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Salo

T117 (EN ISO/IEC 17025)

SAR Compliance Test Report

Test report no.:	SAR0315_04.doc	**Date of report:**	2003-05-14
Number of pages:	56	**Contact person:**	Pasi Vainio
		Responsible test engineer:	Virpi Tuominen
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 Hermia 4 Visiokatu 6, 33721 Tampere FINLAND Tel. +358 (0) 7180 08000

Tested devices: **Phone: PDNNEM-4, Battery: BL-5C**
(Detailed information for each device is listed in section 1).

Supplement reports: -

Testing has been carried out in accordance with: FCC CFR. 47, Part 2.1093 and IEEE 1528-200X Draft CBD 1.0 Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques and FCC OET Bulletin 65, Supplement C, Edition 01-01.

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.

Date and signatures: 2003-05-14

For the contents:

Matti Hänninen **Process Development Manager, TCC Salo**	**Arto Hihnala** **Engineering Manager, EMC**

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1. SUMMARY FOR SAR TEST REPORT

Date of receipt	01.04.2003
Date of test	08.04. – 09.04.2003
Contact person	Pasi Vainio
Test plan referred to	DTX03794-EN
FCC ID	PDNNEM-4
SN, HW, SW and DUT numbers	Phone: PDNNEM-4 SN: 004400/21/170112/1, HW: B5.1 (ID 0515), SW: 1.94, DUT: 06407
Accessories	Battery: BL-5C, DUT #'s: 06365, 06366, 06389 MMC-card: DTS-64, DUT: 06391 Stereo Headset: HDD-2, HW: 1.0, DUT: 06391 Mono Headset: HDC-5, DUT:
Notes	All tests were performed in GSM1900 voice call mode or GPRS 2-slot mode at maximum power level**.**
Document code	SAR0315_04
Responsible test engineer	Virpi Tuominen
Measurement performed by	Arto Hihnala

1.1 Maximum Results Found during SAR Evaluation

The equipment is deemed to fulfill the requirements if the measured values are less than or equal to the limit.

1.1.1 Head Configuration / GSM 1900

Ch / *f* (MHz)	Power EIRP	Position / Options	Limit	Measured	Result
512 / 1850	29.4 dBm	Right Cheek Position / MMC-card / Bluetooth	1.6 mW/g	0.24 mW/g	**PASSED**

1.1.2 Body Worn Configuration / GSM 1900 + GPRS (2-slot TX)

Ch / *f* (MHz)	Power EIRP	Accessory / Options	Separation distance	Limit	Measured	Result
512 / 1850	29.4 dBm	HDD-2 / MMC-card / Bluetooth	15 mm	1.6 mW/g	0.47 mW/g	**PASSED**

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1.1.3 Measurement Uncertainty

Combined Standard Uncertainty	± 14.4%
Expanded Standard Uncertainty (k=2)	± 28.8%

1.2 EIRP Measurements

The measurement of the EIRP from the PDNNEM-4 phone was performed in test laboratory TCC Tampere.

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FIN-33720 Tampere

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Report#: NEM4_501.pdf

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2. DESCRIPTION OF THE TESTED DEVICE(S)

2.1 Device description

FCC ID Number	PDNNEM-4		
RF Exposure Limits	General population / Uncontrolled		
Unit type	Prototype unit		
Case type	Fixed case		
Modes of Operation	GSM 1900	GPRS	Bluetooth
Modulation Mode	GMSK	GMSK	GFSK
Duty Cycle	1/8	2/8	
Maximum Device Rating	Power class 1	Power class 1	
Transmitter Frequency Range (MHz)	1850.2 - 1909.8		2402-2480

Acronyms: GMSK = Gaussian Minimum Shift Keying
GFSK = Gaussian Frequency Shift Keying

Outside of USA, transmitter of tested device is capable of transmitting also in GSM 900 and GSM 1800 modes, which are not part of this filing.

2.2 Picture of Phone

NEM-4, keyboard upwards.

Earpiece ↑

Nem-4, earpiece on slim side.

2.3 Description of the Antenna

Type	PIFA
Location	PIFA: inside the back cover at the top of the device.

2.4 Battery Options

There is only one battery available for the tested device, a rechargeable, Li-ion battery BL-5C.

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2.5 Accessories

The following accessories are tested:

- Stereo Headset HDD-2
- Mono Headset HDC-5
- MMC-card DTS-64

2.6 Body Worn Accessories

The body worn measurements were made with 15 mm separation distance.

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3. DESCRIPTION OF THE TEST EQUIPMENT

3.1 Automated near-field scanning system

The measurements were performed with an automated near-field scanning system, DASY3 manufactured by Schmidt & Partner Engineering AG (SPEAG) in Switzerland.

Schmidt & Partner Engineering AG (SPEAG)
Zeughausstrasse 43
8004 Zurich, Switzerland

Tel. +41 1 245 97 00
Fax. +41 1 245 97 79
www.speag.com

3.2 Robot

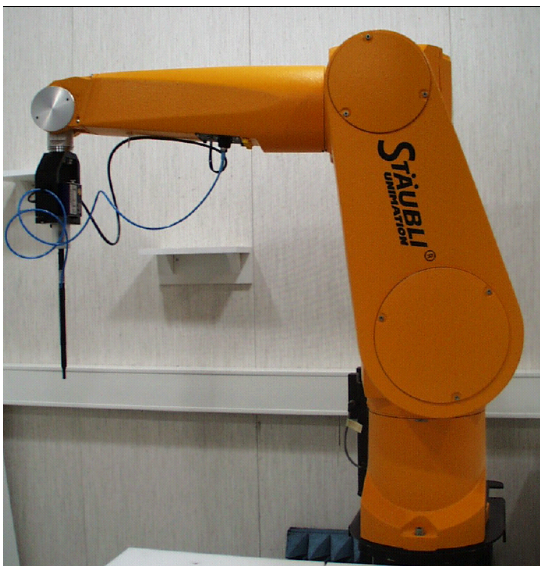

Fig. 3.2.1. Robot RX90L.

The robot is a RX90L manufactured by Stäubli France, www.staubli.com.

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3.3 Isotropic E-field probe ET3DV6R

Serial number	1396
Frequency	10 MHz to 3 GHz
Linearity	± 0.2 dB
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
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 Tip distance to phantom inner surface: 1.4 mm
Calibration	Jan-03 (see Appendix C)
Due date	Jan-04

The E-field probe is connected to the robot arm as can be seen in Figure 3.2.1.

3.4 Device holder

Fig. 3.4.1. Device holder.

The holder was provided by SPEAG as a part of the DASY3 system.

3.5 Dipole antennas for validation

The dipole antenna is matched for use near flat phantoms filled with head/body simulation solutions. The dipole is equipped with 10 mm distance holders.

