Global Product Compliance Laboratory
600-700 Mountain Avenue
Room 5B-108
Murray Hill, New Jersey 07974-0636 USA

TESTING
NVLAP LAB CODE: 100275-0

FCC Certification Part 96 Test Report

Product Evaluated

3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC)
FCC ID: 2AD8UAZQCRH1

Customer

Nokia Solutions and Networks, OY
2000 W. Lucent Lane
Naperville, IL 60563 USA

Test Laboratory

Nokia Bell Labs
Nokia, Global Product Compliance Laboratory
600-700 Mountain Avenue, Rm 5B-108
Murray Hill, New Jersey 07974-0636 USA

Date: December 7, 2018

Revisions

Date	Revision	Section	Change
6/1/2018	0		Multicarrier Initial Release
11/2/2018	1		150 MHz BW added.
11/25/2018	2		Requested revisions.
12/7/2018	3		Antenna Parameters, Sections 3.2, 4.1, 4.1.2

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Prepared By: W. Steve Majkowski NCE

12/7/2018

Product Certification Filing Lead
Nokia Bell Labs
Nokia, Global Product Compliance Laboratory

Approved By: Ray Johnson

12/7/2018

Technical Manager
Nokia Bell Labs
Nokia, Global Product Compliance Laboratory

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1. ATTESTATION OF TEST RESULTS Remove comments

Company Name	**Nokia Solutions and Networks, OY** 2000 W. Lucent Lane Naperville, IL 60563 USA
FCC ID	**2AD8UAZQCRH1**
Product Name	**3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC)**
Model Name	Nokia Flexi Zone Micro BTS CBRS FW2QQWF MBO B48+B48+WiFi,
Part No	090043A.X31, 474156A.101
Serial Number(s)	1M181624827; 1M181624805, 1M181532494, 1M181624804
Test Standard(s)	• 47 CFR FCC Parts 2 • KDB 971168 D01 Licensed DTS Guidance v02 June 4, 2013 • KDB 662911 D01 Multiple Transmitter Output v02r01 Oct 2013 • KDB 940660 D01 Part 96 CBRS Equipment v01
Reference(s)	• 47 CFR FCC Part 2 and Part 99 • ANSI C63.26 (2015) • ANSI C63.4 (2014)
Frequency Band	CBRS (Tx: 3550-3700 MHz), E-UTRAN Band 48
Technology	LTE-TDD with SAS in CBRS Band 48
Test Frequency Range	10MHz – 40GHz
Operation Mode(s)	4x5W MIMO
Submission Type	Initial Filing
FCC Part 15 Subpart B	Compliance with Class B
Test Date	June/July 2018
Test Laboratory	Nokia Global Product Compliance Laboratory 600-700 Mountain Avenue, Rm 5B-108 Murray Hill, New Jersey 07974-0636 USA **NVLAP** Lab Code: 100275-0 **FCC Registration Number: 395774**

This is to certify that the above product has been evaluated and found to be in compliance with the Rules and Regulations set forth in the above standard(s). The data and the descriptions about the test setup, procedures and configuration presented in this report are accurate. The results of testing in this report apply only to the product/system which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Per the requirement of Section 2.911(d) Certification of Technical Test Data, I hereby certify that the technical test data are the results of tests either performed or supervised by me.

W. Steve Majkowski NCE
Member of Technical Staff
Nokia, Global Product Compliance Laboratory

2. SUMMARY OF THE TEST RESULTS

47 CFR FCC Sections	Description of Tests	Compliance Results
2.1046, 96.41 (b)	RF Power Output	Pass
2.1047, 96.41	Modulation Characteristics	Pass
2.1049, 96.41	(a) Occupied Bandwidth (b) Out-of-Band Emissions	Pass
2.1051, 96.41	Spurious Emissions at Antenna Terminals	Pass
2.1053, 96.41	Field Strength of Spurious Radiation	Pass
2.1055, 96.41	Measurement of Frequency Stability	Pass
96.53, WINNF-TS-0122	Citizens Broadband Radio Service Device (CBSD) - Spectrum Access System (SAS) functionality per CBRS CBSD Test Specification WINNF-TS-0122 Tested in accordance with KDB 552295 D01 CBP Guidance for 3650 3700 Band.	Pass

2.1 Measurement Uncertainty

The results of the calculations to estimate uncertainties for the several test methods and standards are shown in the Tables 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-5 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

3. GENERAL INFORMATION

3.1 Product Descriptions

The equipment under test (EUT) has the following specifications.

Table 3.1.1 Product Specifications

Specification Items	Description
Product Type	3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC)
Radio Type	Intentional Transceiver
CBSD Category	Category B CBSD Device
Power Type	DC: -40.5V to -57V AC: 80V to 276V (via external AC/DC converter)
Modulation	LTE-TDD with QPSK, 16QAM, 64QAM and 256QAM
Operating Frequency Range	CBRS (Tx/Rx: 3550-3700 MHz),
Channel Bandwidth	10 MHz & 20 MHz, Multi carrier enabled
Instantaneous Bandwidth	150 MHz
Max Conducted Power (Rated)	Up to 4x5W per TX path (0.1 dB steps down to 50mW)
Operating Mode	4T4R or 2T2R MIMO
Software Version	FLF17SP
Hardware Version	474156A.101
Antenna(s)	Refer to Section 3.2

The EUT supports the following carrier configurations:

Table 3.1.2 EUT Supported Configurations

Carrier Bandwidth (MHz)	Carriers per Path	MIMO Modes	Signal Type	Modulation
10	4	4x	LTE-TDD	QPSK, 16QAM, 64QAM & 256QAM
20	4	4x	LTE-TDD	QPSK, 16QAM, 64QAM & 256QAM

The operating band consists of the following channels and spectrum:

Table 3.1.3 EUTRAN 43, CBRS Band

CBRS Band 48 Center Frequency	TDD Frequency Range (MHz)	Width of Channel (MHz)
3555	3550 – 3560	10
3565	3560 – 3570	10
3575	3580 – 3590	10
3585	3590 – 3600	10
3595	3600 – 3610	10
3605	3600 – 3610	10
3615	3610 – 3620	10
3625	3620 – 3630	10
3635	3630 – 3640	10
3645	3640 – 3650	10
3655	3650 - 3660	10
3665	3660 - 3670	10
3675	3670 – 3680	10
3685	3680 – 3690	10
3695	3690 - 3700	10

3.2 EIRP/ PSD Compliance and Antenna Information.

The product does not incorporate integrated antennas and is not supplied with antennas. Externally mounted antennas must be connected to the unit and mounted remotely. This product requires Certified Professional Installation. The antenna gain/ cable loss and other the parameters of the installation will be resident in the unit and in the SAS. The maximum allowable antenna gain parameters for full power operation per number of carriers are listed in Table 4.1

4. REQUIRED MEASUREMENTS AND RESULTS

This FCC Original Filing Report shall demonstrate compliance to the Part 96 limits and operation over the 3550-3700 MHz frequency range.

Per 47CFR FCC Section 2.1033(c)(14), the following certification tests are required by Section 2.1046 through Section 2.1057. These tests are identified in Table 4.0a below.

Table 4.0a Required Certification Measurements

47 CFR FCC Sections	Description of Tests	Test Required for Original Authorization
2.1046, 96.41(b), 96.41(g)	**RF Power Output** **(b) Power Limits, EIRP, PSD** **(g) Peak-to-Average Power Ratio**	**Yes**
2.1047, 96.41(a)	**Modulation Characteristics**	**Yes**
2.1049, 96.41(e)(2)(3)	**(a) Occupied Bandwidth** **(b) Out-of-Band Emissions**	**Yes**
2.1051, 96.41(e)	**Spurious Emissions at Antenna Terminals**	**Yes**
2.1053, 96.41(e)(2)(3)	**Field Strength of Spurious Radiation**	**Yes**
2.1055, 96.41(e)(2)(3)	**Measurement of Frequency Stability**	**Yes**
96.53, WINNF-TS-0122	**CBSD SAS functionality per CBRS CBSD Test Specification WINNF-TS-0122** **Tested in accordance with KDB 552295 D01 CBP Guidance for 3650 3700 Band.**	**Yes**

The measurements were conducted in accordance with the procedures set out in Section 2.1041. The CBSD-SAS Protocol test was performed in accordance with a PAG Request as detailed in the Operational Description Exhibit 5. The comprehensive list of tests performed included measurements at Left, Center and Right side of the Part 96 Band for each LTE Test Modulation and Signal Bandwidths. The list of tests performed are listed in Table 4.0b below. A subset of these tests are presented to demonstrate compliance with FCC requirements.

Table 4.0b Table of Performed Tests

Test #	mMIMO Channel Frequency	Band Location.	Signal BW, MHz	Modulation Q16 = qpsk + 16QAM	PSD/ CH Power	MOD	PAR	Sig. BW	OBW	CSE 10M-37G
Single carrier: 10MHz BW										
1	3555	Left	10	Q16, 64 & 256QAM	X	X	X	X	X	X
2	3675	Middle	10	Q16	X	X	X	X	X	X
3	3695	Right	10	Q16, 64 & 256QAM	X	X	X	X	X	X
Single carrier: 20MHz BW										
1	3560	Left	20	Q16, 64 & 256QAM	X	X	X	X	X	X
2	3620	Middle	20	Q16	X	X	X	X	X	X
3	3690	Right	20	Q16, 64 & 256QAM	X	X	X	X	X	X
2 Carriers Non-Contiguous: 20+20 MHz										
1	3560+3620	Left	20+20	Q16	X	X	X	X	X	X
2	3600+3660	Middle	20+20	Q16	X	X	X	X	X	X
3	3630+3690	Right	20+20	Q16	X	X	X	X	X	X
3 Carriers Contiguous: 20+20+20 MHz										
1	3560+3580+3600	Left	20+20+20	Q16	X	X	X	X	X	X
2	3600+3620+3640	Middle	20+20+20	Q16	X	X	X	X	X	X
3	3650+3670+3690	Right	20+20+20	Q16	X	X	X	X	X	X
3 Carriers Non-Contiguous: 20+20+20 MHz										
1	3560+3580+3620	Left	20+20+20	Q16	X	X	X	X	X	X
2	3620+3640+3690	Middle	20+20+20	Q16	X	X	X	X	X	X
3	3620+3670+3690	Right	20+20+20	Q16	X	X	X	X	X	X
2 Carriers Non-Contiguous: 10+10 MHz										
1	3555+3625	Left	10+10	Q16	X	X	X	X	X	X
2	3625+3695	Middle	10+10	Q16	X	X	X	X	X	X
2 Carriers Contiguous: 10+10 MHz										
1	3555+3565	Left	10+10	Q16	X	X	X	X	X	X
2	3685+3695	Right	10+10	Q16	X	X	X	X	X	X
3 Carriers Contiguous: 10+10+10 MHz										
1	3555+3565+3575	Left	10+10+10	Q16	X	X	X	X	X	X
2	3615+3625+3535	Middle	10+10+10	Q16	X	X	X	X	X	X
3	3675+3685+3695	Top	10+10+10	Q16	X	X	X	X	X	X
3 Carriers Non-Contiguous: 10+10+10 MHz										
1	3555+3595+3625	Left	10+10+10	Q16	X	X	X	X	X	X
2	3625+3655+3695	Right	10+10+10	Q16	X	X	X	X	X	X
4 Carriers Contiguous: 10+10+10+10 MHz										
1	3555+3565+3675+3585	Left	10+10+10+10	Q16	X	X	X	X	X	X
2	3605+3615+3625+3635	Middle	10+10+10+10	Q16	X	X	X	X	X	X
3	3665+3675+3685+3695	Right	10+10+10+10	Q16	X	X	X	X	X	X
4 Carriers Non-Contiguous: 10+10+10+10 MHz										
1	3555+3575+3595+3625	Left	10+10+10+10	Q16	X	X	X	X	X	X
2	3625+3645+3675+3695	Right	10+10+10+10	Q16	X	X	X	X	X	X
3	3555+3605+3645+3695	Full Band	10+10+10+10	64QAM	X	X	X	X	X	X
2 Carriers Contiguous: 20+20 MHz										
1	3560+3580	Left	20+20	Q16	X	X	X	X	X	X
2	3620+3640	Middle	20+20	Q16	X	X	X	X	X	X
3	3670+3690	Right	20+20	Q16	X	X	X	X	X	X
4 Carriers Contiguous: 20+20+20 MHz										
1	3560+3580+3600+3620	Left	20+20+20+20	Q16	X	X	X	X	X	X
2	3630+3650+3670+3690	Middle	20+20+20+20	Q16						X
4 Carriers Non-Contiguous: 20+20+20+20 MHz										
1	3560+3600+3640+3690	Full	20+20+20+20	256QAM	X	X	X	X	X	X

4.1 Section 2.1046 MEASUREMENT REQUIRED: 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 Figure 4.1.1 below and allowed to warm up and stabilize per KDB 971168 D01 and ANSI C63.26.

For LTE TDD transmit carrier operation, the **3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC),** is specified to provide a maximum power output of 5W/37 dBm per transmit port, for 4 ports, for a Total Power of 20 Watts /43 dBm per unit.

The power is under digital control and is designed to operate under the control of a spectrum access system (SAS) per the Part 96 rules for operation in Band 48.

Under Part 96 the product is limited to the Category B CBSD maximum EIRP of 47 dBm/10 MHz with a PSD of 37 dBm/MHz.

The unit requires an externally mounted antenna assembly.

In the event the customer wants to operate with a single 10 MHz carrier at full power, the maximum antenna gain + cable loss cannot exceed 4 dBi when in order to stay within the EIRP limits for the band. As this product requires Certified Professional Installation the parameters of the installation will be resident in the unit and in the SAS. The maximum allowable antenna gain parameters for full power operation per number of carriers are listed in Table 4.1 below.

Table 4.1 Maximum Antenna Gain for Various Transmit Configurations

Total 4xMIMO Power	Number of carriers	4xMIMO Power/carrier		Part 96 Limit	Maximum Tx Antenna Gain	
					10 MHz Carrier	20 MHz Carrier
W	n	W	dBm	dBm/10 MHz	dBi	dBi
20	1	20	43.01	47	3.99	6.99
20	2	10	40.00	47	7.00	10.00
20	3	6.667	38.24	47	8.76	11.76
20	4	5	36.99	47	10.01	13.01

When the product is installed with antennas, then per FCC Rules the RF exposure compliance shall be addressed at the time of licensing, as required by the responsible FCC Bureau(s), including antenna co- location requirements of Part 1.1307(b)(3).

4.1.1 RF Power Output Measurement

Power measurements of the TDD transmit signal were conducted with an MXA Signal analyzer per KDB 971168 D01 and ANSI C63.26. The applied signal from the **3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC)**, met the recommended characteristics as defined in **3GPP TS 36.141 V14.1.0 (2016-09) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14).** The Channel power was measured when the product was set to provide the maximum rated power at the antenna transmitting terminals. The power was measured at the Left, Center and Right side of the 3550-3700 CBRS frequency range for all three different modulation modes. These were 3GPP standard base station test models for QPSK+16QAM, 64QAM and 256QAM modulation. The measured power level was documented on each Channel Power data sheet.

4.1.1.1 RF Power Output Results

Power output measurements were performed for every modulation and bandwidth combination identified in Table 4.0b, Table of Performed Tests Measurements.

A table of measured RF power outputs of the EUT documenting Power measurements for each modulation, bandwidth and at left, center and right side of the band is given in Table 4.1.1.1 The RF power output was measured for the 4x5W MIMO configuration. The measured performance was in full compliance with the Rules of the Commission. The level is detailed on each of the Peak to Average Ratio (PAR) plots and in comments in Sections 4.3 and 4.4.

Figure 4.1.1 Test Set-Up for Measurement of Radio Frequency Power Output

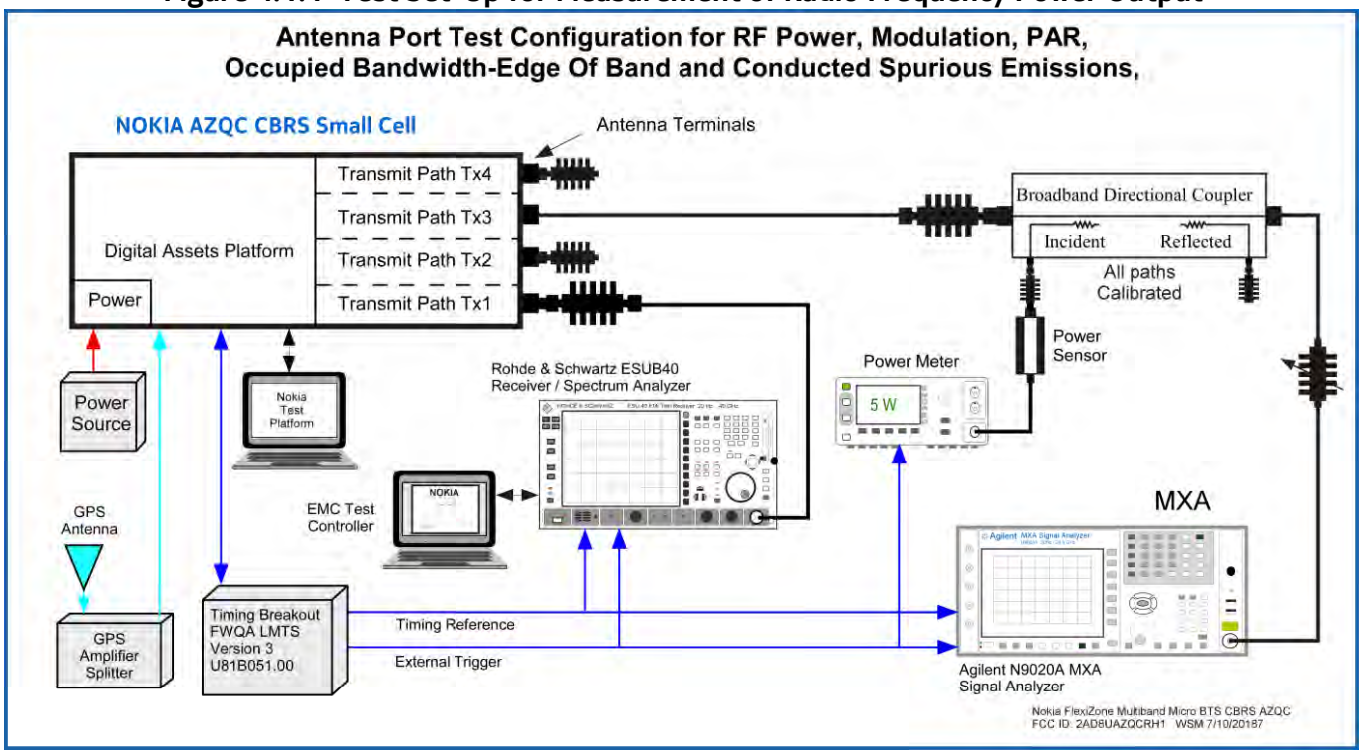


Table 4.1.1.1 Measured Maximum Average RF Output Power of the EUT

Test #	mMIMO Channel Frequency	Band Loc.	Signal BW, MHz	Modulation Q16 = QPSK+16QAM	Total Power dBm	Channel Power dBm/10 MHz
Single carrier: 10MHz BW						
1	3555	Left	10	Q16, 64QAM, 256QAM	36.94 36.92 36.90	36.94 36.92 36.90
2	3675	Middle	10	Q16	37.05	37.05
3	3695	Right	10	Q16, 64QAM, 256QAM	37.18 36.98 37.01	37.18 36.98 37.01
Single carrier: 20MHz BW						
1	3560	Left	20	Q16, 64QAM, 256QAM	36.22 36.55 36.97	33.21 33.54 33.96
2	3620	Middle	20	Q16	36.75	33.74
3	3690	Right	20	Q16, 64QAM, 256QAM	36.95 36.67 37.05	33.94 33.66 34.04
3 Carriers Contiguous: 20+20+20 MHz						
1	3560+3580+3600	Left	20+20+20	Q16	36.86	29.08
2	3600+3620+3640	Middle	20+20+20	Q16	36.90	29.12
3	3650+3670+3690	Right	20+20+20	Q16	36.80	29.02
2 Carriers Contiguous: 10+10 MHz						
1	3555+3565	Left	10+10	Q16	37.07	34.06
2	3685+3695	Right	10+10	Q16	37.02	34.01
3 Carriers Contiguous: 10+10+10 MHz						
1	3555+3565+3575	Left	10+10+10	Q16	35.73	30.96
2	3615+3625+3535	Middle	10+10+10	Q16	35.51	30.74
3	3675+3685+3695	Top	10+10+10	Q16	35.59	30.82
4 Carriers Contiguous: 10+10+10+10 MHz						
1	3555+3565+3675+3585	Left	10+10+10+10	Q16	36.35	30.33
2	3605+3615+3625+3635	Middle	10+10+10+10	Q16	36.22	30.20
3	3665+3675+3685+3695	Right	10+10+10+10	Q16	33.81	27.79
2 Carriers Contiguous: 20+20 MHz						
1	3560+3580	Left	20+20	Q16	36.85	30.83
2	3620+3640	Middle	20+20	Q16	36.97	30.95
3	3670+3690	Right	20+20	Q16	36.76	30.74
4 Carriers Contiguous: 20+20+20 MHz						
1	3560+3580+3600+3620	Left	20+20+20+20	Q16	36.54	27.51
2	3630+3650+3670+3690	Middle	20+20+20+20	Q16	36.30	27.27

4.1.2 EIRP Compliance

The product does not incorporate integrated antennas and is not supplied with antennas. Externally mounted antennas must be connected to the unit and mounted remotely. This is a Category B CBSD and the professional installer will register the overall installed gain which includes the interconnecting cable loss.

Actual transmit EIRP and PSD is under control of the SAS. This antenna gain is specified so that when the product is operating with its maximum capacity of 4 carriers the Part 96.41 maximum Effective Isotropically Radiated Power (EIRP) of 47 dBm/10 MHz is also met. Compliance with the EIRP requirements of Part 96.41 is tabulated in Table 4.1.2 below.

Since no antenna is supplied, then per FCC Rules the RF exposure compliance shall be addressed at the time of licensing, as required by the responsible FCC Bureau(s), including antenna co- location requirements of Part 1.1307(b)(3).

Table 4.1.2a Effective Isotropically Radiated Power (EIRP) Compliance

Transmit Signal Bandwidth	Total 4x MIMO Transmit Power	Maximum Antenna Gain	EIRP Bandwidth Correction	EIRP	Part 96.41 EIRP Limit	Margin to Part 96 EIRP Limit.	EIRP Compliance
MHz	dBm	dBi	dB	dBm/10 MHz	dBm/ 10 MHz	dB	Pass/Fail
10	43.0	4	0.00	47.0	47.00	0	Pass
20	43.0	4	-3.01	43.99	47.00	3.01	Pass

Table 4.1.2b Maximum Antenna Gain for Various Transmit Configurations

Total 4xMIMO Power	Number of carriers	4xMIMO Power/carrier		Part 96.41 EIRP Limit	Maximum Tx Antenna Gain for EIRP Compliance	
					10 MHz Carrier	20 MHz Carrier
W	n	W	dBm	dBm/10 MHz	dBi	dBi
20	1	20	43.01	47	3.99	6.99
20	2	10	40.00	47	7.00	10.00
20	3	6.667	38.24	47	8.76	11.76
20	4	5	36.99	47	10.01	13.01

4.1.3 Power Spectral Density

The Power Spectral Density (PSD) of the EUT was measured per KDB 971168 D01 using the setup in Figure 4.1.1 above and the Channel Power Measurement feature of the MXA Analyzer. The signal bandwidths, modulations and transmit channels identified in Table 4.1.3 were evaluated.

The FCC Part 96 requirement for PSD is that the Power Spectral Density (PSD) of the EUT shall not exceed 37 dBm/MHz.

