Compliance with reference levels (based on basic restrictions) for general public and occupational exposure to radio frequency electromagnetic fields

Product: Nokia Siemens Networks Flexi Multiradio Base Station / Flexi Multiradio 10 Base Station / Flexi Multiradio GSM/EDGE / Flexi Multiradio Base Station GSM/EDGE (called as Flexi Multiradio Base Station family in this point forward).

1. INSTALLING BASE STATIONS TO ENSURE PUBLIC SAFETY

This 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. By observing the compliance boundary, and ensuring the general public has no access to areas inside the established boundaries will ensure that the general public has no exposure to levels in excess of the safety limits.

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 their self against undue risk. The Warnings and Cautions information of this document is taken from the relevant section of Nokia Siemens Network's user manual containing warnings and cautions specific to the equipment.

3. WARNINGS AND CAUTIONS PROVIDED

The statements shown below are taken from Nokia Siemens Network's 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 meters.

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 a BTS, make sure that all transmitters in the area are switched off.

When assessing the applicable compliance boundaries European standards EN 50383, EN 50384, EN 50385 and Council Recommendation 1999/519/EC for occupational and general public electromagnetic exposure limits- see Annex A – have been applied.

3.1. ASSESSMENT APPLYING SAR MEASUREMENTS

European standards EN 50383, EN 50384 and EN 50385 do not include specifications for whole body SAR measurements. Whole body SAR measurements are not required for transmitters that have maximum output power levels too low to result in exposure levels that can reach the whole body SAR

compliance limits under any conditions. Whole body SAR exclusion power levels have been based on worst case assumptions and are as follows:

Exposure category	Maximum output power (rms)
General Public	Max power [W]=general public whole body SAR limit 0.08 [W/kg]* 4-year old child mass 12.5 [kg] = 1 W
Occupational	Max power [W]=occupational whole body SAR limit 0.4 [W/kg]* 16-year old worker 42 [kg] = 16.8 W

Table 1 Whole body SAR exclusion power levels.

Localized SAR measurement can be used only when

1. The separation between the phantom and the outer surface of the energy generating element is 40 cm or less;
2. The surface area of the energy generating element is less than 60 cm by 30 cm;
3. The frequency is in the range of 800 to 3000 MHz.

For the reasons above, SAR measurements are not applicable to

- Nokia Siemens Networks Flexi Multiradio Base Station family

3.2 ASSESSMENT OF COMPLIANCE BOUNDARY

The compliance boundary is defined as the area around the antenna, shown in Figure 1. The center of the antenna is located at the origin. Distances from the antenna are shown. The top and side views are shown in Figure 2 and Figure 3.

