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Report On

RF Exposure Compliance Boundary Assessment of the
Nokia Solutions and Networks
Flexi Base Station Products (698-960 MHz and 1710-2690MHz)

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SECTION 1

REPORT SUMMARY

RF Exposure Compliance Boundary Assessment of the
Nokia Solutions and Networks
Flexi Base Station Products (698-960 MHz and 1710-2690MHz)

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the RF Exposure Compliance Boundary Assessment of the Nokia Solutions and Networks Flexi Base Station Products (698-960 MHz and 1710-2690MHz) to the requirements of the applied test specifications.

Objective	To perform RF Exposure Compliance Boundary Assessment to determine the Equipment Under Test's (EUT's) compliance of the applied rules.
Applicant	Nokia Solutions and Networks
Manufacturer	Nokia Solutions and Networks Oy
Manufacturing Description	Flexi Base Station Products
Model Number(s)	Nokia Flexi Base Station Products (698-960 MHz and 1710-2690 MHz) In this document Flexi Base Station Product is a common name for Flexi Lite BTS, Flexi WCDMA Base Station, Flexi Multiradio Base Station, Flexi Multiradio 10 Base Station, Flexi Compact BTS and Flexi Zone BTS, Flexi Multiradio BTS GSM/EDGE and Flexi EDGE BTS
Power Variants	2, 5, 10, 20, 30, 40, 50, 60, 70, 80 and 90W
Test Specification/Issue/Date	EN 62311:2008 FCC KDB 447498D01 RSS-102 Issue 4 March 2010 Radiocommunications (Electromagnetic Radiation – Human Exposure) Standard: 2003
Related Document(s)	Council Recommendation 1999/519/EC:1999 FCC CFR 47 Part 1: 2013 FCC CFR 47 Part 2: 2013 Health Canada's Safety Code 6 ARPANSA ICNIRP 1998 National Council on Radiation Protection and Measurements (NRPC) - Report No. 86(1986) 50383:2010 IEEE Std C95.1-2005 Australian Standard 2772.2 – 1988

1.2 BRIEF SUMMARY OF RESULTS

1.2.1 Compliance Boundaries (cm) for General Public Levels

Power (W)	Frequency Range (MHz)	
	698-960	1710-2690
	Distance (cm)	
2	150	100
5	230	150
10	320	210
20	450	290
30	550	350
40	640	410
50	710	460
60	780	500
70	840	540
80	900	580
90	950	610

1.2.2 Compliance Boundaries (cm) for Occupational Levels

Power (W)	Frequency Range (MHz)	
	698-960	1710-2690
	Distance (cm)	
2	70	50
5	110	70
10	150	100
20	210	140
30	260	160
40	290	190
50	330	210
60	360	230
70	390	250
80	410	270
90	440	280

The distances are valid for antenna gain 16.4 dBi and RF power as indicated. For other antenna gains and/or RF-power, the compliance boundaries should be recalculated using the formulas in section 2.3 of this report.

1.3 PRODUCT INFORMATION

1.3.1 Attestation

The wireless device described within this report has been shown to be capable of compliance with the 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 specification(s).

1.3.2 Technical Description

The Equipment under test was a Nokia Solutions and Networks Flexi Base Station Products (698-960 MHz and 1710-2690MHz). A full technical description can be found in the manufacturer's documentation.

All reported calculations were carried out on the relevant information supplied for the Nokia Flexi Base Station Products (698-960 MHz and 1710-2690MHz) to demonstrate compliance with the applied test specification(s) the sample assessed was found to comply with the requirements of the applied rules.

1.4 SUMMARY

The RF Exposure Compliance Boundary assessment is based upon the following criteria:

The Nokia Flexi Base Station Products (698-960 MHz and 1710-2690MHz) operate in the frequency range 698-960 MHz and 1710-2690MHz.

Gain	16.4 dBi
Power	2, 5, 10, 20, 30, 40, 50, 60, 70, 80 and 90W
Duty Cycle	100%

SECTION 2

TEST DETAILS

2.1 RATIONALE FOR ASSESSMENT OF THE RF EXPOSURE COMPLIANCE BOUNDARY

The aim of the assessment report is to evaluate the compliance boundary for a set of given input power(s) according to the basic restrictions (directly or indirectly via compliance with reference levels) related to human exposure to radio frequency electromagnetic fields.
The chosen assessment method to establish the compliance boundary in the far-field region is the reference method as defined in EN50383:2002 Clause 5.2; E-field or H-field calculation. The method of calculation used is defined in EN50383:2002; Clause 8.2.2, 8.2.3 and 8.2.4.
The calculated values have been compared with limits provided in the ICNIRP guidelines.
Calculations can be made in three separate regions, based on distance from the antenna. These are called:

- far-field region,
- radiating near-field region,
- reactive near-field region.

