Global Product Compliance Laboratory
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TESTING
NVLAP LAB CODE: 100275-0

Title 47 Code of Federal Regulations Test Report

Regulation:
FCC Part 2 and 27

Client:
NOKIA SOLUTIONS AND NETWORKS

Product Evaluated:
AHBCD AirScale Dual RRH 4T4R 240W

Report Number:
TR-2022-0010-FCC2-27

Date Issued:
April 7, 2022

Table of Contents

Revisions

Date	Revision	Section	Change
04/07/2022	0		Initial Release

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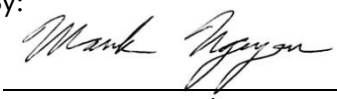
Prepared By:

Signed:  04/07/2022

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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):	AHBCD AirScale Dual RRH 4T4R 240W
Serial Number:	Refer to Section 1.3.2
FCC ID:	VBNAHBCD-01
Hardware Version:	Refer to Section 1.3.2
Software Version:	SBTS22R2
Frequency Range:	746 – 756 MHz
GPCL Project Number:	2022-0010
Manufacturer:	NOKIA SOLUTIONS AND NETWORKS OY KARAKAARI 7, FI-02610 ESPOO FINLAND
Test Requirement(s):	Title 47 CFR Parts 2 and 27
Test Standards:	See Section 1.5.1
Measurement Procedure(s):	See Section 1.5.2
Test Date(s):	3/2/2022 - 3/28/2022
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):	Joe Bordonaro, Nilesh Patel
Test Results: The EUT, *as tested* 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 **AHBCD AirScale Dual RRH 4T4R 240W**, hereinafter referred to as the Equipment Under Test (EUT).

The Nokia AHBCD AirScale Dual RRH 4T4R 240W is a new low power Remote Radio Head (RRH) for operation in the Frequency Band 746-756 MHz.

The AHBCD consists of four transceiver chains (main and diversity) that are capable of transmitting up to a maximum RF Conducted power of 80 W and EIRP power of 1640 W (62.15dBm).

The AHBCD has directional antennas. The AHBCD is typically installed on poles or walls in fixed locations. Therefore, AHBCD is neither a portable nor a mobile wireless device.

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.

The purpose of this current test program is to demonstrate LTE operation for the following bandwidths in the frequency band 746 – 756 MHz:

- 5 MHz
- 10MHz

1.3 EUT Details

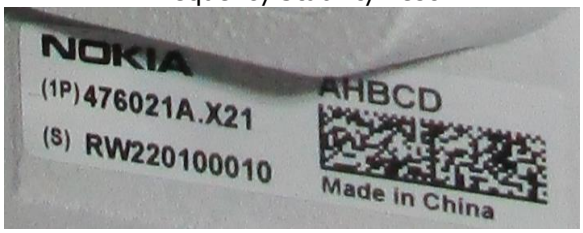
1.3.1 Specifications

Specification Items	Description
Radio Access Technology	LTE
Duplex Mode	Frequency Division Duplex (FDD)
Modulation Type(s)	QPSK, 16QAM, 64QAM, 256QAM
Operation Frequency Range	746 – 756 MHz
Channel Bandwidth	5 and 10 MHz
Number of Tx Ports per Unit	4
MIMO	Yes
Deployment Environment	Outdoor
Supply Voltage	-48.0 VDC
Max RF Output Power	4X20 W (43.01 dBm ± 2.0dBm)

1.3.2 Photographs

Radio Test

Frequency Stability Test



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	Yes

1.5 Test Standards & Measurement Procedures

1.5.1 Test 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.

1.5.2 Measurement 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.
- FCC-IC-FS – GPCL Frequency Stability Measurement Process 6-20-2019.

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

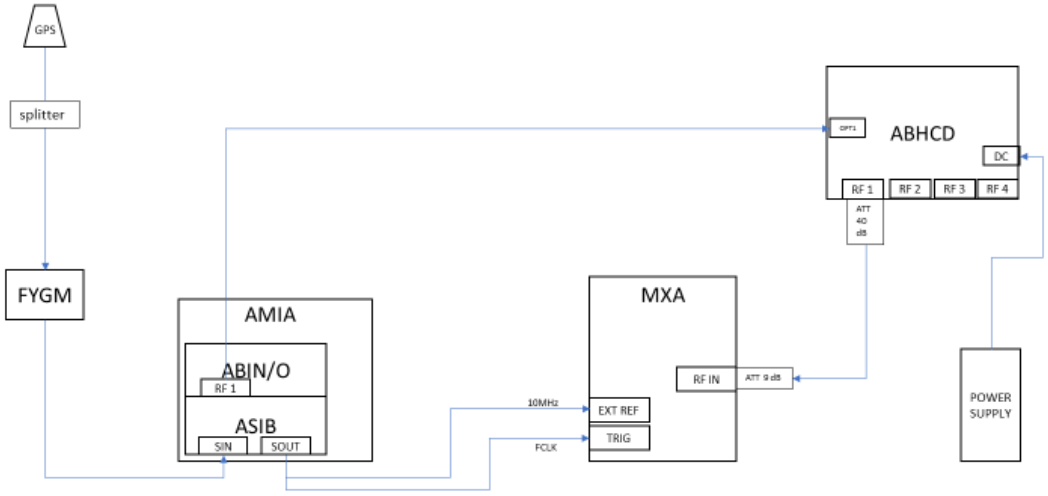
Requirement	Description	Result
47 CFR FCC Parts 2 and 27		
2.1046, 27.53	RF Power Output Peak to Average Power Ratio	COMPLIES
2.1047, 27.53	Modulation Characteristics	COMPLIES
2.1049, 27.53	(a) Occupied Bandwidth (b) Edge of Band Emissions	COMPLIES
2.1051, 27.53	Spurious Emissions at Antenna Terminals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

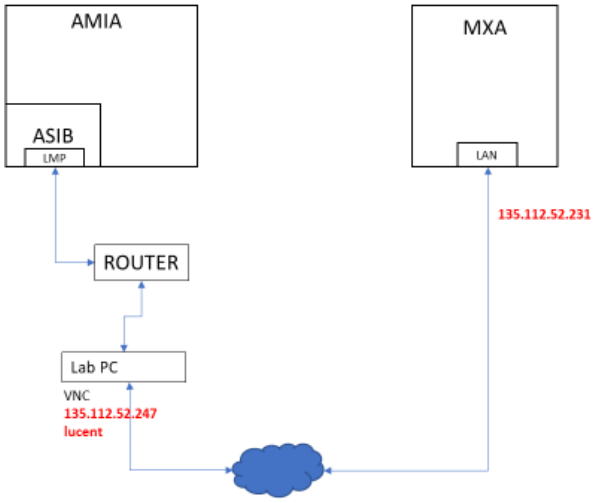
1. **COMPLIES -** Passed all applicable tests.
2. **N/A –** Not Applicable.
3. **NT –** Not Tested.

1.7 Test Configuration

1.8 Test Setup for all Measurement at Antenna Ports

1.8.1 Test Setup for Frequency Stability




AMIA
ASIB
LMP
MXA
LAN
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ROUTER
Lab PC
VNC
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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. The product is rated for 20 W (43.01 dBm +/- 2.0 dBm) per port for each of the four transmit ports.

Power measurements were made with an MXA Signal Analyzer and the procedure of ANSI C63.26:2015 Section 5.4.2.2 was observed. The maximum output is bolded in each case.

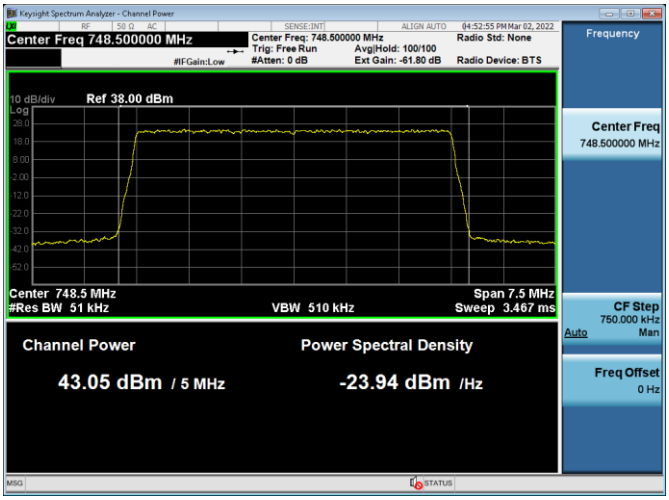
Tabular Data – Channel RF Power (LTE)

Test Model 3.1 Modulation 64QAM Channel Frequency 748.5MHz Signal BW 5MHz		Test Model 3.1 Modulation 64QAM Channel Frequency 751MHz Signal BW 10MHz		Test Model 3.1a Modulation 256QAM Channel Frequency 753.5MHz Signal BW 5MHz	
TX Port	(dBm)	TX Port	(dBm)	TX Port	(dBm)
1	**43.05**	1	**42.98**	1	**42.95**
2	42.86	2	42.79	2	42.79
3	42.83	3	42.77	3	42.78
4	42.95	4	42.88	4	42.93
Total Power (dBm)	48.94	Total Power (dBm)	48.88	Total Power (dBm)	48.88
Total Power (W)	78.41	Total Power (W)	77.20	Total Power (W)	77.34

