NOKIA Bell Labs

Global Product Compliance Laboratory
600-700 Mountain Avenue
Room 5B-108
Murray Hill, New Jersey 07974-0636 USA

**TESTING**
**NVLAP LAB CODE: 100275-0**

# Title 47 Code of Federal Regulations Test Report

Regulation:
FCC Part 2 and 90

Client:
NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:
AHBCD AirScale Dual RRH 4T4R 240W

Report Number:
TR-2022-0010-FCC2-90

Date Issued:
March 31, 2022

# Table of Contents

## Revisions

| Date | Revision | Section | Change |
|---|---|---|---|
| 3/31/2022 | 0 | | Initial Release |
| | | | |
| | | | |
| | | | |

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Prepared By:

Signed:  3/31/2022

Ann Chang
Compliance Engineer
NVLAP Signatory
ann.chang@nokia-bell-labs.com

Approved By:

Signed:  3/31/2022

Raymond Johnson
Technical Manager
NVLAP Signatory
ray.johnson@nokia-bell-labs.com

Reviewed By:

Signed:  3/31/2022

Steve Gordon
EMC Engineer
NVLAP Signatory
steve.gordon@nokia-bell-labs.com

# 1. System Information and Requirements

Report copies and other information not contained in this report are held by either the product engineer or in an identified file at the Global Product Compliance Laboratory in Murray-Hill, NJ.

| | |
|---|---|
| **Equipment Under Test (EUT):** | AHBCD AirScale Dual RRH 4T4R 240W |
| **FCC ID:** | VBNAHBCD-01 |
| **Serial Number:** | RW220100009 (Radio), RW220100010 (Frequency Stability) |
| **Hardware Version:** | 476021A.X21 |
| **Software Version:** | SBTS22R2 |
| **Frequency Range:** | 860-869MHz |
| **GPCL Project Number:** | 2022-0010 |
| **Applicant** | Nokia Solutions and Networks<br>3201 Olympus Blvd<br>Dallas, Texas 75019<br>Steve Mitchell |
| **Manufacturer:** | NOKIA SOLUTIONS AND NETWORKS OY<br>KARAPORTTI 3, FI-02610 ESPOO<br>FINLAND |
| **Test Requirement(s):** | Title 47 CFR Parts 2 and 90z |
| **Test Standards:** | Refer to Section 1.5.1 |
| **Measurement Procedure(s):** | Refer to Section 1.5.2 |
| **Test Date(s):** | 2/9/2022 – 3/23/2022 |
| **Test Performed By:** | Nokia<br>Global Product Compliance Laboratory<br>600-700 Mountain Ave.<br>P.O. Box 636<br>Murray Hill, NJ 07974-0636<br>Test Site Number: US5302 |
| **Product Engineer(s):** | Ron Remy |
| **Lead Engineer:** | Steve Gordon |
| **Test Engineer (s):** | Nilesh Patel, Chris Polanco, Mike Soli, Joe Bordonaro |
| **Test Results:** The EUT, *as tested* met the above listed Test Requirements. The decision rule employed is binary (Pass/Fail) based on the measured values without accounting for Measurement Uncertainty or any Guard Band. The measured values obtained during testing were compared to a value given in the referenced regulation or normative standard. Report copies and other information not contained in this report are held by either the product engineer or in an identified file at the Global Product Compliance Laboratory in New Providence, NJ. | |

## 1.1 Introduction

This Conformity test report applies to the **AHBCD AirScale Dual RRH 4T4R 240W**, hereinafter referred to as the Equipment Under Test (EUT).

## 1.2 Purpose and Scope

The purpose of this document is to provide the testing data required for qualifying the EUT in compliance with FCC Parts 2 and 90z measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

The current test program is to demonstrate the following operation of the AHBCD:

- 5G-NR: 5 MHz
- LTE: 5 MHz

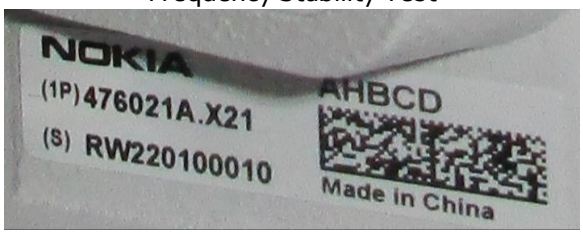
## 1.3 Specification

| Specification Items | Description |
|---|---|
| **Radio Access Technology** | 5G-NR, LTE |
| **Modulation Type(s)** | 64QAM, 256QAM |
| **Operation Frequency Range** | 860-869MHz |
| **Channel Bandwidths** | 5MHz both 5G-NR and LTE |
| **Tx/Rx** | 4T4R |
| **MIMO** | Yes |
| **Deployment Environment** | Outdoor |
| **Supply Voltage** | DC |
| **Max RF Output Power** | 4X40 W (47.78 dBm +/- 2.0dBm) |

### 1.3.1 Photographs

Radio Test


Frequency Stability Test




## 1.4 Test Requirements

Each required measurement is listed below:

| 47 CFR FCC Sections | Description of Tests | Test Required |
|---|---|---|
| 2.1046, 90.1321 | RF Power Output | Yes |
| 2.1047, 90.1323 | Modulation Characteristics | Yes |
| 2.1049, 90.1323 | (a) Occupied Bandwidth<br>(b) Out-of-Band Emissions | Yes |
| 2.1051, 90.1323 | Spurious Emissions at Antenna Terminals | Yes |
| 2.1053, 90.1323 | Field Strength of Spurious Radiation | Yes |
| 2.1055, 90.1323 | Measurement of Frequency Stability | Yes |

## 1.5 Standards & Procedures

### 1.5.1 Standards

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 90z.
- ANSI C63.26, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.
- ANSI C63.4 (2009) entitled: “American National Standard for Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz”, American National Standards Institute, Institute of Electrical and Electronic Engineers, Inc., New York, NY 10017-2394, USA.
- FCC KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013

### 1.5.2 Procedures

- FCC-IC-OB - GPCL Occupied Bandwidth and Power Measurement Test Procedure 12-4-2017
- FCC-IC-SE - GPCL Spurious Emissions Test Procedure 12-4-2017

## 1.5.3 MEASUREMENT UNCERTAINTY

The results of the calculations to estimate uncertainties for the several test methods and standards are shown in the Table below. These are the worst-case values.

**Worst-Case Estimated Measurement Uncertainties**

| Standard, Method or Procedure | Condition | Frequency MHz | Expanded Uncertainty (k=2) |
|---|---|---|---|
| a. Classical Emissions, (*e.g.*, ANSI C63.4, CISPR 11, 14, 22, *etc.*, using ESHS 30, | Conducted Emissions | 0.009 - 30 | ±3.5 dB |
| | Radiated Emissions (AR-6 Semi-Anechoic Chamber) | 30 MHz – 200MHz H<br>30 MHz – 200 MHz V<br>200 MHz – 1000 MHz H<br>200 MHz – 1000 MHz V<br>1 GHz - 18 GHz | ±5.1 dB<br>±5.1 dB<br>±4.7 dB<br>±4.7 dB<br>±3.3 dB |

| Antenna Port Test | Signal Bandwidth | Frequency Range | Expanded Uncertainty (k=2), Amplitude |
|---|---|---|---|
| Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions | 10 Hz<br>100 Hz<br>10 kHz to 1 MHz<br>1MHz | 9 kHz to 20 MHz<br>20 MHz to 1 GHz<br>1 GHz to 10 GHz<br>10 GHz to 40 GHz: | 1.78 dB |
| RF Power | 10 Hz to 20 MHz | 50 MHz to 18 GHz | 0.5 dB |