Antenna	Type	Serial number	Calibration	Due date
1900 MHz dipole	D1900V2	5d013	Jul-02	Jul-04

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3.6 Phantom

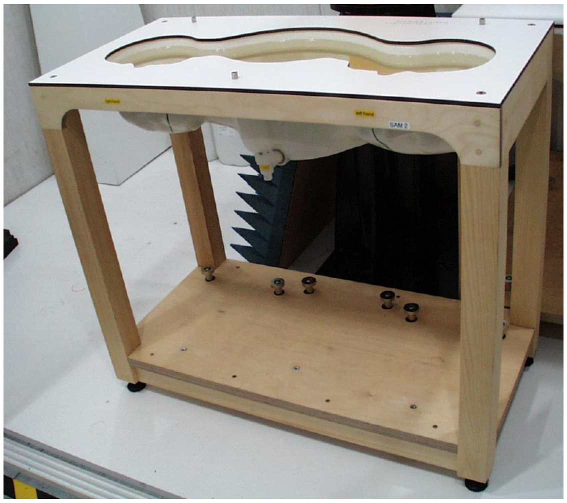

Fig. 3.6.1. SAM-phantom

The phantoms enables dosimetric evaluation of left and right hand phone usage, as well as body mounted usage at the flat phantom region.

Shell thickness	2 ± 0.2 mm, except at Ear Reference Point, where an integrated spacer provides a 6 mm spacing from tissue simulating liquid
Liquid depth	15 ± 0.5 cm

3.7 Base Station Simulaltor

The phone was put into operation using Rhode & Schwarz digital radio testers, CMU 200. Communication between the phone and the testers was established by air links.

Test Equipment	Digital radiocommunication Tester	
Model	CMU 200	
Serial number	101111	838115/061
Calibration	Mar-02	Aug-02
Due date	Mar-03 *)	Aug-03

*) New device. Will be calibrated 07/03.

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3.8 Additional equipment needed in system check

Test Equipment	Model	Serial Number	Calibration	Due Date
Signal Generator	HP 8642B	2531A00362	Apr-03	Apr-04
Amplifier	Minicircuit ZHL-42	N072095-5	-	N/A
Power Meter	R&S NRVS	838624/032	Jul-02	Jul-04
Power Meter	R&S NRVS	849305/028	Jul-02	Jul-04
Power Sensor	R&S NRV-Z32	825600/004	Jul-02	Jul-04
Power Sensor	R&S NRV-Z32	839176/020	Jul/2002	Jul-04
Thermometer	175-H2	20004475/211	Nov-02	Nov-03
Vector Network Analyzer	HP8753E	US38432928	Oct-02	Oct-03
Dielectric Probe Kit	HP85070B	US33020420	-	-

3.9 RF characteristics of the test site

Tests were performed in RF shielded environment.

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4. TEST CONDITIONS

4.1 Ambient Conditions

Date	2003-04-08	2003-04-09
Ambient temperature (°C)	22±1	22±1
Humidity (% RH)	30-40	30-40

4.2 System Performance Check

Manufacturer calibrates the probes annually. Dielectric parameters of the simulating liquids are measured using a dielectric probe kit HP85070B and a vector network analyzer HP8753E.

The SAR measurements of the DUT were done within 24 hours of system performance check, which was done using the dipole validation kit.

The dipole antenna is matched to be used near flat section of the phantom filled with tissue simulating solution. Length of 1900 MHz dipole is 68 mm with overall height of 300 mm. A specific distance holder is used in the positioning of relevant antenna to ensure correct spacing between the phantom and the dipole. Manufacturer's reference dipole data (=calibration data) is presented in Appendix C.

Power level of 250 mW was supplied to a dipole antenna placed under the flat section of SAM phantom. The results are in the table below and printout of the test is presented in Appendix A. The references are the calibration results of the dipole antenna. The reference results of the liquid parameters are those used by Speag during dipole calibrations. The ±10%-limits for SAR values and the ±5%-limits for liquid parameters are calculated from the reference values.

Tissue	Measuring date	SAR (W/kg), 1g	Dielectric Parameters	
			ε_r	σ (S/m)
Head 1900 MHz	Reference Result	11.0	39.8	1.46
	Requirement	9.90 - 12.1	37.8 - 41.8	1.39 - 1.53
	2003-04-08	10.9	39.4	1.46
Muscle 1900 MHz	Reference Result	10.6	51.0	1.57
	Requirement	9.54 - 11.7	48.5 - 53.6	1.49 - 1.65
	2003-04-09	9.68	52.3	1.51

4.3 Tissue Simulants

4.3.1 Measured values of liqid parameters

The tissue simulating liquids are measured by using a HP 85070B dielectric probe kit. The measured dielectric parameters are compared to the

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recommended values for 835 MHz and for 1800-1900 MHz given in OET Bulletin 65, Supplement C, Edition 01-01.

Tissue	Measuring date	Dielectric Parameters	
		ε_r	σ
Head 1880 MHz	Recommended	40.0	1.40
	Limits (± 5%)	38.0-42.0	1.33-1.47
	2003-04-08	39.5	1.44
Muscle 1880 MHz	Recommended	53.3	1.52
	Limits (± 5%)	50.6-56.0	1.44-1.60
	2003-04-09	52.3	1.49
	2003-04-10	52.1	1.52

4.3.2 Recipes of tissue simulating liquids

Tissue simulating liquids on 1800-1900 MHz

Ingredient	Head (% by weight)	Body (% by weight)
De-ionized water	54.88	69.02
Di(ethylene glycol) butyl ether	44.91	30.76
Salt	0.21	0.22

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5. DEVICE POSITIONING

5.1 Positioning procedures

The mobile phone was measured in 2 positions on both “left hand” and “right hand” side of the phantom. Furthermore, the phone was measured in the carrying case under the flat section of the phantom.

5.1.1 Cheek/Touch Position

1) The phone was positioned with the vertical centerline of the body of the phone and the horizontal line crossing the center of the earpiece in a plane parallel to the sagittal plane of the phantom (“initial position”). While maintaining the phone in this plane, the vertical centerline was aligned with the reference plane containing the three ear and mouth reference points (RE, LE and M) and the center of the earpiece was aligned with the line RE-LE.

2) The mobile phone was moved towards the phantom with the earpiece aligned with the line LE-RE until the phone touched the ear. While maintaining the phone contact with the ear, the bottom of the phone was moved until any point of the phone was in contact with a phantom point below the ear.

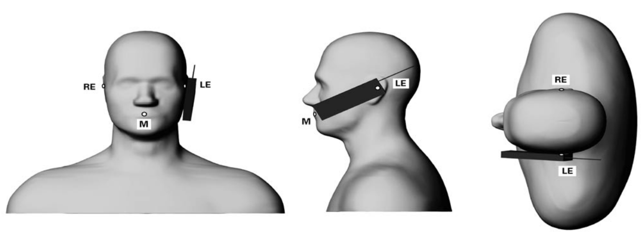

Fig. 5.1.1. Cheek/Touch position

5.1.2 Ear/Tilted Position

1) The phone was positioned in the “cheek/touch” position as described above.

2) While the phone was maintained in the reference plane described above and pivoting against the ear, the phone was moved outward away from the mouth by an angle of 15 degrees or until contact with the ear was lost.

