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

Title 47 Code of Federal Regulations Test Report

Regulation:
Title 47 CFR FCC Part 96

Client:
NOKIA SOLUTIONS AND NETWORKS, OY

Product Evaluated:
AirScale Indoor pico RRH 4T4R n48 AWPQY/Z

Report Number:
TR-2023-0091-FCC96

Date Issued:
August 4, 2023

Table of Contents

Revisions

Date	Revision	Section	Change
8/4/2023	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 Indoor pico RRH 4T4R n48 AWPQY/Z
FCCID	2AD8UAWPQYAWPQZ01
Serial Number:	Refer to Section 1.3.2
Hardware Version:	Refer to Section 1.3.2
Software Version:	SBTS23R3
Frequency Range:	3550 - 3700 MHz
GPCL Project Number:	2023-0091
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Applicant:	NOKIA SOLUTIONS AND NETWORKS, OY 2000 W. Lucent Lane Naperville, IL 60563 Lee Klindenborg
Test Requirement(s):	Title 47 CFR Part 96
Test Standards:	Refer to Section 1.5.1
Measurement Procedure(s):	Refer to Section 1.5.2
Test Date(s):	5/30/2023 – 7/24/2023 (Radio)
Test Performed By:	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636 Test Site Number: US5302
Product Engineer(s):	Ron Remy
Lead Engineer:	Steve Gordon
Test Engineer (s):	Jaideep Yadav
Test Results: The EUT, *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 AirScale Indoor pico RRH 4T4R n48 AWPQY/Z, hereinafter referred to as the Equipment Under Test (EUT).

The Nokia AWPQY/Z is a 4 port radio head that transmits 0.25 Watts per port over the B48/n48 spectrum (3550 – 3700 MHz). This product supports LTE 10MHz & 20MHz single carriers, and up to 4 carriers for multicarrier operation. It also supports 5G-NR 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 MHz single carriers and up to 4 carriers for multicarrier operation. The product utilizes QPSK, 16QAM, 64QAM and 256QAM modulation formats.

1.2 Purpose and Scope

This document is to provide the testing data required for qualifying the EUT in compliance with FCC Part 96 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

FCC testing for Part 96 Class II certification was performed on two models (AWPQY and AWPQZ). This class II permissive change is to add Concurrent 5G and LTE (up to 7 Carrier) at maximum power with either technology having up to 4 carriers. This report will demonstrate compliance to Category A power requirements with integral and optional external antenna specified by the manufacturer for the product.

The AWPQY/Z was previously certified under FCC ID: 2AD8UAWPQYAWPQZ01.

1.3 EUT Details

1.3.1 Specifications

Standard	3GPP / WINNF / CBRS Alliance / FCC Part 96 FCC (Category A CBSD)
Band	3GPP band B48/n48
Spectrum Range	3550–3700MHz
IBW	150MHz
OBW	150MHz
Carriers	Up to 7 contiguous or non-contiguous LTE or NR carriers with 4T4R antenna configuration
Carrier Bandwidths	10/20/ MHz LTE carrier 10/20/30/40/50/60/70/80/90 /100 MHz 5G-NR carrier
RF Chain	4T4R
RF Power	50 to 250mW per path
Total TX Power	1W
Antenna	Configuration: 4 Tx/ 4 Rx AWPQY: Integrated omni AWPQZ: External antenna (SMA female)
MIMO layers	4x4DL MIMO
Modulation Schemes	QPSK 16QAM 64QAM 256QAM

1.3.2 Photographs

Serial Number

AWPQZ

1.4 Test Requirements

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046, 96.41 (b) 96.41(g)	RF Power Output (b) Power Limits, EIRP, PSD[1] (g) Peak-to-Average Power Ratio	Yes
2.1047, 96.41(a)	Modulation Characteristics	Yes
2.1049, 96.41(e)(2)(3)	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051, 96.41(e)	Spurious Emissions at Antenna Terminals	Yes
2.1053, 96.41(e)(2)(3)	Field Strength of Spurious Radiation	No (see sction 6)
2.1055, 96.41(e)(2)(3)	Measurement of Frequency Stability	No[2]

[1]Previously Tested and Passed; Refer to GPCL Project 2023-0049.
[2]Previously Tested and Passed; Refer to GPCL Project 2022-0137.

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 96.
- KDB 940660 D01 Certification And Test Procedures For Citizens Broadband Radio Service Devices Authorized Under Part 96, v03, Oct 29, 2020
- 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 100 Hz 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

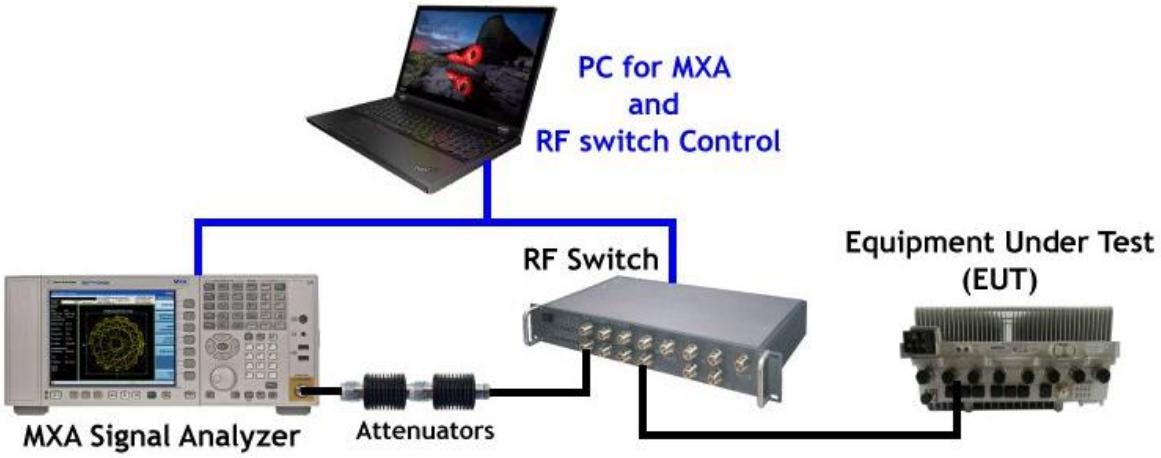
1.7 Executive Summary

Requirement **47 CFR FCC Parts 2 and 96**	**Description of Tests**	**Result**
2.1046, 96.41 (b) 96.41(g)	RF Power Output (b) Power Limits, EIRP, PSD (g) Peak-to-Average Power Ratio	COMPLIES
2.1047, 96.41(a)	Modulation Characteristics	COMPLIES
2.1049, 96.41(e)(2)(3)	(a) Occupied Bandwidth (b) Out-of-Band Emissions	COMPLIES
2.1051, 96.41(e)	Spurious Emissions at Antenna Terminals	COMPLIES
2.1053, 96.41(e)	Field Strength of Spurious Radiation	N/A
2.1055	Measurement of Frequency Stability	N/A

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 and Power Spectral Density

2.1 RF Power Output

2.1.1 Limits

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 product is designed to operate under Part 96 rules for Band 48.

Under Part 96 the product is limited to the Category A CBSD maximum EIRP of 30 dBm/10 MHz with a PSD of 20 dBm/MHz.

This unit can operate with an integrated antenna with an average peak gain of 5.5 dBi, or with the following externally mounted Omni antennas:

Antenna gains are Amphenol (5 dBi), Spinner (4.5 dBi), Amplitec (6.0 dBi), Commscope (5.2 dBi), and Huber Suhner (4.5 dBi).

If the product is installed with other antenna(s), then per FCC Rules the RF exposure compliance shall be addressed at the time of licensing, as required by the responsible FCC Bureau(s), including antenna co-location requirements of Part 1.1307(b)(3).

2.1.2 Results

Power measurements of the TDD transmit signal were conducted with an MXA Signal analyzer per KDB 971168 D01 and ANSI C63.26. The applied signal from the **AirScale Indoor pico RRH 4T4R n48 AWPQY/Z**, met the recommended characteristics as defined in 3GPP TS 36.141 V16.9.0 (2021-04) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14). The Channel power was measured when the product was set to provide the maximum rated power at the antenna transmitting terminals. The output power of the EUT was measured per ANSI C63.26 methods and procedures and the Channel Power Measurement feature of the MXA Analyzer.

The measured output power at antenna ports was documented in the table below. The Maximum Average RF Power Values are bolded in each configuration.

Table 2.1 – 4 Carrier

Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 3555 LTE+ 3565 LTE + 3680.355 NR + 3694.995 NR MHz BW 10 + 10 + 20 + 10 MHz	
TX	Channel Power (dBm/BW)
1	23.27
2	**23.72**
3	23.15
4	23.18
Total Power (dBm)	29.36
Total Power (W)	0.862
Test Model 3.1 Modulation 64QAM Channel Frequency 3560 LTE+ 3605.01 NR + 3645 NR + 3679.995 NR MHz BW 20 + 50 + 30 + 40 MHz	
TX	Channel Power (dBm/BW)
1	23.05
2	**23.55**
3	23.03
4	23.08
Total Power (dBm)	29.20
Total Power (W)	0.832

Table 2.2 – 5 Carrier

Test Model 3.1a Modulation256QAM Channel Frequency 3555 LTE+ 3565 LTE + 3575 LTE +3585 LTE + 3649 NR MHz BW 10 + 10 + 10 + 10 +100 MHz	
TX	Channel Power (dBm/BW)
1	23.91
2	**24.28**
3	23.77
4	23.76
Total Power (dBm)	29.96
Total Power (W)	0.990
Test Model 3.1 Modulation 64QAM Channel Frequency 3570 NR + 3640 LTE + 3660 LTE + 3680 LTE + 3695 LTE MHz BW 50 + 20 + 20 + 20 + 10 MHz	
TX	Channel Power (dBm/BW)
1	22.68
2	**23.21**
3	22.69
4	22.68
Total Power (dBm)	28.84
Total Power (W)	0.766

Table 2.3 – 6 Carrier

Test Model 3.1 Modulation 64QAM Channel Frequency 3555 LTE+ 3565 LTE + 3605 NR +3615 NR + 3640 NR + 3679 NR MHz BW 10 + 10 + 10 + 10 + 40 + 40 MHz	
TX	Channel Power (dBm/BW)
1	23.14
2	**23.83**
3	22.90
4	23.16
Total Power (dBm)	29.29
Total Power (W)	0.850
Test Model 3.2 Modulation QPSK / 16QAM Channel Frequency 3555 LTE+ 3565 LTE + 3579 NR +3600 NR + 3630 NR + 3675 NR MHz BW 10 + 10 + 20 + 20 + 40 + 50 MHz	
TX	Channel Power (dBm/BW)
1	23.30
2	**23.76**
3	22.97
4	23.31
Total Power (dBm)	29.36
Total Power (W)	0.864

Table 2.4 – 7 Carrier

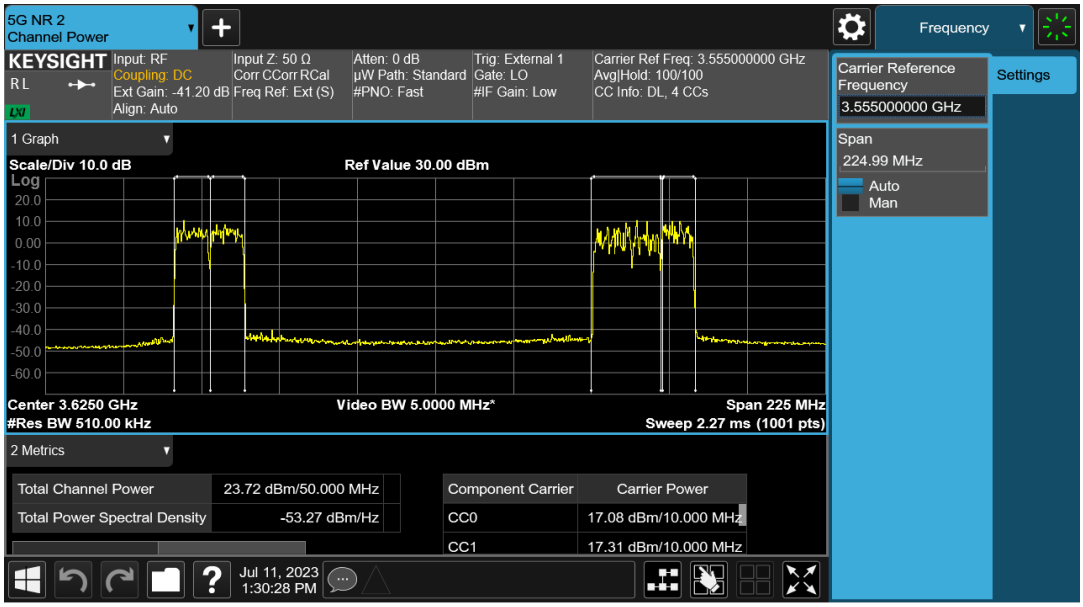
Test Model 1.1 Modulation QPSK Channel Frequency 3560 LTE+ 3580 LTE + 3600 LTE +3645 NR + 3675 NR + 3685 NR +3694 NR MHz BW 20 + 20 + 20 + 40 + 10 + 10 + 10 MHz	
TX	Channel Power (dBm/BW)
1	24.09
2	**24.64**
3	23.84
4	24.15
Total Power (dBm)	30.21
Total Power (W)	1.050
Test Model 3.1a Modulation 256QAM Channel Frequency 3555 LTE+ 3565 LTE + 3575 LTE +3585 LTE + 3675 NR + 3685 NR +3694 NR MHz BW 10 + 10 + 10 + 10 + 10 + 10 + 10 MHz	
TX	Channel Power (dBm/BW)
1	23.55
2	**23.90**
3	23.49
4	23.46
Total Power (dBm)	29.62
Total Power (W)	0.917

2.1.3 Maximum RF Conducted Output Power Plots

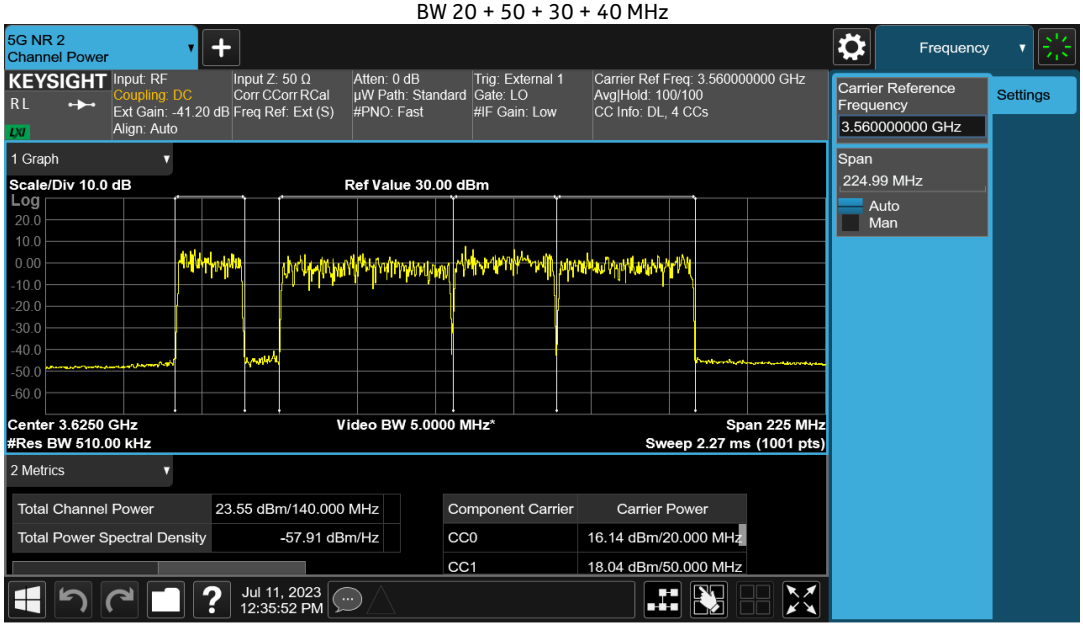
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

4CC, TX2

Test Model 3.2
Modulation QPSK/16QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3680.355 NR + 3694.995 NR MHz
BW 10 + 10 + 20 + 10 MHz



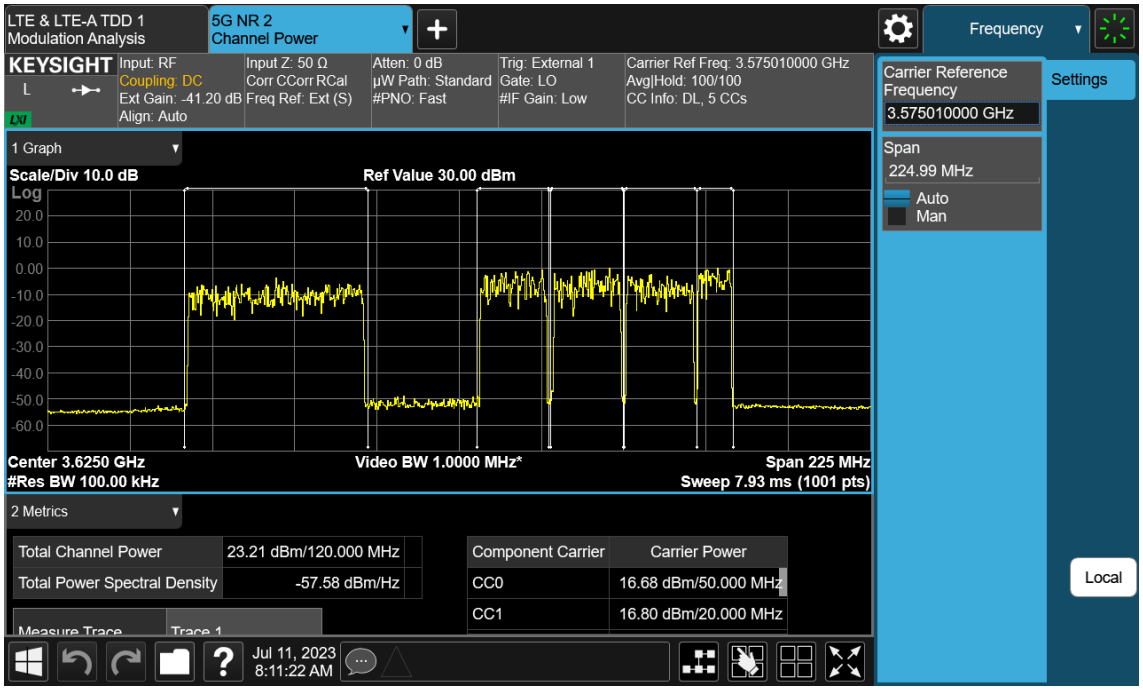
Test Model 3.1
Modulation 64QAM
Channel Frequency 3560 LTE+ 3605.01 NR + 3645 NR + 3679.995 NR MHz
BW 20 + 50 + 30 + 40 MHz



5CC, TX2

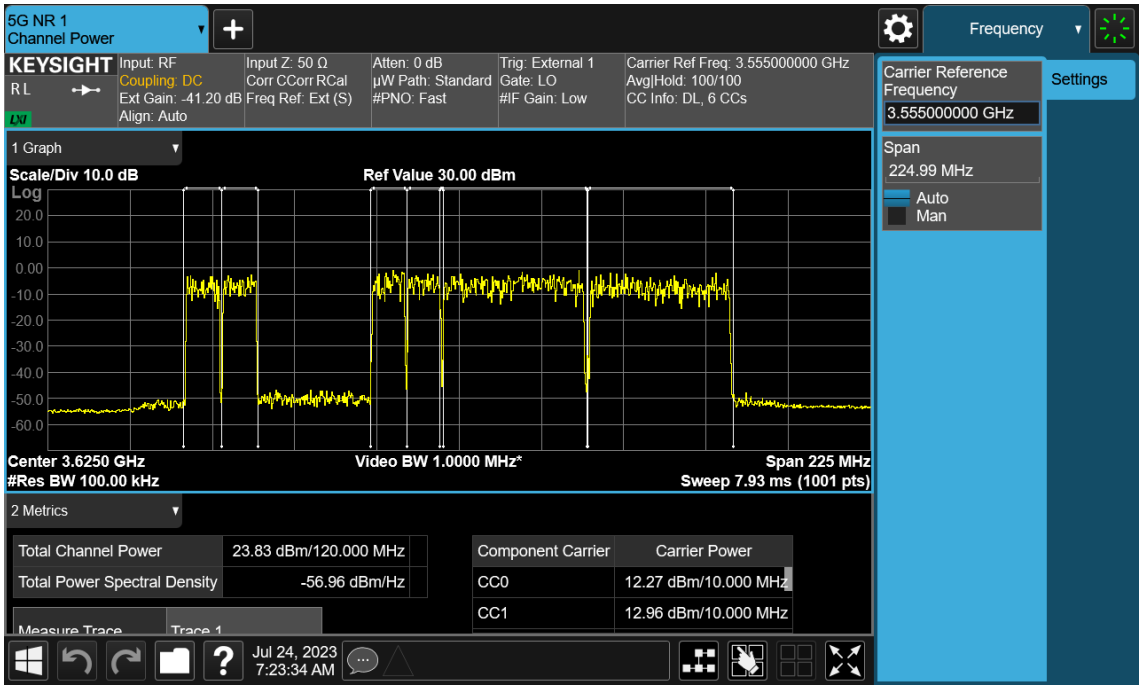
Test Model 3.1a
Modulation256QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3575 LTE +3585 LTE + 3649 NR MHz
BW 10 + 10 + 10 + 10 +100 MHz

