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NVLAP®

**TESTING**
**NVLAP LAB CODE: 100275-0**

# Title 47 Code of Federal Regulations Test Report

Regulation:
FCC Part 2 and 27

Client:
NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:
AirScale MAA 64T64R B41 320W AEHC (AEHC)

Report Number:
TR-2021-0087-FCC2-27

Date Issued:
August 23, 2021

# Table of Contents

## Revisions

| Date | Revision | Section | Change |
|---|---|---|---|
| 08/23/2021 | 0 | | Initial Release |
| | | | |
| | | | |
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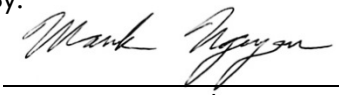
Prepared By:

Signed:  08/23/2021

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# 1. System Information and Requirements

Report copies and other information not contained in this report are held by either the product engineer or in an identified file at the Global Product Compliance Laboratory in Murray-Hill, NJ.

| | |
|---|---|
| **Equipment Under Test (EUT):** | **AirScale MAA 64T64R B41 320W AEHC (AEHC)** |
| **Serial Number:** | L1203206454 |
| **FCC ID:** | VBNAEHC-01 |
| **Hardware Version:** | 475124B.101 |
| **Software Version:** | LTE: SBTS21B<br>5G: 5G20B |
| **Frequency Range:** | 2496-2690 MHz |
| **GPCL Project Number:** | 2021-0087 |
| **Applicant** | Nokia Solutions and Networks<br>Steve Mitchell<br>3201 Olympus Blvd<br>Dallas, TX 75019 |
| **Test Requirement(s):** | Title 47 CFR Parts 2 and 27 |
| **Test Standards:** | • Title 47 CFR Parts 2 and 27<br>• KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.<br>• KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013<br>• ANSI C63.26 (2015)<br>• ANSI C63.4 (2014) |
| **Measurement Procedure(s):** | • FCC-IC-OB - GPCL Power Measurement, Occupied Bandwidth & Modulation Test Procedure 6-20-2019<br>• FCC-IC-SE - GPCL Spurious Emissions Test Procedure 6-20-2019 |
| **Test Date(s):** | 7/14/2021 - 8/12/2021 |
| **Test Performed By:** | Nokia<br>Global Product Compliance Laboratory<br>600-700 Mountain Ave.<br>P.O. Box 636<br>Murray Hill, NJ 07974-0636 |
| **Product Engineer(s):** | Ron Remy |
| **Lead Engineer:** | Steve Gordon |
| **Test Engineer (s):** | Nilesh Patel |
| **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 MAA 64T64R B41 320W AEHC (AEHC), hereinafter referred to as the Equipment Under Test (EUT).

## 1.2 Purpose and Scope

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

This report covers the Class II Permissive change to add new 5G/LTE and only 5G multicarrier configurations to the existing grant. No new bandwidths are being added. The AEHC product is certified under FCC ID: VBNAEHC-01.

The following new multicarrier configurations were tested:

5G NR/LTE (37dBm(5W) per port Total)

- LTE 20+5G NR 90
- 5G NR 50+LTE 20
- 5G NR 50+LTE 2x20
- 5G NR 50+LTE 3x20
- LTE 2x20 + 5G NR 90
- 5G NR 2x40+LTE 2x20
- 5G NR 2x50+LTE 2x20
- 5G NR 2x40+LTE 3x20
- 5G NR 2x50+LTE 3x20
- LTE 3x20 + 5G NR 90

5G NR/5G NR only (37dBm(5W) per port Total)

- 5G NR 100+5G NR 20
- 5G NR 100+5G NR 40
- 5G NR 60+5G NR 100
- 5G NR 80+5G NR 100
- 5G NR 60+5G NR 40

No Frequency Stability testing was considered necessary for this test program since there were no changes to the basic frequency determining and stabilizing circuitry (including clock and data rates).

## 1.3 EUT Details

### 1.3.1 Specifications

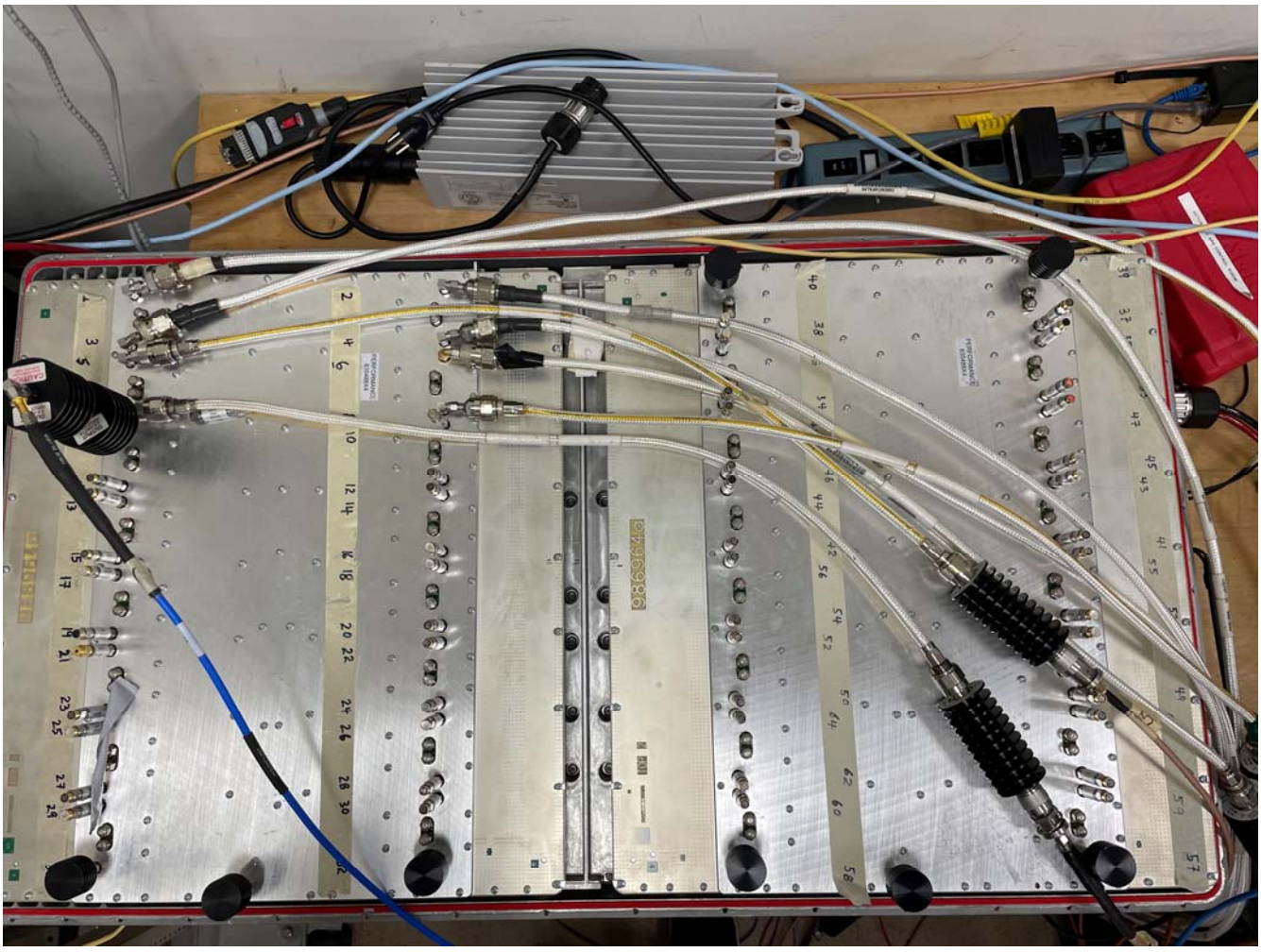
| Radio Characteristics | |
|---|---|
| Max RF Output Power | 320 W (5 W per TRX) |
| TX / RX | 64T64R |
| Band / Frequency Range | n41: 2496 - 2690 MHz |
| Instantaneous bandwidth (IBW) | 194 MHz |
| Occupied bandwidth (OBW) | 190 MHz |
| Carrier bandwidth | 20, 40, 50, 60, 70, 80,100 MHz |
| Operating mode | 64TRX Digital Beamforming |

| Other Characteristics | |
|---|---|
| External Interfaces | 4 * SFP28 for eCPRI 10/25, DC -48 V, AISG-ES-RAE 2.<br>ext. alarms MDR-26 |
| Installation Options | Pole / Wall with mechanical adjustment |

| Antenna Characteristics | |
|---|---|
| Antenna configurations | physical: 12, 8, 2 (192 AE)<br>logical: 4, 8, 2 |
| Minimum beamwidth | horizontal: 15° (boresight)<br>vertical: 6° (boresight) |
| Beamsteering angle | horizontal: ±45°<br>vertical: ±6° |
| Maximum antenna gain | >=25.5 dBi |

## 1.3.2 Photographs

Serial Number

Front

Rear

Left


Right


Top

Bottom

## 1.4 Test Requirements

Each required measurement is listed below:

| 47 CFR FCC Sections | Description of Tests | Test Required |
|---|---|---|
| 2.1046, 27.53 | RF Power Output | Yes |
| 2.1047, 27.53 | Modulation Characteristics | Yes |
| 2.1049, 27.53 | (a) Occupied Bandwidth<br>(b) Out-of-Band Emissions | Yes |
| 2.1051, 27.53 | Spurious Emissions at Antenna Terminals | Yes |
| 2.1053, 27.53 | Field Strength of Spurious Radiation | Yes |
| 2.1055, 27.53 | Frequency Stability | No* |

* No Frequency Stability testing was considered necessary for this test program since there were no changes to the basic frequency determining and stabilizing circuitry (including clock and data rates.)

## 1.5 Test Standards & Measurement Procedures

### 1.5.1 Test Standards

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 27.
- KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.
- KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013
- ANSI C63.26-2015, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
- ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

### 1.5.2 Measurement Procedures

- FCC-IC-OB - GPCL Power Measurement, Occupied Bandwidth & Modulation Test Procedure 6-20-2019
- FCC-IC-SE - GPCL Spurious Emissions Test Procedure 6-20-2019

## 1.6 MEASUREMENT UNCERTAINTY

The results of the calculations to estimate uncertainties for the several test methods and standards are shown in the Table below. These are the worst-case values.

**Worst-Case Estimated Measurement Uncertainties**

| Standard, Method or Procedure | Condition | Frequency MHz | Expanded Uncertainty (k=2) |
|---|---|---|---|
| a. Classical Emissions, (*e.g.*, ANSI C63.4, CISPR 11, 14, 32, *etc.*, using ESHS 30, | Conducted Emissions | 0.009 - 30 | ±3.5 dB |
| | Radiated Emissions (AR-6 Semi-Anechoic Chamber) | 30 MHz – 200MHz H<br>30 MHz – 200 MHz V<br>200 MHz – 1000 MHz H<br>200 MHz – 1000 MHz V<br>1 GHz - 18 GHz | ±5.1 dB<br>±5.1 dB<br>±4.7 dB<br>±4.7 dB<br>±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<br>100 Hz<br>10 kHz to 1 MHz<br>1MHz | 9 kHz to 20 MHz<br>20 MHz to 1 GHz<br>1 GHz to 10 GHz<br>10 GHz to 40 GHz: | 1.78 dB |
| RF Power | 10 Hz to 20 MHz | 50 MHz to 18 GHz | 0.5 dB |

## 1.7 Executive Summary

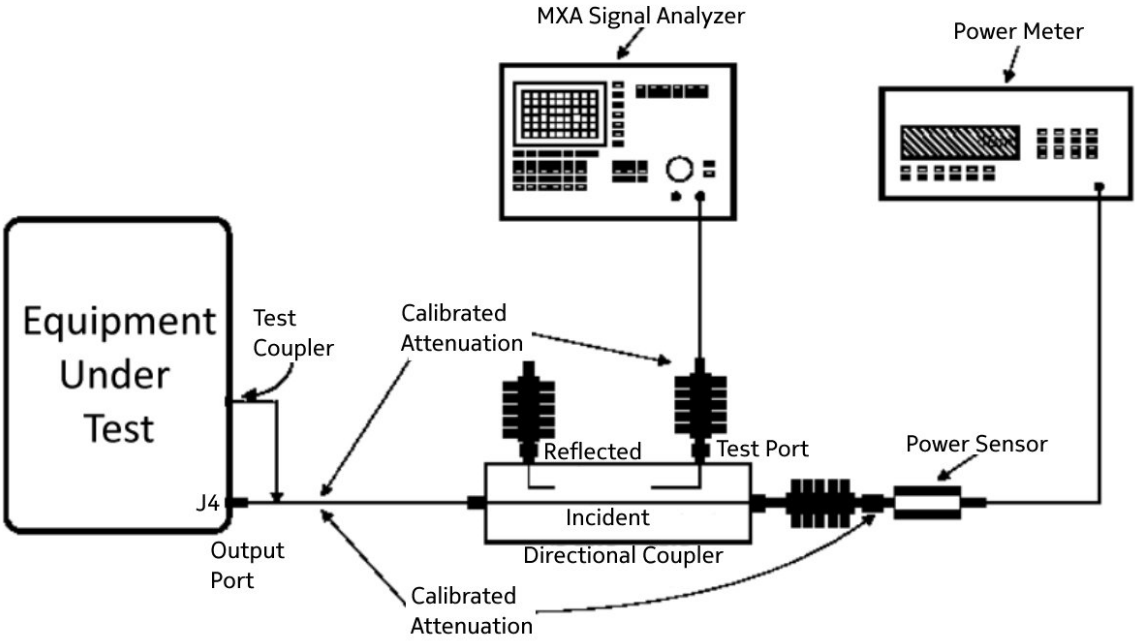
| Requirement | Description | Result |
|---|---|---|
| **47 CFR FCC Parts 2 and 27** | | |
| 2.1046, 27.50 | RF Power Output<br>Peak to Average Power Ratio | COMPLIES |
| 2.1047 | Modulation Characteristics | COMPLIES |
| 2.1049, 27.53 | (a) Occupied Bandwidth<br>(b) Edge of Band Emissions | COMPLIES |
| 2.1051, 27.53 | Spurious Emissions at Antenna Terminals | COMPLIES |
| 2.1053, 27.53 | Field Strength of Spurious Radiation | COMPLIES |
| 2.1055, 27.54 | Frequency Stability | NT* |

* No Frequency Stability testing was considered necessary for this test program since there were no changes to the basic frequency determining and stabilizing circuitry (including clock and data rates.)

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

## 1.8 Test Configurations

Test Setup for all Antenna Port Measurements



# 2. FCC Section 2.1046 - RF Power Output

## 2.1 RF Power Output

This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal. The product was configured for test as shown in section above and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26. The product has 64 ports divided into 8 segments. One segment of 8 ports was measured and is representative of the remaining segments. Power measurements were made with an MXA Signal Analyzer

### 2.1.1 5G-NR Only

Tabular Data – Channel RF Power (2-Carrier TM1.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2559 + 2640 | 60 + 100 | QPSK | 35.75 |
| 2 | 2559 + 2640 | 60 + 100 | QPSK | 37.02 |
| 3 | 2559 + 2640 | 60 + 100 | QPSK | 37.58 |
| 4 | 2559 + 2640 | 60 + 100 | QPSK | 35.98 |
| 5 | 2559 + 2640 | 60 + 100 | QPSK | 36.81 |
| 6 | 2559 + 2640 | 60 + 100 | QPSK | 36.77 |
| 7 | 2559 + 2640 | 60 + 100 | QPSK | 36.07 |
| 8 | 2559 + 2640 | 60 + 100 | QPSK | 35.75 |
| 1 | 2546 + 2616 | 100 + 40 | QPSK | 35.90 |
| 2 | 2546 + 2616 | 100 + 40 | QPSK | 37.16 |
| 3 | 2546 + 2616 | 100 + 40 | QPSK | 37.63 |
| 4 | 2546 + 2616 | 100 + 40 | QPSK | 36.14 |
| 5 | 2546 + 2616 | 100 + 40 | QPSK | 36.96 |
| 6 | 2546 + 2616 | 100 + 40 | QPSK | 36.91 |
| 7 | 2546 + 2616 | 100 + 40 | QPSK | 36.20 |
| 8 | 2546 + 2616 | 100 + 40 | QPSK | 35.95 |

Tabular Data – Channel RF Power (2-Carrier TM3.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2526 + 2606 | 60 + 100 | 64QAM | 35.70 |
| 2 | 2526 + 2606 | 60 + 100 | 64QAM | 36.92 |
| 3 | 2526 + 2606 | 60 + 100 | 64QAM | 37.47 |
| 4 | 2526 + 2606 | 60 + 100 | 64QAM | 35.91 |
| 5 | 2526 + 2606 | 60 + 100 | 64QAM | 36.73 |
| 6 | 2526 + 2606 | 60 + 100 | 64QAM | 36.71 |
| 7 | 2526 + 2606 | 60 + 100 | 64QAM | 36.02 |
| 8 | 2526 + 2606 | 60 + 100 | 64QAM | 35.68 |

| | | | | |
|---|---|---|---|---|
| 1 | 2546 + 2606 | 100 + 20 | 64QAM | 36.88 |
| 2 | 2546 + 2606 | 100 + 20 | 64QAM | 38.19 |
| 3 | 2546 + 2606 | 100 + 20 | 64QAM | 38.51 |
| 4 | 2546 + 2606 | 100 + 20 | 64QAM | 37.11 |
| 5 | 2546 + 2606 | 100 + 20 | 64QAM | 37.92 |
| 6 | 2546 + 2606 | 100 + 20 | 64QAM | 37.87 |
| 7 | 2546 + 2606 | 100 + 20 | 64QAM | 37.14 |
| 8 | 2546 + 2606 | 100 + 20 | 64QAM | 36.89 |

