ATTACHMENT N – SAR MEASUREMENT REPORT

January 17th, 2001

P.O. Box 86
Joensuunkatu 7E
FIN-24101 SALO
Finland

FEDERAL COMMUNICATIONS COMMISSION
Equipment Authorization Branch
7435 Oaklands Mills Road
Columbia, MD 21046

SAR TEST REPORT of Nokia 6180i

Gentlemen,

Please find attached SAR test report of FCC ID: GMLNSD-3GW

For and on behalf of Nokia Mobile Phones Ltd.

Respectfully,

Sami Savela
Senior RF Design Engineer
Responsible for NMP SAR measurements

Contents Page

1. Description of the measurement

These measurements were done by E-field scanning system for dosimetric assessments. It is robot-based system which allows automated E-field scanning in tissue simulating solutions. The measurements are based on the induced specific absorption rate (SAR) definition of relevant ANSI / IEEE standards. The dosimetric assessment system of Nokia Mobile Phones is manufactured by Prof. Niels Kuster at ETH (Schmid & Partner Engineering AG) in Switzerland, Europe.

The method used to determine the 1 gram average value of SAR is:

Initially a coarse scan is performed over the whole area on a 20 x 20 mm grid. From this coarse scan, the location at which the maximum value is measured is used as the centre for a second, more detailed scan. This second scan is based on a 3 dimensional grid of 4 x 4 x 7 points on a grid of 10 mm for 900 MHz. The average SAR values are computed using the 3D spline inter-polation algorithm. The 3D spline is composed on three one-dimensional splines with the “Not a knot” condition in the x, y and z directions (1), (2). The volume is integrated with the trapezoidal algorithm. 1000 points (10x10x10) are interpolated to calculate the average. All neighbouring volumes are evaluated until no neighbouring volume with a higher average is found.

(1) W. Gander, Computermathematik, Birkhauser, Basel, 1992

(2) W. H. Press, S. A Teukolsky, W. T. Vettering and B. P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, second edition, Cambridge University Press, 1992

2. Description of calibration by manufacturer

The calibration of data acquisition electronics and probe was done by the manufacturer. (Appendix 3 and 7)

- the data acquisition unit is calibrated and tested using a FLUKE 702 Process Calibrator

- measurement uncertainty is less than ± 20% for various tissues simulating solutions and frequencies:
  - these calibration parameters were measured using a temperature probe developed by manufacturer
  - description of the probe calibration and examples of the evaluation are enclosed in Appendix 7

3. List of standards

ANSI/IEEE Std C95.1-1992

IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

ANSI/IEEE Std C95.3-1992

IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields-RF and Microwave

4. Device list:

Automated E-field scanning system for dosimetric assessments System. Calibration due June 2001. Technical data (Appendix 1)

Probe ET3DV4, SN: 1105, Recalibrated due June 2001
Technical data (Appendix 2)

DASY-dosimetric assessment system, DAE V2, SN: 213, Calibration due June 2001 (Appendix 3)

Industrial robot and Control unit, type STÄUBLI CS7 RX 90(CR) NO:595148-01, Technical data (Appendix 4)

Generic Twin Phantom Version 3 (Appendix 6).

PC COMPAQ 466
laser printer QMS magicolor plus

Devices for preparation of the brain tissue simulating liquids
-General laboratory equipment for preparation of liquids
-Magnetic stirrer with heating plate IKA RET CV, SN:792708
-Scale Mettler Doleto, SN: 2114177678

HP 85070A Dielectric probe system
- network analyzer HP 8753B, SN:2716U00762, Calibration due May 2001
- cables
- probe stand
- dielectric probe kit NO: US33020242
- PC AST PREMMIA 4/66 d
- HP-IB 82335B (interface and software)

Dipole Validation kit for 900 MHz band, Schmid & Partner Engineering AG, Typ: D900V2, SN: 003, Recalibrated/Verification due June 2002 and

Dipole Validation kit for 1800 MHz band, Schmid & Partner Engineering AG, Typ: D1800V2, SN: 207, Recalibrated/Verification due June 2002

- signal generator ROHDE & SCHWARZ, 1038.6002.03 , Calibration due June 2002
- power meter, ROHDE & SCHWARZ, 857.8008.02, Calibration due December 2001
- amplifier ZHL-42 (SMA), 022488-RM:4152

5. Equipment under test

Unit: NOKIA 6180i
FCC-ID: GMLNSD-3GW

5.1 Verification and results

Validation of the measurement system was made before measurement using the Validation kit. Appendix: 8 and 9.

This validation measurement makes sure that the repeatability of SAR measurement value with careful positioning is better than 10 %.

On 900 MHz error was < 3 % compared to the parameter of manufacturer
SAR results (0.25W): 2.34 mW/g (1g) and 2.40 mW/g (1g).
Appendix: 8 and 9

5.2 Specification of Liquid

The liquids were done using the "Recipe 900MHz ", respectively, and preparation bases on brochure. Appendix 5

900 MHz liquid was used with the 900 MHz Validation measurement.

The parameters were measured by liquid testing of HP85070A Dielectric probe system. The amounts of used liquids were 20 litres.
Liquid parameters e_r *(Relative permittivity) and* s *(Conductivity)* were measured by HP 85070A Dielectric probe system.

