SAR Compliance Test Report

Testing Lab:
Research In Motion Limited
305 Phillip Street
Waterloo, Ontario
Canada N2L 3W8
Phone: 519-888-7465
Fax: 519-880-8173
Web site: www.rim.net

Applicant:
Research In Motion Limited
295 Phillip Street
Waterloo, Ontario
Canada N2L 3W8
Phone: 519-888-7465
Fax: 519-888-6906
Web site: www.rim.net

Statement of Compliance: Research In Motion Limited, declares under its sole responsibility that the product to which this declaration relates, is in conformity with the appropriate RF exposure standards, recommendations and guidelines. It also declares that the product was tested in accordance with the appropriate measurement standards, guidelines and recommended practices. Any deviations from these standards, guidelines and recommended practices are noted below:

(none)

Device Category: This wireless handheld is a portable device, designed to be used in direct contact with the user's head, hand and to be carried in an approved holster when carried on the user's body.

RF exposure environment: This wireless portable device has been shown to be in compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in OET Bulletin 65 Supplement C (Edition 01-01), FCC 96-326 and IEEE Std. C95.1-1999 and had been tested in accordance with the measurement procedures specified in OET Bulletin 65 Supplement C (Edition 01-01) and ANSI/IEEE Std. C95.3-1991.

Approved by:	**Signatures**	**Date**
Paul G. Cardinal, Ph.D. Manager, Compliance & Certification	Paul G Cardinal	July 24, 2003
Tested and documented by: Daoud Attayi Compliance Specialist	Daoud Attayi	July 16, 2003

CONTENTS

1.0 OPERATING CONFIGURATIONS AND TEST CONDITIONS

1.1 Picture of Handheld

Figure 1. BlackBerry Wireless Handheld

1.2 Antenna description

Type	Internal fixed antenna
Location	Left Side
Configuration	Internal fixed antenna

Table 1. Antenna description

1.3 Handheld description

Handheld Model	R6120CN	
FCC ID	L6AR6120CN	
Serial Number	E2 SAR #1	
Prototype or Production Unit	Pre-production	
Mode(s) of Operation	Cellular CDMA	PCS CDMA
Maximum conducted RF Output Power	24.00 dBm	23.00 dBm
Tolerance in Power Setting	± 0.50 dB	± 0.50 dB
Duty Cycle	1:1	1:1
Transmitting Frequency Range (s)	824.70-848.31 MHz	1851.25-1908.75 MHz

Table 2. Test device description

1.4 Body worn accessories

Holsters

The holsters, with integral belt-clip, is designed to allow the BlackBerry handheld to slide in only one way, and that is with the keyboard side facing the user (facing the belt-clip) while in the holster. This positioning has the benefit of protecting the keypad and the large LCD from damage.

The right top portion of Figure 2 shows the holster with the handheld keyboard side facing the user and with the keyboard side facing away from user. Photo to the right shows that the device with keyboard away from the user does not fit into the holster.

Figure 2. Top photo shows Body-Worn Plastic Holster ASY-03991-001 and Leather Swivel Hoslter HDW-04890-001

The device-to-phantom spacing when the handheld is in holster is 15 mm as shown in the bottom portion of Figure 2.

1.5 Headsets

The RIM Blackberry Wireless handheld was tested with and without headset model number HDW-03458-001. The SAR values are shown in the Table 16.

1.6 Procedure used to establish the test signal

The Handheld was put into test mode for the SAR measurements by enabling a call via the Agilent E5515C, CDMA Wireless Communication Test Set 8960 Series 10. Rvs Power Control was set to the "All bits up" option for sending out a command to the Handheld to transmit at full power at the specified frequency.

2.0 DESCRIPTION OF THE TEST EQUIPMENT

2.1 SAR measurement system

SAR measurements were performed using a Dosimetric Assessment System (DASY3), an automated SAR measurement system manufactured by Schmid & Partner Engineering AG (SPEAG), of Zurich, Switzerland.

The DASY3 system for performing compliance tests consists of the following items:

· A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
· An arm extension for accommodating the data acquisition electronics (DAE).
· A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
· A DAE module which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the Electro-optical coupler (EOC).
· A unit to operate the optical surface detector which is connected to the EOC.
· The EOC performs the conversion from an optical signal into the digital electric signal of the DAE. The EOC is connected to the PC plug-in card.
· The functions of the PC plug-in card based on a DSP is to perform the time critical tasks such as signal filtering, surveillance of the robot operation fast movement interrupts.
· A computer operating Windows NT.
· DASY3 software version 3.1C.
· Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
· The SAM Twin Phantom enabling testing left-hand and right-hand usage.
· The device holder for handheld mobile phones.
· Tissue simulating liquid mixed according to the given recipes (see Application Note).
· System validation dipoles allowing for the validation of proper functioning of the system.

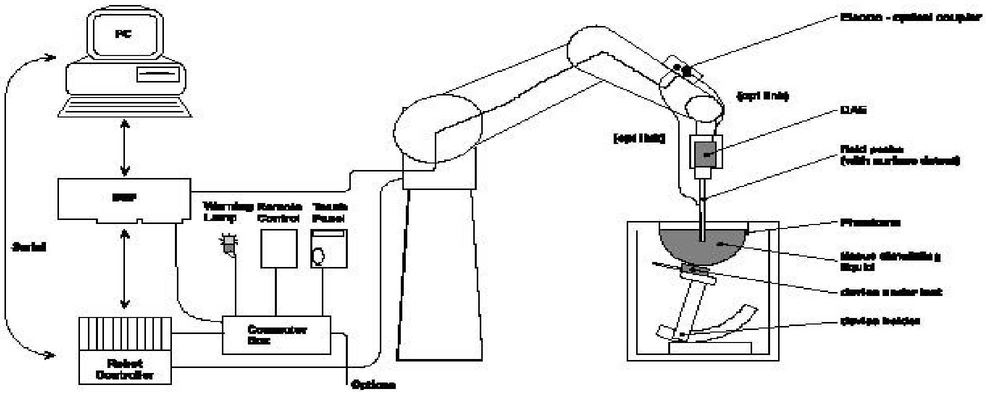


Figure 3: System Description

2.1.1 Equipment List

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
SCHMID & Partner Engineering AG	E-field probe	ET3DV6	1642	26/07/2003
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	472	13/09/2003
SCHMID & Partner Engineering AG	Dipole Validation Kit	D835V2	446	12/11/2003
SCHMID & Partner Engineering AG	Dipole Validation Kit	D1900V2	545	12/11/2003
Agilent Technologies	Signal generator	HP 8648C	4037U03155	20/09/2003
Agilent Technologies	Power meter	E4419B	GB40202821	20/09/2003
Agilent Technologies	Power sensor	8482A	US37295126	21/09/2003
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	21/09/2003
Agilent Technologies	CDMA Wireless Communication Test Set	8960 Series 10 E55115C	US41070110	06/11/2003

Table 3. Equipment list

2.2 Description of the test setup

Before a SAR test is conducted the Handheld and the DASY equipment are setup as follows:

2.2.1 Handheld and base station simulator setup

• Insert SIM card into the Handheld's SIM card slot and power it up.
• Turn on the Test Set and set the carrier frequency and power to the appropriate values.
• Connect an antenna to the RF IN/OUT of the communication test set and place it close to the Handheld.

2.2.2 DASY setup

• Turn the computer on and log on to Windows NT.
• Start DASY3 software by clicking on the icon located on the Windows desktop. Once the software loads, click on the Change to Robot toolbar button to open the State and Robot Monitoring Windows.
• Once the DASY State dialog opens you can ignore all errors and click OK to open the Robot Monitoring window.
• Mount the DAE unit and the probe. Turn on the DAE unit.
• Turn the Robot Controller on by turning the main power switch to the horizontal position
• Align the probe and click the align probe in the light beam button to correct the probe offset.
• Open a program and configure it to the proper parameters
• Establish a connection between the Handheld and the communications test instrument. Place the Handheld on the stand and adjust it under the phantom.
• Start SAR measurements.

3.0 ELECTRIC FIELD PROBE CALIBRATION

3.1 Probe Specification

SAR measurements were conducted using the dosimetric probe ET3DV6, designed by Schmid & Partner Engineering AG for the measurement of SAR. The probe is constructed using the thin film technique, with printed resistive lines on ceramic substrates. It has a symmetrical design with triangular core, built-in optical fiber for the surface detection system and built-in shielding against static discharge. The probe is sensitive to E-fields and thus incorporates three small dipoles arranged so that the overall response is close to isotropic. The table below summarizes the technical data for the probe.

Property	Data
Frequency range	30 MHz – 3 GHz
Linearity	±0.1 dB
Directivity (rotation around probe axis)	= ±0.2 dB
Directivity (rotation normal to probe axis)	±0.4 dB
Dynamic Range	5 mW/kg – 100 W/kg
Probe positioning repeatability	±0.2 mm
Spatial resolution	< 0.125 mm ^{3}

Table 4. Probe specification

3.2 Probe calibration and measurement errors

The probe was calibrated on 26/07/2002 with an accuracy better than ±10%. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe were tested. The probe calibration parameters are shown on Appendix D.

4.0 SAR MEASUREMENT SYSTEM VERIFICATION

Prior to conducting SAR evaluation, the measurements were validated using the dipole validation kit and a flat phantom. A power level of 1.0 W was applied to the dipole antenna. The verification results are in the table below with a comparison to reference values. Printouts are shown in Appendix A. All the measured parameters are satisfactory.

4.1 System accuracy verification for Head Adjacent use

f (MHz)	Limits / Measured	SAR (W/kg) 1 g/ 10 g	Dielectric Parameters		Liquid Temp (°C)
			ε_r	σ [S/m]	
835	Measured	11.8 / 7.4	42.8	0.91	21.7
	Recommended Limits	11.2 / 7.0	41.4	0.90	N/A
1900	Measured	43.0 / 21.7	40.1	1.46	21.8
	Recommended Limits	43.2 / 22.0	40.0	1.45	N/A

Table 5. System accuracy (Validation for Head Adjacent use)

5.0 PHANTOM DESCRIPTION

The SAM Twin Phantom, manufactured by SPEAG, was used during the SAR measurements. The phantom is made of a fiberglass shell integrated with a wooden table.

The SAM Twin Phantom is a fiberglass shell phantom with 2 mm shell thickness. It has three measurement areas:
 Left hand
 Right hand
 Flat phantom

The phantom table dimensions are: 100x50x85 cm (LxWxH). The table is intended for use with free standing robots.

The bottom shelf contains three pair of bolts for locking the device holder in place. The device holder positions are adjusted to the standard measurement positions in the three sections. Only one device holder is
necessary if two phantoms are used (e.g., for different solutions).

A white cover is provided to top the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on the cover are possible; however the optical surface detector does not work properly at the cover surface. Place a sheet of white paper on the cover when using optical surface detection.

Liquid depth of = 15 cm is maintained in the phantom for all the measurement.

Figure 4
SAM Twin Phantom

6.0 TISSUE DIELECTRIC PROPERTY

6.1 Composition of tissue simulant

The composition of the brain and muscle simulating liquids for 800-900 MHz and 1800-1900 MHz are shown in the table below.

INGREDIENT	MIXTURE 800–900MHz		MIXTURE 1800–1900MHz	
	Brain %	Muscle %	Brain %	Muscle %
Water	51.07	65.45	54.88	69.91
Sugar	47.31	34.31	0	0
Salt	1.15	0.62	0.21	0.13
HEC	0.23	0	0	0
Bactericide	0.24	0.10	0	0
DGBE	0	0	44.91	29.96

Table 6. Tissue simulant recipe

6.1.1 Equipment

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
Pyrex, England	Graduated Cylinder	N/A	N/A	N/A
Pyrex, USA	Beaker	N/A	N/A	N/A
Acculab	Weight Scale	V1-1200	018WB2003	N/A
Hart Scientific	Digital Thermometer	61161-302	21352860	10/09/2003
IKA Works Inc.	Hot Plate	RC Basic	3.107433	N/A

Table 7. Tissue simulant preparation equipment

6.1.2 Preparation procedure

800-900 MHz liquids

- Fill the container with **water**. Begin heating and stirring.
- Add the **Cellulose,** the **preservative substance** and the **salt**. After several hours, the liquid will become more transparent again. The container must be covered to prevent evaporation.
- Add **Sugar**. Stir it well until the sugar is sufficiently dissolved.
- Keep the liquid hot but below the boiling point for at least an hour. The container must be covered to prevent evaporation.
- Remove the container from, and turn the hotplate off and allow the liquid to cool off to room temperature prior to performing dielectric measurements.

1800-1900 MHz liquid

- Fill the container with **water**. Begin heating and stirring.
- Add the **salt** and **Glycol**. The container must be covered to prevent evaporation.
- Keep the liquid hot but below the boiling point for at least an hour. The container must be covered to prevent evaporation.
- Remove the container from, and turn the hotplate off and allow the liquid to cool off to room temperature prior to performing dielectric measurements.

