Global Product Compliance Laboratory
600-700 Mountain Avenue
Room 5B-108
Murray Hill, New Jersey 07974-0636 USA

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

# RF Transmitter Certification Test Report
## (FCC ID: VBNAAHC-01)

**Regulation:**
FCC Part 2 and 27

**Client:**
Nokia Mobility

**Product Evaluated:**
AirScale MAA 64T64R 128AE B41 120W AAHC mMIMO Full Band

**Report Number:**
TR-2018-0080-FCC2-27

**Date Issued:**
July 16, 2018

# Table of Contents

## Revisions

| Date | Revision | Section | Change |
|---|---|---|---|
| 07/06/2018 | Initial | | |
| 07/16/2018 | 1 | All | All except data plots. |
| | | | |
| | | | |

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Prepared By:

Signed: _____ 7/16/2018
Nilesh Patel Compliance Engineer

Approved By:

Signed: _____ 7/16/2018
Technical Manager

Reviewed By:

Signed: _____ 7/16/2018
Walter Steve Majkowski
Compliance Engineer

# 1. System Information and Requirements

| | |
|---|---|
| **Equipment Under Test (EUT):** | AirScale MAA 64T64R 128AE B41 120W AAHC |
| **Serial Number:** | (1P) – 474155A.102<br>(Q) – 6Q180712583 |
| **FCC ID:** | **VBNAAHC-01** |
| **Cell Name / Number** | GPCL Project Number:2018-0080 |
| **Company:** | NOKIA SOLUTIONS AND NETWORKS<br>6000 Connection Drive<br>Irving, TX 75039 USA |
| **Manufacturer:** | NOKIA SOLUTIONS AND NETWORKS |
| **Test Requirement(s):** | 47 CFR FCC Part 2 and Part 27 |
| **Measurement Procedure(s):** | ANSI C63.26-2015<br>FCC KDB 971168 D01, v03r01, April 2018<br>FCC KDB 662911 D01, v02r01, October 2013 |
| **Frequency Band** | 2496 - 2690MHz |
| **Nominal Total Transmit Power** | 120W for all ports |
| **Maximum Antenna Gain** | 23.4 dBi |
| **Minimum Antenna Beamwidth** | 9.2 degrees vertical, 12.7 degrees horizontal |
| **Test Date(s):** | May/June 2018 |
| **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<br>FCC Registration No/Designation No: 328881/US5302 |
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| **Product Engineer(s):** | Ron Remy |
| **Lead Engineer** | Steve Majkowski |
| **Test Engineer (s):** | Jaideep Yadav, Eugene Mitchell, Mike Soli |
| **Test Results**: The AAHC mMIMO - Full Band, *as tested* met the above listed 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 New Providence, NJ. | |

**FCC Section 2.911(e) Certification of Technical Test Data**

The technical test data presented in this report are accurate.

## 1.1 Introduction

This Conformity Assessment Report applies to the AAHC mMIMO - Full Band, 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.

## 1.3 EUT Description

Nokia AirScale massive MIMO Adaptive Antenna deploys 64 transmit and 64 receive streams and 16-layer Massive MIMO. It incorporates Carrier Aggregation with broad range of customized variants to deliver up to five times more network capacity, high peak downlink throughput, significantly improved uplink, and greater coverage.

The use of Massive MIMO also enhances conventional beamforming, giving wider coverage and better indoor penetration.

With Massive MIMO, operators now have a powerful new tool to boost capacity using their existing spectrum.

### 1.3.1 Test Requirements

Each required measurement is listed below:

| 47 CFR FCC Sections | Description of Tests | Test Required |
|---|---|---|
| 2.1046 | RF Power Output | Yes |
| 2.1047 | Modulation Characteristics | Yes |
| 2.1049<br>27.53(m) | (a) Occupied Bandwidth<br>(b) Out-of-Band Emissions | Yes<br>Yes |
| 2.1051<br>27.53(m) | Spurious Emissions at Antenna Terminals | Yes |
| 2.1053<br>27.53(m) | Field Strength of Spurious Radiation | Yes |
| 2.1055<br>27.54 | Measurement of Frequency Stability | Yes |

## 1.4 Reference Documents, Test Specifications & Procedures

A list of the applicable documents is provided herein.

## 1.4.1 Test Specifications

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 27.

## 1.4.2 Procedures

1. FCC-IC-0B and FCC-IC-SE
2. 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 9kHz to 40 GHz.
3. ANSI C63.26-2015, American Nation Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.
4. FCC KDB 971168 D01, Measurement Guidance for Certification of Licensed Digital Transmitters, April 2018, v03r01.
5. FCC KDB 662911D01, Emissions Testing of Transmitters with Multiple Outputs in the Same Band, October 2013, v02r01.

### 1.4.3 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-8 Semi-Anechoic Chamber) | 30 MHz – 200MHz<br>200 MHz – 1000 MHz<br>1 GHz - 18 GHz | ±5.4 dB<br>±4.7 dB<br>±3.3 dB |

| Antenna Port Test | Expanded Uncertainty (k=2), Amplitude |
|---|---|
| RF Power | ± 1.4 dB |
| Occupied Bandwidth | ± 2.2 dB |
| Conducted Spurious Emissions | ± 2.8 dB |

## 1.5 Executive Summary

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

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

# 2. FCC Section 2.1046 - RF Power Output

## 2.1 RF Power Output Requirements

Per 47CFR 27.50(h)… The following power limits shall apply in the BRS and EBS:

(1) *Main, booster and base stations.* (i) The maximum EIRP of a main, booster or base station shall not exceed 33 dBW + 10log(X/Y) dBW, where X is the actual channel width in MHz and Y is either 6 MHz if prior to transition or the station is in the MBS following transition or 5.5 MHz if the station is in the LBS and UBS following transition, except as provided in paragraph (h)(1)(ii) of this section.

(ii) If a main or booster station sectorizes or otherwise uses one or more transmitting antennas with a non-omnidirectional horizontal plane radiation pattern, the maximum EIRP in dBW in a given direction shall be determined by the following formula: EIRP = 33 dBW + 10 log(X/Y) dBW + 10 log(360/beamwidth) dBW, where X is the actual channel width in MHz, Y is either (i) 6 MHz if prior to transition or the station is in the MBS following transition or (ii) 5.5 MHz if the station is in the LBS and UBS following transition, and beamwidth is the total horizontal plane beamwidth of the individual transmitting antenna for the station or any sector measured at the half-power points.

The required Total Transmit Port power limits are derived from the EIRP Limits as follows:

From 27.50(h)(ii) … and given a minimum beamwidth of 9.2 degrees and an antenna gain of 23.4 dBi:

EIRP Limit = 33 dBW + 10 LOG (20/6) dBW + 10 LOG (360/9.2) dBW

EIRP Limit = 33+ 5.23 + 15.93 = 54.15 dBW EIRP

therefore:

54.15 dBW EIRP – 23.4 dBi antenna gain = 30.75 dBW = Total Power limit at Antenna Port = 1188 Watts

The maximum power output is rated at 120W so the product clearly meets this criteria.

## 2.2 RF Power Output Measurement

This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal (J4), as shown in the accompanying test set-up diagram in paragraph 2.2.1.

Before the testing was started, the Base Station was given a sufficient “warm-up” period as required.

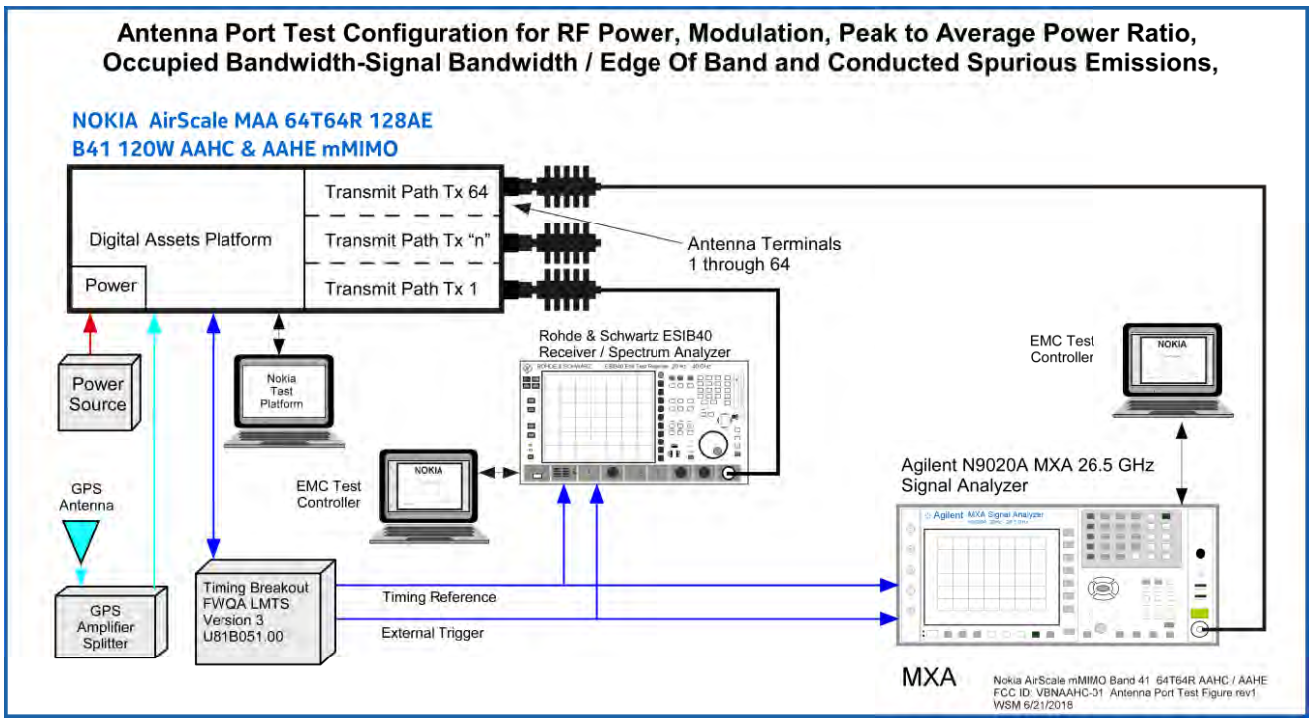
Power measurements were made using the Channel Power measurement feature of the Keysight MXA Signal Analyzer. Corrections for path loss were applied by using the worst case path attenuation for the frequency range of interest. These values were applied and are offset on the display. All parameters were adjusted based upon the designated signal bandwidth and measurement resolution bandwidth per transmit signal.

Power was measured on every port for all carrier configurations to determine the maximum power output.

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

### 2.2.1 RF Antenna Port Measurement Setup

The Test Setup depicted in the diagram below was used for the Measurement of RF Power, Modulation, PAR, Occupied Bandwidth, Edge of Band and Conducted Spurious Emissions

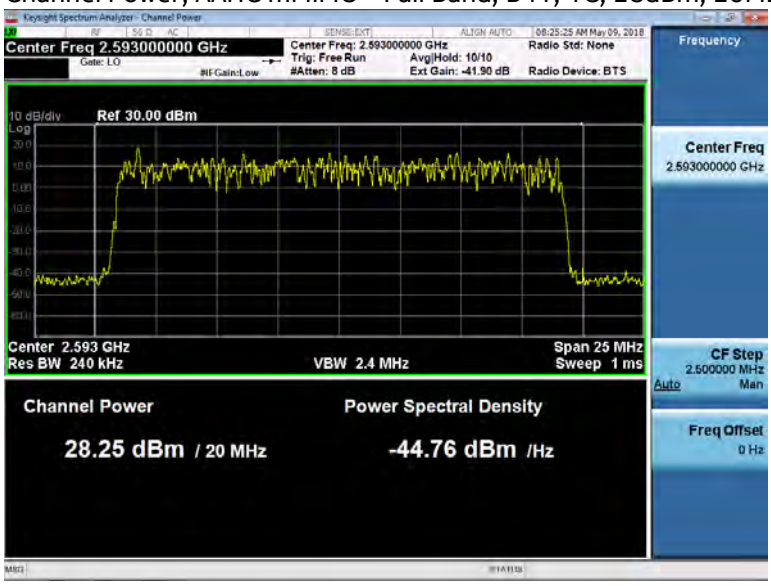


## 2.3 RF Power Data

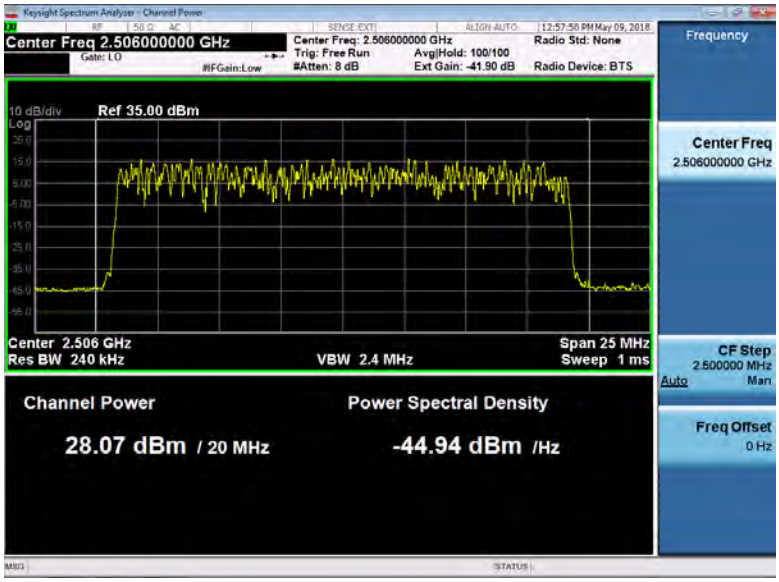
RF Channel Power was measured for the Single, Dual and Three Carrier configurations.

### 2.3.1 RF Channel Power - Single Carrier (1C)

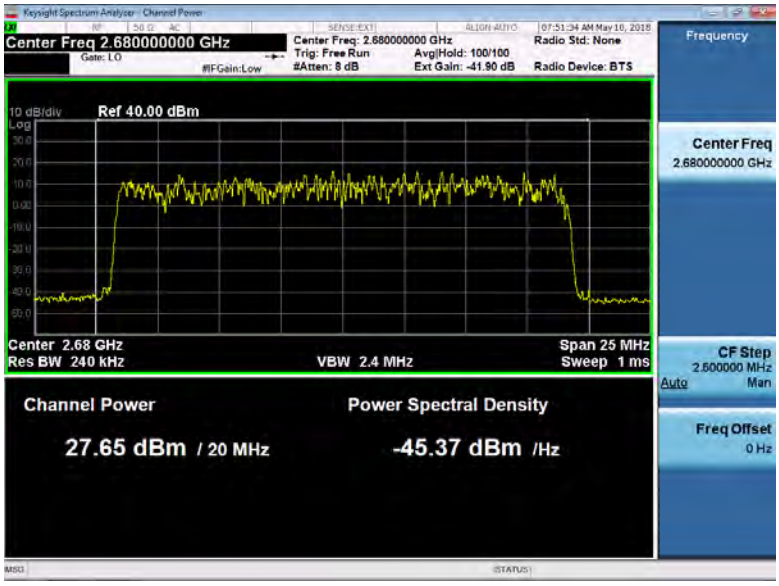
Channel Power, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM1.2, 2593 MHz.



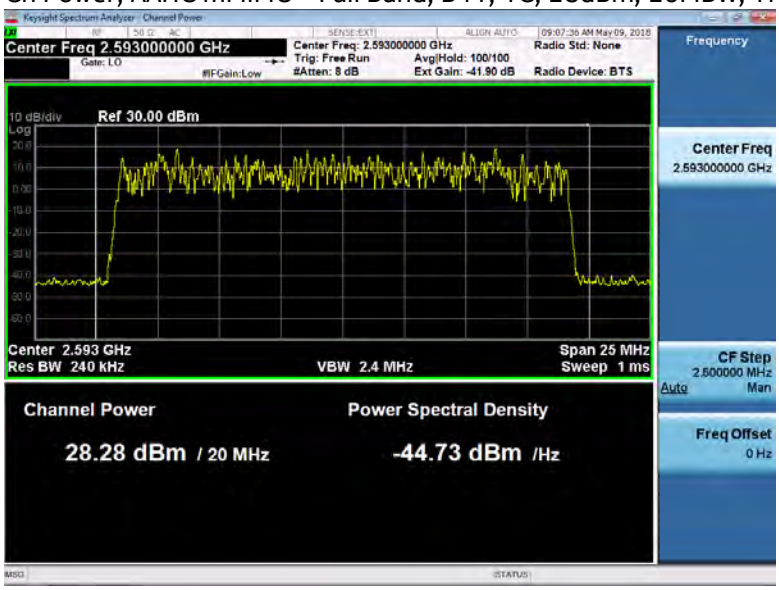

Ch Power, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1, 2506 MHz.



Ch Power, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1, 2680 MHz.

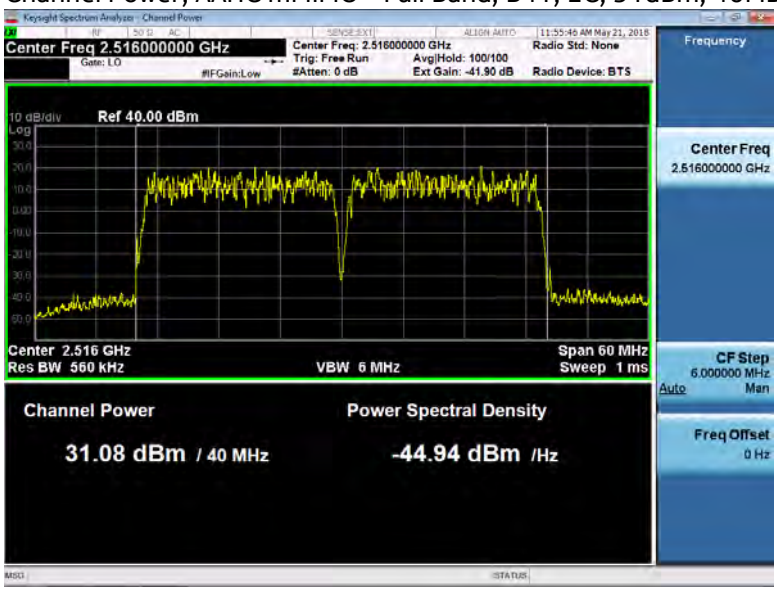



Ch Power, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1A, 2593 MHz.

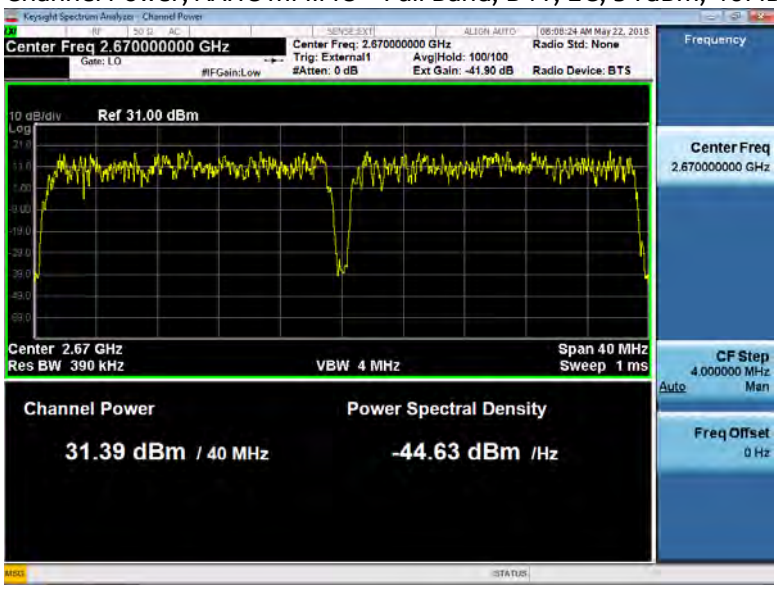


## 2.3.2 RF Channel Power - Dual Carrier (2C)

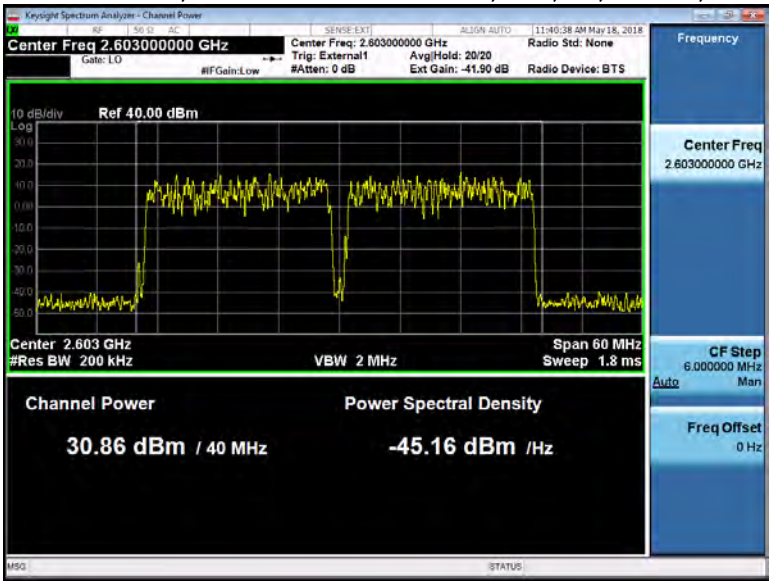
Channel Power, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2506 and 2526 MHz, Port 56.



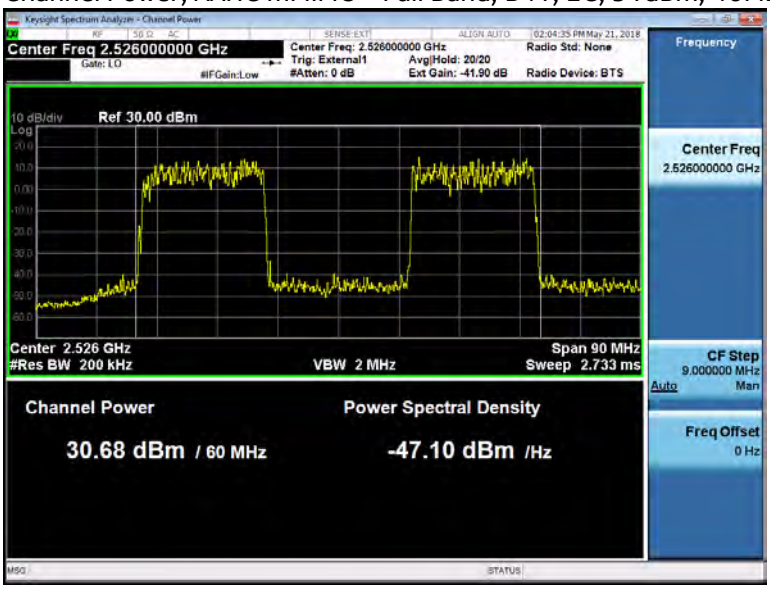

Channel Power, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2660 and 2680 MHz, Port 56.



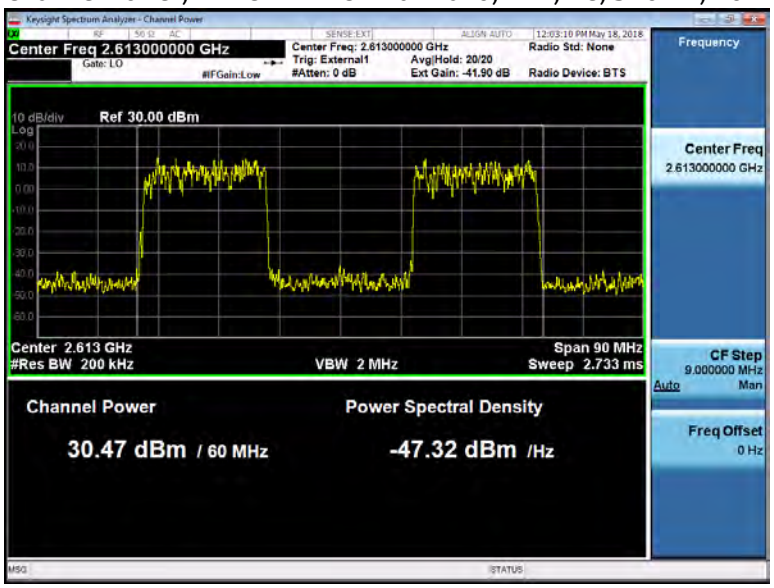
Channel Power, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 2593 and 2613 MHz, Port 56.