The theory that defines these regions is given in EN50383:2002 Annex A.

Far-field region

As shown in EN50383 Annex A, the far-field calculations are accurate when the distance, r, from an antenna of length D to a point of investigation is greater than

$$r = \frac{2D^2}{\lambda}$$

Where, r is the distance from the antenna to the point of investigation.

Radiating near-field region

The radiating near-field region of an antenna of length D as shown in EN50383 Annex A, this region is defined by

$$\frac{\lambda}{4} < r > \frac{2D^2}{\lambda}$$

Reactive near-field region

The reactive near-field region of an antenna as shown in EN50383 Annex A, this region is defined by

$$r \leq \frac{\lambda}{4}$$

Where, r is the distance from the antenna to the point of investigation.
Recommend λ/4 as the boundary between the radiated near-field and reactive near-field for RF Exposure Compliance Boundary compliance assessment.

2.2 DEFINED LIMITS

Normative Reference: ICNIRP Advice on Limiting Exposure to Electromagnetic Fields (0-300GHz). Table A4, Reference Levels for General Public Exposure to Time Varying Electric & Magnetic Fields. Vol 15 No.2. 2004. The defined limits are in accordance with 47 CFR § 1.1310 Radiofrequency radiation exposure limits.

Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values)

At 698 MHz

Power density (W/m^2)	= 3.490	ICNIRP
Power density (mW/cm^2)	= 0.465	FCC 47 CFR § 1.1310
Power density (W/m^2)	= 4.653	Canada's RF Safety Code 6
Power density (W/m^2)	= 3.490	Australian Radiation Protection Series Publication No. 3
E-Field (Vm-1)	= 36.327	ICNIRP
E-Field (Vm-1)	= N/A	FCC 47 CFR § 1.1310
E-Field (Vm-1)	= 41.875	Canada's RF Safety Code 6
E-Field (Vm-1)	= 36.195	Australian Radiation Protection Series Publication No. 3
H-Field (Am-1)	= 0.098	ICNIRP
H-Field (Am-1)	= N/A	FCC 47 CFR § 1.1310
H-Field (Am-1)	= 0.111	Canada's RF Safety Code 6
H-Field (Am-1)	= 0.096	Australian Radiation Protection Series Publication No. 3

At 1710 MHz

Power density (W/m^2)	= 8.550	ICNIRP
Power density (mW/cm^2)	= 1	FCC 47 CFR § 1.1310
Power density (W/m^2)	= 10	Canada's RF Safety Code 6
Power density (W/m^2)	= 8.550	Australian Radiation Protection Series Publication No. 3
E-Field (Vm-1)	= 56.859	ICNIRP
E-Field (Vm-1)	= N/A	FCC 47 CFR § 1.1310
E-Field (Vm-1)	= 61.4	Canada's RF Safety Code 6
E-Field (Vm-1)	= 56.652	Australian Radiation Protection Series Publication No. 3
H-Field (Am-1)	= 0.153	ICNIRP
H-Field (Am-1)	= N/A	FCC 47 CFR § 1.1310
H-Field (Am-1)	= 0.163	Canada's RF Safety Code 6
H-Field (Am-1)	= 0.151	Australian Radiation Protection Series Publication No. 3

Reference levels for occupational exposure to time-varying electric and magnetic fields (unperturbed rms values)

At 698 MHz

Power density (W/m^2)	= 17.450	ICNIRP
Power density (mW/cm^2)	= 2.327	FCC 47 CFR § 1.1310
Power density (W/m^2)	= 23.267	Canada's RF Safety Code 6
Power density (W/m^2)	= 17.450	Australian Radiation Protection Series Publication No. 3
E-Field (Vm-1)	= 79.259	ICNIRP
E-Field (Vm-1)	= N/A	FCC 47 CFR § 1.1310
E-Field (Vm-1)	= 93.526	Canada's RF Safety Code 6
E-Field (Vm-1)	= 81.108	Australian Radiation Protection Series Publication No. 3
H-Field (Am-1)	= 0.211	ICNIRP
H-Field (Am-1)	= N/A	FCC 47 CFR § 1.1310
H-Field (Am-1)	= 0.248	Canada's RF Safety Code 6
H-Field (Am-1)	= 0.215	Australian Radiation Protection Series Publication No. 3

