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# Oreon Holding BV
# TEST REPORT

**SCOPE OF WORK**
EMC TESTING – OLCC TRANSCEIVER MODULE

**REPORT NUMBER**
105659039LEX-001.1

**ISSUE DATE**
5/2/2024

**REVISE DATE**
5/17/2024

**PAGES**
47

**DOCUMENT CONTROL NUMBER**
Non-Specific EMC Report Shell Rev. December 2017


# EMC TEST REPORT

(FULL COMPLIANCE)

**Report Number:** 105659039LEX-001.1
**Project Number:** G105659039

**Report Issue Date:** 5/17/2024

**Model(s) Tested:** OLCC Transceiver Module

**Standards:** FCC Title 47 CFR Part 15.247
RSS-247 Issue 3
RSS-GEN Issue 5

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Dr.
Lexington, KY 40510
USA

Client:
Oreon Holding BV
Lorentzlaan 6, 3401MX IJsselstein (UT), The Netherlands

Report prepared by

Brian Lackey, Staff Engineer

Report reviewed by

Michael Carlson, Team Leader

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## 1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

## 2 Test Summary

| Section | Test full name | Result |
|---|---|---|
| 6 | Occupied/DTS Bandwidth<br>(ANSI C63.10 (2020) §6.9.3 and §11.8) | Pass |
| 7 | Fundamental Emission Output Power<br>(ANSI C63.10 (2020) §11.9) | Pass |
| 8 | Maximum Power Spectral Density<br>(ANSI C63.10 (2020) §11.10) | Pass |
| 9 | Radiated Spurious Emissions<br>ANSI C63.10 (2020) §6.3 §6.5 and §6.6 | Pass |
| 10 | Antenna Requirement<br>(FCC Part 15.203, RSS-Gen Issue 5 § 6.8) | Pass |
| 11 | Conducted Emissions<br>(FCC Part 15.207, RSS-Gen Issue 5 § 7.2) | Pass |

## 3 Client Information

**This product was tested at the request of the following:**

| Client Information | |
|---|---|
| **Client Name:** | Oreon Holding BV |
| **Address:** | Lorentzlaan 6, 3401MX IJsselstein (UT), The Netherlands |
| **Contact:** | Guido Dirkx |
| **Telephone:** | +31(0)627299710 |
| **Email:** | guido@oreon-led.com |
| **Manufacturer Information** | |
| **Manufacturer Name:** | Oreon Holding BV |
| **Manufacturer Address:** | Lorentzlaan 6, 3401MX IJsselstein (UT), The Netherlands |

## 4 Description of Equipment under Test and Variant Models

| Equipment Under Test | |
|---|---|
| **Product Name** | OLCC Transceiver Module |
| **Model Number** | OLCC-TM017-B |
| **Serial Number** | BL04002 |
| **Receive Date** | 4/23/2024 |
| **Test Start Date** | 4/23/2024 |
| **Test End Date** | 4/30/2024 |
| **Device Received Condition** | Good |
| **Test Sample Type** | Production |
| **Transmit Band** | 2402MHz – 2480MHz |
| **Test Channels** | 2402MHz, 2426MHz, 2480MHz |
| **Antenna Type** | Integral Antenna |
| **Antenna Gain[1]** | 1.95 dBi |
| **Rated Voltage** | 12V |
| **Description of Equipment Under Test (provided by client)** | |
| The Oreon Holding BV OLCC Transceiver Module model OLCC-TM017-B is a device for connecting to Bluetooth mesh networks. | |

### 4.1 Variant Models:

There were no variant models covered under this evaluation.

[1] This information was provided by the client and may affect compliance. Intertek does not make any claim of compliance for values other than those shown.

# 5 System Setup and Method

## 5.1 Method:

Configuration as required by ANSI C63.10 (2020)

| No. | Descriptions of EUT Exercising |
|---|---|
| 1 | The EUT was powered by an external DC supply. The EUT was configured to transmit a Bluetooth Low Energy (BLE) signal on a low, middle, or high channel. |
| 2 | The EUT was powered by an external DC supply. The radio was idle. |

| Cables | | | | | |
|---|---|---|---|---|---|
| QTY | Description | Length (m) | Shielding | Ferrites | Termination |
| 1 | AC Mains | 2 | No | No | Plug |

| Support Equipment (Accessories) | | |
|---|---|---|
| Description | Manufacturer | Model Number |
| | | |

# 6 Occupied/DTS Bandwidth

## 6.1 Test Method:

Tests are performed in accordance with ANSI C63.10 §6.9.3 and §11.8.

## 6.2 Test Limits:

Title 47 CFR 15.247(a)

(1) 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.

RSS-247 §5.2

a. The minimum 6 dB bandwidth shall be 500 kHz.

RSS-GEN §6.7

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

### 6.3 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 8258 | Rohde & Schwarz | ESW44 | 9/19/2023 | 9/19/2024 |
| Horn Antenna (1-18GHz) | 3780 | ETS | 3117 | 8/8/2023 | 8/8/2024 |
| 1-18GHz Signal Path without Preamplifier | 3074, 2588, 2593, 8188, 8185 | | | 1/12/2024 | 1/12/2025 |

### 6.4 Test Software Used:

| Description | Manufacturer | Version |
|---|---|---|
| RSCommander | Rohde & Schwarz | 2.4.2 64 bit (2023) |

### 6.5 Measurement Uncertainty

| Description | Expanded Uncertainty (k=2) |
|---|---|
| Automatic Bandwidth Measurement | 2.89% |

No measurement correction based on measurement uncertainty is performed.

### 6.6 Test Conditions

| Test Personnel | Supervising / Reviewing Engineer | Test Date | Ambient Temperature | Relative Humidity | Pressure |
|---|---|---|---|---|---|
| Brian Lackey | NA | 4/23/2024 | 21.1°C | 28.0% | 985.4mbar |

### 6.7 Test Results:

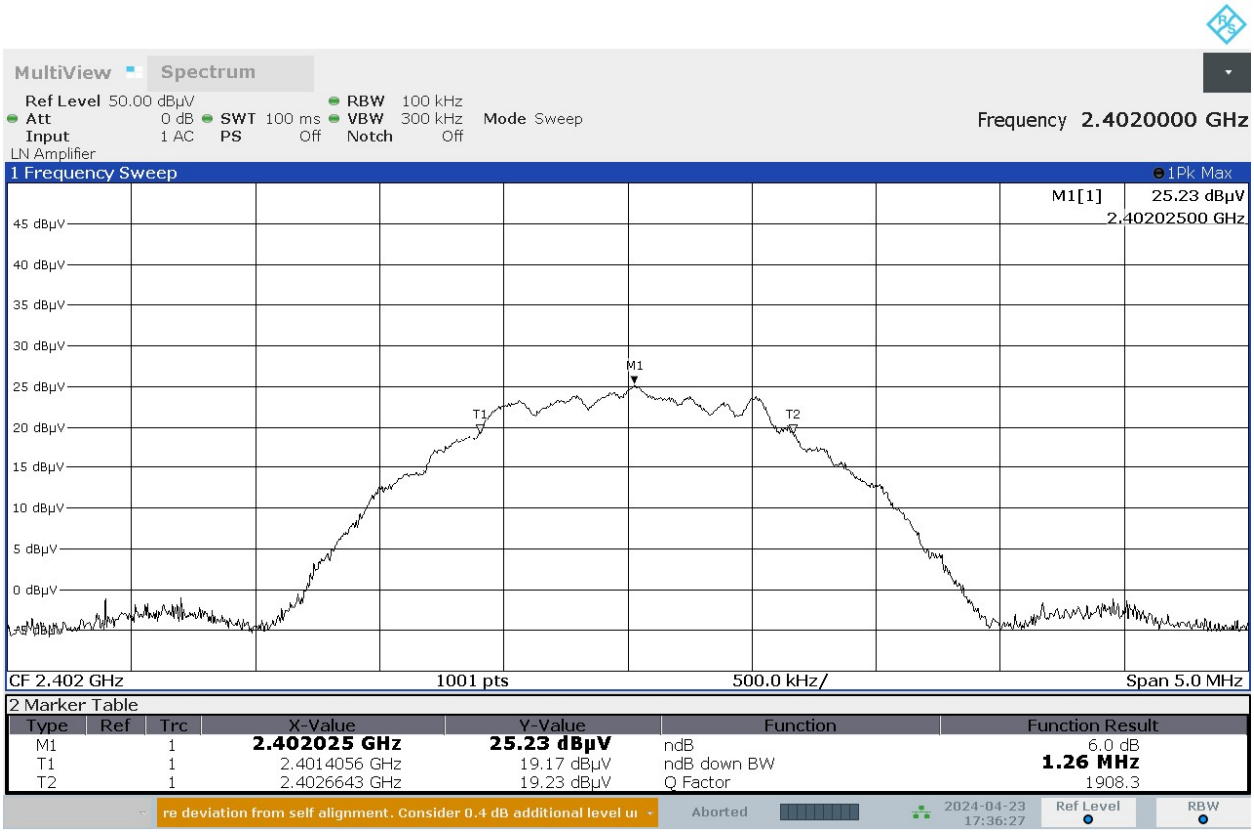
The sample tested was found to Comply. The 6dB bandwidth was at least 500 kHz.

### 6.8 Test Data:

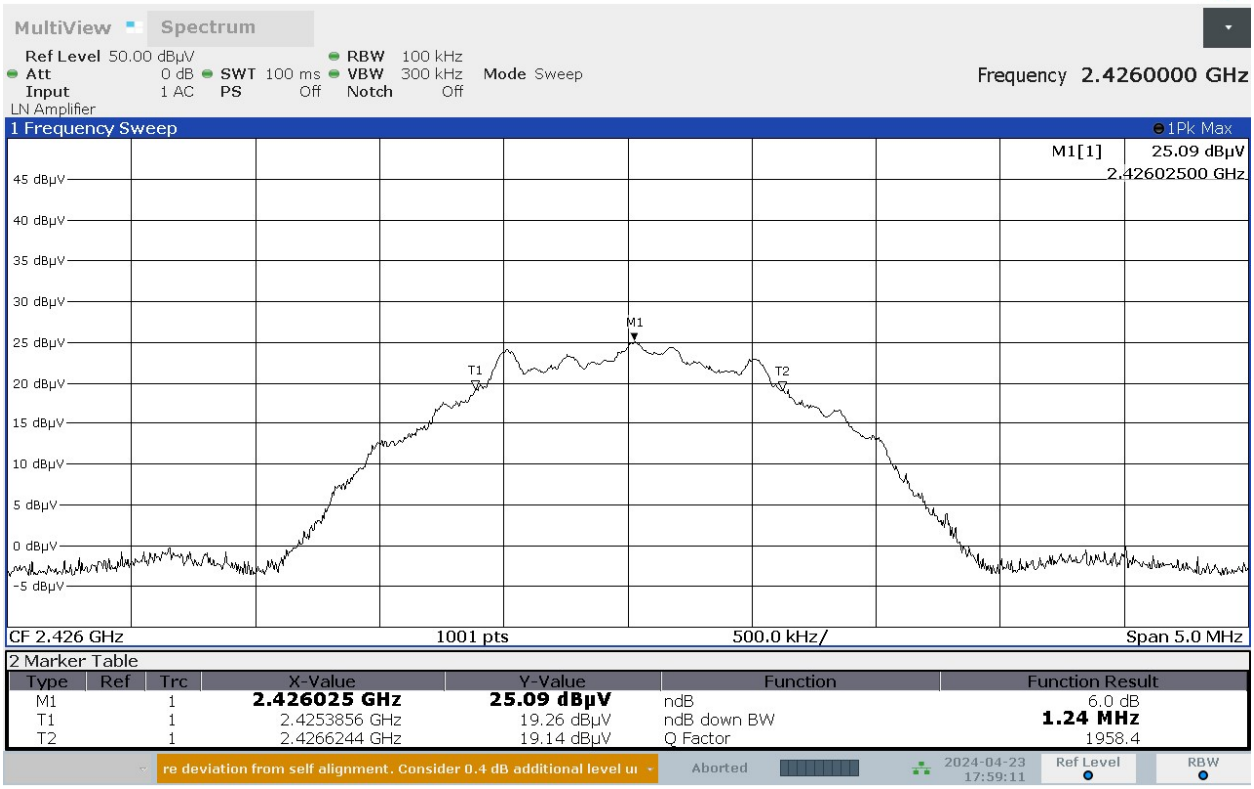
| Frequency (MHz) | 6dB Bandwidth (kHz) | 20dB Bandwidth (kHz) | 99% Bandwidth (kHz) | Limit (kHz) |
|---|---|---|---|---|
| 2402 | 1260 | 2260 | 2212 | 500 |
| 2426 | 1240 | 2270 | 2336 | 500 |
| 2480 | 1330 | 2420 | 2289 | 500 |

