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Title 47 Code of Federal Regulations Test Report

Regulation:

FCC Part 2 and 27

Client:

NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:

FRBG Flexi Multiradio BTS

Report Number:

TR-2021-0024-FCC2-27

Date Issued:

March 12, 2021

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Table of Contents

- 1. SYSTEM INFORMATION AND REQUIREMENTS..... 4**
 - 1.1 INTRODUCTION 5
 - 1.2 PURPOSE AND SCOPE..... 5
 - 1.3 EUT DETAILS..... 5
 - 1.4 TEST REQUIREMENTS 7
 - 1.5 EXECUTIVE SUMMARY 9
 - 1.6 TEST CONFIGURATION FOR ALL ANTENNA PORT MEASUREMENTS. 9
- 2. FCC SECTION 2.1046 - RF POWER OUTPUT 10**
 - 2.1 RF POWER OUTPUT 10
- 3. FCC SECTION 2.1047 - MODULATION CHARACTERISTICS 13**
 - 3.1 MODULATION CHARACTERISTICS..... 13
- 4. FCC SECTION 2.1049 – OCCUPIED BANDWIDTH/EDGE OF BAND EMISSIONS..... 14**
 - 4.1 OCCUPIED BANDWIDTH 14
 - 4.2 EDGE OF BAND EMISSIONS 16
- 5. FCC SECTION 2.1051 - SPURIOUS EMISSIONS AT TRANSMIT ANTENNA PORT..... 16**
 - 5.1 MEASUREMENT OF SPURIOUS EMISSIONS AT TRANSMIT ANTENNA PORT 17
- 6. FCC SECTION 2.1053 - FIELD STRENGTH OF SPURIOUS RADIATION 22**
 - 6.1 SECTION 2.1053 FIELD STRENGTH OF SPURIOUS EMISSIONS 22
 - 6.2 FIELD STRENGTH OF SPURIOUS EMISSIONS - LIMITS..... 22
- 7. NVLAP CERTIFICATE OF ACCREDITATION 23**

Revisions

Date	Revision	Section	Change
3/12/21	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):	FRBG Flexi Multiradio BTS
Serial Number:	K9151101558
FCC ID:	VBNFRBG-01
Hardware Version:	087392A.101
Software Version:	SBTS20B
Frequency Range:	718-728 MHz, 729-745 MHz
GPCL Project Number:	2021-0024
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Applicant:	Nokia Solutions and Networks 3201 Olympus Blvd Dallas, Texas 75019 Steve Mitchell
Test Requirement(s):	Title 47 CFR Parts 2 and 27
Test Standards:	<ul style="list-style-type: none"> • Title 47 CFR Parts 2 and 27 • 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):	<ul style="list-style-type: none"> • 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):	2/25/2021-3/10/2021
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):	Nilesh Patel
Test Results:	The EUT, <i>as tested</i> met the above listed Test Requirements. The decision rule employed is binary (Pass/Fail) based on the measured values without accounting for Measurement Uncertainty or any Guard Band. The measured values obtained during testing were compared to a value given in the referenced regulation or normative standard. 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 FRBG Flexi Multiradio BTS, 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.

This Class II Permissive Change will be submitted to add NB-IoT Guardband operation for the 10 MHz Single carrier configuration at 40W per port in the 729 - 745 MHz band to the existing Grant for FCC ID: VBNFRBG-01. This product has 4 ports where 2 ports operate in each band (718-728 MHz or 729-745 MHz), and only the upper band will support this configuration.

