

DECLARATION OF COMPLIANCE SAR RF EXPOSURE EVALUATION

Test Lab

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Applicant Information

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Rule Part(s): FCC 47 CFR §2.1093; IC RSS-102 Issue 1 (Provisional)
Test Procedure(s): FCC OET Bulletin 65, Supplement C (Edition 01-01)
Device Classification: GHH - Part 80 VHF Hand Held Transmitter (GMDSS)
FCC ID: QFRVHF50
Model: VHF50
DUT Type: Portable VHF PTT Marine Radio Transceiver
Modulation: FM
Tx Frequency Range: 156.025 - 157.425 MHz
RF Output Power Tested: 5.15 Watts (Conducted)
Antenna Type(s): Whip
Battery Type(s): 7.4V Lithium-ion Battery Pack (Model: BP50)
Body-worn Accessories Tested: n/a (radio does not have provision for body-worn transmit operation)
Max. SAR Measured: 1.03 W/kg - Face-held (50% Duty Cycle)

Celltech Labs Inc. declares under its sole responsibility that this wireless portable device has demonstrated compliance with the Specific Absorption Rate (SAR) RF exposure requirements specified in FCC 47 CFR §2.1093 and Health Canada's Safety Code 6. The device was tested in accordance with the measurement standards and procedures specified in FCC OET Bulletin 65, Supplement C (Edition 01-01) and Industry Canada RSS-102 Issue 1 (Provisional) for the General Population / Uncontrolled Exposure environment. All measurements were performed in accordance with the SAR system manufacturer recommendations.

I attest to the accuracy of data. All measurements were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

This test report shall not be reproduced partially, or in full, without the prior written approval of Celltech Labs Inc. The results and statements contained in this report pertain only to the device(s) evaluated.



Russell W. Pipe
 Senior Compliance Technologist
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TABLE OF CONTENTS

1.0	INTRODUCTION.....	3
2.0	DESCRIPTION OF DUT.....	3
3.0	SAR MEASUREMENT SYSTEM.....	4
4.0	MEASUREMENT SUMMARY.....	5
5.0	DETAILS OF SAR EVALUATION.....	6
6.0	EVALUATION PROCEDURES.....	6
7.0	SYSTEM PERFORMANCE CHECK.....	7
8.0	SIMULATED TISSUE MIXTURES.....	8
9.0	SAR LIMITS.....	8
10.0	SYSTEM SPECIFICATIONS.....	9
11.0	PROBE SPECIFICATION.....	10
12.0	PLANAR PHANTOM.....	10
13.0	VALIDATION PHANTOM.....	10
14.0	DEVICE HOLDER.....	10
15.0	TEST EQUIPMENT LIST.....	11
16.0	MEASUREMENT UNCERTAINTIES.....	12-13
17.0	REFERENCES.....	14
APPENDIX A - SAR MEASUREMENT DATA.....		15
APPENDIX B - SYSTEM PERFORMANCE CHECK DATA.....		16
APPENDIX C - SYSTEM VALIDATION PROCEDURES.....		17
APPENDIX D - PROBE CALIBRATION.....		18
APPENDIX E - MEASURED FLUID DIELECTRIC PARAMETERS.....		19
APPENDIX F - SAR TEST SETUP & DUT PHOTOGRAPHS.....		20

1.0 INTRODUCTION

This measurement report demonstrates compliance of the BG Tech Ltd. Model: VHF50 Portable VHF PTT Marine Radio Transceiver FCC ID: QFRVHF50 with the SAR (Specific Absorption Rate) RF exposure requirements specified in FCC 47 CFR §2.1093 (see reference [1]) and Health Canada Safety Code 6 (see reference [2]) for the General Population / Uncontrolled Exposure environment. The test procedures described in FCC OET Bulletin 65, Supplement C (Edition 01-01) (see reference [3]) and IC RSS-102 Issue 1 (Provisional) (see reference [4]), were employed. A description of the product and operating configuration, detailed summary of the test results, methodology and procedures used in the evaluation, equipment used, and the various provisions of the rules are included within this test report.

2.0 DESCRIPTION OF DEVICE UNDER TEST (DUT)

FCC Rule Part(s)	FCC 47 CFR §2.1093
IC Rule Part(s)	RSS-102 Issue 1 (Provisional)
Test Procedure(s)	FCC OET Bulletin 65, Supplement C (Edition 01-01)
Device Type	Portable VHF PTT Marine Radio Transceiver
FCC ID	QFRVHF50
Model No.	VHF50
Serial No.	#3 (Identical Prototype)
Modulation	FM
Tx Frequency Range	156.025 - 157.425 MHz
Max. RF Output Power Tested	5.15 Watts (Conducted)
Battery Type(s)	7.4 Lithium-ion Battery Pack (Model: BP50)
Antenna Type(s)	Whip (Length: 150 mm)
Body-worn Accessories Tested	n/a (radio does not have provision for body-worn transmit operation)

3.0 SAR MEASUREMENT SYSTEM

Celltech Labs Inc. SAR measurement facility utilizes the Dosimetric Assessment System (DASY™) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland. The DASY4 measurement system is comprised of the measurement server, robot controller, computer, near-field probe, probe alignment sensor, specific anthropomorphic mannequin (SAM) phantom, and various planar phantoms for brain and/or body SAR evaluations. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF). A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The Staubli robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the DASY4 measurement server. The DAE4 utilizes a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter and a command decoder and control logic unit. Transmission to the DASY4 measurement server is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe-mounting device includes two different sensor systems for frontal and sidewise probe contacts. The sensor systems are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.



DASY4 SAR Measurement System with validation phantom



DASY4 SAR Measurement System with Plexiglas planar phantom

4.0 MEASUREMENT SUMMARY

SAR EVALUATION RESULTS														
Freq. (MHz)	Chan.	Test Type	Test Mode	Battery Type	Separation Distance to Planar Phantom (cm)	Conducted Power Level			Measured SAR 1g (W/kg)		Max. Cond. Power Drift (dB)	Scaled SAR 1g (W/kg)		
						Before (W)	After (W)	Drift (dB)	Duty Cycle			Duty Cycle		
						100%	50%	100%	100%	50%		100%	50%	
156.700	Mid	Face-held	CW	Li-ion	2.5	5.15	4.78	-0.33	1.91	0.955	-0.33	2.06	1.03	

ANSI / IEEE C95.1 1992 - SAFETY LIMIT BRAIN: 1.6 W/kg (averaged over 1 gram) Spatial Peak - General Population / Uncontrolled Exposure												
Measured Mixture Type			150 MHz Brain			Ambient Temperature			22.7 °C			
Dielectric Constant ϵ_r		IEEE Target		Measured		Fluid Temperature			21.7 °C			
		52.3 (\pm 5%)		52.6		Fluid Depth			\geq 15 cm			
Conductivity σ (mho/m)		IEEE Target		Measured		Relative Humidity			63 %			
		0.76 (\pm 5%)		0.74		Atmospheric Pressure			102.0 kPa			
ρ (Kg/m³)			1000			Phantom Type			Plexiglas Planar			

Note(s):

1. The measurement results were obtained with the DUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum SAR location of the DUT are reported in Appendix A.
2. The transmission band of the DUT is less than 10 MHz, therefore mid channel data only is reported (per FCC OET Bulletin 65, Supplement C, Edition 01-01 - see reference [3]).
3. The conducted power drift measured after the SAR evaluation was > 5% from the start power. The power drift measured was added to the measured SAR level to show scaled SAR results as listed in the above table.
4. The ambient and fluid temperatures were measured prior to, and during, the fluid dielectric parameter check and the SAR evaluation. The temperatures listed in the table above were consistent for all measurement periods.
5. The dielectric properties of the simulated tissue fluid were measured prior to the SAR evaluation using an 85070C Dielectric Probe Kit and an 8753E Network Analyzer (see Appendix E for printout of measured fluid dielectric parameters).
6. The DUT does not have provision for body-worn operation, therefore body-worn SAR was not applicable. The belt-clip accessory provided with the DUT is for carrying purposes only.

5.0 DETAILS OF SAR EVALUATION

The BG Tech Ltd. Model: VHF50 Portable VHF PTT Marine Radio Transceiver FCC ID: QFRVHF50 was compliant for localized Specific Absorption Rate (General Population / Uncontrolled Exposure) based on the test provisions and conditions described below. The detailed test setup photographs are shown in Appendix F.

1. The DUT was evaluated in a face-held configuration with the front of the radio placed parallel to the outer surface of the planar phantom. A 2.5 cm separation distance was maintained between the front side of the DUT and the outer surface of the planar phantom for the duration of the test.
2. The DUT does not have provision for body-worn operation, therefore body-worn SAR was not applicable. The belt-clip accessory provided with the DUT is for carrying purposes only.
3. The conducted power levels were measured before and after the test using a Gigatronics 8652A Universal Power Meter according to the procedures described in FCC 47 CFR §2.1046.
4. The conducted power drift measured after the SAR evaluation was > 5% from the start power. The power drift measured was added to the measured SAR level to show scaled SAR results as shown in the test data table (page 5).
5. The DUT was tested in unmodulated continuous transmit operation (Continuous Wave mode at 100% duty cycle) with the transmit key constantly depressed. For a push-to-talk device the 50% duty cycle compensation reported assumes a transmit/receive cycle of equal time base.
6. The DUT was tested with a fully charged lithium-ion battery pack.
7. The ambient and fluid temperatures were measured prior to, and during, the fluid dielectric parameter check and the SAR evaluation. The temperatures listed were consistent for all measurement periods.
8. The dielectric properties of the simulated tissue fluid were measured prior to the evaluation using an 85070C Dielectric Probe Kit and an 8753E Network Analyzer (see Appendix E for printout of measured fluid dielectric parameters).
9. Due to the dimensions of the DUT, a Plexiglas planar phantom was used in place of the SAM phantom.
10. A stack of low-density, low-loss dielectric foamed polystyrene was used in place of the device holder.

6.0 EVALUATION PROCEDURES

- a. (i) The evaluation was performed in the applicable area of the phantom depending on the type of device being tested. For devices held to the ear during normal operation, both the left and right ear positions were evaluated using the SAM phantom.
 (ii) For body-worn and face-held devices a planar phantom was used.
- b. The SAR was determined by a pre-defined procedure within the DASY4 software. Upon completion of a reference and optical surface check, the exposed region of the phantom was scanned near the inner surface with a grid spacing of 15mm x 15mm.

An area scan was determined as follows:

- c. Based on the defined area scan grid, a more detailed grid is created to increase the points by a factor of 10. The interpolation function then evaluates all field values between corresponding measurement points.
- d. A linear search is applied to find all the candidate maxima. Subsequently, all maxima are removed that are >2 dB from the global maximum. The remaining maxima are then used to position the cube scans.

A 1g and 10g spatial peak SAR was determined as follows:

- e. Extrapolation is used to find the points between the dipole center of the probe and the surface of the phantom. This data cannot be measured, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.4 mm (see probe calibration document in Appendix D). The extrapolation was based on trivariate quadratics computed from the previously calculated 3D interpolated points nearest the phantom surface.
- f. Interpolated data is used to calculate the average SAR over 1g and 10g cubes by spatially discretizing the entire measured cube. The volume used to determine the averaged SAR is a 1mm grid (42875 interpolated points).

7.0 SYSTEM PERFORMANCE CHECK

Prior to the SAR evaluation a system check was performed using a large Plexiglas planar phantom with a 300MHz dipole (see Appendix C for system validation procedure). The dielectric parameters of the simulated tissue fluid were measured prior to the system check using an 85070C Dielectric Probe Kit and an 8753E Network Analyzer (see Appendix E for printout of measured fluid dielectric parameters). A forward power of 250mW was applied to the dipole and the system was verified to a tolerance of $\pm 10\%$ (see Appendix B for system performance check test plot).

SYSTEM PERFORMANCE CHECK													
Test Date	300MHz Equiv. Tissue	SAR 1g (W/kg)		Dielectric Constant ϵ_r		Conductivity σ (mho/m)		ρ (Kg/m ³)	Amb. Temp. (°C)	Fluid Temp. (°C)	Fluid Depth (cm)	Humid. (%)	Barom. Press. (kPa)
		IEEE Target	Measured	IEEE Target	Measured	IEEE Target	Measured						
11/03/03	Brain	0.750 ($\pm 10\%$)	0.816 (+8.8%)	45.3 $\pm 5\%$	45.6	0.87 $\pm 5\%$	0.89	1000	22.7	22.4	≥ 15	63	102.0

Note(s):

1. The ambient and fluid temperatures were measured prior to, and during, the fluid dielectric parameter check and the system performance check. The temperatures listed in the table above were consistent for all measurement periods.

