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TESTING
NVLAP LAB CODE: 100275-0

Title 47 Code of Federal Regulations Test Report

Regulation:

FCC Part 2 and 27

Client:

NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:

AirScale MAA 64T64R 128AE B41 120W
AAHF

Report Number:

TR-2020-0158-FCC2-27

Date Issued:

January 4, 2021

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Revisions

Date	Revision	Section	Change
1/4/2021	0		Initial Release

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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 MAA 64T64R 128AE B41 120W AAHF
Serial Number:	6Q184012463
FCC ID:	VBNAAHF-01
Hardware Version:	474715A.M01
Software Version:	5G20B
Frequency Range:	2496-2690 MHz
GPCL Project Number:	2020-0158
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Applicant:	Nokia Solutions and Networks 3201 Olympus Blvd Dallas, Texas 75019 Steve Mitchell
Test Requirement(s):	Title 47 CFR Parts 2 and 27
Test Standards:	<ul style="list-style-type: none"> Title 47 CFR Parts 2 and 27 KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018. KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 ANSI C63.26 (2015) ANSI C63.4 (2014)
Measurement Procedure(s):	<ul style="list-style-type: none"> 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
Test Date(s):	11/19/2020 – 12/2/2020
Test Performed By:	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636
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 MAA 64T64R 128AE B41 120W AAHF, hereinafter referred to as the Equipment Under Test (EUT).

1.2 Purpose and Scope

This document is to provide the testing data required for qualifying the EUT in compliance with FCC Parts 2 and 27 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

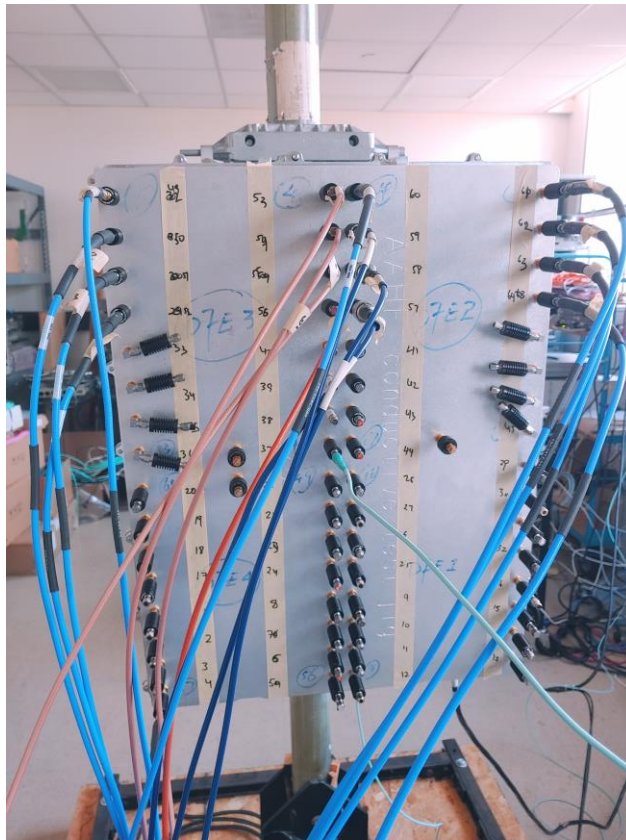
The purpose of this testing is to demonstrate compliance for AAHF mMIMO product for 5G NR operation. This Class II Permissive Change will be submitted to add a mode of operation for 50MHz Single carrier at 120W to the existing Grant for FCC ID: VBNAAHF-01.

1.3 EUT Details

1.3.1 Specifications

Specification Items	Description
Duplex Mode	5G-NR
Modulation Type(s)	QPSK 16QAM 64QAM 256QAM
Operation Frequency Range	2496-2690 MHz
Channel Bandwidth	50 MHz
Tx/Rx	64T64R
MIMO	4X
Deployment Environment	Outdoor
Supply Voltage	-48.0 VDC
Max RF Output Power	1.875 W/port x 64 ports

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, 27.53	RF Power Output	Yes
2.1047, 27.53	Modulation Characteristics	Yes
2.1049, 27.53	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051, 27.53	Spurious Emissions at Antenna Terminals	Yes
2.1053, 27.53	Field Strength of Spurious Radiation	Yes
2.1055, 27.53	Frequency Stability	No*

*Previously tested under project 2018-0258

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 27.
- KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.
- 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, 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

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, 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	9 kHz to 20 MHz	1.78 dB
	100 Hz	20 MHz to 1 GHz	
	10 kHz to 1 MHz	1 GHz to 10 GHz	
	1MHz	10 GHz to 40 GHz:	
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz	0.5 dB

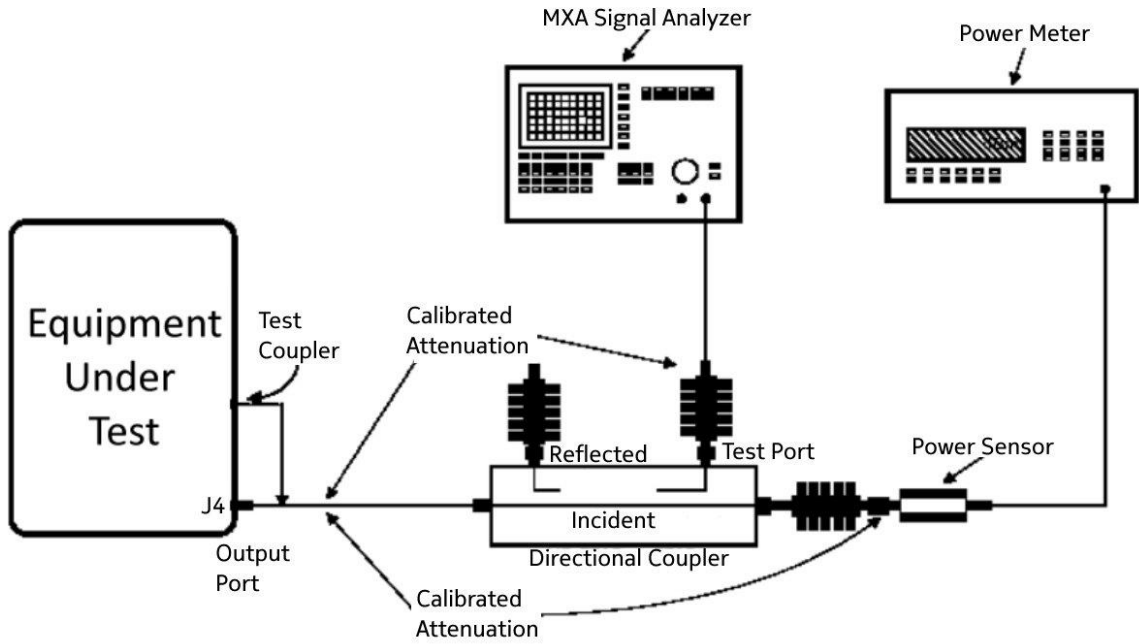
1.7 Executive Summary

Requirement	Description	Result
47 CFR FCC Parts 2 and 27		
2.1046, 27.53	RF Power Output Peak to Average Power Ratio	COMPLIES
2.1047, 27.53	Modulation Characteristics	COMPLIES
2.1049, 27.53	(a) Occupied Bandwidth (b) Edge of Band Emissions	COMPLIES
2.1051, 27.53	Spurious Emissions at Antenna Terminals	COMPLIES
2.1053, 27.53	Field Strength of Spurious Radiation	COMPLIES
2.1055, 27.53	Frequency Stability	NT

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



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. Power measurements were made with an MXA Signal Analyzer.

The Maximum Average RF Power Values are bolded in each configuration.

