NOKIA Bell Labs

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TESTING
NVLAP LAB CODE: 100275-0

Title 47 Code of Federal Regulations Test Report

Regulation:
FCC Part 2 and 90

Client:
Nokia Mobile Networks

Product Evaluated:
AHCC AirScale RRH 4T4R B26A
(NB-IoT Standalone)

Report Number:
TR-2019-0054-FCC2-90

Date Issued:
April 18, 2019

Table of Contents

Revisions

Date	Revision	Section	Change
04/12/2019	0		Initial Release
04/15/2019	1	2.1	Table header revision
04/18/2019	2	2.1, 4.1	Table header revision

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Signed:  4/15/2019

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FCC Filing Lead

1. System Information and Requirements

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

Equipment Under Test (EUT):	AHCC AirScale RRH 4T4R B26A
FCC ID:	VBNAHCC-01
Serial Number:	F7190313011, F7190313015
Hardware Version:	X21
Software Version:	FL19_FSM4_9999_190214_024938
Frequency Range:	862.9-869 MHz
GPCL Project Number:	2019-0054
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAPORTTI 3, FI-02610 ESPOO FINLAND
Applicant:	NOKIA SOLUTIONS AND NETWORKS US LLC 6000 CONNECTION DRIVE IRVING, TEXAS 75039
Test Requirement(s):	Title 47 CFR Parts 2 and 90
Test Standards:	• Title 47 CFR Parts 2 and 90 • KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018. • KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 • ANSI C63.26 (2015) • ANSI C63.4 (2014)
Measurement Procedure(s):	• FCC-IC-OB - GPCL Occupied Bandwidth and Power Measurement Test Procedure 12-4-2017 • FCC-IC-SE - GPCL Spurious Emissions Test Procedure 12-4-2017
Test Date(s):	Mar/Apr 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:	Steve Gordon
Test Engineer (s):	Jaideep Yadav, Eugene Mitchell, Mike Soli, Steve Gordon
Test Results: The AHCC AirScale RRH 4T4R B26A, *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 test report applies to the AHCC AirScale RRH 4T4R B26A, 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 90 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

1.3 EUT Details

1.3.1 Specifications

Specification Items	Description		
Radio Access Technology	LTE		
Duplex Mode	FDD		
Transmit Modes	2Tx2R & 4Tx4R		
Modulation Type(s)	QPSK, 16QAM, 64QAM, 256QAM		
Operation Frequency Range	862.9-869 MHz		
Channel Bandwidth	1.4/3/5 MHz		
Number of Tx Ports per Unit	4		
Number of Rx Ports Per Unit	4		
MIMO	Yes		
Max Conducted Power	100		
Min Conducted Power	5		
Maxi. Number of Carriers per Port	4		
Maxi. Spacing between Carriers in Number of Carriers	N/A		
Deployment Environment	Outdoor		
Environment Temperature Range	-40 ºC to 55 ºC		
Power Source	Voltage Ranges (VAC)		
	Minimum	Nominal	Maximum
	90.0	110.0	264.0
Antenna	Two Integrated Omni or Detachable Directional Panel		

1.3.2 Cable List

Manufacturer	Serial Number	Part Number	Type
Lucent	N/A	848610259	Coax Shielded
Lucent	N/A	848610259	Coax Shielded
Lucent	N/A	848610325	Coax Shielded
Lucent	N/A	848609012	Coax Shielded
RCDS	131115-1181	849158076	Fiber
Carol	N/A	FT-2 P-7K 123033	Power Cable 12AWG
N/A	N/A	N/A	Ground Cable 6AWG

1.4 Test Requirements

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046, 90.691	RF Power Output	Yes
2.1047, 90.691	Modulation Characteristics	Yes
2.1049, 90.691	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051, 90.691	Spurious Emissions at Antenna Terminals	Yes
2.1053, 90.691	Field Strength of Spurious Radiation	Yes
2.1055, 90.691	Measurement of Frequency Stability	Yes

1.5 Standards & Procedures

1.5.1 Standards

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 90.
- ANSI C63.26, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

1.5.2 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. FCC KDB 971168 D01 Power Measurement License Digital Systems v03r01 April 9, 2018.
   FCC KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013

1.5.3 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

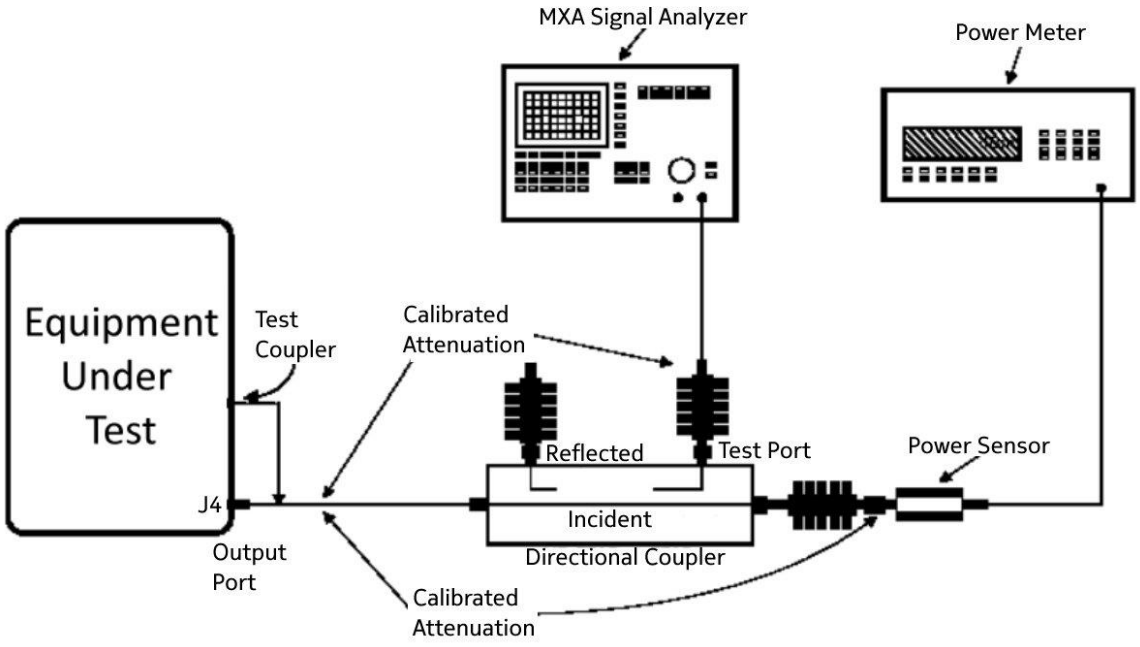
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz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

