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 Micro RRH 3.5GHz 4T/4R 20W (AZQC)

Report Number:
TR-2023-0056-FCC96

Date Issued:
June 21, 2023

Table of Contents

Revisions

Date	Revision	Section	Change
6/21/2023	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 Micro RRH 3.5GHz 4T/4R 20W (AZQC)
Serial Number:	1M181624805
FCC ID:	2AD8UAZQCRH1
Hardware Version:	474156A.101
Software Version:	SBTS23R3
Frequency Range:	3550 - 3700 MHz
GPCL Project Number:	2023-0056
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Applicant:	Nokia Solutions and Networks, OY 2000 Lucent Lane Naperville, Illinois 60563
Test Requirement(s):	Title 47 CFR Part96
Test Standards:	Refer to Section 1.5.1
Measurement Procedure(s):	Refer to Section 1.5.2
Test Date(s):	5/3/2023 – 6/9/2023
Test Performed By:	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636 Test Site Number: US5302
Product Engineer(s):	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 Micro RRH 3.5GHz 4T/4R 20W (AZQC), 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 Part 96 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

This Class II permissive change is to demonstrate compliance for the **AirScale Micro RRH 3.5GHz 4T/4R 20W (AZQC)** product for the addition of bandwidth for both single and multicarrier mode of operation. The change added 10MHz and 2x10MHz (Contiguous and Non-Contiguous) 5G-NR Operation. The AZQC was previously certified for LTE 10 and 20 MHz, 5G-NR 20 MHz bandwidth, and 2x20 5G-NR & LTE Multicarrier (Contiguous and Non-Contiguous) operations. No software changes have been made to the product that would necessitate a repeat of the Spectrum Allocation Server (SAS) testing.

1.3 EUT Details

1.3.1 Specifications

Specification Items	Description
Product Type	AirScale Micro RRH 3.5GHz 4T/4R 20W (AZQC)
Radio Type	Intentional Transceiver
CBSD Category	Category B CBSD Device
Power Type	DC: -48V
Modulation	QPSK, 16QAM, 64QAM and 256QAM
Operating Frequency Range	CBRS (Tx/Rx: 3550-3700 MHz)
Channel Bandwidth	10 MHz / 2x10MHz (Contiguous and Non-Contiguous)
Max Conducted Power (Rated)	Up to 4x5W (37.0 dBm) per TX path (0.1 dB steps down to 50mW)
Antenna Gain	4.0 dBi
Operating Mode	4T4R
Antenna(s)	Refer to Section 1.3.2

1.3.2 EIRP/ PSD Compliance and Antenna Information.

The product does not incorporate integrated antennas and is not supplied with antennas. Externally mounted antennas must be connected to the unit and mounted remotely. This product requires Certified Professional Installation. The antenna gain/ cable loss and other the parameters of the installation will be resident in the unit and in the SAS.

1.3.3 Photographs

Serial Number

Radio Unit

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 (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[1]
2.1055, 96.41(e)(2)(3)	Measurement of Frequency Stability	No[2]

[1]Refer to Section 6
[2]Testing was performed under GPCL project 2018-0097.

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

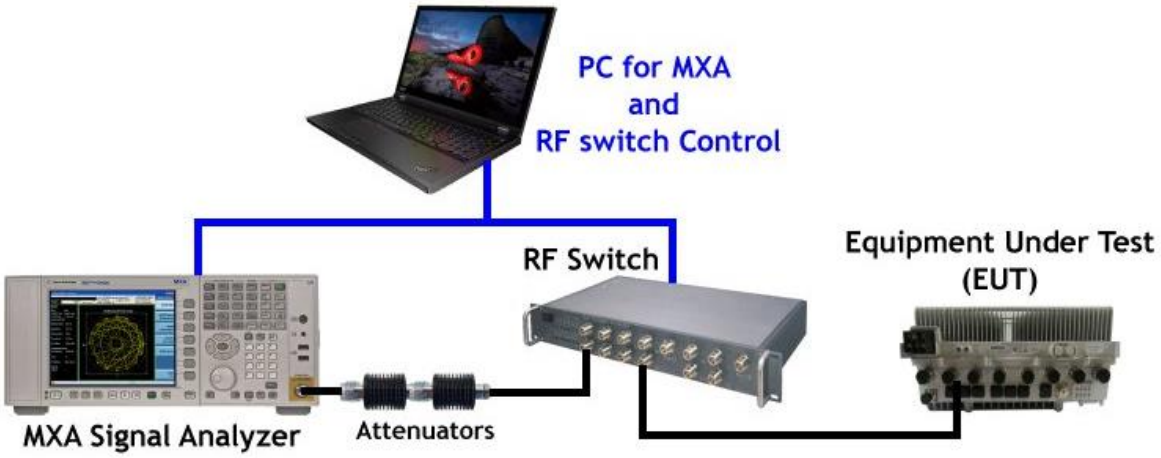
1.7 Executive Summary

Requirement 47 CFR FCC Parts 2 and 96	Description of Tests	Result
2.1046, 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	COMPLIES
2.1055	Measurement of 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 and Power Spectral Density

2.1 RF Power Output

This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal. The product was allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26.

The AirScale Micro RRH 3.5GHz 4T/4R 20W (AZQC), is specified to provide a maximum power output of 5W/37 dBm per transmit port for a sum total of 20 Watts /43 dBm per transmit module.

The power is under digital control. The product is designed to operate under Part 96 rules for Band 48.

Under Part 96 the product is limited to the Category B CBSD maximum EIRP of 47 dBm/10 MHz with a PSD of 37 dBm/MHz.

The unit is supplied with externally mounted Omni antennas for use on the B48 transmit ports. This antenna has a nominal gain of 4 dBi.

In the event the customer wants to use a different antenna, the maximum gain + cable loss cannot exceed 10.98 dBi when operating at full power in order to stay within the EIRP limits for the band.

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).

2.1.1 RF Power Output Measurements

Power measurements of the 5G transmit signal were conducted with an MXA Signal analyzer per KDB 971168 D01 using the gated RF Channel Power Function.

The applied signal from the AirScale Micro RRH 3.5GHz 4T/4R 20W (AZQC), met the recommended characteristics as defined in 3GPP TS 36.141 V14.1.0 (2016-09) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14).

The maximum rated mean power at the antenna transmitting terminal was measured at the Left, Center and Right side of the 3550-3700 CBRS frequency range for three different modulation modes. These were 3GPP standard base station test models for QPSK+16QAM, 64QAM and 256QAM modulation. This power level was documented on each data sheet for Occupied bandwidth.

2.1.2 RF Power Output Results

Table 2.1 RF Power Output Results

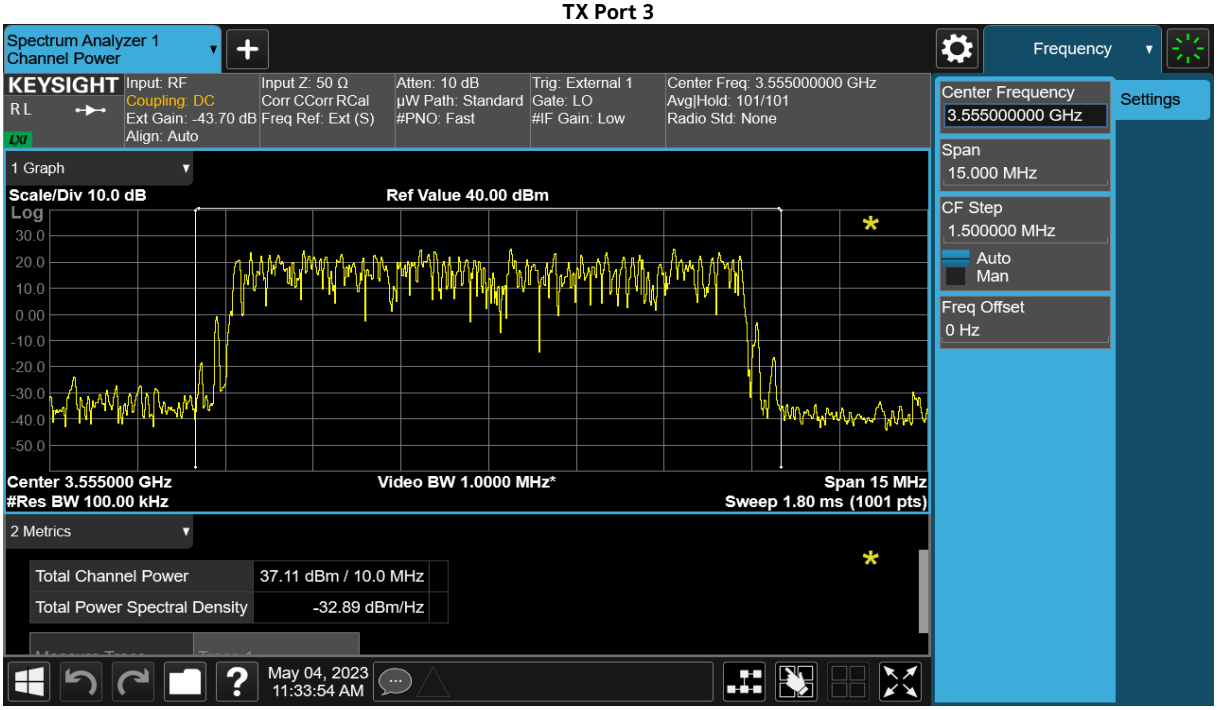
Channel Power - Signal BW 10MHz					
Test Model 3.1 Modulation 64 QAM Channel Frequency 3555MHz		Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 3624.99MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 3694.995MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	36.77	1	36.75	1	36.48
2	36.81	2	36.81	2	36.75
3	**37.11***	3	**37.04**	3	**36.97**
4	37.05	4	37.00	4	36.87
Total Power (dBm)	**42.96**	Total Power (dBm)	42.92	Total Power (dBm)	42.79
Total Power (W)	19.76	Total Power (W)	19.60	Total Power (W)	19.02

Channel Power - Signal BW 10+10MHz (Contiguous)					
Test Model 3.1 Modulation 64 QAM Channel Frequency 3555 +3564.99MHz		Test Model 3.2 Modulation QPSK/16QAM Channel Frequency 3619.995 +3630MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 3684.99+3694.995MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	36.53	1	36.64	1	36.56
2	36.60	2	36.62	2	36.71
3	**36.96**	3	**36.96**	3	**37.04***
4	36.77	4	36.90	4	36.88
Total Power (dBm)	42.74	Total Power (dBm)	42.80	Total Power (dBm)	**42.82**
Total Power (W)	18.79	Total Power (W)	19.07	Total Power (W)	19.15

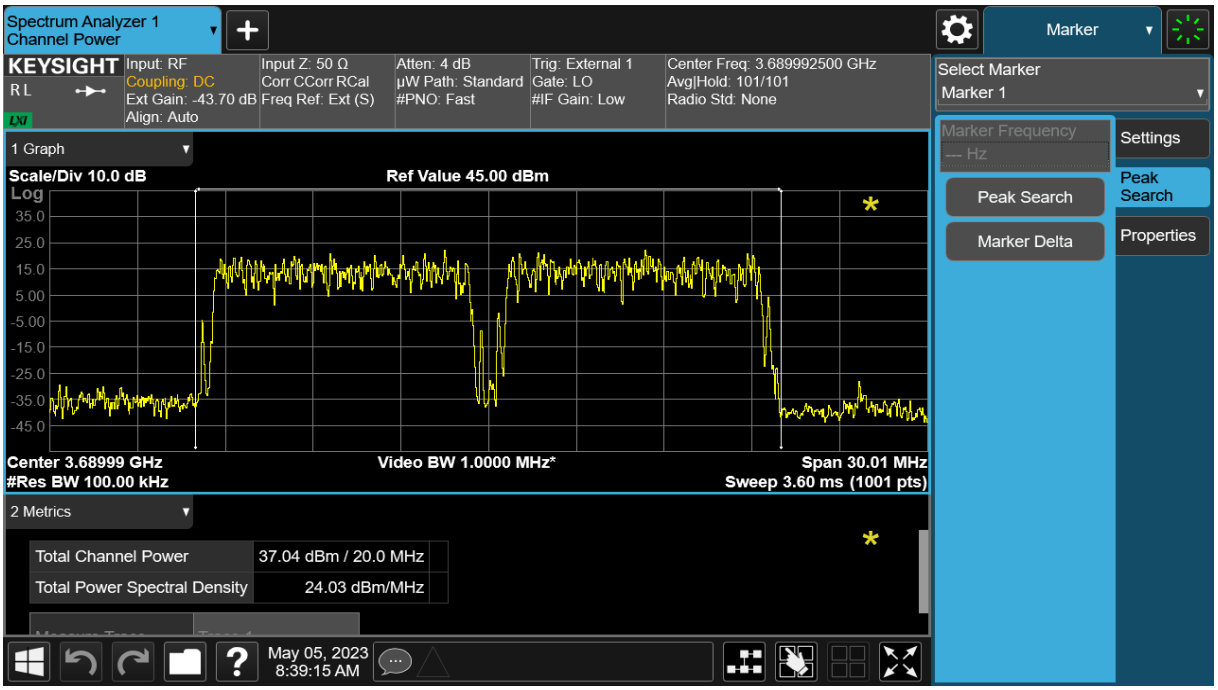
Channel Power - Signal BW 10+10MHz (Non-Contiguous)					
Test Model 3.1 Modulation 64 QAM Channel Frequency 3555 +3654.99MHz		Test Model 3.1 Modulation 64 QAM Channel Frequency 3555 +3664.99MHz		Test Model 1.1 Modulation QPSK Channel Frequency 3594.99 +3694.995MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	**36.96**	1	**36.96**	1	**37.22***
2	36.80	2	36.80	2	36.96
3	36.80	3	36.80	3	36.97
4	36.87	4	36.87	4	36.96
Total Power (dBm)	42.88	Total Power (dBm)	42.88	Total Power (dBm)	**43.05**
Total Power (W)	19.40	Total Power (W)	19.40	Total Power (W)	20.18

