APPENDIX B: RF EXPOSURE

FCC Rules and Regulations Part 1.1307, 1.1310, 2.1091, 2.1093: RF EXPOSURE COMPLIANCE

Please refer to the SAR evaluation that follows.

DECLARATION OF COMPLIANCE
SAR RF EXPOSURE EVALUATION

Test Lab

CELLTECH LABS INC.
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1955 Moss Court
Kelowna, B.C.
Canada V1Y 9L3
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Applicant Information

E.F. JOHNSON CO.
299 Johnson Ave. SW
Waseca, MN 56093

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)**
Equipment Class:	**Licensed Non-Broadcast Transmitter Held to Face (TNF)**
Equipment Type:	**Portable FM PTT Radio Transceiver & Speaker-Microphone with Antenna**
FCC ID:	**ATH2425180**
Model(s):	**242-5180**
Modulation:	**FM**
Tx Frequency Range(s):	**806-824 MHz (25kHz Analog, NPSPAC Analog, P25 Digital)** **851-869 MHz (25kHz Analog, NPSPAC Analog, P25 Digital)**
Max. RF Output Power Tested:	**3.47 Watts (Conducted)**
Antenna Type(s):	**Whip (P/N: 501-0105-013)** **Stubby (P/N: 501-0105-012)**
Battery Type(s):	**7.5V Nickel Metal Hydride (P/N: 587-5100-360)** **AA Alkaline Replaceable Battery Pack (P/N: 250-5100-280) - 1.5V Batteries x12**
Body-Worn Accessories:	**Belt-Clip, Speaker-Microphone, Boom-Microphone Headset**
Class II Permissive Change(s):	**1. Add AA Alkaline Replaceable Battery Pack (P/N: 250-5100-280)** **2. Add Stubby Antenna (P/N: 501-0105-012)**
Maximum SAR Measured:	**2.47 W/kg Face-held (50% Duty Cycle)** **3.67 W/kg Body-worn (50% Duty Cycle)**

Celltech Labs Inc. declares under its sole responsibility that this wireless portable device was compliant 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 Occupational / Controlled 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.

Russell W. Pipe

Russell W. Pipe
Senior Compliance Technologist
Celltech Labs Inc.

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1.0 INTRODUCTION

This measurement report demonstrates that the E.F. Johnson Model: 242-5180 Portable FM PTT Radio Transceiver FCC ID: ATH2425180, with the Class II Permissive Change(s) described in this report, complies with the SAR (Specific Absorption Rate) RF exposure requirements specified in FCC 47 CFR §2.1093 (see reference [1]), and Health Canada's Safety Code 6 (see reference [2]) for the Occupational / Controlled 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 device, 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 EQUIPMENT UNDER TEST (EUT)

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)
Equipment Class	Licensed Non-Broadcast Transmitter Held to Face (TNF)
Equipment Type	Portable FM PTT Radio Transceiver & Speaker-Microphone with Antenna
FCC ID	ATH2425180
Model(s)	242-5180
Serial No.(s)	51830A103A 16525 (Radio Transceiver) V2-100230237 (Speaker-Microphone with Antenna)
Modulation	FM
Tx Frequency Range(s)	806-824 MHz (25kHz Analog, NPSPAC Analog, P25 Digital) 851-869 MHz (25kHz Analog, NPSPAC Analog, P25 Digital)
Max. RF Output Power Measured	3.47 Watts (Conducted)
Antenna Type(s)	1. Whip (P/N: P/N: 501-0105-013) Length - 183 mm 2. Stubby (P/N: P/N: 501-0105-012) Length - 99 mm
Battery Type(s)	1. 7.5V Nickel Metal Hydride (P/N: 587-5100-360) 2. AA Alkaline Replaceable Battery Pack (P/N: 250-5100-280)
Body-worn Accessories Tested	1. Belt-Clip 2. Speaker-Microphone 3. Boom-Microphone Headset
Class II Permissive Change(s)	1. Add AA Alkaline Replaceable Battery Pack (P/N: 250-5100-280) 2. Add Stubby Antenna (P/N: 501-0105-012)

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 Plexiglas validation phantom

DASY4 SAR Measurement System with Plexiglas planar phantom

4.0 SAR MEASUREMENT SUMMARY

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum SAR location of the EUT are reported in Appendix A.