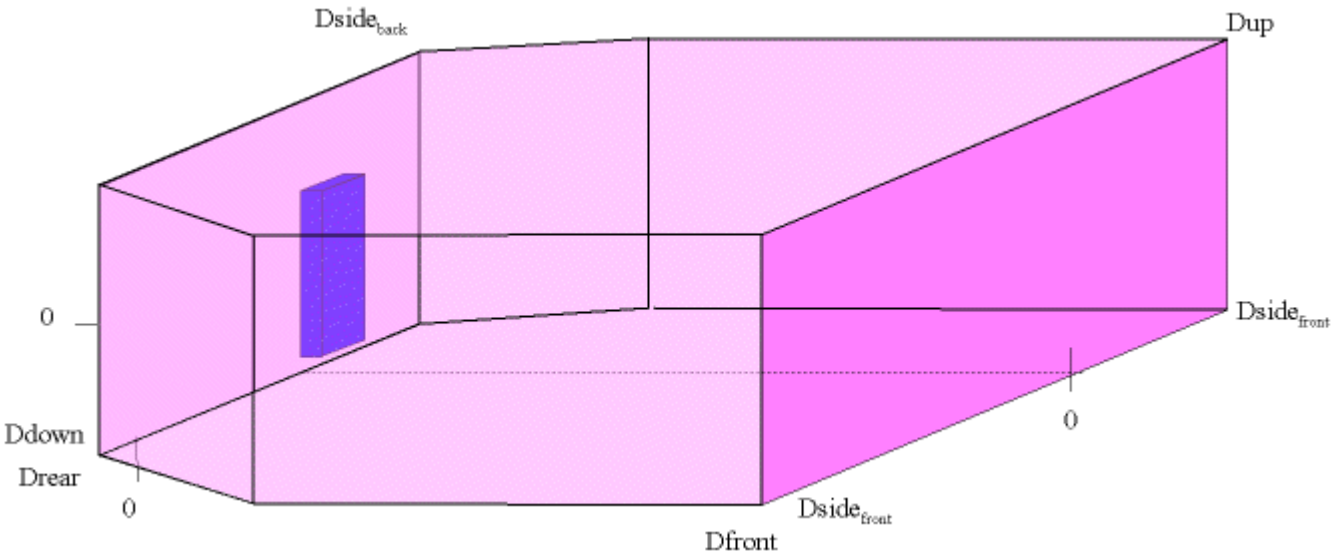

Figure 1

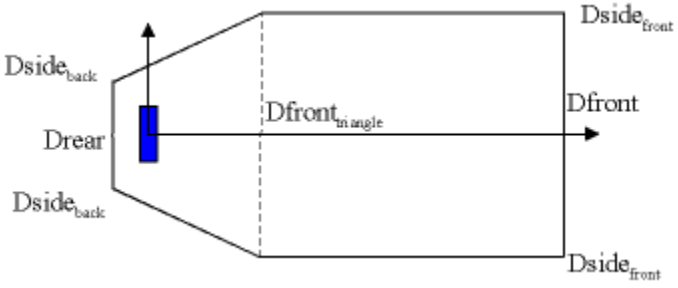

Figure 2

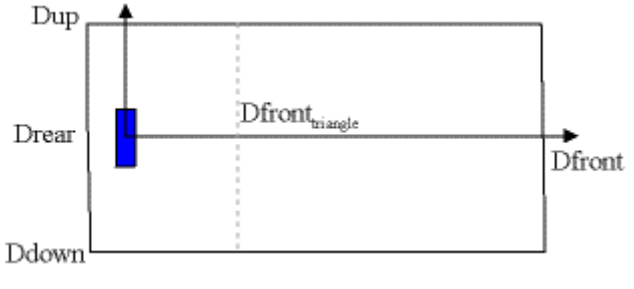

Figure 3

The compliance boundaries for the **Nokia Siemens Networks Flexi Multiradio Base Station family** are given in Table 2 for different power levels at the antenna input. Typical and worst case power level configurations for general public (GP) and occupational (O) exposure limits are included in Table 2.

		Dfront		**$Dfront_{triangle}$**		**Drear**		**$Dside_{back}$**		**$Dside_{front}$**		**Dup**		**Ddown**	
Freq. (MHz)	Power at antenna input (W)	GP	O	GP	O	GP	O	GP	O	GP	O	GP	O	GP	O
900	40	7	2.95	2.4	1	0.3	0.05	0.4	0.2	2	0.6	0.95	0.85	0.95	0.85
900	80	9.8	4.45	2.8	2	0.35	0.1	0.4	0.3	2.9	1.2	1.1	0.9	1.1	0.9
900	95	10.7	4.9	3.5	2.2	0.4	0.25	0.7	0.3	3.1	1.3	1.3	0.9	1.3	0.9
900	120	12	5.5	3.5	1.9	0.45	0.3	0.7	0.3	3.45	1.5	1.35	0.95	1.35	0.95
1800	40	4.6	2.1	1.2	1.1	0.2	0.1	0.2	0.2	1.5	0.65	0.5	0.45	0.5	0.45
1800	80	6.45	3	1.5	1.1	0.25	0.15	0.4	0.2	2.05	0.95	0.6	0.5	0.6	0.5
1800	95	7.05	3.3	2	1	0.45	0.35	0.7	0.3	2.25	1.05	0.65	0.5	0.65	0.5
1800	120	7.9	3.65	2.1	1.2	0.5	0.4	0.7	0.3	2.5	1.2	0.65	0.5	0.65	0.5
2100	8	0,55	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.15	0.1	0.7	0.7	0.7	0.7
2100	20	1.8	0.3	0.5	0.1	0.1	0.1	0.2	0.1	0.55	0.15	0.9	0.7	0.7	0.7
2100	40	4.2	0.65	1.0	0.15	0.1	0.1	0.4	0.15	1	0.25	1.25	0.7	0.75	0.7
2100	60	5.7	1.05	1.9	0.25	0.1	0.1	0.5	0.15	2	0.4	1.55	0.8	1.05	0.7
2600	8	0.85	0.15	0.25	0.1	0.1	0.1	0.15	0.1	0.15	0.1	0.7	0.7	0.7	0.7
2600	20	2.7	0.35	0.75	0.1	0.1	0.1	0.25	0.1	0.65	0.15	1.1	0.7	0.8	0.7
2600	40	4.5	0.85	1.6	0.2	0.1	0.1	0.4	0.15	1.4	0.25	1.45	0.7	1.1	0.7
2600	60	5.8	1.4	1.8	0.3	0.1	0.1	0.5	0.15	2	0.35	1.7	0.75	1.25	0.7