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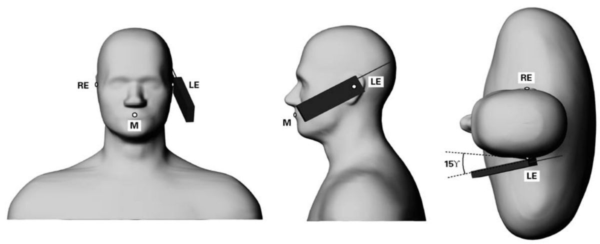

Fig. 5.1.2. Ear/Tilt Position.

5.1.3 Photos of setup

Fig. 5.1.3.1. Cheek position.

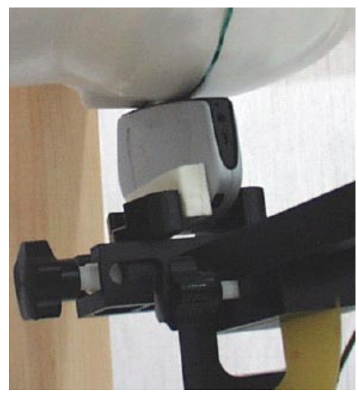

Fig. 5.1.3.2. Cheek position seen from backside of the phone. Polystyrene piece used as positioning support.

Fig. 5.1.3.3. Tilt position.

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5.1.4 Body Worn Configuration

The phone was postioned into the holder and placed below the flat section of the phantom. The distance between the phone and the phantom was kept at 15 mm during all measurements. Measurements were performed with the keyboard side towards the phantom.

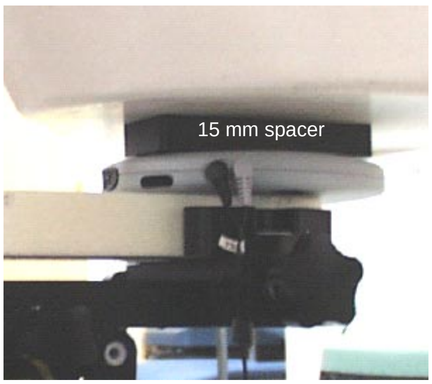

Fig. 5.1.4.1. PDNNEM-4 in body position with 15 mm spacer.

Fig.5.1.4.2. PDNNEM-4 in body position and spacer removed. Phone is on the polystyrene support and has stereo headset HDD-2 connected.

5.2 Scan Procedures

First coarse scan is used for quick determination of the field distribution. Next cube scan, 5x5x7 points; spacing between each point 8x8x5 mm, is performed around the highest E-field value to determine the averaged SAR-distribution over 1g.

5.3 SAR Averaging Methods

The maximum SAR value is averaged over its volume using interpolation and extrapolation.

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of 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 is based on least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 30 mm in all z-

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axis, polynomials of order four are calculated. This polynomial is then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1mm from one another.

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6. MEASUREMENT UNCERTAINTY

6.1 Table – Measurement uncertainty evaluation

a	*b*	*c*	*d*	*e = f(d,k)*	*F*	*h = c x f / e*	*k*
Uncertainty Component	**Section in P1528.**	**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	$(1\text{-cp})^{1/2}$	±1.9	∞
Hemispherical Isotropy	E2.2	±9.6	R	√3	$\sqrt{c_p}$	±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	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	0.7	±1.7	∞
Liquid Conductivity - measurement uncertainty	E3.3	±10.0	R	√3	0.7	±3.5	∞
Liquid Permittivity Target tolerance	E3.2	±5.0	R	√3	0.6	±1.7	∞
Liquid Permittivity - measurement uncertainty	E3.3	±5.0	R	√3	0.6	±1.7	∞
Combined Standard Uncertainty			RSS			**±14.4**	
Expanded Uncertainty (95% CONFIDENCE INTERVAL)						**±28.8**	

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7. RESULTS

The SAR results shown in the tables are maximum SAR values averaged over 1g of tissue. The maximum result of every different test configuration is included in the appendix B as SAR distribution plots. The other SAR distribution plots are substantially similar or equivalent to the plots submitted regardless of used channel in each mode and position.

7.1 Head Configuration

With MMC-card

Position	GSM 1900			
	Channel	Low 512	Mid 661	High 810
	Frequency (MHz)	1850	1880	1910
	EIRP (dBm)	29.4	29.4	29.5
Cheek, Left hand	No Bluetooth	-	0.192	-
	With Bluetooth	-	-	-
Tilt, Left hand	No Bluetooth	-	0.149	-
	With Bluetooth	-	-	-
Cheek, Right hand	No Bluetooth	0.234	0.208	0.205
	With Bluetooth	0.240	-	-
Tilt, Right hand	No Bluetooth	-	0.171	-
	With Bluetooth	-	-	-

Checking without MMC-card

Position	GSM 1900			
	Channel	Low 512	Mid 661	High 810
	Frequency (MHz)	1850	1880	1910
	EIRP (dBm)	29.4	29.4	29.5
Cheek, Right hand	No Bluetooth	0.225	-	-

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7.2 Body configuration

Body SAR measurements were performed with the headset HDD-2 or HDC-5 connected. Keyboard side of the phone was towards the phantom, because in this position the highest SAR values were achieved. The results with 15 mm separation distance are listed in the tables below.

Accessory	GSM 1900 + GPRS (2-slot TX)			
	Channel	Low 512	Mid 661	High 810
	Frequency (MHz)	1850	1880	1910
	EIRP (dBm)	29.4	29.4	29.5
HDD-2 MMC-card	No Bluetooth	0.452	0.395	0.363
	With Bluetooth	0.469	-	-
HDC-5 MMC-card	No Bluetooth	0.455	0.421	0.359
	With Bluetooth	0.454	-	-

Checking without MMC

Accessory	GSM 1900 + GPRS (2-slot TX)			
	Channel	Low 512	Mid 661	High 810
	Frequency (MHz)	1850	1880	1910
	EIRP (dBm)	29.4	29.4	29.5
HDC-5	No Bluetooth	0.438	-	-

Checking in position 'Backside of the phone towards phantom'

Accessory	GSM 1900 + GPRS (2-slot TX)			
	Channel	Low 512	Mid 661	High 810
	Frequency (MHz)	1850	1880	1910
	EIRP (dBm)	29.4	29.4	29.5
HDC-5	No Bluetooth	0.325	-	-

Checking without GPRS

Accessory	GSM 1900			
	Channel	Low 512	Mid 661	High 810
	Frequency (MHz)	1850	1880	1910
	EIRP (dBm)	29.4	29.4	29.5
HDC-5	No Bluetooth	0.241	-	-

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APPENDIX A.