## 1.6 Executive Summary

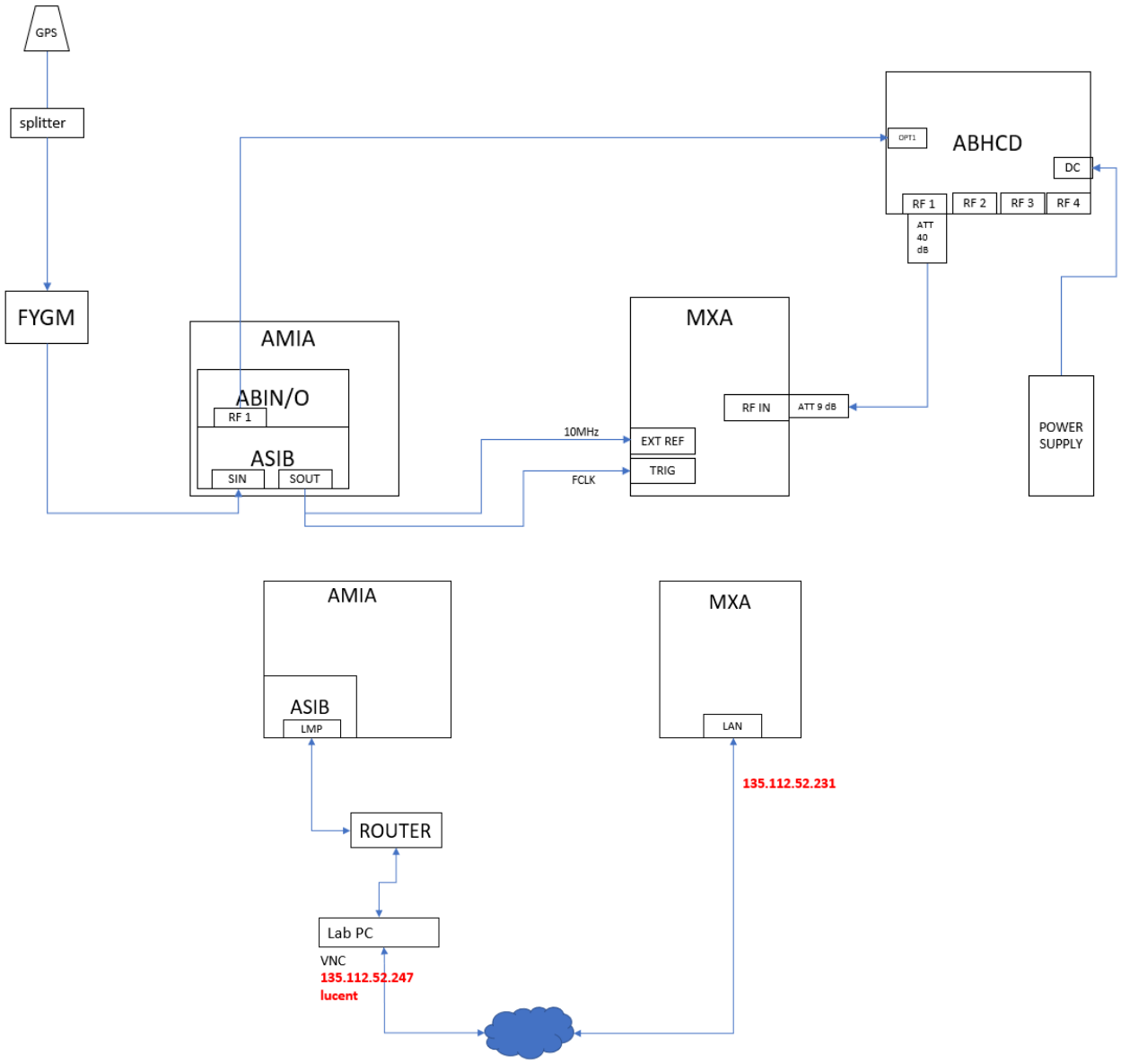
| 47 CFR FCC Sections | Description | Result |
|---|---|---|
| 2.1046, 90.1321 | RF Power Output | COMPLIES |
| 2.1047, 90.1323 | Modulation Characteristics | COMPLIES |
| 2.1049, 90.1323 | (a) Occupied Bandwidth<br>(b) Out-of-Band Emissions | COMPLIES |
| 2.1051, 90.1323 | Spurious Emissions at Antenna Terminals | COMPLIES |
| 2.1053, 90.1323 | Field Strength of Spurious Radiation | COMPLIES |
| 2.1055, 90.1323 | Measurement of Frequency Stability | COMPLIES |

1. **COMPLIES -** Passed all applicable tests.
2. **N/A –** Not Applicable.
3. **NT –** Not Tested.

## 1.7 Test Configuration for all Antenna Port Measurements.

Test Setup for all Antenna Port Measurements

Test Setup for Frequency Stability




**Customer Provided Equipment**

| Module | Part number | Serial number |
|---|---|---|
| AMIA | 473098A.101 | J8162308368 |
| ASIB | 474764A.M02 | L1190510487 |
| ABIO | 475266A.M02 | L1204401482 |
| FYGM | 473394A.102 | 1721800035 |

# 2. FCC Section 2.1046 - RF Power Output

## 2.1 RF Power Output

This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal. The product was configured for test as shown in section above and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26. The product is rated for 40 W (47.78 dBm +/- 2.0 dBm) per port for each of the four transmit ports.

Power measurements were made with an MXA Signal Analyzer and the procedure of ANSI C63.26:2015 Section 5.4.2.2 was observed. The maximum output is bolded in each case.

The product's maximum emission for 160 W (52.0 dBm) conducted power is less than the ERP of 500 W (57.0 dBm) per emission specified in Part 90.635 when coupled with an antenna that does not exceed 5.0 dBi.

**Tabular Data – Channel RF Power**

| **Channel Power - Signal BW 5MHz (5G-NR)** | | | |
|---|---|---|---|
| Test Model 3.1<br>Modulation 64QAM<br>Channel Frequency 862.5MHz | | Test Model 3.1a<br>Modulation 256QAM<br>Channel Frequency 866.5MHz | |
| TX Port | (dBm) | TX Port | (dBm) |
| 1 | 45.70 | 1 | 46.01 |
| 2 | 45.54 | 2 | 45.93 |
| 3 | 45.69 | 3 | 46.13 |
| 4 | **45.87** | 4 | **46.30** |
| Total Power (dBm) | 51.72 | Total Power (dBm) | 52.12 |
| Total Power (W) | 148.67 | Total Power (W) | 162.76 |

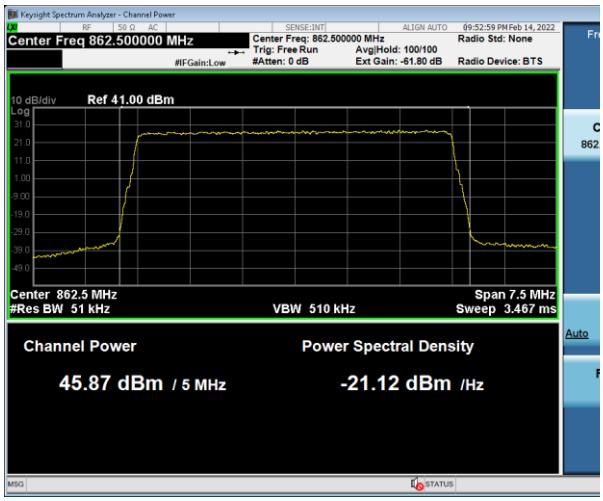
| **Channel Power - Signal BW 5MHz (LTE)** | | | |
|---|---|---|---|
| Test Model 3.1<br>Modulation 64QAM<br>Channel Frequency 862.5MHz | | Test Model 3.1a<br>Modulation 256QAM<br>Channel Frequency 866.5MHz | |
| TX Port | (dBm) | TX Port | (dBm) |
| 1 | **46.13** | 1 | **46.33** |
| 2 | 45.95 | 2 | 46.09 |
| 3 | 45.82 | 3 | 46.08 |
| 4 | 46.02 | 4 | 46.32 |
| Total Power (dBm) | 52.00 | Total Power (dBm) | 52.23 |
| Total Power (W) | 158.56 | Total Power (W) | 167.00 |

## 2.1.1 Channel RF Power - Plots.

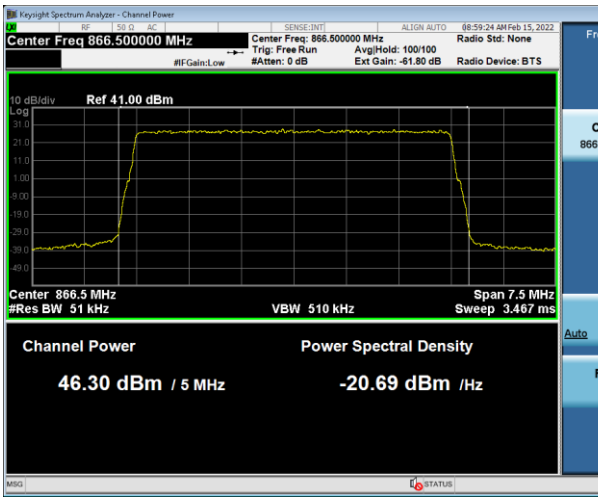
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

