RF Exposure Evaluation Declaration

FCC ID:	2AD8UFZCWO4A1
APPLICANT:	Nokia Solutions and Networks

Application Type:	Certification
Product:	Wi-Fi AP 4x4 OD small omni antenna US
Model No.:	WO4C-AC400
Trademark:	Nokia
FCC Classification:	Digital Transmission System (DTS) Unlicensed National Information Infrastructure (UNII)
Test Procedure(s):	KDB 447498 D01v06

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3261

Revision History

Report No.	Version	Description	Issue Date	Note
1608TW0110-U12	Rev. 01	Initial Report	07-06-2017	Valid

Note: This report is prepared for FCC Class II permissive change and supplement to MRT Original "1608TW0110-U3" Report adding "Wi-Fi AP 4x4 OD small omni antenna US ant" and related data

1. PRODUCT INFORMATION

1.1. Equipment Description

Product Name	Wi-Fi AP 4x4 OD small omni antenna US
Model No.	WO4C-AC400
Brand Name	Nokia
Hardware Version:	AM3
Frequency Range	**2.4GHz:** For 802.11b/g/n-HT20: 2412 ~ 2462 MHz For 802.11n-HT40: 2422 ~ 2452 MHz **5GHz:** For 802.11a/n-HT20/ac-VHT20 5180~5240MHz, 5745~5825MHz For 802.11n-HT40/ac-VHT40: 5190~5230MHz, 5755~5795MHz For 802.11ac-VHT80: 5210MHz, 5775MHz For 802.11ac-VHT80+80: 5210 MHz + 5775 MHz
Type of Modulation	802.11a/n/ac: OFDM
Modulation Technology	CCK, DQPSK, DBPSK for DSSS 16QAM, 64QAM, QPSK, BPSK for OFDM

Note 1: We select the POE adapter (M/N: PoE35-54A) to perform all RF testing.

Note 2: The product name difference as below:

- when the device has been connected the Galtronics Small Omni antenna, the product name is “Wi-Fi AP 4x4 OD small omni antenna WW”;

1.2. Antenna Description

Antenna	Manufacturer	Frequency Band (GHz)	Product Number	Tx Paths
	Galtronics	2.4	Galtronics Small Omni Antenna	2
		5		2

Product Number	Frequency Band (MHz)	Tx Paths	Per Chain Max Antenna Gain (dBi)				Beam Forming Directional Gain (dBi)	CDD Directional Gain (dBi)	
			Ant 0	Ant 1	Ant 2	Ant 3		For Power	For PSD
Galtronics Small Omni Antenna	2412 ~2462	2	2.69	2.41	2.69	2.41	8.57	2.69	8.57
	5150 ~ 5250	2	3.27	3.85	3.27	3.85	9.59	3.85	9.59
	5150 ~ 5250 30°elevation angle	2	3.20	1.81	3.20	1.81	N/A	N/A	N/A
	5725 ~ 5850	2	4.35	4.30	4.35	4.30	10.35	4.35	10.35

Note

1. The EUT supports Cyclic Delay Diversity (CDD) technology for 802.11a/b/g mode, and CDD signals are correlated.
2. The EUT supports Beam Forming technology for 802.11n/ac mode, and exclude 802.11b/g mode. Correlated signals include, but are not limited to, signals transmitted in any of the following modes:
   - Any transmit Beam Forming mode, whether fixed or adaptive (e.g., phased array modes, closed loop MIMO modes, Transmitter Adaptive Antenna modes, Maximum Ratio Transmission (MRT) modes, and Statistical Eigen Beam Forming (EBF) modes).
   - CDD signals are correlated and create unintended array gain that varies with signal bandwidth, antenna geometry, and cyclic delay values. Consequently, depending on system parameters, it may be appropriate to use different values of array gain for compliance with power limits versus compliance with powerspectral density limits.
3. Unequal Antenna gains, with equal transmit powers. For Antenna gains given by G_1, G_2, …, G_N dBi transmit signals are correlated, then
   - Directional gain = $10*\log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2/N_{ANT}]$ dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]
   - For example (Galtronics Small Omni Antenna): 5150 ~ 5250MHz Directional Gain = $10*\log[(10^{3.27/20} + 10^{3.85/20} + 10^{3.27/20} + 10^{3.85/20})^2/4]$ = 9.59 dBi

