TCC
Oulu

T213 (EN ISO/IEC 17025)

SAR Compliance Test Report

Test report no.:	Oulu_SAR0409_02	**Date of report:**	11.03.2004
Template version:	2.0	**Number of pages:**	35
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Responsible test engineer:	Kai Niskala	**Product contact person:**	Jorma Hanni
Measurements made by:	Kai Niskala		
Tested devices:	NPL-5		
FCC ID (USA):	LJPNPL-5	**Industry Canada ID:**	661E-NPL5
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 1528-2003
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

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

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: 11.03.2004

For the contents:

Kai Niskala, Test Engineer

CONTENTS

1. SUMMARY OF SAR TEST REPORT

1.1 Test Details

Period of test	2004-02-16,17, 2004-03-03
SN, HW and SW numbers of tested device	SN: 004400/20/162857/3, HW: 1201, SW: 1.14, DUT#:0072
Batteries used in testing	BL-5B DUT#'s: 0073,0074,0075,0076
Headsets used in testing	HS-5 DUT#: 0045, HS-8 DUT#: 0081
Other accessories used in testing	CC-197D Active Cover: HW: 2.0, SW: 1.1, DUT#: 0077 CC-70D Active Cover: HW: 4.1, SW: MCU 2.07 GPS 2.3.2, DUT#: 0096
State of sample	prototype unit
Notes	Active covers are identical in size and shape, only photos of device with CC-197D are included.

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)	EIRP	Position	SAR limit (1g avg)	Measured SAR value (1g avg)	Result
2-slot GPRS1900	512/1850.2	28.5 dBm	Right Cheek	1.6 W/kg	0.47 W/kg	PASSED

1.2.2 Body Worn Configuration

Mode	Ch / *f* (MHz)	EIRP	Separation distance	SAR limit (1g avg)	Measured SAR value (1g avg)	Result
2-slot GPRS1900	512/1850.2	28.5 dBm	1.5 cm	1.6 W/kg	1.21 W/kg	PASSED

1.2.3 Maximum Drift

Maximum drift during measurements	-0.20 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		
Modes and Bands of Operation	GSM 1900	GPRS 1900	EGPRS(EDGE) 1900
Modulation Mode	GMSK	GMSK	8PSK
Duty Cycle	1/8	1/8 or 2/8	1/8 or 2/8
Transmitter Frequency Range (MHz)	1850.2 - 1909.8	1850.2 - 1909.8	1850.2 - 1909.8

Outside of USA and Canada, the transmitter of tested device is capable of operating also in GSM900 and GSM1800, which are not part of this filing.
EGPRS mode was not measured, because maximum averaged output power is at least 3 dB lower in EGPRS mode than in GPRS mode.
This device has Push-to-Talk/Voice-over-IP capability for use at the ear. Therefore, SAR for 2-slot GPRS mode was also evaluated against the head profile of the phantom.

2.1 Picture of Device

NPL-5

NPL-5 with CC-197D

2.2 Description of the Antenna

The device has an internal patch antenna.

3. TEST CONDITIONS

3.1 Temperature and Humidity

Ambient temperature (°C):	21.0 to 23.5
Ambient humidity (RH %):	25 to 50

3.2 Test Signal, Frequencies, and Output Power

The device was put into operation by using control software.
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.

The power output was measured by a separate accredited test laboratory on the same unit as used for SAR testing.

4. DESCRIPTION OF THE TEST EQUIPMENT

4.1 Measurement system and components

The measurements were performed using an automated near-field scanning system, DASY 4 software version 4.1, 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 interval	Calibration expiry
DAE V1	538	12 months	04/04
E-field Probe ET3DV6	1766	12 months	04/04
Dipole Validation Kit, D1900V2	5d030	24 months	04/05

Additional test equipment used in testing:

Test Equipment	Model	Serial Number	Calibration interval	Calibration expiry
Signal Generator	HP 8657B	3630U08114	12 months	04/04
Amplifier	Amplifier Research 5S1G4	306024	-	-
Power Meter	R&S NRT	101143	12 months	03/04
Power Sensor	R&S NRT-Z43	100239	12 months	03/04
Thermometer	Fluke 52 II	82810048	12 months	05/04
Network Analyzer	HP 8753D	3410A08934	12 months	05/04
Dielectric Probe Kit	Agilent 85070D	US01440162	-	-

4.1.1 Isotropic E-field probe ET3DV6

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 certificate 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 1528-2003.

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 1528-2003 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 verifications and tests were carried out within 24 hours of measuring the dielectric parameters using dielectric probe kit and network analyser.

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:

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. A SAR measurement was made following the determination of the dielectric parameters of the liquids, using the dipole validation kit. The power level used by manufacturer in dipole calibration was supplied to the dipole antenna (see Appendix D). The antenna 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]
1900	Reference result	10.5	38.8	1.44	N/A
	± 10% window	9.5 - 11.6			
	2004-02-16	10.6	38.5	1.42	21.5
	2004-03-03	10.5	38.2	1.43	21.6

System verification, body tissue simulant

f [MHz]	Description	SAR [W/kg], 1g	Dielectric Parameters ε_r	Dielectric Parameters σ [S/m]	Temp [°C]
1900	Reference result	10.7	51.2	1.59	N/A
	± 10% window	9.6 - 11.8			
	2004-02-17	10.4	51.3	1.57	22.0

Plots of the Verification scans are given in Appendix A.

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]	
1880	Recommended value	40.0	1.40	N/A
	± 5% window	38.0 – 42.0	1.33 – 1.47	
	2004-02-16	38.6	1.41	22
	2004-03-03	38.3	1.41	22

Body tissue simulant measurements

f [MHz]	Description	Dielectric Parameters		Temp [°C]
		ε_r	σ [S/m]	
1880	Recommended value	53.3	1.52	N/A
	± 5% window	50.6 – 56.0	1.44 – 1.60	
	2004-02-17	51.3	1.55	22
	2004-03-03	52.1	1.54	22

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 1528-2003 "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”.

