Global Product Compliance Laboratory
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TESTING
NVLAP LAB CODE: 100275-0

Title 47 Code of Federal Regulations Test Report

Regulation:
FCC Part 2 and 22

Client:
NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:
AHCF AirScale RRH 4T4R B26 200W

Report Number:
TR-2023-0112-FCC2-22

Date Issued:
September 20, 2023

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Revisions

Date	Revision	Section	Change
9/20/2023	0		Initial Release

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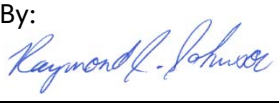
Signed:  9/20/2023

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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):	AHCF AirScale RRH 4T4R B5 200W
FCC ID:	VBNAHCF-01
Serial Number:	6Q201003935
Hardware Version:	475313A.101
Software Version:	SBTS21B
Frequency Range:	869-894MHz
GPCL Project Number:	2023-0054
Applicant	Nokia Solutions and Networks 3201 Olympus Blvd Dallas, Texas 75019 Steve Mitchell
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Test Requirement(s):	Title 47 CFR Parts 2 and 22
Test Standards:	Refer to Section 1.5.1
Measurement Procedure(s):	Refer to Section 1.5.2
Test Date(s):	6/29/2023
Test Performed By:	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636 Test Site Number: US5302
Product Engineer(s):	Ron Remy
Lead Engineer:	Nilesh Patel
Test Engineer (s):	Nilesh Patel
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 **AHCF AirScale RRH 4T4R B26 200W**, hereinafter referred to as the Equipment Under Test (EUT).

The Nokia AHCF AirScale RRH 4T4R B5 200W (RRH) (hereinafter referred to as "AHCF") is a higher power RRH operating under the regulations of FCC Part 22 - Cellular Telephone Systems Operating in Band 26, 869-894 MHz. The AHCF supports 5G-NR and Long Term Evolution - Frequency Division Duplex (LTE FDD) technology, 4 MIMO ports configured for 2x60W + 2x45W or 4x45W MIMO. The AHCF also supports single and multiple carriers (contiguous or noncontiguous), with combinations of LTE + NBIoT (Guardband and Inband), and NBIoT Standalone as well as single and multiple carrier operations.

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 22, per requirements for Class II permissive changes certification, measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

5G-NR carrier tested configurations are as follows:

- 15 MHz – Single 5G-NR carrier
- 20 MHz – Single 5G-NR carrier

This report adds 15 and 20 MHz 5G-NR emissions designators to the existing grant.

The grant already states that the EUT supports 15 and 20 MHz bandwidths, however, this was done in error. The addition of the 15 and 20 MHz in this project would allow for the Grant to stay as is but with Emission Designators added to support the statement.

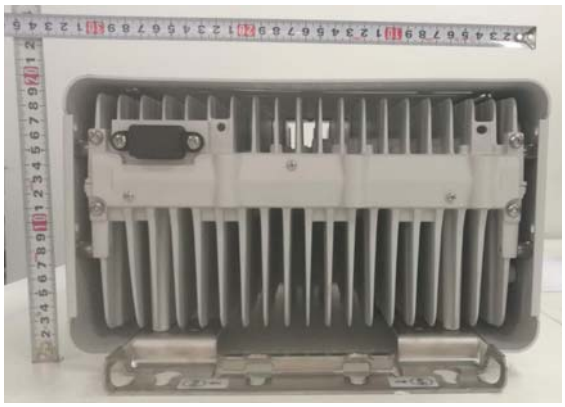
1.3 EUT Details

1.3.1 Specifications

5G-NR

Specification Items	**Description**		
Radio Access Technology	5G-NR		
Duplex Mode	FDD		
Modulation Type(s)	QPSK, 16QAM, 64QAM, 256QAM		
Channel Bandwidth	15 ,20 MHz		
Number of Tx Ports per Unit	4		
MIMO	Yes		
Max Conducted Power	2 x 47.8 dBm (60 W) + 2 x 46.5 dBm (45 W) or 4 x 46.5 dBm (45 W)		
Max Number of Carriers per Port	4		
Deployment Environment	Outdoor		
Environment Temperature Range	-40 °C to 55 °C		
Power Source	Voltage Ranges (VDC)		
	Minimum	Nominal	Maximum
	-40.0	-48.0	-57.0
Antenna	Detachable Directional Panel		

1.3.2 Photographs



1.4 Test Requirements

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046	RF Power Output	Yes
2.1047	Modulation Characteristics	Yes
2.1049	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051	Conducted Out-of-Band Emissions Spurious Emissions at Antenna Terminals	Yes
2.1053, 22.917	Field Strength of Spurious Radiation	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 22.
- FCC KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013.
- ANSI C63.26 (2015), American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
- ANSI C63.4 (2014) 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.

1.5.2 Procedures

- FCC-IC-OB - GPCL Power Measurement, Occupied Bandwidth & Modulation Test Procedure 6-20-2019
- FCC-IC-SE - GPCL Spurious Emissions Test Procedure 6-20-2019

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 30 MHz – 200 MHz V 200 MHz – 1000 MHz H 200 MHz – 1000 MHz V 1 GHz - 18 GHz	±5.1 dB ±5.1 dB ±4.7 dB ±4.7 dB ±3.3 dB

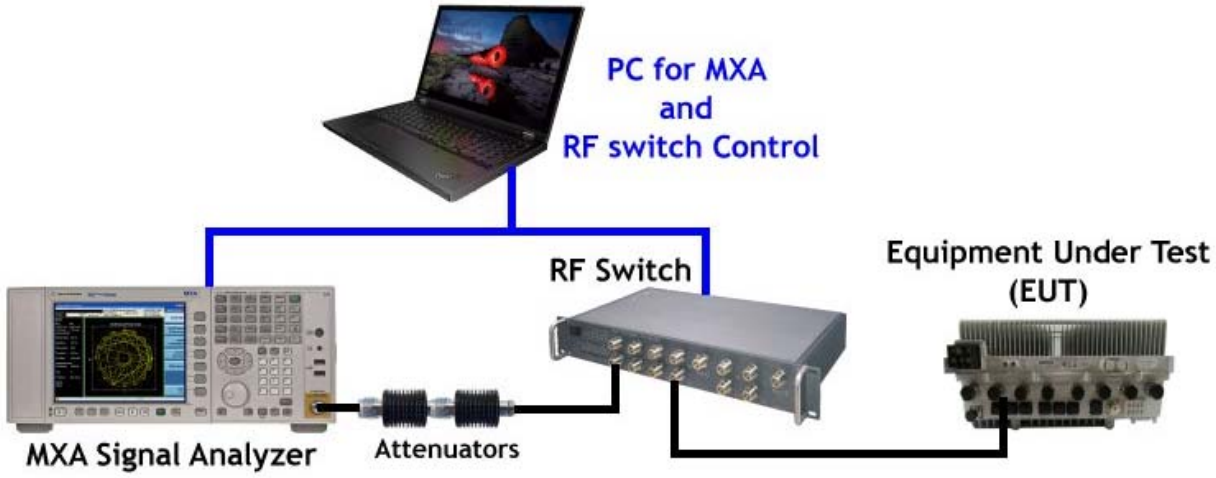
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz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

1.6 Executive Summary

Requirement	Description	Result
47 CFR FCC Parts 2 and 22		
2.1046	RF Power Output Peak to Average Power Ratio	COMPLIES
2.1047	Modulation Characteristics	COMPLIES
2.1049	(a) Occupied Bandwidth (b) Edge of Band Emissions	COMPLIES
2.1051	Spurious Emissions at Antenna Terminals	COMPLIES
2.1053, 22.917	Field Strength of Spurious Radiation	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.



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 45 W (46.5 dBm +/- 2.0 dBm) or 60W (47.8 dBm +/- 2.0 dBm) per port for each of the four transmit ports.

Power measurements were made with an MXA Signal Analyzer.