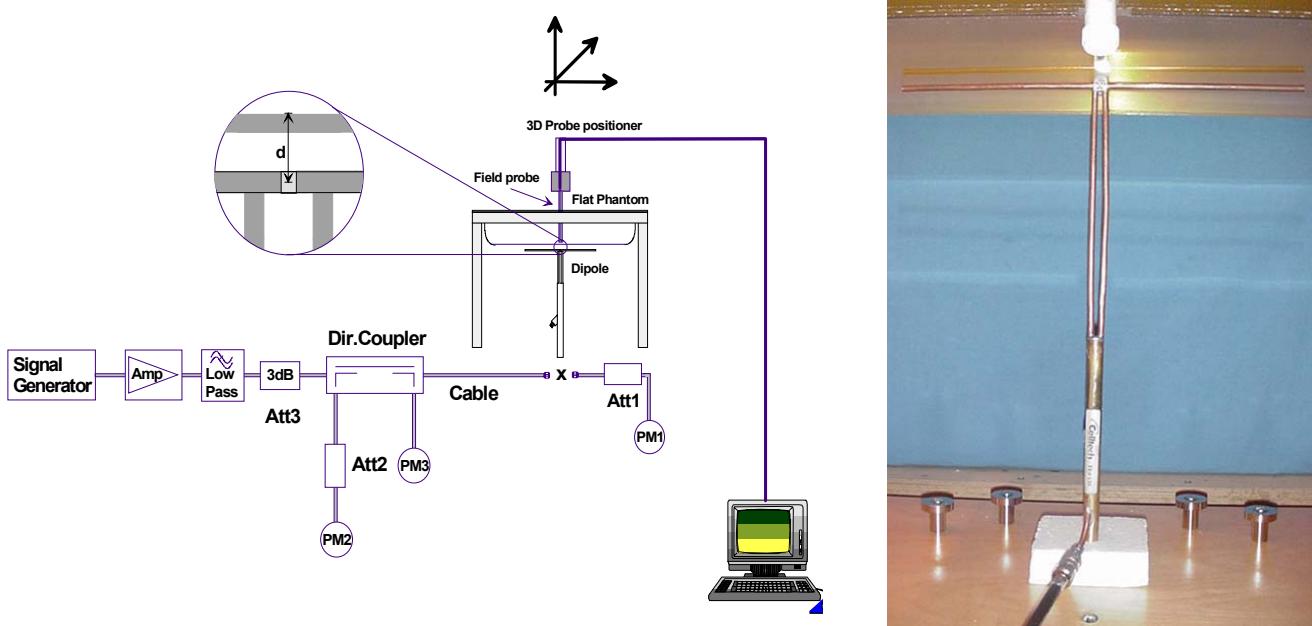


Figure 1. 300 MHz System Check Setup Diagram

300 MHz Dipole Setup

8.0 SIMULATED EQUIVALENT TISSUES

The brain and body simulated tissue mixtures consist of a viscous gel using hydroxethylcellulose (HEC) gelling agent and saline solution. Preservation with a bactericide is added and visual inspection is made to ensure air bubbles are not trapped during the mixing process. The fluid was prepared according to standardized procedures and measured for dielectric parameters (permittivity and conductivity).

SIMULATED TISSUE MIXTURES		
INGREDIENT	300 MHz Brain (System Check)	150 MHz Brain (DUT Evaluation)
Water	37.56 %	38.35 %
Sugar	55.32 %	55.5 %
Salt	5.95 %	5.15 %
HEC	0.98 %	0.9 %
Bactericide	0.19 %	0.1 %

9.0 SAR SAFETY LIMITS

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10g)	4.0	20.0

Notes:

1. Uncontrolled environments are defined as locations where there is potential exposure of individuals who have no knowledge or control of their potential exposure.
2. Controlled environments are defined as locations where there is potential exposure of individuals who have knowledge of their potential exposure and can exercise control over their exposure.

10.0 ROBOT SYSTEM SPECIFICATIONS

Specifications

POSITIONER: Stäubli Unimation Corp. Robot Model: RX60L
Repeatability: 0.02 mm
No. of axis: 6

Data Acquisition Electronic (DAE) System

Cell Controller

Processor: AMD Athlon XP 2400+
Clock Speed: 2.0 GHz
Operating System: Windows XP Professional

Data Converter

Features: Signal Amplifier, multiplexer, A/D converter, and control logic
Software: DASY4 software
Connecting Lines: Optical downlink for data and status info.
 Optical uplink for commands and clock

DASY4 Measurement Server

Function: Real-time data evaluation for field measurements and surface detection
Hardware: PC/104 166MHz Pentium CPU; 32 MB chipdisk; 64 MB RAM
Connections: COM1, COM2, DAE, Robot, Ethernet, Service Interface

E-Field Probe

Model: ET3DV6
Serial No.: 1387
Construction: Triangular core fiber optic detection system
Frequency: 10 MHz to 6 GHz
Linearity: ± 0.2 dB (30 MHz to 3 GHz)

Phantom(s)

Evaluation Phantom

Type: Planar Phantom
Shell Material: Plexiglas
Bottom Thickness: $2.0 \text{ mm} \pm 0.1 \text{ mm}$
Outer Dimensions: 75.0 cm (L) x 22.5 cm (W) x 20.5 cm (H); Back Plane: 25.7 cm (H)

Validation Phantom ($\leq 450\text{MHz}$)

Type: Planar Phantom
Shell Material: Plexiglas
Bottom Thickness: $6.2 \text{ mm} \pm 0.1 \text{ mm}$
Outer Dimensions: 86.0 cm (L) x 39.5 cm (W) x 21.8 cm (H)

11.0 PROBE SPECIFICATION (ET3DV6)

Construction: Symmetrical design with triangular core
 Built-in shielding against static charges
 PEEK enclosure material (resistant to organic solvents, e.g. glycol)

Calibration: In air from 10 MHz to 2.5 GHz
 In brain simulating tissue at frequencies of 900 MHz and 1.8 GHz (accuracy \pm 8%)

Frequency: 10 MHz to > 6 GHz; Linearity: \pm 0.2 dB
 (30 MHz to 3 GHz)

Directivity: \pm 0.2 dB in brain tissue (rotation around probe axis)
 \pm 0.4 dB in brain tissue (rotation normal to probe axis)

Dynamic Range: 5 μ W/g to > 100 mW/g; Linearity: \pm 0.2 dB

Surface Detect.: \pm 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces

Dimensions: Overall length: 330 mm
 Tip length: 16 mm
 Body diameter: 12 mm
 Tip diameter: 6.8 mm
 Distance from probe tip to dipole centers: 2.7 mm

Application: General dosimetry up to 3 GHz
 Compliance tests of mobile phone



ET3DV6 E-Field Probe

12.0 PLANAR PHANTOM

The planar phantom is constructed of Plexiglas material with a 2.0 mm shell thickness for face-held and body-worn SAR evaluations of handheld radio transceivers. The planar phantom is mounted on the side of the DASY4 system.



Plexiglas Planar Phantom

13.0 VALIDATION PLANAR PHANTOM

The validation planar phantom is constructed of Plexiglas material with a 6.0 mm shell thickness for system validations at 450MHz and below. The validation planar phantom is mounted in the DASY4 system.



Validation Planar Phantom

14.0 DEVICE HOLDER

The DASY4 device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections.



Device Holder

15.0 TEST EQUIPMENT LIST

TEST EQUIPMENT	SERIAL NO.	CALIBRATION DATE
Schmid & Partner DASY4 System	-	-
DASY4 Measurement Server	1078	N/A
-Robot	599396-01	N/A
-ET3DV6 E-Field Probe	1387	Feb 2003
-300MHz Validation Dipole	135	Oct 2003
-450MHz Validation Dipole	136	Oct 2003
-900MHz Validation Dipole	054	June 2003
-1800MHz Validation Dipole	247	June 2003
-2450MHz Validation Dipole	150	Sept 2003
-Plexiglas Planar Phantom	161	N/A
-Validation Planar Phantom	137	N/A
HP 85070C Dielectric Probe Kit	N/A	N/A
Gigatronics 8651A Power Meter	8650137	April 2003
Gigatronics 8652A Power Meter	1835267	April 2003
Power Sensor 80701A	1833542	Feb 2003
Power Sensor 80701A	1833699	April 2003
HP E4408B Spectrum Analyzer	US39240170	Dec 2002
HP 8594E Spectrum Analyzer	3543A02721	April 2003
HP 8753E Network Analyzer	US38433013	May 2003
HP 8648D Signal Generator	3847A00611	May 2003
Amplifier Research 5S1G4 Power Amplifier	26235	N/A

16.0 MEASUREMENT UNCERTAINTIES

UNCERTAINTY BUDGET FOR DEVICE EVALUATION						
Error Description	Uncertainty Value ±%	Probability Distribution	Divisor	c_i 1g	Standard Uncertainty ±% (1g)	v_i or v_{eff}
Measurement System						
Probe calibration	± 4.8	Normal	1	1	± 4.8	∞
Axial isotropy of the probe	± 4.7	Rectangular	$\sqrt{3}$	$(1-c_p)$	± 1.9	∞
Spherical isotropy of the probe	± 9.6	Rectangular	$\sqrt{3}$	(c_p)	± 3.9	∞
Spatial resolution	± 0.0	Rectangular	$\sqrt{3}$	1	± 0.0	∞
Boundary effects	± 5.5	Rectangular	$\sqrt{3}$	1	± 3.2	∞
Probe linearity	± 4.7	Rectangular	$\sqrt{3}$	1	± 2.7	∞
Detection limit	± 1.0	Rectangular	$\sqrt{3}$	1	± 0.6	∞
Readout electronics	± 1.0	Normal	1	1	± 1.0	∞
Response time	± 0.8	Rectangular	$\sqrt{3}$	1	± 0.5	∞
Integration time	± 1.4	Rectangular	$\sqrt{3}$	1	± 0.8	∞
RF ambient conditions	± 3.0	Rectangular	$\sqrt{3}$	1	± 1.7	∞
Mech. constraints of robot	± 0.4	Rectangular	$\sqrt{3}$	1	± 0.2	∞
Probe positioning	± 2.9	Rectangular	$\sqrt{3}$	1	± 1.7	∞
Extrapolation & integration	± 3.9	Rectangular	$\sqrt{3}$	1	± 2.3	∞
Test Sample Related						
Device positioning	± 6.0	Normal	$\sqrt{3}$	1	± 6.7	12
Device holder uncertainty	± 5.0	Normal	$\sqrt{3}$	1	± 5.9	8
Power drift	± 5.0	Rectangular	$\sqrt{3}$		± 2.9	∞
Phantom and Setup						
Phantom uncertainty	± 4.0	Rectangular	$\sqrt{3}$	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Liquid conductivity (measured)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (target)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (measured)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Combined Standard Uncertainty						
Expanded Uncertainty (k=2)						
± 13.3						
± 26.6						

Measurement Uncertainty Table in accordance with IEEE Standard 1528-200X (Draft - see reference [5])

MEASUREMENT UNCERTAINTIES (Cont.)

UNCERTAINTY BUDGET FOR SYSTEM VALIDATION						
Error Description	Uncertainty Value ±%	Probability Distribution	Divisor	c_i 1g	Standard Uncertainty ±% (1g)	v_i or v_{eff}
Measurement System						
Probe calibration	± 4.8	Normal	1	1	± 4.8	∞
Axial isotropy of the probe	± 4.7	Rectangular	$\sqrt{3}$	$(1-c_p)$	± 1.9	∞
Spherical isotropy of the probe	± 9.6	Rectangular	$\sqrt{3}$	(c_p)	± 3.9	∞
Spatial resolution	± 0.0	Rectangular	$\sqrt{3}$	1	± 0.0	∞
Boundary effects	± 5.5	Rectangular	$\sqrt{3}$	1	± 3.2	∞
Probe linearity	± 4.7	Rectangular	$\sqrt{3}$	1	± 2.7	∞
Detection limit	± 1.0	Rectangular	$\sqrt{3}$	1	± 0.6	∞
Readout electronics	± 1.0	Normal	1	1	± 1.0	∞
Response time	± 0.8	Rectangular	$\sqrt{3}$	1	± 0.5	∞
Integration time	± 1.4	Rectangular	$\sqrt{3}$	1	± 0.8	∞
RF ambient conditions	± 3.0	Rectangular	$\sqrt{3}$	1	± 1.7	∞
Mech. constraints of robot	± 0.4	Rectangular	$\sqrt{3}$	1	± 0.2	∞
Probe positioning	± 2.9	Rectangular	$\sqrt{3}$	1	± 1.7	∞
Extrapolation & integration	± 3.9	Rectangular	$\sqrt{3}$	1	± 2.3	∞
Dipole						
Dipole Axis to Liquid Distance	± 2.0	Rectangular	$\sqrt{3}$	1	± 1.2	∞
Input Power	± 4.7	Rectangular	$\sqrt{3}$	1	± 2.7	∞
Phantom and Setup						
Phantom uncertainty	± 4.0	Rectangular	$\sqrt{3}$	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Liquid conductivity (measured)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (target)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Liquid permittivity (measured)	± 5.0	Rectangular	$\sqrt{3}$	0.6	± 1.7	∞
Combined Standard Uncertainty						
Expanded Uncertainty (k=2)						
± 9.9						
± 19.8						

Measurement Uncertainty Table in accordance with IEEE Standard 1528-200X (Draft - see reference [5])

17.0 REFERENCES

- [1] Federal Communications Commission, "Radiofrequency radiation exposure evaluation: portable devices", Rule Part 47 CFR §2.1093: 1999.
- [2] Health Canada, "Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz", Safety Code 6.
- [3] Federal Communications Commission, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields", OET Bulletin 65, Supplement C (Edition 01-01), FCC, Washington, D.C.: June 2001.
- [4] Industry Canada, "Evaluation Procedure for Mobile and Portable Radio Transmitters with respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields", Radio Standards Specification RSS-102 Issue 1 (Provisional): September 1999.
- [5] IEEE Standards Coordinating Committee 34, Std 1528-200X, "DRAFT Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques".