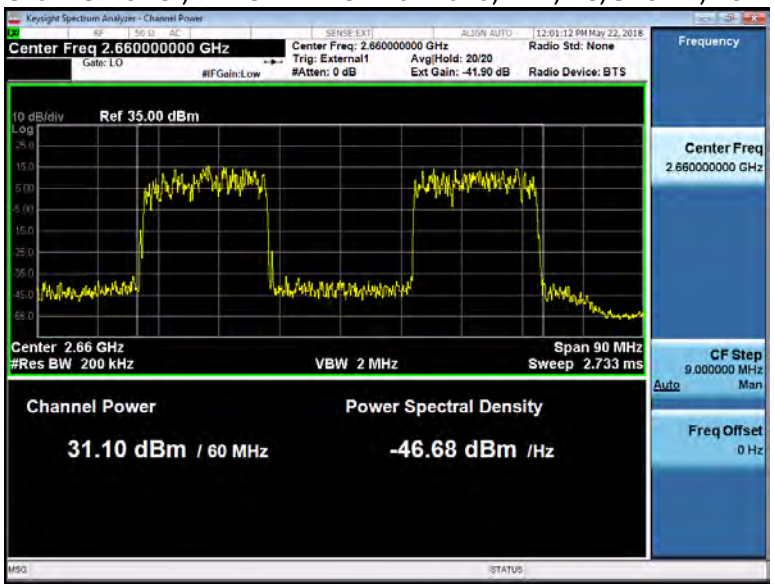

Channel Power, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2506 and 2546 MHz, Port 56.



Channel Power, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 2593 and 2633 MHz, Port 56.

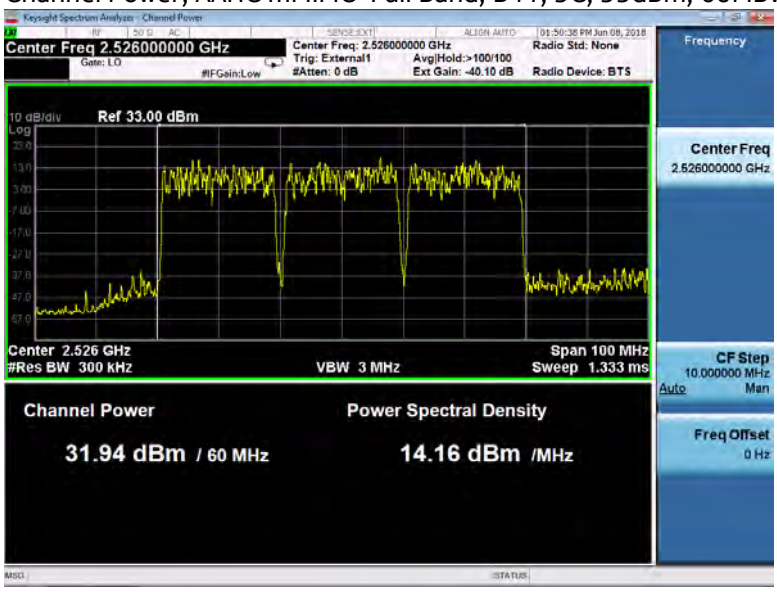



Channel Power, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2640 and 2680 MHz, Port 56.

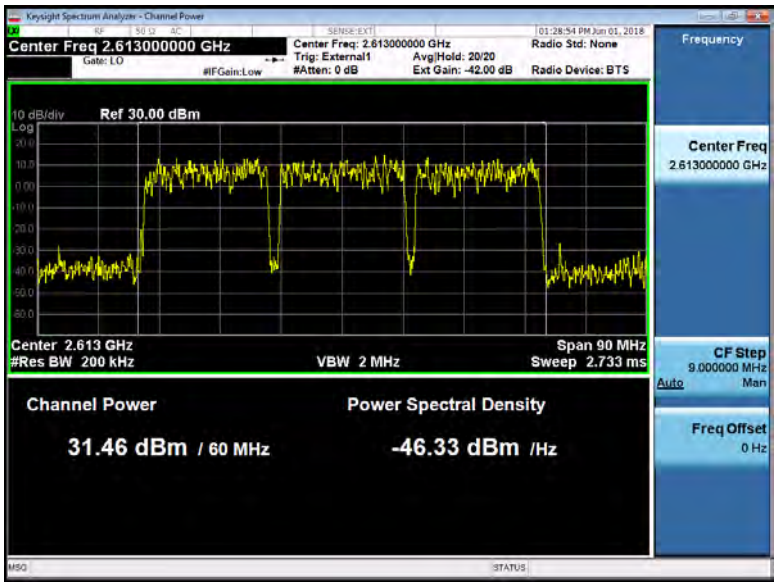


## 2.3.3 RF Channel Power - Triple Carrier (3C)

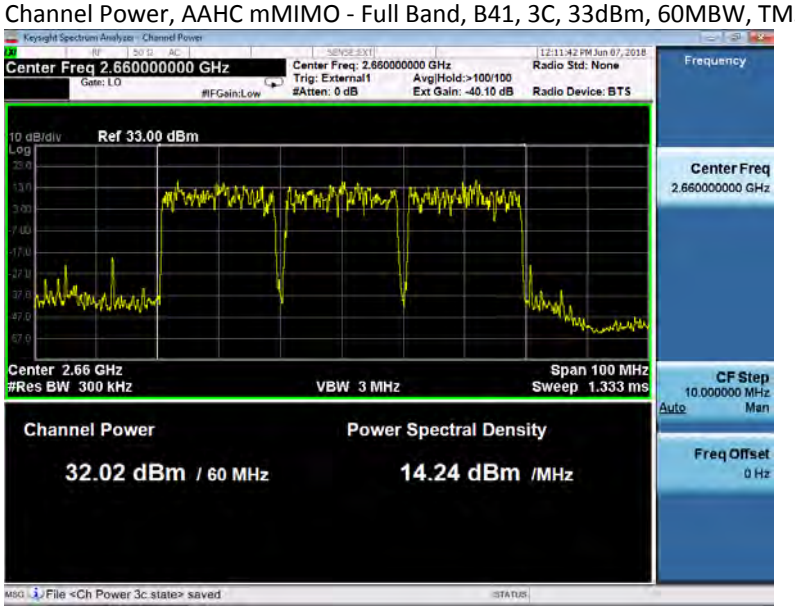
Channel Power, AAHC mMIMO-Full Band, B41, 3C, 33dBm, 60MBW, TM3.1A, 2506, 2526 & 2546 MHz, Port 12




Channel Power, AAHC mMIMO-Full Band, B41, 3C, 33dBm, 60MBW, TM3.1A, 2593, 2613 & 2633 MHz, Port 12.



Channel Power, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.2, 2640, 2660 and 2680 MHz, Port 12.



## 2.4 Peak-to-Average Power Ratio (PAPR) 47CFR 27.50

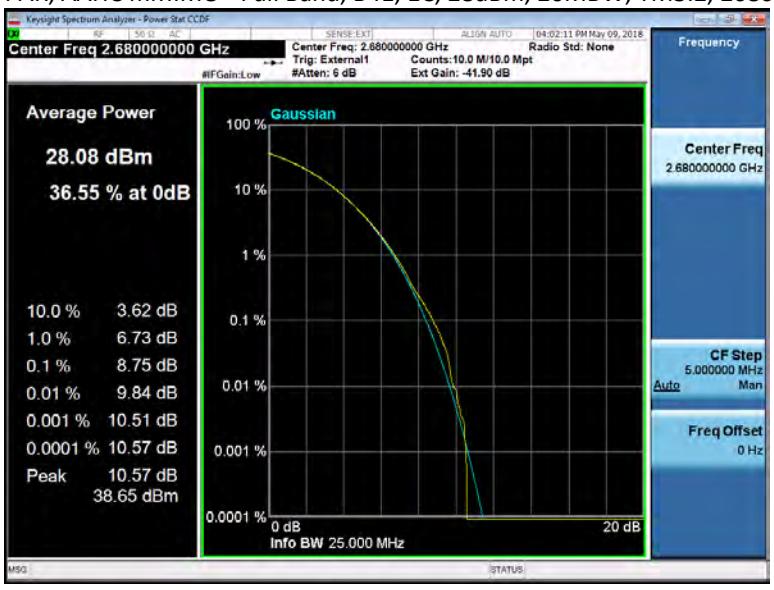
This measurement of the Peak-to-Average Power Ratio (PAPR) was performed using the Complementary Cumulative Distribution Function (CCDF) feature of a Keysight MXA Signal Analyzer. All the measured values were below the required 13dB limit at the required 0.1 percent of the time.

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

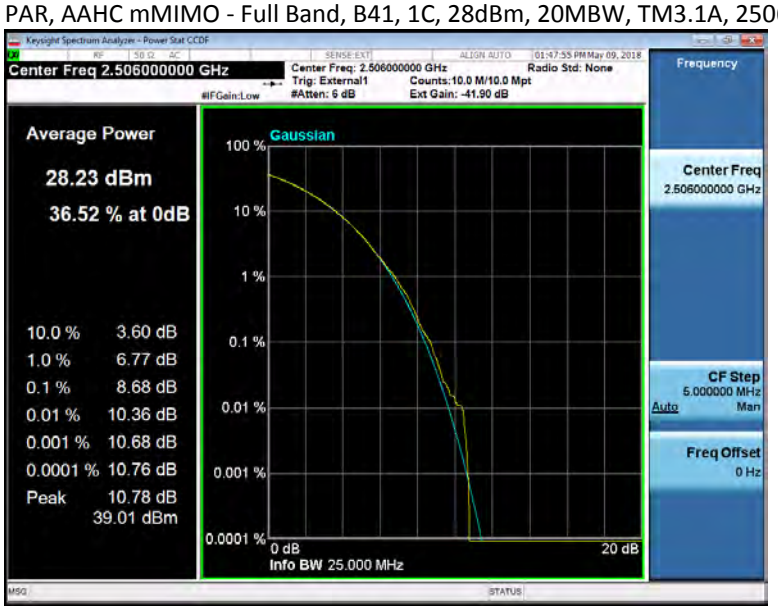
### 2.4.1 PAPR - Single Carrier (1C)

PAR, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM1.2, 2593 MHz.

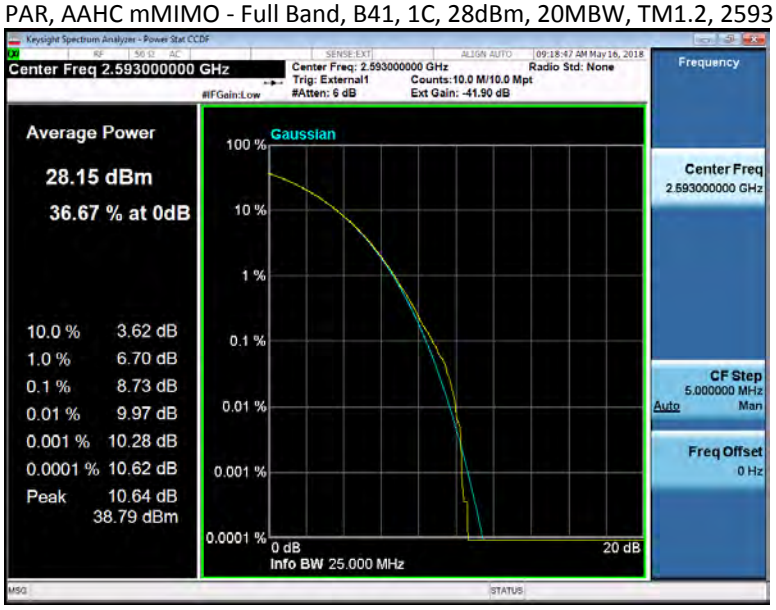

PAR, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.2, 2680 MHz.



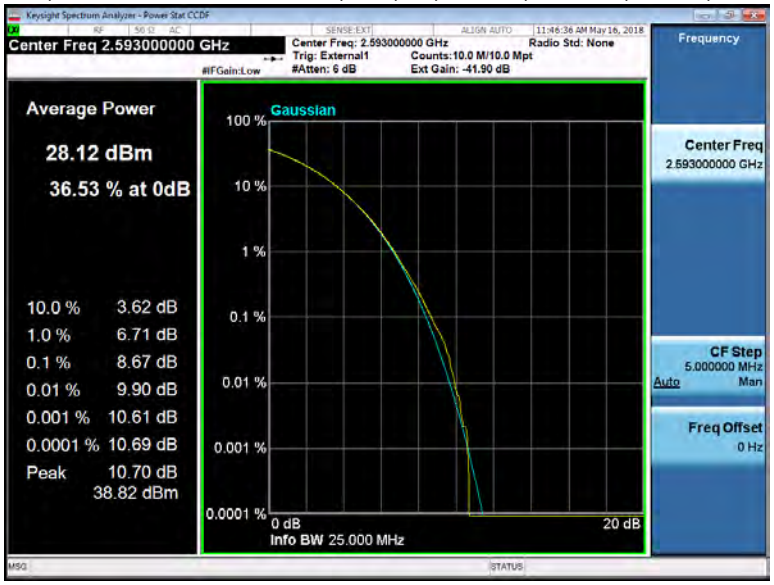
PAR, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1A, 2506 MHz.




PAR, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM1.2, 2593 MHz, Port 61

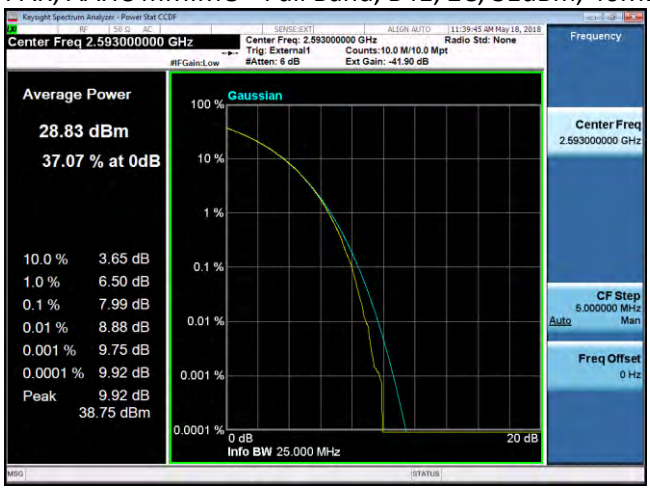


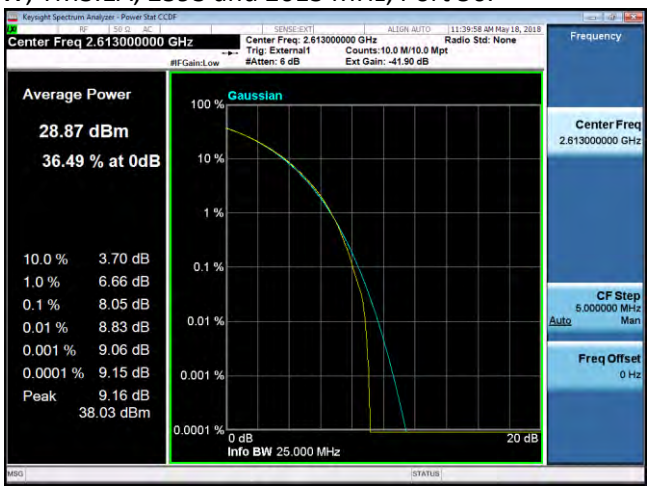
PAR, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.2, 2593 MHz, Port 56.



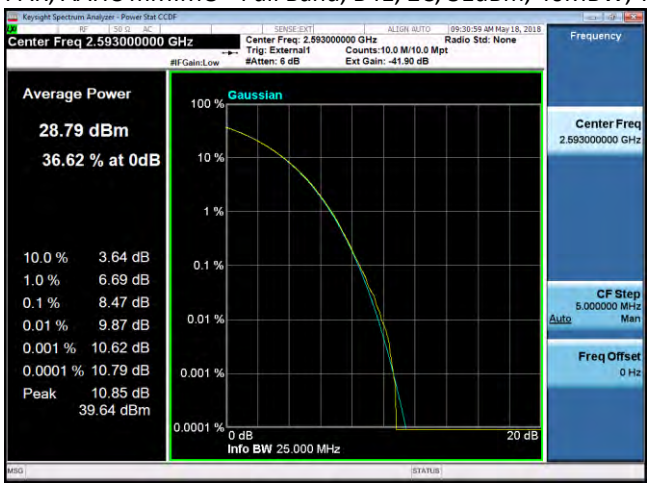
## 2.4.2 PAPR - Dual Carrier (2C)

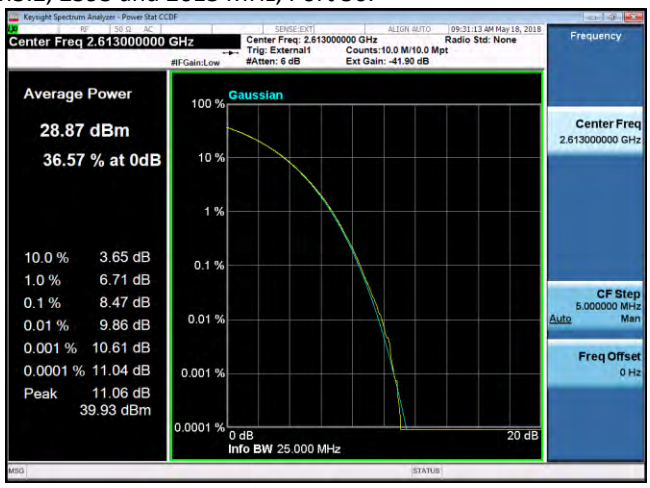
PAR, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 2593 and 2613 MHz, Port 56.



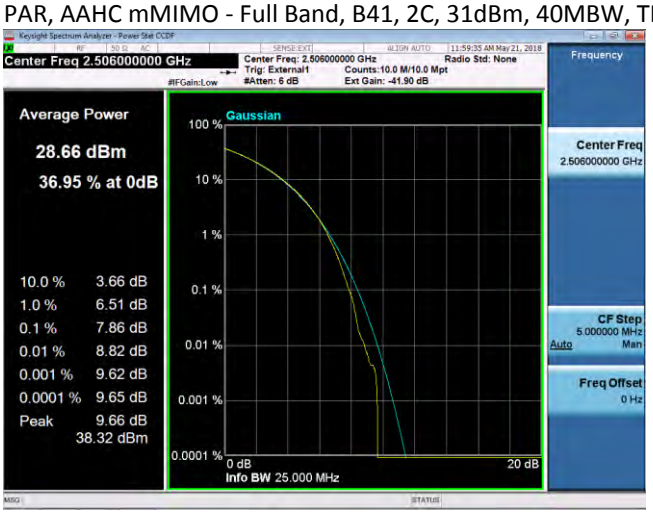




PAR, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2593 and 2613 MHz, Port 56.

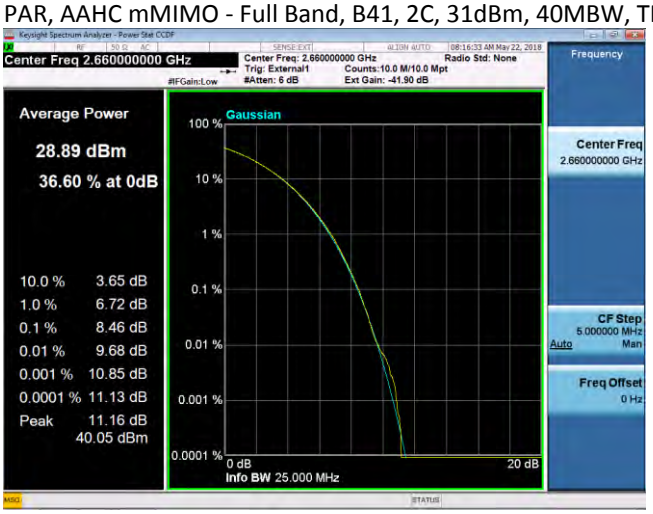


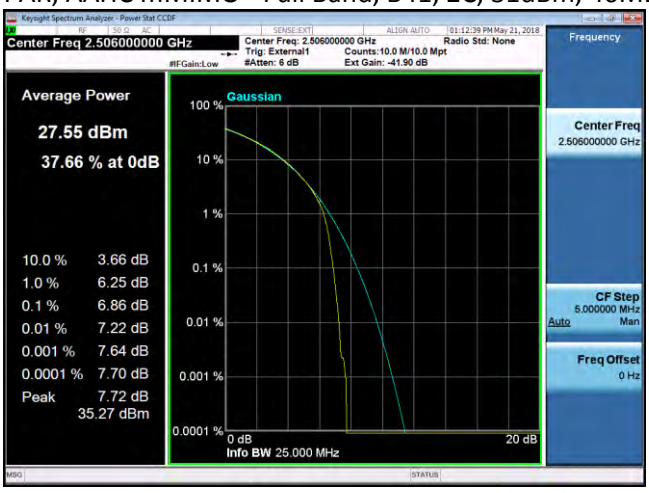
PAR, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2506 and 2526 MHz, Port 56.



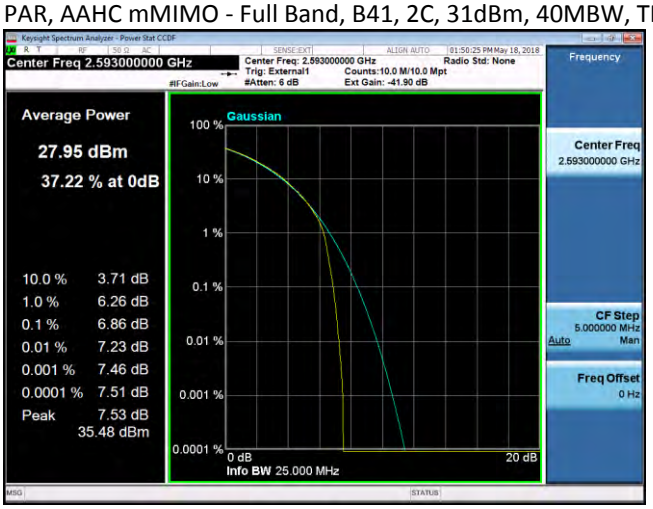

PAR, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2660 and 2680 MHz, Port 56.

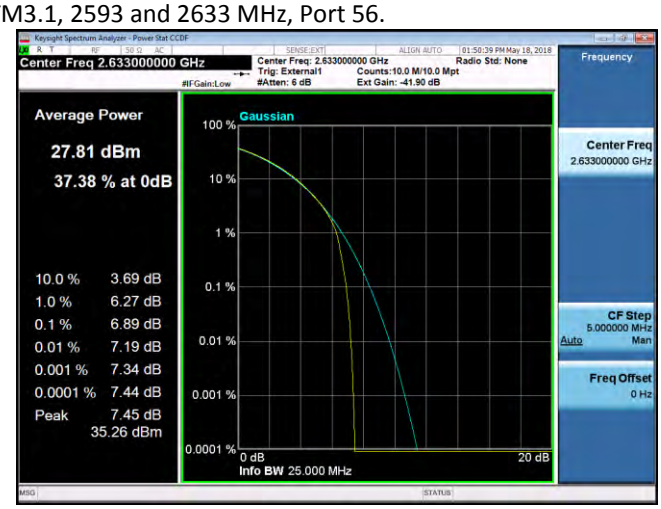



PAR, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 25506 and 2546 MHz, Port 56.

