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Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29 507 456

Test report No:
NIE: 66837RAN.003A2

Assessment report
RF EXPOSURE REPORT ACCORDING TO
FCC 47 CFR Part 1.1307 & FCC 47 CFR Part 1.1310

(*) Identification of item under evaluation	Flexi Zone MulteFire Outdoor Pico BTS
(*) Trademark	Nokia
(*) Model and /or type reference	FW2RH-m
(*) Other identification of the product	HW version: 474710A.X21 SW Version: FLF18A_MF19_0001_200408_000035 FCC ID: 2AVO2FW2RH01 IC ID: 661AF-FW2RH01
(*) Features	MulteFire 1.0
(*) Manufacturer	Nokia Innovations US LLC 600-700 Mountain Ave, Murray Hill, NJ, 07974 USA
Test method requested, standard	FCC 47 CFR Part 1.1307: Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared. FCC 47 CFR Part 1.1310: Radiofrequency radiation exposure limits.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Miguel Lacave Antennas Lab Manager  2021.09.16 09:09:34 +02'00'
Date of issue	2021-09-15
Report template No	FAN36_02 (*) "Data provided by the client"

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Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested", “Other identification of the product”, “Features”, “Manufacturer” and “General description of the device”).
2. Maximum antenna gain and use distance information.

DEKRA Testing and Certification, S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Identification of the client

Company name: Nokia Innovations US LLC

Postal address: 600-700 Mountain Ave, Murray Hill, NJ, 07974 USA

Contact person: Gary Goldstein

Telephone / e-mail: +1 (817) 808-6481 / gary.goldstein@nokia.com

Document history

Report number	Date	Description
66837RAN.003	2021-07-28	First release
66837RAN.003A1	2021-08-25	Second release: Modification of a typo on distance use.
66837RAN.003A2	2021-09-15	Third release: Modification on device use conditions information, updated to fixed. This modification test report cancels and replaces the test report 66837RAN.003A1.

Appendix A: FCC RF Exposure assessment result

General description of the device under evaluation

The device under evaluation consists of a device who acts as an access point and provides wireless data service to connected client devices using MulteFire 1.0 protocol over UNII RF bands.

According to the manufacturer, the device will be installed into a fixed position during its normal use, the separation distance between the radiating structures of the device and nearby users will be greater than 20 cm. In order to perform the assessment a conservative evaluation distance of 20 cm has been used.

As stated into DEKRA Testing and Certification, S.A.U. test report num. 66837RRF.001, the maximum measured output power levels for each supported technology are:

Technology / Mode	Band	Frequency (MHz)	Maximum Conducted Output Power RMS Burst (Incl. Tune-Up) (dBm)	Antenna peak gain (dBi)	Maximum E.I.R.P. (dBm)	Maximum E.I.R.P. (mW)
MulteFire 1.0 MIMO Antenna Port 1 +2	U-NII Low	5150 - 5250	29.20	6.00	35.20	3309.79
	U-NII Mid	5260 - 5320	23.67	6.00	29.67	926.83
	ETSI	5500 - 5700	22.44	6.00	28.44	698.23
	U-NII Up	5725 - 5835	29.12	6.00	35.12	3250.87

Table 1: Equipment specifications

RF Exposure Assessment result and verdict

According to FCC 47 CFR §1.1307 Section (b) (3), “Determination of exemption”, for singles RF sources, any single fixed RF source, mobile device, or portable device is exempted of evaluation if complies any of the (A), (B) or (C) criteria shown in this section.

As the device does not comply with FCC 47 CFR §1.1307 Section (b) (3), “Determination of exemption”, an evaluation of compliance with the maximum permisible exposure limits as indicated into §1.1310 section (d) (2) is necessary.

Limits for Maximum Permissible Exposure (MPE) are defined in “FCC 47 CFR §1.1310 Radiation Exposure limits, paragraph (e) (1)”.

Technology / Mode	Band	Frequency (MHz)	Distance (cm)	Power density (mW/cm^2)	FCC General Population Limit (mW/cm^2)	Verdict
MulteFire 1.0 MIMO Antenna Port 1+2	U-NII Low	5150 - 5250	20.00	0.66	1.00	**Pass**
	U-NII Mid	5260 - 5320	20.00	0.18	1.00	**Pass**
	ETSI	5500 - 5700	20.00	0.14	1.00	**Pass**
	U-NII Up	5725 - 5835	20.00	0.65	1.00	**Pass**

Table 2: Assessment result and verdict

Appendix B: FCC RF Exposure information

RF Exposure determination of exemption

According to FCC 47 CFR §1.1307 (b)(3) Determination of exemption:

(i) For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2), a single RF source is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

(B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by:

$$P_{th}\ (\text{mW}) = \begin{cases} ERP_{20\ cm}(d/20\ \text{cm})^x & d \le 20\ \text{cm} \\ ERP_{20\ cm} & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20\ cm}\ (\text{mW}) = \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$

d = the separation distance (cm);

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least λ/2π, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

TABLE 1 TO §1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	1,920 R^2.
1.34-30	3,450 R^2/f^2.
30-300	3.83 R^2.
300-1,500	0.0128 R^2f.
1,500-100,000	19.2R^2.

(ii) For multiple RF sources: Multiple RF sources are exempt if:

(A) The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required). This exemption may not be used in conjunction with other exemption criteria other than those is paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).

(B) in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(B) of this section for Pth, including existing exempt transmitters and those being added.

b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(C) of this section for Threshold ERP, including existing exempt transmitters and those being added.

c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance including existing evaluated transmitters.

Pi = the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).

Pth,i = the exemption threshold power (Pth) according to paragraph (b)(3)(i)(B) of this section for fixed, mobile, or portable RF source i.

ERPj = the ERP of fixed, mobile, or portable RF source j.

ERPth,j = exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least λ/2π according to the applicable formula of paragraph (b)(3)(i)(C) of this section.

Evaluatedk = the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation at the location of exposure.

Exposure Limitk = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k, as applicable from §1.1310 of this chapter.

RF Exposure evaluation

Limits for Maximum Permissible Exposure (MPE) for RF sources are defined in FCC 47 CFR "§1.1310 Radiation Exposure limits, paragraph (e)":

TABLE 1 TO §1.1310(E)(1)—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*($900/f^2$)	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6
(ii) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	<30
1.34-30	824/f	2.19/f	*($180/f^2$)	<30
30-300	27.5	0.073	0.2	<30
300-1,500			f/1500	<30
1,500-100,000			1.0	<30

f = frequency in MHz. * = Plane-wave equivalent power density.

MPE Evaluation

Each supported transmission technology will be evaluated to determine if it is in compliance with limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst-case" or conservative prediction:

Power density: $S[mW/cm^2] = \frac{P_{E.I.R.P.}[mW]}{4\Pi R[cm]^2}$

Where:

S = power density

$P_{E.I.R.P.}$ = Equivalent isotropically radiated power

R = distance to the center of radiation of the antenna (evaluation distance)

$P_{E.I.R.P.}$ = $P_T + G_T - L_C$

Where:

P_T= transmitter output power (including tune-up tolerance)

G_T= gain of the transmitting antenna

L_C = signal attenuation in the connecting cable between the transmitter and the antenna if applicable