phase**	Line



Remark: Quasi-Peak and Average Emission Plot

Line										
Freq (MHz)	**QP Reading (dBµV)**	**AVG Reading (dBµV)**	**Corr Factor (dB)**	**QP Emission Level (dBµV)**	**AVG Emission Level (dBµV)**	**QP Limit (dBµV)**	**QP Margin (dB)**	**AVG Limit (dBµV)**	**AVG Margin (dB)**	**Test Result**
0.284	12.5	--	9.9	22.4	--	60.7	38.3	--	--	Pass
0.471	7.3	--	9.9	17.2	--	56.5	39.3	--	--	Pass
0.279	--	8.8	9.9	--	18.7	--	--	50.8	32.1	Pass
0.563	--	3.2	9.9	--	13.1	--	--	46.0	32.9	Pass
12.799	13.7	11.5	10.1	23.8	21.6	60.0	36.2	50.0	28.4	Pass

Range:	150kHz to 30MHz	DUT	ECB701/WIFI
Test Voltage:	120Vac 60Hz	Phase	Neutral



Remark: Peak Emission Plot

Neutral										
Freq (MHz)	QP Reading (dBµV)	AVG Reading (dBµV)	Corr Factor (dB)	QP Emission Level (dBµV)	AVG Emission Level (dBµV)	QP Limit (dBµV)	QP Margin (dB)	AVG Limit (dBµV)	AVG Margin (dB)	Test Result
22.182	16.3	--	10.3	26.6	--	60.0	33.4	--	--	Pass
0.279	12.5	8.9	9.9	22.4	18.8	60.8	38.4	50.8	32.0	Pass
12.799	--	11.6	10.1	--	21.7	--	--	50.0	28.3	Pass

4.7.5 Test Equipment List

Equipment ID	Description	Manufacturer	Model	Calibration Date	Calibration Due
EQ_EMC_132	EMI Test Receiver (v6.91.2)	Gauss Instruments	TDEMI X40	Nov 29, 2023	Nov 29, 2025
EQ_EMC_61	LISN	FCC	50/250-16-2-01	Jan 16, 2024	Jan 16, 2026
EQ_EMC_44	Transient Limiter (10dB)	Com-Power	LIT-930A	NCR	NCR
EQ_EMC_84	RF Cable	Times Microwave	LMR-400	NCR	NCR
EQ_EMC_149	Emission Software RE/CE	Gauss Instruments	EMI64k v6.31.2	NCR	NCR

---------- End of Test Report ----------