2.1.1 5G-NR Results

Signal BW - 15 MHz							
45W				60W			
Test Model 3.1 Modulation 64QAM Channel Frequency 876.5MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 886.5MHz		Test Model 3.1 Modulation 64QAM Channel Frequency 876.5MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 886.5MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
2	46.14	2	45.89	0	**47.99**	0	**47.81**
3	**46.17**	3	**45.96**	1	47.89	1	47.76
Total Power (dBm)	49.17	Total Power (dBm)	48.94	Total Power (dBm)	50.95	Total Power (dBm)	50.80
Total Power (W)	82.51	Total Power (W)	78.26	Total Power (W)	124.47	Total Power (W)	120.10

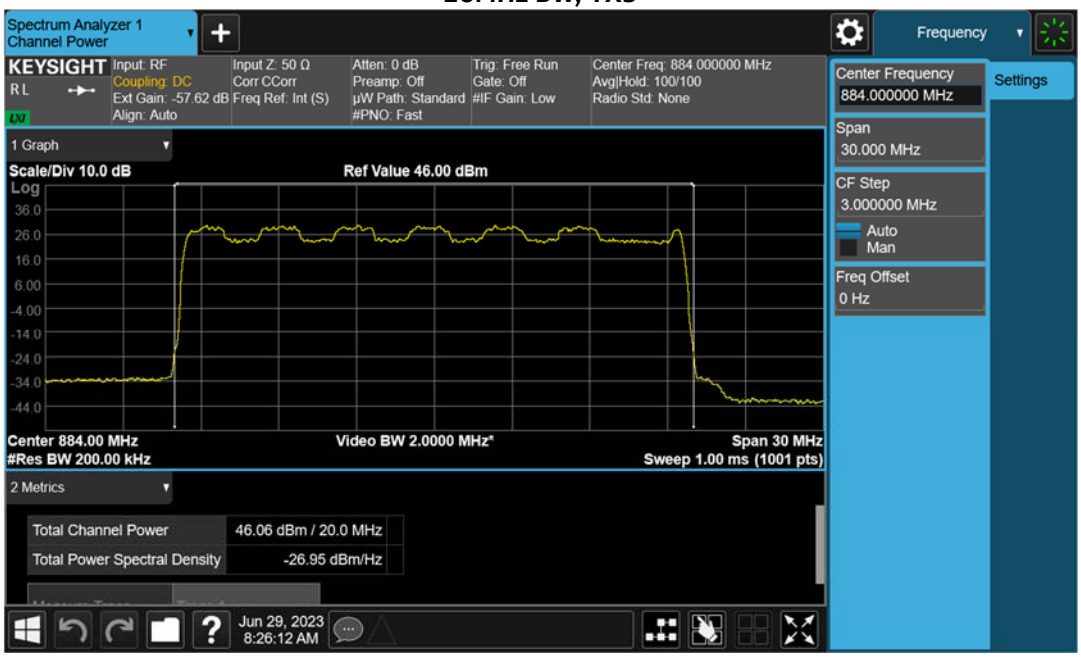
Signal BW - 20 MHz							
45W				60W			
Test Model 1.1 Modulation QPSK Channel Frequency 879MHz		Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 884MHz		Test Model 1.1 Modulation QPSK Channel Frequency 879MHz		Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 884MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
2	45.90	2	45.95	0	**47.89**	0	**47.97**
3	**46.05**	3	**46.06**	1	47.82	1	47.80
Total Power (dBm)	48.99	Total Power (dBm)	49.02	Total Power (dBm)	50.87	Total Power (dBm)	50.90
Total Power (W)	79.18	Total Power (W)	79.72	Total Power (W)	122.05	Total Power (W)	122.92

2.1.2 Channel RF Power – 45W 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.

Channel Frequency 876.5MHz, 64QAM
15MHz BW, TX3

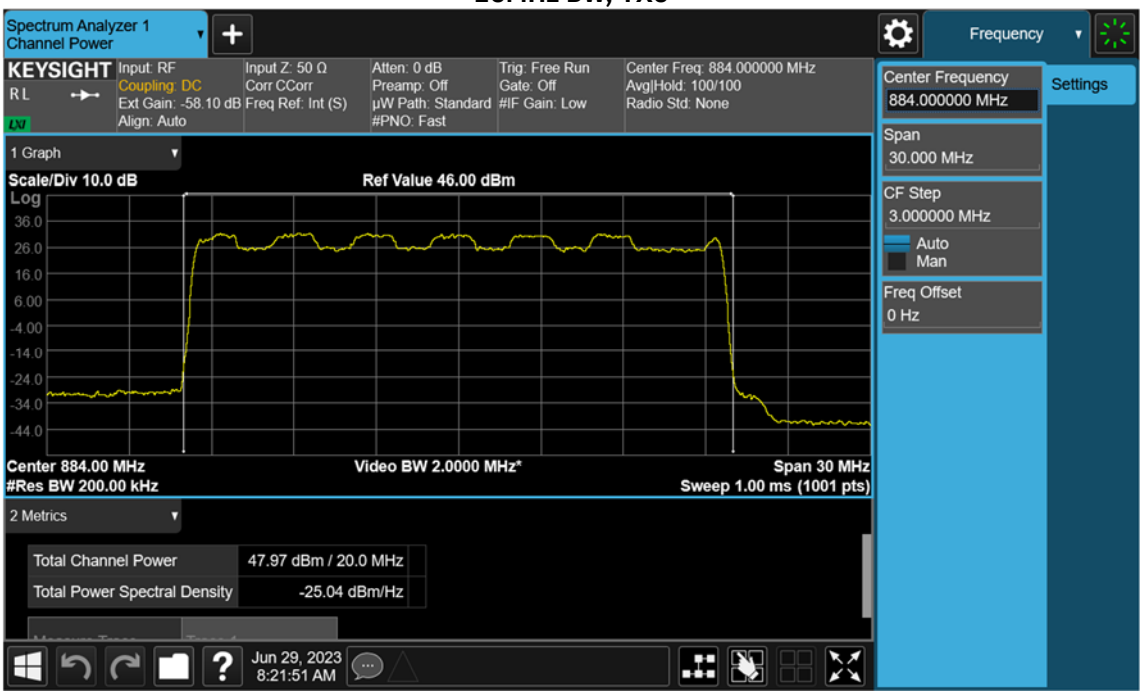
Channel Frequency 884MHz, QPSK/16QAM
20MHz BW, TX3



2.1.3 Channel RF Power – 60W Plots

Channel Frequency 876.5MHz, 64QAM
15MHz BW, TX0

Channel Frequency 884MHz, QPSK/16QAM
20MHz BW, TX0



2.2 Peak-to-Average Power Ratio (PAPR)

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

PAPR Tabular Data (5G-NR)

BW MHz	Modulation	TX Port	Channel Frequency MHz	PAR at 0.1% Limit - 13 dB
15	64QAM	0	876.5	7.24
15	256QAM	0	886.5	7.85
20	QPSK	0	879	7.16
20	QPSK/16QAM	0	884	7.51

2.2.1 Peak-to-Average Power Ratio (PAPR) – Plots

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

2.2.1.1 PAPR Plots

**Channel Frequency 876.5MHz, 64QAM,
15MHz BW, TX0**

**Channel Frequency 886.5MHz, 256QAM,
15MHz BW, TX0**

Channel Frequency 879MHz, QPSK,
20MHz BW, TX0

Channel Frequency 884MHz, QPSK/16WAM,
20MHz BW, TX0

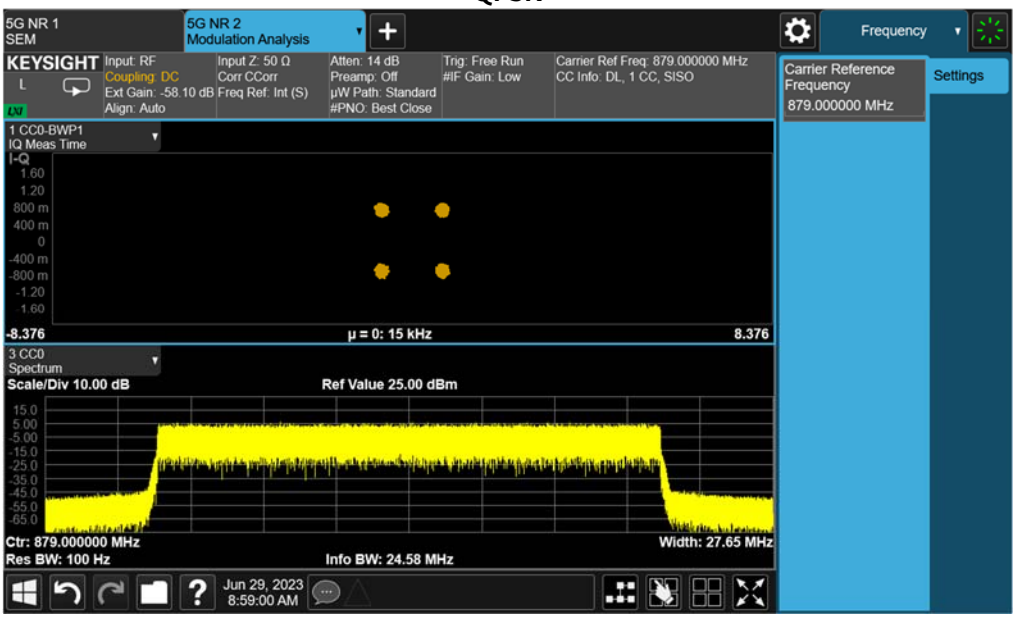
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