## 6.9 Test Plots: Occupied Channel Bandwidth (6dB Bandwidth)

### 6.9.1 Low Channel



### 6.9.2 Mid Channel

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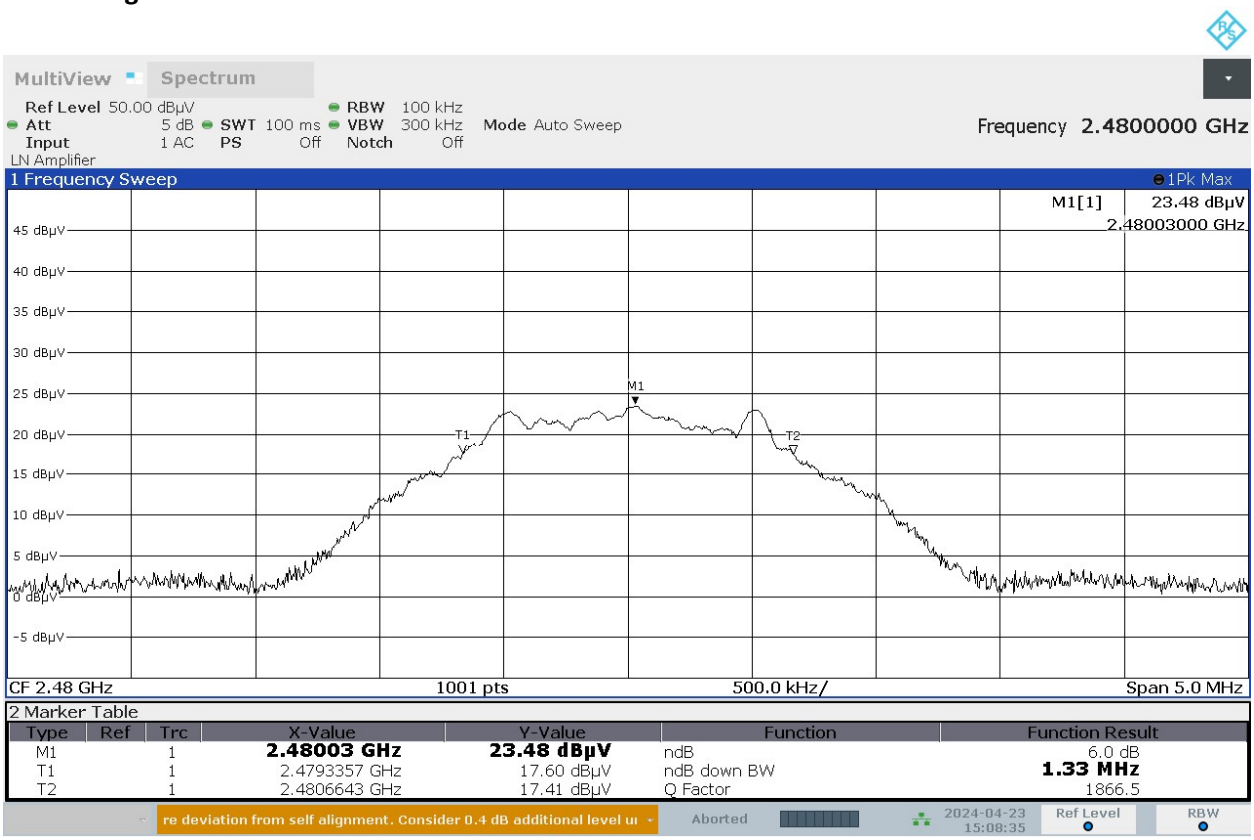
### 6.9.3 High Channel

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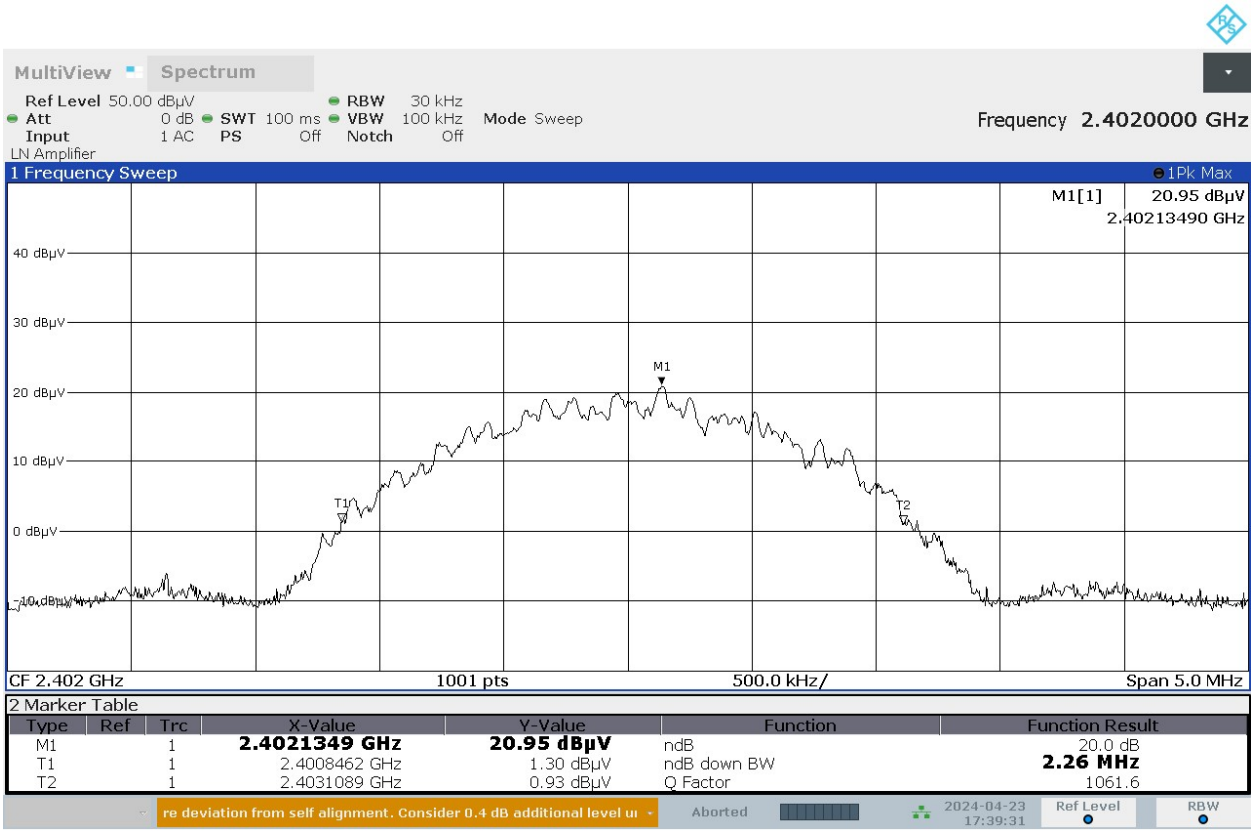
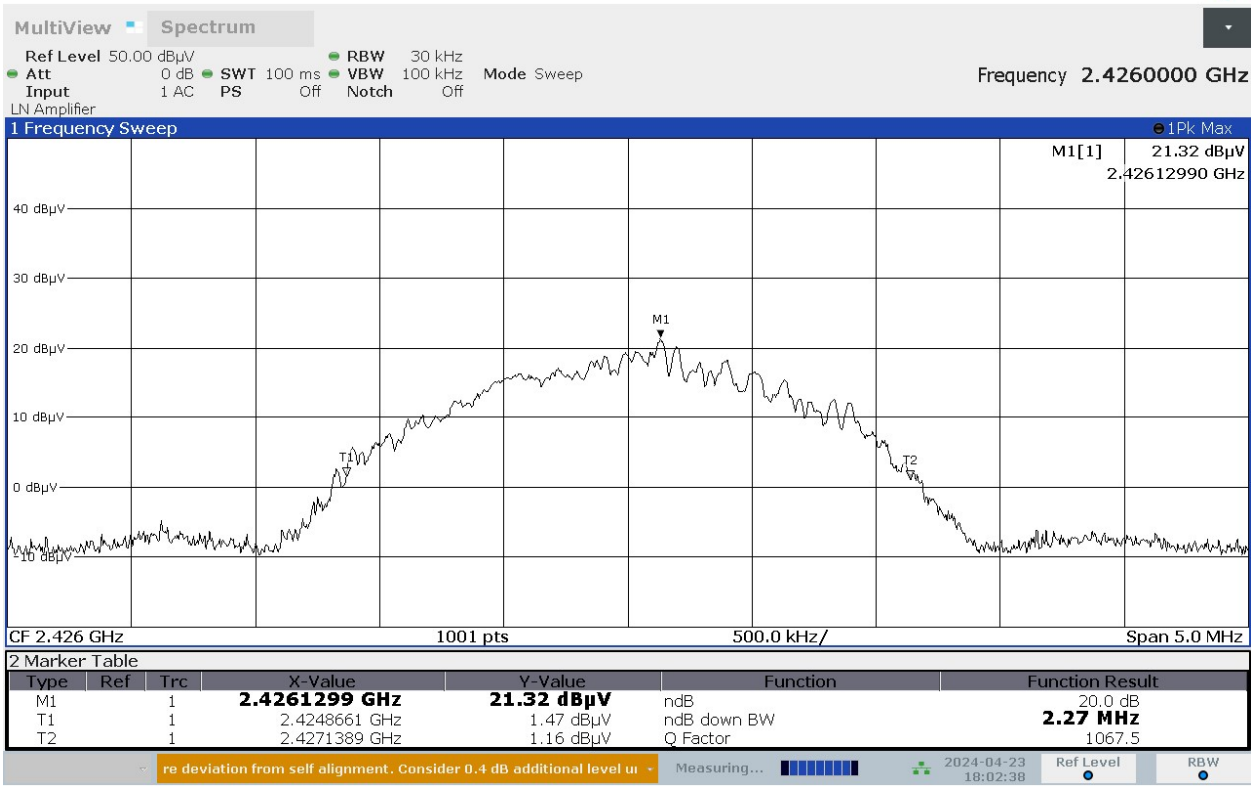
## 6.10 Test Plots: Occupied Channel Bandwidth (20dB Bandwidth)

### 6.10.1 Low Channel



### 6.10.2 Mid Channel



### 6.10.3 High Channel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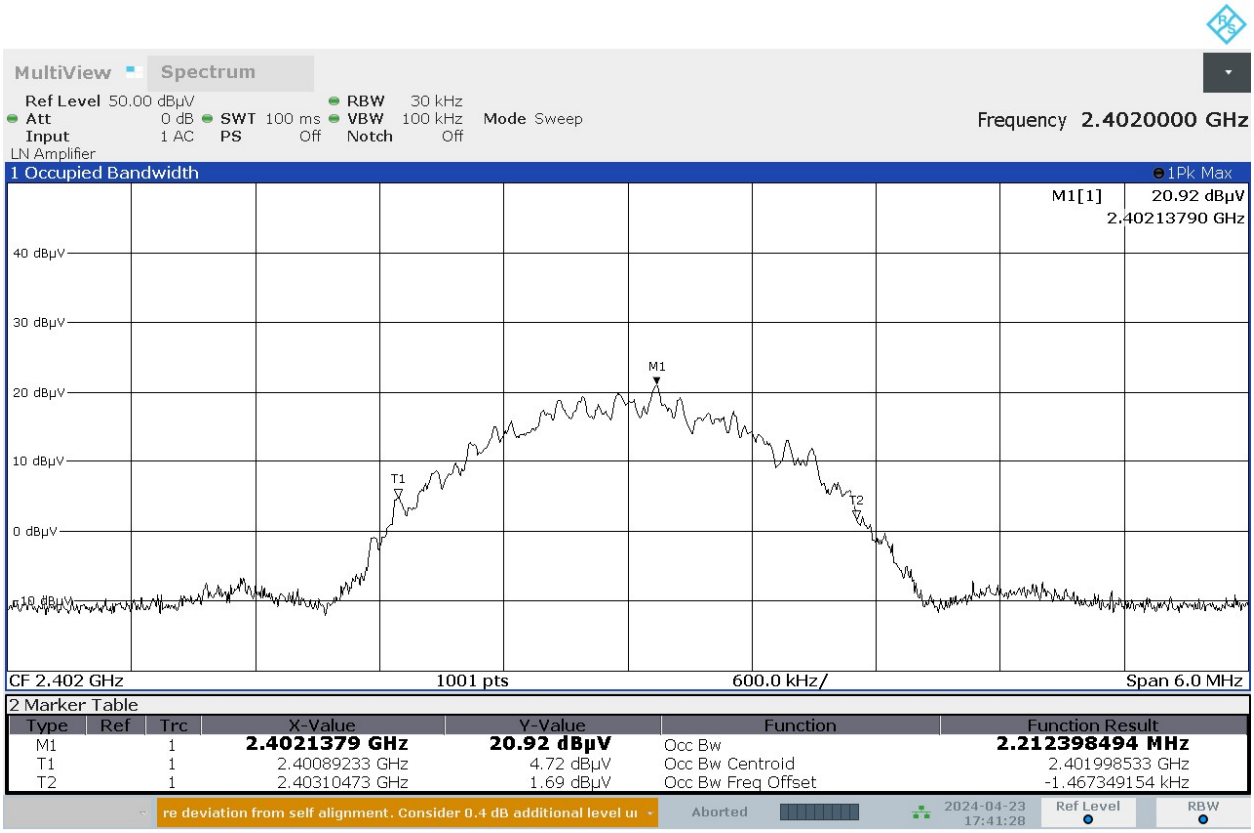
## 6.11 Test Plots: Occupied Channel Bandwidth (99% Bandwidth)

### 6.11.1 Low Channel



### 6.11.2 Mid Channel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### 6.11.3 High Channel

# 7 Fundamental Emissions Output Power

## 7.1 Test Method:

Tests are performed in accordance with ANSI C63.10 §11.9.