Validation Test Printouts

Dipole 1900 MHz
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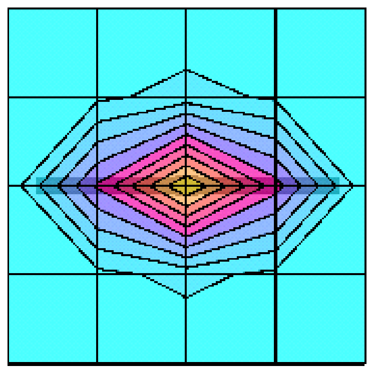
t(liq.)=20.8°C
SAM 2; Flat
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 1.0; Brain 1900 MHz: σ = 1.46 mho/m ε_r = 39.4 ρ = 1.00 g/cm^3
Cubes (2): Peak: 20.9 mW/g ± 0.12 dB, SAR (1g): 10.9 mW/g ± 0.11 dB, SAR (10g): 5.53 mW/g ± 0.12 dB, (Worst-case extrapolation)
Penetration depth: 7.8 (7.4, 8.9) [mm]
Powerdrift: -0.01 dB



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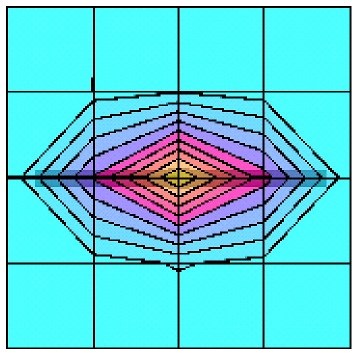
Dipole 1900 MHz

2003-04-09
t(liq.)=21.3°C
SAM 2; Flat
Probe: ET3DV6 - SN1396; ConvF(5.10,5.10,5.10); Crest factor: 1.0; B0DY 1900 MHz: σ = 1.51 mho/m ε_r = 52.3 ρ = 1.00 g/cm^3
Cubes (2): Peak: 16.9 mW/g ± 0.12 dB, SAR (1g): 9.68 mW/g ± 0.13 dB, SAR (10g): 5.13 mW/g ± 0.13 dB, (Advanced extrapolation)
Penetration depth: 9.5 (9.2, 10.1) [mm]
Powerdrift: 0.04 dB



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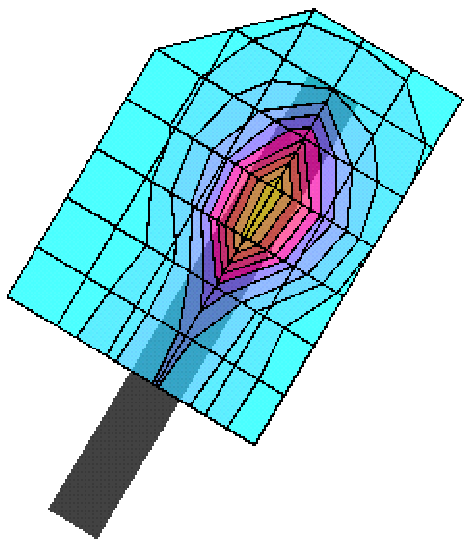
APPENDIX B.

SAR Distribution Printouts

PDNNEM-4, LEFT CHEEK POSITION, NO BLUETOOTH
2003-04-08
t(liq.)=20.7°C

SAM 2 Phantom; Left Hand Section; Cheek Position: (90°,59°); Frequency: 1880 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.44 mho/m ε_r = 39.5 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.192 mW/g, SAR (10g): 0.102 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.19 dB



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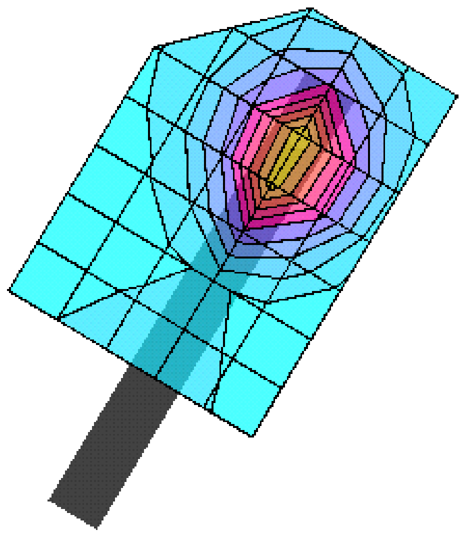
PDNNEM-4, LEFT TILT, NO BLUETOOTH
2003-04-08
t(liq.)=20.6°C

SAM 2 Phantom; Left Hand Section; Tilt Position: (90°,59°); Frequency: 1880 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.44 mho/m ε_r = 39.5 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.149 mW/g, SAR (10g): 0.0827 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.08 dB



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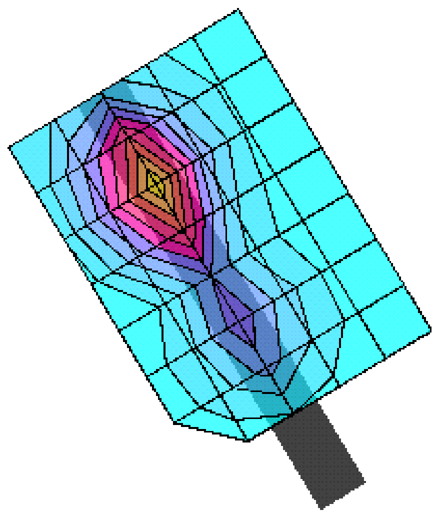
PDNNEM-4, RIGHT CHEEK POSITION, NO BLUETOOTH
2003-04-08
t(liq.)=20.5°C

SAM 2 Phantom; Righ Hand Section; Cheek Position: (90°,301°); Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.44 mho/m ε_r = 39.5 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.234 mW/g, SAR (10g): 0.125 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.04 dB



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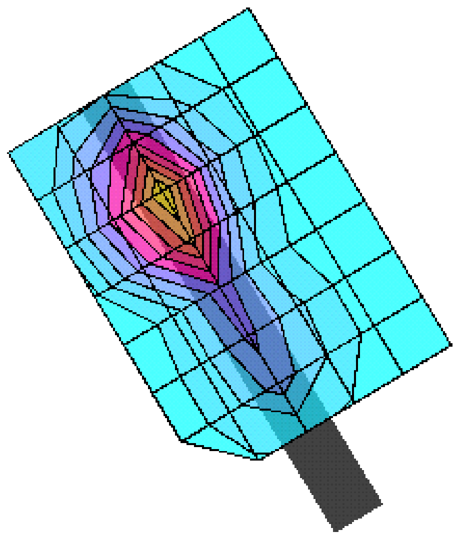
PDNNEM-4, RIGHT CHEEK POSITION, WITH BLUETOOTH
2003-04-08
t(liq.)=20.4°C

SAM 2 Phantom; Righ Hand Section; Cheek Position: (90°,301°); Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.44 mho/m ε_r = 39.5 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.240 mW/g, SAR (10g): 0.127 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.01 dB



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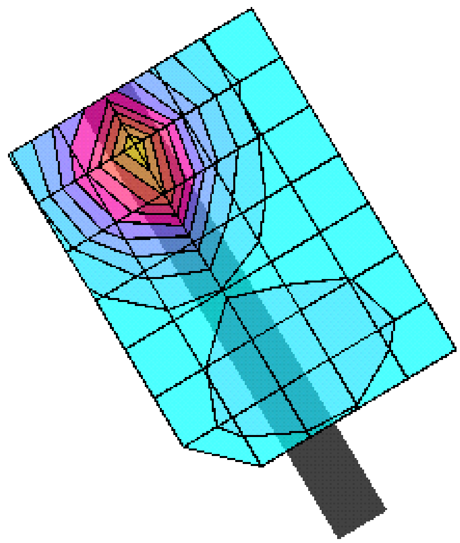
PDNNEM-4, RIGHT TILT, NO BLUETOOTH
2003-04-08
t(liq.)=20.5°C