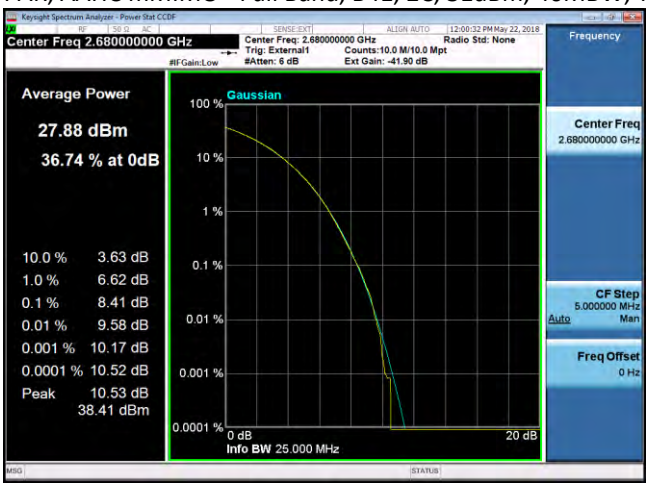


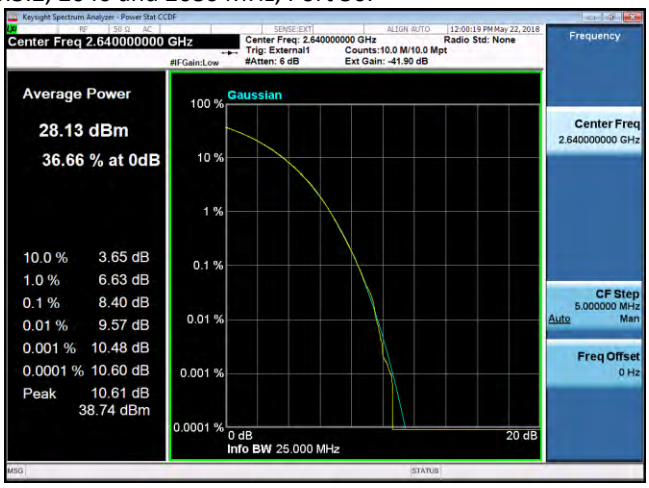
PAR, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2593 and 2633 MHz, Port 56.



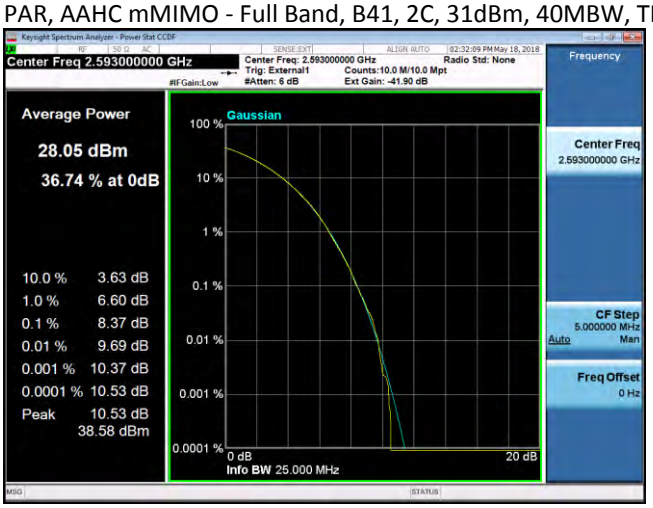



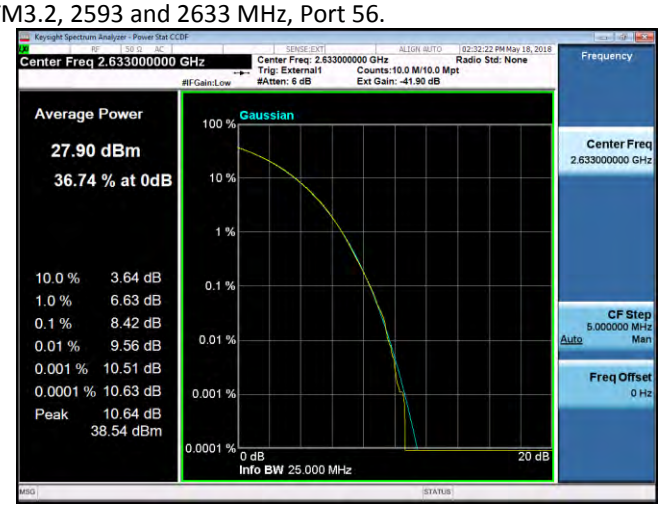

PAR, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2640 and 2680 MHz, Port 56.



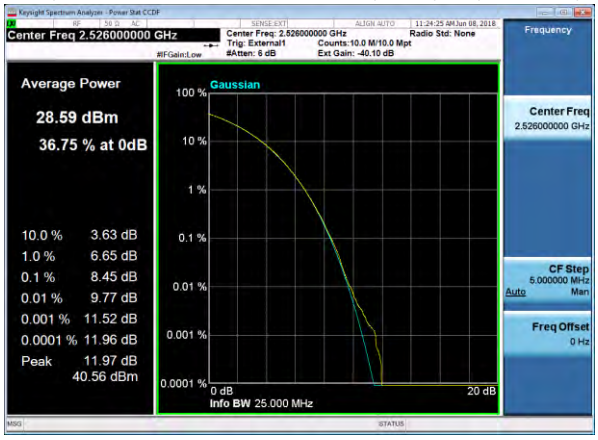

PAR, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2593 and 2633 MHz, Port 56.

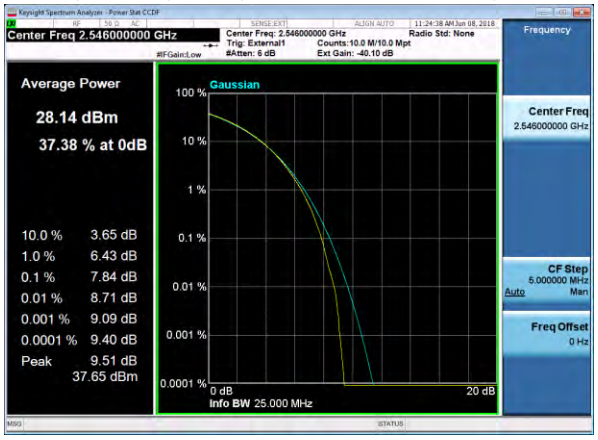


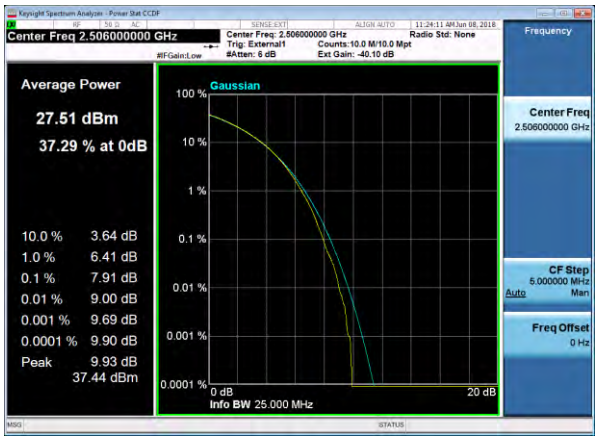



## 2.4.3 PAPR - Triple Carrier (3C)

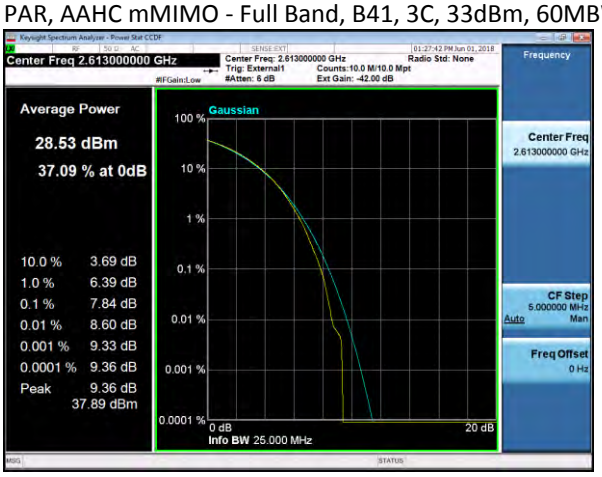
PAR, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.2, 2506, 2526 and 2646 MHz, Port 12.

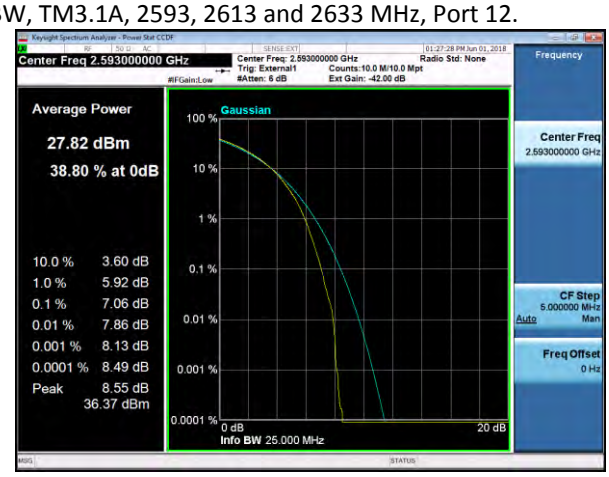


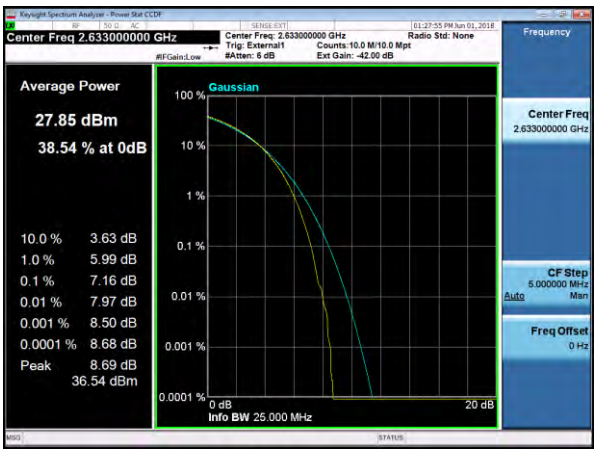



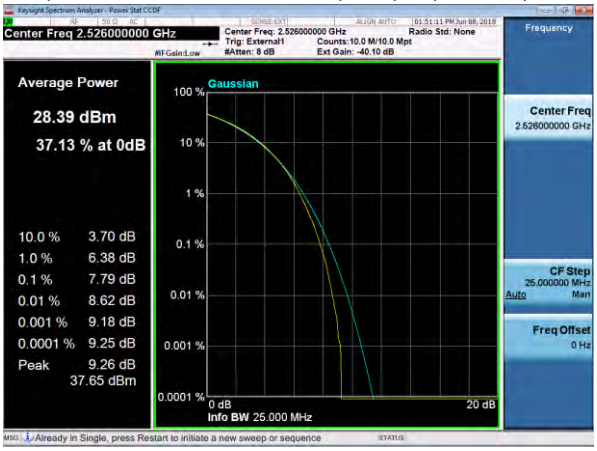
PAR, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.1A, 2593, 2613 and 2633 MHz, Port 12.

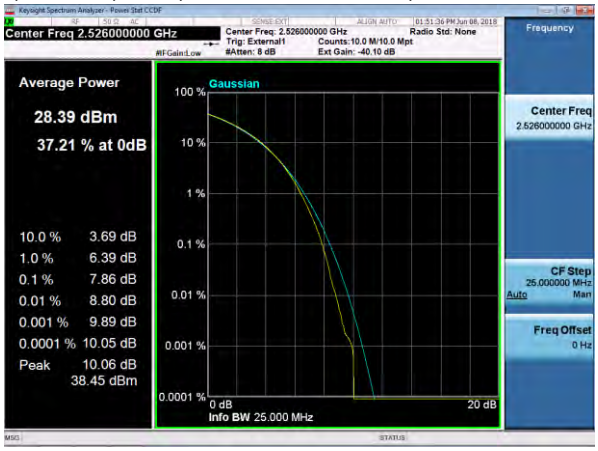


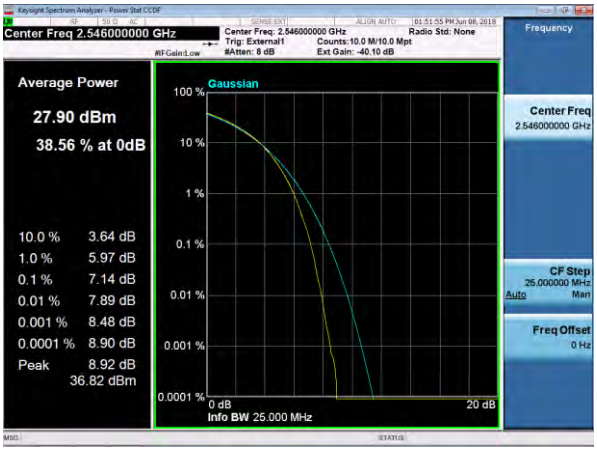



PAR, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.1A, 2506, 2526 and 2546 MHz, Port 12.



# 3. FCC Section 2.1047 - Modulation Characteristics

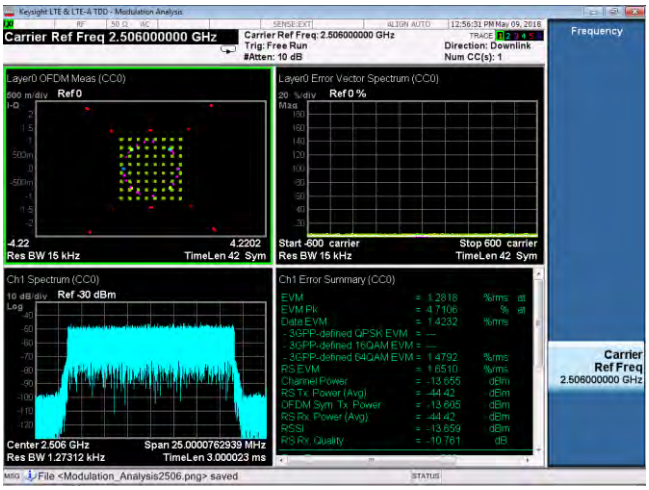
## 3.1 Modulation Characteristics

The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed. For these products the operation with QPSK-16QAM, 64QAM and 256QAM modulation was evaluated and verified.

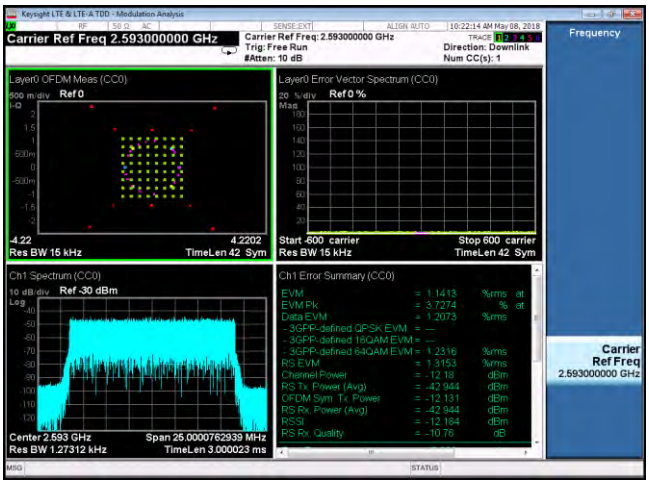
NOTE: Only a sample of all the data taken has been used in this report. The full suite of raw data resides at the MH, New Jersey location.

### 3.1.1 Modulation - Single Carrier (1C)

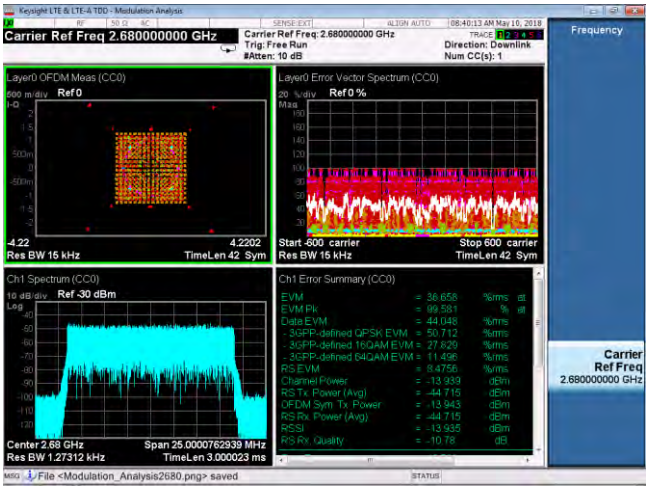
AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1, 2506 MHz.



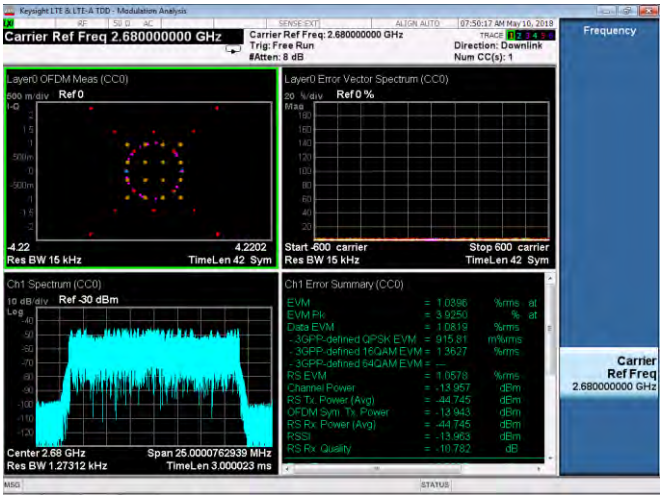

AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1, 2593 MHz.



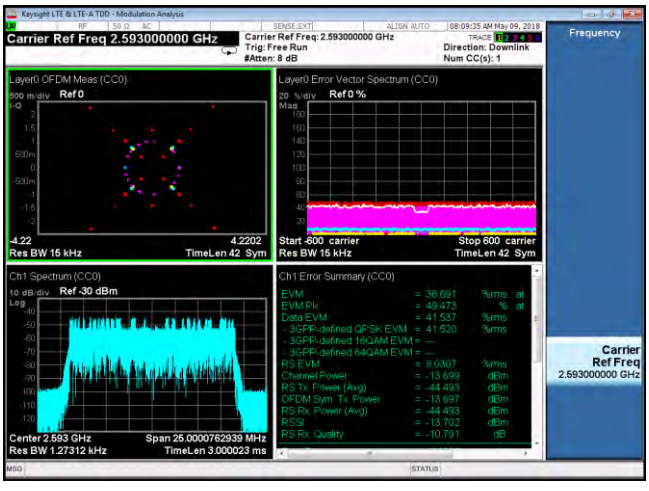
AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1A, 2680 MHz.




AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM1.2, 2680 MHz.

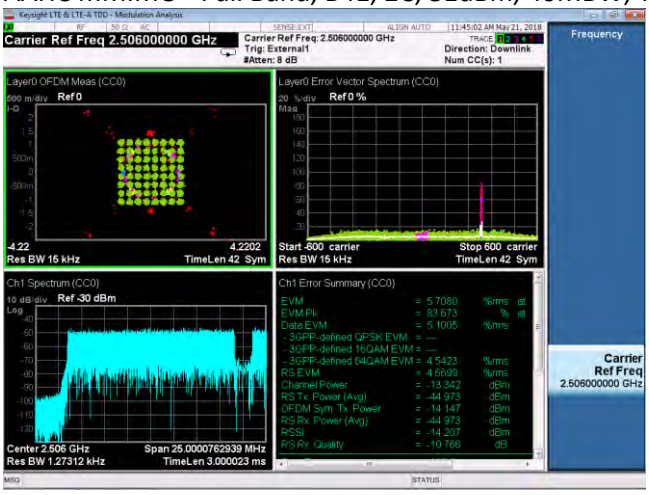



AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM1.2, 2593 MHz.

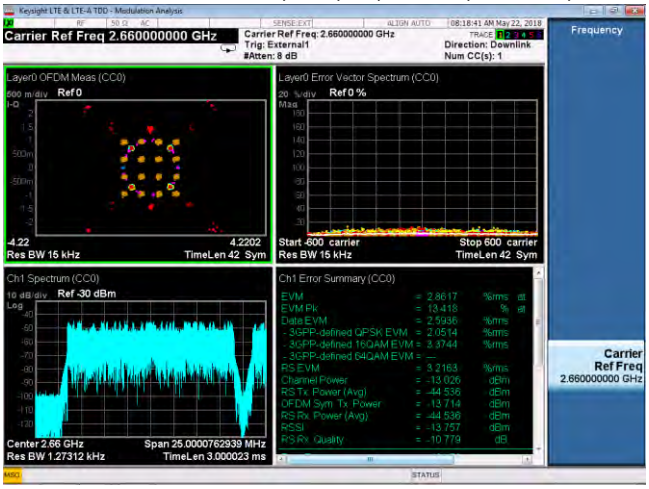


## 3.1.2 Modulation - Dual Carrier (2C)

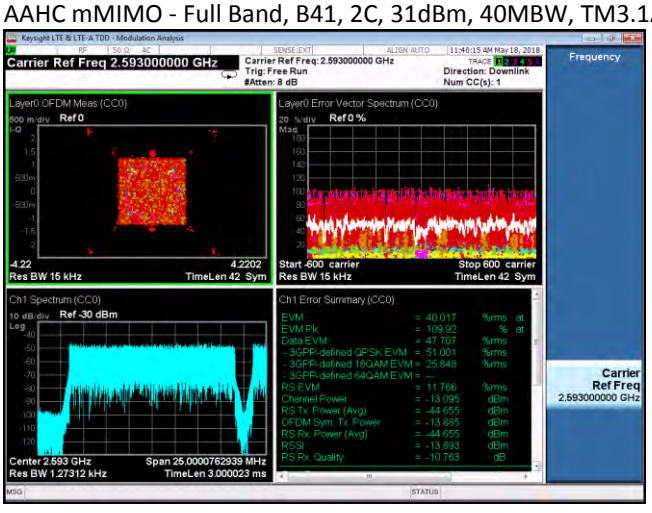
AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2506 and 2526 MHz, Port 56.




AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2660 and 2680 MHz, Port 56.

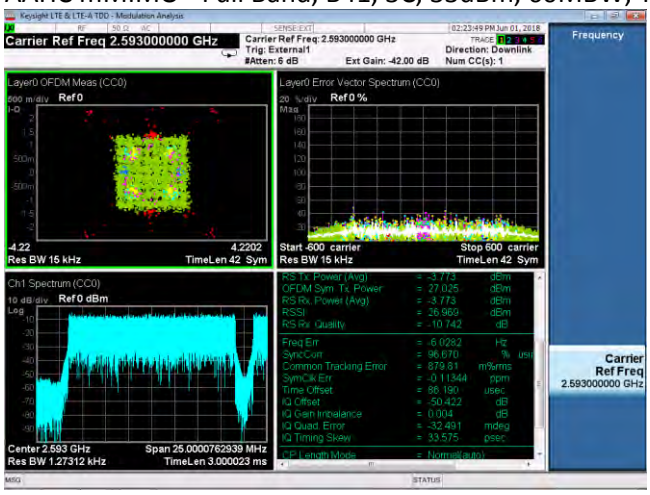



AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 2593 and 2613 MHz, Port 56.