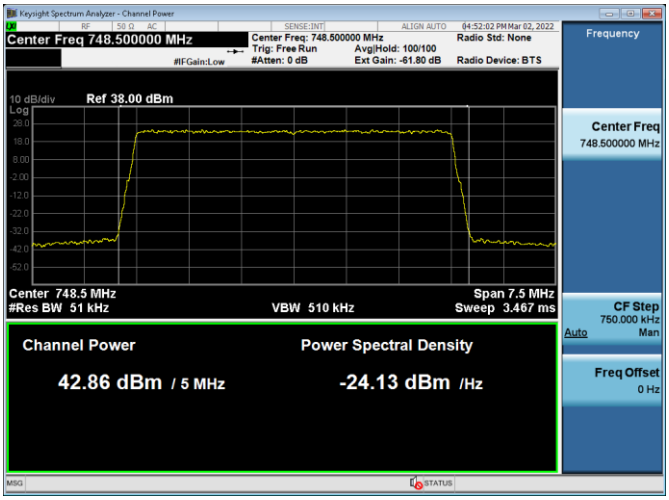
2.2 Channel RF Power – Plots

2.2.1 5 MHz BW, 748.5 MHz, 64QAM

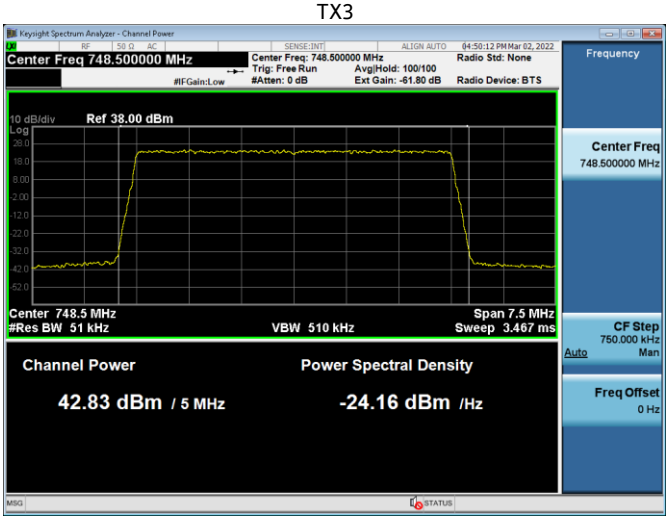
TX1



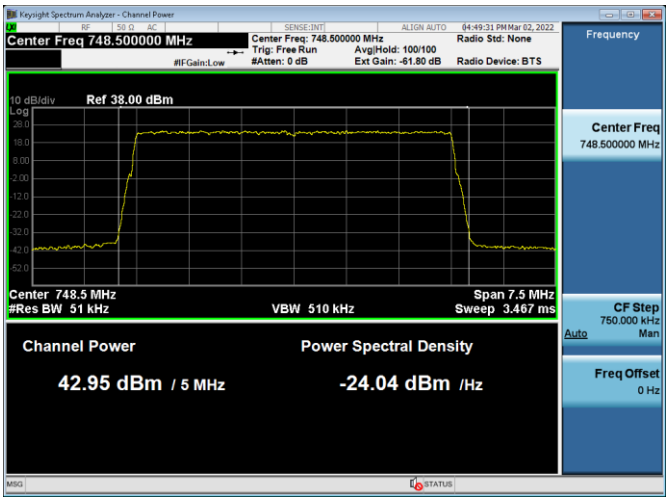
TX2



TX3

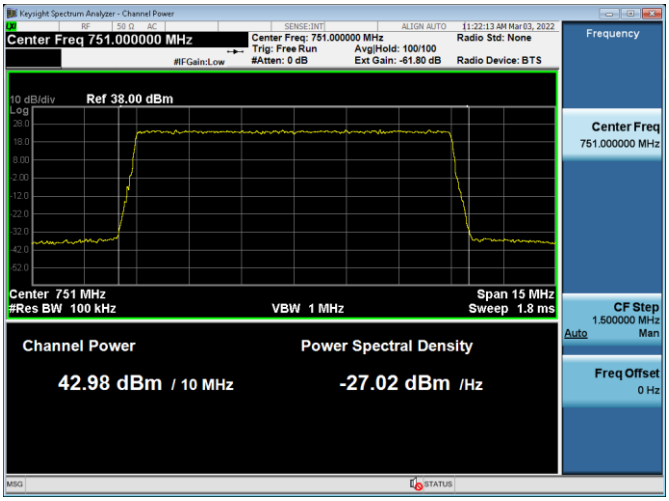


TX4

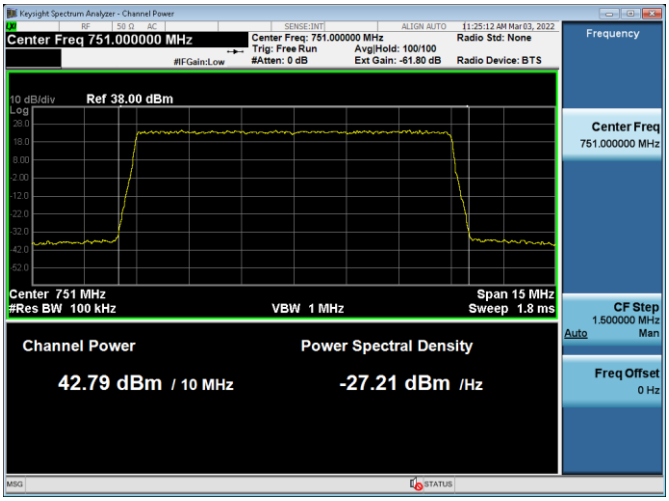


2.2.2 10 MHz BW, 751 MHz, 64QAM

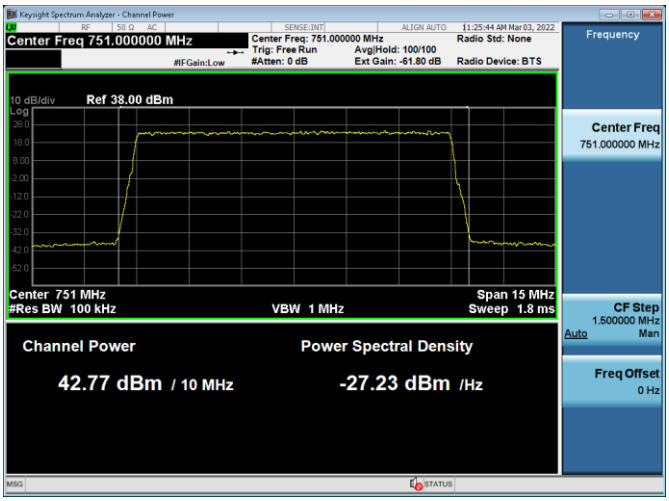
TX1



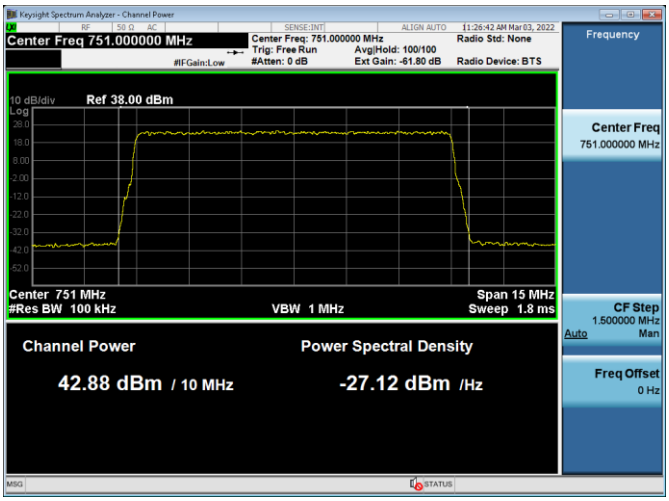
TX2



TX3

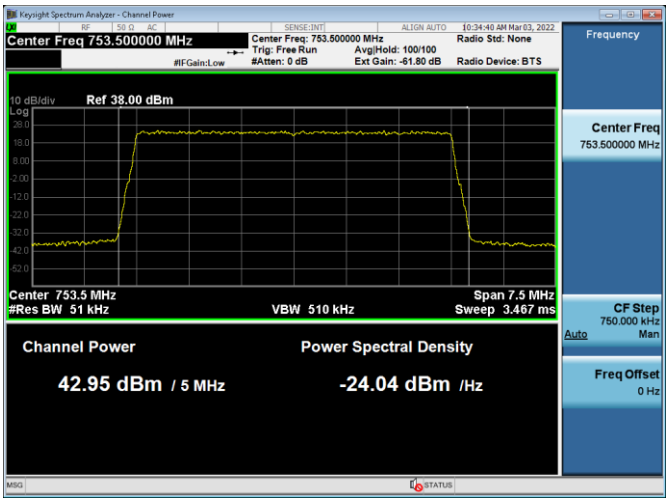


TX4

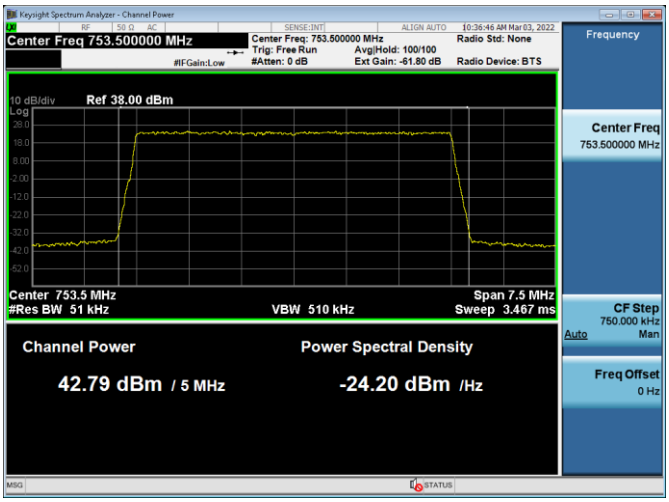


2.2.3 5 MHz BW, 753.5 MHz, 256QAM

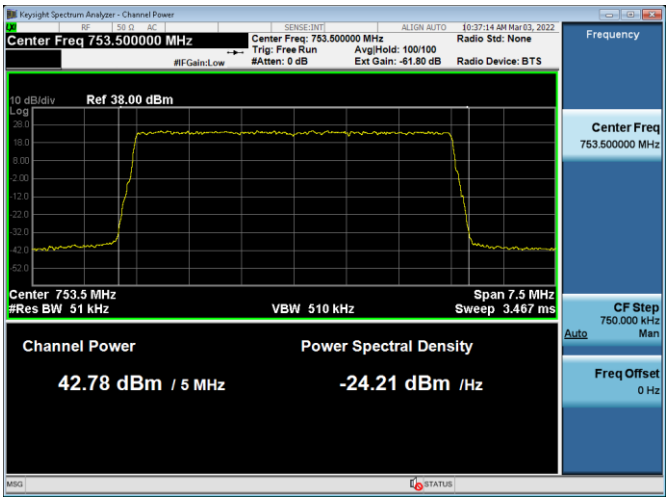
TX1



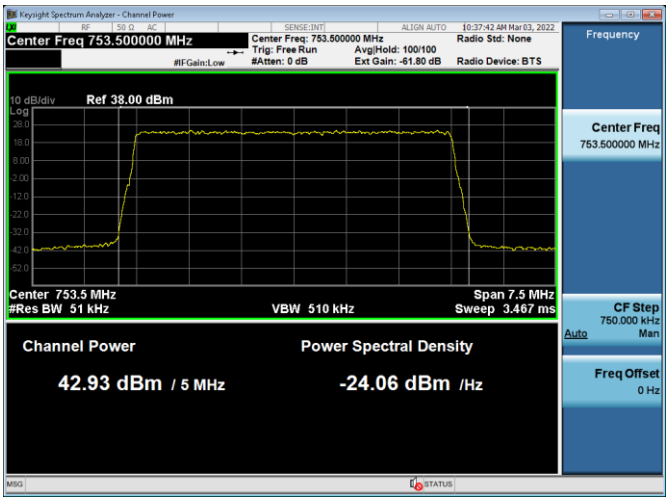
TX2



TX3



TX4



2.3 Peak-to-Average Power Ratio (PAPR)

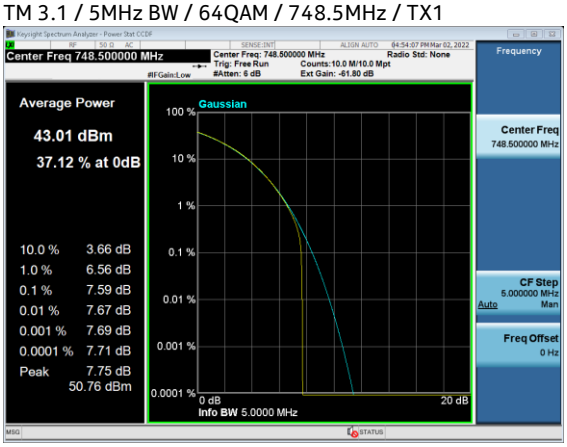
The Peak-to-Average Power Ratio (PAPR) was evaluated per KDB 971168 for Single and Multiple Carriers. The PAPR values of all carriers measured are below 13dB.

