

Bell Labs

Global Product Compliance Laboratory 600-700 Mountain Avenue Bldg. 5, Murray Hill, New Jersey 07974-0636 USA

TESTING NVLAP LAB CODE: 100275-0

Test Report

Regulation: FCC Part 2 and 27

<u>Client:</u> Nokia Mobility

Product Evaluated: (AAHJ mMIMO - Small Band) AirScale MAA 64T64R 128AE B41 120W AAHJ Radio Unit (AAHJ) FCC ID: VBNAAHJ-01

> Report Number: TR-2018-0270-FCC2-27

> > Date Issued: February 13, 2019

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Revisions

Date	Revision	Section	Change	
2/10/2019	0		Initial Release	
2/13/2019	1		Revise page 1 address.	

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2/13/2019

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1. System Information and Requirements

AirScale MAA 64T64R 128AE B41 120W AAHJ Radio UnitFCC ID:VBNAAHJ-01Serial Number:(1P) - 474795A.M01 (S/N) - 6Q184613831 and 6Q184613825Cell Name / NumberGPCL Project Number:2018-0270Company:Nokia Solutions and Networks US LLC 6000 Connection Drive Irving, TX, 75039Manufacturer:Nokia Solutions and Networks US LLCTest 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 2013Measurement 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 Performed By:Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636Nokia Global Product Compliance Laboratories is accredited by the National Voluntary Laboratory Accreditation				
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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 AAHJ mMIMO - Small 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 AAHJ mMIMO - Small 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 AAHJ mMIMO Radio Unit is a 64 port Radio Unit that transmits 1.9W per port over the Band 41 spectrum of 2590 – 2690MHz. 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

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	Yes
	(b) Out-of-Band Emissions	
2.1051	Spurious Emissions at Antenna Terminals	Yes
2.1053	Field Strength of Spurious Radiation	Yes
2.1055	Measurement of Frequency Stability	Yes

Each required measurement is listed below:

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-OB and FCC-IC-SE
- 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.

Standard, Method or Procedure		Condition	Frequency MHz	Expanded Uncertainty (k=2)
a.	Classical Emissions, (<i>e.g.</i> , ANSI C63.4, CISPR 11, 14, 22, <i>etc.</i> , using ESHS 30,	Conducted Emissions	0.009 - 30	±3.5 dB
		Radiated Emissions	30 MHz – 200MHz H	±5.1 dB
		(AR-6 Semi-Anechoic	30 MHz – 200 MHz V	±5.1 dB
		Chamber)	200 MHz – 1000 MHz H	±4.7 dB
			200 MHz – 1000 MHz V	±4.7 dB
			1 GHz - 18 GHz	±3.3 dB

Worst-Case Estimated Measurement Uncertainties

Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
	10 Hz	9 kHz to 20 MHz	
Occupied Bandwidth, Edge of Band,	100 Hz	20 MHz to 1 GHz	1 70 dp
Conducted Spurious Emissions	10 kHz to 1 MHz	1 GHz to 10 GHz	1.70 UD
	1MHz	10 GHz to 40 GHz:	
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	COMPLIES
	(a) Emissions Signal Bandwidth	
	(b) Occupied Bandwidth/ Edge of	
	Band Emissions	
2.1051	Spurious Emissions at Antenna	COMPLIES
	Terminals	
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.

This power is based upon 28 dBm per carrier/port - 32.8 dBm total per port for 64 Ports

2.3 Sample Data Single Carrier (1C)

2.3.1 Sample Data 64QAM - Single Carrier 10 MHz

TM3.1 / 64QAM1C 10MBW 2595







2.3.2 Sample Data 256QAM - Single Carrier 10 MHz



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



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

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





2.3.4 Sample Data 64QAM - Single Carrier 20 MHz

keysight Spectrum Analyzer - Channel PF 50 Q Center Freq 2.6000000 Gate: LO	NFGain:Low	Center Freq: 2.6000 Trig: External1 #Atten: 0 dB	000000 GHz Avg Hold: 20/20 Ext Gain: -40.20 c	11:55:38 44()a Radio Std: No B Radio Device	n 28. 2019 one : BTS	Frequency
10 dB/div Ref 25.00 d	1Bm WWWWWWW	and the state of the	And with first	Ash.		Center Freq 2.60000000 GHz
500 11.7 3.7 5.7 4.7 5.1 4.7 5.1 1 0 0 0 0 0				horitan	ww	
Center 2.6 GHz #Res BW 200 kHz	Span 30 MHz VBW 2 MHz Sweep 1 ms				CF Step 3.000000 MH Auto Mar	
Channel Power 27.10 dBi	n / 20 MHz	Powe	r Spectral De -45.91 dBi	m /Hz		Freq Offset 0 Hz
SC -			-17	ATUS		

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

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

Center Freq 2.640000 Gate: L0	AC Former AC DOOO GHz AFGaintLow	SENSE INC Center Freq: 2.64000 Trig: External1 #Atten: 0 dB	0000 GHz Avg[Hold: 20/20 Ext Gain: -40,20	Radio Std Radio Dev	MJan 28, 2019 : None Hoe: BTS	Frequency
10 dB/div Ref 25.00	dBm MMMMMM	allfankligenslerin	Any Postal Any	M		Center Freq 2.64000000 GHz
450 450 450 450 450					When	
Center 2.64 GHz #Res BW 200 kHz		VBW 2 MHz	Spa Sw	n 30 MHz ep 1 ms	CF Step 3.000000 MHz Auto Man	
Channel Power 27.35 dB	m / 20 MHz	Power Spectral Density -45.66 dBm /Hz				Freq Offset 0 Hz
MBC				TATUS		

2.3.5 Sample Data 256QAM - Single Carrier 20 MHz

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







2.3.6 Sample Data 64QAM - Single Carrier 20 MHz

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



Genter Fren 2.640000000 GHz Enter Fren 2.64000000 GHz Enter Fren 2.640000000 GHz <t

2.4 Sample Data Multi-Carrier

2.4.1 Sample Data 64QAM - Multi-Carrier



64QAM-3C-20+20+10MBW 2600 - 2620 - 2640



64QAM-3C-20+20+10MBW 2650 - 2670 - 2685







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

256QAM-3C-20+20+20MBW 2600-2620-2635



256QAM-3C-20+20+20MBW 2600-2620-2640

Center Fr	eq 2.620 Gate: LO	00 AC 0000000 G	Hz FGein:Low	Center Fi Trig: Ext #Atten: 0	req: 2.62000 ernal1 0 dB	000 GHz Avg Hold Ext Gain:	: 20/20 : -40.20 dB	Radio De	PM Jan 28, 2019 f: None vice: BTS	Frequency
10 dB/div Log 150	Ref 2	5.00 dBm	qiliyalimiy	(MMMM)	hey many	NOTAN	Winter	lur -		Center Freq 2.62000000 GHz
.16.0 -25.0 -35.0 -45.0 -25.0	روم العامر.							Loute	enticol	
Center 2. #Res BW	enter 2.62 GHz Span 90 MHz Res BW 200 kHz VBW 2 MHz Sweep 2.733 ms						CF Step 9.000000 MHz Auto Man			
3	2.54	dBm /	60 MH2	-	-4	45.24	dBm	/Hz		Freq Offset 0 Hz
1195							STATU	5		

QPSK+16QAM-20+20+20MBW 2600-2620-2635



256QAM-3C-20+20+20MBW 2640-2660-2685



256QAM-3C-20+20+20MBW 2640-2660-2680



QPSK+16QAM-20+20+20MBW 2640-2660-2685



QPSK+16QAM-20+20+20MBW 2600-2620-2640



QPSK+16QAM-20+20+20MBW 2640-2660-2680



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, AAHJ mMIMO - Small Band, B41, 1C, 10MHZ BW, TM3.2, 2640 MHz. Port 46





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

2.5.2 Single Carrier 20 MHz

PAR, AAHJ mMIMO - Small Band, B41, 1C, 20MHZ BW, TM3.2, 2600 MHz. Port 46





PAR, AAHJ mMIMO - Small Band, B41, 1C, 20MHZ BW, TM3.2, 2640 MHz. Port 46

PAR, AAHJ mMIMO - Small 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, AAHJ mMIMO, B41, 2C, 20+10 MHZ BW, TM3.2, 2610+2615 MHz. Port 46



