TCC
Salo

T117 (EN ISO/IEC 17025)

SAR Compliance Test Report

Test report no.:	SAR0333_01	**Date of report:**	2003-10-02
Template version:	1	**Number of pages:**	48
Testing laboratory:	TCC Salo P.O. Box 86 Joensuunkatu 7E / Kiila 1B FIN-24101 SALO, FINLAND Tel. +358 (0) 7180 08000 Fax. +358 (0) 7180 45220	**Client:**	Nokia Corporation Summit Avenue, Farnborough Hampshire, GU14 0NG UK Tel. +44 1252 866000 Fax. +44 1252 866001
Responsible test engineer:	Virpi Tuominen	**Product contact person:**	Andrew White
Measurements made by:	Virpi Tuominen		
Tested devices:	NHM-10		
FCC ID (USA):	QFXNHM-10X	**Industry Canada ID:**	661Z-NHM10X
Supplement reports:	-		

Testing has been carried out in accordance with:

47CFR §2.1093
Radiofrequency Radiation Exposure Evaluation: Portable Devices

FCC OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01)
Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

RSS-102
Evaluation Procedure for Mobile and Portable Radio Transmitters with Respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields

IEEE P1528/D1.2, April 21, 2003
Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques

Documentation: The documentation of the testing performed on the tested devices is archived for 15 years at TCC Salo.

Test results: **The tested device complies with the requirements in respect of all parameters subject to the test.** The test results and statements relate only to the items tested. The test report shall not be reproduced except in full, without written approval of the laboratory.

Date and signatures: **2003-10-02**

For the contents:

Juha Tuominen
TCC Manager

Virpi Tuominen
Senior Design Engineer

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1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Period of test	2003-08-08 to 2003-08-12
SN, HW, SW and DUT numbers of tested device	SN: 004400/21/168455/8, HWID: 0602, SW: 1.61, DUT: 06638
Accessories used in testing	Battery: BL-5C, DUT #'s: 06366, 06389, 06526, 06527, 06639, 06640 Headset: HDE-2, DUT: 06420
Notes	-

1.2 Maximum Results

The maximum measured SAR values for Head configuration and Body Worn configuration are given in section 1.2.1 and 1.2.2 respectively. The device conforms to the requirements of the standard(s) when the maximum measured SAR value is less than or equal to the limit.

1.2.1 Head Configuration

Mode	Ch / *f* (MHz)	ERP/EIRP	Position	SAR limit (1g avg)	Measured SAR value (1g avg)	Result
GSM 850	190 / 836	31.6 dBm	Right Cheek	1.6 W/kg	1.12 W/kg	PASSED
GSM 1900	512 / 1850	32.8 dBm	Right Tilt	1.6 W/kg	0.72 W/kg	PASSED

Note: The radiated power for this device was measured by an accredited test lab.

1.2.2 Body Worn Configuration

Mode	Ch / *f* (MHz)	ERP/EIRP	Separation distance	SAR limit (1g avg)	Measured SAR value (1g avg)	Result
GSM 850	128 / 824	31.3 dBm	1.5 cm	1.6 W/kg	1.28 W/kg	PASSED
GSM 1900	512 / 1850	32.8 dBm	1.5 cm	1.6 W/kg	1.12 W/kg	PASSED

1.2.3 Maximum Drift

Maximum drift during measurements	0.39 dB

1.2.4 Measurement Uncertainty

Extended Uncertainty (k=2) 95%	±29.1%

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

Device category	Portable			
Exposure environment	General population/uncontrolled			
Unit type	Prototype unit			
Modes of Operation	GSM 850	GSM 1900	GPRS (GSM)	BT
Modulation Mode	GMSK	GMSK	GMSK	GFSK
Duty Cycle	1/8	1/8	2/8	
Transmitter Frequency Range (MHz)	824.2 – 848.8	1850.2 - 1909.8		2402 - 2480

2.1 Picture of Device

2.2 Description of the Antenna

The device has an internal patch antenna.

2.3 Batteries

The device was measured with battery BL-5C.

2.4 Headsets

The device was measured with headset HDE-2.

3. TEST CONDITIONS

3.1 Temperature and Humidity

Period of measurement:	2003-08-08 to 2003-08-12
Ambient temperature (°C):	22.1 to 22.2
Ambient humidity (RH %):	44 to 53

3.2 Test Signal, Frequencies, and Output Power

The device was put into operation by using a call tester. Communication between the device and the call tester was established by air link.

The device output power was set to maximum power level for all tests; a fully charged battery was used for every test sequence.

In all operating bands the measurements were performed on lowest, middle and highest channels.

4. DESCRIPTION OF THE TEST EQUIPMENT

4.1 Measurement system and components

The measurements were performed using an automated near-field scanning system, DASY 3 software version 3.1d, manufactured by Schmid & Partner Engineering AG (SPEAG) in Switzerland. The SAR extrapolation algorithm used in all measurements on the test device was the 'worst-case extrapolation' algorithm.

The following table lists calibration dates of SPEAG components:

Test Equipment	Serial Number	Calibration expiry
DASY3 DAE3 V1	388	05/2004
E-field Probe ET3DV6	1396	01/2004
Dipole Validation Kit, D835V2	462	07/2004
Dipole Validation Kit, D1900V2	5d013	07/2004

Additional test equipment used in testing:

Test Equipment	Model	Serial Number	Calibration expiry
Signal Generator	SML03	101265	06/2004
Amplifier	TL-2001	501137	-
Power Meter	NRVS	849305/028	07/2004
Power Sensor	NRV-Z32	839176/020	07/2004
Digital Radiocommunication Tester	CMU 200	835734/049	04/2004
Digital Radiocommunication Tester	CMU 200	838115/061	07/2004
Digital Radiocommunication Tester	CMU 200	837728/0022	07/2004
Vector Network Analyzer	8753E	US38432928	10/2003
Dielectric Probe Kit	85070C	US33020420	-

4.1.1 Isotropic E-field probe SN: 1396

Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., butyl diglycol)
Calibration	Calibration certifcate in Appendix A
Frequency	10 MHz to 3 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Optical Surface Detection	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal to probe axis)
Dynamic Range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application	General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

4.2 Phantoms

The phantom used for all tests i.e. for both validation testing and device testing, was the twin-headed "SAM Phantom", manufactured by SPEAG. The phantom conforms to the requirements of IEEE P1528/D1.2, April 21, 2003 (as established by sub committee SCC-34/SC-2).

Validation tests were performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.

The SPEAG device holder (see Section 5.1) was used to position the test device in all tests whilst a tripod was used to position the validation dipoles against the flat section of phantom.

4.3 Simulating Liquids

Recommended values for the dielectric parameters of the simulating liquids are given in IEEE P1528/D1.2, April 21, 2003 and FCC Supplement C to OET Bulletin 65. All tests were carried out using liquids whose dielectric parameters were within ± 5% of the recommended values. All tests were carried out within 24 hours of measuring the dielectric parameters.

The depth of the liquid was 15.0 ± 0.5 cm measured from the ear reference point during validation and device measurements.

4.3.1 Liquid recipes

The following recipes were used for Head and Body liquids:

850MHz band

Ingredient	Head (% by weight)	Muscle (% by weight)
Deionised Water	39.74	50.75
HEC	0.25	-
Sugar	58.31	48.21
Preservative	0.15	0.10
Salt	1.55	0.94

1900MHz band

Ingredient	Head (% by weight)	Muscle (% by weight)
Deionised Water	54.88	69.02
Butyl Diglycol	44.91	30.76
Salt	0.21	0.22

4.3.2 Verification of the System

The manufacturer calibrates the probes annually. Dielectric parameters of the simulating liquids were measured every day using the dielectric probe kit and the network analyser. A SAR measurement was made following the determination of the dielectric parameters of the liquids, using the dipole validation kit. A power level of 250 mW was supplied to the dipole antenna, which was placed under the flat section of the twin SAM phantom. The validation results (dielectric parameters and SAR values) are given in the table below.