APPENDIX A - SAR MEASUREMENT DATA

Date Tested: 11/03/03

DUT: BG Tech Ltd. Model: VHF50; Type: PTT VHF Marine Radio Transceiver; Serial #3

Ambient Temp: 22.7°C; Fluid Temp: 21.7°C; Barometric Pressure: 102.0 kPa; Humidity: 63%

Communication System: VHF FM

RF Output Power: 5.15 Watts (Conducted)

Frequency: 156.7 MHz; Duty Cycle: 1:1

Medium: HSL150 ($\sigma = 0.74$ mho/m, $\epsilon_r = 52.6$, $\rho = 1000$ kg/m³)

- Probe: ET3DV6 - SN1387; ConvF(9.1, 9.1, 9.1); Calibrated: 26/02/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn370; Calibrated: 19/05/2003
- Phantom: Planar; Type: Plexiglas; Serial: 161
- Measurement SW: DASY4, V4.1 Build 47; Post processing SW: SEMCAD, V1.6 Build 116

Face-Held/Area Scan 2 (101x181x1): Measurement grid: dx=15mm, dy=15mm

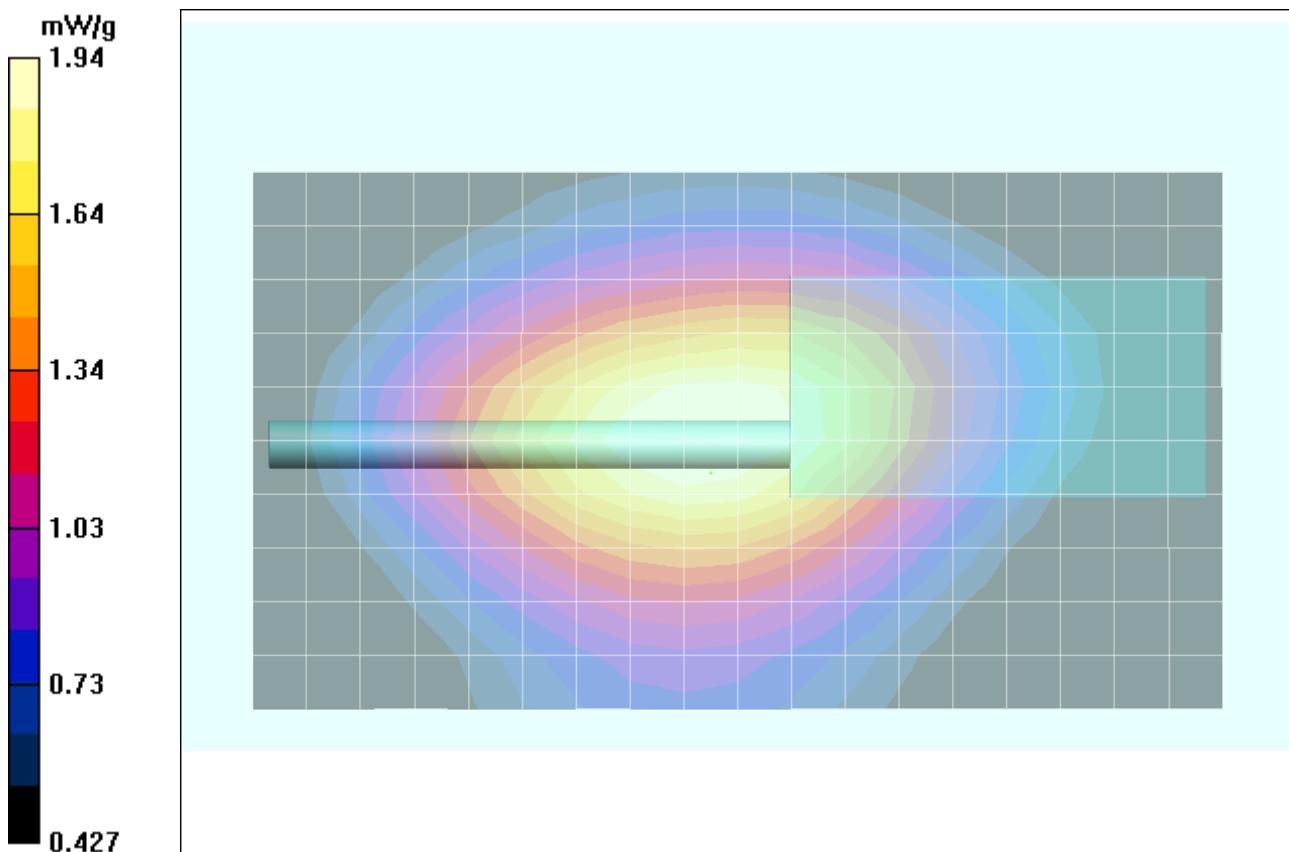
Face-Held/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

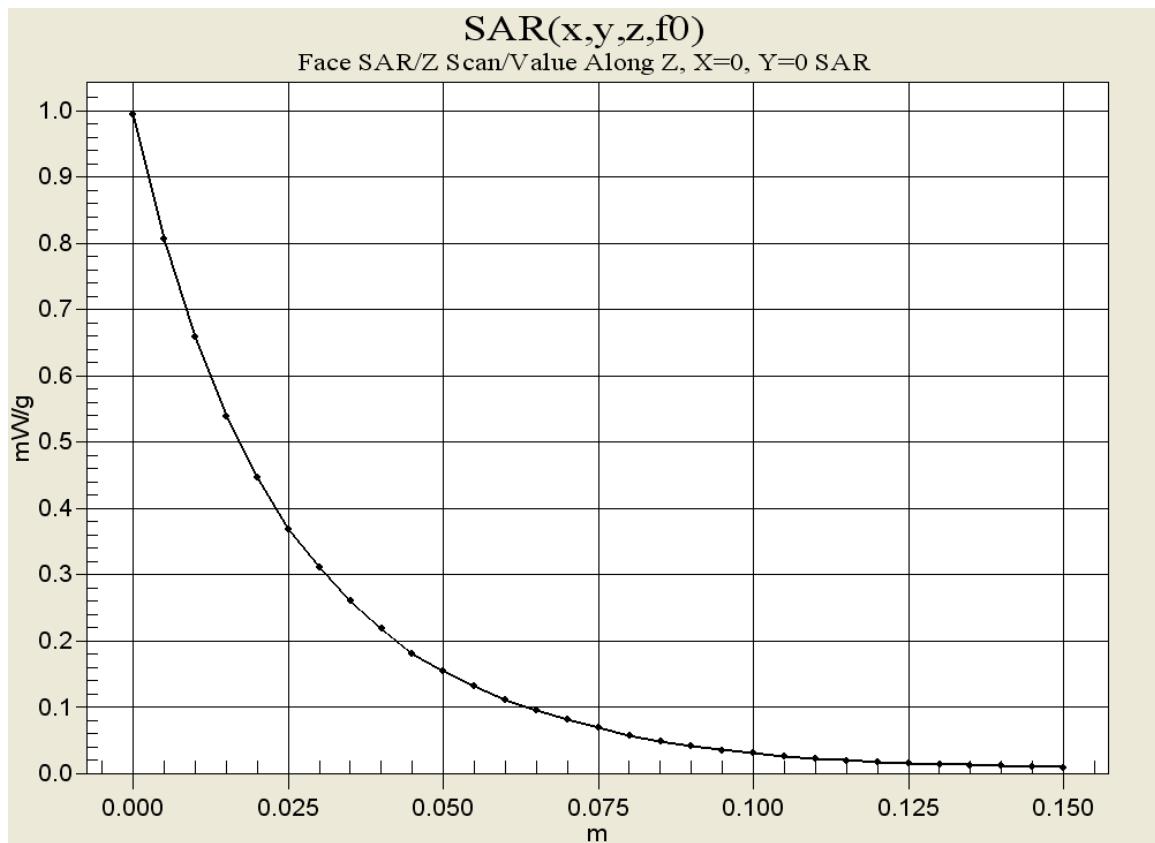
Peak SAR (extrapolated) = 2.98 W/kg

SAR(1 g) = 1.91 mW/g; SAR(10 g) = 1.4 mW/g

Reference Value = 50.7 V/m

Power Drift = -0.32 dB





APPENDIX B - SYSTEM PERFORMANCE CHECK DATA

Date Tested: 11/03/03

DUT: Dipole 300 MHz; Model: D300V2; Type: System Performance Check; Serial: 135

Ambient Temp: 22.7°C; Fluid Temp: 22.4°C; Barometric Pressure: 102.0 kPa; Humidity: 63%

Communication System: CW

Forward Conducted Power: 250 mW

Frequency: 300 MHz; Duty Cycle: 1:1

Medium: 300 HSL ($\sigma = 0.89$ mho/m, $\epsilon_r = 45.6$, $\rho = 1000$ kg/m³)

- Probe: ET3DV6 - SN1387; ConvF(7.9, 7.9, 7.9); Calibrated: 26/02/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn370; Calibrated: 19/05/2003
- Phantom: Validation Planar; Type: Plexiglas; Serial: 137
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

System Validation at 300 MHz/Area Scan (51x101x1): Measurement grid: dx=15mm, dy=15mm

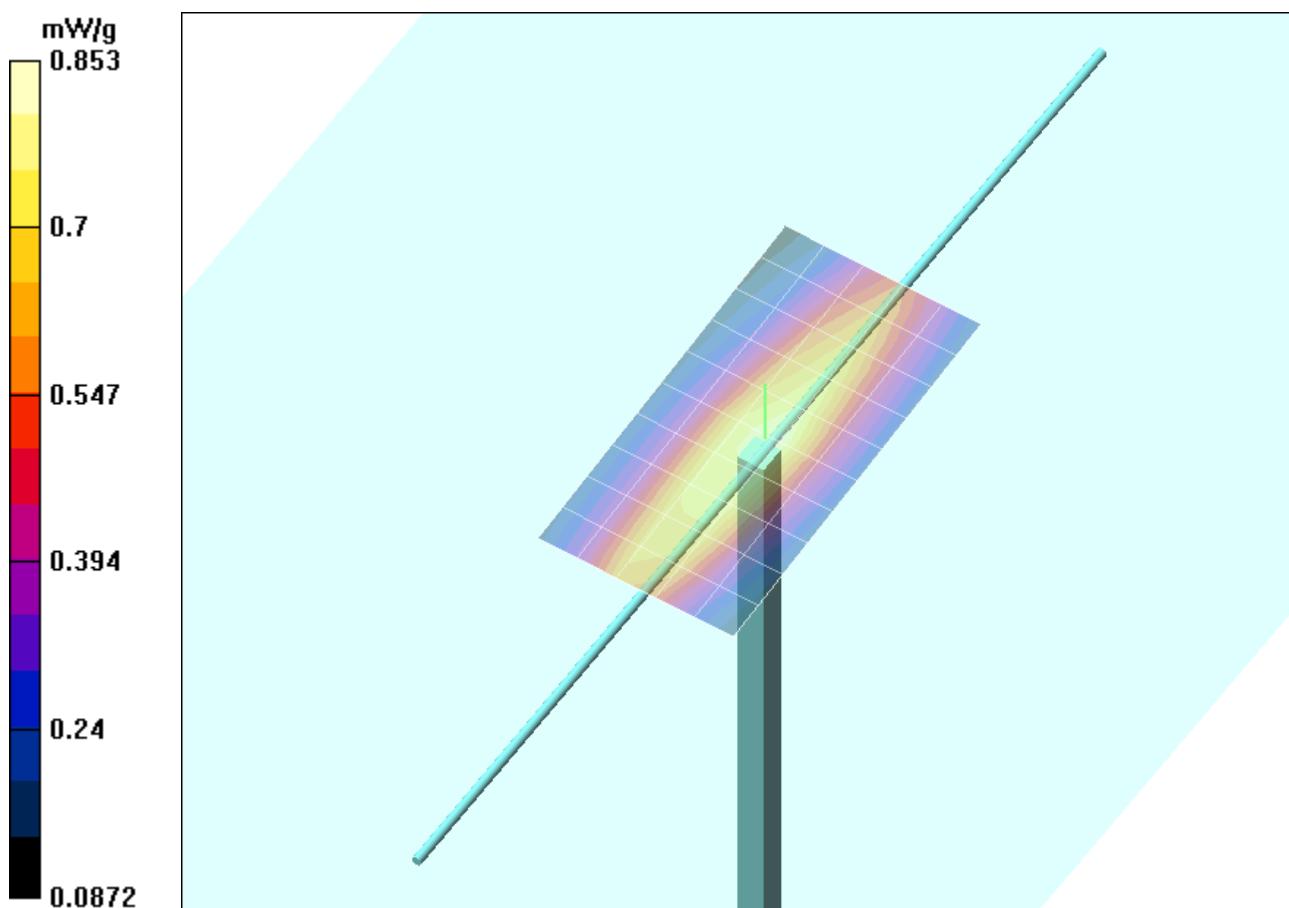
System Validation at 300 MHz/Zoom Scan 2 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

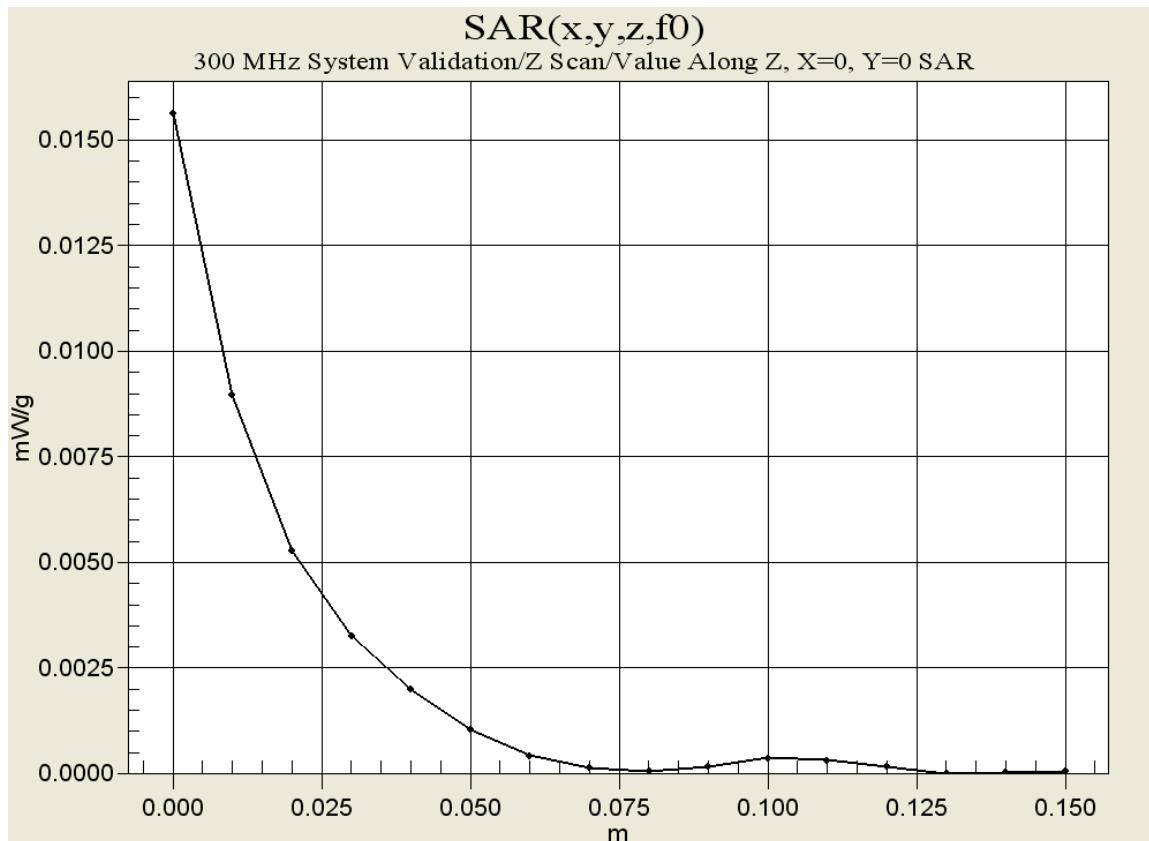
Peak SAR (extrapolated) = 1.45 W/kg

SAR(1 g) = 0.816 mW/g; SAR(10 g) = 0.518 mW/g

Reference Value = 30.6 V/m

Power Drift = -0.07 dB





APPENDIX C - SYSTEM VALIDATION

300MHz SYSTEM VALIDATION DIPOLE

Type:

300MHz Validation Dipole

Serial Number:

135

Place of Calibration:

Celltech Labs Inc.