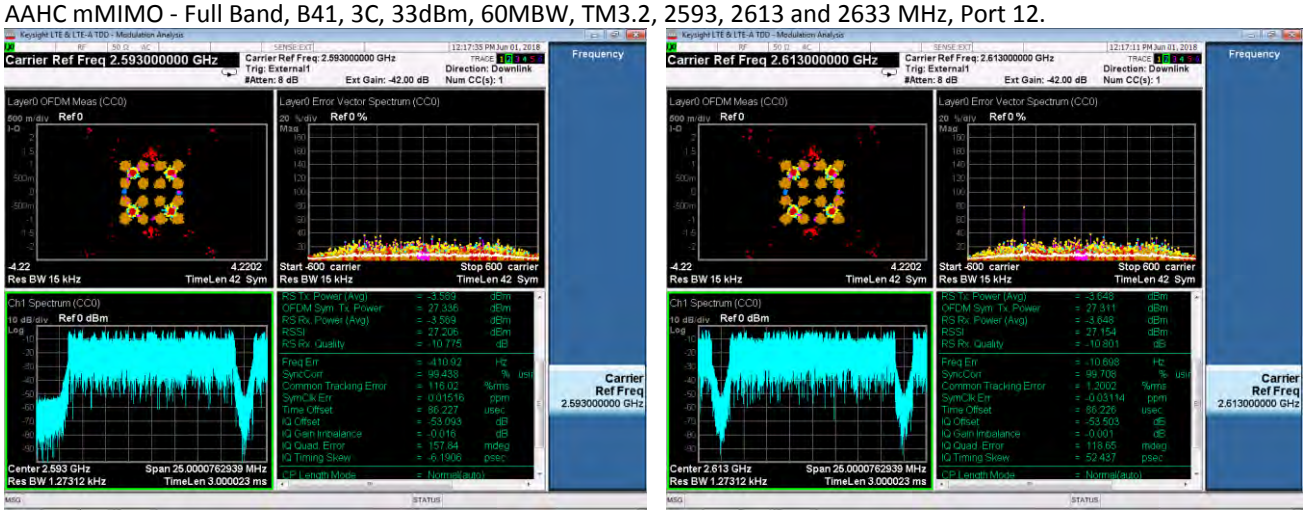


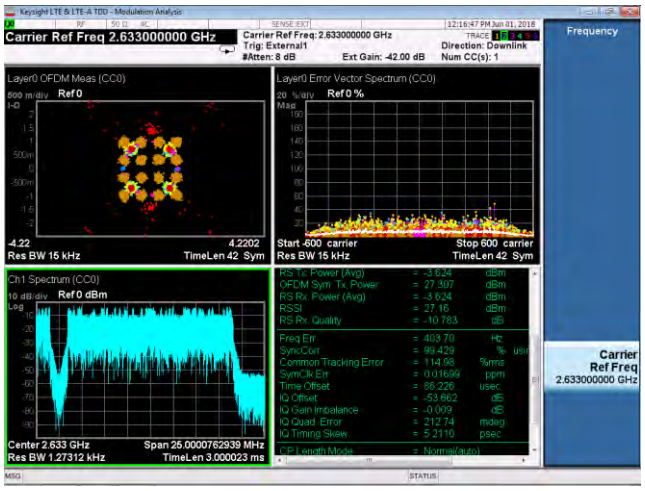
## 3.1.3 Modulation – Triple Carrier (3C)

AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.1, 2593, 2613 and 2633 MHz, Port 12.

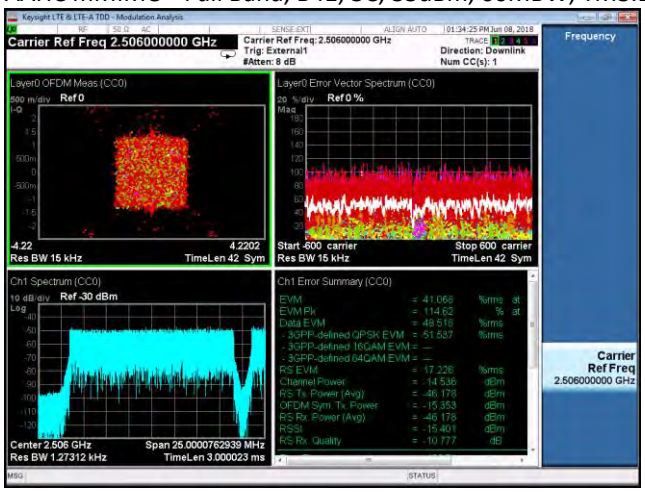


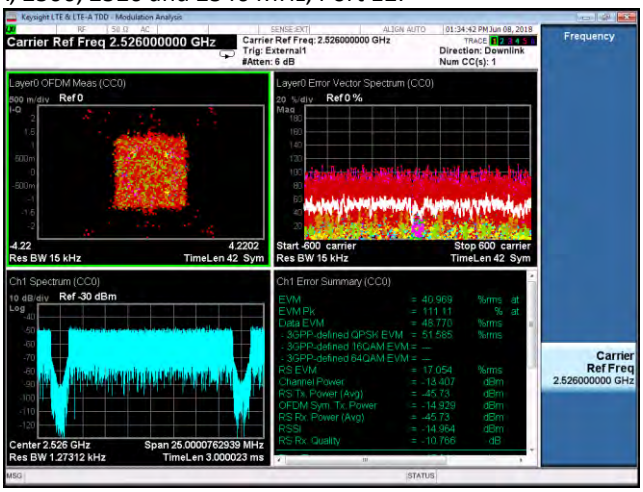

AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.2, 2593, 2613 and 2633 MHz, Port 12.

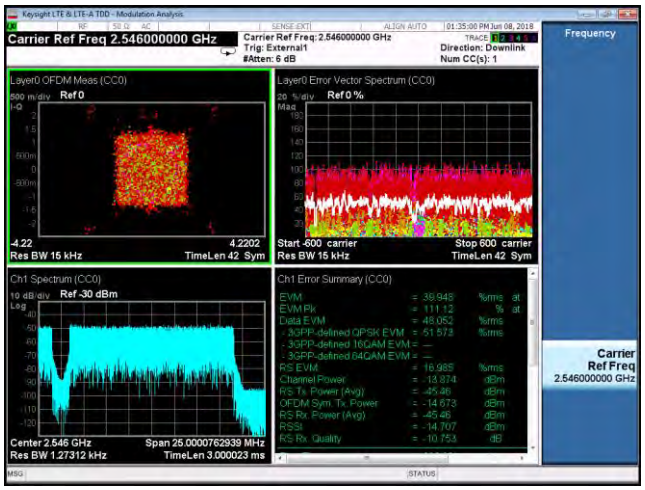





AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.1A, 2506, 2526 and 2546 MHz, Port 12.



# 4. FCC Section 2.1049 – Occupied Bandwidth

## 4.1 Occupied Bandwidth –(Signal Bandwidth OBW - Si)

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. The -26 dB bandwidth values were also recorded.

During these measurements it is customary to measure the required Edge of Band emissions at the channel and block/band edges.

The product was measured to determine the Occupied Signal Bandwidth per Part 2.1049 when tested per ANSI C63.26, KDB 971168 D01, v03r01, and KDB 662911 D01, v02r01.

The RF output from the EAC port to spectrum analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator/ test coupler. Measurements were performed using a Keysight MXA Signal Analyzer.

Corrections for path loss were applied by using the worst case path attenuation for the frequency range of interest. These values were applied and are offset on the display. All parameters were adjusted based upon the designated signal bandwidth and measurement resolution bandwidth per transmit signal.

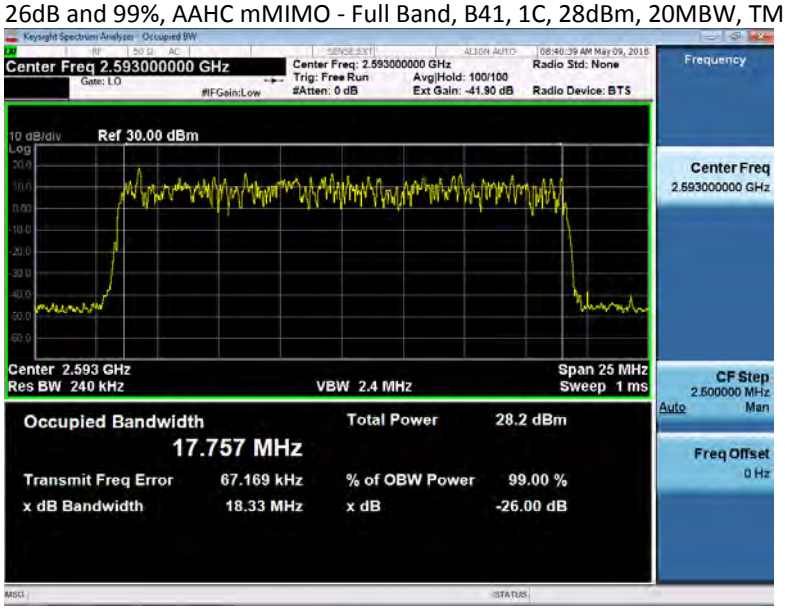
Specific Emissions Signal bandwidths were recorded for the one, two and three carrier configurations.

Sample Charts are below.

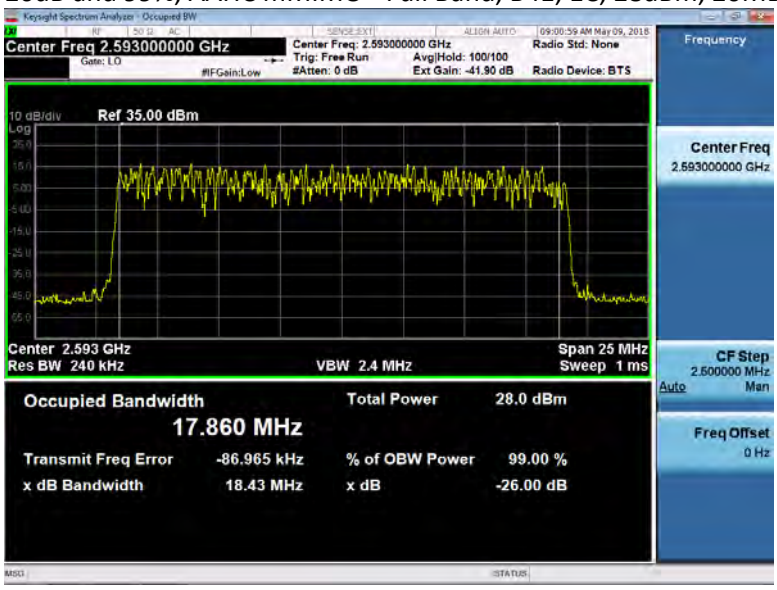
NOTE: Only a sample of all the data taken has been used in this report. The full suite of raw data resides at the MH, New Jersey location.

### 4.1.1 Signal Bandwidth OBW - Single Carrier (1C)

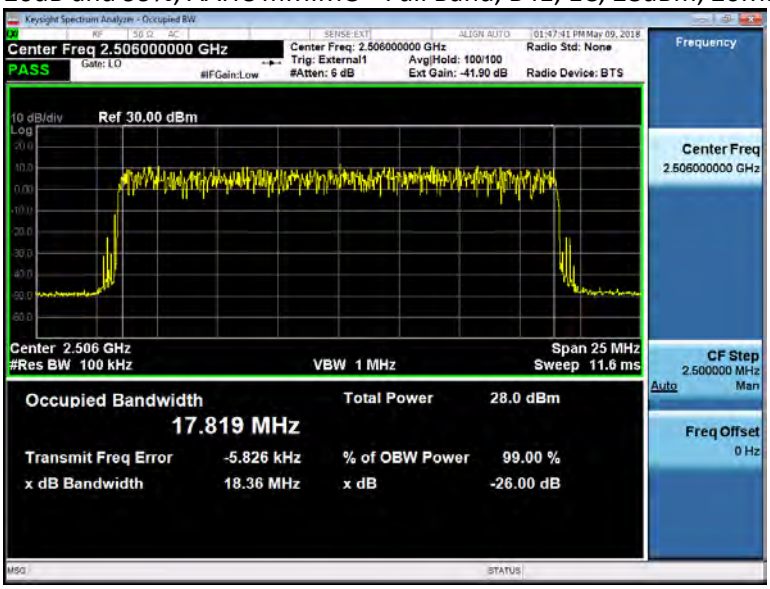
26dB and 99%, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM1.2, 2593 MHz.



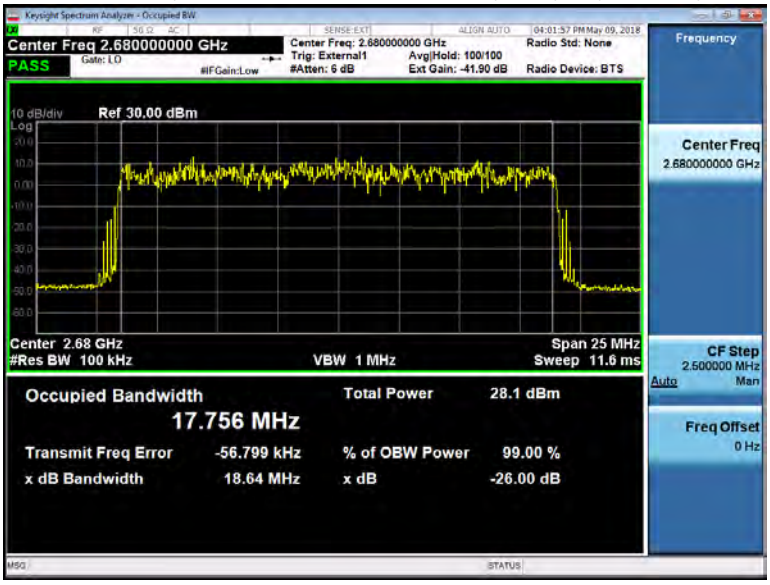

26dB and 99%, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1, 2593 MHz.



26dB and 99%, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1A, 2506 MHz.

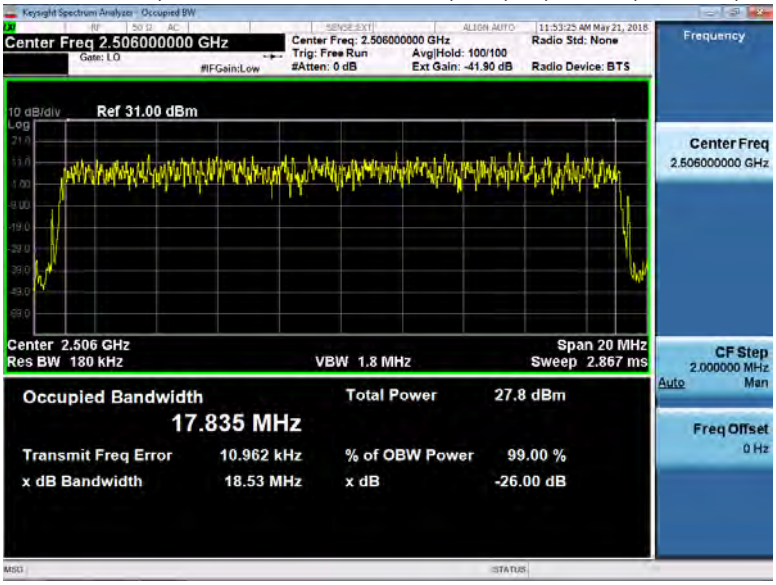


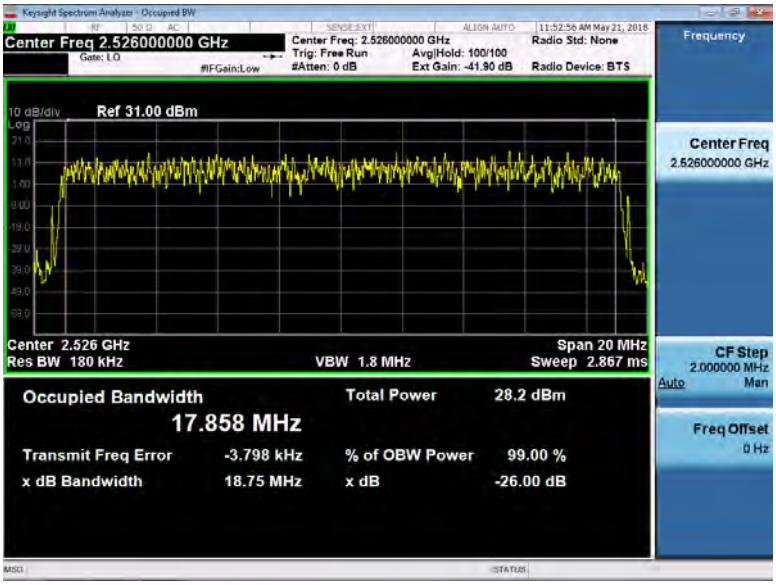

26dB and 99%, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.2, 2680 MHz.



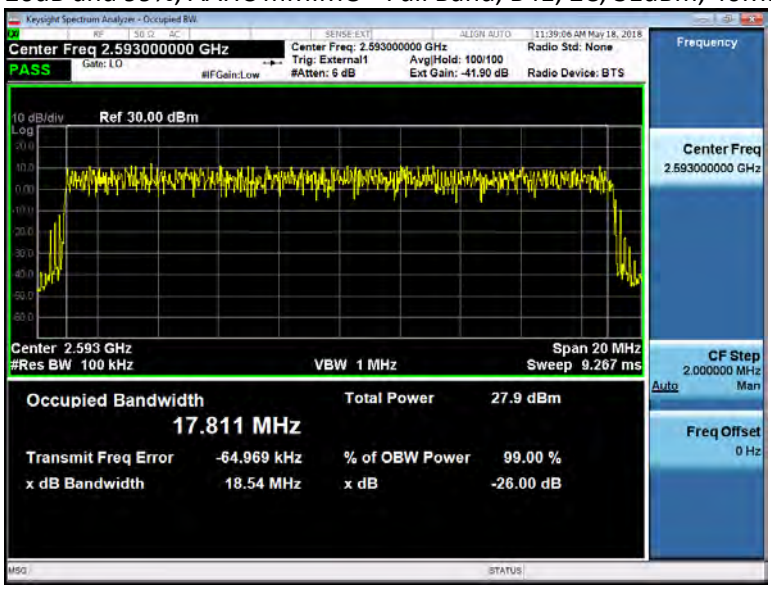
## 4.1.2 Signal Bandwidth OBW - Dual Carrier (2C)

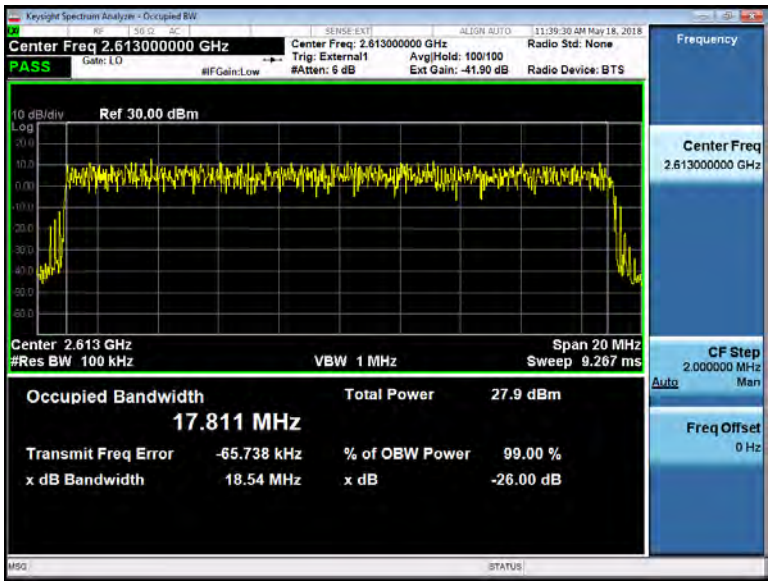
26dB and 99%, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2506 and 2526 MHz, Port 56.



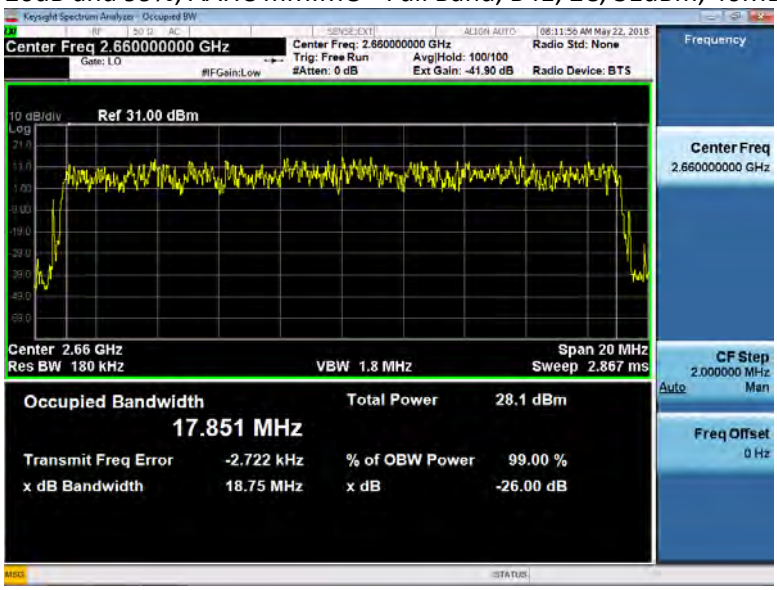



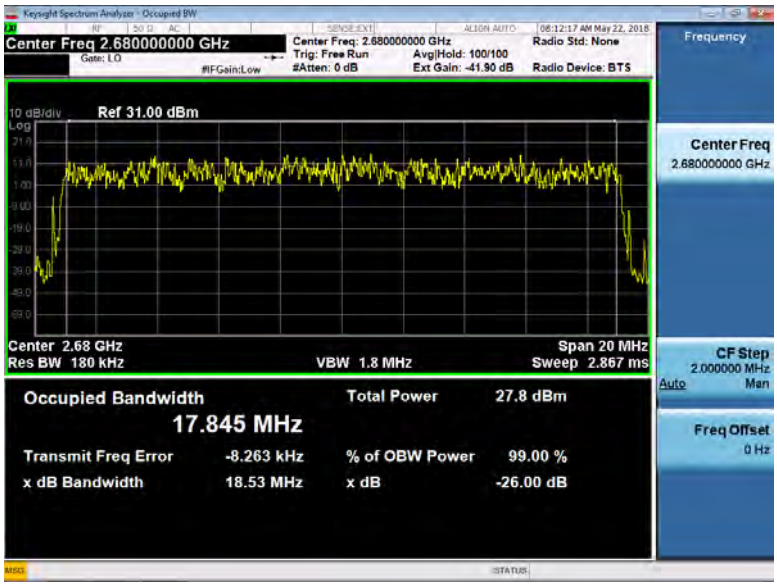
26dB and 99%, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 2593 and 2613 MHz, Port 56.