System verification, head tissue simulant

f [MHz]	Description	SAR [W/kg], 1g	Dielectric Parameters ε_r	Dielectric Parameters σ [S/m]	Temp [°C]
835	Reference result	2.45	42.5	0.90	N/A
	± 10% window	2.21 to 2.70			
	2003-08-11	2.57	40.4	0.90	20.8
1900	Reference result	11.0	39.8	1.46	N/A
	± 10% window	9.90 to 12.1			
	2003-08-12	10.8	38.2	1.44	21.7

System verification, body tissue simulant

f [MHz]	Description	SAR [W/kg], 1g	Dielectric Parameters ε_r	Dielectric Parameters σ [S/m]	Temp [°C]
835	Reference result	2.28	55.5	0.96	N/A
	± 10% window	2.23 to 2.73			
	2003-08-08	2.57	53.0	0.96	21.7
1900	Reference result	10.6	51.0	1.57	N/A
	± 10% window	9.54 to 11.7			
	2003-08-08	9.71	50.7	1.55	20.6

4.3.3 Tissue simulants used in the measurements

Head tissue simulant measurements

f [MHz]	Description	Dielectric Parameters		Temp [°C]
		ε_r	σ [S/m]	
836	Recommended value	41.5	0.90	N/A
	± 5% window	39.4 to 43.6	0.86 to 0.95	
	2003-08-11	40.4	0.90	21.0
1880	Recommended value	40.0	1.40	N/A
	± 5% window	38.0 to 42.0	1.33 to 1.47	
	2003-08-12	38.3	1.42	21.0

Body tissue simulant measurements

f [MHz]	Description	Dielectric Parameters		Temp [°C]
		ε_r	σ [S/m]	
836	Recommended value	55.2	0.97	N/A
	± 5% window	52.5 to 58.0	0.92 to 1.02	
	2003-08-08	53.0	0.96	21.0
1880	Recommended value	53.3	1.52	N/A
	± 5% window	50.6 to 56.0	1.44 to 1.60	
	2003-08-08	50.8	1.53	21.0

5. DESCRIPTION OF THE TEST PROCEDURE

5.1 Device Holder

The test device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the Dasy system.

Device holder supplied by SPEAG

A Nokia designed spacer (illustrated below) was used to position the test device within the SPEAG holder. The spacer positions the test device so that the holder has minimal effect on the test results but still holds the device securely. The spacer was removed before the tests.

Nokia spacer

5.2 Test Positions

5.2.1 Against Phantom Head

Measurements were made in “cheek” and “tilt” positions on both the left hand and right hand sides of the phantom.

The positions used in the measurements were according to IEEE P1528/D1.2 April 21 2003 "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”.

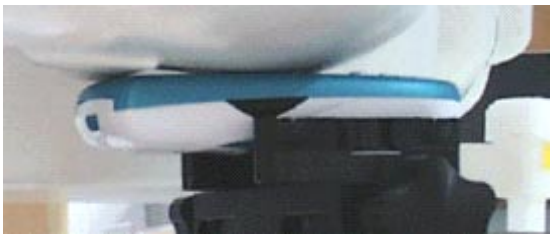


Photo of the device in “cheek” position.

Photo of the device in “tilt” position.

5.2.2 Body Worn Configuration

The device was placed in the SPEAG holder using the Nokia spacer and placed below the flat section of the phantom. The distance between the device and the phantom was kept at 1.5 cm using a separate flat spacer that was removed before the start of the measurements. The device was oriented with its antenna facing the phantom since this orientation gave higher results.

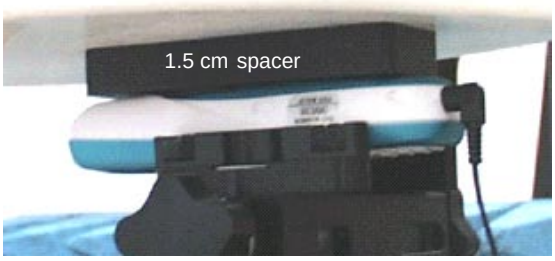


Photo of the device positioned for Body SAR measurement.
The spacer was removed for the tests.

5.3 Scan Procedures

First coarse scans were used for determination of the field distribution. Next a cube scan, 5x5x7 was performed around the highest E-field value to determine the averaged SAR value. Drift was determined by measuring the same point at the start of the coarse scan and again at the end of the cube scan.

5.4 SAR Averaging Methods

The maximum SAR value was averaged over a cube of tissue using interpolation and extrapolation.

The interpolation of the points was done with a 3d-Spline. The 3d-Spline comprised three one-dimensional splines with the "Not a knot" -condition [W. Gander, Computermathematik, p. 141-150] (x, y and z -directions) [Numerical Recipes in C, Second Edition, p 123].

The extrapolation was based on least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 30 mm in all z-axis, a fourth order polynomial was calculated. This polynomial was then used to evaluate the points between the phantom surface and the probe tip. The points, calculated from the phantom surface, were at 1mm spacing.

6. MEASUREMENT UNCERTAINTY

Table 6.1 – Measurement uncertainty evaluation

Uncertainty Component	P1528 Sec	Tol. (%)	Prob Dist	Div	c_i	u_i (%)	v_i
Measurement System							
Probe Calibration	E2.1	±4.8	N	1	1	±4.8	∞
Axial Isotropy	E2.2	±4.7	R	√3	$(1\text{-}c_p)^{1/2}$	±1.9	∞
Hemispherical Isotropy	E2.2	±9.6	R	√3	$(c_p)^{1/2}$	±3.9	∞
Boundary Effect	E2.3	±8.3	R	√3	1	±4.8	∞
Linearity	E2.4	±4.7	R	√3	1	±2.7	∞
System Detection Limits	E2.5	±1.0	R	√3	1	±0.6	∞
Readout Electronics	E2.6	±1.0	N	1	1	±1.0	∞
Response Time	E2.7	±0.8	R	√3	1	±0.5	∞
Integration Time	E2.8	±2.6	R	√3	1	±1.5	∞
RF Ambient Conditions - Noise	E6.1	±3.0	R	√3	1	±1.7	∞
RF Ambient Conditions - Reflections	E6.1	±3.0	R	√3	1	±1.7	∞
Probe Positioner Mechanical Tolerance	E6.2	±0.4	R	√3	1	±0.2	∞
Probe Positioning with respect to Phantom Shell	E6.3	±2.9	R	√3	1	±1.7	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E5.2	±3.9	R	√3	1	±2.3	∞
Test sample Related							
Test Sample Positioning	E4.2.1	±6.0	N	1	1	±6.0	11
Device Holder Uncertainty	E4.1.1	±5.0	N	1	1	±5.0	7
Output Power Variation - SAR drift measurement	6.6.3	±10.0	R	√3	1	±5.8	∞
Phantom and Tissue Parameters							
Phantom Uncertainty (shape and thickness tolerances)	E3.1	±4.0	R	√3	1	±2.3	∞
Liquid Conductivity Target - tolerance	E3.2	±5.0	R	√3	0.64	±1.8	∞
Liquid Conductivity - measurement uncertainty	E3.3	±5.5	N	1	0.64	±3.5	5
Liquid Permittivity Target tolerance	E3.2	±5.0	R	√3	0.6	±1.7	∞
Liquid Permittivity - measurement uncertainty	E3.3	±2.9	N	1	0.6	±1.7	5
Combined Standard Uncertainty			RSS			**±14.5**	208
Coverage Factor for 95%			**k=2**				
Expanded Standard Uncertainty						**±29.1**	

7. RESULTS

The measured Head SAR values for the test device are tabulated below:

850 MHz Head SAR results

Mode	Position		SAR, averaged over 1g (W/kg)		
			Ch 128 824 MHz	Ch 190 836 MHz	Ch 251 849 MHz
GSM 850	Power level		31.3 dBm	31.6 dBm	31.9 dBm
	Left	Cheek with MMC-card	1.06	1.09	1.04
		Tilt With MMC-card	-	0.536	-
	Right	Cheek with MMC-card	1.06	**1.12**	1.05
		Tilt With MMC-card	-	0.566	-
GSM 850	Right Cheek position without MMC-card		-	0.893	-
	Right Cheek position with MMC-card and with BT active		-	**0.904**	-

1900 MHz Head SAR results

Mode	Position		SAR, averaged over 1g (W/kg)		
			Ch 512 1850 MHz	Ch 661 1880 MHz	Ch 810 1910 MHz
GSM 1900	Power level		32.8 dBm	32.4 dBm	31.4 dBm
	Left	Cheek with MMC-card	-	0.454	-
		Tilt With MMC-card	-	0.533	-
	Right	Cheek with MMC-card	-	0.504	-
		Tilt With MMC-card	**0.698**	0.618	0.590
GSM 1900	Right Tilt position without MMC-card		**0.718**	-	**-**
	Right Tilt position without MMC-card and with BT active		0.707	**-**	-

The measured Body SAR values for the test device are tabulated below:

850 MHz Body SAR results

Mode	Body-worn location setup	SAR, averaged over 1g (W/kg)		
		Ch 128 824 MHz	Ch 190 836 MHz	Ch 251 849 MHz
GSM 850	Power level	31.3 dBm	31.6 dBm	31.9 dBm
	Headset HDE-2, MMC-card	**1.15**	1.13	0.975
GSM 850	Headset HDE-2, without MMC-card	1.16	-	-
	Headset HDE-2, without MMC-card, with BT active	**1.28**	-	-

1900 MHz Body SAR results

Mode	Body-worn location setup	SAR, averaged over 1g (W/kg)		
		Ch 512 1850 MHz	Ch 661 1880 MHz	Ch 810 1910 MHz
GSM 1900	Power level	32.8 dBm	32.4 dBm	31.4 dBm
	Headset HDE-2, MMC-card	**1.12**	0.981	0.874
GSM 1900	Headset HDE-2, without MMC-card	**1.09**	-	-
	Headset HDE-2, with MMC-card, with BT active	1.07	-	-

7.1 Validation printouts

Available in Appendix A.

7.2 Measurement printouts

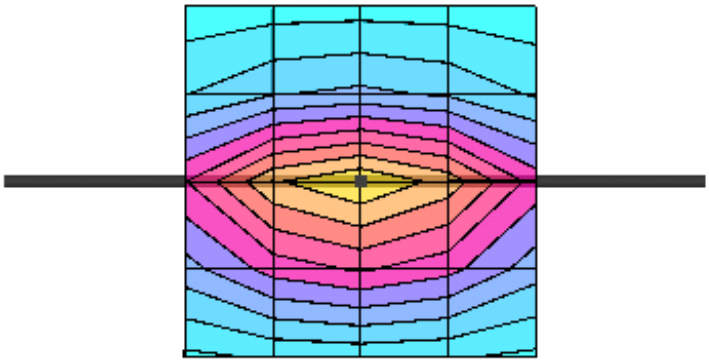
Available in Appendix B.

APPENDIX A: VALIDATION SCANS

System verification, head tissue simulant, 835 MHz
2003-08-11
t(liq.)=20.8°C

Dipole 835 MHz

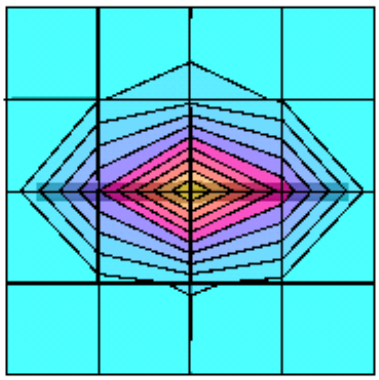
SAM 2; Flat
Probe: ET3DV6 - SN1396; ConvF(6.90,6.90,6.90); Crest factor: 1.0; Brain 835 MHz: $\sigma = 0.90$ mho/m $\varepsilon_r = 40.4$ $\rho = 1.00$ g/cm^3
Cubes (2): Peak: 4.05 mW/g ± 0.14 dB, SAR (1g): 2.57 mW/g ± 0.13 dB, SAR (10g): 1.65 mW/g ± 0.12 dB, (Worst-case extrapolation)
Penetration depth: 12.1 (10.9, 13.7) [mm]
Powerdrift: 0.04 dB



System verification, head tissue simulant, 1900 MHz
2003-08-12
t(liq.)=21.7°C

Dipole 1900 MHz

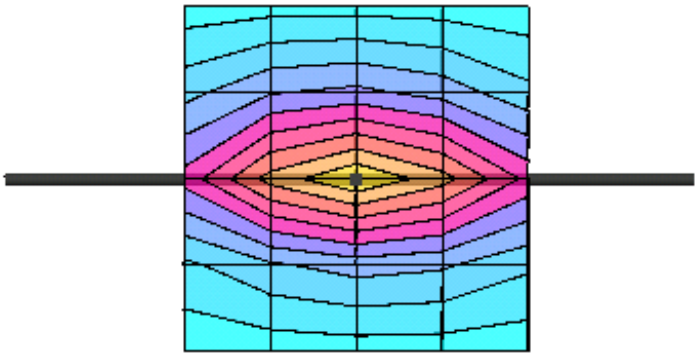
SAM; Flat
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 1.0; Brain 1900 MHz: σ = 1.44 mho/m ε_r = 38.2 ρ = 1.00 g/cm^3
Cubes (2): Peak: 20.7 mW/g ± 0.20 dB, SAR (1g): 10.8 mW/g ± 0.18 dB, SAR (10g): 5.52 mW/g ± 0.15 dB, (Worst-case extrapolation)
Penetration depth: 7.9 (7.4, 8.9) [mm]
Powerdrift: 0.04 dB



System verification, body tissue simulant, 835 MHz
2003-08-08
t(liq.)=21.7°C

Dipole 835 MHz

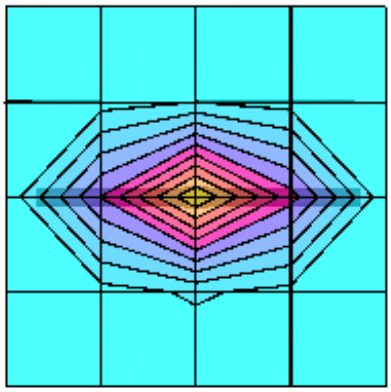
SAM; Flat
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; BODY 835 MHz: $\sigma = 0.96$ mho/m $\varepsilon_r = 53.0$ $\rho = 1.00$ g/cm^3
Cubes (2): Peak: 3.78 mW/g ± 0.17 dB, SAR (1g): 2.57 mW/g ± 0.14 dB, SAR (10g): 1.70 mW/g ± 0.13 dB, (Advanced extrapolation)
Penetration depth: 13.7 (13.1, 14.4) [mm]
Powerdrift: 0.02 dB



System verification, body tissue simulant, 1900 MHz
2003-08-08
t(liq.)=20.6°C

Dipole 1900 MHz

SAM 2; Flat
Probe: ET3DV6 - SN1396; ConvF(5.10,5.10,5.10); Crest factor: 1.0; BODY 1900 MHz: σ = 1.55 mho/m ε_r = 50.7 ρ = 1.00 g/cm^3
Cubes (2): Peak: 17.0 mW/g ± 0.22 dB, SAR (1g): 9.71 mW/g ± 0.17 dB, SAR (10g): 5.16 mW/g ± 0.15 dB, (Advanced extrapolation)
Penetration depth: 9.3 (9.1, 9.7) [mm]
Powerdrift: -0.01 dB