1.6 Executive Summary

47 CFR FCC Sections	Description	Result
2.1046, 90.691	RF Power Output	COMPLIES
2.1047, 90.691	Modulation Characteristics	COMPLIES
2.1049, 90.691	(a) Occupied Bandwidth (b) Out-of-Band Emissions	COMPLIES
2.1051, 90.691	Spurious Emissions at Antenna Terminals	COMPLIES
2.1053, 90.691	Field Strength of Spurious Radiation	COMPLIES
2.1055, 90.691	Measurement of Frequency Stability	COMPLIES

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

1.7 Test Configuration for all Antenna Port Measurements.



2. FCC Section 2.1046 - RF Power Output

2.1 RF Power Output

This test is a measurement of the total RF power level transmitted at the antenna-transmitting terminal. The product was configured for test as shown in section above and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26. This product can operate as a 2x40W (80W total) or as a 4x25W (100W Total).

Power measurements were made with an MXA Signal Analyzer.

Tabular Data – Channel RF Power (40W)

Channel Frequency MHz	Signal BW MHz	Modulation	Channel Power dBm
864.1	3	64QAM	46.52
		256QAM	46.32
		QPSK + 16QAM	46.38
865.1	5	64QAM	46.85
		256QAM	46.91
		QPSK + 16QAM	46.83
868.3	1.4	64QAM	46.64
		256QAM	46.55
		QPSK + 16QAM	46.67
863.3+866.5	1.4+5	256QAM	46.91
		QPSK + 16QAM	46.78
867.5	3	256QAM	46.70
		QPSK + 16QAM	46.82

Tabular Data – Channel RF Power (25W)

Channel Frequency MHz	Signal BW MHz	Modulation	Channel Power dBm
864.1	3	64QAM	43.40
		256QAM	43.53
		QPSK + 16QAM	43.38
866.5	5	64QAM	43.36
		256QAM	43.29
		QPSK + 16QAM	43.21

Tabular Data – Channel RF Power (40W) – NBIoT

Channel Frequency MHz	Signal BW MHz	Modulation	Channel Power dBm
866.5	5+SA	256QAM	46.29
866.5	5+2SA	256QAM	45.95
863.3+867.5	1.4+3+SA	256QAM	45.51
863.3 + 864.7	1.4+1.4+SA	256QAM	46.06
864.1+867.1	3+3+SA	256QAM	45.21

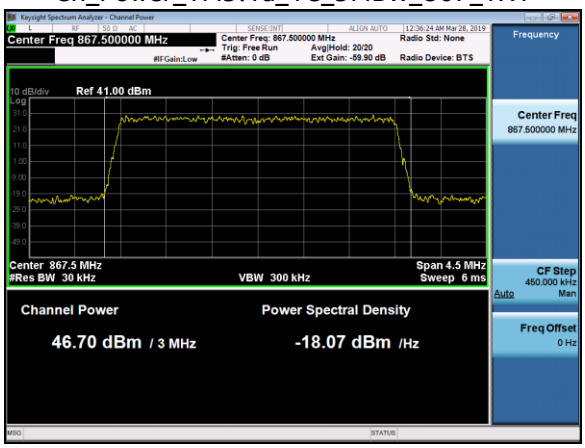
Tabular Data – Channel RF Power (25W) – NBIoT

Channel Frequency MHz	Signal BW MHz	Modulation	Channel Power dBm
866.5	5+2SA	256QAM	43.81
863.3 + 864.7	1.4+1.4+SA	256QAM	44.42
864.1+867.1	3+3+SA	256QAM	42.33

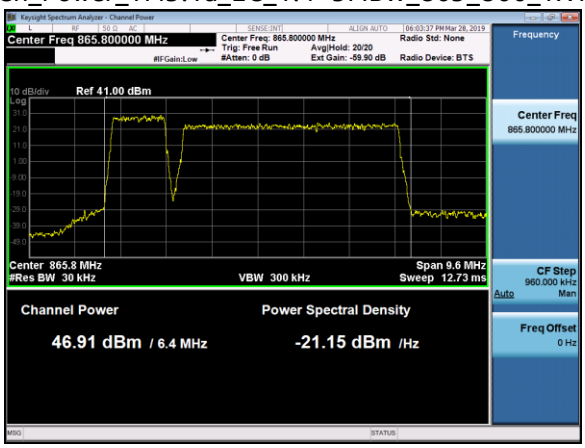
2.1.1 Channel RF Power - Plots.