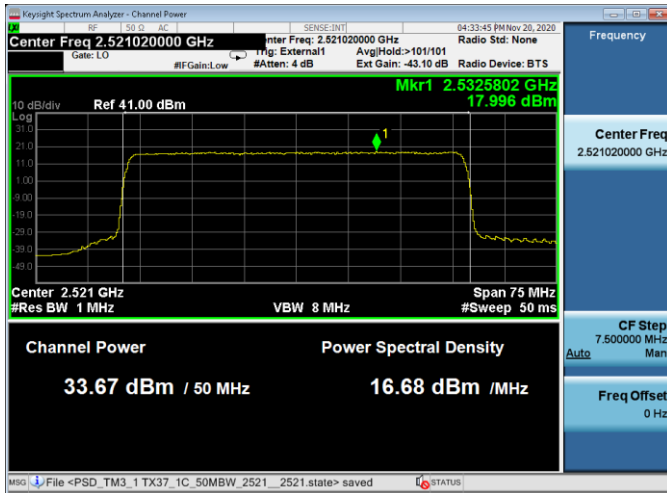
Tabular Data – Channel RF Power 50MHz BW

Test Model 3.1 Modulation 64QAM Channel Frequency 2521.02MHz				Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 2593.02MHz				Test Model 3.1a Modulation 256QAM Channel Frequency 2664.99MHz			
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	33.05	33	33.04	1	33.16	33	33.11	1	32.91	33	32.90
2	33.13	34	32.99	2	33.11	34	33.00	2	32.97	34	32.78
3	33.02	35	32.94	3	32.75	35	32.66	3	32.71	35	32.54
4	32.59	36	32.52	4	32.57	36	32.44	4	32.44	36	32.38
5	33.55	37	33.67	5	33.55	37	33.80	5	33.30	37	33.41
6	33.37	38	33.35	6	33.24	38	33.33	6	33.17	38	33.13
7	33.32	39	33.23	7	33.25	39	33.10	7	33.00	39	33.00
8	32.85	40	32.39	8	32.85	40	32.49	8	32.83	40	32.34
9	33.37	41	33.32	9	33.39	41	33.26	9	33.14	41	33.02
10	33.10	42	32.94	10	32.82	42	32.98	10	32.90	42	32.87
11	33.19	43	33.11	11	33.05	43	32.93	11	32.93	43	32.77
12	33.44	44	33.36	12	33.05	44	33.38	12	33.36	44	33.35
13	33.24	45	33.26	13	33.23	45	33.24	13	32.97	45	33.06
14	33.39	46	33.30	14	33.29	46	33.26	14	33.25	46	33.20
15	33.17	47	33.37	15	33.21	47	33.31	15	32.93	47	33.14
16	32.87	48	32.90	16	32.96	48	32.88	16	32.88	48	32.78
17	32.88	49	32.91	17	32.73	49	32.77	17	32.73	49	32.64
18	32.90	50	32.94	18	32.79	50	32.81	18	32.77	50	32.78
19	32.64	51	32.61	19	32.49	51	32.57	19	32.49	51	32.56
20	32.48	52	32.38	20	32.42	52	32.35	20	32.49	52	32.39
21	33.27	53	33.09	21	33.26	53	33.10	21	33.11	53	33.11
22	32.98	54	32.70	22	32.82	54	32.63	22	32.79	54	32.43
23	32.94	55	12.98	23	32.86	55	12.68	23	32.79	55	12.56
24	32.72	56	32.58	24	32.65	56	32.72	24	32.67	56	32.72
25	33.18	57	33.04	25	33.10	57	33.13	25	33.05	57	33.04
26	32.91	58	32.81	26	32.87	58	32.79	26	32.87	58	32.83
27	32.96	59	32.78	27	32.87	59	32.81	27	32.73	59	32.76
28	33.45	60	33.40	28	33.39	60	33.32	28	33.36	60	33.33
29	32.95	61	32.93	29	33.05	61	33.05	29	32.95	61	33.04
30	33.01	62	33.06	30	33.05	62	33.05	30	32.93	62	33.04
31	32.98	63	32.99	31	32.96	63	32.97	31	32.79	63	32.87
32	32.91	64	32.84	32	32.90	64	32.84	32	32.85	64	32.93
Total Power (dBm)			51.03	Total Power (dBm)			50.98	Total Power (dBm)			50.89
Total Power (W)			126.709	Total Power (W)			125.436	Total Power (W)			122.849

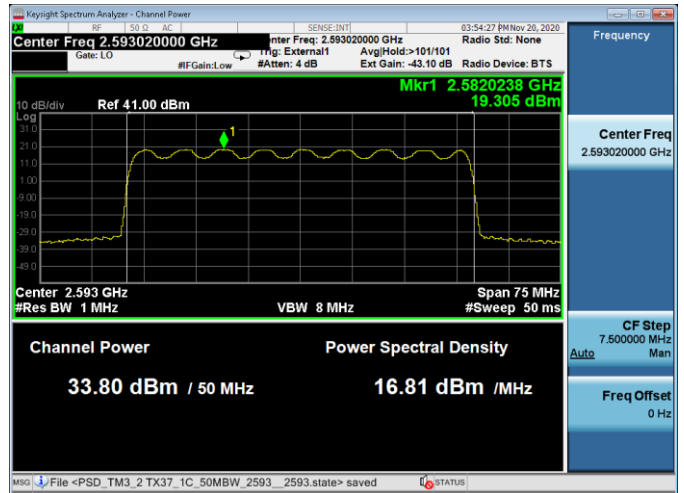
Channel RF Power – Plots

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

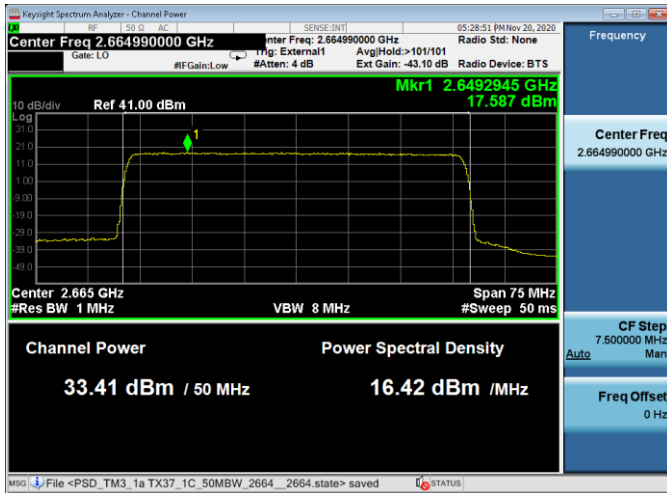
Test Model 3.1
Modulation 64QAM
Channel Frequency 2521.02MHz
TX37