4.1.3.1 Power Spectral Density Results:

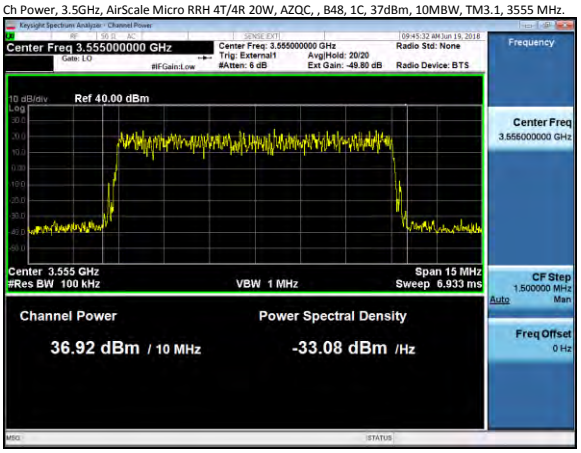
The maximum Power Spectral Density (PSD) of the EUT measured at its antenna transmitting terminals were measured to be 27.18 dBm/MHz which is 9.82 dB below the 37 dBm/MHz limit. This is in full compliance with the requirement. The measured values are in Table 4.1.3 below.

Table 4.1.3 Power Spectral Density Results

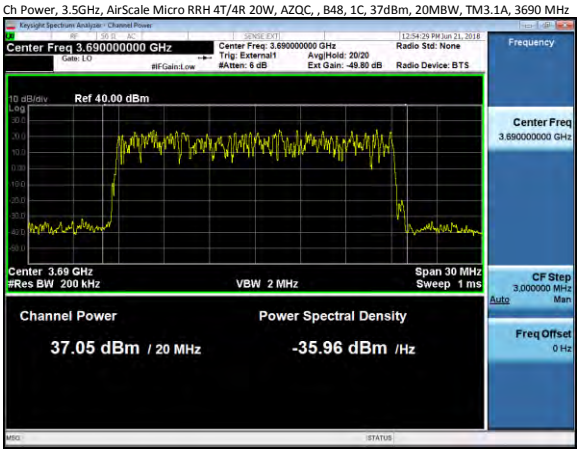
Test #	mMIMO Channel Frequency	Band Loc.	Signal BW, MHz	Modulation Q16 = qpsk + 16qam	Measured PSD dBm/MHz Limit=37dBm/MHz
Single carrier: 10MHz BW					
1	3555	Left	10	Q16, 64QAM, 256QAM	26.94 26.92 26.90
2	3675	Middle	10	Q16	27.05
3	3695	Right	10	Q16, 64QAM, 256QAM	27.18 26.95 27.01
Single carrier: 20MHz BW					
1	3560	Left	20	Q16, 64QAM, 256QAM	23.21 23.54 23.96
2	3620	Middle	20	Q16	23.74
3	3690	Right	20	Q16, 64QAM, 256QAM	23.94 23.66 24.04
3 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600	Left	20+20+20	Q16	19.07
2	3600+3620+3640	Middle	20+20+20	Q16	19.12
3	3650+3670+3690	Right	20+20+20	Q16	19.02
2 Carriers Contiguous: 10+10 MHz					
1	3555+3565	Left	10+10	Q16	24.06
2	3685+3695	Right	10+10	Q16	24.01
3 Carriers Contiguous: 10+10+10 MHz					
1	3555+3565+3575	Left	10+10+10	Q16	20.95
2	3615+3625+3535	Middle	10+10+10	Q16	20.73
3	3675+3685+3695	Top	10+10+10	Q16	20.82
4 Carriers Contiguous: 10+10+10+10 MHz					
1	3555+3565+3675+3585	Left	10+10+10+10	Q16	20.33
2	3605+3615+3625+3635	Middle	10+10+10+10	Q16	20.20
3	3665+3675+3685+3695	Right	10+10+10+10	Q16	19.79
2 Carriers Contiguous: 20+20 MHz					
1	3560+3580	Left	20+20	Q16	20.83
2	3620+3640	Middle	20+20	Q16	20.95
3	3670+3690	Right	20+20	Q16	20.74
4 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600+3620	Left	20+20+20+20	Q16	17.51
2	3630+3650+3670+3690	Right	20+20+20+20	Q16	17.26

Figure 4.1.3 Power Spectral Density (PSD) - Sample Measurement Plots

Ch Power, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 10MBW, TM3.1, 3555 MHz.



Ch Power, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 20MBW, TM3.1A, 3690 MHz



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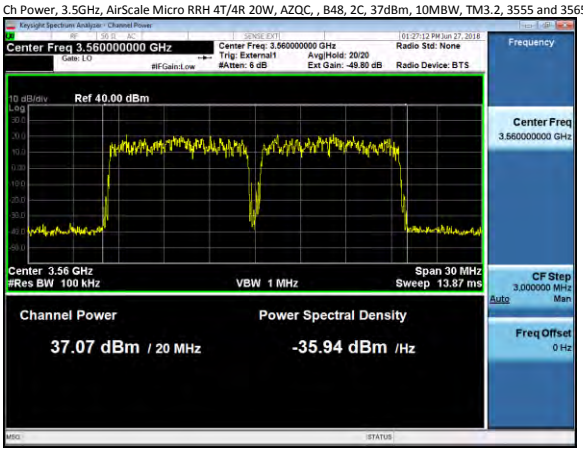
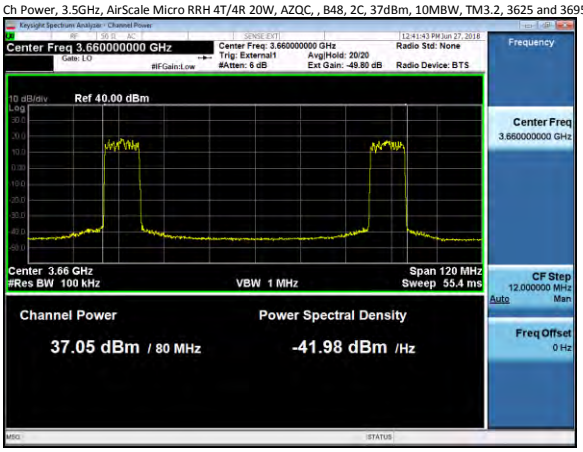
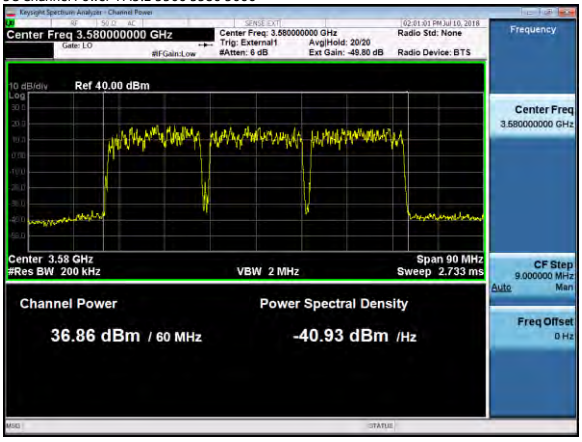
Ch Power, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 2C, 37dBm, 10MBW, TM3.2, 3555 and 3565 MHz.



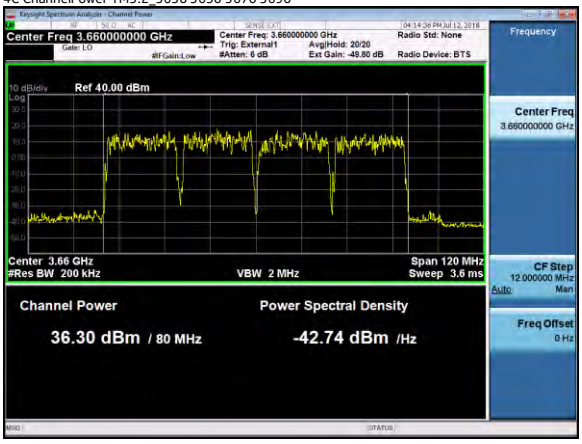
Ch Power, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 2C, 37dBm, 10MBW, TM3.2, 3625 and 3695 MHz.



3C Channel Power TM3.2 3560 3580 3600



4C ChannelPower TM3.2_3630 3650 3670 3690



4.1.4 Peak-to-Average Power Ratio Measurement

The Peak-to-Average Power Ratio (PAPR) of the EUT was measured per KDB 971168 D01 using the setup in Figure 4.1.1 above and the Power Complementary Cumulative Distribution Function (CCDF) feature of the MXA Analyzer. All modulations and all transmit ports were evaluated. The PAPR measurements were made for every carrier in the test table for nominal 5W Total port power as tabulated in Table 4.1.4.

The FCC requirement for PAPR is that the transmitter's peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission. The maximum PAPR value for each measured configuration is given in Table 4.1.4. Sample measurements are shown in the plots in Figure 4.1.4 below.

4.1.4.1 Peak-to-Average Power Ratio Results:

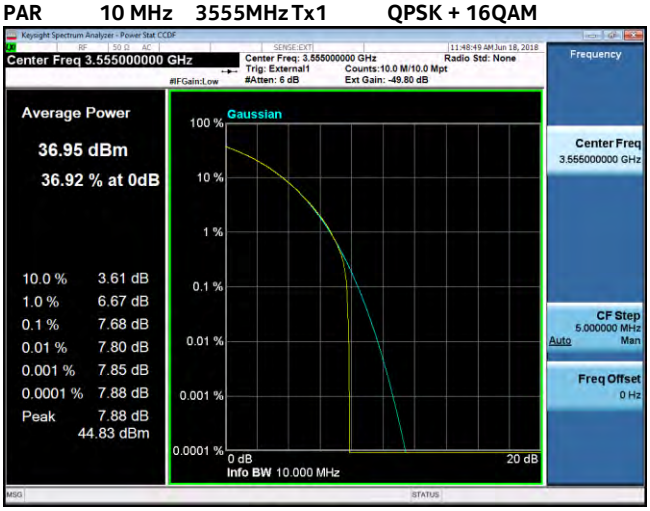
The maximum Peak-to-Average Power Ratio (PAPR) of the EUT measured at its antenna transmitting terminals was measured to be **8.37 dB** maximum, which is in full compliance with the requirement to not exceed 13 dB as specified by the FCC. The representative data sets exact values are listed in Table 4.1.4 below.

Table 4.1.4 The Maximum PAPR Value at 0.1% probability of the EUT

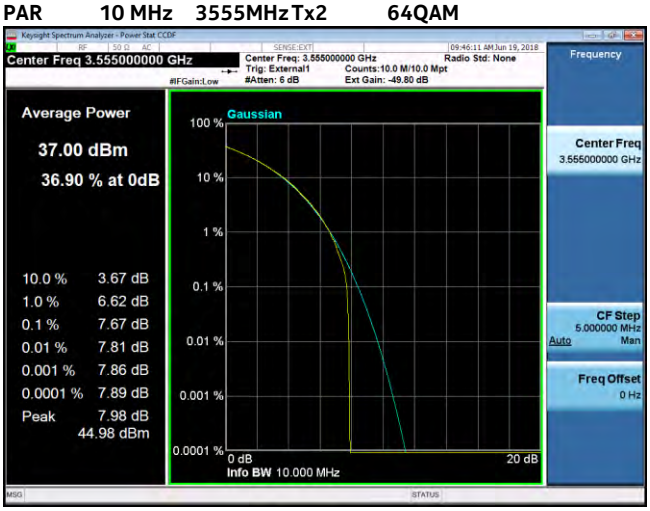
Test #	mMIMO Channel Frequency	Band Loc.	Signal BW, MHz	Modulation Q16 = QPSK + 16QAM	PAR at 0.1% Limit = 13
Single carrier: 10MHz BW					
1	3555	Left	10	Q16, 64QAM, 256QAM	7.68 7.67 7.69
2	3675	Middle	10	Q16	7.64
3	3695	Right	10	Q16, 64QAM, 256QAM	7.65 7.65 7.70
Single carrier: 20MHz BW					
1	3560	Left	20	Q16, 64QAM, 256QAM	7.60 7.64 7.64
2	3620	Middle	20	Q16	7.61
3	3690	Right	20	Q16, 64QAM, 256QAM	7.65 7.63 7.64
2 Carriers Non-Contiguous: 20+20 MHz					
1	3560+3620	Left	20+20	Q16	5.66/5.60
2	3600+3660	Middle	20+20	Q16	7.87/7.98
3	3630+3690	Right	20+20	Q16	7.89/7.94
3 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600	Left	20+20+20	Q16	8.24/**8.37**/8.26
2	3600+3620+3640	Middle	20+20+20	Q16	8.23/2.29/8.17
3	3650+3670+3690	Right	20+20+20	Q16	7.76/8.21/8.21
3 Carriers Non-Contiguous: 20+20+20 MHz					
1	3560+3580+3620	Left	20+20+20	Q16	8.28/8.2/8.11
2	3620+3640+3690	Middle	20+20+20	Q16	8.31/8.29/8.07
3	3620+3670+3690	Right	20+20+20	Q16	7.06/7.48/8.11
2 Carriers Non-Contiguous: 10+10 MHz					
1	3555+3625	Left	10+10	Q16	7.81/7.70
2	3625+3695	Middle	10+10	Q16	7.80/7.82
2 Carriers Contiguous: 10+10 MHz					
1	3555+3565	Left	10+10	Q16	8.09/8.06
2	3685+3695	Right	10+10	Q16	8.05/8.11
3 Carriers Contiguous: 10+10+10 MHz					
1	3555+3565+3575	Left	10+10+10	Q16	8.12/7.70/7.71
2	3615+3625+3535	Middle	10+10+10	Q16	6.22/6.67/6.20
3	3675+3685+3695	Top	10+10+10	Q16	8.12/7.88/7.66
3 Carriers Non-Contiguous: 10+10+10 MHz					
1	3555+3595+3625	Left	10+10+10	Q16	6.82/7.91/6.91
2	3625+3655+3695	Right	10+10+10	Q16	8.04/6.96/6.78
4 Carriers Contiguous: 10+10+10+10 MHz					
1	3555+3565+3675+3585	Left	10+10+10+10	Q16	7.47/7.53/7.56/7.74
2	3605+3615+3625+3635	Middle	10+10+10+10	Q16	5.63/6.00/5.75/5.50
3	3665+3675+3685+3695	Right	10+10+10+10	Q16	8.20/7.45/7.60/7.23
4 Carriers Non-Contiguous: 10+10+10+10 MHz					
1	3555+3575+3595+3625	Left	10+10+10+10	Q16	6.43/6.39/6.46/8.15
2	3625+3645+3675+3695	Right	10+10+10+10	Q16	5.18/5.33/5.33/5.18
2 Carriers Contiguous: 20+20 MHz					
1	3560+3580	Left	20+20	Q16	8.16/8.13
2	3620+3640	Middle	20+20	Q16	7.22/7.42
3	3670+3690	Right	20+20	Q16	7.13/7.57
4 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600+3620	Left	20+20+20+20	Q16	7.93/8.13/8.33/7.90
2	3630+3650+3670+3690	Middle	20+20+20+20	Q16	7.88/8.10/8.34/7.89

Figure 4.1.4 Peak to Average Power Ratio - Sample Measurement Plots

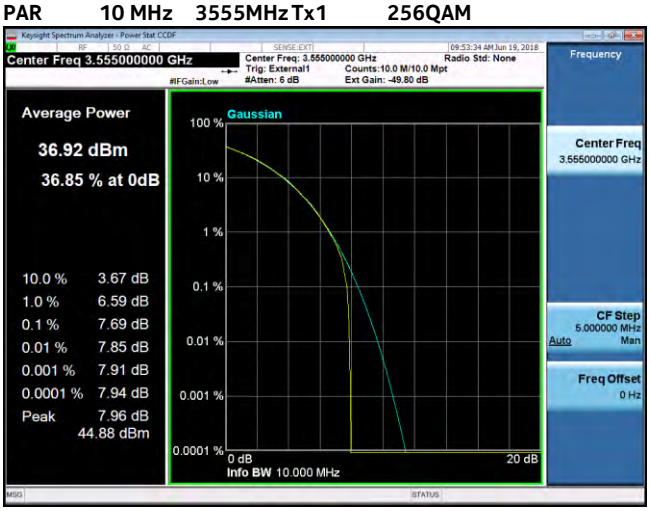
PAR 10 MHz 3555MHz Tx1 QPSK + 16QAM



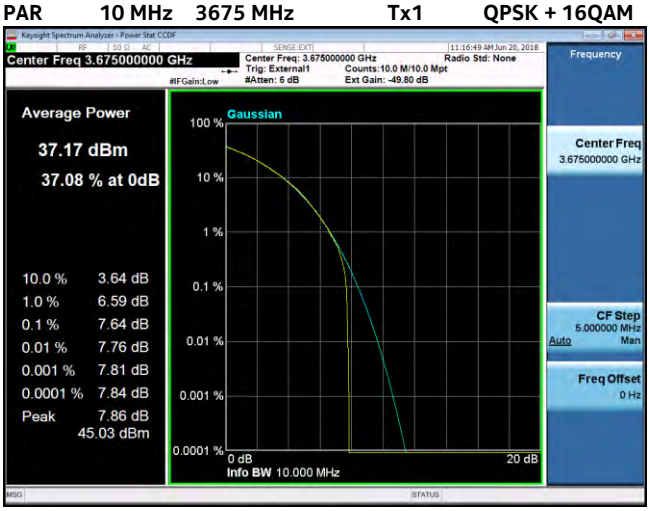
PAR 10 MHz 3555MHz Tx2 64QAM



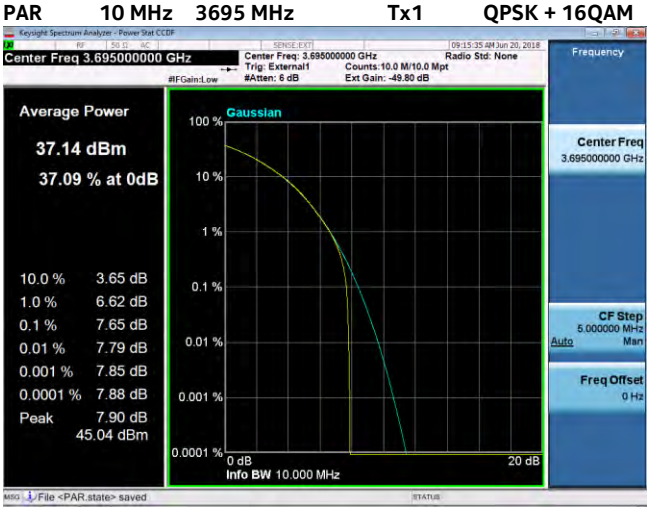
PAR 10 MHz 3555MHz Tx1 256QAM



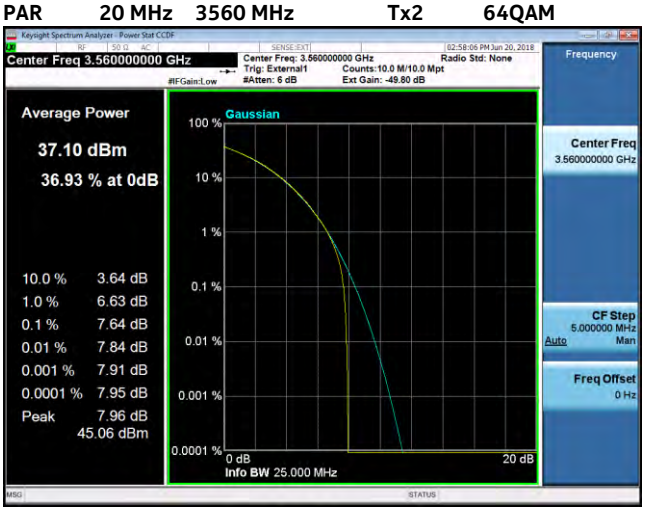
PAR 10 MHz 3675 MHz Tx1 QPSK + 16QAM



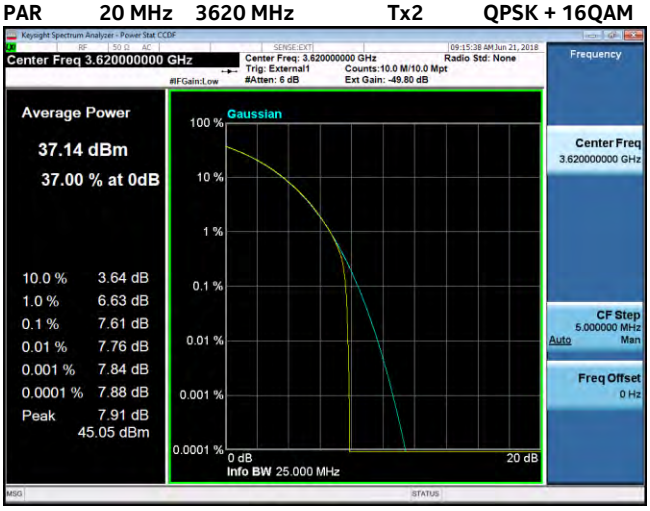
PAR 10 MHz 3695 MHz Tx1 QPSK + 16QAM



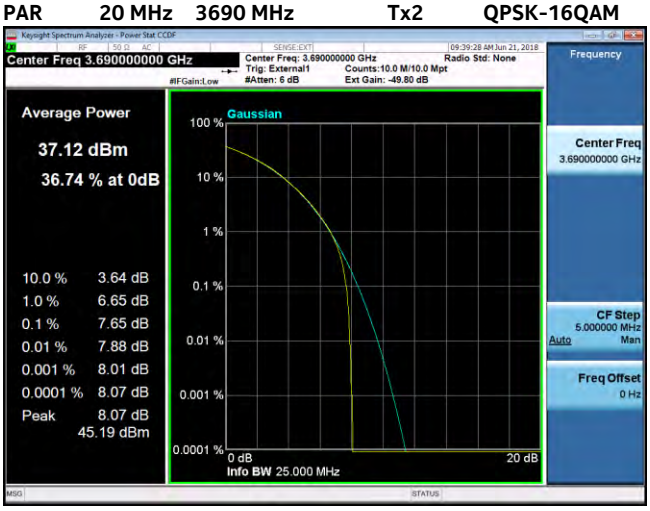
PAR 20 MHz 3560 MHz Tx2 64QAM



PAR 20 MHz 3620 MHz Tx2 QPSK + 16QAM



PAR 20 MHz 3690 MHz Tx2 QPSK-16QAM



4.2 Section 2.1047 MEASUREMENT REQUIRED: MODULATION CHARACTERISTICS

The **3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC)** supports LTE TDD technologies. LTE utilizes Orthogonal Frequency Division Multiplexing (OFDM) which splits the carrier frequency bandwidth into many small subcarriers. Each individual subcarrier can be modulated with a combined QPSK + 16QAM, 64QAM or with a 256QAM digital modulation formats.

In QPSK, there are 4 possible symbol states and each symbol carries 2 bits of information. In 16QAM, there are 16 possible symbol states and each 16-QAM symbol carries 4 bits of information. In 64QAM, there are 64 possible symbol states and each 64-QAM symbol carries 6 bits of information. While in 256QAM, there are 256 possible symbol states and each 256-QAM symbol carries 8 bits of information. The higher-order modulations, where the constellations become more dense, are more sensitive to poor channel conditions than the lower-order modulation.

The modulation characteristics measurement of LTE carriers measures the difference between the ideal symbols and the measured symbols after the equalization. The measurement was performed for all of the channels as documented in table 4.2 below.

4.2.1 Modulation Characteristics Measurement

The measurements were performed at the antenna transmitting terminal of the base station system with a signal analyzer which was calibrated in accordance with ISO 9001 process.

The test set-up diagram is given in Figure 4.2.1, where the signal analyzer used the external signals from the base station as its trigger source and time reference. Figure 4.2.2 below shows representative screen plots of the modulation measurement for an LTE carrier in the various modulations.

4.2.2 Modulation Measurements Results:

The measured modulation characteristics of the EUT are tabulated in Table 4.2 and are in full compliance with the FCC. Sample plots are in Figure 4.2.2 below.