Frequency / MHz	Relative permittivity / e_r	Conductivity / mho/m
824	44.8	0.79
836	44.6	0.80
849	44.5	0.82
900	44.1	0.87

5.3 Specification of position with phone against generic twin phantom

The position of the phone relative to the head phantom is shown on page 8. The centre of the phone's earpiece is aligned such that it is co-axial with a mark on the phantom which represents the centre of the ear of the head.

Measurements were done with a Left-Hand (L.H.) side because the antenna is situated in the top right corner of the phone (viewed from the earpiece side). Therefore, the antenna is closer to the head in the measurement position using a L.H. side rather than a R.H. side. It is concluded that the L.H. side is worst case measurement position.

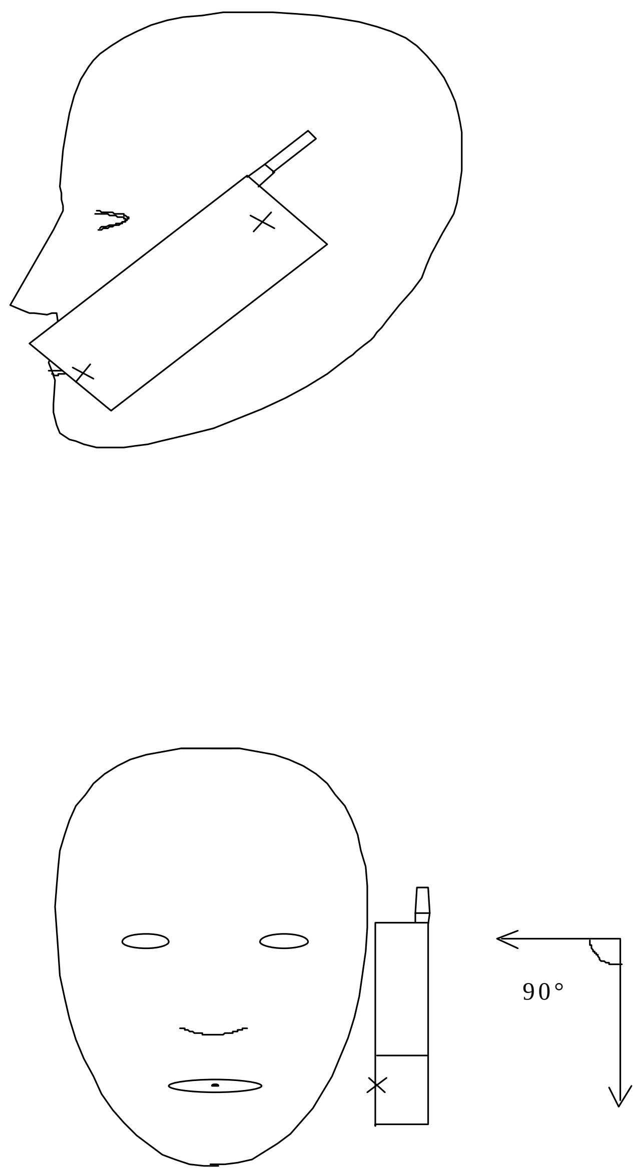
The test signal for measurements was Analog AMPS. CDMA mode (Cellular) at the same frequency range than AMPS was not measured due to considerably lower power levels.

The phone positions against the head were 90° (for the IEEE Std C95.1-1991 (ANSI / IEEE) and FCC measurement). The angle between the reference line of the phone and the line connecting both auditory canal openings was 90°. The distance between the handset and the brain simulation liquid was 6 mm (page 8).

The used radio channels on AMPS mode were: 991, 383 and 799. Peak TX power of analog AMPS ("Power" in the tables of the paragraph 5.5) was measured from external antenna connector of the transceiver using maximum power level. During the tests the battery was fully charged.

Ambient and "brain tissue" liquid temperature was 23 °C ± 1 °C.

5.4 The phone position against generic twin phantom



Picture 5.4.
The centre of the ear piece were placed directly at the entrance of the imaginary auditory canal of the phantom. The reference line of the phone lie in the reference plane defined by the following three points: auditory canal openings of both ears and the centre of the mouth.

5.5 Results of SAR for 1g.

Appendix: 10

The plots in Appendix 10 are a graphical representation of the SAR values over the whole area being scanned.

The size of the area being scanned is sufficiently large to ensure that all possible regions of peak SAR are measured. This is indicated by the fact that the position of peak SAR is in the measured area, and the value of SAR reduces asymptotically in the x- and y- directions as the probe is moved towards the border of the measured area.

Analog Mode AMPS, Left Hand Phantom, Whip in

Meas Nr:	Phone position	Frequency MHz / channel	Power [dBm]	SAR (1g)[mW/g]
1	90°	824 / 991	26.5	0.52
2	90°	836 / 383	26.5	0.85
3	90°	849 / 799	26.5	0.78
FCC ID: GMLNSD-3GW MEASURED: 2001-1-17/NMP		FCC limit		1.60[mW/g] (ANSI/IEEE)

Analog Mode AMPS, Left Hand Phantom, Whip up

Meas nr:	Phone position	Frequency MHz / channel	Power [dBm]	SAR (1g)[mW/g]
4	90°	824 / 991	26.5	1.08
5	90°	836 / 383	26.5	1.11
6	90°	849 / 799	26.5	1.07
FCC ID: GMLNSD-3GW MEASURED: 2001-1-17/NMP		FCC limit		1.60[mW/g] (ANSI/IEEE)

5.6 Evaluation of SAR in body worn configurations

5.6.1 Introduction

SAR was measured when phone was placed with body worn accessory against the Flat Phantom. Body worn accessory Belt Clip BCH-12U (Picture 1) were tested. The measurement test equipment and setup was the same as used in Head SAR measurements.

