SGS Germany GmbH

Assessment Report No.: G2VG0001

Order No.: G2VG **Pages:** 15 **Munich,** Dec 13, 2013

Client:	Nokia Solutions and Networks US L.L.C.
Equipment Under Test:	Flexi Zone Micro small cell Omni configuration (1), (1710 MHz – 2170 MHz) PCTEL MHO80617102NM, Laird WXC2400SMRP-NS1
Manufacturer:	Nokia Solutions and Networks US L.L.C
Task:	Assessment of compliance with the requirements for safety of general public to radio frequency electromagnetic fields on base of
Test Specification(s):	• Council Recommendation 1999/519/EC • EN 50385 • FCC 47 CFR § 1.1310
Result:	The configuration meets the above cited requirements

The results relate only to the items tested as described in this test report.

edited by:	**Date**	**Signature**
Werner Qualification Engineer	Dec 13, 2013	

approved by:	**Date**	**Signature**
Bauer Lab Manager EMC	Dec 13, 2013	

This document was signed electronically.

CONTENTS

1 Summary

This assessment is based on calculations according to EN 50383 [4] to demonstrate the compliance with the basic restrictions related to general public exposure to radio frequency electromagnetic fields EN 50385 and FCC 47 CFR § 1.1310. The compliance is shown in Table 1-1 via the compliance boundary of the configuration according to EN 50383 (section 5.2).

Flexi Zone Micro small cell, Omni configuration (1) consists of a Blue Tooth (BT) antenna (Laird WXC2400SMRP-NS1) and two LTE Omni-directional antennas (PCTEL MHO80617102NM). Details of the configuration are given in section 4.

Flexi Zone Micro small cell, Omni configuration (1) is compliant with the cited standards at every point outside the compliance boundary (CB).

Provisions have to be taken to guarantee that no public access is possible to regions within the compliance boundaries. Warnings and information have to be provided (see Annex C).

The results of this assessment report refer exclusively to the item described in section 4 of this report

The compliance boundaries for general public are given in Table 1-1. The assignment of the boundaries of the compliance region is displayed in Figure 1-1 and Figure 1-2. For details see section 5.

	PCTEL MHO80617102NM LTE Main	PCTEL MHO80617102NM LTE Div	Laird WXC2400SMRP-NS1, BT	Omni Configuration (1)
	CB[1][m]	CB[1][m]	CB [m]	CB [m]
D_{front}	0.31	0.31	0.13	**0.46**
D_{rear}	0.28	0.31	0.13	**0.44**
D_{left}	0.34	0.46	0.13	**0.59**
D_{right}	0.31	0.28	0.13	**0.44**
D_{up}	0.19	0.28	0.13	**0.36**
D_{down}	0.29	0.32	0.13	**0.45**

Table 1-1: Compliance boundary with respect to the centre of Flexi Zone Micro small cell, Omni Configuration (1)

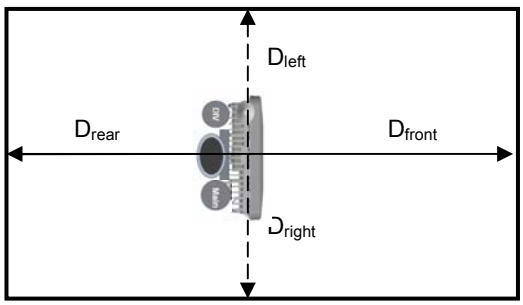

Figure 1-1 Top view

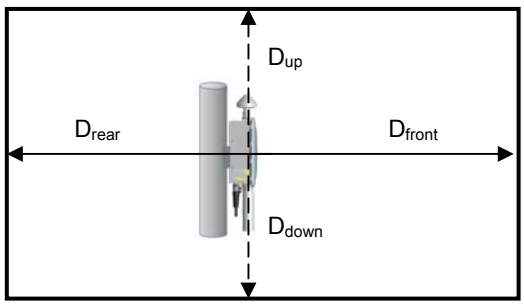

Figure 1-2 Side view

[1] CB calculated + 10%

2 References

2.1 Specifications

[1] Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (Official Journal L 197 of 30 July 1999).