6.2 Electrical parameters of the tissue simulating liquid

The tissue dielectric parameters shall be measured before a batch can be used for SAR measurements to ensure that the simulated tissue was properly made and will simulate the desired human characteristic. Limits and measured electrical parameters are show in the table below.
Recommended limits are adopted from IEEE Std P1528/D1.2, April 21, 2003
" Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", SPEAG dipole calibration certificates and from FCC Tissue Dielectric Properties web page at http://www.fcc.gov/fcc-bin/dielec.sh

f (MHz)	Tissue Type	Limits / Measured	Dielectric Parameters		Liquid Temp (°C)
			ε_r	σ [S/m]	
835	Head	Measured	42.8	0.91	21.7
		Recommended Limits	41.4	0.90	N/A
	Muscle	Measured	53.9	0.99	22.8
		Recommended Limits	55.2	0.97	N/A
1900	Head	Measured	40.1	1.46	21.8
		Recommended Limits	40.0	1.45	N/A
	Muscle	Measured	52.4	1.57	21.4
		Recommended Limits	53.3	1.52	N/A

Table 8. Electrical parameters of tissue simulating liquid

6.2.1 Equipment

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date
Agilent Technologies	Network Analyzer	8753ES	US39174857	21/09/2003
Agilent Technologies	Dielectric probe kit	HP 85070C	US9936135	CNR
Dell	PC using GPIB card	GX110	347	N/A
Hart Scientific	Digital Thermometer	61161-302	21352860	10/09/2003

Table 9. Equipment required for electrical parameter measurements

6.2.2 Test Configuration

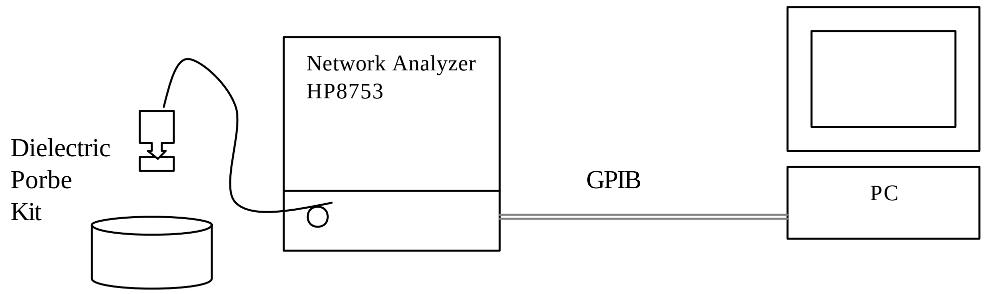


Figure 5: Test configuration

6.2.3 Procedure

1. Turn NWA on and allow at least 30 minutes for warm up.
2. Mount dielectric probe kit so that interconnecting cable to NWA will not be moved during measurements or calibration.
3. Pour de-ionized water and measure water temperature (±1°).
4. Set water temperature in HP-Software (Calibration Setup).
5. Perform calibration.
6. Validate calibration with dielectric material of known properties (e.g. polished ceramic slab with >8mm thickness ε'=10.0, ε''=0.0). If measured parameters do not fit within tolerance, repeat calibration (±0.2 for ε': ±0.1 for ε'').
7. Relative permittivity $\varepsilon_r = \varepsilon'$ and conductivity can be calculated from ε''
   $\sigma = \omega \varepsilon_0 \varepsilon''$
8. Measure liquid shortly after calibration.
9. Stir the liquid to be measured. Take a sample (~50ml) with a syringe from the center of the liquid container.
10. Pour the liquid into a small glass flask. Hold the syringe at the bottom of the flask to avoid air bubbles.
11. Put the dielectric probe in the glass flask. Check that there are no air bubbles in front of the opening in the dielectric probe kit.
12. Perform measurements.
13. Adjust medium parameters in DASY3 for the frequencies necessary for the measurements (‘Setup Config’, select medium (e.g. Brain 900 MHz) and press ‘Option’-button.
14. Select the current medium for the frequency of the validation (e.g. Setup Medium Brain 900 MHz).

Sample calculation for 835 MHz head tissue dielectric parameters using data from Table 10.

Relative permittivity $\varepsilon_r = \varepsilon'$ = 42.82

Conductivity $\sigma = \omega \varepsilon_0 \varepsilon''$ = 2 x 3.1416 x 835 e+6 x 8.854e-12 x 19.63 = 0.91 S/m

Title

SubTitle

July 14, 2003 05:21 PM

Frequency	e'	e''
800.000000 MHz	43.2578	19.7013
805.000000 MHz	43.2004	19.6932
810.000000 MHz	43.1255	19.6577
815.000000 MHz	43.0838	19.6404
820.000000 MHz	43.0159	19.6414
825.000000 MHz	42.9216	19.6022
830.000000 MHz	42.8996	19.6066
835.000000 MHz	42.8196	19.6277
840.000000 MHz	42.7504	19.5721
845.000000 MHz	42.6809	19.5487
850.000000 MHz	42.6373	19.5390
855.000000 MHz	42.5945	19.5293
860.000000 MHz	42.4918	19.5064
865.000000 MHz	42.4311	19.4820
870.000000 MHz	42.3534	19.4834
875.000000 MHz	42.3236	19.4708
880.000000 MHz	42.2610	19.4479
885.000000 MHz	42.2262	19.4473
890.000000 MHz	42.1621	19.4305
895.000000 MHz	42.1686	19.4125
900.000000 MHz	42.0984	19.4031
905.000000 MHz	42.0448	19.3641
910.000000 MHz	41.9914	19.3551
915.000000 MHz	41.9536	19.3464

Title

SubTitle

July 11, 2003 12:25 PM

Frequency	e'	e''
800.000000 MHz	54.2163	21.4247
805.000000 MHz	54.2058	21.4305
810.000000 MHz	54.1381	21.3999
815.000000 MHz	54.0799	21.3607
820.000000 MHz	54.0464	21.3411
825.000000 MHz	53.9924	21.3234
830.000000 MHz	53.9261	21.2994
835.000000 MHz	53.8636	21.2524
840.000000 MHz	53.8393	21.2468
845.000000 MHz	53.7990	21.2252
850.000000 MHz	53.7263	21.1722
855.000000 MHz	53.6986	21.1791
860.000000 MHz	53.6245	21.1169
865.000000 MHz	53.5727	21.1116
870.000000 MHz	53.5148	21.0872
875.000000 MHz	53.4952	21.0487
880.000000 MHz	53.4498	21.0521
885.000000 MHz	53.3912	21.0184
890.000000 MHz	53.3534	21.0086
895.000000 MHz	53.3275	20.9733
900.000000 MHz	53.2878	20.9541
905.000000 MHz	53.2318	20.9310
910.000000 MHz	53.2179	20.9073
915.000000 MHz	53.1583	20.8965

Table 10. 835 MHz head and muscle tissue dielectric parameters

Title

SubTitle

July 08, 2003 10:18 AM

Frequency	e'	e"
1.700000000 GHz	40.8684	13.1188
1.710000000 GHz	40.8180	13.1504
1.720000000 GHz	40.7859	13.1681
1.730000000 GHz	40.7492	13.1916
1.740000000 GHz	40.7139	13.2205
1.750000000 GHz	40.7075	13.2537
1.760000000 GHz	40.6592	13.2873
1.770000000 GHz	40.6346	13.3220
1.780000000 GHz	40.6032	13.3483
1.790000000 GHz	40.5632	13.3985
1.800000000 GHz	40.5335	13.4330
1.810000000 GHz	40.4691	13.4738
1.820000000 GHz	40.4345	13.5206
1.830000000 GHz	40.3884	13.5563
1.840000000 GHz	40.3223	13.6016
1.850000000 GHz	40.2830	13.6484
1.860000000 GHz	40.2297	13.6709
1.870000000 GHz	40.1928	13.7406
1.880000000 GHz	40.1608	13.7496
1.890000000 GHz	40.1236	13.7863
1.900000000 GHz	40.0775	13.8258
1.910000000 GHz	40.0279	13.8347

Title

SubTitle

July 09, 2003 11:47 AM

Frequency	e'	e"
1.700000000 GHz	53.0499	14.2086
1.710000000 GHz	53.0296	14.2232
1.720000000 GHz	53.0155	14.2473
1.730000000 GHz	53.0017	14.2784
1.740000000 GHz	52.9895	14.3045
1.750000000 GHz	52.9810	14.3238
1.760000000 GHz	52.9441	14.3594
1.770000000 GHz	52.9090	14.3900
1.780000000 GHz	52.8699	14.4352
1.790000000 GHz	52.8265	14.4770
1.800000000 GHz	52.7912	14.5085
1.810000000 GHz	52.7276	14.5428
1.820000000 GHz	52.6950	14.5981
1.830000000 GHz	52.6575	14.6325
1.840000000 GHz	52.6422	14.6732
1.850000000 GHz	52.6193	14.7279
1.860000000 GHz	52.5902	14.7483
1.870000000 GHz	52.5553	14.7887
1.880000000 GHz	52.5313	14.7942
1.890000000 GHz	52.4759	14.8355
1.900000000 GHz	52.4429	14.8715
1.910000000 GHz	52.3871	14.8960
1.920000000 GHz	52.3471	14.9356
1.930000000 GHz	52.3042	14.9818
1.940000000 GHz	52.2816	15.0243
1.950000000 GHz	52.2624	15.0566

Table 11. 1900 MHz head and muscle tissue dielectric parameters

7.0 SAR SAFETY LIMITS

Standards/Guideline	Localized SAR Limit (W/kg) General public (uncontrolled)	Localized SAR Limits (W/kg) Workers (controlled)
ICNIRP (1998) Standard	2.0 (10g)	10.0 (10g)
IEEE C95.1 (1999) Standard	1.6 (1g)	8.0 (1g)

Table 12. SAR safety limits for Controlled / Uncontrolled environment

Human Exposure	Localized SAR Limits (W/kg) 10g, ICNIRP (1998) Standard	Localized SAR Limits (W/kg) 1g, IEEE C95.1 (1999) Standard
Spatial Average (averaged over the whole body)	0.08	0.08
Spatial Peak (averaged over any X g of tissue)	2.00	1.60
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.00	4.00 (10g)

Table 13. SAR safety limits

Uncontrolled Environments are defined as locations where there is exposure of individuals who have no knowledge or control of their exposure.

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

8.0 DEVICE POSITIONING

8.1 Device holder for SAM Twin Phantom

The Handheld was positioned for all test configurations using the DASY3 holder. The device holder facilitates the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can be easily, accurately and with repeatability positioned according to FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

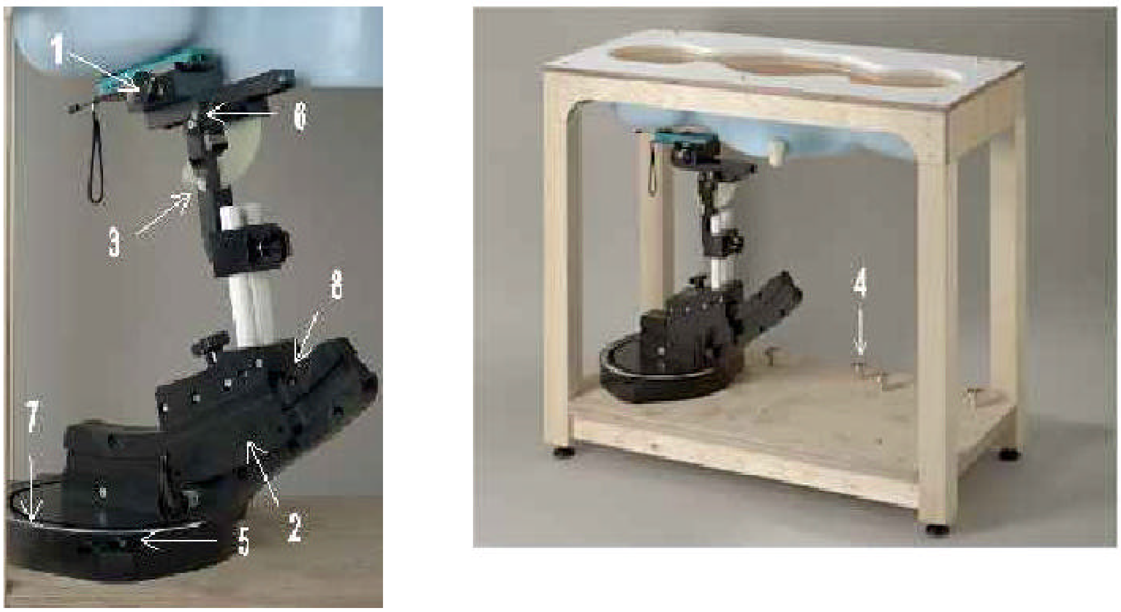


Figure 6
Device Holder

1. Put the phone in the clamp mechanism (1) and hold it straight while tightening. (Curved phones or phones with asymmetrical ear pieces should be positioned so that the ear piece is in the symmetry plane of the clamp).

2. Adjust the sliding carriage (2) to 90°. Then adjust the phone holder angle (3) until the reference line of the phone is horizontal (parallel to the flat phantom bottom). The phone reference line is defined as the front tangential line between the ear piece and the center of the device bottom (or the center of the flip hinge). For devices with parallel front and back sides, the phone holder angle (3) is 0°.

3. Place the device holder at the desired phantom section and move it securely against the positioning pins (4). The screw in front of the turning plate can be applied for correct positioning (5). (Do not tighten it too strongly).

4. Shift the phone clamp (6) so that the ear piece is exactly below the ear marking of the phantom. The phone is now correctly positioned in the holder for all standard phantom measurements, even

after changing the phantom or phantom section.

5. Adjust the device position angles to the desired measurement position.

6. After fixing the device angles, move the phone fixture up until the phone touches the ear marking. (The point of contact depends on the design of the device and the positioning angle).

8.2 Description of the test positioning

8.2.1 Test Positions of Device Relative to Head

The handset was tested in two test positions against the head phantom, the "cheek" position and the "tilted" position, on both left and right sides of the phantom.

The handset was tested in the above positions according to IEEE 1528-Draft 6.1 "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques".

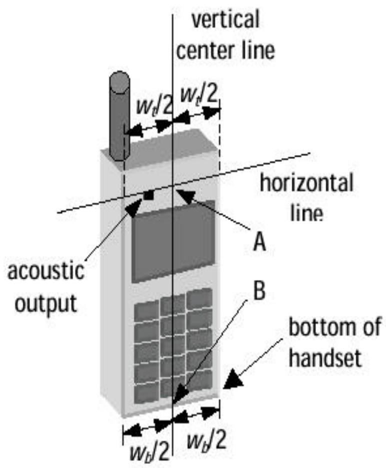


Figure 7a – Handset vertical and horizontal reference lines – fixed case

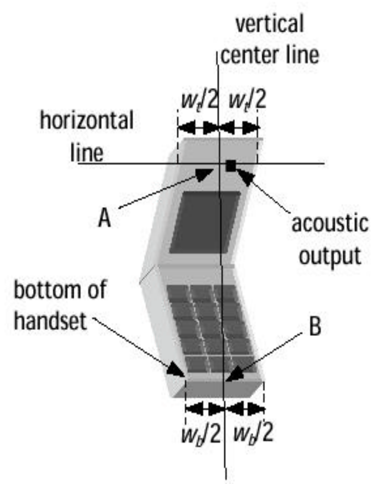


Figure 7b – Handset vertical and horizontal reference lines – "clam-shell"

8.2.1.1 Definition of the "cheek" position

1) Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece, open the cover.
2) Define two imaginary lines on the handset: the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width *wt* of the handset at the level of the acoustic output (point A on Figures 7a and 7b), and the midpoint of the width *wb* of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 7a). The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output. However, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset (see Figure 7b), especially for clamshell handsets, handsets with flip pieces, and other irregularly shaped handsets.
3) Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 7), such that the plane defined by the vertical center line and the horizontal center line is in a plane approximately parallel to the sagittal plane of the phantom.
4) Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear.
5) While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is the plane normal to MB ("*mouth-back*") - NF ("*neck-front*") including the line MB (reference plane).
6) Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF.
7) While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the ear (cheek).

