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Title 47 Code of Federal Regulations Test Report

Regulation:

FCC Part 2 and 24

Client:

Nokia Mobile Networks

Product Evaluated:

UHFB 65MHz RRH – Addition of 20MHz

Report Number:

TR-2019-0120-FCC2-24

Date Issued:

October 25, 2019

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Revisions

Date	Revision	Section	Change
10/25/2019	0		Initial Release

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1. System Information and Requirements

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

Equipment Under Test (EUT):	UHFB 65 MHz RRH - Addition of 20MHz
FCC ID:	AS5BBTRX-05
Serial Number:	See Section 1.3
Hardware Version:	See Section 1.3
Software Version:	FL19A
Frequency Range:	1930 – 1990 MHz
GPCL Project Number:	2019-0120
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAPORTTI 3, FI-02610 ESPOO FINLAND
Test Requirement(s):	Title 47 CFR Parts 2 and 24
Test Standards:	• Title 47 CFR Parts 2 and 24 • 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):	September 2019
Test Performed By:	Nokia Global Product Compliance Laboratory 600-700 Mountain Ave. P.O. Box 636 Murray Hill, NJ 07974-0636
Product Engineer(s):	Ron Remy
Lead Engineer:	Steve Gordon
Test Engineer (s):	Jaideep Yadav, Eugene Mitchell, Mike Soli
Test Results: The EUT, <i>as tested</i> 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 UHFB 65MHz RRH, hereinafter referred to as the Equipment Under Test (EUT).

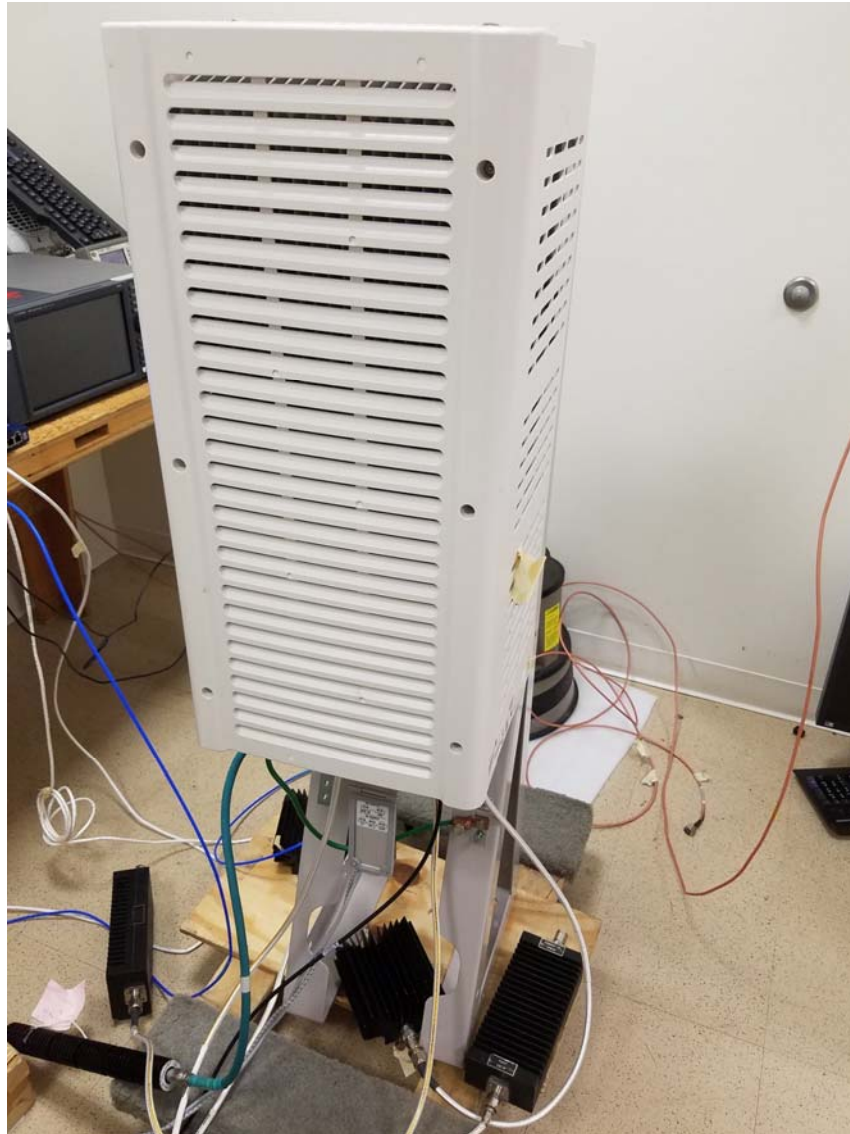
1.2 Purpose and Scope

The purpose of this document is to provide the testing data required for qualifying the EUT in compliance with FCC Parts 2 and 24 measured in accordance with the procedures set out in Section 2.1033 (c) (14) of the Rules.