Table 2 Dimensions of compliance boundary in meters

3.3 TYPICAL CONFIGURATION

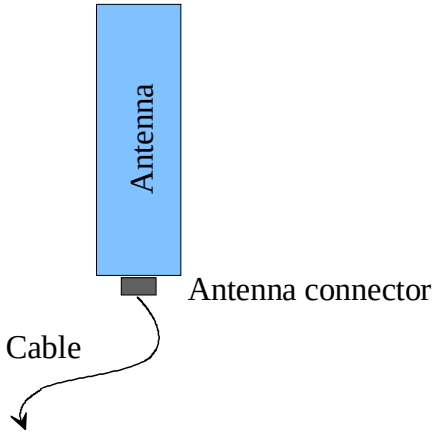

Figure 4

The antenna is connected through a connector and cable(s) to the base station as shown in Figure 4.

A detailed description of the components is given below:

Power (***P*****$_{out}$**)	40 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 = $P_{out} N 10^{\frac{-L}{10}}$	40 W

Table 3

The worst-case power level configuration is when ***N*** is (3 for GSM/EDGE and 1 for LTE/WCDMA/Multiradio) for and there is no loss. In such a case the power at antenna input is 120 W max for GSM/EDGE and 40/60/80 W max for LTE/WCDMA/Multiradio depenting of configuration.

Typical antenna specifications for 900 MHz and 1800 MHz are given below:

Frequency	900 MHz	1800 MHz
Gain	18 dBi	17.2 dBi
Half-power beam width	H-plane: 60 deg.	H-plane: 68 deg.
	E-plane: 8 deg.	E-plane: 10 deg.
Electrical downtilt	0 deg	0 deg
Height/width/depth	2300 / 500 / 200 mm	1000 / 200 / 100 mm

Table 4

3.4 WHEN USING DIFFERENT CONFIGURATIONS

IMPORTANT:

In Table 2, the compliance boundaries are given for different power levels, including the typical and worst case levels. If an exposure limit, antenna, and/or configuration are used which does not correspond to the levels or frequencies given in Table 2, the compliance boundary must be re-calculated according to EN50383.

The formula for calculating the compliance boundary using the far-field model, which is referenced in EN50383, is given in Annex B. 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 $\lambda/4$.

ANNEX A: Council Recommendation 1999/519/EC for occupational and general public electromagnetic exposure limits

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	61	10
	400-2000 MHz	$3f^{1/2}$	f/40
	2-300 GHz	137	50
General public exposure	10-400 MHz	28	2
	400-2000 MHz	$1.375f^{1/2}$	f/200
	2-300 GHz	61	10

Notes:

- f is 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).

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 $\lambda/4$, which is 4.17 cm at 1800 MHz. Therefore all the calculations are valid when the compliance boundary is greater or equal to the antenna dimensions plus $\lambda/4$.

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

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

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.