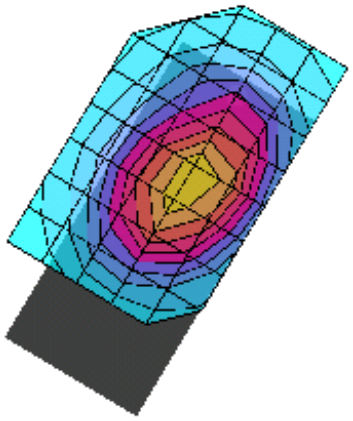


APPENDIX B: MEASUREMENT SCANS

LH Cheek / GSM 850

NHM-10 with MMC-card
2003-08-11
t(liq.)=20.6°C

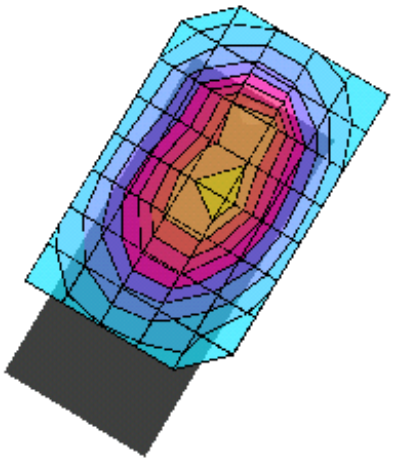
SAM 2 Phantom; Left Hand Section; Position: (90°,59°); Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.90,6.90,6.90); Crest factor: 8.0; Brain 836 MHz: σ = 0.90 mho/m ε_r = 40.4 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.09 mW/g, SAR (10g): 0.775 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.22 dB



LH Tilt / GSM 850

NHM-10 with MMC-card
2003-08-11
t(liq.)=20.6°C

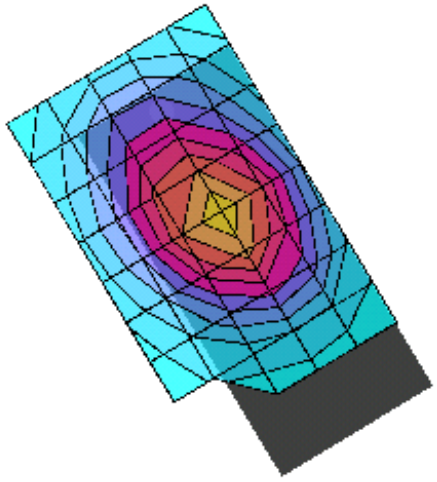
SAM 2 Phantom; Left Hand Section; Position: (90°,59°); Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.90,6.90,6.90); Crest factor: 8.0; Brain 836 MHz: σ = 0.90 mho/m ε_r = 40.4 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.536 mW/g, SAR (10g): 0.380 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.06 dB



RH Cheek / GSM 850

NHM-10 with MMC-card
2003-08-11
t(liq.)=20.5°C

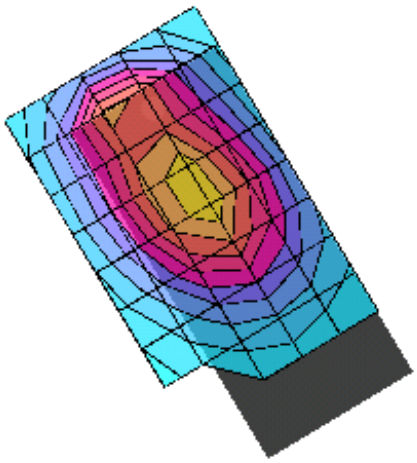
SAM 2 Phantom; Righ Hand Section; Position: (90°,301°); Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.90,6.90,6.90); Crest factor: 8.0; Brain 836 MHz: σ = 0.90 mho/m ε_r = 40.4 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.12 mW/g, SAR (10g): 0.794 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.24 dB



RH Tilt / GSM 850

NHM-10 with MMC-card
2003-08-11
t(liq.)=20.6°C

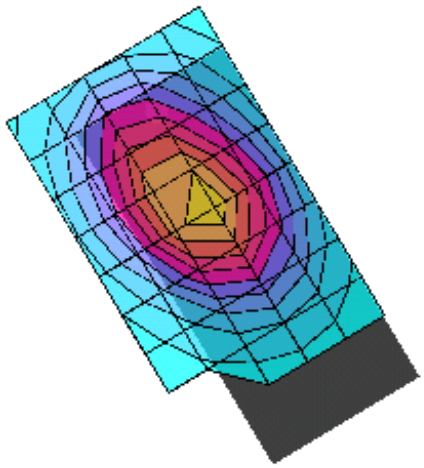
SAM 2 Phantom; Righ Hand Section; Position: (90°,301°); Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.90,6.90,6.90); Crest factor: 8.0; Brain 836 MHz: σ = 0.90 mho/m ε_r = 40.4 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.566 mW/g, SAR (10g): 0.394 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.05 dB



RH Cheek / GSM 850

NHM-10 with with MMC-card and BT active
2003-08-11
t(liq.)=20.4°C

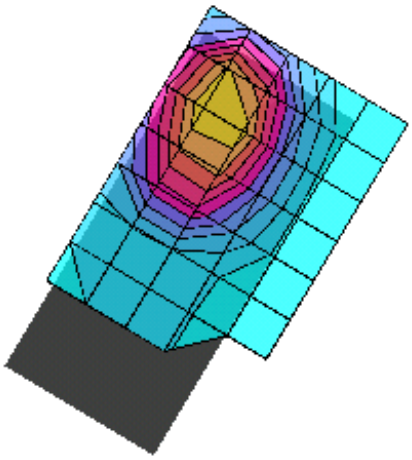
SAM 2 Phantom; Righ Hand Section; Position: (90°,301°); Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.90,6.90,6.90); Crest factor: 8.0; Brain 836 MHz: σ = 0.90 mho/m ε_r = 40.4 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.904 mW/g, SAR (10g): 0.631 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.12 dB



LH Cheek / GSM 1900

NHM-10 with MMC-card
2003-08-12
t(liq.)=21.5°C

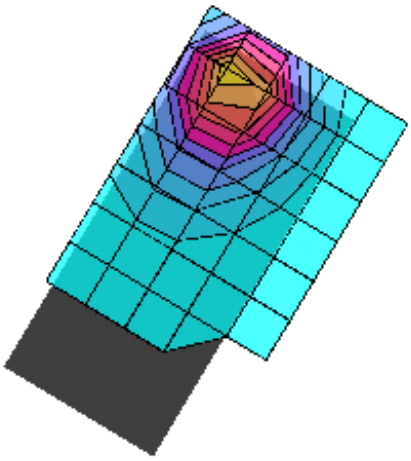
SAM Phantom; Left Hand Section; Position: (90°,59°); Frequency: 1880 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.42 mho/m ε_r = 38.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.454 mW/g, SAR (10g): 0.279 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.12 dB



LH Tilt / GSM 1900

NHM-10 with MMC-card
2003-08-12
t(liq.)=21.4°C

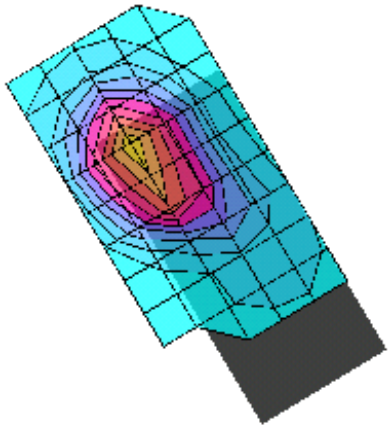
SAM Phantom; Left Hand Section; Position: (90°,59°); Frequency: 1880 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.42 mho/m ε_r = 38.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.533 mW/g, SAR (10g): 0.305 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: 0.04 dB