**5G-NR**

TM 3.1, 64QAM, 862.5MHz, TX4

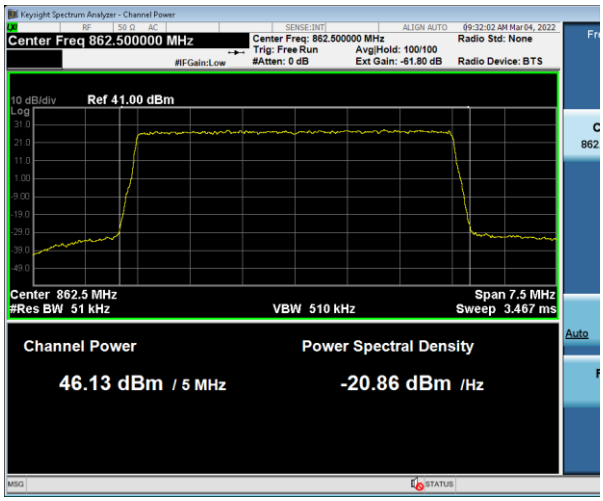



TM 3.1a, 256QAM, 866.5MHz, TX4

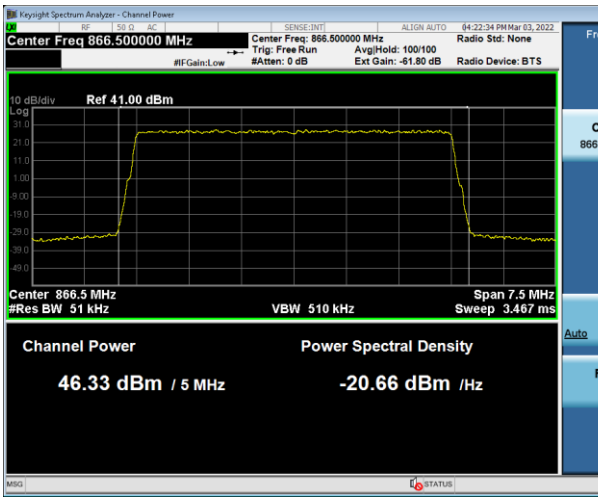



**LTE**

TM 3.1, 64QAM, 862.5MHz, TX1




TM 3.1a, 256QAM, 866.5MHz, TX1



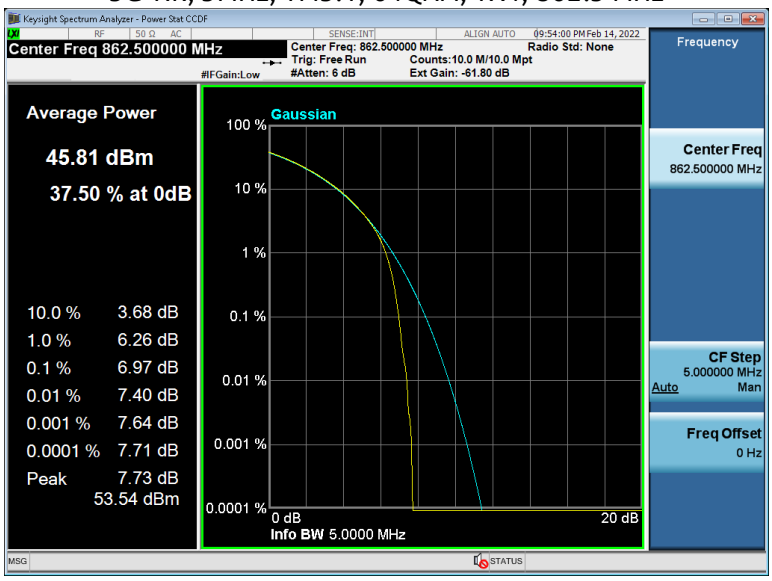
## 2.1.2 Peak-to-Average Power Ratio (PAPR)

The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168 for 5MHz bandwidths. The PAPR values of all carriers measured are below 13dB.

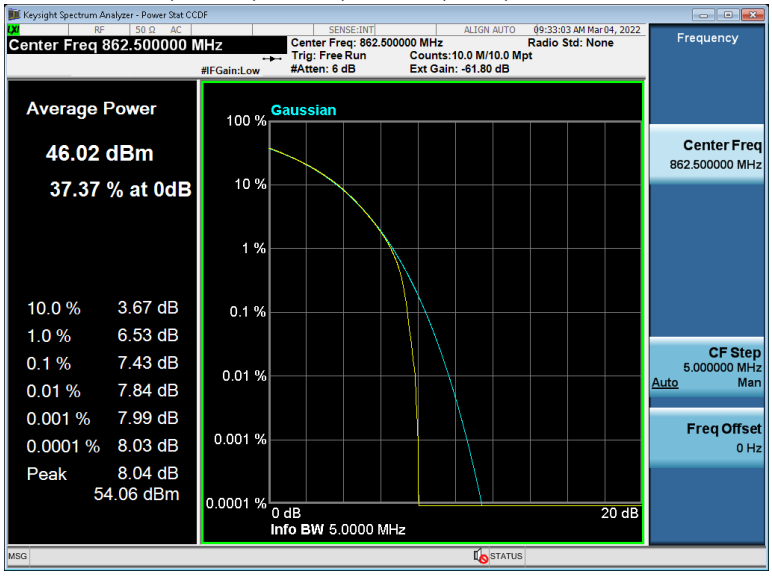
**PAPR Tabular Data**

| Radio Technology | # of Carrier | Signal BW MHz | Test Model | Modulation | TX Port | Channel Frequency MHz | PAR at 0.1% Limit - 13 dB |
|---|---|---|---|---|---|---|---|
| 5G-NR | 1 | 5 | 3.1 | 64QAM | 4 | 862.5 | **6.97** |
| 5G-NR | 1 | 5 | 3.1a | 256QAM | 4 | 866.5 | 6.72 |
| LTE | 1 | 5 | 3.1 | 64QAM | 1 | 862.5 | **7.43** |
| LTE | 1 | 5 | 3.1a | 256QAM | 1 | 866.5 | 7.35 |

5G-NR, 5MHz, TM3.1, 64QAM, TX4, 862.5 MHz




LTE, 5MHz, TM3.1, 64QAM, TX1, 862.5 MHz



# 3. FCC Section 2.1047 - Modulation Characteristics

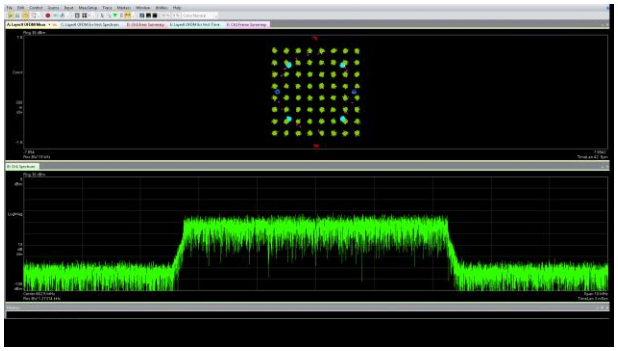
## 3.1 Modulation Characteristics

The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed. For these products the operation with, 64QAM and 256QAM modulation was evaluated for both LTE and 5G-NR and verified to demonstrate proper operation before testing.

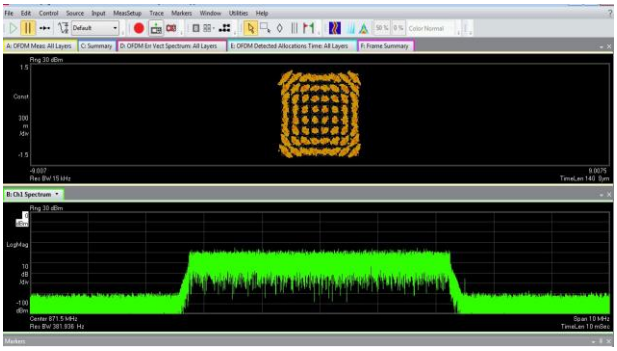
### 3.1.1 Modulation Characteristics – Plots.

64QAM (TM3.1)

LTE

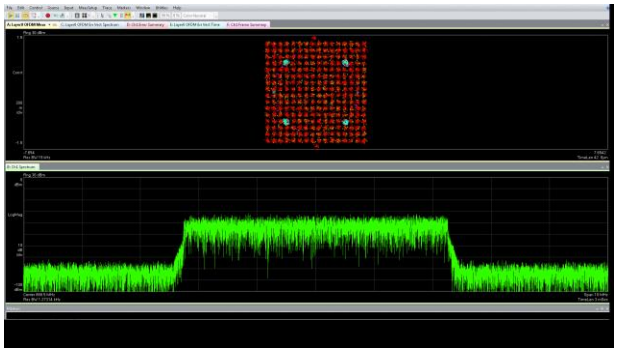


5G-NR

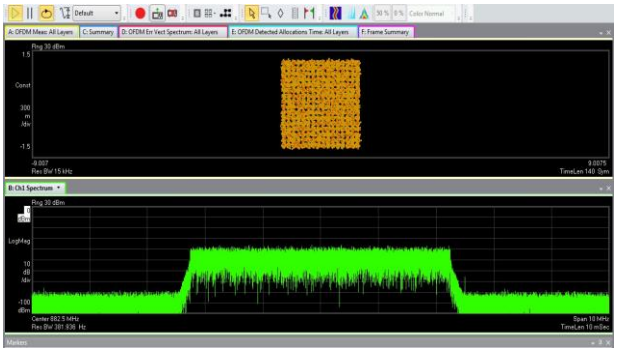


256QAM (TM3.1a)

LTE



5G-NR



# 4. FCC Section 2.1049 – Occupied Bandwidth/Edge of Band Emissions

## 4.1 Occupied Bandwidth

In 47CFR 2.1049 the FCC requires:

> "The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable."

This required measurement is the 99% Occupied Bandwidth, also called the designated signal bandwidth and needs to be within the parameters of the products specified emissions designator. During these measurements it is customary to evaluate the Edge of Band emissions at block/band edges.

The transmitted signal occupied bandwidth was measured using a Keysight MXA Signal Analyzer. All emissions were within the parameters as required.

