# RF Test Report

| | |
|---|---|
| **Standard(s):** | FCC Part 15 Subpart 15.247,<br>RSS-247 Issue 3:2023<br>Unlicensed Intentional Radiators |
| **Issued To:** | Ecobee Inc<br>207 Queens Quay Suite 600<br>Toronto, ON M5J 1A7<br>Canada |
| **Product Name:** | Smart Thermostat Lite & Smart Thermostat Essential |
| **Model:** | ECB701 |
| **FCC ID:** | WR9202428847PR |
| **IC:** | 7981A-202428847PR |
| **Report No.** | ML301244A-RF01 (DTS – BLE) |
| **Date of Issue:** | August 9, 2024 |

**Report Prepared By:**

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**Reviewed By:**

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# 1. Revision History

| Project No. & Revision | Report Date | Initials | Description |
|---|---|---|---|
| ML301244A-RF00 (DTS – BLE) | July 26, 2024 | MX | Initial Release |
| ML301244A-RF01 (DTS – BLE) | August 9, 2024 | MX | Updated Product name and added duty cycle to section 3.3. |

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<br>15.247(b)(4) | RSS-247<br>5.4(d) | Antenna Gain and Requirement | Pass | PCB Trace Antenna<br>2.5 dBi |
| 15.247(a)(2) | RSS-247<br>5.2(a) | Emission Bandwidth | Pass | 6dB Bandwidth > 500kHz |
| 15.247(b)(3) | RSS-247<br>5.4(d) | Peak Conducted Output Power | Pass | < 1 Watt |
| 15.247(d) | RSS-247<br>5.5 | Spurious Out of Band Emissions | Pass | < 20dBc |
| 15.247(d)<br>15.209 | RSS-GEN 8.9<br>(Table 5 & 6) | Transmitter Spurious Radiated Emissions | Pass | --- |
| 15.205<br>15.209 | RSS-GEN<br>8.10<br>(Table 7) | Lower and Upper Band Edges | Pass | Transmitter spurious radiated emissions which fall in the restricted bands |
| 15.247(e) | RSS-247<br>5.2(b) | Power Spectral Density | Pass | < 8 dBm in 3kHz BW |
| 15.207 | RSS-GEN<br>(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 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<br>Toronto, ON M5J 1A7<br>Canada |
| Contact | John Russomanno |
| Email | john@ecobee.com |

## 3.2 Device Under Test (DUT)

### 3.2.1 DUT Information

| | |
|---|---|
| DUT Name | Smart Thermostat Lite & 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 |
| Connectors Available on DUT | Standard thermostat connections |
| **Transmitter Information** | |
| FCC ID | WR9202428847PR |
| IC | 7981A-202428847PR |
| Technology Used | BLE |
| Operating Frequency | 2402 MHz to 2480 MHz |
| Modulation Type | GFSK |
| 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; it contains 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 BLE 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; 61.8% for 1 MBPS (0.772 ms ON time with a period of 1.25 ms) and 31.5% for 2 MBPS (0.394 ms ON time with a period of 1.25 ms)
- Output Power: +20 dBm
- Channels:
    - low, 2402MHz
    - Mid, 2440MHz
    - High, 2480MHz

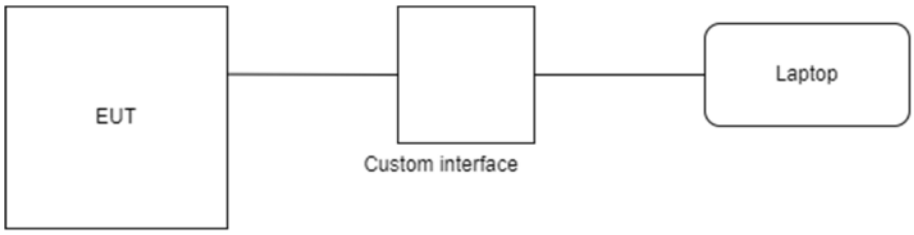



Figure 1 – Configuration Block Diagram

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

### 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

EUT meets minimum of 500 kHz 6dB bandwidth.

| 1 MBPS | | | | |
|---|---|---|---|---|
| 6dB (DTS) & 99% Bandwidth | | | | |
| **Frequency (MHz)** | **6dB DTS Bandwidth (MHz)** | **99% Occupied Bandwidth (MHz)** | **6dB Bandwidth Limit (MHz)** | **Test Result** |
| 2402 | 0.663 | 1.03 | > 0.50 | Pass |
| 2440 | 0.669 | 1.03 | > 0.50 | Pass |
| 2480 | 0.666 | 1.03 | > 0.50 | Pass |

| 2 MBPS | | | | |
|---|---|---|---|---|
| 6dB (DTS) & 99% Bandwidth | | | | |
| **Frequency (MHz)** | **6dB DTS Bandwidth (MHz)** | **99% Occupied Bandwidth (MHz)** | **6dB Bandwidth Limit (MHz)** | **Test Result** |
| 2402 | 1.12 | 2.07 | > 0.50 | Pass |
| 2440 | 1.14 | 2.06 | > 0.50 | Pass |
| 2480 | 1.14 | 2.07 | > 0.50 | Pass |

### *4.1.3.1. 1 MBPS Plots*

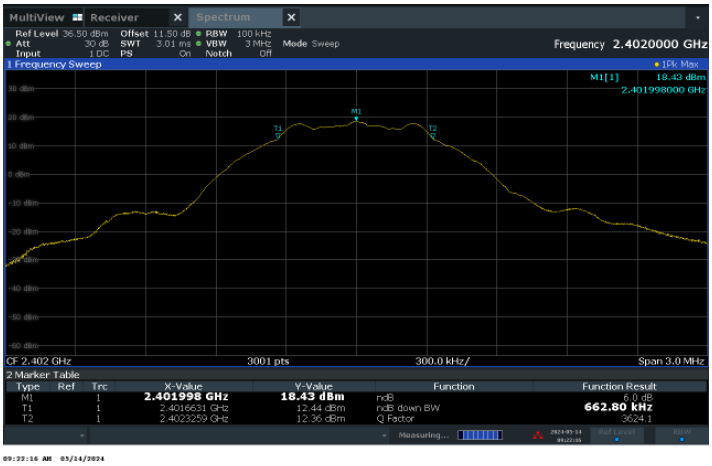



Figure 2 – 6dB Bandwidth – 2402 MHz

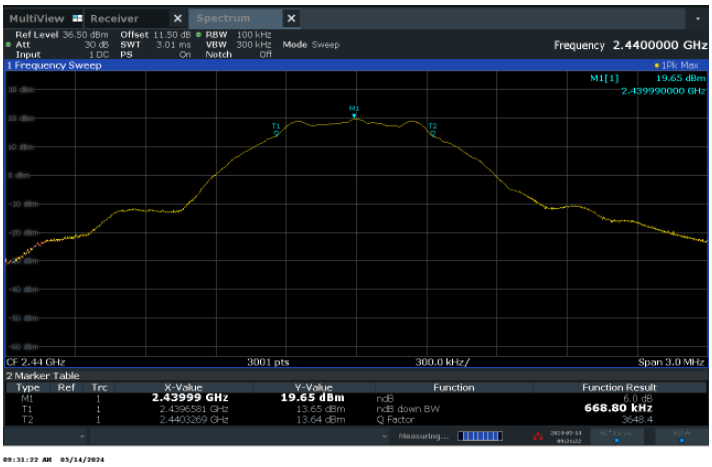



Figure 3 – 6dB Bandwidth – 2440 MHz

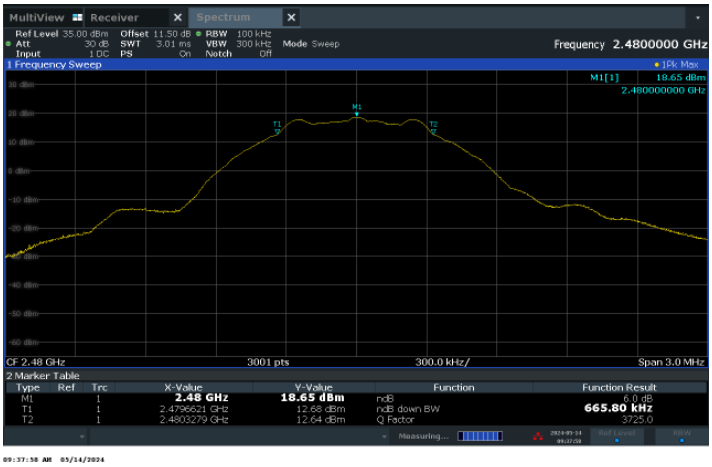



Figure 4 – 6dB Bandwidth – 2480 MHz


Figure 5 – 99% Bandwidth – 2402 MHz

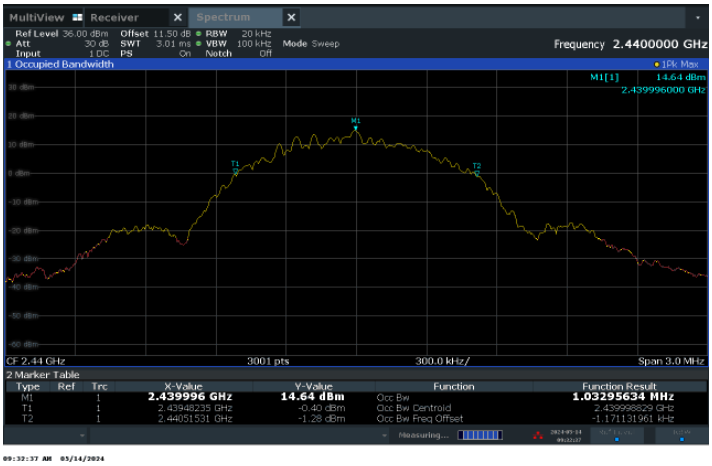



Figure 6 – 99% Bandwidth – 2440 MHz

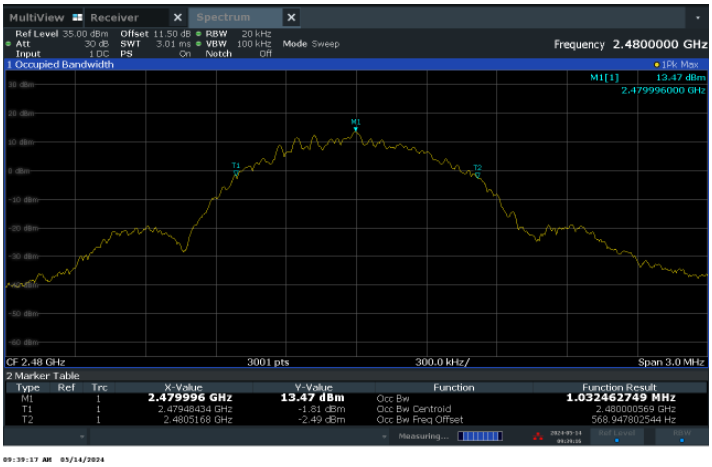



Figure 7 – 99% Bandwidth – 2480 MHz

### *4.1.3.2. 2 MBPS Plots*

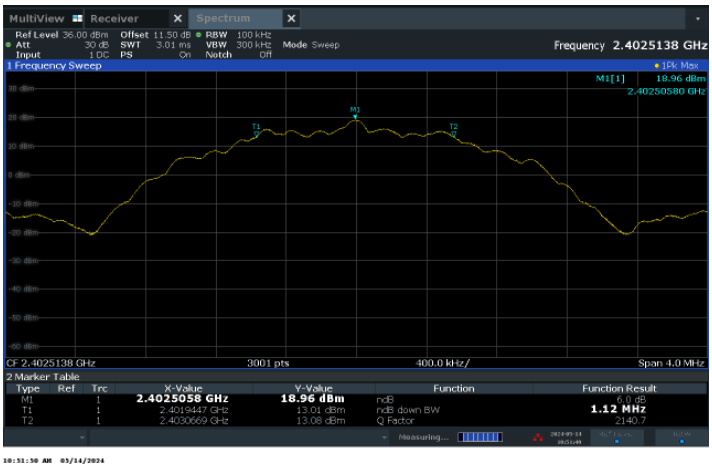



Figure 8 – 6dB Bandwidth – 2402 MHz

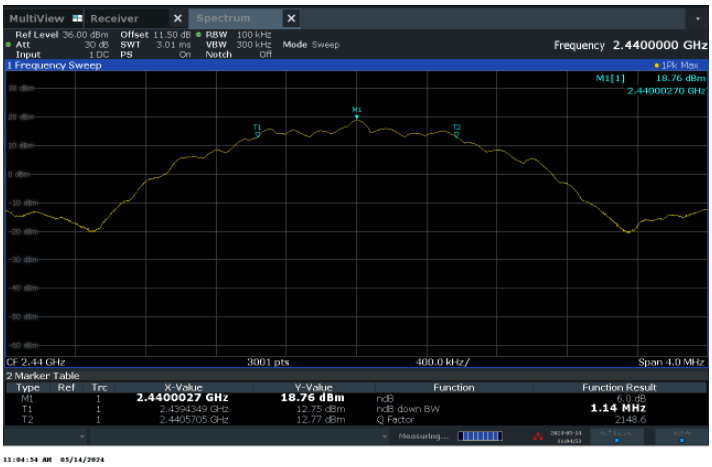



Figure 9 – 6dB Bandwidth – 2440 MHz

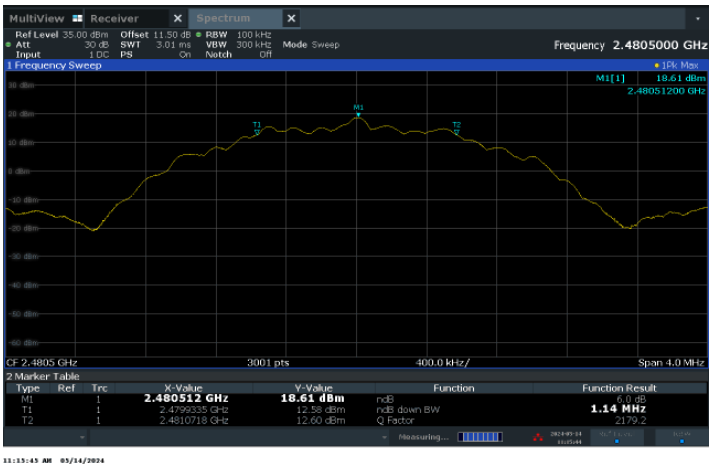



Figure 10 – 6dB Bandwidth – 2480 MHz

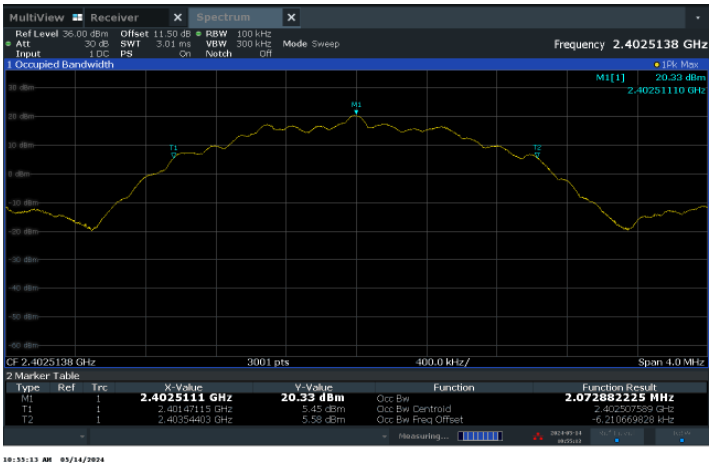



Figure 11 – 99% Bandwidth – 2402 MHz

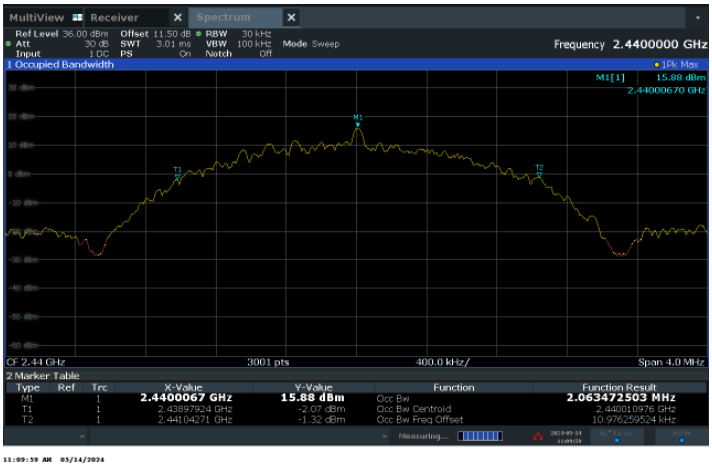



Figure 12 – 99% Bandwidth – 2440 MHz

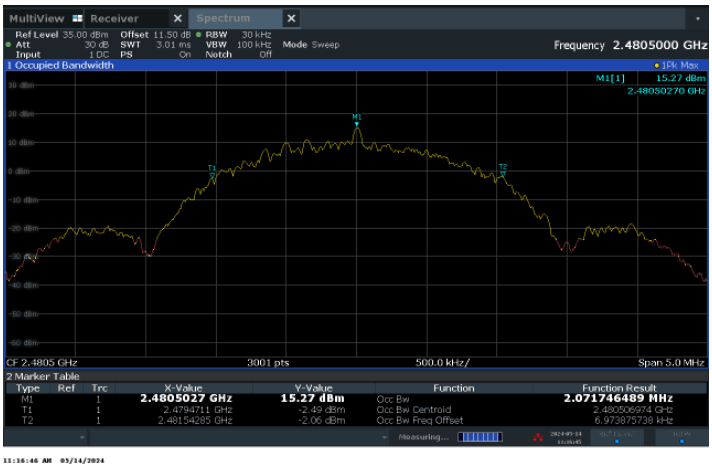



Figure 13 – 99% Bandwidth – 2480 MHz

### 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 Peak Conducted Output Power

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

### 4.2.1 Limits

The maximum peak 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. The maximum conducted output power is the highest total transmit power occurring in any mode.

### 4.2.2 Test Procedure

Tested according to ANSI C63.10 Section 11.9.1.

The test was performed using a spectrum analyzer with a resolution bandwidth greater than the DTS bandwidth.

a) Set RBW ≥ DTS Bandwidth 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.