## 7.2 Test Limits:

47 CFR 15.247(b)

(2) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. 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. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

RSS-247 §5.4

d. For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

### 7.3 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 8258 | Rohde & Schwarz | ESW44 | 9/19/2023 | 9/19/2024 |
| Horn Antenna (1-18GHz) | 3780 | ETS | 3117 | 8/8/2023 | 8/8/2024 |
| 1-18GHz Signal Path without Preamplifier | 3074, 2588, 2593, 8188, 8185 | | | 1/12/2024 | 1/12/2025 |

### 7.4 Test Software Used:

| Description | Manufacturer | Version |
|---|---|---|
| RSCommander | Rohde & Schwarz | 2.4.2 64 bit (2023) |

### 7.5 Measurement Uncertainty

| Description | Expanded Uncertainty (k=2) |
|---|---|
| Output Power | 1.2dB |

No measurement correction based on measurement uncertainty is performed.

### 7.6 Test Conditions

| Test Personnel | Supervising / Reviewing Engineer | Test Date | Ambient Temperature | Relative Humidity | Pressure |
|---|---|---|---|---|---|
| Brian Lackey | NA | 4/23/2024 | 21.1°C | 28.0% | 985.4mbar |

### 7.7 Test Results:

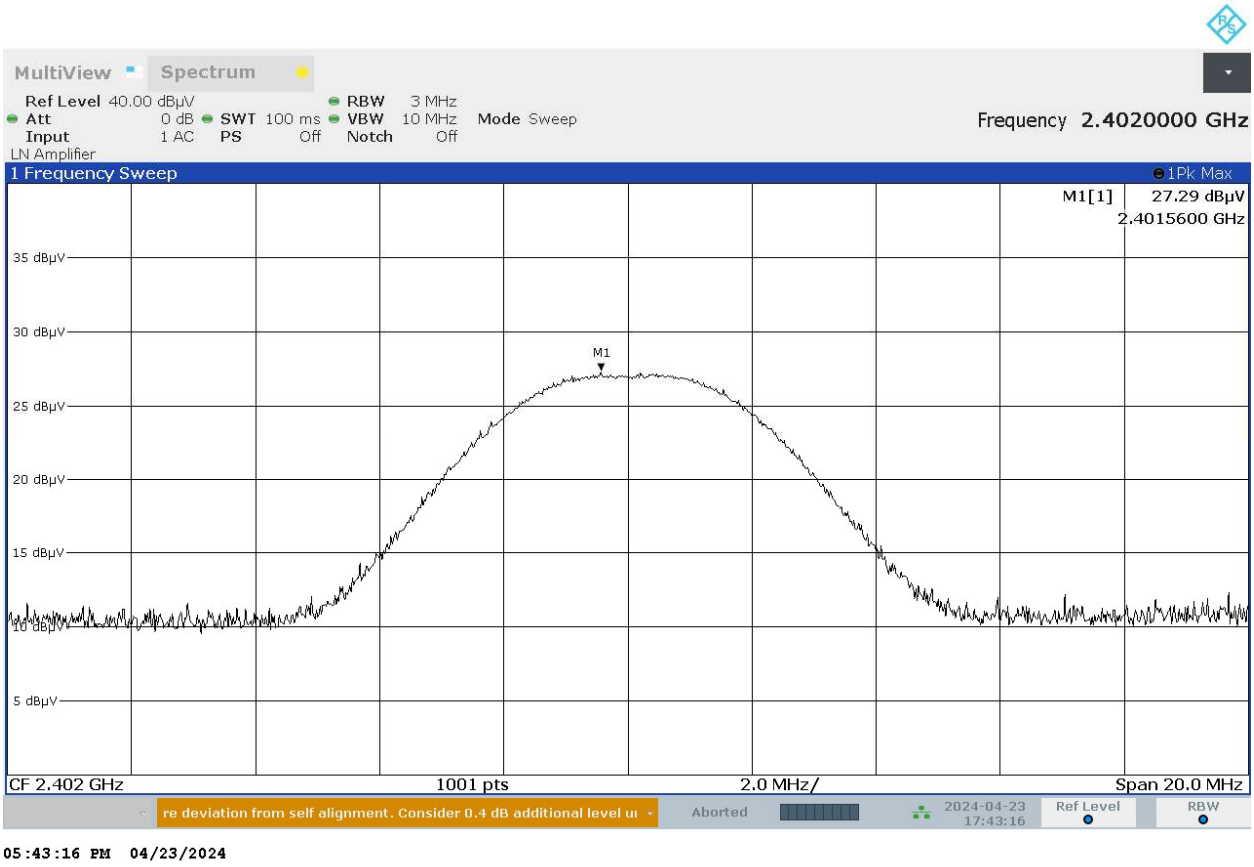
The sample tested was found to Comply. The conducted output power was less than 1 W. The EIRP was last than 4 W.

### 7.8 Test Data:

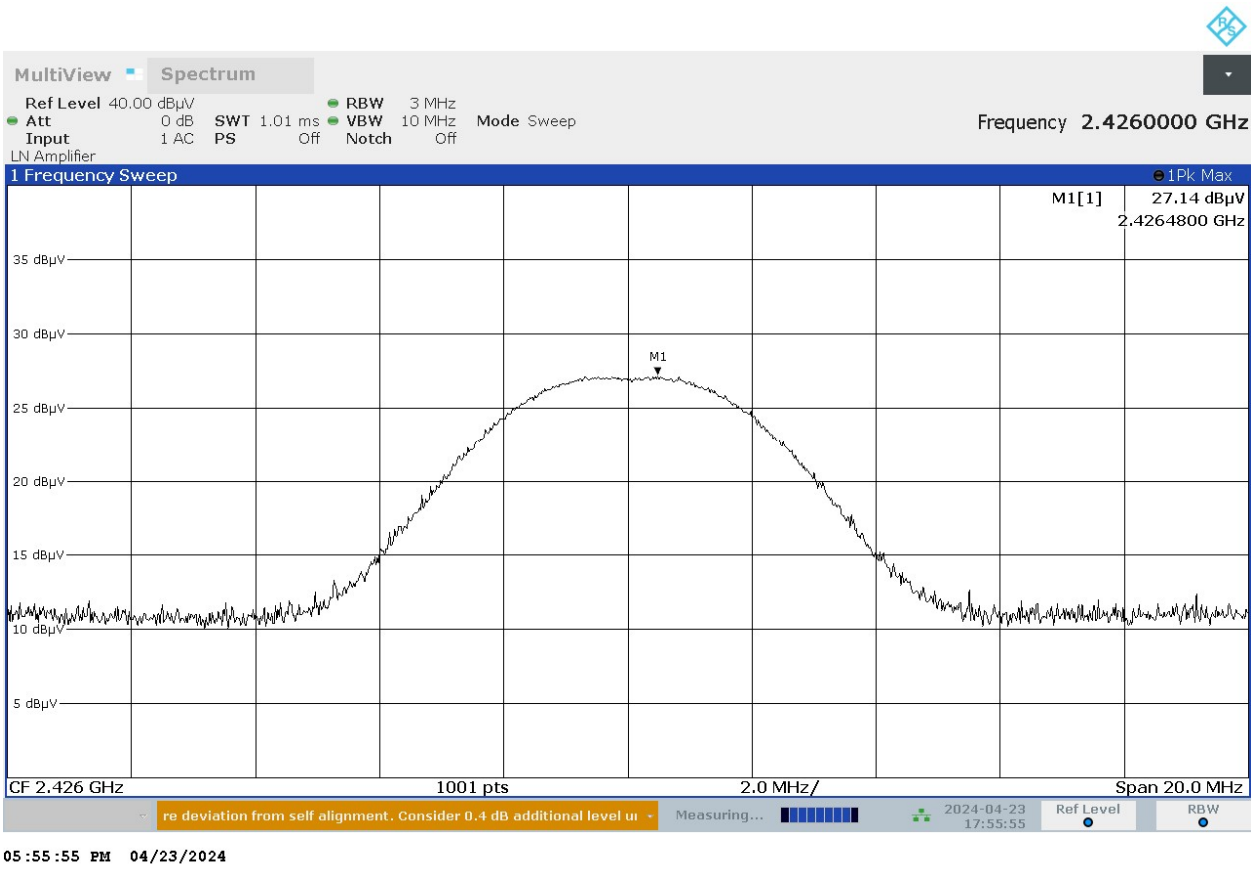
| Frequency (MHz) | Receiver Reading (dBµV) | Cable Loss (dB) | Antenna Factor ($dBm^{-1}$) | Electric Field (dBµV/m) | EIRP (dBm) | Antenna Gain (dBi) | Calculated Conducted Power (dBm) |
|---|---|---|---|---|---|---|---|
| 2402 | 27.29 | 7.04 | 32.02 | 66.35 | -28.88 | 1.95 | -30.83 |
| 2426 | 27.14 | 7.08 | 32.20 | 66.42 | -28.81 | 1.95 | -30.76 |
| 2480 | 27.48 | 7.18 | 32.48 | 67.14 | -28.09 | 1.95 | -30.04 |