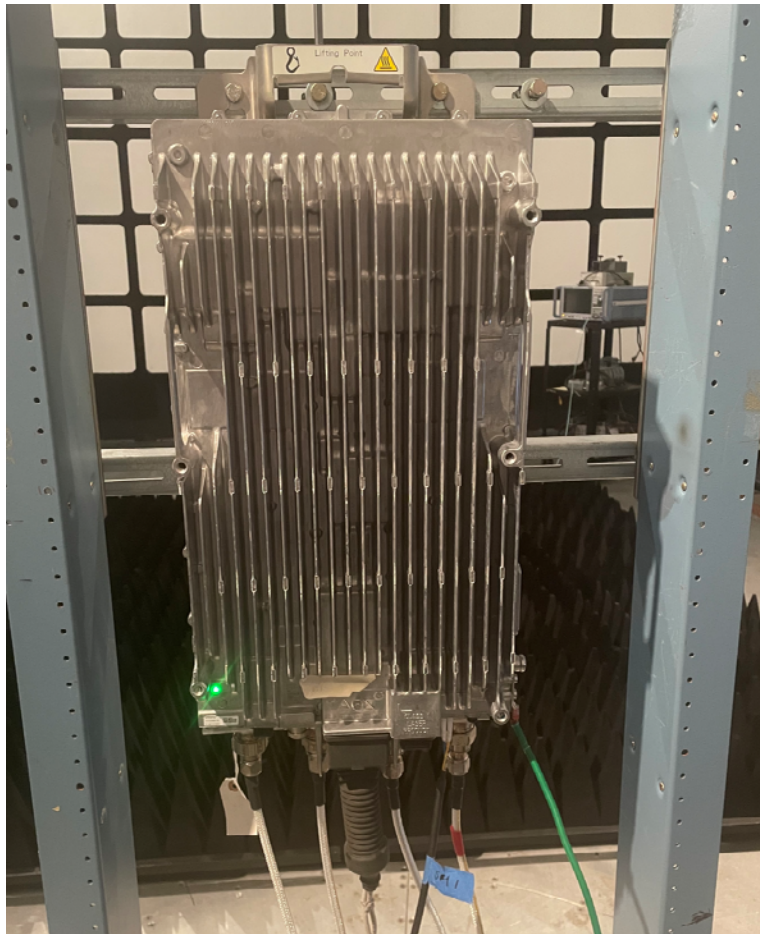
No Frequency Stability testing was considered necessary for this test program since there were no changes to the basic frequency determining and stabilizing circuitry (including clock and data rates).

1.3 EUT Details

1.3.1 Specifications

Specification Items	Description
Radio Access Technology	LTE
Duplex Mode	Frequency Division Duplex (FDD)
Modulation Type(s)	QPSK 16QAM 64QAM
Operation Frequency Range	718-728 MHz, 729-745 MHz
Channel Bandwidths	5, 10MHz
Tx/Rx	4T4R
MIMO	Yes
Deployment Environment	Outdoor
Supply Voltage	-48.0 VDC
Max RF Output Power	46.0 dBm per Port (+/- 1.0 dBm) 160W Total

1.3.2 Photographs



1.4 Test Requirements

Each required measurement is listed below:

47 CFR FCC Sections	Description of Tests	Test Required
2.1046, 27.53	RF Power Output	Yes
2.1047, 27.53	Modulation Characteristics	Yes
2.1049, 27.53	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Yes
2.1051, 27.53	Spurious Emissions at Antenna Terminals	Yes
2.1053, 27.53	Field Strength of Spurious Radiation	Yes
2.1055, 27.53	Frequency Stability	No*

* No Frequency Stability testing was considered necessary for this test program since there were no changes to the basic frequency determining and stabilizing circuitry (including clock and data rates. Standards & Procedures

1.4.1 Standards

- Title 47 Code of Federal Regulations, Federal Communications Commission Part 2.
- Title 47 Code of Federal Regulations, Federal Communications Commission Part 27.
- 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, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
- ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

1.4.2 Procedures

- FCC-IC-OB - GPCL Power Measurement, Occupied Bandwidth & Modulation Test Procedure 6-20-2019
- FCC-IC-SE - GPCL Spurious Emissions Test Procedure 6-20-2019

1.4.3 MEASUREMENT UNCERTAINTY

The results of the calculations to estimate uncertainties for the several test methods and standards are shown in the Table below. These are the worst-case values.

Worst-Case Estimated Measurement Uncertainties

Standard, Method or Procedure	Condition	Frequency MHz	Expanded Uncertainty (k=2)
a. Classical Emissions, (<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