### 4.2.3 Test Results

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

| 1 MBPS | | | | | |
|---|---|---|---|---|---|
| **Channel** | **Frequency (MHz)** | **Peak Power (dBm)** | **Peak Power (mW)** | **Limit (dBm)** | **Test Result** |
| Low | 2402 | 18.55 | 71.61 | 30 | Pass |
| Mid | 2440 | 19.62 | 91.62 | 30 | Pass |
| High | 2480 | 20.11 | 102.57 | 30 | Pass |

| 2 MBPS | | | | | |
|---|---|---|---|---|---|
| **Channel** | **Frequency (MHz)** | **Peak Power (dBm)** | **Peak Power (mW)** | **Limit (dBm)** | **Test Result** |
| Low | 2402 | 18.79 | 75.68 | 30 | Pass |
| Mid | 2440 | 18.84 | 76.56 | 30 | Pass |
| High | 2480 | 18.69 | 73.96 | 30 | Pass |

### *4.2.3.1. 1 MBPS Plots*

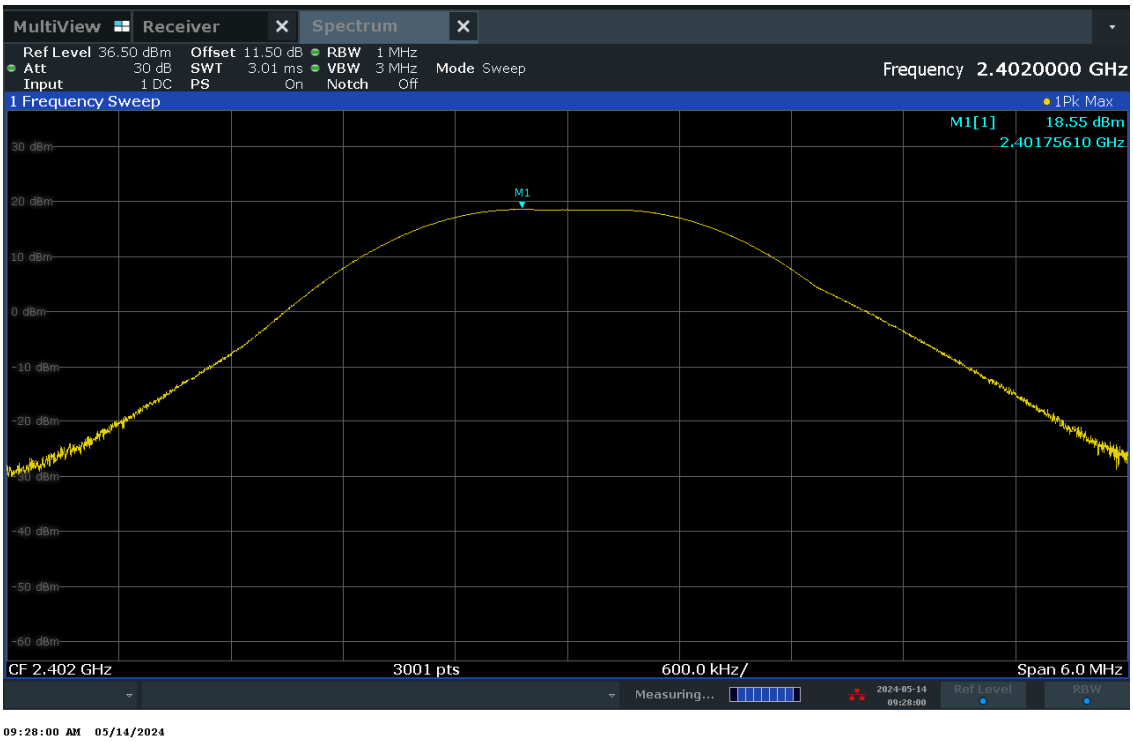



Figure 14 – Peak Power - Low Channel

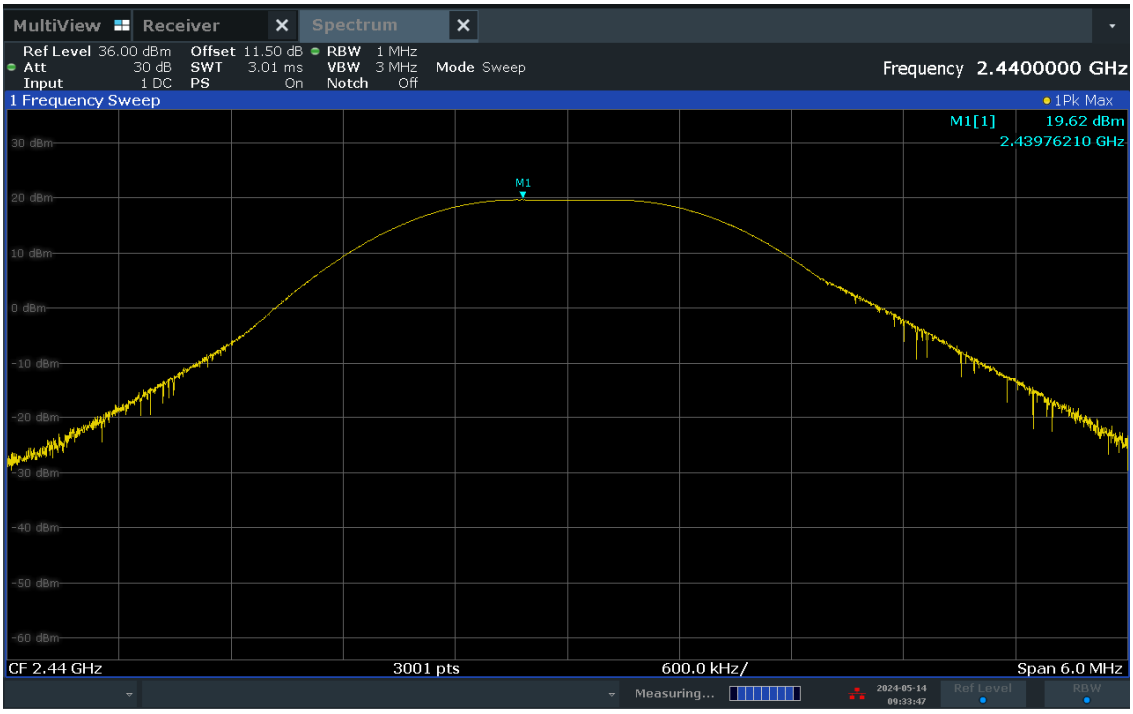



Figure 15 – Peak Power - Mid Channel

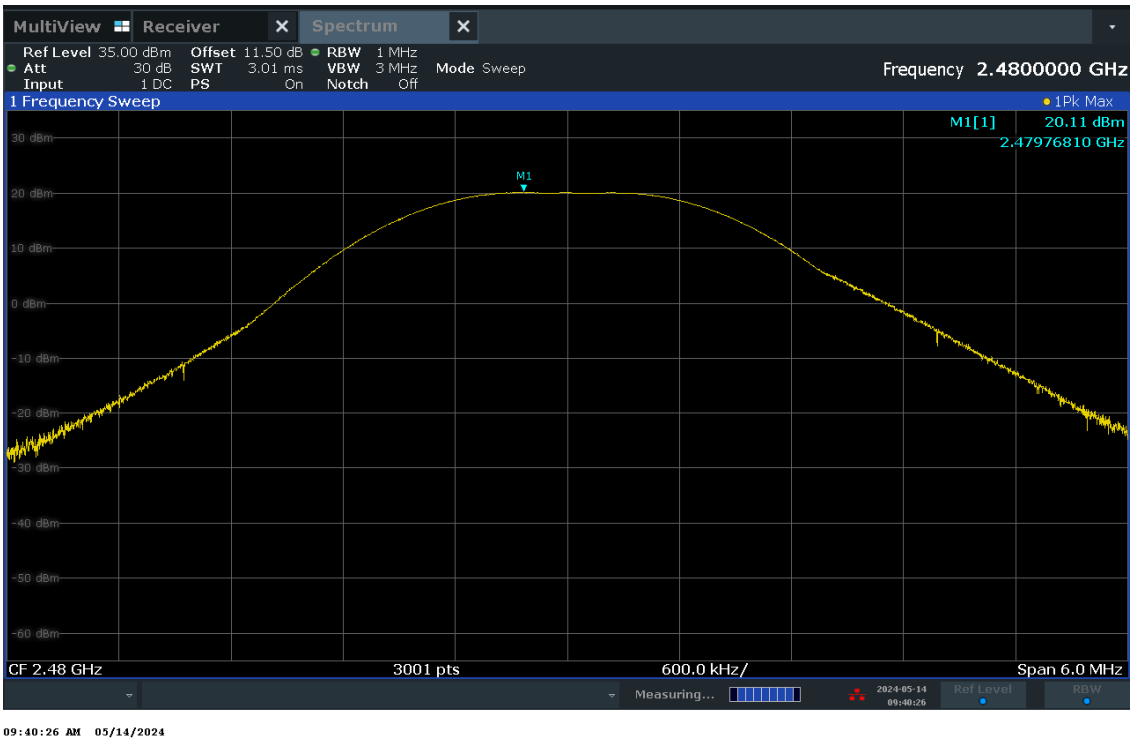



Figure 16 – Peak Power - High Channel

### *4.2.3.2. 2 MBPS Plots*

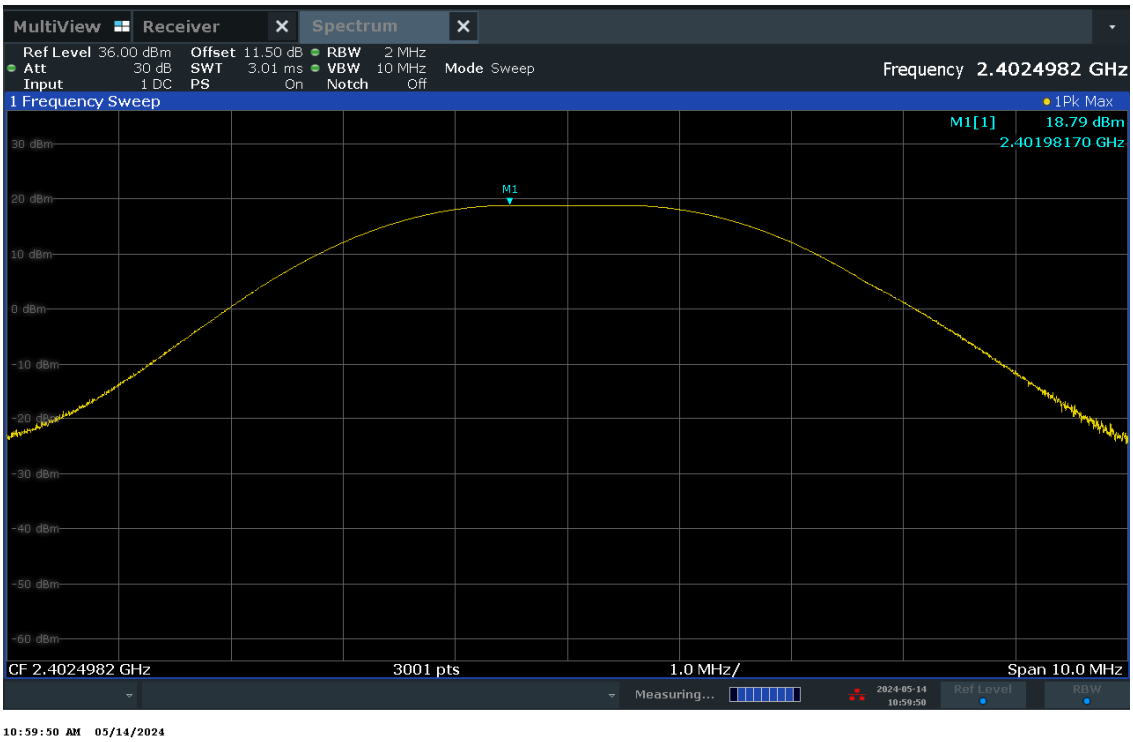



Figure 17 – Peak Power - Low Channel

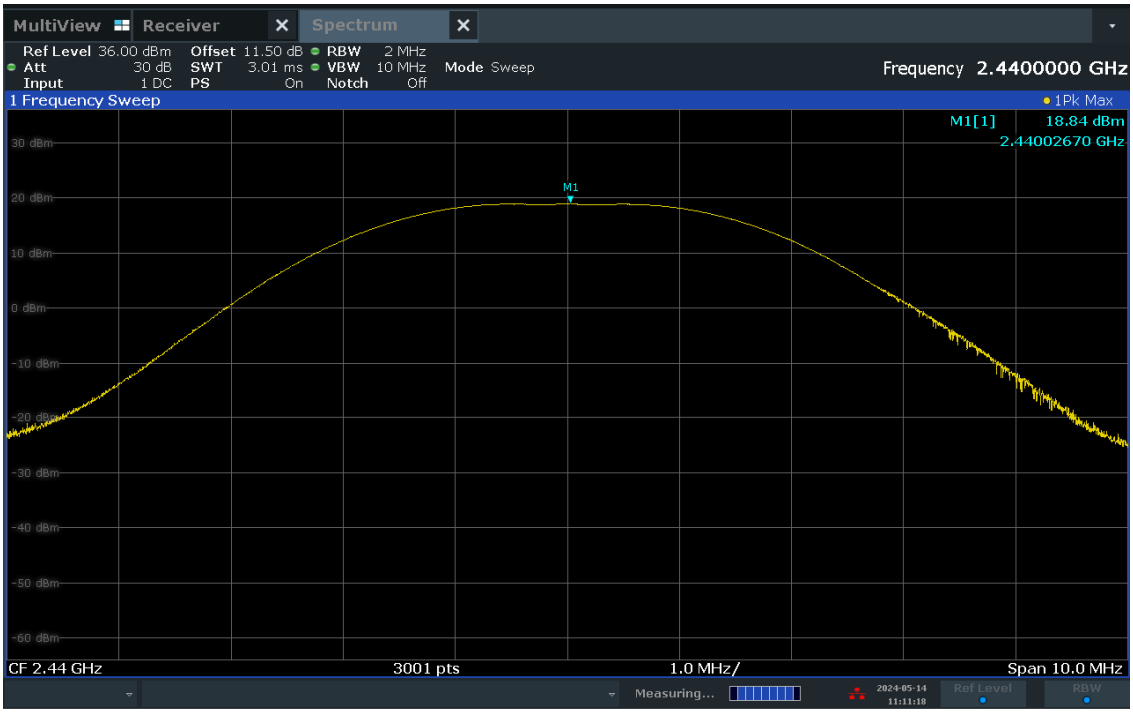



Figure 18 – Peak Power - Mid Channel

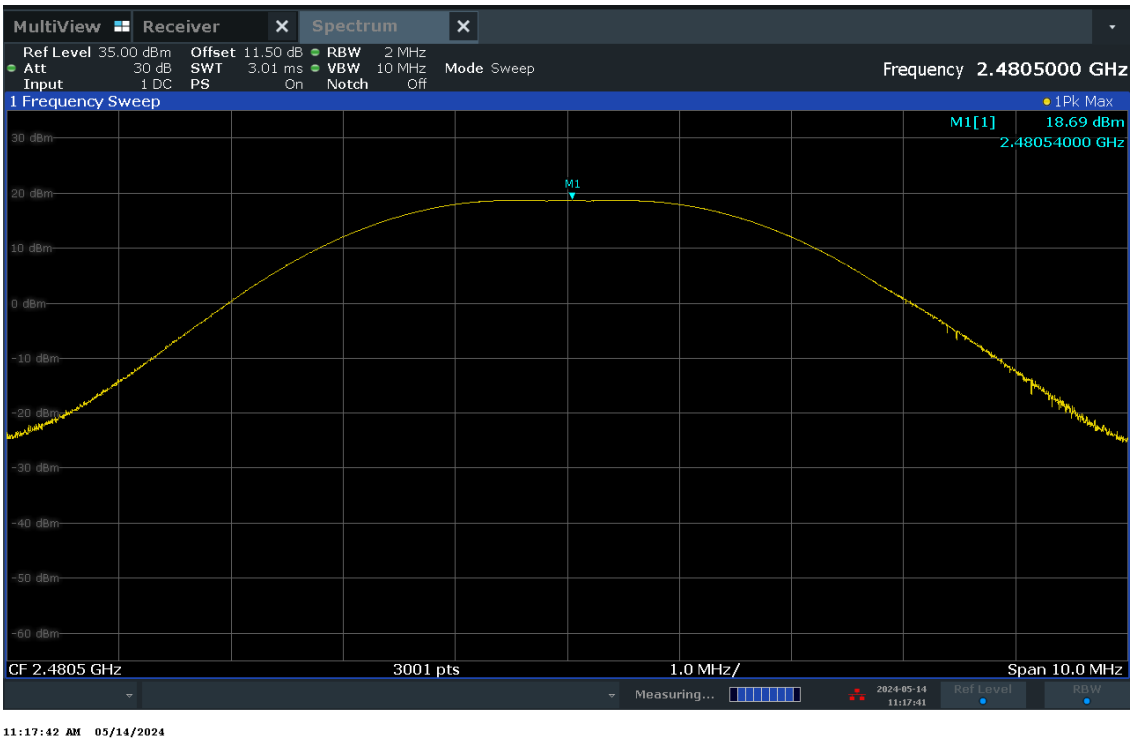



Figure 19 – Peak Power - High Channel

### 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

f) Set RBW = 3kHz and VBW ≥ [3 × RBW].
g) Set Span to 1.5 times the DTS Bandwidth.
h) Detector = Peak and Trace Mode = Max Hold.
i) Sweep = Auto Couple.
j) 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.

| 1 MBPS | | | | |
|---|---|---|---|---|
| **Channel** | **Frequency (MHz)** | **PSD (dBm)** | **Limit (dBm)** | **Test Result** |
| Low | 2402 | 5.07 | 8 | Pass |
| Mid | 2440 | 3.62 | 8 | Pass |
| High | 2480 | 4.93 | 8 | Pass |

| 2 MBPS | | | | |
|---|---|---|---|---|
| **Channel** | **Frequency (MHz)** | **PSD (dBm)** | **Limit (dBm)** | **Test Result** |
| Low | 2402 | 0.71 | 8 | Pass |
| Mid | 2440 | 0.82 | 8 | Pass |
| High | 2480 | 0.73 | 8 | Pass |