Table 4.2 Modulation Results

Test #	mMIMO Channel Frequency	Band Loc.	Signal BW, MHz	Modulation Q16 = QPSK + 16QAM	Modulation Results
Single carrier: 10MHz BW					
1	3555	Left	10	Q16, 64QAM, 256QAM	PASS PASS PASS
2	3675	Middle	10	Q16	PASS
3	3695	Right	10	Q16, 64QAM, 256QAM	PASS PASS PASS
Single carrier: 20MHz BW					
1	3560	Left	20	Q16, 64QAM, 256QAM	PASS PASS PASS
2	3620	Middle	20	Q16	PASS
3	3690	Right	20	Q16, 64QAM, 256QAM	PASS PASS PASS
2 Carriers Non-Contiguous: 20+20 MHz					
1	3560+3620	Left	20+20	Q16	PASS
2	3600+3660	Middle	20+20	Q16	PASS
3	3630+3690	Right	20+20	Q16	PASS
3 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600	Left	20+20+20	Q16	PASS
2	3600+3620+3640	Middle	20+20+20	Q16	PASS
3	3650+3670+3690	Right	20+20+20	Q16	PASS
3 Carriers Non-Contiguous: 20+20+20 MHz					
1	3560+3580+3620	Left	20+20+20	Q16	PASS
2	3620+3640+3690	Middle	20+20+20	Q16	PASS
3	3620+3670+3690	Right	20+20+20	Q16	PASS
2 Carriers Non-Contiguous: 10+10 MHz					
1	3555+3625	Left	10+10	Q16	PASS
2	3625+3695	Middle	10+10	Q16	PASS
2 Carriers Contiguous: 10+10 MHz					
1	3555+3565	Left	10+10	Q16	PASS
2	3685+3695	Right	10+10	Q16	PASS
3 Carriers Contiguous: 10+10+10 MHz					
1	3555+3565+3575	Left	10+10+10	Q16	PASS
2	3615+3625+3535	Middle	10+10+10	Q16	PASS
3	3675+3685+3695	Top	10+10+10	Q16	PASS
3 Carriers Non-Contiguous: 10+10+10 MHz					
1	3555+3595+3625	Left	10+10+10	Q16	PASS
2	3625+3655+3695	Right	10+10+10	Q16	PASS
4 Carriers Contiguous: 10+10+10+10 MHz					
1	3555+3565+3675+3585	Left	10+10+10+10	Q16	PASS
2	3605+3615+3625+3635	Middle	10+10+10+10	Q16	PASS
3	3665+3675+3685+3695	Right	10+10+10+10	Q16	PASS
4 Carriers Non-Contiguous: 10+10+10+10 MHz					
1	3555+3575+3595+3625	Left	10+10+10+10	Q16	PASS
2	3625+3645+3675+3695	Right	10+10+10+10	Q16	PASS
2 Carriers Contiguous: 20+20 MHz					
1	3560+3580	Left	20+20	Q16	PASS
2	3620+3640	Middle	20+20	Q16	PASS
3	3670+3690	Right	20+20	Q16	PASS
4 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600+3620	Left	20+20+20+20	Q16	PASS
2	3630+3650+3670+3690	Middle	20+20+20+20	Q16	PASS

Figure 4.2.1 Test Set-Up for Measurement of Modulation, Occupied Bandwidth and Out-of-Band Emissions

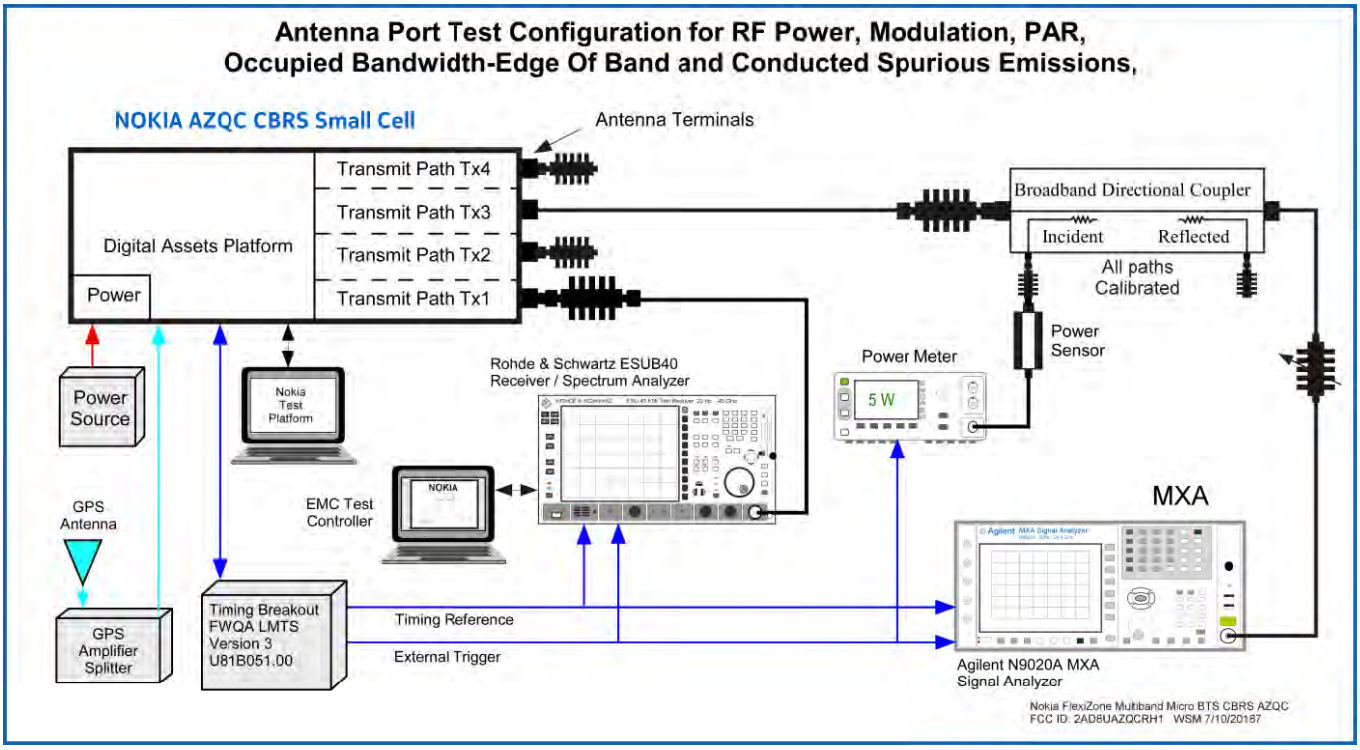
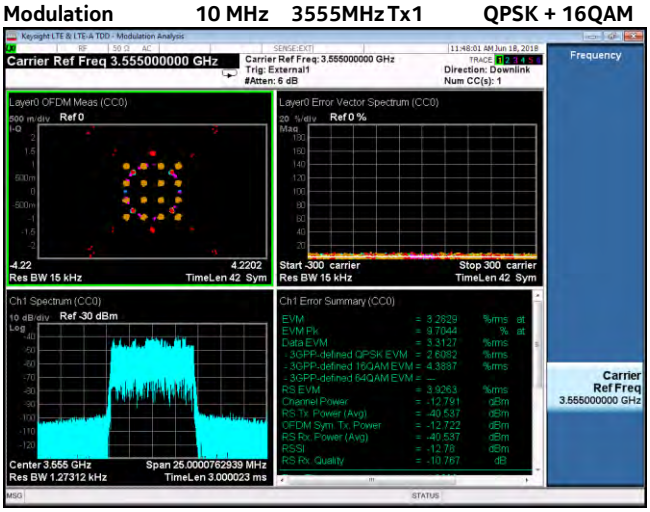
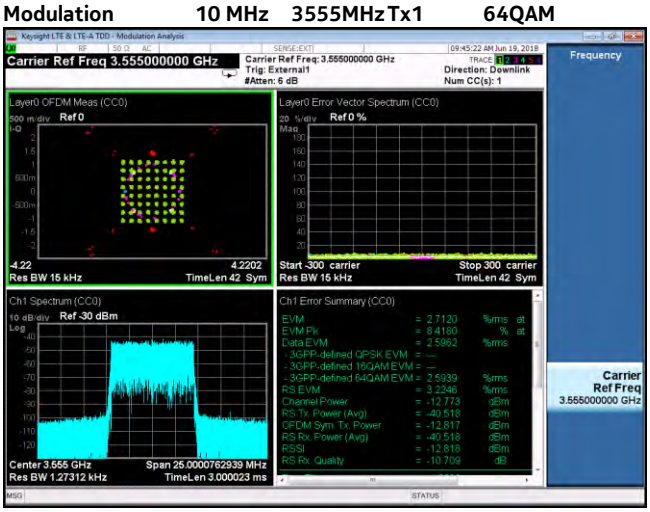


Figure 4.2.2 Typical Modulation Measurements - Sample Measurement Plots

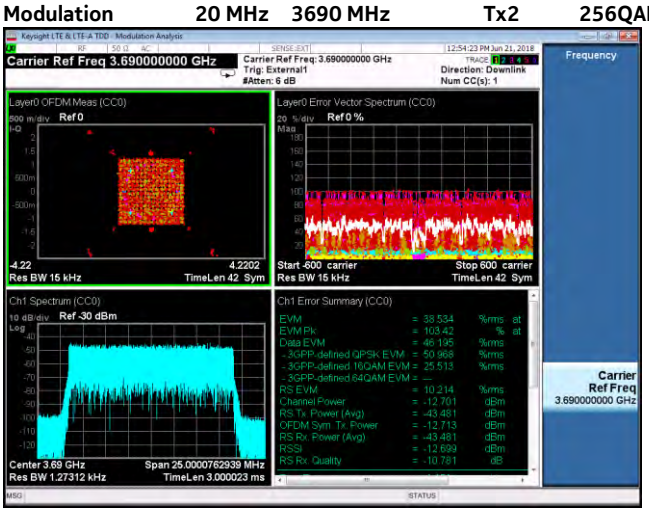
Modulation 10 MHz 3555MHz Tx1 QPSK + 16QAM



Modulation 10 MHz 3555MHz Tx1 64QAM



Modulation 20 MHz 3690 MHz Tx2 256QAM



4.3 Section 2.1049 MEASUREMENT REQUIRED: OCCUPIED BANDWIDTH and EDGE of BLOCK EMISSIONS

This test measures the Occupied Bandwidth of the transmitting carrier and the Edge of-Block Emissions in the frequency spectrum immediately outside and adjacent to the transmitting carrier(s).

The occupied bandwidth (OBW) is usually defined either as the 99% power OBW or a relative OBW. The 99% OBW is the signal bandwidth such that, below its lower and above its upper frequency limits, the mean power radiated or conducted are each equal to 0.5 percent of the total mean power radiated or conducted by a given emission. The relative OBW is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated by at least X dB below the transmitter power, where the value of X is typically specified as 26.

Per KDB 971168 D01 v02, the relative OBW must be measured and reported when it is specified in the applicable rule part; otherwise, the 99% OBW shall be measured and reported. The OBW shall be measured when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment is operated.

4.3.1 Occupied Bandwidth (Signal Bandwidth) Results

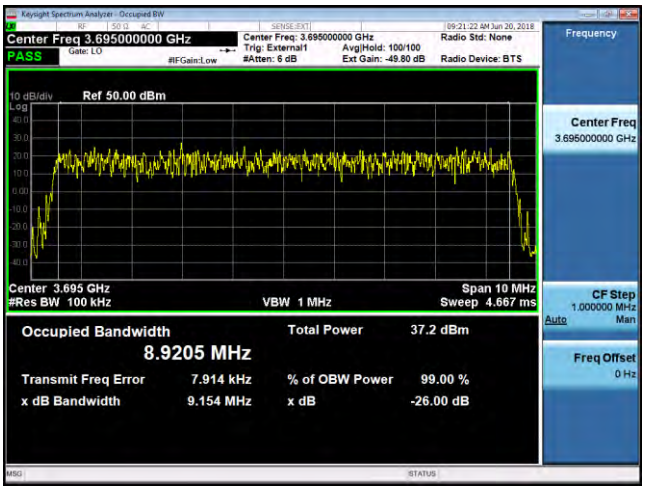
The 99% occupied bandwidth and -26 dB relative bandwidth was measured with an Agilent/Keysight MXA signal analyzer for the 10M0F9W and 20M0F9W emission designators. The results are tabulated in Table 4.3.1 and examples are in Figure 4.3.1 below and shows that the measured signals are within the parameters of the emissions designator for the FCC.

Table 4.3.1 Signal Bandwidth Results

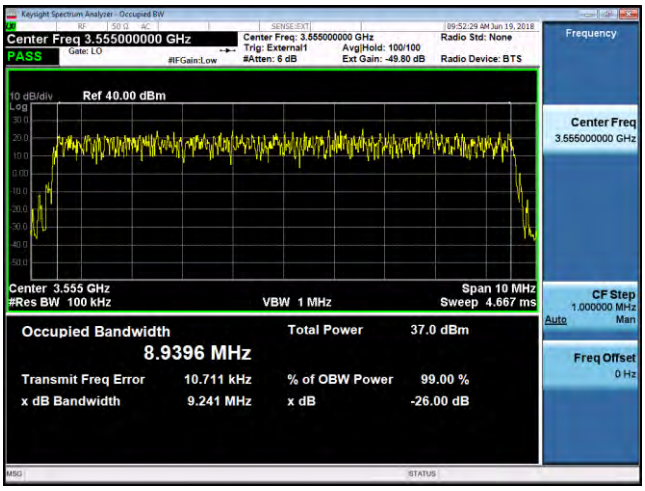
Test #	mMIMO Channel Frequency	Band Loc.	Nominal Signal BW MHz	Modulation Q16 = QPSK + 16QAM	Measured 99% Signal BW MHz
Single carrier: 10MHz BW					
1	3555	Left	10	Q16, 64QAM, 256QAM	8.9397 8.9205 8.9396
2	3675	Middle	10	Q16	8.9416
3	3695	Right	10	Q16, 64QAM, 256QAM	8.9401 8.9204 8.9385
Single carrier: 20MHz BW					
1	3560	Left	20	Q16, 64QAM, 256QAM	17.775 17.859 17.803
2	3620	Middle	20	Q16	17.781
3	3690	Right	20	Q16, 64QAM, 256QAM	17.780 17.859 17.804
2 Carriers Non-Contiguous: 20+20 MHz					
1	3560+3620	Left	20+20	Q16	35.538
2	3600+3660	Middle	20+20	Q16	35.528
3	3630+3690	Right	20+20	Q16	35.526
3 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600	Left	20+20+20	Q16	57.449
2	3600+3620+3640	Middle	20+20+20	Q16	57.389
3	3650+3670+3690	Right	20+20+20	Q16	57.584
3 Carriers Non-Contiguous: 20+20+20 MHz					
1	3560+3580+3620	Left	20+20+20	Q16	55.356
2	3620+3640+3690	Middle	20+20+20	Q16	55.377
3	3620+3670+3690	Right	20+20+20	Q16	55.376
2 Carriers Non-Contiguous: 10+10 MHz					
1	3555+3625	Left	10+10	Q16	17.829
2	3625+3695	Middle	10+10	Q16	17.877
2 Carriers Contiguous: 10+10 MHz					
1	3555+3565	Left	10+10	Q16	18.788
2	3685+3695	Right	10+10	Q16	18.793
3 Carriers Contiguous: 10+10+10 MHz					
1	3555+3565+3575	Left	10+10+10	Q16	28.834
2	3615+3625+3535	Middle	10+10+10	Q16	28.850
3	3675+3685+3695	Top	10+10+10	Q16	28.864
3 Carriers Non-Contiguous: 10+10+10 MHz					
1	3555+3595+3625	Left	10+10+10	Q16	26.021
2	3625+3655+3695	Right	10+10+10	Q16	26.818
4 Carriers Contiguous: 10+10+10+10 MHz					
1	3555+3565+3675+3585	Left	10+10+10+10	Q16	38.376
2	3605+3615+3625+3635	Middle	10+10+10+10	Q16	38.542
3	3665+3675+3685+3695	Right	10+10+10+10	Q16	38.533
4 Carriers Non-Contiguous: 10+10+10+10 MHz					
1	3555+3575+3595+3625	Left	10+10+10+10	Q16	35.759
2	3625+3645+3675+3695	Right	10+10+10+10	Q16	35.762
2 Carriers Contiguous: 20+20 MHz					
1	3560+3580	Left	20+20	Q16	37.589
2	3620+3640	Middle	20+20	Q16	37.611
3	3670+3690	Right	20+20	Q16	37.603
4 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600+3620	Left	20+20+20+20	Q16	77.23
2	3630+3650+3670+3690	Middle	20+20+20+20	Q16	77.32

Figure 4.3.1- Occupied Bandwidth – 99% Signal Bandwidths Sample Plots

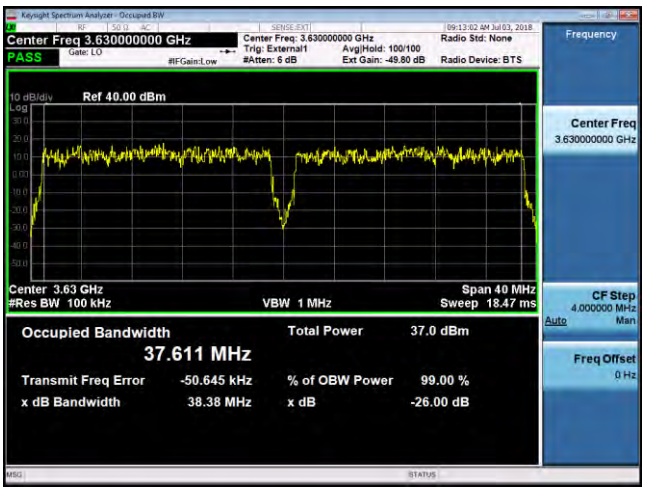
1C 26dB and 99 TM3.1 3695



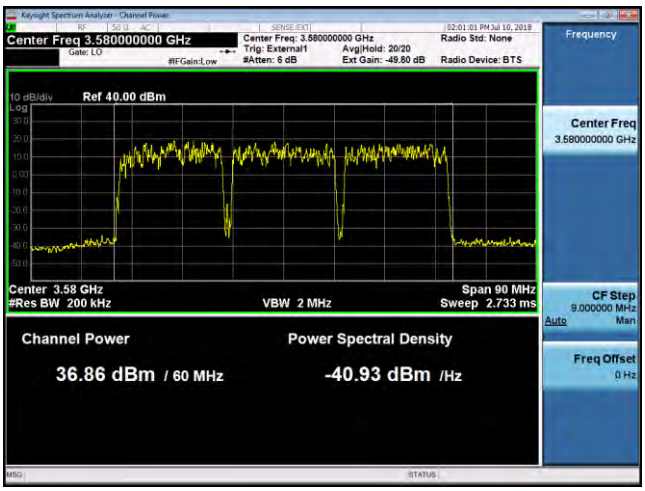
1C 26dB and 99 TM3.1A 3555



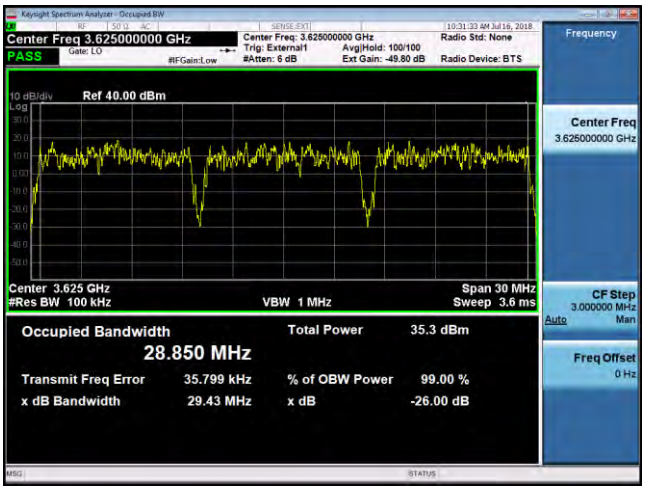
2C 26dB and 99 TM3.2 3620 3640



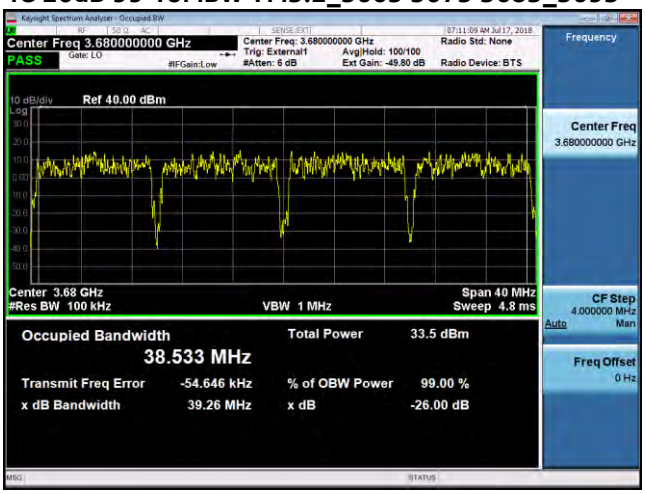
3C Channel Power TM3.2 3560 3580 3600



3C 26dB 99 10MBW TM3.2 3615 3525 3635



4C 26dB 99 10MBW TM3.2_3665 3675 3685_3695



4.3.2 Occupied Bandwidth-Edge of Block Emissions

Classical Occupied Bandwidth – Edge of Block Emissions is an evaluation of the transmit carrier compliance with edge of block/edge of band requirements. This measurement documents the product's ability to maintain compliance with FCC Parts 2 and Part 96.41 limitations on emissions outside the block of operation.

The **3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC)**supports single and multi-carrier LTE TDD technologies.

In each test configuration the carriers were configured at the left side, center and right side of the Part 96 band as appropriate. All power adjustments were performed prior to other measurements. Power was set to the total per port maximum for the specific configuration with equal levels of power per carrier. The measurements are described below.

The occupied bandwidth of each of the signals identified in Table 4.3.6.1 was measured using a MXA signal analyzer and a Rohde & Schwarz ESIB-40 EMI Receiver/ Spectrum Analyzer. The measurement process meets the requirements of ANSI C63.26 and ISO17025. The RF power level was measured and adjusted via the test setup in Figure 4.3. The set RF output from the transmitter was reduced by calibrated broadband attenuators to amplitudes usable by the spectrum analyzer and power meter. The attenuation factors are reflected in the displayed values of the charts. The typical occupied bandwidth measurement displays the signal adjusted to the reference level corresponding to the corrected RF power level for the signal bandwidth and given resolution bandwidth (RBW). This set-point was performed as follows:

For each test the power calibration was individually verified at the transmitter antenna connection (J4) with a power meter by using the test setup depicted in Figure 4.3. The power calibration was performed to calibrate the spectrum analyzers power measurement against the more accurate power meter measurement. This provides a specific reference for measurements performed with either a 100 kHz, and/or 200 kHz Resolution Bandwidth signal.

Plots are provided using the triggered LTE-TDD functionality of the MXA and peak detected plots using the EMC Test Receiver. The plots complement each other and demonstrate compliance with edge of band limits.

The duality of the measurements is necessary as conducted spurious measurements are required to be performed with the same detector functions as the RF Power/Occupied Bandwidth/Edge of Band Emissions. Conducted spurious measurements were therefore performed over the frequency range of 10 MHz-26.5 GHz with the N9020A MXA Signal analyzer (average detector) and 10 MHz to 37 GHz with the ESIB40 EMC Test receiver (peak detector). Since CBRS Band 48 (3550-3700MHz) requires Conducted spurious testing to 37 GHz the second measurement using peak detector was performed to 40 GHz

The test procedure above as applied to Figure 4.3.5, calibrates the carrier power against the Mask and accurately places the measured occupied bandwidth carrier at the appropriate reference line. All of the plots are presented with a sufficiently wide frequency span for the specific signals or Block of interest. This allows for ease of comparison of the multi-carrier performance. These sheets contain data for multiple mixed carrier configurations for "Left Edge of Block", and "Right Edge of Block" across CBRS Band 48.

4.3.3 Requirements 3.5 GHz Emissions and Interference Limits

The Limit in 47 CFR 96.41 (e) for 3.5 GHz Emissions and Interference Limits is as follows:

(1) Except as otherwise specified in paragraph (e)(2) of this section, for channel and frequency assignments made by the SAS to CBSDs, the conducted power of any emission outside the fundamental emission (whether in or outside of the authorized band) shall not exceed −13 dBm/MHz within 0-10 megahertz above the upper SAS-assigned channel edge and within 0-10 megahertz below the lower SAS-assigned channel edge.

At all frequencies greater than 10 megahertz above the upper SAS assigned channel edge and less than 10 MHz below the lower SAS assigned channel edge, the conducted power of any emission shall not exceed −25 dBm/MHz. The upper and lower SAS assigned channel edges are the upper and lower limits of any channel assigned to a CBSD by an SAS, or in the case of multiple contiguous channels, the upper and lower limits of the combined contiguous channels.

(2) *Additional protection levels.* Notwithstanding paragraph (d)(1) of this section, the conducted power of any emissions below 3530 MHz or above 3720 MHz shall not exceed −40dBm/MHz.

