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# Otodata Wireless Network Inc.
# TEST REPORT

**SCOPE OF WORK**
EMC TESTING – TM5240 TANK MONITOR

**REPORT NUMBER**
105397891LEX-002.1

**ISSUE DATE** **REVISED DATE**
12/8/2023 1/22/2024

**PAGES**
46

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


# EMC TEST REPORT

(FULL COMPLIANCE)

**Report Number:** 105397891LEX-002.1
**Project Number:** G105397891

**Report Issue Date:** 12/8/2023
**Report Revised Date:** 1/22/2024

**Model(s) Tested:** TM5240 Tank Monitor

**Standards:** Title 47 CFR Part 15.247
RSS-247 Issue 2
RSS-Gen Issue 5

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

Client:
Otodata Wireless Network Inc.
1180 De Louvain Street West
Montreal, QC H4N 1G5
Canada

Report prepared by

Seth Parker, Associate Engineer

Report reviewed by

Michael Carlson, EMC Engineer

# Table of Contents

## 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 | Radiated Spurious Emissions<br>(FCC Part 15.247(d), RSS-247 Issue 2 § 5.5) | Pass |
| 7 | Conducted Spurious Emissions<br>(FCC Part 15.247(d), RSS-247 Issue 2 § 5.5) | Pass |
| 8 | Output Power<br>(FCC Part 15.247(b)(3), RSS-247 Issue 2 § 5.4(d)) | Pass |
| 9 | Occupied Bandwidth<br>(FCC Part 15.247, RSS-247 Issue 2 § 5.2(a)) | Pass |
| 10 | Power Spectral Density<br>(FCC Part 15.247(e), RSS-247 Issue 2 § 5.2(b)) | Pass |
| 11 | Antenna Requirement<br>(FCC Part 15.203, RSS-Gen Issue 5 § 6.8) | Pass |

## 3 Client Information

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

| Client Information | |
|---|---|
| **Client Name:** | Otodata Wireless Network Inc. |
| **Address:** | 1180 De Louvain Street West<br>Montreal, QC H4N 1G5<br>Canada |
| **Contact:** | Julien Renaud |
| **Email:** | jrenaud@otodata.com |
| **Manufacturer Information** | |
| **Manufacturer Name:** | Otodata Wireless Network Inc. |
| **Manufacturer Address:** | 1180 De Louvain Street West<br>Montreal, QC H4N 1G5<br>Canada |

## 4 Description of Equipment under Test and Variant Models

| Equipment Under Test | |
|---|---|
| **Product Name** | TM5240 Tank Monitor |
| **Model Numbers** | MZ03AD |
| **Hardware Version** | C032 V1 |
| **Software Version** | 2208 |
| **Supported Transmit Bands** | BLE: 2402 MHz – 2480 MHz |
| **Embedded Module** | STMicroelectronics STM32WB55Cx |
| **Receive Date** | 6/28/2023 |
| **Test Start Date** | 8/24/2023 |
| **Test End Date** | 9/11/2023 |
| **Device Received Condition** | Good |
| **Test Sample Type** | Production |
| **Antenna Gain** | 2402 MHz: 1.73 dBi[1]<br>2440 MHz: 1.55 dBi[1]<br>2480 MHz: 1.77 dBi[1] |
| **Input Ratings** | Non-rechargeable 3.6VDC, 19Ah Battery |
| **Description of Equipment Under Test (provided by client)** | |
| The TM5240 Tank Monitor is a battery-operated Wireless Remote Tank Level Monitor. | |

### 4.1 Variant Models:

There were no variant models covered by this evaluation.

1 The antenna gain values are sourced from the Antenna Performance Test Report, Document Control Number: 208535. Intertek does not make claims of compliance for values other than those shown here.

# 5 System Setup and Method

## 5.1 Method:

Configuration as required by ANSI C63.10:2013.

| No. | Descriptions of EUT Exercising |
|---|---|
| 1 | Transmitting a Bluetooth Low Energy (BLE) signal or low, middle, or high channel with a duty cycle >98%. |

| Cables | | | | | |
|---|---|---|---|---|---|
| Qty | Description | Length (m) | Shielding | Ferrites | Termination |
| - | - | - | - | - | - |

| Support Equipment | | | |
|---|---|---|---|
| Description | Manufacturer | Model Number | Serial Number |
| - | - | - | - |

## 5.2 EUT Block Diagram:

# 6 Transmitter Spurious Emissions & Band Edge

**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.

## 6.1 Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

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:**

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

## 6.2 Test Limits:

**FCC Part 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 Issue 2 § 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 be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

## 6.3 Test Method:

Tests are performed in accordance with ANSI C63.10:2013 § 11.12.1 Radiated emission measurements.

### 6.4 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 8285 | Rohde & Schwarz | EW44 | 12/23/2022 | 12/23/2023 |
| Magnetic Loop Antenna | 2366 | ETS | 6502 | 8/28/2023 | 8/28/2024 |
| Bilog Antenna (30MHz-1GHz) | 7085 | SunAR | JB6 | 3/7/2023 | 3/7/2024 |
| Horn Antenna (1-18GHz) | 4001 | ETS | 3117 | 2/28/2023 | 2/28/2024 |
| Horn Antenna (18-40GHz) | 3779 | ETS | 3116c | 8/29/2022 | 8/29/2023 |
| System Controller | 4096 | ETS Lindgren | 2090 | Verify at Time of Use | Verify at Time of Use |
| System Controller | 3957 | Sunol Sciences | SC99V | Verify at Time of Use | Verify at Time of Use |
| Preamplifier | 3918 | Rohde & Schwarz | TS-PR18 | 1/10/2023 | 1/10/2024 |
| Coaxial Cable | 3074 | | | 1/10/2023 | 1/10/2024 |
| Coaxial Cable | 2588 | | | 1/10/2023 | 1/10/2024 |
| Coaxial Cable | 2593 | | | 1/10/2023 | 1/10/2024 |
| Coaxial Cable | 3918 | | | 1/10/2023 | 1/10/2024 |
| Coaxial Cable | 8185 | | | 1/10/2023 | 1/10/2024 |
| Coaxial Cable | 8188 | | | 1/10/2023 | 1/10/2024 |
| Preamplifier (18-40GHz) | 3921 | Rohde & Schwarz | TS-PR40 | 1/12/2023 | 1/12/2024 |
| Coaxial Cable | 7020 | | | 1/12/2023 | 1/12/2024 |
| Coaxial Cable | 7021 | | | 1/12/2023 | 1/12/2024 |

### 6.5 Software Utilized:

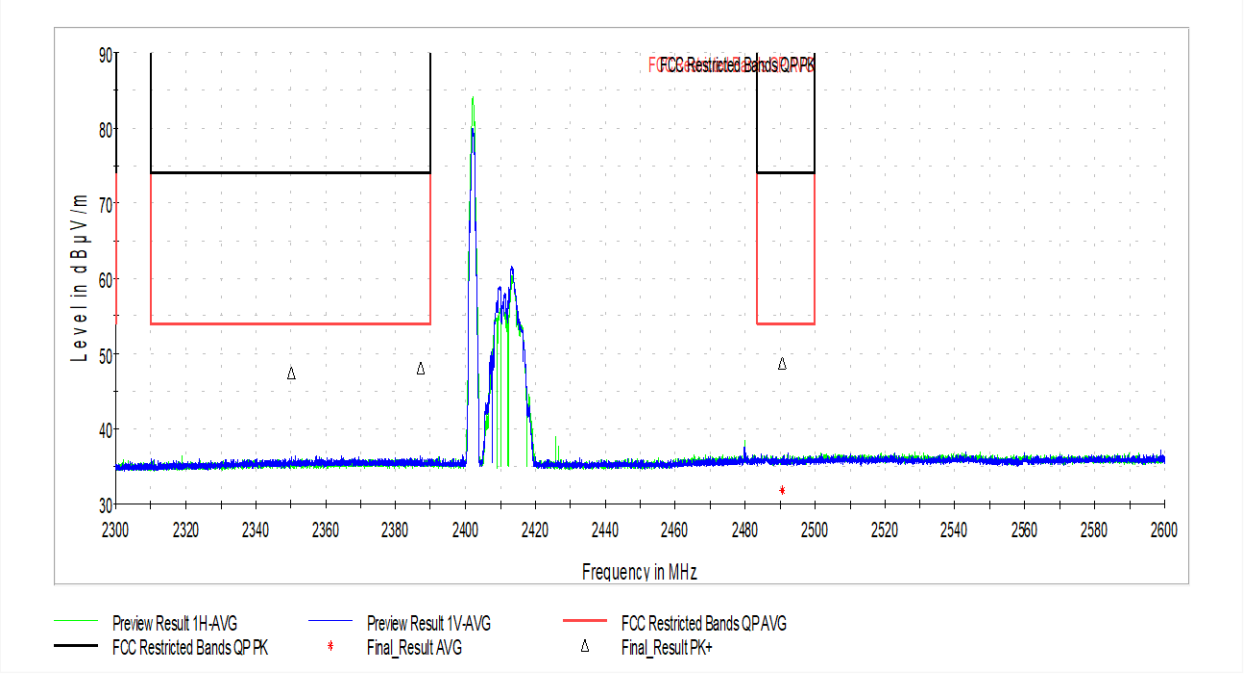
| Name | Manufacturer | Version |
|---|---|---|
| EMC32 | Rohde & Schwarz | Version 10.60.20 |

### 6.6 Test Results:

The sample tested was found to be **compliant**. The data presented represents the worst-case emissions with the device positioned in three orthogonal positions.

## 6.7 Test Data: Radiated Band Edge:

### 6.7.1 2402 MHz:



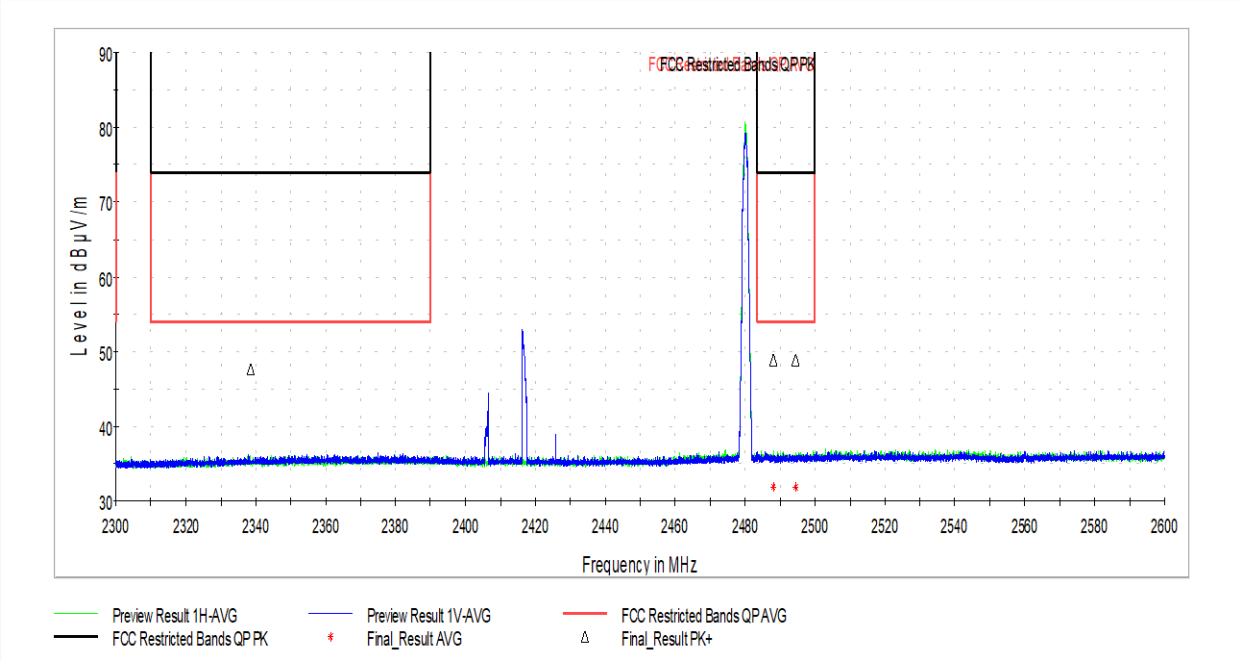

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 2350.150 | 47.46 | 73.98 | 26.52 | 300.0 | V | 228.0 | 25.7 |
| 2387.100 | 48.09 | 73.98 | 25.89 | 198.0 | V | 0.0 | 25.7 |
| 2490.717 | 48.73 | 73.98 | 25.25 | 350.0 | H | 167.0 | 25.8 |

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 2350.150 | 29.83 | 53.98 | 24.15 | 300.0 | V | 228.0 | 25.7 |
| 2387.100 | 29.83 | 53.98 | 24.15 | 198.0 | V | 0.0 | 25.7 |
| 2490.717 | 31.77 | 53.98 | 22.21 | 350.0 | H | 167.0 | 25.8 |

| | | | |
|---|---|---|---|
| Test Personnel: | Seth Parker | Test Date: | 8/23/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.209 in Restricted Bands from FCC Part 15.205 |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 23.5 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 45.5 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 988.7 mbar |

Deviations, Additions, or Exclusions: None

### 6.7.2 2480 MHz:




| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 2338.483 | 47.57 | 73.98 | 26.41 | 364.0 | H | 253.0 | 25.7 |
| 2488.150 | 48.87 | 73.98 | 25.11 | 259.0 | H | 168.0 | 25.8 |
| 2494.533 | 48.91 | 73.98 | 25.07 | 259.0 | H | 0.0 | 25.8 |

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 2338.483 | 29.51 | 53.98 | 24.47 | 364.0 | H | 253.0 | 25.7 |
| 2488.150 | 31.82 | 53.98 | 22.16 | 259.0 | H | 168.0 | 25.8 |
| 2494.533 | 31.85 | 53.98 | 22.13 | 259.0 | H | 0.0 | 25.8 |

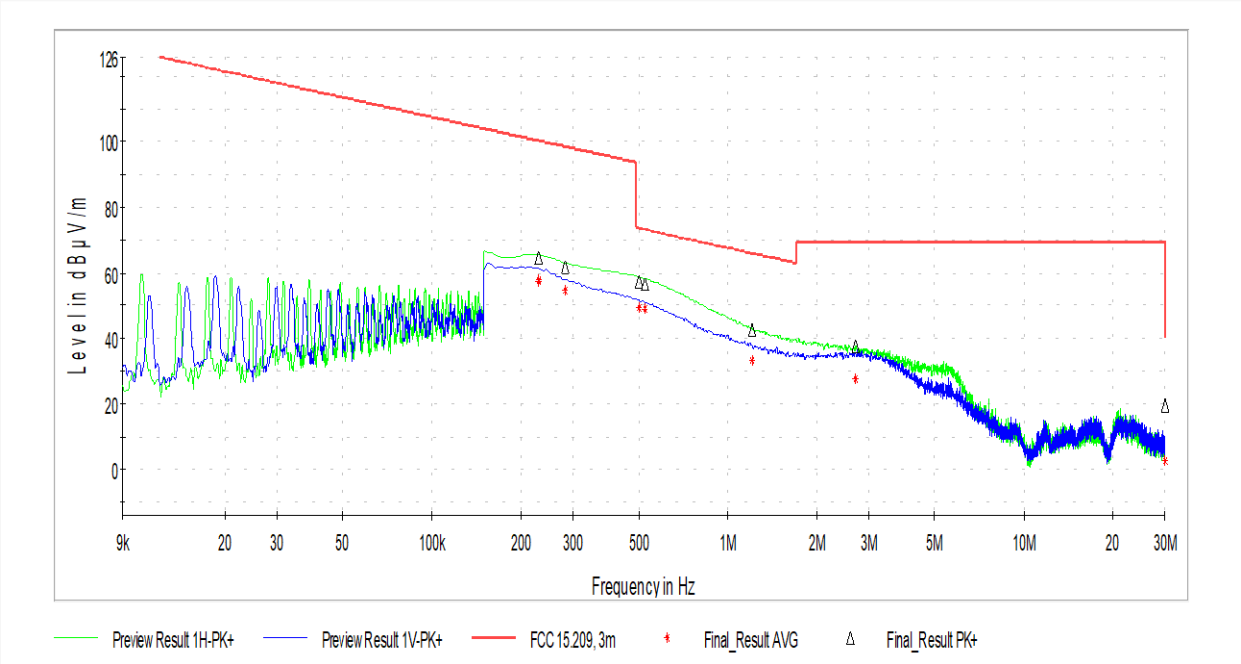
| | | | |
|---|---|---|---|
| Test Personnel: | Seth Parker | Test Date: | 8/23/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.209 in Restricted Bands from FCC Part 15.205 |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 23.5 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 45.5 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 988.7 mbar |

