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

TESTING
NVLAP LAB CODE: 100275-0

Test Report

Regulation:
FCC Part 2 and 27

Client:
Nokia Mobility

Product Evaluated:
(AAHF mMIMO - Full Band)
AirScale MAA 64T64R 128AE B41 120W AAHF Radio Unit
FCC ID: VBNAAHF-01

Report Number:
TR-2018-0258-FCC2-27

Date Issued:
February 14, 2019

Table of Contents

Revisions

Date	Revision	Section	Change
2/5/2019	0		Initial Release
2/7/2019	1		Pages 5 and 8
2/14/2019	2		Cover, Pages 5 & 56

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Prepared By:

Signed: _____ 2/14/2019
Walter Steve Majkowski
Compliance Engineer

Approved By:

Signed: _____ 2/14/2019
Technical Manager

1. System Information and Requirements

Equipment Under Test (EUT):	AAHF mMIMO - Full Band , formally identified as: **AirScale MAA 64T64R 128AE B41 120W AAHF Radio Unit**
FCC ID:	**VBNAAHF-01**
Serial Number:	(1P) – 474715A.M01 (S/N) – 6Q184012463 and 6Q183702544
Cell Name / Number	GPCL Project Number:2018-0258
Company:	Nokia Solutions and Networks US LLC 6000 Connection Drive Irving, TX, 75039
Manufacturer:	Nokia Solutions and Networks US LLC
Test Standards and Requirement(s):	• 47 CFR FCC Part 2 and Part 27 • KDB 971168 D01 Licensed DTS Guidance v03r01 April 9, 2018 • KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013
Measurement Procedure(s):	• ANSI C63.4 (2014), • ANSI C63.26 (2015) • FCC-IC-0B; Power Measurement, Occupied Bandwidth & Modulation Test Procedure (12-4-17) • FCC-IC-SE; Spurious Emissions Test Procedure (12-4-17)
Test Date(s):	December, 2018/ January 2019
Test Performed By:	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636
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Product Engineer(s):	Ron Remy
Lead Engineer	W. Steve Majkowski
Test Engineer (s):	Jaideep Yadav, Eugene Mitchell, Mike Soli
Test Results: The AAHF 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.	

1.1 Introduction

This Conformity Assessment Report applies to the AAHF 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

The Nokia's AirScale AAHF mMIMO Radio Head is a 64 port radio head that transmits 1.9W per port over the Band 41 spectrum of 2496 – 2690 MHz. The product provides 28 dBm per carrier for 1 to 3 carriers for a total of 33 dBm / 1.9W per Transmit port / 120 Watts total for all 64 ports. The product supports 10 and 20 MHz LTE carriers utilizing QPSK, 16 QAM, 64QAM and 256QAM modulation formats. The 64 individual transmit ports are identical in design, rated power and performance.

Nokia's AirScale massive MIMO Adaptive Antenna deploys 64 transmit and 64 receive streams,16-layer Massive MIMO, and 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.

1.3.1 EUT Test Configurations

The EUT was configured with LTE digital modulation in accordance to the latest guidelines of the following standards:

3GPP TS 36.211: 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation.

3GPP TS 36.141 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing

3GPP TS 36 104: E-UTRA Base Station (BS) radio transmission and reception.

The following Base Station Test Models were used:

TM 3.1	**64QAM**
TM 3.1a	**256QAM**
TM 3.2	**QPSK+16QAM**

The product was configured for both single and multiple carrier configurations for up to three carriers. Testing was performed for Contiguous and Non-Contiguous carrier configurations

1.3.2 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	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051	Spurious Emissions at Antenna Terminals	Yes
2.1053	Field Strength of Spurious Radiation	Yes
2.1055	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 47, Federal Communications Commission Part 27.

1.4.2 Procedures

1. FCC-IC-0B and FCC-IC-SE

2. ANSI C63.4 (2014) entitled: "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", American National Standards Institute, Institute of Electrical and Electronic Engineers, Inc., New York, NY 10017-2394, USA.

3. ANSI C63.26 (2015) entitled: "American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services", American National Standards Institute, Institute of Electrical and Electronic Engineers, Inc., New York, NY 10017-2394, USA.

4. FCC KDB 971168 D01 v03r01 Measurement Guidance for Certification of Licensed Digital Transmitters

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-6 Semi-Anechoic Chamber)	30 MHz – 200MHz H 30 MHz – 200 MHz V 200 MHz – 1000 MHz H 200 MHz – 1000 MHz V 1 GHz - 18 GHz	±5.1 dB ±5.1 dB ±4.7 dB ±4.7 dB ±3.3 dB

Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz	0.5 dB

1.5 Executive Summary

Requirement	Description	Result
47 CFR FCC Parts 2 and 27		
2.1046	RF Power Output Peak to Average Power Ratio	COMPLIES
2.1047	Modulation Characteristics	COMPLIES
2.1049	Occupied Bandwidth (a) Emissions Signal Bandwidth (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

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.
Power measurements were made using the MXA Channel Power Functionality. The transmit port was connected to the MXA with calibrated attenuators and cable whose path loss was verified before test. The Base Station was given a sufficient "warm-up" period prior to testing as required by ANSI C63.26-2015.. .

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.

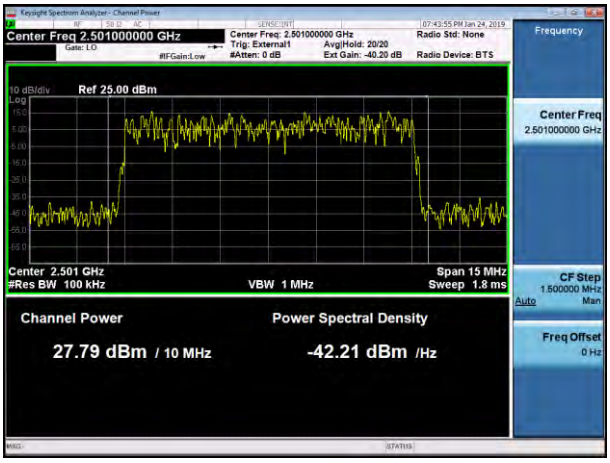
2.2 RF Power Output Results

The data below documents that the total power that the products 64 ports can provide is 120 Watts. That power is up to 40W/ carrier for 1-3 carriers.

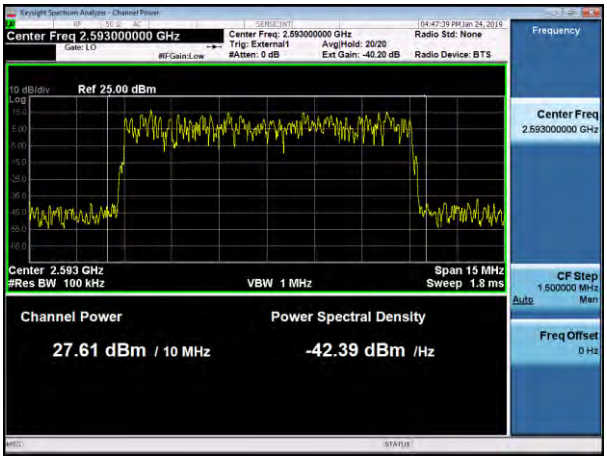
2.3 Sample Data Single Carrier (1C)