SAM 2 Phantom; Righ Hand Section; Tilt Position: (90°,301°); Frequency: 1880 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.44 mho/m ε_r = 39.5 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.171 mW/g, SAR (10g): 0.0950 mW/g, (Worst-case extrapolation)
Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0
Powerdrift: -0.09 dB



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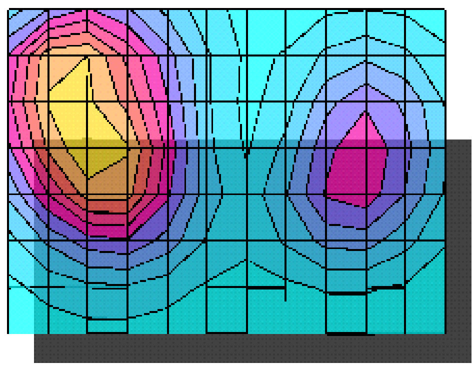
PDNNEM-4 WITH HDD-2, BODY POSITION, GPRS, NO BLUETOOTH

2003-04-09
t(liq.)=20.7°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; BODY 1880 MHz: σ = 1.49 mho/m ε_r = 52.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.452 mW/g, SAR (10g): 0.288 mW/g, (Worst-case extrapolation)
Coarse: Dx = 14.0, Dy = 12.0, Dz = 10.0
Powerdrift: -0.12 dB



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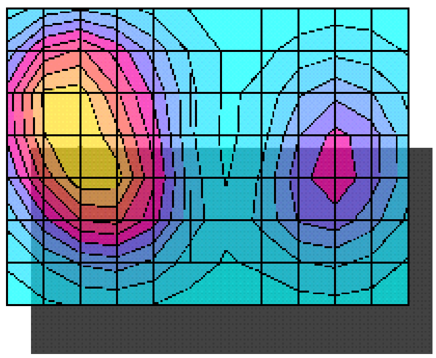
PDNNEM-4 WITH HDD-2, BODY POSITION, GPRS, WITH BLUETOOTH
2003-04-10
t(liq.)=21.5°C

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; BODY 1880 MHz: σ = 1.52 mho/m ε_r = 52.1 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.469 mW/g, SAR (10g): 0.297 mW/g, (Worst-case extrapolation)
Coarse: Dx = 14.0, Dy = 12.0, Dz = 10.0
Powerdrift: -0.06 dB



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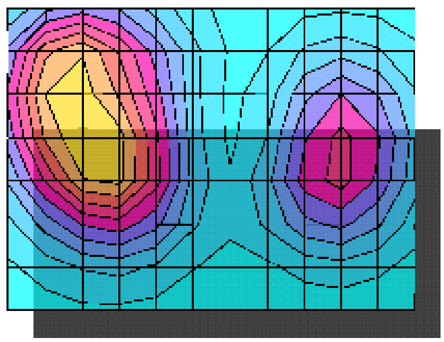
PDNNEM-4 WITH HDC-5, BODY POSITION, GPRS, NO BLUETOOTH
2003-04-09
t(liq.)=20.6°C

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; BODY 1880 MHz: σ = 1.49 mho/m ε_r = 52.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.455 mW/g, SAR (10g): 0.284 mW/g, (Worst-case extrapolation)
Coarse: Dx = 14.0, Dy = 12.0, Dz = 10.0
Powerdrift: -0.07 dB



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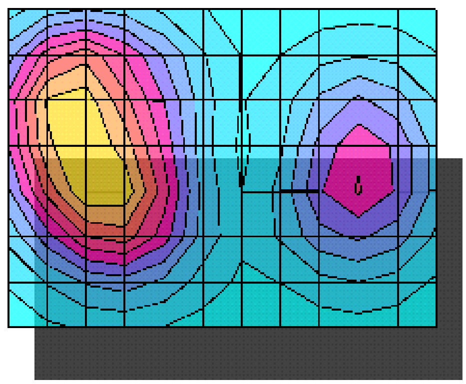
PDNNEM-4 WITH HDC-5, BODY POSITION, GPRS, WITH BLUETOOTH
2003-04-10
t(liq.)=21.7°C

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 = 1.52 mho/m ε_r = 52.1 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.454 mW/g, SAR (10g): 0.288 mW/g, (Worst-case extrapolation)
Coarse: Dx = 14.0, Dy = 12.0, Dz = 10.0
Powerdrift: -0.13 dB



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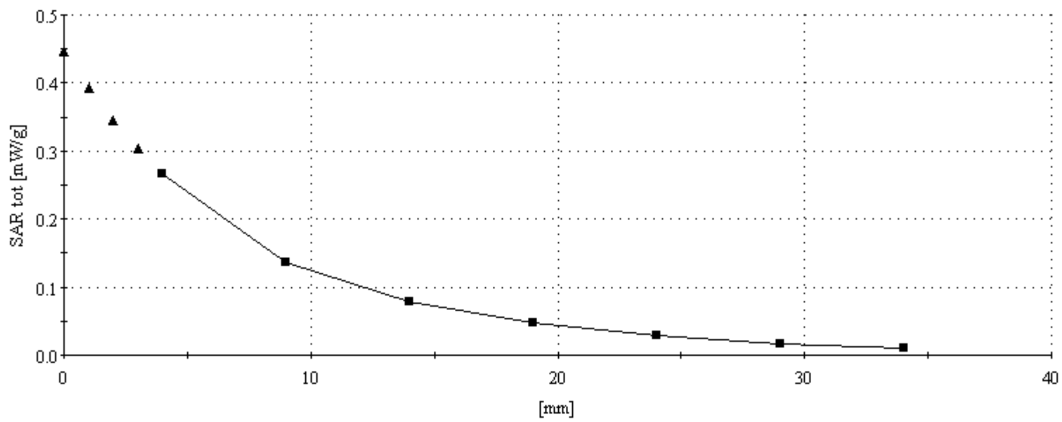
Z-PLOTS OF THE MAXIMUM RESULTS

PDNNEM-4, RIGHT CHEEK POSITION, WITH BLUETOOTH

2003-04-08
t(liq.)=20.4°C

Max.point:

SAM 2 Phantom; Section; Position: ; Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.60,5.60,5.60); Crest factor: 8.0; Brain 1880 MHz: σ = 1.44 mho/m ε_r = 39.5 ρ = 1.00 g/cm^3
: , ()
Z-Axis: Dx = 0.0, Dy = 0.0, Dz = 5.0