Tabular Data – Channel RF Power (2-Carrier TM3.1a)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2526 + 2670 | 60 + 40 | 256QAM | 35.58 |
| 2 | 2526 + 2670 | 60 + 40 | 256QAM | 36.83 |
| 3 | 2526 + 2670 | 60 + 40 | 256QAM | 37.41 |
| 4 | 2526 + 2670 | 60 + 40 | 256QAM | 35.82 |
| 5 | 2526 + 2670 | 60 + 40 | 256QAM | 36.63 |
| 6 | 2526 + 2670 | 60 + 40 | 256QAM | 36.61 |
| 7 | 2526 + 2670 | 60 + 40 | 256QAM | 35.91 |
| 8 | 2526 + 2670 | 60 + 40 | 256QAM | 35.70 |
| 1 | 2620 + 2670 | 60 + 40 | 256QAM | 35.36 |
| 2 | 2620 + 2670 | 60 + 40 | 256QAM | 36.73 |
| 3 | 2620 + 2670 | 60 + 40 | 256QAM | 36.57 |
| 4 | 2620 + 2670 | 60 + 40 | 256QAM | 35.62 |
| 5 | 2620 + 2670 | 60 + 40 | 256QAM | 36.50 |
| 6 | 2620 + 2670 | 60 + 40 | 256QAM | 36.43 |
| 7 | 2620 + 2670 | 60 + 40 | 256QAM | 35.71 |
| 8 | 2620 + 2670 | 60 + 40 | 256QAM | 35.44 |
| 1 | 2550 + 2640 | 80 + 100 | 256QAM | 35.63 |
| 2 | 2550 + 2640 | 80 + 100 | 256QAM | 36.79 |
| 3 | 2550 + 2640 | 80 + 100 | 256QAM | 36.81 |
| 4 | 2550 + 2640 | 80 + 100 | 256QAM | 35.87 |
| 5 | 2550 + 2640 | 80 + 100 | 256QAM | 36.72 |
| 6 | 2550 + 2640 | 80 + 100 | 256QAM | 36.47 |
| 7 | 2550 + 2640 | 80 + 100 | 256QAM | 35.96 |
| 8 | 2550 + 2640 | 80 + 100 | 256QAM | 35.68 |
| 1 | 2619 + 2679 | 100 + 20 | 256QAM | 36.91 |
| 2 | 2619 + 2679 | 100 + 20 | 256QAM | 38.35 |
| 3 | 2619 + 2679 | 100 + 20 | 256QAM | 38.07 |
| 4 | 2619 + 2679 | 100 + 20 | 256QAM | 37.20 |
| 5 | 2619 + 2679 | 100 + 20 | 256QAM | 38.05 |
| 6 | 2619 + 2679 | 100 + 20 | 256QAM | 37.97 |
| 7 | 2619 + 2679 | 100 + 20 | 256QAM | 37.29 |
| 8 | 2619 + 2679 | 100 + 20 | 256QAM | 36.99 |

| | | | | |
|---|---|---|---|---|
| 1 | 2599 + 2670 | 100 + 40 | 256QAM | 35.51 |
| 2 | 2599 + 2670 | 100 + 40 | 256QAM | 36.96 |
| 3 | 2599 + 2670 | 100 + 40 | 256QAM | 37.38 |
| 4 | 2599 + 2670 | 100 + 40 | 256QAM | 35.79 |
| 5 | 2599 + 2670 | 100 + 40 | 256QAM | 36.63 |
| 6 | 2599 + 2670 | 100 + 40 | 256QAM | 36.56 |
| 7 | 2599 + 2670 | 100 + 40 | 256QAM | 35.84 |
| 8 | 2599 + 2670 | 100 + 40 | 256QAM | 35.63 |

Tabular Data – Channel RF Power (2-Carrier TM3.2)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2526 + 2576 | 60 + 40 | QPSK/16QAM | 35.60 |
| 2 | 2526 + 2576 | 60 + 40 | QPSK/16QAM | 36.62 |
| 3 | 2526 + 2576 | 60 + 40 | QPSK/16QAM | 36.79 |
| 4 | 2526 + 2576 | 60 + 40 | QPSK/16QAM | 35.84 |
| 5 | 2526 + 2576 | 60 + 40 | QPSK/16QAM | 36.65 |
| 6 | 2526 + 2576 | 60 + 40 | QPSK/16QAM | 36.45 |
| 7 | 2526 + 2576 | 60 + 40 | QPSK/16QAM | 35.92 |
| 8 | 2526 + 2576 | 60 + 40 | QPSK/16QAM | 35.66 |
| 1 | 2593 + 2643 | 60 + 40 | QPSK/16QAM | 35.56 |
| 2 | 2593 + 2643 | 60 + 40 | QPSK/16QAM | 36.77 |
| 3 | 2593 + 2643 | 60 + 40 | QPSK/16QAM | 36.71 |
| 4 | 2593 + 2643 | 60 + 40 | QPSK/16QAM | 35.79 |
| 5 | 2593 + 2643 | 60 + 40 | QPSK/16QAM | 36.65 |
| 6 | 2593 + 2643 | 60 + 40 | QPSK/16QAM | 36.59 |
| 7 | 2593 + 2643 | 60 + 40 | QPSK/16QAM | 35.89 |
| 8 | 2593 + 2643 | 60 + 40 | QPSK/16QAM | 35.62 |
| 1 | 2536 + 2626 | 80 + 100 | QPSK/16QAM | 35.74 |
| 2 | 2536 + 2626 | 80 + 100 | QPSK/16QAM | 36.90 |
| 3 | 2536 + 2626 | 80 + 100 | QPSK/16QAM | 37.52 |
| 4 | 2536 + 2626 | 80 + 100 | QPSK/16QAM | 35.98 |
| 5 | 2536 + 2626 | 80 + 100 | QPSK/16QAM | 36.81 |
| 6 | 2536 + 2626 | 80 + 100 | QPSK/16QAM | 36.77 |
| 7 | 2536 + 2626 | 80 + 100 | QPSK/16QAM | 36.06 |
| 8 | 2536 + 2626 | 80 + 100 | QPSK/16QAM | 35.75 |
| 1 | 2546 + 2679 | 100 + 20 | QPSK/16QAM | 36.44 |
| 2 | 2546 + 2679 | 100 + 20 | QPSK/16QAM | 37.70 |
| 3 | 2546 + 2679 | 100 + 20 | QPSK/16QAM | 37.57 |
| 4 | 2546 + 2679 | 100 + 20 | QPSK/16QAM | 36.71 |
| 5 | 2546 + 2679 | 100 + 20 | QPSK/16QAM | 37.53 |
| 6 | 2546 + 2679 | 100 + 20 | QPSK/16QAM | 37.48 |
| 7 | 2546 + 2679 | 100 + 20 | QPSK/16QAM | 36.78 |
| 8 | 2546 + 2679 | 100 + 20 | QPSK/16QAM | 36.49 |

| | | | | |
|---|---|---|---|---|
| 1 | 2592 + 2652 | 100 + 20 | QPSK/16QAM | 36.84 |
| 2 | 2592 + 2652 | 100 + 20 | QPSK/16QAM | 38.11 |
| 3 | 2592 + 2652 | 100 + 20 | QPSK/16QAM | 38.70 |
| 4 | 2592 + 2652 | 100 + 20 | QPSK/16QAM | 37.09 |
| 5 | 2592 + 2652 | 100 + 20 | QPSK/16QAM | 37.93 |
| 6 | 2592 + 2652 | 100 + 20 | QPSK/16QAM | 37.86 |
| 7 | 2592 + 2652 | 100 + 20 | QPSK/16QAM | 37.17 |
| 8 | 2592 + 2652 | 100 + 20 | QPSK/16QAM | 36.87 |
| 1 | 2592 + 2663 | 100 + 40 | QPSK/16QAM | 35.61 |
| 2 | 2592 + 2663 | 100 + 40 | QPSK/16QAM | 36.93 |
| 3 | 2592 + 2663 | 100 + 40 | QPSK/16QAM | 37.45 |
| 4 | 2592 + 2663 | 100 + 40 | QPSK/16QAM | 35.87 |
| 5 | 2592 + 2663 | 100 + 40 | QPSK/16QAM | 36.71 |
| 6 | 2592 + 2663 | 100 + 40 | QPSK/16QAM | 36.63 |
| 7 | 2592 + 2663 | 100 + 40 | QPSK/16QAM | 35.93 |
| 8 | 2592 + 2663 | 100 + 40 | QPSK/16QAM | 35.69 |

### 2.1.2 5G-NR + LTE Data

Tabular Data – Channel RF Power (2-Carrier TM1.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2521 + 2680 | 50 + 20 | QPSK | 36.47 |
| 2 | 2521 + 2680 | 50 + 20 | QPSK | 37.49 |
| 3 | 2521 + 2680 | 50 + 20 | QPSK | 37.40 |
| 4 | 2521 + 2680 | 50 + 20 | QPSK | 36.81 |
| 5 | 2521 + 2680 | 50 + 20 | QPSK | 37.73 |
| 6 | 2521 + 2680 | 50 + 20 | QPSK | 37.90 |
| 7 | 2521 + 2680 | 50 + 20 | QPSK | 36.89 |
| 8 | 2521 + 2680 | 50 + 20 | QPSK | 36.81 |

### 2.1.3 5G-NR + 2xLTE Data

Tabular Data – Channel RF Power (3-Carrier TM1.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2521 + 2660 + 2680 | 50 + 20 + 20 | QPSK | 36.67 |
| 2 | 2521 + 2660 + 2680 | 50 + 20 + 20 | QPSK | 37.77 |
| 3 | 2521 + 2660 + 2680 | 50 + 20 + 20 | QPSK | 37.54 |
| 4 | 2521 + 2660 + 2680 | 50 + 20 + 20 | QPSK | 37.05 |
| 5 | 2521 + 2660 + 2680 | 50 + 20 + 20 | QPSK | 38.13 |

| | | | | |
|---|---|---|---|---|
| 6 | 2521 + 2660 + 2680 | 50 + 20 + 20 | QPSK | 38.38 |
| 7 | 2521 + 2660 + 2680 | 50 + 20 + 20 | QPSK | 37.28 |
| 8 | 2521 + 2660 + 2680 | 50 + 20 + 20 | QPSK | 37.33 |

### 2.1.4 5G-NR + 3xLTE Data

Tabular Data – Channel RF Power (4-Carrier TM1.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2521 + 2640 + 2660 + 2680 | 50 + 20 + 20 + 20 | QPSK | 36.86 |
| 2 | 2521 + 2640 + 2660 + 2680 | 50 + 20 + 20 + 20 | QPSK | 38.03 |
| 3 | 2521 + 2640 + 2660 + 2680 | 50 + 20 + 20 + 20 | QPSK | 37.90 |
| 4 | 2521 + 2640 + 2660 + 2680 | 50 + 20 + 20 + 20 | QPSK | 37.36 |
| 5 | 2521 + 2640 + 2660 + 2680 | 50 + 20 + 20 + 20 | QPSK | 38.53 |
| 6 | 2521 + 2640 + 2660 + 2680 | 50 + 20 + 20 + 20 | QPSK | 38.92 |
| 7 | 2521 + 2640 + 2660 + 2680 | 50 + 20 + 20 + 20 | QPSK | 37.66 |
| 8 | 2521 + 2640 + 2660 + 2680 | 50 + 20 + 20 + 20 | QPSK | 37.75 |

### 2.1.5 2x5G-NR + 2xLTE Data

Tabular Data – Channel RF Power (4-Carrier TM3.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2516 + 2556 + 2660 + 2680 | 40 + 40 + 20 + 20 | 64QAM | 35.26 |
| 2 | 2516 + 2556 + 2660 + 2680 | 40 + 40 + 20 + 20 | 64QAM | 36.62 |
| 3 | 2516 + 2556 + 2660 + 2680 | 40 + 40 + 20 + 20 | 64QAM | 36.98 |
| 4 | 2516 + 2556 + 2660 + 2680 | 40 + 40 + 20 + 20 | 64QAM | 35.75 |
| 5 | 2516 + 2556 + 2660 + 2680 | 40 + 40 + 20 + 20 | 64QAM | 36.90 |
| 6 | 2516 + 2556 + 2660 + 2680 | 40 + 40 + 20 + 20 | 64QAM | 37.21 |
| 7 | 2516 + 2556 + 2660 + 2680 | 40 + 40 + 20 + 20 | 64QAM | 36.12 |
| 8 | 2516 + 2556 + 2660 + 2680 | 40 + 40 + 20 + 20 | 64QAM | 36.26 |

Tabular Data – Channel RF Power (4-Carrier TM3.1a)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2521 + 2571 + 2640 + 2680 | 50 + 50 + 20 + 20 | 256QAM | 35.13 |
| 2 | 2521 + 2571 + 2640 + 2680 | 50 + 50 + 20 + 20 | 256QAM | 36.42 |
| 3 | 2521 + 2571 + 2640 + 2680 | 50 + 50 + 20 + 20 | 256QAM | 36.85 |
| 4 | 2521 + 2571 + 2640 + 2680 | 50 + 50 + 20 + 20 | 256QAM | 35.59 |
| 5 | 2521 + 2571 + 2640 + 2680 | 50 + 50 + 20 + 20 | 256QAM | 36.71 |
| 6 | 2521 + 2571 + 2640 + 2680 | 50 + 50 + 20 + 20 | 256QAM | 36.93 |
| 7 | 2521 + 2571 + 2640 + 2680 | 50 + 50 + 20 + 20 | 256QAM | 35.96 |
| 8 | 2521 + 2571 + 2640 + 2680 | 50 + 50 + 20 + 20 | 256QAM | 35.91 |

### 2.1.6 2x5G-NR + 3xLTE Data

Tabular Data – Channel RF Power (5-Carrier TM1.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2521 + 2592+2640 + 2660 + 2680 | 50 + 50 + 60 | QPSK | 34.84 |
| 2 | 2521 + 2592+2640 + 2660 + 2680 | 50 + 50 + 60 | QPSK | 36.28 |
| 3 | 2521 + 2592+2640 + 2660 + 2680 | 50 + 50 + 60 | QPSK | 36.56 |
| 4 | 2521 + 2592+2640 + 2660 + 2680 | 50 + 50 + 60 | QPSK | 35.44 |
| 5 | 2521 + 2592+2640 + 2660 + 2680 | 50 + 50 + 60 | QPSK | 36.85 |
| 6 | 2521 + 2592+2640 + 2660 + 2680 | 50 + 50 + 60 | QPSK | 37.38 |
| 7 | 2521 + 2592+2640 + 2660 + 2680 | 50 + 50 + 60 | QPSK | 36.07 |
| 8 | 2521 + 2592+2640 + 2660 + 2680 | 50 + 50 + 60 | QPSK | 36.36 |

Tabular Data – Channel RF Power (5-Carrier TM3.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2516 + 2556+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 35.15 |
| 2 | 2516 + 2556+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 36.66 |
| 3 | 2516 + 2556+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 36.90 |
| 4 | 2516 + 2556+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 35.76 |
| 5 | 2516 + 2556+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 37.12 |
| 6 | 2516 + 2556+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 37.60 |
| 7 | 2516 + 2556+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 36.32 |
| 8 | 2516 + 2556+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 36.64 |
| 1 | 2516 + 2592+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 35.60 |
| 2 | 2516 + 2592+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 37.05 |
| 3 | 2516 + 2592+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 37.38 |
| 4 | 2516 + 2592+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 36.14 |
| 5 | 2516 + 2592+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 37.49 |
| 6 | 2516 + 2592+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 37.92 |
| 7 | 2516 + 2592+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 36.69 |
| 8 | 2516 + 2592+2640 + 2660 + 2680 | 40 + 40 + 20 + 20 + 20 | 64QAM | 36.97 |
| 1 | 2521 + 2571+2640 + 2660 + 2680 | 50 + 50 + 20 + 20 + 20 | 64QAM | 34.65 |
| 2 | 2521 + 2571+2640 + 2660 + 2680 | 50 + 50 + 20 + 20 + 20 | 64QAM | 36.17 |
| 3 | 2521 + 2571+2640 + 2660 + 2680 | 50 + 50 + 20 + 20 + 20 | 64QAM | 36.41 |
| 4 | 2521 + 2571+2640 + 2660 + 2680 | 50 + 50 + 20 + 20 + 20 | 64QAM | 35.29 |
| 5 | 2521 + 2571+2640 + 2660 + 2680 | 50 + 50 + 20 + 20 + 20 | 64QAM | 36.67 |
| 6 | 2521 + 2571+2640 + 2660 + 2680 | 50 + 50 + 20 + 20 + 20 | 64QAM | 37.22 |
| 7 | 2521 + 2571+2640 + 2660 + 2680 | 50 + 50 + 20 + 20 + 20 | 64QAM | 35.90 |
| 8 | 2521 + 2571+2640 + 2660 + 2680 | 50 + 50 + 20 + 20 + 20 | 64QAM | 36.20 |