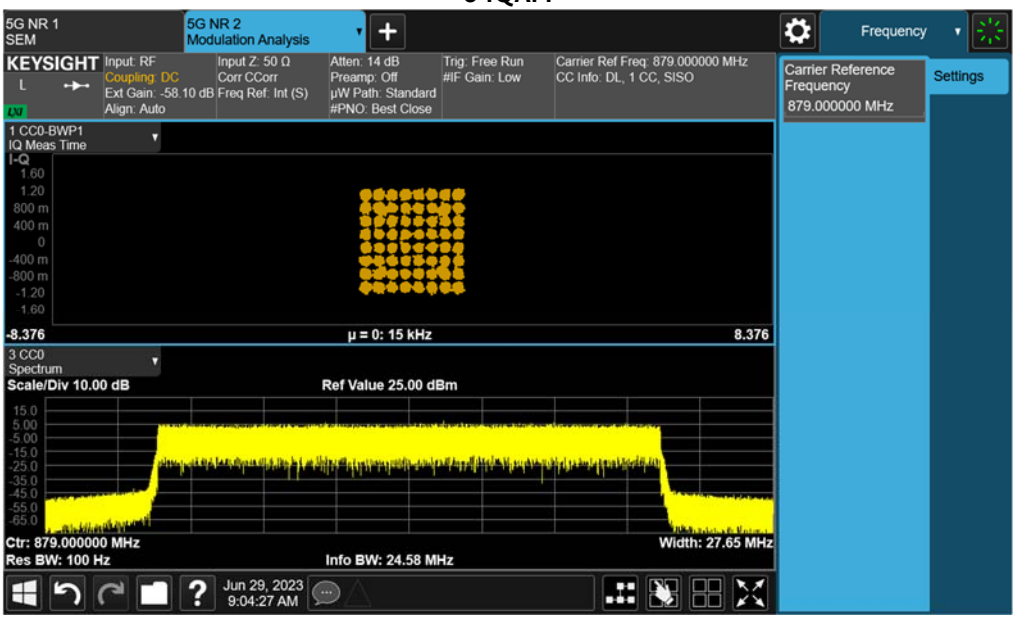
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

3.1.1 Modulation Characteristics – Plots

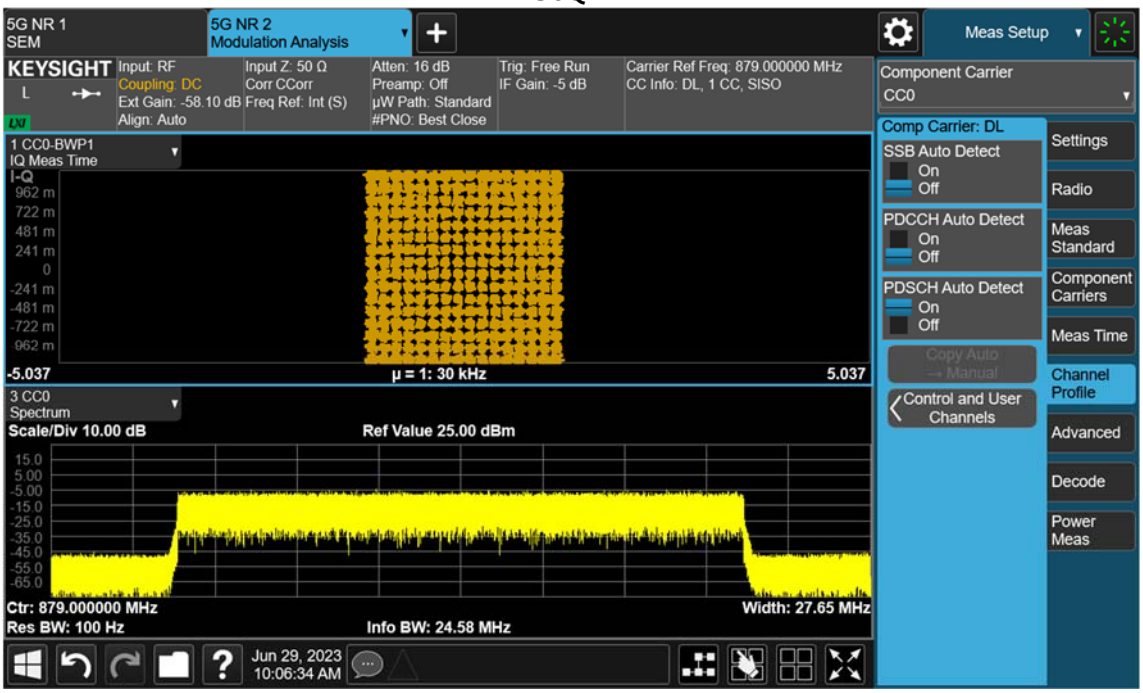
QPSK



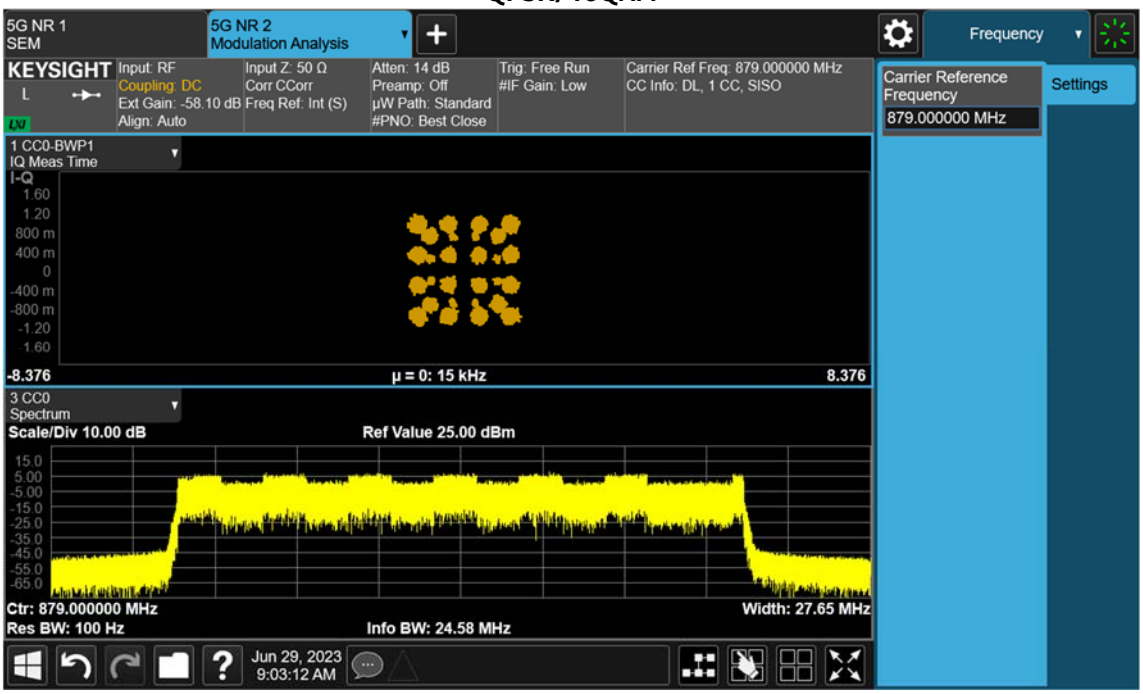
64QAM



256QAM



QPSK/16QAM



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

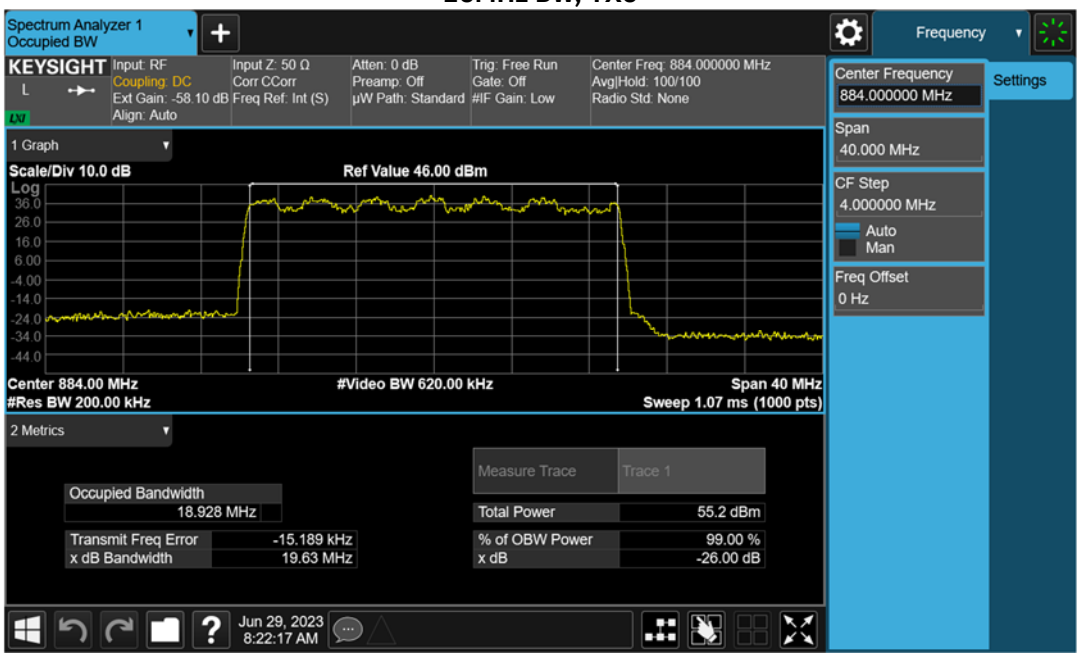
BW MHz	Modulation	TX Port	Channel Frequency MHz	Occupied BW (MHz)
15	64QAM	0	876.5	**14.10**
15	256QAM	0	886.5	14.075
20	QPSK	0	879	18.916
20	QPSK/16QAM	0	884	**18.928**

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.