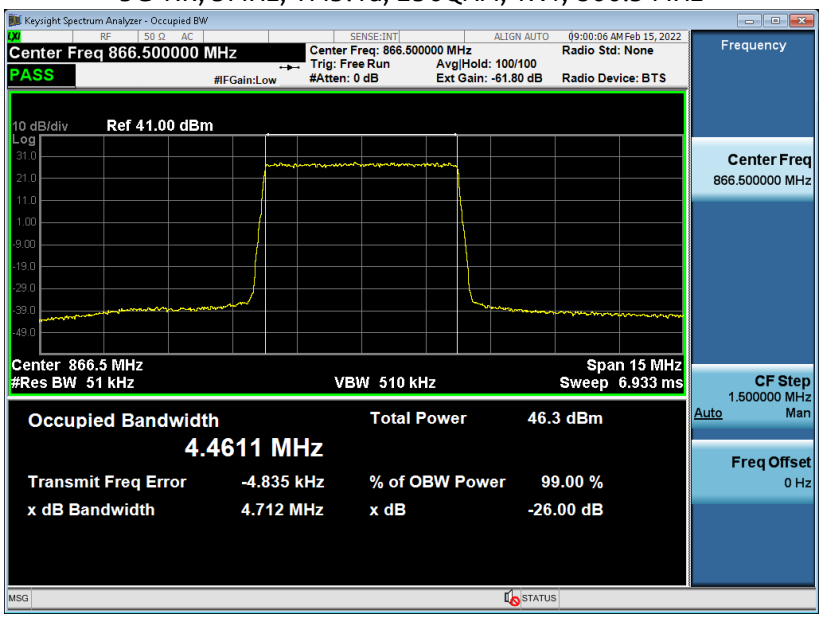
**Tabular Data – Occupied Bandwidth**

| Radio Technology | # of Carrier | Signal BW MHz | Test Model | Modulation | TX Port | Channel Frequency MHz | 99% OBW MHz |
|---|---|---|---|---|---|---|---|
| 5G-NR | 1 | 5 | 3.1 | 64QAM | 4 | 862.5 | 4.4569 |
| 5G-NR | 1 | 5 | 3.1a | 256QAM | 4 | 866.5 | **4.4611** |
| LTE | 1 | 5 | 3.1 | 64QAM | 1 | 862.5 | 4.4727 |
| LTE | 1 | 5 | 3.1a | 256QAM | 1 | 866.5 | **4.4806** |

### 4.1.1 Occupied Bandwidth – Plots.

NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

5G-NR, 5MHz, TM3.1a, 256QAM, TX4, 866.5 MHz




LTE, 5MHz, TM3.1a, 256QAM, TX1, 866.5 MHz

## 4.2 Edge of band Emissions

The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. Before measuring the Edge of Band emissions, the RF power level was confirmed with the Keysight MXA Signal Analyzer. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator and RF Switch. The path attenuation was offset on the display and the signal for the carrier was adjusted to the corrected RF power level for the resolution bandwidth used for the transmit signal. All mask values were adjusted based upon the designated signal bandwidth and measurement bandwidths.

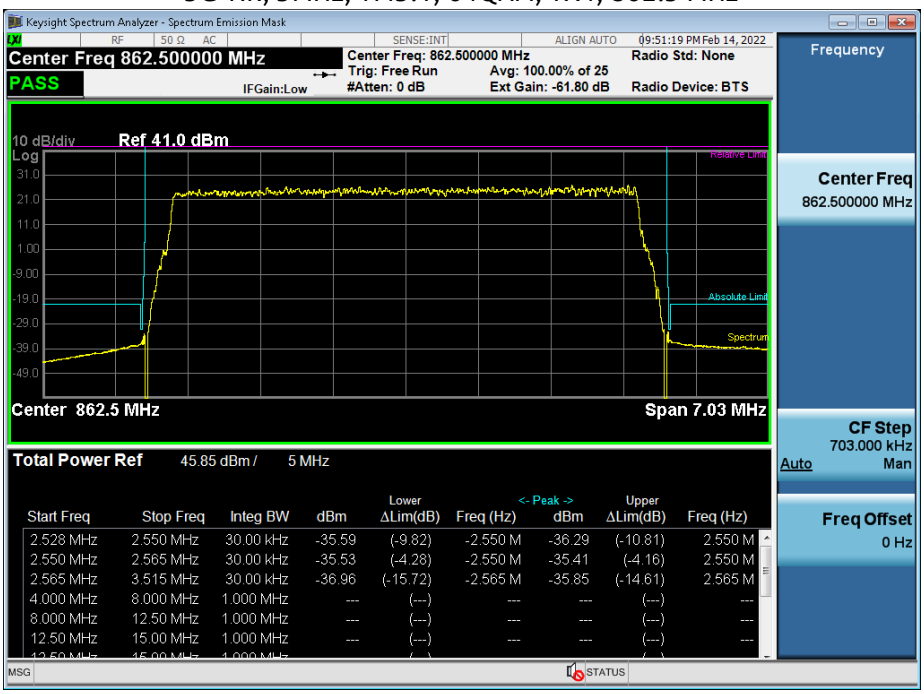
Note that the RF Switch is used only for units with a large number of ports and coincides with the photo and diagram, otherwise is removed.

In accordance with KDB 662911 D01 Multiple Transmitter Output, the limit of -13 dBm has been adjusted to -19 dBm to reflect 10 log(n) where n=4 for the 4x4 MIMO operation, then adjusted for the 1 MHz bands immediately outside and adjacent to the frequency block where a smaller RBW than the required 100 kHz stated in 47 CFR Parts 90.669 & 90.691 were used.

### 4.2.1 Edge of Band Emissions - Plots.

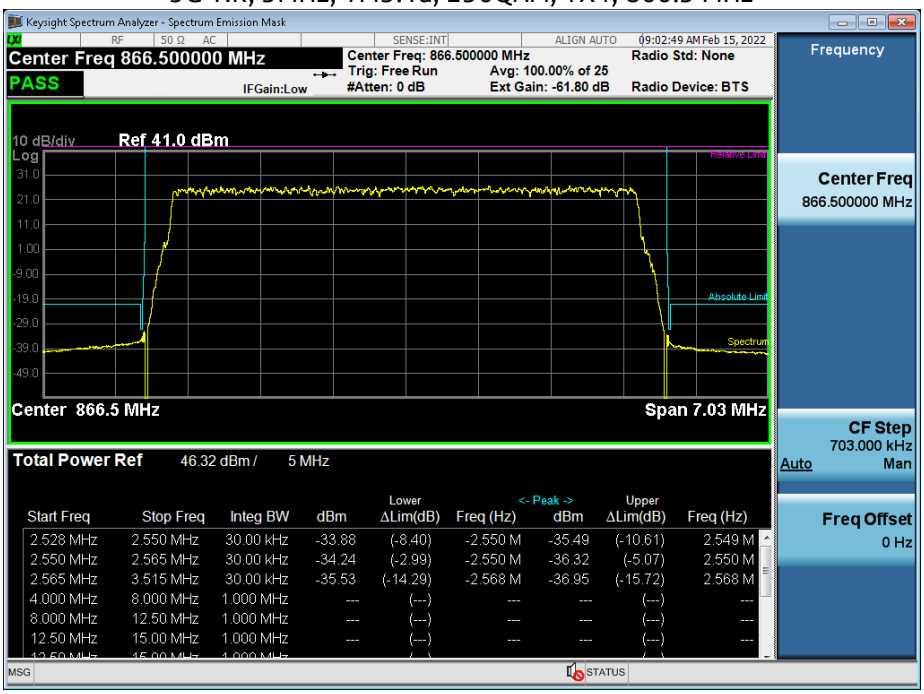
All of the measurements met the requirements of Part 2.1049 and 90z.

5G-NR, 5MHz, TM3.1, 64QAM, TX4, 862.5 MHz



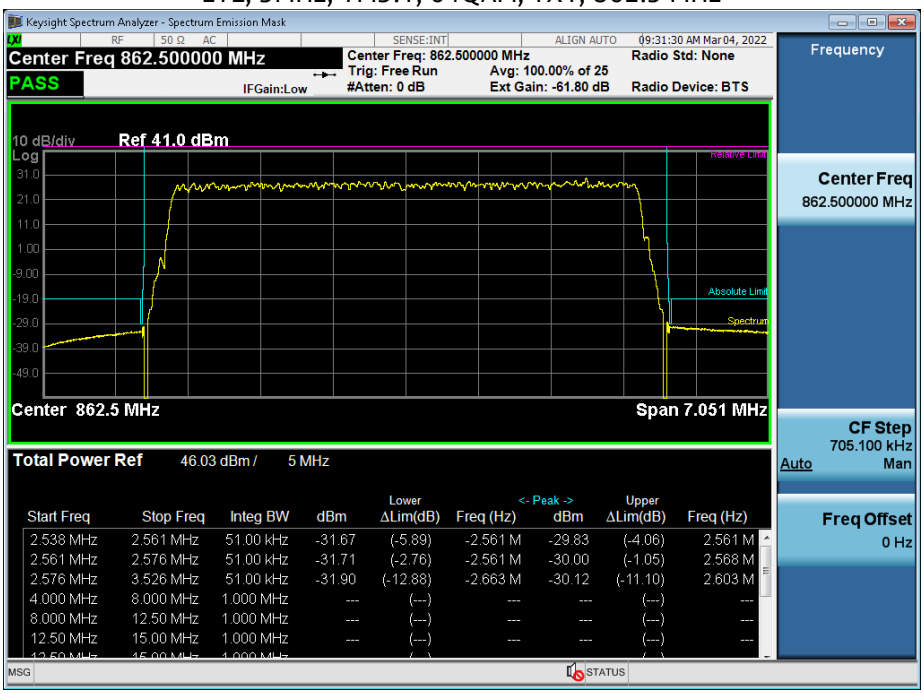

| Start Freq | Stop Freq | Integ BW | dBm | Lower ΔLim(dB) | Lower Freq (Hz) | <- Peak -> dBm | Upper ΔLim(dB) | Upper Freq (Hz) |
|---|---|---|---|---|---|---|---|---|
| 2.528 MHz | 2.550 MHz | 30.00 kHz | -35.59 | (-9.82) | -2.550 M | -36.29 | (-10.81) | 2.550 M |
| 2.550 MHz | 2.565 MHz | 30.00 kHz | -35.53 | (-4.28) | -2.550 M | -35.41 | (-4.16) | 2.550 M |
| 2.565 MHz | 3.515 MHz | 30.00 kHz | -36.96 | (-15.72) | -2.565 M | -35.85 | (-14.61) | 2.565 M |
| 4.000 MHz | 8.000 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |
| 8.000 MHz | 12.50 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |
| 12.50 MHz | 15.00 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |

5G-NR, 5MHz, TM3.1a, 256QAM, TX4, 866.5 MHz



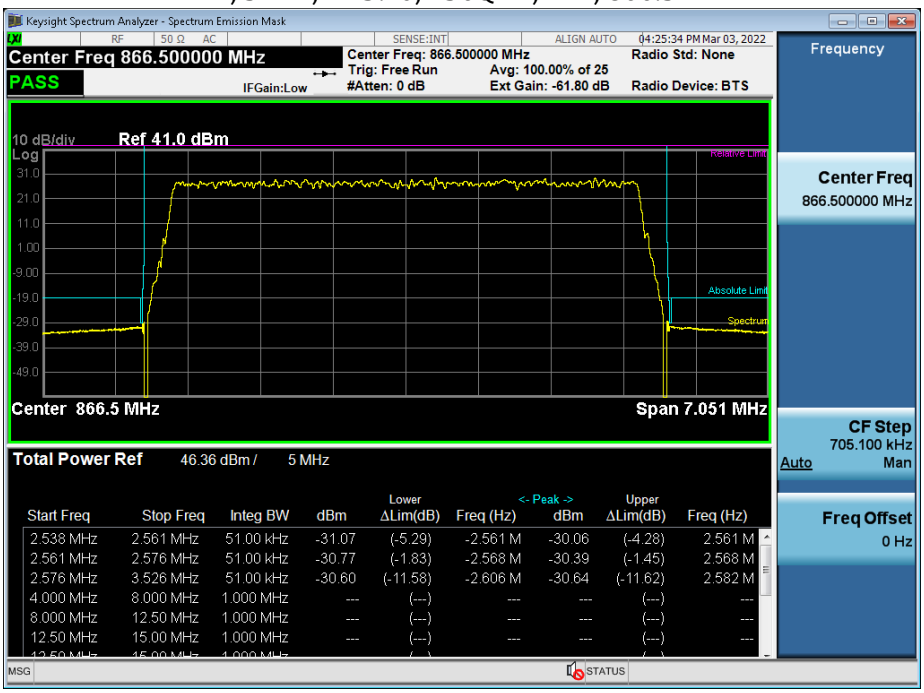

| Start Freq | Stop Freq | Integ BW | dBm | Lower ΔLim(dB) | Lower Freq (Hz) | <- Peak -> dBm | Upper ΔLim(dB) | Upper Freq (Hz) |
|---|---|---|---|---|---|---|---|---|
| 2.528 MHz | 2.550 MHz | 30.00 kHz | -33.88 | (-8.40) | -2.550 M | -35.49 | (-10.61) | 2.549 M |
| 2.550 MHz | 2.565 MHz | 30.00 kHz | -34.24 | (-2.99) | -2.550 M | -36.32 | (-5.07) | 2.550 M |
| 2.565 MHz | 3.515 MHz | 30.00 kHz | -35.53 | (-14.29) | -2.568 M | -36.95 | (-15.72) | 2.568 M |
| 4.000 MHz | 8.000 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |
| 8.000 MHz | 12.50 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |
| 12.50 MHz | 15.00 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |

LTE, 5MHz, TM3.1, 64QAM, TX1, 862.5 MHz




| Start Freq | Stop Freq | Integ BW | dBm | Lower ΔLim(dB) | Freq (Hz) | <- Peak -> dBm | Upper ΔLim(dB) | Freq (Hz) |
|---|---|---|---|---|---|---|---|---|
| 2.538 MHz | 2.561 MHz | 51.00 kHz | -31.67 | (-5.89) | -2.561 M | -29.83 | (-4.06) | 2.561 M |
| 2.561 MHz | 2.576 MHz | 51.00 kHz | -31.71 | (-2.76) | -2.561 M | -30.00 | (-1.05) | 2.568 M |
| 2.576 MHz | 3.526 MHz | 51.00 kHz | -31.90 | (-12.88) | -2.663 M | -30.12 | (-11.10) | 2.603 M |
| 4.000 MHz | 8.000 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |
| 8.000 MHz | 12.50 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |
| 12.50 MHz | 15.00 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |

LTE, 5MHz, TM3.1a, 256QAM, TX1, 866.5 MHz




| Start Freq | Stop Freq | Integ BW | dBm | Lower ΔLim(dB) | Freq (Hz) | <- Peak -> dBm | Upper ΔLim(dB) | Freq (Hz) |
|---|---|---|---|---|---|---|---|---|
| 2.538 MHz | 2.561 MHz | 51.00 kHz | -31.07 | (-5.29) | -2.561 M | -30.06 | (-4.28) | 2.561 M |
| 2.561 MHz | 2.576 MHz | 51.00 kHz | -30.77 | (-1.83) | -2.568 M | -30.39 | (-1.45) | 2.568 M |
| 2.576 MHz | 3.526 MHz | 51.00 kHz | -30.60 | (-11.58) | -2.606 M | -30.64 | (-11.62) | 2.582 M |
| 4.000 MHz | 8.000 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |
| 8.000 MHz | 12.50 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |
| 12.50 MHz | 15.00 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | --- |

# 5. FCC Section 2.1051 - Spurious Emissions at Transmit Antenna Port

## 5.1 Measurement of Spurious Emissions at Transmit Antenna Port

Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. For this band of operation, the measurements were performed up to 10GHz. Measurements were made using a Keysight MXA Signal Analyzer. The RF output from the transmitter was reduced (to an amplitude usable by the receivers) using calibrated attenuators.

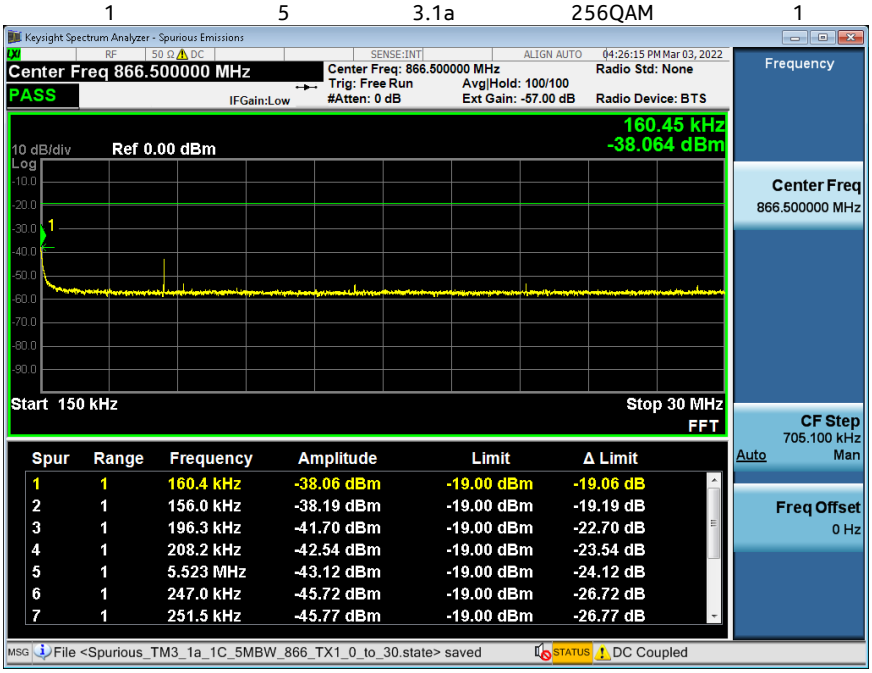
The measured spurious emission levels were plotted for the frequency range as specified in 2.1057. There were no reportable emissions. Data below documents performance up to 10 GHz. In accordance with KDB 662911 D01 Multiple Transmitter Output, the limit of -13 dBm has been adjusted to -19 dBm to reflect 10 log(n) where n=4 for the 4x4 MIMO operation.

NOTES: Only the emissions plots which give the minimum emission margin in each frequency range and with the emissions margin less than 20dB were used in this report. The full suite of raw data resides at the MH, New Jersey location.