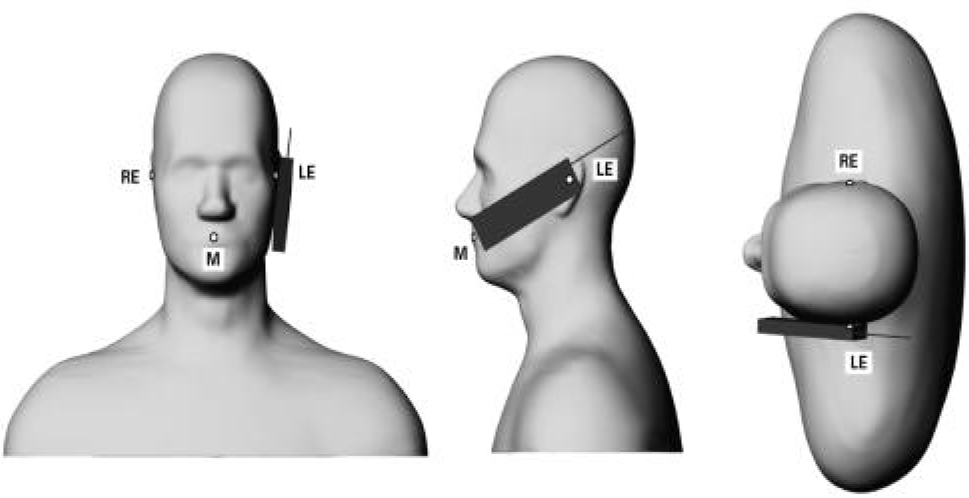


Figure 8 – Phone position 1, "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

8.2.1.2 Definition of the "Tilted" Position

1) Repeat steps 1 to 7 of 5.4.1 (in this report 8.2.1.1) to replace the device in the "cheek position."
2) While maintaining the device in the reference plane (described above) and pivoting against the ear, move the device outward away from the mouth by an angle of 15 degrees, or until the antenna touches the phantom.

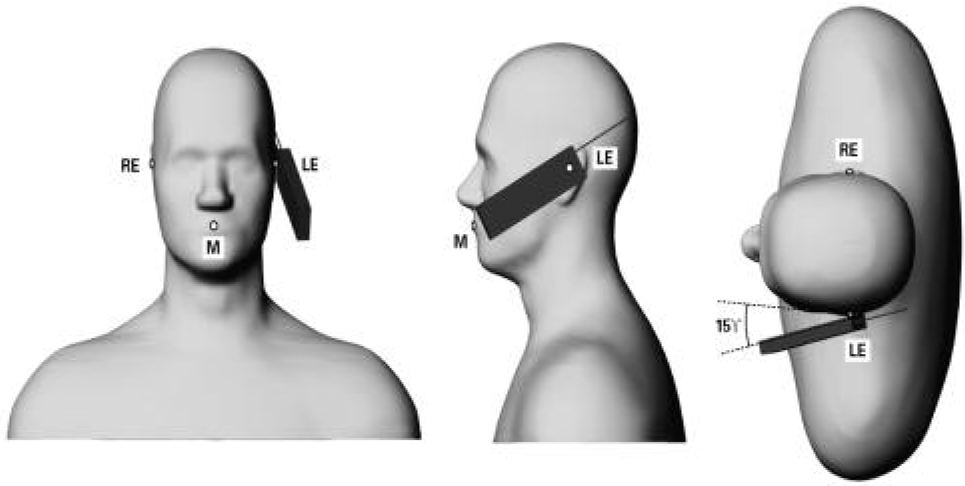


Figure 9 – Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

8.2.2 Body Holster Configuration

A body worn holster, as shown on Figure 2, was tested with the Wireless Handheld for FCC RF exposure compliance. The EUT was positioned in the holster case and the belt clip was placed against the flat section of the phantom. A headset was then connected to the handheld to simulate hands-free operation in a body worn holster configuration.

9.0 High Level Evaluation

9.1 Maximum search

The maximumsearch is automatically performed after each coarse scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacing. After the coarse scan measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations.

9.2 Extrapolation

The extrapolation can be used in z-axis scans with automatic surface detection. The SAR values can be extrapolated to the inner phantom surface. The extrapolation distance is the sum of the probe sensor offset, the surface detection distance and the grid offset. The extrapolation is based on fourth order polynomial functions. The extrapolation is only available for SAR values.

9.3 Boundary correction

The correction of the probe boundary effect in the vicinity of the phantom surface is done in the standard (worst case) evaluation; the boundary effect is reduced by different weights for the lowest measured points in the extrapolation routine. The result is a slight overestimation of the extrapolated SAR values (2% to 8%) depending on the SAR distribution and gradient. The advanced evaluation makes a full compensation of the boundary effect before doing the extrapolation. This is only possible for probes with specifications on the boundary effect.

9.4 Peak search for 1g and 10g cube averaged SAR

The 1g and 10g peak evaluations are only available for the predefined cube 5x5x7 scan. The routines are verified and optimized for the grid dimensions used in these cube measurements.
The measure volume of 32x32x35mm mm contains about 35g of tissue. The first procedure is an extrapolation (incl. Boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume in a 1mm grid (35000 points). In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is then moved around until the highest averaged SAR is found. This last procedure is repeated for a 10 g cube. If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

10.0 MEASUREMENT UNCERTAINTIES

Uncertainty Component	Tolerance (± %)	Probability Distribution	Sensitivity coefficient (1-g)	Sensitivity coefficient (10-g)	1-g Standard Uncertainty (±%)	10-g Standard Uncertainty (±%)
Measurement System						
Probe Calibration (*k*=1)	3.3	Normal	1	1	3.3	3.3
Axial Isotropy	4.7	Rectangle	0.7	0.7	1.9	1.9
Hemispherical Isotropy	9.6	Rectangle	0.7	0.7	3.9	3.9
Boundary Effect	11.0	Rectangle	1	1	6.4	6.4
Linearity	4.7	Rectangle	1	1	2.7	2.7
System Detection Limits	1.0	Rectangle	1	1	0.6	0.6
Readout Electronics	1.0	Normal	1	1	1.0	1.0
Response Time	0.8	Rectangle	1	1	0.5	0.5
Integration Time	1.8	Rectangle	1	1	1.1	1.1
RF Ambient Conditions	3.0	Rectangle	1	1	1.7	1.7
Probe Positioner Mechanical Tolerance	0.4	Rectangle	1	1	0.2	0.2
Probe Positioning with respect to Phantom Shell	2.9	Rectangle	1	1	1.7	1.7
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	3.9	Rectangle	1	1	2.3	2.3
Test sample Related						
Test Sample Positioning		Normal	1	1	6.7	6.7
Device Holder Uncertainty		Normal	1	1	5.9	5.9
Output Power Variation - SAR drift measurement	5	Rectangle	1	1	2.9	2.9
Phantom and Tissue Parameters						
Phantom Uncertainty (shape and thickness tolerances)	4.0	Rectangle	1	1	2.3	2.3
Liquid Conductivity - deviation from target values	5.0	Rectangle	0.7	0.5	2.0	1.4
Liquid Conductivity - measurement uncertainty	10.0	Rectangle	0.7	0.5	4.0	2.9
Liquid Permittivity - deviation from target values	5.0	Rectangle	0.6	0.5	1.7	1.4
Liquid Permittivity - measurement uncertainty	5.0	Rectangle	0.6	0.5	1.7	1.4
Combined Standard Uncertainty		RSS			14.5	14.1
Expanded Uncertainty (95% CONFIDENCE LEVEL)					29.0	28.2

Table 14. Measurement uncertainty

11.0 TEST RESULTS

11.1 SAR Measurement results at highest power measured against the head

Mode	f (MHz)	Conducted Output Power (dBm)	SAR, averaged over 1 g (W/Kg) Left-hand: Liquid Temp (°C)	Left-hand: Cheek	Left-hand: Tilted	SAR, averaged over 1 g (W/Kg) Right-hand: Liquid Temp (°C)	Right-hand: Cheek	Right-hand: Tilted
CDMA Cellular 835	824.70	24.00	22.8	0.83	-	-	-	-
	*836.52	23.74	22.8	1.04	0.46	22.8	0.77	0.36
	848.31	24.01	22.8	**1.23**	-	-	-	-
CDMA PCS 1900	1851.25	22.17	20.9	0.63	-	21.0	0.85	-
	*1880.00	22.56	20.8	0.97	0.43	21.0	1.34	0.61
	1908.75	22.50	20.8	1.06	-	21.1	**1.45**	-

Table 15. SAR results for head configuration

11.2 SAR measurement results at highest power measured against the body using Holster and Leather Swivel Holster

Mode	f (MHz)	Conducted Output Power (dBm)	Liquid Temp (°C)	SAR, averaged over 1 g (W/kg) Holster	SAR, averaged over 1 g with headset (W/kg) Holster	SAR, averaged over 1 g (W/kg) Leather Swivel Holster	SAR, averaged over 1 g with headset (W/kg) Leather Swivel Holster
CDMA Cellular 835	824.70	-	-	-	-	-	-
	* 836.52	23.74	22.6	**0.56**	0.34	0.50	0.32
	848.31	-	-	-	-	-	-
CDMA PCS 1900	1851.25	-	-	-	-	-	-
	*1880.00	22.56	22.1	**0.25**	0.24	0.20	0.22
	1908.75	-	-	-	-	-	-

11.3 Table 16. SAR results with Holster and Leather Swivel Holster for body worn configuration

* Supplement C: Middle channel testing is sufficient only if SAR < 3dB below limit see PN 02-1438

12.0 REFERENCES

[1] EN 50360: 2001, Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300 MHz – 3 GHz)

[2] EN 50361: 2001, Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz)

[3] ICNIRP, International Commission on Non-Ionizing Radiation Protection (1998), Guidelines for limiting exposure in time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz).

[4] Council Recommendation 1999/519/EC of July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)

[5] IEEE C95.3-1991, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

[6] IEEE C95.1-1999, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[7] OET Bulletin 65 (Edition 97-01) Supplement C (Edition 01-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

[8] FCC 96-326, Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation.

[9] DASY 3 DOSIMETRIC ASSESSMENT SYSTEM SOFTWARE MANUAL
Schmid & Partner Engineering AG, August 99.

[10] IEEE P1528/D1.2 Recommended Practice for Determining the Peak Spatial-Average Specific Aborption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

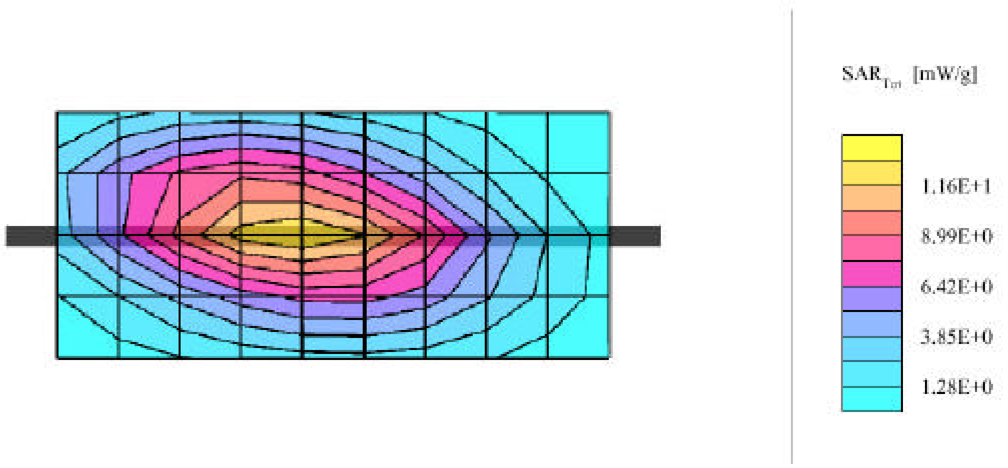
APPENDIX A: SAR DISTRIBUTION COMPARISON FOR THE ACCURACY VERIFICATION

07/10/03

Dipole 835

SAM 1; Flat
Probe: ET3DV6 - SN1642; ConvF(6.50,6.50,6.50); Crest factor: 1.0; Head 835 MHz: σ = 0.91 mho/m ε_r = 42.8 ρ = 1.00 g/cm^3
Cube 5x5x7: Peak: 19.7 mW/g, SAR (1g): 11.8 mW/g, SAR (10g): 7.39 mW/g, (Worst-case extrapolation)
Penetration depth: 11.4 (9.7, 13.6) [mm]
Powerdrift: 0.01 dB

Date Tested: July 10, 2003
Ambient Temperature: 23.4 Deg. Cel.
Liquid Temperature: 21.7 Deg. Cel.



