NOKIA Bell Labs

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NVLAP®

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:
AEQK Airscale MAA 64T64R 192AE n77 200W

Report Number:
TR-2022-0089-FCC2-27

Date Issued:
August 12, 2022

Table of Contents

Revisions

Date	Revision	Section	Change
8/12/2022	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):	**AEQK Airscale MAA 64T64R 192AE n77 200W**
Serial Number:	1M222400012 (Radio / RE) 1M222400011 (Frequency Stability)
FCC ID:	VBNAEQK-01
Hardware Version:	092516A.202
Software Version:	SBTS22R4
Frequency Range:	3700-3980 MHz
GPCL Project Number:	2022-0089
Applicant	Nokia Solutions and Networks Steve Mitchell 3201 Olympus Blvd Dallas, TX 75019
Test Requirement(s):	Title 47 CFR Parts 2 and 27
Test Standards:	• 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):	• 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):	7/14/2022 – 8/2/2022
Test Performed By:	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636 MRA test site number US5302
Product Engineer(s):	Ron Remy
Lead Engineer:	Steve Gordon
Test Engineer (s):	Nilesh Patel, Mike Soli, Greg Manuel, Joe Bordonaro
Test Results: The EUT, *as tested* met the above listed Test Requirements. The decision rule employed is binary (Pass/Fail) based on the measured values without accounting for Measurement Uncertainty or any Guard Band. The measured values obtained during testing were compared to a value given in the referenced regulation or normative standard. Report copies and other information not contained in this report are held by either the product engineer or in an identified file at the Global Product Compliance Laboratory in New Providence, NJ.	

1.1 Introduction

This Conformity test report applies to the **AEQK Airscale MAA 64T64R 192AE n77 200W**, 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 27 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

The original filing for this product was documented in GPCL project 2020-0149 for FCC ID: VBNAEQK-01which includes 20 MHz at 100 W, 40 MHz at 200 W, and 100 MHz at 200 W in the 5G-NR mode of operation in the frequency range of 3700 – 3980 MHz. The maximum power was determined through the measurement and summing of the 64 ports in Watts. Each port is rated for 3.125 W (34.95 dBm) per port or 200 W for the 64 ports (53.01 dBm +/- 2.0 dBm)

An additional Class II change including single carrier 50 MHz at 200 W, 60 MHz at 200 W, 80 MHz at 200 W, 90 MHz at 200 W and dual carrier 20+20 MHz at 200W, 40+40 MHz at 200W, 50+50 MHz at 200W were documented under GPCL Project 2021-0029.

This Class II Change is due to an alternate component change. The new components have the same basic function as the old components and only a small area of the PCB has been changed to accommodate the new chip. Two single carrier configurations (20 and 100 MHz) and one Dual Carrier (50+50 MHz) were tested.

1.3 EUT Details

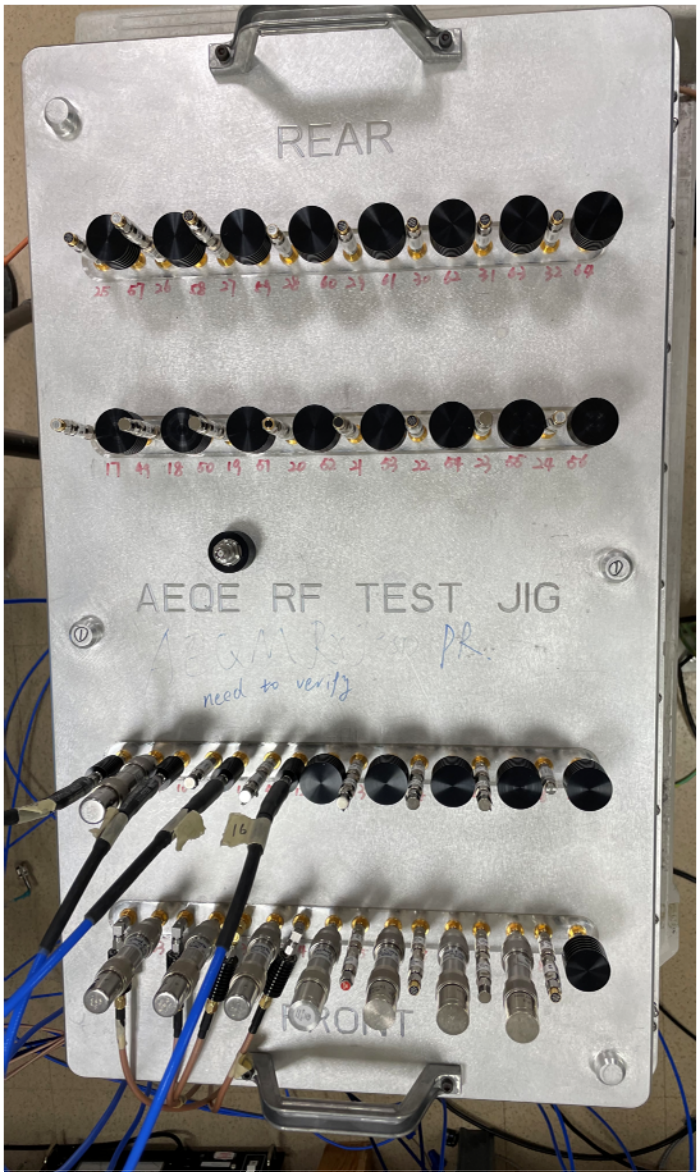
1.3.1 Specifications

Radio Characteristics	
Max RF Output Power	200W (3.125W per TRX)
TX/RX	64T64R
Band/Frequency Range	n77: 3700 - 3980 MHz
Instantaneous bandwidth (IBW)	200MHz (HW ready: 200+200 in split mode)
Occupied bandwidth (OBW)	100 MHz (HW ready: 100+100 in split mode)
Carrier bandwidth	20, 40, 50, 60, 70, 80,90, 100MHz; 20+20, 40+40, 40+50 MHz
Operating mode	64TRx Digital Beamforming
Other Characteristic	
External Interfaces	2 * SFP28 for CPRI 9.8Gbps, DC -48 V, AISG-ES-RAE 2.1, ext. alarms MDR-26
Installation Options	Pole / Wall with mechanical adjustment Fit into sPAA (stacked Hybrid Antenna)
Antenna Characteristics	
Antenna configurations	physical: 12, 8, 2 (192 AE) logical: 4, 8, 2
Minimum beamwidth	horizontal: 15° (boresight) vertical: 6° (boresight)
Beamsteering angle	horizontal: ±45° vertical: +6° (pre-tilt) ±7° (SLS>6dB)
Maximum antenna gain	>=24.5 dBi

1.3.2 Photographs

Radio and RE unit

Frequency Stability Unit



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	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 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, 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

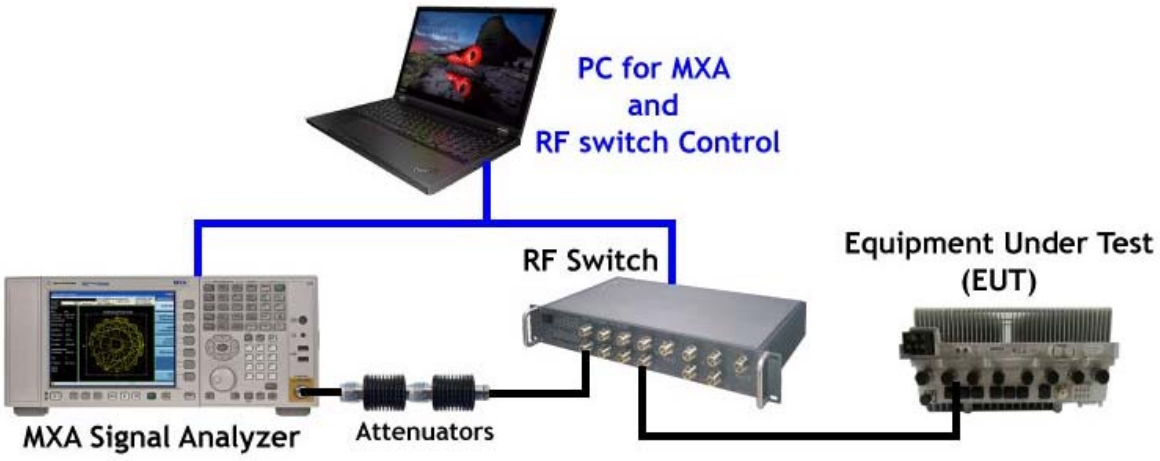
1.7 Executive Summary

Requirement	Description	Result
47 CFR FCC Parts 2 and 27		
2.1046, 27.50	RF Power Output Peak to Average Power Ratio	COMPLIES
2.1047	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, 27.54	Frequency Stability	COMPLIES

