

RF Exposure Evaluation Declaration

Product Evaluated

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

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Revisions

Date	Revision	Section	Change
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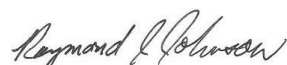
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1. Introduction

This RF Exposure Assessment applies to the Nokia 3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC), hereinafter referred to as the **AZQC**, as operated under Part 96 in the CBRS Band. The AZQC is a 4xMIMO transmitter rated at 5W/ 37dBm per Tx port. The total unit power is limited to 20W/43dBm. This RF assessment is also called the Maximum Permissible Exposure (**MPE**).

1.1 Purpose and Scope

The purpose of this document is to provide the overall RF exposure assessment for the 3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC) product when operated with the Nokia supplied antenna. The FCC requires the evaluation and documentation of the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Title 47CFR Section 1.1307(b). The safe distances documented herein are applicable only with the Nokia supplied antenna as documented.

If the product is installed with other antenna(s), 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).

1.2 Product Description

This 3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC) is a single box base station that supports 2x and 4x MIMO LTE operation in Band 48. Each LTE Radio Module supports 4 duplex Tx/Rx ports.

Each of the 4 LTE TX ports branches has a rated maximum RF output power of 5W for a total power of 20W for the product.

Under Part 96 the AZQC is limited to a maximum power of 47 dBm/ 10 MHz EIRP. The maximum total output power of 20W/43 dBm as applied to the maximum 4 carrier signal bandwidth of 80 MHz results in a conducted carrier power of 0.25W/24dBm/10MHz. Under these conditions the maximum allowable antenna gain is 23.02 dBi. The antenna supplied with the AZQC has a specified gain of 10.5 dBi.

1.2.1 Product Installation and Usage

The Nokia 3.5GHz AirScale Micro RRH 4T/4R 20W (AZQC) is professionally installed on poles or walls in fixed locations. Therefore, AZQC is neither a portable nor a mobile wireless device.).

The AZQC outputs are directly-connected to an antenna module supplied by Nokia or customer-supplied remote antennas. In this evaluation, only the Nokia supplied antennas per Table 1.2.1 were evaluated. The limits specified in FCC Section 1.1310 Table 1(B) for occupational/ controlled exposure and general population/uncontrolled exposure, which are tabulated below in Table 1.4, shall be met.

Table 1.2.1. Nokia Supplied 10.5 dBi Gain Directional Antenna

Model	Frequency Range GHz	Nominal Gain dBi	Supported Configuration	Horizontal Beamwidth	Vertical Beamwidth	Polarization
AAQA-474520A 474156A	3.3-3.8	10.5 dBi	4Tx/4Rx MIMO	65° +/- 10	35° +/- 10	±45° Cross Polarized

1.3 Required Limits

1.3.1 47CFR Part 1.1310 Radio Frequency Radiation Exposure Limits

Per 47CFR-1.1310 "The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Section 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of § 2.1093 of this chapter. Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation"

Table 1 FCC Part 1.1310 LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (Minutes)
(A) Limits for Occupational/ Control Exposures				
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6
(B) Limits for General Population/ Uncontrolled Exposures				
300-1500	--	--	f/1500	6
1500-100,000	--	--	1	30

Where f is the frequency in MHz

1.3.2 47CFR Part 15.247(i) RF Exposure Requirement for 2.4GHz DTS (Digital Transmission System) Unlicensed Transmitter Operating in 2400-2483.5MHz Band."

Per Section 15.247 "Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See 1.1307(b)(1) of this chapter."

1.3.3 47CFR Part 15.407(f) RF Exposure Requirement for 5GHz UNII (National Information Infrastructure) Unlicensed Transmitter Operating in the 5.15-5.35 GHz, 5.47-5.725 GHz and 5.725-5.85 GHz bands

U-NII devices are subject to the radio frequency radiation exposure requirements specified in 1.1307(b), 2.1091 and 2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a "general population/uncontrolled" environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

1.3.4 47CFR 1.1307 Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.