Date of Calibration:

October 30, 2003

Celltech Labs Inc. hereby certifies that this device has been calibrated on the date indicated above.

Calibrated by:



Approved by:



1. Validation Dipole Construction & Electrical Characteristics

The validation dipole was constructed in accordance with the IEEE Std. "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques". The electrical properties were measured using an HP 8753E Network Analyzer. The network analyzer was calibrated to the validation dipole N-type connector feed point using an HP85032E Type N calibration kit. The dipole was placed parallel to a planar phantom at a separation distance of 15.0mm from the simulating fluid using a loss-less dielectric spacer. The measured input impedance is:

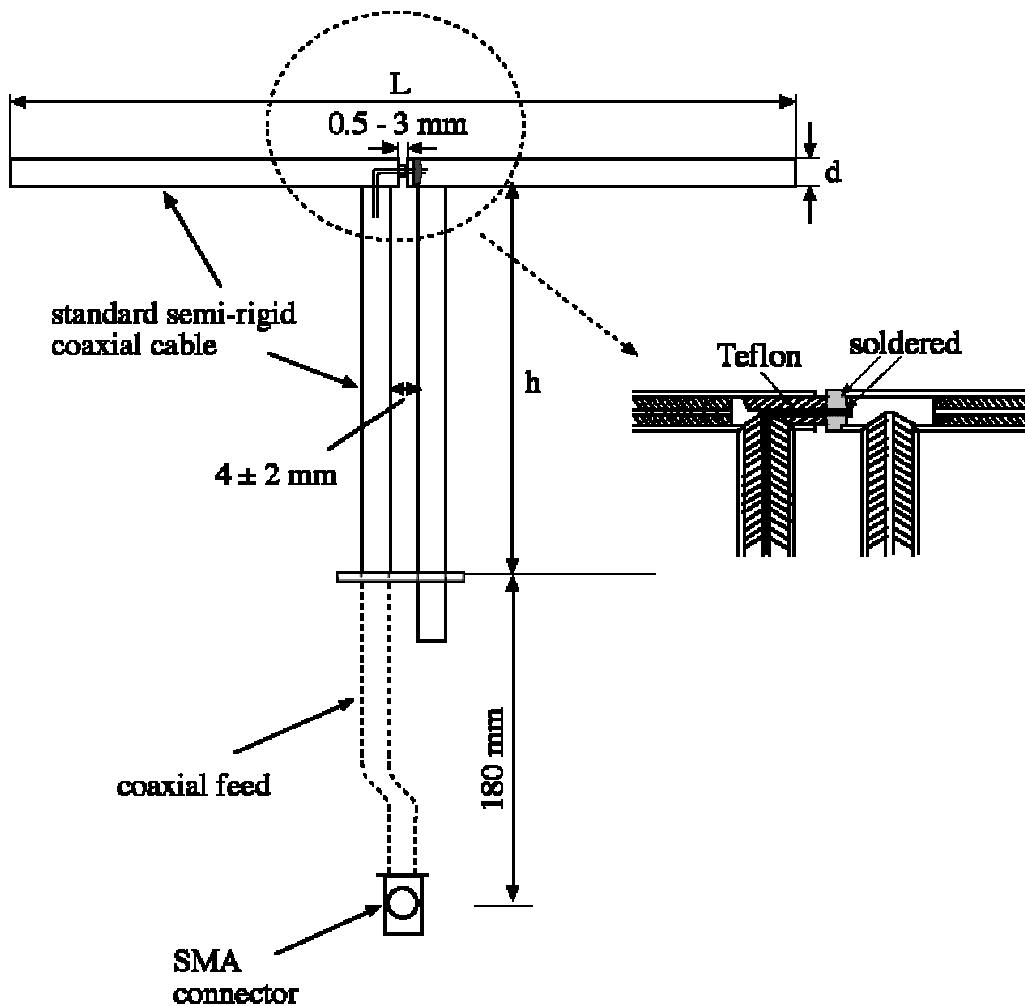
Feed point impedance at 300MHz

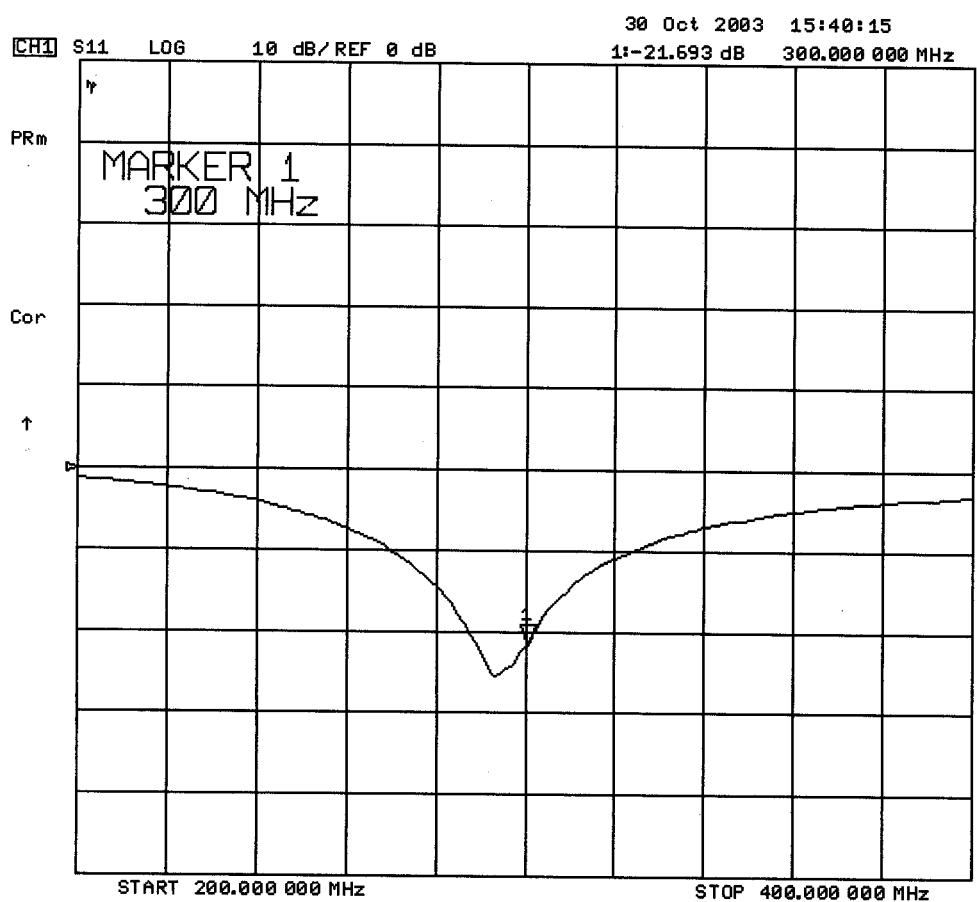
$$\text{Re}\{Z\} = 43.586\Omega$$

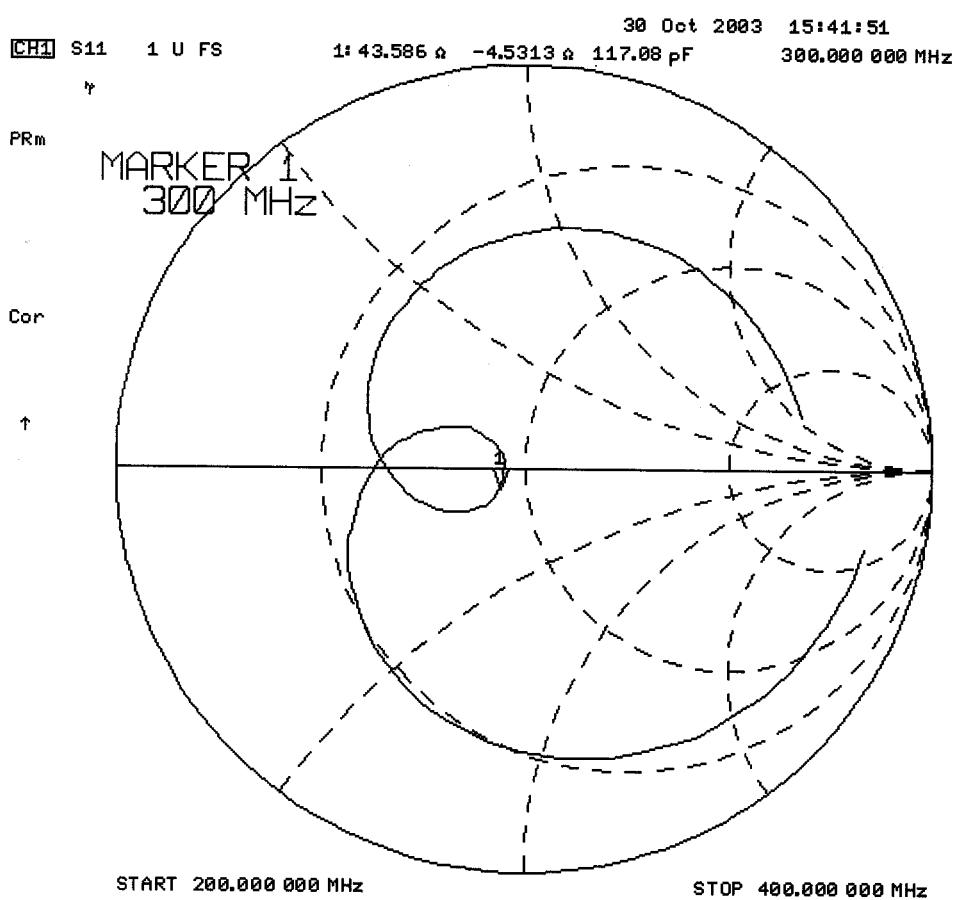
$$\text{Im}\{Z\} = -4.5313\Omega$$

Return Loss at 300MHz

$$-21.693\text{dB}$$







2. Validation Dipole Dimensions

Frequency (MHz)	L (mm)	H (mm)	D (mm)
300	420.0	250.0	6.2
450	288.0	167.0	6.2
835	161.0	89.8	3.6
900	149.0	83.3	3.6
1450	89.1	51.7	3.6
1800	72.0	41.7	3.6
1900	68.0	39.5	3.6
2000	64.5	37.5	3.6
2450	51.8	30.6	3.6
3000	41.5	25.0	3.6

3. Validation Phantom

The validation phantom was constructed using relatively low-loss tangent Plexiglas material. The inner dimensions of the phantom are as follows:

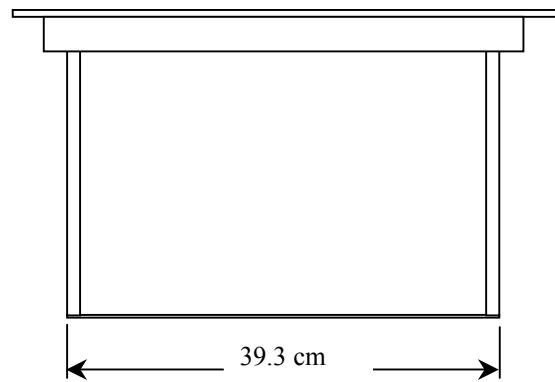
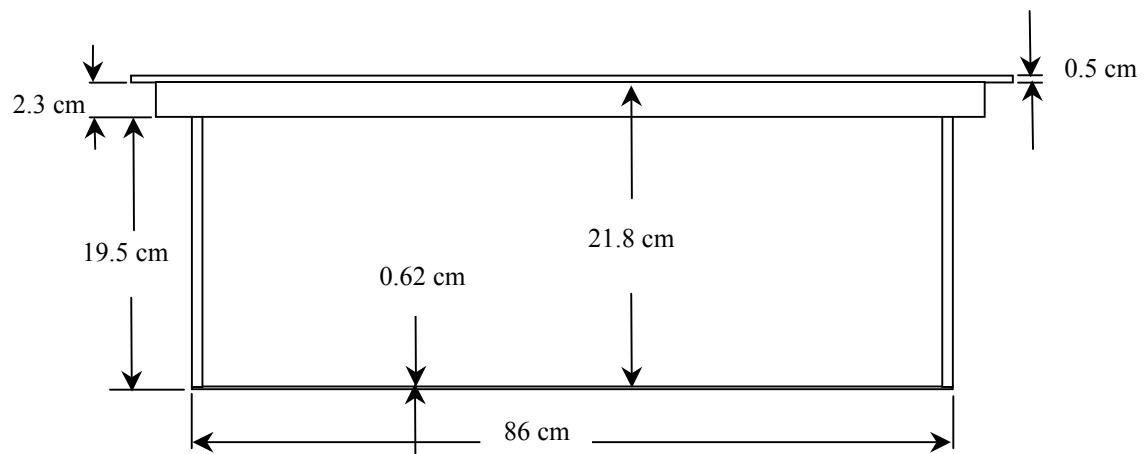
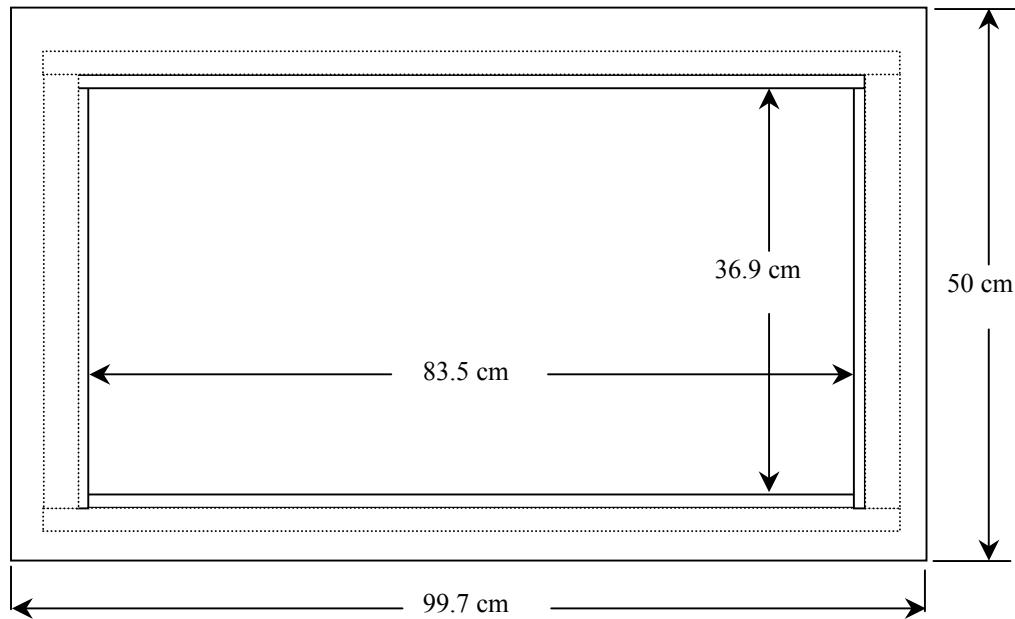
Length: 83.5 cm

Width: 36.9 cm

Height: 21.8 cm

The bottom section of the validation phantom is constructed of 6.2 ± 0.1 mm Plexiglas.