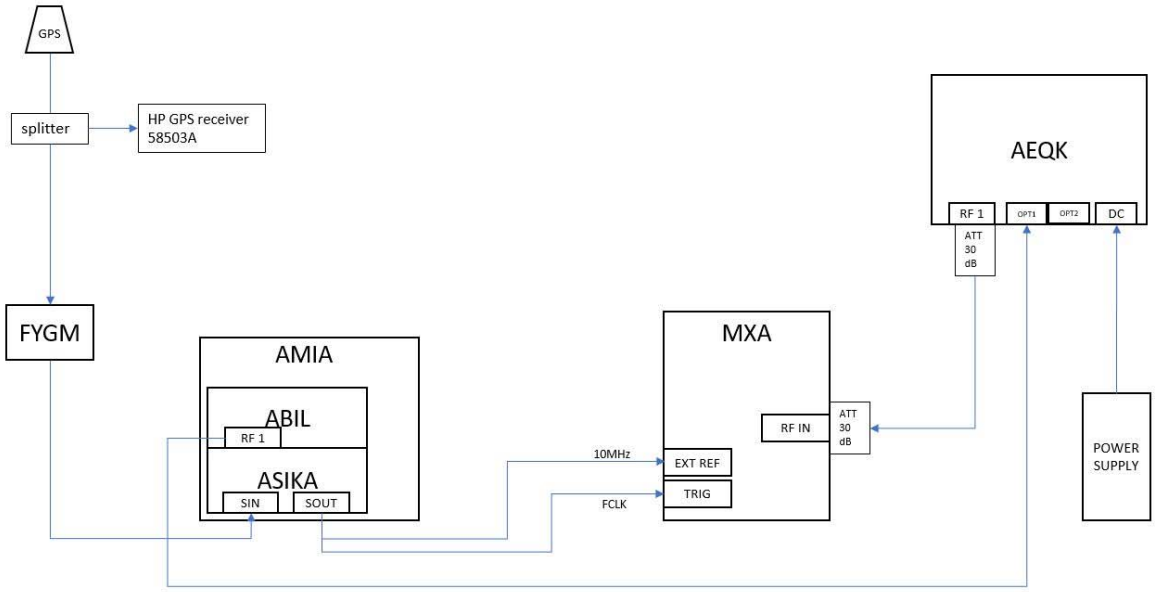
1. **COMPLIES -** Passed all applicable tests.
2. **N/A –** Not Applicable.
3. **NT –** Not Tested.

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 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.

Per FCC 27.50(J)(2), the power of each fixed or base station transmitting in the 3700-3980MHz band is limited to an EIRP of 1640W/MHz, i.e., 62.15dBm/MHz EIRP. With 24.5dBi antenna gain, the total conducted Power Spectral Density limit is 38dBm/MHz per 32 ports (per polarization). See **Summary of PSD Results** Table below.

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

Summary of PSD Results

Channel Bandwidth	Maximum Channel Power (dBm)	Correction for 32 Ports (10 Log n)	Conversion Power/MHz	Maximum PSD (dBm)/ MHz	PSD Limit (dBm/MHz)	Margin (dBm/MHz)
20	32.18	15	-13.01	34.17	38	3.83
100 / 50+50	34.97	15	-20.00	29.97	38	8.03

2.1.1 1 Carrier Data

Channel RF Power 20MHz BW

Channel Power - 5G-NR 20MHz					
Test Model 3.1 Modulation 64QAM Channel Frequency 3710.01MHz		Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 3840 MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 3969.99MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
4	31.40	4	31.95	4	31.69
5	31.30	5	31.80	5	31.54
6	31.26	6	31.81	6	31.53
7	30.97	7	31.33	7	31.07
8	**31.83**	8	**32.18**	8	**32.04**
9	**31.83**	9	**32.18**	9	**32.04**
10	31.62	10	31.98	10	31.84
11	31.62	11	31.98	11	31.84

Channel RF Power 100MHz BW

Channel Power - 5G-NR 100MHz					
Test Model 3.1 Modulation 64QAM Channel Frequency 3750MHz		Test Model 1.1 Modulation QPSK Channel Frequency 3840 MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 3930MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
4	34.79	4	34.56	4	**34.52**
5	34.54	5	34.35	5	34.40
6	34.45	6	34.44	6	34.40
7	34.21	7	33.98	7	34.02
8	**34.84**	8	**34.68**	8	34.47
9	**34.84**	9	**34.68**	9	34.36
10	34.64	10	34.48	10	34.29
11	34.64	11	34.48	11	34.29

2.1.2 2 Carrier Non-Contiguous Data

Channel RF Power Non-Contiguous 50+50MHz BW

Channel Power - non-Contiguous 5G-NR 50MHz + 50MHz	
Test Model 1.1 Modulation QPSK Channel Frequency 3725.01 + 3875.01 MHz	
TX Port	(dBm)
4	34.55
5	**34.97**
6	34.87
7	34.47
8	34.87
9	34.87
10	34.66
11	34.47

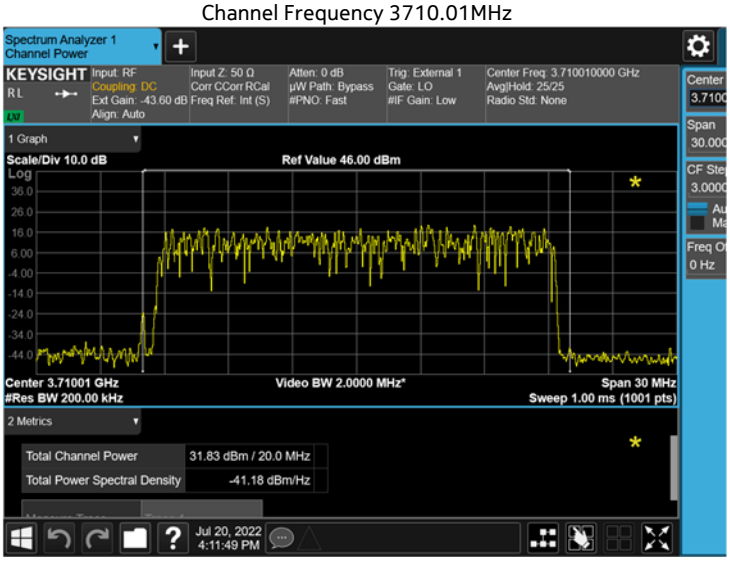
2.2 Channel RF Power – Plots

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.

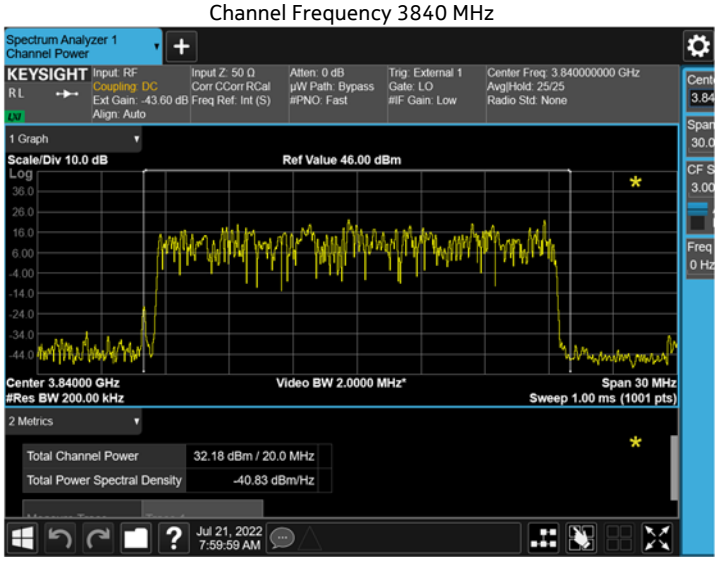
2.2.1 1 Carrier Plots

Channel RF Power 20MHz BW, TX8

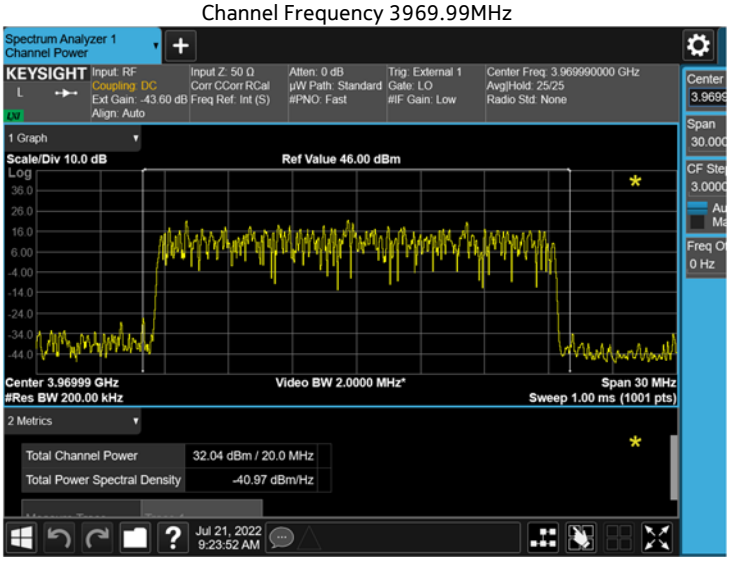
Test Model 3.1
Modulation 64QAM
Channel Frequency 3710.01MHz