2.3.1 Sample Data 64QAM - Single Carrier 10 MHz

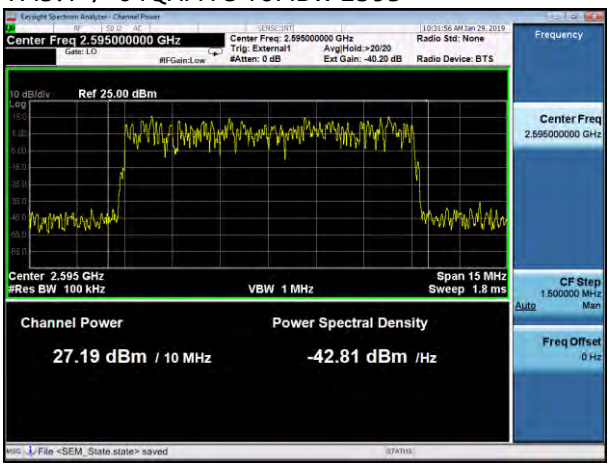
TM3.1 / 64QAM1C 10MBW 2501



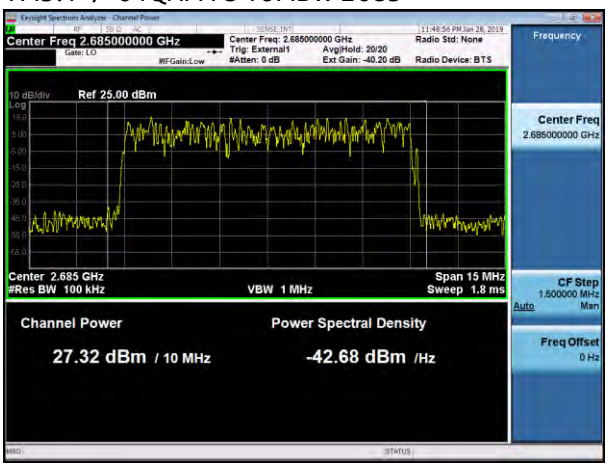
TM3.1 / 64QAM1C 10MBW 2593



TM3.1 / 64QAM1C 10MBW 2595

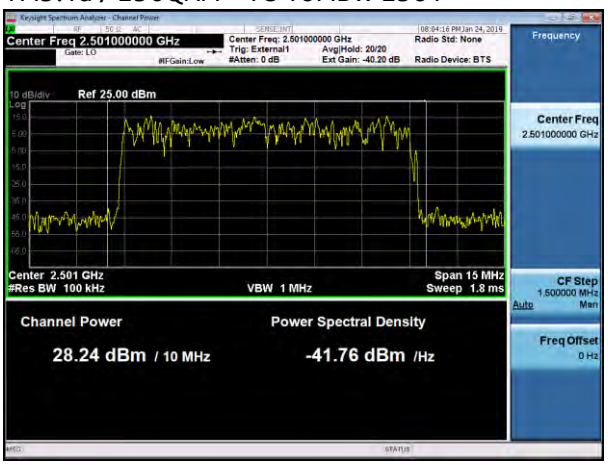


TM3.1 / 64QAM1C 10MBW 2685

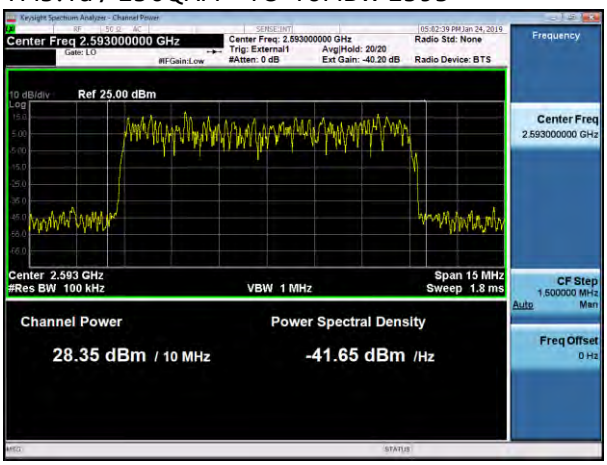


2.3.2 Sample Data 256QAM - Single Carrier 10 MHz

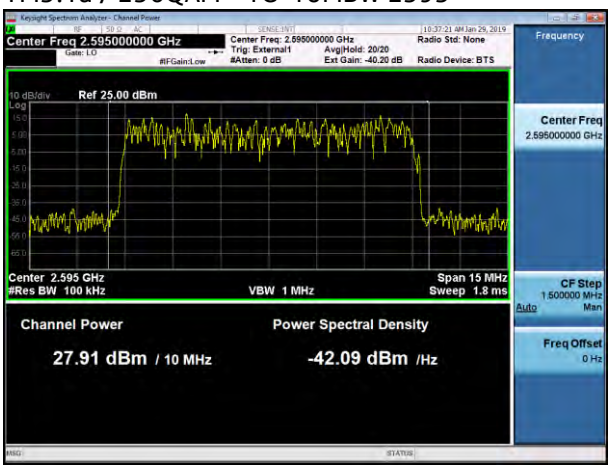
TM3.1a / 256QAM - 1C 10MBW 2501



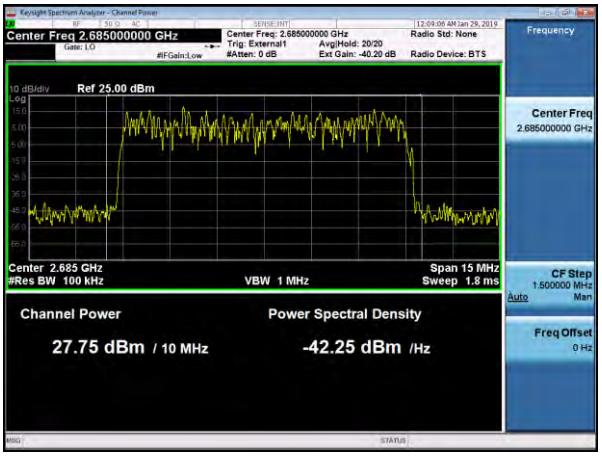
TM3.1a / 256QAM - 1C 10MBW 2593



TM3.1a / 256QAM - 1C 10MBW 2595

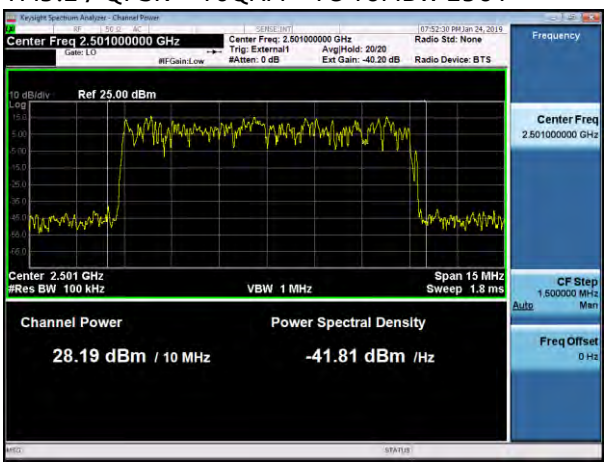


TM3.1a / 256QAM - 1C 10MBW 2685

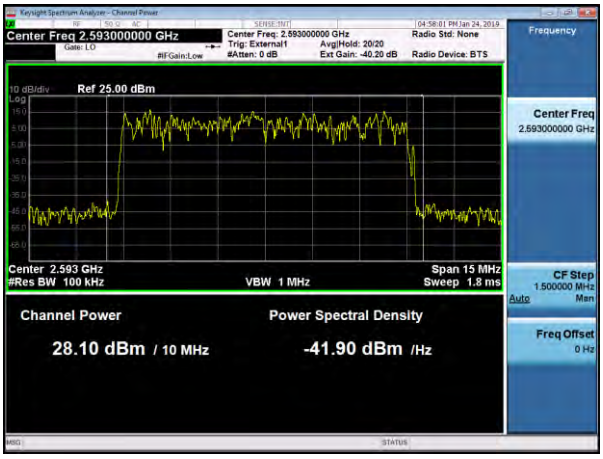


2.3.3 Sample Data QPSK + 16QAM - Single Carrier 10 MHz

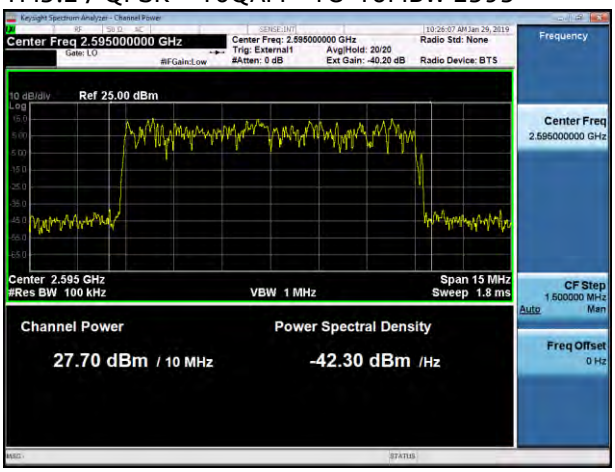
TM3.2 / QPSK + 16QAM - 1C 10MBW 2501



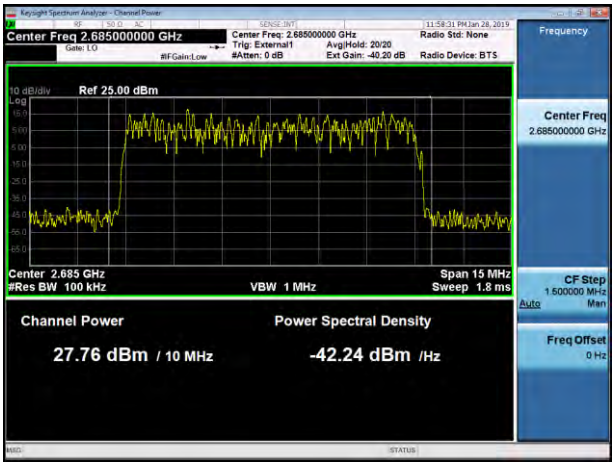
TM3.2 / QPSK + 16QAM - 1C 10MBW 2593



TM3.2 / QPSK + 16QAM - 1C 10MBW 2595

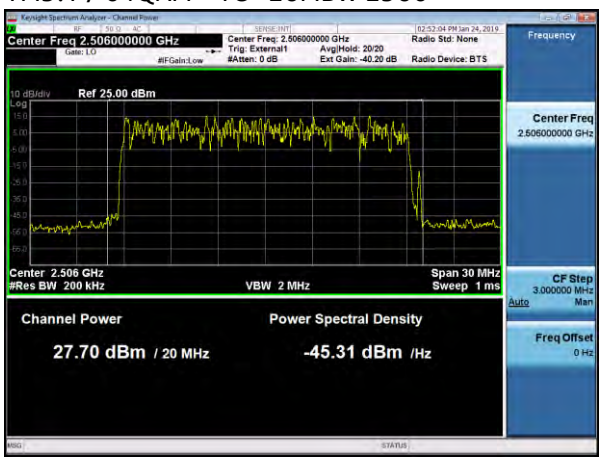


TM3.2 / QPSK + 16QAM - 1C 10MBW 2685

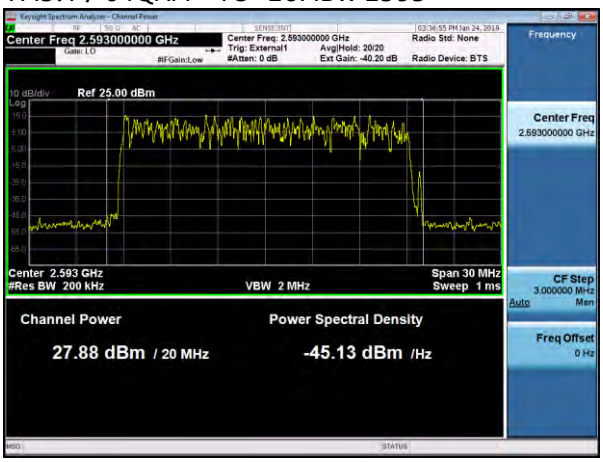


2.3.4 Sample Data 64QAM - Single Carrier 20 MHz

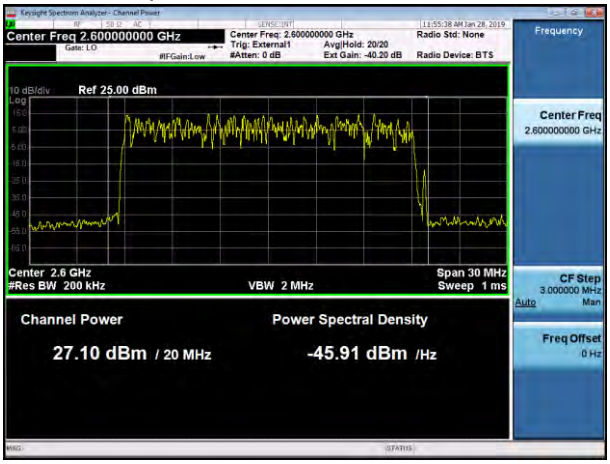
TM3.1 / 64QAM - 1C 20MBW 2506



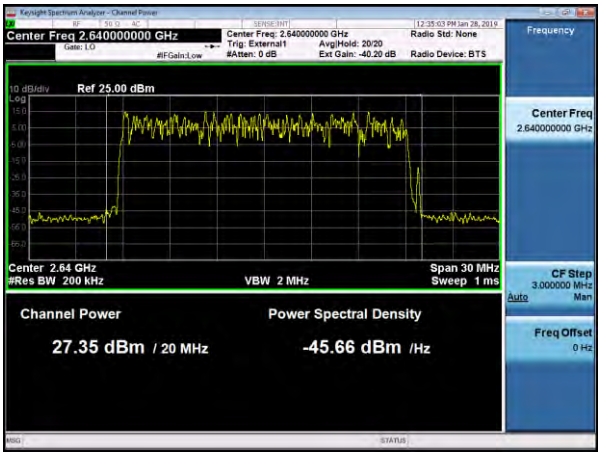
TM3.1 / 64QAM - 1C 20MBW 2593



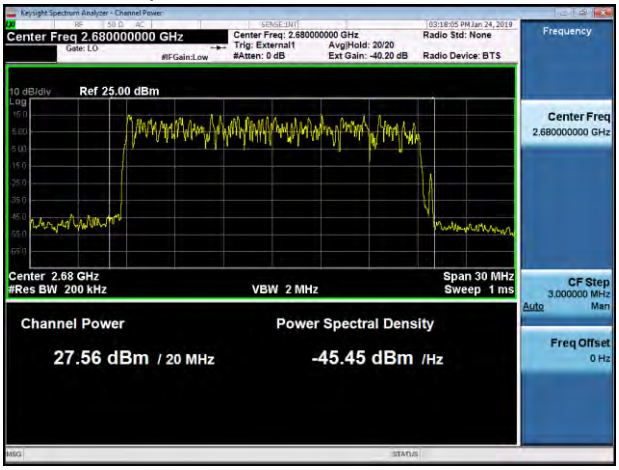
TM3.1 / 64QAM - 1C 20MBW 2600



TM3.1 / 64QAM - 1C 20MBW 2640

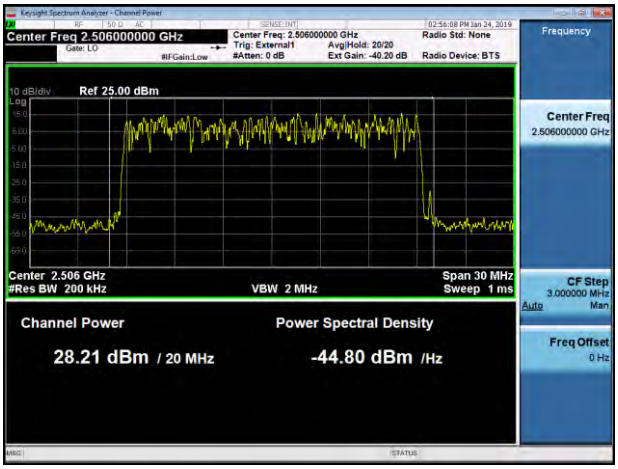


TM3.1 / 64QAM - 1C 20MBW 2680

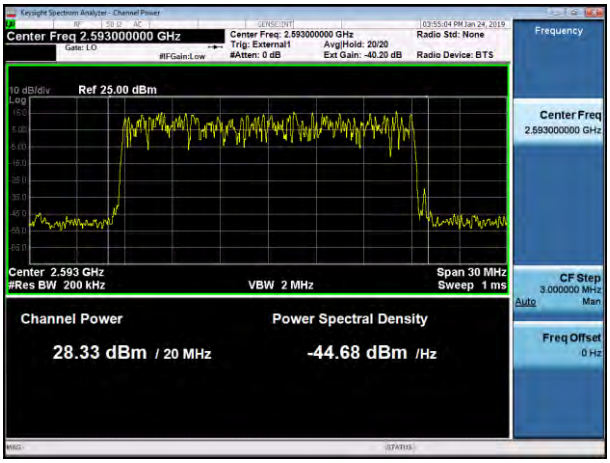


2.3.5 Sample Data 256QAM - Single Carrier 20 MHz

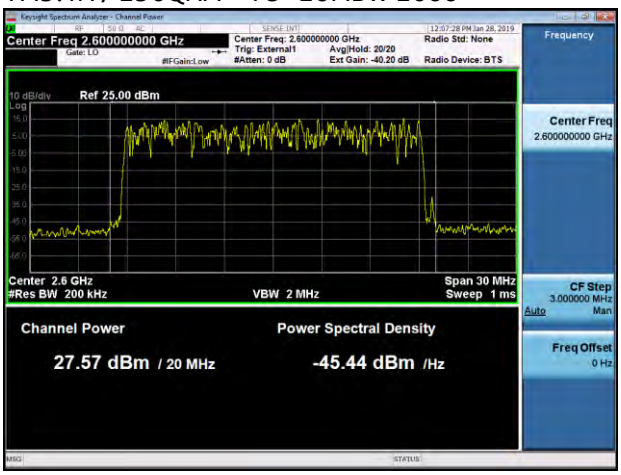
TM3.1A / 256QAM - 1C 20MBW 2506



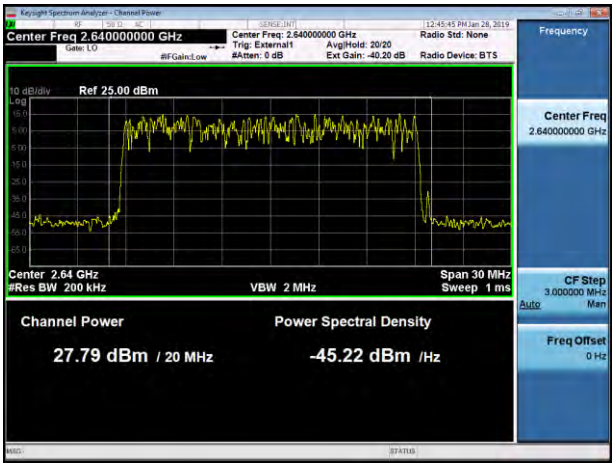
TM3.1A / 256QAM - 1C 20MBW 2593



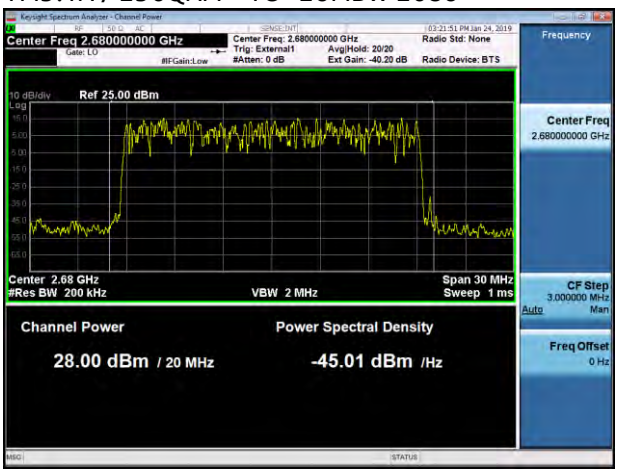
TM3.1A / 256QAM - 1C 20MBW 2600



TM3.1A / 256QAM - 1C 20MBW 2640

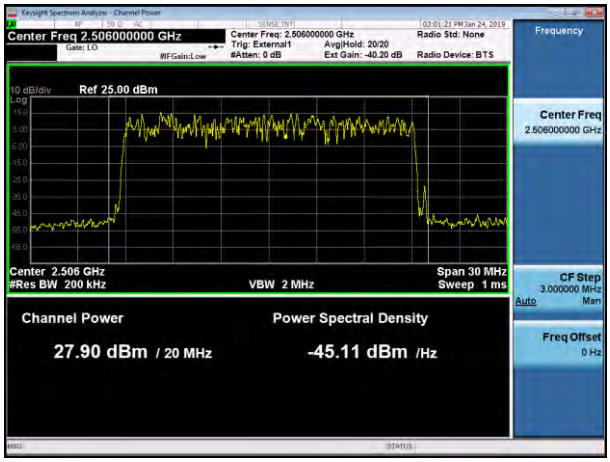


TM3.1A / 256QAM - 1C 20MBW 2680

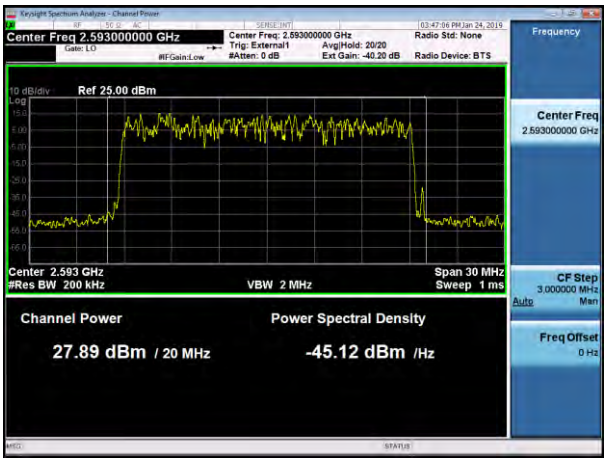


2.3.6 Sample Data 64QAM - Single Carrier 20 MHz

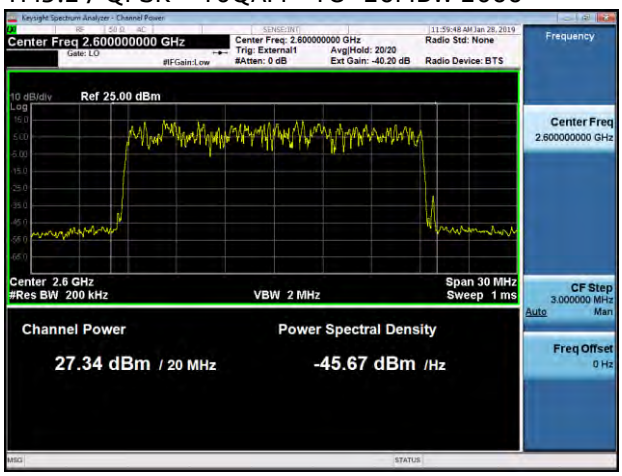
TM3.2 / QPSK + 16QAM - 1C 20MBW 2506



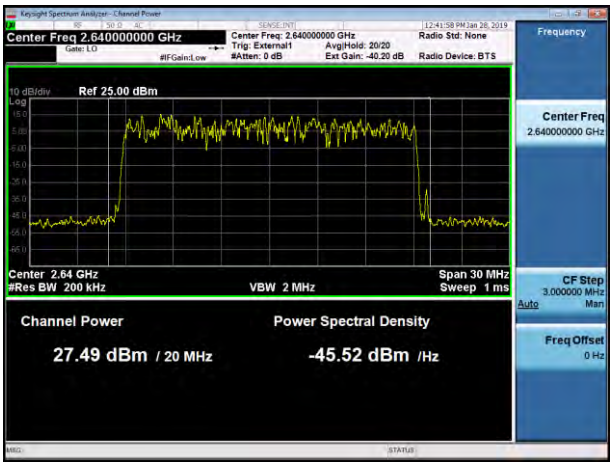
TM3.2 / QPSK + 16QAM - 1C 20MBW 2593



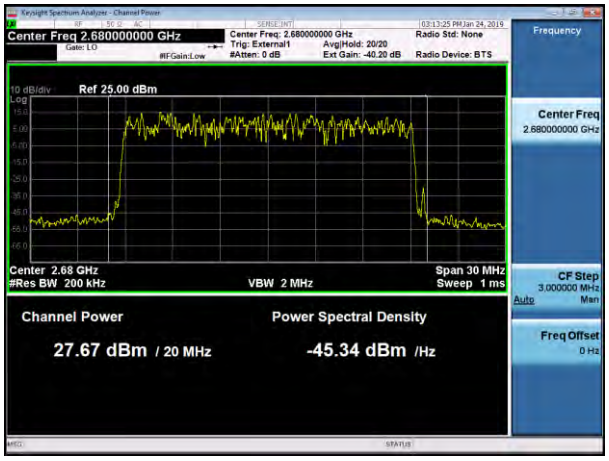
TM3.2 / QPSK + 16QAM - 1C 20MBW 2600



TM3.2 / QPSK + 16QAM - 1C 20MBW 2640



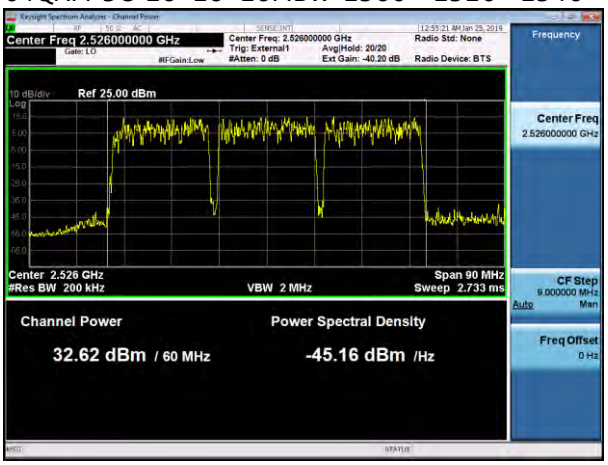
TM3.2 / QPSK + 16QAM - 1C 20MBW 2680



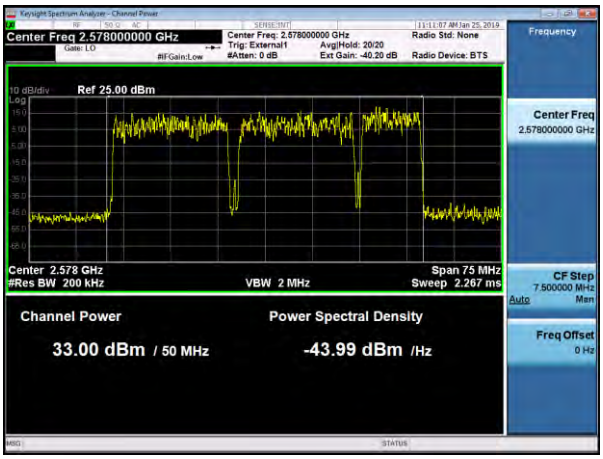
2.4 Sample Data Multi-Carrier

2.4.1 Sample Data 64QAM - Multi-Carrier

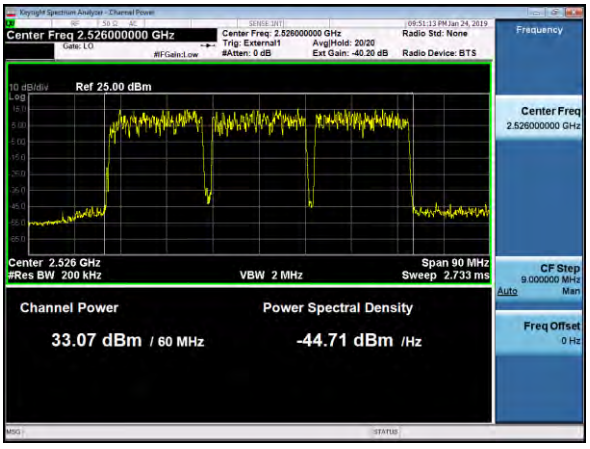
64QAM-3C-20+20+20MBW 2506 – 2526 - 2546



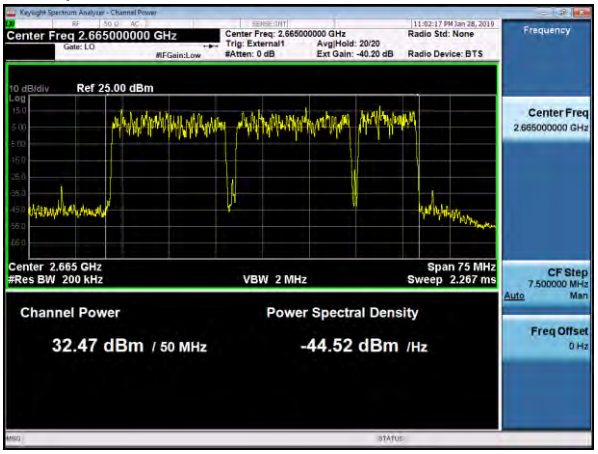
64QAM-3C-20+20+10MBW 2506 – 2526 - 2546



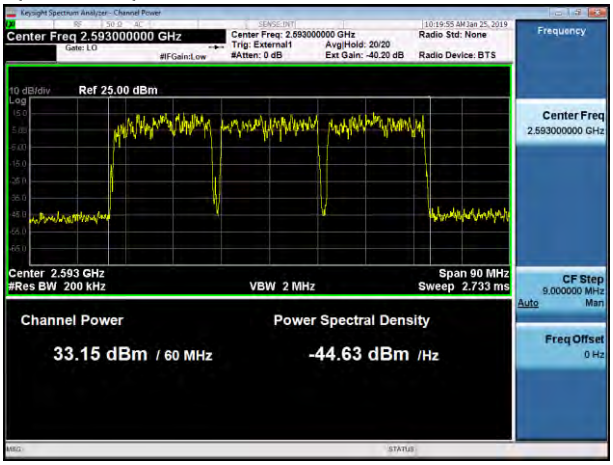
256QAM-3C-20+20+20MBW 2506 – 2526 – 2546



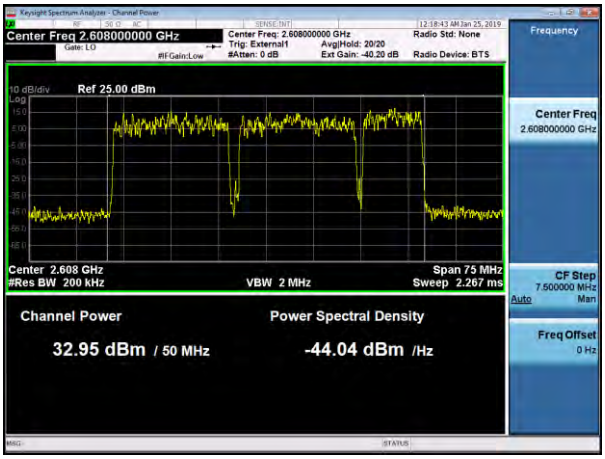
256QAM-3C-20+20+20MBW 2506 – 2526 – 2546



QPSK+16QAM-20+20+20MBW 2593–2526–2613



QPSK+16QAM-20+20+20MBW 2593–2613–2628



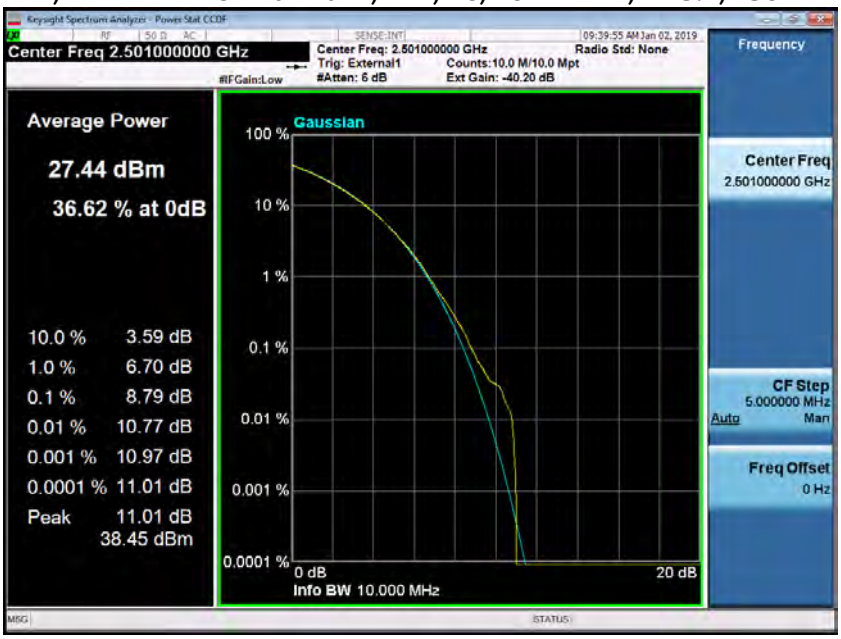
2.5 Peak-to-Average Power Ratio (PAPR) 47CFR 27.50

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.

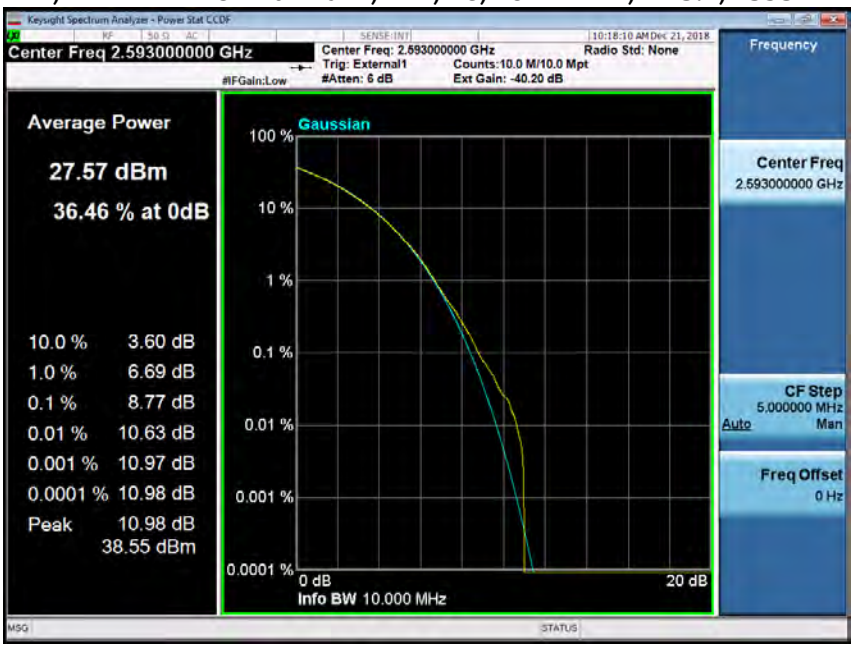
NOTE: Only a sample of all the data taken has been used in this report. The full suite of raw data resides at the MH, New Jersey location.