BODY-WORN SAR MEASUREMENT RESULTS													
Freq. (MHz)	Chan.	Test Device	Battery Type	Antenna Type	Separation Distance to Planar Phantom (cm)	Conducted Power			Measured SAR 1g (W/kg)		Max. Cond. Power Drift (dB)	Scaled SAR 1g (W/kg)	
						Before (W)	After (W)	Drift (dB)	100% Duty Cycle	50% Duty Cycle		100% Duty Cycle	50% Duty Cycle
815.0125	LB Mid	Radio with Belt-Clip & Headset	NiMH	Stubby	1.3	3.37	3.16	-0.28	6.03	3.02	-0.39	6.60	3.30
815.0125	LB Mid	Radio with Belt-Clip & Headset	Alkaline	Stubby	1.3	3.36	3.14	-0.29	4.77	2.39	-0.39	5.22	2.61
860.0125	HB Mid	Radio with Belt-Clip & Headset	NiMH	Stubby	1.3	3.44	3.26	-0.24	5.53	2.77	-0.39	6.05	3.03
						2nd Maximum Peak SAR			4.48	2.24	-0.39	4.90	2.45
860.0125	HB Mid	Radio with Belt-Clip & Headset	Alkaline	Stubby	1.3	3.45	3.31	-0.18	4.24	2.12	-0.39	4.64	2.32
815.0125	LB Mid	Radio with Belt-Clip & Spkr-Mic	NiMH	Stubby	1.3	3.47	3.20	-0.35	5.62	2.81	-0.39	6.15	3.08
						2nd Maximum Peak SAR			5.27	2.64	-0.39	5.77	2.89
ANSI / IEEE C95.1 1992 - SAFETY LIMIT BODY: 8.0 W/kg (averaged over 1 gram) Spatial Peak - Controlled Exposure / Occupational													

Test Date	October 15, 2003		Relative Humidity	56 %
Measured Mixture Type	835MHz Body		Ambient Temperature	20.6 °C
Dielectric Constant	IEEE Target	Measured	Fluid Temperature	20.3 °C
	55.2 (+/-5%)	54.5	Fluid Depth	≥ 15 cm
Conductivity	IEEE Target	Measured	Atmospheric Pressure	101.9 kPa
	0.97 (+/-5%)	1.00	Phantom Type	Plexiglas Planar
ρ (Kg/m^3)	1000		Abbreviations	LB = Low Band HB = High Band

Note(s):

1. The EUT was tested at the mid channel of the frequency bands (815.0125MHz, 860.0125MHz). If the SAR measurements performed at the middle channel were ≥ 3dB below the SAR limit, SAR evaluation for the low and high channels was optional (per FCC OET Bulletin 65, Supplement C, Edition 01-01 (see reference [3]).
2. Several conducted power drifts measured before and after the SAR evaluations were > 5%. The maximum measured conducted power drift was added to the measured SAR levels to show scaled SAR results as listed in the above table. The maximum measured conducted power drift added was -0.39 dB from the face-held SAR evaluation on October 20, 2003.
3. Secondary peak SAR locations within 2dB of the maximum were evaluated and reported as shown in the table above and in Appendix A.
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 body 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).

SAR MEASUREMENT SUMMARY (Cont.)