2.1.3 Maximum RF Conducted Output Power Plots

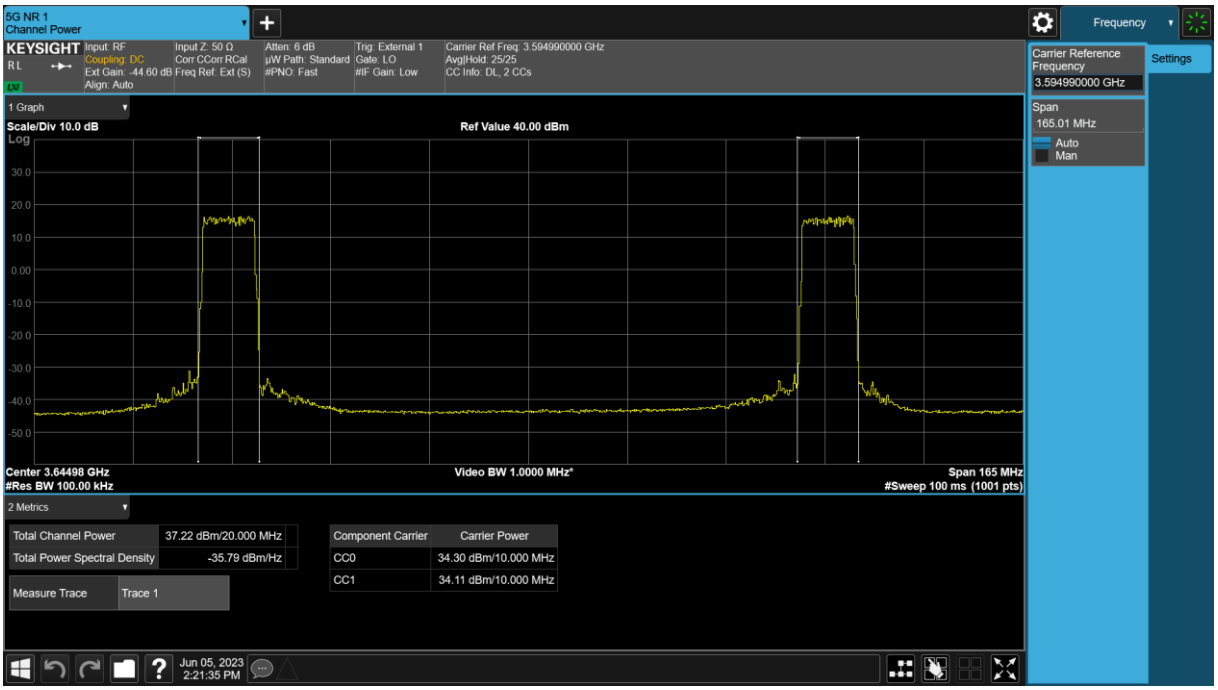
Signal BW 10MHz
Test Model 3.1, Modulation 64 QAM
Channel Frequency 3555MHz
TX Port 3



Signal BW 10+10MHz (Contiguous)
Test Model 3.1a, Modulation 256QAM
Channel Frequency 3684.99+3694.995MHz
TX Port 3



Signal BW 10+10MHz (Non-Contiguous)
Test Model 1.1, Modulation QPSK
Channel Frequency 3594.99 +3694.995MHz
TX Port 1



2.2 EIRP Compliance

The product does not incorporate integrated antennas. Externally mounted antennas can be attached to the unit or mounted remotely. The unit is supplied with unit mounted Omni antennas for use on the B48 transmit ports. This antenna has a nominal gain of 4 dBi. Compliance with the supplied antennas is documented in Table 2.2 for EIRP.

Under Part 96.41 the product is limited to a maximum Effective Isotropically Radiated Power (EIRP) of 47 dBm/10 MHz. Compliance with the EIRP requirements of Part 96.41 is tabulated in Table 2.2 below.

When set to the maximum total output power of 37 dBm the maximum allowable antenna gain is 10.98 dBi.

In the event the customer wants to use a different antenna, the maximum gain + cable loss cannot exceed 10.98 dBi when operating at full power in order to stay within the EIRP limits for the band.

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).

Table 2.2 Effective Isotropically Radiated Power (EIRP) Compliance

Transmit Signal Bandwidth	Maxi Total Transmit Power*	Antenna Gain	EIRP Bandwidth Correction for /10 MHz	Total Product EIRP	Part 96.41 EIRP Limit	Margin to Part 96 EIRP Limit.	EIRP Compliance
MHz	dBm	dBi	dB	dBm/10 MHz	dBm/ 10 MHz	dB	Pass/Fail
10	42.96	4.0	-	46.96	47.00	0.04	Pass
10+10 (Contiguous)	42.82	4.0	-3.01	43.81	47.00	3.19	Pass
10+10 (Non-Contiguous)	43.05	4.0	-3.01	44.04	47.00	2.96	Pass

*Value from Table 2.1

2.3 Power Spectral Density

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

The FCC Part 96 requirement for PSD is that the Power Spectral Density (PSD) of the EUT shall not exceed 37 dBm/MHz.

2.3.1 Results

The maximum Power Spectral Density (PSD) of the EUT measured at its antenna transmitting terminals were measured to be 25.98 dBm/MHz plus 6.02 dBm adjustment for 4 ports. **The measured values are in Table 2.3 below and provide a maximum allowable antenna gain that satisfies the requirement**

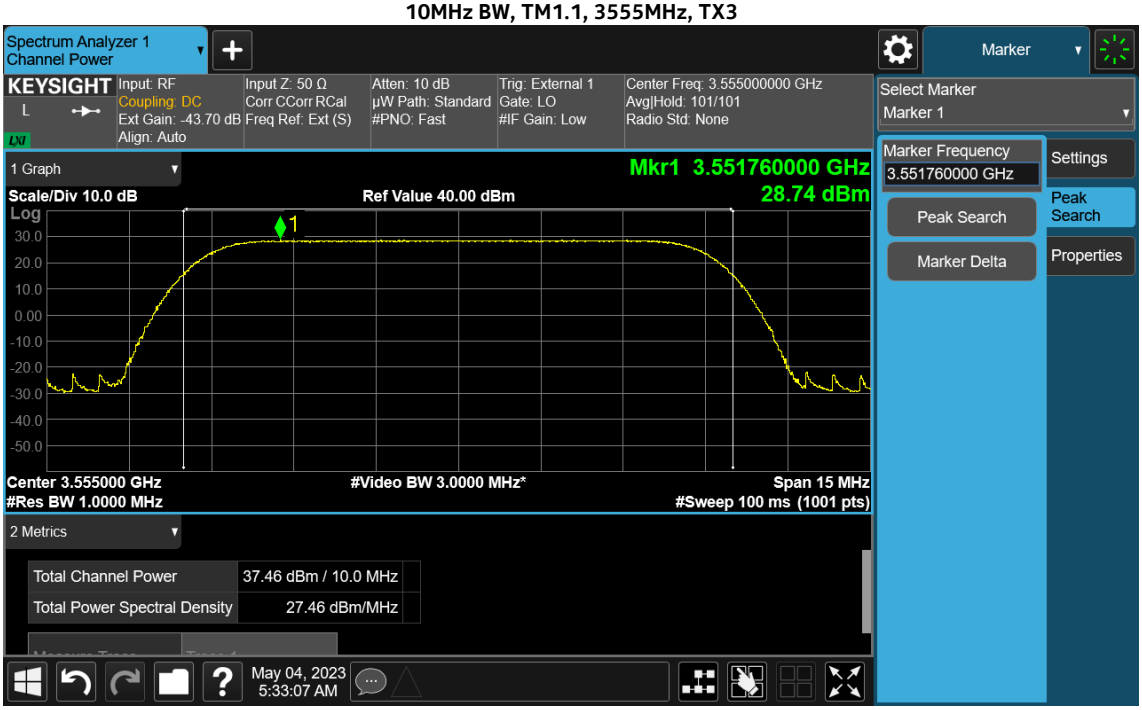
Table 2.3 Power Spectral Density Results

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz	Peak Power Spectrum Density (dBm) / 1MHz
1	10	1.1	QPSK	3	3555	**28.74**
1	10	1.1	QPSK	3	3624.99	28.38
1	10	1.1	QPSK	3	3694.995	28.59
2	10+10	1.1	QPSK	3	3555 +3564.99	**25.55**
2	10+10	1.1	QPSK	3	3619.995 +3630	24.94
2	10+10	1.1	QPSK	3	3684.99+3694.995	24.77
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3555 +3664.99	24.76
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3555 +3654.99	24.76
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995	**25.48**

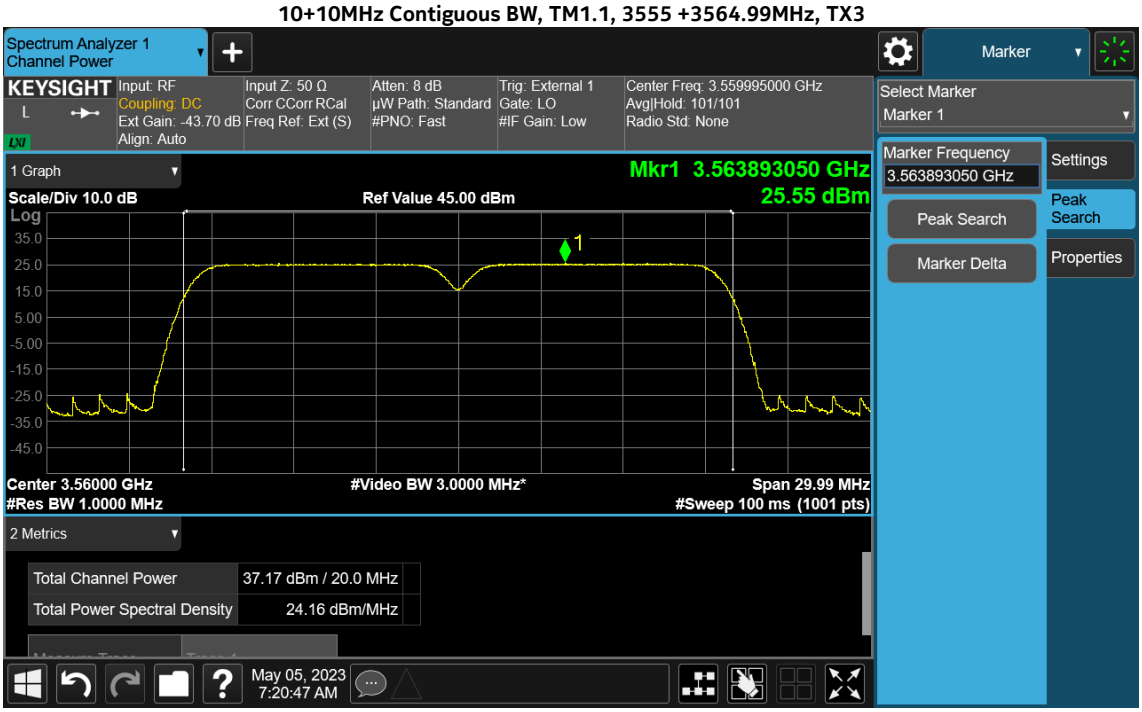
# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	Max PPSD (1 Port) dBm/1MHz	Total PSD (4 Ports) dBm/MHz	Max Allowable Ant Gain	PSD Limit dBm/MHz	PSD Results
1	1.1	QPSK	3	3555	10	28.74	34.76	2.24	37	Pass
2	1.1	QPSK	3	3555 +3564.99	10+10	25.55	31.57	5.43	37	Pass
2 Non-Contiguous	1.1	QPSK	1	3594.99 +3694.995	10+10	25.48	31.50	5.50	37	Pass

2.3.2 PSD Plots

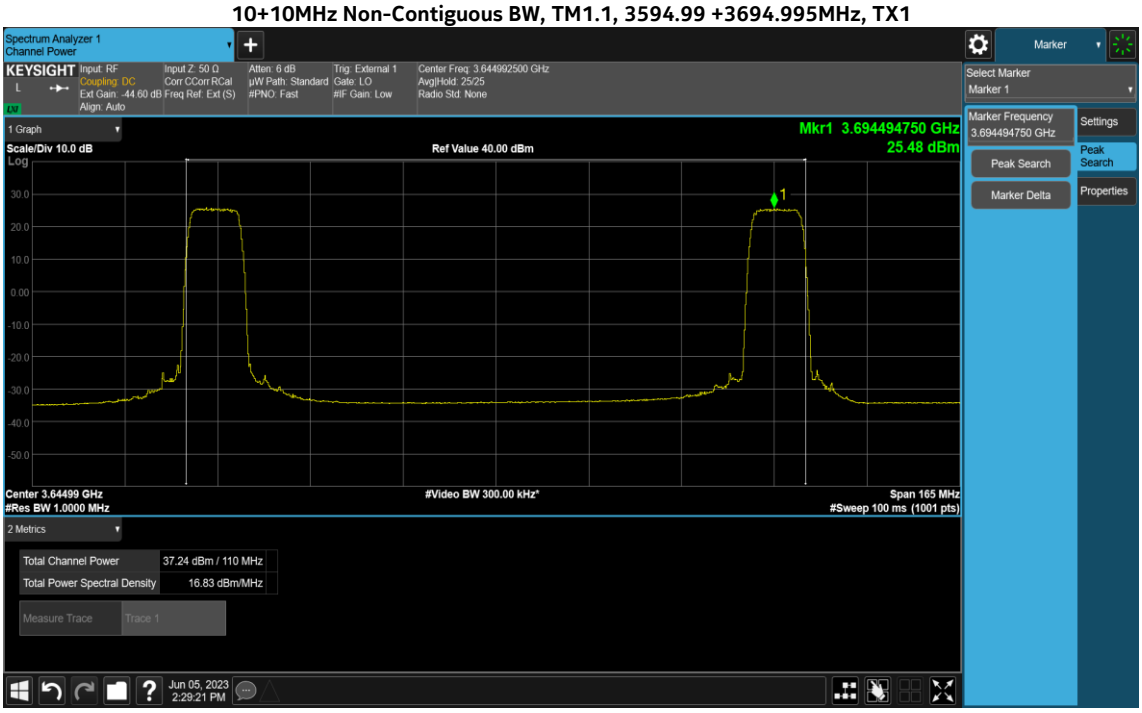
10MHz BW, TM1.1, 3555MHz, TX3



10+10MHz Contiguous BW, TM1.1, 3555 +3564.99MHz, TX3



10+10MHz Non-Contiguous BW, TM1.1, 3594.99 +3694.995MHz, TX1



2.4 Peak-to-Average Power Ratio (PAPR)

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

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 2.4.

