Nokia Solutions and Networks

Radio Test Report

Application for Class II Permissive Change of Equipment Authorization

FCC Part 27

[2496MHz – 2690MHz]

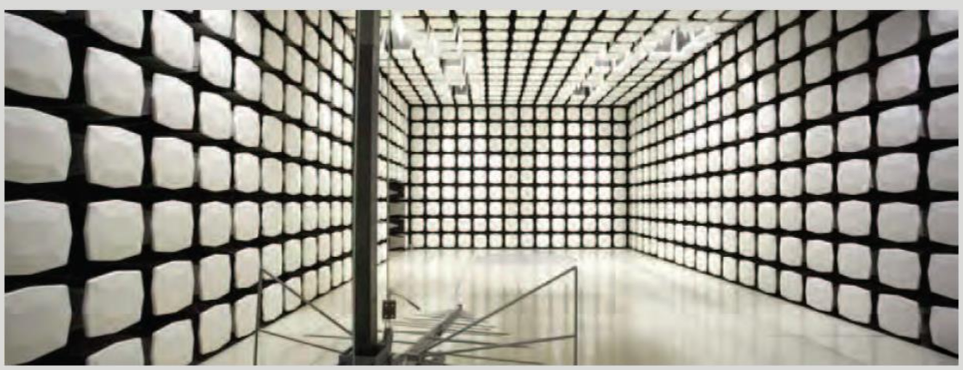
FCC ID: VBNAZHL-01

Nokia Solutions and Networks

Airscale Base Transceiver Station Remote Radio Head

Model: AZHL

Report: NOKI0077.0 Rev. 0, Issue Date: May 24, 2024



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CERTIFICATE OF TEST

Last Date of Test: May 16, 2024
Nokia Solutions and Networks
EUT: Airscale Base Transceiver Station Remote Radio Head, Model AZHL

Radio Equipment Testing

Standards

Specification	Method
Code of Federal Regulations (CFR) Title 47 Part 2 CFR Title 47 Part 27 Subpart C	ANSI C63.26-2015 with FCC KDB 971168 D01 v03r01 FCC KDB 662911D01 v02r01 FCC KDB 662911D02 v01

Results

Test Description	Result	Comments
Occupied Bandwidth	Pass	
Average Power	Pass	
Peak to Average Power (PAPR)CCDF	Pass	
Band Edge Compliance	Pass	
Spurious Conducted Emissions	Pass	

Deviations From Test Standards

None

Approved By:

Jody House, Certification Engineer
Signed for and on behalf of Element

Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information. As indicated in the Statement of Work sent with the quotation, Element's standard process is to always use the latest published version of the test methods even when earlier versions are cited in the test specification. Issuance of a purchase order was de facto acceptance of this approach. Otherwise, the client would have advised Element in writing of the specific version of the test methods they wanted applied to the subject testing.

REVISION HISTORY

element
2018.07.17

Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS

2021.09.01

United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Each laboratory is accredited by A2LA to ISO / IEC 17025, and as a product certifier to ISO / IEC 17065 which allows Element to certify transmitters to FCC and IC specifications.

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB) and as a CAB for the acceptance of test data.

European Union

European Commission – Recognized as an EU Notified Body validated for the EMCD and RED Directives.

United Kingdom

BEIS – Recognized by the UK as an Approved Body under the UK Radio Equipment and UK EMC Regulations.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIT / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

MOC – Recognized by MOC as a CAB for the acceptance of test data.

Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

MIC – Recognized by MIC as a CAB for the acceptance of test data.

SCOPE

For details on the Scopes of our Accreditations, please visit:

California Minnesota Oregon Texas Washington

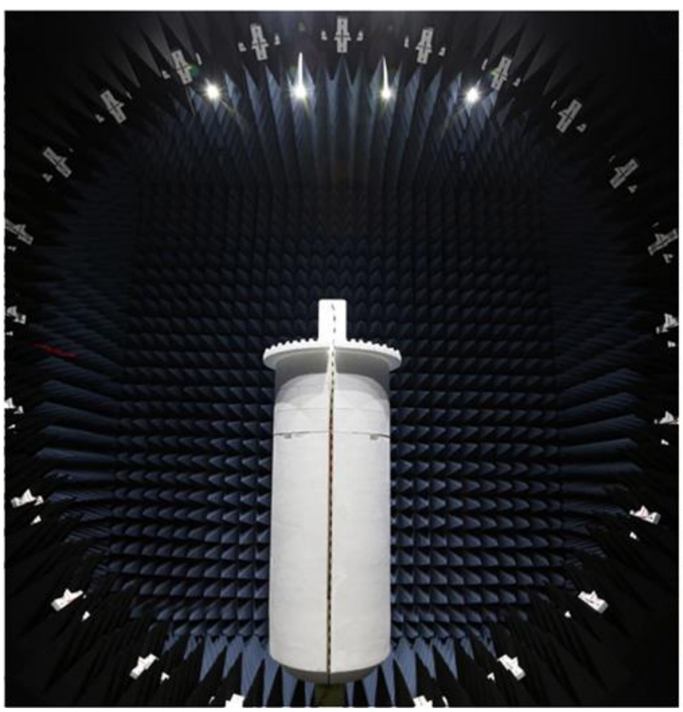
FACILITIES

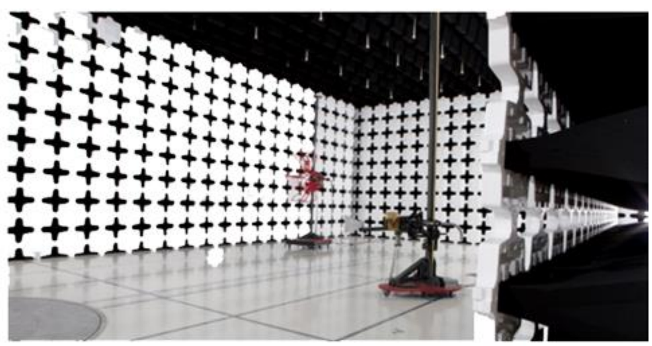
Testing was performed at the following location(s)

	Location	Labs (1)	Address	A2LA (2)	ISED (3)	BSMI (4)	VCCI (5)	CAB (6)	FDA (7)
☐	California	OC01-17	41 Tesla Irvine, CA 92618 (949) 861-8918	3310.04	2834B	SL2-IN-E-1154R	A-0029	US0158	TL-55
☐	Minnesota	MN01-11	9349 W Broadway Ave. Brooklyn Park, MN 55445 (612) 638-5136	3310.05	2834E	SL2-IN-E-1152R	A-0109	US0175	TL-57
☐	Oregon	EV01-12	6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	3310.02	2834D	SL2-IN-E-1017	A-0108	US0017	TL-56
☒	Texas	TX01-09	3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	3310.03	2834G	SL2-IN-E-1158R	A-0201	US0191	TL-54
☐	Washington	NC01-05	19201 120th Ave NE Bothell, WA 98011 (425) 984-6600	3310.06	2834F	SL2-IN-E-1153R	A-0110	US0157	TL-67
☐	Offsite	N/A	See Product Description	N/A	N/A	N/A	N/A	N/A	N/A

See data sheets for specific labs

(1) The lab designations denote individual rooms within each location. (OC01, OC02, OC03, etc.)
(2) A2LA Certificate No.
(3) ISED Company No.
(4) BSMI No.
(5) VCCI Site Filing No.
(6) CAB Identifier. Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA
(7) FDA ASCA No.





MEASUREMENT UNCERTAINTY

Measurement Uncertainty

When a measurement is made, the result will be different from the true or theoretically correct value. The difference is the result of tolerances in the measurement system that cannot be completely eliminated. To the extent that technology allows us, it has been our aim to minimize this error. Measurement uncertainty is a statistical expression of measurement error qualified by a probability distribution.

A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found in the table below. A lab specific value may also be found in the applicable test description section. Our measurement data meets or exceeds the measurement uncertainty requirements of the applicable specification; therefore, the test data can be compared directly to the specification limit to determine compliance. The calculations for estimating measurement uncertainty are based upon ETSI TR 100 028 (or CISPR 16-4-2 as applicable), and are available upon request.

The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.1 dB	-5.1 dB
AC Powerline Conducted Emissions (dB)	3.1 dB	-3.1 dB

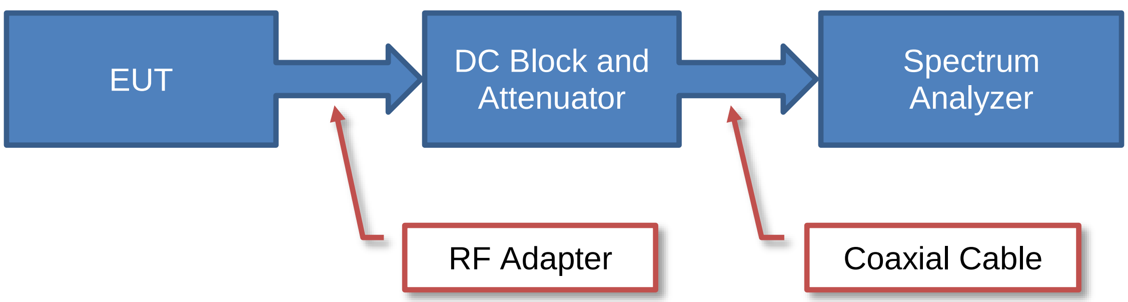
TEST SETUP BLOCK DIAGRAMS

Measurement Bandwidths

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.01 - 0.15	1.0	0.2	0.2
0.15 - 30.0	10.0	9.0	9.0
30.0 - 1000	100.0	120.0	120.0
Above 1000	1000.0	N/A	1000.0

Unless otherwise stated, measurements were made using the bandwidths and detectors specified. No video filter was used.

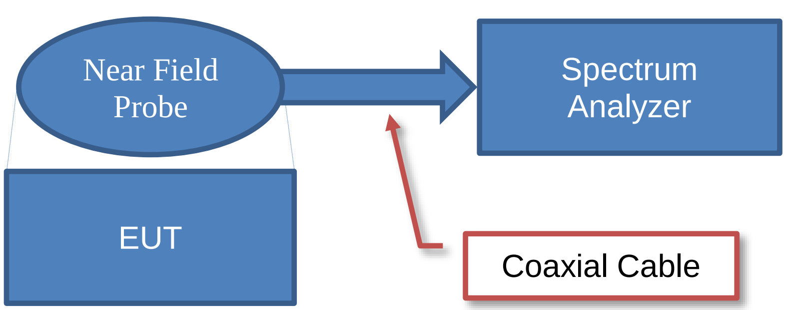
Antenna Port Conducted Measurements



Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

Near Field Test Fixture Measurements



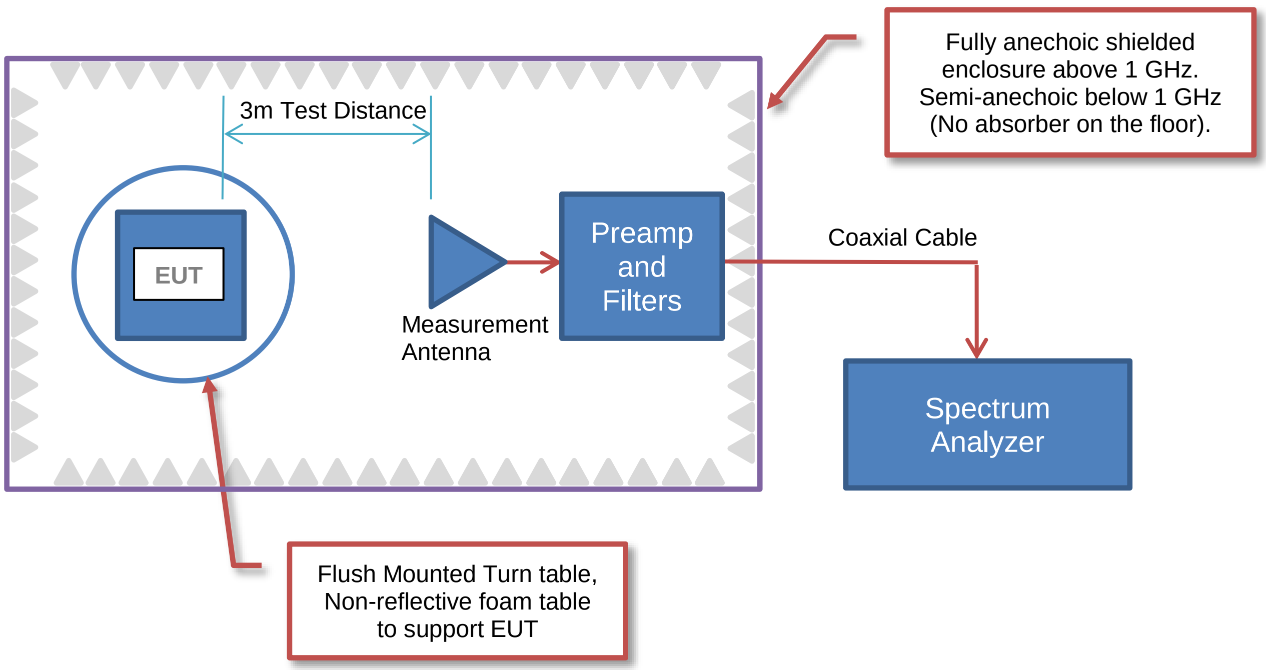
Sample Calculation (logarithmic units)