2.5.1 Single Carrier 10 MHz

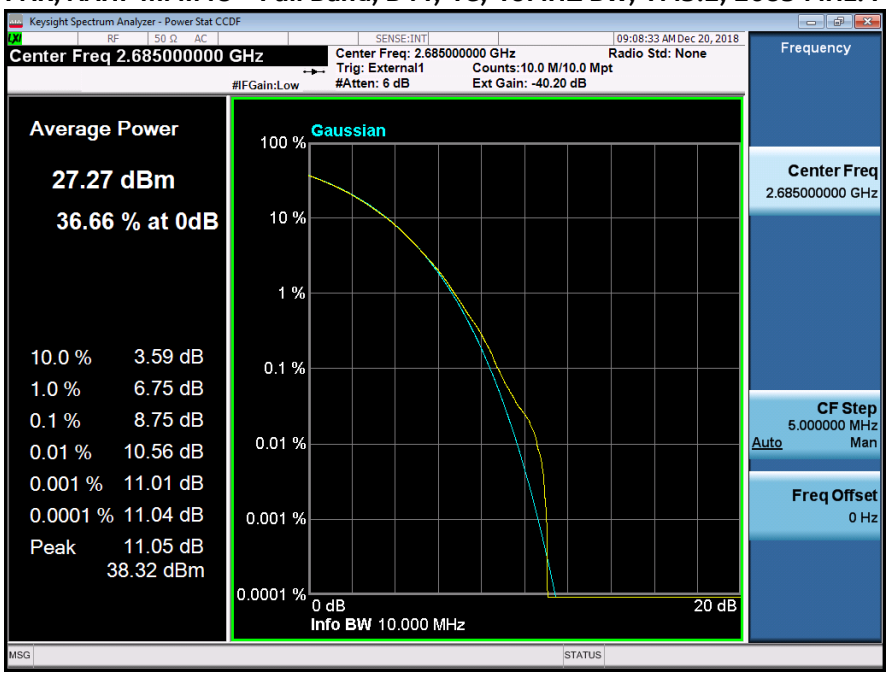
PAR, AAHF mMIMO - Full Band, B41, 1C, 10MHZ BW, TM3.2, 2501 MHz. Port 46



PAR, AAHF mMIMO - Full Band, B41, 1C, 10MHZ BW, TM3.2, 2593 MHz. Port 46

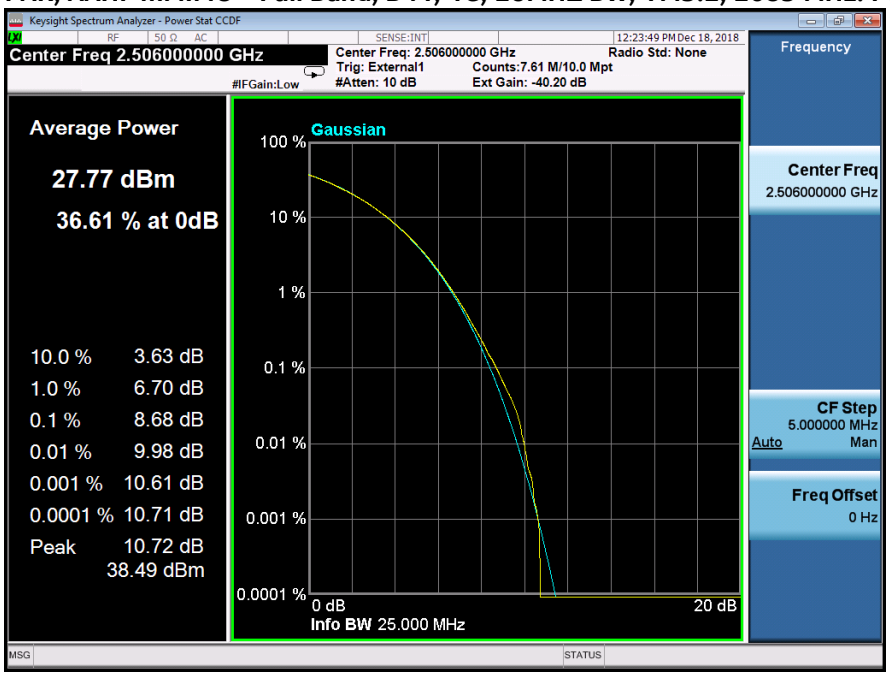


PAR, AAHF mMIMO - Full Band, B41, 1C, 10MHZ BW, TM3.2, 2685 MHz. Port 46

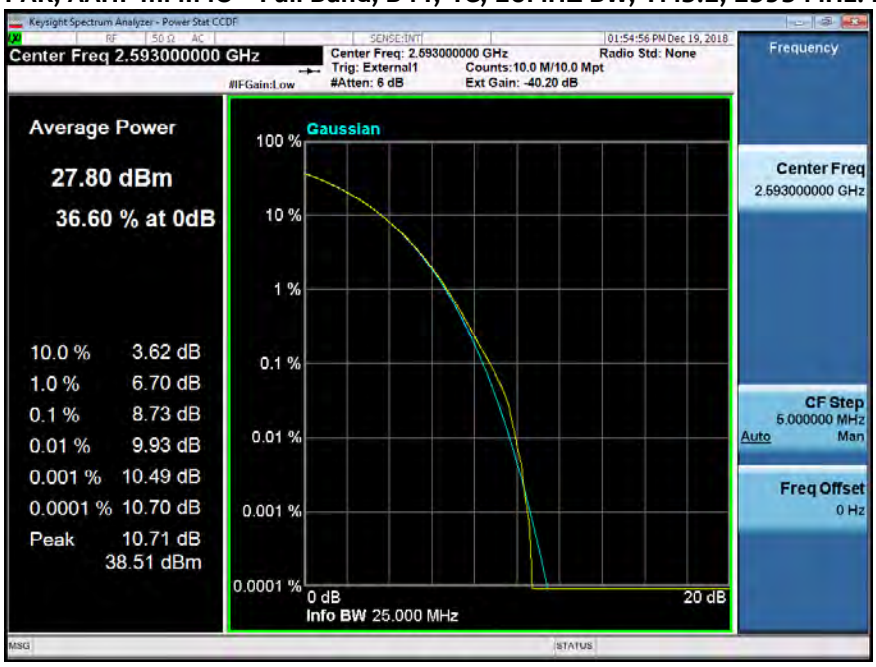


2.5.2 Single Carrier 20 MHz

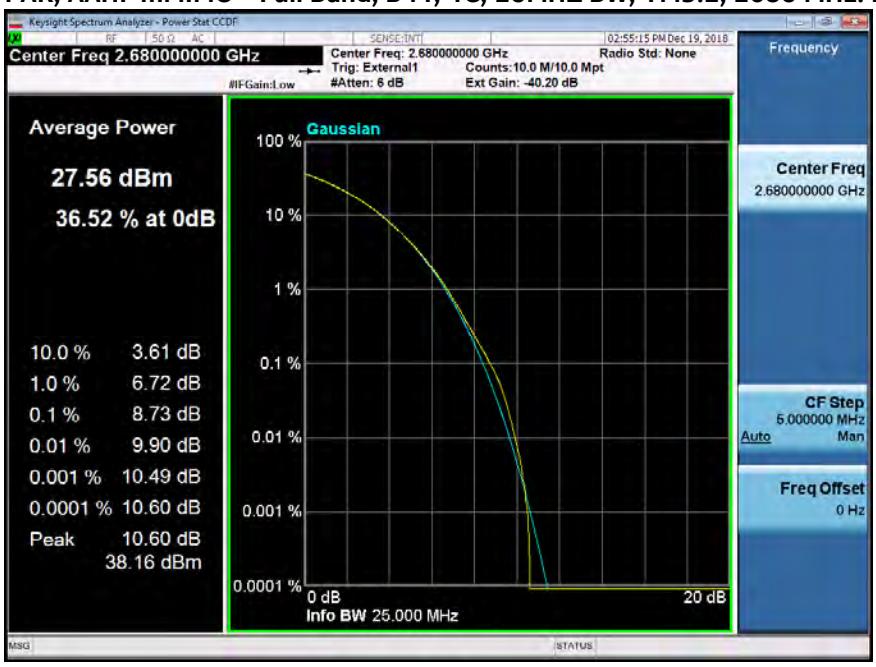
PAR, AAHF mMIMO - Full Band, B41, 1C, 20MHZ BW, TM3.2, 2685 MHz. Port 46



PAR, AAHF mMIMO - Full Band, B41, 1C, 20MHZ BW, TM3.2, 2593 MHz. Port 46



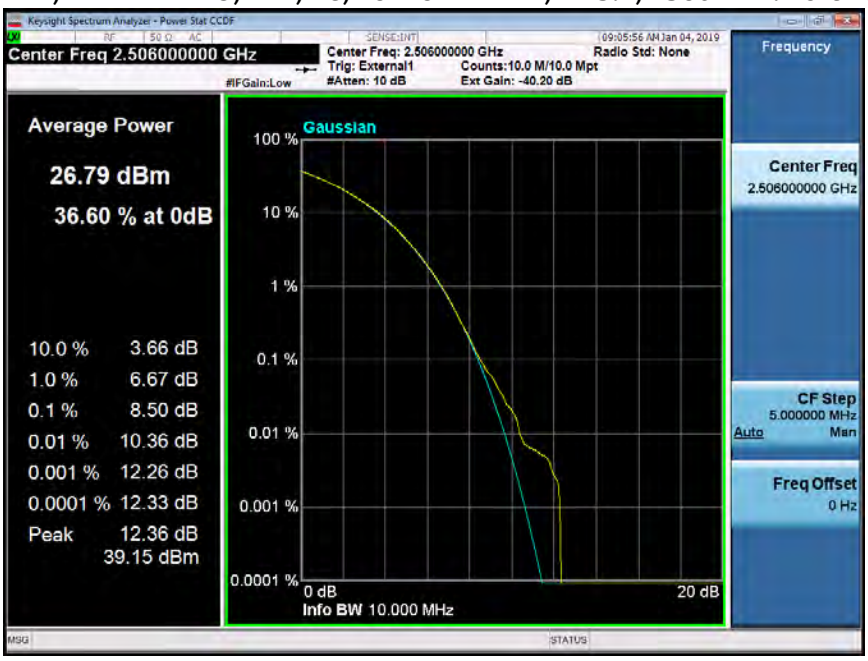
PAR, AAHF mMIMO - Full Band, B41, 1C, 20MHZ BW, TM3.2, 2680 MHz. Port 46



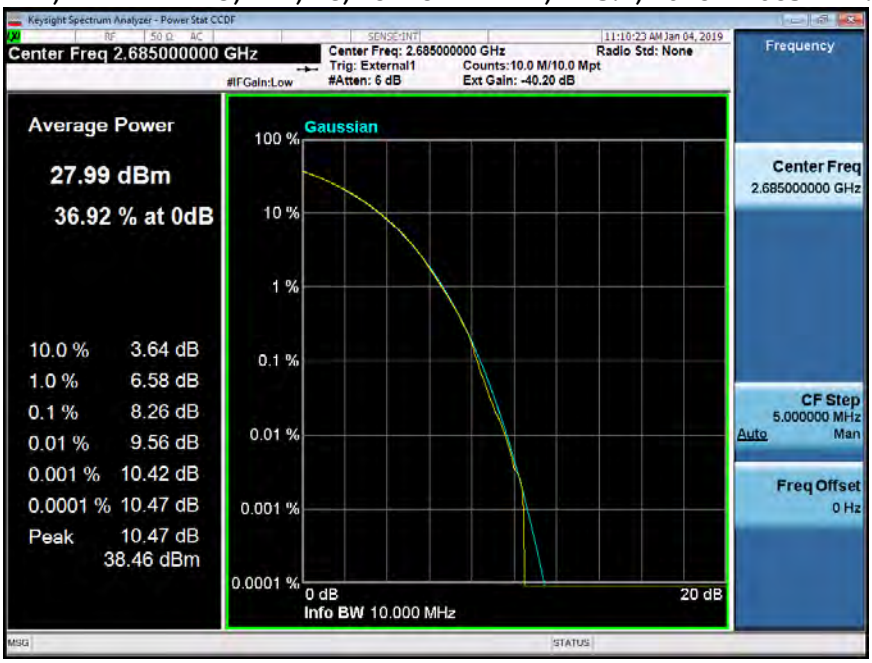
2.5.3 Dual Carrier (2C) 10 MHz and 20 MHz

2.5.3.1 Contiguous Carriers

PAR, AAHF mMIMO, B41, 2C, 20+10 MHZ BW, TM3.2, 2506 MHz. Port 46

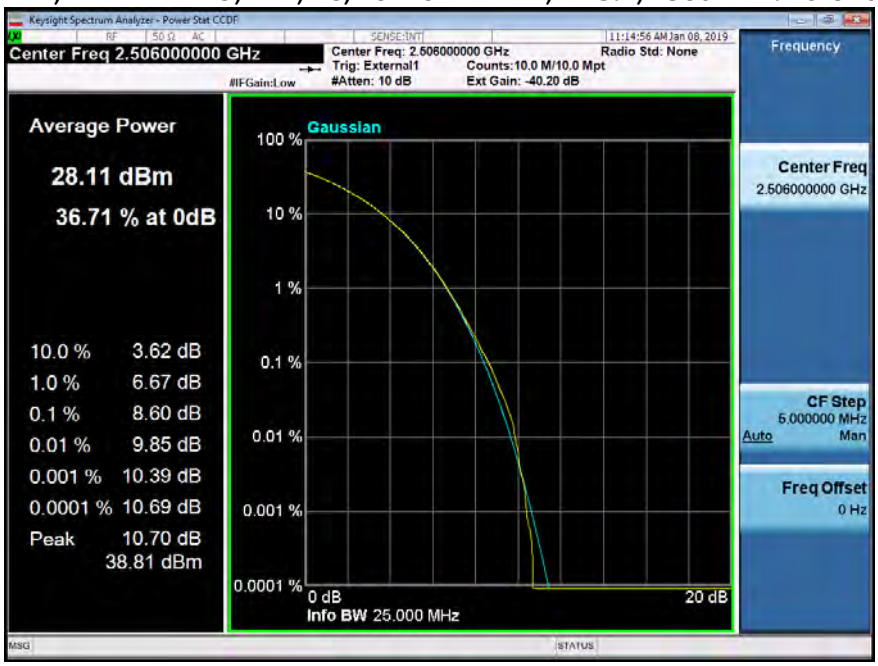


PAR, AAHF mMIMO, B41, 2C, 20+10 MHZ BW, TM3.2, 2670 + 2685 MHz. Port 46

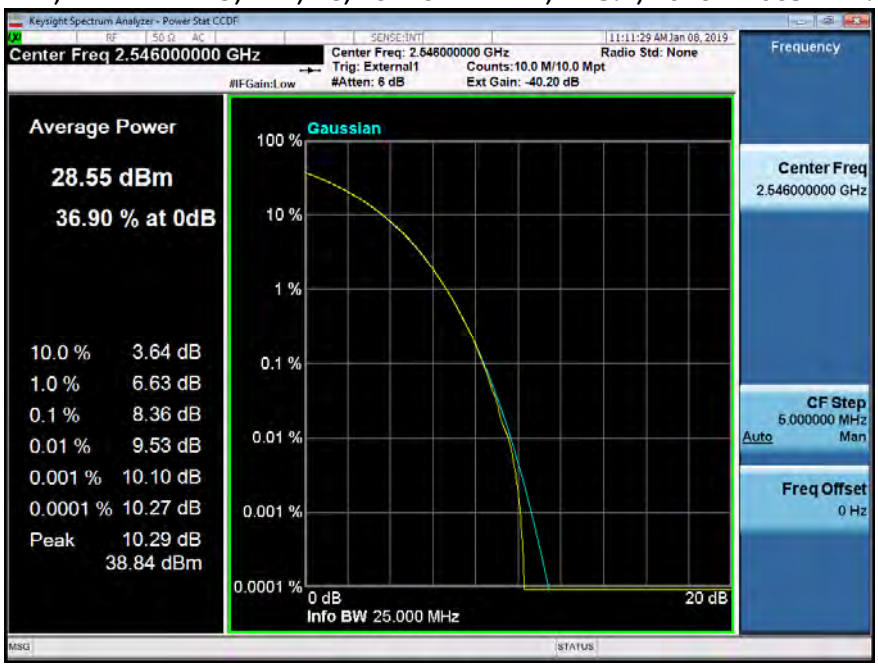


2.5.3.2 Non-Contiguous Carriers

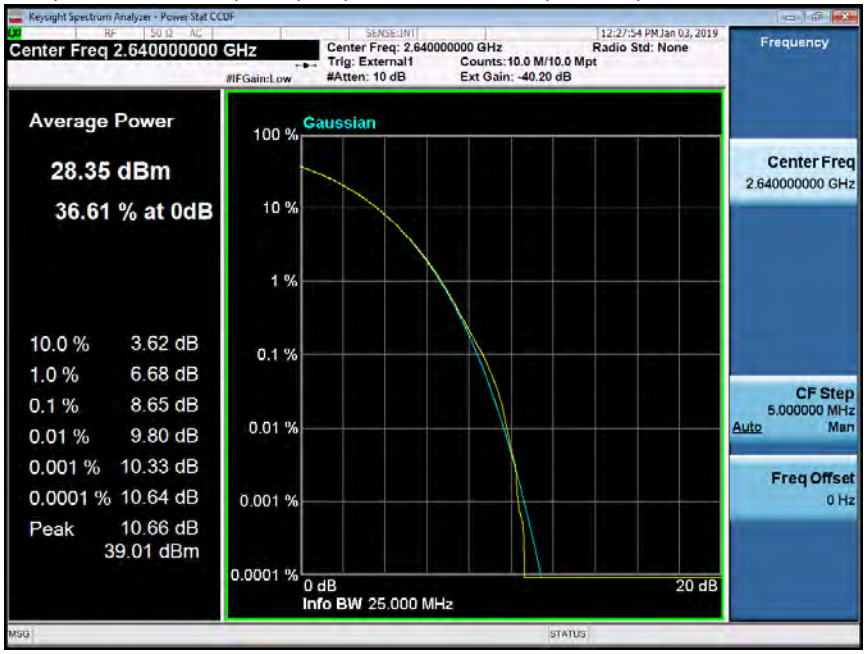
PAR, AAHF mMIMO, B41, 2C, 20+20 MHZ BW, TM3.2, 2506 MHz. Port 46



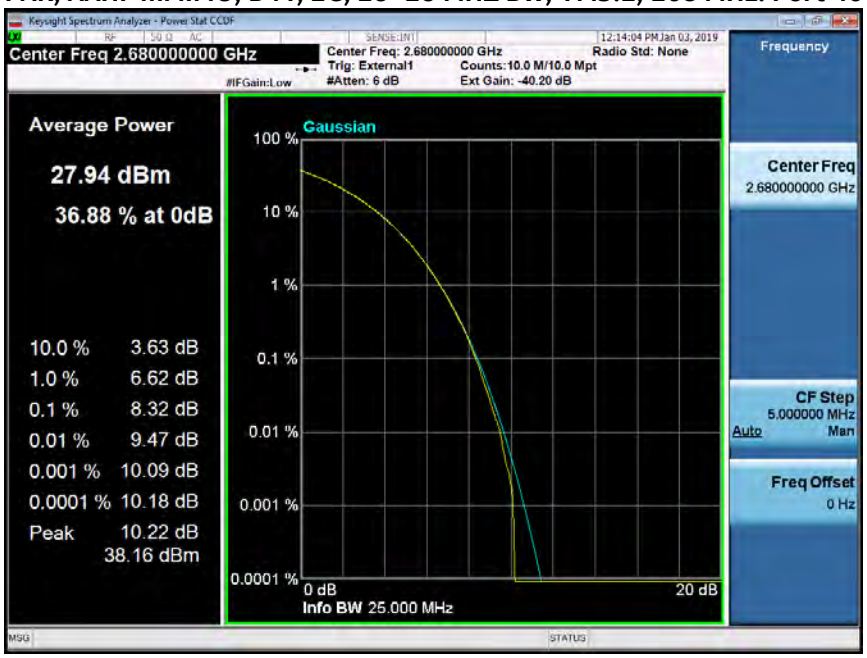
PAR, AAHF mMIMO, B41, 2C, 20+10 MHZ BW, TM3.2, 2670 + 2685 MHz. Port 46



PAR, AAHF mMIMO, B41, 2C, 20+20 MHZ BW, TM3.2, 2546 MHz. Port 46



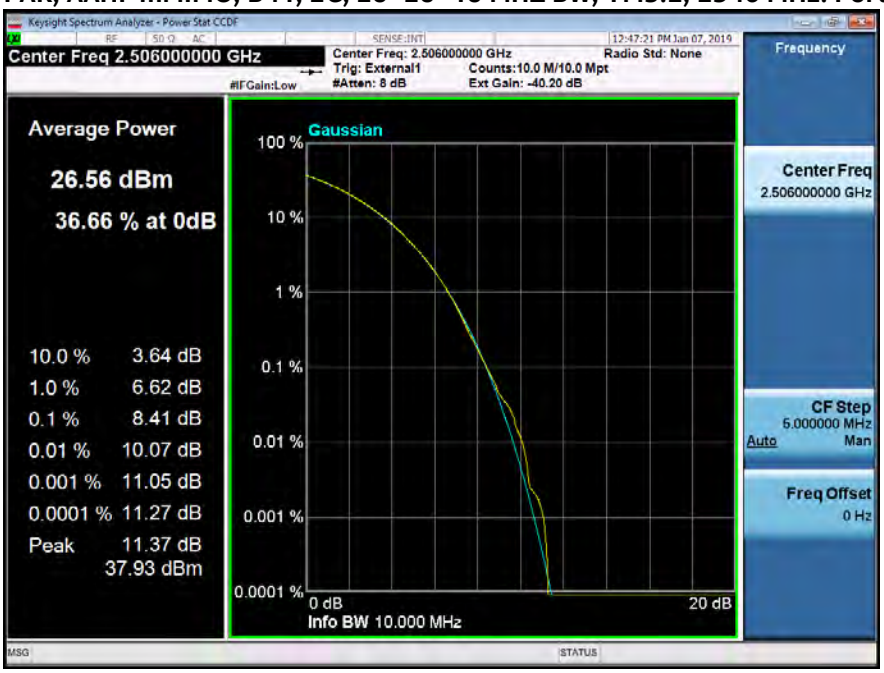
PAR, AAHF mMIMO, B41, 2C, 20+20 MHZ BW, TM3.2, 268 MHz. Port 46



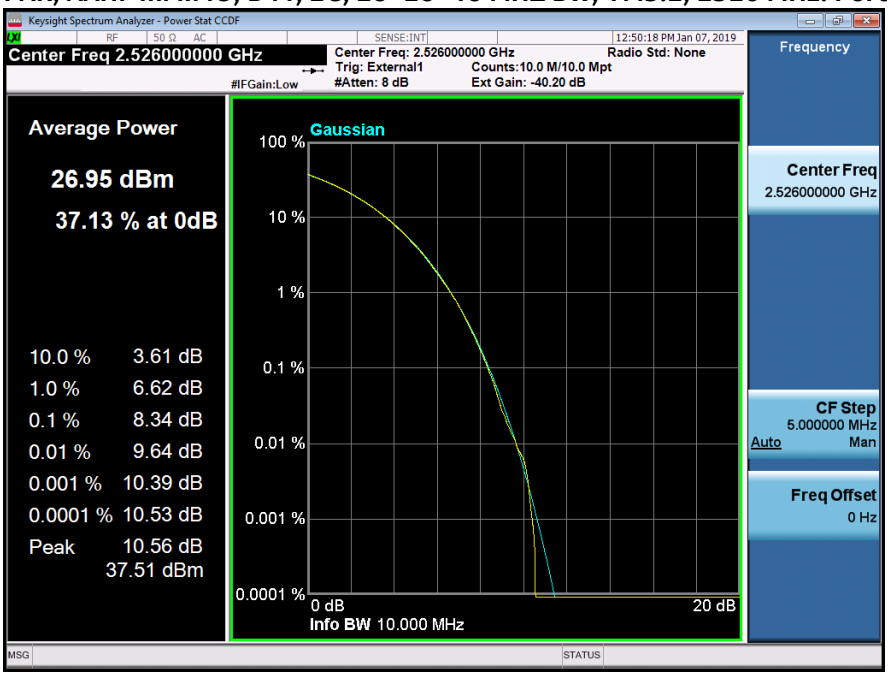
2.5.4 Triple Carrier (3C)