07/08/03

Dipole 1900 MHz

SAM 1; Flat

Probe: ET3DV6 - SN1642; ConvF(5.30,5.30,5.30); Crest factor: 1.0; Head 1900 MHz: σ = 1.46 mho/m ε_r = 40.1 ρ = 1.00 g/cm^3

Cube 5x5x7: Peak: 84.0 mW/g, SAR (1g): 43.0 mW/g, SAR (10g): 21.7 mW/g, (Worst-case extrapolation)

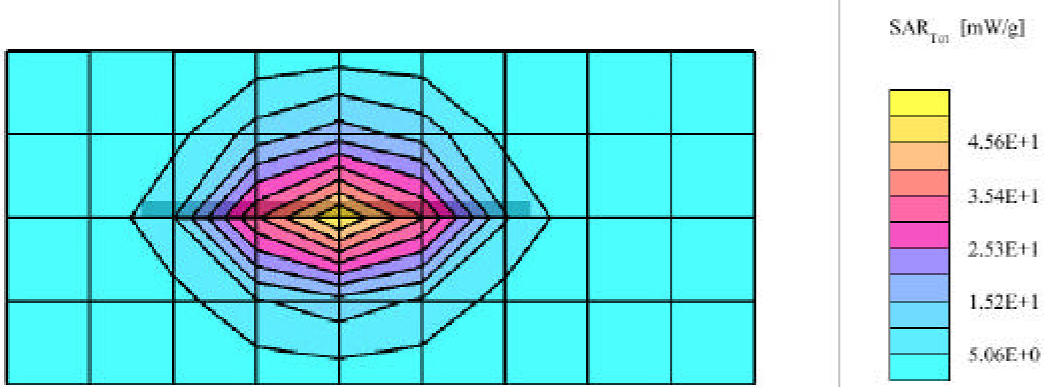
Penetration depth: 7.7 (7.2, 9.0) [mm]

Powerdrift: 0.07 dB

Date tested: July 08, 2003

Ambient Temperature: 22.8 (°C)

Liquid Temperature: 21.8 (°C)



APPENDIX B: SAR DISTRIBUTION PLOTS FOR HEAD CONFIGURATION

07/11/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 1; Left Hand

Probe: ET3DV6 - SN1642; ConvF(6.50,6.50,6.50); Crest factor: 1.0; Head 835 MHz: σ = 0.91 mho/m ε_r = 42.8 ρ = 1.00 g/cm^3

Cube 5x5x7: Peak: 2.15 mW/g, SAR (1g): 1.23 mW/g, SAR (10g): 0.714 mW/g, (Worst-case extrapolation)

Penetration depth: 11.9 (9.5, 15.5) [mm]

Powerdrift: -0.34 dB

Date tested: July 11, 2003

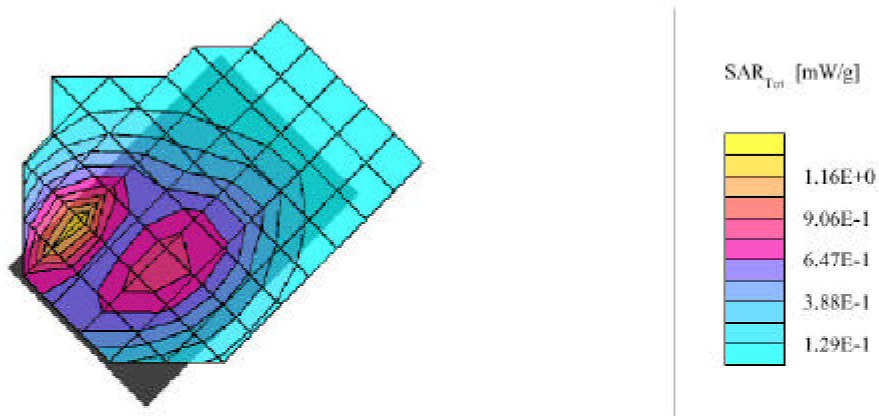
Ambient Temperature: 24.4 (°C)

Liquid Temperature: 22.8 (°C)

Band: Cellular CDMA

Channel: 777

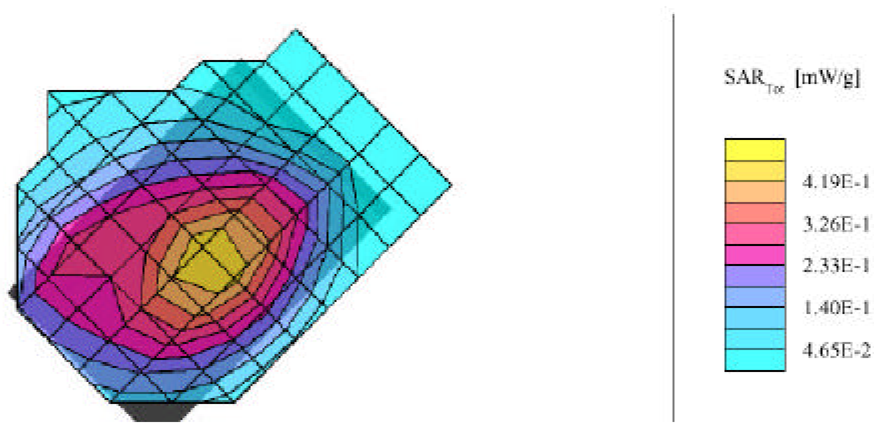
Configuration: Touch left side



07/11/03

BlackBerry Wireless Handheld Model No. RAN20CN
SAM 1; Left Hand
Probe: ET3DV6 - SN1642; ConvF(6.50,6.50,6.50); Crest factor: 1.0; Head 835 MHz: σ = 0.91 mho/m ε_r = 42.8 ρ = 1.00 g/cm³
Cube 5x5x7: Peak: 0.658 mW/g, SAR (1g): 0.455 mW/g, SAR (10g): 0.323 mW/g, (Worst-case extrapolation)
Penetration depth: 17.4 (14.3, 20.5) [mm]
Powerdrift: 0.06 dB

Date tested: July 11, 2003
Ambient Temperature: 24.5 (°C)
Liquid Temperature: 22.8 (°C)
Band: Cellular CDMA
Channel: 384
Configuration: Tilted left side

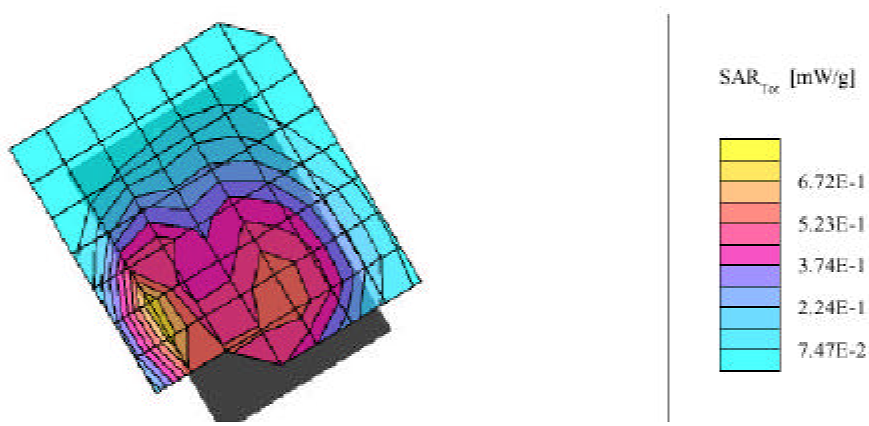


07/11/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 1; Right Hand
Probe: ET3DV6 - SN1642; ConvF(6.50,6.50,6.50); Crest factor: 1.0; Head 835 MHz: $\sigma = 0.91$ mho/m $\varepsilon_r = 42.8$ $\rho = 1.00$ g/cm³
Cube 5x5x7: Peak: 1.38 mW/g, SAR (1g): 0.769 mW/g, SAR (10g): 0.480 mW/g * Max outside, (Worst-case extrapolation)
Penetration depth: 14.1 (11.2, 17.6) [mm]
Powerdrift: -0.14 dB

Date tested: July 11, 2003
Ambient Temperature: 23.9 (°C)
Liquid Temperature: 22.8 (°C)
Band: Cellular CDMA
Channel: 384
Configuration: Touch right side

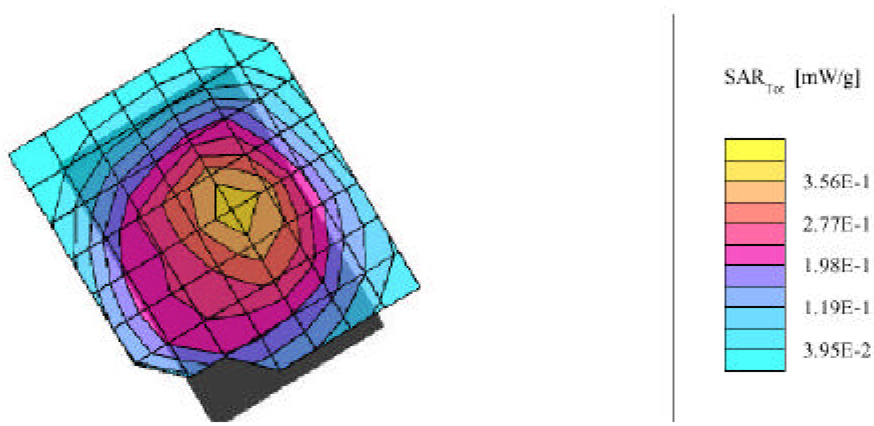


07/11/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 1; Right Hand
Probe: ET3DV6 - SN1642; ConvF(6.50,6.50,6.50); Crest factor: 1.0; Head 835 MHz: σ = 0.91 mho/m ε_r = 42.8 ρ = 1.00 g/cm³
Cube 5x5x7: Peak: 0.548 mW/g, SAR (1g): 0.363 mW/g, SAR (10g): 0.254 mW/g, (Worst-case extrapolation)
Penetration depth: 16.0 (12.8, 19.6) [mm]
Powerdrift: -0.33 dB

Date tested: July 11, 2003
Ambient Temperature: 23.7 (°C)
Liquid Temperature: 22.6 (°C)
Band: Cellular CDMA
Channel: 384
Configuration: Tilted right side



07/08/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 1; Left Hand

Probe: ET3DV6 - SN1642; ConvF(5.30,5.30,5.30); Crest factor: 1.0; Head 1900 MHz: $\sigma = 1.46$ mho/m $\varepsilon_r = 40.1$ $\rho = 1.00$ g/cm^3

Cube 5x5x7: Peak: 2.14 mW/g, SAR (1g): 1.06 mW/g * , SAR (10g): 0.478 mW/g * Max outside, (Worst-case extrapolation)

Penetration depth: 8.2 (7.2, 10.1) [mm]

Powerdrift: -0.45 dB

Date Tested: July 08, 2003

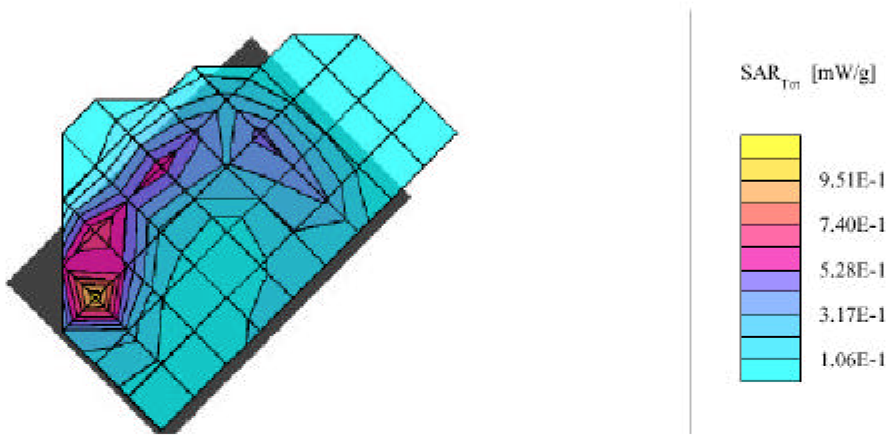
Ambient Temperature: 23.0 Deg. Cel.

Liquid Temperature: 20.8 Deg. Cel.

Band: PCS CDMA

Channel: 1175

Configuration: Left side "Touch" postion



07/08/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 1; Left Hand

Probe: ET3DV6 - SN1642; ConvF(5.30,5.30,5.30); Crest factor: 1.0; Head 1900 MHz: σ = 1.46 mho/m ε_r = 40.1 ρ = 1.00 g/cm³

Cube 5x5x7: Peak: 0.895 mW/g, SAR (1g): 0.430 mW/g, SAR (10g): 0.212 mW/g, (Worst-case extrapolation)

Penetration depth: 7.7 (6.8, 9.5) [mm]

Powerdrift: 0.30 dB

Date Tested: July 08, 2003

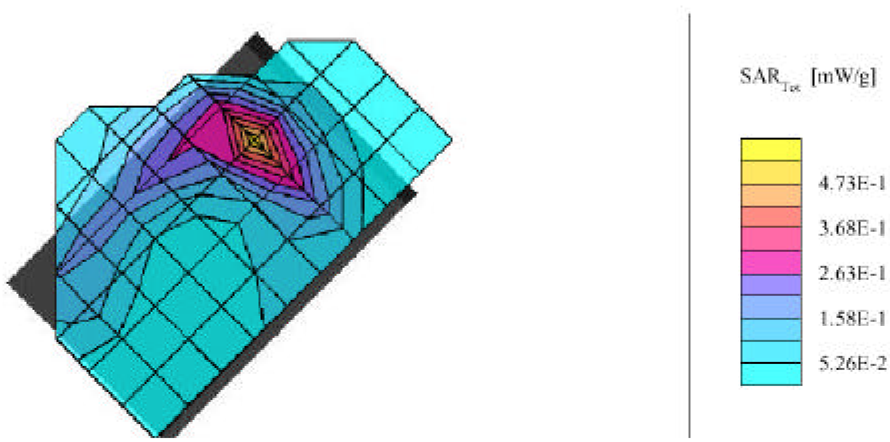
Ambient Temperature: 23.0 Deg. Cel.

Liquid Temperature: 20.8 Deg. Cel.