## 7.9 Test Plots: Output Power

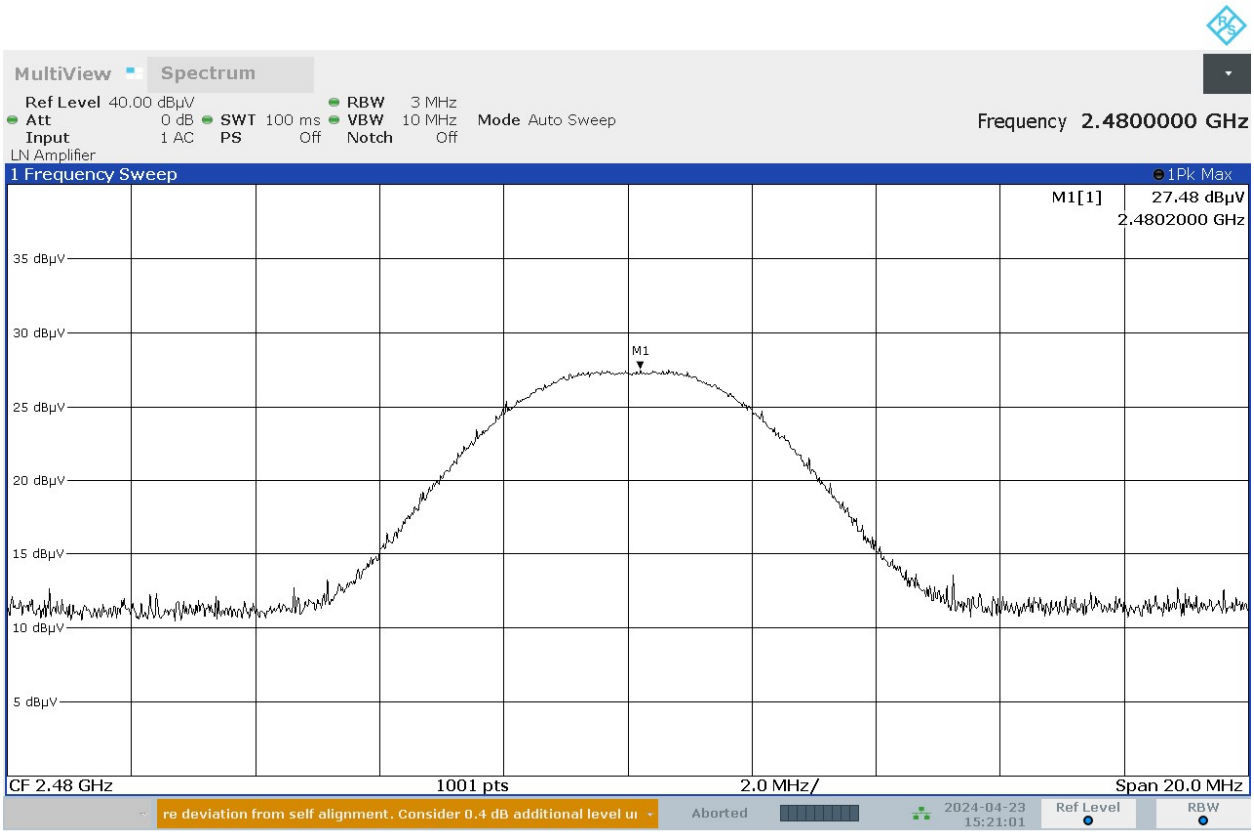
### 7.9.1 Low Channel



### 7.9.2 Mid Channel



### 7.9.3 High Channel



# 8 Maximum Power Spectral Density (PSD)

## 8.1 Test Method:

Tests are performed in accordance with ANSI C63.10 §11.10.

## 8.2 Test Limits:

47 CFR 15.247(e)

> For digitally modulated systems, the power spectral density 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

RSS-247 §5.2

b. The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

### 8.3 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 8258 | Rohde & Schwarz | ESW44 | 9/19/2023 | 9/19/2024 |
| Horn Antenna (1-18GHz) | 3780 | ETS | 3117 | 8/8/2023 | 8/8/2024 |
| 1-18GHz Signal Path without Preamplifier | 3074, 2588, 2593, 8188, 8185 | | | 1/12/2024 | 1/12/2025 |

### 8.4 Test Software Used:

| Description | Manufacturer | Version |
|---|---|---|
| RSCommander | Rohde & Schwarz | 2.4.2 64 bit (2023) |

### 8.5 Measurement Uncertainty

| Description | Expanded Uncertainty (k=2) |
|---|---|
| PPSD | 1.2dB |

No measurement correction based on measurement uncertainty is performed.

### 8.6 Test Conditions

| Test Personnel | Supervising / Reviewing Engineer | Test Date | Ambient Temperature | Relative Humidity | Pressure |
|---|---|---|---|---|---|
| Brian Lackey | NA | 4/23/2024 | 21.1°C | 28.0% | 985.4mbar |

### 8.7 Test Results:

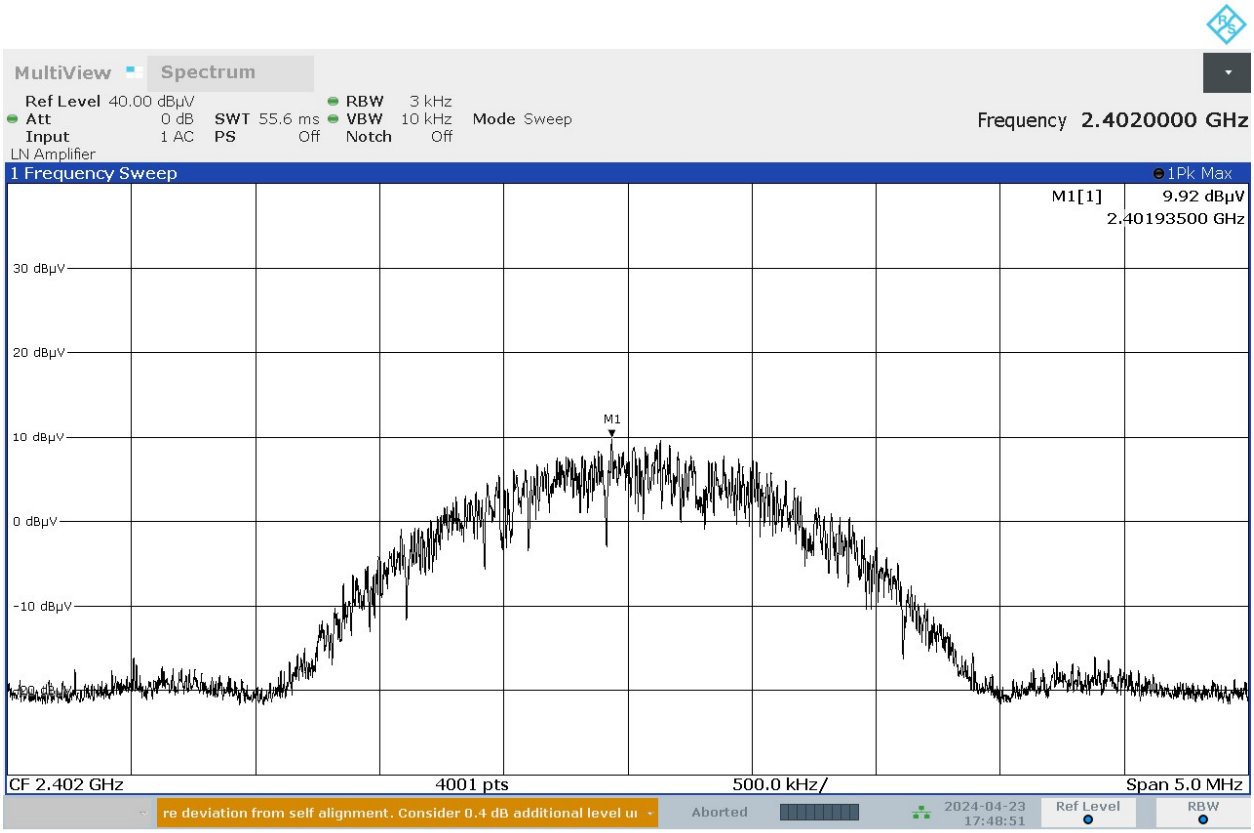
The sample tested was found to Comply. The power spectral density was less than 8 dBm/3kHz.

### 8.8 Test Data:

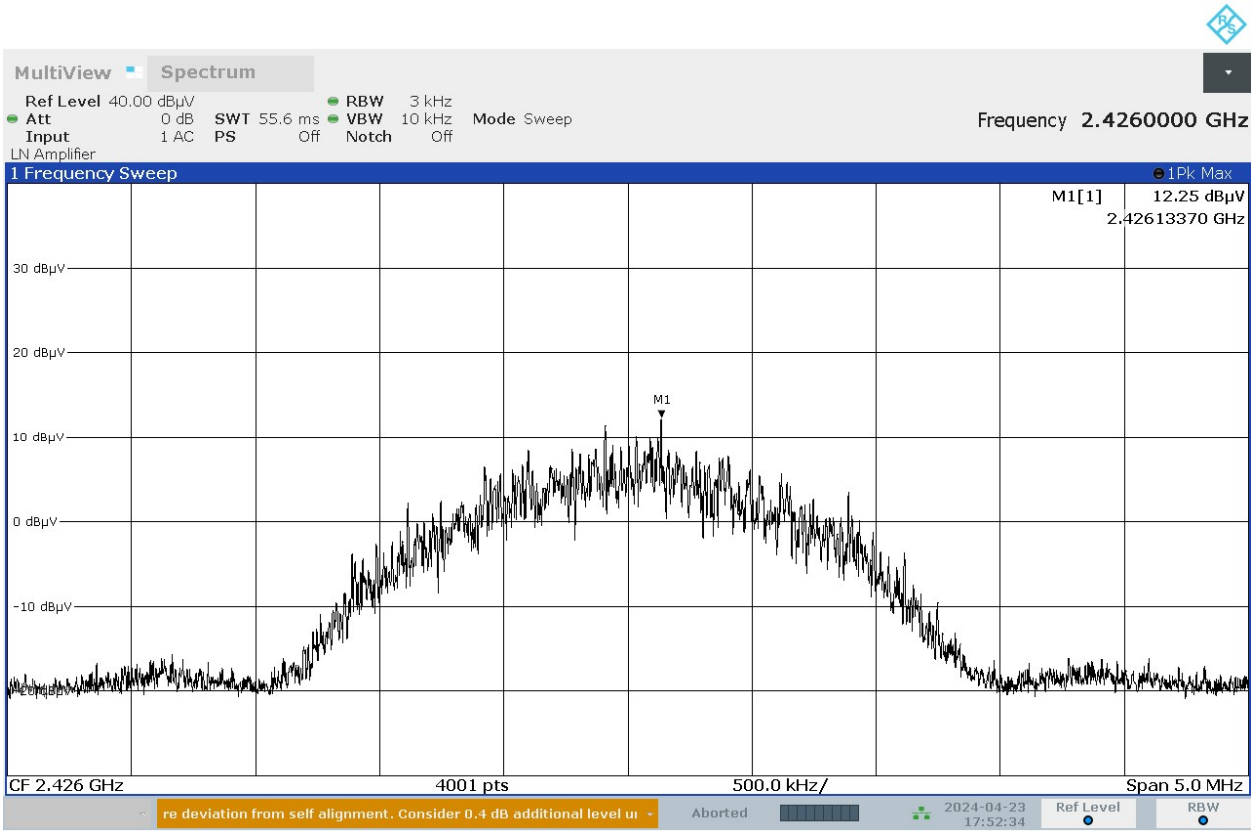
| Frequency (MHz) | Receiver Reading (dBµV/3kHz) | Cable Loss (dB) | Antenna Factor ($dBm^{-1}$) | Electric Field ($dB\mu Vm^{-1}$/3kHz) | EIRP (dBm/3kHz) | Antenna Gain (dBi) | Calculated Conducted PPSD (dBm/3kHz) |
|---|---|---|---|---|---|---|---|
| 2402 | 9.92 | 7.04 | 32.02 | 48.98 | -46.25 | 1.95 | -48.20 |
| 2426 | 12.25 | 7.08 | 32.20 | 51.53 | -43.70 | 1.95 | -45.65 |
| 2480 | 11.11 | 7.18 | 32.48 | 50.77 | -44.46 | 1.95 | -46.41 |