(3) *Measurement procedure.* (i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's authorized frequency channel, a resolution bandwidth of no less than one percent of the fundamental emission bandwidth may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full reference bandwidth (*i.e.,* 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(ii) When measuring unwanted emissions to demonstrate compliance with the limits, the CBSD and End User Device nominal carrier frequency/channel shall be adjusted as close to the licensee's authorized frequency block edges, both upper and lower, as the design permits.

(iii) Compliance with emission limits shall be demonstrated using either average (RMS)-detected or peak-detected power measurement techniques.

In order to address the limit as imposed for the requirement in 47CFR 96.41 we evaluated emissions per the requirements in ANSI C63.26 and per KDB 940660 D01 Part 96 CBRS Equipment.

The average detector function was used for all MXA measurements and the Peak detector function were used for EMC receiver measurements.

4.3.4 Measurement Offset and MIMO

The spectrum analysis output plots show the peak of the LTE channel signal at the reference line that is an appropriate number of dB below the top of Mask reference of the spectrum analyzer. For the LTE system there is no carrier without modulation. Since the LTE signal is broadband and is 10, or 20 MHz wide, all of the measurements performed at narrower resolution bandwidths need to be evaluated with limits adjusted for the reduction in signal energy. The following relationship was used to provide the correct level for an unmodulated carrier vs. the modulated signal.

10*log (Resolution Bandwidth/ Transmit Bandwidth) = Signal Offset (1)

For the peak of the 10, or 20 MHz LTE signal measured with a RBW of 100, or 200 kHz the signal offset is:
For a 10 MHz carrier the Signal Offset = 10*log (100 kHz /10 MHz) = -20.00 dB
For a 20 MHz carrier the Signal Offset = 10*log (200 kHz /20 MHz) = -20.00 dB

For MIMO operation in accordance with KDB 662911 D01 the limits must be adjusted per the equation:

MIMO Offset = 10LOG(n) where n= MIMO Value

For 4x MIMO = 10LOG(4)= 6.02 dB

4.3.5 Occupied Bandwidth-Edge of Block Emissions Measurement

The occupied bandwidth and out-of-band emissions measurements were made at the antenna transmitting terminal for one, two, three and four carriers. These included measurements with QPSK+16QAM, 64QAM and 256QAM modulation. The appropriate E-UTRA test model specified in **3GPP TS 36.141 V14.1.0 (2016-09) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14).** was used for these LTE carriers.

The measurements were performed with both a spectrum analyzer and with an MXA signal analyzer in compliance with the procedure and requirements of ANSI C63.26. The test set-up diagram in Figure 4.3 is used for RF Power, Modulation, Peak to Average Ratio, occupied bandwidth, out-of-band emissions and Antenna Port Conducted Spurious Emissions.

Testing was performed for the 10, and 20 MHz carrier configurations at the left side, center and right side of the Part 96 Band. The total overall carrier power level at each antenna terminal was adjusted to the maximum rated mean power 37 dBm (5W) for 4xMIMO configurations. This is 20W total for the two ports.

Mask parameters were as stated in Table 4.3.5. For proper evaluation of the carrier the measurement parameters for Resolution Bandwidth and Mask Edge Offsets were followed as shown in Table 4.3.6. All of the Mask Edge Offsets are equal to ½ of the Resolution Bandwidths used for the measurements.

Table 4.3.6. Measurement Parameters and Mask Edge Offsets

Signal Bandwidth	Measurement Resolution Band Width (RBW)	Resolution Bandwidth Offsets
MHz	MHz	MHz
10	0.1	0.05
20	0.2	0.1

4.3.6 Occupied Bandwidth-Edge of Block Emissions Results

The occupied bandwidth plots for operation at the left side and the right side of the band for all of the signal bandwidths are below. The mask accurately depicts the limits for the specific blocks to determine compliance with FCC Part 96. The mask limits include the appropriate considerations for 4x5W MIMO operation.

From the out-of-band emissions plots attached below, it can be seen that all the emissions are under the required emission masks for MIMO operation.

The measurement results of the occupied bandwidth and the out-of-band emissions as documented in the plots and Table 4.3.6.1 demonstrate the full compliance with the Rules of the Commission for the operating band.

Table 4.3.6.1 Compliance Tabulation of Occupied Bandwidth-Edge of Block Measurements

Test #	mMIMO Channel Frequency	Band Loc.	Nominal Signal BW MHz	Modulation Q16 = QPSK + 16QAM	Occupied Bandwidth / Edge of Block Results
Single carrier: 10MHz BW					
1	3555	Left	10	Q16, 64QAM, 256QAM	PASS
2	3675	Middle	10	Q16	PASS
3	3695	Right	10	Q16, 64QAM, 256QAM	PASS
Single carrier: 20MHz BW					
1	3560	Left	20	Q16, 64QAM, 256QAM	PASS
2	3620	Middle	20	Q16	PASS
3	3690	Right	20	Q16, 64QAM, 256QAM	PASS
2 Carriers Non-Contiguous: 20+20 MHz					
1	3560+3620	Left	20+20	Q16	PASS
2	3600+3660	Middle	20+20	Q16	PASS
3	3630+3690	Right	20+20	Q16	PASS
3 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600	Left	20+20+20	Q16	PASS
2	3600+3620+3640	Middle	20+20+20	Q16	PASS
3	3650+3670+3690	Right	20+20+20	Q16	PASS
3 Carriers Non-Contiguous: 20+20+20 MHz					
1	3560+3580+3620	Left	20+20+20	Q16	PASS
2	3620+3640+3690	Middle	20+20+20	Q16	PASS
3	3620+3670+3690	Right	20+20+20	Q16	PASS
2 Carriers Non-Contiguous: 10+10 MHz					
1	3555+3625	Left	10+10	Q16	PASS
2	3625+3695	Middle	10+10	Q16	PASS
2 Carriers Contiguous: 10+10 MHz					
1	3555+3565	Left	10+10	Q16	PASS
2	3685+3695	Right	10+10	Q16	PASS
3 Carriers Contiguous: 10+10+10 MHz					
1	3555+3565+3575	Left	10+10+10	Q16	PASS
2	3615+3625+3535	Middle	10+10+10	Q16	PASS
3	3675+3685+3695	Top	10+10+10	Q16	PASS
3 Carriers Non-Contiguous: 10+10+10 MHz					
1	3555+3595+3625	Left	10+10+10	Q16	PASS
2	3625+3655+3695	Right	10+10+10	Q16	PASS
4 Carriers Contiguous: 10+10+10+10 MHz					
1	3555+3565+3675+3585	Left	10+10+10+10	Q16	PASS
2	3605+3615+3625+3635	Middle	10+10+10+10	Q16	PASS
3	3665+3675+3685+3695	Right	10+10+10+10	Q16	PASS
4 Carriers Non-Contiguous: 10+10+10+10 MHz					
1	3555+3575+3595+3625	Left	10+10+10+10	Q16	PASS
2	3625+3645+3675+3695	Right	10+10+10+10	Q16	PASS
3	3555+3605+3645+3695	Full Band	10+10+10+10	64QAM	PASS
2 Carriers Contiguous: 20+20 MHz					
1	3560+3580	Left	20+20	Q16	PASS
2	3620+3640	Middle	20+20	Q16	PASS
3	3670+3690	Right	20+20	Q16	PASS
4 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600+3620	Left	20+20+20+20	Q16	PASS
2	3630+3650+3670+3690	Middle	20+20+20+20	Q16	PASS
4 Carriers Non-Contiguous: 20+20+20+20 MHz					
1	3560+3600+3640+3690	Full Band	20+20+20+20	256QAM	Pass

Figure 4.3 - Test Set-Up for Measurement of Occupied Bandwidth and Out-of-Band Emissions

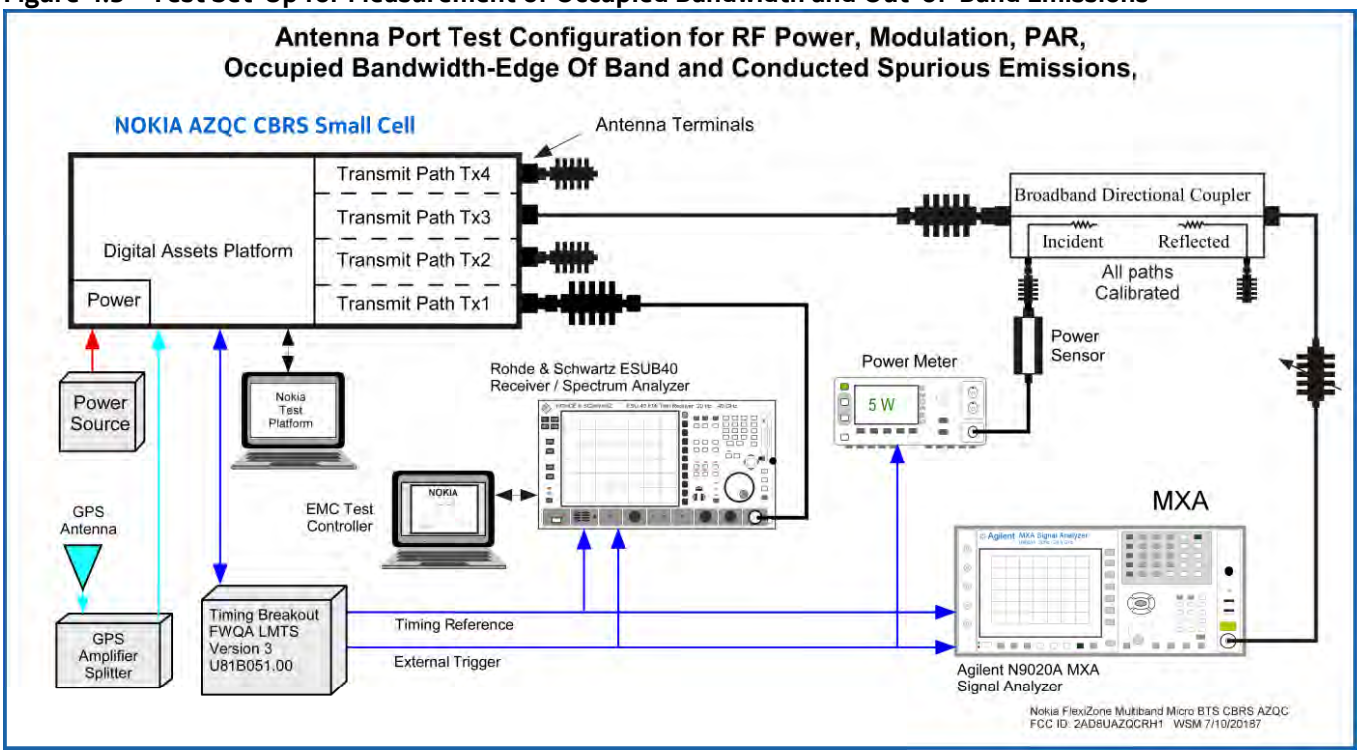
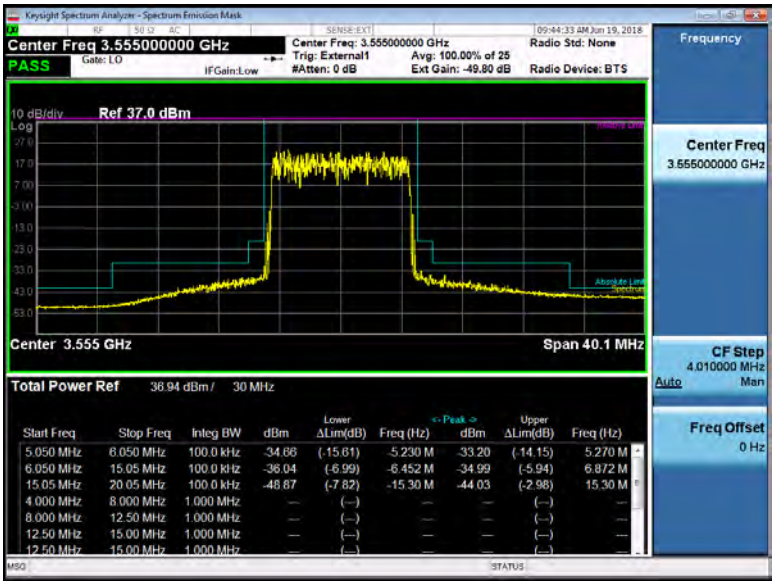
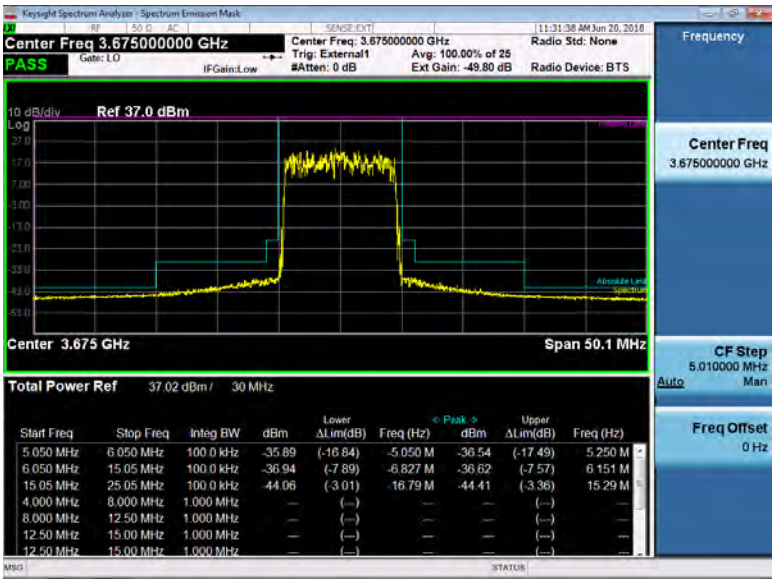


Figure 4.3.7 Transmitter Measurements of Occupied Bandwidth and Edge of Band Emissions - Sample Measurement Plots

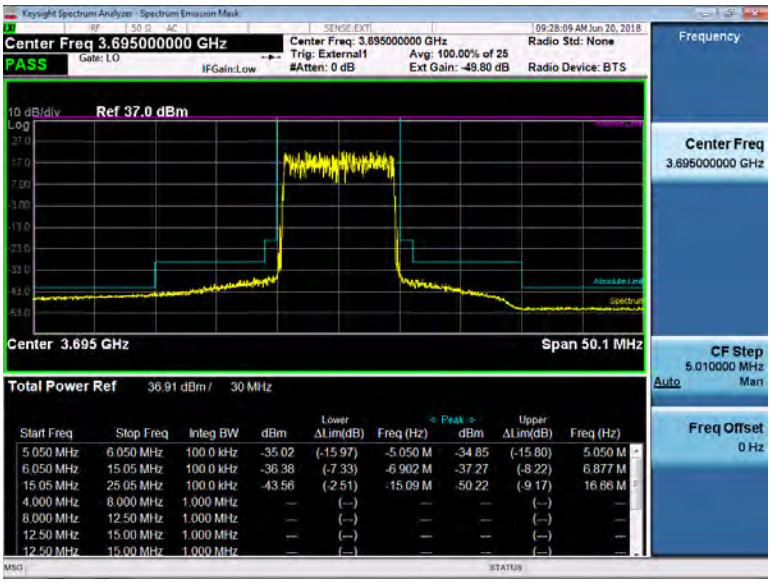
Unwanted Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 10MBW, TM3.1, 3555 MHz.



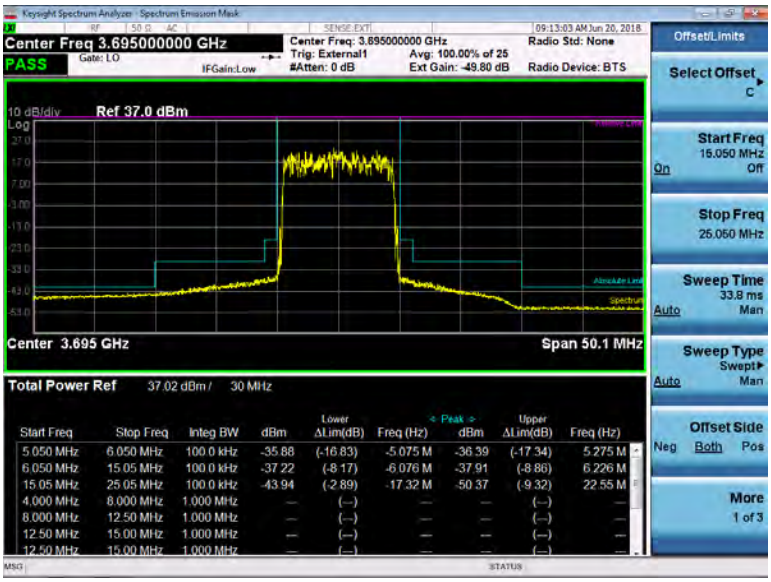
Unwanted Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 10MBW, TM3.2, 3675 MHz.



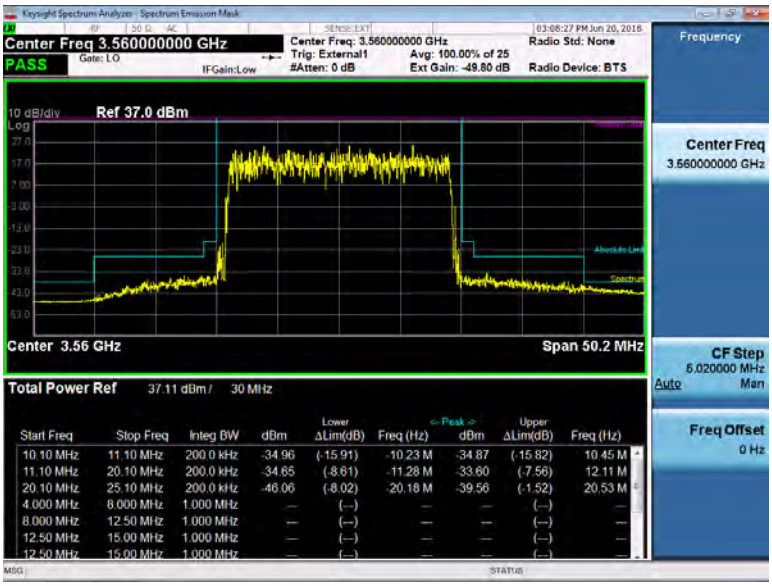
Unwanted Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 10MBW, TM3.1A, 3695 MHz.



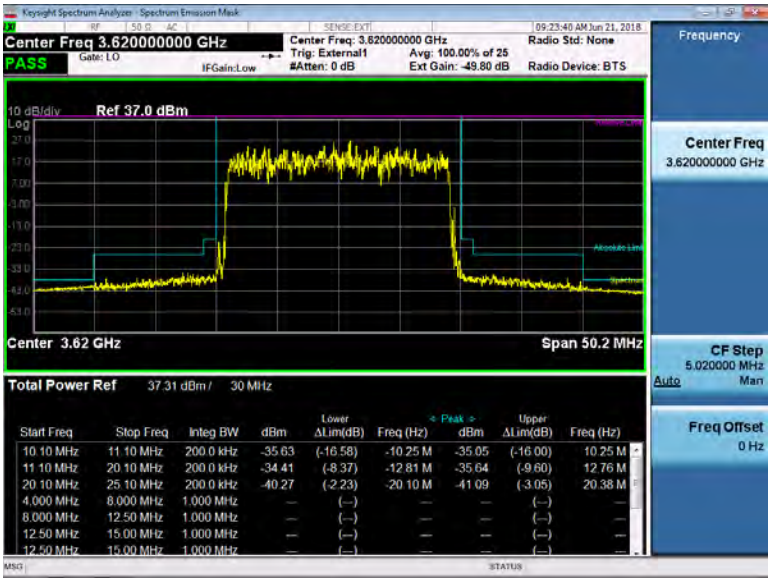
Unwanted Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 10MBW, TM3.2, 3695 MHz.



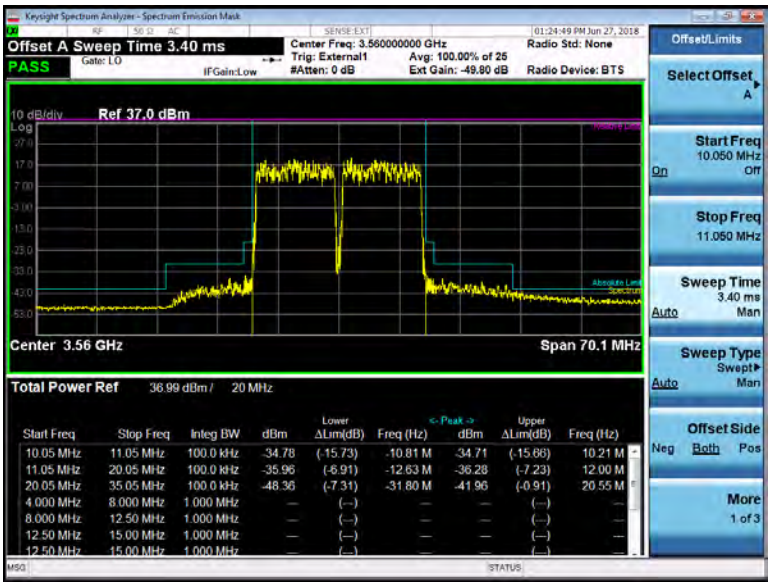
Unwanted Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 20MBW, TM3.1, 3560 MHz.



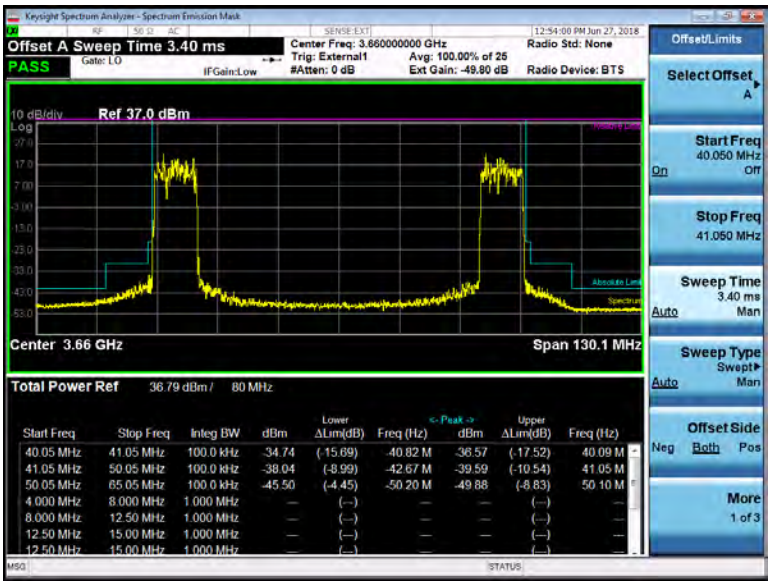
Unwanted Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 20MBW, TM3.2, 3620 MHz.



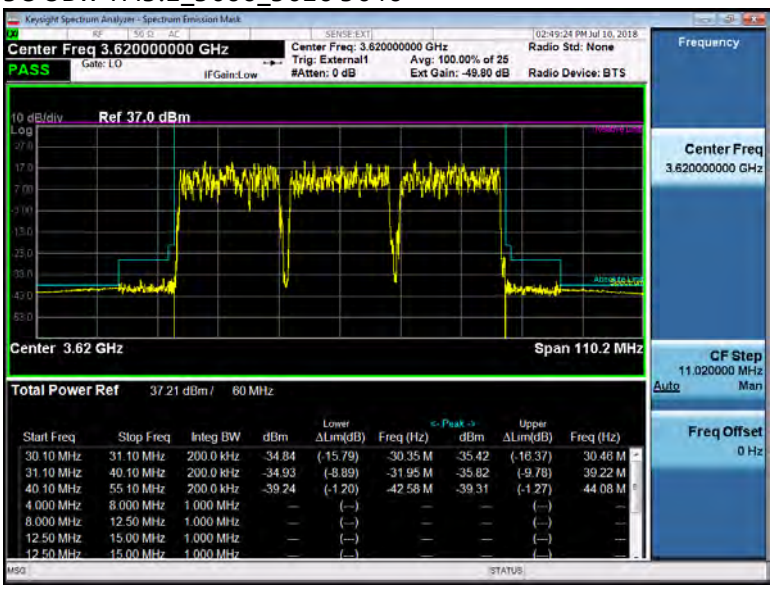
Unwanted Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 2C, 37dBm, 10MBW, TM3.2, 3555 and 3565 MHz.