2. RF Exposure Evaluation

2.1. Limits

According to FCC 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)

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

f= Frequency in MHz

Calculation Formula: Pd = (Pout*G)/(4*pi*r2)

Where
Pd = power density in mW/cm2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
Pi = 3.1416
r = distance between observation point and center of the radiator in cm

Pd is the limit of MPE, $1mW/cm^2$. If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance r where the MPE limit is reached.

2.2. Test Result of RF Exposure Evaluation

Product	Wi-Fi AP 4x4 OD small omni antenna US
Test Item	RF Exposure Evaluation (For General Population)

Test Mode	Frequency Band (MHz)	Maximum EIRP (dBm)	Safety Distance (cm)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
802.11b/g/n-HT20/ n-HT40	2412 ~ 2462	35.23	23	0.5016	1
802.11a/n-HT20/ n-H40/ac-VHT20 ac-VHT40/ac-VHT80/ ac-VHT80+80	5150 ~ 5250, 5725 ~ 5850	34.46	23	0.4201	1

Note: Directional Gain Calculation as below:

2412 ~ 2462MHz Directional Gain = $10*\log[(10^{2.69/20} + 10^{2.41/20} + 10^{2.69/20} + 10^{2.41/20})^2/4] = 8.57$ dBi

5150 ~ 5250MHz Directional Gain = $10*\log[(10^{3.27/20} + 10^{3.85/20} + 10^{3.27/20} + 10^{3.85/20})^2/4] = 9.59$ dBi

5725 ~ 5850MHz Directional Gain = $10*\log[(10^{4.35/20} + 10^{4.30/20} + 10^{4.35/20} + 10^{4.30/20})^2/4] = 10.35$ dBi

Product	Wi-Fi AP 4x4 OD small omni antenna US
Test Item	RF Exposure Evaluation (For Occupational)

Test Mode	Frequency Band (MHz)	Maximum EIRP (dBm)	Safety Distance (cm)	Power Density (mW/cm^2)	Limit of Power Density (mW/cm^2)
802.11b/g/n-HT20/ n-HT40	2412 ~ 2462	35.23	20	0.6633	5
802.11a/n-HT20/ n-H40/ac-VHT20 ac-VHT40/ac-VHT80/ ac-VHT80+80	5150 ~ 5250, 5725 ~ 5850	34.46	20	0.5556	5

Note: Directional Gain Calculation as below:

2412 ~ 2462MHz Directional Gain = $10*\log[(10^{2.69/20} + 10^{2.41/20} + 10^{2.69/20} + 10^{2.41/20})^2/4] = 8.57$ dBi

5150 ~ 5250MHz Directional Gain = $10*\log[(10^{3.27/20} + 10^{3.85/20} + 10^{3.27/20} + 10^{3.85/20})^2/4] = 9.59$ dBi

5725 ~ 5850MHz Directional Gain = $10*\log[(10^{4.35/20} + 10^{4.30/20} + 10^{4.35/20} + 10^{4.30/20})^2/4] = 10.35$ dBi

2.3. Summary of Test Result

The maximum calculations of above situations

Model	Configuration	The formula of calculated the MPE (mW/cm2)	Calculation Power Density (mW/cm2)	Limit	Result
General Population	2.4GHz + 5GHz	0.5016 + 0.4201	0.9217	1	Pass
Occupational	2.4GHz + 5GHz	0.6633 + 0.5556	1.2189	5	Pass

The wireless device described within this report has been shown to be capable of compliance with basic restrictions related to human exposure to electromagnetic fields for both General public and Occupational. The calculations shown in this report were made in accordance the procedures specified in the applied test specifications

Antenna Product Number	Configuration	Required Compliance Boundary (cm)	
		General Population	Occupational
Galtronics Small Omni Antenna	2.4GHz + 5GHz	23	20

The End