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



2.5.3.2 Non-Contiguous Carriers

PAR, AAHJ mMIMO, B41, 2C, 20+10 MHZ BW, TM3.2, 2600 +2645 MHz. Port 46 2600 MHz 2645 MHz





PAR, AAHJ mMIMO, B41, 2C, 20+10 MHZ BW, TM3.2, 2640 + 2685 MHz. Port 46 2640MHz 2685 MHz





2.5.4 Triple Carrier (3C)

2.5.4.1 Contiguous Carriers

PAR, AAHJ mMIMO, B41, 20+10 MHZ BW, TM3.2, 2600+2620+2635 MHz. Port 46



2.5.4.2 Non-Contiguous Carriers

PAR, AAHJ mMIMO, B41, 2C, 20+20+10 MHZ BW, TM3.2, 2640+2660+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

2595 MHz Progent 1 & 11 & 100 - Measure Analysis Carrier Ref Freq 2.595000000 GHz Teg Enternal Carrier Ref Freq 2.595000000 GHz Teg Enternal Develope Cert 1 Develope Cert 1

Modulation, AAHJ mMIMO, B41, 1C, TM3.1 64QAM 10 MHZ BW, ,. Port 1





Modulation, AAHJ mMIMO, B41, 1C, TM3.1a 256QAM 10 MHZ BW, ,. Port 1

2595 MHz





Modulation, AAHJ mMIMO, B41, 1C, TM3.2, QPSK+16QAM 10 MHZ BW, ,. Port 1 2595 MHz 2685 MHz





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3.1.2 Sample Modulation 20 MHz

Modulation, AAHJ mMIMO, B41, 1C, TM3.1 64QAM, 20 MHZ BW, 2600 MHz,. Port 1





Modulation, AAHJ mMIMO, B41, 1C, TM3.1a 256QAM, 20 MHZ BW, 2600 MHz,. Port 1 2600 MHz 2680 MHz





Modulation, AAHJ mMIMO, B41, 1C, TM3.2, QPSK+16QAM, 20 MHZ BW, 2600 MHz,. Port 1 2600 MHz 2680 MHz





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, AAHJ mMIMO, B41, 1C, 10 MHZ BW, TM3.1 - 2595 MHz. Port 46



99% & 26dB BW, AAHJ mMIMO, B41, 1C, 10 MHZ BW, TM3.1 – 2460 MHz. Port 46

 Methodia shericota wasakta - riccotaro na 	(v)					
Center Freq 2.640000000 Gate: LO) GHz #FGain:Low	SENSE:INT Center Freq: 2.640 Trig: External1 #Atten: 0 dB	0000000 GHz Avg[Hold: 100/ Ext Gain: -40.2	07:48:48 / Radio Sto (100 10 dB Radio De	M Jan 15, 2019 I: None vice: BTS	Frequency
10 dB/div Ref 23.00 dBr	n					
13 0 2 / 0 7 .00	Whenthe	handhaddhhaipphni	antalana an			Center Freq 2.640000000 GHz
(7.0 27.0						
r o Nandel-Jodynellatleranet se 20				Hadeletware	At Sharppe	
Center 2.64 GHz Res BW 100 kHz		VBW 1 MI	Hz	Spa Sweep	n 20 MHz 9.267 ms	CF Step 2.000000 MHz
Occupied Bandwidt	th	Total	Power	27.8 dBm		Auto Man
8. Transmit Freq Error x dB Bandwidth	-19.014 NH -19.014 N 9.280 M	HZ % of	OBW Power	99.00 % -26.00 dB		Freq Offset 0 Hz
SG				STATUS		

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



TM3.1a, 256QAM

99% & 26dB BW, AAHJ mMIMO, B41, 1C, 10 MHZ BW, TM3.1a – 2595 MHz. Port 46



99% & 26dB BW, AAHJ mMIMO, B41, 1C, 10 MHZ BW, TM3.1a - 2640 MHz. Port 46

· sichell is the stranging and the site								
Center Freq 2.640000000 (Gate: L0	GHz	Center F Trig: Ext	req: 2.64000 ernal1	0000 GHz Avg Hold: 10	0/100	07:58:59 A Radio Std	M Jan 15, 2019 : None	Frequency
	#IFGain:Low	#Atten: (dB	Ext Gain: -40	.20 dB	Radio Dev	rice: BTS	
I dB/div Ref 23.00 dBm	-							
13.0 3.00	eliter and the	winite la	WARNY	k here all and the first				Center Free 2.64000000 GH:
7.00 (7.0								
27 0 47 0 ที่_{สา}ปัญญาต่าไปที่สารีที่สุบไหญ่สารประกับไปไป 57 0					hypery	shawing	nakila lahilit	
Center 2.64 GHz						Spa	n 20 MHz	CF Step
Res DW TOURNZ		VD				Sweep	9.207 1115	2.000000 MH:
Occupied Bandwidth			Total P	ower	27.8	3 dBm		(inc)
8.9	287 MI	z						Freq Offse
Transmit Freq Error x dB Bandwidth	-10.476 I 9.277 N	(Hz IHz	% of OE x dB	3W Power	99 -26.	9.00 % 00 dB		OH
en					STATE	9		

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

Keysight Spectrum Analyzer - Docupied BW				0.0
Center Freq 2.685000000 (Gate: LO	Clinic Certain	nter Freq: 2.685000000 GHz g: External Avg Hold:= tten: 0 dB Ext Gain: -	12:10:48 PM Jan 11, 2019 Radio Std: None >100/100 40.20 dB Radio Device: BTS	Frequency
0 dB/div Ref 23.00 dBm				
10 10 10	juliprophysionija	animitat with post post	N ₁	Center Freq 2.685000000 GHz
7.0 N				
- VIPANNANANANANANANANANANANANANANANANANANA			Managen and an and an and an and an	
enter 2.685 GHz Res BW 200 kHz		VBW 2 MHz	Span 20 MHz Sweep 2.333 ms	CF Step 2.000000 MH
Occupied Bandwidth 8.9	145 MHz	Total Power	26.9 dBm	Auto Mar
Transmit Freq Error x dB Bandwidth	-9.458 kHz 9.424 MHz	% of OBW Powe x dB	r 99.00 % -26.00 dB	OH
ia			STATUS	-

TM3.2, QPSK + 16QAM

99% & 26dB BW, AAHJ mMIMO, B41, 1C, 10 MHZ BW, TM3.2 – 2595 MHz. Port 46



99% & 26dB BW, AAHJ mMIMO, B41, 1C, 10 MHZ BW, TM3.2 - 2640 MHz. Port 46

Transmit Freq Er x dB Bandwidth	ror -61.093 k 9.287 M	Hz % of O Hz x dB	BW Power 9 -26	9.00 % 6.00 dB	Preq Offset 0 Hz
Occupied Band	width 8 9393 MH	Total F	ower 28.	.0 dBm	Auto Man
Center 2.64 GHz #Res BW 100 kHz		VBW 1 MH	·	Span 20 MHz Sweep 9.267 ms	CF Step 2.000000 MHz
710 770 270 270 270 270 270 570 570	mola			glymeykingingingingerfer	
10 dB/div Ref 23.0	00 dBm	ecompletion back and	ulalay.Myday.Malay		Center Freq 2.640000000 GHz
Center Freq 2.6400 Gate: LO	MFGain:Low	Center Freq: 2.6400 Trig: External1 #Atten: 0 dB	00000 GHz Avg Hold: 100/100 Ext Gain: -40.20 dB	Radio Std: None Radio Device: BTS	Frequency

99% & 26dB BW, AAHJ 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, AAHJ mMIMO, B41, 1C, 20 MHZ BW, TM3.1 - 2600 MHz. Port 46