Picture 1. Belt Clip BCH-12U

5.6.2 Test method

Measurements were done with the Dasy 2 dosimetric assessment system DAE V2, SN: 213 and with the generic Twin Phantom version 3 from Schmid & Partner Engineering Ag. Positioning of the phone in all measurements were done according to the user guide instructions in section *Radio Frequency (RF) Signals*. Separation distance for BCH-12U is presented in picture 2. The point of maximum SAR was searched and SAR was measured with a 3-dimensional cube measurement averaged over 1 gram mass.

Picture 2. Separation distance with Belt Clip BCH-12U

The maximum output power level in lowest, middle and highest channel was used (824, 836 and 849 MHz on AMPS mode. Brain equivalent liquid was used.

Permittivity and conductivity of muscle tissue simulating liquids at 836 MHz is shown in table 1. FCC recommendation is from http://www.fcc.gov/fcc-bin-dielec.sh. The used brain tissue has higher conductivity and lower permittivity than the liquid FCC recommends to be used. Thus all SAR values are overestimated.

	Permittivity	Conductivity
FCC recommendation	56.111336	0.946714
Used brain tissue	44.6	0.80

Table 2. Properties of liquids simulating muscle tissue @ 836 MHz

FCC recommended conductivity would lead to higher SAR results than the liquid used. On the other hand, the used permittivity compensates difference caused by the conductivity.

When the measured SAR values are multiplied by factor 1.18, which is the difference between the conductivity values, the maximum body SAR result changes from 1.08 to 1.27. This approach leads to overestimate of SAR.

5.6.3 Results

Graphical presentations of test positions with SAR values are presented in the end of this report.

Body Worn, Belt Clip (BCH-12U) against Flat Phantom

Meas. nr:	Test signal	Frequency MHz / channel	Power dBm	SAR (1g)[mW/g]
7	AMPS (whip in)	824 / 991	26.5	0.57
8	AMPS (whip in)	836 / 383	26.5	0.75
9	AMPS (whip in)	849 / 799	26.5	0.76
10	AMPS (whip up)	824 / 991	26.5	1.04
11	AMPS (whip up)	836 / 383	26.5	1.08
12	AMPS (whip up)	849 / 799	26.5	1.05
FCC ID: GMLNSD-3GW MEASURED: 2001-1-17/NMP		FCC limit		1.60[mW/g] (ANSI/IEEE)

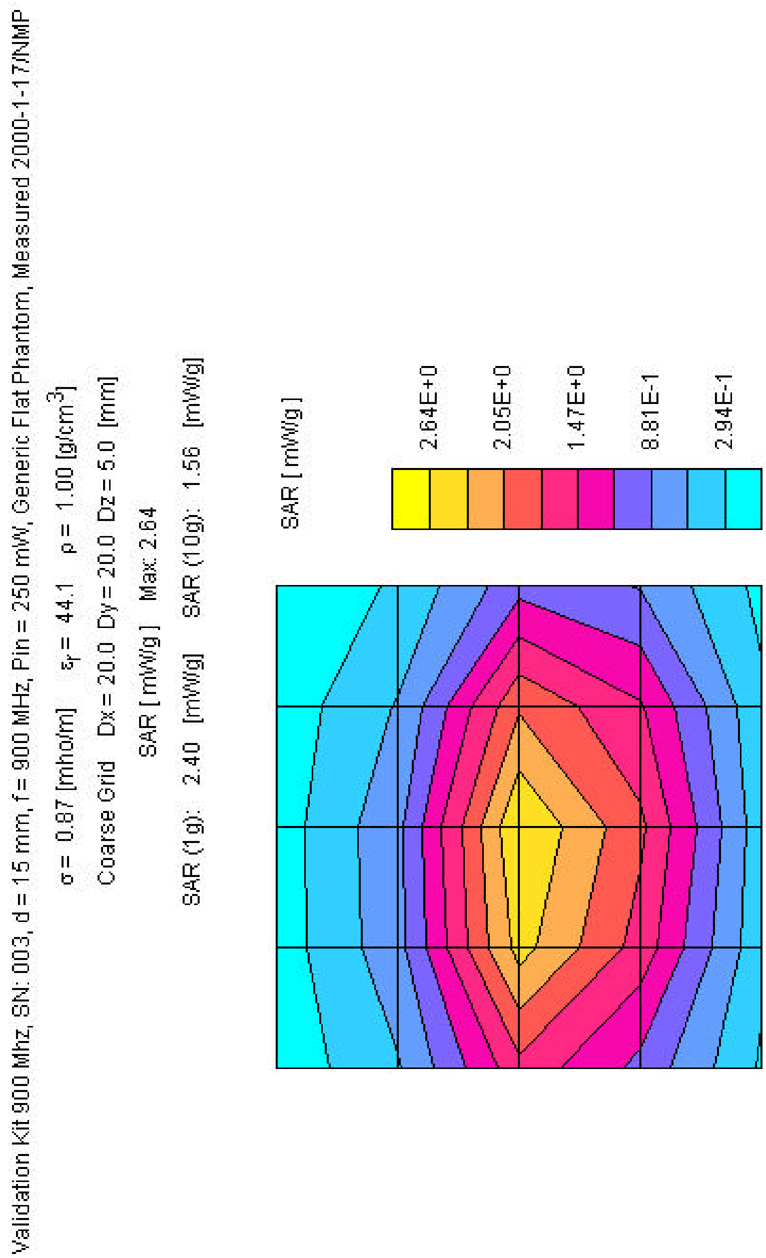
5.6.4 Summary

The SAR values found for the portable cellular phone (FCC ID: GMLNSD-3GW) are below the maximum recommended levels of 1.6 mW/g.

