SAR Compliance Test Report

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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 hand, body and to be carried in an approved holster.

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	24 July, 2003
Tested and documented by: Daoud Attayi Compliance Specialist	Daoud Attayi	26 June, 2003

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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	RAM10MN
FCC ID	L6ARAM10MN
Serial Number	031/17/156161
Prototype or Production Unit	Pre-production
Mode(s) of Operation	Mobitex 900 MHz
Maximum conducted RF Output Power	33.0 dBm
Tolerance in Power Setting	32.7 ± 0.3 dB
Duty Cycle	1:12
Transmitting Frequency Range (s)	896 - 901 MHz

Table 2. Test device description

1.4 Body worn accessories

Holster

The holster, 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.

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Figure 2. Body-worn Holster ASY-03802-001

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 Procedure used to establish the test signal

The Handheld was put into test mode for the SAR measurements by enabling a call via RIM Config Tool , Wireless Type Test Tool, PC and a Signal Generator to simulate a Base Station. An antenna was connected to the output of the signal generator to communicate with the handheld over the air. The Wireless Type Test Tool sends a command to the singnal generator via GPIB and another command to the handheld to transmit at full power at the specified frequency.

The frequency, power level and duty cycle can be controlled by this Wireless Type Test Tool during testing. Final product will have a fixed power level and duty cycle which cannot be altered by the users.

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.

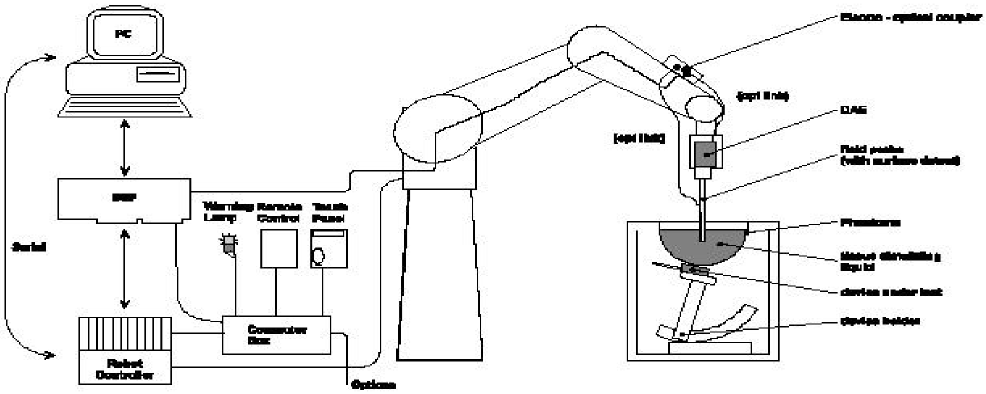


Figure 3: System Description

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	D900V2	133	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
Giga-Tronics	Power meter	8541C	1837762	30/10/2003
Giga-Tronics	Power sensor	80401A	1835838	21/09/2003
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	21/09/2003

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

- Power up the handheld
- Turn on the Signal Generator, PC and open the Wireless Type Test Tool software and set the frequency, power, duty cycle, receiver frequency and signal level to the appropriate values.
- Connect an antenna to the RF IN/OUT of the signal genrator and place it close to the Handheld.
- Start the Wireless Type Test Tool to start transmitting.

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]	
900	Measured	11.9 / 7.4	42.4	0.99	23.5
	Recommended Limits	11.6 / 7.3	41.5	0.97	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]	
900	Head	Measured	42.4	0.99	23.5
		Recommended Limits	41.5	0.97	N/A
	Muscle	Measured	53.8	1.05	23.3
		Recommended Limits	55.0	1.06	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

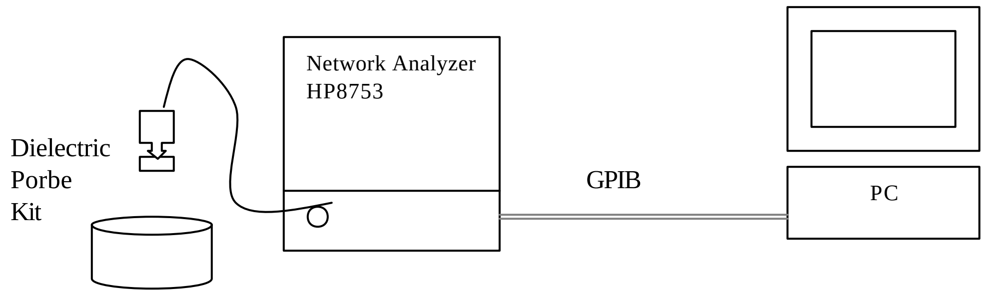


Figure 5: Test configuration

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 900 MHz head tissue dielectric parameters using data from Table 10.

Relative permittivity $\varepsilon r = \varepsilon'$ = 42.46

Conductivity $\sigma = \omega \varepsilon_0 \varepsilon''$ = 2 x 3.1416 x 835 e+6 x 8.854e-12 x 19.70 = 0.99 S/m

Title
SubTitle
June 23, 2003 10:06 AM

Frequency	e'	e"
800.000000 MHz	43.6730	20.0289
805.000000 MHz	43.5807	19.9787
810.000000 MHz	43.5226	20.0066
815.000000 MHz	43.4456	19.9640
820.000000 MHz	43.3983	19.9459
825.000000 MHz	43.3299	19.9448
830.000000 MHz	43.2907	19.9301
835.000000 MHz	43.1949	19.9003
840.000000 MHz	43.1410	19.9011
845.000000 MHz	43.0755	19.8949
850.000000 MHz	43.0247	19.8637
855.000000 MHz	42.9584	19.8479
860.000000 MHz	42.8912	19.8431
865.000000 MHz	42.8383	19.8137
870.000000 MHz	42.7816	19.7858
875.000000 MHz	42.7229	19.7487
880.000000 MHz	42.6764	19.7491
885.000000 MHz	42.6001	19.7485
890.000000 MHz	42.5600	19.7472
895.000000 MHz	42.5320	19.7172
900.000000 MHz	42.4589	19.7014
905.000000 MHz	42.4333	19.6911
910.000000 MHz	42.3677	19.6934
915.000000 MHz	42.3126	19.6630
920.000000 MHz	42.2433	19.6473
925.000000 MHz	42.1924	19.6408
930.000000 MHz	42.1130	19.6337