NPL-5 in “cheek” position

NPL-5 in “tilt” position

NPL-5 with CC-197D in “cheek” position

NPL-5 with CC-197D in “cheek” 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 gives higher results.

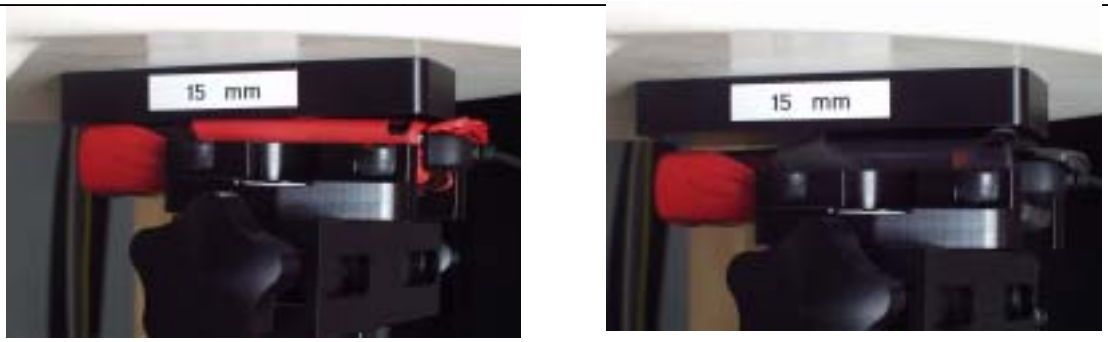


Photo of the device positioned for Body SAR measurement with normal cover and with CC-197D on the left and right, respectively. The spacer was removed for the tests.

5.3 Scan Procedures

First coarse scans were used for determination of the field distribution. Next a cube scan, 5x5x7 points covering a volume of 30x30x30mm, 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, extrapolation and maximum search routines within Dasy4 are all based on the modified Quadratic Shepard's method (Robert J. Renka, "Multivariate Interpolation Of Large Sets Of Scattered Data", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148).

The interpolation scheme combines a least-square fitted function method with a weighted average method. A trivariate 3-D / bivariate 2-D quadratic function is computed for each measurement point and fitted to neighbouring points by a least-square method. For the cube scan, inverse distance weighting is incorporated to fit distant points more accurately. The interpolating function is finally calculated as a weighted average of the quadratics.

In the cube scan, the interpolation function is used to extrapolate the Peak SAR from the deepest measurement points to the inner surface of the phantom.

6. MEASUREMENT UNCERTAINTY

Table 6.1 – Measurement uncertainty evaluation

Uncertainty Component	Section in IEEE 1528	Tol. (%)	Prob Dist	Div	c_i	$c_i \cdot u_i$ (%)	v_i
Measurement System							
Probe Calibration	E2.1	±4.8	N	1	1	±4.8	∞
Axial Isotropy	E2.2	±4.7	R	√3	$(1-c_p)^{1/2}$	±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**	187
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:

1900MHz Head SAR results

Mode and Band	Position		SAR, averaged over 1g (W/kg)		
			Ch 512 1850.2 MHz	Ch 661 1880.0 MHz	Ch 810 1909.8 MHz
2-slot GPRS1900	Power level		28.5 dBm	27.6 dBm	26.1 dBm
	Left	Cheek		0.31	
		Tilt		0.30	
	Right	Cheek	**0.47**	0.43	0.41
		Tilt		0.29	
	Right Cheek position with optional cover CC-1970		0.31	0.37	0.31
	Right Cheek position with optional cover CC-70D		0.34	0.33	0.33

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

1900MHz Body SAR results

Mode and Band	Body-worn location setup	SAR, averaged over 1g (W/kg)		
		Ch 512 1850.2 MHz	Ch 661 1880.0 MHz	Ch 810 1909.8 MHz
2-slot GPRS1900	Power level	28.5 dBm	27.6 dBm	26.1 dBm
	Headset HS-5	**1.21**	1.08	1.01
	Headset HS-8	0.98	0.92	0.99
	Optional cover CC-1970 with headset HS-5	0.75	0.74	0.67
	Optional cover CC-70D with headset HS-5	0.75	0.66	0.63

Plots of the Measurement scans are given in Appendix B.

APPENDIX A: VALIDATION SCANS

Date/Time: 02/16/04 10:23:51

Test Laboratory: TCC Oulu; 040-001709-EN

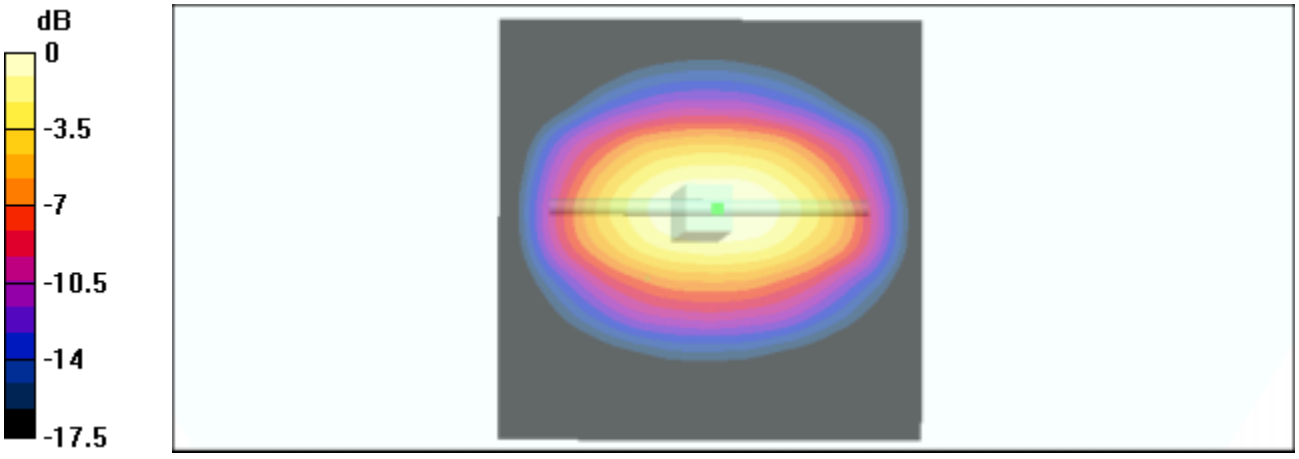
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d030