4. Dimensions of Plexiglas Planar Phantom



5. 300MHz System Validation Setup



300MHz System Validation Setup



6. Measurement Conditions

The planar phantom was filled with simulated brain tissue having the following parameters at 300MHz:

Relative Permittivity:	45.7
Conductivity:	0.88 mho/m
Fluid Temperature:	22.2°C
Fluid Depth:	≥ 15cm

Environmental Conditions:

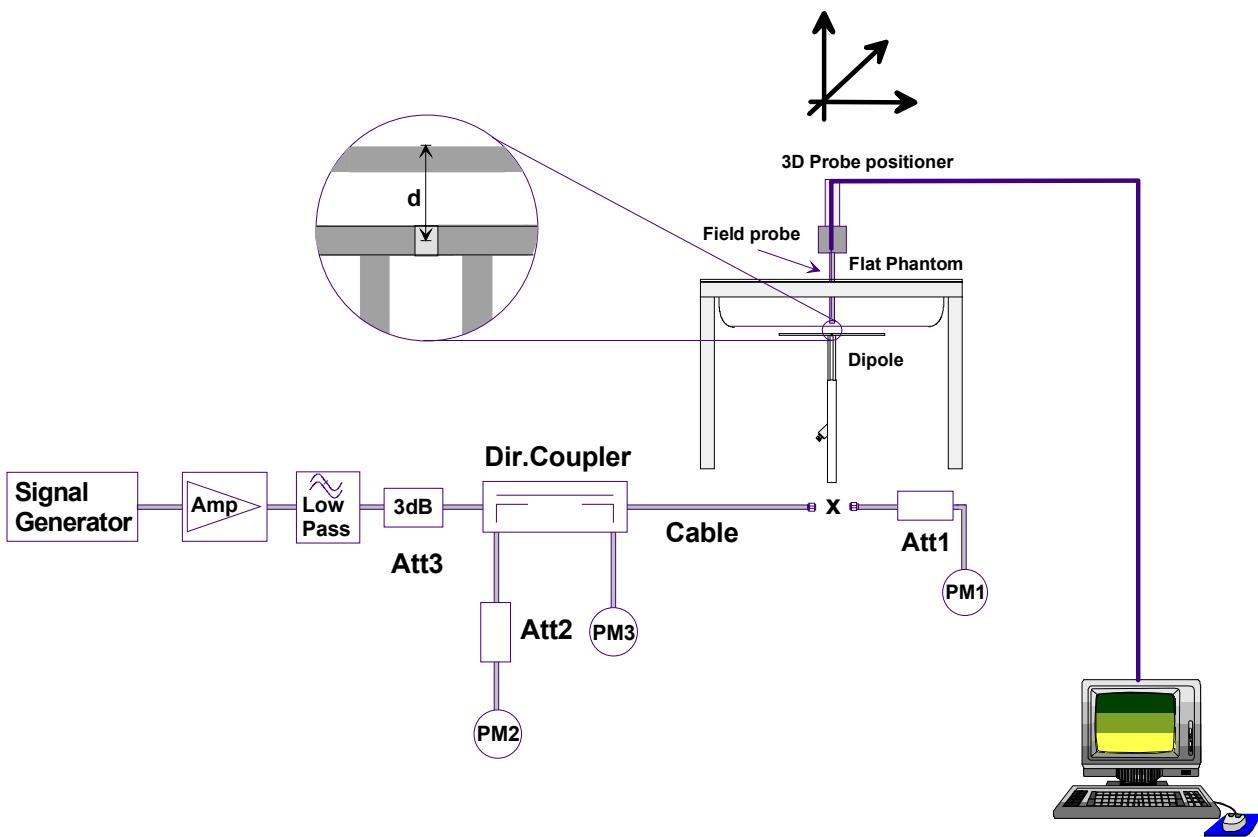
Ambient Temperature:	22.1°C
Humidity:	56%
Barometric Pressure:	103.4 kPa

The 300MHz simulated tissue mixture consists of the following ingredients:

Ingredient	Percentage by weight
Water	37.56%
Sugar	55.32%
Salt	5.95%
HEC	0.98%
Dowicil 75	0.19%
300MHz Target Dielectric Parameters at 22°C	$\epsilon_r = 45.3$ $\sigma = 0.87 \text{ S/m}$

7. SAR Measurement

The SAR measurement was performed with the E-field probe in mechanical detection mode only. The setup and determination of the forward power into the dipole was performed using the following procedures.



First the power meter PM1 (including attenuator Att1) is connected to the cable to measure the forward power at the location of the dipole connector (X). The signal generator is adjusted for the desired forward power at the dipole connector (taking into account the attenuation of Att1) as read by power meter PM2. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2. If the signal generator does not allow adjustment in 0.01dB steps, the remaining difference at PM2 must be taken into consideration. PM3 records the reflected power from the dipole to ensure that the value is not changed from the previous value. The reflected power should be 20dB below the forward power.

8. Validation Dipole SAR Test Results

Ten SAR measurements were performed in order to achieve repeatability and to establish an average target value.

Validation Measurement	SAR @ 0.25W Input averaged over 1g	SAR @ 1W Input averaged over 1g	SAR @ 0.25W Input averaged over 10g	SAR @ 1W Input averaged over 10g	Peak SAR @ 0.25W Input
Test 1	0.781	3.12	0.497	1.99	1.39
Test 2	0.779	3.12	0.495	1.98	1.39
Test 3	0.780	3.12	0.496	1.98	1.38
Test 4	0.788	3.15	0.501	2.00	1.41
Test 5	0.787	3.15	0.498	1.99	1.39
Test 6	0.780	3.12	0.492	1.97	1.38
Test 7	0.776	3.10	0.494	1.98	1.37
Test 8	0.784	3.14	0.500	2.00	1.39
Test 9	0.785	3.14	0.500	2.00	1.39
Test 10	0.784	3.14	0.496	1.98	1.40
Average Value	0.782	3.13	0.497	1.99	1.39

The results have been normalized to 1W (forward power) into the dipole.

IEEE Target over 1cm³ (1g) of tissue: 0.750 mW/g (+/- 10%)

Averaged over 1cm³ (1g) of tissue: 3.13 mW/g

Averaged over 10cm³ (10g) of tissue: 1.99 mW/g

Test Date: 10/30/03

DUT: Dipole 300 MHz; Model: D300V2; Type: System Validation; Serial: 135

Ambient Temp: 22.1°C; Fluid Temp: 22.2°C; Barometric Pressure: 103.4 kPa; Humidity: 56%

Communication System: CW

Forward Conducted Power: 250 mW

Frequency: 300 MHz; Duty Cycle: 1:1

Medium: 300 HSL ($\sigma = 0.88$ mho/m, $\epsilon_r = 45.7$, $\rho = 1000$ kg/m³)

- Probe: ET3DV6 - SN1387; ConvF(7.9, 7.9, 7.9); Calibrated: 26/02/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn370; Calibrated: 19/05/2003
- Phantom: Validation Planar; Type: Plexiglas; Serial: 137
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

300 MHz Validation/Area Scan (6x11x1): Measurement grid: dx=15mm, dy=15mm

Reference Value = 30.4 V/m

Power Drift = -0.1 dB

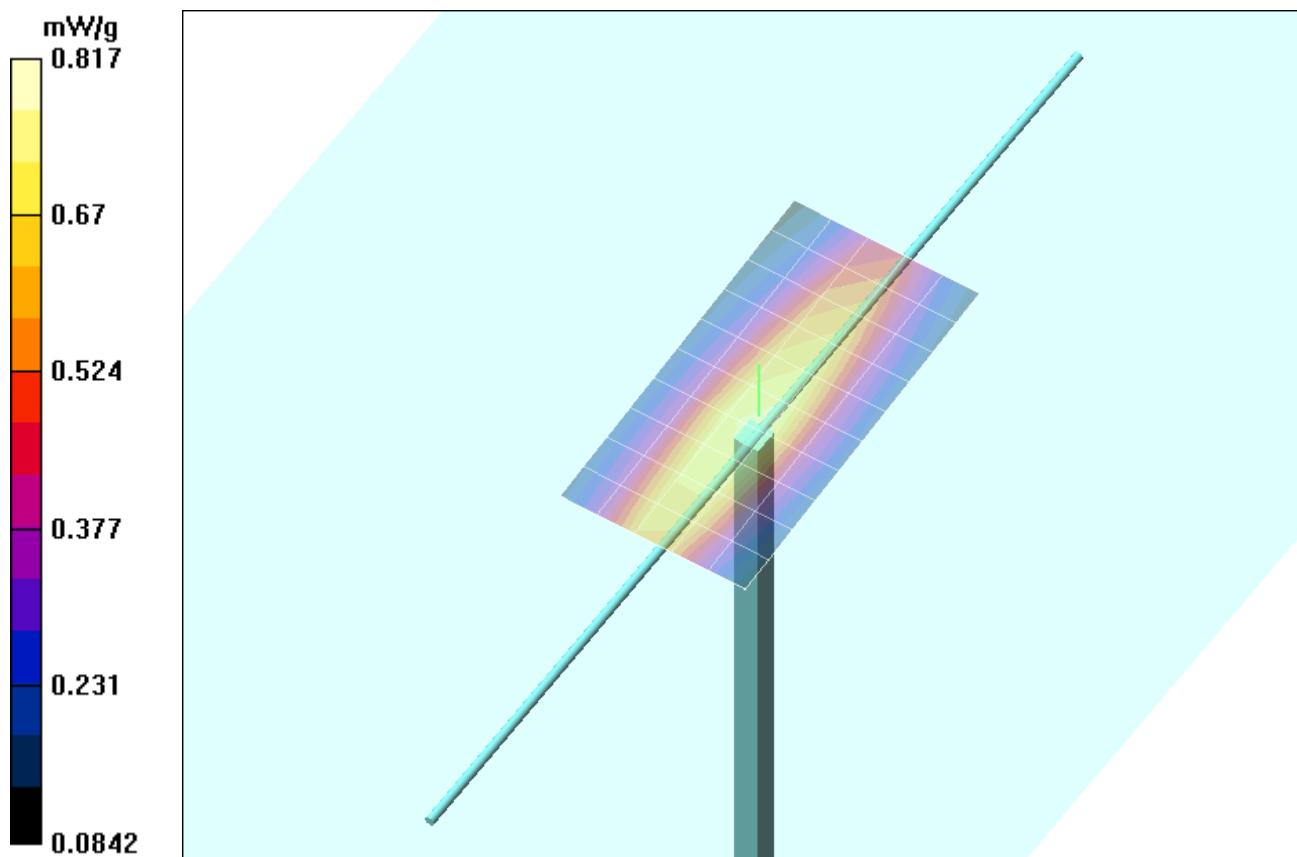
300 MHz Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