Title
SubTitle
June 23, 2003 11:11 AM

Frequency	e'	e"
800.000000 MHz	54.7337	21.3559
805.000000 MHz	54.7014	21.3395
810.000000 MHz	54.6528	21.3064
815.000000 MHz	54.5907	21.2954
820.000000 MHz	54.5388	21.2473
825.000000 MHz	54.4910	21.2539
830.000000 MHz	54.4648	21.2250
835.000000 MHz	54.4065	21.1969
840.000000 MHz	54.3325	21.1530
845.000000 MHz	54.2632	21.1190
850.000000 MHz	54.2453	21.1316
855.000000 MHz	54.2066	21.0867
860.000000 MHz	54.1274	21.0466
865.000000 MHz	54.0896	21.0561
870.000000 MHz	54.0385	21.0277
875.000000 MHz	53.9998	20.9735
880.000000 MHz	53.9370	20.9928
885.000000 MHz	53.8986	20.9762
890.000000 MHz	53.8856	20.9815
895.000000 MHz	53.8311	20.9189
900.000000 MHz	53.7997	20.9001
905.000000 MHz	53.7925	20.8875
910.000000 MHz	53.7509	20.8781
915.000000 MHz	53.7030	20.8248
920.000000 MHz	53.6693	20.8178
925.000000 MHz	53.5675	20.7922
930.000000 MHz	53.5689	20.7663

Table 10. 900 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 11. 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 12. 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).

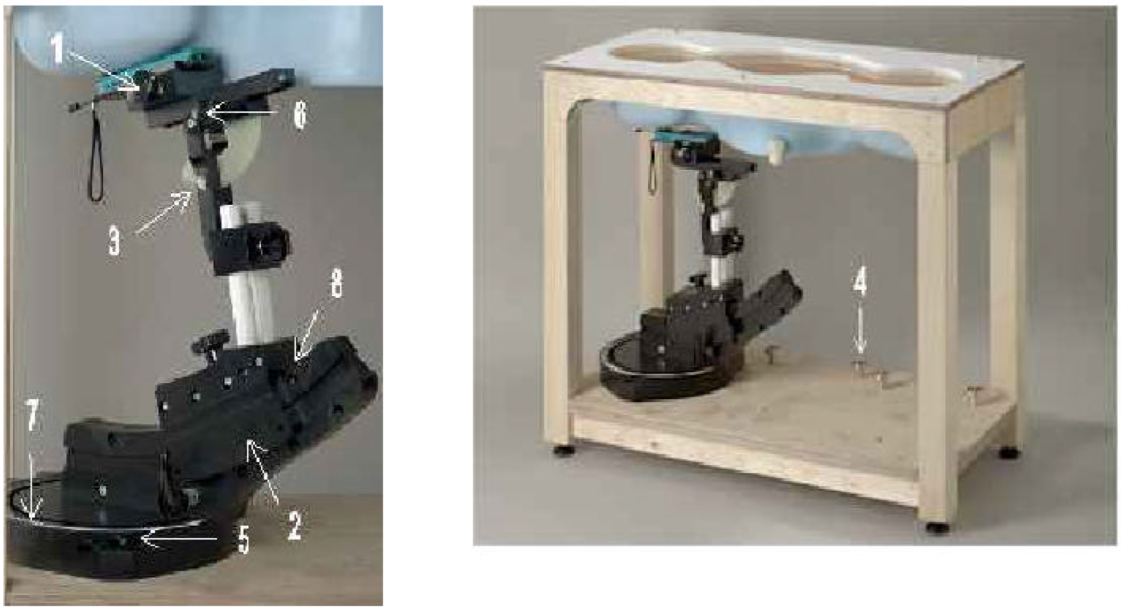


Figure 6
Device Holder

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".

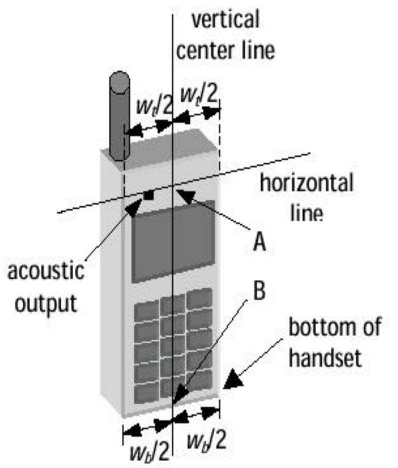


Figure 7a – Handset vertical and horizontal reference lines – fixed case

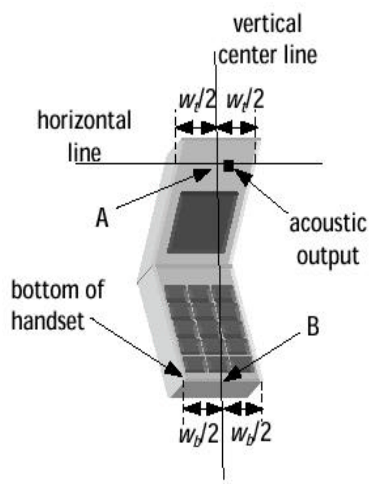


Figure 7b – Handset vertical and horizontal reference lines – "clam-shell"

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).

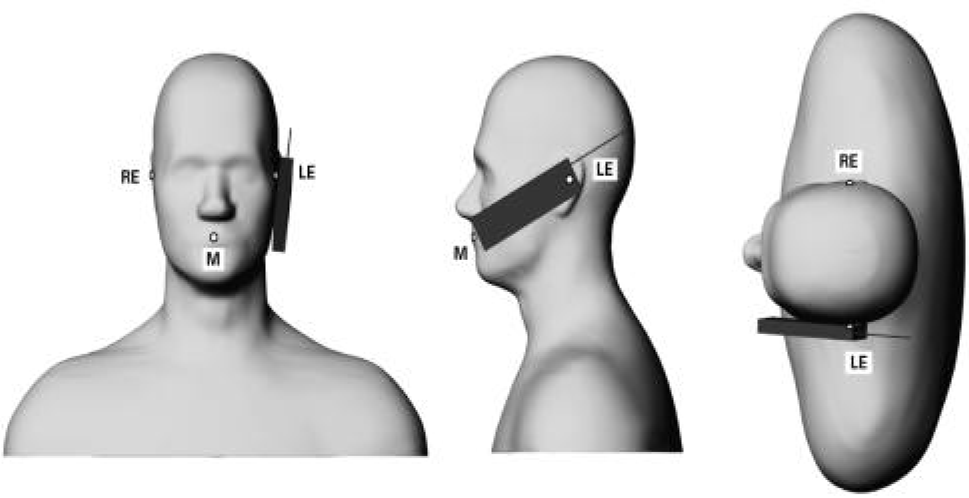


Figure 8 – Phone position 1, “cheek” or “touch” position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

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.