2.5.4.1 Contiguous Carriers

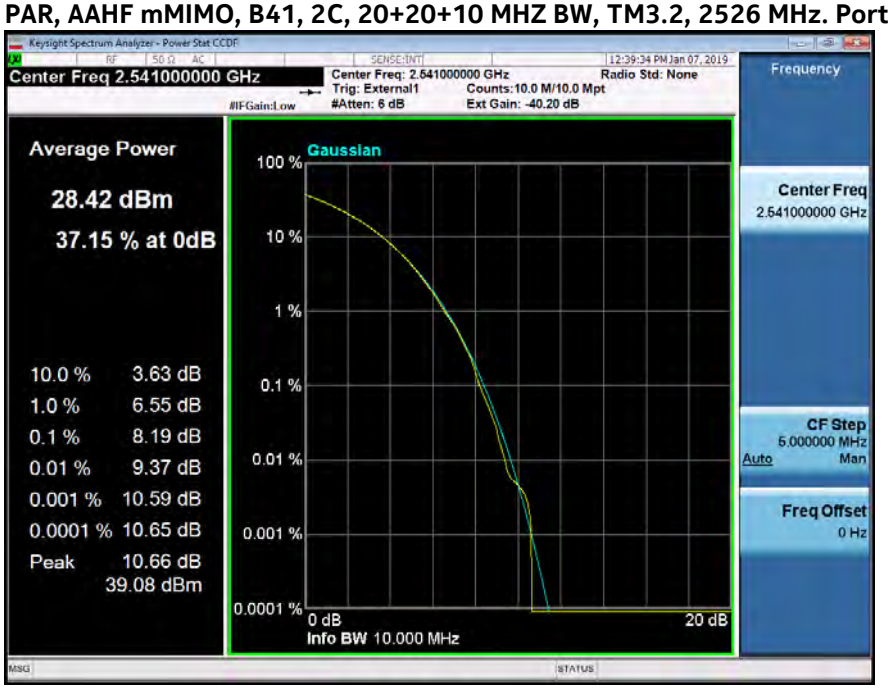
PAR, AAHF mMIMO, B41, 2C, 20+20+10 MHZ BW, TM3.2, 2546 MHz. Port 46



PAR, AAHF mMIMO, B41, 2C, 20+20+10 MHZ BW, TM3.2, 2526 MHz. Port 46

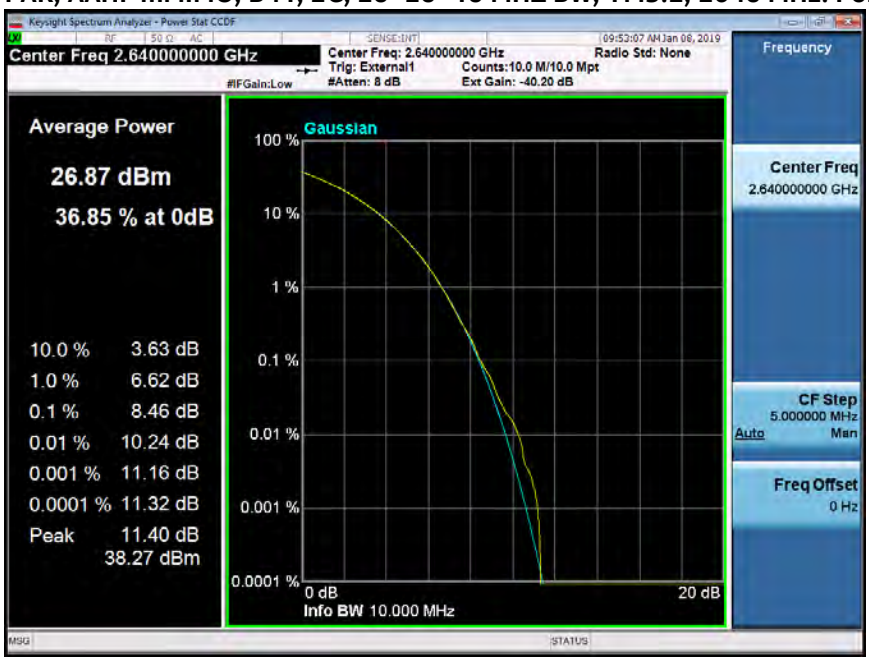


PAR, AAHF mMIMO, B41, 2C, 20+20+10 MHZ BW, TM3.2, 2526 MHz. Port 46

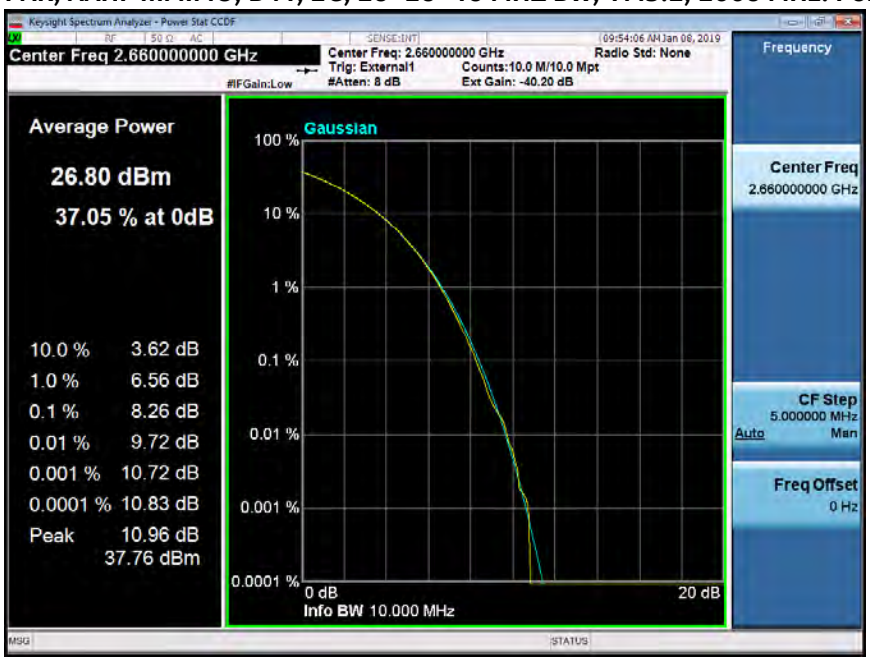


2.5.4.2 Non-Contiguous Carriers

PAR, AAHF mMIMO, B41, 2C, 20+20+10 MHZ BW, TM3.2, 2640 MHz. Port 46



PAR, AAHF mMIMO, B41, 2C, 20+20+10 MHZ BW, TM3.2, 2660 MHz. Port 46



PAR, AAHF mMIMO, B41, 2C, 20+20+10 MHZ BW, TM3.2, 2685 MHz. Port 46

3. FCC Section 2.1047 - Modulation Characteristics

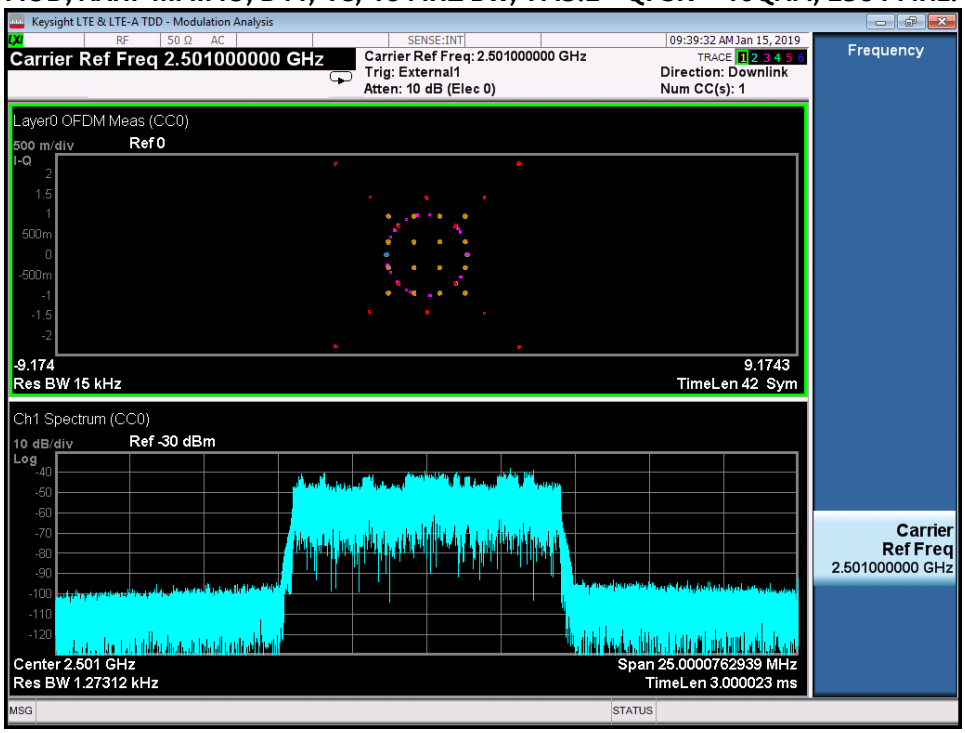
3.1 Modulation Characteristics

The RF signal at the antenna port was evaluated with a Keysight MXA and verified for correctness of the modulation signal used before each test was performed. For these products the operation with 256QAM modulation was evaluated and verified. The Modulation test model for 256QAM, TM 3.1a, was deemed the worst case modulation configuration. Samples of the Modulation configurations are shown below.

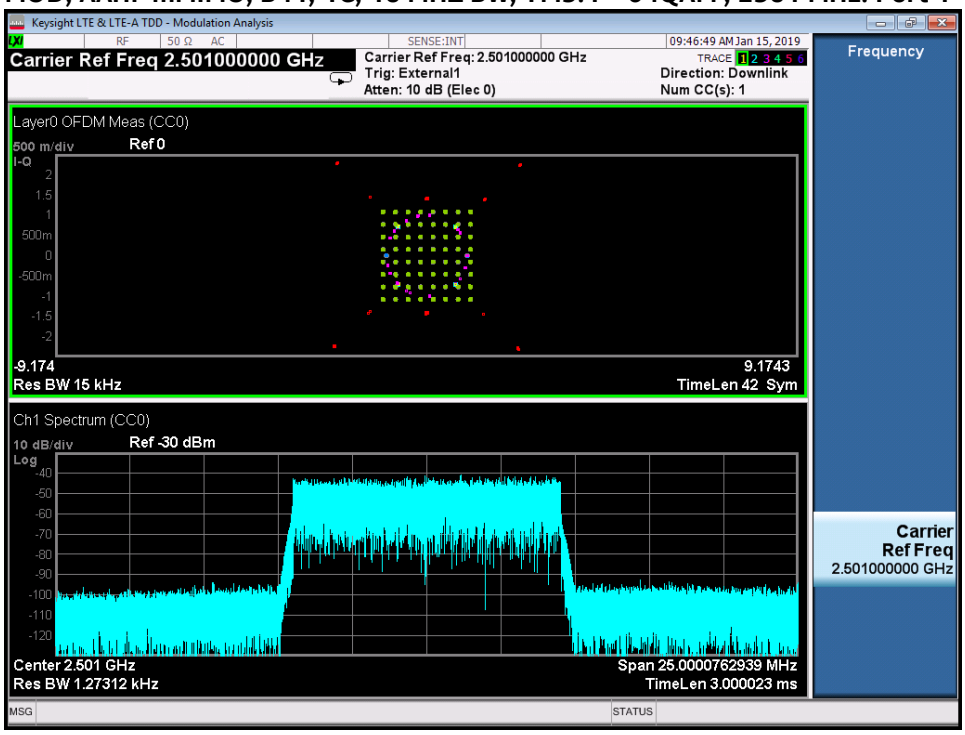
NOTE: Only a sample of all the data taken has been used in this report. The full suite of raw data resides at the MH, New Jersey location.

3.1.1 Sample Modulation 10 MHz

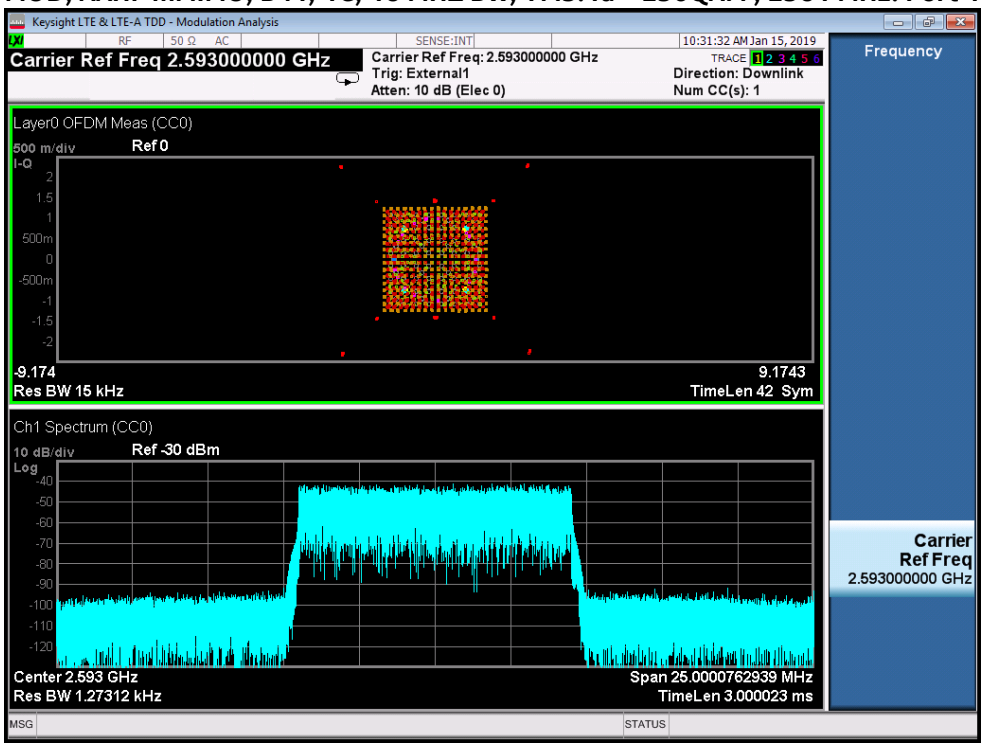
MOD, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.2 - QPSK + 16QAM, 2501 MHz. Port 1



MOD, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.1 – 64QAM , 2501 MHz. Port 1

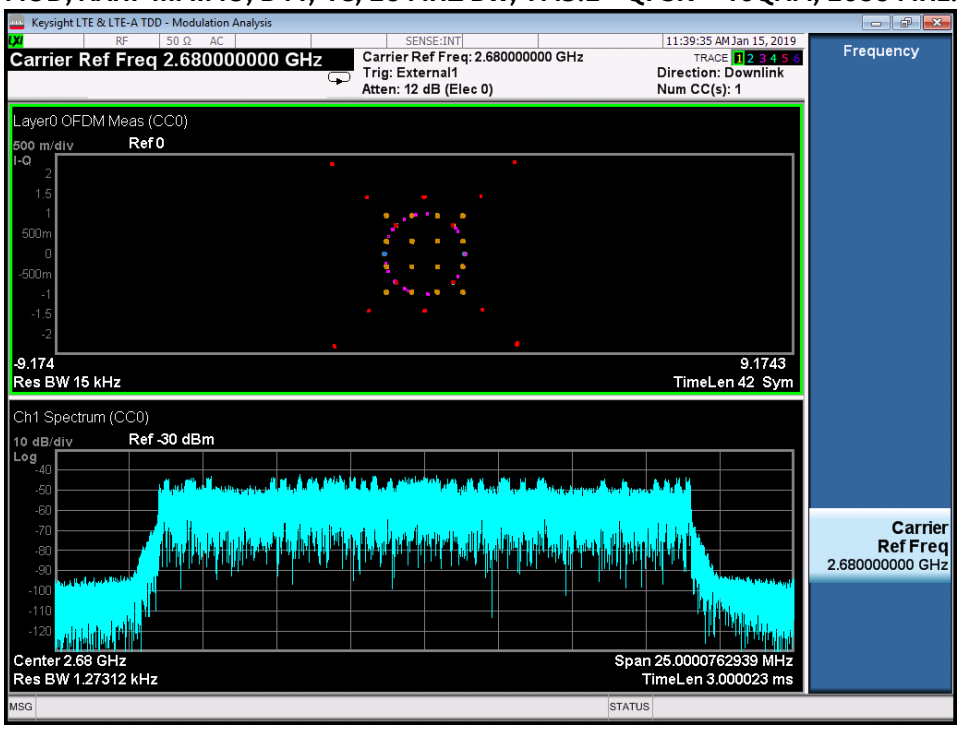


MOD, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.1a – 256QAM , 2501 MHz. Port 1

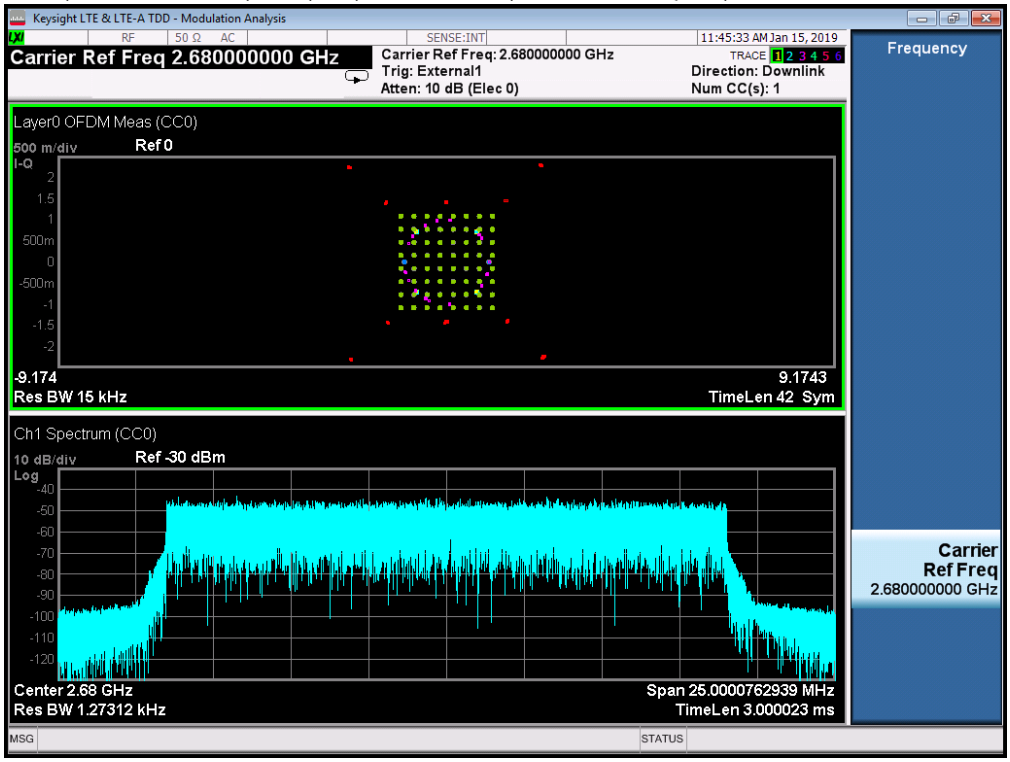


3.1.2 Sample Modulation 20 MHz

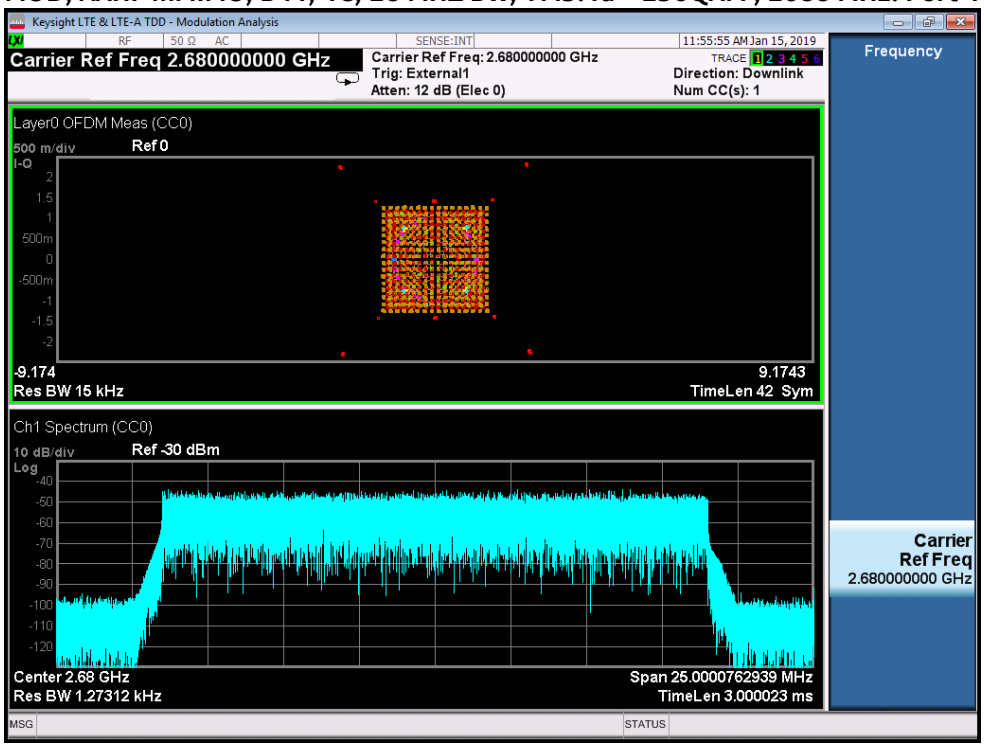
MOD, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.2 - QPSK + 16QAM, 2680 MHz. Port 1



MOD, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.1 – 64QAM , 2680 MHz. Port 1



MOD, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.1a – 256QAM , 2680 MHz. Port 1



4. FCC Section 2.1049 – Occupied Bandwidth

4.1 Occupied Bandwidth (Signal 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. The -26 dB bandwidth values were also recorded.