PAPR Tabular Data

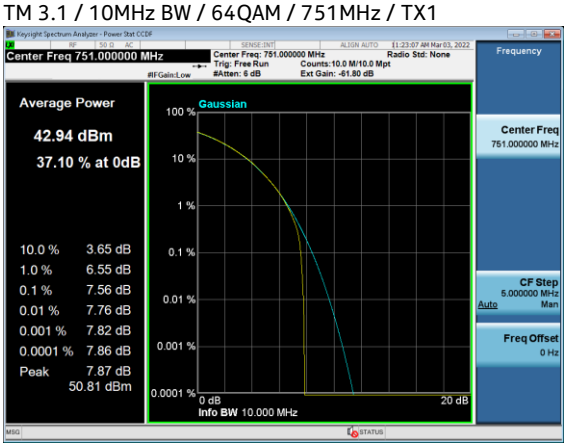
Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz	PAR at 0.1% Limit - 13 dB
5	3.1	64QAM	1	748.5	**7.59**
10	3.1	64QAM	1	751.0	7.56
5	3.1a	256QAM	1	753.5	**7.59**

2.3.1 Peak-to-Average Power Ratio Plots

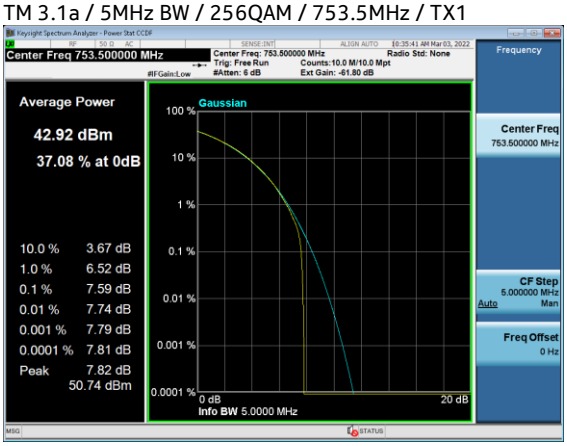
TM 3.1 / 5MHz BW / 64QAM / 748.5MHz / TX1



TM 3.1 / 10MHz BW / 64QAM / 751MHz / TX1



TM 3.1a / 5MHz BW / 256QAM / 753.5MHz / TX1



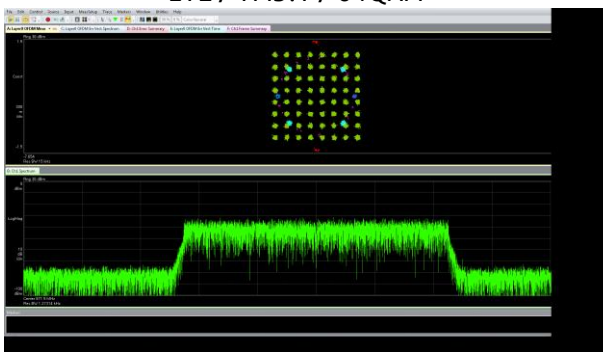
3. FCC Section 2.1047 - Modulation Characteristics

3.1 Modulation Characteristics

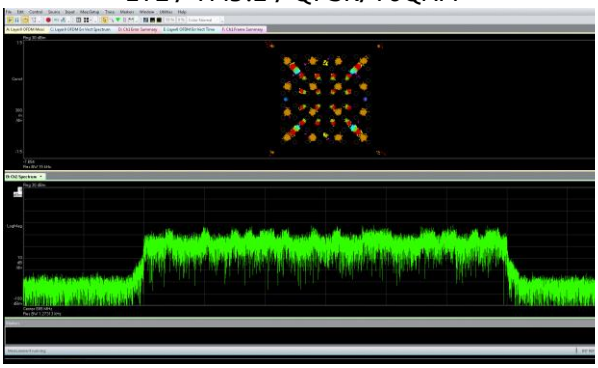
The RF signal at the antenna port was demodulated and verified for correctness of the modulation signal used before each test was performed.

