ncee labs
Product Compliance Solutions

4740 Discovery Drive | Lincoln, NE 68521
tel- 402.323.6233 | tel -888.657.6860 | fax - 402.323.6238
info@nceelabs.com | http://nceelabs.com

# FCC/ISED Test Report

| | |
|---|---|
| **Prepared for:** | **Digital Monitoring Products** |
| **Address:** | **2500 North Partnership Blvd.<br>Springfield, MO 65803** |
| **EUT:** | **1101 Wireless Transmitter** |
| **IC:** | **5251A-PC0248** |
| **FCC ID:** | **CCKPC0248** |
| **Test Report No:** | **R20221221-20-E1C** |
| **Approved by:** |  <br>**Fox Lane,<br>EMC Test Engineer** |
| **DATE:** | **April 14, 2023** |
| **Total Pages:** | **35** |



ilac-MRA A2LA ACCREDITED TESTING LABORATORY CERTIFICATE NO. 1953.01

## REVISION PAGE

| Rev. No. | Date | Description |
|---|---|---|
| 0 | 23 February 2023 | Issued By FLane<br>Prepared by BWinter |
| A | 10 April 2023 | Updated Client Address - FL |
| B | 12 April 2023 | Updated HVIN/EUT Name and Power values - FL |
| C | 14 April 2023 | Updated HVIN and PMN - FL |

## 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

ANSI C63.10-2013 was used as a test method, with guidance from KBD 558074 D01 v05

| SUMMARY | | | |
|---|---|---|---|
| **Standard Section** | **Test Type and Limit** | **Result** | **Remark** |
| FCC 15.203 | Unique Antenna Requirement | Pass | Internal wire antenna |
| FCC 15.35<br>RSS-Gen, 6.10 | Duty cycle of pulsed emissions | Informative only | Duty cycle was applied |
| FCC 15.209<br>RSS-Gen, 7.1 | Receiver Radiated Emissions | Pass | Meets the requirement of the limit. |
| FCC 15.247(a)(1)(i)<br>RSS-247, 5.1(c) | Maximum 20dB Bandwidth,<br>Limit: Max. 250kHz for transmitters with >50 channels | Pass | Meets the requirement of the limit. |
| FCC 15.247(b)(1)<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 20 Second Period | Pass | Meets the requirement of the limit. |
| FCC 15.209, 15.205<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 | NA |

# 2.0 EUT DESCRIPTION

## 2.1 EQUIPMENT UNDER TEST

**Summary**
The Equipment Under Test (EUT) was 1101 wireless transmitter manufactured by DMP wireless devices. It operates in the 902 to 928 MHz ISM band and has transmit and receive capabilities.

| | |
|---|---|
| **EUT** | 1101 Wireless Transmitter |
| **IC** | 5251A-PC0248 |
| **FCC ID** | CCKPC0248 |
| **EUT Received** | 1/23/2023 |
| **EUT Tested** | 1/27/2023 - 1/30/2023 |
| **Serial No.** | 010569 (Assigned by test lab) (Conducted Sample)<br>010903 (Assigned by test lab) (Radiated Sample) |
| **Operating Band** | 902 – 928 MHz |
| **Device Type** | FHSS |
| **Power Supply** | Internal Battery, 3VDC |
| **Antenna** | Internal Wire Antenna, +0.982dBi |

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 | 903.30 |
| Middle | 915.00 |
| High | 926.70 |

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.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, highest and one channel in the middle.

## 2.3 DESCRIPTION OF SUPPORT UNITS

None

# 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 |
| NCC CAB Identification No: | US0177 |

Environmental conditions varied slightly throughout the tests.

## 3.2 TEST PERSONNEL

| No. | PERSONNEL | TITLE | ROLE |
|---|---|---|---|
| 1 | Nic Johnson | Technical Manager | Review of Results |
| 2 | Fox Lane | Test Engineer | Report |
| 3 | Blake Winter | Test Engineer | Testing and Report |
| 4 | Ethan Schmidt | Test Technician | 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 19, 2022 | July 19, 2024 |
| Keysight MXE Signal Analyzer (26.5GHz)** | N9038A | MY56400083 | July 19, 2022 | July 19, 2024 |
| SunAR RF Motion | JB1 | A082918-1 | July 26, 2022 | July 26, 2023 |
| ETS EMCO Red Horn Antenna | 3115 | 00218655 | July 21, 2022 | July 21, 2023 |
| Rohde & Schwarz Preamplifier* | TS-PR18 | 3545700803 | March 21, 2022 | March 21, 2024 |
| Trilithic High Pass Filter* | 6HC330 | 23042 | March 21, 2022 | March 21, 2024 |
| MiniCircuits High Pass Filter* | VHF-1320+ | 15542 | March 21, 2022 | March 21, 2024 |
| RF Cable (preamplifier to antenna)* | MFR-57500 | 01-07-002 | March 21, 2022 | March 21, 2024 |
| 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 | 01E3874 | 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 |
| TDK Emissions Lab Software | V11.25 | 700307 | NA | NA |

*Internal Calibration
**2 year cal cycle

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

## 4.0 DETAILED RESULTS

| Radio Measurements | | | | | |
|---|---|---|---|---|---|
| CHANNEL | Occupied Bandwidth | 20 dB Bandwidth | Peak Power | Peak Power | RESULT |
| | (kHz) | (kHz) | (dBm) | (mW) | |
| Low | 73.61 | 71.83 | 7.890 | 6.15 | PASS |
| Mid | 73.25 | 71.83 | 7.963 | 6.26 | PASS |
| High | 73.41 | 71.83 | 8.051 | 6.38 | PASS |
| 20 dB Bandwidth Limit < 250 kHz | | | Peak Output Power Limit = 30dBm/1000mW; | | |

| Unrestricted Band-Edge | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CHANNEL | Hopping /Continuous | Band edge /Measurement Frequency (MHz) | Relative Highest out of band level (dBm) | Relative Fundamental (dBm) | Measurement Type | Delta (dB) | Min Delta (dB) | Result |
| Low | Hopping | 902.00 | -61.58 | -4.36 | Peak | 57.22 | 20.00 | PASS |
| Low | Continuous | 902.00 | -62.52 | -3.67 | Peak | 58.85 | 20.00 | PASS |
| High | Hopping | 928.00 | -64.04 | -3.47 | Peak | 60.57 | 20.00 | PASS |
| High | Continuous | 928.00 | -63.38 | -2.04 | Peak | 61.34 | 20.00 | PASS |

| Quasi-Peak - Restricted Band-Edge | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CHANNEL | Band edge /Measurement Frequency (MHz) | Highest out of band level (dBuV/m @ 3m) | Measurement Type | Limit (dBuV/m @ 3m)* | Margin | Result | Cable loss** | Antenna Factor** | Uncorrected out of band (dBuV)** |
| Low | 608-614 MHz | 32.03 | Quasi-Peak | 46.02 | 13.99 | PASS | - | - | - |
| High | 960-1000MHz | 35.55 | Quasi-Peak | 53.98 | 18.43 | PASS | - | - | - |

*Limit shown is the quasi-peak limit taken from FCC Part 15.209.
**If no uncorrected out of band, cable loss, or antenna factor value is show, plot already shows corrected value

## 4.1 DUTY CYCLE

**Manufacturer declared duty cycle:**

Manufacturer declares worst case duty cycle is 12ms within a 100ms window.

Duty Cycle Correction Factor (DCCF) = 20*log(Duty Cycle)

-18.42dB = 20*log(12 / 100)

## 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 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. The orientation with the worst-case emissions was used for final measurements.

i. Receive mode emissions were tested and found to be within the measurement noise floor of the test laboratory

**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:**

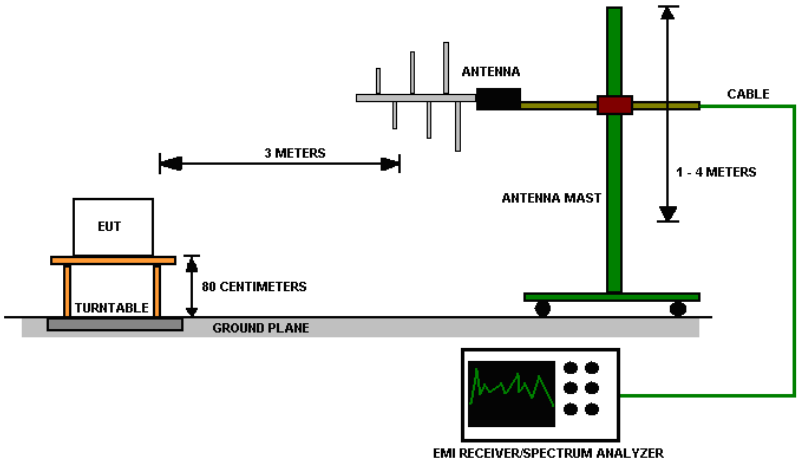


**Figure 1 - Radiated Emissions Test Setup**

**EUT operating conditions**
The EUT was powered by internal battery unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