Band: PCS CDMA

Channel: 600

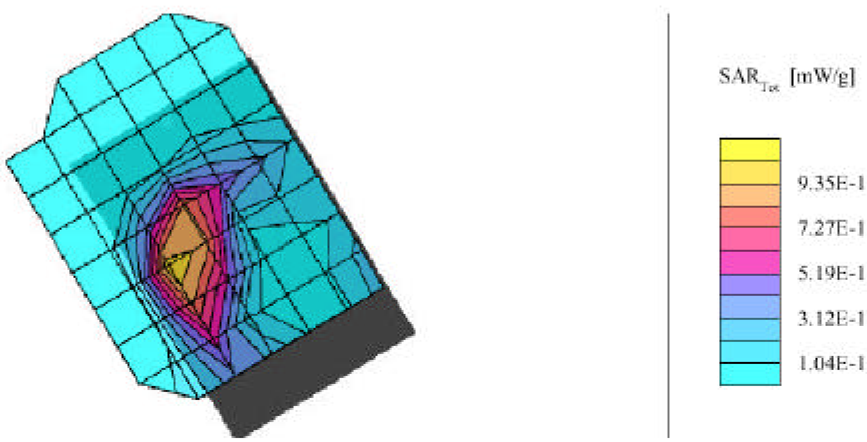
Configuration: Left side "Tilted" position



07/08/03

BlackBerry Wireless Handheld Model No. RAN20CN
SAM 1; Right Hand
Probe: ET3DV6 - SN1642; ConvF(5.30,5.30,5.30); Crest factor: 1.0; Head 1900 MHz: $\sigma = 1.46$ mho/m $\varepsilon_r = 40.1$ $\rho = 1.00$ g/cm³
Cube 5x5x7: Peak: 3.21 mW/g, SAR (1g): 1.45 mW/g, SAR (10g): 0.639 mW/g, (Worst-case extrapolation)
Penetration depth: 6.8 (6.2, 8.5) [mm]
Powerdrift: -0.36 dB

Date Tested: July 08, 2003
Ambient Temperature: 22.9 Deg. Cel.
Liquid Temperature: 21.1 Deg. Cel.
Band: PCS CDMA
Channel: 1175
Configuration: Right side "Touch" postion

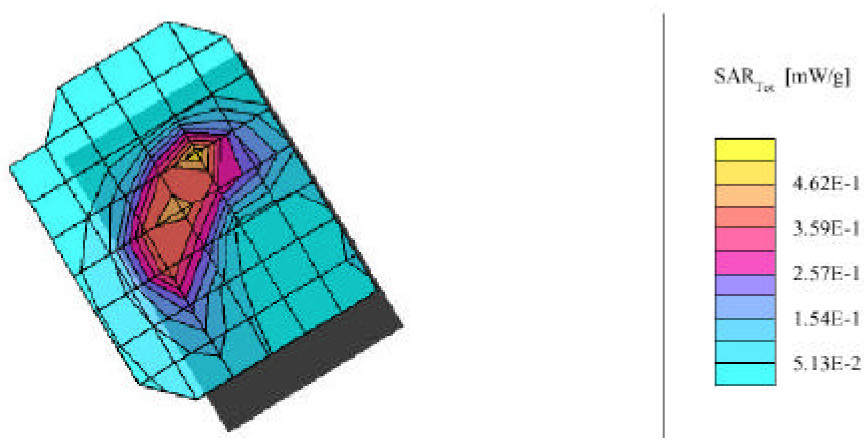


07/08/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 1; Right Hand
Probe: ET3DV6 - SN1642; ConvF(5.30,5.30,5.30); Crest factor: 1.0; Head 1900 MHz: σ = 1.46 mho/m ε_r = 40.1 ρ = 1.00 g/cm³
Cube 5x5x7: Peak: 1.44 mW/g, SAR (1g): 0.605 mW/g, SAR (10g): 0.272 mW/g, (Worst-case extrapolation)
Penetration depth: 5.7 (5.1, 7.6) [mm]
Powerdrift: -0.38 dB

Date Tested: July 08, 2003
Ambient Temperature: 22.9 Deg. Cel.
Liquid Temperature: 21.0 Deg. Cel.
Band: PCS CDMA
Channel: 600
Configuration: Right side "Tilted" position



APPENDIX C: SAR DISTRIBUTION PLOTS FOR BODY-WORN CONFIGURATION

07/11/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 2; Flat

Probe: ET3DV6 - SN1642; ConvF(6.40,6.40,6.40); Crest factor: 1.0; Muscle 835 MHz: σ = 0.99 mho/m ε_r = 53.9 ρ = 1.00 g/cm³

Cube 5x5x7: Peak: 0.796 mW/g, SAR (1g): 0.557 mW/g, SAR (10g): 0.399 mW/g, (Worst-case extrapolation)

Penetration depth: 16.4 (14.1, 18.9) [mm]

Powerdrift: 0.01 dB

Date tested: July 11, 2003

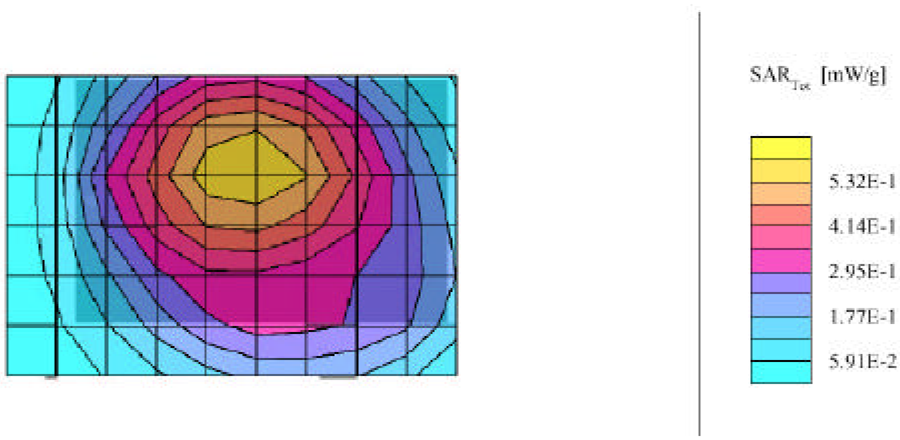
Ambient Temperature: 24.4 (°C)

Liquid Temperature: 22.6 (°C)

Band: Cellular CDMA

Channel: 384

Configuration: Body-Worn with Holster



07/11/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 2; Flat

Probe: ET3DV6 - SN1642; ConvF(6.40,6.40,6.40); Crest factor: 1.0; Muscle 835 MHz: σ = 0.99 mho/m ε_r = 53.9 ρ = 1.00 g/cm³

Cube 5x5x7: Peak: 0.728 mW/g, SAR (1g): 0.501 mW/g, SAR (10g): 0.355 mW/g, (Worst-case extrapolation)

Penetration depth: 16.3 (13.7, 18.9) [mm]

Powerdrift: -0.16 dB

Date tested: July 11, 2003

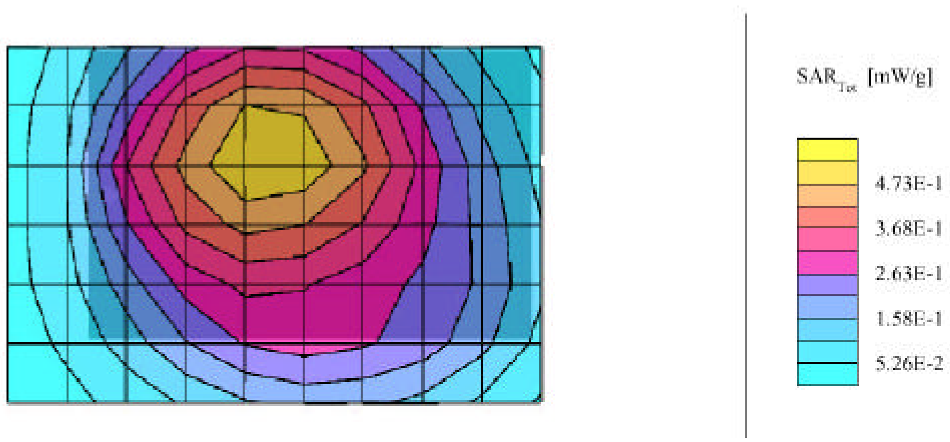
Ambient Temperature: 24.2 (°C)

Liquid Temperature: 22.5 (°C)

Band: Cellular CDMA

Channel: 384

Configuration: Body-Worn with Leather Swivel Holster



07/10/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 2; Flat

Probe: ET3DV6 - SN1642; ConvF(4.80,4.80,4.80); Crest factor: 1.0; Muscle 1900 MHz: σ = 1.57 mho/m ε_r = 52.4 ρ = 1.00 g/cm³

Cube 5x5x7: Peak: 0.446 mW/g, SAR (1g): 0.254 mW/g, SAR (10g): 0.151 mW/g, (Worst-case extrapolation)

Penetration depth: 9.9 (8.7, 11.7) [mm]

Powerdrift: 0.01 dB

Date Tested: July 10, 2003

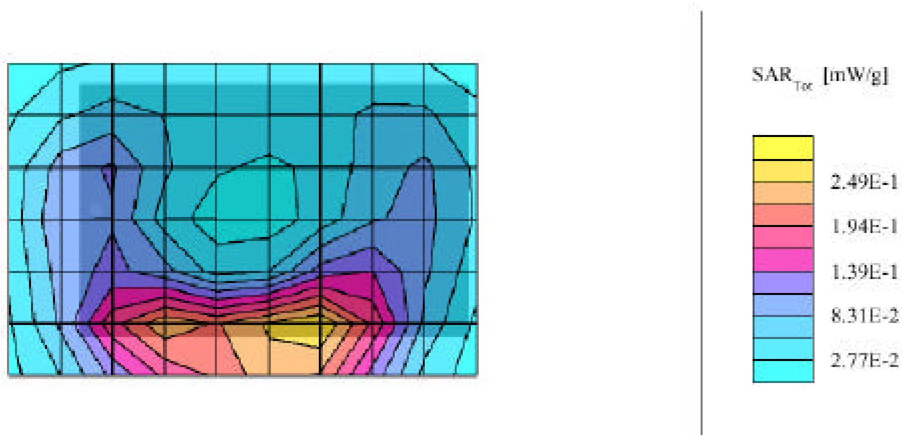
Ambient Temperature: 23.3 Deg. Cel.

Liquid Temperature: 22.1 Deg. Cel.

Band: PCS CDMA

Channel: 600

Configuration: Body worn with Holster

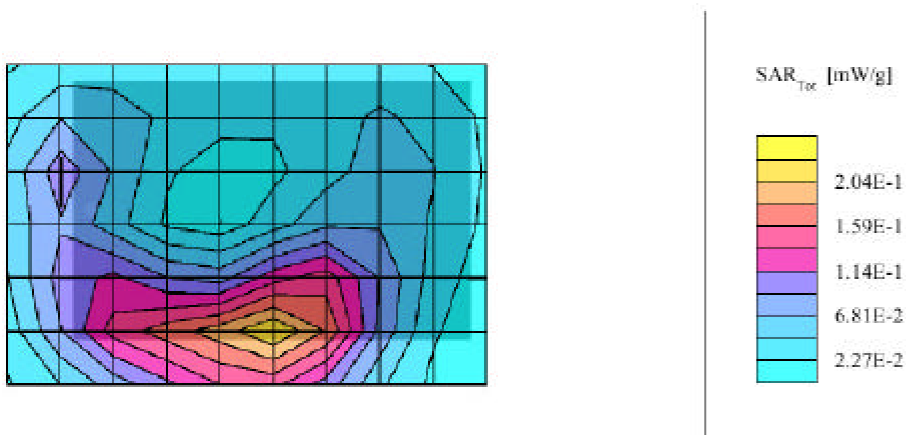


07/10/03

BlackBerry Wireless Handheld Model No. RAN20CN

SAM 2; Flat
Probe: ET3DV6 - SN1642; ConvF(4.80,4.80,4.80); Crest factor: 1.0; Muscle 1900 MHz: $\sigma = 1.57$ mho/m $\varepsilon_r = 52.4$ $\rho = 1.00$ g/cm^3
Cube 5x5x7: Peak: 0.344 mW/g, SAR (1g): 0.197 mW/g, SAR (10g): 0.117 mW/g, (Worst-case extrapolation)
Penetration depth: 9.7 (8.6, 11.5) [mm]
Powerdrift: 0.15 dB

Date Tested: July 10, 2003
Ambient Temperature: 23.4 Deg. Cel.
Liquid Temperature: 22.1 Deg. Cel.
Band: PCS CDMA
Channel: 600
Configuration: Body worn with Leather Swivel Holster



APPENDIX D: PROBE & DIPOLE CALIBRATION DATA

Schmid & Partner
Engineering AG

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

Calibration Certificate

Dosimetric E-Field Probe

Type:	**ET3DV6**
Serial Number:	**1642**
Place of Calibration:	**Zurich**
Date of Calibration:	**July 26, 2002**
Calibration Interval:	**12 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: D. Vetter

Approved by: [signature]

Schmid & Partner Engineering AG

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

Probe ET3DV6

SN:1642

Manufactured:	November 7, 2001
Last calibration:	November 26, 2001
Recalibrated:	July 26, 2002

Calibrated for System DASY3

ET3DV6 SN:1642 **July 26, 2002**

DASY3 - Parameters of Probe: ET3DV6 SN:1642

Sensitivity in Free Space

NormX	**1.62** $\mu V/(V/m)^2$	
NormY	**1.85** $\mu V/(V/m)^2$	
NormZ	**1.61** $\mu V/(V/m)^2$	

Diode Compression

DCP X	**96**	mV
DCP Y	**96**	mV
DCP Z	**96**	mV

Sensitivity in Tissue Simulating Liquid

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

ConvF X	**6.5** ± 8.9% (k=2)	Boundary effect:		
ConvF Y	**6.5** ± 8.9% (k=2)	Alpha	**0.34**	
ConvF Z	**6.5** ± 8.9% (k=2)	Depth	**2.68**	

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

ConvF X	**5.4** ± 8.9% (k=2)	Boundary effect:	
ConvF Y	**5.4** ± 8.9% (k=2)	Alpha	**0.53**
ConvF Z	**5.4** ± 8.9% (k=2)	Depth	**2.33**

Boundary Effect

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

Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	9.9	5.7
SAR_{be} [%]	With Correction Algorithm	0.4	0.5

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

Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	12.0	7.8
SAR_{be} [%]	With Correction Algorithm	0.2	0.2

Sensor Offset

Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.1 ± 0.2**	mm

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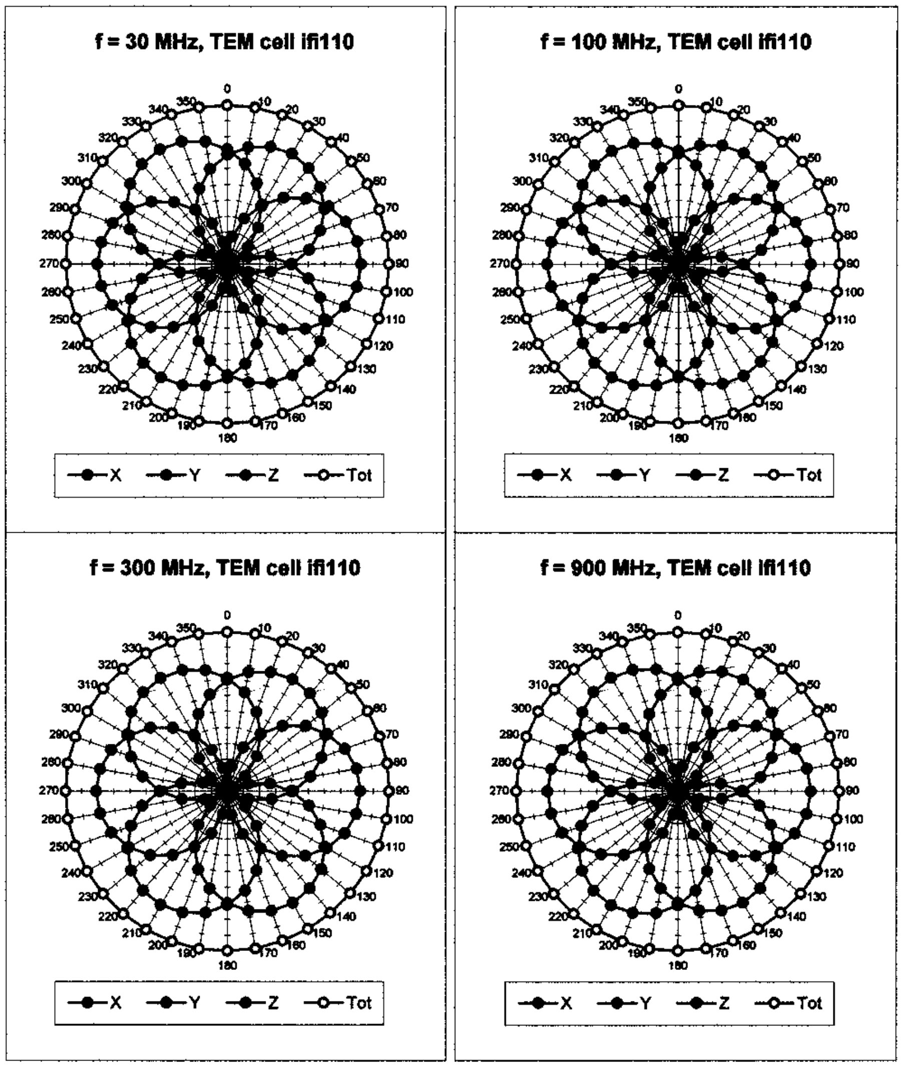
Receiving Pattern (ϕ), $\theta = 0°$