99% & 26dB BW, AAHJ mMIMO, B41, 1C, 20 MHZ BW, TM3.1 – 2640 MHz. Port 1



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



TM3.1a, 256QAM

99% & 26dB BW, AAHJ mMIMO, B41, 1C, 20 MHZ BW, TM3.1a - 2600 MHz. Port 46



99% & 26dB BW, AAHJ mMIMO, B41, 1C, 20 MHZ BW, TM3.1a - 2640 MHz. Port 1

Center Freq 2.640000 Gate: LO	#IFGain:Low	SENSE:INT Center Freq: 2.6400 Trig: External1 #Atten: 0 dB	000000 GHz Avg Hold: 100/ Ext Gain: -40.20	03:14:16 P Radio Std 100 0 dB Radio Dev	MJan 09, 2019 : None rice: BTS	Frequency
10 dB/div Ref 23.00 d Log 130 300 -7 00 47 0	Bm AVPHANIMANA	k Mullima M	h managarta	γM		Center Freq 2.64000000 GHz
27.0 27.0 47.0 mv ^N hykyri MvHyKyl 57.0 57.0				Www	fel belle from t	
Center 2.64 GHz #Res BW 200 kHz		VBW 2 MH	z	Spa Swe	n 30 MHz eep 1 ms	CF Step 3.000000 MHz
Occupied Bandw	idth 18.015 MH	Total Z	Power	27.9 dBm		Freq Offset
Transmit Freq Error x dB Bandwidth	6.329 k 18.46 M	Hz % of C Hz xdB	BW Power	99.00 % -26.00 dB		0 Hz
MSG				STATUS		

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



TM3.2, QPSK + 16QAM 99% & 26dB BW, AAHJ mMIMO, B41, 1C, 20 MHZ BW, TM3.2 – 2600 MHz. Port 46



99% & 26dB BW, AAHJ mMIMO, B41, 1C, 20 MHZ BW, TM3.2 - 2640 MHz. Port 1

Center Freq 2.640000 Gate: LO	AC 1000 GHz #FGain:Low	SENSE INT Center Freq: 2.6400 Trig: External1 #Atten: 0 dB	00000 GHz Avg Hold: 100/100 Ext Gain: -40.20 dB	02:42:38 PM Jan 09, 2 Radio Std: None Radio Device: BTS	Frequency
10 dB/div Ref 23.00	dBm Myw ^{NN} WwMydhy	WYMMAN/V	MANARANAN	M	Center Freq 2.640000000 GHz
170 270 370 470 <mark>Apl hys Maring Mari 870 870</mark>				Uningeneric	•
Center 2.64 GHz #Res BW 200 kHz		VBW 2 MH	z	Span 30 M Sweep 1 r	Hz CF Step ns 3.000000 MHz
Occupied Bandy	vidth 17.890 MH	Total F	Power 27	.6 dBm	Freq Offset
Transmit Freq Erro x dB Bandwidth	er 75.898 k 18.42 M	Hz % of O Hz x dB	BW Power 9 -20	99.00 % 6.00 dB	0 Hz
MSG			STAT	rus	1

99% & 26dB BW, AAHJ 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:

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

10LOG₁₀ (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 - Ma	ask values for Ol	BW and Conducted	Spurious n	neasureme	nts at various bandw	vidths

Ca Po	nrier ower	Signal Bandwidth	Measurement RBW	Signal Refere	l Offset nce level	''n'' x MIMO	MIMO Factor	1st MH	z limit	Beyond MHz	the 1st 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, AAHJ mMIMO, B41, 1C, 10MBW, TM3.2, 2595 MHz.

Keysight Spectrue	m Analyzer - Spectrue	n Emission Mask							See at a
Center Frec PASS	2.5950000 ate: LO	00 GHz IFGain:L	.ow	SENSE INT Center Freq: 2. Trig: External1 Atten: 0 dB	595000000 GH Avg: Ext G	tz 100.00% of 1 ain: -40.20 c	01:34 Radio 25 IB Radio	Std: None Device: BTS	Frequency
to dataly	Ref 23.0 dB	m							
Log	Ref 10.0 dia							REAL PROPERTY AND A DESCRIPTION OF THE P	
13.0			s. lat. a Jak	the distant	DALK ARK.				Center Freq
9.00.			NETHON	ALC: NOT THE OWNER.	144 14 11				2.595000000 GHz
7 00									
17.0			ľ I						
77.0									
-37 B								REGOLDE LIND	
47 0	1 million	anglo and the state				and souther	A service and a service and	Spectrum	
57.0	and a start of the								
67.ù									
Center 2.59	5 GHz						Sp	an 30.1 MHz	CF Step
Total Power	Ref 27.3	1 dBm / 10	0 MHz						Auto Mar
				Lower		Peak ->	Upper		Ener Office
Start Freq	Stop Freq	Integ BW	dBm	ΔLim(dB)	Freq (Hz)	dBm	ΔLim(dB)	Freq (Hz)	Frequise
5.050 MHz	6.050 MHz	100.0 kHz	-43.03	(-12.01)	-5.650 M	-41.57	(-10.55)	5.990 M 🚊	0 H2
6.050 MHz	10.05 MHz	100.0 kHz	-43.82	(-2.80)	-6.230 M	-42.82	(-1.80)	6.130 M	
10.05 MHz	15.05 MHz	100.0 kHz	-50.09	(-9.07)	-10.15 M	-44.49	(-3.47)	10.15 M =	
4.000 MHz	8.000 MHz	1.000 MHz					()		
8.000 MHz	12.50 MHz	1.000 MHz		- ()			()		
A DEC MILLS	15:00 MHz	1.000 MHz		· ()			()		
12.30 MHZ									

Out of Band Emissions, AAHJ mMIMO, B41, 1C, 10MBW, TM3.2, 2640 MHz.



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



4.3.1.2 20 MHz Bandwidth

Out of Band Emissions, AAHJ mMIMO, B41, 1C, 20MBW, TM3.2, 2600 MHz.



Out of Band Emissions, AAHJ mMIMO, B41, 1C, 20MBW, TM3.2, 2640 MHz.

Center Frec PASS	2.6400000 ne: LO	00 GHz IFGain:Lo	w #A	nter Freq: 2. g: External1 tten: 0 dB	640000000 GH Avg: 1 Ext G:	z 100.00% of ain: -40.20	Radio 25 dB Radio	Std: None Device: BTS	Frequency
10 dB/div	Ref 23.0 dB	m							
13.0 3.00 7.00		Adapat	h/hyph	mirmin	(mphilling	PM			Center Freq 2.640000000 GHz
17 0 27 0 -37 0 -47 0 14 4 14 14 14	New Marked						him wanta	Absolute Lind Spectra Markel MdMana Jugar	
Center 2.64	GHz Ref 28.16	dBm/ 201	MHz				Sp	oan 40.2 MHz	CF Step 4.020000 MHz Auto Man
Start Freg	Stop Freq	Integ BW	dBm	Lower ALim(dB)	Freq (Hz)	Peak -> dBm	Upper <u>ALim(dB)</u>	Freg (Hz)	Freq Offset
10.10 MHz 11.10 MHz 15.10 MHz 4.000 MHz 8.000 MHz	11,10 MHz 15,10 MHz 20,10 MHz 8,000 MHz 12,50 MHz	200.0 kHz 200.0 kHz 200.0 kHz 1.000 MHz 1.000 MHz	-36.78 -38.89 -41.22	(-5.76) (-0.88) (-3.21) ()	-10.65 M -12.12 M -16.48 M	-37.74 -39.09 -41.37	(-6.72) (-1.08) (-3.36) ()	11.01 M 13.95 M 16.62 M	0 Hz
12.50 MHz 12.50 MHz 12.50 MHz	15.00 MHz 15.00 MHz 15.00 MHz	1.000 MHz 1.000 MHz 1.000 MHz		() ()					

Out of Band Emissions, AAHJ mMIMO, B41, 1C, 20MBW, TM3.2, 2685 MHz.



4.3.2 Dual Carrier (2C)

4.3.2.1 20+10 MHz Bandwidth, Contiguous

Out of Band Emissions, AAHJ mMIMO, B41, 2C, 20+10 MBW, TM3.2, 2600 +2615 MHz Port 46.