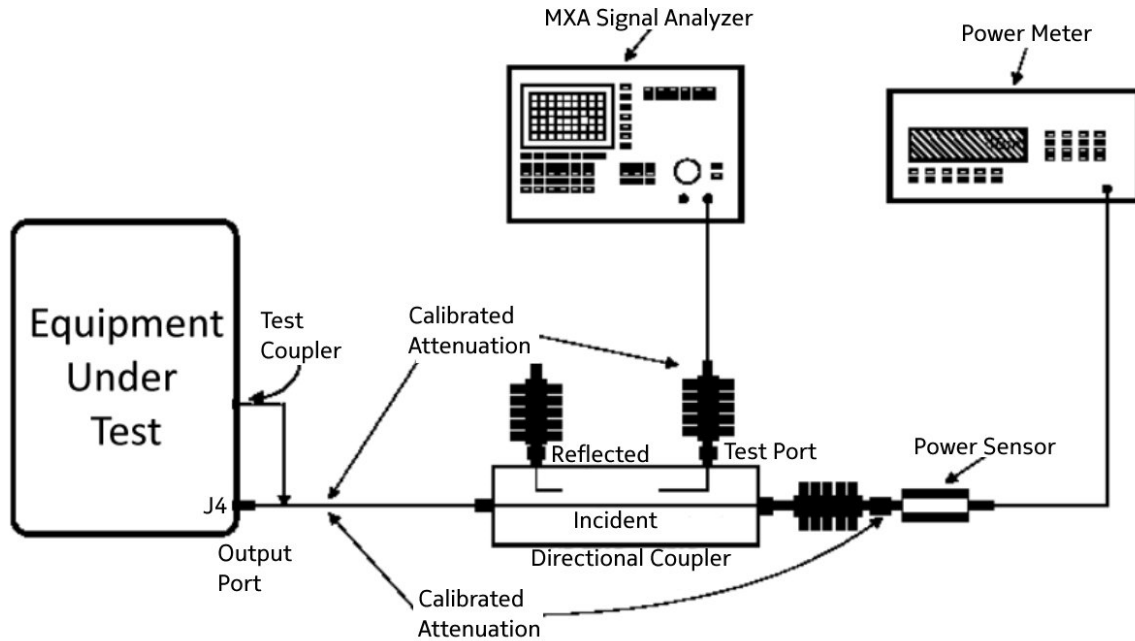
Antenna Port Test	Signal Bandwidth	Frequency Range	Expanded Uncertainty (k=2), Amplitude
Occupied Bandwidth, Edge of Band, Conducted Spurious Emissions	10 Hz	9 kHz to 20 MHz	1.78 dB
	100 Hz	20 MHz to 1 GHz	
	10 kHz to 1 MHz	1 GHz to 10 GHz	
	1MHz	10 GHz to 40 GHz:	
RF Power	10 Hz to 20 MHz	50 MHz to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

1.5 Executive Summary

Requirement	Description	Result
47 CFR FCC Parts 2 and 27		
2.1046, 27.53	RF Power Output Peak to Average Power Ratio	COMPLIES
2.1047, 27.53	Modulation Characteristics	COMPLIES
2.1049, 27.53	(a) Occupied Bandwidth (b) Edge of Band Emissions	COMPLIES
2.1051, 27.53	Spurious Emissions at Antenna Terminals	COMPLIES
2.1053, 27.53	Field Strength of Spurious Radiation	COMPLIES
2.1055, 27.53	Frequency Stability	NT

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

1.6 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. The maximum output is bolded in each case.

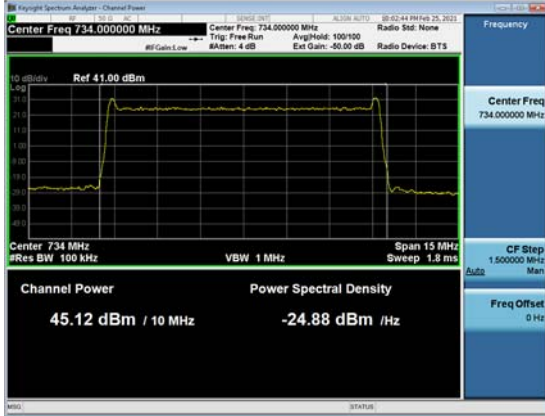
2.1.1 Channel RF Power - Tables

Channel Power - 10 MHz BW					
Test Model 1.1 Modulation QPSK Channel Frequency 734MHz		Test Model 1.1 Modulation QPSK Channel Frequency 737MHz		Test Model 1.1 Modulation QPSK Channel Frequency 740MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	45.12	1	45.08	1	45.08
2	45.09	2	45.00	2	45.02

