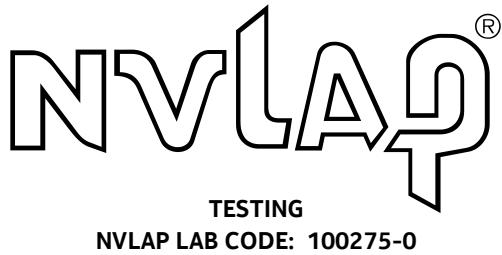


Global Product Compliance Laboratory
600-700 Mountain Avenue
Room 5B-108
Murray Hill, New Jersey 07974-0636 USA



Title 47 Code of Federal Regulations

Test Report

Regulation:
FCC Part 2 and 22

Client:
NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:
Airscale 2 Remote Radio Head

Report Number:
TR-2022-0122-FCC2-22

Date Issued:
October 19, 2022

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Revisions

Date	Revision	Section	Change
10/19/2022	0		Initial Release

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10/19/2022

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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):	Airscale 2 Remote Radio Head
FCC ID:	VBNAHCA-01
Serial Number:	L1171302323
Hardware Version:	473966A.101
Software Version:	SBTS22R4
Frequency Range:	869-894MHz
GPCL Project Number:	2022-0122
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):	9/27/2022 – 10/6/2022
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:	Steve Gordon
Test Engineer (s):	Jaideep Yadav
Test Results:	The EUT, <i>as tested</i> 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 **Airscale 2 Remote Radio Head**, 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 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.

This project requires an FCC Class II change to add new mode of operation for WCDMA 5 MHz carrier operation at 40 W per port. The product was previously certified for LTE and 5G modes of operation under FCC ID: VBNAHCA-01.

1.3 EUT Details

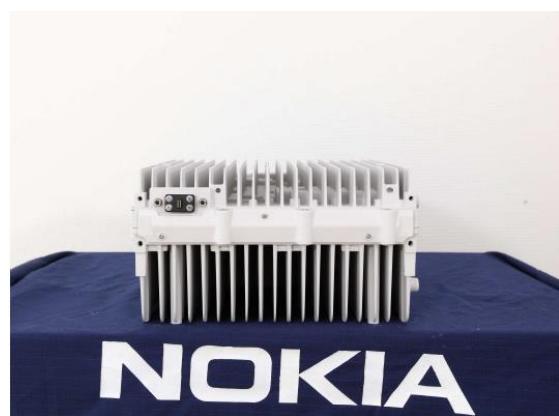
The EUT is a Base transceiver station RRH 850 MHz with 4 power amplifiers.

1.3.1 Specifications

Specification Items	Description
Radio Access Technology	WCDMA
Modulation Type(s)	QPSK, 16QAM, 64QAM
Operation Frequency Range	869-894MHz
Channel Bandwidths	5MHz
Tx/Rx	2T2R / 2T2R
MIMO	Yes
Deployment Environment	Outdoor
Supply Voltage	120V AC
Max RF Output Power	4X40 W MIMO

1.3.2 Photographs

AHCA Unit



Serial Number



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

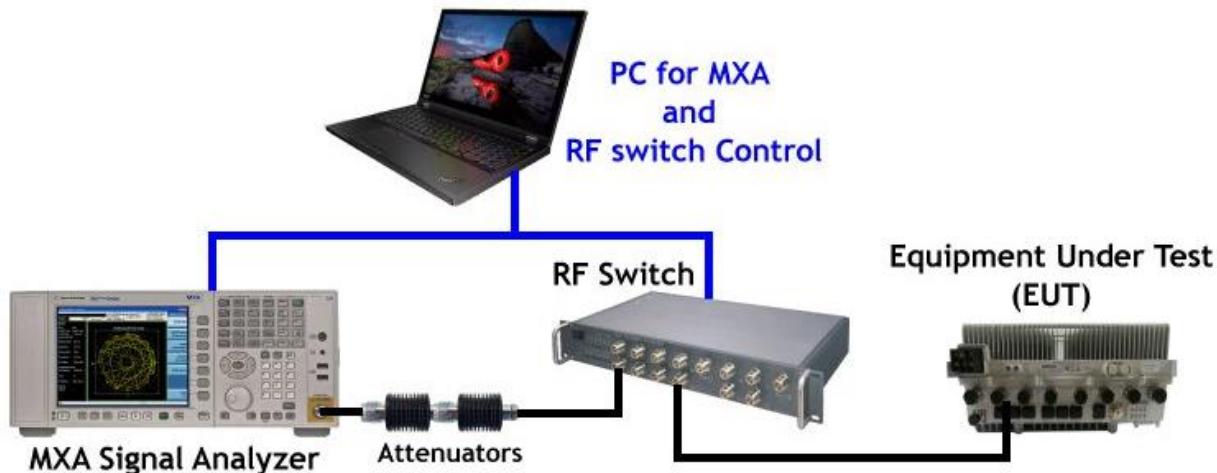
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz	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 40 W (46 dBm +/- 2.0 dBm) per port for each of the four transmit ports.

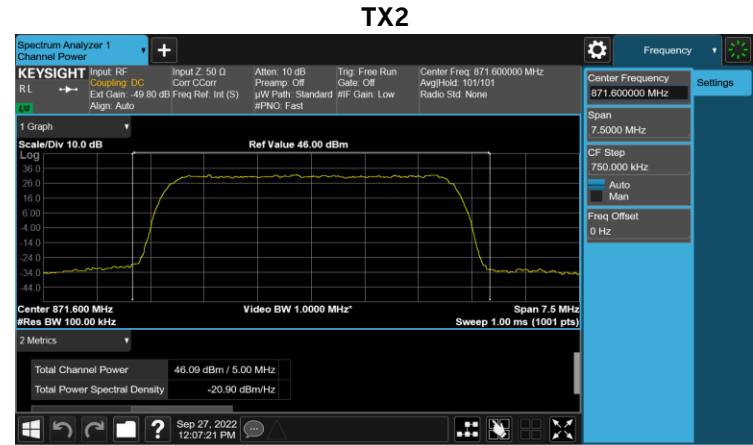
Power measurements were made with an MXA Signal Analyzer. The maximum output is bolded in each case.

Channel RF Power – 1C, 5MHz BW (40W)

Channel Power - Signal BW 5MHz					
Test Model 1 Modulation QPSK Channel Frequency 871.6MHz		Test Model 5 Modulation 16QAM Channel Frequency 881.6MHz		Test Model 6 Modulation 64QAM Channel Frequency 891.5MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	45.92	1	46.08	1	45.95
2	46.09	2	45.97	2	45.92

2.1.1 Channel RF Power – Plots

Channel Frequency 871.6MHz, TM1, QPSK, Signal BW 5MHz (40W)



Channel Frequency 881.6MHz, TM5, 16QAM, Signal BW 5MHz (40W)



Channel Frequency 891.6MHz, TM6, 64QAM, Signal BW 5MHz (40W)

TX1



TX2



2.2 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 (5MHz BW)

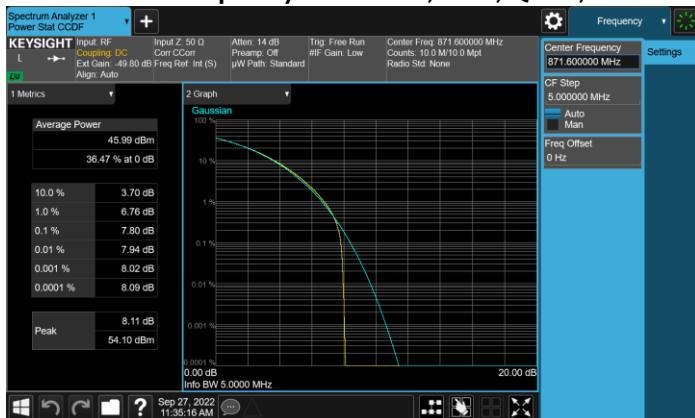
Radio Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	PAR at 0.1% Limit - 13 dB
WCDMA	1	QPSK	1	871.6	7.80
WCDMA	1	QPSK	2	871.6	7.79
WCDMA	5	16QAM	1	881.6	8.08
WCDMA	5	16QAM	2	881.6	7.93
WCDMA	6	64QAM	1	891.6	7.77
WCDMA	6	64QAM	2	891.6	7.78

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

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.