Test Model 3.2
Modulation QPSK/16QAM
Channel Frequency 2593.02MHz
TX37

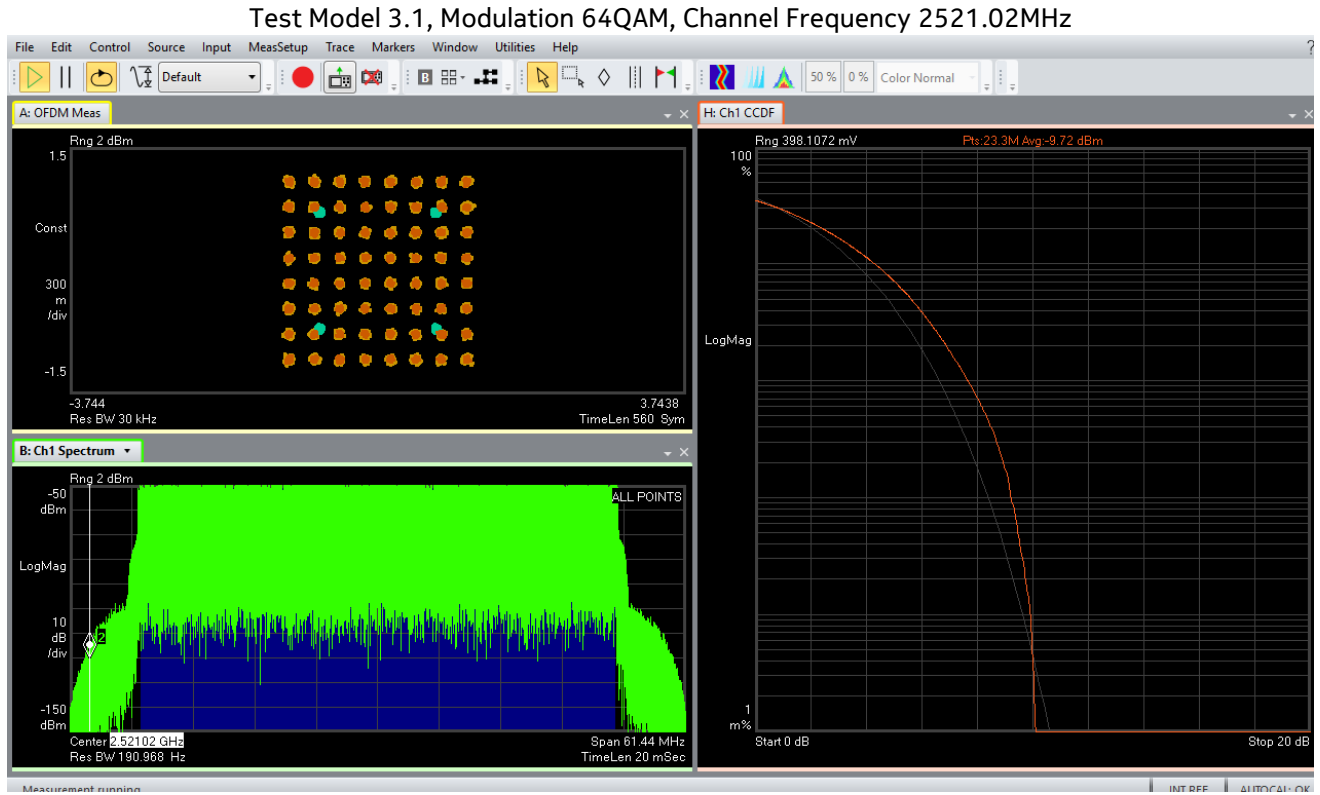


Test Model 3.1a
Modulation 256QAM
Channel Frequency 2664.99MHz
TX37

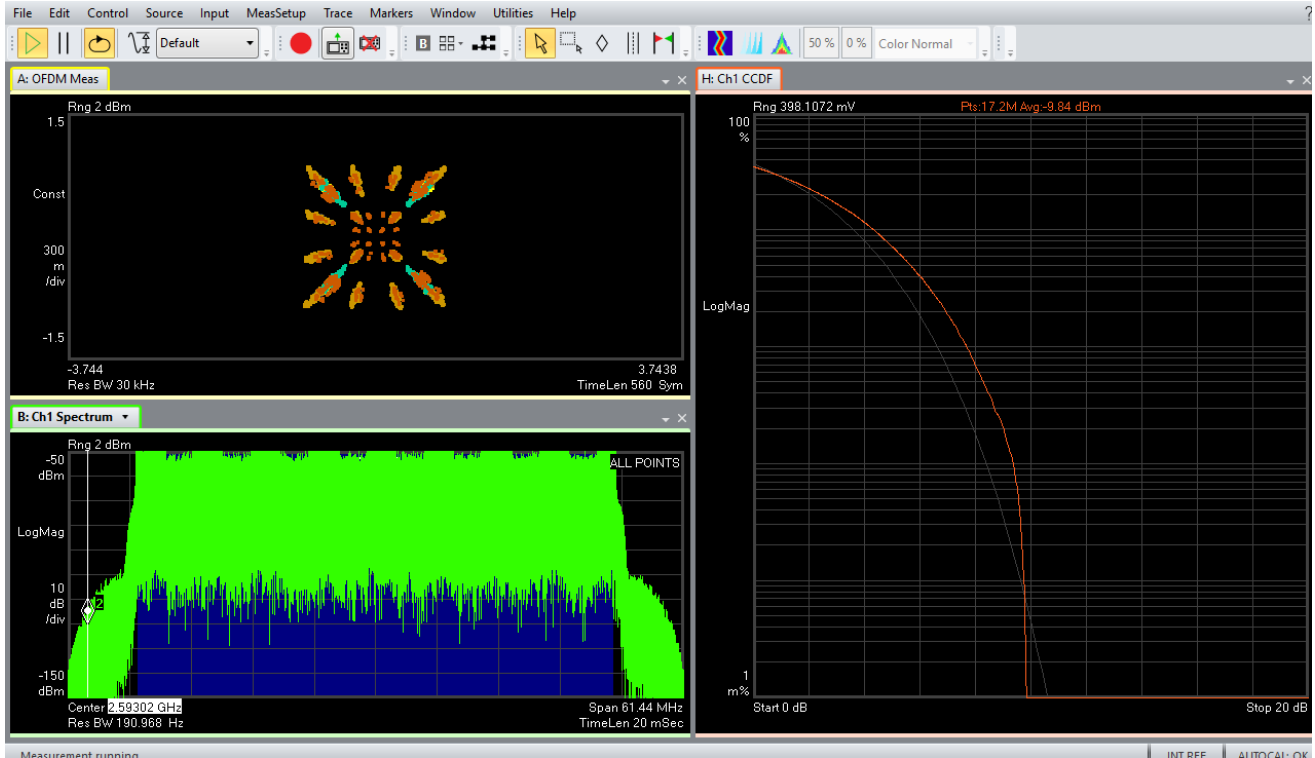


2.1.1 Peak-to-Average Power Ratio (PAPR) – Plots

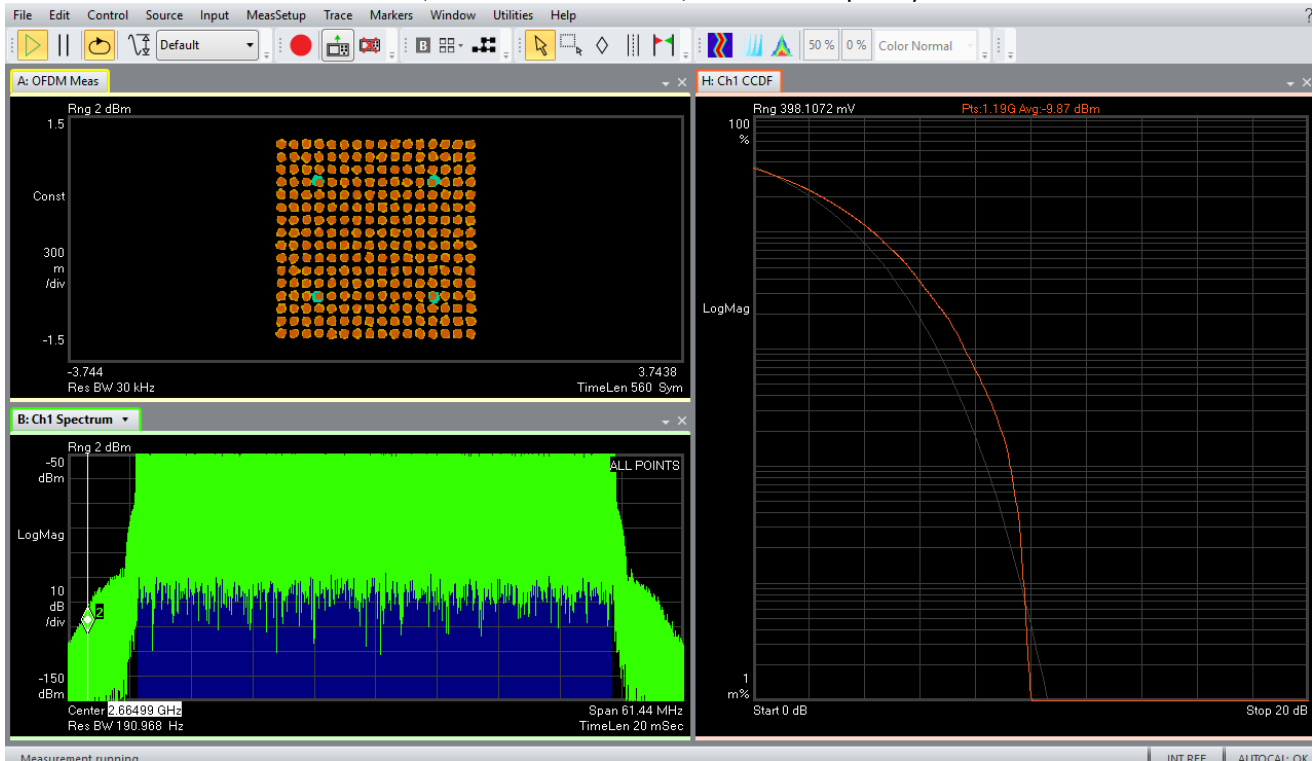
The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168 for 50 MHz bandwidth. The PAPR values of all carriers measured are below 13dB.



