

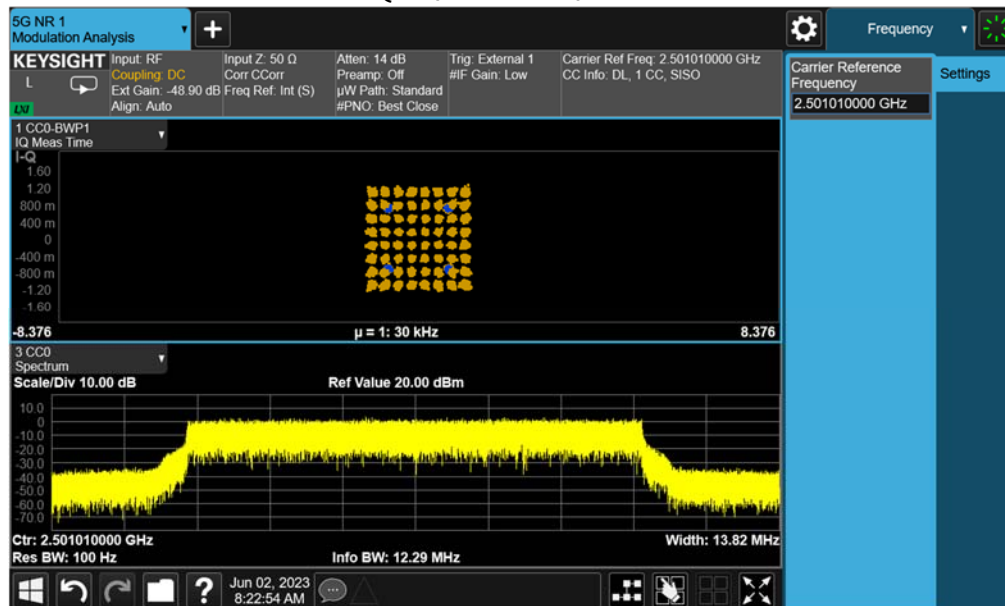
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

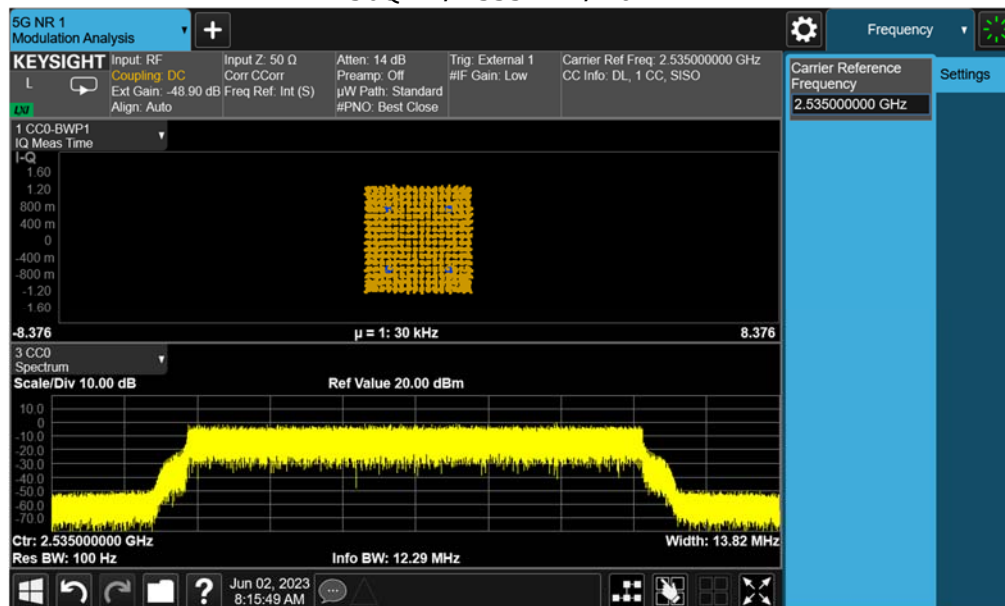
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

3.1.1 Modulation Characteristics – Plots

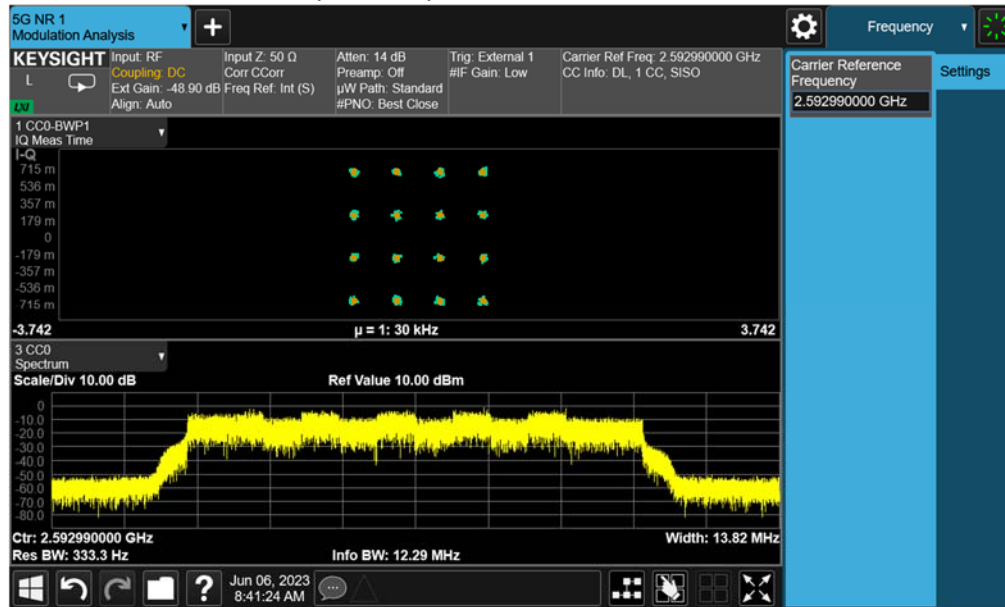
64QAM / 2501MHz / 10MBW



256QAM / 2535MHz / 10MBW



QPSK/16QAM / 2592MHz / 10MBW



4. FCC Section 2.1049 – Occupied Bandwidth/Edge of Band Emissions

4.1 Occupied Bandwidth

In 47CFR 2.1049 the FCC requires:

“The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable.”

This required measurement is the 99% Occupied Bandwidth, also called the designated signal bandwidth and needs to be within the parameters of the products specified emissions designator. During these measurements it is customary to evaluate the Edge of Band emissions at block/band edges.

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

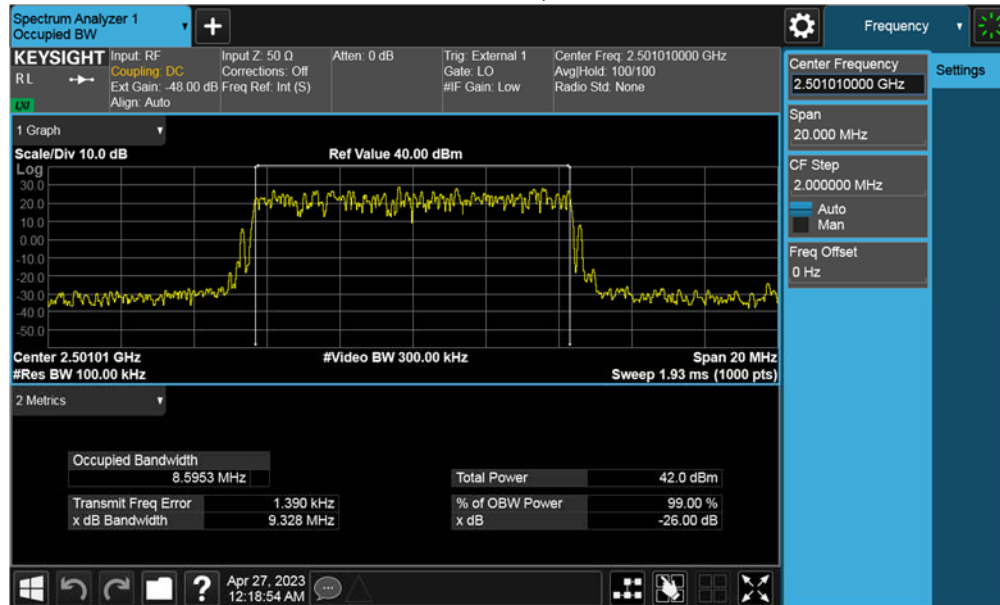
Tabular Data – Occupied Bandwidth (5G-NR)

# of Carriers	Signal BW MHz	Modulation	TX Port	Channel Frequency MHz	99% Occupied BW MHz	26dB Emission Bandwidth MHz
1	10	64QAM	9	2501	8.5953	9.328
1	10	QPSK/16QAM	9	2592	8.5104	9.068
1	10	256QAM	11	2685	8.5787	9.322
2	10 + 10	QPSK/16QAM	10	2501 + 2510	18.277	18.90
2	10 + 10	256QAM	8	2535 + 2685	8.5158 + 8.4817	9.332 + 9.014
2	10 + 10	QPSK/16QAM	9	2588 + 2597	18.272	18.87
2	10 + 10	256QAM	8	2675 + 2684	18.407	19.30