[2] FCC 47 CFR §1.1310
Radiofrequency radiation exposure limits

[3] EN 50385:2002;
Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz – 40 GHz) – General public

[4] EN 50383:2010;
Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz – 40 GHz)

[5] IEC 62232 Ed.1.0 (2011)
Determination of RF field strength and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure

2.2 Glossary of Terms

EUT: Equipment under Test/Assessment
BT: Blue Tooth
CB: Compliance Boundary
GP: General Public
LTE: Long Term Evolution
Oc: Occupational exposure

2.3 Bibliographical Data

[6] Antenna Specification: RF Multiband Omni-directional , PCTEL MHO6982170NM-NSN, NSN, D450393045 1.1, 2013-09-30, Matt Schirmacher
[7] Antenna Specification: 2.4 – 2.5 GHz Quarter Wave Omni Dipol , Laird WXC2400SMRP-NS1, NSN, DocID_tbd 0.6, 2013-09-30, Matt Schirmacher
[8] Operation data, NSN_Argon_BasestationEMErequest.xlsx, NSN, 2013-10-25, Terry Schwenk
[9] Test report: FZM Argon 2.1GHz Antenna Pattern, NSN, 2013-08-01, Jason Onstot.

3 General Information

3.1 Identification of Client

Nokia Solutions and Networks US L.L.C.
1455 W Shure Drive
Arlington Heights, IL. 60004
Terry Schwenk

3.2 Test Laboratory

SGS Germany GmbH
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81379 München

3.3 Time Schedule

Start of assessment:	Nov 27, 2013
End of assessment:	Dec 03, 2013

3.4 Participants

Name	Function
Helmut Werner	Editor / EMF-Assessment

4 Equipment Under Assessment (EUT)

- The EUT is a multi antenna configuration with a Blue Tooth (BT) antenna and two LTE Omni-directional antennas. The GPS Antenna was not part of the assessment because only the transmitting parts are relevant.

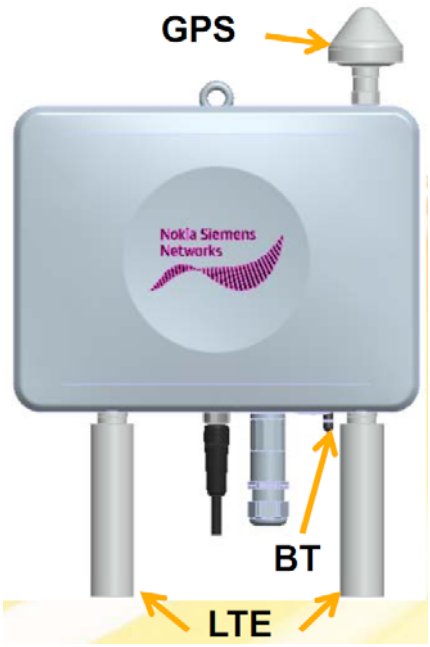

Figure 4-1 EUT: Omni configuration (1)

4.1 Typical Configuration

The antenna is connected through a power connector and cable to the Transceiver as shown in Figure 4-2.