Keysight Sp	ectrum Analyzer - Spectru	m Emission Mask							- 6 💌
LXI	RF 50 Ω A	IC		SENSE:INT	750000000000000000000000000000000000000		11:01	:04 AM Jan 11, 2019	Frequency
Center F	req 2.6750000	000 GHz	Cen	iter Freq: 2.t	Avg: 1	z 00.00% of 2	Radio	Std: None	. requerrey
PASS	Gate: LO	IFGain:Lo	w #At	ten: 0 dB	Ext Ga	in: -40.20 dl	B Radio	Device: BTS	
		ii dunizo							
10 dB/div	Ref 23.0 dE	3m							
LOG						that in a		Relative Limit	
13.0		All a shall be a start	内副人品	A PLAN .					Center Freq
3.00		An office of the other states	t da i su a	an tali ta					2.675000000 GHz
-7.00									
-17.0									
07.0									
-27.0									
-37.0								Absolute Limt	
-47.0 444	alayah yang sa				<u> </u>			WWW PARALA	
-57.0								The second s	
-67.0									
Center 2	675 CH7			ļ				an 50 2 MHz	
Genter Z	.075 GHZ						ъþ	an 50.2 Minz	CF Step
									5.020000 MHz
Total Pov	ver Ref 30.5	2 dBm / 30 l	MHz						<u>Auto</u> Man
01.15	01 5		10	Lower	<-	Peak ->	Upper	E (11)	Freq Offset
Start Free	Stop Freq	Integ BW	dBm	$\Delta Lim(dB)$	Freq (Hz)	dBm	∆Lim(dB)	Fleq (Hz)	
15.10 MH	Iz 16.10 MHz	200.0 kHz	-38.23	(-7.21)	-16.06 M	-41.28	(-10.26)	15.40 M 🔶	0 112
16.10 MF	lz 20.10 MHz	200.0 kHz	-40.70	(-2.69)	-16.72 M	-41.05	(-3.04)	18.42 M	
20.10 MF	Hz 25.10 MHz	200.0 kHz	-40.07	(-2.06)	-24.85 M	-43.96	(-5.95)	20.36 M ≡	
4.000 MI	Hz 8.000 MHz	1.000 MHz		()			()		
8.000 MI	Iz 12.50 MHz	1.000 MHz		()			()		
12.50 MF	Iz 15.00 MHz	1.000 MHz		()			()		
12.50 M	IZ 15.00 MHz	1.000 MHz		()			()		
MSG						STA	ATUS		

4.3.2.2 20+10 MHz Bandwidth, Non-Contiguous

Out of Band Emissions, AAHJ mMIMO, B41, 2C, 20+10 MBW, TM3.2, 2600 +2685 MHz Port 46.



Out of Band Emissions, AAHJ 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, AAHJ mMIMO, B41, 2C, 20+20 MBW, TM3.2, 2600 +2620 MHz Port 46.



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

Keysight Sp	ectrum Analyzer - Spe	ectrum Emission Mask							
L <mark>XI</mark>	RF 50 Ω	AC		SENSE:INT			10:26:	08 AM Jan 09, 2019	Frequency
Center F	req 2.67000	00000 GHz	Cent	ter Freq: 2.6	570000000 GHz	0 00% -6 0	Radio	Std: None	riequency
PASS	Gate: LO	IF Colori	μ. Irig	en: 0 dB	Avg: 10	0.00% of 2	B Dadio	Device: BTS	
		IFGain:L	.ow #Att		Ext Gai	n40.20 u		Device. D13	
10 dB/div	Ref 26.0	dBm							
Log								Relative Linit	
16.0		1 11.1							Center Freg
6.00	<u>k</u>	and the late of th	Al-Andria Andria Andria	dia mana	AL ALLANDARY	d. Alt. And A	4		2 67000000 CH-
0.00		adh adh an an a'	a the statistic statistics of the statistics of	and Name	udar di bur ya di	ala	<u>-110,</u>		2.67000000 GHz
-4.00						- ·			
-14.0									
24.0									
-24.0									
-34.0							_	Absolute Limit	
-44.0	the Later of Land			<u>M</u>				Spectrum	
A WARKING	White the second second						6.5	NY WARK WARKS	
-54.0								19794	
-64.0									
Center 2	.67 GHz						Sp	an 60.2 MHz	CE Sten
									6 020000 MHz
									Auto Man
Total Pov	wer Ref 3	30.54 dBm / 40	0 MHZ						<u>Auto</u> mari
Otort From	01 5		10	Lower	<- P	eak ->	Upper		Freg Offset
Start Free	Stop F	req Integ BW	aBm	ΔLIM(dB)	Freq (Hz)	abm	∆LIM(dB)	Freq (Hz)	0.11-
20.10 MF	Hz 21.10 Mi	Hz 200.0 kHz	-41.58	(-10.56)	-20.37 M	-40.56	(-9.54)	20.54 M 🔶	0 H2
21.10 M	Hz 25.10 MI	Hz 200.0 kHz	-41.71	(-3.70)	-22.67 M	-39.96	(-1.95)	23.18 M	
25.10 MI	Iz 30.10 MI	Hz 200.0 kHz	-41.46	(-3.45)	-26.04 M	-44.21	(-6.20)	25.62 M ≡	
4.000 MH	Iz 8.000 MI	Hz 1.000 MHz		()			()		
8.000 MH	Hz 12.50 MH	Hz 1.000 MHz		()			()		
12.50 MI	Iz 15.00 MI	Hz 1.000 MHz		()			()		
12.50 MI	Iz 15.00 Mi	Hz 1.000 MHz		()			()		
MSG						ST	ATUS		

4.3.2.4 20+20 MHz Bandwidth, Non-Contiguous





Out of Band Emissions, AAHJ 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

🔤 Keysight Sp	pectrum Ana	lyzer - Spe	ectrum Emissio	n Mask									
l XI	RF	50 Ω	AC			SENSE:	INT			02:5	0:06 PM Jan 10, 2	2019	Fraguanay
Center F	req 2.0	61500	10000 GI	Ηz	Ce	enter Freq:	2.61500	0000 GHz		Radio	o Std: None		Frequency
PASS	Gate: LO	D			Ir	ig: Externa	al1	Avg: 10	0.00% of 25) Dedi		.	
TASS			IF	Gain:Low	##	Atten: 0 dB		Ext Gai	n: -40.20 dE	Radio	Device: B13	<u>`</u>	
	Do	f 23 A	dBm										
Loa	NG	23.0									Relative	Limit	
13.0			1101-111-0	la serate						den de sales			Contor From
0.00		l had		(WWWW)	4/MA	Net start of	ar alama	M ADA A	N MMP	1 W A			Centerrieq
3.00		T I I I	A destant	╎╢╌┝╷╢	1.11	1. 10 M M	en diret.	- 1 1.	<u>' ' '</u>				2.615000000 GHz
-7.00		+											
-17.0													
-27.0													
-37.0		-							_ <mark>\</mark>		Absolute	Linit	
-47 N		la <mark>l</mark> í			V				<u>\(</u>		ANT	(dela	
A. S.	White and a	ii i											
-57.0													
-67.0													
Center 2	2.615 G	Hz								S	oan 70.2 №	Hz	CE Oton
		_											Auto Map
Total Po	wer Ref	i 3	2.66 dBm /	50 M	Hz								Huto Mari
01-15		01 5			-ID	Lower		<- P	eak ->	Upper	E (11		Freq Offset
Start Fre	p	Stop Fi	req Integ) BW	dBm	ΔLim(di	B) Free	1 (HZ)	dBm ∠	VTIM(dB)	Freq (HZ)		
25.10 M	Hz 2	6.10 MI	z 200.0) kHz	-41.06	(-10.04)) -2	5.62 M	-38.29	(-7.27)	25.60 M		UHZ
26.10 M	Hz 3	0.10 MI	lz 200.0) kHz	-42.50	(-4.49)) -2	7.31 M	-40.50	(-2.49)	30.05 N		
30.10 M	Hz 3	5.10 MI	lz 200.0) kHz	-47.19	(-9.18) -30	0.15 M	-40.71	(-2.70)	34.50 M	Ξ	
4.000 M	Hz 8	.000 MI	lz 1.000	MHz		()			()			
8.000 M	Hz 1	2.50 MI	lz 1.000	MHz		()			()			
12.50 M	Hz 1	5.00 MI	lz 1.000	MHz		()			()			
12.50 M	Hz 1	5.00 MI	lz 1.000	MHz		()			()			
MSG									STA	TUS			
												_	

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





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



OOBE, AAHJ mMIMO, B41, 3C, 20+20+10 MBW, TM3.2, 2600+2640+2645 MHz Port 46.