2.4.1 Peak-to-Average Power Ratio Results:

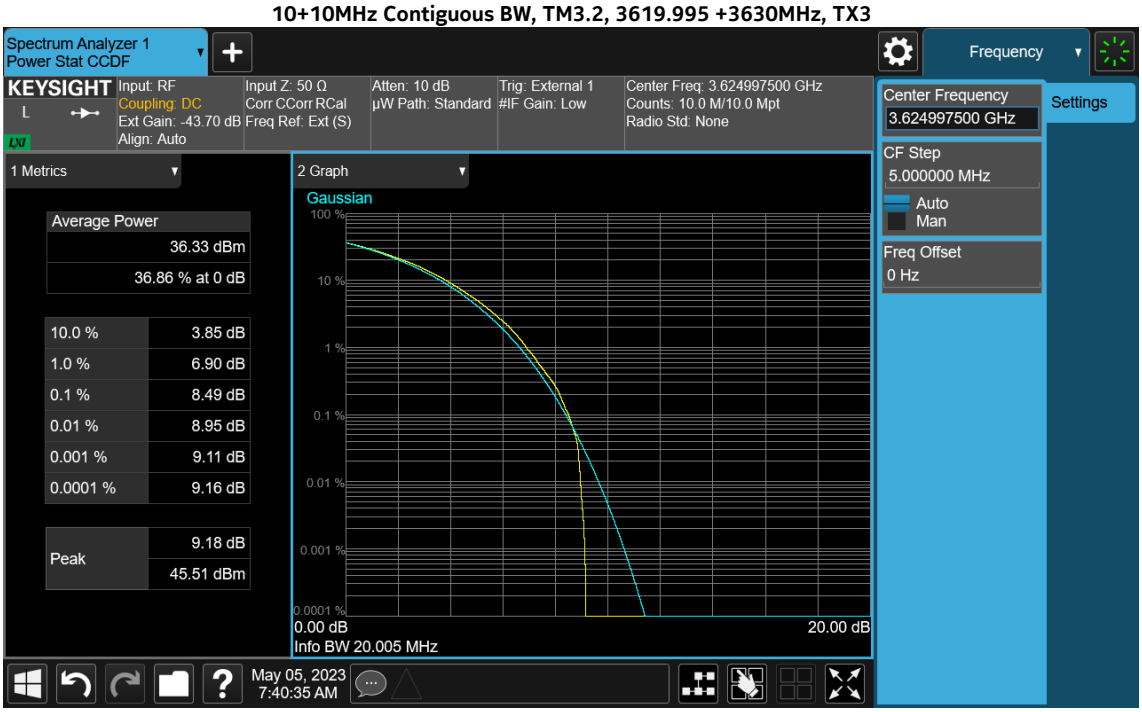
The maximum Peak-to-Average Power Ratio (PAPR) of the EUT measured at its antenna transmitting terminals was measured to be 8.11dB maximum, which is in full compliance with the requirement to not exceed 13 dB as specified by the FCC. The representative data sets exact values are listed in Table 2.4 below.

Table 2.4 Peak to Average Power Ratio

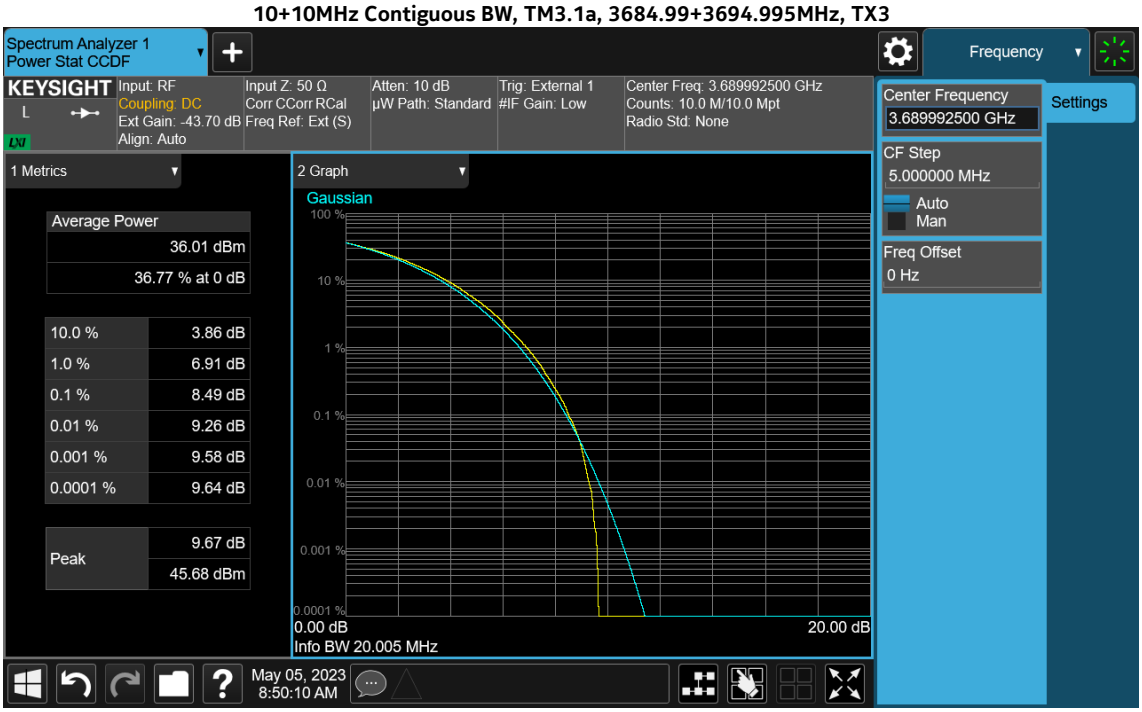
# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz	PAR at 0.1% Limit - 13 dB
1	10	3.1	64QAM	3	3555	8.00
1	10	3.2	QPSK/16QAM	3	3624.99	8.11
1	10	3.1a	256QAM	3	3694.995	7.99
2	10+10	3.1	64QAM	3	3555 +3564.99	8.27
2	10+10	3.2	QPSK/16QAM	3	3619.995 +3630	**8.49**
2	10+10	3.1a	256QAM	3	3684.99+3694.995	**8.49**
2 (Non-Contiguous)	10+10	3.1	64QAM	1	3555 +3664.99	8.21 / 8.29
2 (Non-Contiguous)	10+10	3.1	64QAM	1	3555 +3654.99	8.21 / 8.29
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995	8.17 / 8.33

2.4.2 Peak-to-Average Power Ratio Plots

10+10MHz Contiguous BW, TM3.2, 3619.995 +3630MHz, TX3



10+10MHz Contiguous BW, TM3.1a, 3684.99+3694.995MHz, TX3



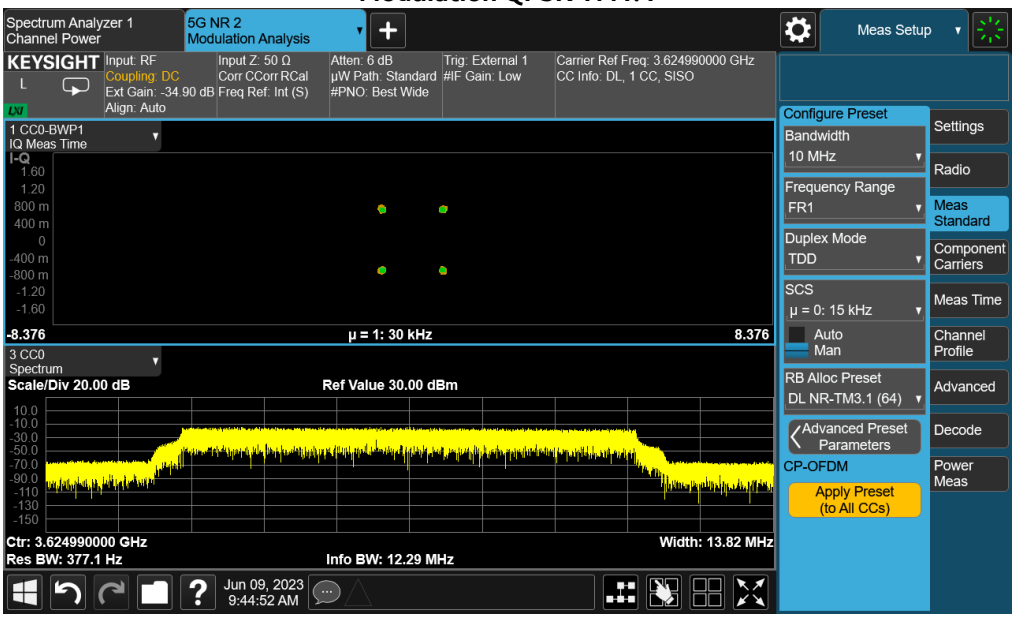
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

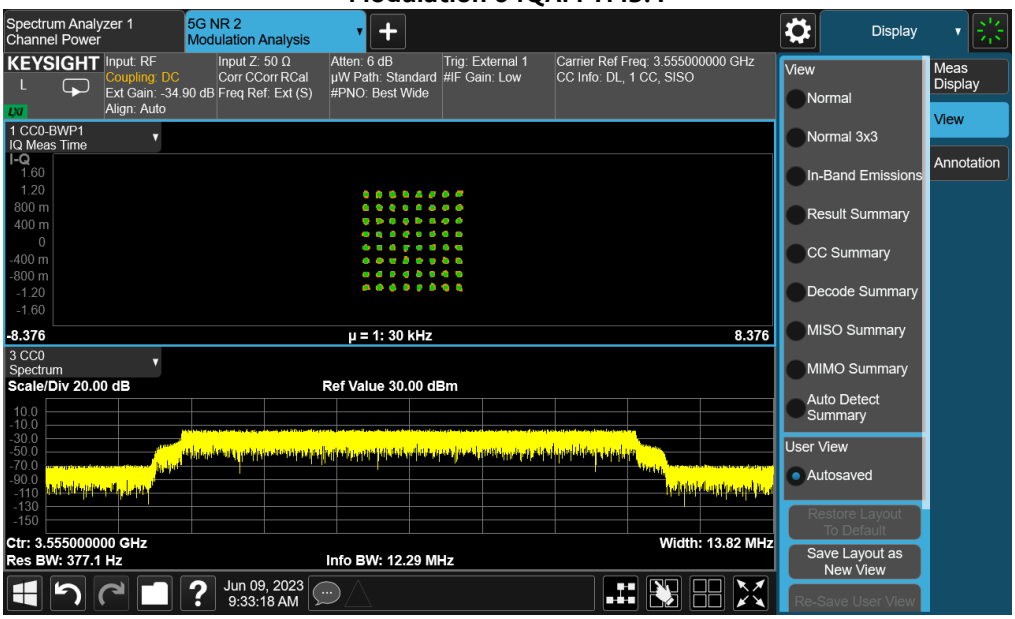
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

3.1.1 Modulation Characteristics – Plots

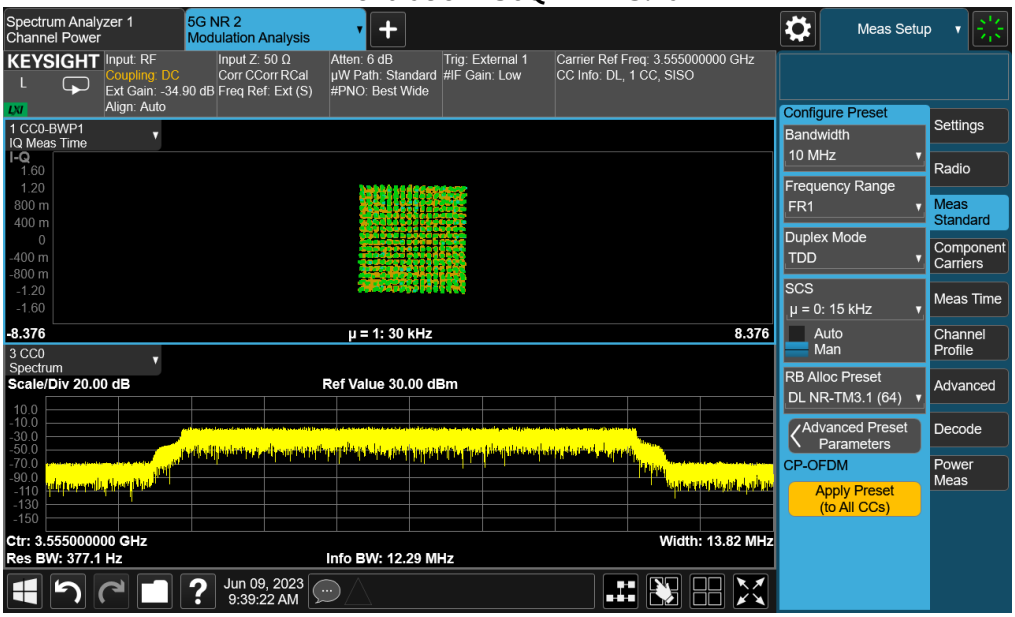
Modulation QPSK TM1.1



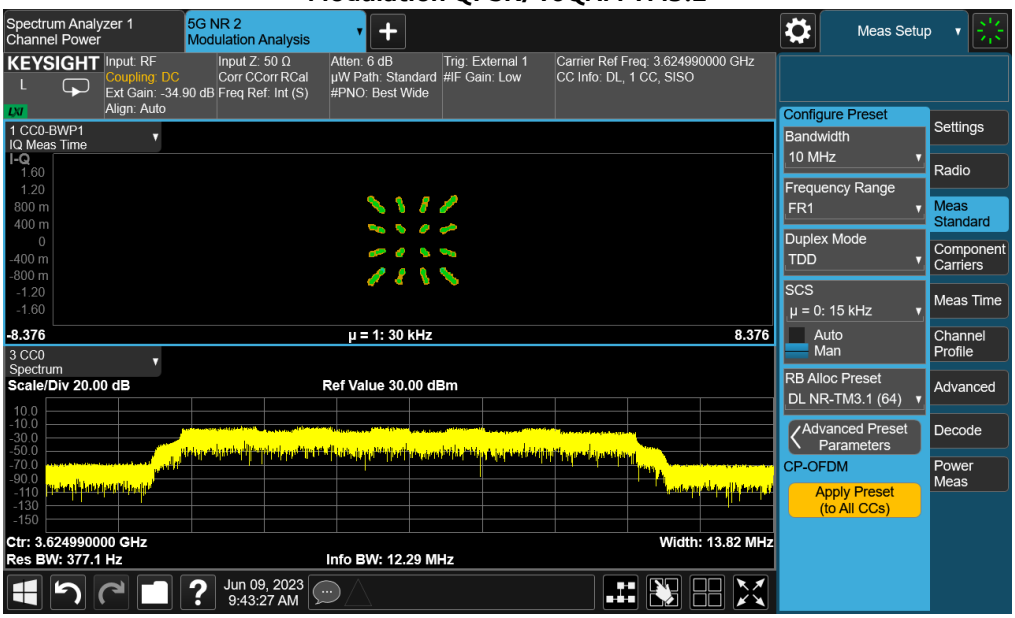
Modulation 64QAM TM3.1



Modulation 256QAM TM3.1a



Modulation QPSK/16QAM TM3.2



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.

4.1.1 Occupied Bandwidth (Signal Bandwidth) Results

The 99% occupied bandwidth and -26 dB relative bandwidth was measured with an Agilent/Keysight MXA signal analyzer for the emission designators. The results are tabulated in Tables 4.1 & 4.2 and plots are in section 4.1.2 and shows that the measured signals are within the parameters of the emissions designator for the FCC.