### 2.1.7 LTE + 5G-NR Data

Tabular Data – Channel RF Power (2-Carrier TM3.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2506 + 2644 | 20 + 90 | 64QAM | 35.74 |
| 2 | 2506 + 2644 | 20 + 90 | 64QAM | 36.70 |
| 3 | 2506 + 2644 | 20 + 90 | 64QAM | 36.89 |
| 4 | 2506 + 2644 | 20 + 90 | 64QAM | 36.20 |
| 5 | 2506 + 2644 | 20 + 90 | 64QAM | 37.13 |
| 6 | 2506 + 2644 | 20 + 90 | 64QAM | 37.30 |
| 7 | 2506 + 2644 | 20 + 90 | 64QAM | 36.44 |
| 8 | 2506 + 2644 | 20 + 90 | 64QAM | 36.40 |

### 2.1.8 2xLTE + 5G-NR Data

Tabular Data – Channel RF Power (3-Carrier TM3.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2506 + 2526 + 2644 | 20 + 20 + 90 | 64QAM | 35.95 |
| 2 | 2506 + 2526 + 2644 | 20 + 20 + 90 | 64QAM | 37.01 |
| 3 | 2506 + 2526 + 2644 | 20 + 20 + 90 | 64QAM | 37.02 |
| 4 | 2506 + 2526 + 2644 | 20 + 20 + 90 | 64QAM | 36.49 |
| 5 | 2506 + 2526 + 2644 | 20 + 20 + 90 | 64QAM | 37.53 |
| 6 | 2506 + 2526 + 2644 | 20 + 20 + 90 | 64QAM | 37.90 |
| 7 | 2506 + 2526 + 2644 | 20 + 20 + 90 | 64QAM | 36.85 |
| 8 | 2506 + 2526 + 2644 | 20 + 20 + 90 | 64QAM | 36.97 |

### 2.1.9 3xLTE + 5G-NR Data

Tabular Data – Channel RF Power (4-Carrier TM3.1)

| TX Port | Channel Frequency MHz | Signal BW MHz | Modulation | Channel Power dBm |
|---|---|---|---|---|
| 1 | 2506 + 2526 + 2546 + 2644 | 20 + 20 + 20 + 90 | 64QAM | 36.36 |
| 2 | 2506 + 2526 + 2546 + 2644 | 20 + 20 + 20 + 90 | 64QAM | 37.42 |
| 3 | 2506 + 2526 + 2546 + 2644 | 20 + 20 + 20 + 90 | 64QAM | 37.25 |
| 4 | 2506 + 2526 + 2546 + 2644 | 20 + 20 + 20 + 90 | 64QAM | 36.91 |
| 5 | 2506 + 2526 + 2546 + 2644 | 20 + 20 + 20 + 90 | 64QAM | 38.05 |
| 6 | 2506 + 2526 + 2546 + 2644 | 20 + 20 + 20 + 90 | 64QAM | 38.57 |
| 7 | 2506 + 2526 + 2546 + 2644 | 20 + 20 + 20 + 90 | 64QAM | 37.34 |
| 8 | 2506 + 2526 + 2546 + 2644 | 20 + 20 + 20 + 90 | 64QAM | 37.58 |

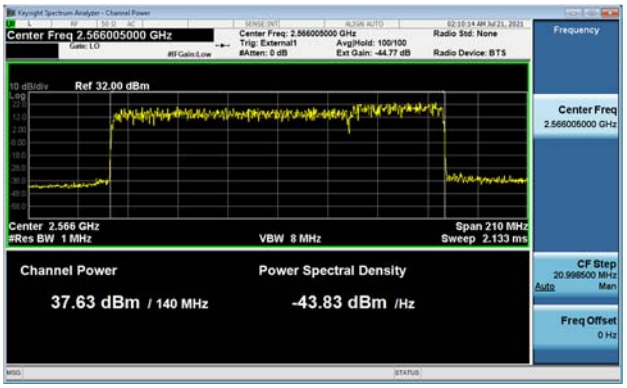
## 2.2 Channel RF Power – Plots

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

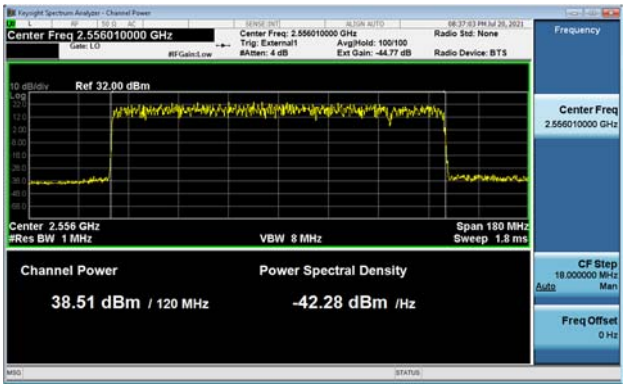
### 2.2.1 5G-NR Only Plots

**Channel RF Power 2-Carrier**

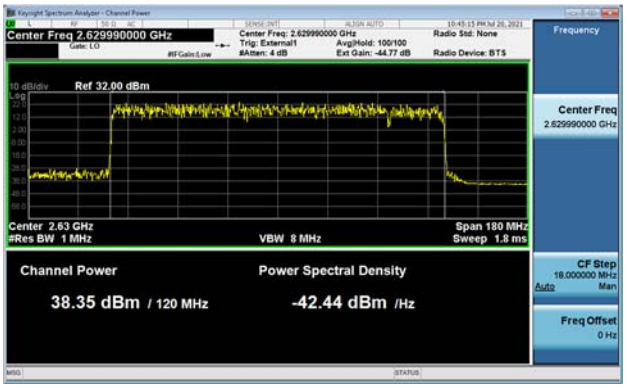
Test Model 1.1
Modulation QPSK
Channel Frequency 2546 + 2616MHz
TX3



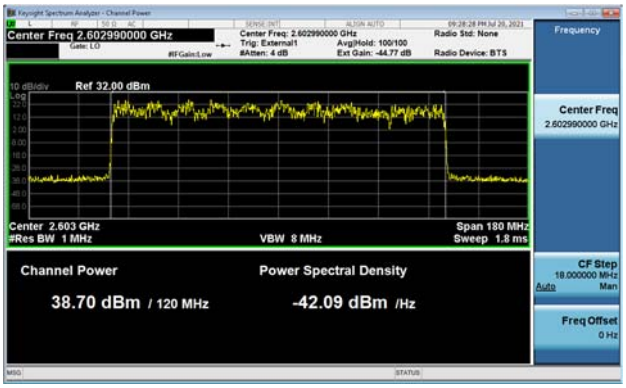

Test Model 3.1
Modulation 64QAM
Channel Frequency 2546 + 2606MHz
TX3




Test Model 3.1a
Modulation 256QAM
Channel Frequency 2619 + 2679MHz
TX2



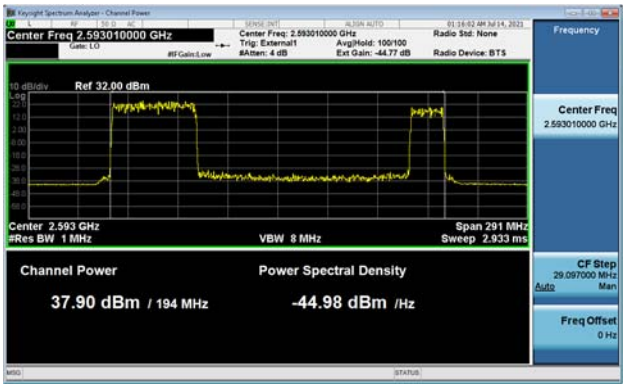

Test Model 3.2
Modulation QPSK/16QAM
Channel Frequency 2592 + 2652MHz
TX3



## 2.2.2 5G-NR + LTE Plots

**Channel RF Power 2-Carrier**

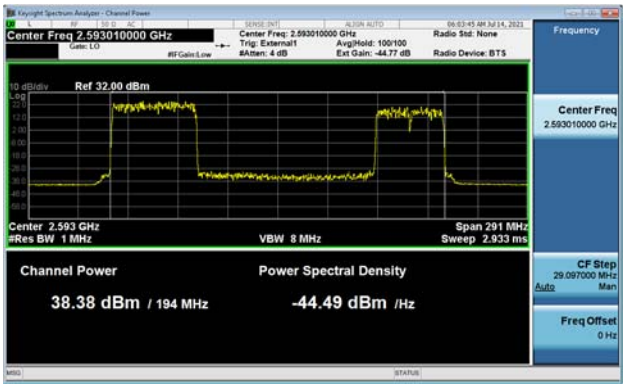
Test Model 1.1
Modulation QPSK
Channel Frequency 2521 + 2680MHz
TX6




## 2.2.3 5G-NR + 2xLTE Plots

**Channel RF Power 3-Carrier**

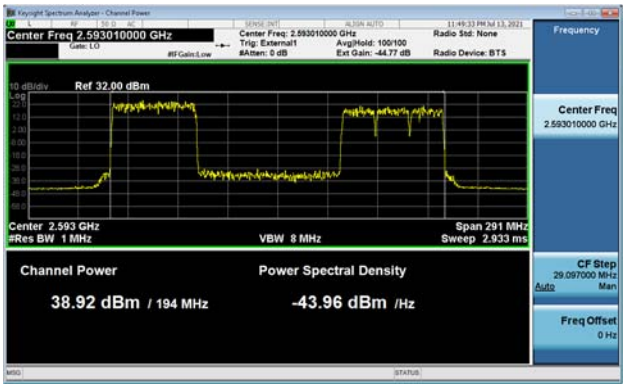
Test Model 1.1
Modulation QPSK
Channel Frequency 2521 + 2660 + 2680MHz
TX6



## 2.2.4 5G-NR + 3xLTE Plots

**Channel RF Power 4-Carrier**

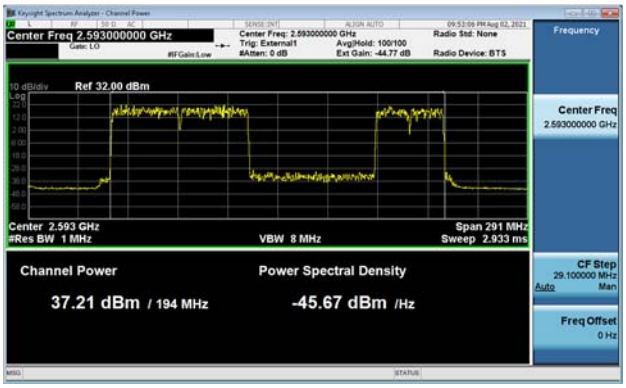
Test Model 1.1
Modulation QPSK
Channel Frequency 2521 + 2640 + 2660 + 2680MHz
TX6



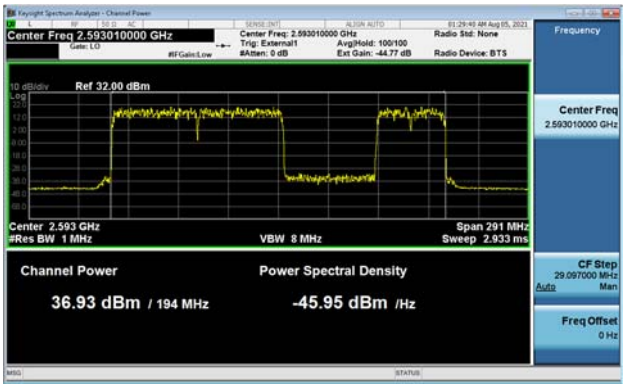

## 2.2.5 2x5G-NR + 2xLTE Plots

**Channel RF Power 4-Carrier**

Test Model 3.1
Modulation 64QAM
Channel Frequency 2516 + 2556 + 2660 + 2680MHz
TX6



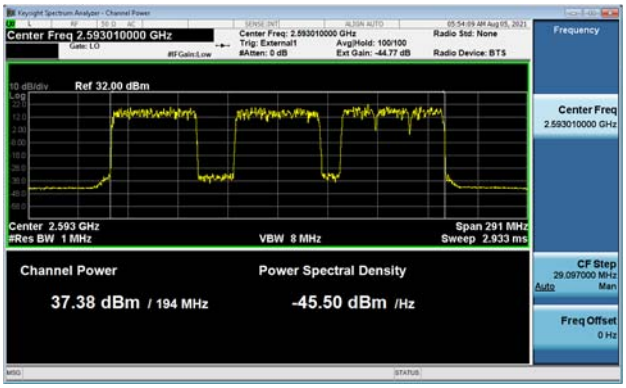

Test Model 3.1a
Modulation 256QAM
Channel Frequency 2521 + 2571 + 2640 + 2680MHz
TX6



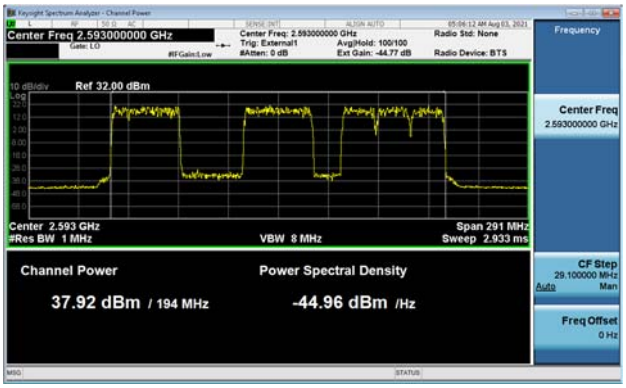
## 2.2.6 2x5G-NR + 3xLTE Plots

**Channel RF Power 5-Carrier**

Test Model 1.1
Modulation QPSK
Channel Frequency 2521 + 2592 + 2640 + 2660 + 2680MHz
TX6



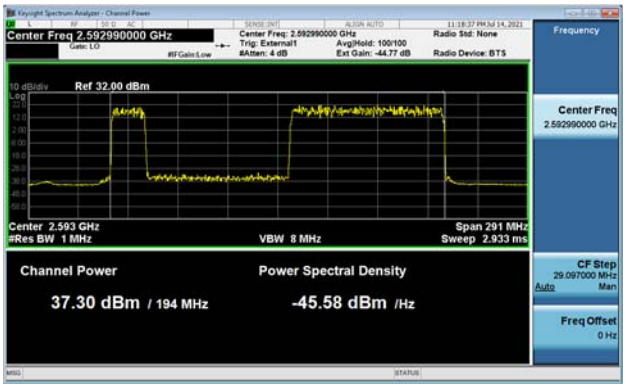

Test Model 3.1
Modulation 64QAM
Channel Frequency 2516 + 2592 + 2640 + 2660 + 2680MHz
TX6




## 2.2.7 LTE + 5G-NR Plots

**Channel RF Power 2-Carrier**

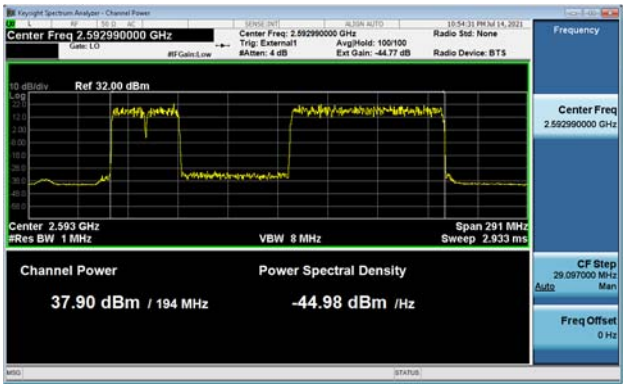
Test Model 3.1
Modulation 64QAM
Channel Frequency 2506 + 2644MHz
TX6



## 2.2.8 2xLTE + 5G-NR Plots

**Channel RF Power 3-Carrier**

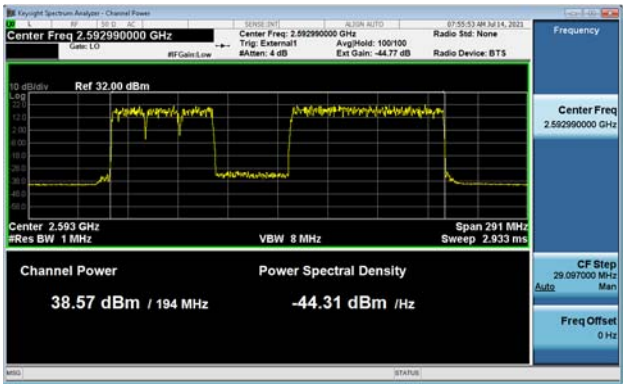
Test Model 3.1
Modulation 64QAM
Channel Frequency 2506 + 2526 + 2644MHz
TX6




## 2.2.9 3xLTE + 5G-NR Plots

**Channel RF Power 4-Carrier**

Test Model 3.1
Modulation 64QAM
Channel Frequency 2506 + 2526 + 2546 + 2644MHz
TX6