Appendix 9

pages 1

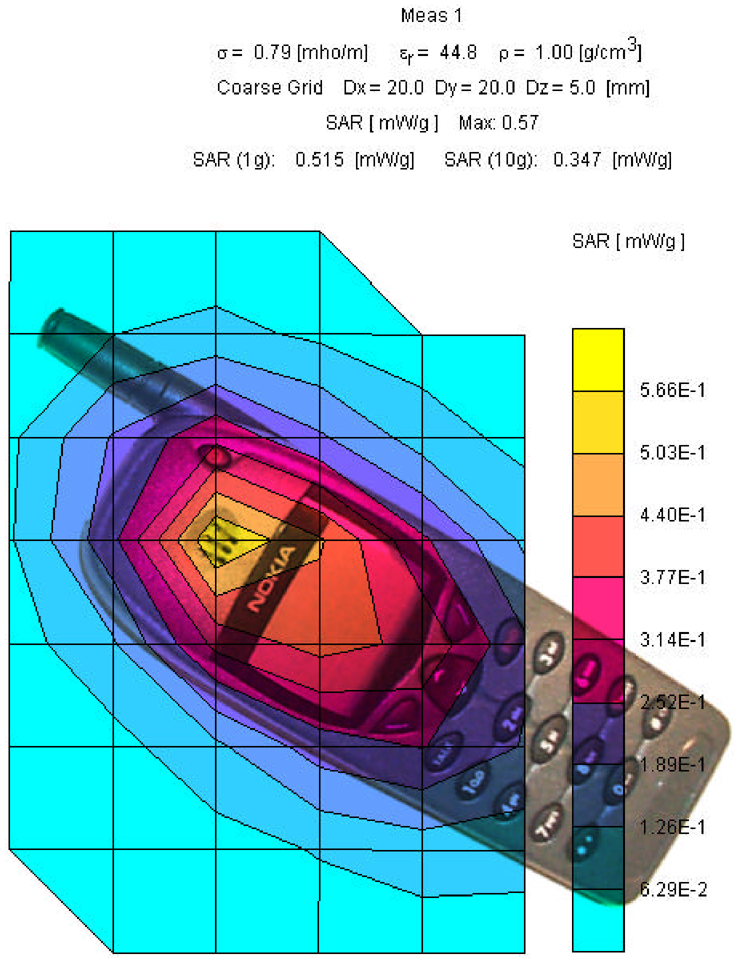
VERIFY WITH DIPOLE VALIDATION KIT


Validation Kit 900 Mhz, SN: 003, d = 15 mm, f = 900 MHz, Pin = 250 mW, Generic Flat Phantom, Measured 2000-1-17/NMP
σ = 0.87 [mho/m] εr = 44.1 ρ = 1.00 [g/cm3]
Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]
SAR [mW/g] Max: 2.64
SAR (1g): 2.40 [mW/g] SAR (10g): 1.56 [mW/g]
SAR [mW/g]
2.64E+0
2.05E+0
1.47E+0
8.81E-1
2.94E-1

Appendix 10

pages 1 - 12

SAR MEASUREMENT RESULTS


Meas 1
σ = 0.79 [mho/m]   εr = 44.8   ρ = 1.00 [g/cm3]
Coarse Grid   Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]
SAR [mW/g]   Max: 0.57
SAR (1g): 0.515 [mW/g]   SAR (10g): 0.347 [mW/g]
SAR [mW/g]
5.66E-1
5.03E-1
4.40E-1
3.77E-1
3.14E-1
2.52E-1
1.89E-1
1.26E-1
6.29E-2
NOKIA

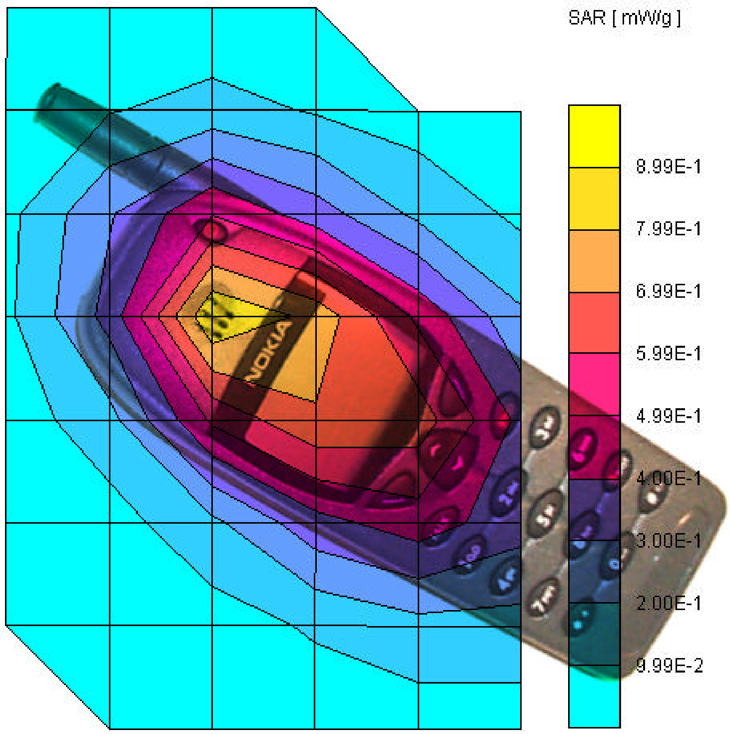
Meas 2

σ = 0.80 [mho/m] ε_r = 44.6 ρ = 1.00 [g/cm^3]

Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]

SAR [mW/g] Max: 0.90

SAR (1g): 0.849 [mW/g] SAR (10g): 0.577 [mW/g]



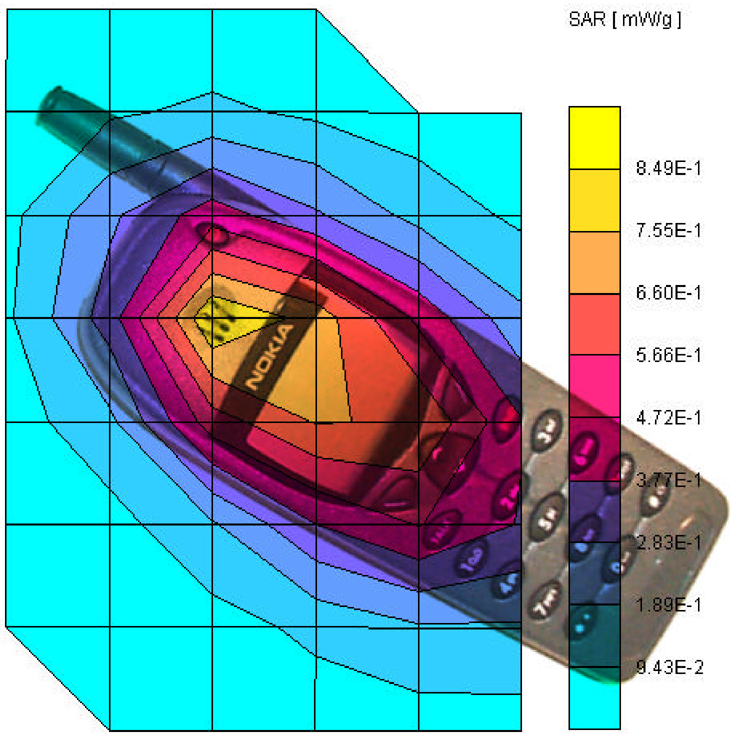
Meas 3

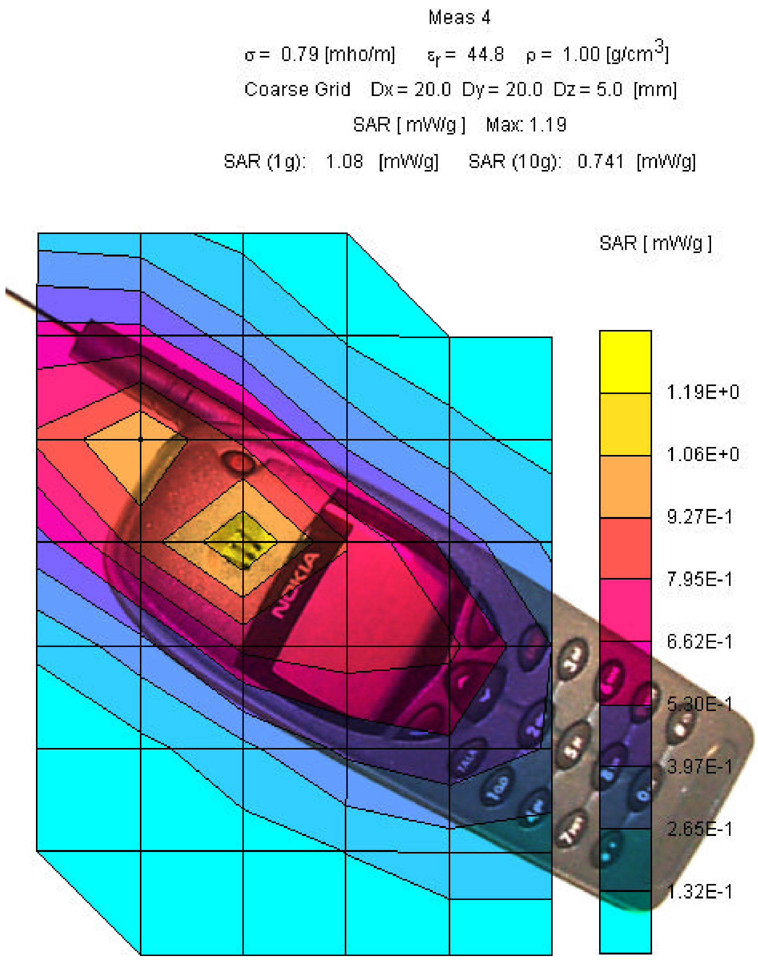
σ = 0.82 [mho/m] ε_r = 44.5 ρ = 1.00 [g/cm^3]

Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]

SAR [mW/g] Max: 0.85

SAR (1g): 0.783 [mW/g] SAR (10g): 0.533 [mW/g]