3.1.1 Modulation Characteristics – Plots

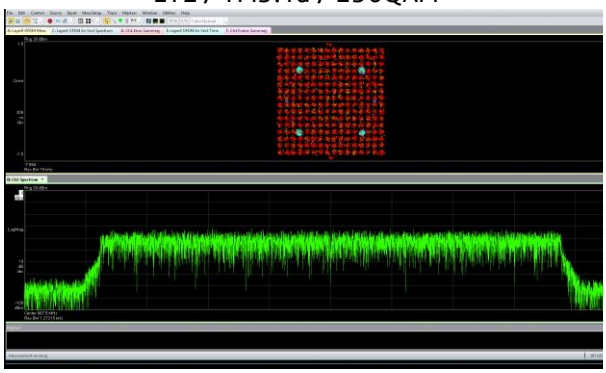
LTE / TM3.1 / 64QAM



LTE / TM3.2 / QPSK/16QAM



LTE / TM3.1a / 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

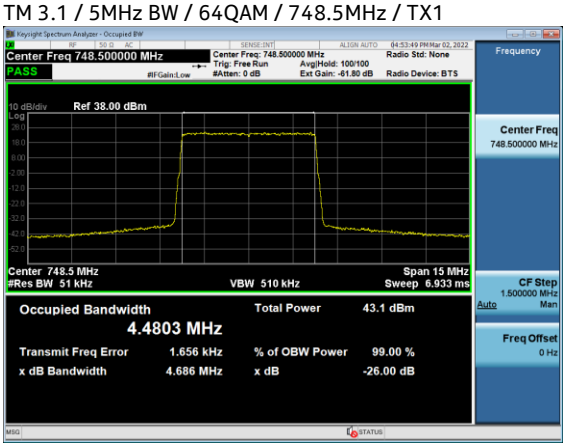
Signal BW MHz	Test Model	Modulation	TX Port	Channel Frequency MHz	99% Occupied BW MHz
5	3.1	64QAM	1	748.5	4.4803
10	3.1	64QAM	1	751.0	8.9305
5	3.1a	256QAM	1	753.5	4.4788

Tabular Data – 26 dB Occupied Bandwidth

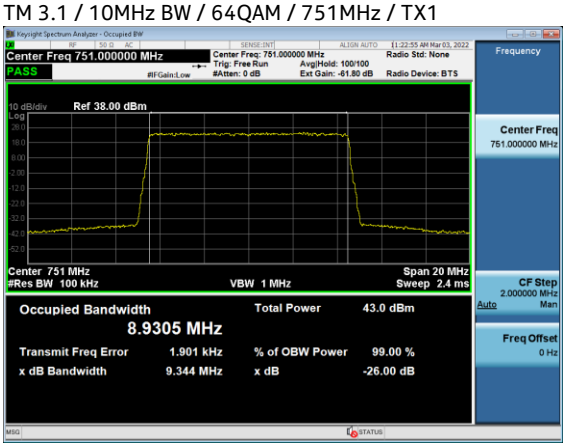
Signal BW MHz	**Test Model**	**Modulation**	**TX Port**	**Channel Frequency MHz**	**26dB Emission Bandwidth MHz**
5	3.1	64QAM	1	748.5	4.686
10	3.1	64QAM	1	751.0	9.344
5	3.1a	256QAM	1	753.5	4.707

4.2 Occupied Bandwidth – Plots

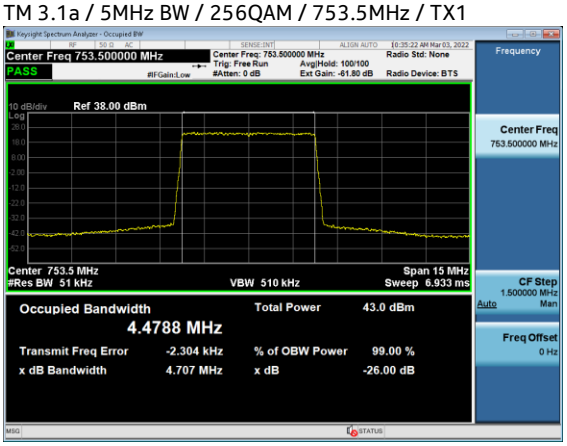
TM 3.1 / 5MHz BW / 64QAM / 748.5MHz / TX1



TM 3.1 / 10MHz BW / 64QAM / 751MHz / TX1



TM 3.1a / 5MHz BW / 256QAM / 753.5MHz / TX1



4.3 Edge of band Emissions

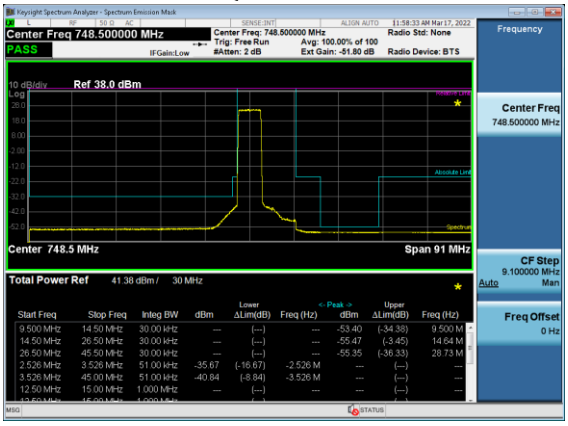
The Edge of Band emissions of the EUT at the external antenna connector (EAC) were measured using a Keysight MXA Signal Analyzer. Before measuring the Edge of Band emissions, the RF power level was confirmed with the Keysight MXA Signal Analyzer. The RF output from the EAC port to signal analyzer was reduced (to an amplitude usable by the signal analyzer) by using a calibrated attenuator and RF Switch. 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. In accordance with KDB 662911 D01 Multiple Transmitter Output, the limit of -13 dBm has been adjusted to -19 dBm to reflect 10 log(n) where n=4 for the 4x4 MIMO operation. For the conducted limits at 76 + 10 log (p), the second level of the mask is -52 dBm (i.e 46 dBm + 6.02 for MIMO adjustments).

In addition, the limit of -46 dBm in the frequency ranges of 763-775 MHz and 793-805 MHz has been adjusted to -52 dBm for 4x4 MIMO operation.

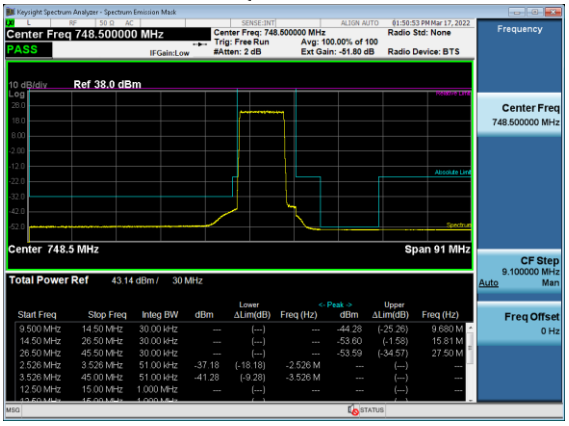
4.3.1 Edge of Band Emissions – Plots

All of the measurements met the requirements of Part 27.53 when measured per Part 2.1049.

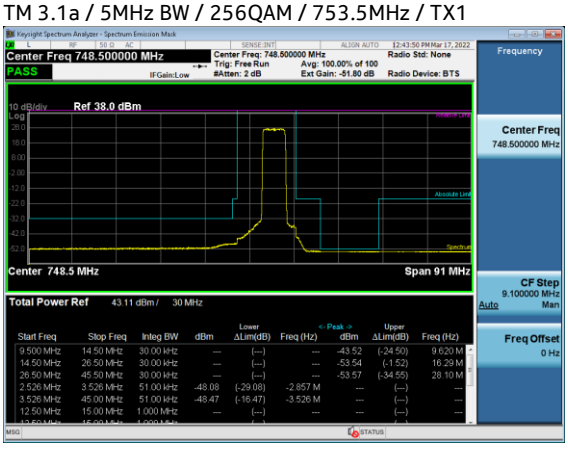
TM 3.1 / 5MHz BW / 64QAM / 748.5MHz / TX1



TM 3.1 / 10MHz BW / 64QAM / 751MHz / TX1



TM 3.1a / 5MHz BW / 256QAM / 753.5MHz / TX1



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

5.1 Measurement of Spurious Emissions at Transmit Antenna Port

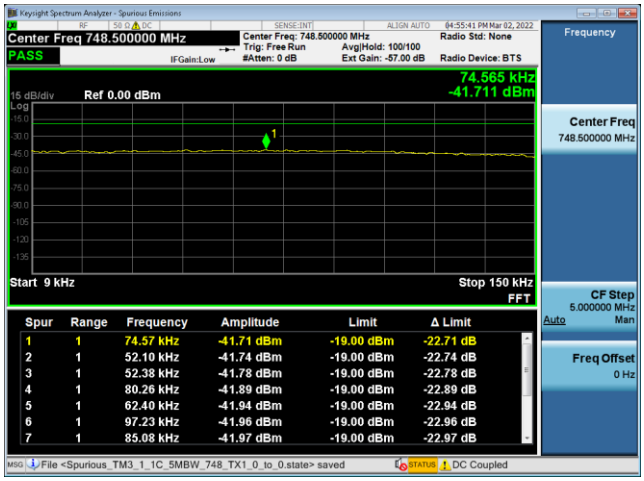
Spurious Emissions at the transmit-antenna terminals were investigated over the frequency range of 10 MHz to beyond the 10th harmonic of the specific transmit band. Carrier Bandwidth is exempt. For this band of operation, the measurements were performed up to 10 GHz. Measurements were made using a Keysight 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 Keysight MXA Signal Analyzer.

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.