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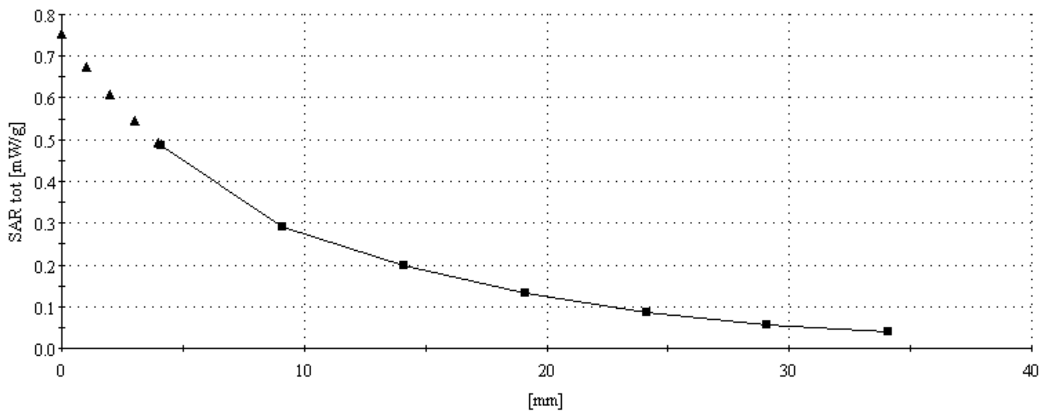
PDNNEM-4 WITH HDD-2, BODY POSITION, GPRS, WITH BLUETOOTH
2003-04-10
t(liq.)=21.5°C

Max. point:

SAM 2 Phantom; Section; Position: ; Frequency: 1850 MHz
Probe: ET3DV6 - SN1396; ConvF(5.10,5.10,5.10); Crest factor: 4.0; B0DY 1880 MHz: σ = 1.52 mho/m ε_r = 52.1 ρ = 1.00 g/cm^3
: , ()
Z-Axis: Dx = 0.0, Dy = 0.0, Dz = 5.0



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APPENDIX C.
Calibration Certificates

E-FIELD PROBE:

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	N. Vetterli
Approved by:	Katja Pokovic	Laboratory Director	Pokovic Katja

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.

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Schmid & Partner
Engineering AG

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

Probe ET3DV6

SN:1396

Manufactured:	October 1, 1999
Last calibration:	January 29, 2002
Recalibrated:	January 15, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

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ET3DV6 SN:1396 January 15, 2003

DASY - Parameters of Probe: ET3DV6 SN:1396

Sensitivity in Free Space

NormX	1.72	$\mu V/(V/m)^2$
NormY	1.73	$\mu V/(V/m)^2$
NormZ	1.84	$\mu V/(V/m)^2$

Diode Compression

DCP X	93	mV
DCP Y	93	mV
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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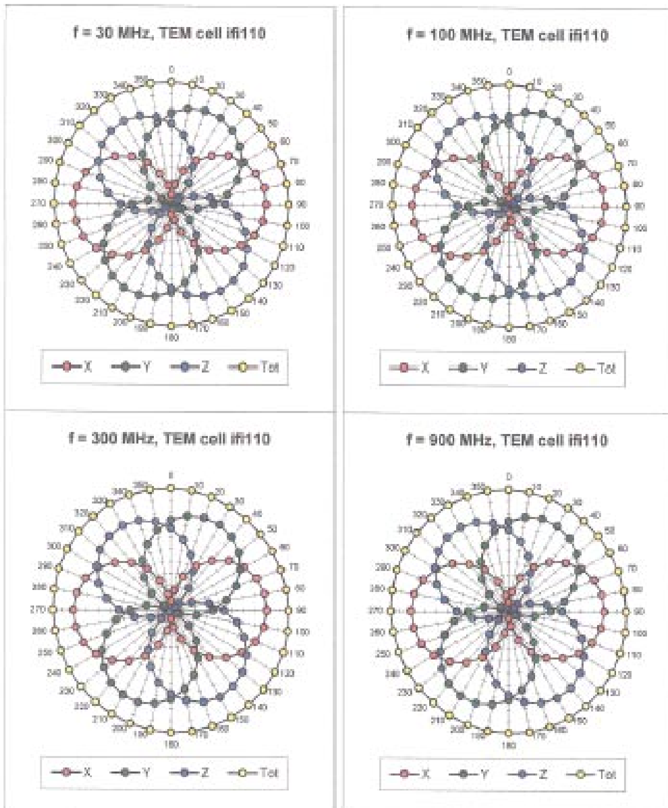
Receiving Pattern (ϕ), θ = 0°



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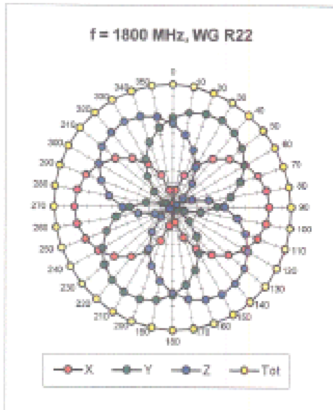
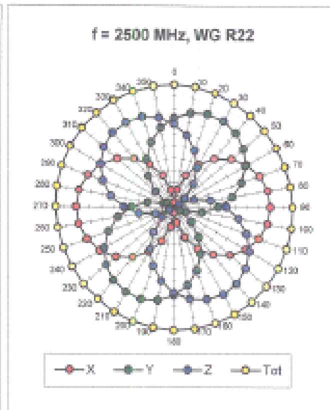
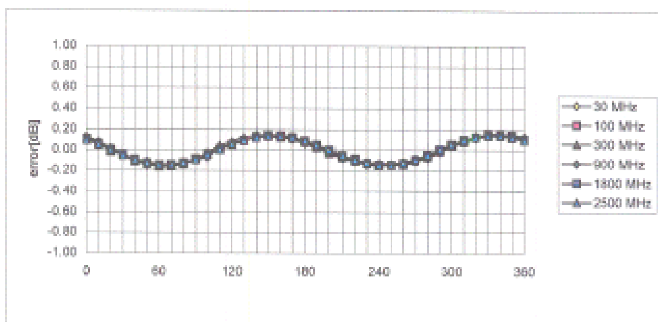




Isotropy Error (ϕ), θ = 0°



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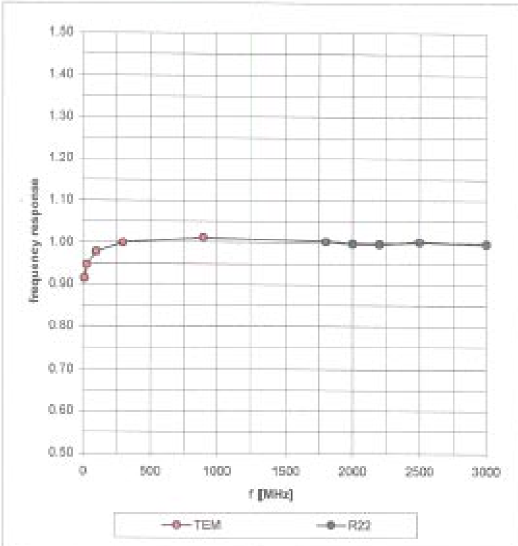
Frequency Response of E-Field

(TEM-Cell:ifi110, Waveguide R22)



