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T117 (EN ISO/IEC 17025)

SAR Compliance Test Report

Test report no.:	SAR0306_04.doc	Date of report:	2003-02-12
Number of pages:	47	Contact person:	Mary Washington
		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, INC 12278 Scripps Summit Dr. San Diego CA 92131, USA Tel. +1 858 831 5000 Fax. +1 858 831 6500

Tested devices:	**QMNRH-17,** Battery: BL-5C, Headsets: HDB-4 and HDK-1K
Supplement reports:	SAR0246_03
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: 2003-02-12

For the contents:

Arto Hihnala	Virpi Tuominen
Engineering Manager, EMC	Senior Design Engineer, EMC

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P.O. Box 86
Joensuunkatu 7E / Kiila 1B
FIN-24101 SALO, FINLAND
Tel. +358 (0) 7180 08000
Fax. +358 (0) 7180 45220

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P.O. Box 86
Joensuunkatu 7E / Kiila 1B
FIN-24101 SALO, FINLAND
Tel. +358 (0) 7180 08000
Fax. +358 (0) 7180 45220

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Joensuunkatu 7E / Kiila 1B
FIN-24101 SALO, FINLAND
Tel. +358 (0) 7180 08000
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1. SUMMARY FOR SAR TEST REPORT

Date of receipt of headset	2003-02-07
Date of test	2003-02-11
Contact person	Mary Washington
Test plan referred to	ATCB 2003-01-21
FCC ID	QMNRH-17
SN, HW, SW and DUT numbers	DUT: 06130 SN: 235/14062886 HW: 2001 SW: F100-02 W33-5.nbr PSN: 91132
Accessories	Battery: BL-5C DUT #'s: 06124, 06285, 06286
	Headsets: HDB-4, DUT: 06131 HDK-1K, DUT: 06293
Notes	This report comprises body worn measurements only with headsets HDB-4 and HDK-1K. Other test results concerning SAR measurements of QMNRH-17 are documented in the report SAR0246_03, dated 2002-12-18.
Document code	SAR0306_04.doc
Responsible test engineer	Virpi Tuominen
Measurement performed by	Virpi Tuominen, Tomi Lipponen, Arto Hihnala

1.1 Maximum Results Found during SAR Evaluation

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

1.1.1 Body Worn Configuration

Ch / *f* (MHz)	Mode of operation	Conducted Power	Accessory / Antenna Option	Limit	Measured	Result
383 / 836	AMPS 800	24.7 dB	HDK-1K / Antenna retracted	1.6 mW/g	0.97 mW/g	PASSED

1.1.2 Measurement Uncertainty

Combined Standard Uncertainty	**± 14.0%**
Expanded Standard Uncertainty (k=2)	**± 28.0%**

P.O. Box 86
Joensuunkatu 7E / Kiila 1B
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Tel. +358 (0) 7180 08000
Fax. +358 (0) 7180 45220

2. DESCRIPTION OF THE TESTED DEVICE(S)

2.1 Device description

FCC ID Number	QMNRH-17	
Device category	Portable Device	
RF Exposure Limits	General population / Uncontrolled	
Unit type	Prototype unit	
Case type	Fixed case	
Modes of Operation	AMPS 800	CDMA 800
Modulation Mode	FM	QPSK
Duty Cycle	1	1
Maximum Device Rating	Power Class III	Power Class III
Transmitter Frequency Range (MHz)	824.04 - 848.97	824.70 – 848.31

Acronyms: QPSK = Quadrature Phase Shift Keying
FM = Frequency Modulation

2.2 Picture of Phone

Fig. 2.2.1
QMNRH-17 antenna retracted.

Fig. 2.2.2
QMNRH-17 antenna extended.

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2.3 Description of the Antenna

Type	Rectractable whip antenna with PIFA
Location	PIFA: inside the back cover at the top of the device. Rectractable whip: back of phone, right hand side.

2.4 Battery Options

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

2.5 Accessories

Headsets HDB-4 and HDK-1K were used for the measurements.

2.6 Body Worn Accessories

The body worn measurements were made with 22 mm separation distance.

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Joensuunkatu 7E / Kiila 1B
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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, Schwitzerland

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.

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: 1.5 mm
Calibration	2003-01-15 (see Appendix C)
Due date	Jan-04

In Figure 3.2.1 the E-field probe is connected to the robot arm.

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 900 MHz dipole antenna is matched for use near flat phantoms filled with head/body simulation solutions. The dipole is equipped with 15 mm distance holders.

Antenna	Type	Serial number	Calibration	Due date
900 MHz dipole	D900V2	056	2002-01-29	Jan -04

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3.6 Phantom

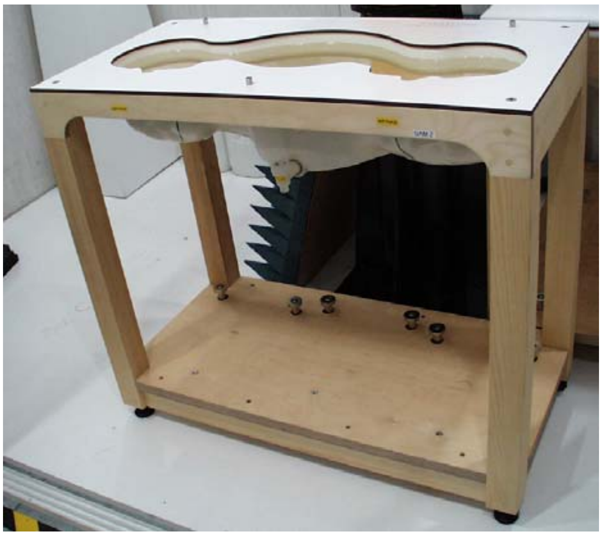

Fig. 3.6.1. SAM-phantom.

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 QMNRH-17 cellular phone was put into operation using a Rhode & Schwarz digital radio tester, CMU 200. Communication between the phone and the tester was established by air link. The tests were performed with two CMU-testers, the first one had CDMA-option and the second one had both the CDMA- and AMPS-options.

Test Equipment	Digital radiocommunication Tester with AMPS- and CDMA-options
Model	CMU 200
Serial number	101111
Calibration	2002-03-07
Due date	Mar-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	Jan-02	Jan-03
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
Data logger	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	2003-02-11
Ambient temperature (°C)	21.9
Humidity (% RH)	35-45

4.2 System Performance Check

The 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 liquid parameter measurements and system performance check.

The dipole antenna is matched to be used near flat section of the phantom filled with tissue simulating solution. Length of 900 MHz dipole is 149 mm with overall height of 330 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 printouts of the tests are 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 requirements for SAR values are calculated from the reference results (reference ± 10%).

Tissue	*f* (MHz)	Measuring date	SAR (W/kg), 1g	Dielectric Parameters	
				ε_r	σ (S/m)
Muscle	900	Reference Result	2.92	54.8	1.00
		Requirement	2.63 – 3.21	52.1 – 57.5	0.95 – 1.05
		2003-02-11	3.06	55.7	1.01

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4.3 Tissue Simulants

4.3.1 Measured values of liquid parameters

The tissue simulating liquids are measured by using a HP 85070B dielectric probe kit. The measured dielectric parameters are compared to the recommended values for 835 MHz given in OET Bulletin 65 (97-01) Supplement C (01-01).