Test Model 1.1
Modulation QPSK
Channel Frequency 3840 MHz

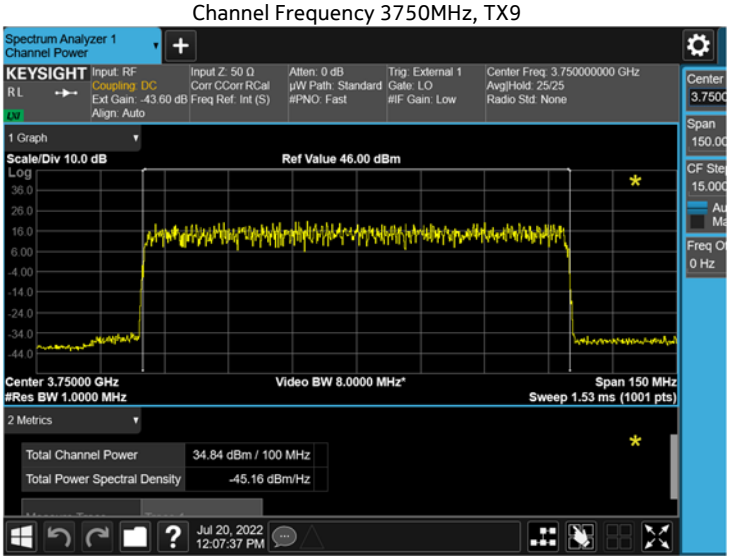


Test Model 3.1a
Modulation 256QAM
Channel Frequency 3969.99MHz

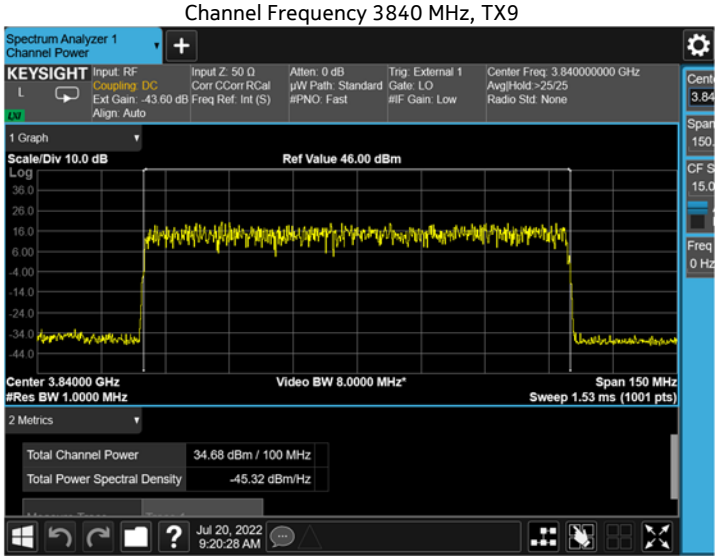


Channel RF Power 100MHz BW

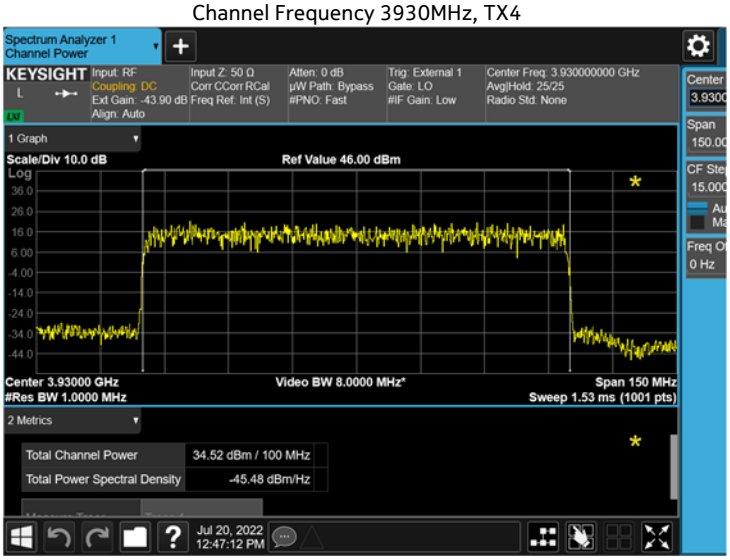
Test Model 3.1
Modulation 64QAM
Channel Frequency 3750MHz, TX9



Test Model 1.1
Modulation QPSK
Channel Frequency 3840 MHz, TX9

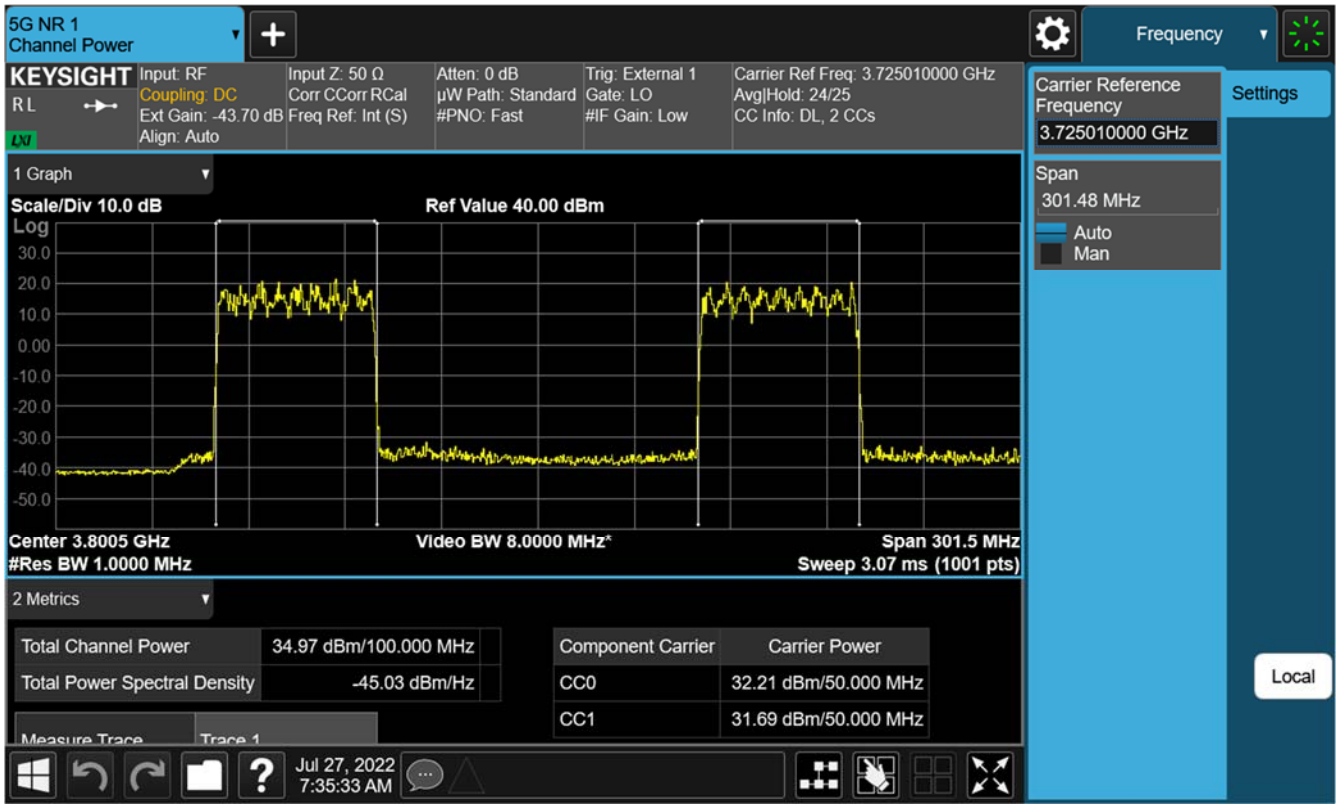


Test Model 3.1a
Modulation 256QAM
Channel Frequency 3930MHz, TX4



2.2.2 2 Carrier Non-Contiguous Plots

Non-Contiguous 50+50MHz BW
Test Model 1.1
Modulation QPSK
Channel Frequency 3725.01 + 3875.01 MHz
TX5



2.3 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 FCC requirement for PAPR is 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 below.