Test Model 3.1
Modulation 64QAM
Channel Frequency 3570 NR + 3640 LTE + 3660 LTE + 3680 LTE + 3695 LTE MHz
BW 50 + 20 + 20 + 20 + 10 MHz

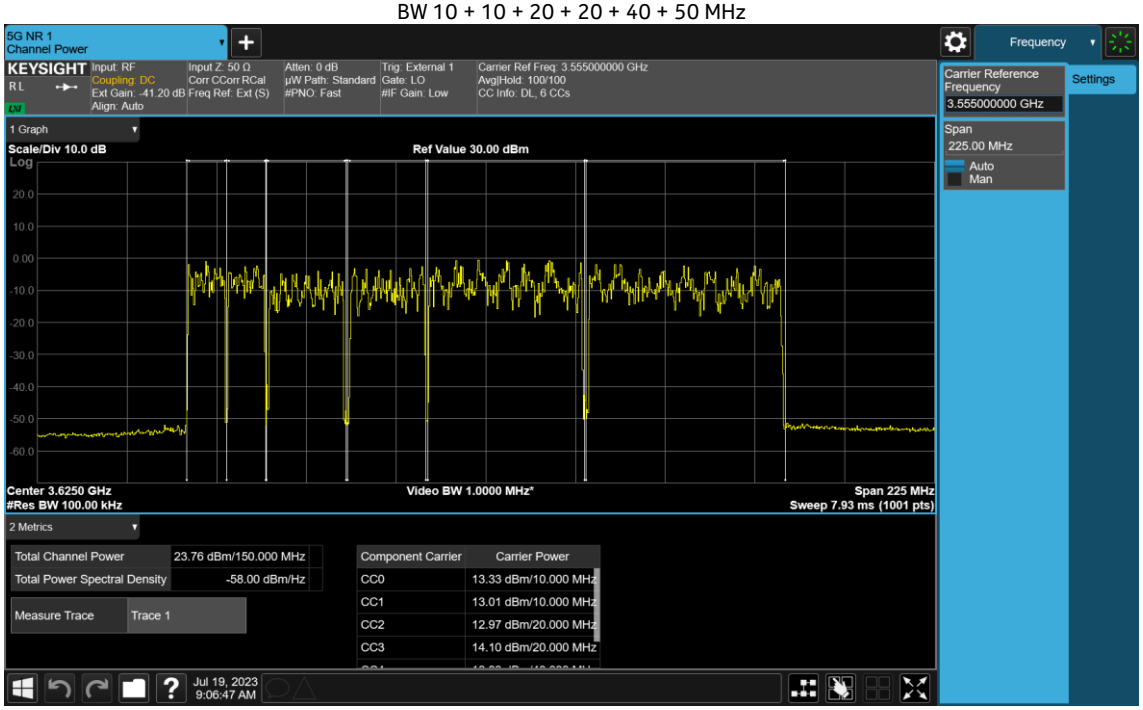


6CC, TX2

Test Model 3.1
Modulation 64QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3605 NR +3615 NR + 3640 NR + 3679 NR MHz
BW 10 + 10 + 10 + 10 + 40 + 40 MHz



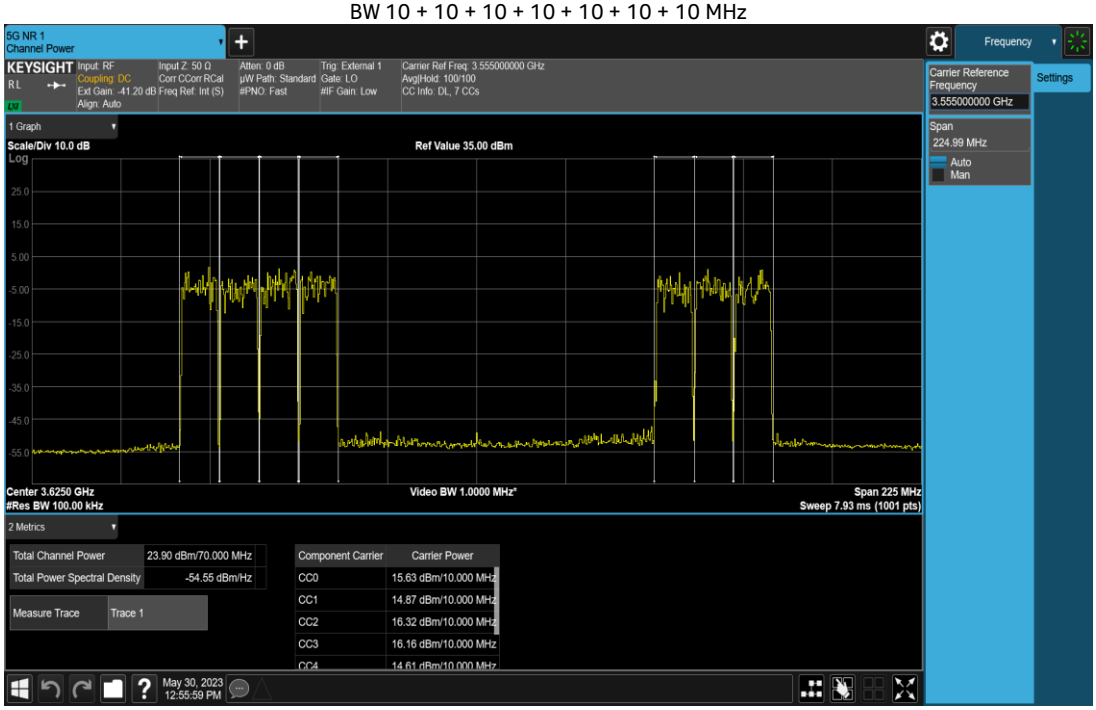
Test Model 3.2
Modulation QPSK / 16QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3579 NR +3600 NR + 3630 NR + 3675 NR MHz
BW 10 + 10 + 20 + 20 + 40 + 50 MHz



7CC, TX2

Test Model 1.1
Modulation QPSK
Channel Frequency 3560 LTE+ 3580 LTE + 3600 LTE +3645 NR + 3675 NR + 3685 NR +3694 NR MHz
BW 20 + 20 + 20 + 40 + 10 + 10 + 10 MHz

Test Model 3.1a
Modulation 256QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3575 LTE +3585 LTE + 3675 NR + 3685 NR +3694 NR MHz
BW 10 + 10 + 10 + 10 + 10 + 10 + 10 MHz



2.2 Power Spectral Density

Previously Tested for maximum power at lowest bandwidth and multicarrier operation and Passed; Refer to GPCL Project 2023-0049.

2.3 EIRP Compliance

Table 2.5 Maximum Total EIRP Measured
Integrated Antenna

# of carrier	Transmit Signal Bandwidth (MHz)	Total Conducted Output Power (dBm) for 4 Ports*	Effective Average Antenna Gain (dBi)	Total EIRP (dBm/BW)	EIRP BW Correction for /10 MHz	Total EIRP (dBm/10MHz)	Total EIRP Limit (dBm/10MHz) Cat A	Results
4	50	29.36	5.5	34.86	-6.99	27.87	30	Pass
4	140	29.20	5.5	34.7	-11.46	23.24	30	Pass
5	140	29.96	5.5	35.46	-11.46	24.00	30	Pass
5	120	28.84	5.5	34.34	-10.79	23.55	30	Pass
6	120	29.29	5.5	34.79	-10.79	24.00	30	Pass
6	100	29.36	5.5	34.86	-10.00	24.86	30	Pass
7	130	30.21	5.5	35.71	-11.14	24.57	30	Pass
7	70	29.62	5.5	35.12	-8.45	26.67	30	Pass

The sample calculation for the Total EIRP (dBm/10 MHz) as follows,

*Total Conducted Output Power from tables 2.1- 2.4
Total EIRP = 29.36 + 5.50 (antenna gain) = 34.86 dBm.
Correction for /10MHz = 34.86 dBm – 10 x log (5) = 27.87 dBm

2.4 Peak-to-Average Power Ratio (PAPR)

The Peak-to-Average Power Ratio (PAPR) was evaluated per ANSI C63.26. The PAPR values of all carriers measured are below 13dB.

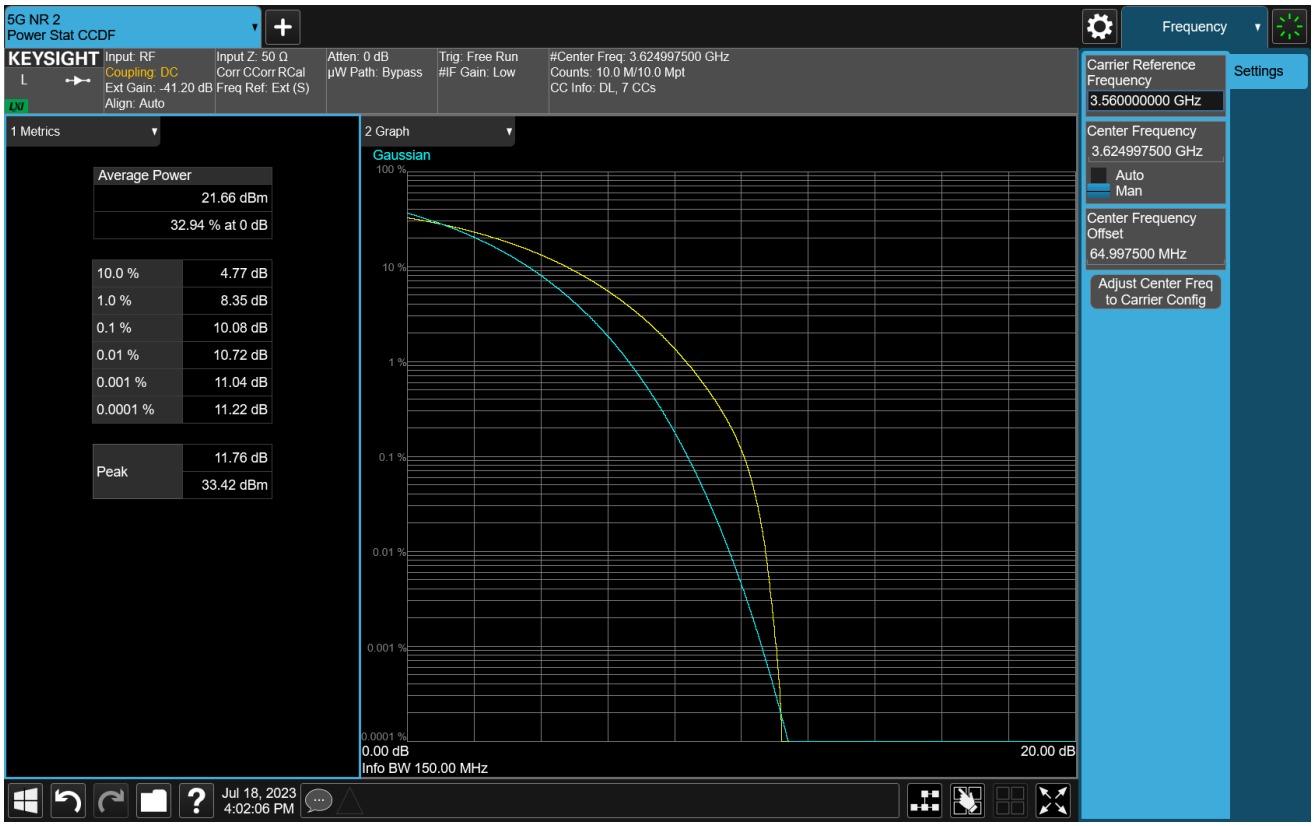
Table 2.4.1 Peak to Average Power Ratio

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX	PAR at 0.1% Limit - 13 dB
4	3.2	QPSK/16QAM	3555 LTE 3565 LTE 3680.355 NR 3694.995 NR	10 10 20 10	2	8.13 / 8.23
4	3.1	64QAM	3560 LTE 3605.01 NR 3645 NR 3679.995 NR	20 50 30 40	2	8.27 / 8.39
5	3.1a	256QAM	3555 LTE 3565 LTE 3575 LTE 3585 LTE 3649 NR	10 10 10 10 100	2	8.39 / 8.17
5	3.1	64QAM	3570 NR 3640 LTE 3660 LTE 3680 LTE 3695 LTE	50 20 20 20 10	2	8.30 / 8.42
6	3.1	64QAM	3555 LTE 3565 LTE 3605 NR 3615 NR 3640 NR 3679 NR	10 10 10 10 40 40	2	8.02
6	3.2	QPSK/16QAM	3555 LTE 3565 LTE 3579 NR 3600 NR 3630 NR 3675 NR	10 10 20 20 40 50	2	8.06
7	1.1	QPSK	3560 LTE 3580 LTE 3600 LTE 3645 NR 3675 NR 3685 NR 3694 NR	20 20 20 40 10 10 10	2	**10.08**
7	3.1a	256QAM	3555 LTE 3565 LTE 3575 LTE 3585 LTE 3675 NR 3685 NR 3694 NR	10 10 10 10 10 10 10	2	8.01

2.4.1 Maximum PAPR 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 1.1
Modulation QPSK
Channel Frequency 3560 LTE+ 3580 LTE + 3600 LTE +3645 NR + 3675 NR + 3685 NR +3694 NR MHz
BW 20 + 20 + 20 + 40 + 10 + 10 + 10 MHz
TX2



3. FCC Section 2.1047 - Modulation Characteristics

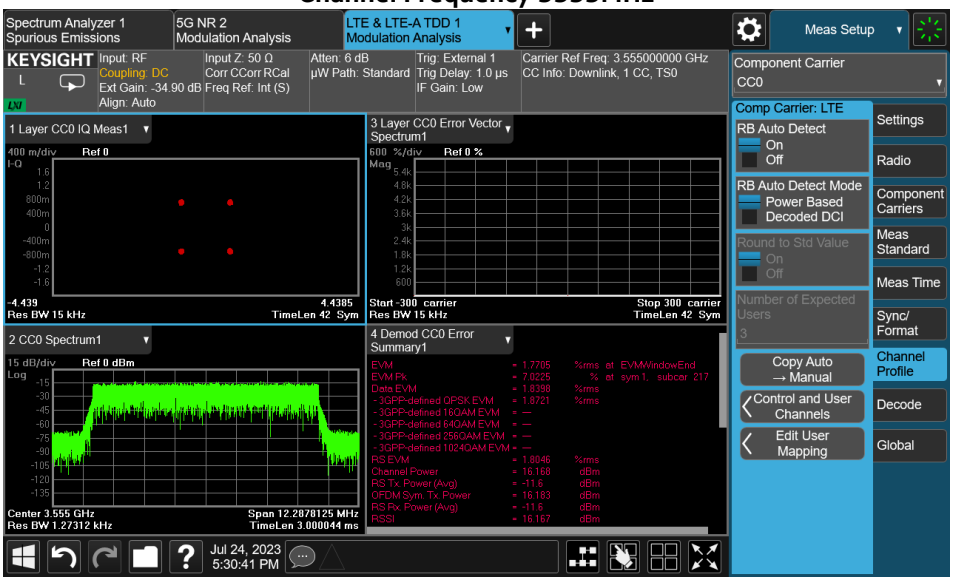
3.1 Modulation Characteristics

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

3.1.1 Modulation Characteristics – Plots

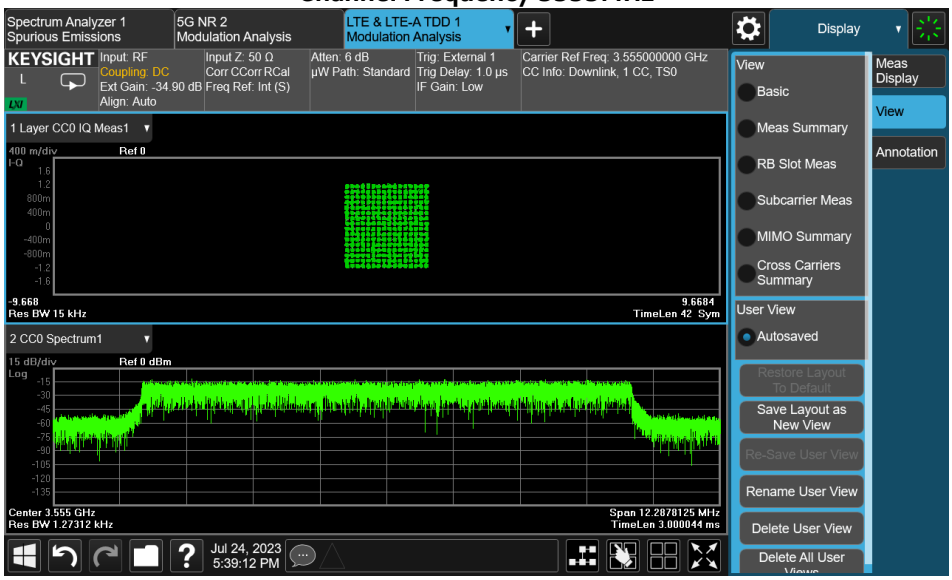
LTE

Modulation QPSK TM1.1
Channel Frequency 3555MHz

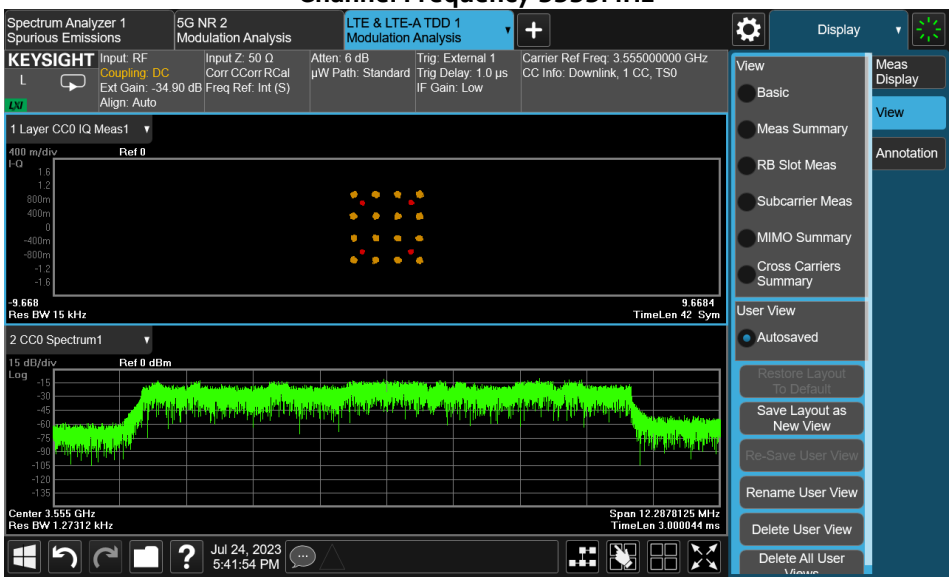


Modulation 64QAM TM3.1
Channel Frequency 3555MHz

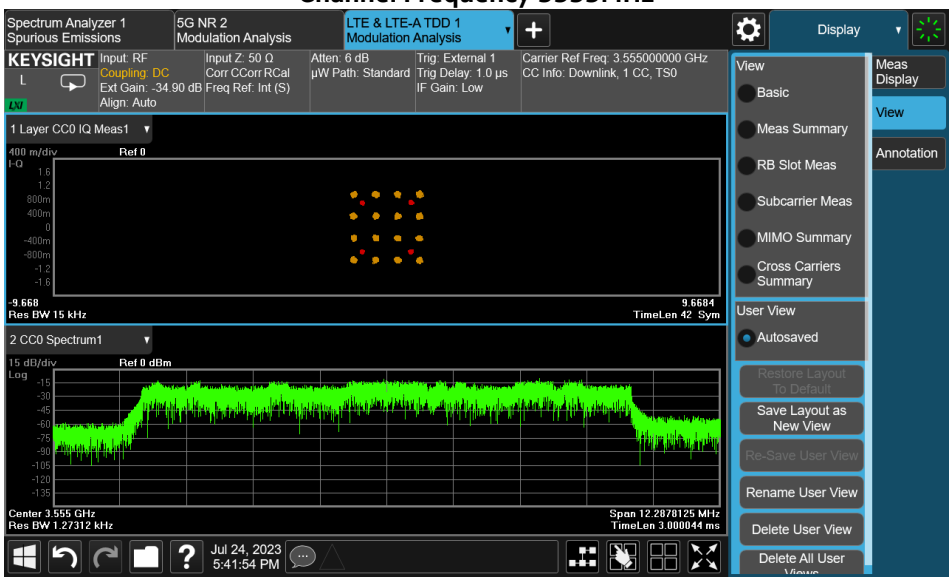
Modulation 256QAM TM3.1a
Channel Frequency 3555MHz



