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Report No.: 1712TW0104-U4 Report Version: V01 Issue Date: 01-30-2018

RF Exposure Evaluation Declaration

FCC ID: 2AD8UFZCWMBOM2

APPLICANT: Nokia Solutions and Networks, OY

Application Type: Certification

Product: AC220m Wi-Fi module OD US

Model No.: FZCWMBOM2

Trademark: NOKIA

FCC Classification: Digital Transmission System (DTS)

Unlicensed National Information Infrastructure (UNII)

Test Procedure(s): KDB 447498 D01v06

Reviewed By : Paddy Chen

(Paddy Chen)

Approved By

(Chenz Ker)





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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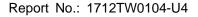
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Revision History

Report No.	Version	Description	Issue Date	Note
1712TW0104-U4	Rev. 01	Initial Report	01-30-2018	Valid





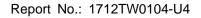
§2.1033 General Information

Applicant:	Nokia Solutions and Networks, OY			
Applicant Address:	2000 W. Lucent Lane, Naperville, Illinois, United States, 60563			
Manufacturer:	Nokia Solutions and Networks, OY			
Manufacturer Address:	2000 W. Lucent Lane, Naperville, Illinois, United States, 60563			
Test Site:	MRT Technology (Taiwan) Co., Ltd			
Test Site Address:	No. 38, Fuxing Second Rd., Guishan Dist., Taoyuan City 333,			
	Taiwan (R.O.C)			
FCC Registration No.:	153292			
FCC Rule Part(s):	Part15 Subpart C (Section 15.247)			
Test Device Serial No.:	N/A ☐ Production ☐ Pre-Production ☐ Engineering			

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:	AC220m Wi-Fi module OD US				
Model No.:	FZCWMBOM2				
Brand Name:	Nokia				
Wi-Fi Specification	802.11a/b/g/n/ac				
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	802.11b: DSSS				
	802.11g/n/ac: OFDM				
Modulation Technology	CCK, DQPSK, DBPSK for DSSS				
	16QAM, 64QAM, 256QAM, QPSK, BPSK for OFDM				



1.2. Antenna Description

Antenna	Manufacturer	Frequency Band (GHz)	Antenna Name	Tx Paths
	Malifa	2.4	473171A / FAWH	2
	Nokia	5	(WiFi Omni Ant)	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	Frequency	Tx	Per Chain Max		Beam Forming		CDD Directional	
Name	Band (MHz)	Paths	Antenna Gain		Directional Gain		Gain (dBi)	
			(dBi)		(d	Bi)		
			Ant 0	Ant 1	For	For	For	For
			Anto	Anti	Power	PSD	Power	PSD
473171A /	2412 ~2462	2	4.00	4.00	7.01	7.01	4.00	7.01
FAWH (WiFi Omni	5150 ~ 5250	2	7.00	7.00	10.01	10.01	7.00	10.01
Ant)	5725 ~ 5850	2	7.00	7.00	10.01	10.01	7.00	10.01

Note1: The EUT supports Cyclic Delay Diversity (CDD) technology for 802.11a/b/g mode, and CDD signals are correlated.

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

Note 3: For CDD transmissions, directional gain is calculated as follows, $N_{ANT} = 2$, $N_{SS} = 1$.

Two 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 $N_{ANT} \le 4$;

Note 4: For Beam Forming transmissions, Two antennas 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/cm²)	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	AC220m Wi-Fi module OD US
Test Item	RF Exposure Evaluation (For General Population)

Test Mode	Frequency Band (MHz)	Maximum EIRP (dBm)	Safety Distance (cm)	Power Density (mW/cm²)	Limit of Power Density (mW/cm²)
802.11b/g/n-HT20/ n-HT40	2412 ~ 2462	34.98	24	0.4349	1
802.11a/n-HT20/ n-H40/ac-VHT20 ac-VHT40/ac-VHT80	5150 ~ 5250 5725 ~ 5850	35.83	24	0.5289	1

Note: Directional Gain Calculation as below:

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

 $5725 \sim 5850 \text{MHz}$ Directional Gain = $10*log[(10^{7.00/20} + 10^{7.00/202}/2] = 10.01 dBi$

Product	AC220m Wi-Fi module OD US
Test Item	RF Exposure Evaluation (For Occupational)

	Test Mode	Frequency Band (MHz)	Maximum EIRP (dBm)	Safety Distance (cm)	Power Density (mW/cm²)	Limit of Power Density (mW/cm²)
80	02.11b/g/n-HT20/ n-HT40	2412 ~ 2462	34.98	20	0.6262	5
r	802.11a/n-HT20/ n-H40/ac-VHT20 -VHT40/ac-VHT80	5150 ~ 5250 5725 ~ 5850	35.83	20	0.7616	5

Note: Directional Gain Calculation as below:

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

 $5725 \sim 5850 \text{MHz}$ Directional Gain = $10*log[(10^{7.00/20} + 10^{7.00/202}/2] = 10.01 dBi$



2.3. Summary of Test Result

The maximum calculations of above situations

Model	Configuration	The formula of	Calculation	Limit	Result
		calculated the MPE	Power Density		
		(mW/cm ²)	(mW/cm ²)		
General Population	2.4GHz + 5GHz	0.4349 + 0.5289	0.9638	1	Pass
Occupational	2.4GHz + 5GHz	0.6262 + 0.7616	1.3878	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

Configuration	Required Compliance Boundary (cm)		
Configuration	General Population	Occupational	
2.4GHz + 5GHz	24	20	

The End
