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:
Title 47 CFR FCC Part 25

Client:
NOKIA SOLUTIONS AND NETWORKS, OY

Product Evaluated:
AirScale Micro RRH AWHNB 4T4R Band 53 1W

Report Number:
TR-2023-0129-FCC25

Date Issued:
December 5, 2023

Table of Contents

Revisions

Date	Revision	Section	Change
12/5/2023	0		Initial Release

Nokia Global Product Compliance Laboratories is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP®) for specific services, listed on the Scope of Accreditation, for: Electromagnetic Compatibility and 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). NVLAP LAB CODE: 100275-0.

Nokia Global Product Compliance Laboratory represents to the client that the laboratory's accreditation or any of its calibration or test reports in no way constitutes or implies product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

Prepared By:

Signed:  12/5/2023

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

Reviewed By:

Signed:  12/5/2023

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

Approved By:

Signed:  12/5/2023

Raymond Johnson
Technical Manager
NVLAP Signatory
ray.johnson@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):	AWHNB AirScale Micro RRH 4T4R Band 53 1W
Serial Number:	EB2331R0040
FCC ID:	2AD8UAWHNB01
Hardware Version:	476437A.21
Software Version:	SBTS24R1
Frequency Range:	2483.5 - 2495 MHz
GPCL Project Number:	2023-0129
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Applicant:	Nokia Solutions and Networks, OY 200 Lucent Lane Naperville, Illinois 60563
Test Requirement(s):	Title 47 CFR Part25
Test Standards:	Refer to Section 1.5.1
Measurement Procedure(s):	Refer to Section 1.5.2
Test Date(s):	10/11/2023 – 11/16/2023
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):	Ronald Remy
Lead Engineer:	Steve Gordon
Test Engineer (s):	Norberto Batista, Mike Soli, Jaideep Yadav
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 **Nokia AirScale Micro RRH AWHNB 4T4R Band 53 1W**, hereinafter referred to as the Equipment Under Test (EUT).

1.2 Purpose and Scope

AirScale AWHNB is a variant of 5G/LTE Micro Remote Radio Head (mRRH), operating in B53 in the range of 2483.5-2495MHz. It supports LTE and NR technologies, 10MHz carriers and 4xMIMOs with 0.25W per port. AWHNB requires a new FCC certification filing.

This document is to provide the testing data required for qualifying the EUT in compliance with FCC Part 25 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

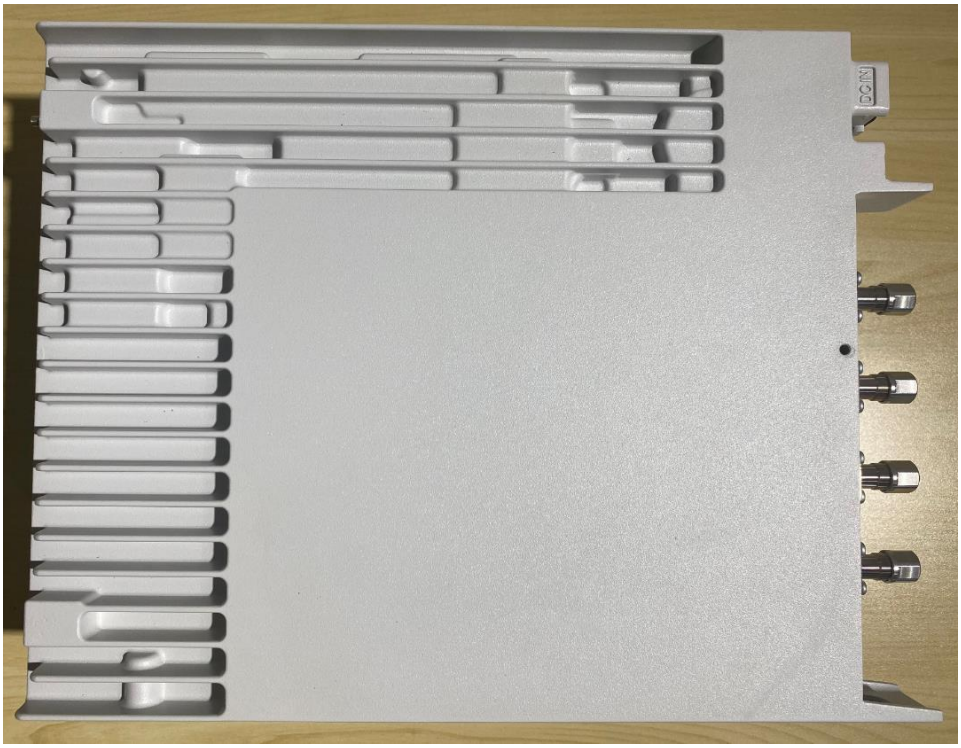
1.3 EUT Details

1.3.1 Specifications

Specification Items	Description
Product	Nokia AirScale Micro RRH AWHNB 4T4R B53
Radio Type	Radio Transmitter Device
Power Type	DC
Modulation	QPSK, 16QAM, 64QAM and 256QAM
Operating Frequency Range	2483.5 - 2495 MHz
Channel Bandwidth	10 MHz
Max Conducted Power (Rated)	Up to 4x0.25W (23.98 dBm per TX Port)
Operating Mode	4T4R
Software Version	SBTS24R1
Hardware Version	476437A.X21

1.3.2 Photographs

Serial Number



1.4 Test Requirements

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046, FCC O&A 20-48 III(H)(2), 25.253(d)(1)(2)	RF Power Output, SD	Yes
2.1047	Modulation Characteristics	Yes
2.1049, FCC O&A 20-48 III(H)(3), 25.202(f),	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051, FCC O&A 20-48 III(H)(2), 25.202(f),	Spurious Emissions at Antenna Terminals	Yes
2.105325.202(f), 15 Class B	Field Strength of Spurious Radiation	Yes
2.1055, 25.202(d)	Measurement of Frequency Stability	Yes

1.5 Test Standards & Measurement Procedures

1.5.1 Test Standards

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 25.
- FCC 20-48 Order and Authorization, April 19, 2020.
- KDB 273109 D01 Equipment Authorization Guidance for Part 25 Transceivers v02r02 2011.
- KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.
- KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013.
- FCC KDB 662911 D02 MIMO with Cross-Polarized Antenna (October 25, 2011) - MIMO with Cross-Polarized Antenna.
- FCC KDB 662911 D03 MIMO with Cross-Polarized Antenna (October 13, 2020) - Provision to Allow Measurement of Directional Gain of Multi-Antenna Systems for Compliance Verification.
- ANSI C63.26-2015, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.
- ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- ANSI/TIA/EIA-603-E (2016) - Commercial Mobile Services (FCC Licensed Radio Service Equipment) in 47 CFR FCC Parts 22 (cellular), 24, 25 (below 3 GHz), and 27.

1.5.2 Measurement 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

1.6 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, 32, *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

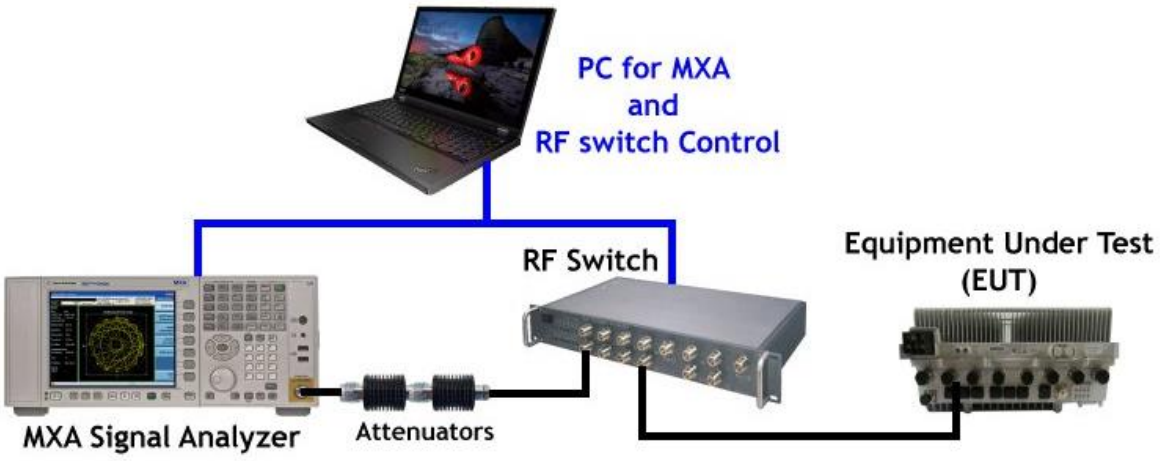
1.7 Executive Summary

Requirement 47 CFR FCC Parts 2 and 96	Description of Tests	Result
2.1046, FCC O&A 20-48 III(H)(2), 25.253(d)(1)(2)	RF Power Output, PSD	COMPLIES
2.1047	Modulation Characteristics	COMPLIES
2.1049, FCC O&A 20-48 III(H)(3), 25.202(f),	(a) Occupied Bandwidth (b) Out-of-Band Emissions	COMPLIES
2.1051, FCC O&A 20-48 III(H)(2), 25.202(f),	Spurious Emissions at Antenna Terminals	COMPLIES
2.105325.202(f), 15 Class B	Field Strength of Spurious Radiation	COMPLIES
2.1055, 25.202(d)	Measurement of Frequency Stability	COMPLIES

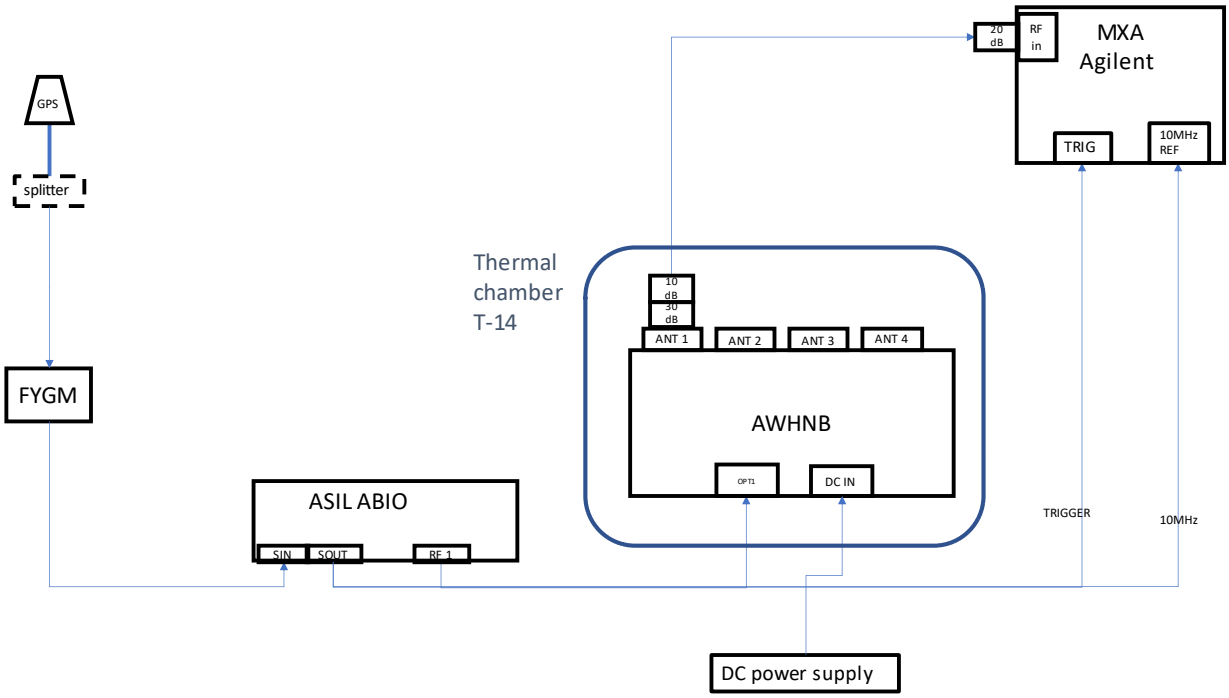
1. **COMPLIES -** Passed all applicable tests.
2. **N/A –** Not Applicable.
3. **NT –** Not Tested.

1.8 Test Configurations

Test Setup for all Antenna Port Measurements



Test Setup for Frequency Stability



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 allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26.

The power is under digital control. The product is designed to operate under FCC 20-48 O&A, Part 25 rules for Band 53.

Under FCC 25 the product is limited to the maximum EIRP of 6 dBW or 3.98W.

2.1.1 RF Power Output Measurements

Power measurements of the LTE and NR transmit signal were conducted with an MXA Signal analyzer per KDB 971168 D01 using the gated RF Channel Power Function.

2.1.2 RF Power Output Results

Table 2.1a - RF Power - LTE

Channel Power -LTE 10 MHz			
Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 2488.5 MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 2490 MHz	
TX Port	(dBm)	TX Port	(dBm)
0	23.69	0	23.72
1	23.69	1	23.72
2	23.75	2	23.78
3	**23.80**	3	**23.82**
Total Power (dBm)	29.75	Total Power (dBm)	29.78
Total Power (W)	0.945	Total Power (W)	0.951

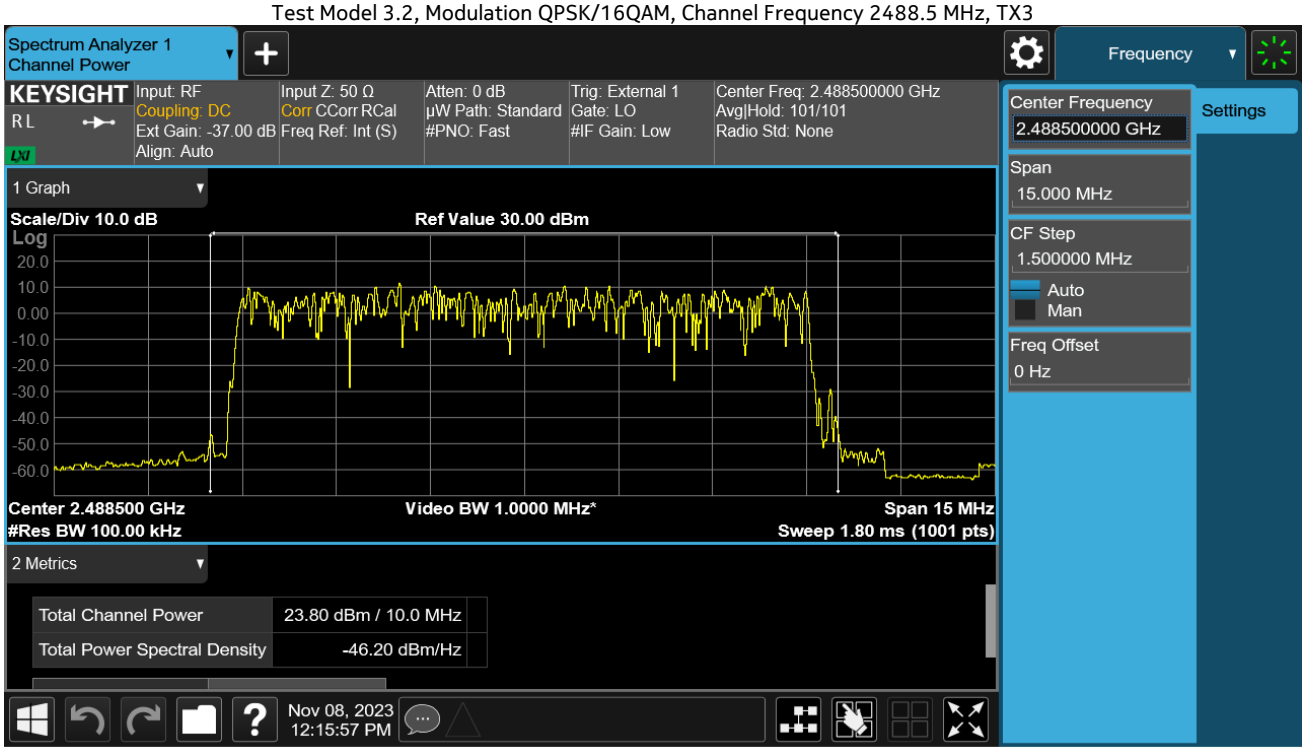
Table 2.1b - RF Power - 5G-NR

Channel Power - 5G-NR 10 MHz			
Test Model 3.1 Modulation 64QAM Channel Frequency 2488.5 MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 2490 MHz	
TX Port	(dBm)	TX Port	(dBm)
0	23.88	0	23.60
1	23.89	1	**23.74**
2	23.94	2	23.60
3	**23.99**	3	23.67
Total Power (dBm)	29.95	Total Power (dBm)	29.67
Total Power (W)	0.988	Total Power (W)	0.928