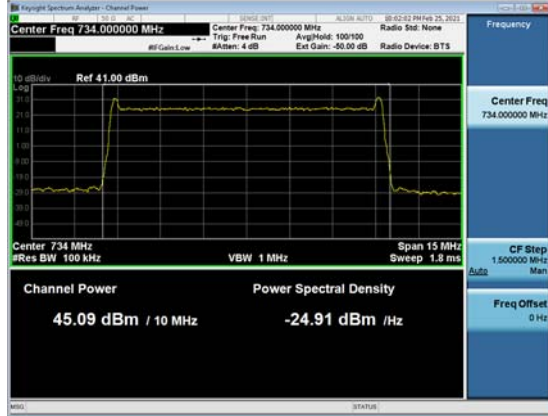
2.1.2 Channel RF Power - Plots

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 Frequency 734 MHz, Modulation QPSK, TX1



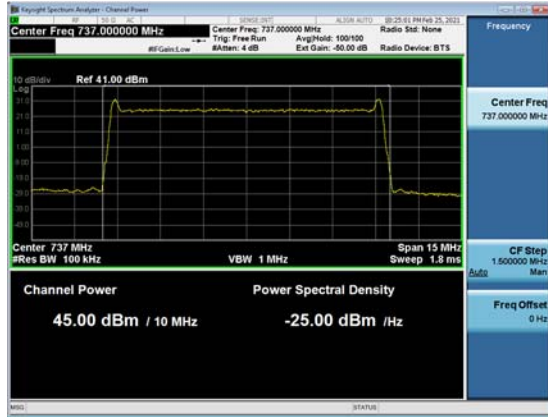
Channel Frequency 734 MHz, Modulation QPSK, TX2



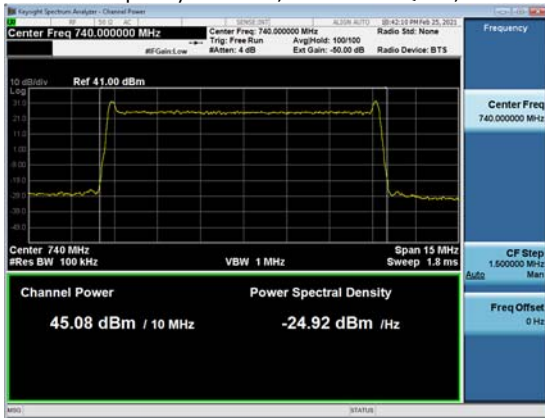
Channel Frequency 737 MHz, Modulation QPSK, TX1



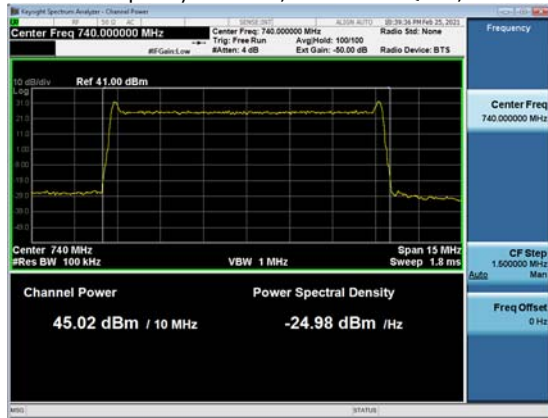
Channel Frequency 737 MHz, Modulation QPSK, TX2



Channel Frequency 740 MHz, Modulation QPSK, TX1



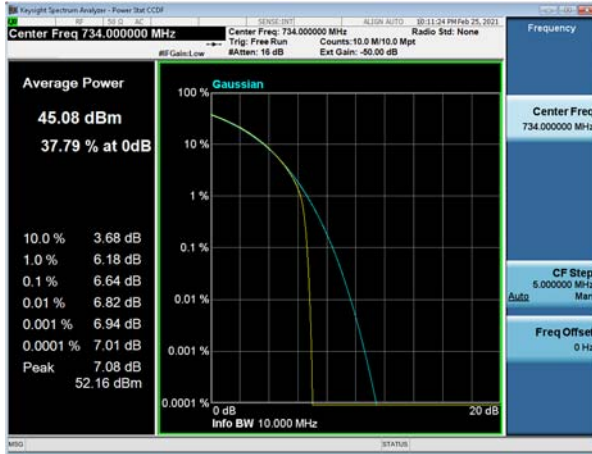
Channel Frequency 740 MHz, Modulation QPSK, TX2