Measured Value		Measured Level		Reference Level Offset
71.2	=	42.6	+	28.6

TEST SETUP BLOCK DIAGRAMS

element
2022.04.22

Emissions Measurements



Sample Calculation (logarithmic units)

Radiated Emissions:

Measured Level (Amplitude)		Factor: Antenna Factor		Factor: Cable Factor		Factor: Amplifier Gain		Distance Adjustment Factor		External Attenuation		Field Strength
42.6	+	28.6	+	3.1	-	40.8	+	0.0	+	0.0	=	**33.5**

Conducted Emissions:

Measured Level (Amplitude)		Factor: Transducer Factor		Factor: Cable Factor		External Attenuation		Adjusted Level
26.7	+	0.3	+	0.1	+	20.0	=	**47.1**

Radiated Power (ERP/EIRP) – Substitution Method:

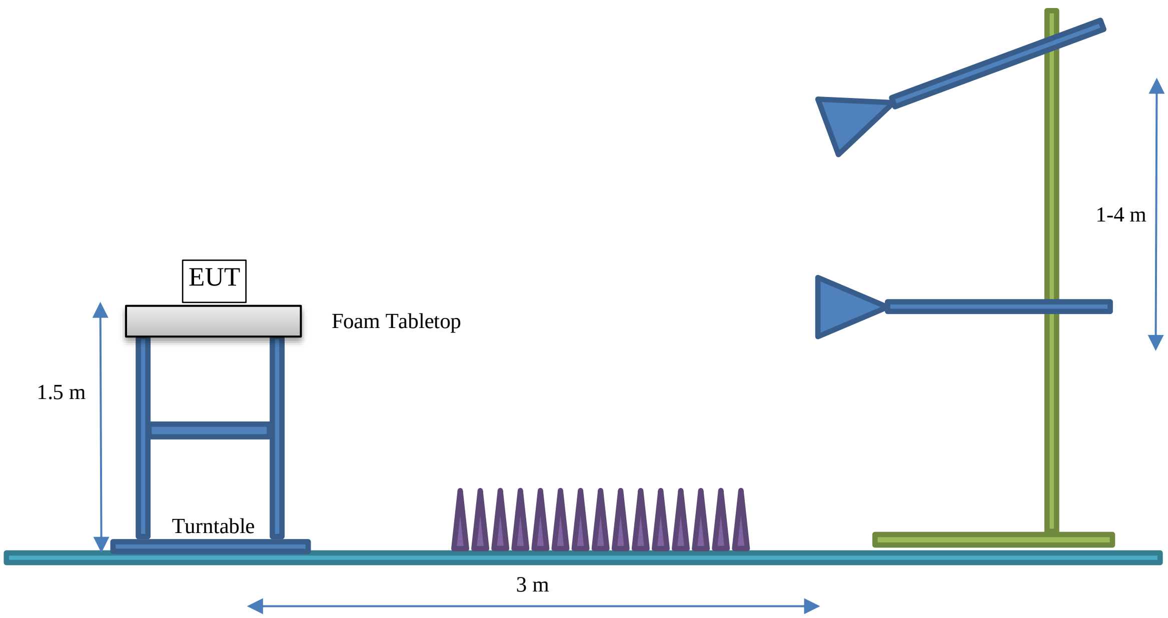
Measured Level into Substitution Antenna (Amplitude dBm)		Substitution Antenna Factor (dBi)		EIRP to ERP (if applicable)		Measured power (dBm ERP/EIRP)
10.0	+	6.0	-	2.15	=	**13.9/16.0**

TEST SETUP BLOCK DIAGRAMS

element
2022.04.22

Bore Sighting (>1GHz)

The diameter of the illumination area is the dimension of the line tangent to the EUT formed by 3 dB beamwidth of the measurement antenna at the measurement distance. At a 3 meter test distance, the diameter of the illumination area was 3.8 meters at 1 GHz and greater than 2.1 meters up to 6 GHz. Above 1 GHz, when required by the measurement standard, the antenna is pointed for both azimuth and elevation to maintain the receive antenna within the cone of radiation from the EUT. The specified measurement detectors were used for comparison of the emissions to the peak and average specification limits.



PRODUCT DESCRIPTION

Client and Equipment under Test (EUT) Information

Company Name:	Nokia Solutions and Networks
Address:	3201 Olympus Blvd
City, State, Zip:	Dallas, TX 75019
Test Requested By:	Steve Mitchell
EUT:	Airscale Base Transceiver Station Remote Radio Head, Model AZHL
First Date of Test:	May 16, 2024
Last Date of Test:	May 16, 2024
Receipt Date of Samples:	May 16, 2024
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:

Remote Radio Head (RRH) variant AZHL is being developed under this effort. The AZHL remote radio head is a multi-standard multi-carrier unit. The RRH designed to support 4G LTE TDD and 5G NR TDD. The original radio certification test effort demonstrated FCC compliance for 4G LTE TDD single carrier LTE10, LTE15 and LTE20 channel bandwidths and for 5G NR TDD single carrier NR20, NR40, NR60, NR80 and NR 100 channel bandwidths (see Element Report NOKI0018.1 Rev 0 dated 3/19/2021). An FCC permissive class 2 change test effort was performed to add 5G NR TDD single carrier NR30, NR50, NR70, & NR90 channel bandwidths (see Element Report NOKI0025 dated 10/27/2021). An FCC permissive class 2 change test effort was performed to add 5G NR TDD single carrier NR10 channel bandwidths (see Element Report NOKI0067.0 dated 07/28/2023). **This FCC permissive class 2 change effort is to add 5G NR TDD 15MHz channel bandwidth.**

The AZHL RRH has 8 transmit/receive antenna ports that supports 3GPP frequency band 41/band n41 operations (BTS RX: 2496 to 2690 MHz/BTS TX: 2496 to 2690 MHz). The maximum RF output power of each antenna port is 40 watts. The total RF output power for the AZHL remote radio head is 320 watts (8 x 40 watts). The remote radio head software supports 10, 15, and 20MHz 4G LTE TDD bandwidths. The remote radio head software supports 10, 15, 20, 30, 40, 50, 60, 70, 80, 90 and 100MHz 5G NR TDD bandwidths. The maximum RF output power levels for single carrier operations is provided below.

Single Carrier Maximum RF Output Power per Port for each Radio Access Technology Channel Bandwidth										
LTE10 & NR10	LTE15 & NR15	LTE20 & NR20	NR30	NR40	NR50	NR60	NR70	NR80	NR90	NR100
4.0 W or 36.0dBm	5.6 W or 37.5dBm	7.5 W or 38.8dBm	11.3 W or 40.5dBm	15.0 W or 41.8dBm	18.8 W or 42.7dBm	22.5 W or 43.5dBm	26.3 W or 44.2dBm	30.0 W or 44.8dBm	33.8 W or 45.3dBm	40.0 W or 46.0dBm

The AZHL software supports four downlink modulation types (QPSK, 16QAM, 64QAM, and 256QAM) for both 4G and 5G technologies. The 5G NR modulation types for this testing are setup according to 3GPP TS 38.141-1 Test Models and are NR-FR1-TM 1.1 (QPSK modulation type), NR-FR1-TM 3.2 (16QAM modulation type), NR-FR1- TM 3.1 (64QAM modulation type), and NR-FR1-TM 3.1a (256QAM modulation type). Single carrier operations for NR15 will be certified/verified under this effort. Multicarrier operations have been verified/certified under previously listed separate efforts.

The AZHL MIMO operating modes include 8T8R, 2x 4T4R and 4x 2T2R. The AZHL is designed to operate with cross-polarized (orthogonal radiators) antennas only. The eight transmit/receive ports connected to ±45° cross-polarized (orthogonal) radiators (four ports are connected to +45° radiators/antennas and four ports are connected to the -45° radiators/antennas).

The remote radio head has external interfaces including DC power (DC In), ground, RF transmit/receive (ANT), beamforming calibration (BF Cal), optical (OPT) and remote electrical tilt (RET). The RRH with applicable installation kit may be pole or wall mounted. The remote radio head may be configured with an optional cooling fan.

This testing is being performed to obtain an FCC radio grant for band n41 (BTS RX: 2496 to 2690 MHz/BTS TX: 2496 to 2690 MHz) requirement covered within FCC CFR 47 Part 27. Tests performed include RF channel power, peak to average power ratio, emission bandwidth, band edge spurious emissions, spurious emissions conducted. The radiated emission and frequency stability/accuracy results from the original certification had enough margin to preclude requiring additional testing. The same frequency stability/accuracy radio design is the same for all radio technologies/modulation types.

Single Carrier Test Case Descriptions:

5G carriers are tested at top, middle and bottom frequencies of 5G band n41.

<u>3GPP Frequency Band n41 5G-NR Band Edge NR-ARFCNs</u>

The 3GPP frequency band n41 (2496-2690 MHz) band edge NR-ARFCNs for the 5G NR channel bandwidth of 15MHz are provided in Table below. The NR-ARFCN is defined as New Radio - Absolute Radio Frequency Channel Number.

	5G NR NR-ARFCN	Downlink Frequency (MHz)	5G NR Channels 15MHz Bandwidth
AZHL Band n41 (Antennas 1 -- 8)	**Lower Band Edge**	**2496.00**	
	……		
	500700	2503.50	Bottom Channel
	……		
	518598	2592.99	Middle Channel
	……		
	536496	2682.48	Top Channel
	……		
	Upper Band Edge	**2690.00**	

Test Case Descriptions

The 5G NR 15MHz carrier was enabled at maximum power (5.6 watts/port) for all testing. All testing was performed on antenna port 1. The test port selected was based on the previous testing of same EUT. The testing is being performed per ANSI C63.26-2015 guidance.

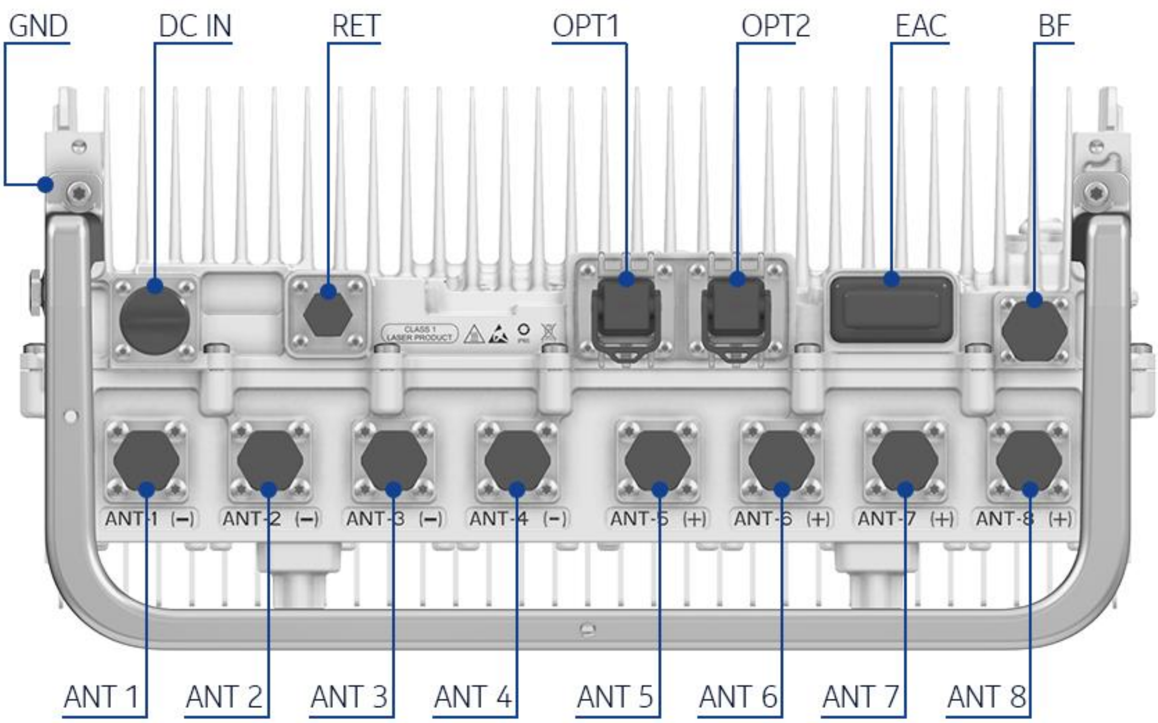
(1) Conducted power measurements (Average RMS Power and CCDF) were performed for the NR15 channel bandwidth on the middle channel (2592.99MHz) for all modulation types (QPSK, 16QAM, 64QAM and 256QAM). The output power variation between modulation types was small/negligible and 256QAM modulation was used for power measurements for the Top (2682.48MHz) and Bottom (2503.50MHz) channels.

(2) Emission Bandwidth measurements (99% and 26dB down) were performed for the NR15 channel bandwidth on the middle channel (2592.99MHz) for all modulation types (QPSK, 16QAM, 64QAM and 256QAM). The emission bandwidth variation between modulation types was small therefore only the 256QAM modulation type was used for the Top (2682.48MHz) and Bottom (2503.50MHz) channels. (See ANSI C63.26. clause 5.7.2e).

(3) Spurious Emissions at the Band edges on the Bottom (2503.50MHz) and Top (2682.48MHz) channels for the NR15 channel bandwidth were performed. Only the 256QAM modulation type (highest rate) was tested because the OBW variation was small between modulation types. (See ANSI C63.26. clause 5.7.2e).