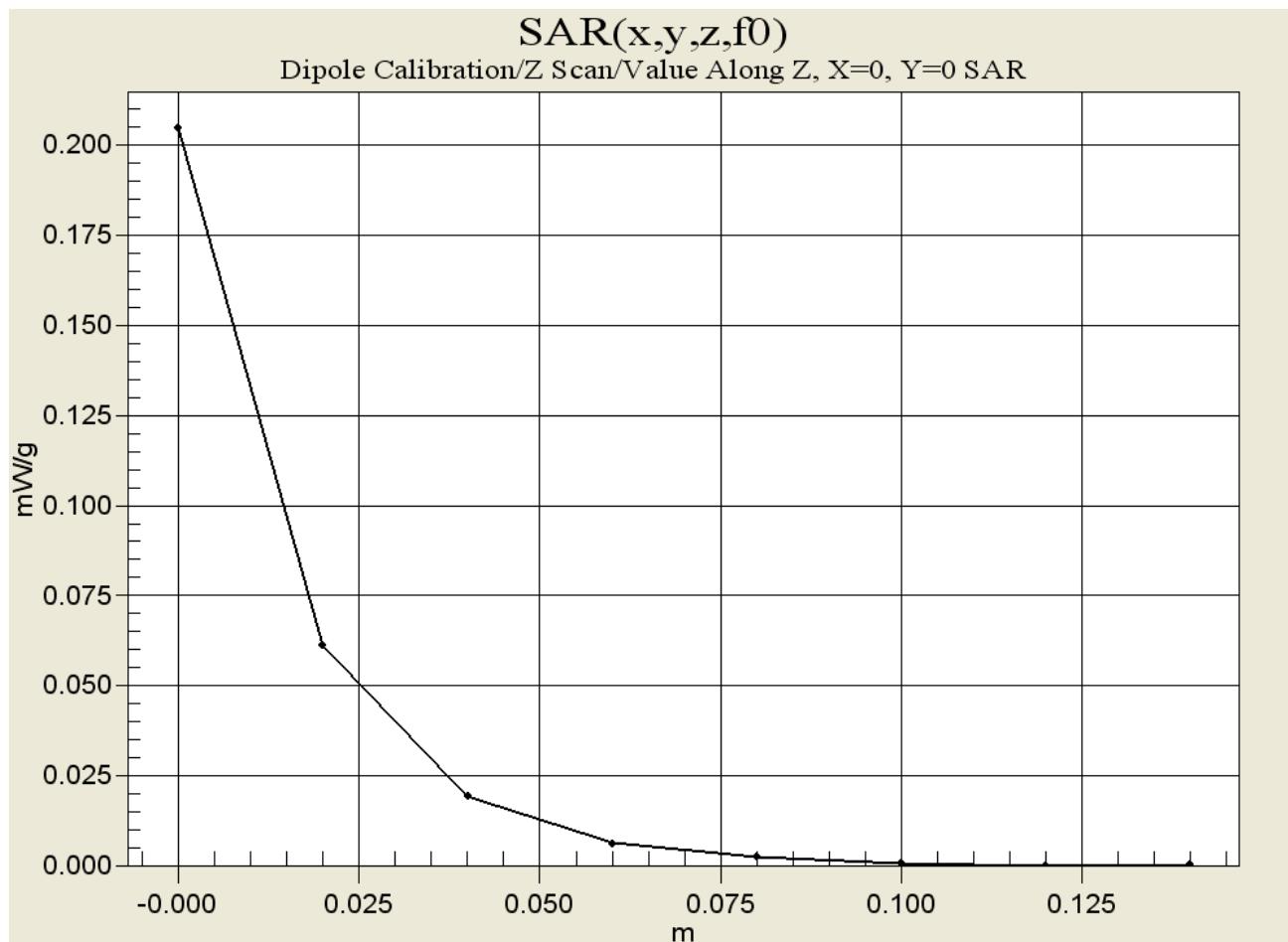
Peak SAR (extrapolated) = 1.39 W/kg

SAR(1 g) = 0.781 mW/g; SAR(10 g) = 0.497 mW/g

Reference Value = 30.4 V/m

Power Drift = -0.1 dB





APPENDIX D - PROBE CALIBRATION

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

Client

Celltech Labs

CALIBRATION CERTIFICATE

Object(s) **ET3DV6 - SN: 1387**

Calibration procedure(s) **QA CAL-01.v2**
Calibration procedure for dosimetric E-field probes

Calibration date: **February 26, 2003**

Condition of the calibrated item **In Tolerance (according to the specific calibration document)**

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date	Scheduled Calibration
RF generator HP 8684C	US3642U01700	4-Aug-99 (in house check Aug-02)	In house check: Aug-05
Power sensor E4412A	MY41495277	8-Mar-02	Mar-03
Power sensor HP 8481A	MY41092180	18-Sep-02	Sep-03
Power meter EPM E4419B	GB41293874	13-Sep-02	Sep-03
Network Analyzer HP 8753E	US38432426	3-May-00	In house check: May 03
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01	Sep-03

Calibrated by: **Name** **Nico Vetterli** **Function** **Technician** **Signature** **N. Vetterli**

Approved by: **Katja Pokovic** **Laboratory Director** **Signature** **K. Pokovic**

Date issued: February 26, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

Probe ET3DV6

SN:1387

Manufactured:	September 21, 1999
Last calibration:	February 22, 2002
Recalibrated:	February 26, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ET3DV6 SN:1387

Sensitivity in Free Space

NormX	1.55 $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	1.65 $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	1.64 $\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression

DCP X	92	mV
DCP Y	92	mV
DCP Z	92	mV

Sensitivity in Tissue Simulating Liquid

Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\%$ mho/m
	ConvF X	6.6 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	6.6 $\pm 9.5\%$ (k=2)	Alpha 0.37
	ConvF Z	6.6 $\pm 9.5\%$ (k=2)	Depth 2.61
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
Head	1900 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
	ConvF X	5.2 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	5.2 $\pm 9.5\%$ (k=2)	Alpha 0.50
	ConvF Z	5.2 $\pm 9.5\%$ (k=2)	Depth 2.73

Boundary Effect

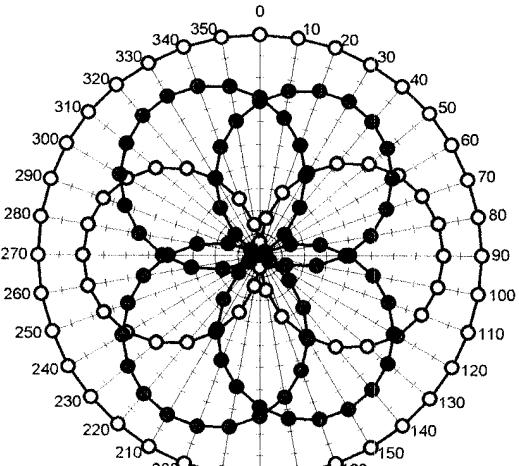
Head	900 MHz	Typical SAR gradient: 5 % per mm		
	Probe Tip to Boundary	1 mm	2 mm	
	SAR _{be} [%] Without Correction Algorithm	10.2	5.9	
	SAR _{be} [%] With Correction Algorithm	0.4	0.6	
Head	1800 MHz	Typical SAR gradient: 10 % per mm		
	Probe Tip to Boundary	1 mm	2 mm	
	SAR _{be} [%] Without Correction Algorithm	14.6	9.8	
	SAR _{be} [%] With Correction Algorithm	0.2	0.0	

Sensor Offset

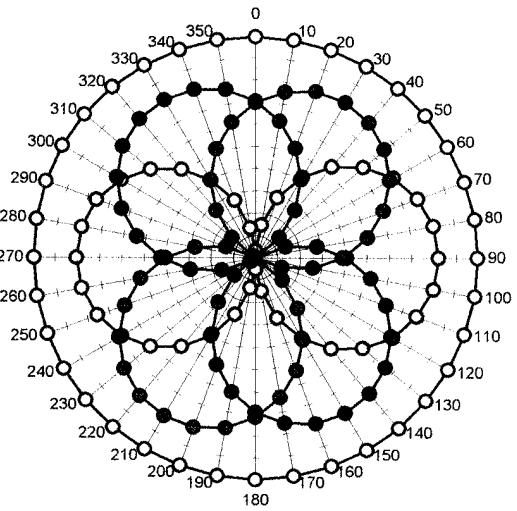
Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.4 \pm 0.2	mm