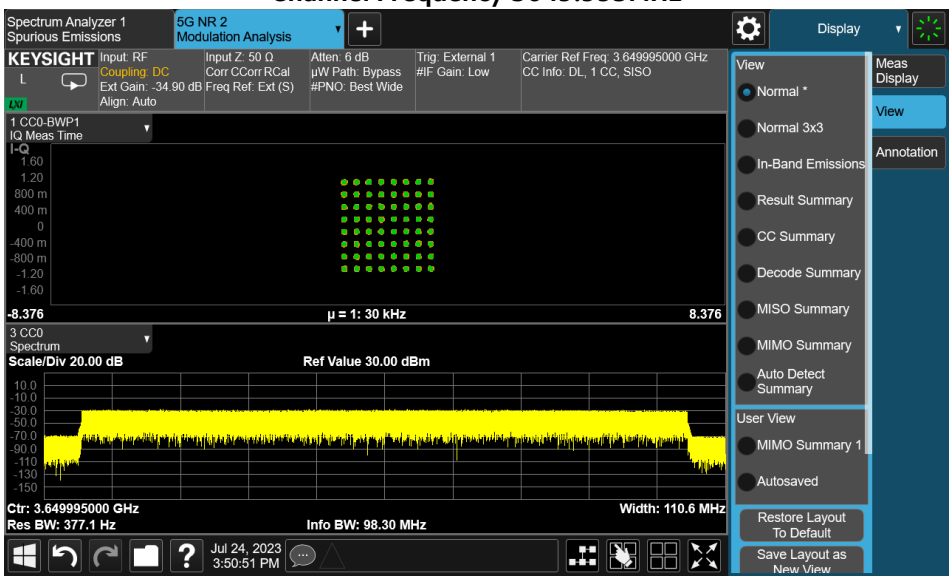
Modulation QPSK/16QAM TM3.2
Channel Frequency 3555MHz



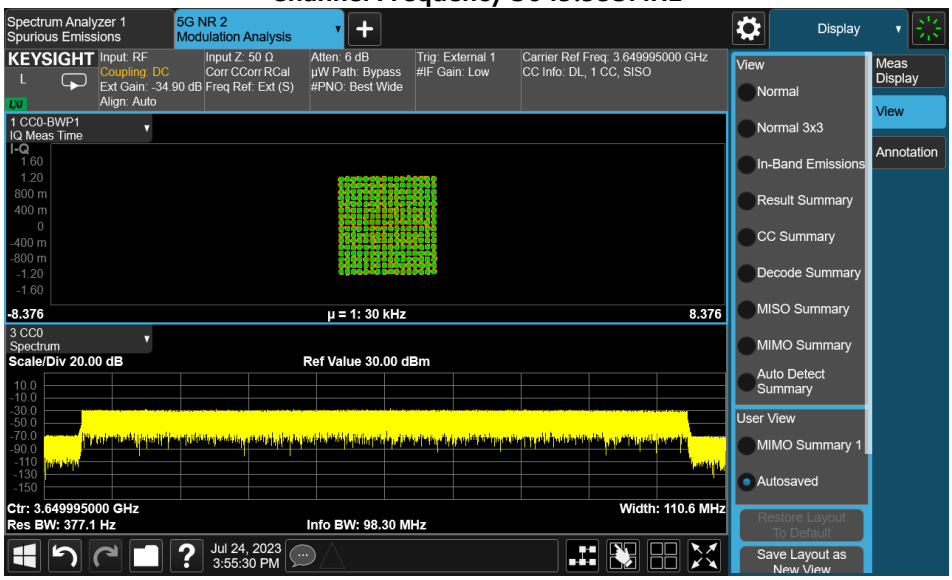
5G-NR
Modulation QPSK TM1.1
Channel Frequency 3555MHz



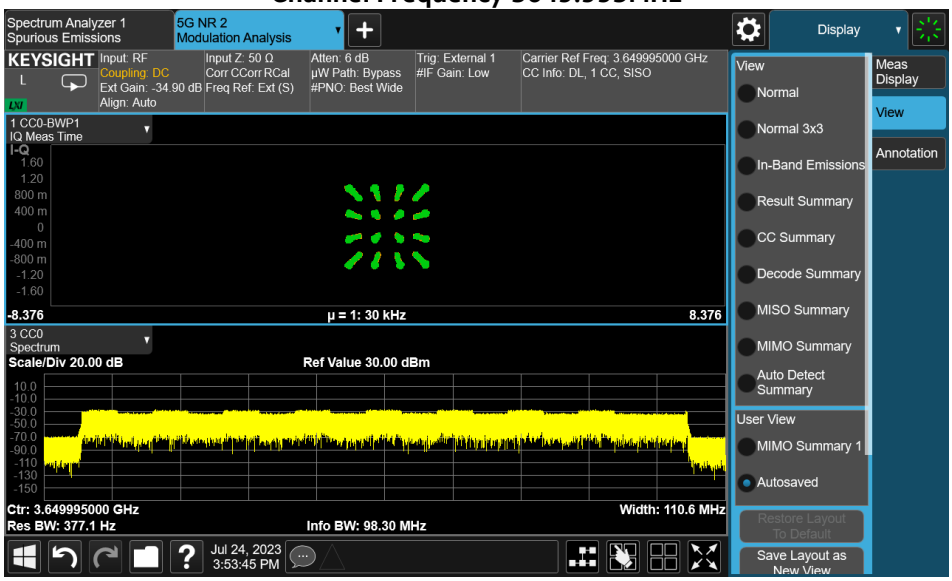
Modulation 64QAM TM3.1
Channel Frequency 3649.995MHz



Modulation 256QAM TM3.1a
Channel Frequency 3649.995MHz



Modulation QPSK/16QAM TM3.2
Channel Frequency 3649.995MHz



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.

Part 96.41e(3) specified that the fundamental emission bandwidth 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.

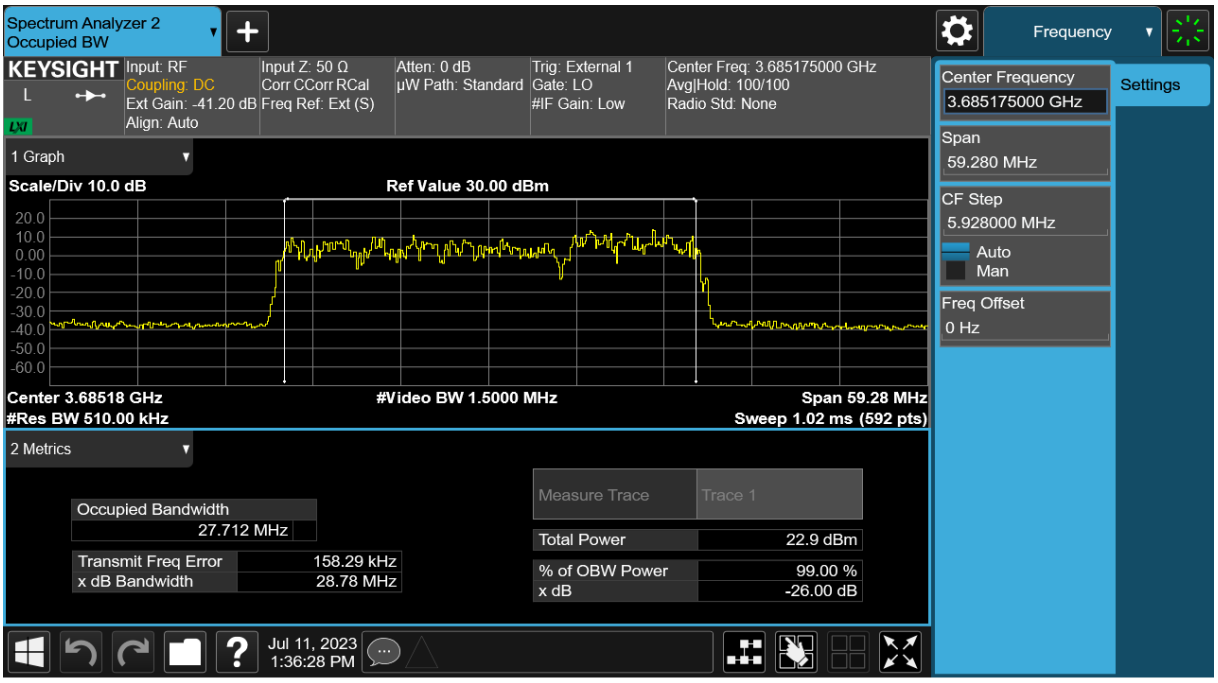
The transmitted signal occupied bandwidth was measured using a Keysight MXA Signal Analyzer. All emissions were within the parameters as required.

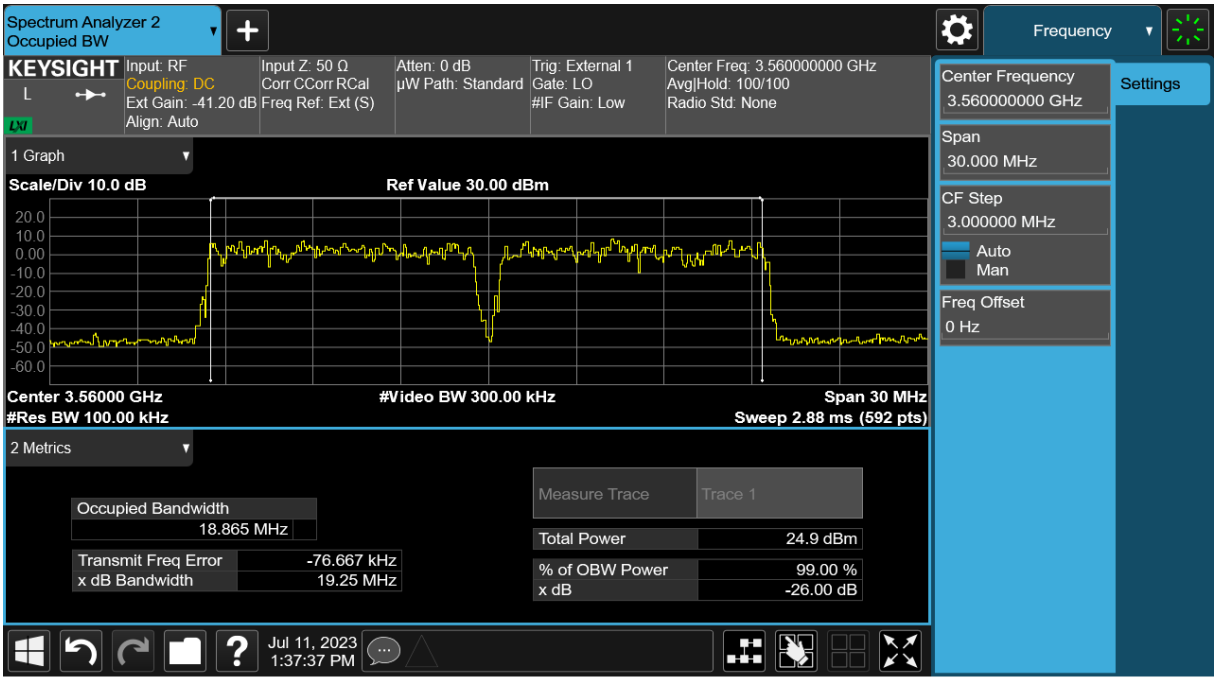
Table 4.1.1 AWPQY AWPQZ 99% & 26dBm Occupied Bandwidth

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX	99% Occupied BW (MHz)	26dBm BW (MHz)
4	3.2	QPSK/16QAM	3555 LTE 3565 LTE 3680.355 NR 3694.995 NR	10 10 20 10	2	27.712/ 18.865	28.78 / 19.25
4	3.1	64QAM	3560 LTE 3605.01 NR 3645 NR 3679.995 NR	20 50 30 40	2	146.78 / 17.854	148.8 / 18.84
5	3.1a	256QAM	3555 LTE 3565 LTE 3575 LTE 3585 LTE 3649 NR	10 10 10 10 100	2	97.895 / 38.799	110.1 / 41.04
5	3.1	64QAM	3570 NR 3640 LTE 3660 LTE 3680 LTE 3695 LTE	50 20 20 20 10	2	67.306 / 47.129	69.59 / 48.78
7	3.1a	256QAM	3555 LTE 3565 LTE 3575 LTE 3585 LTE 3675 NR 3685 NR 3694 NR	10 10 10 10 10 10 10	2	148.32	149.1

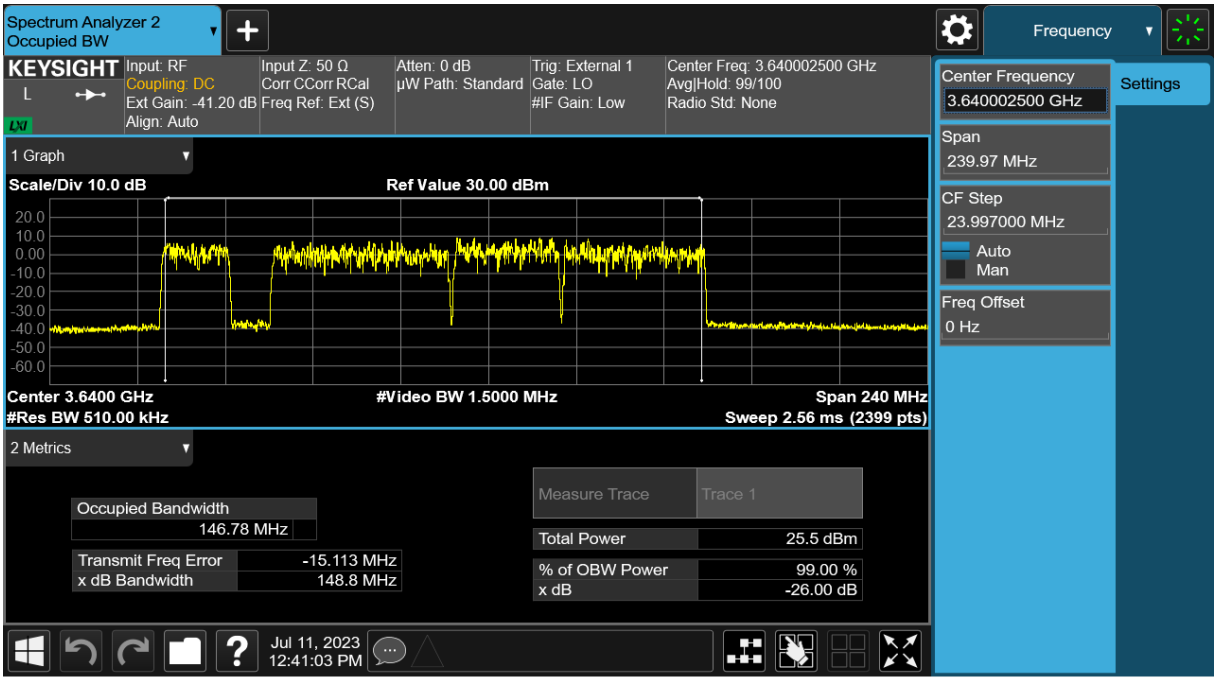
4.1.1 Occupied Bandwidth – Plots

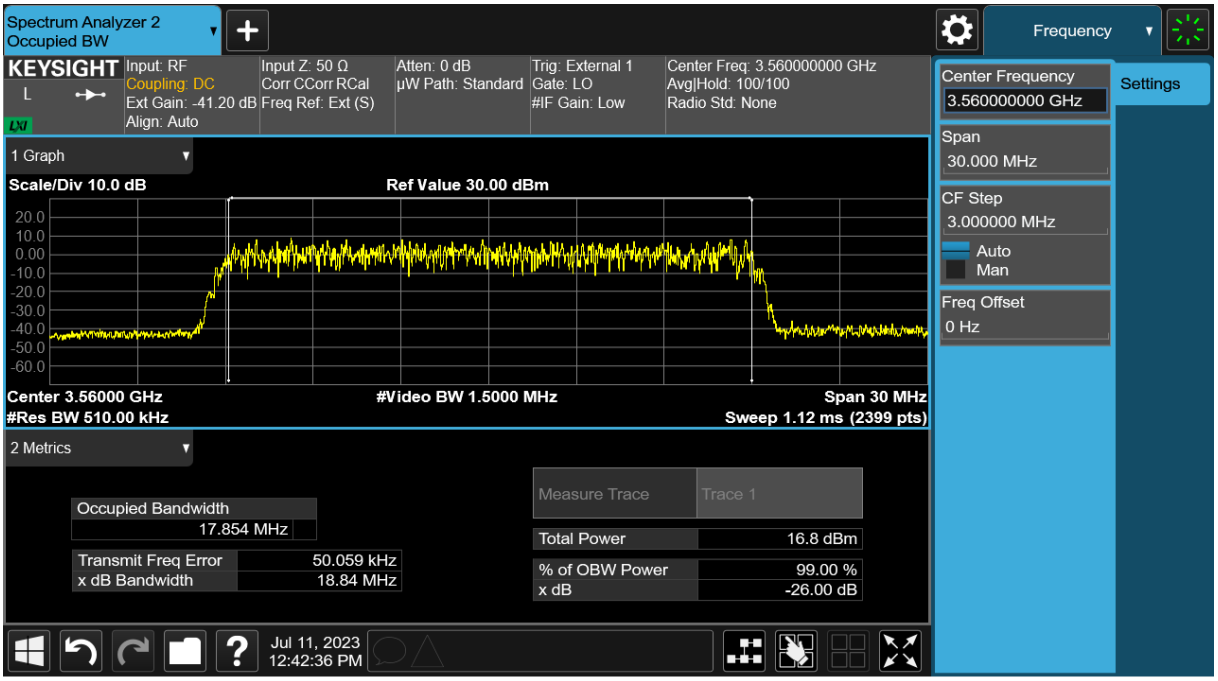
4CC, TX2
Test Model 3.2
Modulation QPSK/16QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3680.355 NR + 3694.995 NR MHz
BW 10 + 10 + 20 + 10 MHz