The 65MHz RRH was previously qualified for 1.25 CDMA and 5, 10, 15 and 20 MHz LTE. This testing is for an LTE 20MHz upgrade, 20MHz single carrier and 5+15 and 10+10 contiguous/non-contiguous multi-carrier.

1.3 EUT Details





1.4 Test Requirements

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046, 24.238	RF Power Output	Yes
2.1047, 24.238	Modulation Characteristics	Yes
2.1049, 24.238	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051, 24.238	Spurious Emissions at Antenna Terminals	Yes
2.1053, 24.238	Field Strength of Spurious Radiation	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 24.
- 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, (<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 (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

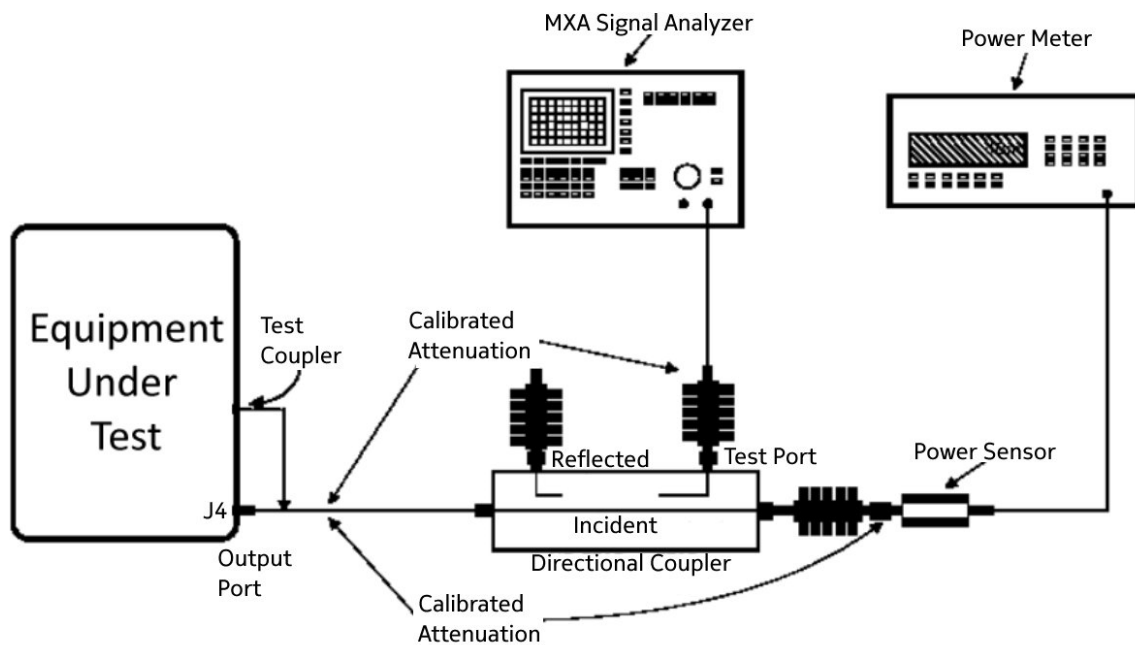
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz 100 Hz 10 kHz to 1 MHz 1MHz	9 kHz to 20 MHz 20 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 40 GHz:	1.78 dB
RF Power	10 Hz to 20 MHz	50 MHz to 18 GHz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

1.6 Executive Summary

Requirement	Description	Result
47 CFR FCC Parts 2 and 24		
2.1046, 24.238	RF Power Output	COMPLIES
2.1047, 24.238	Modulation Characteristics	COMPLIES
2.1049, 24.238	(a) Occupied Bandwidth (b) Edge of Band Emissions	COMPLIES
2.1051, 24.238	Spurious Emissions at Antenna Terminals	COMPLIES
2.1053, 24.238	Field Strength of Spurious Radiation	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.

