RF Exposure Evaluation Declaration

FCC ID:	2AD8UFZCWMBOM1
APPLICANT:	Nokia Solutions and Networks

Application Type:	Certification
Product:	US Wi-Fi AP 2x2 OD ext. antenna
Model No.:	FZCWMBOM1
Trademark:	Nokia
FCC Classification:	Digital Transmission System (DTS)
	Unlicensed National Information Infrastructure (UNII)

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Testing Laboratory
3261

Revision History

Report No.	Version	Description	Issue Date	Note
1703TW0103-U3	Rev. 01	Initial Report	05-03-2017	Valid

§2.1033 General Information

Applicant:	Nokia Solutions and Networks
Applicant Address:	1455 W Shure Drive, Arlington Heights, IL 60004
Manufacturer:	Nokia Solutions and Networks
Manufacturer Address:	1455 W Shure Drive, Arlington Heights, IL 60004
Test Site:	MRT Technology (Taiwan) Co., Ltd
Test Site Address:	No. 38, Fuxing Second Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C)
MRT FCC Registration No.:	153292
Test Device Serial No.:	N/A ☐ Production ☒ Pre-Production ☐ Engineering
FCC Classification:	Digital Transmission System (DTS) Unlicensed National Information Infrastructure (UNII)

Test Facility / Accreditations

Measurements were performed at MRT Laboratory located in Fuxing Rd., Taoyuan, Taiwan (R.O.C)

- **MRT facility is a FCC registered (Reg. No. 153292) test facility with the site description report on file and is designated by the FCC as an Accredited Test Film.**
- **MRT facility is an IC registered (MRT Reg. No. 21723-1) test laboratory with the site description on file at Industry Canada.**
- **MRT Lab is accredited to ISO 17025 by the American Association for Laboratory Accreditation (TAF) under the American Association for Laboratory Accreditation Program (TAF Cert. No. 3261) in EMC, Telecommunications and Radio testing for FCC, Industry Taiwan, EU and TELEC Rules.**

1. PRODUCT INFORMATION

1.1. Equipment Description

Product Name	US Wi-Fi AP 2x2 OD ext. antenna
Model No.	FZCWMBOM1
Brand Name	Nokia
Hardware Version:	AM2
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
Type of Modulation	802.11a/n/ac: OFDM
Modulation Technology	CCK, DQPSK, DBPSK for DSSS 16QAM, 64QAM, QPSK, BPSK for OFDM

1.2. Antenna Description

Antenna	Manufacturer	Frequency Band (GHz)	Antenna Name	T_X Paths
	Nokia	2.4	473171A / FAWH (WiFi Omni Ant)	2
		5		2

Antenna Name	Frequency Band (MHz)	T_X Paths	Per Chain Max Antenna Gain (dBi)		Beam Forming Directional Gain (dBi)	CDD Directional Gain (dBi)
			Ant 2	Ant 2		
473171A / FAWH (WiFi Omni Ant)	2412 ~2462	2	4.00	4.00	7.01	7.01
	5150 ~ 5250	2	7.00	7.00	10.01	10.01
	5150 ~ 5250 30°elevation angle	2	7.00	7.00	N/A	N/A
	5725 ~ 5850	2	7.00	7.00	10.01	10.01

Note 1: The EUT supports Cyclic Delay Diversity (CDD) technology for 802.11a/b/g mode and Beam Forming technology for 802.11n mode, and the transmitter output signal is correlated.
For CDD transmissions, directional gain is calculated as follows, $N_{ANT} = 2$, $N_{SS} = 1$.
Three antennas have the same gain, G_{ANT}, Directional gain = G_{ANT} + Array Gain, where Array Gain is as follows.

- For power spectral density (PSD) measurements on all devices,
  Array Gain = 10 log (N_{ANT}/ N_{SS}) dB = 3.01;
- For power measurements on IEEE 802.11 devices,
  Array Gain = 0 dB for $N_{ANT} \leq 4$;

Note 2: The EUT also supports Beam Forming technology, and the Beam Forming only support 802.11ac mode. Two antenna have the same gain, G_{ANT}:
Directional gain = G_{ANT} + 10 log (N_{ANT}/N_{SS}) dBi, where N_{SS} = the number of independent spatial streams of data and G_{ANT} is the antenna gain in 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/cm². 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	US Wi-Fi AP 2x2 OD ext. antenna
Test Item	RF Exposure Evaluation (For General Population)

WiFi Dual-band Omni Directional Antenna:

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	31.70	20	0.2943	1
802.11a/n-HT20/ n-H40/ac-VHT20 ac-VHT40/ac-VHT80	5150 ~ 5250, 5725 ~ 5850	34.05	20	0.5055	1

Note: Directional Gain Calculation as below:

2412 ~ 2462MHz Directional Gain = $10*\log[(10^{4.00/20} + 10^{4.00/20})^2/2] = 7.01$ dBi

5150 ~ 5250MHz Directional Gain = $10*\log[(10^{7.00/20} + 10^{7.00/20})^2/2] = 10.01$ dBi

5725 ~ 5850MHz Directional Gain = $10*\log[(10^{7.00/20} + 10^{7.00/20})^2/2] = 10.01$ dBi

Product	US Wi-Fi AP 2x2 OD ext. antenna
Test Item	RF Exposure Evaluation (For Occupational)

WiFi Dual-band Omni Directional Antenna:

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	31.70	20	0.2943	5
802.11a/n-HT20/ n-H40/ac-VHT20 ac-VHT40/ac-VHT80	5150 ~ 5250, 5725 ~ 5850	34.05	20	0.5055	5

Note: Directional Gain Calculation as below:

2412 ~ 2462MHz Directional Gain = $10*\log[(10^{4.00/20} + 10^{4.00/20})^2/2] = 7.01$ dBi

5150 ~ 5250MHz Directional Gain = $10*\log[(10^{7.00/20} + 10^{7.00/20})^2/2] = 10.01$ dBi

5725 ~ 5850MHz Directional Gain = $10*\log[(10^{7.00/20} + 10^{7.00/20})^2/2] = 10.01$ 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	0.2943 + 0.5055	0.7998	1	Pass
Occupational	2.4GHz + 5GHz	0.2943 + 0.5055	0.7998	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
WiFi Omni Ant	2.4GHz + 5GHz	20	20

The End