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

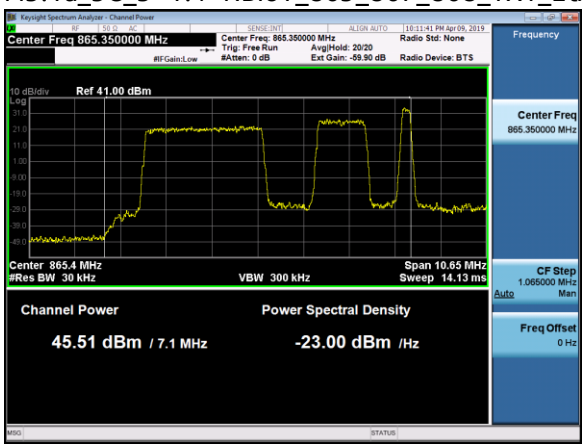
Ch_Power_TM3.1a_1C_3MBW_867_TX1



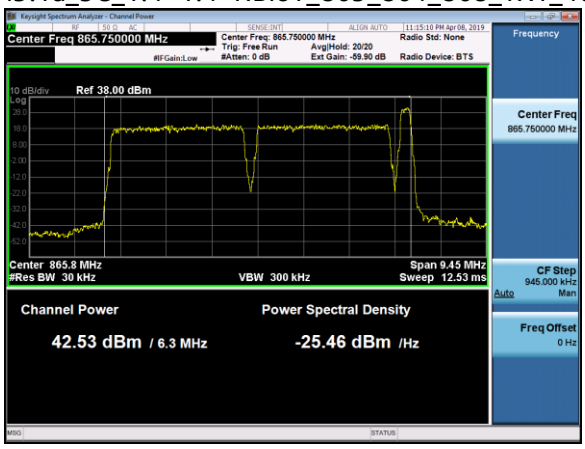
Ch_Power_TM3.1a_2C_1.4+5MBW_863_866_TX1



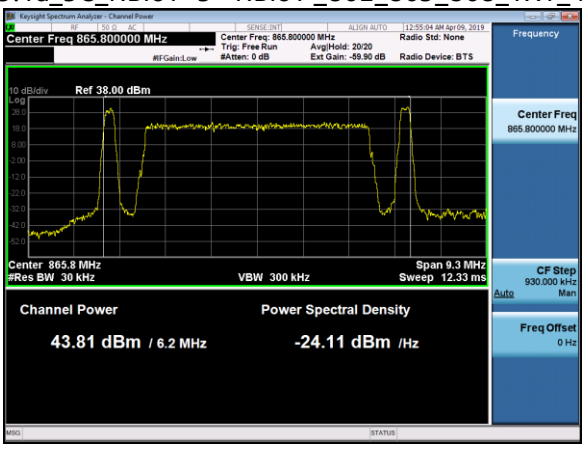
Ch_Power_TM3.1a_3C_3+1.4+NBIoT_863_867_868_TX1_2tx (NBIoT_SA)



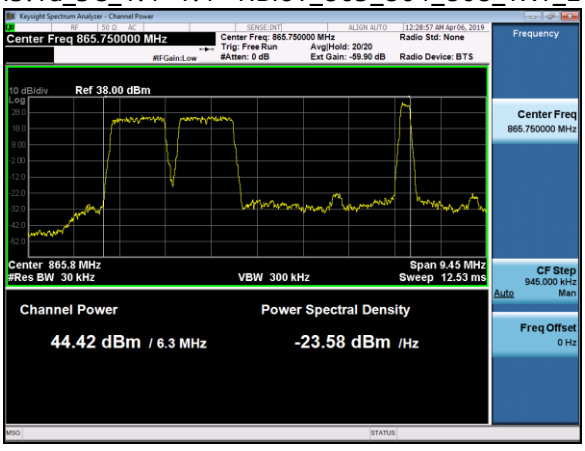
Ch_Power_TM3.1a_3C_1.4+1.4+NBIoT_863_864_868_TX1_4tx (NBIoT_SA)



Ch_Power_TM3.1a_3C_NBIoT+5+ NBIoT _862_865_868_TX1_4tx (NBIoT 2SA)



Ch_Power_TM3.1a_3C_1.4+1.4+ NBIoT_863_864_868_TX1_2tx (NBIoT_SA)

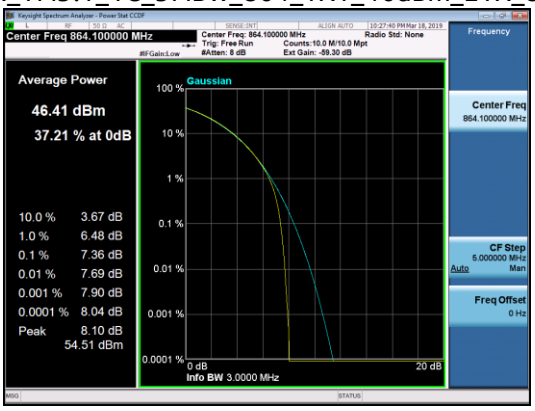


2.1.2 Peak-to-Average Power Ratio (PAPR) - Plots.

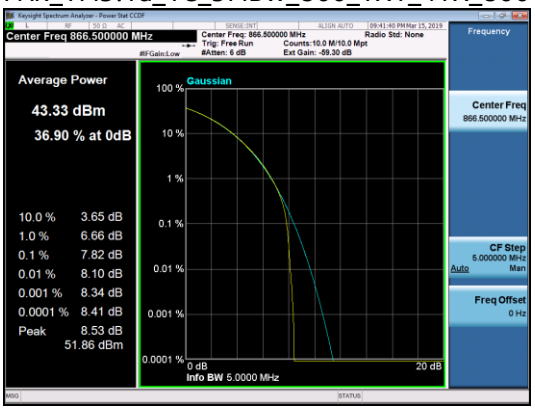
The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168 for 1.4, 3 and 5 MHz bandwidths with QPSK, 16QAM, 64QAM and 256QAM modulation. The PAPR values of all carriers measured are below 13dB.