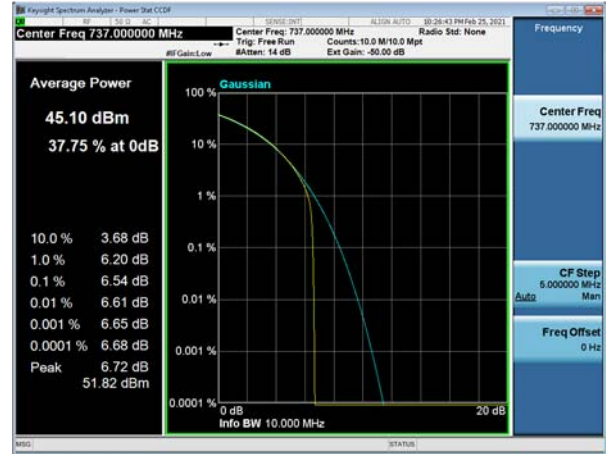
2.1.3 Peak-to-Average Power Ratio (PAPR) – Plots

The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168. 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.

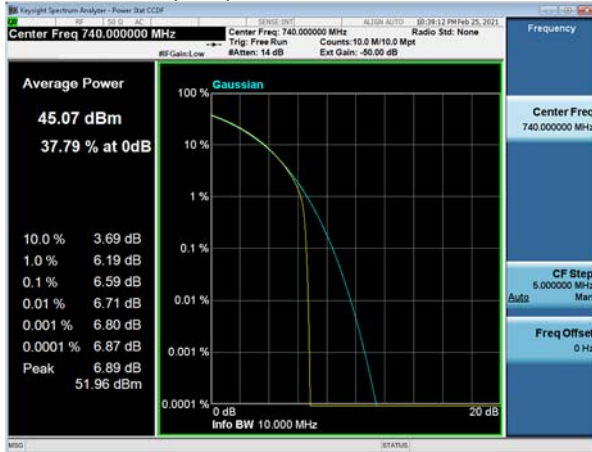
Channel Frequency 734 MHz, Modulation QPSK, TX1