#### *4.3.3.1. 1 MBPS*

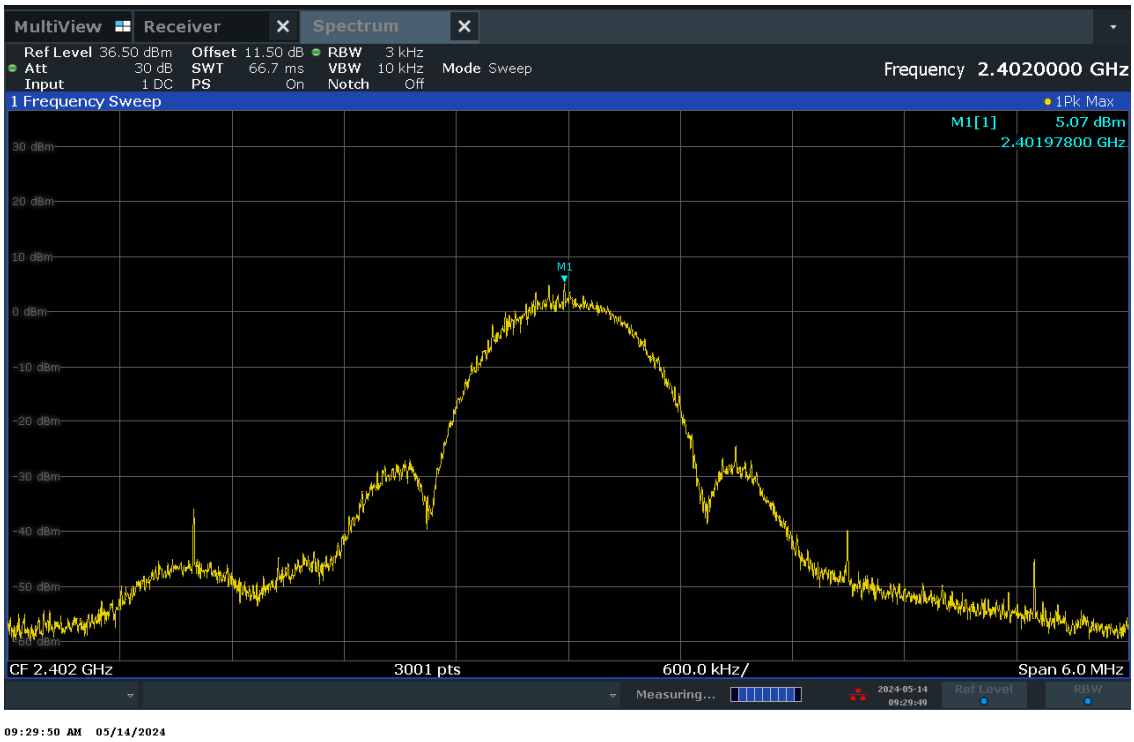



Figure 20 – PSD - Low Channel

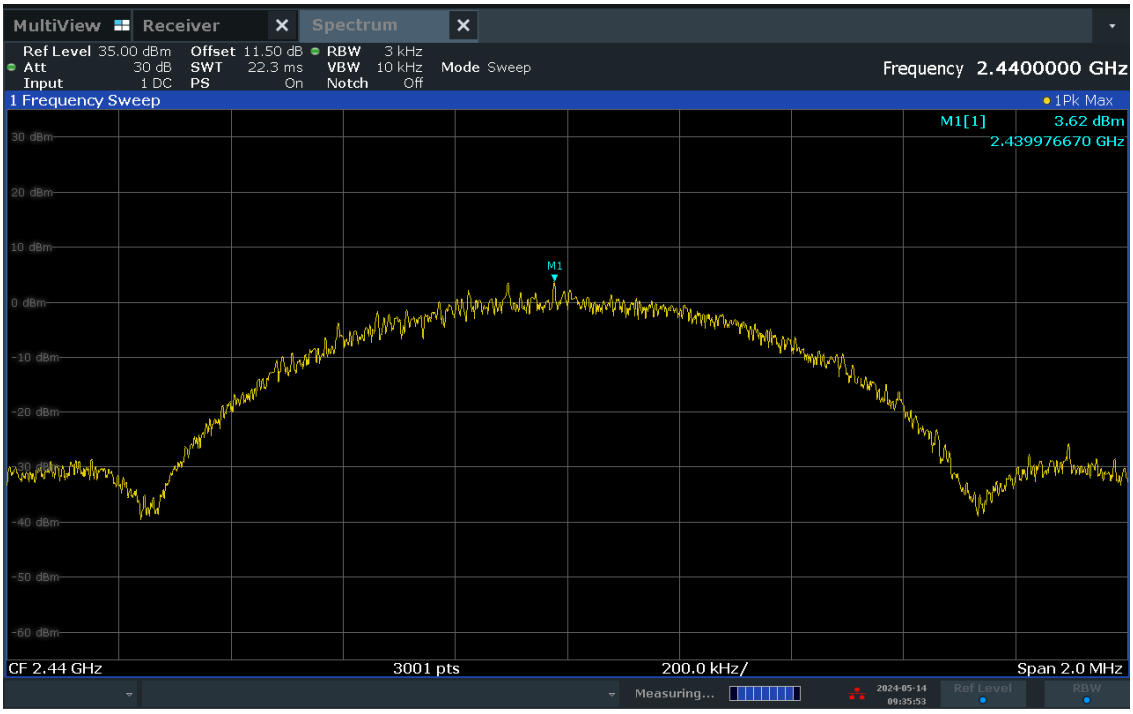



Figure 21 – PSD - Mid Channel

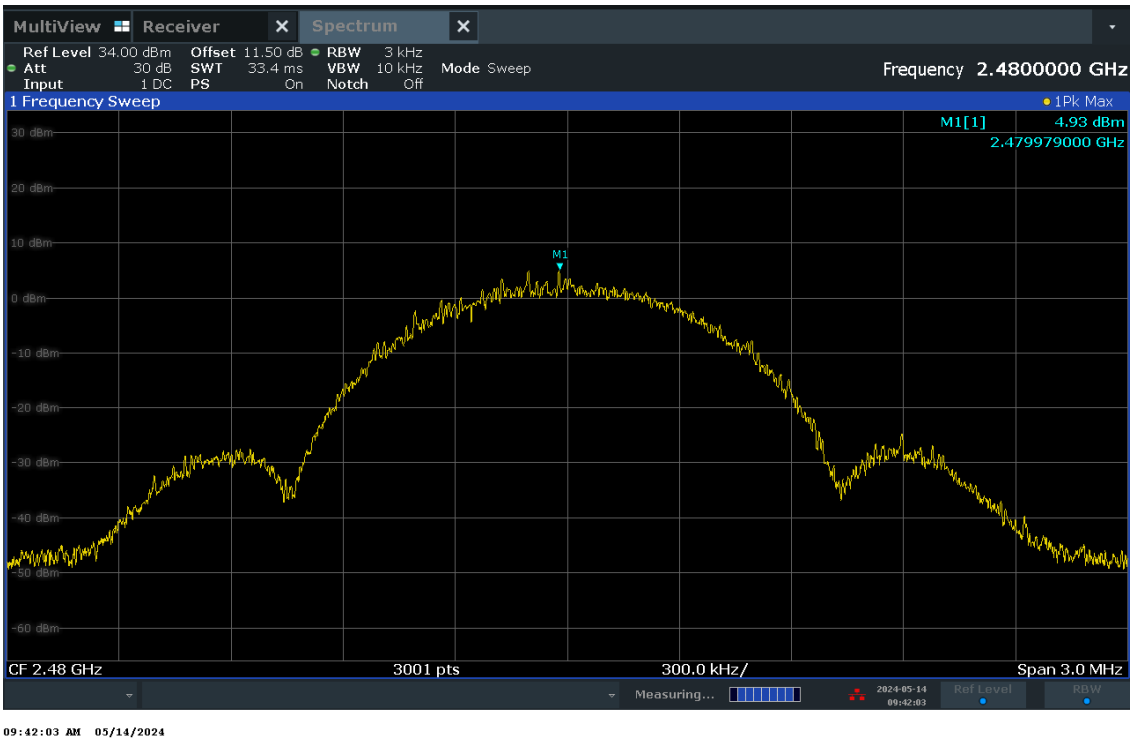



Figure 22 – PSD - High Channel

### *4.3.3.2. 2 MBPS*

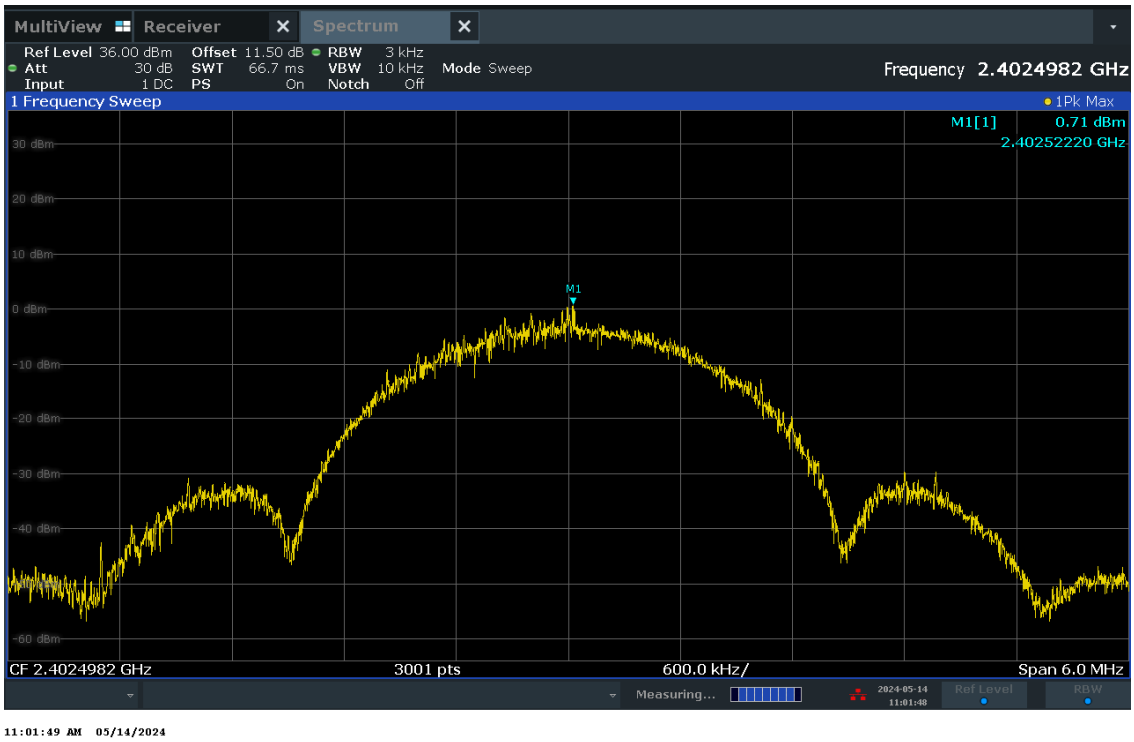



Figure 23 – PSD - Low Channel

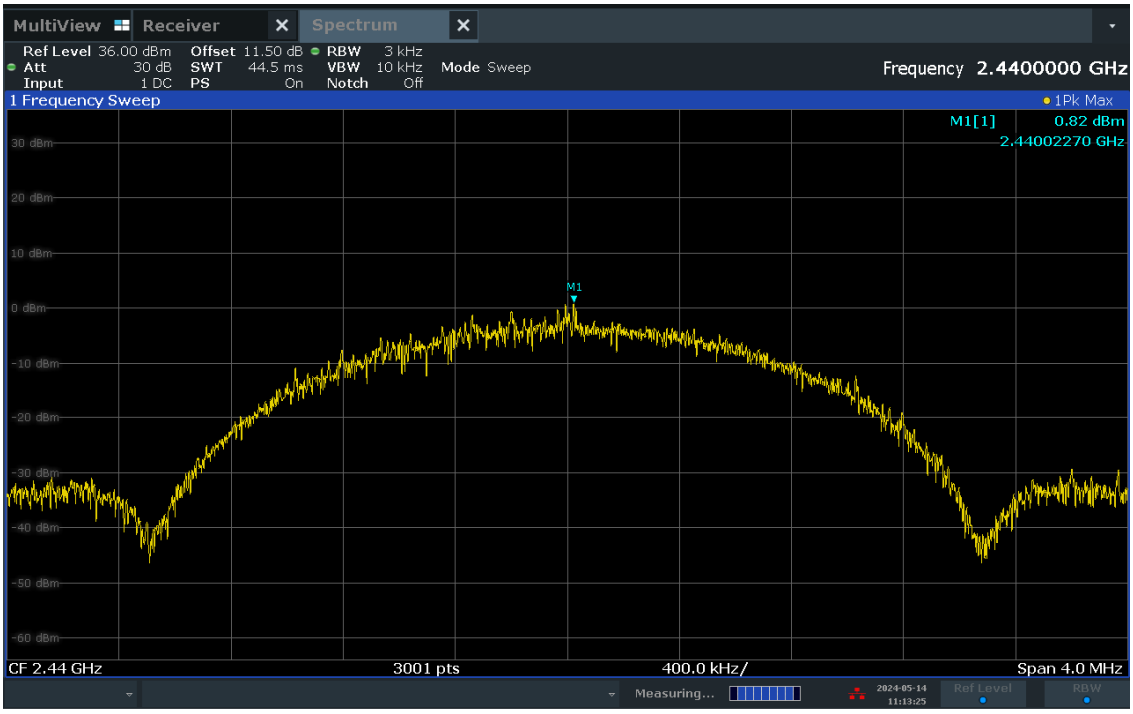



Figure 24 – PSD - Mid Channel

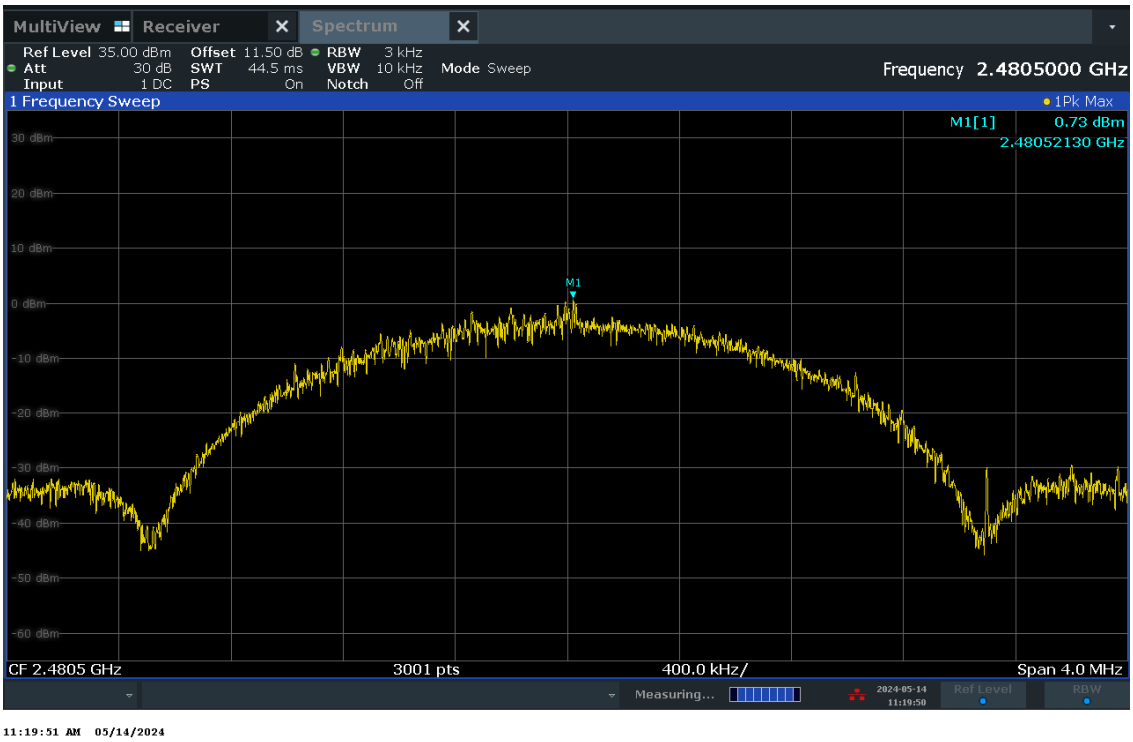



Figure 25 – PSD - High Channel

### 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 Out of Band Emissions (-20dBc)

| | | | |
|---|---|---|---|
| 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 20dB below carrier requirement for out of band emissions.

#### *4.4.3.1. 1 MBPS*

| 1 MBPS | | | |
|---|---|---|---|
| **Channel** | **Frequency (MHz)** | **Peak PSD w/ RBW=100 kHz (dBm)** | **20 dBc Limit (dBm)** |
| Low | 2402 | 18.49 | -1.51 |
| Mid | 2440 | 19.14 | -0.86 |
| High | 2480 | 19.52 | -0.48 |

The highest peak power in 100 kHz is 19.52 dBm; therefore, the 20 dBc limit is -0.48 dBm.