(4) Conducted spurious emissions (9k to 27GHz) were performed for the NR15 channel bandwidth on the middle frequency channel. Only the 256QAM modulation type (highest rate) was tested because the OBW variation was small between modulation types. (See ANSI C63.26. clause 5.7.2e).

AZHL Connector Layout



AZHL External Interfaces

Name	Qty	Connector Type	Purpose (and Description)
DC In	1	Screw Terminal	2-pole Power Input Terminal
GND	1	Screw lug (2xM5)	Ground
ANT	8	4.3-10	RF signal for Transmitter/Receiver (50 Ohm)
BF	1	4.3-10	Beamforming Calibration
EAC	1	MDR26	External Alarm Interface
OPT	2	SFP28	Optical CPRI Interface
RET	1	8-pin circular connector	AISG 2.0 to external devices
Fan	1	Nokia	Power for RRH Fan. Located on the side of RRH.

Testing Objective:

A permissive change on the original filing is being pursued to add 15MHz carrier bandwidth operations to the Nokia Solutions and Networks AirScale Base Transceiver Station (BTS) Remote Radio Head (RRH) model AZHL for FCC radio certifications.

CONFIGURATIONS

Test Configuration 1 RF Conducted Emissions

Software/Firmware Running during test	
Description	**Version**
Radio Module Software	SB RF.ERM6.trunk.20240410.034
5G BTS Software Version: 24R3	SBTS24R3_ENB_9999_240411_000014

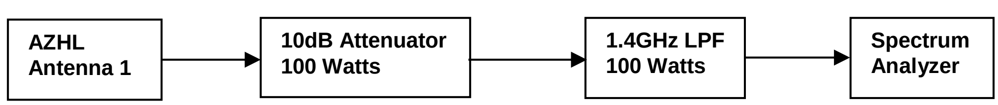
Equipment being tested (include Peripherals)			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
AMIA (BTS System Module)	Nokia Solutions and Networks	473098A.203	J8173107703
ASIB (BTS System Module)	Nokia Solutions and Networks	473764A.102	K9214331950
ABIO (BTS Baseband Module)	Nokia Solutions and Networks	475266A.104	DH223246457
AZHL (Radio Module Model)	Nokia Solutions and Networks	475432A.101	YK203400016
Low Pass Filter 1.4GHz/100W	Microwave Circuits,Inc.	L13502G1	SN2454-01
Attenuator 100W/10dB	Weinschel Corp	48-10-43-LIM	BJ1771
AOMC SFP28+ 9.8G,70M,850NM (Radio)	Nokia	P47900A.101	VF2020001BQ
AOMC SFP28+ 9.8G,70M,850NM (Radio)	Nokia	P47900A.101	VF20470022K
AOMC SFP28 + 9.8G,70M,850NM (BS)	Nokia	P47900A.101	VF20180016Z
AOMC SFP28 + 9.8G,70M,850NM (BS)	Nokia	P47900A.101	VF2023002SU
ThinkPad T490 (WebEM- PC)	Lenovo	20N3	PF26RVZ8
DC System power supply	Keysight	N8757A	US23L1724S
FPAD (DC-PWR supply-BS)	Nokia	472805A.X21	A9124600282
2 Meter RF cable	Maketron	M17/75-RG214	993437
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531429/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531432/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531431/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531429/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531433/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531434/6
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR299
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR300
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR301
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR302
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	PZ465
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	LY351
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SK301
Fiber Optic cable 2m	Amphenol Fiber Optic	995741A	VZ1701
Fiber Optic cable 2m	Amphenol Fiber Optic	995741A	VZ1701/2
GPS Receiver Cable	Nokia	995426C	CA2029
FYGB GPS Receiver	Nokia	472748A.101	71231431
Cat-5e cable	CSA	E151955	LL79189
2 Meter RF cable X2-pc	Huber + Suhner, Inc.	HS-SUCOFLEX_106	SN297374/x2
1 Meter RF cable	Huber + Suhner, Inc.	HS-SUCOFLEX_104	SN551432/4
Coaxial cable (Frame Clock & Trigger)	Fairviewmicrowave	FMC0808058	120
Coaxial cable (Frame Clock & Trigger)	Fairviewmicrowave	FMC0808058	120

CONFIGURATIONS

Cables (Peripheral)					
Description	**Shield (Y/N)**	**Length (m)**	**Ferrite (Y/N)**	**Connection 1 (5G/4G)**	**Connection 2**
Fiber Optic Cable (2)	N	2 meters	N	ASIB/ABIO	AZHL
GPS Receiver Cable	Y	100 meters	N	ASIB/ABIO	FYGB GPS receiver
Cat-5e Cable	Y	7 meters	N	ASIB/ABIO	WebEM- PC
HUBER+SUHNER – RF CABLE	Y	2 meters	N	EUT [RRH] Ant ports 2-8	150W -50ohm -Load
Reference cables (Frame Clock & Trigger)	Y	1 meter	N	ASIB/ABIO	Analyzer

Cables					
Description	**Shield (Y/N)**	**Length (m)**	**Ferrite (Y/N)**	**Connection 1**	**Connection 2**
HS-SUCOFLEX_106 0.5dB (cable x2) attenuator	Y	4 meters total	N	EUT [AZHL] Ant port #1	Attenuator 100W/10dB
Attenuator 100W/10dB	N	N/A	N	RF cable HS-SUCOFLEX_106	Low Pass filter 1.4G/100W
Low Pass Filter 1.4G/100W	N	N/A	N	Attenuator 100W/10dB	RF cable HS-SUCOFLEX_104
HS-SUCOFLEX_104	Y	1 meter	N	Low Pass Filter 1.4G/100W	Analyzer

RF Test Setup Diagram:



CONFIGURATIONS

Test Configuration 2 RF Conducted Emissions

Software/Firmware Running during test	
Description	**Version**
Radio Module Software	SB RF.ERM6.trunk.20240410.034
5G BTS Software Version: 24R3	SBTS24R3_ENB_9999_240411_000014

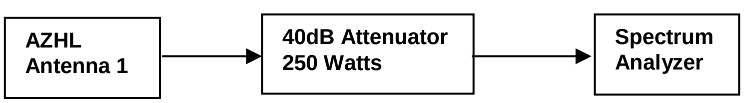
Equipment being tested (include Peripherals)			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
AMIA (BTS System Module)	Nokia Solutions and Networks	473098A.203	J8173107703
ASIB (BTS System Module)	Nokia Solutions and Networks	473764A.102	K9214331950
ABIO (BTS Baseband Module)	Nokia Solutions and Networks	475266A.104	DH223246457
AZHL (Radio Module Model)	Nokia Solutions and Networks	475432A.101	YK203400016
Attenuator 250W/40dB	API Weinschel	50-40-33-LIM	UN619
AOMC SFP28+ 9.8G,70M,850NM (Radio)	Nokia	P47900A.101	VF2020001BQ
AOMC SFP28+ 9.8G,70M,850NM (Radio)	Nokia	P47900A.101	VF20470022K
AOMC SFP28 + 9.8G,70M,850NM (BS)	Nokia	P47900A.101	VF20180016Z
AOMC SFP28 + 9.8G,70M,850NM (BS)	Nokia	P47900A.101	VF2023002SU
ThinkPad T490 (WebEM- PC)	Lenovo	20N3	PF26RVZ8
DC System power supply	Keysight	N8757A	US23L1724S
FPAD (DC-PWR supply-BS)	Nokia	472805A.X21	A9124600282
2 Meter RF cable	Maketron	M17/75-RG214	993437
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531429/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531432/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531431/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531429/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531433/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531434/6
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR299
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR300
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR301
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR302
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	PZ465
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	LY351
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SK301
Fiber Optic cable 2m	Amphenol Fiber Optic	995741A	VZ1701
Fiber Optic cable 2m	Amphenol Fiber Optic	995741A	VZ1701
GPS Receiver Cable	Nokia	995426C	CA2029
FYGB GPS Receiver	Nokia	472748A.101	71231431
Cat-5e cable	CSA	E151955	LL79189
2 Meter RF cable X2-pc	Huber + Suhner, Inc.	HS-SUCOFLEX_106	SN297374/x2
1 Meter RF cable	Huber + Suhner, Inc.	HS-SUCOFLEX_104	SN551432/4
Coaxial cable (Frame Clock & Trigger)	Fairviewmicrowave	FMC0808058	120
Coaxial cable (Frame Clock & Trigger)	Fairviewmicrowave	FMC0808058	120

CONFIGURATIONS

Cables (Peripheral)					
Description	**Shield (Y/N)**	**Length (m)**	**Ferrite (Y/N)**	**Connection 1 (5G/4G)**	**Connection 2**
Fiber Optic Cable (2)	N	2 meters	N	ASIB/ABIO	AZHL
GPS Receiver Cable	Y	100 meters	N	ASIB/ABIO	FYGB GPS receiver
Cat-5e Cable	Y	7 meters	N	ASIB/ABIO	WebEM- PC
HUBER+SUHNER – RF CABLE	Y	2 meters	N	EUT [RRH] Ant ports 2-8	150W -50ohm -Load
Reference cables (Frame Clock & Trigger)	Y	1 meter	N	ASIB/ABIO	Analyzer

Cables					
Description	**Shield (Y/N)**	**Length (m)**	**Ferrite (Y/N)**	**Connection 1**	**Connection 2**
HS-SUCOFLEX_106 0.5dB (cable x2) attenuator	Y	4 meters	N	EUT [AZHL] Ant port #1	Attenuator 250W/40dB
Attenuator 250W/40dB	N	NA	N	RF cable HS-SUCOFLEX_106	RF cable HS-SUCOFLEX_104
HS-SUCOFLEX_104	Y	1 meter	N	Attenuator 250W/40dB	Analyzer

RF Test Setup Diagram:



CONFIGURATIONS

Test Configuration 3 RF Conducted Emissions

Software/Firmware Running during test	
Description	**Version**
Radio Module Software	SB RF.ERM6.trunk.20240410.034
5G BTS Software Version: 24R3	SBTS24R3_ENB_9999_240411_000014

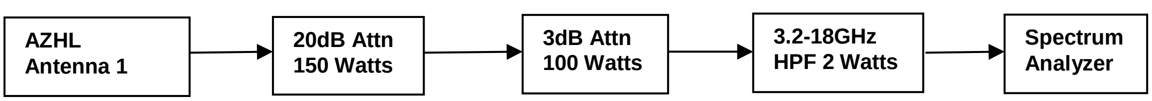
Equipment being tested (include Peripherals)			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
AMIA (BTS System Module)	Nokia Solutions and Networks	473098A.203	J8173107703
ASIB (BTS System Module)	Nokia Solutions and Networks	473764A.102	K9214331950
ABIO (BTS Baseband Module)	Nokia Solutions and Networks	475266A.104	DH223246457
AZHL (Radio Module Model)	Nokia Solutions and Networks	475432A.101	YK203400016
High Pass Filter 3.2-18GHz/2W	RLC Electronics	RHPF23G03G18	20121400045
Attenuator 150W/20dB	Aeroflex Weinschel	66-20-33	BZ1165
Attenuator 100W/3dB	Aeroflex Weinschel	47-3-33	CG5493
AOMC SFP28+ 9.8G,70M,850NM (Radio)	Nokia	P47900A.101	VF2020001BQ
AOMC SFP28+ 9.8G,70M,850NM (Radio)	Nokia	P47900A.101	VF20470022K
AOMC SFP28 + 9.8G,70M,850NM (BS)	Nokia	P47900A.101	VF20180016Z
AOMC SFP28 + 9.8G,70M,850NM (BS)	Nokia	P47900A.101	VF2023002SU
ThinkPad T490 (WebEM- PC)	Lenovo	20N3	PF26RVZ8
DC System power supply	Keysight	N8757A	US23L1724S
FPAD (DC-PWR supply-BS)	Nokia	472805A.X21	A9124600282
2 Meter RF cable	Maketron	M17/75-RG214	993437
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531429/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531432/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531431/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531429/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531433/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531434/6
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR299
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR300
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR301
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR302
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	PZ465
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	LY351
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SK301
Fiber Optic cable 2m	Amphenol Fiber Optic	995741A	VZ1701
Fiber Optic cable 2m	Amphenol Fiber Optic	995741A	VZ1701
GPS Receiver Cable	Nokia	995426C	CA2029
FYGB GPS Receiver	Nokia	472748A.101	71231431
Cat-5e cable	CSA	E151955	LL79189
2 Meter RF cable X2-pc	Huber + Suhner, Inc.	HS-SUCOFLEX_106	SN297374/x2
1 Meter RF cable	Huber + Suhner, Inc.	HS-SUCOFLEX_104	SN551432/4
Coaxial cable (Frame Clock & Trigger)	Fairviewmicrowave	FMC0808058	120
Coaxial cable (Frame Clock & Trigger)	Fairviewmicrowave	FMC0808058	120

CONFIGURATIONS

Cables (Peripheral)					
Description	**Shield (Y/N)**	**Length (m)**	**Ferrite (Y/N)**	**Connection 1 (5G/4G)**	**Connection 2**
Fiber Optic Cable (2pc)	N	2 meters	N	ASIB/ABIO	AZHL
GPS Receiver Cable	Y	100 meters	N	ASIB/ABIO	FYGB GPS receiver
Cat-5e Cable	Y	7 meters	N	ASIB/ABIO	WebEM- PC
HUBER+SUHNER – RF CABLE	Y	2 meters	N	EUT [RRH] Ant ports 2-8	150W -50ohm -Load
Reference cables (Frame Clock & Trigger)	Y	1 meter	N	ASIB/ABIO	Analyzer