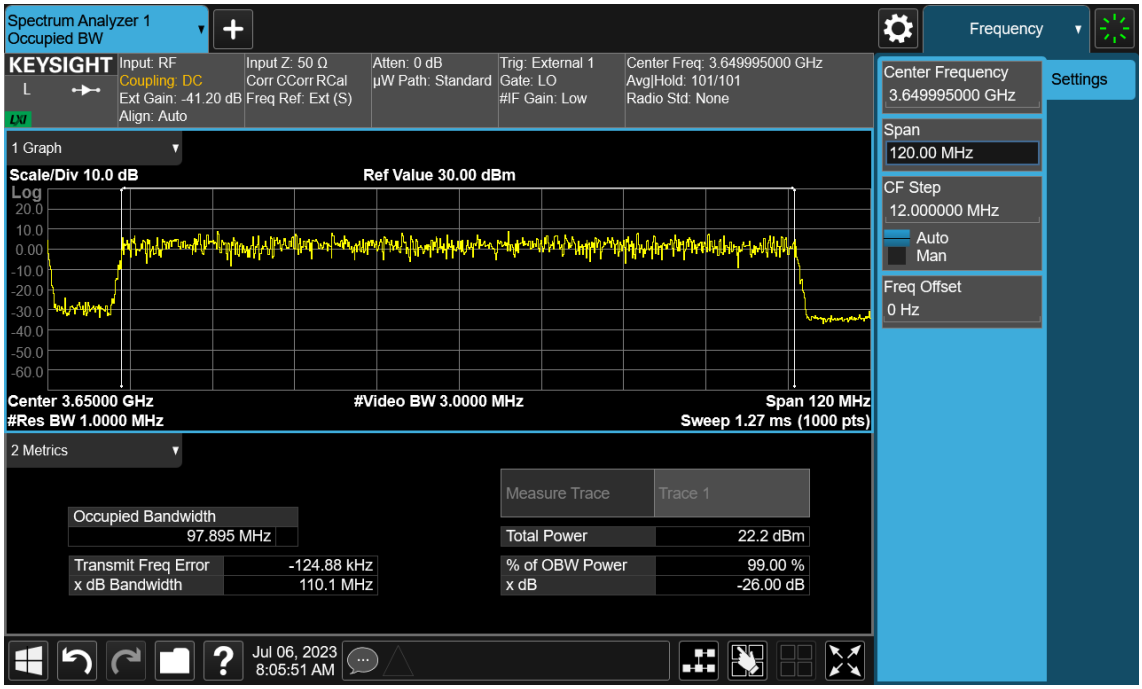


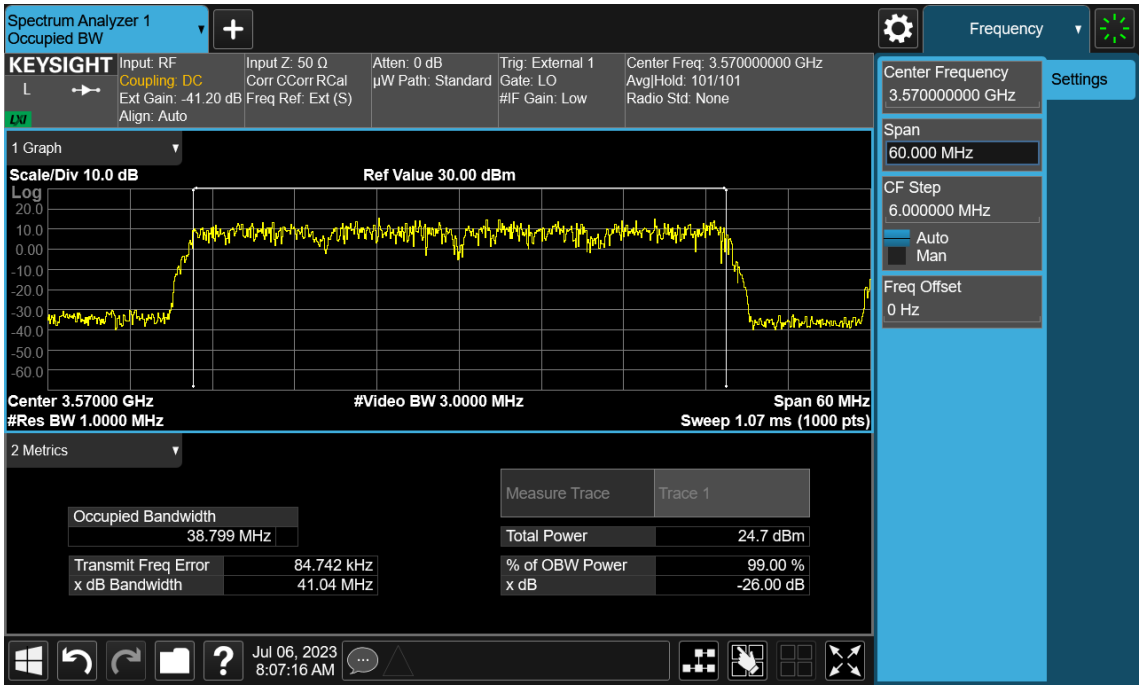
4CC, TX2
Test Model 3.1
Modulation 64QAM
Channel Frequency 3560 LTE+ 3605.01 NR + 3645 NR + 3679.995 NR MHz
BW 20 + 50 + 30 + 40 MHz



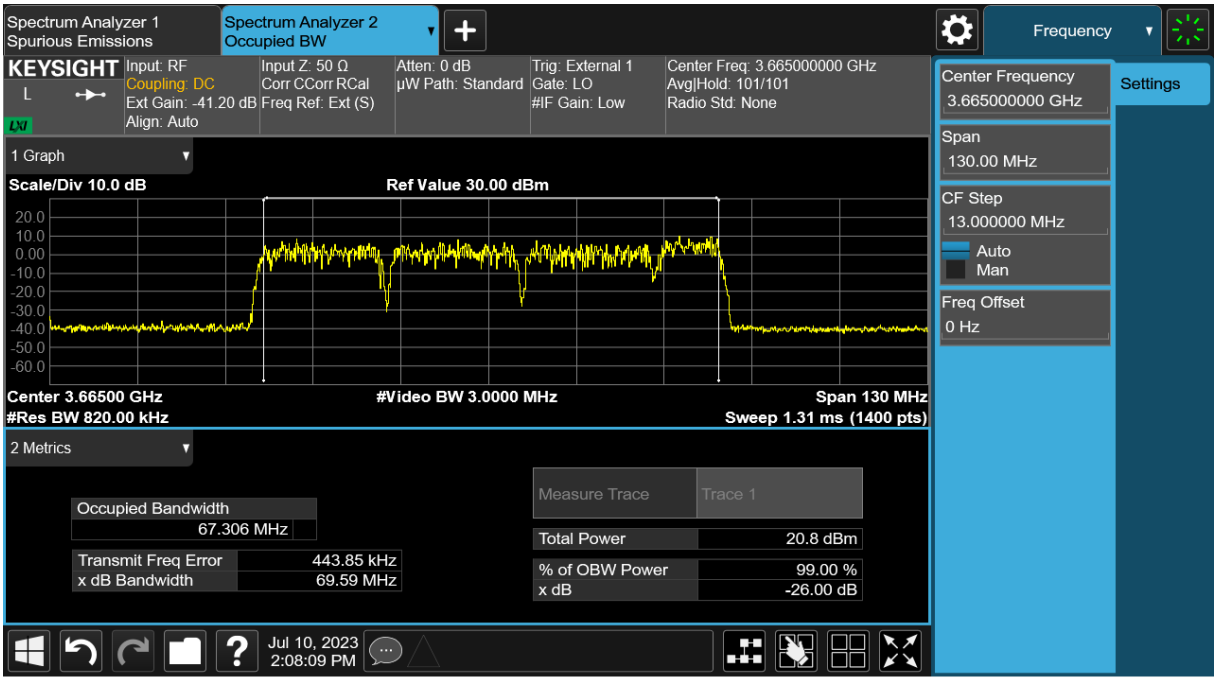


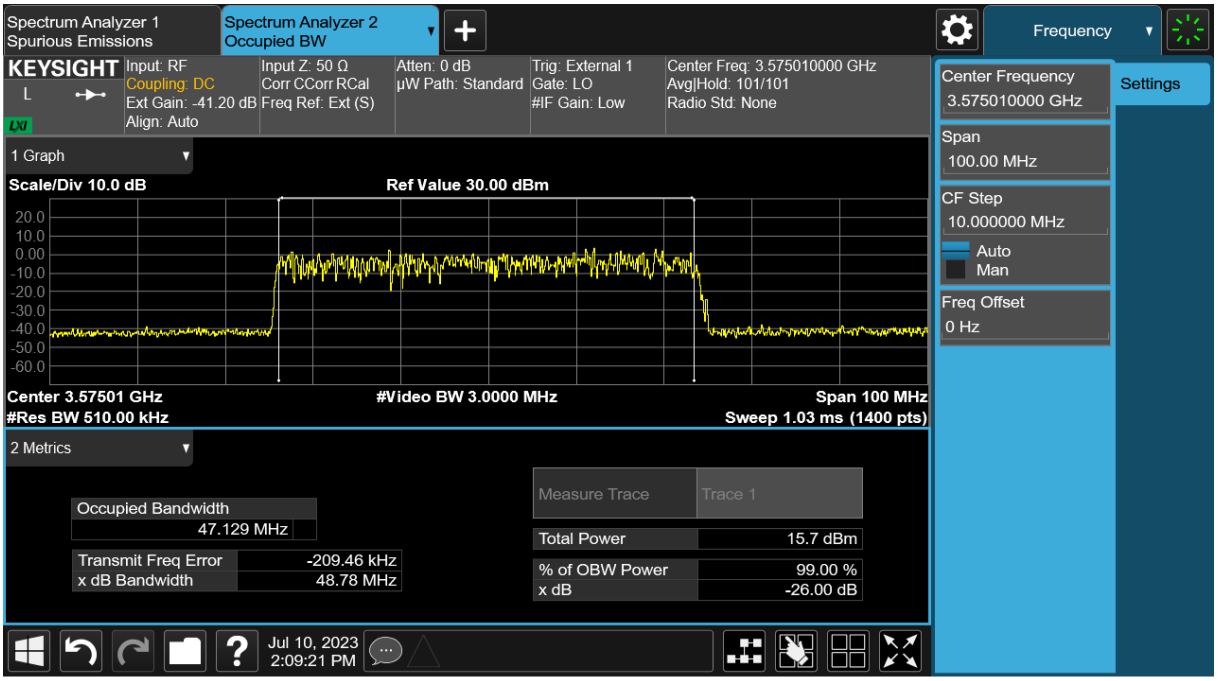
5CC, TX2
Test Model 3.1a
Modulation256QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3575 LTE +3585 LTE + 3649 NR MHz
BW 10 + 10 + 10 + 10 +100 MHz





5CC, TX2
Test Model 3.1
Modulation 64QAM
Channel Frequency 3570 NR + 3640 LTE + 3660 LTE + 3680 LTE + 3695 LTE MHz
BW 50 + 20 + 20 + 20 + 10 MHz





7CC, TX2
Test Model 3.1a
Modulation 256QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3575 LTE +3585 LTE + 3675 NR + 3685 NR +3694 NR MHz
BW 10 + 10 + 10 + 10 + 10 + 10 + 10 MHz

4.2 Edge of band Emissions

47CFR 96.41 (e)(1) (i) and KDB 940660 D01 Section 3.2 (b)(6) specified that the limits for the emissions outside the fundamental are as follows.

- within 0 MHz to 10 MHz above and below the assigned channel $\leqslant$ −13 dBm/MHz,
- greater than 10 MHz above and below the assigned channel $\leqslant$ −25 dBm/MHz,
- any emission below 3530 MHz and above 3720 MHz $\leqslant$ −40 dBm/MHz.

47CFR 96.41 (e)(3) and KDB 940660 D01 Section 3.2 (b)(6) specified stated that (i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 Megahertz bands immediately outside and adjacent to the licensee's authorized frequency channel, a resolution bandwidth of no less than one percent of the fundamental emission bandwidth may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full reference bandwidth (*i.e.,* 1 MHz or 1 percent of emission bandwidth, as specified). The fundamental emission bandwidth 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. (ii) When measuring unwanted emissions to demonstrate compliance with the limits, the CBSD and End User Device nominal carrier frequency/channel shall be adjusted as close to the licensee's authorized frequency block edges, both upper and lower, as the design permits. (iii) Compliance with emission limits shall be demonstrated using either average (RMS)-detected or peak-detected power measurement techniques.

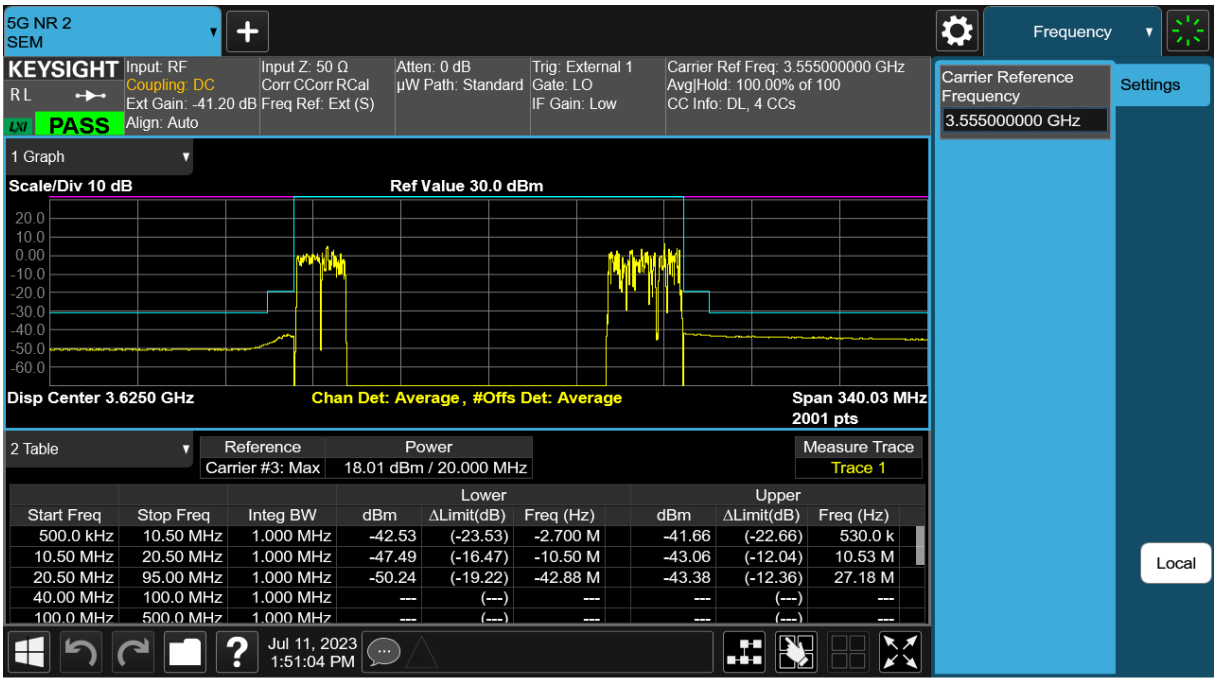
KDB 940660 D01 Section 3.2 (b)(6) specified that measurements must be performed for low, mid, and high channels. It is acceptable to apply the procedures in Section 5.7 of ANSI C63.26-2015. When antenna-port conducted measurements are performed to demonstrate compliance to the applicable unwanted emission limits (Section 2.1051), a separate radiated measurement is required to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation (Section 2.1053). The Section 96.41(e) limits generally also apply to radiated unwanted 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 limits have been adjusted to -19, -31 and -46 dBm to reflect 10 log(n) where n=4 for the 4x4 MIMO operation.

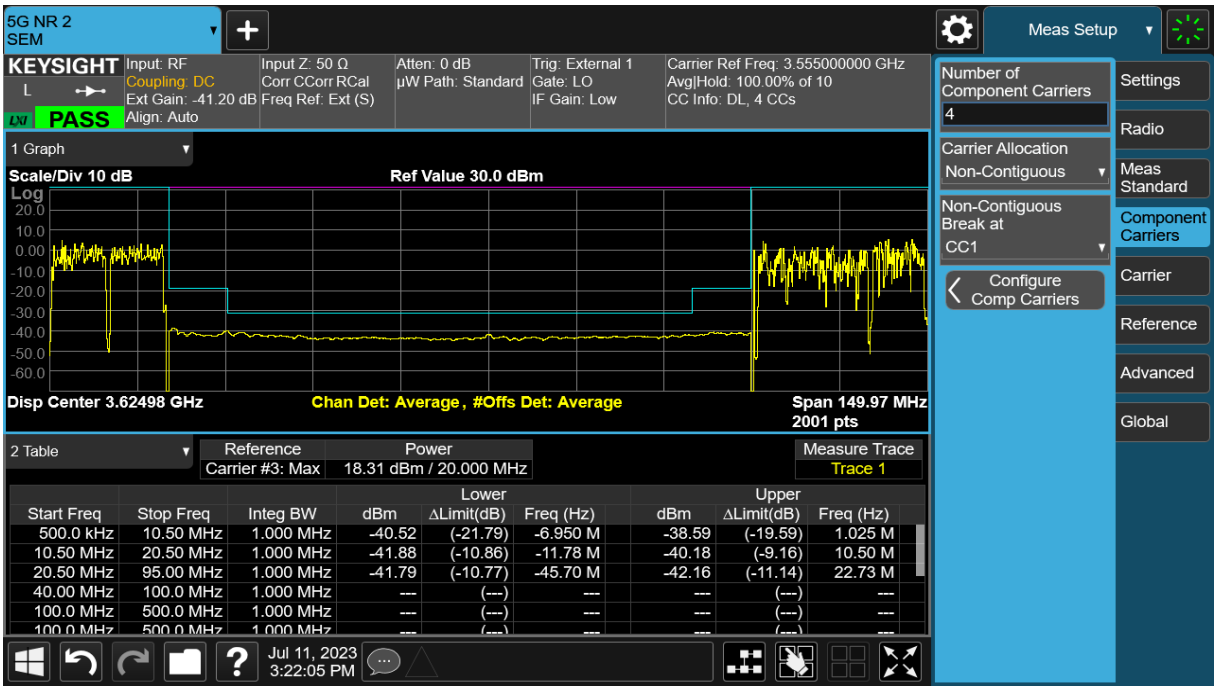
4.2.1 Edge of Band Emissions - Plots.

All of the measurements met the requirements of Part 96.41(e)(1) and KDB 940660 D01 Section 3.2 (b)(6) when measured per Part 2.1049.