Power measurements were made with an MXA Signal Analyzer.

Tabular Data – Channel RF Power, 1C, 64QAM, 20MHz BW

Channel Frequency MHz	Channel Power dBm
1940	44.73
1955	44.64
1985	44.91

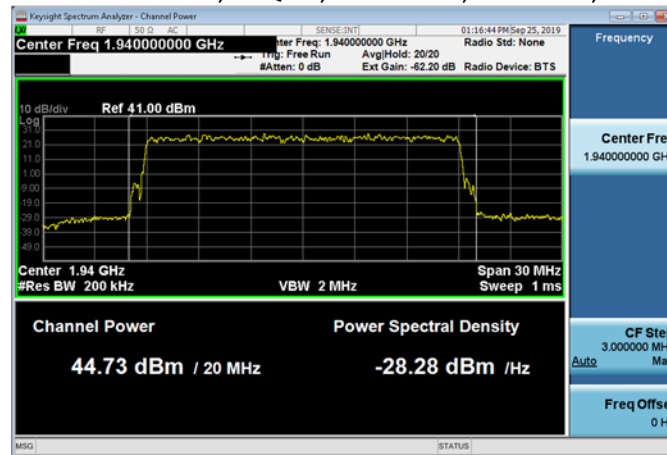
Tabular Data – Channel RF Power, 2C

Channel Frequency MHz	Bandwidth MHz	Modulation	Channel Power dBm
1937.5+1947.5	5+15	64QAM+256QAM	42.39
1980+1990	10+10	64QAM+256QAM	42.33
1937.5+1992.5	5+15	64QAM+256QAM	41.72
1935+1990	10+10	64QAM+256QAM	42.39
1962.5+1990	10+10	Q16+256QAM	43.57
1962.5+1992.5	15+5	Q16+256QAM	43.33

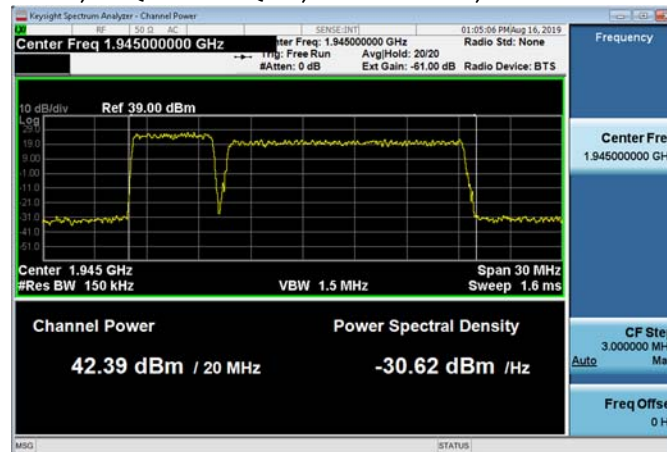
2.1.1 Channel RF Power - Plots.

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.

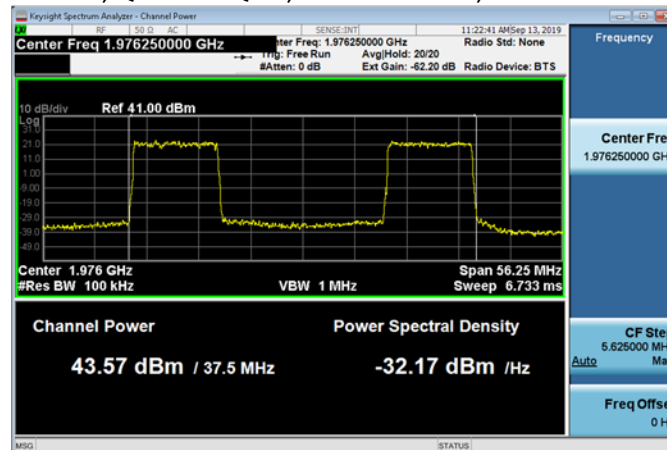
Channel Power, 64QAM, 20MHz BW, 1940MHz, TX1