Cables					
Description	**Shield (Y/N)**	**Length (m)**	**Ferrite (Y/N)**	**Connection 1**	**Connection 2**
HS-SUCOFLEX_106 0.5dB (cable x2) attenuator	Y	4 meters total	N	EUT [AZHL] Ant port #1	Attenuator 150W/20dB
Attenuator 150W/20dB	N	NA	N	RF cable HS-SUCOFLEX_106	Attenuator 100W/3dB
Attenuator 100W/3dB	N	NA	N	Attenuator 150W/20dB	High Pass Filter 3.2GHz
High Pass Filter 3.2GHz/2W	N	NA	N	Attenuator 100W/3dB	RF cable HS-SUCOFLEX_104
HS-SUCOFLEX_104	Y	1 meter	N	High Pass Filter 3.2GHz/2W	Analyzer

RF Test Setup Diagram:



CONFIGURATIONS

Test Configuration 4 RF Conducted Emissions

Software/Firmware Running during test	
Description	**Version**
Radio Module Software	SB RF.ERM6.trunk.20240410.034
5G BTS Software Version: 24R3	SBTS24R3_ENB_9999_240411_000014

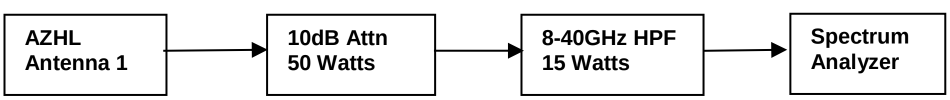
Equipment being tested (include Peripherals)			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
AMIA (BTS System Module)	Nokia Solutions and Networks	473098A.203	J8173107703
ASIB (BTS System Module)	Nokia Solutions and Networks	473764A.102	K9214331950
ABIO (BTS Baseband Module)	Nokia Solutions and Networks	475266A.104	DH223246457
AZHL (Radio Module Model)	Nokia Solutions and Networks	475432A.101	YK203400016
Attenuator 50W/10dB	RF-Lambda	RFS50G26S10FF	20031702
High Pass Filter 8-40GHz/15W	RF-Lambda	RHPF23G08G40	17102700014
RF-Lambda High Frequency Cable - AC20040003	RF-Lambda	RF6767A-B7RU1219	AC20040003
AOMC SFP28+ 9.8G,70M,850NM (Radio)	Nokia	P47900A.101	VF2020001BQ
AOMC SFP28+ 9.8G,70M,850NM (Radio)	Nokia	P47900A.101	VF20470022K
AOMC SFP28 + 9.8G,70M,850NM (BS)	Nokia	P47900A.101	VF20180016Z
AOMC SFP28 + 9.8G,70M,850NM (BS)	Nokia	P47900A.101	VF2023002SU
ThinkPad T490 (WebEM- PC)	Lenovo	20N3	PF26RVZ8
DC System power supply	Keysight	N8757A	US23L1724S
FPAD (DC-PWR supply-BS)	Nokia	472805A.X21	A9124600282
2 Meter RF cable	Maketron	M17/75-RG214	993437
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531429/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531432/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531431/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531429/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531433/6
2 Meter RF cable	HUBER+SUHNER	SUCOFLEX 106	531434/6
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR299
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR300
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR301
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SR302
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	PZ465
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	LY351
150W -50ohm -Terminating Load	API Weinschel inc	1435-3-LIM	SK301
Fiber Optic cable 2m	Amphenol Fiber Optic	995741A	VZ1701
Fiber Optic cable 2m	Amphenol Fiber Optic	995741A	VZ1701
GPS Receiver Cable	Nokia	995426C	CA2029
FYGB GPS Receiver	Nokia	472748A.101	71231431
Cat-5e cable	CSA	E151955	LL79189
2 Meter RF cable X2-pc	Huber + Suhner, Inc.	HS-SUCOFLEX_106	SN297374/x2
1 Meter RF cable	Huber + Suhner, Inc.	HS-SUCOFLEX_104	SN551432/4
Coaxial cable (Frame Clock & Trigger)	Fairviewmicrowave	FMC0808058	120
Coaxial cable (Frame Clock & Trigger)	Fairviewmicrowave	FMC0808058	120

CONFIGURATIONS

Cables (Peripheral)					
Description	**Shield (Y/N)**	**Length (m)**	**Ferrite (Y/N)**	**Connection 1 (5G/4G)**	**Connection 2**
Fiber Optic Cable (2)	N	2 meters	N	ASIB/ABIO	AZHL
GPS Receiver Cable	Y	100 meters	N	ASIB/ABIO	FYGB GPS receiver
Cat-5e Cable	Y	7 meters	N	ASIB/ABIO	WebEM- PC
HUBER+SUHNER – RF CABLE	Y	2 meters	N	EUT [RRH] Ant ports 2-8	150W -50ohm -Load
Reference cables (Frame Clock & Trigger)	Y	1 meter	N	ASIB/ABIO	Analyzer

Cables					
Description	**Shield (Y/N)**	**Length (m)**	**Ferrite (Y/N)**	**Connection 1**	**Connection 2**
HS-SUCOFLEX_106 0.5dB (cable x2) attenuator	Y	4 meters total	N	EUT [AZHL] Ant port #1	Attenuator 50W/10dB
Attenuator 50W/10dB	N	NA	N	RF cable HS-SUCOFLEX_104	High Pass Filter 8-40GHz
High Pass Filter 8-40GHz/15W	N	NA	N	Attenuator 50W/10dB	RF-Lambda -AC20040003
RF-Lambda -AC20040003	Y	1 meter	N	High Pass Filter 8-40GHz/15W	Analyzer

RF Test Setup Diagram:



MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2024-05-16	Band Edge Compliance	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2024-05-16	Occupied Bandwidth	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
3	2024-05-16	Peak to Average Power (PAPR) CCDF	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
4	2024-05-16	Spurious Conducted Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
5	2024-05-16	Output Power	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

OCCUPIED BANDWIDTH

element
TbtTx 2023.12.06.3
WTD.2024.01.16.0

TEST DESCRIPTION

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The fundamental emission Occupied Bandwidth was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

RF conducted emissions testing was performed only on one port. The testing was performed on the same version of hardware (AZHL) as the original certification test. The AZHL antenna ports are essentially electrically identical (the RF power variation between antenna ports is small as shown in this certification testing) and antenna port 1 was selected to perform the testing under this effort as allowed by ANSI C63.26-2015 paragraphs 5.2.5.3, 5.7.2i, and 6.4.

The method in section 5.4 of ANSI C63.26 was used to make this measurement. The spectrum analyzer settings were as follows:

- RBW is 1% - 5% of the occupied bandwidth
- VBW is ≥ 3x the RBW
- Peak Detector was used
- Trace max hold was used

The 26dB emission bandwidth is measured in accordance with section 4 of FCC KDB 971168 D01v03r01 and ANSI C63.26 section 5.4. FCC 2.1049 requires an emission bandwidth measurement. FCC 27.53(m)(6) defines the emission bandwidth to be used as 26 dB down. Measurements shall be performed with the transmitter at full power per the bandwidth on the middle channel (also Bottom & Top for 256QAM) for all bandwidths and modulation types for 4G LTE and 5G NR.

FCC Emission Designators for 5G-NR Band n41 (2496MHz to 2690MHz)					
Ch BW	**Radio Channel**	**QPSK**	**16QAM**	**64QAM**	**256QAM**
15MHz	Low				14M8G7W
	Mid	14M7G7W	14M8G7W	14M7G7W	14M8G7W
	High				14M8G7W
Note: FCC emission designators are based on 26dB emission bandwidth.					

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFQ	2024-03-12	2025-03-12
Generator - Signal	Agilent	N5173B	TIW	2023-08-07	2026-08-07
Block - DC	Fairview Microwave	SD3379	AMM	2023-08-04	2024-08-04

OCCUPIED BANDWIDTH

TbtTx 2023.12.06.3
WTD.2024.01.16.0

EUT:	Airscale Base Transceiver Station Remote Radio Head, Model AZHL	Work Order:	NOKI0077
Serial Number:	YK203400016	Date:	2024-05-16
Customer:	Nokia Solutions and Networks	Temperature:	21.2°C
Attendees:	John Rattanavong, Mitch Hill	Relative Humidity:	59.9%
Customer Project:	None	Bar. Pressure (PMSL):	1007 mbar
Tested By:	Jarrod Brenden	Job Site:	TX07
Power:	54 VDC	Configuration:	NOKI0077-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 27:2024	ANSI C63.26:2015

COMMENTS

Losses in the measurement path were accounted for in the reference level offset; DC block, attenuators, cables, and filters where used. External 1 gating was set using a trigger delay = 5.006ms and a gate length = 3.6408ms. The 15Mhz Carrier power is set to maximum at 5.6watt/port for all testing.

DEVIATIONS FROM TEST STANDARD

None

CONCLUSION

Pass

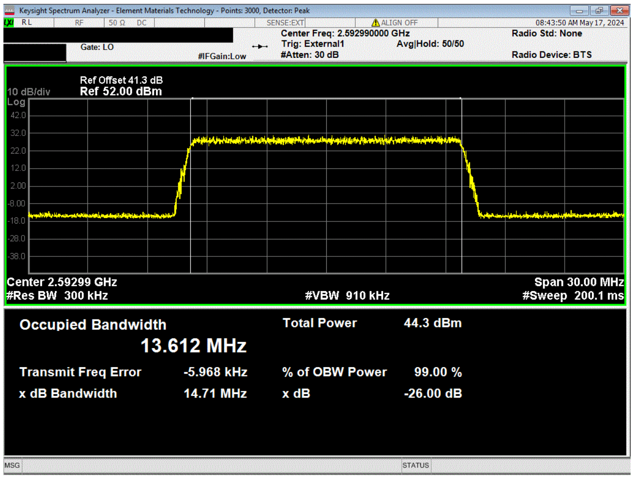
Tested By

TEST RESULTS

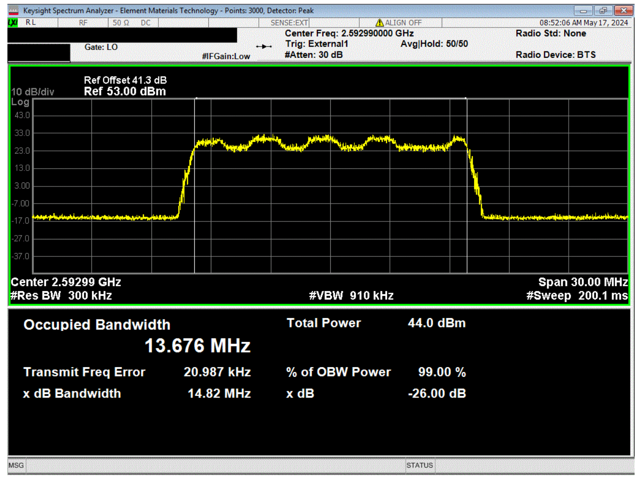
	99% Value	26dB Value	Limit	Result
5G NR, BRS Band n41, 2496 MHz to 2690 MHz				
15 MHz Channel Bandwidth				
QPSK Modulation				
Mid Channel, 2592.99 MHz	13.612 MHz	14.712 MHz	Within Band	Pass
16QAM Modulation				
Mid Channel, 2592.99 MHz	13.676 MHz	14.817 MHz	Within Band	Pass
64QAM Modulation				
Mid Channel, 2592.99 MHz	13.623 MHz	14.677 MHz	Within Band	Pass
256QAM Modulation				
Low Channel, 2503.50 MHz	13.616 MHz	14.752 MHz	Within Band	Pass
Mid Channel, 2592.99 MHz	13.621 MHz	14.808 MHz	Within Band	Pass
High Channel, 2682.48 MHz	13.607 MHz	14.784 MHz	Within Band	Pass

OCCUPIED BANDWIDTH

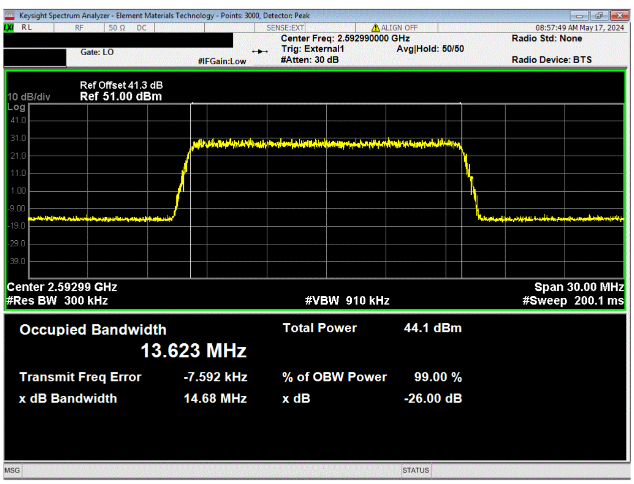
TbtTx 2023.12.06.3
WTD.2024.01.16.0



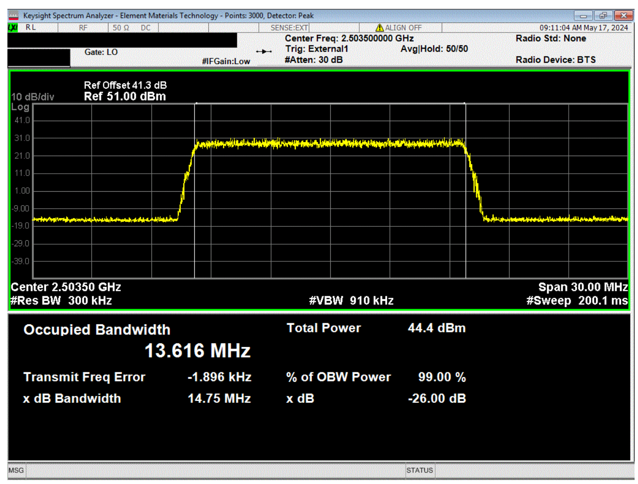
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
QPSK
Mid Channel, 2592.99 MHz