Test Model 3.2, Modulation QPSK/16QAM, Channel Frequency 2593.02MHz



Test Model 3.1a, Modulation 256QAM, Channel Frequency 2664.99MHz

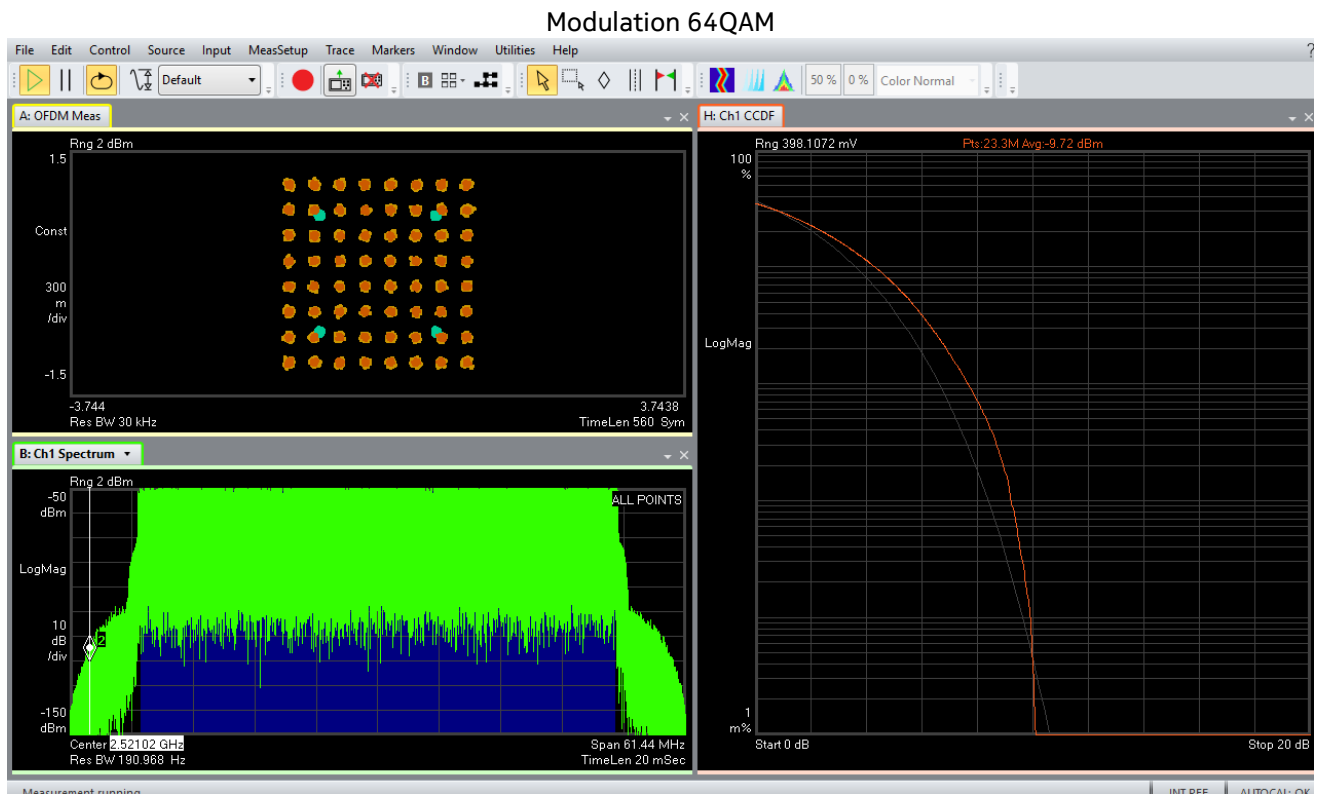


3. FCC Section 2.1047 - Modulation Characteristics

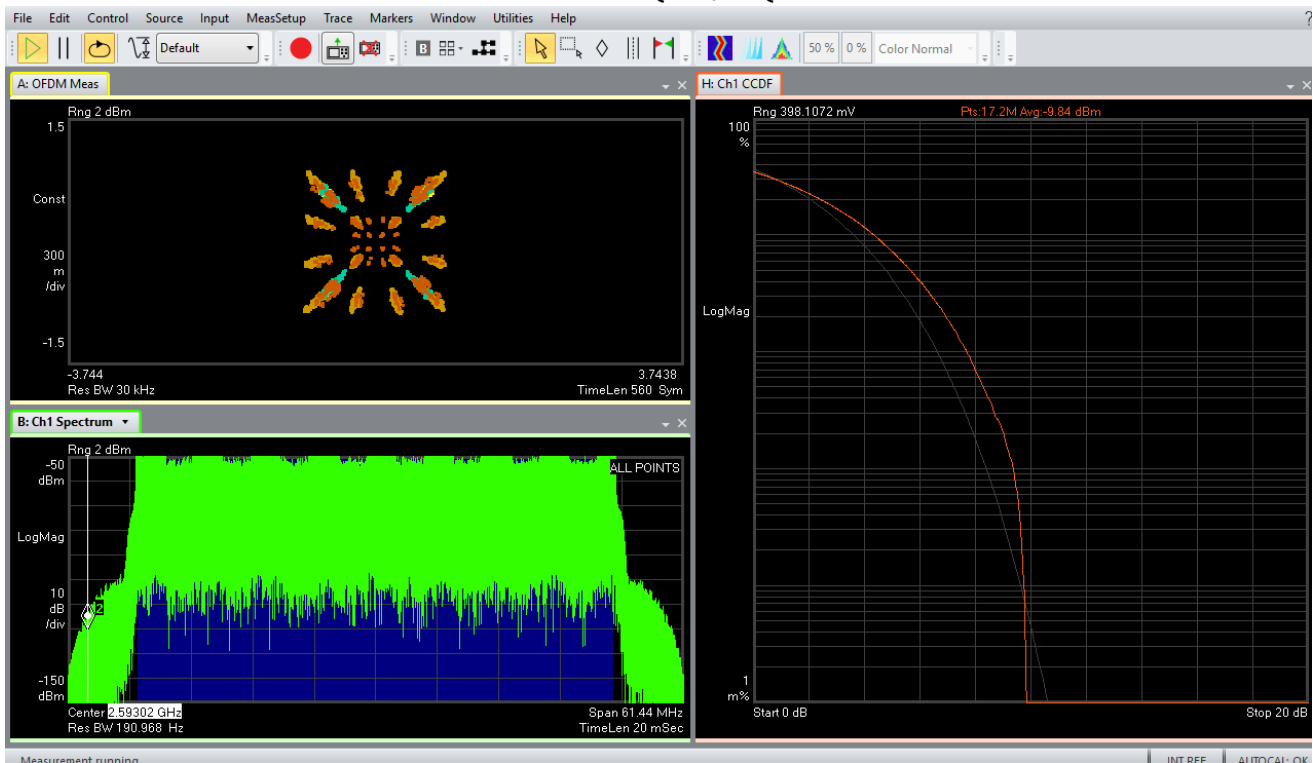
3.1 Modulation Characteristics

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

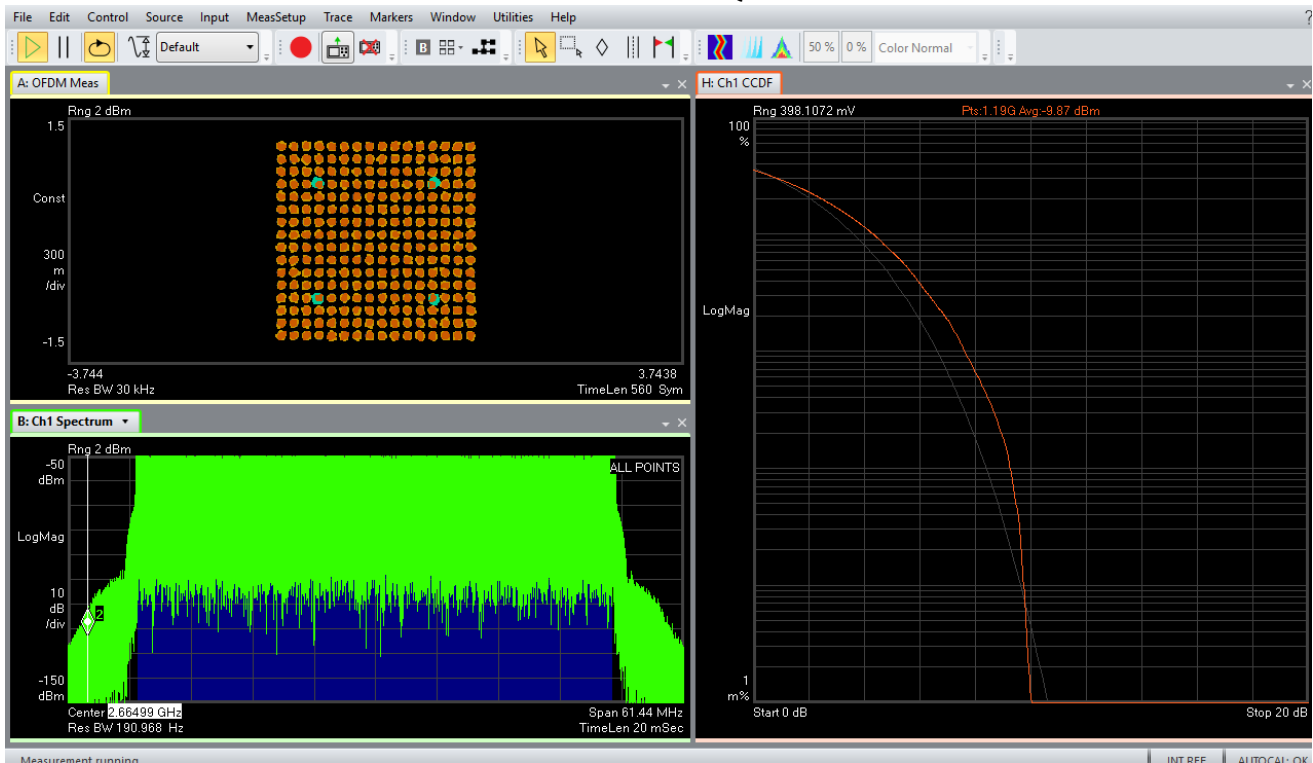
3.1.1 Modulation Characteristics – Plots



Modulation QPSK/16QAM



Modulation 256QAM



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.

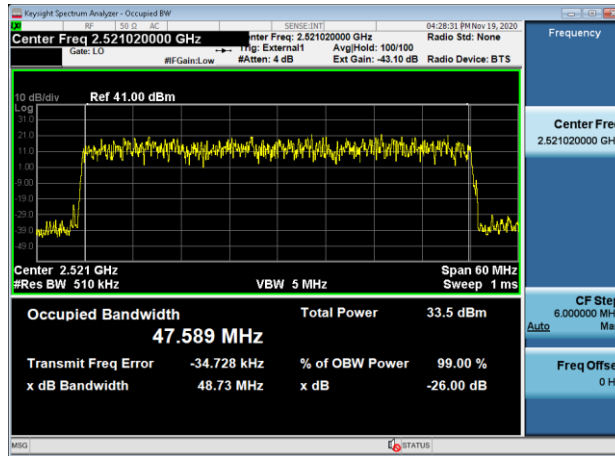
Tabular Data – Occupied Bandwidth

Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz	Occupied BW MHz
50	3.1	64QAM	5	2521.02	47.589
50	3.1	64QAM	28	2521.02	47.582
50	3.1	64QAM	37	2521.02	47.588
50	3.1	64QAM	60	2521.02	47.588
50	3.2	QPSK/16QAM	5	2593.02	47.371
50	3.2	QPSK/16QAM	28	2593.02	47.369
50	3.2	QPSK/16QAM	37	2593.02	47.372
50	3.2	QPSK/16QAM	60	2593.02	47.372
50	3.1a	256QAM	12	2664.99	47.489
50	3.1a	256QAM	28	2664.99	47.476