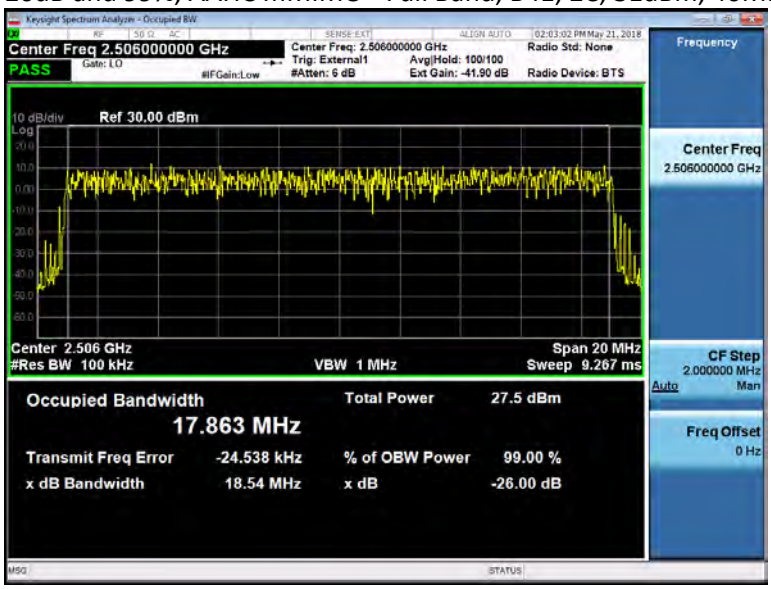



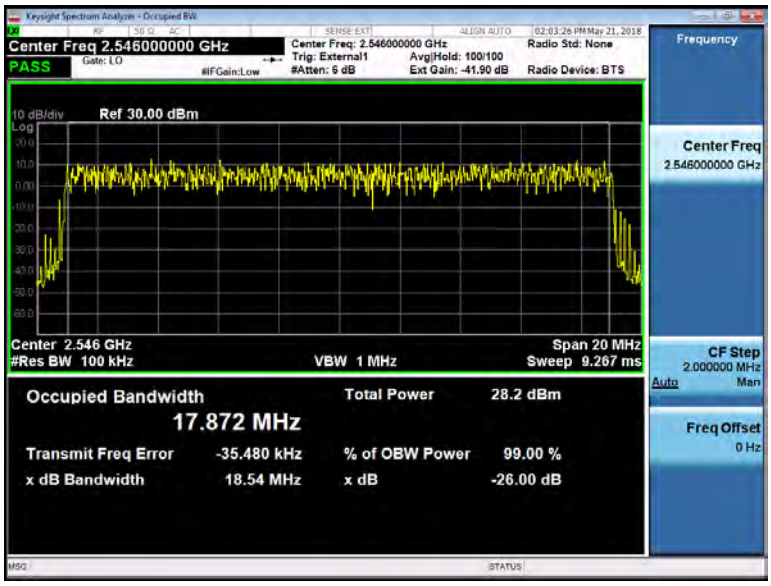
26dB and 99%, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2660 and 2680 MHz, Port 56.



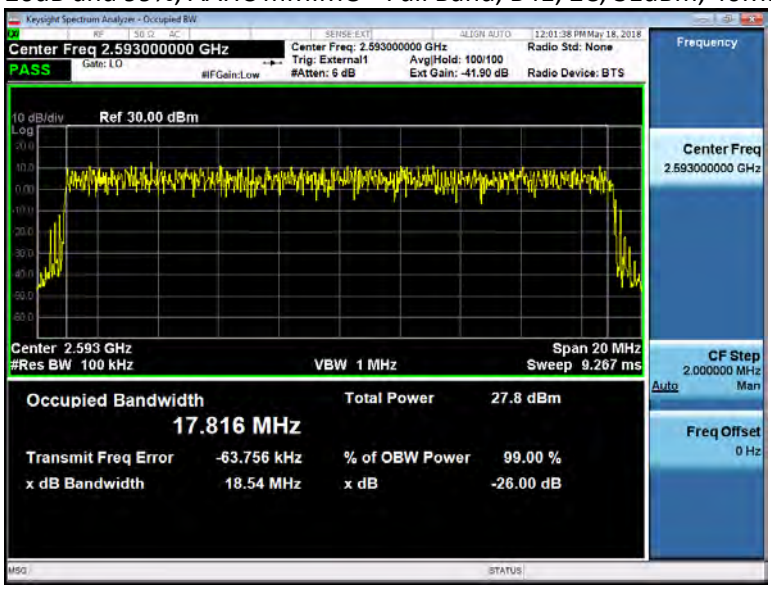



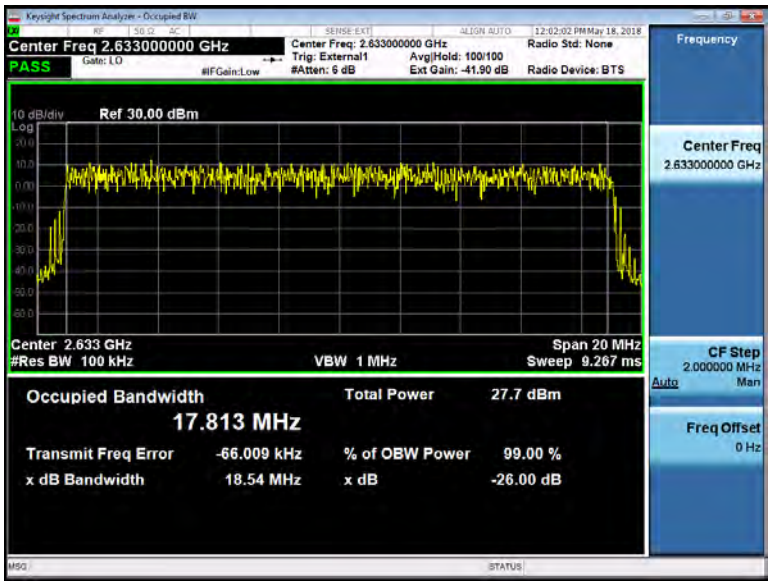
26dB and 99%, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2506 and 2546 MHz, Port 56.



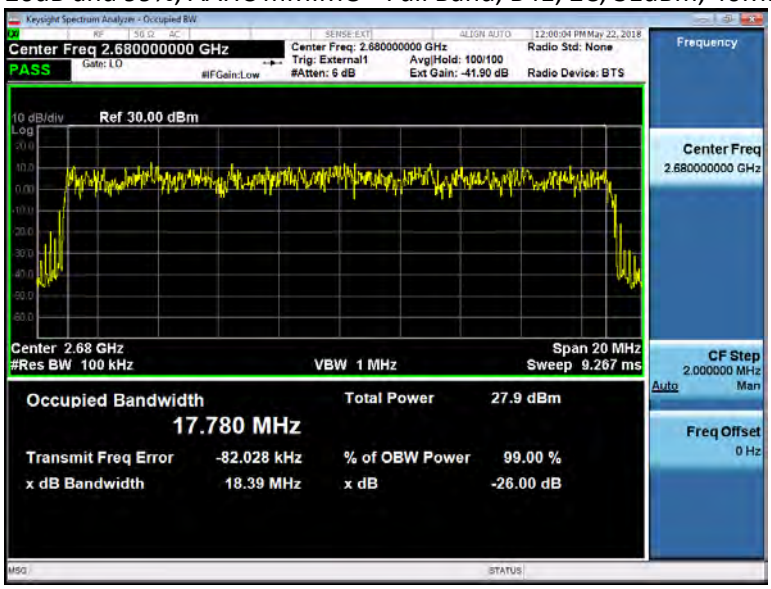



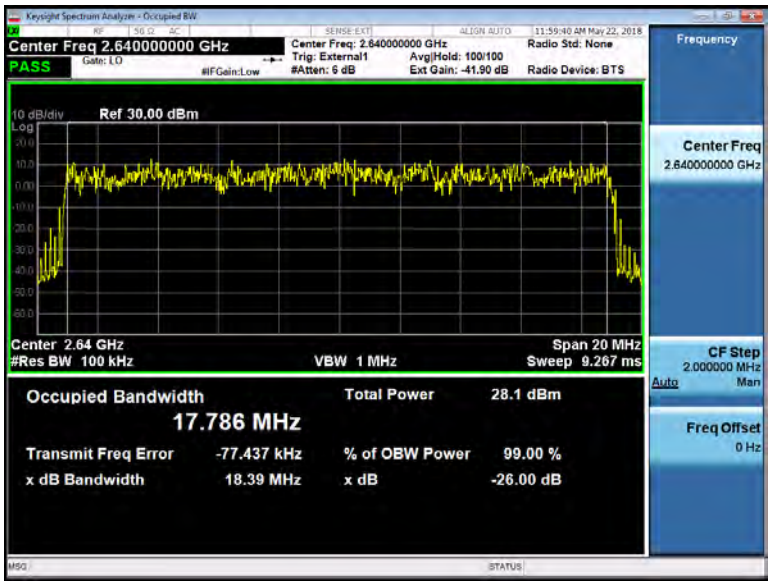
26dB and 99%, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 2593 and 2633 MHz, Port 56.



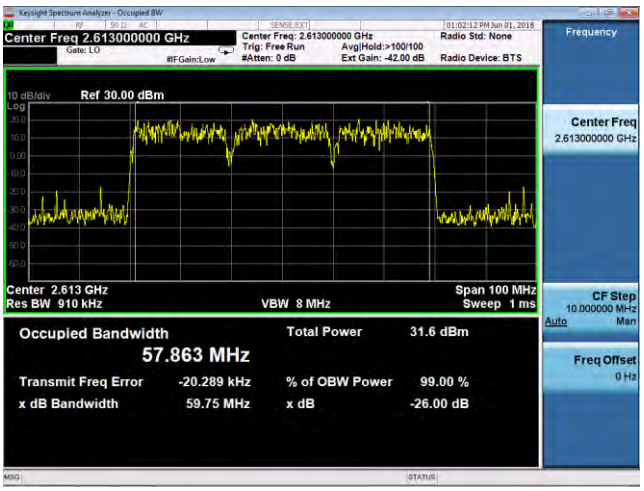
26dB and 99%, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2640 and 2680 MHz, Port 56.

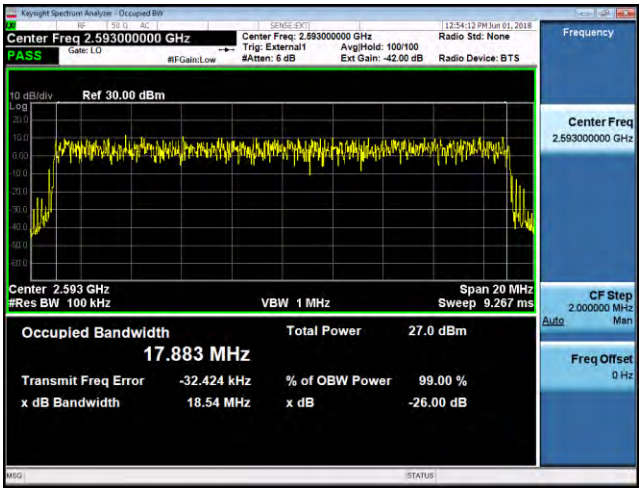


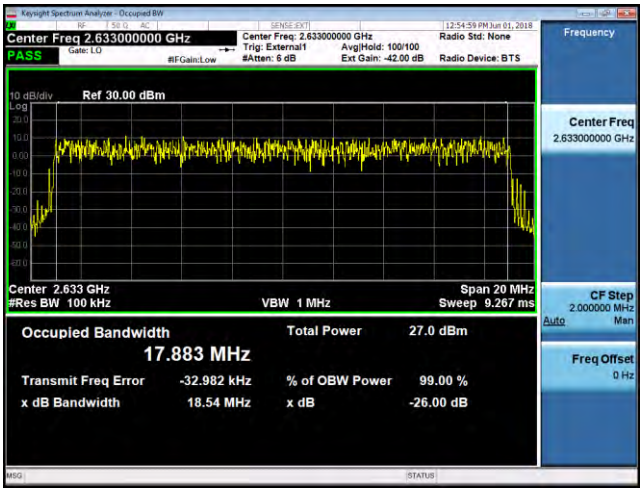



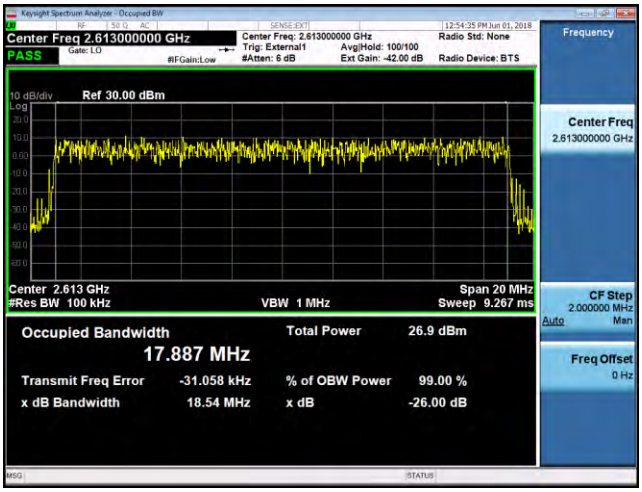
## 4.1.3 Signal Bandwidth OBW - Triple Carrier (3C)

26dB and 99%, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.1, 2593, 2613 and 2633 MHz, Port 12.

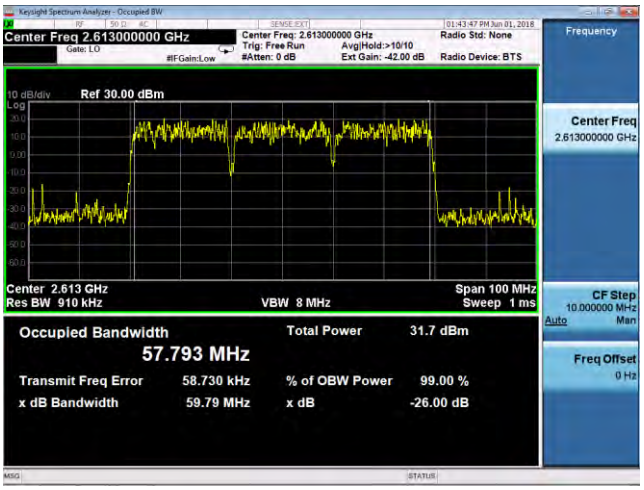


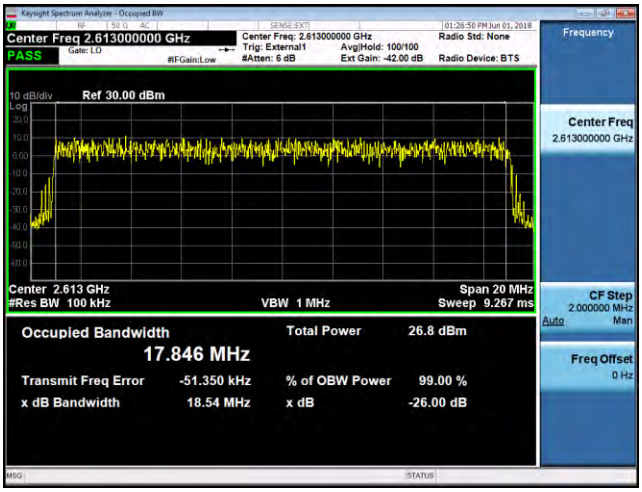



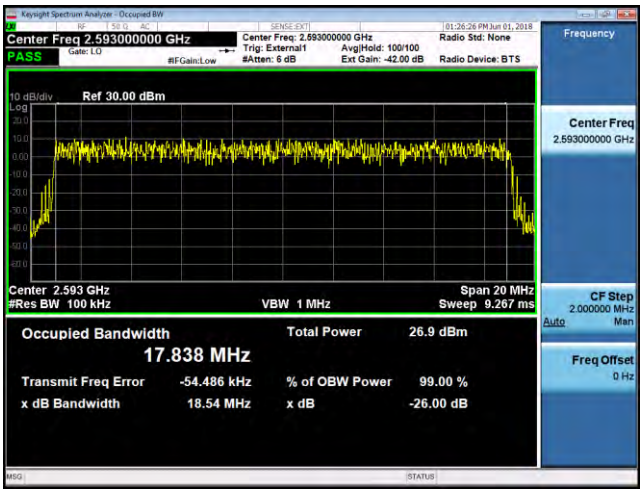



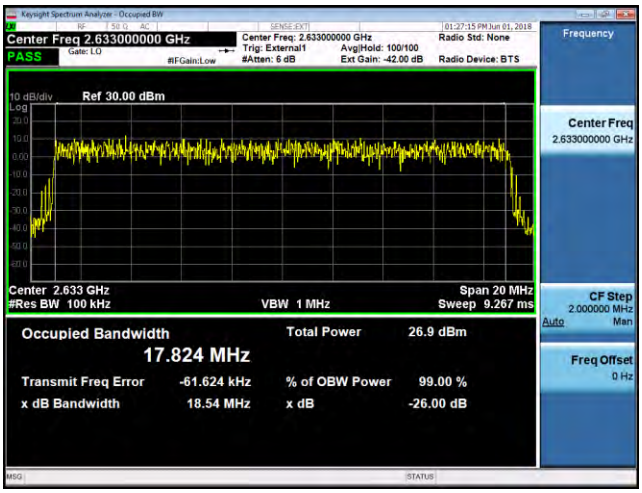



26dB and 99%, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.1A, 2593, 2613 and 2633 MHz, Port 12.

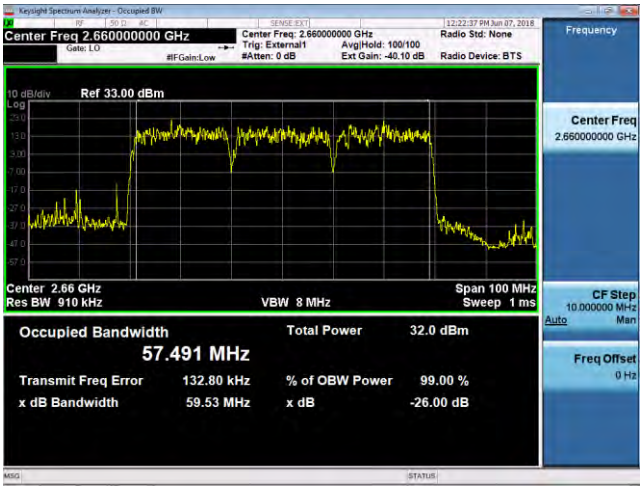


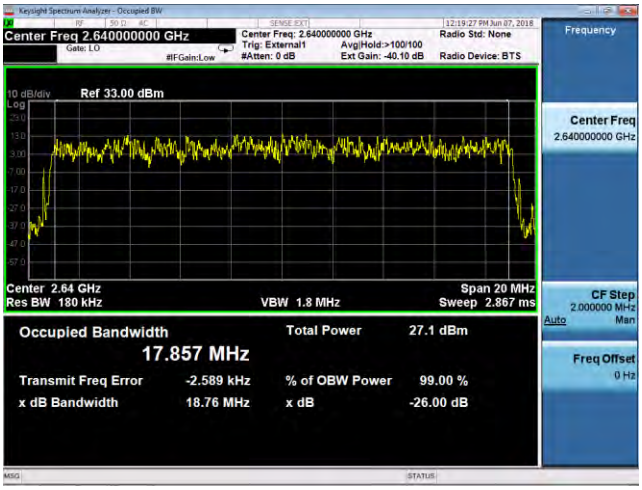



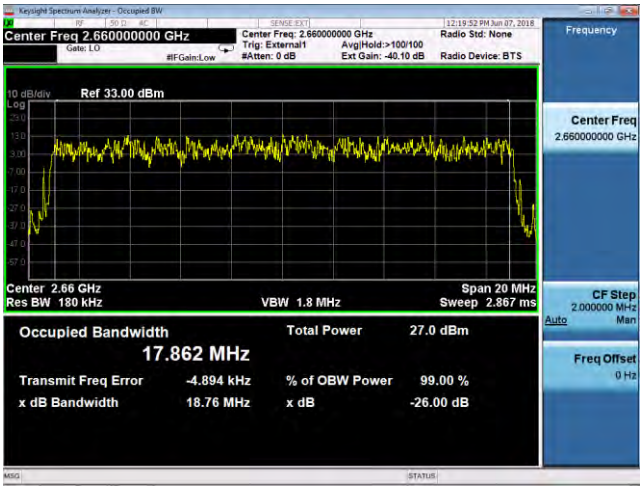



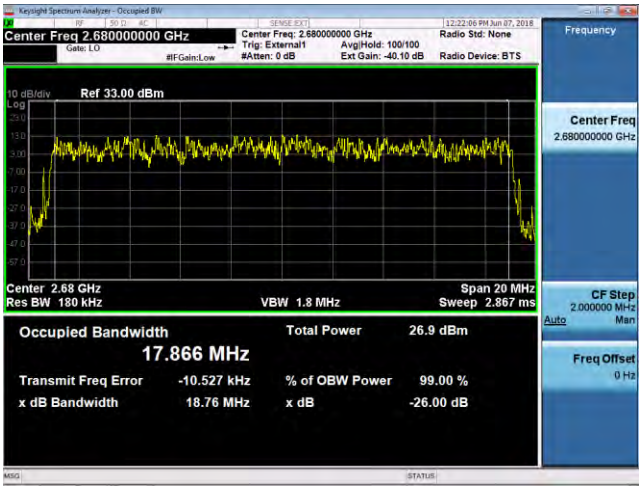



26dB and 99%, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.2, 2640, 2660 and 2680 MHz, Port 12.



## 4.2 Occupied Bandwidth/ Edge of Band Emissions (OBW-Edge of Band)

The Occupied Bandwidth / Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured to determine compliance with the limits of Part 27.53 when tested per ANSI C63.26, KDB 971168 D01, v03r01, and KDB 662911 D01, v02r01. The RF output from the EAC port to spectrum analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator/ test coupler. Measurements were performed using a Keysight MXA Signal Analyzer. The Block edge requirements as specified in 47CFR 27.53 were followed and are listed in Table 4.2 below:

Table 4.2 Mask values for OBW and Conducted Spurious measurements at various measurement bandwidths

| Carrier Power | | Signal Bandwidth | OBW Measurement RBW | Signal Offset Reference level | | "n" x MIMO | MIMO Factor | 1st MHz limit | | Beyond the 1st MHz Limit | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| W | dBm | MHz | MHz | dBc | dBm | integer | dB | dBm | dBc | dBm | dBc |
| 1.875 | 32.73 | 20 | 0.1 | -23.01 | 9.72 | 64 | 18.06 | -34.07 | -66.80 | -41.06 | -73.79 |
| 1.875 | 32.73 | 20 | 0.2 | -20.00 | 12.73 | 64 | 18.06 | -31.06 | -63.79 | -38.05 | -70.78 |
| 1.875 | 32.73 | 20 | 1 | -13.01 | 19.72 | 64 | 18.06 | -24.07 | -56.80 | -31.06 | -63.79 |

Corrections for path loss were applied by using the worst case path attenuation for the frequency range of interest. These values were applied and are offset on the display. All parameters were 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 mask values requirements as specified in 47CFR 27.53 were followed. These include the 10LOG(N) correction equal to 18.06 dB for 64x MIMO.

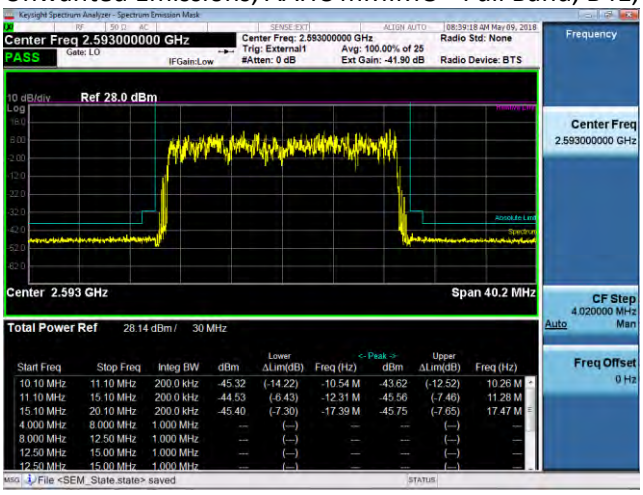
The Top of Mask corresponds to the set rated power level as confirmed by the RF Channel power. This allows confirmation that the measured trace is properly calibrated to the mask.