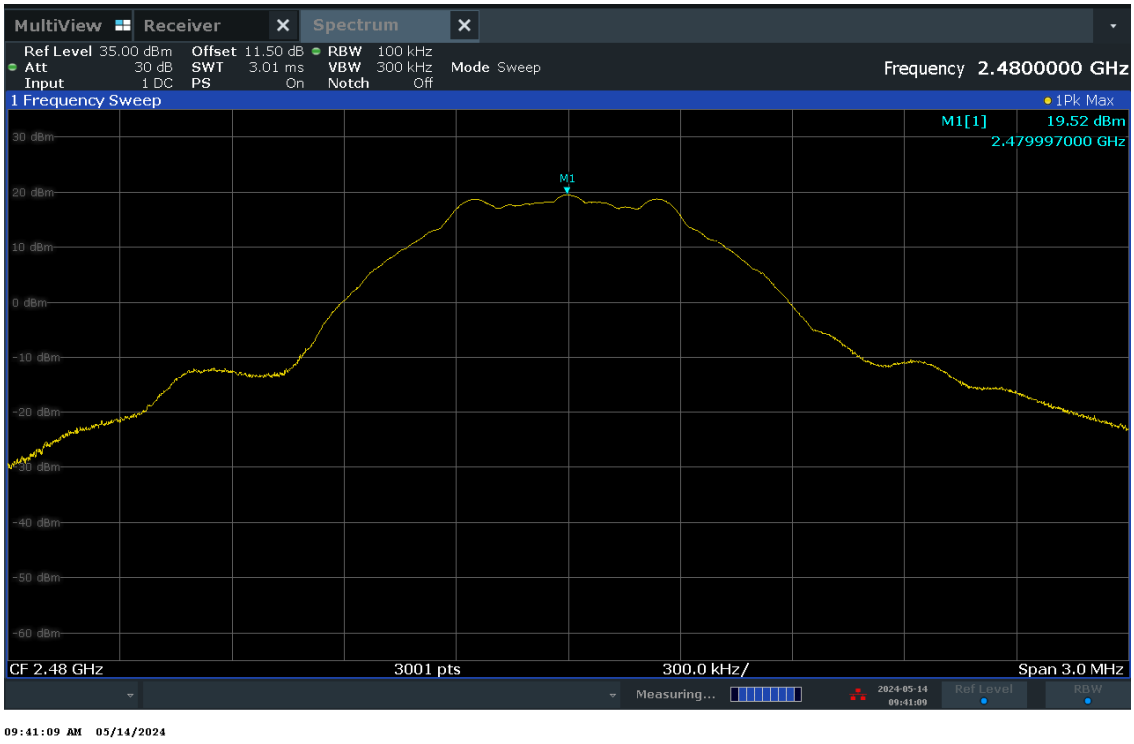



Figure 26 – -20dBc Reference Level - High Channel

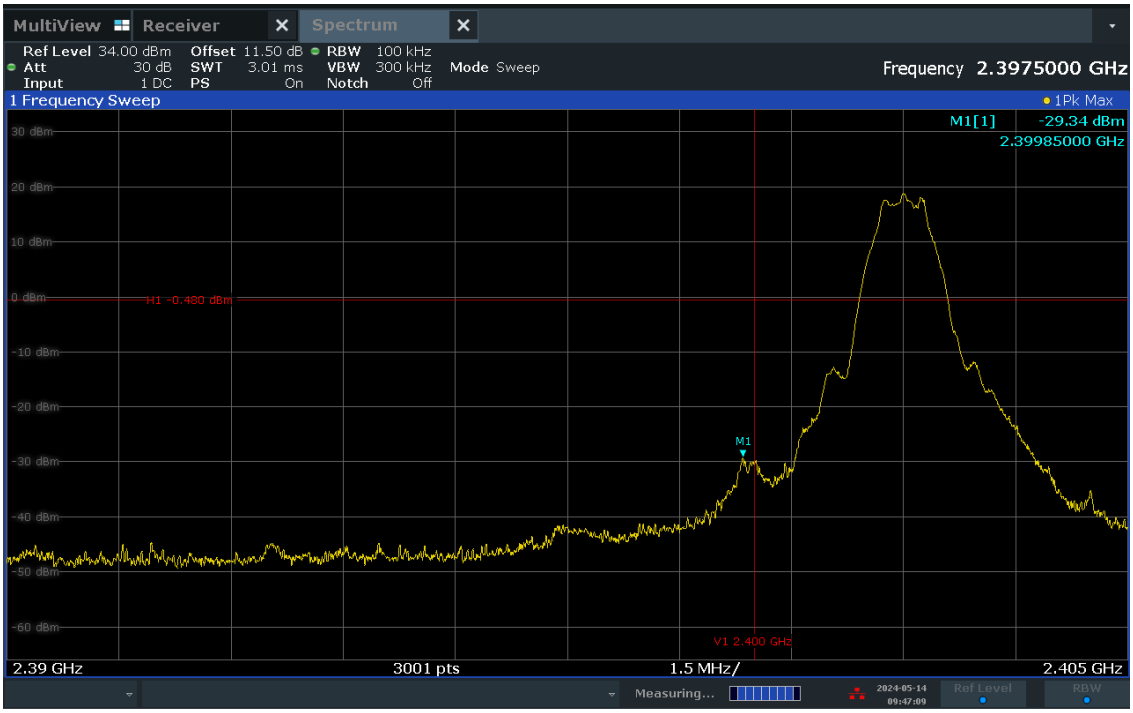



Figure 27 – -20dBc Band Edge - Low Channel

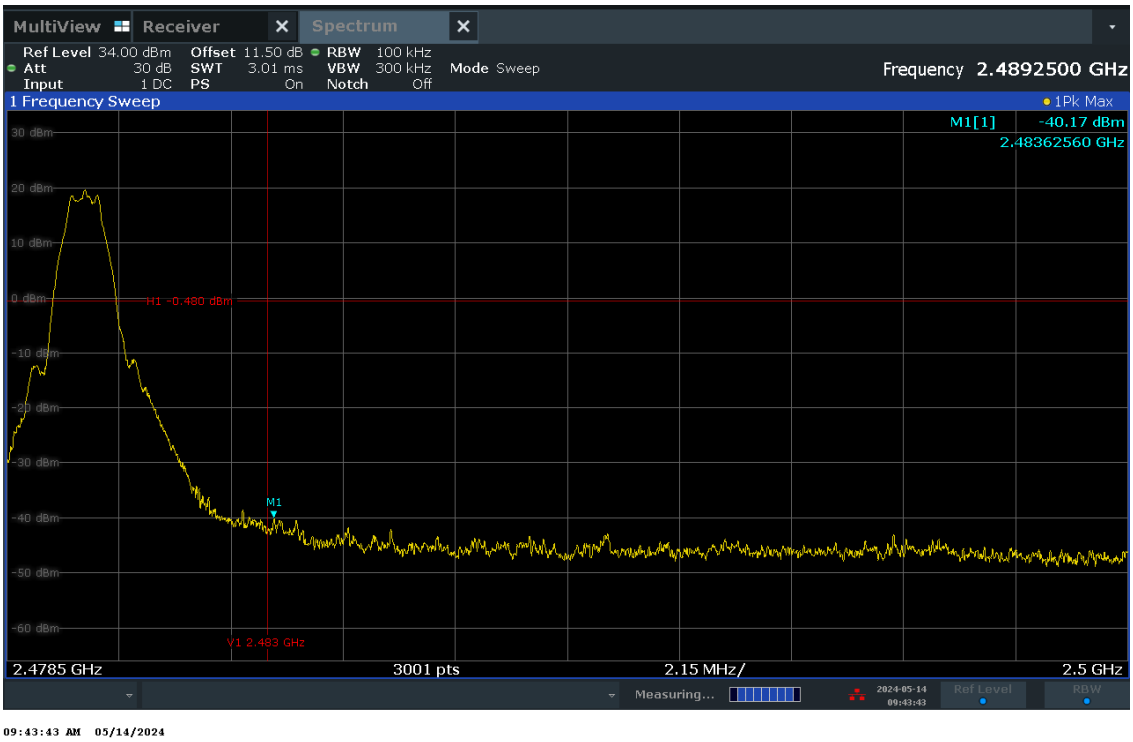



Figure 28 – -20dBc Band Edge - Low Channel

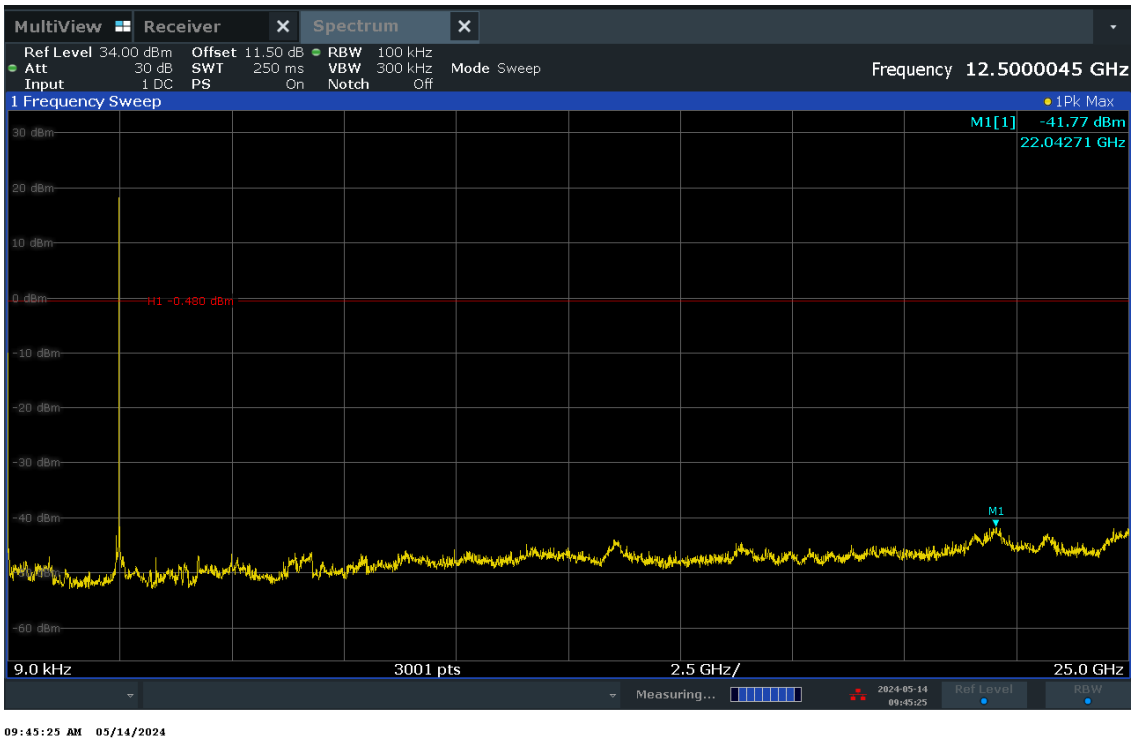



Figure 29 – -20dBc Low Channel 9kHz – 25 GHz

#### *4.4.3.2. 2 MBPS*

| 2 MBPS | | | |
|---|---|---|---|
| **Channel** | **Frequency (MHz)** | **Peak PSD w/ RBW=100 kHz (dBm)** | **20 dBc Limit (dBm)** |
| Low | 2402 | 18.67 | -1.33 |
| Mid | 2440 | 18.87 | -1.13 |
| High | 2480 | 18.86 | -1.14 |

The highest peak power in 100 kHz is 18.86 dBm; therefore, the 20 dBc limit is -1.14 dBm.

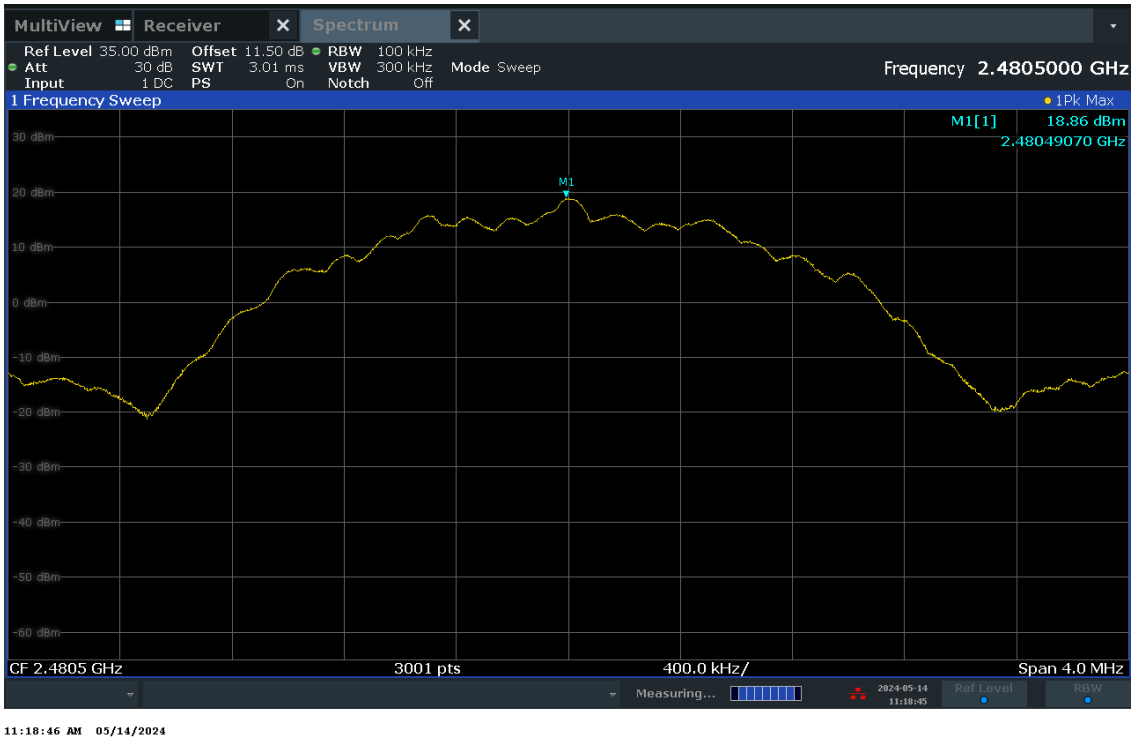



Figure 30 – -20dBc Reference Level - High Channel

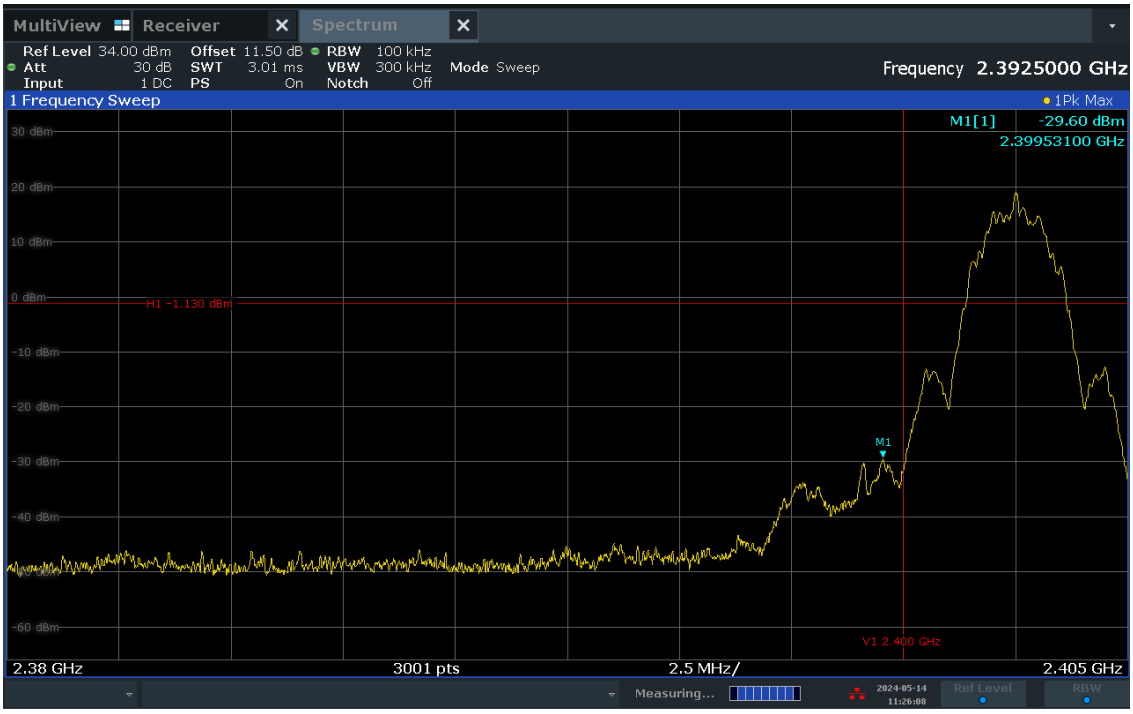



Figure 31 – -20dBc Band Edge - Low Channel

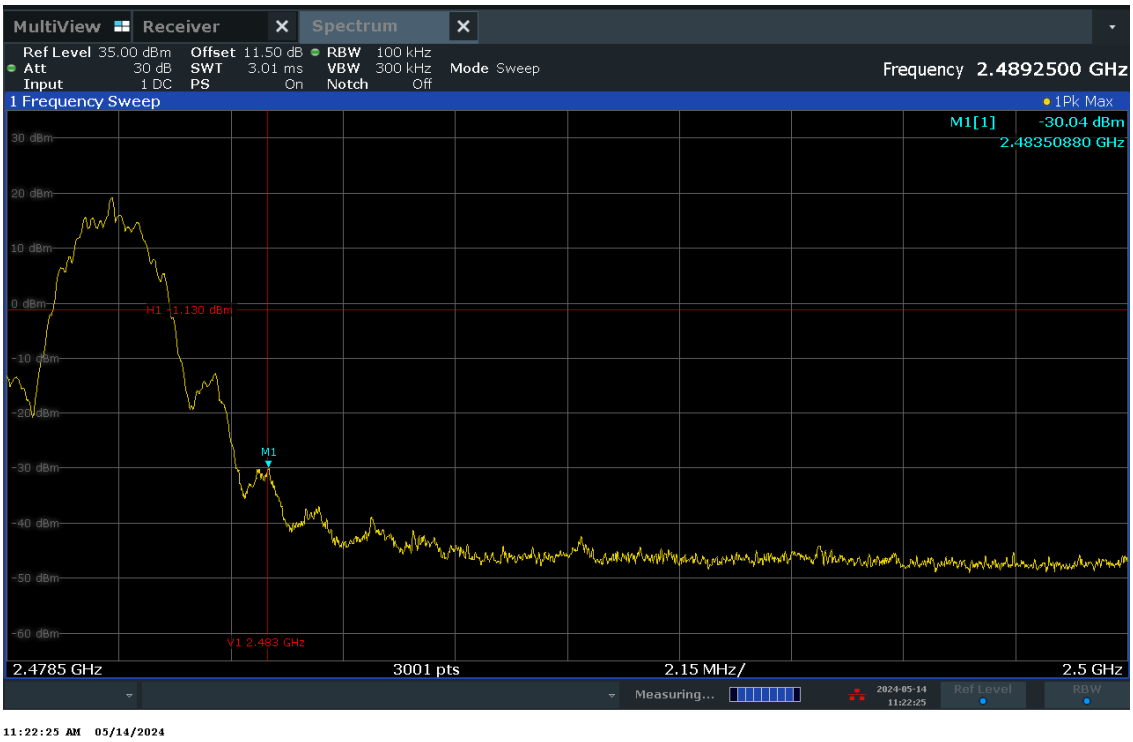



Figure 32 – -20dBc Band Edge - Low Channel

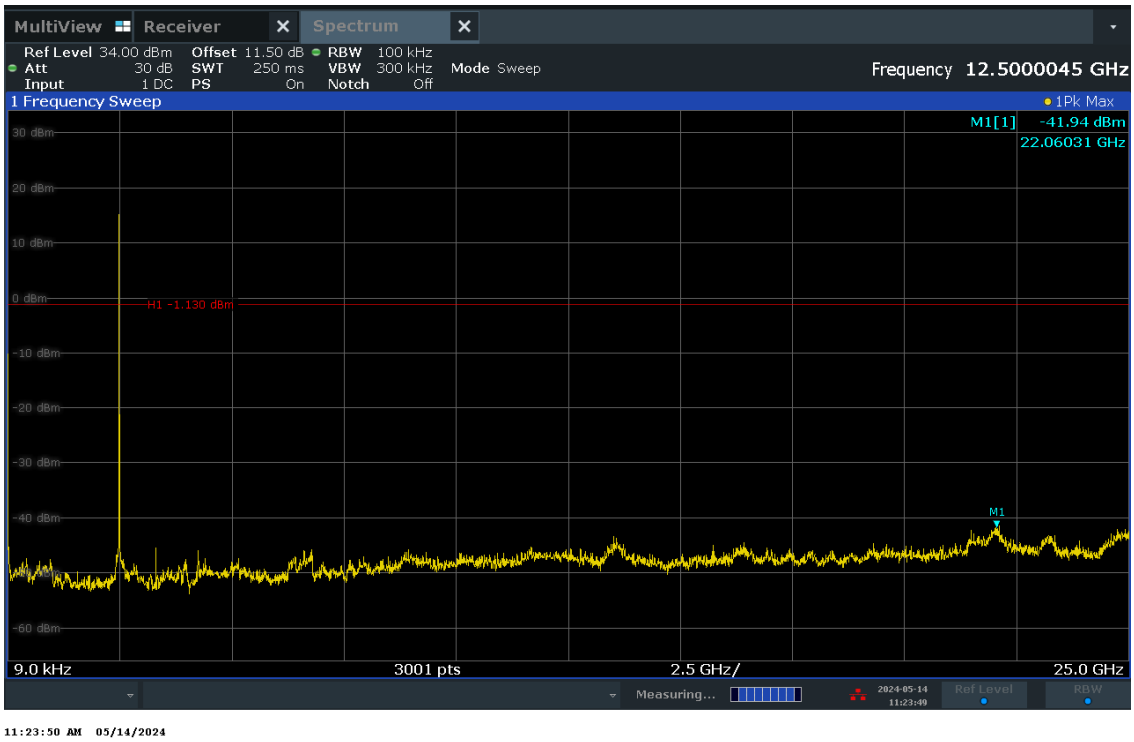



Figure 33 – -20dBc Low Channel 9kHz – 25 GHz

### 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.

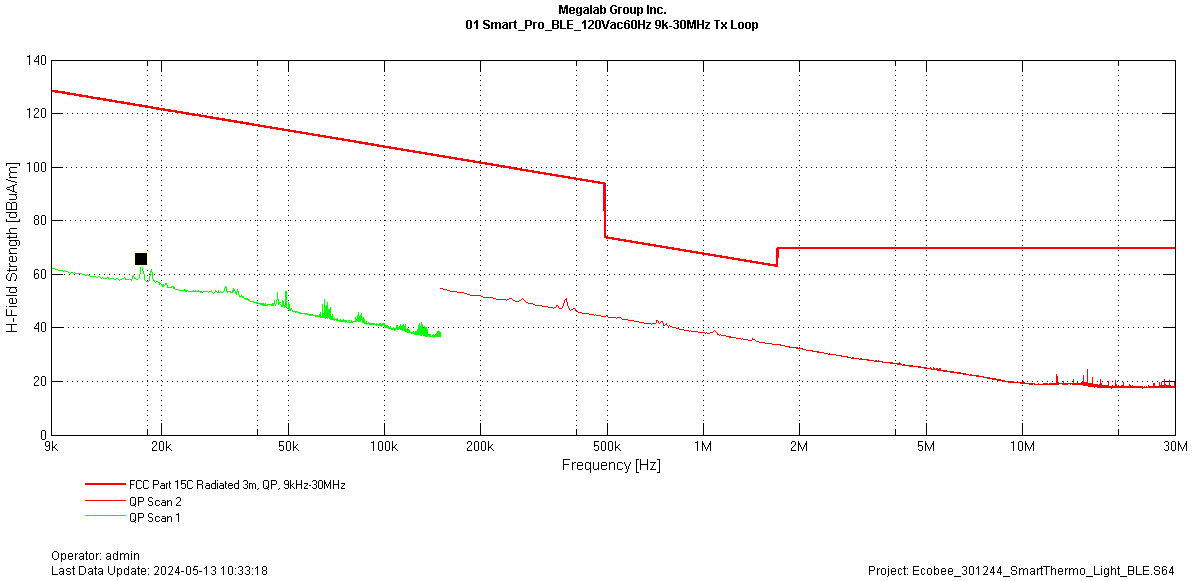
For each suspected emission, final measurements of the DUT radiated emissions with the Quasi-Peak, Average or Peak detector, as defined in the limit tables above, were made with the turntable azimuth rotated 0° to 360° and antenna height varied from 1m to 4m. The antenna was positioned to receive emissions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

