

RF Exposure Evaluation Declaration

Product Evaluated

**Flexi Zone Micro BTS CBRS FW2QQWF
FCC ID: 2AD8UFW2QMBOM1**

Composed of

**Flexi Zone Micro BTS CBRS Band 48 RF Module, FW2QMBOM1
2AD8UFZCWMBOM1; Wi-Fi AP Module 802.11 ac
2AD8UNBTM01; Bluetooth (2.4GHz)
Operated under 47CFR Part 90Z**

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Revisions


Date	Revision	Section	Change
11/16/2017	0		Initial Release
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1. Introduction

This RF Exposure Assessment applies to the Nokia Flexi Zone Multiband Outdoor BTS Variant FW2QQWF, hereinafter referred to as the MBO BTS FW2QQWF as operated under Part 90Z in the upper CBRS Band. The MBO BTS FW2QQWF is a 2xMIMO transmitter module rated at 2W/ 33dBm per Tx port. Each module total power is limited to 4W/36dBm. Since two FW2QMBOM1 modules, **FCC ID: 2AD8UFW2QMBOM1**, can be mounted on a Nokia Flexi Zone Multiband Outdoor BTS. The MPE evaluation will therefore consider two modules.

Under Part 90Z the MBO BTS FW2QQWF is limited to a maximum power of 25W/25 MHz EIRP which is 43.98 dBm/25 MHz. When set to the maximum total output power of 4W/36.02 dBm, the maximum allowable antenna gain is 7.96 dBi.

1.1 Purpose and Scope

The purpose of this document is to provide the overall RF exposure assessment for the integrated MBO B48/B48/WIFI/BT product when operated with 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 Flexi Zone Multiband Outdoor BTS is a single box base station that supports two LTE Band Class radios (B48 & B48) a dual band Wi-Fi band radio (2.4GHz & 5 GHz) + Bluetooth (2.4 GHz). Each LTE Radio Module supports 2 duplex Tx/Rx ports.

Each of the 4 LTE TX ports branches has a rated maximum RF output power of 2W. Each of the 2.4 GHz Wi-Fi antenna ports RF output power are rated at 28.2 dBm maximum for the US Market. Each of the 5 GHz Wi-Fi antenna ports RF output power are rated at 27.5 dBm maximum for the US Market. The 2.4 GHz Bluetooth RF output power is rated at 9.6 dBm maximum.

1.2.1 Product Installation and Usage

The Nokia Flexi Zone Multiband Outdoor Micro Base Station (MBO) is typically installed on poles or walls in fixed locations. Therefore, MBO is neither a portable nor a mobile wireless device. The maximum configuration of the MBO B48/B48/BT/Wi-Fi consists of four RF transceiver modules: MBO B48 FW2QMBOM1 (3.7GHz) MBO B48 FW2QMBOM1 (3.7GHz), Wi-Fi AP FZCWMBOM1 (2.4GHz and 5GHz) and Bluetooth NBTM01 (2.4GHz).

The MBO BTS B48 outputs can have either directly-connected omnidirectional stick antennas supplied by Nokia or customer-supplied remote antennas. In this evaluation, only the Nokia supplied Omni 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 6 dBi Gain Omni-Directional Antennas

Model	Frequency Range	Nominal Gain	VSWR	Elevation Half Power Beamwidth	Maximum Average Power	Nominal Impedance
BOA34006NF-NOK	3.4-3.8 GHz	6 dBi	< 2.0	25°	20 watts	50 ohms

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/cm²
- G_{AV} = Antenna Gain, Linear = 10^(GdBi/10)
- P_{output} = output power to antenna in mW
- π = 3.141592654
- P_d = MPE Limit, mW/cm²
- $EIRP$ = $P_{\text{output}}G_{AV}$
- 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 conducted output power for Wi-Fi AP module FZCWMBOM1 was obtained from its FCC/IC certification under FCC ID: 2AD8UFZCWMBOM1 and IC ID: 109D-FZCWMBOM1.

The maximum authorized output power for the licensed Band 48 transmitters under FCC ID: 2AD8UFW2QQWF, (2W/port 2 ports each x 2 modules) was used for the assessment.

1.4.2.2 Antenna Gain

The unit is supplied with a unit mounted Omni antenna for use on the B48 transmit ports. This antenna has a nominal gain of 6 dBi. The exposure calculations are based upon this antenna for all transmit ports.

Under Part 90Z the product is limited to a maximum power of 25W/25 MHz EIRP which is 43.98 dBm/25 MHz. When set to the maximum total output power of 36.02 dBm the maximum allowable antenna gain is 7.96 dBi.

In the event the customer wants to use a different antenna, the maximum gain + cable loss cannot exceed 8dBi when operating at full power in order to stay within the EIRP limits for the band.

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).

(In the future if 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 individual RF module and for the entire base station, where it is assumed that the RF carriers in the B48 licensed bands, and 2.4GHz and 5GHz unlicensed bands can operate simultaneously at their maximum rated power. The computed values are listed in the tables below.