## 8.9 Test Plots: Power Spectral Density

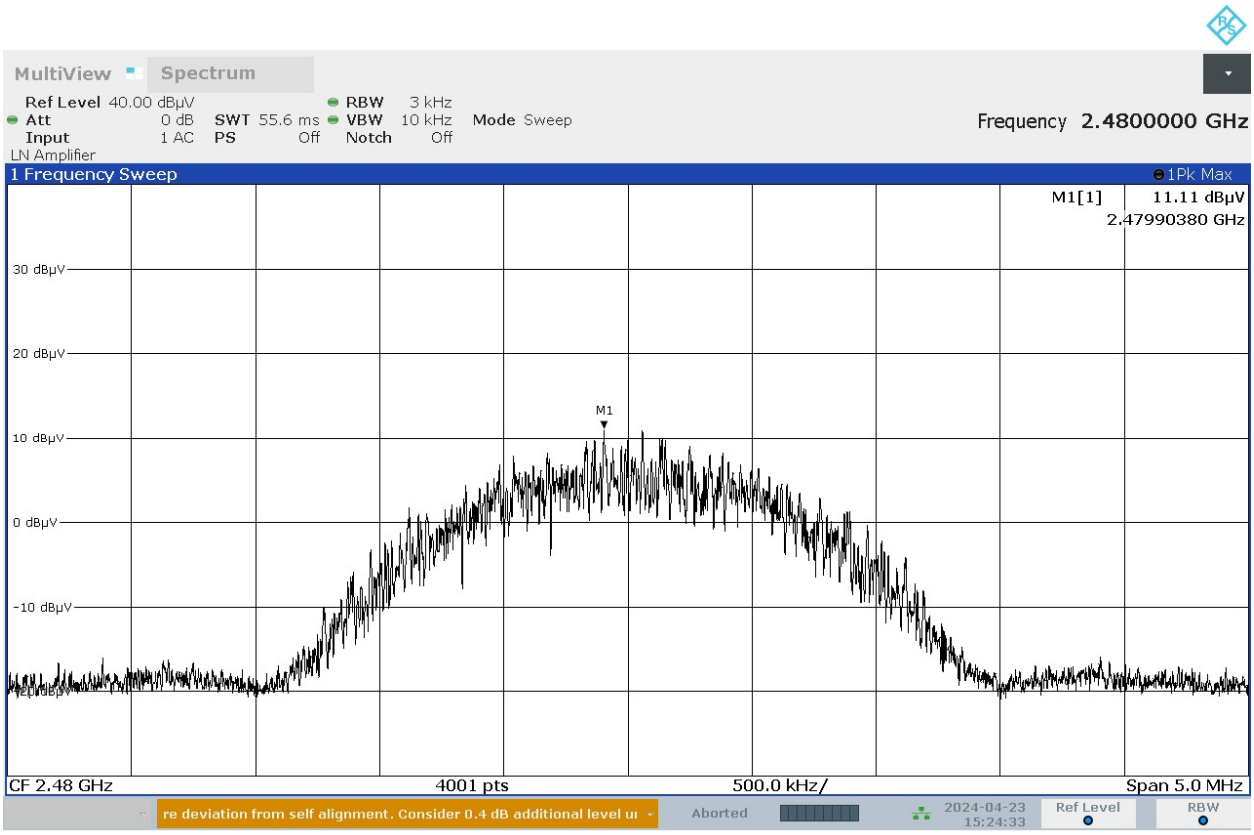
### 8.9.1 Low Channel



### 8.9.2 Mid Channel



### 8.9.3 High Channel



# 9 Radiated Spurious Emissions

## 9.1 Test Method:

Tests are performed in accordance with ANSI C63.10 §6.3 §6.5 and §6.6.

## 9.2 Test Limits:

47 CFR 15.247(d)

> 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 20 dB below that in the 100 kHz 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, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

RSS-247 §5.5

> In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

### 9.3 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 8258 | Rohde & Schwarz | ESW44 | 9/19/2023 | 9/19/2024 |
| Horn Antenna (18-40GHz) | 3779 | ETS | 3116c | 8/23/2023 | 8/23/2024 |
| Horn Antenna (1-18GHz) | 3780 | ETS | 3117 | 8/8/2023 | 8/8/2024 |
| Bilog Antenna | 7085 | SunAR | JB6 | 3/18/2024 | 3/18/2025 |
| Magnetic Loop Antenna | 2366 | ETS | 6502 | 8/28/2023 | 8/28/2024 |
| System Controller | 3957 | Sunol Sciences | SC99V | Verify at Time of Use | Verify at Time of Use |
| Preamplifier (1-18GHz) | 3918 | Rohde & Schwarz | TS-PR18 | 1/12/2024 | 1/12/2025 |
| 1-18GHz Signal Path with Preamplifier | 3074, 3918, 2588, 2593, 8188, 8185 | | | 1/12/2024 | 1/12/2025 |
| 30M-1G 3m Signal Path without Preamplifier | 3339, 2592, 8188, 8185 | | | 1/12/2024 | 1/12/2025 |
| 1-18GHz Signal Path without Preamplifier | 3074, 2588, 2593, 8188, 8185 | | | 1/12/2024 | 1/12/2025 |
| 18-40GHz Signal Path with Preamplifier | 7020, 3921, 7021 | | | 1/12/2024 | 1/12/2025 |
| Band Reject Filter | 7033 | Micro-Tronics | BRM50702 | Verify at Time of Use | Verify at Time of Use |

### 9.4 Measurement Uncertainty

| Measurement | Frequency Range | Expanded Uncertainty (k=2) | Ucispr |
|---|---|---|---|
| Radiated Emissions, 10m | 30-1000 MHz | 3.9dB | 6.3 dB |
| Radiated Emissions, 3m | 30-1000 MHz | 4.0dB | 6.3 dB |
| Radiated Emissions, 3m | 1-6 GHz | 4.7dB | 5.2 dB |
| Radiated Emissions, 3m | 6-15 GHz | 4.7dB | 5.5 dB |
| Radiated Emissions, 3m | 15-18 GHz | 4.7dB | 5.5 dB |
| Radiated Emissions, 3m | 18-40 GHz | 4.7dB | 5.5 dB |

As shown in the table above our radiated emissions $U_{lab}$ is less than the corresponding $U_{CISPR}$ reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.

### 9.5 Test Software Used:

| Description | Manufacturer | Version |
|---|---|---|
| EMC32 | Rohde & Schwarz | 10.60.20 |

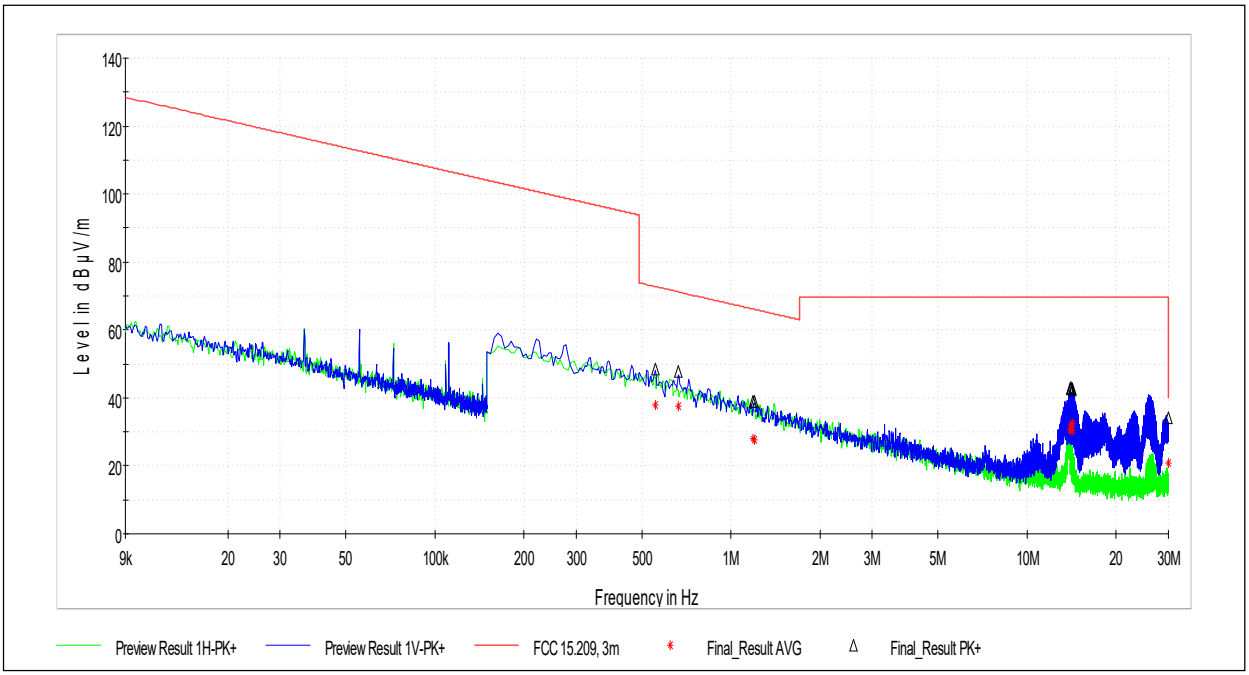
### 9.6 Test Results:

The sample tested was found to Comply. The device was investigated in three orthogonal axes.

## 9.7 Test Data: Radiated Spurious Emissions, General

### 9.7.1 Frequency Range 9kHz – 30MHz

#### 9.7.1.1 Middle Channel[1]




| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 0.554 | 48.58 | 72.74 | 24.16 | 100.0 | V | 108.0 | 12.4 |
| 0.664 | 47.77 | 71.17 | 23.40 | 100.0 | V | 0.0 | 12.3 |
| 1.186 | 38.97 | 66.14 | 27.17 | 100.0 | H | 262.0 | 12.4 |
| 1.199 | 38.92 | 66.05 | 27.13 | 100.0 | V | 290.0 | 12.4 |
| 13.986 | 42.51 | 69.50 | 26.99 | 100.0 | V | 331.0 | 11.3 |
| 14.026 | 42.87 | 69.50 | 26.63 | 100.0 | V | 0.0 | 11.3 |
| 14.065 | 42.85 | 69.50 | 26.65 | 100.0 | V | 6.0 | 11.3 |
| 14.184 | 42.66 | 69.50 | 26.84 | 100.0 | V | 0.0 | 11.3 |
| 14.223 | 42.36 | 69.50 | 27.14 | 100.0 | V | 0.0 | 11.3 |
| 30.000 | 34.16 | 40.00 | 5.84 | 100.0 | V | 6.0 | 8.8 |

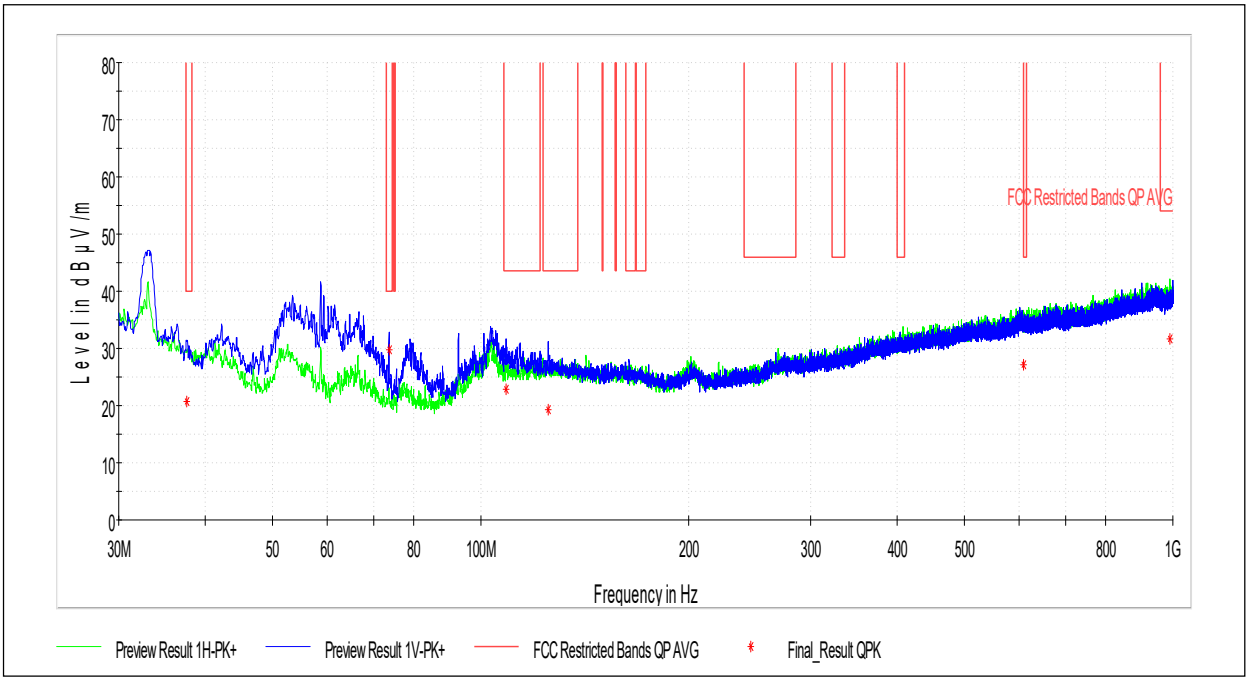
| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/23/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | See Section 9.2 |
| Product Standard: | FCC 15.247 RSS-247 | Ambient Temperature: | 21.1°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 28.0% |
| | | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: The peak emissions were less than the quasipeak limit and the device is thereby deemed to comply.

[1] Testing represents the worst case of low, middle, and high channels.