2.3.1 Peak-to-Average Power Ratio Results:

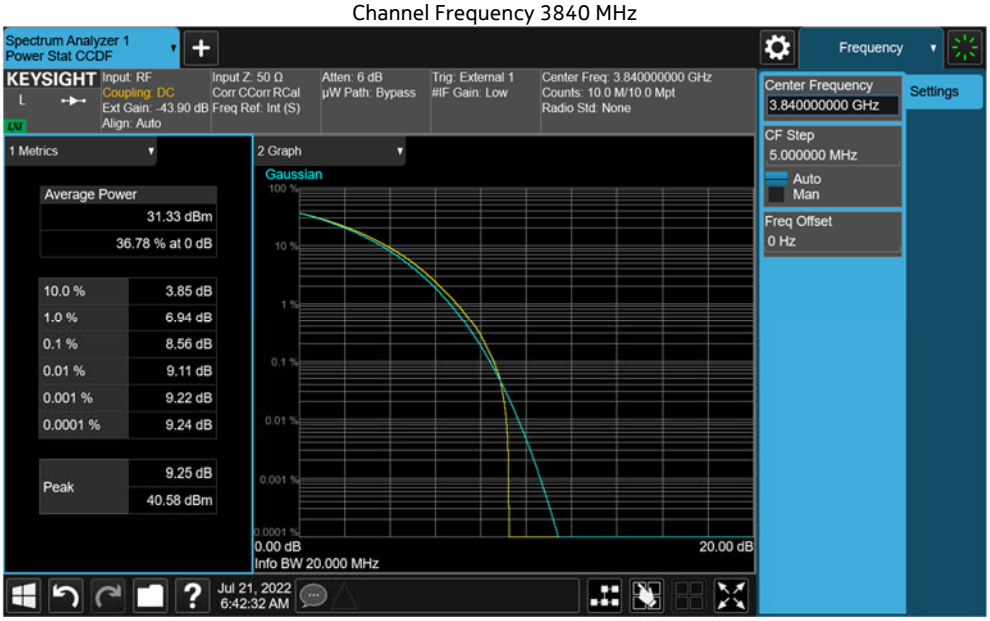
The maximum Peak-to-Average Power Ratio (PAPR) of the EUT measured at its antenna transmitting terminals was measured to be 8.56 dB maximum, which is in full compliance with the requirement to not exceed 13 dB as specified by the FCC.

Peak to Average Power Ratio Table

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	Radio Access Technology	PAR at 0.1% Limit - 13 dB
1	3.1	64QAM	8	3710.01	20	5G-NR	8.52
1	3.2	QPSK/16QAM	8	3840	20	5G-NR	**8.56**
1	3.1a	256QAM	8	3969.99	20	5G-NR	8.52
1	3.1	64QAM	8	3750	100	5G-NR	8.48
1	1.1	QPSK	8	3840	100	5G-NR	8.39
1	3.1a	256QAM	4	3930	100	5G-NR	8.45

2.3.2 Peak-to-Average Power Ratio Plots

20 MHz BW, TX8
Modulation QPSK/16QAM
Channel Frequency 3840 MHz



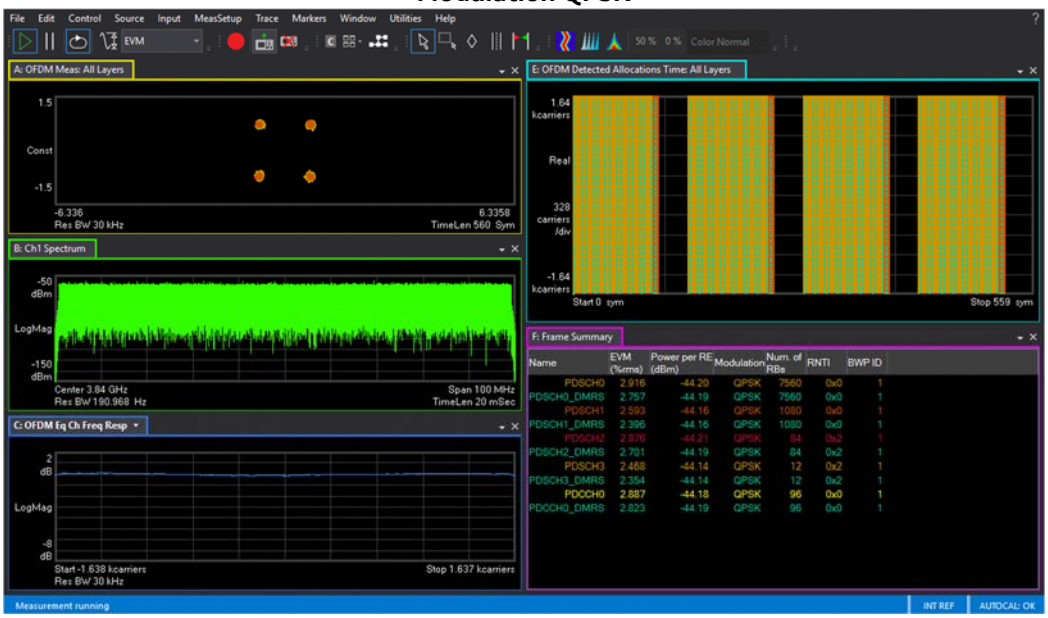
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

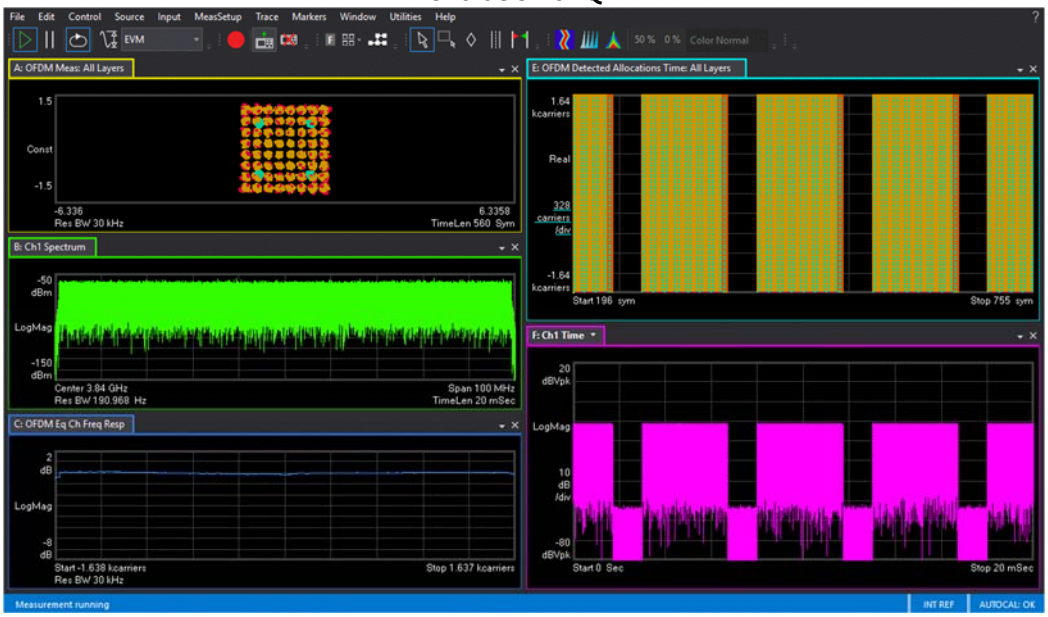
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

3.1.1 Modulation Characteristics – Plots

Modulation QPSK

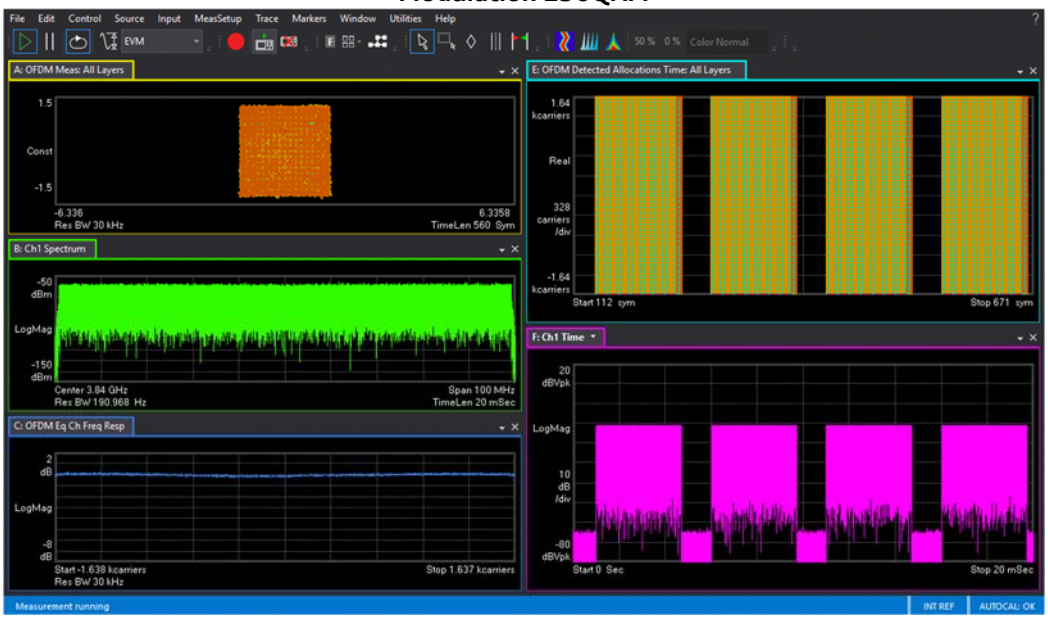


Modulation 64QAM



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.