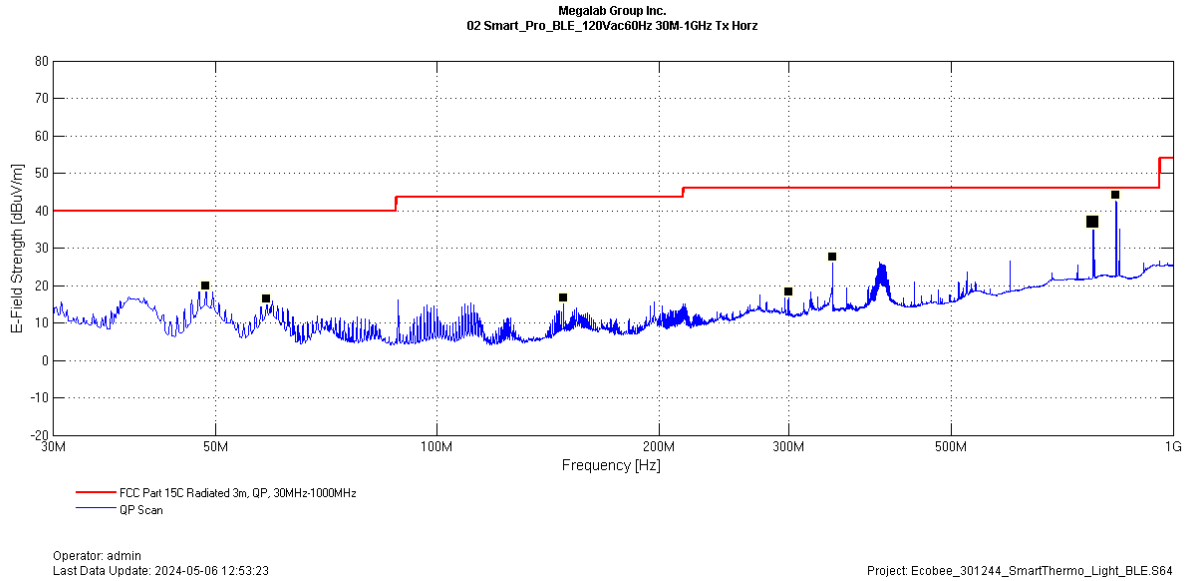
### 4.5.3 Test Results

| **Range:** | 9kHz to 30 MHz | **Tx Frequency** | 2480 MHz |
|---|---|---|---|
| **Test Voltage:** | 24Vac 60Hz | **Antenna Polarization** | XZ-Plane |



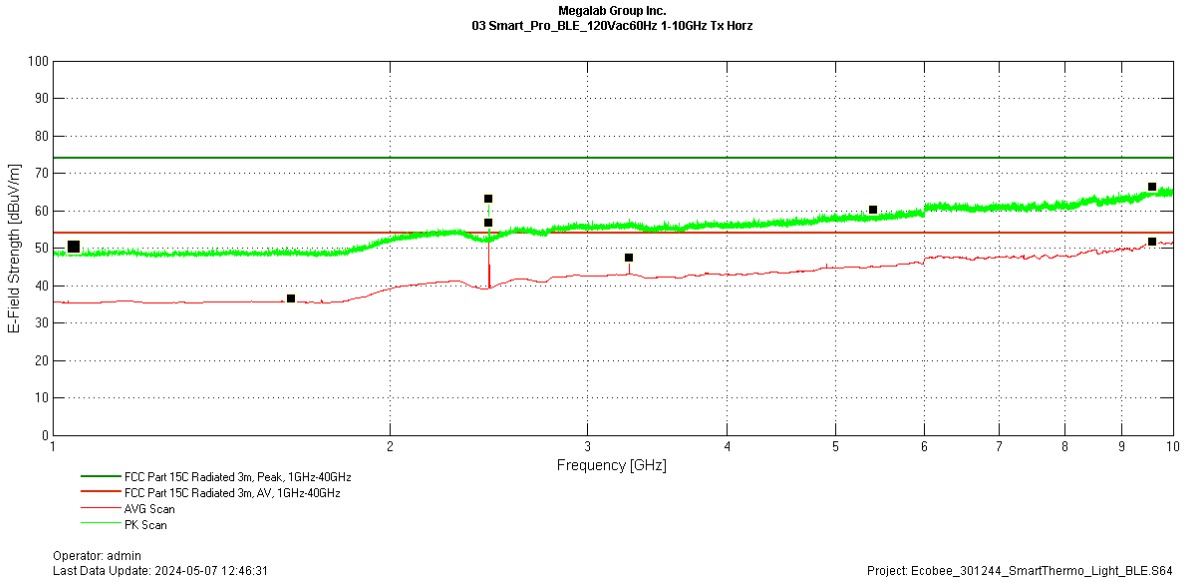

Remark: Quasi-Peak Emission Plot

| **Range:** | 30MHz to 1GHz | **Tx Frequency** | 2480 MHz |
|---|---|---|---|
| **Test Voltage:** | 24Vac 60Hz | **Antenna Polarization** | Horizontal |



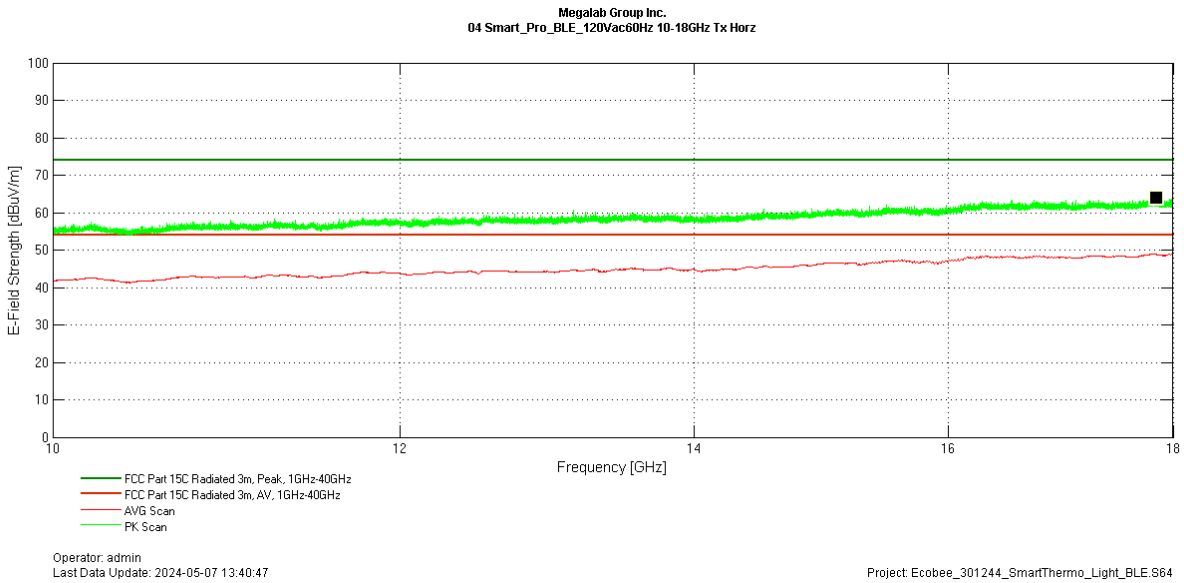

Remark: - Quasi-Peak Emission Plot
- A Notch filter was used to filter out the fundamental

| **Range:** | 1GHz to 10GHz | **Tx Frequency** | 2480 MHz |
|---|---|---|---|
| **Test Voltage:** | 24Vac 60Hz | **Antenna Polarization** | Horizontal |



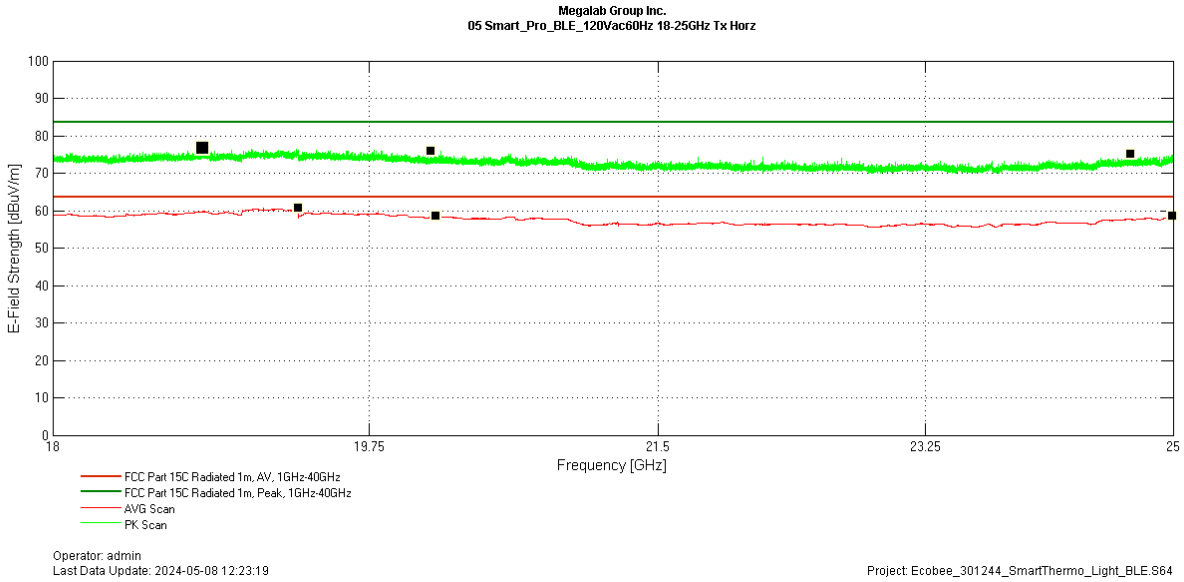

Remark: - Peak and Average Emission Plot
- A Notch filter was used to filter out the fundamental

| **Range:** | 10GHz to 18GHz | **Tx Frequency** | 2480 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 | 2480 MHz |
|---|---|---|---|
| Test Voltage: | 24Vac 60Hz | Antenna Polarization | Horizontal |

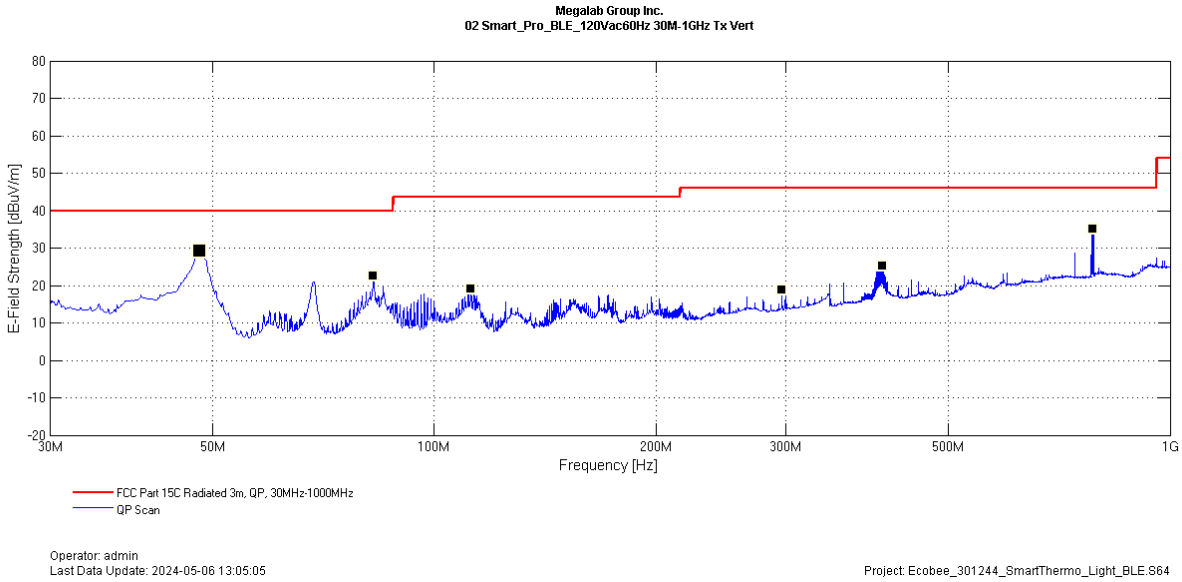



Remark: - Peak and Average Emission Plot

| Horizontal Antenna Polarization | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Detector** | **Reading (dBµV)** | **Correction Factor (dB)** | **Emission Level (dBµV/m)** | **Limit (dBµV/m)** | **Margin (dB)** | **Test Result** |
| 836.20 | QP | 41.6 | 2.4 | 44.1 | 46.0 | 2.0 | Pass |
| 778.00 | QP | 35.2 | 1.8 | 37.0 | 9.0 | 9.0 | Pass |
| 344.25 | QP | 34.2 | -6.6 | 27.6 | 46.0 | 18.4 | Pass |
| 48.50 | QP | 35.7 | -15.8 | 20.0 | 40.0 | 20.0 | Pass |
| 58.60 | QP | 32.2 | -15.9 | 16.3 | 40.0 | 23.7 | Pass |
| 148.50 | QP | 30.0 | -13.2 | 16.8 | 43.5 | 26.7 | Pass |

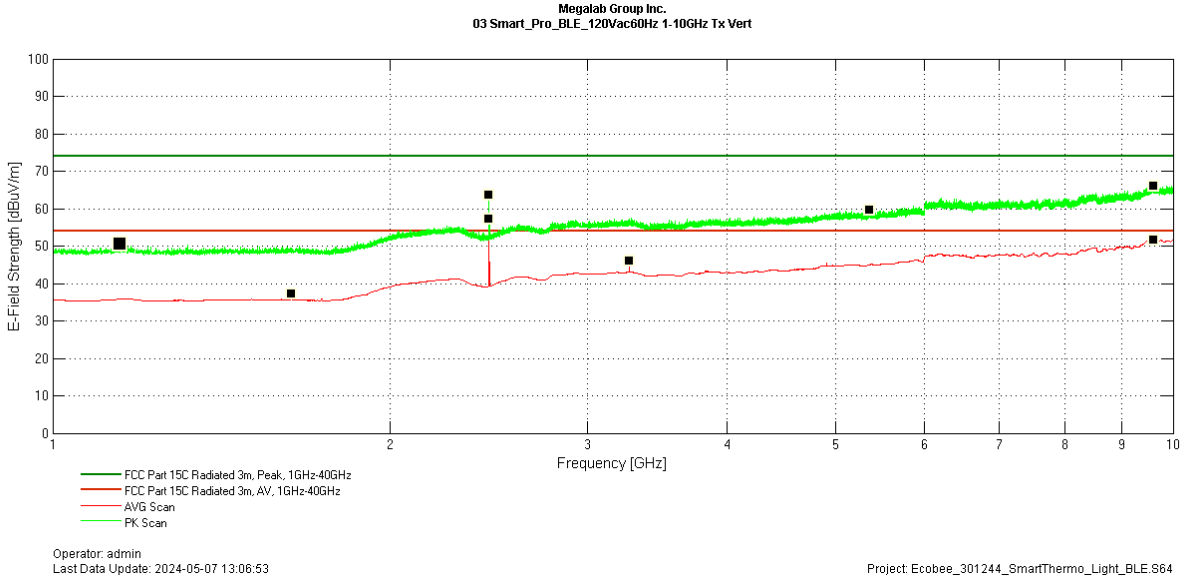
| Horizontal Antenna Polarization – Harmonic Emissions | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency (MHz)** | **Detector** | **Reading (dBµV)** | **Correction Factor (dB)** | **Emission Level (dBµV/m)** | **Limit (dBµV/m)** | **Margin (dB)** | **Test Result** |
| **Low Channel** | | | | | | | |
| 4804 | PEAK | 49.9 | 0.8 | 50.7 | 74.0 | 23.3 | Pass |
| 4804 | AVG | 42.2 | 0.8 | 43.0 | 54.0 | 11.0 | Pass |
| 7206 | PEAK | 47.4 | 4.0 | 51.4 | 74.0 | 22.6 | Pass |
| 7206 | AVG | 36.3 | 4.0 | 40.3 | 54.0 | 13.7 | Pass |
| **Mid Channel** | | | | | | | |
| 4880 | PEAK | 49.8 | 1.1 | 50.9 | 74.0 | 23.1 | Pass |
| 4880 | AVG | 42.1 | 1.1 | 43.2 | 54.0 | 10.8 | Pass |
| 7320 | PEAK | 47.6 | 4.2 | 51.9 | 74.0 | 22.1 | Pass |
| 7320 | AVG | 36.3 | 4.2 | 40.5 | 54.0 | 13.5 | Pass |
| **High Channel** | | | | | | | |
| 4960 | PEAK | 48.9 | 1.4 | 50.3 | 74.0 | 23.7 | Pass |
| 4960 | AVG | 36.4 | 1.4 | 37.8 | 54.0 | 16.2 | Pass |
| 7440 | PEAK | 48.6 | 4.5 | 53.0 | 74.0 | 21.0 | Pass |
| 7440 | AVG | 36.7 | 4.5 | 41.2 | 54.0 | 12.8 | Pass |

| **Range:** | 30MHz to 1GHz | **Tx Frequency** | 2480 MHz |
|---|---|---|---|
| **Test Voltage:** | 24Vac 60Hz | **Antenna Polarization** | Vertical |



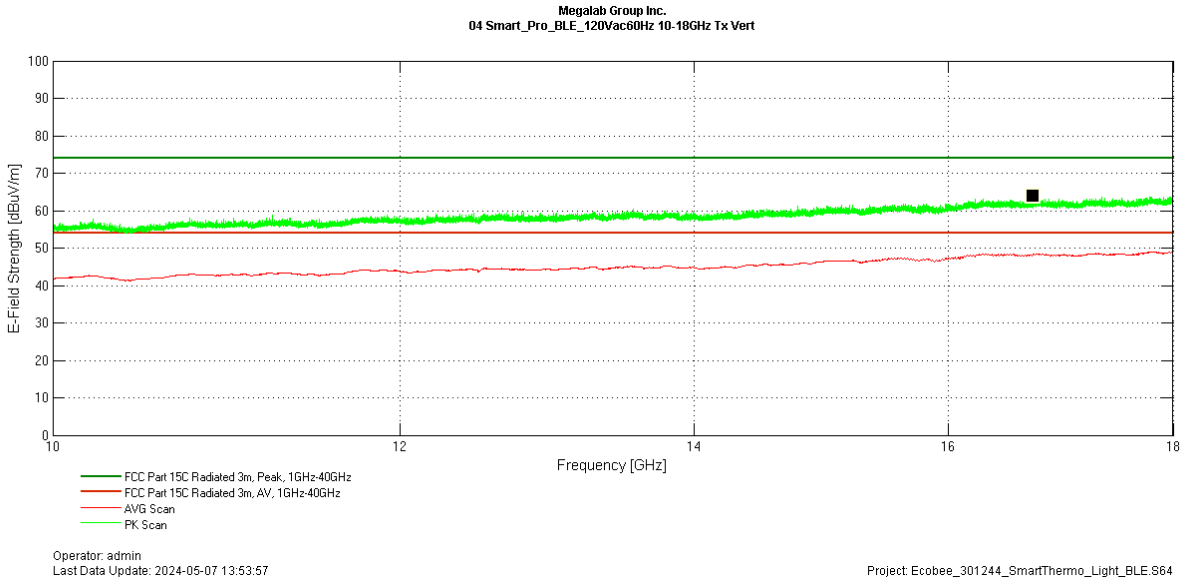

Remark: - Quasi-Peak Emission Plot
- A Notch filter was used to filter out the fundamental

| **Range:** | 1GHz to 10GHz | **Tx Frequency** | 2480 MHz |
|---|---|---|---|
| **Test Voltage:** | 24Vac 60Hz | **Antenna Polarization** | Vertical |



