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# FCC/ISED Test Report

**Prepared for:** **Hunter Douglas**

**Address:** **1 Duette Way,**
**Broomfield, CO 80020**

**Product:** **1012000449, 2015000036, and 1012000565**

**Test Report No:** **R20210324-21-E1C**

**Approved by:**

**Mahendra Karthik Vepuri, NCE**
**EMC Test Engineer,**
**iNARTE Certified EMC Engineer #EMC-041453-E**

**DATE:** **25 April 2024**

**Total Pages:** **53**

## REVISION PAGE

| Rev. No. | Date | Description |
|---|---|---|
| 0 | 16 January 2024 | Issued by FLane<br>Prepared by FLane |
| A | 25 February 2024 | Re-issued report. No change in data. Verified data in report to be valid. -FLane |
| B | 8 March 2024 | Updated data referencing plan and corrected items from TCB comments. |
| C | 24 April 2024 | Updated model numbers throughout the report - KV |

## CONTENTS

## 1.0 SUMMARY OF TEST RESULTS

The purpose of this report is to compare the results from the previous model. The device was investigated to ensure it complies with updated standards such as RSS-247 Issue 3. This data is leveraged from a previous model FCC ID: UXUPC6. Worst case emissions were investigated and found to be compliant negligibly different from the previous model.

The EUT has been tested according to the following specifications:

(1) US Code of Federal Regulations, Title 47, Part 15
(2) ISED RSS-Gen, Issue 5
(3) ISED RSS-247, Issue 3

| APPLIED STANDARDS AND REGULATIONS | | |
|---|---|---|
| **Standard Section** | **Test Type** | **Result** |
| FCC Part 15.35<br>RSS Gen, Issue 5, Section 6.10 | Duty Cycle | Complies |
| FCC Part 15.247(b)(3)<br>RSS-247 Issue 3, Section 5.4(d) | Peak output power | Complies |
| FCC Part 15.247(a)(2)<br>RSS-247 Issue 3, Section 5.2 (a) | Bandwidth | Complies |
| FCC Part 15.209<br>RSS-Gen Issue 5, Section 7.3 | Receiver Radiated Emissions | Complies |
| FCC Part 15.209 (restricted bands), 15.247 (unrestricted)<br>RSS-247 Issue 3, Section 5.5, RSS-Gen Issue 5, Section 8.9 | Transmitter Radiated Emissions | Complies |
| FCC Part 15.247(e)<br>RSS-247 Issue 3, Section 5.2 (b) | Power Spectral Density | Complies |
| FCC Part 15.209, 15.247(d)<br>RSS-247 Issue 3, Section 5.5 | Band Edge Measurement | Complies |
| FCC Part 15.207<br>RSS-Gen Issue 5, Section 7.2 | AC Conducted Emissions | Complies |

See Section 4 for details on the test methods used for each test.

**Test Plan / Spot-check plan – tested on variant model on November 13, 2023**

## (1) US Code of Federal Regulations, Title 47, Part 15

| APPLIED STANDARDS AND REGULATIONS | | | |
|---|---|---|---|
| **Standard Section** | **Test Type** | **Variant 1 certified** | **Variant 2 New certification** |
| FCC Part 15.35 | Duty Cycle | Full test | Full test** |
| FCC Part 15.247(b)(3) | Peak output power | Full test | Full test** |
| FCC Part 15.247(a)(2) | Bandwidth | Full test | Full test** |
| FCC Part 15.209 | Receiver Radiated Emissions | Full test | Full test** |
| FCC Part 15.209 (restricted bands) | Transmitter Radiated Emissions | Full test | Spot-check* |
| FCC Part 15.247 (unrestricted) | Transmitter Radiated Emissions | Full test | Full test** |
| FCC Part 15.247(e) | Power Spectral Density | Full test | Full test** |
| FCC Part 15.209, 15.247(d) | Band Edge Measurement | Full test | Spot-check* |
| FCC Part 15.207 | AC Conducted Emissions | Full test | Full test** |

*Spot-check will include verification of 2 worse-case test frequencies to ensure that the device remains complaint and the margin has not decreased by more than 2 dB.

**Full testing data will be referenced from original certification actual testing. Justification has been provided with the Equipment Compliance Review (ECR) plan submitted to the TCB and FCC.

The purpose of this test plan is to compare the results from the previous model. The device was investigated to ensure it complies with updated standards such as RSS-247 Issue 3. This data is leveraged from a previous model FCC ID: UXUPC6. Worst case emissions were investigated and found to be compliant negligibly different from the previous model.

# 2.0 EUT DESCRIPTION

## 2.1 EQUIPMENT UNDER TEST

**Summary and Operating Condition:**

| | |
|---|---|
| **EUT** | 1012000449, 2015000036, and 1012000565 |
| **FCC ID** | UXUPC7 |
| **IC ID** | 7316A-PC7 |
| **EUT Received** | 20 November 2020 (Variant 1)<br>30 October 2023 (Variant 2) |
| **EUT Tested** | 23 November 2020- 27 January 2021 (Variant 1)<br>Spot check: Nov 13, 2023 (Variant 2) |
| **Serial No.** | 00220 (conducted antenna port measurements);<br>00219 (radiated measurements);<br>91557130 (spot check on 2nd variant)<br>Serial numbers assigned by the test lab except for variant 2 model. |
| **Operating Band** | 2400 MHz – 2483.5 MHz |
| **Device Type** | ☒ BLE ☒ NRF |
| **Power Supply / Voltage** | TP-POE-48<br>SN:139049622D RC03 |

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

## 2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:
The only modulations/transmitters used in this specific radio is BLE and Nordics proprietary Bluetooth modes.

For Bluetooth Transmissions:

| Channel | Frequency |
|---|---|
| Low | 2402 MHz |
| Mid | 2440 MHz |
| High | 2480 MHz |

These are the only representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

## 2.3 DESCRIPTION OF SUPPORT UNITS

None

# 3.0 LABORATORY AND GENERAL TEST DESCRIPTION

## 3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

| | |
|---|---|
| A2LA Certificate Number: | 1953.01 |
| FCC Accredited Test Site Designation No: | US1060 |
| Industry Canada Test Site Registration No: | 4294A-1 |
| NCC CAB Identification No: | US0177 |

Environmental conditions varied slightly throughout the tests:
Relative humidity of 35 ± 4%
Temperature of 22 ± 3° Celsius

## 3.2 TEST PERSONNEL

| No. | PERSONNEL | TITLE | ROLE |
|---|---|---|---|
| 1 | Fox Lane | Test Engineer | Testing and Report |
| 2 | Karthik Vepuri | Test Engineer | Review |

**Notes:**
All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.

## 3.3 TEST EQUIPMENT

| DESCRIPTION AND MANUFACTURER | MODEL NO. | SERIAL NO. | LAST CALIBRATION DATE | CALIBRATION DUE DATE |
|---|---|---|---|---|
| Keysight MXE Signal Analyzer (44GHz) | N9038A | MY59050109 | July 17, 2023 | July 17, 2025 |
| Keysight MXE Signal Analyzer (26.5GHz) | N9038A | MY56400083 | July 17, 2023 | July 17, 2025 |
| Keysight EXA Signal Analyzer | N9010A | MY56070862 | July 18, 2023 | July 17, 2025 |
| ETS-Lindgren Red Horn Antenna | 3115 | 218576 | July 31, 2023 | July 30, 2024 |
| SunAR RF Motion | JB1 | A091418 | July 27, 2023 | July 26, 2024 |
| 8447F POT H64 Preamplifier* | 8447F POT H64 | 3113AD4667 | March 21, 2022 | March 21, 2024 |
| Agilent Preamp* | 87405A | 3950M00669 | June 5, 2023 | June 5, 2025 |
| Rohde & Schwarz Preamplifier* | TS-PR18 | 3545700803 | June 5, 2023 | June 5, 2025 |
| Trilithic High Pass Filter* | 6HC330 | 23042 | June 5, 2023 | June 5, 2025 |
| Com-Power LISN, Single Phase | LI-220C | 20070017 | July 17, 2023 | July 17, 2025 |
| RF Cable (preamplifier to antenna)* | MFR-57500 | 01-07-002 | June 5, 2023 | June 5, 2025 |
| ETS – Lindgren- VSWR on 10m Chamber | 10m Semi-anechoic chamber-VSWR | 4740 Discovery Drive | July 30, 2020 | July 30, 2024 |
| NCEE Labs-NSA on 10m Chamber* | 10m Semi-anechoic chamber-NSA | NCEE-001 | May 25, 2022 | May 25, 2025 |
| RF Cable (antenna to 10m chamber bulkhead) | FSCM 64639 | 01E3872 | June 5, 2023 | June 5, 2025 |
| RF Cable (10m chamber bulkhead to control room bulkhead) | FSCM 64639 | 01E3874 | June 5, 2023 | June 5, 2025 |
| RF Cable (control room bulkhead to test receiver) | FSCM 64639 | 01F1206 | June 5, 2023 | June 5, 2025 |
| N connector bulkhead (10m chamber) | PE9128 | NCEEBH1 | June 5, 2023 | June 5, 2025 |
| TDK Emissions Lab Software | V11.25 | 700307 | NA | NA |

*Internal Characterization

**Notes**: All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

### 3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

Measurement type presented in this report (Please see the checked box below):

## Conducted ☒

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

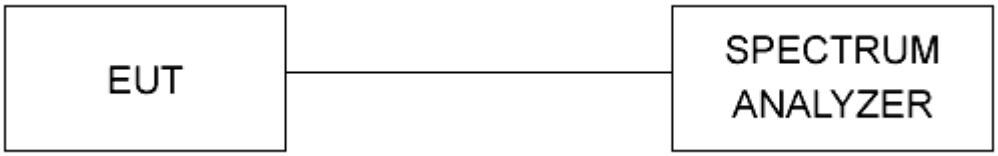



**Figure 1 - Bandwidth Measurements Test Setup**

## Radiated ☒

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

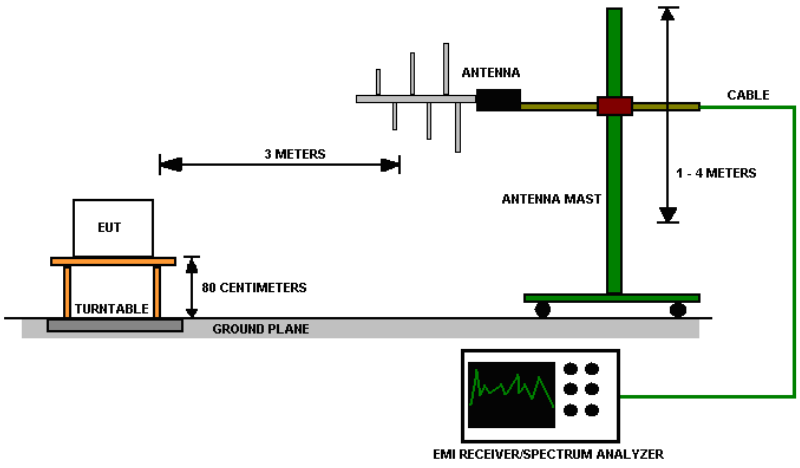



**Figure 2 - Radiated Emissions Test Setup**

## 4.0 RESULTS

| Conducted DTS Radio Measurements | | | | | | | |
|---|---|---|---|---|---|---|---|
| CHANNEL | Transmitter | Occupied Bandwidth (kHz) | 6 dB Bandwidth (kHz) | PEAK OUTPUT POWER (dBm) | PEAK OUTPUT POWER (mW) | PSD (dBm) | RESULT |
| Low | GMSK | 2073.00 | 1257.00 | 7.144 | 5.181 | -8.364 | PASS |
| Mid | GMSK | 2063.70 | 1165.00 | 7.306 | 5.378 | -8.419 | PASS |
| High | GMSK | 2069.50 | 1248.00 | 6.872 | 4.866 | -9.798 | PASS |
| Low | NRF | 1859.40 | 886.00 | 7.403 | 5.499 | -5.653 | PASS |
| Mid | NRF | 1872.00 | 843.40 | 7.387 | 5.479 | -5.598 | PASS |
| High | NRF | 1824.20 | 886.40 | 7.440 | 5.546 | -4.803 | PASS |
| Occupied Bandwidth = N/A; 6 dB Bandwidth Limit =500 kHz | | | | Peak Output Power Limit = 30 dBm; PSD Limit = 8 dBm | | | |

| Radiated Unrestricted Band-Edge | | | | | | | |
|---|---|---|---|---|---|---|---|
| CHANNEL | Mode | Band edge /Measurement Frequency (MHz) | Relative Highest out of band level (dBm) | Relative Fundamental (dBm) | Delta (dB) | Min Delta (dB) | Result |
| Low | BLE | 2400.00 | -45.32 | -14.74 | 30.59 | 20.00 | PASS |
| Low | NRF | 2400.00 | -52.79 | -14.65 | 38.15 | 20.00 | PASS |
| High** | BLE | 2483.50 | -61.04** | -23.97** | 37.06 | 20.00 | PASS |
| High** | NRF | 2483.50 | -61.12** | -20.04** | 41.08 | 20.00 | PASS |

*Graphs in Appendix C include corrections, but they are intended to be relative measurements.
**Higher bandedge measurements show dBuV in the graphs presented in appendix C, they were converted from dBuV to dBm (dBm = dBuV – 107).

| Radiated Peak Restricted Band-Edge | | | | | | | |
|---|---|---|---|---|---|---|---|
| CHANNEL | Mode | Band edge /Measurement Frequency (MHz) | Highest out of band level (dBuV/m @ 3m) | Measurement Type | Limit (dBuV/m @ 3m) | Margin | Result |
| Low | BLE | 2386.10 | 60.04 | Peak | 73.98 | 13.94 | PASS |
| Low | NRF | 2387.30 | 60.00 | Peak | 73.98 | 13.98 | PASS |
| High | BLE | 2497.30 | 59.11 | Peak | 73.98 | 14.88 | PASS |
| High | NRF | 2496.30 | 59.17 | Peak | 73.98 | 14.81 | PASS |

*Limit shown is the peak limit taken from FCC Part 15.209; Graphs in Appendix C include corrections.

| Radiated Average Restricted Band-Edge | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CHANNEL** | **Mode** | **Band edge /Measurement Frequency (MHz)** | **Highest out of band level (dBuV/m @ 3m)** | **Measurement Type** | **Limit (dBuV/m @ 3m)** | **Margin** | **Result** |
| Low | BLE | 2389.90 | 48.48 | Average | 53.98 | 5.50 | PASS |
| Low | NRF | 2389.90 | 48.52 | Average | 53.98 | 5.46 | PASS |
| High | BLE | 2495.90 | 47.78 | Average | 53.98 | 6.20 | PASS |
| High | NRF | 2496.50 | 47.80 | Average | 53.98 | 6.18 | PASS |
| *Limit shown is the average limit taken from FCC Part 15.209; Graphs in Appendix C include corrections. | | | | | | | |

## 4.1 OUTPUT POWER

**Test Method**: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

**Limits of power measurements:**
**For FCC Part 15.247 Device:**
The maximum allowed peak output power is 30 dBm.

**Test procedures:**
Details can be found in section 3.4 of this report.

**Deviations from test standard:**
No deviation.

**Test setup:**
Details can be found in section 3.4 of this report.

**EUT operating conditions:**
Details can be found in section 2.1 of this report.

**Test results:**

# Pass

Comments:

1. All the output power plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.

## 4.2 BANDWIDTH

**Test Method**: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

**Limits of bandwidth measurements:**
**For FCC Part 15.247 Device:**
The 99% occupied bandwidth is for informational purpose only. The 6dB bandwidth of the signal must be greater than 500 kHz.

**Test procedures:**
Details can be found in section 3.4 of this report.

**Deviations from test standard:**
No deviation.

**Test setup:**
Test setup details can be found in section 3.4 of this report.

**EUT operating conditions:**
Details can be found in section 2.1 of this report.

**Test results:**

**Pass**

Comments:

1. All the bandwidth plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.

## 4.3 DUTY CYCLE

**Test Method**: NA

## 4.4 RADIATED EMISSIONS

**Test Method**: ANSI C63.10-2013, Section 6.5, 6.6

**Limits for radiated emissions measurements:**

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

| FREQUENCIES (MHz) | FIELD STRENGTH (µV/m) | MEASUREMENT DISTANCE (m) |
|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | 300 |
| 0.490-1.705 | 24000/F(kHz) | 30 |
| 1.705-30.0 | 30 | 3 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

**NOTE:**
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (µV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.
4. The EUT was tested for spurious emissions while running off of battery power and external USB power. The worse-case emissions were produced while running off of USB power, so results from this mode are presented.

**Test procedures:**

a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements from 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise, the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

h. During the preview scan, the EUT was tested with all 3 radios transmitting simultaneously to investigate for any intermodulation products. In cases where intermodulation products were found, they were maximized and presented in the tables

**Test setup:**

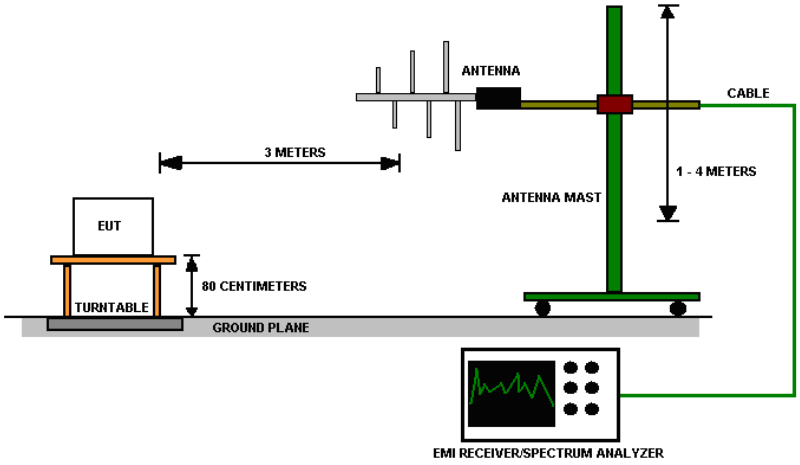



**Figure 3 - Radiated Emissions Test Setup**

**NOTE:**
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

**Deviations from test standard:**

No deviation.