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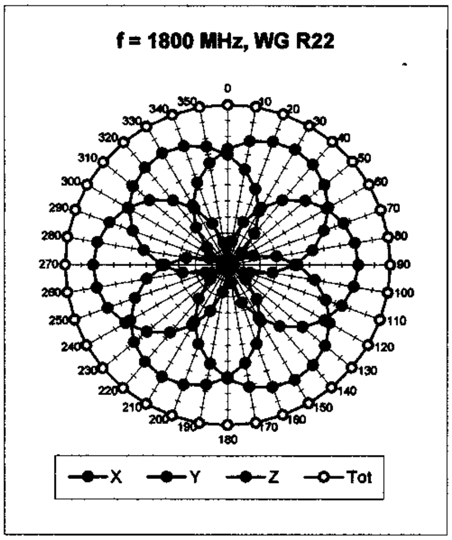
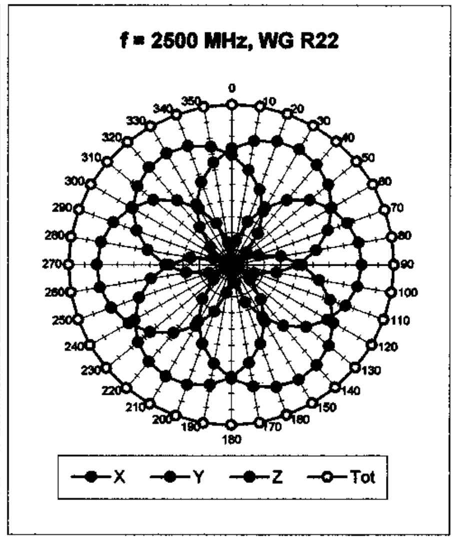
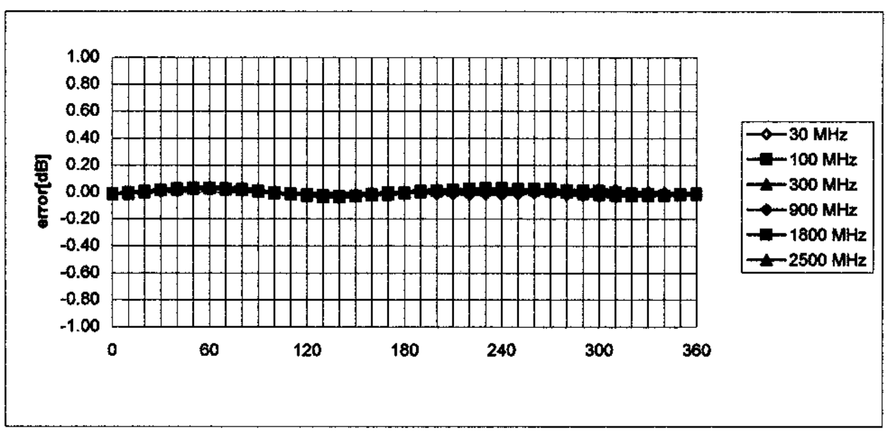




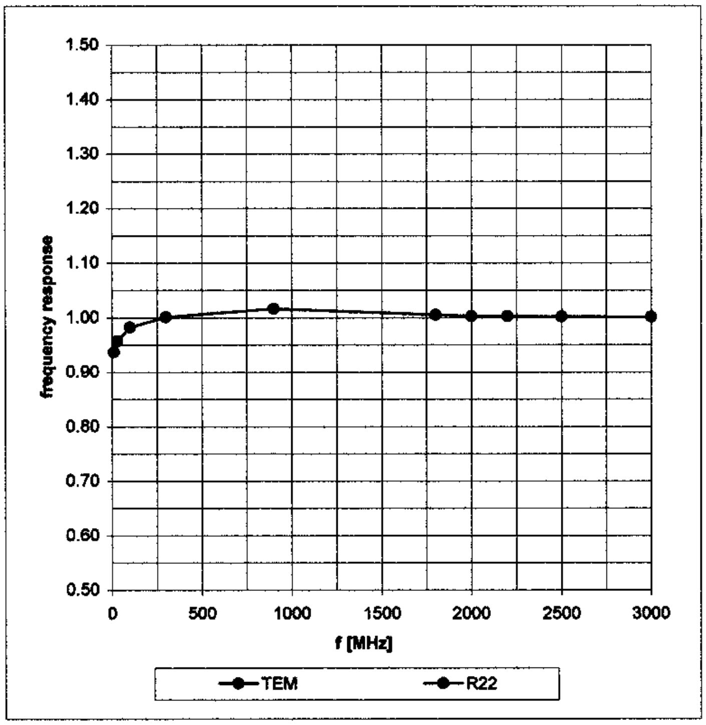
Isotropy Error (ϕ), θ = 0°



ET3DV6 SN:1642 **July 26, 2002**

Frequency Response of E-Field

(TEM-Cell:ifi110, Waveguide R22)



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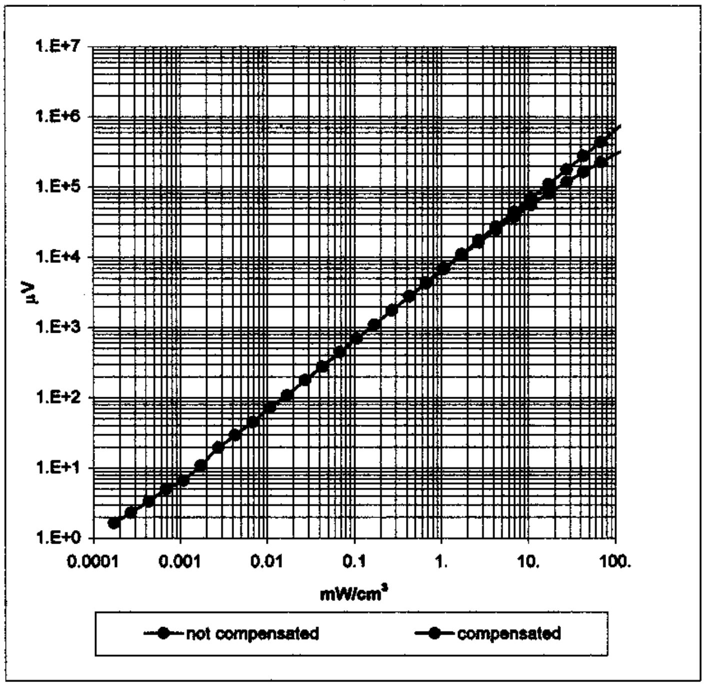
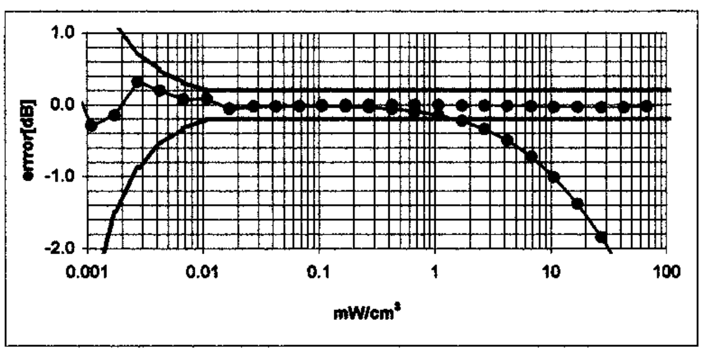
Dynamic Range f(SAR_{brain})

(Waveguide R22)





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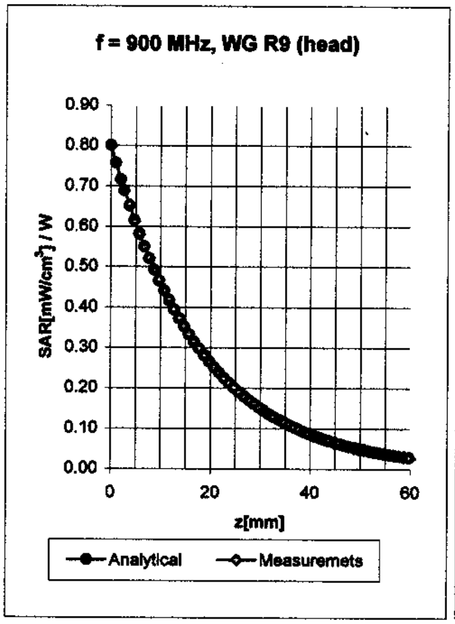
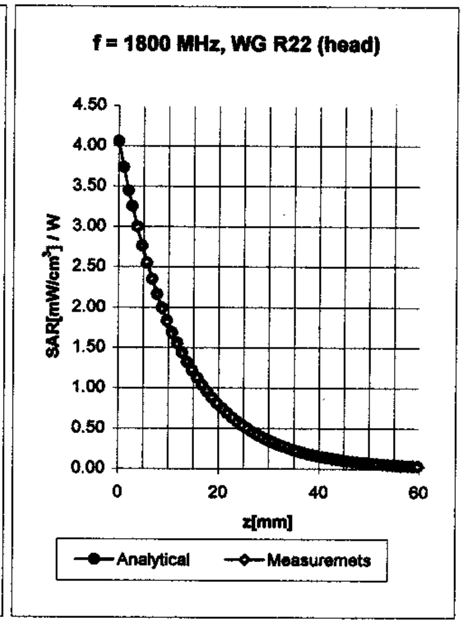
Conversion Factor Assessment



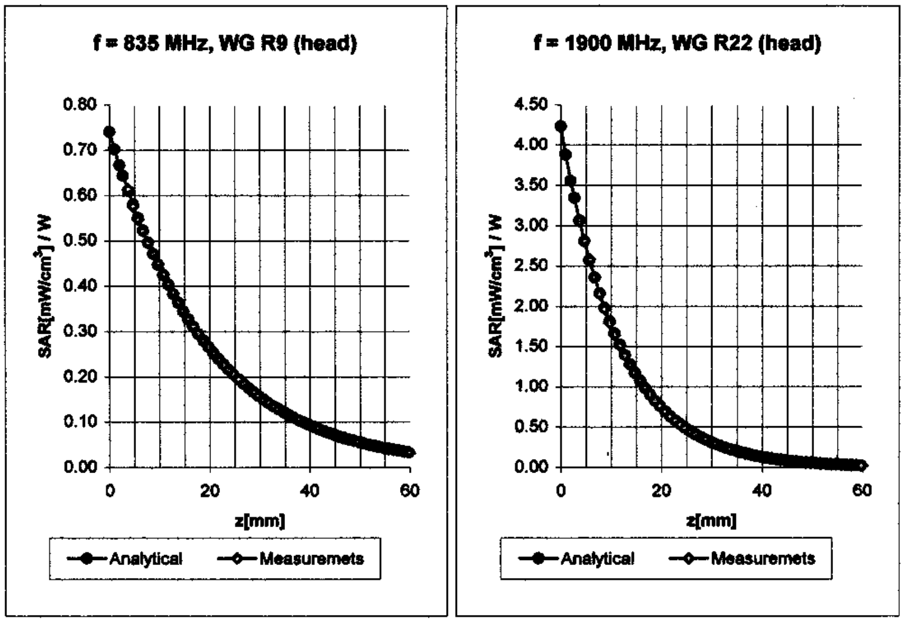


Head	**900 MHz**	ε_r **= 41.5 ± 5%**		**σ = 0.97 ± 5% mho/m**	
	ConvF X	**6.5** ± 8.9% (k=2)		Boundary effect:	
	ConvF Y	**6.5** ± 8.9% (k=2)		Alpha	**0.34**
	ConvF Z	**6.5** ± 8.9% (k=2)		Depth	**2.68**

Head	**1800 MHz**	ε_r **= 40.0 ± 5%**		**σ = 1.40 ± 5% mho/m**	
	ConvF X	**5.4** ± 8.9% (k=2)		Boundary effect:	
	ConvF Y	**5.4** ± 8.9% (k=2)		Alpha	**0.53**
	ConvF Z	**5.4** ± 8.9% (k=2)		Depth	**2.33**

