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# Test Report

**Prepared for:** **Inovonics**

**Address:** **11000 Westmoor Circle**
**Building 10, Suite 250**
**Westminster, CO 80021**

**Product:** **EN1262HT**

**Test Report No:** **R20211022-21-E1B**

**Approved by:**

**Nic S. Johnson, NCE**
**Technical Manager**
**iNARTE Certified EMC Engineer #EMC-003337-NE**

**DATE:** **5 May 2022**

**Total Pages:** **44**

## REVISION PAGE

| Rev. No. | Date | Description |
|---|---|---|
| 0 | 11 March 2022 | Original – NJohnson<br>Prepared by KVepuri |
| A | 29 March 2022 | Section 4.0, section 4.1, and section 4.2 were modified -KV |
| B | 5 May 2022 | 1. Section 4.6 was modified<br>2. Plots were added to Appendix C<br>3. Section 1 was modified<br>-KV |

## CONTENTS

## 1.0 SUMMARY OF TEST RESULTS

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 2

| SUMMARY | | | |
|---|---|---|---|
| **Standard Section** | **Test Type and Limit** | **Result** | **Remark** |
| FCC 15.203 | Unique Antenna Requirement | Pass | PCB antenna |
| FCC 15.35<br>RSS-Gen, 6.10 | Duty cycle of pulsed emissions | Pass | Pulsed emissions duty cycle was applied |
| FCC 15.109<br>RSS-Gen, 7.3 | Receiver Radiated Emissions | NA | The EUT does not receive |
| FCC 15.247(a)(1)(i)<br>RSS-247, 5.1(c) | Minimum Bandwidth,<br>Limit: Min. 250kHz,<br>Frequency Separation | Pass | Meets the requirement of the limit. |
| FCC 15.247(b)(2)<br>RSS-247, 5.1 | Maximum Peak Output Power, Limit: Max. 24 dBm | Pass | Meets the requirement of the limit. |
| FCC 15.209<br>RSS-Gen, 8.9<br>RSS-247, 5.5 | Transmitter Radiated Emissions | Pass | Meets the requirement of the limit. |
| FCC 15.247(a) (1) (i)<br>RSS-247, 5.1(c) | Frequency hopping system,<br>Limit: Max. 0.4 Seconds in 10 Second Period | Pass | Meets the requirement of the limit. |
| FCC 15.209, 15.205,15.247<br>RSS-Gen, 8.9<br>RSS-247, 5.5 | Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency | Pass | Meets the requirement of the limit. |
| FCC 15.207<br>RSS-Gen. 8.8 | Conducted AC Emissions | NA | Battery Powered Equipment |

# 2.0 EUT DESCRIPTION

## 2.1 EQUIPMENT UNDER TEST

The Equipment Under Test (EUT) was a wireless FHSS transmitter, EN1262HT.

| | |
|---|---|
| EUT | EN1262HT |
| EUT Received | 1/25/2022 |
| EUT Tested | 2/4/2022- 2/24/2022 |
| Serial No./ Tx ID | 4216874 |
| Operating Band | 902.0 – 928.0 MHz |
| Device Type | FHSS |
| Power Supply | 3VDC (2xAA (Lithium)) |

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

## 2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

| Channel | Frequency |
|---|---|
| Low | 902.4 |
| Middle | 914.8 |
| High | 927.6 |

These are the only three 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.

EUT was modified to transmit at the highest practical duty cycle on the lowest, highest and one channel in the middle that was used for all RF tests.

## 2.3 DESCRIPTION OF SUPPORT UNITS

N/A

# 3.0 LABORATORY 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 |
| CAB MRA Recognition 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 | Nic Johnson | Technical Manager | Review |
| 2 | Karthik Vepuri | EMC Test Engineer | Testing and Report |
| 3 | Fox Lane | EMC Test Engineer | Testing |
| 4 | Blake Winter | EMC Test Engineer | Testing |

**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 21, 2021 | July 21, 2023 |
| Keysight MXE Signal Analyzer (26.5GHz) | N9038A | MY56400083 | May 5, 2020 | May 5, 2022 |
| Keysight EXA Signal Analyzer | N9010A | MY56070862 | July 20, 2021 | July 20, 2023 |
| SunAR RF Motion | JB1 | A091418 | July 27, 2021 | July 27, 2022 |
| EMCO Horn Antenna | 3115 | 6415 | March 16, 2020 | March 16, 2022 |
| 8447F POT H64 Preamplifier* | 8447F POT H64 | 3113AD4667 | February 1, 2021 | February 1, 2023 |
| Rohde & Schwarz Preamplifier* | TS-PR18 | 3545700803 | April 14, 2020 | April 14, 2022 |
| Trilithic High Pass Filter* | 6HC330 | 23042 | April 14, 2020 | April 14, 2022 |
| MiniCircuits High Pass Filter* | VHF-1320+ | 15542 | April 14, 2020 | April 14, 2022 |
| ETS – Lindgren- VSWR on 10m Chamber | 10m Semi-anechoic chamber-VSWR | 4740 Discovery Drive | July 30, 2020 | July 30, 2023 |
| NCEE Labs-NSA on 10m Chamber | 10m Semi-anechoic chamber-NSA | NCEE-001 | October 25, 2019 | October 25, 2022 |
| TDK Emissions Lab Software | V11.25 | 700307 | NA | NA |
| RF Cable (preamplifier to antenna)* | MFR-57500 | 01-07-002 | April 14, 2020 | April 14, 2022 |
| RF Cable (antenna to 10m chamber bulkhead)* | FSCM 64639 | 01E3872 | September 24, 2021 | September 24, 2023 |
| RF Cable (10m chamber bulkhead to control room bulkhead)* | FSCM 64639 | 01E3864 | September 24, 2021 | September 24, 2023 |
| RF Cable (control room bulkhead to test receiver)* | FSCM 64639 | 01F1206 | September 24, 2021 | September 24, 2023 |
| N connector bulkhead (10m chamber)** | PE9128 | NCEEBH1 | September 24, 2021 | September 24, 2023 |
| N connector bulkhead (control room)** | PE9128 | NCEEBH2 | September 24, 2021 | September 24, 2023 |

*Internal Characterization

**2 year calibration cycle

**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.

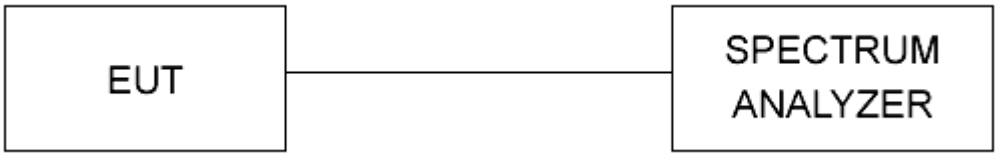



**Figure 1 - Bandwidth Measurements Test Setup**

## 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.

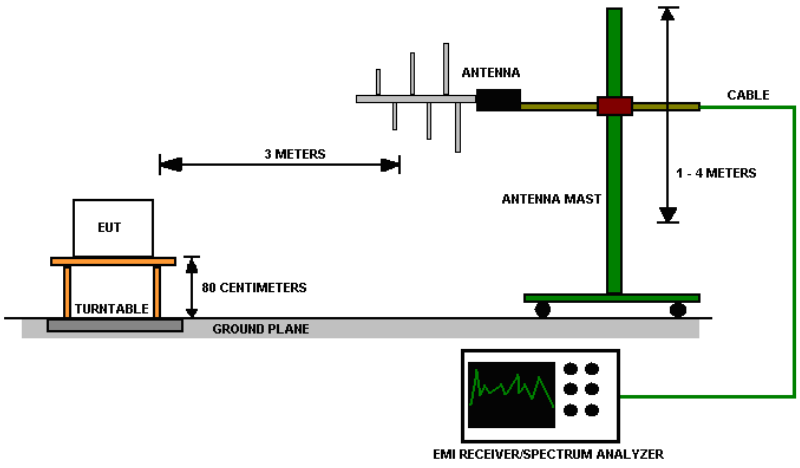



**Figure 2 - Radiated Emissions Test Setup**

## 4.0 DETAILED RESULTS

| DSS Radiated Radio Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **CHANNEL** | **Transmitter** | **99% Occupied Bandwidth (kHz)** | **20 dB Bandwidth (kHz)** | **PEAK EIRP (dBm)** | **PEAK EIRP (mW)** | **RESULT** | No. of Hopping Channels | Time of Occupancy* |
| | | | | | | | 25 | **0.0876** s* |
| Low | Continuous | 251.21 | 302.70 | 13.681 | 23.340 | PASS | Min Frequency Separation | Duty Cycle Correction |
| Mid | Continuous | 250.93 | 302.00 | 14.259 | 26.662 | PASS | | |
| High | Continuous | 250.74 | 302.10 | 19.348 | 86.060 | PASS | 804 kHz | -13.31 |
| Occupied Bandwidth = N/A; 20 dB Bandwidth Limit 250 kHz ≤ BW ≤ 500 kHz. | | | | Peak Output Power Limit = 24 dBm; corrections can be found in the last table of this section and in the graphs in Appendix C. | | | | |
| | | | | Time of Occupancy<0.4 S in 10 S | | | | |
| | | | | *Manufacturer declares that the worst-case average channel occupancy time is 0.0876 s within any 10 second period. | | | | |

| Unrestricted Band-Edge | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CHANNEL** | **Mode** | **Band edge /Measurement Frequency (MHz)** | **Relative Highest out of band level (dBuV/m)** | **Relative Fundamental (dBuV/m)** | **Delta (dB)** | **Min Delta (dB)** | **Result** |
| Low | Continuous | 902.4 | 70.136 | 107.009 | 36.873 | 20 | PASS |
| Low* | Hopping | 902.4 | 49.485 | 86.729 | 37.244 | 20 | PASS |
| High | Continuous | 927.6 | 76.502 | 112.597 | 36.095 | 20 | PASS |
| High | Hopping | 927.6 | 73.099 | 110.702 | 37.603 | 20 | PASS |
| *Measurement was taken in dBm and converted to dBuV using: dBuV = dBm +107 | | | | | | | |

| 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 | Continuous | 610.916 | 32.57 | Radiated | 46.02 | 13.450 | PASS |
| Low | Hopping | 609.512 | 32.82 | Radiated | 46.02 | 13.200 | PASS |
| High | Continuous | 964.84 | 48.333 | Radiated | 53.98 | 8.612 | PASS |
| High | Hopping | 965.92 | 45.368 | Radiated | 53.98 | 5.647 | PASS |
| *Limit shown is the peak limit taken from FCC Part 15.209 | | | | | | | |

| Corrections and Raw Values for EIRP | | | | | |
|---|---|---|---|---|---|
| **Channel** | **Antenna Factor (dB)** | **Cable Loss (dB)** | **dBm to dBuV** | **EIRP Conversion from 3m** | **Correction/Reference level offset** |
| Low | 26.50 | 5.32 | 107 | 95.23 | 43.59 |
| Mid | 26.64 | 5.39 | 107 | 95.23 | 43.80 |
| High | 26.60 | 5.43 | 107 | 95.23 | 43.80 |
| EIRP (dBm) at 3 m test distance = Uncorrected Level (dBm) - 95.23 +107+Antenna Factor+ Cable | | | | | |

## 4.1 DUTY CYCLE

Manufacturer declared that the maximum on time possible per channel is 21.6 ms in a given 100 ms period. So, Duty cycle correction factor for spurious emissions related to the transmitter is 20 log 21.6/100 = -13.31 dB.

## 4.2 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.

**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 form 30MHz-1GHz and 1.5m for measurements from 1GHz to 10 GHz.

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.