50	3.1a	256QAM	37	2664.99	47.473
50	3.1a	256QAM	60	2664.99	47.488

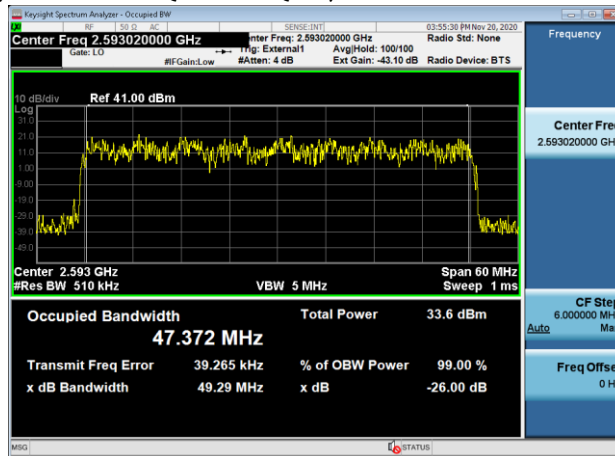
4.1.1 Occupied Bandwidth – Plots

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.

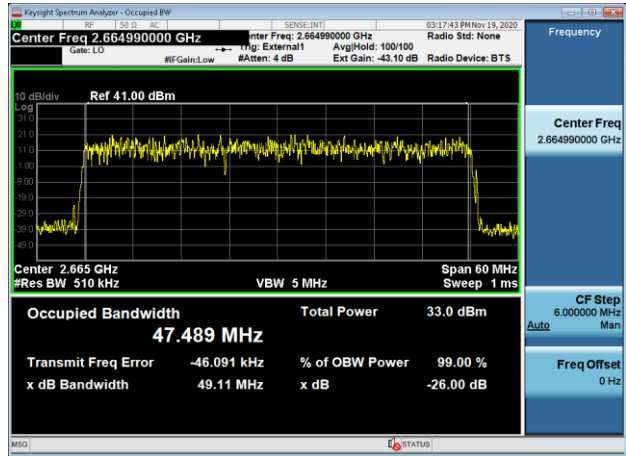
Test Model 3.1, Modulation 64QAM, 2521.02MHz Channel Frequency, TX5



Test Model 3.2, Modulation QPSK/16QAM, 2593.02MHz Channel Frequency, TX37



Test Model 3.1a, Modulation 256QAM, 2664.99MHz Channel Frequency, TX12



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. The RF power level was continuously measured using a RF broadband power meter. 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 test coupler. 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. The Top of Mask corresponds to the set rated power level as confirmed by the RF power meter.

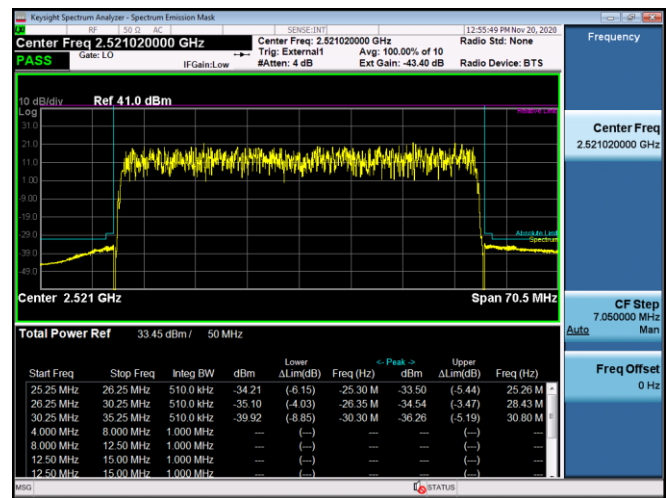
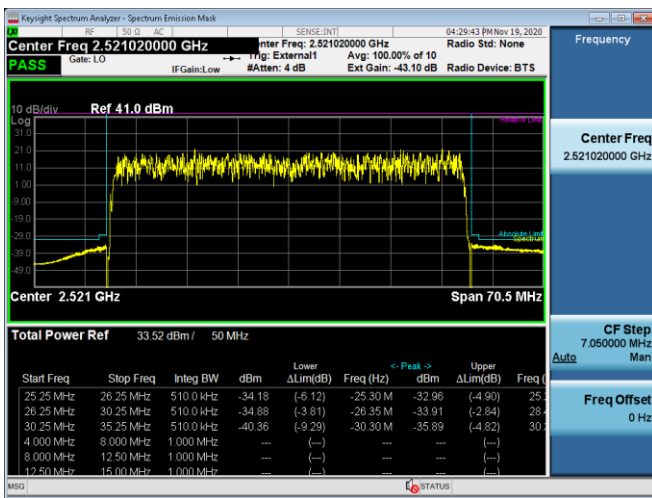
4.2.1 Edge of Band Emissions - Plots.

All of the measurements met the requirements of Part 27.53 when measured per Part 2.1049.

