

RF Exposure Evaluation Declaration

FCC ID: 2AD8UFZCWMBOM1
IC: 109D-FZCWMBOM1
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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The test results relate only to the samples tested.

The test results shown in the test report are traceable to the national/international standards through the calibration of the equipment and evaluated measurement uncertainty herein.

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Revision History

Report No.	Version	Description	Issue Date	Note
1703TW0103-U8	Rev. 01	Initial Report	05-14-2017	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 <input type="checkbox"/> Production <input checked="" type="checkbox"/> Pre-Production <input type="checkbox"/> 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
Wi-Fi Specification	802.11a/b/g/n/ac
Frequency Range	<p><u>2.4GHz:</u> For 802.11b/g/n-HT20: 2412 ~ 2462 MHz For 802.11n-HT40: 2422 ~ 2452 MHz</p> <p><u>5GHz:</u> For 802.11a/n-HT20: 5180~5320MHz, 5500~5700MHz, 5745~5825MHz For 802.11ac-VHT20: 5180~5320MHz, 5500~5720MHz, 5745~5825MHz For 802.11n-HT40: 5190~5310MHz, 5510~5670MHz, 5755~5795MHz For 802.11ac-VHT40: 5190~5310MHz, 5510~5710MHz, 5755~5795MHz For 802.11ac-VHT80: 5210MHz, 5290MHz, 5530MHz, 5610MHz, 5690MHz, 5775MHz</p>
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	Tx Paths
	Nokia	2.4	473171A / FAWH (WiFi Omni Ant)	2
		5		2

Note: The manufacture has provided an antenna cable to connect WiFi Omni Antenna with EUT, and the cable loss is: 0.45dB Max @ 0~3 GHz; 0.75dB Max @ 0~6 GHz

Antenna Name	Frequency Band (MHz)	Tx 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
	5250 ~ 5350	2	7.00	7.00	10.01	10.01
	5470 ~ 5725	2	7.00	7.00	10.01	10.01
	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 CDD signals are correlated.

2. The EUT supports Beam Forming technology for 802.11n/ac mode.

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 = $G_{ANT} + \text{Array Gain}$, where Array Gain is as follows.

- For power spectral density (PSD) measurements on all devices,
 $\text{Array Gain} = 10 \log (N_{ANT}/ N_{SS}) \text{ dB} = 3.01$;
- For power measurements on IEEE 802.11 devices,
 $\text{Array Gain} = 0 \text{ dB}$ 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 = $G_{ANT} + 10 \log (N_{ANT}/N_{SS}) \text{ dBi}$, 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: $Pd = (Pout \cdot G) / (4 \cdot \pi \cdot r^2)$

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	5150 ~ 5250	20.66	20	0.0232	1
	5250 ~ 5350	29.58	20	0.1806	1
ac-VHT40/ac-VHT80/ac-VHT80+80	5470 ~ 5725	29.60	20	0.1814	1
	5725 ~ 5850	34.05	20	0.5055	1

Note: Directional Gain Calculation as below:

$$2412 \sim 2462\text{MHz Directional Gain} = 10 \cdot \log[(10^{5.00/20} + 10^{5.00/20})^2/2] = 8.01 \text{ dBi}$$

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

$$5250 \sim 5350\text{MHz Directional Gain} = 10 \cdot \log[(10^{7.00/20} + 10^{7.00/20})^2/2] = 10.01 \text{ dBi}$$

$$5470 \sim 5725\text{MHz Directional Gain} = 10 \cdot \log[(10^{7.00/20} + 10^{7.00/20})^2/2] = 10.01 \text{ dBi}$$

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

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	20.66	20	0.0232	5
	5250 ~ 5350	29.58	20	0.1806	5
	5470 ~ 5725	29.60	20	0.1814	5
	5725 ~ 5850	34.05	20	0.5055	5

Note: Directional Gain Calculation as below:

$$2412 \sim 2462\text{MHz Directional Gain} = 10 \cdot \log\left[\frac{10^{5.00/20} + 10^{5.00/20}}{2}\right] = 8.01 \text{ dBi}$$

$$5150 \sim 5250\text{MHz Directional Gain} = 10 \cdot \log\left[\frac{10^{7.00/20} + 10^{7.00/20}}{2}\right] = 10.01 \text{ dBi}$$

$$5250 \sim 5350\text{MHz Directional Gain} = 10 \cdot \log\left[\frac{10^{7.00/20} + 10^{7.00/20}}{2}\right] = 10.01 \text{ dBi}$$

$$5470 \sim 5725\text{MHz Directional Gain} = 10 \cdot \log\left[\frac{10^{7.00/20} + 10^{7.00/20}}{2}\right] = 10.01 \text{ dBi}$$

$$5725 \sim 5850\text{MHz Directional Gain} = 10 \cdot \log\left[\frac{10^{7.00/20} + 10^{7.00/20}}{2}\right] = 10.01 \text{ dBi}$$

2.3. Summary of Test Result

The maximum calculations of above situations

Model	Configuration	The formula of calculated the MPE (mW/cm ²)	Calculation Power Density (mW/cm ²)	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 Dual-band Omni Directional Antenna	2.4GHz + 5GHz	20	20

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