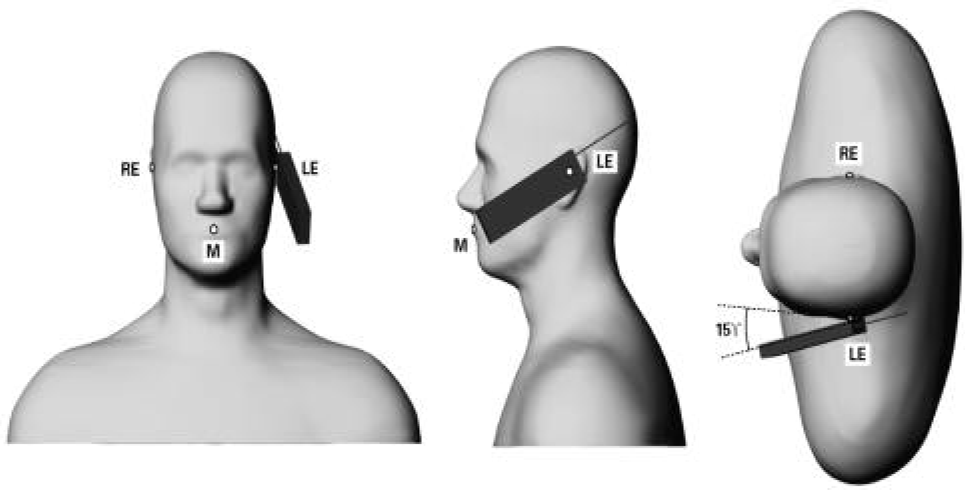


Figure 9 – Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

8.2.2 Body-Worn 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.

In addition, handheld was placed with zero distance to the flat phantom for front and back side for bdoy-worn inside shirt pocket configuration.

9.0 High Level Evaluation

9.1 Maximum search

The maximum search 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 13. Measurement uncertainty

11.0 TEST RESULTS

11.1 SAR measurement results at highest power measured against the body, handheld touching flat phantom for shirt pocket configuration.

Mode	**f (MHz)**	**Conducted Output Power (dBm)**	**Liquid Temp (°C)**	**Handheld configuration touching flat phantom with 0 mm distance**	**SAR, averaged over 1 g (W/kg)**
Mobitex 900	896	32.81	22.8	Front side	1.39
	899	32.91	22.8	Front side	1.52
	901	32.85	22.7	Front side	1.35
	896	32.81	22.5	Back side	1.51
	899	32.91	22.4	Back side	**1.53**
	901	32.85	22.4	Back side	1.47

Table 14. SAR results for Body-Worn configuration for shirt pocket

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

Mode	**f (MHz)**	**Conducted Output Power (dBm)**	**Liquid Temp (°C)**	**SAR, averaged over 1 g (W/kg)**
Mobitex 900	896	32.81	22.8	0.37
	899	32.91	22.7	**0.43**
	901	32.85	22.8	0.36

Table 15. SAR results with Holster for body configuration

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

06/23/03

Dipole 900

SAM 1; Flat

Probe: ET3DV6 - SN1642; ConvF(6.50,6.50,6.50); Crest factor: 1.0; Head 900 MHz: σ = 0.99 mho/m ε_r = 42.5 ρ = 1.00 g/cm³

Cube 5x5x7: Peak: 19.7 mW/g, SAR (1g): 11.9 mW/g, SAR (10g): 7.42 mW/g, (Worst-case extrapolation)

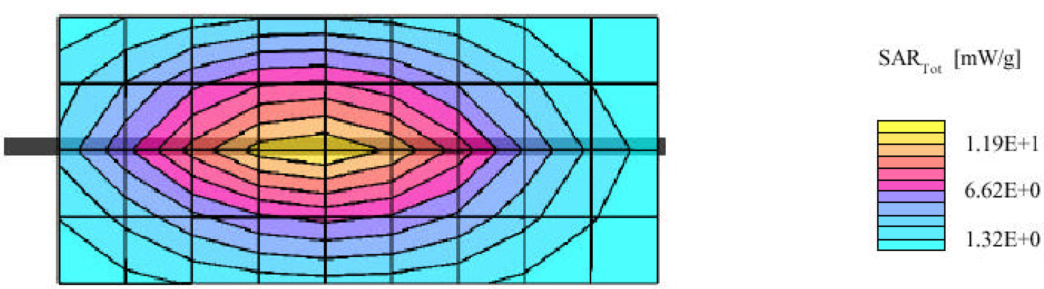
Penetration depth: 11.1 (9.7, 13.1) [mm]

Powerdrift: 0.04 dB

Date tested: June 23, 2003

Ambient temperature: 24.2 (°C)

Liquid temperature: 23.5 (°C)



APPENDIX B: SAR DISTRIBUTION PLOTS FOR BODY-WORN CONFIGURATION

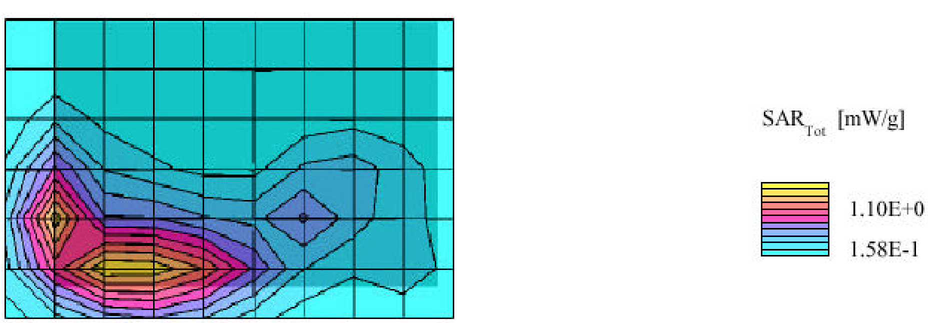
06/24/03

RIM 967 Wireless Handheld Model RAM10MN

SAM 2; Flat

Probe: ET3DV6 - SN1642; ConvF(6.30,6.30,6.30); Crest factor: 12.0; Muscle 900 MHz: $\sigma = 1.05$ mho/m $\varepsilon_r = 53.8$ $\rho = 1.00$ g/cm^3
Cube 5x5x7: Peak: 3.03 mW/g, SAR (1g): 1.52 mW/g, SAR (10g): 0.813 mW/g * Max outside, (Worst-case extrapolation)
Penetration depth: 10.5 (10.4, 10.6) [mm]
Powerdrift: 0.11 dB

Date tested: June 25, 2003
Ambient temperature: 23.8 (°C)
Liquid temperature: 22.8 (°C)
Band: Mobitex 900 MHz
Frequency: 899 MHz
Configuration: Body-worn inside shirt pocket with zero distance,
front side of handheld touching flat phantom