(b) In addition to the actions listed in paragraph (a) of this section, Commission actions granting construction permits, licenses to transmit or renewals thereof, equipment authorizations or modifications in existing facilities, require the preparation of an Environmental Assessment (EA) if the particular facility, operation or transmitter would cause human exposure to levels of radiofrequency radiation in excess of the limits in §§1.1310 and 2.1093 of this chapter. Applications to the Commission for construction permits, licenses to transmit or renewals thereof, equipment authorizations or modifications in existing facilities must contain a statement confirming compliance with the limits unless the facility, operation, or transmitter is categorically excluded, as discussed below. Technical information showing the basis for this statement must be submitted to the Commission upon request. Such compliance statements may be omitted from license applications for transceivers subject to the certification requirement in §25.129 of this chapter.

1.4 Evaluation Rational

According to 47CFR Part 1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in 1.1307(b)

Table 1.4 FCC Part 1.1310 LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (Minutes)
(A) Limits for Occupational/ Control Exposures				
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6
(B) Limits for General Population/ Uncontrolled Exposures				
300-1500	--	--	f/1500	6
1500-100,000	--	--	1	30

Where f is the frequency in MHz

1.4.1 Calculations

The calculation of 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.

$$\text{Equation for Power Density } P_d = (P_{\text{output}} G_{AV}) / (4\pi r^2) \quad (1)$$

Per FCC's OST/OET Bulletin Number 65, the appropriate EIRP (equivalent or effective isotropically radiated power) limits can be calculated based on the relationship between power density and EIRP.

$$P_d = (EIRP) / (4\pi r^2) \quad (2)$$

$$\text{Therefore: } r = ((EIRP) / (4\pi P_d))^{0.5} = ((P_{\text{output}} G_{AV}) / (4\pi P_d))^{0.5} \quad (3)$$

Where:

P_d	= power density in mW/cm ²	G_{AV}	= Antenna Gain, Linear = 10 ^(GdBi/10)
P_{output}	= output power to antenna in mW	π	= 3.141592654
P_d	= MPE Limit, mW/cm ²	$EIRP$	= $P_{\text{output}} G_{AV}$
r	= distance to antenna, cm		

Since all of the transmitters operate between 1900 – 5900 MHz the overall evaluation can be performed as a worst case analysis by summation of the total power density and evaluation of the safe distance from the total combined EIRP.

$$\Sigma EIRP = P_{\text{outputPort1}} G_{AVPort1} + P_{\text{outputPort2}} G_{AVPort2} + \dots P_{\text{outputPortn}} G_{AVPortn} \quad (4)$$

$$\text{Therefore: } r = ((\Sigma EIRP) / (4\pi P_d))^{0.5} \quad (5)$$

$$\text{And } EIRP(\text{mW}) = 10^{(0.1 * EIRP_{\text{dBm}})} \quad (6)$$

1.4.2 Values Used for Calculations

1.4.2.1 RF Power

The maximum authorized output power for the AZQC Band 48 transmitters under FCC ID: 2AD8UAZQCRH1. The products total power, $5W/\text{port} \times 4 \text{ ports} = 20 \text{ Watts total}$ was used for the assessment.

1.4.2.2 Antenna Gain

The unit is supplied with a unit mounted antenna for use on the B48 transmit ports. This antenna has a nominal gain of 10.5 dBi. The exposure calculations are based upon this antenna for all transmit ports.

Under Part 96Z the products power is limited by the Spectrum Allocation System. The products maximum output power is 20W for all ports which can be divided among 4 simultaneous carriers. The maximum antenna gain for this product is 10.5 dBi +/- 1.5 dB. The Calculations were performed for the Maximum Antenna gain of $10.5\text{dBi} + 1.5 \text{ dB} = 12 \text{ dBi}$.

If the product is installed with other antenna(s), 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).

When operated under Part 96 rules the maximum Part 96 EIRP limit for a Category B CBSD is 47 dBm/10 MHz with a PSD of 37 dBm/MHz.

1.5 Results

The minimum RF safety distances were calculated for the entire base station, where it is assumed that the RF carriers in the B48 licensed bands are operated simultaneously at their maximum rated power. The computed values are listed in the tables below.

Calculations for minimum safety distances were performed using the maximum gain value for the transmit antenna.

An additional calculation was performed for the nominal gain value as well.