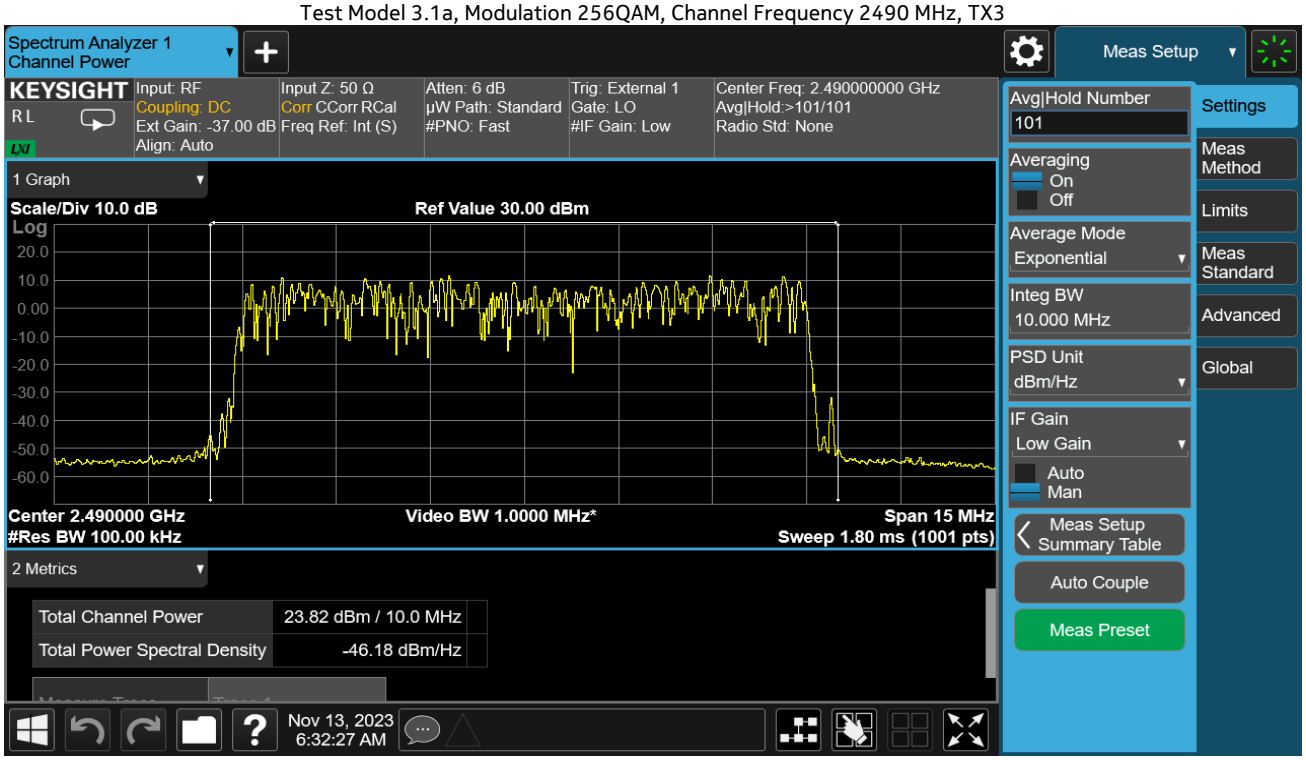
2.1.3 Maximum RF Conducted Output Power Plots

LTE, 10MHz BW

Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 2488.5 MHz, TX3

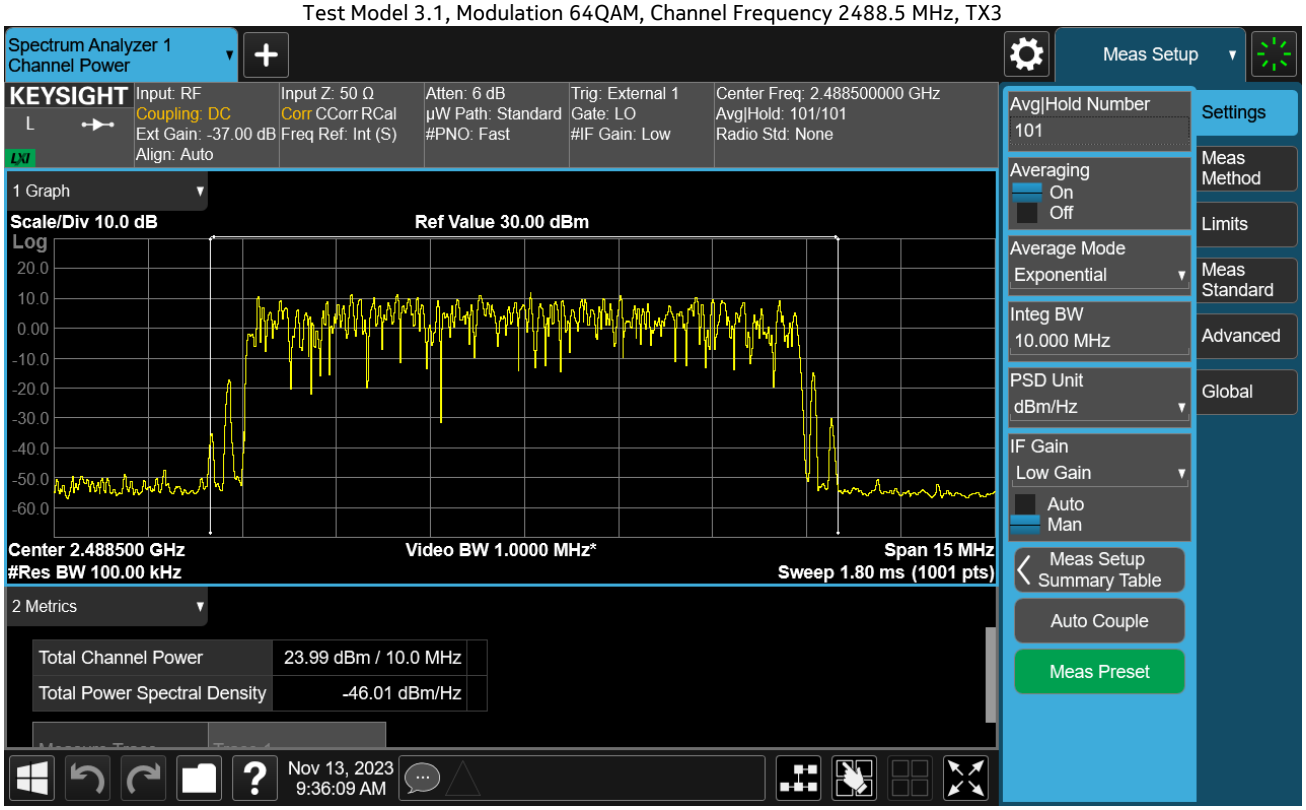


Test Model 3.1a, Modulation 256QAM, Channel Frequency 2490 MHz, TX3

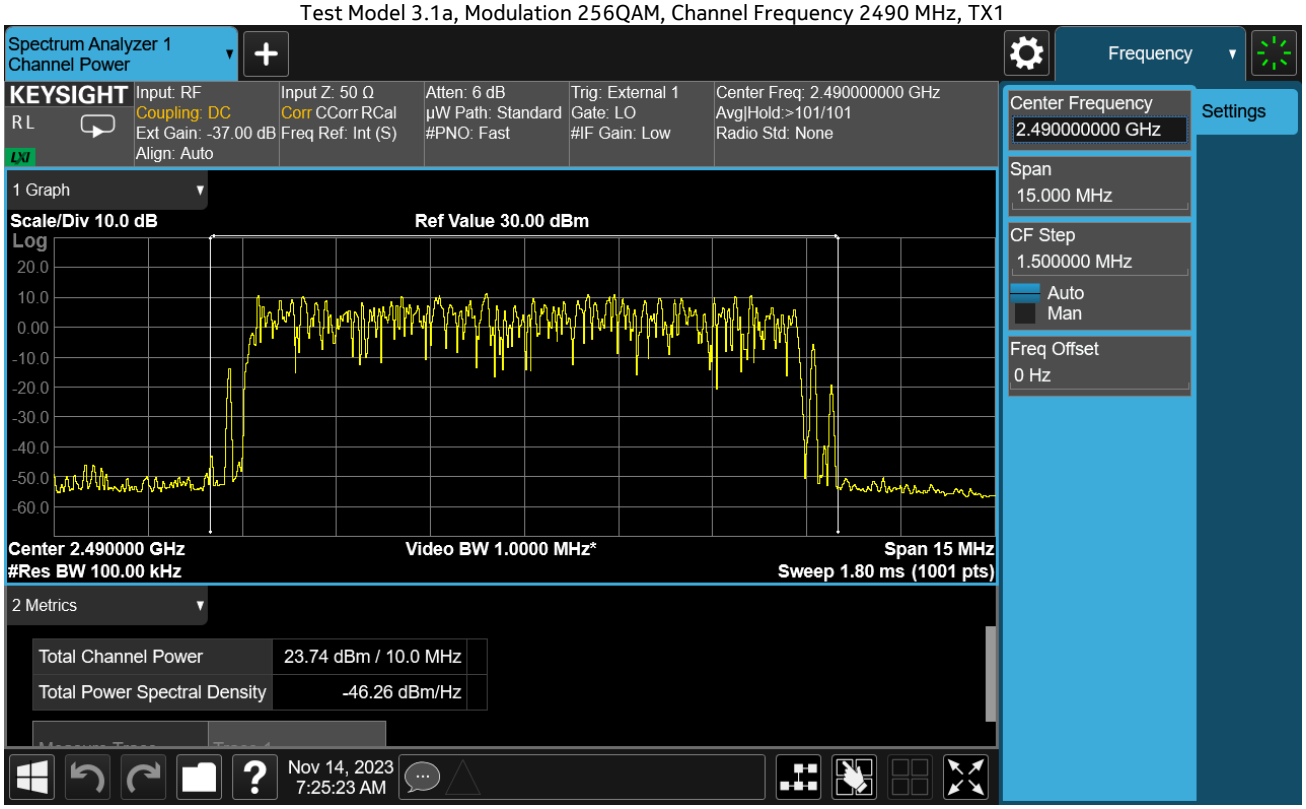


5G-NR, 10MHz BW

Test Model 3.1, Modulation 64QAM, Channel Frequency 2488.5 MHz, TX3



Test Model 3.1a, Modulation 256QAM, Channel Frequency 2490 MHz, TX1



2.2 EIRP Compliance

Under FCC 25 the product is limited to the maximum EIRP of 6 dBW or 3.98W. Compliance with the EIRP requirements is tabulated in Table 2.2 below.

In the event the antenna gain path loss is less than what listed in the table, the output power setting will be reduced in order to stay within the EIRP limits for the band.

Table 2.2 Effective Isotropically Radiated Power (EIRP) Compliance

Radio Access Technology	Maximum Total 4x MIMO Transmit Power	EIRP Limit	Maximum Permissible Antenna Gain + Pathloss*	EIRP Compliance
	dBm	dBm	dB	Pass/Fail
LTE	29.78	36	6.22	Pass
5G-NR	29.95	36	6.05	Pass

*- If Maximum Antenna Gain and Installation Pathloss (Cabling loss) exceeds this value, the product Output Power Setting must be reduced for compliance to be maintained.

2.3 Power Spectral Density

The Power Spectral Density (PSD) of the EUT was measured per KDB 971168 D01 the Channel Power Measurement feature of the MXA Analyzer. The signal bandwidths, modulations and transmit channels identified in Table 2.3 were evaluated.

Federal Communications Commission FCC 16-181

(iv) The maximum power spectral density conducted to the antenna is not greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Results
The maximum Power Spectral Density (PSD) of the EUT measured at its antenna transmitting terminals were measured to be -6.63 dBm/MHz. The measured values are in Table 2.3 below.

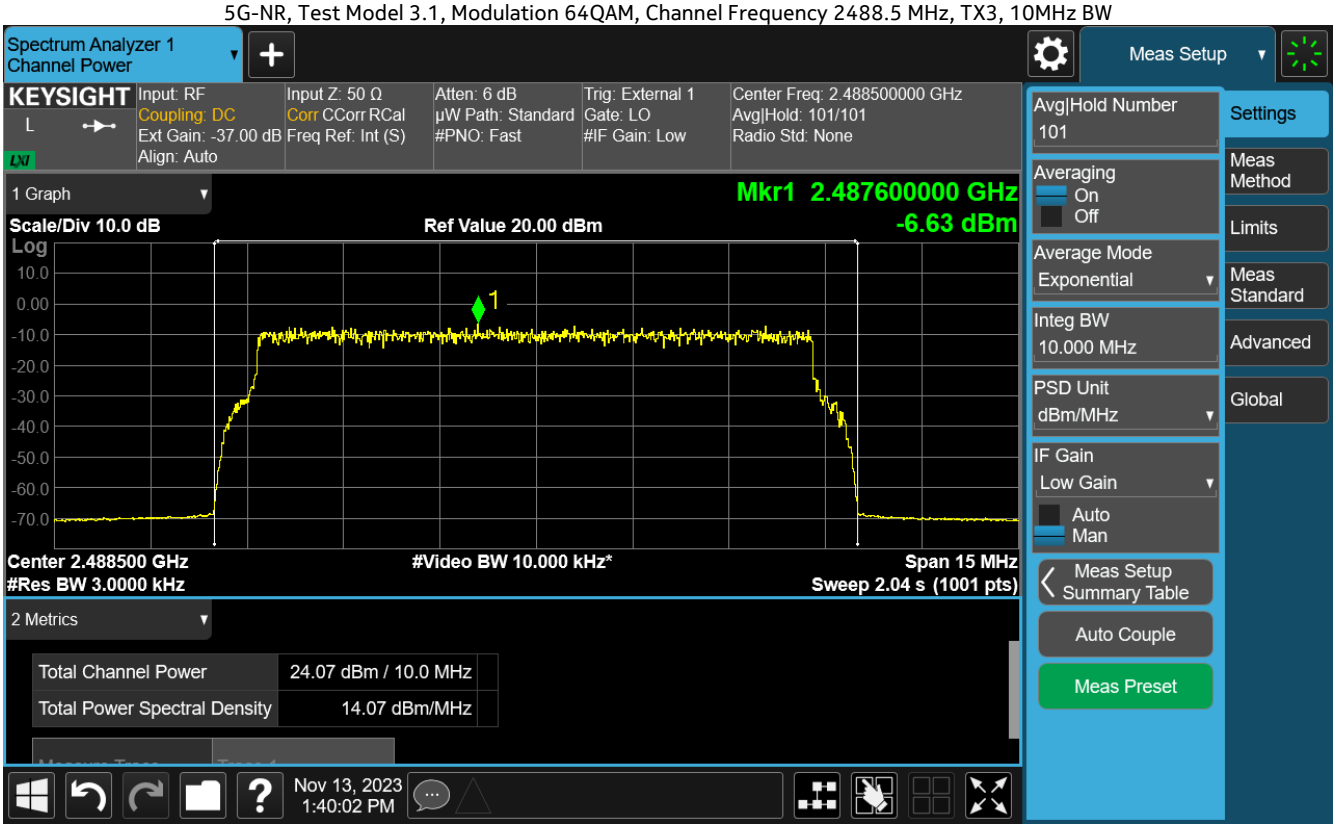
Table 2.3 Power Spectral Density Results

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	PPSD per Port (dBm / 3kHz)	Total PPSD exclude Antenna Gain (dBm/3kHz)	FCC Limit (dBm/3kHz)	maximum Permissible Antenna Gain
LTE	3.2	QPSK/16QAM	3	2488.5	10	-11.31	-5.29	8	13.29
LTE	3.1a	256QAM	3	2490	10	-13.86	-7.84	8	15.84
5G-NR	3.1	64QAM	3	2488.5	10	-6.63	-0.61	8	8.61
5G-NR	3.1a	256QAM	1	2490	10	-9.91	-3.89	8	11.89

Total PPSD exclude Antenna Gain = PPSD + 10 log (4)
Maximum Permissible Antenna Gain = FCC Limit - Total PPSD exclude Antenna Gain

2.3.1 Power Spectral Density Plots

5G-NR, Test Model 3.1, Modulation 64QAM, Channel Frequency 2488.5 MHz, TX3, 10MHz BW



2.4 Peak-to-Average Power Ratio (PAPR)

The Peak-to-Average Power Ratio (PAPR) of the EUT was measured per KDB 971168 D01 using the Power Complementary Cumulative Distribution Function (CCDF) feature of the MXA Analyzer. The PAPR measurements are tabulated in Table 2.4.

Often it is expected that the transmitter's peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission. The maximum PAPR value for each measured configuration is given in Table 2.4.

The data presented in this section is for information only.