Deviations, Additions, or Exclusions: None

## 6.8 Test Data: Radiated Spurious Emissions:

### 6.8.1 9kHz – 30 MHz:

#### 6.8.1.1 2442 MHz:



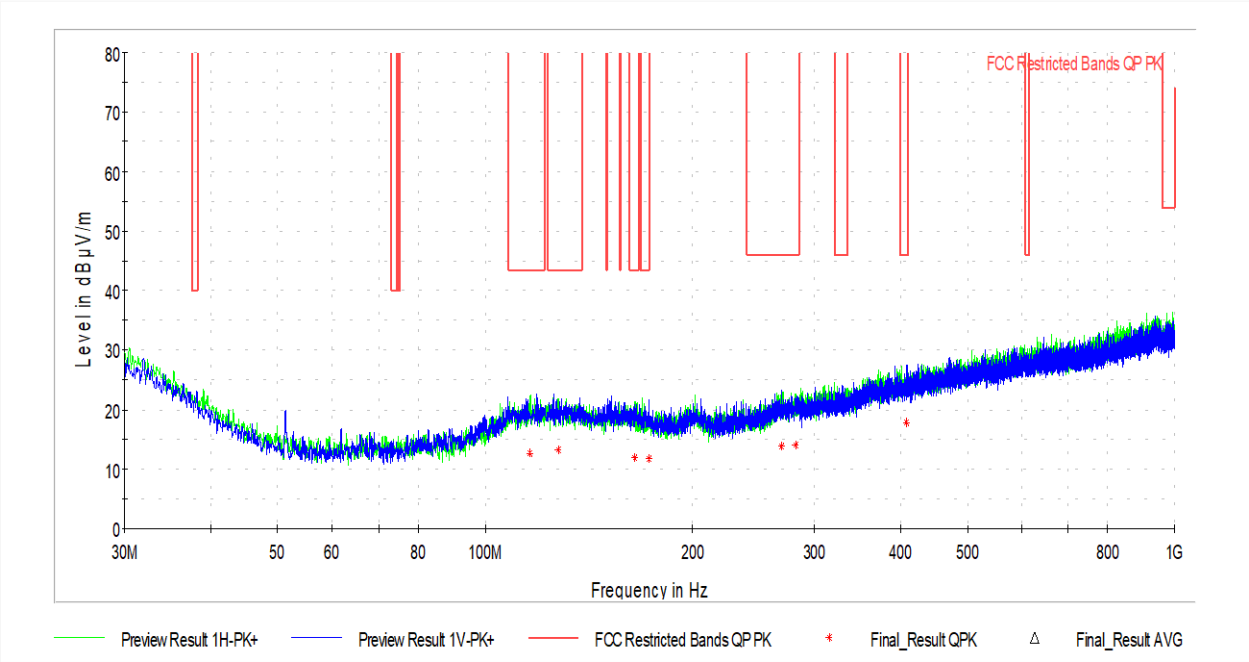

| Frequency (MHz) | Average (dBµV/m) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Bandwidth (kHz) | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 0.229 | 57.34 | --- | 100.40 | 43.06 | 9.000 | 81.0 | 11.7 |
| 0.229 | --- | 64.71 | 100.40 | 35.69 | 9.000 | 81.0 | 11.7 |
| 0.229 | 57.62 | --- | 100.40 | 42.79 | 9.000 | 78.0 | 11.7 |
| 0.229 | --- | 64.85 | 100.40 | 35.55 | 9.000 | 78.0 | 11.7 |
| 0.282 | 54.69 | --- | 98.61 | 43.91 | 9.000 | 359.0 | 11.7 |
| 0.282 | --- | 61.95 | 98.61 | 36.66 | 9.000 | 359.0 | 11.7 |
| 0.501 | 49.50 | --- | 73.61 | 24.10 | 9.000 | 0.0 | 11.6 |
| 0.501 | --- | 57.36 | 73.61 | 16.25 | 9.000 | 0.0 | 11.6 |
| 0.523 | 48.87 | --- | 73.23 | 24.36 | 9.000 | 270.0 | 11.6 |
| 0.523 | --- | 56.75 | 73.23 | 16.48 | 9.000 | 270.0 | 11.6 |
| 1.208 | 33.30 | --- | 65.99 | 32.68 | 9.000 | 270.0 | 11.7 |
| 1.208 | --- | 42.64 | 65.99 | 23.35 | 9.000 | 270.0 | 11.7 |
| 2.705 | 27.69 | --- | 69.50 | 41.81 | 9.000 | 270.0 | 11.2 |
| 2.705 | --- | 37.57 | 69.50 | 31.93 | 9.000 | 270.0 | 11.2 |
| 30.000 | 2.55 | --- | 69.50 | 66.95 | 9.000 | 270.0 | 8.1 |
| 30.000 | --- | 19.51 | 69.50 | 49.99 | 9.000 | 270.0 | 8.1 |

| | | | |
|---|---|---|---|
| Test Personnel: | David Perry, Leo Richter | Test Date: | 9/7/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.209 in Restricted Bands from FCC Part 15.205 |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 22.4 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 59.1 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 980.2 mbar |

Note: Testing represents the worst case of low, middle, and high channels.

### 6.8.2 30MHz – 1 GHz:

### 6.8.2.1 2402 MHz:



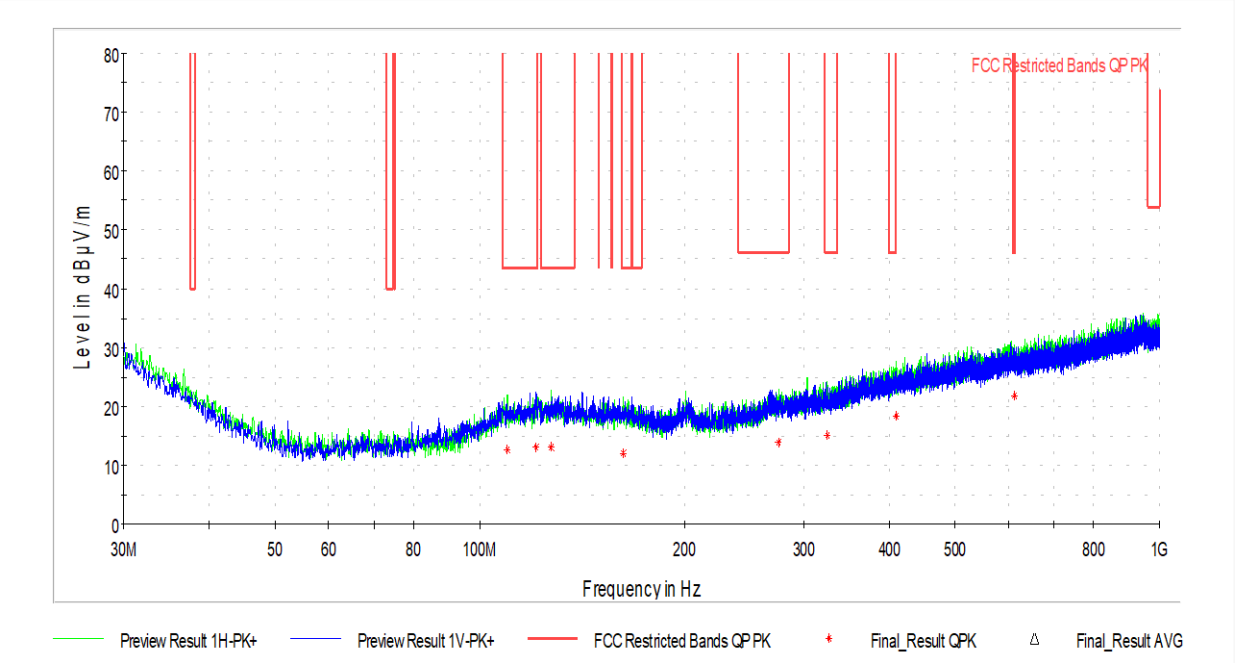

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 116.168 | 12.74 | 43.52 | 30.78 | 400.0 | H | 318.0 | 20.4 |
| 127.647 | 13.11 | 43.52 | 30.41 | 100.0 | H | 330.0 | 20.9 |
| 164.830 | 11.92 | 43.52 | 31.60 | 232.0 | H | 256.0 | 20.0 |
| 172.752 | 11.69 | 43.52 | 31.83 | 398.0 | V | 57.0 | 19.6 |
| 268.836 | 13.73 | 46.02 | 32.29 | 100.0 | V | 17.0 | 21.3 |
| 281.984 | 13.95 | 46.02 | 32.07 | 242.0 | H | 137.0 | 21.7 |
| 408.623 | 17.74 | 46.02 | 28.28 | 400.0 | V | 184.0 | 24.3 |

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 116.168 | 12.71 | 43.52 | 30.81 | 400.0 | H | 318.0 | 20.4 |
| 127.647 | 13.13 | 43.52 | 30.39 | 100.0 | H | 329.0 | 20.9 |
| 164.830 | 11.95 | 43.52 | 31.57 | 232.0 | H | 256.0 | 20.0 |
| 172.752 | 11.75 | 43.52 | 31.78 | 400.0 | V | 57.0 | 19.6 |
| 268.836 | 13.80 | 46.02 | 32.22 | 100.0 | V | 17.0 | 21.3 |
| 281.984 | 13.98 | 46.02 | 32.04 | 242.0 | H | 136.0 | 21.7 |
| 408.623 | 17.76 | 46.02 | 28.26 | 400.0 | V | 184.0 | 24.3 |

| | | | |
|---|---|---|---|
| Test Personnel: | Jeremiah Andrade | Test Date: | 8/17/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.209 in Restricted Bands from FCC Part 15.205 |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 22.0 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 53.9 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 982.5 mbar |

Deviations, Additions, or Exclusions: None

**6.8.2.2 2442 MHz:**



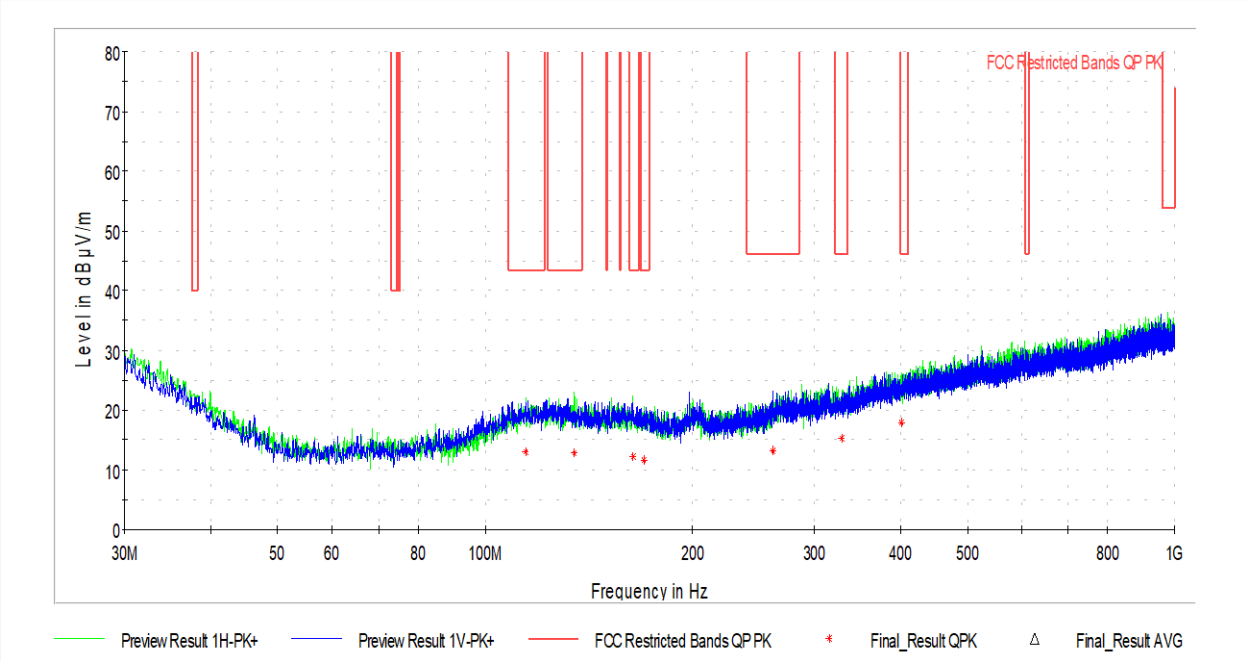

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 110.079 | 12.58 | 43.52 | 30.94 | 95.0 | H | 149.0 | 19.7 |
| 121.234 | 13.15 | 43.52 | 30.38 | 323.0 | V | 286.0 | 20.8 |
| 127.323 | 13.11 | 43.52 | 30.41 | 95.0 | H | 89.0 | 20.9 |
| 162.836 | 12.07 | 43.52 | 31.45 | 211.0 | H | 0.0 | 20.1 |
| 275.356 | 13.91 | 46.02 | 32.11 | 400.0 | H | 275.0 | 21.6 |
| 324.287 | 15.15 | 46.02 | 30.87 | 302.0 | H | 284.0 | 22.6 |
| 409.647 | 18.28 | 46.02 | 27.74 | 400.0 | H | 351.0 | 24.7 |

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 110.079 | 12.56 | 43.52 | 30.96 | 95.0 | H | 149.0 | 19.7 |
| 121.234 | 13.16 | 43.52 | 30.36 | 323.0 | V | 287.0 | 20.8 |
| 127.323 | 13.11 | 43.52 | 30.41 | 95.0 | H | 90.0 | 20.9 |
| 162.836 | 12.01 | 43.52 | 31.51 | 211.0 | H | 0.0 | 20.1 |
| 275.356 | 13.85 | 46.02 | 32.17 | 400.0 | H | 276.0 | 21.6 |
| 324.287 | 15.16 | 46.02 | 30.86 | 302.0 | H | 285.0 | 22.6 |
| 409.647 | 18.27 | 46.02 | 27.75 | 400.0 | H | 0.0 | 24.7 |

| | | | |
|---|---|---|---|
| Test Personnel: | Jeremiah Andrade | Test Date: | 8/17/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.209 in Restricted Bands from FCC Part 15.205 |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 22.0 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 53.9 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 982.5 mbar |

Deviations, Additions, or Exclusions: None

### 6.8.2.3 2480 MHz:




| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 114.498 | 12.98 | 43.52 | 30.55 | 400.0 | H | 152.0 | 20.2 |
| 134.760 | 12.83 | 43.52 | 30.69 | 170.0 | H | 154.0 | 20.7 |
| 163.752 | 12.08 | 43.52 | 31.45 | 232.0 | H | 234.0 | 20.1 |
| 169.680 | 11.63 | 43.52 | 31.89 | 400.0 | H | 108.0 | 19.6 |
| 261.453 | 13.15 | 46.02 | 32.87 | 339.0 | V | 36.0 | 20.9 |
| 328.652 | 15.28 | 46.02 | 30.74 | 249.0 | H | 90.0 | 22.7 |
| 401.079 | 17.86 | 46.02 | 28.16 | 256.0 | H | 208.0 | 24.5 |