Signal BW 5MHz (40W)

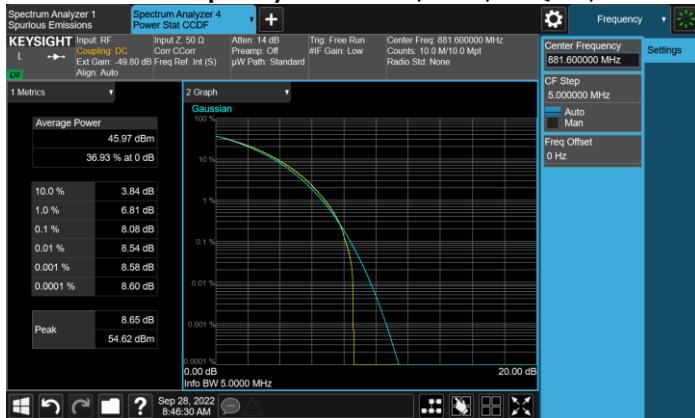
Channel Frequency 871.6MHz, TM1, QPSK, TX1



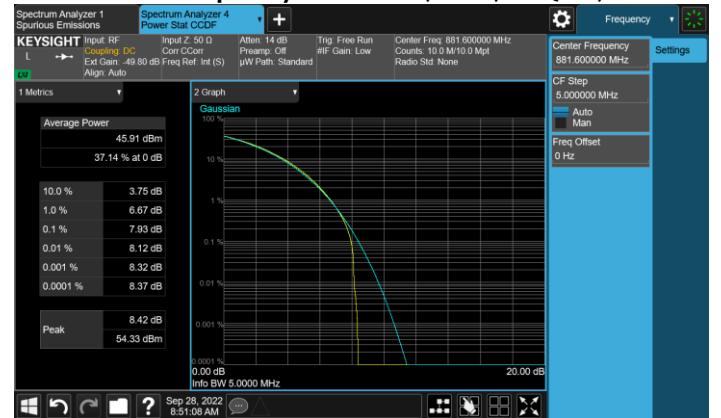
Channel Frequency 871.6MHz, TM1, QPSK, TX2



Channel Frequency 881.6MHz, TM5, 16QAM, TX1



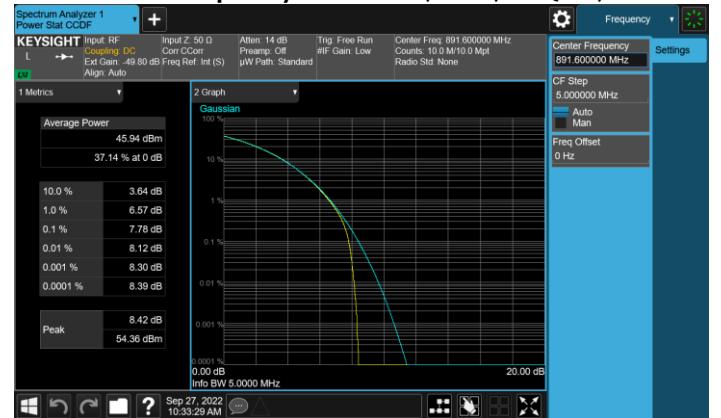
Channel Frequency 881.6MHz, TM5, 16QAM, TX2



Channel Frequency 891.6MHz, TM6, 64QAM, TX1



Channel Frequency 891.6MHz, TM6, 64QAM, TX2



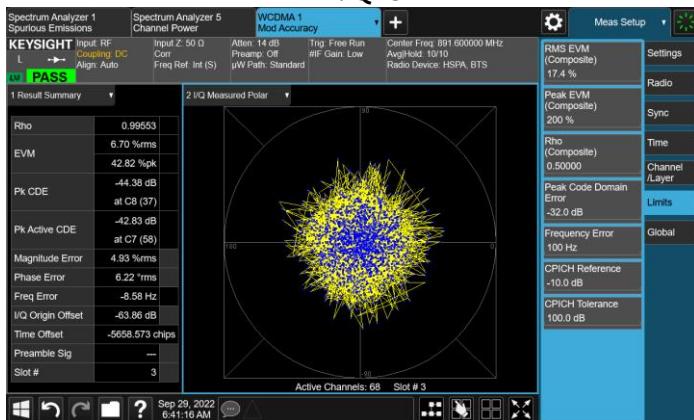
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

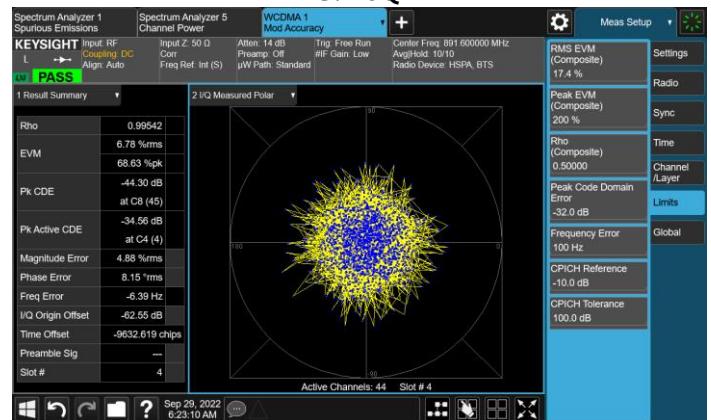
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

3.1.1 Modulation Characteristics – Plots

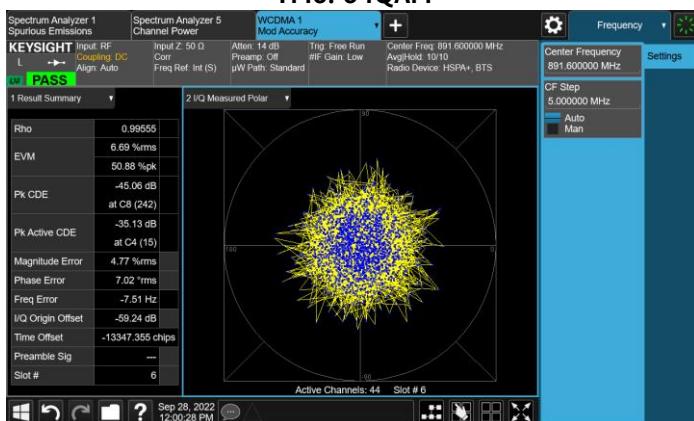
TM1: QPSK



TM5: 16QAM



TM6: 64QAM



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.

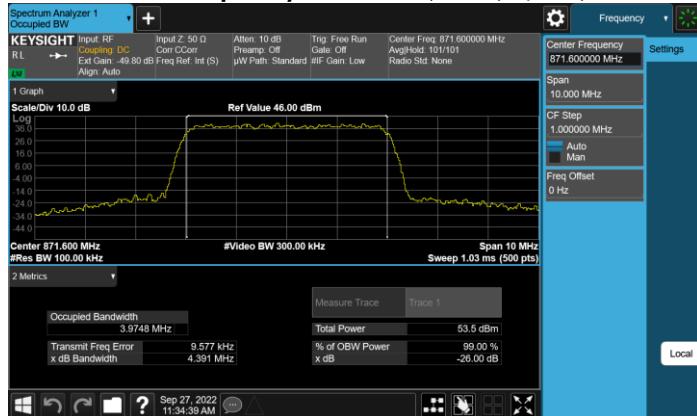
The transmitted signal occupied bandwidth was measured using a Keysight MXA Signal Analyzer. All emissions were within the parameters as required.