1.5.1 Uncontrolled Exposure Results – 6 dBi Gain Omni Antenna

Table 1.5.1-a; Minimum RF Safety Distances for Uncontrolled Exposure for MBO B48/B48/BT

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)
MBO B48	3.7	33	6	39	7943.282	1	25.1
MBO B48	3.7	33	6	39	7943.282	1	25.1
Bluetooth	2.4	9.6	0	9.6	9.099	1	0.9
Total (Simultaneous-Transmission)					15895.664	1	35.6

Table 1.5.1-b; Minimum RF Safety Distances for Uncontrolled Exposure for MBO B48/B48/BT/Wi-Fi

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)
MBO B48	3.7	33	6	39	7943.2823	1	25.1
MBO B48	3.7	33	6	39	7943.2823	1	25.1
Wi-Fi AP	2.4	28.2	4.5	32.7	1862.09	1	12.2
Wi-Fi AP	5	27.5	7	34.5	2818.38	1	15.0
Bluetooth	2.4	9.6	0	9.6	9.099	1	0.9
Total (Simultaneous-Transmission)					20576.13	1	40.5

Table 1.5.1-c; Uncontrolled Exposure Power Density at the Proposed RF Safety Distance; MBO B48/B48/BT

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)
MBO B48	3.7	33	6	39	7943.2823	50	0.2528
MBO B48	3.7	33	6	39	7943.2823	50	0.2528
Bluetooth	2.4	9.6	0	9.6	9.099	1	0.9
Total (Simultaneous-Transmission)					15895.66	50	0.5060

Table 1.5.1-d; Uncontrolled Exposure Power Density at the Proposed RF Safety Distance; MBO B48/B48/BT/Wi-Fi

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)
MBO B48	3.7	33	6	39	7943.2823	50	0.2528
MBO B48	3.7	33	6	39	7943.2823	50	0.2528
Wi-Fi AP	2.4	28.2	4.5	32.7	1862.09	50	0.0593
Wi-Fi AP	5	27.5	7	34.5	2818.38	50	0.0897
Bluetooth	2.4	9.6	0	9.6	9.099	1	0.9
Total (Simultaneous-Transmission)					20576.13	50	0.6550

1.5.2 Controlled Exposure Results - 6 dBi Gain Omni Antenna

Table 1.5.2-a; Minimum RF Safety Distances for Controlled Exposure for MBO B48/B48/BT

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)
MBO B48	3.7	33	6	39	7943.282	5	11.2
MBO B48	3.7	33	6	39	7943.282	5	11.2
Bluetooth	2.4	9.6	0	9.6	9.099	5	0.4
Total (Simultaneous-Transmission)					15895.66	5	15.9

Table 1.5.2-b; Minimum RF Safety Distances for Controlled Exposure for MBO B48/B48/BT/Wi-Fi

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)
MBO B48	3.7	33	6	39	7943.282	5	11.2
MBO B48	3.7	33	6	39	7943.282	5	11.2
Wi-Fi AP	2.4	28.2	4.5	32.7	1862.09	5	5.4
Wi-Fi AP	5	27.5	7	34.5	2818.38	5	6.7
Bluetooth	2.4	9.6	0	9.6	9.099	5	0.4
Total (Simultaneous-Transmission)					20576.13	5	18.1

Table 1.5.2-c; Controlled Exposure Power Density at the Proposed RF Safety Distance; MBO B48/B48/BT

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)
MBO B48	3.7	33	6	39	7943.282	25	1.0114
MBO B48	3.7	33	6	39	7943.282	25	1.0114
Bluetooth	2.4	9.6	0	9.6	9.099	25	0.0012
Total (Simultaneous-Transmission)					15895.66	25	2.0239

Table 1.5.2-d; Controlled Exposure Power Density at the Proposed RF Safety Distance; MBO B48/B48/BT/Wi-Fi

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)
MBO B48	3.7	33	6	39	7943.282	25	1.0114
MBO B48	3.7	33	6	39	7943.282	25	1.0114
Wi-Fi AP	2.4	28.2	4.5	32.7	1862.09	25	0.2371
Wi-Fi AP	5	27.5	7	34.5	2818.38	25	0.3588
Bluetooth	2.4	9.6	0	9.6	9.099	25	0.0012
Total (Simultaneous-Transmission)					20576.13	25	2.6198

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 MBO B48/B48/BT 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:

MBO B48/B48/BT 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 **MBO B48/B48/BT** product.

MBO B48/B48/BT/Wi-Fi 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 **MBO B48/B48/BT/Wi-Fi**.

Table 1.5.3-a; Proposed Minimum RF Safety Distances for MBO B48/B48/BT

Exposure	RF Safety Distance (cm)	Total Power Density (mW/cm²)	Required Power Density Limit (mW/cm²)
Occupational/Controlled	25	2.0239	5
General Population/Uncontrolled	50	0.5060	1

Table 1.5.3-b; Proposed Minimum RF Safety Distances for MBO B48/B48/BT/Wi-Fi

Exposure	RF Safety Distance (cm)	Total Power Density (mW/cm²)	Required Power Density Limit (mW/cm²)
Occupational/Controlled	25	2.6198	5
General Population/Uncontrolled	50	0.6550	1