🔤 Keysight Spectrum Analyzer - Spectrum Emission Mask									
Center F	RF 50 Ω A req 2.6600000 Gate: LO	C IOO GHz IFGain:Lov	Cento ↔→ Trig: , #Atte	SENSE:INT er Freq: 2.66 External1 n: 0 dB	60000000 GHz Avg: 100 Ext Gain	.00% of 2 : -40.20 d	02:31:3 Radio \$ 25 IB Radio [9 PM Jan 11, 2019 Std: None Device: BTS	Frequency
10 d <u>B/div</u> Log	Ref 23.0 dE	3m						Relative Limit	
13.0 3.00	///// //	with a fifth		www.www.	/ ¹⁴ 4#A		y le /Wwhyk		Center Freq 2.66000000 GHz
-7.00									
-37.0 -47.0					Made Market	n hall		Absolute Limit Spectrum	
-67.0									
Center 2	.66 GHZ ver Ref 32.6	5 dBm / 60 N	1Hz				Spa	in 80.2 MHz	CF Step 8.020000 MHz <u>Auto</u> Man
Start Free	Stop Freq	Integ BW	dBm 4	Lower \Lim(dB)	<- Pe Freq (Hz)	ak -> dBm	Upper ∆Lim(dB)	Freq (Hz)	Freq Offset
30.10 MF	lz 31.10 MHz	200.0 kHz	-39.94	(-8.92)	-30.68 M	-38.87	(-7.85)	30.54 M 🔶	0 Hz
31.10 MF	Iz 35.10 MHz	200.0 kHz	-39.87	(-1.86)	-35.01 M	-40.32	(-2.31)	31.32 M	
35.10 MF	1z 40.10 MHz	200.0 kHz	-39.40	(-1.39)	-36.33 M	-43.38	(-5.37)	36.25 M ≡	
4.000 MF	12 0.000 MHZ 12 12 50 MHz	1.000 MHz		()			()		
12.50 MF	z 15.00 MHz	1.000 MHz		()			()		
12.50 MH	z 15.00 MHz	1.000 MHz		()			()		
MSG						ST	ATUS		

4.3.3.3 20+20+20 MHz Bandwidth



OOBE, AAHJ mMIMO, B41, 3C, 20+20+20 MBW, TM3.2, 2600+2620+2680 MHz Port 46.



🔤 Keysight Sp	ectrum Analyzer - Spectru	m Emission Mask							
L <mark>XI</mark>	RF 50 Ω A	AC		SENSE:INT			09:38:	03 AM Jan 09, 2019	Frequency
Center F	req 2.6600000)00 GHz	Cer	nter Freq: 2.0 a: External1	560000000 GH	Z 00.00% of '	Radio	Std: None	riequeriey
PASS	Gate: LO	IFGain:Low	v #A1	tten: 0 dB	Ext Ga	in: -40.20 d	dB Radio	Device: BTS	
		ii dameoi							
10 dB/div	Ref 26.0 dE	3m							
LOG								Relative Limit	
10.0	the state		and the set of the set	the table of	անություններին հետև	Mindl Alau	d. islandstate		Center Freq
6.00	M CAT I	49 A PA 494		19441	°₩₩₩ <u>₩</u> ₩	<u> YN HYN</u>	l MAR M		2.660000000 GHz
-4.00	- Inter Le	<u>. Hul - alt ad.</u>	<u>\</u> }₽₽₽			14			
-14 በ									
21.0									
-24.U								1	
-34.0			\downarrow					Absolute Limit	
-44.0			<u> </u>					Made and Markey or	
54.0	Charles and the second		Y I		u.			and the state of t	
-34.0									
-64.0									
Conton 2	66 011-						0		
Center 2	.00 GH2						sp	an 80.2 MHZ	CF Step
									8.020000 MHz
Total Pov	ver Ref 32.5	i9 dBm / 60 M	ЛНz						<u>Auto</u> Man
				Lower	<-	Peak ->	Upper		Erea Offect
Start Free	Stop Freq	Integ BW	dBm	∆Lim(dB)	Freq (Hz)	dBm	∆Lim(dB)	Freq (Hz)	Frequise
30.10 MH	Iz 31.10 MHz	200.0 kHz	-37.32	(-6.30)	-30.22 M	-40.09	(-9.07)	30.34 M 🔶	0 Hz
31.10 MF	Iz 35.10 MHz	200.0 kHz	-40.85	(-2.84)	-32.32 M	-39.97	(-1.96)	33.16 M	
35.10 MH	Iz 40.10 MHz	200.0 kHz	-40.26	(-2.25)	-39.34 M	-42.67	(-4.66)	35.57 M ≡	
4.000 MH	Iz 8.000 MHz	1.000 MHz		()			()		
8.000 MH	Iz 12.50 MHz	1.000 MHz		()			()		
12.50 MH	Iz 15.00 MHz	1.000 MHz		()			()		
12.50 MH	Iz 15.00 MHz	1.000 MHz		()			()		
MSG						ST	TATUS		

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, AAHJ mMIMO - Small Band, B41, 1C, 20MBW, TM3.2, 2506 MHz, Port 46. Spurious Emissions 10 MHz – 1000 MHz

OM RF 50 g A DC SENSE:INT 09:11:32 AMJan 10,2019 Free Center Freq 2.600000000 GHz Center Freq 2.60000000 GHz Radio Std: None Free PASS Gate: LO IFGain:Low Atten: 0 dB Ext Gain: -39:60 dB Radio Device: BTS 904.95 MH2	quency
Center Freq 2.60/00/00/00 GHz Center Freq: 2.50/00/00 GHz Radio Std: None PASS Gate: LO Trig: External 1 Avg Hold: 100/100 #Atten: 0 dB Ext Gain: -39.60 dB Radio Device: BTS 9044.95 MH2 Std: None	
PASS Gate: LO IFGain:Low #Atten: 0 dB Ext Gain: -39.60 dB Radio Device: BTS #Atten: 0 dB 904.95 MH2	
904.95 MHz	
904.95 MHZ	
10 dB/div Ref -10.00 dBm -61.525 dBm	
Log	
	enter Freq
30.0 2.600	000000 GHz
300	
-100	
Start 10 MHz Stop 1 GHz	CF Step
5.	000000 MHz
Onur Danza Franciscu Amplituda Limit Alimit	Man
1 1 904.9 MHz -53.56 dBm -31.10 dBm -22.46 dB 🚔 🔤	
2 1 693.6 MHz -53.73 dBm -31.10 dBm -22.63 dB	req Offset
3 1 828.3 MHz -54.34 dBm -31.10 dBm -23.24 dB	0 Hz
4 1 843 9 MHz -54 46 dBm -31 10 dBm -23 36 dB	
5 1 335.0 MHz 54.54 dBm 31.10 dBm 23.44 dB	
6 1 263.7 MHZ -54.55 dBm -31.10 dBm -23.45 dB	
7 1 769.3 MHz -54.56 dBm -31.10 dBm -23.46 dB	
MSG 🕹 File <spurious_tm3_2_1c_20mbw_2600_tx1_10_to_1000.png> saved</spurious_tm3_2_1c_20mbw_2600_tx1_10_to_1000.png>	