All emissions were within the parameters as required by Part 27.53 for compliance.
Sample Charts are below

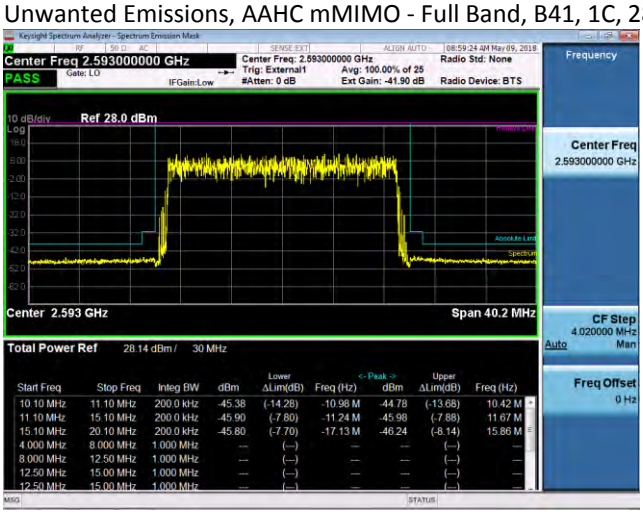
NOTE: Only a sample of all the data taken has been used in this report. The full suite of raw data resides at the MH, New Jersey location.

## 4.2.1 OBW-Edge of Band - Single Carrier (1C)

Unwanted Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM1.2, 2593 MHz.

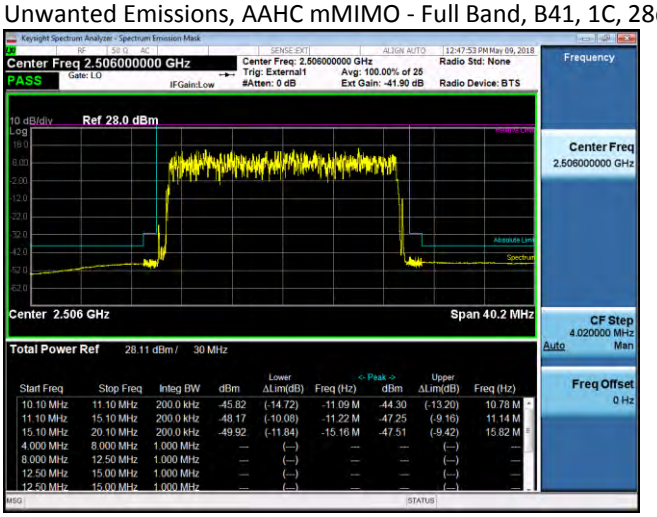



Unwanted Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1, 2593 MHz.

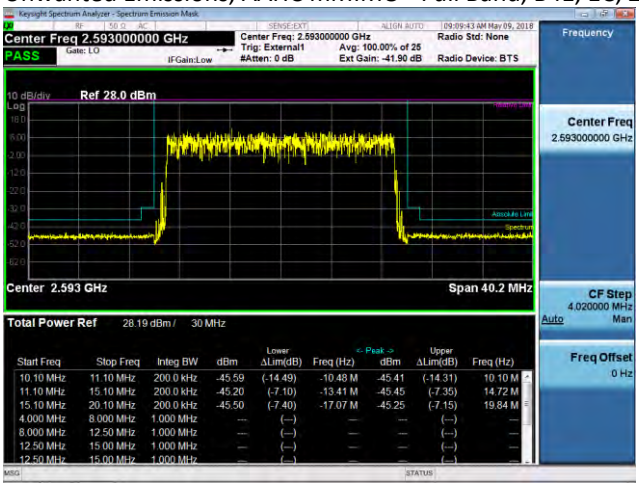



Unwanted Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1, 2680 MHz.

Unwanted Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1, 2506 MHz.

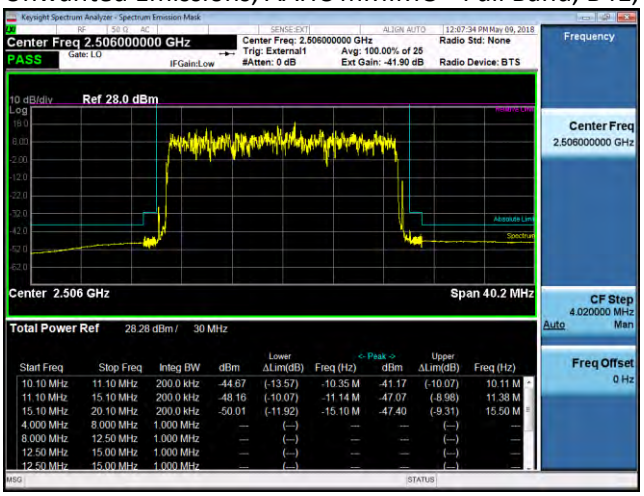



Unwanted Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1A, 2593 MHz.




Unwanted Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1A, 2506 MHz.

Unwanted Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.2, 2506 MHz.

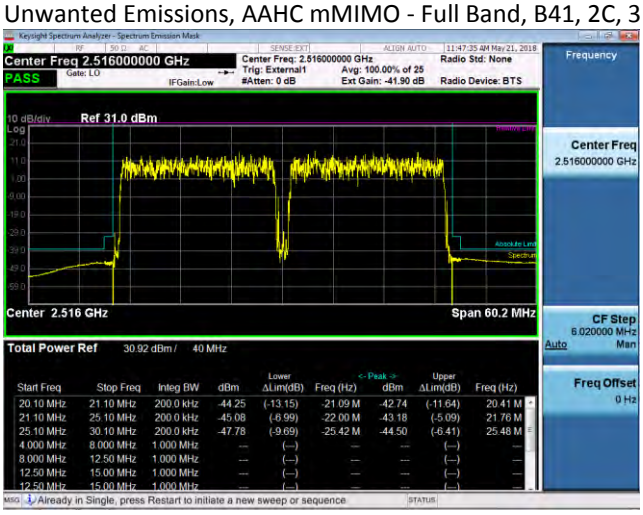



Unwanted Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.1A, 2680 MHz.

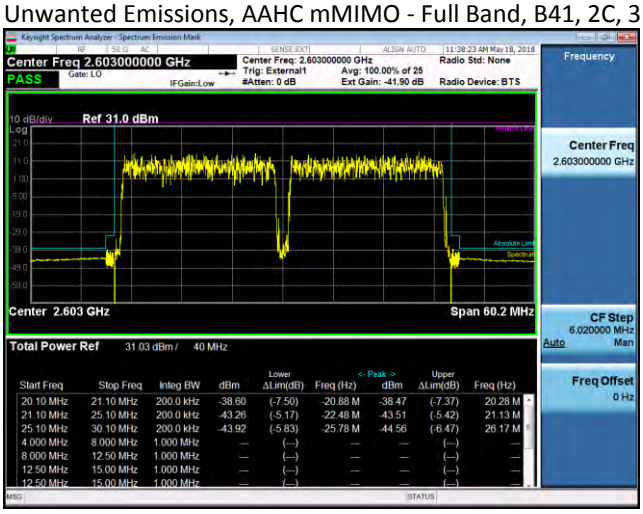

Unwanted Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM3.2, 2680 MHz.

## 4.2.2 OBW-Edge of Band - Dual Carrier (2C)

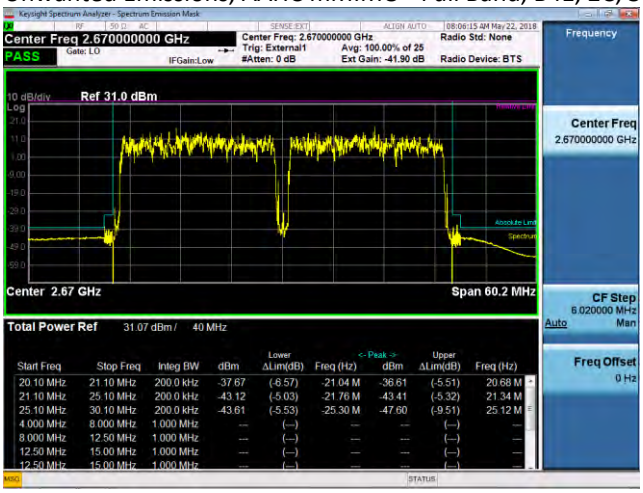
Unwanted Emissions, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2506 & 2526 MHz, Port 56.



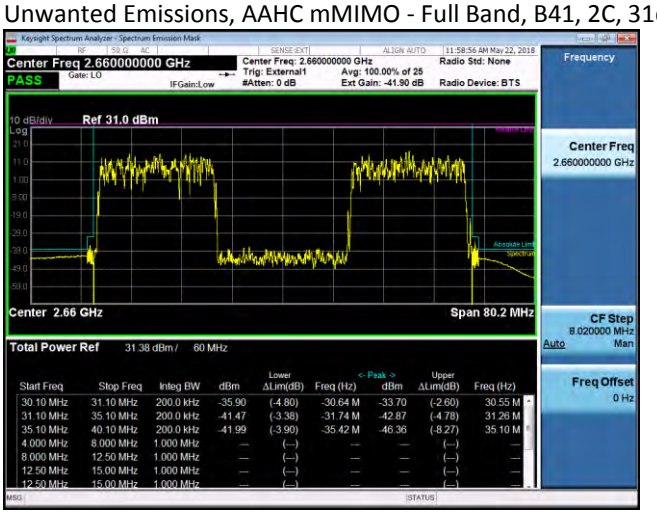

Unwanted Emissions, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 2593 and 2613 MHz, Port 56.



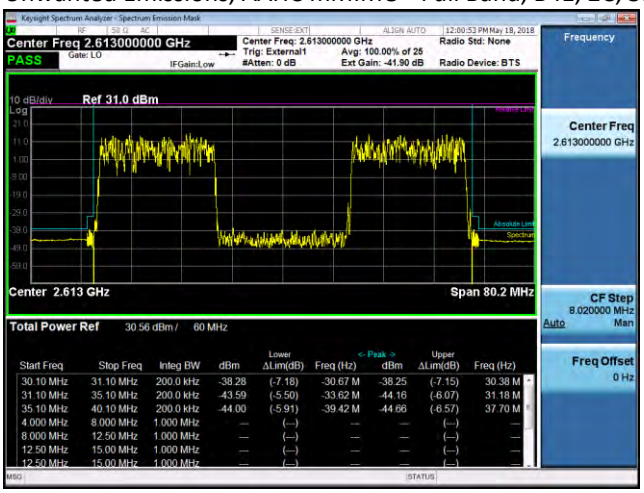

Unwanted Emissions, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2660 and 2680 MHz, Port 56.



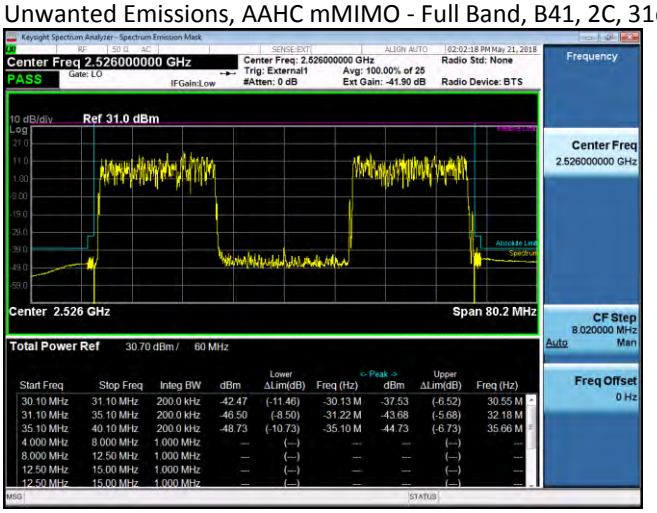
Unwanted Emissions, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.2, 2640 and 2680 MHz, Port 56.




Unwanted Emissions, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 2593 and 2633 MHz, Port 56.

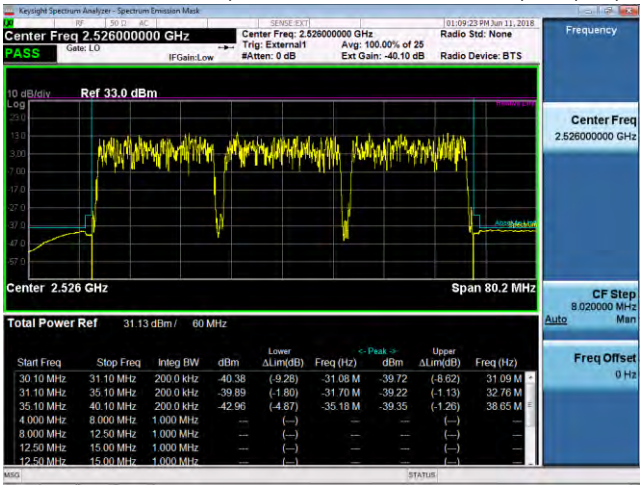



Unwanted Emissions, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2506 and 2546 MHz, Port 56.

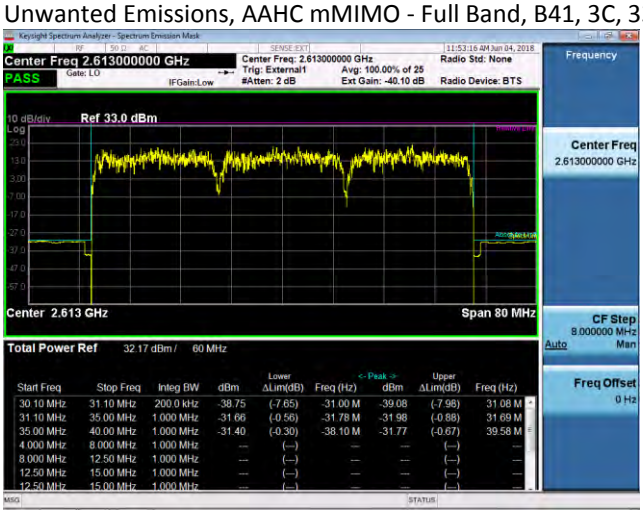


## 4.2.3 OBW-Edge of Band - Triple Carrier (3C)

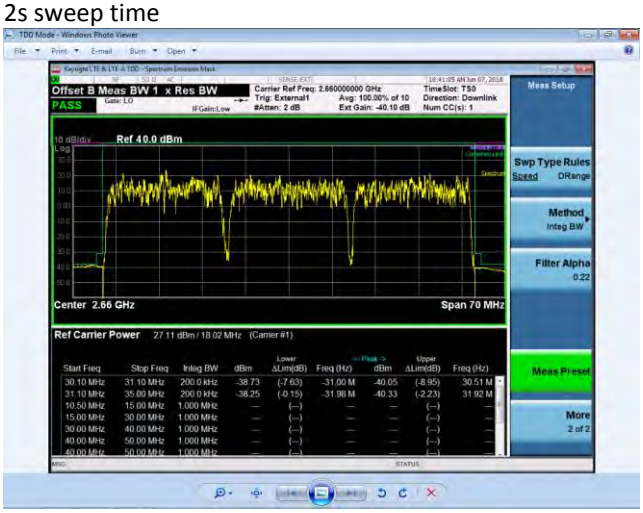
Unwanted Emissions, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.1A, 2593, 2613 and 2633 MHz, Port 12.



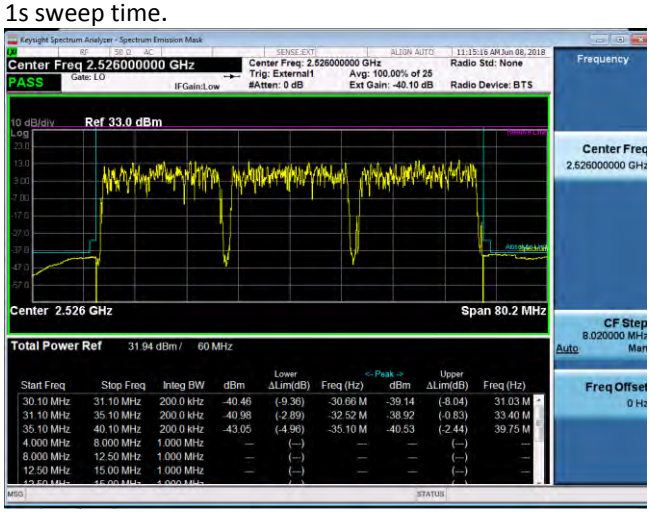

Unwanted Emissions, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.2, 2593, 2613 and 2633 MHz, Port 12.



Unwanted Emissions, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.2, 2640, 2660 and 2680 MHz, Port 12.
2s sweep time




Unwanted Emissions, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.2, 2506, 2526 and 2546 MHz, Port 12.
1s sweep time.



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

## 5.1 Measurement of Spurious Emissions at Transmit Antenna Port

The Spurious Emissions at the transmit-antenna terminals of the EUT (EAC) were measured to determine compliance with the limits of Part 27.53 when tested per ANSI C63.26, KDB 971168 D01, v03r01, and KDB 662911 D01, v02r01. The RF output from the EAC port to spectrum analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator/ test coupler. Measurements above 10 GHz incorporated a high pass filter to reduce path loss. Measurements were performed using a Keysight MXA Signal Analyzer. The Spurious Emissions requirements as specified in 47CFR 27.53 were followed. These include the 10LOG(N) correction equal to 18.06 dB for 64x MIMO.

The applicable per port limits are as follows

Corrections for path loss were applied by using the worst case path attenuation for the frequency range of interest. These values were applied and are offset on the display. All parameters were adjusted to the corrected RF power level for the resolution bandwidth used for the transmit signal.

The measured spurious emission levels were plotted for the frequency range of 10 MHz to 26.5 GHz. Data below documents performance up to 26.5 GHz.

All emissions were within the parameters as required by Part 27.53 for compliance.
Sample Charts are below

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

## 5.1.1 Antenna Port Spurious Emissions - Single Carrier (1C)

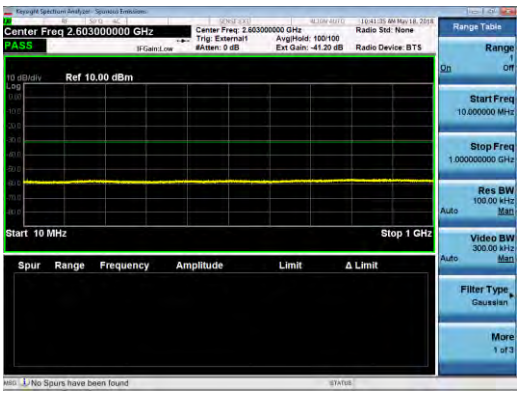
Spurious Emissions, AAHC mMIMO - Full Band, B41, 1C, 28dBm, 20MBW, TM1.1, 2593 MHz.






## 5.1.2 Antenna Port Spurious Emissions - Dual Carrier (2C)

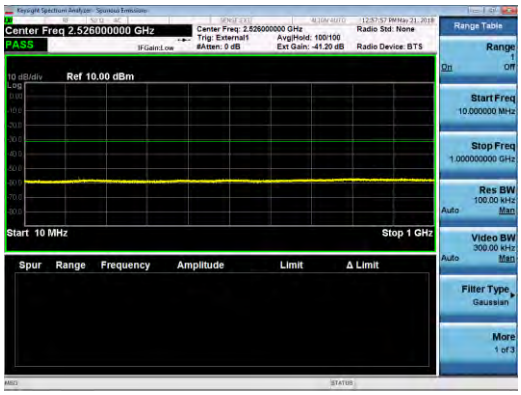
Spurious Emissions, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1, 2593 and 2613 MHz, Port 56.







Spurious Emissions, AAHC mMIMO - Full Band, B41, 2C, 31dBm, 40MBW, TM3.1A, 2506 and 2546 MHz, Port 56.

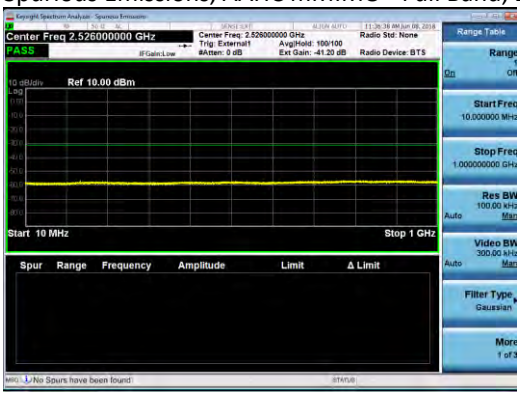






## 5.1.3 Antenna Port Spurious Emissions - Triple Carrier (3C)

Spurious Emissions, AAHC mMIMO - Full Band, B41, 3C, 33dBm, 60MBW, TM3.2, 2506, 2526 and 2546 MHz, Port 12.







# 6. FCC Section 2.1053 and Part 15.109

## 6.1 Section 2.1053 Field Strength of Spurious Emissions

Field strength measurements of radiated spurious emissions were made in a 10m Semi-Anechoic Chamber the of Global Product Compliance Laboratories of Nokia Bell Labs in Murray Hill NJ. A complete description and full measurement data for the site is on file with the Commission (FCC File 328881).

The spectrum from 30 MHz to the tenth harmonic of the carrier, as high as 27 GHz depending upon the product, 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 have sufficient margin below the specification limit, the use of field strength measurements for compliance determination is acceptable. For this case the evaluation of acceptable radiated field strength is as follows.

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 non-report compliance limit is 62.23 dBμV/m for 64x64 MIMO
The FCC Part 15 Class B limit is 54 dBμV/m above 1GHz.

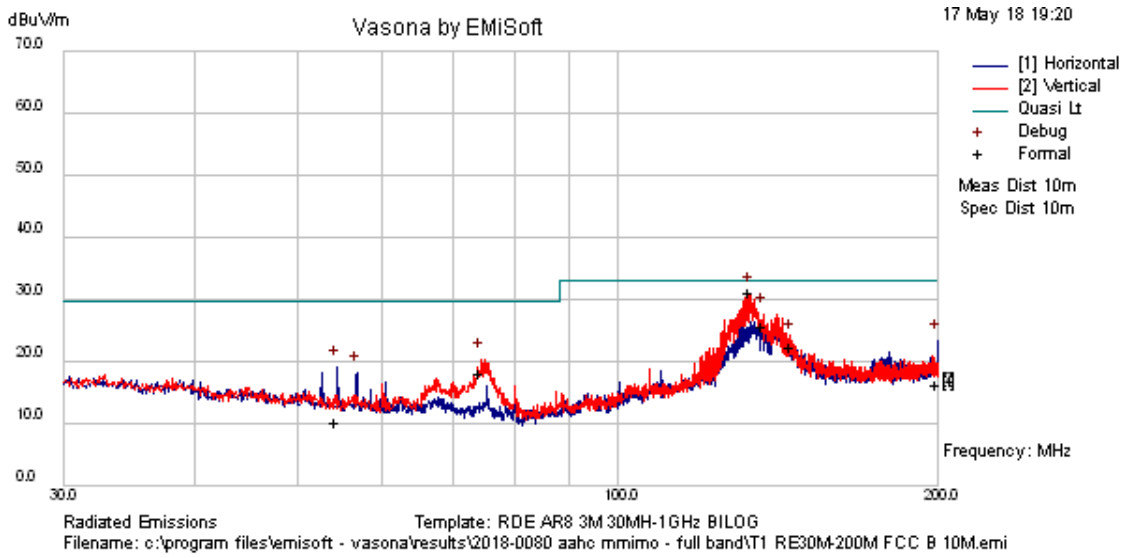
The calculated emission levels were found by:

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

## 6.2 Field Strength of Spurious Emissions 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 @ 3m. Emissions equal to or less than 64.2 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 27 GHz), no spurious emissions above the limits were detected. A representative set of measurement scans are included below.