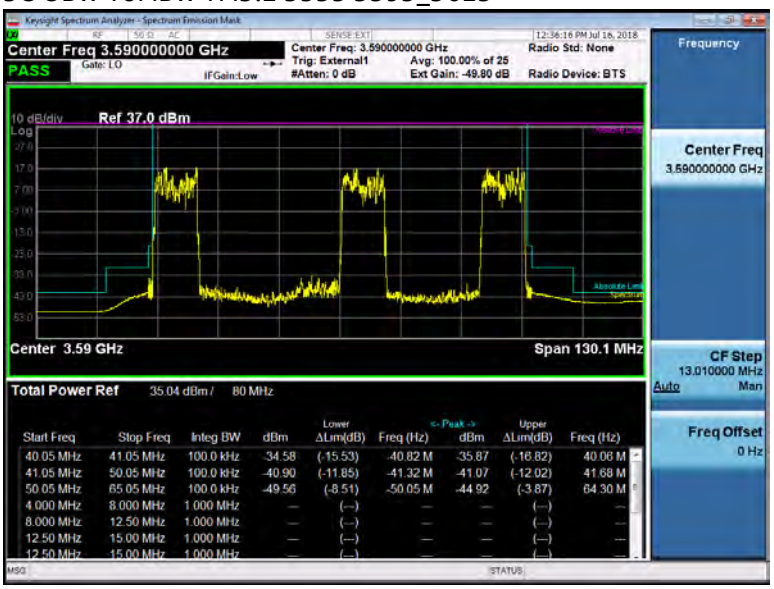
Unwanted Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 2C, 37dBm, 10MBW, TM3.2, 3625 and 3695 MHz.



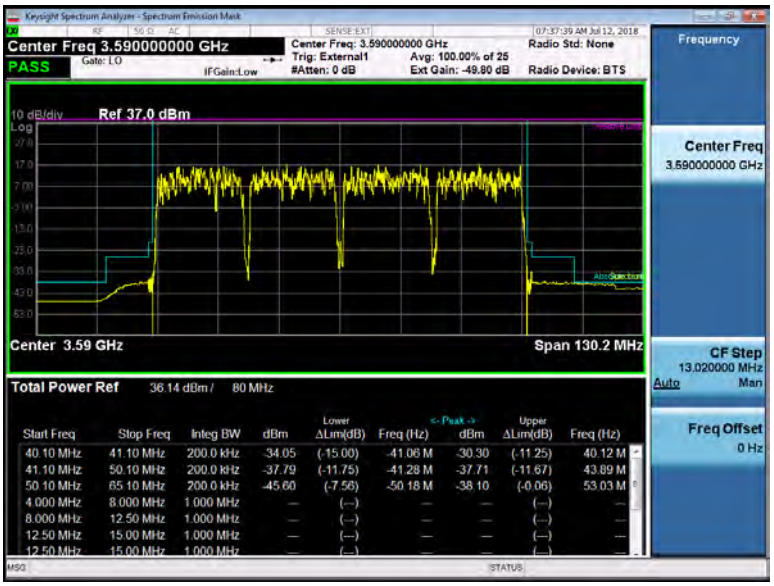
3C OBW TM3.2_3600_3620 3640



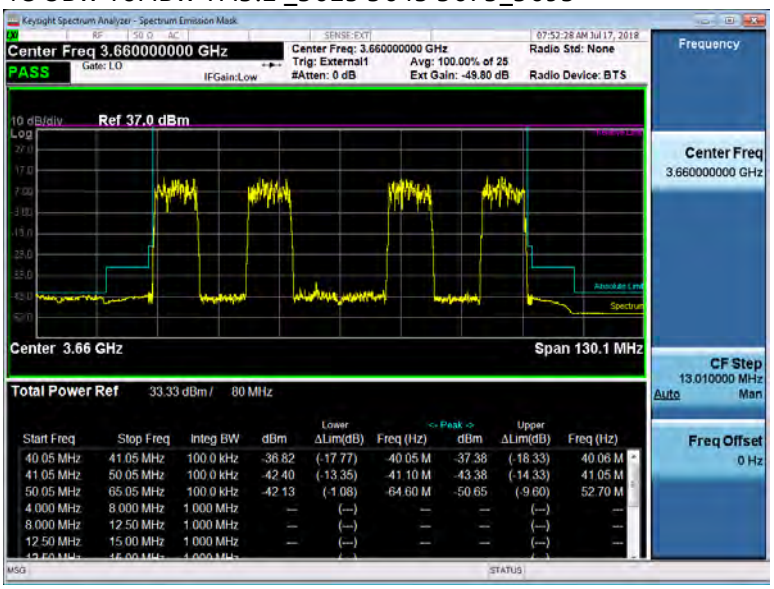
3C OBW 10MBW TM3.2 3555 3595_3625



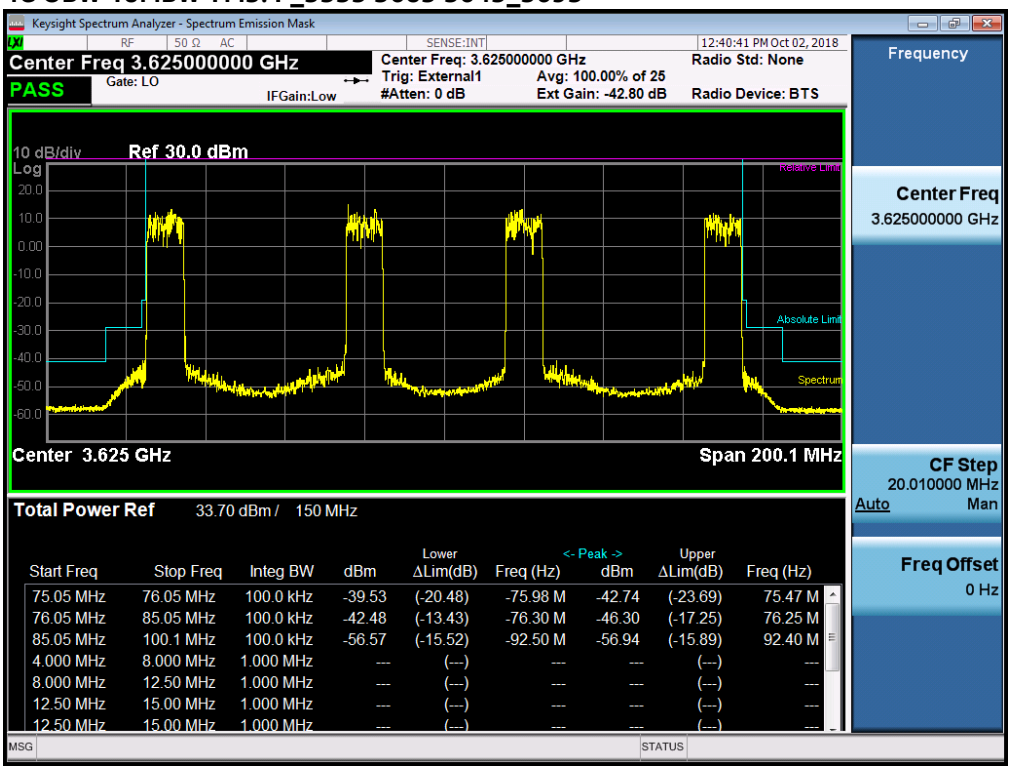
4C OBW TM3.2 3560 3580 3600 3620



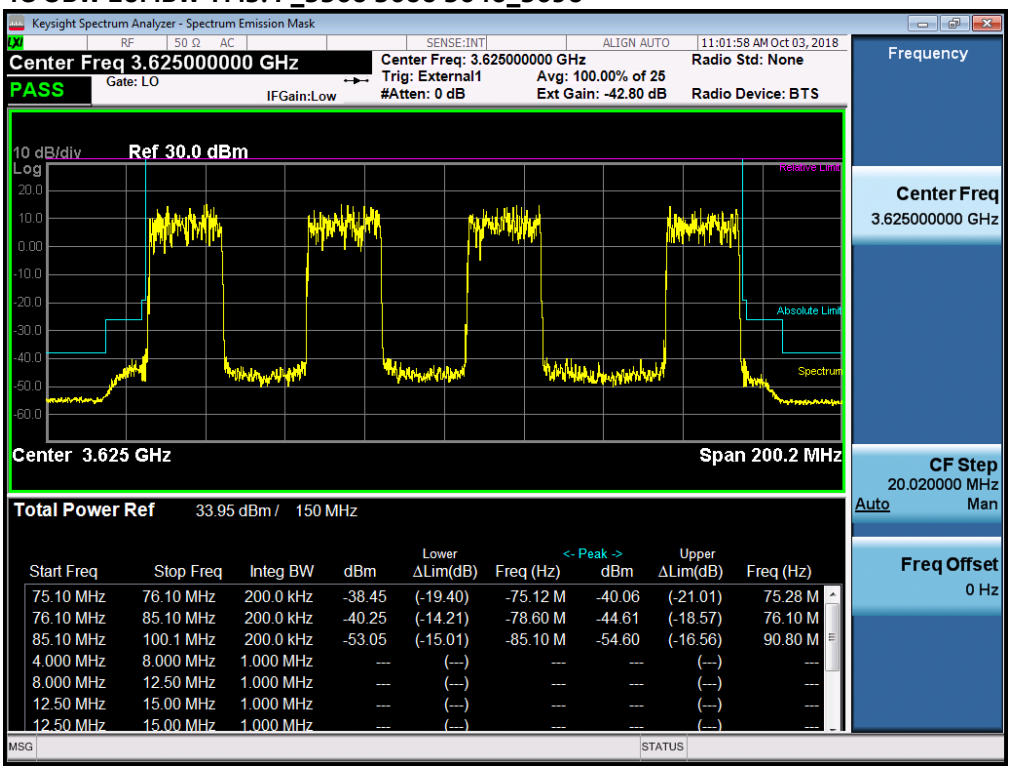
4C OBW 10MBW TM3.2 _3625 3645 3675_3695



4C OBW 10MBW TM3.1 _3555 3605 3645_3695



4C OBW 20MBW TM3.1 _3560 3600 3640_3690



4.4 Section 2.1051 MEASUREMENT REQUIRED: SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS

This test measures the emissions of spurious signals which may come from harmonic, parasitic, intermodulation and frequency conversion products and are outside the necessary bandwidth but excludes Edge-of-Band emissions.

4.4.1 Section 2.1051 Spurious Emissions at Antenna Terminals

Spurious Emissions at the antenna terminals were investigated per 47CFR Section 2.1057(a)(1) over the frequency range of 10 MHz to 37 GHz which is beyond the 10th harmonic of the carrier frequency. A test coupler which incorporates a low intermod broadband RF attenuator was used to reduce the transceiver's amplitude to a level usable by the spectrum analyzer. The test configuration is shown in Figure 4.4.1 which documents the test set up used for the measurements. In this set up the complete RF test path was calibrated over the 10 MHz-37 GHz range.

The spurious measurements were made using a PC based automated test system which controls either a MXA Signal Analyzer or a Rohde & Schwarz ESU-40 Test Receiver/ Spectrum Analyzer. These measurements are performed in compliance with ANSI C63.26 and our ISO17025 process. The measurement meets the ANSI C63.26 requirements in paragraphs 5.2.4.4.1 and 5.7 which requires that the number of points in the sweep be > 2 × Span/RBW. The MXA signal analyzer measurements examine the 10 MHz to 26.5 GHz range while the ESU-40 extends the frequency range to examine the 26.5 GHz to 37 GHz range.

Measurements were performed for all of the test configurations in Table 4.5.4 and these matches the test configurations used for Occupied Bandwidth / Edge of Band Emissions, RF Power and modulation.

4.4.2 Required Limit

The required emission limitation specified in **47CFR 96.41 (e)** was applied to these tests. Based upon the criterion given in Section 96 of the Code and as developed in 4.3.3, the required emission limit for emissions outside a licensee's frequency block is:

47CFR 96.41 (e)(2) *Additional protection levels.* Notwithstanding paragraph (d)(1) of this section, the conducted power of any emissions below 3530 MHz or above 3720 MHz shall not exceed −40dBm/MHz.

In order to account for the spectral adding of identical signals from the primary and diversity ports, per KDB 662911 D01 Multiple Transmitter Output v01r01, the level needs be adjusted by 10LOG(n) where n= number of outputs.

The adjustment for n=4 is: 6.02 dB = 10LOG(4)

Therefore the limit for emissions >1 MHz outside a licensees frequency block when measured with a RBW of 1 MHz is:

-40 dBm - 6.02 dB = -46.02 dBm for 4x MIMO

4.4.3 Operational Configuration

The modulation used in this evaluation are described in the pertinent standards documents which include **3GPP TS 36.141 V14.1.0 (2016-09) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14)**. The modulation is Orthogonal Frequency Division Multiple Access (OFDMA) which is processed into an uplink IF signal. The input data stream is divided into several parallel sub-streams of reduced data rate and each sub-stream is transmitted on a separate orthogonal sub-carrier. For this test the sub-carriers were modulated using 256QAM.

4.4.4 Spurious Emissions at Antenna Terminals Results:

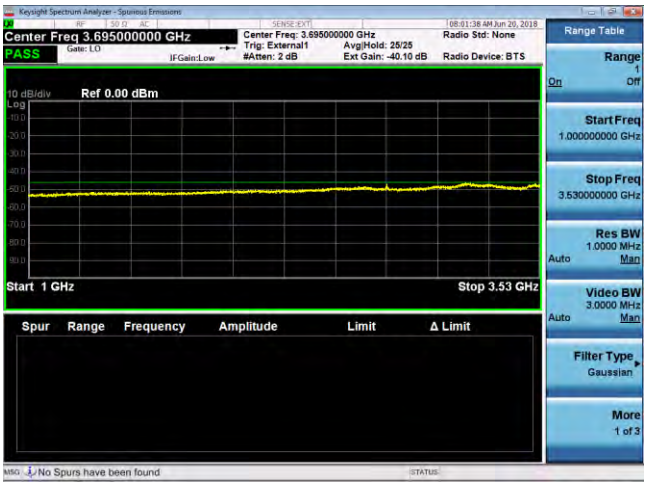
Over the required frequency spectrum investigated for the EUT, no reportable out-of-block spurious emissions were detected. The out-of-block spurious emissions in the entire spectrum investigated are under the required reportable emission limit and are tabulated in Table 4.4.4 below. Two sets of data which represent the two extremes of MIMO configurations tested are attached below. The measurement results demonstrate that the subject of the application is in full compliance with the Rules of the Commission and Industry Canada.

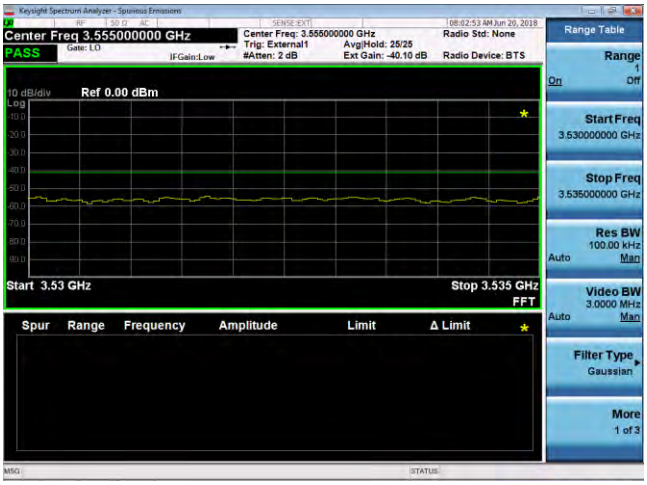
Table 4.4.4 Compliance Tabulation of Conducted Spurious Emissions Measurements

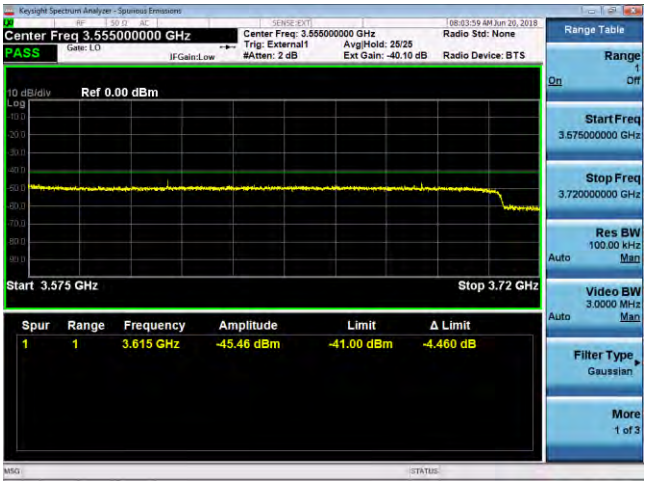
Test #	mMIMO Channel Frequency	Band Loc.	Nominal Signal BW MHz	Modulation Q16 = QPSK + 16QAM	Conducted Spurious Emissions Results Pass / Fail
Single carrier: 10MHz BW					
1	3555	Left	10	Q16, 64QAM, 256QAM	PASS
2	3675	Middle	10	Q16	PASS
3	3695	Right	10	Q16, 64QAM, 256QAM	PASS
Single carrier: 20MHz BW					
1	3560	Left	20	Q16, 64QAM, 256QAM	PASS
2	3620	Middle	20	Q16	PASS
3	3690	Right	20	Q16, 64QAM, 256QAM	PASS
2 Carriers Non-Contiguous: 20+20 MHz					
1	3560+3620	Left	20+20	Q16	PASS
2	3600+3660	Middle	20+20	Q16	PASS
3	3630+3690	Right	20+20	Q16	PASS
3 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600	Left	20+20+20	Q16	PASS
2	3600+3620+3640	Middle	20+20+20	Q16	PASS
3	3650+3670+3690	Right	20+20+20	Q16	PASS
3 Carriers Non-Contiguous: 20+20+20 MHz					
1	3560+3580+3620	Left	20+20+20	Q16	PASS
2	3620+3640+3690	Middle	20+20+20	Q16	PASS
3	3620+3670+3690	Right	20+20+20	Q16	PASS
2 Carriers Non-Contiguous: 10+10 MHz					
1	3555+3625	Left	10+10	Q16	PASS
2	3625+3695	Middle	10+10	Q16	PASS
2 Carriers Contiguous: 10+10 MHz					
1	3555+3565	Left	10+10	Q16	PASS
2	3685+3695	Right	10+10	Q16	PASS
3 Carriers Contiguous: 10+10+10 MHz					
1	3555+3565+3575	Left	10+10+10	Q16	PASS
2	3615+3625+3535	Middle	10+10+10	Q16	PASS
3	3675+3685+3695	Top	10+10+10	Q16	PASS
3 Carriers Non-Contiguous: 10+10+10 MHz					
1	3555+3595+3625	Left	10+10+10	Q16	PASS
2	3625+3655+3695	Right	10+10+10	Q16	PASS
4 Carriers Contiguous: 10+10+10+10 MHz					
1	3555+3565+3675+3585	Left	10+10+10+10	Q16	PASS
2	3605+3615+3625+3635	Middle	10+10+10+10	Q16	PASS
3	3665+3675+3685+3695	Right	10+10+10+10	Q16	PASS
4 Carriers Non-Contiguous: 10+10+10+10 MHz					
1	3555+3575+3595+3625	Left	10+10+10+10	Q16	PASS
2	3625+3645+3675+3695	Right	10+10+10+10	Q16	PASS
2 Carriers Contiguous: 20+20 MHz					
1	3560+3580	Left	20+20	Q16	PASS
2	3620+3640	Middle	20+20	Q16	PASS
3	3670+3690	Right	20+20	Q16	PASS
4 Carriers Contiguous: 20+20+20 MHz					
1	3560+3580+3600+3620	Left	20+20+20+20	Q16	PASS
2	3630+3650+3670+3690	Middle	20+20+20+20	Q16	PASS

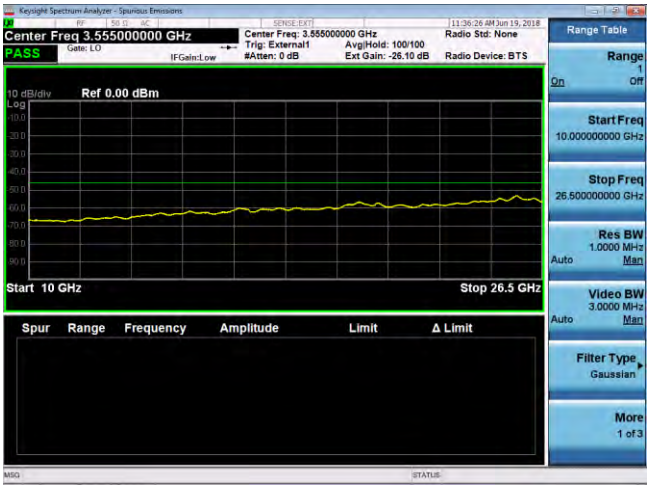
Figure 4.4.4 Transmitter Measurements of Conducted Spurious Emissions - Sample Measurement Plots

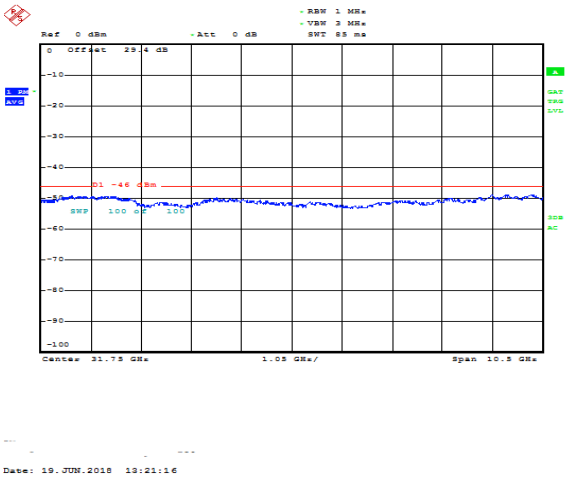
Spurious Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 10MBW, TM3.1A, 3555 MHz.



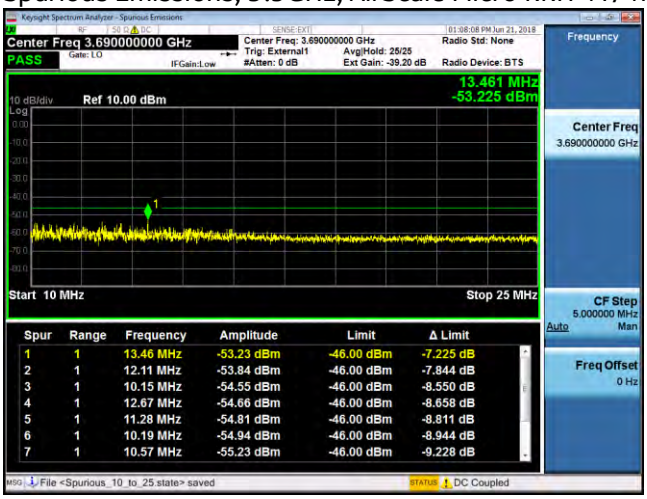




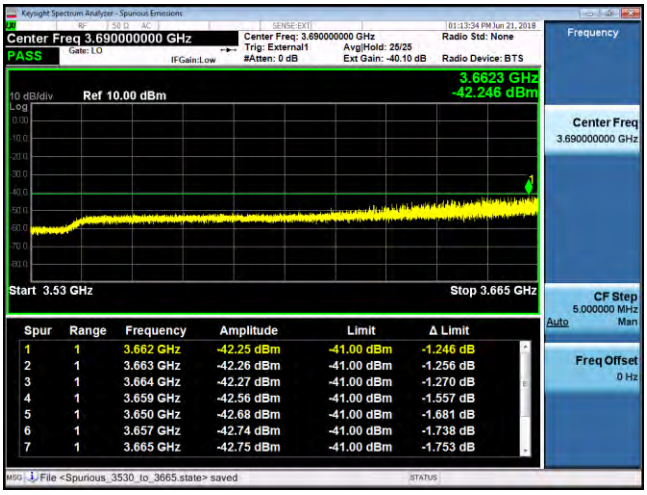


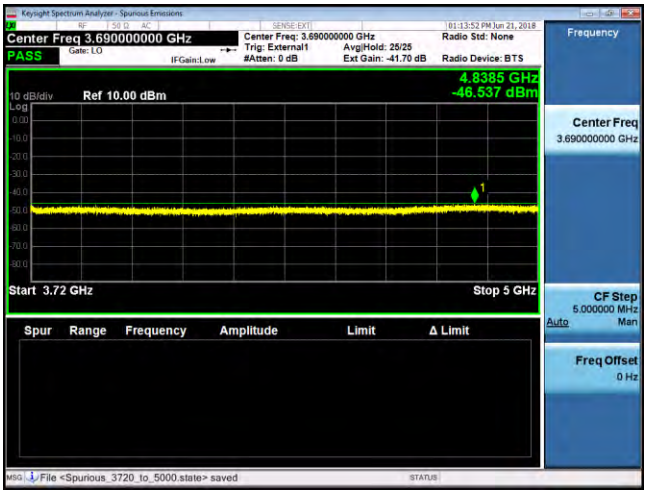


Spurious Emissions, 3.5GHz, AirScale Micro RRH 4T/4R 20W, AZQC, , B48, 1C, 37dBm, 20MBW, TM3.1A, 3690 MHz.