Channel Frequency 737 MHz, Modulation QPSK, TX1



Channel Frequency 740 MHz, Modulation QPSK, TX1

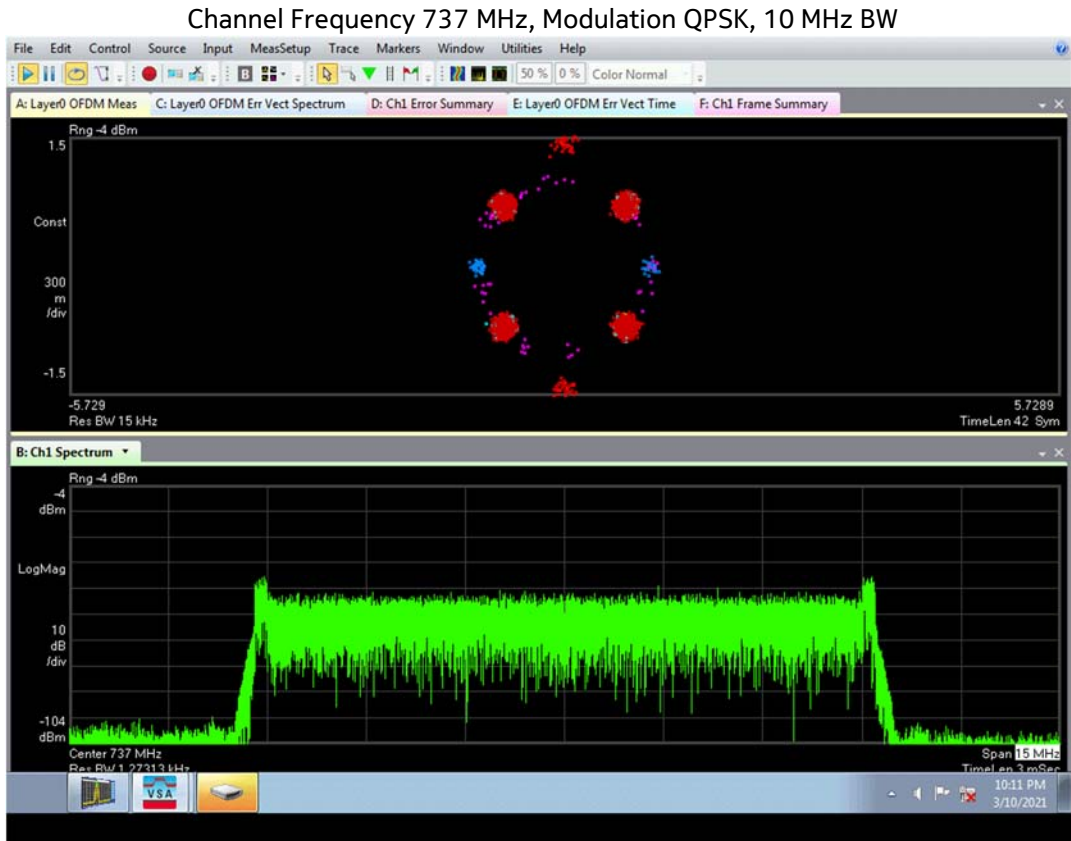


3. FCC Section 2.1047 - Modulation Characteristics

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.

3.1.1 Modulation Characteristics – Plots



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

# of Carriers	Test Model	Modulation	TX Port	Channel Frequency MHz	Signal BW MHz	Occupied BW MHz
1	1.1	QPSK	1	734	10	9.405
1	1.1	QPSK	1	737	10	9.403
1	1.1	QPSK	1	740	10	9.403

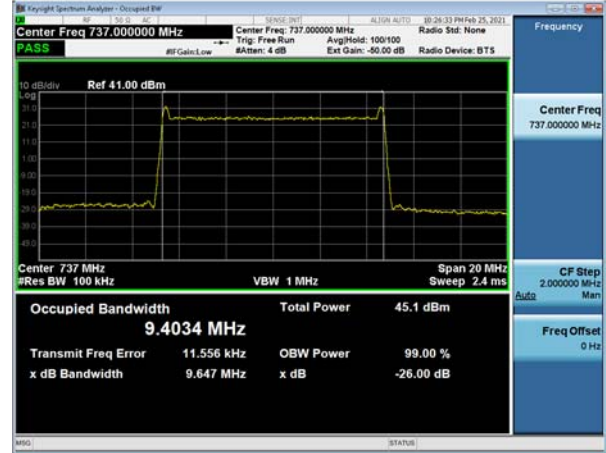
4.1.1 Occupied Bandwidth – Plots

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.

Channel Frequency 734 MHz, Modulation QPSK, TX1



Channel Frequency 737 MHz, Modulation QPSK, TX1



Channel Frequency 740 MHz, Modulation QPSK, 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 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.

NOTES: Only the emissions plots which give the minimum emission margin evaluated were used in this report. The full suite of raw data resides at the MH, New Jersey location. All the measurements met the requirements of Part 27.53 when measured per Part 2.1049. The limit is derived using the 10 Log (n) rule for limits with n=2 for the ports in the transmit band under test.

Channel Frequency 734 MHz, Modulation QPSK, TX1



Channel Frequency 737 MHz, Modulation QPSK, TX1



Channel Frequency 740 MHz, Modulation QPSK, TX1



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

5.1 Measurement of Spurious Emissions at Transmit Antenna Port

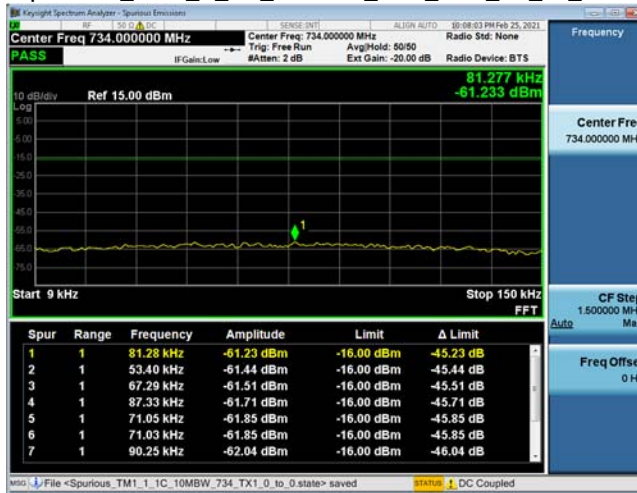
Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. Carrier Bandwidth is exempt. For this band of operation, the measurements were performed up to 10 GHz. Measurements were made using a Keysight 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 required emission limitation is specified as appropriate in 27.53. 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 10 GHz. The limit is derived using the 10 Log (n) rule for limits with n=2