06/24/03

RIM 967 Wireless Handheld Model RAM10MN

SAM 2; Flat

Probe: ET3DV6 - SN1642; ConvF(6.30,6.30,6.30); Crest factor: 12.0; Muscle 900 MHz: σ = 1.05 mho/m ε_r = 53.8 ρ = 1.00 g/cm³

Cube 5x5x7: Peak: 2.73 mW/g, SAR (1g): 1.53 mW/g * , SAR (10g): 0.904 mW/g * Max outside, (Worst-case extrapolation)

Penetration depth: 10.0 (9.7, 10.8) [mm]

Powerdrift: -0.06 dB

Date tested: June 24, 2003

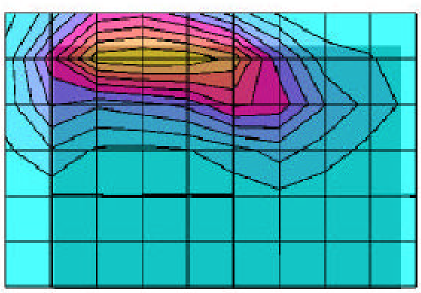
Ambient temperature: 23.5 (°C)

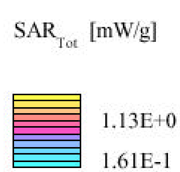
Liquid temperature: 22.4 (°C)

Band: Mobitex 900 MHz

Frequency: 899 MHz

Configuration: Body-worn inside shirt pocket with zero distance, back side of handheld touching flat phantom





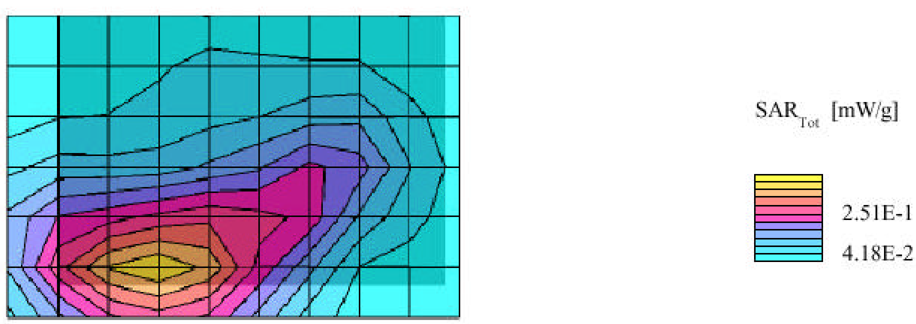
06/24/03

BlackBerry Wireless Handheld Model RAM10MN

SAM 2; Flat

Probe: ET3DV6 - SN1642; ConvF(6.30,6.30,6.30); Crest factor: 12.0; Muscle 900 MHz: σ = 1.05 mho/m ε_r = 53.8 ρ = 1.00 g/cm³
Cube 5x5x7: Peak: 0.935 mW/g, SAR (1g): 0.426 mW/g, SAR (10g): 0.255 mW/g, (Worst-case extrapolation)
Penetration depth: 30.5 (13.2, 101.7) [mm]
Powerdrift: 0.35 dB

Date tested: June 25, 2003
Ambient temperature: 23.8 (°C)
Liquid temperature: 22.7 (°C)
Band: Mobitex 900 MHz
Frequency: 899 MHz
Configuration: Body-worn with holster



APPENDIX C: 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:

Approved by:

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**

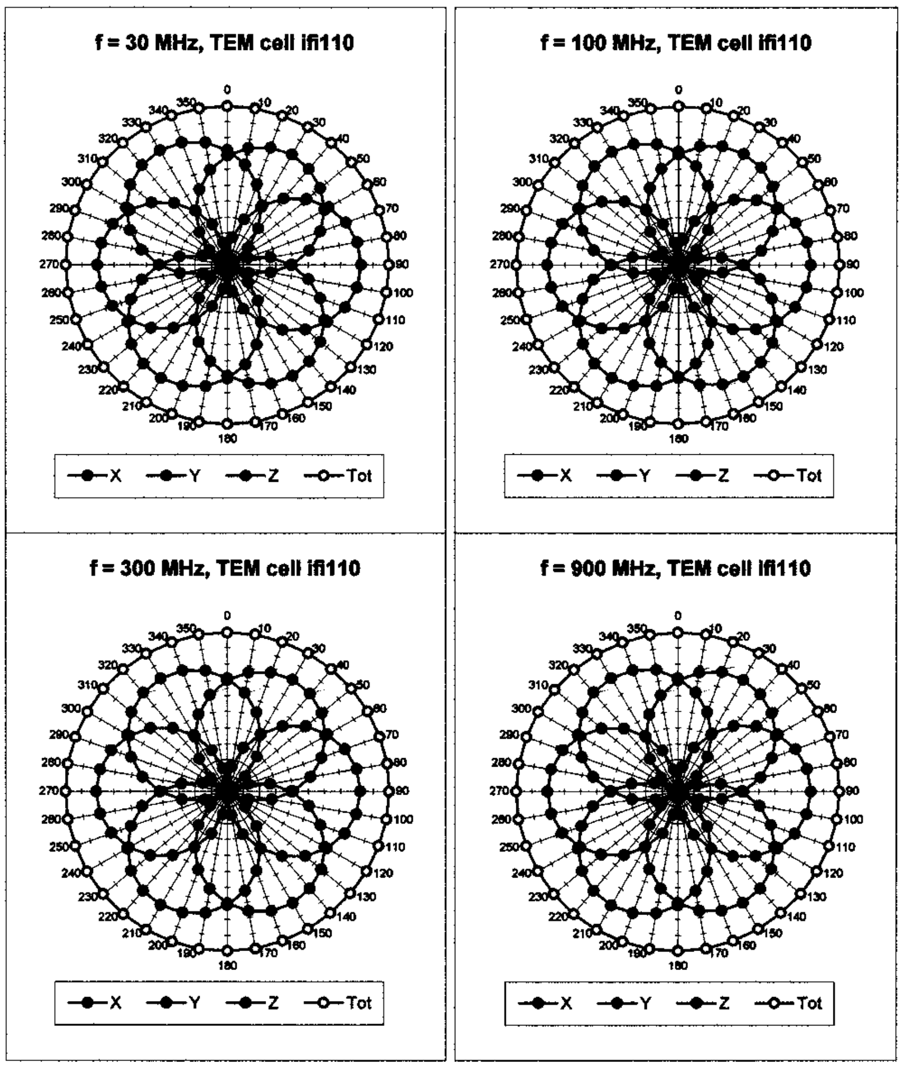
Probe Tip to Boundary		1 mm	2 mm
SAR_{be} [%]	Without Correction Algorithm	12.0	7.8
SAR_{be} [%]	With Correction Algorithm	0.2	0.2