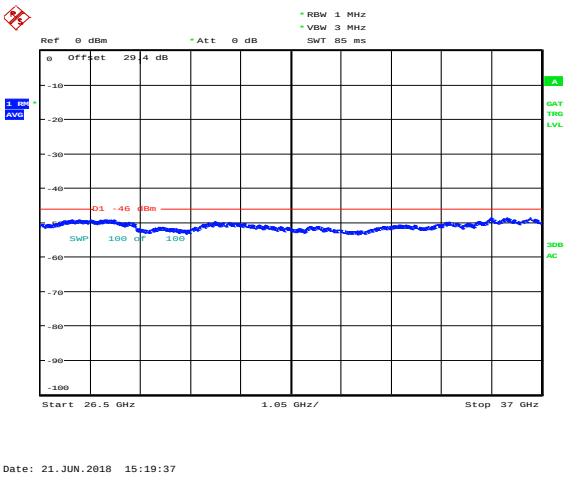

Keysight Spectrum Analyzer - Spurious Emissions
Center Freq 3.690000000 GHz
PASS
Center Freq: 3.690000000 GHz
Trig: External1
Avg|Hold: 25/25
#Atten: 0 dB
Ext Gain: -40.10 dB
Radio Std: None
Radio Device: BTS
IFGain:Low
10 dB/div
Ref 10.00 dBm
1.1270 GHz
-47.637 dBm
Start 1 GHz
Stop 3.53 GHz
Range Table
Range
Start Freq
1.000000000 GHz
Stop Freq
3.530000000 GHz
Res BW
1.0000 MHz
Auto
Man
Video BW
3.0000 MHz
Filter Type
Gaussian
More
1 of 3
Spur Range Frequency Amplitude Limit Δ Limit
1 1 1.127 GHz -47.64 dBm -46.00 dBm -1.637 dB


Keysight Spectrum Analyzer - Spurious Emissions
Center Freq 3.690000000 GHz
PASS
Center Freq: 3.690000000 GHz
Trig: External1
Avg|Hold: 25/25
#Atten: 0 dB
Ext Gain: -40.10 dB
Radio Std: None
Radio Device: BTS
IFGain:Low
10 dB/div
Ref 10.00 dBm
3.6623 GHz
-42.246 dBm
Start 3.53 GHz
Stop 3.665 GHz
Frequency
Center Freq
3.690000000 GHz
CF Step
5.000000 MHz
Auto
Man
Freq Offset
0 Hz
Spur Range Frequency Amplitude Limit Δ Limit
1 1 3.662 GHz -42.25 dBm -41.00 dBm -1.246 dB
2 1 3.663 GHz -42.26 dBm -41.00 dBm -1.256 dB
3 1 3.664 GHz -42.27 dBm -41.00 dBm -1.270 dB
4 1 3.659 GHz -42.56 dBm -41.00 dBm -1.557 dB
5 1 3.650 GHz -42.68 dBm -41.00 dBm -1.681 dB
6 1 3.657 GHz -42.74 dBm -41.00 dBm -1.738 dB
7 1 3.665 GHz -42.75 dBm -41.00 dBm -1.753 dB
File <Spurious_3530_to_3665.state> saved


Keysight Spectrum Analyzer - Spurious Emissions
Center Freq 3.690000000 GHz
PASS
Center Freq: 3.690000000 GHz
Trig: External1
Avg|Hold: 25/25
#Atten: 0 dB
Ext Gain: -41.70 dB
Radio Std: None
Radio Device: BTS
IFGain:Low
10 dB/div
Ref 10.00 dBm
4.8385 GHz
-46.537 dBm
Start 3.72 GHz
Stop 5 GHz
Frequency
Center Freq
3.690000000 GHz
CF Step
5.000000 MHz
Auto
Man
Freq Offset
0 Hz
Spur Range Frequency Amplitude Limit Δ Limit
File <Spurious_3720_to_5000.state> saved


Keysight Spectrum Analyzer - Spurious Emissions
Center Freq 3.690000000 GHz
PASS
Center Freq: 3.690000000 GHz
Trig: External1
Avg|Hold: 25/25
#Atten: 0 dB
Ext Gain: -26.70 dB
Radio Std: None
Radio Device: BTS
IFGain:Low
10 dB/div
Ref 0.00 dBm
Start 5 GHz
Stop 10 GHz
Range Table
Range
Start Freq
5.000000000 GHz
Stop Freq
10.000000000 GHz
Res BW
1.0000 MHz
Auto
Man
Video BW
3.0000 MHz
Auto
Man
Filter Type
Gaussian
More
1 of 3
Spur Range Frequency Amplitude Limit Δ Limit
1 1 7.378 GHz -57.02 dBm -46.00 dBm -11.02 dB


Keysight Spectrum Analyzer - Spurious Emissions
Center Freq 3.690000000 GHz
PASS
Center Freq: 3.690000000 GHz
Trig: External1
Avg|Hold: 25/25
#Atten: 0 dB
Ext Gain: -26.10 dB
Radio Std: None
Radio Device: BTS
IFGain:Low
10 dB/div
Ref 0.00 dBm
Start 10 GHz
Stop 26.5 GHz
Range Table
Range
Start Freq
10.000000000 GHz
Stop Freq
26.500000000 GHz
Res BW
1.0000 MHz
Auto
Man
Video BW
3.0000 MHz
Auto
Man
Filter Type
Gaussian
More
1 of 3
Spur Range Frequency Amplitude Limit Δ Limit
No Spurs have been found


RBW 1 MHz
VBW 3 MHz
Ref 0 dBm
Att 0 dB
SWT 85 ms
Offset 29.4 dB
D1 -46 dBm
SWP 100 OF 100
Start 26.5 GHz
1.05 GHz/
Stop 37 GHz
Date: 21.JUN.2018 15:19:37

4.5 Section 2.1053 MEASUREMENT REQUIRED: FIELD STRENGTH OF SPURIOUS RADIATION

The field strength measurements of radiated spurious emissions were made in a FCC registered 3-meter semi-anechoic chamber AR-6, (FCC Registration Number: 395774) **NVLAP** Lab Code: 100275-0 and IC (Filing Number: 6933F-5) which is maintained by Nokia Bell Labs in Murray Hill, New Jersey.

The **3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC)** (EUT) was configured with four transmit modules in semi-anechoic chamber AR-6 in the normal field installation. The recommendations of ANSI C63.4–2014 and C63.26-2015 were followed for EUT testing setup and cabling. The EUT was configured to operate per the E-UTRA test model specified in **3GPP TS 36.141 V14.1.0 (2016-09) Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (Release 14).** A depiction of the setup is in Figure 4.5

The base station was configured into the worst case transmit configuration to transmit four 4x MIMO 10 MHz LTE carrier with the total transmit power of 20W (5W per port/43.01 dBm). This configuration provides the highest Power Spectral Density transmit signal for the product. All transmit ports were terminated into non-radiating 50 Ω resistive loads. The product in the below configurations was evaluated over the 30 MHz to 40 GHz frequency range.

Table 4.5.1 EUT Configurations

Test Configuration	CBRS Frequency MHz	Active Ports	Signal Bandwidth, MHz	Modulation	Total Power, Watts	Radiated Emissions Pass / Fail
4c x 10M Non Continuous	3580, 3600, 3620 & 3640	Tx1, Tx2 Tx1, Tx2	10	256QAM	20	Pass

4.5.1 Spurious Radiation and Radiated Emissions Requirements.

This product meets Part 15, Part 90Z and Part 96 requirements. FCC Part 15 Class B require emissions to be below 54.5 dBuV/m at 3m. Part 96 does not contain any additional radiated requirements.

Title 47CFR section 90.1323 and 2.1053 contains the requirements for the levels of spurious radiation as a function of the EIRP of the unmodulated carrier. The reference level for the unmodulated carrier is calculated as the field produced by an isotropic radiator excited by the transmitter output power according to the following relation taken from Reference Data for Radio Engineers, page 27-7, 6th edition, IT&T Corp.

$$E = (120\pi P)^{1/2} = [(30*P)^{1/2}] / R$$

$$20 \log (E*10^6) - (43 + 10 \log P) = 102.23 \text{dB } \mu\text{V/meter}$$

Where: E = Field Intensity in Volts/ meter R = Distance in meters = 3 m
P = Transmitted Power, Watts = 20 W

The field strength of radiated spurious emissions measured was determined by

$$E(\text{dB}\mu\text{V/m}) = V_{meas}(\text{dB}\mu\text{V}) + \text{Cable Loss (dB)} + \text{Antenna Factor (dBi/m)}.$$

Field strength measurements of radiated spurious emissions were made in the 3m semi-anechoic chamber, AR-6 as detailed above. The recommendations of ANSI C63.4 and ANSI C63.26 were followed for EUT testing setup, cabling, and measurement approach and procedures. All the measurement equipment used, including antennas, was calibrated in accordance with ISO 9001 process. The EUT setup diagram is given in the Figure 4.5. The minimum margin to the Part 90.1323 limit as measured in accordance with 2.1053 is more than 20dB. Sample data plots are per Table 4.6.2.

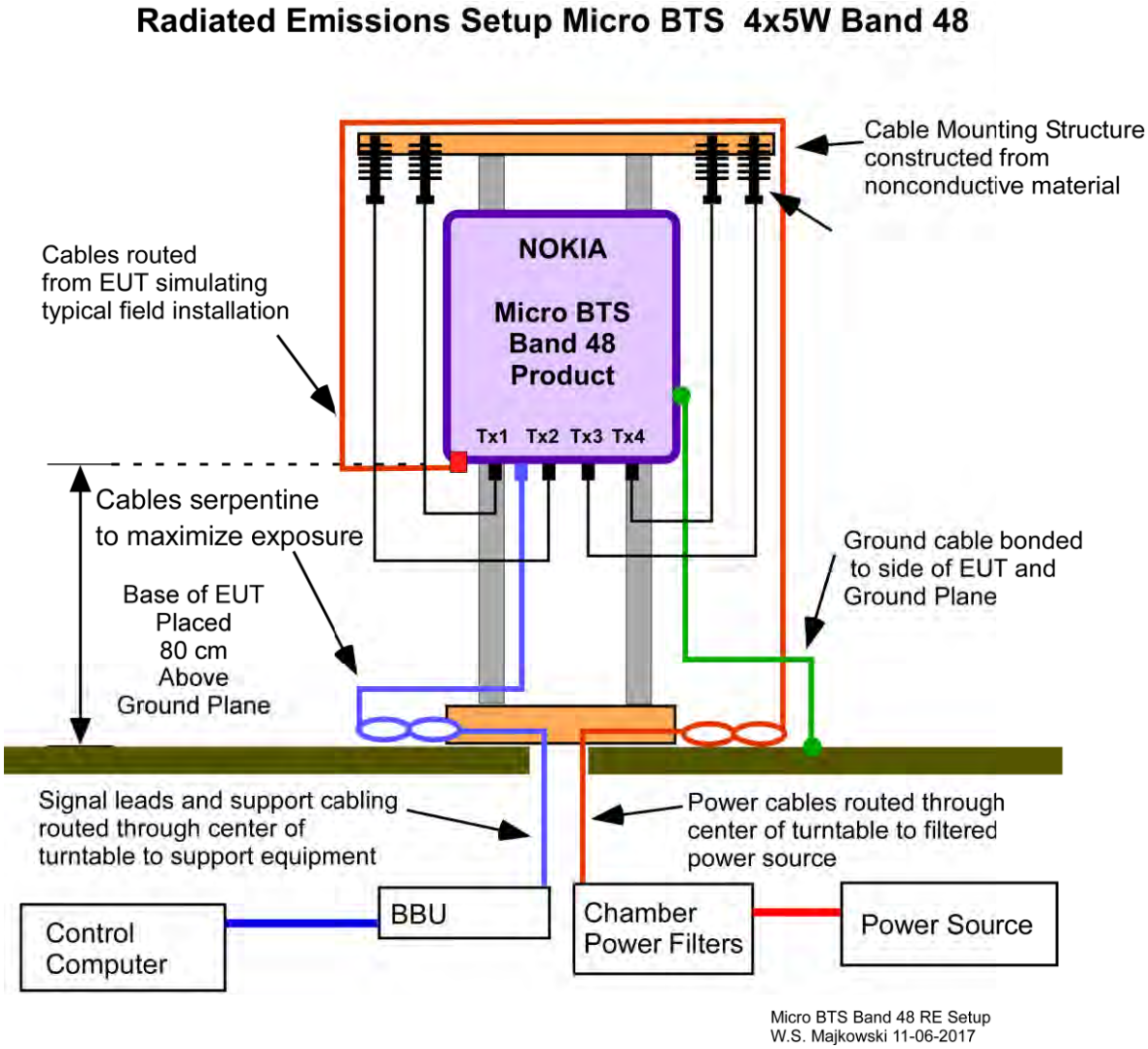
4.5.2 Field Strength of Spurious Radiation Results:

This product meets both Part 90Z and Part 96 Requirements. Part 96 does not have additional radiated Emissions limits beyond those of Part 90Z. For the Title 47CFR section 90.1323 and 2.1053 test, the field strength of any spurious radiation, measured at 3m, is required to be less than 102.23dBμV/meter. Emissions equal to or less than 82.23 dBμV/meter are not reportable and may be verified using field strength measurements with broadband antennas.

Over the out of band spectrum investigated from 10 MHz to beyond the tenth harmonic of the carrier (37GHz), no reportable spurious emissions were detected. Additionally, from 10 MHz to beyond the tenth harmonic of the carrier (37GHz), all non-transmit carrier emissions were below 54.5 dBV/m. This demonstrates that the **3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC)**, the subject of this application, complies with FCC Part 15 Class B, and FCC Sections 2.1053, 90.1323 and 2.1057 of the Rules.

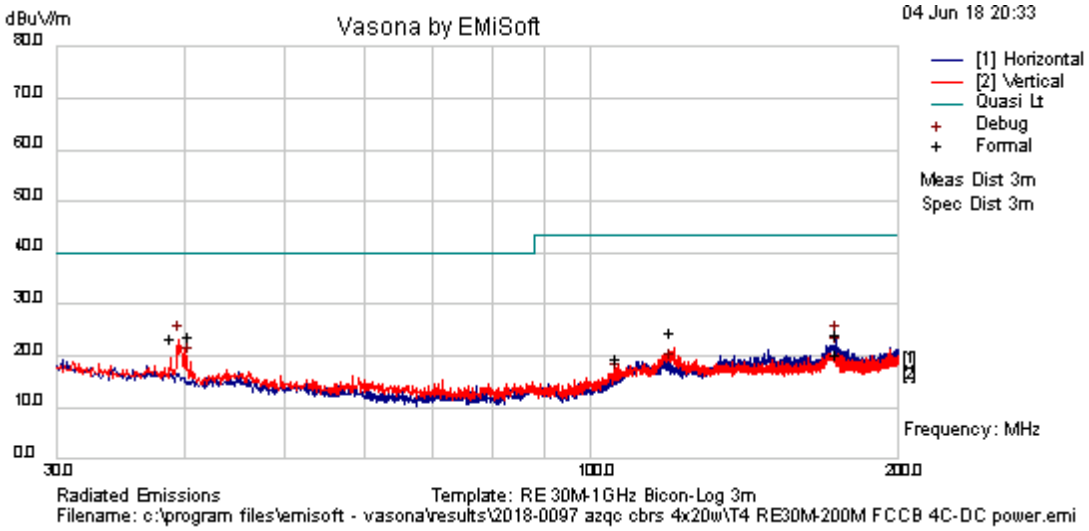
Photographs of the measurement setup are in the filing exhibits.

Figure 4.5 Radiated Emissions Product Setup



4.5.3 Transmitter Measurements of Radiated Spurious Emissions

T4 RE 30M-200MHz 4C FCC B DC Powered



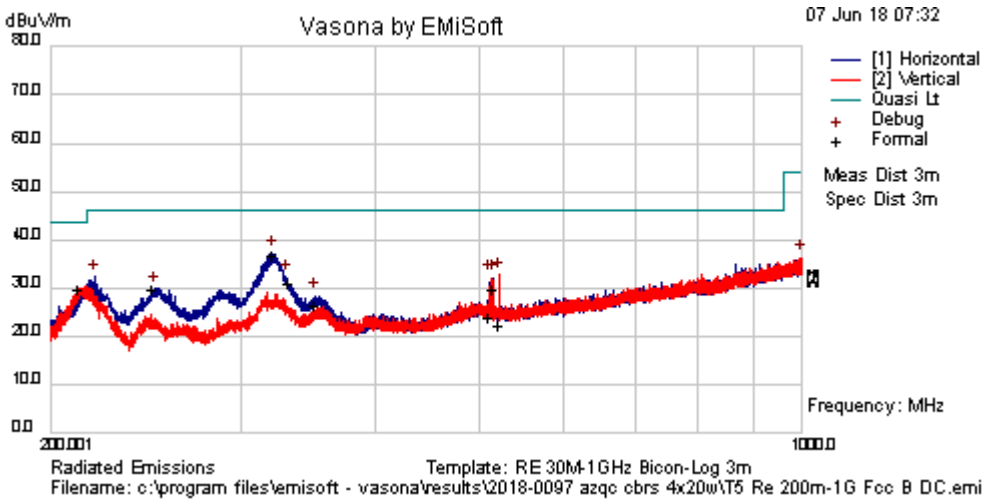
Results Title:	RE 30M-1GHz Bicon-Log 3m
File Name:	c:\program files\emisoft - vasona\results\2018-0097 azqc cbrs 4x20w\T4 RE30M-200M FCCB 4C-DC power.emi
Test Laboratory:	GPCL AR6MH 22C,38%RH, 1006mB
Test Engineer:	MJS
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	AZQC CBRS 4X5W, Powered by -48VDC / 4c - 10 MHz Non-Contiguous & Non-Adjacent, Fc = 3580M, 3600M, 3620M & 3640M with modulation @ 256 QAM.
Configuration:	Radiated Emissions 30 MHz - 200 MHz, FCC Part 15 B Class B, RCVR E908, Preamp E507, 6dB pad - E1131, Bicon Antenna E051, 3M Distance offset, ESI- detector; Preview BW (default RBW/ default VBW); Formal BW (Default RBW).
Date:	2018-06-04 20:33:53

FORMAL DATA												
Freq. (MHz)	**Raw (dBuV)**	**Cable (dB)**	**Factor (dB)**	**Level (dBuV/m)**	**Emission Type**	**Pol (H/V)**	**Ht (cm)**	**Az (deg)**	**Limit (dBuV/m)**	**Margin (dB)**	**Pass /Fail**	**Comments**
40.485	33.59	6.81	-19.8	20.6	Quasi Max	V	115	138	40	-19.4	Pass	
38.784	32.93	6.81	-19.5	20.21	Quasi Max	V	105	349	40	-19.79	Pass	
120.174	34.26	7.54	-20.3	21.46	Quasi Max	V	132	344	43.5	-22.04	Pass	
174.365	32.93	7.8	-19.7	21.08	Quasi Max	H	170	0	43.5	-22.42	Pass	
174.796	28.84	7.81	-19.6	17	Quasi Max	V	141	54	43.5	-26.5	Pass	
106.434	31	7.45	-22	16.47	Quasi Max	V	102	336	43.5	-27.03	Pass	

PREVIEW DATA												
Freq. (MHz)	**Raw (dBuV)**	**Cable (dB)**	**Factor (dB)**	**Level (dBuV/m)**	**Emission Type**	**Pol (H/V)**	**Ht (cm)**	**Az (deg)**	**Limit (dBuV/m)**	**Margin (dB)**	**Pass /Fail**	**Comments**
39.523	36.02	6.81	-19.7	23.19	Preview	V	105	180	40	-16.81	Pass	
174.365	34.92	7.8	-19.7	23.06	Preview	H	105	225	43.5	-20.44	Pass	
40.485	31.78	6.81	-19.8	18.79	Preview	V	105	135	40	-21.21	Pass	
174.796	32.32	7.81	-19.6	20.49	Debug	V	109	315	43.5	-23.01	Pass	
120.174	30.16	7.54	-20.3	17.36	Debug	V	109	315	43.5	-26.14	Pass	
106.434	29.99	7.45	-22	15.46	Debug	V	109	315	43.5	-28.04	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T5 FCC Part 15 Class B 200 MHz – 1GHz



Results Title:	RE 30M-1GHz Bicon-Log 3m
File Name:	c:\program files\emisoft - vasona\results\2018-0097 azqc cbrs 4x20w\T5 Re 200m-1G Fcc B DC.emi
Test Laboratory:	GPCL AR6MH 22C,40%RH, 1006mB
Test Engineer:	EEM
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	AZQC CBRS 4X5W, Powered by -48VDC / 4c - 10 MHz Non-Contiguous & Non-Adjacent, Fc = 3580M, 3600M, 3620M & 3640M with modulation @ 256 QAM.
Configuration:	Radiated Emissions 200 MHz - 1000 MHz, FCC Part 15 B Class B, RCVR E908, Preamp E507, 6dB pad - E1131, Log Periodic Antenna E060, 3M Distance offset, ESI- detector; Preview BW (100 kHz RBW/ 300 KHz VBW); Formal BW (Default RBW).
Date:	2018-06-07 07:32:01

FORMAL DATA

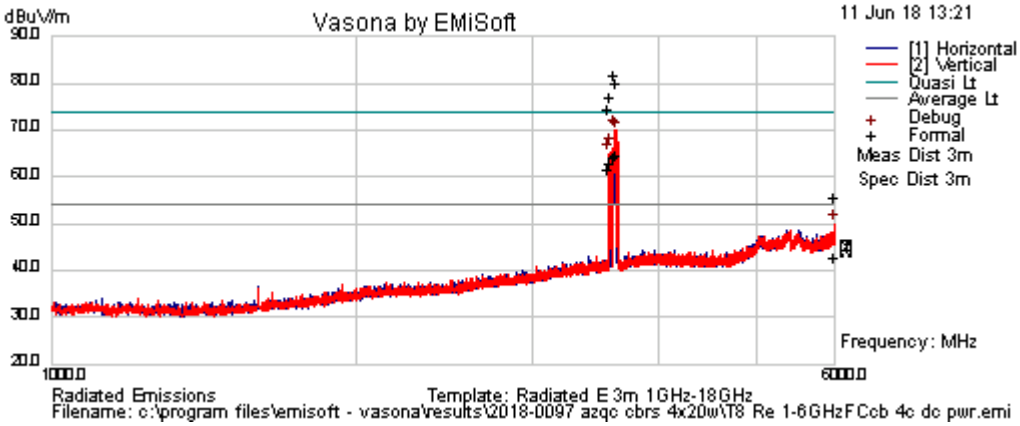
Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht cm	Az deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
322.275	43.07	8.29	-17.4	34.02	Quasi Max	H	100	58	46	-11.98	Pass	
212.409	39.19	7.95	-20.3	26.82	Quasi Max	H	142	275	43.5	-16.68	Pass	
332.673	37.02	8.33	-17.1	28.25	Quasi Max	H	104	68	46	-17.75	Pass	
249.242	37.84	8.06	-19.2	26.74	Quasi Max	H	100	105	46	-19.26	Pass	
515.052	30.8	8.93	-13.1	26.66	Quasi Max	H	299	178	46	-19.34	Pass	
352.768	31.97	8.41	-16.7	23.7	Quasi Max	H	321	63	46	-22.3	Pass	
512.381	25.1	8.92	-13	21.04	Quasi Max	V	229	30	46	-24.96	Pass	
523.082	23.62	8.96	-13.3	19.3	Quasi Max	V	170	340	46	-26.7	Pass	