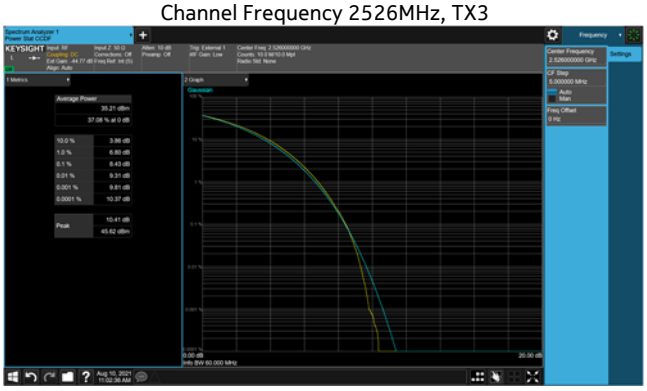
## 2.3 Peak-to-Average Power Ratio (PAPR)

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

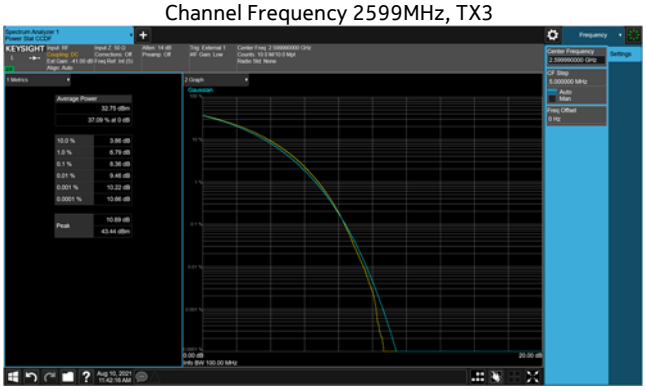
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

### 2.3.1 Peak-to-Average Power Ratio – 5G Only Plots

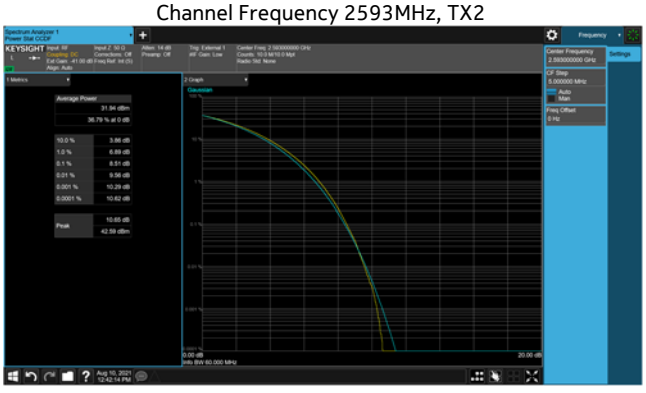
Test Model 3.1
Modulation 64QAM
Channel Frequency 2526MHz, TX3



Test Model 3.1a
Modulation 256QAM
Channel Frequency 2599MHz, TX3

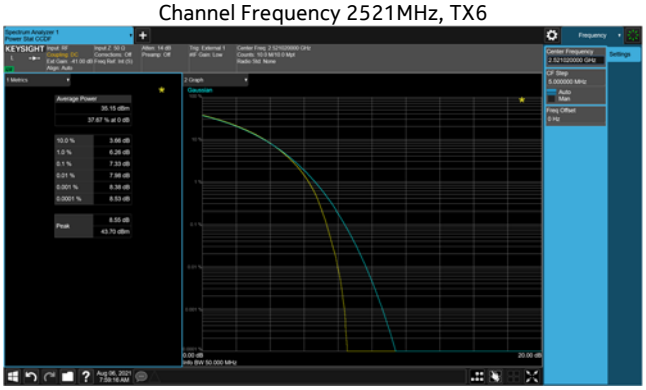


Test Model 3.2
Modulation QPSK/16QAM
Channel Frequency 2593MHz, TX2



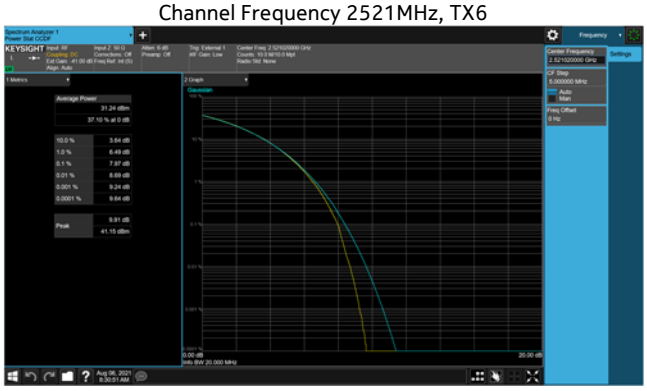
## 2.3.2 Peak-to-Average Power Ratio – 5G-NR + LTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521MHz, TX6



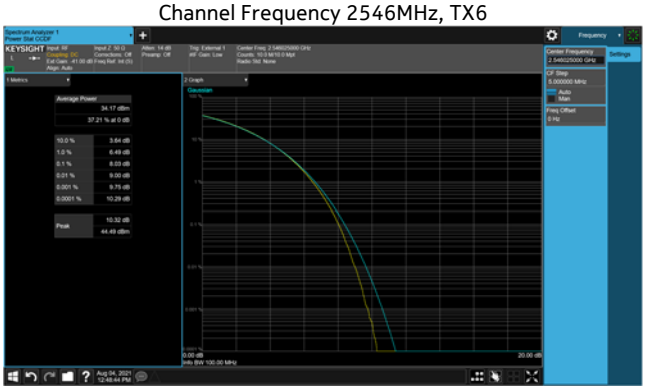
## 2.3.3 Peak-to-Average Power Ratio – 5G-NR + 2xLTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521MHz, TX6



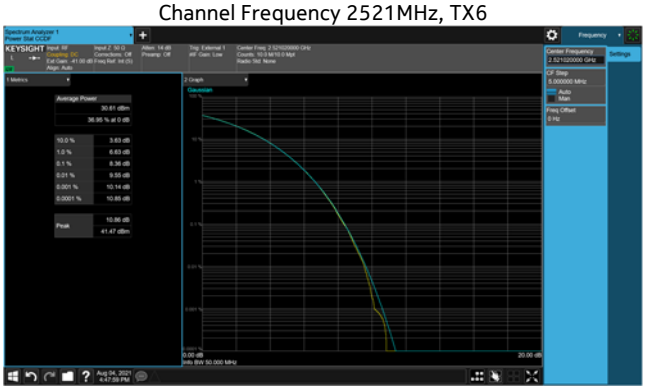
## 2.3.4 Peak-to-Average Power Ratio – 2x5G-NR + 2xLTE Plots

Test Model 3.1a
Modulation 256QAM
Channel Frequency 2546MHz, TX6

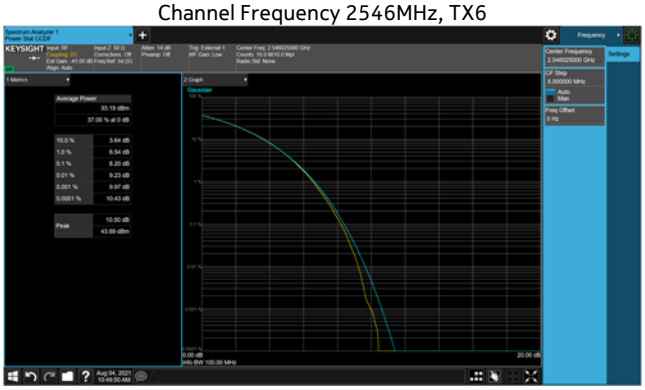


## 2.3.5 Peak-to-Average Power Ratio – 2x5G-NR + 3xLTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521MHz, TX6

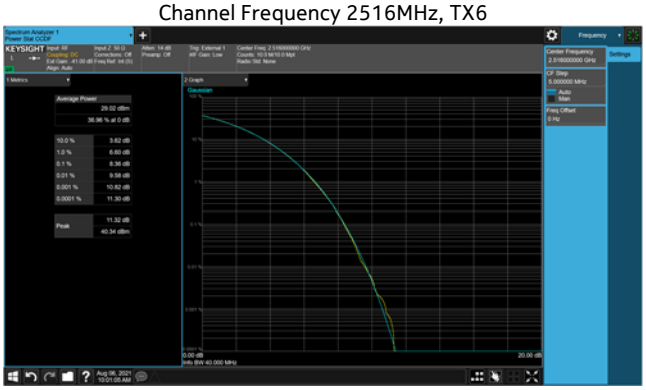


Test Model 3.1
Modulation 64QAM
Channel Frequency 2546MHz, TX6



## 2.3.6 Peak-to-Average Power Ratio – 2xLTE + 5G-NR Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2516MHz, TX6



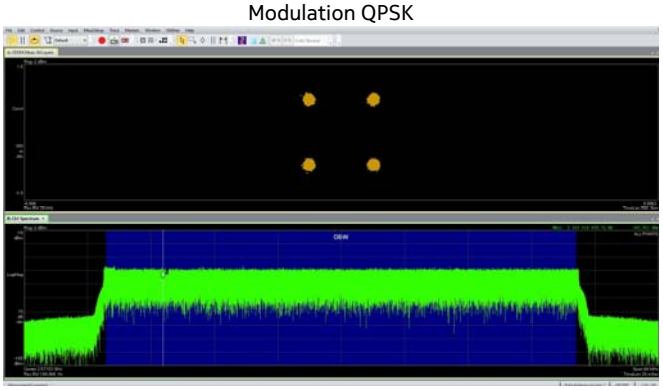
# 3. FCC Section 2.1047 - Modulation Characteristics

## 3.1 Modulation Characteristics

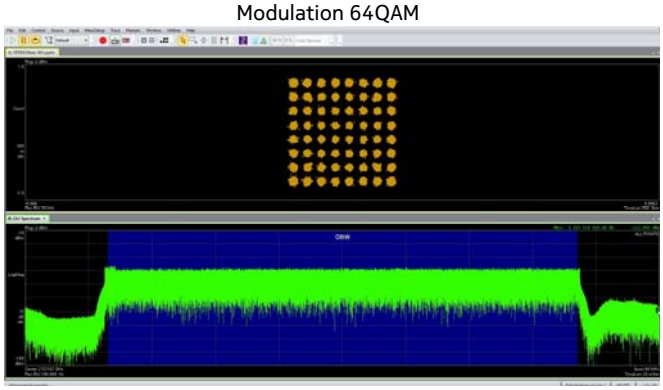
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

### 3.1.1 Modulation Characteristics – 5G-NR Plots

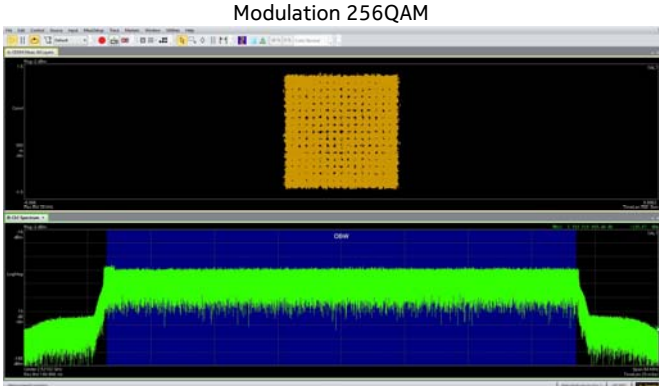
Modulation QPSK



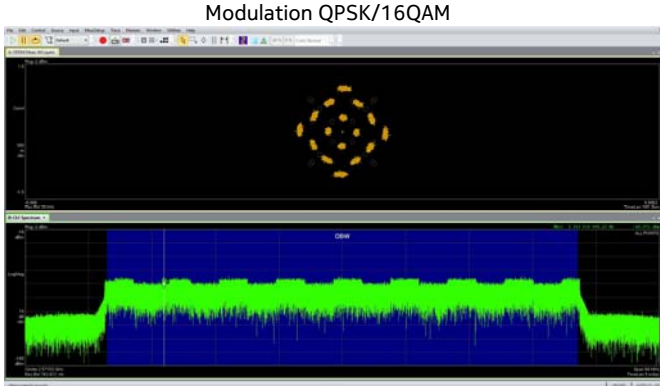
Modulation 64QAM



Modulation 256QAM

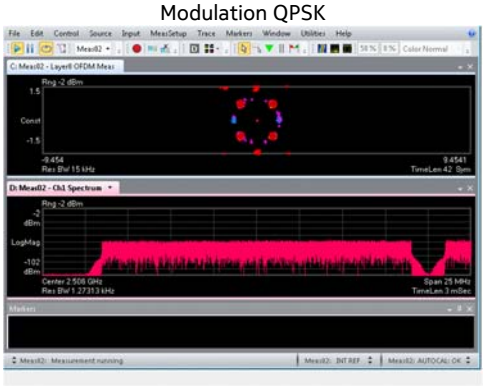


Modulation QPSK/16QAM

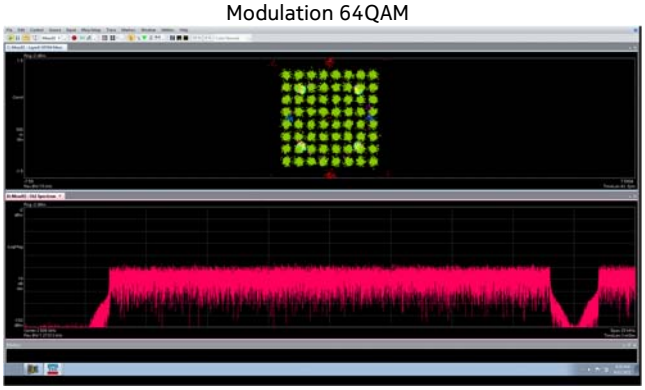


## 3.1.2 Modulation Characteristics – LTE Plots

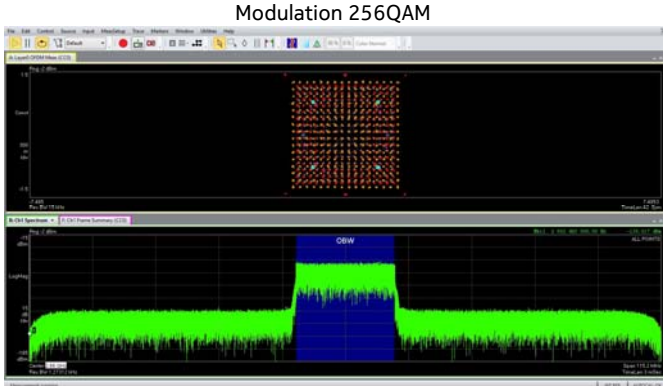
Modulation QPSK



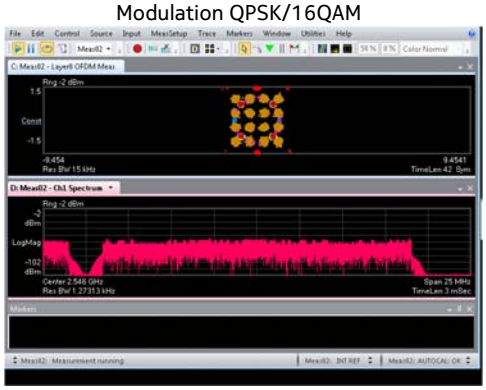
Modulation 64QAM



Modulation 256QAM




Modulation QPSK/16QAM



# 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**

| # of Carriers | Test Model | Modulation | TX Port | Channel Frequency MHz | Signal BW MHz | Radio Access Technology | Occupied BW MHz |
|---|---|---|---|---|---|---|---|
| 2 | 1.1 | QPSK | 2 | 2546_2616 | 140 | 5G-NR | 136.48 |
| 2 | 1.1 | QPSK | 3 | 2559_2640 | 160 | 5G-NR | 156.41 |
| 2 | 3.1 | 64QAM | 3 | 2546+2606 | 100+20 | 5G-NR | 116.66 |
| 2 | 3.1 | 64QAM | 3 | 2526_2606 | 160 | 5G-NR | 156.42 |
| 2 | 3.1a | 256QAM | 3 | 2526+2670 | 60+40 | 5G-NR | 57.699+38.140 |
| 2 | 3.1a | 256QAM | 3 | 2620+2670 | 60+40 | 5G-NR | 97.343 |
| 2 | 3.1a | 256QAM | 3 | 2550+2640 | 80+100 | 5G-NR | 175.69 |
| 2 | 3.1a | 256QAM | 2 | 2619+2679 | 100+20 | 5G-NR | 116.95 |
| 2 | 3.1a | 256QAM | 3 | 2599_2670 | 140 | 5G-NR | 137.24 |
| 2 | 3.2 | QPSK/16QAM | 3 | 2536_2626 | 180 | 5G-NR | 176.47 |
| 2 | 3.2 | QPSK/16QAM | 2 | 2593+2643 | 60+40 | 5G-NR | 97.604 |
| 2 | 3.2 | QPSK/16QAM | 2 | 2546+2679 | 100+20 | 5G-NR | 97.018+18.847 |
| 2 | 3.2 | QPSK/16QAM | 3 | 2592+2652 | 100+20 | 5G-NR | 117.68 |
| 2 | 3.2 | QPSK/16QAM | 3 | 2526_2576 | 100 | 5G-NR | 97.501 |
| 2 | 3.2 | QPSK/16QAM | 3 | 2592_2663 | 140 | 5G-NR | 136.94 |
| 2 | 1.1 | QPSK | 6 | 2521+2680 | 50+20 | 5G-NR+LTE | 47.506+18.369 |
| 3 | 1.1 | QPSK | 6 | 2521+2660+2680 | 50+20+20 | 5G-NR+LTE+LTE | 47.501+37.891 |
| 4 | 1.1 | QPSK | 6 | 2521+2640+2660+2680 | 50+20+20+20 | 5G-NR+ LTE+LTE+LTE | 47.502+57.437 |
| 4 | 3.1 | 64QAM | 5 | 2516+2556+2660+2680 | 40+40+20+20 | 5G-NR+5G-NR+ LTE+LTE | 77.624+37.861 |
| 4 | 3.1a | 256QAM | 6 | 2521+2571+2640+2680 | 50+50+20+20 | 5G-NR+5G-NR+ LTE+LTE | 97.334+37.729 |
| 5 | 1.1 | QPSK | 6 | 2521+2592+2640+2660+2680 | 50+50+60 | 5G-NR+5G-NR+ LTE+LTE+LTE | 47.668+47.691+57.411 |
| 5 | 3.1 | 64QAM | 6 | 2516+2556+2640+2660+2680 | 40+40+20+20+20 | 5G-NR+5G-NR+ LTE+LTE+LTE | 77.611+57.544 |
| 5 | 3.1 | 64QAM | 6 | 2516+2592+2640+2660+2680 | 40+40+20+20+20 | 5G-NR+5G-NR+ LTE+LTE+LTE | 38.128+38.306+57.159 |
| 5 | 3.1 | 64QAM | 6 | 2521+2571+2640+2660+2680 | 50+50+20+20+20 | 5G-NR+5G-NR+ LTE+LTE+LTE | 97.011+57.464 |