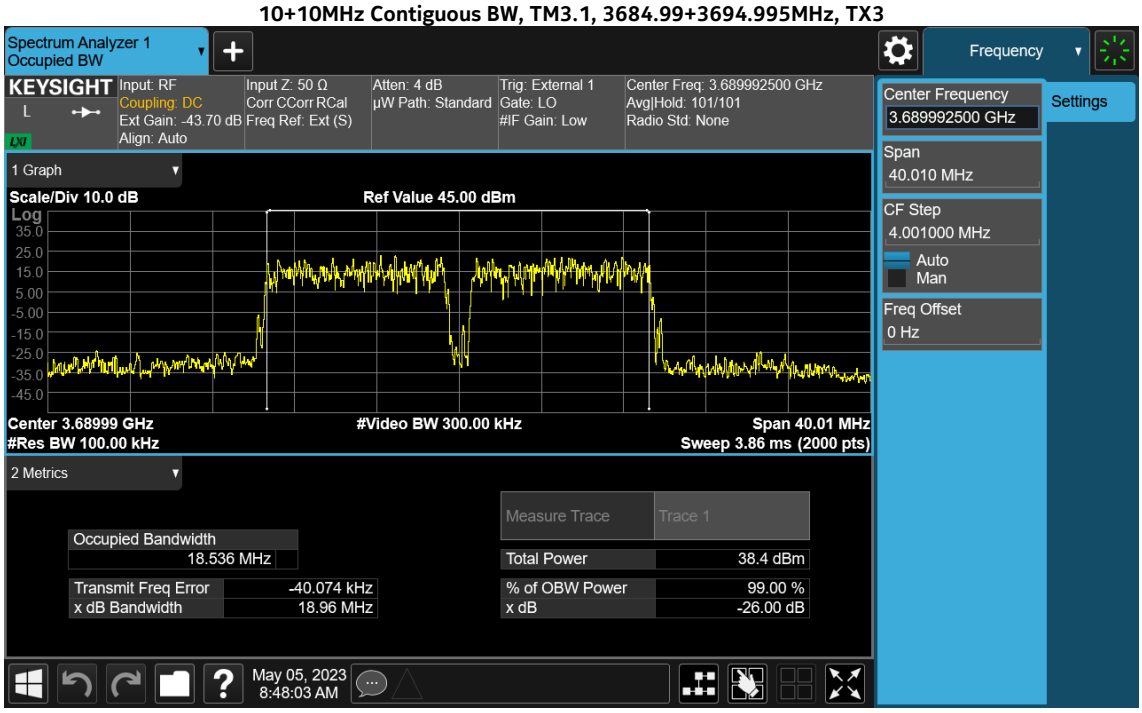
Table 4.1: 99% and 26dB Occupied Bandwidth

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz	99% Occupied BW MHz	26dB Occupied BW MHz
1	10	3.1	64QAM	3	3555	8.5554	**9.346**
1	10	3.2	QPSK/16QAM	3	3624.99	8.5338	9.296
1	10	3.1a	256QAM	3	3694.995	8.5269	8.864
2	10+10	3.1	64QAM	3	3555 +3564.99	18.481	18.83
2	10+10	3.2	QPSK/16QAM	3	3619.995 +3630	18.417	18.95
2	10+10	3.1a	256QAM	3	3684.99+3694.995	**18.536**	**18.96**
2 (Non-Contiguous)	10+10	3.1	64QAM	1	3555 +3664.99	8.5490 / 8.6034	9.168 / 9.308
2 (Non-Contiguous)	10+10	3.1	64QAM	1	3555 +3654.99	8.5490 / 8.6034	9.168 / 9.308
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995	**8.6037** / 8.5338	8.987 / 8.849

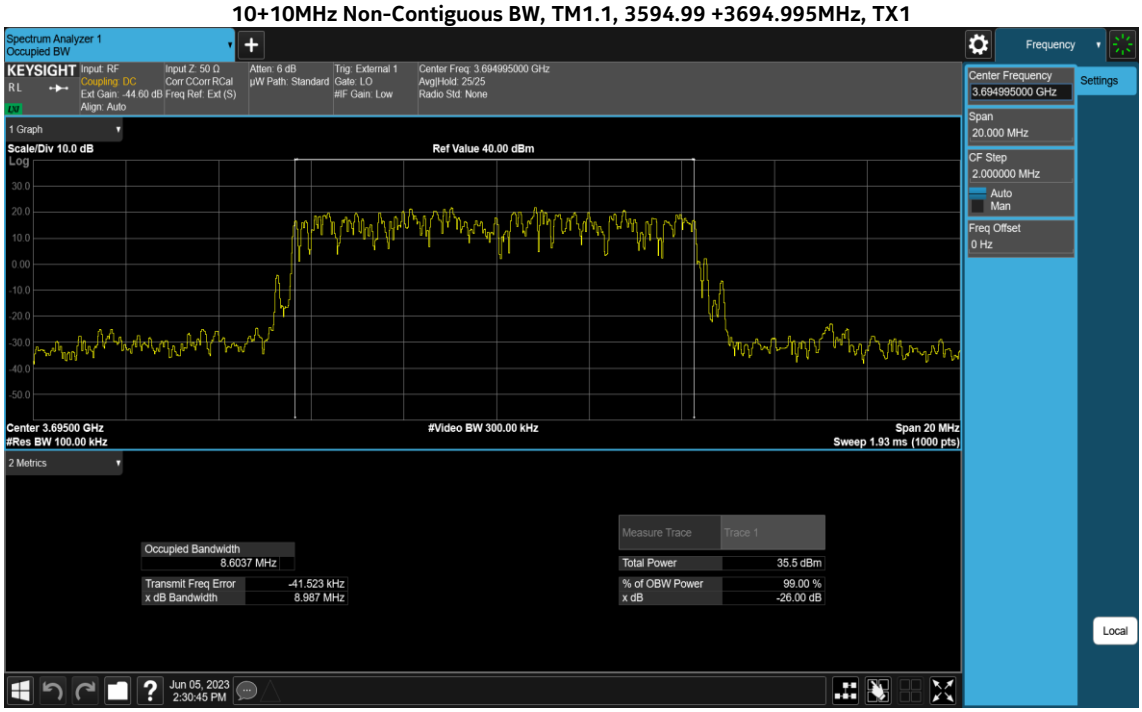
4.1.2 Occupied Bandwidth – Plots

Maximum 99% Occupied BW

10+10MHz Contiguous BW, TM3.1, 3684.99+3694.995MHz, TX3

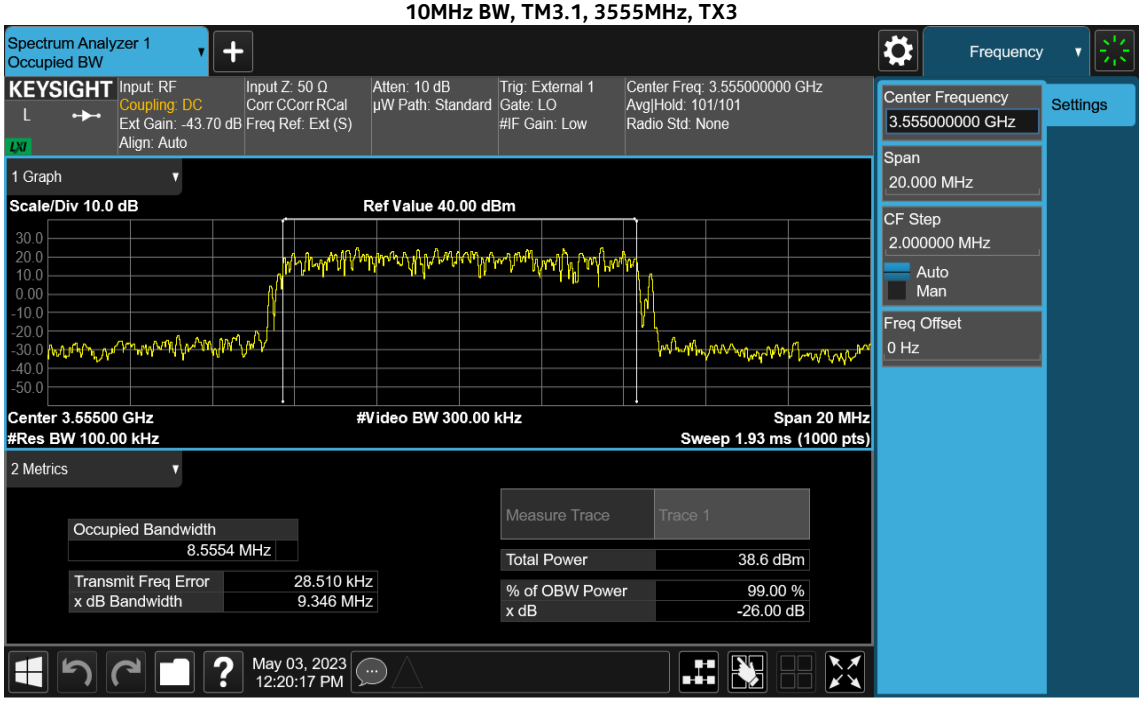


10+10MHz Non-Contiguous BW, TM1.1, 3594.99 +3694.995MHz, TX1

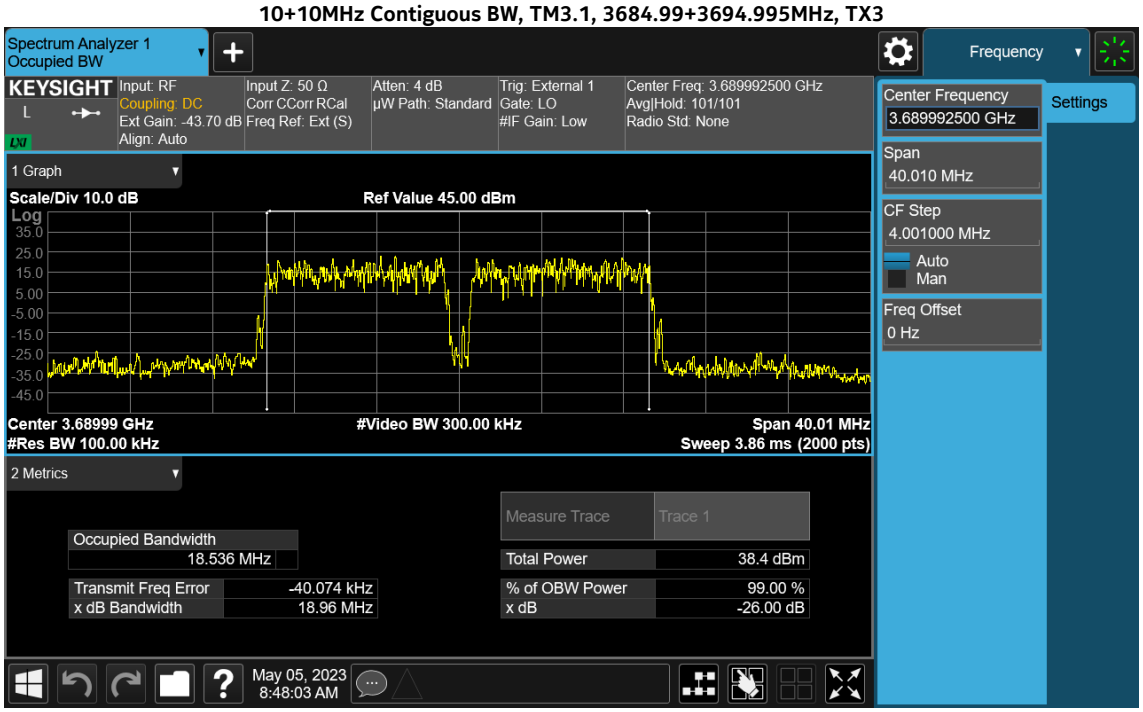


Maximum 26dB Occupied BW

10MHz BW, TM3.1, 3555MHz, TX3



10+10MHz Contiguous BW, TM3.1, 3684.99+3694.995MHz, TX3



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 ⩽ −13 dBm/MHz,
- greater than 10 MHz above and below the assigned channel ⩽ −25 dBm/MHz,
- any emission below 3530 MHz and above 3720 MHz ⩽ −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 band 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 Top of Mask corresponds to the set rated power level as confirmed by the RF power meter.

4.2.1 Edge of Band Emissions - Results

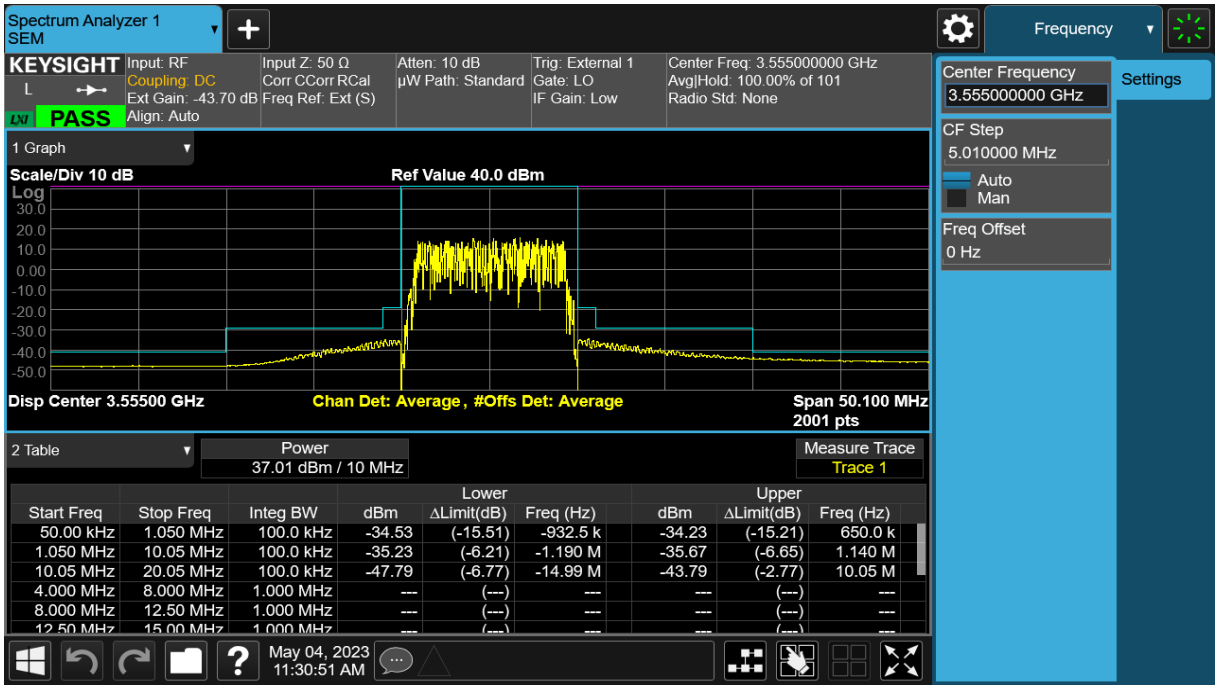
All of the measurements met the requirements of Part 96.41(e)(1) and KDB 940660 D01 Section 3.2 (b)(6) when measured per Part 2.1049.