## Test results:

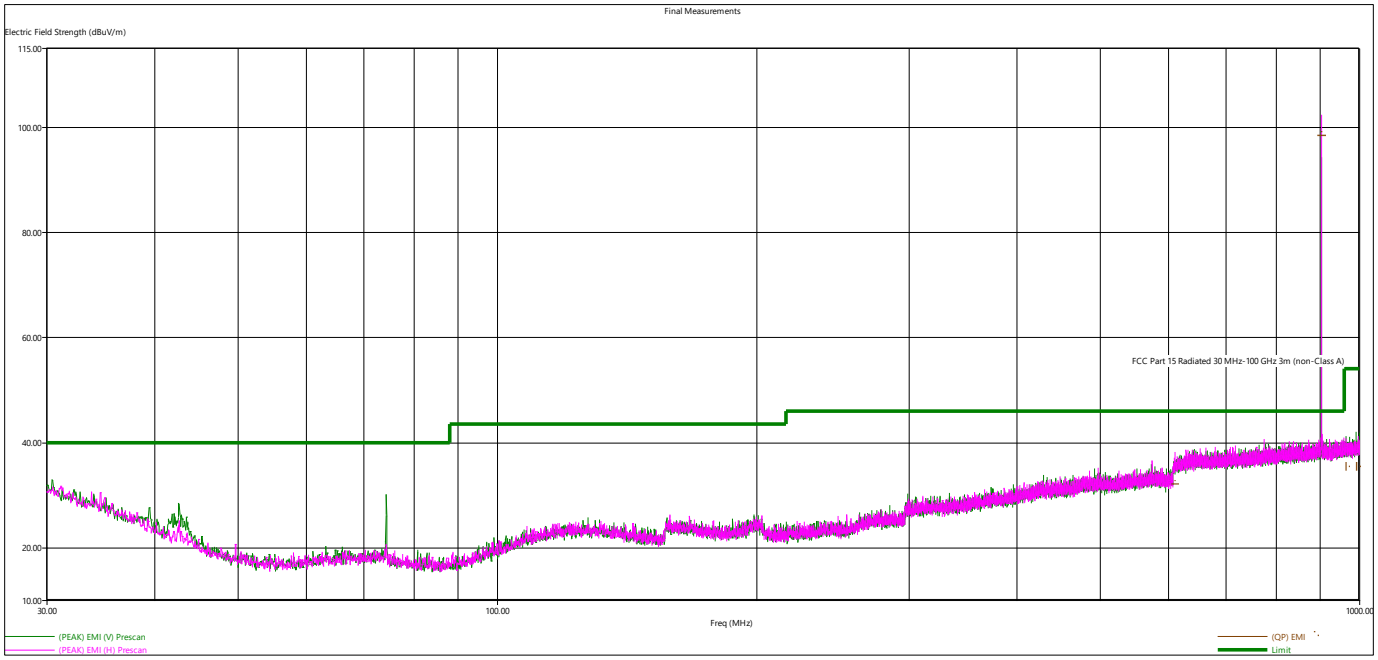


**Figure 2 – Radiated Emissions Plot, Low Channel**

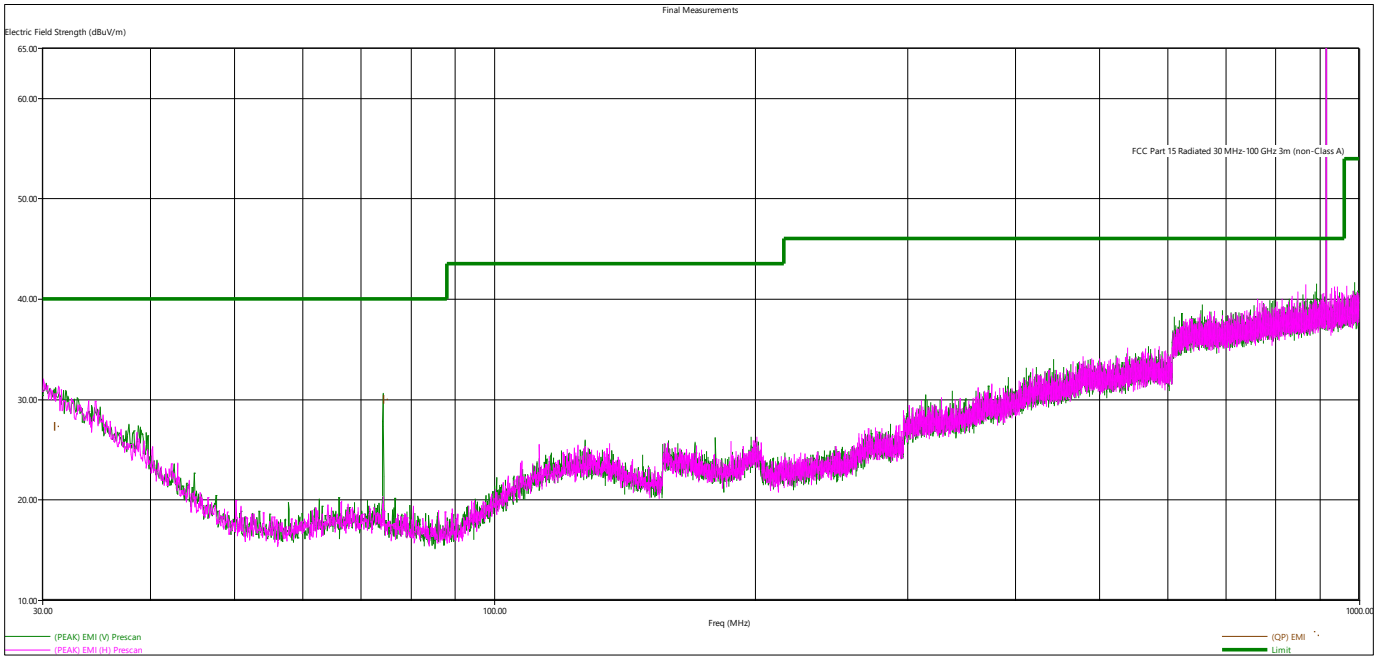


**Figure 3 – Radiated Emissions Plot, Mid Channel**

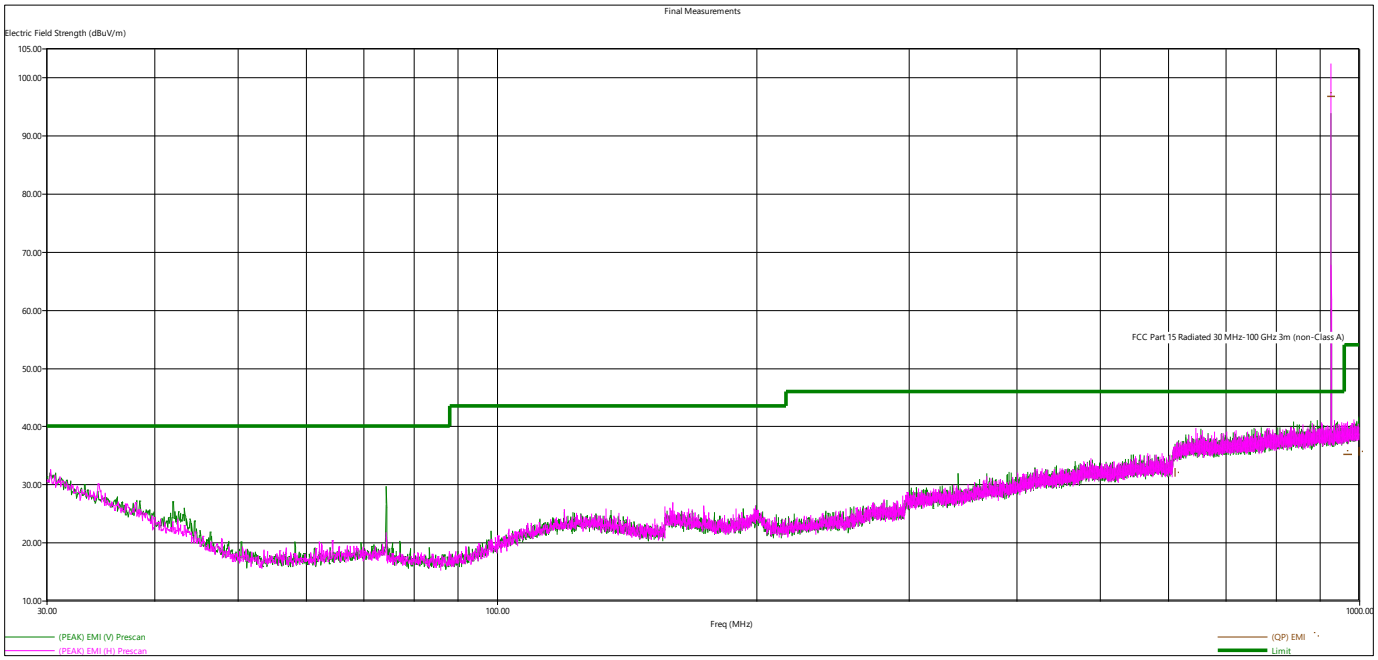


**Figure 4 – Radiated Emissions Plot, High Channel**

**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 both the horizontal and vertical orientation.

| Quasi-Peak Measurements, 30 MHz -1 GHz | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency** | **Level** | **Limit** | **Margin** | **Height** | **Angle** | **Pol** | **Channel** |
| **MHz** | **dBµV/m** | **dBµV/m** | **dB** | **cm.** | **deg.** | | |
| 610.776480 | 32.03 | 46.02 | 13.99 | 130.00 | 31.00 | H | Low |
| 903.343680 | 98.32 | NA | NA | 104.00 | 154.00 | H | Low |
| 964.045200 | 35.29 | 53.98 | 18.69 | 268.00 | 240.00 | V | Low |
| 990.093600 | 35.32 | 53.98 | 18.66 | 217.00 | 217.00 | V | Low |
| 914.974080 | 98.40 | NA | NA | 104.00 | 156.00 | H | Mid |
| 30.998640 | 27.23 | 40.00 | 12.77 | 121.00 | 168.00 | V | Mid |
| 74.249760 | 29.94 | 40.00 | 10.06 | 204.00 | 267.00 | V | Mid |
| 926.652000 | 96.76 | NA | NA | 103.00 | 127.00 | H | High |
| 966.928800 | 35.14 | 53.98 | 18.84 | 198.00 | 8.00 | H | High |
| **610.834320** | **32.00** | **46.02** | **14.02** | **219.00** | **120.00** | **V** | **High** |
| 997.278960 | 35.55 | 53.98 | 18.43 | 228.00 | 131.00 | V | High |

*All other measurements found to be at least 6dB below the limit line.

| Peak Measurements, 1 GHz - 10 GHz | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency** | **Level** | **Limit** | **Margin** | **Height** | **Angle** | **Pol** | **Channel** |
| **MHz** | **dBµV/m** | **dBµV/m** | **dB** | **cm.** | **deg.** | | |
| 1806.698000 | 39.78 | 73.98 | 34.20 | 274.00 | 188.00 | H | Low |
| 2709.988000 | 47.97 | 73.98 | 26.01 | 559.00 | 302.00 | V | Low |
| 2745.004000 | 45.98 | 73.98 | 28.00 | 442.00 | 238.00 | H | Mid |
| 1728.262000 | 45.52 | 73.98 | 38.53 | 251.00 | 265.00 | V | Mid |
| 1727.320000 | 35.57 | 73.98 | 38.41 | 161.00 | 105.00 | H | High |
| 2780.032000 | 47.44 | 73.98 | 26.54 | 541.00 | 230.00 | H | High |
| 6323.24 | 55.21 | 73.98 | 18.77 | 151.00 | 357.00 | V | Low |
| 8130.08 | 56.05 | 73.98 | 17.93 | 308.00 | 62.00 | V | Low |
| 9936.59 | 54.26 | 73.98 | 19.72 | 114.00 | 306.00 | V | Low |
| 4575.16 | 46.03 | 73.98 | 27.95 | 554.00 | 137.00 | H | Mid |
| 5764.80 | 44.73 | 73.98 | 29.25 | 220.00 | 358.00 | V | Mid |
| 6404.88 | 57.17 | 73.98 | 16.81 | 402.00 | 0.00 | V | Mid |