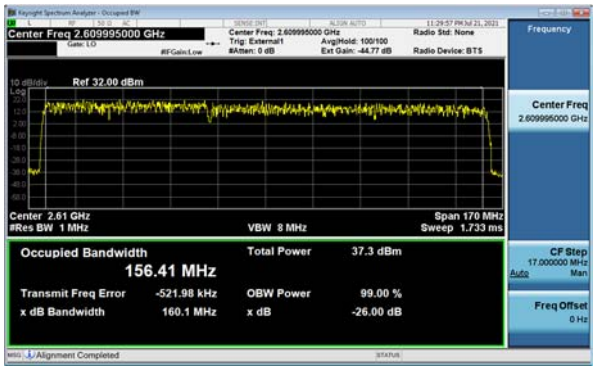
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | 3.1 | 64QAM | 6 | 2506+2644 | 20+90 | LTE+5G-NR | 18.314+87.230 |
| 3 | 3.1 | 64QAM | 6 | 2506 + 2526 + 2644 | 20+20+90 | LTE+LTE+5G-NR | 37.972+87.254 |
| 4 | 3.1 | 64QAM | 6 | 2506+2526+2546+2644 | 20+20+20+90 | LTE+LTE+LTE+5G-NR | 57.804+86.974 |

## 4.1.1 Occupied Bandwidth - Plots

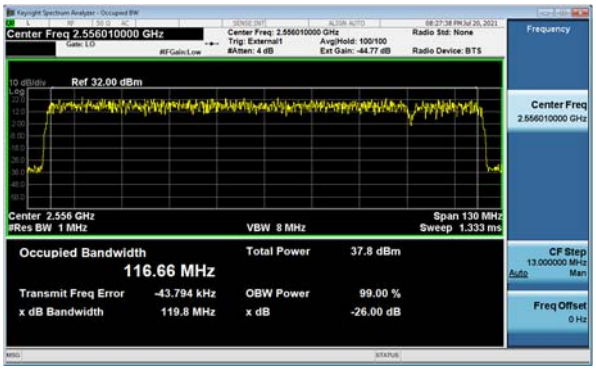
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

### 4.1.1.1 5G-NR Only Plots

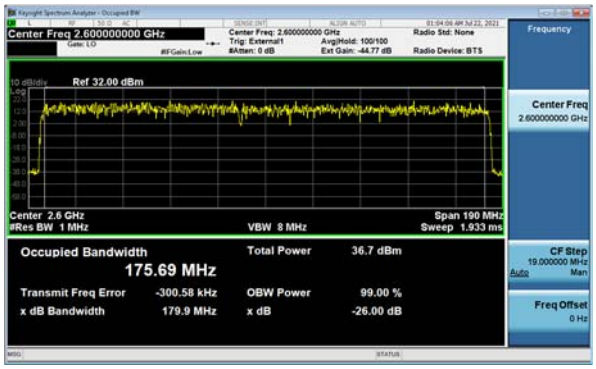
Test Model 1.1
Modulation QPSK
Channel Frequency 2559_2640MHz
TX3



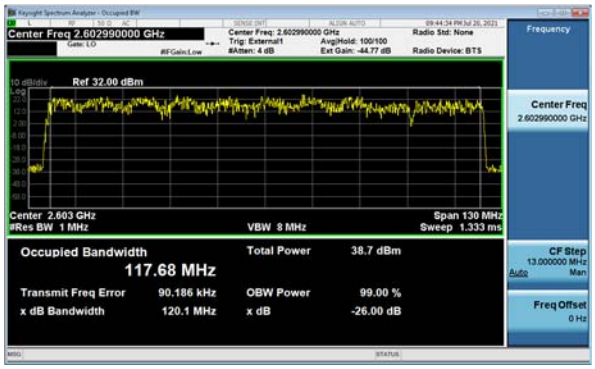

Test Model 3.1
Modulation 64QAM
Channel Frequency 2546+2606MHz
TX3




Test Model 3.1a
Modulation 256QAM
Channel Frequency 2550+2640MHz
TX3

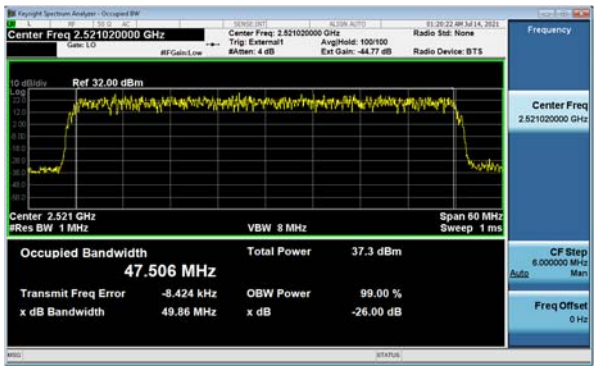



Test Model 3.2
Modulation QPSK/16QAM
Channel Frequency 2592+2652MHz
TX3



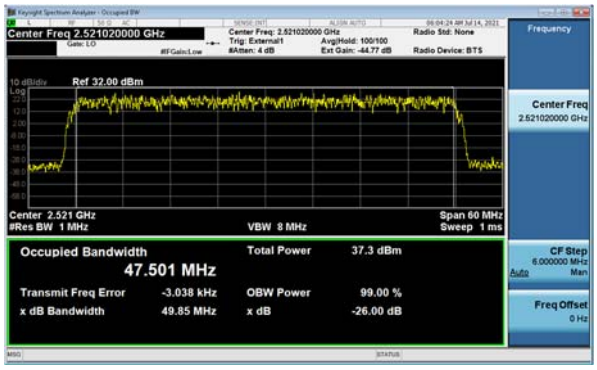
### 4.1.1.2 5G-NR + LTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521MHz
TX6



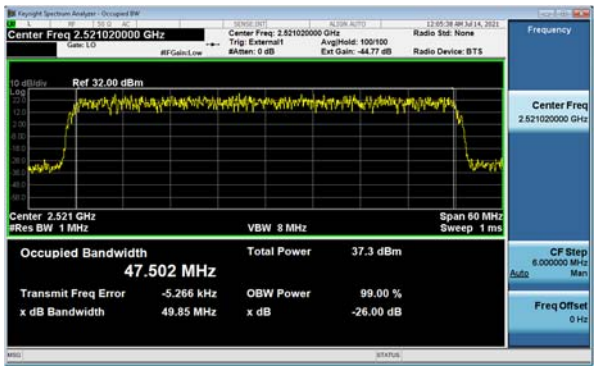

### 4.1.1.3 5G-NR + 2xLTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521MHz
TX6



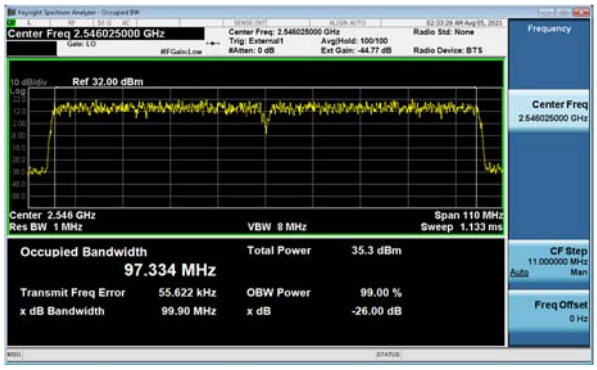
### 4.1.1.4 5G-NR + 3xLTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521MHz
TX6



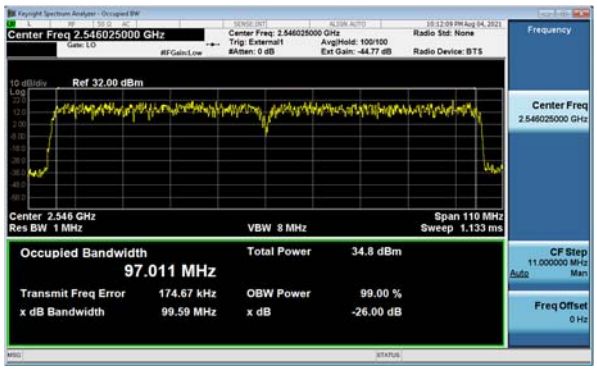

### 4.1.1.5 2x5G-NR + 2xLTE Plots

Test Model 3.1a
Modulation 256QAM
Channel Frequency 2546MHz
TX6



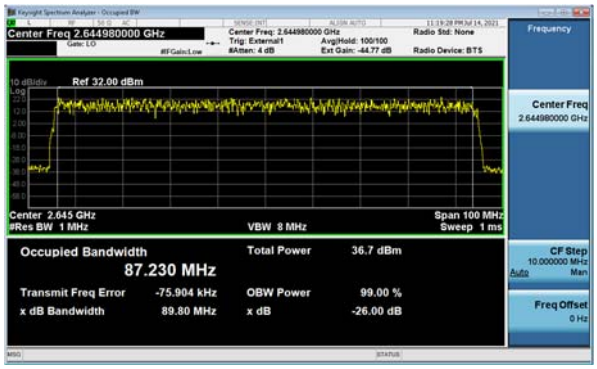
### 4.1.1.6 2x5G-NR + 3xLTE Plots

Test Model 3.1
Modulation 64QAM
Channel Frequency 2546MHz
TX6



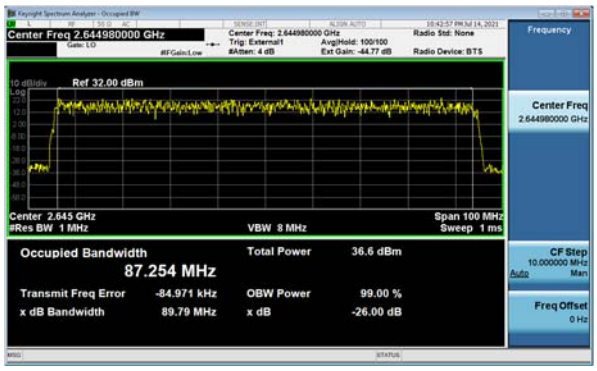

### 4.1.1.7 LTE + 5G-NR Plots

Test Model 3.1
Modulation 64QAM
Channel Frequency 2644MHz
TX6



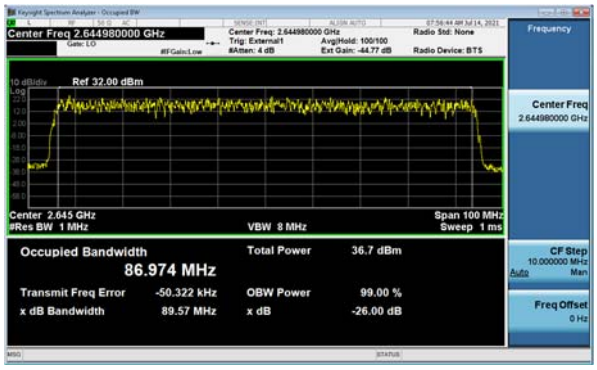
### 4.1.1.8 2xLTE + 5G-NR Plots

Test Model 3.1
Modulation 64QAM
Channel Frequency 2644MHz
TX6




### 4.1.1.9 3xLTE + 5G-NR Plots

Test Model 3.1
Modulation 64QAM
Channel Frequency 2644MHz
TX6



## 4.2 Edge of band Emissions

The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. The RF power level was continuously measured using a RF broadband power meter. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator and test coupler. The path attenuation was offset on the display and the signal for the carrier was adjusted to the corrected RF power level for the resolution bandwidth used for the transmit signal. All mask values were adjusted based upon the designated signal bandwidth and measurement bandwidths. The Top of Mask corresponds to the set rated power level as confirmed by the RF power meter.

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

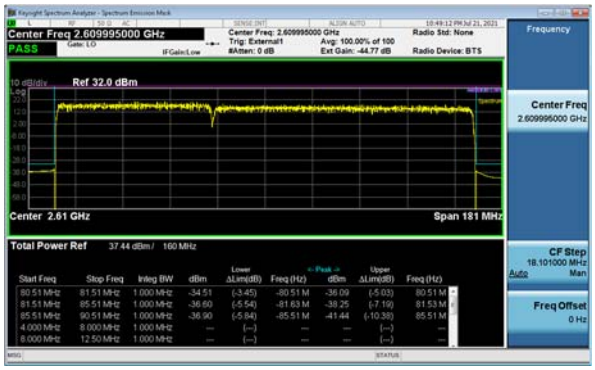
## 4.2.1 Edge of Band Emissions – Plots

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

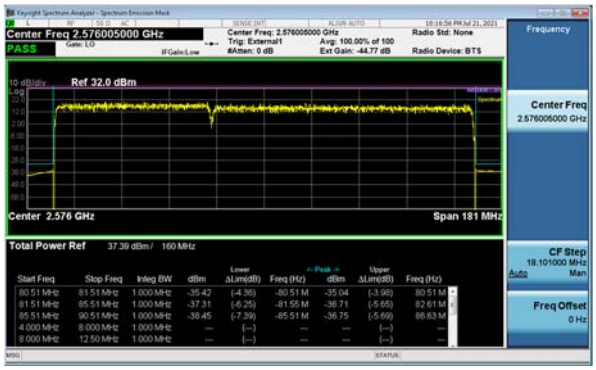
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

### 4.2.1.1 Edge of Band Emissions – 5G-NR Only Plots

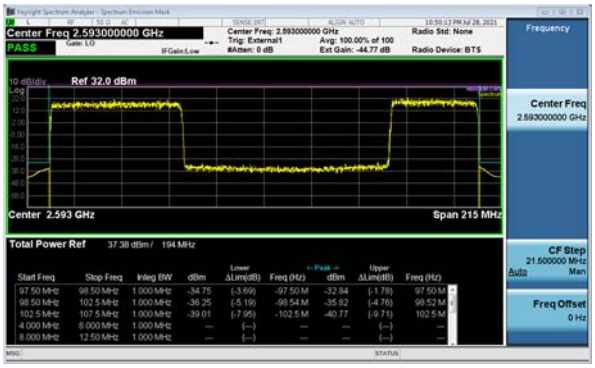
Test Model 1.1
Modulation QPSK
Channel Frequency 2559+2640MHz
TX3



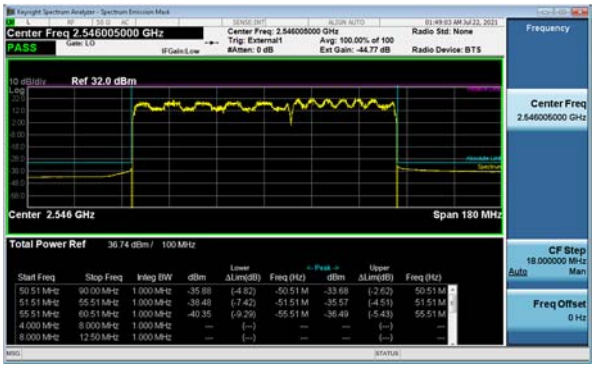

Test Model 3.1
Modulation 64QAM
Channel Frequency 2526+2606MHz
TX3




Test Model 3.1a
Modulation 256QAM
Channel Frequency 2526+2670MHz
TX3

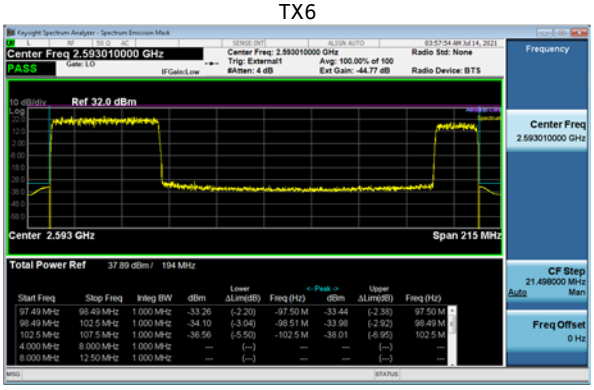



Test Model 3.2
Modulation QPSK/16QAM
Channel Frequency 2526+2576MHz
TX3



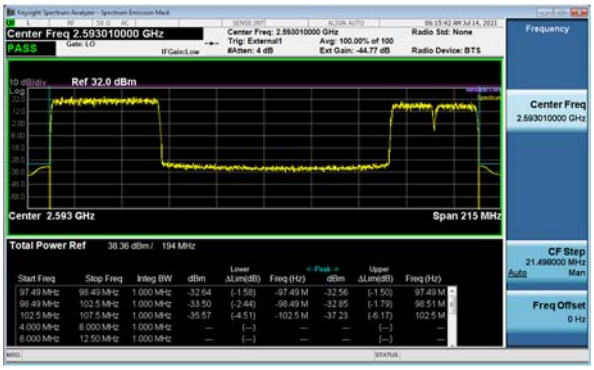
### 4.2.1.2 Edge of Band Emissions – 5G-NR + LTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521+2680MHz
TX6