Sensor Offset

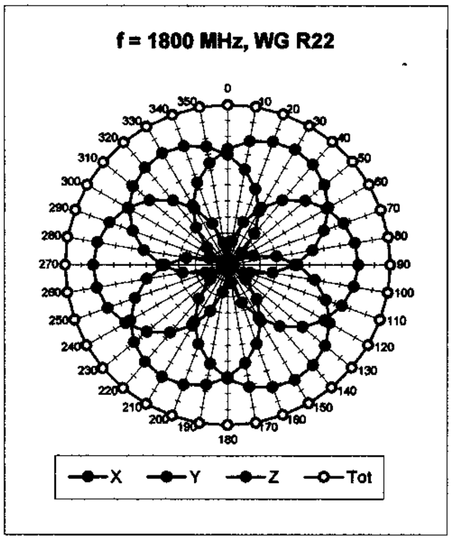
Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.1 ± 0.2**	mm

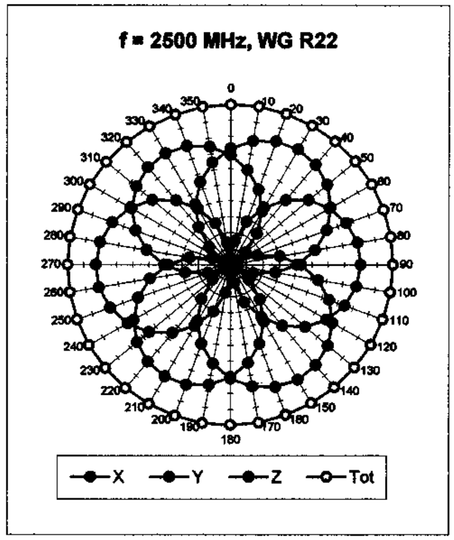
ET3DV6 SN:1642 **July 26, 2002**

Receiving Pattern (ϕ), θ = 0°

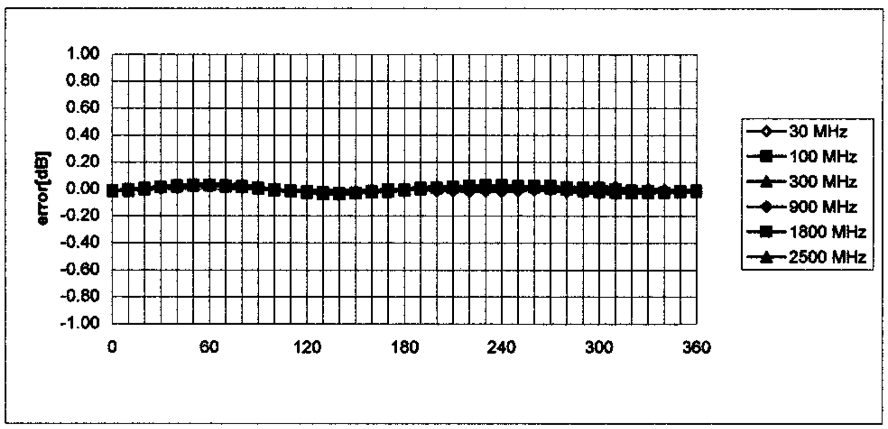


ET3DV6 SN:1642 **July 26, 2002**





Isotropy Error (ϕ), θ = 0°



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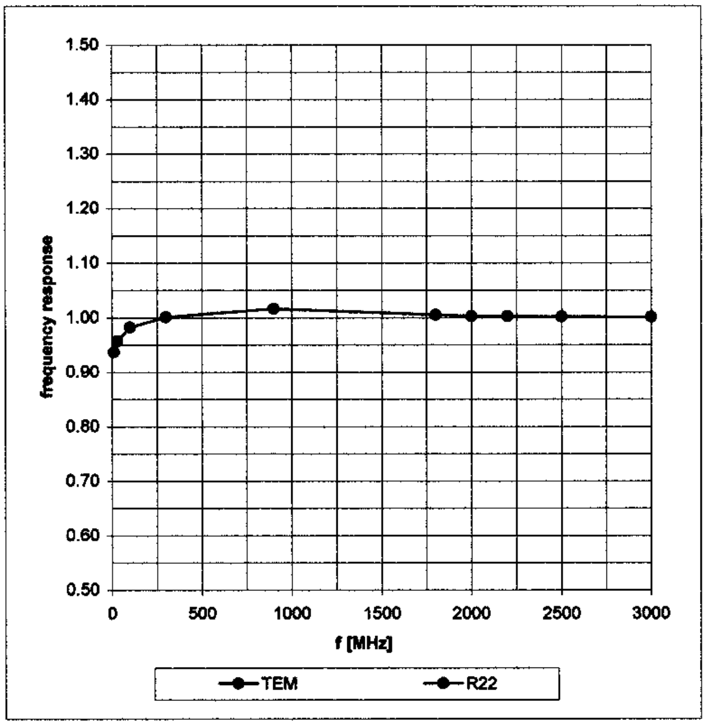
ET3DV6 SN:1642 **July 26, 2002**

Frequency Response of E-Field

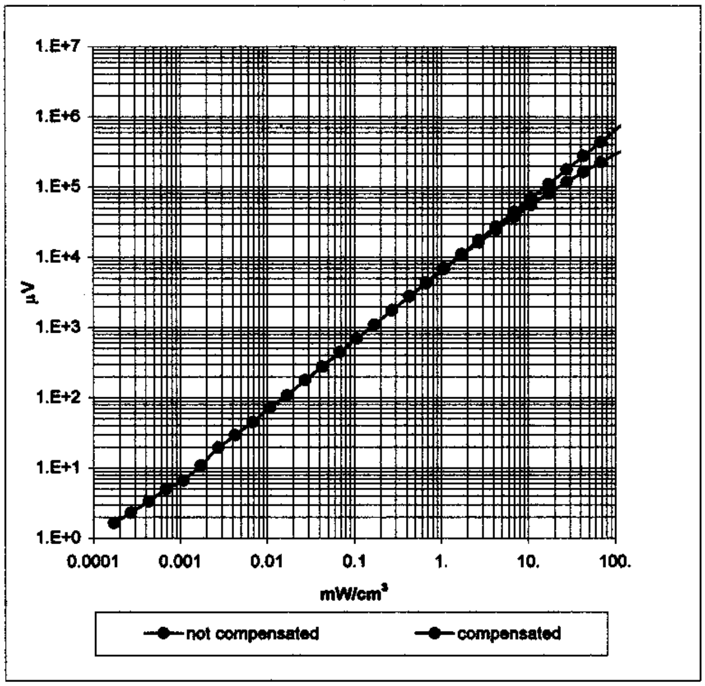
(TEM-Cell:ifi110, Waveguide R22)