| 8235.16 | 58.32 | 73.98 | 15.66 | 508.00 | 205.00 | V | Mid |
| 9354.75 | 51.47 | 73.98 | 22.51 | 480.00 | 153.00 | V | Mid |
| 9722.70 | 51.17 | 73.98 | 22.81 | 207.00 | 203.00 | V | Mid |
| 4176.45 | 43.20 | 73.98 | 30.78 | 439.00 | 346.00 | H | High |
| 4633.59 | 47.56 | 73.98 | 26.42 | 402.00 | 249.00 | H | High |
| 5770.41 | 48.02 | 73.98 | 25.96 | 319.00 | 333.00 | V | High |
| 6486.48 | 55.48 | 73.98 | 18.50 | 167.00 | 42.00 | V | High |
| 8339.96 | 58.33 | 73.98 | 15.65 | 508.00 | 346.00 | V | High |

| Average Measurements, 1 GHz - 10 GHz | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency** | **Average Level*** | **Limit** | **Margin** | **Height** | **Angle** | **Pol** | **Channel** |
| **MHz** | **dBµV/m** | **dBµV/m** | **dB** | **cm.** | **deg.** | | |
| 1806.698 | 21.36 | 53.98 | 32.62 | 274.00 | 188.00 | H | Low |
| 2709.988 | 29.55 | 53.98 | 24.43 | 559.00 | 302.00 | V | Low |
| 2745.004 | 27.56 | 53.98 | 26.42 | 442.00 | 238.00 | H | Mid |
| 1728.262 | 27.10 | 53.98 | 26.88 | 251.00 | 265.00 | V | Mid |
| 1727.320 | 17.15 | 53.98 | 36.83 | 161.00 | 105.00 | H | High |
| 2780.032 | 29.02 | 53.98 | 24.96 | 541.00 | 230.00 | H | High |
| 6323.24 | 36.79 | 53.98 | 17.19 | 151.00 | 357.00 | V | Low |
| 8130.08 | 37.63 | 53.98 | 16.35 | 308.00 | 62.00 | V | Low |
| 9936.59 | 35.84 | 53.98 | 18.14 | 114.00 | 306.00 | V | Low |
| 4575.16 | 27.61 | 53.98 | 26.37 | 554.00 | 137.00 | H | Mid |
| 5764.80 | 26.31 | 53.98 | 27.67 | 220.00 | 358.00 | V | Mid |
| 6404.88 | 38.75 | 53.98 | 15.23 | 402.00 | 0.00 | V | Mid |
| 8235.16 | 39.90 | 53.98 | 14.08 | 508.00 | 205.00 | V | Mid |
| 9354.75 | 33.05 | 53.98 | 20.93 | 480.00 | 153.00 | V | Mid |
| 9722.70 | 32.75 | 53.98 | 21.23 | 207.00 | 203.00 | V | Mid |
| 4176.45 | 24.78 | 53.98 | 29.20 | 439.00 | 346.00 | H | High |
| 4633.59 | 29.14 | 53.98 | 24.84 | 402.00 | 249.00 | H | High |
| 5770.41 | 29.60 | 53.98 | 24.38 | 319.00 | 333.00 | V | High |
| 6486.48 | 37.06 | 53.98 | 16.92 | 167.00 | 42.00 | V | High |
| 8339.96 | 39.91 | 53.98 | 14.07 | 508.00 | 346.00 | V | High |

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the table above.
Average Level = Peak Level + DCCF, see section 4.1 for more details regarding DCCF

## 4.3 CONDUCTED OUTPUT POWER

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

**Limits of bandwidth measurements:**
For an FHSS system with 50 channels or more, the output power is required to be less than 1000 mW or 30 dBm.

**Test procedure:**
Measurements were performed conducted.

The device was directly connected to a spectrum analyzer.