Tabular Data – Occupied Bandwidth (5MHz BW, 40W)

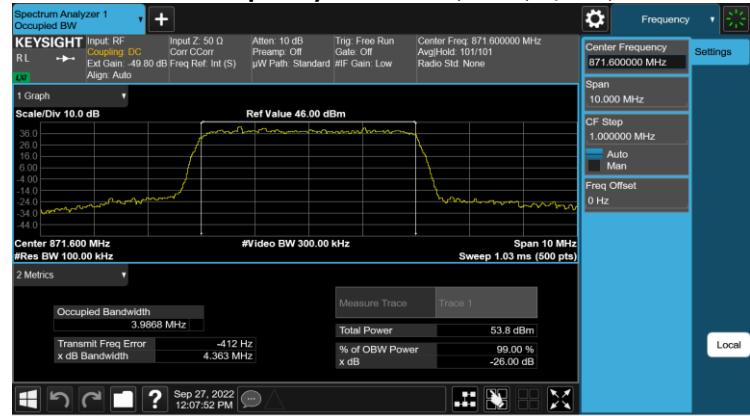
Modulation	TX Port	Channel Frequency (MHz)	Occupied BW (MHz)
QPSK	1	871.6	3.9748
QPSK	2	871.6	3.9868
16QAM	1	881.6	3.9431
16QAM	2	881.6	3.9493
64QAM	1	891.6	3.9342
64QAM	2	891.6	3.9341

4.1.1 Occupied Bandwidth – Plots

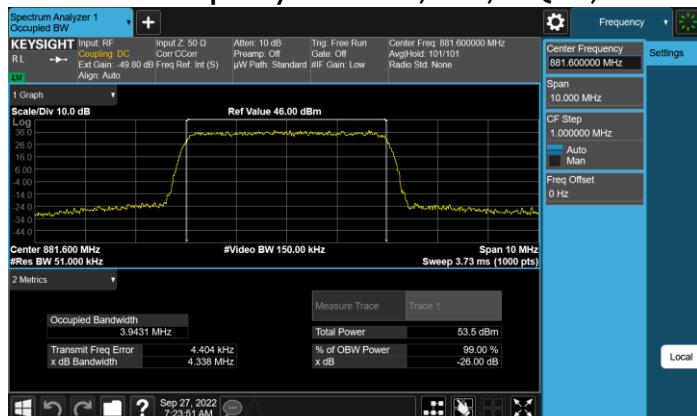
Channel Frequency 871.6MHz, TM1, QPSK, TX1



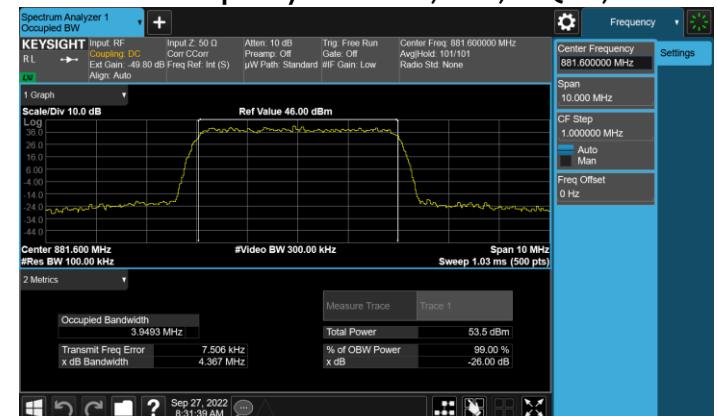
Channel Frequency 871.6MHz, TM1, QPSK, TX2



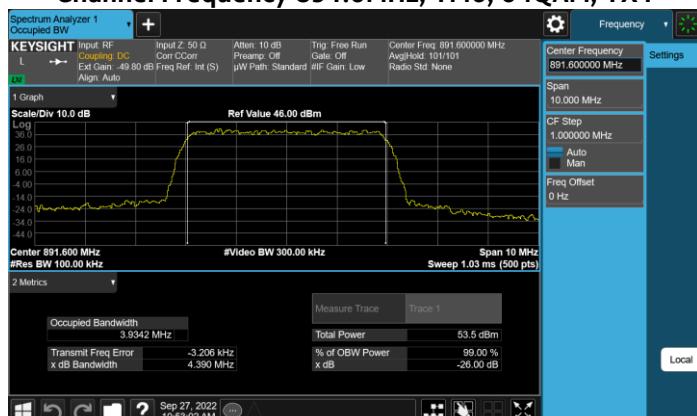
Channel Frequency 881.6MHz, TM5, 16QAM, TX1



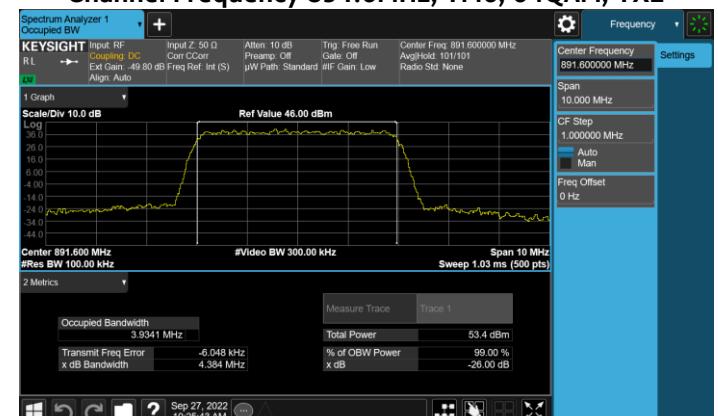
Channel Frequency 881.6MHz, TM5, 16QAM, TX2



Channel Frequency 891.6MHz, TM6, 64QAM, TX1



Channel Frequency 891.6MHz, TM6, 64QAM, TX2

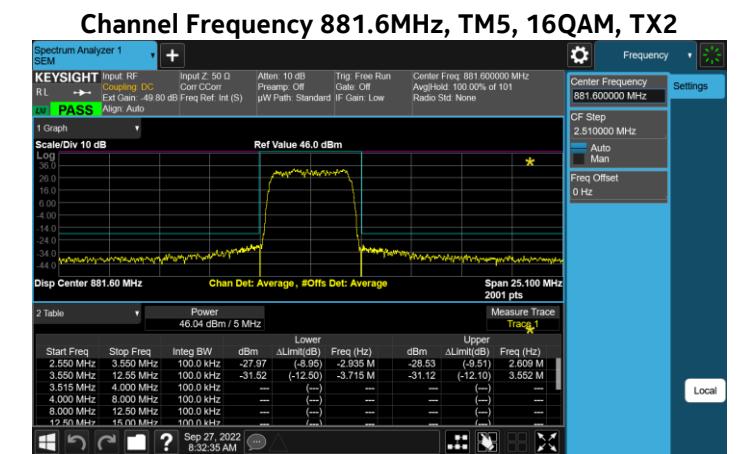
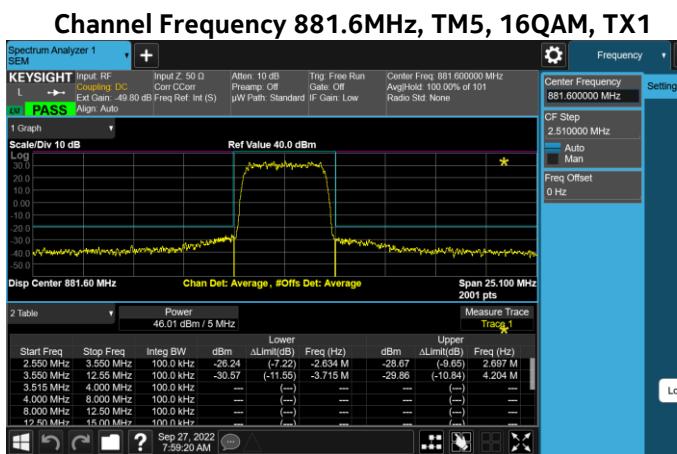
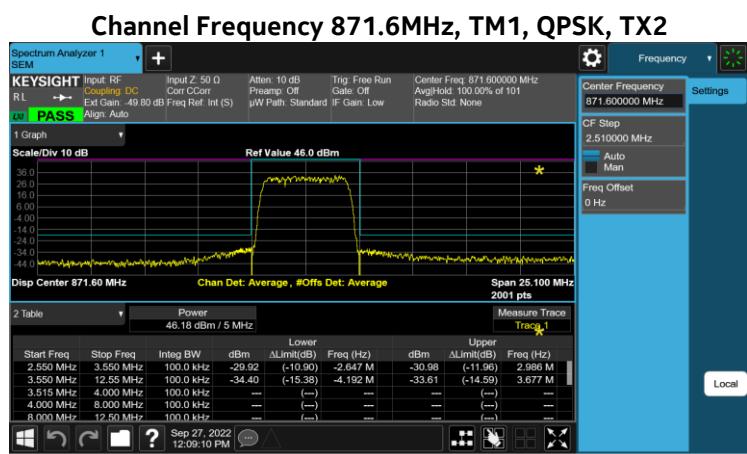
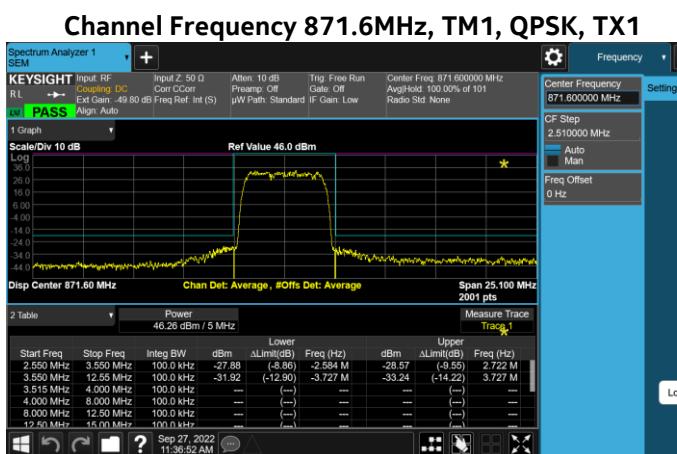