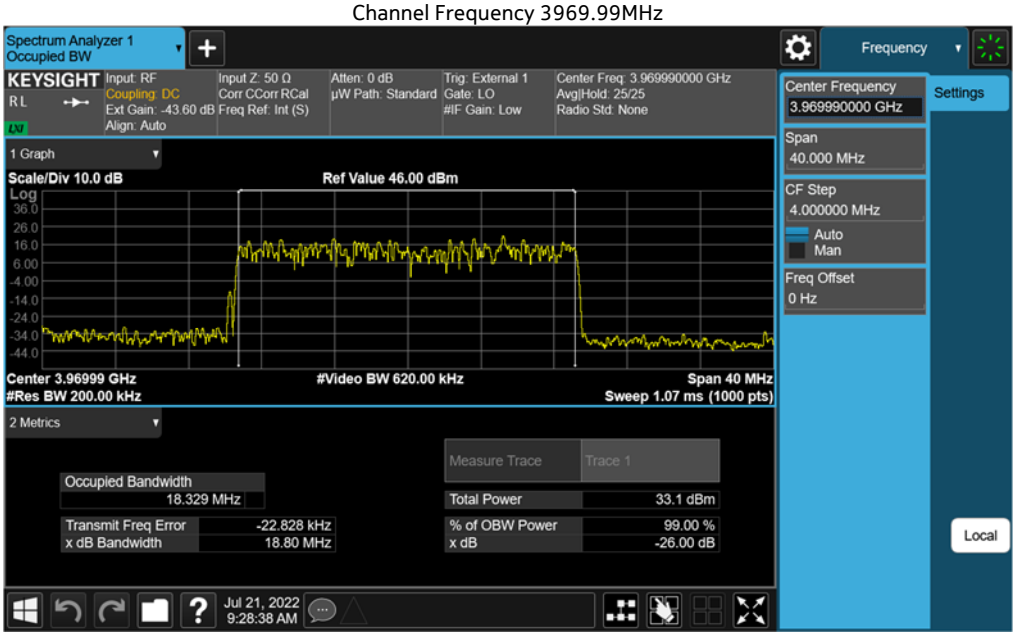
Tabular Data – 99% Occupied Bandwidth

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	Radio Access Technology	99% Occupied BW MHz
1	3.1	64QAM	8	3710.01	20	5G-NR	18.257
1	3.2	QPSK/16QAM	8	3840	20	5G-NR	18.206
1	3.1a	256QAM	8	3969.99	20	5G-NR	**18.329**
1	3.1	64QAM	8	3750	100	5G-NR	97.522
1	1.1	QPSK	8	3840	100	5G-NR	**97.690**
1	3.1a	256QAM	4	3930	100	5G-NR	96.897

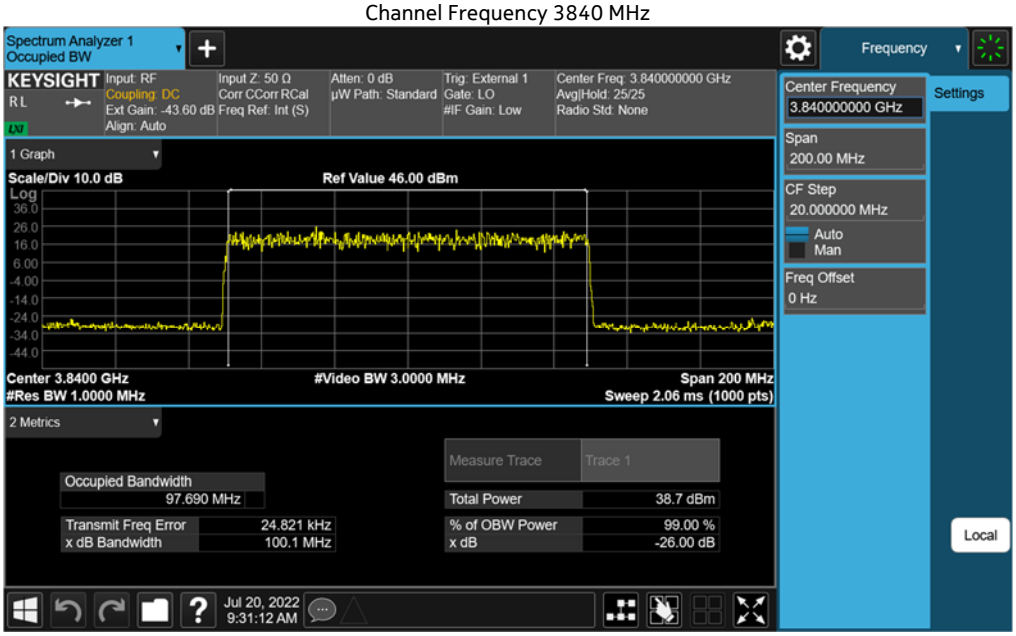
4.1.1 Occupied Bandwidth Plots

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.

20 MHz BW, TX8
Modulation 256QAM
Channel Frequency 3969.99MHz



100 MHz BW, TX8
Modulation QPSK
Channel Frequency 3840 MHz



4.2 Edge of band Emissions

The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. 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.

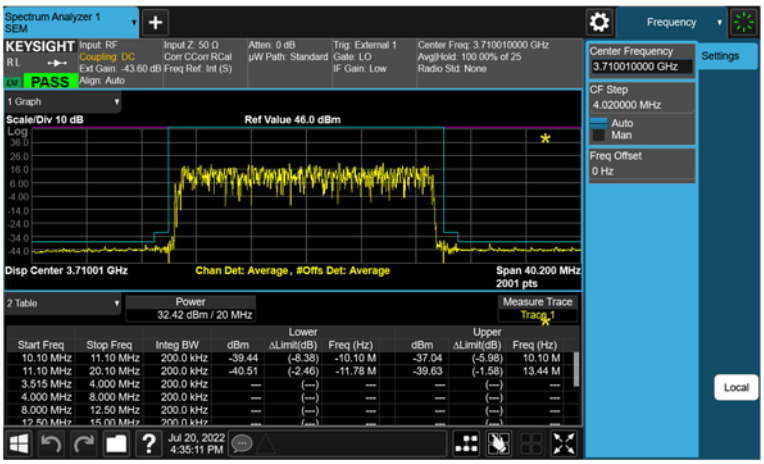
Per FCC Part 27.53 (L)(1), for base station operations in the 3700-3980 MHz band, the conducted power of any emission outside the licensee's authorized bandwidth shall not exceed −13 dBm/MHz. Compliance with this paragraph (L)(1) is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 MHz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the 26dB emission bandwidth of the fundamental emission of the transmitter may be employed. Therefore, with 64 TX ports, the conducted limit per port is -31dBm/1% BW in the 1MHz immediately outside and adjacent to the licensee's frequency block and -31dBm/MHz outside the 1MHz.

4.2.1 Edge of Band Emissions – 1 Carrier Plots

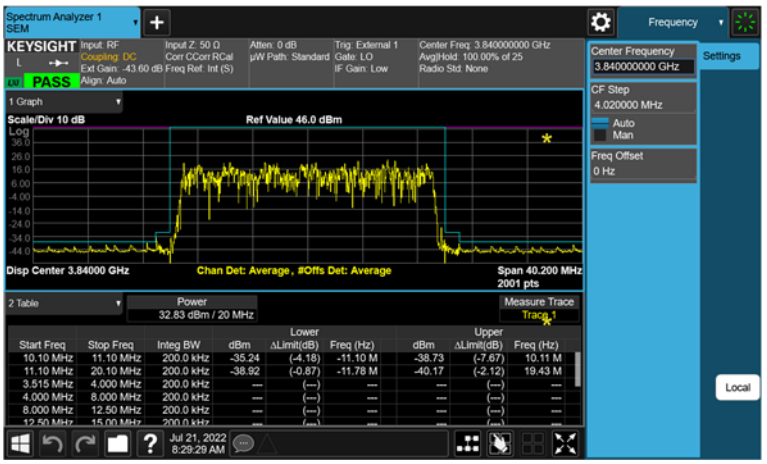
All of the measurements met the requirements of Part 27.53 when measured per Part 2.1049.