Channel Frequency 876.5MHz, 64QAM
15MHz BW, TX0

Channel Frequency 884MHz, QPSK/16QAM
20MHz BW, TX0



4.2 Edge of band Emissions

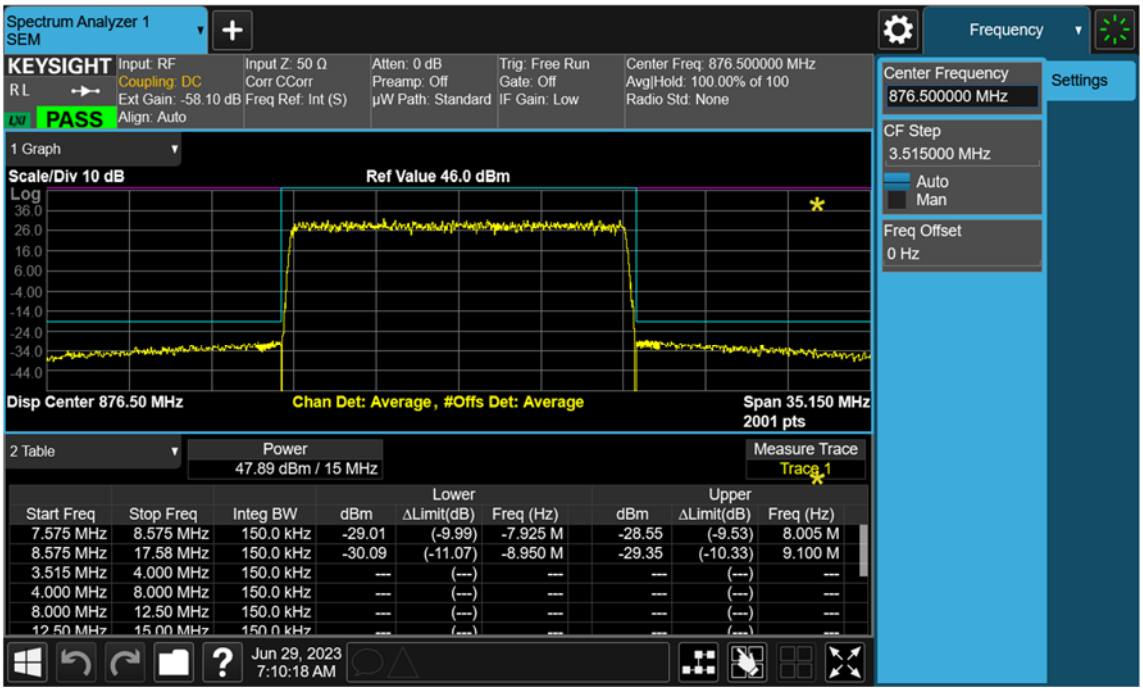
The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. Before measuring the Edge of Band emissions, the RF power level was confirmed with the Keysight MXA Signal Analyzer. The RF output from the EAC port to signal analyzer was 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.

4.2.1 Edge of Band Emissions – Plots

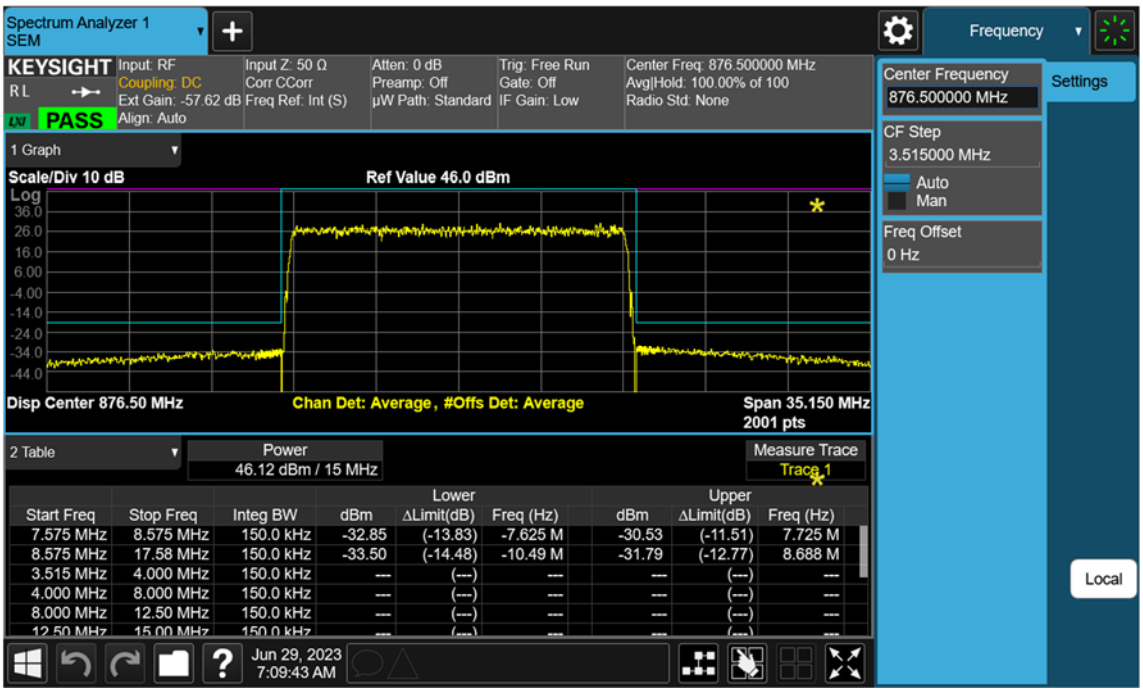
All of the measurements met the requirements of Part 2.1049. The limit line was set to -19 dBm to reflect the -13 dBm limit corrected for MIMO operation using 10 log (4).