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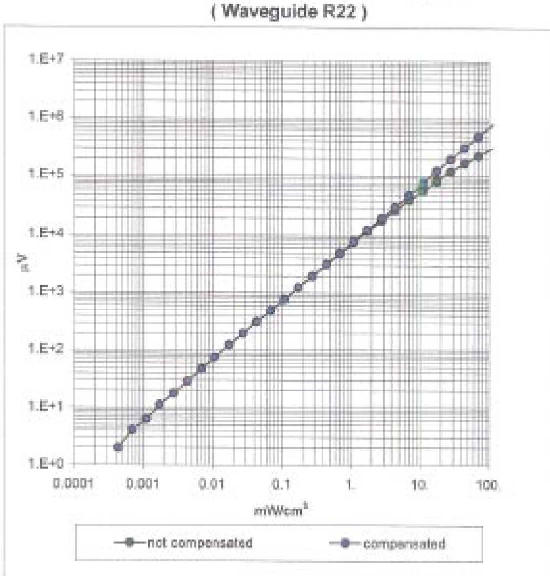
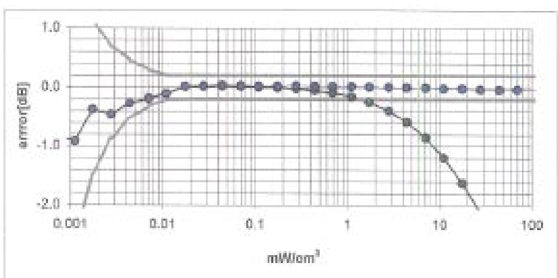
Dynamic Range f(SAR_{brain})

(Waveguide R22)





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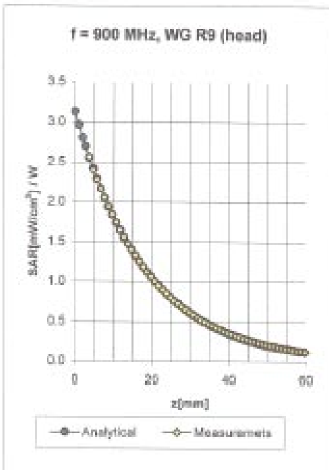
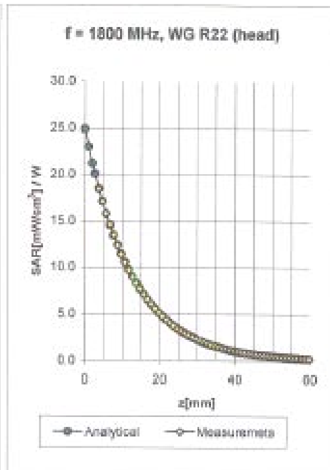
Conversion Factor Assessment





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	

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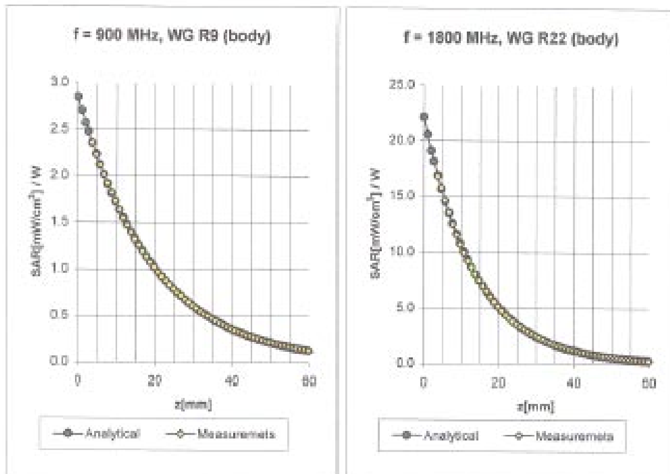
Conversion Factor Assessment



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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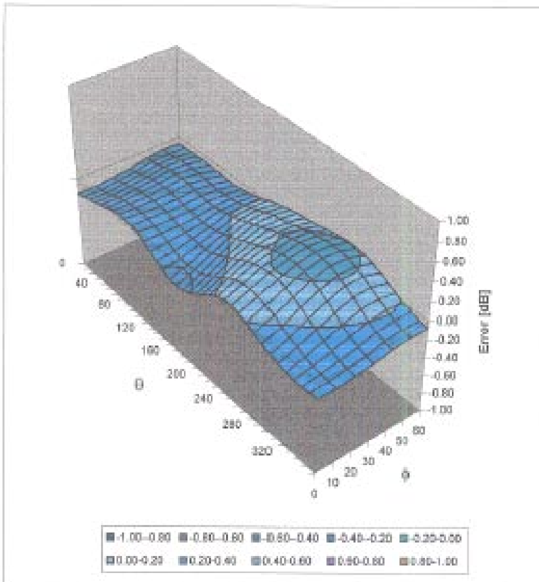
Deviation from Isotropy in HSL

Error (θ,ϕ), f = 900 MHz



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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

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1. Measurement Conditions

The measurements were performed in the flat section of the new generic twin phantom filled with brain simulating sugar solution of the following electrical parameters at 1900 MHz:

Relative permitivity	**39.8**	± 5%
Conductivity	**1.46 mho/m**	± 10%

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.2 at 1900 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 20mm was aligned with the dipole. The 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 90° turned probe orientations and averaging.
The dipole input power (forward power) was 250mW ± 3 %. The results are normalized to 1W input power.

2.1. SAR Measurement with DASY3 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the worst-case extrapolation are:

averaged over 1 cm^3 (1 g) of tissue:	**44.0 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**22.8 mW/g**

2.2 SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue:	**40.4 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**21.4 mW/g**

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3. Dipole Impedance and Return Loss

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	**1.194 ns**	(one direction)
Transmission factor:	**0.993**	(voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 1900 MHz:	Re{Z} = **50.1 Ω**
	Im {Z} = **3.0 Ω**
Return Loss at 1900 MHz	**- 30.6 dB**

4. Handling

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

5. Design

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

Small end caps have been added to the dipole arms in order to improve matching when loaded according to the position as explained in Section 1. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

6. Power Test

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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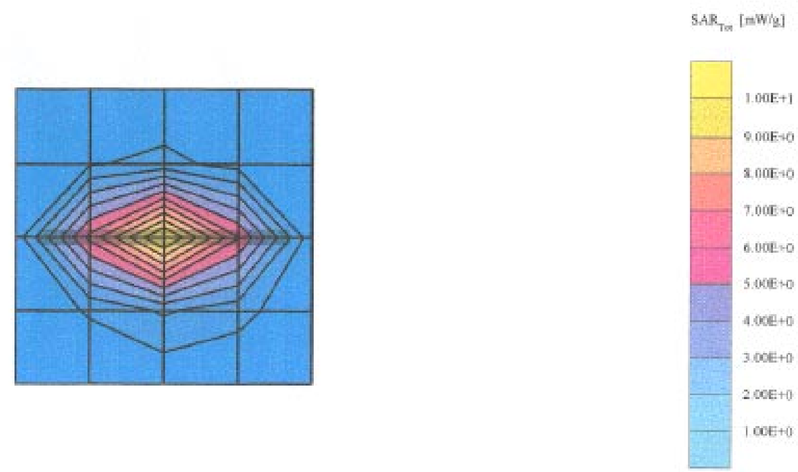
07/01/02