Tissue	*f* (MHz)	Measuring date	Dielectric Parameters	
			ε_r	σ (S/m)
Muscle	836	Recommended	55.2	0.97
		Limits	52.4 – 58.0	0.92 – 1.02
		2003-02-11	56.3	0.95

4.3.2 Recipes of tissue simulating liquids

Tissue simulating liquids on 835 MHz

Ingredient	Head (% by weight)	Muscle (% by weight)
Sugar	58.31	41.76
De-Ionized Water	39.74	55.97
Salt	1.55	0.79
HEC	0.25	1.21
Bactericide	0.15	0.27

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5. DEVICE POSITIONING

5.1 Positioning procedures

The cellular phone was measured in 2 positions on both "left hand" and "right hand" side of the phantom with the antenna in both extended and retracted positions. Furthermore, the cellular phone was measured under the flat section of the phantom antenna side towards the phantom and antenna extended and retracted. A headset was connected to the phone during the body SAR measurements.

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.

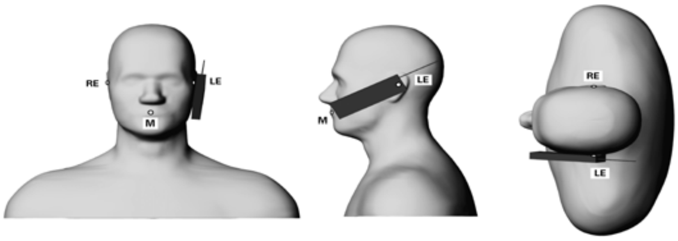

Fig. 5.1.1. Cheek/Touch position

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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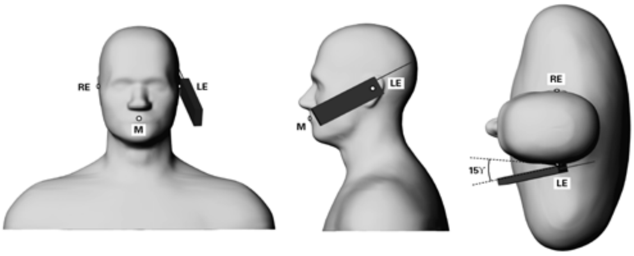

Fig. 5.1.2. Ear/Tilt Position.

5.1.3 Body Worn Configuration

The phone was postioned into the holder and placed below the flat section of the phantom. The measurements were made to show compliance with 22 mm separation distance. Measurements were performed with the antenna side towards the phantom.

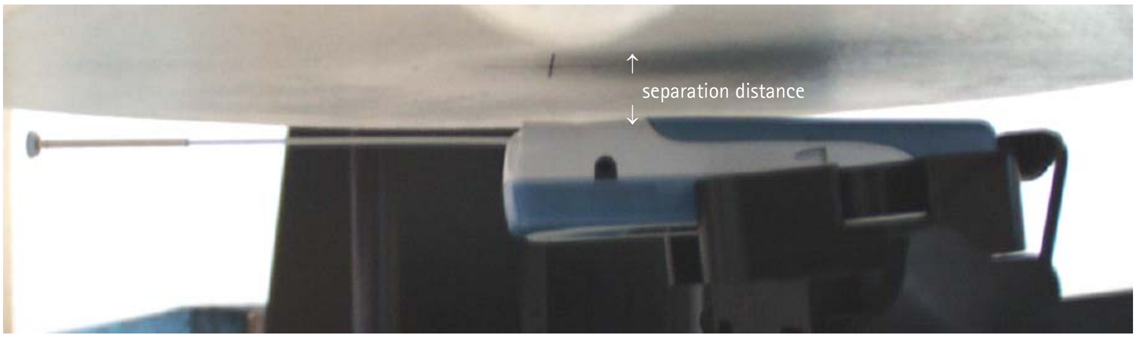

Fig. 5.1.3.1. QMNRH-17 in body position with antenna extended and headset HDB-4 connected.

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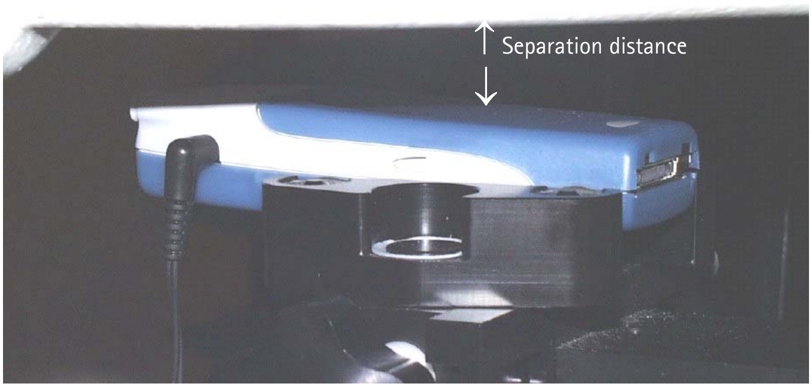

Fig. 5.1.3.2. QMNRH-17 in body position with antenna retracted and headset HDK-1K connected.

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-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.

P.O. Box 86
Joensuunkatu 7E / Kiila 1B
FIN-24101 SALO, FINLAND
Tel. +358 (0) 7180 08000
Fax. +358 (0) 7180 45220

6. MEASUREMENT UNCERTAINTY

Uncertainty description	Error	Probability distribution	Weight	Standard Deviation
Axial isotropy	± 0.2 dB	U-shape	0.5	± 2.4%
Spherical Isotropy	± 0.4 dB	U-shape	0.5	± 4.8%
Spatial resolution	± 0.5 %	normal	1	± 0.5%
Linearity error	± 0.2 dB	rectangular	1	± 2.7%
Calibration error	± 3.3 %	normal	1	± 3.3%
Total Probe Uncertainty				**± 6.87%**
Data acquisition error	± 1%	rectangular	1	± 0.6%
ELF and RF disturbances	± 0.25%	normal	1	± 0.25%
Conductivity assessment	± 10%	rectangular	1	± 5.8%
Total SAR Evaluation Uncertainty				**± 5.84%**
Extrapolation + boundary effect	± 3%	normal	1	± 3%
Probe positioning error	± 0.1mm	normal	1	± 1%
Integration and cube orientation	± 3%	normal	1	± 3%
Cube shape inaccuracies	± 2%	rectangular	1	± 1.2%
Total Spatial Peak SAR Evaluation Uncertainty				**± 4.52%**
Total Measurement Uncertainty				**± 10.09%**
Device positioning	± 6%	normal	1	± 6%
Phantom dimensions	± 7%	normal	1	± 7%
Laboratory set up	± 3%	normal	1	± 3%
Total Source Uncertainty				**± 9.70%**
Combined Uncertainty				**± 14.0%**
Expanded Uncertainty (k=2) 95.5%				**± 28.0%**

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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 Body configuration

Body SAR measurements were performed with the headset HDB-4 or HDK-1K connected. Antenna side of the phone was towards the phantom in order to achieve the highest SAR values. The results with 22 mm separation distance are listed in the tables below.