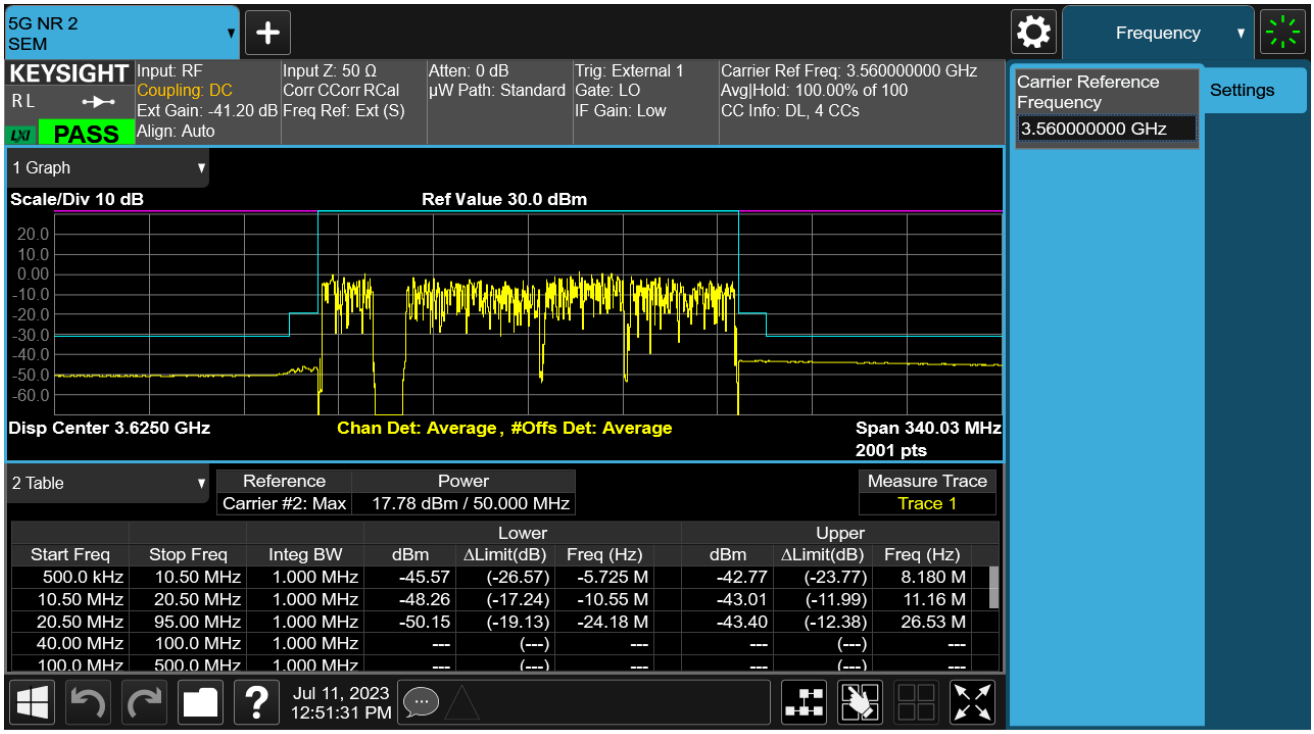
4CC, TX2
Test Model 3.2
Modulation QPSK/16QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3680.355 NR + 3694.995 NR MHz
BW 10 + 10 + 20 + 10 MHz



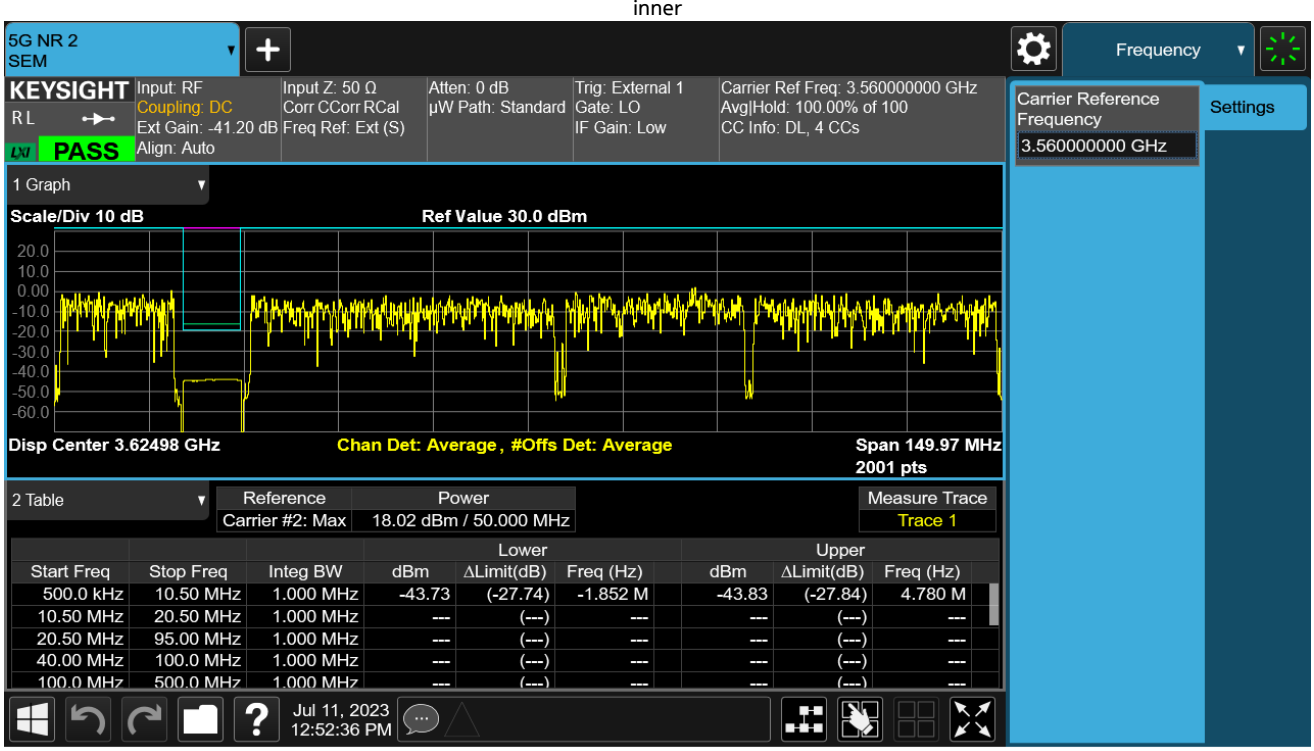
inner



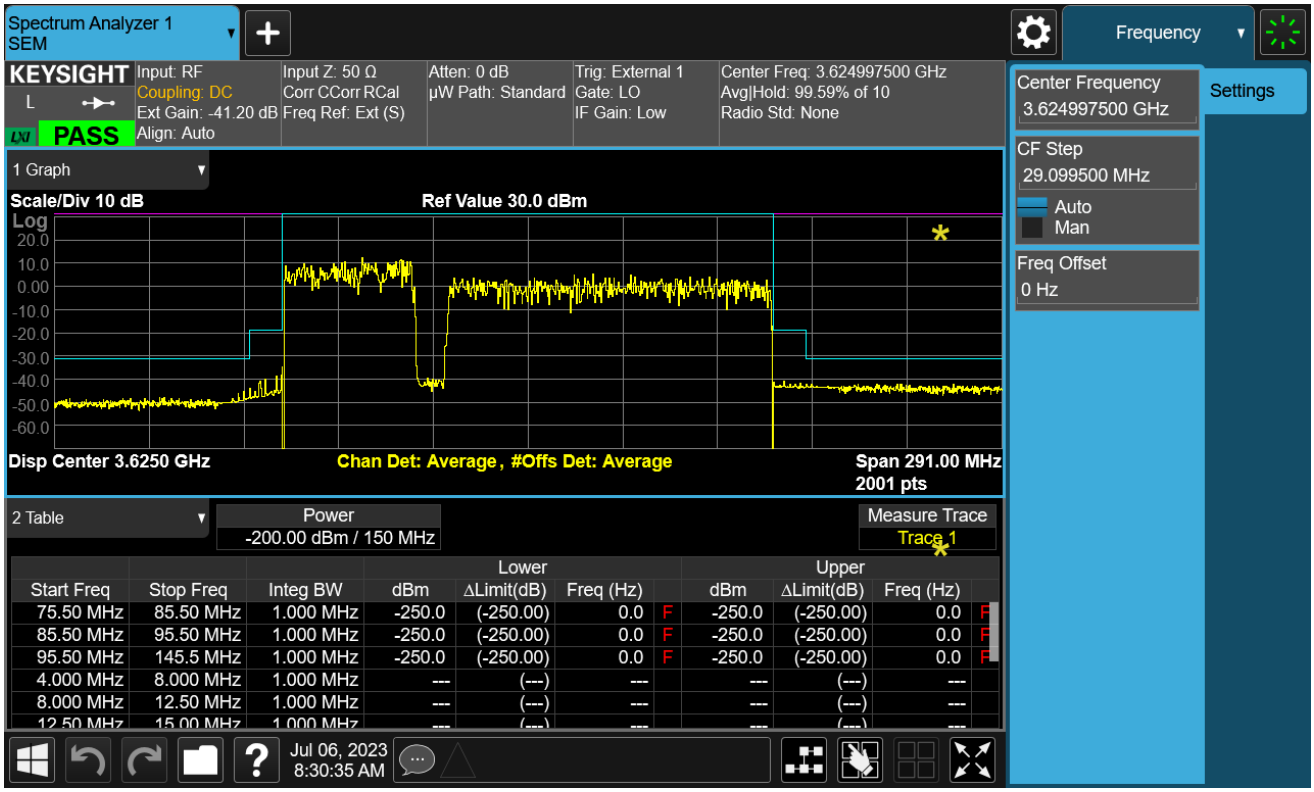
4CC, TX2
Test Model 3.1
Modulation 64QAM
Channel Frequency 3560 LTE+ 3605.01 NR + 3645 NR + 3679.995 NR MHz
BW 20 + 50 + 30 + 40 MHz



inner

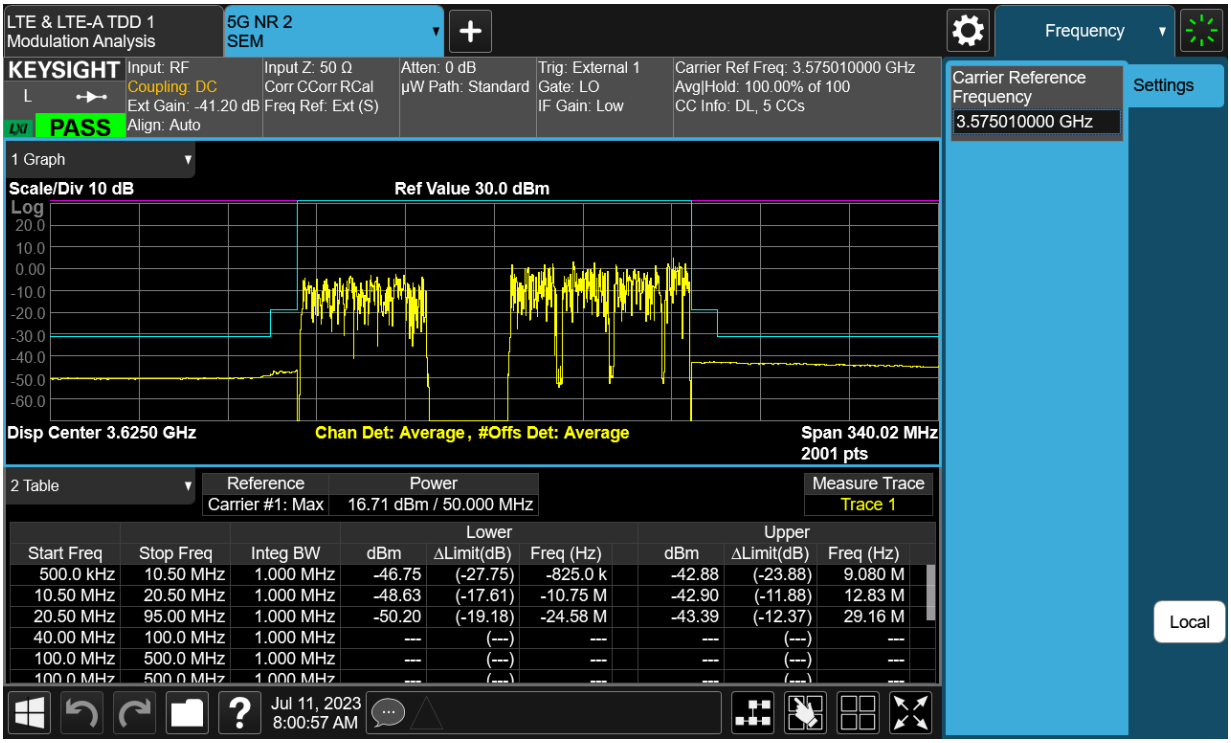


5CC, TX2
Test Model 3.1a
Modulation256QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3575 LTE +3585 LTE + 3649 NR MHz
BW 10 + 10 + 10 + 10 +100 MHz

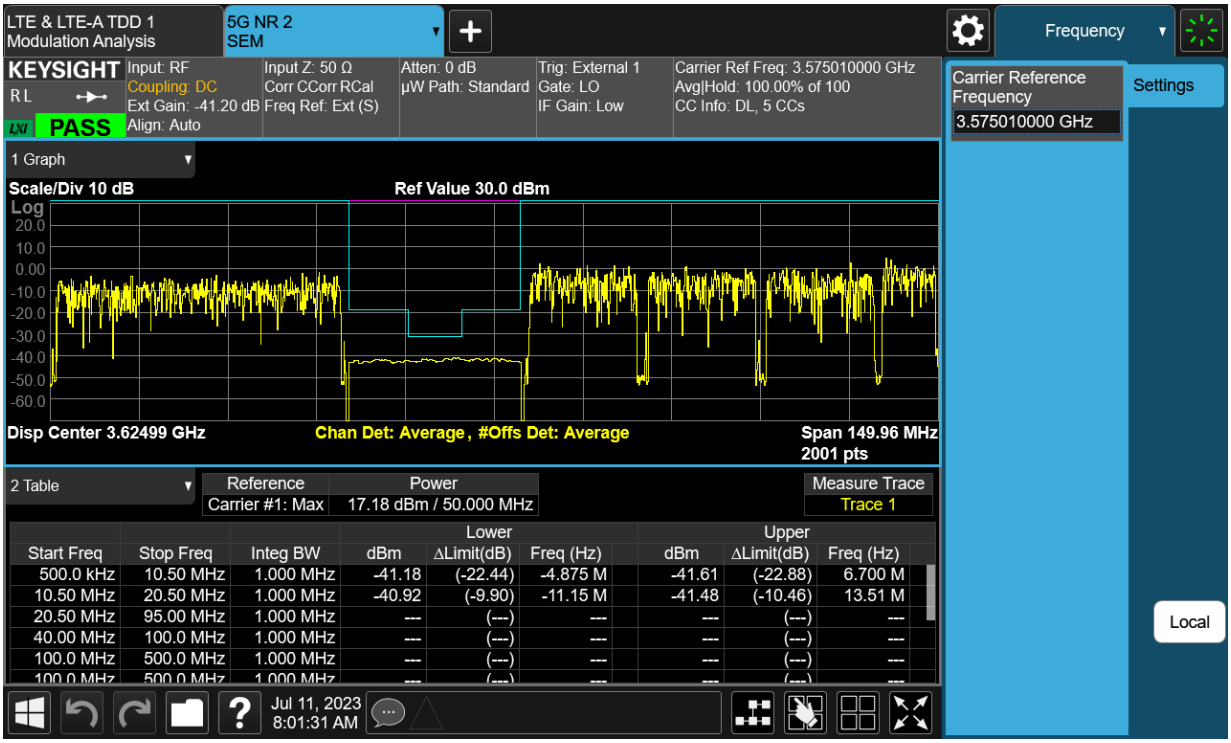


			Lower				Upper			
Start Freq	Stop Freq	Integ BW	dBm	ΔLimit(dB)	Freq (Hz)		dBm	ΔLimit(dB)	Freq (Hz)	
75.50 MHz	85.50 MHz	1.000 MHz	-250.0	(-250.00)	0.0	F	-250.0	(-250.00)	0.0	F
85.50 MHz	95.50 MHz	1.000 MHz	-250.0	(-250.00)	0.0	F	-250.0	(-250.00)	0.0	F
95.50 MHz	145.5 MHz	1.000 MHz	-250.0	(-250.00)	0.0	F	-250.0	(-250.00)	0.0	F
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---		---	(---)	---	
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---		---	(---)	---	
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---		---	(---)	---	

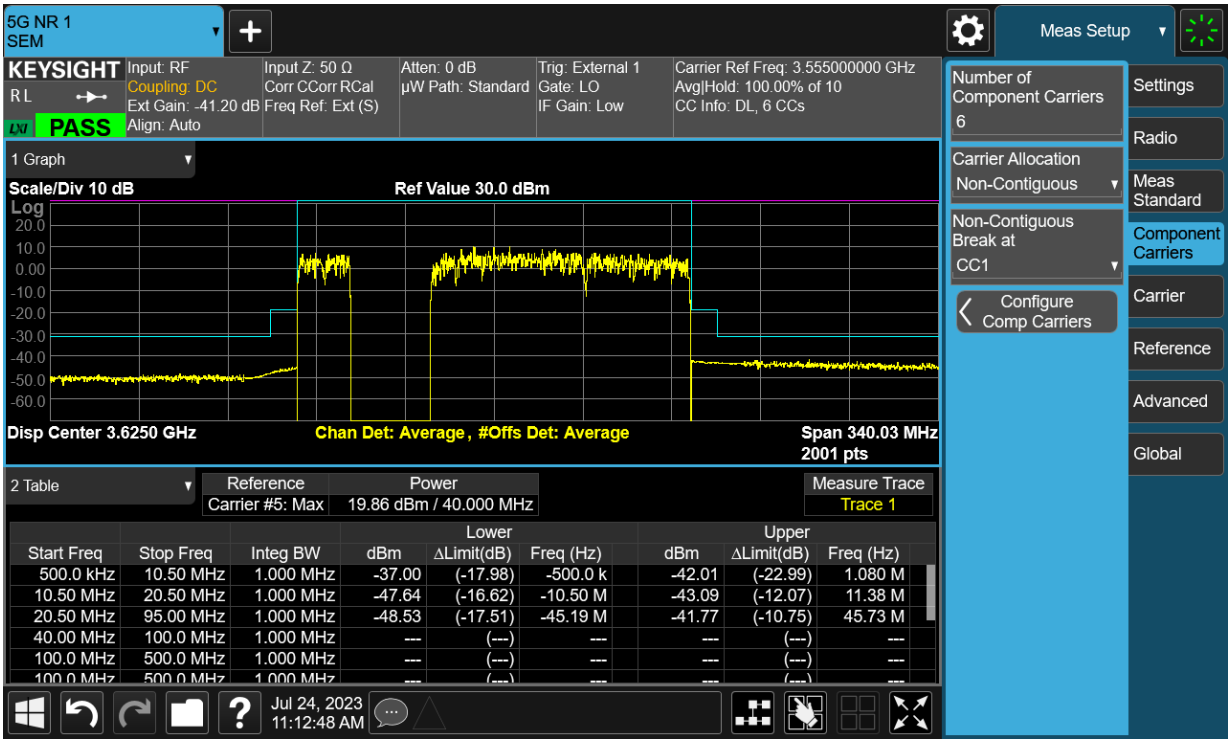
5CC, TX2
Test Model 3.1
Modulation 64QAM
Channel Frequency 3570 NR + 3640 LTE + 3660 LTE + 3680 LTE + 3695 LTE MHz
BW 50 + 20 + 20 + 20 + 10 MHz