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
16QAM
Mid Channel, 2592.99 MHz

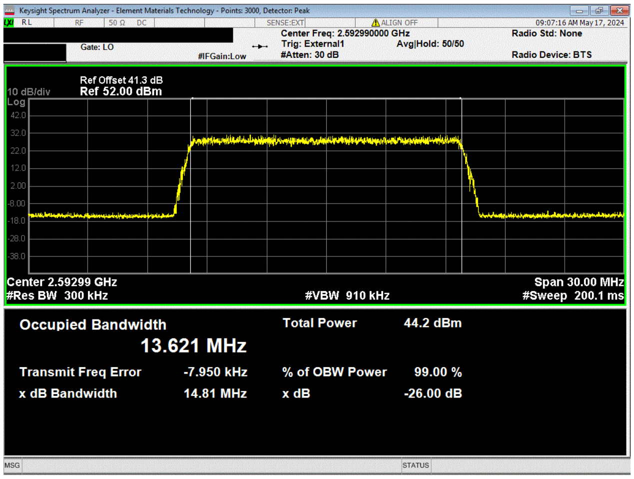


5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
64QAM
Mid Channel, 2592.99 MHz

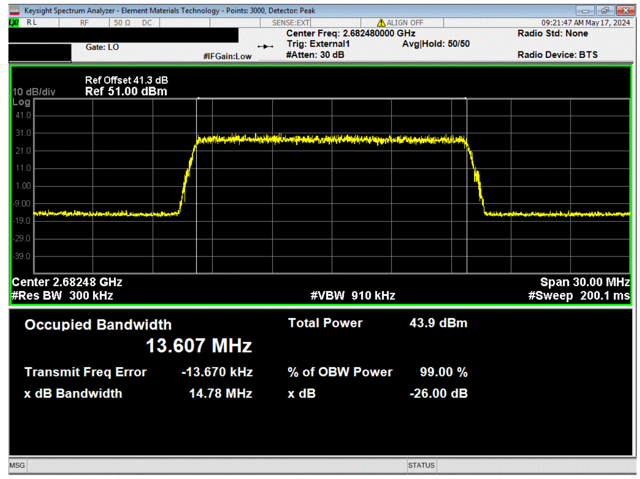


5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Low Channel, 2503.50 MHz

OCCUPIED BANDWIDTH



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Mid Channel, 2592.99 MHz



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
High Channel, 2682.48 MHz

AVERAGE POWER

TEST DESCRIPTION

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The fundamental emission Output Power (maximum average conducted output power) was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

RF conducted emissions testing was performed only on one port. The testing was performed on the same version of hardware AZHL as the original certification test. The AZHL antenna ports are essentially electrically identical (the RF power variation between antenna ports is small as shown in this certification testing) and antenna port 1 was selected to perform the testing under this effort as allowed by ANSI C63.26-2015 paragraphs 5.2.5.3, 5.7.2i and 6.4.

The RMS average power measurement method for FCC is detailed in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.4.4. This method uses trace averaging across the ON and OFF times of the EUT transmissions in the spectrum analyzer channel power function using an RMS detector. Following the measurement a duty cycle correction was applied by adding [10 log (1/D)], where D is the duty cycle in decimal, to the measured power to compute the average power during the actual transmission times.

The RMS average power measurement method for FCC is detailed in section 5.2 of KDB 971168 D01v03r01 and ANSI C63.26-2015 section 5.2.4.4. Measurements shall be performed at full power on the channel(s) and bandwidth(s) specified by the TCB for 4G LTE and 5G NR.

The output power was measured for a single carrier over the carrier channel bandwidth. The total output power for multiport (2x2 MIMO, 4x4 MIMO, 8x8 MIMO) operations was determined based per ANSI C63.26 clauses 6.4.3.1 and 6.4.3.2.4 (10 log N_{out}). The total output power for two port operation is the single port power +3 dB [i.e. 10*log(2)]. The total power for four port operations is single port power +6 dB [i.e. 10*log(4)]. The total power for eight port operation is single power +9 dB [i.e. 10*log(8)].

The EIRP limit is defined by 27.50(h)(ii) as 33dBW+ 10Log(X/Y) dBW + 10 log(360/beamwidth) dBW where X is the channel width in MHz and Y is 5.5 or 6MHz. Power Spectral Density (power/1MHz) measurements are not required for this radio since the FCC limits for EIRP are in watts.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFQ	2024-03-12	2025-03-12
Generator - Signal	Agilent	N5173B	TIW	2023-08-07	2026-08-07
Block - DC	Fairview Microwave	SD3379	AMM	2023-08-04	2024-08-04

5G NR EIRP Calculations for Eight Port MIMO Operations

EIRP calculations are needed at each transmitter location to optimize base station operational performance while meeting regulatory requirements. Each cell site installation needs to consider the power measurements in the radio certification report as well as site specific regulatory requirements (such as antenna height, population density, etc.), site installation parameters (line loss between antenna and radio, antenna parameters, etc.) and base station operational parameters (MIMO operational setup, carrier power level, channel bandwidth, modulation type, etc.) to optimize performance. Transmitter output power may be reduced (from maximum) by base station setup parameters. Base station antennas are selected by the customer.

The base station antenna is selected by the customer and this EIRP calculation is based upon a sample worst case antenna. The EIRP calculation is based upon the Commscope Planar Array Antenna model T4-90A-R1-V2. This antenna assembly has four columns with a maximum beamforming gain of 22.3 ± 0.8dBi. The columns within the antenna have ±45° cross-polarized (orthogonal) radiators. The eight AZHL transmitter outputs are connected to the columns (four are connected to +45° radiators/antennas and four are connected to the -45° radiators/antennas). The AZHL provides transmitter outputs for one 4-column antenna.

Equivalent Isotropically Radiated Power (EIRP) is calculated (as specified in ANSI C63.26-2015 section 6.4 for a system of correlated output signals) from the results of power measurements (highest measured average power for each channel bandwidth type). The maximum antenna assembly beamforming gain was used for this calculation. The cable loss between the antenna and transmitter is site dependent (will not be 0 dB) but for this worst case EIRP calculation 0 dB was used. Calculations of worst-case EIRP for eight port MIMO are as follows:

Parameter	15 MHz Ch BW
Power Out /Radio Antenna Port	37.6 dBm
Cable Loss	0 dB
Number of Ant Ports per Polarization	4
Total Power per Polarization	43.6 dBm
Maximum Antenna Beamforming Gain per Polarization	23.1 dBi
EIRP per Polarization	66.7 dBm
Number of Polarizations	2
EIRP Total (See Note 1)	66.7 dBm
EIRP Limit Calculation (See Note 2)	78.4 dBm

Note 1: The EIRP per antenna polarity is required to be below the regulatory limit as described in ANSI C63.26-2015 section 6.4.6.3 b)2) and KDB 662911 D02v01 page 3 example (2) since the two transmitter outputs to each antenna are 90 degree-phase shifted relative to each other (cross-polarized radiators).

Note 2: The EIRP limit is defined by FCC part 27.50(h)(ii) as 33dBW+ 10Log(X/Y) dBW + 10 log(360/beamwidth) dBW where X is the channel width in MHz and Y is 5.5 or 6MHz. The Commscope model T4-90A-R1-V2 antenna has a horizontal beamwidth of 26 degrees. Y was selected to be 6MHz for this calculation.

Calculation Summary: The worst case AZHL eight port MIMO EIRP levels for all 5G NR channel bandwidths using the Commscope antenna assembly model “T4-90A-R1-V2” are less than the FCC regulatory limits.

AVERAGE POWER

element
TbtTx 2023.12.06.3
WTD.2024.01.16.0

EUT:	Airscale Base Transceiver Station Remote Radio Head, Model AZHL	Work Order:	NOKI0077
Serial Number:	YK203400016	Date:	2024-05-16
Customer:	Nokia Solutions and Networks	Temperature:	21.4°C
Attendees:	John Rattanavong, Mitch Hill	Relative Humidity:	59%
Customer Project:	None	Bar. Pressure (PMSL):	1010 mbar
Tested By:	Jarrod Brenden	Job Site:	TX07
Power:	54 VDC	Configuration:	NOKI0077-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 27:2024	ANSI C63.26:2015

COMMENTS

Losses in the measurement path were accounted for in the reference level offset; DC block, attenuators, cables, and filters where used. External 1 gating was set using a trigger delay = 5.006ms and a gate length = 3.6408ms. The 15Mhz Carrier power is set to maximum at 5.6watt/port for all testing.

DEVIATIONS FROM TEST STANDARD

None

CONCLUSION

Pass

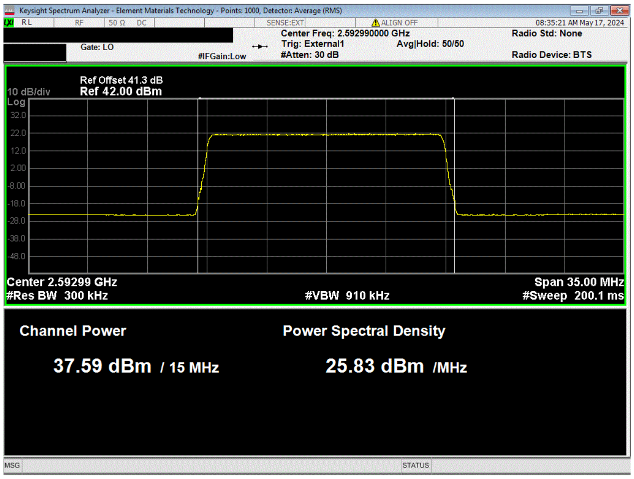
Tested By

TEST RESULTS

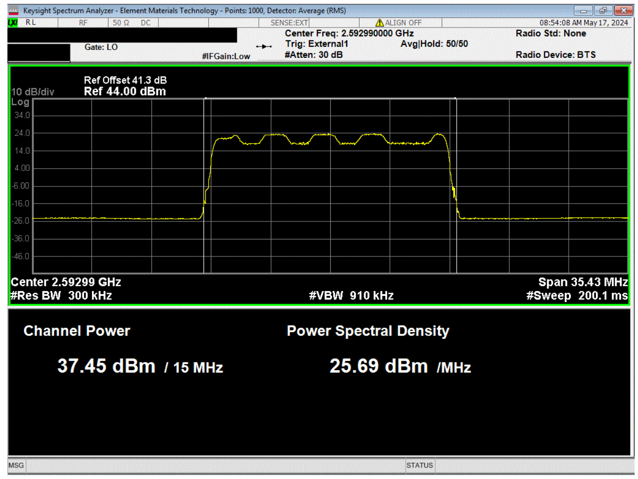
	Initial Value dBm/Carrier BW	Duty Cycle	Single Port dBm/Carrier BW	2 Port (2x2 MIMO) dBm/Carrier BW	4 Port (4x4 MIMO) dBm/Carrier BW	8 Port (8x8 MIMO) dBm/Carrier BW
5G NR, BRS Band n41, 2496 MHz to 2690 MHz						
15 MHz Channel Bandwidth						
QPSK Modulation						
Mid Channel, 2592.99 MHz	37.593	0	37.59	40.59	43.59	46.59
16QAM Modulation						
Mid Channel, 2592.99 MHz	37.449	0	37.45	40.45	43.45	46.45
64QAM Modulation						
Mid Channel, 2592.99 MHz	37.399	0	37.40	40.40	43.40	46.40
256QAM Modulation						
Low Channel, 2503.50 MHz	37.649	0	37.65	40.65	43.65	46.65
Mid Channel, 2592.99 MHz	37.435	0	37.44	40.44	43.44	46.44
High Channel, 2682.48 MHz	37.123	0	37.12	40.12	43.12	46.12