RH Cheek / GSM 1900

NHM-10 with MMC-card
2003-08-12
t(liq.)=21.7°C

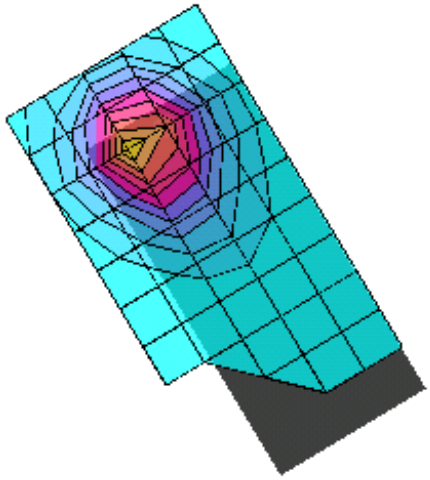
SAM Phantom; Righ Hand Section; Position: (90°,301°); Frequency: 1880 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.42 mho/m ε_r = 38.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.504 mW/g, SAR (10g): 0.301 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: 0.04 dB



RH Tilt / GSM 1900

NHM-10 with MMC-card
2003-08-12
t(liq.)=21.3°C

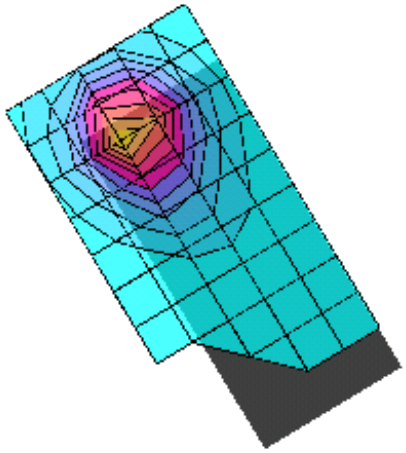
SAM Phantom; Righ Hand Section; Position: (90°,301°); Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.42 mho/m ε_r = 38.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.698 mW/g, SAR (10g): 0.396 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: 0.00 dB



RH Tilt / GSM 1900

NHM-10 without MMC-card
2003-08-12
t(liq.)=21.2°C

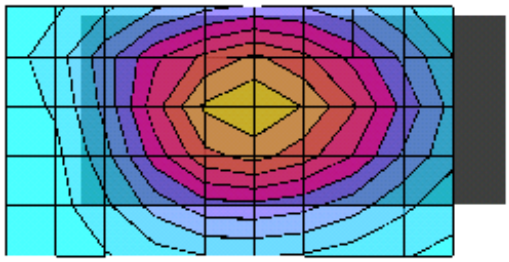
SAM Phantom; Righ Hand Section; Position: (90°,301°); Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.42 mho/m ε_r = 38.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.718 mW/g, SAR (10g): 0.403 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.04 dB



Body 1.5 cm / GSM 850

NHM-10 with HDE-2 and MMC-card
2003-08-08
t(liq.)=21.7°C

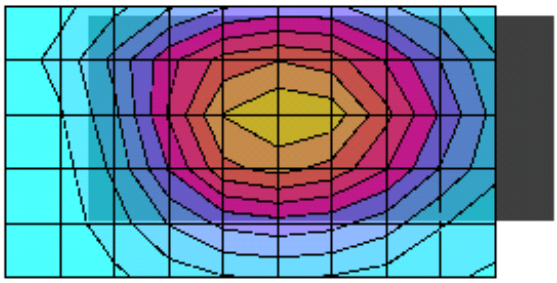
SAM Phantom; Flat Section; Position: (270°,90°); Frequency: 824 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 4.0; Body 836MHz: σ = 0.96 mho/m ε_r = 53.0 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.15 mW/g, SAR (10g): 0.829 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.09 dB



Body 1.5 cm / GSM 850

NHM-10 with HDE-2, without MMC-card, BT active
2003-08-08
t(liq.)=21.3°C

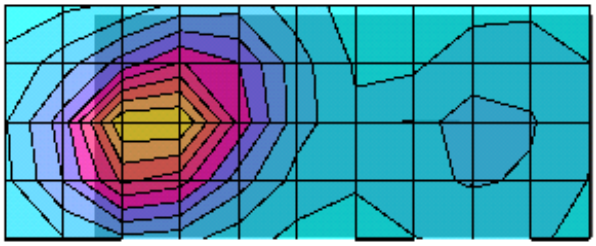
SAM Phantom; Flat Section; Position: (270°,90°); Frequency: 824 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 4.0; Body 836MHz: σ = 0.96 mho/m ε_r = 53.0 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.28 mW/g, SAR (10g): 0.912 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.09 dB



Body 1.5 cm / GSM 1900

NHM-10 with HDE-2 and with MMC-card
2003-08-08
t(liq.)=22.0°C

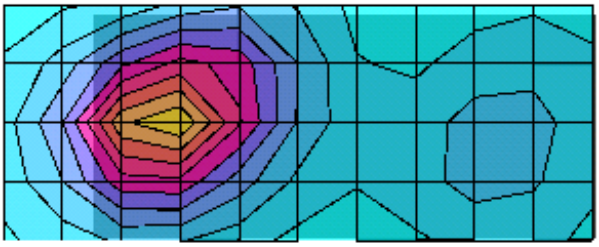
SAM 2 Phantom; Flat Section; Position: (270°,90°); Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.10,5.10,5.10); Crest factor: 4.0; B0DY 1880 MHz: σ = 1.53 mho/m ε_r = 50.8 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.12 mW/g, SAR (10g): 0.658 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 15.0
Powerdrift: -0.10 dB



Body 1.5 cm / GSM 1900

NHM-10 with HDE-2, without MMC-card
2003-08-08
t(liq.)=21.6°C

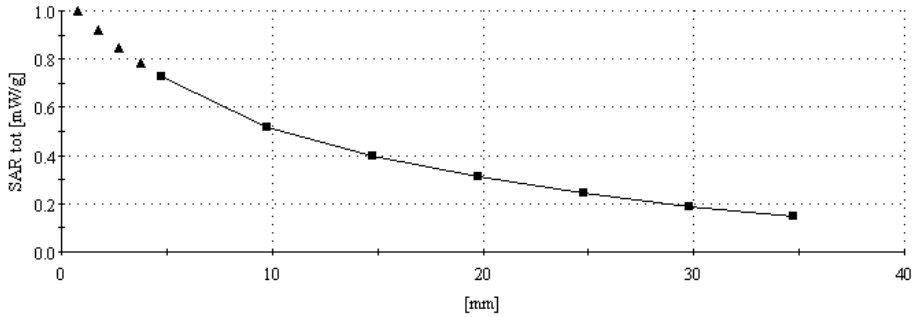
SAM 2 Phantom; Flat Section; Position: (270°,90°); Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.10,5.10,5.10); Crest factor: 4.0; B0DY 1880 MHz: σ = 1.53 mho/m ε_r = 50.8 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.09 mW/g, SAR (10g): 0.637 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 15.0
Powerdrift: -0.17 dB



Z-PLOT corresponding Maximum Head SAR result / GSM 850:

NHM-10, RH Cheek
2003-08-11
t(liq.)=20.5°C

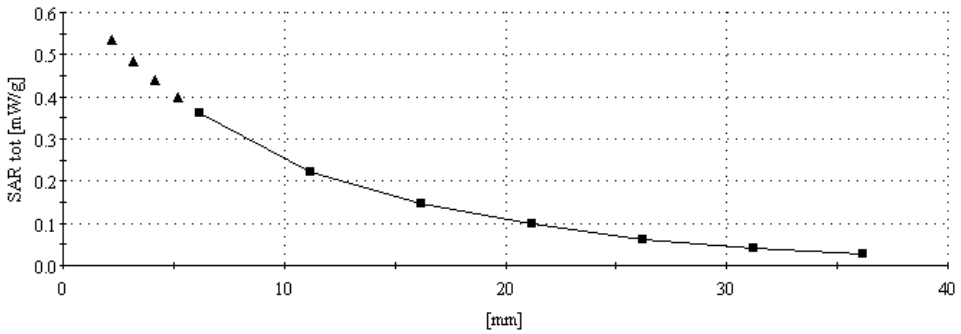
SAM 2 Phantom; Righ Hand Section; Position: (90°,301°); Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.90,6.90,6.90); Crest factor: 8.0; Brain 836 MHz: σ = 0.90 mho/m ε_r = 40.4 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.12 mW/g, SAR (10g): 0.794 mW/g, (Worst-case extrapolation)
Cube 5x5x7: Dx = 8.0, Dy = 8.0, Dz = 5.0



Z-PLOT corresponding Maximum Head SAR result / GSM 1900:

NHM-10, RH Tilt
2003-08-12
t(liq.)=21.2°C

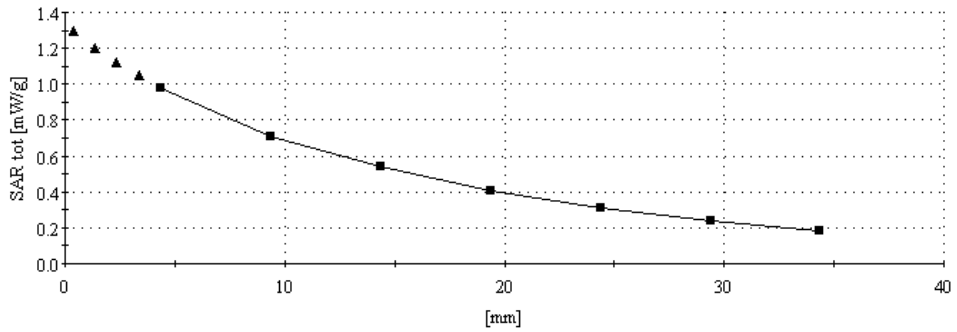
SAM Phantom; Righ Hand Section; Position: (90°,301°); Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.42 mho/m ε_r = 38.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.718 mW/g, SAR (10g): 0.403 mW/g, (Worst-case extrapolation)
Cube 5x5x7: Dx = 8.0, Dy = 8.0, Dz = 5.0



Z-PLOT corresponding Maximum Body SAR result / GSM 850

NHM-10 with HDE-2, BT active, Body 1.5 cm
2003-08-08
t(liq.)=21.3°C

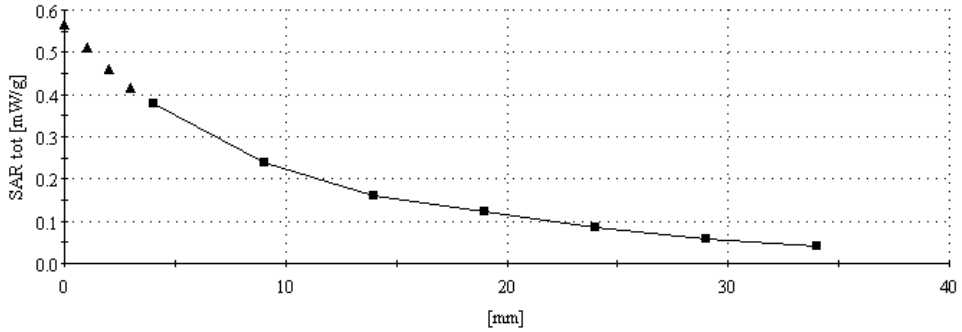
SAM Phantom; Flat Section; Position: (270°,90°); Frequency: 824 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 4.0; Body 836MHz: σ = 0.96 mho/m ε_r = 53.0 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.28 mW/g, SAR (10g): 0.912 mW/g, (Worst-case extrapolation)
Cube 5x5x7: Dx = 8.0, Dy = 8.0, Dz = 5.0



Z-PLOT corresponding Maximum Body SAR result / GSM 1900

NHM-10 with HDE-2, Body 1.5 cm
2003-08-08
t(liq.)=22.0°C

SAM 2 Phantom; Flat Section; Position: (270°,90°); Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.10,5.10,5.10); Crest factor: 4.0; B0DY 1880 MHz: σ = 1.53 mho/m ε_r = 50.8 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.12 mW/g, SAR (10g): 0.658 mW/g, (Worst-case extrapolation)
Cube 5x5x7: Dx = 8.0, Dy = 8.0, Dz = 5.0



APPENDIX C: RELEVANT PAGES FROM PROBE CALIBRATION REPORT

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client Nokia Salo (TTC)

CALIBRATION CERTIFICATE

Object(s) ET3DV6 - SN:1396

Calibration procedure(s) QA CAL-01.v2
Calibration procedure for dosimetric E-field probes

Calibration date: January 15, 2003

Condition of the calibrated item In Tolerance (according to the specific calibration document)

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date	Scheduled Calibration
RF generator HP 8684C	US3642U01700	4-Aug-99 (in house check Aug-02)	In house check: Aug-05
Power sensor E4412A	MY41495277	8-Mar-02	Mar-03
Power sensor HP 8481A	MY41092180	18-Sep-02	Sep-03
Power meter EPM E4419B	GB41293874	13-Sep-02	Sep-03
Network Analyzer HP 8753E	US38432426	3-May-00	In house check: May 03
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01	Sep-03

	Name	Function	Signature
Calibrated by:	Nico Vetterli	Technician	
Approved by:	Katja Pokovic	Laboratory Director	

Date issued: January 16, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

ET3DV6 SN:1396 January 15, 2003

DASY - Parameters of Probe: ET3DV6 SN:1396

Sensitivity in Free Space

NormX	1.72 μV/(V/m)²	DCP X	93	mV
NormY	1.73 μV/(V/m)²	DCP Y	93	mV
NormZ	1.84 μV/(V/m)²	DCP Z	93	mV

Sensitivity in Tissue Simulating Liquid

Head	900 MHz	ε_r = 41.5 ± 5%	σ = 0.97 ± 5% mho/m
Head	835 MHz	ε_r = 41.5 ± 5%	σ = 0.90 ± 5% mho/m

ConvF X	6.9 ± 9.5% (k=2)	Boundary effect:	
ConvF Y	6.9 ± 9.5% (k=2)	Alpha	0.35
ConvF Z	6.9 ± 9.5% (k=2)	Depth	2.53

Head	1800 MHz	ε_r = 40.0 ± 5%	σ = 1.40 ± 5% mho/m
Head	1900 MHz	ε_r = 40.0 ± 5%	σ = 1.40 ± 5% mho/m

ConvF X	5.6 ± 9.5% (k=2)	Boundary effect:	
ConvF Y	5.6 ± 9.5% (k=2)	Alpha	0.46
ConvF Z	5.6 ± 9.5% (k=2)	Depth	2.71

Boundary Effect

Head 900 MHz **Typical SAR gradient: 5 % per mm**

Probe Tip to Boundary		1 mm	2 mm
SAR_{be} [%]	Without Correction Algorithm	9.2	5.2
SAR_{be} [%]	With Correction Algorithm	0.3	0.5

Head 1800 MHz **Typical SAR gradient: 10 % per mm**

Probe Tip to Boundary		1 mm	2 mm
SAR_{be} [%]	Without Correction Algorithm	13.1	8.9
SAR_{be} [%]	With Correction Algorithm	0.2	0.1