1.5.1 Uncontrolled Exposure Results – 12 dBi Gain Omni Antenna

Table 1.5.1-a; Minimum RF Safety Distances for Uncontrolled Exposure for AZQC with Maximum Gain Antenna

Module	Freq. Band GHz	Max. Total Pout (2x2) (dBm)	Antenna Gain (dBi)	Maximum Total EIRP (dBm)	Maximum Total EIRP (mW)	Power Density Limit (mW/cm ²)	Minimum RF Safety Distance (cm)
AZQC B48	3.7	43	12	55	316227.77	1	158.6
Total (Simultaneous-Transmission)					316227.77	1	158.6

Table 1.5.1-b; Uncontrolled Exposure Power Density at the Proposed RF Safety Distance; AZQC with Maximum Gain Antenna.

Module	Freq. Band GHz	Max. Total Pout (2x2) (dBm)	Antenna Gain (dBi)	Maximum Total EIRP (dBm)	Maximum Total EIRP (mW)	RF Safety Distance (cm)	Power Density (mW/cm ²)
AZQC B48	3.7	43	12	55	316227.77	160	0.9830
Total (Simultaneous-Transmission)					316227.77	160	0.9830

Table 1.5.1-c; Uncontrolled Exposure Power Density at the Proposed RF Safety Distance; AZQC with Nominal Gain Antenna.

Module	Freq. Band GHz	Max. Total Pout (2x2) (dBm)	Antenna Gain (dBi)	Maximum Total EIRP (dBm)	Maximum Total EIRP (mW)	RF Safety Distance (cm)	Power Density (mW/cm ²)
AZQC B48	3.7	43	10.5	53.5	223872.11	160	0.6959
Total (Simultaneous-Transmission)					223872.11	160	0.6959

1.5.2 Controlled Exposure Results - 12 dBi Gain Antenna

Table 1.5.2-a; Minimum RF Safety Distances for Controlled Exposure for AZQC with Maximum Gain Antenna

Module	Freq. Band GHz	Max. Total Pout (2x2) (dBm)	Antenna Gain (dBi)	Maximum Total EIRP (dBm)	Maximum Total EIRP (mW)	Power Density Limit (mW/cm ²)	RF Safety Distance (cm)
AZQC B48	3.7	43	12	55	316227.8	5	70.9
Total (Simultaneous-Transmission)					316227.8	5	70.9

Table 1.5.2-b; Controlled Exposure Power Density at the Proposed RF Safety Distance; AZQC with Maximum Gain Antenna

Module	Freq. Band GHz	Max. Total Pout (2x2) (dBm)	Antenna Gain (dBi)	Maximum Total EIRP (dBm)	Maximum Total EIRP (mW)	RF Safety Distance (cm)	Power Density (mW/cm ²)
AZQC B48	3.7	43	12	55	316227.8	75	4.4737
Total (Simultaneous-Transmission)					316227.8	75	4.4737

Table 1.5.2-c; Controlled Exposure Power Density at the Proposed RF Safety Distance; AZQC with Nominal Gain Antenna

Module	Freq. Band GHz	Max. Total Pout (2x2) (dBm)	Antenna Gain (dBi)	Maximum Total EIRP (dBm)	Maximum Total EIRP (mW)	RF Safety Distance (cm)	Power Density (mW/cm ²)
AZQC B48	3.7	43	10.5	53.5	223872.1	75	3.1671
Total (Simultaneous-Transmission)					223872.1	75	3.1671

1.5.3 Summary of Results

The results of the evaluation identify a proposed Controlled Exposure distance of 25cm and a proposed Uncontrolled Exposure distance of 50 cm for the AZQC Product. The addition of the Wi-Fi modules results in a 29% increase in the overall EIRP but does not change the proposed RF Safety Distances. Specifically:

AZQC Product

The RF Safety Distances criteria and exposure levels for the Controlled and Uncontrolled exposure cases are summarized below in Table 1.5.3-a for the **AZQC** product.

AZQC Product

The RF Safety Distances criteria and exposure levels for the Controlled and Uncontrolled exposure cases are summarized below in Table 1.5.3-b for the **AZQC**.

Table 1.5.3-a; Proposed Minimum RF Safety Distances for AZQC

Exposure	RF Safety Distance (cm)	Total Power Density (mW/cm²)	Required Power Density Limit (mW/cm²)
Occupational/Controlled	75	4.1091	5
General Population/Uncontrolled	160	0.9611	1