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

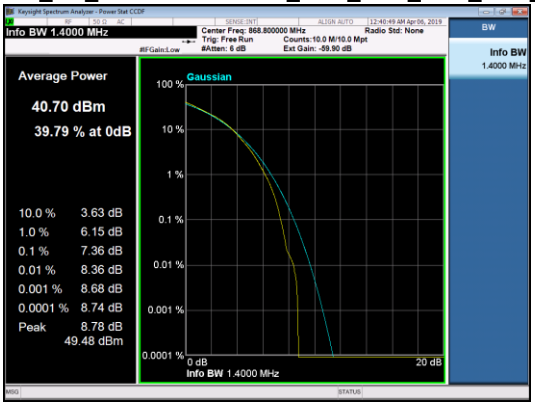
PAR_TM3.1_1C_3MBW_864_TX1_46dBm_2TX_864



PAR_TM3.1a_1C_5MBW_866_TX1_4TX_866



PAR_TM3.1a_3C_1.4+1.4+ NBIoT_863_864_868_TX1_2tx_868



3. FCC Section 2.1047 - Modulation Characteristics

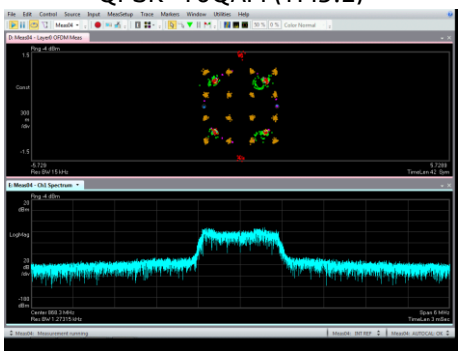
3.1 Modulation Characteristics

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

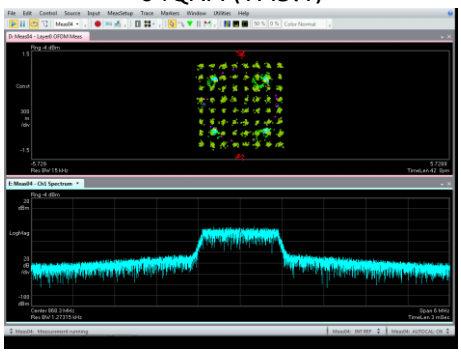
3.1.1 Modulation Characteristics – Plots.

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

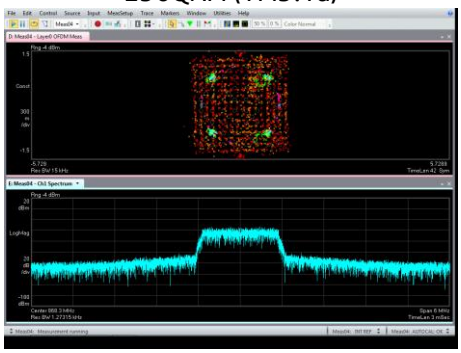
QPSK+16QAM (TM3.2)



64QAM (TM3.1)



256QAM (TM3.1a)



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

4.1 Occupied Bandwidth

In 47CFR 2.1049 the FCC requires:

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

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

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

Tabular Data – Occupied Bandwidth (40W)

Channel Frequency MHz	Signal BW MHz	Modulation	OBW MHz
864.1	3	64QAM	2.6893
		256QAM	2.6939
		QPSK + 16QAM	2.6907
866.5	5	64QAM	4.4741
		256QAM	4.4649
		QPSK + 16QAM	4.4477
868.3	1.4	64QAM	1.0996
		256QAM	1.0981
		QPSK + 16QAM	1.0997
863.3+866.5	1.4+5	256QAM	5.9556
		QPSK + 16QAM	5.9330
867.5	3	256QAM	2.6930
		QPSK + 16QAM	2.6949

Tabular Data – Occupied Bandwidth (25W)

Channel Frequency MHz	Signal BW MHz	Modulation	OBW MHz
864.1	3	64QAM	2.6847
		256QAM	2.6911
		QPSK + 16QAM	2.6870
865.1	5	64QAM	4.4776
		256QAM	4.4771
		QPSK + 16QAM	4.4458

Tabular Data – Occupied Bandwidth (40W) - NBIoT

Channel Frequency MHz	Signal BW MHz	Modulation	OBW MHz
866.5	5+SA	256QAM	4.4689+0.19121
866.5	5+2SA	256QAM	0.19152+4.4727+0.19231
863.3+867.5	1.4+3+SA	256QAM	1.0967+2.6906+0.18550
863.3 + 864.7	1.4+1.4+SA	256QAM	2.4763+0.18844
864.1+867.1	3+3+SA	256QAM	6.1377

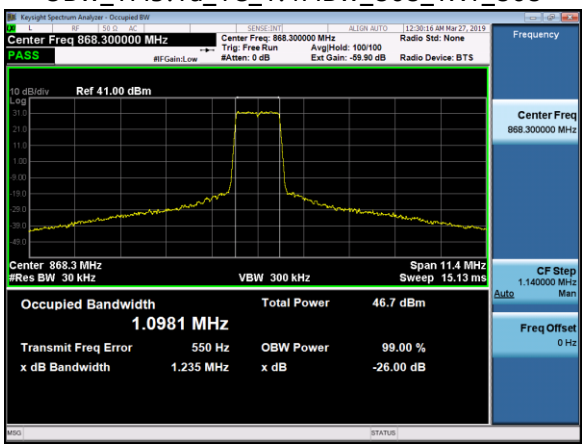
Tabular Data – Occupied Bandwidth (25W) - NBIoT

Channel Frequency MHz	Signal BW MHz	Modulation	OBW MHz
866.5	5+2SA	256QAM	0.18856+4.4719+1.8558
863.3 + 864.7	1.4+1.4+SA	256QAM	2.4761+0.19323
864.1+867.1	3+3+SA	256QAM	6.1377

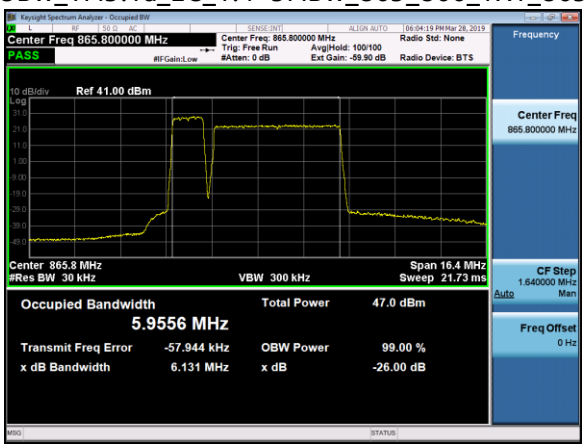
4.1.1 Occupied Bandwidth – Plots.