2.4.1 Peak-to-Average Power Ratio Results:

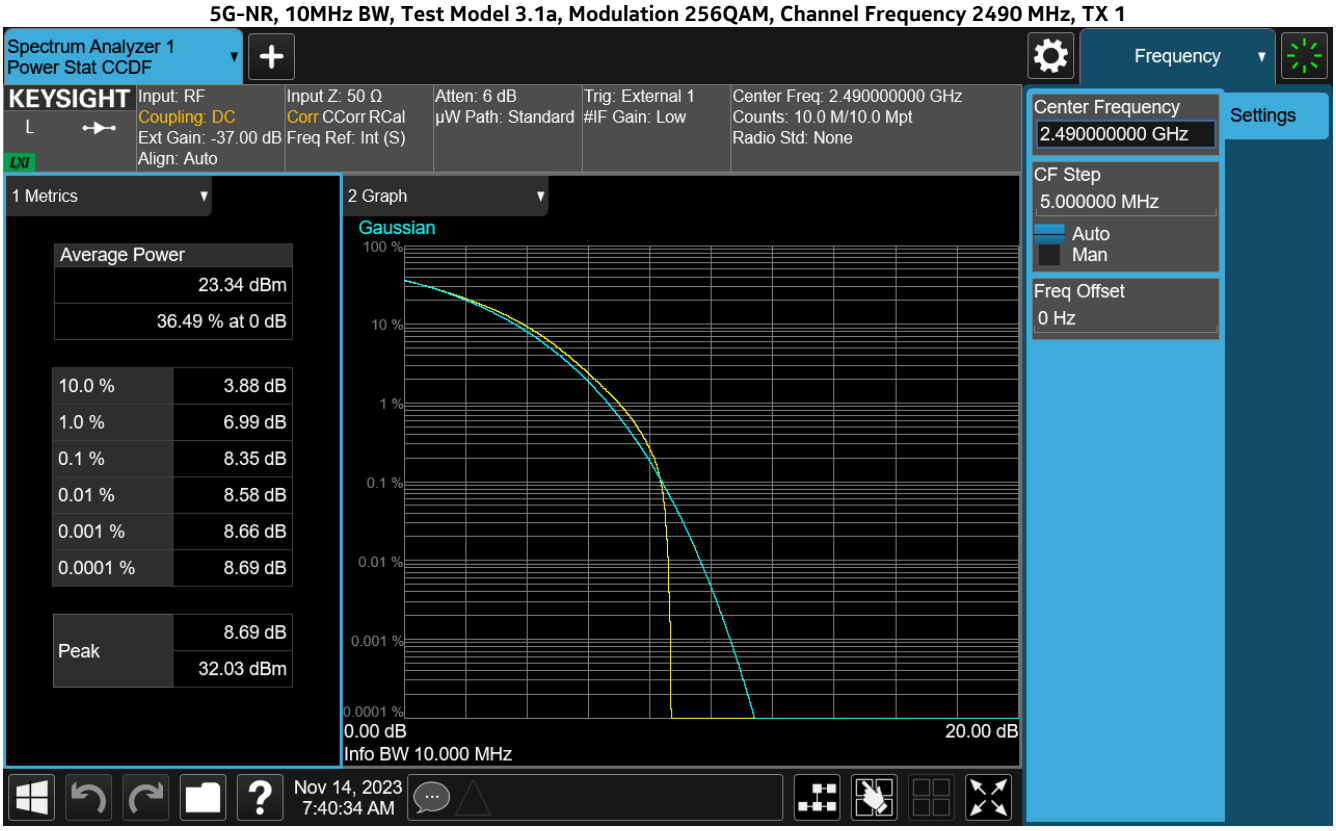
The maximum Peak-to-Average Power Ratio (PAPR) of the EUT measured at its antenna transmitting terminals was measured to be 8.38dB maximum, which is in full compliance with the requirement to not exceed 13 dB as specified by the FCC. The representative data sets exact values are listed in Table 2.4 below.

Table 2.4 Peak to Average Power Ratio

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	PAR at 0.1% Limit - 13 dB
LTE	3.2	QPSK/16QAM	3	2488.5	10	7.78
LTE	3.1a	256QAM	3	2490	10	7.79
5G-NR	3.1	64QAM	3	2488.5	10	8.30
5G-NR	3.1a	256QAM	1	2490	10	**8.35**

2.4.2 Peak-to-Average Power Ratio Plots

5G-NR, 10MHz BW, Test Model 3.1a, Modulation 256QAM, Channel Frequency 2490 MHz, TX 1



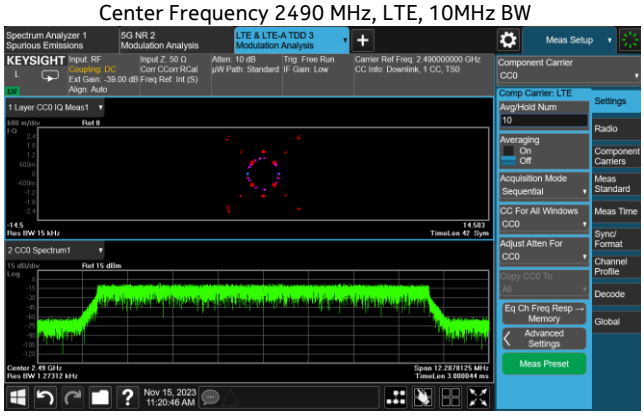
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

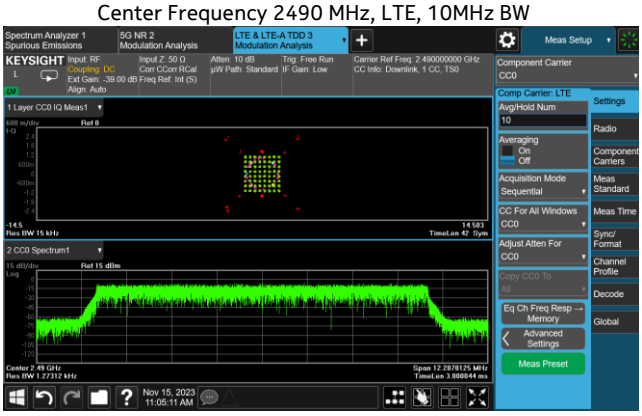
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

3.1.1 Modulation Characteristics – Plots

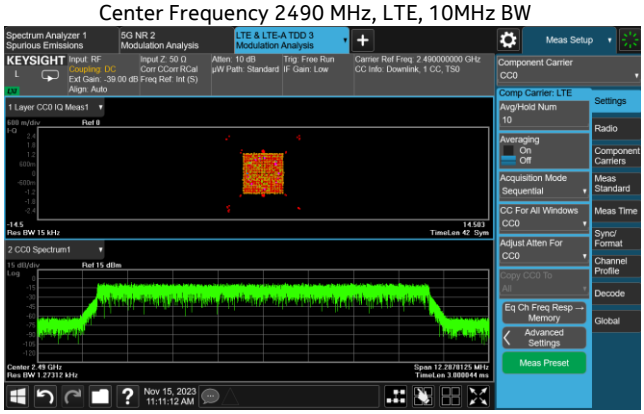
Modulation QPSK TM1.1
Center Frequency 2490 MHz, LTE, 10MHz BW



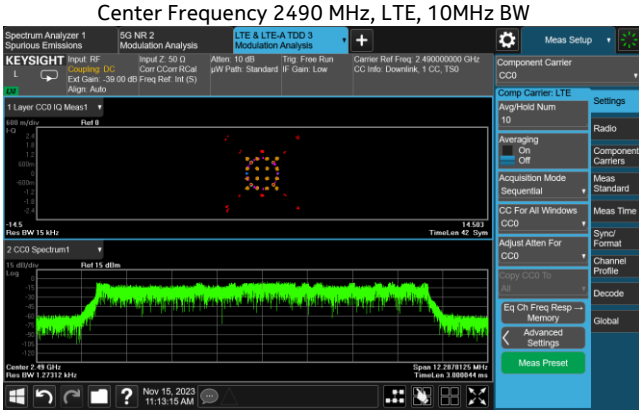
Modulation QPSK TM3.1
Center Frequency 2490 MHz, LTE, 10MHz BW



Modulation QPSK TM3.1a
Center Frequency 2490 MHz, LTE, 10MHz BW



Modulation QPSK TM3.2
Center Frequency 2490 MHz, LTE, 10MHz BW



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.

4.1.1 Occupied Bandwidth (Signal Bandwidth) Results

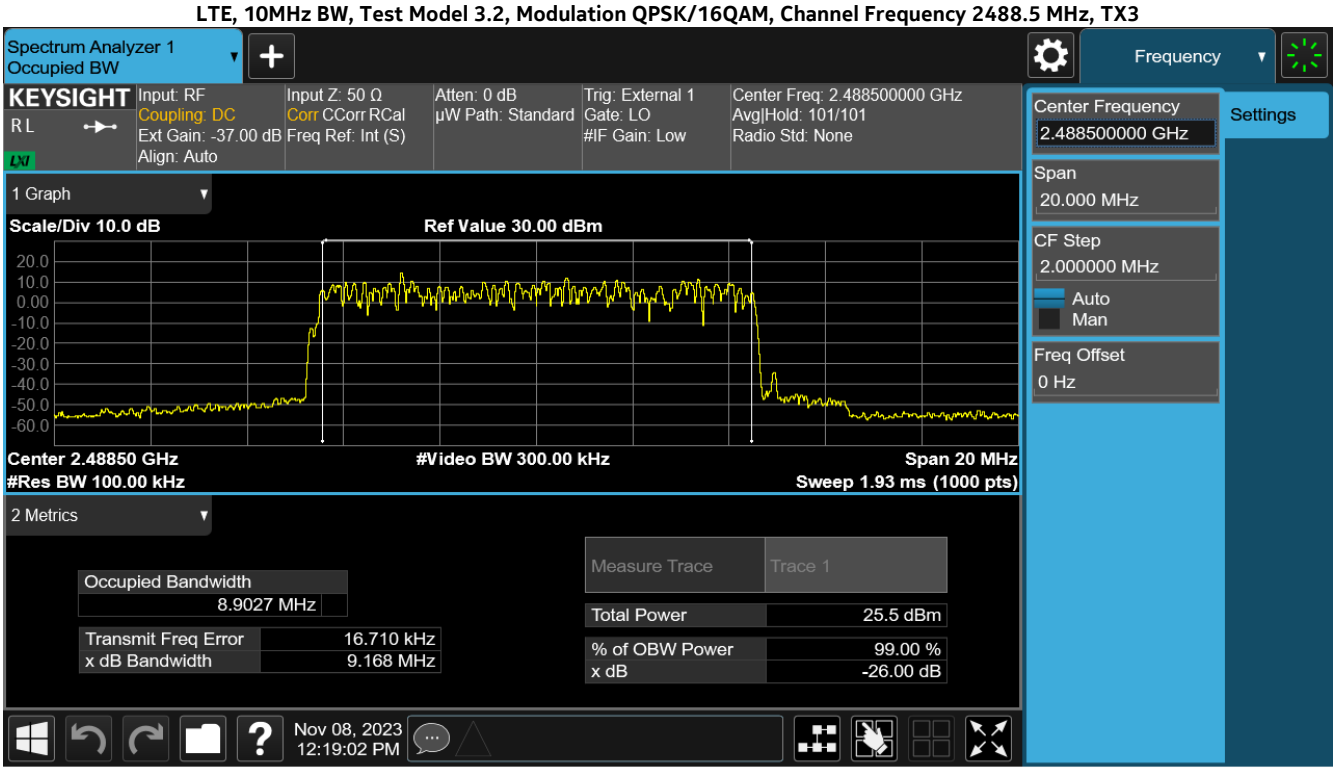
The 99% occupied bandwidth and -26 dB relative bandwidth were measured with an Agilent/Keysight MXA signal analyzer for the emission designators. The results are tabulated in Table 4.1 and example plots are in section 4.1. 2.

Table 4.1: Occupied Bandwidth

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	99% Occupied BW MHz
LTE	3.2	QPSK/16QAM	3	2488.5	10	**8.9027**
LTE	3.1a	256QAM	3	2490	10	8.8442
5G-NR	3.1	64QAM	3	2488.5	10	8.5977
5G-NR	3.1a	256QAM	1	2490	10	8.5483

4.1.2 Occupied Bandwidth – Plots

LTE, 10MHz BW, Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 2488.5 MHz, TX3



4.2 Edge of Band Emissions

Per Federal Communications Commission amends title 47 of the Code of Federal Regulations, part 25:
PART 25 – SATELLITE COMMUNICATIONS
Federal Communications Commission FCC 16-181

(iv)The maximum power spectral density conducted to the antenna is not greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

(v) Emissions below 2483.5 MHz are attenuated below the transmitter power (P) measured in watts by a factor of at least 40 + 10 log (P) dB at the channel edge at 2483.5 MHz, 43 + 10 log (P) dB at 5 MHz from the channel edge, and 55 + 10 log (P) dB at X MHz from the channel edge where X is the greater of 6 MHz or the actual emission bandwidth.

(vi) Emissions above 2495 MHz are attenuated below the transmitter power (P) measured in watts by a factor of at least 43 + 10 log (P) dB on all frequencies between the channel edge at 2495 MHz and X MHz from this channel edge and 55 + 10 log (P) dB on all frequencies more than X MHz from this channel edge, where X is the greater of 6 MHz or the actual emission bandwidth.

(vii) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately above and adjacent to the 2495 MHz a resolution bandwidth of at least 1 percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. If 1 percent of the emission bandwidth of the fundamental emission is less than 1 MHz, the power measured must be integrated over the required measurement bandwidth of 1 MHz. A resolution bandwidth narrower than 1 MHz is permitted to improve measurement accuracy, provided the measured power is integrated over the full required measurement bandwidth (i.e., 1 MHz). The emission bandwidth of the fundamental emission of a transmitter is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power. When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section “.

Table 4.2 Emission Limits Per Port

	Mask for 2483.5-2495MHz				
Δf (MHz) from Bandedge at 2483.5 MHz and 2495MHz	-10	-5	0	0	10
Limit per Port (dBm)	-31.02	-19.02	-16.02	-19.02	-31.02
RBW (MHz)	1	1	1	1	1

The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a 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 Results

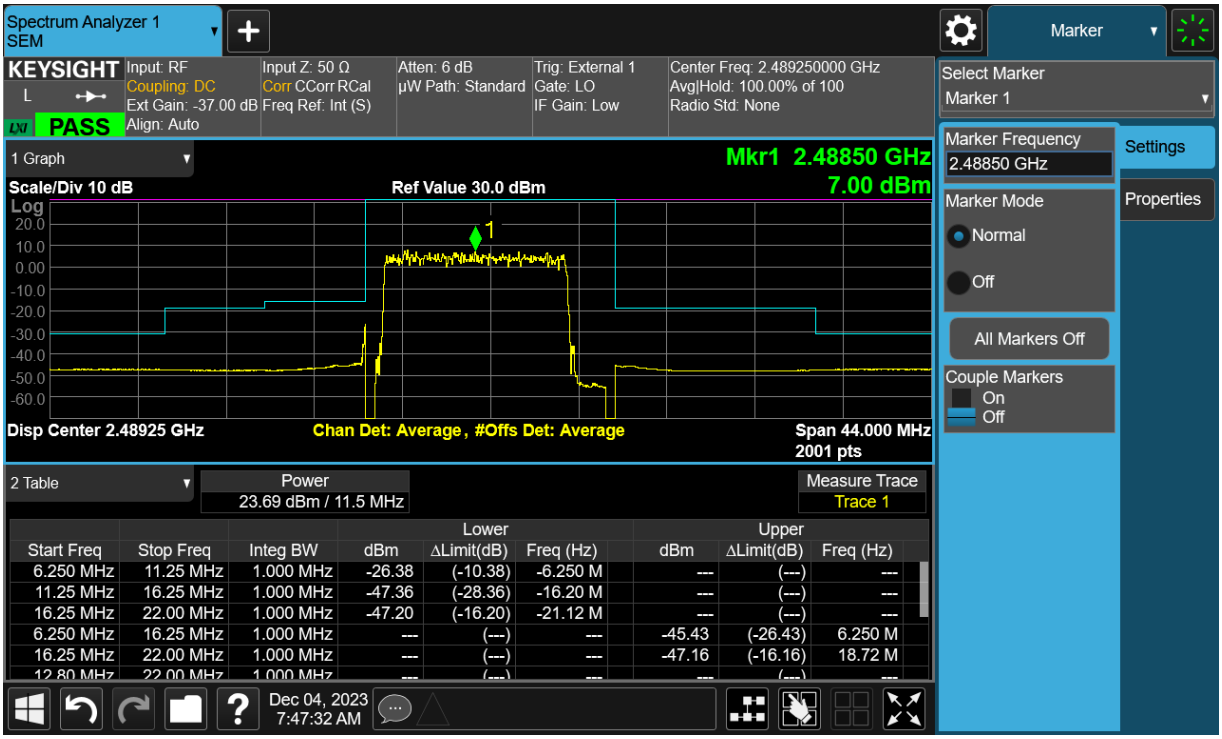
The conducted approach was used to measure the emissions of the block and band edges on ports which have the highest output power, respectively, to find the worst emissions.

The minimum margin measured is -16.21dB. The unwanted out-of-block and out-of-band emissions measured are all below the EIRP limits required.