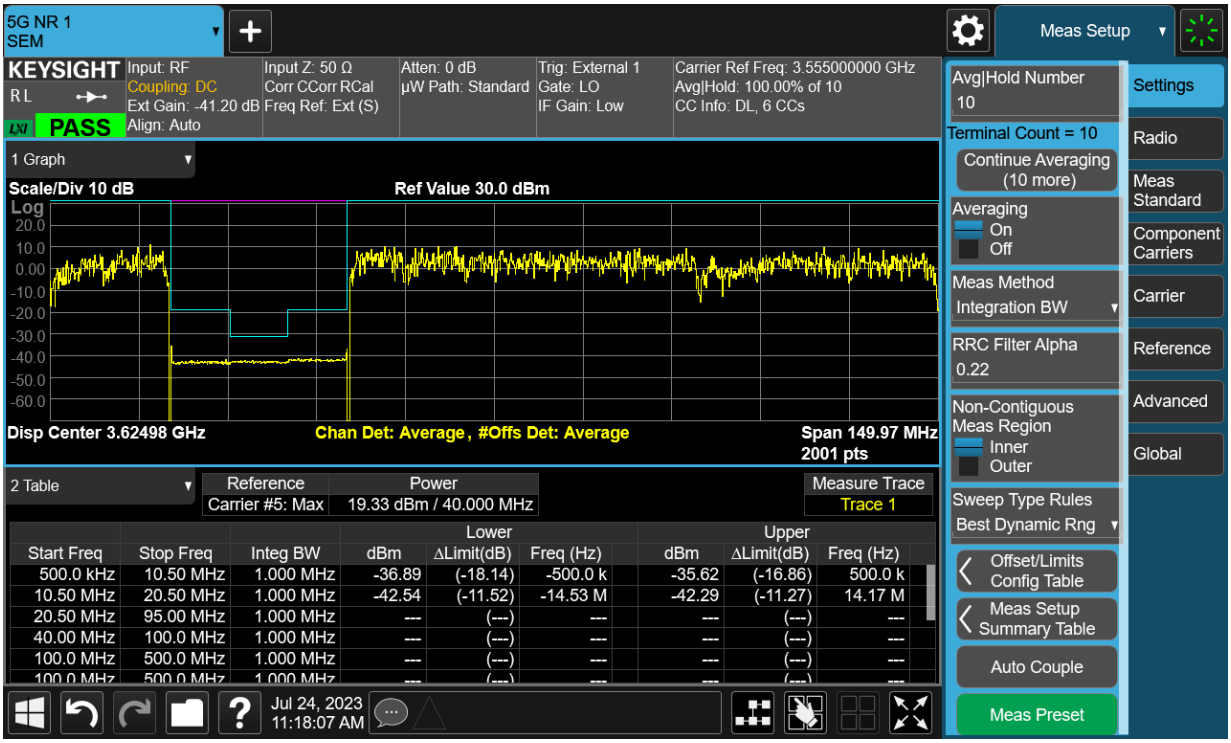
inner



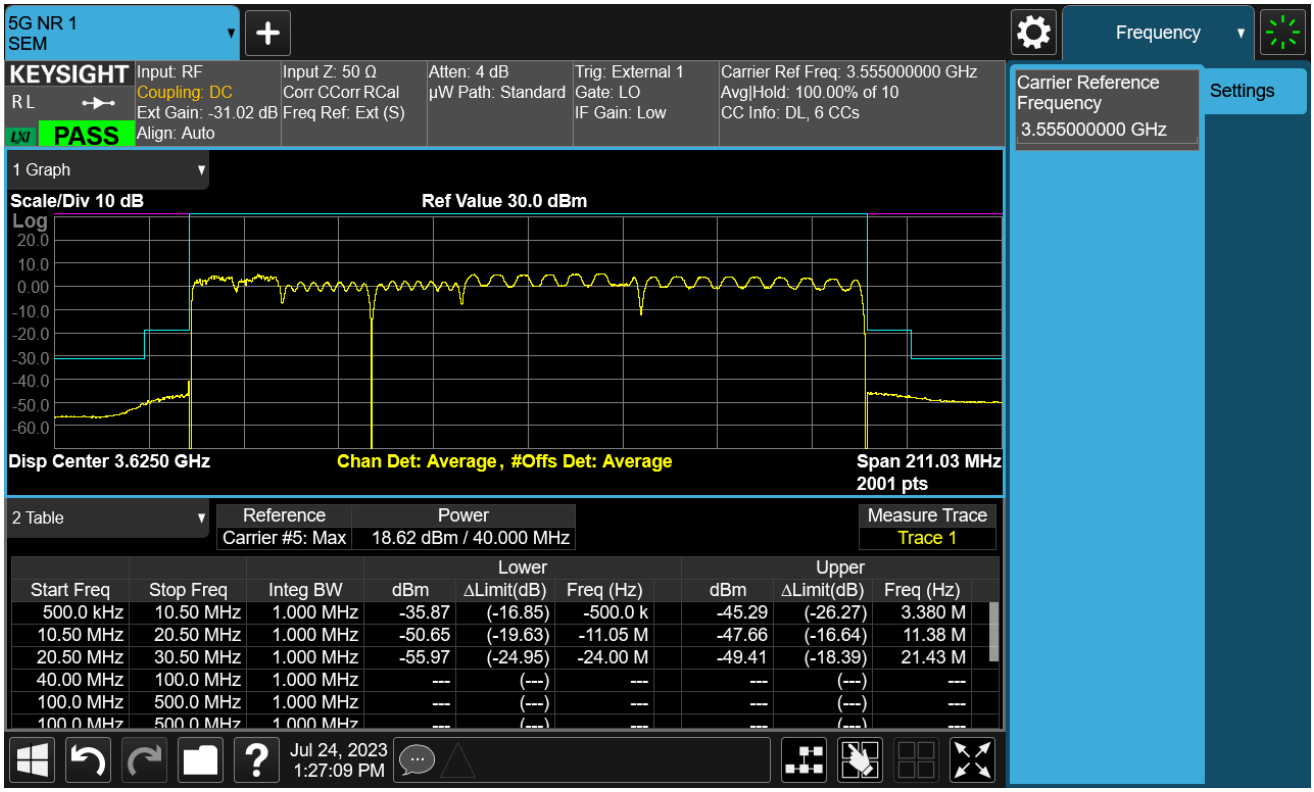
6CC, TX2
Test Model 3.1
Modulation 64QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3605 NR +3615 NR + 3640 NR + 3679 NR MHz
BW 10 + 10 + 10 + 10 + 40 + 40 MHz



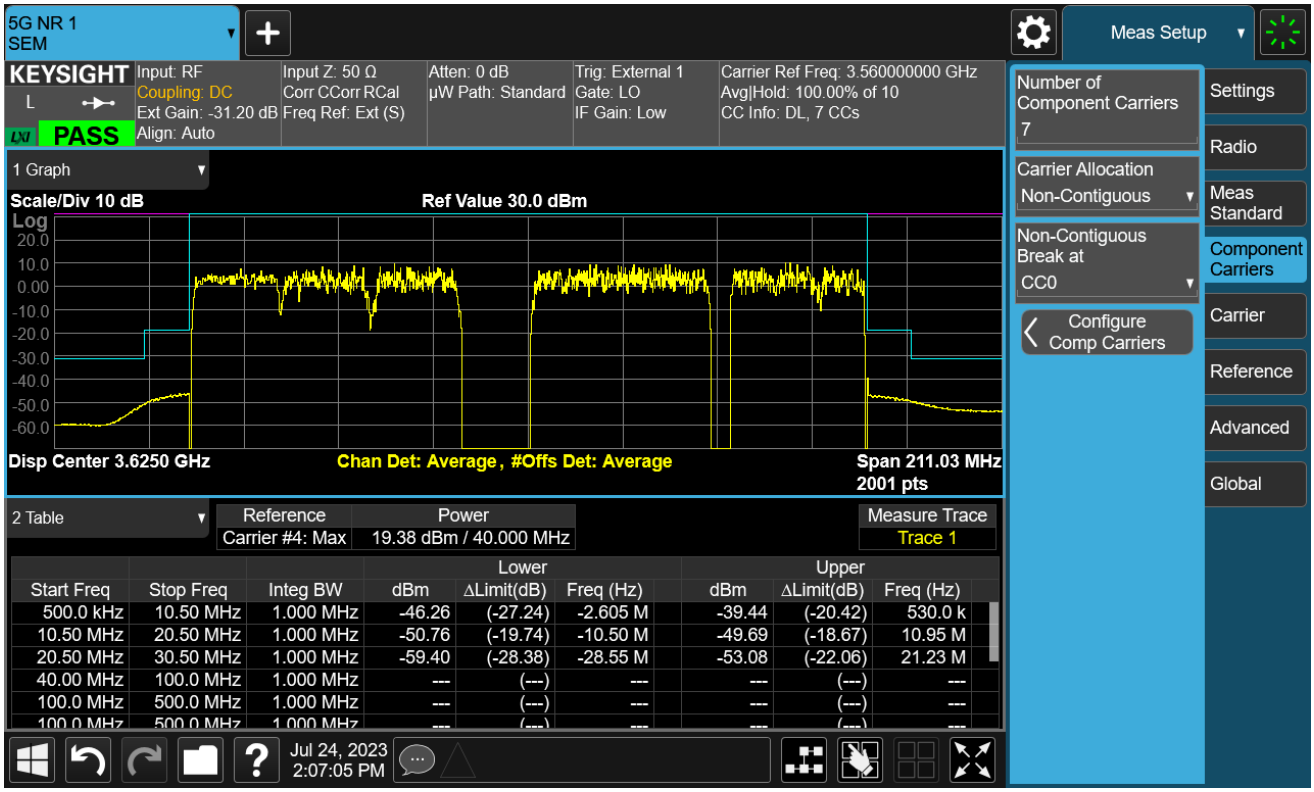
inner



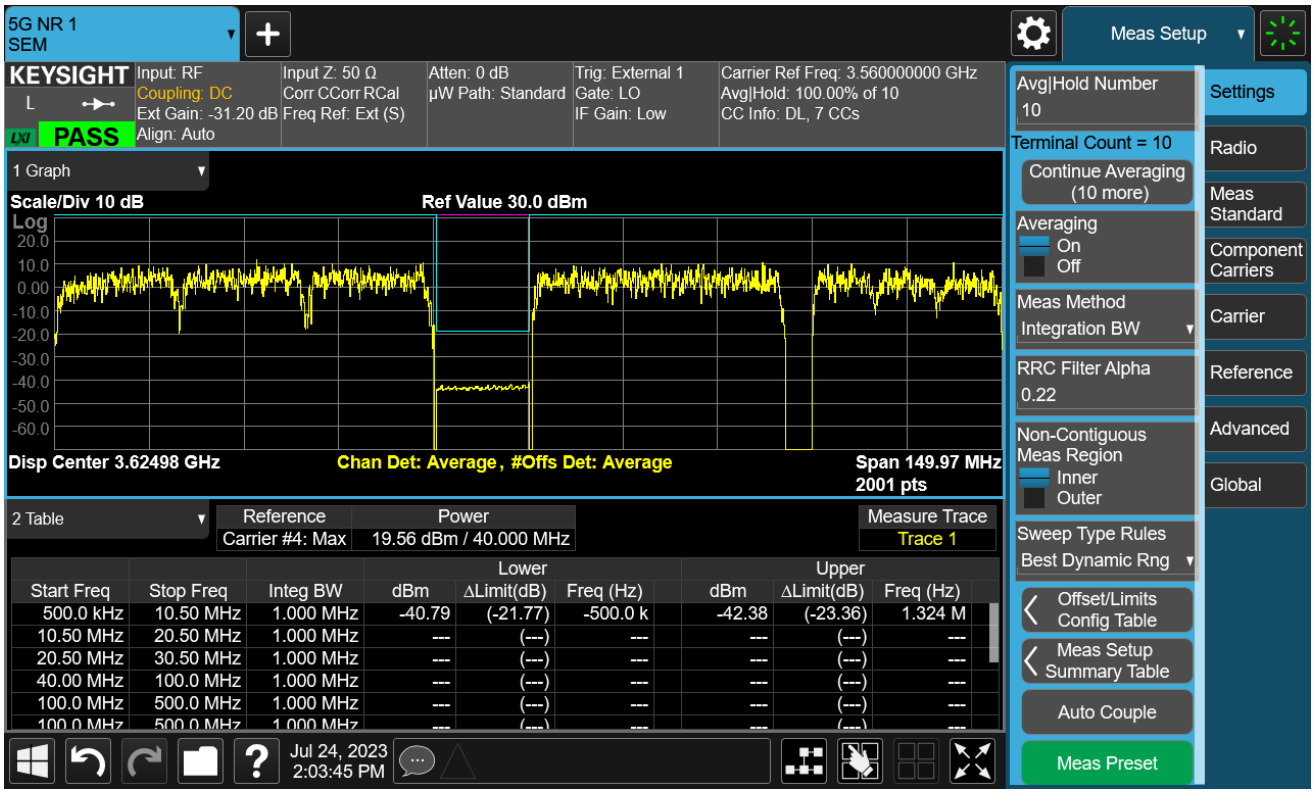
6CC, TX2
Test Model 3.2
Modulation QPSK / 16QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3579 NR +3600 NR + 3630 NR + 3675 NR MHz
BW 10 + 10 + 20 + 20 + 40 + 50 MHz

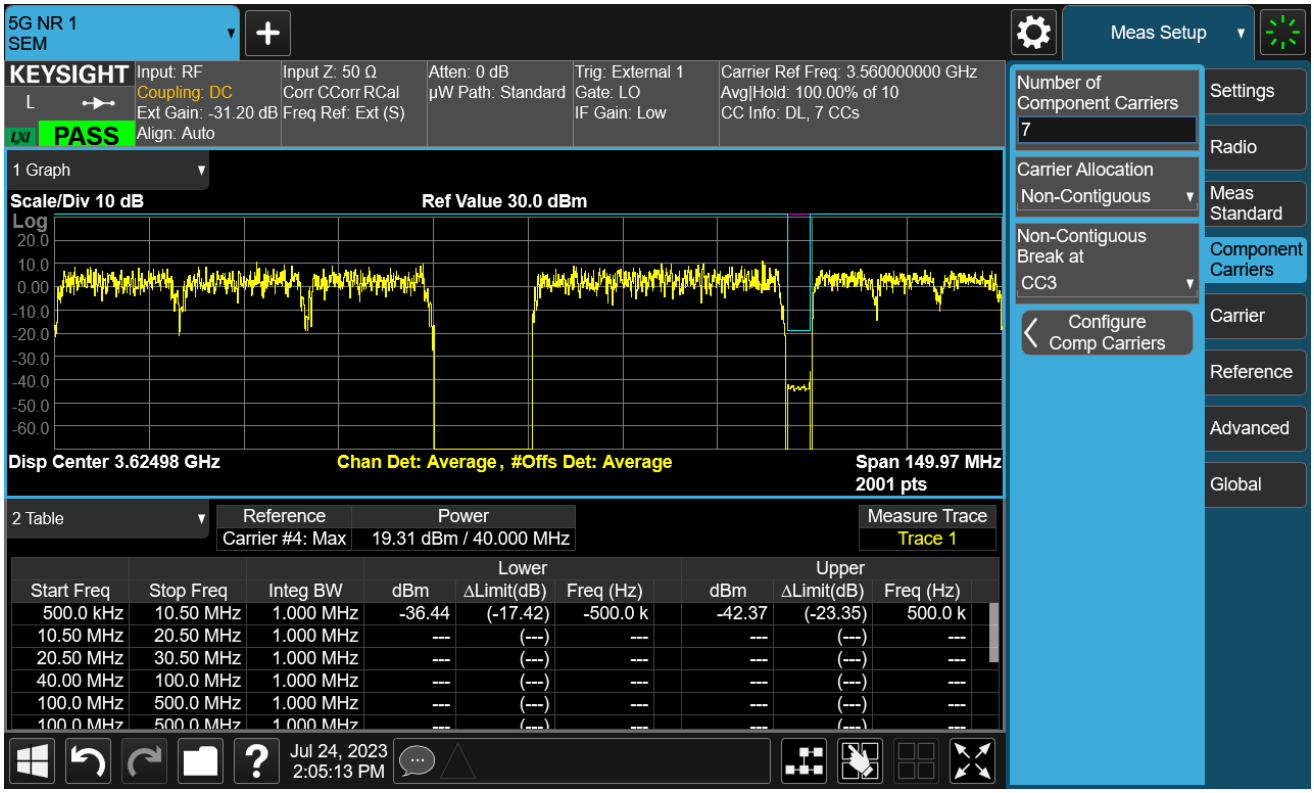


7CC, TX2
Test Model 1.1
Modulation QPSK
Channel Frequency 3560 LTE+ 3580 LTE + 3600 LTE +3645 NR + 3675 NR + 3685 NR +3694 NR MHz
BW 20 + 20 + 20 + 40 + 10 + 10 + 10 MHz

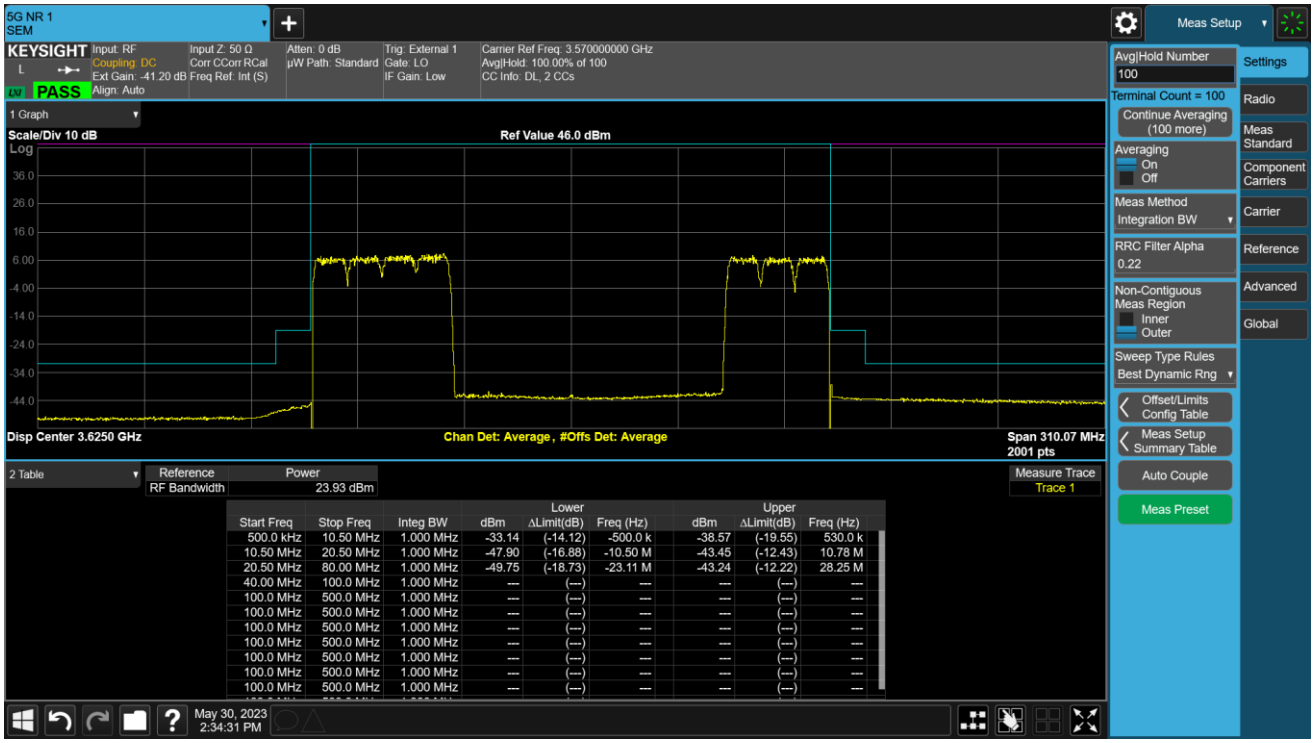


inner

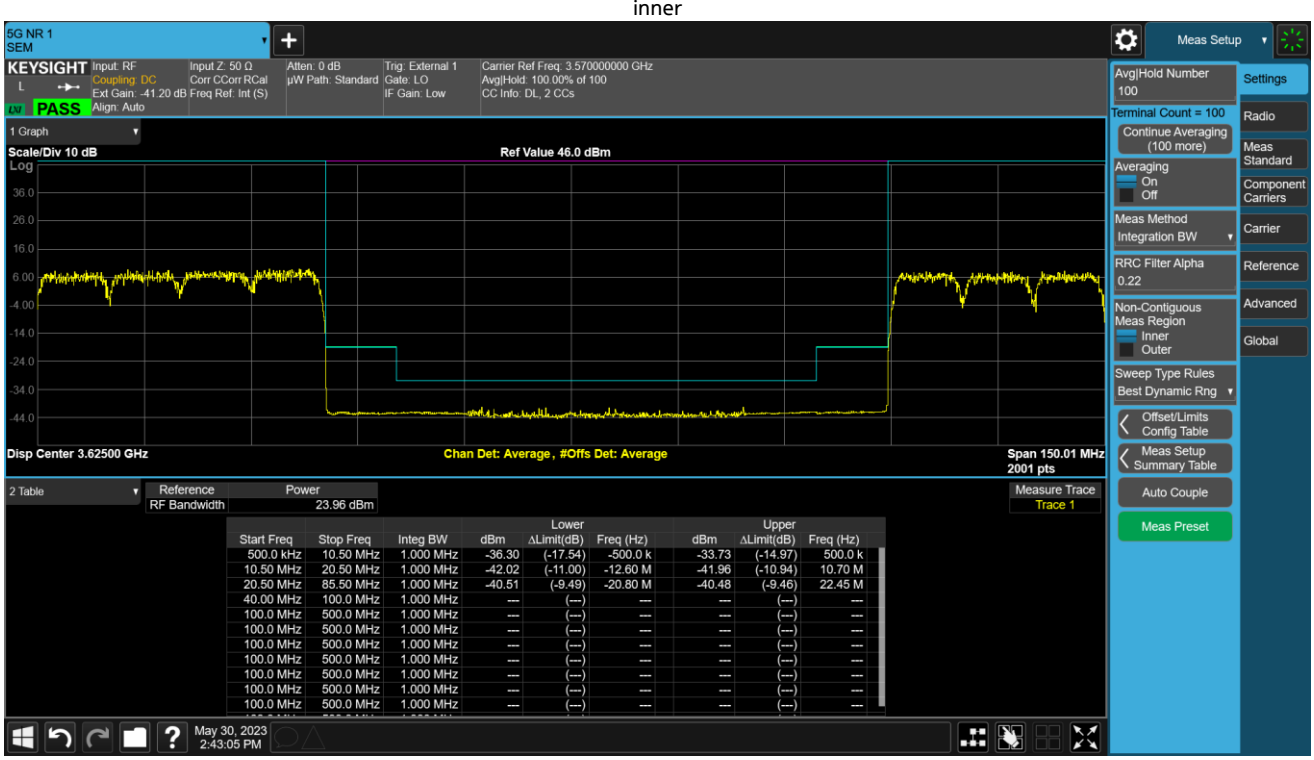

5G NR 1
SEM
KEYSIGHT
PASS
Input: RF
Coupling: DC
Ext Gain: -31.20 dB
Align: Auto
Input Z: 50 Ω
Corr CCorr RCal
Freq Ref: Ext (S)
Atten: 0 dB
µW Path: Standard
Trig: External 1
Gate: LO
IF Gain: Low
Carrier Ref Freq: 3.560000000 GHz
Avg|Hold: 100.00% of 10
CC Info: DL, 7 CCs
Meas Setup
1 Graph
Scale/Div 10 dB
Ref Value 30.0 dBm
Log
20.0
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
Disp Center 3.62498 GHz
Chan Det: Average, #Offs Det: Average
Span 149.97 MHz
2001 pts
2 Table
Reference
Carrier #4: Max
Power
19.56 dBm / 40.000 MHz
Measure Trace
Trace 1
Lower
Upper
Start Freq | Stop Freq | Integ BW | dBm | ΔLimit(dB) | Freq (Hz) | dBm | ΔLimit(dB) | Freq (Hz)
500.0 kHz | 10.50 MHz | 1.000 MHz | -40.79 | (-21.77) | -500.0 k | -42.38 | (-23.36) | 1.324 M
10.50 MHz | 20.50 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | ---
20.50 MHz | 30.50 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | ---
40.00 MHz | 100.0 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | ---
100.0 MHz | 500.0 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | ---
Jul 24, 2023
2:03:45 PM
Avg|Hold Number
10
Terminal Count = 10
Continue Averaging (10 more)
Averaging
On
Off
Meas Method
Integration BW
RRC Filter Alpha
0.22
Non-Contiguous Meas Region
Inner
Outer
Sweep Type Rules
Best Dynamic Rng
Offset/Limits Config Table
Meas Setup Summary Table
Auto Couple
Meas Preset
Settings
Radio
Meas Standard
Component Carriers
Carrier
Reference
Advanced
Global