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: HSL1900 (σ = 1.42449 mho/m, ε_r = 38.4804, ρ = 1000 kg/m^3)
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(5.1, 5.1, 5.1); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

d=10mm, Pin=250mW, t=21.5 C/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 96.3 V/m
Power Drift = -0.005 dB
Maximum value of SAR = 12 mW/g

d=10mm, Pin=250mW, t=21.5 C/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 18.4 W/kg
SAR(1 g) = 10.6 mW/g; SAR(10 g) = 5.51 mW/g
Reference Value = 96.3 V/m
Power Drift = -0.005 dB
Maximum value of SAR = 11.7 mW/g



0 dB = 11.7mW/g

Date/Time: 03/03/04 09:34:01

Test Laboratory: TCC Oulu; 040-001709-EN

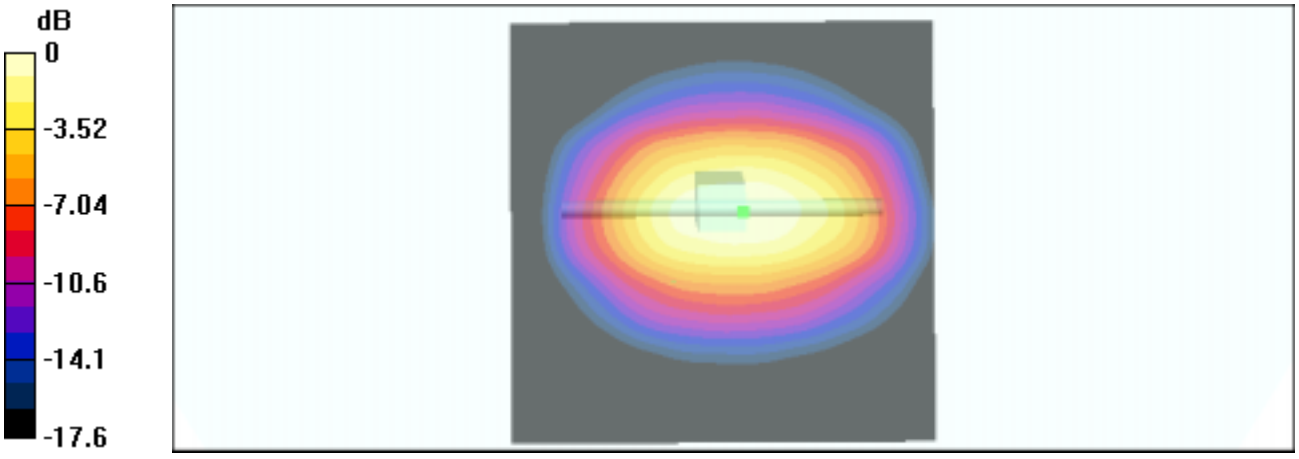
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d030

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: HSL1900 (σ = 1.42692 mho/m, ε_r = 38.1954, ρ = 1000 kg/m^3)
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(5.1, 5.1, 5.1); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

d=10mm, Pin=250mW, t=21.6 C/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 95.6 V/m
Power Drift = -0.02 dB
Maximum value of SAR = 12 mW/g

d=10mm, Pin=250mW, t=21.6 C/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 18.6 W/kg
SAR(1 g) = 10.5 mW/g; SAR(10 g) = 5.47 mW/g
Reference Value = 95.6 V/m
Power Drift = -0.02 dB
Maximum value of SAR = 11.8 mW/g



0 dB = 11.8mW/g

Date/Time: 02/17/04 10:42:39

Test Laboratory: TCC Oulu; 040-001709-EN

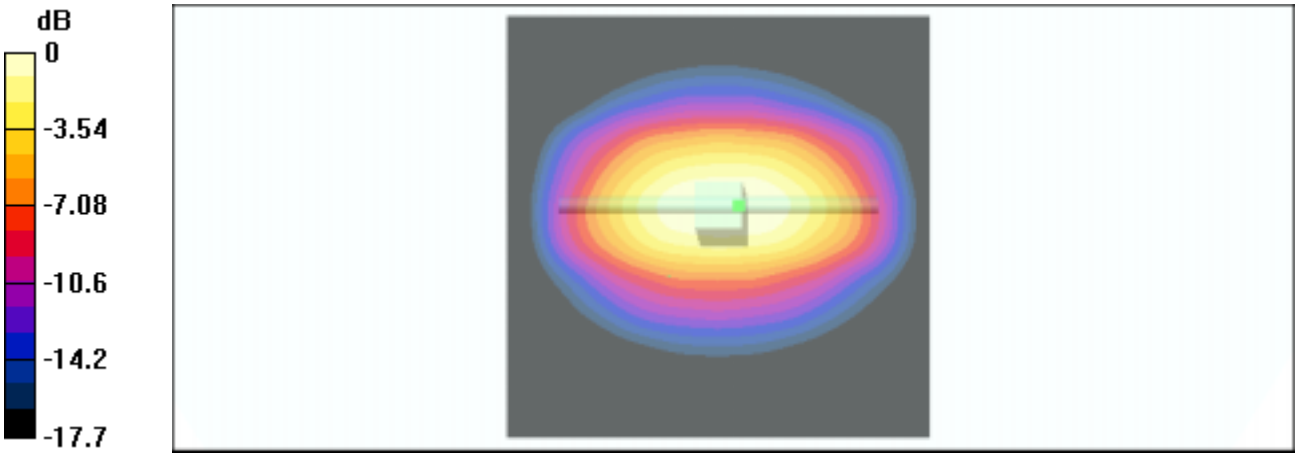
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d030