Accessory	AMPS 800			
	Channel	Low	Mid	High
	Channel #	991	383	799
	Conducted power (dBm)	23.5	24.7	24.4
HDB-4	Antenna retracted	0.477	0.481	0.553
	Antenna extended	0.381	0.361	0.444
HDK-1K	Antenna retracted	0.855	**0.965**	0.759
	Antenna extended	0.488	0.479	0.498

Accessory	CDMA 800			
	Channel	Low	Mid	High
	Channel #	1013	383	777
	Conducted power (dBm)	23.6	24.7	24.4
HDB-4	Antenna retracted	0.533	0.587	0.528
	Antenna extended	0.385	0.389	0.468
HDK-1K	Antenna retracted	0.882	0.951	0.792
	Antenna extended	0.466	0.468	0.526

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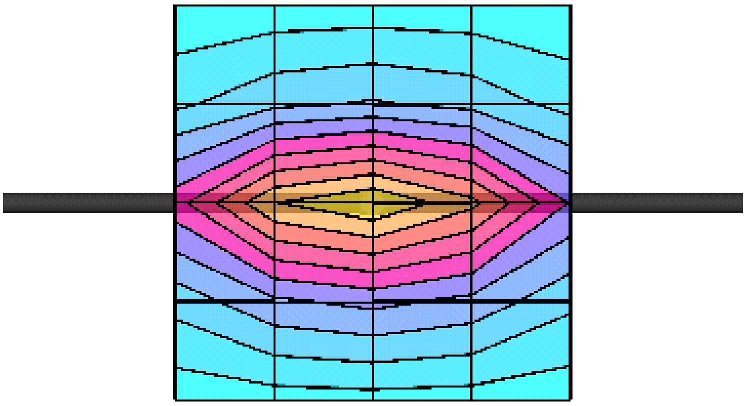
APPENDIX A.

Validation Test Printouts

Dipole 900 MHz

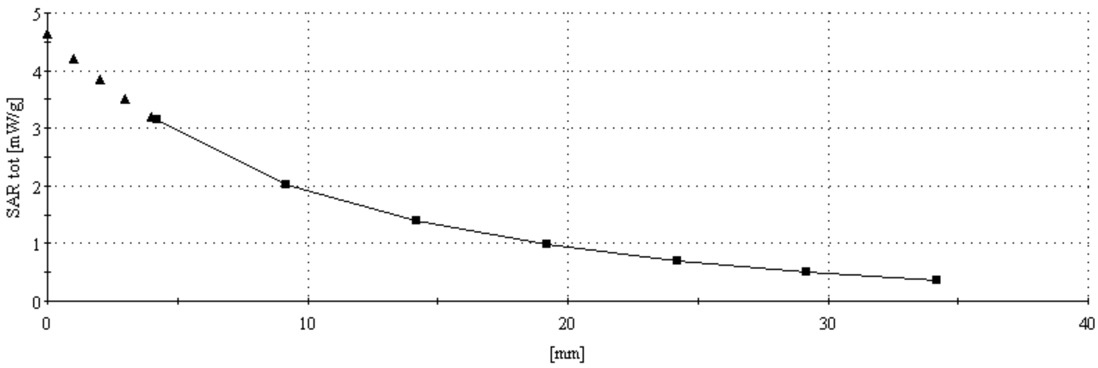
2003-02-11
t(liq.)=21.5°C
SAM 2; Flat
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body900 MHz: σ = 1.01 mho/m ε_r = 55.7 ρ = 1.00 g/cm^3
Cubes (2): Peak: 4.83 mW/g ± 0.08 dB, SAR (1g): 3.06 mW/g ± 0.10 dB, SAR (10g): 1.96 mW/g ± 0.12 dB, (Worst-case extrapolation)
Penetration depth: 12.4 (11.2, 14.1) [mm]
Powerdrift: -0.04 dB



Z-AXIS PLOT OF THE MAXIMUM POINT OF THE VALIDATION MEASUREMENT ON 900 MHz

2003-02-11

SAM 2 Phantom; Section; Position: ; Frequency: 900 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body900 MHz: σ = 1.01 mho/m ε_r = 55.7 ρ = 1.00 g/cm^3
:, ()
Z-Axis: Dx = 0.0, Dy = 0.0, Dz = 5.0



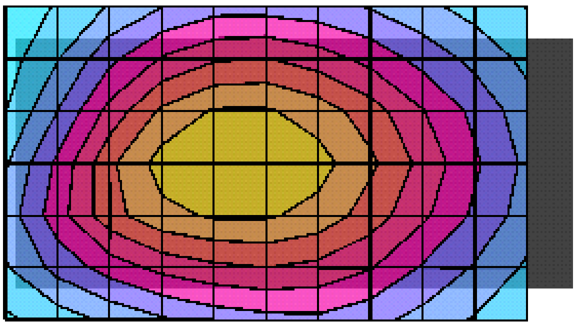
APPENDIX B.

SAR Distribution Printouts

QMNRH-17 WITH HDB-4, ANTENNA RETRACTED, BODY POSITION, AMPS 800

2003-02-11
t(liq.)=20.7°C

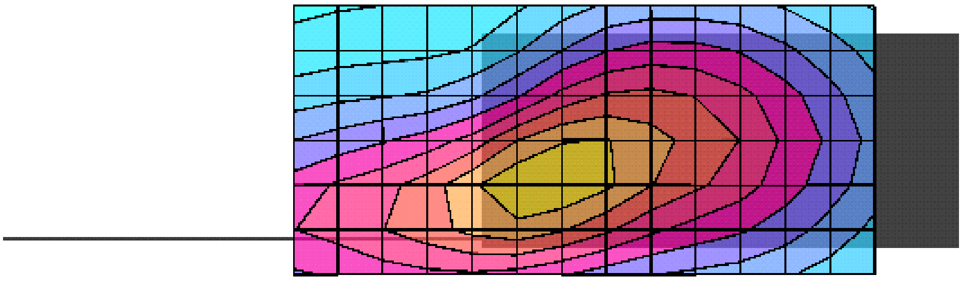
SAM 2 Phantom; Flat Section; Body Position; Frequency: 848 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body 836MHz: σ = 0.95 mho/m ε_r = 56.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.553 mW/g, SAR (10g): 0.401 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Powerdrift: -0.01 dB