Table 4.3: Edge of Band Emissions

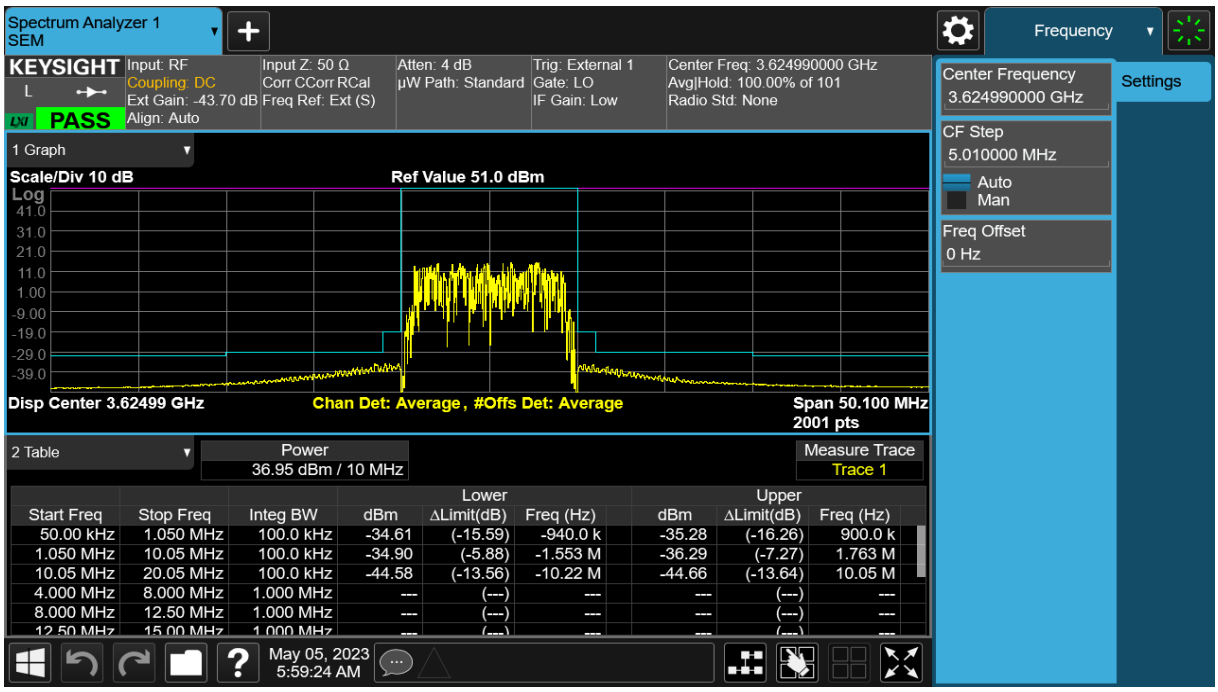
# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz	Result
1	10	3.1	64QAM	3	3555	Pass
1	10	3.2	QPSK/16QAM	3	3624.99	Pass
1	10	3.1a	256QAM	3	3694.995	Pass
2	10+10	3.1	64QAM	3	3555 +3564.99	Pass
2	10+10	3.2	QPSK/16QAM	3	3619.995 +3630	Pass
2	10+10	3.1a	256QAM	3	3684.99+3694.995	Pass
2 (Non-Contiguous)	10+10	3.1	64QAM	1	3555 +3664.99	Pass
2 (Non-Contiguous)	10+10	3.1	64QAM	1	3555 +3654.99	Pass
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995	Pass

4.2.2 Edge of Band Emissions - Plots

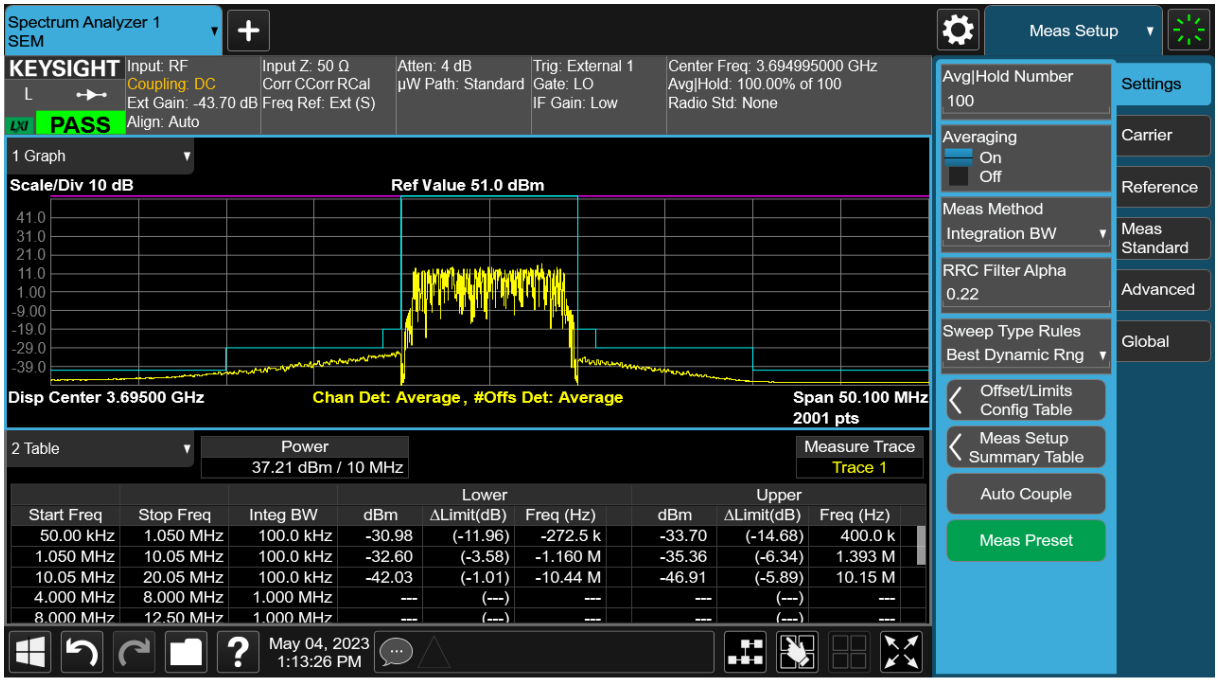
10 MHz BW - 3555 MH



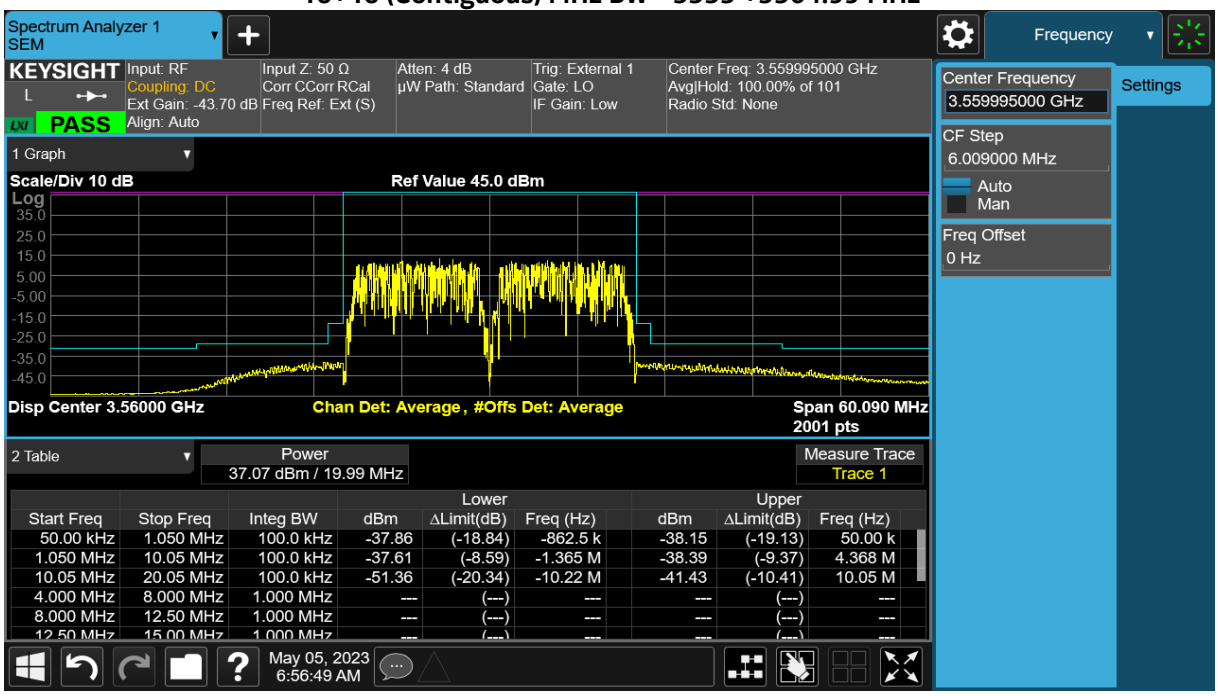
10MHz - 3624.99 MHz



10MHz - 3694.995 MHz

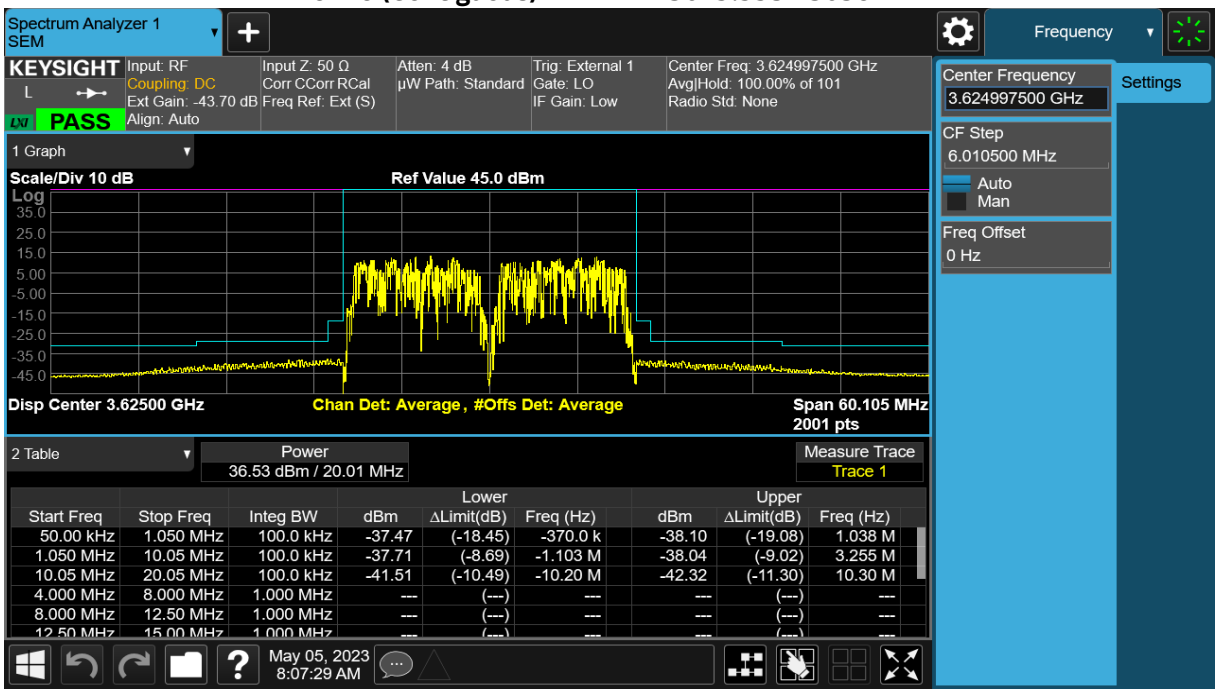


10+10 (Contiguous) MHz BW - 3555 +3564.99 MHz



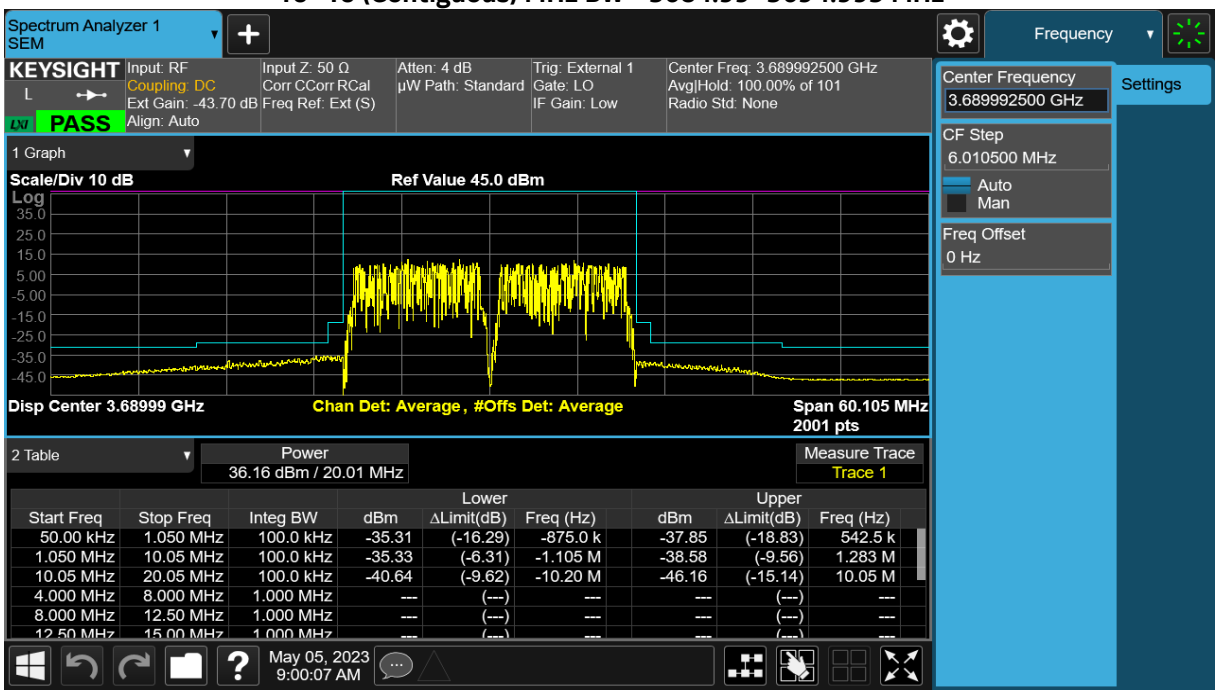
			Lower			Upper		
Start Freq	Stop Freq	Integ BW	dBm	ΔLimit(dB)	Freq (Hz)	dBm	ΔLimit(dB)	Freq (Hz)
50.00 kHz	1.050 MHz	100.0 kHz	-37.86	(-18.84)	-862.5 k	-38.15	(-19.13)	50.00 k
1.050 MHz	10.05 MHz	100.0 kHz	-37.61	(-8.59)	-1.365 M	-38.39	(-9.37)	4.368 M
10.05 MHz	20.05 MHz	100.0 kHz	-51.36	(-20.34)	-10.22 M	-41.43	(-10.41)	10.05 M
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	---	(---)	---	---	(---)	---