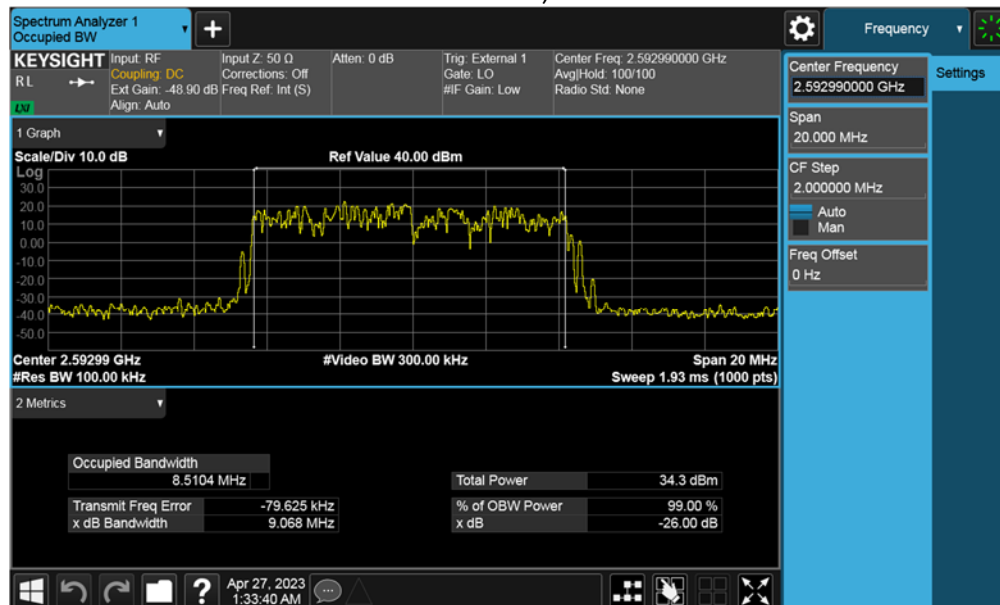
4.2 Occupied Bandwidth – Plots

4.2.1 1 Carrier, 10 MHz BW

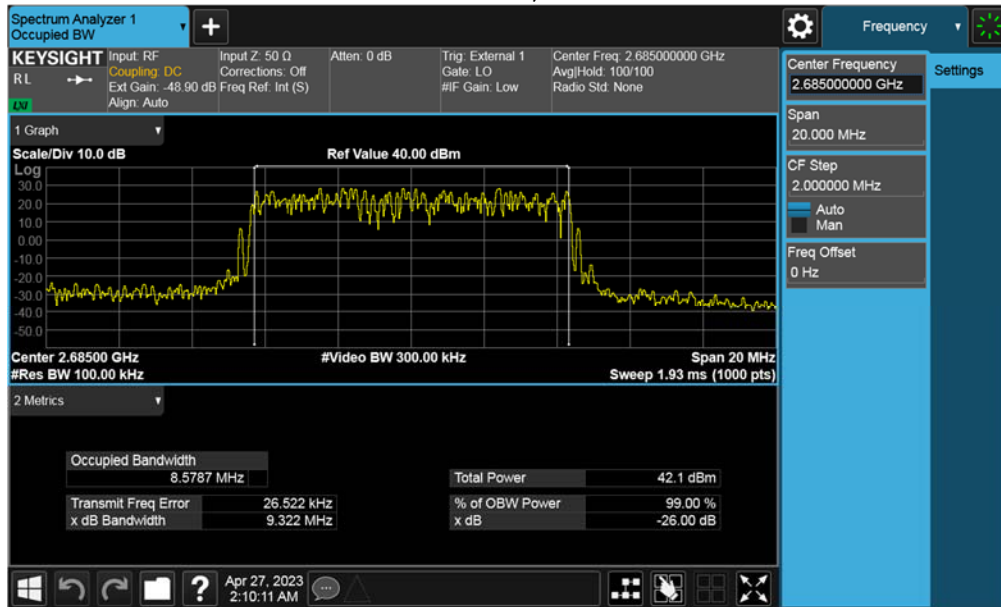
2501 MHz, TX9



2592 MHz, TX9

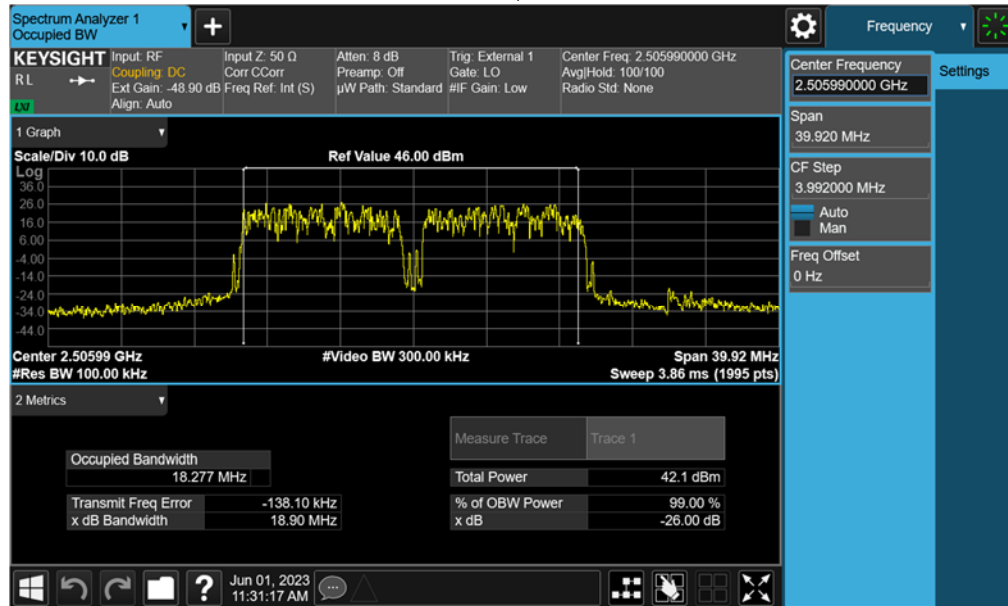


2685 MHz, TX11

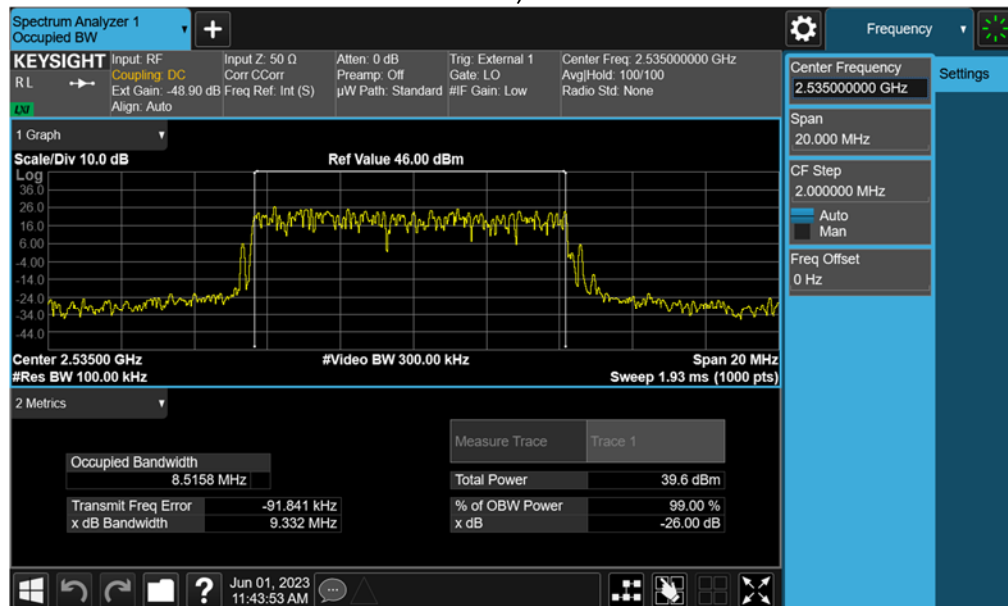


4.2.2 2 Carrier, 10 + 10 MHz BW

2501 + 2510 MHz, 10 + 10 MHz BW



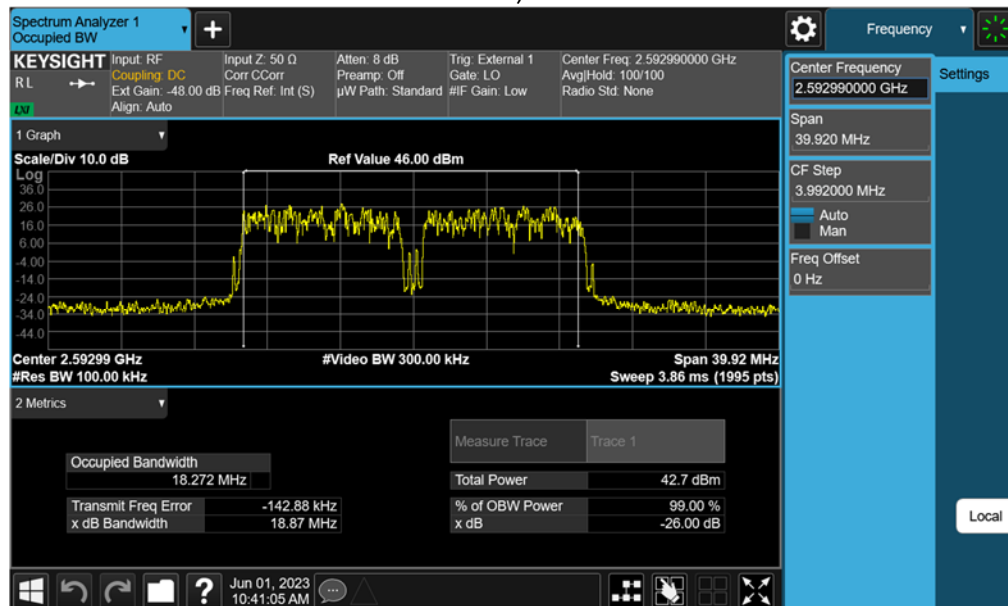
2535 + 2685 MHz, 10 + 10 MHz BW



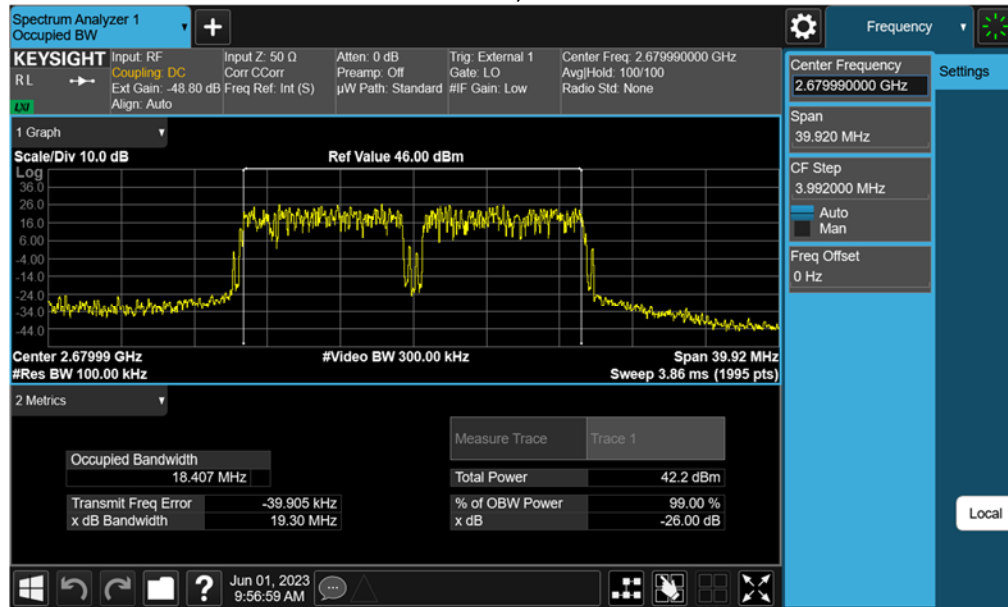
2535 + 2685 MHz, 10 + 10 MHz BW



2588 + 2597 MHz, 10 + 10 MHz BW



2675 + 2684 MHz, 10 + 10 MHz BW



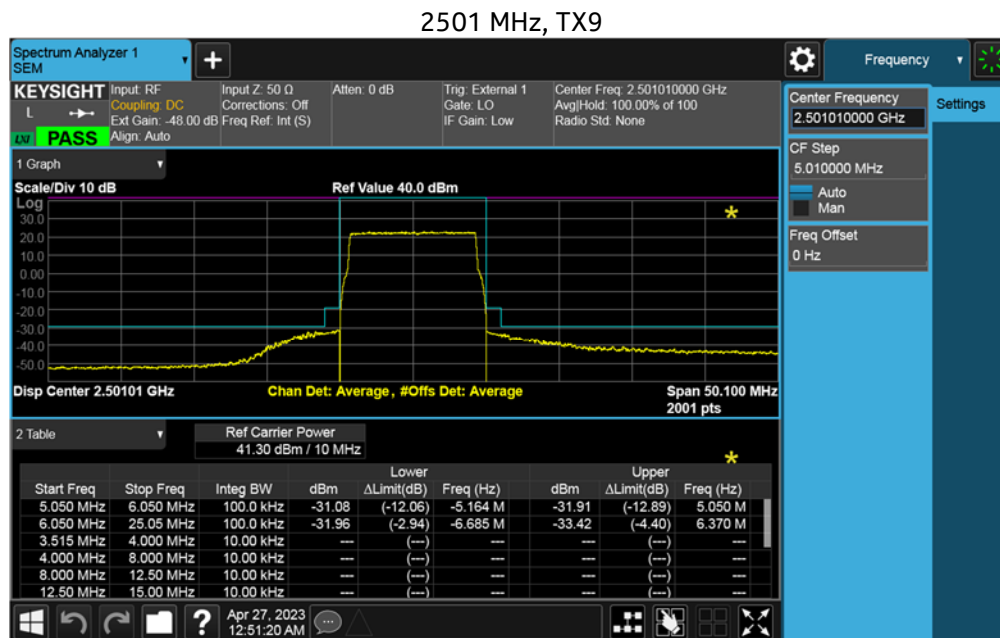
4.3 Edge of band Emissions

The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. Before measuring the Edge of Band emissions, the RF power level was confirmed with the Keysight MXA Signal Analyzer. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator and RF Switch. The path attenuation was offset on the display and the signal for the carrier was adjusted to the corrected RF power level for the resolution bandwidth used for the transmit signal. All mask values were adjusted based upon the designated signal bandwidth and measurement bandwidths. In accordance with KDB 662911 D01 Multiple Transmitter Output, the limit of -13 dBm has been adjusted to -19 dBm to reflect $10 \log(n)$ where $n=4$ for the 4x4 MIMO operation.