**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.

**Test setup:**

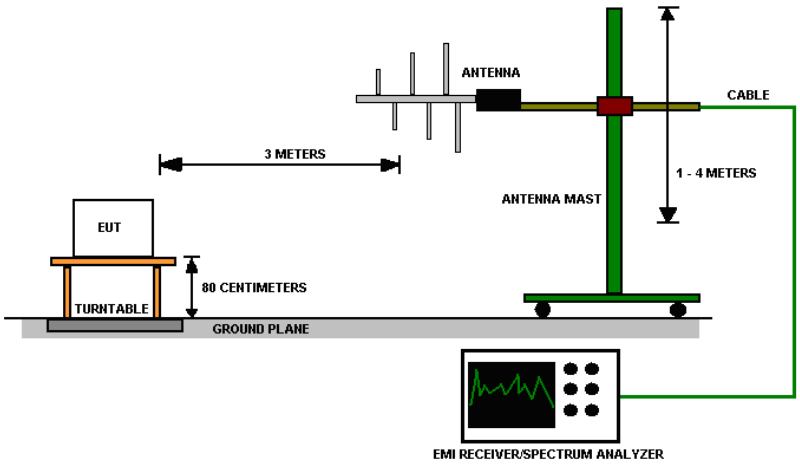



**Figure 3 - Radiated Emissions Test Setup**

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

**Test results:**

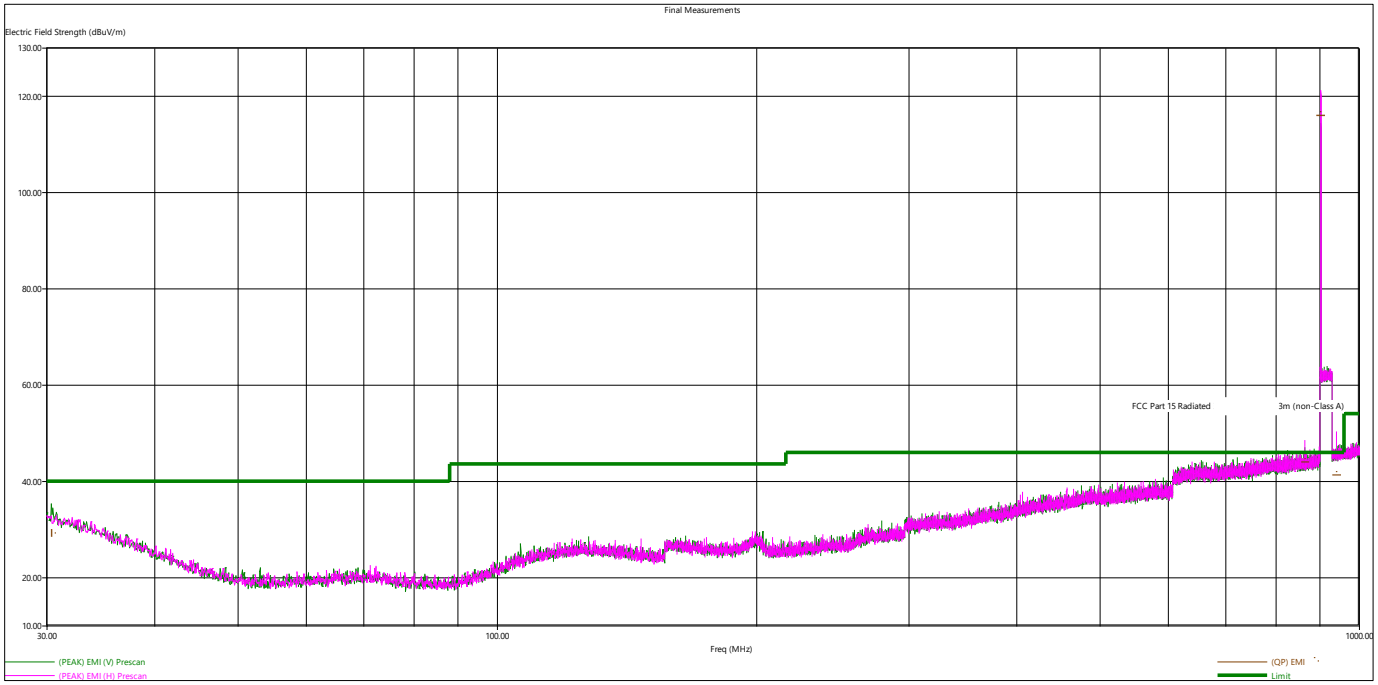



**Figure 4 - Radiated Emissions Plot, Low Channel, 30 MHz-1GHz**

*Noise floor on this plot looks higher than the other plots because of the receiver settings during the test to avoid saturation. The worst-case measurements are listed in the tables below, all other measurements were found to be at least 6 dB below the limit.

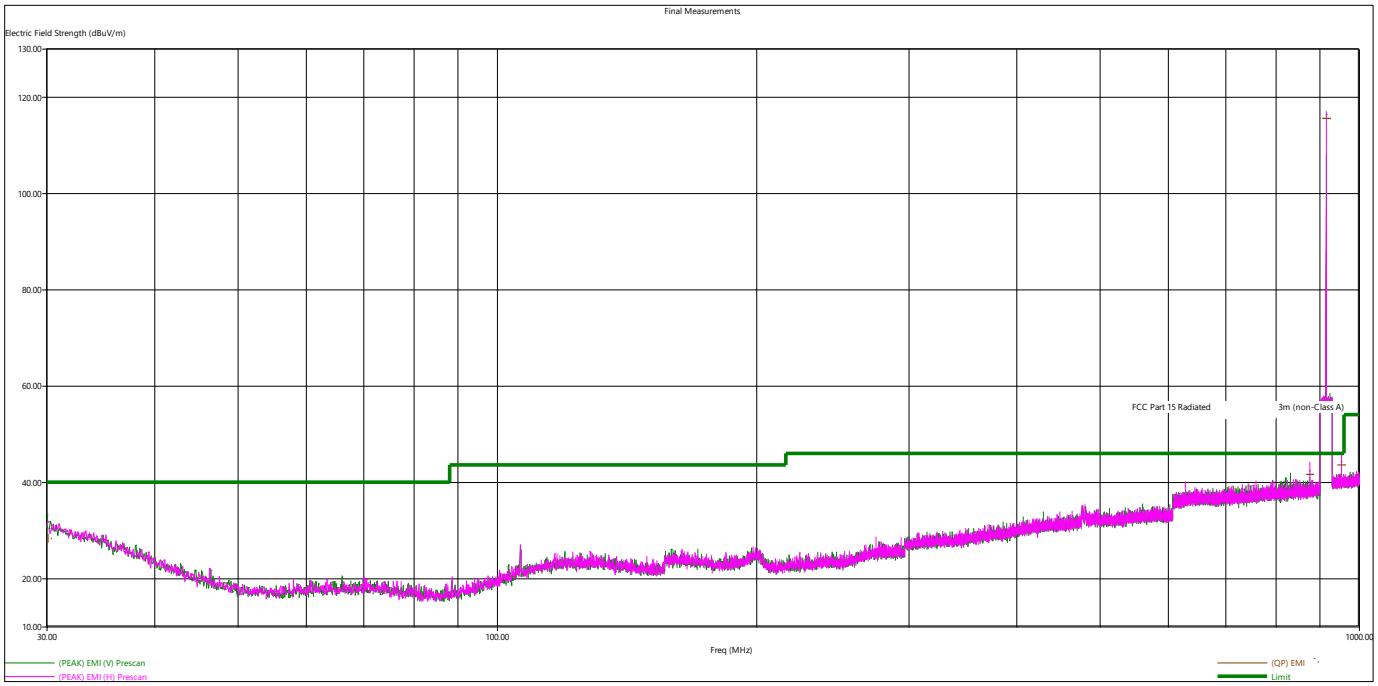



**Figure 5 - Radiated Emissions Plot, Mid Channel, 30 MHz-1GHz**

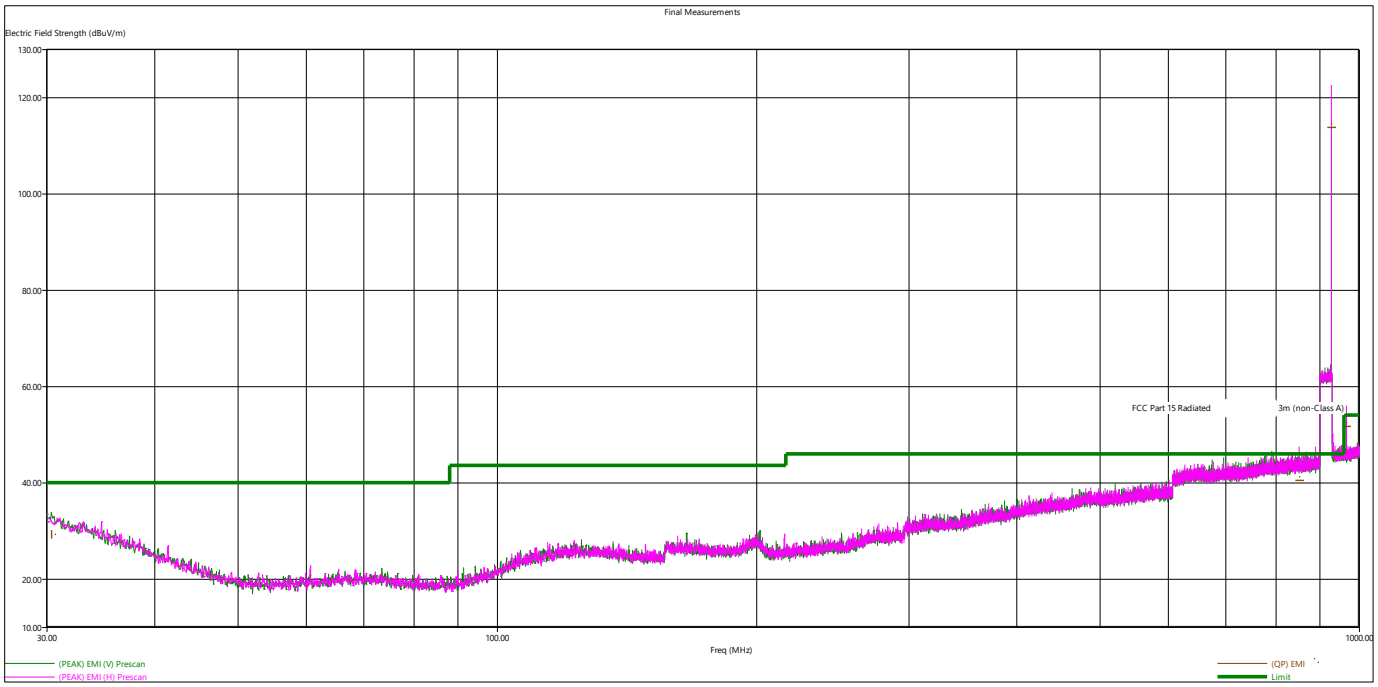



**Figure 6 - Radiated Emissions Plot, High Channel, 30 MHz-1GHz**

*Noise floor on this plot looks higher than the other plots because of the receiver settings during the test to avoid saturation. The worst-case measurements are listed in the tables below, all other measurements were found to be at least 6 dB below the limit.

| Quasi Peak Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frequency | Level | Limit | Margin | Height | Angle | Pol | Channel | Radio Band |
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | | MHz |
| 863.94456 | 43.85 | 46.02 | 2.17 | 192 | 256 | H | Low | 902-928 |
| 30.51504 | 29.09 | 40 | 10.91 | 349 | 269 | V | Low | 902-928 |
| 940.63512 | 41.22 | 46.02 | 4.80 | 340 | 1 | H | Low | 902-928 |
| 876.38016 | 41.45 | 46.02 | 4.57 | 176 | 117 | H | Mid | 902-928 |
| 30.11952 | 28.16 | 40 | 11.84 | 304 | 176 | V | Mid | 902-928 |
| 953.154 | 43.46 | 46.02 | 2.56 | 106 | 282 | H | Mid | 902-928 |
| 850.98576 | 40.22 | 46.02 | 5.80 | 202 | 9 | H | High | 902-928 |
| 30.52008 | 29.06 | 40 | 10.94 | 395 | 246 | V | High | 902-928 |
| 965.9904 | 51.48 | 53.98 | 2.50 | 108 | 66 | H | High | 902-928 |

The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions. The worst-case emissions are reported. Manufacturer declared that the EUT doesn't have receive capabilities.