Report No.: TR-2018-0270-FCC2-27 Product: AAHJ mMIMO - Small Band

0 Hz

Ke 09:12:14 AM Jan 10, 2019 Radio Std: None GHz Center Freq: 2.600000000 GHz IFGain:Low #Atten: 0 dB Ext Gain: -40.20 dB Frequency Center Freq 2.600000000 GHz PASS Gate: LO Radio Device: BTS 2.5830 GHz -49.093 dBm Ref 0.00 dBm 10 dB/div _og **Center Freq** 2.600000000 GHz Start 1 GHz Stop 2.585 GHz CF Step 5.000000 MHz Man <u>Auto</u> Spur Range Frequency Amplitude Limit Δ Limit -45.17 dBm -46.56 dBm -14.07 dB -15.46 dB 2.583 GHz -31.10 dBm Freq Offset 2.549 GHz -31.10 dBm 2 1 2.488 GHz -46.64 dBm -31.10 dBm -15.54 dB 4 2.541 GHz -46.85 dBm -31.10 dBm -15.75 dB 1 -46.89 dBm -31.10 dBm -15.79 dB 2.493 GHz 1 6 2.354 GHz -46.92 dBm -31.10 dBm -15.82 dB 1

Spurious Emissions 1000 MHz – 2585 MHz

Spurious Emissions 2615 – 2690 MHz

G 🕹 File <Spurious_TM3_2_1C_20MBW_2600_TX1_1000_to_2585.png> saved

2.554 GHz

7

1

-47.04 dBm

🔤 Keysight Sp	Keysight Spectrum Analyzer - Spurious Emissions										
(X) Contor E	RF 5		SEN Center Fr	ISE:INT		09:12:31 / Radio Std	M Jan 10, 2019	Frequency			
	Gate: LO	000000 GHZ	Trig: Exte	ernal1 Avg Ho	ld:>100/100		. Hone				
PASS		IFGain	:Low #Atten: 0	dB Ext Gai	n: -40.20 dB	Radio Dev	vice: BTS				
						2.6	564 GHz				
10 dB/div	Ref 0.	.00 dBm				-52.5	18 dBm				
Log 10.0								O E			
20.0								Center Freq			
-20.0								2.60000000 GHZ			
-30.0											
-40.0				1							
-50.0 Julana	welnesserver	warman warma warma w	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	amon and and and and and and and and and an	warante	wayaha waka waka waka waka waka waka waka w					
-60.0											
-70.0											
-80.0											
-90.0											
Start 2.6	15 GHz					Stop	2.69 GHz	CF Step			
								5.000000 MHz			
Spur	Range	Frequency	Amplitude	Limit		∆ Limit		<u>Auto</u> Man			
1	1	2.656 GHz	-45.21 dBm	-38.10 d	3m -7	.109 dB	*				
2	1	2.678 GHz	-45.35 dBm	-38.10 d	Bm -7	.248 dB		Freq Offset			
3	1	2.679 GHz	-45.46 dBm	-38.10 d	Bm -7	.364 dB	=	0 Hz			
4	1	2.619 GHz	-45.61 dBm	-38.10 d	Bm -7	.506 dB					
5	1	2.666 GHz	-45.92 dBm	-38.10 d	Bm -7	.817 dB					
6	1	2.633 GHz	-46.36 dBm	-38.10 d	Bm -8	3.263 dB					
7	1	2.637 GHz	-46.37 dBm	-38.10 d	Bm -8	3.267 dB	+				
мsg 🧼 File	se UFile <spurious_tm3_2_1c_20mbw_2600_tx1_2615_to_2690.png> saved status</spurious_tm3_2_1c_20mbw_2600_tx1_2615_to_2690.png>										

-31.10 dBm

-15.94 dB

STATUS

Report No.: TR-2018-0270-FCC2-27 Product: AAHJ mMIMO - Small Band

🔤 Keysight Spectrum Analyzer - Spurious Emissions										
Center F	RF : 10	50 Ω AC 0000000 GHz	Center Fr Trig: Exte	vse:INT req: 2.600000000 GHz ernal1 Avg Hold:	09:15:37 Radio St 100/100	AM Jan 10, 2019 d: None	Frequency			
PASS	Oute: EO	IFGain	:Low 🔭 #Atten: 0	dB Ext Gain:	-42.50 dB Radio De	vice: BTS				
10 dBidiy	Ref ()	.00 dBm			2.6 -44.2	900 GHz 232 dBm				
Log										
-10.0							Center Freq			
20.0							2.00000000 8112			
-40.0										
-50.0	<u>~</u>									
-60.0										
-70.0										
-80.0										
-90.0										
Start 2.6	9 GHz				St	op 10 GHz	CE Sten			
							5.000000 MHz			
Spur	Range	Frequency	Amplitude	Limit	∆ Limit		<u>Auto</u> Man			
1	1	2.690 GHz	-42.76 dBm	-31.10 dBn	n -11.66 dB	<u>^</u>	Ener Offerst			
2	1	6.255 GHz	-43.39 dBm	-31.10 dBn	n -12.29 dB		FreqUnset			
3	1	5.427 GHz	-43.97 dBm	-31.10 dBn	n -12.87 dB	=	UHZ			
4	1	3.206 GHz	-44.12 dBm	-31.10 dBn	n -13.02 dB					
5	1	5.268 GHz	-44.13 dBm	-31.10 dBn	n -13.03 dB					
6	1	5.447 GHz	-44.16 dBm	-31.10 dBn	n -13.06 dB					
7	1	8.860 GHz	-44.19 dBm	-31.10 dBn	n -13.09 dB	*				
мsg 🗼 File	<spurious_< td=""><td>TM3_2_1C_20MB</td><td>W_2600_TX1_2690</td><td>_to_10000.png> saved</td><td>STATUS</td><td></td><td></td></spurious_<>	TM3_2_1C_20MB	W_2600_TX1_2690	_to_10000.png> saved	STATUS					

Spurious Emissions 2690 MHz – 10000 MHz

Spurious Emissions 10 GHz- 27 GHz



5.1.2 Dual Carrier (2C)

Spurious Emissions, AAHJ mMIMO - Small Band, B41, 2C, 20 + 10 MHz BW, TM3.2, 2640, 2685 MHz, Spurious Emissions 10 MHz – 1000 MHz



Spurious Emissions 1000 MHz – 2590 MHz



Report No.: TR-2018-0270-FCC2-27 Product: AAHJ mMIMO - Small Band

Spurious Emissions 2590 – 2625 MHz



Spurious Emissions 2655 – 2675 MHz



Report No.: TR-2018-0270-FCC2-27 Product: AAHJ mMIMO - Small Band



Spurious Emissions 2695 MHz – 10000 MHz

Spurious Emissions 10 GHz- 27 GHz



5.1.3 Triple Carrier (3C)

Spurious Emissions, AAHJ mMIMO - Small Band, B41, 3C, 33dBm, 60MBW, TM3.2, 2640, 2660 and 2680 MHz,

Spurious Emissions 10 MHz – 1000 MHz

Keysight Spectrum Analyzer - Spurious Emissions												
Center Fro	RF 5 eq 2.660	:0 Ω <u>≜</u> DC 0000000 GHz	Center Fre	eq: 2.660000000 GHz ernal1 Avg Hold:	09:47:14 Radio S : 100/100	AM Jan 09, 2019 d: None	Frequency					
PASS	Gale. LO	IFGain:Lo	w #Atten: 0	dB Ext Gain:	-39.60 dB Radio D	evice: BTS						
10 dB/div	Ref -1	0.00 dBm			85 -62.).91 MHz 358 dBm						
Log												
-20.0							Center Freq					
-30.0							2.66000000 GHz					
-40.0												
-50.0					1							
-60.0					? `							
-70.0												
-80.0												
-90.0												
-100												
Start 10 №	Hz					stop 1 GHz	CF Step 8.020000 MHz					
Spur	Range	Frequency	Amplitude	Limit	Δ Limit		<u>Auto</u> Man					
1	1	850.9 MHz	-53.95 dBm	-31.10 dBr	n -22.85 dB	Â	Ener Offerst					
2	1	141.9 MHz	-54.29 dBm	-31.10 dBr	n -23.19 dB		FreqOffset					
3	1	859.6 MHz	-54.32 dBm	-31.10 dBr	n -23.22 dB	=	0 H2					
4	1	722.8 MHz	-54.43 dBm	-31.10 dBr	n -23.33 dB							
5	1	798.0 MHz	-54.46 dBm	-31.10 dBr	n -23.36 dB							
6	1	139.1 MHz	-54.50 dBm	-31.10 dBr	n -23.40 dB							
	1	594.9 MHz	-54.52 dBm	-31.10 dBr	n -23.42 dB	-						
мsg 🕕 File <	Spurious_T	M3_2_3C_20+20+2	0MBW_2640_266	60_2680_TX2_10_to_	1000 STATUS LDC C	oupled						