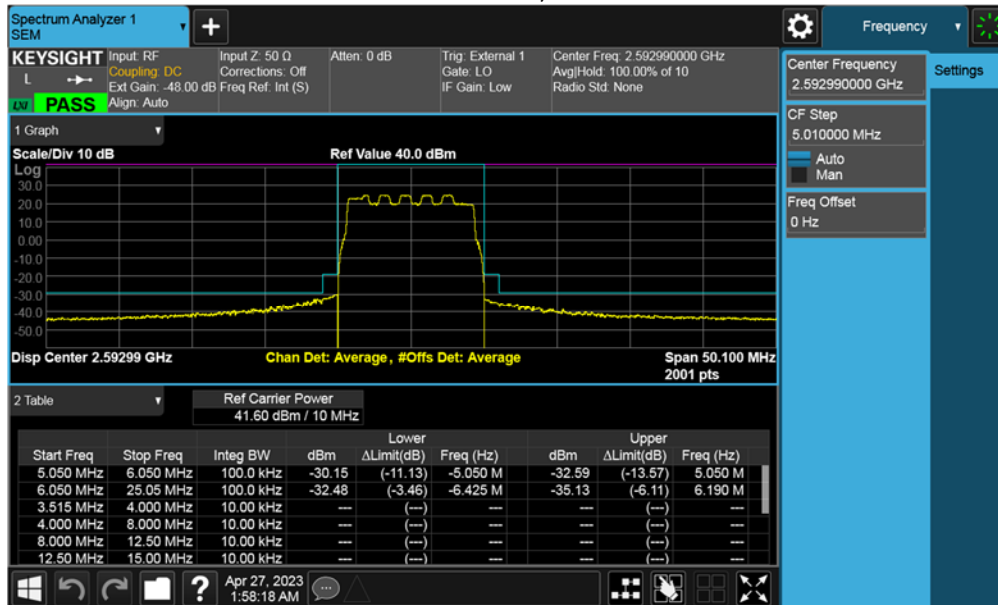
4.3.1 Edge of Band Emissions – Plots

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

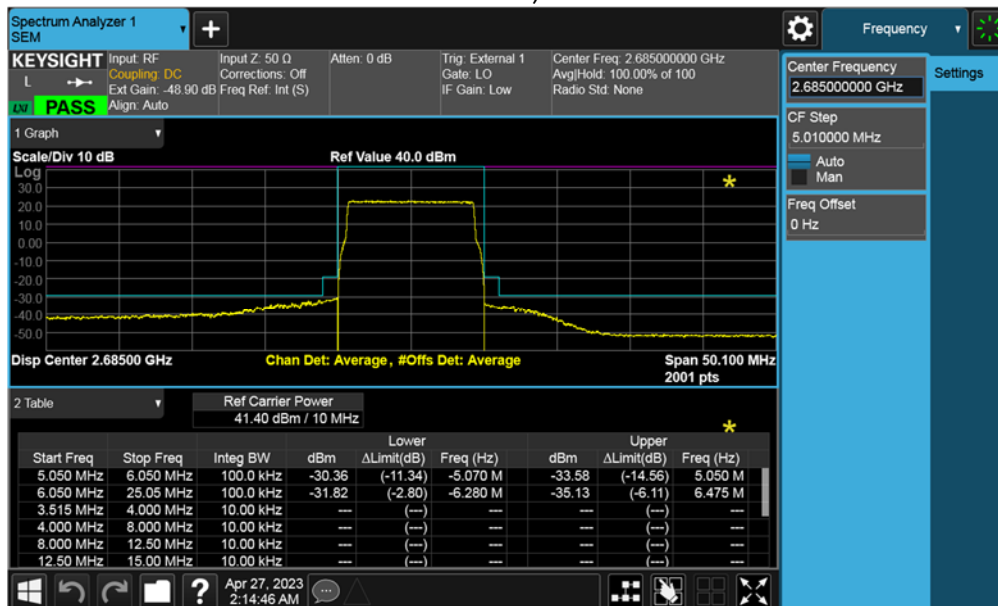
4.3.1.1 1 Carrier, 10MBW



2592 MHz, TX9

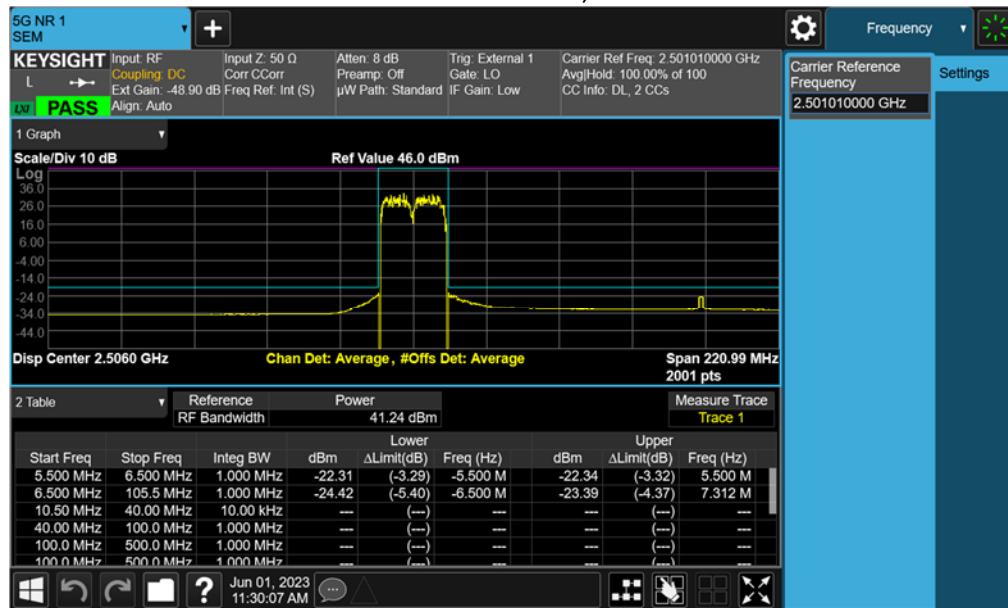


2685 MHz, TX11

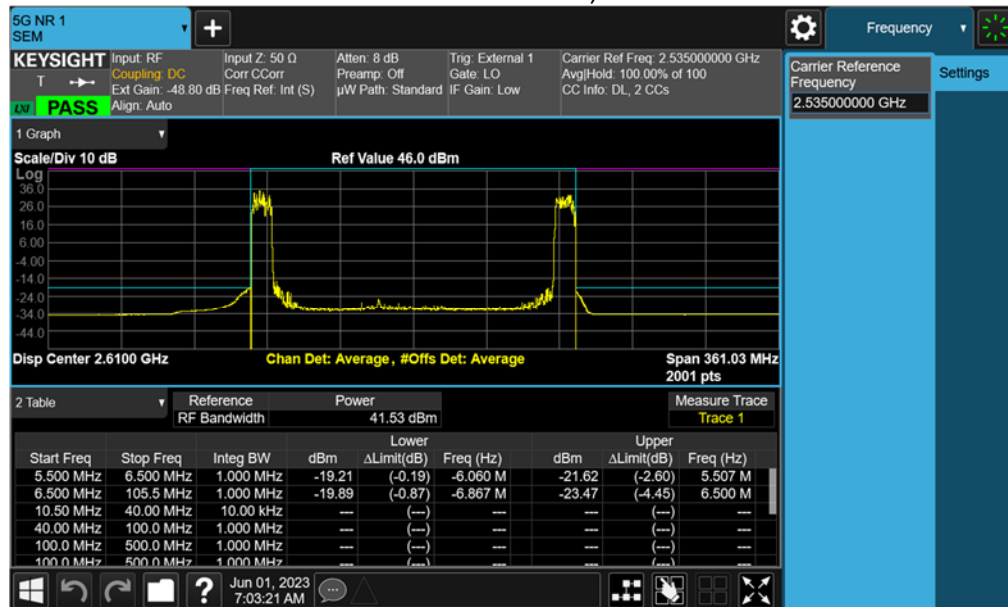


4.3.1.2 2 Carrier, 10 + 10 MHz BW

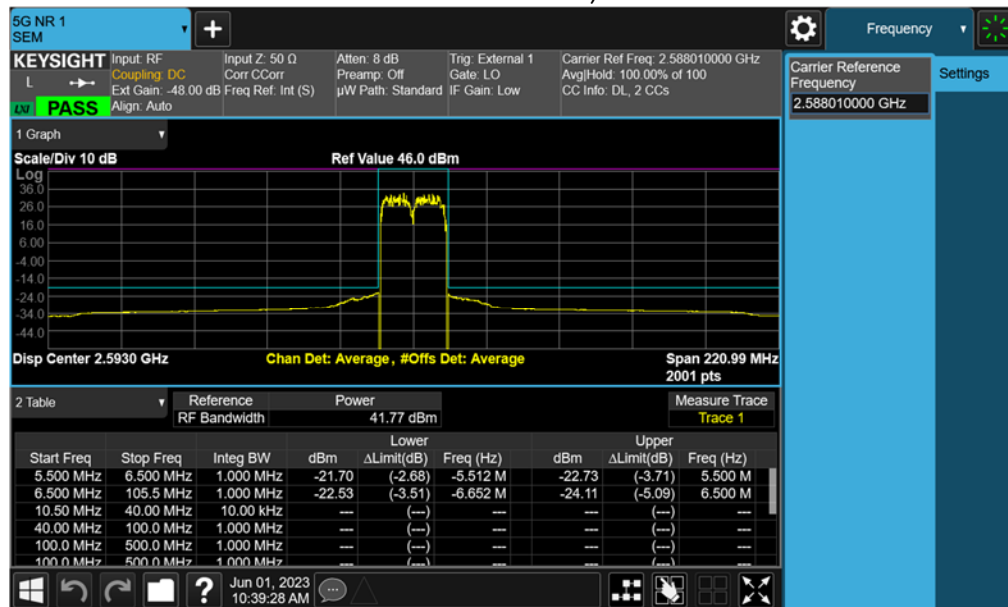
2501 + 2510 MHz, TX10



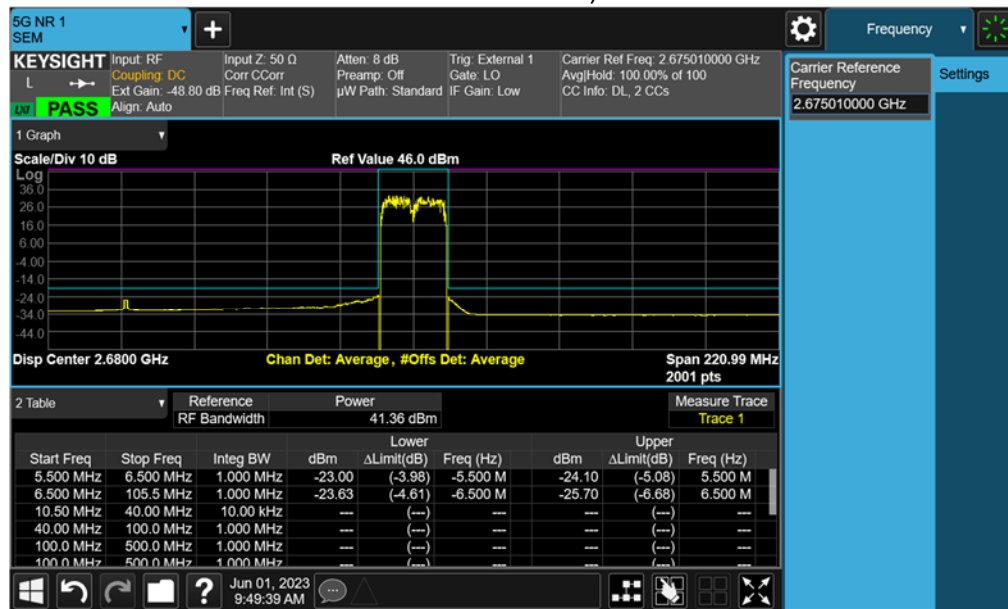
2535 + 2685 MHz, TX8



2588 + 2597 MHz, TX9



2675 + 2684 MHz, TX8



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

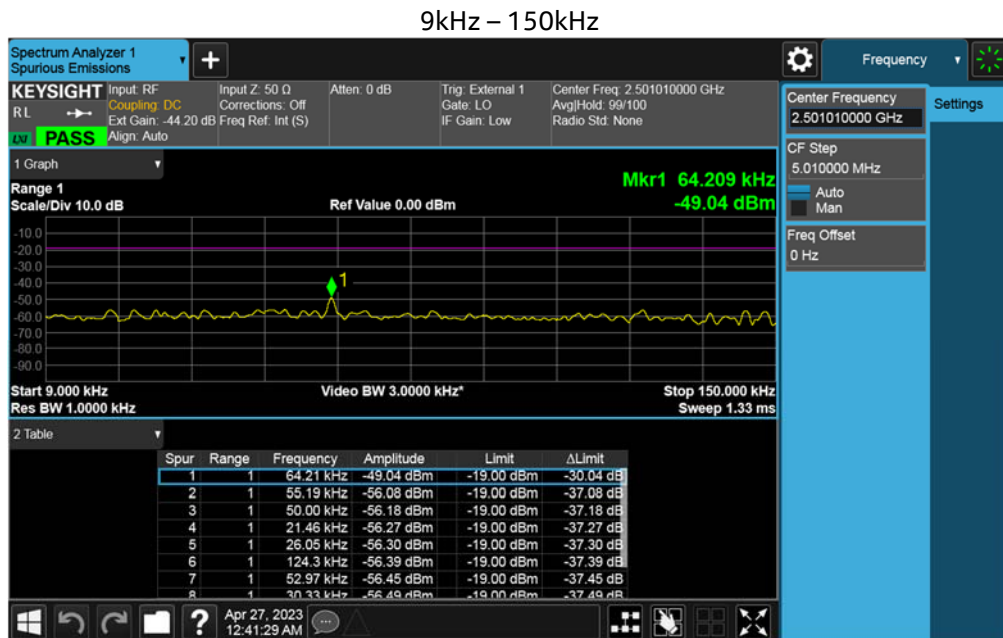
5.1 Measurement of Spurious Emissions at Transmit Antenna Port

Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. Carrier Bandwidth is exempt. For this band of operation, the measurements were performed up to 30 GHz. Measurements were made using a Keysight MXA Signal Analyzer. The RF output from the transmitter was reduced (to an amplitude usable by the receivers) using calibrated attenuators. The RF power level was continuously monitored via a Keysight MXA Signal Analyzer.

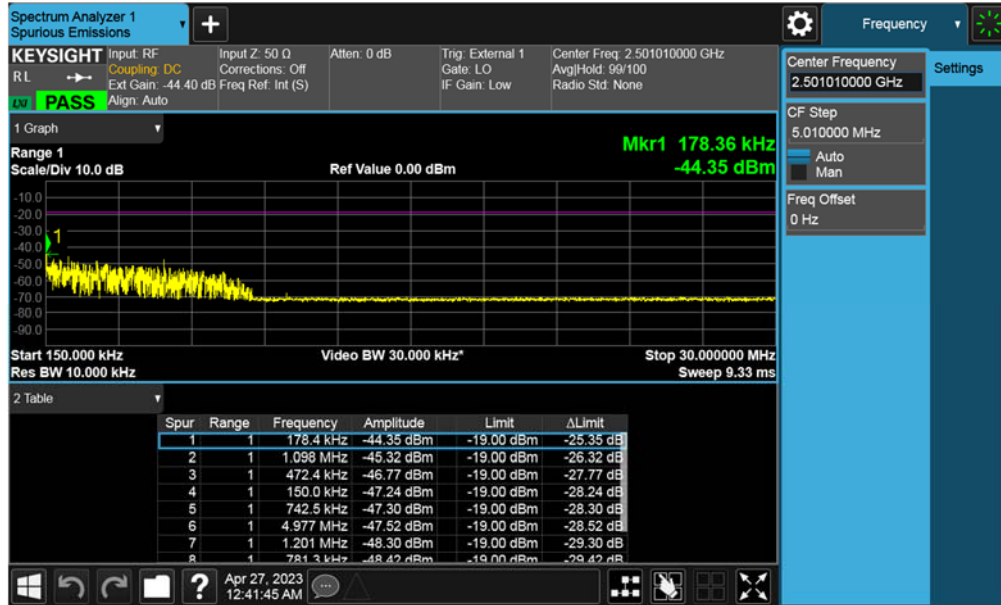
The required emission limitation is specified as appropriate in 27.53. The measured spurious emission levels were plotted for the frequency range as specified in 2.1057. There were no reportable emissions. Data below documents performance up to 30 GHz.