### 5.1.1 Spurious Emissions at Tx Port - Plots

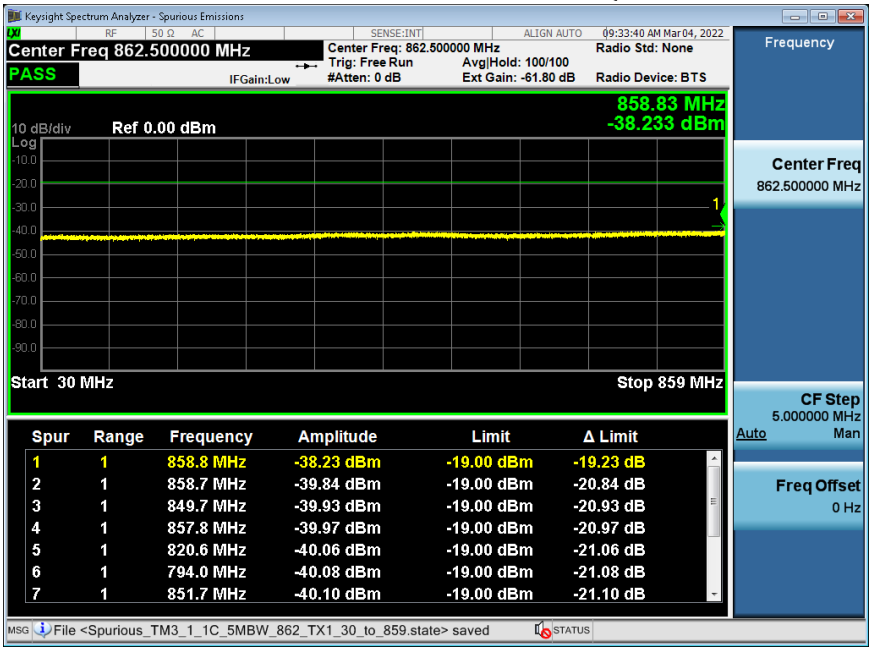
**150 kHz – 30MHz**

| Radio Technology | # of Carrier | Signal BW MHz | Test Model | Modulation | TX Port | Channel Frequency MHz |
|---|---|---|---|---|---|---|
| LTE | 1 | 5 | 3.1a | 256QAM | 1 | 866.5 |



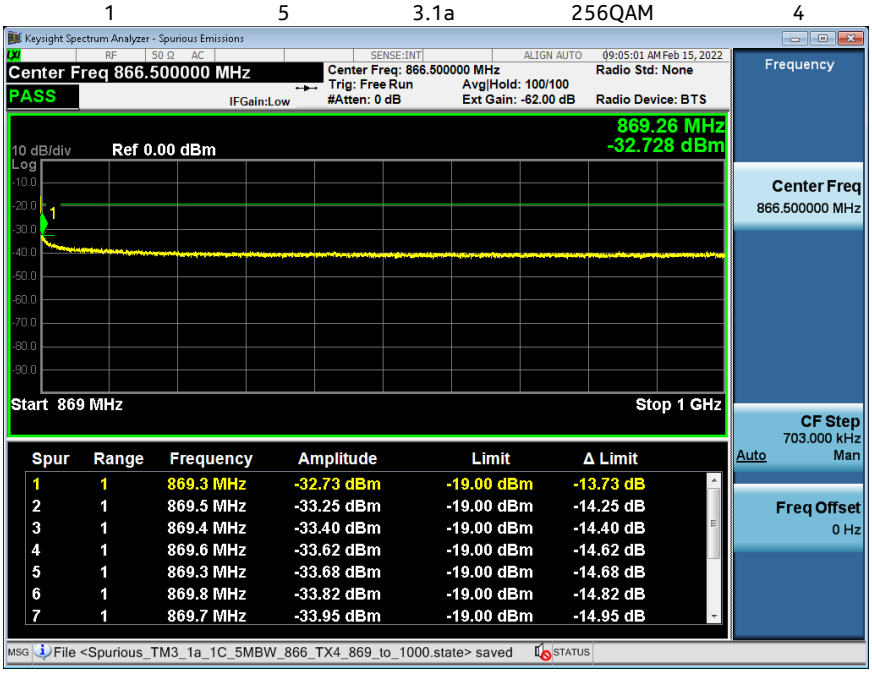
## 30MHz – 859 MHz

| Radio Technology | # of Carrier | Signal BW MHz | Test Model | Modulation | TX Port | Channel Frequency MHz |
|---|---|---|---|---|---|---|
| LTE | 1 | 5 | 3.1 | 64QAM | 1 | 862.5 |



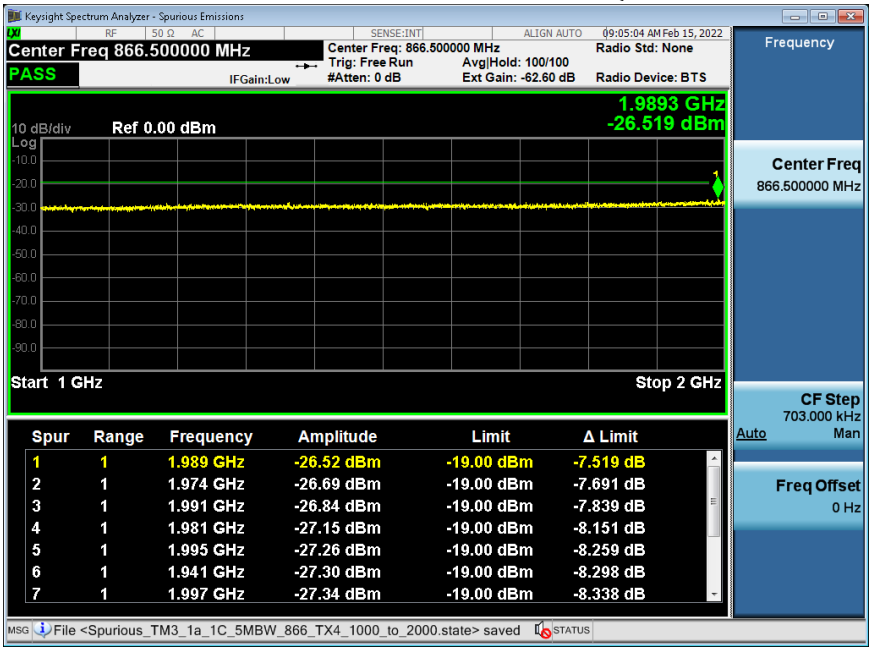

## 869MHz – 1 GHz

| Radio Technology | # of Carrier | Signal BW MHz | Test Model | Modulation | TX Port | Channel Frequency MHz |
|---|---|---|---|---|---|---|
| 5G-NR | 1 | 5 | 3.1a | 256QAM | 4 | 866.5 |



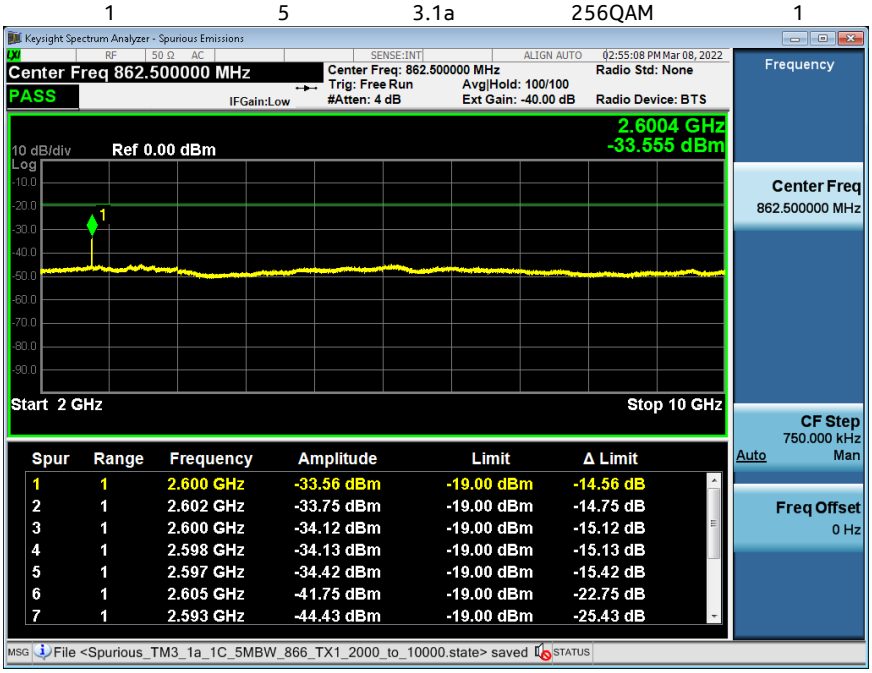
## 1GHz – 2 GHz

| Radio Technology | # of Carrier | Signal BW MHz | Test Model | Modulation | TX Port | Channel Frequency MHz |
|---|---|---|---|---|---|---|
| 5G-NR | 1 | 5 | 3.1a | 256QAM | 4 | 866.5 |