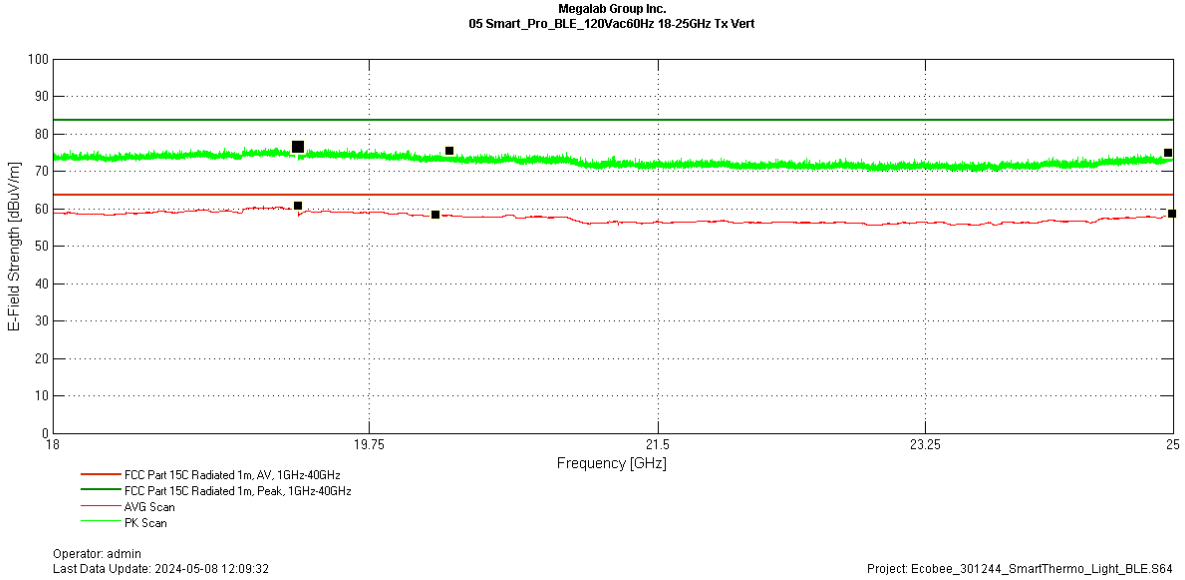

Remark: - Peak and Average Emission Plot
- A Notch filter was used to filter out the fundamental

| **Range:** | 10GHz to 18GHz | **Tx Frequency** | 2480 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** | 2480 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 |
| 48.00 | QP | 44.7 | -15.6 | 29.1 | 40.0 | 10.9 | Pass |
| 786.30 | QP | 33.0 | 2.0 | 35.0 | 46.0 | 11.0 | Pass |
| 82.65 | QP | 38.0 | -15.5 | 22.4 | 40.0 | 17.6 | Pass |
| 406.10 | QP | 28.9 | -3.7 | 25.2 | 46.0 | 20.8 | Pass |

| 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** | | | | | | | |
| 4804 | PEAK | 49.7 | 0.8 | 50.5 | 74.0 | 23.5 | Pass |
| 4804 | AVG | 41.8 | 0.8 | 42.5 | 54.0 | 11.5 | Pass |
| 7206 | PEAK | 47.8 | 4.0 | 51.8 | 74.0 | 22.2 | Pass |
| 7206 | AVG | 36.1 | 4.0 | 40.1 | 54.0 | 13.9 | Pass |
| **Mid Channel** | | | | | | | |
| 4880 | PEAK | 50.0 | 1.1 | 51.1 | 74.0 | 22.9 | Pass |
| 4880 | AVG | 41.5 | 1.1 | 42.6 | 54.0 | 11.4 | Pass |
| 7320 | PEAK | 47.2 | 4.2 | 51.4 | 74.0 | 22.6 | Pass |
| 7320 | AVG | 35.3 | 4.2 | 39.5 | 54.0 | 14.5 | Pass |
| **High Channel** | | | | | | | |
| 4960 | PEAK | 48.3 | 1.4 | 49.7 | 74.0 | 24.3 | Pass |
| 4960 | AVG | 37.3 | 1.4 | 38.7 | 54.0 | 15.3 | Pass |
| 7440 | PEAK | 48.8 | 4.5 | 53.3 | 74.0 | 20.7 | Pass |
| 7440 | AVG | 36.8 | 4.5 | 41.2 | 54.0 | 12.8 | 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.

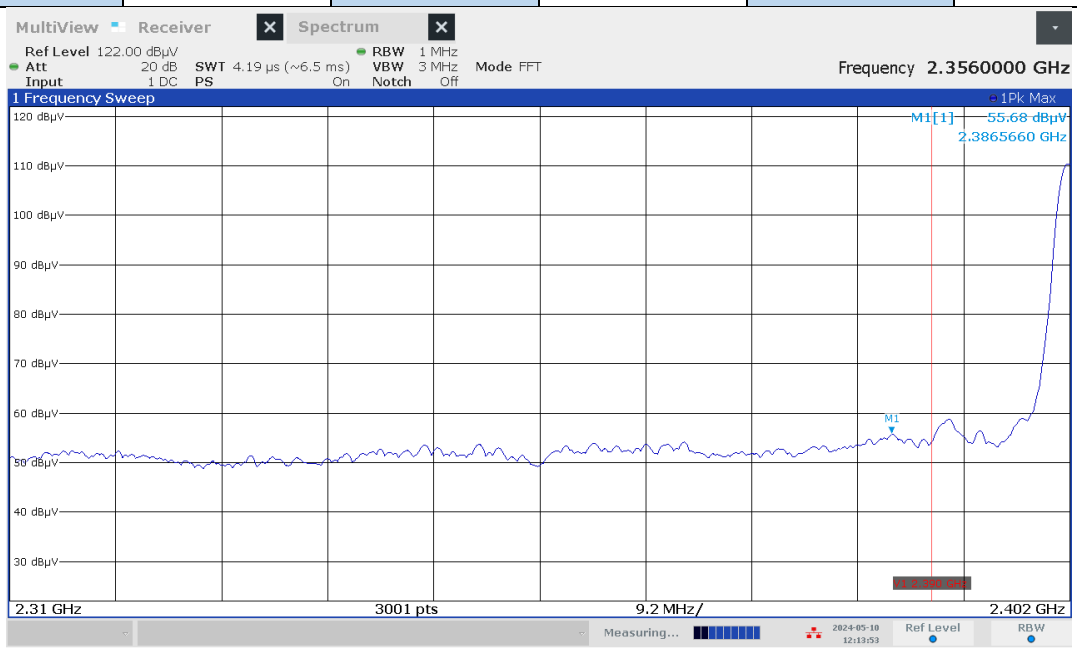
The radiated band edge measurements were made with the DUT in normal operation position.

### 4.6.3 Test Results – 1 MBPS

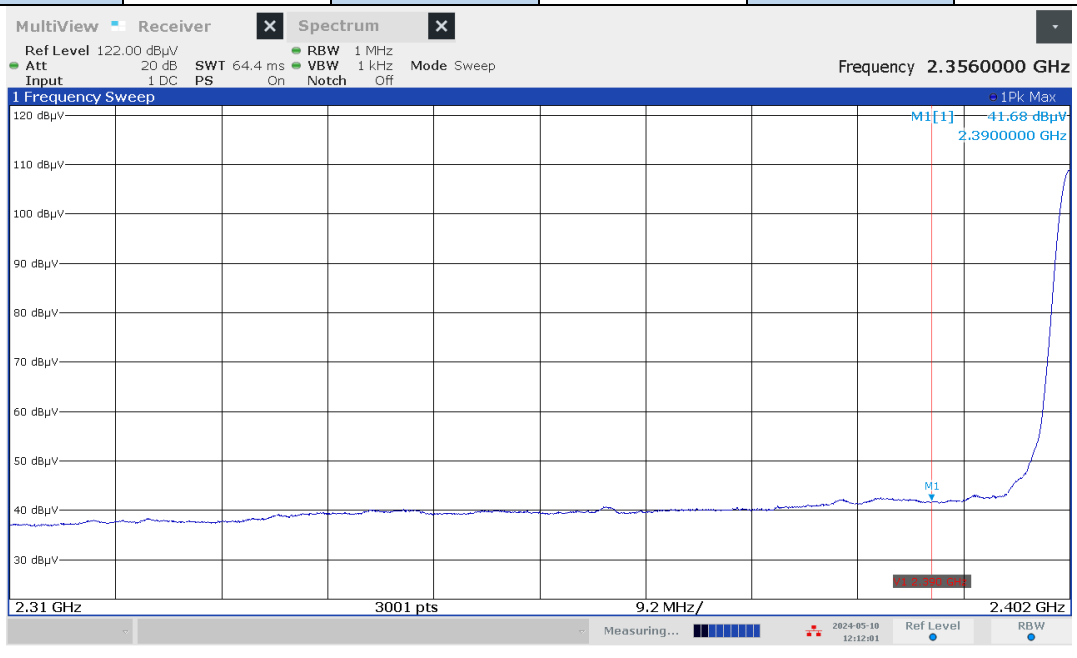
The DUT met the band edge requirements. Peak output power for low, mid and high channels were measured and the Plots Section below contains the maximum radiated emission levels captured on the spectrum analyzer at the band edges. The Final Measurements Section contains the final results with the correction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

### *4.6.3.1. Plots*

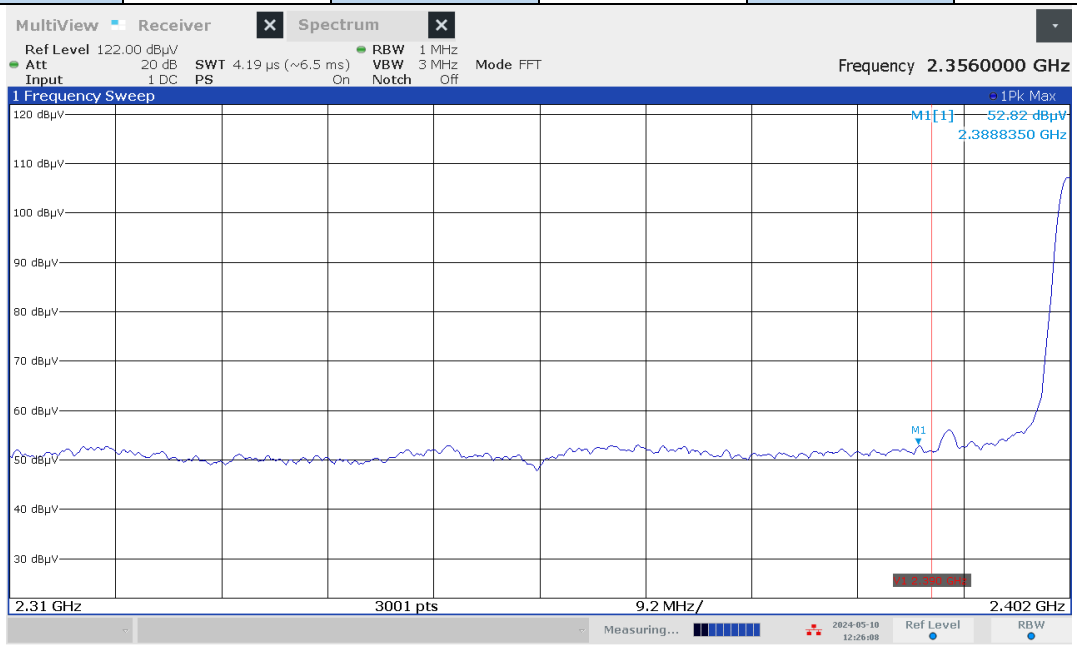
| **Tx Frequency** | Low Channel | **Antenna Polarization** | Horizontal | **Emission** | Peak |
|---|---|---|---|---|---|




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

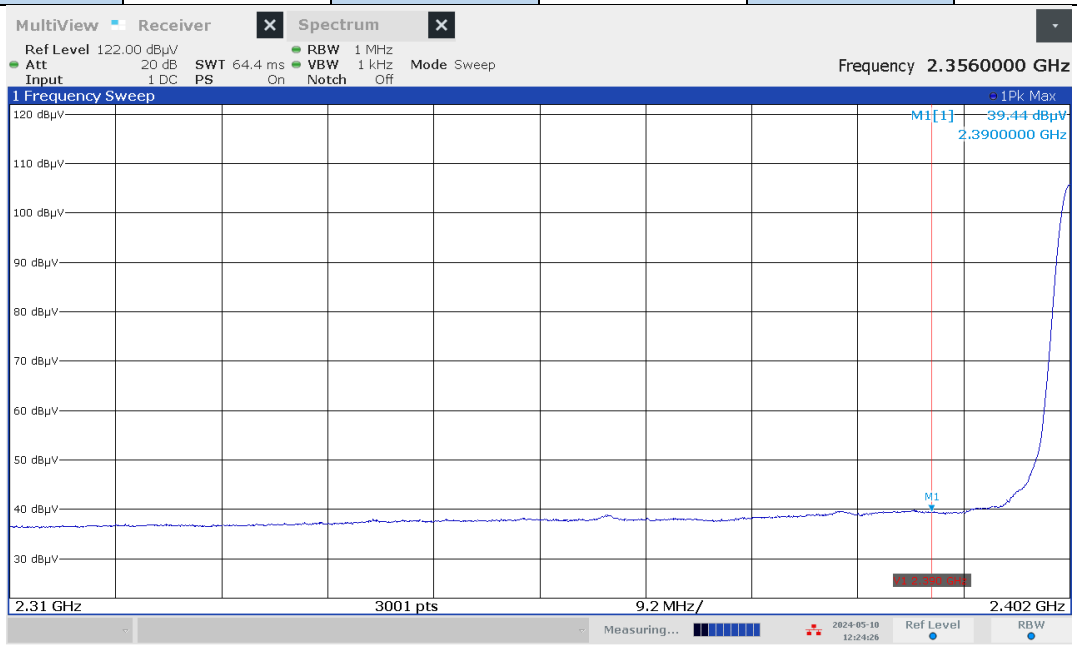


| **Tx Frequency** | Low Channel | **Antenna Polarization** | Vertical | **Emission** | Peak |
|---|---|---|---|---|---|



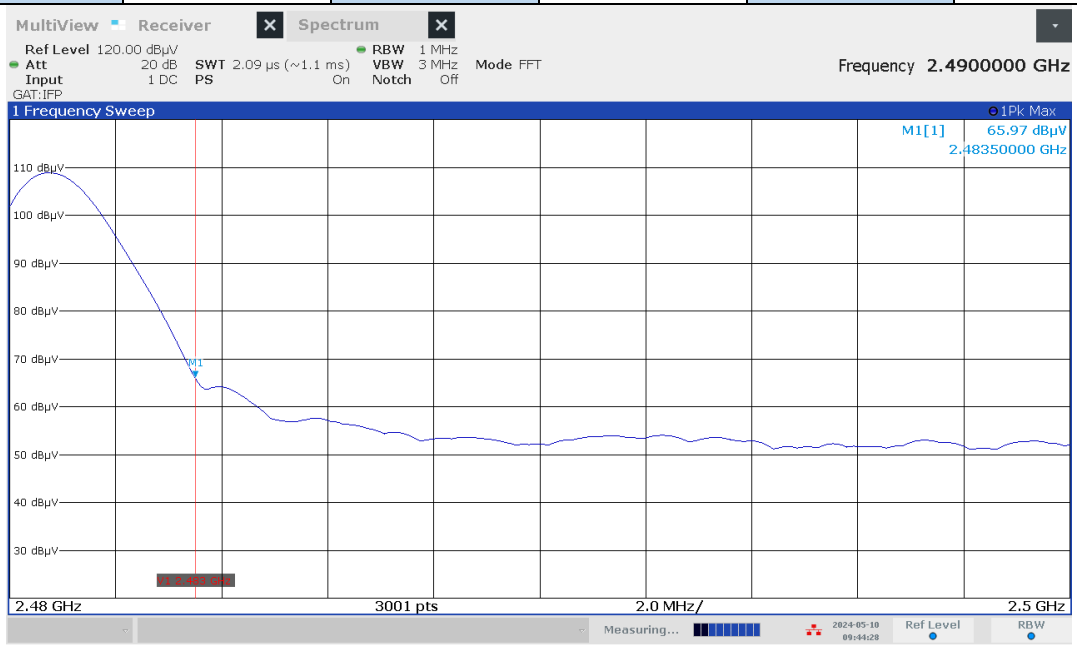

12:26:08 PM 05/10/2024

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

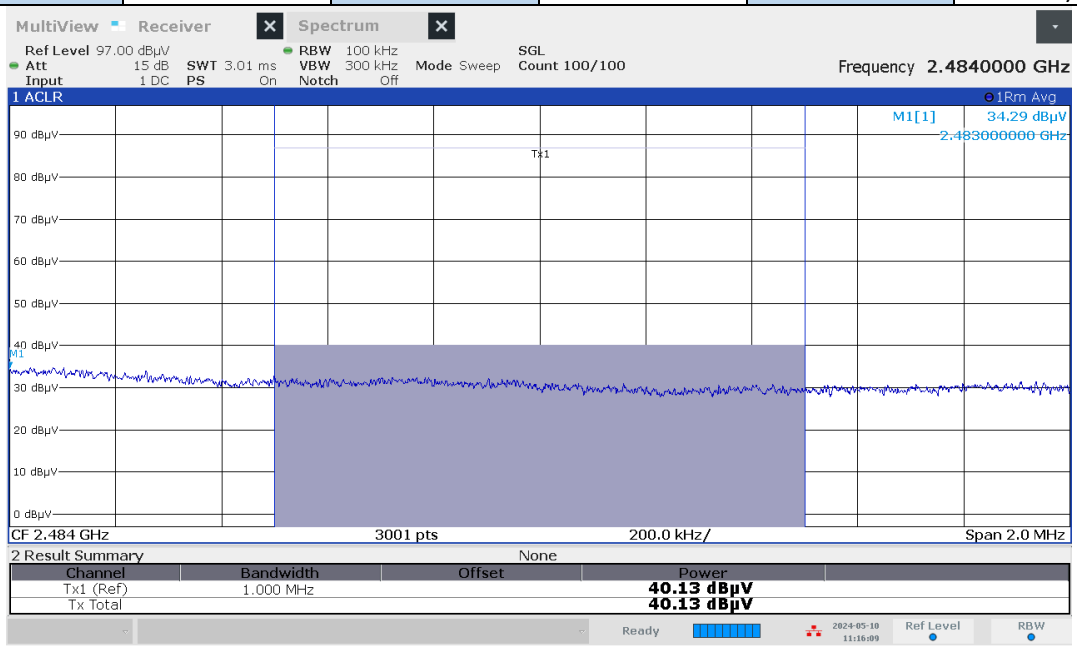



12:24:26 PM 05/10/2024

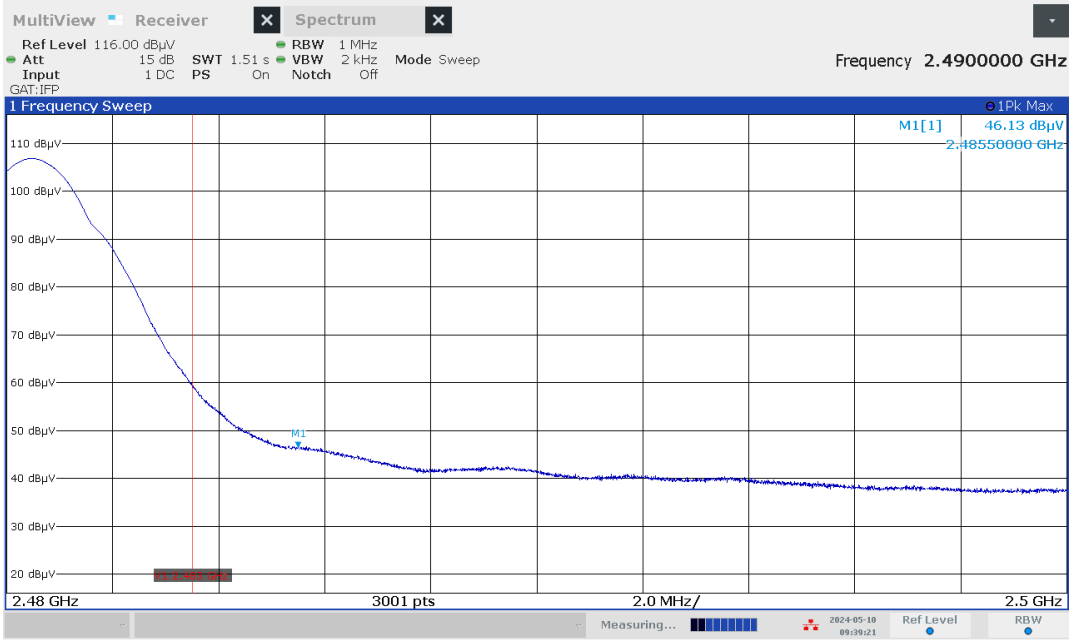
| **Tx Frequency** | High Channel | **Antenna Polarization** | Horizontal | **Emission** | Peak |
|---|---|---|---|---|---|