5.1.1 Spurious Emissions at Tx Port - Plots

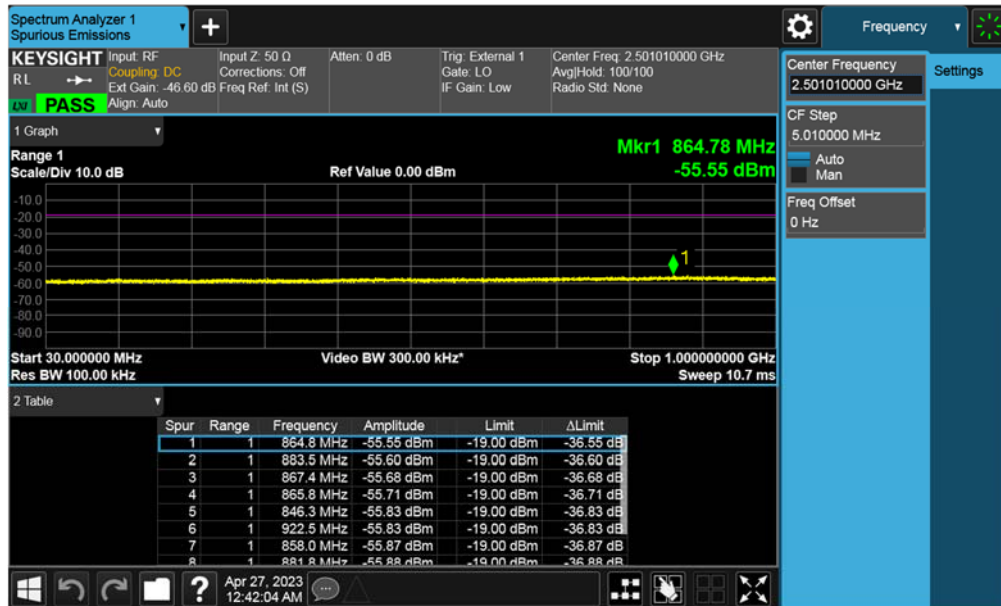
5.1.1.1 2501 MHz, 64QAM, 10 MHz BW, TX9



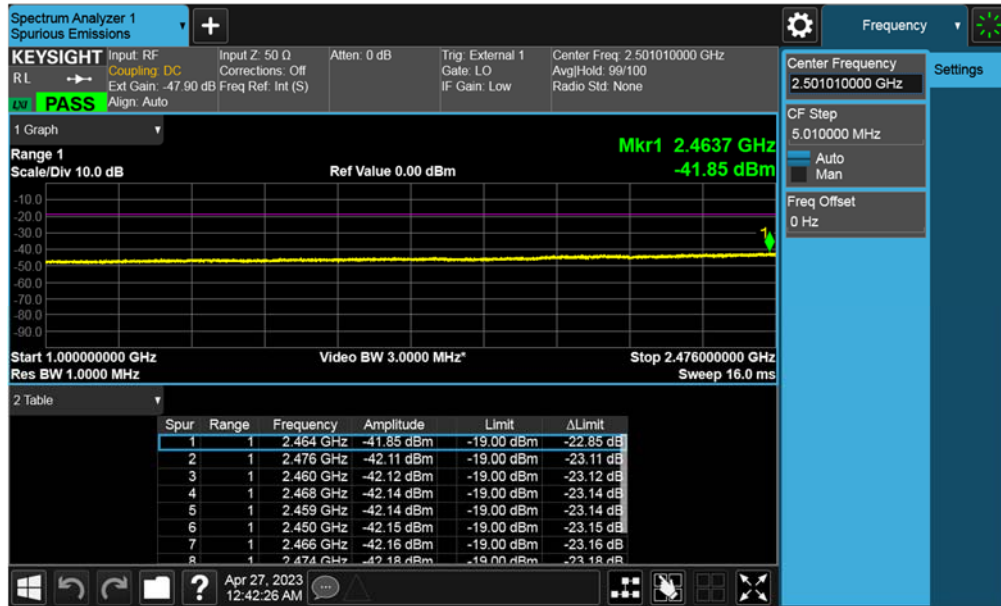
150kHz – 30MHz



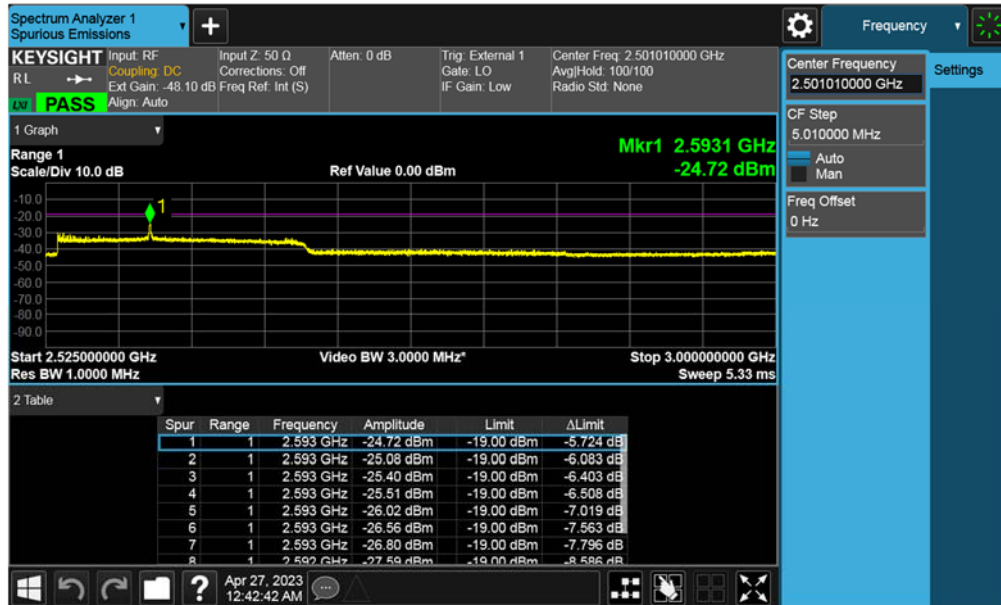
30MHz – 1GHz



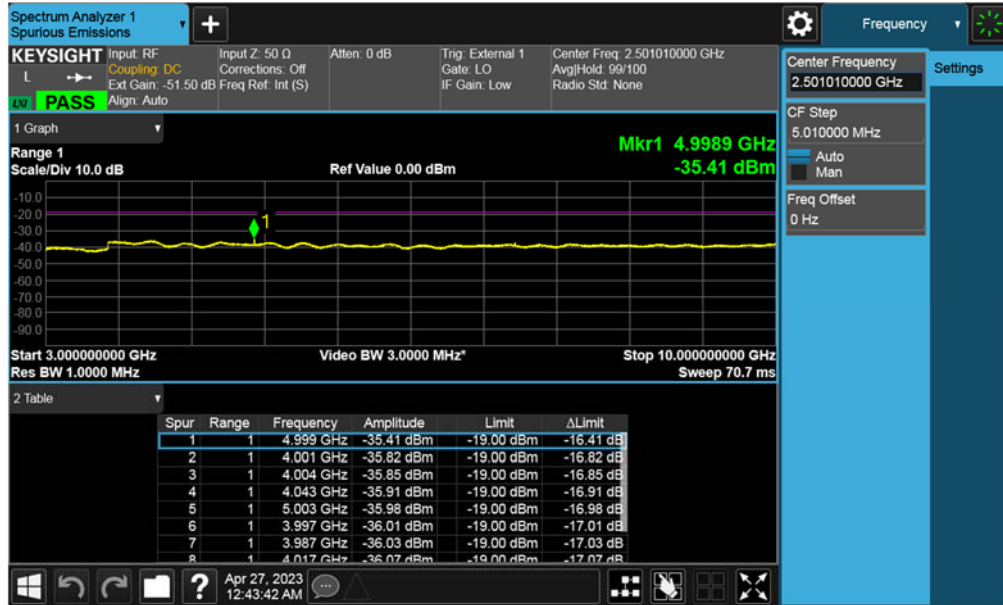
1GHz – 2.476GHz



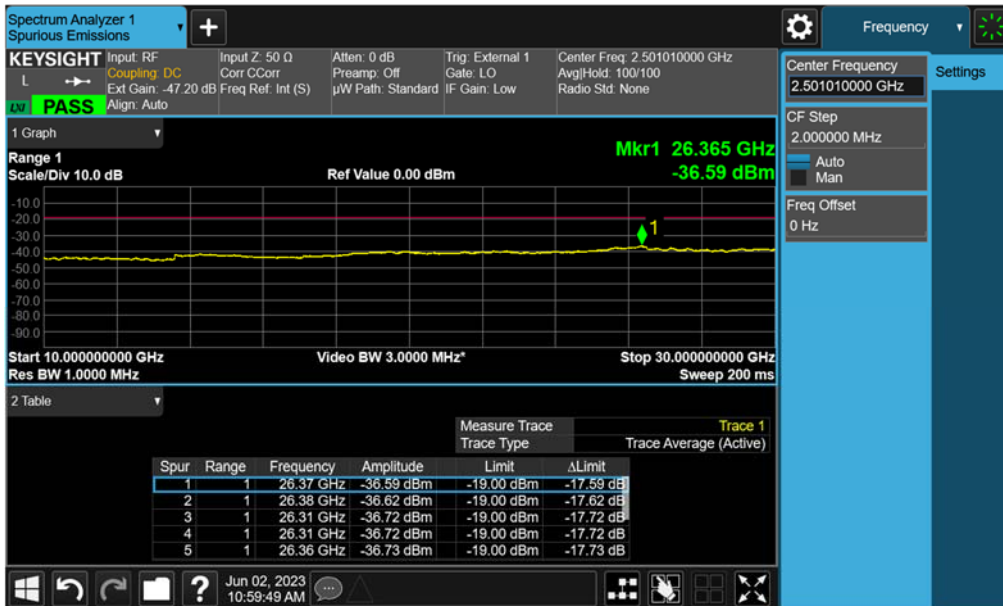
2.525GHz – 3GHz



3GHz – 10GHz

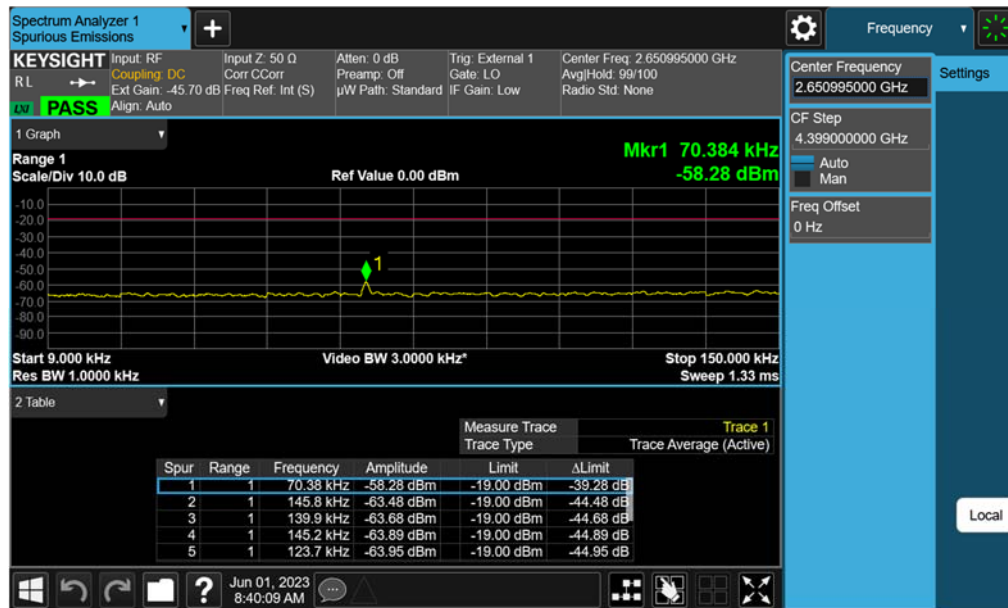


10GHz – 30GHz

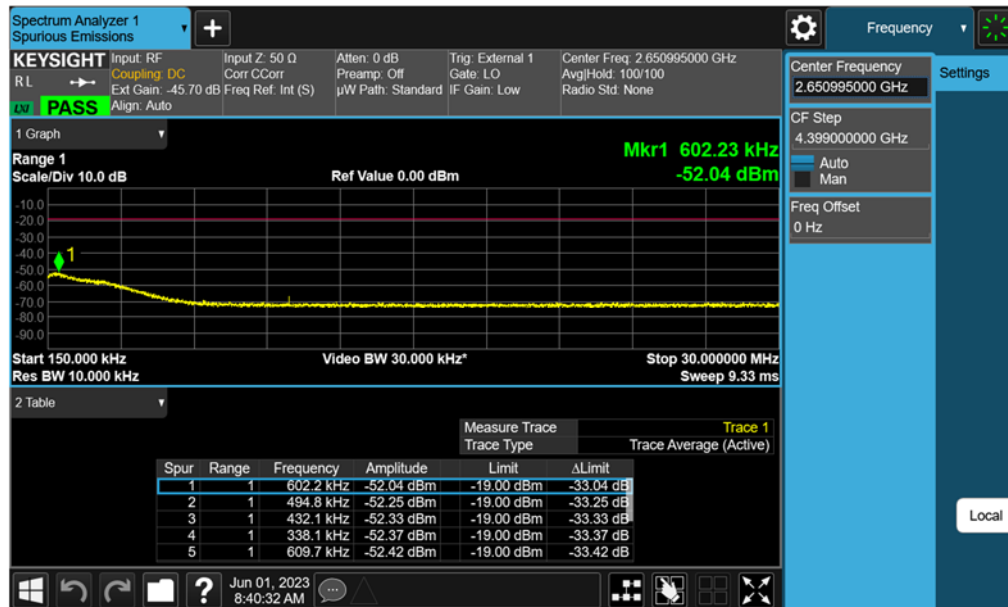


5.1.1.2 2501 + 2650 MHz, 64QAM, 10 + 10 MHz BW, TX8

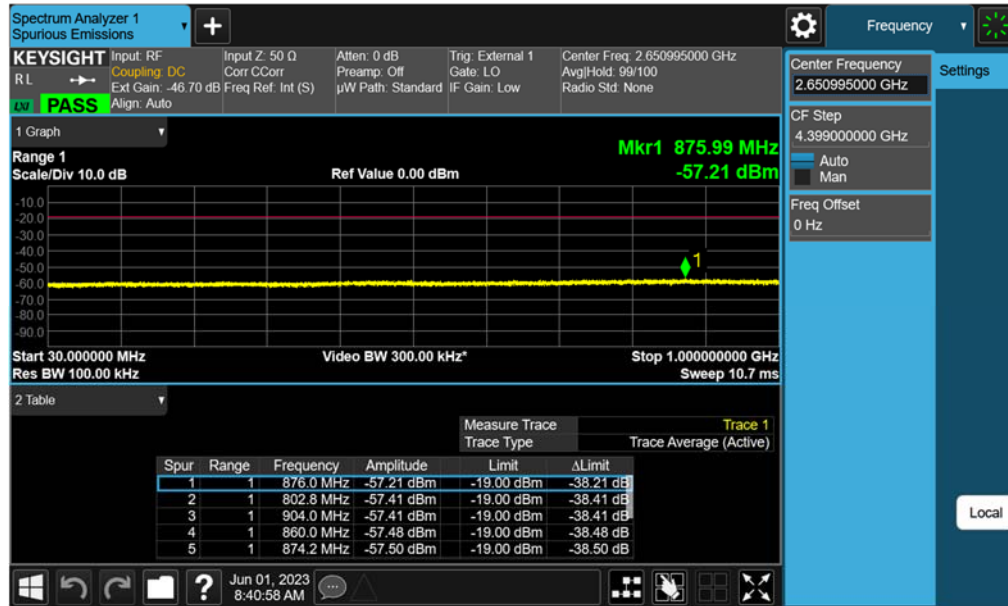
9kHz – 150kHz



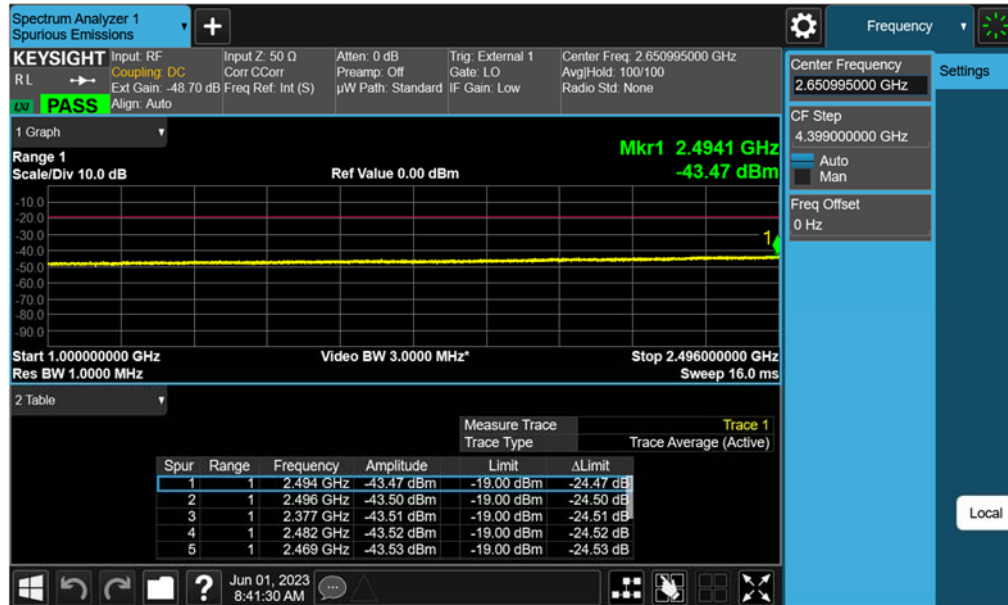
150kHz – 30MHz



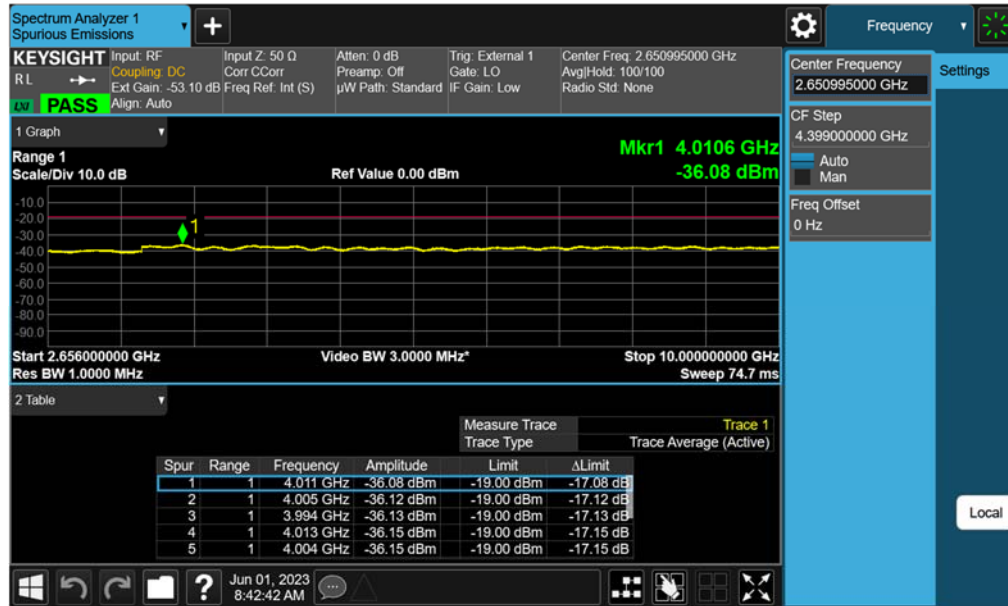
30MHz – 1GHz



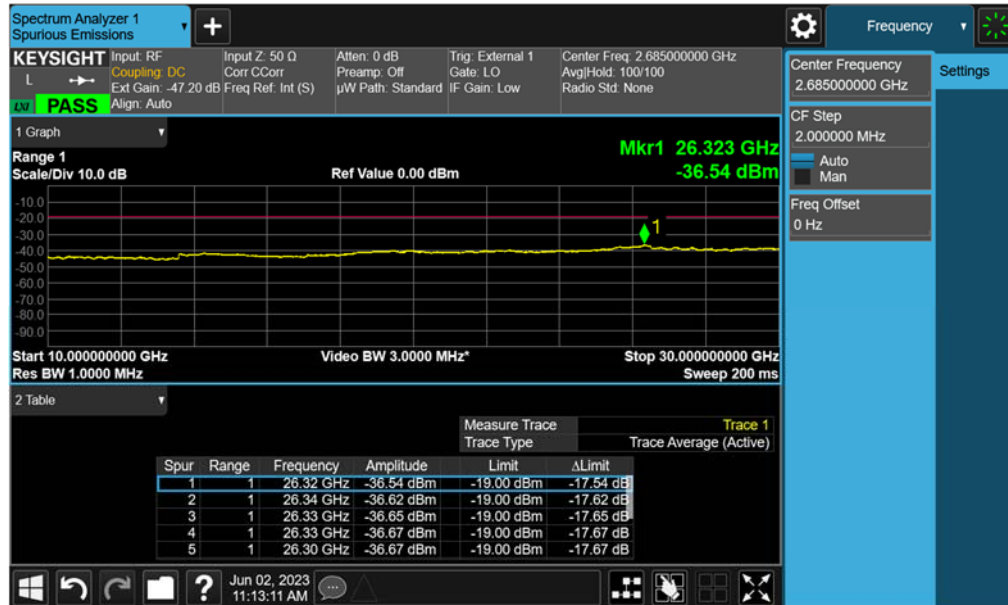
1GHz – 2.496GHz



2.656GHz – 10GHz

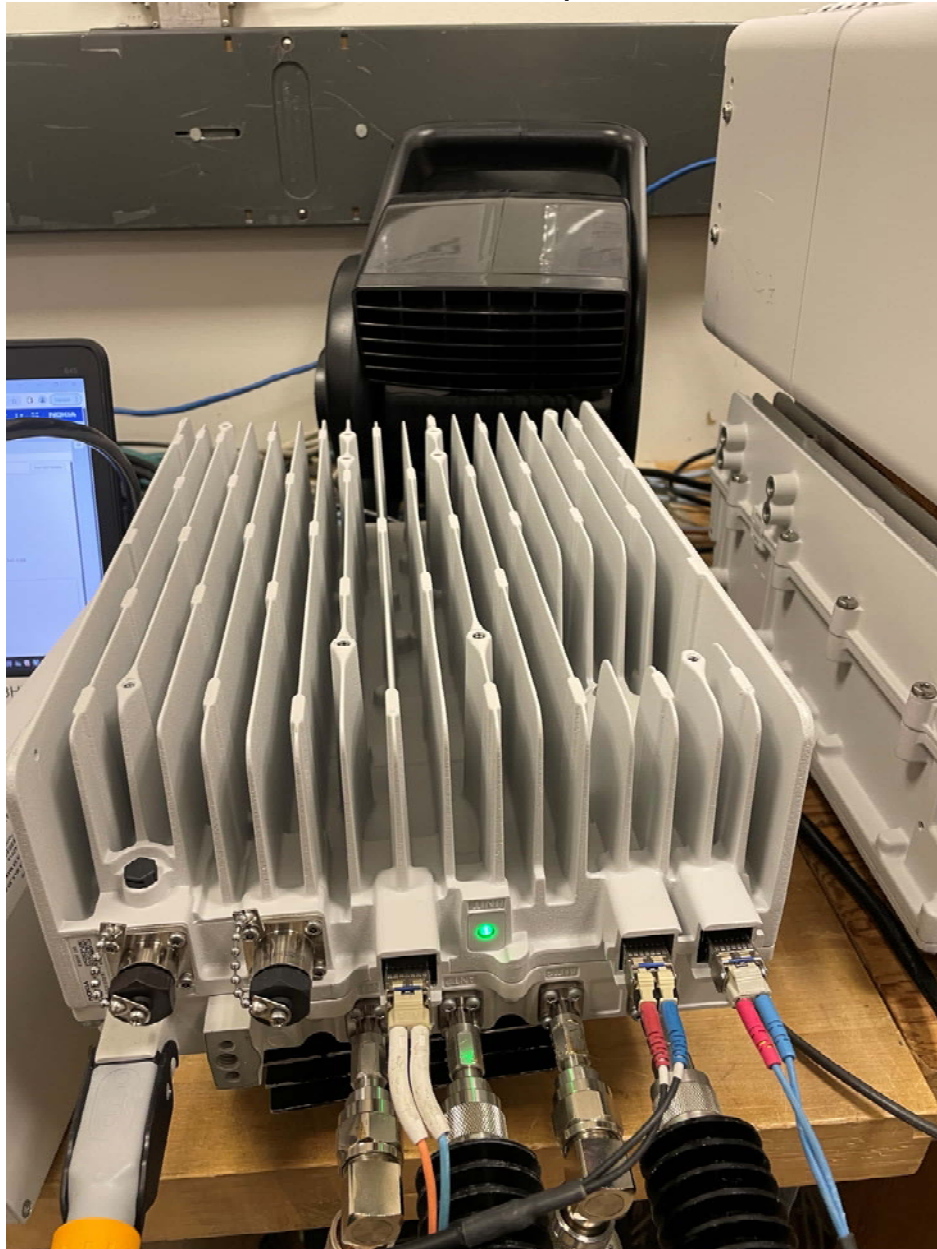


10GHz – 30GHz



Photographs

Radio Test Setup



Test Equipment

Radio Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E1338	KeySight Technologies	MXA Signal Analyzer	20 Hz-44 GHz (Analysis Bandwidth 125 MHz)	N9020B	MY57430927	2023-05-06	2025-05-06
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2023-02-08	2025-02-08
1609	Traceable	Data Logger	Barometric Humidity Temp Data Logger	6453,98767-15	221743404	2022-08-25	2024-08-25

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E1208	RLC Electronics Inc	Filter, High Pass	2.5 - 26 GHz	F-19391	1440-001	CNR-V	CNR-V
E1156	Weinschel	Attenuator	10dB 0.05GHz-26GHz 25W	74-10-12	1069	CNR-V	CNR-V
E1155	Weinschel	Attenuator	10dB 25Watt 0.05GHz - 26GHz	74-10-12	1068	CNR-V	CNR-V
E1154	Weinschel	Attenuator	30dB 25W 0.05GHz-26GHz	74-30-12	1065	CNR-V	CNR-V
E1347	Fairview Microwave	Attenuator	10 dB, DC - 40 GHz, 20 watt	SA4023-10	N/A	CNR-V	CNR-V