Sensor Offset

Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.5 ± 0.2	mm

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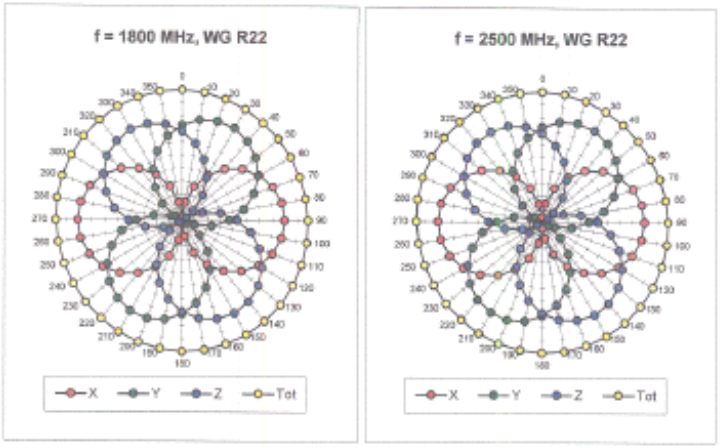
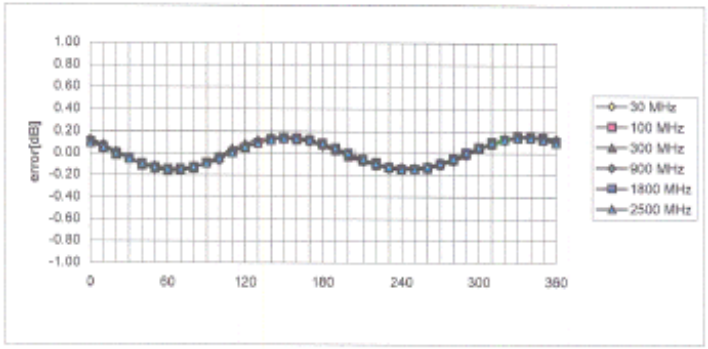
ET3DV6 SN:1396 January 15, 2003



Isotropy Error (ϕ), θ = 0°



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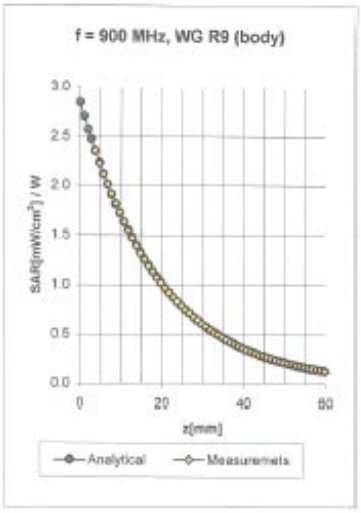
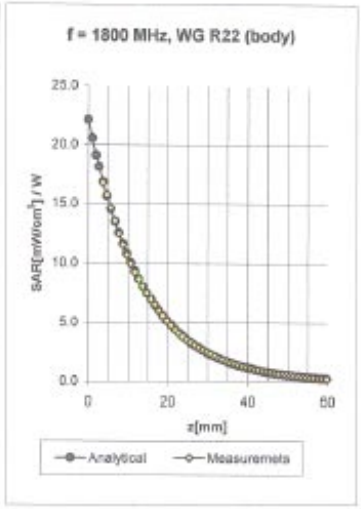
ET3DV6 SN:1396 January 15, 2003

Conversion Factor Assessment





Body	900 MHz	ε_r = 55.0 ± 5%	σ = 1.05 ± 5% mho/m
Body	835 MHz	ε_r = 55.2 ± 5%	σ = 0.97 ± 5% mho/m
ConvF X	6.6 ± 9.5% (k=2)	Boundary effect:	
ConvF Y	6.6 ± 9.5% (k=2)	Alpha	0.36
ConvF Z	6.6 ± 9.5% (k=2)	Depth	2.57

Body	1800 MHz	ε_r = 53.3 ± 5%	σ = 1.52 ± 5% mho/m
Body	1900 MHz	ε_r = 53.3 ± 5%	σ = 1.52 ± 5% mho/m
ConvF X	5.1 ± 9.5% (k=2)	Boundary effect:	
ConvF Y	5.1 ± 9.5% (k=2)	Alpha	0.53
ConvF Z	5.1 ± 9.5% (k=2)	Depth	2.75

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APPENDIX D: RELEVANT PAGES FROM DIPOLE VALIDATION KIT REPORT

835 MHz DIPOLE, HEAD CALIBRATION:

Schmid & Partner
Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

Calibration Certificate

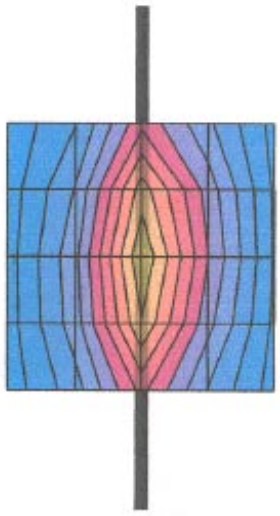
835 MHz System Validation Dipole

Type:	D835V2
Serial Number:	462
Place of Calibration:	Zurich
Date of Calibration:	July 1, 2002
Calibration Interval:	24 months

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

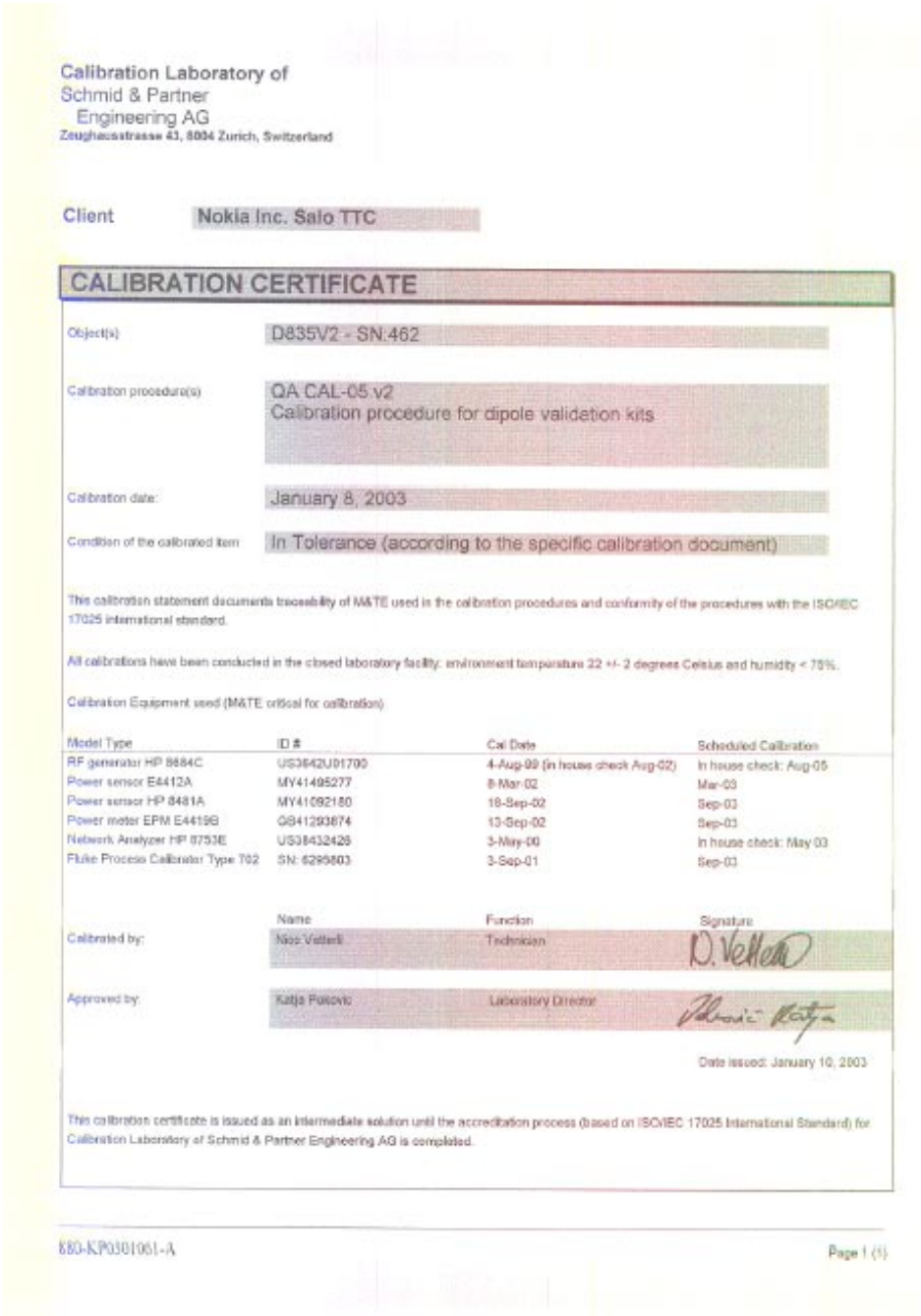
Calibrated by:	
Approved by:	