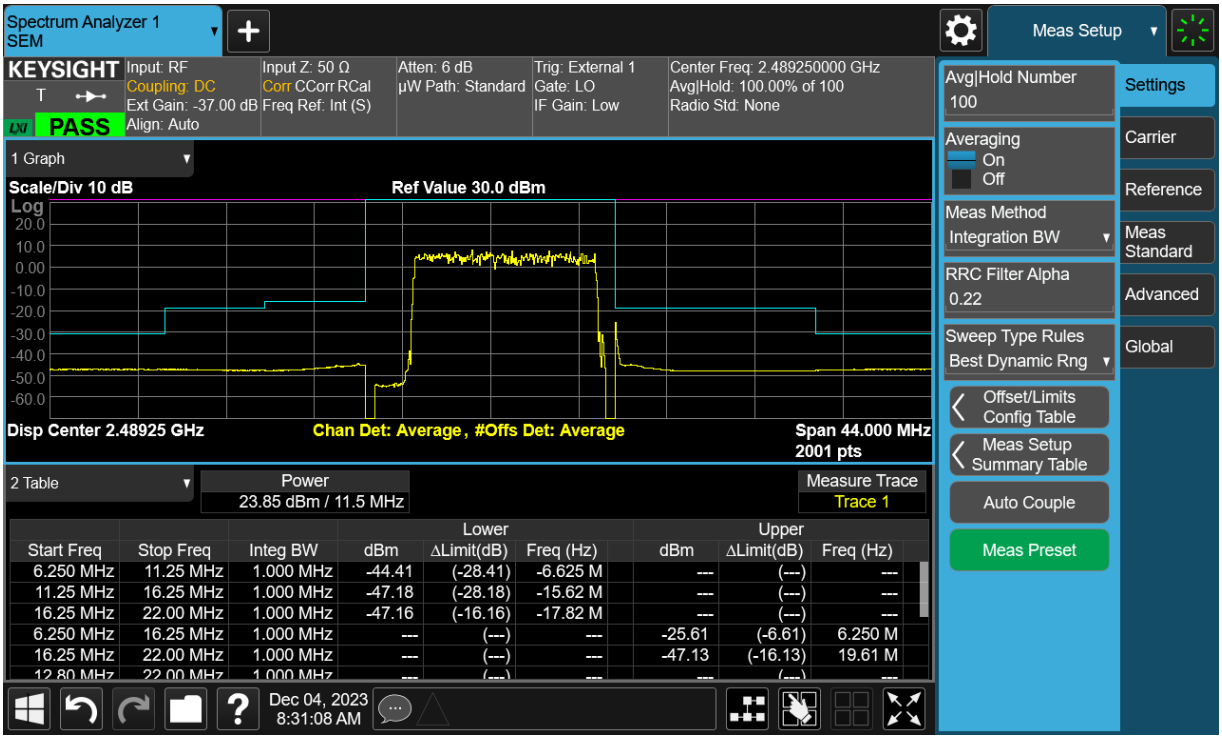
4.2.2 Edge of Band Emissions - Plots

LTE

Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
3.2	QPSK/16QAM	3	2488.5	10

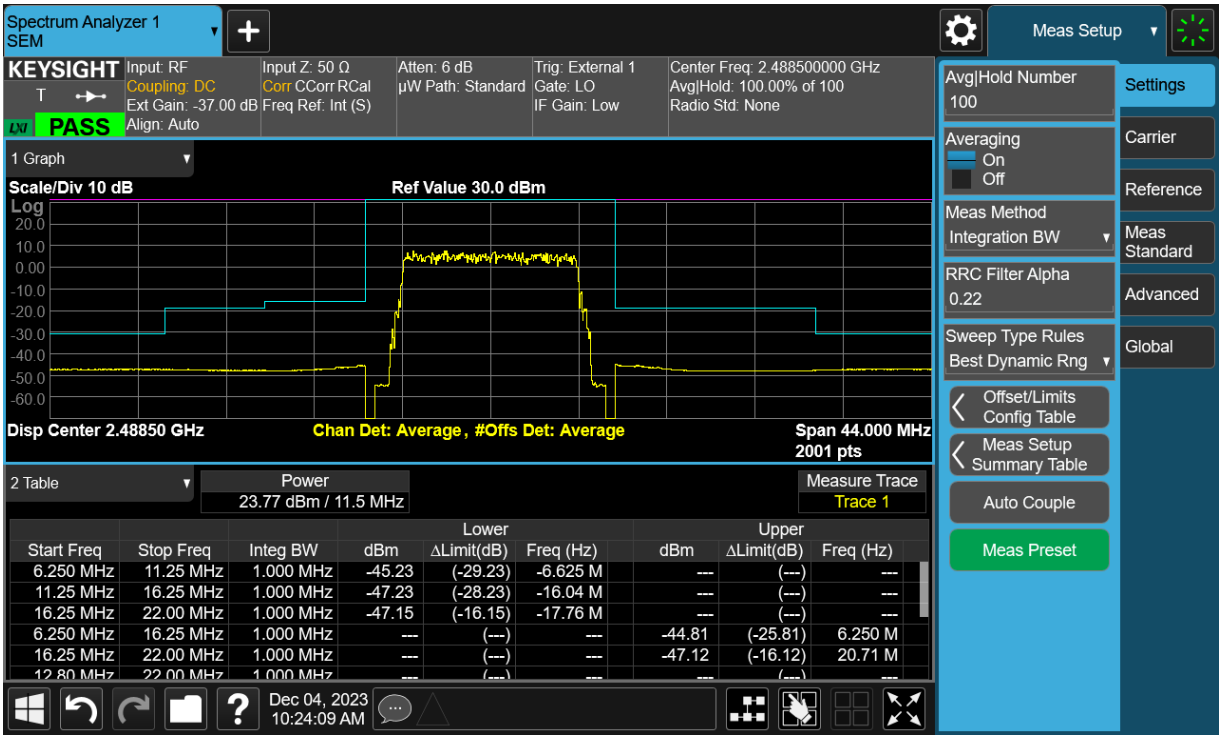


Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
3.1a	256QAM	3	2490	10

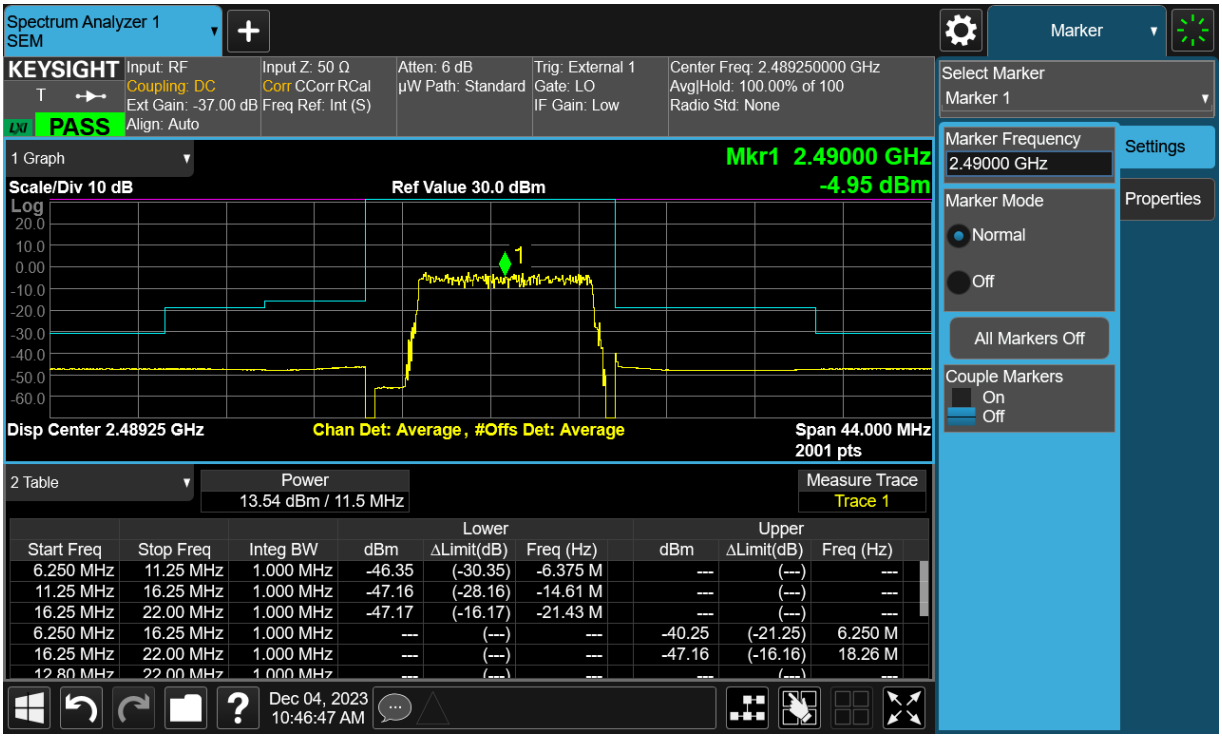


5G-NR

Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
3.1	64QAM	3	2488.5	10



Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
3.1a	256QAM	1	2490	10



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

This test measures the emissions of spurious signals which may come from harmonic, parasitic, intermodulation and frequency conversion products and are outside the necessary bandwidth but excludes Edge-of-Band emissions.

5.1 Section 2.1051 Spurious Emissions at Antenna Terminals

Spurious Emissions at the antenna terminals were investigated per 47CFR Section 2.1057(a)(1) over the frequency range of 10 MHz to 25 GHz which is beyond the 10th harmonic of the carrier frequency. A test coupler which incorporates a low intermod broadband RF attenuator was used to reduce the transceiver's amplitude to a level usable by the spectrum analyzer. The test configuration is shown in Figure 4.4.1 which documents the test set up used for the measurements. In this set up the complete RF test path was calibrated over the 10 MHz-25 GHz range.

The spurious measurements were made using an MXA Signal Analyzer. These measurements are performed in compliance with ANSI C63.26 and our ISO17025 process. The measurement meets the ANSI C63.26 requirements in paragraphs 5.2.4.4.1 and 5.7 which requires that the number of points in the sweep be > 2 × Span/RBW. The MXA signal analyzer measurements examine the 10 MHz to 16 GHz range.

Measurements were performed for all of the test configurations in Table 5.1 and these matches the test configurations used for Occupied Bandwidth / Edge of Band Emissions, RF Power and modulation.

5.2 Required Limit

The required emission limitation specified in FCC 20-48 O&A Section III H(3) and 47CFR 25.202(f) was applied to these tests.

The emission limits were given in Section 4.2.

5.3 Spurious Emissions at Antenna Terminals Results

Over the required frequency spectrum investigated for the EUT, no reportable out-of-block spurious emissions were detected. The measurement results demonstrate that the subject of the application is in full compliance with the Rules of the Commission.

Table 5.1: Spurious Emissions & Discrete Conducted Spurious Emissions at Antenna Terminals

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	Conducted Spurious Emissions Results	Discrete Conducted Spurious Emissions Results
LTE	3.2	QPSK/16QAM	3	2488.5	10	Pass	Pass
LTE	3.1a	256QAM	3	2490	10	Pass	Pass
5G-NR	3.1	64QAM	3	2488.5	10	Pass	Pass
5G-NR	3.1a	256QAM	1	2490	10	Pass	Pass

5.4 Spurious Emissions Plots

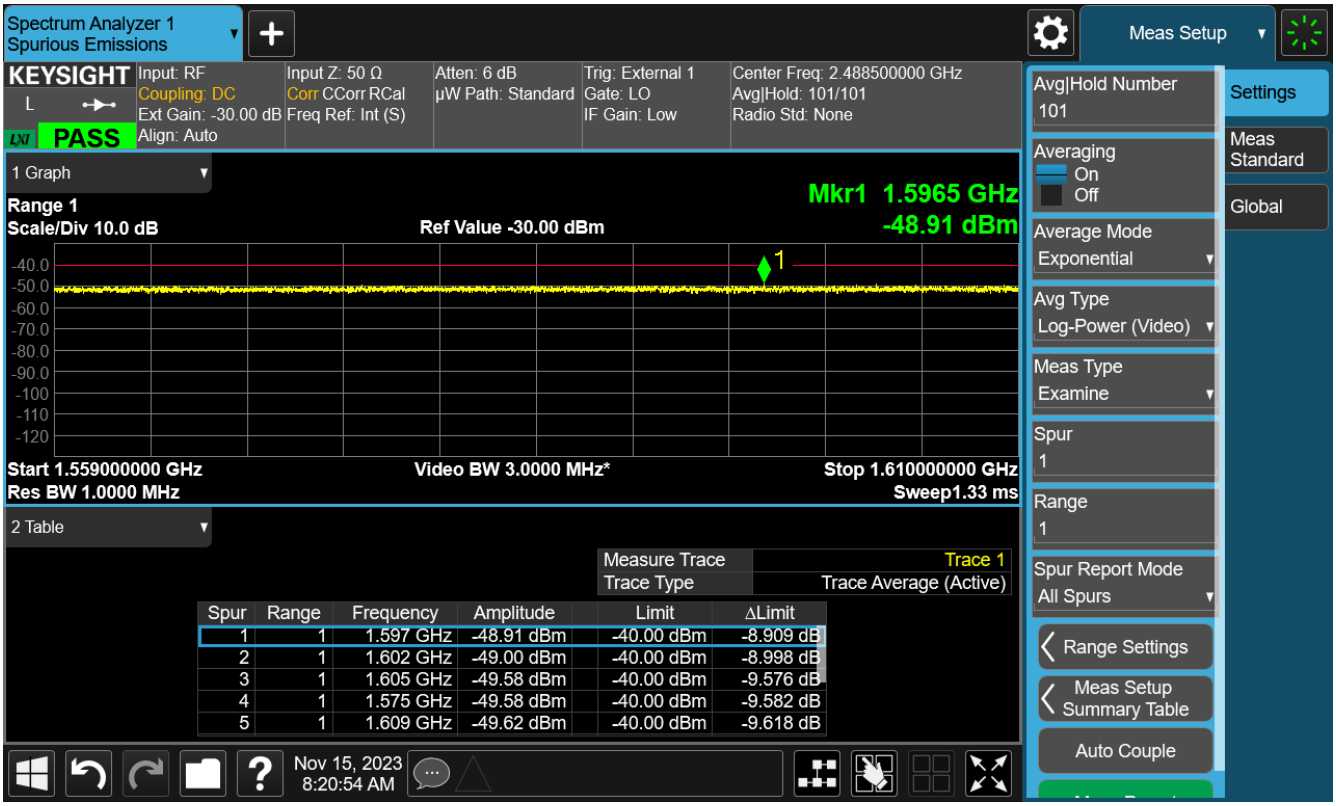
NOTE: Only plots with lowest margin in each frequency range are used in this report. The full suite of raw data resides at the MH, New Jersey location.

5.4.1 Discrete Spurious Emissions

1.559 GHz – 1.61 GHz

5G-NR

Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
3.1	64QAM	3	2488.5	10

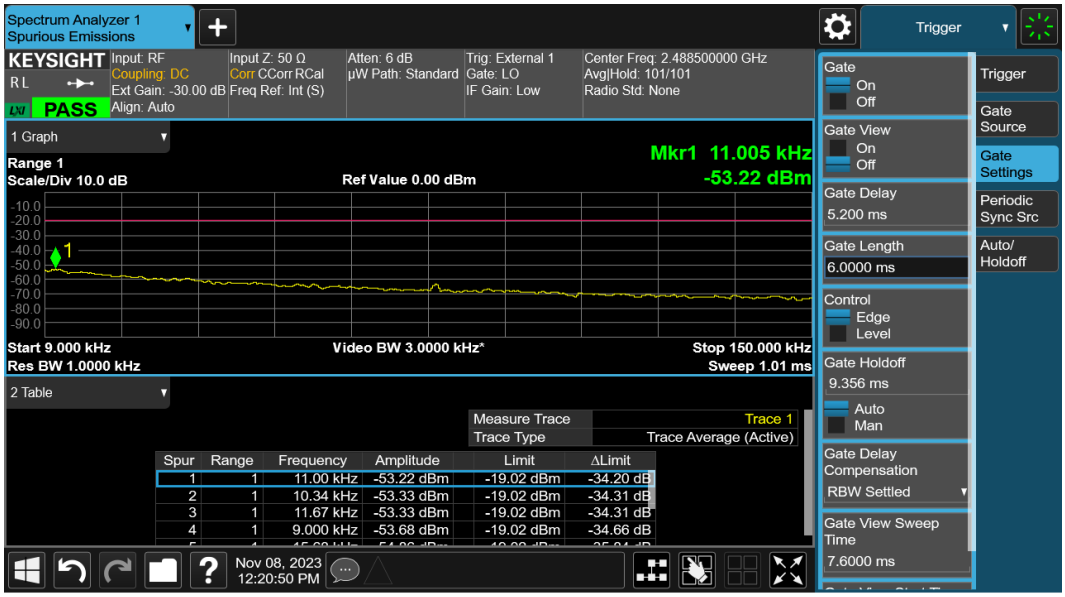


5.4.2 (9kHz – 25GHz) Compliance

The unwanted emissions near the band edges were provided in Section 4.2. The unwanted emissions between 1559-1610MHz were provided in Section 5.4.1 where the limits there are much tighter than that of 25.202(f).