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

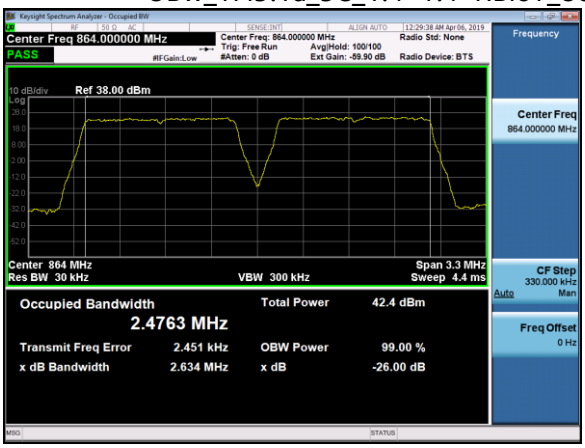
OBW_TM3.1a_1C_1.4MBW_868_TX1_868

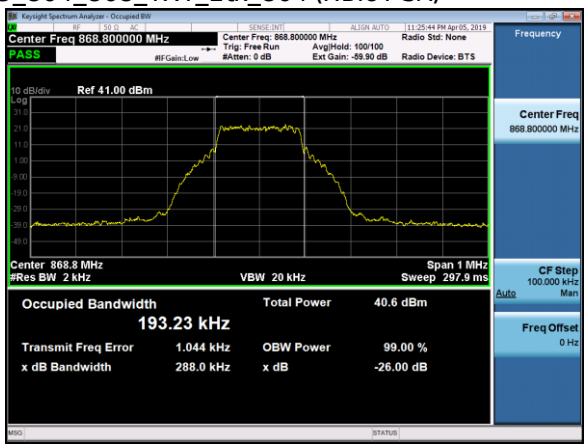


OBW_TM3.1a_2C_1.4+5MBW_863_866_TX1_865

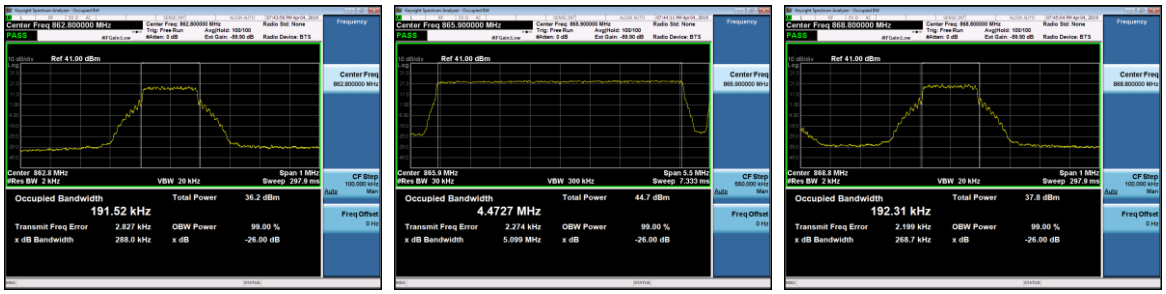


OBW_TM3.1a_3C_1.4+1.4+NBIoT_863_864_868_TX1_2tx_864 (NBIoT SA)





OBW_TM3_1a_3C_NBIoT+5+NBIoT_862_865_868_TX1_862 (NBIoT 2SA)



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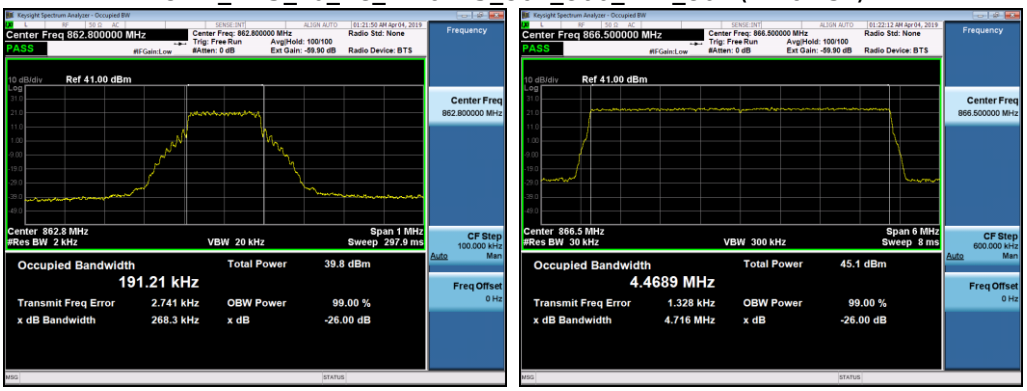


4.2 Edge of band Emissions

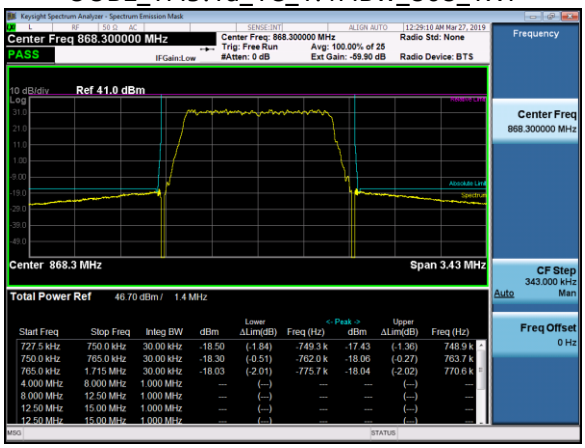
The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. The RF power level was continuously measured using a RF broadband power meter. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the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

4.2.1 Edge of Band Emissions - Plots.

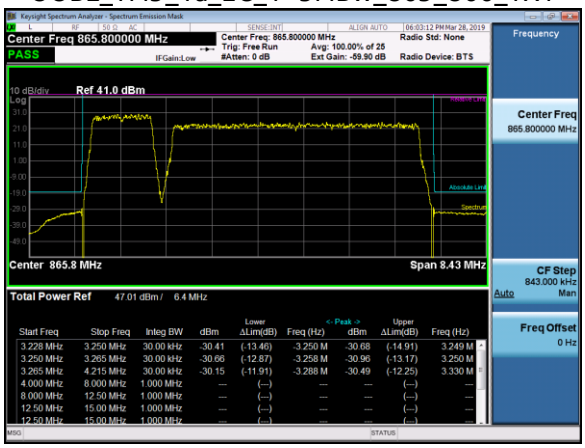
All of the measurements met the requirements of Part 2.1049 and 90.