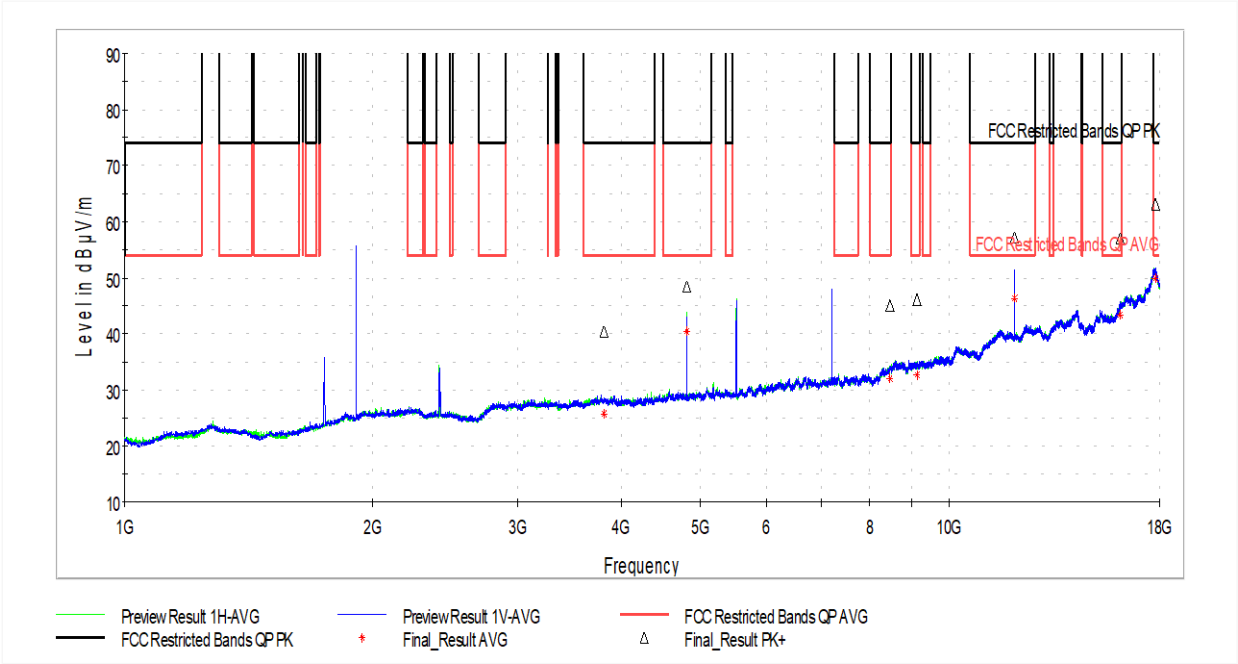
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 114.498 | 13.04 | 43.52 | 30.48 | 400.0 | H | 152.0 | 20.2 |
| 134.760 | 12.84 | 43.52 | 30.68 | 170.0 | H | 154.0 | 20.7 |
| 163.752 | 12.13 | 43.52 | 31.39 | 232.0 | H | 235.0 | 20.1 |
| 169.680 | 11.57 | 43.52 | 31.95 | 400.0 | H | 108.0 | 19.6 |
| 261.453 | 13.16 | 46.02 | 32.86 | 340.0 | V | 37.0 | 20.9 |
| 328.652 | 15.24 | 46.02 | 30.78 | 249.0 | H | 90.0 | 22.7 |
| 401.079 | 17.87 | 46.02 | 28.15 | 255.0 | H | 210.0 | 24.5 |

| | | | |
|---|---|---|---|
| Test Personnel: | Jeremiah Andrade | Test Date: | 8/17/2023 |
| Supervising/Reviewing Engineer: | | | FCC Part 15.209 in Restricted |
| (Where Applicable) | NA | Limit Applied: | Bands from FCC Part 15.205 |
| | FCC Part 15.247 | | |
| Product Standard: | RSS-247 Issue 2 | Ambient Temperature: | 22.0 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 53.9 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 982.5 mbar |

Deviations, Additions, or Exclusions: None

### 6.8.3 1 GHz – 18 GHz:

### 6.8.3.1 2402 MHz:



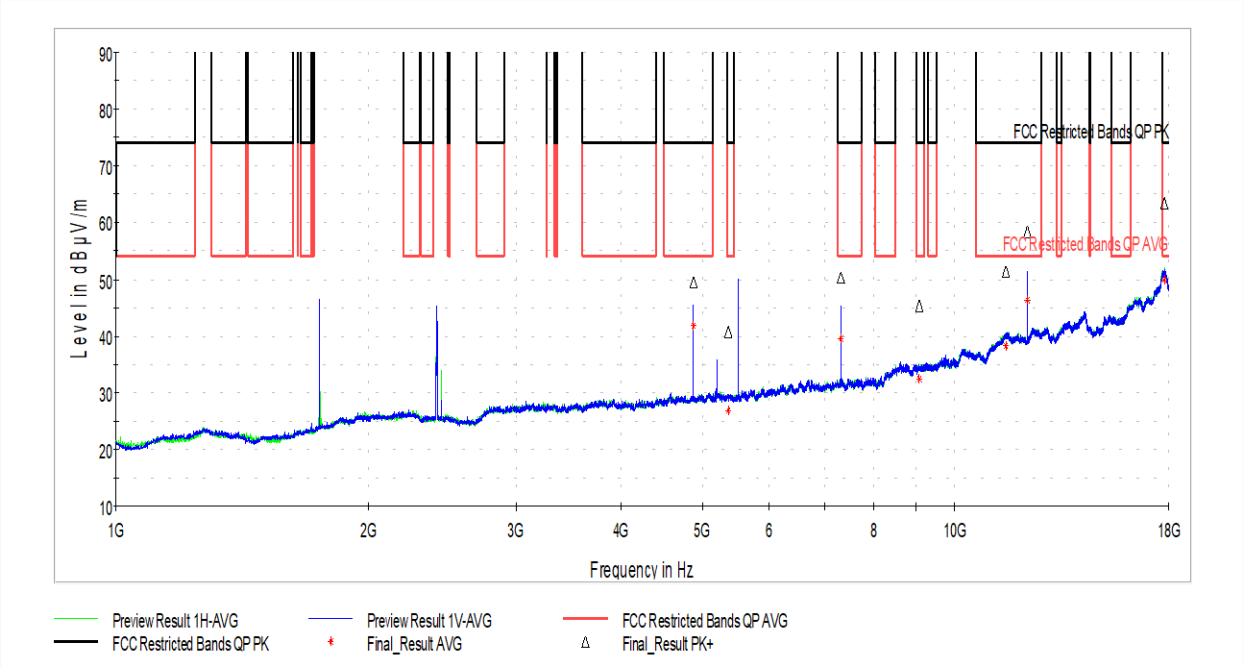

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 3818.500 | 40.43 | 73.98 | 33.55 | 134.0 | V | -1.0 | 8.8 |
| 4804.000 | 48.46 | 73.98 | 25.52 | 354.0 | H | 307.0 | 10.4 |
| 8472.000 | 45.10 | 73.98 | 28.88 | 242.0 | H | 101.0 | 15.8 |
| 9133.000 | 46.14 | 73.98 | 27.84 | 108.0 | H | 330.0 | 17.2 |
| 12011.500 | 57.32 | 73.98 | 16.66 | 335.0 | V | 175.0 | 21.5 |
| 17787.000 | 63.05 | 73.98 | 10.93 | 152.0 | V | 0.0 | 34.5 |

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 3818.500 | 25.85 | 53.98 | 28.13 | 134.0 | V | -1.0 | 8.8 |
| 4804.000 | 40.49 | 53.98 | 13.49 | 354.0 | H | 307.0 | 10.4 |
| 8472.000 | 32.00 | 53.98 | 21.98 | 242.0 | H | 101.0 | 15.8 |
| 9133.000 | 32.63 | 53.98 | 21.35 | 108.0 | H | 330.0 | 17.2 |
| 12011.500 | 46.33 | 53.98 | 7.65 | 335.0 | V | 175.0 | 21.5 |
| 17787.000 | 49.99 | 53.98 | 3.99 | 152.0 | V | 0.0 | 34.5 |

| | | | |
|---|---|---|---|
| Test Personnel: | Jeremiah Andrade | Test Date: | 8/17/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.209 in Restricted Bands from FCC Part 15.205 |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 22.0 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 53.9 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 982.5 mbar |

Deviations, Additions, or Exclusions: None

### 6.8.3.2 2442 MHz:



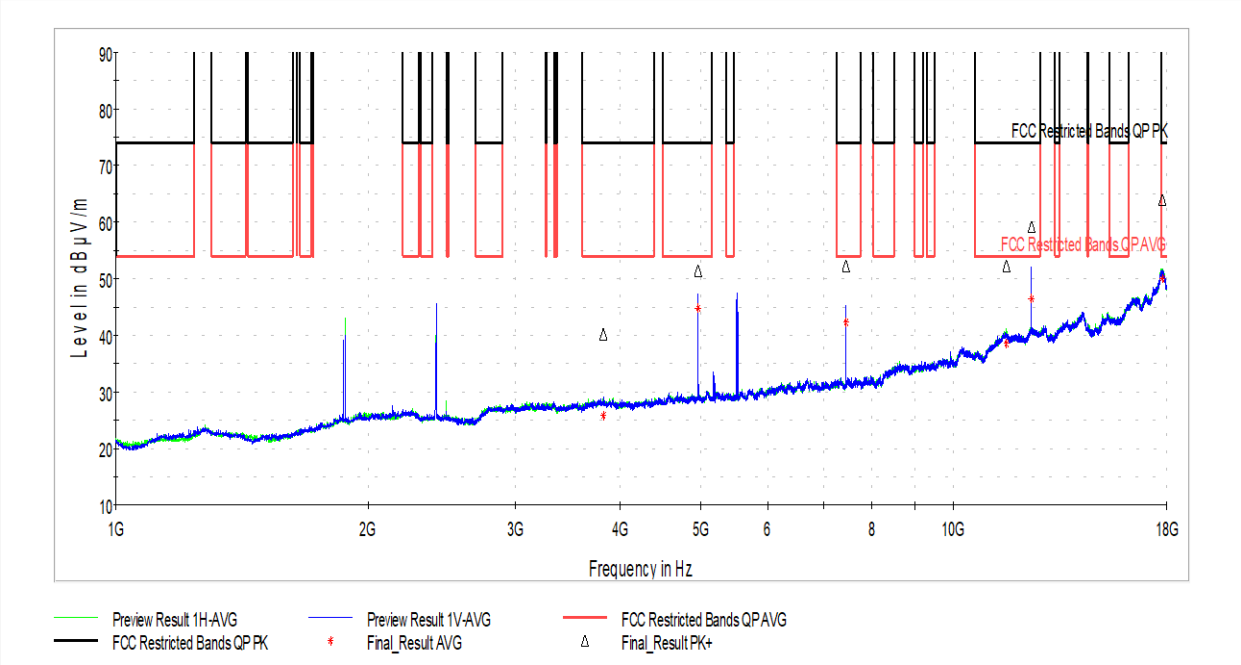

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 4880.000 | 49.38 | 73.98 | 24.60 | 322.0 | V | 240.0 | 10.3 |
| 5374.000 | 40.80 | 73.98 | 33.18 | 197.0 | V | 146.0 | 11.2 |
| 7321.000 | 50.22 | 73.98 | 23.76 | 302.0 | V | 39.0 | 14.4 |
| 9069.500 | 45.39 | 73.98 | 28.59 | 230.0 | V | 146.0 | 16.9 |
| 11506.000 | 51.42 | 73.98 | 22.56 | 307.0 | H | 234.0 | 20.6 |
| 12199.000 | 58.36 | 73.98 | 15.62 | 304.0 | V | 182.0 | 21.7 |
| 17778.000 | 63.44 | 73.98 | 10.54 | 346.0 | H | 20.0 | 34.5 |

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 4880.000 | 41.81 | 53.98 | 12.17 | 322.0 | V | 240.0 | 10.3 |
| 5374.000 | 26.89 | 53.98 | 27.09 | 197.0 | V | 146.0 | 11.2 |
| 7321.000 | 39.43 | 53.98 | 14.55 | 302.0 | V | 39.0 | 14.4 |
| 9069.500 | 32.35 | 53.98 | 21.63 | 230.0 | V | 146.0 | 16.9 |
| 11506.000 | 38.32 | 53.98 | 15.66 | 307.0 | H | 234.0 | 20.6 |
| 12199.000 | 46.36 | 53.98 | 7.62 | 304.0 | V | 182.0 | 21.7 |
| 17778.000 | 49.90 | 53.98 | 4.08 | 346.0 | H | 20.0 | 34.5 |

| | | | |
|---|---|---|---|
| Test Personnel: | Jeremiah Andrade | Test Date: | 8/17/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.209 in Restricted Bands from FCC Part 15.205 |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 22.0 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 53.9 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 982.5 mbar |

Deviations, Additions, or Exclusions: None

### 6.8.3.3 2480 MHz:




| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 3821.000 | 40.29 | 73.98 | 33.69 | 100.0 | V | 307.0 | 8.8 |
| 4960.000 | 51.45 | 73.98 | 22.53 | 258.0 | V | 241.0 | 10.1 |
| 7439.500 | 52.36 | 73.98 | 21.62 | 321.0 | V | 9.0 | 13.9 |
| 11588.000 | 52.26 | 73.98 | 21.72 | 100.0 | H | 98.0 | 20.9 |
| 12399.000 | 59.10 | 73.98 | 14.88 | 259.0 | V | 181.0 | 22.5 |
| 17781.500 | 63.98 | 73.98 | 10.00 | 292.0 | H | 247.0 | 34.5 |

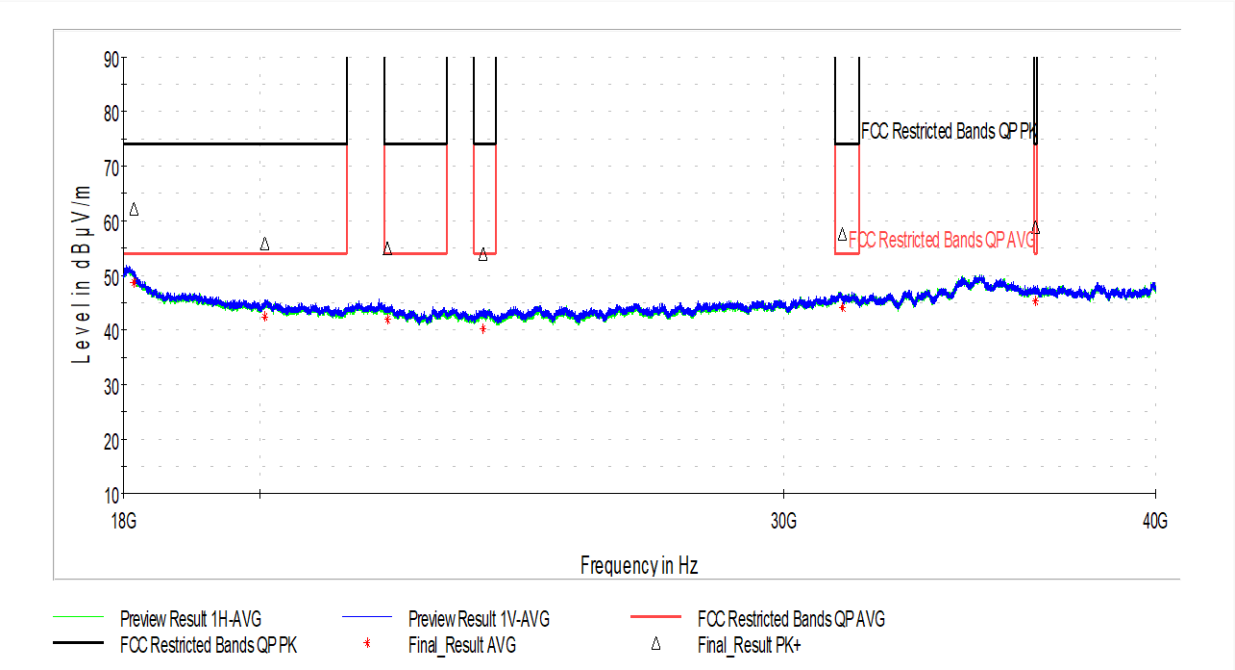
| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 3821.000 | 25.84 | 53.98 | 28.14 | 100.0 | V | 307.0 | 8.8 |
| 4960.000 | 44.88 | 53.98 | 9.10 | 258.0 | V | 241.0 | 10.1 |
| 7439.500 | 42.20 | 53.98 | 11.78 | 321.0 | V | 9.0 | 13.9 |
| 11588.000 | 38.52 | 53.98 | 15.46 | 100.0 | H | 98.0 | 20.9 |
| 12399.000 | 46.37 | 53.98 | 7.61 | 259.0 | V | 181.0 | 22.5 |
| 17781.500 | 49.95 | 53.98 | 4.03 | 292.0 | H | 247.0 | 34.5 |

| | | | |
|---|---|---|---|
| Test Personnel: | Jeremiah Andrade | Test Date: | 8/17/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.209 in Restricted Bands from FCC Part 15.205 |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 22.0 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 53.9 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 982.5 mbar |

Deviations, Additions, or Exclusions: None

### 6.8.4 18 GHz – 40 GHz:

### 6.8.4.1 2442 MHz:




| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 18136.500 | 62.24 | 73.98 | 11.74 | 410.0 | V | 266.0 | 30.3 |
| 20074.000 | 55.83 | 73.98 | 18.15 | 410.0 | V | 0.0 | 21.0 |
| 22077.000 | 54.98 | 73.98 | 19.00 | 410.0 | V | 0.0 | 15.1 |
| 23766.500 | 54.04 | 73.98 | 19.94 | 410.0 | V | 0.0 | 13.1 |
| 31397.000 | 57.50 | 73.98 | 16.48 | 410.0 | H | 349.0 | 19.9 |
| 36447.000 | 58.82 | 73.98 | 15.16 | 410.0 | H | 54.0 | 21.2 |

| Frequency (MHz) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 18136.500 | 48.61 | 53.98 | 5.37 | 410.0 | V | 266.0 | 30.3 |
| 20074.000 | 42.27 | 53.98 | 11.71 | 410.0 | V | 0.0 | 21.0 |
| 22077.000 | 41.84 | 53.98 | 12.14 | 410.0 | V | 0.0 | 15.1 |
| 23766.500 | 40.27 | 53.98 | 13.71 | 410.0 | V | 0.0 | 13.1 |
| 31397.000 | 44.02 | 53.98 | 9.96 | 410.0 | H | 349.0 | 19.9 |
| 36447.000 | 45.34 | 53.98 | 8.64 | 410.0 | H | 54.0 | 21.2 |

| | | | |
|---|---|---|---|
| Test Personnel: | Jeremiah Andrade | Test Date: | 8/17/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | FCC Part 15.209 in Restricted Bands from FCC Part 15.205 |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 22.0 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 53.9 % |
| Pretest Verification w / Ambient Signals or BB Source: | Yes | Atmospheric Pressure: | 982.5 mbar |

Deviations, Additions, or Exclusions: None

Notes: Testing represents the worst case of low, middle, and high channels.