Channel Power, 64QAM+256QAM, 5+15MHz BW, 1937.5+1947.5MHz, TX1



Channel Power, Q16+256QAM, 10+10MHz BW, 1962.5+1990MHz, TX1



3. FCC Section 2.1047 - Modulation Characteristics

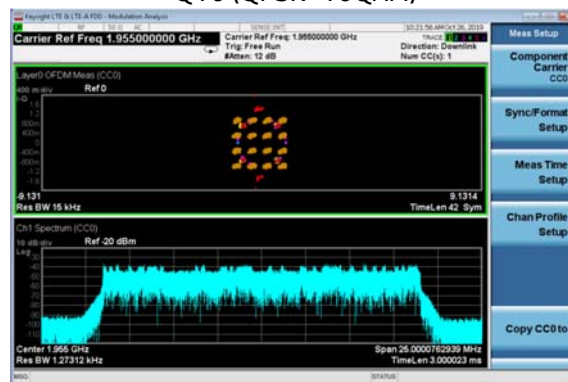
3.1 Modulation Characteristics

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.

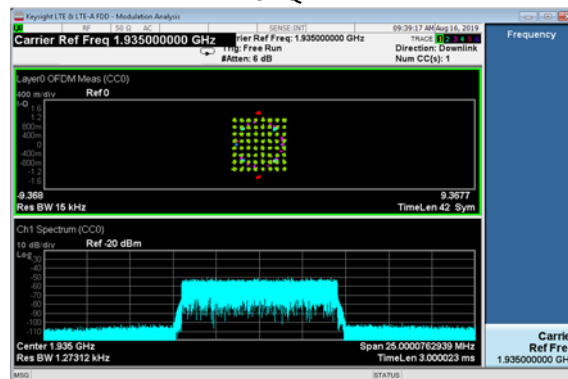
3.1.1 Modulation Characteristics – Plots.

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.

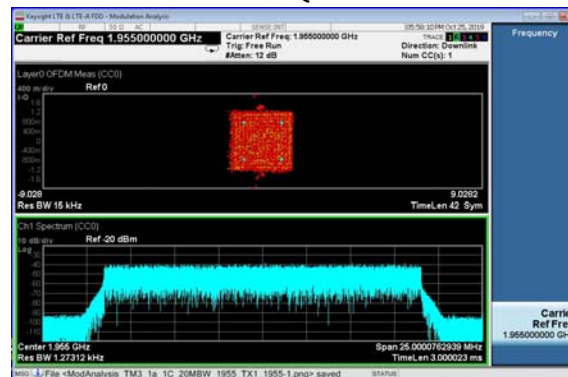
Q16 (QPSK+16QAM)



64QAM



256QAM



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, 1C, 64QAM, 20MHz BW

Channel Frequency MHz	Occupied BW MHz
1940	17.822
1955	17.849
1985	17.846

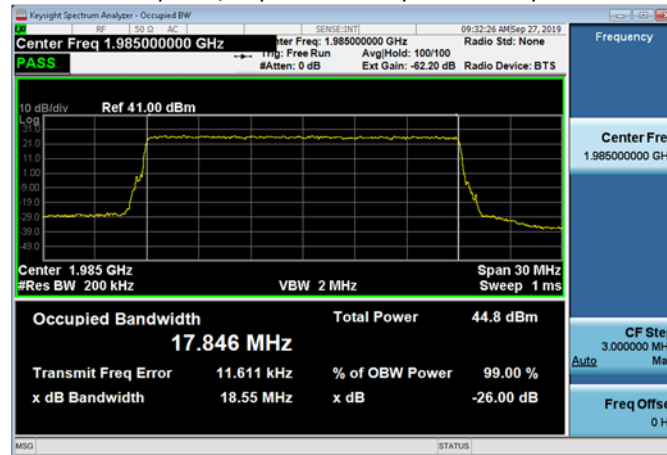
Tabular Data – Occupied Bandwidth, 2C

Channel Frequency MHz	Bandwidth MHz	Modulation	Occupied BW MHz
1937.5+1947.5	5+15 Contiguous	64QAM+256QAM	18.862
1980+1990	10+10 Contiguous	64QAM+256QAM	18.834
1937.5+1992.5	5+15 Non-Contiguous	64QAM+256QAM	4.5283+13.388
1935+1990	10+10 Non-Contiguous	64QAM+256QAM	8.9364+8.9315
1962.5+1990	10+10 Non-Contiguous	Q16+256QAM	8.9302+8.9433
1962.5+1992.5	15+5 Non-Contiguous	Q16+256QAM	13.383+4.4660