Meas 4
σ = 0.79 [mho/m] εr = 44.8 ρ = 1.00 [g/cm3]
Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]
SAR [mW/g] Max: 1.19
SAR (1g): 1.08 [mW/g] SAR (10g): 0.741 [mW/g]
SAR [mW/g]
1.19E+0
1.06E+0
9.27E-1
7.95E-1
6.62E-1
5.30E-1
3.97E-1
2.65E-1
1.32E-1

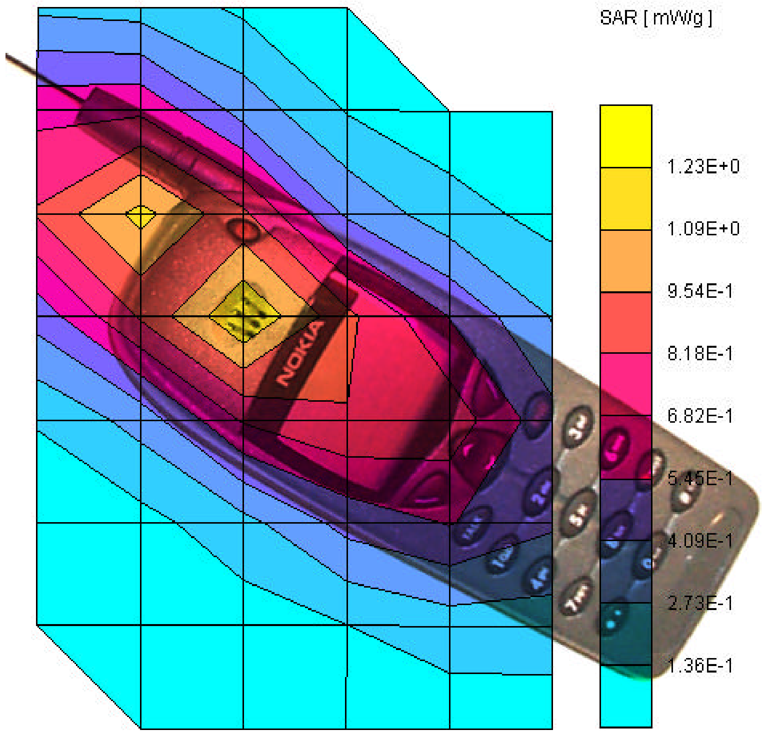
Meas 5

σ = 0.80 [mho/m] ε_r = 44.6 ρ = 1.00 [g/cm^3]

Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]

SAR [mW/g] Max: 1.23

SAR (1g): 1.11 [mW/g] SAR (10g): 0.771 [mW/g]



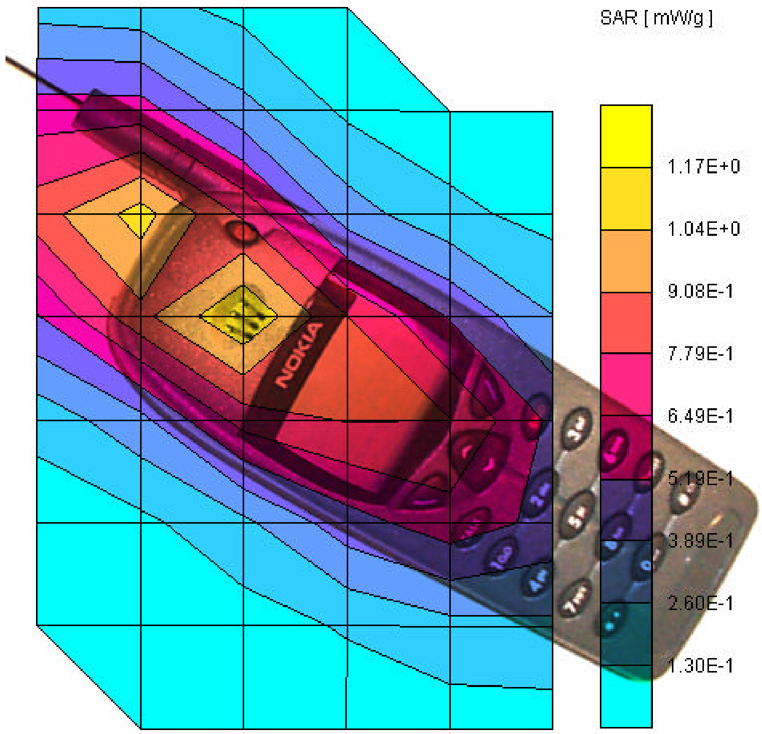
Meas 6

σ = 0.82 [mho/m] ε_r = 44.5 ρ = 1.00 [g/cm^3]

Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]

SAR [mW/g] Max: 1.17

SAR (1g): 1.07 [mW/g] SAR (10g): 0.733 [mW/g]