5G NR 1
SEM
KEYSIGHT
PASS
Input: RF
Coupling: DC
Ext Gain: -31.20 dB
Align: Auto
Input Z: 50 Ω
Corr CCorr RCal
Freq Ref: Ext (S)
Atten: 0 dB
µW Path: Standard
Trig: External 1
Gate: LO
IF Gain: Low
Carrier Ref Freq: 3.560000000 GHz
Avg|Hold: 100.00% of 10
CC Info: DL, 7 CCs
Meas Setup
1 Graph
Scale/Div 10 dB
Ref Value 30.0 dBm
Log
20.0
10.0
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
Disp Center 3.62498 GHz
Chan Det: Average, #Offs Det: Average
Span 149.97 MHz
2001 pts
2 Table
Reference
Carrier #4: Max
Power
19.31 dBm / 40.000 MHz
Measure Trace
Trace 1
Lower
Upper
Start Freq | Stop Freq | Integ BW | dBm | ΔLimit(dB) | Freq (Hz) | dBm | ΔLimit(dB) | Freq (Hz)
500.0 kHz | 10.50 MHz | 1.000 MHz | -36.44 | (-17.42) | -500.0 k | -42.37 | (-23.35) | 500.0 k
10.50 MHz | 20.50 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | ---
20.50 MHz | 30.50 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | ---
40.00 MHz | 100.0 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | ---
100.0 MHz | 500.0 MHz | 1.000 MHz | --- | (---) | --- | --- | (---) | ---
Jul 24, 2023
2:05:13 PM
Number of Component Carriers
7
Carrier Allocation
Non-Contiguous
Non-Contiguous Break at
CC3
Configure Comp Carriers
Settings
Radio
Meas Standard
Component Carriers
Carrier
Reference
Advanced
Global

7CC, TX2
Test Model 3.1a
Modulation 256QAM
Channel Frequency 3555 LTE+ 3565 LTE + 3575 LTE +3585 LTE + 3675 NR + 3685 NR +3694 NR MHz
BW 10 + 10 + 10 + 10 + 10 + 10 + 10 MHz



inner



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 37 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-37 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 37 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 **47CFR 96.41 (e)** was applied to these tests. Based upon the criterion given in Section 96 of the Code and as developed in 4.3.3, the required emission limit for emissions outside a licensee's frequency block is:

47CFR 96.41 (e)(2) *Additional protection levels.* Notwithstanding paragraph (e)(1) of this section, the conducted power of any emissions below 3540 MHz or above 3710 MHz shall not exceed −25 dBm/MHz, and the conducted power of emissions below 3530 MHz or above 3720 MHz shall not exceed −40 dBm/MHz.

In order to account for the spectral adding of identical signals from the primary and diversity ports, per KDB 662911 D01 Multiple Transmitter Output v01r01, the level needs be adjusted by 10LOG(n) where n=number of outputs.

The adjustment for n=4 is: 6.02 dB = 10LOG(4)

Therefore, the limit for emissions below 3540 MHz or above 3710 MHz frequency block when measured with a RBW of 1 MHz is:

-25 dBm - 6.02 dB = -31.02 dBm for 4x MIMO

Therefore, the limit for emissions below 3530 MHz or above 3720 MHz frequency block when measured with a RBW of 1 MHz is:

-40 dBm - 6.02 dB = -46.02 dBm for 4x MIMO

5.3 Spurious Emissions at Antenna Terminals Results

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.

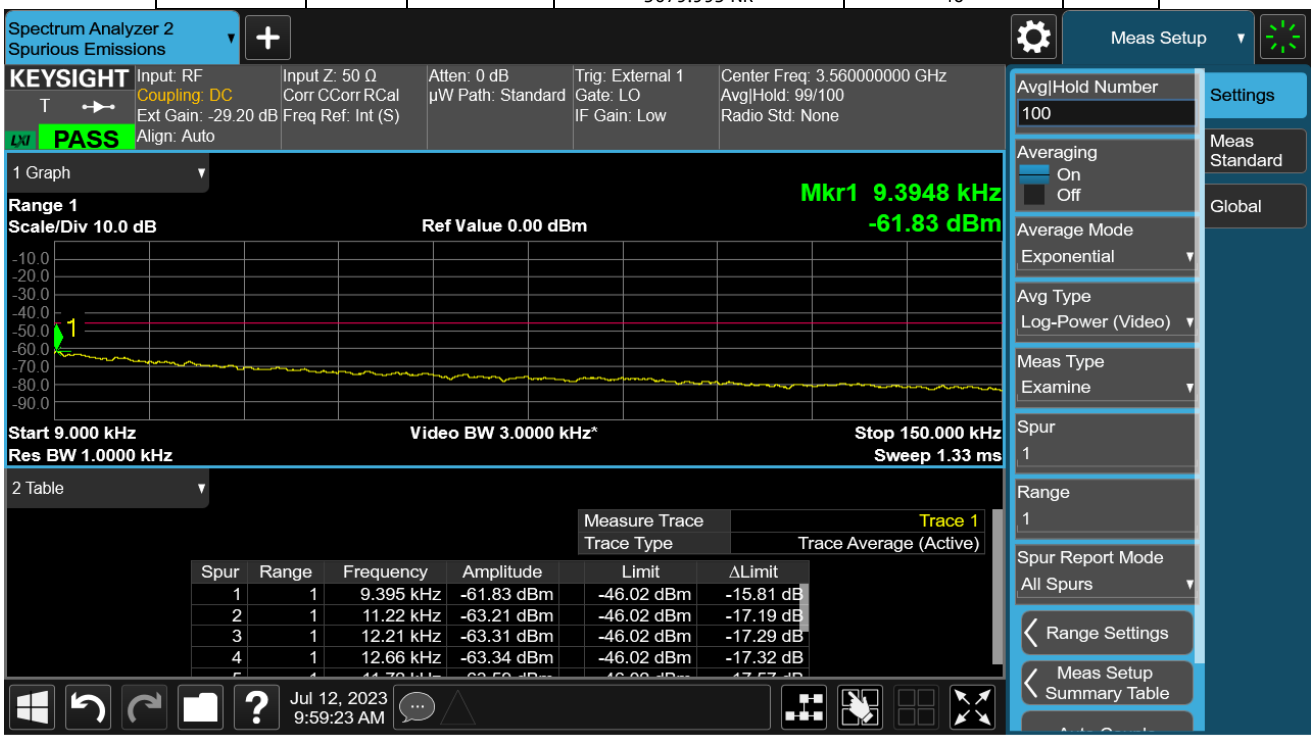
Tabular Data – Spurious Emissions at Antenna Terminals

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX	Conducted Spurious Emissions Results
4	3.2	QPSK/16QAM	3555 LTE 3565 LTE 3680.355 NR 3694.995 NR	10 10 20 10	2	Pass
4	3.1	64QAM	3560 LTE 3605.01 NR 3645 NR 3679.995 NR	20 50 30 40	2	Pass
5	3.1a	256QAM	3555 LTE 3565 LTE 3575 LTE 3585 LTE 3649 NR	10 10 10 10 100	2	Pass
5	3.1	64QAM	3570 NR 3640 LTE 3660 LTE 3680 LTE 3695 LTE	50 20 20 20 10	2	Pass
6	3.1	64QAM	3555 LTE 3565 LTE 3605 NR 3615 NR 3640 NR 3679 NR	10 10 10 10 40 40	2	Pass
6	3.2	QPSK/16QAM	3555 LTE 3565 LTE 3579 NR 3600 NR 3630 NR 3675 NR	10 10 20 20 40 50	2	Pass
7	1.1	QPSK	3560 LTE 3580 LTE 3600 LTE 3645 NR 3675 NR 3685 NR 3694 NR	20 20 20 40 10 10 10	2	Pass
7	3.1a	256QAM	3555 LTE 3565 LTE 3575 LTE 3585 LTE 3675 NR 3685 NR 3694 NR	10 10 10 10 10 10 10	2	Pass

5.4 Spurious Emissions at Antenna Terminals Plots

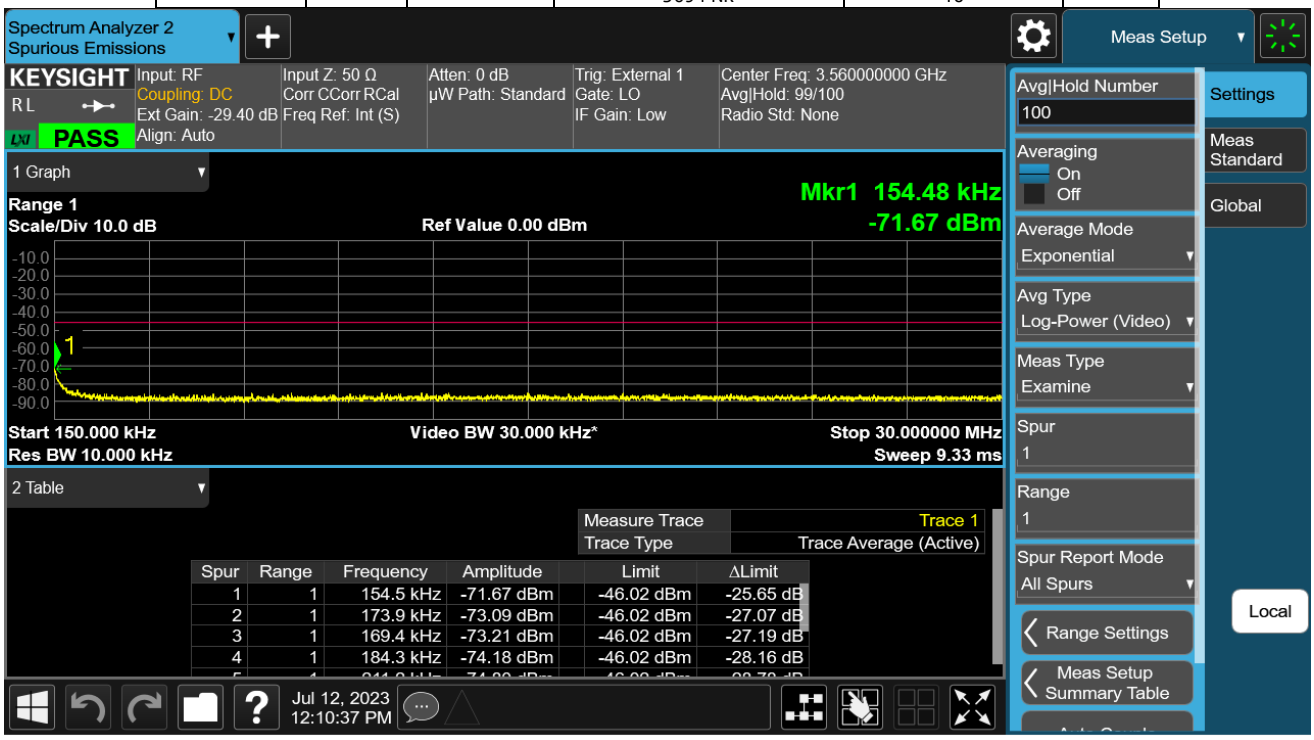
9KHz – 150kHz

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX
4	3.1	64QAM	3560 LTE 3605.01 NR 3645 NR 3679.995 NR	20 50 30 40	2



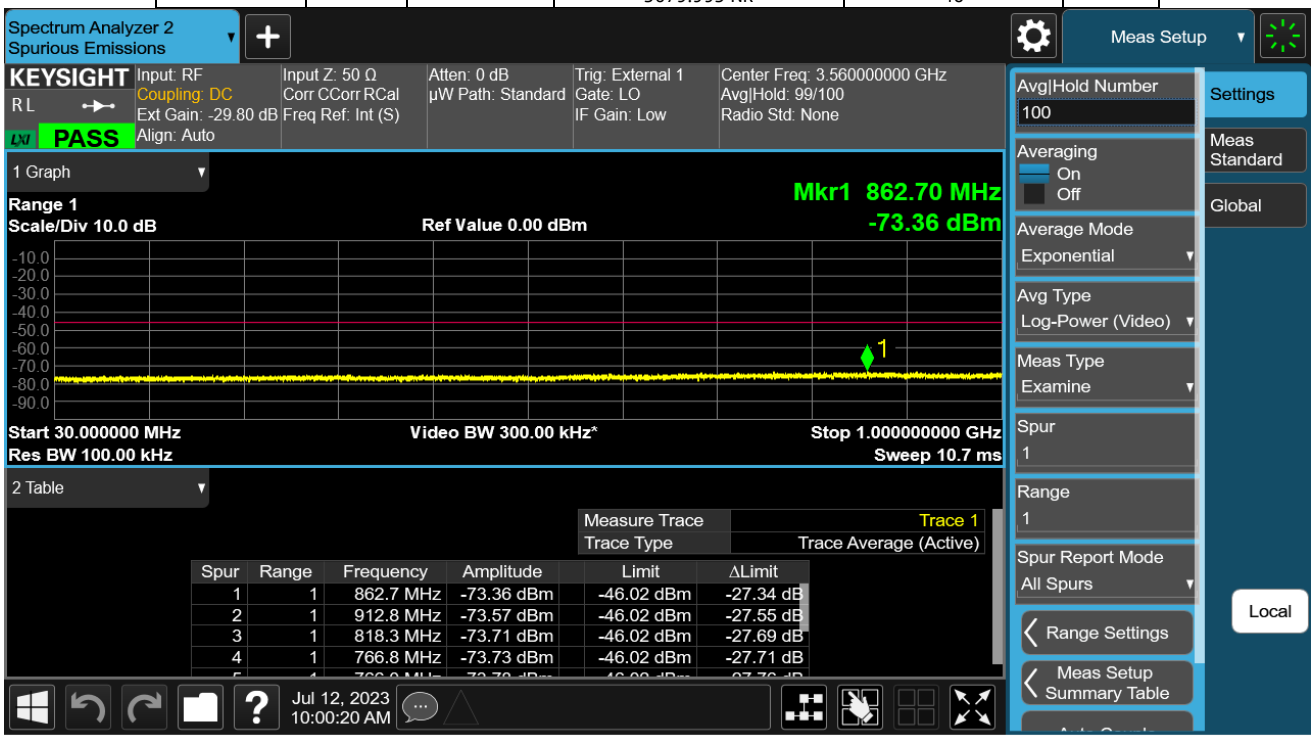
150kHz – 30MHz

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX
7	3.1a	256QAM	3555 LTE 3565 LTE 3575 LTE 3585 LTE 3675 NR 3685 NR 3694 NR	10 10 10 10 10 10 10	2



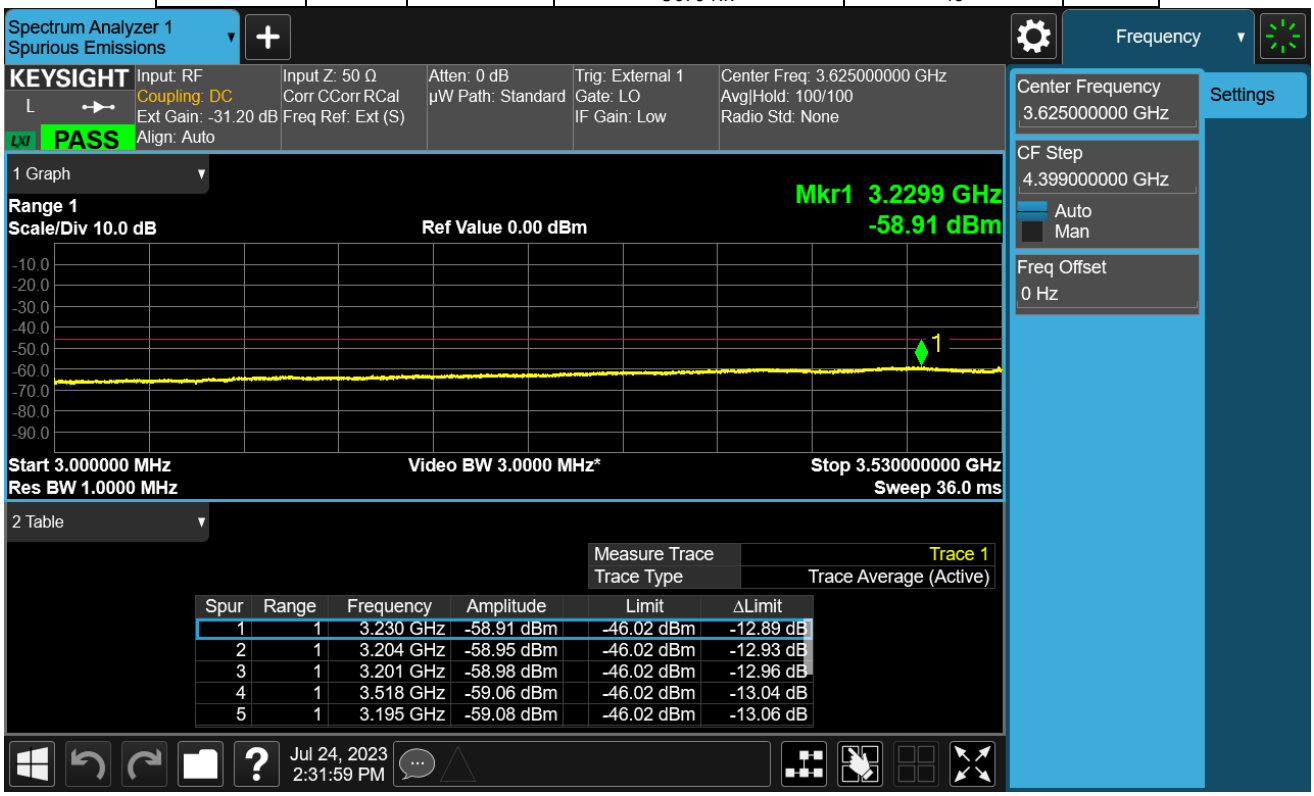
30MHz – 1GHz

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX
4	3.1	64QAM	3560 LTE 3605.01 NR 3645 NR 3679.995 NR	20 50 30 40	2