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: BSL1900 (σ = 1.56659 mho/m, ε_r = 51.2452, ρ = 1000 kg/m^3)
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(4.8, 4.8, 4.8); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

d=10mm, Pin=250mW, t=22.0 C/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 92.1 V/m
Power Drift = -0.03 dB
Maximum value of SAR = 12 mW/g

d=10mm, Pin=250mW, t=22.0 C/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 18.3 W/kg
SAR(1 g) = 10.4 mW/g; SAR(10 g) = 5.4 mW/g
Reference Value = 92.1 V/m
Power Drift = -0.03 dB
Maximum value of SAR = 11.6 mW/g



0 dB = 11.6mW/g

APPENDIX B: MEASUREMENT SCANS

Date/Time: 02/16/04 11:27:21

Test Laboratory: TCC Oulu; 040-001709-EN

DUT: NPL-5; Serial: 004400/20/162857/3

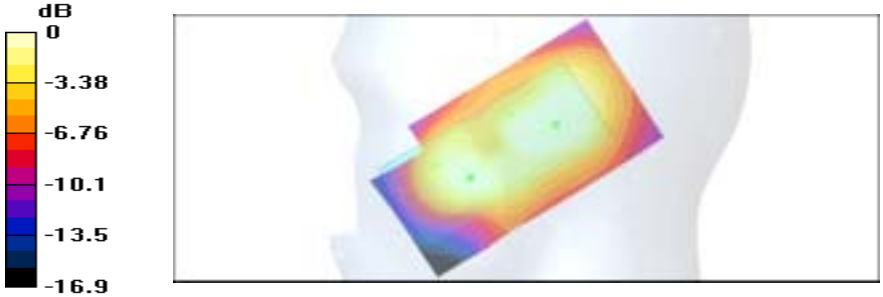
Communication System: GPRS 1900; Frequency: 1880 MHz;Duty Cycle: 1:4.2
Medium: HSL1900 (σ = 1.40618 mho/m, ε_r = 38.59, ρ = 1000 kg/m^3)
Phantom section: Left Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(5.1, 5.1, 5.1); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

Touch position - Middle, t=21.4 C, worst case extrapolation/Area Scan (51x91x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 14.3 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.342 mW/g

Touch position - Middle, t=21.4 C, worst case extrapolation/Zoom Scan (5x5x7) (5x5x7)/Cube 0 (upper): Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Peak SAR (extrapolated) = 0.556 W/kg
SAR(1 g) = 0.314 mW/g; SAR(10 g) = 0.186 mW/g
Reference Value = 14.3 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.331 mW/g

Touch position - Middle, t=21.4 C, worst case extrapolation/Zoom Scan (5x5x7) (5x5x7)/Cube 1 (lower): Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Peak SAR (extrapolated) = 0.54 W/kg
SAR(1 g) = 0.26 mW/g; SAR(10 g) = 0.147 mW/g
Reference Value = 14.3 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.273 mW/g



0 dB = 0.273mW/g

Date/Time: 02/16/04 11:27:21

Test Laboratory: TCC Oulu; 040-001709-EN

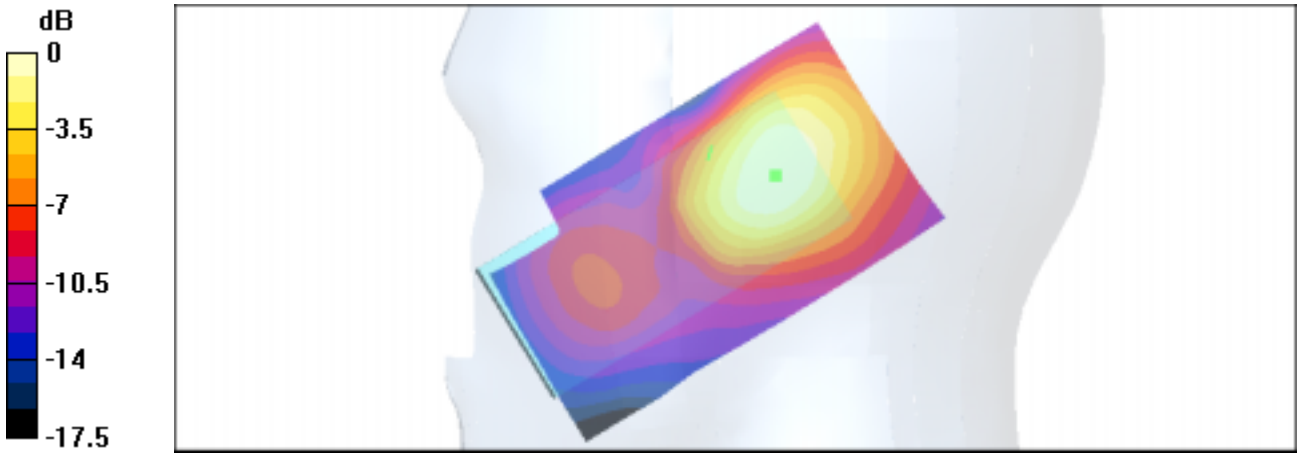
DUT: NPL-5; Serial: 004400/20/162857/3

Communication System: GPRS 1900; Frequency: 1880 MHz;Duty Cycle: 1:4.2
Medium: HSL1900 (σ = 1.40618 mho/m, ε_r = 38.59, ρ = 1000 kg/m^3)
Phantom section: Left Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(5.1, 5.1, 5.1); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

Tilt position - Middle, t=21.3 C, worst case extrapolation/Area Scan (51x91x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 14.5 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.323 mW/g

Tilt position - Middle, t=21.3 C, worst case extrapolation/Zoom Scan (5x5x7) (5x5x7)/Cube 0:
Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Peak SAR (extrapolated) = 0.54 W/kg
SAR(1 g) = 0.295 mW/g; SAR(10 g) = 0.17 mW/g
Reference Value = 14.5 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.308 mW/g