AVERAGE POWER

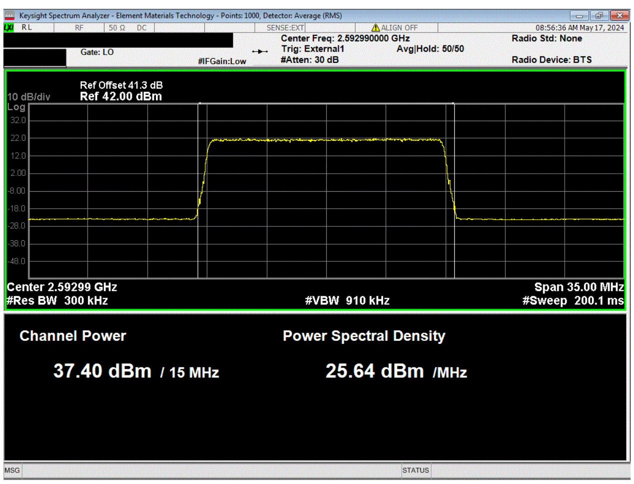
TbtTx 2023.12.06.3
WTD.2024.01.16.0



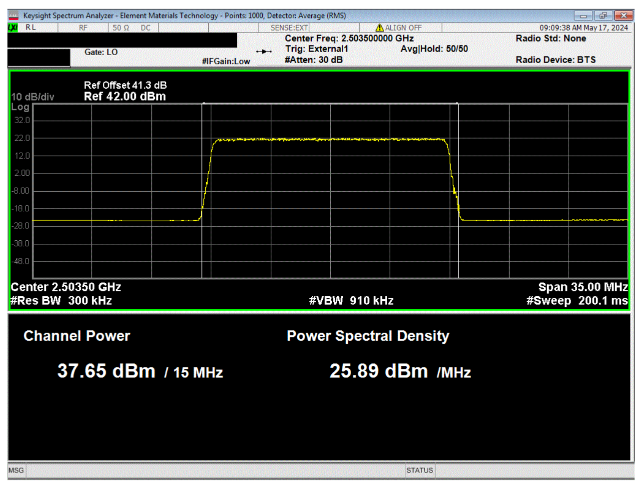
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
QPSK
Mid Channel, 2592.99 MHz



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
16QAM
Mid Channel, 2592.99 MHz



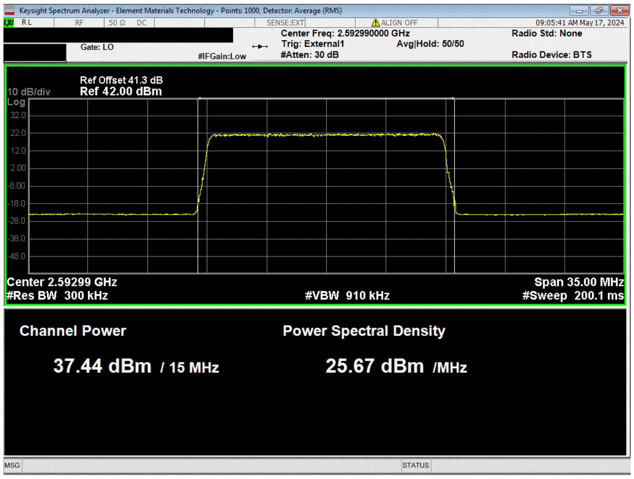
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
64QAM
Mid Channel, 2592.99 MHz



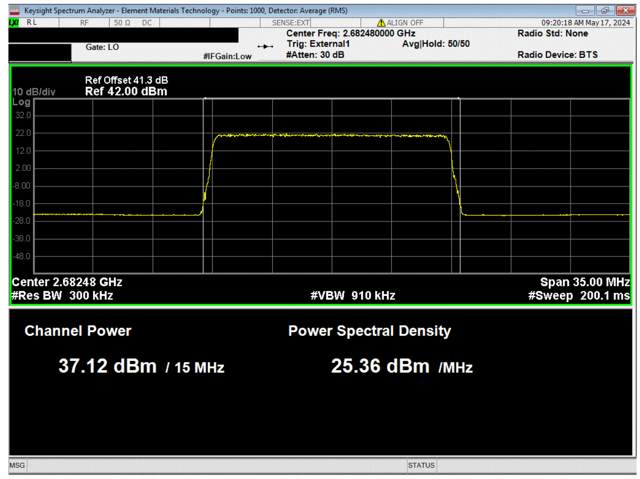
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Low Channel, 2503.50 MHz

AVERAGE POWER

TbtTx 2023.12.06.3
WTD.2024.01.16.0



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Mid Channel, 2592.99 MHz



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
High Channel, 2682.48 MHz

BAND EDGE COMPLIANCE

element
TbtTx 2023.12.06.3
WTD.2024.01.16.0

TEST DESCRIPTION

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The spurious RF conducted emissions at the edges of the authorized bands were measured on the low and high transmit frequencies of the available band. The channels closest to the band edges were selected. The EUT was transmitting at the power and data rate(s) listed in the datasheet.

RF conducted emissions testing was performed only on one port. The testing was performed on the same version of hardware (AZHL) as the original certification test. The AZHL antenna ports are essentially electrically identical (the RF power variation between antenna ports is small as shown in this certification testing) and antenna port 1 was selected to perform the testing under this effort as allowed by ANSI C63.26-2015 paragraph 5.7.2i.

The spectrum was scanned below the lower band edge and above the higher band edge.

The measurement methods for FCC measurements are detailed in KDB971168 D01v03 section 6 and ANSI C63.26-2015. Measurements shall be performed at full power on the channel(s) and bandwidth(s) specified by the compliance lab for 5G NR modulation. These measurements are for first 1.0 MHz bands immediately outside and adjacent to the frequency block.

Per section 27.53(m)(2), the power of any emission outside of the authorized operating frequency range cannot exceed -13 dBm. The BTS operates as a 8 port MIMO transmitter with transmitter outputs connected to four cross-polarized antennas [four transmitter outputs are connected to (+) radiators and four transmitter outputs are connected to (-) radiators]. The limit is adjusted to -19 dBm [-13 dBm -10 log (4)] per FCC KDB 662911D01 v02r01, ANSI C63.26-2015 section 6.4.6.3 b)2) and KDB 662911 D02v01 page 3 example (2) since the transmitter outputs to each antenna are 90 degree-phase shifted relative to each other (cross-polarized radiators).

The resolution bandwidth to be used for these measurements shall be 1% of the measured emission bandwidth per FCC 27.53(m)(6). A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided that the measured power is integrated over the full required measurement bandwidth (i.e.: 1MHz or 1% of measured emission bandwidth as specified) per FCC 27.53(m)(6).

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFQ	2024-03-12	2025-03-12
Generator - Signal	Agilent	N5173B	TIW	2023-08-07	2026-08-07
Block - DC	Fairview Microwave	SD3379	AMM	2023-08-04	2024-08-04

BAND EDGE COMPLIANCE

TbtTx 2023.12.06.3
WTD.2024.01.16.0

EUT:	Airscale Base Transceiver Station Remote Radio Head, Model AZHL	Work Order:	NOKI0077
Serial Number:	YK203400016	Date:	2024-05-16
Customer:	Nokia Solutions and Networks	Temperature:	20.6°C
Attendees:	John Rattanavong, Mitch Hill	Relative Humidity:	61.4%
Customer Project:	None	Bar. Pressure (PMSL):	1007 mbar
Tested By:	Jarrod Brenden	Job Site:	TX07
Power:	54 VDC	Configuration:	NOKI0077-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 27:2024	ANSI C63.26:2015

COMMENTS

Losses in the measurement path were accounted for in the reference level offset; DC block, attenuators, cables, and filters where used. External 1 gating was set using a trigger delay = 5.006ms and a gate length = 3.6408ms. The 15Mhz Carrier power is set to maximum at 5.6watt/port for all testing.

DEVIATIONS FROM TEST STANDARD

None

CONCLUSION

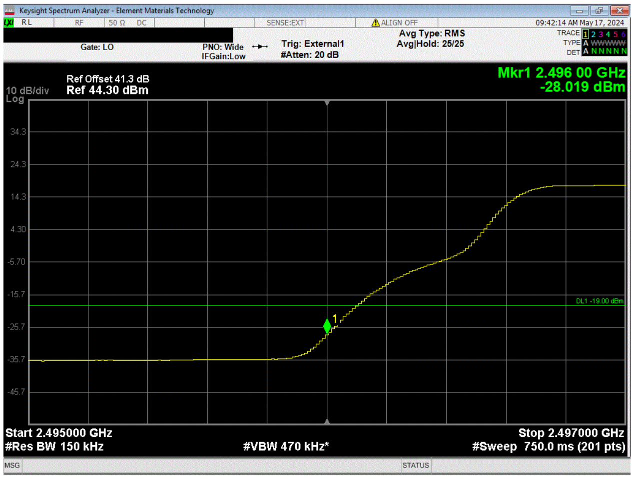
Pass

Tested By

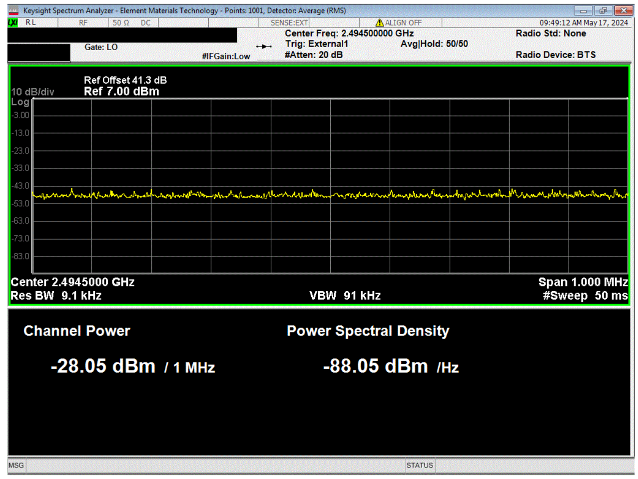
TEST RESULTS

	Frequency Range	Value (dBm)	Limit (dBm)	Result
5G NR, BRS Band n41, 2496 MHz to 2690 MHz				
15 MHz Channel Bandwidth				
256QAM Modulation				
Low Channel, 2503.50 MHz	2495 MHz - 2497 MHz	-28.019	-19	Pass
	2494 MHz - 2495 MHz	-28.05	-19	Pass
	2474 MHz - 2494 MHz	-27.499	-19	Pass
High Channel, 2682.48 MHz	2689 MHz - 2691 MHz	-30.752	-19	Pass
	2691 MHz - 2692 MHz	-27.92	-19	Pass
	2692 MHz - 2712 MHz	-27.101	-19	Pass

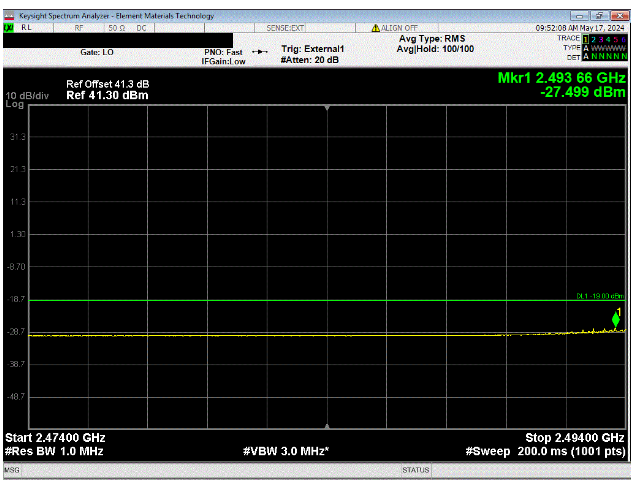
element
TbtTx 2023.12.06.3
WTD.2024.01.16.0



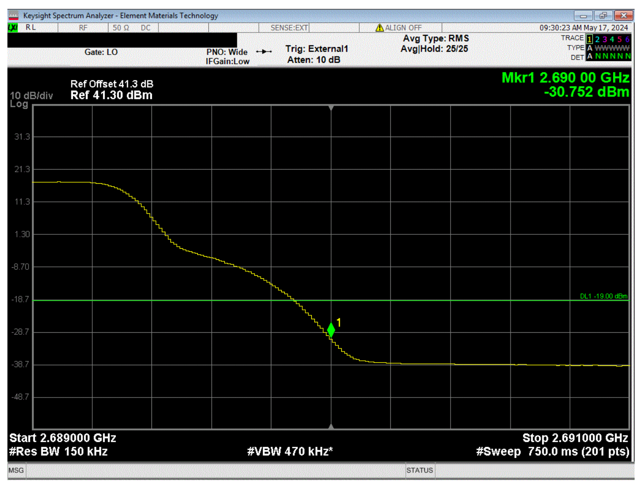
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Low Channel, 2503.50 MHz



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Low Channel, 2503.50 MHz



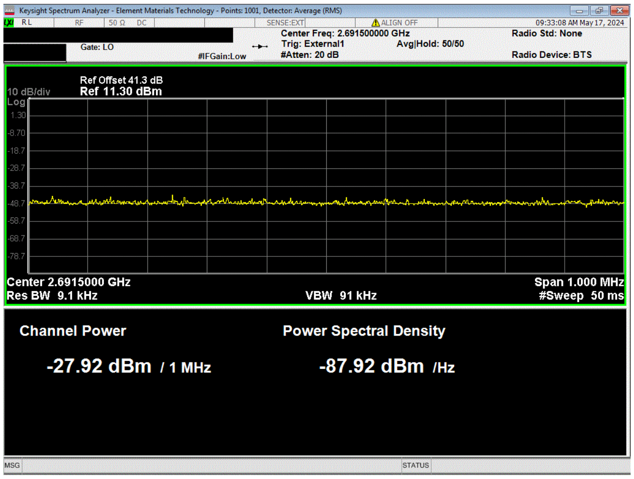
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Low Channel, 2503.50 MHz



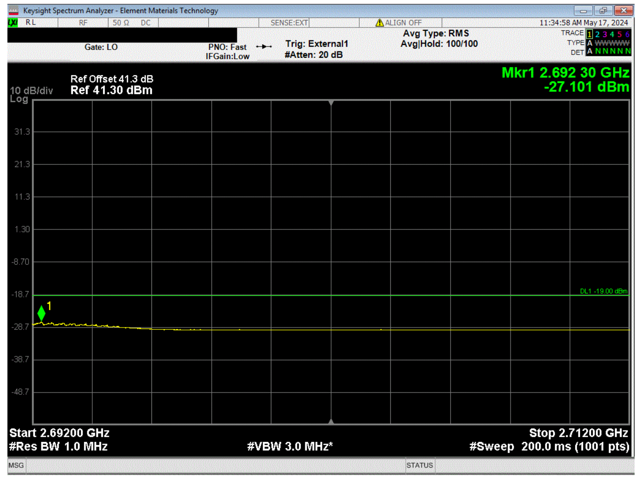
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
High Channel, 2682.48 MHz

BAND EDGE COMPLIANCE

TbtTx 2023.12.06.3
WTD.2024.01.16.0



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
High Channel, 2682.48 MHz



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
High Channel, 2682.48 MHz

SPURIOUS CONDUCTED EMISSIONS

element
TbtTx 2023.12.06.3
WTD.2024.01.16.0

TEST DESCRIPTION

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The antenna port spurious emissions were measured at the RF output terminal of the EUT through four different attenuation configurations which continues through to the RF input of the spectrum analyzer. Analyzer plots utilizing a resolution bandwidth called out by the client's test approach were made 256QAM modulation from 9 kHz to 27 GHz. The conducted power of spurious emissions, up to the 10th harmonic of the transmit frequency, were investigated to ensure they were less than the limits also called out by the client's test plan (included elsewhere in this report).