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

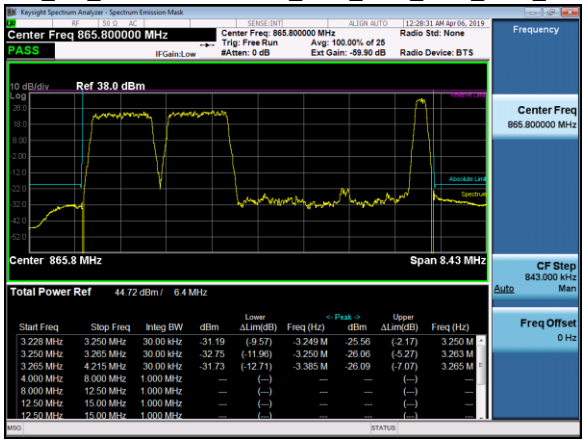
OOBE_TM3.1a_1C_1.4MBW_868_TX1



OOBE_TM3_1a_2C_1+5MBW_863_866_TX1



OOBE_TM3.1a_3C_1.4+1.4+ NBIoT_863_864_868_TX1_2tx (NBIoT SA)



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

5.1 Measurement of Spurious Emissions at Transmit Antenna Port

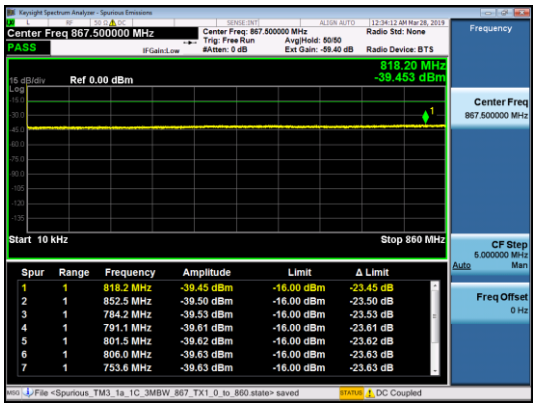
Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 kHz to beyond the 10th harmonic of the specific transmit band. For this band of operation, the measurements were performed up to 9 GHz. Measurements were made using a Keysight MXA Signal Analyzer. The RF output from the transmitter was reduced (to an amplitude usable by the receivers) using calibrated attenuators. The RF power level was continuously monitored via a coupled RF Power Meter.

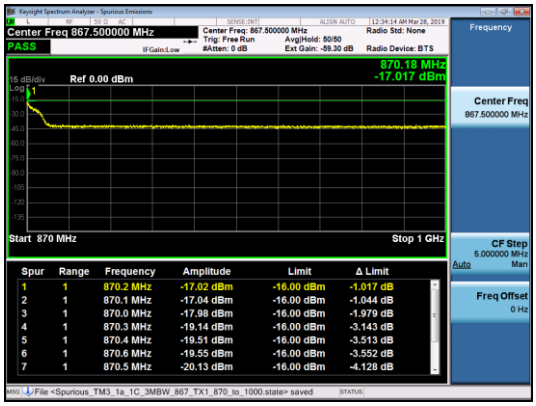
The measured spurious emission levels were plotted for the frequency range as specified in 2.1057. There were no reportable emissions. Data below documents performance up to 9 GHz.

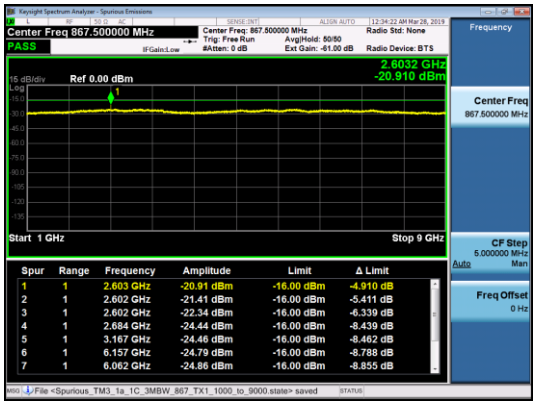
5.1.1 Spurious Emissions at Tx Port - Plots

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

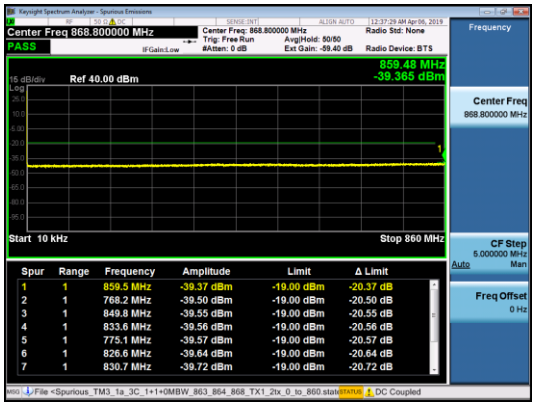
Spurious_TM3.1a_1C_3MBW_867_TX1 (10kHz – 9GHz)

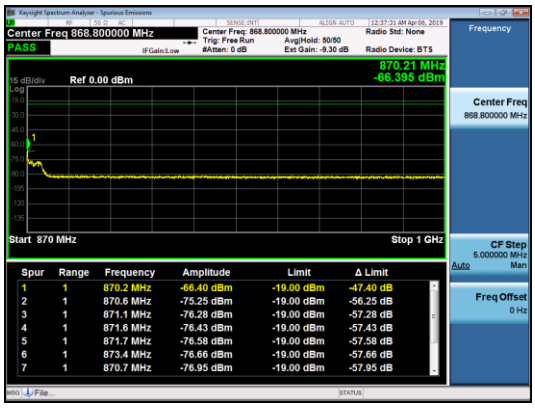


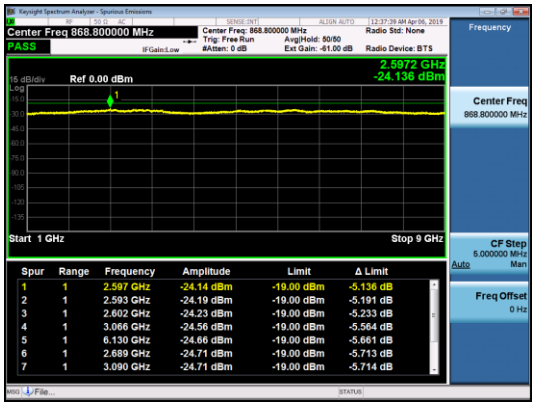




Spurious_TM3.1a_3C_1.4+1.4+0MBW_863_864_868_TX1 (10kHz – 9GHz)