T1 Radiated Emissions 30M-200MHz FCC Class B




| | |
|---|---|
| **Results Title:** | RDE AR8 3M 30MH-200 MHz BILOG |
| **File Name:** | c:\program files\emisoft - vasona\results\2018-0080 AAHC mmimo - full band\T1 RE30M-200M FCC B 10M.emi |
| **Test Laboratory:** | AR8 MH GPCL 21C, 38% RH 1000mB |
| **Test Engineer:** | JY / MJS |
| **Test Software:** | Vasona by EMISoft, version 2.161 |
| **Equipment:** | Nokia |
| **EUT Details:** | AAHC mMIMO - Full Band |
| **Configuration:** | Powered by -48VDC, 20 Amps, Tx-2593MHz, 256QAM, 1C, 28dBm per port. All ports transmitting. Radiated Emissions FCC Part 15, RE 30MHz-200MHz, Bicon Antenna E051, 6dB pad-E1130, Sonoma Preamp E813, ESI-E936. |
| **Date:** | 2018-05-17 19:20:49 |

**FORMAL DATA**

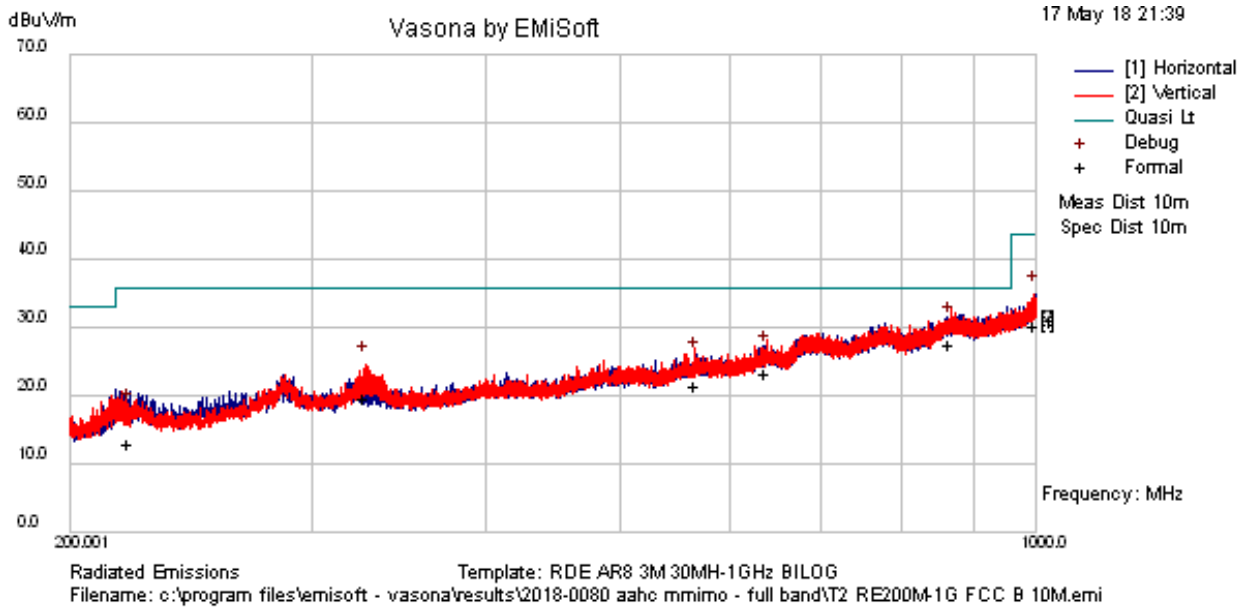
| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 133.305 | 40.38 | 6.97 | -19.3 | 28.06 | Quasi Max | V | 112 | 288 | 33 | -4.94 | Pass | |
| 137.176 | 34.78 | 6.99 | -19.2 | 22.59 | Quasi Max | V | 126 | 276 | 33 | -10.41 | Pass | |
| 145.766 | 31.4 | 7.02 | -19.2 | 19.22 | Quasi Max | V | 100 | 219 | 33 | -13.78 | Pass | |
| 74.344 | 32.22 | 6.67 | -24 | 14.88 | Quasi Max | V | 162 | 180 | 29.5 | -14.62 | Pass | |
| 199.962 | 23.71 | 7.21 | -17.8 | 13.14 | Quasi Max | H | 100 | 248 | 33 | -19.86 | Pass | |
| 54.4329 | 22.71 | 6.53 | -22 | 7.23 | Quasi Max | H | 338 | 148 | 29.5 | -22.27 | Pass | |

**PREVIEW DATA**

| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 133.407 | 43.05 | 6.97 | -19.3 | 30.74 | Preview | V | 100 | 270 | 33 | -2.26 | Pass | |
| 137.158 | 39.74 | 6.99 | -19.2 | 27.55 | Preview | V | 100 | 270 | 33 | -5.45 | Pass | |
| 74.3447 | 37.44 | 6.67 | -24 | 20.1 | Preview | V | 185 | 180 | 29.5 | -9.4 | Pass | |
| 145.816 | 35.45 | 7.02 | -19.2 | 23.27 | Preview | V | 100 | 270 | 33 | -9.73 | Pass | |
| 199.583 | 33.83 | 7.21 | -17.8 | 23.24 | Preview | H | 385 | 180 | 33 | -9.76 | Pass | |
| 54.4329 | 34.44 | 6.53 | -22 | 18.96 | Preview | H | 385 | 0 | 29.5 | -10.54 | Pass | |
| 56.7415 | 33.95 | 6.55 | -22.4 | 18.13 | Preview | H | 385 | 0 | 29.5 | -11.37 | Pass | |

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T2 Radiated Emissions 200M-1 GHz 1C FCC Class B




| | |
|---|---|
| **Results Title:** | RDE AR8 3M 200 MHz-1GHz BILOG |
| **File Name:** | c:\program files\emisoft - vasona\results\2018-0080 AAHC mmimo - full band\T2 RE200M-1G FCC B 10M.emi |
| **Test Laboratory:** | AR8 MH GPCL 21C, 38% RH 1000mB |
| **Test Engineer:** | JY / MJS |
| **Test Software:** | Vasona by EMISoft, version 2.161 |
| **Equipment:** | Nokia |
| **EUT Details:** | AAHC mMIMO - Full Band |
| **Configuration:** | Powered by -48VDC, 20 Amps, Tx-2593MHz, 256QAM, 1C, 28dBm per port. All ports transmitting. Radiated Emissions FCC Part 15, RE 200MHz-1GHz, 6dB pad E1130, Log-Periodic E061, Sonoma Preamp E813, ESI-E936. |
| **Date:** | 2018-05-17 21:39:40 |

**FORMAL DATA**

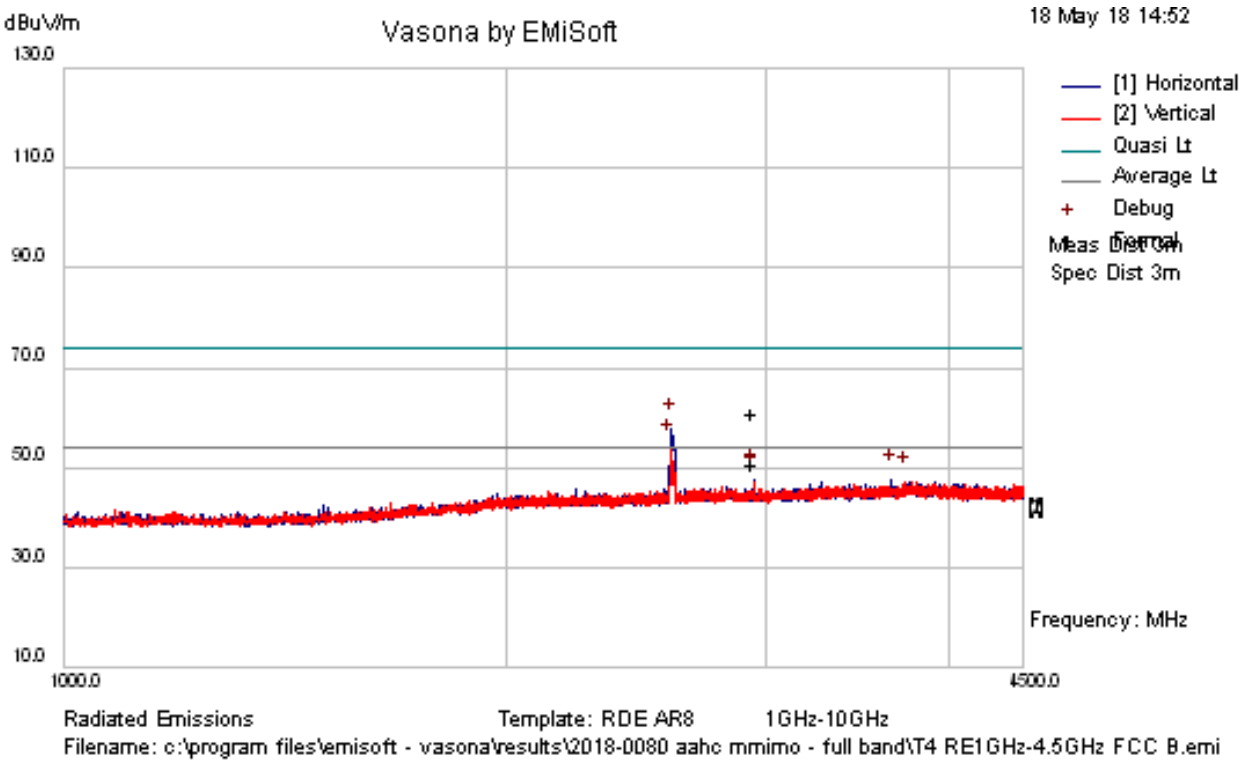
| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 868.73 | 23.8 | 9.1 | -8.37 | 24.53 | Quasi Max | V | 200 | 192 | 35.6 | -11.07 | Pass | |
| 639.945 | 23.52 | 8.16 | -11.6 | 20.12 | Quasi Max | V | 305 | 289 | 35.6 | -15.48 | Pass | |
| 998.978 | 23.8 | 9.44 | -6.21 | 27.04 | Quasi Max | H | 110 | 261 | 43.5 | -16.46 | Pass | |
| 568.37 | 23.32 | 7.92 | -12.9 | 18.37 | Quasi Max | V | 261 | 69 | 35.6 | -17.23 | Pass | |
| 328.1 | 26.23 | 7.61 | -17.2 | 16.66 | Quasi Max | V | 115 | 280 | 35.6 | -18.94 | Pass | |
| 221.344 | 22.82 | 7.29 | -20.4 | 9.73 | Quasi Max | V | 233 | 117 | 35.6 | -25.87 | Pass | |

**PREVIEW DATA**

| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 868.73 | 29.51 | 9.1 | -8.37 | 30.24 | Debug | V | 100 | 317 | 35.6 | -5.36 | Pass | |
| 998.978 | 31.56 | 9.44 | -6.21 | 34.79 | Preview | H | 385 | 225 | 43.5 | -8.71 | Pass | |
| 639.945 | 29.48 | 8.16 | -11.6 | 26.08 | Debug | V | 100 | 317 | 35.6 | -9.52 | Pass | |
| 568.37 | 30.03 | 7.92 | -12.9 | 25.07 | Debug | V | 100 | 317 | 35.6 | -10.53 | Pass | |
| 328.1 | 34.05 | 7.61 | -17.2 | 24.48 | Preview | V | 385 | 270 | 35.6 | -11.12 | Pass | |
| 221.344 | 30.53 | 7.29 | -20.4 | 17.44 | Debug | V | 100 | 317 | 35.6 | -18.16 | Pass | |

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T4a Radiated Emissions 1GHz-4.5GHz FCC B Tilt




| | |
|---|---|
| **Results Title:** | RDE AR8 1GHz-4.5 GHz |
| **File Name:** | c:\program files\emisoft - vasona\results\2018-0080 aahc mmimo - full band\T4a RE1GHz-4.5GHz FCC B Tilt.emi |
| **Test Laboratory:** | AR8 MH GPCL 23C, 53% RH 1000mB |
| **Test Engineer:** | GM |
| **Test Software:** | Vasona by EMISoft, version 2.161 |
| **Equipment:** | Nokia |
| **EUT Details:** | AAHC mMIMO - Full Band |
| **Configuration:** | Powered by -48VDC, 20 Amps, Tx-2593MHz, 256QAM, 1C, 28dBm per port. All ports transmitting. Radiated Emissions FCC Part 15, RE 1GHz-4.5GHz, Horn Antenna E1073, HPF-HP Preamp E376, ESI-1G-E936. Preview RBW: 30kHz / 1M Formals. VBW: 1 MHz. 0dB internal Attenuation |
| **Date:** | 2018-05-18 15:39:54 |

**FORMAL DATA**

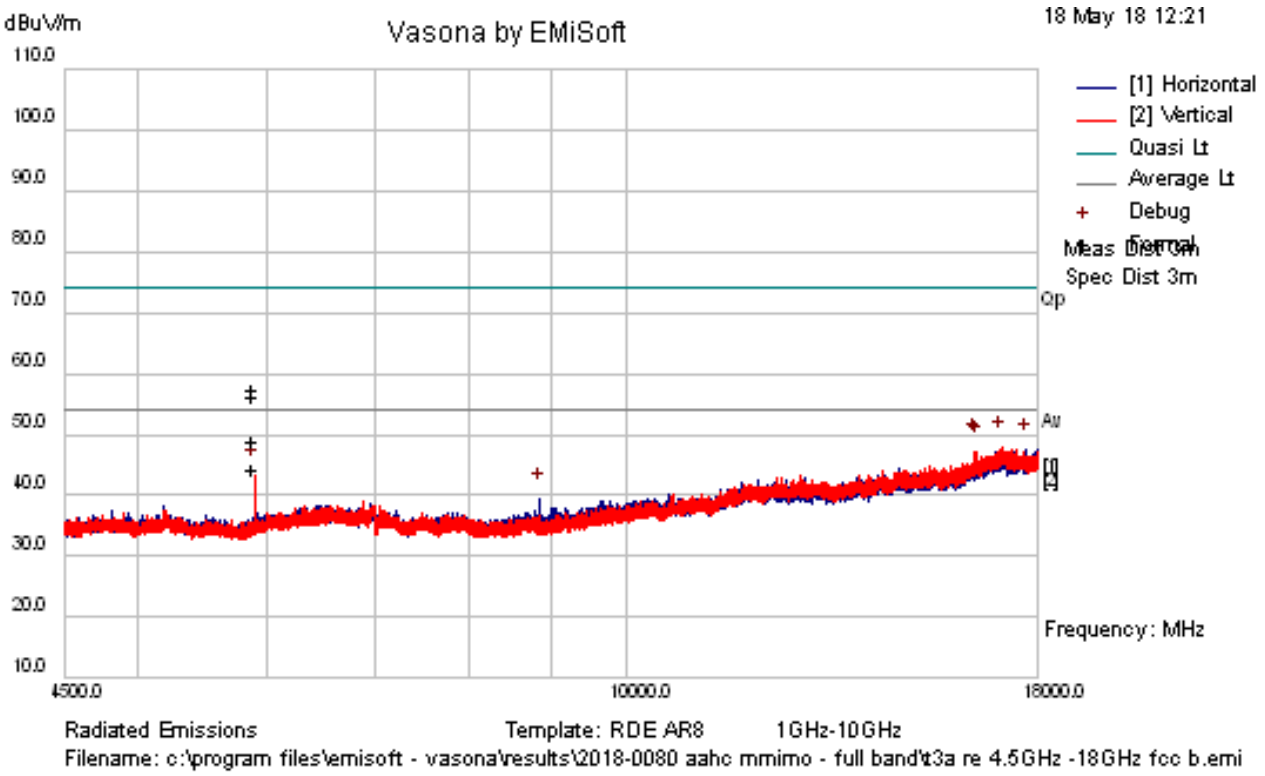
| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2949.13 | 37.02 | 9.41 | -1.28 | 45.15 | AvgMax | H | 355 | 254 | 54 | -8.85 | Pass | 42.6 Degrees |
| 2949.14 | 35.98 | 9.41 | -1.28 | 44.11 | AvgMax | V | 247 | 156 | 54 | -9.89 | Pass | 42.6 Degrees |
| 2949.13 | 47.17 | 9.41 | -1.28 | 55.29 | Quasi Max | H | 355 | 254 | 74 | -18.71 | Pass | 42.6 Degrees |
| 2949.14 | 46.16 | 9.41 | -1.28 | 54.28 | Quasi Max | V | 247 | 156 | 74 | -19.72 | Pass | 42.6 Degrees |

**PREVIEW DATA**

| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2949.15 | 39.52 | 9.41 | -1.28 | 47.64 | Debug | H | 395 | 225 | 54 | -6.36 | Pass | |
| 2949.08 | 38.98 | 9.41 | -1.28 | 47.1 | Debug | V | 100 | 317 | 54 | -6.9 | Pass | |

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T3a Radiated Emissions 4.5GHz -18GHz FCC B




| | |
|---|---|
| **Results Title:** | RDE AR8 1GHz-10GHz |
| **File Name:** | c:\program files\emisoft - vasona\results\2018-0080 aahc mmimo - full band\t3a re 4.5GHz -18GHz fcc b.emi |
| **Test Laboratory:** | AR8 MH GPCL 21C, 38% RH 1000mB |
| **Test Engineer:** | JY/GM |
| **Test Software:** | Vasona by EMISoft, version 2.161 |
| **Equipment:** | Nokia |
| **EUT Details:** | AAHC mMIMO - Full Band |
| **Configuration:** | Powered by -48VDC, 20 Amps, Tx-2593MHz, 256QAM, 1C, 28dBm per port. All ports transmitting. Radiated Emissions FCC Part 15, RE 4.5GHz-18GHz, Horn Antenna E1073, HPF-HP Preamp E376, ESI-1G-E936. Preview RBW: 30kHz / 1M Formals. VBW: 1 MHz. 0dB internal Attenuation |
| **Date:** | 2018-05-18 12:21:08 |

**FORMAL DATA**

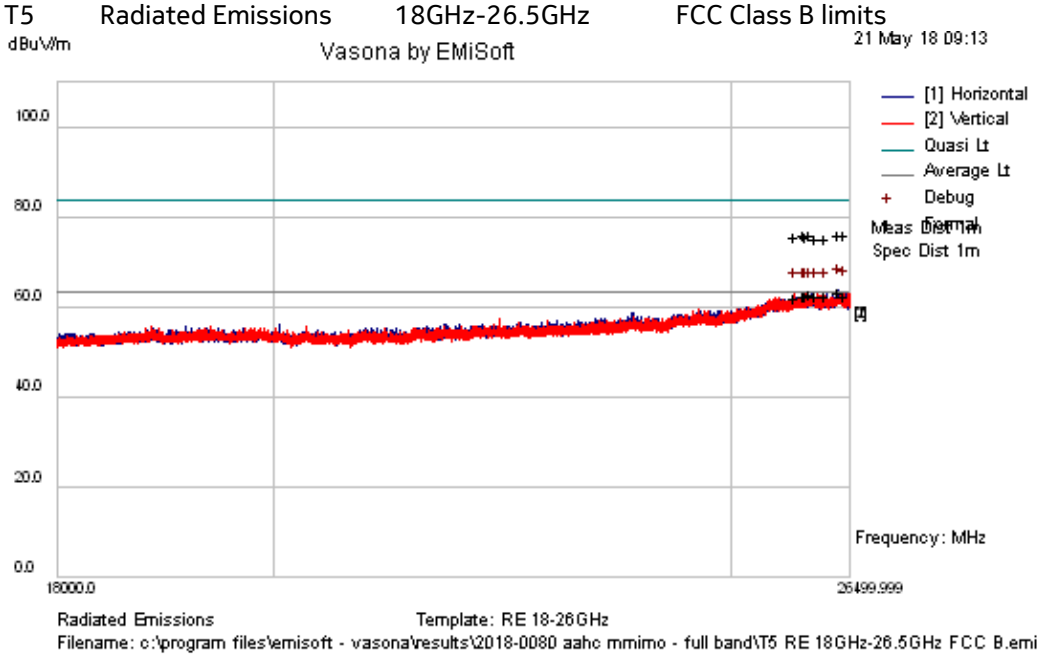
| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5898.28 | 36.8 | 5.85 | 1.9 | 44.55 | AvgMax | V | 103 | 176 | 54 | -9.45 | Pass | 14.2 Degrees |
| 5898.24 | 31.89 | 5.85 | 1.9 | 39.65 | AvgMax | V | 220 | 180 | 54 | -14.35 | Pass | 42.6 Degrees |
| 5898.28 | 45.15 | 5.85 | 1.9 | 52.91 | Quasi Max | V | 103 | 176 | 74 | -21.09 | Pass | 14.2 Degrees |
| 5898.24 | 43.82 | 5.85 | 1.9 | 51.58 | Quasi Max | V | 220 | 180 | 74 | -22.42 | Pass | 42.6 Degrees |

**PREVIEW DATA**

| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5898.04 | 35.61 | 5.85 | 1.9 | 43.37 | Preview | V | 100 | 154 | 54 | -10.63 | Pass | |

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T5 Radiated Emissions 18GHz-26.5GHz FCC Class B limits




| | |
|---|---|
| **Results Title:** | RE 18-26GHz |
| **File Name:** | c:\program files\emisoft - vasona\results\2018-0080 aahc mmimo - full band\T5 RE 18GHz-26.5GHz FCC B.emi |
| **Test Laboratory:** | AR8 MH GPCL 23C, 53% RH 1000mB |
| **Test Engineer:** | GM |
| **Test Software:** | Vasona by EMISoft, version 2.161 |
| **Equipment:** | Nokia |
| **EUT Details:** | AAHC mMIMO - Full Band |
| **Configuration:** | Powered by -48VDC, 20 Amps, Tx-2593MHz, 256QAM, 1C, 28dBm per port. All ports transmitting. Radiated Emissions FCC Part 15, RE 18GHz-26.5GHz, Horn Antenna E1073, HP Preamp E376, ESI-1G-E936. Preview RBW: 1MHz VBw 3MHzFormals. VBW: RBW 1MHz VBW 3 MHz. 0dB internal Attenuation |
| **Date:** | 2018-05-21 09:18:29 |