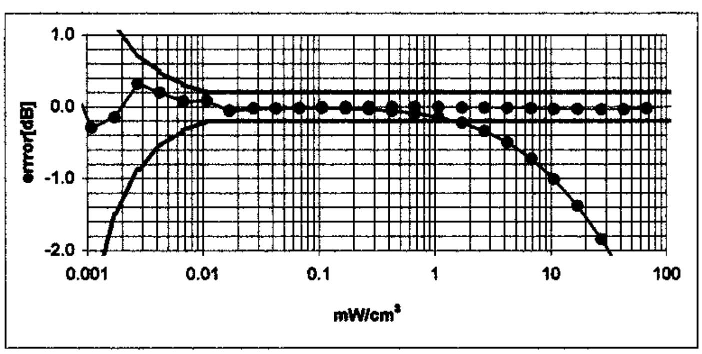


ET3DV6 SN:1642 **July 26, 2002**

Dynamic Range f(SAR_{brain})

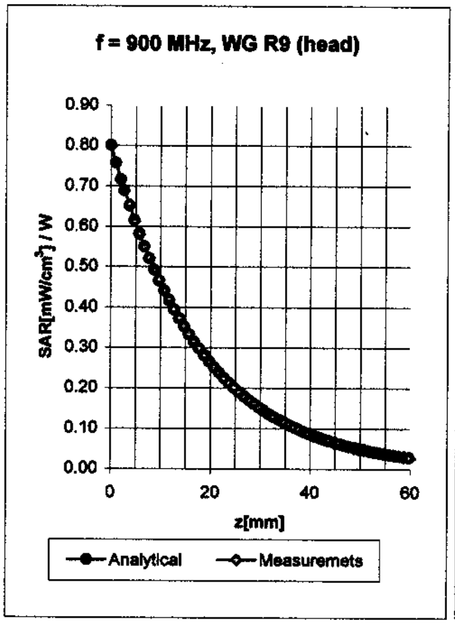
(Waveguide R22)

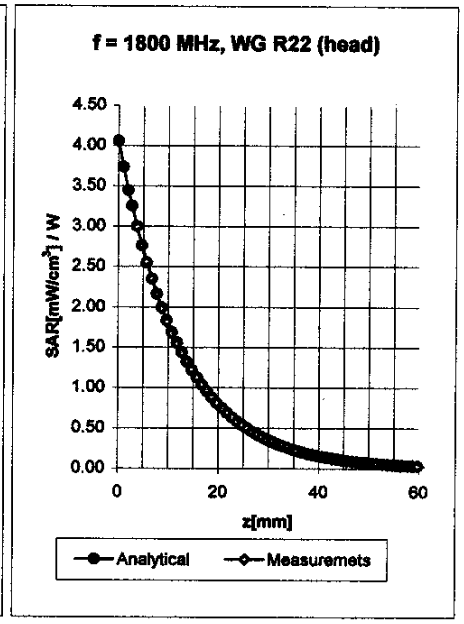




ET3DV6 SN:1642 **July 26, 2002**

Conversion Factor Assessment



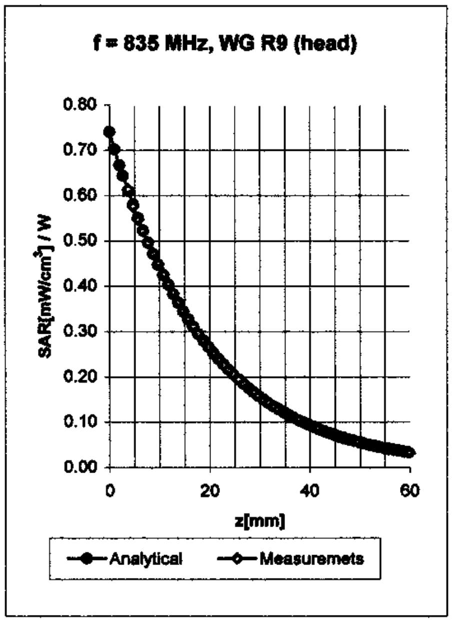


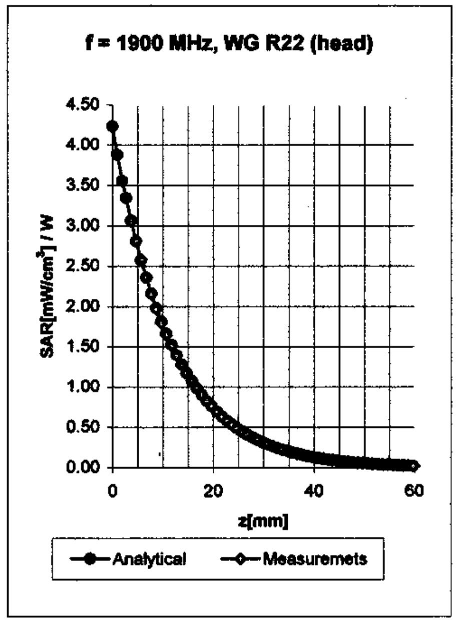
Head	**900 MHz**		ε_r **= 41.5 ± 5%**	**σ = 0.97 ± 5% mho/m**	
	ConvF X	**6.5**	± 8.9% (k=2)	Boundary effect:	
	ConvF Y	**6.5**	± 8.9% (k=2)	Alpha	**0.34**
	ConvF Z	**6.5**	± 8.9% (k=2)	Depth	**2.68**

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**

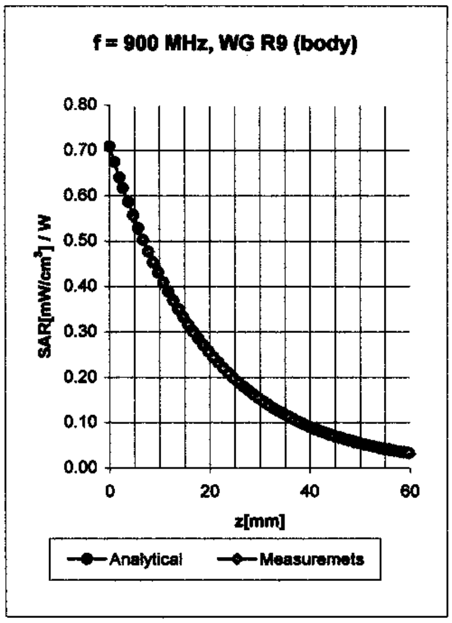
ConvF X	**6.5**	± 8.9% (k=2)	Boundary effect:	
ConvF Y	**6.5**	± 8.9% (k=2)	Alpha	**0.34**
ConvF Z	**6.5**	± 8.9% (k=2)	Depth	**2.65**