### 9.7.2 Frequency Range 30MHz – 1GHz

#### 9.7.2.1 Middle Channel[1]




| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 37.598 | 20.70 | 40.00 | 19.30 | 120.0 | V | 268.0 | 21.8 |
| 73.704 | 29.87 | 40.00 | 10.13 | 119.0 | V | 296.0 | 14.5 |
| 108.786 | 22.92 | 43.52 | 20.60 | 99.0 | V | 330.0 | 19.8 |
| 125.168 | 19.24 | 43.52 | 24.29 | 250.0 | V | 256.0 | 21.0 |
| 608.120 | 27.25 | 46.02 | 18.77 | 350.0 | H | 200.0 | 28.3 |
| 989.923 | 31.59 | 53.98 | 22.39 | 308.0 | H | 152.0 | 32.7 |

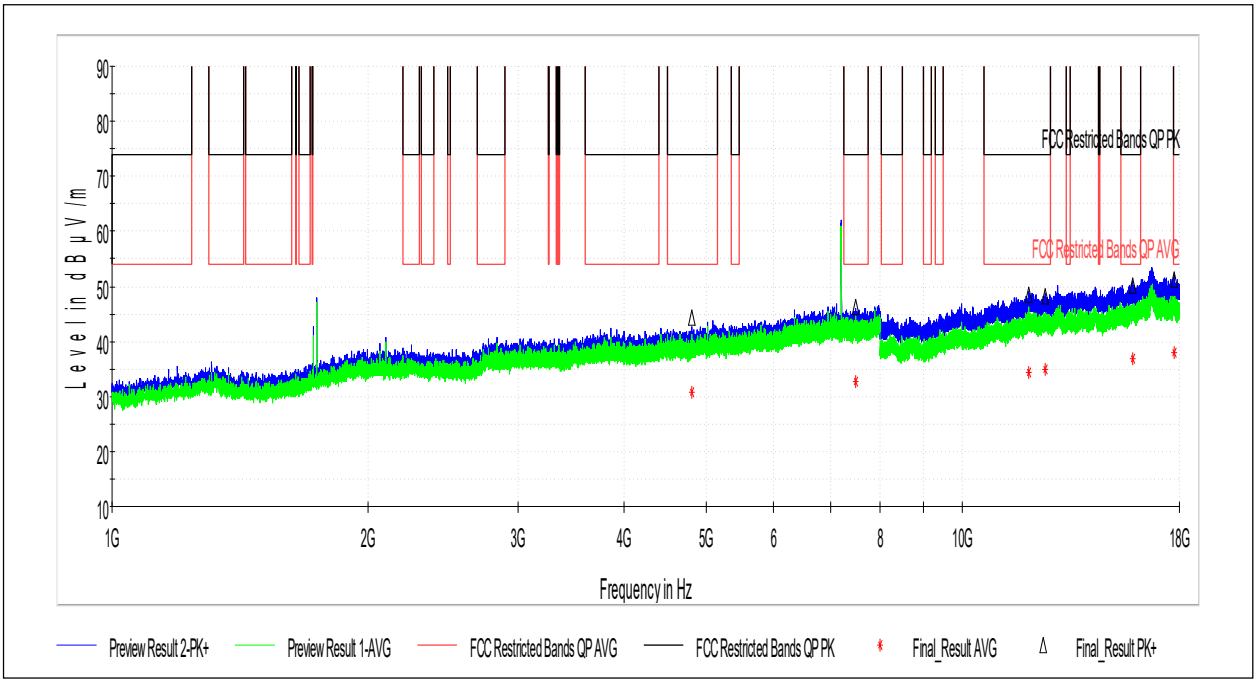
| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/23/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | See Section 9.2 |
| Product Standard: | FCC 15.247 RSS-247 | Ambient Temperature: | 21.1°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 28.0% |
| | | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: None

[1] Testing represents the worst case of low, middle, and high channels.

### 9.7.3 Frequency Range 1GHz – 18GHz

#### 9.7.3.1 Low Channel



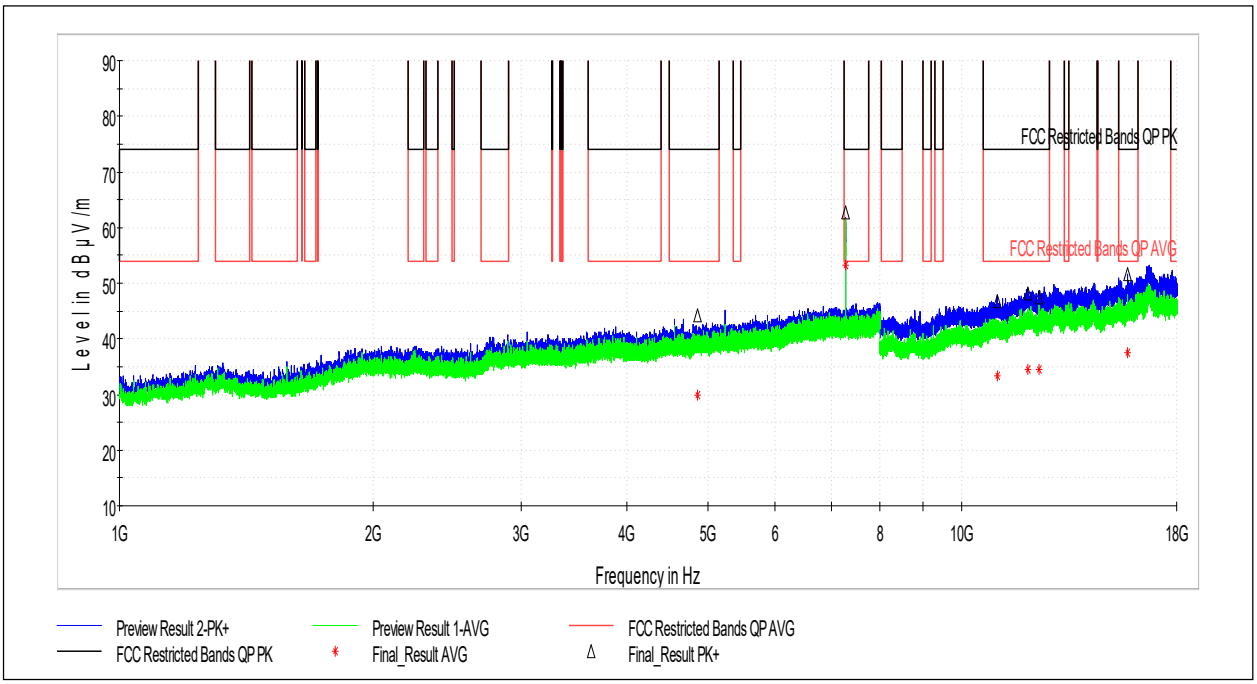

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 4804.818 | 44.26 | 73.98 | 29.72 | 153.0 | V | 259.0 | 9.6 |
| 7484.545 | 46.34 | 73.98 | 27.64 | 410.0 | H | 116.0 | 13.6 |
| 11971.000 | 48.39 | 73.98 | 25.59 | 410.0 | V | 0.0 | 20.5 |
| 12521.500 | 48.22 | 73.98 | 25.76 | 410.0 | H | 342.0 | 21.2 |
| 15863.500 | 50.26 | 73.98 | 23.72 | 410.0 | H | 309.0 | 24.2 |
| 17748.500 | 51.11 | 73.98 | 22.87 | 100.0 | H | 36.0 | 26.4 |

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 4804.818 | 30.74 | 53.98 | 23.24 | 153.0 | V | 259.0 | 9.6 |
| 7484.545 | 32.79 | 53.98 | 21.19 | 410.0 | H | 116.0 | 13.6 |
| 11971.000 | 34.47 | 53.98 | 19.51 | 410.0 | V | 0.0 | 20.5 |
| 12521.500 | 34.80 | 53.98 | 19.18 | 410.0 | H | 342.0 | 21.2 |
| 15863.500 | 36.98 | 53.98 | 17.00 | 410.0 | H | 309.0 | 24.2 |
| 17748.500 | 37.86 | 53.98 | 16.12 | 100.0 | H | 36.0 | 26.4 |

| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/23/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | See Section 9.2 |
| Product Standard: | FCC 15.247 RSS-247 | Ambient Temperature: | 21.1°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 28.0% |
| | | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: None

### 9.7.3.2 Middle Channel



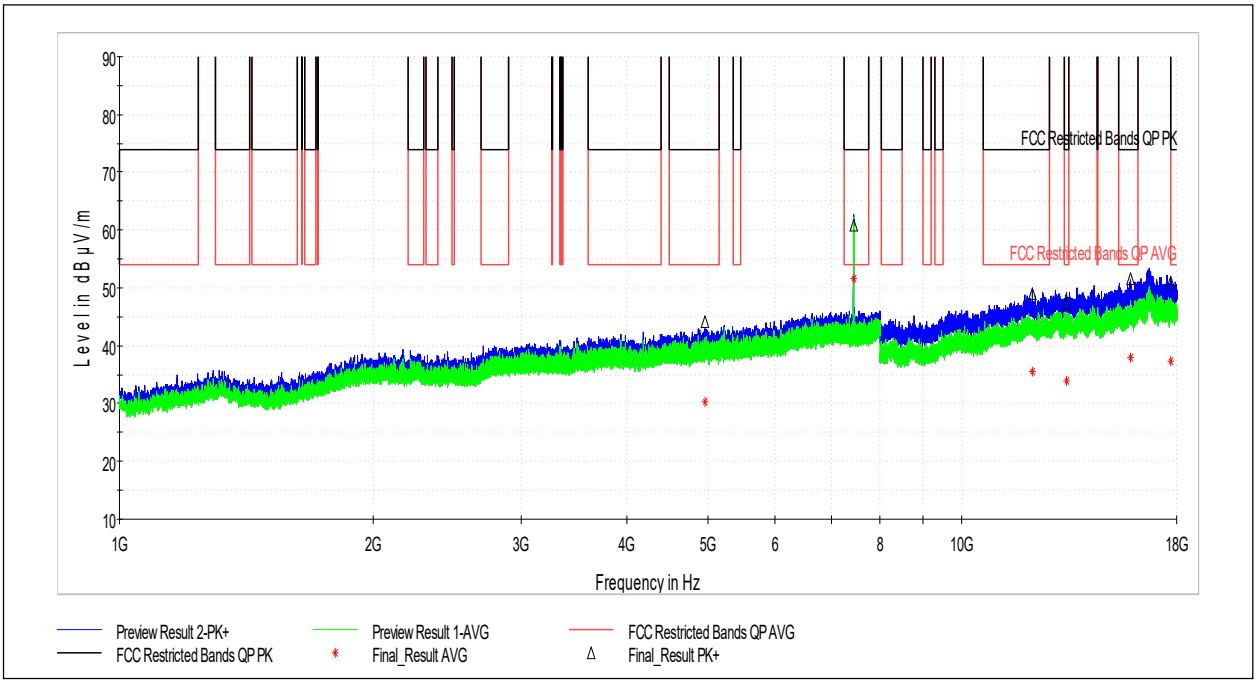

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 4852.864 | 44.25 | 73.98 | 29.73 | 304.0 | V | 246.0 | 9.7 |
| 7279.636 | 62.69 | 73.98 | 11.29 | 143.0 | V | 203.0 | 13.4 |
| 11014.000 | 46.86 | 73.98 | 27.12 | 410.0 | H | 334.0 | 19.1 |
| 11985.000 | 48.07 | 73.98 | 25.91 | 410.0 | H | 258.0 | 20.4 |
| 12347.500 | 47.52 | 73.98 | 26.46 | 410.0 | V | 46.0 | 20.9 |
| 15743.000 | 51.63 | 73.98 | 22.35 | 100.0 | V | 208.0 | 23.9 |

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 4852.864 | 29.93 | 53.98 | 24.05 | 304.0 | V | 246.0 | 9.7 |
| 7279.636 | 53.22 | 53.98 | 0.76 | 143.0 | V | 203.0 | 13.4 |
| 11014.000 | 33.42 | 53.98 | 20.56 | 410.0 | H | 334.0 | 19.1 |
| 11985.000 | 34.58 | 53.98 | 19.40 | 410.0 | H | 258.0 | 20.4 |
| 12347.500 | 34.43 | 53.98 | 19.55 | 410.0 | V | 46.0 | 20.9 |
| 15743.000 | 37.56 | 53.98 | 16.42 | 100.0 | V | 208.0 | 23.9 |

| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/23/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | See Section 9.2 |
| Product Standard: | FCC 15.247<br>RSS-247 | Ambient Temperature: | 21.1°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 28.0% |
| | | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: None