4.2 Edge of band Emissions

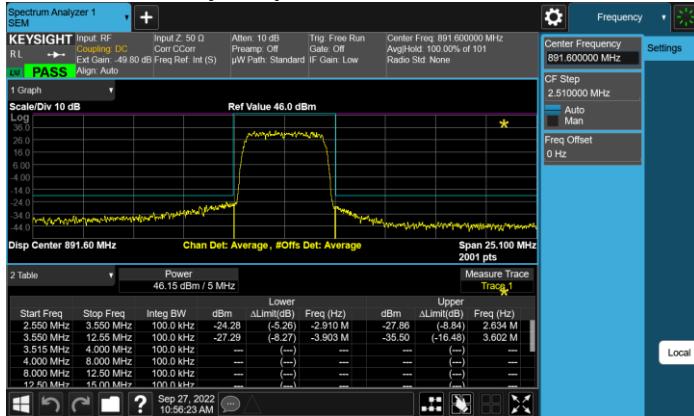
The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. Before measuring the Edge of Band emissions, the RF power level was confirmed with the Keysight MXA Signal Analyzer. The RF output from the EAC port to signal analyzer was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

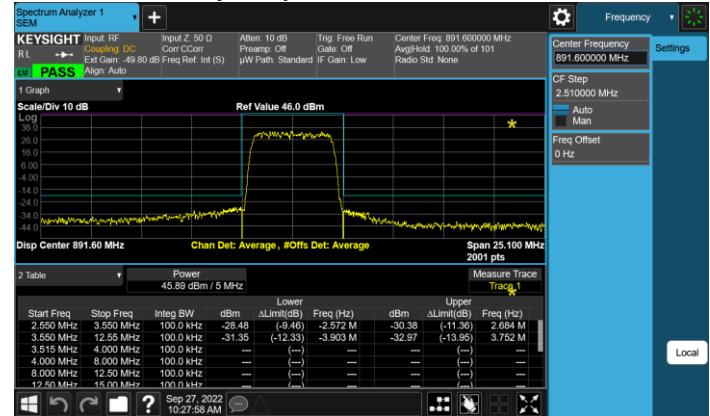
All of the measurements met the requirements of Part 2.1049. The limit line was set to -19 dBm to reflect the -13 dBm limit corrected for MIMO operation using 10 log (4).



Channel Frequency 891.6MHz, TM6, 64QAM, TX1



Channel Frequency 891.6MHz, TM6, 64QAM, TX2



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 9 GHz.

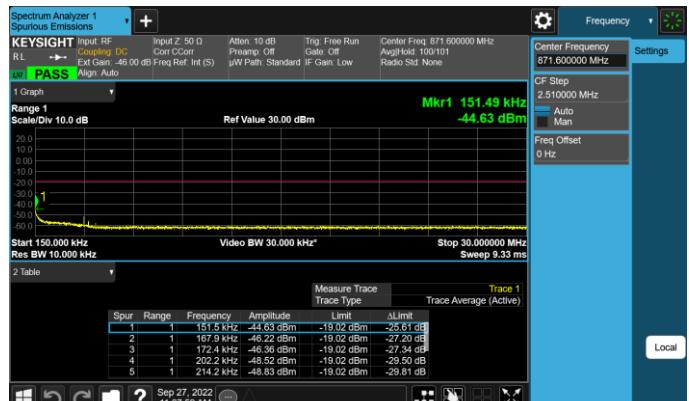
5.1.1 Spurious Emissions at Tx Port – Plots