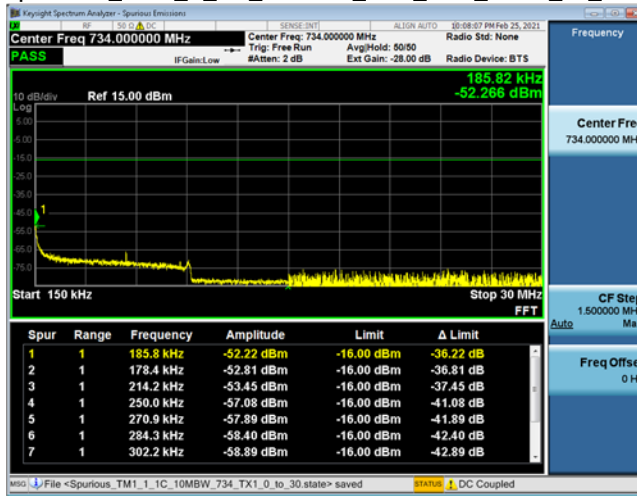
5.1.1 Spurious Emissions at Tx Port - Plots

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.

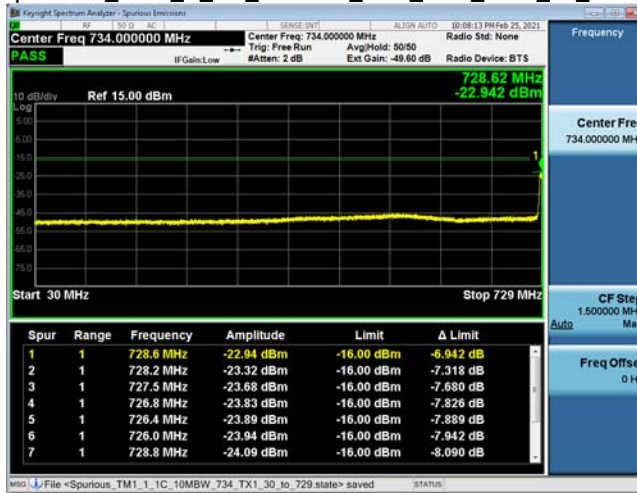
Spurious_TM1_1_1C_10MBW_734_TX1_9k_to_150k



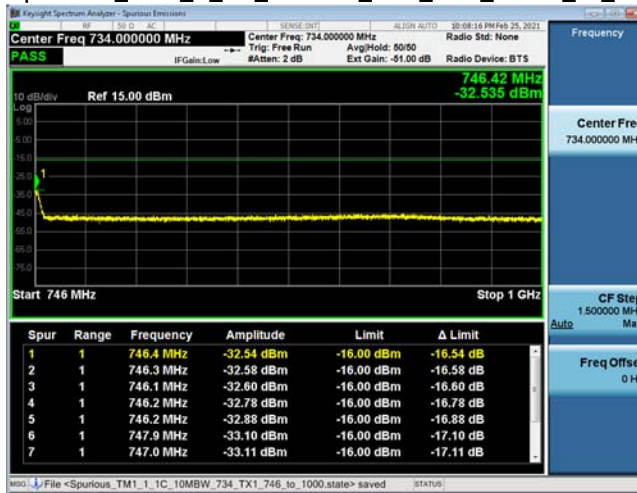
Spurious_TM1_1_1C_10MBW_734_TX1_150k_to_30M