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



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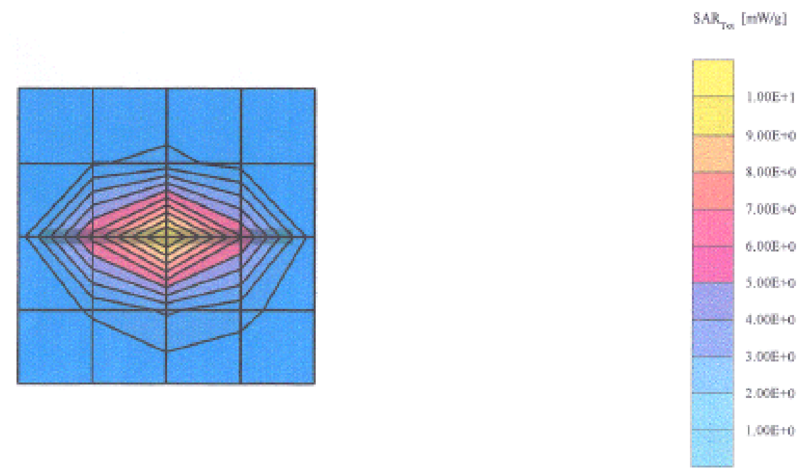
07/01/02

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: 17.7 mW/g ± 0.03 dB, SAR (1g): 10.1 mW/g ± 0.02 dB, SAR (10g): 5.34 mW/g ± 0.01 dB, (Advanced extrapolation)
Penetration depth: 8.8 (8.7, 9.0) [mm]
Powerdrift: 0.02 dB



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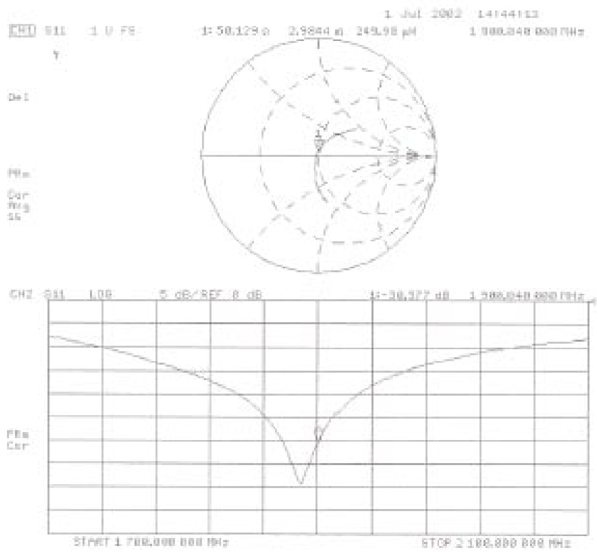

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1900 MHz DIPOLE, BODY CALIBRATION:

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
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	D. Vetterli
Approved by:	Katja Pokovic	Laboratory Director	[signature]

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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Schmid & Partner
Engineering AG

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

DASY

Dipole Validation Kit

Type: D1900V2

Serial: 5d013

Manufactured: April 30, 2002
Calibrated: January 9, 2003

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1. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with body simulating glycol solution of the following electrical parameters at 1900 MHz:

Relative Dielectricity	**51.0**	± 5%
Conductivity	**1.57 mho/m**	± 5%

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 4.9 at 1900 MHz) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.
The dipole input power (forward power) was 250mW ± 3 %. The results are normalized to 1W input power.

2. SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue:	**42.4 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**21.7 mW/g**

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3. Dipole Impedance and Return Loss

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	**1.193 ns**	(one direction)
Transmission factor:	**0.997**	(voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 1900 MHz:	Re{Z} = **46.7 Ω**
	Im {Z} = **2.8 Ω**
Return Loss at 1900 MHz	**-26.9 dB**

4. Handling

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

5. Design

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

Small end caps have been added to the dipole arms in order to improve matching when loaded according to the position as explained in Section 1. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

6. Power Test

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

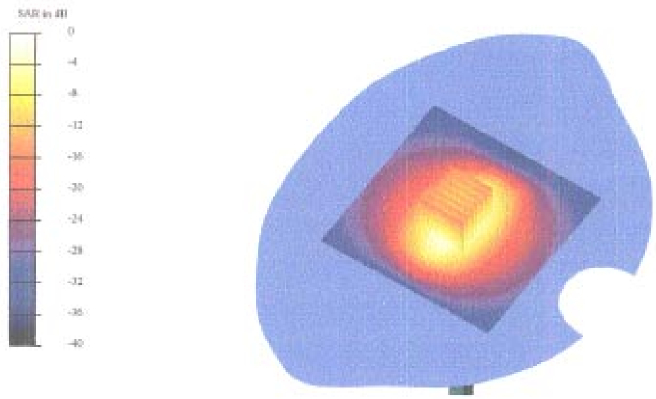
Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN5d013_SN1507_M1900_090103.da4

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_r = 50.97, ρ = 1000 kg/m3)
Phantom section: FlatSection

DASY4 Configuration:
- 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



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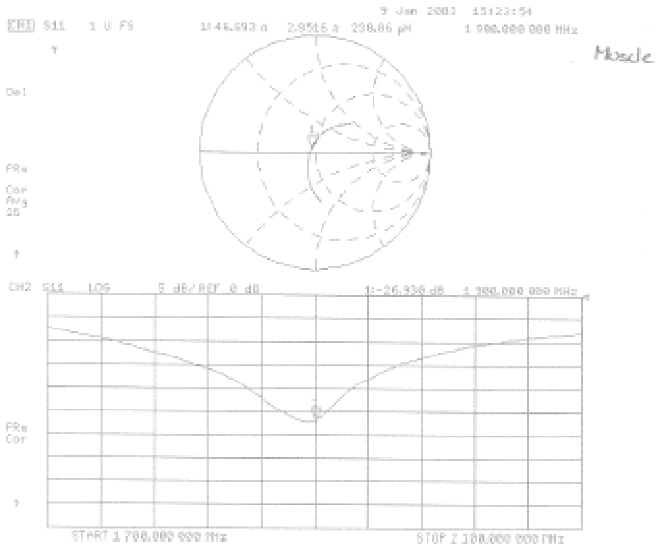

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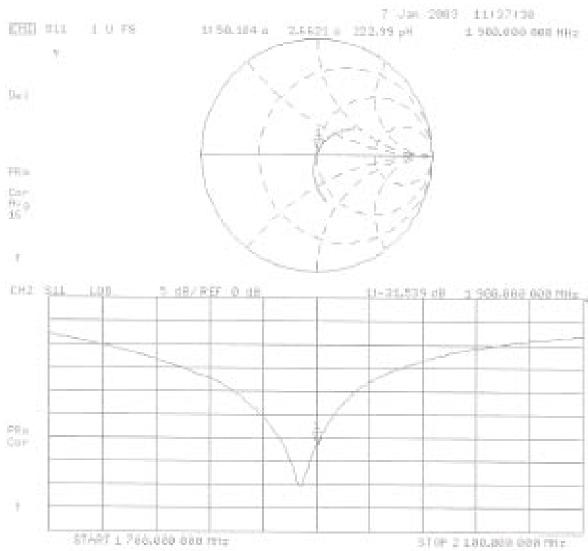

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