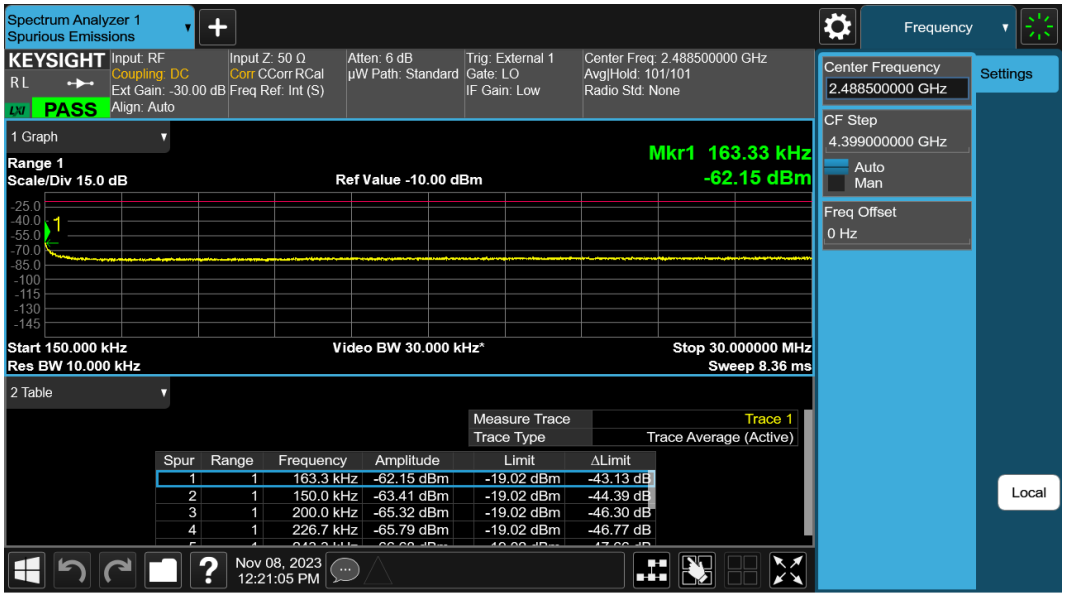
9kHz – 150kHz

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
LTE	3.2	QPSK/16QAM	3	2488.5	10



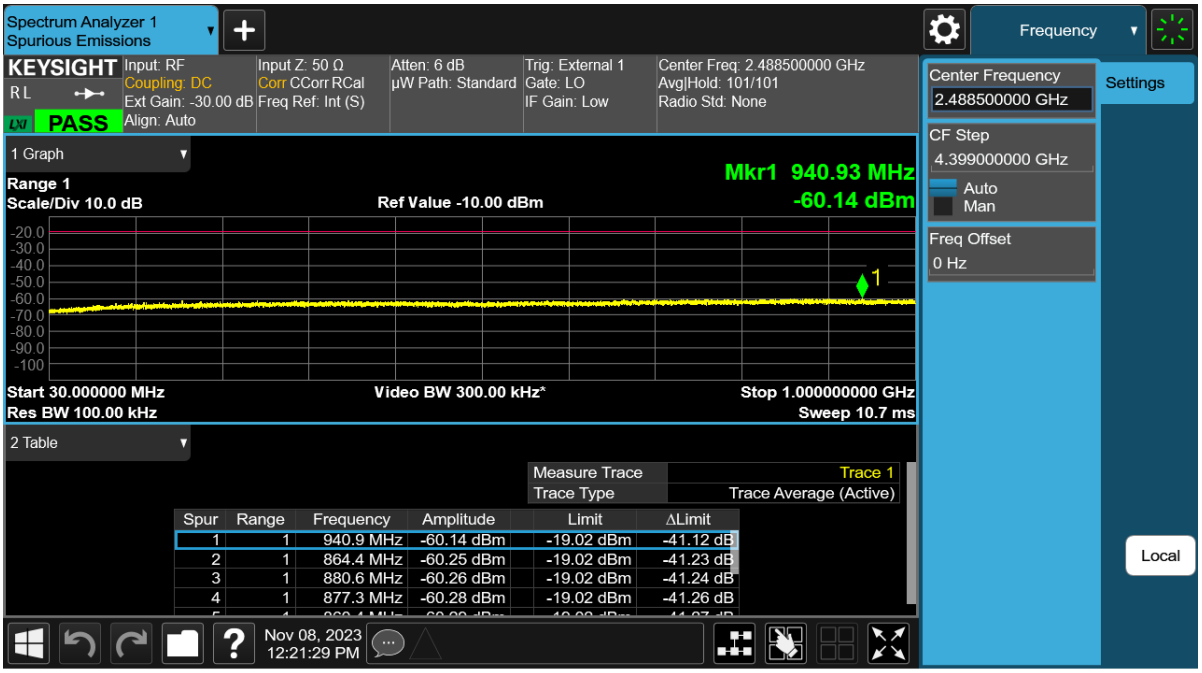
150kHz – 30MHz

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
LTE	3.2	QPSK/16QAM	3	2488.5	10



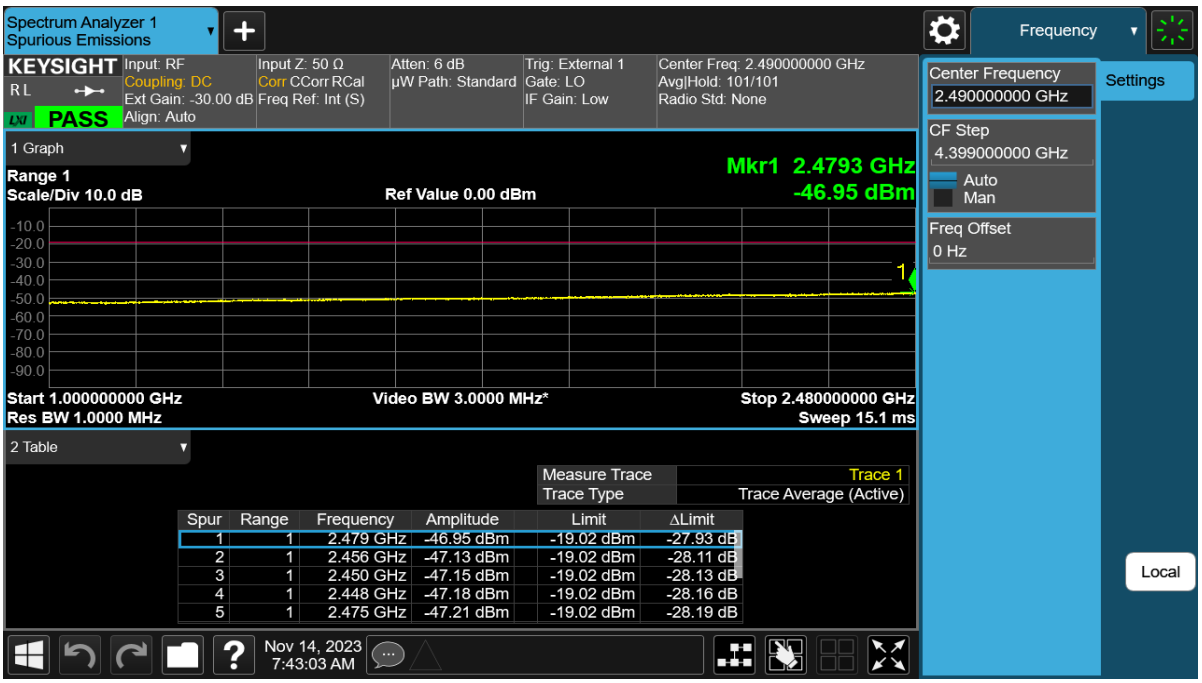
30MHz – 1GHz

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
LTE	3.2	QPSK/16QAM	3	2488.5	10



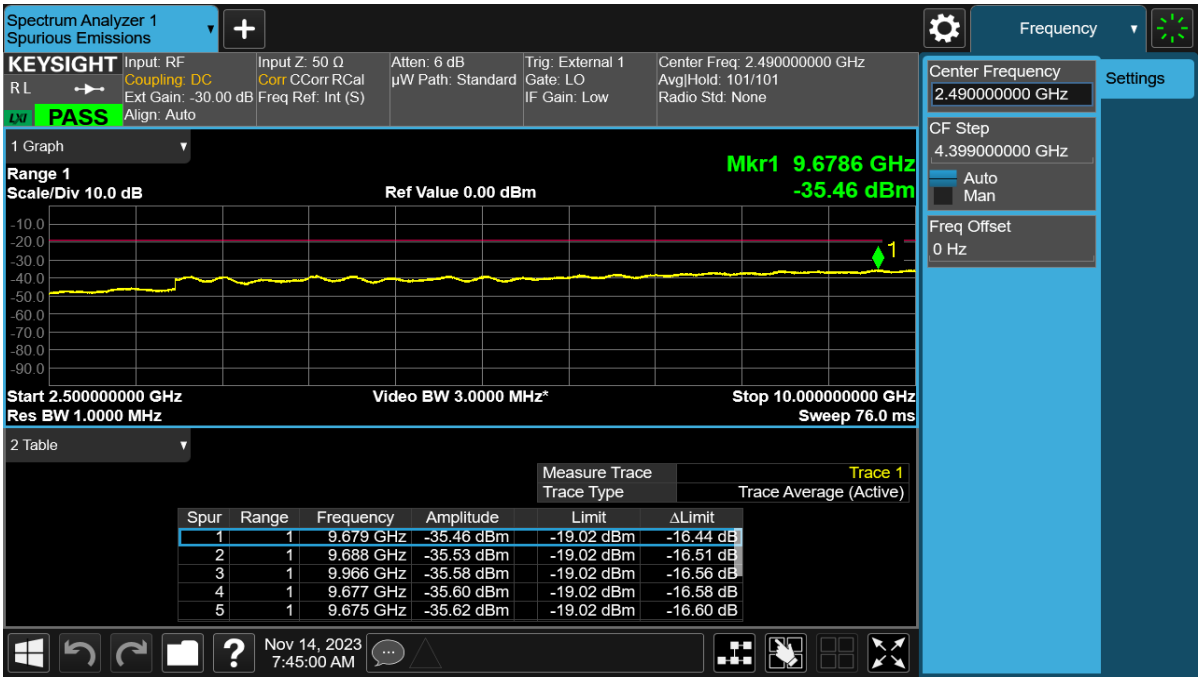
1GHz – 2.48GHz

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
5G-NR	3.1a	256QAM	1	2490	10



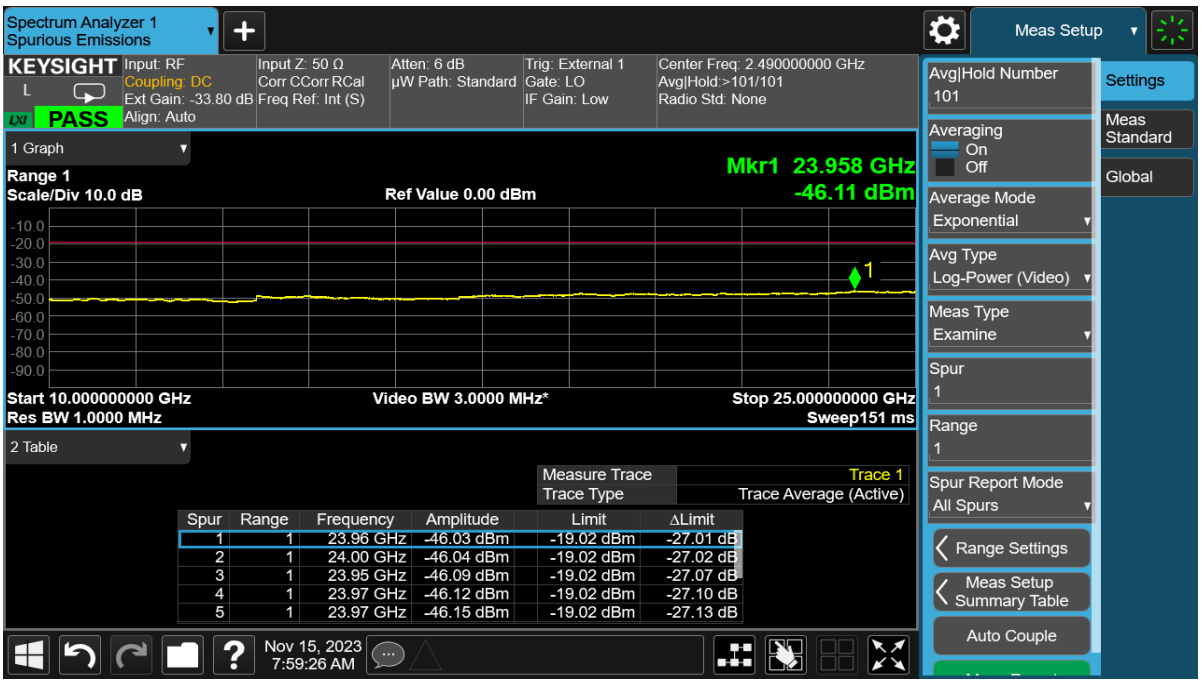
2.5GHz – 10GHz

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
5G-NR	3.1a	256QAM	1	2490	10



10GHz – 25GHz

Radio Access Technology	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
5G-NR	3.1a	256QAM	1	2490	10



6. Section 2.1053 - Measurement Required: Field Strength of Spurious Radiation

The field strength measurements of radiated spurious emissions were made in a FCC registered 3-meter semi-anechoic chamber AR-5, (FCC Registration Number: 395774) **NVLAP** Lab Code: 100275-0 and IC (Filing Number: 6933F-5) which is maintained by Nokia Bell Labs in Murray Hill, New Jersey.

6.1 Spurious Radiation and Radiated Emissions Requirements.

This product meets Parts 2,15 and 25 requirements. FCC Part 15 Class B require emissions to be below 54.5 dBuV/m at 3m.

47CFR 25.202(f) specified that the mean power limit for the spurious emissions which are two bandwidths away from the channel edges is -13dBm/4kHz.

The requirements for the levels of spurious radiation as a function of the level of 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.

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

$$E\ (dB\mu V/m) = EIRP\ (dBm) -20 \log d\ (m) + 104.77,$$

where:
E = Field Intensity in Volts/meter EIRP = Transmitted Power in Watts
R = Measurement distance in meters

At 3m and -13dBm/4kHz EIRP,

$$E= 82.23\ dB\mu V/m/4kHz.$$

The non-report level is 62.2 dBμV/m. The FCC Part 15 Class B limit is 54 dBμV/m above 1GHz.

The field strength of radiated spurious emissions measured was determined by

$$E\ (dB\mu V/m) = V_{meas}\ (dB\mu V) + Cable\ Loss\ (dB) + Antenna\ Factor\ (dBi/m).$$

Field strength measurements of radiated spurious emissions were made in the 3m semi-anechoic chamber, AR-5 as detailed above. The recommendations of ANSI C63.4 and ANSI C63.26 were followed for EUT testing setup, cabling, and measurement approach and procedures. All the measurement equipment used, including antennas, was calibrated in accordance with ISO 9001 process. The EUT setup diagram is given in section 6.2.

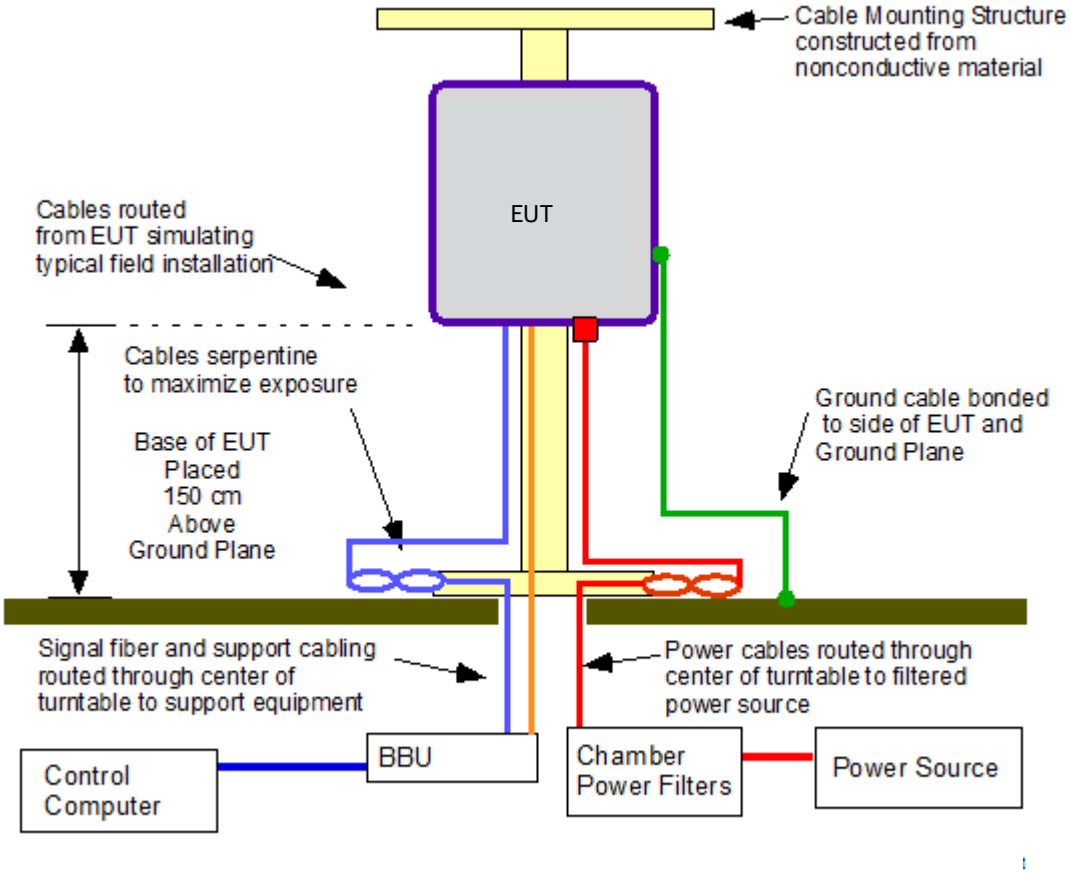
The spectrum from 30MHz to 25GHz, the tenth harmonic of the carrier, was searched for spurious radiation. Measurements were made using both horizontally and vertically polarized broadband antennas. Per FCC regulations, the comparison of the emissions directly to the limit is appropriately made using the substitution method. However, when the emissions have sufficient margin below the specification limit, the use of field strength measurements for compliance determination is acceptable. There are no reportable emissions, remove the remainder including data plots.