QMNRH-17 WITH HDB-4, ANTENNA EXTENDED, BODY POSITION, AMPS 800

2003-02-11
t(liq.)=20.5°C

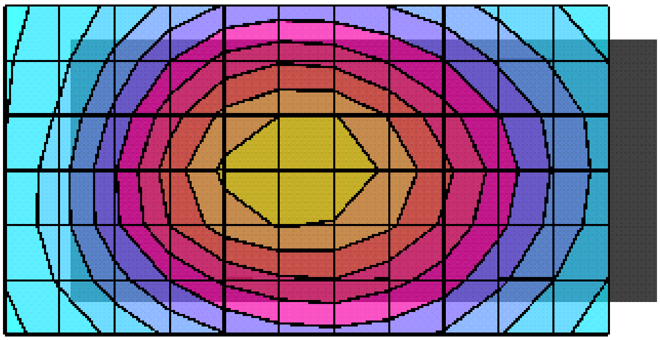
SAM 2 Phantom; Flat Section; Body Position; Frequency: 848 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body 836MHz: σ = 0.95 mho/m ε_r = 56.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.444 mW/g, SAR (10g): 0.307 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Powerdrift: 0.01 dB



QMNRH-17 WITH HDK-1K, ANTENNA RETRACTED, BODY POSITION, AMPS 800

2003-02-11
t(liq.)=21.2°C

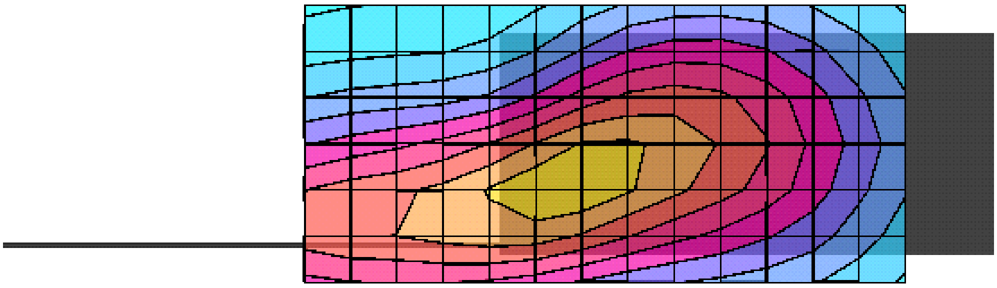
SAM 2 Phantom; Flat Section; Body Position; Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body 836MHz: σ = 0.95 mho/m ε_r = 56.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.965 mW/g, SAR (10g): 0.700 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Powerdrift: 0.01 dB



QMNRH-17 WITH HDK-1K, ANTENNA EXTENDED, BODY POSITION, AMPS 800

2003-02-11
t(liq.)=20.5°C

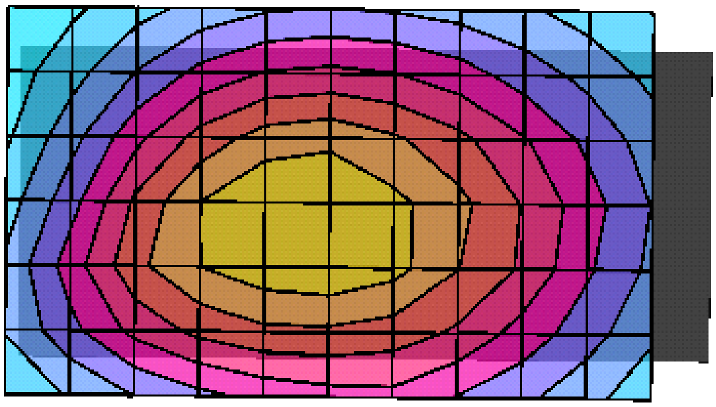
SAM 2 Phantom; Flat Section; Body Position; Frequency: 848 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body 836MHz: σ = 0.95 mho/m ε_r = 56.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.498 mW/g, SAR (10g): 0.344 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Powerdrift: 0.03 dB



QMNRH-17 WITH HDB-4, ANTENNA RETRACTED, BODY POSITION, CDMA 800

2003-02-11
t(liq.)=20.6°C

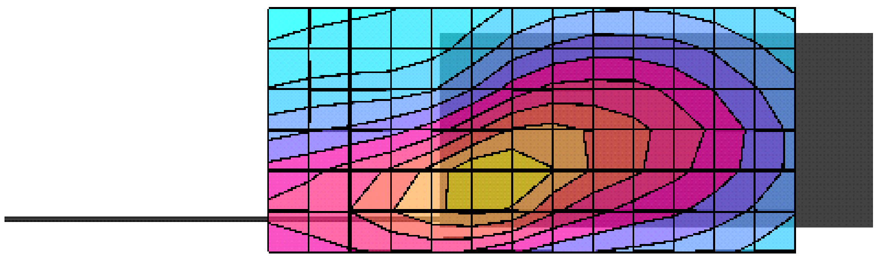
SAM 2 Phantom; Flat Section; Body Position; Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body 836MHz: σ = 0.95 mho/m ε_r = 56.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.587 mW/g, SAR (10g): 0.425 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Powerdrift: 0.01 dB



QMNRH-17 WITH HDB-4, ANTENNA EXTENDED, BODY POSITION, CDMA 800

2003-02-11
t(liq.)=20.3°C

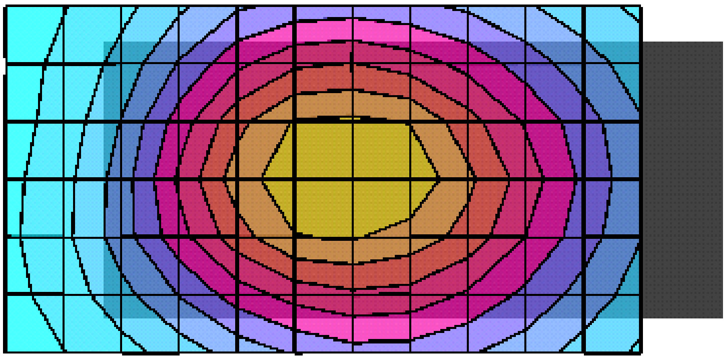
SAM 2 Phantom; Flat Section; Body Position; Frequency: 849 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body 849MHz: σ = 0.95 mho/m ε_r = 56.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.468 mW/g, SAR (10g): 0.317 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Powerdrift: 0.03 dB



QMNRH-17 WITH HDK-1K, ANTENNA RETRACTED, BODY POSITION, CDMA 800

2003-02-11
t(liq.)=21.4°C

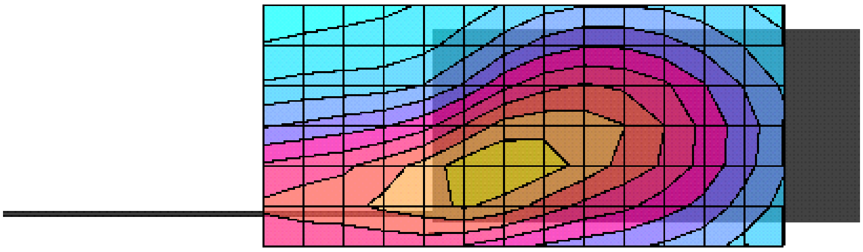
SAM 2 Phantom; Flat Section; Body Position; Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body 836MHz: σ = 0.95 mho/m ε_r = 56.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.951 mW/g, SAR (10g): 0.682 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Powerdrift: 0.03 dB



