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Report On

RF Exposure Compliance Boundary Assessment of the
Nokia Solutions and Networks
AirScale Base Station Products and Flexi Base Station Products
(462.5-467.5 MHz, 698-960 MHz, 1452-1492 MHz, 1710-2690 MHz
and 3400-3800 MHz)

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Product Service

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REPORT ON

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This report has been up issued to Issue 3 and should be read in place of Issue 2. This report has been up issued to Issue 3 to add the frequency band 1452-1492 MHz and to add new power variants 8, 96, 100, 110,120,128, 130,140,150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350 and 360W

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SECTION 1

REPORT SUMMARY

RF Exposure Compliance Boundary Assessment of the
Nokia Solutions and Networks AirScale Base Station Products and Flexi Base Station Products
(462.5-467.5 MHz, 698-960 MHz, 1452-1492 MHz, 1710-2690 MHz and 3400-3800 MHz)

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 AirScale Base Station Products and Flexi Base Station Products (462.5-467.5 MHz, 698-960 MHz, 1452-1492 MHz, 1710-2690 MHz and 3400-3800 MHz) 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	AirScale Base Station Products and Flexi Base Station Products
Model Number(s)	Nokia AirScale Base Station Products and Flexi Base Station Products (462.5-467.5 MHz, 698-960 MHz, 1452-1492 MHz, 1710-2690 MHz and 3400-3800 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, 8, 10, 20, 30, 40, 50, 60, 70, 80, 90, 96, 100, 110, 120, 128, 130, 140, 150, 160 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350 and 360 W
Test Specification/Issue/Date	EN 62311:2008 CFR 47 Pt1.1310 Health Canada Safety Code 6 ARPANSA Radiation Protection Series No.3
Related Documents	EN 50385: 2002

1.2 BRIEF SUMMARY OF RESULTS

1.2.1 Compliance Boundaries (cm) for General Public Levels

Power (W)	Frequency Range (MHz)				
	462.5-467.5	698-960	1452-1492	1710-2690	3400-3800
	Distance (cm)				
2	201	174	136	128	102
5	317	275	214	203	161
8	401	348	271	256	203
10	448	389	303	287	227
20	633	550	428	405	320
30	775	674	525	496	392
40	895	778	606	573	453
50	1000	870	677	460	506
60	1100	952	742	500	555
70	1180	840	801	701	599
80	1266	1100	856	810	640
90	1342	1166	908	859	679
96	1386	1204	938	887	701
100	1415	1230	957	905	716
110	1484	1289	1004	949	751
120	1550	1347	1049	992	784
128	1601	1391	1083	1024	810
130	1614	1402	1092	1032	816
140	1674	1455	1133	1071	847
150	1733	1506	1172	1109	877
160	1790	1555	1211	1145	905
170	1844	1602	1248	1180	933
180	1898	1649	1284	1214	960
190	1951	1695	1320	1248	987
200	2001	1739	1354	1280	1012
210	2050	1781	1387	1312	1037
220	2098	1823	1419	1342	1061
230	2147	1865	1452	1373	1086
240	2192	1904	1483	1402	1109
250	2238	1944	1514	1431	1132
260	2282	1983	1544	1460	1154
270	2324	2019	1572	1487	1176
280	2367	2057	1602	1515	1198
290	2409	2093	1629	1541	1219
300	2451	2129	1658	1568	1240
310	2490	2164	1685	1593	1260
320	2531	2199	1712	1619	1280
330	2572	2235	1740	1645	1301
340	2608	2266	1764	1668	1319
350	2647	2300	1791	1693	1339
360	2684	2332	1816	1717	1358