0 dB = 0.308mW/g

Date/Time: 02/16/04 13:24:15

Test Laboratory: TCC Oulu; 040-001709-EN

DUT: NPL-5; Serial: 004400/20/162857/3

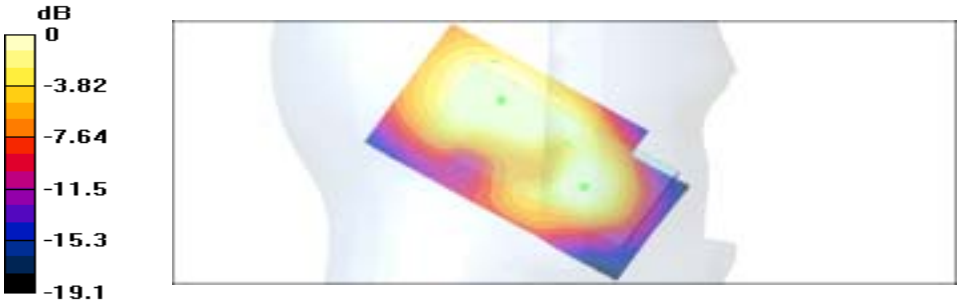
Communication System: GPRS 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:4.2
Medium: HSL1900 (σ = 1.37917 mho/m, ε_r = 38.7402, ρ = 1000 kg/m^3)
Phantom section: Right Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(5.1, 5.1, 5.1); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

Touch position - Low, t=21.3 C, worst case extrapolation/Area Scan (51x91x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 14.7 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.463 mW/g

Touch position - Low, t=21.3 C, worst case extrapolation/Zoom Scan (5x5x7) (5x5x7)/Cube 0 (upper): Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Peak SAR (extrapolated) = 0.958 W/kg
SAR(1 g) = 0.465 mW/g; SAR(10 g) = 0.249 mW/g
Reference Value = 14.7 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.496 mW/g

Touch position - Low, t=21.3 C, worst case extrapolation/Zoom Scan (5x5x7) (5x5x7)/Cube 1 (lower): Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Peak SAR (extrapolated) = 0.52 W/kg
SAR(1 g) = 0.286 mW/g; SAR(10 g) = 0.158 mW/g
Reference Value = 14.7 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.304 mW/g



0 dB = 0.304mW/g

Date/Time: 02/16/04 13:24:15

Test Laboratory: TCC Oulu; 040-001709-EN

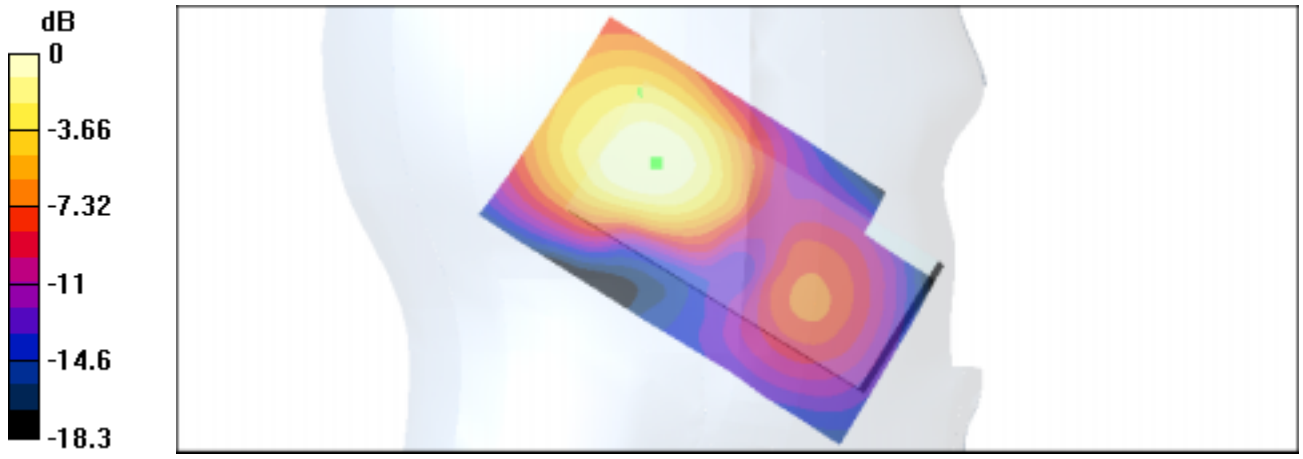
DUT: NPL-5; Serial: 004400/20/162857/3

Communication System: GPRS 1900; Frequency: 1880 MHz;Duty Cycle: 1:4.2
Medium: HSL1900 (σ = 1.40618 mho/m, ε_r = 38.59, ρ = 1000 kg/m^3)
Phantom section: Right Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(5.1, 5.1, 5.1); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

Tilt position - Middle, t=21.3 C, worst case extrapolation/Area Scan (51x91x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 14.4 V/m
Power Drift = -0.08 dB
Maximum value of SAR = 0.305 mW/g

Tilt position - Middle, t=21.3 C, worst case extrapolation/Zoom Scan (5x5x7) (5x5x7)/Cube 0:
Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Peak SAR (extrapolated) = 0.509 W/kg
SAR(1 g) = 0.287 mW/g; SAR(10 g) = 0.165 mW/g
Reference Value = 14.4 V/m
Power Drift = -0.08 dB
Maximum value of SAR = 0.298 mW/g