10+10 (Contiguous) MHz BW - 3619.995 +3630MHz

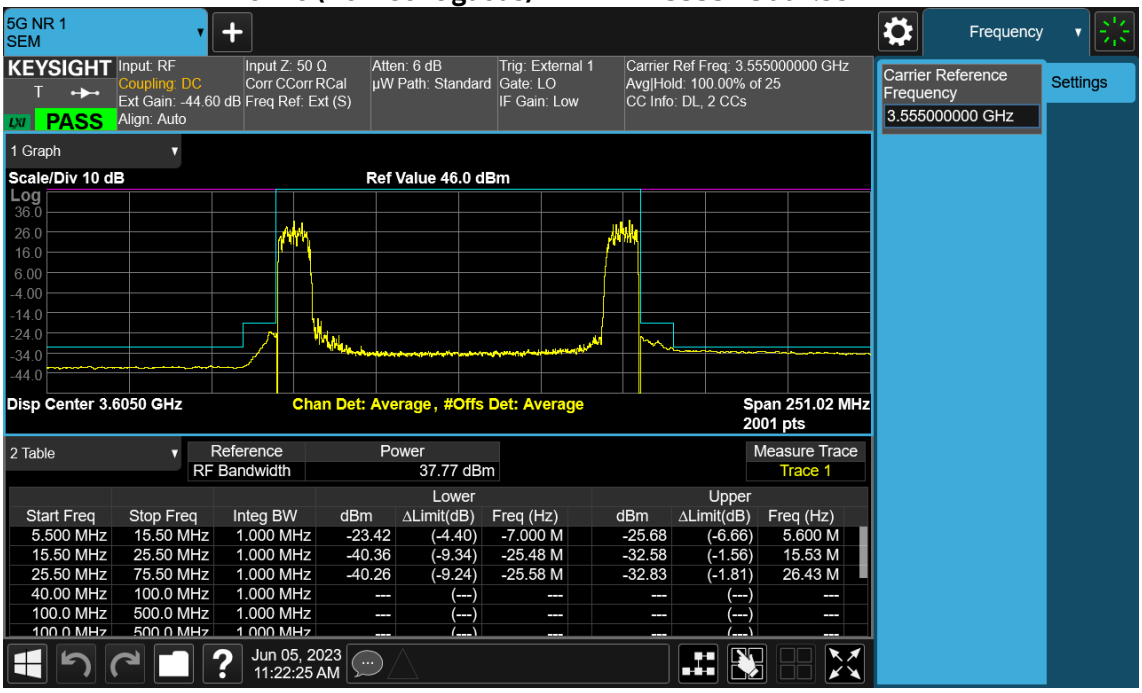


			Lower			Upper		
Start Freq	Stop Freq	Integ BW	dBm	ΔLimit(dB)	Freq (Hz)	dBm	ΔLimit(dB)	Freq (Hz)
50.00 kHz	1.050 MHz	100.0 kHz	-37.47	(-18.45)	-370.0 k	-38.10	(-19.08)	1.038 M
1.050 MHz	10.05 MHz	100.0 kHz	-37.71	(-8.69)	-1.103 M	-38.04	(-9.02)	3.255 M
10.05 MHz	20.05 MHz	100.0 kHz	-41.51	(-10.49)	-10.20 M	-42.32	(-11.30)	10.30 M
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	---	(---)	---	---	(---)	---

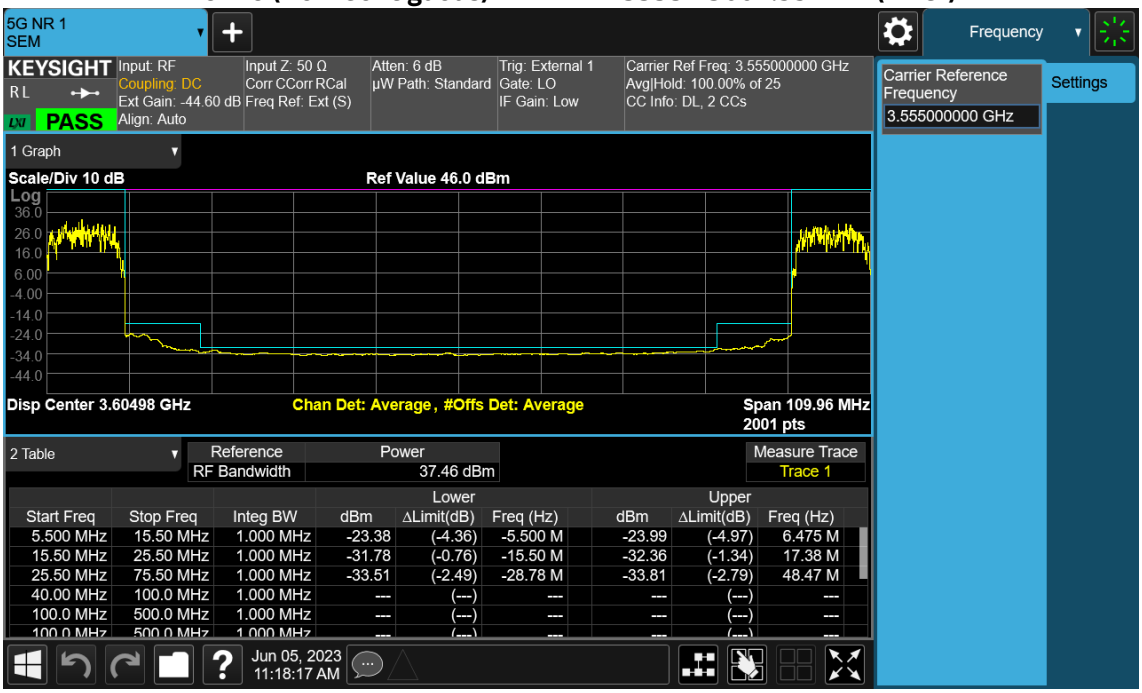
10+10 (Contiguous) MHz BW - 3684.99+3694.995 MHz



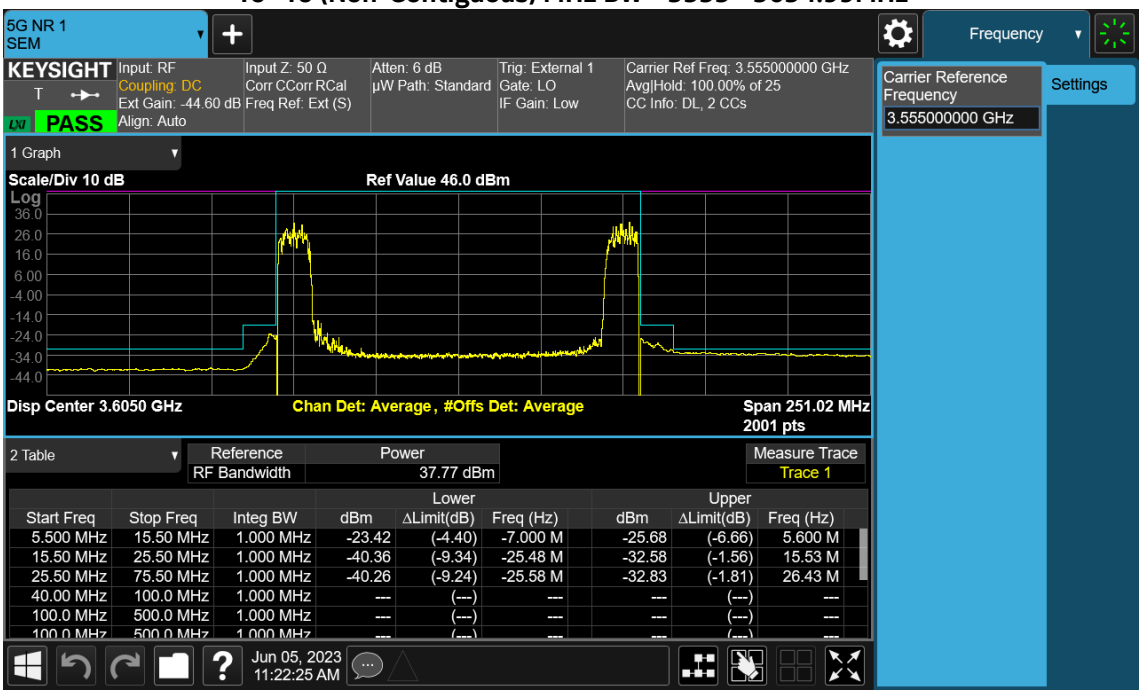
10+10 (Non-Contiguous) MHz BW - 3555 +3664.99 MHz



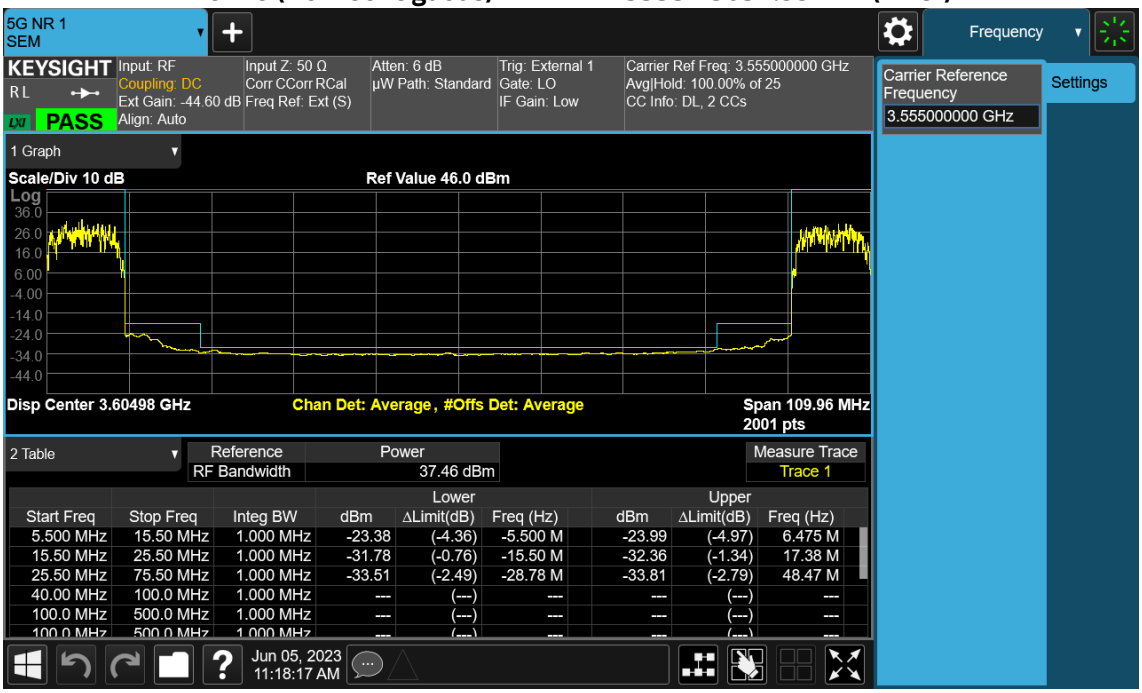
10+10 (Non-Contiguous) MHz BW – 3555 +3664.99 MHz (Inner)



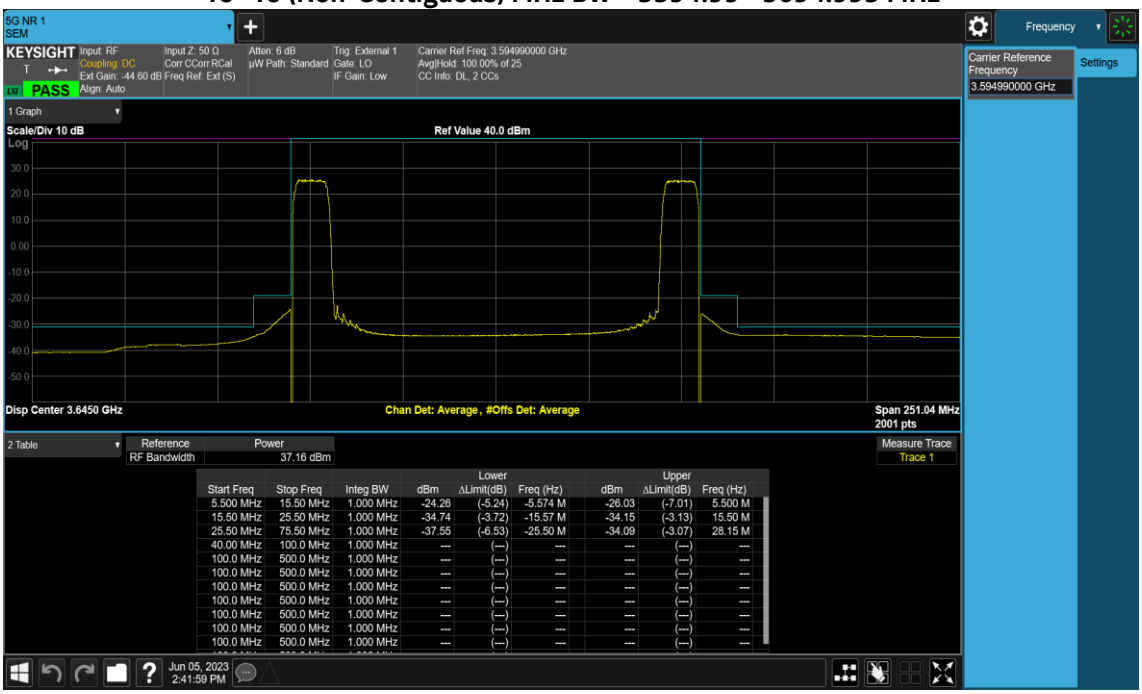
10+10 (Non-Contiguous) MHz BW - 3555 +3654.99MHz



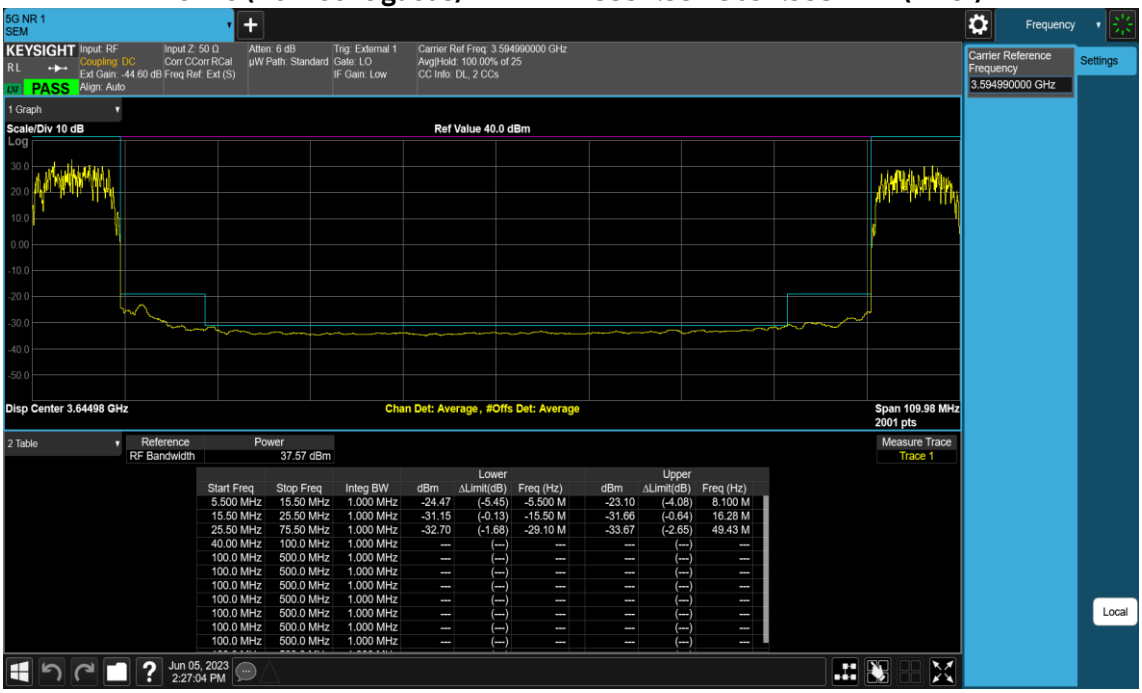
10+10 (Non-Contiguous) MHz BW - 3555 +3654.99MHz (Inner)



