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Report No.: 1708TW0101-U3 Report Version: Issue Date: 10-13-2017

RF Exposure Evaluation Declaration

FCC ID: 2AD8UFZCWI2B1

APPLICANT: Nokia Solutions and Networks, OY

Application Type: Certification

Product: AC220i Wi-Fi AP ID omni antenna US

Model No.: WI2B-AC220i

NOKIA Trademark:

FCC Classification: Digital Transmission System (DTS)

Unlicensed National Information Infrastructure (UNII)

Test Procedure(s): KDB 447498 D01v06

Reviewed By

Approved By





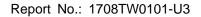
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The test results relate only to the samples tested.

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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FCC ID: 2AD8UFZCWI2B1 Page Number: 1 of 8





Revision History

Report No.	Version	Description	Issue Date	Note
1708TW0101-U3	Rev. 01	Draft Report	08-07-2017	



1. PRODUCT INFORMATION

1.1. Equipment Description

Product Name	AC220i Wi-Fi AP ID omni antenna US
Model No.	WI2B-AC220i
Brand Name	NOKIA
Frequency Range	2.4GHz:
	For 802.11b/g/n-HT20: 2412 ~ 2462 MHz
	For 802.11n-HT40: 2422 ~ 2452 MHz
	<u>5GHz:</u>
	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
	802.11a/n/ac: OFDM
Modulation Technology	CCK, DQPSK, DBPSK for DSSS
	16QAM, 64QAM, 256QAM, QPSK, BPSK for OFDM



1.2. Antenna Description

Antenna	Frequency	TX	Per Chain Max		Beam Forming	CDD Directional			
Туре	Band	Paths	Antenna Gain (dBi)		Antenna Gain (dBi)		Directional Gain	Gain	(dBi)
	(MHz)		Ant 1	Ant 2	(dBi)	For Power	For PSD		
O:	2412 ~ 2462	2	3.5	4.0	6.76	4.00	6.76		
Omni	5150 ~ 5250	2	3.8	3.6	6.71	3.80	6.71		
Antenna	5725 ~ 5850	2	5.2	4.3	7.77	5.20	7.77		

Note:

- 1. The EUT supports Cyclic Delay Diversity (CDD) mode, and CDD signals are correlated. For CDD transmissions, directional gain is calculated as follows, $N_{ANT} = 2$, $N_{SS} = 1$.
 - 1) If all 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} ≤ 4;
 - 2) If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream:
 - Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain;

• Directional Gain =
$$10 \cdot \log \left[\frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^{2}}{N_{ANT}} \right]$$

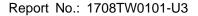
 $g_{i,k} = 10^{G_k/20}$ if the kth antenna is being fed by spatial stream j, or zero if it is not;

 G_k is the gain in dBi of the kth antenna.

2. The EUT also supports Beam Forming mode, and the Beam Forming support 802.11n, not include 802.11a/ac.

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).





Unequal antenna gains, with equal transmit powers. For antenna gains given by $G_1,\,G_2,\,...,\,G_NdBi.$

- transmit signals are correlated, then
- Directional gain = $10*log[(10^{G1/20} + 10^{G2/20} + ... + 10^{GN/20})^2/N_{ANT}]dBi$ [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.]



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	Electric Field	Magnetic Field	Power Density	Average Time		
(MHz)	Strength (V/m)	Strength (A/m)	(mW/cm ²)	(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.

FCC ID: 2AD8UFZCWI2B1 Page Number: 6 of 8



2.2. Test Result of RF Exposure Evaluation

Product	AC220i Wi-Fi AP ID 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/cm²)	Limit of Power Density (mW/cm²)
802.11b/g/n-HT20/ n-HT40	2412 ~ 2462	31.24	20	0.2647	1
802.11a/n-HT20/ n-H40/ac-VHT20 ac-VHT40/ac-VHT80	5150 ~ 5250, 5725 ~ 5850	33.10	20	0.4062	1

Note: Directional Gain Calculation as below:

2412 ~ 2462MHz Directional Gain = $10*log[(10^{3.5/20} + 10^{4.0/20})^2/2] = 6.76dBi$

5150 ~ 5250MHz Directional Gain = $10*log[(10^{3.8/20} + 10^{3.6/20})^2/2] = 6.71dBi$

 $5725 \sim 5850$ MHz Directional Gain = $10*log[(10^{5.2/20} + 10^{4.3/20})^2/2] = 7.77$ dBi

Product	AC220i Wi-Fi AP ID omni antenna US
Test Item	RF Exposure Evaluation (For Occupational)

Test Mode	Frequency	Maximum	Safety	Power	Limit of Power
	Band (MHz)	EIRP (dBm)	Distance	Density	Density
			(cm)	(mW/cm ²)	(mW/cm ²)
802.11b/g/n-HT20/ n-HT40	2412 ~ 2462	31.24	20	0.2647	5
802.11a/n-HT20/ n-H40/ac-VHT20 ac-VHT40/ac-VHT80	5150 ~ 5250, 5725 ~ 5850	33.10	20	0.4062	5

Note: Directional Gain Calculation as below:

2412 ~ 2462MHz Directional Gain = $10*log[(10^{3.5/20} + 10^{4.0/20})^2/2] = 6.76dBi$

5150 ~ 5250MHz Directional Gain = $10*log[(10^{3.8/20} + 10^{3.6/20})^2/2] = 6.71dBi$

 $5725 \sim 5850 \text{MHz}$ Directional Gain = $10 \log[(10^{5.2/20} + 10^{4.3/20})^2/2] = 7.77 \text{dBi}$

FCC ID: 2AD8UFZCWI2B1 Page Number: 7 of 8



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	0.2647 + 0.4062	0.6709	1	Pass
Occupational	2.4GHz + 5GHz	0.2647 + 0.4062	0.6709	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	20	20	