QMNRH-17 WITH HDK-1K, ANTENNA EXTENDED, BODY POSITION, CDMA 800

2003-02-11
t(liq.)=20.4°C

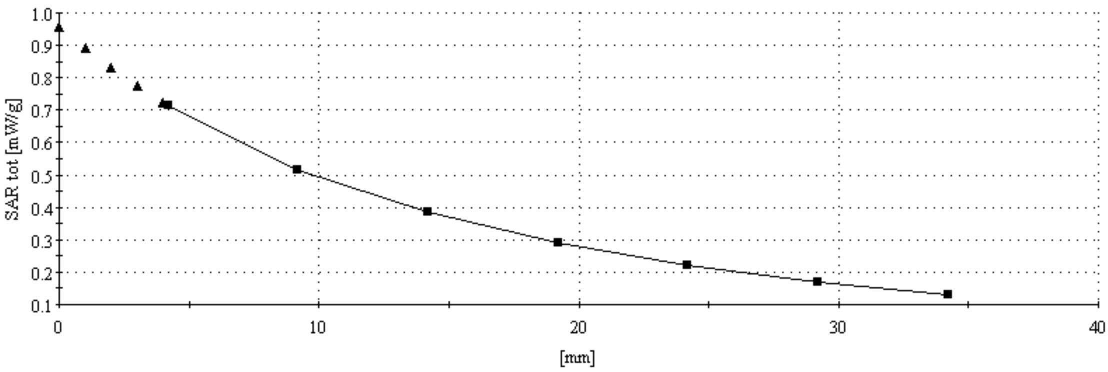
SAM 2 Phantom; Flat Section; Position: (270°,90°); Frequency: 849 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body 849MHz: σ = 0.95 mho/m ε_r = 56.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.526 mW/g, SAR (10g): 0.362 mW/g, (Worst-case extrapolation)
Coarse: Dx = 10.0, Dy = 10.0, Dz = 10.0
Powerdrift: 0.01 dB



Z-PLOT OF THE MAXIMUM BODY RESULT

2003-02-11

SAM 2 Phantom; Flat Section; Body Position; Frequency: 836 MHz
Probe: ET3DV6 - SN1396; ConvF(6.60,6.60,6.60); Crest factor: 1.0; Body 836MHz: σ = 0.95 mho/m ε_r = 56.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.965 mW/g, SAR (10g): 0.700 mW/g, (Worst-case extrapolation)
Cube 5x5x7: Dx = 8.0, Dy = 8.0, Dz = 5.0



APPENDIX C.
Calibration Certificates

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.

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!)

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

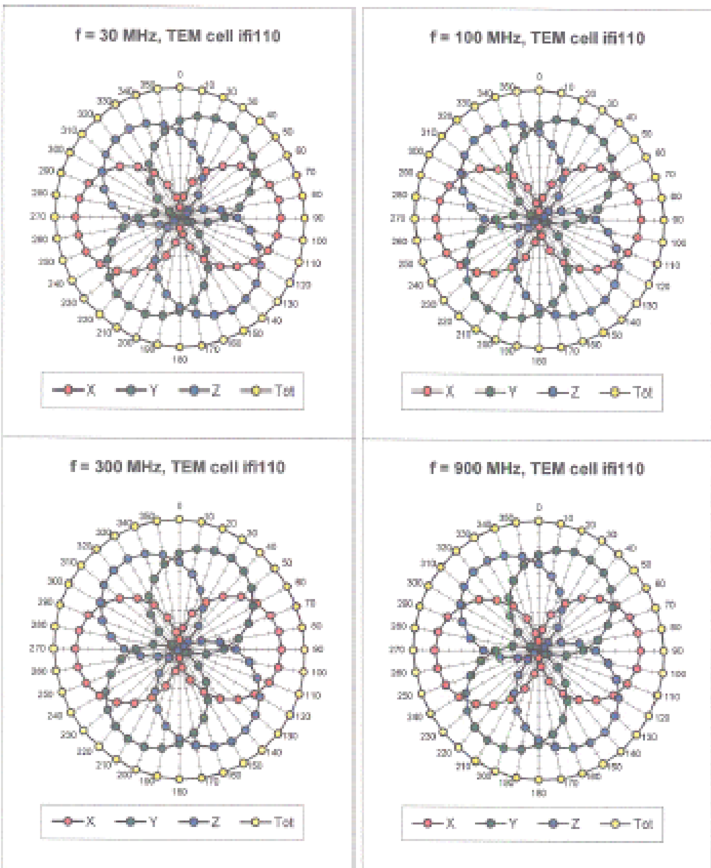
Head 1800 MHz **Typical SAR gradient: 10 % per mm**

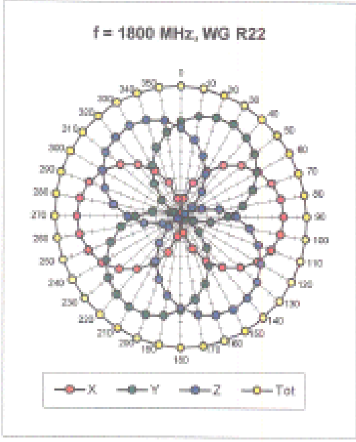
Probe Tip to Boundary	1 mm	2 mm
SAR_{be} [%] Without Correction Algorithm	13.1	8.9
SAR_{be} [%] With Correction Algorithm	0.2	0.1