Channel Frequency 2521.02 MHz
 Test Model 3.1
 Modulation 64QAM

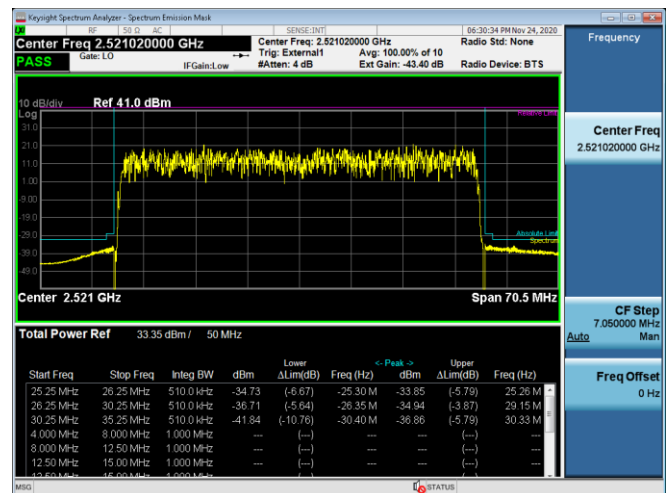
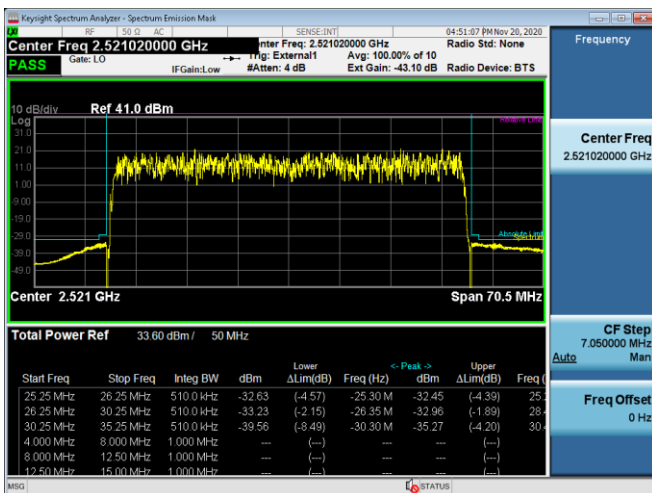
TX5

TX28



TX37

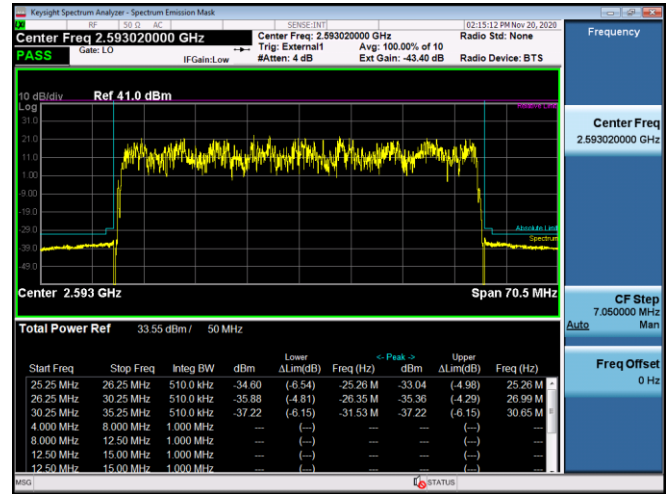
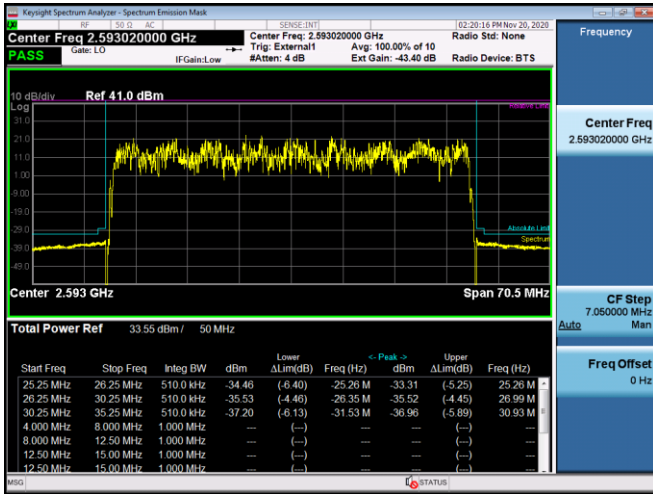
TX60



Channel Frequency 2593.02 MHz
 Test Model 3.2
 Modulation QPSK/16QAM

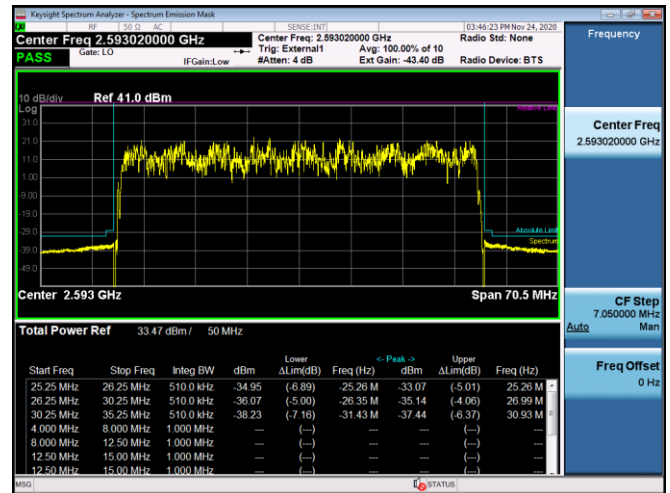
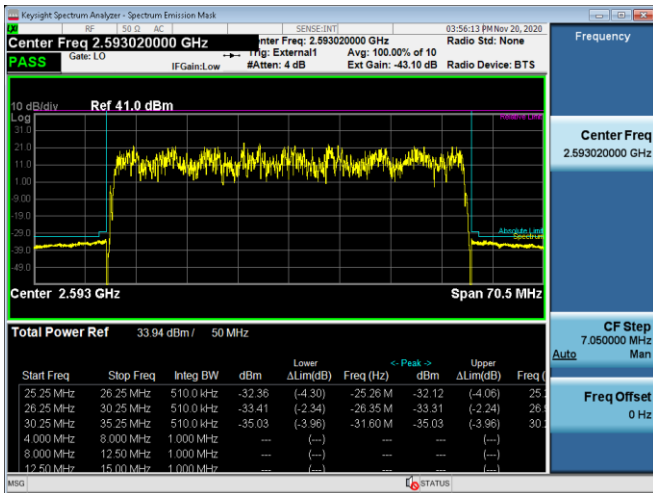
TX5

TX28



TX37

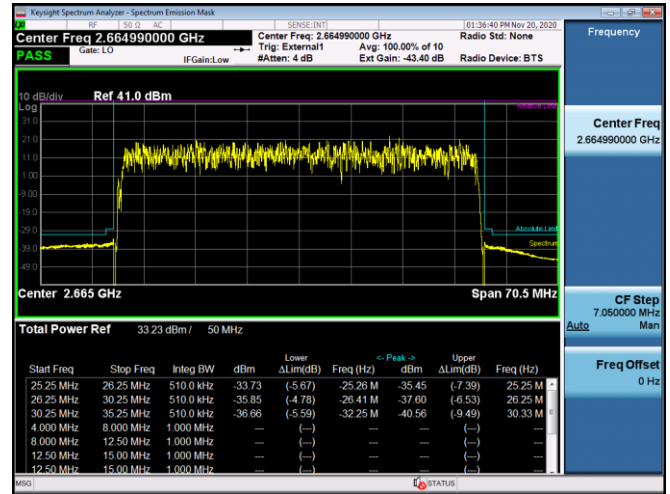
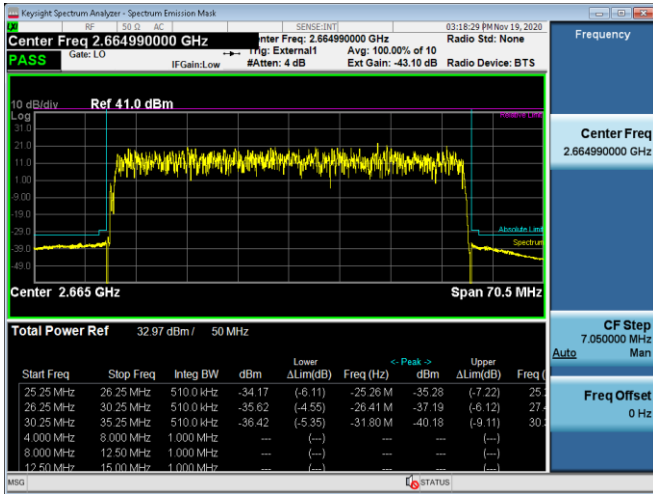
TX60