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

**Test setup:**

See Section 4.2

**EUT operating conditions:**
The EUT was powered by internal battery unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

**Test results:**
Refer to section 4.0 for the results table.

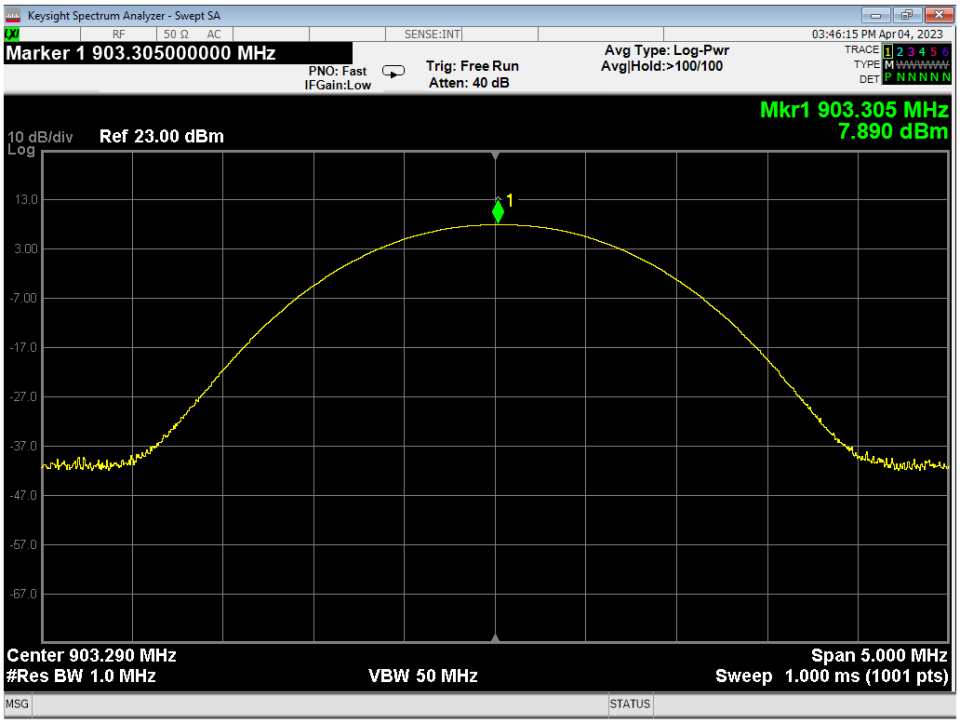


**Figure 5 – Conducted Output Power, Low Channel.**

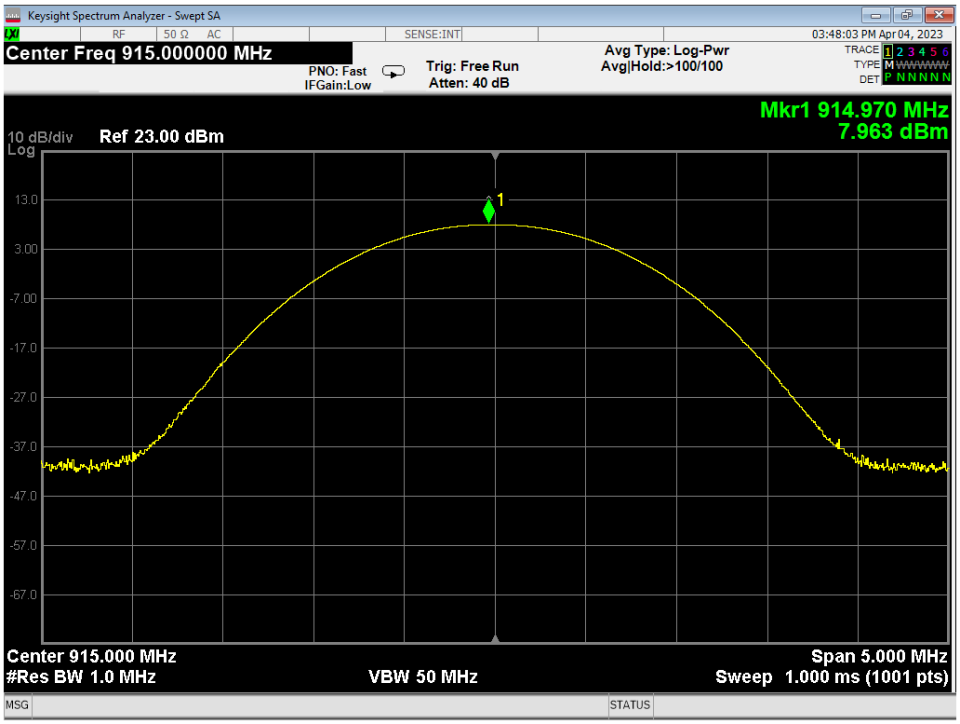


**Figure 6 – Conducted Output Power, Mid Channel**

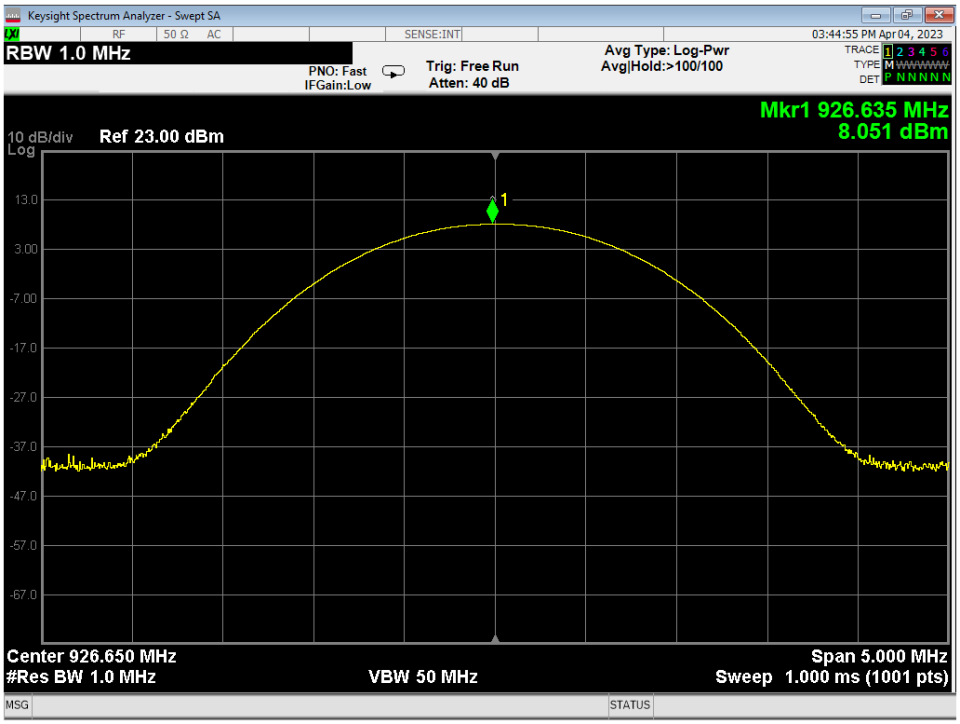


**Figure 7 – Conducted Output Power, High Channel**

## 4.4 BANDWIDTH

**Test Method:** ANSI C63.10, Section(s) 6.9.2 (20 dB BW)
ANSI C63.10, Section(s) 6.9.3 (99% BW)

**Limits of bandwidth measurements:**
From FCC Part 15.247 (1) (i) and RSS-247 5.1(c)

The maximum allowed 20 dB bandwidth of the hopping channel is 250 kHz.

**Test procedures:**
Bandwidth measurement was taken with the EUT connected to the receiver through the EUT's coaxial cable. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW.

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

The 99% occupied bandwidth was measured using the test receiver's occupied bandwidth function.

**Test setup:**

All the measurements were done with the EUT connected to the receiver while operating at low, mid, and high channels. See Section 4.3 for more details.

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

**Test setup:**

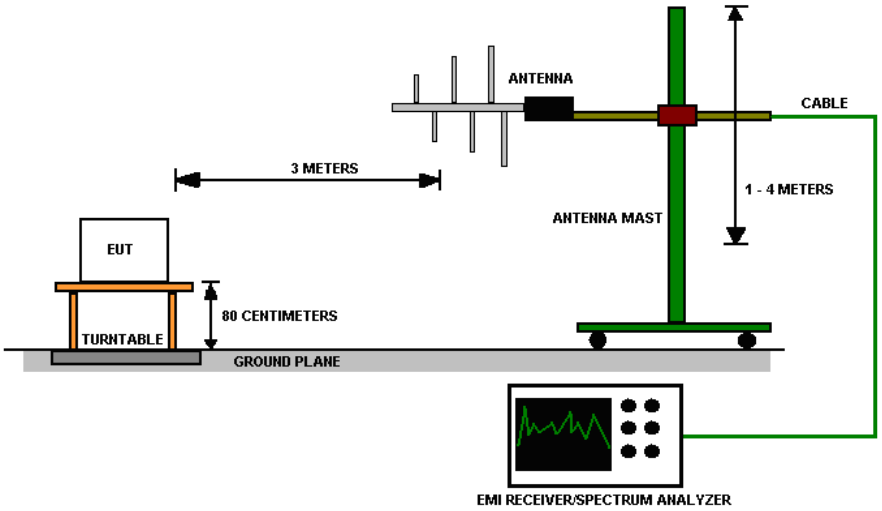


**Figure 8 - Bandwidth Measurements Test Setup**

**EUT operating conditions:**
The EUT was powered by internal battery unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