Validation Dipole D835V2 SN462, d = 15 mm
Frequency: 835 MHz; Antenna Input Power: 250 [mW]
SAM Phantom, Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(6.60,6.60,6.60) at 835 MHz; IEEE1528 835 MHz: σ = 0.90 mho/m ε_r = 42.5 ρ = 1.00 g/cm³
Cubes (2): Peak: 3.82 mW/g ± 0.02 dB, SAR (1g): 2.45 mW/g ± 0.02 dB, SAR (10g): 1.58 mW/g ± 0.02 dB, (Worst-case extrapolation)
Penetration depth: 12.2 (11.2, 13.5) [mm]
Powerdrift: -0.09 dB

07/01/02

835 MHz DIPOLE, BODY CALIBRATION:



Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client Nokia Inc. Salo TTC

CALIBRATION CERTIFICATE

Object(s)	D835V2 - SN:462
Calibration procedure(s)	QA CAL-05 v2 Calibration procedure for dipole validation kits
Calibration date:	January 8, 2003
Condition of the calibrated item	In Tolerance (according to the specific calibration document)

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date	Scheduled Calibration
RF generator HP 8684C	US3642U01700	4-Aug-99 (in house check Aug-02)	In house check: Aug-05
Power sensor E4412A	MY41495277	8-Mar-02	Mar-03
Power sensor HP 8481A	MY41092180	18-Sep-02	Sep-03
Power meter EPM E4419B	GB41293874	13-Sep-02	Sep-03
Network Analyzer HP 8753E	US38432426	3-May-00	In house check: May 03
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01	Sep-03

	Name	Function	Signature
Calibrated by:	Nico Vetterli	Technician	
Approved by:	Katja Pokovic	Laboratory Director	

Date issued: January 10, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

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Date/Time: 01/08/03 14:26:58

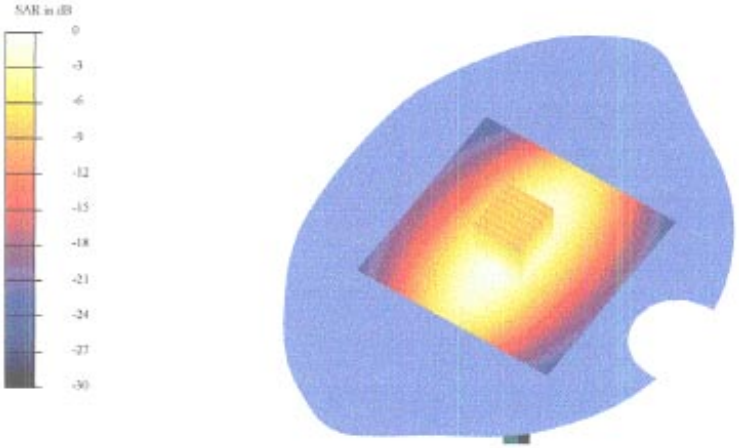
Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN462_SN1507_M835_080103.da4

DUT: Dipole 835 MHz Type & Serial Number: D835V2 - SN462
Program: Dipole Calibration; Pin = 250 mW; d = 15 mm

Communication System: CW-835; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: Muscle 835 MHz (σ = 0.96 mho/m, ε = 55.47, ρ = 1000 kg/m3)
Phantom section: FlatSection

DASY4 Configuration:
- Probe: ET3DV6 - SN1507; ConvF(6.2, 6.2, 6.2); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 51

Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm
Reference Value = 56 V/m
Peak SAR = 3.45 mW/g
SAR(1 g) = 2.48 mW/g; SAR(10 g) = 1.63 mW/g
Power Drift = -0.003 dB



1900 MHz DIPOLE; HEAD CALIBRATION:

Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

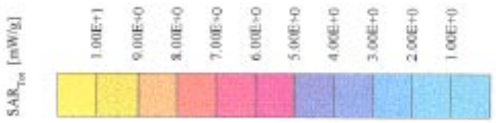
DASY3

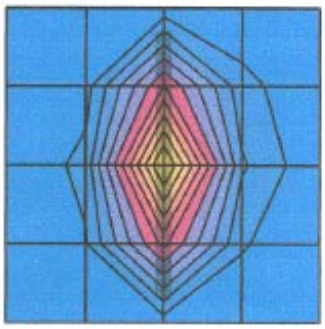
Dipole Validation Kit

Type: D1900V2

Serial: 5d013

Manufactured: April 30, 2002
Calibrated: July 1, 2002





07/01/02

Validation Dipole D1900V2 SN5d013, d = 10 mm
Frequency: 1900 MHz; Antenna Input Power: 250 [mW]
SAM Phantom, Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(5.20,5.20,5.20) at 1900 MHz; IEEE1528 1900 MHz: σ = 1.46 mho/m ε_r = 39.8 ρ = 1.00 g/cm³
Cubes (2): Peak: 20.5 mW/g ± 0.03 dB, SAR (1g): 11.0 mW/g ± 0.02 dB, SAR (10g): 5.70 mW/g ± 0.01 dB, (Worst-case extrapolation)
Penetration depth: 8.1 (7.8, 8.9) [mm]
Powerdrift: 0.02 dB

1900 MHz DIPOLE, BODY CALIBRATION:

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client Nokia Inc. Salo TTC

CALIBRATION CERTIFICATE

Object(s)	D1900V2 - SN:5d013
Calibration procedure(s)	QA CAL-05.v2 Calibration procedure for dipole validation kits
Calibration date:	January 9, 2003
Condition of the calibrated item	In Tolerance (according to the specific calibration document)

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date	Scheduled Calibration
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Power sensor HP 8481A	MY41092180	18-Sep-02	Sep-03
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Network Analyzer HP 8753E	US38432426	3-May-00	In house check: May 03
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01	Sep-03

	Name	Function	Signature
Calibrated by:	Nico Vetterli	Technician	
Approved by:	Katja Pokovic	Laboratory Director	

Date issued: January 11, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

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Date/Time: 01/09/03 17:04:5

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN5d013_SN1507_M1900_090103.da4

DUT: Dipole 1900 MHz Type & Serial Number: D1900V2 - SN5d013
Program: Dipole Calibration; Pin = 250 mW; d = 10 mm

Communication System: CW-1900; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: Muscle 1900 MHz (σ = 1.57 mho/m, ε = 50.97, ρ = 1000 kg/m3)
Phantom section: FlatSection

DASY4 Configaration:
- Probe: ET3DV6 - SN1507; ConvF(4.9, 4.9, 4.9); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 51

Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm
Reference Value = 91.7 V/m
Peak SAR = 19.4 mW/g
SAR(1 g) = 10.6 mW/g; SAR(10 g) = 5.44 mW/g
Power Drift = -0.003 dB