0 dB = 0.298mW/g

Date/Time: 02/17/04 15:24:34

Test Laboratory: TCC Oulu; 040-001709-EN

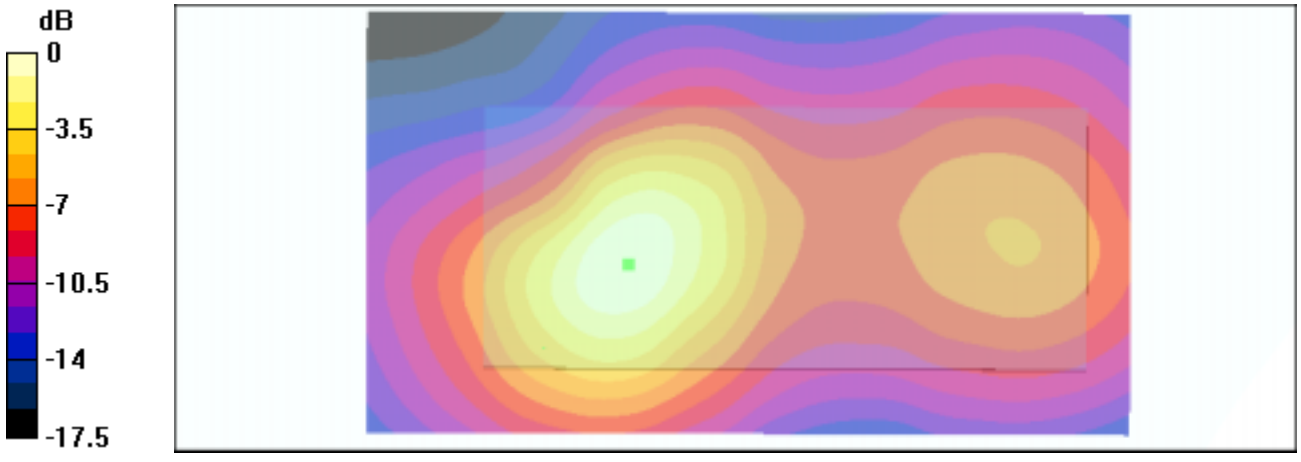
DUT: NPL-5; Serial: 004400/20/162857/3; Headset: HS-5

Communication System: GPRS 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:4.2
Medium: BSL1900 (σ = 1.51958 mho/m, ε_r = 51.4353, ρ = 1000 kg/m^3)
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(4.8, 4.8, 4.8); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

Body worn - Low, t=22.1 C, worst case extrapolation/Area Scan (51x91x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 17.9 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 1.3 mW/g

Body worn - Low, t=22.1 C, worst case extrapolation/Zoom Scan (5x5x7) (5x5x7)/Cube 0:
Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Peak SAR (extrapolated) = 2.49 W/kg
SAR(1 g) = 1.21 mW/g; SAR(10 g) = 0.629 mW/g
Reference Value = 17.9 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 1.28 mW/g



0 dB = 1.28mW/g

Date/Time: 02/16/04 13:24:15

Test Laboratory: TCC Oulu; 040-001709-EN

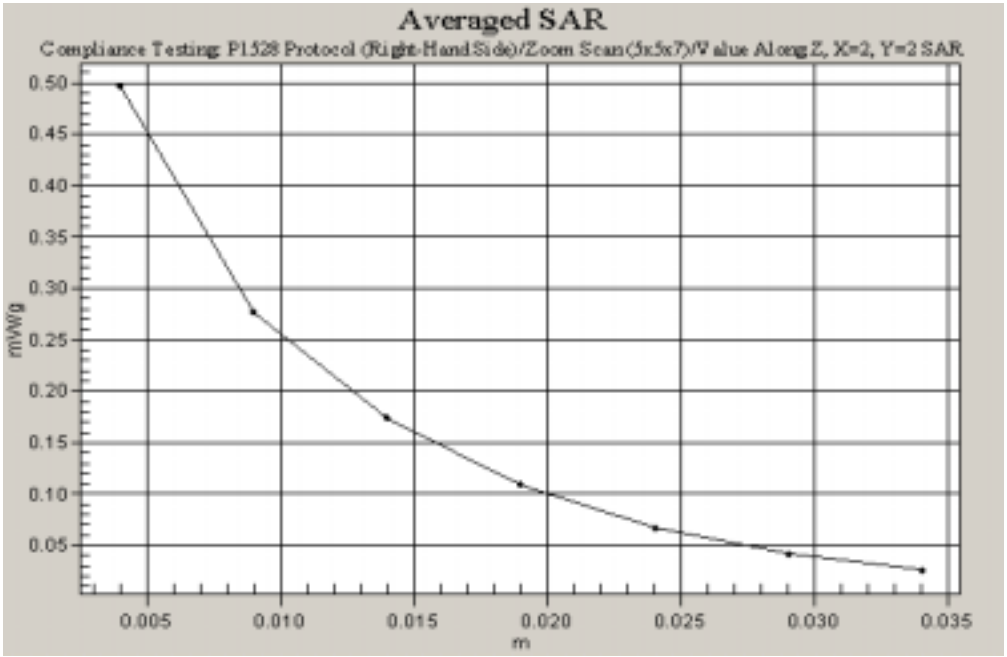
DUT: NPL-5; Serial: 004400/20/162857/3

Communication System: GPRS 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:4.2
Medium: HSL1900 (σ = 1.37917 mho/m, ε_r = 38.7402, ρ = 1000 kg/m^3)
Phantom section: Right Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(5.1, 5.1, 5.1); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

Touch position - Low, t=21.3 C, worst case extrapolation/Area Scan (51x91x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 14.7 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.463 mW/g

Touch position - Low, t=21.3 C, worst case extrapolation/Zoom Scan (5x5x7) (5x5x7)/Cube 0:
Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Peak SAR (extrapolated) = 0.958 W/kg
SAR(1 g) = 0.465 mW/g; SAR(10 g) = 0.249 mW/g
Reference Value = 14.7 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 0.496 mW/g