ET3DV6 SN:1642 **July 26, 2002**

Conversion Factor Assessment

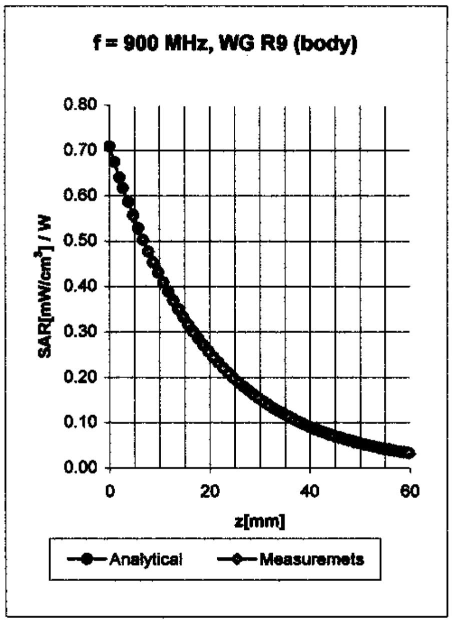


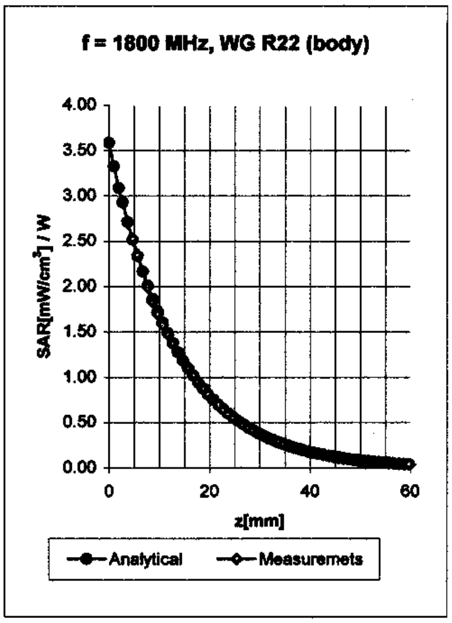
Head	**835 MHz**		ε_r = **41.5 ± 5%**	σ = **0.90 ± 5% mho/m**		
	ConvF X	**6.5**	± 8.9% (k=2)		Boundary effect:	
	ConvF Y	**6.5**	± 8.9% (k=2)		Alpha	**0.34**
	ConvF Z	**6.5**	± 8.9% (k=2)		Depth	**2.65**

Head	**1900 MHz**		ε_r = **40.0 ± 5%**	σ = **1.40 ± 5% mho/m**		
	ConvF X	**5.3**	± 8.9% (k=2)		Boundary effect:	
	ConvF Y	**5.3**	± 8.9% (k=2)		Alpha	**0.57**
	ConvF Z	**5.3**	± 8.9% (k=2)		Depth	**2.28**

ET3DV6 SN:1642 **July 26, 2002**

Conversion Factor Assessment



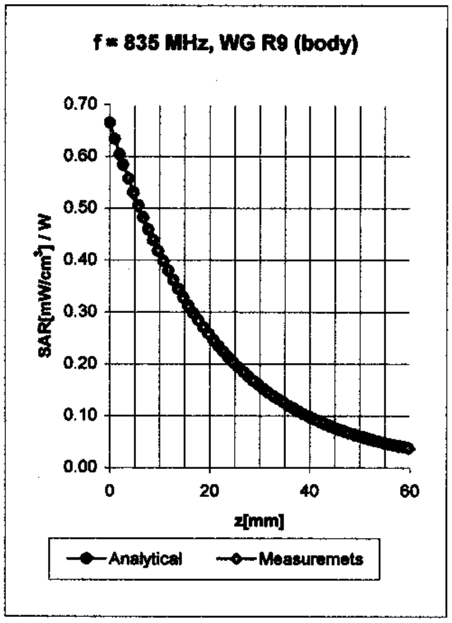


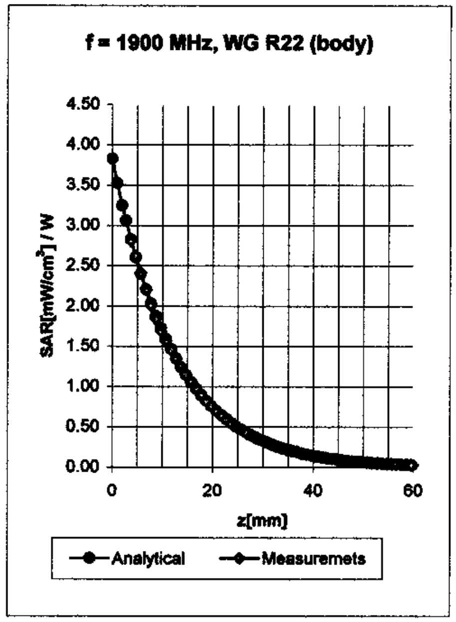
Body	**900 MHz**	ε_r = **55.2 ± 5%**	σ = **0.97 ± 5% mho/m**	
	ConvF X	**6.3** ± 8.9% (k=2)	Boundary effect:	
	ConvF Y	**6.3** ± 8.9% (k=2)	Alpha	**0.36**
	ConvF Z	**6.3** ± 8.9% (k=2)	Depth	**2.63**

Body	**1800 MHz**	ε_r = **53.3 ± 5%**	σ = **1.52 ± 5% mho/m**	
	ConvF X	**5.2** ± 8.9% (k=2)	Boundary effect:	
	ConvF Y	**5.2** ± 8.9% (k=2)	Alpha	**0.61**
	ConvF Z	**5.2** ± 8.9% (k=2)	Depth	**2.30**

ET3DV6 SN:1642 **July 26, 2002**

Conversion Factor Assessment





Body **835 MHz** ε_r **= 55.0 ± 5%** **σ = 1.05 ± 5% mho/m**

ConvF X	**6.4** ± 8.9% (k=2)	Boundary effect:	
ConvF Y	**6.4** ± 8.9% (k=2)	Alpha	**0.36**
ConvF Z	**6.4** ± 8.9% (k=2)	Depth	**2.66**

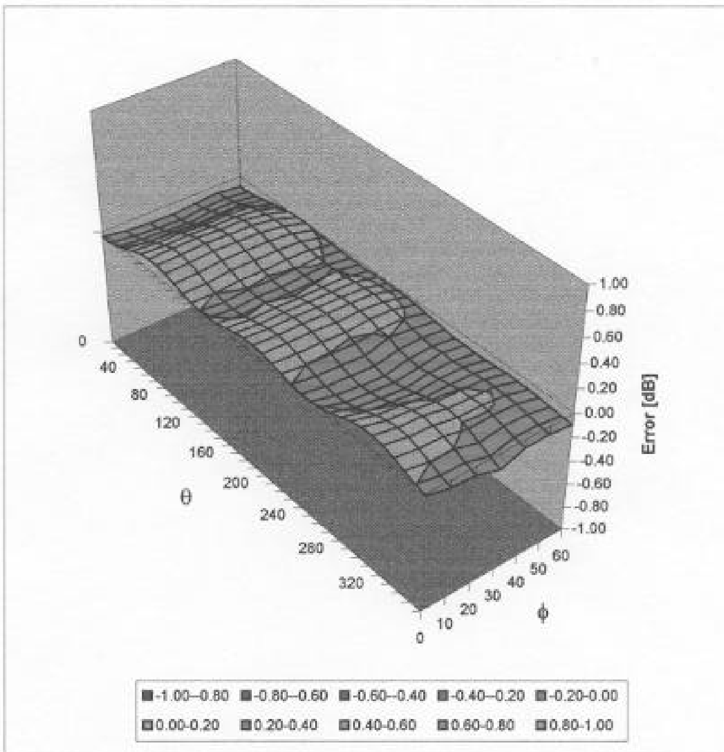
Body **1900 MHz** ε_r **= 53.3 ± 5%** **σ = 1.52 ± 5% mho/m**

ConvF X	**4.8** ± 8.9% (k=2)	Boundary effect:	
ConvF Y	**4.8** ± 8.9% (k=2)	Alpha	**0.74**
ConvF Z	**4.8** ± 8.9% (k=2)	Depth	**2.07**

ET3DV6 SN:1642 July 26, 2002

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

835 MHz System Validation Dipole

Type:	**D835V2**
Serial Number:	**446**
Place of Calibration:	**Zurich**
Date of Calibration:	**November 12, 2001**
Calibration Interval:	**24 months**

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

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

Calibrated by:

Approved by:

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: D835V2

Serial: 446

Manufactured: October 24, 2001
Calibrated: November 12, 2001

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 835 MHz:

Relative Dielectricity	**42.3**	± 5%
Conductivity	**0.91 mho/m**	± 5%

The DASY3 System (Software version 3.1c) with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.27 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:	**10.7 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**6.84 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:	**1.401 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 835 MHz:	**Re{Z} = 49.8 Ω**
	Im {Z} = -4.8 Ω
Return Loss at 835 MHz	**-26.4 dB**

4. Handling

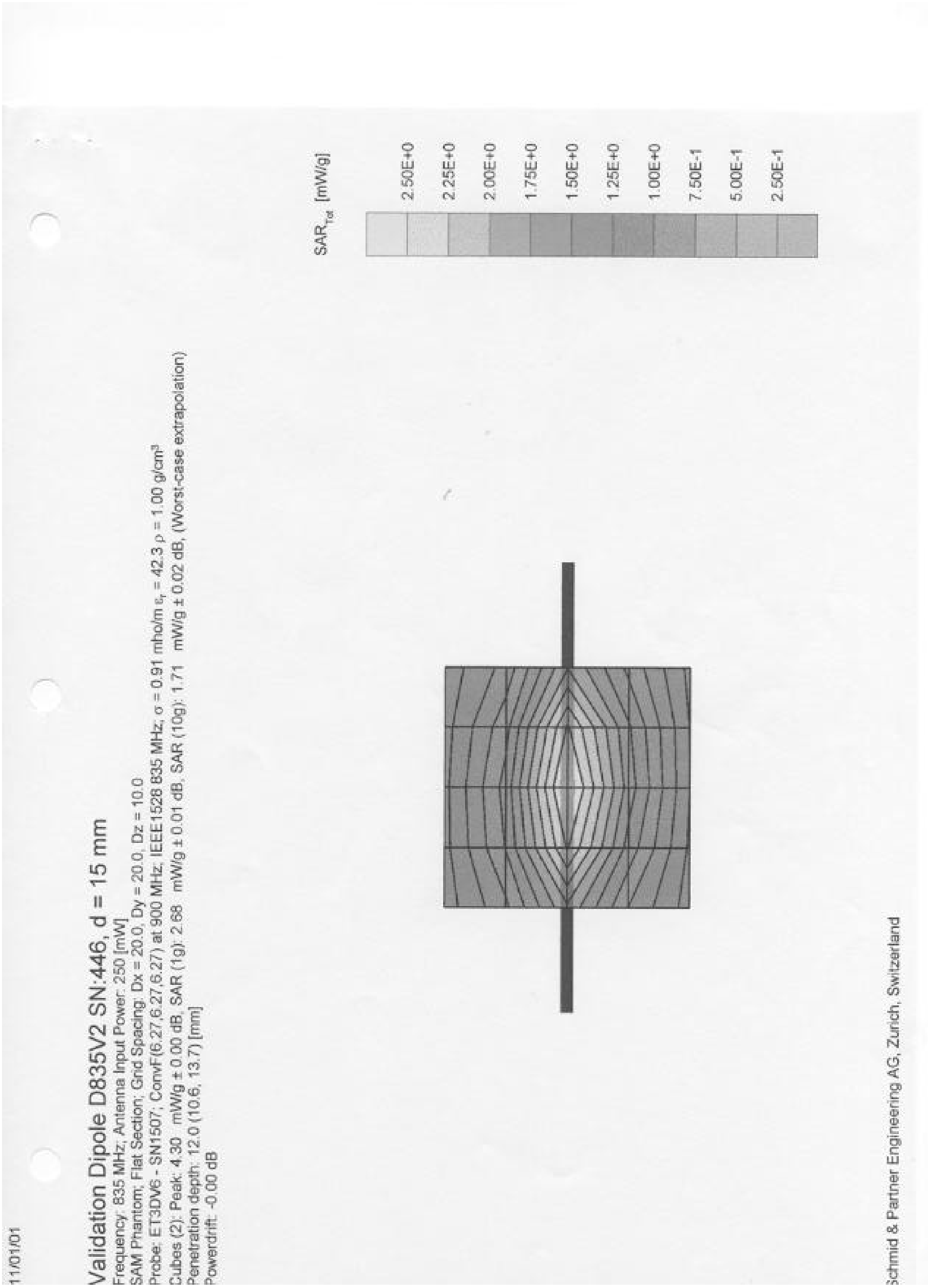
Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

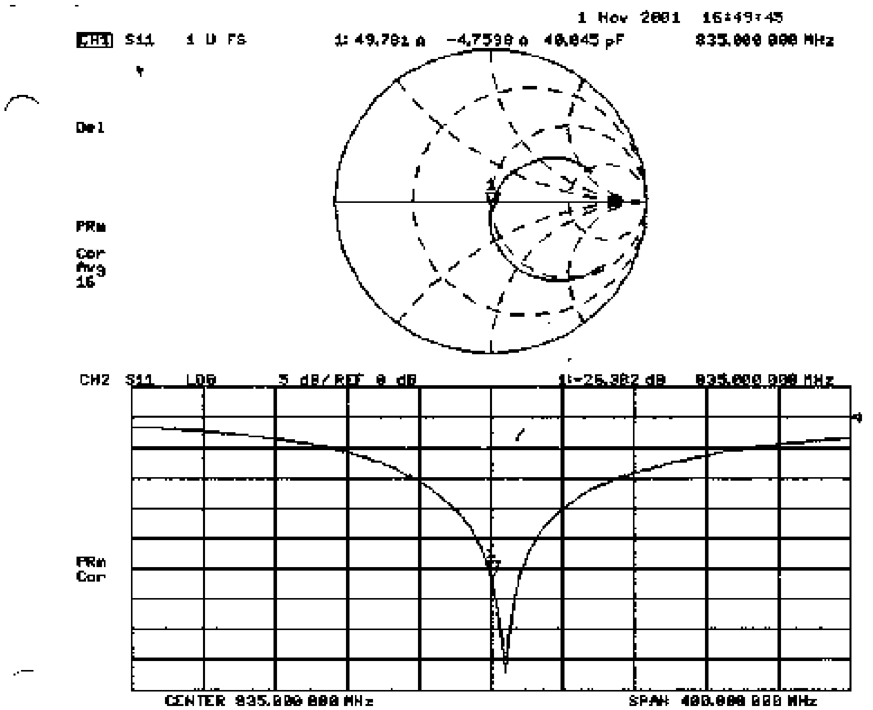
5. Design

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.