1.2.2 Compliance Boundaries (cm) for Occupational Levels

Power (W)	Frequency Range (MHz)				
	462.5-467.5	698-960	1452-1492	1710-2690	3400-3800
	Distance (cm)				
2	80	65	54	52	43
5	126	103	85	81	68
8	159	130	107	103	86
10	178	145	119	115	97
20	251	205	169	162	136
30	308	251	206	198	167
40	355	289	238	190	193
50	397	323	266	229	215
60	435	354	292	280	236
70	470	390	315	250	255
80	502	409	337	323	272
90	532	434	357	343	289
96	550	448	369	354	298
100	561	457	376	361	304
110	589	479	394	379	319
120	615	501	412	396	333
128	635	517	426	409	344
130	640	521	429	412	347
140	664	541	445	427	360
150	687	560	461	442	373
160	710	578	476	457	385
170	731	595	490	471	396
180	753	613	505	484	408
190	774	630	519	498	419
200	794	646	532	511	430
210	813	662	545	523	441
220	832	677	558	535	451
230	851	693	571	548	461
240	869	708	583	559	471
250	887	722	595	571	481
260	905	737	606	582	490
270	922	750	618	593	499
280	939	764	629	604	509
290	955	778	640	615	518
300	972	791	651	625	527
310	988	804	662	635	535
320	1004	817	673	646	544
330	1020	830	684	656	553
340	1034	842	693	665	560
350	1050	855	703	675	569
360	1064	866	713	685	577

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 AirScale Base Station Products and Flexi Base Station Products (462.5-467.5 MHz, 698-960 MHz, 1452-1492 MHz, 1710-2690 MHz and 3400-3800 MHz). 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 AirScale Base Station Products and Flexi Base Station Products (462.5-467.5 MHz, 698-960 MHz, 1452-1492 MHz, 1710-2690 MHz and 3400-3800 MHz) 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 AirScale Base Station Products and Flexi Base Station Products operate in the frequency ranges 462.5-467.5 MHz, 698-960 MHz, 1452-1492 MHz, 1710-2690 MHz and 3400-3800 MHz.

Gain	16.4 dBi
Power	2, 5, 8, 10, 20, 30, 40, 50, 60, 70, 80, 90, 96, 100, 110, 120, 128, 130, 140, 150, 160 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350 and 360 W
Duty Cycle	100%

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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 ESTABLISHING WAVELENGTH AND 1/4 WAVELENGTH

Frequency (MHz)	$\lambda = \frac{3x10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
462.5	0.648649	64.86486	0.162162	16.21622
465	0.645161	64.51613	0.16129	16.12903
467.5	0.641711	64.17112	0.160428	16.04278

Frequency (MHz)	$\lambda = \frac{3x10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
698	0.429799	42.97994	0.10745	10.74499
829	0.361882	36.18818	0.09047	9.047045
960	0.3125	31.25	0.078125	7.8125

Frequency (MHz)	$\lambda = \frac{3x10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
1452	0.206612	20.66116	0.051653	5.165289
1472	0.203804	20.38043	0.050951	5.095109
1492	0.201072	20.10724	0.050268	5.02681

Frequency (MHz)	$\lambda = \frac{3x10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
1710	0.175439	17.54386	0.04386	4.385965
2200	0.136364	13.63636	0.034091	3.409091
2690	0.111524	11.15242	0.027881	2.788104

Frequency (MHz)	$\lambda = \frac{3x10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
3400	0.088235	8.823529	0.022059	2.205882
3600	0.083333	8.333333	0.020833	2.083333
3800	0.078947	7.894737	0.019737	1.973684

2.3 FAR FIELD CALCULATIONS

The following calculations are based on: 16.4 dBi gain antenna

For 2W – 462.5 MHz
P = 2 Watts or 2000 milliwatts
G = 43.652 Numeric Gain
r = 201centimetres or 2.0 metres

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$ S = 1.72 W/m^2

S= 0.17 mW/cm^2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$ E = 25.46 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$ H = 0.07 A/m

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 – 1452 MHz

P = 2 Watts or 2000 milliwatts
G = 43.652 Numeric Gain
r = 136 centimetres or 1.36 metres

The power flux:

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

S = 3.76 W/m^2

S= 0.376 mW/cm^2

The electric field strength:

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

E = 37.63 V/m

The magnetic field strength:

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

H = 0.09 A/m

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 2W – 3400 MHz

P = 2 Watts or 2000 milliwatts
G = 43.652 Numeric Gain
r = 102 centimetres or 1.0 metres

The power flux:

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

S = 6.68 W/m^2

S= 0.67 mW/cm^2

The electric field strength:

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

E = 50.17 V/m

The magnetic field strength:

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

H = 0.13 A/m

For 360 W – 462.5 MHz

P = 360 Watts or 360000 milliwatts
G = 43.652 Numeric Gain
r = 2684 centimetres or 26.84 metres

The power flux:

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

S = 1.73 W/m^2

S= 0.17 mW/cm^2

The electric field strength:

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

E = 25.57 V/m

The magnetic field strength:

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

H = 0.07 A/m

For 360 W – 698 MHz

P = 360 Watts or 360000 milliwatts
G = 43.652 Numeric Gain
r = 2332 centimetres or 23.32metres

The power flux:

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

S = 2.29 W/m^2

S= 0.23 mW/cm^2

The electric field strength:

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

E = 29.43 V/m

The magnetic field strength:

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

H = 0.08 A/m

For 360 W – 1710 MHz

P = 160Watts or 160000 milliwatts
G = 43.652 Numeric Gain
r = 1717 centimetres or 17.17 metres

The power flux:

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

S = 4.23 W/m^2

S= 0.423 mW/cm^2

The electric field strength:

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

E = 39.97 V/m

The magnetic field strength:

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

H = 0.16 A/m

For 360W – 1452 MHz

P = 360 Watts or 360000 milliwatts
G = 43.652 Numeric Gain
r = 1816 centimetres or 18.16 metres

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$ S = 3.78 W/m^2

S= 0.38 mW/cm^2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$ E = 37.79 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$ H = 0.10 A/m

For 360W – 3400 MHz

P = 360 Watts or 360000 milliwatts
G = 43.652 Numeric Gain
r = 1358 centimetres or 13.58 metres

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$ S = 6.78 W/m^2

S= 0.68 mW/cm^2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$ E = 50.57 V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$ H = 0.13 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.

ANNEX A

REGIONAL REQUIREMENTS

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.065 - 1	-	610/f	1.6/f
1 - 10	-	610/f	1.6/f
10 - 400	10	61	0.162
400 - 2000	f/40	3*f^0.5	0.00796*f^0.5
2000 - 300000	50	137	0.363

Table A.1 – EN 62311:2008 Occupational Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.003 - 0.15	-	87	5
0.15 - 1	-	87/f	0.73/f
1 - 10	-	87/f^0.5	0.73/f
10 - 400	2	27	0.071
400 - 2000	f/200	1.375*f^0.5	0.00364*f^0.5
2000 - 300000	10	61	0.162

Table A.2 – EN 62311:2008 General Population Limits

Frequency Range (MHz)	S Field (mW/cm^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	900/f^2	1842/f	4.89/f
30 - 300	1	61.4	0.163
300 - 1500	f/300	-	-
1500 - 100000	5	-	-

Table A.3 – CFR 47 Pt1.1310 Occupational Limits

Frequency Range (MHz)	S Field (mW/cm^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	180/f^2	824/f	2.19/f
30 - 300	0.2	27.5	0.073
300 - 1500	f/1500	-	-
1500 - 100000	1	-	-

Table A.4 – CFR 47 Pt1.1310 General Population Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
10 - 20	10	61.4	0.163
20 - 48	44.72/f^0.5	129.8/f^0.25	0.3444/f^0.25
48 - 100	6.455	49.33	0.1309
100 - 6000	0.6455*f^0.5	15.60*f^0.25	0.04138*f^0.25
6000 - 150000	50	137	0.364

Table A.5 – Health Canada Safety Code 6 Occupational Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
10 - 20	2	27.46	0.0728
20 - 48	8.944/f^0.5	58.07/f^0.25	0.1540/f^0.25
48 - 300	1.291	22.06	0.05852
300 - 6000	0.02619*f^0.6834	3.142*f^0.3417	0.008335*f^0.3417
6000 - 15000	10	61.4	0.163

Table A.6 – Health Canada Safety Code 6 General Population Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.1 - 1	-	614	1.63/f
1 - 10	1000/f^2	614	1.63/f
10 - 400	10	61.4	0.163
400 - 2000	f/40	3.07*f^0.5	0.00814*f^0.5
2000 - 300000	50	137	0.364

Table A.7 – ARPANSA Radiation Protection Series No.3 Occupational Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0.1 - 0.15	-	86.8	4.86
0.15 - 1	-	86.8	0.729/f
1 - 10	-	86.8/f^0.5	0.729/f
10 - 400	2	27.4	0.0729
400 - 2000	f/200	1.37*f^0.5	0.00364*f^0.5
2000 - 300000	10	61.4	0.163

Table A.8 – ARPANSA Radiation Protection Series No.3 General Population Limits