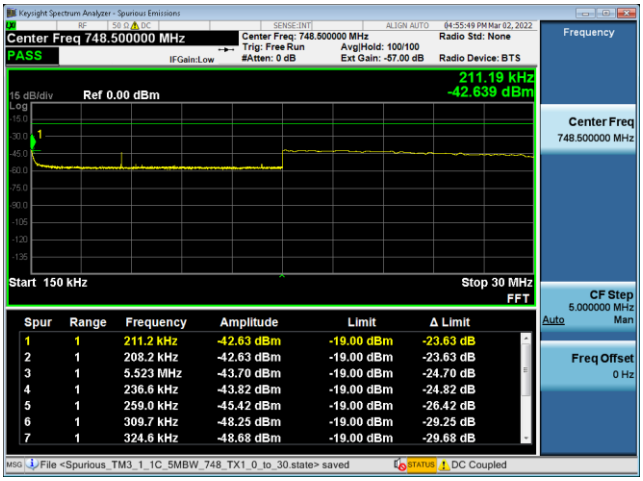
5.1.1 Spurious Emissions at Tx Port - Plots

5.1.1.1 TM3.1, 5 MHz BW, 64QAM, 748.5 MHz, TX1

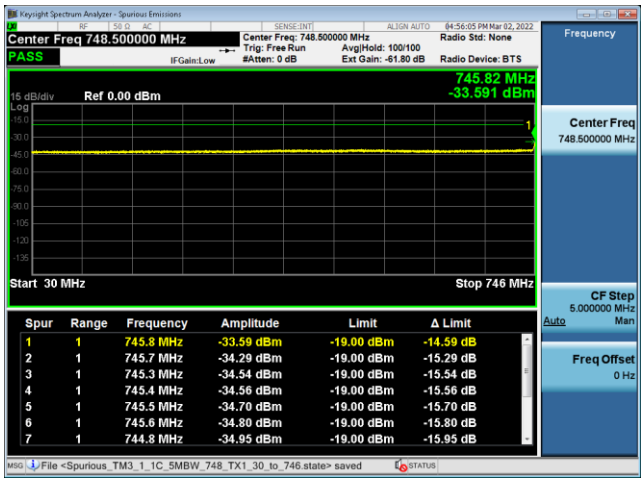
9kHz – 150kHz



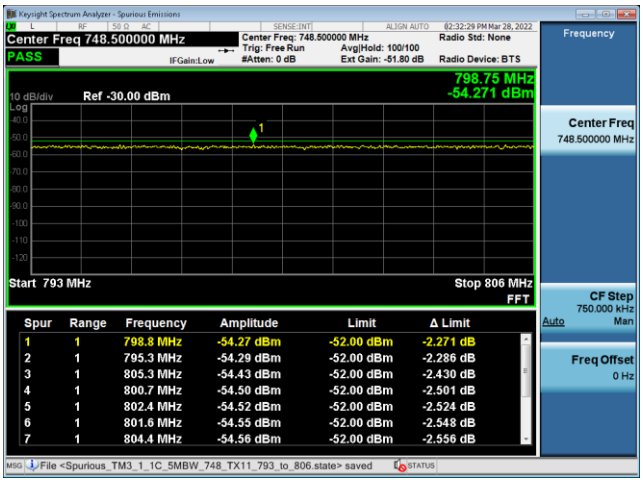
150kHz – 30MHz



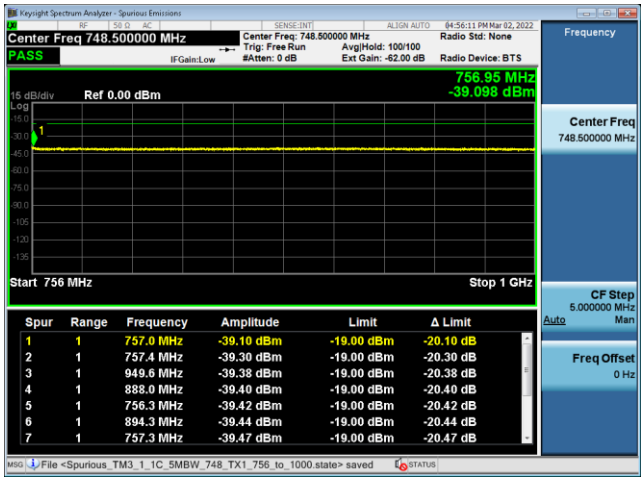
30MHz – 746MHz



793MHz – 806MHz

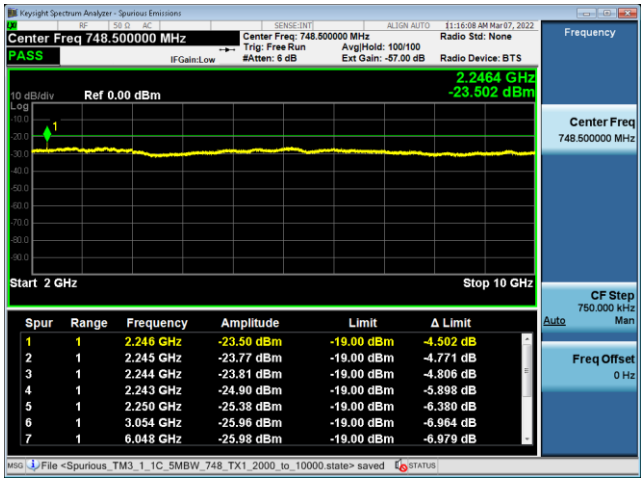


756MHz – 1GHz



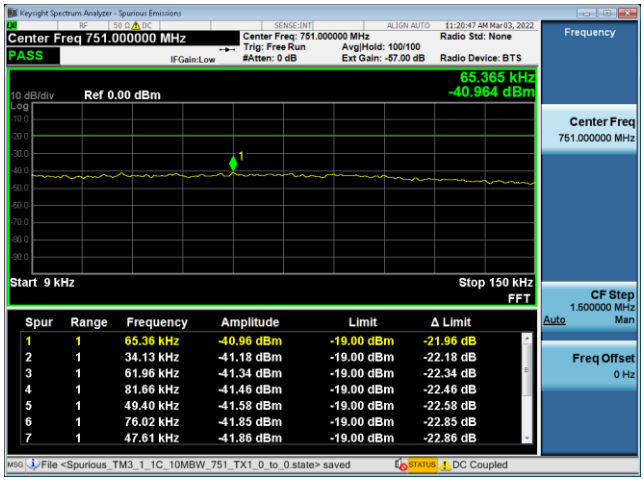
1GHz – 2GHz

2GHz – 10GHz

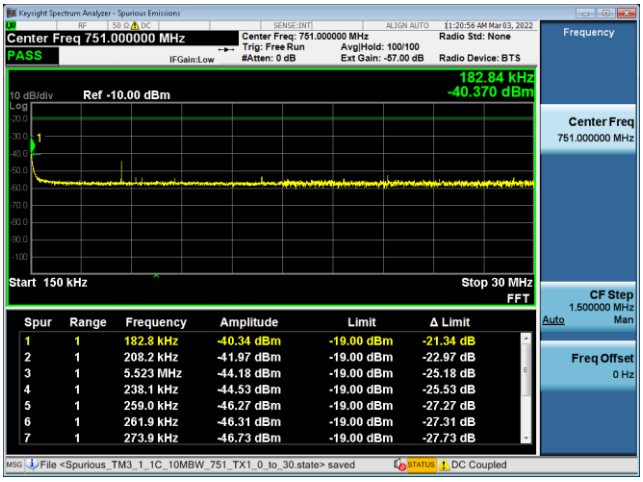


5.1.1.2 TM3.1, 10 MHz BW, 64QAM, 751 MHz, TX1

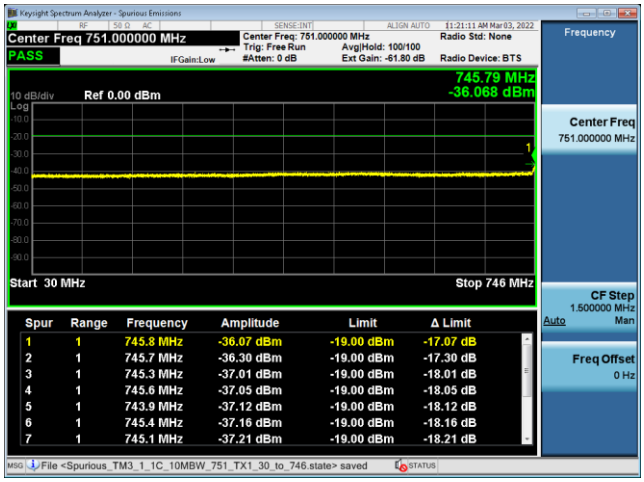
9kHz – 150kHz



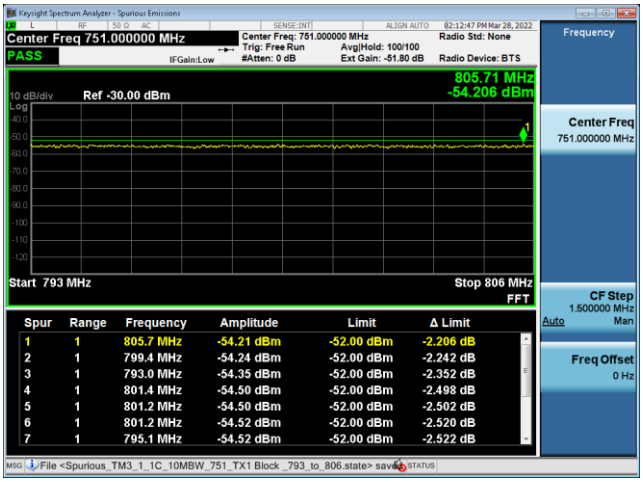
150kHz – 30MHz



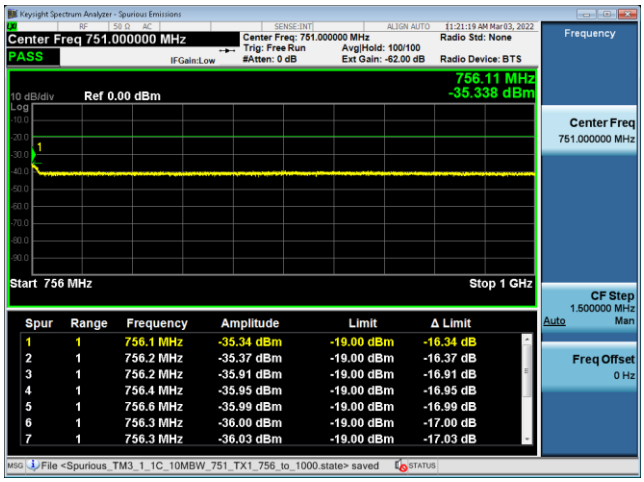
30MHz – 746MHz



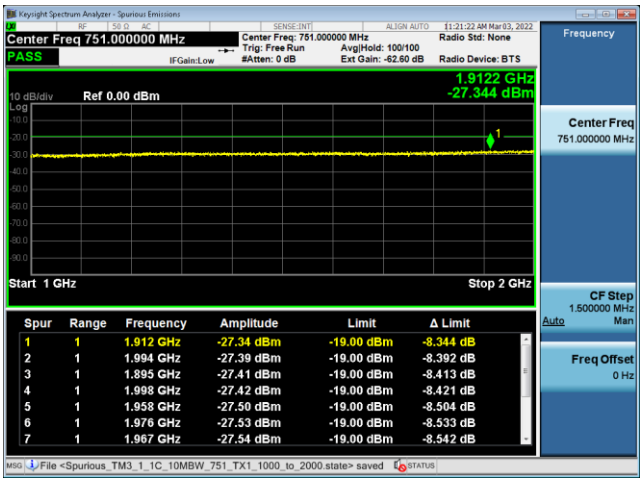
793MHz – 806MHz



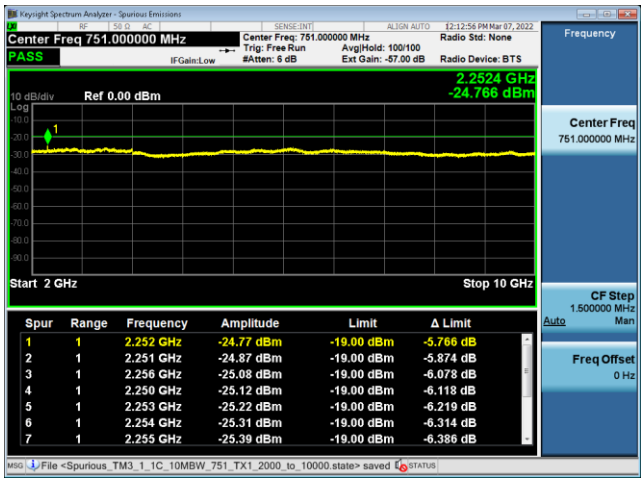
756MHz – 1GHz



1GHz – 2GHz

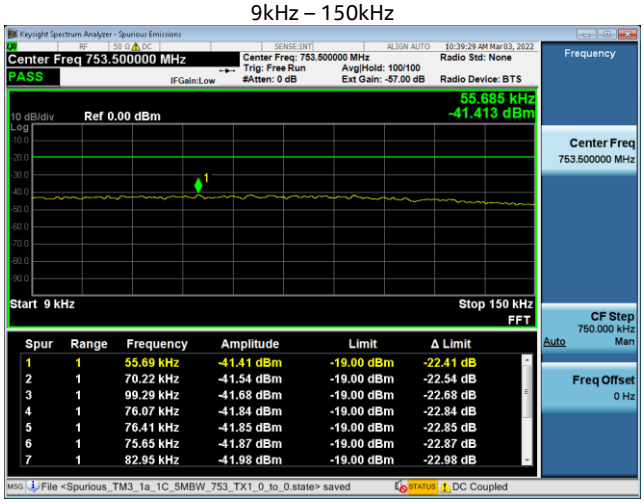


2GHz – 10GHz

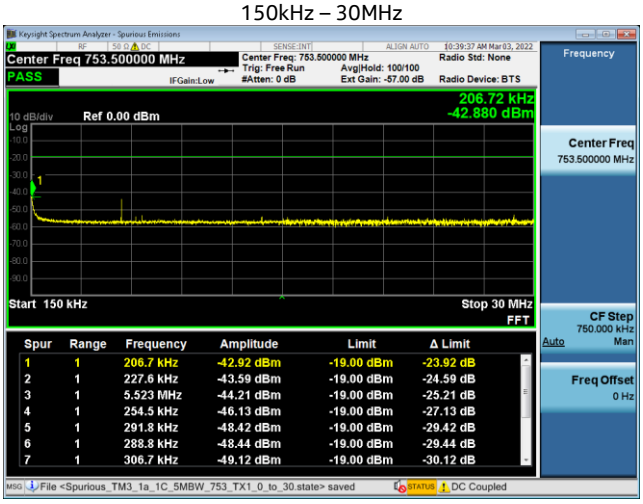


5.1.1.3 TM3.1a, 5 MHz BW, 256QAM, 753.5 MHz, TX1

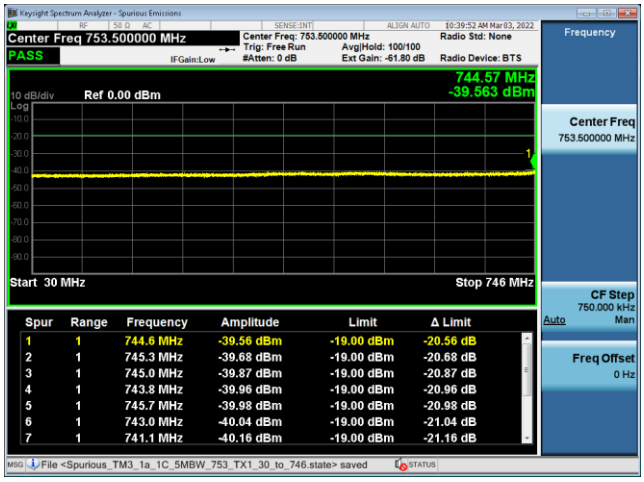
9kHz – 150kHz



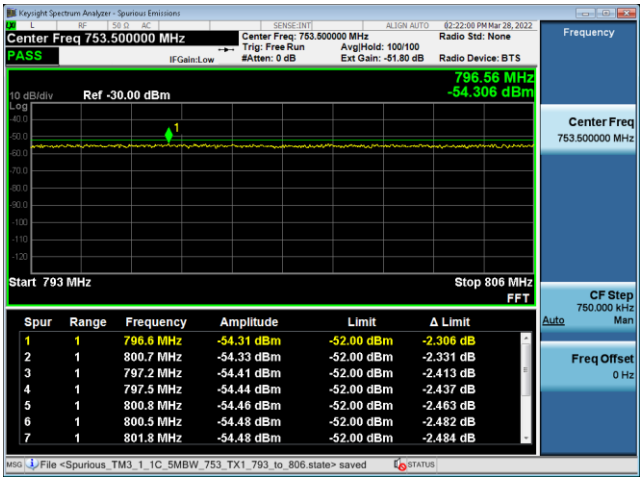
150kHz – 30MHz



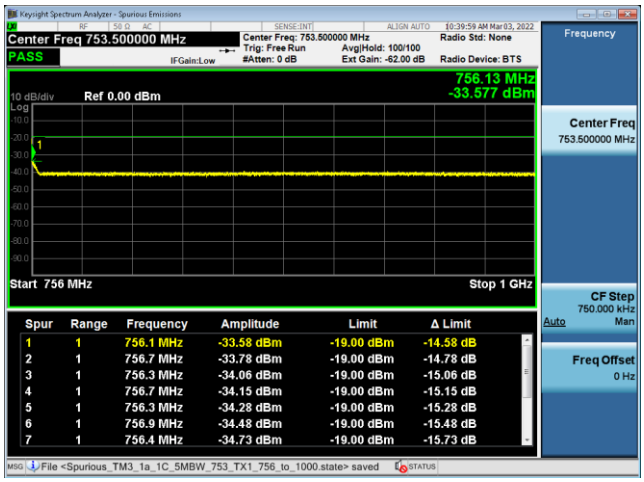
30MHz – 746MHz



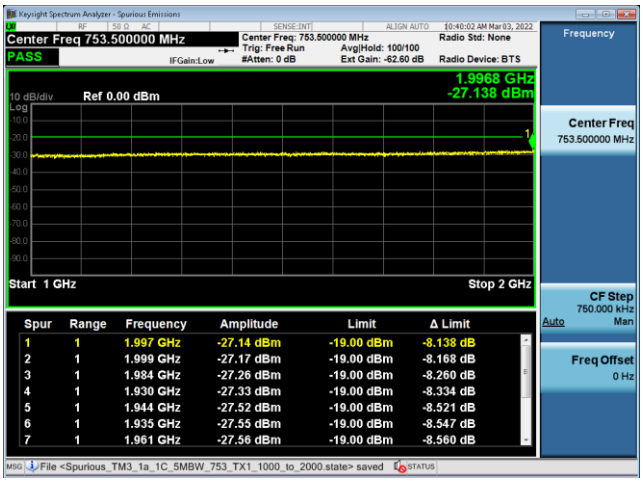
793MHz – 806MHz



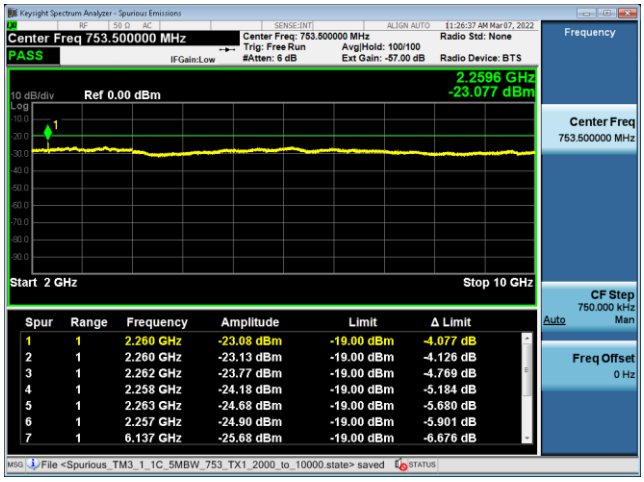
756MHz – 1GHz



1GHz – 2GHz

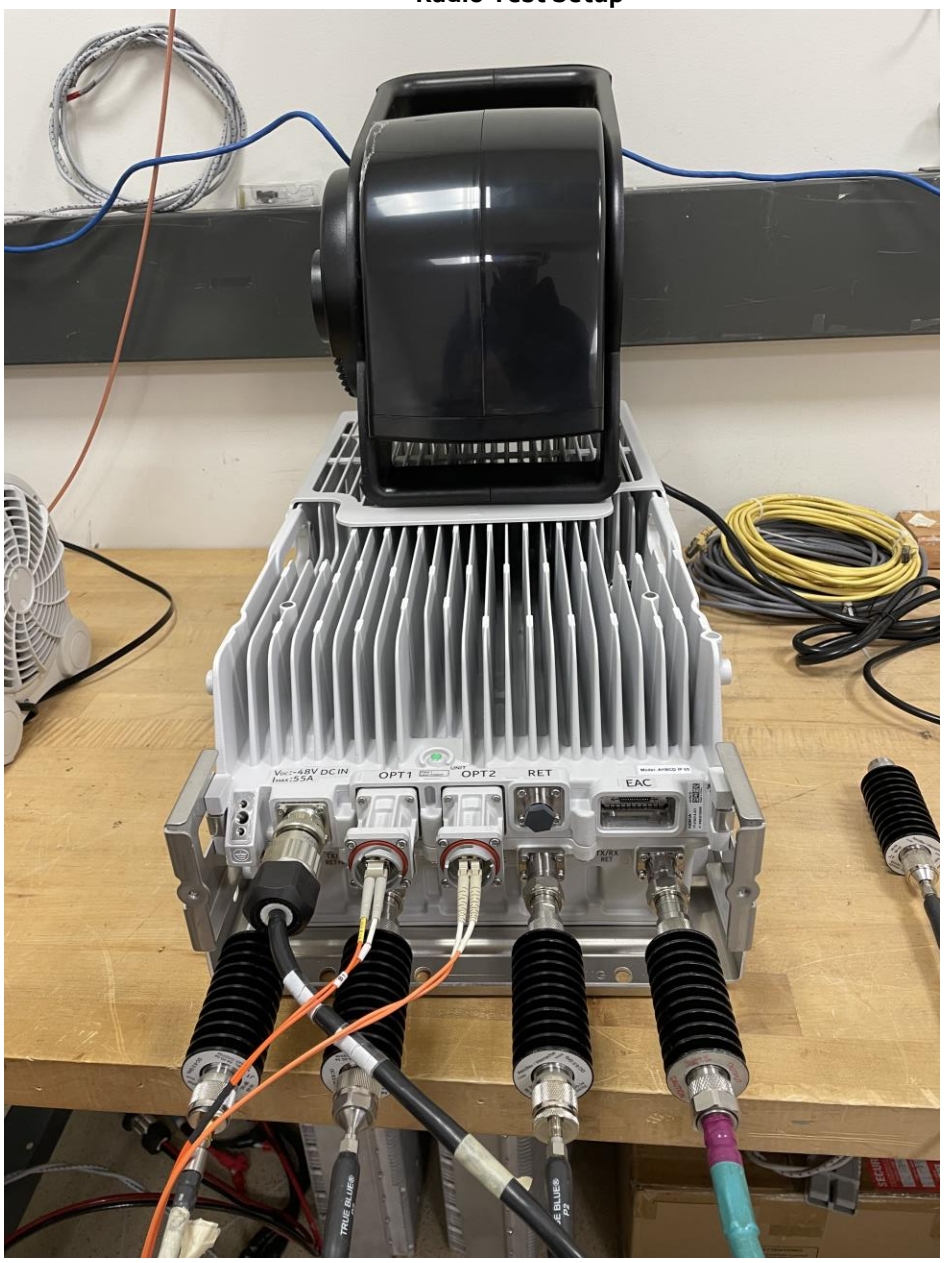


2GHz – 10GHz



Photographs

Radio Test Setup



Test Equipment

Radio Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
E1217	KeySight Technologies	EMI Receiver	MXE EMI Receiver 26.5GHz	N9038A	MY54130087	2021-05-11	2023-05-11
EIH74	KeySight Technologies	EMI Receiver	20 Hz-44 GHz (Analysis Bandwidth 125 MHz)	N9020B	MY57120303	2020-12-21	2022-12-21
E896	Agilent Technologies	Network Analyzer	10 MHz - 40 GHz	N5230C	MY49000897	2021-03-03	2023-03-03