6. Power Test

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


11/01/01
Validation Dipole D835V2 SN:446, d = 15 mm
Frequency: 835 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(6.27,6.27,6.27) at 900 MHz; IEEE1528 835 MHz: σ = 0.91 mho/m εr = 42.3 ρ = 1.00 g/cm3
Cubes (2): Peak: 4.30 mW/g ± 0.00 dB, SAR (1g): 2.68 mW/g ± 0.01 dB, SAR (10g): 1.71 mW/g ± 0.02 dB, (Worst-case extrapolation)
Penetration depth: 12.0 (10.6, 13.7) [mm]
Powerdrift: -0.00 dB
SAR Tot [mW/g]
2.50E+0
2.25E+0
2.00E+0
1.75E+0
1.50E+0
1.25E+0
1.00E+0
7.50E-1
5.00E-1
2.50E-1
Schmid & Partner Engineering AG, Zurich, Switzerland


1 Nov 2001 16:49:45
CH1 S11 1 U FS
1: 49.781 Ω -4.7598 Ω 40.045 pF 835.000 000 MHz
Del
PRm
Cor
Avg
16
CH2 S11 LOG 5 dB/ REF 0 dB 1:-25.382 dB 835.000 000 MHz
PRm
Cor
CENTER 835.000 000 MHz
SPAN 400.000 000 MHz

Schmid & Partner Engineering AG

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

Calibration Certificate

1900 MHz System Validation Dipole

Type:	D1900V2
Serial Number:	545
Place of Calibration:	Zurich
Date of Calibration:	November 26, 2001
Calibration Interval:	24 months

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

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

Calibrated by:

Approved by:

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: 545

Manufactured: November 15, 2001
Calibrated: November 26, 2001

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	**40.0**	± 5%
Conductivity	**1.45 mho/m**	± 10%

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.31 at 1800 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. SAR Measurement

Standard SAR-measurements were performed with the head phantom according to the measurement conditions described in section 1. The results (see figure) 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:	**43.2 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**22.0 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. The estimated sensitivities of SAR-values and penetration depths to the liquid parameters are listed in the DASY Application Note 4: 'SAR Sensitivities'.

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:	**1.216 ns**	(one direction)
Transmission factor:	**0.992**	(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} = **50.4 Ω**
	Im {Z} = **1.9 Ω**
Return Loss at 1900 MHz	**- 34.3 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.

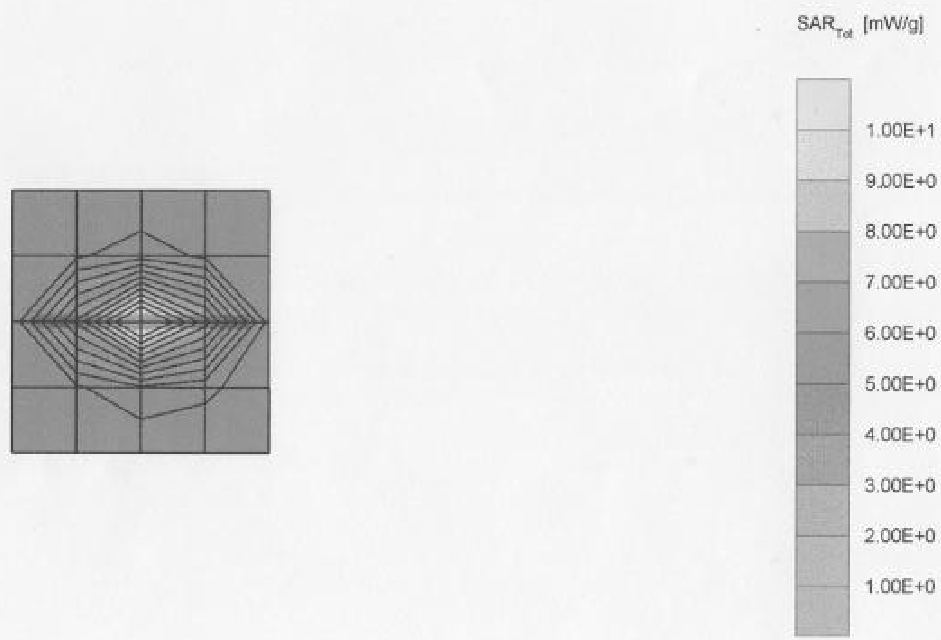
6. Power Test

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

11/21/01

Validation Dipole D1900V2 SN:545, 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(5.31,5.31,5.31) at 1800 MHz; IEEE1528 1900 MHz ; σ = 1.45 mho/m ε_r = 40.0 ρ = 1.00 g/cm³
Cubes (2): Peak: 20.8 mW/g ± 0.07 dB, SAR (1g): 10.8 mW/g ± 0.05 dB, SAR (10g): 5.51 mW/g ± 0.03 dB, (Worst-case extrapolation)
Penetration depth: 7.8 (7.4, 8.9) [mm]
Powerdrift: -0.02 dB



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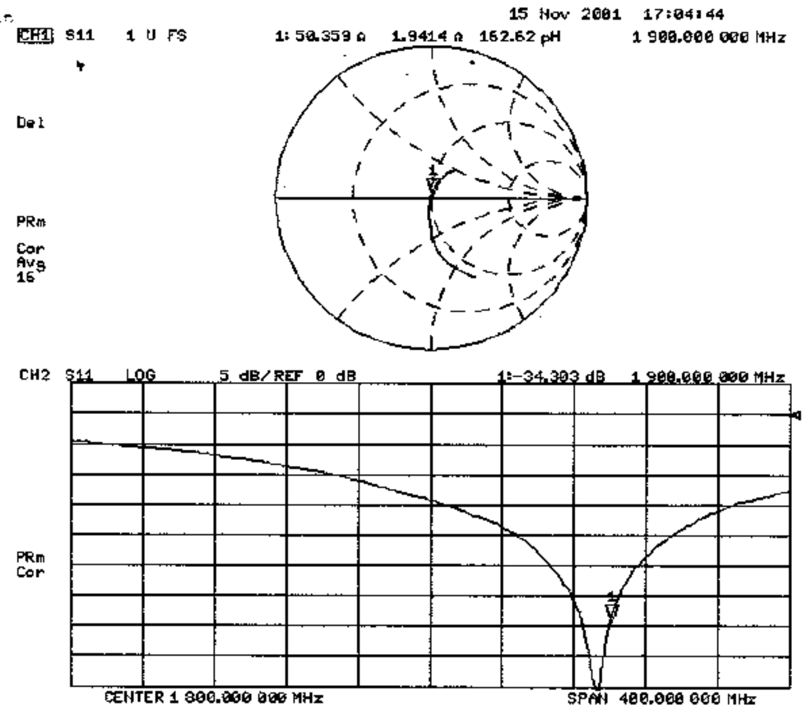
15 Nov 2001 17:04:44
CH1 S11 1 U FS
1: 50.359 Ω 1.9414 Ω 162.62 pH 1 900.000 000 MHz
Del
PRm
Cor
Avg
16
CH2 S11 LOG 5 dB/ REF 0 dB 1:-34.303 dB 1 900.000 000 MHz
PRm
Cor
CENTER 1 800.000 000 MHz
SPAN 400.000 000 MHz

APPENDIX E: SAR SET UP PHOTOS

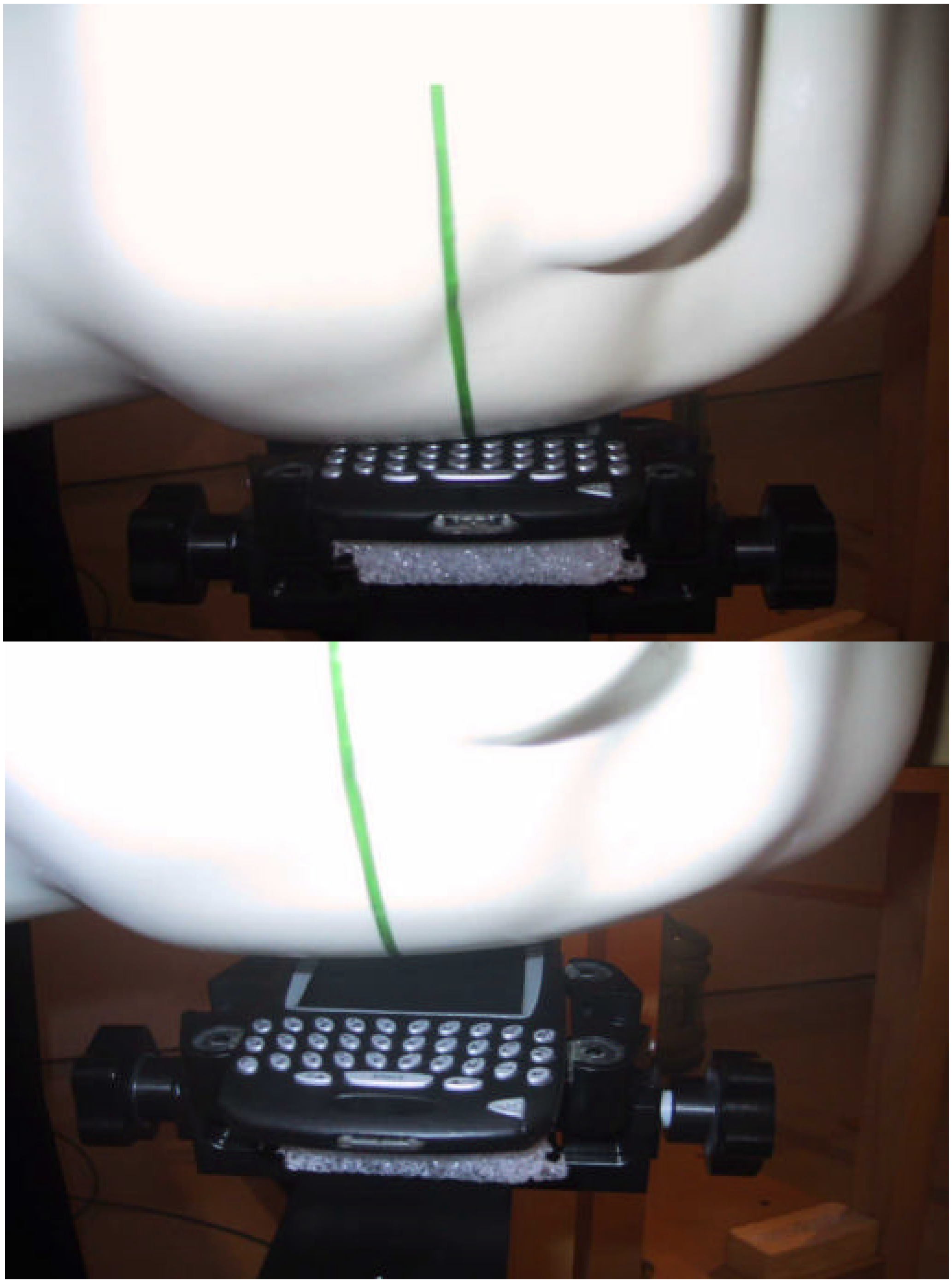

Figure E1. Left ear configuration

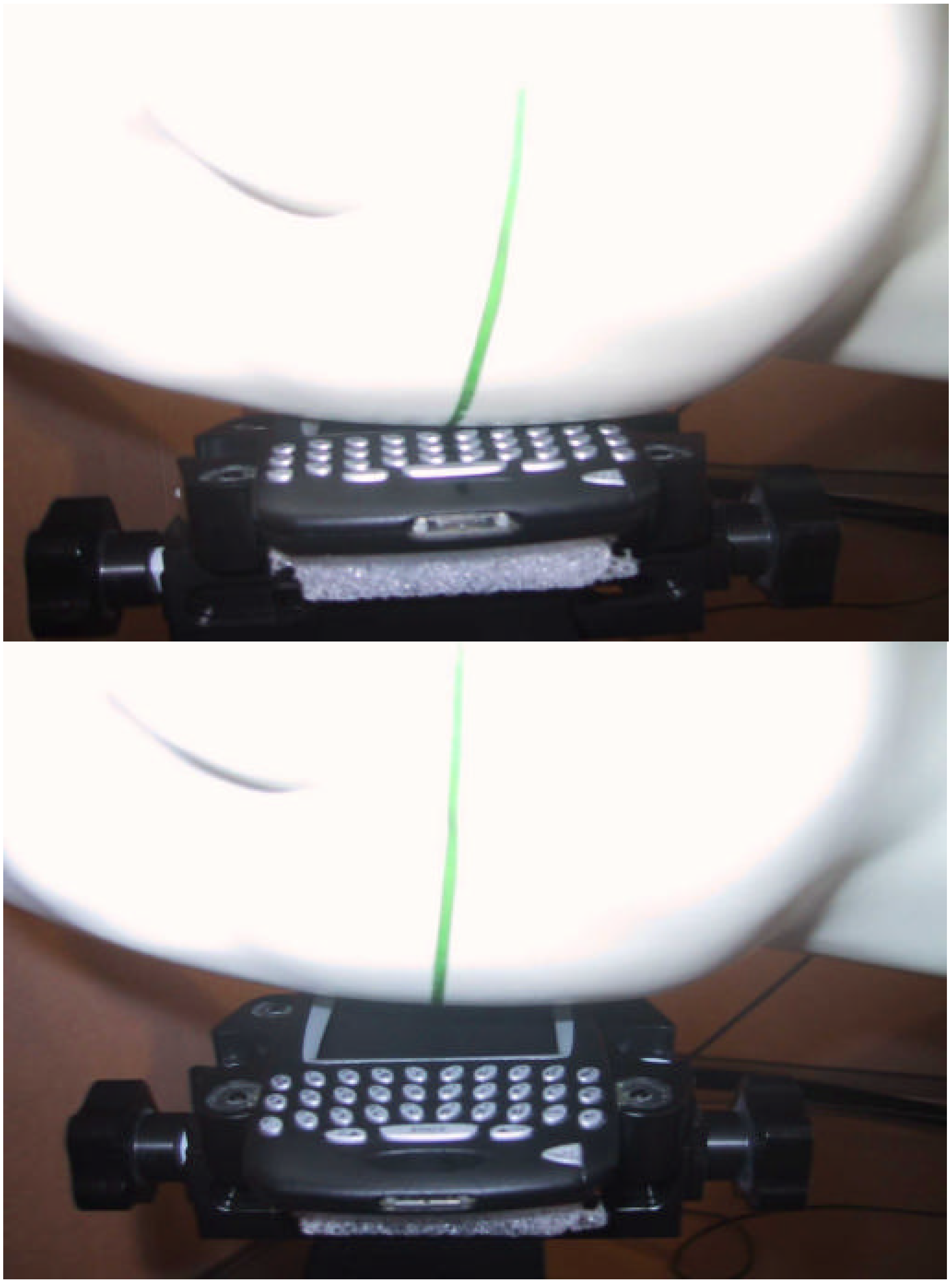

Figure E2. Right ear configuration

Figure E3. Body worn configuration with Plastic Holster ASY-0399-001 and headset

Figure E4. Body worn configuration with Leather Swivel Holster HDW-04890-001 and headset