4.2.1.1.1 OOBE Plots (15MHz BW)

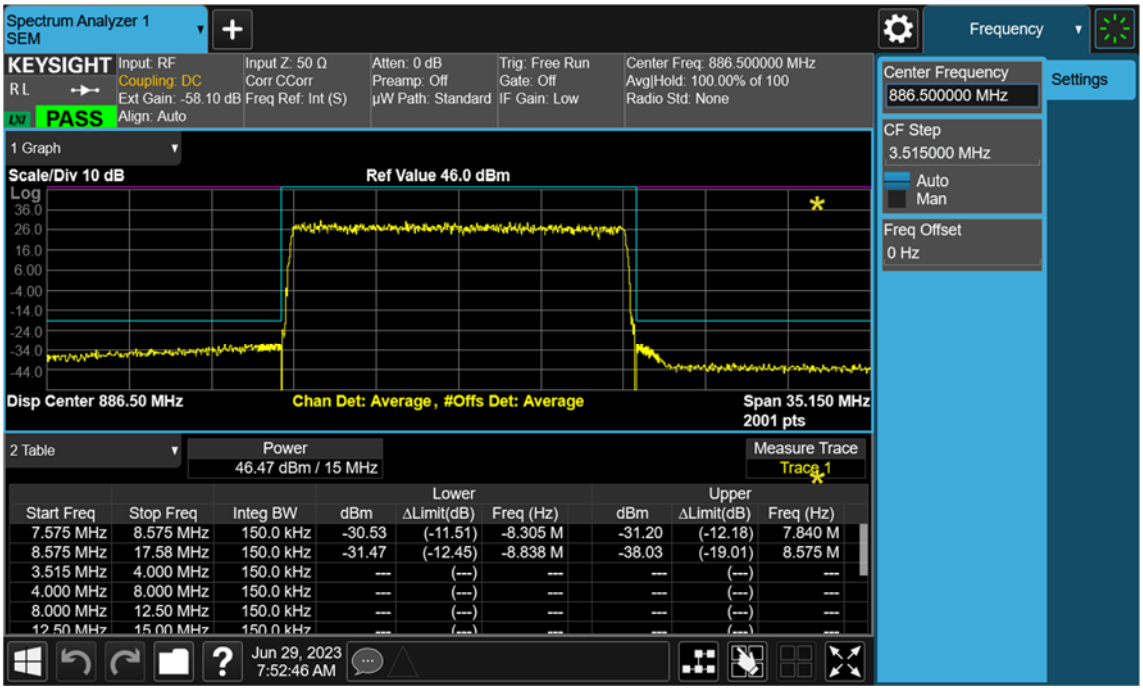
Channel Frequency 876.5MHz, 64QAM
TX0



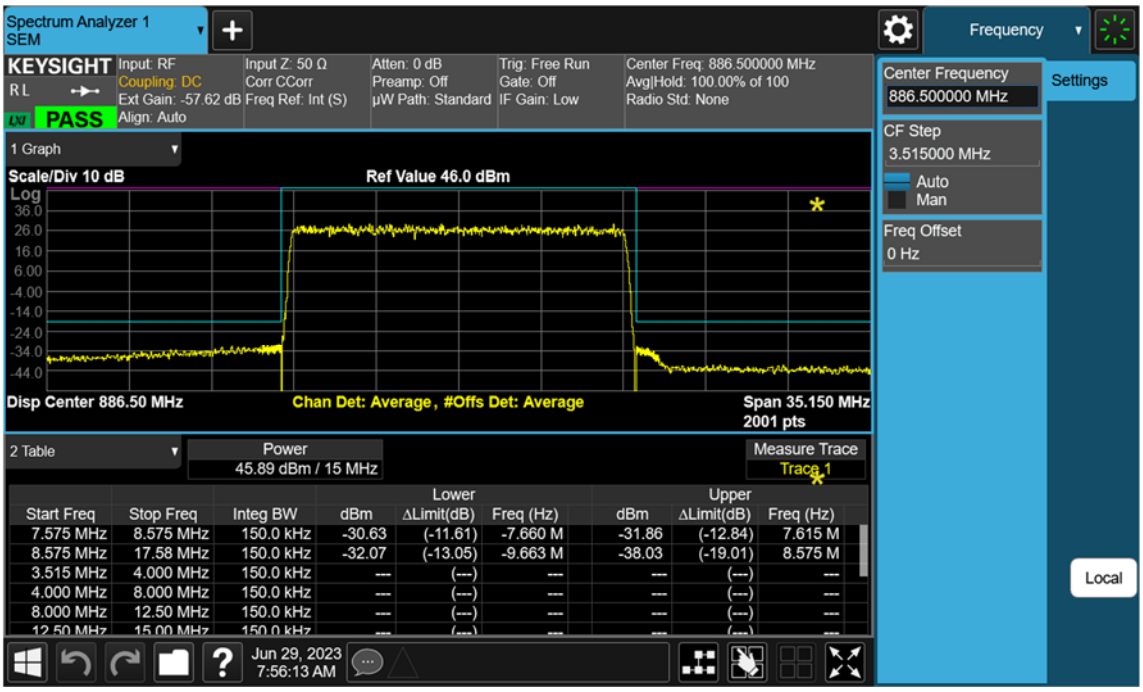
Channel Frequency 876.5MHz, 64QAM
TX3



Channel Frequency 886.5MHz, 256QAM
TX0

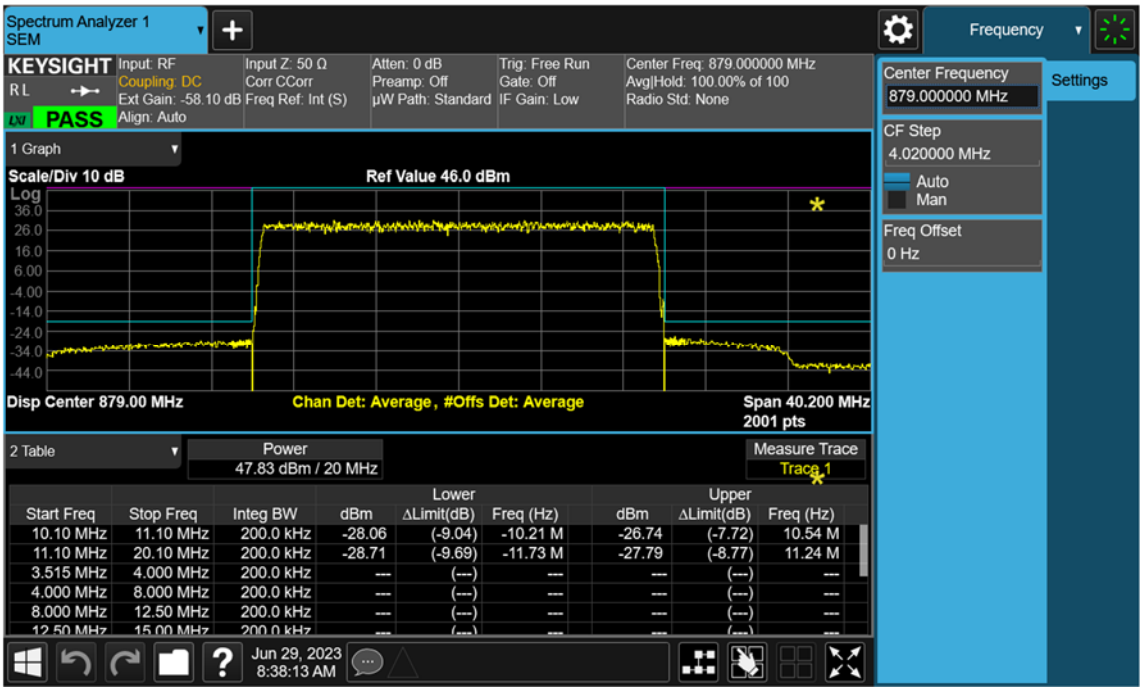


Channel Frequency 886.5MHz, 256QAM
TX3

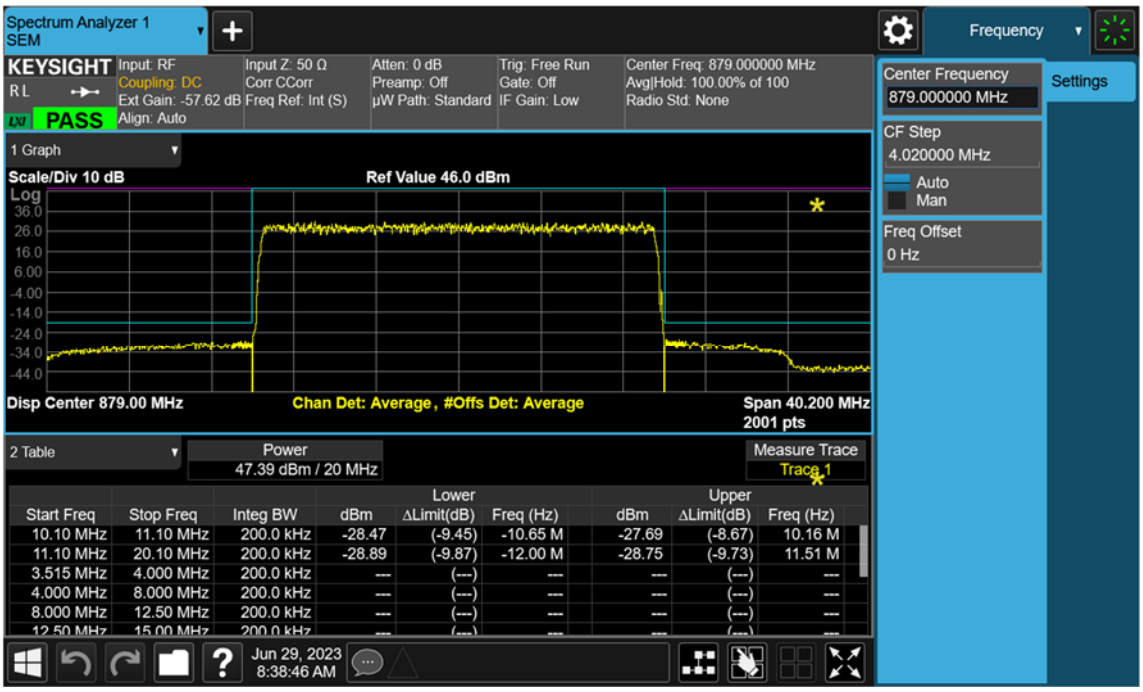


4.2.1.1.2 OOBE Plots (20MHz BW)

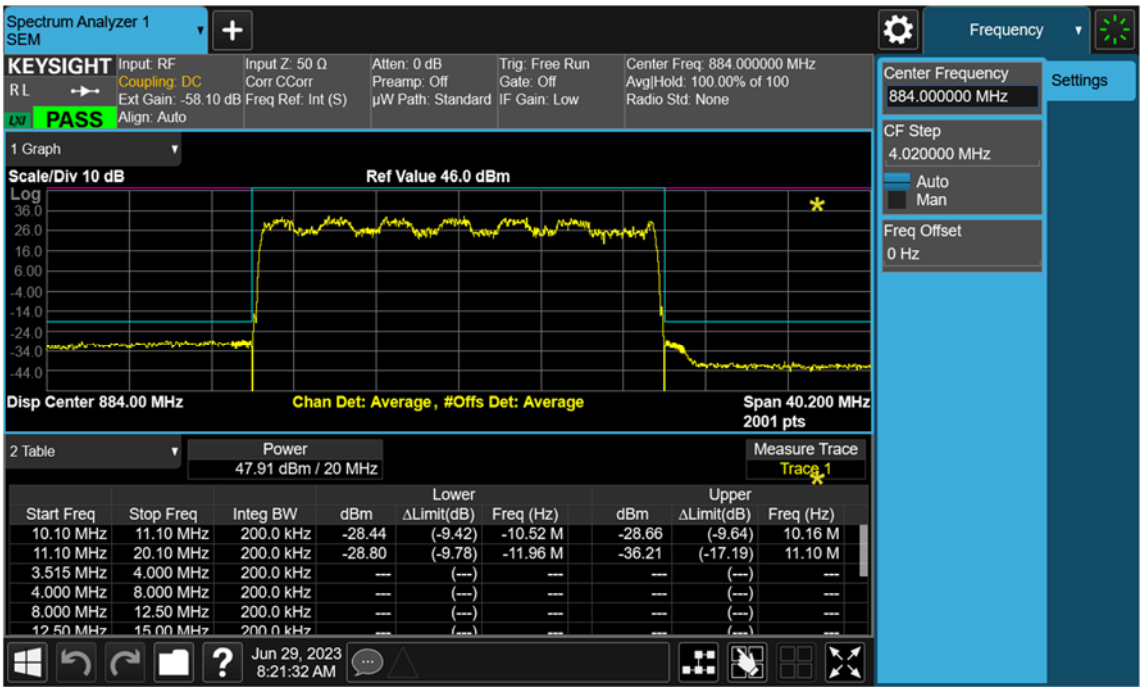
Channel Frequency 879MHz, QPSK
TX0



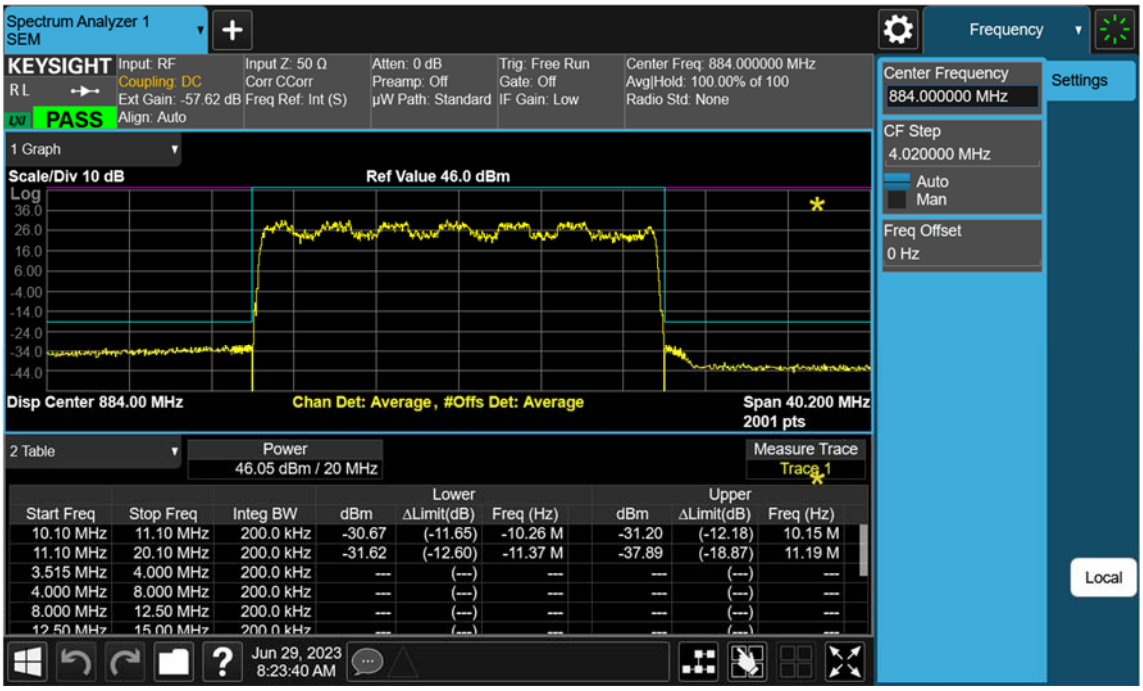
Channel Frequency 879MHz, QPSK
TX3



Channel Frequency 884MHz, QPSK/16QAM
TX0



Channel Frequency 884MHz, QPSK/16QAM
TX3



