

MRT Technology (Taiwan) Co., Ltd Phone: +886-3-3288388

www.mrt-cert.com

Report No.: 1708TW0101-U7 Report Version: Issue Date: 11-26-2017

# **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 : Paddy Chen (Paddy Chen)

Approved By : Change Reviewed By



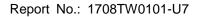


The test results relate only to the samples tested.

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  |
|---------------|---------|----------------|------------|-------|
| 1708TW0101-U7 | Rev. 01 | Initial Report | 11-26-2017 | Valid |
|               |         |                |            |       |



## 1. PRODUCT INFORMATION

## 1.1. Equipment Description

| AC220i Wi-Fi AP ID omni antenna US                      |
|---|
| WI2B-AC220i   |
| NOKIA   |
| 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-VHT20:5180~5320MHz, 5500~5720MHz, |
| 5745~5825MHz  |
| For 802.11n-HT40/ac-VHT40:5190~5310MHz, 5510~5710MHz,   |
| 5755~5795MHz  |
| For 802.11ac-VHT80:5210MHz, 5290MHz, 5530MHz, 5610MHz,  |
| 5690MHz, 5775MHz  |
| 802.11b: DSSS   |
| 802.11a/n/ac: OFDM                                      |
| 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 Dir   | rectional |          |  |
|---------|-------------|-------|--------------------|-------|----------------------------------|-----------|-----------|----------|--|
| Type    | Band        | Paths | Antenna Gain (dBi) |       | Antenna Gain (dBi) Directional C |           | Gain      | ain(dBi) |  |
|         | (MHz)       |       | Ant 1              | Ant 2 | Gain (dBi)                       | For Power | For PSD   |          |  |
|         | 2412 ~ 2462 | 2     | 3.5                | 4.0   | 6.76                             | 4.00      | 6.76      |          |  |
| O       | 5150 ~ 5250 | 2     | 3.8                | 3.6   | 6.71                             | 3.80      | 6.71      |          |  |
| Omni    | 5250 ~ 5350 | 2     | 4.0                | 3.6   | 6.81                             | 4.00      | 6.81      |          |  |
| Antenna | 5470 ~ 5725 | 2     | 5.1                | 3.9   | 7.53                             | 5.10      | 7.53      |          |  |
|         | 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<sub>ANT</sub>/ N<sub>SS</sub>) dB = 3.01;
  - For power measurements on IEEE 802.11 devices,
     Array Gain = 0 dB for N<sub>ANT</sub> ≤ 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<sub>ANT</sub> set equal to the gain of the antenna having the highest gain;

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

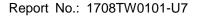
 $g_{i,k} = 10^{G_k/20}$  if the kth antenna is being fed by spatial stream j, or zero if it is not;

 $G_{k}$  is the gain in dBi of the kth antenna.

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  $G_1$ ,  $G_2$ , ...,  $G_N dBi$ .

- 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 (MHz) | Electric Field<br>Strength (V/m)                          | Magnetic Field<br>Strength (A/m) | Power Density<br>(mW/cm²) | Average Time<br>(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<sup>2</sup>. 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.

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## 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<br>Band (MHz)     | Maximum<br>EIRP (dBm) | Safety<br>Distance<br>(cm) | Power Density (mW/cm²) | Limit of Power Density (mW/cm²) |
|--|-----------------------------|-----------------------|----------------------------|------------------------|---------------------------------|
| 802.11b/g/n-HT20/<br>n-HT40                            | 2412 ~ 2462                 | 31.24                 | 20                         | 0.2647                 | 1                               |
| 802.11a/n-HT20/<br>n-H40/ac-VHT20<br>ac-VHT40/ac-VHT80 | 5250 ~ 5350,<br>5470 ~ 5725 | 29.77                 | 20                         | 0.1887                 | 1                               |

Note: Directional Gain for Beam-Forming Mode Calculation as below:

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

 $5250 \sim 5350 \text{MHz}$  Directional Gain =  $10 \log[(10^{4.0/20} + 10^{3.6/20})^2/2] = 6.81 \text{dBi}$ 

 $5470 \sim 5725$ MHz Directional Gain =  $10*log[(10^{5.1/20} + 10^{3.9/20})^2/2] = 7.53$ dBi

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

| Test Mode  | Frequency Band (MHz)        | Maximum<br>EIRP (dBm) | Safety<br>Distance | Power<br>Density      | Limit of Power Density |
|--|-----------------------------|-----------------------|--------------------|-----------------------|------------------------|
|  | Barra (Wir 12)              | Entr (dBin)           | (cm)               | (mW/cm <sup>2</sup> ) | (mW/cm <sup>2</sup> )  |
| 802.11b/g/n-HT20/<br>n-HT40                            | 2412 ~ 2462                 | 31.24                 | 20                 | 0.2647                | 1                      |
| 802.11a/n-HT20/<br>n-H40/ac-VHT20<br>ac-VHT40/ac-VHT80 | 5250 ~ 5350,<br>5470 ~ 5725 | 29.77                 | 20                 | 0.1887                | 5                      |

Note: Directional Gain for Beam-Forming Mode Calculation as below:

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

 $5250 \sim 5350$ MHz Directional Gain =  $10*log[(10^{4.0/20} + 10^{3.6/20})^2/2] = 6.81$ dBi

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## 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 <sup>2</sup> ) | (mW/cm <sup>2</sup> ) |       |        |
| General Population | 2.4GHz + 5GHz | 0.2647 + 0.1887       | 0.4534                | 1     | Pass   |
| Occupational       | 2.4GHz + 5GHz | 0.2647 + 0.1887       | 0.4534                | 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           |  |

————— The End