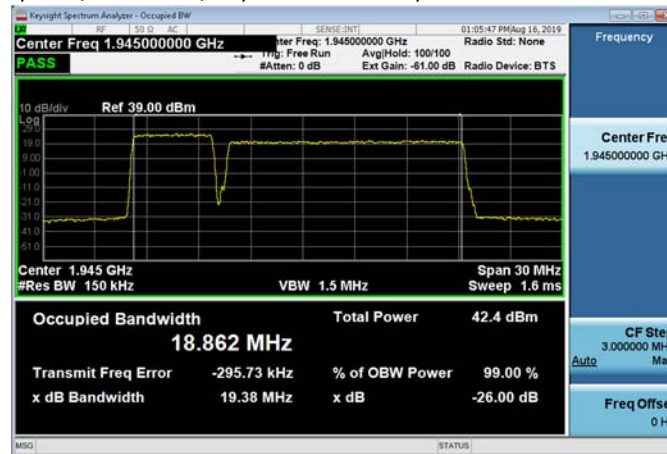
4.1.1 Occupied Bandwidth – Plots.

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.

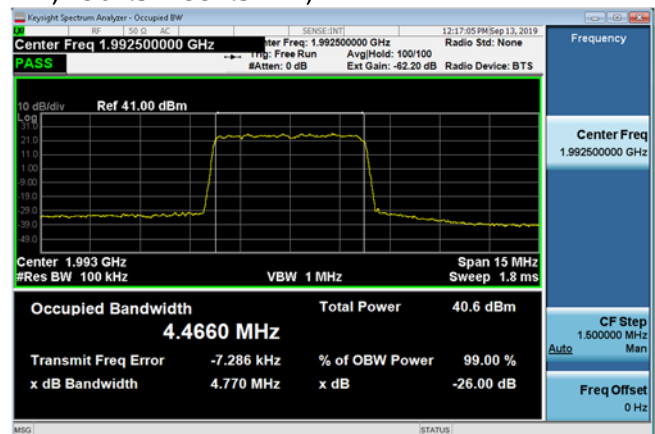
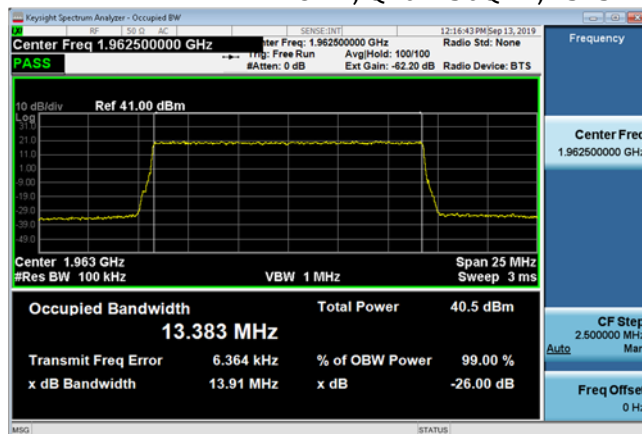
OBW, 64QAM, 20MHz BW, 1985MHz, TX1



OBW, 64QAM+256QAM, 5+15MHz BW, 1937.5+1947.5MHz, TX1



OBW, Q16+256QAM, 15+5MHz BW, 1962.5+1992.5MHz, TX1



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 spectrum analyzer was reduced (to an amplitude usable by the spectrum analyzer) by using a calibrated attenuator and test coupler. The path attenuation was offset on the display and the signal for single 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.

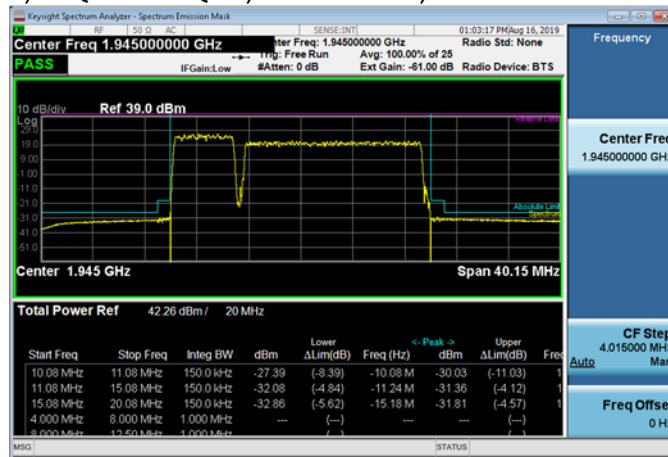
All of the measurements met the requirements of Part 24.238 when measured per Part 2.1049.