4.2 Occupied Bandwidth (Signal Bandwidth) Results

The transmitted signal occupied bandwidth was measured using a Keysight MXA Signal Analyzer.
The nominal 10 MHz bandwidth signal was within 9.3 MHz and the 20 MHz Nominal bandwidth signal was within 18.5 MHz

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.

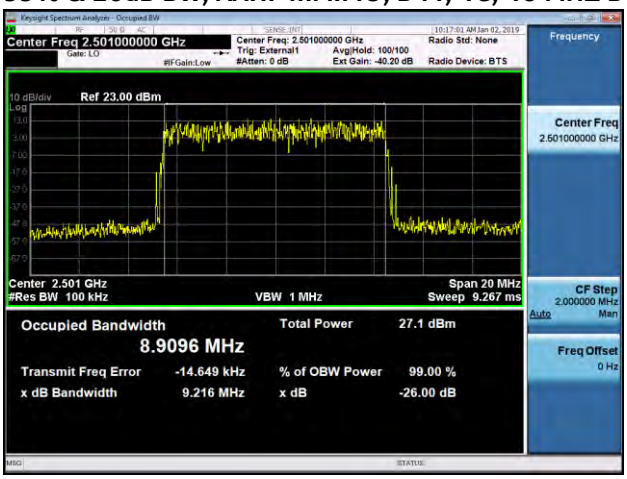
4.2.1 Single Carrier

The single carrier bandwidth measurements are presented below for left center and right side of band. They are organized by LTE Bandwidth and modulation type.

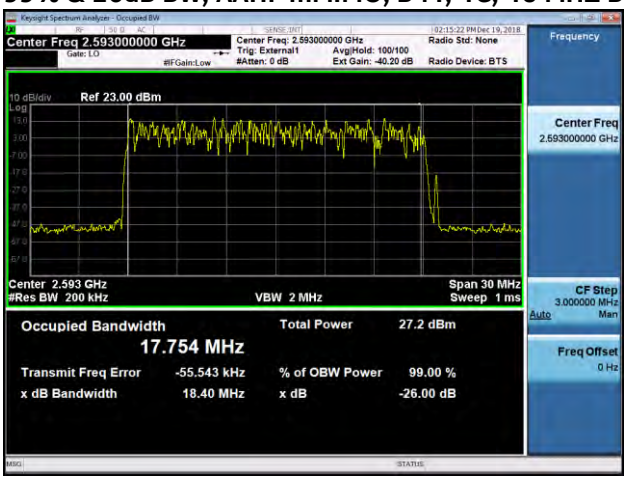
4.2.1.1 10 MHz BW LTE

TM3.1 , 64 QAM

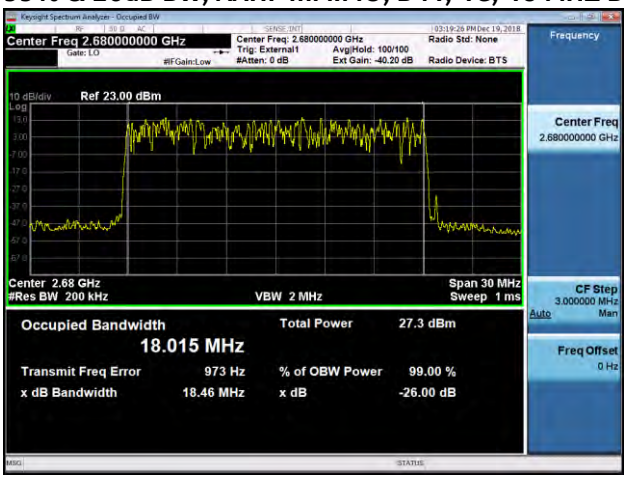
99% & 26dB BW, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.1 – 2501 MHz. Port 46



99% & 26dB BW, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.1 – 2593 MHz. Port 46

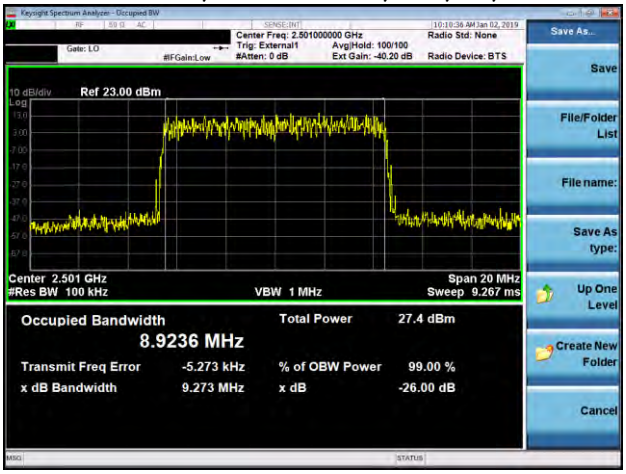


99% & 26dB BW, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.1– 2685 MHz. Port 46

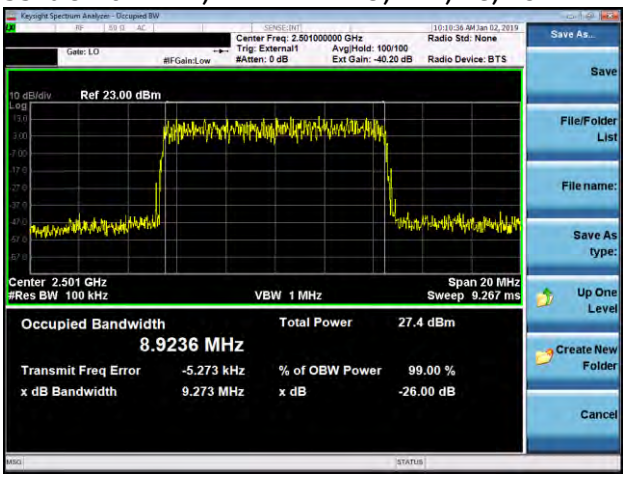


TM3.1a, 256QAM

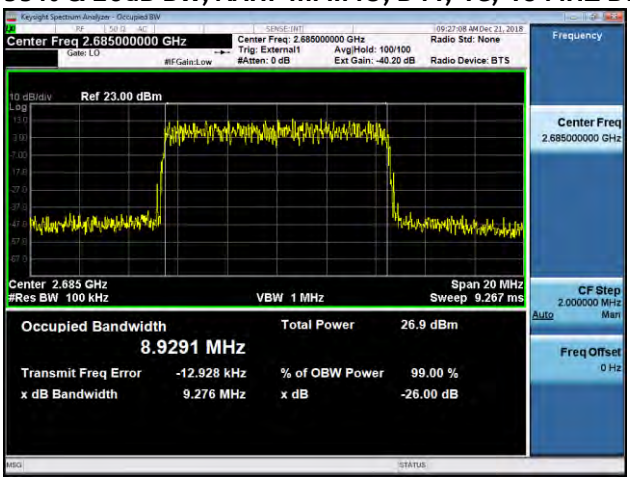
99% & 26dB BW, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.1a – 2501 MHz. Port 46



99% & 26dB BW, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.1a – 2593 MHz. Port 46

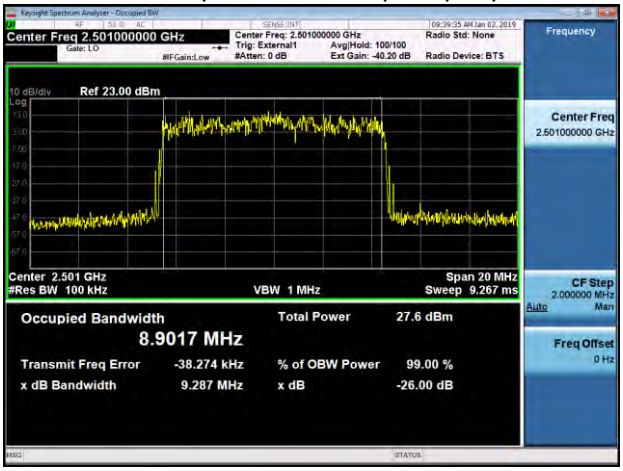


99% & 26dB BW, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.1a – 2685 MHz. Port 46

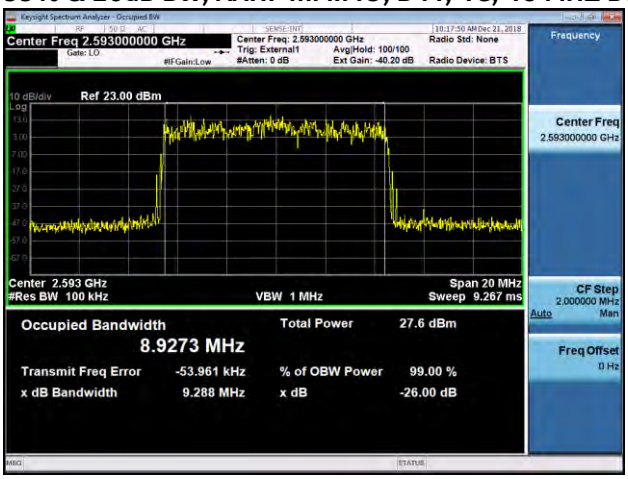


TM3.2, QPSK + 16QAM

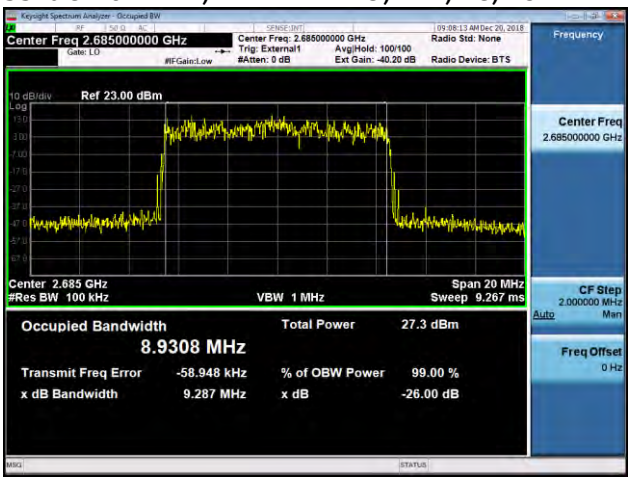
99% & 26dB BW, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.2 – 2501 MHz. Port 46



99% & 26dB BW, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.2 – 2593 MHz. Port 46



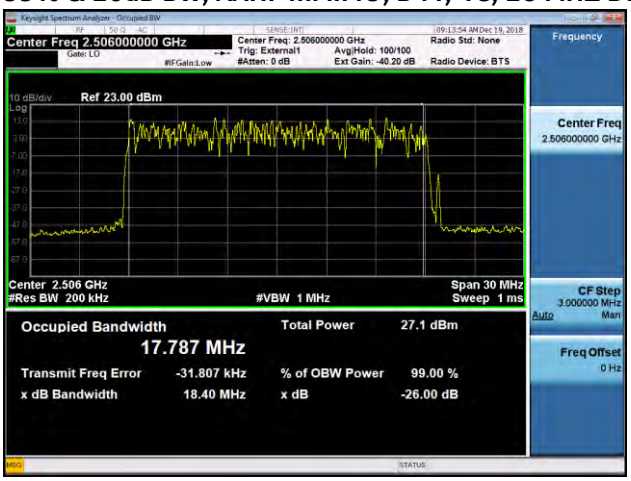
99% & 26dB BW, AAHF mMIMO, B41, 1C, 10 MHZ BW, TM3.2 – 2685 MHz. Port 46



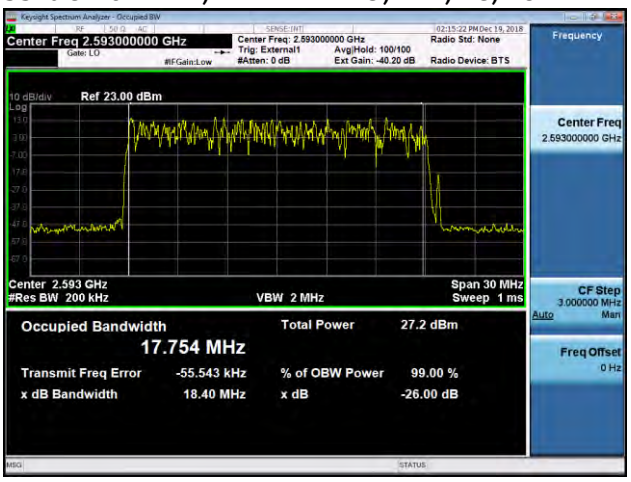
4.2.1.2 20 MHz BW LTE

TM3.1 , 64 QAM

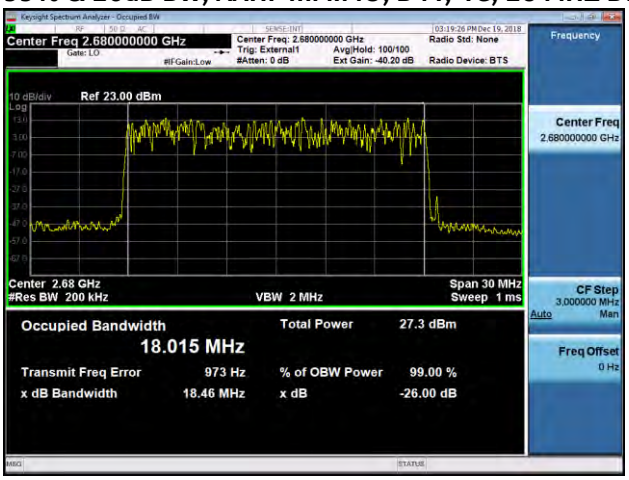
99% & 26dB BW, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.1 – 2506 MHz. Port 46



99% & 26dB BW, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.1 – 2593 MHz. Port 1

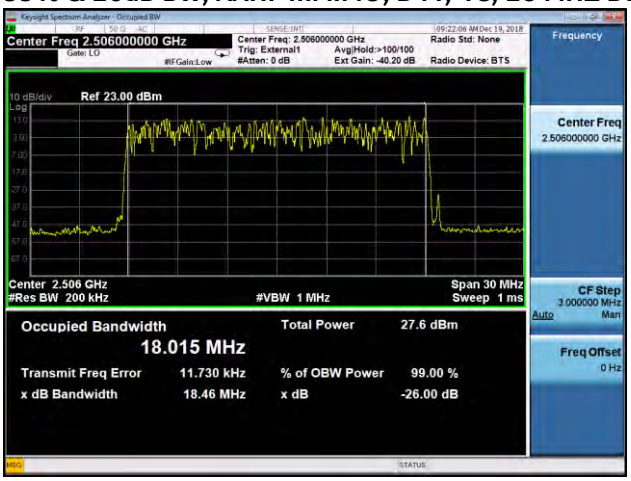


99% & 26dB BW, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.1 – 2680 MHz. Port 1

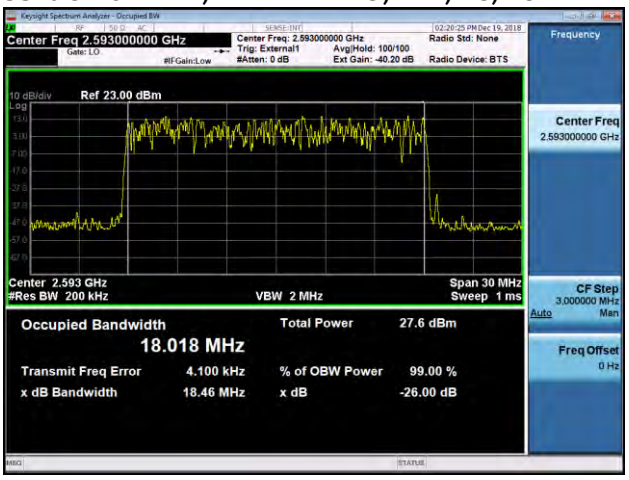


TM3.1a, 256QAM

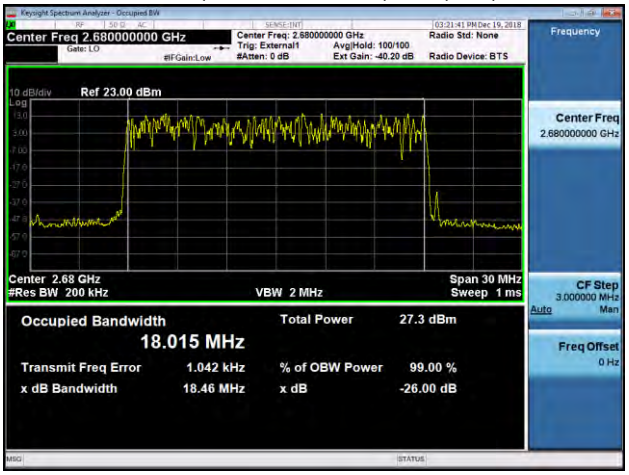
99% & 26dB BW, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.1a – 2506 MHz. Port 46



99% & 26dB BW, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.1a – 2593 MHz. Port 1

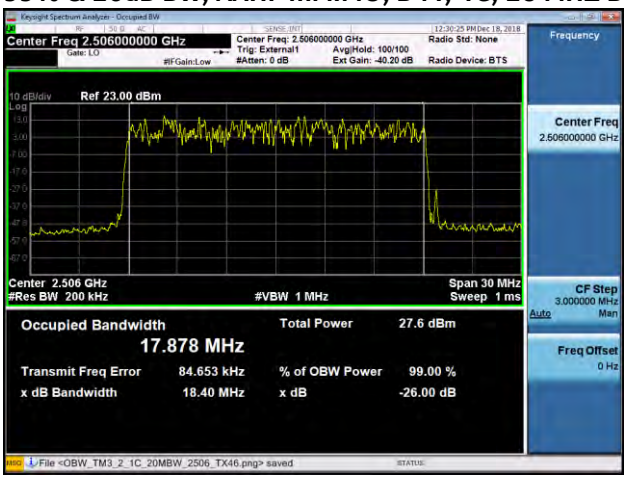


99% & 26dB BW, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.1a – 2680 MHz. Port 1

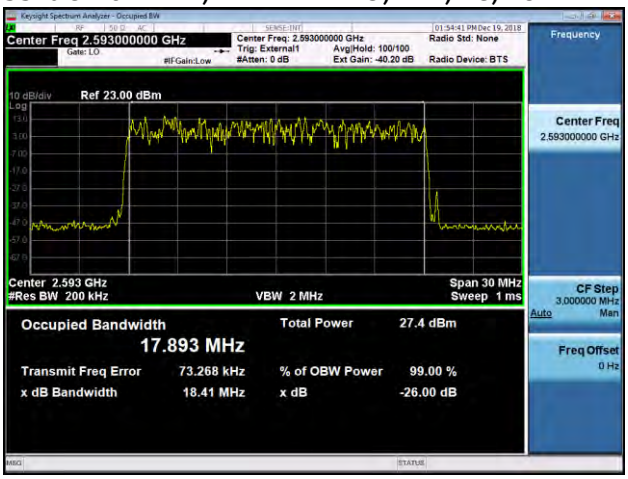


TM3.2, QPSK + 16QAM

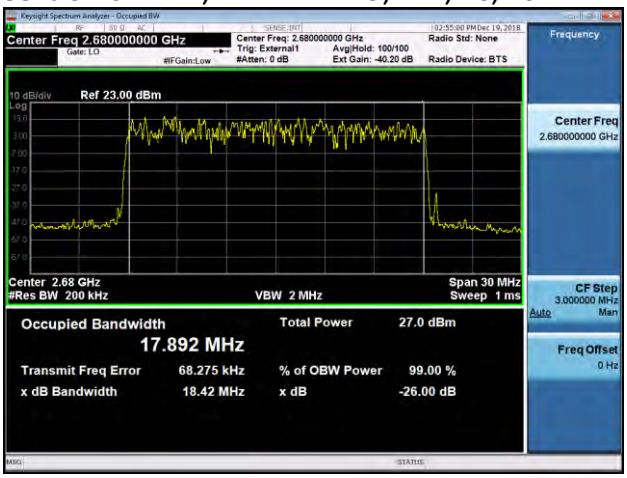
99% & 26dB BW, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.2 – 2506 MHz. Port 46



99% & 26dB BW, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.2 – 2593 MHz. Port 1



99% & 26dB BW, AAHF mMIMO, B41, 1C, 20 MHZ BW, TM3.2 – 2680 MHz. Port 1



4.3 Occupied Bandwidth/ Edge of band Emissions

The Occupied Bandwidth / 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 and modulation was verified before measurement. The RF output from the EAC port to spectrum analyzer was reduced (to an amplitude usable by the spectrum analyzer) by using a calibrated attenuator and test cable. The maximum path attenuation was offset on the display and the signal was set to the maximum RF power level. The resolution bandwidth was set to 1% of the nominal bandwidth of the transmit signal. All mask values were adjusted based upon the designated signal bandwidth and measurement bandwidths as listed in Table 4.2 below.

The Block edge requirements as specified in 47CFR 27.53 were followed. The mask for emissions outside the band were set to be:

$$-43 + 10LOG_{10}(P) = -13 \text{ dBm}$$

The resolution bandwidth of 1% of the signal bandwidth was used and the mask for greater than 1MHz outside the band was adjusted by

$10LOG_{10}$ (rbw/1MHz)= -6.997dB for 200 kHz rbw and -10 dB for 100 kHz rbw.