PREVIEW DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm	Az. deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
322.329	46.2	8.29	-17.3	37.14	Preview	H	105	45	46	-8.86	Pass	
523.082	37.02	8.96	-13.3	32.7	Preview	V	105	45	46	-13.3	Pass	
219.575	44.78	7.97	-20.3	32.43	Preview	H	105	90	46	-13.57	Pass	
512.79	36.27	8.92	-13	32.19	Preview	V	305	315	46	-13.81	Pass	
331.659	40.94	8.33	-17.1	32.15	Preview	H	105	45	46	-13.85	Pass	
515.098	36.18	8.93	-13.1	32.05	Preview	H	390	0	46	-13.95	Pass	
250.281	40.95	8.06	-19.1	29.91	Preview	H	190	90	46	-16.09	Pass	
351.956	36.59	8.41	-16.7	28.31	Preview	H	290	90	46	-17.69	Pass	
997.836	31.67	10.27	-5.66	36.28	Preview	V	305	225	54	-17.72	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

FCC Part 15B Class B: RE 1 GHz – 6GHz (4 Carrier Configuration)



Results Title:	Radiated E 3m 1GHz-18GHz
File Name:	c:\program files\emisoft - vasona\results\2018-0097 azqc cbrs 4x20w\T8 Re 1-6GHzFCcb 4c dc pwr.emi
Test Laboratory:	GPCL AR6MH 22C,40%RH, 1006mB
Test Engineer:	EEM
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	AZQC CBRS 4X5W, Powered by -48VDC / 4c - 10 MHz Non-Contiguous & Non-Adjacent, Fc = 3580M, 3600M, 3620M & 3640M with modulation @ 256 QAM.
Configuration:	Radiated Emissions 1 GHz - 6 GHz, FCC Part 15 B Class B, RCVR E908, Preamp E1166, 6dB pad - E1131, Horn Antenna E393, 3M Distance offset, ESI- detector; Preview BW (100 kHz RBW/ 3000 KHz VBW); Formal BW (1MHz RBW).
Date:	2018-06-11 13:21:27

FORMAL DATA

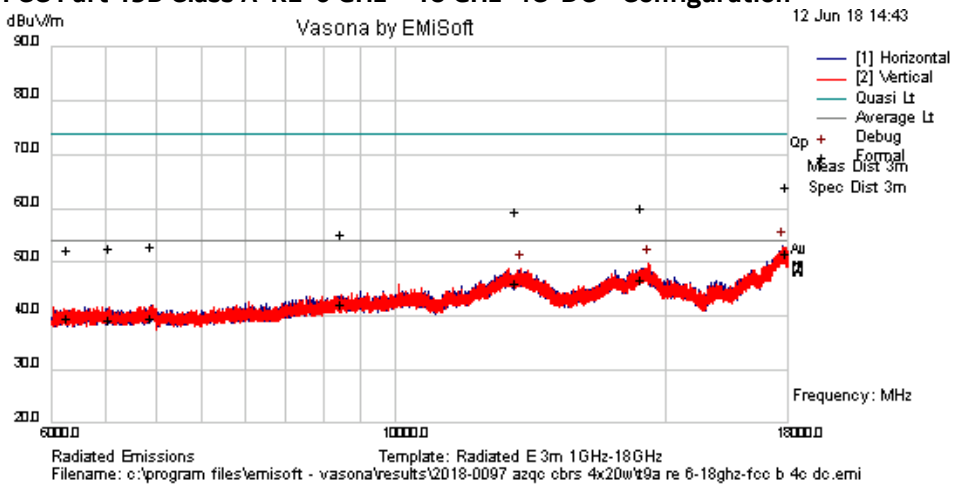
Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm.	Az. deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
3641.11	55.88	12.77	-6.17	62.49	AvgMax	V	103	360	54	8.49	Fail	TX Carrier
3624.78	55.77	12.74	-6.22	62.29	AvgMax	V	103	360	54	8.29	Fail	TX Carrier
3597.71	54.23	12.68	-6.31	60.61	Average	V	107	172	54	6.61	Fail	TX Carrier
3576.01	53.37	12.63	-6.37	59.62	AvgMax	V	117	0	54	5.62	Fail	TX Carrier
3624.78	73.02	12.74	-6.22	79.53	Peak	V	103	360	74	5.53	Fail	TX Carrier
3641.11	71.23	12.77	-6.17	77.83	Peak	V	103	360	74	3.83	Fail	TX Carrier
3597.71	68.5	12.68	-6.31	74.88	Peak	V	107	172	74	0.88	Fail	TX Carrier
3576.01	66.06	12.63	-6.37	72.32	Peak	V	117	0	74	-1.68	Pass	TX Carrier
5989.5	29.34	14.53	-3.2	40.67	AvgMax	V	171	167	54	-13.33	Pass	
5989.5	42.22	14.53	-3.2	53.54	Peak	V	171	167	74	-20.46	Pass	

PREVIEW DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol H/V	Ht. cm.	Az. deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
3625.04	63.69	12.74	-6.22	70.21	Preview	V	105	0	54	16.21	Fail	
3641.11	63.3	12.77	-6.17	69.91	Preview	V	105	0	54	15.91	Fail	
3597.71	59.8	12.68	-6.31	66.17	Preview	V	105	0	54	12.17	Fail	
3576.01	58.62	12.63	-6.37	64.88	Preview	V	105	180	54	10.88	Fail	
5989.5	38.71	14.53	-3.2	50.04	Preview	V	390	315	54	-3.96	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

FCC Part 15B Class A RE 6 GHz – 18 GHz 4C DC - Configuration



Results Title:	Radiated E 3m 1GHz-18GHz
File Name:	c:\program files\emisoft - vasona\results\2018-0097 azqc cbrs 4x20w\T9B RE 6-18GHz-FCc B 4c dc.emi
Test Laboratory:	GPCL AR6MH 22C,40%RH, 1006mB
Test Engineer:	MJS / JY
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	AZQC CBRS 4X5W, Powered by -48VDC / 4c - 10 MHz Non-Contiguous & Non-Adjacent, Fc = 3580M, 3600M, 3620M & 3640M with modulation @ 256 QAM.
Configuration:	Radiated Emissions 6 GHz - 18 GHz, FCC Part 15 B Class B, RCVR E908, Preamp E1166, HPF pad - E1235, Horn Antenna E393, 3M Distance offset, ESI- detector; Preview BW (100 kHz RBW/ 3000 KHz VBW); Formal BW (1MHz RBW).
Date:	2018-06-14 10:28:28

FORMAL DATA

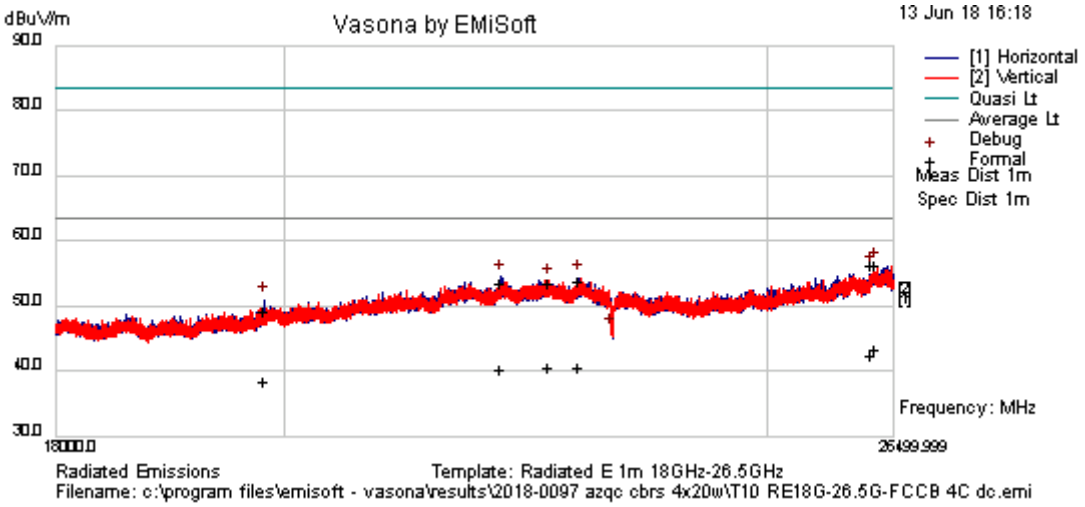
Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol. H/V	Ht. cm.	Az. deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
17936.6	26.78	12.44	9.64	48.86	AvgMax	H	145	47	54	-5.14	Pass	Noise Floor
14458.8	25.87	11.71	6.27	43.85	AvgMax	V	291	248	54	-10.15	Pass	
12000.9	26.65	15.51	1.05	43.2	AvgMax	V	307	107	54	-10.8	Pass	
17936.6	38.98	12.44	9.64	61.06	Peak	H	145	47	74	-12.94	Pass	Noise Floor
9239.74	28.89	10.74	-0.38	39.25	AvgMax	V	117	197	54	-14.75	Pass	
14458.8	39.12	11.71	6.27	57.09	Peak	V	291	248	74	-16.91	Pass	
6964.61	29.04	9.99	-2.42	36.62	AvgMax	H	208	250	54	-17.38	Pass	
6146.78	28.94	10.79	-3.19	36.55	AvgMax	V	287	250	54	-17.45	Pass	
12000.9	39.94	15.51	1.05	56.5	Peak	V	307	107	74	-17.5	Pass	Noise Floor
6540.41	29.15	10.4	-3.1	36.44	AvgMax	V	393	143	54	-17.56	Pass	Noise Floor
9239.74	42.09	10.74	-0.38	52.46	Peak	V	117	197	74	-21.54	Pass	Noise Floor
6964.61	42.35	9.99	-2.42	49.92	Peak	H	208	250	74	-24.08	Pass	Noise Floor
6540.41	42.48	10.4	-3.1	49.77	Peak	V	393	143	74	-24.23	Pass	Noise Floor
6146.78	41.71	10.79	-3.19	49.31	Peak	V	287	250	74	-24.69	Pass	Noise Floor

PREVIEW DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol. H/V	Ht. cm.	Az. deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
17936.6	34.11	12.44	9.64	56.2	Preview	H	390	180	54	2.2	Fail	
14458.8	35.41	11.71	6.27	53.38	Preview	V	390	225	54	-0.62	Pass	
17858.6	31.24	12.5	9.15	52.9	Preview	H	105	45	54	-1.1	Pass	
14606.6	32.21	11.72	5.81	49.74	Preview	V	205	270	54	-4.26	Pass	
12000.9	33.17	15.51	1.05	49.73	Debug	V	100	316	54	-4.27	Pass	
12074	32.62	15.15	1.09	48.86	Preview	H	205	0	54	-5.14	Pass	
6964.61	40.47	9.99	-2.42	48.05	Preview	H	205	180	54	-5.95	Pass	
9239.74	36.07	10.74	-0.38	46.44	Debug	V	100	316	54	-7.56	Pass	
6540.41	38.15	10.4	-3.1	45.45	Debug	V	100	316	54	-8.55	Pass	
6146.78	37.53	10.79	-3.19	45.14	Debug	V	100	316	54	-8.86	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

T10 RE 18G-26.5 GHz FCC B 4C 10M BW 256QAM dc



Results Title:	Radiated E 1m 18GHz-26.5GHz
File Name:	c:\program files\emisoft - vasona\results\2018-0097 azqc cbrs 4x20w\T10 RE18G-26.5G-FCCB 4C dc.emi
Test Laboratory:	GPCL AR6MH 22C,40%RH, 1006mB
Test Engineer:	JY
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	AZQC CBRS 4X5W, Powered by -48VDC / 4c - 10 MHz Non-Contiguous & Non-Adjacent, Fc = 3580M, 3600M, 3620M & 3640M with modulation @ 256 QAM.
Configuration:	Radiated Emissions 18 GHz - 26.5 GHz, FCC Part 15 B Class B, RCVR E908, Preamp E1166, HPF pad - E1213, Horn Antenna E513, 1M Distance offset, ESI- detector; Preview BW (100 kHz RBW/ 3000 KHz VBW); Formal BW (1MHz RBW).
Date:	2018-06-13 16:18:38

FORMAL DATA

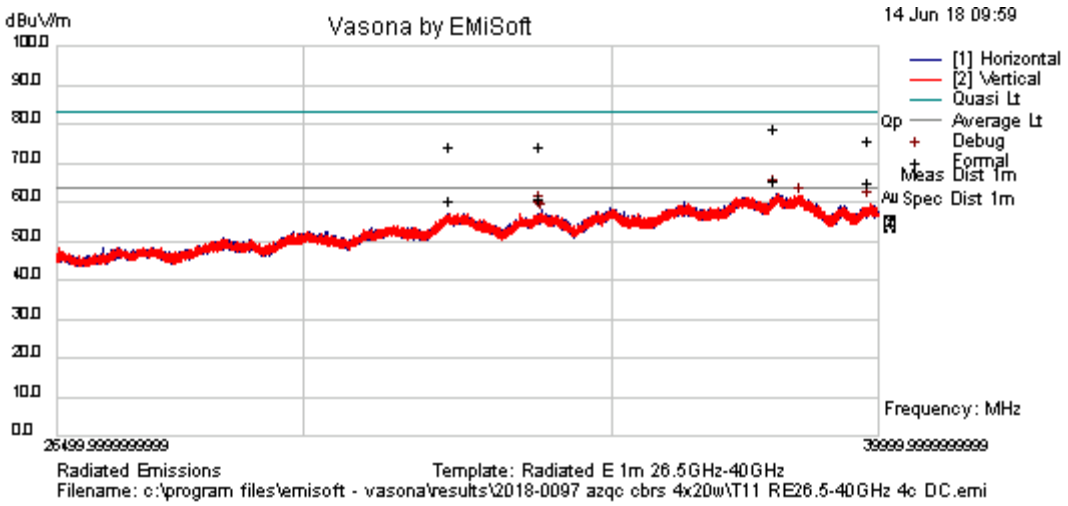
Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol. H/V	Ht. cm.	Az. deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
26308.4	19.4	11.12	10.62	41.13	Average	V	167	81	63.5	-22.37	Pass	
26252.9	18.59	11.1	10.46	40.15	Average	V	100	156	63.5	-23.35	Pass	
22610.4	20	10.13	8.2	38.33	Average	V	159	38	63.5	-25.17	Pass	
22930.2	19.85	10.27	8.09	38.22	Average	H	161	116	63.5	-25.28	Pass	
22116	20	9.9	8.08	37.98	Average	H	142	129	63.5	-25.52	Pass	
19821.3	19.08	9.24	7.89	36.21	Average	H	181	103	63.5	-27.29	Pass	
26252.9	32.54	11.1	10.46	54.1	Peak	V	100	156	83.5	-29.4	Pass	
26308.4	32.28	11.12	10.62	54.02	Peak	V	167	81	83.5	-29.48	Pass	
22930.2	33.21	10.27	8.09	51.57	Peak	H	161	116	83.5	-31.93	Pass	
22116	33.21	9.9	8.08	51.19	Peak	H	142	129	83.5	-32.31	Pass	
22610.4	32.8	10.13	8.2	51.13	Peak	V	159	38	83.5	-32.37	Pass	
19821.3	29.92	9.24	7.89	47.04	Peak	H	181	103	83.5	-36.46	Pass	

PREVIEW DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol. H/V	Ht. cm.	Az. deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
26308.4	34.36	11.12	10.62	56.09	Debug	V	100	354	63.5	-7.41	Pass	
26252.9	34.1	11.1	10.46	55.66	Debug	V	100	354	63.5	-7.84	Pass	
22116	36.36	9.9	8.08	54.34	Debug	H	100	354	63.5	-9.16	Pass	
22930.2	35.85	10.27	8.09	54.21	Debug	H	100	354	63.5	-9.29	Pass	
22610.4	35.53	10.13	8.2	53.86	Debug	V	100	354	63.5	-9.64	Pass	
19821.3	33.8	9.24	7.89	50.93	Debug	H	100	354	63.5	-12.57	Pass	
23277.9	27.55	10.34	8.03	45.93	Debug	H	181	103	63.5	-17.57	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

FCC Part 15B Class B - 26.5GHz – 40 GHz [4C DC-Configuration]



Results Title:	Radiated E 1m 26.5GHz-40GHz
File Name:	c:\program files\emisoft - vasona\results\2018-0097 azqc cbrs 4x20w\T11 RE26.5-40GHz 4c DC.emi
Test Laboratory:	GPCL AR6MH 22C,40%RH, 1006mB
Test Engineer:	MJS / JY
Test Software:	Vasona by EMISoft, version 2.161
Equipment:	Nokia
EUT Details:	AZQC CBRS 4X5W, Powered by -48VDC / 4c - 10 MHz Non-Contiguous & Non-Adjacent, Fc = 3580M, 3600M, 3620M & 3640M with modulation @ 256 QAM.
Configuration:	Radiated Emissions 26.5 GHz - 40 GHz, FCC Part 15 B Class B, RCVR E908, Antenna E526, 1M Distance offset, ESI-1G detector; Preview BW (30 kHz RBW/ 3000 KHz VBW); Formal BW (1MHz RBW).
Date:	2018-06-14 09:59:23

FORMAL DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol. H/V	Ht. cm.	Az. deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
38014.4	33.92	0	28.09	62	AvgMax	H	113	151	63.5	-1.5	Pass	Noise Floor
39852.8	33.06	0	28.12	61.18	AvgMax	V	101	156	63.5	-2.32	Pass	Noise Floor
33789.9	32.8	0	24.36	57.16	AvgMax	H	202	325	63.5	-6.34	Pass	Noise Floor
32283.7	33	0	23.98	56.98	AvgMax	V	182	43	63.5	-6.52	Pass	Noise Floor
38014.4	47.37	0	28.09	75.46	Peak	H	113	151	83.5	-8.04	Pass	Noise Floor
39852.8	44.04	0	28.12	72.16	Peak	V	101	156	83.5	-11.34	Pass	Noise Floor
33789.9	46.35	0	24.36	70.71	Peak	H	202	325	83.5	-12.79	Pass	Noise Floor
32283.7	46.61	0	23.98	70.59	Peak	V	182	43	83.5	-12.91	Pass	Noise Floor

PREVIEW DATA

Freq. MHz	Raw dBuV	Cable dB	Factor dB	Level dBuV/m	Emission Type	Pol. H/V	Ht. cm.	Az. deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
38014.4	34.19	0	28.09	62.28	Preview	H	140	154	63.5	-1.22	Pass	
39852.8	31.37	0	28.12	59.48	Preview	V	105	198	63.5	-4.02	Pass	
33789.9	33.78	0	24.36	58.14	Preview	H	200	0	63.5	-5.36	Pass	
32283.7	32.99	0	23.98	56.97	Preview	V	125	330	63.5	-6.53	Pass	
33835.5	31.74	0	24.39	56.13	Debug	H	100	354	63.5	-7.37	Pass	
33799.6	32.17	0	24.37	56.54	Debug	H	100	354	63.5	-6.96	Pass	
38513.2	32.75	0	27.59	60.34	Debug	H	100	354	63.5	-3.16	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

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4.6 Section 2.1055 MEASUREMENT REQUIRED: FREQUENCY STABILITY

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

4.6.1 Frequency Stability Test Article and Configuration

The unit under test is identified as follows:
Nokia AZQC AirScale Micro RRH: PN: 474156A.101, S/N: 1M181624805.

4.6.2 Frequency Stability Test

Frequency Stability Testing was completed on AZQC AirScale Micro RRH with CF 3675MHz. The testing was performed from 06/27/2018 through 06/29/2018 on the AZQC, which was located in the T-11 Thermal chamber of the GPCL test facility located in Building 4, Room 4-280, Murray Hill, NJ, and witnessed by Joe Bordonaro from GPCL. The temperatures to which the UUT were subjected to comprised high temperature (+50ºC, system ambient) and low temperature (-30ºC system ambient). The system level Frequency Stability testing of the UUT yielded results in compliance with established design criteria.
Frequency Stability performance was verified by measuring Frequency Tolerance at the Equipment Antenna Connection using an MXA Signal Analyzer. Frequency Tolerance is a measurement of the difference between the actual transmit frequency and the assigned frequency (3675MHz).

UUT: AZQC AirScale Micro RRH: PN: 474156A.101, SN: 1M181624805.

4.6.3 Frequency Stability Test Equipment

Instrument Type	Serial Number	Vendor	Cal Due Date
MXA Signal Analyzer	MY49060086	AGILENT N9020A	12/07/2018
Power Meter	MY40511034	AGILENT E4419B	01/10/2020
Power Sensor	MY52280001	AGILENT E9301A	02/08/2019
Multimeter	JP35001820	HP 971A	06/08/2019
Thermal Logger	12W942552	YOKOGAWA MV2000	06/02/2019
GPS Receiver	KR93200773	SYMMETRICOM 58503B	No Cal Req.
Power supply	04243	BEHLMAN AC Source Model BL1350	No Cal Req.

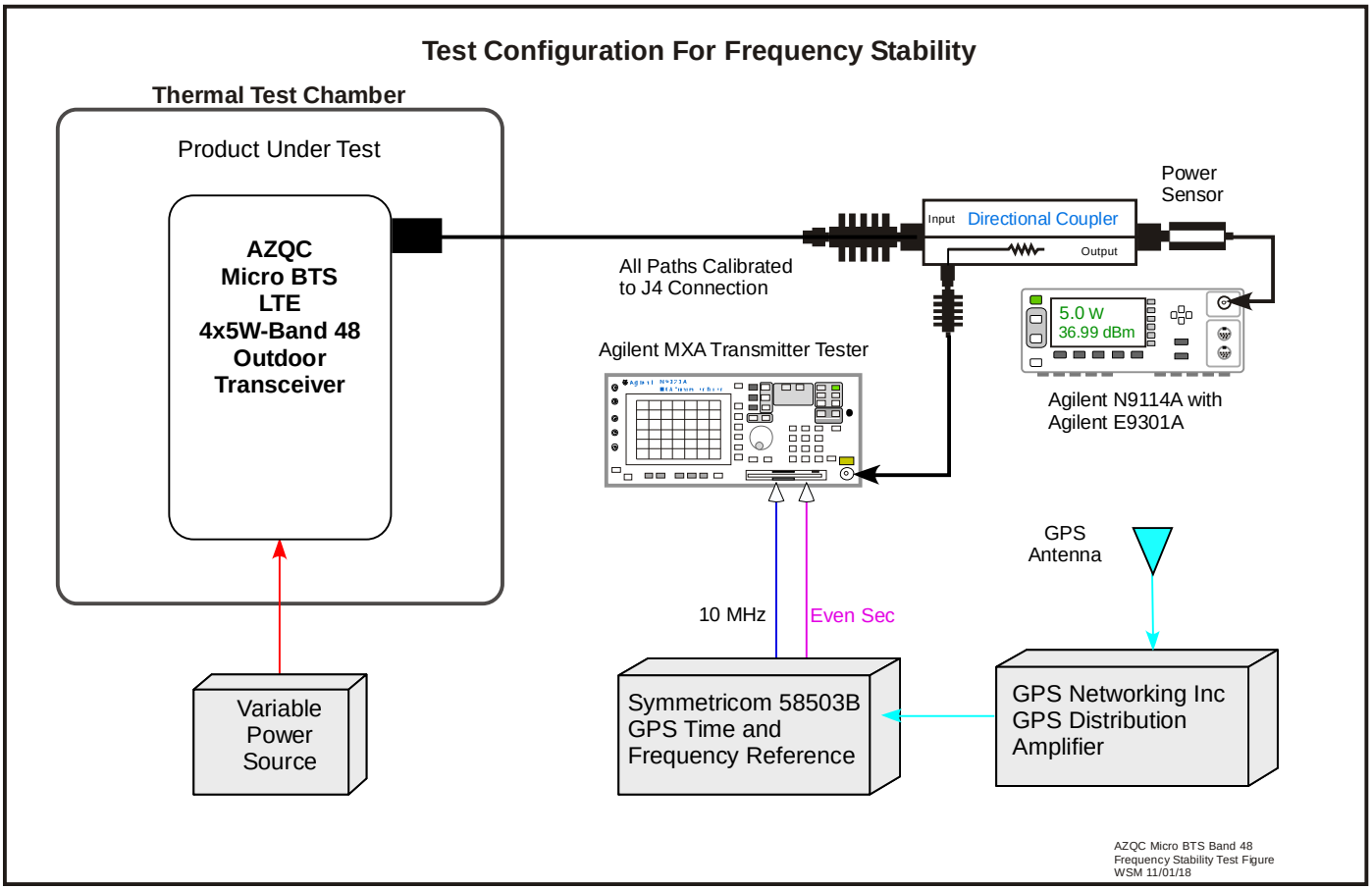
4.6.4 Frequency Stability Test process

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.