E1534	Traceable	Data Logger	Barometric Humidity Temp Data Logger	6529	200648430	2020-10-21	2022-10-21
E1212	RLC Electronics	Filter, High Pass	10 - 30 GHz, 2W, 5dB	F-19414	1444002	CNR-V	CNR-V
E1022	Weinschel	Attenuator	10dB DC-18GHz 25W	46-10-34-LIM	BN3118	CNR-V	CNR-V
E1023	Weinschel	Attenuator	20 dB DC-18 GHz 25W	46-20-34	BJ4772	CNR-V	CNR-V
E1344	Macom	Attenuator	3 dB, DC - 4 GHz, 2W	2082-6171-03	N/A	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	Aeroflex	Attenuator	30dB 150W DC-18GHz Attenuator	66-30-33	BV1667	CNR-V	CNR-V

CNR-V: Calibration Not Required, Must Be Verified
Tests Dates: 3/2/2022 – 3/28/2022.

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.

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

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

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

The Part 27 Limit is 82.23 dBµV/m at 3m and 91.77 dBuV/m at 1m
The Part 27 non-report level is 62.23 dBµV/m at 3m.

The calculated emission levels were found by:

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

Frequency Stability testing was completed on the AHBCD Unit with Center Frequency 751 MHz. Testing was performed from 03/16/2022 through 03/17/2022 on the radio, which was located in the T-11 Thermal chamber of the Global Product Compliance Laboratory (GPCL) test facility located in Building 4, Room 4-280, Murray Hill, NJ, by Joe Bordonaro from GPCL.

The temperatures to which the UUT were subjected ranged from a high temperature of +50°C system ambient to a low temperature of -30°C system ambient with measurements recorded at 10°C increments

Transmit frequency error measures the deviation between the actual transmit frequency and the assigned frequency. The transmit frequency error in this case was measured by capturing the transmitted signal using a receiving antenna and then cabling it to an MXA signal analyzer. The system level frequency stability testing resulted in compliance with established design criteria.