Channel Frequency 2664.99 MHz
 Test Model 3.1a
 Modulation 256QAM

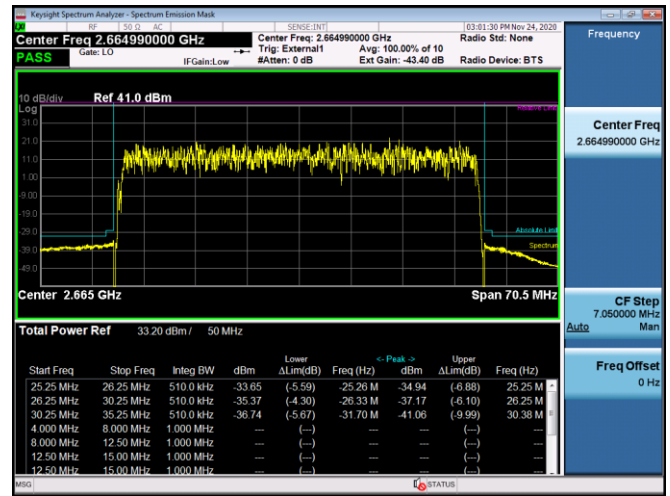
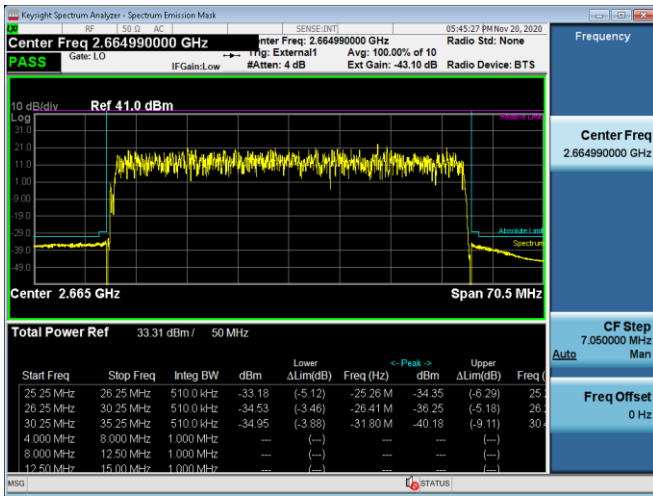
TX12

TX28



TX37

TX60



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

5.1 Measurement of Spurious Emissions at Transmit Antenna Port

Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. Carrier Bandwidth is exempt. For this band of operation, the measurements were performed up to 27 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 RF power level was continuously monitored via a coupled RF Power Meter.

The required emission limitation is specified as appropriate in 27.53. The measured spurious emission levels were plotted for the frequency range as specified in 2.1057. Data below documents performance up to 27 GHz. The limit is derived using the 10 Log (n) rule for limits with n=64.

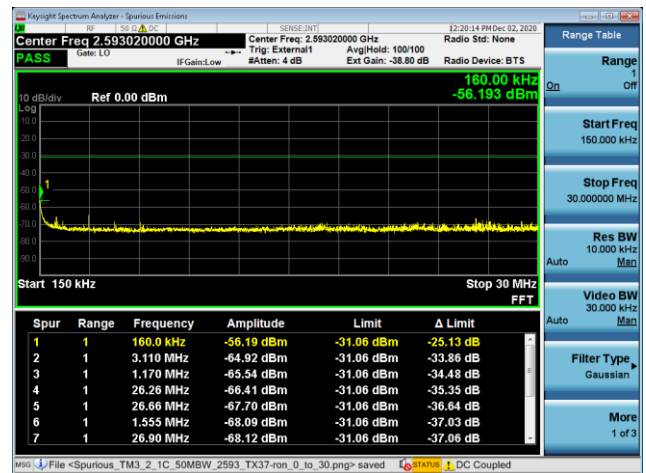
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

Test Model 3.2
 Modulation QPSK/16QAM
 Channel Frequency 2593.02MHz
 TX37

9KHz – 150kHz

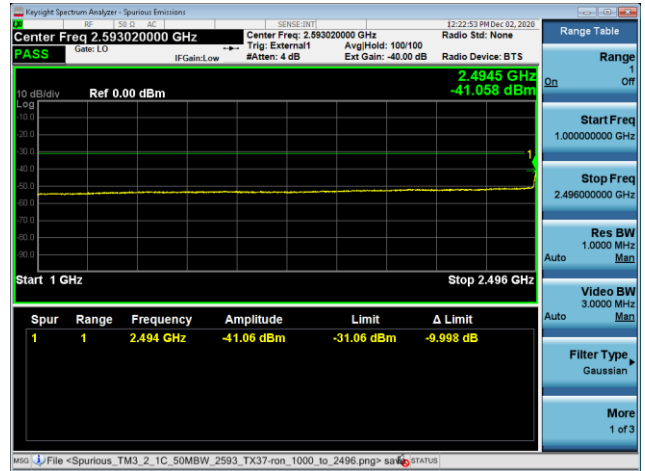
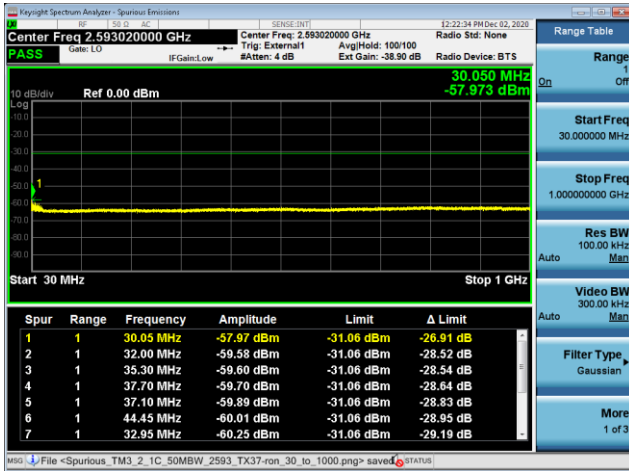