Channel Frequency 871.6MHz, TM1, QPSK, TX1

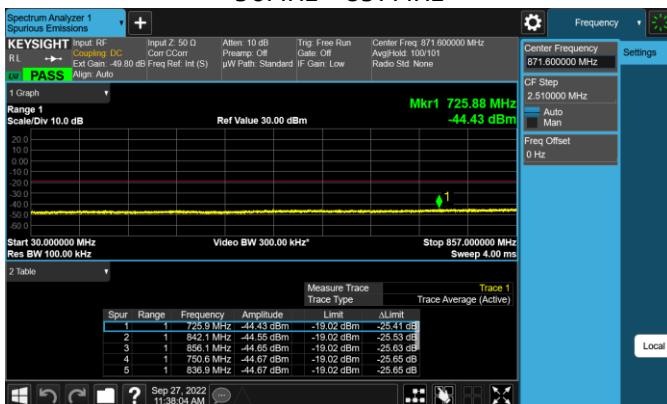
9kHz – 150kHz



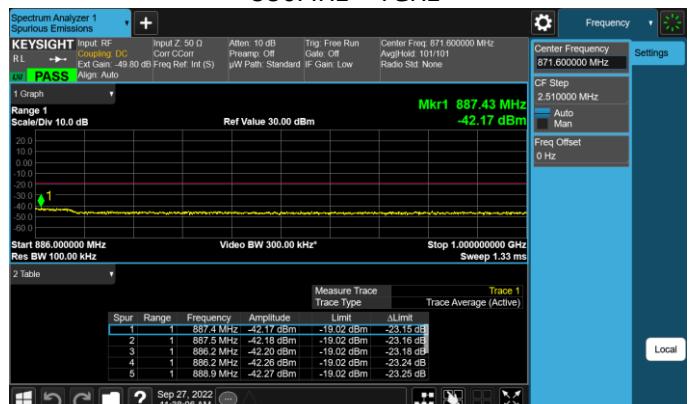
150kHz – 30MHz



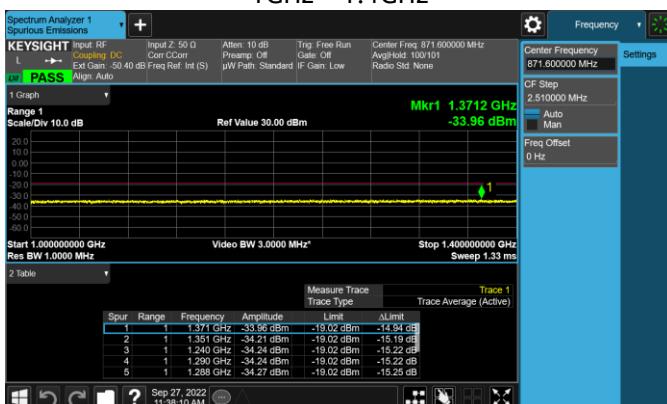
30MHz – 857MHz



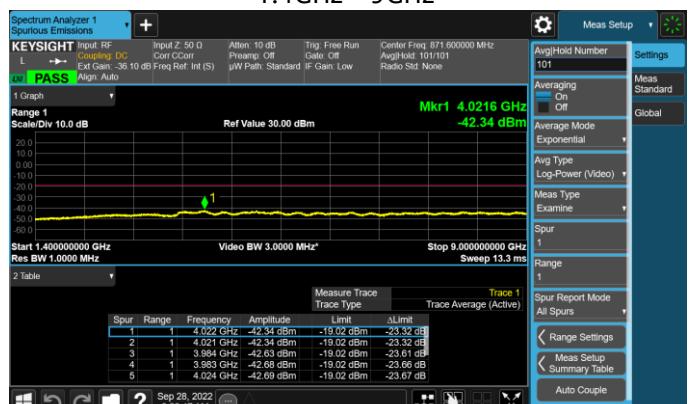
886MHz – 1GHz



1GHz – 1.4GHz

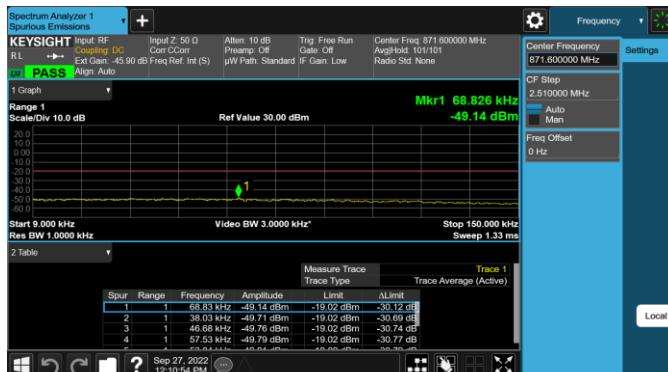


1.4GHz – 9GHz

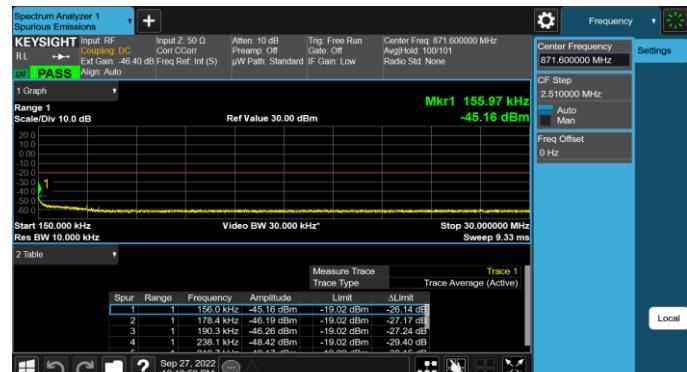


Channel Frequency 871.6MHz, TM1, QPSK, TX2

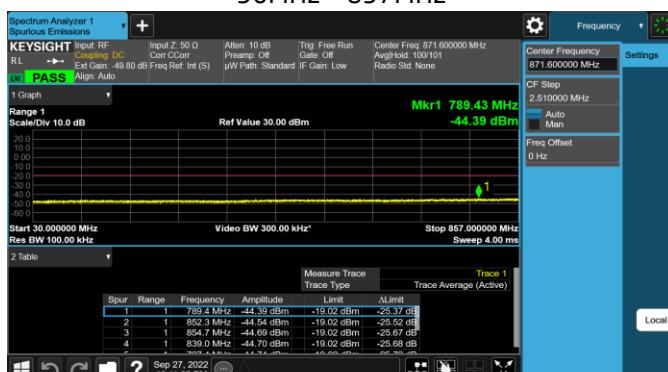
9kHz – 150kHz



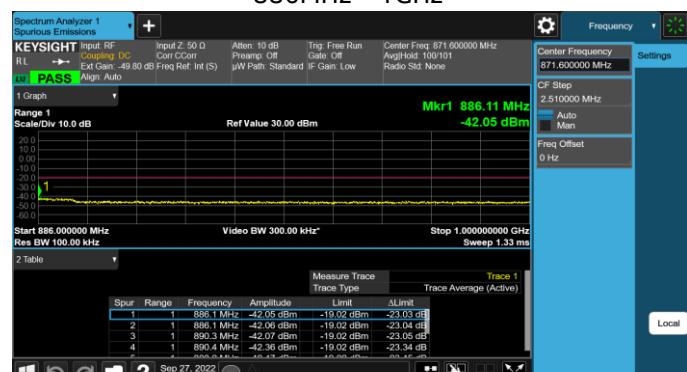
150kHz – 30MHz



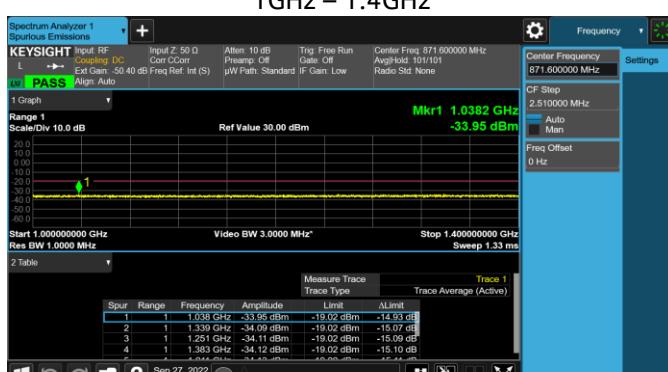
30MHz – 857MHz



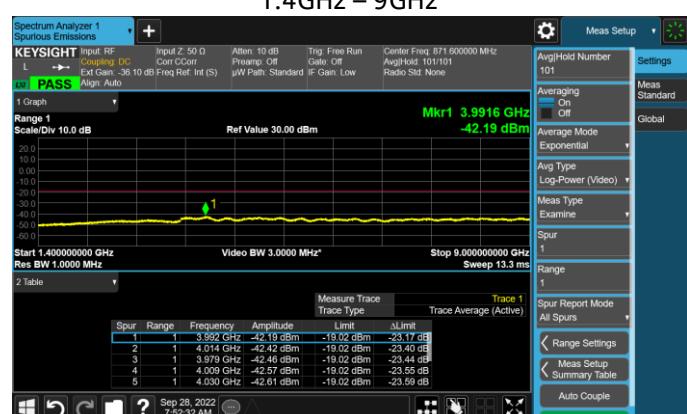
886MHz – 1GHz



1GHz – 1.4GHz



1.4GHz – 9GHz

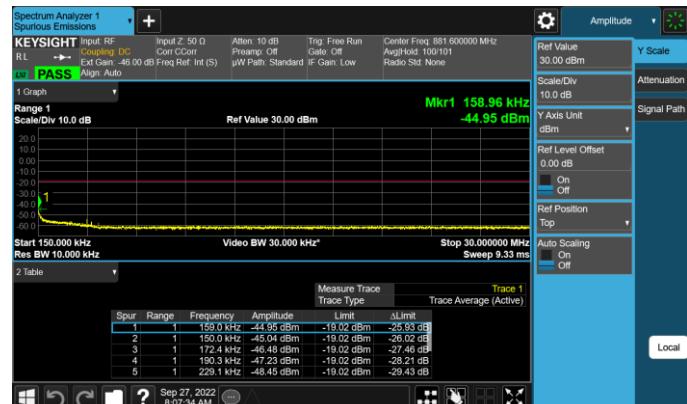


Channel Frequency 881.6MHz, TM5, 16QAM, TX1

9kHz – 150kHz



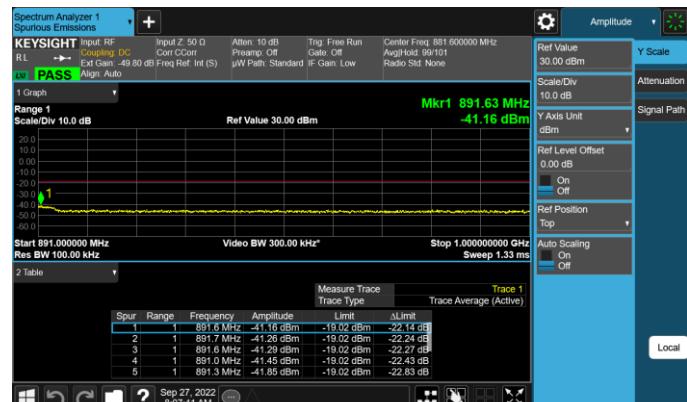
150kHz – 30MHz



30MHz – 872MHz



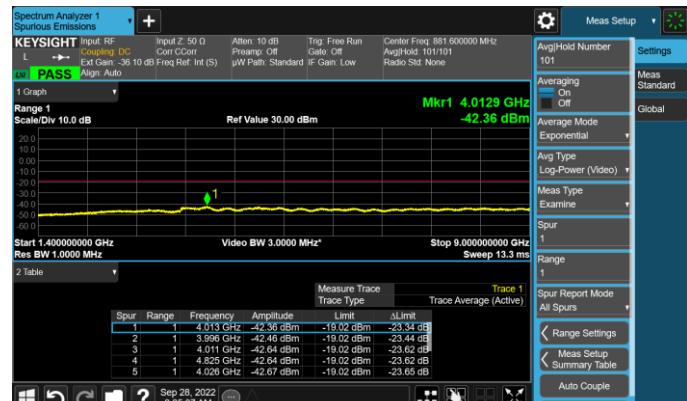
891MHz – 1GHz



1GHz – 1.4GHz

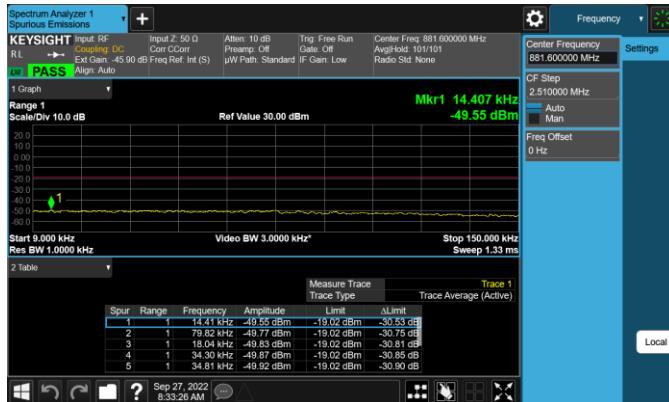


1.4GHz – 9GHz

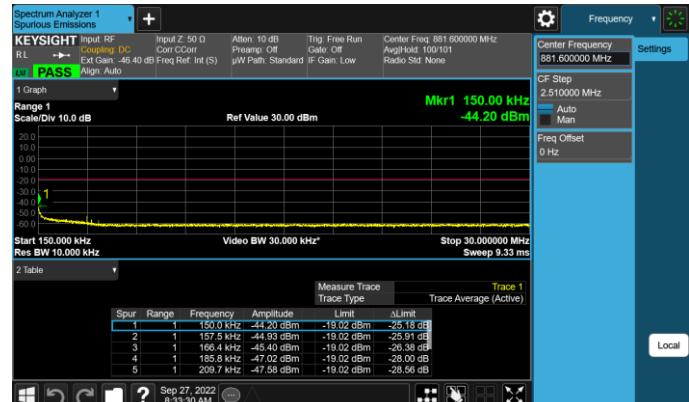


Channel Frequency 881.6MHz, TM5, 16QAM, TX2

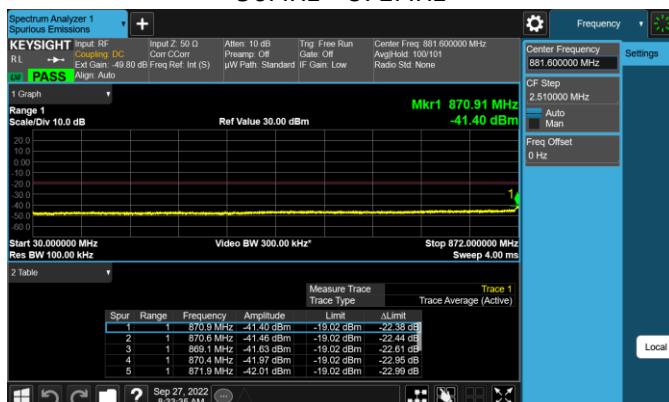
9kHz – 150kHz