Receiving Pattern (ϕ), $\theta = 0^\circ$

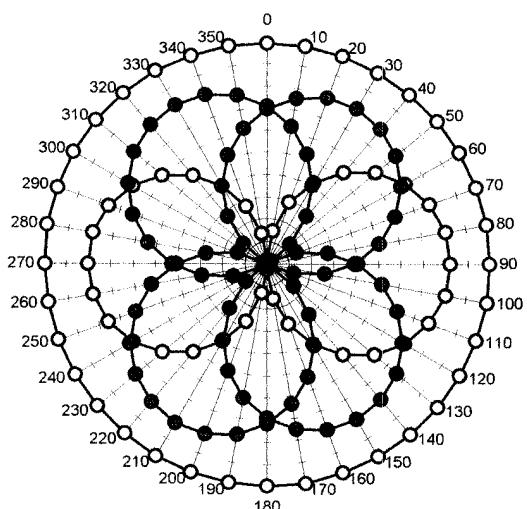
$f = 30$ MHz, TEM cell ifi110



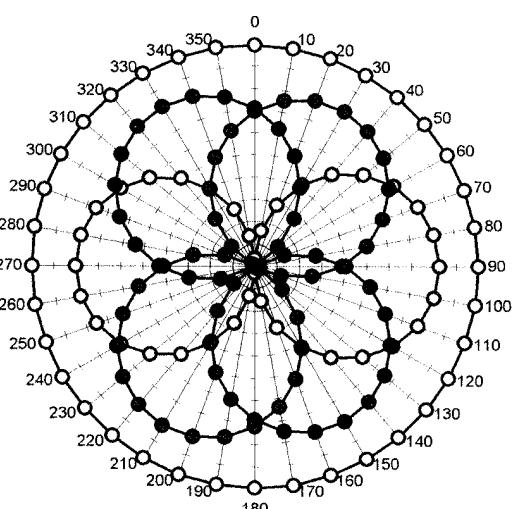
$f = 100$ MHz, TEM cell ifi110

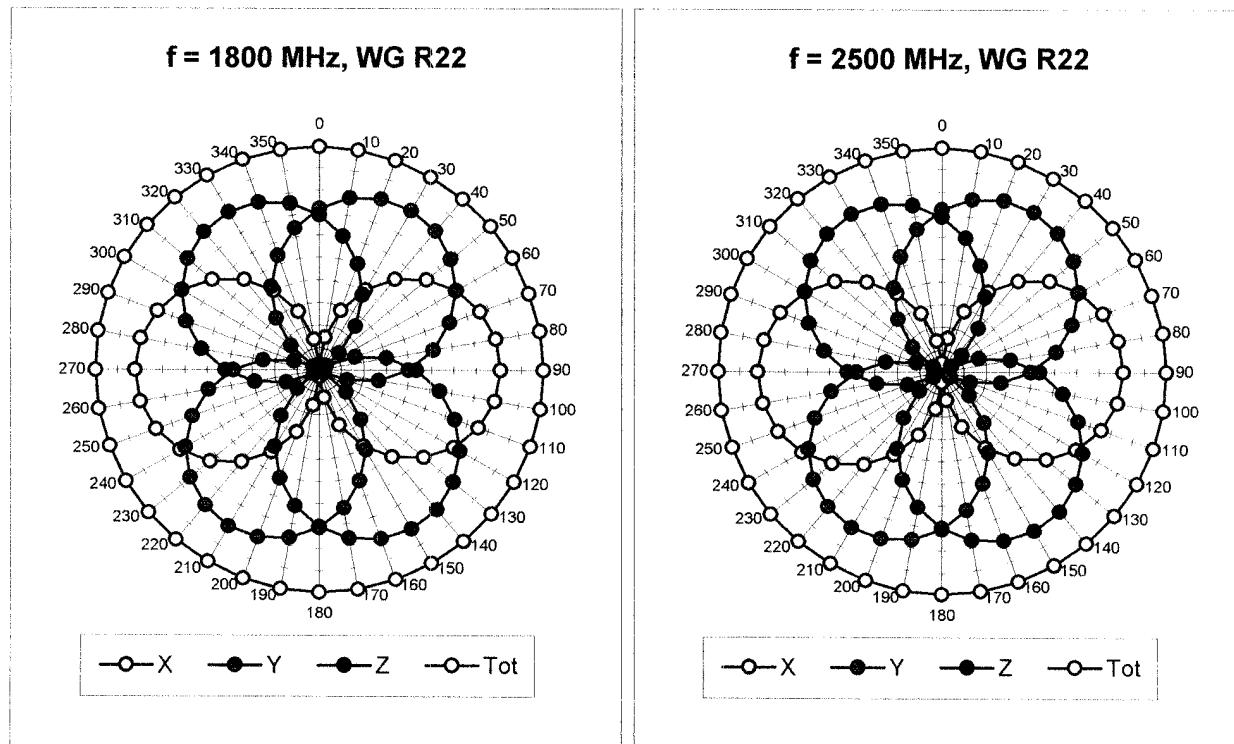


$f = 300$ MHz, TEM cell ifi110

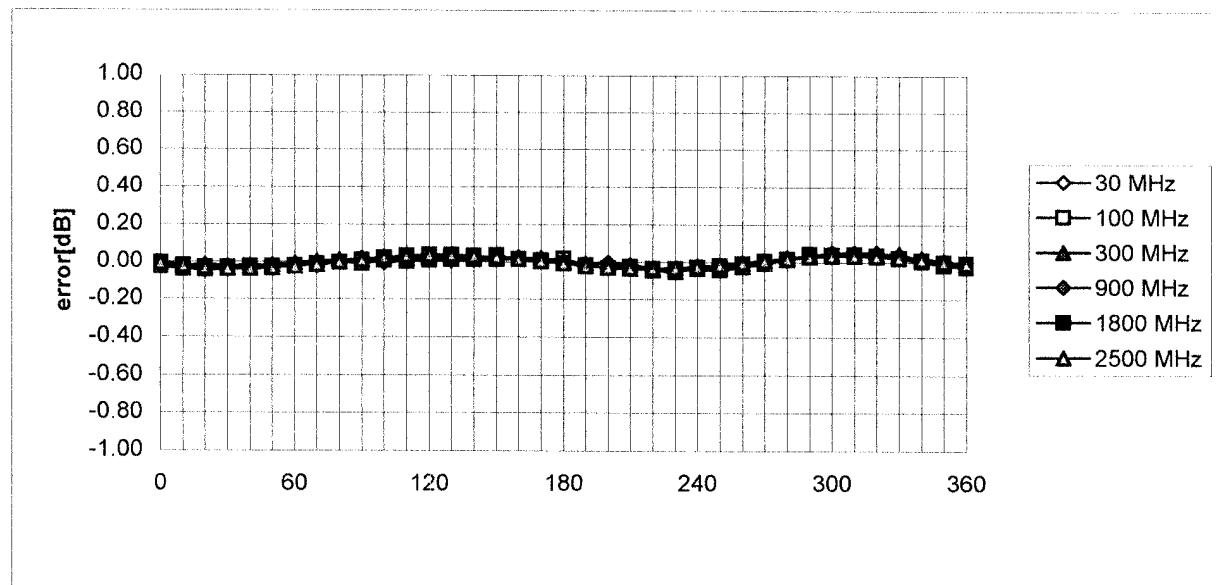


$f = 900$ MHz, TEM cell ifi110



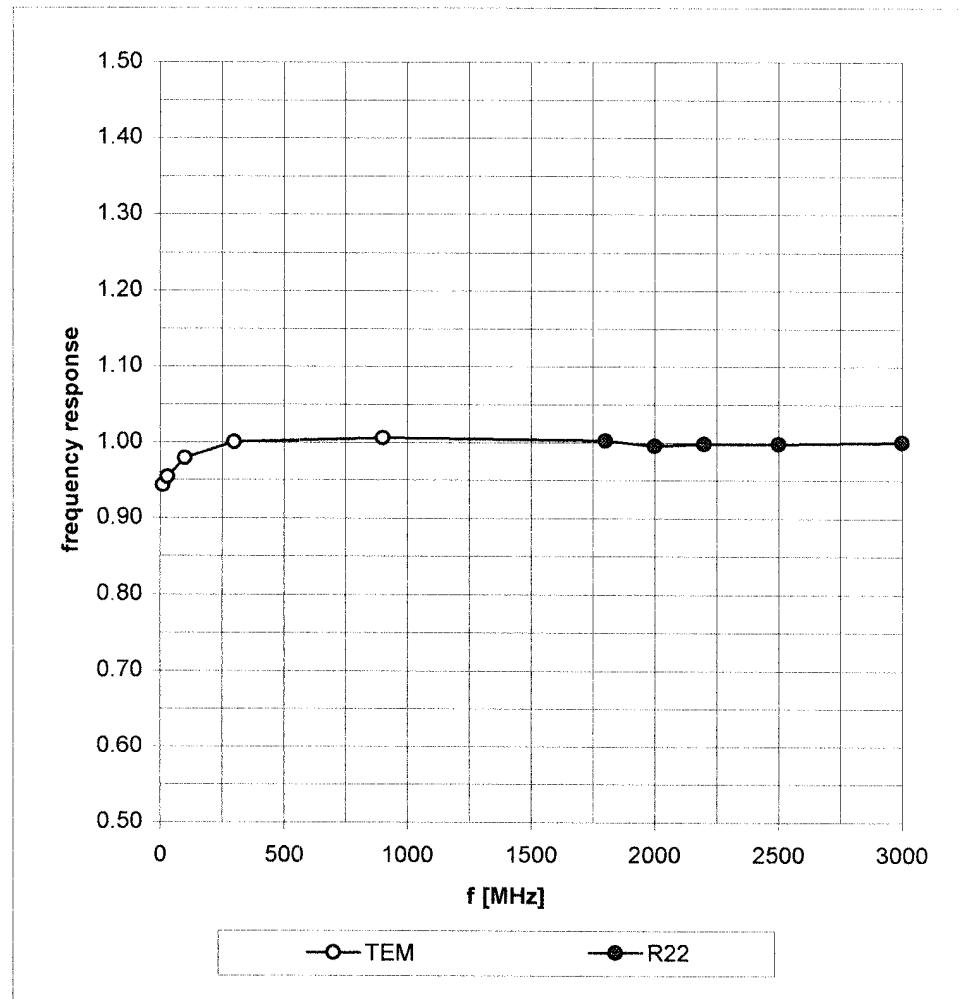


Isotropy Error (ϕ), $\theta = 0^\circ$

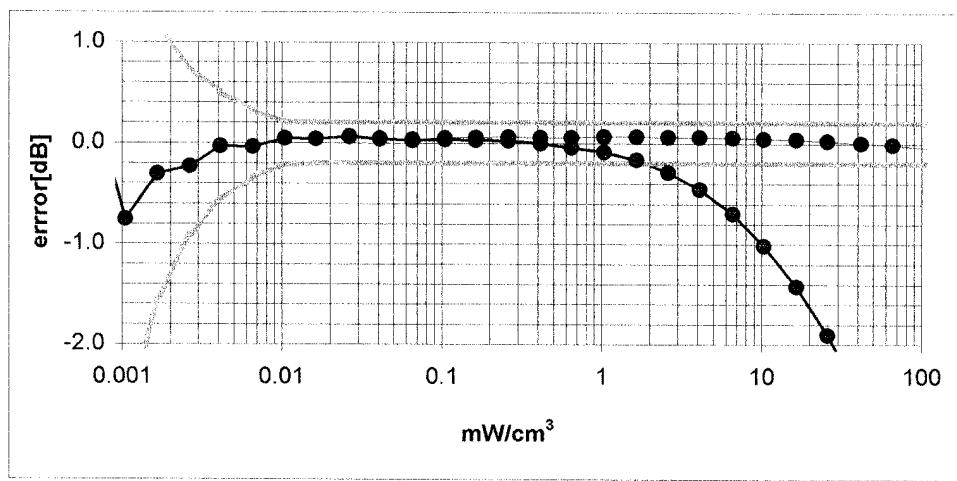
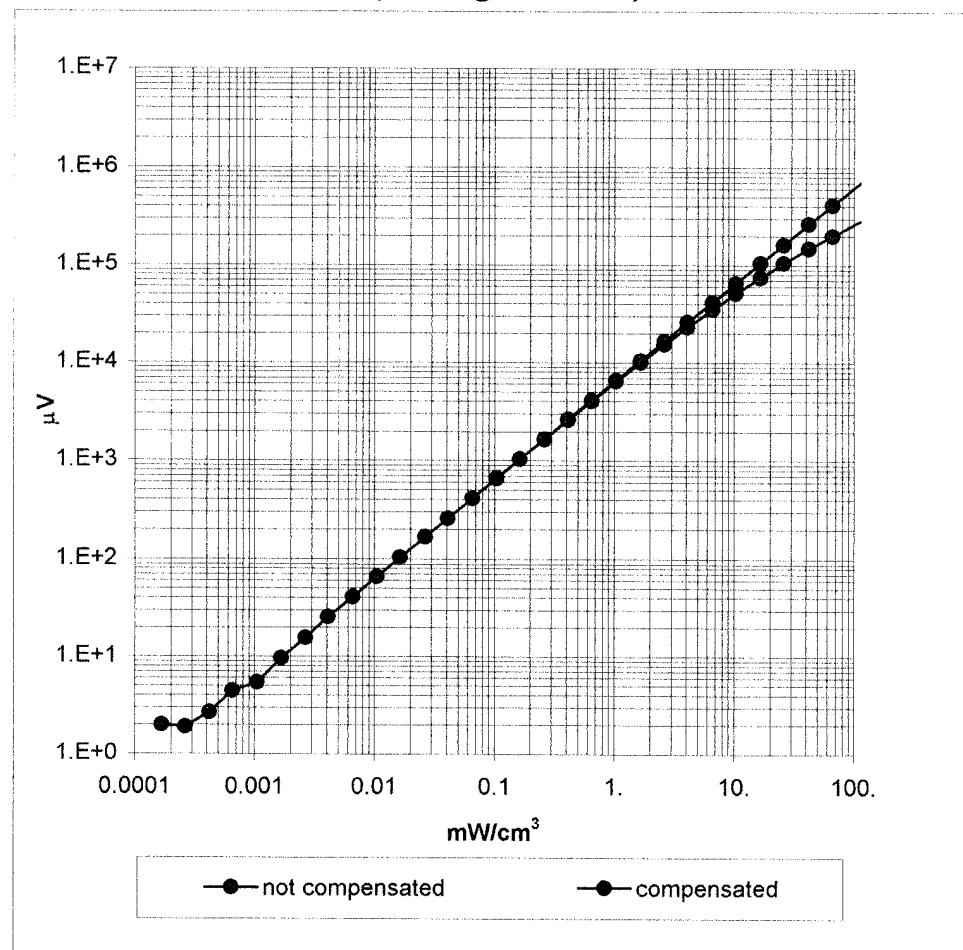


Frequency Response of E-Field

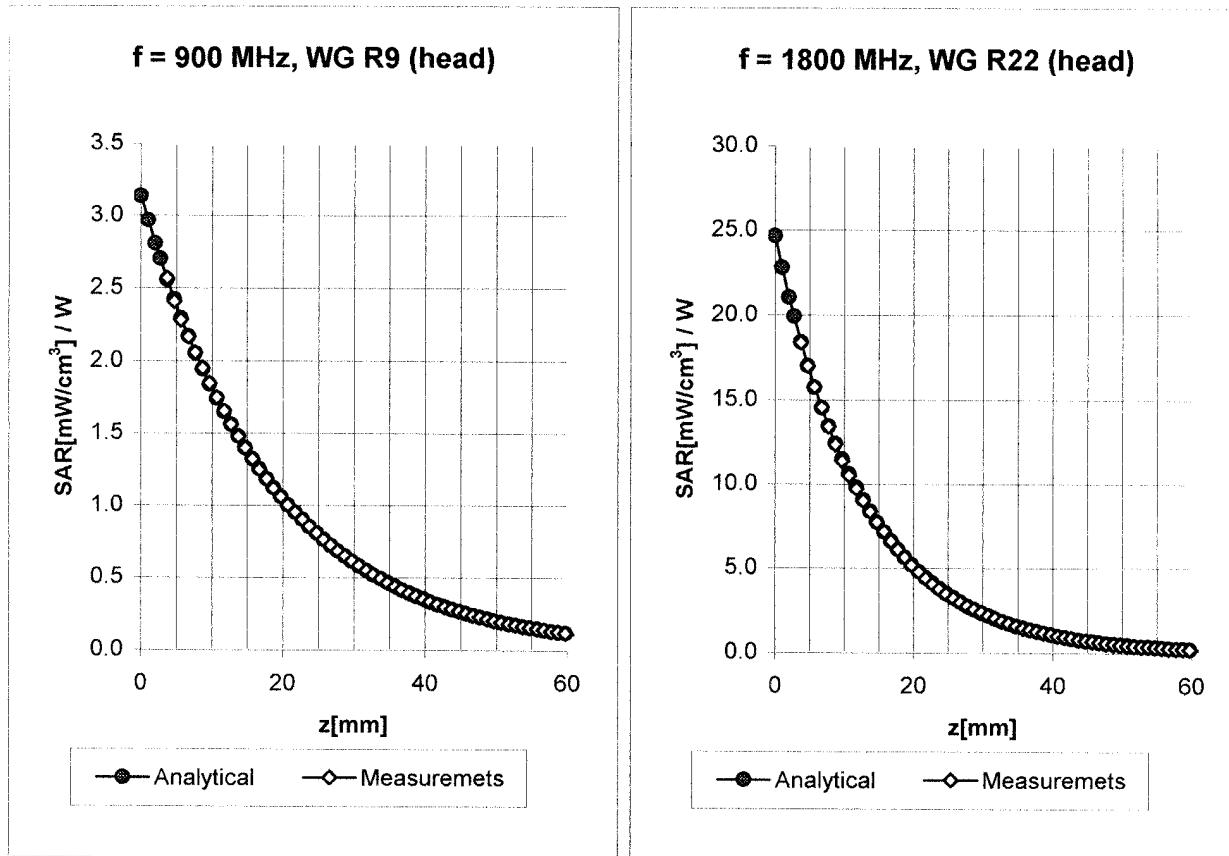
(TEM-Cell:ifi110, Waveguide R22)



Dynamic Range f(SAR_{brain}) (Waveguide R22)

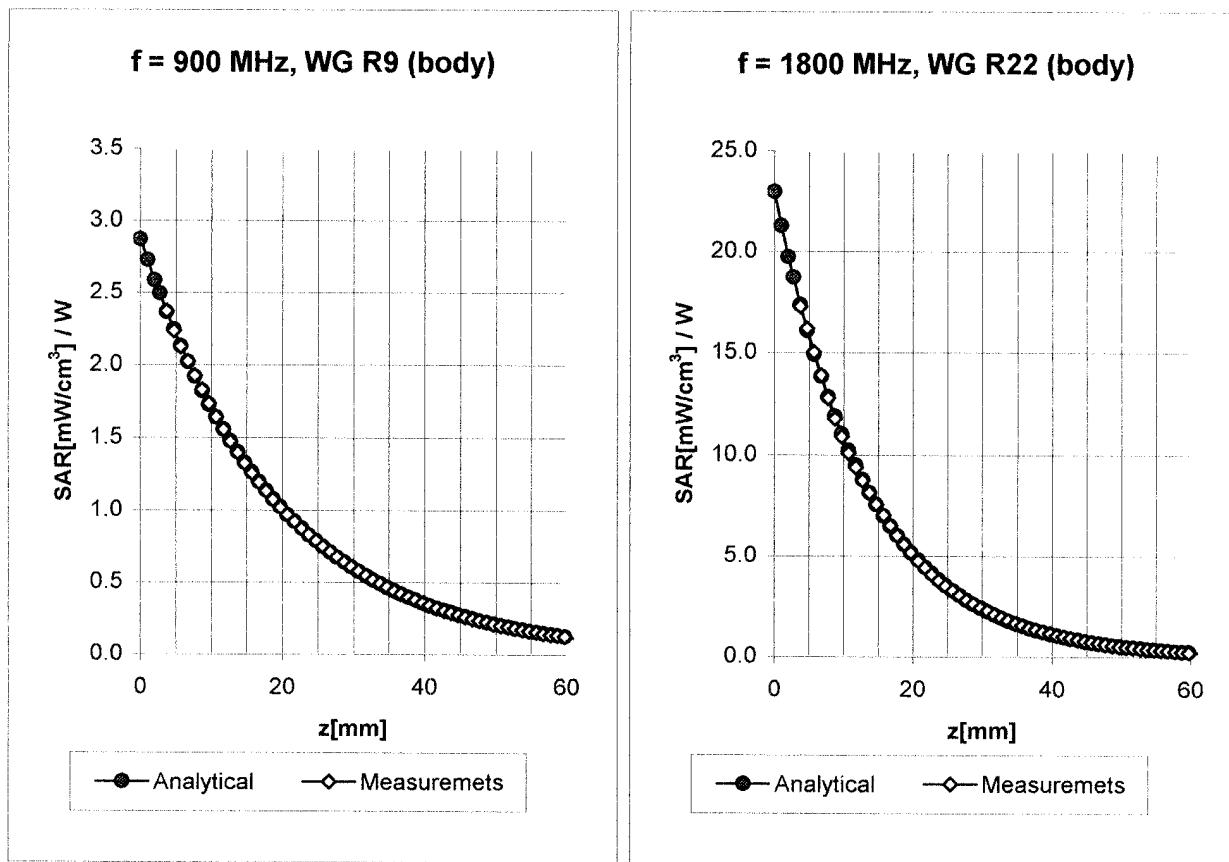


Conversion Factor Assessment



Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\% \text{ mho/m}$
	ConvF X	6.6 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	6.6 $\pm 9.5\%$ (k=2)	Alpha 0.37
	ConvF Z	6.6 $\pm 9.5\%$ (k=2)	Depth 2.61
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
Head	1900 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
	ConvF X	5.2 $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	5.2 $\pm 9.5\%$ (k=2)	Alpha 0.50
	ConvF Z	5.2 $\pm 9.5\%$ (k=2)	Depth 2.73