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

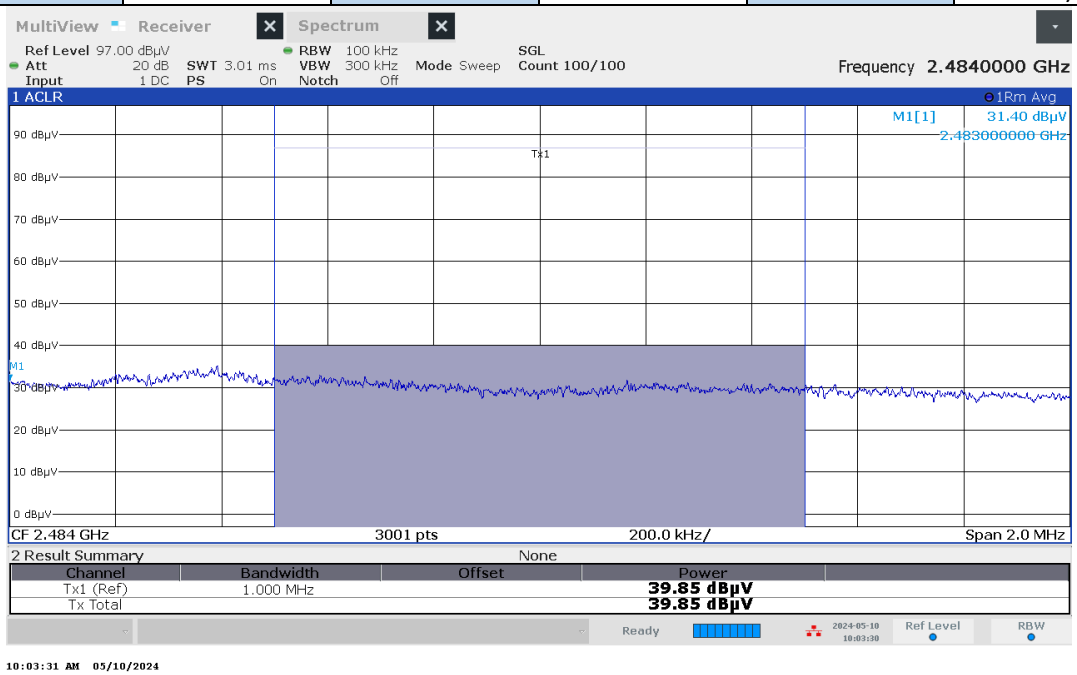


| **Tx Frequency** | High Channel | **Antenna Polarization** | Horizontal | **Emission** | Average |
|---|---|---|---|---|---|

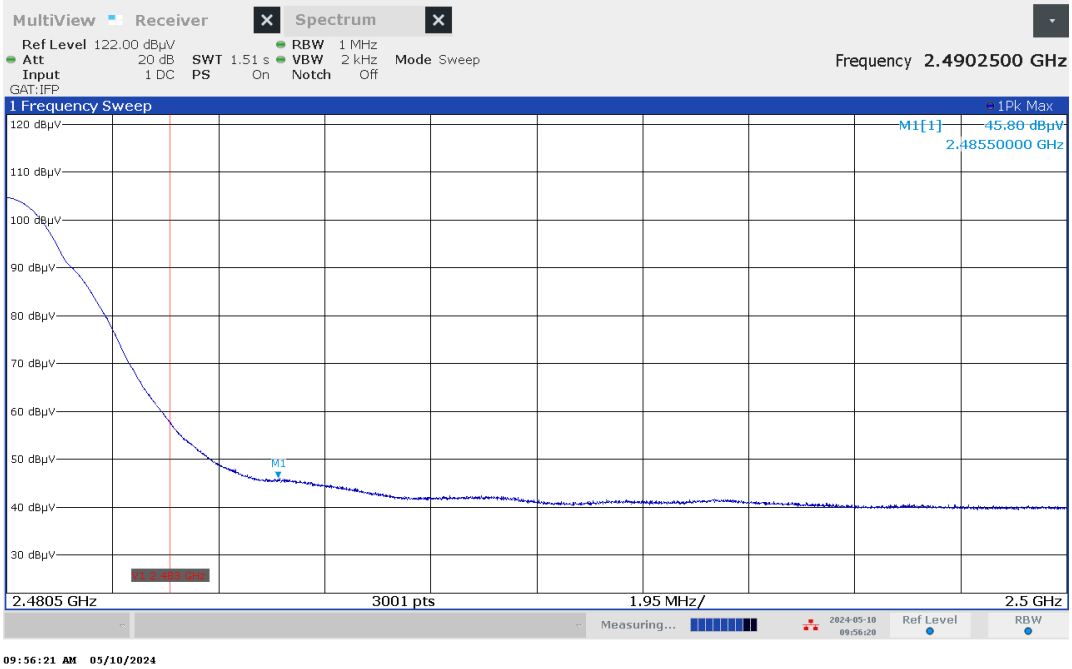


| **Tx Frequency** | High Channel | **Antenna Polarization** | Vertical | **Emission** | Peak |
|---|---|---|---|---|---|


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



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




### *4.6.3.2. Final Measurements*

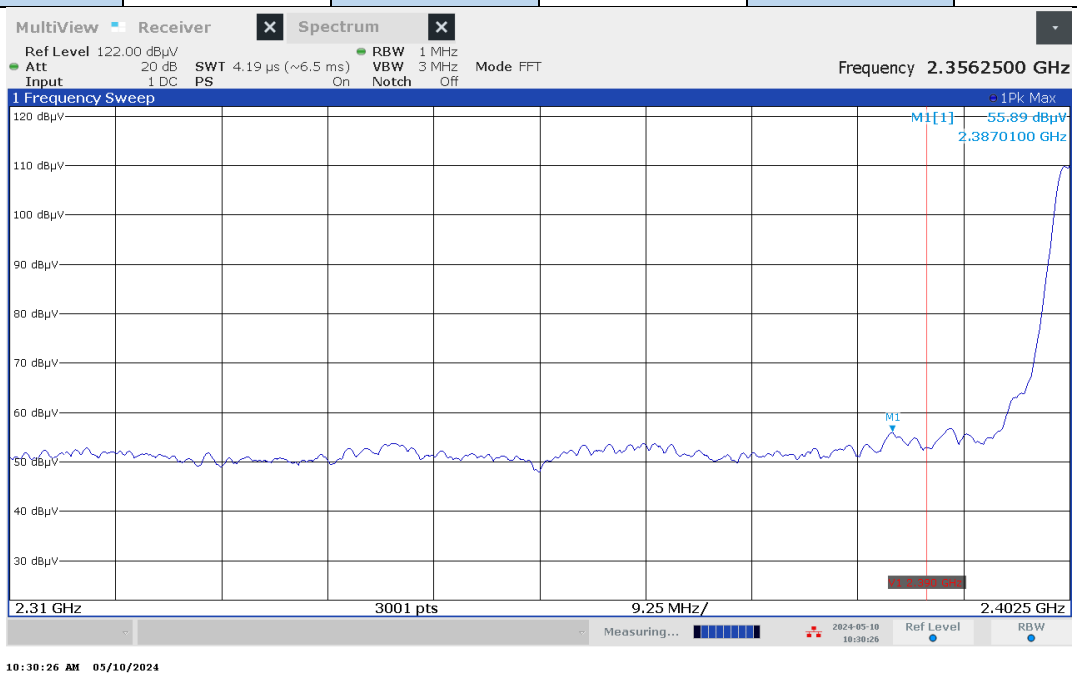
| Frequency (MHz) | Detector | Antenna Polarity | Reading (dBµV) | Antenna Factor (dB/m) | Cable Factor (dB) | Attenuator (dB) | Pre-Amp Gain (dB) | Emission Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Test Result |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Low Channel BLE - 1 MBPS** | | | | | | | | | | | |
| 2402 | PEAK | Horz | 110.2 | 32.5 | 6.8 | 10.0 | -41.6 | 117.9 | | | Pass |
| 2402 | AVG | Horz | 109.0 | 32.5 | 6.8 | 10.0 | -41.6 | 116.7 | | | Pass |
| 2402 | PEAK | Vert | 107.0 | 32.5 | 6.8 | 10.0 | -41.6 | 114.6 | | | Pass |
| 2402 | AVG | Vert | 105.8 | 32.5 | 6.8 | 10.0 | -41.6 | 113.4 | | | Pass |
| 2390 | PEAK | Horz | 55.7 | 32.4 | 6.8 | 10.0 | -41.6 | 63.3 | 74.0 | 10.7 | Pass |
| 2390 | AVG | Horz | 41.6 | 32.4 | 6.8 | 10.0 | -41.6 | 49.3 | 54.0 | 4.7 | Pass |
| 2390 | PEAK | Vert | 52.8 | 32.4 | 6.8 | 10.0 | -41.6 | 60.5 | 74.0 | 13.5 | Pass |
| 2390 | AVG | Vert | 39.4 | 32.4 | 6.8 | 10.0 | -41.6 | 47.1 | 54.0 | 6.9 | Pass |
| **High Channel BLE - 1 MBPS** | | | | | | | | | | | |
| 2480 | PEAK | Horz | 109.0 | 32.6 | 6.9 | 10.0 | -41.7 | 116.7 | | | Pass |
| 2480 | AVG | Horz | 106.8 | 32.6 | 6.9 | 10.0 | -41.7 | 114.5 | | | Pass |
| 2480 | PEAK | Vert | 106.8 | 32.6 | 6.9 | 10.0 | -41.7 | 114.6 | | | Pass |
| 2480 | AVG | Vert | 104.7 | 32.6 | 6.9 | 10.0 | -41.7 | 112.4 | | | Pass |
| 2483.6 | PEAK | Horz | 66.0 | 32.6 | 6.9 | 10.0 | -41.7 | 73.7 | 74.0 | 0.3 | Pass |
| 2483.5 | AVG | Horz | 40.1 | 32.6 | 6.9 | 10.0 | -41.7 | 47.9 | 54.0 | 6.1 | Pass |
| 2483.6 | PEAK | Vert | 63.8 | 32.6 | 6.9 | 10.0 | -41.7 | 71.5 | 74.0 | 2.5 | Pass |
| 2483.5 | AVG | Vert | 39.9 | 32.6 | 6.9 | 10.0 | -41.7 | 47.6 | 54.0 | 6.4 | Pass |
| 2485.5 | AVG | Horz | 46.1 | 32.6 | 6.9 | 10.0 | -41.7 | 53.9 | 54.0 | 0.1 | Pass |
| 2485.5 | AVG | Vert | 45.8 | 32.6 | 6.9 | 10.0 | -41.7 | 53.5 | 54.0 | 0.5 | Pass |

### 4.6.4 Test Results – 2 MBPS

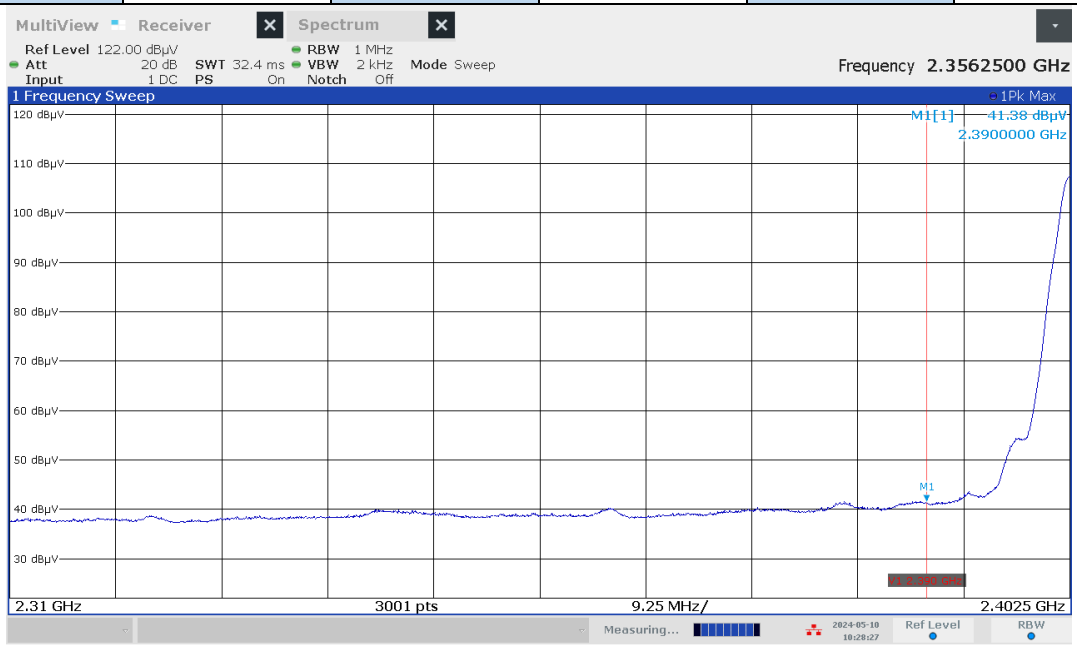
The DUT met the band edge requirements. Peak output power for low, mid and high channels were measured and the Plots Section below contains the maximum radiated emission levels captured on the spectrum analyzer at the band edges. The Final Measurements Section contains the final results with the correction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

#### *4.6.4.1. Plots*

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

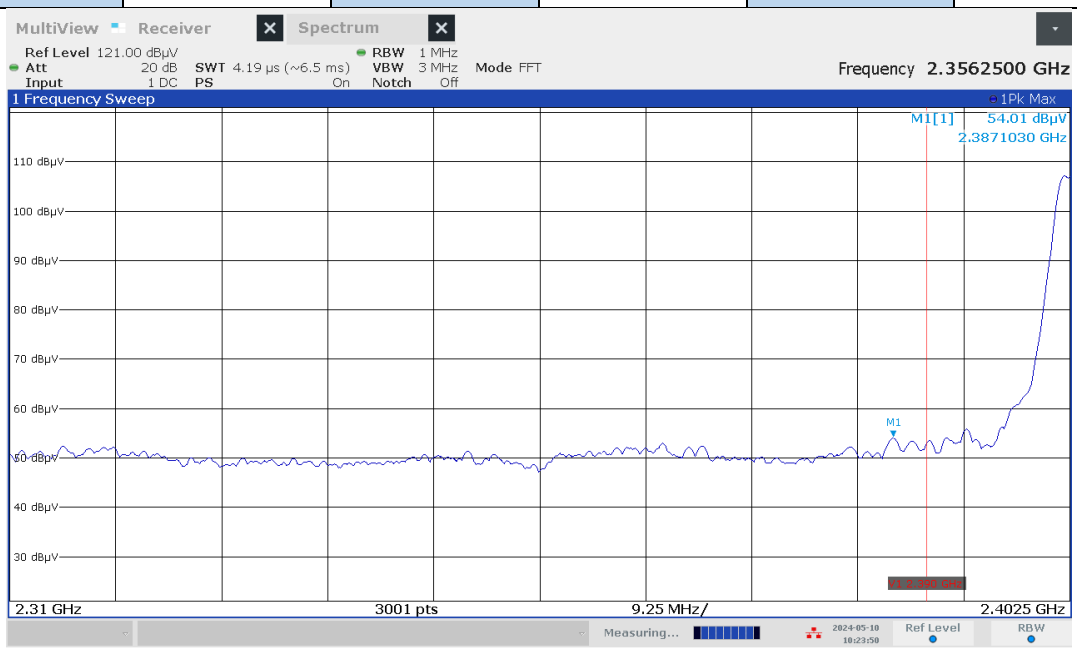


| **Tx Frequency** | Low Channel | **Antenna Polarization** | Horizontal | **Emission** | Average |
|---|---|---|---|---|---|



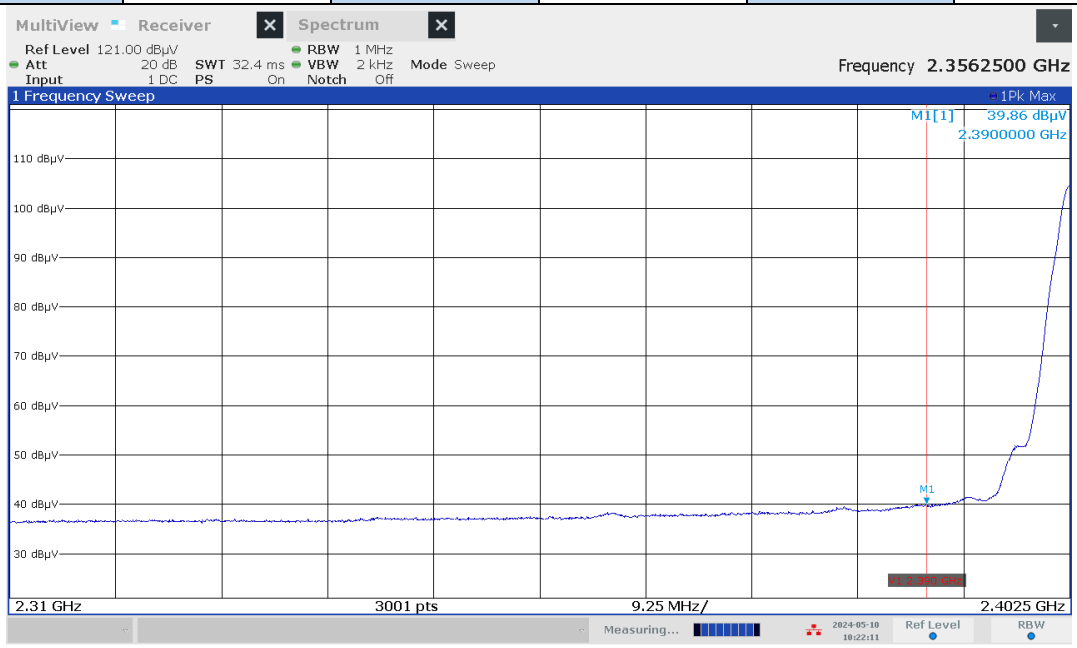

10:28:28 AM 05/10/2024

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




10:23:51 AM 05/10/2024

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

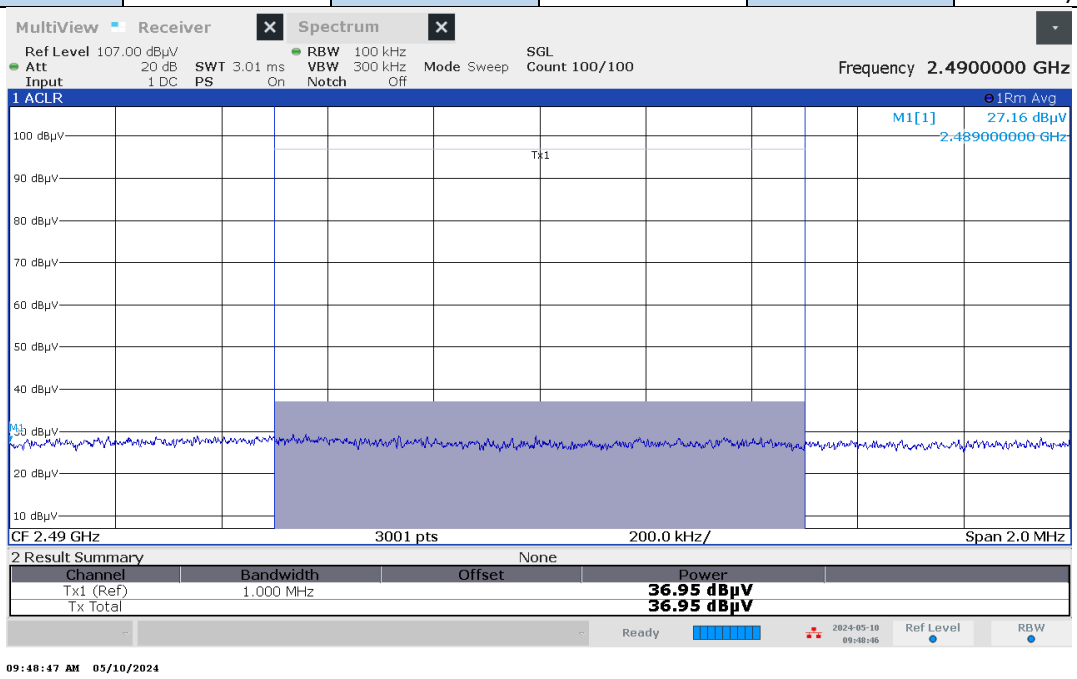



10:22:11 AM 05/10/2024

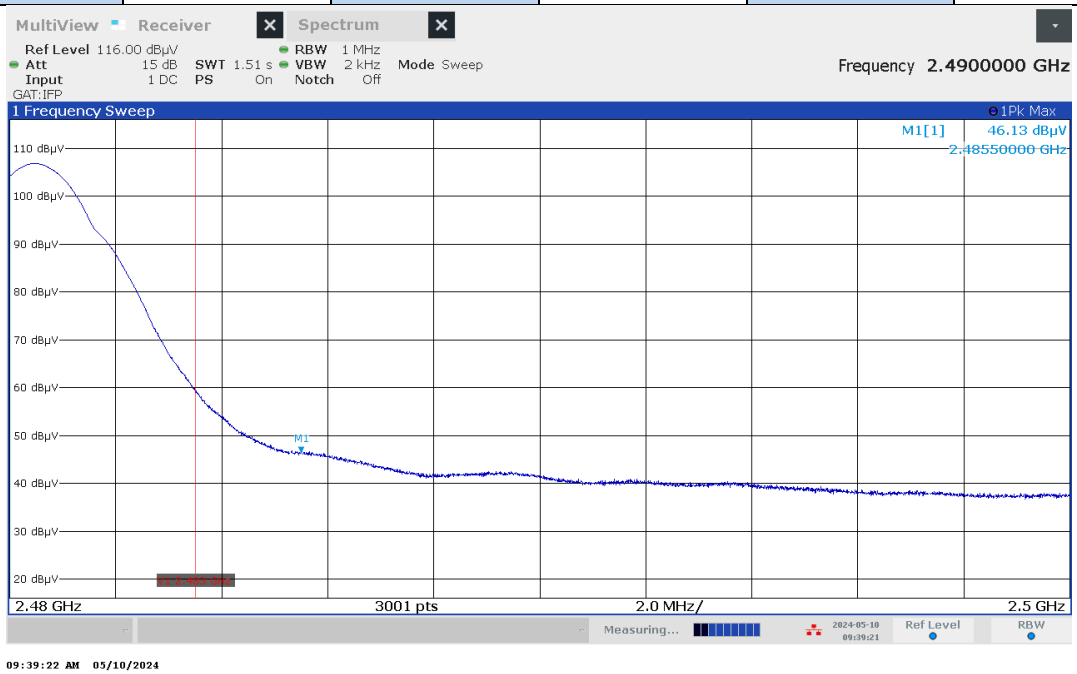
| **Tx Frequency** | High Channel | **Antenna Polarization** | Horizontal | **Emission** | Peak |
|---|---|---|---|---|---|