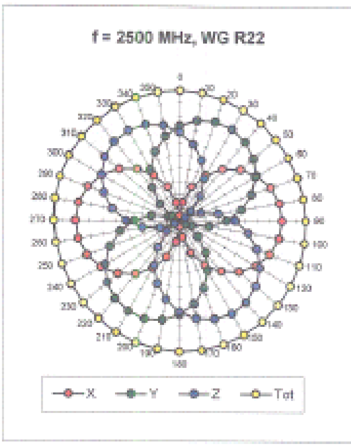
Sensor Offset

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

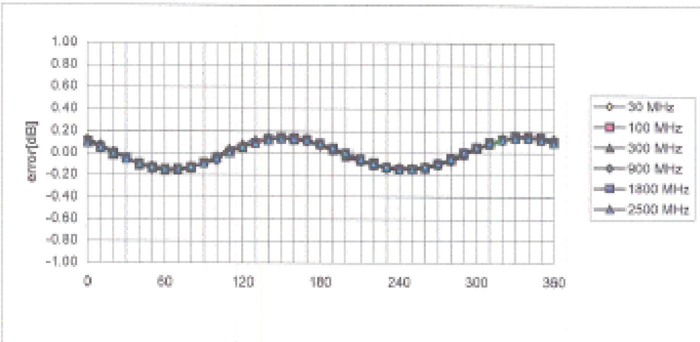
Receiving Pattern (ϕ), $\theta = 0°$





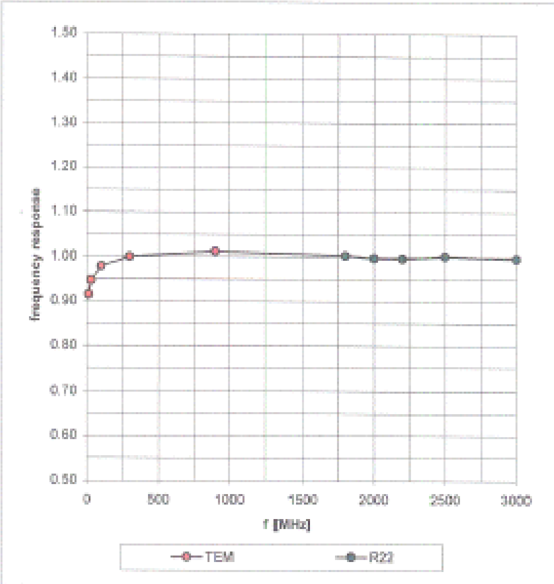


Isotropy Error (ϕ), θ = 0°



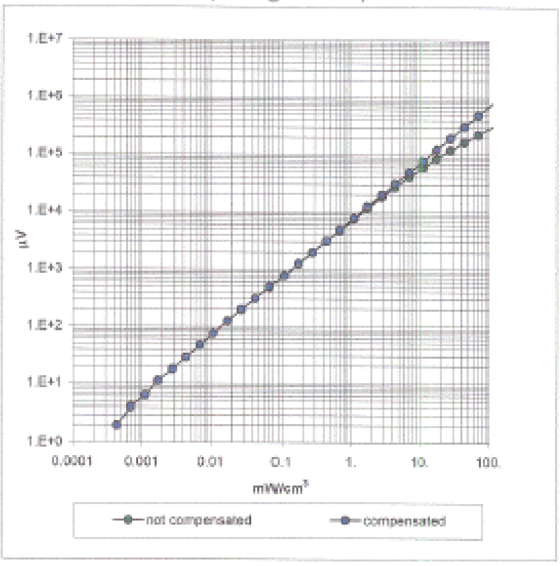
Frequency Response of E-Field

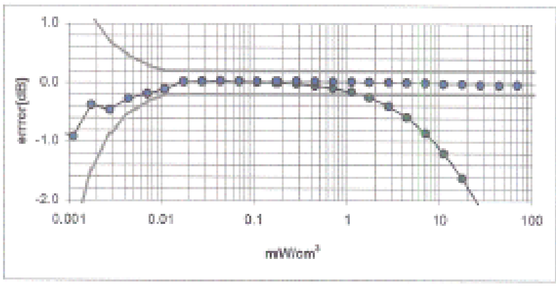
(TEM-Cell:ifi110, Waveguide R22)



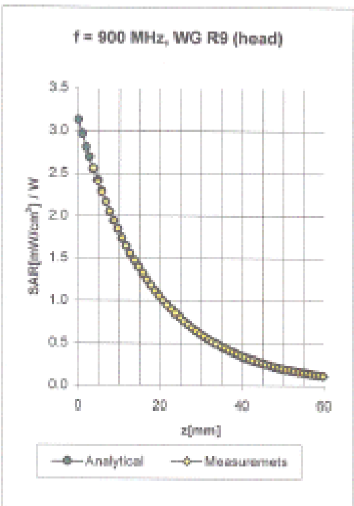
Dynamic Range f(SAR_{brain})

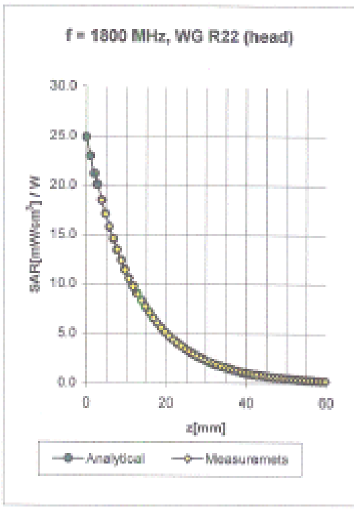
(Waveguide R22)





Conversion Factor Assessment

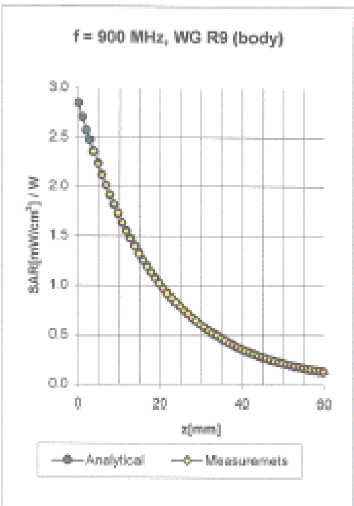


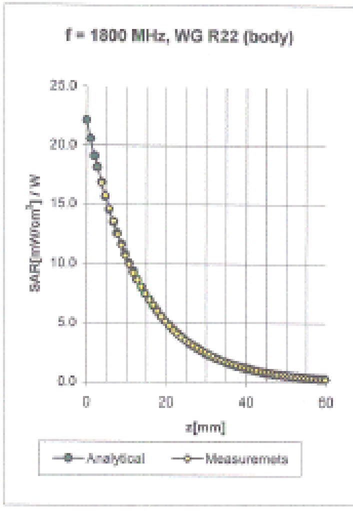


Head	900 MHz	ε_r = 41.5 ± 5%		σ = 0.97 ± 5% mho/m	
Head	835 MHz	ε_r = 41.5 ± 5%		σ = 0.90 ± 5% mho/m	
	ConvF X	6.9	± 9.5% (k=2)	Boundary effect:	
	ConvF Y	6.9	± 9.5% (k=2)	Alpha	0.35
	ConvF Z	6.9	± 9.5% (k=2)	Depth	2.53

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

Conversion Factor Assessment



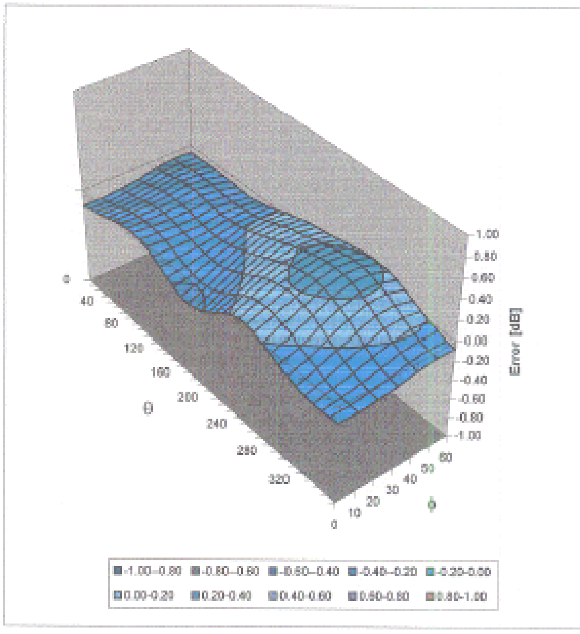


Body	900 MHz	ε_r = 55.0 ± 5%		σ = 1.05 ± 5% mho/m	
Body	835 MHz	ε_r = 55.2 ± 5%		σ = 0.97 ± 5% mho/m	
	ConvF X	6.6	± 9.5% (k=2)	Boundary effect:	
	ConvF Y	6.6	± 9.5% (k=2)	Alpha	0.36
	ConvF Z	6.6	± 9.5% (k=2)	Depth	2.57