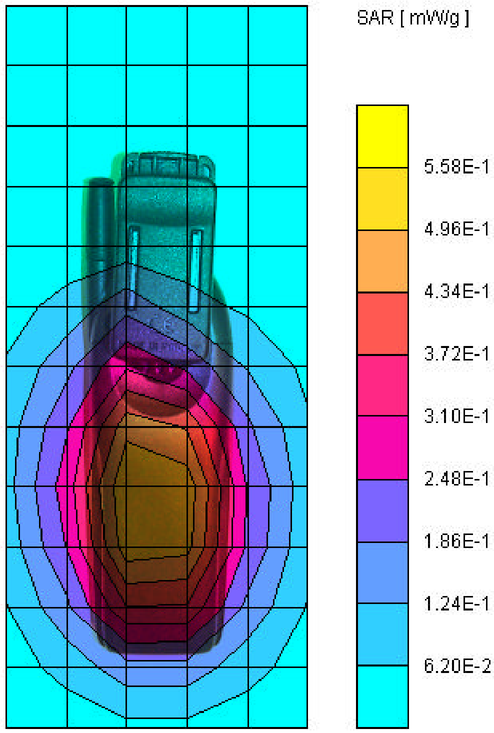
Meas 7

σ = 0.79 [mho/m] ε_r = 44.8 ρ = 1.00 [g/cm^3]

Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]

SAR [mW/g] Max: 0.56

SAR (1g): 0.565 [mW/g] SAR (10g): 0.408 [mW/g]



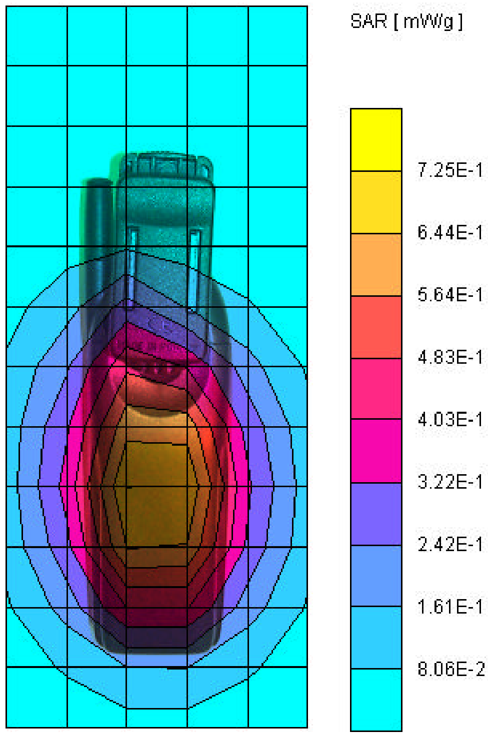
Meas 8

σ = 0.80 [mho/m] ε_r = 44.6 ρ = 1.00 [g/cm^3]

Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]

SAR [mW/g] Max: 0.73

SAR (1g): 0.754 [mW/g] SAR (10g): 0.543 [mW/g]



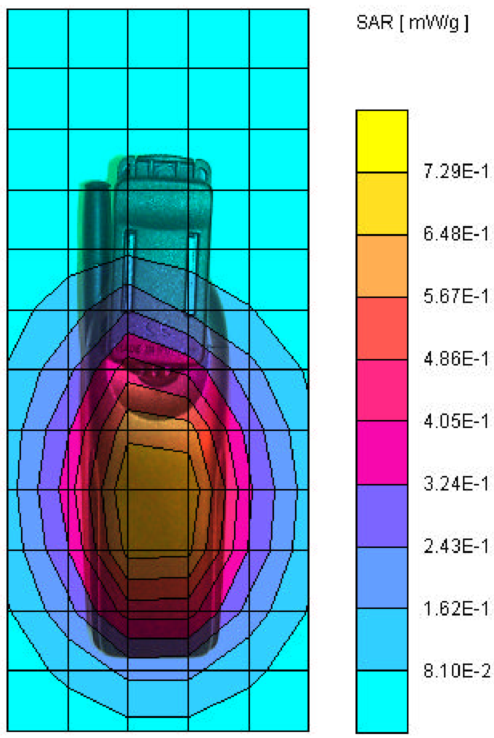
Meas 9

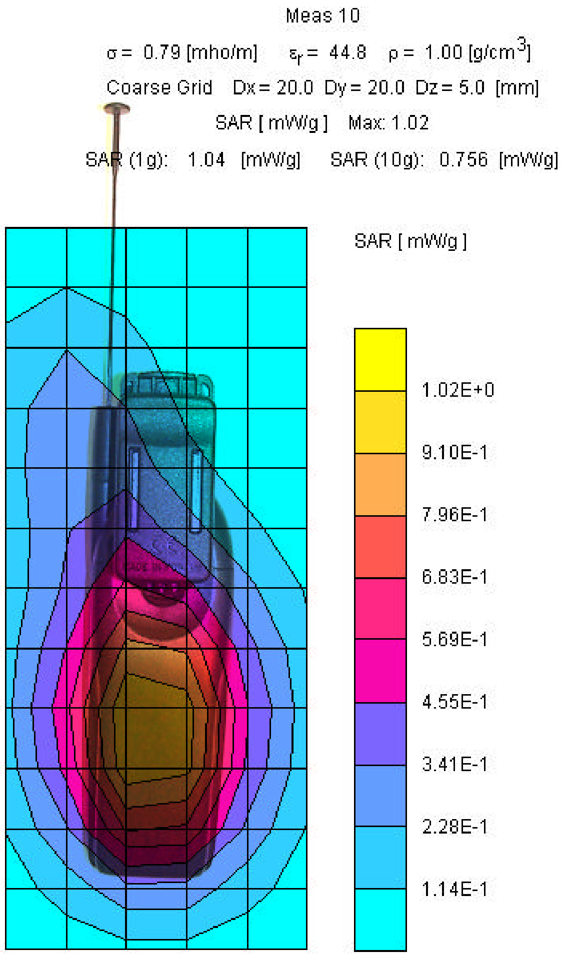
σ = 0.82 [mho/m] ε_r = 44.5 ρ = 1.00 [g/cm^3]