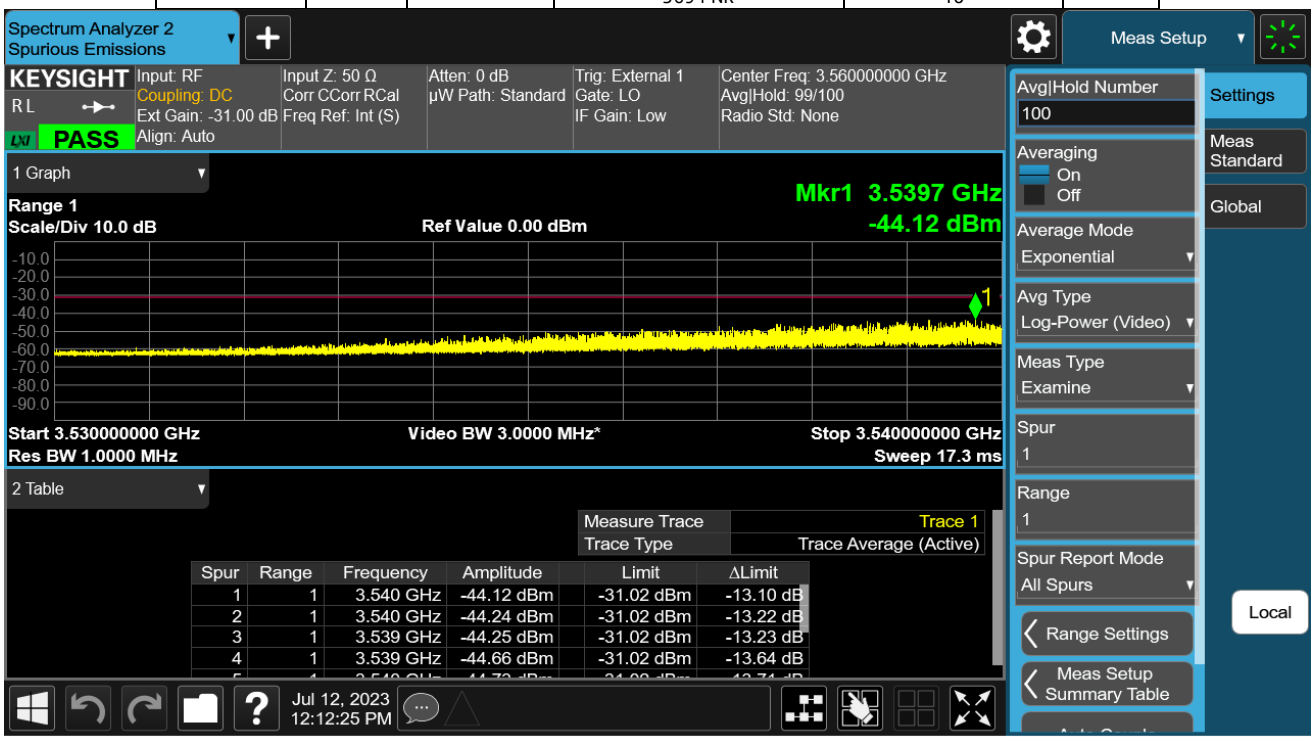
30MHz – 3.53GHz

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX
6	3.1	64QAM	3555 LTE 3565 LTE 3605 NR 3615 NR 3640 NR 3679 NR	10 10 10 10 40 40	2



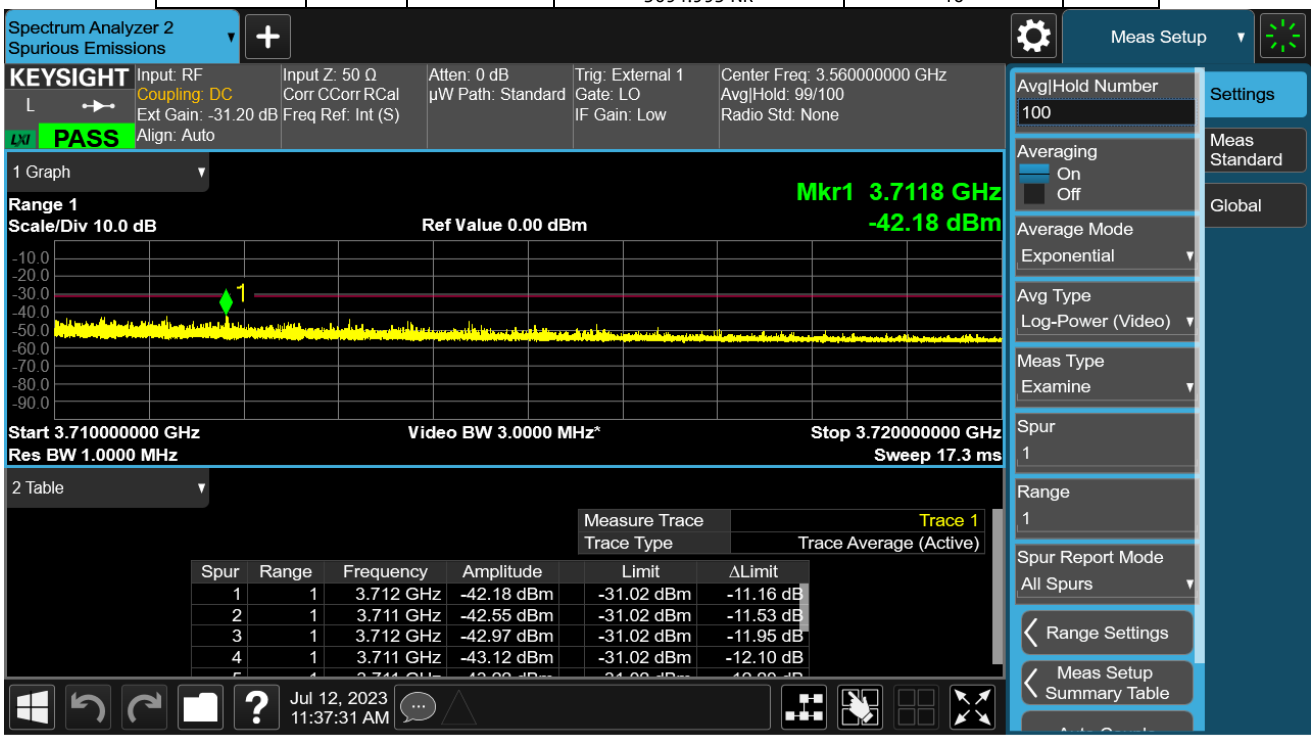
3.53GHz – 3.54GHz

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX
7	3.1a	256QAM	3555 LTE	10	2
			3565 LTE	10	
			3575 LTE	10	
			3585 LTE	10	
			3675 NR	10	
			3685 NR	10	
			3694 NR	10	



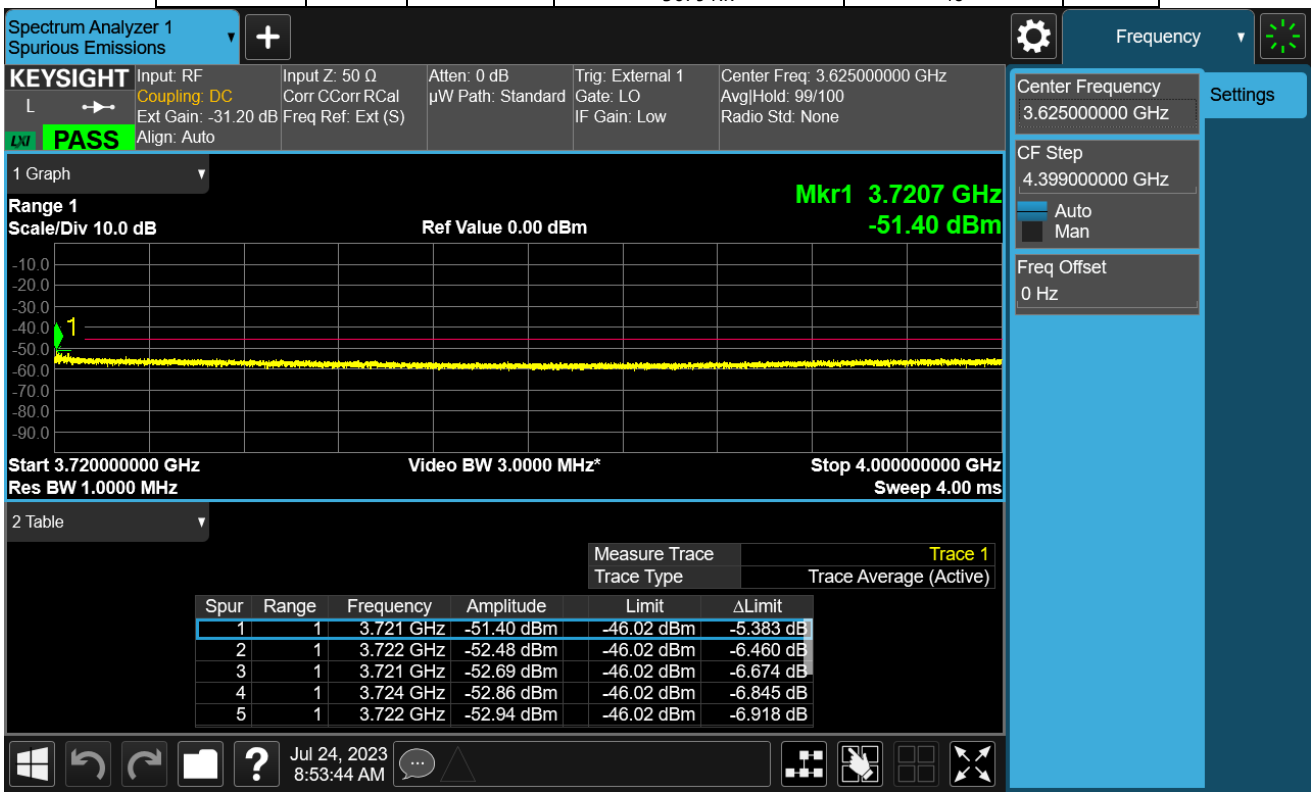
3.71GHz – 3.72GHz

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX
4	3.2	QPSK/16QAM	3555 LTE 3565 LTE 3680.355 NR 3694.995 NR	10 10 20 10	2



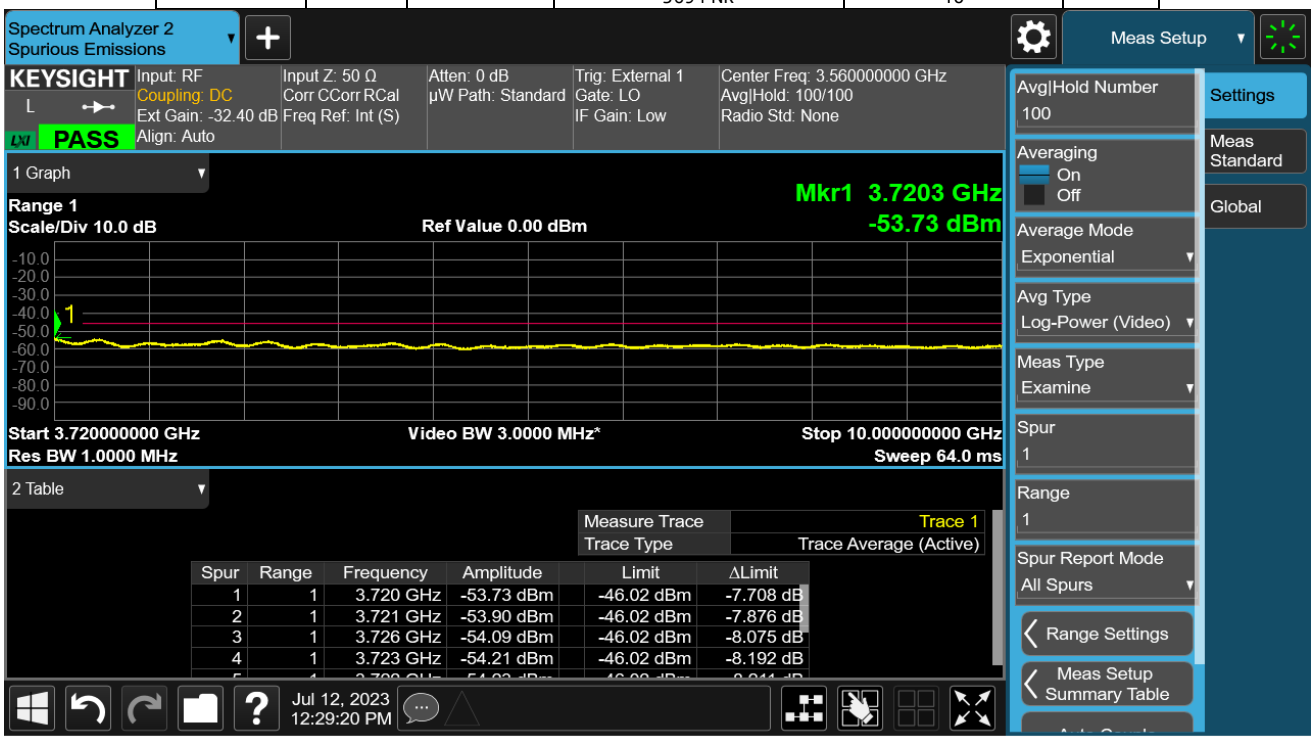
3.72GHz – 4GHz

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX
6	3.1	64QAM	3555 LTE 3565 LTE 3605 NR 3615 NR 3640 NR 3679 NR	10 10 10 10 40 40	2



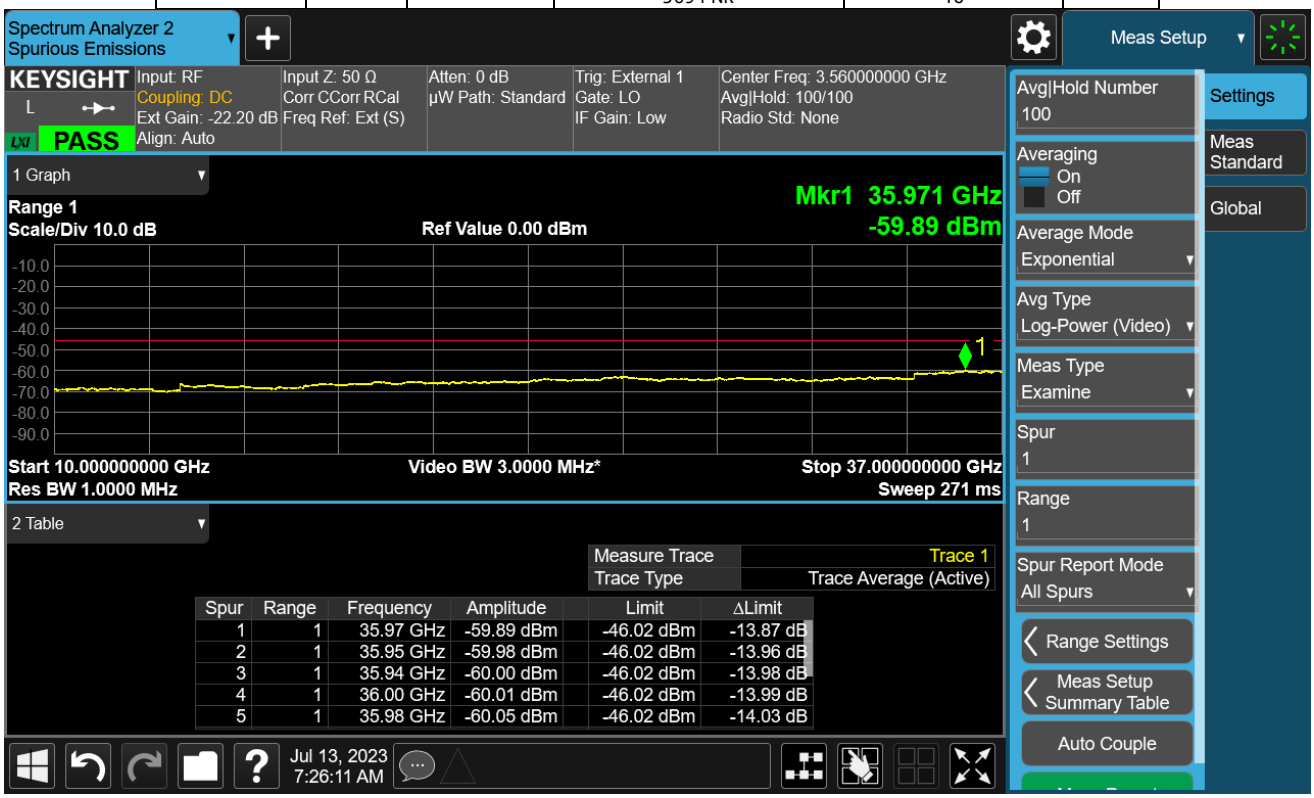
3.72GHz – 10GHz

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX
7	3.1a	256QAM	3555 LTE	10	2
			3565 LTE	10	
			3575 LTE	10	
			3585 LTE	10	
			3675 NR	10	
			3685 NR	10	
			3694 NR	10	



10GHz – 37GHz

# of carrier	TM	Modulation	Channel Frequency (MHz)	Signal BW (MHz)	TX
7	3.1a	256QAM	3555 LTE	10	2
			3565 LTE	10	
			3575 LTE	10	
			3585 LTE	10	
			3675 NR	10	
			3685 NR	10	
			3694 NR	10	



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

6.1 Section 2.1053 Field Strength of Spurious Emissions

Field strength measurements of radiated spurious emissions were made in an FCC registered 3m Semi-Anechoic Chamber which is maintained by Nokia Bell Labs in Murray Hill, New Jersey. A complete description and full measurement data for the site is on file with the Commission (Site Registration Number: 515091).

The spectrum from 30 MHz to beyond the tenth harmonic of the carrier, 10 GHz, was searched for spurious radiation. Measurements were made using both horizontally and vertically polarized broadband antennas. Per FCC regulations, the comparison of out of band spurious emissions directly to the limit is appropriately made using the substitution method. However, when the emissions are more than 20 dB below the specification limit, the use of field strength measurements for compliance determination is acceptable and those emissions are considered not reportable (Section 2.1053 and the FCC Interpretive database for 2.1053). For this case the evaluation of acceptable radiated field strength is as follows.

6.2 Field Strength of Spurious Emissions - Limits

Section 2.1053 contains the requirements for the levels of spurious radiation as a function of the level of the unmodulated carrier. The reference level for the unmodulated carrier is calculated as the field produced by an ideal dipole excited by the transmitter output power according to the following relation taken from Reference Data for Radio Engineers, page 676, 4th edition, IT&T Corp.

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

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

Where:
E = Field Intensity in Volts/meter P = Transmitted Power in Watts
R = Measurement distance in meters = 3 m

The Part 2.1053 Limit is 82.23 dBuV/m at 3m and 91.77 dBuV/m at 1m
The Part 2.1053 non-report level is 62.23 dBuV/m at 3m.

The calculated emission levels were found by:

Measured level (dBμV) + Cable Loss(dB)+Antenna Factor(dB) = Field Strength (dBμV/m)

RESULTS:
For compliance with 47CFR Part 2.1053, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 dBμV/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dBμV/meter at 3m are not reportable and may be verified using field strength measurements and broadband antennas. Over the out of band spectrum investigated from 30 MHz to beyond the tenth harmonic of the carrier (up to 37 GHz), no reportable spurious emissions were detected.

Testing is waived based on previous testing of LTE and 5G configurations. Reference test reports are
TR-2022-0137-FCC96 – AirScale Indoor pico RRH 4T4R n48 AWPQY-Z
TR-2023-0049-FCC96 - AirScale Indoor pico RRH 4T4R n48 AWPQYZ

Photographs

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	N5230C	MY49000897	2023-02-08	2025-02-08
E1347	Fairview Microwave	Attenuator	10 dB, DC - 40 GHz, 20 watt	SA4023-10	N/A	CNR-V	CNR-V
E1367	Fairview Microwave	Attenuator	20 dB, DC - 40 GHz, 5 watt	SA4017-20	N/A	CNR-V	CNR-V
E1579	KeySight Technologies	MXA Signal Analyzer	10 Hz - 50 GHz	N9021B	MY60080199	2021-11-30	2023-11-30
E1212	RLC Electronics Inc	Filter, High Pass	10 - 30 GHz, 2W, 5dB	F-19414	1444002	CNR-V	CNR-V
E1587	Reactel, Inc.	Filter, High Pass	6 - 24 GHz	11HS-6G/24G-K11	20-02	CNR-V	CNR-V
E1154	Weinschel	Attenuator	30dB 25W 0.05GHz-26GHz	74-30-12	1065	CNR-V	CNR-V
Customer Provided Equipment							
	Micro Coax Utiflex	RF Cable	MFR-64639-228872-001	UF142A-000400-200-2G0	MFR-64639-228872-001	NA	NA
	Mini Circuit	Modular Test System		ZTM-53	91701250030	NA	NA
		CBRS Notch Filter	3550-3700MHz	ZTM-53	B6 163500004	NA	NA

CNR-V: Calibration Not Required, Must Be Verified
Test Dates: 5/30/2023 – 7/24/2023

7. NVLAP Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

ilac-MRA

Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 100275-0

Nokia, Global Product Compliance Lab
Murray Hill, NJ

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

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

DEPARTMENT OF COMMERCE * UNITED STATES OF AMERICA *

For the National Voluntary Laboratory Accreditation Program