BODY-WORN SAR MEASUREMENT RESULTS													
Freq. (MHz)	Chan.	Test Device	Battery Type	Antenna Type	Separation Distance to Planar Phantom (cm)	Conducted Power			Measured SAR 1g (W/kg)		Max. Cond. Power Drift (dB)	Scaled SAR 1g (W/kg)	
						Before (W)	After (W)	Drift (dB)	100% Duty Cycle	50% Duty Cycle		100% Duty Cycle	50% Duty Cycle
815.0125	LB Mid	Radio with Belt-Clip & Spkr-Mic	Alkaline	Stubby	1.3	3.42	3.18	-0.32	4.28	2.14	-0.39	4.68	2.34
860.0125	HB Mid	Radio with Belt-Clip & Spkr-Mic	NiMH	Stubby	1.3	3.45	3.35	-0.13	5.59	2.80	-0.39	6.12	3.06
						2nd Maximum Peak SAR			5.06	2.53	-0.39	5.54	2.77
860.0125	HB Mid	Radio with Belt-Clip & Spkr-Mic	Alkaline	Stubby	1.3	3.46	3.35	-0.14	4.16	2.08	-0.39	4.55	2.28
815.0125	LB Mid	Speaker-Mic w/ Antenna	NiMH	Stubby	1.2	3.46	3.23	-0.30	6.52	3.26	-0.39	7.13	3.57
860.0125	HB Mid	Speaker-Mic w/ Antenna	NiMH	Stubby	1.2	3.38	3.27	-0.14	6.31	3.16	-0.39	6.90	3.45
ANSI / IEEE C95.1 1992 - SAFETY LIMIT BODY: 8.0 W/kg (averaged over 1 gram) Spatial Peak - Controlled Exposure / Occupational													

Test Date	October 16, 2003		Relative Humidity	54 %
Measured Mixture Type	835MHz Body		Ambient Temperature	20.4 °C
Dielectric Constant	IEEE Target	Measured	Fluid Temperature	20.2 °C
	55.2 (+/-5%)	54.7	Fluid Depth	≥ 15 cm
Conductivity	IEEE Target	Measured	Atmospheric Pressure	101.1 kPa
	0.97 (+/-5%)	1.01	Phantom Type	Plexiglas Planar
ρ (Kg/m^3)	1000		Abbreviations	LB = Low Band HB = High Band

Note(s):

1. The EUT was tested at the mid channel of the frequency bands (815.0125MHz, 860.0125MHz). If the SAR measurements performed at the middle channel were ≥ 3dB below the SAR limit, SAR evaluation for the low and high channels was optional (per FCC OET Bulletin 65, Supplement C, Edition 01-01 (see reference [3]).
2. Several conducted power drifts measured before and after the SAR evaluations were > 5%. The maximum measured conducted power drift was added to the measured SAR levels to show scaled SAR results as listed in the above table. The maximum measured conducted power drift added was -0.39 dB from the face-held SAR evaluation on October 20, 2003.
3. Secondary peak SAR locations within 2dB of the maximum were evaluated and reported as shown in the table above and in Appendix A.
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 body 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).
6. The alkaline battery pack is not intended for use with the speaker-microphone antenna configuration.

MEASUREMENT SUMMARY (Cont.)

BODY-WORN SAR MEASUREMENT RESULTS

Freq. (MHz)	Chan.	Test Device	Battery Type	Antenna Type	Separation Distance to Planar Phantom (cm)	Conducted Power			Measured SAR 1g (W/kg)		Max. Cond. Power Drift (dB)	Scaled SAR 1g (W/kg)	
						Before (W)	After (W)	Drift (dB)	100% Duty Cycle	50% Duty Cycle		100% Duty Cycle	50% Duty Cycle
815.0125	LB Mid	Radio with Belt-Clip & Spkr-Mic	Alkaline	Whip	1.3	3.39	3.16	-0.30	3.66	1.83	-0.39	4.00	2.00
860.0125	HB Mid	Radio with Belt-Clip & Spkr-Mic	Alkaline	Whip	1.3	3.45	3.33	-0.16	5.36	2.68	-0.39	5.86	2.93
815.0125	LB Mid	Radio with Belt-Clip & Headset	Alkaline	Whip	1.3	3.42	3.24	-0.23	6.70	3.35	-0.39	7.33	3.67
860.0125	HB Mid	Radio with Belt-Clip & Headset	Alkaline	Whip	1.3	3.44	3.33	-0.15	6.04	3.02	-0.39	6.61	3.31