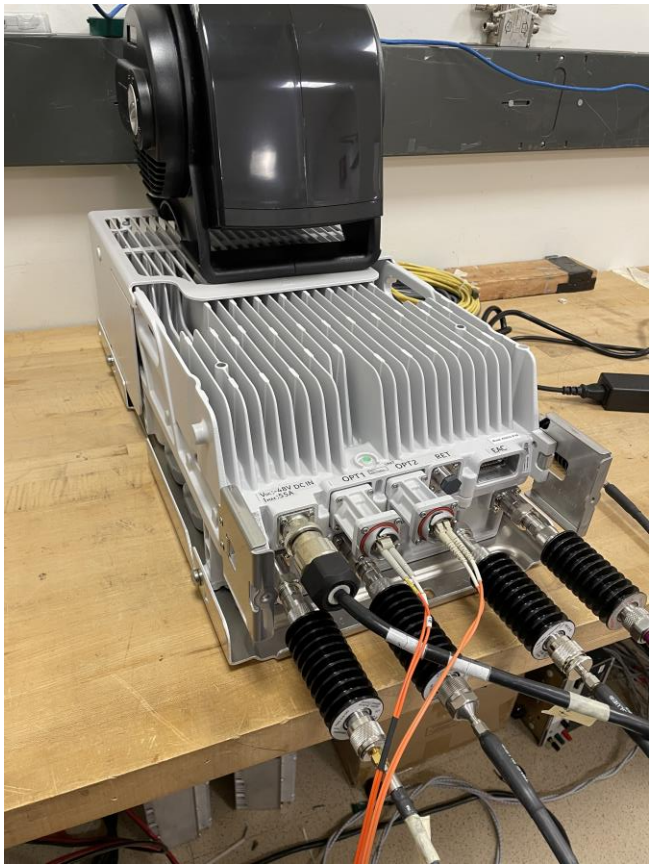



## 2GHz – 10GHz

| Radio Technology | # of Carrier | Signal BW MHz | Test Model | Modulation | TX Port | Channel Frequency MHz |
|---|---|---|---|---|---|---|
| LTE | 1 | 5 | 3.1a | 256QAM | 1 | 866.5 |



## Photographs

## Test Equipment

| Asset ID | Manufacturer | Type | Description | Model | Serial | Calibration Date | Calibration Due |
|---|---|---|---|---|---|---|---|
| E1217 | KeySight Technologies | EMI Receiver | MXE EMI Receiver 26.5GHz | N9038A | MY54130087 | 2021-05-11 | 2023-05-11 |
| EIH74 | KeySight Technologies | EMI Receiver | 20 Hz-44 GHz (Analysis Bandwidth 125 MHz) | N9020B | MY57120303 | 2020-12-21 | 2022-12-21 |
| E896 | Agilent Technologies | Network Analyzer | 10 MHz - 40 GHz | N5230C | MY49000897 | 2021-03-03 | 2023-03-03 |
| E1534 | Traceable | Data Logger | Barometric Humidity Temp Data Logger | 6529 | 200648430 | 2020-10-21 | 2022-10-21 |
| E1212 | RLC Electronics | Filter, High Pass | 10 - 30 GHz, 2W, 5dB | F-19414 | 1444002 | CNR-V | CNR-V |
| E1022 | Weinschel | Attenuator | 10dB DC-18GHz 25W | 46-10-34-LIM | BN3118 | CNR-V | CNR-V |
| E1023 | Weinschel | Attenuator | 20 dB DC-18 GHz 25W | 46-20-34 | BJ4772 | CNR-V | CNR-V |
| E1344 | Macom | Attenuator | 3 dB, DC - 4 GHz, 2W | 2082-6171-03 | N/A | CNR-V | CNR-V |
| E1155 | Weinschel | Attenuator | 10dB 25W 0.05- 26GHz | 74-10-12 | 1068 | CNR-V | CNR-V |
| E1154 | Weinschel | Attenuator | 30dB 25W 0.05GHz-26GHz | 74-30-12 | 1065 | CNR-V | CNR-V |
| E1250 | Weinschel | Attenuator | 3dB Attenuator 100W | 24-3-43 | BB9072 | CNR-V | CNR-V |
| E1251 | Aeroflex | Attenuator | 30dB 150W DC-18GHz Attenuator | 66-30-33 | BV1667 | CNR-V | CNR-V |

# 6. FCC Section 2.1053 - Field strength of spurious radiation

## 6.1 Section 2.1053 Field Strength of Spurious Emissions

Field strength measurements of radiated spurious emissions were made in an FCC registered 3m Semi-Anechoic Chamber which is maintained by Nokia Bell Labs in Murray Hill, New Jersey. A complete description and full measurement data for the site is on file with the Commission (Site Registration Number: 515091).

The spectrum from 30 MHz to beyond the tenth harmonic of the carrier, 10 GHz, was searched for spurious radiation. Measurements were made using both horizontally and vertically polarized broadband antennas. Per FCC regulations, the comparison of out of band spurious emissions directly to the limit is appropriately made using the substitution method. However, when the emissions are more than 20 dB below the specification limit, the use of field strength measurements for compliance determination is acceptable and those emissions are considered not reportable (Section 2.1053 and the FCC Interpretive database for 2.1053). For this case the evaluation of acceptable radiated field strength is as follows.

Section 2.1053 contains the requirements for the levels of spurious radiation as a function of the level of the unmodulated carrier. The reference level for the unmodulated carrier is calculated as the field produced by an ideal dipole excited by the transmitter output power according to the following relation taken from Reference Data for Radio Engineers, page 676, 4th edition, IT&T Corp.

$$E = [(30*P)^{1/2}]/R$$

$$20 \log (E*10^{6}) - (43 + 10 \log P) = 82.23 \text{ dB}\mu\text{V/meter}$$

Where:
E = Field Intensity in Volts/meter P = Transmitted Power in Watts
R = Measurement distance in meters = 3 m

The Part 2.1053 Limit is 82.23 dBuV/m at 3m and 91.77 dBuV/m at 1m
The Part 2.1053 non-report level is 62.23 dBuV/m at 3m.

The calculated emission levels were found by:

Measured level (dBμV) + Cable Loss(dB)+Antenna Factor(dB) = Field Strength (dBμV/m)

RESULTS:

For compliance with 47CFR Part 2.1053, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 dBμV/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dBμV/meter at 3m are not reportable and may be verified using field strength measurements and broadband antennas. Over the out of band spectrum investigated from 30 MHz to beyond the tenth harmonic of the carrier (up to 10 GHz), no reportable spurious emissions were detected.

# 7. FCC Section 2.1055 - Measurement of Frequency Stability

**Frequency Block Tested: *AHBCD (CF = 864 MHz)***

**Baseline Measurement at +25°C**

| Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -422.69 |
| 0.5 | -856.56 |
| 1.0 | 717.63 |
| 1.5 | 41.531 |
| 2.0 | 120.87 |
| 2.5 | 168.43 |
| 3.0 | -1.0987 Hz |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -429.82 |
| 0.5 | -322.53 |
| 1.0 | -153.28 |
| 1.5 | -629.56 |
| 2.0 | 1.0045 Hz |
| 2.5 | -58.006 |
| 3.0 | 104.11 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | 573..31 |
| 0.5 | -664.06 |
| 1.0 | -616.57 |
| 1.5 | -782.50 |
| 2.0 | -231.26 |
| 2.5 | -525.50 |
| 3.0 | -1.0632 Hz |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -8.6316 |
| 0.5 | -367.31 |
| 1.0 | -744.36 |
| 1.5 | -222.88 |
| 2.0 | 458.72 |
| 2.5 | -579.34 |
| 3.0 | 407.05 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -493.13 |
| 0.5 | -338.57 |
| 1.0 | -24.146 |
| 1.5 | -116.28 |
| 2.0 | -240.94 |
| 2.5 | -864.78 |
| 3.0 | -386.72 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -646.81 |
| 0.5 | 168.05 |
| 1.0 | -993.19 |
| 1.5 | -514.95 |
| 2.0 | -284.99 |
| 2.5 | -558.23 |
| 3.0 | -250.96 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| **Time (minutes)** | **Transmit Carrier Deviation (mHz)** |
| **0** | **1.3103 Hz** |
| **0.5** | **-525.80** |
| **1.0** | **-670.32** |
| **1.5** | **-501.56** |
| **2.0** | **-336.07** |
| **2.5** | **-486.38** |
| **3.0** | **-352.85** |
| **FCC SPECIFICATION** | **864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz** |
| **FCC RESULT** | **Pass** |

| Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| **Time (minutes)** | **Transmit Carrier Deviation (mHz)** |
| **0** | **-147.71** |
| **0.5** | **-373.83** |
| **1.0** | **201.67** |
| **1.5** | **-315.27** |
| **2.0** | **-377.12** |
| **2.5** | **-587.67** |
| **3.0** | **-252.86** |
| **FCC SPECIFICATION** | **864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz** |
| **FCC RESULT** | **Pass** |

| Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| **Time (minutes)** | **Transmit Carrier Deviation (mHz)** |
| **0** | **-167.55** |
| **0.5** | **240.99** |
| **1.0** | **-293.40** |
| **1.5** | **-616.86** |
| **2.0** | **-745.93** |
| **2.5** | **-899.03** |
| **3.0** | **-482.22** |
| **FCC SPECIFICATION** | **864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz** |
| **FCC RESULT** | **Pass** |

| Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -665.08 |
| 0.5 | -1.0520Hz |
| 1.0 | -812.97 |
| 1.5 | 512.20 |
| 2.0 | -445.02 |
| 2.5 | -1.4002Hz |
| 3.0 | 960.04 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