Table 1: Unit Under Test

Series	Vendor	Serial Number	Comcode
AHBCD	Nokia	RW220100010	475021A.X21

Frequency Block Tested: *AHBCD (CF = 751 MHz)*

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 **mHz =milli-hertz**

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	294.52
0.5	852.91
1.0	-220.42
1.5	-619.29
2.0	-75.093
2.5	61.943
3.0	-317.70
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	512.93
0.5	164.55
1.0	179.27
1.5	283.03
2.0	-853.74
2.5	-43.026
3.0	-663.66
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	-141.33
0.5	-38.711
1.0	473.19
1.5	-760.82
2.0	-363.12

2.5	382.64
3.0	688.65
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	483.66
0.5	-493.77
1.0	683.42
1.5	39.884
2.0	455.81
2.5	376.04
3.0	-527.26
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	102.48
0.5	-628.59
1.0	-389.28
1.5	407.21
2.0	-29.718
2.5	746.00
3.0	-546.84
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	847.49
0.5	572.77
1.0	691.59
1.5	412.87
2.0	-444.43

2.5	-212.46
3.0	347.21
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	Transmit Carrier Deviation (mHz)
0	-529.87
0.5	-134.18
1.0	-613.96
1.5	-551.96
2.0	4.6011
2.5	46.788
3.0	1.3834Hz
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	-145.97
0.5	-521.68
1.0	-6.8645
1.5	341.28
2.0	-543.98
2.5	11.096
3.0	315.35
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	210.20
0.5	-310.76
1.0	133.94
1.5	313.03
2.0	201.68

2.5	-456.01
3.0	96.543
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, -48VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	416.21
0.5	-328.01
1.0	-116.07
1.5	512.34
2.0	-989.61
2.5	668.06
3.0	515.09
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Upon return to +25°C.