6.2 Field Strength of Spurious Radiation Results:

This product meets Part 25 Requirements. For the Title 47CFR section 25.202(f) and 2.1053 test, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.2dBμV/m/4kHz or 58.2 dBμV/m/MHz. Emissions equal to or less than 38.23 dBμV/m/MH are not reportable and may be verified using field strength measurements with broadband antennas.

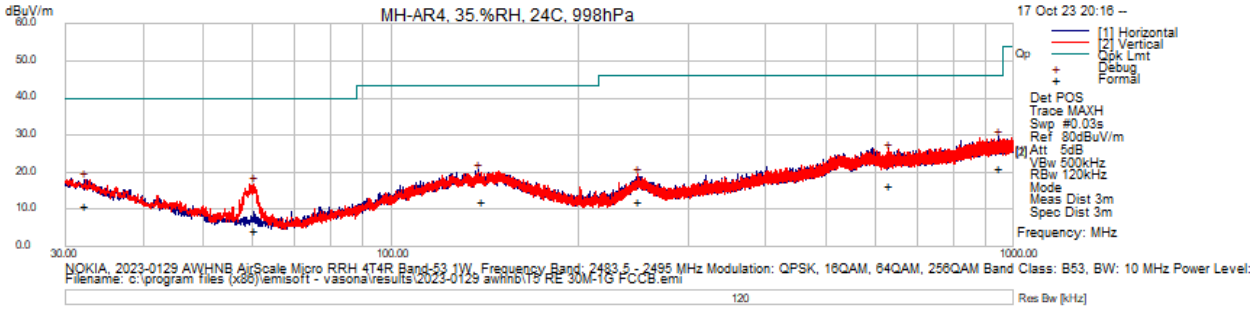
Over the out of band spectrum investigated from 30 MHz to beyond the tenth harmonic of the carrier (16GHz), no reportable spurious emissions were detected. Additionally, from 30 MHz to beyond the tenth harmonic of the carrier (16GHz), all non-transmit carrier emissions were below 54.5 dBμV/m. This demonstrates that the AWHKB 5G AirScale Micro RRH 4T4R B24, complies with FCC Part 15 Class B, and FCC Sections 2.1053, 25.202(f) and 2.1057 of the Rules.

Radiated Emission Setup



6.3 Transmitter Measurements of Radiated Spurious Emissions Plots

RE 30MHz – 1GHz



Test Information

Results Title	Radiated E 3m 30MHz-1GHz
File Name	T5 RE 30M-1G FCCB.emi
Test Laboratory	MH-AR4, 35%RH, 24C, 998hPa
Test Engineer	BB/MJS
Test Software	Vasona by EMISoft, version 6.061
Equipment	NOKIA
EUT Details	2023-0129 AWHNB AirScale Micro RRH 4T4R Band-53 1W, Frequency Band: 2483.5 - 2495 MHz Modulation: QPSK, 16QAM, 64QAM, 256QAM Band Class: B53, BW: 10 MHz Power Level: 4 x 0.25W, MIMO, Part 25 2483.5 - 2495 MHz, SN EB2331R0040 PN476437A.x21
Configuration	2023-0129 AWHNB, RE FCC B 30MHz-1GHz @ 3 meter distance Offset bore, Antenna E785, PreAmp E813, Instrument ESW E1511, LPF E792, AR4 cable set,
Date	2023-10-17 20:16:04

Formal Data

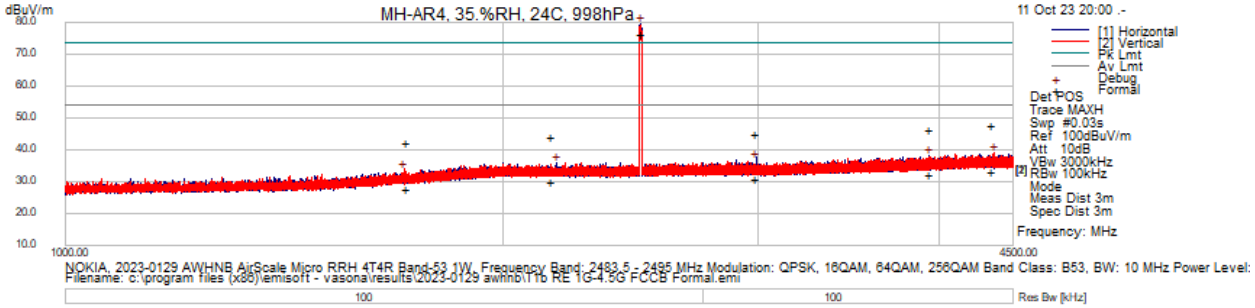
Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
946.469	20.77	3.33	-3.21	20.89	QuasiMax	H	254	206	46.00	-25.11	Pass	
32.151	20.64	0.53	-10.43	10.73	QuasiMax	H	297	137	40.00	-29.27	Pass	
629.620	20.87	2.58	-7.14	16.31	QuasiMax	H	165	139	46.00	-29.69	Pass	
140.129	19.87	1.17	-9.13	11.91	QuasiMax	H	132	330	43.50	-31.59	Pass	
249.990	21.37	1.49	-10.59	12.27	QuasiMax	H	105	34	46.00	-33.73	Pass	
60.316	24.24	0.76	-20.91	4.09	QuasiMax	H	120	241	40.00	-35.91	Pass	

Preview Data

Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
947.167333	29.43	3.33	-3.19	29.56	Debug	H	302	270	46.00	-16.44	Pass	
32.120	27.78	0.53	-10.42	17.89	Debug	H	100	353	40.00	-22.11	Pass	
60.212	36.89	0.76	-20.91	16.74	Debug	H	100	353	40.00	-23.26	Pass	
249.044	28.68	1.48	-10.77	19.40	Debug	H	100	353	46.00	-26.60	Pass	
629.107	30.55	2.57	-7.16	25.96	Debug	H	100	353	46.00	-20.04	Pass	
138.313	28.52	1.17	-9.19	20.49	Debug	H	100	353	43.50	-23.01	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

RE 1GHz – 4.5GHz



Test Information

Results Title	Radiated E 3m 1-18GHz
File Name	T1b RE 1G-4.5G FCCB Formal.emi
Test Laboratory	MH-AR4, 35%RH, 24C, 998hPa
Test Engineer	BB/MJS
Test Software	Vasona by EMISoft, version 6.061
Equipment	NOKIA
EUT Details	2023-0129 AWHNB AirScale Micro RRH 4T4R Band-53 1W, Frequency Band: 2483.5 - 2495 MHz Modulation: QPSK, 16QAM, 64QAM, 256QAM Band Class: B53, BW: 10 MHz Power Level: 4 x 0.25W, MIMO, Part 25 2483.5 - 2495 MHz, SN EB2331R0040 PN476437A.x21
Configuration	2023-0129 AWHNB, RE FCC B 1GHz-4.5GHz @ 3 meter distance straight bore, Antenna E1073, PreAmp E1602, Instrument ESW E1511, 6dB Pad E889, AR4 direct set,
Date	2023-10-11 20:00:34

Formal Data

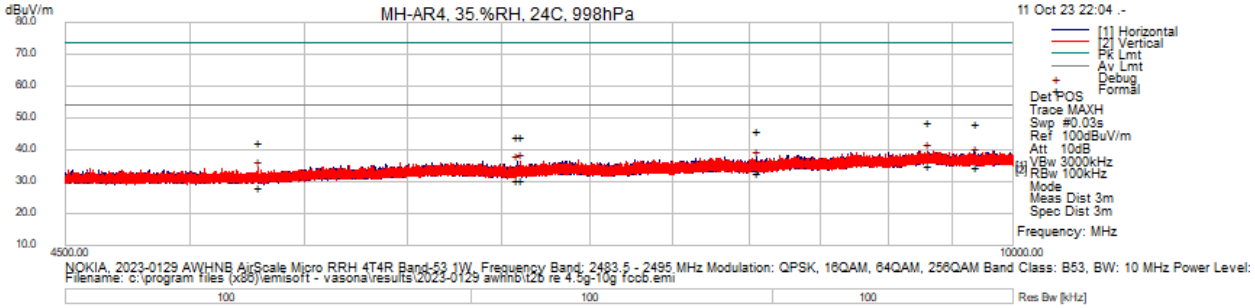
Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2492.024	78.11	8.22	-9.96	76.37	AvgMax	H	226	319	54.00	22.37	Fail	Carrier
2492.024	94.06	8.22	-9.96	92.33	PeakMax	H	226	319	74.00	18.33	Fail	Carrier
4347.631	32.40	9.12	-8.43	33.09	AvgMax	V	248	234	54.00	-20.91	Pass	
3939.460	31.99	8.86	-8.47	32.38	AvgMax	H	163	192	54.00	-21.62	Pass	
2990.132	32.26	8.43	-9.71	30.98	AvgMax	H	102	163	54.00	-23.02	Pass	
2159.891	31.88	8.12	-9.91	30.09	AvgMax	V	224	91	54.00	-23.91	Pass	
1715.094	31.94	7.89	-12.01	27.82	AvgMax	V	248	269	54.00	-26.18	Pass	
4347.631	46.88	9.12	-8.43	47.57	PeakMax	V	248	234	74.00	-26.43	Pass	
3939.460	46.17	8.86	-8.47	46.57	PeakMax	H	163	192	74.00	-27.43	Pass	
2990.132	46.26	8.43	-9.71	44.98	PeakMax	H	102	163	74.00	-29.02	Pass	
2159.891	45.76	8.12	-9.91	43.98	PeakMax	V	224	91	74.00	-30.02	Pass	
1715.094	46.36	7.89	-12.01	42.24	PeakMax	V	248	269	74.00	-31.76	Pass	

Preview Data

Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2490.416667	81.50	8.22	-9.96	79.76	Debug	H	102	308	54.00	25.76	Fail	
4364.375	38.64	9.13	-8.43	39.33	Debug	V	202	132	54.00	-14.67	Pass	
1710.277	38.00	7.88	-12.05	33.84	Debug	V	101	353	54.00	-20.16	Pass	
2180.902	37.93	8.13	-9.91	36.15	Debug	V	101	353	54.00	-17.85	Pass	
2990.945	38.15	8.43	-9.71	36.87	Debug	H	101	353	54.00	-17.13	Pass	
3933.358	38.03	8.86	-8.48	38.41	Debug	H	101	353	54.00	-15.59	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

RE 4.5GHz – 10GHz



Test Information

Results Title	Radiated E 3m 1-18GHz
File Name	t2b re 4.5g-10g fccb.emi
Test Laboratory	MH-AR4, 35%RH, 24C, 998hPa
Test Engineer	BB/MJS
Test Software	Vasona by EMISoft, version 6.061
Equipment	NOKIA
EUT Details	2023-0129 AWHNB AirScale Micro RRH 4T4R Band-53 1W, Frequency Band: 2483.5 - 2495 MHz Modulation: QPSK, 16QAM, 64QAM, 256QAM Band Class: B53, BW: 10 MHz Power Level: 4 x 0.25W, MIMO, Part 25 2483.5 - 2495 MHz, SN EB2331R0040 PN476437A.x21
Configuration	2023-0129 AWHNB, RE FCC B 4.5GHz-10GHz @ 3 meter distance straight bore, Antenna E1073, PreAmp E1602, Instrument ESW E1511, HPF E1480, AR4 direct set,
Date	2023-10-11 22:04:40

Formal Data

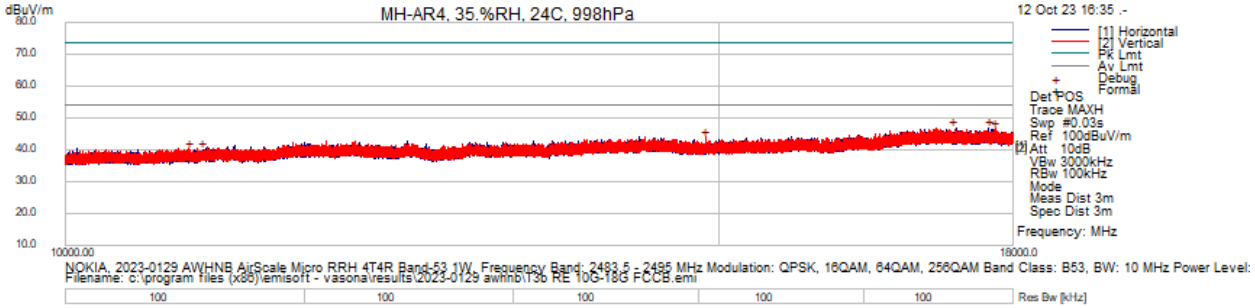
Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
9303.027905	32.49	5.52	-3.06	34.95	AvgMax	V	169	329	54.00	-19.05	Pass	
9687.307	31.42	5.60	-2.66	34.35	AvgMax	V	176	351	54.00	-19.65	Pass	
8054.727	32.15	4.76	-4.20	32.70	AvgMax	V	251	118	54.00	-21.30	Pass	
6599.873	31.84	4.87	-6.11	30.59	AvgMax	V	300	133	54.00	-23.41	Pass	
6580.534	31.79	4.87	-6.14	30.52	AvgMax	V	274	90	54.00	-23.48	Pass	
9303.027905	46.05	5.52	-3.06	48.52	PeakMax	V	169	329	74.00	-25.48	Pass	
5290.961	31.97	4.00	-7.67	28.30	AvgMax	V	298	241	54.00	-25.70	Pass	
9687.307	45.29	5.60	-2.66	48.22	PeakMax	V	176	351	74.00	-25.78	Pass	
8054.727	45.37	4.76	-4.20	45.93	PeakMax	V	251	118	74.00	-28.07	Pass	
6580.534	45.51	4.87	-6.14	44.24	PeakMax	V	274	90	74.00	-29.76	Pass	
6599.873	45.21	4.87	-6.11	43.97	PeakMax	V	300	133	74.00	-30.03	Pass	
5290.961	45.81	4.00	-7.67	42.14	PeakMax	V	298	241	74.00	-31.86	Pass	

Preview Data

Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
9303.027905	37.30	5.52	-3.06	39.77	Debug	V	302	66	54.00	-14.23	Pass	
5290.961	38.15	4.00	-7.67	34.48	Debug	V	100	353	54.00	-19.52	Pass	
6599.873	37.70	4.87	-6.11	36.45	Debug	V	100	353	54.00	-17.55	Pass	
6580.534	37.22	4.87	-6.14	35.95	Debug	V	100	353	54.00	-18.05	Pass	
8054.727	36.67	4.76	-4.20	37.23	Debug	V	100	353	54.00	-16.77	Pass	
9687.307	35.26	5.60	-2.66	38.20	Debug	V	100	353	54.00	-15.80	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

RE 10GHz – 18GHz



Test Information

Results Title	Radiated E 3m 1-18GHz
File Name	T3b RE 10G-18G FCCB.emi
Test Laboratory	MH-AR4, 35%RH, 24C, 998hPa
Test Engineer	BB/MJS
Test Software	Vasona by EMISoft, version 6.061
Equipment	NOKIA
EUT Details	2023-0129 AWHNB AirScale Micro RRH 4T4R Band-53 1W, Frequency Band: 2483.5 - 2495 MHz Modulation: QPSK, 16QAM, 64QAM, 256QAM Band Class: B53, BW: 10 MHz Power Level: 4 x 0.25W, MIMO, Part 25 2483.5 - 2495 MHz, SN EB2331R0040 PN476437A.x21
Configuration	2023-0129 AWHNB, RE FCC B 10GHz-18GHz @ 3 meter distance straight bore, Antenna E1073, PreAmp E1602, Instrument ESW E1511, HPF E1480, AR4 direct set,
Date	2023-10-12 16:35:43