The procedural direction of KDB 662911 D01 were followed and the mask limits were adjusted for a MIMO value corresponding to $10LOG_{10}$ (N) where N=64
For this product The MIMO adjustment is equal to:

$$10LOG(N) = 10(LOG_{10}(64) = 18.06 \text{ dB}$$

The mask values are as listed in the table below:

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

Carrier Power		Signal Bandwidth	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
40	46.02	20	0.2	-20.00	26.02	64	18.06	-31.06	-77.08	-38.05	-84.07
40	46.02	10	0.1	-20.00	26.02	64	18.06	-31.06	-77.08	-41.06	-87.08
40	46.02	10	0.2	-16.99	29.03	64	18.06	-28.05	-74.07	-38.05	-84.07

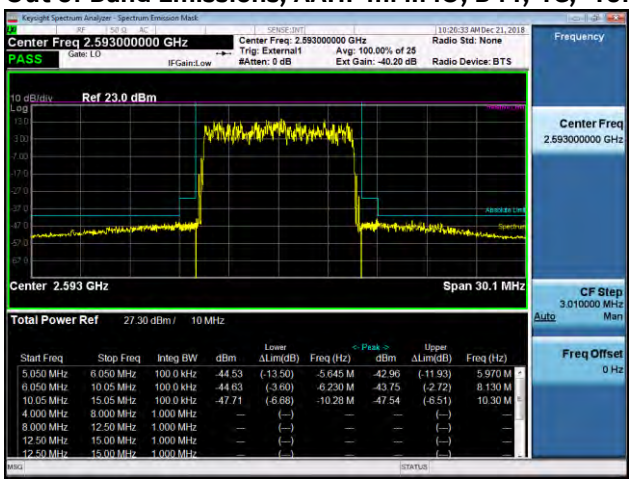
NOTE: Only a sample of all the data taken has been used in this report. The full suite of raw data resides at the GPCL MH, New Jersey location.

4.3.1 Single Carrier (1C)

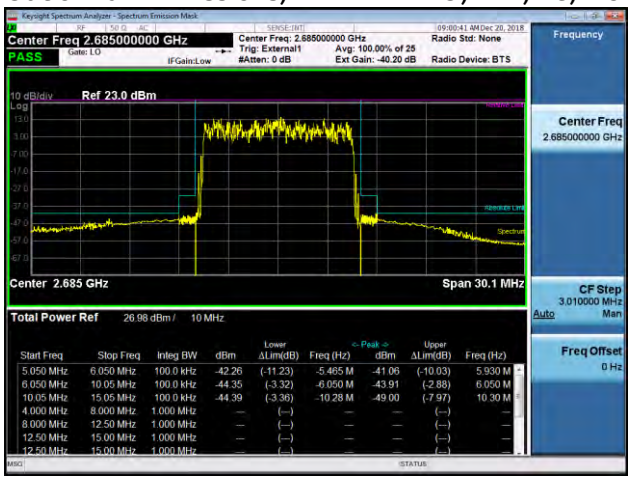
4.3.1.1 10 MHz Bandwidth

Out of Band Emissions, AAHF mMIMO, B41, 1C, 10MBW, TM3.2, 2501 MHz.

Out of Band Emissions, AAHF mMIMO, B41, 1C, 10MBW, TM3.2, 2593 MHz.

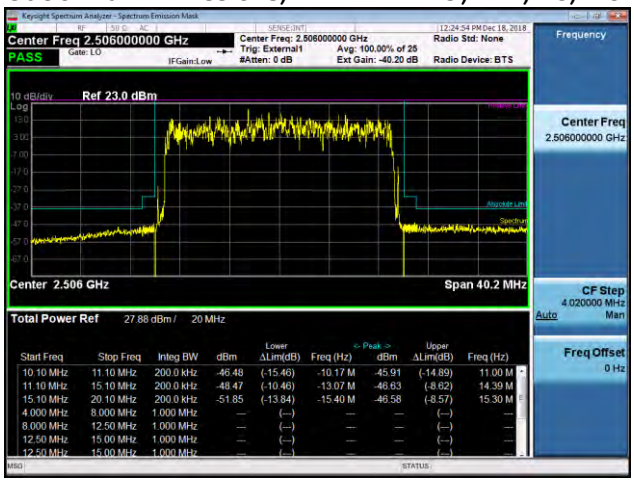


Out of Band Emissions, AAHF mMIMO, B41, 1C, 10MBW, TM3.2, 2685 MHz.

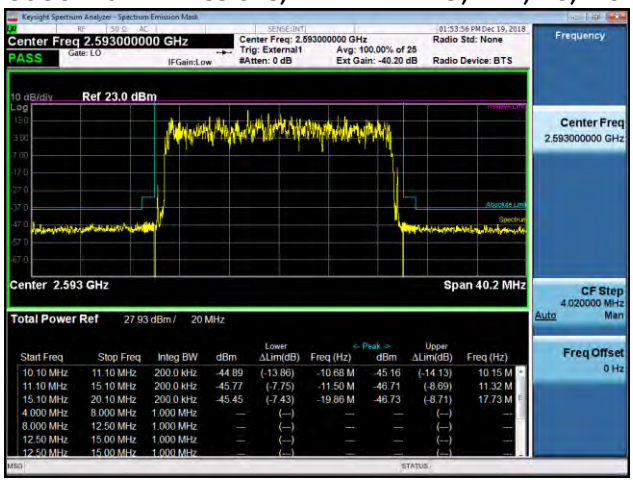


4.3.1.2 20 MHz Bandwidth

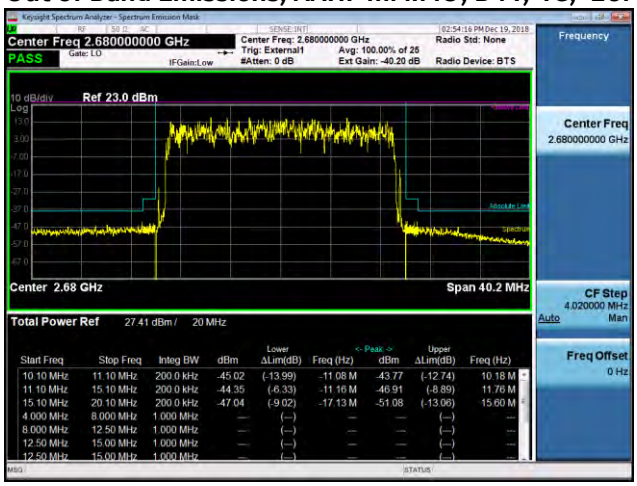
Out of Band Emissions, AAHF mMIMO, B41, 1C, 20MBW, TM3.2, 2506 MHz.



Out of Band Emissions, AAHF mMIMO, B41, 1C, 20MBW, TM3.2, 2593 MHz.



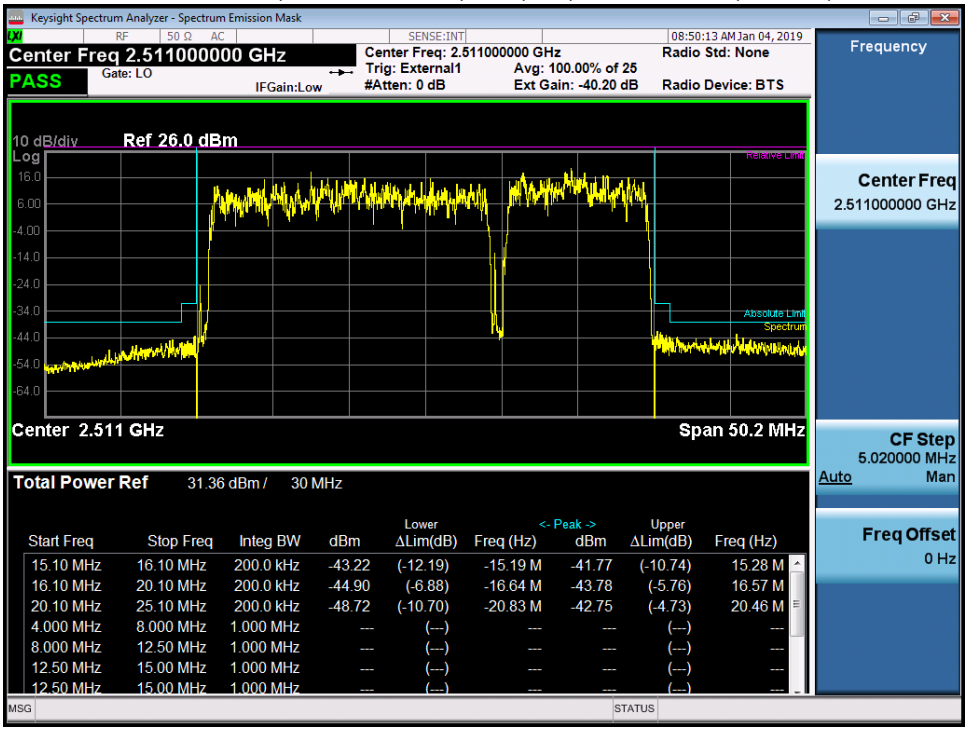
Out of Band Emissions, AAHF mMIMO, B41, 1C, 20MBW, TM3.2, 2680 MHz.



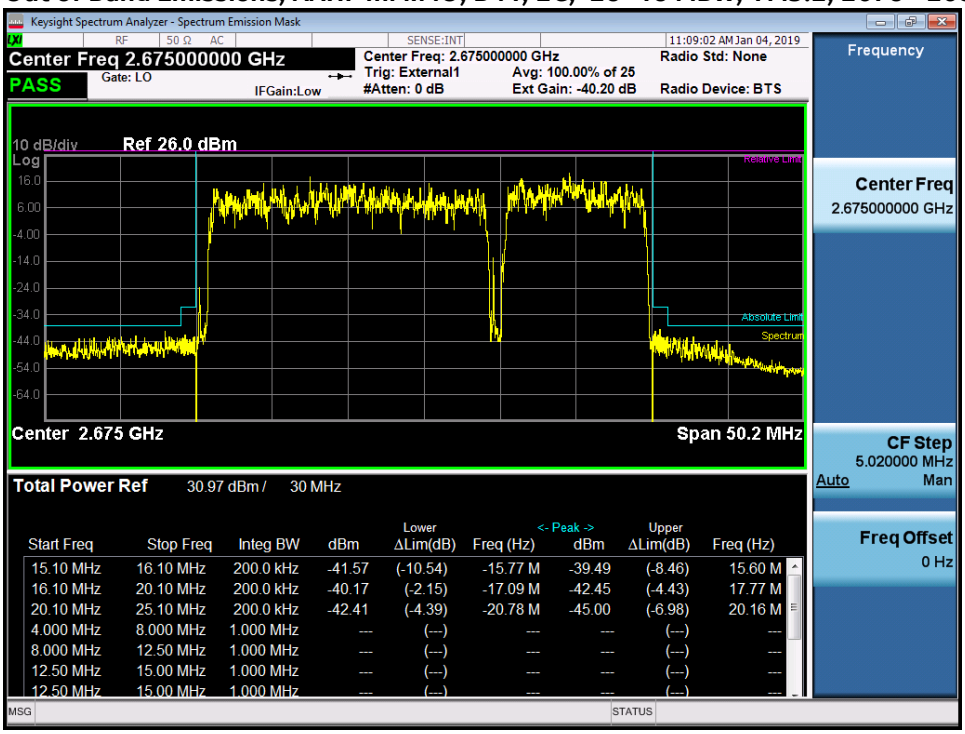
4.3.2 Dual Carrier (2C)

4.3.2.1 20+10 MHz Bandwidth, Contiguous

Out of Band Emissions, AAHF mMIMO, B41, 2C, 20+10 MBW, TM3.2, 2506 +2521 MHz Port 46.

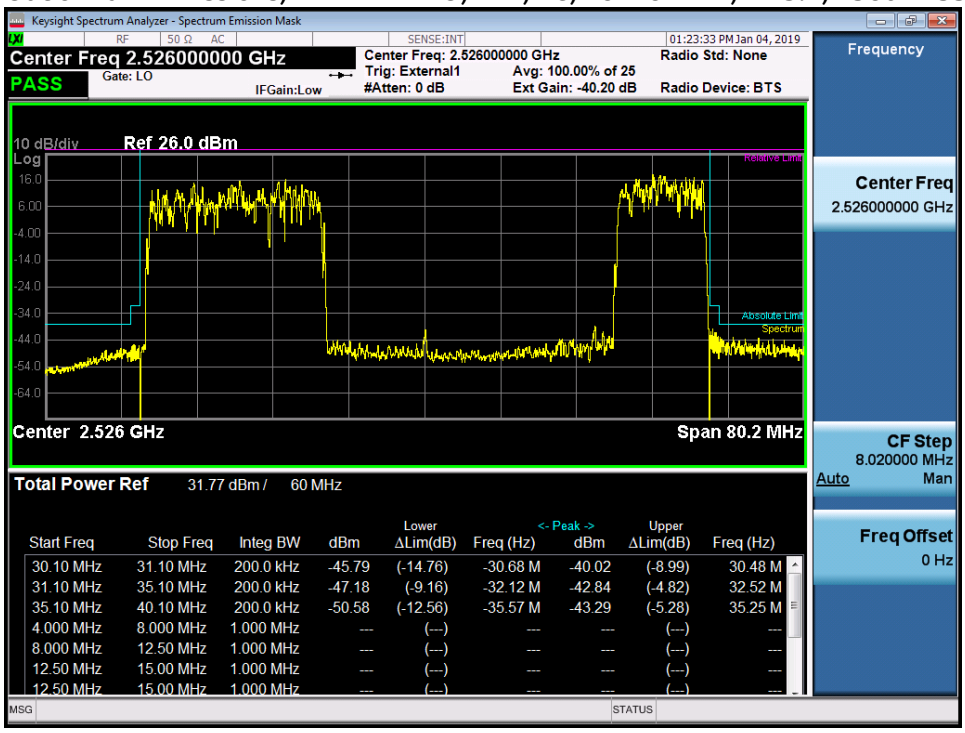


Out of Band Emissions, AAHF mMIMO, B41, 2C, 20+10 MBW, TM3.2, 2670 +2685 MHz Port 46.

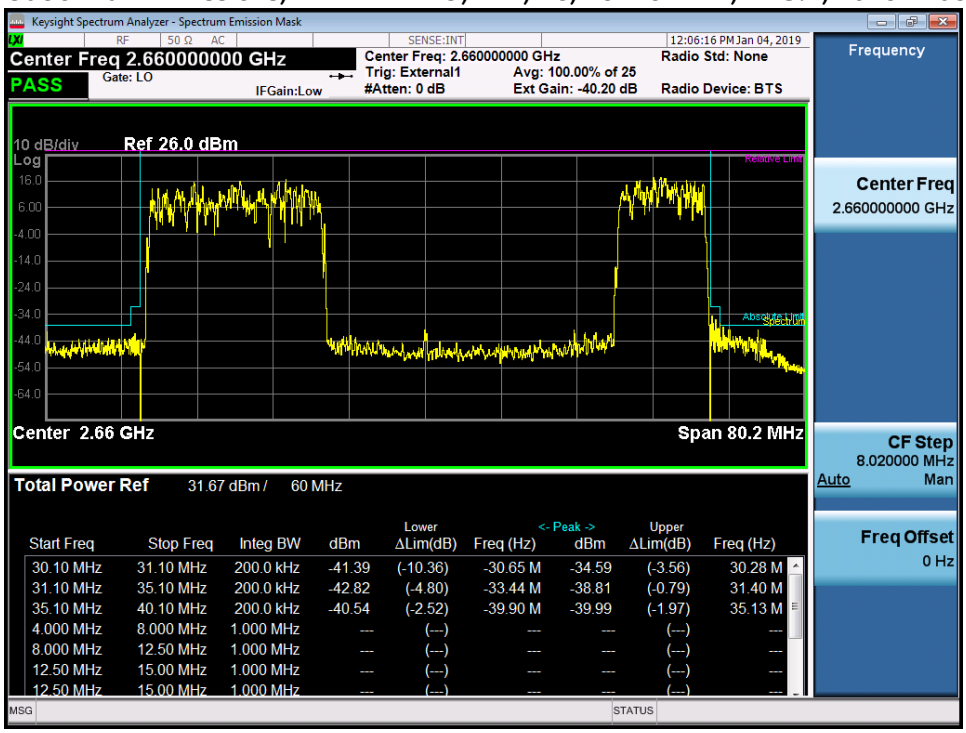


4.3.2.2 20+10 MHz Bandwidth, Non-Contiguous

Out of Band Emissions, AAHF mMIMO, B41, 2C, 20+10 MBW, TM3.2, 2506 +2551 MHz Port 46.

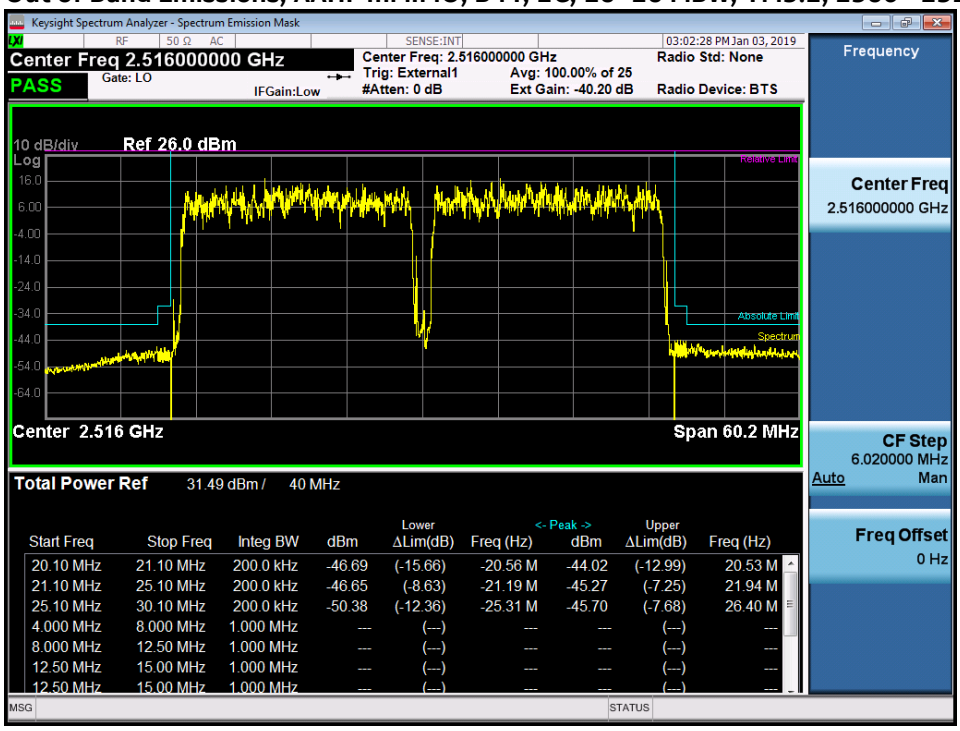


Out of Band Emissions, AAHF mMIMO, B41, 2C, 20+10 MBW, TM3.2, 2640 +2685 MHz Port 46.



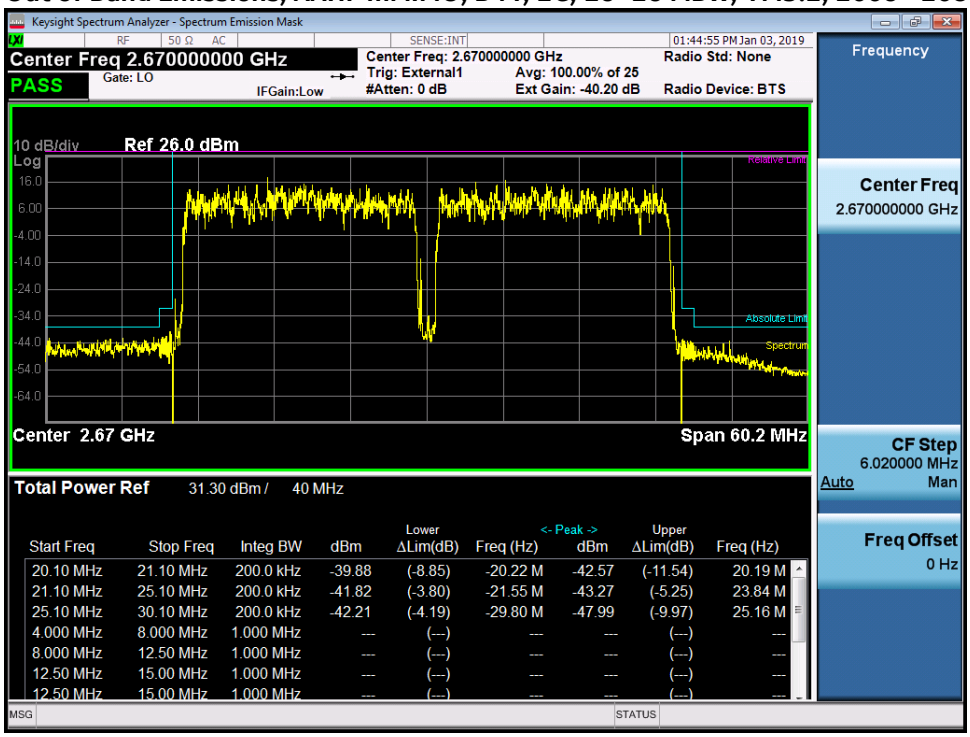
4.3.2.3 20+20 MHz Bandwidth, Contiguous

Out of Band Emissions, AAHF mMIMO, B41, 2C, 20+20 MBW, TM3.2, 2506 +2526 MHz Port 46.



Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
20.10 MHz	21.10 MHz	200.0 kHz	-46.69	(-15.66)	-20.56 M	-44.02	(-12.99)	20.53 M
21.10 MHz	25.10 MHz	200.0 kHz	-46.65	(-8.63)	-21.19 M	-45.27	(-7.25)	21.94 M
25.10 MHz	30.10 MHz	200.0 kHz	-50.38	(-12.36)	-25.31 M	-45.70	(-7.68)	26.40 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

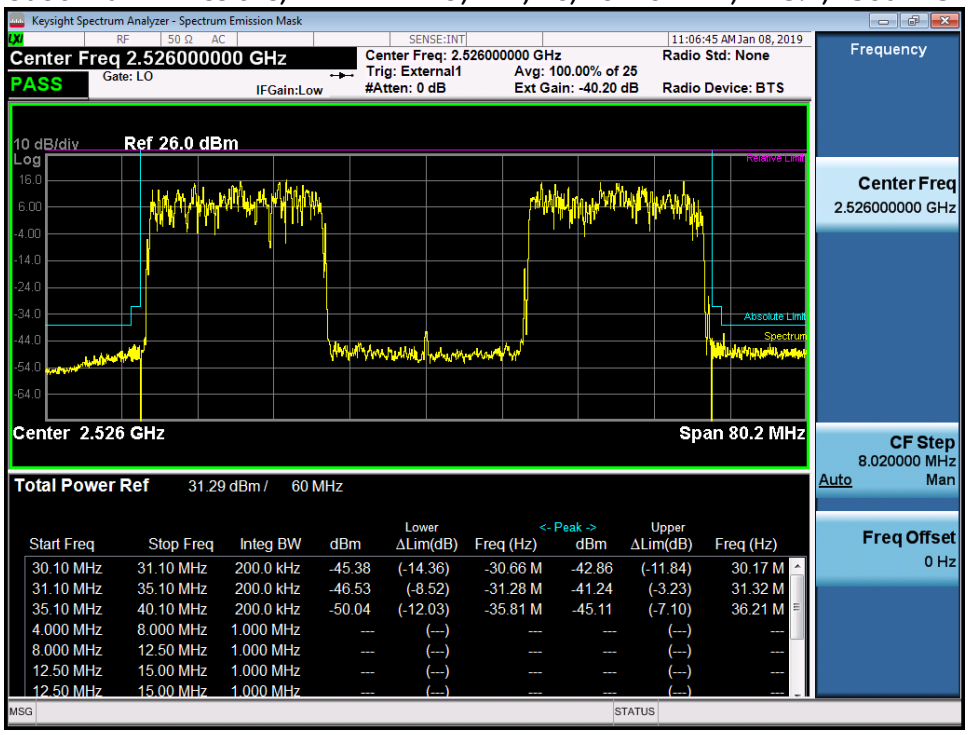
Out of Band Emissions, AAHF mMIMO, B41, 2C, 20+20 MBW, TM3.2, 2660 +2680 MHz Port 46.



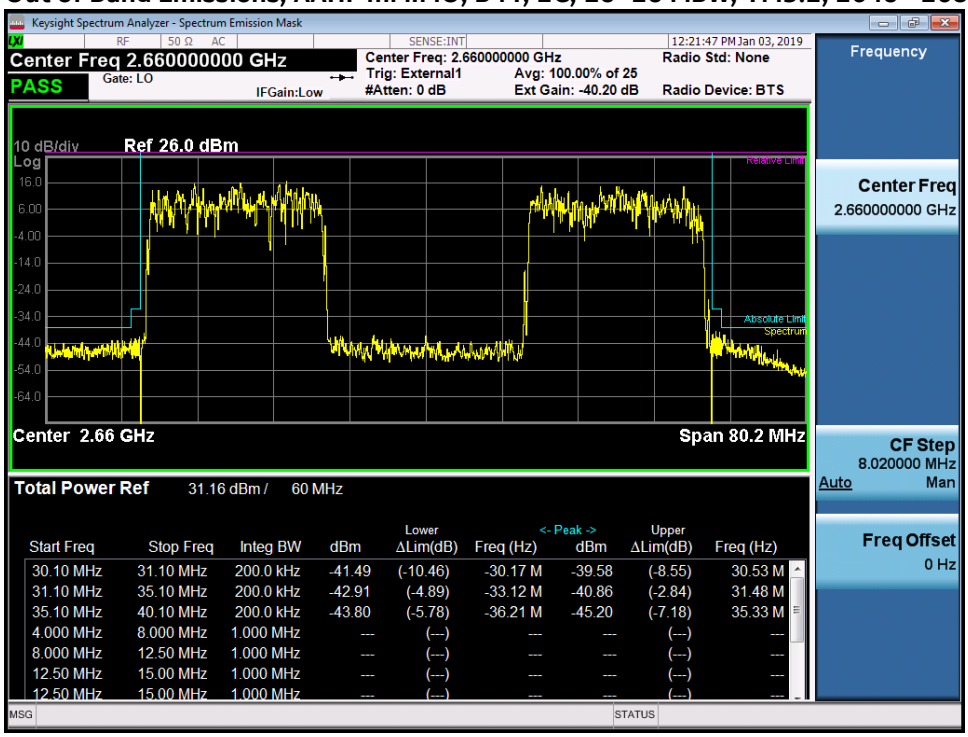
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
20.10 MHz	21.10 MHz	200.0 kHz	-39.88	(-8.85)	-20.22 M	-42.57	(-11.54)	20.19 M
21.10 MHz	25.10 MHz	200.0 kHz	-41.82	(-3.80)	-21.55 M	-43.27	(-5.25)	23.84 M
25.10 MHz	30.10 MHz	200.0 kHz	-42.21	(-4.19)	-29.80 M	-47.99	(-9.97)	25.16 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

4.3.2.4 20+20 MHz Bandwidth, Non-Contiguous

Out of Band Emissions, AAHF mMIMO, B41, 2C, 20+20 MBW, TM3.2, 2506 +2546 MHz Port 46.



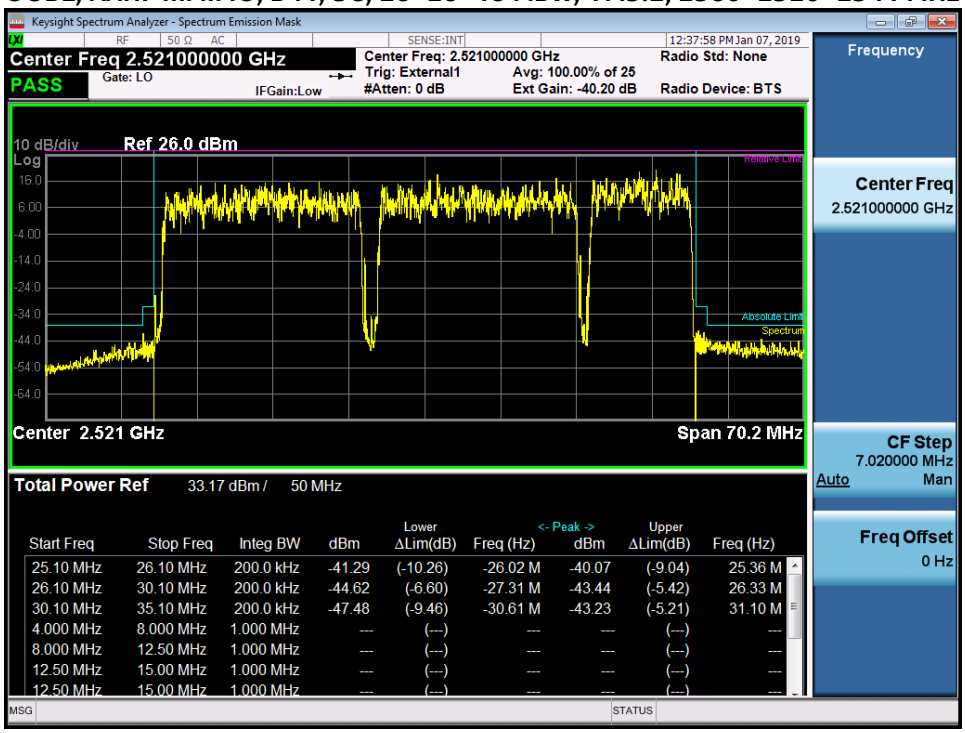
Out of Band Emissions, AAHF mMIMO, B41, 2C, 20+20 MBW, TM3.2, 2640 +2680 MHz Port 46.



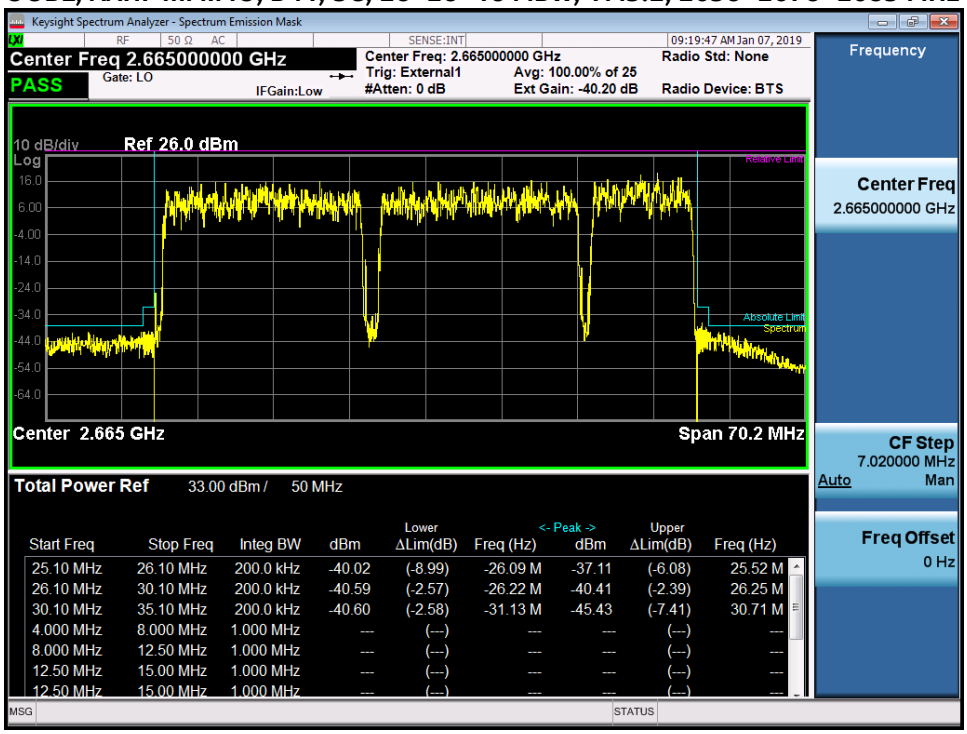
4.3.3 Triple Carrier (3C)

4.3.3.1 20+20+10 MHz Bandwidth, Contiguous

OOBE, AAHF mMIMO, B41, 3C, 20+20+10 MBW, TM3.2, 2506+2526+2541 MHz Port 46.

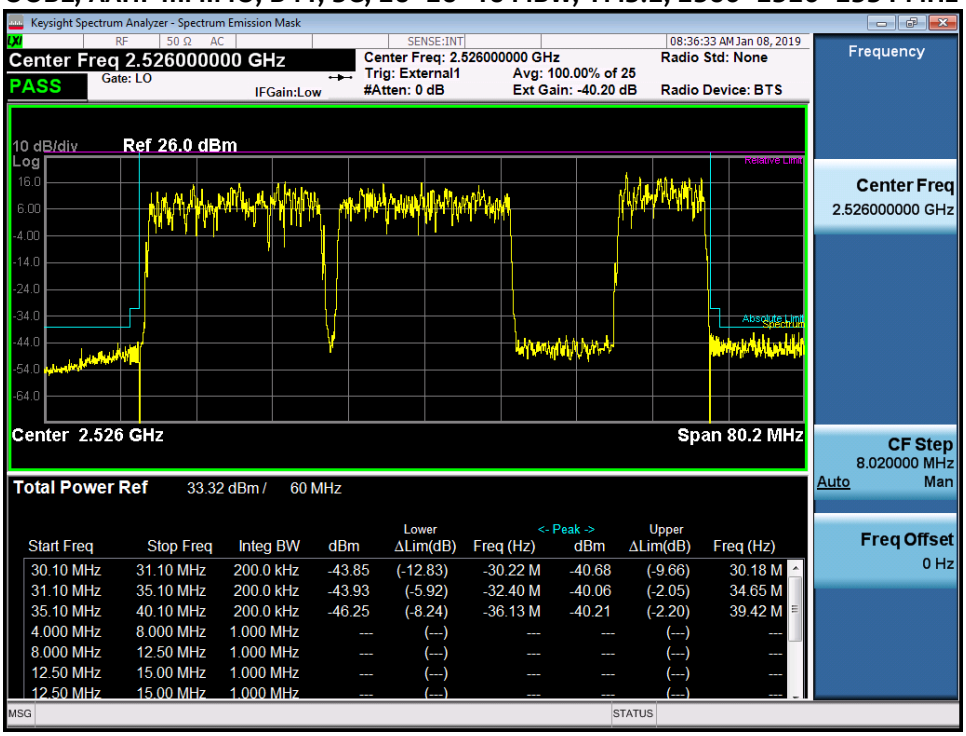


OOBE, AAHF mMIMO, B41, 3C, 20+20+10 MBW, TM3.2, 2650+2670+2685 MHz Port 46.

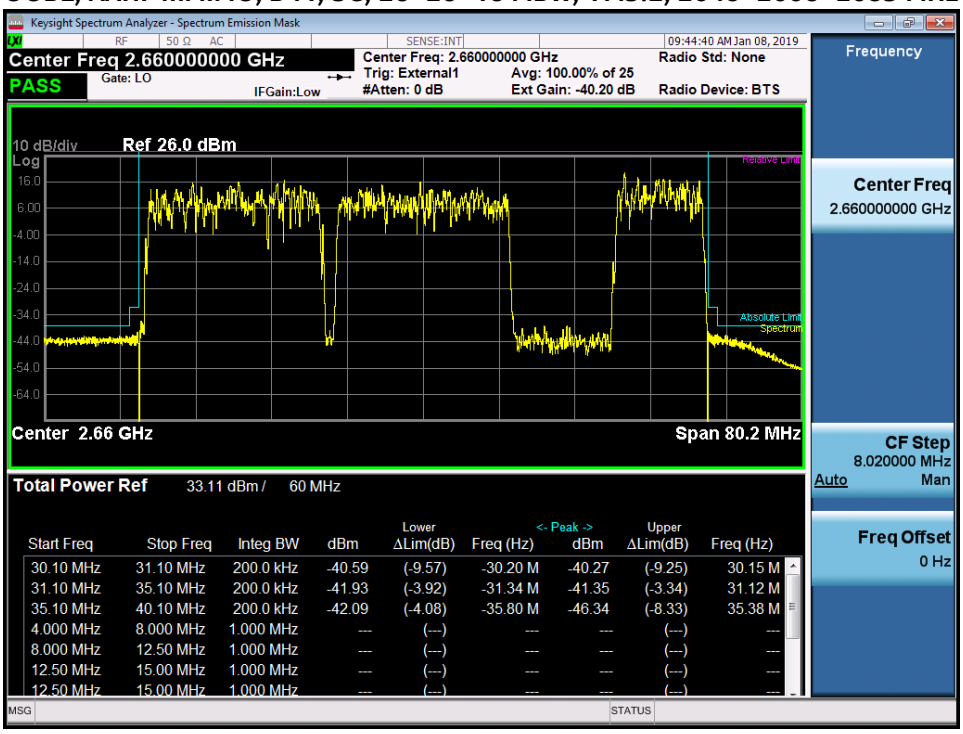


4.3.3.2 20+20+10 MHz Bandwidth, Non-Contiguous

OOBE, AAHF mMIMO, B41, 3C, 20+20+10 MBW, TM3.2, 2506+2526+2551 MHz Port 46.

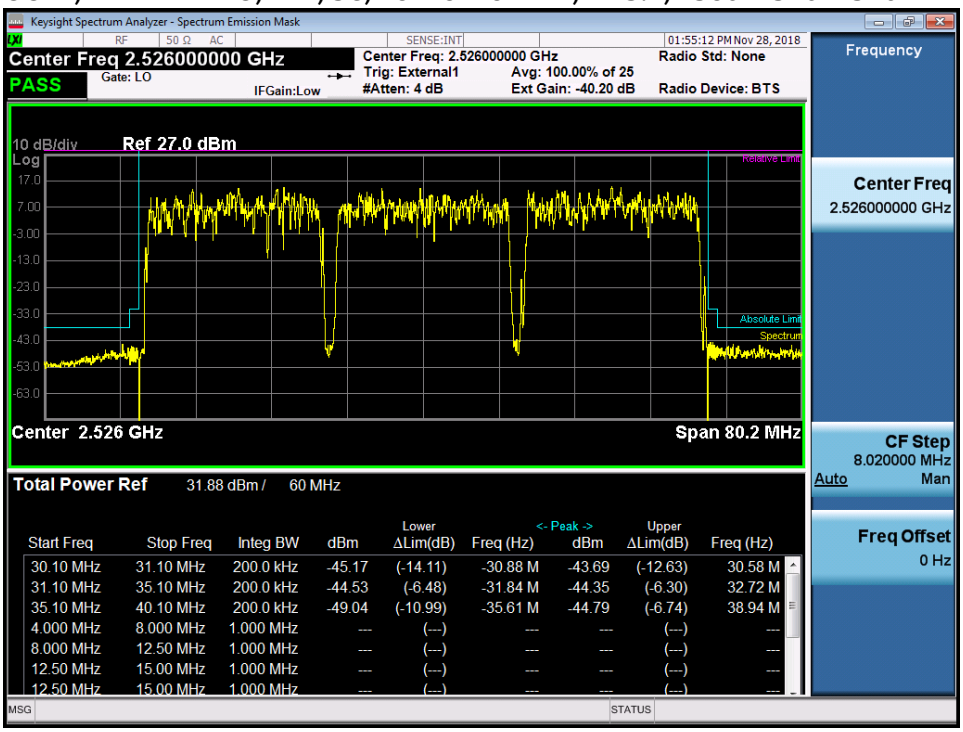


OOBE, AAHF mMIMO, B41, 3C, 20+20+10 MBW, TM3.2, 2640+2660+2685 MHz Port 46.



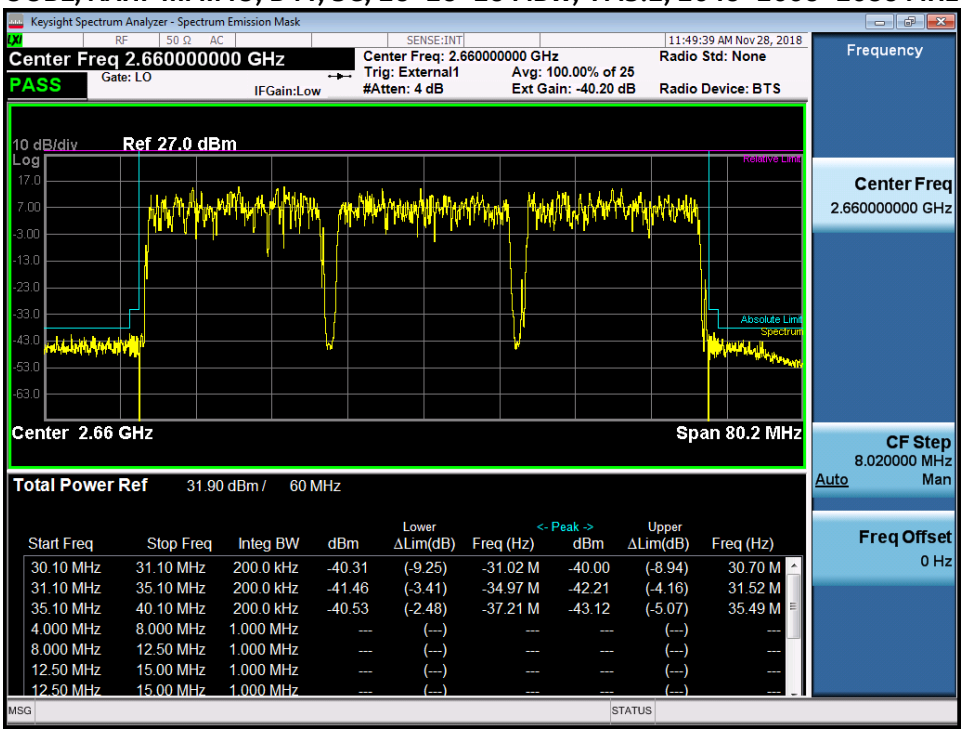
4.3.3.3 20+20+20 MHz Bandwidth

OOBE, AAHF mMIMO, B41, 3C, 20+20+20 MBW, TM3.2, 2506+2526+2546 MHz Port 46.



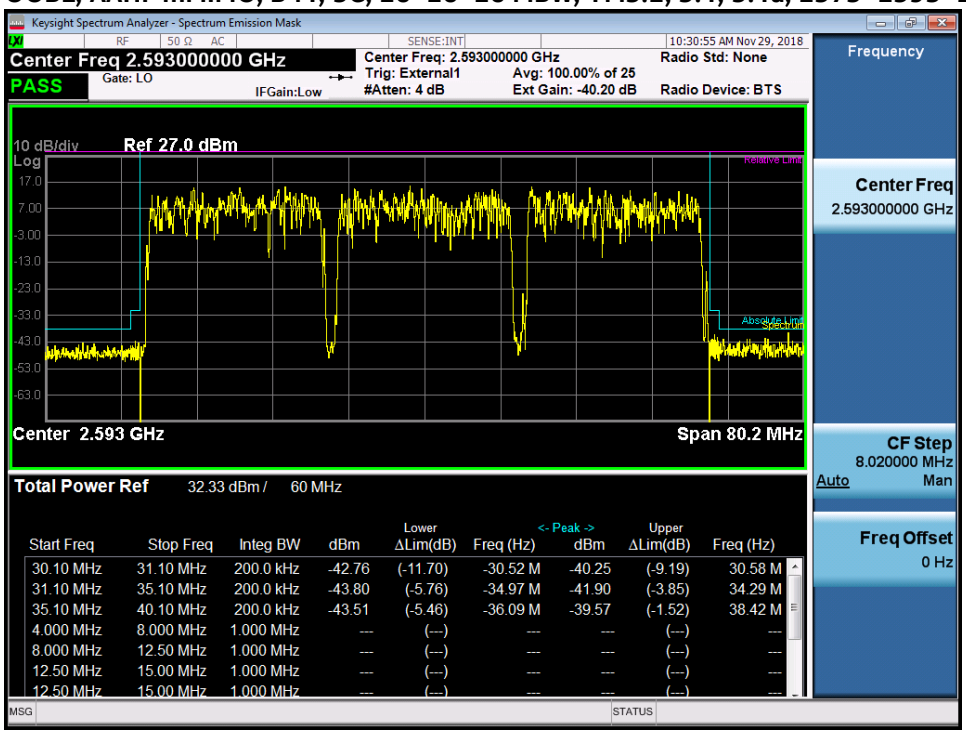
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
30.10 MHz	31.10 MHz	200.0 kHz	-45.17	(-14.11)	-30.88 M	-43.69	(-12.63)	30.58 M
31.10 MHz	35.10 MHz	200.0 kHz	-44.53	(-6.48)	-31.84 M	-44.35	(-6.30)	32.72 M
35.10 MHz	40.10 MHz	200.0 kHz	-49.04	(-10.99)	-35.61 M	-44.79	(-6.74)	38.94 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

OOBE, AAHF mMIMO, B41, 3C, 20+20+20 MBW, TM3.2, 2640+2660+2680 MHz Port 46.