RF conducted emissions testing was performed only on one port. The AZHL antenna ports are essentially electrically identical (the RF power variation between antenna ports is small as shown in output power testing) and antenna port 1 was selected to perform the testing under this effort as allowed by ANSI C63.26-2015 paragraphs 5.2.5.3, 5.7.2i, and 6.4.

Per section 27.53(m)(2), the power of any emission outside of the authorized operating frequency range cannot exceed -13 dBm. The BTS operates as a 8 port MIMO transmitter with transmitter outputs connected to four cross-polarized antennas [four transmitter outputs are connected to (+) radiators and four transmitter outputs are connected to (-) radiators]. The limit is adjusted to -19 dBm [-13 dBm -10 log (4)] per FCC KDB 662911D01 v02r01, ANSI C63.26-2015 section 6.4.6.3 b)2) and KDB 662911 D02v01 page 3 example (2) since the transmitter outputs to each antenna are 90 degree-phase shifted relative to each other (cross-polarized radiators).

The limit for the 9kHz to 150kHz frequency range was adjusted to –49dBm to correct for a spectrum analyzer RBW of 1kHz versus required RBW of 1MHz [i.e.: -49dBm = -19dBm -10log(1MHz/1kHz)]. The limit for the 150kHz to 20MHz frequency range was adjusted to –39dBm to correct for a spectrum analyzer RBW of 10kHz versus required RBW of 1MHz [i.e.: -39dBm = -19dBm -10log(1MHz/10kHz)]. The required limit of -19dBm with a RBW of $\geq$ 1MHz was used for all other frequency ranges.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFQ	2024-03-12	2025-03-12
Generator - Signal	Agilent	N5173B	TIW	2023-08-07	2026-08-07
Block - DC	Fairview Microwave	SD3379	AMM	2023-08-04	2024-08-04
Block - DC	Fairview Microwave	SD3235-2148	ANF	2023-05-24	2024-05-24

SPURIOUS CONDUCTED EMISSIONS

element
TbtTx 2023.12.06.3
WTD.2024.01.16.0

EUT:	Airscale Base Transceiver Station Remote Radio Head, Model AZHL	Work Order:	NOKI0077
Serial Number:	YK203400016	Date:	2024-05-16
Customer:	Nokia Solutions and Networks	Temperature:	21.7°C
Attendees:	John Rattanavong, Mitch Hill	Relative Humidity:	58.3%
Customer Project:	None	Bar. Pressure (PMSL):	1010 mbar
Tested By:	Jarrod Brenden	Job Site:	TX07
Power:	54 VDC	Configuration:	NOKI0077-1 NOKI0077-2 NOKI0077-3 NOKI0077-4

TEST SPECIFICATIONS

Specification:	Method:
FCC 27:2024	ANSI C63.26:2015

COMMENTS

Losses in the measurement path were accounted for in the reference level offset; DC block, attenuators, cables, and filters where used and in the appropriate frequency range and configuration. External 1 gating was set using a trigger delay = 5.006ms and a gate length = 3.6408ms. The 15Mhz Carrier power is set to maximum at 5.6watt/port for all testing.

DEVIATIONS FROM TEST STANDARD

None

CONCLUSION

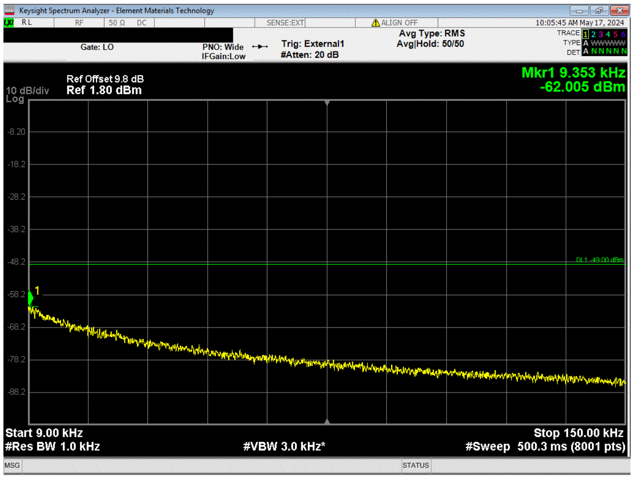
Pass

Tested By

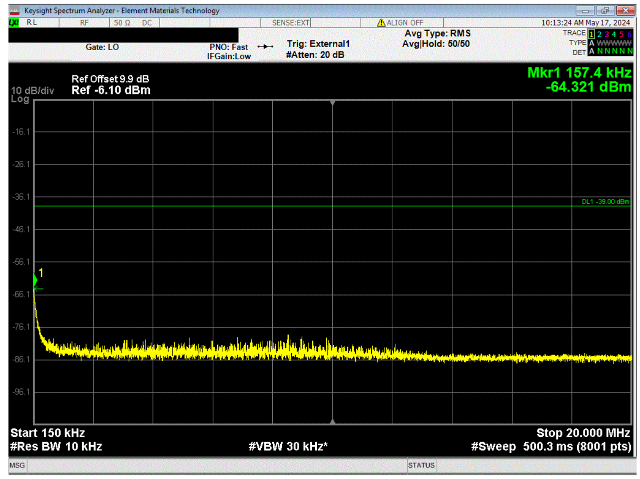
TEST RESULTS

	Frequency Range	Measured Freq (MHz)	Max Value (dBm)	Limit (dBm)	Result
5G NR, BRS Band n41, 2496 MHz to 2690 MHz					
15 MHz Channel Bandwidth					
256QAM Modulation					
Mid Channel, 2592.99 MHz	9 kHz - 150 kHz	0.01	-62.01	-49	Pass
	150 kHz - 20 MHz	0.16	-64.32	-39	Pass
	20 MHz - 4 GHz	3999.01	-28.05	-19	Pass
	4 GHz - 11 GHz	4024.85	-49.17	-19	Pass
	11 GHz - 18 GHz	14336.9	-47.47	-19	Pass
	18 GHz - 27 GHz	26125.2	-49.8	-19	Pass

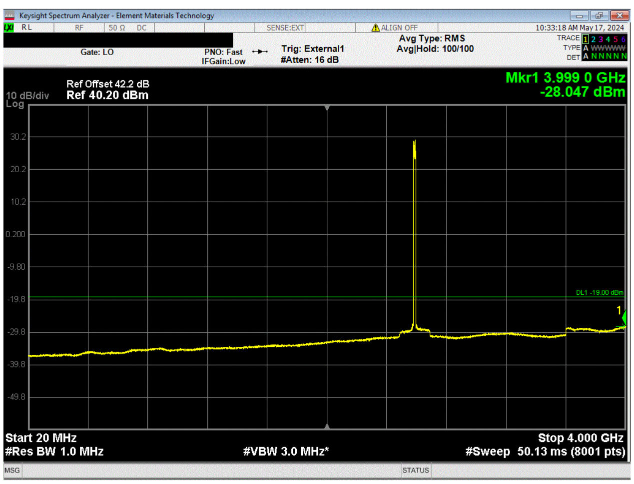
SPURIOUS CONDUCTED EMISSIONS



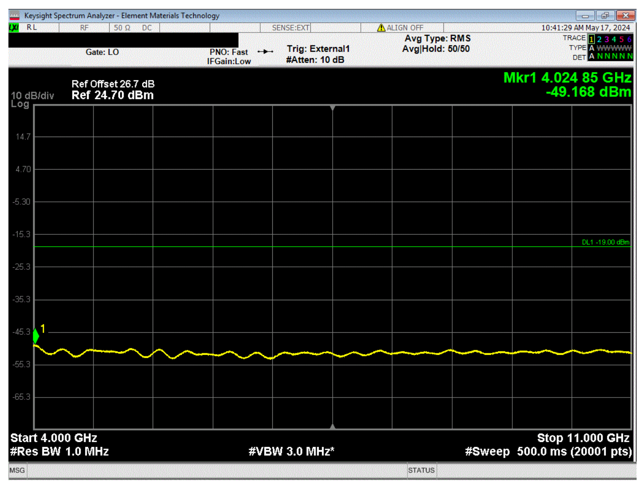
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Mid Channel, 2592.99 MHz



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Mid Channel, 2592.99 MHz



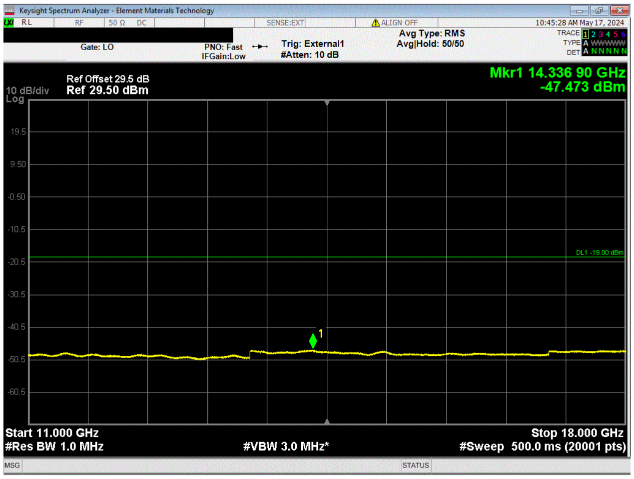
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Mid Channel, 2592.99 MHz



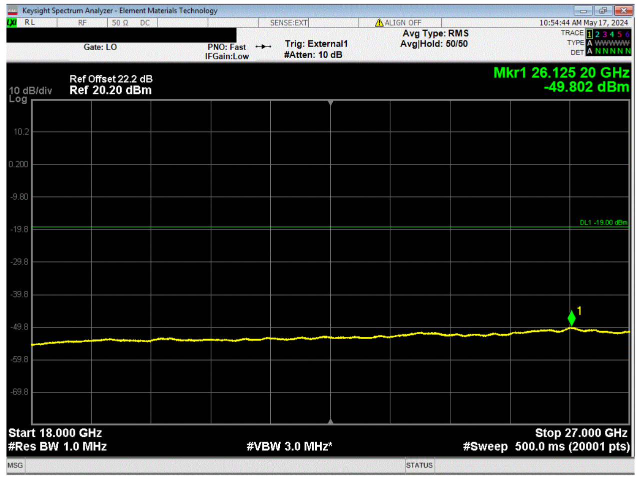
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Mid Channel, 2592.99 MHz

SPURIOUS CONDUCTED EMISSIONS

TbtTx 2023.12.06.3
WTD.2024.01.16.0



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Mid Channel, 2592.99 MHz



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Mid Channel, 2592.99 MHz

PEAK AND AVERAGE (PAPR) CCDF

TbtTx 2023.12.06.3
WTD.2024.01.16.0

TEST DESCRIPTION

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer.

The fundamental emission Peak to Average Power was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

RF conducted emissions testing was performed only on one port. The testing was performed on the same version of hardware (AZHL) as the original certification test. The AZHL antenna ports are essentially electrically identical (the RF power variation between antenna ports is small as shown in this certification testing) and antenna port 1 was selected to perform the testing under this effort as allowed by ANSI C63.26-2015 paragraphs 5.2.5.3, 5.7.2i, and 6.4.

Because the conducted Output Power was measured using a RMS Average detector, the Peak to Average Power Ratio (PAPR) was measured to show that the maximum peak-max-hold spectrum to the maximum of the average spectrum does not exceed the rule part defined limit.

The PAPR measurement method is described in KDB971168 D01v03r01 and ANSI C63.26 section 5.2.3.4.