ANSI / IEEE C95.1 1992 - SAFETY LIMIT
BODY: 8.0 W/kg (averaged over 1 gram)
Spatial Peak - Controlled Exposure / Occupational

Test Date	October 17, 2003		**Relative Humidity**	64 %
Measured Mixture Type	835MHz Body		**Ambient Temperature**	19.7 °C
Dielectric Constant	**IEEE Target**	**Measured**	**Fluid Temperature**	21.3 °C
	55.2 (+/-5%)	54.9	**Fluid Depth**	≥ 15 cm
Conductivity	**IEEE Target**	**Measured**	**Atmospheric Pressure**	101.0 kPa
	0.97 (+/-5%)	1.01	**Phantom Type**	Plexiglas Planar
ρ (Kg/m^3)	1000		**Abbreviations**	LB = Low Band HB = High Band

Note(s):

1. The EUT was tested at the mid channel of the frequency bands (815.0125MHz, 860.0125MHz). If the SAR measurements performed at the middle channel were ≥ 3dB below the SAR limit, SAR evaluation for the low and high channels was optional (per FCC OET Bulletin 65, Supplement C, Edition 01-01 (see reference [3]).
2. Several conducted power drifts measured before and after the SAR evaluations were > 5%. The maximum measured conducted power drift was added to the measured SAR levels to show scaled SAR results as listed in the above table. The maximum measured conducted power drift added was -0.39 dB from the face-held SAR evaluation on October 20, 2003.
3. 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.
4. The dielectric properties of the simulated body 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).

SAR MEASUREMENT SUMMARY (Cont.)

FACE-HELD SAR MEASUREMENT RESULTS

Freq. (MHz)	Chan.	Test Device	Battery Type	Antenna Type	Separation Distance to Planar Phantom (cm)	Conducted Power			Measured SAR 1g (W/kg)		Max. Cond. Power Drift (dB)	Scaled SAR 1g (W/kg)	
						Before (W)	After (W)	Drift (dB)	100% Duty Cycle	50% Duty Cycle		100% Duty Cycle	50% Duty Cycle
815.0125	LB Mid	Radio	NiMH	Stubby	2.5	3.42	3.13	-0.38	4.51	2.26	-0.39	4.93	2.47
860.0125	HB Mid	Radio	NiMH	Stubby	2.5	3.43	3.33	-0.13	3.52	1.76	-0.39	3.85	1.93
						2nd Maximum Peak SAR			2.59	1.30	-0.39	2.83	1.42
815.0125	LB Mid	Radio	Alkaline	Stubby	2.5	3.41	3.14	-0.36	3.99	2.00	-0.39	4.36	2.18
						2nd Maximum Peak SAR			2.52	1.26	-0.39	2.76	1.38
860.0125	HB Mid	Radio	Alkaline	Stubby	2.5	3.44	3.24	-0.26	2.84	1.42	-0.39	3.11	1.56
						2nd Maximum Peak SAR			2.43	1.23	-0.39	2.66	1.33
815.0125	LB Mid	Radio	Alkaline	Whip	2.5	3.43	3.13	-0.39	3.30	1.65	-0.39	3.61	1.81
860.0125	HB Mid	Radio	Alkaline	Whip	2.5	3.46	3.34	-0.15	3.03	1.52	-0.39	3.31	1.66
815.0125	LB Mid	Speaker-Mic w/ Antenna	NiMH	Stubby	2.5	3.46	3.19	-0.35	3.28	1.64	-0.39	3.59	1.80
860.0125	HB Mid	Speaker-Mic w/ Antenna	NMH	Stubby	2.5	3.43	3.36	-0.09	3.07	1.54	-0.39	3.36	1.68