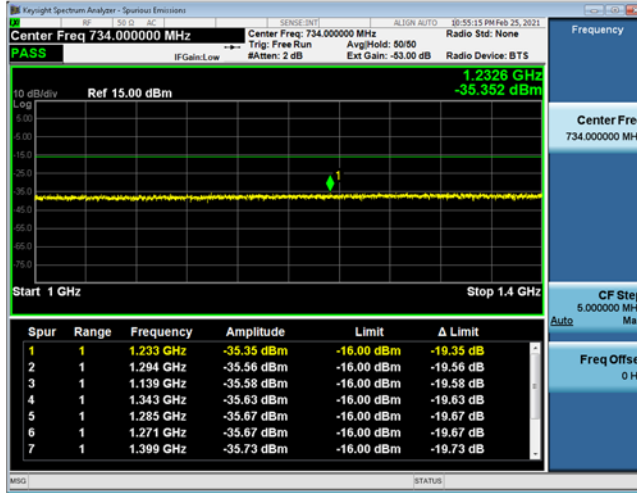
Spurious_TM1_1_1C_10MBW_734_TX1_30M_to_729M



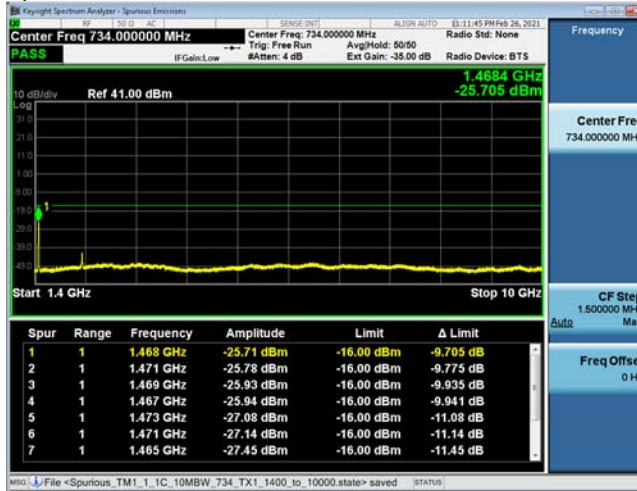
Spurious_TM1_1_1C_10MBW_734_TX1_746M_to_1G



Spurious_TM1_1_1C_10MBW_734_TX1_1G_to_1.4G



Spurious_TM1_1_1C_10MBW_734_TX1_1.4G_to_10G



Photographs

Test Setup



Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E1259	KeySight Technologies	Network Analyzer	43.5 GHz	N5234A	MY55441410	2019-02-08	2021-03-08*
E1218	KeySight Technologies	EMI Receiver	MXE EMI Receiver 26.5GHz	N9038A	MY54130037	2020-08-28	2022-08-28
E1022	Weinschel	Attenuator	10dB DC-18GHz 25W	46-10-34-LIM	BN3118	CNR-V	CNR-V
E1043	Weinschel	Attenuator	30dB 50W DC-8.5GHz	24-30-43		CNR-V	CNR-V
E1344	Macom	Attenuator	3 dB, DC - 4 GHz, 2W	2082-6171-03	N/A	CNR-V	CNR-V
E1397	Trilithic	Filter, High Pass		4HC1350/9000-1-LK	200802162	CNR-V	CNR-V
E1155	Weinschel	Attenuator	10dB 25W 0.05- 26GHz	74-10-12	1068	CNR-V	CNR-V
E1154	Weinschel	Attenuator	30dB 25W 0.05GHz- 26GHz	74-30-12	1065	CNR-V	CNR-V
E1250	Weinschel	Attenuator	3dB Attenuator 100W	24-3-43	BB9072	CNR-V	CNR-V
E1251	Weinschel	Attenuator	0dB 150W DC-18GHz	66-30-33	BV1667	CNR-V	CNR-V

CNR-V: Calibration Not Required, must be Verified

* Equipment last used on 2/26/2021

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

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.

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

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

Where:

E = Field Intensity in Volts/meter

P = Transmitted Power in Watts

R = Measurement distance in meters = 3 m

The Part 27 Limit is 82.23 dBuV/m at 3m and 91.77 dBuV/m at 1m

The Part 27 non-report level is 62.23 dBuV/m at 3m.

The calculated emission levels were found by:

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

RESULTS:

For compliance with 47CFR Parts 2 and 27, the field strength of any spurious radiation, measured at 3m, is required to be less than 82.23 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 10 GHz), no reportable spurious emissions were detected.

7. NVLAP Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology




Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 100275-0

Nokia, Global Product Compliance Lab
Murray Hill, NJ

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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).*

2020-09-25 through 2021-09-30

Effective Dates





For the National Voluntary Laboratory Accreditation Program