### 9.7.3.3 High Channel




| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 4960.091 | 44.13 | 73.98 | 29.85 | 309.0 | H | 188.0 | 9.8 |
| 7441.591 | 60.94 | 73.98 | 13.04 | 144.0 | V | 202.0 | 13.5 |
| 12136.500 | 48.96 | 73.98 | 25.02 | 410.0 | H | 188.0 | 20.6 |
| 13330.500 | 47.35 | 73.98 | 26.63 | 410.0 | H | 258.0 | 21.8 |
| 15879.000 | 51.63 | 73.98 | 22.35 | 410.0 | V | 282.0 | 24.3 |
| 17703.000 | 51.06 | 73.98 | 22.92 | 100.0 | H | 56.0 | 26.4 |

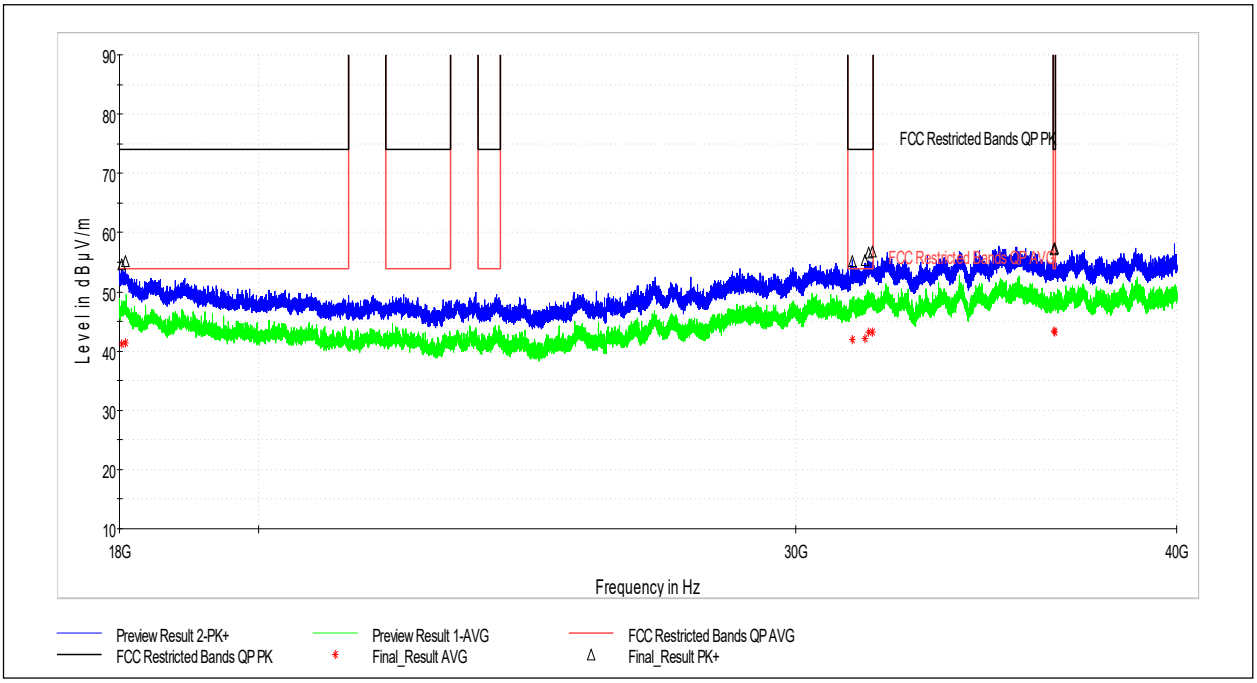
| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 4960.091 | 30.21 | 53.98 | 23.77 | 309.0 | H | 188.0 | 9.8 |
| 7441.591 | 51.65 | 53.98 | 2.33 | 144.0 | V | 202.0 | 13.5 |
| 12136.500 | 35.46 | 53.98 | 18.52 | 410.0 | H | 188.0 | 20.6 |
| 13330.500 | 34.00 | 53.98 | 19.98 | 410.0 | H | 258.0 | 21.8 |
| 15879.000 | 38.01 | 53.98 | 15.97 | 410.0 | V | 282.0 | 24.3 |
| 17703.000 | 37.28 | 53.98 | 16.70 | 100.0 | H | 56.0 | 26.4 |

| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/23/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | See Section 9.2 |
| Product Standard: | FCC 15.247 RSS-247 | Ambient Temperature: | 21.1°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 28.0% |
| | | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: None

### 9.7.4 Frequency Range 18GHz – 40GHz

#### 9.7.4.1 Middle Channel[1]




| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 18030.000 | 54.56 | 73.98 | 19.42 | 100.0 | H | 0.0 | 29.1 |
| 18085.000 | 55.10 | 73.98 | 18.88 | 410.0 | H | 0.0 | 28.9 |
| 31313.000 | 55.18 | 73.98 | 18.80 | 410.0 | V | 0.0 | 22.2 |
| 31610.000 | 55.39 | 73.98 | 18.59 | 410.0 | V | 346.0 | 22.5 |
| 31702.000 | 56.55 | 73.98 | 17.43 | 410.0 | V | 0.0 | 22.3 |
| 31779.000 | 56.72 | 73.98 | 17.26 | 410.0 | V | 0.0 | 22.3 |
| 36456.000 | 57.24 | 73.98 | 16.74 | 410.0 | H | 264.0 | 23.5 |
| 36488.000 | 57.39 | 73.98 | 16.59 | 410.0 | V | 0.0 | 23.4 |

1 The “worst-case” scenario between the low, middle, and high channels

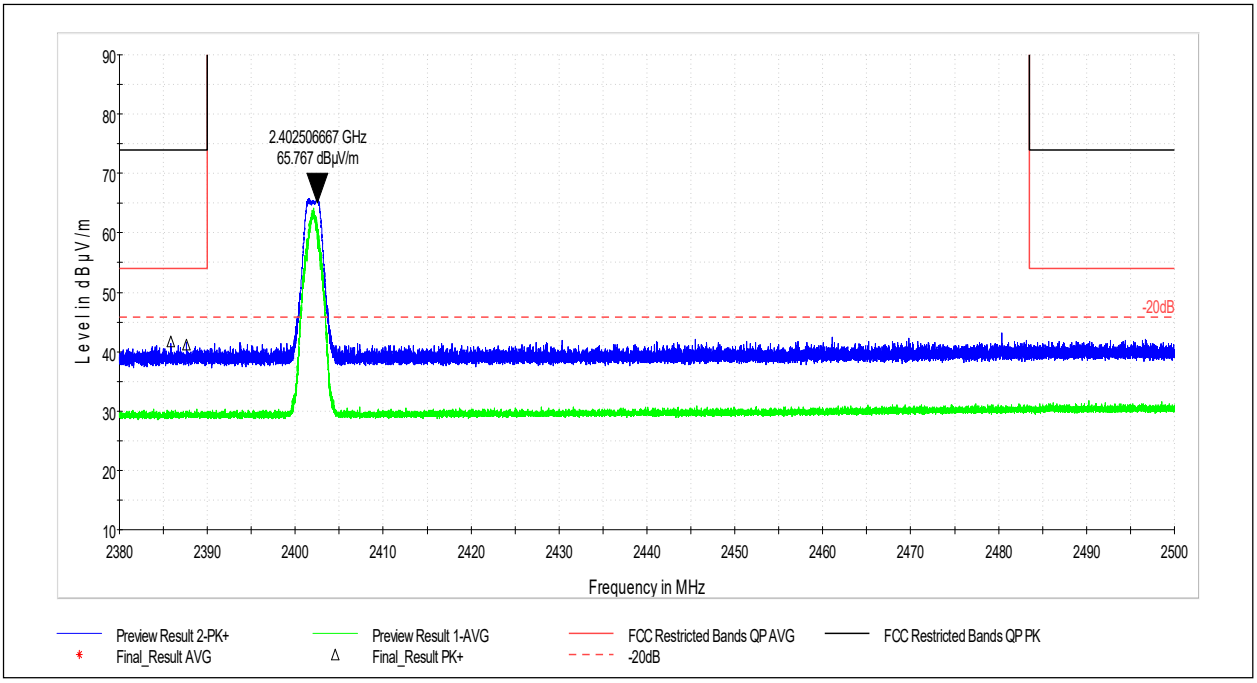
| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 18030.000 | 41.17 | 53.98 | 12.81 | 100.0 | H | 0.0 | 29.1 |
| 18085.000 | 41.37 | 53.98 | 12.61 | 410.0 | H | 0.0 | 28.9 |
| 31313.000 | 41.95 | 53.98 | 12.03 | 410.0 | V | 0.0 | 22.2 |
| 31610.000 | 42.12 | 53.98 | 11.86 | 410.0 | V | 346.0 | 22.5 |
| 31702.000 | 43.13 | 53.98 | 10.85 | 410.0 | V | 0.0 | 22.3 |
| 31779.000 | 43.18 | 53.98 | 10.80 | 410.0 | V | 0.0 | 22.3 |
| 36456.000 | 43.39 | 53.98 | 10.59 | 410.0 | H | 264.0 | 23.5 |
| 36488.000 | 43.19 | 53.98 | 10.79 | 410.0 | V | 0.0 | 23.4 |

| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/23/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | See Section 9.2 |
| Product Standard: | FCC 15.247 RSS-247 | Ambient Temperature: | 21.1°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 28.0% |
| | | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: None

## 9.8 Test Data: Radiated Emissions, Band Edge

### 9.8.1 Low Channel Band Edge



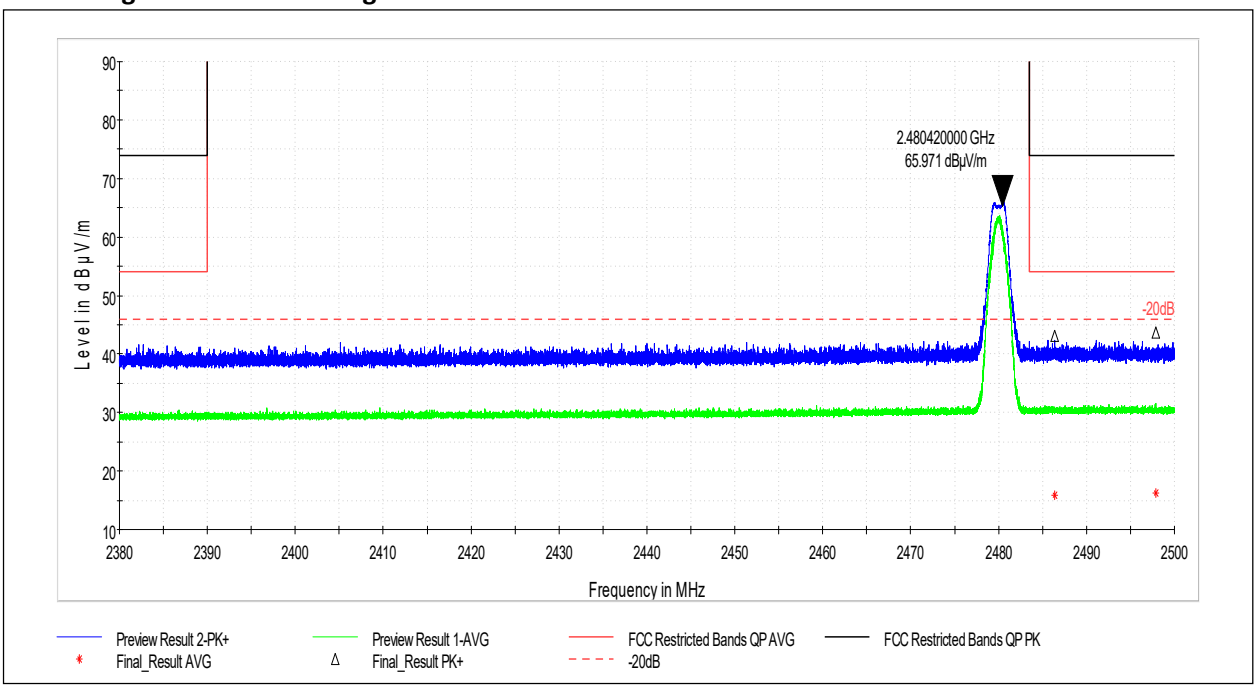

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 2385.820 | 41.64 | 73.98 | 32.34 | 293.0 | H | 335.0 | 39.0 |
| 2387.647 | 41.19 | 73.98 | 32.79 | 187.0 | H | 0.0 | 39.0 |

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 2385.820 | 8.02 | 53.98 | 45.96 | 293.0 | H | 335.0 | 39.0 |
| 2387.647 | 8.15 | 53.98 | 45.83 | 187.0 | H | 0.0 | 39.0 |

| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/23/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | See Section 9.2 |
| Product Standard: | FCC 15.247 RSS-247 | Ambient Temperature: | 21.1°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 28.0% |
| | | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: None

### 9.8.2 High Channel Band Edge




| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 2486.407 | 43.11 | 73.98 | 30.87 | 410.0 | H | 210.0 | 39.7 |
| 2497.860 | 43.73 | 73.98 | 30.25 | 393.0 | H | 69.0 | 39.6 |

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 2486.407 | 15.90 | 53.98 | 38.08 | 410.0 | H | 210.0 | 39.7 |
| 2497.860 | 16.27 | 53.98 | 37.71 | 393.0 | H | 69.0 | 39.6 |

| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/23/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | See Section 9.2 |
| Product Standard: | FCC 15.247 RSS-247 | Ambient Temperature: | 21.1°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 28.0% |
| | | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: None

# 10 Antenna Requirement

## 10.1 Test Limits

**FCC Part 15.203:**

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

**RSS-Gen Issue 5 § 6.8:**

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the license-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

License-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the license-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of license-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

*This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.*

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

## 10.2 Test Results

The device was found to be **compliant**. The device has an internal, permanently affixed antenna.