Date/Time: 02/17/04 15:24:34

Test Laboratory: TCC Oulu; 040-001709-EN

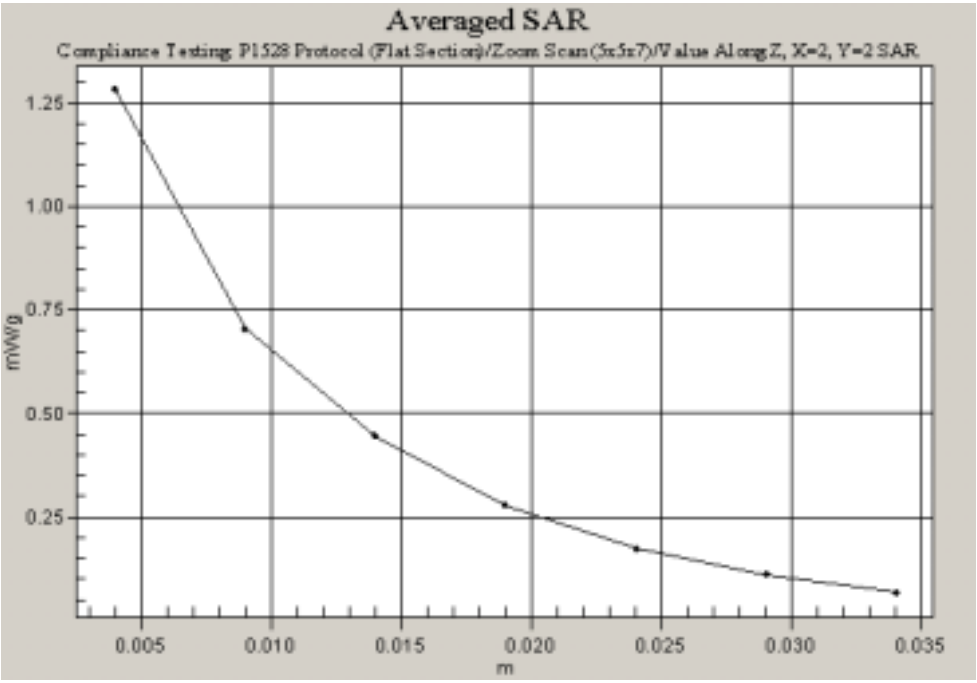
DUT: NPL-5; Serial: 004400/20/162857/3; Headset: HS-5

Communication System: GPRS 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:4.2
Medium: BSL1900 (σ = 1.51958 mho/m, ε_r = 51.4353, ρ = 1000 kg/m^3)
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1766; ConvF(4.8, 4.8, 4.8); Calibrated: 16.04.2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn538; Calibrated: 09.04.2003
- Phantom: SAM 3; Type: SAM 4.0; Serial: 1215
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

Body worn - Low, t=22.1 C, worst case extrapolation/Area Scan (51x91x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 17.9 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 1.3 mW/g

Body worn - Low, t=22.1 C, worst case extrapolation/Zoom Scan (5x5x7) (5x5x7)/Cube 0:
Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Peak SAR (extrapolated) = 2.49 W/kg
SAR(1 g) = 1.21 mW/g; SAR(10 g) = 0.629 mW/g
Reference Value = 17.9 V/m
Power Drift = -0.1 dB
Maximum value of SAR = 1.28 mW/g



APPENDIX C: PROBE CALIBRATION REPORT(S)

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

Client **Nokia Oyj, Oulu**

CALIBRATION CERTIFICATE

Object(s)	ET3DV6 - SN:1766
Calibration procedure(s)	QA CAL-01.v2 Calibration procedure for dosimetric E-field probes
Calibration date:	April 16, 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	2-Apr-03	Apr-04
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: April 17, 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.

DASY - Parameters of Probe: ET3DV6 SN:1766

Sensitivity in Free Space

Diode Compression

NormX	**1.89** $\mu V/(V/m)^2$	DCP X	**93**	mV
NormY	**1.65** $\mu V/(V/m)^2$	DCP Y	**93**	mV
NormZ	**1.80** $\mu V/(V/m)^2$	DCP Z	**93**	mV

Sensitivity in Tissue Simulating Liquid

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

Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**6.6** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.6** ± 9.5% (k=2)	Alpha	**0.48**
ConvF Z	**6.6** ± 9.5% (k=2)	Depth	**2.07**

Head **1880 MHz** ε_r **= 40.0 ± 5%** σ **= 1.40 ± 5% mho/m**

Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	**5.1** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.1** ± 9.5% (k=2)	Alpha	**0.56**
ConvF Z	**5.1** ± 9.5% (k=2)	Depth	**2.47**

Boundary Effect

Head **835 MHz** **Typical SAR gradient: 5 % per mm**

Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	9.0	4.8
SAR_{be} [%]	With Correction Algorithm	0.2	0.4

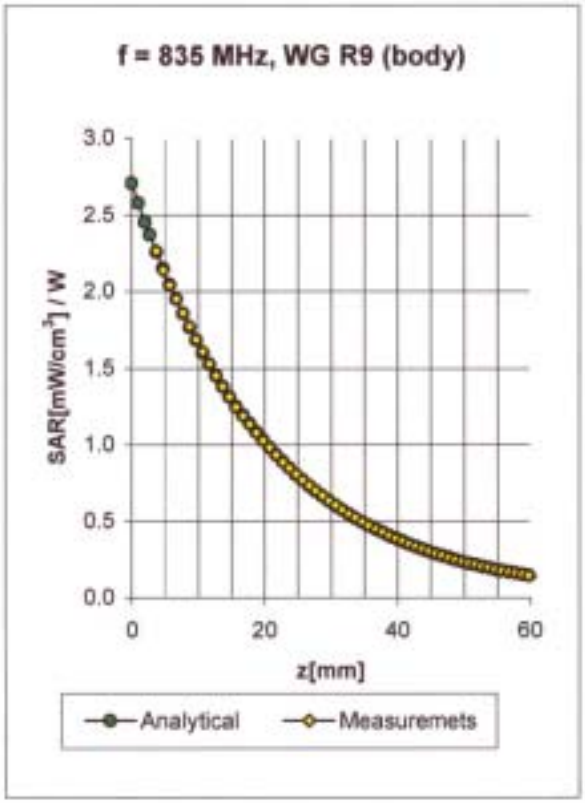
Head **1880 MHz** **Typical SAR gradient: 10 % per mm**