Edge of Band Emissions 20MHz BW

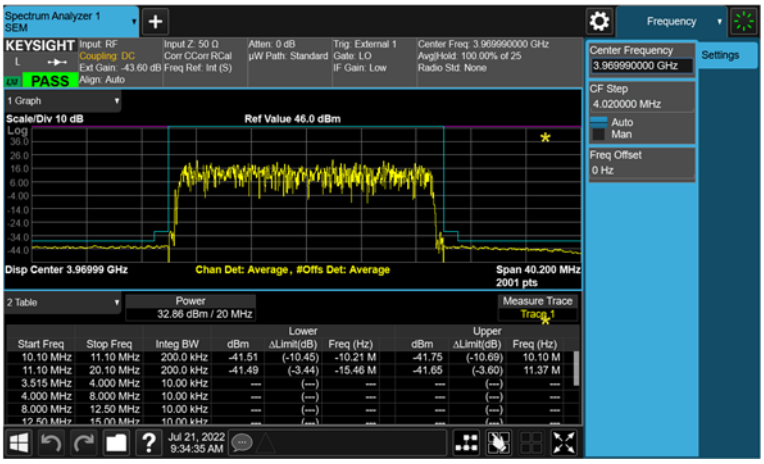
Test Model 3.1
Modulation 64QAM
Channel Frequency 3710.01MHz
TX8



Test Model 3.2
Modulation QPSK/16QAM
Channel Frequency 3840 MHz
TX8

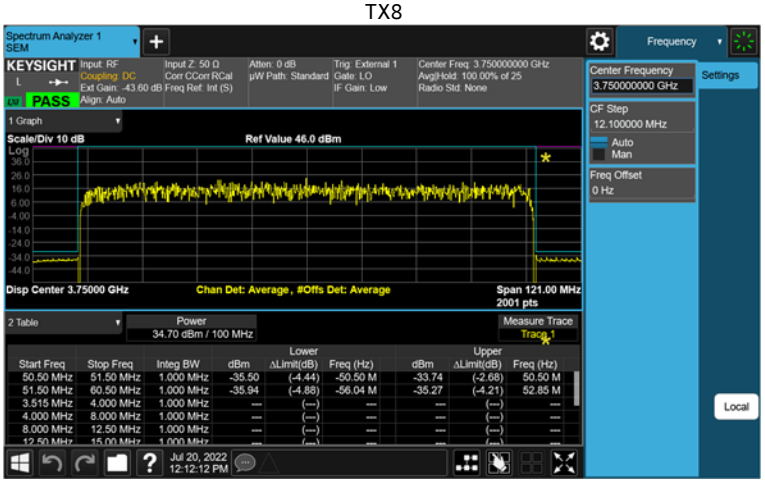


Test Model 3.1a
Modulation 256QAM
Channel Frequency 3969.99MHz
TX8

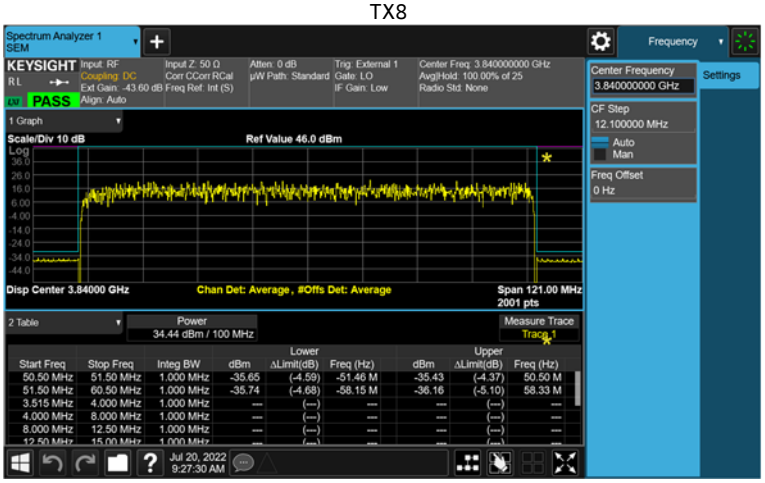


Edge of Band Emissions 100MHz BW

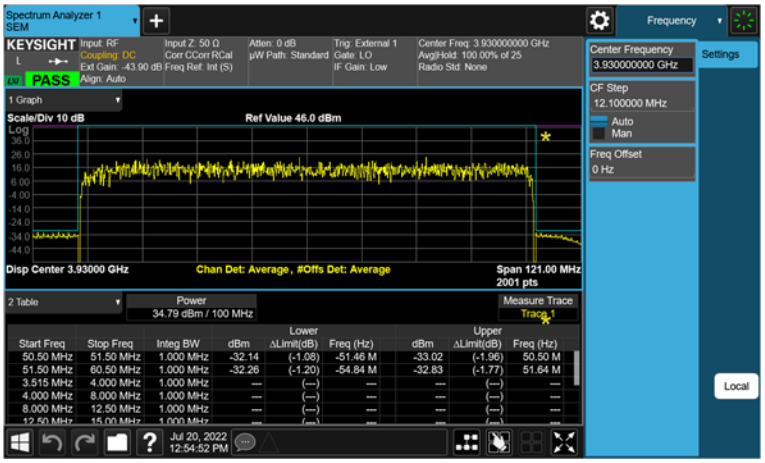
Test Model 3.1
Modulation 64QAM
Channel Frequency 3750MHz
TX8



Test Model 1.1
Modulation QPSK
Channel Frequency 3840 MHz
TX8

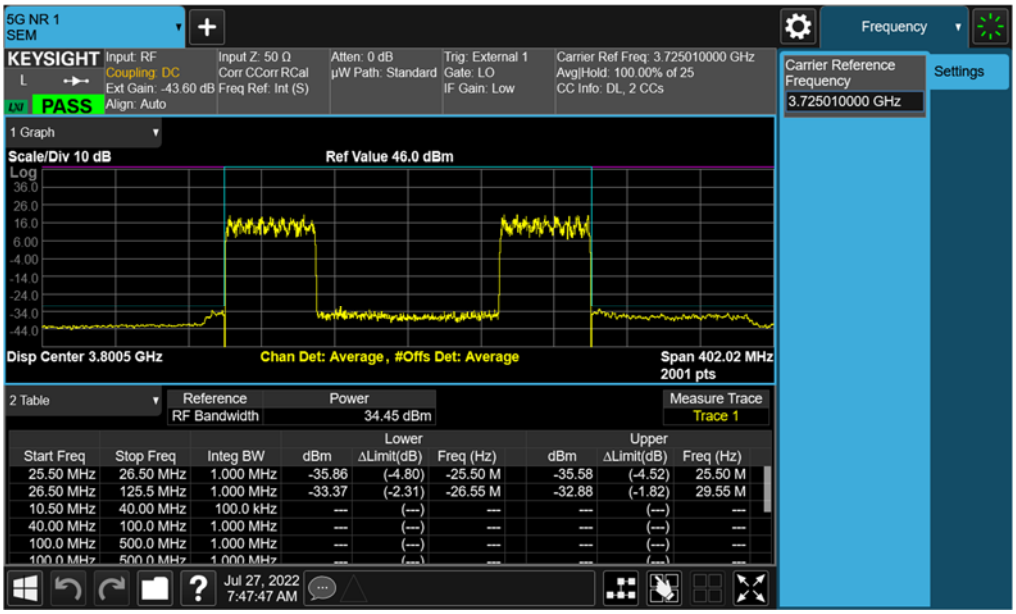


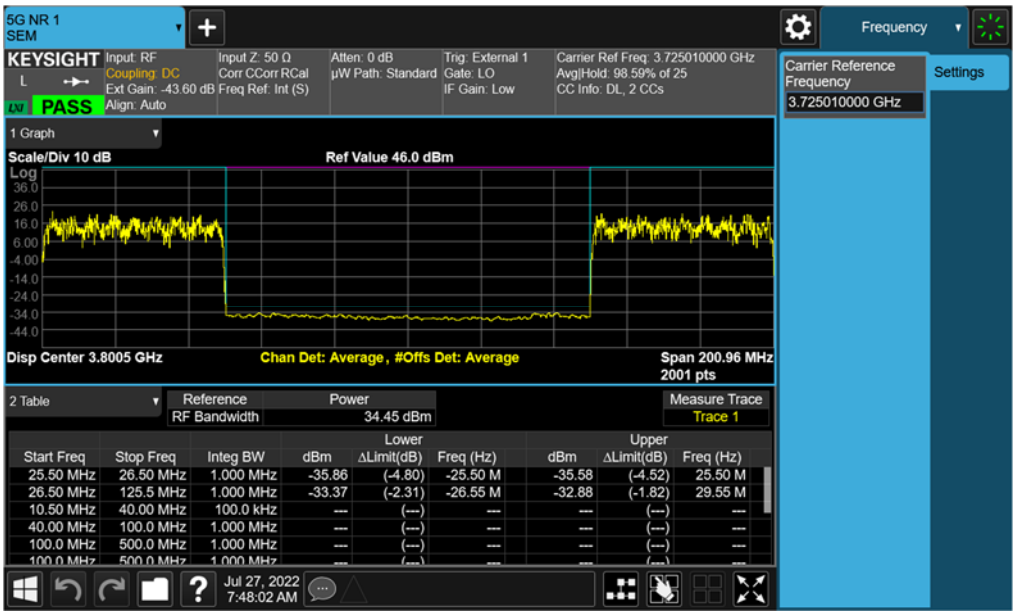
Test Model 3.1a
Modulation 256QAM
Channel Frequency 3930MHz
TX4