At 1710 MHz

Power density (W/m^2)	= 42.750	ICNIRP
Power density (mW/cm^2)	= 5	FCC 47 CFR § 1.1310
Power density (W/m^2)	= 50	Canada's RF Safety Code 6
Power density (W/m^2)	= 42.750	Australian Radiation Protection Series Publication No. 3
E-Field (Vm-1)	= 124.056	ICNIRP
E-Field (Vm-1)	= N/A	FCC 47 CFR § 1.1310
E-Field (Vm-1)	= 137	Canada's RF Safety Code 6
E-Field (Vm-1)	= 126.951	Australian Radiation Protection Series Publication No. 3
H-Field (Am-1)	= 0.331	ICNIRP
H-Field (Am-1)	= N/A	FCC 47 CFR § 1.1310
H-Field (Am-1)	= 0.364	Canada's RF Safety Code 6
H-Field (Am-1)	= 0.337	Australian Radiation Protection Series Publication No. 3

2.3 ESTABLISHING WAVELENGTH AND 1/4 WAVELENGTH

Frequency (MHz)	$\lambda = \frac{3x10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
703	0.42674253200569	42.674253200569	0.106685633001422	10.6685633001422
775.5	0.386847195357834	38.6847195357834	0.0967117988394584	9.67117988394584
793	0.378310214375788	37.8310214375788	0.094577553593947	9.4577553593947

Frequency (MHz)	$\lambda = \frac{3x10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
1710	0.175438596491228	17.5438596491228	0.043859649122807	4.3859649122807
2200	0.136363636363636	13.6363636363636	0.0340909090909091	3.40909090909091
2690	0.111524163568773	11.1524163568773	0.0278810408921933	2.78810408921933

2.4 FAR FIELD CALCULATIONS

The following calculations are based on: 16.4 dBi gain antenna

For 2W – 698 MHz

P = 2 Watts or 2000 milliwatts
G = 43.652 Numeric Gain
r = 150 centimetres or 1.5metres

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$

S = 3.09 W/m^2

S= 0.309 mW/cm^2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$

E = 34.12 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$

H = 0.09 A/m

The following calculations are based on: 16.4 dBi gain antenna

For 2W – 1710 MHz

P = 2 Watts or 2000 milliwatts
G = 43.652 Numeric Gain
r = 100 centimetres or 1metres

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$

S = 6.95 W/m^2

S= 0.695 mW/cm^2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$

E = 51.18 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$

H = 0.14 A/m

For 90 W – 698 MHz

P = 90 Watts or 90000 milliwatts
G = 43.652 Numeric Gain
r = 950 centimetres or 9.5metres

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$ S = 3.46 W/m^2

S= 0.346 mW/cm^2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$ E = 36.14 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$ H = 0.0956 A/m

For 90 W – 1710 MHz

P = 90 Watts or 90000 milliwatts
G = 43.652 Numeric Gain
r = 610 centimetres or 6.1metres

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$ S = 8.40 W/m^2

S= 0.840 mW/cm^2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$ E = 56.28 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$ H = 0.15 A/m

The calculations meet the General Public Exposure Levels described in the ICNIRP Guidelines.
The calculations meet the General Public Exposure Levels described in the FCC 47CFR§1.1310.
The calculations meet the General Public Exposure Levels described in the Canada's RF Safety Code 6.
The calculations meet the General Public Exposure Levels described in the Australian Radiation Protection Series Publication No. 3
The calculations meet the Occupational Exposure Levels described in the ICNIRP Guidelines.
The calculations meet the Occupational Exposure Levels described in the FCC 47CFR§1.1310
The calculations meet the Occupational Exposure Levels described in the Canada's RF Safety Code 6
The calculations meet the Occupational Exposure Levels described in the Australian Radiation Protection Series Publication No. 3

SECTION 3

DISCLAIMERS AND COPYRIGHT

3.1 DISCLAIMERS AND COPYRIGHT

This report relates only to the actual item/items tested.