# 7 Conducted Spurious Emissions

## 7.1 Test Limits:

**FCC Part 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 Issue 2 § 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 be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

## 7.2 Test Method:

Tests are performed in accordance with ANSI C63.10:2013 § 11.11 Emissions in nonrestricted frequency bands.

## 7.3 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 3900 | Rohde & Schwarz | ESU40 | 10/3/2022 | 10/3/2023 |

## 7.4 Measurement Uncertainty

| Measurement | Frequency Range | Expanded Uncertainty (k=2) |
|---|---|---|
| Conducted Spurious Emissions | 30MHz – 1GHz | 1.2dB |
| Conducted Spurious Emissions | 1GHz – 18GHz | 1.2dB |

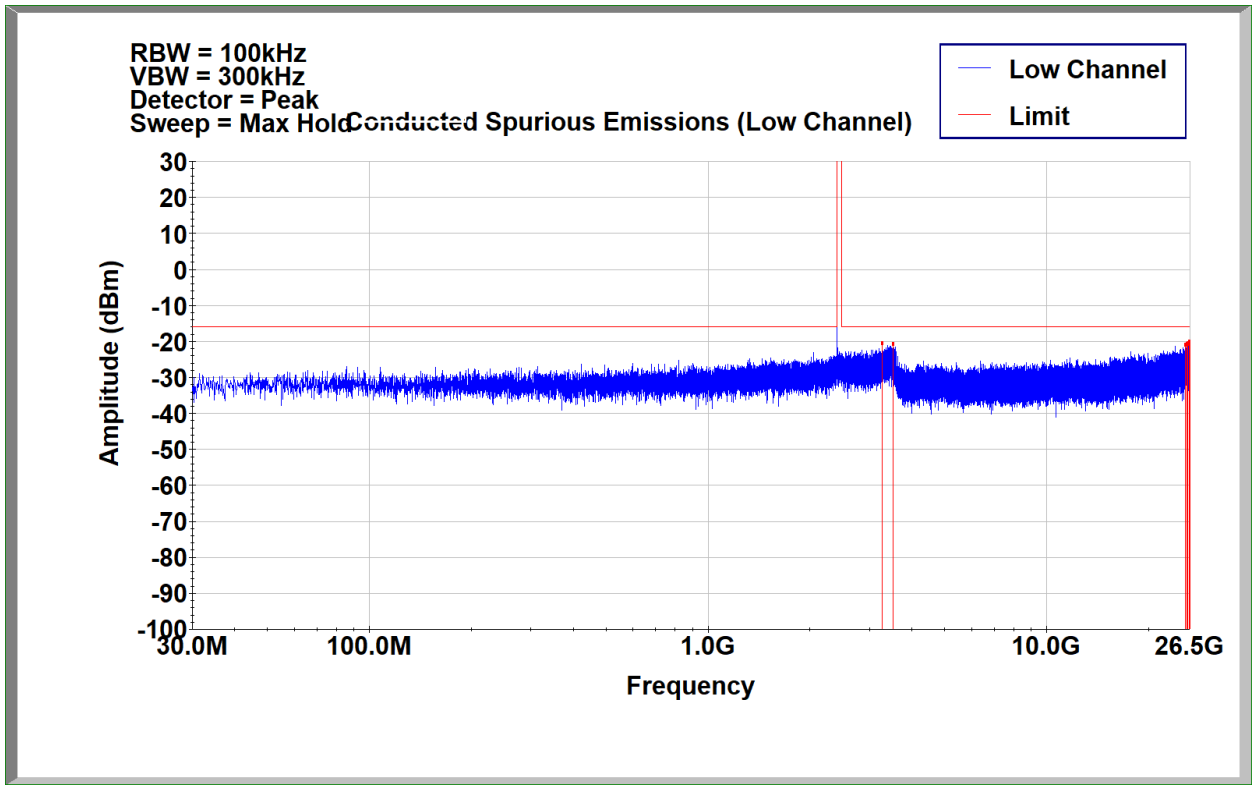
No measurement uncertainty correction is performed.

## 7.5 Test Results:

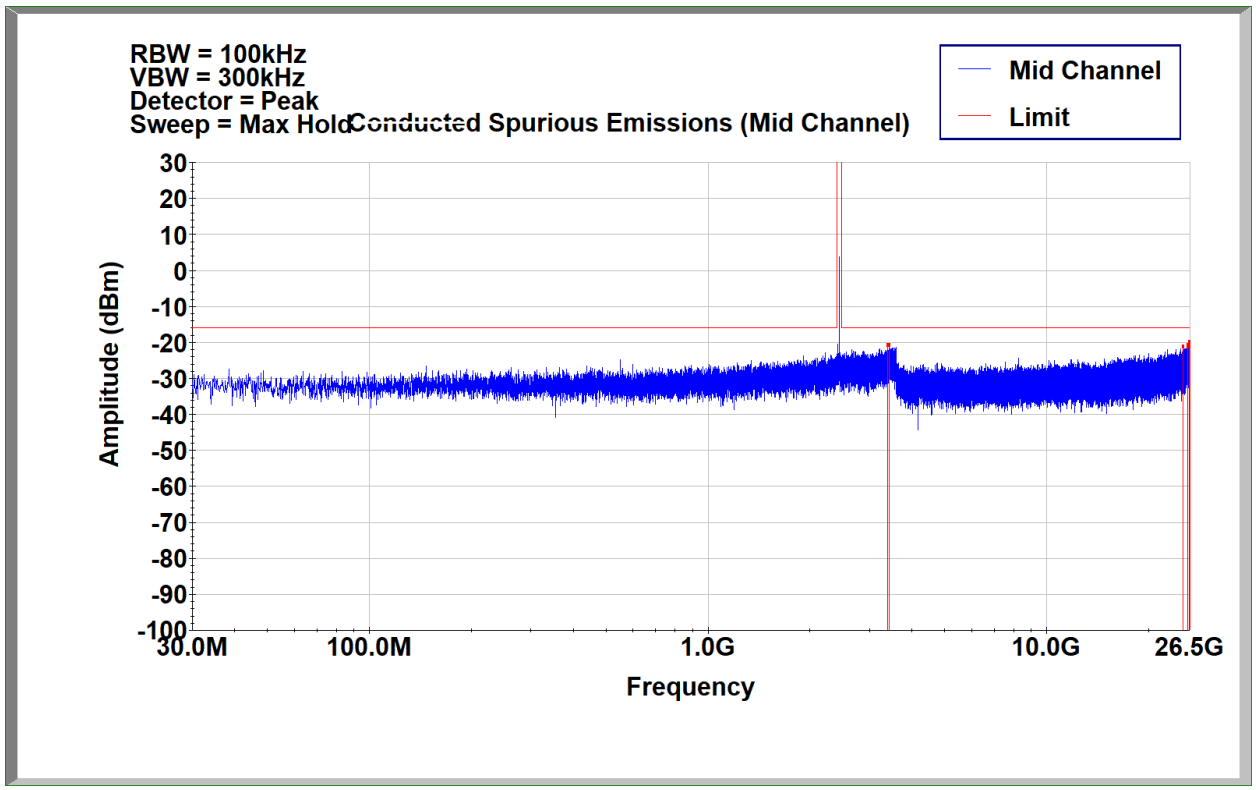
The device was found to be **compliant**. All spurious emissions were found to be attenuated more than 20dB below the level of the fundamental.

## 7.6 Test Data: Conducted Spurious Emissions:

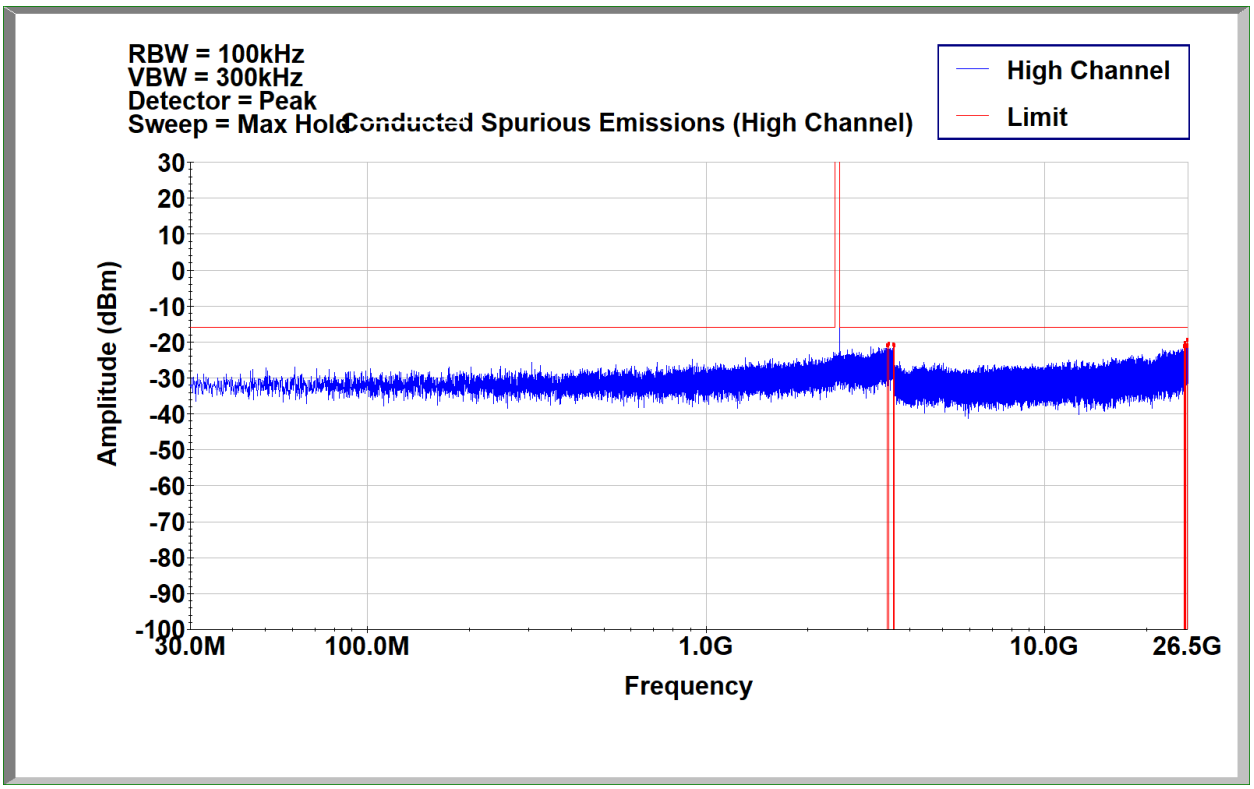
### 7.6.1 2402 MHz:



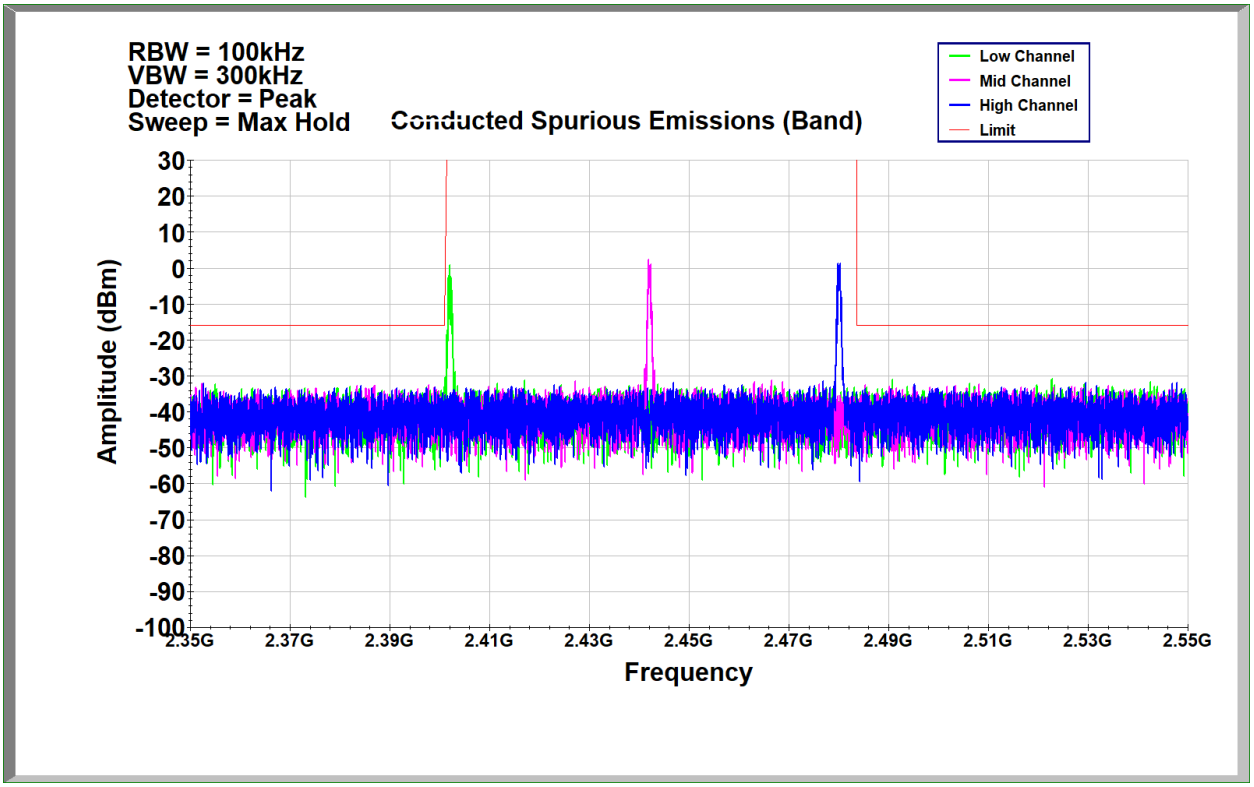

### 7.6.2 2440 MHz:



### 7.6.3 2480 MHz:


RBW = 100kHz
VBW = 300kHz
Detector = Peak
Sweep = Max Hold
Conducted Spurious Emissions (High Channel)
High Channel
Limit
Amplitude (dBm)
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
30.0M
100.0M
1.0G
10.0G
26.5G
Frequency

### 7.6.4 Band Edge:




| PPSD Data | | |
|---|---|---|
| **Operating Mode** | **Frequency (MHz)** | **PPSD (dBm/100KHz)** |
| BLE | 2402 | 3.66 |
| | 2442 | 3.84 |
| | 2480 | 3.75 |

Note: The reference level was established from the highest recorded PPSD measurement. These values were sourced from section 10.7 of this document.