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

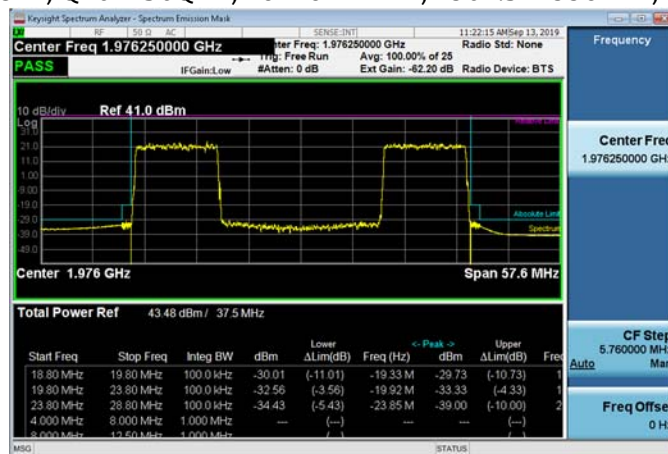
OOBE, 64QAM, 20MHz BW, 1985MHz, TX1



OOBE, 64QAM+256QAM, 5+15MHz BW, 1937.5+1947.5MHz, TX1



OOBE, Q16+256QAM, 10+10MHz BW, 1962.5+1990MHz, TX1



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

5.1 Measurement of Spurious Emissions at Transmit Antenna Port

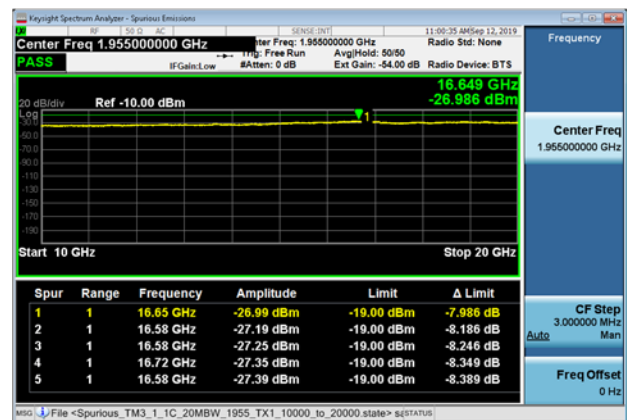
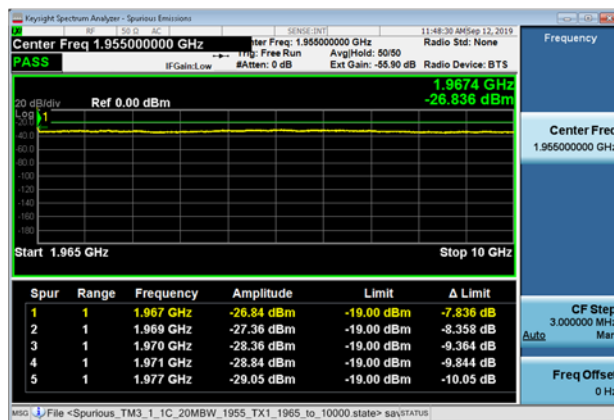
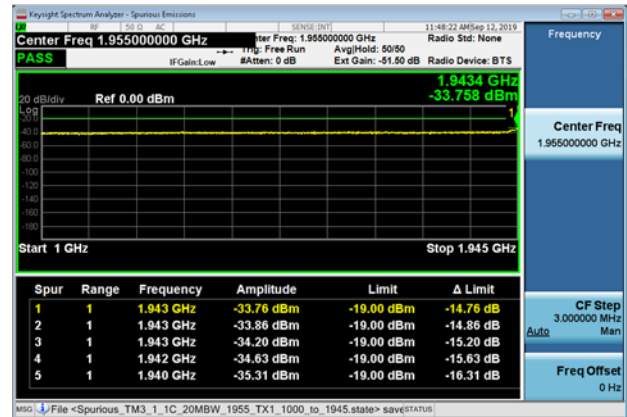
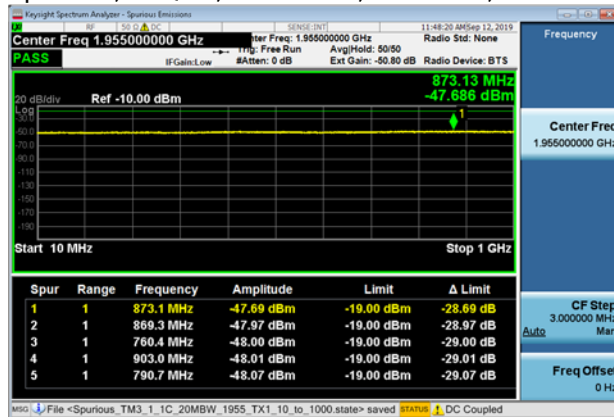
Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. For this band of operation, the measurements were performed up to 20GHz. Measurements were made using a Keysight MXA Signal Analyzer. The RF output from the transmitter was reduced (to an amplitude usable by the receivers) using calibrated attenuators. The RF power level was continuously monitored via a coupled RF Power Meter.