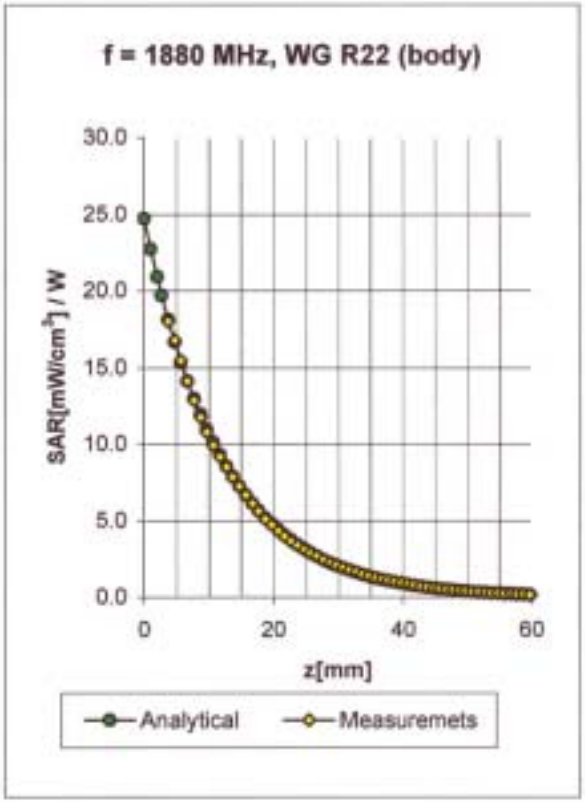
Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	14.0	9.3
SAR_{be} [%]	With Correction Algorithm	0.2	0.2

Sensor Offset

Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.3 ± 0.2**	mm

Conversion Factor Assessment





Body **835 MHz** ε_r = 55.2 ± 5% σ = 0.97 ± 5% mho/m

Valid for f=800-1000 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	**6.4** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.4** ± 9.5% (k=2)	Alpha	**0.44**
ConvF Z	**6.4** ± 9.5% (k=2)	Depth	**2.26**

Body **1880 MHz** ε_r = 53.3 ± 5% σ = 1.52 ± 5% mho/m

Valid for f=1710-1910 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	**4.8** ± 9.5% (k=2)	Boundary effect:	
ConvF Y	**4.8** ± 9.5% (k=2)	Alpha	**0.62**
ConvF Z	**4.8** ± 9.5% (k=2)	Depth	**2.46**

APPENDIX D: DIPOLE VALIDATION KIT REPORT(S)

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

Client **Nokia Oyj, Oulu**

CALIBRATION CERTIFICATE

Object(s)	D1900V2 - SN:5d030
Calibration procedure(s)	QA CAL-05.v2 Calibration procedure for dipole validation kits
Calibration date:	April 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 R&S SML-03	100698	27-Mar-2002	In house check: Mar-05
Power sensor HP 8481A	MY41092317	18-Oct-02	Oct-04
Power sensor HP 8481A	US37292783	30-Oct-02	Oct-03
Power meter EPM E442	GB37480704	30-Oct-02	Oct-03
Network Analyzer HP 8753E	US38432426	3-May-00	In house check: May 03

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Laboratory Director	
Approved by:	Niels Kuster	Quality Manager	

Date issued: April 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.

Date/Time: 04/01/03 15:53:35

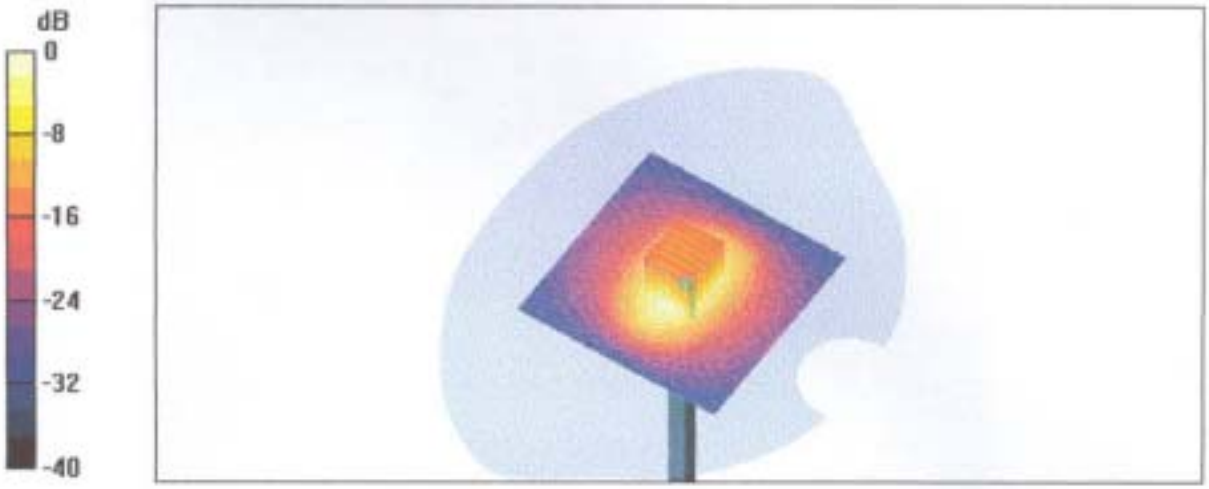
Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN5d030_SN1507_HSL1900_010403.da4

DUT: Dipole 1900 MHz; Serial: D1900V2 - SN5d030
Program: Dipole Calibration

Communication System: CW-1900; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: HSL 1900 MHz; (σ = 1.44 mho/m, ε_r = 38.78, ρ = 1000 kg/m^3)
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1507; ConvF(5.2, 5.2, 5.2); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN411; Calibrated: 1/16/2003
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.1 Build 33; Postprocessing SW: SEMCAD, V1.6 Build 109

Pin = 250 mW; d = 10 mm/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.5 V/m
Peak SAR = 18.4 W/kg
SAR(1 g) = 10.5 mW/g; SAR(10 g) = 5.42 mW/g
Power Drift = 0.03 dB



Date/Time: 04/08/03 14:15:07

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN5d030_SN1507_M1900_080403.da4

DUT: Dipole 1900 MHz; Serial: D1900V2 - SN5d030
Program: Dipole Calibration

Communication System: CW-1900; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: Muscle 1900 MHz; (σ = 1.59 mho/m, ε_r = 51.2, ρ = 1000 kg/m^3)
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6 - SN1507; ConvF(4.8, 4.8, 4.8); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN411; Calibrated: 1/16/2003
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.1 Build 33; Postprocessing SW: SEMCAD, V1.6 Build 109

Pin = 250 mW; d = 10 mm/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 91.4 V/m
Peak SAR = 18.7 W/kg
SAR(1 g) = 10.7 mW/g; SAR(10 g) = 5.52 mW/g
Power Drift = 0.03 dB