# 8 Output Power

## 8.1 Test Limits:

**FCC Part 15.247(b)(3):**

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 Issue 2 § 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).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is 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 transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

## 8.2 Test Method:

Tests are performed in accordance with ANSI C63.10:2013 § 11.9.1.1

## 8.3 Measurement Uncertainty

| Measurement | Frequency Range | Expanded Uncertainty (k=2) |
|---|---|---|
| Fundamental Emission Output Power (Conducted) | 1GHz – 18GHz | 1.2dB |

No measurement uncertainty correction is performed.

## 8.4 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 3900 | Rohde & Schwarz | ESU40 | 10/3/2022 | 10/3/2023 |

## 8.5 Test Results:

The device was found to be **compliant**. The peak output power was less than 1W and the EIRP was less than 4W.

## 8.6 Test Conditions:

| | | | |
|---|---|---|---|
| Test Personnel: | Seth Parker | Test Date: | 8/22/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | From FCC Part 15.247(b)(3), RSS-247 Issue 2 § 5.4(d) |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 24.5 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 42.9 % |
| | | Atmospheric Pressure: | 988.3 mbar |

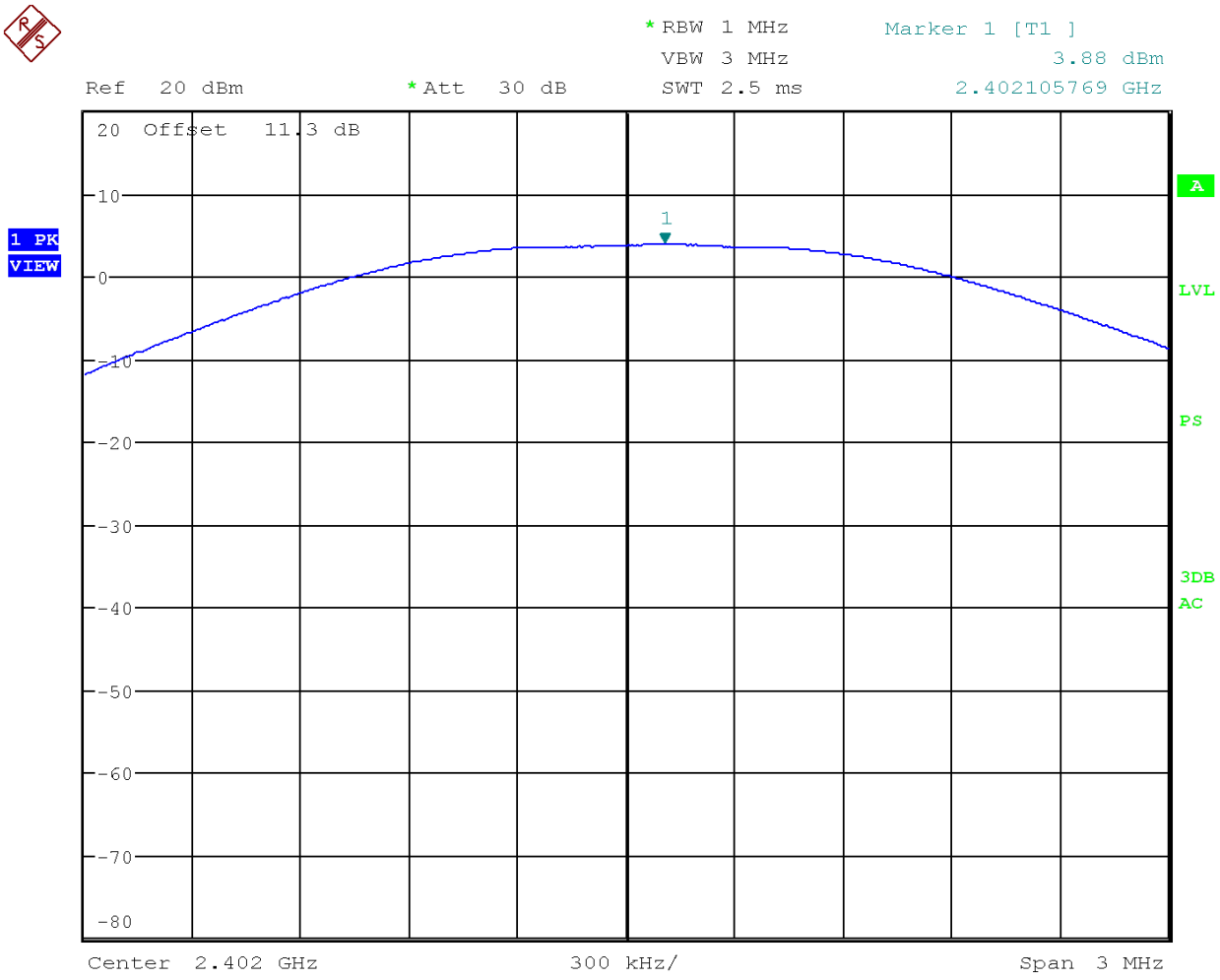
Deviations, Additions, or Exclusions: None

## 8.7 Test Data:

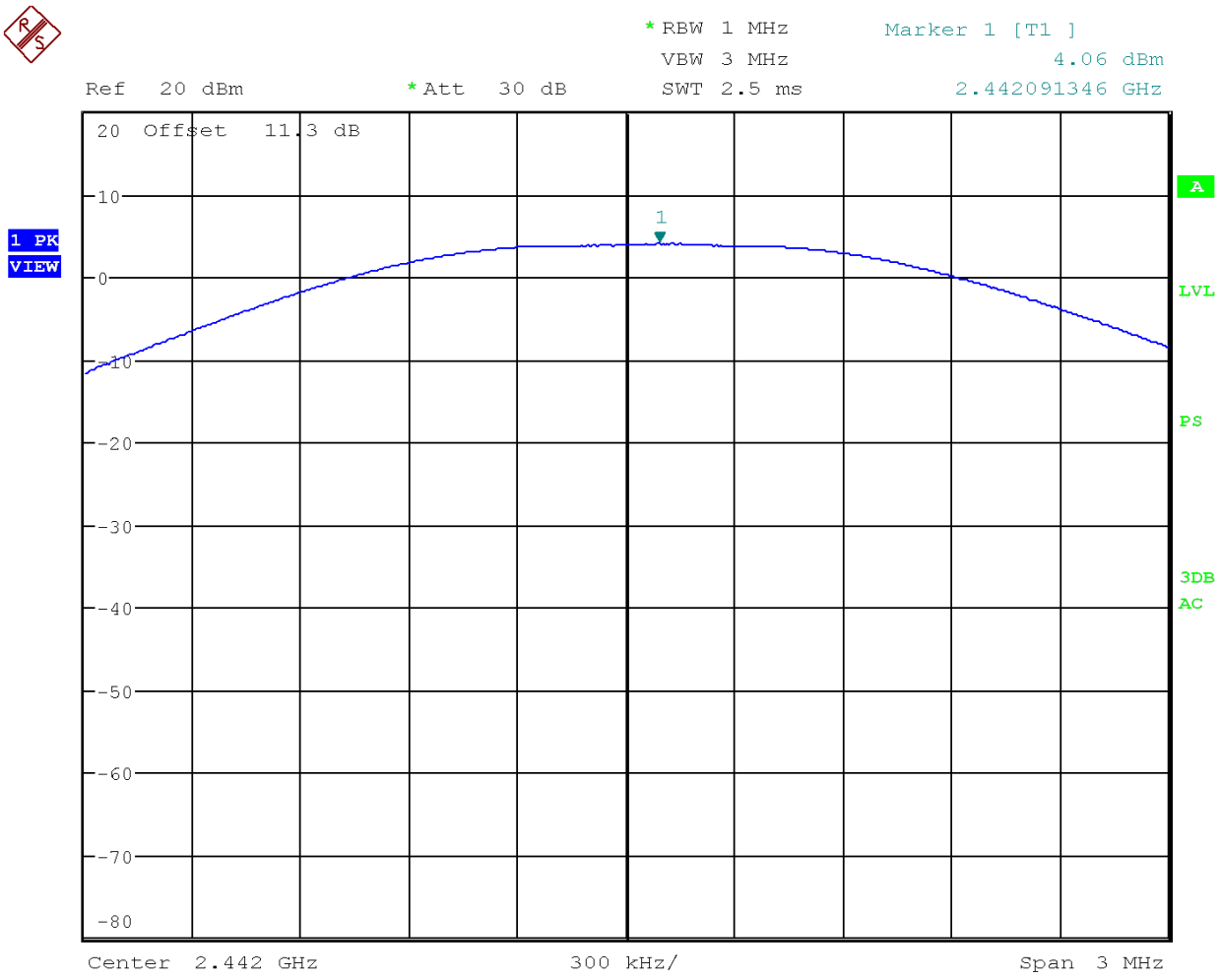
| Frequency (MHz) | Conducted Power (dBm) | Conducted Power Limit (dBm) | Max Antenna Gain (dBi) | EIRP (dBm) | EIRP Limit (dBm) |
|---|---|---|---|---|---|
| 2402 | 3.88 | 30.00 | 1.73 | 5.61 | 36.02 |
| 2442 | 4.06 | 30.00 | 1.55 | 5.61 | 36.02 |
| 2480 | 4.02 | 30.00 | 1.77 | 5.79 | 36.02 |

## 8.8 Spectrum Plots:

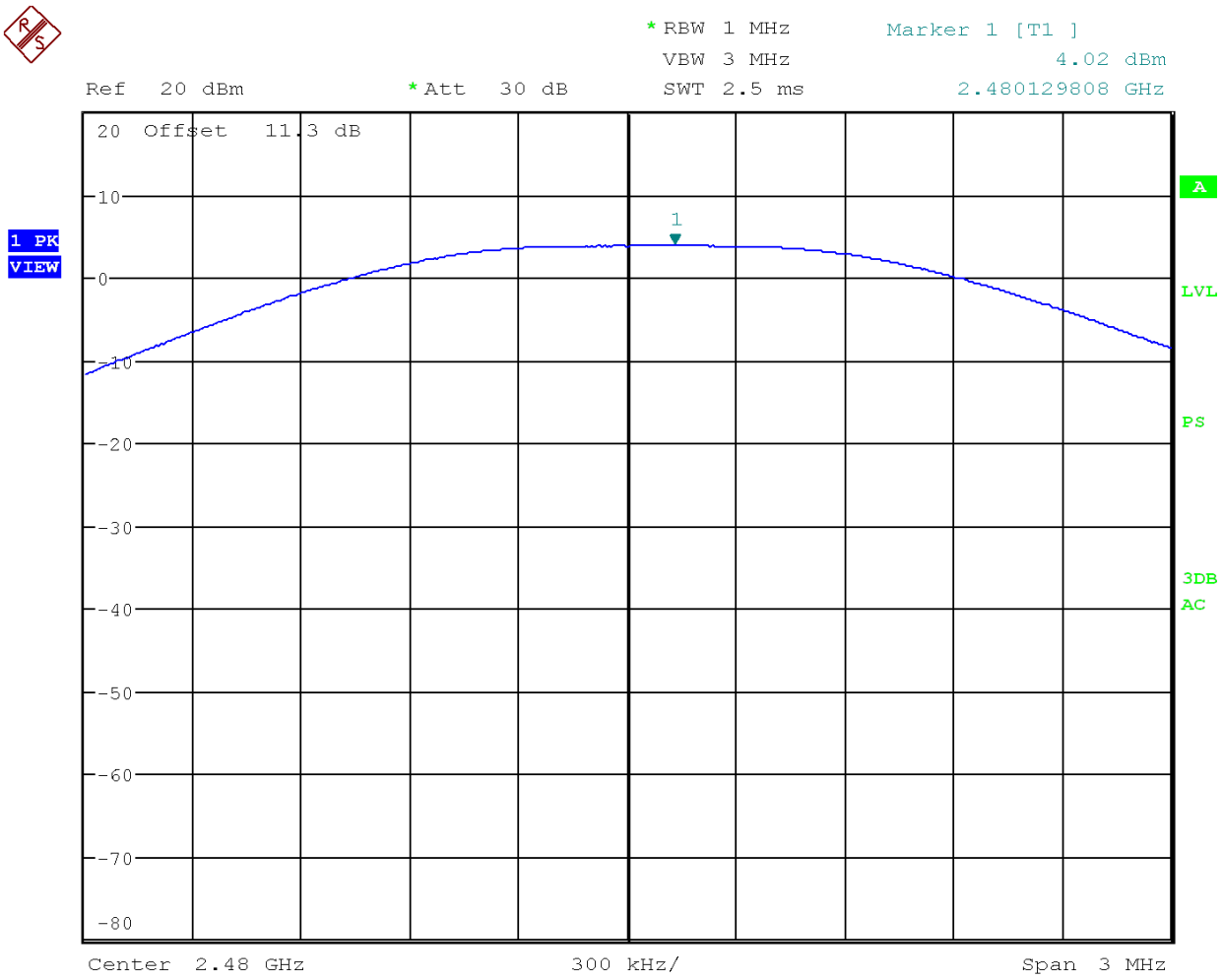
### 8.8.1 2402 MHz:



### 8.8.1 2442 MHz:


* RBW 1 MHz
VBW 3 MHz
SWT 2.5 ms
Marker 1 [T1 ]
4.06 dBm
2.442091346 GHz
Ref 20 dBm
* Att 30 dB
20 Offset 11.3 dB
1 PK
VIEW
A
LVL
PS
3DB
AC
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 2.442 GHz
300 kHz/
Span 3 MHz

### 8.8.2 2480 MHz:


* RBW 1 MHz
VBW 3 MHz
SWT 2.5 ms
Marker 1 [T1 ]
4.02 dBm
2.480129808 GHz
Ref 20 dBm
* Att 30 dB
20 Offset 11.3 dB
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1 PK
VIEW
A
LVL
PS
3DB
AC
Center 2.48 GHz
300 kHz/
Span 3 MHz

# 9 Occupied Bandwidth

## 9.1 Test Limits:

**FCC Part 15.247(a)(2):**

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 Issue 2 § 5.2(a):**

The minimum 6 dB bandwidth shall be 500 kHz.

## 9.2 Test Method:

Tests are performed in accordance with ANSI C63.10:2013 § 11.8.1.

## 9.3 Measurement Uncertainty

| Measurement | Frequency Range | Expanded Uncertainty (k=2) |
|---|---|---|
| Occupied Bandwidth | 30MHz – 18GHz | 2.89% |

No measurement uncertainty correction is performed.

## 9.4 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 3900 | Rohde & Schwarz | ESU40 | 10/3/2022 | 10/3/2023 |

## 9.5 Test Results:

The device was found to be **compliant**. The 6dB bandwidth was at least 500kHz.