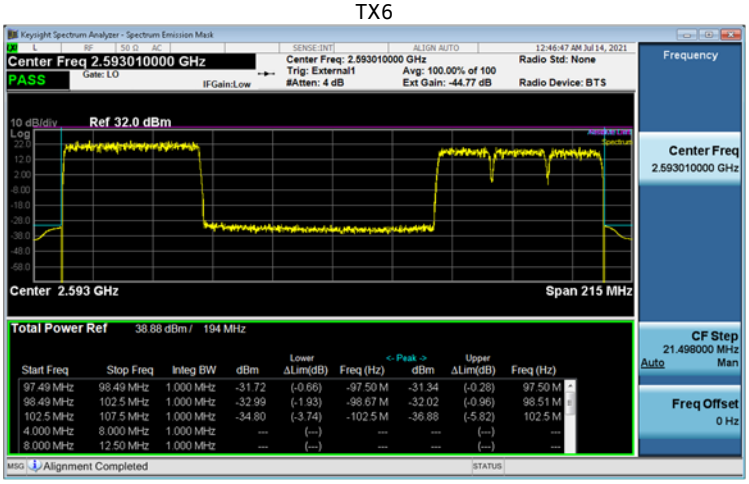

### 4.2.1.3 Edge of Band Emissions – 5G-NR + 2xLTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521+2660+2680MHz
TX6



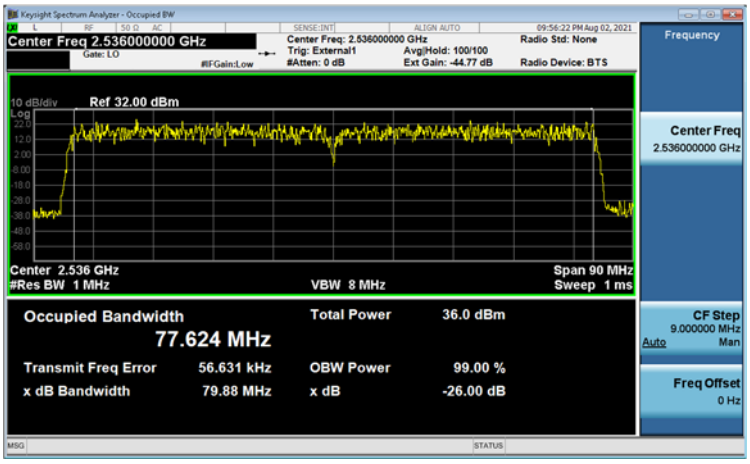
### 4.2.1.4 Edge of Band Emissions – 5G-NR + 3xLTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521+2640+2660+2680MHz
TX6

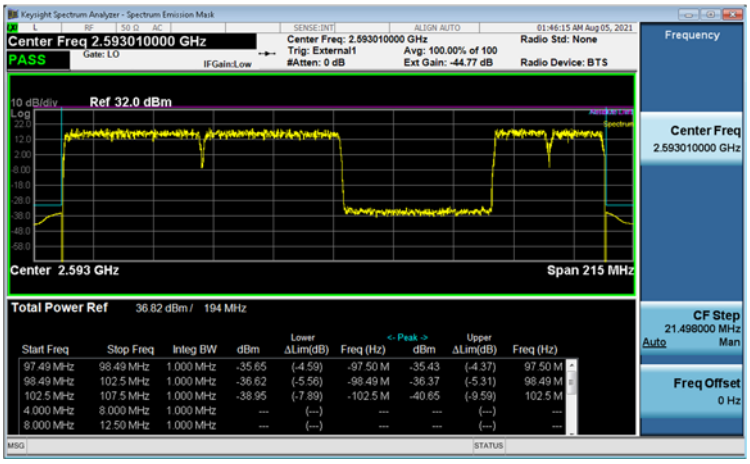



### 4.2.1.5 Edge of Band Emissions – 2x5G-NR + 2xLTE Plots

Test Model 3.1
Modulation 256QAM
Channel Frequency 2516+2556+2660+2680MHz
TX5

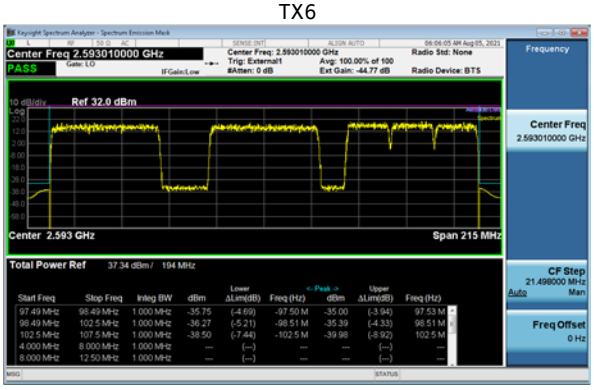



Test Model 3.1a
Modulation 256QAM
Channel Frequency 2521+2571+2640+2680MHz
TX6

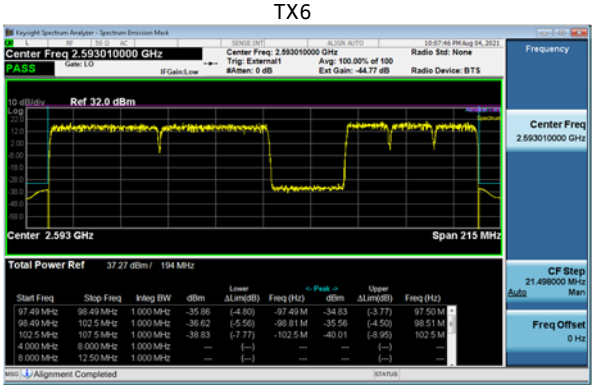


### 4.2.1.6 Edge of Band Emissions – 2x5G-NR + 3xLTE Plots

Test Model 1.1
Modulation QPSK
Channel Frequency 2521+2592+2640+2660+2680MHz
TX6

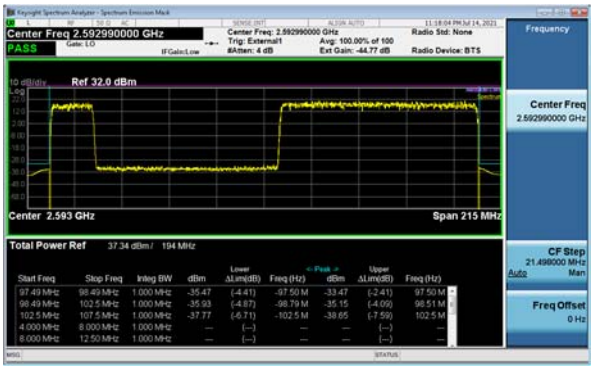



Test Model 3.1
Modulation 64QAM
Channel Frequency 2521+2571+2640+2660+2680MHz
TX6



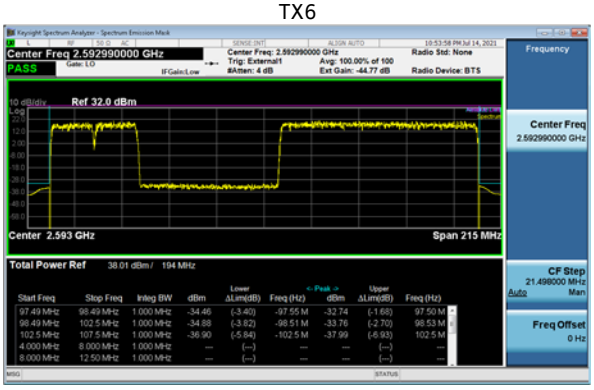

### 4.2.1.7 Edge of Band Emissions – LTE + 5G-NR Plots

Test Model 3.1
Modulation 64QAM
Channel Frequency 2506+2644MHz
TX6



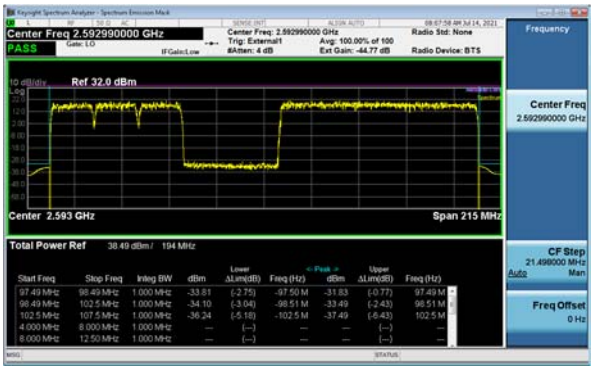
### 4.2.1.8 Edge of Band Emissions – 2xLTE + 5G-NR Plots

Test Model 3.1
Modulation 64QAM
Channel Frequency 2506+2526+2644MHz
TX6




### 4.2.1.9 Edge of Band Emissions – 3xLTE + 5G-NR Plots

Test Model 3.1
Modulation 64QAM
Channel Frequency 2506+2526+2546+2644MHz
TX6



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

## 5.1 Measurement of Spurious Emissions at Transmit Antenna Port

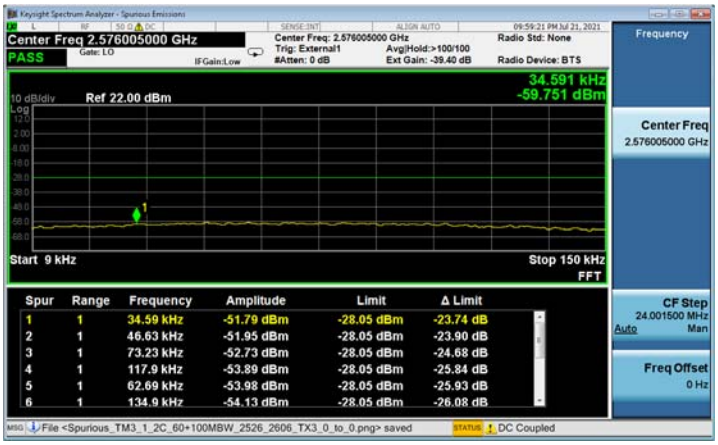
Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. Carrier Bandwidth is exempt. For this band of operation, the measurements were performed up to 37 GHz. Measurements were made using a Keysight MXA Signal Analyzer. The RF output from the transmitter was reduced (to an amplitude usable by the receivers) using calibrated attenuators. The RF power level was continuously monitored via a coupled RF Power Meter.

The required emission limitation is specified as appropriate in 27.53. The measured spurious emission levels were plotted for the frequency range as specified in 2.1057. For 64 ports where 10log (64) = 18dBm, the limit is 31dBm/MHz.. Data below documents performance up to 37 GHz.

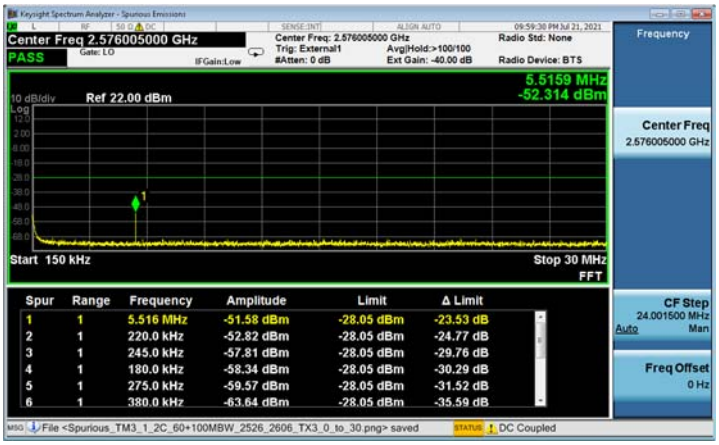
NOTE: Only a sample of the plots are used in this report. The full suite of raw data resides at the MH, New Jersey location.