**EUT operating conditions**
Details can be found in section 2.1 of this report.

**Test results:**

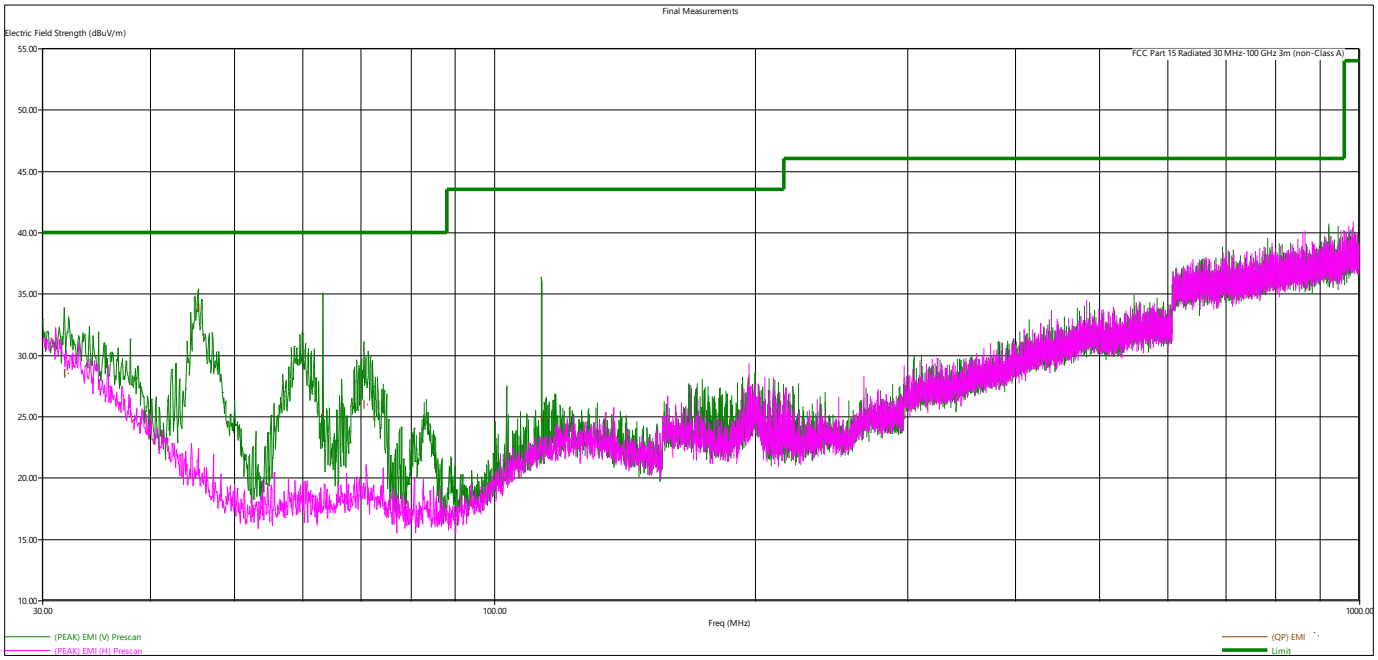



**Figure 4 - Radiated Emissions Plot, Receive**

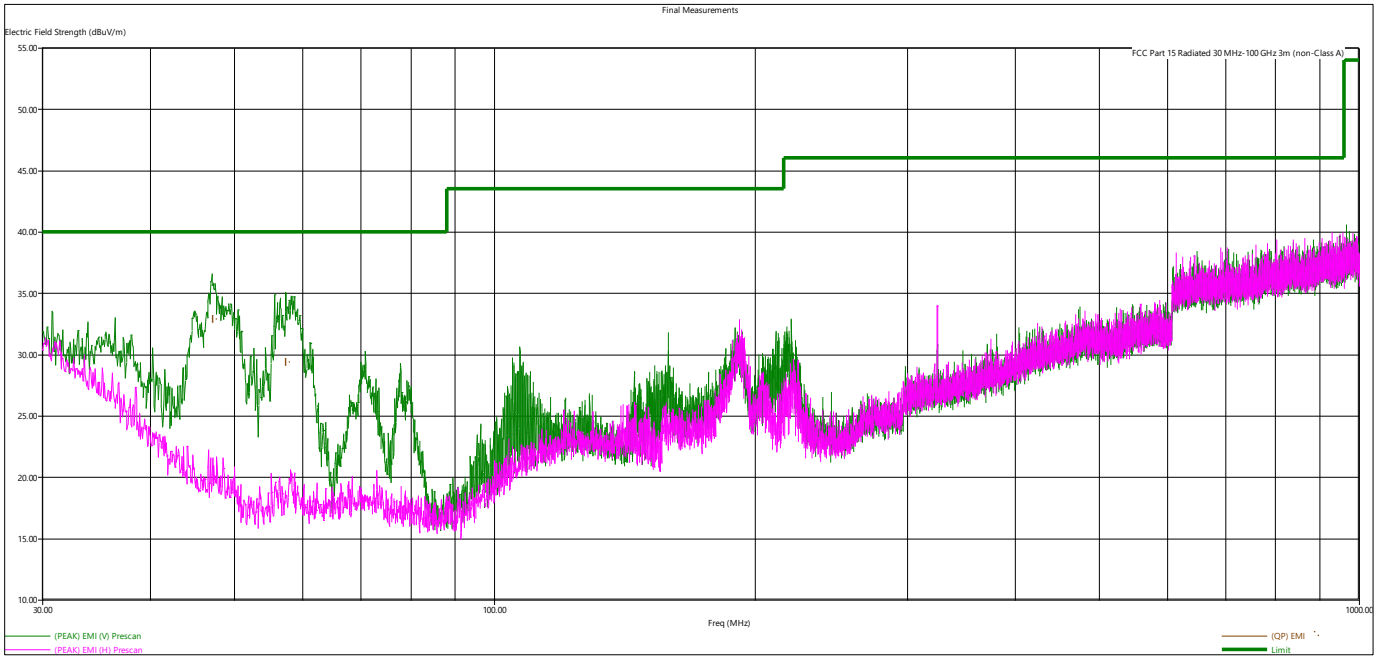



**Figure 5 - Radiated Emissions Plot, Low Channel, BLE**

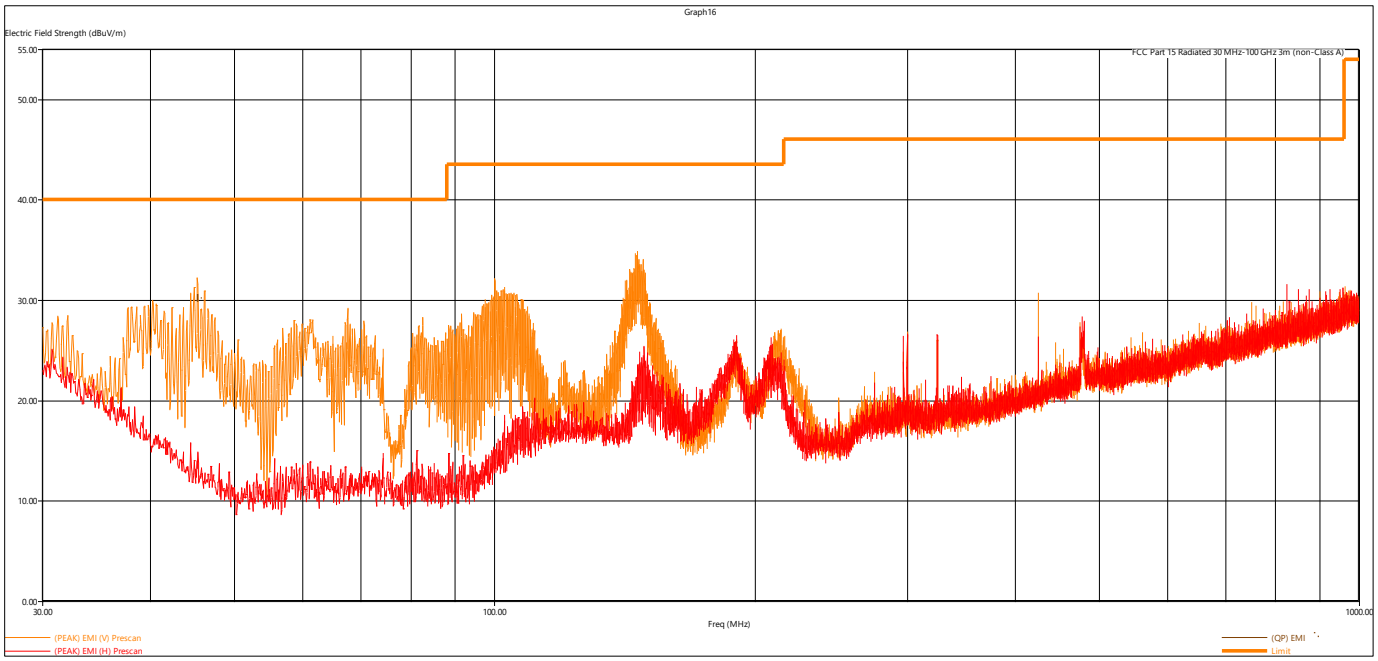



**Figure 6 - Radiated Emissions Plot, High Channel, NRF**

**REMARKS**:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The worst-case emissions were presented in this section.
4. Margin value = Emission level – Limit value
5. The lowest, middle and high channel were all examined in the 30 MHz – 1 GHz range. The worse-case is shown.

| Quasi-Peak Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Frequency** | **Level** | **Limit** | **Margin** | **Height** | **Angle** | **Pol** | **Channel** | **Modulation** |
| **MHz** | **dBµV/m** | **dBµV/m** | **dB** | **cm.** | **deg.** | | | |
| 45.323760 | 30.13 | 40.00 | 9.87 | 128 | 140 | V | High | NRF |
| 47.226720 | 32.84 | 40.00 | 7.16 | 106 | 294 | V | Low | GMSK |
| 57.381600 | 29.33 | 40.00 | 10.67 | 135 | 342 | V | Low | GMSK |
| 31.744800 | 28.43 | 40.00 | 11.57 | 217 | 314 | V | RX mode | |
| 45.358080 | 33.80 | 40.00 | 6.20 | 107 | 0 | V | RX mode | |
| 63.394080 | 25.26 | 40.00 | 14.74 | 119 | 144 | V | RX mode | |
| 70.470000 | 25.91 | 40.00 | 14.09 | 139 | 32 | V | RX mode | |
| 113.075040 | 24.76 | 43.52 | 18.76 | 105 | 360 | V | RX mode | |

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above.

| Peak Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frequency | Level | Limit | Margin | Height | Angle | Pol | Channel | Modulation |
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | | |
| 2402.294000 | 102.52 | NA | NA | 156.000 | 27.000 | H | Low | NRF |
| 2402.504000 | 102.78 | NA | NA | 189.000 | 153.000 | H | Low | GMSK |
| 4804.800000 | 46.51 | 73.98 | 27.47 | 131.000 | 87.000 | V | Low | NRF |
| 4880.206000 | 44.91 | 73.98 | 29.07 | 131.000 | 131.000 | V | Mid | NRF |
| 4959.612000 | 44.59 | 73.98 | 29.39 | 149.000 | 308.000 | H | High | NRF |
| 4804.000000 | 44.75 | 73.98 | 29.23 | 151.000 | 45.000 | V | Low | GMSK |
| 4879.184000 | 44.62 | 73.98 | 29.36 | 156.000 | 359.000 | H | Mid | GMSK |
| 4958.928000 | 44.68 | 73.98 | 29.30 | 163.000 | 306.000 | H | High | GMSK |
| 1261.562000 | 36.18 | 73.98 | 37.80 | 200.000 | 360.000 | V | Rx mode | |
| 2464.212000 | 40.81 | 73.98 | 33.17 | 300.000 | 219.000 | V | Rx mode | |

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above.

| Average Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frequency | Level | Limit | Margin | Height | Angle | Pol | Channel | Modulation |
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | | |
| 2402.294000 | 99.64 | NA | NA | 156 | 27 | H | Low | NRF |
| 2402.504000 | 96.52 | NA | NA | 189 | 153 | H | Low | GMSK |
| 4804.800000 | 34.73 | 53.98 | 19.25 | 131 | 87 | V | Low | NRF |
| 4880.206000 | 34.13 | 53.98 | 19.85 | 131 | 131 | V | Mid | NRF |
| 4959.612000 | 33.32 | 53.98 | 20.66 | 149 | 308 | H | High | NRF |
| 4804.000000 | 32.60 | 53.98 | 21.38 | 151 | 45 | V | Low | GMSK |
| 4879.184000 | 31.64 | 53.98 | 22.34 | 156 | 359 | H | Mid | GMSK |
| 4958.928000 | 32.15 | 53.98 | 21.83 | 163 | 306 | H | High | GMSK |
| 1261.562000 | 22.21 | 53.98 | 31.77 | 200 | 360 | V | Rx mode | |
| 2464.212000 | 24.65 | 53.98 | 29.33 | 300 | 219 | V | Rx mode | |

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above.

## 4.5 BAND EDGES

**Test Method**: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

**Limits of band-edge measurements:**

**For FCC Part 15.247 Device:**
For emissions outside of the allowed band of operation (2400.0MHz – 2480.0MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

**Test procedures:**

The highest emissions level beyond the band-edge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209. More details can be found in section 3.4 of this report.

**Deviations from test standard:**
No deviation.

**Test setup:**
Test setup details can be found in section 3.4 of this report.

**EUT operating conditions:**
Details can be found in section 2.1 of this report.

**Test results:**
**Pass**

Comments:
1. All the band edge plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
4. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209. The limit shown in the graph accounts for the antenna gain of the device.

## 4.6 POWER SPECTRAL DENSITY

**Test Method**: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

**Limits of power measurements:**
**For FCC Part 15.249 Device:**
Not Applicable

**For FCC Part 15.247 Device:**
The maximum PSD allowed is 8 dBm.

**Test procedures:**
Details can be found in section 3.4 of this report.

**Deviations from test standard:**
No deviation.

**Test setup:**
Details can be found in section 3.4 of this report.

**EUT operating conditions:**
Details can be found in section 2.1 of this report.

**Test results:**

**Pass**

Comments:

4. All the Power Spectral Density (PSD) plots can be found in the Appendix C.
5. All the measurements were found to be compliant.
6. The measurements are reported on the graph.

## 4.7 CONDUCTED AC MAINS EMISSIONS

**Test Method**: ANSI C63.10-2013, Section(s) 6.2

**Limits for conducted emissions measurements:**

| FREQUENCY OF EMISSION (MHz) | CONDUCTED LIMIT (dBµV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56 | 56 to 46 |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

**Notes:**
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

**Test Procedures:**

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
d. Results were compared to the 15.207 limits.