4.6.5 Frequency Stability Results:

The worst case Frequency Stability over temperature and voltage was **4.931 Hz which is -0.0013 ppm.** This is within the +/- 0.05ppm desired performance required for LTE operation.

FIGURE 4.6.2: Frequency Stability Test Set-Up



4.6.6 Frequency Stability Test Photos

Photographs of the Frequency Stability test setups are in section 4.8 below.

4.6.7 Frequency Stability Data:

Frequency Block Tested: *AZQC AirScale Micro RRH (CF = 3675MHz)*

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, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	1.071
0.5	3.466
1.0	0.952
1.5	2.864
2.0	1.022
2.5	0.342
3.0	3.776
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +50°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	4.648
0.5	1.421
1.0	3.933
1.5	1.069
2.0	2.887
2.5	1.134
3.0	0.746
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +40°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	2.347
0.5	3.829
1.0	1.206
1.5	1.012
2.0	3.688
2.5	2.863
3.0	4.931
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +30°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**3.616**
0.5	**2.921**
1.0	**1.013**
1.5	**3.788**
2.0	**2.946**
2.5	**1.002**
3.0	**1.117**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +20°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**3.862**
0.5	**1.031**
1.0	**2.958**
1.5	**4.720**
2.0	**3.816**
2.5	**1.001**
3.0	**2.053**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +10°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	**3.943**
0.5	**1.076**
1.0	**2.624**
1.5	**3.907**
2.0	**1.069**
2.5	**2.961**
3.0	**1.117**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at 0°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**3.797**
0.5	**2.876**
1.0	**1.032**
1.5	**3.951**
2.0	**1.005**
2.5	**2.850**
3.0	**1.103**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at -10°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**1.002**
0.5	**3.857**
1.0	**2.503**
1.5	**0.926**
2.0	**2.419**
2.5	**3.705**
3.0	**1.041**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at -20°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**3.662**
0.5	**1.027**
1.0	**2.904**
1.5	**3.138**
2.0	**1.317**
2.5	**0.909**
3.0	**1.057**
FCC SPECIFICATION	**±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at -30°C at 100% of Nominal Voltage, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**3.836**
0.5	**1.012**
1.0	**2.953**
1.5	**1.798**
2.0	**1.946**
2.5	**2.079**
3.0	**1.704**
FCC SPECIFICATION	**±3675MHz (±0.05ppm), ±0.05ppm = ±183.75Hz**
FCC 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, 120VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**3.887**
0.5	**1.925**
1.0	**2.011**
1.5	**1.982**
2.0	**2.786**
2.5	**1.021**
3.0	**0.879**
FCC SPECIFICATION	**±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at +15% of Nominal Voltage, 138.0VAC	
Time (minutes)	**Transmit Carrier Deviation (Hz)**
0	**2.905**
0.5	**3.730**
1.0	**1.884**
1.5	**2.926**
2.0	**1.073**
2.5	**3.007**
3.0	**0.785**
FCC SPECIFICATION	**±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz**
FCC RESULT	**PASS**

Transmit Frequency Deviation at +25°C at +12% of Nominal Voltage, 134.40VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	2.841
0.5	3.096
1.0	1.835
1.5	2.740
2.0	2.939
2.5	1.814
3.0	1.791
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at +9% of Nominal Voltage, 130.80VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	2.915
0.5	3.508
1.0	1.788
1.5	3.007
2.0	2.829
2.5	1.954
3.0	0.803
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at +6% of Nominal Voltage, 127.20VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	3.019
0.5	2.825
1.0	2.807
1.5	1.650
2.0	0.946
2.5	2.724
3.0	1.996
FCC SPECIFICATION	±3675MHz (±0.05ppm) ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at +3% of Nominal Voltage, 123.60VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	2.642
0.5	1.905
1.0	2.837
1.5	3.053
2.0	2.886
2.5	2.621
3.0	1.947
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -3% of Nominal Voltage, 116.40VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	2.828
0.5	1.771
1.0	0.916
1.5	2.547
2.0	0.710
2.5	3.063
3.0	2.892
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -6% of Nominal Voltage, 112.80VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	2.890
0.5	0.917
1.0	3.003
1.5	2.722
2.0	3.883
2.5	1.957
3.0	0.705
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -9% of Nominal Voltage, 109.20VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	2.989
0.5	3.725
1.0	1.996
1.5	2.642
2.0	3.101
2.5	2.882
3.0	0.961
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -12% of Nominal Voltage, 105.60VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	3.072
0.5	2.610
1.0	1.861
1.5	1.917
2.0	1.769
2.5	1.607
3.0	0.918
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

Transmit Frequency Deviation at +25°C at -15% of Nominal Voltage, 102.0VAC	
Time (minutes)	Transmit Carrier Deviation (Hz)
0	2.735
0.5	1.977
1.0	3.021
1.5	2.684
2.0	2.927
2.5	1.726
3.0	2.811
FCC SPECIFICATION	±3675MHz (±0.05ppm); ±0.05ppm = ±183.75Hz
FCC RESULT	PASS

4.7 List of Test Equipment

4.7.1 List of Radiated Emissions Test Equipment

The following equipment was used for the measurement of Radiated Emissions.

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due	Calibration Type	Status
E1105	EMC Test Systems	Multi-Device Controller	Multi-Device Controller	2090	1600	N/A	N/A	Calibration Not Required	Active
E051	EMCO	Biconical Antenna	Biconical Antenna 20 MHz - 300 MHz	3109	2187	2016-12-01	2018-12-01	Requires Calibration	Active
E060	EMCO	Log Periodic Antenna	Log periodic antenna 300 MHz to 1 GHz	3146	1458	2016-12-06	2018-12-06	Requires Calibration	Active
E1321	Extech	Data Logger	Barometric Pressure/Humidity/Temperature Datalogger	SD700	A075782				Active
E507	Sonoma Instrument Co.	Amplifier	Broadband Amplifier 9KHz-1GHz	310	185794	2016-06-15	2018-06-15	Requires Calibration	Active
E1132	Weinschel	Attenuator	Fixed Coaxial Attenuator 6dB	2-6	CD2534	2017-05-23	2019-05-23	Requires Calibration	Active
E526	A.H. Systems Inc.	Horn Antenna	Ridged Horn 26.5 GHz - 40 GHz	SAS-200/573	137	2017-10-04	2019-10-04	Requires Calibration	Active
E1166	Agilent Technologies	Amplifier	Pre-Amplifier 1-26.5GHz	8449B	3008A01740	2016-02-25	2018-05-25	Requires Calibration	Active
E513	EMC Test Systems	Horn Antenna	Double Ridged Horn 18-40 GHz	3116	2539	2017-06-16	2019-06-16	Requires Calibration	Active
E393	EMCO	Horn Antenna	Double Ridged Horn 1-18 Ghz	3115	9903-5769	2017-06-05	2019-06-05	Requires Calibration	Active
E1213	RLC Electronics Inc	High Pass Filter	5-40GHz Filter	F-19414	1444001			Calibration Not Required, Must Be Verified	Active
E908	Rohde & Schwarz	Test Receiver	EMI (20Hz to 40 GHz) -150 +30dBM	ESIB40	100100	2018-03-12	2020-03-12	Requires Calibration	Active

4.7.2 List of Antenna Port Test Equipment

The following equipment was used for conducted measurement performed at the products antenna ports.

Asset ID	Manufacturer	Type	Description	Model	Serial	Calibration Date	Calibration Due	Calibration Type	Status
E1213	RLC Electronics Inc	High Pass Filter	5-40GHz Filter	F-19414	1444001			Calibration Not Required, Must Be Verified	Active
E954	Rohde & Schwarz	Test Receiver	EMI 20Hz - 40GHz -155 dBm +30 dBm	ESU40	100246	2016-12-05	2018-12-05	Requires Calibration	Active
E851	TUV SUD BABT	Monitor	ESD Wrist Strap	725	739271	2013-03-23	2014-03-23	Field Calibration Verification	Out of Service
E1155	Weinschel	Attenuator	10dB 25Watt 0.05GHz - 26GHz	74-10-12	1068			Calibration Not Required, Must Be Verified	Active
E1154	Weinschel	Attenuator	30dB 25W 0.05GHz-26GHz	74-30-12	1065			Calibration Not Required, Must Be Verified	Active

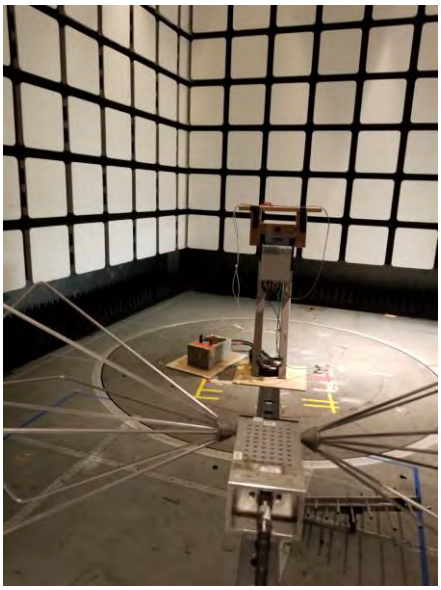
4.8 PHOTOGRAPHS OF THE TEST SETUPS

Response:

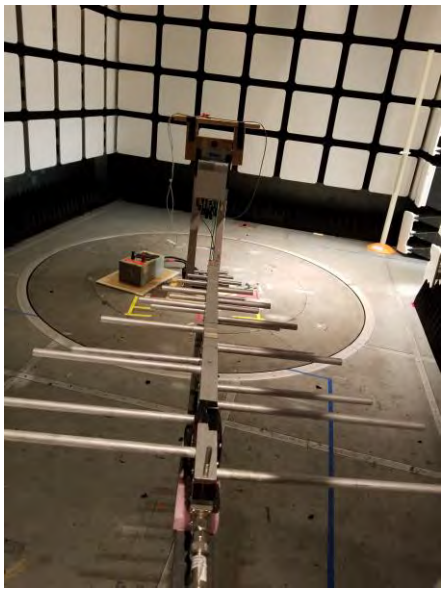
The photographs of the test setups for the **3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC)**are provided in the Filing exhibits.

4.8.1 Radiated Emissions Test Setup Photos

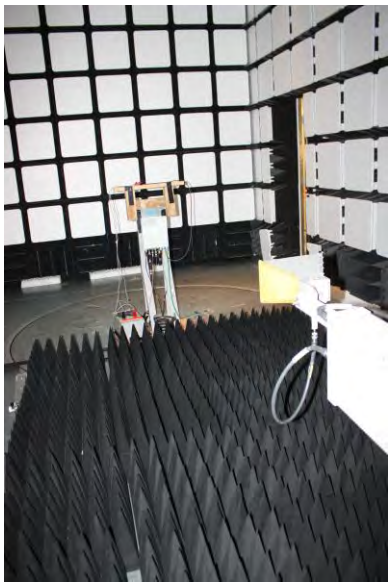
30-200MHz



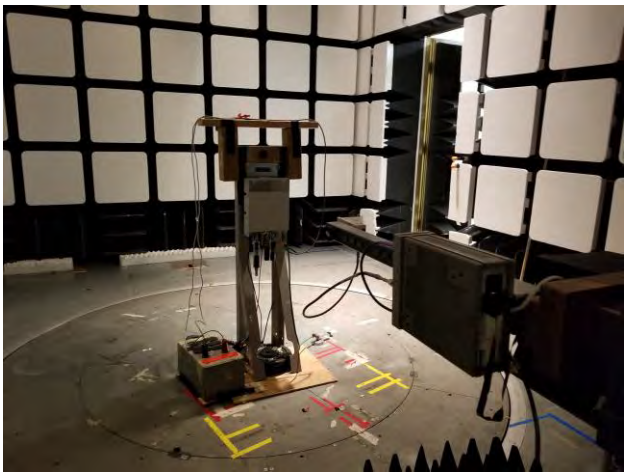
200-1000 MHz-



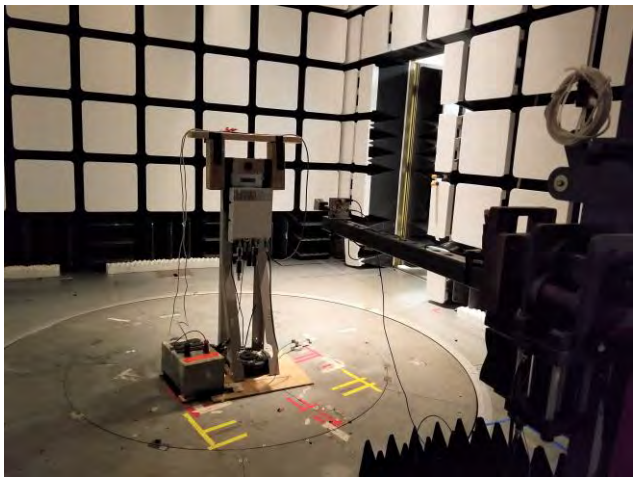
1-18 GHz



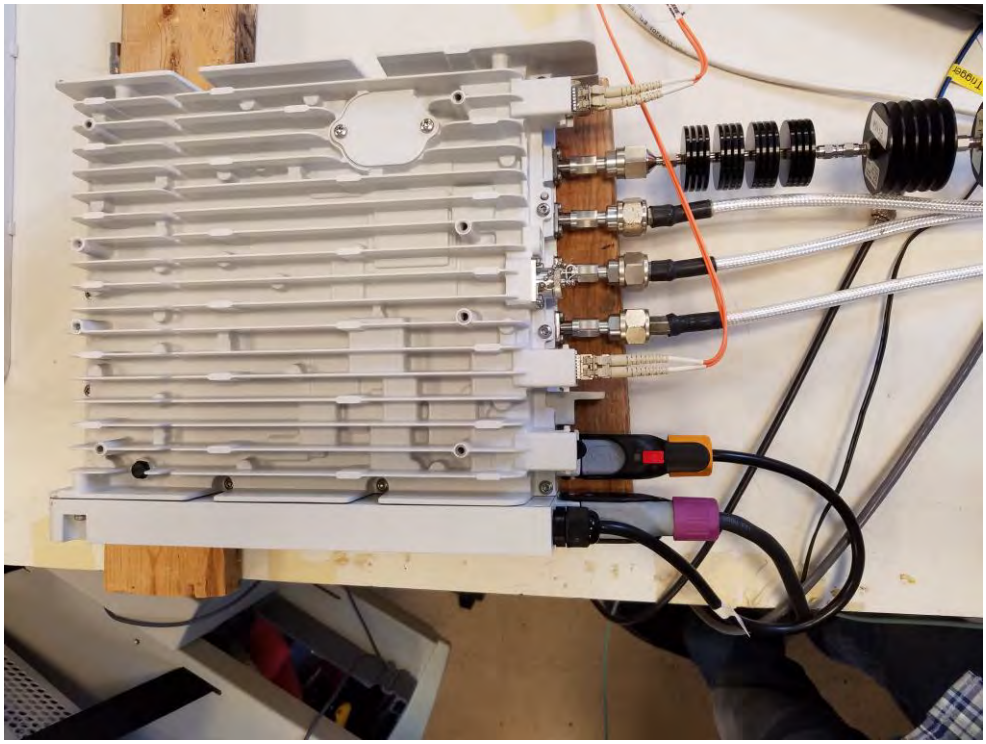
18-26.5 GHz

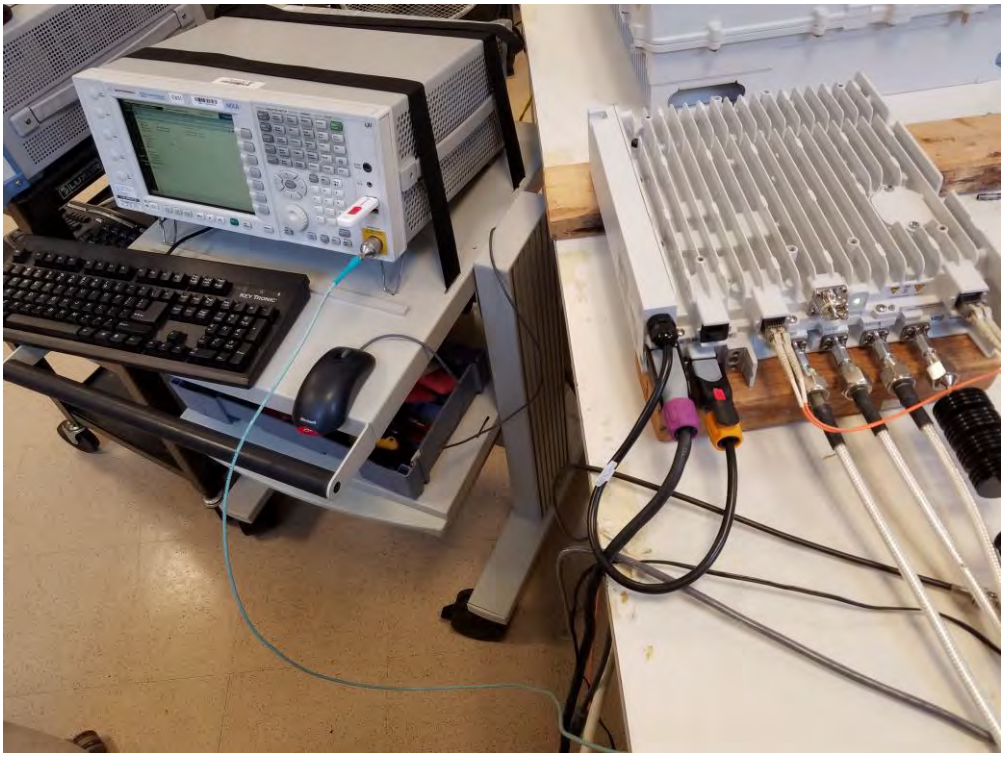


26.5-40 GHz



4.8.2 Antenna Port Measurements Test Setup Photos

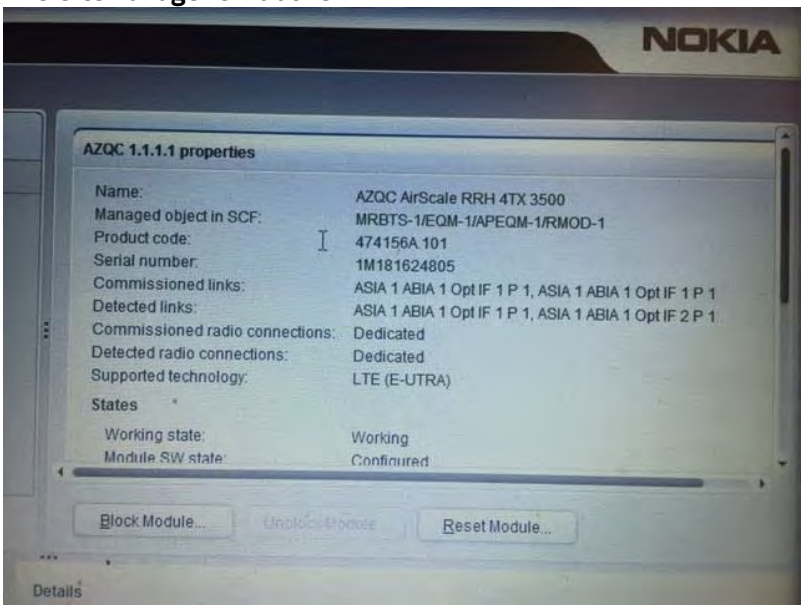




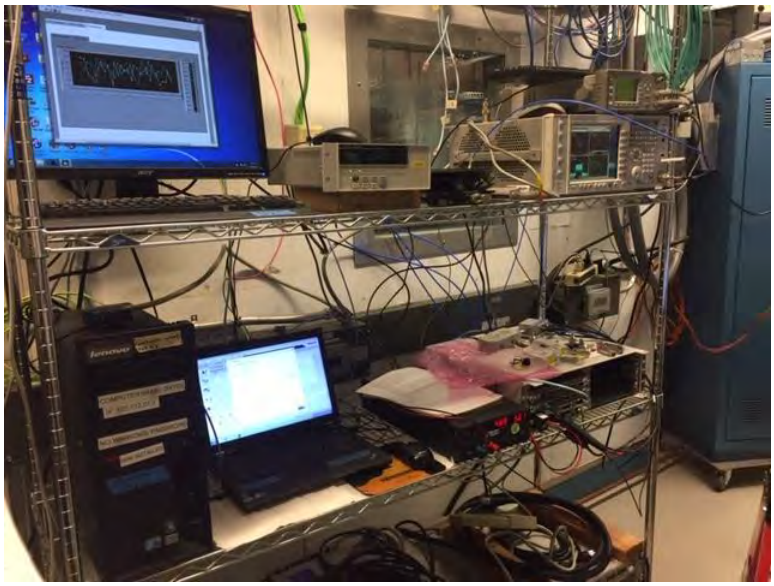
4.8.3 Frequency stability Test Setup Photos

Test Chamber Photos:

BTS SiteManager SN above



Test Equipment Setup



AZQC In Chamber

4.9 FACILITIES AND ACCREDITATION

Measurement facilities at Nokia, Global Product Compliance Laboratory (GPCL) a member of the Nokia family of companies, was used to collect the measurement data in the test report. The laboratory, which is part of Nokia Bell Labs, is located at 600-700 Mountain Avenue, Murray Hill, New Jersey 07974-0636 USA.

The field strength measurements of radiated spurious emissions were made in a FCC registered 3-meter semi-anechoic chamber AR-6, (FCC Registration Number: 395774) **NVLAP** Lab Code: 100275-0 and IC (Filing Number: 6933F-5) which is maintained by Nokia Bell Labs in Murray Hill, New Jersey. The sites were constructed and are continuously in conformance with the requirements of ANSI C63.4 and CISPR Publication 22.

Nokia Global Product Compliance Laboratory FCC OET Accredited Test Firm Scope List is accessible at:

https://apps.fcc.gov/oetcf/eas/reports/ViewTestFirmAccredScopes.cfm?calledFromFrame=N&RequestTimeout=500&regnum_specified=N&test_firm_id=7007

and is as listed in the Table below.

OET Accredited Test Firm Scope List

Test Firm: Nokia, Global Product Compliance Lab

Scope	FCC Rule Parts	Maximum Assessed Frequency, MHz	Status	Expiration Date	Recognition Date
Unintentional Radiators	FCC Part15, Subpart B	40000	Approved	9/30/2018	7/6/2017
Intentional Radiators	FCC Part 15 Subpart C	40000	Approved	9/30/2018	6/5/2018
U-NII without DFS Intentional Radiators	FCC Part 15, Subpart E	40000	Approved	9/30/2018	6/5/2018
U-NII with DFS Intentional Radiators	FCC Part 15, Subpart E	40000	Approved	9/30/2018	6/5/2018
Commercial Mobile Services	Part 22 (cellular), Part 24, Part 25 (below 3 GHz), Part 27	40000	Approved	9/30/2018	6/5/2018
General Mobile Radio Services	Part 22 (non-cellular), Part 90 (below 3 GHz), Part 95 (below 3 GHz), Part 97 (below 3 GHz), Part 101 (below 3 GHz)	40000	Approved	9/30/2018	6/5/2018
Citizens Broadband Radio Services	Part 96	40000	Approved	9/30/2018	7/6/2017
Microwave and Millimeter Bands Radio Services	Part 25, Part30, Part 74, Part 90 (90M DSRC, Y, Z), Part 95 (M & L), Part 101	200000	Approved	9/30/2018	7/6/2017

Nokia Global Product Compliance Laboratory is accredited with the US Department of Commerce National Institute of Standards and Technology's National Voluntary Laboratory Accreditation Program (NVLAP) for satisfactory compliance with criteria established in Title 15, Part 7 Code of Federal Regulations for offering test services for selected test methods in Electromagnetic Compatibility; Voluntary Control Council for Interference (VCCI), Japan; Australian Communications and Media Authority (ACMA). The laboratory is ISO 9001:2008 Certified.

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).

2017-08-17 through 2018-09-30
Effective Dates

For the National Voluntary Laboratory Accreditation Program