**5G-NR Only Data**
**60+100MHz BW**
Test Model 3.1
Modulation 64QAM
Channel Frequency 2526 + 2606MHz
TX3

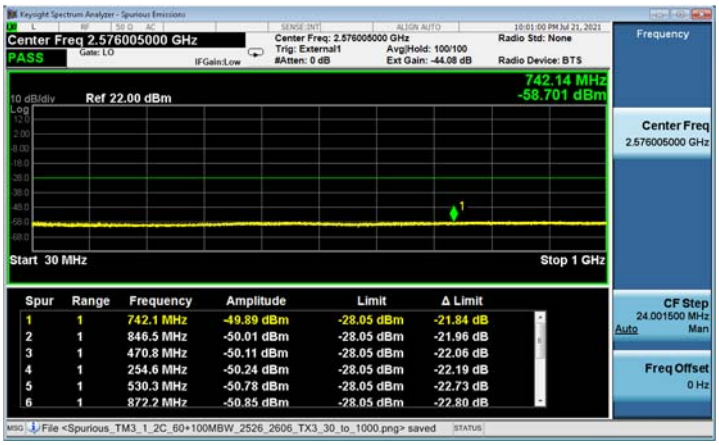
**9KHz – 150KHz**



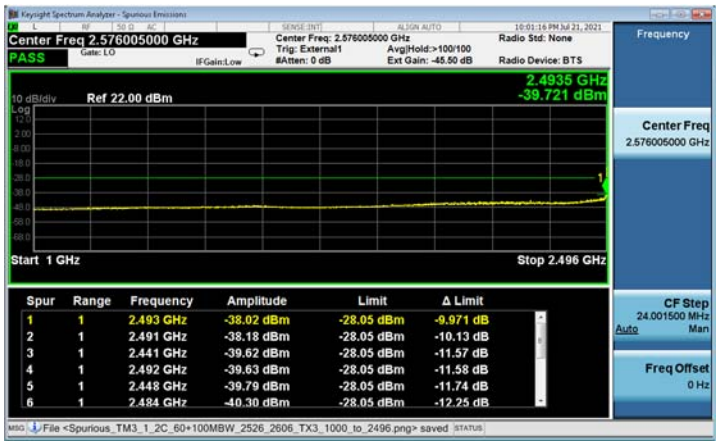

**150KHz – 30MHz**



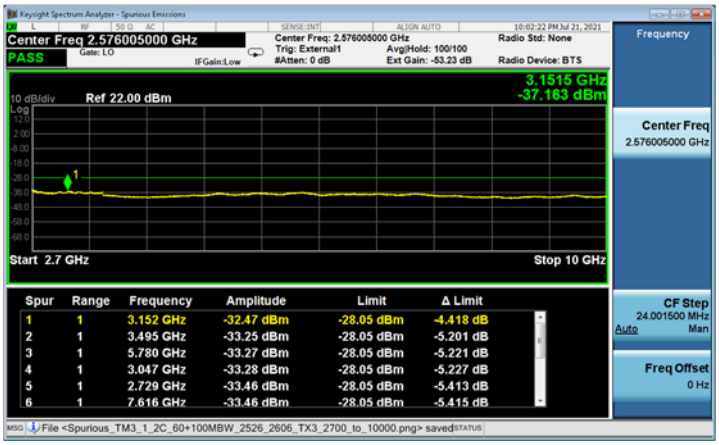
### 30MHz – 1GHz



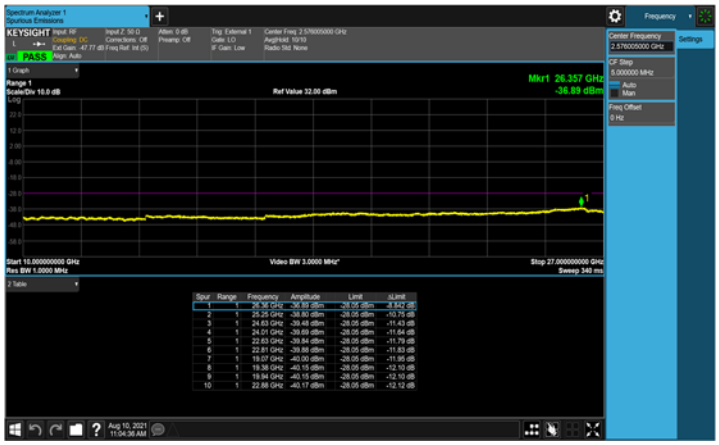

### 1GHz – 2.496GHz




### 2.7GHz – 10GHz



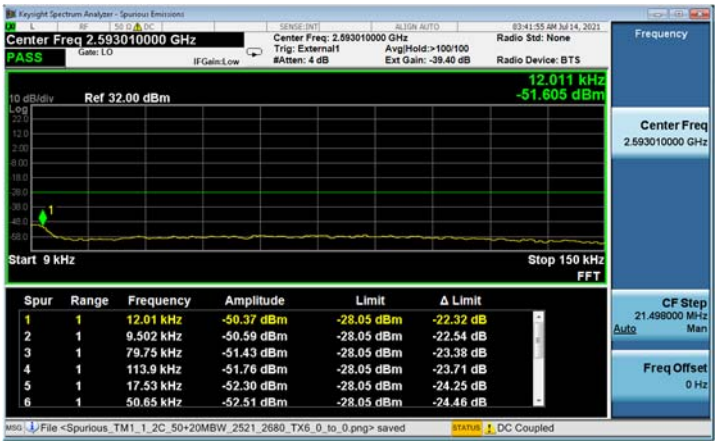

### 10GHz – 27GHz



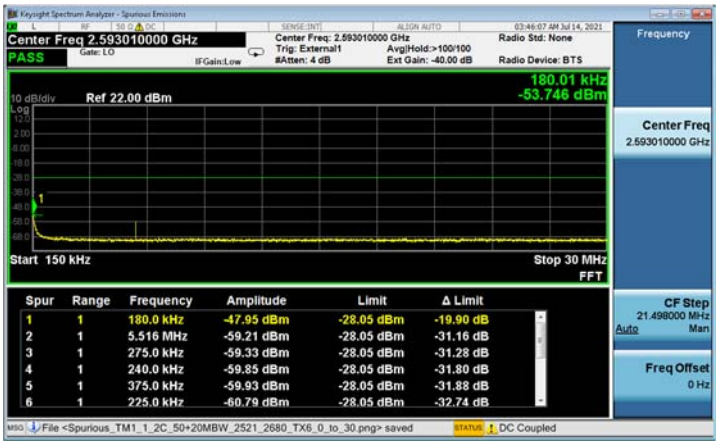
## 5G-NR + LTE Data
## 50+20MHz BW

Test Model 1.1
Modulation QPSK
Channel Frequency 2521 + 2680MHz
TX6

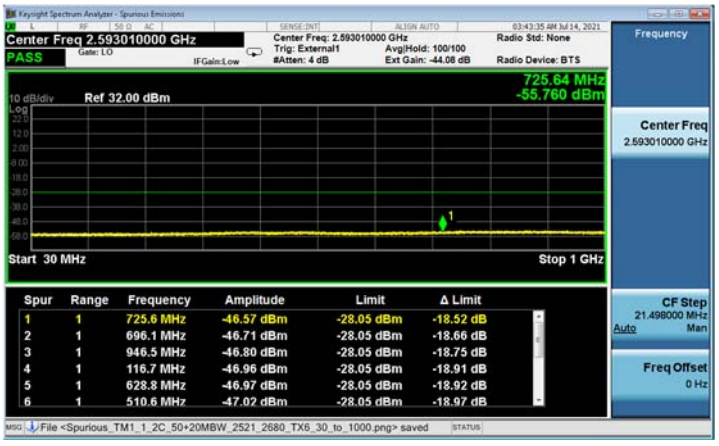
### 9KHz – 150kHz



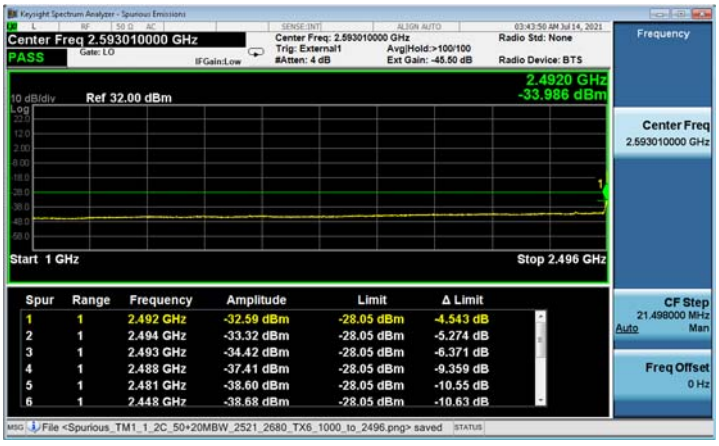

### 150KHz – 30MHz



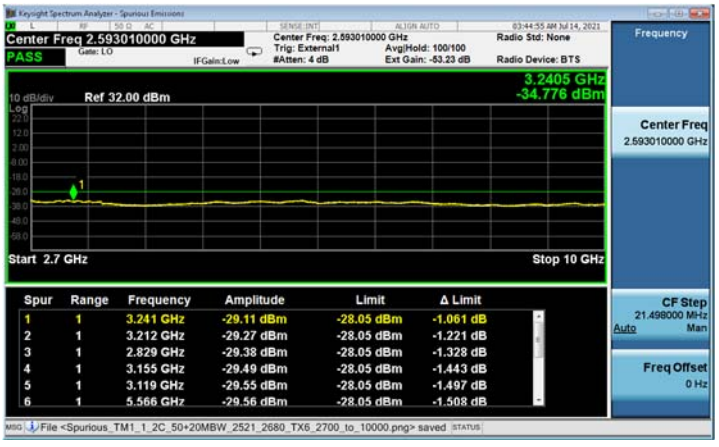

### 30MHz – 1GHz



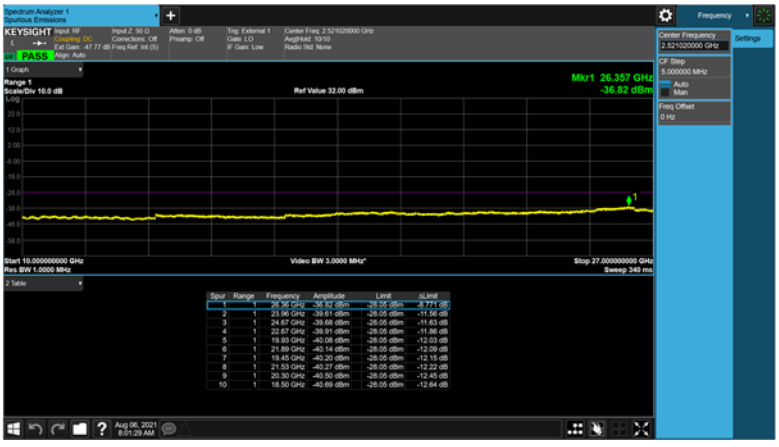

### 1GHz – 2.496GHz




### 2.7GHz – 10GHz



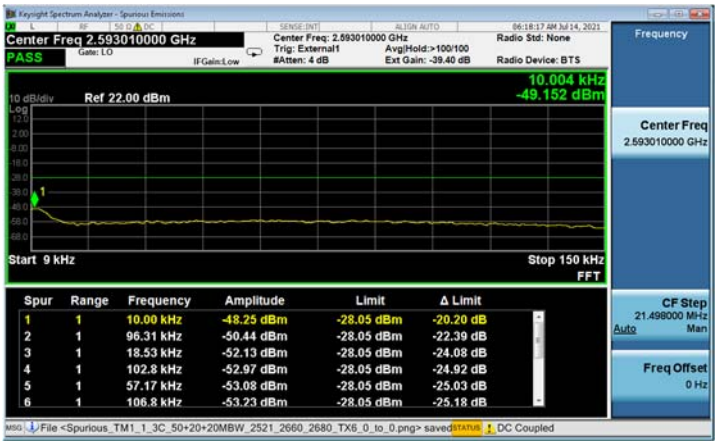

### 10GHz – 27GHz



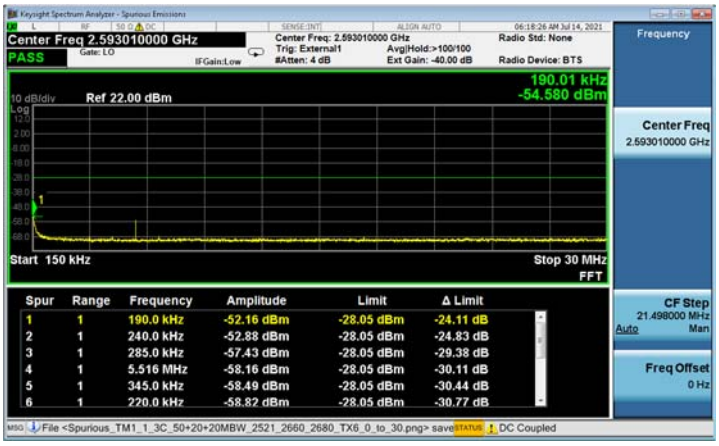
## 5G-NR + 2xLTE Data
## 50+20+20MHz BW

Test Model 1.1
Modulation QPSK
Channel Frequency 2521 + 2660 + 2680MHz
TX6

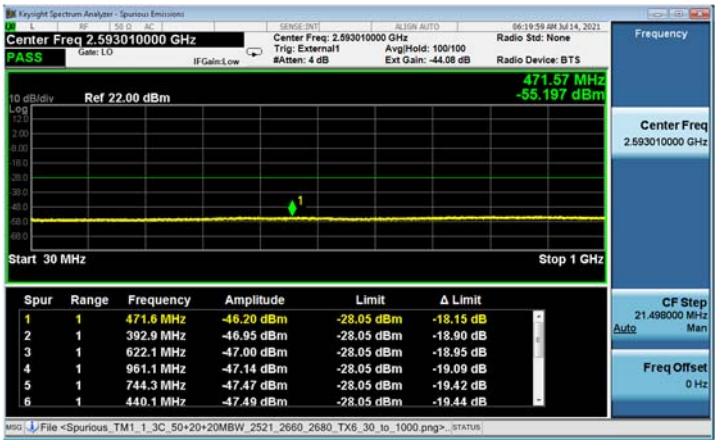
### 9KHz – 150kHz



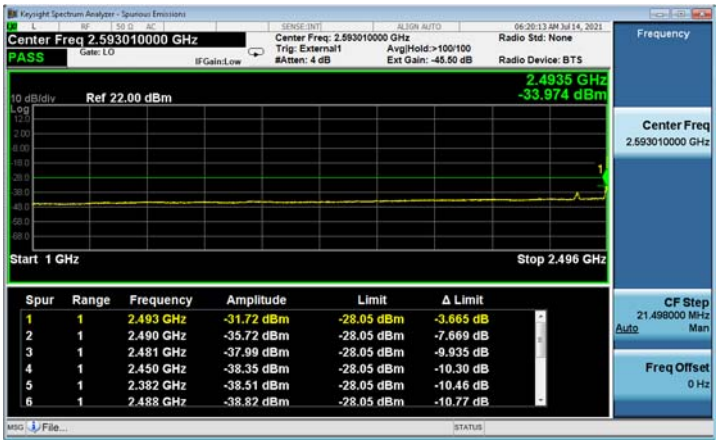

### 150KHz – 30MHz




### 30MHz – 1GHz

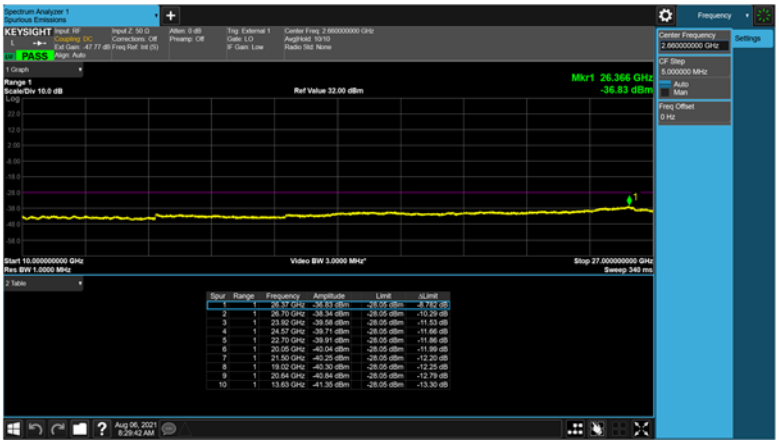



### 1GHz – 2.496GHz




### 2.7GHz – 10GHz

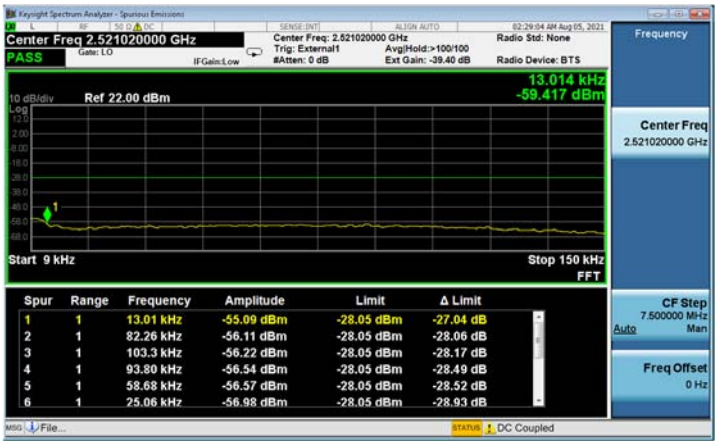

### 10GHz – 27GHz



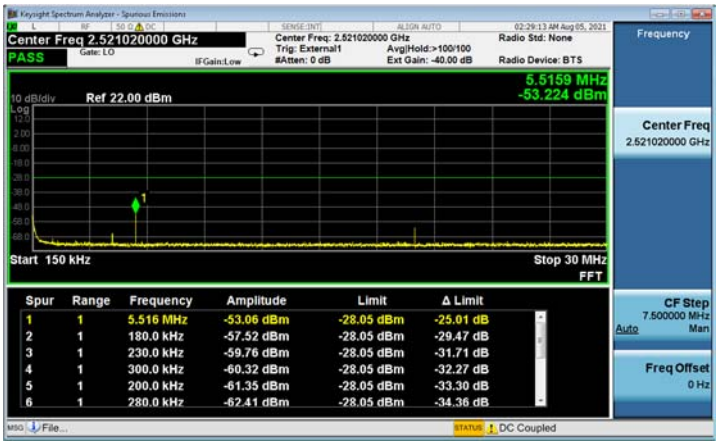
## 2x5G-NR + 2xLTE Data
## 50+50+20+20MHz BW

Test Model 3.1a
Modulation 256QAM
Channel Frequency 2521 + 2571 + 2640 + 2680MHz
TX6