4.2.2 Edge of Band Emissions - 2 Carrier Plots

Edge of Band Emissions Contiguous 50+50MHz BW
Test Model 1.1; Modulation QPSK
Channel Frequency 3725.01 + 3875.01 MHz
TX5





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

5.1 Measurement of Spurious Emissions at Transmit Antenna Port

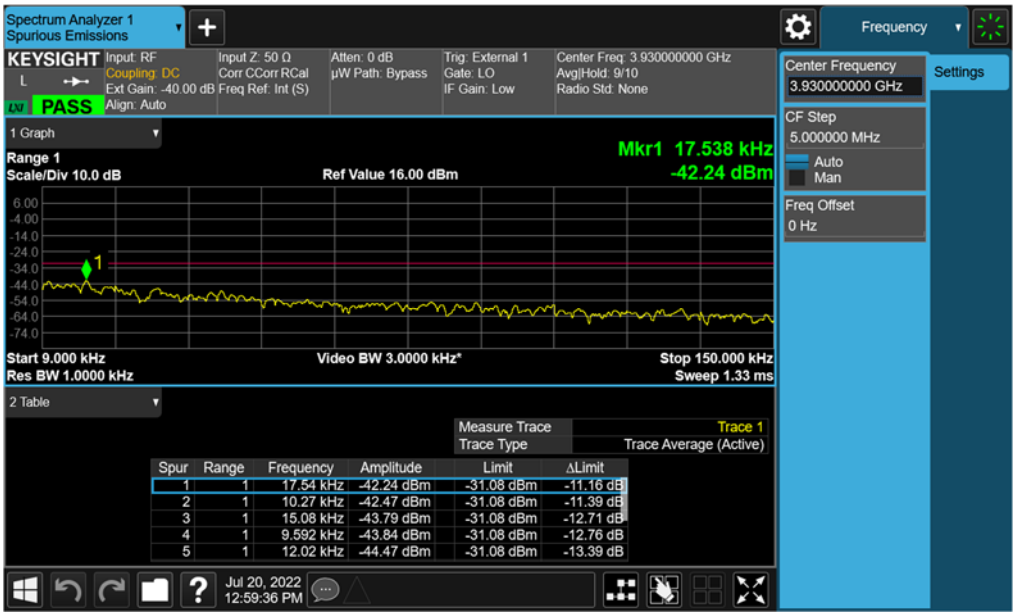
Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. Carrier Bandwidth is exempt. For this band of operation, the measurements were performed up to 37 GHz. Measurements were made using a Keysight 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. For 64 ports where 10log (64) = 18dBm, the limit is 31dBm/MHz. Data below documents performance up to 37 GHz.

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

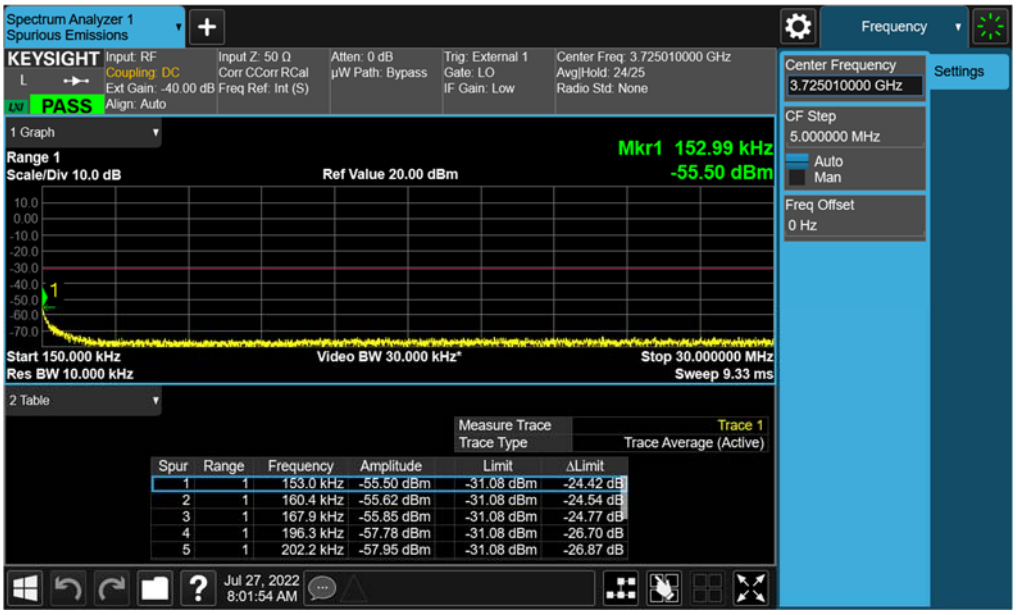
9KHz – 150KHz

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
1	3.1a	256QAM	4	3930	100



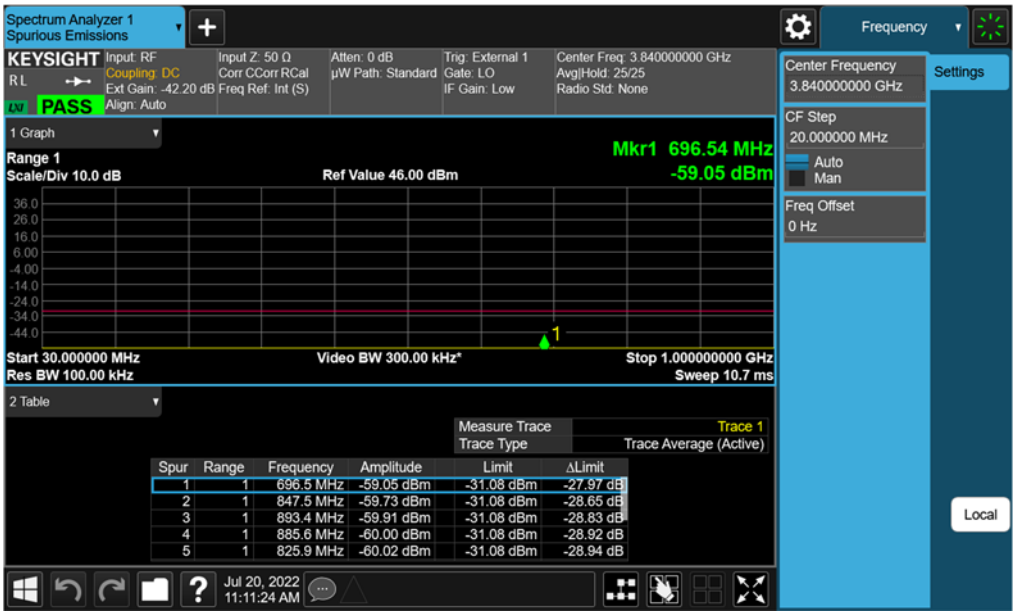
150KHz – 30MHz

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
2	1.1	QPSK	5	3725.01 + 3875.01	50+50