E1237	Weinschel	Attenuator	10dB 25 Watt	46-10-34	BH8105	CNR-V	CNR-V

CNR-V: Calibration Not Required, Must Be Verified

Tests Dates: 4/27/2023 – 6/6/2023.

6. FCC Section 2.1053 - Field strength of spurious radiation

6.1 Section 2.1053 Field Strength of Spurious Emissions

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

The spectrum from 30 MHz to beyond the tenth harmonic of the carrier, 27 GHz, was searched for spurious radiation. Measurements were made using both horizontally and vertically polarized broadband antennas. Per FCC regulations, the comparison of out of band spurious emissions directly to the limit is appropriately made using the substitution method. However, when the emissions are more than 20 dB below the specification limit, the use of field strength measurements for compliance determination is acceptable and those emissions are considered not reportable (Section 2.1053 and the FCC Interpretive database for 2.1053). For this case the evaluation of acceptable radiated field strength is as follows.

Testing is waived based on previous testing of LTE and 5G configurations. Reference test reports are TR-2020-0117-FCC2-27 AWHHF Airscale Micro RRH 4T4R 5G n41 4x20W, TR-2022-0155-FCC2-27, and TR-2020-0180-FCC2-27 AWHHF 5G-NR 50 & 90 MHz. In all previous testing there were no reportable emissions.

6.2 Field Strength of Spurious Emissions - Limits

Sections 2.1053 and 27.53 contain the requirements for the levels of spurious radiation as a function of the level of the unmodulated carrier. The reference level for the unmodulated carrier is calculated as the field produced by an ideal dipole excited by the transmitter output power according to the following relation taken from Reference Data for Radio Engineers, page 676, 4th edition, IT&T Corp.