The required emission limitation is specified as appropriate in 24.238. 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 20 GHz.

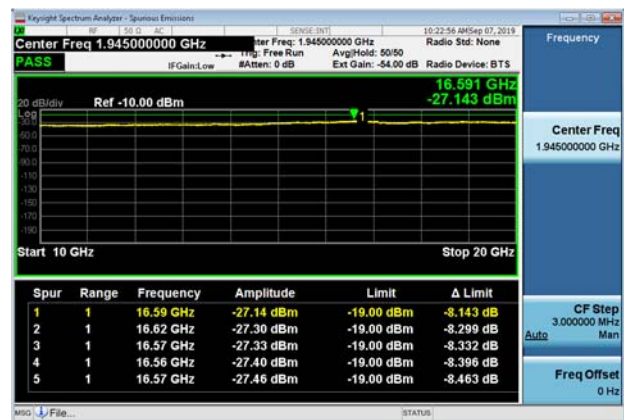
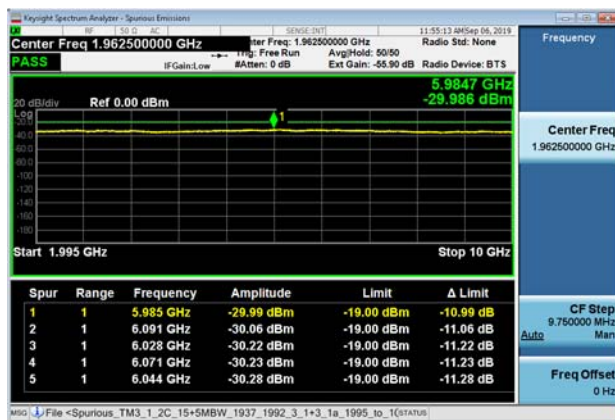
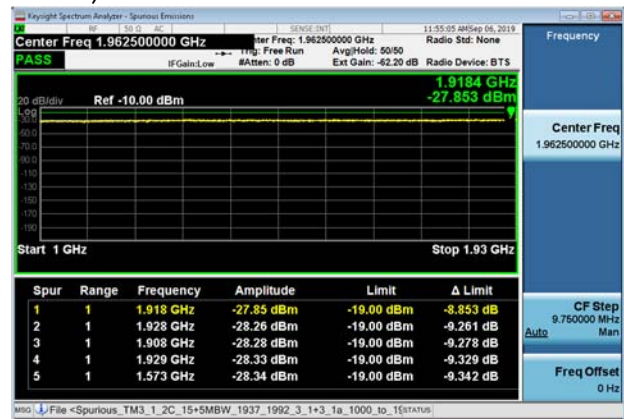
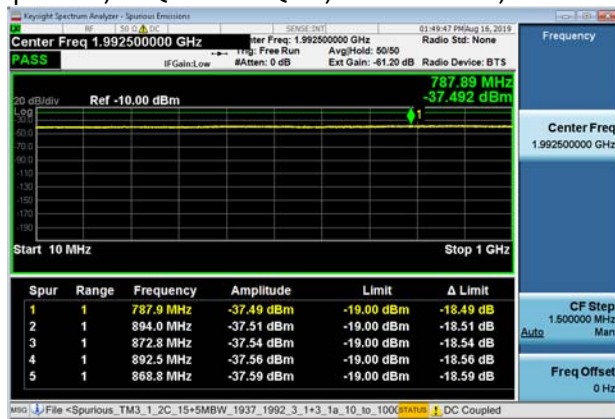
5.1.1 Spurious Emissions at Tx Port - Plots

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.