**Test results:**

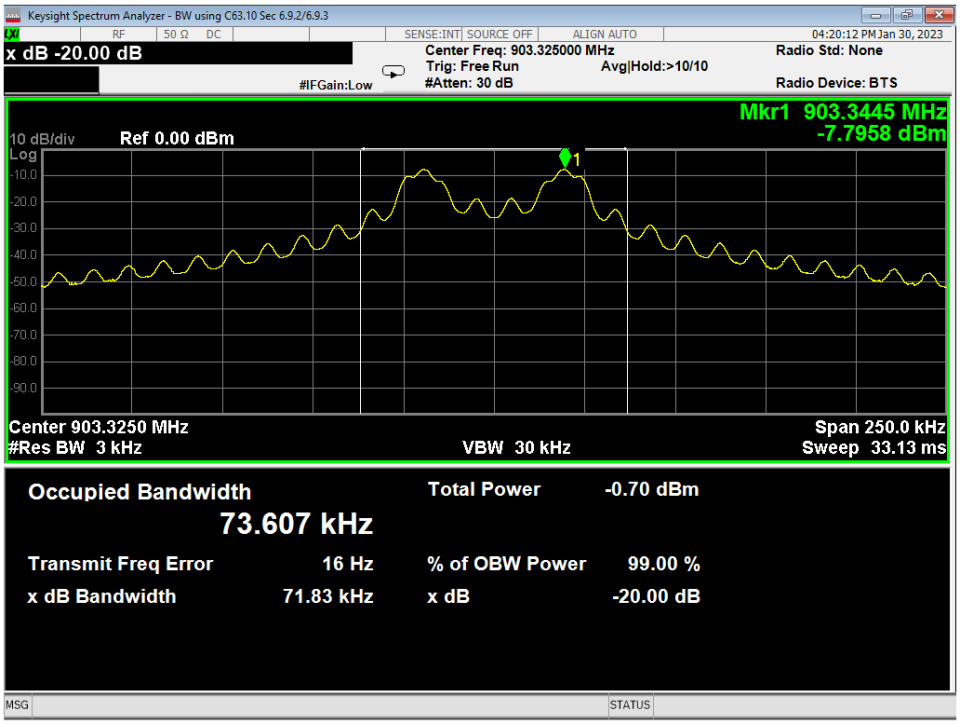


Figure 9 –Bandwidth, Low Channel

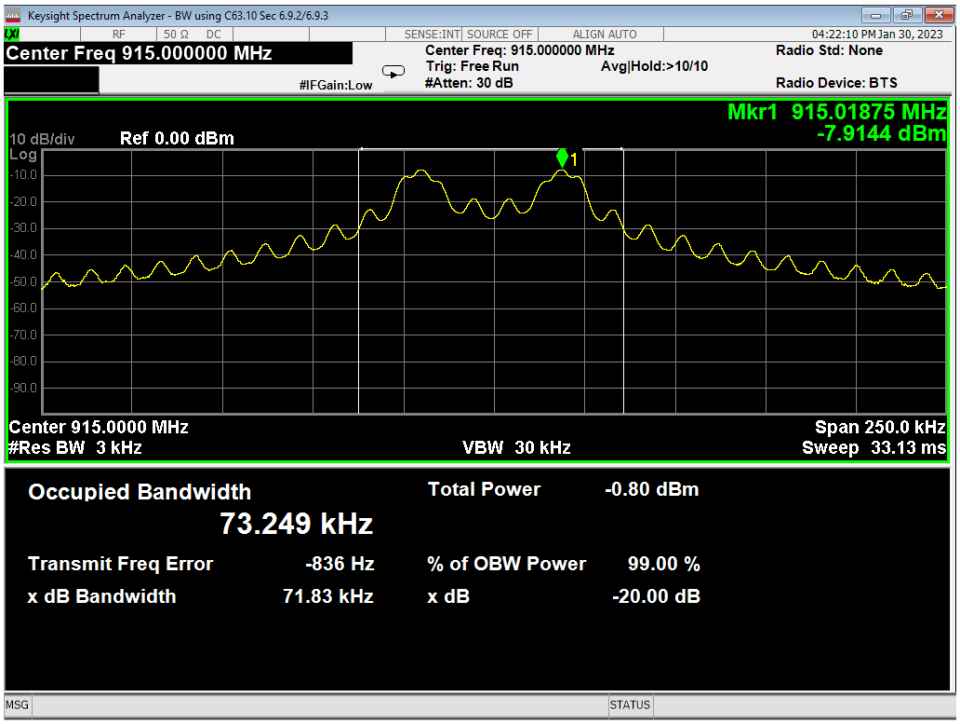


Figure 10 - Bandwidth, Mid Channel

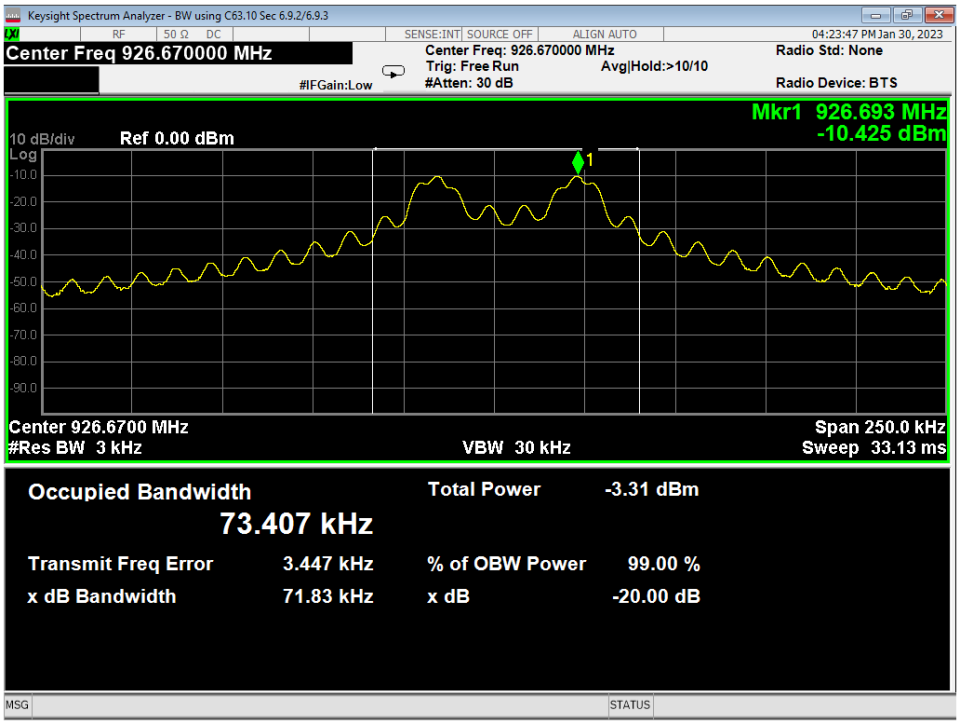


**Figure 11 - Bandwidth, High Channel**

## 4.5 BANDEDGES

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

**Limits of bandedge 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 restricted band edge measurements were taken at a distance of 3m from the EUT.

The EUT was maximized in all 3 orthogonal positions in a similar manner as described in Section 4.2.

The unrestricted band edges were measured with the EUT connected to the receiver through the EUT's coaxial cable.

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

**Test setup:**
The restricted band edge measurements were done at 3m test distance while operating on the highest and lowest channel depending on which band edge was investigated.

The unrestricted band edge measurements were done with the EUT connected to the receiver through the EUT's coaxial cable.

**EUT operating conditions:**
The EUT was powered by internal battery unless specified and set to transmit continuously on the lowest frequency channel and the highest frequency channel.