| Peak Measurements, 900 MHz Radio, | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frequency | Level | Limit | Margin | Height | Angle | Pol | Channel | Radio Band |
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | | MHz |
| 2707.058000 | 48.92 | 73.98 | 25.06 | 484 | 358 | H | Low | 900 -928 |
| 1804.712000 | 61.15 | 73.98 | 12.83 | 549 | 110 | V | Low | 900 -928 |
| 3609.672000 | 51.71 | 73.98 | 22.27 | 237 | 199 | V | Low | 900 -928 |
| 6316.712000 | 52.10 | 73.98 | 21.88 | 466 | 78 | V | Low | 900 -928 |
| 9021.618000 | 52.47 | 73.98 | 21.51 | 219 | 358 | V | Low | 900 -928 |
| 1829.524000 | 63.07 | 73.98 | 10.91 | 528 | 352 | H | Mid | 900 -928 |
| 2744.280000 | 48.50 | 73.98 | 25.48 | 286 | 34 | V | Mid | 900 -928 |
| 9148.312000 | 53.07 | 73.98 | 20.91 | 347 | 61 | H | Mid | 900 -928 |
| 3659.150000 | 53.25 | 73.98 | 20.73 | 310 | 205 | V | Mid | 900 -928 |
| 6403.598000 | 52.11 | 73.98 | 21.87 | 353 | 90 | V | Mid | 900 -928 |
| 1855.206000 | 64.91 | 73.98 | 9.07 | 500 | 207 | H | High | 900 -928 |
| 2782.634000 | 47.27 | 73.98 | 26.71 | 246 | 41 | V | High | 900 -928 |
| 3710.372000 | 52.75 | 73.98 | 21.23 | 439 | 18 | V | High | 900 -928 |
| 5565.768000 | 52.43 | 73.98 | 21.55 | 528 | 105 | V | High | 900 -928 |
| 9275.762000 | 50.62 | 73.98 | 23.36 | 194 | 212 | V | High | 900 -928 |

| Average Measurements, 900 MHz Radio, | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Frequency** | **Level** | **Limit** | **Margin** | **Height** | **Angle** | **Pol** | **Channel** | **Radio Band** |
| **MHz** | **dBµV/m** | **dBµV/m** | **dB** | **cm.** | **deg.** | | | **MHz** |
| 2707.058000 | 35.61 | 53.98 | 18.37 | 484 | 358 | H | Low | 900 -928 |
| 1804.712000 | 47.84 | 53.98 | 6.14 | 549 | 110 | V | Low | 900 -928 |
| 3609.672000 | 38.40 | 53.98 | 15.58 | 237 | 199 | V | Low | 900 -928 |
| 6316.712000 | 38.79 | 53.98 | 15.19 | 466 | 78 | V | Low | 900 -928 |
| 9021.618000 | 39.16 | 53.98 | 14.82 | 219 | 358 | V | Low | 900 -928 |
| 1829.524000 | 49.76 | 53.98 | 4.22 | 528 | 352 | H | Mid | 900 -928 |
| 2744.280000 | 35.19 | 53.98 | 18.79 | 286 | 34 | V | Mid | 900 -928 |
| 9148.312000 | 39.76 | 53.98 | 14.22 | 347 | 61 | H | Mid | 900 -928 |
| 3659.150000 | 39.94 | 53.98 | 14.04 | 310 | 205 | V | Mid | 900 -928 |
| 6403.598000 | 38.80 | 53.98 | 15.18 | 353 | 90 | V | Mid | 900 -928 |
| 1855.206000 | 51.60 | 53.98 | 2.38 | 500 | 207 | H | High | 900 -928 |
| 2782.634000 | 33.96 | 53.98 | 20.02 | 246 | 41 | V | High | 900 -928 |
| 3710.372000 | 39.44 | 53.98 | 14.54 | 439 | 18 | V | High | 900 -928 |
| 5565.768000 | 39.12 | 53.98 | 14.86 | 528 | 105 | V | High | 900 -928 |
| 9275.762000 | 37.31 | 53.98 | 16.67 | 194 | 212 | V | High | 900 -928 |
| Average Level is obtained by adding the duty cycle correction factor found in section 4.1 to the Peak level. All the measurements were compared to general limits from FCC part 15.209 to show compliance. | | | | | | | | |

**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 other emission levels were very low against the limit.
4. Margin value = Limit Value – Emission Level.
5. The EUT was measured in all 3 orthogonal axes. See the test setup photo exhibit for details on the orientations.

## 4.3 PEAK OUTPUT POWER

**Test Method:** ANSI C63.10, Section(s) 7.8.5

**Limits of bandwidth measurements:**
**Per FCC Part 15**
For an FHSS system with 25 channels, the output power is required to be less than 250 mW or 24 dBm.

**Test procedures:**
Spectrum analyzer was set with a resolution bandwidth greater than occupied bandwidth and centered on the operating channel. Output power was measured radiated as EIRP.

**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.

## 4.4 BANDWIDTH

**Test Method:** ANSI C63.10, Section(s) 6.9.2

**Limits of bandwidth measurements:**
The allowed 20 dB bandwidth of the hopping channel is 250 kHz ≤ BW ≤ 500 kHz.

**Test procedures:**
The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW and 30 kHz VBW.

The 20 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 20dB.
The 99% bandwidth is defined as the bandwidth that contains 99% of the power.

**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 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.

## 4.5 BANDEDGES

**Test Method**: ANSI C63.10, Section(s) 6.10.6

**Limits of band edge measurements:**
For emissions outside of the allowed band of operation (902 – 928MHz), 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 resolution bandwidth was set to 100kHz and the EMI receiver was used to scan from the band edge to the fundamental frequency with a Peak detector. The highest emissions level beyond the band edge was measured and recorded. For restricted band edge measurements, the unit was tested to the same method as section 4.2 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 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 CARRIER FREQUENCY SEPARATION, NUMBER OF HOPPING CHANNELS, TIME OF OCCUPANCY

**Test Method**: ANSI C63.10, Section 7.8.2, 7.8.3, 7.8.4

**Limits for Time of Occupancy**

Average time of occupancy on any frequency, not to exceed 0.4 seconds within a 10 second period.

**Test procedures:**
The method from KDB 558074 D01 v05;

**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 plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are reported on the graph.
4. **Declaration from manufacturer:** The EchoStream protocol defines 64 channels spaced 400 kHz apart. Manufacturer uses only 25 channels from the set of 64. The minimum spacing between channels is ~ 800 kHz with some channels space ~1.2 MHz apart. The entire channel map uses a spacing of 400 kHz, but the used channels are either 800 kHz or 1.2 MHz apart.

## 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

where 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*

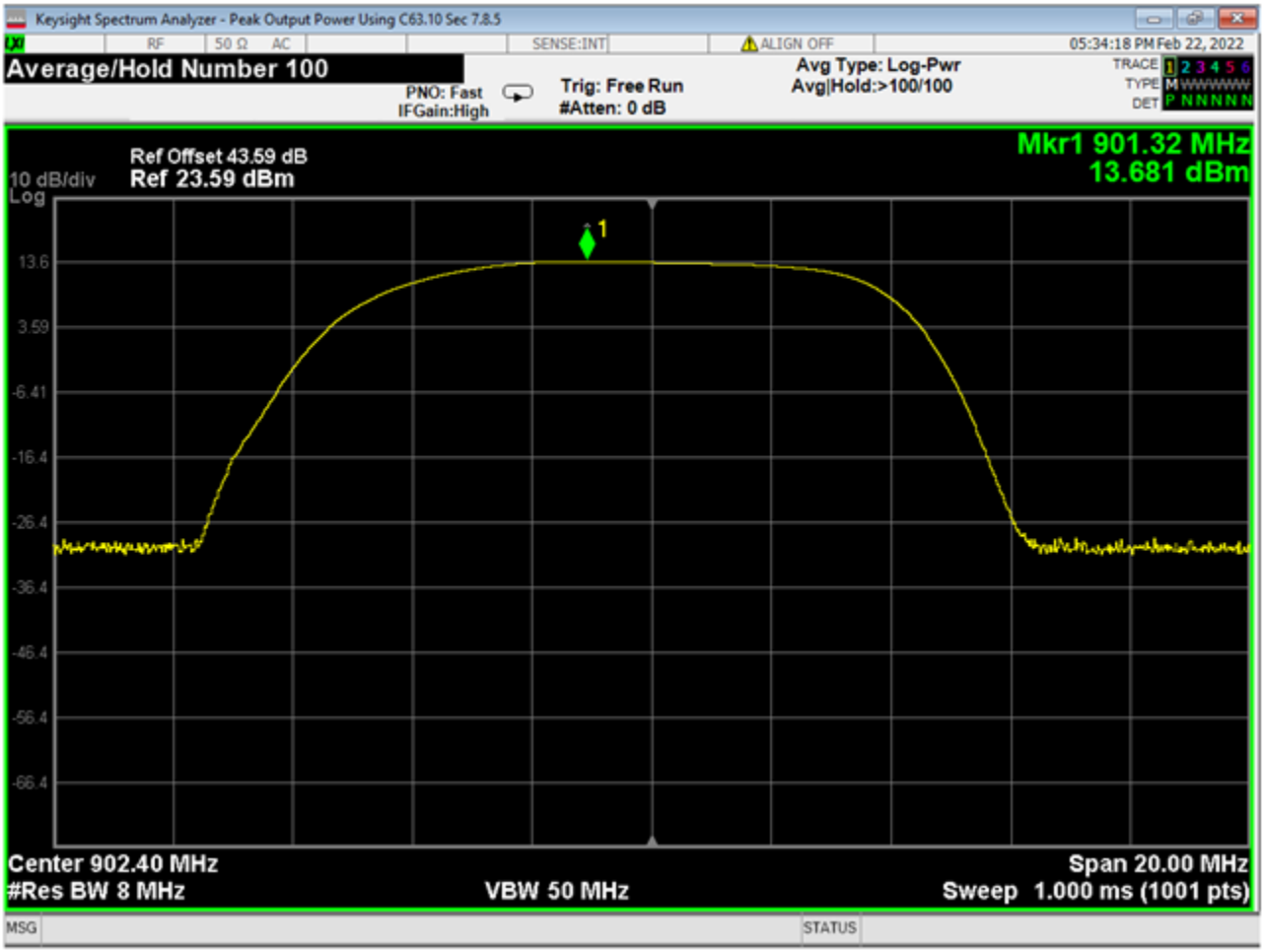
## APPENDIX B – MEASUREMENT UNCERTAINTY

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

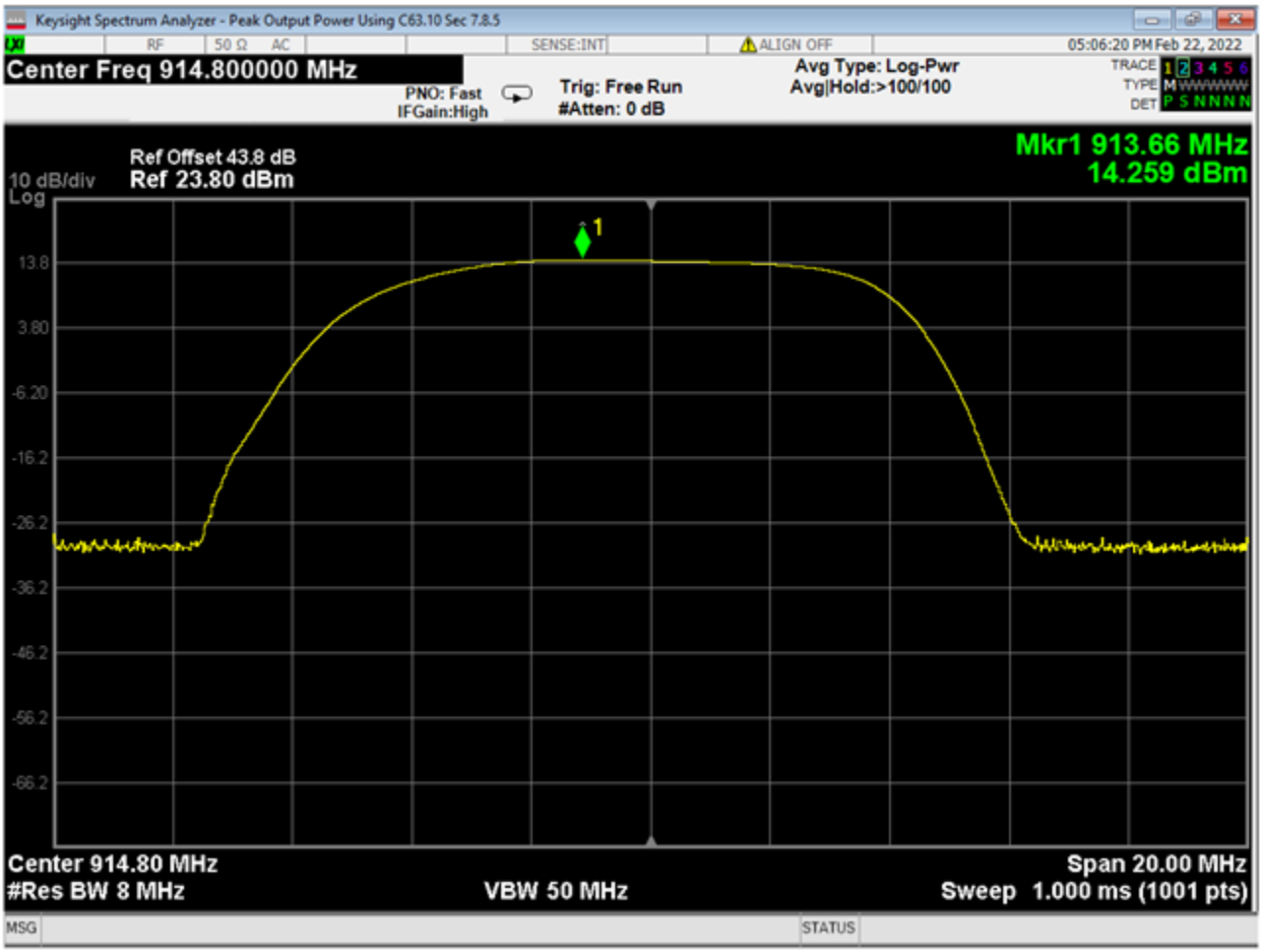
| Test | Frequency Range | Uncertainty Value (dB) |
|---|---|---|
| Radiated Emissions, 3m | 30MHz - 1GHz | 3.82 |
| Radiated Emissions, 3m | 1GHz - 18GHz | 4.44 |
| Emissions limits, conducted | 30MHz – 18GHz | ±3.30 dB |