## 9.6 Test Conditions:

| | | | |
|---|---|---|---|
| Test Personnel: | Seth Parker | Test Date: | 8/22/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Ambient Temperature | 24.5 °C |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Relative Humidity: | 42.9 % |
| Input Voltage: | 3.6 VDC, Battery | Atmospheric Pressure: | 988.3 mbar |

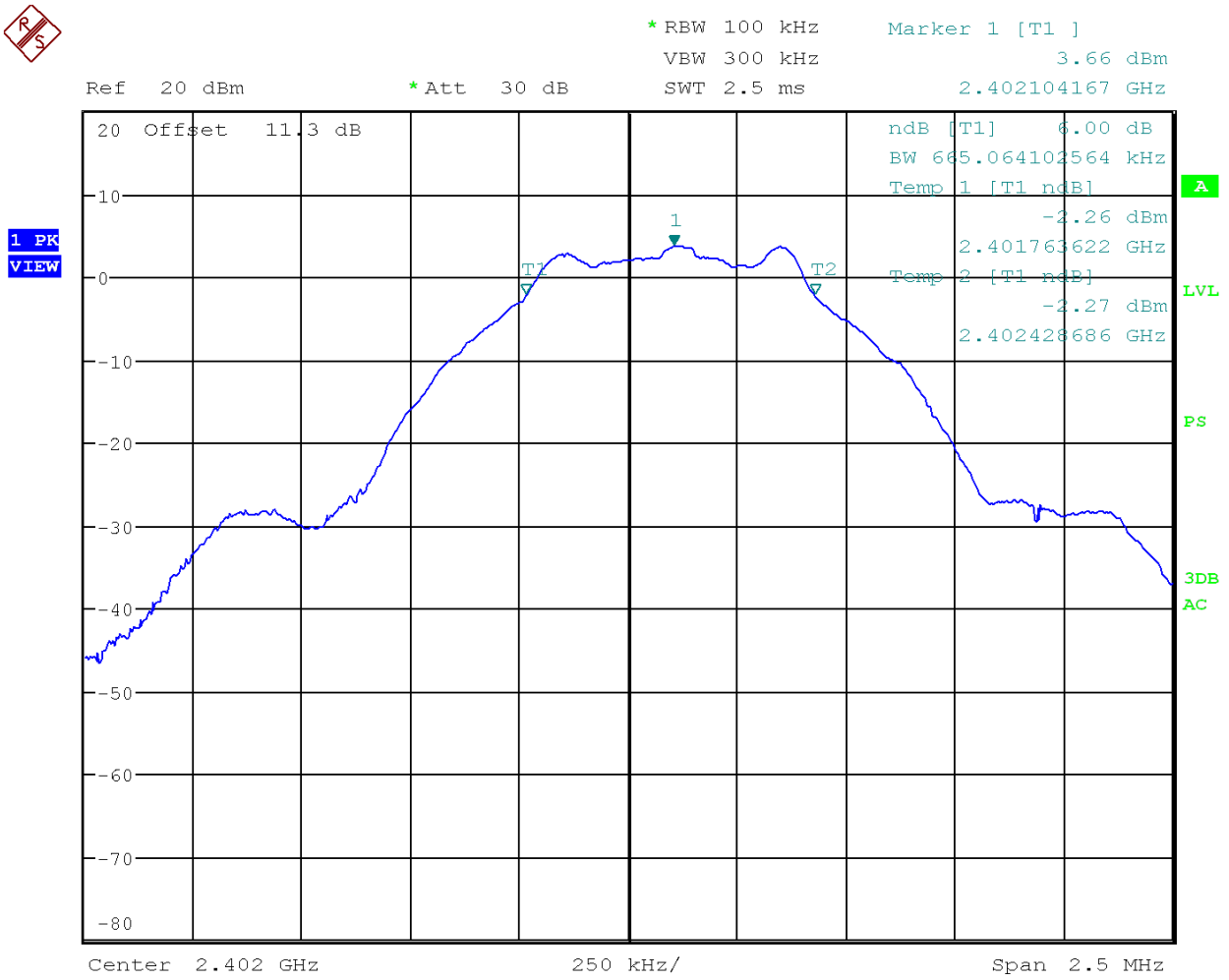
Deviations, Additions, or Exclusions: None

## 9.7 Test Data:

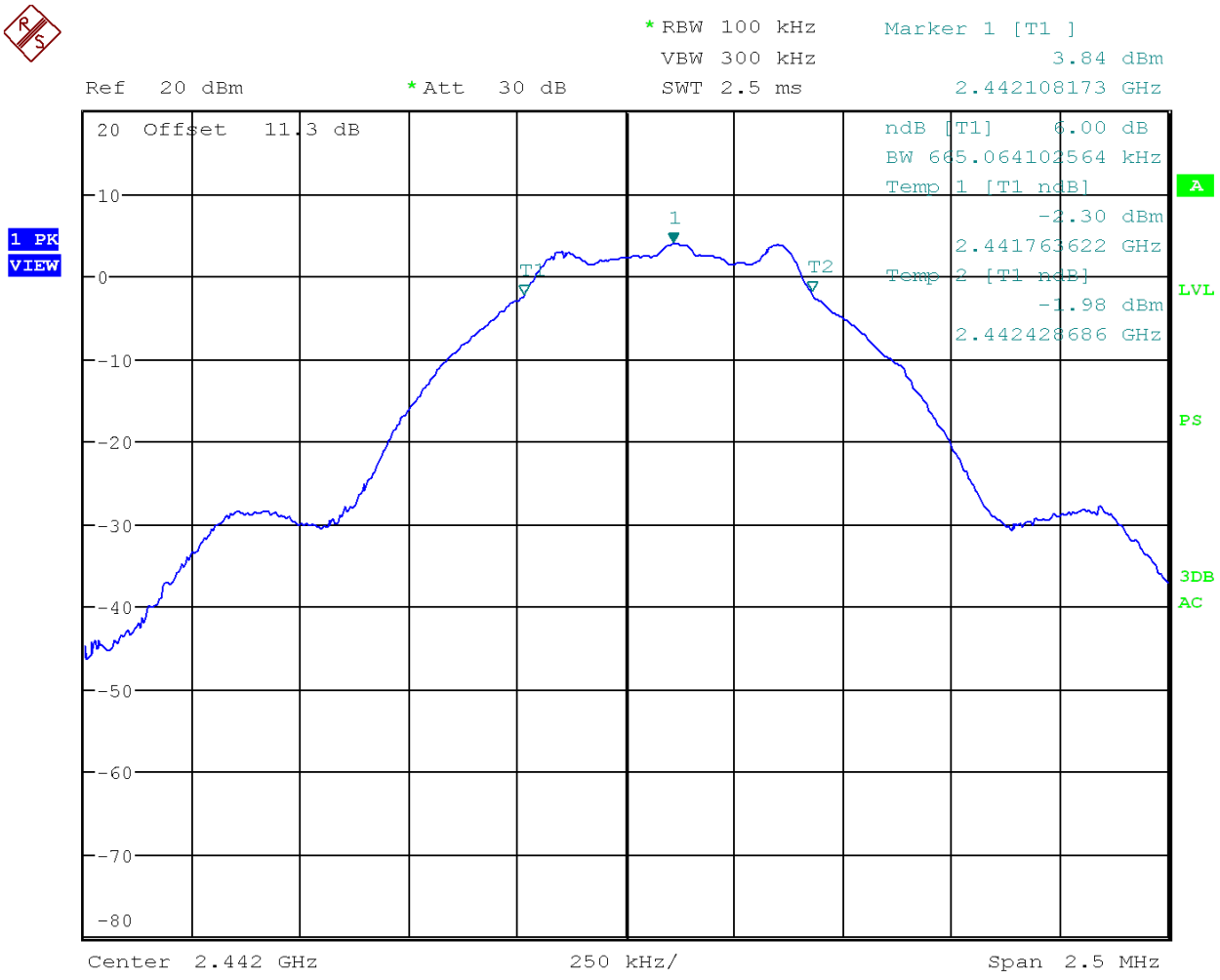
| Frequency (MHz) | 6dB BW (kHz) | 20dB BW (kHz) | 99% BW (kHz) |
|---|---|---|---|
| 2402 | 665.00 | 1080.00 | 1006.00 |
| 2440 | 665.00 | 1080.00 | 1006.00 |
| 2480 | 669.00 | 1080.00 | 1003.00 |

## 9.8 Spectrum Plots, 6 dB Bandwidth:

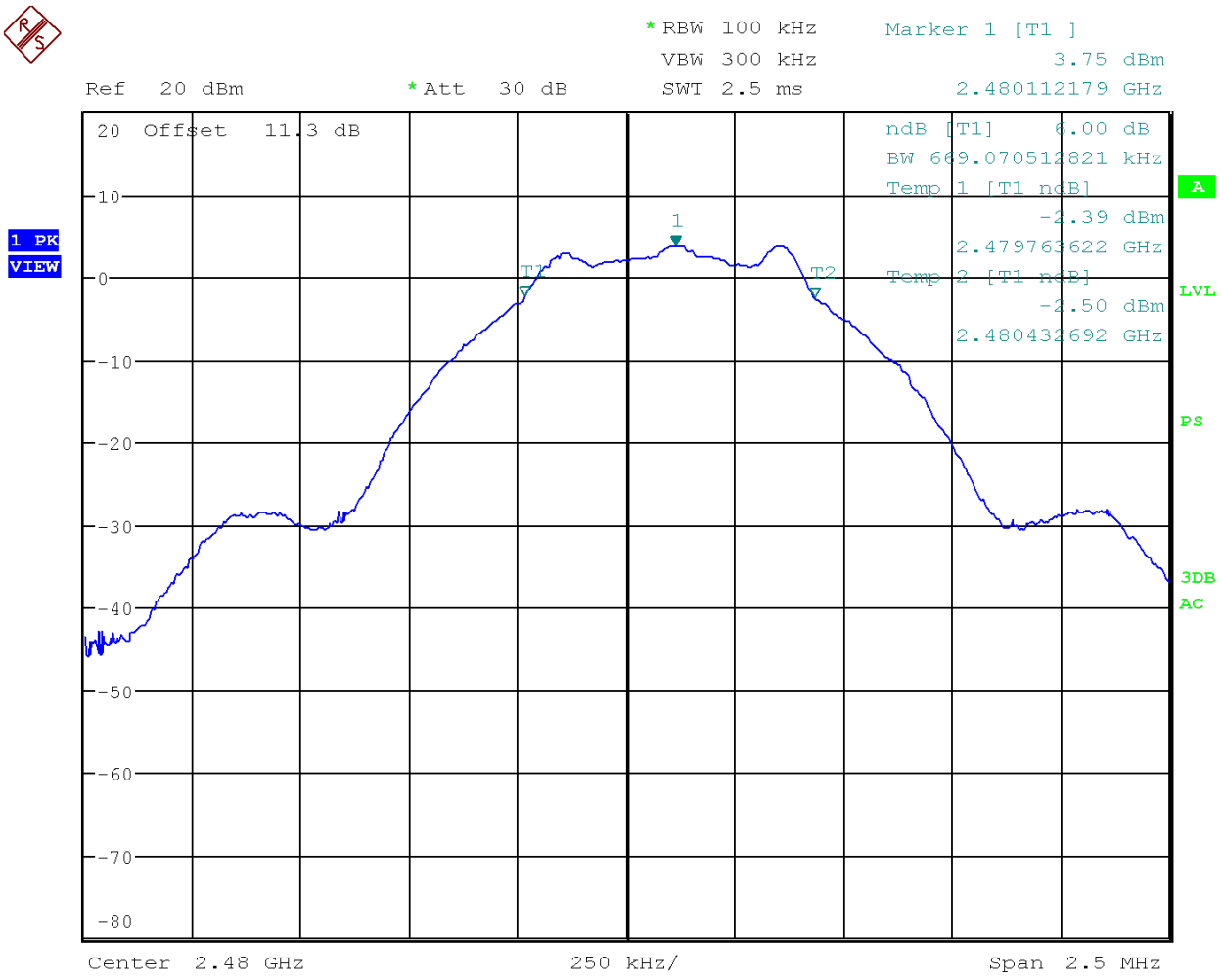
### 9.8.1 2402 MHz:



### 9.9 2442MHz:

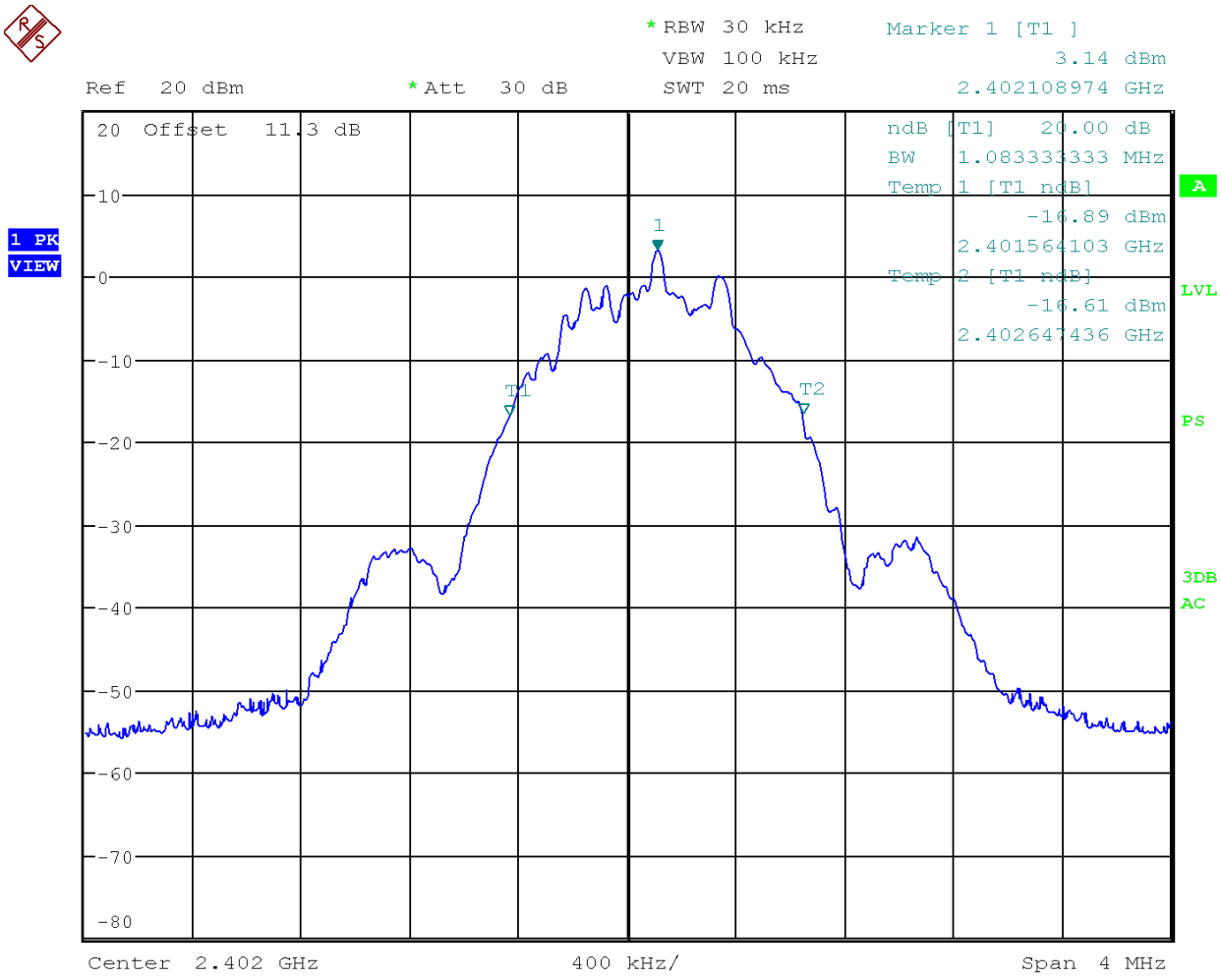

* RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1 ]
3.84 dBm
2.442108173 GHz
Ref 20 dBm
* Att 30 dB
20 Offset 11.3 dB
ndB [T1] 6.00 dB
BW 665.064102564 kHz
Temp 1 [T1 ndB]
-2.30 dBm
2.441763622 GHz
Temp 2 [T1 ndB]
-1.98 dBm
2.442428686 GHz
1 PK
VIEW
A
LVL
PS
3DB
AC
10
0
-10
-20
-30
-40
-50
-60
-70
-80
T1
T2
1
Center 2.442 GHz
250 kHz/
Span 2.5 MHz

### 9.9.1 2480 MHz:

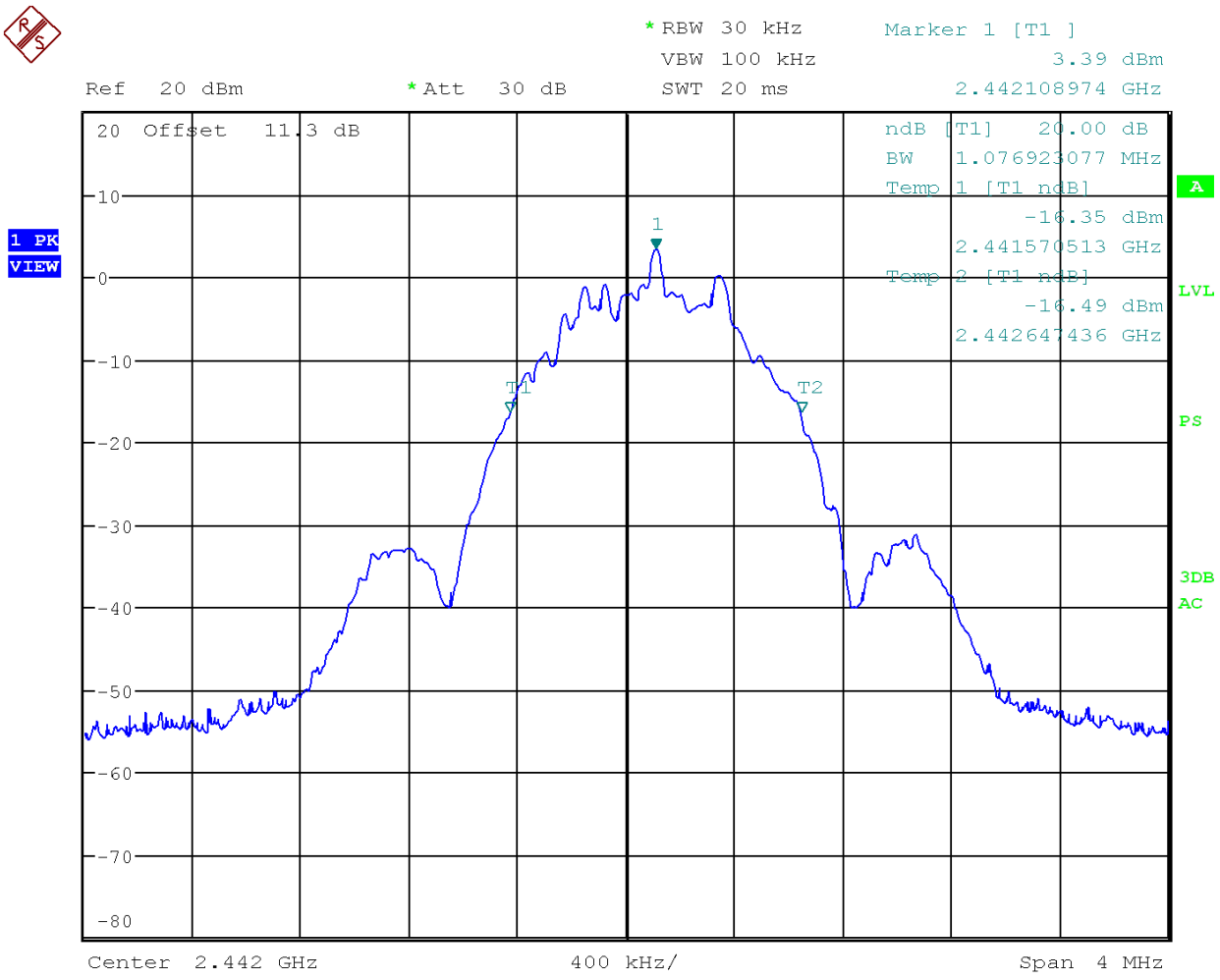

* RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1 ]
3.75 dBm
2.480112179 GHz
Ref 20 dBm
* Att 30 dB
20 Offset 11.3 dB
ndB [T1] 6.00 dB
BW 669.070512821 kHz
Temp 1 [T1 ndB]
-2.39 dBm
2.479763622 GHz
Temp 2 [T1 ndB]
-2.50 dBm
2.480432692 GHz
1 PK
VIEW
A
LVL
PS
3DB
AC
10
0
-10
-20
-30
-40
-50
-60
-70
-80
T1
T2
1
Center 2.48 GHz
250 kHz/
Span 2.5 MHz

## 9.10 Spectrum Plots, 20 dB Bandwidth:

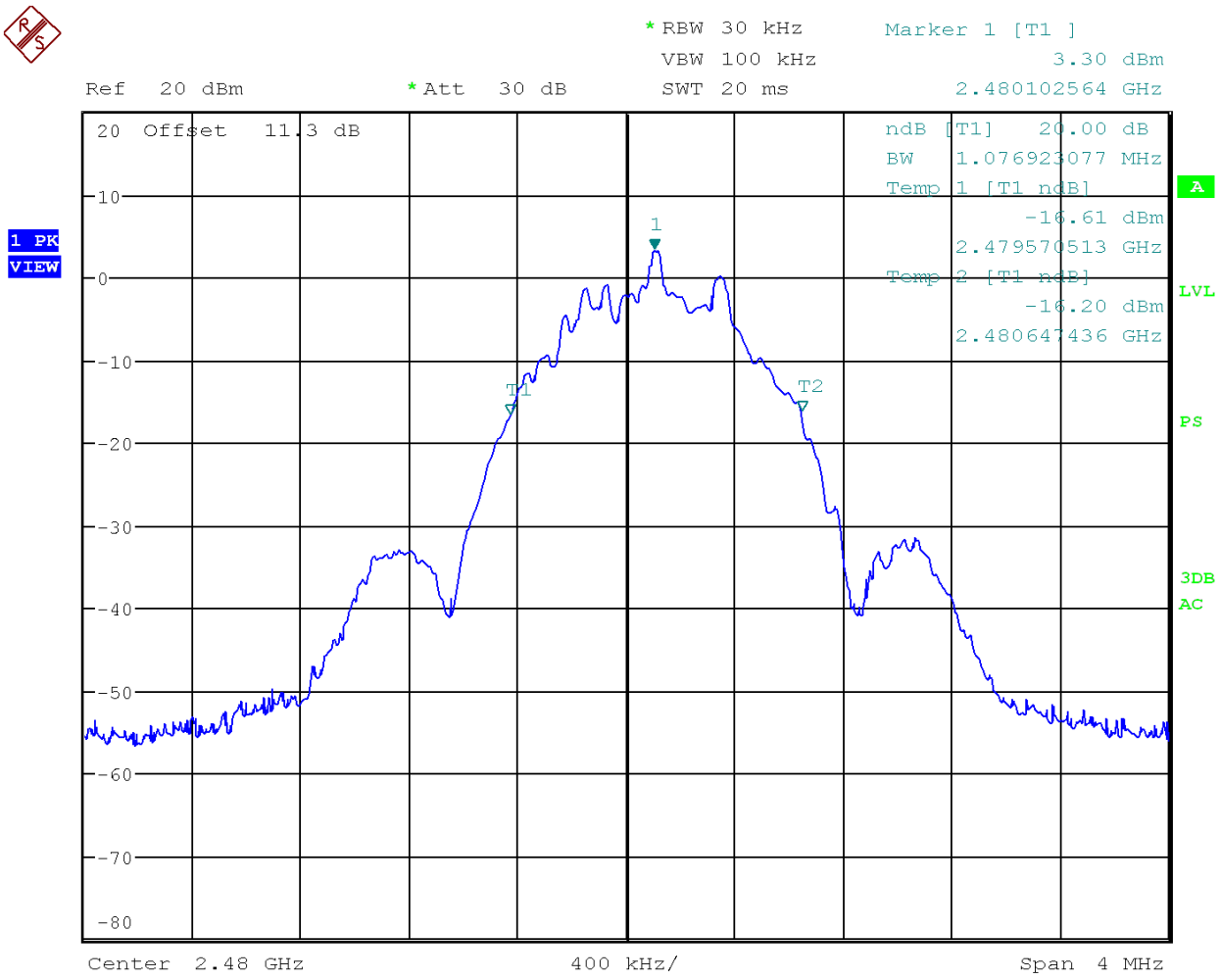
### 9.10.1 2402 MHz:



**9.10.2 2442MHz:**

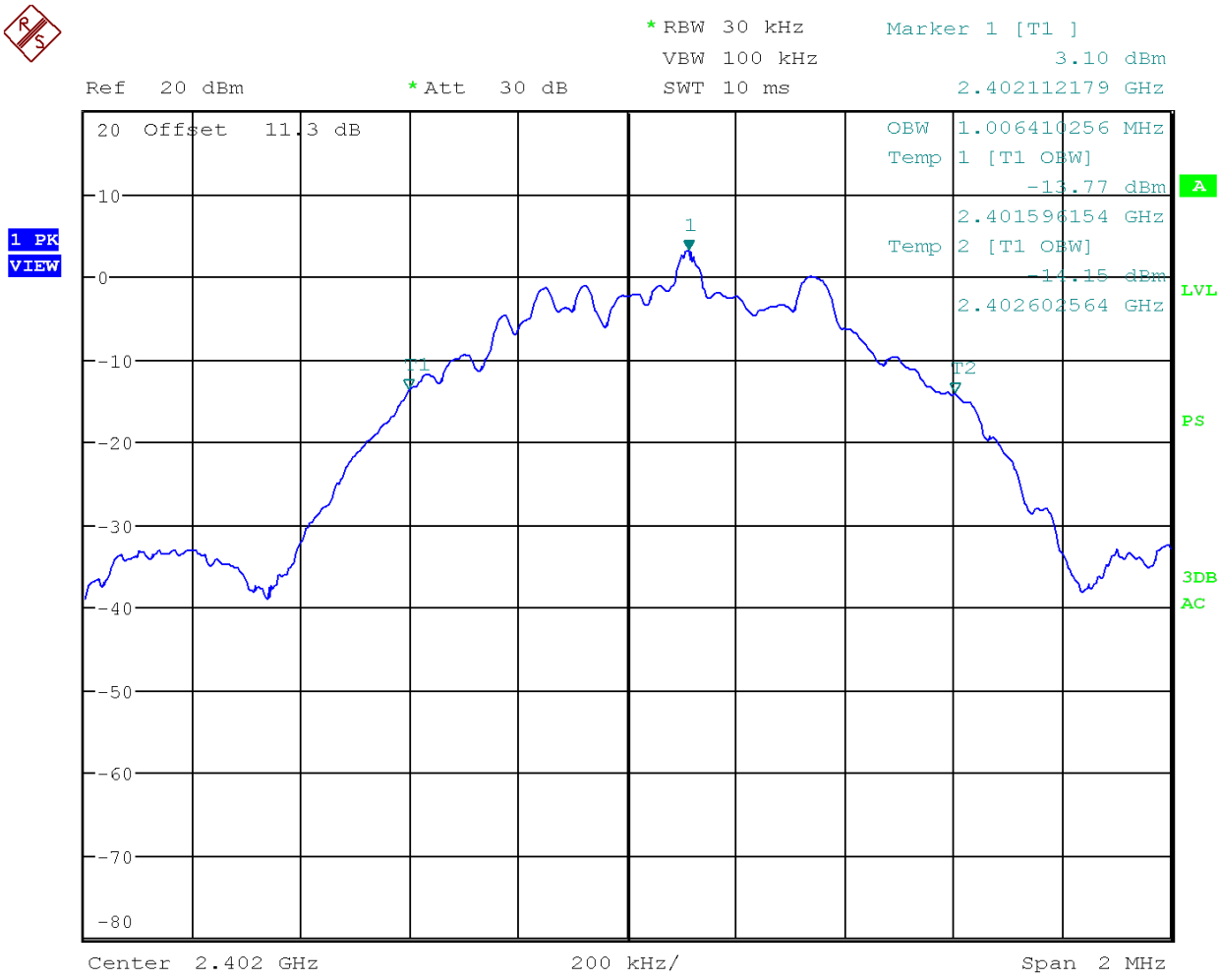


**9.10.3 2480 MHz:**

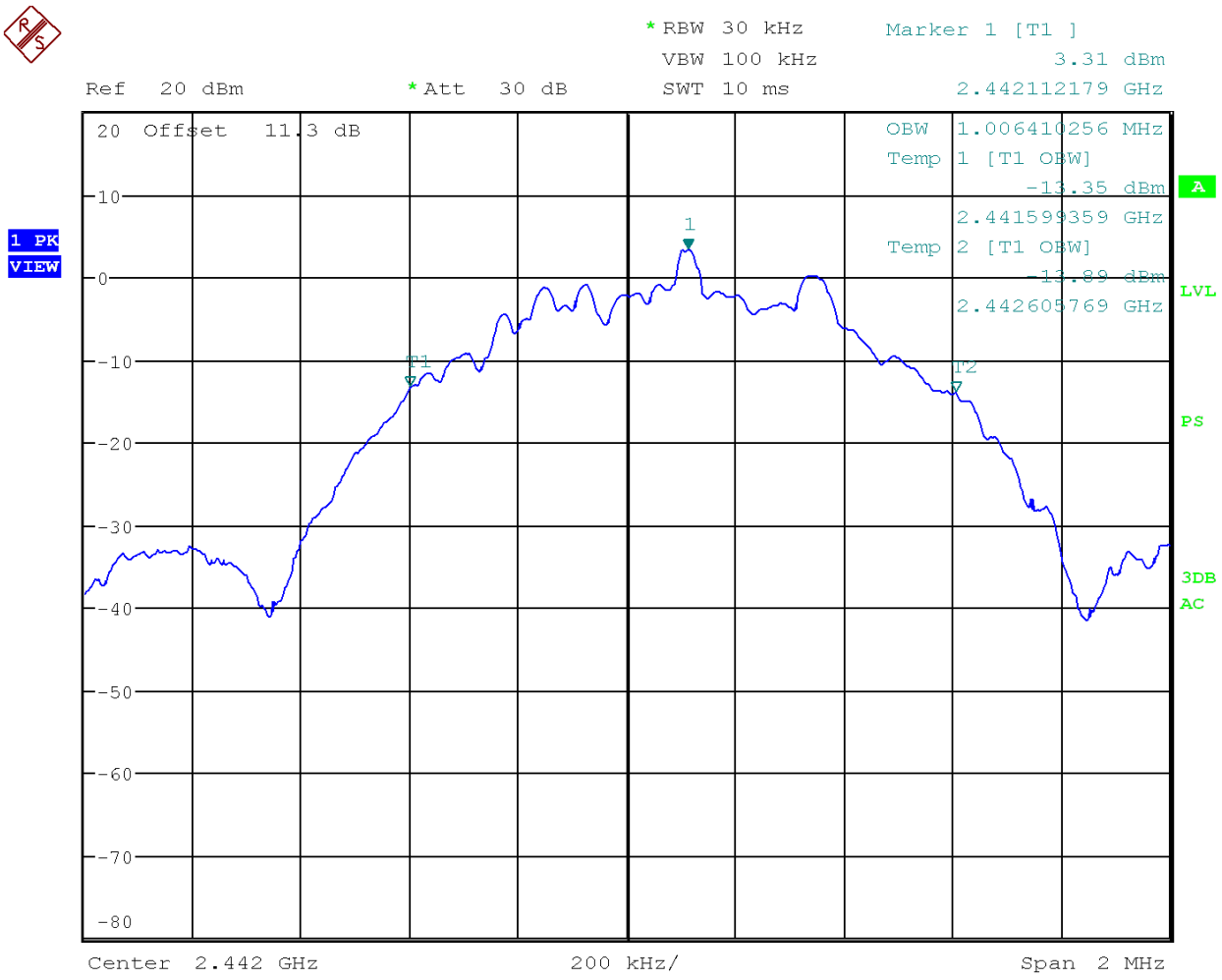


## 9.11 Spectrum Plots, 99% Bandwidth:

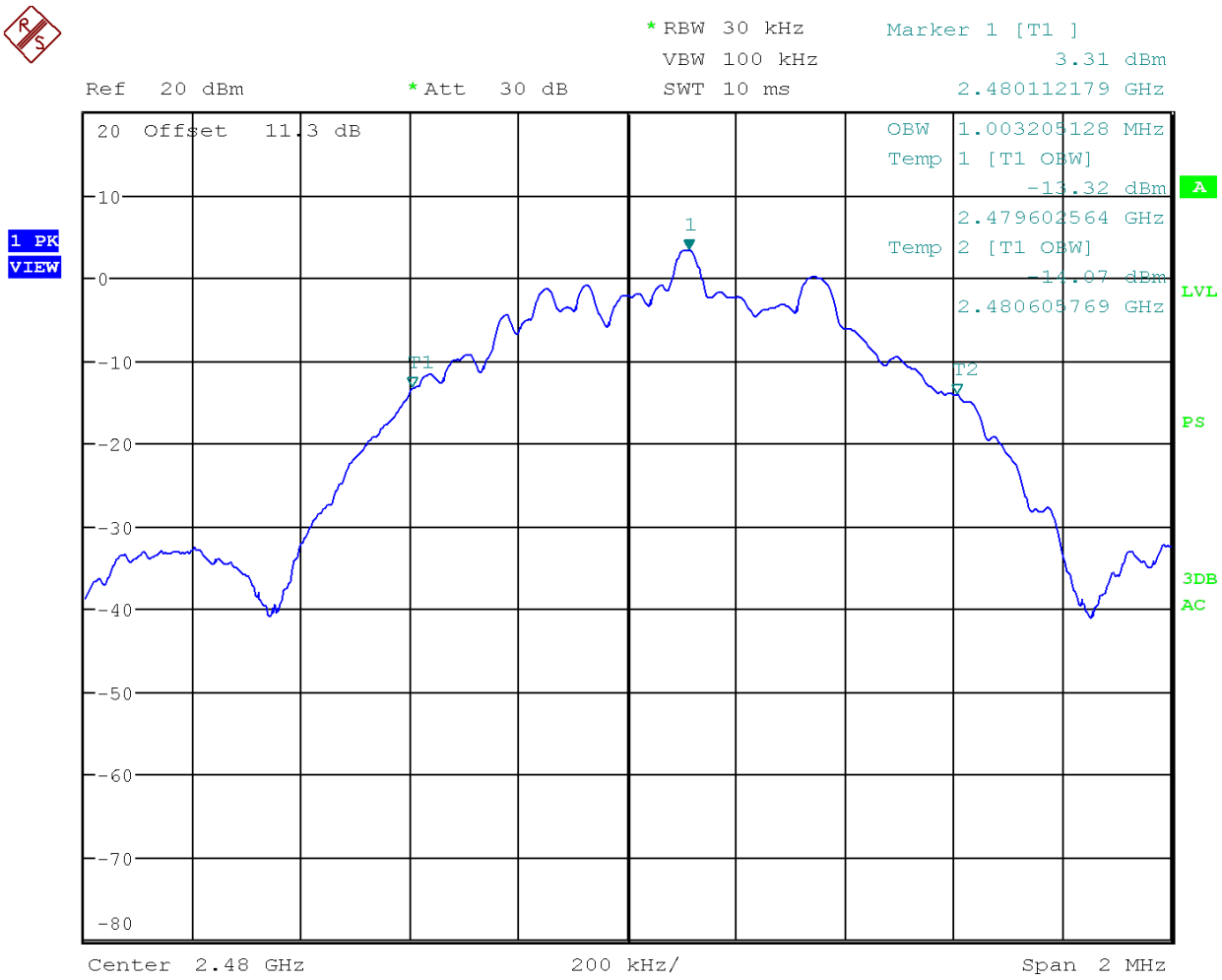
### 9.11.1 2402 MHz:



**9.11.2 2442MHz:**



### 9.11.3 2480 MHz:



# 10 Power Spectral Density

## 10.1 Test Limits:

**FCC Part 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 Issue 2 § 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).