**Test results:**
Refer to section 4.0 for the results table.

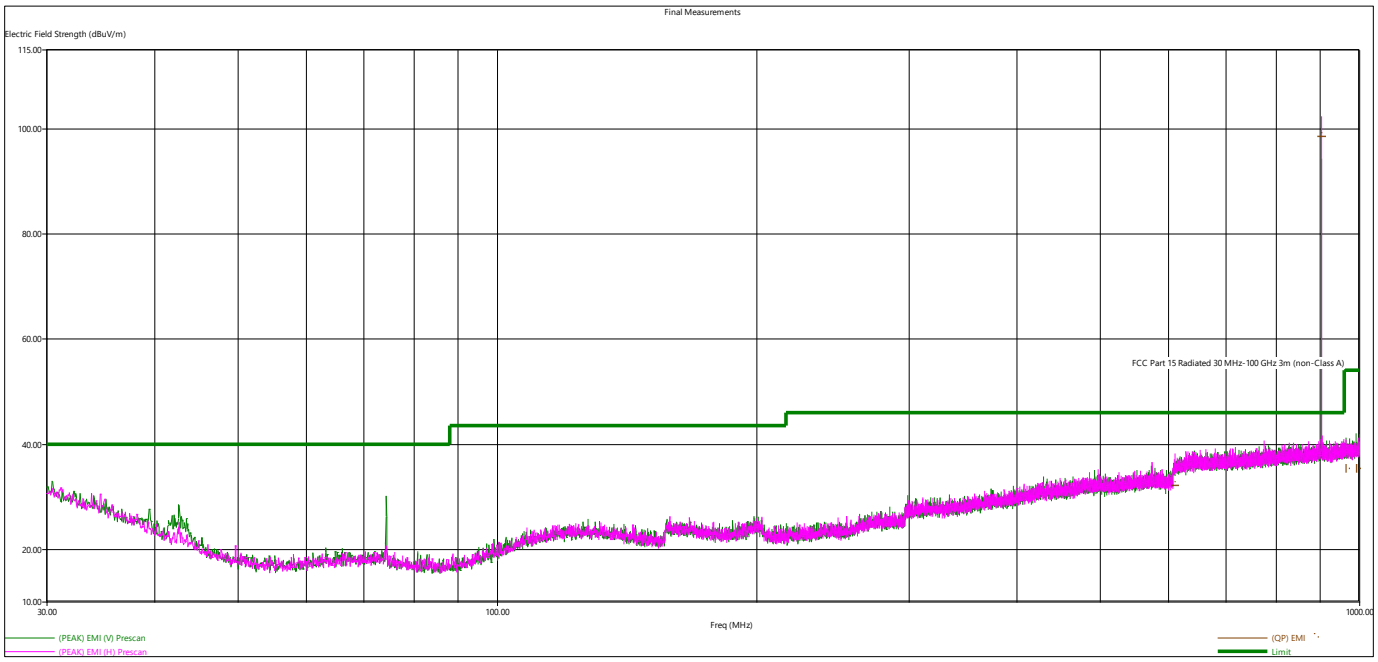


Figure 12 - Band-edge Measurement, Low Channel, Restricted Frequency, Continuous

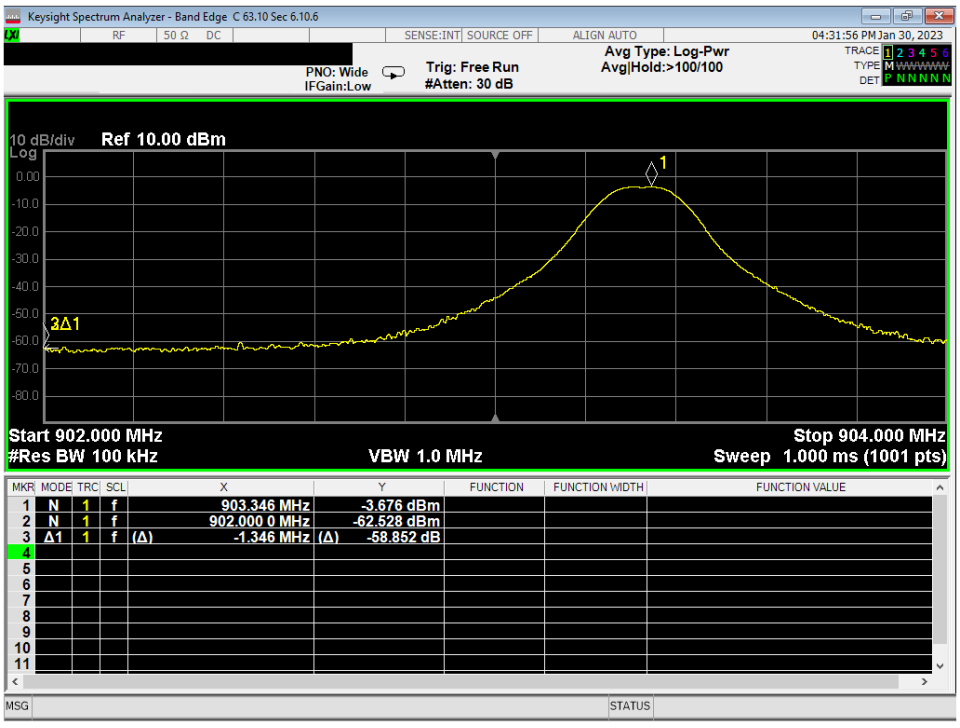


Figure 13 - Band-edge Measurement, Low Channel, Unrestricted Frequency, Continuous