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

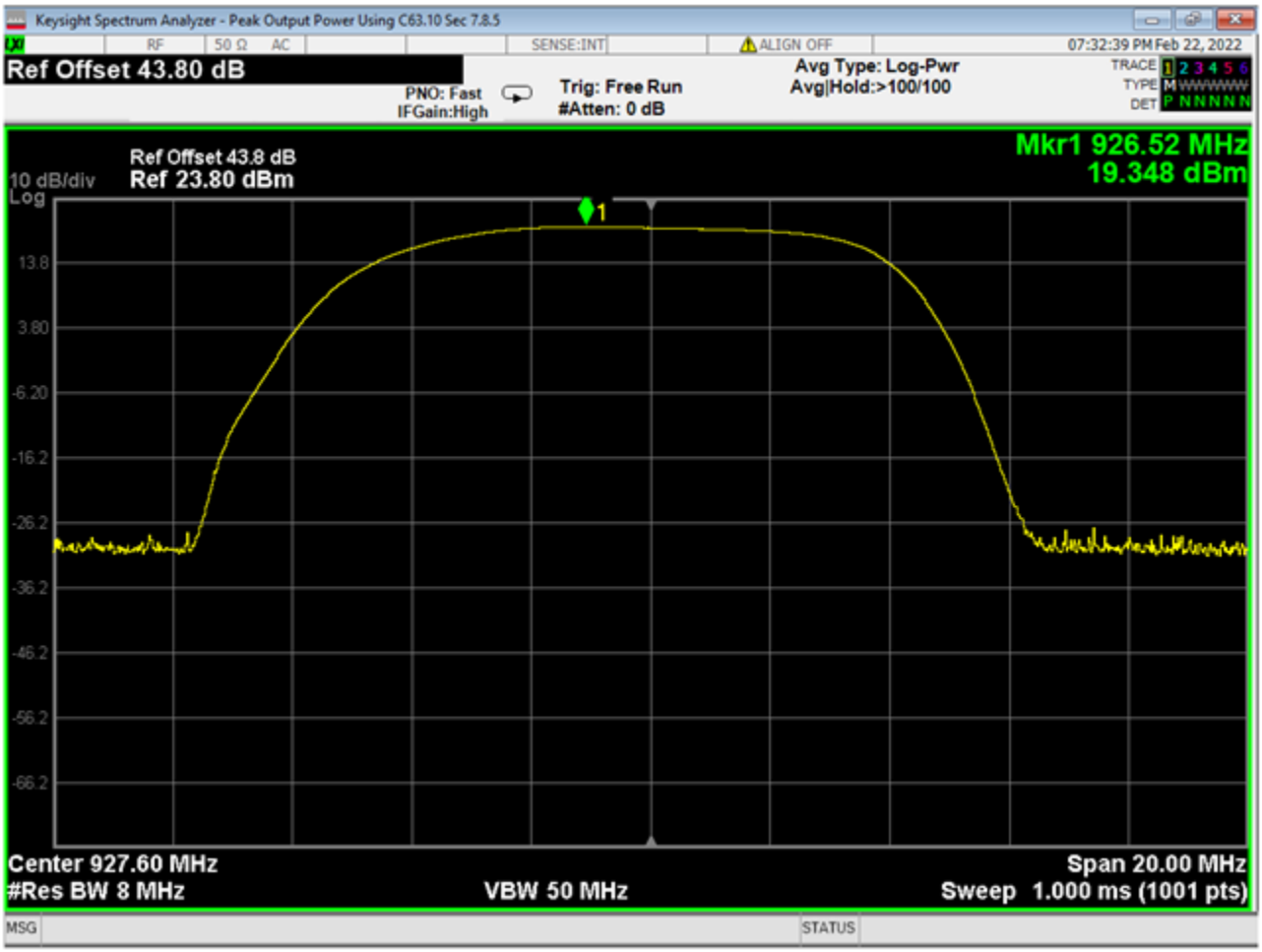
## APPENDIX C – GRAPHS AND TABLES



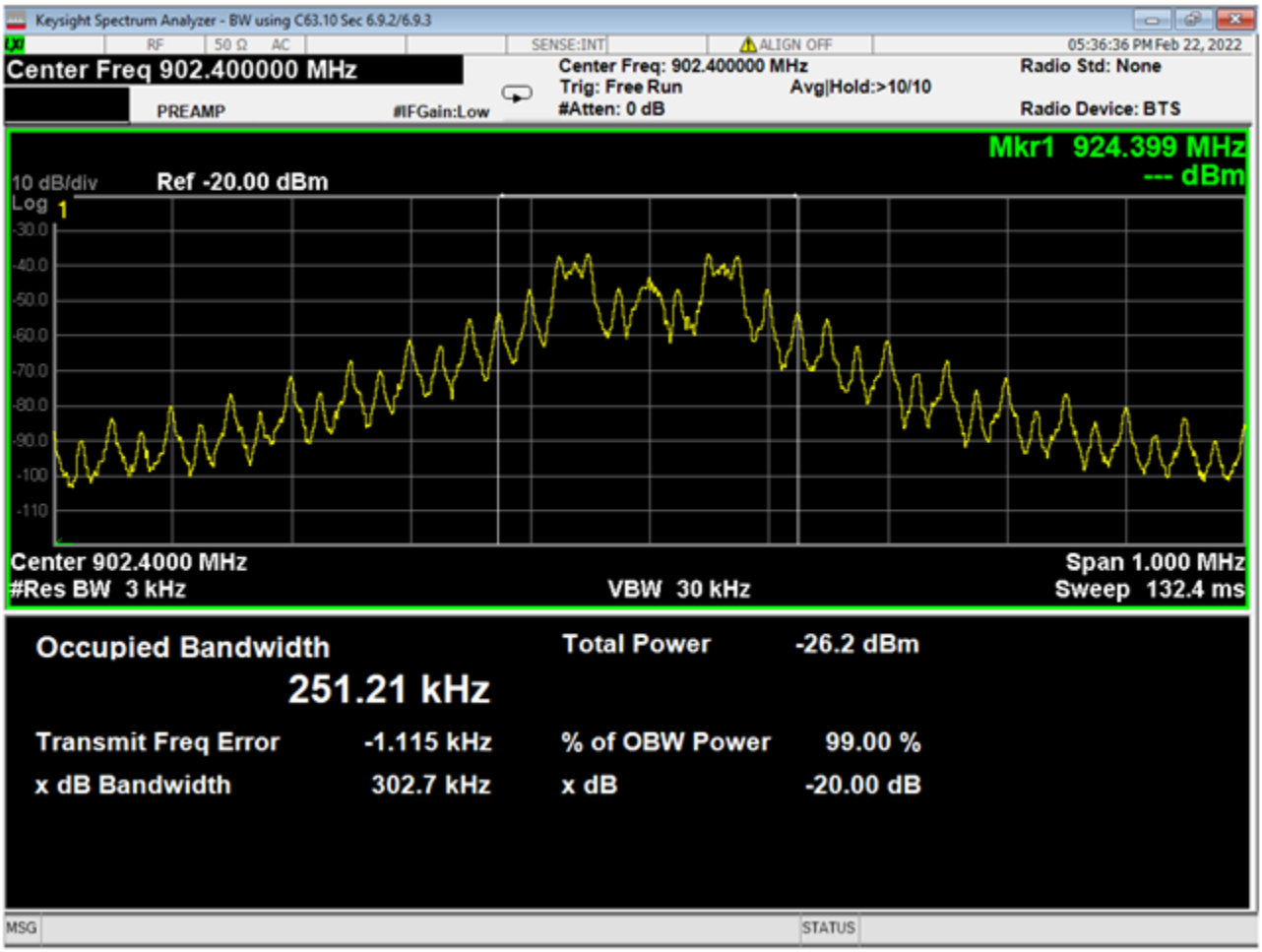

**01 EIRP Low Channel with correction**



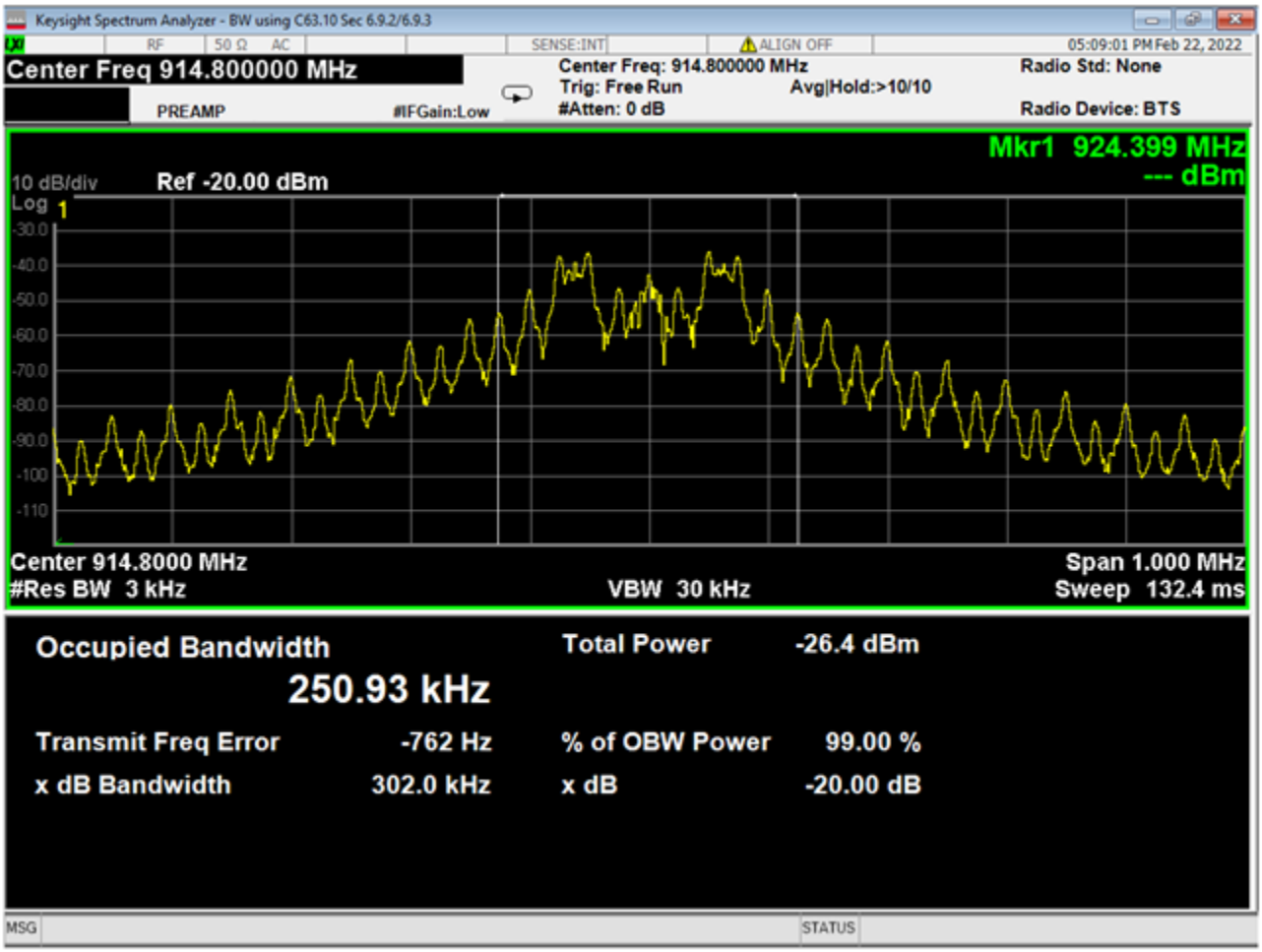

**02. EIRP Mid Channel with corrections**



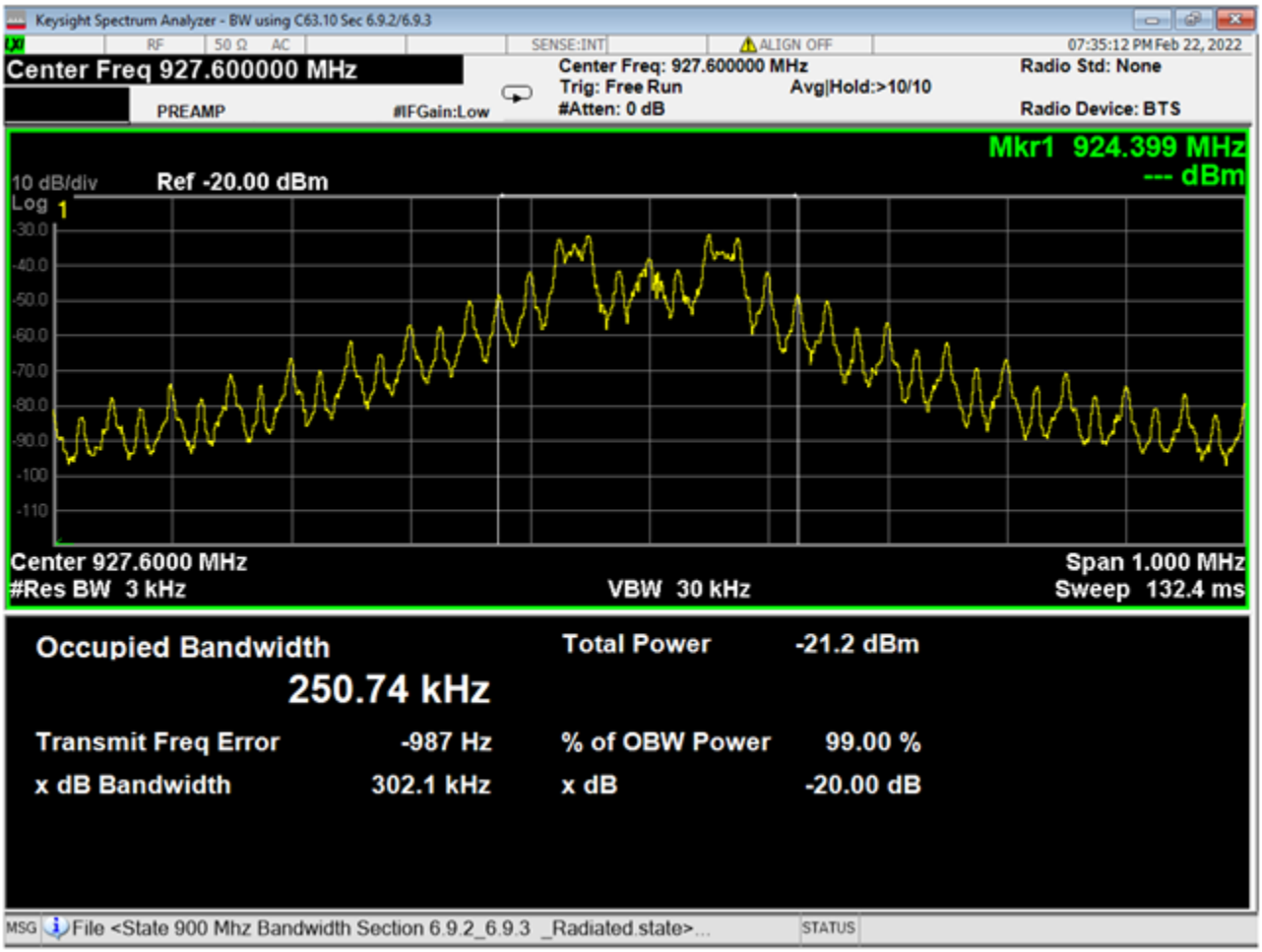

**03 EIRP High Channel with correction**



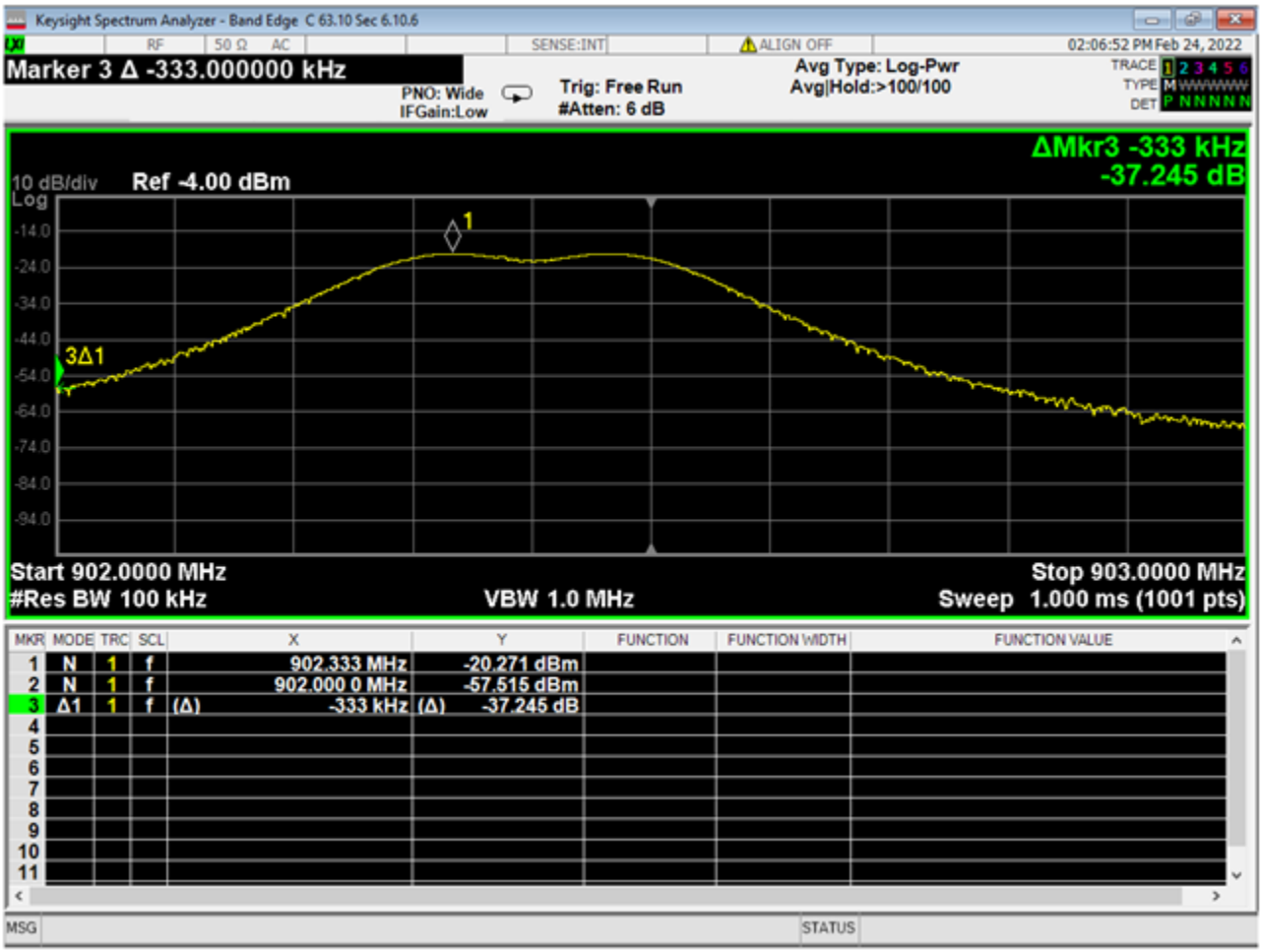