150kHz – 30MHz

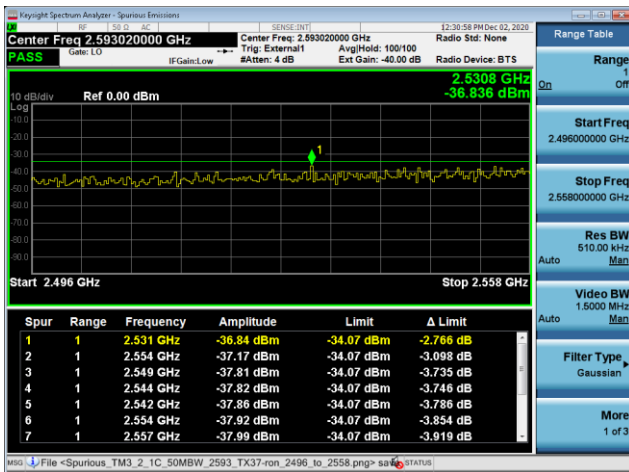


30MHz – 1GHz

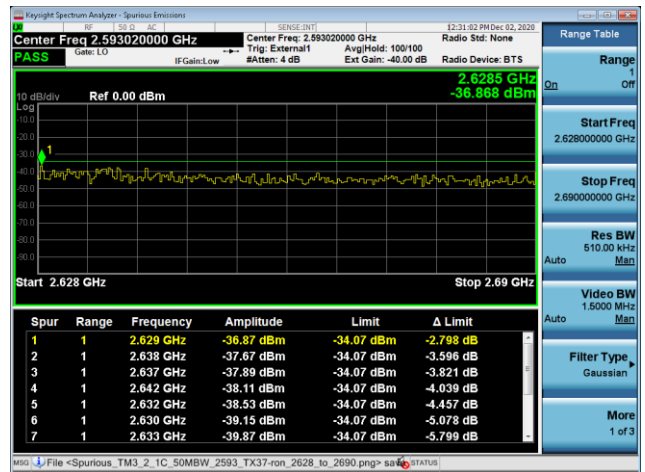
1GHz – 2.496GHz



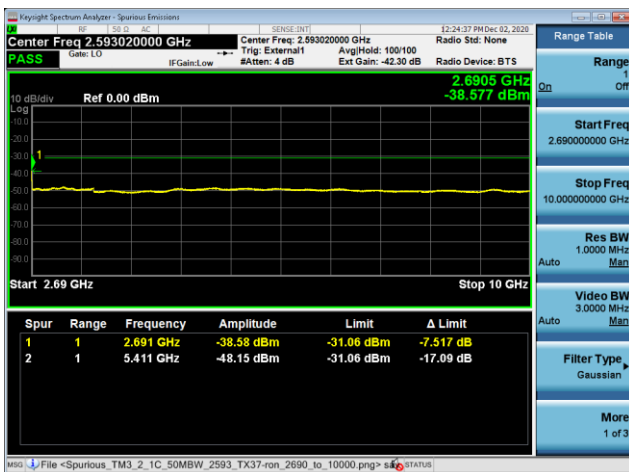
2.496GHz – 2.558GHz



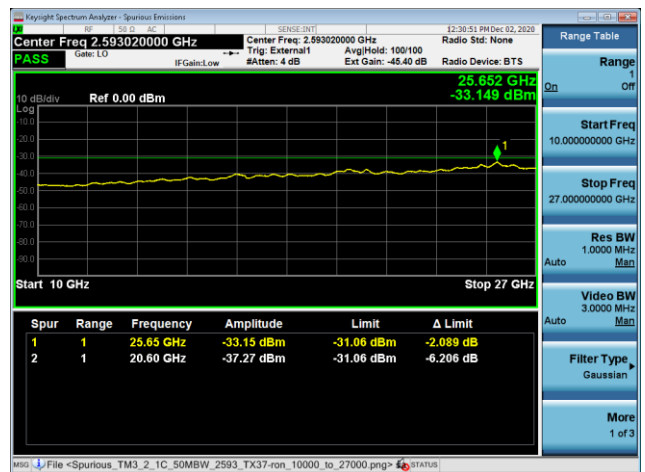
2.628GHz – 2.69GHz



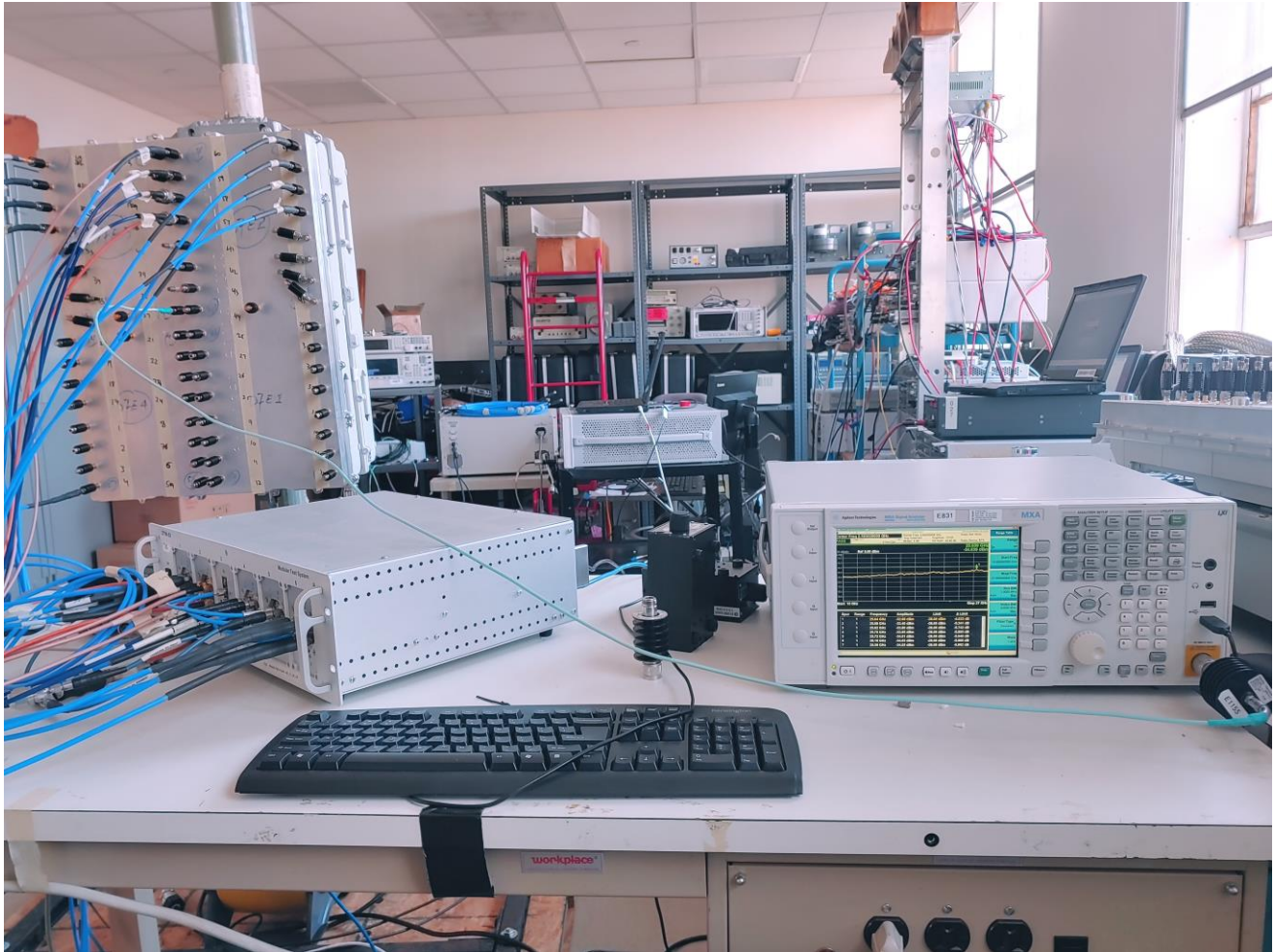
2.69GHz – 10GHz



10GHz – 27GHz



Photographs



Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E831	Agilent Technologies	MXA Signal Analyzer	20Hz-26.5GHz	N9020A	MY48011791	2020-06-16	2022-06-16
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2019-01-31	2021-01-31
E1156	Weinschel	Attenuator	10dB 0.05GHz-26GHz 25W	74-10-12	1069	CNR-V	CNR-V
E1155	Weinschel	Attenuator	10dB 0.05GHz-26GHz 25W	74-10-12	1068	CNR-V	CNR-V
E1250	Weinschel	Attenuator	3dB Attenuator 100W	24-3-43	BB9072	CNR-V	CNR-V

Customer Provided Equipment

Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
	Attenuator	30dB 10W dc-6ghz	P/NZSJ30-10RS-6TA		CNR-V	CNR-V
Micro-Coax	Cable	Utiflex	UFB142A-0-0720-2G0200/A	MFR 64639 227883-001	CNR-V	CNR-V

CNR-V: Calibration Not Required, Must Be Verified

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, 27 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 27.53 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.

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

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

Where:

E = Field Intensity in Volts/meter

P = Transmitted Power in Watts

R = Measurement distance in meters = 3 m

The Part 27 Limit is 82.23 dB μ V/m at 3m and 91.77 dB μ V/m at 1m

The Part 27 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 27, 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 27 GHz), no reportable spurious emissions were detected. Refer to TR-2020-0149-FCC15 for Radiated Emissions test results.

7. NVLAP Certificate of Accreditation

<p>United States Department of Commerce National Institute of Standards and Technology</p> <p>NVLAP® </p> <hr/> <p>Certificate of Accreditation to ISO/IEC 17025:2017</p> <hr/> <p>NVLAP LAB CODE: 100275-0</p> <p>Nokia, Global Product Compliance Lab Murray Hill, NJ</p> <p><i>is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:</i></p> <p>Electromagnetic Compatibility & Telecommunications</p> <p><i>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).</i></p> <hr/> <p>2020-09-25 through 2021-09-30 <i>Effective Dates</i></p> <p style="text-align: center;"></p> <p style="text-align: right;"> <i>For the National Voluntary Laboratory Accreditation Program</i></p>	
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