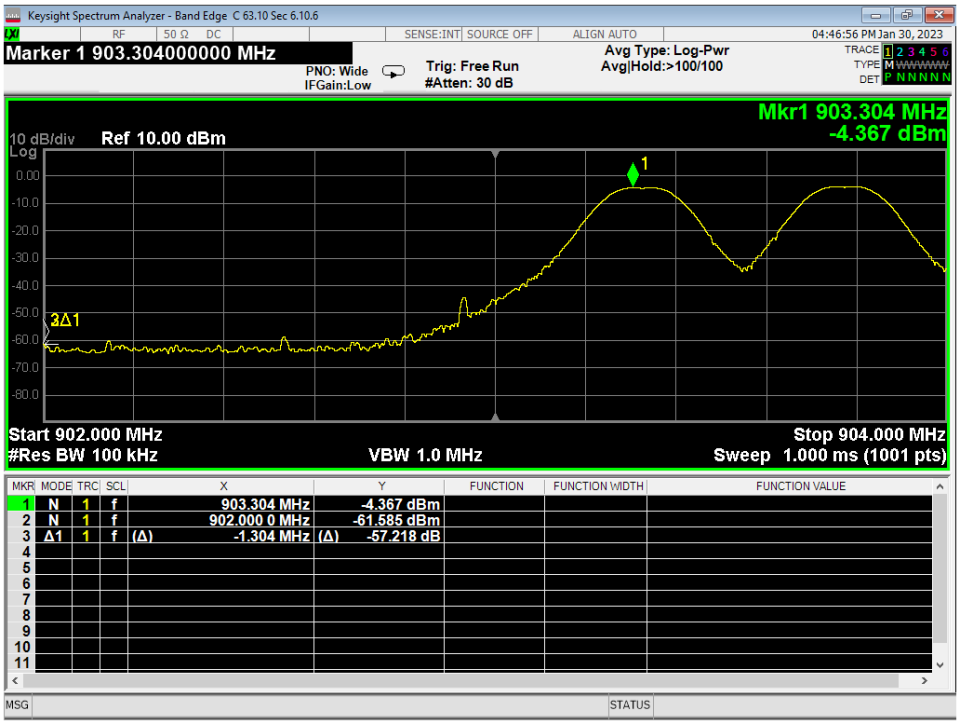


**Figure 14 - Band-edge Measurement, Low Channel, Unrestricted Frequency, Hopping**

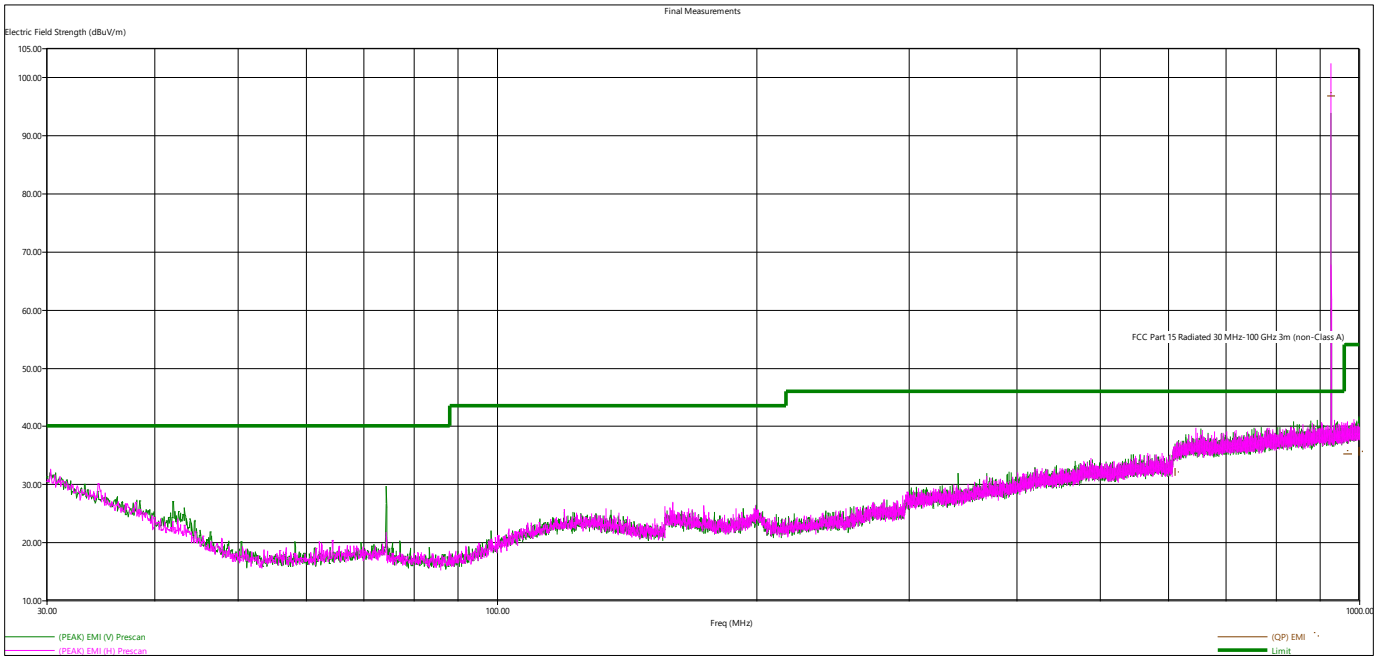


**Figure 15 - Band-edge Measurement, High Channel, Restricted Frequency, Continuous**

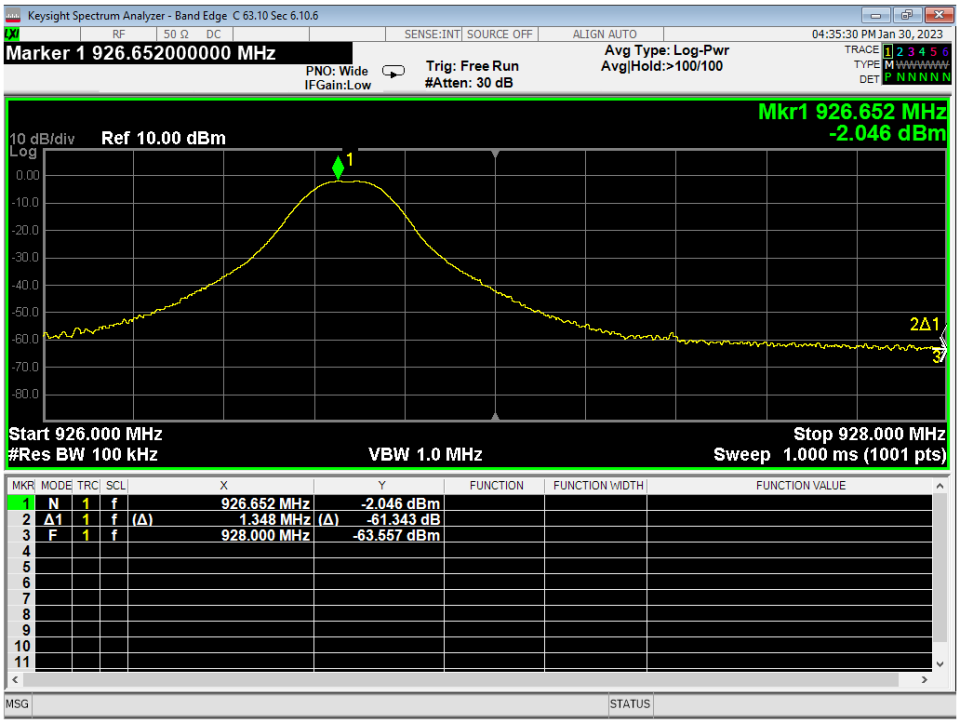


**Figure 16 - Band-edge Measurement, High Channel, Unrestricted Frequency, Continuous**

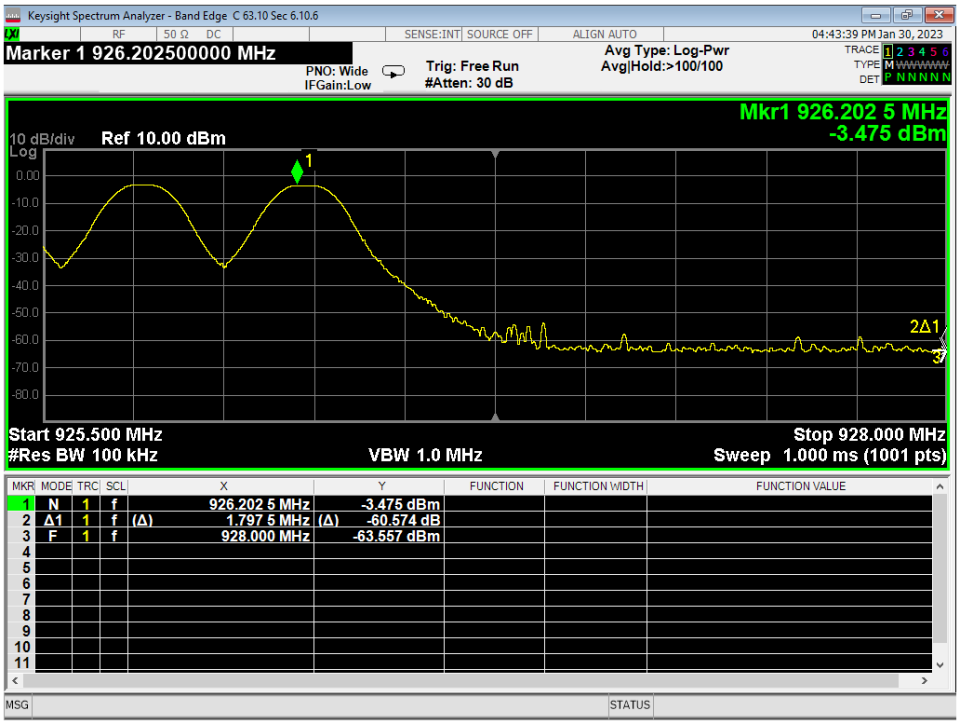


**Figure 17 - Band-edge Measurement, High Channel, Unrestricted Frequency, Hopping**

## 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 should not to exceed 0.4 seconds within a 20 second period.

**Test procedures:**
The method from FCC DA 00-705

All measurements were taken with the EUT connected to the receiver through the EUT's coaxial cable.

**Test setup:**
All the measurements were taken with the EUT connected to the receiver while hopping mode was enabled.

**EUT operating conditions:**
The EUT was powered internal battery unless otherwise specified and set to Hopping mode. Both Low interference mode and Standard mode were investigated, worst case was reported.

**Test results:**

Lowest recorded Period was 1.580 seconds, 20s/1.580s = 12.65 transmissions within 20 second Dwell.

Manufacturer declares 12ms maximum on time.
**On Time = 12ms**

**Time of Occupancy =**
**On time * number of transmissions over 20 seconds**
**12ms * 12.65 transmissions = 151.8ms < 400ms (15.247 Limit)**