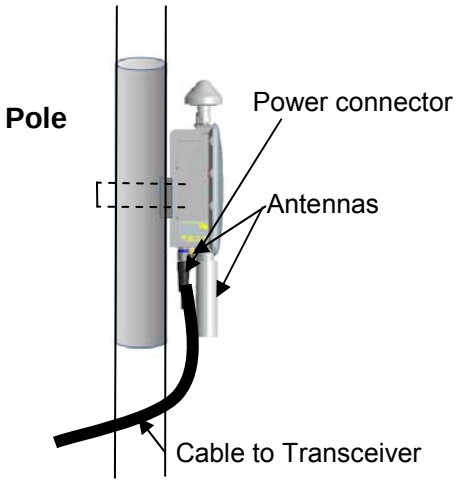

Figure 4-2 Typical configuration

The operation data for Flexi Zone Micro small cell, Omni configuration (1) are given in Table 4-1 and [8]

Power (P_{out})	LTE Main	5 W
	LTE Div	5 W
	BT	0.01 W
Total connector loss		0.0 dB
Total cable loss		0.0 dB
Total Loss (L) = Total connector loss + Total cable loss		0.0 dB
Number of transmitter unit (N)		1
Power at antenna input $= P_{out} N 10^{\frac{-L}{10}}$	LTE Main	5 W
	LTE Div	5 W
	BT	0.01 W
Antenna mounting height		≥ 4.6 m

Table 4-1 Antenna input data

The antenna specification for Flexi Zone Micro small cell, Omni configuration (1) is given in Table 4-2 and [8].

Type	PCTEL MHO80617102NM [6], [8]	Laird WXC2400SMRP-NS1 [7], [8]
Frequency (MHz)	1710 - 2170	2400 - 2483
Nominal Gain (dBi)	2 dBi	0 dBi
Polarization	vertical	vertical
Horizontal beam width (deg)	360	360
Vertical beam width (deg)	35	≥ 50
Electrical downtilt (deg)	0	0
Height (mm)	211	61

Table 4-2 Antenna data

E-UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit	Downlink (DL) operating band BS transmit UE receive	Duplex Mode
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	
1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
4	1710 MHz – 1755 MHz	2110 MHz – 2155 MHz	FDD

Table 4-3 Operating mode

4.2 When using different configurations

IMPORTANT:

In Table 1-1 the compliance boundaries are given for the nominal power levels and the worst case combination of all antennas comprised by this configuration. If an exposure limit, antenna, and/or configuration is used which does not correspond to the levels given in Table 1-1 the compliance boundary must be re-calculated according to EN 50383.

The formula for calculating the compliance boundary using the far-field model, which is referenced in EN50383, is given in Annex B: Far-Field Calculation Method. This model is applicable for calculating the compliance boundary for the far-field region and over estimates the compliance boundary for the radiating near-field region, but is not applicable for calculating the compliance boundary for the reactive near-field region where the distance from the antenna is less than or equal to MAX(λ, D, D^2/4/λ) (D: maximum antenna dimension)

5 Evaluation of the EUT

5.1 Assessment of compliance boundary (CB)

When assessing the applicable compliance boundaries (CB) European standards EN 50383, EN 50385, Council Recommendation 1999/519/EC and FCC 47 CFR § 1.1310 for general public electromagnetic exposure limits- see Annex A - have been applied.

The CB is defined as the area around the antenna configuration, shown in Figure 5-1and Figure 5-2. The antenna is located at the origin and the distances from the configuration are depicted.

According to EN 50383 sec. 8 and IEC 62232 sec. 6.3 the CB for distances outside the reactive near-field can be calculated by a cylindrical wave model and/or a modified far field model. The border between reactive and radiating near-field is determined by a distance from the antenna of MAX(λ, d, d^2/4/λ) (d: maximum antenna dimension)

Since the compliance boundaries of the antennas are in the adequate distance to the antennas the calculations have been carried out with the formulas given in EN 50383 sections 8.3.4 and EN 50383 Annex A.4 “modified gain mask” for the spherical approach.

To incorporate the influence of the antenna configuration the CB is calculated based on the measured real radiation patterns of each antenna [9]. The exposure limit (section 6, Annex A) is applied with a margin of 10 % to respect the uncertainty of determining the gain and the uncertainty of calculation.