ANSI / IEEE C95.1 1992 - SAFETY LIMIT
BRAIN: 8.0 W/kg (averaged over 1 gram)
Spatial Peak - Controlled Exposure / Occupational

Test Date	October 20, 2003		Relative Humidity	62 %
Measured Mixture Type	835MHz Brain		Ambient Temperature	20.0°C
Dielectric Constant	IEEE Target	Measured	Fluid Temperature	22.0°C
	41.5 (+/-5%)	42.1	Fluid Depth	≥ 15 cm
Conductivity	IEEE Target	Measured	Atmospheric Pressure	101.4 kPa
	0.90 (+/-5%)	0.93	Phantom Type	Plexiglas Planar
ρ (Kg/m^3)	1000		Abbreviations	LB = Low Band HB = High Band

Note(s):

1. The EUT was tested at the mid channel of the frequency bands (815.0125MHz, 860.0125MHz). If the SAR measurements performed at the middle channel were ≥ 3dB below the SAR limit, SAR evaluation for the low and high channels was optional (per FCC OET Bulletin 65, Supplement C, Edition 01-01 (see reference [3]).
2. Several conducted power drifts measured before and after the SAR evaluations were > 5%. The maximum measured conducted power drift was added to the measured SAR levels to show scaled SAR results as listed in the above table. The maximum measured conducted power drift added was -0.39 dB from the face-held SAR evaluation on October 20, 2003.
3. Secondary peak SAR locations within 2dB of the maximum were evaluated and reported as shown above and in Appendix A (SAR Test Plots).
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 brain fluid were measured prior to the evaluation using an 85070C Dielectric Probe Kit and an 8753E Network Analyzer (see Appendix E for measured fluid dielectric parameters).
6. The alkaline battery pack is not intended for use with the speaker-microphone antenna configuration.

5.0 DETAILS OF SAR EVALUATION

The E.F. Johnson Model: 242-5180 Portable FM PTT Radio Transceiver FCC ID: ATH2425180, with the Class II Permissive Change(s) described in this report, was found to be compliant for localized Specific Absorption Rate (Controlled Exposure) based on the test provisions and conditions described below. Detailed photographs of the test setup are shown in Appendix F.

1. The radio transceiver was tested in a face-held configuration with the front of the device placed parallel to the outer surface of the planar phantom with a 2.5 cm separation distance.
2. The speaker-microphone with antenna was tested in a face-held configuration with the front of the device placed parallel to the outer surface of the planar phantom with a 2.5 cm separation distance. The speaker-microphone with antenna was tested with the NiMH battery only, since the alkaline battery pack is not intended for use with the speaker-microphone antenna configuration.
3. The radio transceiver was tested in a body-worn configuration with the back of the device placed parallel to the outer surface of the planar phantom. The attached belt-clip accessory was touching the outer surface of the planar phantom and provided a 1.3 cm separation distance between the back of the radio transceiver and the planar phantom. The radio transceiver was tested in a body-worn configuration with the speaker-microphone and boom-microphone headset accessories.
4. The speaker-microphone with antenna was tested in a body-worn configuration with the back of the device placed parallel to the outer surface of the planar phantom. The attached lapel-clip was touching the outer surface of the planar phantom and provided a 1.2 cm separation distance between the back of the speaker-microphone and the planar phantom. The speaker-microphone with antenna was tested with the NiMH battery only, since the alkaline battery pack is not intended for use with the speaker-microphone antenna configuration.
5. The conducted power levels were measured before and after each test according to the procedures described in FCC 47 CFR §2.1046. Several of the power drifts measured after the SAR evaluations were > 5% from the start power levels measured before the SAR evaluations. The maximum power drift measured was added to the measured SAR levels to show scaled SAR results, as shown in the test data tables (pages 5-8).
6. The EUT was tested in unmodulated continuous transmit operation (Continuous Wave mode at 100% duty cycle) with no turn-on delay and 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.
7. Due to the dimensions of the EUT a Plexiglas planar phantom was used in place of the SAM phantom.
8. A stack of low-density, low-loss dielectric foamed polystyrene was used in place of the device holder.
9. The EUT was tested with fully charged alkaline and NiMH batteries.