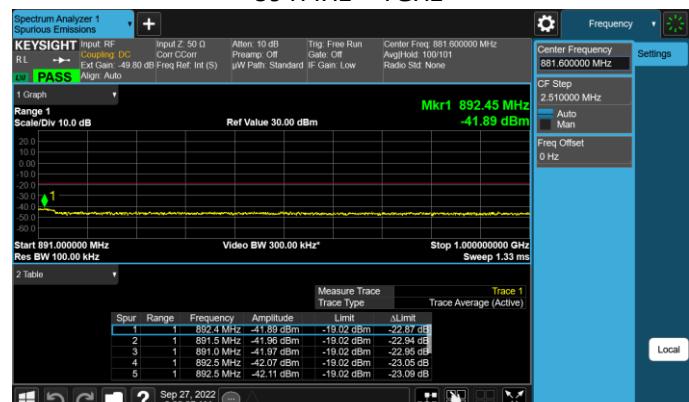
150kHz – 30MHz



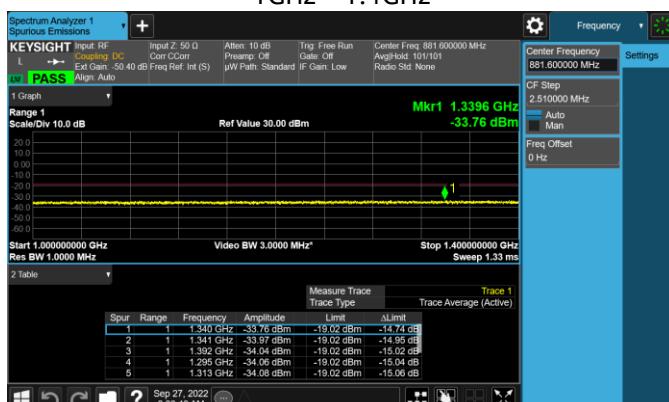
30MHz – 872MHz



891MHz – 1GHz



1GHz – 1.4GHz

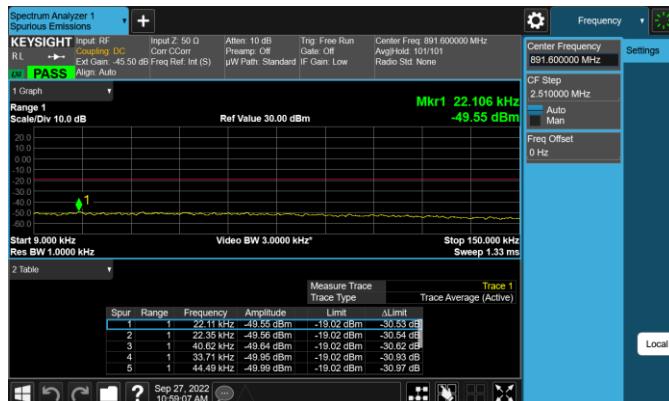


1.4GHz – 9GHz

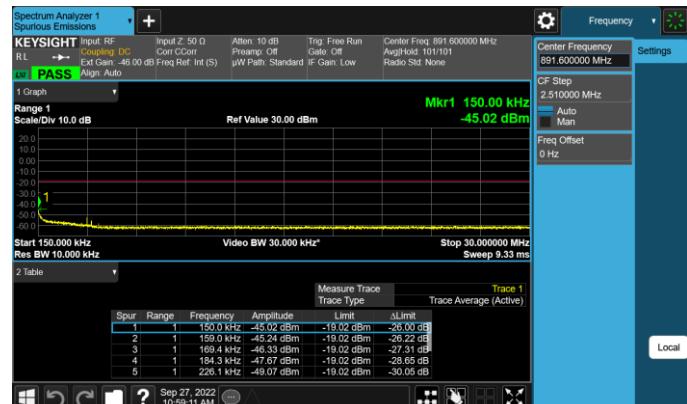


Channel Frequency 891.6MHz, TM6, 64QAM, TX1

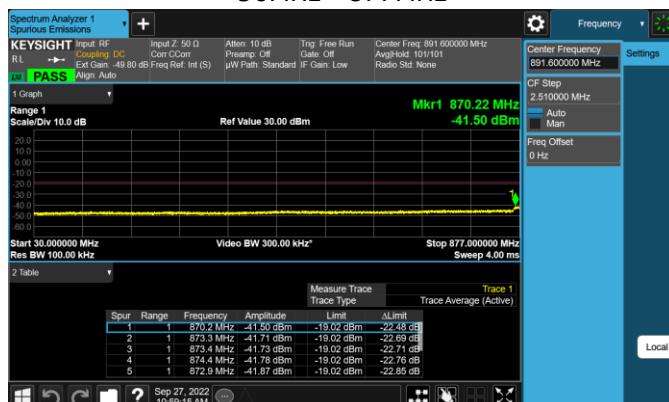
9kHz – 150kHz



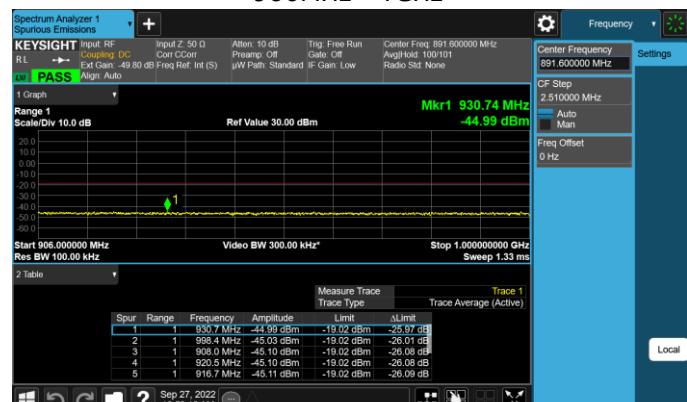
150kHz – 30MHz



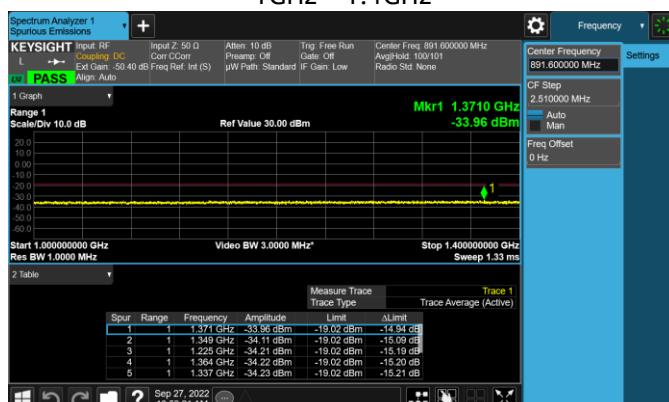
30MHz – 877MHz



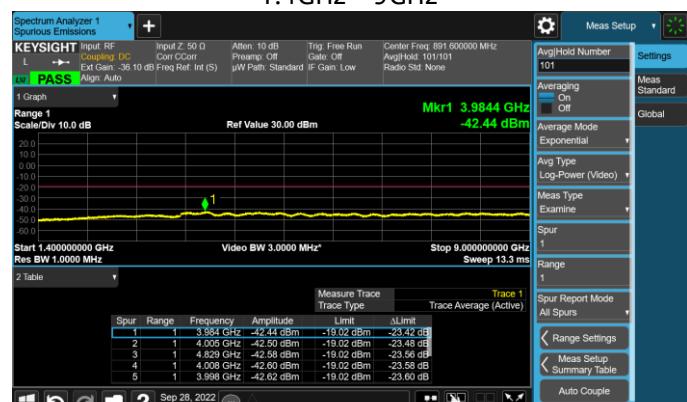
906MHz – 1GHz



1GHz – 1.4GHz

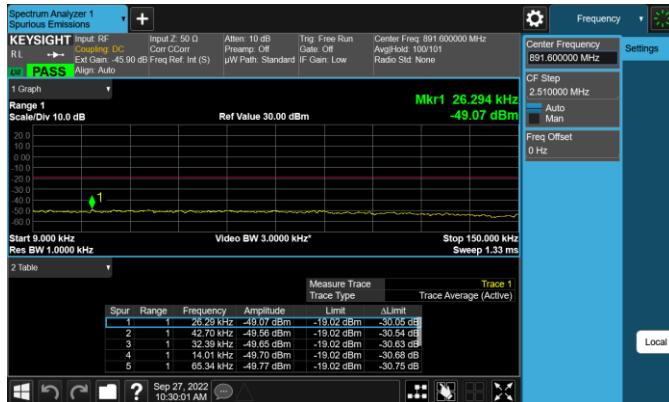


1.4GHz – 9GHz

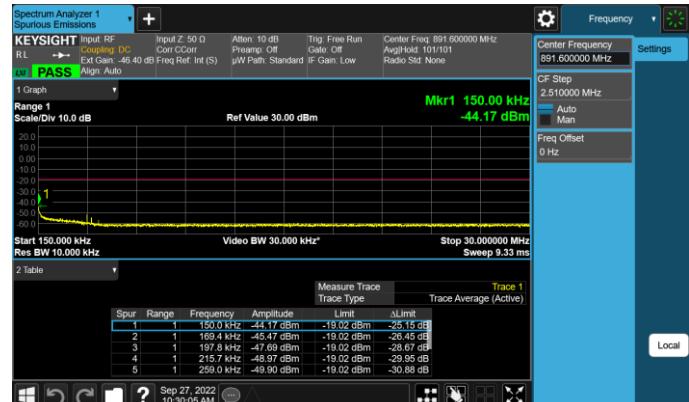


Channel Frequency 891.6MHz, TM6, 64QAM, TX2

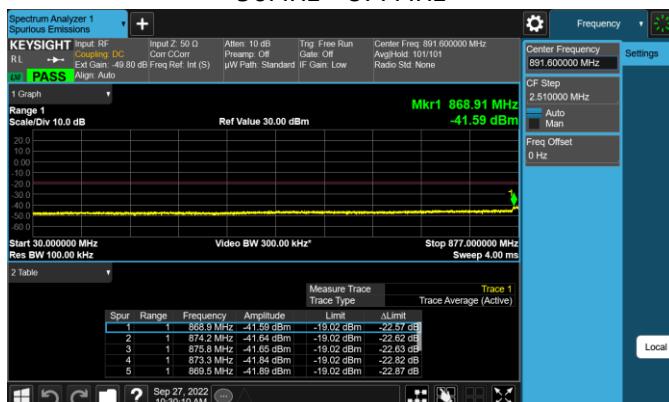
9kHz – 150kHz



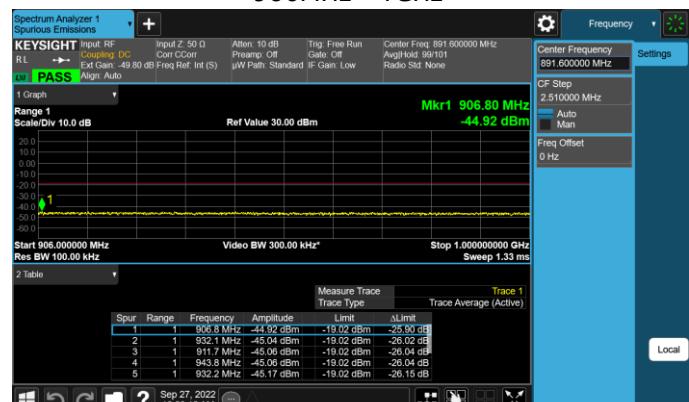
150kHz – 30MHz



30MHz – 877MHz



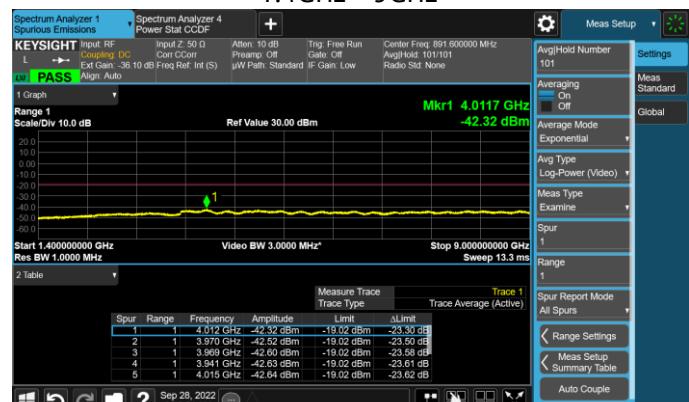
906MHz – 1GHz



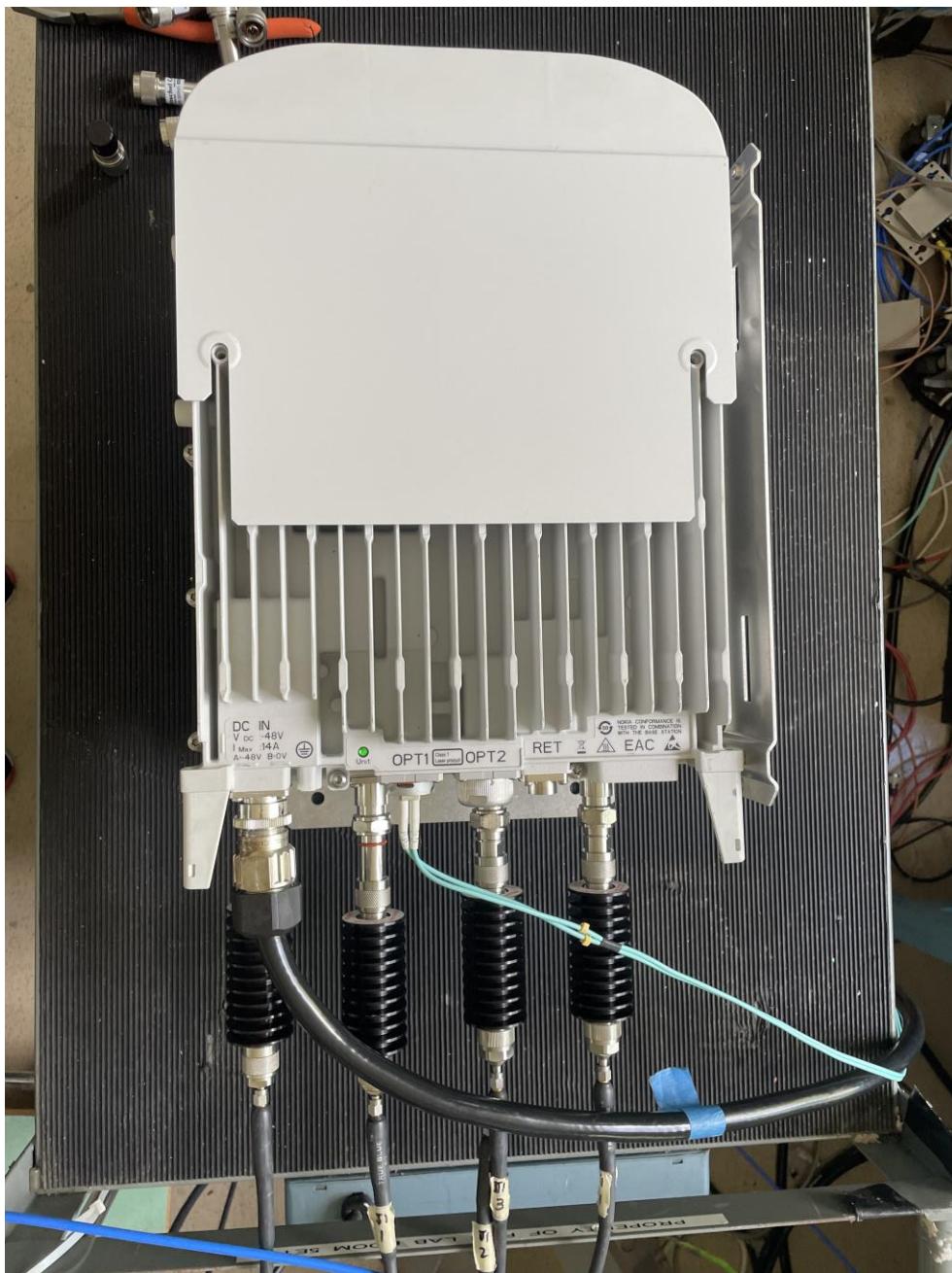
1GHz – 1.4GHz



1.4GHz – 9GHz



Photographs



Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2021-03-03	2023-03-03
E1338	KeySight Technologies	MXA Signal Analyzer		N9020B	MY57430927	2021-01-07	2023-01-07