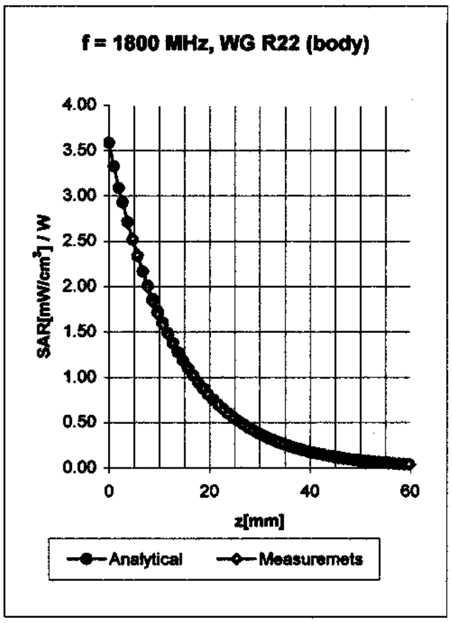
Head **1900 MHz** **ε_r = 40.0 ± 5%** **σ = 1.40 ± 5% mho/m**

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

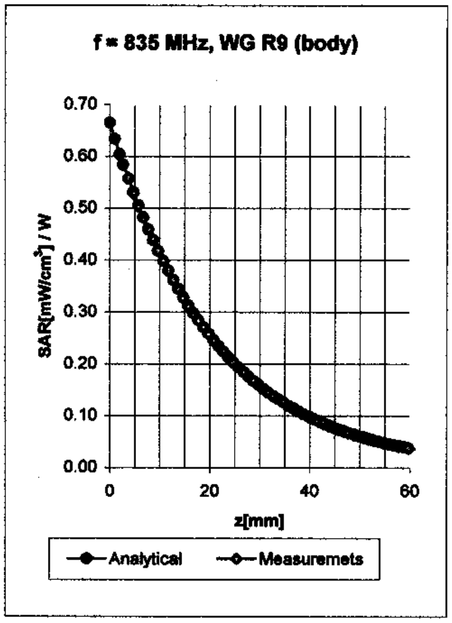
ConvF X	**6.3** ± 8.9% (k=2)		Boundary effect:	
ConvF Y	**6.3** ± 8.9% (k=2)		Alpha	**0.36**
ConvF Z	**6.3** ± 8.9% (k=2)		Depth	**2.63**

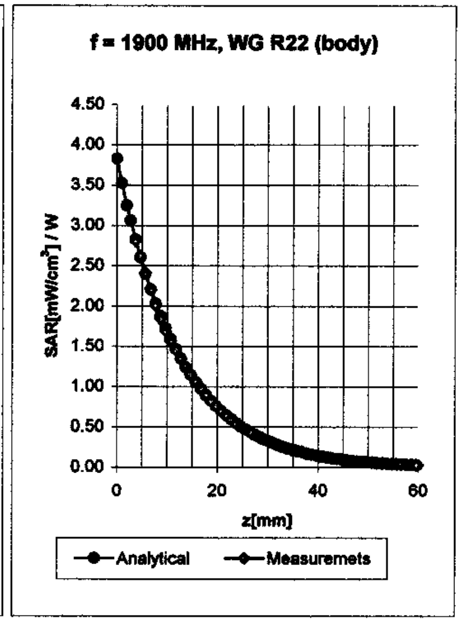
Body **1800 MHz** ε_r = 53.3 ± 5% σ = 1.52 ± 5% mho/m

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**

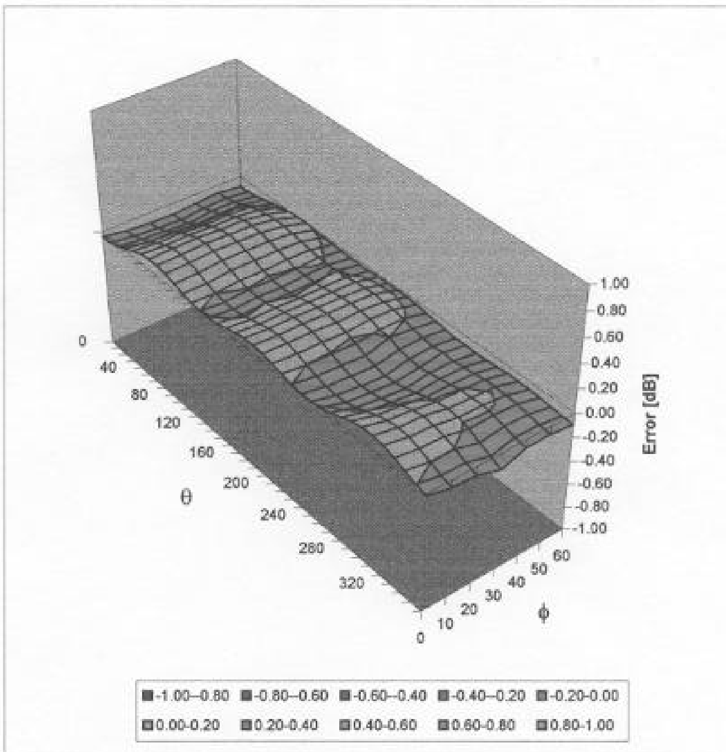
Body	1900 MHz	ε_r = 53.3 ± 5%	σ = 1.52 ± 5% mho/m

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

900 MHz System Validation Dipole

Type:	**D900V2**
Serial Number:	**133**
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: D900V2

Serial: 133

Manufactured: October 25, 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 900 MHz:

Relative Dielectricity	**41.5**	± 5%
Conductivity	**0.97 mho/m**	± 5%

The DASY3 System (Software version 3.1d) 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:	**11.6 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**7.32 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:	**1.417 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 900 MHz:	Re{Z} = **50.4 Ω**
	Im {Z} = **-6.5 Ω**
Return Loss at 900 MHz	**-23.9 dB**