**04 Bandwidth Low Channel**




**05. Bandwidth Mid Channel**

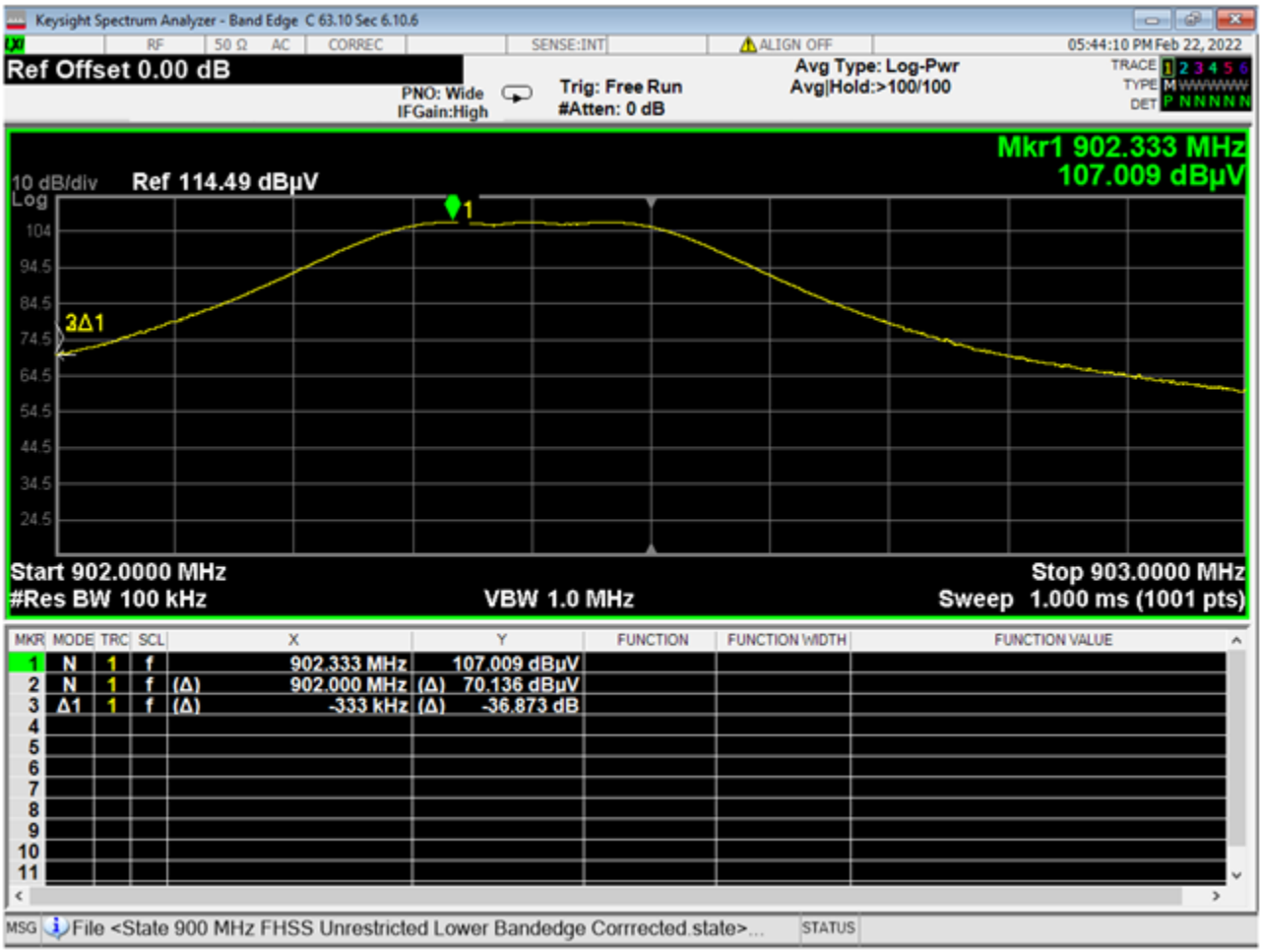



**06 Bandwidth High Channel**

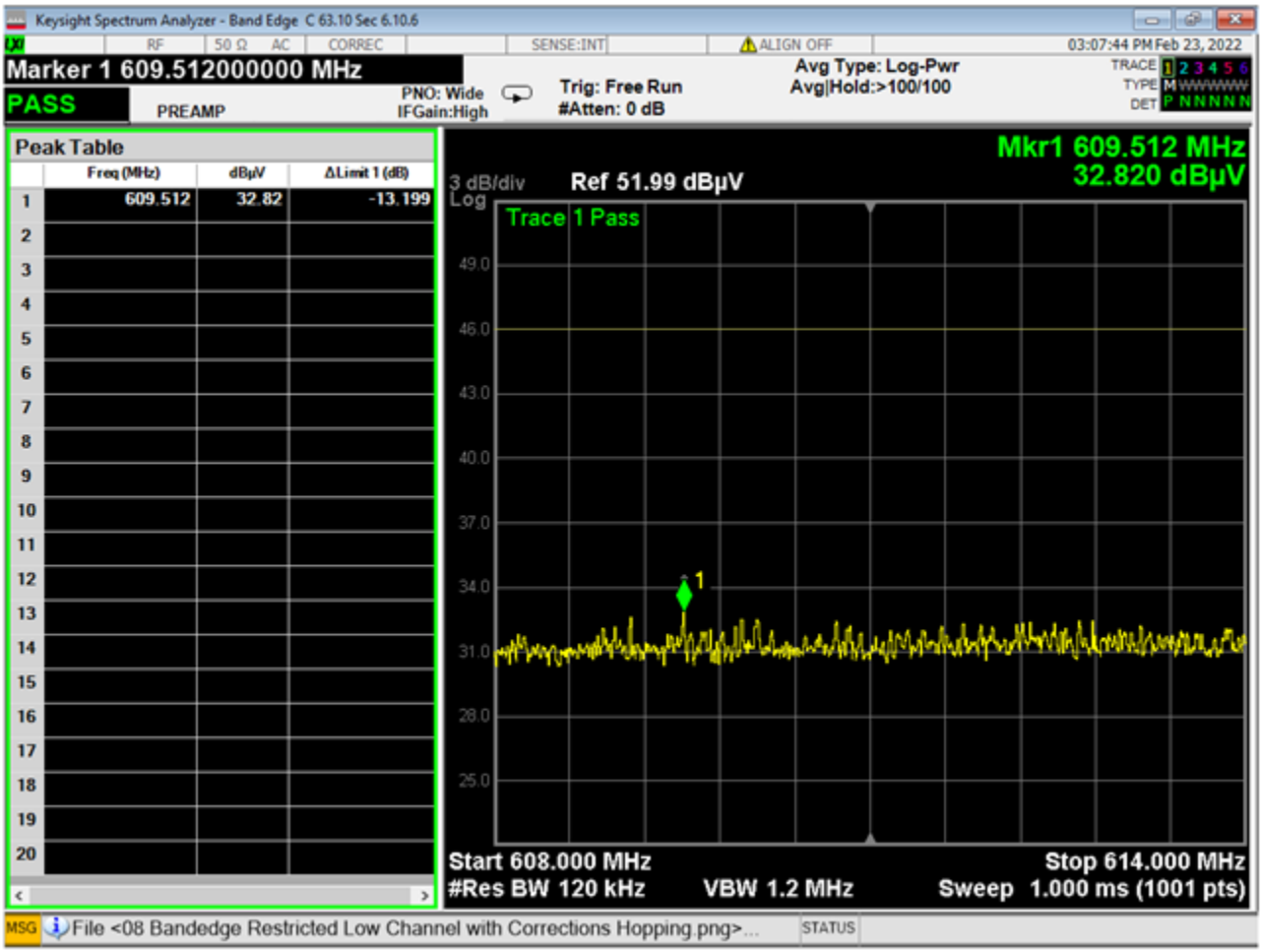



**07 Bandedge Unrestricted Low Channel Hopping**

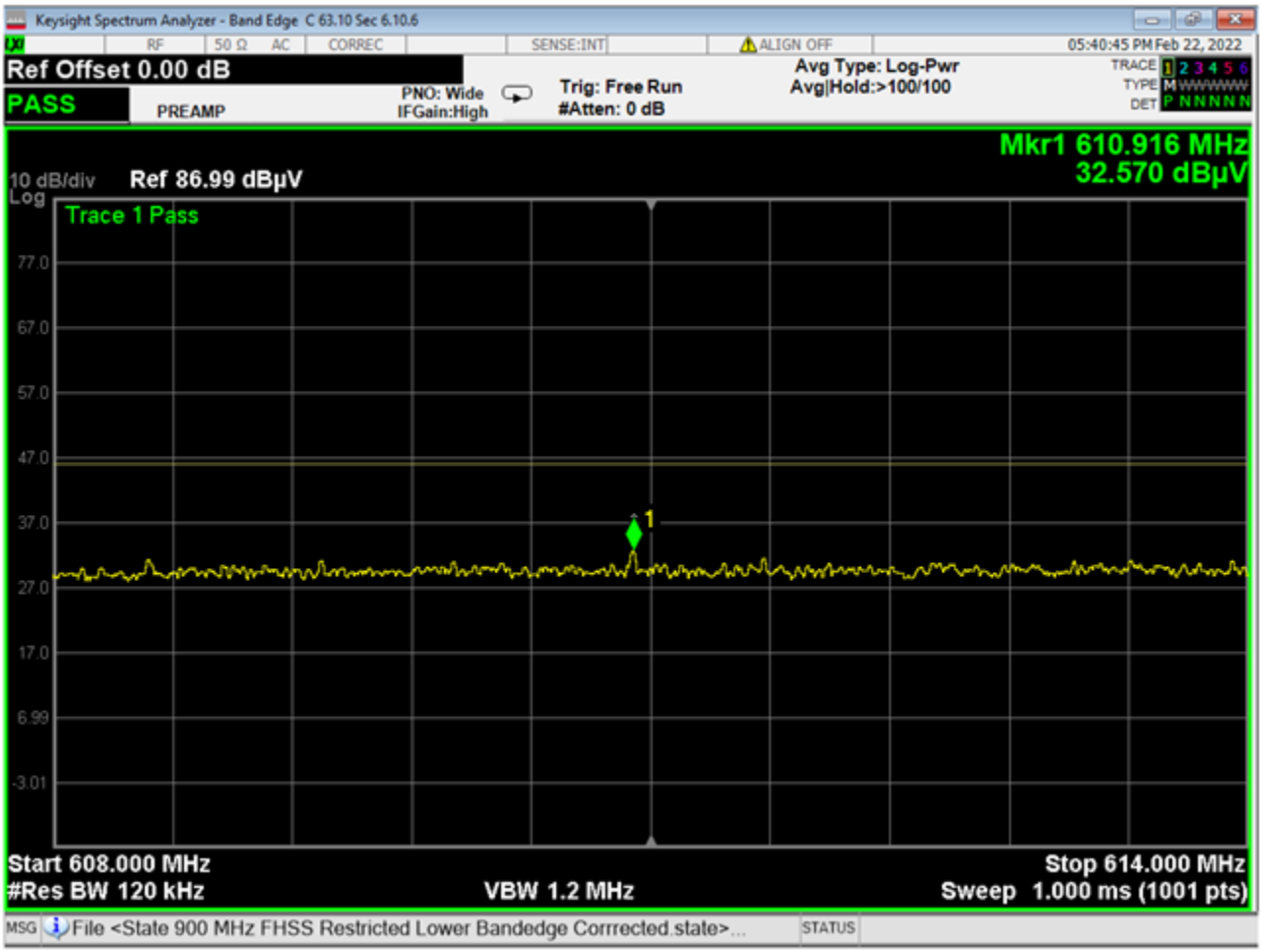
Measurement was taken in dBm and converted to dBuV using: dBuV = dBm +107, in results table. eg: -20.271+107=86.729.