**Deviation from the test standard:**
No deviation

**EUT operating conditions:**
Details can be found in section 2.1 of this report.
.

**Test Results:**

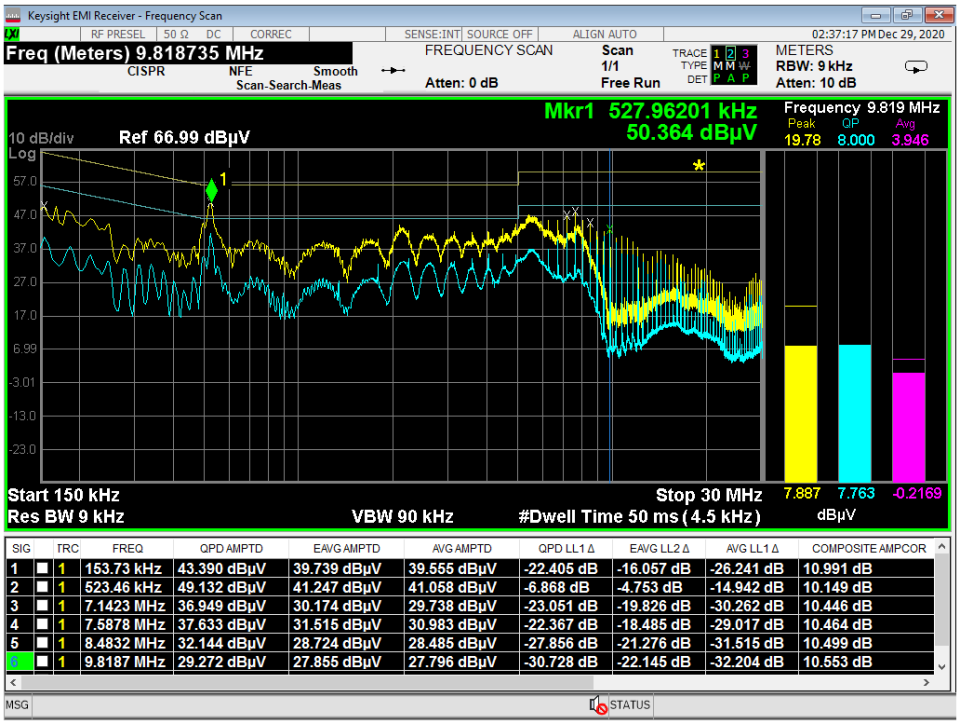



**Figure 7 - Conducted Emissions Plot, Line**

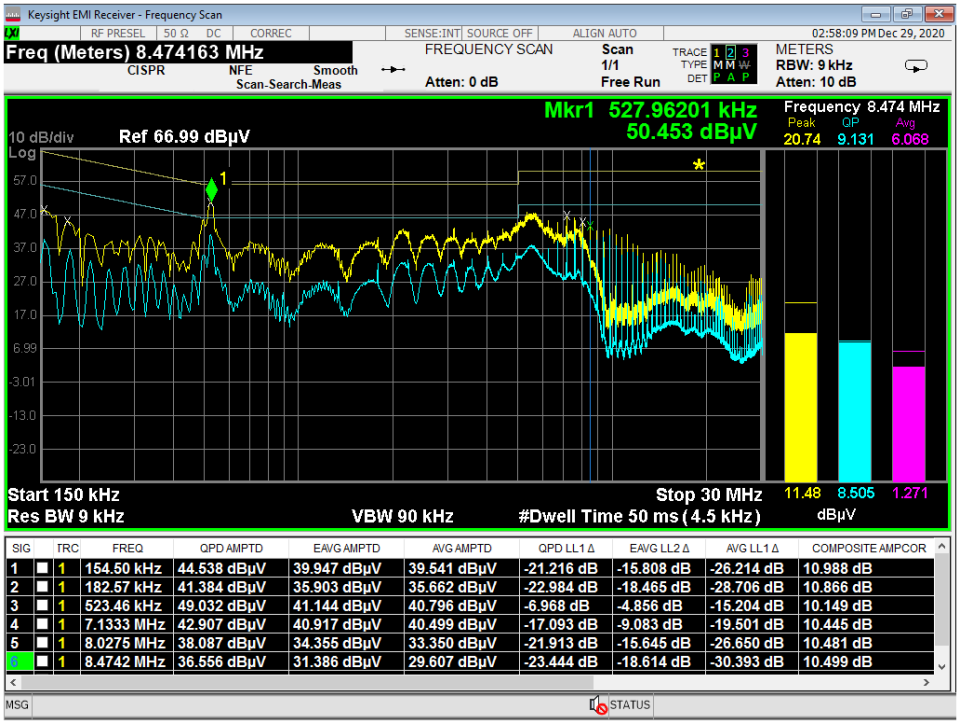



**Figure 8 - Conducted Emissions Plot, Neutral**

## APPENDIX A: SAMPLE CALCULATION

**Field Strength 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) + AV

FS = Field Strength

RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain
AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log($T_{on}$/100) where $T_{on}$ is the maximum transmission time in any 100ms window.

**EIRP Calculations**

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

*EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]$^2$ / 30*
*Power (watts) = 10^[Power (dBm)/10] / 1000*
*Voltage (dBμV) = Power (dBm) + 107 (for 50Ω measurement systems)*
*Field Strength (V/m) = 10^[Field Strength (dBμV/m) / 20] / 10^6*
*Gain = 1 (numeric gain for isotropic radiator)*
*Conversion from 3m field strength to EIRP (d=3):*
*EIRP = [FS(V/m) x d^2]/30 = FS [0.3] for d = 3*
*EIRP(dBm) = FS(dBμV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBμV/m) - 95.23*
*10log( 10^9) is the conversion from micro to milli*

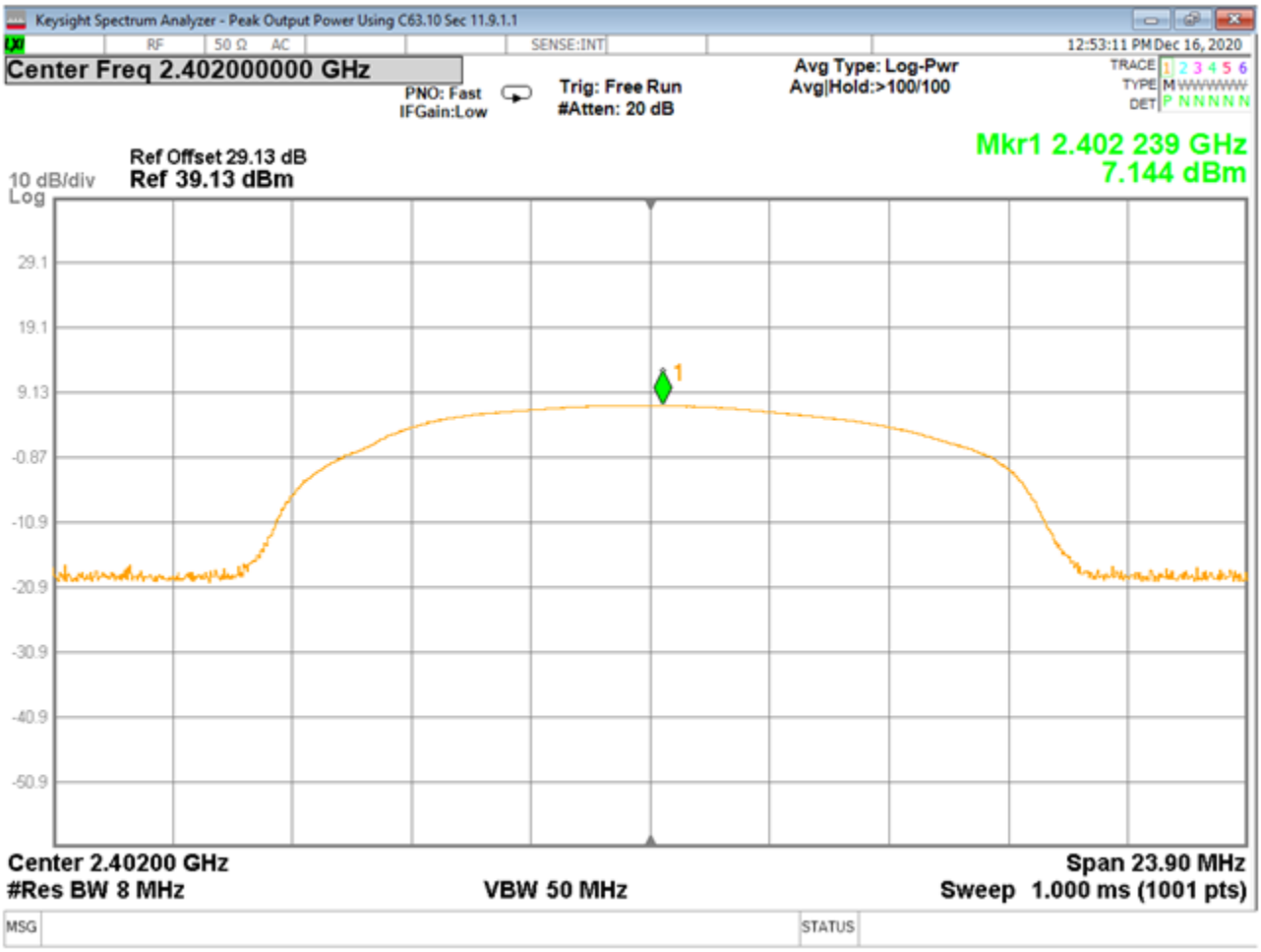
## APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

| Test | Frequency Range | Uncertainty Value (dB) |
|---|---|---|
| Radiated Emissions, 3m | 30MHz - 1GHz | ±4.31 |
| Radiated Emissions, 3m | 1GHz - 18GHz | ±5.08 |
| Emissions limits, conducted | 30MHz – 18GHz | ±3.03 |

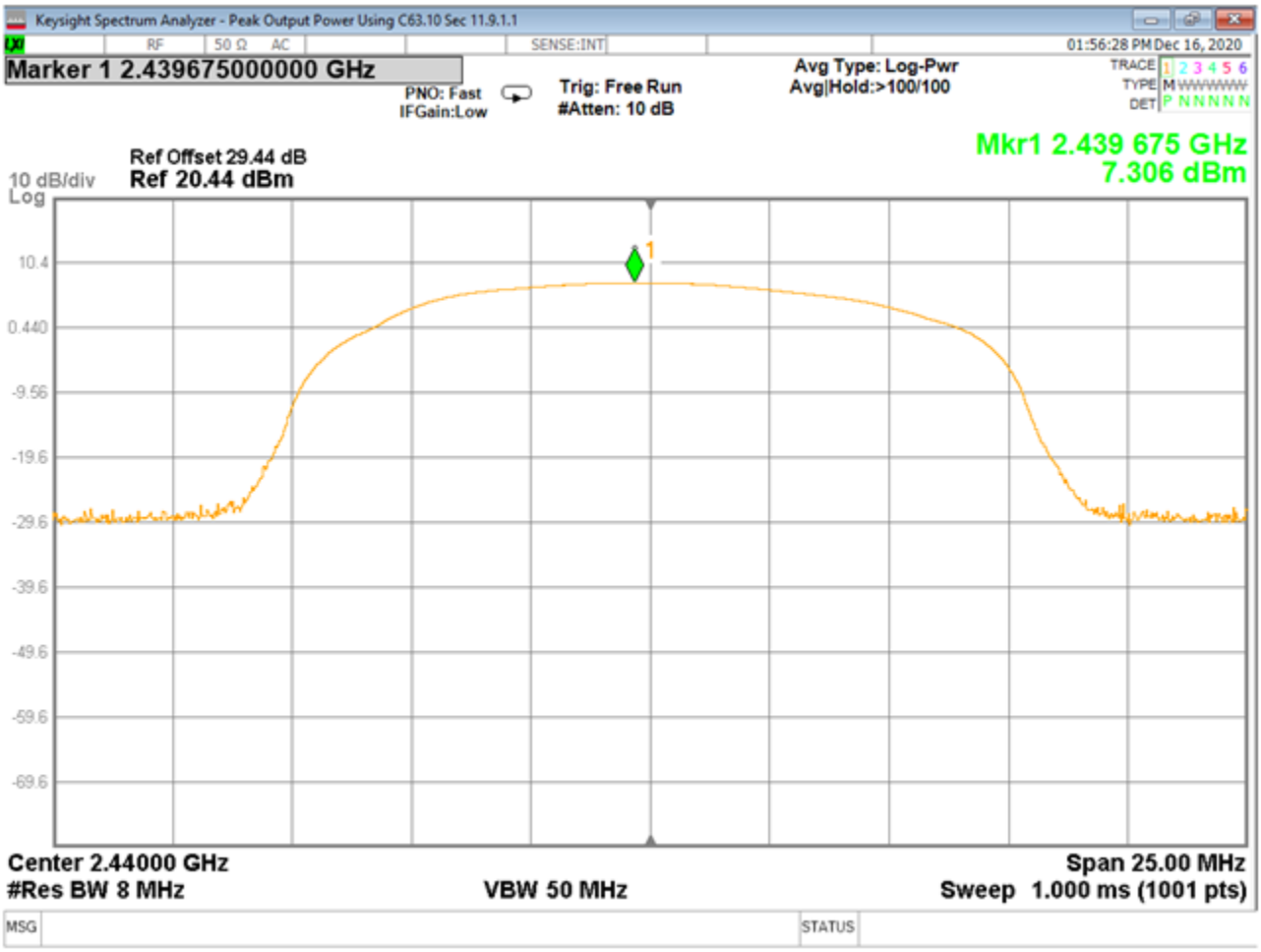
Expanded uncertainty values are calculated to a confidence level of 95%.