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 9kHz to beyond the 10th harmonic of the specific transmit band. For this band of operation, the measurements were performed up to 9 GHz. 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 required emission limitation is specified as appropriate in 22.917. The limit line was set to -19 dBm to reflect the -13 dBm limit corrected for MIMO operation using 10 log (4). 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.

5.1.1 Spurious Emissions at Tx Port – Plots

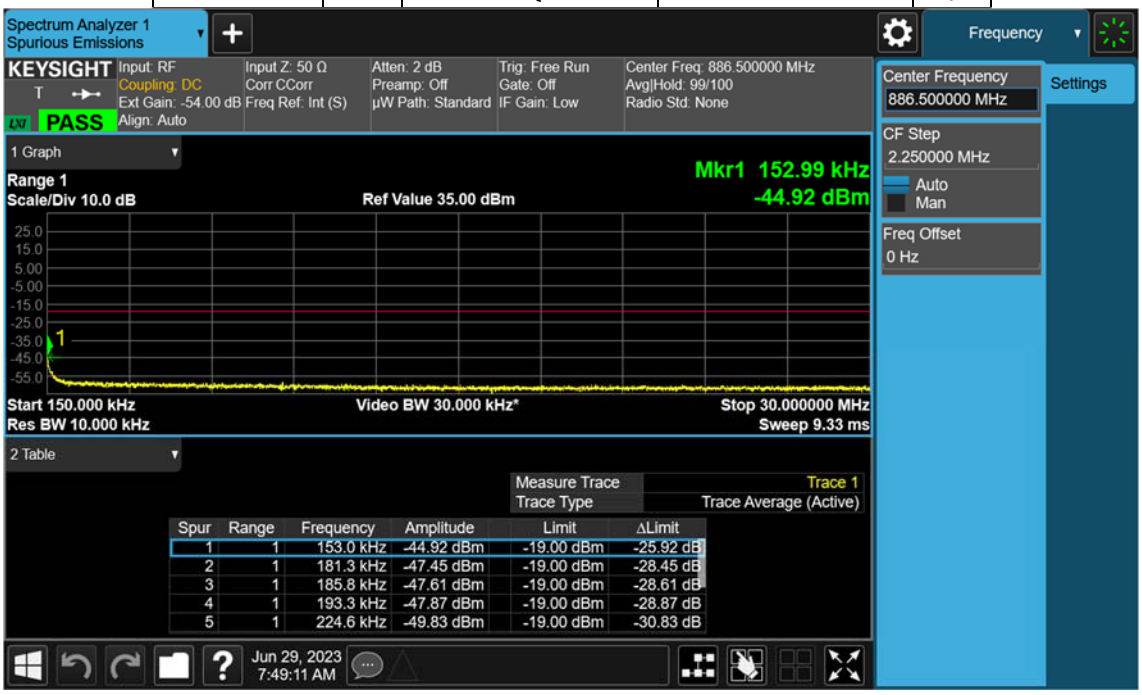
NOTE: Only plots with lowest margin in each frequency range are used in this report. The full suite of raw data resides at the MH, New Jersey location.