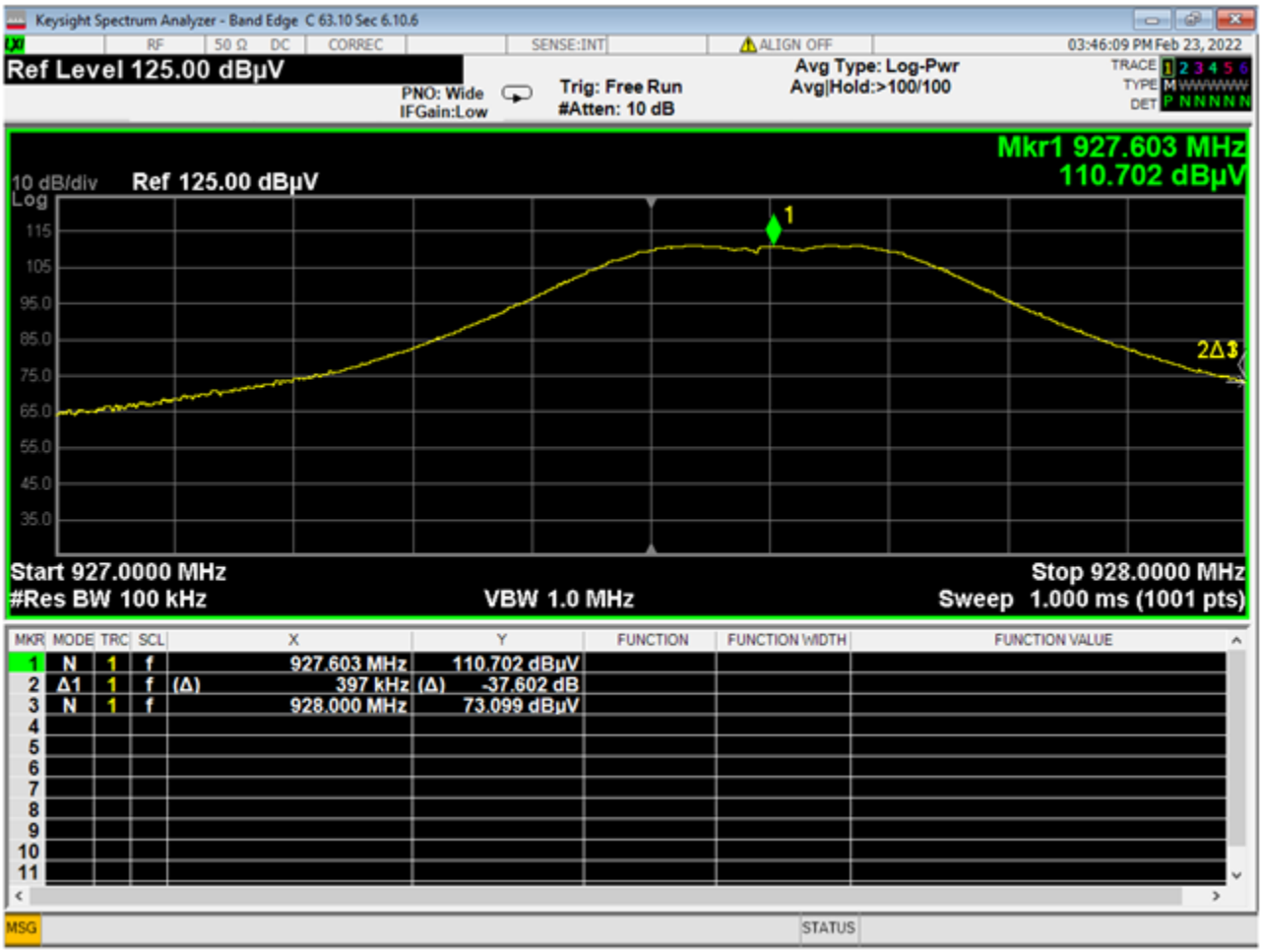

**07 Bandedge Unrestricted Low Channel Relative**



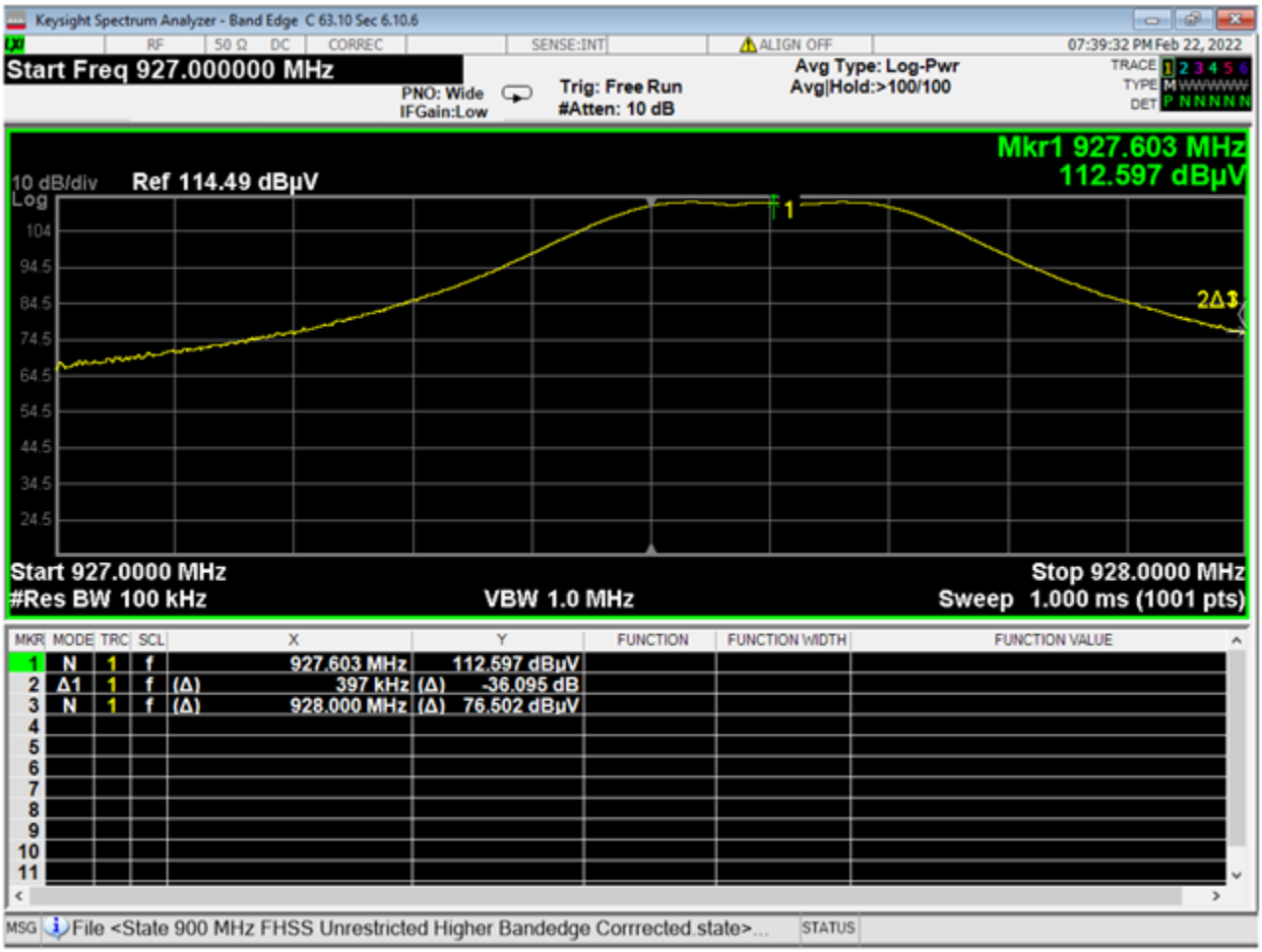

**08 Bandedge Restricted Low Channel with Corrections Hopping**



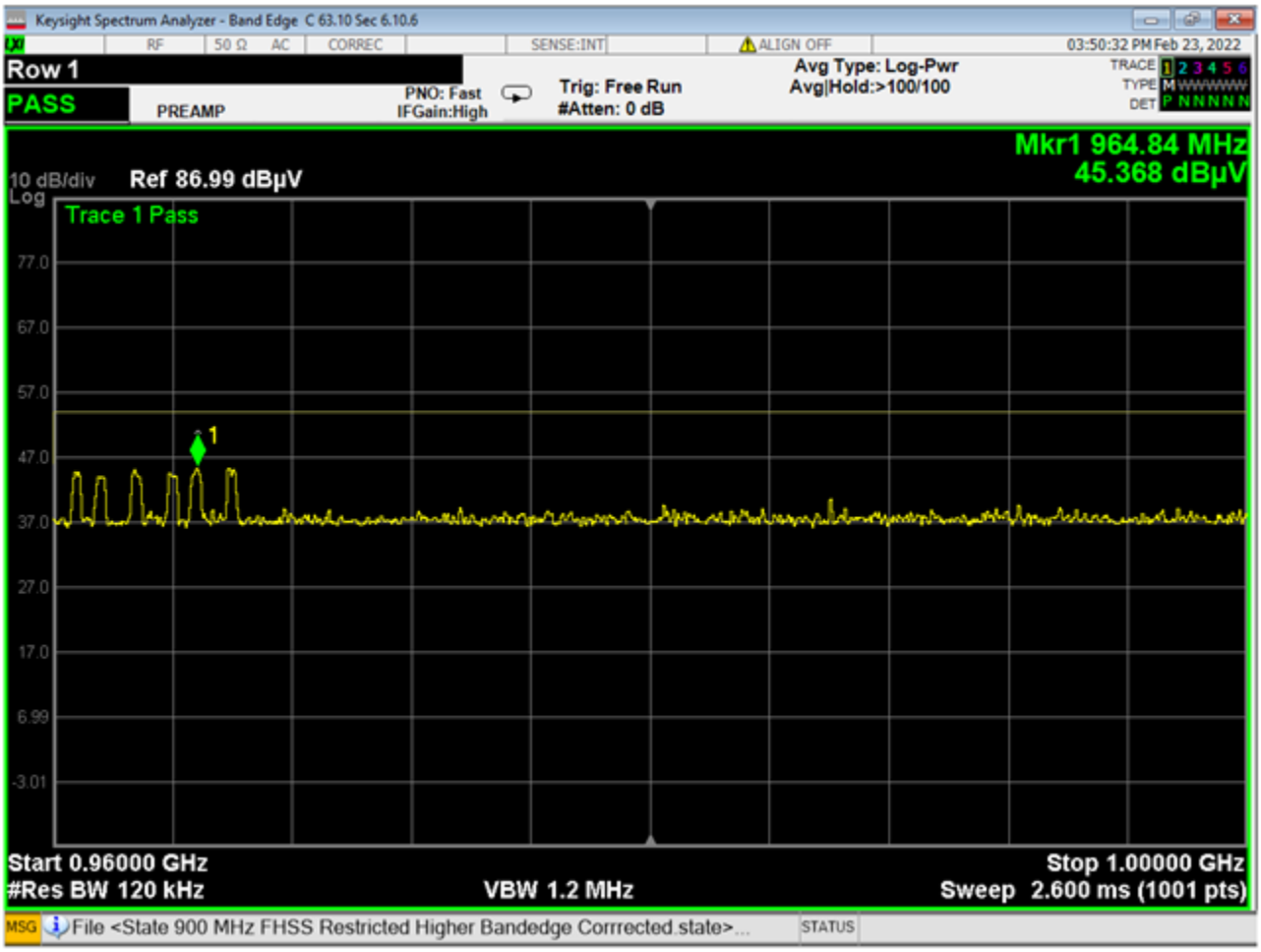

**08 Bandedge Restricted Low Channel with Corrections**



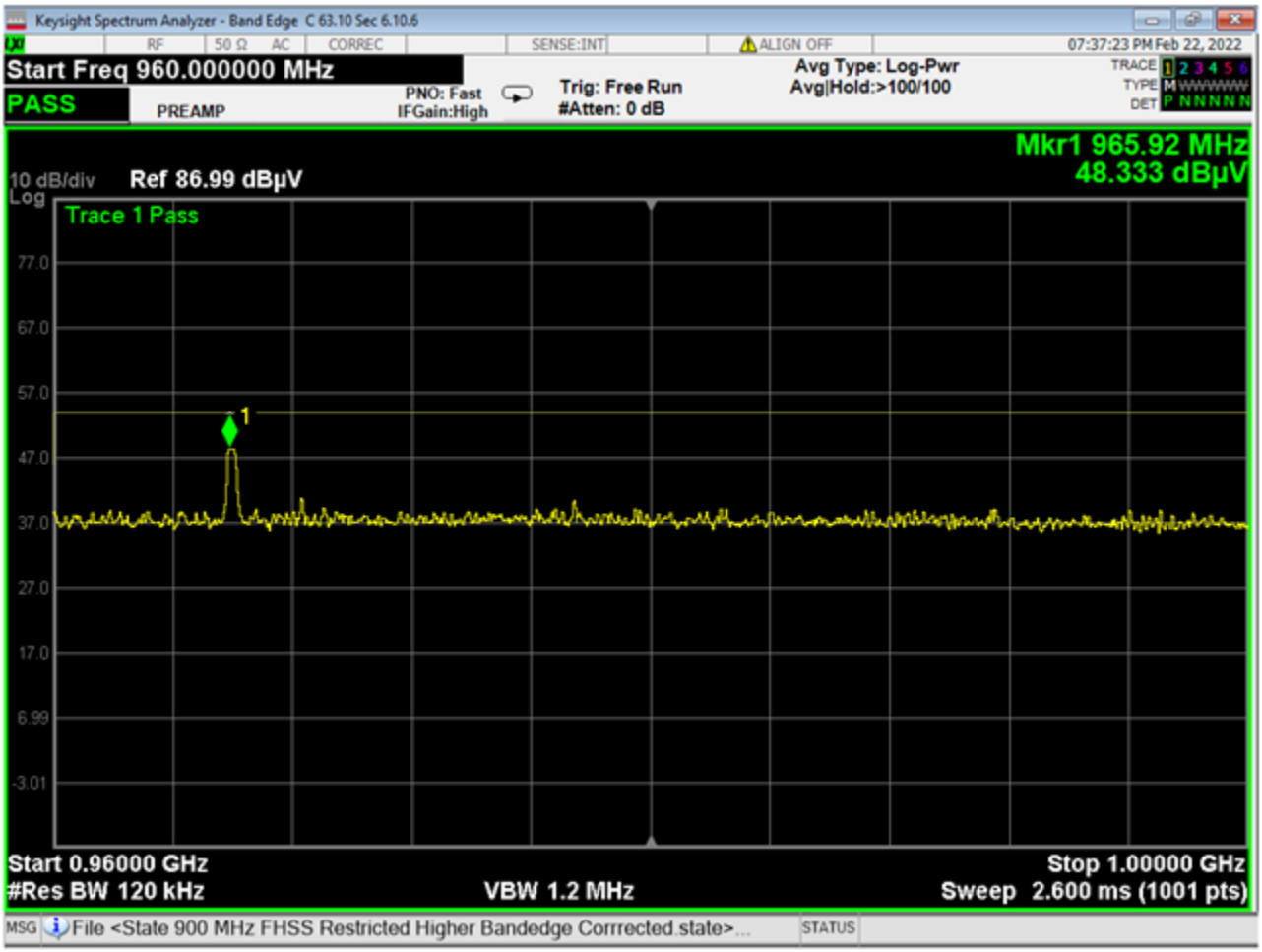

**09 Bandedge Unrestricted High Channel Hopping**



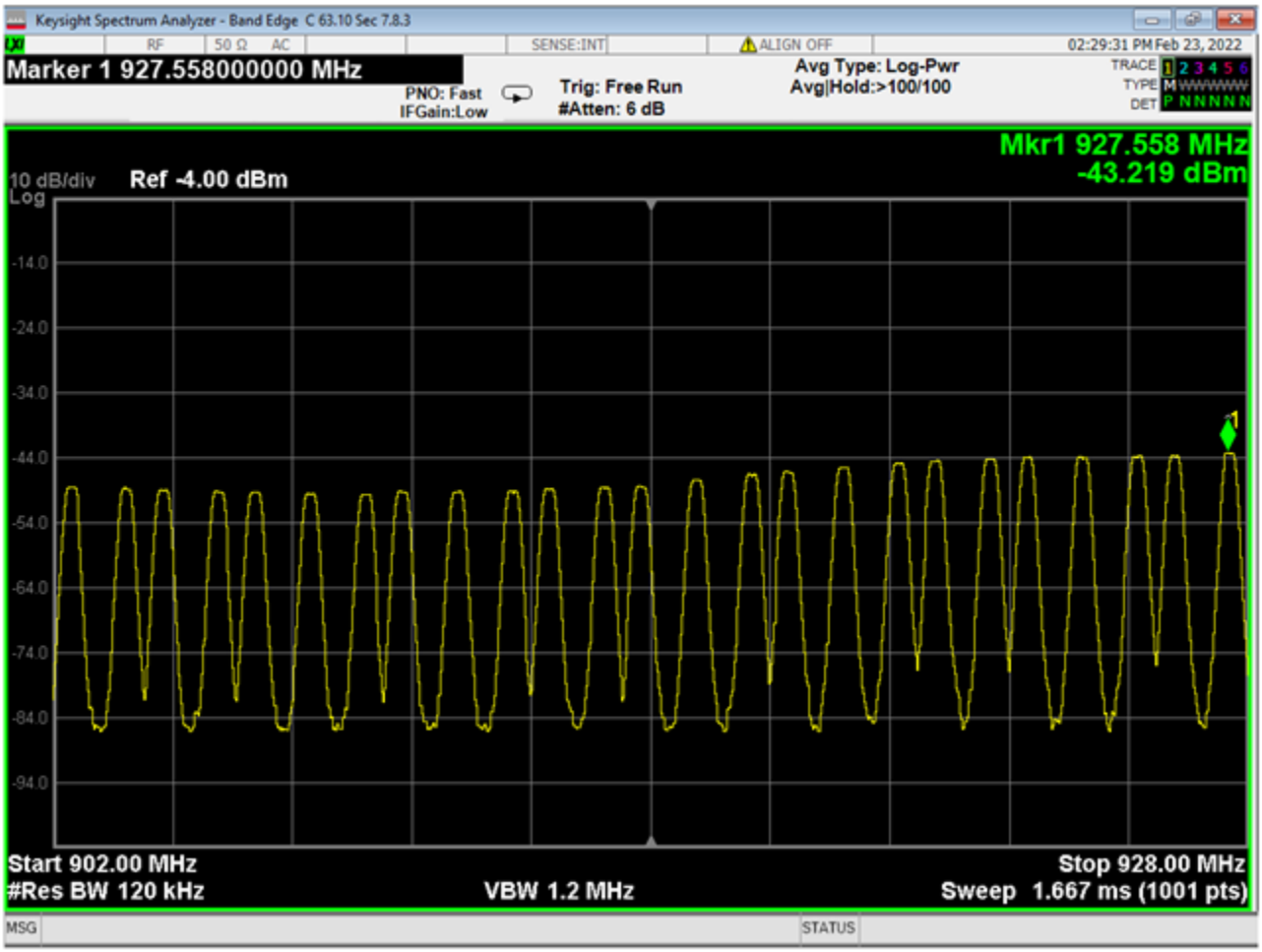