Formal Data

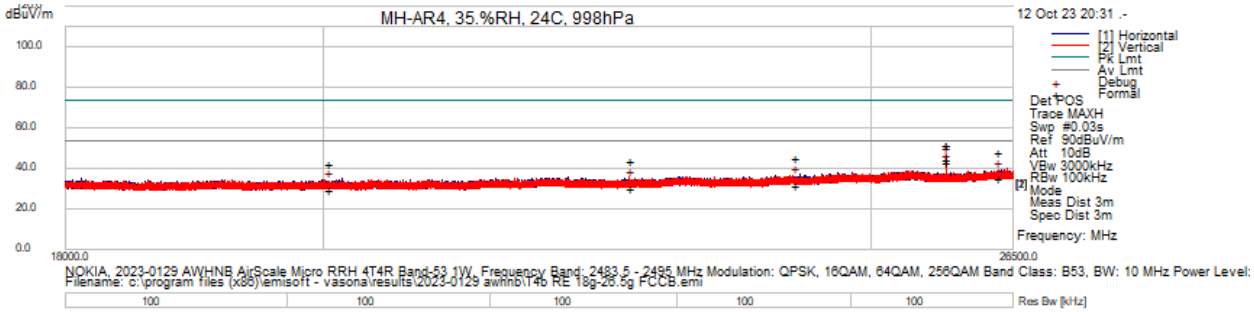
Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
9303.027905	32.65	5.52	-3.06	35.12	AvgMax	V	126	46	54.00	-18.88	Pass	
9303.027905	32.60	5.52	-3.06	35.07	AvgMax	V	225	55	54.00	-18.93	Pass	
9687.307	31.38	5.60	-2.66	34.31	AvgMax	V	139	2	54.00	-19.69	Pass	
9687.307	31.32	5.60	-2.66	34.26	AvgMax	V	204	3	54.00	-19.74	Pass	
8054.727	32.30	4.76	-4.20	32.86	AvgMax	V	118	3	54.00	-21.14	Pass	
8054.727	32.26	4.76	-4.20	32.82	AvgMax	V	226	339	54.00	-21.18	Pass	
6599.873	32.38	4.87	-6.11	31.13	AvgMax	V	161	5	54.00	-22.87	Pass	
6580.534	32.27	4.87	-6.14	31.00	AvgMax	V	242	147	54.00	-23.00	Pass	
6599.873	31.95	4.87	-6.11	30.71	AvgMax	V	247	180	54.00	-23.29	Pass	
6580.534	31.92	4.87	-6.14	30.65	AvgMax	V	295	152	54.00	-23.35	Pass	
5290.961	32.57	4.00	-7.67	28.91	AvgMax	V	126	89	54.00	-25.09	Pass	
5290.961	32.55	4.00	-7.67	28.88	AvgMax	V	139	145	54.00	-25.12	Pass	
9303.027905	46.13	5.52	-3.06	48.60	PeakMax	V	225	55	74.00	-25.40	Pass	
9303.027905	46.10	5.52	-3.06	48.57	PeakMax	V	126	46	74.00	-25.43	Pass	
9687.307	45.62	5.60	-2.66	48.56	PeakMax	V	139	2	74.00	-25.44	Pass	
9687.307	44.88	5.60	-2.66	47.82	PeakMax	V	204	3	74.00	-26.18	Pass	
8054.727	46.27	4.76	-4.20	46.82	PeakMax	V	118	3	74.00	-27.18	Pass	
8054.727	45.58	4.76	-4.20	46.14	PeakMax	V	226	339	74.00	-27.86	Pass	
6599.873	46.41	4.87	-6.11	45.16	PeakMax	V	161	5	74.00	-28.84	Pass	
6599.873	46.01	4.87	-6.11	44.76	PeakMax	V	247	180	74.00	-29.24	Pass	
6580.534	45.96	4.87	-6.14	44.69	PeakMax	V	242	147	74.00	-29.31	Pass	
6580.534	45.78	4.87	-6.14	44.51	PeakMax	V	295	152	74.00	-29.49	Pass	
5290.961	46.37	4.00	-7.67	42.70	PeakMax	V	139	145	74.00	-31.30	Pass	
5290.961	46.27	4.00	-7.67	42.60	PeakMax	V	126	89	74.00	-31.40	Pass	

Preview Data

Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
17341.073	37.41	7.10	2.44	46.96	NoTune	H	302	220	54.00	-7.04	Pass	
10889.203	35.68	5.49	-0.83	40.34	NoTune	V	100	352	54.00	-13.66	Pass	
10807.510	35.93	5.37	-0.96	40.34	NoTune	V	100	352	54.00	-13.66	Pass	
14881.404	37.27	6.75	-0.15	43.87	NoTune	V	100	352	54.00	-10.13	Pass	
17740.942	37.40	7.07	2.37	46.84	NoTune	V	100	352	54.00	-7.16	Pass	
17805.260	37.21	7.16	2.36	46.73	NoTune	V	100	352	54.00	-7.27	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

RE 18GHz – 26.5GHz



Test Information

Results Title	Radiated E 3M 18-26.5GHz
File Name	T4b RE 18g-26.5g FCCB.emi
Test Laboratory	MH-AR4, 35%RH, 24C, 998hPa
Test Engineer	BB/MJS
Test Software	Vasona by EMISoft, version 6.061
Equipment	NOKIA
EUT Details	2023-0129 AWHNB AirScale Micro RRH 4T4R Band-53 1W, Frequency Band: 2483.5 - 2495 MHz Modulation: QPSK, 16QAM, 64QAM, 256QAM Band Class: B53, BW: 10 MHz Power Level: 4 x 0.25W, MIMO, Part 25 2483.5 - 2495 MHz, SN EB2331R0040 PN476437A.x21
Configuration	2023-0129 AWHNB, RE FCC B 18GHz-26.5GHz @ 3 meter distance straight bore, Antenna E1451, PreAmp E1600, Instrument ESW E1511, HPF E1211, E1528+E1529 cable set,
Date	2023-10-12 20:31:38

Formal Data

Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
25781.256	44.09	13.39	-13.46	44.02	AvgMax	V	103	316	54.00	-9.98	Pass	
25781.264	42.94	13.39	-13.46	42.86	AvgMax	H	103	328	54.00	-11.14	Pass	
26345.510	35.39	13.41	-13.88	34.93	AvgMax	V	321	208	54.00	-19.07	Pass	
25781.256	51.87	13.39	-13.46	51.79	PeakMax	V	103	316	74.00	-22.21	Pass	
24249.129	32.41	12.94	-13.72	31.63	AvgMax	H	245	163	54.00	-22.37	Pass	
25781.264	51.62	13.39	-13.46	51.54	PeakMax	H	103	328	74.00	-22.46	Pass	
22673.691	32.83	12.55	-15.45	29.92	AvgMax	H	103	242	54.00	-24.08	Pass	
20046.369	35.35	11.81	-18.11	29.05	AvgMax	H	239	301	54.00	-24.95	Pass	
26345.510	48.49	13.41	-13.88	48.02	PeakMax	V	321	208	74.00	-25.98	Pass	
24249.129	45.86	12.94	-13.72	45.09	PeakMax	H	245	163	74.00	-28.91	Pass	
22673.691	46.18	12.55	-15.45	43.28	PeakMax	H	103	242	74.00	-30.72	Pass	
20046.369	48.77	11.81	-18.11	42.47	PeakMax	H	239	301	74.00	-31.53	Pass	

Preview Data

Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
25781.256	43.32	13.39	-13.46	43.25	NoTune	V	102	353	54.00	-10.75	Pass	
25781.264	46.61	13.39	-13.46	46.54	NoTune	H	102	353	54.00	-7.46	Pass	
20046.369	40.88	11.81	-18.11	34.58	NoTune	H	102	353	54.00	-19.42	Pass	
22673.691	38.00	12.55	-15.45	35.09	NoTune	H	102	353	54.00	-18.91	Pass	
24249.129	37.80	12.94	-13.72	37.03	NoTune	H	102	353	54.00	-16.97	Pass	
26345.510	40.18	13.41	-13.88	39.71	NoTune	V	102	353	54.00	-14.29	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

7. FCC Section 2.1055 - Measurement of Frequency Stability

FCC Part 25 specified frequency tolerance for earth stations in 25.202(d) which requires the frequency tolerance to be within 10ppm.

Frequency Block Tested: ***AWHNB (CF = 2489.50MHz)***

Baseline Measurement at +25°C

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-2.3691**
0.5	**-1.4343**
1.0	**342.33mHz**
1.5	**49.438 mHz**
2.0	**-1.5543**
2.5	**-172.95 mHz**
3.0	**597.31 mHz**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm)** **±0.05ppm = ± 37.3 Hz**
FCC RESULT	**Pass**

Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**1.9741**
0.5	**-1.3506**
1.0	**-319.66 mHz**
1.5	**1.4184**
2.0	**2.8825**
2.5	**-33.778 mHz**
3.0	**1.1222**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm)** **±0.05ppm = ± 37.3 Hz**
FCC RESULT	**Pass**

Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-1.0305**
0.5	**1.5086**
1.0	**1.2836**
1.5	**-3.0188**
2.0	**-1.7825**
2.5	**2.8440**
3.0	**-695.45 mHz**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm)** **±0.05ppm = ± 37.3 Hz**
FCC RESULT	**Pass**

Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**1.0580**
0.5	**-1.2964**
1.0	**-567.72 mHz**
1.5	**3.5354**
2.0	**-946.58 mHz**
2.5	**-331.37 mHz**
3.0	**484.96 mHz**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz**
FCC RESULT	**Pass**

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**1.1255**
0.5	**1.0733**
1.0	**-1.4396**
1.5	**3.8277**
2.0	**-2.5287**
2.5	**663.95 mHz**
3.0	**-2.5453**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz Hz**
FCC RESULT	**Pass**

Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**635.41 mHz**
0.5	**1.2917**
1.0	**1.1591**
1.5	**234.23 mHz**
2.0	**626.50 mHz**
2.5	**1.8196**
3.0	**2.3358**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz Hz**
FCC RESULT	**Pass**

Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-688.64 mHz**
0.5	**-1.5095**
1.0	**-2.4486**
1.5	**1.2816**
2.0	**-97.003 mHz**
2.5	**2.9665**
3.0	**74.927 mHz**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz Hz**
FCC RESULT	**Pass**

Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-2.3670**
0.5	**1.7072**
1.0	**31.181 mHz**
1.5	**-3.2043**
2.0	**445.66 mHz**
2.5	**-2.6323**
3.0	**-1.0068**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz**
FCC RESULT	**Pass**

Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-754.62 mHz**
0.5	**1.2469**
1.0	**351.62 mHz**
1.5	**23.299 mHz**
2.0	**2.4317**
2.5	**-1.6442**
3.0	**1.7531**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz**
FCC RESULT	**Pass**

Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-1.0253
0.5	1.8673
1.0	649.72 mHz
1.5	-1.0747
2.0	-2.1904
2.5	1.4896
3.0	-2.0134
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 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 (Hz)
0	-806.02 mHz
0.5	1.3653
1.0	1.5655
1.5	2.3650
2.0	1.1646
2.5	2.2891
3.0	-665.09 mHz
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

Transmit Frequency Deviation at +25°C at 103% of Nominal Voltage, -49.44VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-2.7455
0.5	-1.1336
1.0	-744.40 mHz
1.5	1.5837
2.0	-345.46 mHz
2.5	285.71 mHz
3.0	1.6358
938 MHz (±0.05ppm) ±0.05ppm = ±46.9Hz	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

Transmit Frequency Deviation at +25°C at 106% of Nominal Voltage, -50.88VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	2.7924
0.5	1.5185
1.0	1.6558
1.5	1.0988
2.0	688.12 mHz
2.5	2.1525
3.0	3.3243
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

Transmit Frequency Deviation at +25°C at 109% of Nominal Voltage, -52.32VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	802.20 mHz
0.5	2.7095
1.0	-249.05 mHz
1.5	1.2422
2.0	914.84 mHz
2.5	-362.09 mHz
3.0	940.28 mHz
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

Transmit Frequency Deviation at +25°C at 112% of Nominal Voltage, -53.76VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-2.7167
0.5	-77.235 mHz
1.0	376.95 mHz
1.5	771.24 mHz
2.0	2.0967
2.5	2.3766
3.0	202.20 mHz
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

Transmit Frequency Deviation at +25°C at 115% of Nominal Voltage, -55.20VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-707.67 mHz
0.5	956.30 mHz
1.0	-1.2760
1.5	-2.7004
2.0	3.6370
2.5	-2.3136
3.0	2.3999
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48.0VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	1.0752
0.5	3.1825
1.0	1.3775
1.5	-826.20 mHz
2.0	-489.75 mHz
2.5	1.2042
3.0	500.85 mHz
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, -46.56VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-675.22 mHz
0.5	238.88 mHz
1.0	1.3397
1.5	930.18 mHz
2.0	1.4159
2.5	32.162 mHz
3.0	-2.4753
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

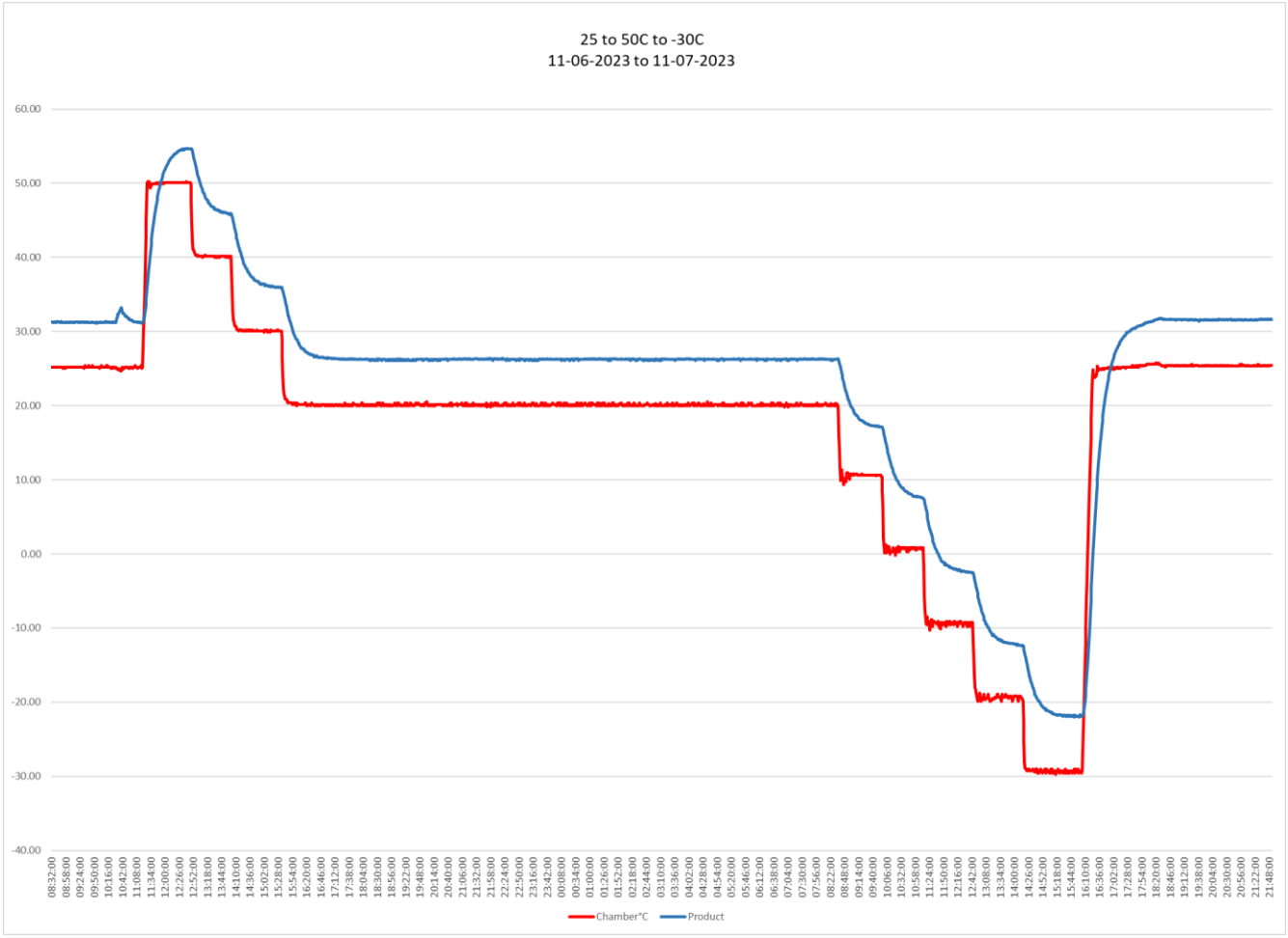
Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, -45.12VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	1.7091
0.5	6.4453 mHz
1.0	3.4951
1.5	133.81 mHz
2.0	-1.5127
2.5	162.38 mHz
3.0	-929.58 mHz
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, -43.68VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	1.9097
0.5	489.18 mHz
1.0	123.79 mHz
1.5	2.6926
2.0	-831.83 mHz
2.5	632.01 mHz
3.0	1.2351
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, -42.24VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-836.72 mHz
0.5	-1.2414
1.0	925.67 mHz
1.5	-254.35 mHz
2.0	1.7810
2.5	-1.3604
3.0	301.64 mHz
FCC SPECIFICATION	2489.50 MHz (±0.05ppm) ±0.05ppm = ± 37.3 Hz
FCC RESULT	Pass