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

Deviation from Isotropy in HSL

Error (θ,ϕ), f = 900 MHz



Schmid & Partner
Engineering AG

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

Calibration Certificate

900 MHz System Validation Dipole

Type:	**D900V2**
Serial Number:	**056**
Place of Calibration:	**Zurich**
Date of Calibration:	**January 29, 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:	N. Kuster E. Meriano
Approved by:	Alexis Katja

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: D900V2

Serial: 056

Manufactured: September 25, 1999
Calibrated: January 29, 2002

1. Measurement Conditions

The measurements were performed in the flat section of the new generic twin phantom filled with head simulating solution of the following electrical parameters at 900 MHz:

Relative Dielectricity	**41.1**	± 5%
Conductivity	**0.95 mho/m**	± 5%

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.48 at 900 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 15mm 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. SAR Measurement

Standard SAR-measurements were performed with the phantom according to the measurement conditions described in section 1. The results have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

averaged over 1 cm^3 (1 g) of tissue:	**11.1 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**7.00 mW/g**

Note: If the liquid parameters for validation are slightly different from the ones used for initial calibration, the SAR-values will be different as well.

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:	**1.348 ns**	(one direction)
Transmission factor:	**0.986**	(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 900 MHz:	Re{Z} = **50.2 Ω**
	Im {Z} = **-0.7 Ω**
Return Loss at 900 MHz	**-42.9 dB**

4. Measurement Conditions

The measurements were performed in the flat section of the new generic twin phantom filled with body simulating solution of the following electrical parameters at 900 MHz:

Relative Dielectricity	**54.8**	± 5%
Conductivity	**1.03 mho/m**	± 5%

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.17 at 900 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 15mm 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.

5. SAR Measurement

Standard SAR-measurements were performed with the phantom according to the measurement conditions described in section 4. The results have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

averaged over 1 cm^3 (1 g) of tissue:	**11.7 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**7.44 mW/g**

6. Dipole Impedance and Return Loss

The dipole was positioned at the flat phantom sections according to section 4 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 900 MHz:	Re{Z} = **45.7 Ω**
	Im {Z} = **-2.4 Ω**
Return Loss at 900 MHz	**-25.7 dB**

7. 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.

8. 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.

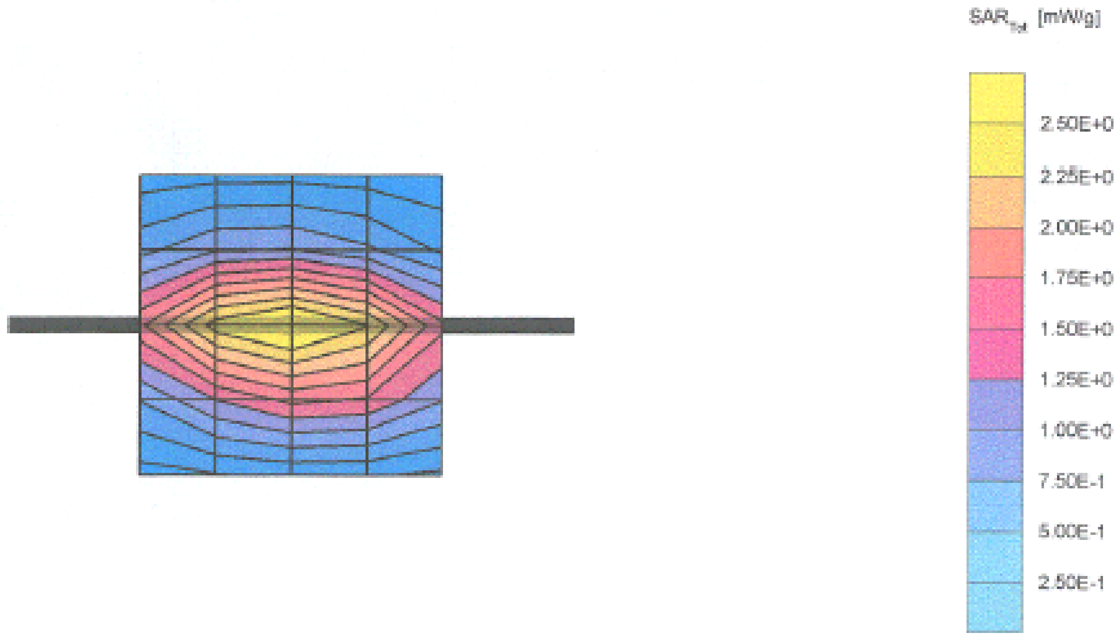
9. Power Test

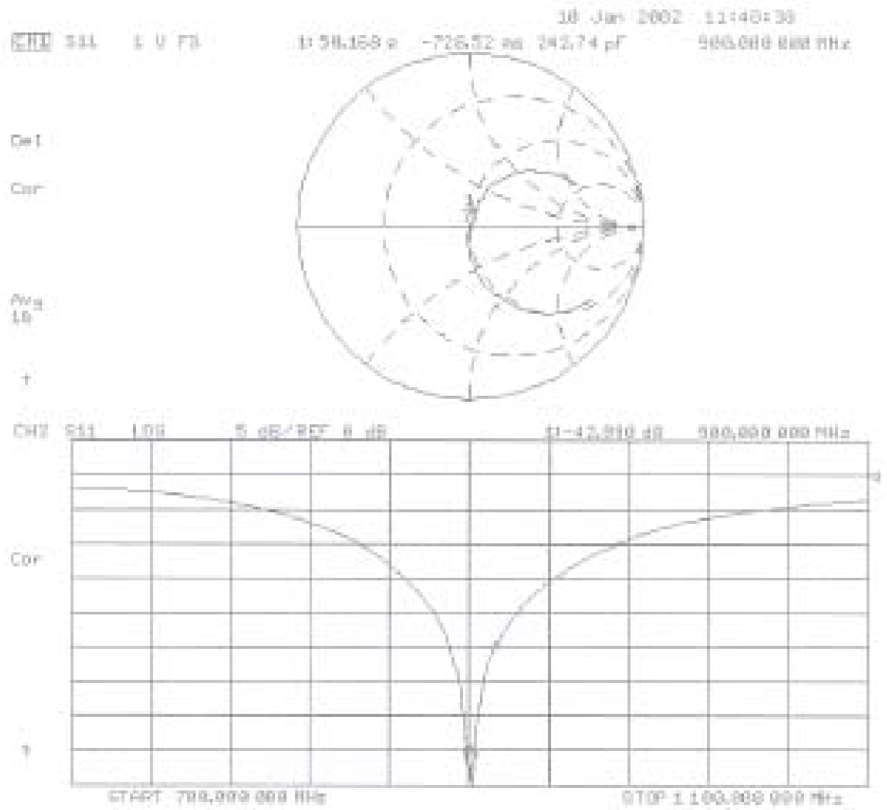
After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