**09 Bandedge Unrestricted High Channel**



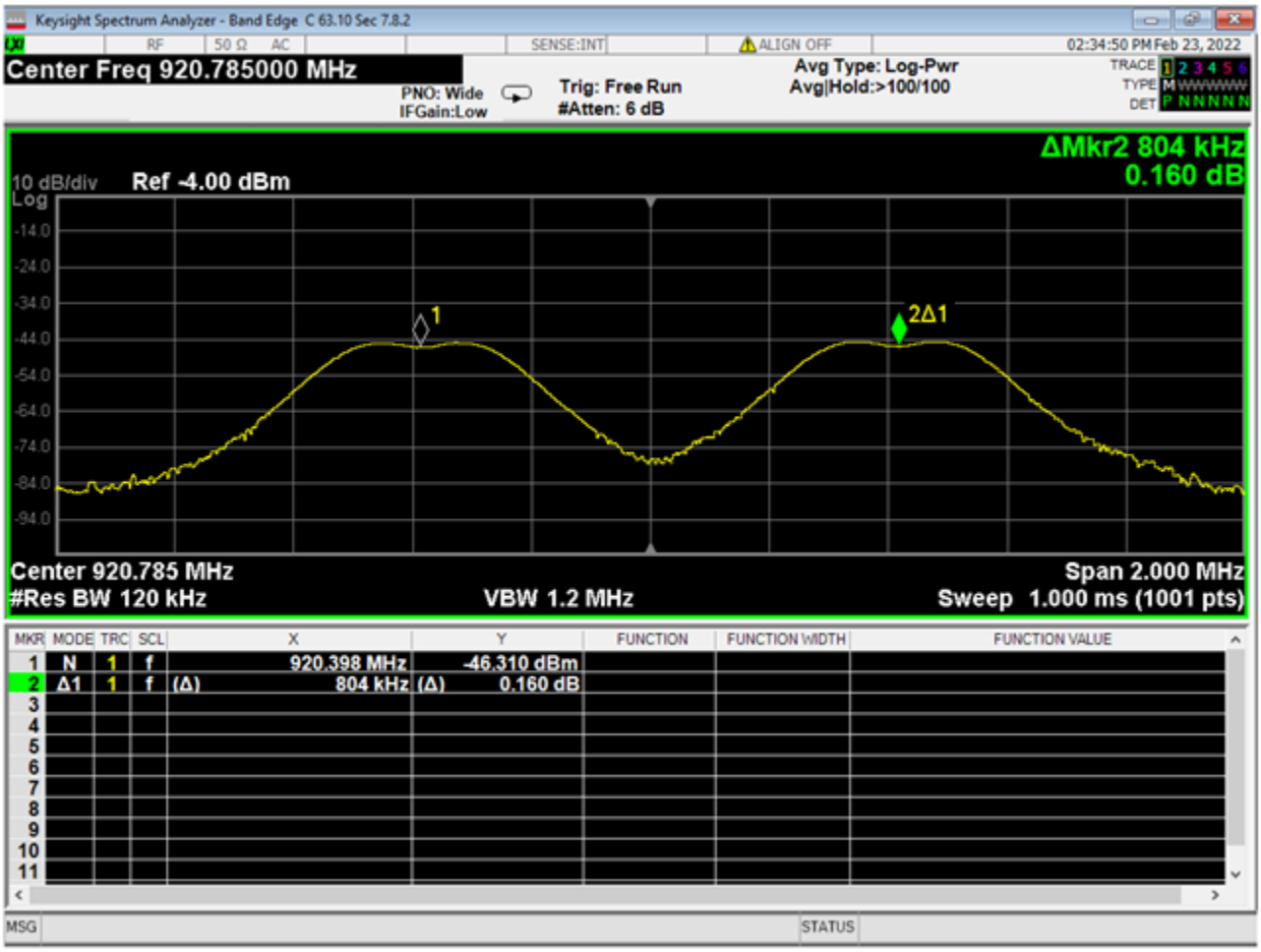

**10 Bandedge Restricted High Channel with Corrections Hopping**




**10 Bandedge Restricted High Channel with Corrections**

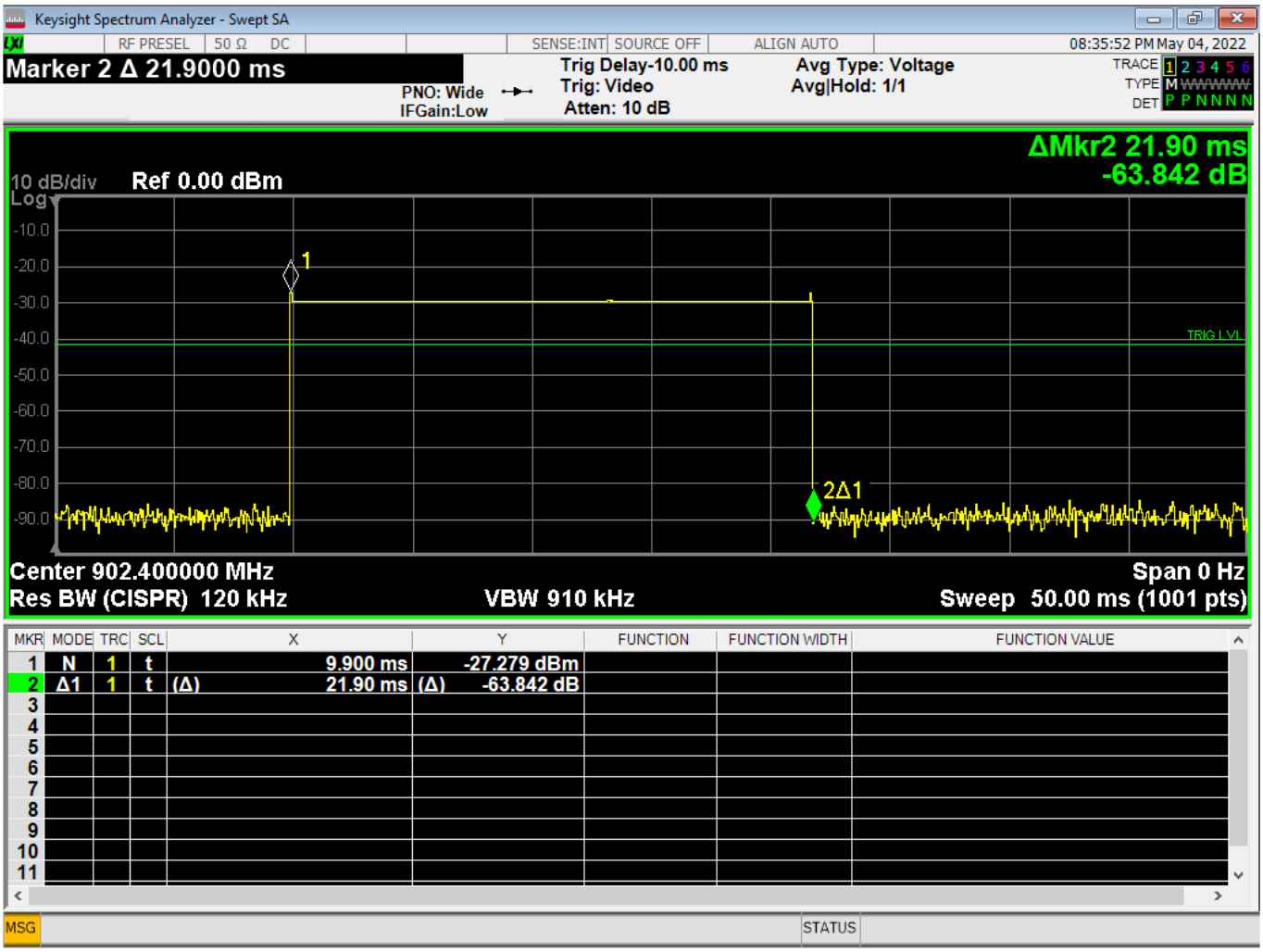



**11 Hop Count, 25 Hops**



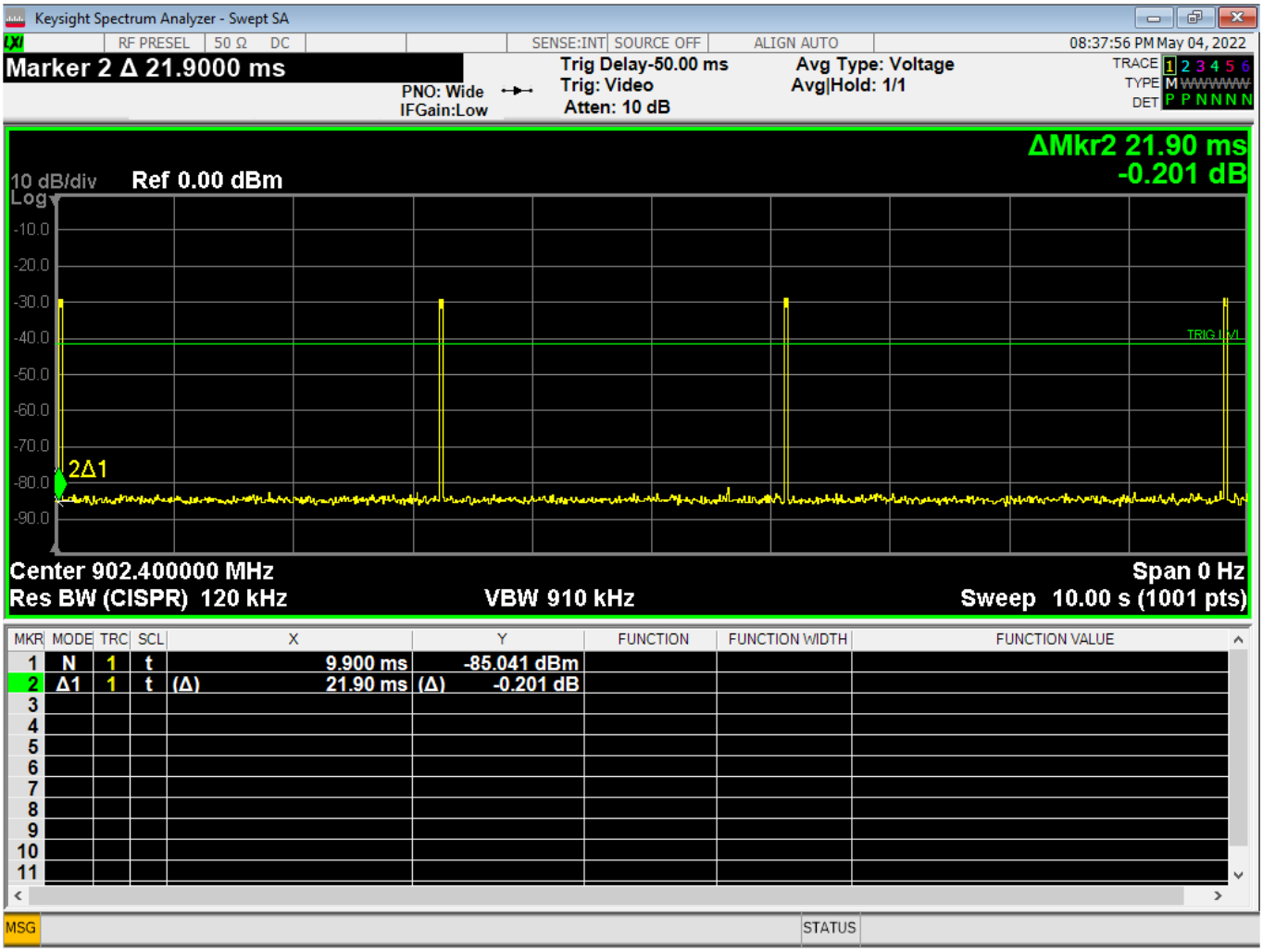

**12 Minimum Frequency Separation**

**Declaration from manufacturer:** The EchoStream protocol defines 64 channels spaced 400 kHz apart. Manufacturer uses only 25 channels from the set of 64. The minimum spacing between channels is ~ 800 kHz with some channels space ~1.2 MHz apart. The entire channel map uses a spacing of 400 kHz, but the used channels are either 800 kHz or 1.2 MHz apart.




**13 Channel Occupancy, On time***

***Measured in hopping mode provided by the manufacturer.**




**14 Channel Occupancy in 10 s window, 4 Hops possible***

***Measured in hopping mode provided by the manufacturer.**

**21.9 ms x4=87.6 ms=0.0876 s**

REPORT END