2. At ambient, vary voltage to +15% and -15% of nominal VAC 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 (mHz)**
0	-544.10
0.5	346.00
1.0	-387.29
1.5	-19.667
2.0	-344.03
2.5	-130.03
3.0	-654.98
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at 103% of Nominal Voltage, -49.44VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	944.26
0.5	-520.36
1.0	-334.55
1.5	-200.64
2.0	195.38
2.5	311.32
3.0	-162.27
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at 106% of Nominal Voltage, -50.88VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	203.51
0.5	-282.08
1.0	305.24
1.5	198.74
2.0	-285.26
2.5	33.882
3.0	-222.30

SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at 109% of Nominal Voltage, -52.32VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	-248.88
0.5	29.125
1.0	737.15
1.5	77.997
2.0	-108.71
2.5	-225.63
3.0	95.967
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at 112% of Nominal Voltage, -53.76VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	-883.13
0.5	117.89
1.0	-42.029
1.5	-183.63
2.0	381.23
2.5	332.44
3.0	8.3603
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at 115% of Nominal Voltage, -55.20VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	44.415
0.5	-586.26
1.0	-264.71
1.5	-163.49
2.0	178.08
2.5	-16.381
3.0	-222.30
SPECIFICATION	751 MHz (±0.05ppm)

	±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at 100% of Nominal Voltage, -48.0VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	-133.49
0.5	-84.345
1.0	-502.84
1.5	-220.16
2.0	510.18
2.5	-320.03
3.0	113.73
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, -46.56VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	141.11
0.5	825.28
1.0	-61.139
1.5	248.12
2.0	-179.04
2.5	-342.67
3.0	-148.68
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, -45.12VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	-290.19
0.5	301.00
1.0	249.65
1.5	19.768
2.0	-776.71
2.5	535.26
3.0	-439.19
SPECIFICATION	751 MHz (±0.05ppm)

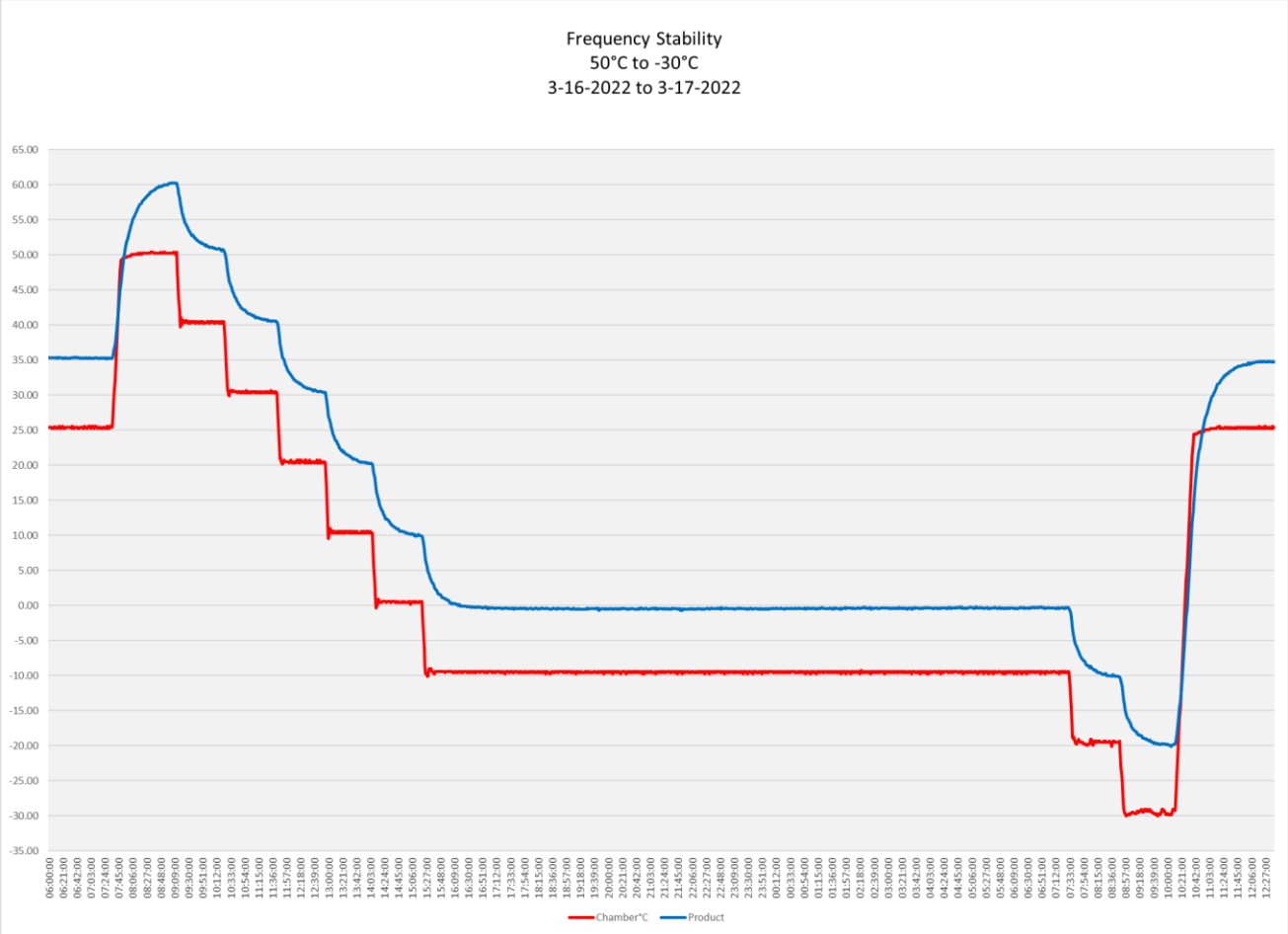
	±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, -43.68VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	-427.40
0.5	-348.28
1.0	559.74
1.5	250.69
2.0	-545.85
2.5	-248.36
3.0	-129.02
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, -42.24VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	-180.61
0.5	197.68
1.0	-651.39
1.5	-591.57
2.0	-299.99
2.5	237.77
3.0	613.77
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

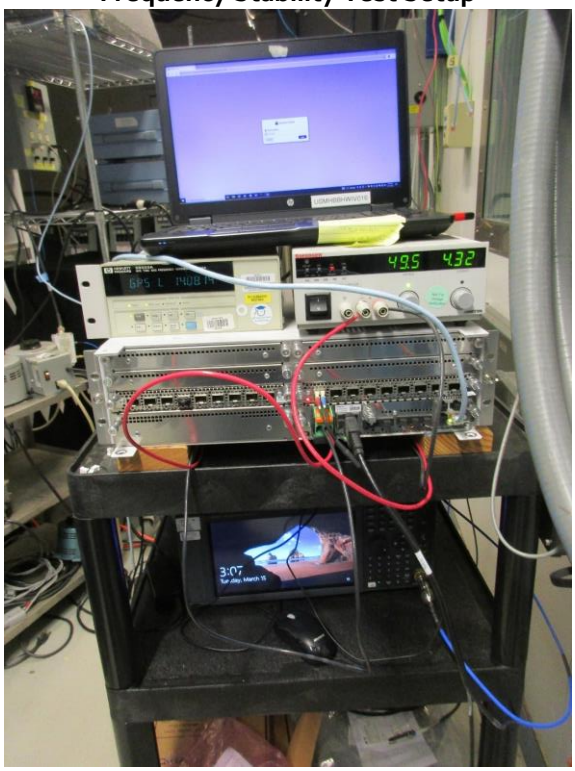
Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, -40.80VDC	
Time (minutes)	**Transmit Carrier Deviation (mHz)**
0	-726.12
0.5	468.21
1.0	-230.70
1.5	456.79
2.0	23.946
2.5	-80.685
3.0	-505.93
SPECIFICATION	751 MHz (±0.05ppm) ±0.05ppm = ± 37.55 Hz
RESULT	Pass

Chamber Temperature Profile



Photographs

Frequency Stability Test Setup



Frequency Stability – AHBCD in Thermal Chamber

Frequency Stability Test Equipment

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due
TH509-T11	Envirotronics	Controller	Solutions Plus Controller	Envirotronics SPPCM	SP000638	2021-06-08	2023-06-08
TH-T11	Envirotronics	Thermal Chamber	Thermal Chamber	N/A	0999-4722	N/A	N/A
TH069	Extech	Data Logger	Barometric Pressure/Humidity / Temperature	SD700	Q690305	2021-07-20	2023-07-20
TH017	Yokogawa	Recorder	MVAdvanced portable paperless recorder	MV2048	S5JC04823	2021-07-21	2023-08-21
MY57431033	KeySight Technologies	MXA Signal Analyzer	20 Hz-44 GHz (Analysis Bandwidth 125 MHz)	N9020B	MY5712033	2020-07-08	2022-07-08
TH073	Fluke	DMM	Digital Multimeter	87V	25910080	2022-02-24	2024-02-24
	Power Ten	DC power supply	66V 330A DC Powersupply	R66C-60330	021AA9018		

Test Dates: 3/16/2022 - 3/17/2022

8. NVLAP Certificate of Accreditation

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

ilac-MRA

Certificate of Accreditation to ISO/IEC 17025:2017

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 17025:2017. 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).

2021-09-24 through 2022-09-30
Effective Dates

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

For the National Voluntary Laboratory Accreditation Program