Spurious Emissions 1000 MHz – 2600

Keysight Spe	ectrum Analyzer	- Spurious Emissions							
	RF 5	50 Ω AC		SENSE:II	IT		09:48:05	AM Jan 09, 2019	Frequency
enter F	req 2.660	0000000 GHz		Center Freq: 2	2.660000000 G	Hz Hold:>100	Radio St	d: None	requeriey
ASS	Gate: LO	IFGai	n:Low	#Atten: 0 dB	Ext	Gain: -40.20	dB Radio De	vice: BTS	
							2.5		
							_39.4	565 dBm	
0 dB/div	Rer U.	.vv aBm					-00.0		
0.0									Center Fred
									2 66000000 GHz
.0.0									2.880000000 GH2
0.0								<u> </u>	
0.0								<mark>.</mark>	
0.0									
0.0									
'0.0									
0.0									
0.0									
tart 1 G	Hz						Sto	n 2.6 GHz	
							510	p 2.0 Onz	CF Step
									8.020000 MHZ
Spur	Range	Frequency	Am	plitude	Lir	nit	Δ Limit		Auto
1	1	2.599 GHz	-32.4	45 dBm	-31.10	dBm	-1.355 dB	^	
2	1	2.593 GHz	-32.5	58 dBm	-31.10	dBm	-1.483 dB		Freq Offset
3	1	2 594 GHz	-32 (98 dBm	-31 10	dBm	-1 881 dB	_	0 Hz
4	1 _	2 589 GHz	-33.9	81 dBm	-31_10	dBm	-2 708 dB		
5	1	2 501 GHz	-34 7	75 dBm	-31 10	dBm	-3.654 dB		
6	1	2.591 GHZ	-34.0		-31.10	dBm	-5.654 dB		
7		2.592 GHZ	-34.0		-31.10	dBm	-3.098 dB		
1	1	2.588 GHZ	-35.0	J4 aBM	-31.10	aBM	-3.935 dB	-	
S VFIIe							STATUS		

Report No.: TR-2018-0270-FCC2-27 Product: AAHJ mMIMO - Small Band

Spurious Emissions 2600 – 2625 MHz

Keysight :	Spectrum Analyzer	- Spurious Emissions						
Center	RF 5		Center Fr	NSE:INT rea: 2.66000000 GH	Hz	09:48:31 A	MJan 09, 2019 : None	Frequency
PASS	Gate: LO	IFGain:	:Low Trig: Exte	ernal1 Avg dB Ext G	Hold:>100/100 ain: -40.20 dB	Radio Dev	ice: BTS	
10 dB/div	Ref 0	.00 dBm				2.60 -42.3	14 GHz 18 dBm	
-10.0 -20.0								Center Freq 2.660000000 GHz
-30.0 -40.0 -50.0	↓1 الرسیدین	ᠬᠬ᠕ᡁᡡᡅᡗᡁ	ww	ᠧ᠕᠋ᢔᡁᡀᠬᢧᢪᡗᠰ᠋ᢩ	ԻՄ ^{ՆԻ} ԴԱպյիս	<mark>Լ</mark> Ա _{ԴՐԴ} ՈՆ	ᡁᠾᠬ᠋᠆ᢧᡗᡀ	
-60.0 -70.0								
-90.0	6 CH7					Stop 2	625 CHz	
Start 2.	o GH2					Stop-2	.023 GH2	CF Step 8.020000 MHz Auto Man
Spur	Range	Frequency	Amplitude	Lim	it i	∆ Limit		
1 2	1 1	2.601 GHz 2.607 GHz	-39.40 dBm -39.89 dBm	-38.10 -38.10	dBm -1 dBm -1	.296 dB .789 dB	<u>^</u>	Freq Offset
3	1	2.602 GHz	-40.44 dBm	-38.10	dBm -2	.335 dB	=	0 Hz
4	1	2.624 GHz	-40.44 dBm	-38.10	dBm -2	.339 dB		
5	1	2.616 GHz	-40.72 dBm	-38.10	dBm -2	.618 dB		
6 7	1	2.613 GHz 2.620 GHz	-41.25 dBm -41.44 dBm	-38.10 -38.10	dBm -3 dBm -3	.147 dB .338 dB	-	
мsg 🤳 File	e				STATU	IS		

Spurious Emissions 2695 MHz – 10000 MHz

🔤 Keysight Sp	ectrum Analyzer	- Spurious Emissions					
l XI	RF	50 Ω AC	SEI	NSE:INT	09:51:40	AM Jan 09, 2019	Frequency
Center F	req 2.660	0000000 GHz	Center Fr	req: 2.660000000 GHz	Radio St	d: None	ricqueriey
PASS	Gate: LO	IFGair	n:Low #Atten: 0	dB Ext Gain:	-42.50 dB Radio De	evice: BTS	
					0.0		
					2.0	334 GHZ	
10 dB/div	Ref 0	.00 dBm			-59.4	+51 UBIII	
-10.0							Contor From
							CenterFreq
-20.0							2.660000000 GHz
-30.0 1							
-40.0 📛							
-50.0							
60.0							
-00.0							
-70.0							
-80.0						_	
-90.0							
Start 2.6	i95 GHz				St	op 10 GHz	CE Sten
							8.020000 MHz
Spur	Pange	Frequency	Amplitude	Limit	A Limit		<u>Auto</u> Man
opui	Kunge	ricquericy	Amplitude				
1	1	2.695 GHZ	-36.93 dBm	-31.10 dBr	n -5.827 dB	<u></u>	Erea Offset
2	1	5.335 GHz	-41.95 dBm	-31.10 dBr	n -10.85 dB		i requiser
3	1	3.138 GHz	-42.32 dBm	-31.10 dBr	n -11.22 dB	=	0 Hz
4	1	5.420 GHz	-42.38 dBm	-31.10 dBr	n -11.28 dB		
5	1	6.288 GHz	-42.62 dBm	-31.10 dBr	n -11.52 dB		
6	1	3.039 GHz	-43.08 dBm	-31.10 dBr	n -11.98 dB		
7	1	5.326 GHz	-43.23 dBm	-31.10 dBr	n -12.13 dB		
						· · ·	
MSG DFile					STATUS		
· IIC.							

Product: AAHJ mMIMO - Small Band

🔤 Keys	sight Spectrum Analyzer	- Spurious Emissions					
(X) Cent	er Freg 2.66	50 Ω AC 000000 GHz	Center Fr	vse:INT req: 2.660000000 GHz	Ra	9:59:13 AM Jan 09, 20 dio Std: None	Frequency
PAS	Gate: LO	IFGain:	Low Trig: Extent	ernal1 Avg Hold: dB Ext Gain:	25/25 -35.30 dB Ra	dio Device: BTS	
10 dB	idiv Ref 0	.00 dBm				25.635 GH -43.161 dBi	n n
-10.0 - -20.0 -							Center Freq 2.66000000 GHz
-40.0 -							
-50.0 -		~~~~~					
-70.0 - -80.0 -							
Start	10 GHz					Stop 27 GH	7
Otart							CF Step 359.000000 MHz
S	our Range	Frequency	Amplitude	Limit	Δ Liı	mit	Auto Mari
1	1	25.63 GHz	-43.16 dBm	-31.10 dBr	n -12.06) dB	Freq Offset 0 Hz
MSG					STATUS		