5.1.2 Spurious Emissions Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due	Calibration Type	Status
E1218	KeySight Technologies	EMI Receiver	MXE EMI Receiver 26.5GHz	N9038A	MY54130037	2018-07-02	2020-07-02	Requires Calibration	Active
E796	Weinschel	Attenuator	30dB 25W DC-18GHz	47-30-34	BX1061	2018-05-09	2020-05-09	Requires Calibration	Active
E1251	Aeroflex	Attenuator	30dB 150W DC-18GHz Attenuator	66-30-33	BV1667			Must Be Verified	Active
	Megaphase	Cable	24" RF Cable	1GVT4	16157202	N/A	N/A	N/A	N/A
	Megaphase	Cable	48" RF Cable	1GVT4	16157203	N/A	N/A	N/A	N/A

CNR = Calibration Not Required

6. FCC Section 2.1053 - Field strength of spurious radiation

6.1 Section 2.1053 Field Strength of Spurious Emissions

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

The spectrum from 30 MHz to beyond the tenth harmonic of the carrier, 10 GHz, was searched for spurious radiation. Measurements were made using both horizontally and vertically polarized broadband antennas. Per FCC regulations, the comparison of out of band spurious emissions directly to the limit is appropriately made using the substitution method. However, when the emissions are more than 20 dB below the specification limit, the use of field strength measurements for compliance determination is acceptable and those emissions are considered not reportable (Section 2.1053 and the FCC Interpretive database for 2.1053). For this case the evaluation of acceptable radiated field strength is as follows.

6.2 Field Strength of Spurious Emissions - Limits

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

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

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

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

The Part 2.1053 Limit is 82.23 dBuV/m at 3m and 91.77 dBuV/m at 1m
The Part 2.1053 non-report level is 62.23 dBuV/m at 3m.

The calculated emission levels were found by:

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

6.3 RESULTS - Field Strength of Spurious Emissions

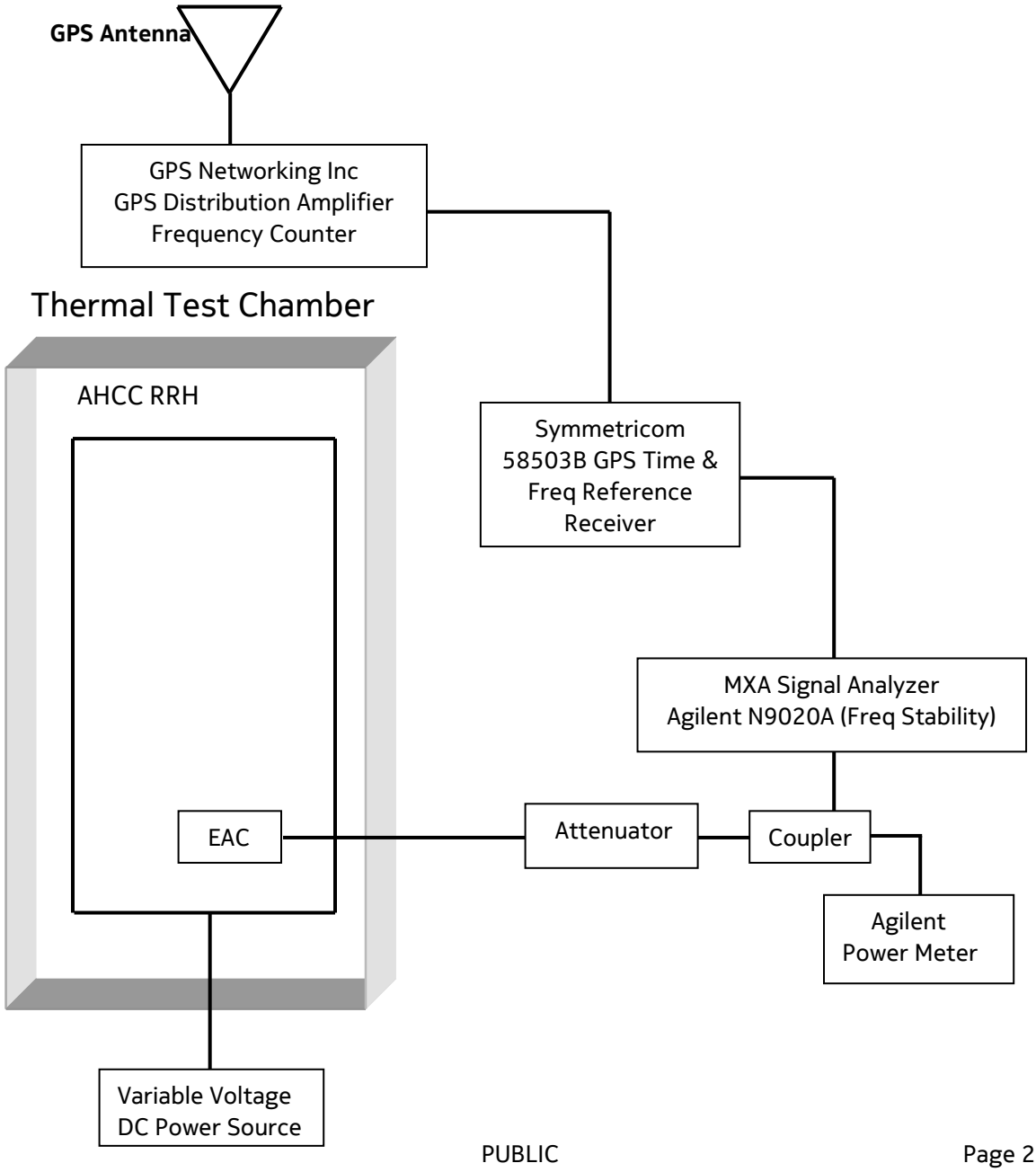
For compliance with 47CFR Part 2.1053, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 dBμV/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dBμV/meter at 3m are not reportable and may be verified using field strength measurements and broadband antennas. Over the out of band spectrum investigated from 30 MHz to beyond the tenth harmonic of the carrier (up to 10 GHz) no reportable spurious emissions were detected.