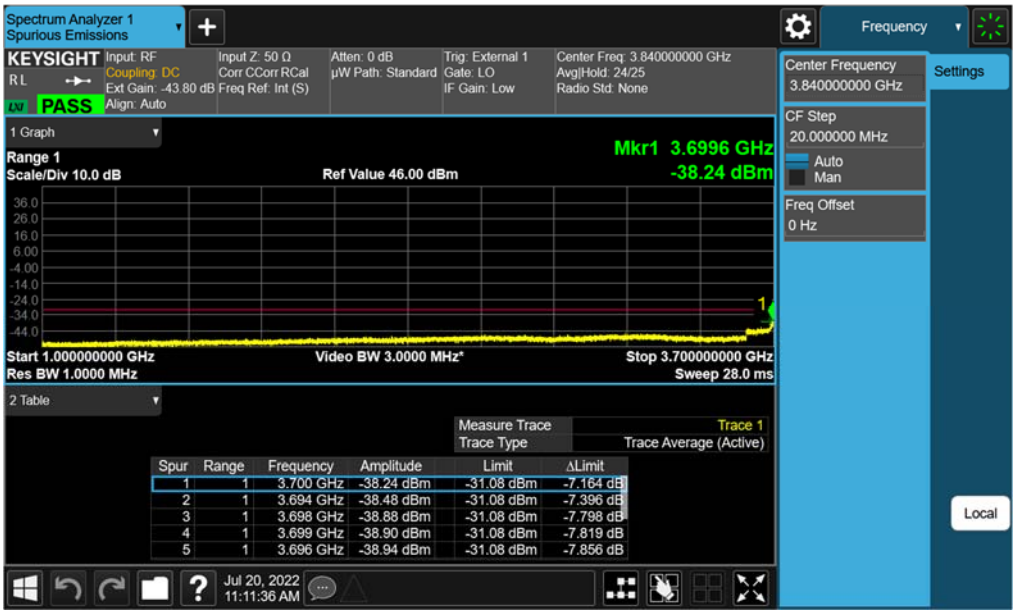
30MHz – 1GHz

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
1	1.1	QPSK	8	3840	100



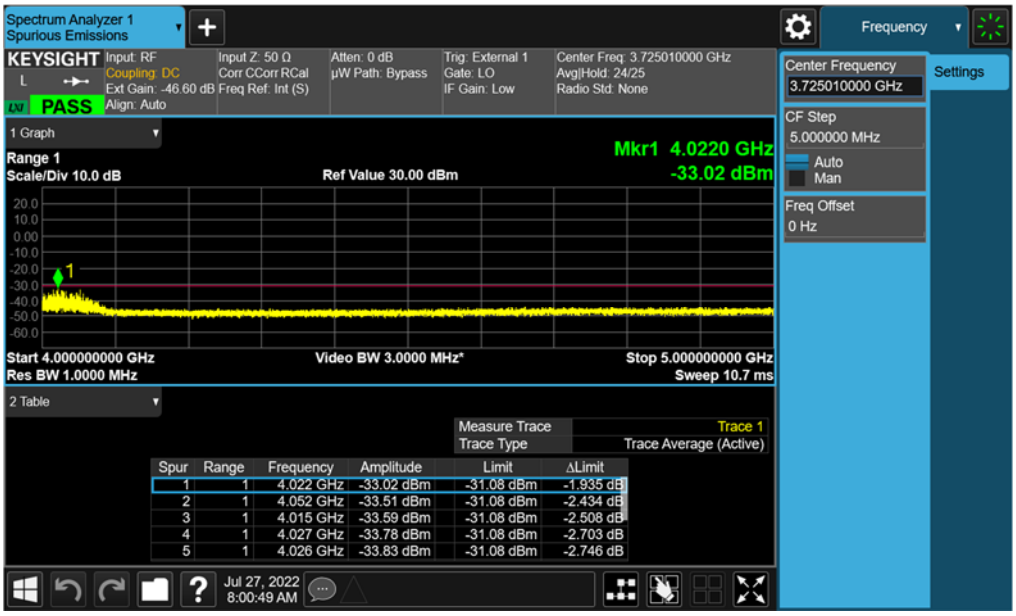
1GHz – 3.7GHz

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
1	1.1	QPSK	8	3840	100



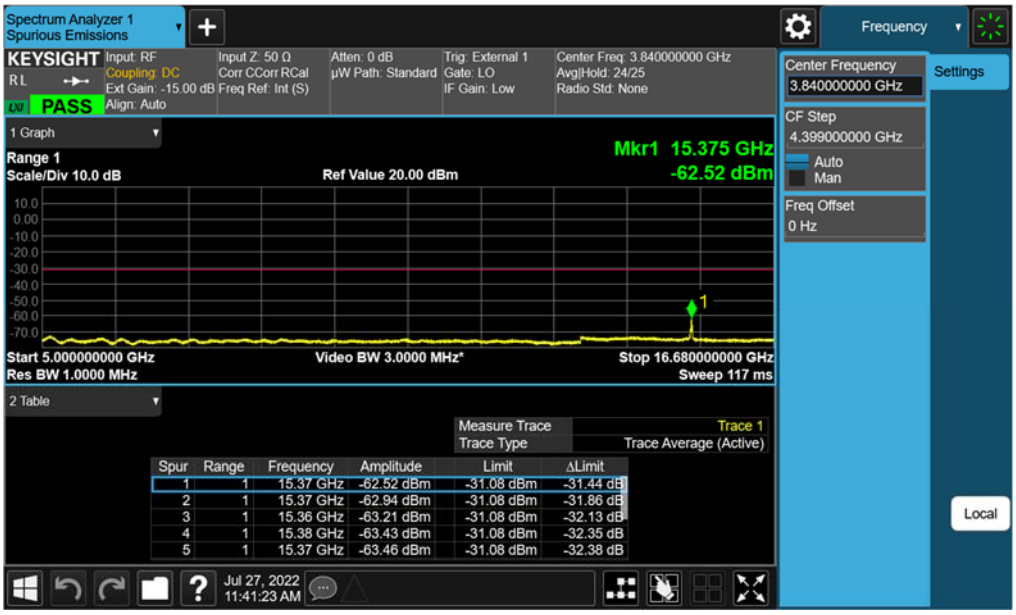
4GHz – 5GHz

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
2	1.1	QPSK	5	3725.01 + 3875.01	50+50



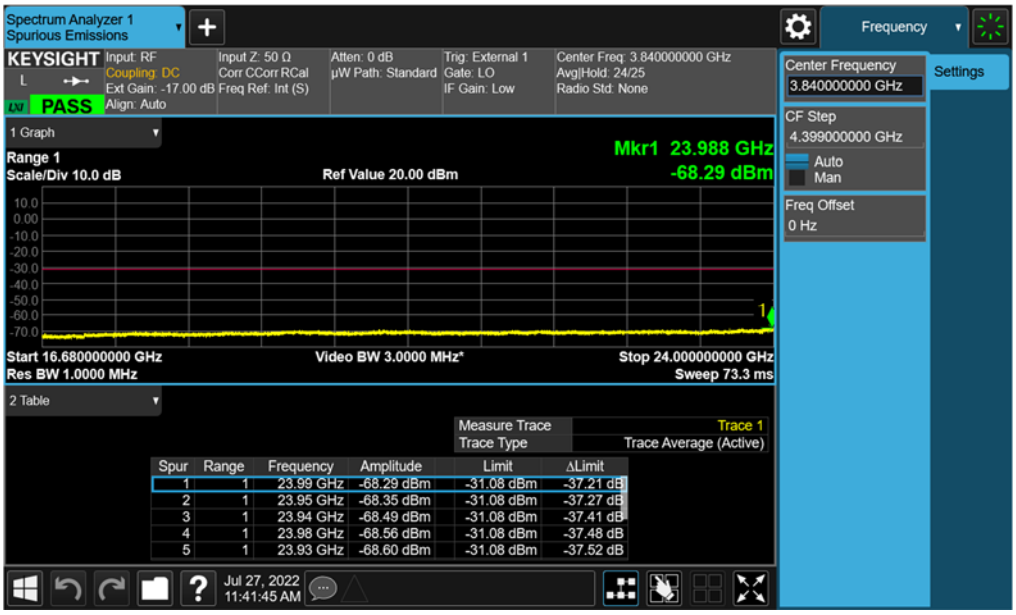
5GHz – 16.68GHz

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
1	3.2	QPSK/16QAM	8	3840	20



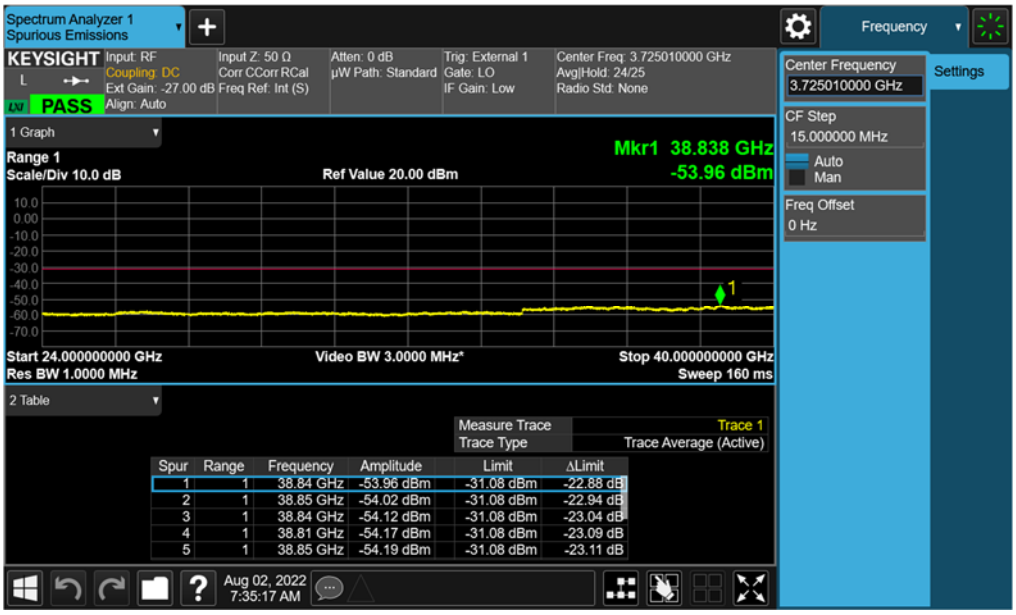
16.68GHz – 24GHz

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
1	3.2	QPSK/16QAM	8	3840	20



24GHz – 40GHz

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz
2	1.1	QPSK	5	3725.01 + 3875.01	50+50



Photographs