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	Туре	Description	Model	Serial	Calibration Date	Calibration Due	Calibration Type	Status
<u>E831</u>	Agilent Technologies	MXA Signal Analyzer	20Hz- 26.5GHz	N9020A	MY48011791	2018-02-15	2020-02-15	Requires Calibration	Active
<u>E1208</u>	RLC Electronics Inc	High Pass Filter	5GHz to 26GHz High Pass Filter	F-19391	1440-001		2018-08-07	Calibration Not Required, Must Be Verified	Active
<u>E1156</u>	Weinschel	Attenuator	10dB 0.05GHz- 26GHz 25W	74-10-12	1069		2018-08-07	Calibration Not Required, Must Be Verified	Active
<u>E1155</u>	Weinschel	Attenuator	10dB 25Watt 0.05GHz - 26GHz	74-10-12	1068		2018-08-07	Calibration Not Required, Must Be Verified	Active
<u>E1154</u>	Weinschel	Attenuator	30dB 25W 0.05GHz- 26GHz	74-30-12	1065		2018-08-07	Calibration Not Required, Must Be Verified	Active
	UTIFLEX Micro Coax	RF Cable	UFB142A- 0-0720- 2G0200/A. MFR65639 227883-001	142A Series 503609-G			2018-08-07	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
AAHJ	Nokia	64T64R B41 RRH	6Q184613825	474795A.M01	DC

6.2 Frequency Stability Test

Frequency Stability Testing was completed on AirScale 64T64R 128AE B41 AAHJ Radio Unit for massive MIMO with a center frequency of 2640 MHz using an external ASMI (AirScale System Module Indoor BBU). The testing was performed from 1/29/2019 through 1/30/2019 on the AAHJ 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 (+50°C, system ambient) and low temperature (-30°C 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 (2640 MHz).

<u>UUT:</u> AirScale AAS 64T64R 128AE B41 AAHJ Radio Unit, PN: 474795A.M01, SN: 6Q184613825.

6.2.1 Frequency Stability Results:

The worst case Frequency Stability over temperature and voltage for the DC Product was **+15.872 Hz** which is **+0.00601 ppm**.

This are within the +/- 0.05ppm desired performance required for LTE operation.

FIGURE 6.2: Frequency Stability Test Set-Up DC Power

FIGURE 1: 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: <u>AAHJ AirScale AAS 64T64R 128AE B41 RRH_(CF = 2640MHz)</u>

(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.

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	7.499	
0.5	8.298	
1.0	1.037	
1.5	4.733	
2.0	6.514	
2.5	5.972	
3.0	2.328	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	\pm 0.05ppm = \pm 132 Hz	
FCC RESULT	PASS	

Baseline Measurement at +25°C

Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	8.076	
0.5	3.837	
1.0	11.333	
1.5	13.721	
2.0	0.583	
2.5	5.208	
3.0	4.063	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	±0.05ppm = ±132 Hz	
FCC RESULT	PASS	

Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	8.871	
0.5	1.709	
1.0	5.888	
1.5	15.872	
2.0	8.670	
2.5	2.926	
3.0	8.570	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	±0.05ppm = ±132 Hz	
FCC RESULT	PASS	

Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	1.877	
0.5	7.363	
1.0	6.489	
1.5	5.537	
2.0	9.170	
2.5	6.291	
3.0	1.622	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	± 0.05 ppm = ± 132 Hz	
FCC RESULT	PASS	

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	5.553	
0.5	8.405	
1.0	9.062	
1.5	2.395	
2.0	6.969	
2.5	10.926	
3.0	2.847	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	±0.05ppm = ±132 Hz	
FCC RESULT	PASS	

Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	11.983	
0.5	3.096	
1.0	8.532	
1.5	15.172	
2.0	5.216	
2.5	1.905	
3.0	3.084	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	±0.05ppm = ±132 Hz	
FCC RESULT	PASS	

Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	10.079	
0.5	13.306	
1.0	3.176	
1.5	6.892	
2.0	3.101	
2.5	4.663	
3.0	1.667	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	±0.05ppm = ±132 Hz	
FCC RESULT	PASS	

Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	3.825	
0.5	5.211	
1.0	1.053	
1.5	4.081	
2.0	10.881	
2.5	12.864	
3.0	5.519	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	\pm 0.05ppm = \pm 132 Hz	
FCC RESULT	PASS	

Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	7.038	
0.5	11.192	
1.0	7.754	
1.5	6.094	
2.0	2.112	
2.5	0.518	
3.0	7.701	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	±0.05ppm = ±132 Hz	
FCC RESULT	PASS	

Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC		
Time, (minutes)	Transmit Carrier Deviation, (Hz)	
0	5.601	
0.5	12.567	
1.0	4.594	
1.5	7.607	
2.0	6.427	
2.5	7.401	
3.0	5.390	
FCC SPECIFICATION	±2640 MHz (±0.05ppm)	
	±0.05ppm = ±132 Hz	
FCC RESULT	PASS	

Upon return to +25°C.

 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	4.741
0.5	11.970
1.0	2.033
1.5	9.450
2.0	2.313
2.5	7.034
3.0	4.846
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	±0.05ppm = ±132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at 103% of Nominal Voltage, -49.44VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	8.225
0.5	2.716
1.0	10.580
1.5	3.269
2.0	8.427
2.5	4.931
3.0	9.330
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	± 0.05 ppm = ± 132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at 106% of Nominal Voltage, -50.88VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	1.693
0.5	4.827
1.0	6.422
1.5	1.906
2.0	11.061
2.5	6.050
3.0	7.472
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	± 0.05 ppm = ± 132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at 109% of Nominal Voltage, -52.32VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	10.796
0.5	2.241
1.0	6.893
1.5	9.628
2.0	10.270
2.5	7.286
3.0	2.138
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	\pm 0.05ppm = \pm 132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at 112% of Nominal Voltage, -53.76VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	5.803
0.5	2.459
1.0	1.413
1.5	9.606
2.0	8.839
2.5	2.761
3.0	6.242
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	±0.05ppm = ±132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at 115% of Nominal Voltage, -55.20VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	6.189
0.5	1.044
1.0	9.081
1.5	7.924
2.0	6.607
2.5	2.126
3.0	4.211
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	±0.05ppm = ±132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48.0VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	2.722
0.5	7.437
1.0	10.639
1.5	6.489
2.0	4.561
2.5	6.950
3.0	2.494
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	\pm 0.05ppm = \pm 132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, -46.56VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	5.902
0.5	1.619
1.0	3.003
1.5	6.708
2.0	7.131
2.5	11.387
3.0	1.316
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	±0.05ppm = ±132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, -45.12VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	1.127
0.5	5.219
1.0	11.311
1.5	6.399
2.0	1.876
2.5	3.454
3.0	5.271
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	\pm 0.05ppm = \pm 132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, -43.68VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	3.378
0.5	8.581
1.0	6.193
1.5	2.532
2.0	3.147
2.5	5.952
3.0	9.348
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	±0.05ppm = ±132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, -42.24VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	1.029
0.5	5.904
1.0	10.796
1.5	8.492
2.0	6.931
2.5	4.263
3.0	1.017
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	\pm 0.05ppm = \pm 132 Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, -40.80VDC	
Time, (minutes)	Transmit Carrier Deviation, (Hz)
0	3.602
0.5	1.419
1.0	7.145
1.5	9.774
2.0	1.301
2.5	6.685
3.0	3.973
FCC SPECIFICATION	±2640 MHz (±0.05ppm)
	\pm 0.05ppm = \pm 132 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*10⁶) – (43 + 10 log P) = 82.23 dBµV/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 dB μ V/m. The non-report level is 62.23 dB μ V/m which is higher than the FCC Part 15 Class B limit of 54 dB μ V/m.

The calculated emission levels were found by:

Measured level (dB μ V) + Cable Loss(dB)+Antenna Factor(dB) = Field Strength (dB μ V/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 dB μ V/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dB μ V/meter at 3m are not reportable and may be verified using field strength measurements and broadband antennas. Over the out of band spectrum investigated from 30 MHz to beyond the tenth harmonic of the carrier (up to 27GHz), no reportable spurious emissions were detected.

The product was also compliant with Part 15 Class B.

7.3 Radiated Emissions Test Equipment

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