The compliance boundary for the complete configuration is calculated by the summation of the CB of each antenna in the different directions according to:

$$Dx = \sqrt{\sum_i Dx_i^2}$$

Dx: front (D_{front}), rear (D_{rear}), left (D_{left}), right (D_{right}) up (D_{up}) and down (D_{down})

i: Antenna 1, Antenna 2, …….

5.2 Calculation and results

The BT Antenna has an input level ≤ 0.01 W and a gain of 0dBi [8]. Therefore its maximum radiation level cannot exceed 0.02W. According to EN 50385 and EN 50384 Section 6 the BT antenna can be regarded as compliant in all distances. For worst case assumption the CB is set to the border between reactive and radiating near-field.

The calculations for Flexi Zone Micro small cell, Omni configuration (1) is carried out for the two LTE antennas type PCTEL MHO80617102NM.

Gain is derived from test report NSN_FZM_OMNI_Pattern data_2.1GHz.pdf [9]

CB Calculation according to EN 50383

- D_{front}, D_{rear}, D_{left}, D_{right}, cylindrical wave model
- D_{up}, D_{down} , spherical approach with modified gain mask based on maximum Gain

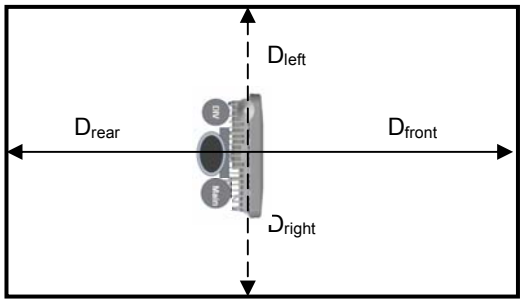

Figure 5-1 Top view

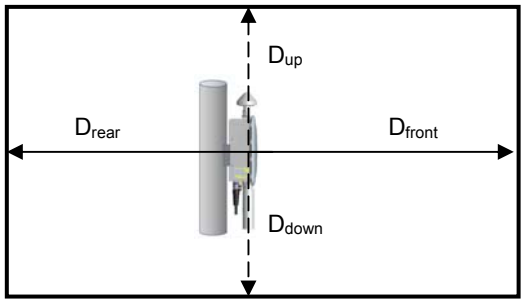

Figure 5-2 Side view

	LTE Main		LTE Div		BT	Omni Configuration
	Gain [dBi]	CB[2] [m]	Gain [dBi]	CB[2] [m]	CB [m]	CB [m]
D_{front}	3	0.31	3	0.44	0.13	**0.44**
D_{rear}	2	0.28	3	0.42	0.13	**0.42**
D_{left}	4	0.34	7	0.57	0.13	**0.57**
D_{right}	3	0.31	2	0.42	0.13	**0.42**
D_{up}	0	0.19	7	0.34	0.13	**0.34**
D_{down}	4	0.29	5	0.43	0.13	**0.43**

Table 5-1 Compliance Boundary (CB)

[2] CB calculated + 10%

6 Annexes

ANNEX A: Exposure limits

Council Recommendation 1999/519/EC, Electromagnetic exposure limits according for occupational and general public.

Basic restrictions are

Exposure Characteristics	Frequency range	Whole body average SAR [W kg^{-1}]	Localized SAR (head and trunk) [W kg^{-1}]	Localized SAR (limbs) [W kg^{-1}]
Occupational exposure	10 MHz-10 GHz	0.4	10	20
General public exposure	10 MHz-10 GHz	0.08	2	4

Notes:

- All SAR values are to be averaged over any period of 6 minutes.
- Localized SAR averaging mass is any 10 g of contiguous tissue: the maximum SAR so obtained should be the value used for the estimation of exposure.
- Basic restrictions between 10 GHz and 300 GHz are given in power densities. For occupational exposure it is 50 Wm^{-2} and for general public exposure it is 10 Wm^{-2}.