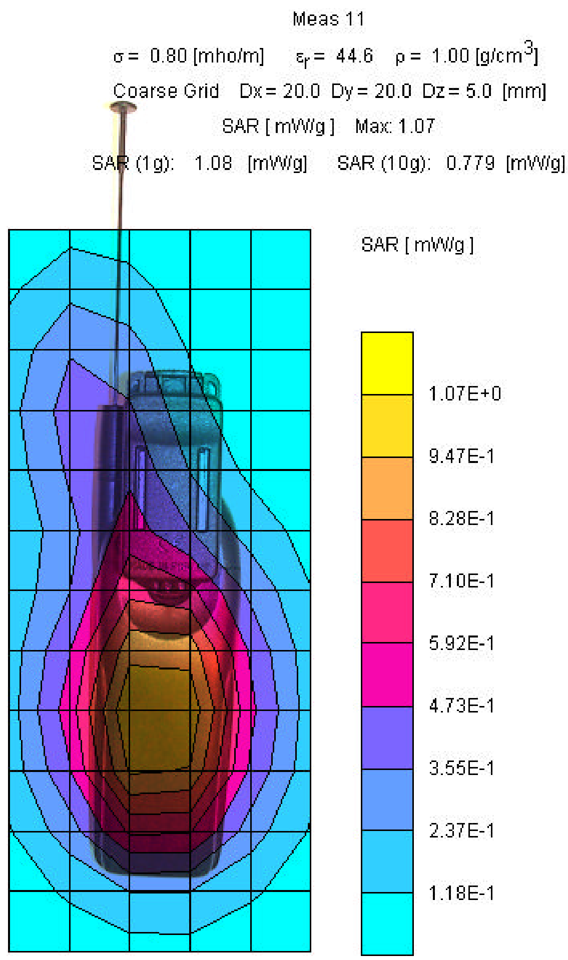
Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]

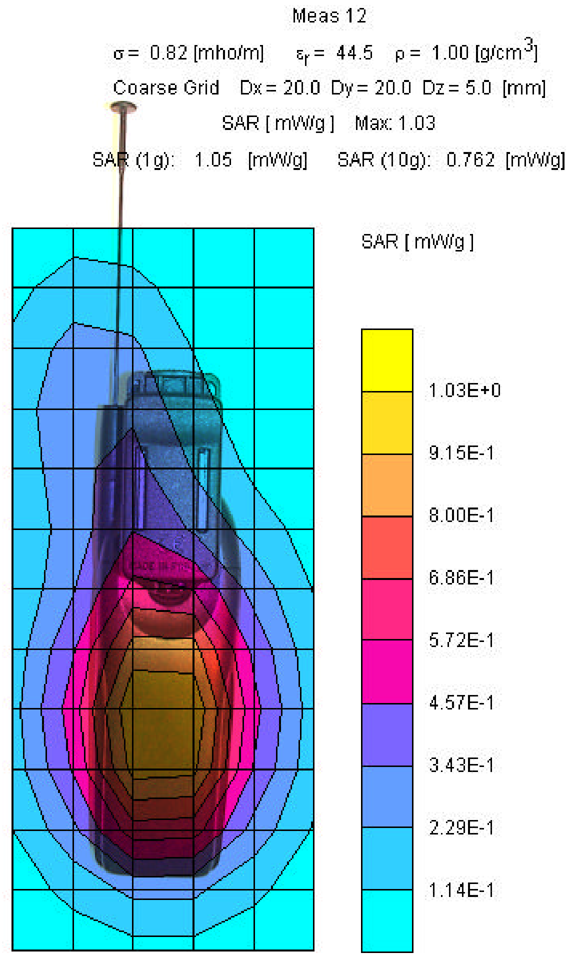
SAR [mW/g] Max: 0.73

SAR (1g): 0.758 [mW/g] SAR (10g): 0.547 [mW/g]




Meas 10
σ = 0.79 [mho/m] ε_r = 44.8 ρ = 1.00 [g/cm3]
Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]
SAR [mW/g] Max: 1.02
SAR (1g): 1.04 [mW/g] SAR (10g): 0.756 [mW/g]
SAR [mW/g]
1.02E+0
9.10E-1
7.96E-1
6.83E-1
5.69E-1
4.55E-1
3.41E-1
2.28E-1
1.14E-1


Meas 11
σ = 0.80 [mho/m] εr = 44.6 ρ = 1.00 [g/cm3]
Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]
SAR [mW/g] Max: 1.07
SAR (1g): 1.08 [mW/g] SAR (10g): 0.779 [mW/g]
SAR [mW/g]
1.07E+0
9.47E-1
8.28E-1
7.10E-1
5.92E-1
4.73E-1
3.55E-1
2.37E-1
1.18E-1


Meas 12
σ = 0.82 [mho/m] εr = 44.5 ρ = 1.00 [g/cm3]
Coarse Grid Dx = 20.0 Dy = 20.0 Dz = 5.0 [mm]
SAR [mW/g] Max: 1.03
SAR (1g): 1.05 [mW/g] SAR (10g): 0.762 [mW/g]
SAR [mW/g]
1.03E+0
9.15E-1
8.00E-1
6.86E-1
5.72E-1
4.57E-1
3.43E-1
2.29E-1
1.14E-1