## APPENDIX C – GRAPHS AND TABLES



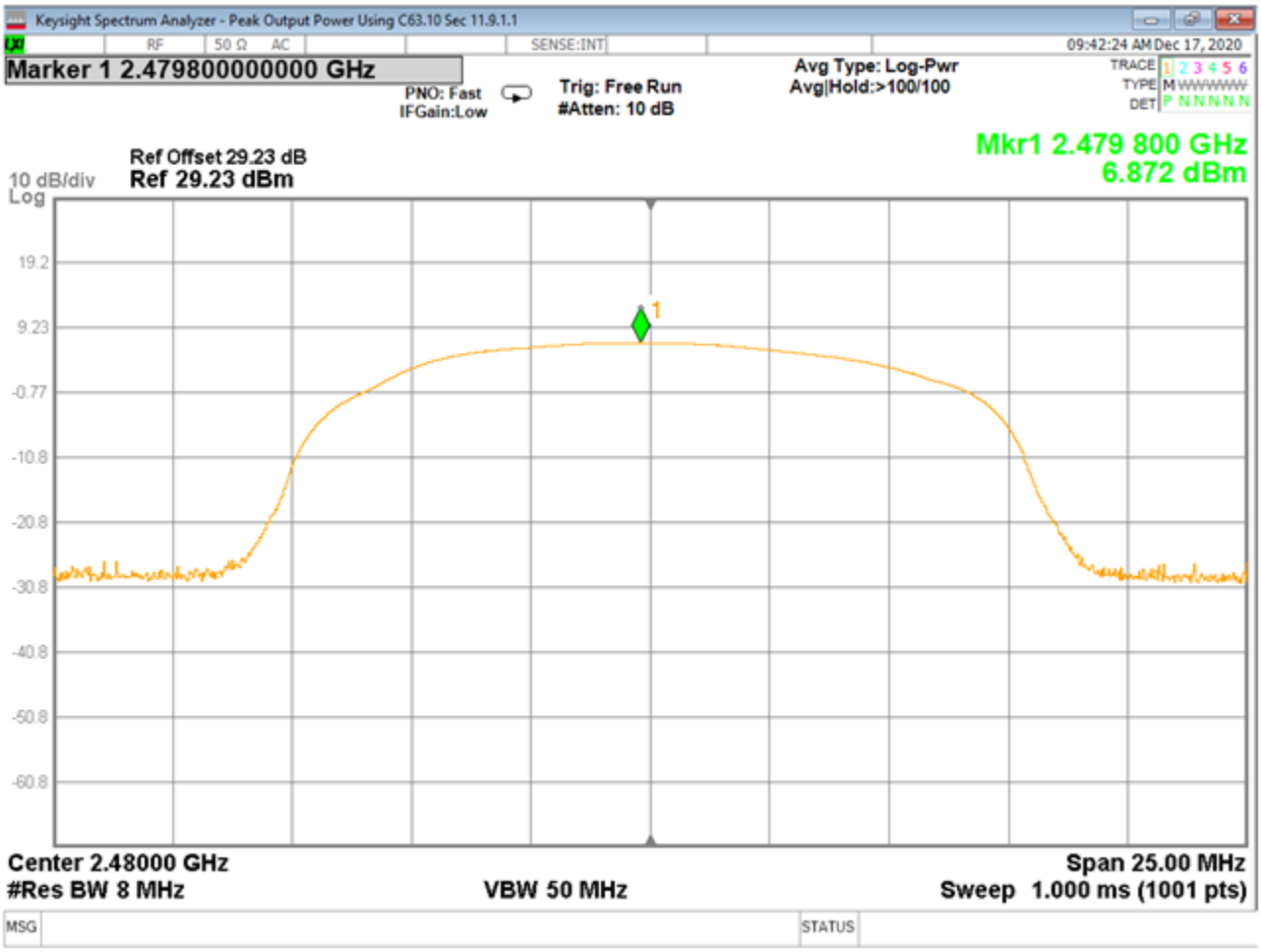

**01. Output Power_Radio1_BLE_Low Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



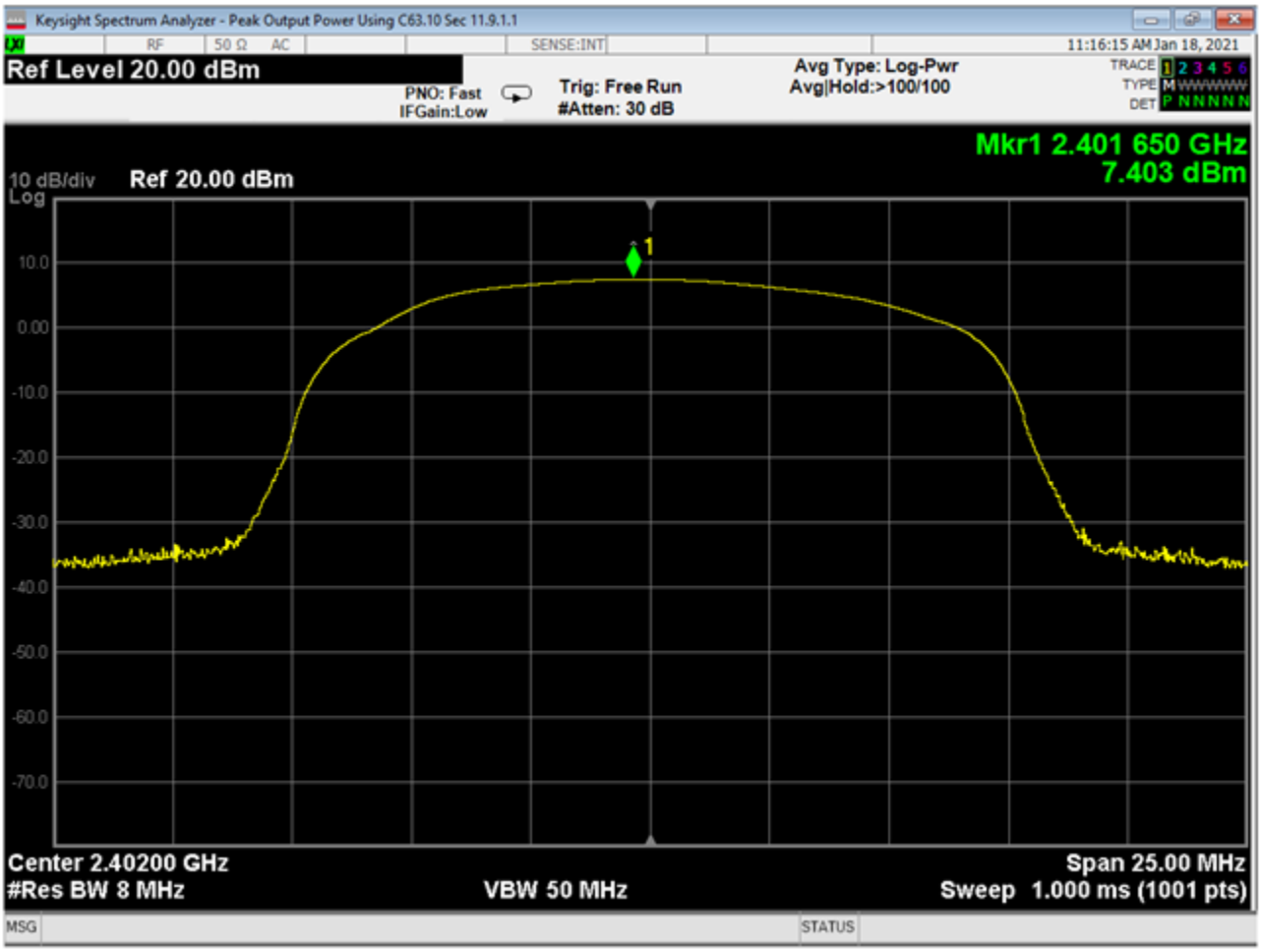

**02. Output Power_Radio2_BLE_Mid Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



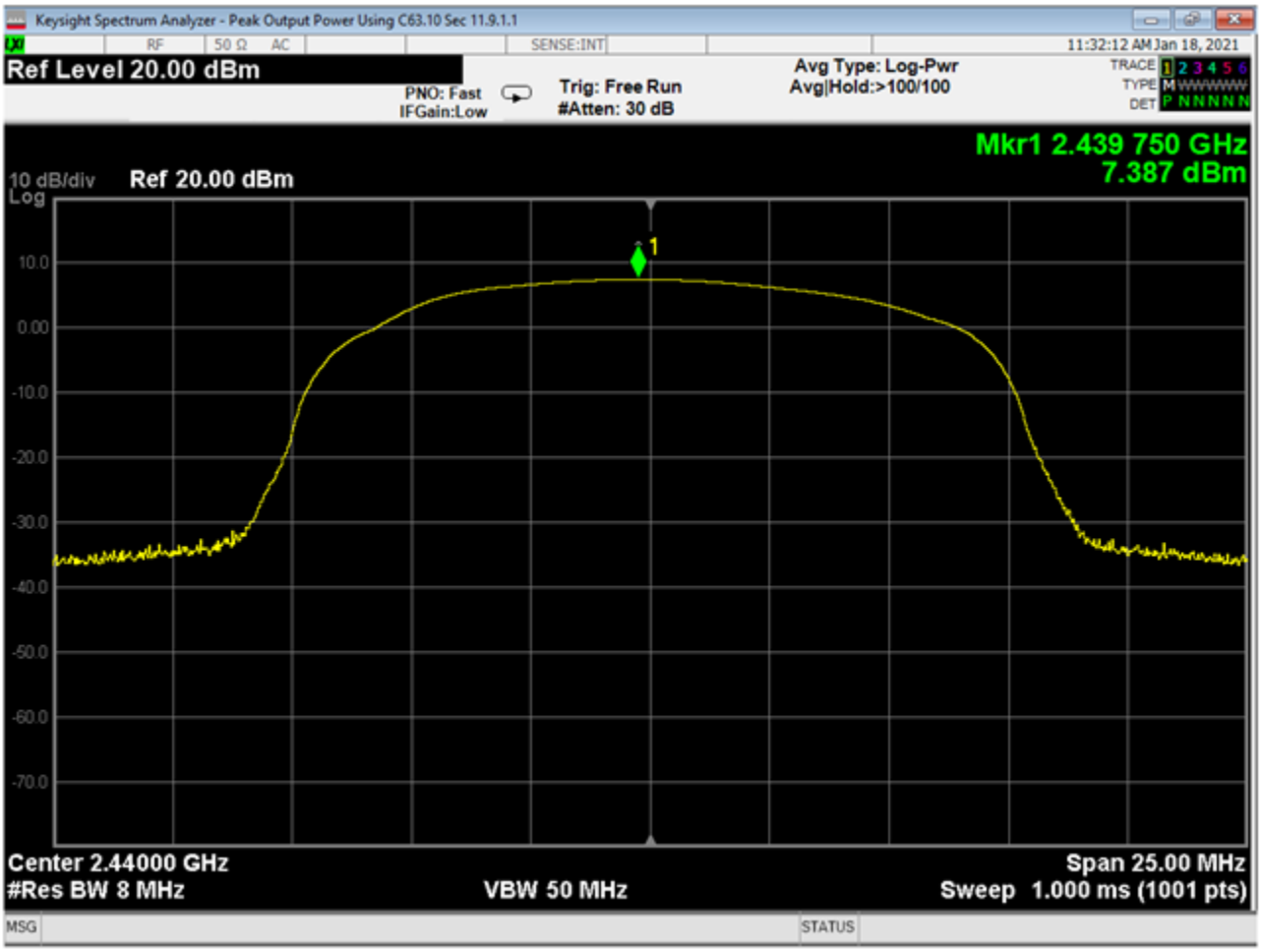

**03. Output Power_Radio1_BLE_High Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



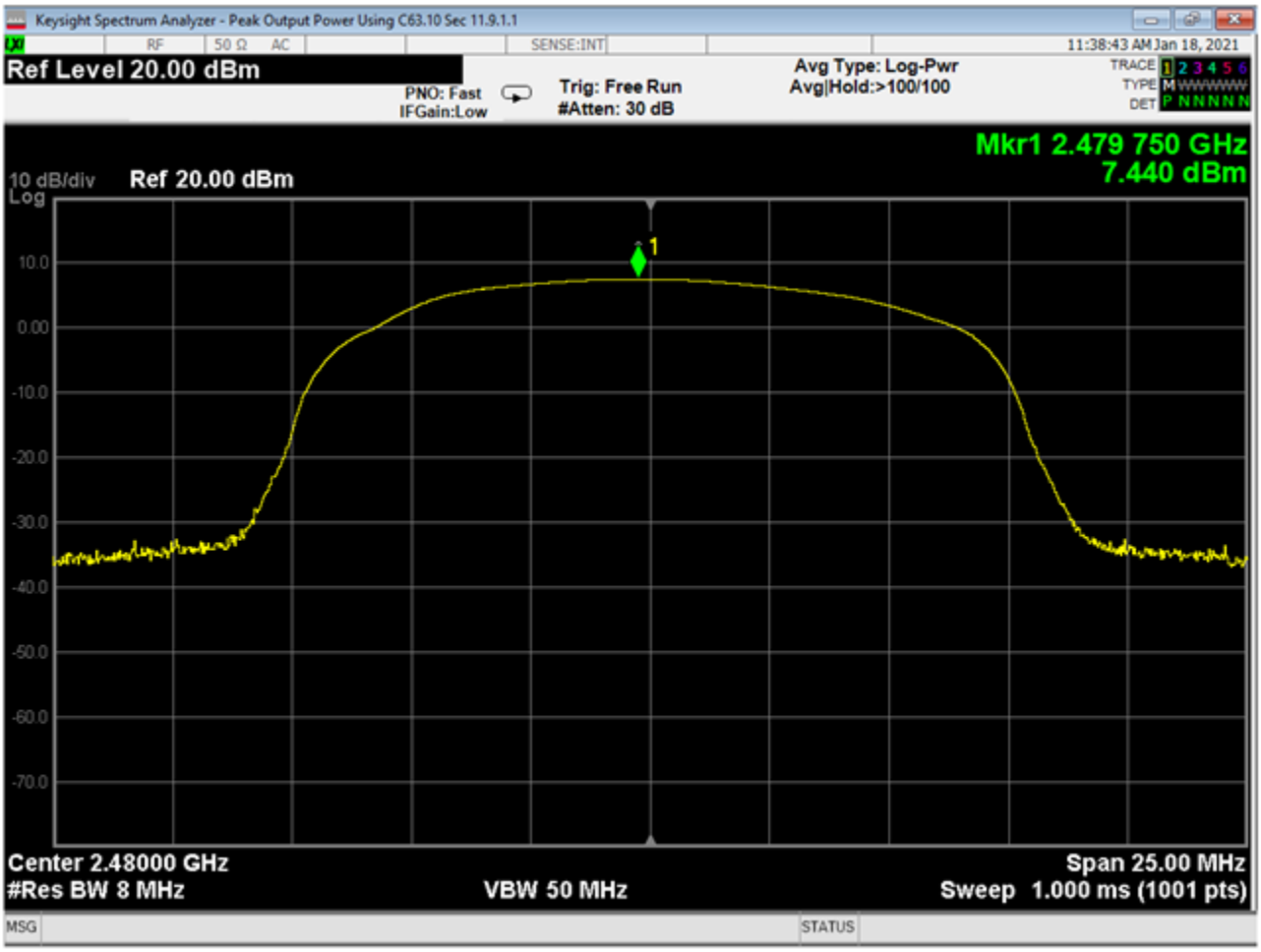

**04. Output Power_Radio1_NRF_Low Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



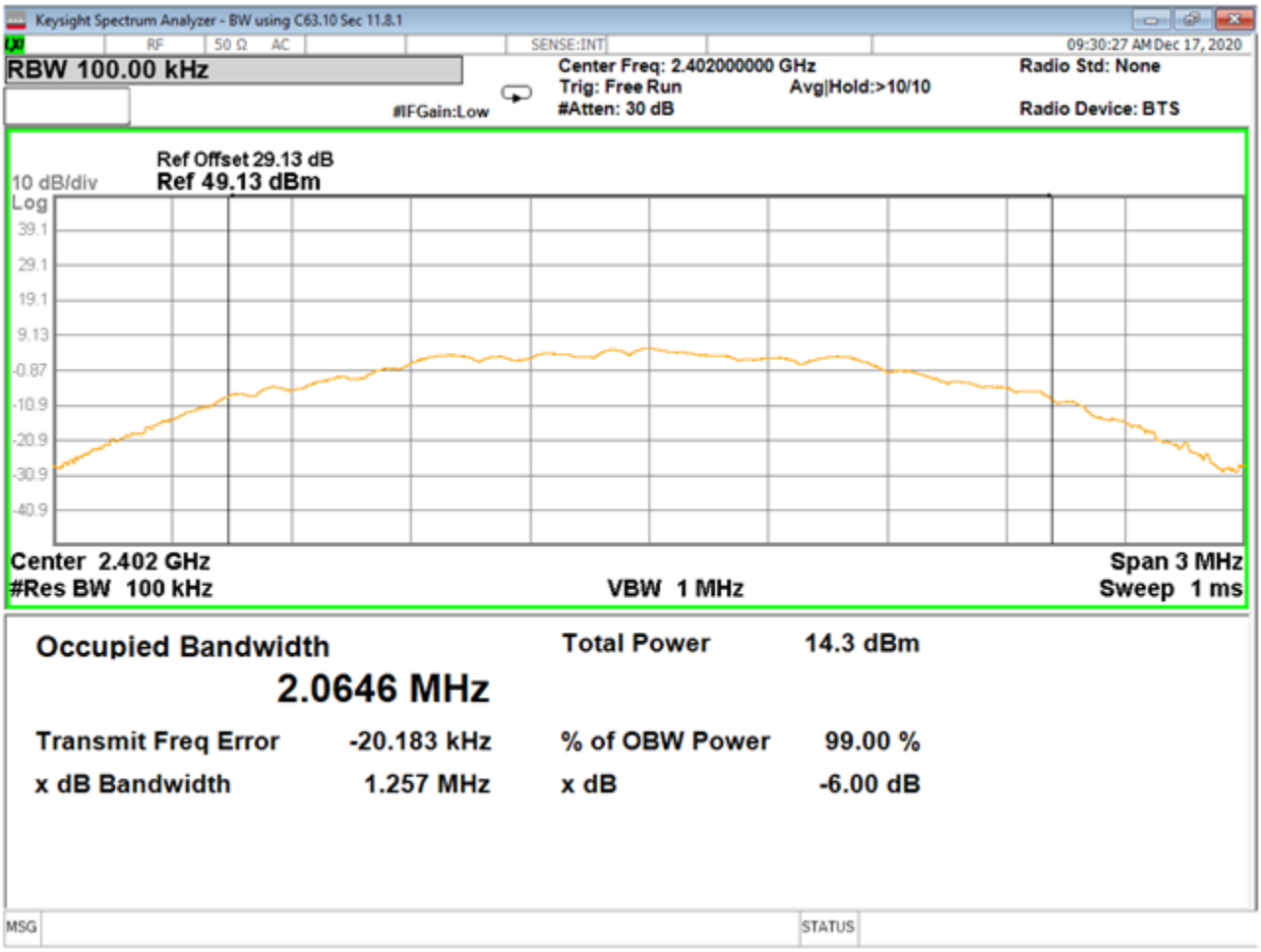

**05. Output Power_Radio1_NRF_Mid Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



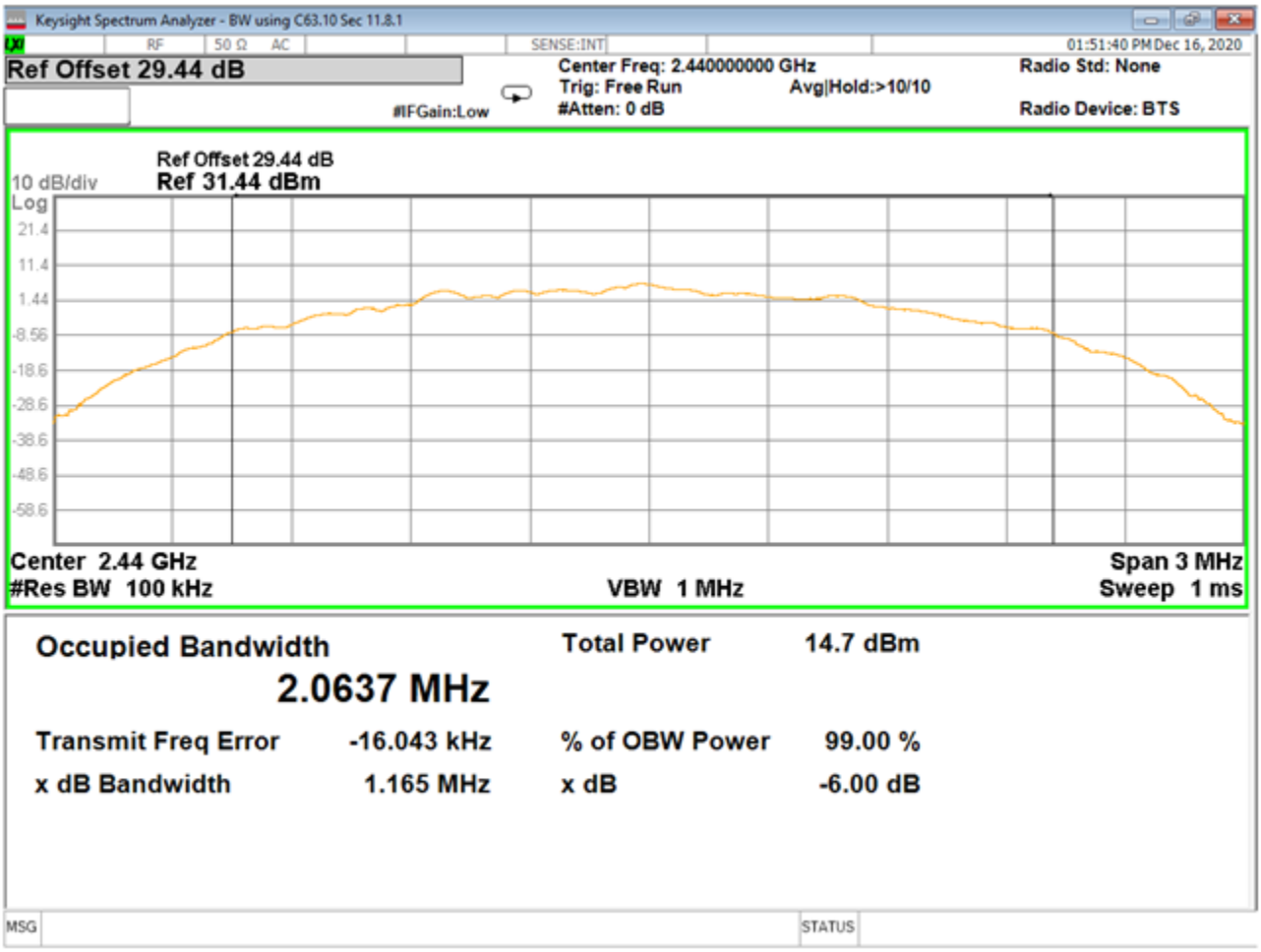

**06. Output Power_Radio1_NRF_High Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



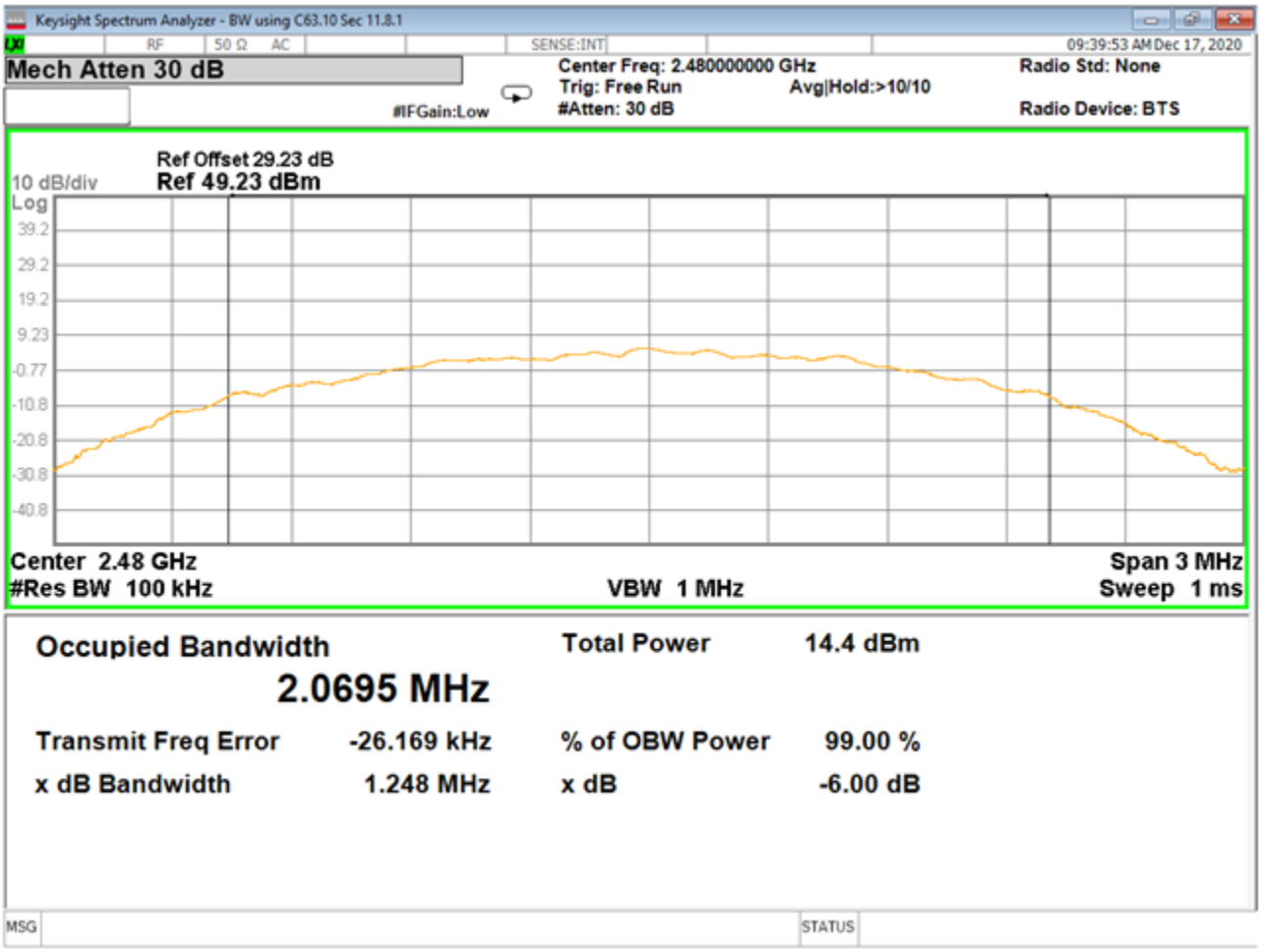