10+10 (Non-Contiguous) MHz BW – 3594.99 +3694.995 MHz



10+10 (Non-Contiguous) MHz BW - 3594.99 +3694.995 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 match 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 −40dBm/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

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

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

Table 5.1: Spurious Emissions at Antenna Terminals

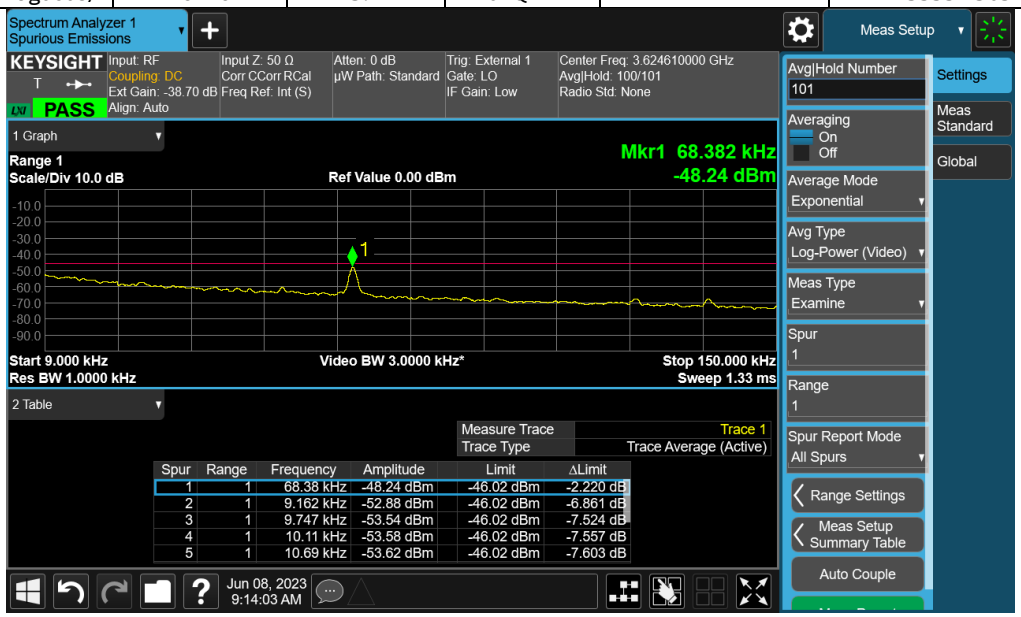
# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz	Conducted Spurious Emissions Results Pass/ Fail
1	10	3.1	64QAM	3	3555	Pass
1	10	3.2	QPSK/16QAM	3	3624.99	Pass
1	10	3.1a	256QAM	3	3694.995	Pass
2	10+10	3.1	64QAM	3	3555 +3564.99	Pass
2	10+10	3.2	QPSK/16QAM	3	3619.995 +3630	Pass
2	10+10	3.1a	256QAM	3	3684.99+3694.995	Pass
2 (Non-Contiguous)	10+10	3.1	64QAM	1	3555 +3654.99	Pass
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995	Pass

5.4 Spurious Emissions 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.

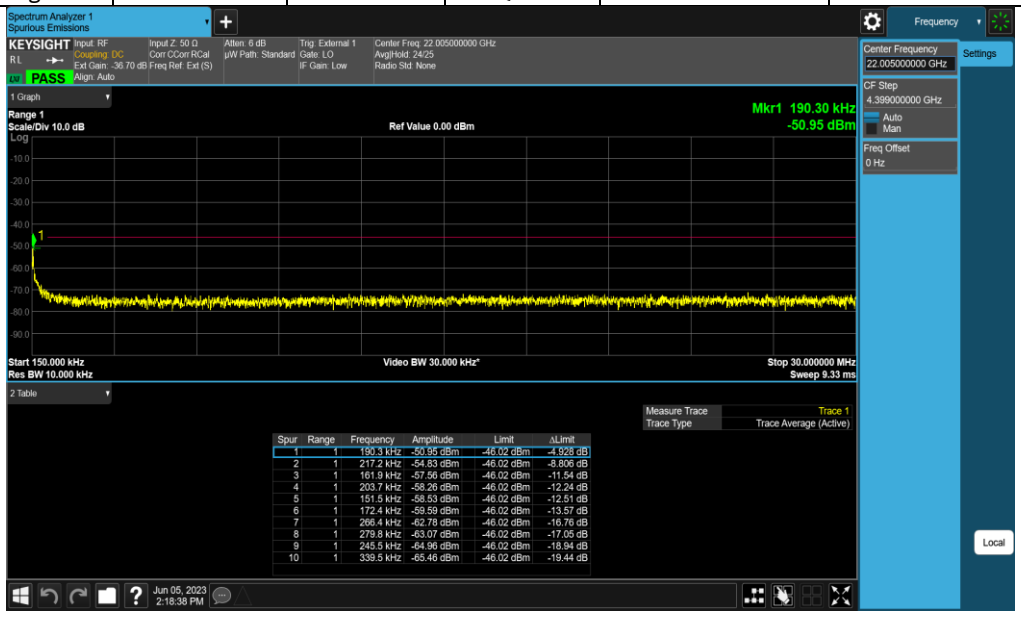
9 kHz – 150 kHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
2 (Non-Contiguous)	10+10	3.1	64QAM	1	3555 +3654.99



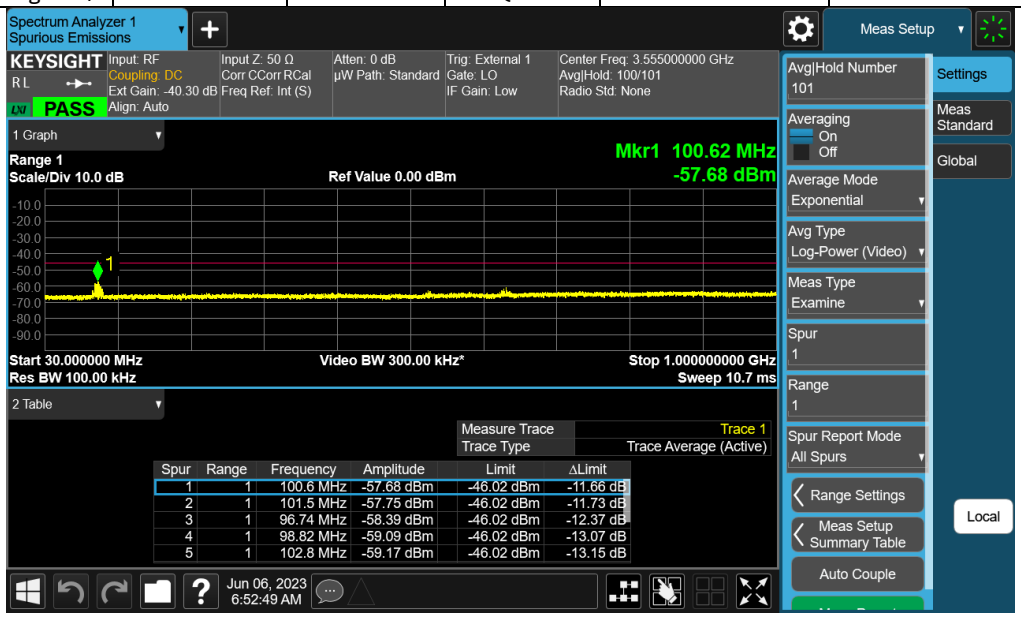
150 kHz – 30 MHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995



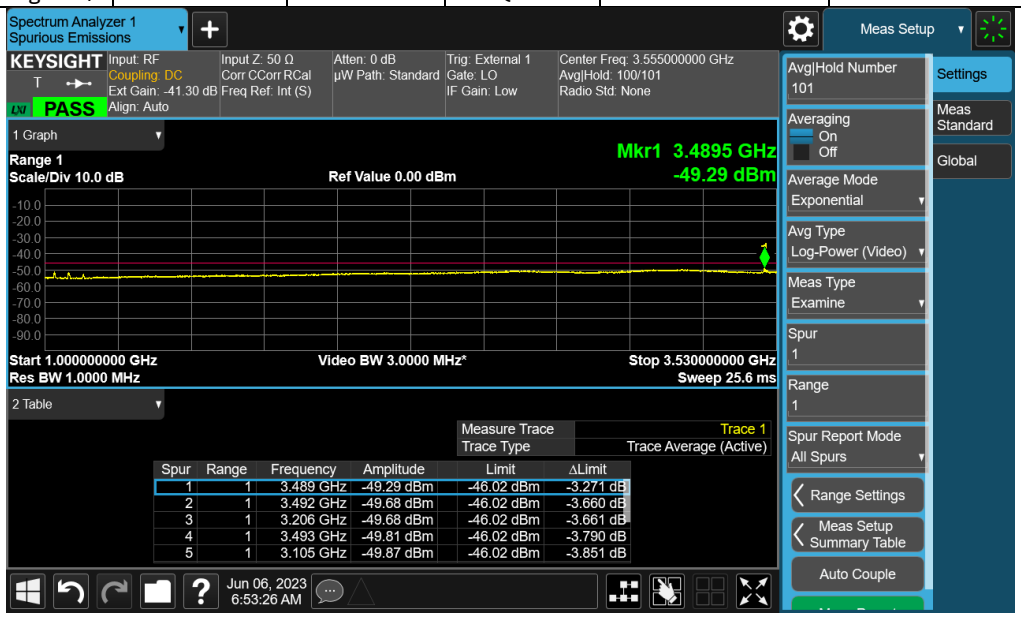
30 MHz – 1 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995



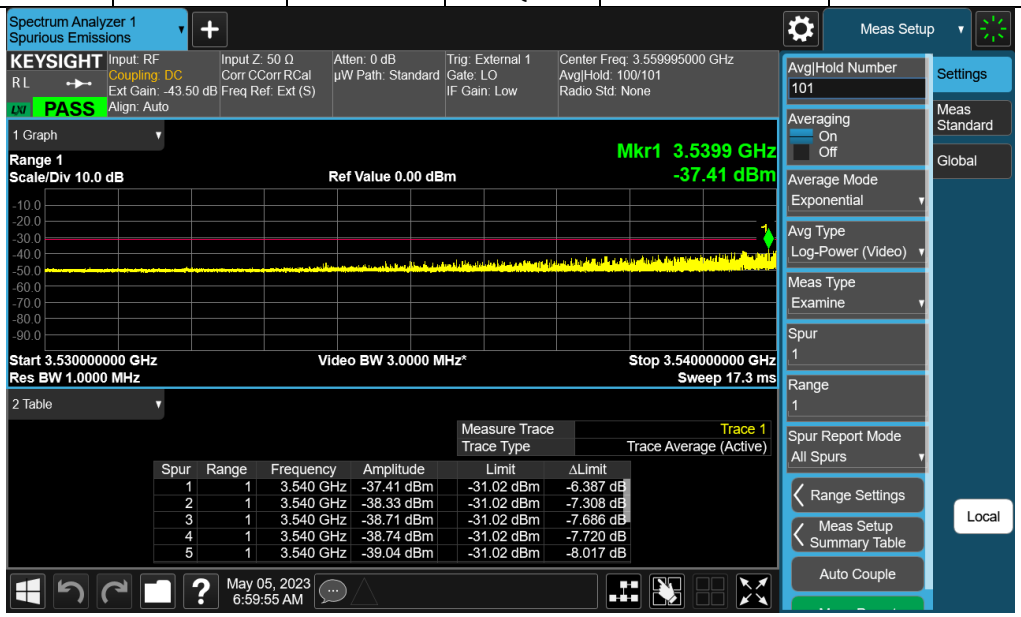
1 GHz – 3.53 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995



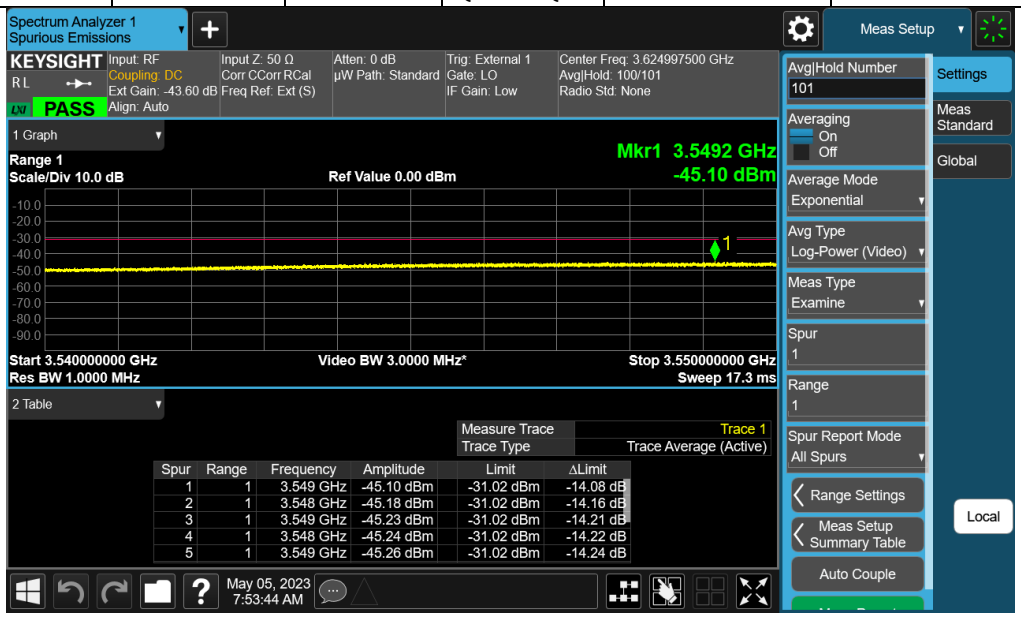
3.53 GHz – 3.54 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
2	10+10	3.1	64QAM	3	3555 +3564.99