E966	Trilithic	Filter, High Pass	Cellular	4HC1400/8000-1-KK	850-HPF-11	CNR	CNR
E1237	Weinschel	Attenuator	10dB 25 Watt	46-10-34	BH8105	CNR-V	CNR-V

Customer Support Equipment						
Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
Aeroflex/ Weinschel	Attenuator	20dB 50Watt	24-20-34	CG3752	CNR-V	CNR-V
Narda Micro-Pad	Attenuator	3dB 2Watts	4772-3	9603	CNR-V	CNR-V
Aeroflex/ Weinschel	Attenuator	20dB 50Watt	24-20-34	CG3743	CNR-V	CNR-V
Aeroflex/ Weinschel	Attenuator	20dB 50Watt	24-20-34	CE9361	CNR-V	CNR-V
Utriflex Micro-coax	RF Cable		MFR6 64639 858616-001	UFB142A-Q-0760-2002G0	NA	NA
Teledyne Storm Products	RF Cable	MFR-57500	090-2872-001	09-08-832	NA	NA
Mini Circuit	RF Switch		ZTS-8SP8T-63	1170228003	NA	NA
Mini Circuit	RF Switch		RCM-202	0211020002	NA	NA

CNR: Calibration Not Required.

CNR-V: Calibration Not Required. Must Be Verified.

Test Dates: 9/27/2022 – 10/6/2022

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.

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

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

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 dB μ V/m at 3m and 91.77 dB μ V/m at 1m

The Part 22 non-report level is 62.23 dB μ V/m at 3m.

The calculated emission levels were found by:

$$\text{Measured level (dB}\mu\text{V)} + \text{Cable Loss(dB)} + \text{Antenna Factor(dB)} = \text{Field Strength (dB}\mu\text{V/m)}$$

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 dB μ V/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dB μ V/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



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 Communiqué dated January 2009).*

2020-09-25 through 2021-09-30

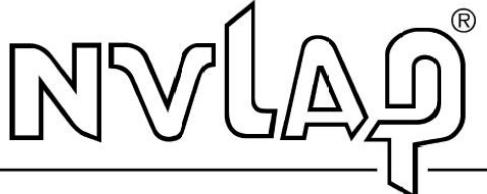
Effective Dates



For the National Voluntary Laboratory Accreditation Program

A handwritten signature in blue ink that reads "Della S. Laman".

United States Department of Commerce
National Institute of Standards and Technology



Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 100275-0

Nokia, Global Product Compliance Lab
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management system (refer to joint ISO-ILAC-IAF Communiqué dated January 2009).*

2022-09-28 through 2023-09-30

Effective Dates



For the National Voluntary Laboratory Accreditation Program

A handwritten signature in blue ink that reads 'Daniel S. Leman'.