**07. Bandwidth_Radio1_BLE_Low Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



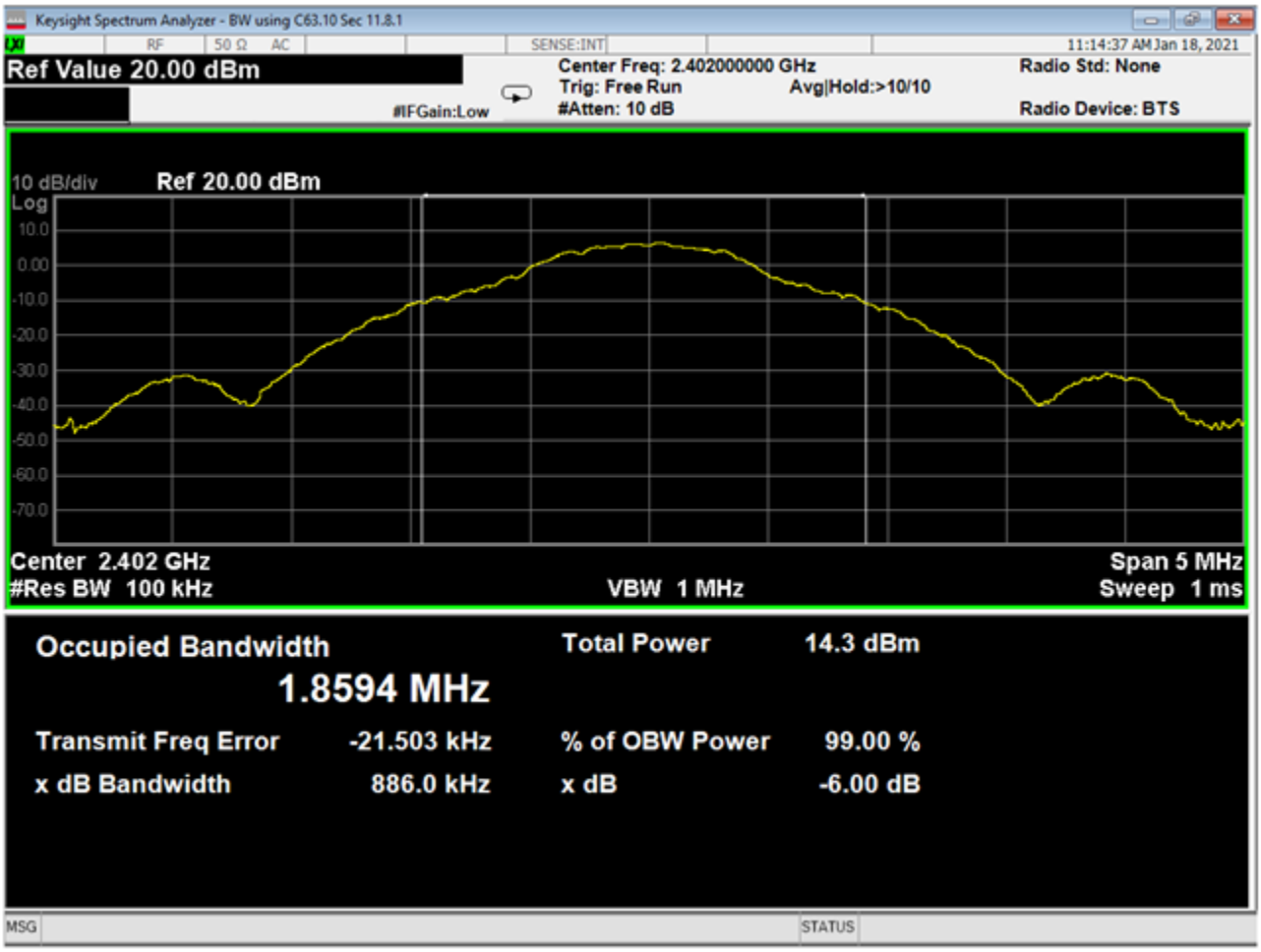

**08. Bandwidth_Radio1_BLE_Mid Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



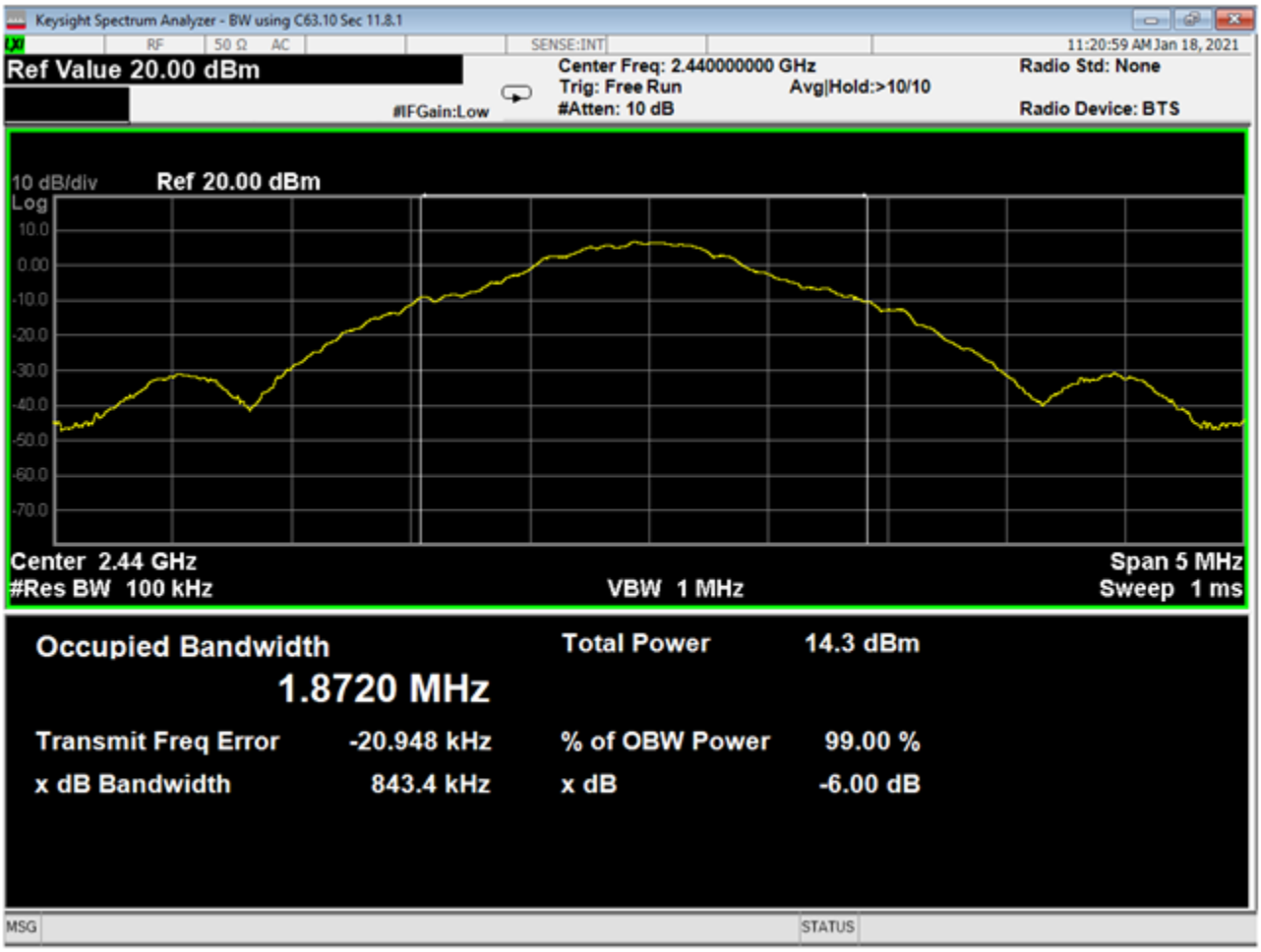

**09. Bandwidth_Radio1_BLE_High Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



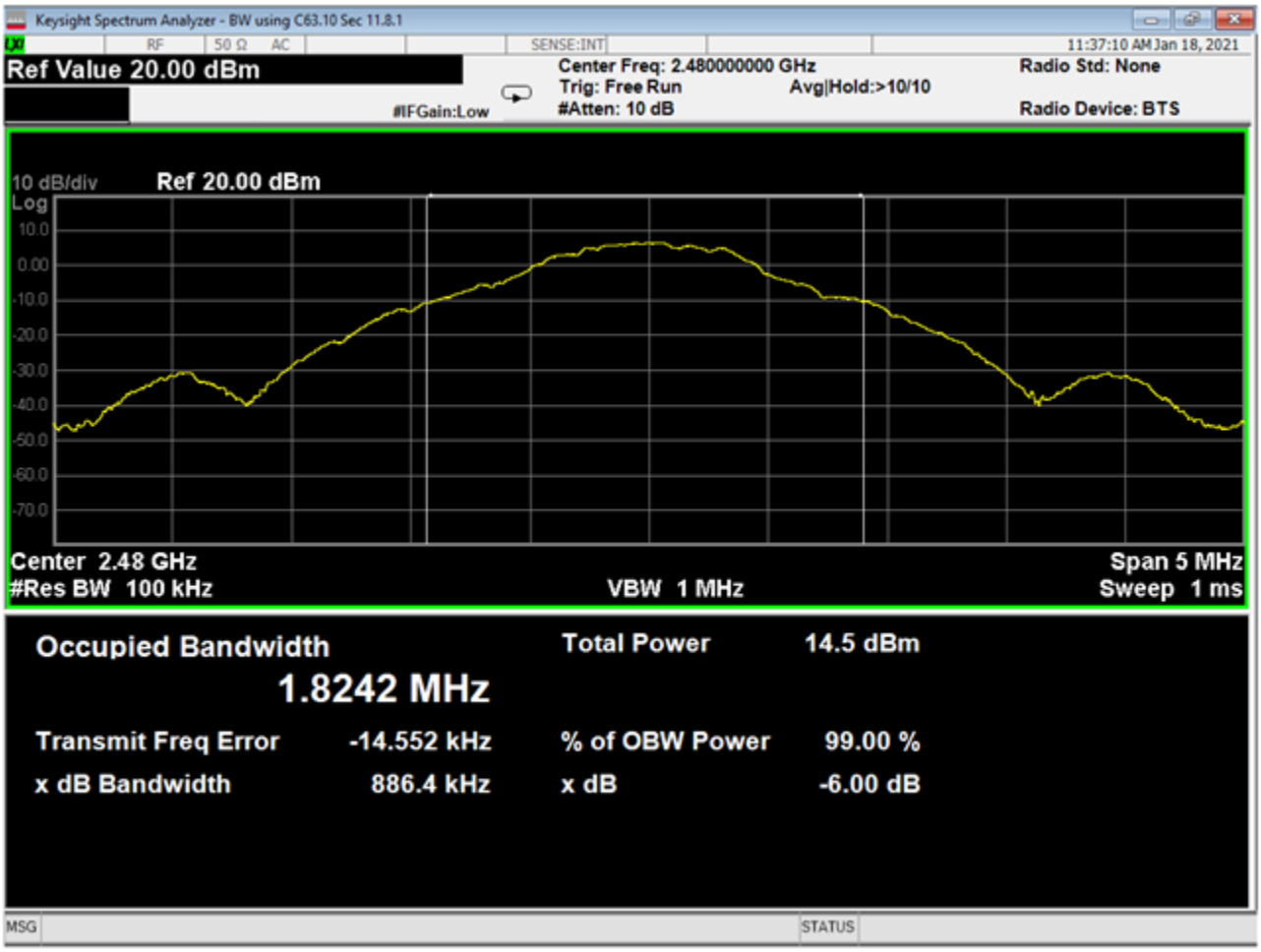

**10. Bandwidth_Radio1_NRF_Low Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



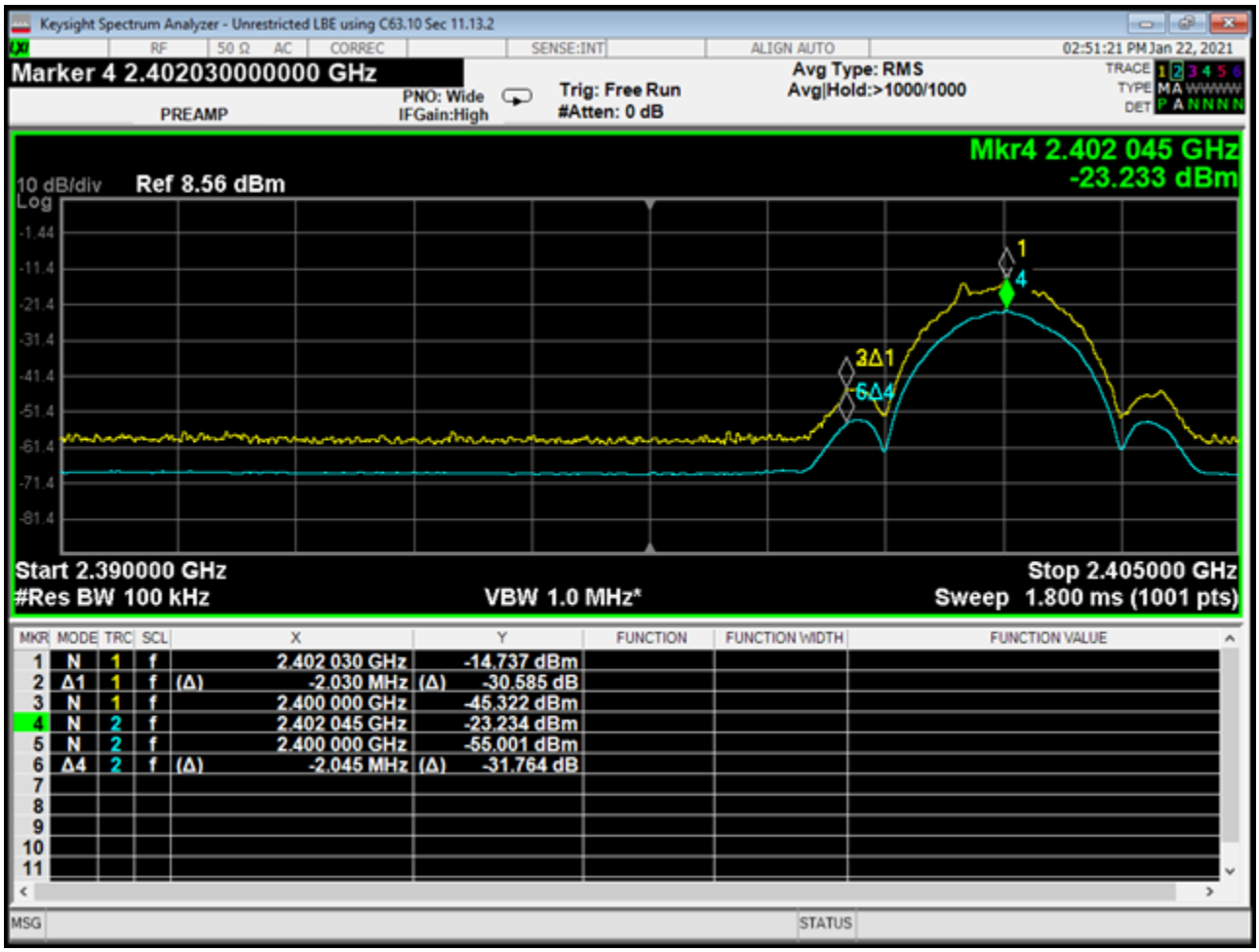

**11. Bandwidth_Radio1_NRF_Mid Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



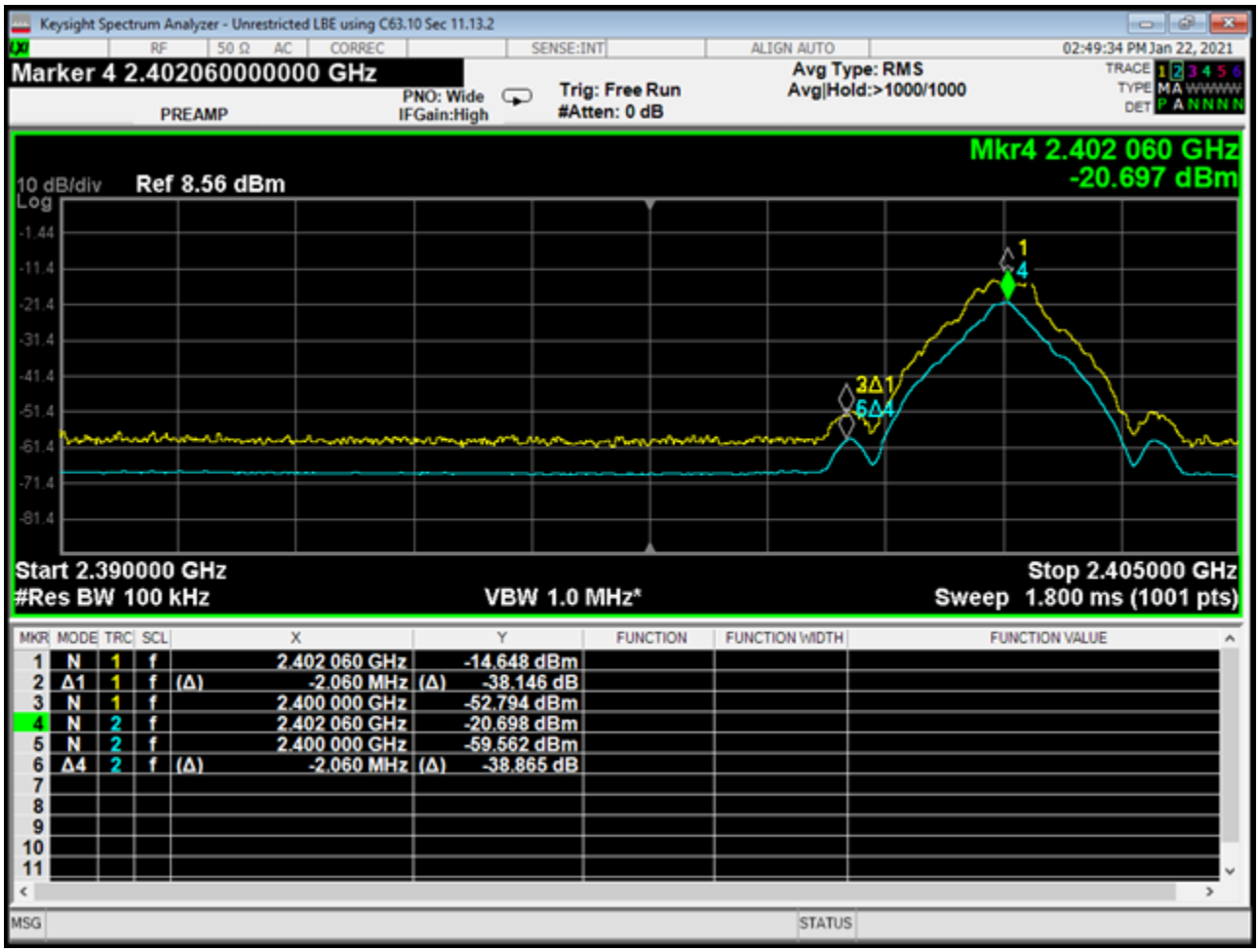

**12. Bandwidth_Radio1_NRF_High Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



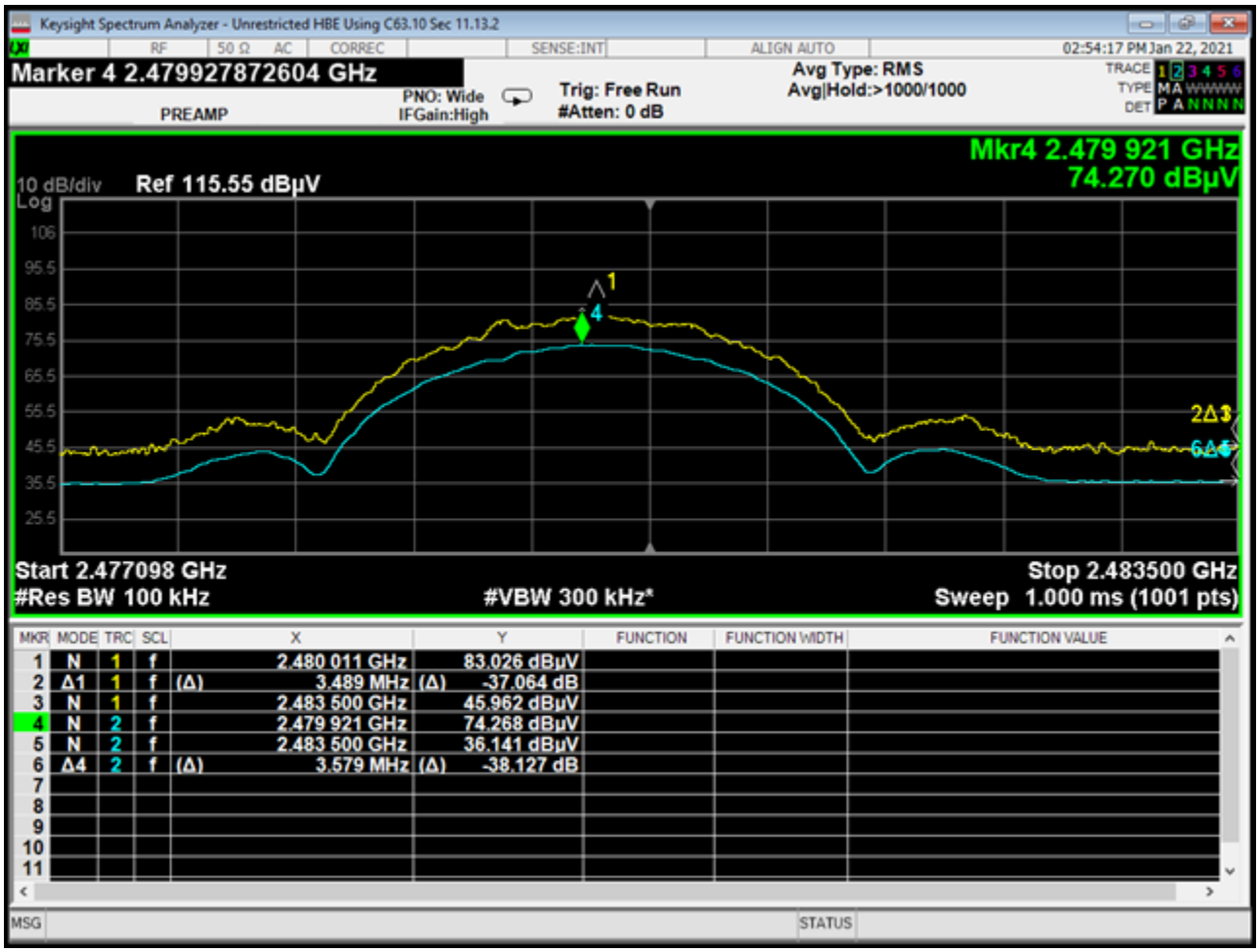