09:44:28 AM 05/10/2024

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

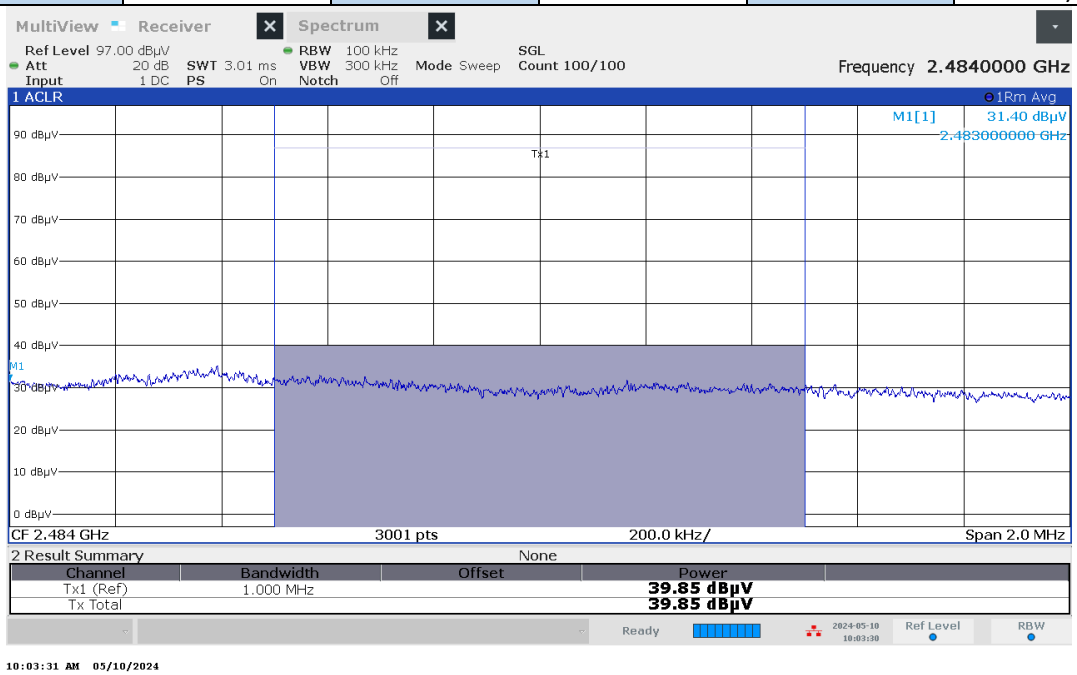



| **Tx Frequency** | High Channel | **Antenna Polarization** | Horizontal | **Emission** | Average |
|---|---|---|---|---|---|

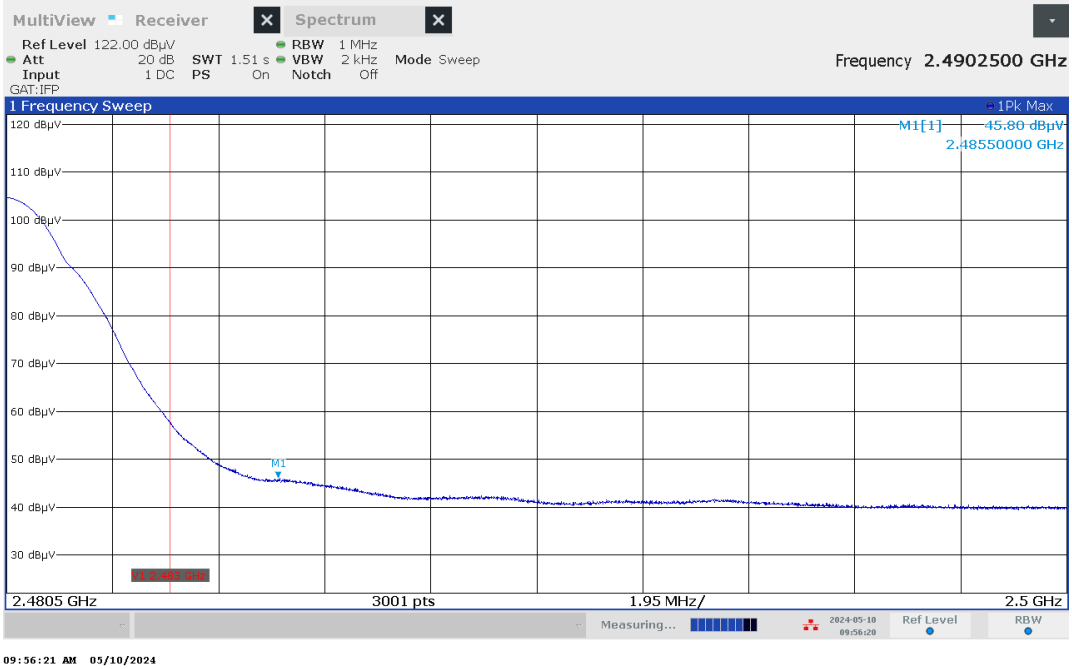


| **Tx Frequency** | High Channel | **Antenna Polarization** | Vertical | **Emission** | Peak |
|---|---|---|---|---|---|


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



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




### *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 BLE- 2 MBPS** | | | | | | | | | | | |
| 2402 | PEAK | Horz | 109.9 | 32.5 | 6.8 | 10.0 | -41.6 | 117.5 | | | Pass |
| 2402 | AVG | Horz | 107.5 | 32.5 | 6.8 | 10.0 | -41.6 | 115.2 | | | Pass |
| 2402 | PEAK | Vert | 107.1 | 32.5 | 6.8 | 10.0 | -41.6 | 114.7 | | | Pass |
| 2402 | AVG | Vert | 104.7 | 32.5 | 6.8 | 10.0 | -41.6 | 112.3 | | | Pass |
| 2387 | PEAK | Horz | 55.9 | 32.4 | 6.8 | 10.0 | -41.6 | 63.5 | 74.0 | 10.5 | Pass |
| 2390 | AVG | Horz | 41.4 | 32.4 | 6.8 | 10.0 | -41.6 | 49.0 | 54.0 | 5.0 | Pass |
| 2387 | PEAK | Vert | 54.0 | 32.4 | 6.8 | 10.0 | -41.6 | 61.7 | 74.0 | 12.3 | Pass |
| 2390 | AVG | Vert | 39.9 | 32.4 | 6.8 | 10.0 | -41.6 | 47.5 | 54.0 | 6.5 | Pass |
| **High Channel BLE 2 MBPS** | | | | | | | | | | | |
| 2480 | PEAK | Horz | 109.6 | 32.6 | 6.9 | 10.0 | -41.7 | 117.4 | | | Pass |
| 2480 | AVG | Horz | 108.3 | 32.6 | 6.9 | 10.0 | -41.7 | 116.1 | | | Pass |
| 2480 | PEAK | Vert | 108.3 | 32.6 | 6.9 | 10.0 | -41.7 | 116.0 | | | Pass |
| 2480 | AVG | Vert | 107.1 | 32.6 | 6.9 | 10.0 | -41.7 | 114.8 | | | Pass |
| 2483.5 | PEAK | Horz | 66.0 | 32.6 | 6.9 | 10.0 | -41.7 | 73.7 | 74.0 | 0.3 | Pass |
| 2484 | AVG | Horz | 37.0 | 32.6 | 6.9 | 10.0 | -41.7 | 44.7 | 54.0 | 9.3 | Pass |
| 2483.5 | PEAK | Vert | 63.8 | 32.6 | 6.9 | 10.0 | -41.7 | 71.5 | 74.0 | 2.5 | Pass |
| 2484 | AVG | Vert | 39.9 | 32.6 | 6.9 | 10.0 | -41.7 | 47.6 | 54.0 | 6.4 | Pass |
| 2485.5 | AVG | Horz | 46.1 | 32.6 | 6.9 | 10.0 | -41.7 | 53.9 | 54.0 | 0.1 | Pass |
| 2485.5 | AVG | Vert | 45.8 | 32.6 | 6.9 | 10.0 | -41.7 | 53.5 | 54.0 | 0.5 | Pass |

### 4.6.5 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

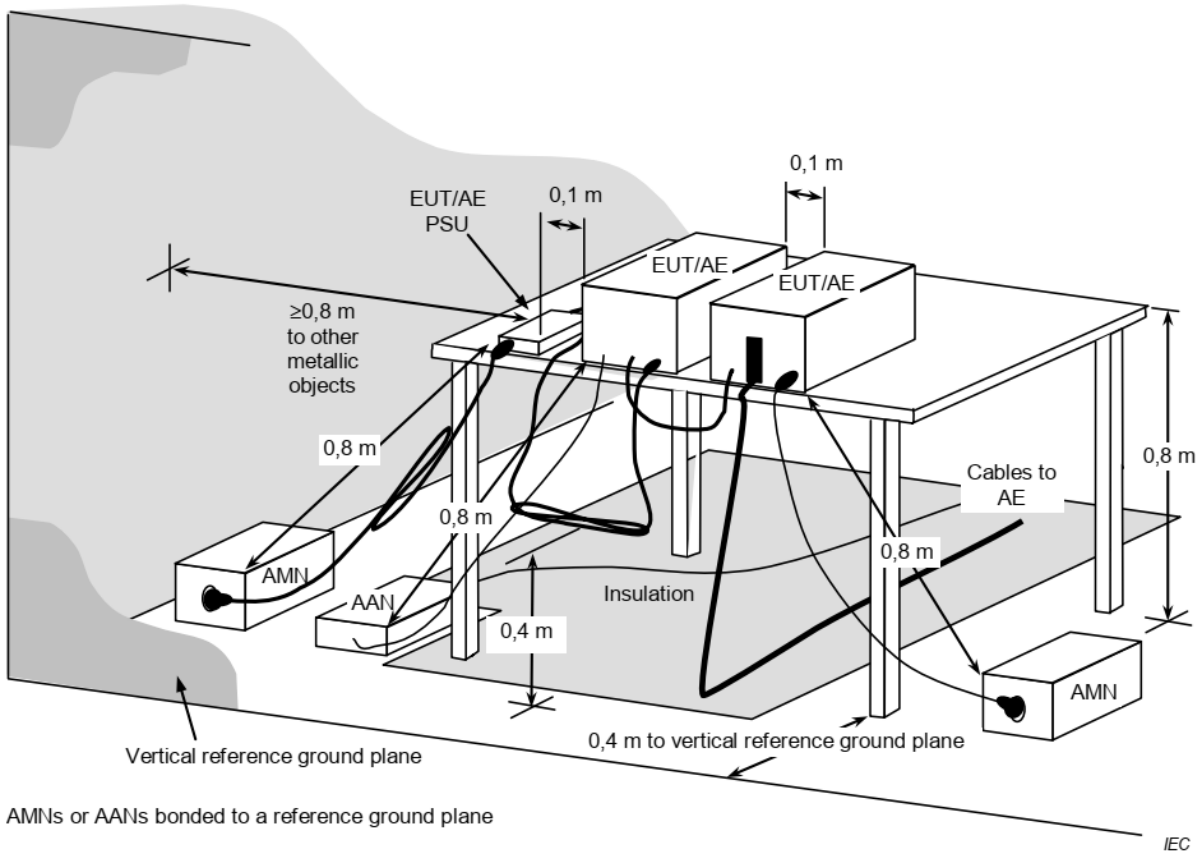
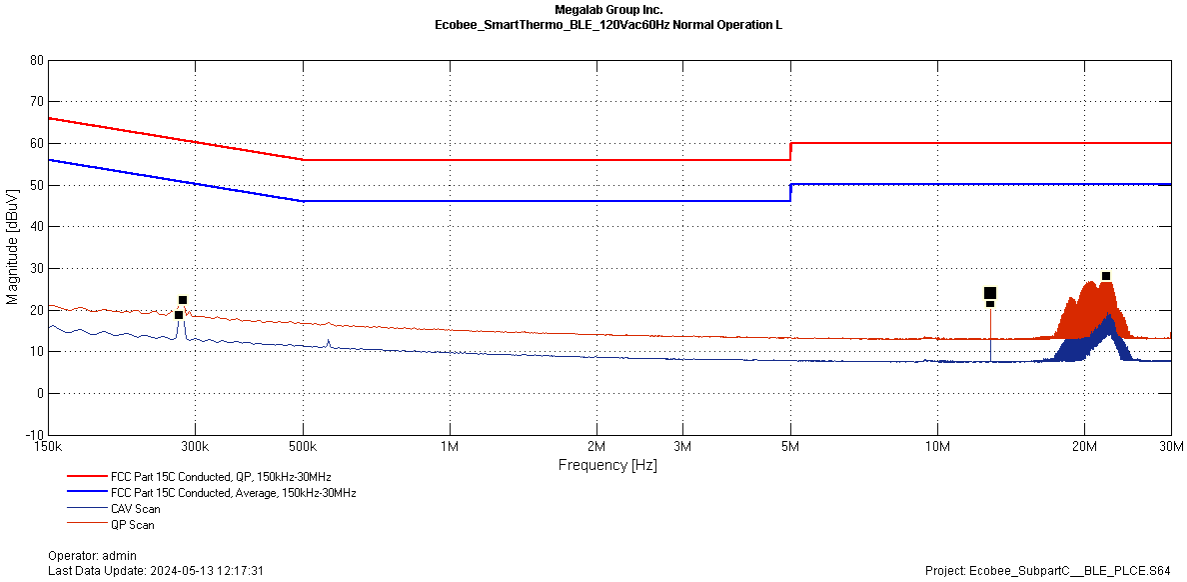



Figure 34 – Sample Measurement Arrangement for DUT

### 4.7.4 Test Results

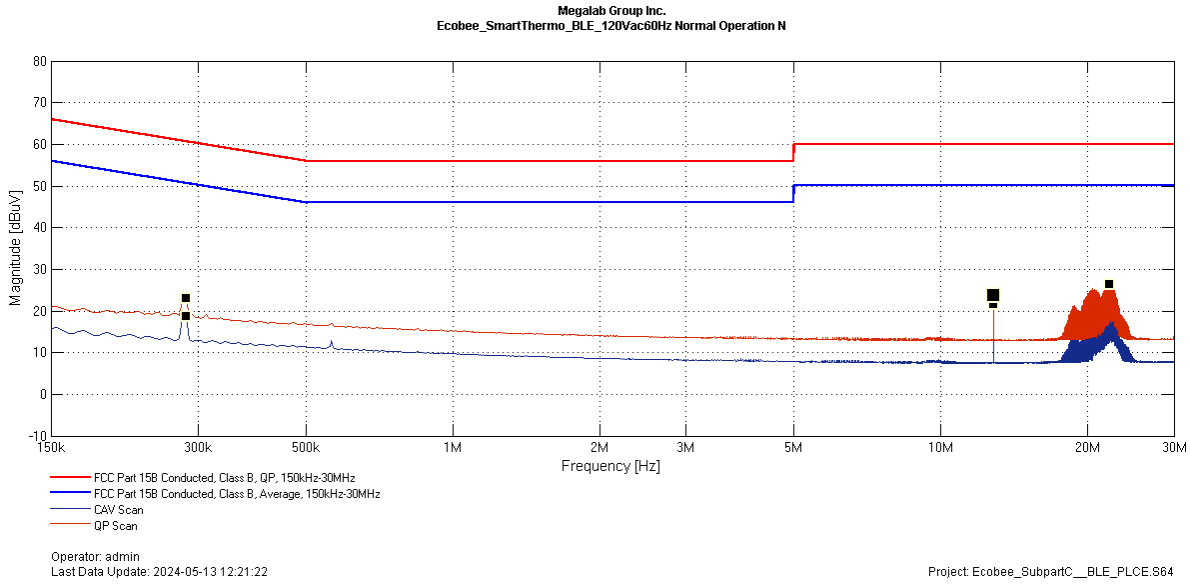
| **Range:** | 150kHz to 30MHz | **DUT** | ECB701/BLE |
|---|---|---|---|
| **Test Voltage:** | 120Vac 60Hz | **Phase** | Line |




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 | 13.1 | 8.8 | 9.9 | 23.0 | 18.7 | 60.7 | 37.8 | 50.7 | 32.0 | Pass |
| 22.132 | 16.2 | -- | 10.3 | 26.4 | -- | 60.0 | 33.6 | -- | -- | Pass |
| 12.799 | 13.6 | 11.5 | 10.1 | 23.7 | 21.6 | 60.0 | 36.3 | 50.0 | 28.4 | Pass |

| | | | |
|---|---|---|---|
| **Range:** | 150kHz to 30MHz | **DUT** | ECB701/BLE |
| **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** |
| 0.284 | 13.1 | 8.8 | 9.9 | 23.0 | 18.7 | 60.7 | 37.8 | 50.7 | 32.0 | Pass |
| 22.132 | 16.2 | -- | 10.3 | 26.4 | -- | 60.0 | 33.6 | -- | -- | Pass |
| 12.799 | 13.6 | 11.5 | 10.1 | 23.7 | 21.6 | 60.0 | 36.3 | 50.0 | 28.4 | 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 ----------