Conversion Factor Assessment



Body **900 MHz** $\epsilon_r = 55.0 \pm 5\%$ $\sigma = 1.05 \pm 5\% \text{ mho/m}$

Body **835 MHz** $\epsilon_r = 55.2 \pm 5\%$ $\sigma = 0.97 \pm 5\% \text{ mho/m}$

ConvF X **6.4** $\pm 9.5\%$ (k=2) Boundary effect:

ConvF Y **6.4** $\pm 9.5\%$ (k=2) Alpha **0.45**

ConvF Z **6.4** $\pm 9.5\%$ (k=2) Depth **2.35**

Body **1800 MHz** $\epsilon_r = 53.3 \pm 5\%$ $\sigma = 1.52 \pm 5\% \text{ mho/m}$

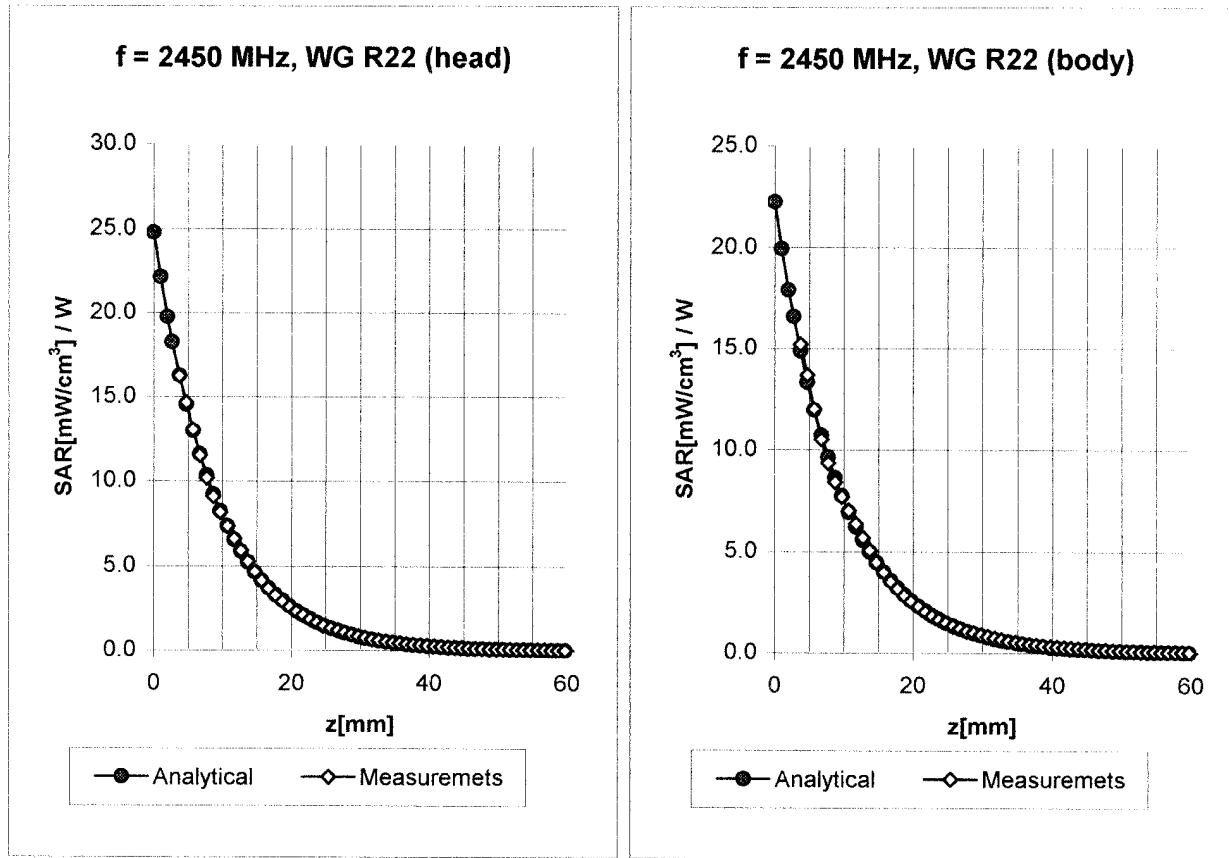
Body **1900 MHz** $\epsilon_r = 53.3 \pm 5\%$ $\sigma = 1.52 \pm 5\% \text{ mho/m}$

ConvF X **4.9** $\pm 9.5\%$ (k=2) Boundary effect:

ConvF Y **4.9** $\pm 9.5\%$ (k=2) Alpha **0.60**

ConvF Z **4.9** $\pm 9.5\%$ (k=2) Depth **2.59**

Conversion Factor Assessment



Head 2450 MHz $\epsilon_r = 39.2 \pm 5\%$ $\sigma = 1.80 \pm 5\% \text{ mho/m}$

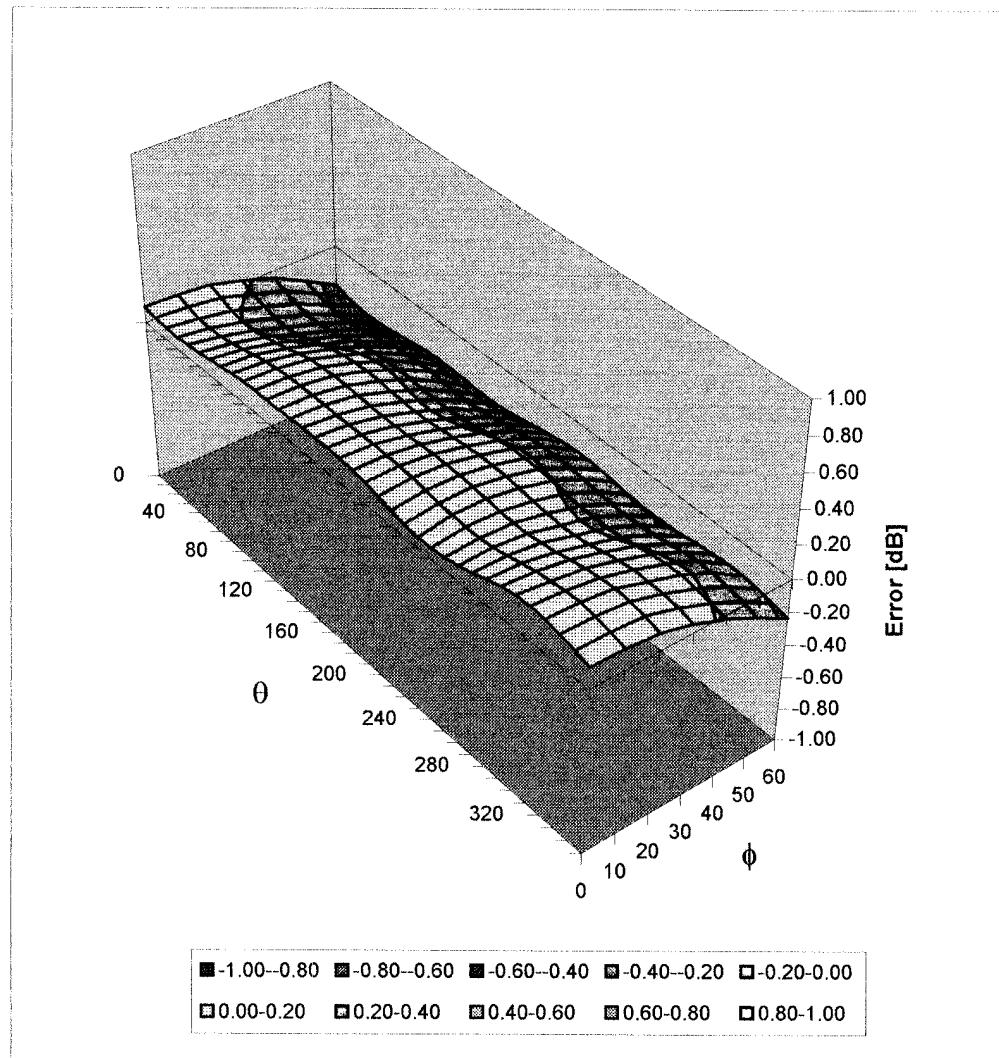
ConvF X	5.0 $\pm 8.9\%$ (k=2)	Boundary effect:	
ConvF Y	5.0 $\pm 8.9\%$ (k=2)	Alpha	1.04
ConvF Z	5.0 $\pm 8.9\%$ (k=2)	Depth	1.85

Body 2450 MHz $\epsilon_r = 52.7 \pm 5\%$ $\sigma = 1.95 \pm 5\% \text{ mho/m}$

ConvF X	4.6 $\pm 8.9\%$ (k=2)	Boundary effect:	
ConvF Y	4.6 $\pm 8.9\%$ (k=2)	Alpha	1.20
ConvF Z	4.6 $\pm 8.9\%$ (k=2)	Depth	1.60

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

**Additional Conversion Factors
for Dosimetric E-Field Probe**

Type:

ET3DV6

Serial Number:

1387

Place of Assessment:

Zurich

Date of Assessment:

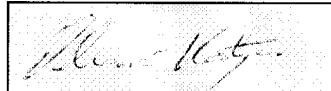
February 28, 2003

Probe Calibration Date:

February 26, 2003

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. Since the evaluation is coupled with measured conversion factors, it has to be recalculated yearly, i.e., following the re-calibration schedule of the probe. The uncertainty of the numerical assessment is based on the extrapolation from measured value at 900 MHz or at 1800 MHz.

Assessed by:



Dosimetric E-Field Probe ET3DV6 SN:1387

Conversion factor (\pm standard deviation)

150 MHz	ConvF	9.1 ± 8%	$\epsilon_r = 52.3$ $\sigma = 0.76 \text{ mho/m}$ (head tissue)
300 MHz	ConvF	7.9 ± 8%	$\epsilon_r = 45.3$ $\sigma = 0.87 \text{ mho/m}$ (head tissue)
450 MHz	ConvF	7.5 ± 8%	$\epsilon_r = 43.5$ $\sigma = 0.87 \text{ mho/m}$ (head tissue)
150 MHz	ConvF	8.8 ± 8%	$\epsilon_r = 61.9$ $\sigma = 0.80 \text{ mho/m}$ (body tissue)
300 MHz	ConvF	8.0 ± 8%	$\epsilon_r = 58.2$ $\sigma = 0.92 \text{ mho/m}$ (body tissue)
450 MHz	ConvF	7.7 ± 8%	$\epsilon_r = 56.7$ $\sigma = 0.94 \text{ mho/m}$ (body tissue)

APPENDIX E - MEASURED FLUID DIELECTRIC PARAMETERS

300MHz System Performance Check

Measured Fluid Dielectric Parameters (Brain)

November 03, 2003

Frequency	e'	e"
200.000000 MHz	49.5488	72.3165
210.000000 MHz	49.1184	69.5839
220.000000 MHz	48.8911	67.1942
230.000000 MHz	48.2655	64.9177
240.000000 MHz	47.7940	62.7668
250.000000 MHz	47.4192	60.8457
260.000000 MHz	46.9808	59.2384
270.000000 MHz	46.5943	57.7459
280.000000 MHz	46.3559	56.1809
290.000000 MHz	45.9617	54.8399
300.000000 MHz	45.5592	53.3659
310.000000 MHz	45.1741	52.1348
320.000000 MHz	44.9330	51.0837
330.000000 MHz	44.5616	49.9192
340.000000 MHz	44.2747	48.9134
350.000000 MHz	43.9709	47.9673
360.000000 MHz	43.7082	47.0574
370.000000 MHz	43.4464	46.1623
380.000000 MHz	43.2502	45.3506
390.000000 MHz	42.8873	44.5476
400.000000 MHz	42.6994	43.8266

150MHz DUT Evaluation (Face-held)

Measured Fluid Dielectric Paramaters (Brain)

November 03, 2003

Frequency	e'	e"
50.000000 MHz	59.9807	238.5590
60.000000 MHz	58.6071	201.5381
70.000000 MHz	58.1450	174.4127
80.000000 MHz	57.3978	153.8016
90.000000 MHz	56.6391	138.7016
100.000000 MHz	55.9404	126.0398
110.000000 MHz	55.0931	115.8990
120.000000 MHz	54.3122	107.7792
130.000000 MHz	53.6289	100.3034
140.000000 MHz	53.1260	94.2009
150.000000 MHz	52.5753	89.1277
160.000000 MHz	52.0882	84.4763
170.000000 MHz	51.5547	80.5164
180.000000 MHz	51.2050	76.7298
190.000000 MHz	50.6634	73.3952
200.000000 MHz	50.3164	70.5422
210.000000 MHz	49.7688	67.9157
220.000000 MHz	49.5820	65.5909
230.000000 MHz	49.0239	63.2994
240.000000 MHz	48.5812	61.3445
250.000000 MHz	48.2047	59.4731

APPENDIX F - SAR TEST SETUP & DUT PHOTOGRAPHS

FACE-HELD SAR TEST SETUP PHOTOGRAPHS
2.5 cm Separation Distance from Front of Radio to Planar Phantom



DUT PHOTOGRAPHS



DUT PHOTOGRAPHS



DUT PHOTOGRAPHS



Battery Compartment



7.4V Lithium-ion Battery Pack