**13. Lower Bandedge_Radio 1_BLE_Unrestricted**

Relative measurements only. Peak Measurement is used in the results table in section 4.0 of this report.




**14. Lower Bandedge_Radio 1_NRF_Unrestricted**

Relative measurements only. Peak Measurement is used in the results table in section 4.0 of this report.

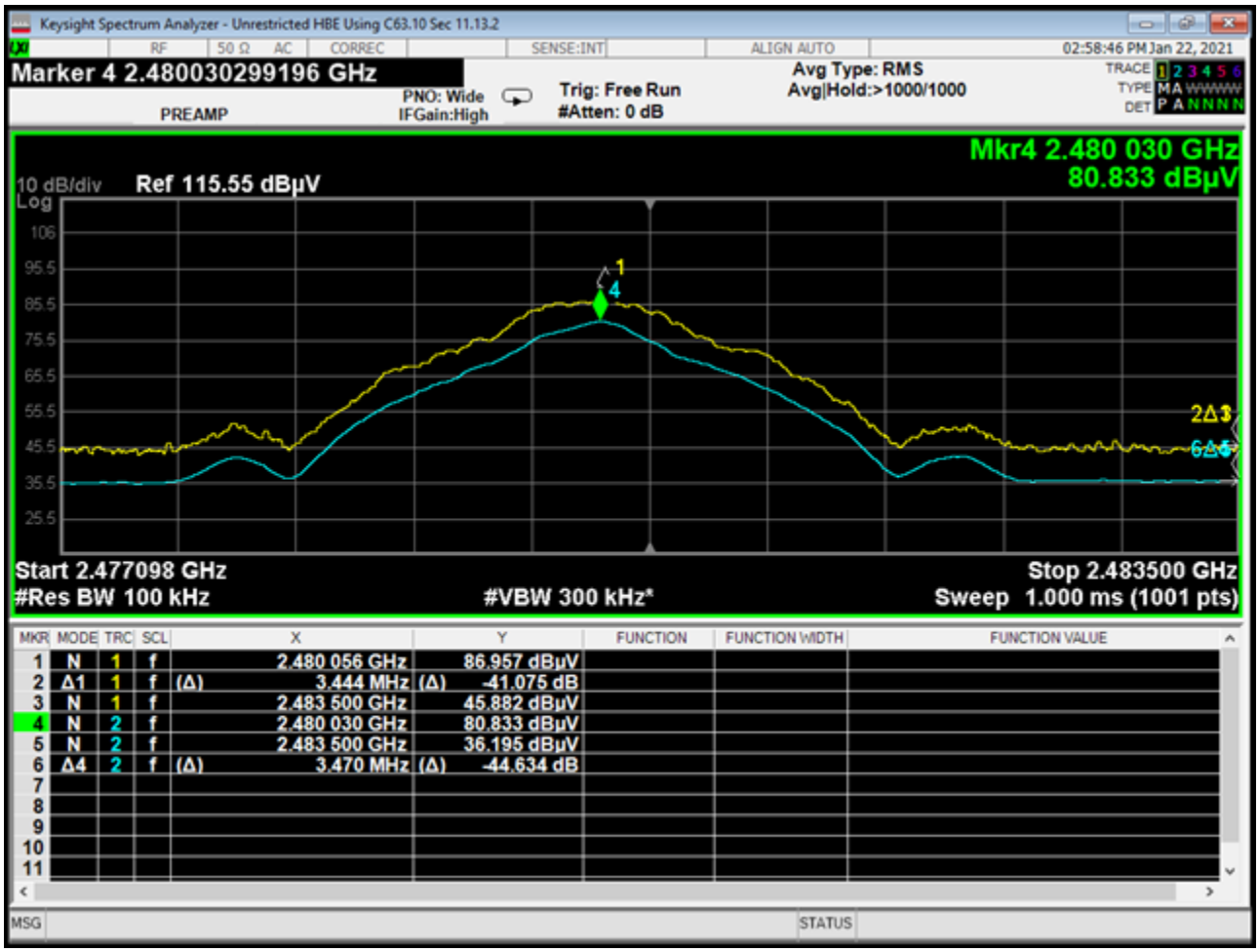



**15. High Bandedge_Radio 1_BLE_Unrestricted**

Relative measurements only. Peak Measurement is used in the results table in section 4.0 of this report.

Peak Fundamental= 83.026 dBuV=-23.97 dBm (dBm=dBuV-107)

Peak out of band measurement = 45.962 dBuV=-61.04 dBm (dBm=dBuV-107)

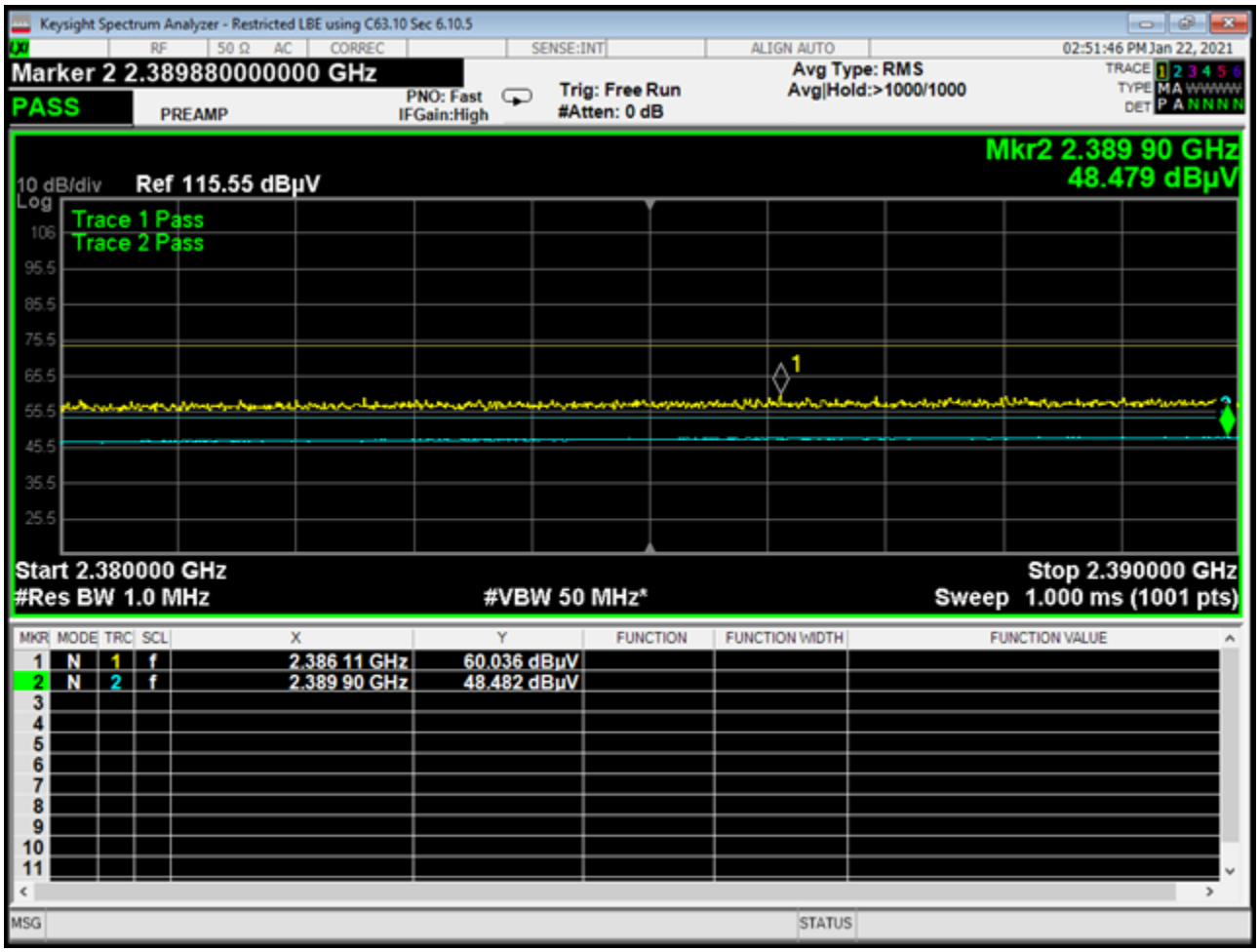



**16. High Bandedge_Radio 1_NRF_Unrestricted**

Relative measurements only. Peak Measurement is used in the results table in section 4.0 of this report.