From basic restrictions, reference values are calculated, which are

Exposure Characteristics	Frequency range	Electric field strength [V/m]	Equivalent plane wave power density S [W m^{-2}]
Occupational exposure	10-400 MHz 400-2000 MHz 2-300 GHz	61 $3f^{1/2}$ 137	10 f/40 50
General public exposure	10-400 MHz 400-2000 MHz 2-300 GHz	28 $1.375f^{1/2}$ 61	2 f/200 10

Notes:

- f: frequency in MHz.
- For frequencies between 100 kHz and 10 GHz, S is to be averaged over any period of 6 minutes.
- For frequencies exceeding 10 GHz, S is to be averaged over any period of $68/f^{1.05}$ minutes (f in GHz).

FCC 47 CFR §1.1310, electromagnetic exposure limits (MPE) for occupational and general public.

Exposure Characteristics	Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Equivalent plane wave power density S (mW/cm^2)
Occupational / Controlled exposure	0.3 – 3.0	614	1.63	100
	3.0 – 30	1842/f	4.89/f	900/f²
	30 – 300	61.4	0.163	1
	300 – 1500			f/300
	1500 – 100,000			5
General Population / Uncontrolled Exposure	0.3 – 3.0	614	1.63	100
	3.0 – 30	824/f	2.19/f	180/f²
	30 – 300	27.5	0.073	0.2
	300 – 1500	--	--	f/1500
	1500 – 100,000	--	--	1.0

ANNEX B: Far-Field Calculation Method

This model is applicable for calculating the compliance boundary for the far-field region and over estimates the compliance boundary for the radiating near-field region, but is not applicable for the calculating the compliance boundary for the reactive near-field region where the distance from the antenna is less than or equal to λ. Therefore all the calculations are valid when the compliance boundary is greater or equal to the antenna dimensions plus λ.

The compliance boundary in metres, or r_{min}, is calculated according to the following equation:

$$r_{\min} = \sqrt{\frac{N 10^{(G-L)/10} P_{\text{out}}}{4\pi S}}$$ **Equation 1**

where *N* is the number of transmitter units per one antenna, *G* is the antenna gain (dBi), *L* is the minimum cable losses (dB), P_{out} is the maximum power of one transmitter unit (W), and *S* is the power density limit (W/m^2).

In the far-field, the field calculation does not take into account the antenna size, which is assumed to be a point source. Therefore when calculating the compliance boundary, the far-field data, antenna size and reactive field criteria have to be taken into account.

ANNEX C: Safety for Public and Workers

1. INSTALLING BASE STATIONS TO ENSURE PUBLIC SAFETY

The equipment generates radio frequency energy, which has a thermal effect when absorbed by the human body. For this reason compliance boundaries specific to this equipment have been established. The thermal effects of radio frequency energy can exceed safety levels when a person is inside the established compliance boundaries. Observe the compliance boundary, and make sure the general public has no access to areas inside the established boundaries. The information shown in section 3 of this document is taken from the relevant section of Nokia's user manual containing warnings and cautions specific to the equipment.

2. INSTALLING BASE STATIONS TO ENSURE INSTALLER SAFETY

Installation engineers need to be aware of the potential risk of the thermal effects of radio frequency energy and how to protect him/herself against undue risk. The information shown in section 3 of this Annex has to be included into the adequate section of the ***user manual*** containing warnings and cautions specific to the equipment.

3. WARNINGS AND CAUTIONS PROVIDED

The statements shown below have to be included into the adequate section of the ***user manual*** containing warning and cautions specific to the equipment.

Reference safety distances

When working close to transmitter antennas, the proper safety distances must be observed. The minimum safe distance from an antenna is measured in metres.

WARNING

Do not go any closer to a live antenna than the compliance boundary. The radio frequency energy generated by the antenna poses a serious health risk.

WARNING

If performing installation or maintenance procedures on cables or antennas of the BTS in an area closer than the compliance boundary, make sure that all transmitters in this area are switched off.

7 Disclaimer

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