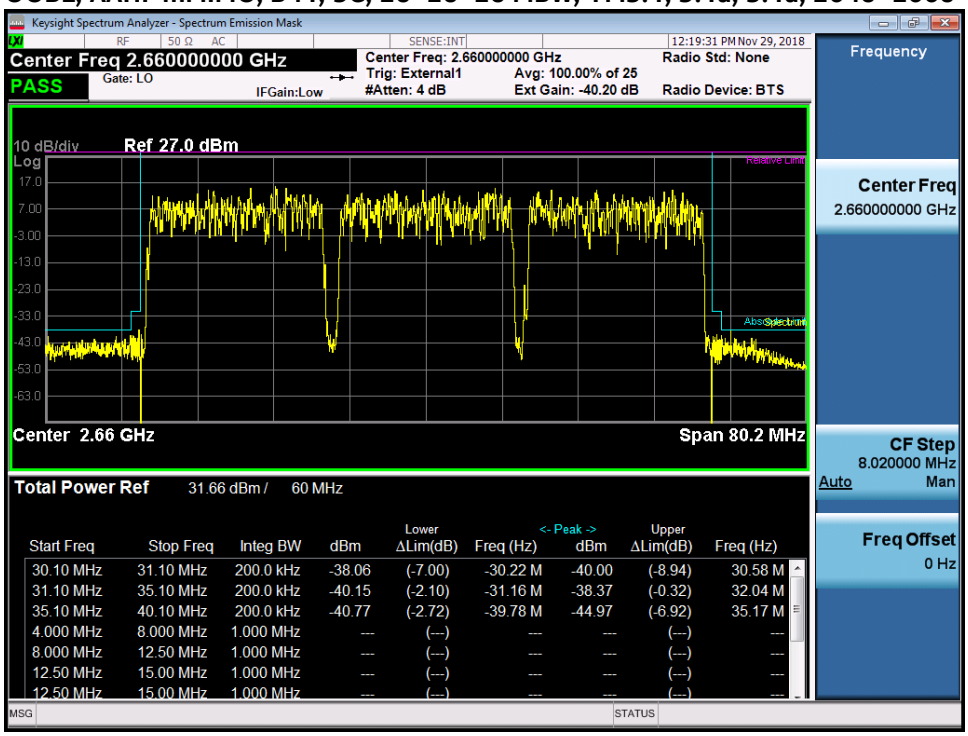


Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
30.10 MHz	31.10 MHz	200.0 kHz	-40.31	(-9.25)	-31.02 M	-40.00	(-8.94)	30.70 M
31.10 MHz	35.10 MHz	200.0 kHz	-41.46	(-3.41)	-34.97 M	-42.21	(-4.16)	31.52 M
35.10 MHz	40.10 MHz	200.0 kHz	-40.53	(-2.48)	-37.21 M	-43.12	(-5.07)	35.49 M
4.000 MHz	8.000 MHz	1.000 MHz	---	(---)	---	---	(---)	---
8.000 MHz	12.50 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

OOBE, AAHF mMIMO, B41, 3C, 20+20+20 MBW, TM3.2, 3.1, 3.1a, 2573+2593+2613 MHz Port 46.



OOBE, AAHF mMIMO, B41, 3C, 20+20+20 MBW, TM3.1, 3.1a, 3.1a, 2640+2660+2680 MHz Port 46.



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 the 10th harmonic of the specific transmit band. Depending on the specific band of operation, the measurements were performed up to 27GHz. Measurements were made either by using a Keysight MXA Signal Analyzer. The RF output from the transmitter was reduced (to an amplitude usable by the receivers) using calibrated attenuators and cables that were verified as a group. Above 10 GHz a high pass filter was used with reduced attenuation to maintain dynamic range.

The required emission limitation is specified as appropriate in 27.53 and as tabulated in Table 4.2. The measured spurious emission levels were plotted for the frequency range as specified in 2.1057. Data below documents performance up to 27 GHz.

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 Single Carrier (1C)

Spurious Emissions, AAHF mMIMO - Full Band, B41, 1C, 20MBW, TM3.2, 2506 MHz, Port 46.

Spurious Emissions 10 MHz – 1000 MHz

Spurious Emissions 1000 MHz – 2491 MHz

Spurious Emissions 2560 – 2690 MHz

Spurious Emissions 2690 MHz – 10000 MHz

Spurious Emissions 10 GHz- 27 GHz

5.1.2 Dual Carrier (2C)

Spurious Emissions, AAHF mMIMO - Full Band, B41, 2C, 20 + 10 MHz BW, TM3.2, 2640, 2685 MHz,

Spurious Emissions 10 MHz – 1000 MHz

Spurious Emissions 1000 MHz – 2496 MHz

Spurious Emissions 2496 – 2625 MHz

Spurious Emissions 2690 MHz – 10000 MHz

Spurious Emissions 10 GHz- 27 GHz

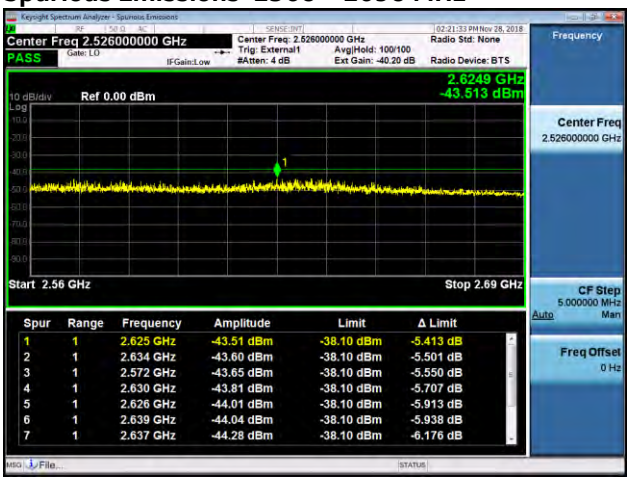
5.1.3 Triple Carrier (3C)

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

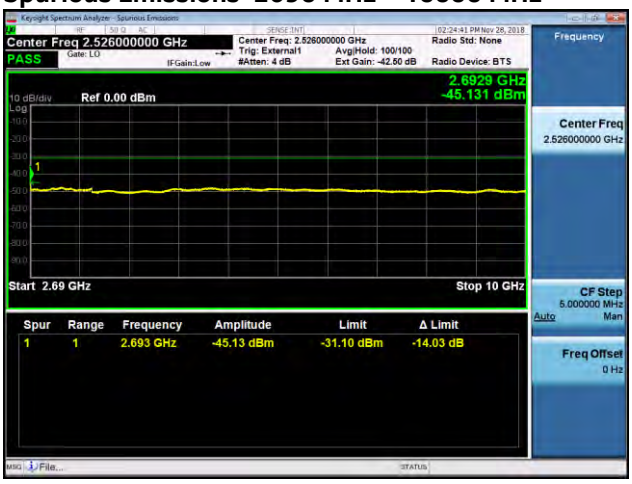
Spurious Emissions 10 MHz – 1000 MHz

Spurious Emissions 1000 MHz – 2491 MHz

Spurious Emissions 2560 – 2690 MHz



Spurious Emissions 2690 MHz – 10000 MHz



Spurious Emissions 10 GHz- 27 GHz

5.2 Test Setup Photographs

The Test Setup Photographs are detailed in Exhibit 12 of the filing Package

5.3 Test Equipment

The following Test equipment was used for antenna port testing.

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due	Calibration Type	Status
E831	Agilent Technologies	MXA Signal Analyzer	20Hz-26.5GHz	N9020A	MY48011791	2018-02-15	2020-02-15	Requires Calibration	Active
E1208	RLC Electronics Inc	High Pass Filter	5GHz to 26GHz High Pass Filter	F-19391	1440-001			Calibration Not Required, Must Be Verified	Active
E1156	Weinschel	Attenuator	10dB 0.05GHz-26GHz 25W	74-10-12	1069			Calibration Not Required, Must Be Verified	Active
E1155	Weinschel	Attenuator	10dB 25Watt 0.05GHz - 26GHz	74-10-12	1068			Calibration Not Required, Must Be Verified	Active
E1154	Weinschel	Attenuator	30dB 25W 0.05GHz-26GHz	74-30-12	1065			Calibration Not Required, Must Be Verified	Active
	UTIFLEX Micro Coax	RF Cable	UFB142A-0-0720-2G0200/A. MFR65639 227883-001	142A Series 503609-G				Pathloss verified with attenuators	

6. Section 2.1055 MEASUREMENT REQUIRED: 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 a BBU (baseband unit), can be located outside the chamber if it is a separated unit.

6.1 Frequency Stability Test Article and Configuration

The unit under test is identified as follows:

Series	Vendor	Model	Serial Number	Comcode	Version
AAHF	Nokia	64T64R B41 RRH	6Q183702544	474715A.M01	DC

6.2 Frequency Stability Test

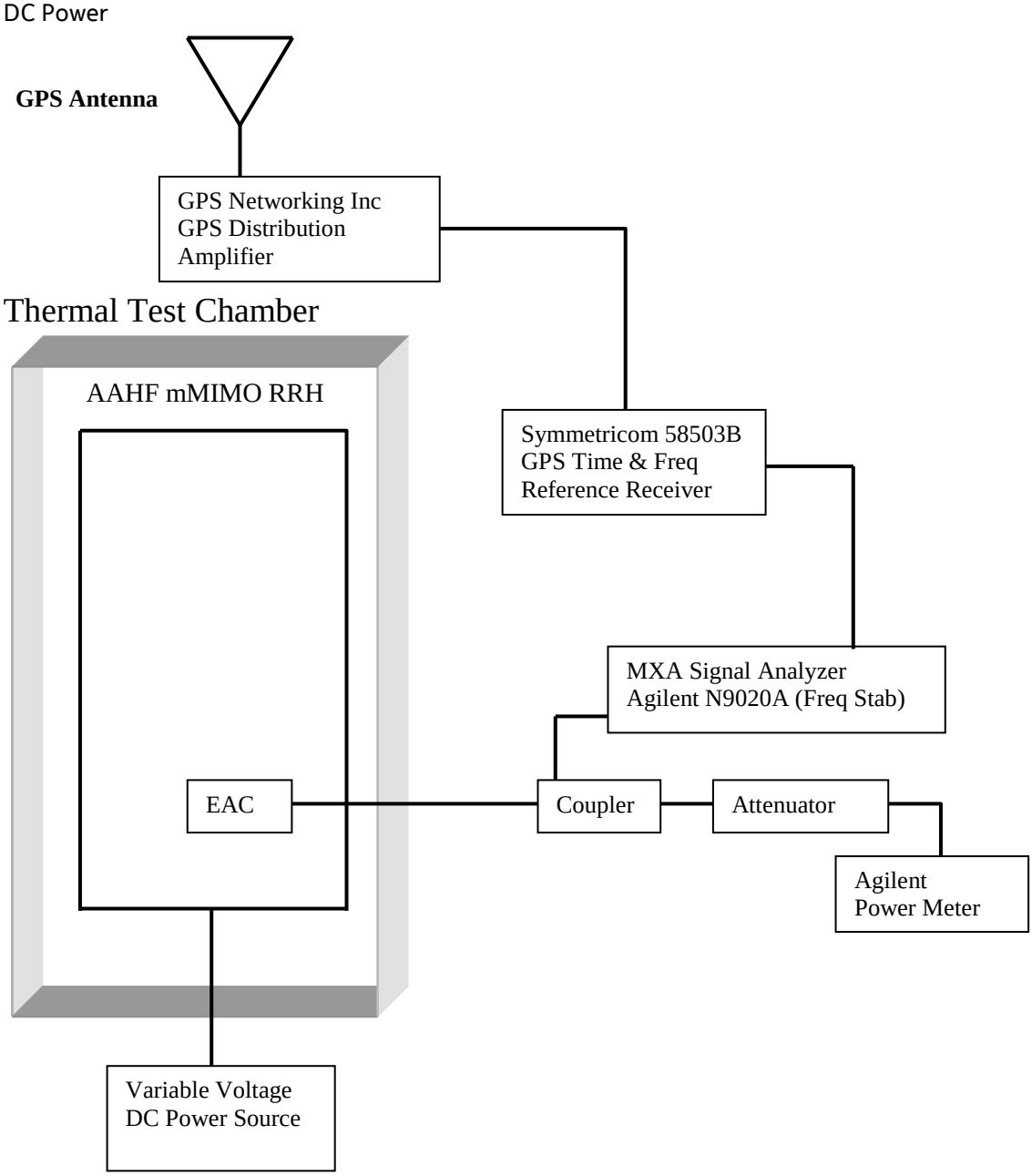
Frequency Stability Testing was completed on AirScale MAA 64T64R 128AE B41 Radio Unit for massive MIMO with a center frequency of 2593 MHz using an external ASMI (AirScale System Module Indoor BBU). The testing was performed from 01/31/2019 through 02/01/2019 on the AAHF mMIMO B41 120W RRH, which was located in the T-11 Thermal chamber of the GPCL test facility located in Bldg 4, Room 4-280, Murray Hill, NJ, and witnessed by Joe Bordonaro from GPCL. The temperatures to which the UUT were subjected to comprised high temperature (+50ºC, system ambient) and low temperature (-30ºC system ambient). The system level Frequency Stability testing of the UUT yielded results in compliance with established design criteria.
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 (2593 MHz).

UUT: AirScale MAA 64T64R 128AE B41 AAHF Radio Unit, PN: 474715A.M01, SN: 6Q183702544.

6.2.1 Frequency Stability Results:

The worst case Frequency Stability over temperature and voltage for the DC Product was **+17.594 Hz** which is **+0.00679 ppm.**
This are within the +/- 0.05ppm desired performance required for LTE operation.

FIGURE 6.2: Frequency Stability Test Set-Up



6.3 Frequency Stability Test Photos

Photographs of the Frequency Stability test setups are in Exhibit 12 of the filing exhibits.

6.4 Frequency Stability Test Equipment

Instrument Type	Serial Number	Vendor	Cal Due Date
MXA Signal Analyzer	MY53420147	Agilent N9020A	03/13/2019
Power Meter	MY40511034	AGILENT E4419B	01/10/2020
Power Sensor	MY51020039	AGILENT E9300A	09/10/2019
Power Sensor	MY51020035	AGILENT E9300A	02/08/2019
Multimeter	74910377	FLUKE 83 III	02/12/2020
Thermal Logger	S5U604860	YOKOGAWA GP10	11/09/2020
GPS Receiver	KR93200773	SYMMETRICOM 58503B	No Cal Req.
Power supply	13N5112J	TDK-LAMBDA GEN60-85-3P208	No Cal Req.

6.5 Frequency Stability Data:

Frequency Block Tested: ***AAHF AirScale 64T64R B41 120W RRH_(CF = 2593MHz)***

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, (minutes)	Transmit Carrier Deviation, (Hz)
0	8.211
0.5	1.243
1.0	6.011
1.5	3.175
2.0	4.277
2.5	7.211
3.0	2.792
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	10.337
0.5	13.853
1.0	7.421
1.5	2.967
2.0	6.178
2.5	1.261
3.0	4.729
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	5.041
0.5	9.980
1.0	6.687
1.5	8.511
2.0	2.653
2.5	5.409
3.0	8.233
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	4.277
0.5	1.893
1.0	7.501
1.5	9.044
2.0	2.457
2.5	10.963
3.0	8.627
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	9.036
0.5	3.621
1.0	1.919
1.5	7.573
2.0	3.392
2.5	10.448
3.0	7.304
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	6.334
0.5	1.291
1.0	7.605
1.5	2.762
2.0	8.413
2.5	9.986
3.0	10.992
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	9.423
0.5	10.078
1.0	7.321
1.5	1.552
2.0	3.827
2.5	7.473
3.0	9.716
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	4.228
0.5	11.812
1.0	2.806
1.5	3.141
2.0	10.923
2.5	12.592
3.0	5.087
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	6.355
0.5	12.544
1.0	5.419
1.5	7.460
2.0	14.071
2.5	16.199
3.0	8.105
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	7.914
0.5	10.426
1.0	6.445
1.5	3.942
2.0	**17.594**
2.5	2.091
3.0	6.375
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	8.030
0.5	2.217
1.0	7.066
1.5	10.842
2.0	4.267
2.5	9.013
3.0	2.709
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	8.890
0.5	1.736
1.0	7.449
1.5	6.591
2.0	1.201
2.5	7.921
3.0	11.740
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	3.442
0.5	6.817
1.0	8.241
1.5	10.426
2.0	6.231
2.5	10.218
3.0	8.757
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	9.015
0.5	4.711
1.0	2.431
1.5	9.306
2.0	1.859
2.5	8.073
3.0	2.478
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	6.045
0.5	8.007
1.0	11.524
1.5	7.599
2.0	3.681
2.5	9.614
3.0	1.826
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	10.870
0.5	3.983
1.0	5.261
1.5	1.773
2.0	6.149
2.5	8.237
3.0	2.123
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	6.248
0.5	9.483
1.0	8.998
1.5	1.335
2.0	10.283
2.5	6.177
3.0	8.140
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	6.050
0.5	1.527
1.0	9.042
1.5	4.413
2.0	10.471
2.5	1.107
3.0	5.693
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	9.224
0.5	5.176
1.0	1.626
1.5	2.822
2.0	9.897
2.5	3.642
3.0	9.412
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	7.428
0.5	3.671
1.0	10.060
1.5	2.144
2.0	8.217
2.5	1.165
3.0	5.541
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	7.127
0.5	9.360
1.0	1.679
1.5	7.981
2.0	2.799
2.5	10.612
3.0	4.903
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±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	1.027
0.5	3.266
1.0	9.042
1.5	7.784
2.0	5.057
2.5	10.611
3.0	6.376
FCC SPECIFICATION	±2593 MHz (±0.05ppm) ±0.05ppm = ±129.65 Hz
FCC RESULT	PASS

7. FCC Section 2.1053 and Part 15.109

7.1 Section 2.1053 Field Strength of Spurious Emissions

Field strength measurements of radiated spurious emissions were made in 3m Semi-Anechoic Chambers 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 515091).

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 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.

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 compliance limit is 82.23 dBμV/m. The non-report level is 62.23 dBμV/m which is higher than the FCC Part 15 Class B limit of 54 dBμV/m.

The calculated emission levels were found by:

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

7.2 Results - Field Strength of Spurious Emissions:

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 27GHz), no reportable spurious emissions were detected.

The product was also compliant with Part 15 Class B.

7.3 Radiated Emissions Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due	Calibration Type	Status
E526	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
E513	EMC Test Systems	Horn Antenna	Double Ridged Horn 18-40 GHz	3116	2539	2017-06-16	2019-06-16	Requires Calibration	Active
E393	EMCO	Horn Antenna	Double Ridged Horn 1-18 Ghz	3115	9903-5769	2017-06-05	2019-06-05	Requires Calibration	Active
E1255	ETS Lindgren	Multi-Device Controller		2090	00078509			Calibration Not Required	Active
E447	Hewlett Packard	Pre-Amplifier	Preamplifier 1-26.5 GHz	8449B	3008A01384	2018-04-10	2020-04-10	Requires Calibration	Active
E1235	RLC Electronics Inc	High Pass Filter	High Pass filter 5GHz to 26GHz	F-19413	1446-006			Calibration Not Required, Must Be Verified	Active
EIH69	Rohde & Schwarz	Test Receiver	EMI 20Hz - 40GHz -155 dBm +30 dBm	ESU40	100247	2018-05-22	2020-05-22	Requires Calibration	Active
E1131	Weinschel	Attenuator	6dB	2-6	CD2518	2017-05-01	2019-05-01	Requires Calibration	Active
E601	A.H. Systems Inc.	Bilogical Antenna	25 - 2000 MHz	SAS-521-2	408	2017-07-11	2019-07-11	Requires Calibration	Active
E812	Sonoma Instrument Co.	Amplifier	9kHz-1GHz Vasona File TRANS 261	310N	186744	2018-09-14	2020-09-14	Requires Calibration	Active
E051	EMCO	Biconical Antenna		3109	2187	2016-12-01	2018-12-01	Requires Calibration	Active
E061	EMCO	Log Periodic Antenna		3146	2082	2017-05-24	2019-05-24	Requires Calibration	Active
E481	Hewlett Packard	HP-IB Extender		37204	3212U31136			Calibration Not Required	Active
E258	Hewlett Packard	HP-IB Extender		37204A	3212U27554			Calibration Not Required	Active

Test Cables

Test	Cable	S/N	Part #	MMFG	Cal Date
RE 1-18 GHz	#1	13171302-002	EMC1-K1K1-48	Cage 1GVT4	12/4/2018
	#2	13171301-001	EMC1-K1K1-108	Cage 1GVT4	12/4/2018
RE 30M-1GHz	#1	D230-N1N1 36	1GVT414198302-001		5/2/2018
	#2	D230-N1N1 72	1GVT414198501-001		5/2/2018
	#3	D230-N1N1 278	1GVT414198301-001		5/2/2018
RE 18-26.5	#1	13171302-002	EMC1-K1K1-48	Cage 1GVT4	12/4/2018
	#2	13171301-001	EMC1-K1K1-108	Cage 1GVT4	12/4/2018
RE 26.5-40G	#1				
This cable is part of E526	#1	504586-D0000090	UBF-142A-0-2000-2002G0	64839-232491-001	11/16/2018

8. 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).

2018-09-05 through 2019-09-30
Effective Dates

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

For the National Voluntary Laboratory Accreditation Program