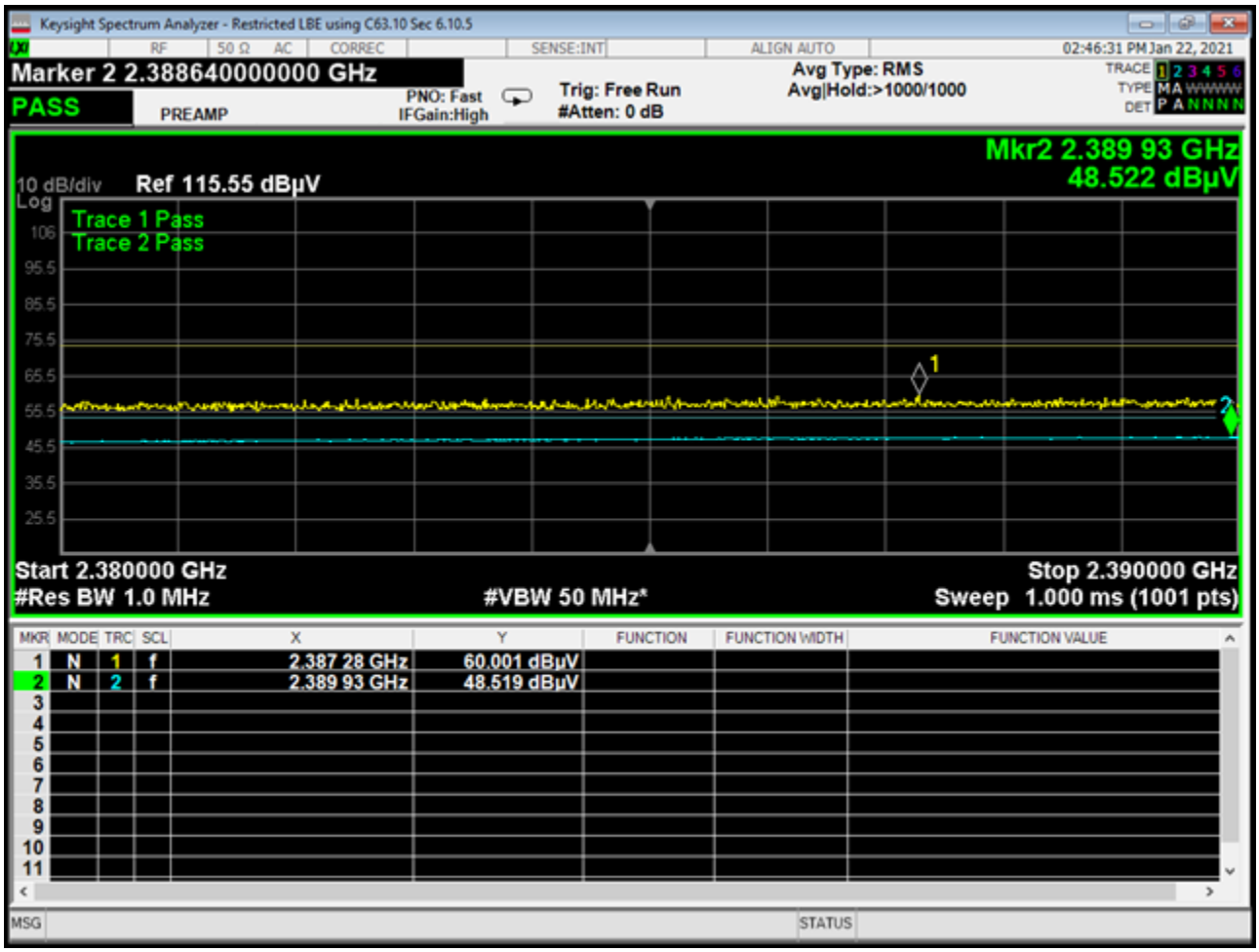
Peak Fundamental= 86.957 dBuV=-20.04 dBm (dBm=dBuV-107)

Peak out of band measurement = 45.882 dBuV=-61.12 dBm (dBm=dBuV-107)



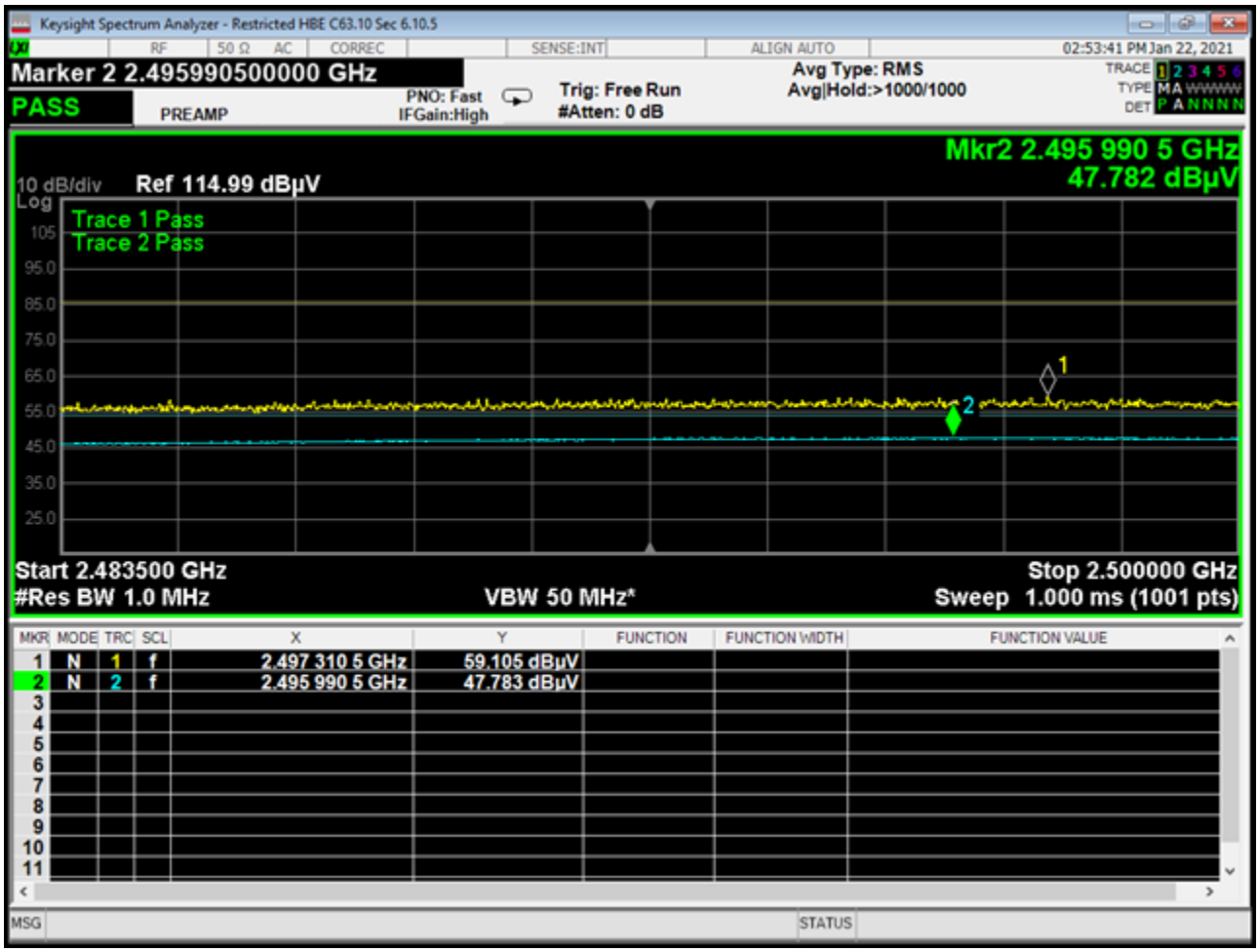

**17. Lower Bandedge_Radio 1_BLE_Restricted**

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Use of average detector is permitted as the duty cycle of the radio for these tests was >98%. Corrections are included in the graph.



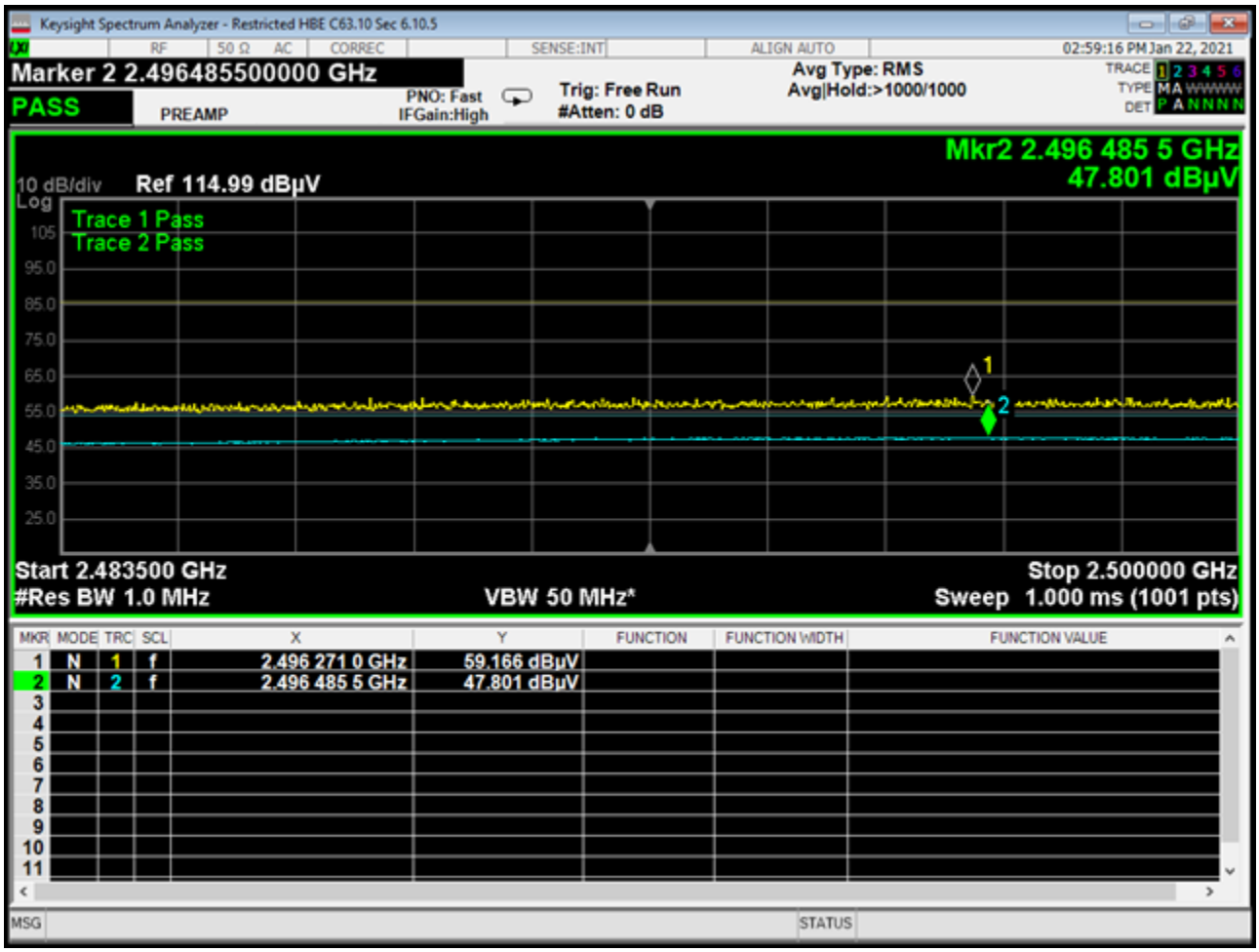

**18. Lower Bandedge_Radio 1_NRF_Restricted**

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Use of average detector is permitted as the duty cycle of the radio for these tests was >98%. Corrections are included in the graph.



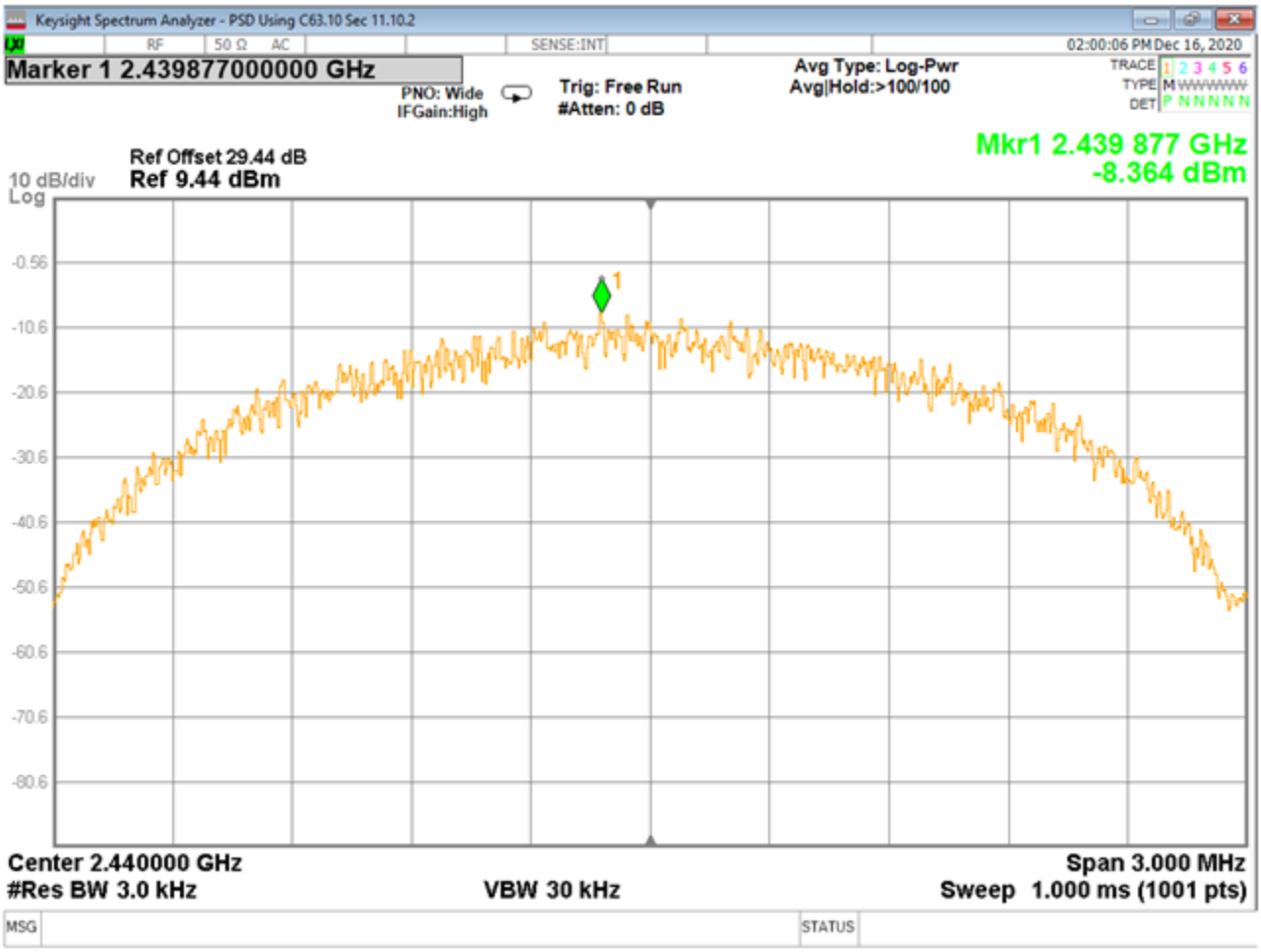

**19. High Bandedge_Radio 1_BLE_Restricted**

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Use of average detector is permitted as the duty cycle of the radio for these tests was >98%. Corrections are included in the graph.



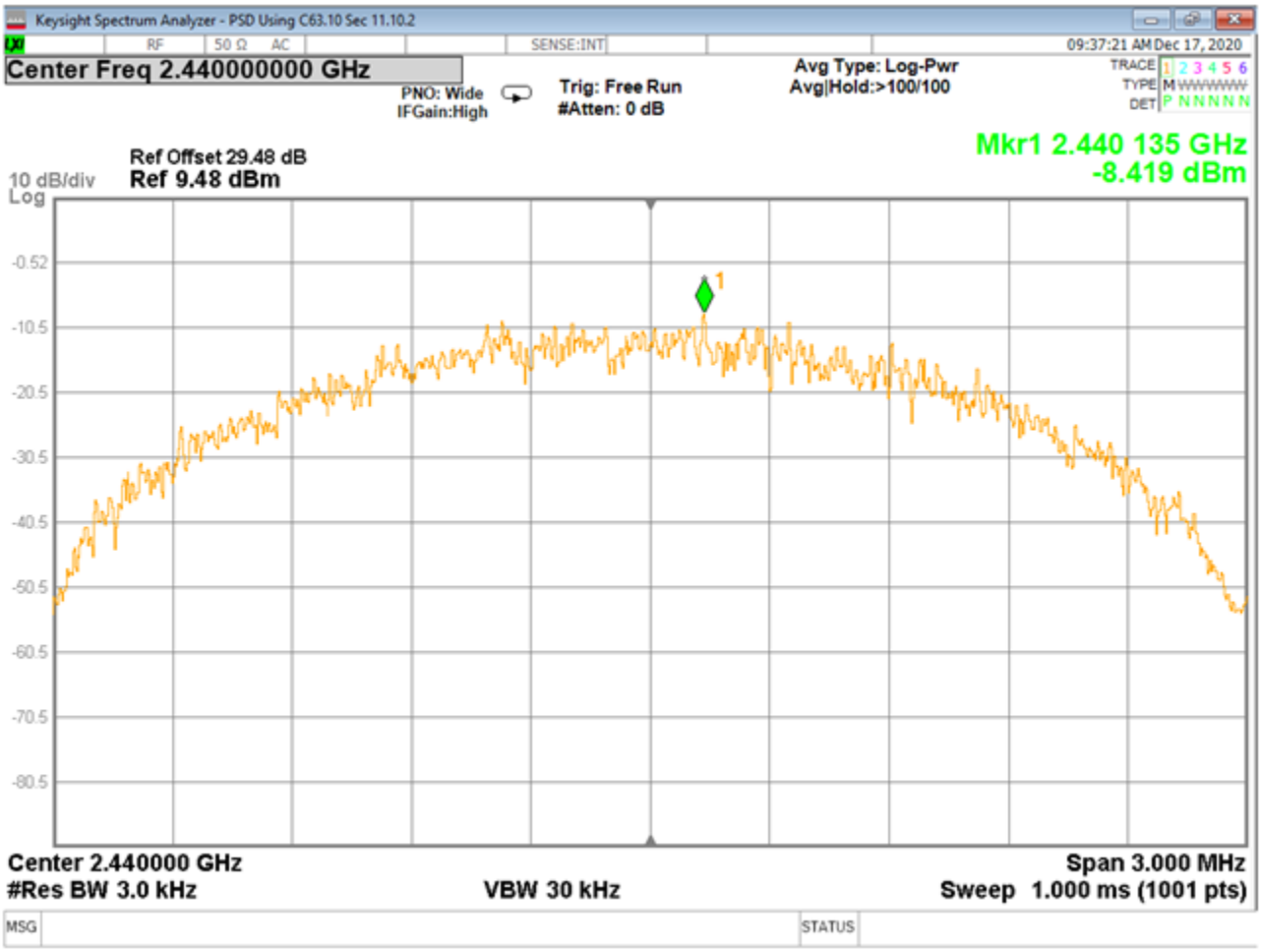

**20. High Bandedge_Radio 1_NRF_Restricted**

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Use of average detector is permitted as the duty cycle of the radio for these tests was >98%. Corrections are included in the graph.