**FORMAL DATA**

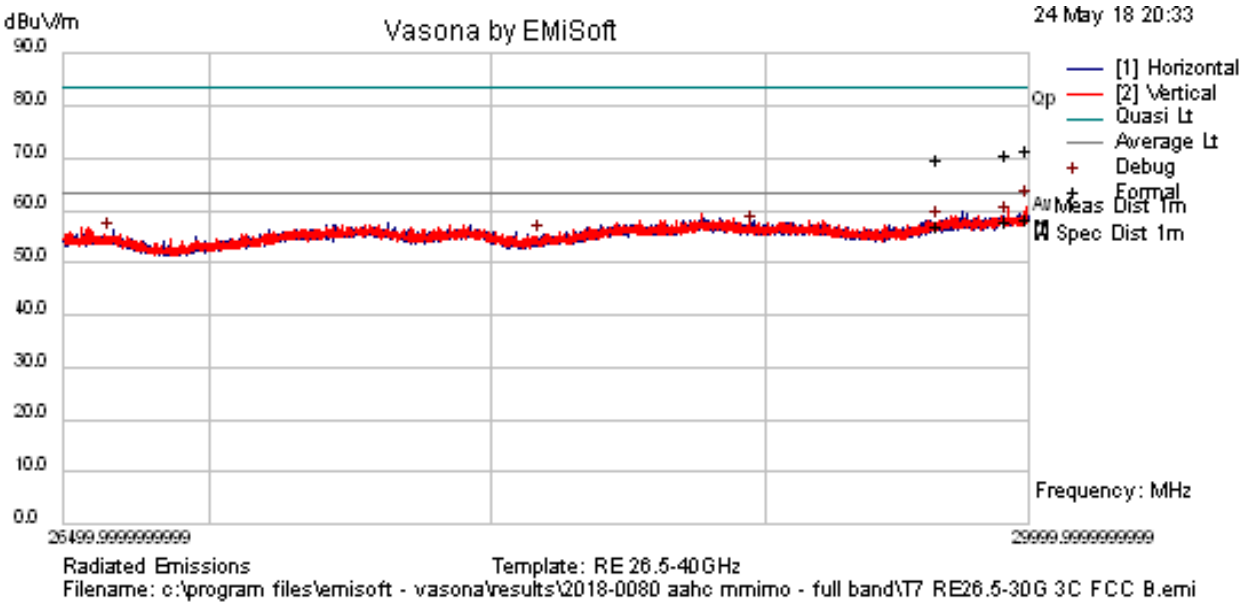
| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26343.3 | 26.65 | 10.32 | 21.09 | 58.05 | AvgMax | H | 111 | 56 | 63.5 | -5.45 | Pass | |
| 25990.5 | 26.91 | 10.19 | 20.47 | 57.58 | AvgMax | H | 125 | 68 | 63.5 | -5.92 | Pass | |
| 26187.7 | 26.44 | 10.26 | 20.82 | 57.53 | AvgMax | H | 133 | 0 | 63.5 | -5.97 | Pass | |
| 26427.7 | 25.95 | 10.35 | 21.23 | 57.52 | AvgMax | V | 115 | 181 | 63.5 | -5.98 | Pass | |
| 25929.8 | 26.98 | 10.17 | 20.31 | 57.46 | AvgMax | H | 117 | 35 | 63.5 | -6.04 | Pass | |
| 26068 | 26.37 | 10.22 | 20.62 | 57.21 | AvgMax | V | 128 | 75 | 63.5 | -6.29 | Pass | |
| 25906.5 | 26.71 | 10.16 | 20.25 | 57.12 | AvgMax | V | 100 | 52 | 63.5 | -6.38 | Pass | |
| 25788.3 | 26.78 | 10.12 | 19.92 | 56.83 | AvgMax | V | 118 | 66 | 63.5 | -6.67 | Pass | |
| 26427.7 | 39.35 | 10.35 | 21.23 | 70.92 | Quasi Max | V | 115 | 181 | 83.5 | -12.58 | Pass | |
| 25906.5 | 40.46 | 10.16 | 20.25 | 70.87 | Quasi Max | V | 100 | 52 | 83.5 | -12.63 | Pass | |
| 25990.5 | 40.19 | 10.19 | 20.47 | 70.86 | Quasi Max | H | 125 | 68 | 83.5 | -12.64 | Pass | |
| 26343.3 | 39.35 | 10.32 | 21.09 | 70.75 | Quasi Max | H | 111 | 56 | 83.5 | -12.75 | Pass | |
| 25929.8 | 39.93 | 10.17 | 20.31 | 70.41 | Quasi Max | H | 117 | 35 | 83.5 | -13.09 | Pass | |
| 25788.3 | 40.33 | 10.12 | 19.92 | 70.37 | Quasi Max | V | 118 | 66 | 83.5 | -13.13 | Pass | |
| 26068 | 39.35 | 10.22 | 20.62 | 70.19 | Quasi Max | V | 128 | 75 | 83.5 | -13.31 | Pass | |
| 26187.7 | 38.79 | 10.26 | 20.82 | 69.88 | Quasi Max | H | 133 | 0 | 83.5 | -13.62 | Pass | |

**PREVIEW DATA**

| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26342.9 | 32.33 | 10.32 | 21.08 | 63.73 | Preview | H | 100 | 330 | 63.5 | 0.23 | Fail | |
| 26427.7 | 31.6 | 10.35 | 21.23 | 63.17 | Debug | V | 100 | 354 | 63.5 | -0.33 | Pass | |
| 26068 | 32.17 | 10.22 | 20.62 | 63.01 | Debug | V | 100 | 354 | 63.5 | -0.49 | Pass | |
| 25906.5 | 32.59 | 10.16 | 20.25 | 63 | Debug | V | 100 | 354 | 63.5 | -0.5 | Pass | |
| 26187.7 | 31.89 | 10.26 | 20.82 | 62.97 | Debug | H | 100 | 354 | 63.5 | -0.53 | Pass | |
| 25929.8 | 32.48 | 10.17 | 20.31 | 62.96 | Debug | H | 100 | 354 | 63.5 | -0.54 | Pass | |
| 25990.5 | 32.2 | 10.19 | 20.47 | 62.87 | Debug | H | 100 | 354 | 63.5 | -0.63 | Pass | |
| 25788.3 | 32.77 | 10.12 | 19.92 | 62.82 | Debug | V | 100 | 354 | 63.5 | -0.68 | Pass | |

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T7 Radiated Emissions 26.5G-30GHz FCC Class B limits




| | |
|---|---|
| **Results Title:** | RE 26.5-30GHz |
| **File Name:** | c:\program files\emisoft - vasona\results\2018-0080 AAHC mMimo - full band\T7 RE26.5-30G 3C FCC B.emi |
| **Test Laboratory:** | AR8 MH GPCL 23C, 53% RH 1000mB |
| **Test Engineer:** | MJS JY |
| **Test Software:** | Vasona by EMISoft, version 2.161 |
| **Equipment:** | Nokia |
| **EUT Details:** | AAHC mMIMO - Full Band |
| **Configuration:** | Powered by -48VDC, 20 Amps, Tx-2640MHz, 256QAM, 2660-256QAM, 2680-64QAM. 3C, 31.8dBm per port. All ports transmitting. Radiated Emissions FCC Part 15, RE 26.5GHz-30GHz, Horn Antenna E526, ESI-40G-E936. Preview RBW: 1MHz VBw 3M, Formals. VBW: RBW 1MHz VBW 3 MHz. 0dB internal Attenuation |
| **Date:** | 2018-05-24 20:33:51 |

**FORMAL DATA**

| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29996.1 | 31.97 | 0 | 22.74 | 54.71 | Average | V | 100 | 314 | 63.5 | -8.79 | Pass | |
| 29921.9 | 31.82 | 0 | 22.64 | 54.46 | Average | H | 112 | 275 | 63.5 | -9.04 | Pass | |
| 29657.7 | 31.36 | 0 | 22.28 | 53.64 | Average | H | 100 | 187 | 63.5 | -9.86 | Pass | |
| 29996.1 | 45.42 | 0 | 22.74 | 68.17 | Peak | V | 100 | 314 | 83.5 | -15.33 | Pass | |
| 29921.9 | 44.38 | 0 | 22.64 | 67.02 | Peak | H | 112 | 275 | 83.5 | -16.48 | Pass | |
| 29657.7 | 43.98 | 0 | 22.28 | 66.26 | Peak | H | 100 | 187 | 83.5 | -17.24 | Pass | |

**PREVIEW DATA**

| Freq. MHz | Raw dBuV | Cable dB | Factor dB | Level dBuV/m | Emission Type | Pol H/V | Ht cm | Az deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29996.1 | 37.98 | 0 | 22.74 | 60.73 | Preview | V | 200 | 22 | 63.5 | -2.77 | Pass | |
| 28171.3 | 33.43 | 0 | 20.59 | 54.02 | Debug | V | 100 | 354 | 63.5 | -9.48 | Pass | |
| 26656.6 | 35.04 | 0 | 19.2 | 54.24 | Debug | V | 100 | 354 | 63.5 | -9.26 | Pass | |
| 28956.1 | 34.23 | 0 | 21.55 | 55.78 | Debug | V | 100 | 354 | 63.5 | -7.72 | Pass | |
| 29657.7 | 34.54 | 0 | 22.28 | 56.82 | Debug | H | 100 | 354 | 63.5 | -6.68 | Pass | |
| 29921.9 | 34.8 | 0 | 22.64 | 57.44 | Debug | H | 100 | 354 | 63.5 | -6.06 | Pass | |

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

# 7. FCC Section 2.1055 Frequency Stability

## 7.1 Section 2.1055 Measurement of Frequency Stability

This measurement evaluates the frequency difference between the actual transmit carrier frequency and the specified transmit frequency assignment. Only the portion of the transmitter system containing the frequency determining and stabilizing circuitry need be put in an environmental chamber and subjected to the temperature variation test per FCC Section 2.1055 and RSS-133. The unit which provides baseband signals, such as BBU (baseband unit), can be located outside the chamber if it is a separated unit.

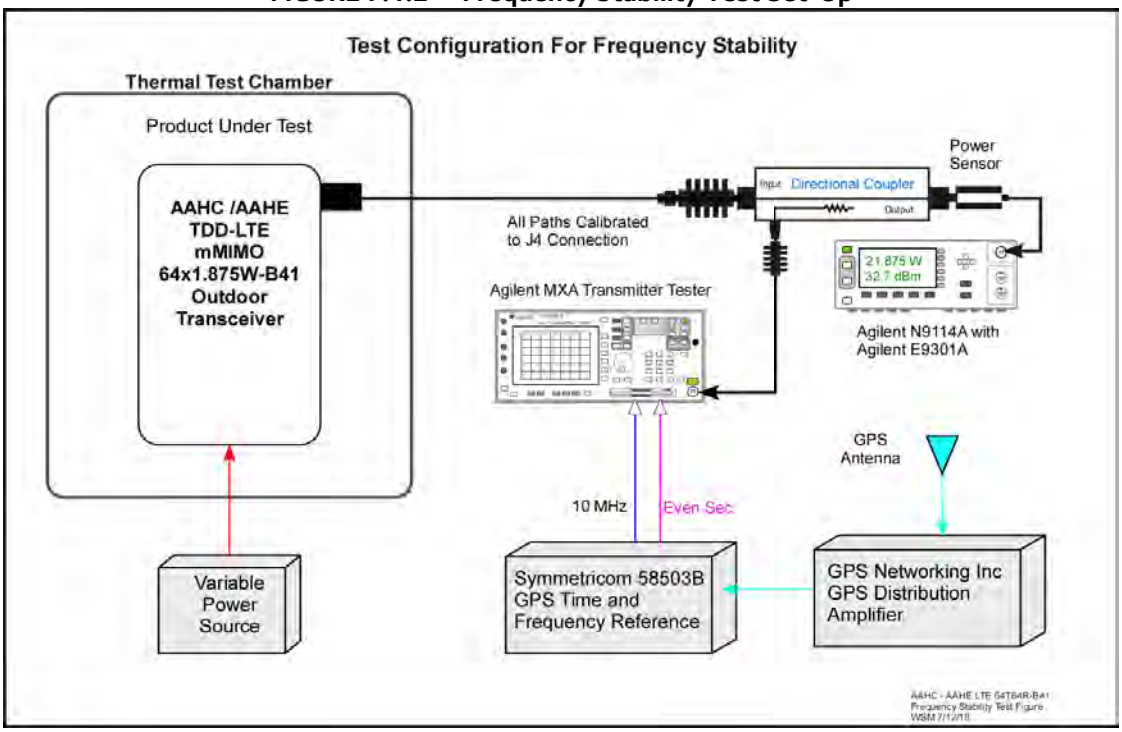
### 7.1.1 Frequency Stability Test Article and Configuration

The unit under test is identified as follows: AirScale MAA 64T64R 128AE B41 120W AAHC , PN (1P) 474155A.102, SN: 6Q180712583 - FCC ID: VBNAAHC-01

### 7.1.2 Frequency Stability Test

Frequency Stability Testing was performed on the Nokia AAHC AirScale MAA 64T64R 2600 B41 120W, PN: 474155A.102, SN: 6Q180712580., FCC ID: VBNAAHC-01.
The testing was performed on the B41 AAHC from 06/07/2018 through 06/09/2018. The product was configured per Figure 6.1.2 and tested in the T-11 Thermal chamber of the GPCL test facility located in Bldg. 4, Room 4-280, Murray Hill, NJ. Testing was witnessed by Joe Bordonaro from GPCL. The UUT was subjected to a range of temperature from ambient to +50ºC to -30ºC and back to ambient. Frequency Stability performance was verified by measuring Frequency Tolerance at EAC using an MXA Signal Analyzer. Frequency Tolerance is a measurement of the difference between the actual transmit frequency and the assigned frequency (2593MHz). The system level Frequency Stability testing of the UUT yielded results in compliance with established design criteria.

**FIGURE 7.1.2 Frequency Stability Test Set-Up**



### 7.1.3 Frequency Stability Test process

a) Set the power supply to nominal Voltage.
b) Record the frequency at ~25°C.
c) Raise EUT operating temperature to 50°C.
d) Record the frequency difference.
**e)** Repeat step d) at each 10°C step down to -30°C. Result will be 10 readings and take temperature readings to establish thermal stability at each point.

Upon return to +25°C.

f) At ambient, vary voltage to +15% and -15% of nominal and record frequency difference. Result will be 12 readings for each voltage (nominal, ~+ 3%, ~+6%, ~+%9, ~+12%, +15%, and nominal, ~- 3%, ~-6%, ~-%9, ~-12%, -15%).

### 7.1.4 Frequency Stability Results:

The worst case Frequency Stability over temperature and voltage was **+9.064 Hz which is 0.0035 ppm.** This is within the +/- 0.05ppm desired performance required for LTE operation under 3GPP and FCC requirements.

### 7.1.5 Frequency Stability Data:

The frequency data below documents performance of the AAHC AirScale MAA 64T64R 128AE B41 120W RRH When operated at a center frequency of 2593 MHz.
Process Step:

1. (a)Set the power supply to nominal Voltage. (b) Record the frequency at ~25°C. (c)Raise EUT operating temperature to 50°C. (d)Record the frequency difference. (e) Repeat step (d) at each 10°C step down to -30°C. Result will be 10 readings and take temperature readings to establish thermal stability at each point.

Baseline Measurement at +25°C

| **Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time<br>(minutes) | Transmit Carrier Deviation<br>(Hz) |
| 0 | 2.409 |
| 0.5 | 3.117 |
| 1.0 | 1.930 |
| 1.5 | 6.592 |
| 2.0 | 1.123 |
| 2.5 | 5.250 |
| 3.0 | 1.881 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 1.449 |
| 0.5 | 5.553 |
| 1.0 | 7.301 |
| 1.5 | 3.047 |
| 2.0 | 1.828 |
| 2.5 | 4.291 |
| 3.0 | 2.422 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 4.010 |
| 0.5 | 1.175 |
| 1.0 | 6.299 |
| 1.5 | 8.468 |
| 2.0 | 1.542 |
| 2.5 | 1.263 |
| 3.0 | 4.997 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 8.141 |
| 0.5 | 8.575 |
| 1.0 | 3.620 |
| 1.5 | 1.604 |
| 2.0 | 1.878 |
| 2.5 | 5.194 |
| 3.0 | 3.522 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 0.897 |
| 0.5 | 2.934 |
| 1.0 | 5.816 |
| 1.5 | 1.603 |
| 2.0 | 3.019 |
| 2.5 | 2.547 |
| 3.0 | 1.149 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 2.374 |
| 0.5 | 5.430 |
| 1.0 | 4.816 |
| 1.5 | 0.703 |
| 2.0 | 2.964 |
| 2.5 | 1.375 |
| 3.0 | 2.166 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 6.421 |
| 0.5 | 4.534 |
| 1.0 | 2.919 |
| 1.5 | 2.941 |
| 2.0 | 1.516 |
| 2.5 | 3.820 |
| 3.0 | 1.203 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 1.154 |
| 0.5 | 3.976 |
| 1.0 | 1.770 |
| 1.5 | 0.308 |
| 2.0 | 4.477 |
| 2.5 | 2.293 |
| 3.0 | 5.416 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 9.064 |
| 0.5 | 3.095 |
| 1.0 | 1.593 |
| 1.5 | 2.309 |
| 2.0 | 4.847 |
| 2.5 | 1.632 |
| 3.0 | 3.758 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 3.058 |
| 0.5 | 7.782 |
| 1.0 | 6.168 |
| 1.5 | 1.801 |
| 2.0 | 3.419 |
| 2.5 | 2.851 |
| 3.0 | 1.335 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

Upon return to +25°C.

2. At ambient, vary voltage to +15% and -15% of nominal and record frequency difference. Result will be 12 readings for each voltage (nominal, ~+ 3%, ~+6%, ~+%9, ~+12%, +15%, and nominal, ~- 3%, ~-6%, ~-%9, ~-12%, -15%).

| **Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 1.902 |
| 0.5 | 5.736 |
| 1.0 | 3.831 |
| 1.5 | 5.008 |
| 2.0 | 2.679 |
| 2.5 | 1.953 |
| 3.0 | 4.501 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at 103% of Nominal Voltage, -49.44VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 1.663 |
| 0.5 | 4.601 |
| 1.0 | 1.449 |
| 1.5 | 3.692 |
| 2.0 | 5.554 |
| 2.5 | 2.726 |
| 3.0 | 1.806 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at 106% of Nominal Voltage, -50.88VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 2.843 |
| 0.5 | 6.305 |
| 1.0 | 4.072 |
| 1.5 | 1.704 |
| 2.0 | 2.935 |
| 2.5 | 1.016 |
| 3.0 | 5.523 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at 109% of Nominal Voltage, -52.32VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 2.765 |
| 0.5 | 1.262 |
| 1.0 | 5.121 |
| 1.5 | 3.320 |
| 2.0 | 1.039 |
| 2.5 | 5.068 |
| 3.0 | 4.140 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at 112% of Nominal Voltage, -53.76VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 6.261 |
| 0.5 | 1.430 |
| 1.0 | 4.552 |
| 1.5 | 3.988 |
| 2.0 | 2.801 |
| 2.5 | 5.113 |
| 3.0 | 4.006 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at 115% of Nominal Voltage, -55.20VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 2.931 |
| 0.5 | 1.636 |
| 1.0 | 3.570 |
| 1.5 | 4.252 |
| 2.0 | 5.360 |
| 2.5 | 1.557 |
| 3.0 | 3.162 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48.0VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 3.301 |
| 0.5 | 4.181 |
| 1.0 | 1.547 |
| 1.5 | 2.202 |
| 2.0 | 1.786 |
| 2.5 | 3.022 |
| 3.0 | 4.407 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, -46.56VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 2.391 |
| 0.5 | 5.057 |
| 1.0 | 2.908 |
| 1.5 | 1.705 |
| 2.0 | 3.203 |
| 2.5 | 5.726 |
| 3.0 | 4.611 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, -45.12VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 3.531 |
| 0.5 | 2.367 |
| 1.0 | 5.932 |
| 1.5 | 4.106 |
| 2.0 | 1.347 |
| 2.5 | 3.092 |
| 3.0 | 6.463 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, -43.68VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 2.957 |
| 0.5 | 4.601 |
| 1.0 | 7.966 |
| 1.5 | 3.252 |
| 2.0 | 1.536 |
| 2.5 | 5.411 |
| 3.0 | 2.527 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, -42.24VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 4.911 |
| 0.5 | 3.486 |
| 1.0 | 6.461 |
| 1.5 | 1.117 |
| 2.0 | 6.247 |
| 2.5 | 4.295 |
| 3.0 | 1.268 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

| **Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, -40.80VDC** | |
|---|---|
| Time (minutes) | Transmit Carrier Deviation (Hz) |
| 0 | 5.309 |
| 0.5 | 1.837 |
| 1.0 | 7.032 |
| 1.5 | 6.197 |
| 2.0 | 1.917 |
| 2.5 | 4.582 |
| 3.0 | 6.096 |
| FCC SPECIFICATION | ±2593 MHz (±0.05ppm)<br>±0.05ppm = ±129.65 Hz |
| FCC RESULT | PASS |

# 8. Test Equipment and Test Set-up Photographs

## 8.1 Test Set-up Photographs

The Test Setup photographs are supplied in the filing documents as a separate exhibit

## 8.2 Antenna Port Test Equipment

The following Test Equipment was used to perform Antenna Port testing.

| Manufacturer | Type | Description | Model | Serial | Calibration Date | Calibration Due | Calibration Type | Status |
|---|---|---|---|---|---|---|---|---|
| Agilent Technologies | MXA Signal Analyzer | 20Hz-26.5GHz | N9020A | MY48011791 | 2018-02-15 | 2020-02-15 | Requires Calibration | Active |
| Hewlett Packard | High Pass Filter | 3.5 GHz | 84300-80038 | 006 | | | Calibration Not Required, Must Be Verified | Active |
| Weinschel | Attenuator | 10dB 25Watt 0.05GHz - 26GHz | 74-10-12 | 1068 | | | Calibration Not Required, Must Be Verified | Active |
| Weinschel | Attenuator | 30dB 25W 0.05GHz-26GHz | 74-30-12 | 1065 | | | Calibration Not Required, Must Be Verified | Active |

## 8.3 Radiated Emissions Test Equipment

The following Test Equipment was used to perform Radiated Emissions testing

| Manufacturer | Type | Description | Model | Serial | Calibration Date | Calibration Due | Calibration Type | Status |
|---|---|---|---|---|---|---|---|---|
| ETS Lindgren | Horn Antenna | Double-Ridged Waveguide Horn 1-18 GHz | 3117 | 00135198 | 2017-06-09 | 2019-06-09 | Requires Calibration | Active |
| ETS Lindgren | Multi-Device Controller | | 2090 | 00078509 | | | Calibration Not Required | Active |
| Hewlett Packard | HP-IB Extender | | 37204 | 3212U31136 | | | Calibration Not Required | Active |
| Hewlett Packard | HP-IB Extender | | 37204A | 3212U27554 | | | Calibration Not Required | Active |
| Hewlett Packard | Pre-Amplifier | Preamplifier 1-26.5 GHz | 8449B | 3008A01270 | 2018-01-17 | 2019-01-17 | Requires Calibration | Active |
| RLC Electronics Inc | High Pass Filter | 2.5GHz to 26GHz High Pass Filter | F-19391 | 1440-001 | | | Calibration Not Required, Must Be Verified | Active |
| A.H. Systems Inc. | Horn Antenna | Ridged Horn 26.5 GHz - 40 GHz | SAS-200/573 | 137 | 2017-10-04 | 2019-10-04 | Requires Calibration | Active |
| EMC Test Systems | Horn Antenna | Double Ridged Horn 18-40 GHz | 3116 | 2539 | 2017-06-16 | 2019-06-16 | Requires Calibration | Active |
| EMCO | Biconical Antenna | | 3109 | 2187 | 2016-12-01 | 2018-12-01 | Requires Calibration | Active |
| EMCO | Log Periodic Antenna | | 3146 | 2082 | 2017-05-24 | 2019-05-24 | Requires Calibration | Active |
| Rohde & Schwarz | Test Receiver | EMI (20Hz to 40 GHz)-150 +30dBM | ESIB40 | 100119 | 2017-11-06 | 2019-11-06 | Requires Calibration | Active |
| Sonoma Instrument Co. | Amplifier | 9kHz-1GHz | 310N | 186750 | 2016-07-27 | 2018-07-27 | Requires Calibration | Active |
| Weinschel | Attenuator | 6dB | 2/6 | CD2545 | 2017-03-03 | 2019-03-03 | Requires Calibration | Active |

## 8.4 Frequency Stability Test Equipment

The following Test Equipment was used to perform Frequency Stability testing.

| Manufacturer | Instrument Type | Model | Serial Number | Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| Agilent | MXA Signal Analyzer | N9020A | MY49060086 | 12/07/2016 | 12/07/2018 |
| Agilent | Power Meter | E4419B | MY40511034 | 01/10/2018 | 01/10/2020 |
| Agilent | Power Sensor | E9301A | MY52280001 | 02/08/2017 | 02/08/2019 |
| Agilent | MY52280001 | E9301A | MY52280011 | 02/08/2017 | 02/08/2019 |
| Hewlett Packard | Multimeter | HP 971A | JP35001820 | 06/08/2017 | 06/08/2019 |
| Yokogawa | Thermal Logger | MV2000 | 12W942552 | 06/02/2017 | 06/02/2019 |
| Symmetricon | GPS Receiver | 58503B | KR93200773 | No Cal Req. | No Cal Req. |
| TDK-Lambda | Power supply | GEN60-85-3P208 | 13N5112J | No Cal Req. | No Cal Req. |

# 9. NVLAP Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

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 17025:2005. 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).*

2017-08-17 through 2018-09-30
*Effective Dates*

*For the National Voluntary Laboratory Accreditation Program*