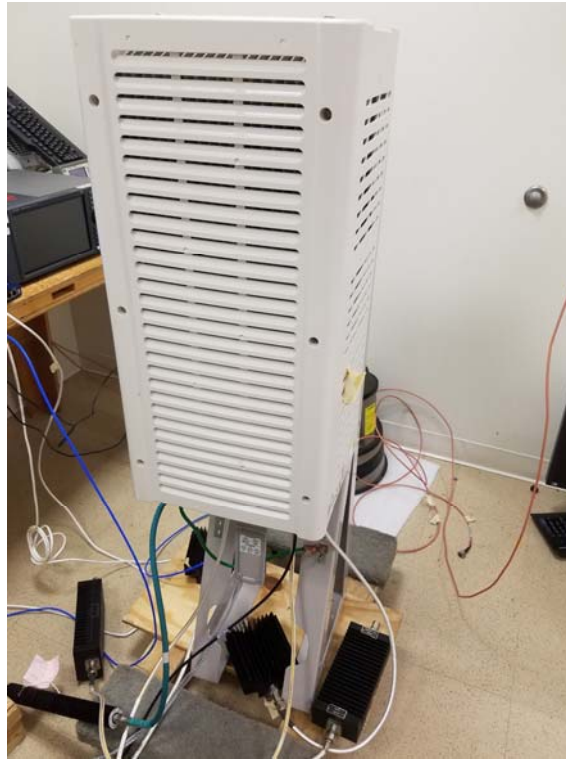
Spurious, 64QAM, 20MHz BW, 1955MHz, TX1



Spurious, 64QAM+256QAM, 15+5MHz BW, 1937.5+1992.5 MHz, TX1



Photographs



Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E1152	Agilent Technologies	MXA Signal Analyzer	20Hz-26.5GHz Analyzer	N9020A	MY53420147	2019-04-24	2021-04-24
E1006	Weinschel	Attenuator	30 dB DC-18GHz 150W	6528-30-34-LIM	BN4172	CNR	CNR
E986	Trilithic	High Pass Filter	PCS	5HC2850/18050-1.8-KK	PCS-HPF-5	CNR	CNR
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2019-01-31	2021-01-31

Environmental Conditions: RH= 34.6%, Temp=24.5°C, Pressure=1005.9hPa

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

6.2 Field Strength of Spurious Emissions - Limits

Sections 2.1053 and 24.238 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.

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

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

Where:

E = Field Intensity in Volts/meter

P = Transmitted Power in Watts

R = Measurement distance in meters = 3 m

The Part 24 Limit is 82.23 dBuV/m at 3m and 91.77 dBuV/m at 1m

The Part 24 non-report level is 62.23 dBuV/m at 3m.

The calculated emission levels were found by:

$$\text{Measured level (dB}\mu\text{V)} + \text{Cable Loss(dB)} + \text{Antenna Factor(dB)} = \text{Field Strength (dB}\mu\text{V/m)}$$

RESULTS:

For compliance with 47CFR Parts 2 and 24, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 dBuV/meter (82.23 @ 3m). Emissions equal to or less than 62.23 dBuV/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 21GHz), no reportable spurious emissions were detected.

7. 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 <i>is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:</i> Electromagnetic Compatibility & Telecommunications <i>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).</i> <table><tr><td> 2019-09-20 through 2020-09-30 <i>Effective Dates</i> </td><td></td><td>  <i>For the National Voluntary Laboratory Accreditation Program</i> </td></tr></table>		2019-09-20 through 2020-09-30 <i>Effective Dates</i>		 <i>For the National Voluntary Laboratory Accreditation Program</i>
2019-09-20 through 2020-09-30 <i>Effective Dates</i>		 <i>For the National Voluntary Laboratory Accreditation Program</i>		