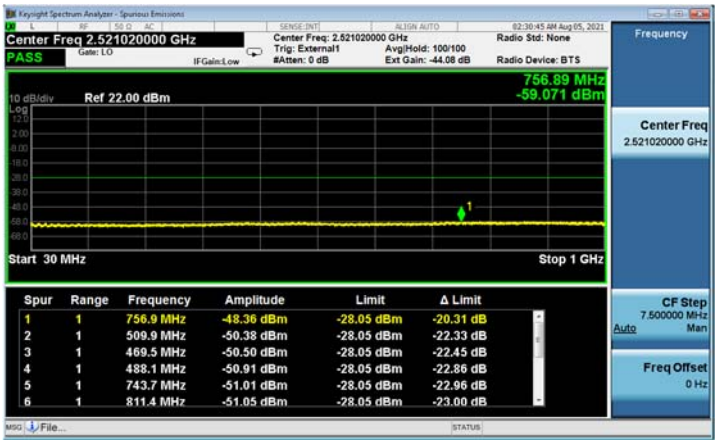
### 9KHz – 150kHz



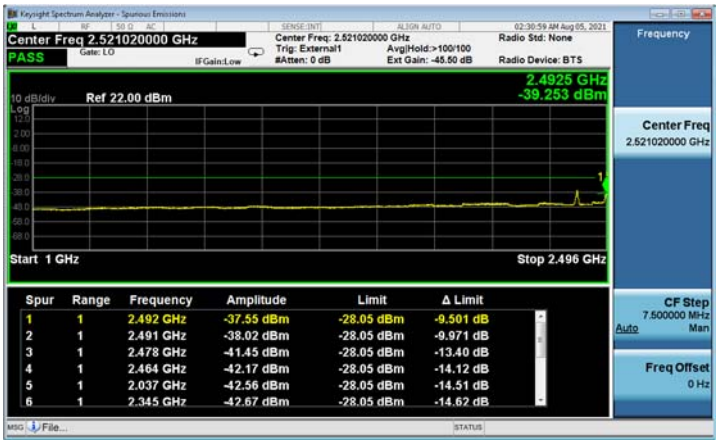

### 150KHz – 30MHz



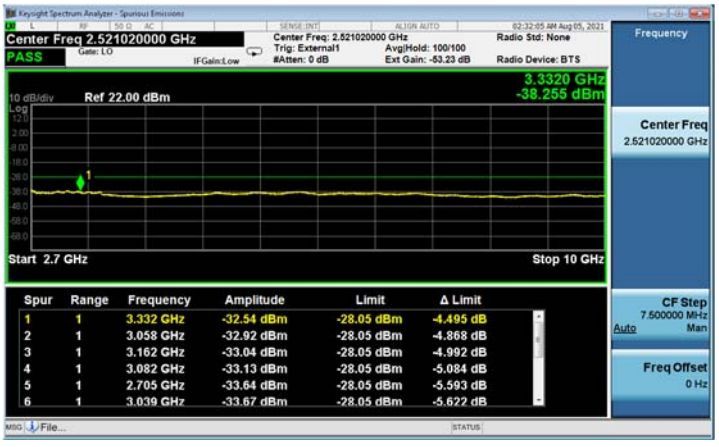

### 30MHz – 1GHz



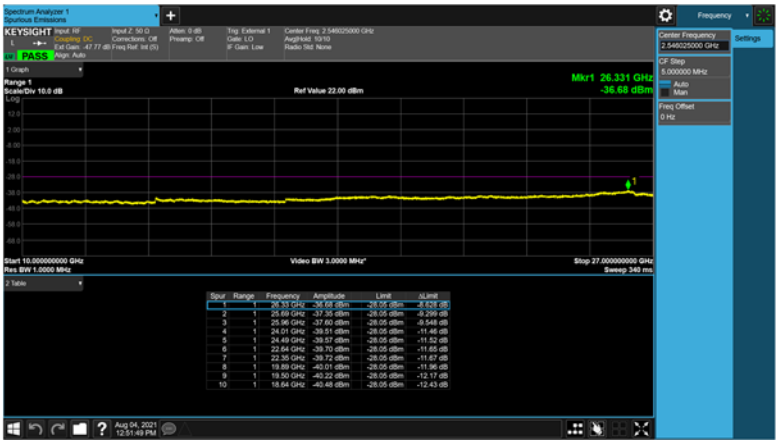

### 1GHz – 2.496GHz




### 2.7GHz – 10GHz




### 10GHz – 27GHz

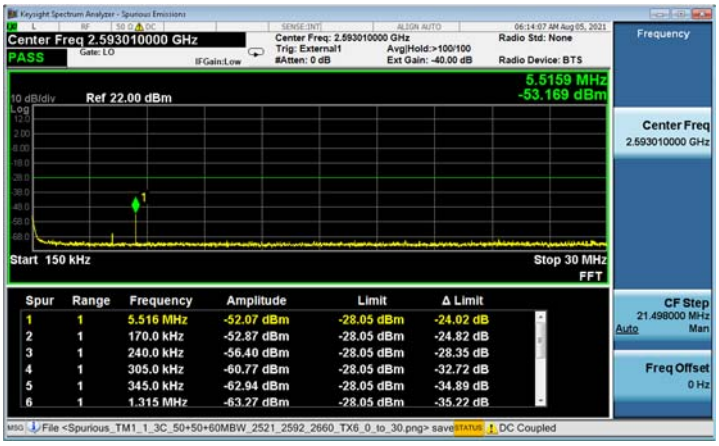


## 2x5G-NR + 3xLTE Data
## 50+50+60MHz BW

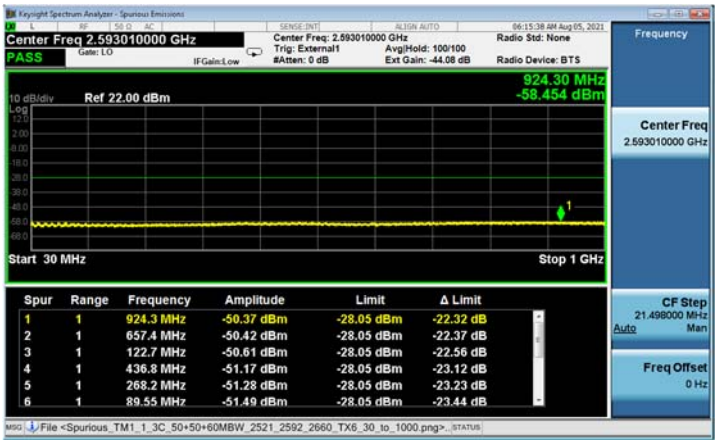
Test Model 1.1
Modulation QPSK
Channel Frequency 2521 + 2592 + 2640 + 2660 + 2680MHz
TX6

### 9KHz – 150kHz

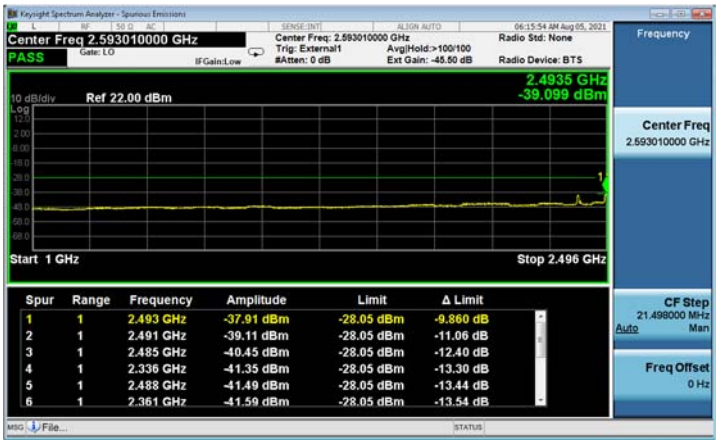

### 150KHz – 30MHz



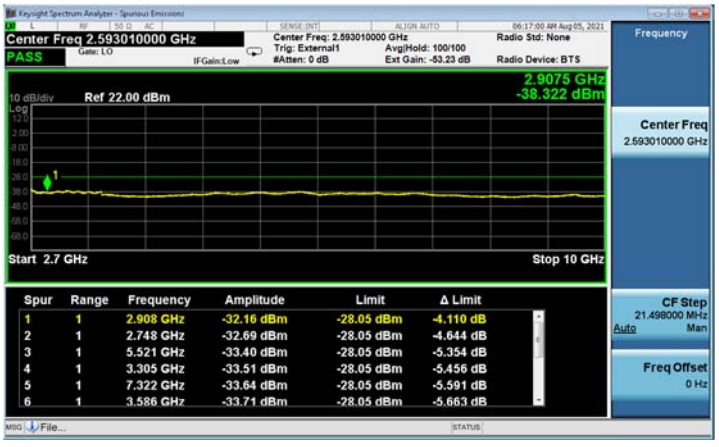

### 30MHz – 1GHz



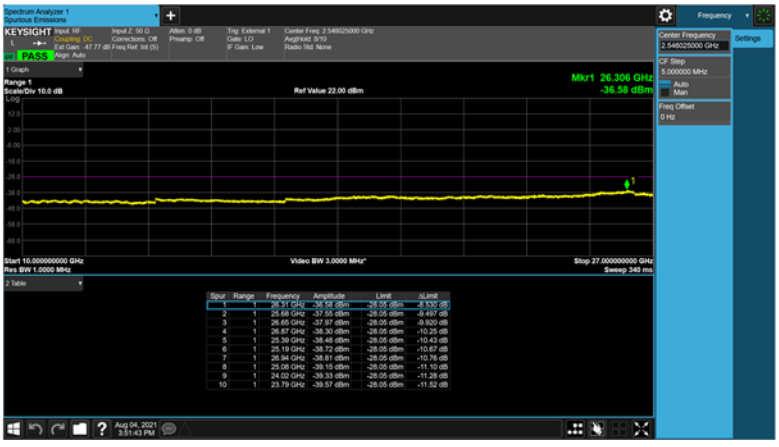

### 1GHz – 2.496GHz




### 2.7GHz – 10GHz




### 10GHz – 27GHz



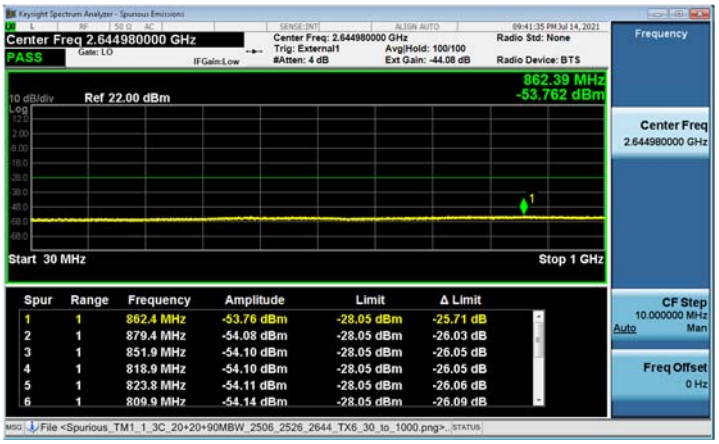
## 2xLTE + 5G-NR Data
## 20+20+90MHz BW

Test Model 3.1
Modulation 64QAM
Channel Frequency 2506 + 2526 + 2644MHz
TX6

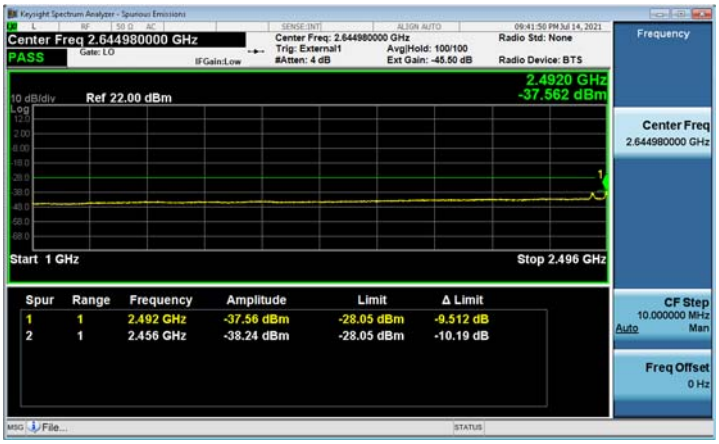
### 9KHz – 150kHz


### 150KHz – 30MHz

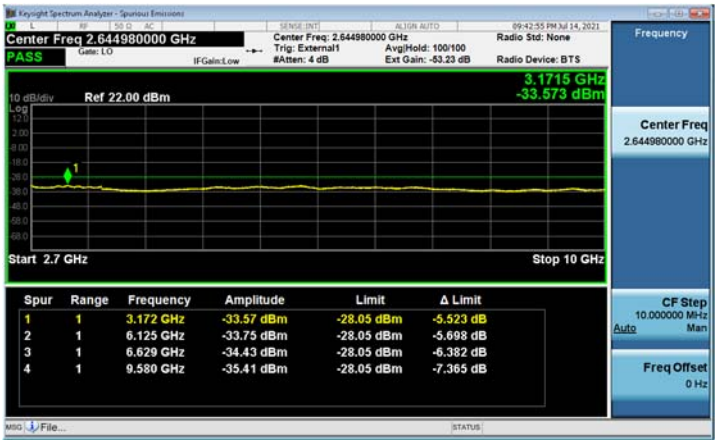

### 30MHz – 1GHz



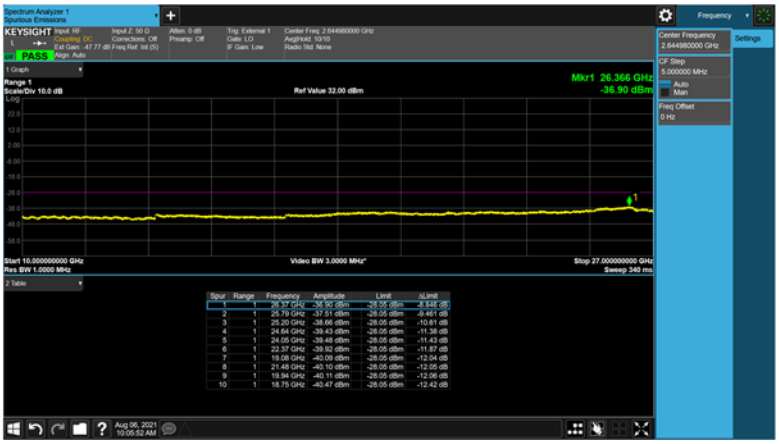

### 1GHz – 2.496GHz




### 2.7GHz – 10GHz

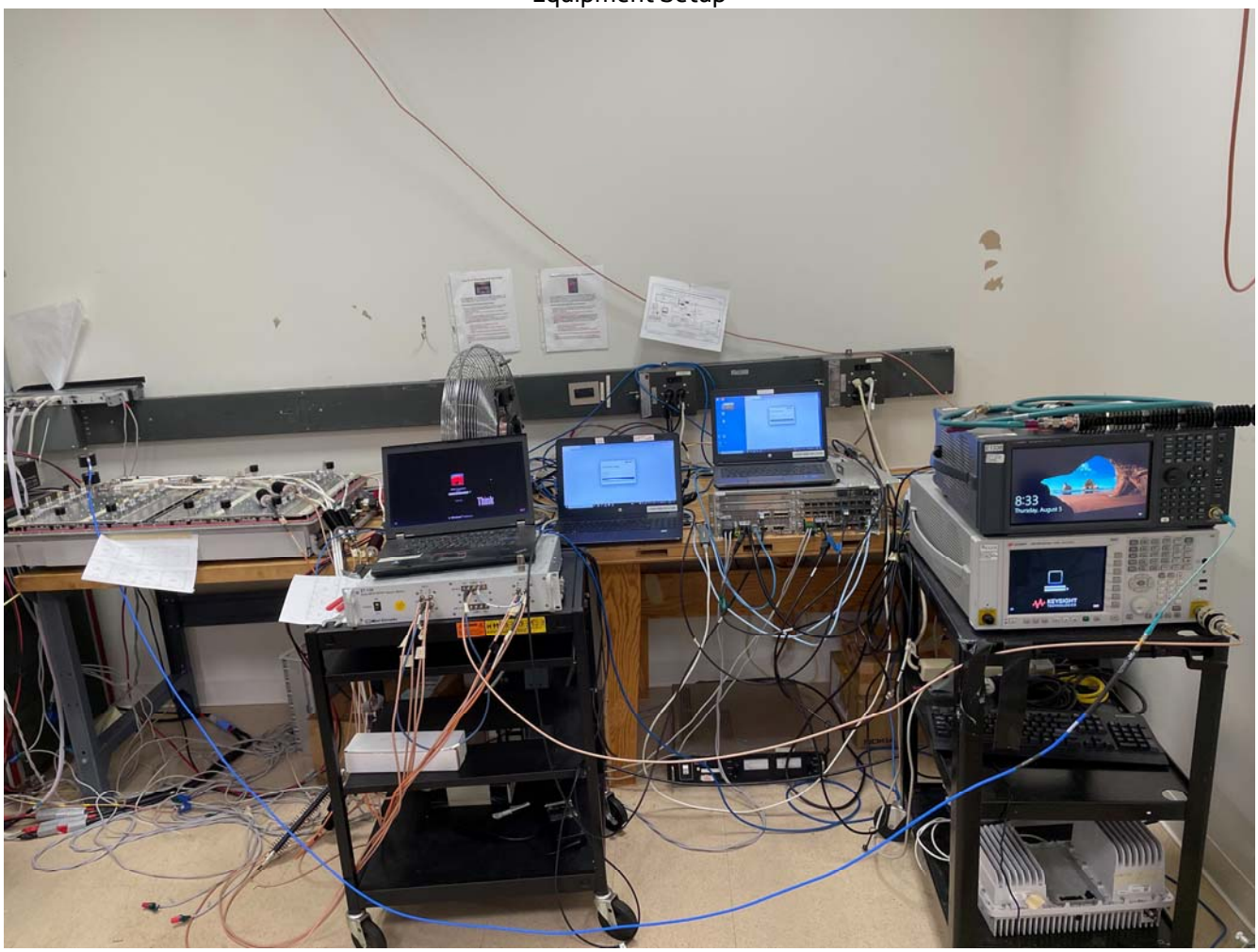



### 10GHz – 27GHz



## Photographs

Equipment Setup



## Test Equipment

| Asset ID | Manufacturer | Type | Description | Model | Serial | Calibration Date | Calibration Due |
|---|---|---|---|---|---|---|---|
| E1218 | KeySight Technologies | EMI Receiver | MXE EMI Receiver 26.5GHz | N9038A | MY54130037 | 2020-08-28 | 2022-08-28 |
| E1338 | KeySight Technologies | MXA Signal Analyzer | | N9020B | MY57430927 | 2019-11-14 | 2021-11-14 |
| E896 | Agilent Technologies | Network Analyzer | 10 MHz - 40 GHz | N5230C | MY49000897 | 2021-03-03 | 2023-03-03 |
| E1534 | Traceable | Data Logger | Barometric Humidity Temp Data Logger | 6529 | 200648430 | 2020-10-21 | 2022-10-21 |
| E1022 | Weinschel | Attenuator | 10dB DC-18GHz 25W | 46-10-34-LIM | BN3118 | CNR-V | CNR-V |
| E1023 | Weinschel | Attenuator | 20 dB DC-18 GHz 25W | 46-20-34 | BJ4772 | CNR-V | CNR-V |
| E1344 | Macom | Attenuator | 3 dB, DC - 4 GHz, 2W | 2082-6171-03 | N/A | CNR-V | CNR-V |
| E1155 | Weinschel | Attenuator | 10dB 25W 0.05- 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 |
| E1250 | Weinschel | Attenuator | 3dB Attenuator 100W | 24-3-43 | BB9072 | CNR-V | CNR-V |
| E1251 | Aeroflex | Attenuator | 30dB 150W DC-18GHz Attenuator | 66-30-33 | BV1667 | CNR-V | CNR-V |

CNR-V: Calibration Not Required, Must Be Verified

Tests were performed between 7/14/2021 to 8/12/2021.

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

## 6.2 Field Strength of Spurious Emissions - Limits

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

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

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

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

The Part 27 Limit is 82.23 dBµV/m at 3m and 91.77 dBuV/m at 1m
The Part 27 non-report level is 62.23 dBµV/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 Parts 2 and 27, 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 26.5 GHz), no reportable spurious emissions were detected.

# 7. 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

*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).*

2020-09-25 through 2021-09-30
*Effective Dates*

*For the National Voluntary Laboratory Accreditation Program*