7. FCC Section 2.1055 - Measurement of Frequency Stability

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

7.1 FREQUENCY STABILITY TEST SET-UP

FREQUENCY STABILITY TEST SET-UP



7.2 RESULTS - FREQUENCY STABILITY

Frequency Stability Testing was completed on the AHCC AirScale RRH for with CF 866.5MHz at 100% RF output using an external ASMI (AirScale System Module Indoor BBU). The testing was performed from 04/03/2019 through 04/05/2019 on the AHCC B26, 4T4R 4x25W RRH, which was placed 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 at which the EUT were subjected to, comprised high temperature (+50ºC, system ambient) and low temperature (-30ºC system ambient). The system level Frequency Stability testing of the EUT 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 (866.5MHz).

EUT: AHCC AirScale RRH 4TX-4RX, PN: 474469A.X21, SN: F7190313015.

7.3 FREQUENCY STABILITY DATA

Frequency Block Tested: PRI20190054 - AHCC AirScale RRH (CF = 866.5MHz)

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	-0.537
0.5	-0.601
1.0	-0.330
1.5	-0.719
2.0	-0.118
2.5	-1.075
3.0	-0.943
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.0973
0.5	-1.2395
1.0	-1.1053
1.5	-0.8455
2.0	-0.8374
2.5	-0.3025
3.0	-0.4888
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.8439
0.5	-0.267
1.0	-1.0064
1.5	-0.3401
2.0	-0.04145
2.5	0.34338
3.0	0.5853
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-1.306
0.5	-0.217
1.0	-0.144
1.5	-1.333
2.0	-0.333
2.5	-0.034
3.0	0.436
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.571
0.5	0.3672
1.0	-0.2119
1.5	-1.0385
2.0	-0.8195
2.5	-0.5764
3.0	-1.562
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.2188
0.5	-2.208
1.0	-1.320
1.5	-0780
2.0	-1.064
2.5	-1.329
3.0	-0.4885
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.495
0.5	-0.365
1.0	-1.857
1.5	-0.397
2.0	-1.300
2.5	-0.0397
3.0	0.897
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.257
0.5	-0.210
1.0	-0.067
1.5	-0.658
2.0	-0.260
2.5	-0.850
3.0	-0.352
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.343
0.5	-1.179
1.0	0.884
1.5	0.504
2.0	0.875
2.5	-0,265
3.0	-1.048
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-1.343
0.5	-0.4221
1.0	-1.032
1.5	0.572
2.0	0.169
2.5	-1.007
3.0	-1.690
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
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	0.794
0.5	-1.759
1.0	-0.0814
1.5	0.326
2.0	-0.483
2.5	-0.562
3.0	0.313
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at 103% of Nominal Voltage, -49.44VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.964
0.5	-1.0113
1.0	-0.467
1.5	-0.663
2.0	-0.673
2.5	-0.583
3.0	0.507
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at 106% of Nominal Voltage, -50.88VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.534
0.5	0.176
1.0	-0.189
1.5	-0.247
2.0	-0.561
2.5	-0.183
3.0	-0.419
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at 109% of Nominal Voltage, -52.32VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.197
0.5	-0.674
1.0	-0.745
1.5	-0.599
2.0	-0.102
2.5	0.433
3.0	-1.103
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at 112% of Nominal Voltage, -53.76VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.427
0.5	-1.312
1.0	-1.436
1.5	-0.123
2.0	-0.321
2.5	-0.805
3.0	-0.552
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at 115% of Nominal Voltage, -55.20VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.776
0.5	-0.431
1.0	-0.291
1.5	-0.212
2.0	-1.992
2.5	1.184
3.0	0.440
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48.0VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-0.852
0.5	-0.931
1.0	-1.414
1.5	0.718
2.0	0.083
2.5	-1.520
3.0	0.045
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, -46.56VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	-1.139
0.5	0.088
1.0	0.418
1.5	-0.922
2.0	-0.592
2.5	0.354
3.0	0.113
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, -45.12VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	0.394
0.5	-0.334
1.0	-1.395
1.5	-0.183
2.0	-1.086
2.5	-0.108
3.0	0.533
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, -43.68VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	0.343
0.5	1.746
1.0	-0.401
1.5	-1.054
2.0	-0.932
2.5	-1.028
3.0	-1.247
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, -42.24VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	0.574
0.5	0.485
1.0	-0.092
1.5	-0.100
2.0	-0.758
2.5	-0.579
3.0	0.021
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, -40.80VDC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	0.197
0.5	-0.847
1.0	-1.655
1.5	0.995
2.0	0.147
2.5	0.775
3.0	1.505
FCC SPECIFICATION	±866.5 MHz (±0.05ppm) ±0.05ppm = ±43.325 Hz
RESULT	PASS

7.3.1 Frequency Stability Test Photographs:

The Frequency Stability Test Photographs are in Exhibit 14 of the filing package.

7.3.2 Frequency Stability Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
TH509-T11	Envirotronics	Controller		Envirotronics SPPCM	SP000638	2017-06-26	2019-06-26
TH-T11	Envirotronics	Thermal Chamber		N/A	0999-4722	2018-09-19	2020-09-19
TH044	Fluke	Multimeter		83III	74910377	2018-02-12	2020-02-12
E1217	KeySight Technologies	EMI Receiver	MXE EMI Receiver 26.5GHz	N9038A	MY54130087	2019-02-13	2021-02-13
TH088	Yokogawa	Data Logger	10 Channel Paperless Recorder	GP10	S5U604860	2018-11-09	2020-11-09

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