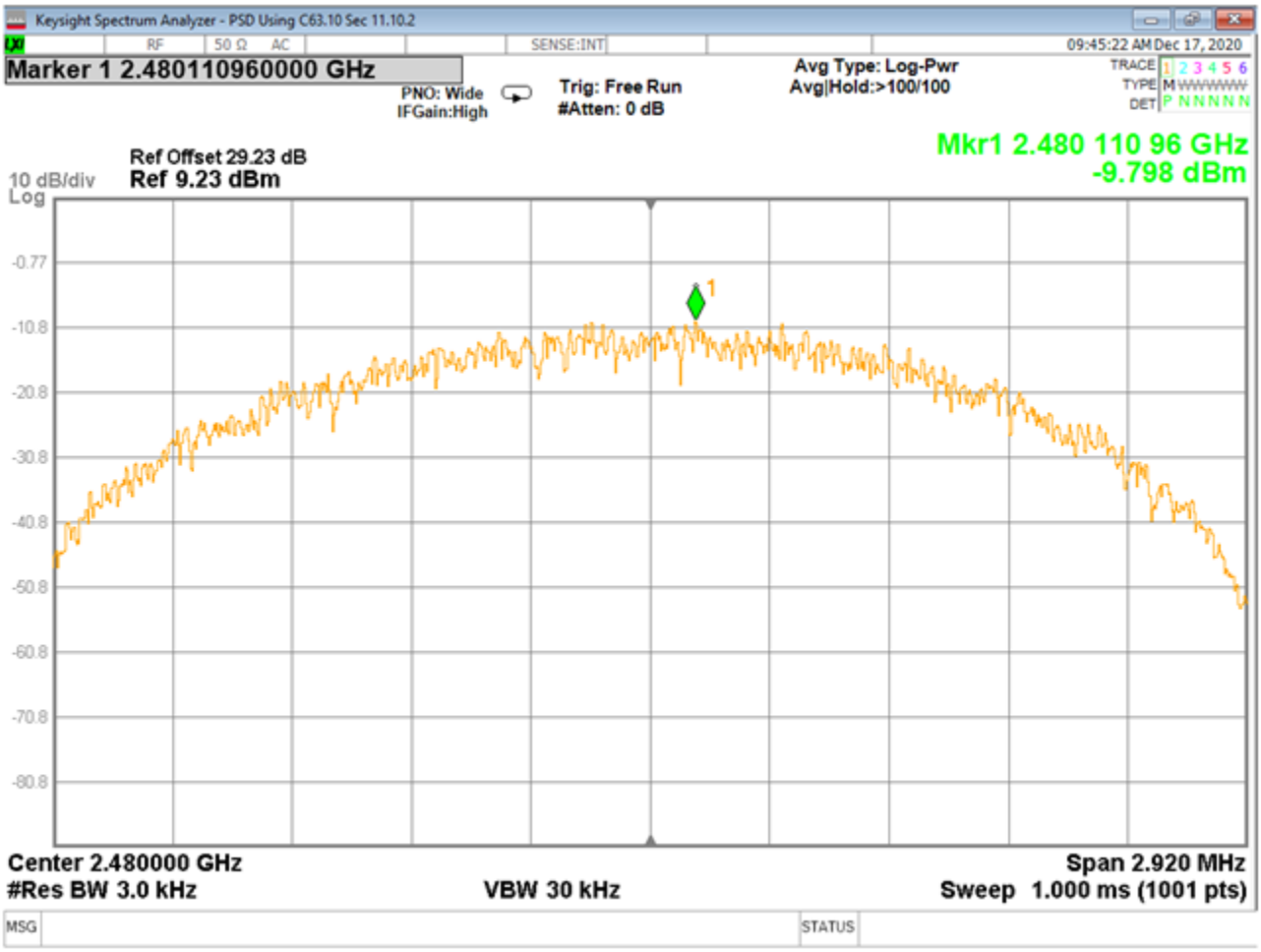

**21. Power Spectral Density_Radio1_BLE_Low Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



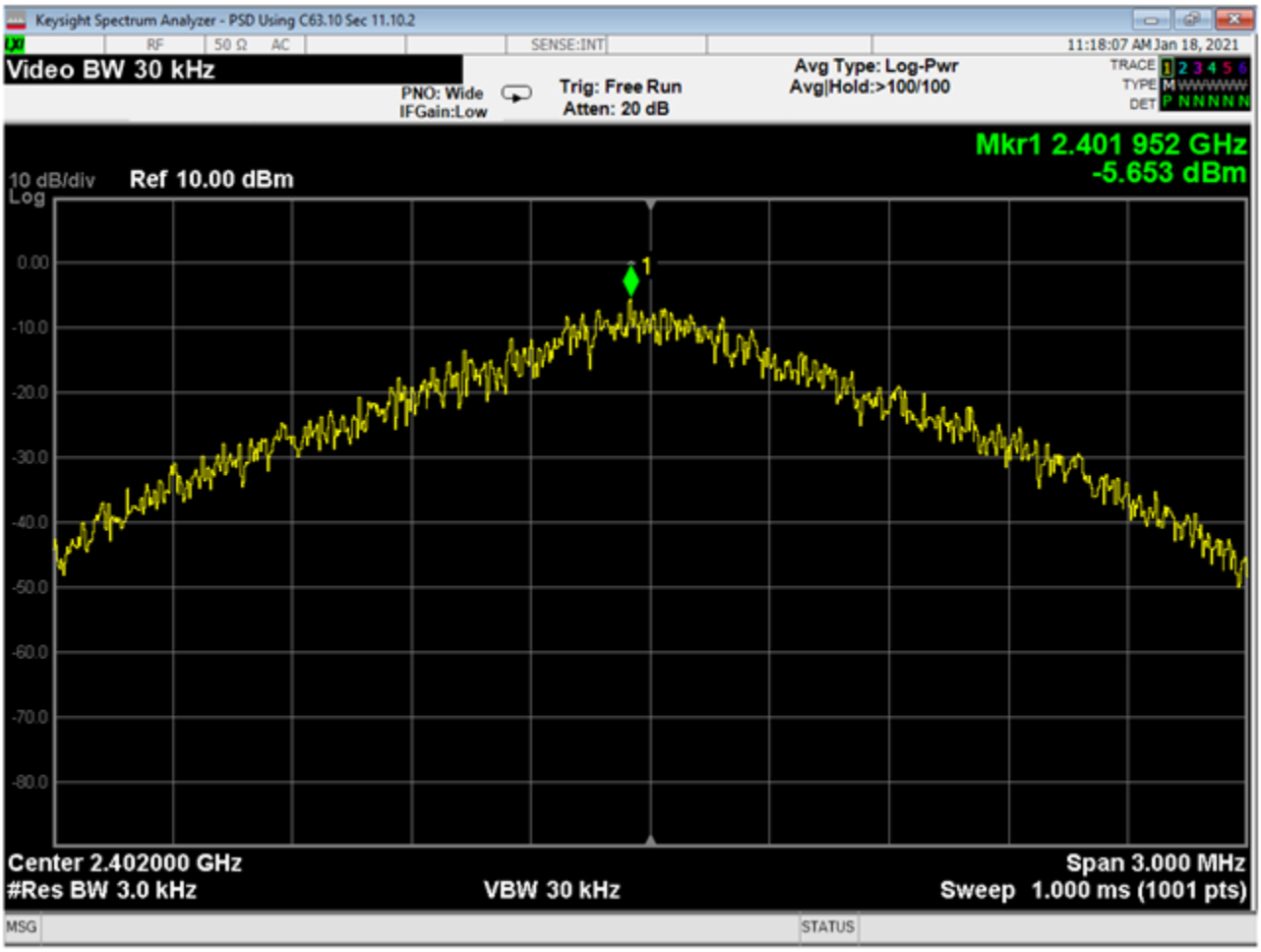

**22. Power Spectral Density_Radio1_BLE_Mid Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



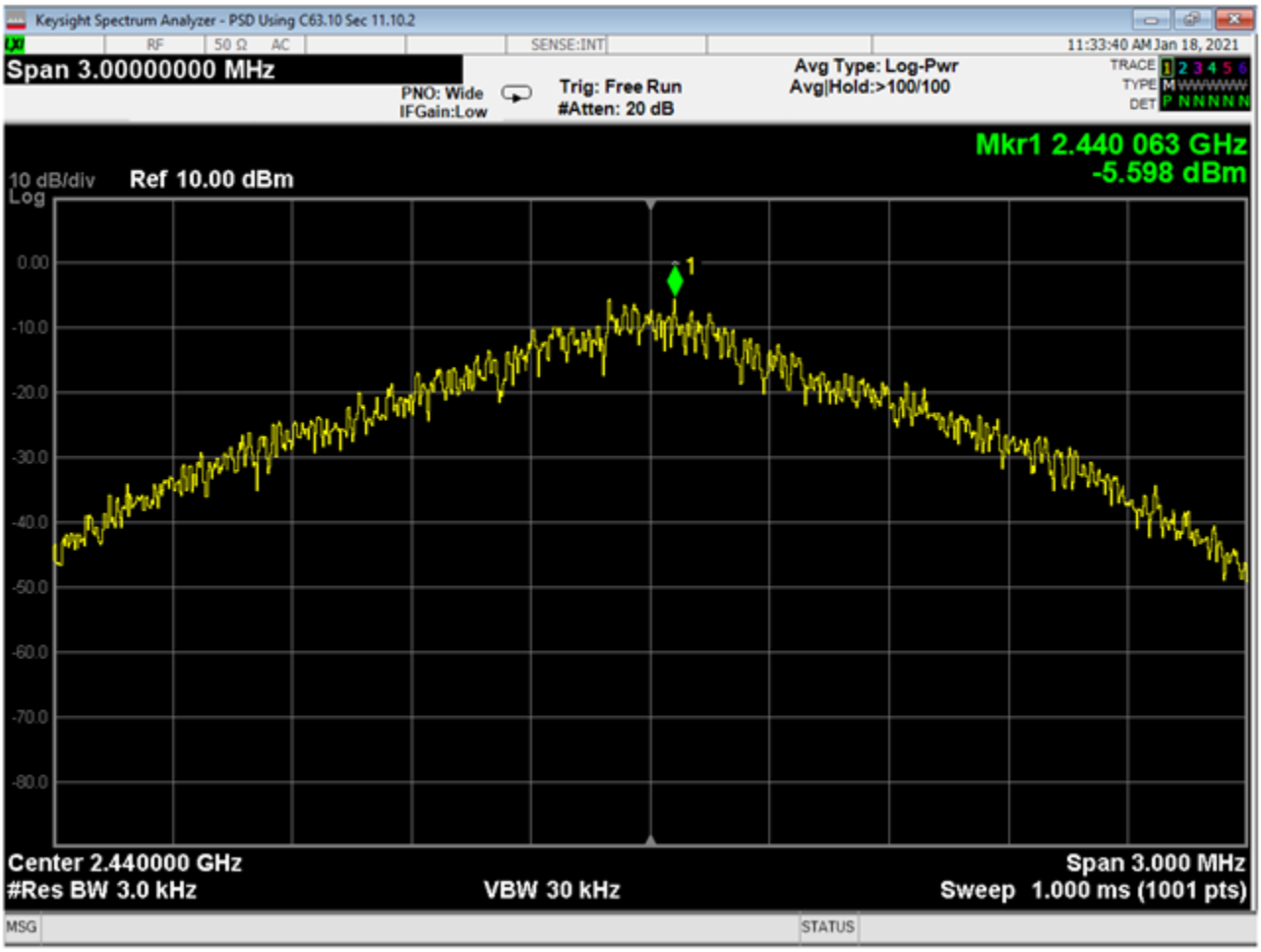

**23. Power Spectral Density_Radio1_BLE_High Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



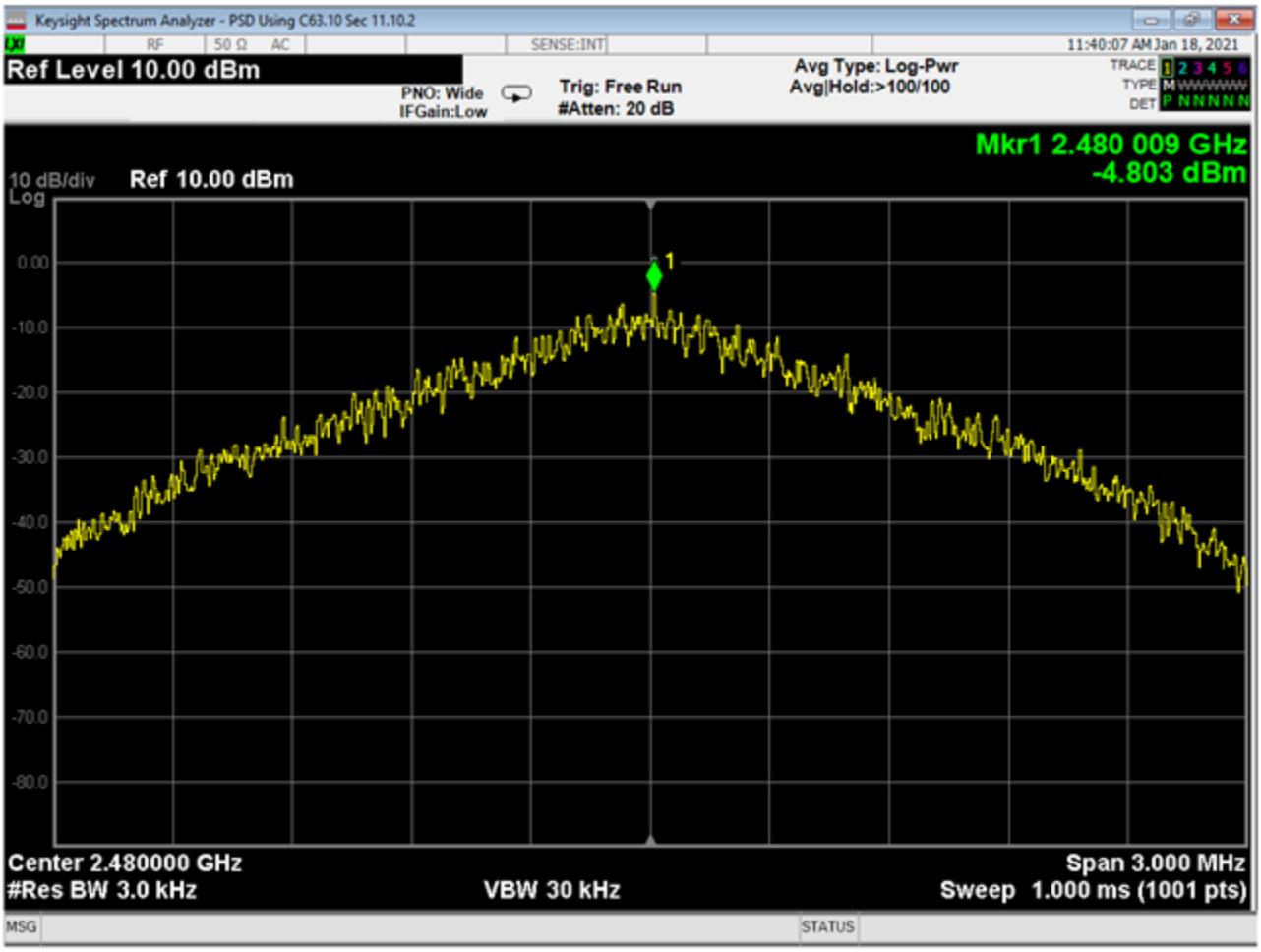

**24. Power Spectral Density_Radio1_NRF_Low Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.




**25. Power Spectral Density_Radio1_NRF_Mid Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.




**26. Power Spectral Density_Radio1_NRF_High Channel**

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.

REPORT END