01/28/02

Validation Dipole D900V2 SN:056, d = 15 mm

Frequency: 900 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(6.48,6.48,6.48) at 900 MHz; IEEE1528 900 MHz; σ = 0.95 mho/m ε_r = 41.1 ρ = 1.00 g/cm³
Cubes (2): Peak: 4.48 mW/g ± 0.01 dB, SAR (1g): 2.78 mW/g ± 0.02 dB, SAR (10g): 1.75 mW/g ± 0.02 dB, (Worst-case extrapolation)
Penetration depth: 11.5 (10.3, 13.0) [mm]
Powerdrift: -0.02 dB

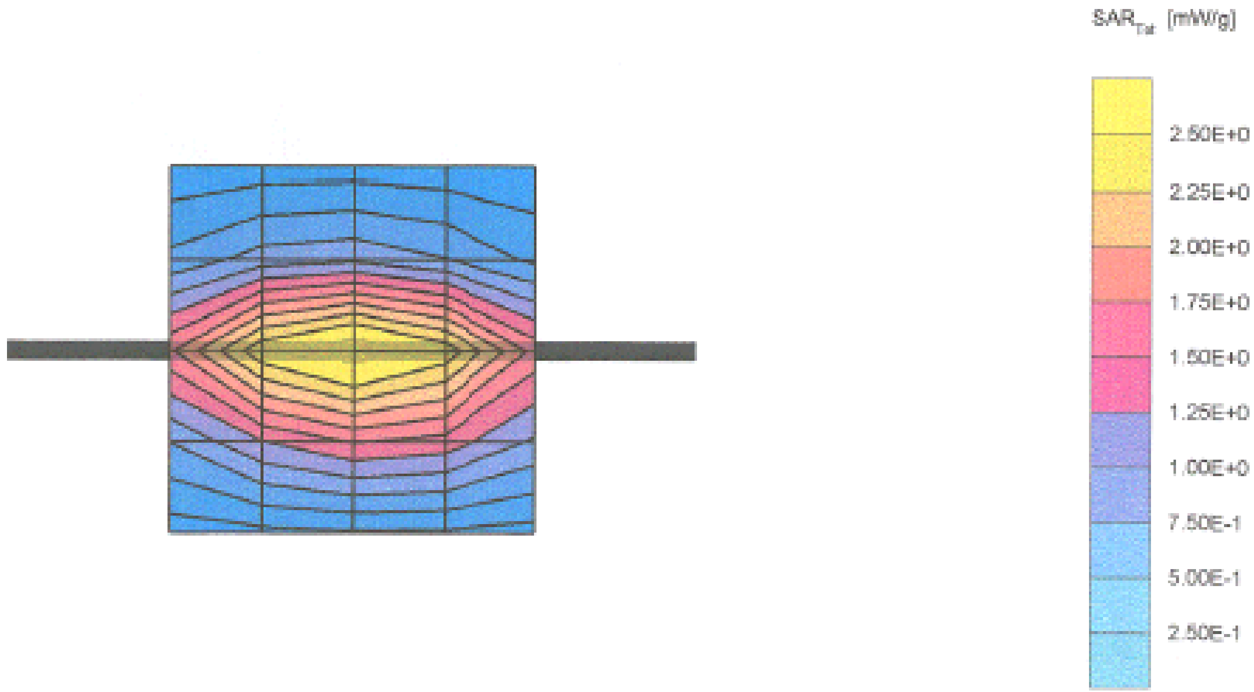


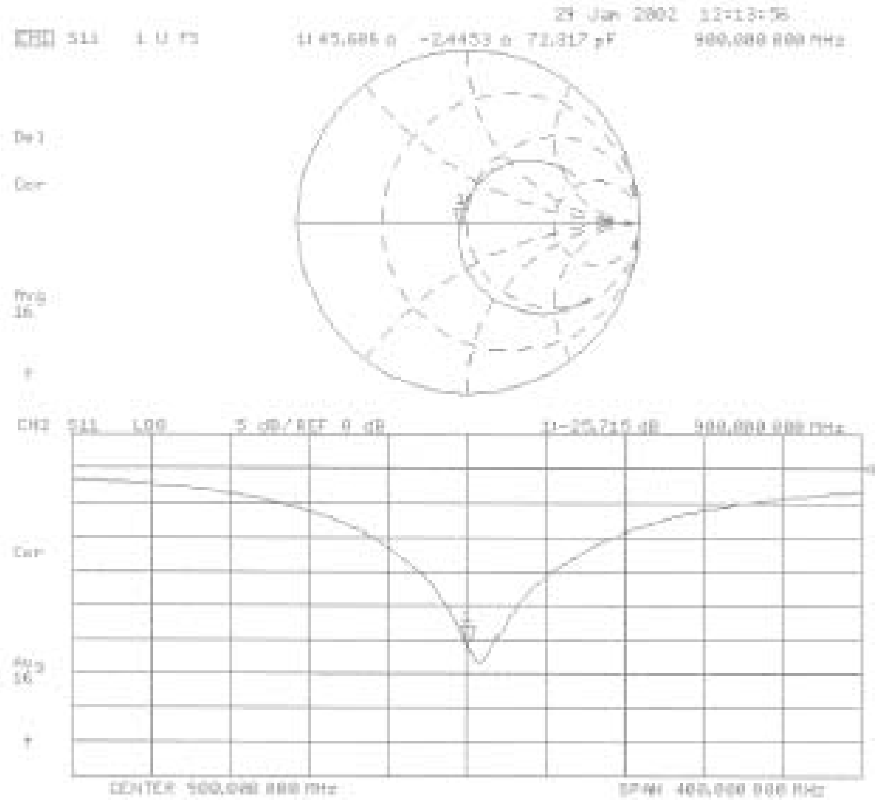

18 Jan 2002
CH1 S11
Del
Cor
Avg
16
CH2 S11 LOG
5 dB/ REF 0 dB
Cor
START 700.000 000 MHz
STOP 1 100.000 000 MHz

01/29/02

Validation Dipole D900V2 SN:056, d = 15 mm

Frequency: 900 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(6.17,6.17,6.17) at 900 MHz; Muscle 900 MHz; σ = 1.03 mho/m ϵ_r = 54.8 ρ = 1.00 g/cm^3
Cubes (2): Peak: 4.65 mW/g ± 0.01 dB, SAR (1g): 2.92 mW/g ± 0.00 dB, SAR (10g): 1.86 mW/g ± 0.01 dB, (Worst-case extrapolation)
Penetration depth: 12.0 (10.7, 13.7) [mm]
Powerdrift: -0.02 dB





29 Jan 2002 12:13:56
CH1 S11 1 U FS
1: 45.686 Ω -2.4453 Ω 72.317 pF
900.000 000 MHz
Del
Cor
Avg
16
CH2 S11 LOG 5 dB/REF 0 dB
1:-25.715 dB
900.000 000 MHz
Cor
Avg
16
CENTER 900.000 000 MHz
SPAN 400.000 000 MHz