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

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

Where:

E = Field Intensity in Volts/meter

P = Transmitted Power in Watts

R = Measurement distance in meters = 3 m

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

The Part 27 non-report level is 62.23 dB μ V/m at 3m.

The calculated emission levels were found by:

$$\text{Measured level (dB}\mu\text{V)} + \text{Cable Loss(dB)} + \text{Antenna Factor(dB)} = \text{Field Strength (dB}\mu\text{V/m)}$$

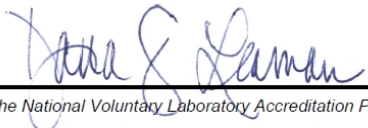
RESULTS:

For compliance with 47CFR Parts 2 and 27, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 dB μ V/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dB μ V/meter at 3m are not reportable and may be verified using field strength measurements and broadband antennas. Over the out of band spectrum investigated from 30 MHz to beyond the tenth harmonic of the carrier (up to 27 GHz), no reportable spurious emissions were detected.

7. FCC Section 2.1055 - Measurement of Frequency Stability

Frequency Stability testing not required.

8. NVLAP Certificate of Accreditation

United States Department of Commerce National Institute of Standards and Technology  Certificate of Accreditation to ISO/IEC 17025:2017 NVLAP LAB CODE: 100275-0 Nokia, Global Product Compliance Lab Murray Hill, NJ <i>is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:</i> Electromagnetic Compatibility & Telecommunications <i>This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).</i> 2022-09-28 through 2023-09-30 <i>Effective Dates</i>   <i>For the National Voluntary Laboratory Accreditation Program</i>	
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