4. Handling

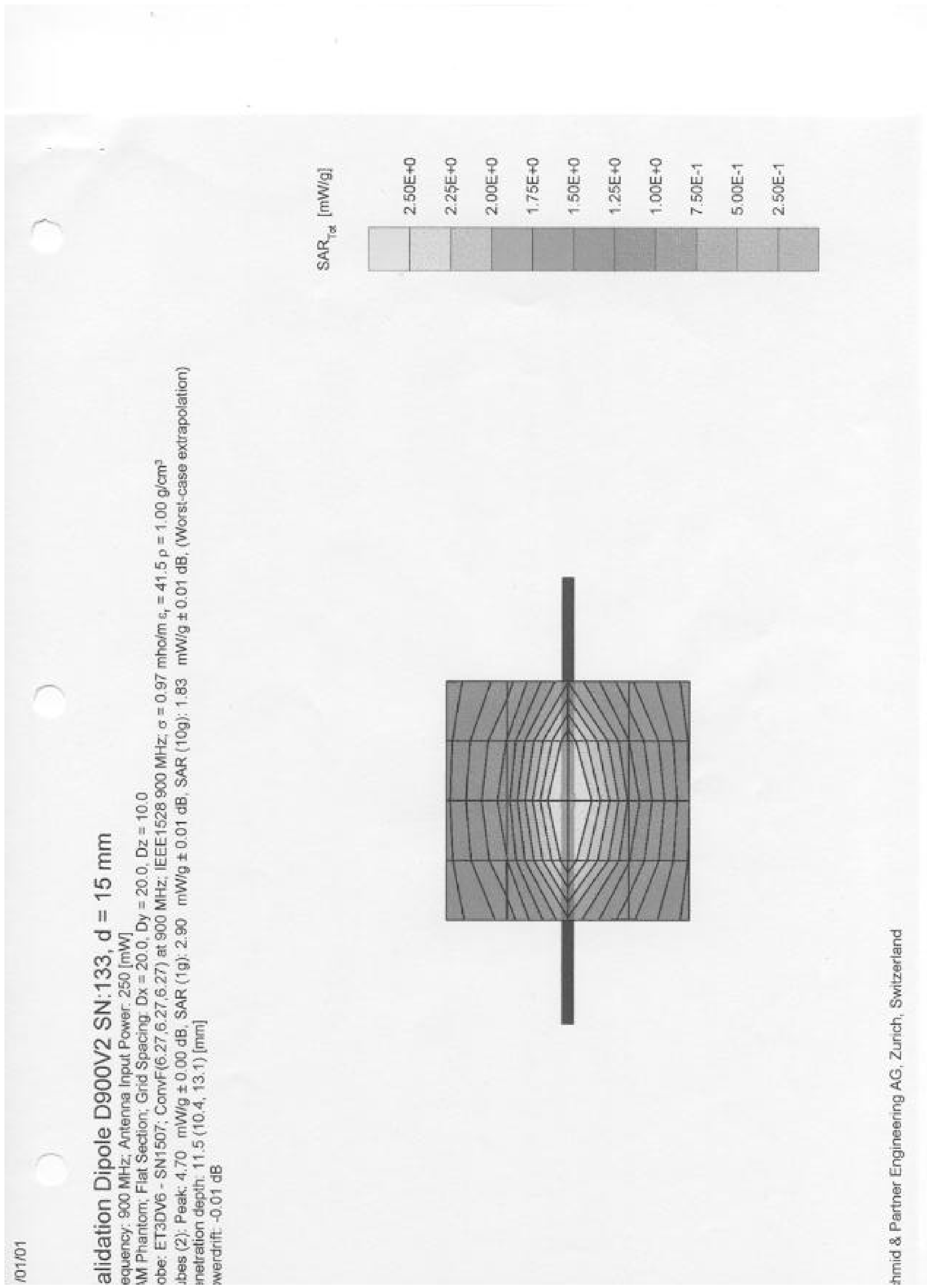
Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

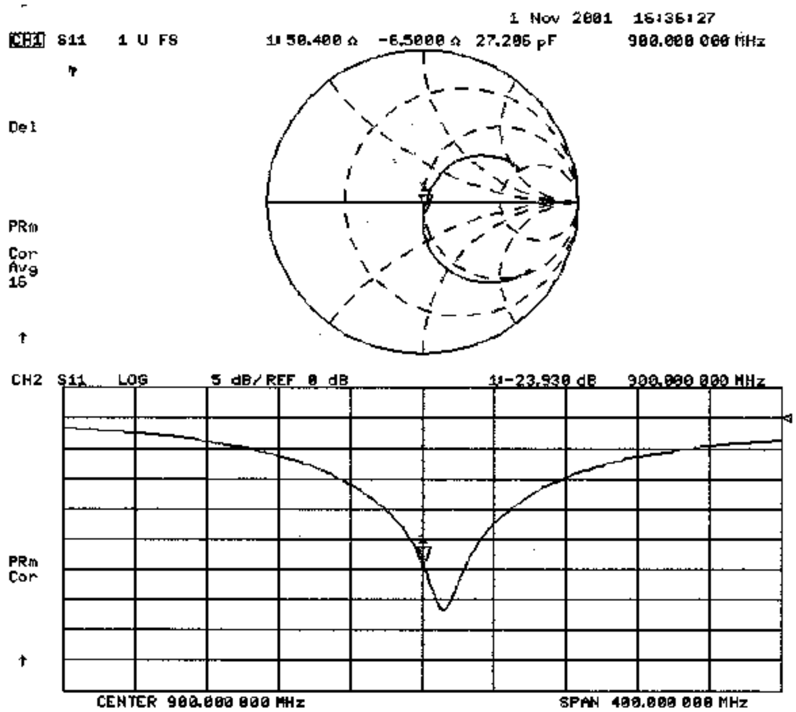
5. Design

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

6. Power Test

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


/01/01
alidation Dipole D900V2 SN:133, d = 15 mm
equency: 900 MHz; Antenna Input Power: 250 [mW]
AM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
obe: ET3DV6 - SN1507; ConvF(6.27,6.27,6.27) at 900 MHz; IEEE1528 900 MHz: σ = 0.97 mho/m εr = 41.5 ρ = 1.00 g/cm³
ubes (2); Peak: 4.70 mW/g ± 0.00 dB, SAR (1g): 2.90 mW/g ± 0.01 dB, SAR (10g): 1.83 mW/g ± 0.01 dB, (Worst-case extrapolation)
enetration depth: 11.5 (10.4, 13.1) [mm]
owerdrift: -0.01 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
hmid & Partner Engineering AG, Zurich, Switzerland


1 Nov 2001 16:36:27
CH1 S11 1 U FS
1: 50.400 Ω -6.5000 Ω 27.205 pF 900.000 000 MHz
Del
PRm
Cor
Avg
16
CH2 S11 LOG 5 dB/ REF 0 dB 1:-23.930 dB 900.000 000 MHz
PRm
Cor
CENTER 900.000 000 MHz
SPAN 400.000 000 MHz

APPENDIX D: SAR SET UP PHOTOS

Figure E1. Body worn with front side of handheld touching flat phantom for inside shirt pocket configuration

Figure E2. Body worn with back side of handheld touching flat phantom for inside shirt pocket configuration

Figure E3. Body worn configuration with Holster