# 11 Conducted Emissions

## 11.1 Method

Tests are performed in accordance with ANSI C63.4:2014.

**TEST SITE:** Ground Plane

**Site Designation:** Ground Plane

**Measurement Uncertainty**

| Measurement | Frequency Range | Expanded Uncertainty (k=2) | Ucispr |
|---|---|---|---|
| Power Line Conducted Emissions | 150 kHz - 30 MHz | 3.1dB | 3.4dB |

As shown in the table above our conducted emissions $U_{lab}$ is less than the corresponding $U_{CISPR}$ reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.

## 11.2 Sample Calculations

The following is how net line-conducted readings were determined:

NF = RF + LF + CF + AF
Where NF = Net Reading in dBμV
RF = Reading from receiver in dBμV
LF = LISN or ISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

**Example:**

NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBμV
$UF = 10^{(49.1\ dB\mu V / 20)}$ = 285.1 μV/m

### 11.3 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 8296 | Rohde & Schwarz | EPL1000 | 1/1/2024 | 1/1/2025 |
| LISN | 2508 | Fischer Custom Communication | FCC-LISN-50-50-2M | 7/31/2023 | 7/31/2024 |
| Coaxial Cable | 8307 | | | 1/22/2024 | 1/22/2025 |

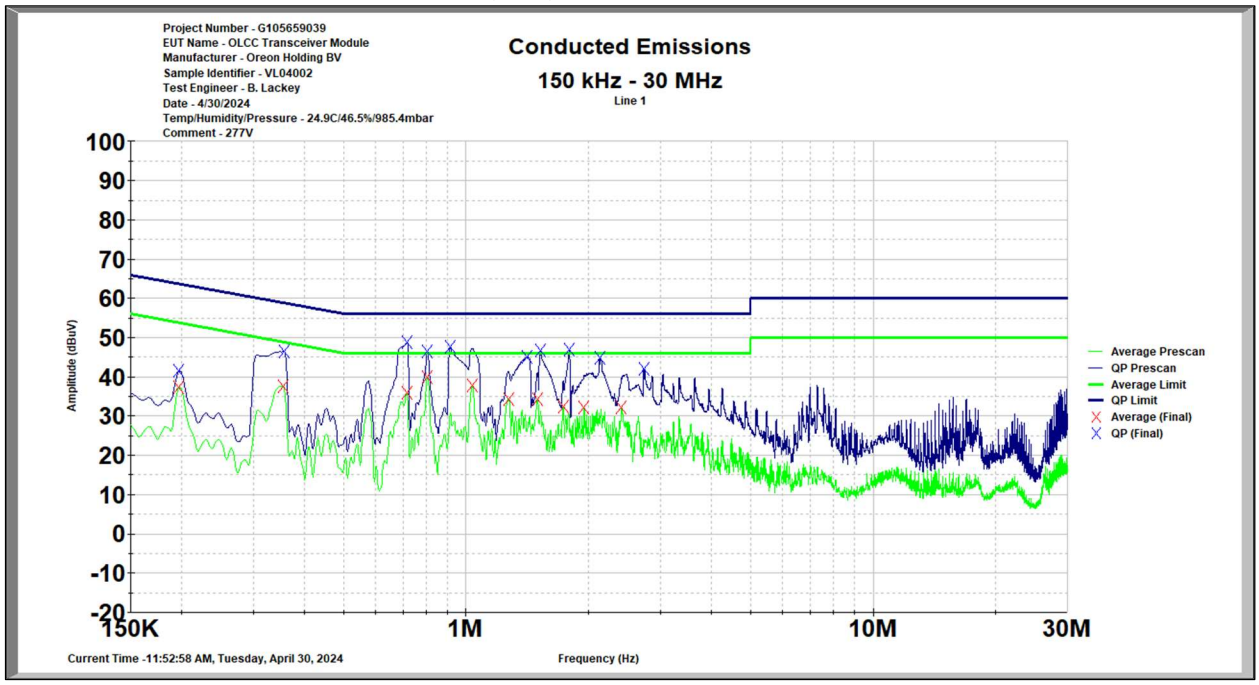
### 11.4 Software Utilized:

| Name | Manufacturer | Version |
|---|---|---|
| TILE | ETS Lindgren | V7.0.6.545 |

### 11.5 Results:

The sample tested was found to Comply.

## 11.6 Plots/Data: Conducted Emissions (Line)



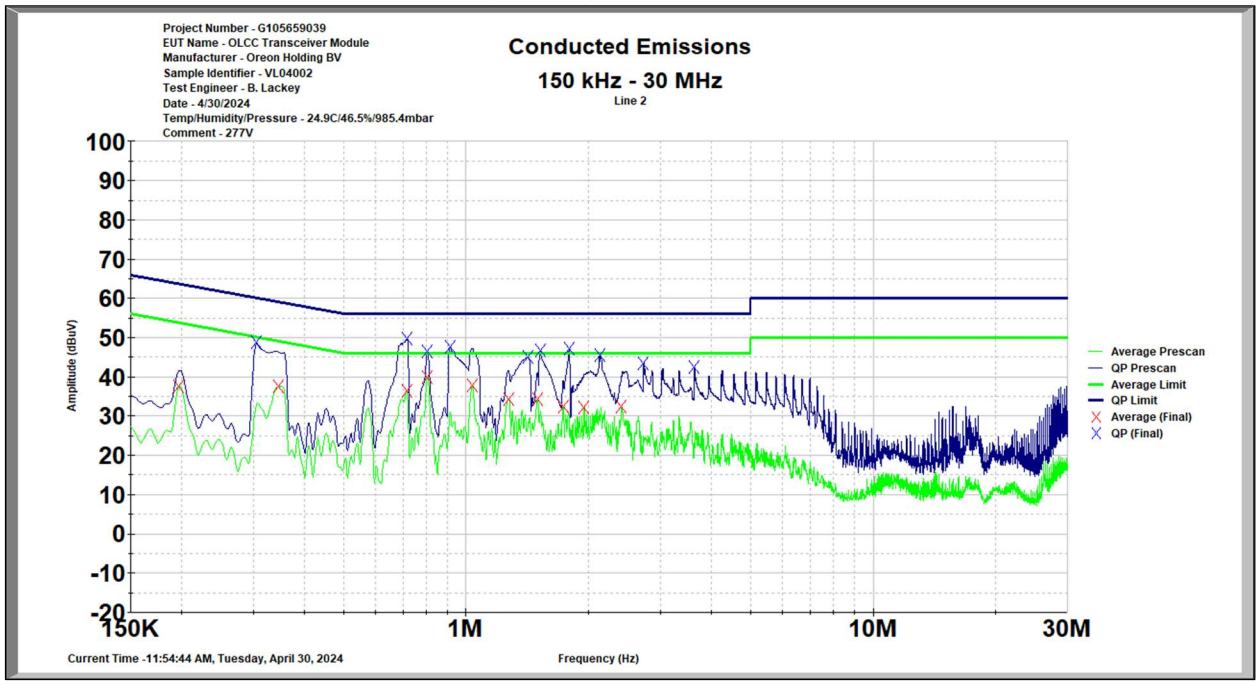

| Frequency (MHz) | Quasi-Peak (dBuV) | Quasi-Peak Limit (dBuV) | Quasi-Peak Margin (dB) |
|---|---|---|---|
| 0.197 | 41.420 | 64.650 | 23.230 |
| 0.357 | 46.549 | 60.086 | 13.537 |
| 0.717 | 48.866 | 56.000 | 7.134 |
| 0.805 | 46.459 | 56.000 | 9.541 |
| 0.915 | 47.537 | 56.000 | 8.463 |
| 1.415 | 45.004 | 56.000 | 10.996 |
| 1.525 | 46.772 | 56.000 | 9.228 |
| 1.793 | 46.923 | 56.000 | 9.077 |
| 2.135 | 44.849 | 56.000 | 11.151 |
| 2.742 | 42.072 | 56.000 | 13.928 |

| Frequency (MHz) | Average (dBuV) | Average Limit (dBuV) | Average Margin (dB) |
|---|---|---|---|
| 0.197 | 37.430 | 54.650 | 17.220 |
| 0.355 | 37.627 | 50.150 | 12.523 |
| 0.715 | 35.803 | 46.000 | 10.197 |
| 0.805 | 39.953 | 46.000 | 6.047 |
| 1.034 | 37.679 | 46.000 | 8.321 |
| 1.273 | 34.272 | 46.000 | 11.728 |
| 1.498 | 34.283 | 46.000 | 11.717 |
| 1.732 | 32.414 | 46.000 | 13.586 |
| 1.950 | 32.130 | 46.000 | 13.870 |
| 2.409 | 32.268 | 46.000 | 13.732 |

| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/30/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.207 RSS-Gen Issue 5 Table 3 |
| Product Standard: | FCC Part 15.207 RSS-Gen Issue 5 | Ambient Temperature: | 24.9°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 46.5% |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: None

## 11.7 Plots/Data: Conducted Emissions (Neutral)




| Frequency (MHz) | Quasi-Peak (dBuV) | Quasi-Peak Limit (dBuV) | Quasi-Peak Margin (dB) |
|---|---|---|---|
| 0.305 | 48.678 | 61.564 | 12.887 |
| 0.717 | 49.691 | 56.000 | 6.309 |
| 0.805 | 46.468 | 56.000 | 9.532 |
| 0.915 | 47.684 | 56.000 | 8.316 |
| 1.421 | 44.980 | 56.000 | 11.020 |
| 1.523 | 46.703 | 56.000 | 9.297 |
| 1.793 | 47.108 | 56.000 | 8.892 |
| 2.132 | 45.488 | 56.000 | 10.512 |
| 2.726 | 43.405 | 56.000 | 12.595 |
| 3.635 | 42.424 | 56.000 | 13.576 |

| Frequency (MHz) | Average (dBuV) | Average Limit (dBuV) | Average Margin (dB) |
|---|---|---|---|
| 0.197 | 37.484 | 54.650 | 17.166 |
| 0.346 | 37.586 | 50.407 | 12.821 |
| 0.715 | 36.488 | 46.000 | 9.512 |
| 0.805 | 39.965 | 46.000 | 6.035 |
| 1.034 | 37.703 | 46.000 | 8.297 |
| 1.273 | 34.310 | 46.000 | 11.690 |
| 1.498 | 34.328 | 46.000 | 11.672 |
| 1.732 | 32.527 | 46.000 | 13.473 |
| 1.950 | 32.226 | 46.000 | 13.774 |
| 2.409 | 32.475 | 46.000 | 13.525 |

| | | | |
|---|---|---|---|
| Test Personnel: | Brian Lackey | Test Date: | 4/30/2024 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.207 RSS-Gen Issue 5 Table 3 |
| Product Standard: | FCC Part 15.207 RSS-Gen Issue 5 | Ambient Temperature: | 24.9°C |
| Input Voltage: | 120V/60Hz | Relative Humidity: | 46.5% |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 985.4mbar |

Deviations, Additions, or Exclusions: None

## 12 Revision History

| Revision Level | Date | Report Number | Prepared By | Reviewed By | Notes |
|---|---|---|---|---|---|
| 0 | 5/2/2024 | 105659039LEX-001 | BL | MC | Original Issue |
| 1 | 5/17/2024 | 105659039LEX-001.1 | BL | MC | Corrected naming/labeling/units |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |