

# Test Report

HELEM2304000201-1 v1.1



## INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 C AND ISED CANADA REQUIREMENTS

|                        |                                                                                                                                                                                                                                                    |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Equipment Under Test:  | Remote controller for AINA PTT with BLE connection                                                                                                                                                                                                 |
| Model:                 | AINA MULTIFUNCTION BUTTON                                                                                                                                                                                                                          |
| Type:                  | AMB                                                                                                                                                                                                                                                |
| Trademark:             | AINA                                                                                                                                                                                                                                               |
| Manufacturer/Customer: | AINA Wireless Finland Oy<br>Joensuunkatu 7 G<br>FI-24100, Salo<br>Finland                                                                                                                                                                          |
| FCC Rule Part:         | §15.247                                                                                                                                                                                                                                            |
| IC Rule Part:          | RSS-247, Issue 3, 2023<br>RSS-GEN Issue 5 Amendment 2, 2021                                                                                                                                                                                        |
| KDB:                   | 558074 D01 15.247 Meas Guidance v05r02<br>Guidance for Compliance Measurements on Digital Transmission<br>Systems, Frequency Hopping Spread Spectrum System, and Hybrid<br>System Devices Operating Under §15.247 of the FCC rules (April 2, 2019) |

Date: 1 July 2024

Issued by:

Pekka Kälviäinen  
Testing Engineer

Date: 1 July 2024

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Henri Mäki  
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**GENERAL REMARKS****Disclaimer**

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*Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.*

**RELEASE HISTORY**

| Version | Changes                            | Issued       |
|---------|------------------------------------|--------------|
| 1.0     | Initial release                    | 13 July 2023 |
| 1.1     | RSS-247 Issue 2 updated to Issue 3 | 1 July 2024  |

## PRODUCT DESCRIPTION

### Equipment Under Test

|                       |                                                                   |
|-----------------------|-------------------------------------------------------------------|
| Equipment Under Test: | Remote controller for AINA PTT with BLE connection                |
| Trademark:            | AINA                                                              |
| Model:                | AINA MULTIFUNCTION BUTTON                                         |
| Type:                 | AMB                                                               |
| Serial no:            | -                                                                 |
| FCC ID:               | -                                                                 |
| IC:                   | -                                                                 |
| Parallel models:      | AINA PTT SMART BUTTON. Electrically identical, different housing. |
| Radio module or chip: | Nordic Semiconductor nRF52833                                     |

### General Description

The equipment under test is a remote controller for AINA PTT voice responder. Connection works with Bluetooth Low Energy. The EUT also has a passive NFC tag.

### Classification

|                                              |                                     |
|----------------------------------------------|-------------------------------------|
| Fixed device                                 | <input type="checkbox"/>            |
| Mobile Device (Human body distance > 20cm)   | <input type="checkbox"/>            |
| Portable Device (Human body distance < 20cm) | <input checked="" type="checkbox"/> |

### Samples and Modifications

| No. | Name     | Description                                                                                                                                                 |
|-----|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Sample 1 | Sample with test software enabling continuous transmit mode. Used for radiated tests.                                                                       |
| 2   | Sample 2 | Sample with test software enabling continuous transmit mode. Temporary antenna connector soldered in to replace original antenna. Used for conducted tests. |

### Ratings and declarations

|                              |                                                |
|------------------------------|------------------------------------------------|
| Operating frequency range:   | 2402-2480 MHz                                  |
| Nominal channel bandwidth:   | 1 MHz                                          |
| Number of channels:          | 40                                             |
| Channel separation:          | 2 MHz                                          |
| Transmission technique:      | DSSS                                           |
| Modulation:                  | GFSK                                           |
| Data rate:                   | 1 Mbps                                         |
| Antenna type:                | Integral ceramic chip                          |
| Antenna gain:                | +0.5 dBi                                       |
| Antenna count:               | 1                                              |
| EUT dimensions:              | Height: 16 mm    Width: 46 mm    Length: 76 mm |
| Power requirements:          | 3.0 VDC (CR2032 battery)                       |
| Operating temperature range: | -20...+60 °C                                   |

## Product Description

### Ports and Cables

| Cable / Port | Description |
|--------------|-------------|
| -            | -           |

### Peripherals

| Peripheral | Description / Usage |
|------------|---------------------|
| -          | -                   |

## SUMMARY OF TESTING

| Test Specification             | Description of Test                 | Result |
|--------------------------------|-------------------------------------|--------|
| §15.203                        | Antenna Requirement                 | PASS   |
| §15.207 / RSS-Gen 8.8          | AC Power-Line Conducted Emissions   | PASS   |
| §15.247(a)(2) / RSS-247 5.2 a) | 6 dB Bandwidth                      | PASS   |
| RSS-Gen 6.7                    | Occupied Bandwidth 99 %             | PASS   |
| §15.247(b)(3) / RSS-247 5.4 d) | Maximum Peak Conducted Output Power | PASS   |
| §15.247(d) / RSS-247 5.5       | Unwanted Emissions                  | PASS   |
| §15.247(e) / RSS-247 5.2 b)    | Power Spectral Density              | PASS   |

*The decision rule applied for the tests results stated in this test report is according to the requirements of section 1.4 of ANSI C63.10-2020.*

## EUT Test Conditions during Testing

The EUT had a test software installed that allowed the radio to be set to transmit continually with the EUT buttons. Same modulation and transmit power as with the production model were used during the tests. The orientation with the highest emissions was determined by testing all possible orientations.

Conducted RF tests were performed with an automated Rohde & Schwarz TS8997 measurement system. The EUT was connected to the measurement system with a coaxial cable and was configured with the EUT buttons.

Radiated tests were performed in a semi-anechoic chamber with a measurement distance of 3 meters. During measurements above 1 GHz absorbers were placed on the floor. The EUT was configured with its own buttons.

A modified CR2032 battery was used in all tests, allowing the use of a laboratory power supply to feed power into the EUT instead of a normal CR2032 battery. This was done because a CR2032 cannot supply enough power for continuous radio transmit. Input voltage was 3.0 DCV.



**Figure 1:** Test setup block diagram (conducted RF tests)



**Figure 2:** Test setup block diagram (radiated tests)

**Table 1:** Test frequencies and settings

| Data rate          | Channel | Frequency [MHz] |
|--------------------|---------|-----------------|
| 1 Mbps (LE 1M PHY) | 37      | 2402            |
|                    | 17      | 2440            |
|                    | 39      | 2480            |

## Test Facility

|                                                                                                            |                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Testing Laboratory / address:<br>FCC designation number: <b>FI0002</b><br>ISED CAB identifier: <b>T004</b> | SGS Fimko Ltd<br>Takomotie 8<br>FI-00380, HELSINKI<br>FINLAND                                                                                                                                                     |
| Test Site:                                                                                                 | <input type="checkbox"/> K10LAB, ISED Canada registration number: <b>8708A-1</b><br><input checked="" type="checkbox"/> K5LAB, ISED Canada registration number: <b>8708A-2</b><br><input type="checkbox"/> T10LAB |

## TEST RESULTS

## Antenna Requirement

Standard: FCC Rule §15.203  
Tested by: HAM  
Date: 7 July 2023  
Test result: **PASS**

## FCC §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.

| Specification | Requirement (at least one of the following shall be applied)                                                                                                                                                                                                                                                            | Conclusion  |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| §15.203       | <ol style="list-style-type: none"><li>1. Permanently attached antenna</li><li>2. Unique coupling to the intentional radiator</li><li>3. Professionally installed radio. The installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.</li></ol> | <b>PASS</b> |
| Note          | Option 1 is used                                                                                                                                                                                                                                                                                                        |             |

## 6 dB Bandwidth

**Standard:** ANSI C63.10-2020  
**Tested by:** HAM  
**Date:** 7 July 2023  
**Temperature:** 24 °C  
**Humidity:** 44 %RH  
**Test result:** **PASS**

### FCC §15.247(a)(2) RSS-247 clause 5.2 a)

The 6 dB bandwidth is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emissions is attenuated 6 dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emissions.

The minimum 6 dB bandwidth shall be at least 500 kHz.

Sample 2 was used for the test.

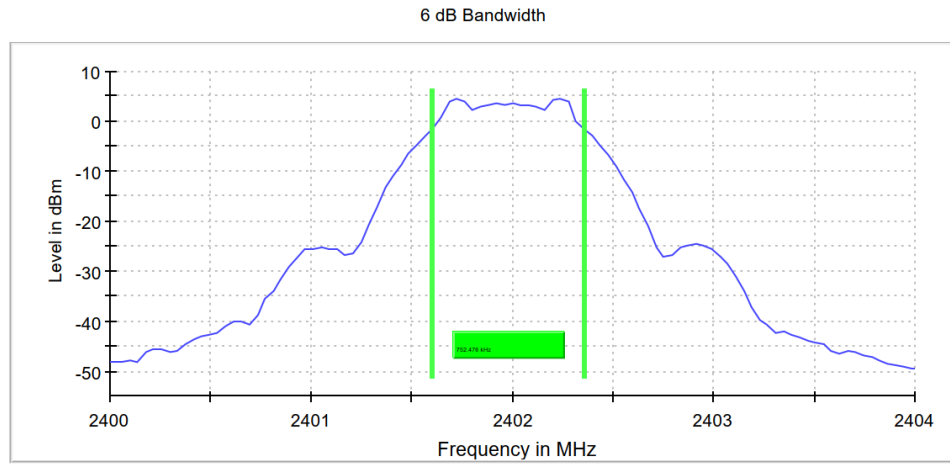
## Test results

**Table 2:** Test results for 6 dB Bandwidth

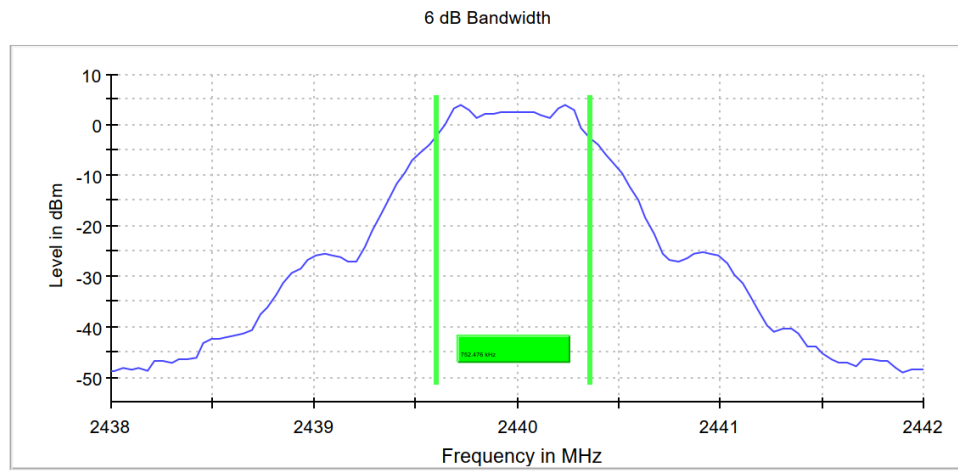
| Data Rate | Frequency [MHz] | 6 dB BW [kHz] | Limit [kHz] | Result      |
|-----------|-----------------|---------------|-------------|-------------|
| 1 Mbps    | 2402            | 752.476       | ≥ 500       | <b>PASS</b> |
|           | 2440            | 752.476       |             | <b>PASS</b> |
|           | 2480            | 752.476       |             | <b>PASS</b> |

The conducted measurement was performed with a spectrum analyzer using the following settings:

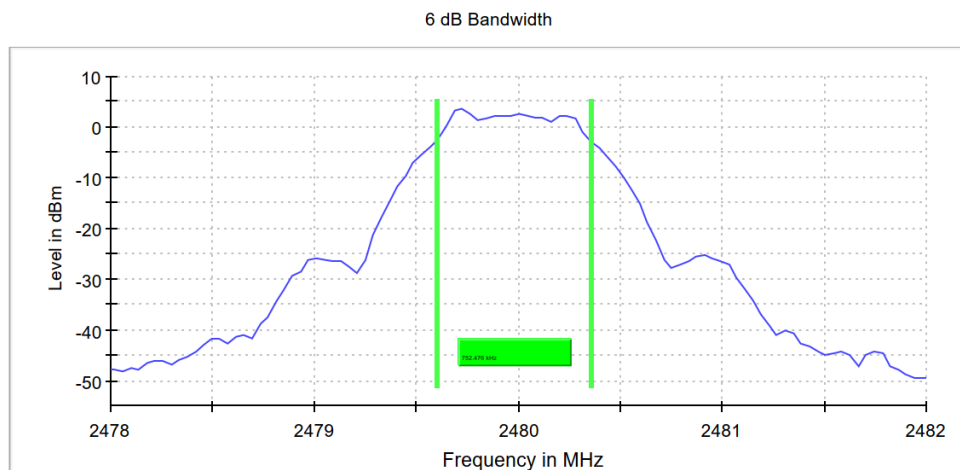
| Setting         | Value       |
|-----------------|-------------|
| Span            | 4.000 MHz   |
| RBW             | 100.000 kHz |
| VBW             | 300.000 kHz |
| Sweep Points    | 101         |
| Sweep Time      | 18.938 μs   |
| Reference Level | 0.000 dBm   |
| Attenuation     | 20.000 dB   |
| Detector        | MaxPeak     |
| Filter          | 3 dB        |
| Trace Mode      | Max Hold    |
| Sweep Type      | FFT         |
| Preamp          | off         |



**Figure 3: 6 dB Bandwidth (TX 2402 MHz)**



**Figure 4: 6 dB Bandwidth (TX 2440 MHz)**



**Figure 5: 6 dB Bandwidth (TX 2480 MHz)**

## Occupied Bandwidth 99%

**Standard:** RSS-Gen  
**Tested by:** HAM  
**Date:** 7 July 2023  
**Temperature:** 24 °C  
**Humidity:** 44 %RH  
**Test result:** **PASS**

### RSS-Gen clause 6.7

The occupied 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 emission is contained. Sample 2 was used for the test.

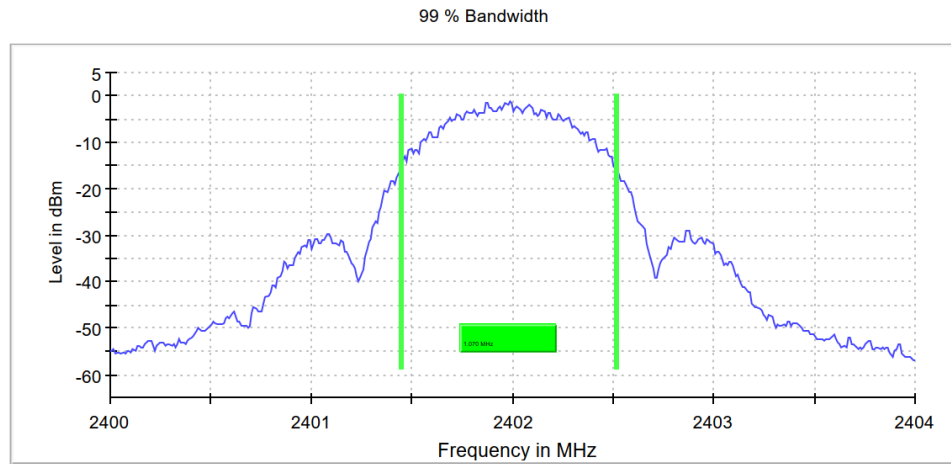
### Test results

**Table 3:** Test results for Occupied Bandwidth 99%

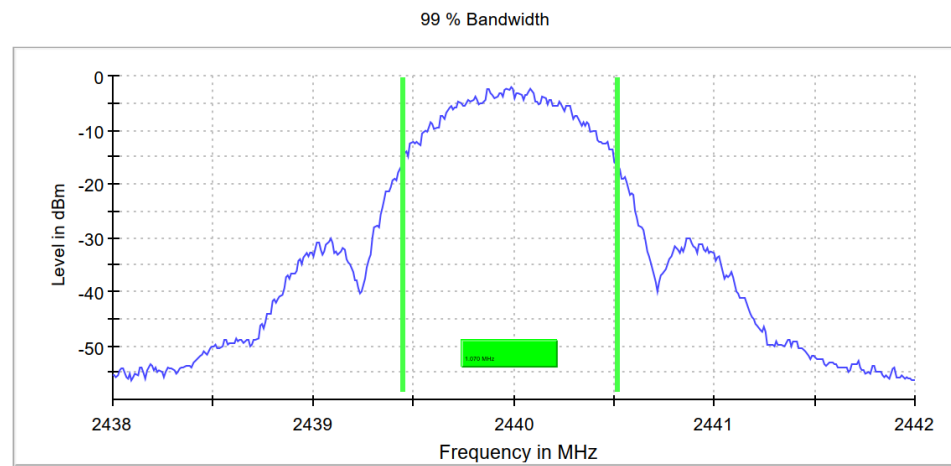
| Data Rate | Frequency [MHz] | OBW 99% [MHz] | Limit [MHz] | Result      |
|-----------|-----------------|---------------|-------------|-------------|
| 1 Mbps    | 2402            | 1.070000      | -           | <b>PASS</b> |
|           | 2440            | 1.070000      |             | <b>PASS</b> |
|           | 2480            | 1.070000      |             | <b>PASS</b> |

The conducted measurement was performed with a spectrum analyzer using the following settings:

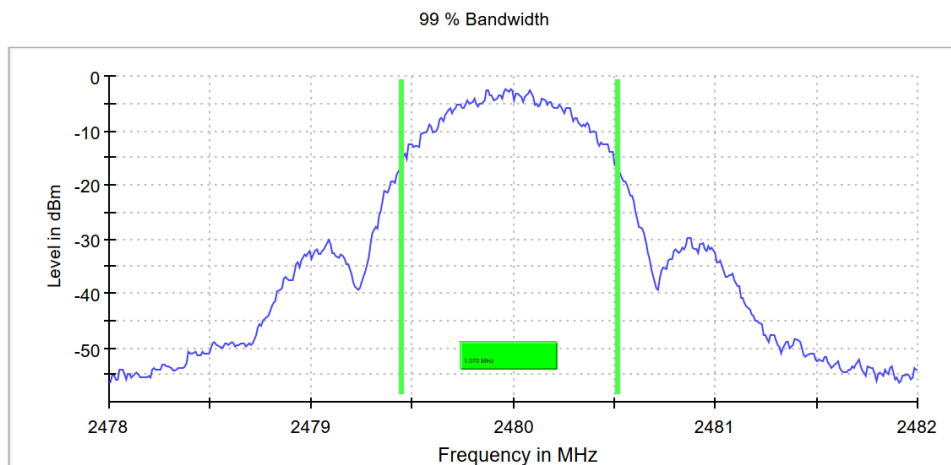
| Setting         | Value       |
|-----------------|-------------|
| Span            | 4.000 MHz   |
| RBW             | 20.000 kHz  |
| VBW             | 100.000 kHz |
| Sweep Points    | 400         |
| Sweep Time      | 94.824 µs   |
| Reference Level | 0.000 dBm   |
| Attenuation     | 20.000 dB   |
| Detector        | MaxPeak     |
| Filter          | 3 dB        |
| Trace Mode      | Max Hold    |
| Sweep Type      | FFT         |
| Preamp          | off         |



**Figure 6:** Occupied Bandwidth 99% (TX 2402 MHz)



**Figure 7:** Occupied Bandwidth 99% (TX 2440 MHz)



**Figure 8:** Occupied Bandwidth 99% (TX 2480 MHz)

**Maximum Peak Conducted Output Power****Maximum Peak Conducted Output Power**

**Standard:** ANSI C63.10-2020  
**Tested by:** HAM  
**Date:** 7 July 2023  
**Temperature:** 24 °C  
**Humidity:** 44 %RH  
**Measurement uncertainty:** ± 2.87dB, level of confidence 95 % (k = 2)  
**Test result:** **PASS**

**FCC §15.247(b)(3)**  
**RSS-247 clause 5.4 d)**

For systems using digital modulation in the 2400-2483.5 MHz band the maximum peak conducted output power of the intentional radiator shall not exceed 1 W (30 dBm). The conducted output power limit is based on the use of antennas with directional gains that do not exceed 6 dBi.  
Sample 2 was used for the test.

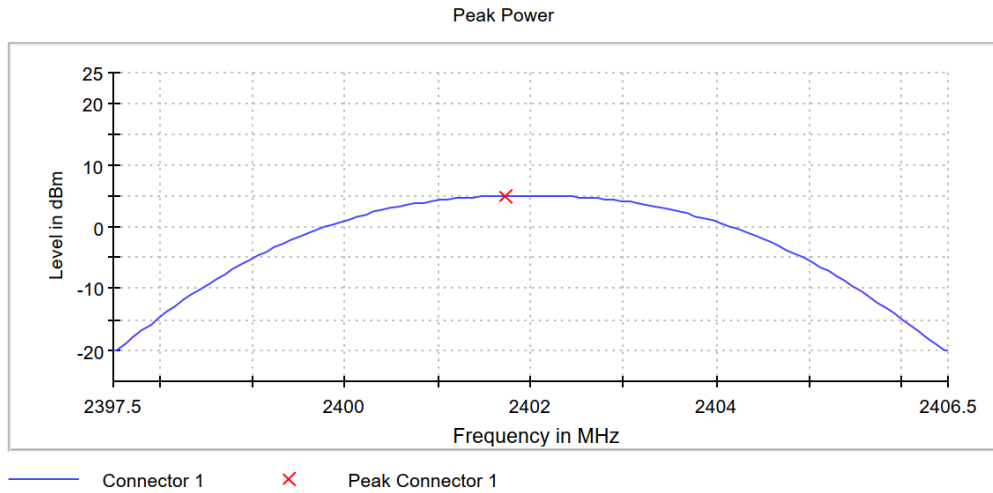
**Test results****Table 4:** Test results for Maximum Peak Conducted Output Power

| Data Rate | Frequency [MHz] | Output Power [dBm] | Limit [dBm] | Result |
|-----------|-----------------|--------------------|-------------|--------|
| 1 Mbps    | 2402            | 4.9                | 30          | PASS   |
|           | 2440            | 4.1                |             | PASS   |
|           | 2480            | 3.9                |             | PASS   |

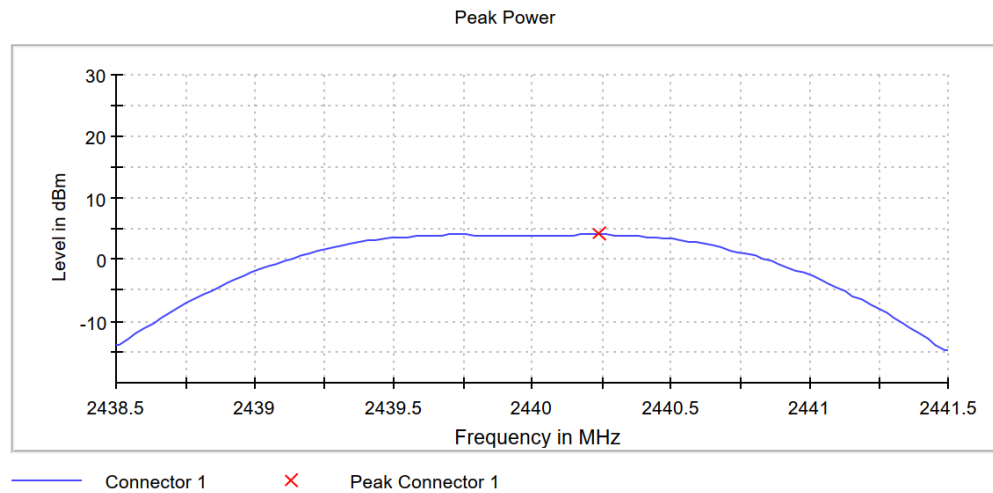
The conducted measurement was performed with a spectrum analyzer using the following settings:

| Setting         | Value      |
|-----------------|------------|
| Span            | 9.000 MHz  |
| RBW             | 3.000 MHz  |
| VBW             | 10.000 MHz |
| SweepPoints     | 101        |
| SweepTime       | 1.271 µs   |
| Reference Level | 10.000 dBm |
| Attenuation     | 30.000 dB  |
| Detector        | MaxPeak    |
| Filter          | 3 dB       |
| Trace Mode      | Max Hold   |
| SweepType       | FFT        |
| Preamp          | off        |

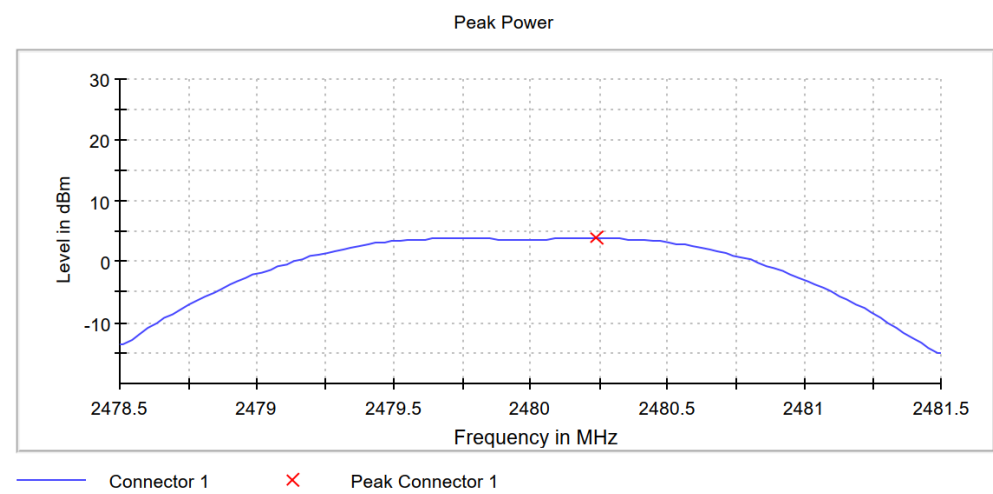
Maximum Peak Conducted Output Power



**Figure 9:** Maximum Peak Conducted Output Power (TX 2402 MHz)



**Figure 10:** Maximum Peak Conducted Output Power (TX 2440 MHz)



**Figure 11:** Maximum Peak Conducted Output Power (TX 2480 MHz)

**Unwanted Emissions (conducted)**

---

**Unwanted Emissions (conducted)**

|                                 |                                             |
|---------------------------------|---------------------------------------------|
| <b>Standard:</b>                | ANSI C63.10-2020                            |
| <b>Tested by:</b>               | HAM                                         |
| <b>Date:</b>                    | 7 July 2023                                 |
| <b>Temperature:</b>             | 24 °C                                       |
| <b>Humidity:</b>                | 44 %RH                                      |
| <b>Measurement uncertainty:</b> | ± 2.87 dB, level of confidence 95 % (k = 2) |
| <b>Test result:</b>             | <b>PASS</b>                                 |

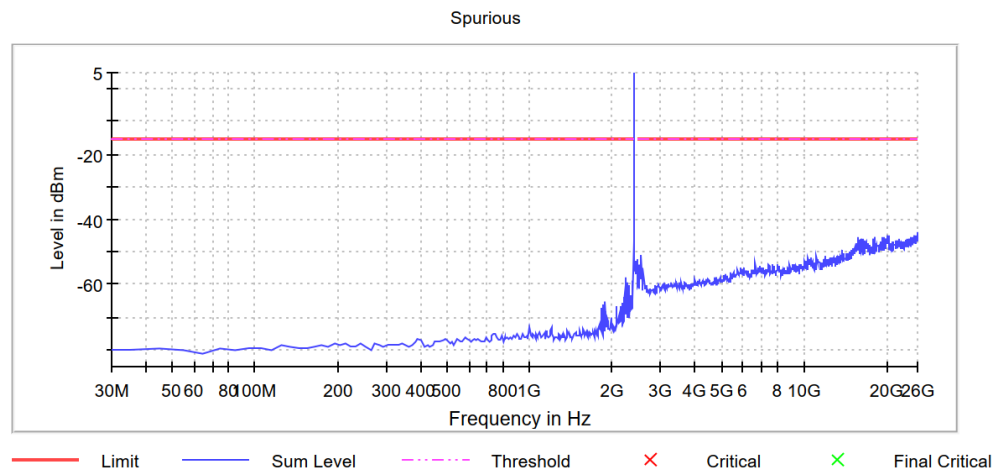
**FCC §15.247(d)**  
**RSS-247 clause 5.5**

In any 100 kHz bandwidth outside the frequency band in which the 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.

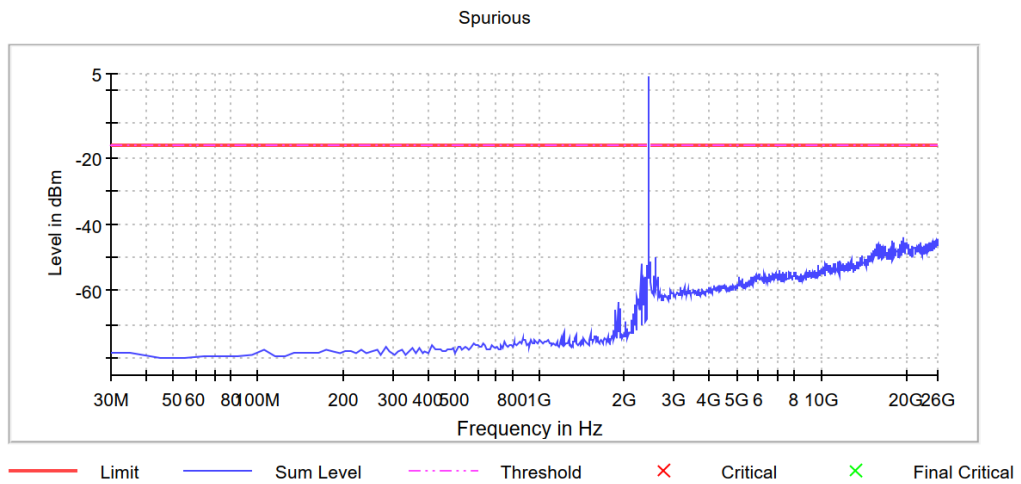
Sample 2 was used for the test.

## Unwanted Emissions (conducted)

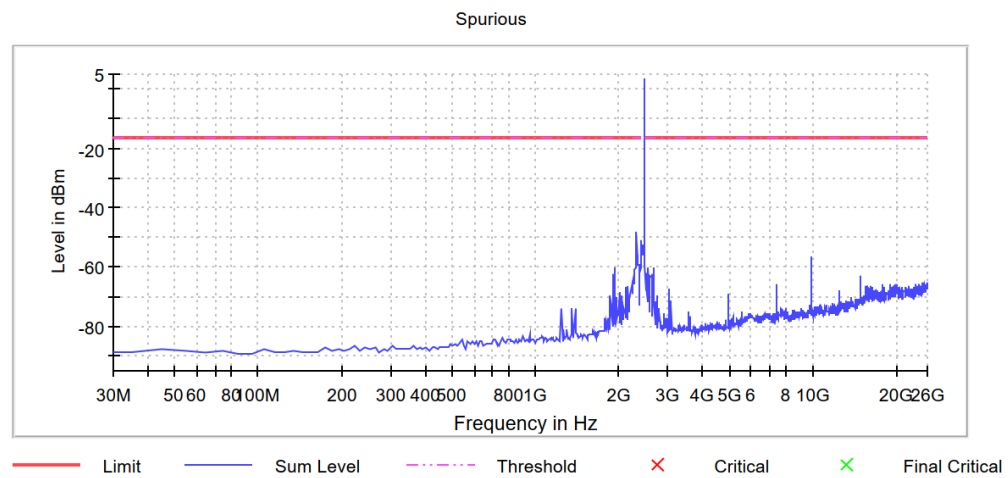
### Test results



**Figure 12:** Unwanted Emissions, conducted (TX 2402 MHz)



**Figure 13:** Unwanted Emissions, conducted (TX 2440 MHz)



**Figure 14:** Unwanted Emissions, conducted (TX 2480 MHz)

Unwanted Emissions (conducted)

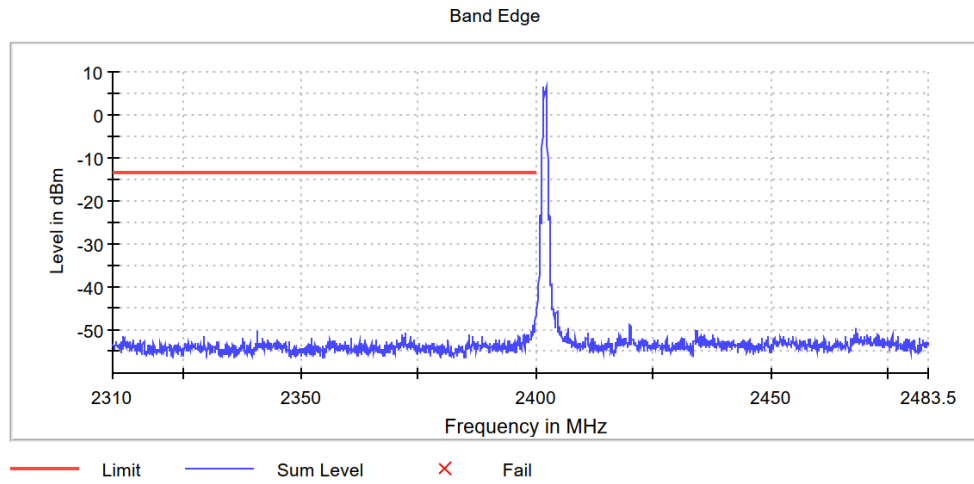


Figure 15: Lower Band-Edge, conducted (TX 2402 MHz)

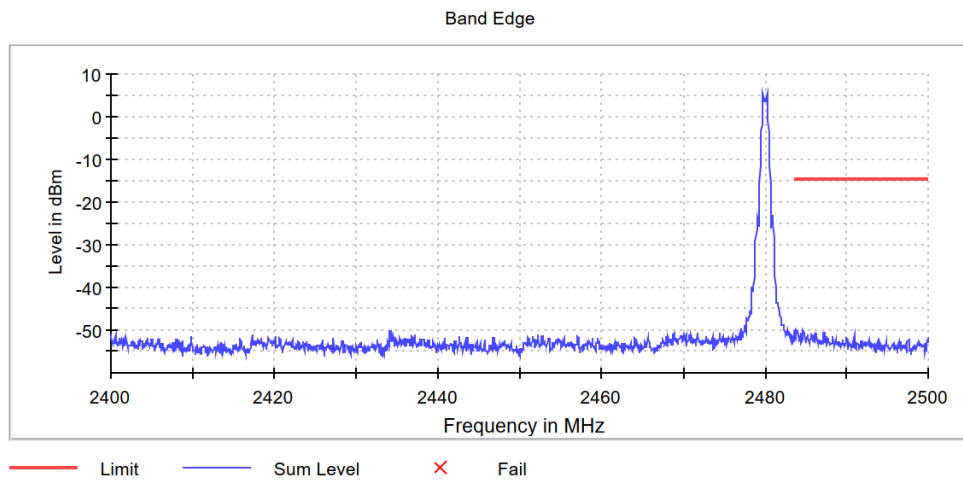


Figure 16: Upper Band-Edge, conducted (TX 2480 MHz)

**Unwanted Emissions (radiated)**

|                                 |                                             |              |
|---------------------------------|---------------------------------------------|--------------|
| <b>Standard:</b>                | ANSI C63.10-2020                            |              |
| <b>Tested by:</b>               | LAS                                         | LAS          |
| <b>Date:</b>                    | 8 July 2023                                 | 10 July 2023 |
| <b>Temperature:</b>             | 22 °C                                       | 23 °C        |
| <b>Humidity:</b>                | 55 %RH                                      | 46 %RH       |
| <b>Measurement uncertainty:</b> | ± 4.51 dB, level of confidence 95 % (k = 2) |              |
| <b>Test result:</b>             | <b>PASS</b>                                 |              |

**FCC §15.247(d)  
RSS-247 clause 5.5**

In any 100 kHz bandwidth outside the frequency band in which the 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. Attenuation below the general limits specified in §15.209(a) and RSS-Gen clause 8.9 is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) and RSS-Gen clause 8.10, must also comply with the radiated emission limits specified in §15.209(a) and RSS-Gen clause 8.9.

Investigative measurements were performed in order to find the worst-case orientation for the EUT. The final measurements were performed in the worst-case orientation.

The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables). The result value is the measured value corrected with the correction factor.

Sample 1 was used for the test.

## Unwanted Emissions (radiated)

### Test results (TX 2402 MHz)

**Table 5:** Test results with quasi-peak detector (TX 2402 MHz)

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 30.440000       | 16.84              | 40.00          | 23.16       | 15 x 1000.0     | 120.000         | 378.0       | V   | 0.0           | 16.8       |
| 947.725000      | 24.05              | 46.00          | 21.95       | 15 x 1000.0     | 120.000         | 247.0       | H   | 133.0         | 31.9       |

**Table 6:** Test results with peak detector (TX 2402 MHz)

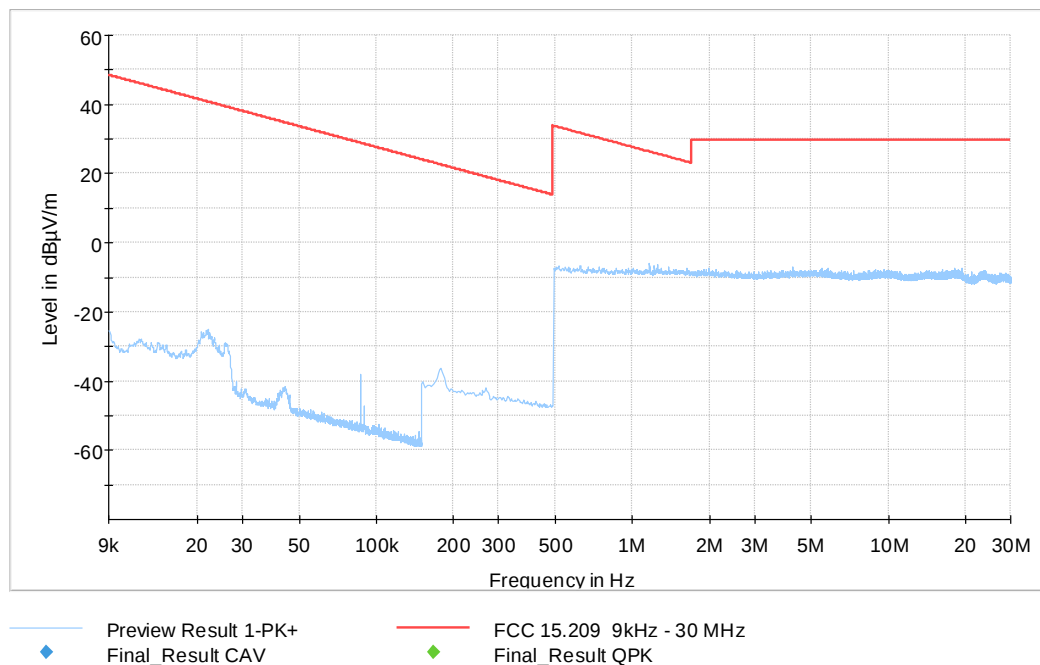
| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 2400.000000     | 53.03            | 75.94 *)       | 22.91       | 15 x 1000.0     | 1000.000        | 226.0       | V   | 73.0          | 13.7         |
| 2402.200000     | 95.94            | ---            | ---         | 15 x 1000.0     | 1000.000        | 271.0       | H   | 243.0         | 13.7         |

\*) -20 dBc

**Table 7:** Test results with average detector (TX 2402 MHz)

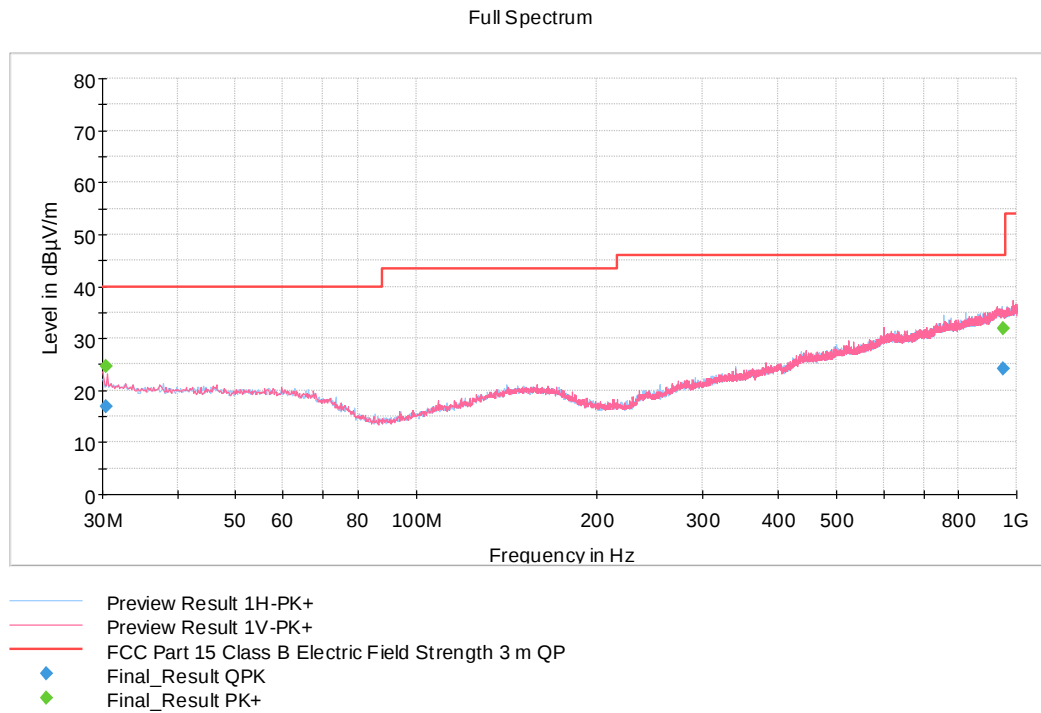
| Frequency (MHz) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|-------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 2370.025000     | 35.87             | 54.00          | 18.13       | 15 x 1000.0     | 1000.000        | 225.0       | H   | 111.0         | 13.3         |
| 2400.000000     | 43.45             | ---            | ---         | 15 x 1000.0     | 1000.000        | 200.0       | H   | 255.0         | 13.7         |
| 2494.750000     | 36.02             | 54.00          | 17.98       | 15 x 1000.0     | 1000.000        | 237.0       | H   | 167.0         | 13.8         |
| 2882.050000     | 36.68             | 54.00          | 17.32       | 15 x 1000.0     | 1000.000        | 180.0       | V   | 29.0          | 14.4         |
| 3266.900000     | 36.51             | 54.00          | 17.49       | 15 x 1000.0     | 1000.000        | 100.0       | V   | 240.0         | 14.3         |
| 3334.900000     | 36.53             | 54.00          | 17.47       | 15 x 1000.0     | 1000.000        | 215.0       | V   | 239.0         | 14.4         |
| 3345.950000     | 36.56             | 54.00          | 17.44       | 15 x 1000.0     | 1000.000        | 215.0       | V   | 26.0          | 14.4         |
| 17995.900000    | 38.39             | 54.00          | 15.61       | 15 x 1000.0     | 1000.000        | 230.0       | V   | 0.0           | 26.3         |
| 18676.950000    | 40.17             | 54.00          | 13.83       | 15 x 1000.0     | 1000.000        | 100.0       | H   | 171.0         | 8.0          |

Full Spectrum

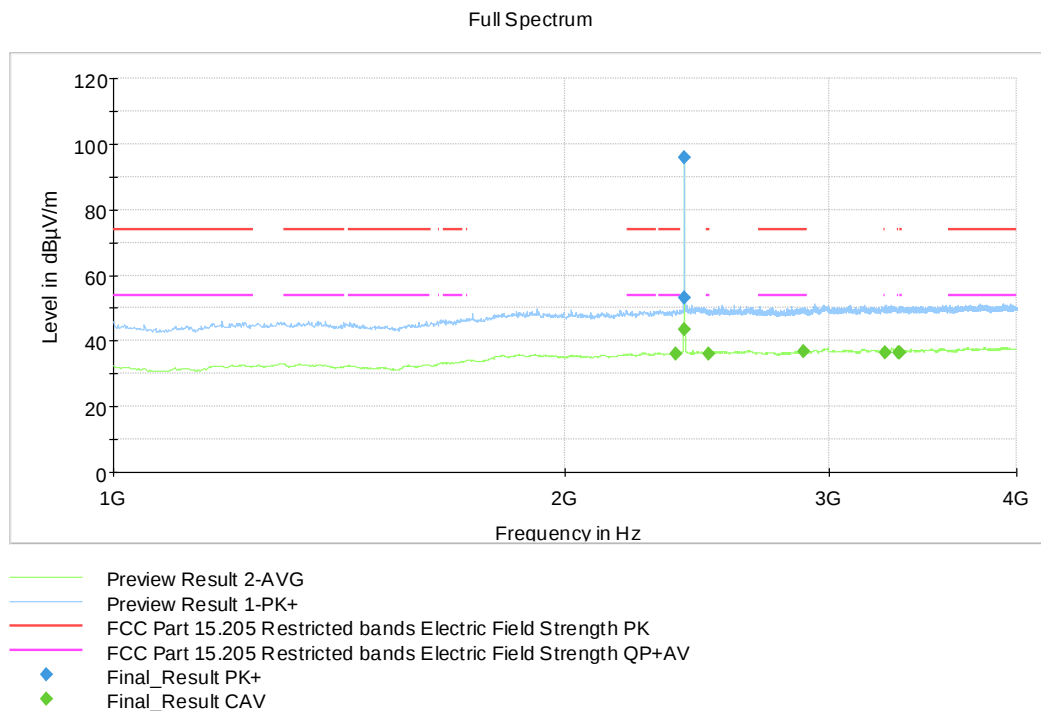


**Figure 17:** Unwanted Emissions, radiated 9 kHz – 30 MHz (TX 2402 MHz)

## Unwanted Emissions (radiated)

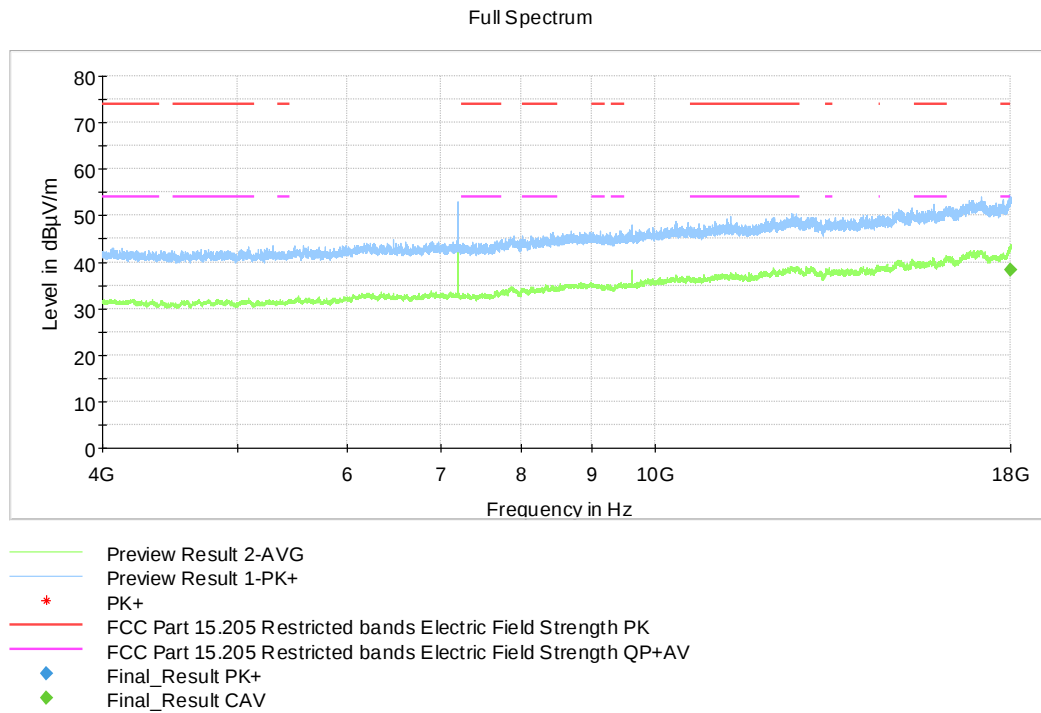


**Figure 18:** Unwanted Emissions, radiated 30 – 1000 MHz (TX 2402 MHz)

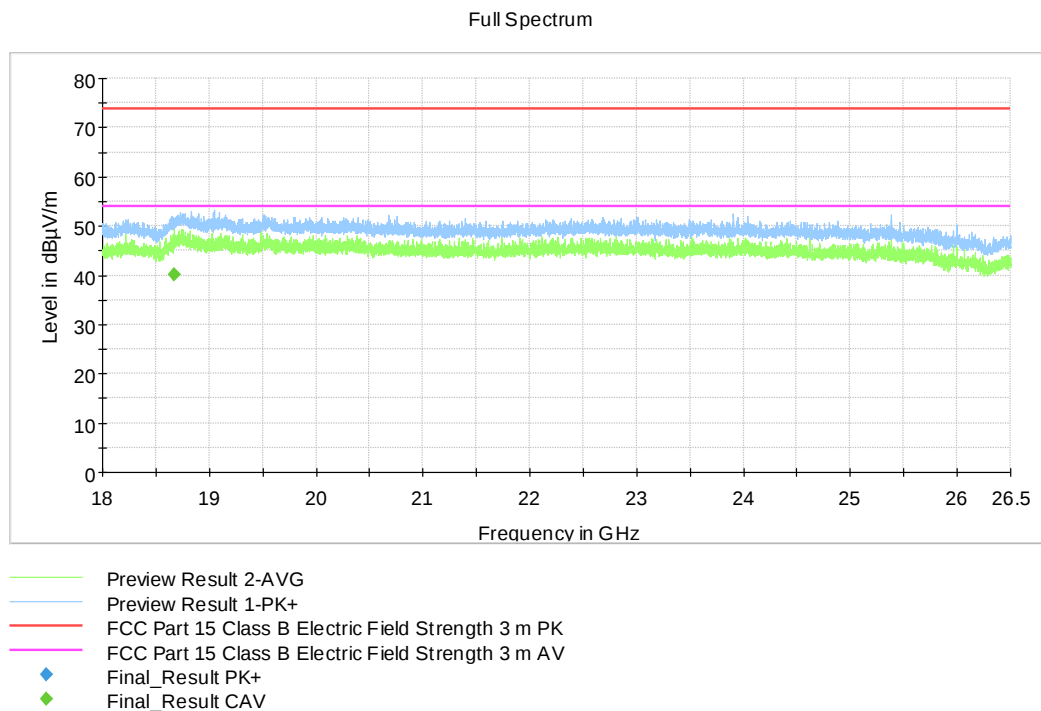


**Figure 19:** Unwanted Emissions, radiated 1 – 4 GHz (TX 2402 MHz)

## Unwanted Emissions (radiated)



**Figure 20:** Unwanted Emissions, radiated 4 – 18 GHz (TX 2402 MHz)



**Figure 21:** Unwanted Emissions, radiated 18 – 26.5 GHz (TX 2402 MHz)

## Unwanted Emissions (radiated)

### Test results (TX 2440 MHz)

**Table 8:** Test results with quasi-peak detector (TX 2440 MHz)

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 34.375000       | 16.21              | 40.00          | 23.79       | 15 x 1000.0     | 120.000         | 382.0       | V   | 20.0          | 16.6       |
| 954.285000      | 24.26              | 46.00          | 21.74       | 15 x 1000.0     | 120.000         | 140.0       | H   | 333.0         | 31.9       |

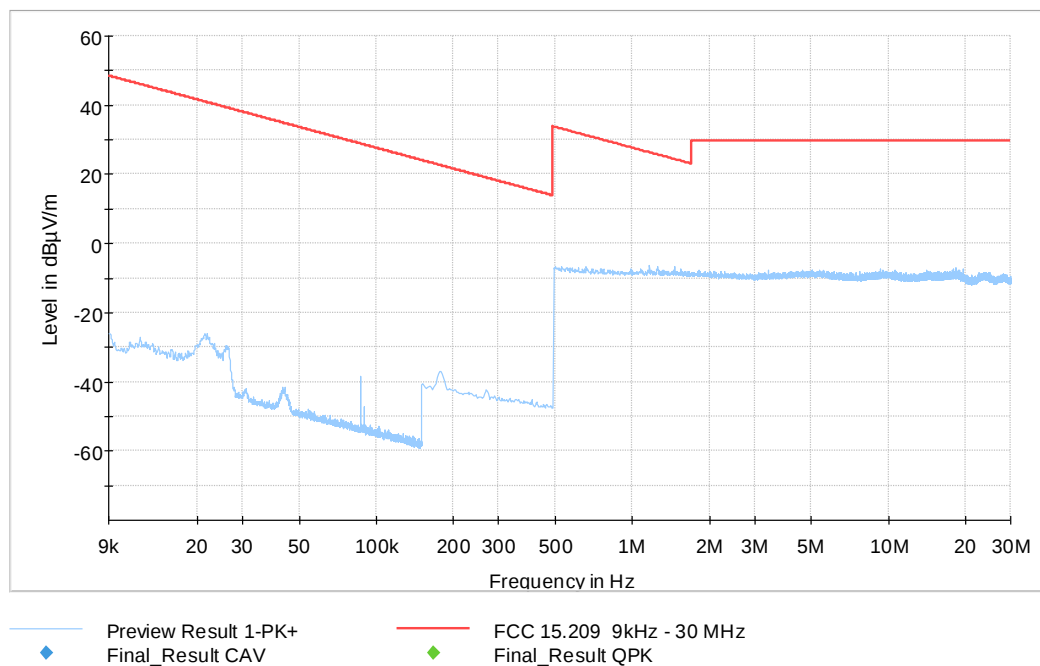
**Table 9:** Test results with peak detector (TX 2440 MHz)

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 2439.750000     | 96.21            | ---            | ---         | 15 x 1000.0     | 1000.000        | 240.0       | H   | 68.0          | 13.6         |
| 7319.200000     | 54.04            | 74.00          | 19.96       | 15 x 1000.0     | 1000.000        | 100.0       | V   | 268.0         | 10.7         |

**Table 10:** Test results with average detector (TX 2440 MHz)

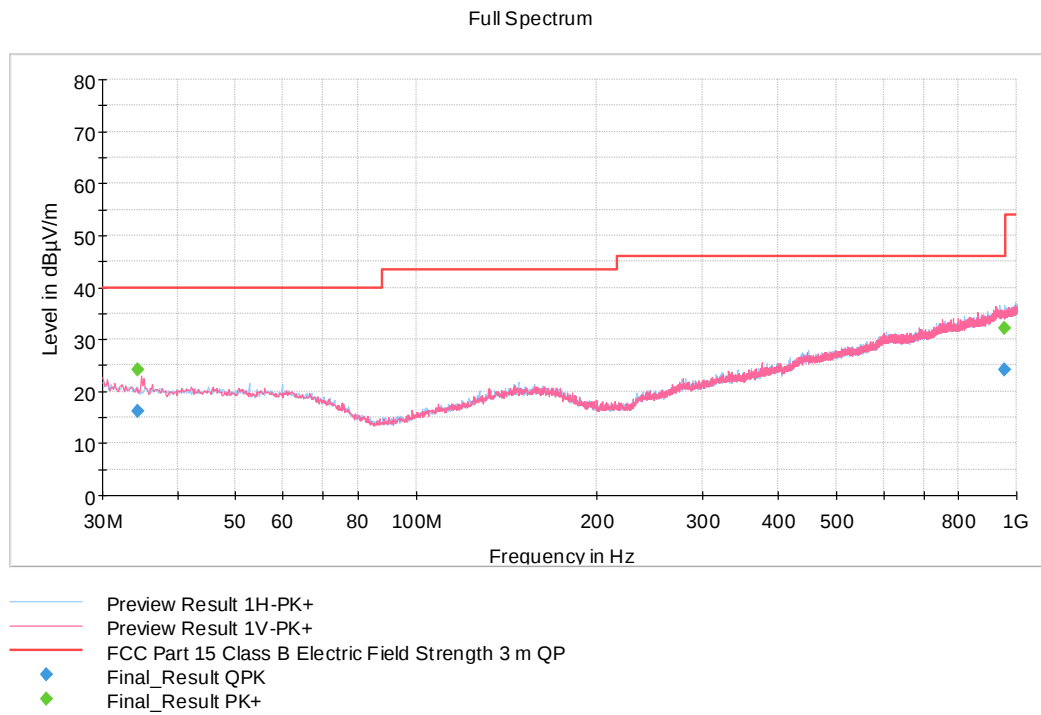
| Frequency (MHz) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|-------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 2259.975000     | 35.68             | 54.00          | 18.32       | 15 x 1000.0     | 1000.000        | 284.0       | H   | 353.0         | 13.5         |
| 2389.125000     | 35.77             | 54.00          | 18.23       | 15 x 1000.0     | 1000.000        | 206.0       | V   | 190.0         | 13.6         |
| 2881.000000     | 36.67             | 54.00          | 17.33       | 15 x 1000.0     | 1000.000        | 190.0       | H   | 225.0         | 14.4         |
| 3260.450000     | 36.56             | 54.00          | 17.44       | 15 x 1000.0     | 1000.000        | 250.0       | H   | 115.0         | 14.4         |
| 3345.550000     | 36.56             | 54.00          | 17.44       | 15 x 1000.0     | 1000.000        | 235.0       | V   | 296.0         | 14.4         |
| 3349.800000     | 36.53             | 54.00          | 17.47       | 15 x 1000.0     | 1000.000        | 201.0       | H   | 29.0          | 14.4         |
| 7319.300000     | 46.01             | 54.00          | 7.99        | 15 x 1000.0     | 1000.000        | 107.0       | V   | 269.0         | 10.7         |
| 9437.000000     | 32.76             | 54.00          | 21.24       | 15 x 1000.0     | 1000.000        | 205.0       | V   | 183.0         | 14.2         |
| 12637.700000    | 36.12             | 54.00          | 17.88       | 15 x 1000.0     | 1000.000        | 261.0       | H   | 22.0          | 18.2         |
| 13385.700000    | 34.34             | 54.00          | 19.66       | 15 x 1000.0     | 1000.000        | 230.0       | V   | 141.0         | 17.4         |
| 14499.400000    | 36.03             | 54.00          | 17.97       | 15 x 1000.0     | 1000.000        | 100.0       | V   | 351.0         | 18.7         |
| 16196.900000    | 37.31             | 54.00          | 16.69       | 15 x 1000.0     | 1000.000        | 266.0       | H   | 2.0           | 22.1         |
| 18801.400000    | 40.21             | 54.00          | 13.79       | 15 x 1000.0     | 1000.000        | 209.0       | V   | 194.0         | 8.0          |
| 26038.900000    | 37.65             | 54.00          | 16.35       | 15 x 1000.0     | 1000.000        | 100.0       | H   | 324.0         | 9.9          |

Full Spectrum

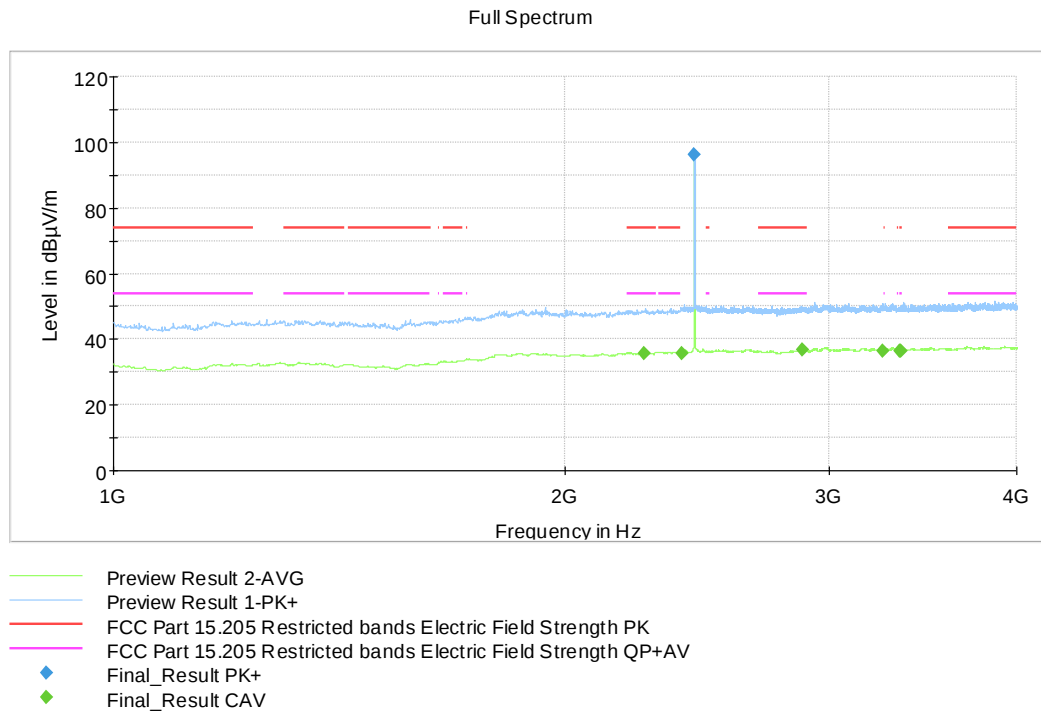


**Figure 22:** Unwanted Emissions, radiated 9 kHz – 30 MHz (TX 2440 MHz)

## Unwanted Emissions (radiated)

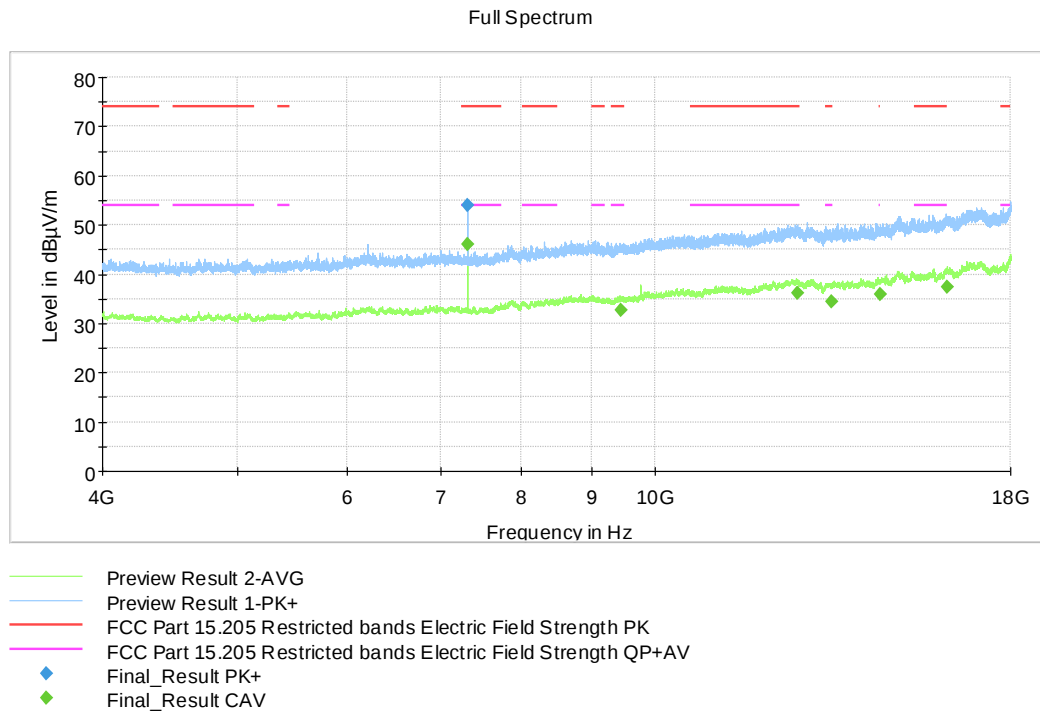


**Figure 23:** Unwanted Emissions, radiated 30 – 1000 MHz (TX 2440 MHz)

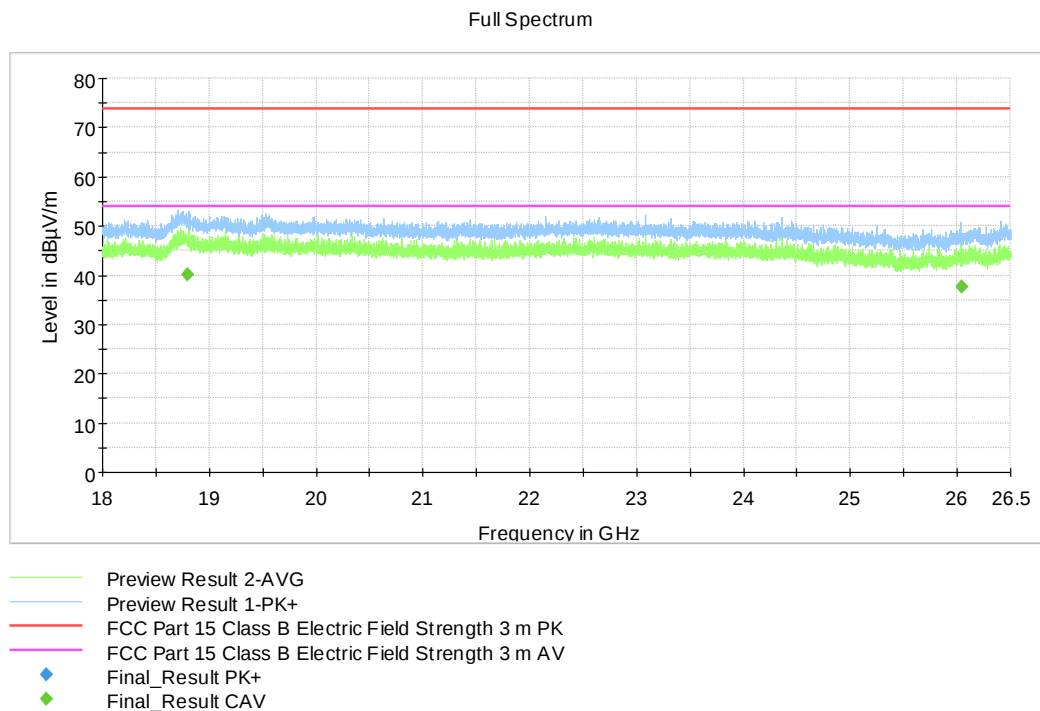


**Figure 24:** Unwanted Emissions, radiated 1 – 4 GHz (TX 2440 MHz)

## Unwanted Emissions (radiated)



**Figure 25:** Unwanted Emissions, radiated 4 – 18 GHz (TX 2440 MHz)



**Figure 26:** Unwanted Emissions, radiated 18 – 26.5 GHz (TX 2440 MHz)

## Unwanted Emissions (radiated)

### Test results (TX 2480 MHz)

**Table 11:** Test results for quasi-peak detector (2480 MHz)

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 30.400000       | 16.85              | 40.00          | 23.15       | 15 x 1000.0     | 120.000         | 342.0       | V   | 221.0         | 16.8       |
| 926.705000      | 24.25              | 46.00          | 21.75       | 15 x 1000.0     | 120.000         | 371.0       | V   | 356.0         | 31.8       |

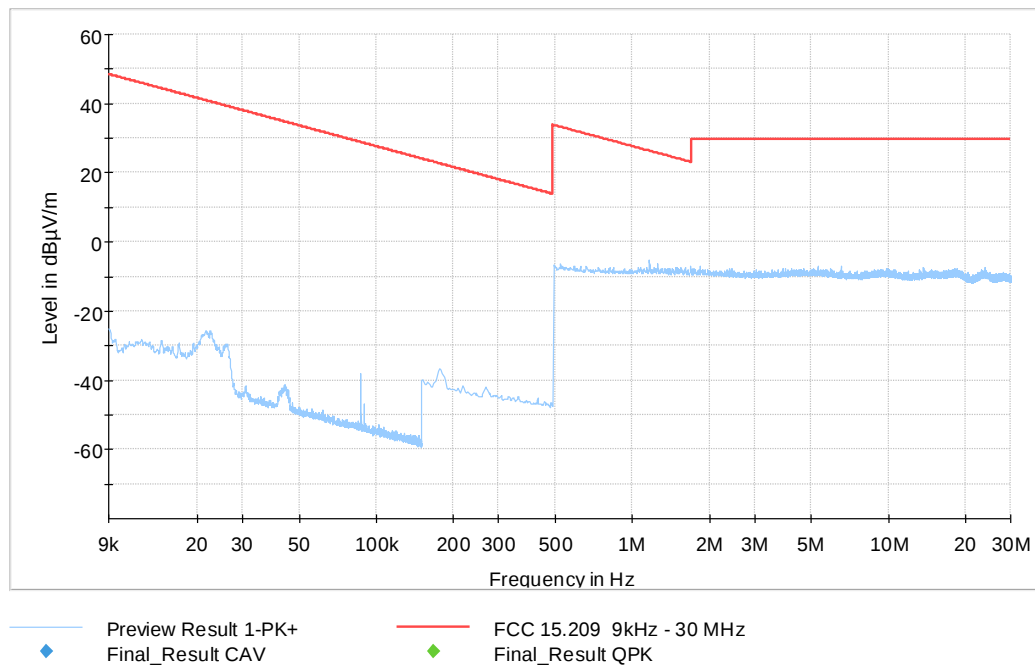
**Table 12:** Test results with peak detector (TX 2480 MHz)

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 2479.800000     | 98.68            | ---            | ---         | 15 x 1000.0     | 1000.000        | 100.0       | H   | 96.0          | 13.7         |
| 2483.500000     | 52.70            | 74.00          | 21.30       | 15 x 1000.0     | 1000.000        | 264.0       | H   | 240.0         | 13.7         |

**Table 13:** Test results with average detector (TX 2480 MHz)

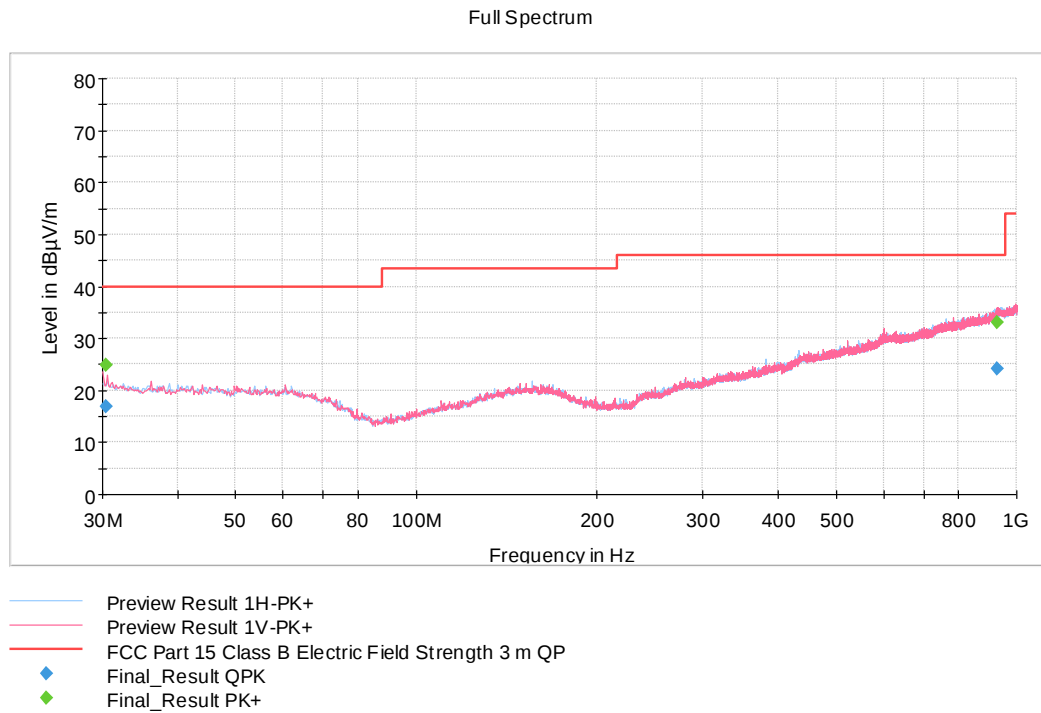
| Frequency (MHz) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|-------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 2389.375000     | 35.84             | 54.00          | 18.16       | 15 x 1000.0     | 1000.000        | 250.0       | V   | 342.0         | 13.6         |
| 2483.500000     | 38.38             | 54.00          | 15.62       | 15 x 1000.0     | 1000.000        | 285.0       | H   | 111.0         | 13.7         |
| 2492.100000     | 36.03             | 54.00          | 17.97       | 15 x 1000.0     | 1000.000        | 149.0       | H   | 94.0          | 13.8         |
| 2881.450000     | 36.69             | 54.00          | 17.31       | 15 x 1000.0     | 1000.000        | 284.0       | V   | 87.0          | 14.4         |
| 3266.150000     | 36.54             | 54.00          | 17.46       | 15 x 1000.0     | 1000.000        | 234.0       | V   | 115.0         | 14.3         |
| 3335.800000     | 36.55             | 54.00          | 17.45       | 15 x 1000.0     | 1000.000        | 214.0       | V   | 12.0          | 14.4         |
| 3351.200000     | 36.54             | 54.00          | 17.46       | 15 x 1000.0     | 1000.000        | 200.0       | H   | 145.0         | 14.4         |
| 7439.300000     | 45.76             | 54.00          | 8.24        | 15 x 1000.0     | 1000.000        | 100.0       | V   | 291.0         | 10.4         |
| 18742.350000    | 41.06             | 53.90          | 12.84       | 15 x 1000.0     | 1000.000        | 128.0       | V   | 150.0         | 8.2          |
| 26204.450000    | 38.02             | 53.90          | 15.88       | 15 x 1000.0     | 1000.000        | 107.0       | H   | 193.0         | 9.8          |

Full Spectrum

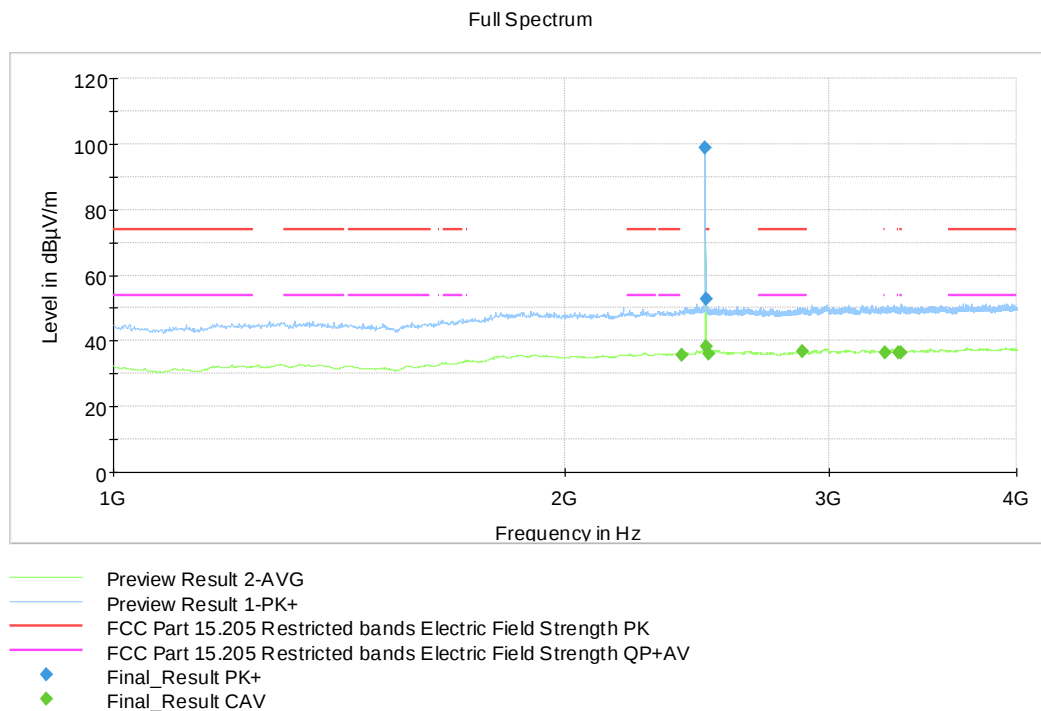


**Figure 27:** Unwanted Emissions, radiated 9 kHz – 30 MHz (TX 2480 MHz)

## Unwanted Emissions (radiated)

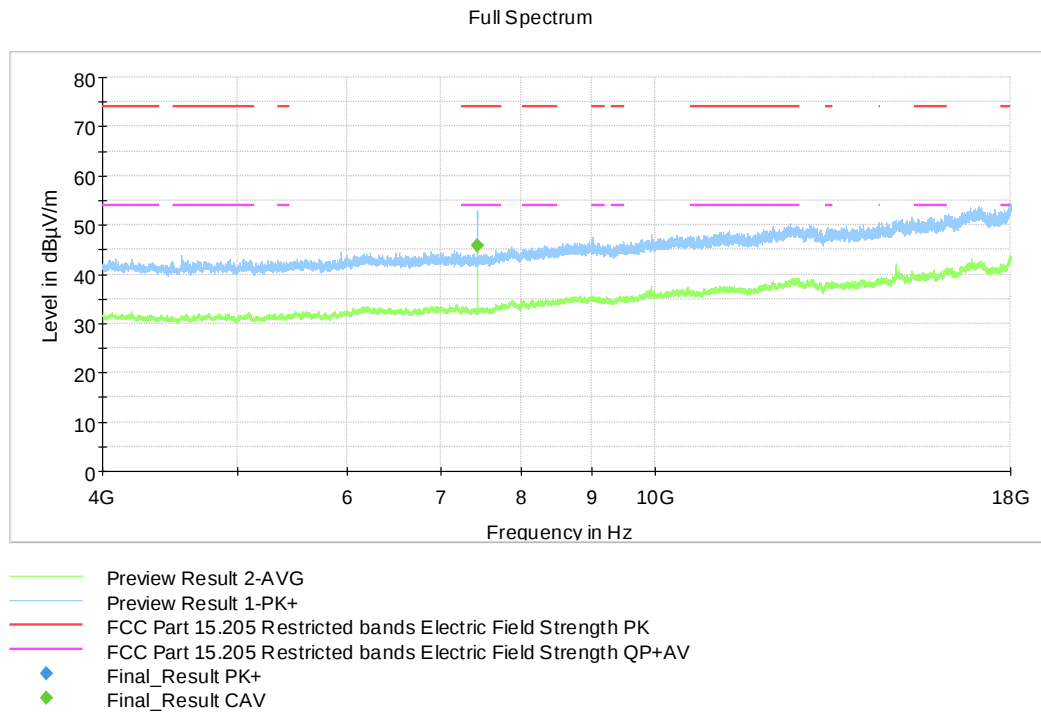


**Figure 28:** Unwanted Emissions, radiated 30 – 1000 MHz (TX 2480 MHz)

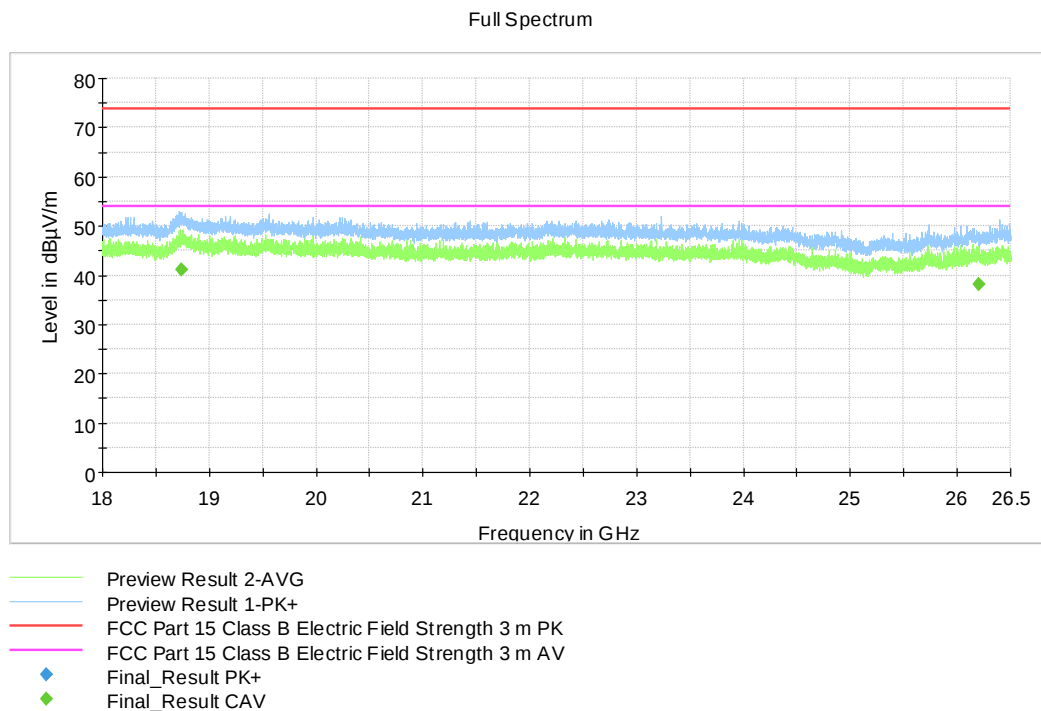


**Figure 29:** Unwanted Emissions, radiated 1 – 4 GHz (TX 2480 MHz)

## Unwanted Emissions (radiated)

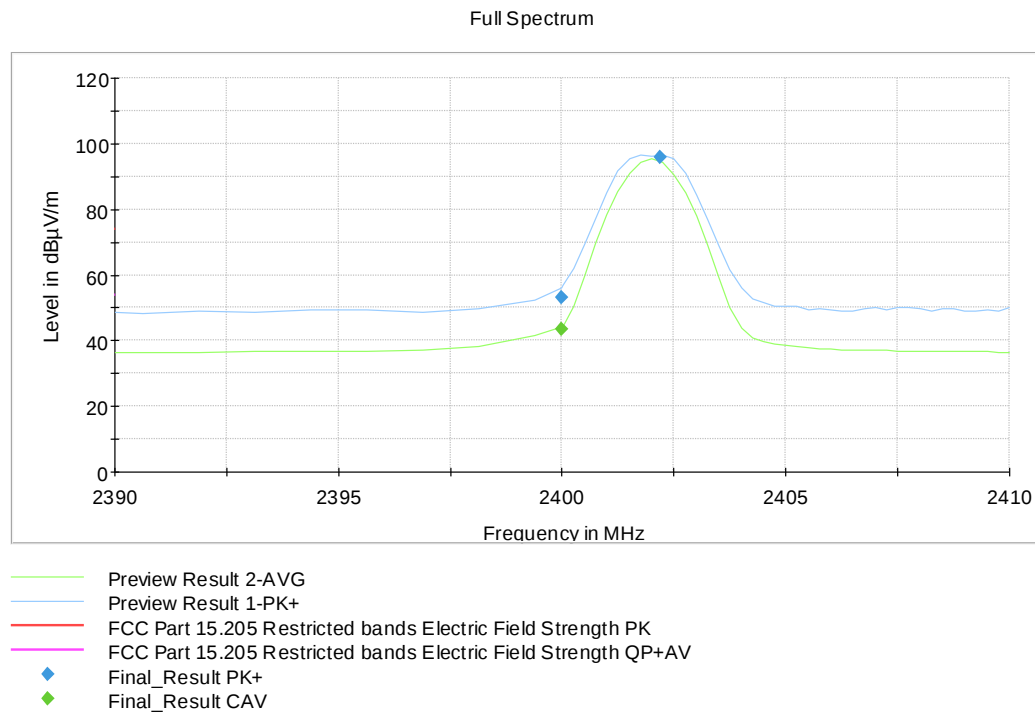


**Figure 30:** Unwanted Emissions, radiated 4 – 18 GHz (TX 2480 MHz)

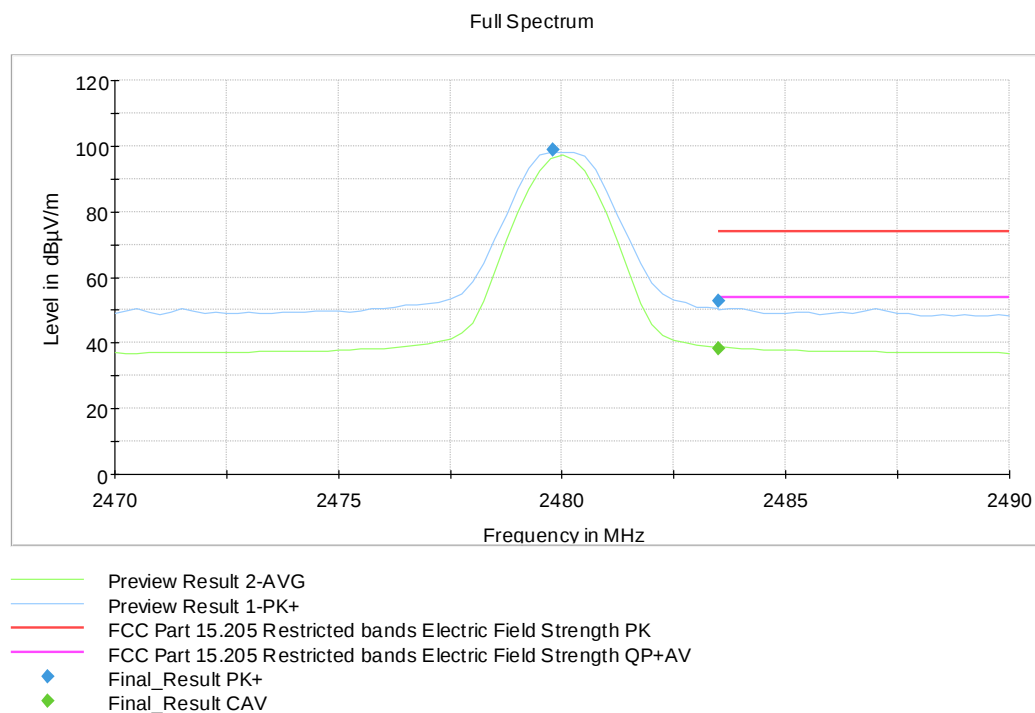


**Figure 31:** Unwanted Emissions, radiated 18 – 26.5 GHz (TX 2480 MHz)

## Radiated lower and upper band edge results



**Figure 32:** Lower Band-Edge, radiated (TX 2402 MHz)



**Figure 33:** Upper Band-Edge, radiated (TX 2480 MHz)

## Unwanted Emissions (radiated)

**Table 14:** Radiated lower and upper band edge peak results

| Frequency (MHz) | MaxPeak (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 2400.000000     | 53.03            | 75.94 *)       | 22.91       | 15 x 1000.0     | 1000.000        | 226.0       | V   | 73.0          | 13.7         |
| 2402.200000     | 95.94            | ---            | ---         | 15 x 1000.0     | 1000.000        | 271.0       | H   | 243.0         | 13.7         |
| 2479.800000     | 98.68            | ---            | ---         | 15 x 1000.0     | 1000.000        | 100.0       | H   | 96.0          | 13.7         |
| 2483.500000     | 52.70            | 74.00          | 21.30       | 15 x 1000.0     | 1000.000        | 264.0       | H   | 240.0         | 13.7         |

\*) -20 dBc

**Table 15:** Radiated lower and upper band edge average results

| Frequency (MHz) | CAverage (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|-------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|--------------|
| 2400.000000     | 43.45             | ---            | ---         | 15 x 1000.0     | 1000.000        | 200.0       | H   | 255.0         | 13.7         |
| 2483.500000     | 38.38             | 54.00          | 15.62       | 15 x 1000.0     | 1000.000        | 285.0       | H   | 111.0         | 13.7         |

## Power Spectral Density

**Standard:** ANSI C63.10-2020  
**Tested by:** HAM  
**Date:** 7 July 2023  
**Temperature:** 24 °C  
**Humidity:** 44 %RH  
**Test result:** **PASS**

### FCC §15.247(e) RSS-247 clause 5.2 b)

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. The same method of determining the conducted output power shall be used to determine the power spectral density.

Sample 2 was used for the test.

### Test results

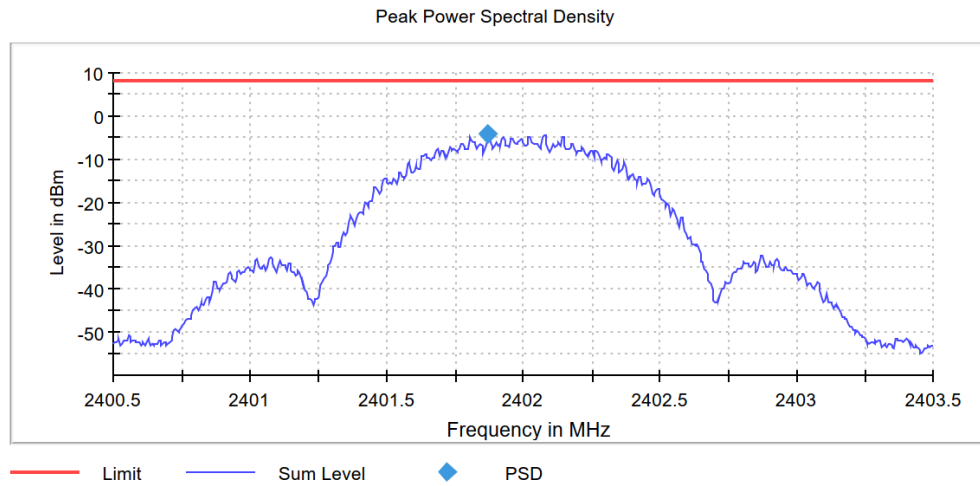
**Table 16:** Test results for Power Spectral Density

| Data rate | Frequency [MHz] | PSD [dBm/10 kHz] | Limit [dBm/3 kHz] | Result |
|-----------|-----------------|------------------|-------------------|--------|
| 1 Mbps    | 2402            | -4.339           | ≤ 8               | PASS   |
|           | 2440            | -5.171           |                   | PASS   |
|           | 2480            | -5.484           |                   | PASS   |

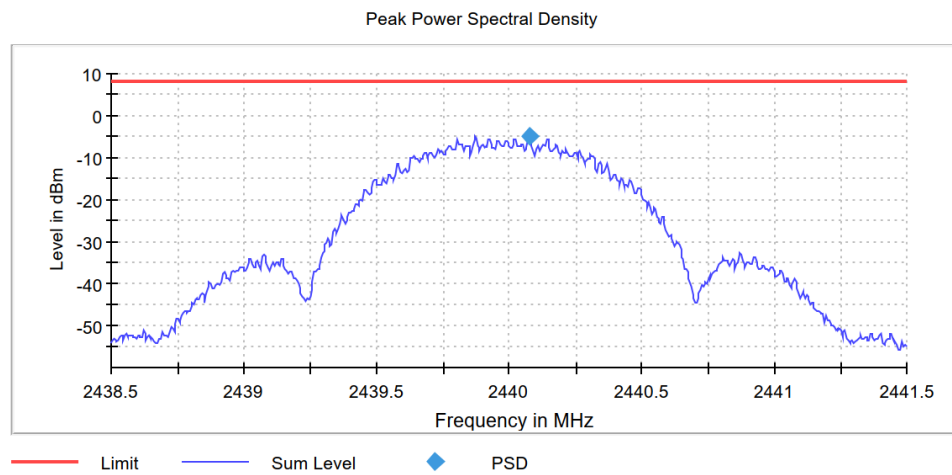
Note: Compliance was determined in a 10 kHz band.

The conducted measurement was performed with a spectrum analyzer using the following settings:

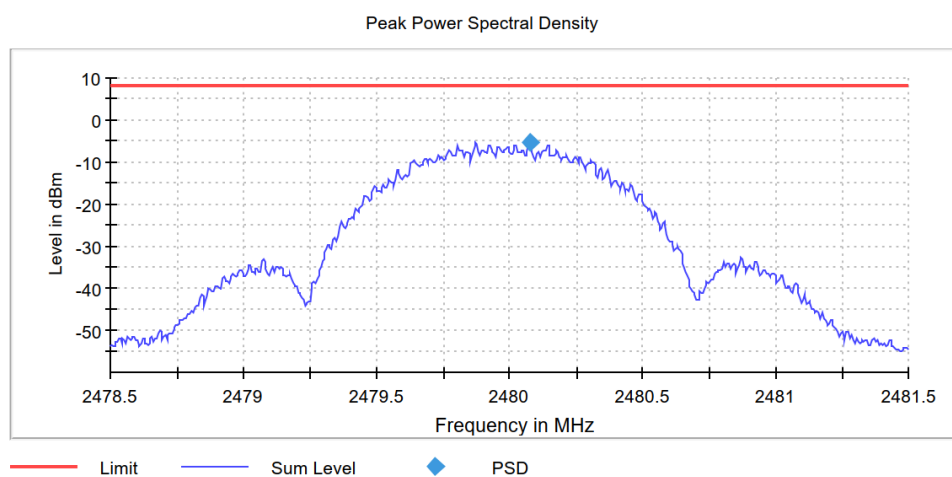
| Setting         | Value      |
|-----------------|------------|
| Span            | 3.000 MHz  |
| RBW             | 10.000 kHz |
| VBW             | 30.000 kHz |
| Sweep Points    | 600        |
| Sweep Time      | 3.000 ms   |
| Reference Level | 0.000 dBm  |
| Attenuation     | 20.000 dB  |
| Detector        | MaxPeak    |
| Filter          | 3 dB       |
| Trace Mode      | Max Hold   |
| Sweep Type      | Sweep      |
| Preamp          | off        |



**Figure 34: Power Spectral Density (TX 2402 MHz)**



**Figure 35: Power Spectral Density (TX 2440 MHz)**



**Figure 36: Power Spectral Density (TX 2480 MHz)**

## TEST EQUIPMENT

## Conducted RF Tests

| Description                      | Manufacturer    | Model      | Identifier  | Cal. Date  | Cal. Due   |
|----------------------------------|-----------------|------------|-------------|------------|------------|
| MULTIMETER                       | FLUKE           | 289        | sn:59090035 | 2022-11-29 | 2023-11-29 |
| SWITCH UNIT FOR BASE MODULE      | ROHDE & SCHWARZ | OSP120     | inv:10882   | 2023-07-03 | 2024-07-02 |
| BASE MODULE                      | ROHDE & SCHWARZ | OSP-B157W8 | inv:10883   | 2023-07-03 | 2024-07-02 |
| EXTENSION MODULE                 | ROHDE & SCHWARZ | OSP-B157WX | inv:10884   | 2023-07-03 | 2024-07-02 |
| SWITCH UNIT FOR EXTENSION MODULE | ROHDE & SCHWARZ | OSP120     | inv:9289    | 2023-07-03 | 2024-07-02 |
| POWER SUPPLY                     | THANDAR         | PL330TP    | inv:9787    | NCR        | NCR        |
| SPECTRUM ANALYZER                | ROHDE & SCHWARZ | FSV40      | inv:10881   | 2023-06-16 | 2024-06-16 |
| TEST SOFTWARE                    | ROHDE & SCHWARZ | WMS32      | -           | -          | -          |

## Unwanted Emissions (radiated)

| Description                 | Manufacturer    | Model                 | Identifier  | Cal. Date  | Cal. Due   |
|-----------------------------|-----------------|-----------------------|-------------|------------|------------|
| ANTENNA                     | EMCO            | 3160-09               | inv. 7294   | 2023-02-23 | 2024-02-23 |
| ANTENNA                     | EMCO            | 3117                  | inv. 7293   | 2022-06-16 | 2024-06-16 |
| ANTENNA                     | ROHDE & SCHWARZ | HFH2-Z2 , 335.4711.52 | inv. 8013   | 2022-10-25 | 2024-10-25 |
| ANTENNA                     | SCHWARZBECK     | VULB 9168             | inv. 8911   | 2022-11-29 | 2024-11-29 |
| ANTENNA MAST                | MATURO          | TAM 4.0E              | inv. 10181  | NCR        | NCR        |
| ATTENUATOR                  | PASTERNAK       | 10 dB, DC-40 GHz      | sn. A1      | 2023-03-20 | 2025-03-20 |
| ATTENUATOR                  | PASTERNAK       | PE 7004-4 (4dB)       | inv. 10126  | 2023-03-13 | 2024-03-13 |
| EMI TEST RECEIVER           | ROHDE & SCHWARZ | ESW26                 | inv:10670   | 2023-06-19 | 2024-06-19 |
| FILTER                      | WAINWRIGHT      | WHKX4.0/18G-10SS      | inv. 10403  | 2023-01-09 | 2025-01-09 |
| MAST & TURNTABLE CONTROLLER | MATURO          | NCD                   | inv. 10183  | NCR        | NCR        |
| MULTIMETER                  | FLUKE           | 289                   | sn:59090035 | 2022-11-29 | 2023-11-29 |
| POWER SUPPLY                | THANDAR         | PL330TP               | inv:9787    | NCR        | NCR        |
| RF PREAMPLIFIER             | CIAO            | CA1840-5019           | inv. 10593  | 2022-09-21 | 2023-09-21 |
| RF PREAMPLIFIER             | CIAO            | CA118-3123            | inv. 10278  | 2022-09-21 | 2023-09-21 |
| TEST SOFTWARE               | ROHDE & SCHWARZ | EMC32                 | -           | -          | -          |
| TURNTABLE                   | MATURO          | DS430 UPGRADED        | inv. 10182  | NCR        | NCR        |

NCR = No Calibration Required

END OF REPORT