## 10.2 Test Method:

Tests are performed in accordance with ANSI C63.10:2020 § 11.10.2 Method PKPSD (peak PSD).

## 10.3 Measurement Uncertainty

| Measurement | Frequency Range | Expanded Uncertainty (k=2) |
|---|---|---|
| Peak Power Spectral Density (Conducted) | Peak Power Spectral Density (Conducted) | 1.2dB |

No measurement uncertainty correction is performed.

## 10.4 Test Equipment Used:

| Description | Asset | Manufacturer | Model | Cal Date | Cal Due |
|---|---|---|---|---|---|
| EMI Test Receiver | 3900 | Rohde & Schwarz | ESU40 | 10/3/2022 | 10/3/2023 |

## 10.5 Test Results:

The device was found to be **compliant**. The peak power spectral density was less than 8dBm.

## 10.6 Test Conditions:

| | | | |
|---|---|---|---|
| Test Personnel: | Seth Parker | Test Date: | 8/22/2023 |
| Supervising/Reviewing Engineer: (Where Applicable) | NA | Limit Applied: | From FCC Part 15.247(e), RSS-247 Issue 2 § 5.4(b) |
| Product Standard: | FCC Part 15.247 RSS-247 Issue 2 | Ambient Temperature: | 24.5 °C |
| Input Voltage: | 3.6 VDC, Battery | Relative Humidity: | 42.9 % |
| | | Atmospheric Pressure: | 988.3 mbar |

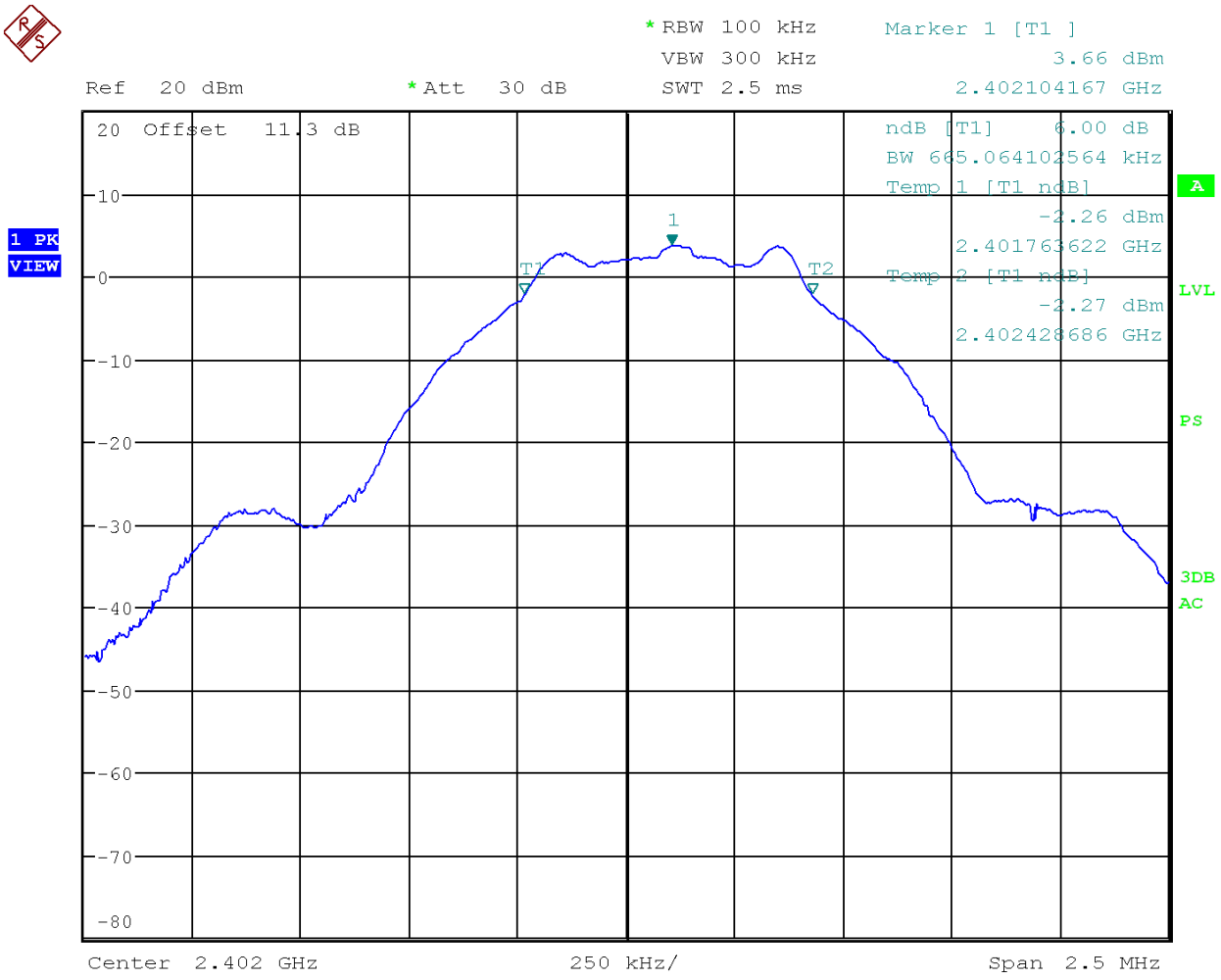
Deviations, Additions, or Exclusions: Measurements were taken with an RBW of 100kHz. PPSD measurements taken with a RBW of 100kHz are greater than those taken with an RBW of 3kHz and therefore represent the worst-case scenario.

## 10.7 Test Data:

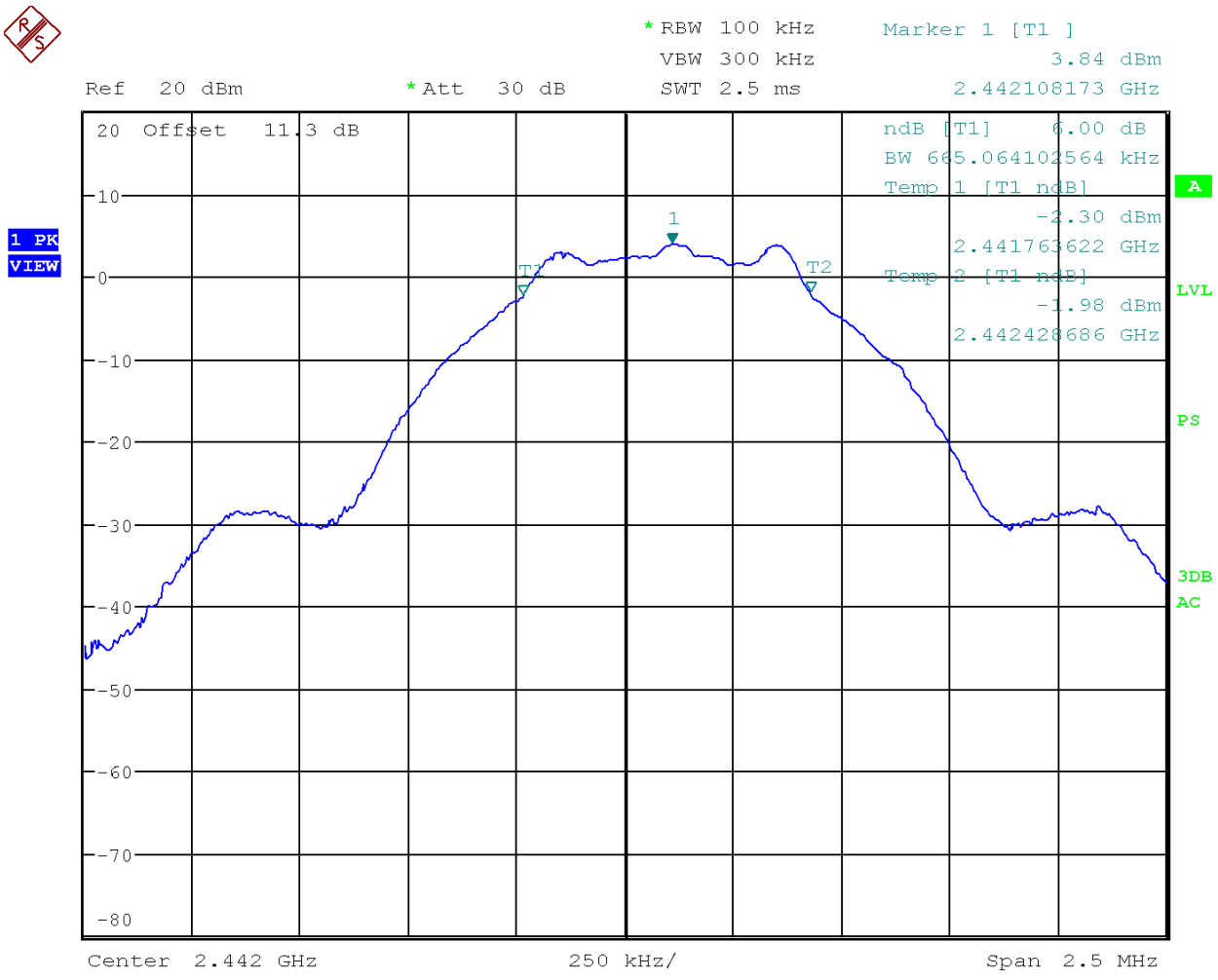
| Operating Mode | Frequency (MHz) | PPSD (dBm/100KHz) | Limit (dBm/3KHz) | Result |
|---|---|---|---|---|
| BLE | 2402 | 3.66 | 8 | Pass |
| | 2442 | 3.84 | 8 | Pass |
| | 2480 | 3.75 | 8 | Pass |

## 10.8 Spectrum Plots:

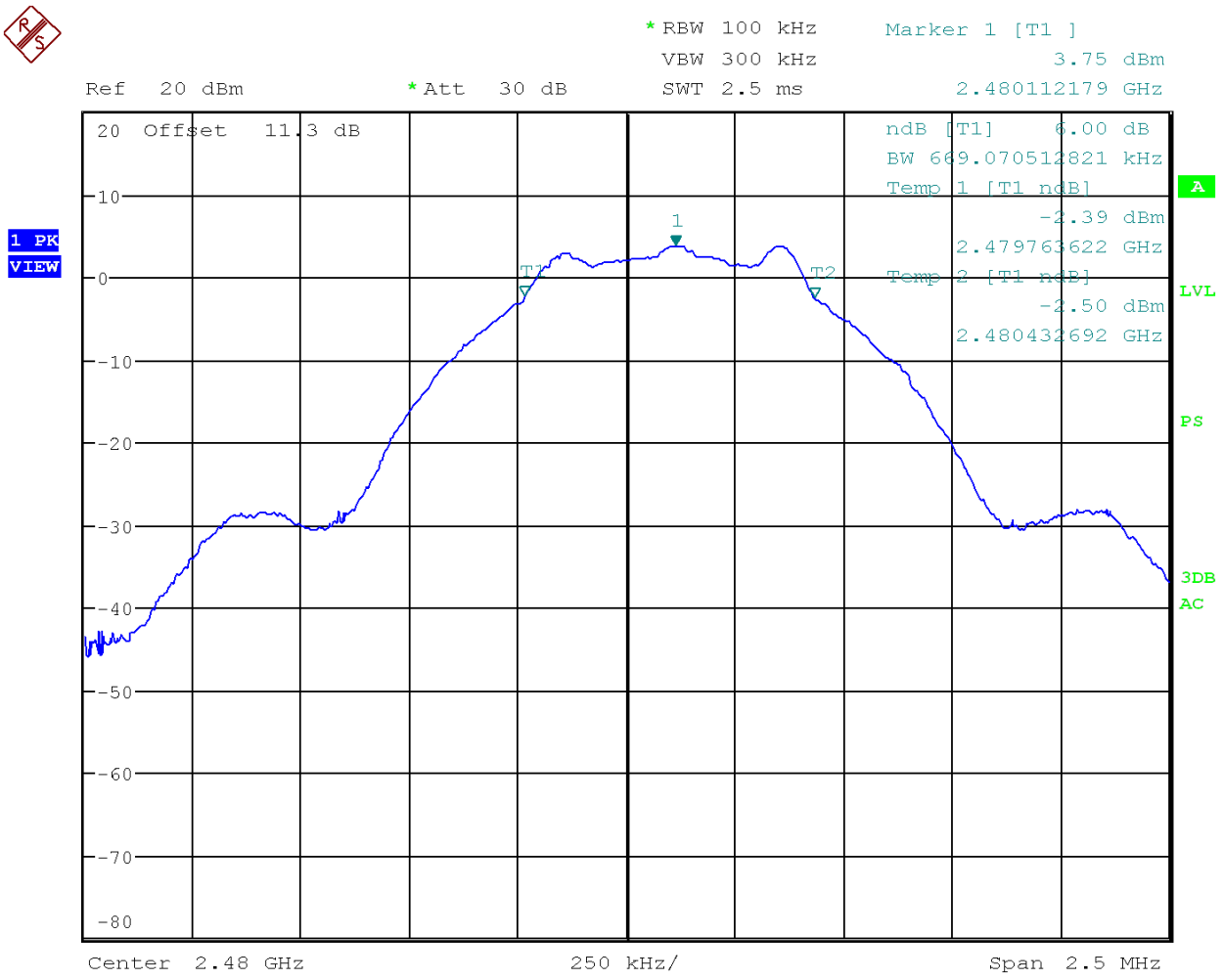
### 10.8.1 2402 MHz:



**10.8.2 2442MHz:**



**10.8.3 2480 MHz:**



# 11 Antenna Requirement

## 11.1 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 isotopically 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).

## 11.2 Test Results:

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

## 12 Revision History

| Revision Level | Date | Report Number | Prepared By | Reviewed By | Notes |
|---|---|---|---|---|---|
| 0 | 12/8/2023 | 105397891LEX-002 | | MC | Original Issue |
| 1 | 1/22/2024 | 105397891LEX-002.1 | | MC | Corrected Antenna Gain. Added missing MU & Sample Calculations. Added note to section 7.6.4 regarding reference level measurement. |
| | | | | | |
| | | | | | |