**Upon return to +25°C.**

| Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -525.00 |
| 0.5 | 597.28 |
| 1.0 | -727.54 |
| 1.5 | -414.84 |
| 2.0 | -359.97 |
| 2.5 | 383.37 |
| 3.0 | -417.82 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at 103% of Nominal Voltage, -49.44VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -61.718 |
| 0.5 | -540.11 |
| 1.0 | 486.99 |
| 1.5 | -400.15 |
| 2.0 | 107.77 |
| 2.5 | -232.92 |
| 3.0 | -316.30 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at 106% of Nominal Voltage, -50.88VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -274.95 |
| 0.5 | 529.63 |
| 1.0 | 1.0348Hz |
| 1.5 | -682.86 |
| 2.0 | -911.02 |
| 2.5 | -170.29 |
| 3.0 | 190.62 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at 109% of Nominal Voltage, -52.32VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | 180.97 |
| 0.5 | -560.57 |
| 1.0 | 271.93 |
| 1.5 | 296.48 |
| 2.0 | -450.22 |
| 2.5 | -227.22 |
| 3.0 | -306.08 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at 112% of Nominal Voltage, -53.76VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -141.92 |
| 0.5 | -1.6025Hz |
| 1.0 | 497.97 |
| 1.5 | 177.10 |
| 2.0 | 451.19 |
| 2.5 | 466.90 |
| 3.0 | -988.93 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at 115% of Nominal Voltage, -55.20VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -771.12 |
| 0.5 | 44.783 |
| 1.0 | -1.0030Hz |
| 1.5 | 671.91 |
| 2.0 | -199.85 |
| 2.5 | -67.816 |
| 3.0 | 507.77 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm)<br>±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48.0VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -177.56 |
| 0.5 | 519.88 |
| 1.0 | -482.54 |
| 1.5 | -327.46 |
| 2.0 | -467.87 |
| 2.5 | 1.3165 Hz |
| 3.0 | 46.765 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm)<br>±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, -46.56VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | 249.34 |
| 0.5 | 298.55 |
| 1.0 | -276.33 |
| 1.5 | 584.52 |
| 2.0 | 989.65 |
| 2.5 | -693.86 |
| 3.0 | 570.25 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm)<br>±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, -45.12VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | 308.54 |
| 0.5 | -1.1915 Hz |
| 1.0 | -318.54 |
| 1.5 | -590.64 |
| 2.0 | -237.12 |
| 2.5 | -307.20 |
| 3.0 | 436.07 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, -43.68VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | -256.94 |
| 0.5 | 393.41 |
| 1.0 | 35.093 |
| 1.5 | 896.87 |
| 2.0 | 80.098 |
| 2.5 | -917.57 |
| 3.0 | -555.96 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, -42.24VDC | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (mHz) |
| 0 | 325.45 |
| 0.5 | -633.24 |
| 1.0 | -916.93 |
| 1.5 | -187.70 |
| 2.0 | 21.521 |
| 2.5 | 578.24 |
| 3.0 | 267.14 |
| FCC SPECIFICATION | 864 MHz (±0.05ppm) ±0.05ppm = ± 43.2 Hz |
| FCC RESULT | Pass |

| **Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, -40.80VDC** | |
|---|---|
| **Time (minutes)** | **Transmit Carrier Deviation (mHz)** |
| **0** | **-613.58** |
| **0.5** | **-312.21** |
| **1.0** | **157.50** |
| **1.5** | **-555.19** |
| **2.0** | **171.37** |
| **2.5** | **-187.61** |
| **3.0** | **-849.09** |
| **FCC SPECIFICATION** | **864 MHz (±0.05ppm)**<br>**±0.05ppm = ± 43.2 Hz** |
| **FCC RESULT** | **Pass** |

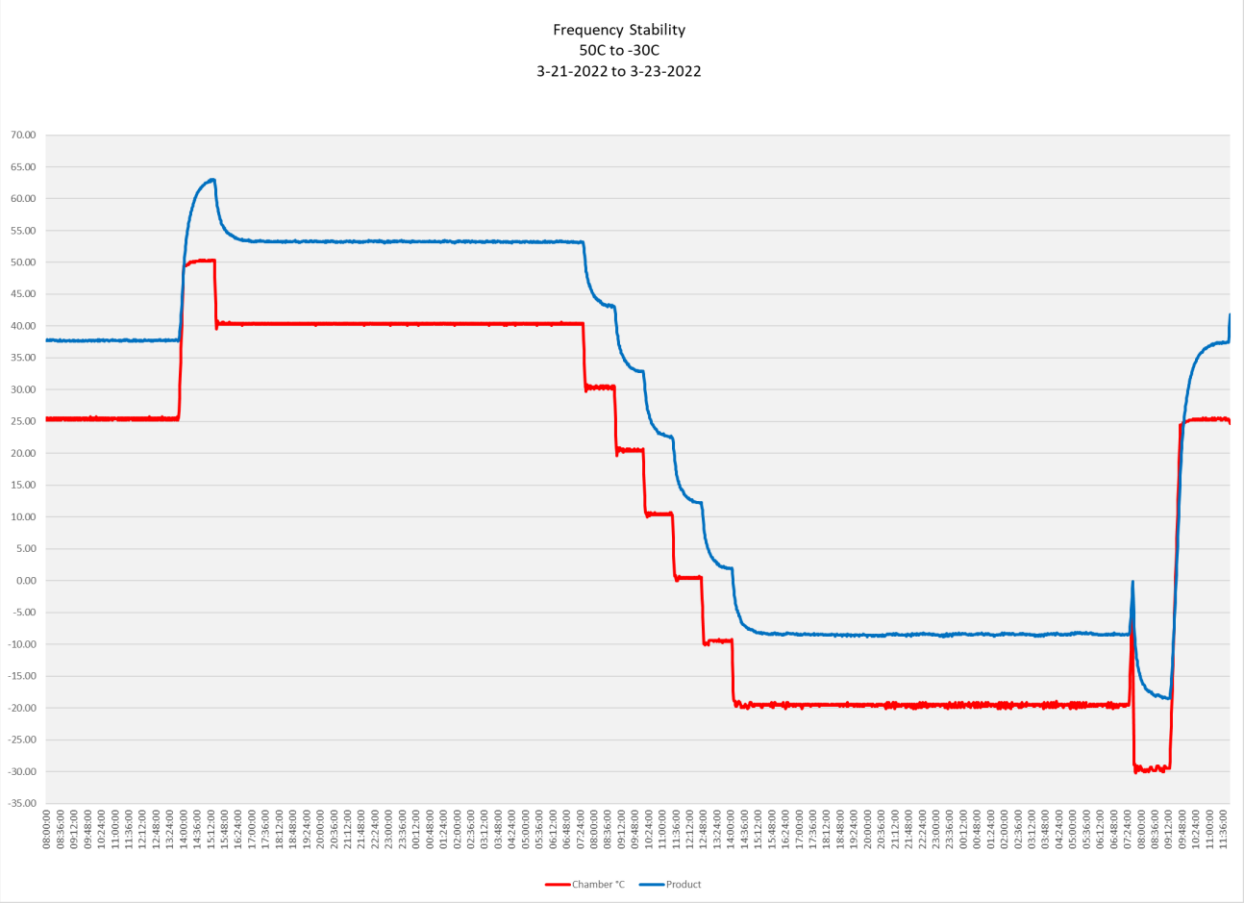
## Photographs

## Test Equipment

| Asset ID | Manufacturer | Type | Description | Model | Serial | Calibration Date | Calibration Due |
|---|---|---|---|---|---|---|---|
| TH509-T11 | Envirotronics | Controller | Solutions Plus Controller | Envirotronics SPPCM | SP000638 | 2021-06-08 | 2023-06-08 |
| TH-T11 | Envirotronics | Thermal Chamber | Thermal Chamber | N/A | 0999-4722 | CNR | CNR |
| TH069 | Extech | Data Logger | Barometric Pressure/Humidity/Temperature | SD700 | Q690305 | 2021-07-20 | 2023-07-20 |
| TH017 | Yokogawa | Recorder | MVAdvanced portable paperless recorder | MV2048 | S5JC04823 | 2021-07-21 | 2023-08-21 |
| MY57431033 | KeySight Technologies | MXA Signal Analyzer | 20 Hz-44 GHz (Analysis Bandwidth 125 MHz) | N9020B | MY5712033 | 2020-07-08 | 2022-07-08 |
| TH073 | Fluke | DMM | Digital Multimeter | 87V | 25910080 | 2022-02-24 | 2024-02-24 |
| N/A | Power Ten | DC power supply | 66V 330A DC Powersupply | R66C-60330 | 021AA9018 | CNR | CNR |

CNR: Calibration Not Required

## Chamber Plot



# 8. NVLAP Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

ilac-MRA

## Certificate of Accreditation to ISO/IEC 17025:2017

**NVLAP LAB CODE: 100275-0**

**Nokia, Global Product Compliance Lab**
Murray Hill, NJ

*is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:*

**Electromagnetic Compatibility & Telecommunications**

*This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).*

2021-09-24 through 2022-09-30
*Effective Dates*

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

*For the National Voluntary Laboratory Accreditation Program*