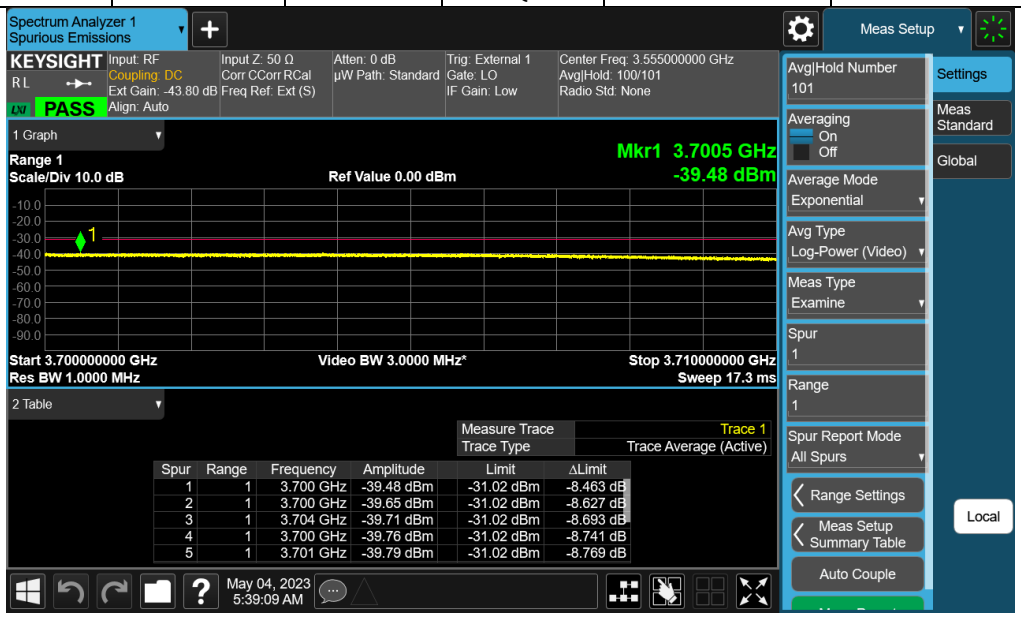
3.54 GHz – 3.55 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
2	10+10	3.2	QPSK/16QAM	3	3619.995 +3630



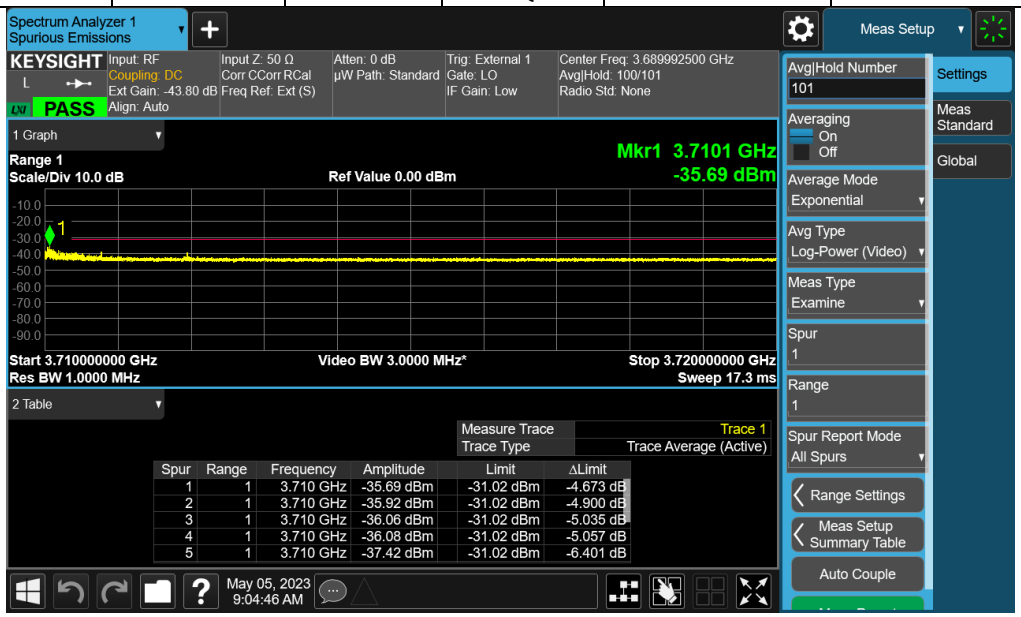
3.70 GHz – 3.71 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
1	10	3.1	64QAM	3	3555



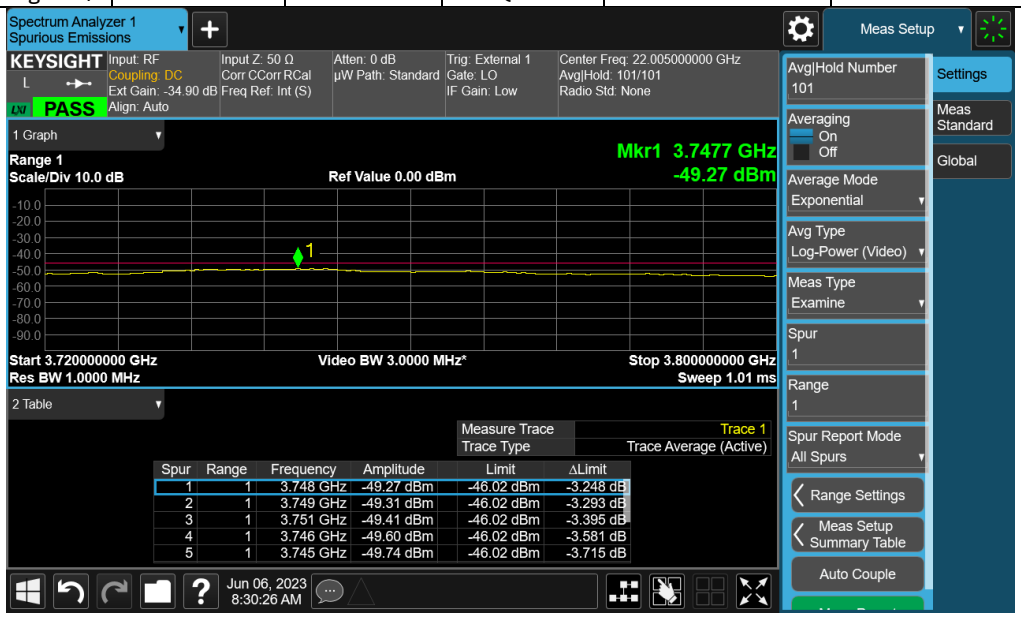
3.71 GHz – 3.72 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
2	10+10	3.1a	256QAM	3	3684.99+3694.995



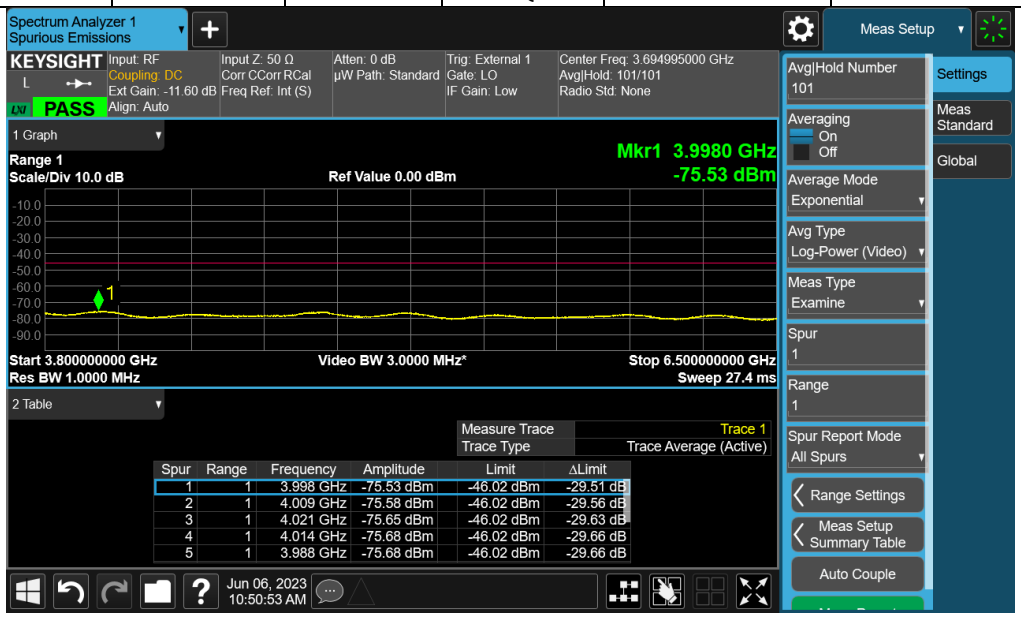
3.72 GHz – 3.8 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995



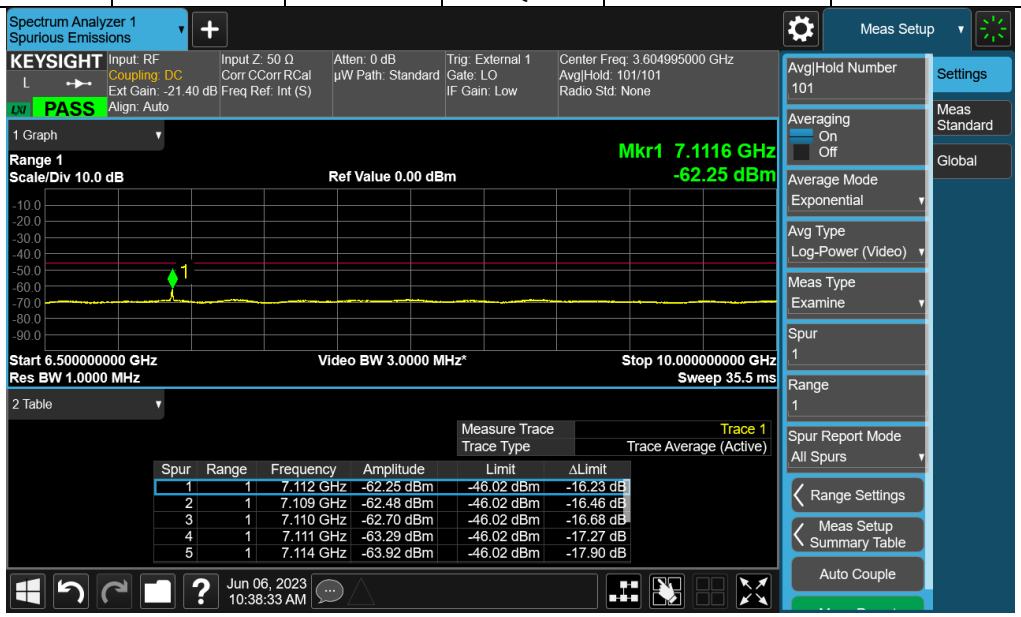
3.8 GHz – 6.5 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
1	10	3.1a	256QAM	3	3694.995



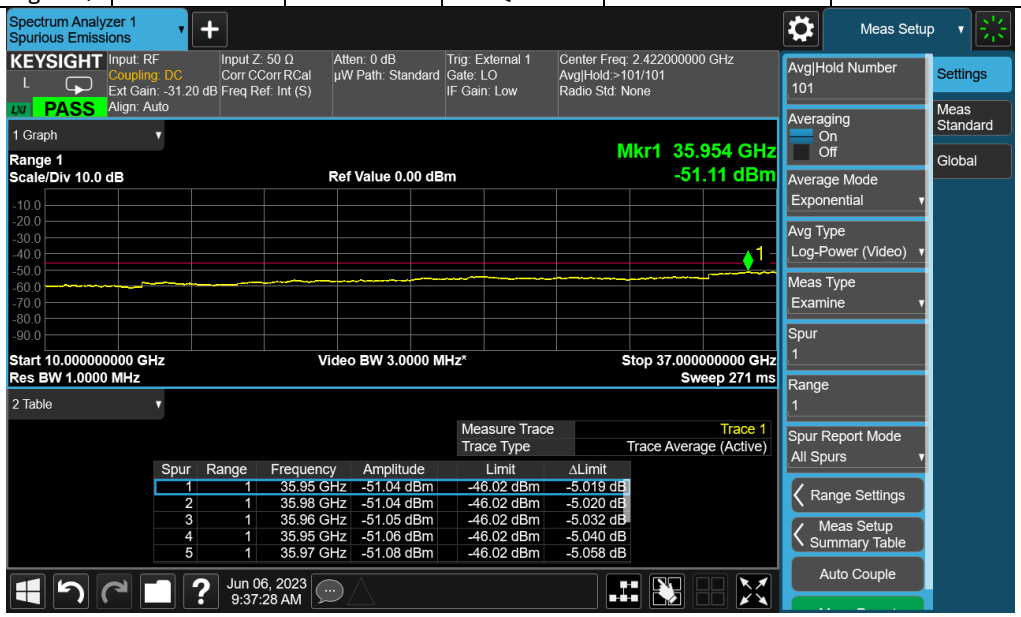
6.5 GHz – 10 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
1	10	3.1	64QAM	3	3555



10 GHz – 37 GHz

# of Carriers	Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz
2 (Non-Contiguous)	10+10	1.1	QPSK	1	3594.99 +3694.995



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.

Testing is waived based on previous testing of LTE and 5G configurations. Reference test reports are
2018-0097_2AD8UAZQCRH1_Part_96_FCC_Filling_Report-Final_r3
TR-2021-0133-FCC96 - AirScale Micro RRH 3.5GHz 4T4R 20W (AZQC)
TR-2022-0077-FCC96 - AirScale Micro RRH 3.5GHz 4T4R 20W (AZQC)
TR-2022-0139-FCC96 - AirScale Micro RRH 3.5GHz 4T4R 20W (AZQC)

In all previous testing there were no reportable emissions.

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:

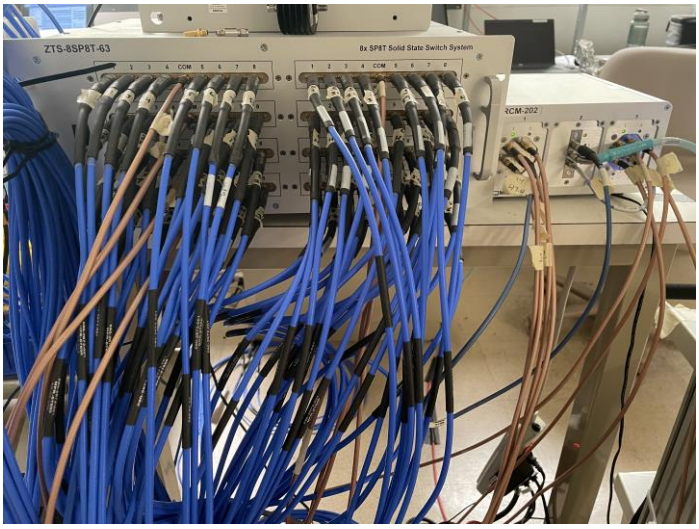
Measured level (dBμV) + Cable Loss(dB)+Antenna Factor(dB) = Field Strength (dBμV/m)

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.

Photographs

Radio Test Setup



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

Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
Micro Coax Utiflex	RF Cable	MFR-64639-228872-001	UF142A-000400-200-2G0	MFR-64639-228872-001	CNR-V	CNR-V
Mini Circuit	Modular Test System		ZTM-53	91701250030	CNR-V	CNR-V
	CBRS Notch Filter	3550-3700MHz	ZTM-53	B6 163500004	CNR-V	CNR-V

CNR-V: Calibration Not Required, Must Be Verified
Test Dates: 5/3/2023 – 6/9/2023

7. NVLAP Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

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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