9KHz – 150kHz

Signal BW (MHz)	TM	Modulation	Channel Frequency (MHz)	TX
15	3.1a	256QAM	886.5	0

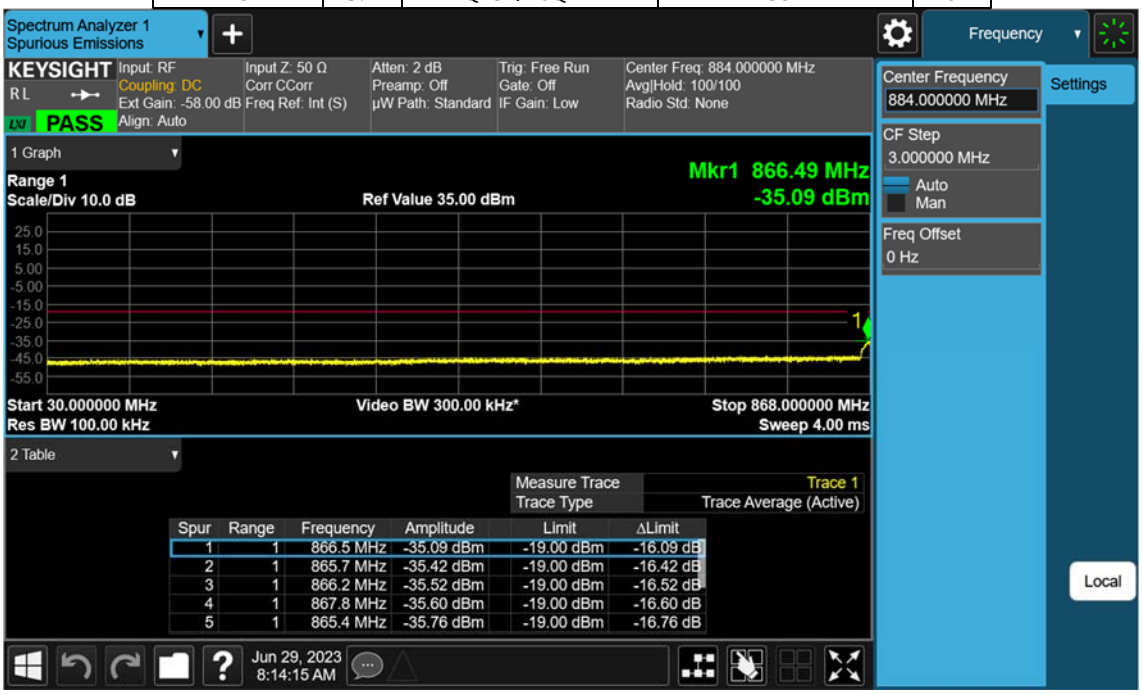
150kHz – 30MHz

Signal BW (MHz)	TM	Modulation	Channel Frequency (MHz)	TX
15	3.1a	256QAM	886.5	0



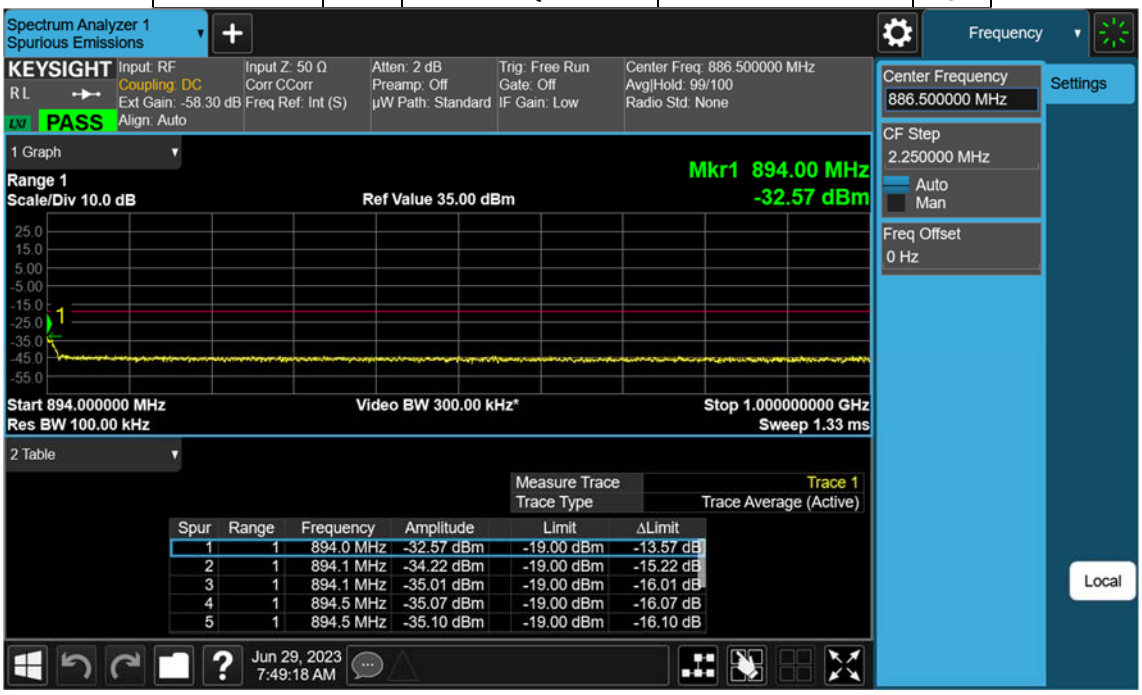
30MHz – 868MHz

Signal BW (MHz)	TM	Modulation	Channel Frequency (MHz)	TX
20	3.2	QPSK/16QAM	884	0



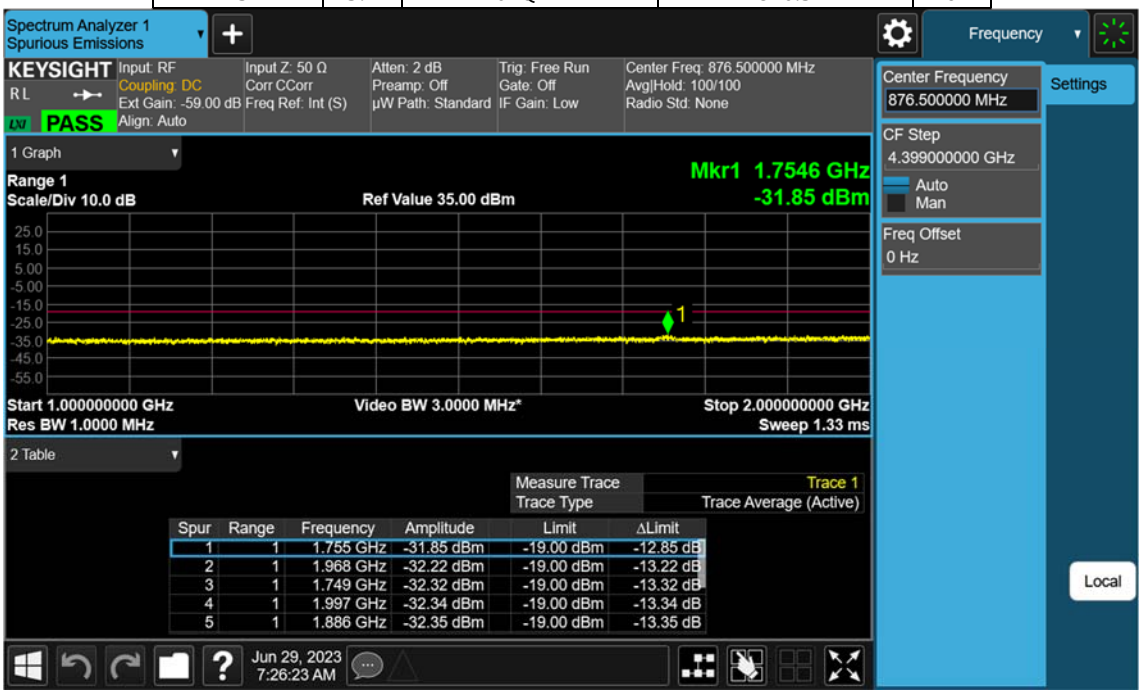
894MHz – 1GHz

Signal BW (MHz)	TM	Modulation	Channel Frequency (MHz)	TX
15	3.1a	256QAM	886.5	0



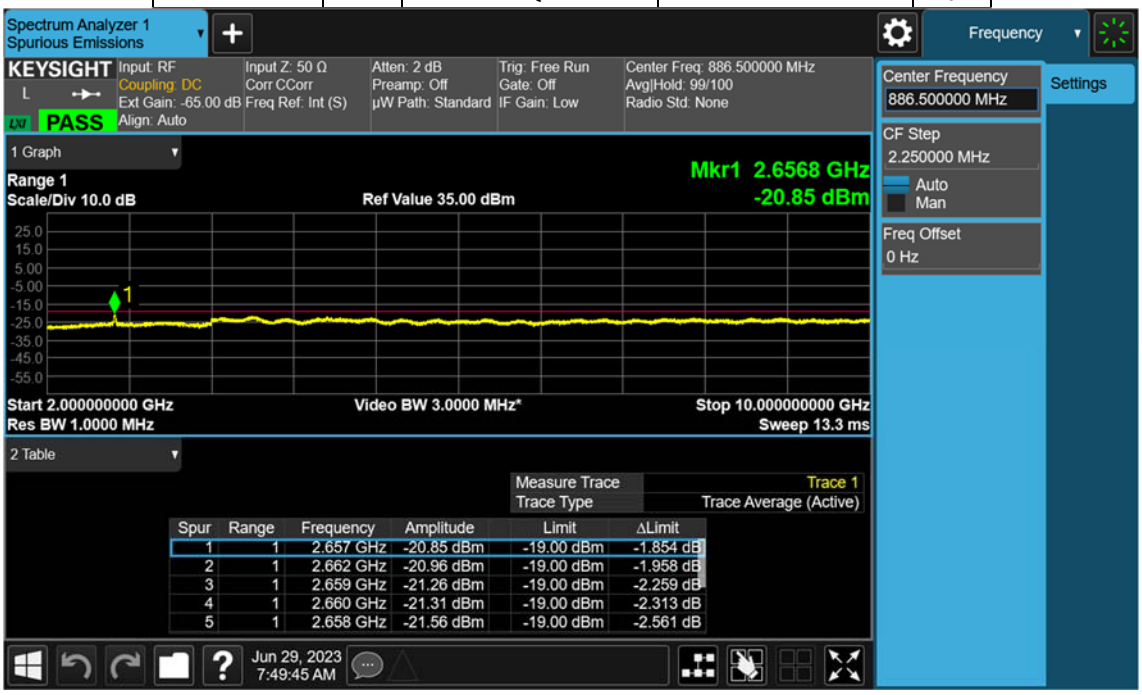
1GHz – 2GHz

Signal BW (MHz)	TM	Modulation	Channel Frequency (MHz)	TX
15	3.1	64QAM	876.5	0

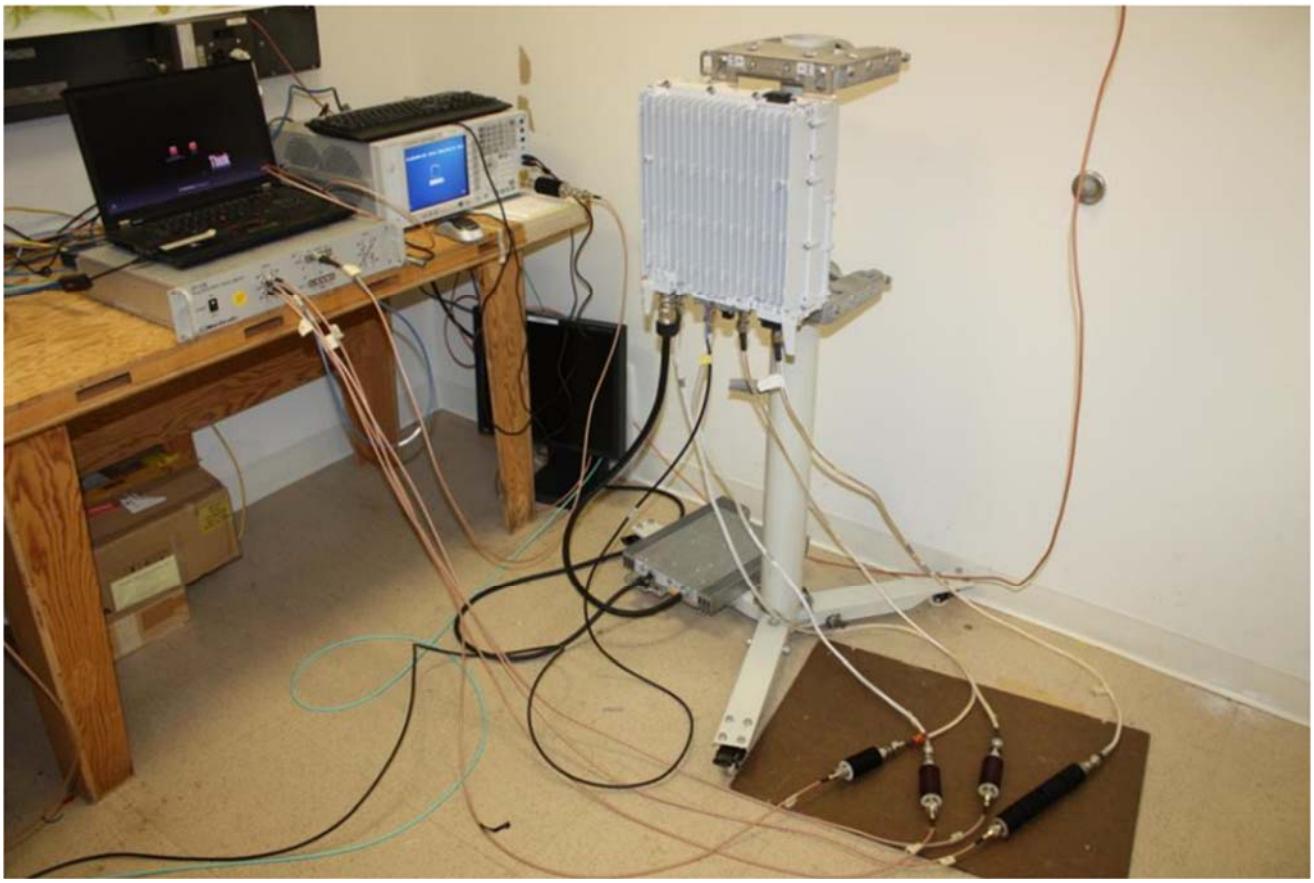


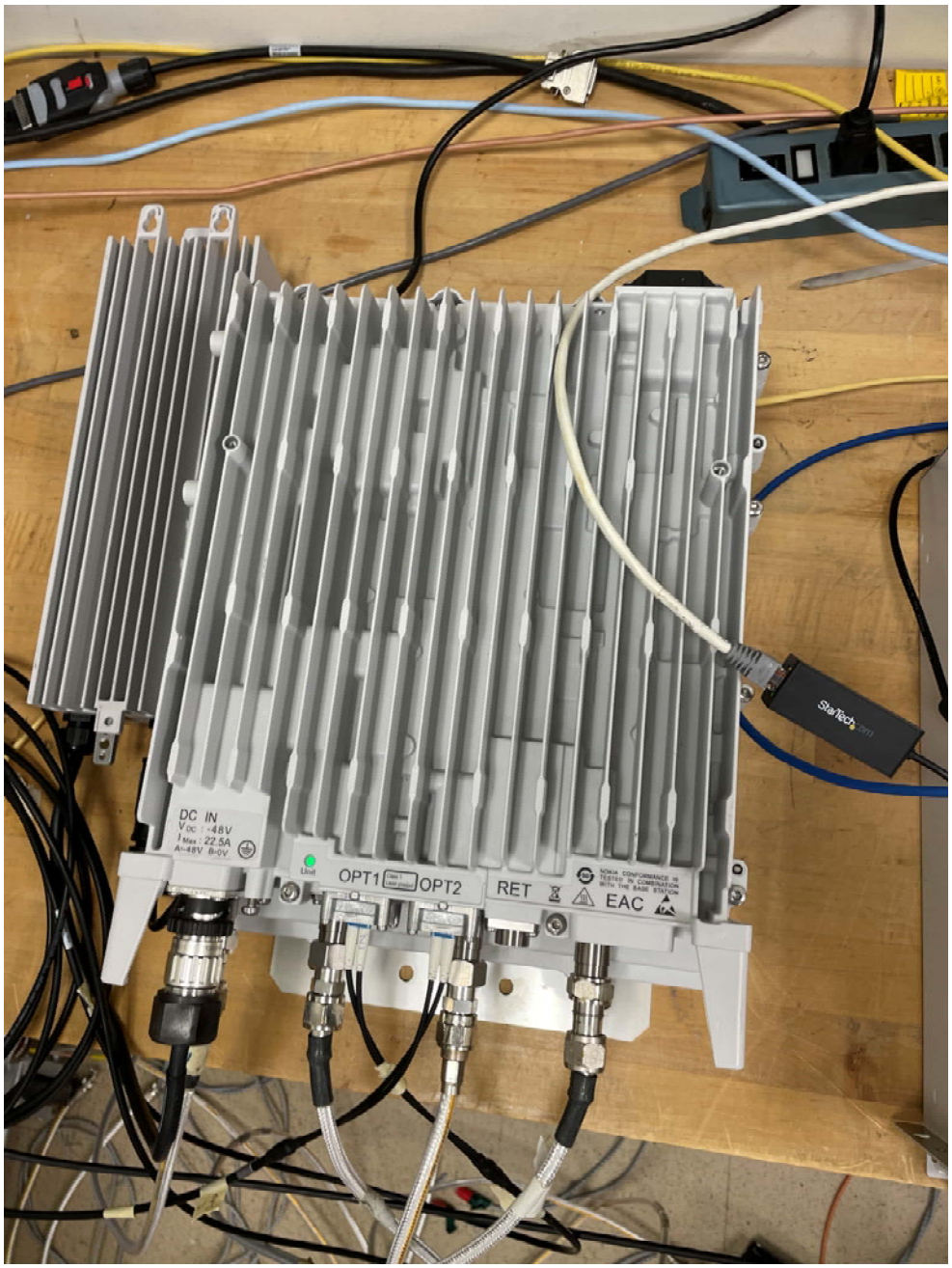
2GHz – 10GHz

Signal BW (MHz)	TM	Modulation	Channel Frequency (MHz)	TX
15	3.1a	256QAM	886.5	0



Photographs




DC IN
OPT1
OPT2
RET
EAC

Test Equipment

Radio Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E1218	KeySight Technologies	EMI Receiver	MXE EMI Receiver 44 GHz	N9038A	MY54130037	2021-12-29	2023-12-29
E1338	KeySight Technologies	MXA Signal Analyzer	20 Hz-44 GHz (Analysis Bandwidth 125 MHz)	N9020B	MY57430927	2023-05-06	2025-05-06
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2023-02-08	2025-02-08
E1534	Traceable	Data Logger	Barometric Humidity Temp Data Logger	6529	200648430	2023-01-16	2025-01-16
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

CNR-V: Calibration Not Required. Must Be Verified.
Test Date: 6/29/2023

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.

6.2 Field Strength of Spurious Emissions - Limits

Sections 2.1053 and 22.917 contain 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 22 Limit is 82.23 dBµV/m at 3m and 91.77 dBµV/m at 1m
The Part 22 non-report level is 62.23 dBµV/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 Parts 2 and 22, 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. 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).

2022-09-28 through 2023-09-30
Effective Dates

DEPARTMENT OF COMMERCE * UNITED STATES OF AMERICA *

For the National Voluntary Laboratory Accreditation Program