**Total Hop Count =**
**52 Channels**

**Minimum Frequency Separation = 911.407MHz – 910.961MHz = 0.446MHz = 446kHz**
**Limit = 20dB Bandwidth = 71.83kHz**

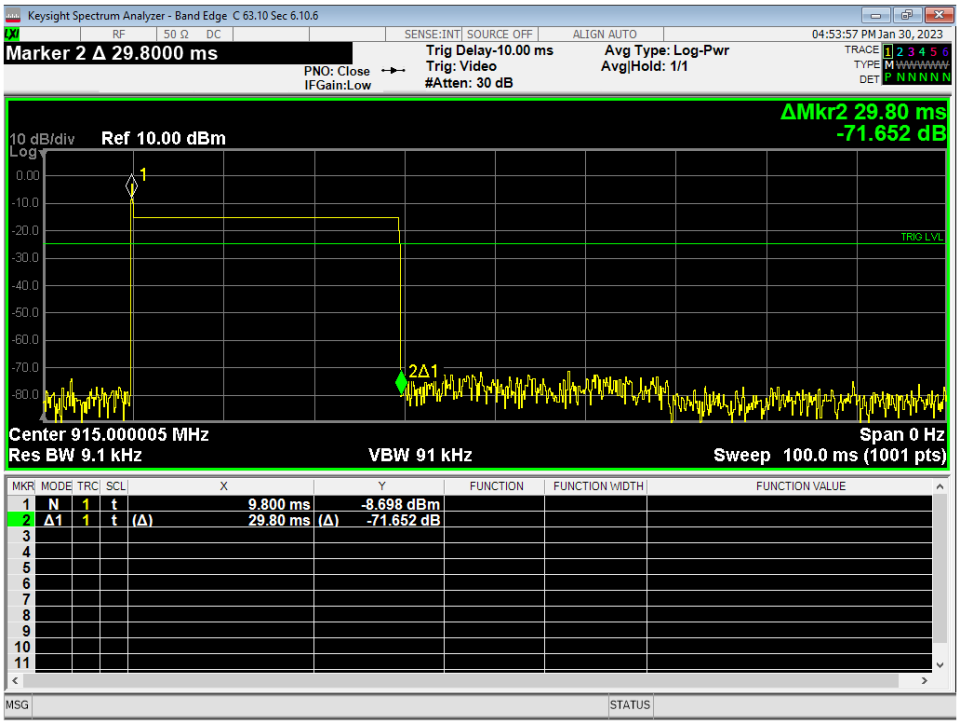


Figure 18 – On time

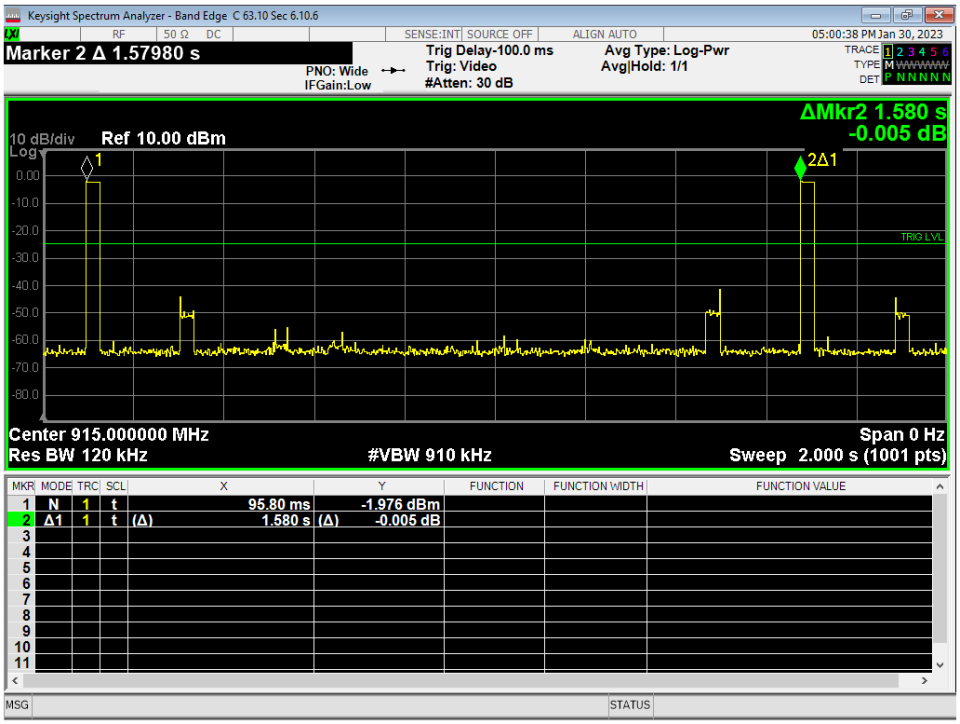


Figure 19 – Period

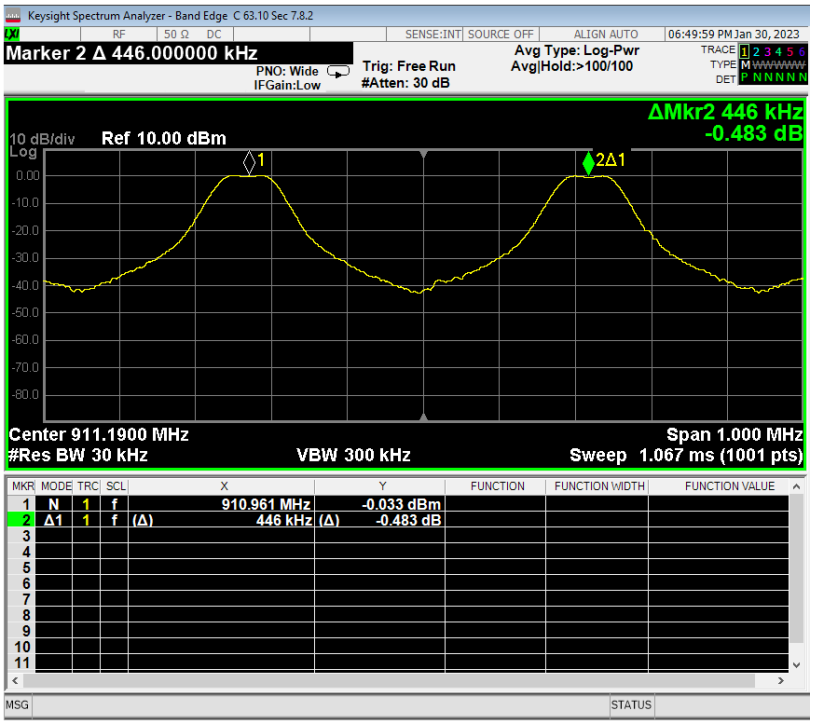


Figure 20 – Minimum Frequency Separation

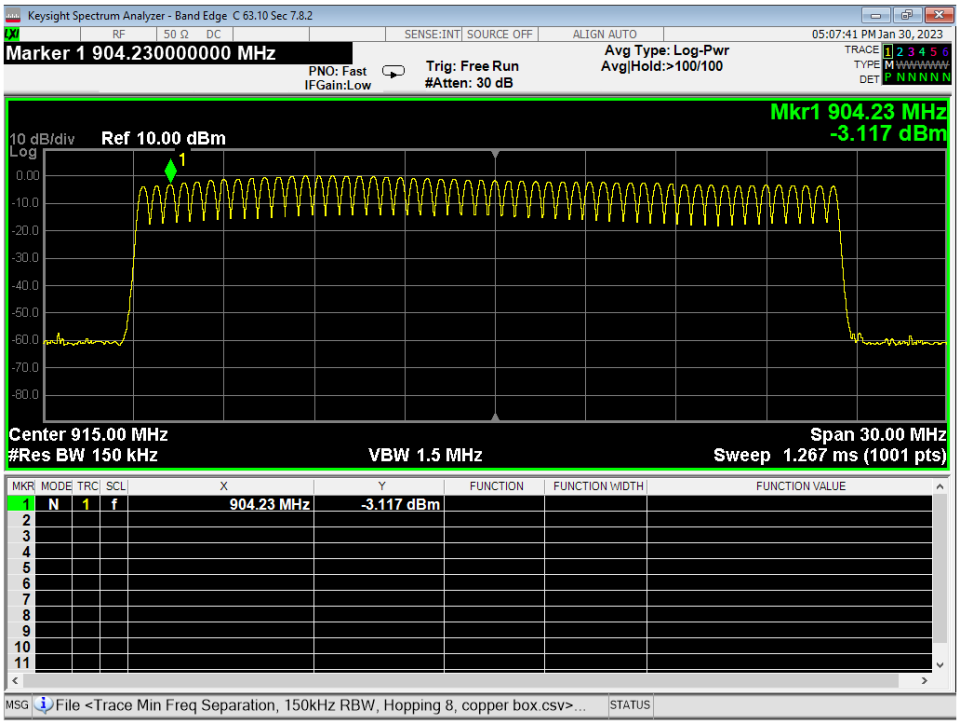


Figure 21 – Hop Count, 902-928MHz

## APPENDIX A: SAMPLE CALCULATION

***Radiated Emissions***

The field strength is calculated in decibels (dB) 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:

$$FS = R + AF - (-CF + AG)$$

where FS = Field Strength

R = Receiver Amplitude Receiver reading in dBµV

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Preamplifier Amplifier Gain

Assume a receiver reading of 55.00 dBµV is obtained. The Antenna Factor of 12.00 and a Cable Factor of 1.10 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.10 dBµV/m.

FS = 55.00 + 12.00 – (-1.10 + 20.00) = 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

***Conducted Emissions***

Receiver readings are compared directly to the conducted emissions limits in decibels (dB) by adding the cable loss and LISN insertion loss to the receiver reading. The basic equations with a sample calculation is as follows;

$$FS = R + IL - (-CF)$$

where V = Conducted Emissions Voltage Measurement

R = Receiver reading in dBµV

IL = LISN Insertion Loss

CF = Cable Attenuation Factor

## APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels apply to tests performed in this test report:

| Test | Frequency Range | NCEE Labs Uncertainty Value (dB) | Maximum Uncertainty Values per CISPR 16-4-2:2011/A1:2018 |
|---|---|---|---|
| Radiated Emissions, 3m | 30MHz - 1GHz | 4.31 | 5.34 |
| Radiated Emissions, 3m | 1GHz – 18GHz | 5.08 | 5.48 |

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

NCEE Labs meets the maximum uncertainty requirements per CISPR 16-4-2:2011/A1:2018, and therefore does not require a minimum passing margin to state that an EUT is less than the field strength limits of the applicable CISPR, IEC or EN limit per CISPR 16-4-2:2011/A1:2018, Section 4.1.

NCEE Labs employs tilting when testing at 3m test distance at frequencies above 1GHz. The maximum uncertainty associated with this method is used.

Maximum uncertainty values show the worst-case of all test distances used.

REPORT END