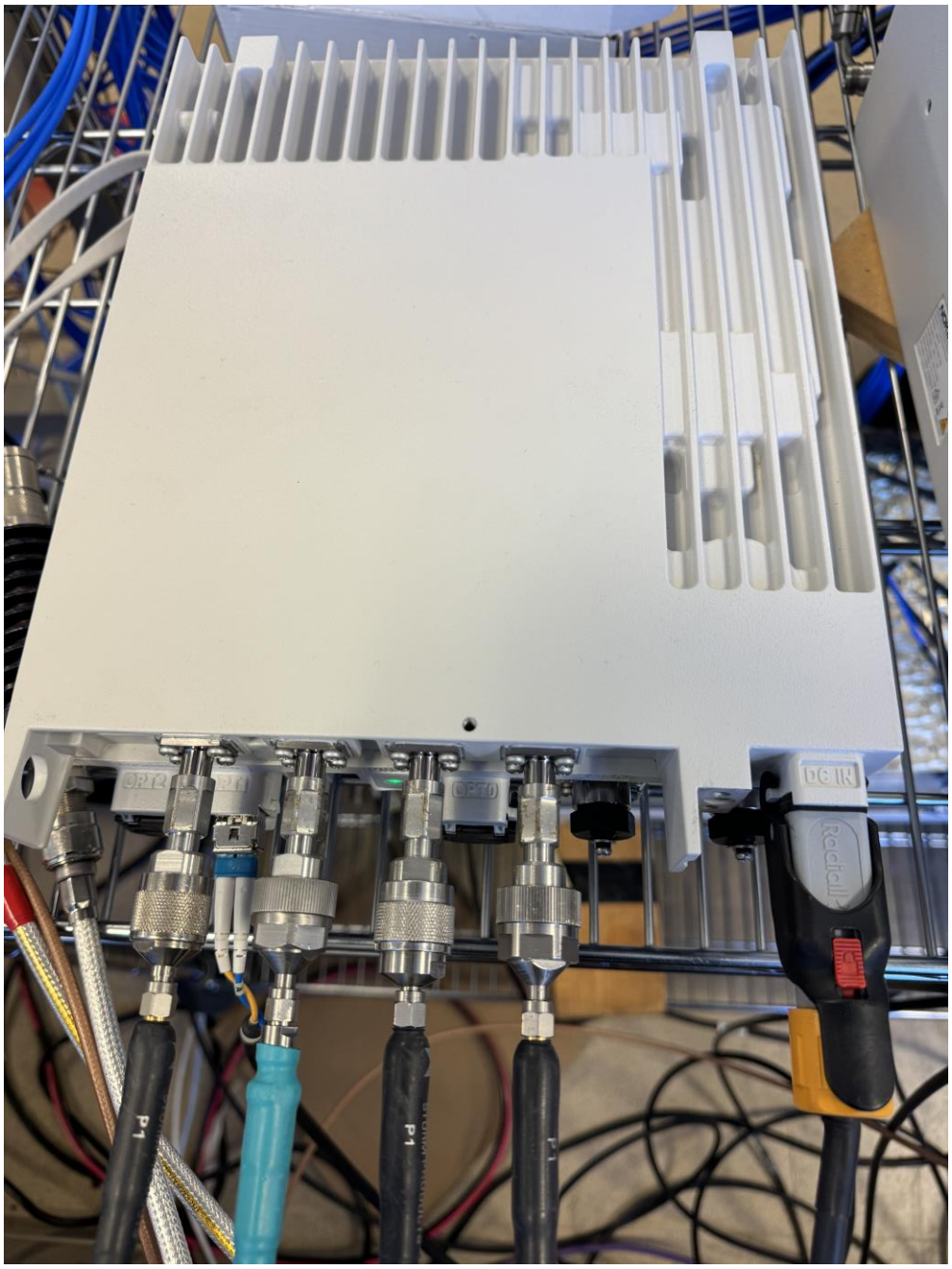
Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, -40.80VDC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**-1.1934**
0.5	**2.7160**
1.0	**-1.4140**
1.5	**-382.89 mHz**
2.0	**-365.46 mHz**
2.5	**1.6634**
3.0	**352.01 mHz**
FCC SPECIFICATION	**2489.50 MHz (±0.05ppm)** **±0.05ppm = ± 37.3 Hz**
FCC RESULT	**Pass**

Chamber Plot



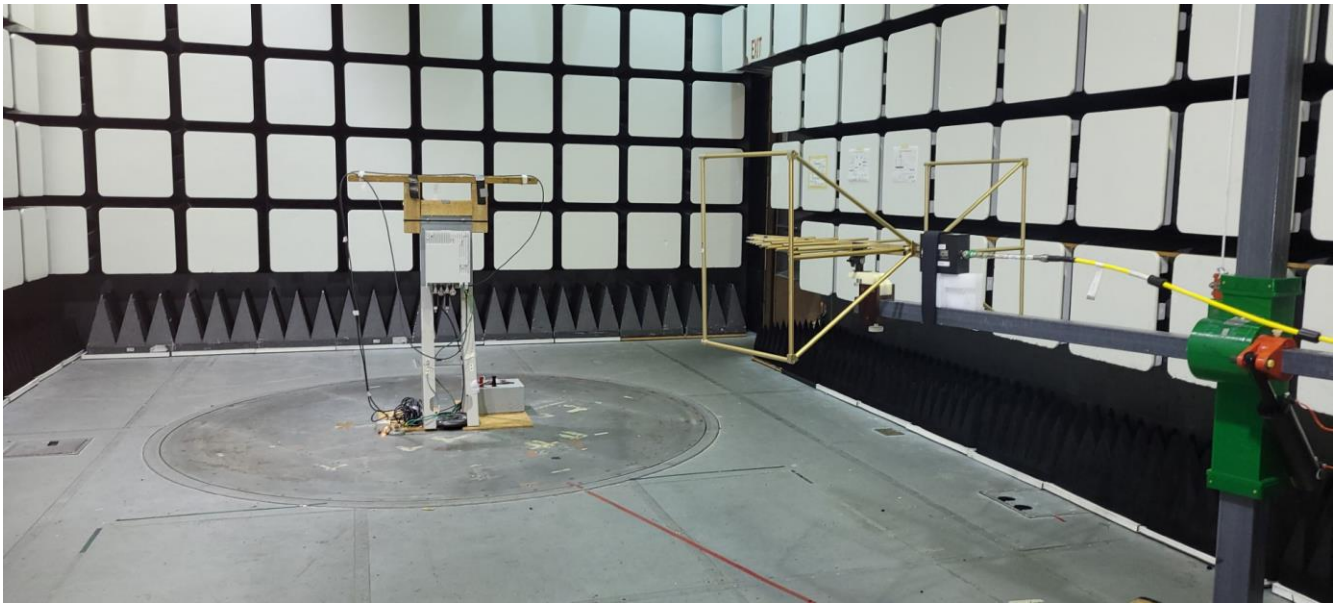
8. Photographs

Radio Test

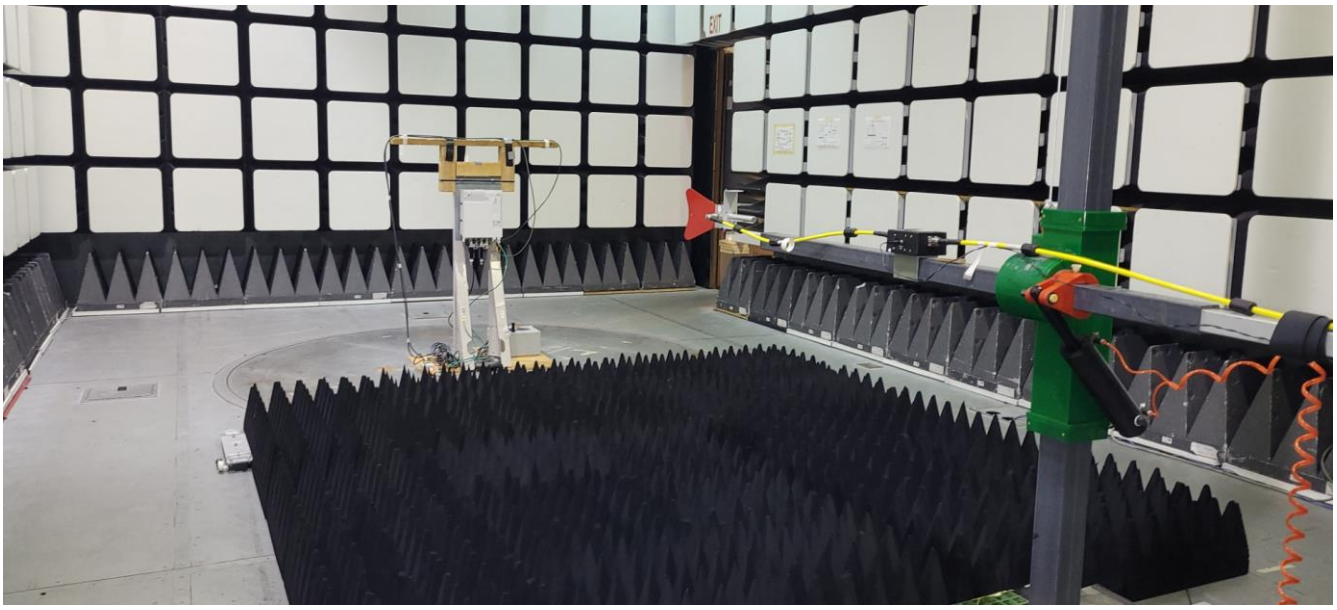


Radiated Emission Test

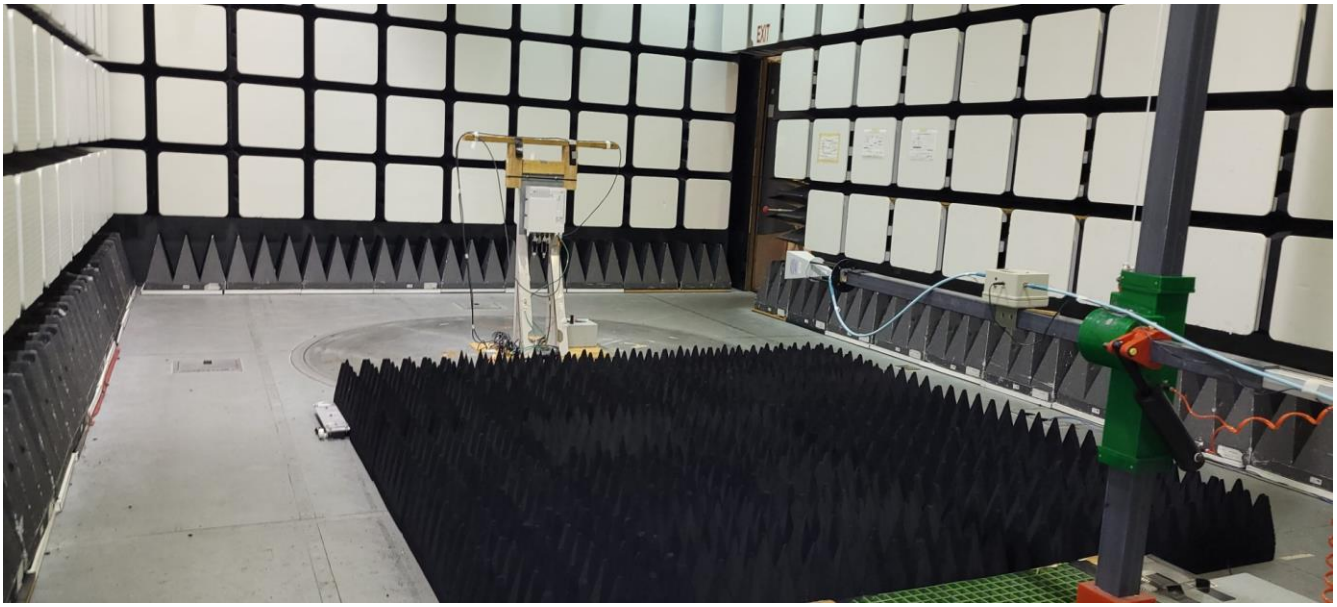
30MHz- 1GHz



1GHz – 18GHz



18GHz – 26.5GHz



Frequency Stability Test

9. Test Equipment

Radio Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz, PNA-L Microwave Network Analyzer	N5230C	MY49000897	2023-02-08	2025-02-08
E1579	KeySight Technologies	MXA Signal Analyzer	10 Hz - 50 GHz	N9021B	MY60080199	2021-11-30	2023-12-30
E1479	Reactel, Inc.	Filter, High Pass	DC - 4.3 GHz	11HS-X4.3 GS11	SN20-01	CNR-V	CNR-V
Customer Provided Equipment							
	Aeroflex/Weinschel	Attenuator	24-20-12-LIM	CE5783		CNR-V	CNR-V
	Micro Coax Utiflex	RF Cable	MFR-64639-228872-001	UF142A-000400-200-2G0	MFR-64639-228872-001	CNR-V	CNR-V
	Mini Circuit	Modular Test System		ZTS-8SP8T-63	02203170006	CNR	CNR
	Mini Circuit	Modular Test System		RCM-202	02110200002	CNR	CNR

CNR: Calibration Not Required
CNR-V: Calibration Not Required, Must Be Verified
Test Dates: 11/8/2023 – 12/4/2023

Frequency Stability Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
TH536-T14	Envirotronics	Controller	Controller	SPPCM	SP001513	2023-03-23	2025-03-23
TH-T14	Thermotron	Thermal Chamber	Thermal Chamber	N/A	28431	CNR	CNR
TH090	Yokogawa	Data Logger	10 Channel Paperless Recorder	GP10	S5V108472	2023-07-25	2025-07-25
TH073	Fluke	DMM	Digital Multimeter	87V	25910080	2022-02-24	2024-02-24
MY59050106	KeySight Technologies	EMI Receiver	MXA EMI Receiver	N9020B		2022-10-22	2024-10-22
TH069	Extech	Data Logger	Barometric Pressure/Humidity/Temperature	SD700	Q690305	2023-07-24	2025-07-24

CNR: Calibration Not Required
Test Dates: 11/6/2023 – 11/7/2023

Radiated Emission Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E1451	A-Info	Horn Antenna	18 to 26.5 GHz WR42 25 dB	LB-42-25-C2-KF	J202066360	2023-01-10	2025-01-10
E758	A.H. Systems Inc.	Bilogical Antenna	25 - 2000 MHz	SAS-521-2	458	2022-03-01	2024-03-01
E1600	A.H. Systems Inc.	Pre-Amplifier	18 - 42 GHz	PAM-1842	101	2023-01-10	2025-01-10
E1602	A.H. Systems Inc.	Pre-Amplifier	20 MHz - 18 GHz, 1 Watt Input limiter	PAM-0118P	620	2023-03-06	2025-03-06
E1073	ETS Lindgren	Horn Antenna	Double-Ridged Waveguide Horn 1-18 GHz	3117	00135198	2023-06-06	2025-06-06
E1211	RLC Electronics Inc	Filter, High Pass	10 - 30 GHz, 2W, 5dB	F-19414	1444003	CNR-V	CNR-V
E1480	Reactel, Inc.	Filter, High Pass	DC - 4.3 GHz	11HS-X4.3GS11	SN20-02	CNR-V	CNR-V
E1511	Rohde & Schwarz	Test Receiver	EMI Test Receiver 2 Hz - 44 GHz	ESW44	101965	2023-07-31	2025-07-31
E813	Sonoma Instrument Co.	Amplifier	9kHz-1GHz	310N	186750	2022-11-28	2024-11-28
E792	Trilithic	Filter, Low Pass	900-2000 MHz, 50W	H10LC2000-1-AA	200817067	CNR-V	CNR-V
E889	Weinschel	Attenuator	DC - 18 GHz, 6 dB, 5W	2-6	BX3438	2022-12-06	2024-12-06

CNR-V: Calibration Not Required, Must Be Verified
Test Dates: 10/11/2023 – 10/17/2023

10. 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).

2023-09-07 through 2024-09-30
Effective Dates

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

For the National Voluntary Laboratory Accreditation Program