The PAPR was measured using the CCDF function of the spectrum analyzer.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFQ	2024-03-12	2025-03-12
Generator - Signal	Agilent	N5173B	TIW	2023-08-07	2026-08-07
Block - DC	Fairview Microwave	SD3379	AMM	2023-08-04	2024-08-04

PEAK AND AVERAGE (PAPR) CCDF

element
TbtTx 2023.12.06.3
WTD.2024.01.16.0

EUT:	Airscale Base Transceiver Station Remote Radio Head, Model AZHL	Work Order:	NOKI0077
Serial Number:	YK203400016	Date:	2024-05-16
Customer:	Nokia Solutions and Networks	Temperature:	19.3°C
Attendees:	John Rattanavong, Mitch Hill	Relative Humidity:	62.2%
Customer Project:	None	Bar. Pressure (PMSL):	1007 mbar
Tested By:	Jarrod Brenden	Job Site:	TX07
Power:	54 VDC	Configuration:	NOKI0077-2

TEST SPECIFICATIONS

Specification:	Method:
FCC 27:2024	ANSI C63.26:2015

COMMENTS

Losses in the measurement path were accounted for in the reference level offset; DC block, attenuators, cables, and filters where used. External 1 gating was set using a trigger delay = 5.006ms and a gate length = 3.6408ms. The 15Mhz Carrier power is set to maximum at 5.6watt/port for all testing.

DEVIATIONS FROM TEST STANDARD

None

CONCLUSION

Pass

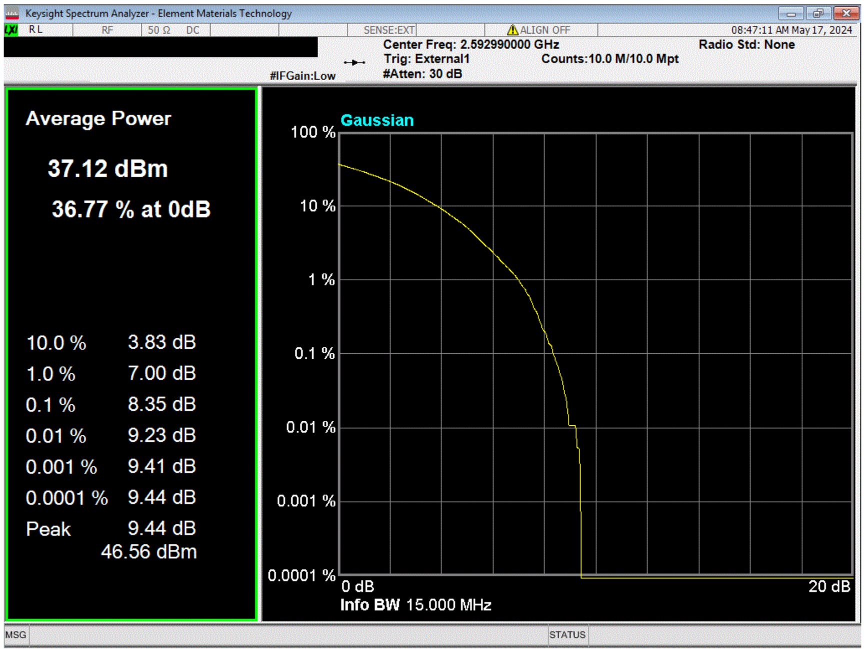
Tested By

TEST RESULTS

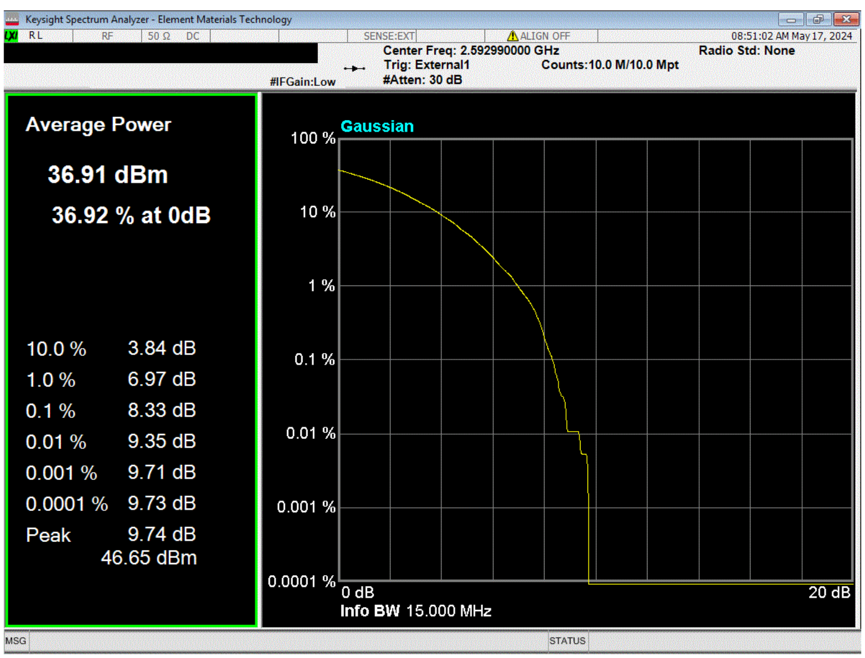
	0.1% Value (dB)	Limit (dB)	Results
5G NR, BRS Band n41, 2496 MHz to 2690 MHz			
15 MHz Channel Bandwidth			
QPSK Modulation			
Mid Channel, 2592.99 MHz	8.35	13	Pass
16QAM Modulation			
Mid Channel, 2592.99 MHz	8.33	13	Pass
64QAM Modulation			
Mid Channel, 2592.99 MHz	8.54	13	Pass
256QAM Modulation			
Low Channel, 2503.50 MHz	8.3	13	Pass
Mid Channel, 2592.99 MHz	8.36	13	Pass
High Channel, 2682.48 MHz	8.54	13	Pass

PEAK AND AVERAGE (PAPR) CCDF

TbtTx 2023.12.06.3
WTD.2024.01.16.0

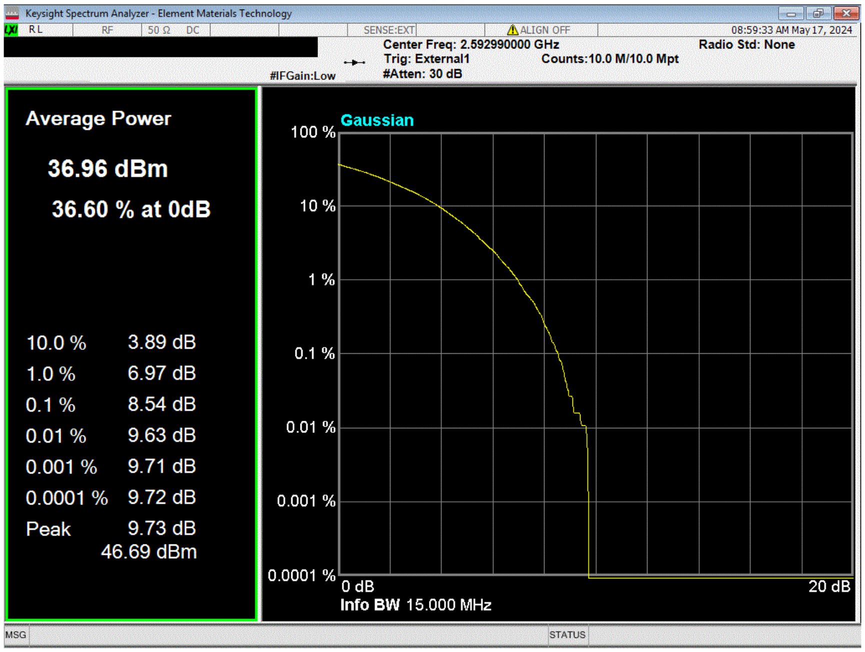


5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
QPSK
Mid Channel, 2592.99 MHz

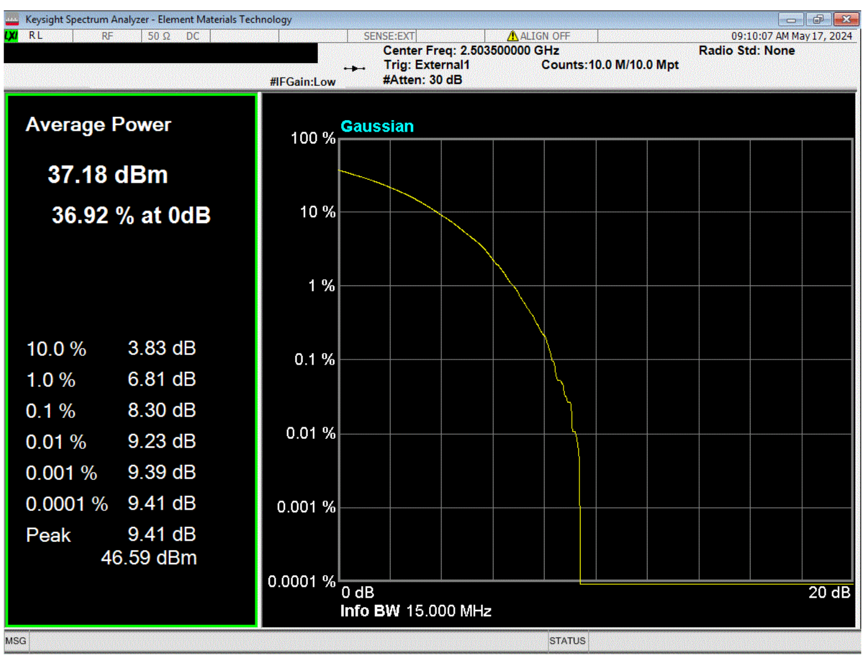


5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
16QAM
Mid Channel, 2592.99 MHz

PEAK AND AVERAGE (PAPR) CCDF



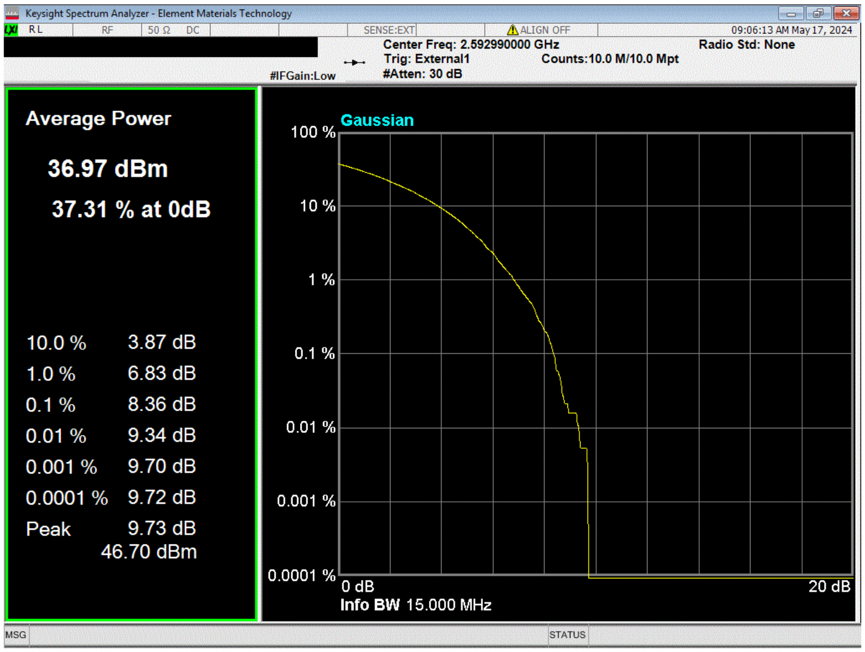
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
64QAM
Mid Channel, 2592.99 MHz



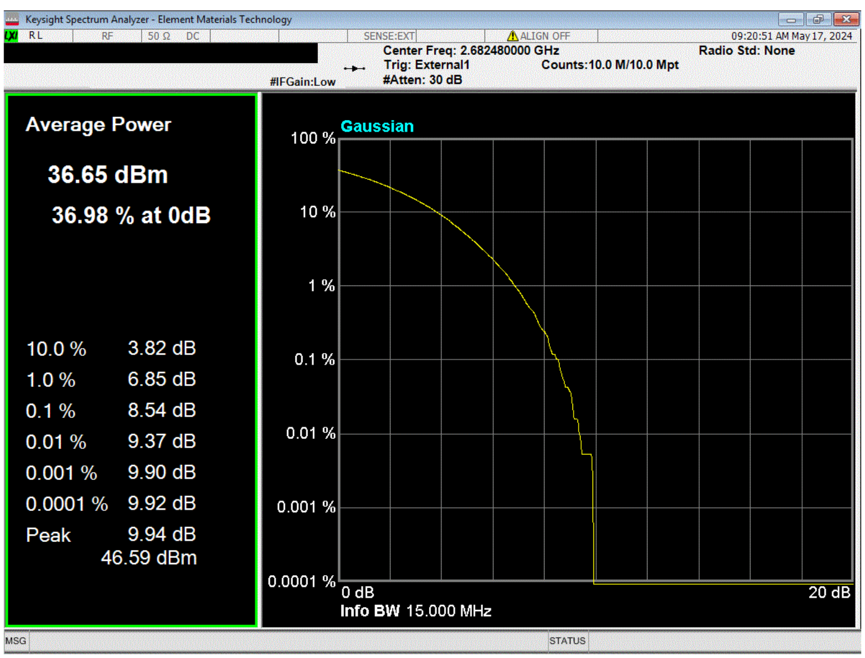
5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Low Channel, 2503.50 MHz

PEAK AND AVERAGE (PAPR) CCDF

TbtTx 2023.12.06.3
WTD.2024.01.16.0



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
Mid Channel, 2592.99 MHz



5G NR, BRS Band n41, 2496 MHz to 2690 MHz
15 MHz Channel Bandwidth
256QAM
High Channel, 2682.48 MHz

End of Test Report