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 form 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 at the planar section of the SAM phantom with a 900MHz dipole (see Appendix C for system validation procedures). Prior to the system performance check the dielectric parameters of the simulated brain tissue mixture were verified 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 250 mW was applied to the dipole and the system was verified to a tolerance of ±10% (see Appendix B for system check test plot).

Test Date	900MHz Equiv. Tissue	SAR 1g (W/kg)		Dielectric Constant ε_r		Conductivity σ (mho/m)		ρ (Kg/m^3)	Ambient Temp.	Fluid Temp.	Humid.	Atmos. Press. (kPa)	Fluid Depth (cm)
		IEEE Target	Measured	IEEE Target	Measured	IEEE Target	Measured						
10/15/03	Brain	2.70 ±10%	2.73	41.5 ±5%	40.6	0.97 ±5%	0.98	1000	20.5°C	20.3°C	56%	102.0	≥ 15
10/16/03	Brain	2.70 ±10%	2.48	41.5 ±5%	40.8	0.97 ±5%	0.98	1000	20.4°C	21.1°C	54%	101.1	≥ 15
10/17/03	Brain	2.70 ±10%	2.55	41.5 ±5%	40.7	0.97 ±5%	0.98	1000	20.7°C	21.5°C	64%	101.0	≥ 15
10/20/03	Brain	2.70 ±10%	2.77	41.5 ±5%	40.7	0.97 ±5%	0.99	1000	20.0°C	22.0°C	62%	101.4	≥ 15

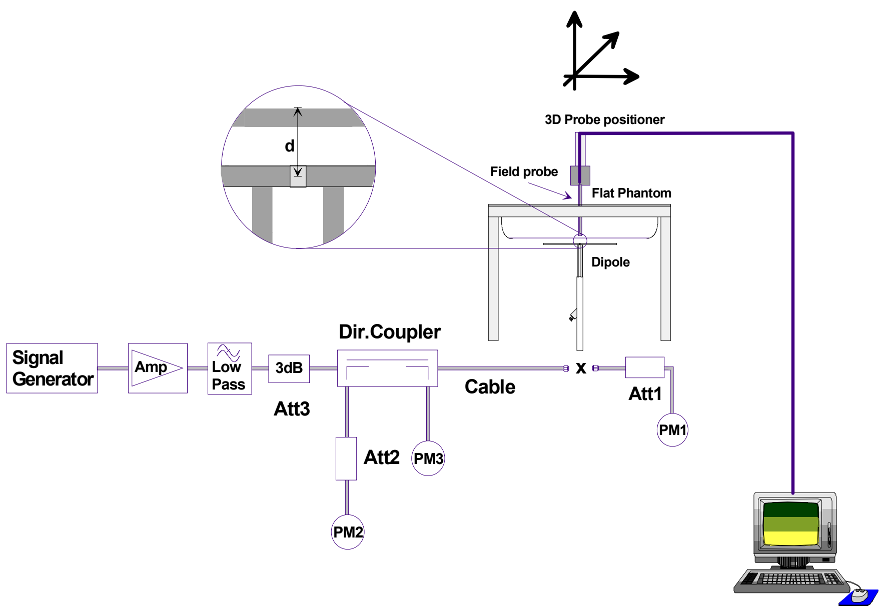


Figure 1. System Check Setup Diagram

900MHz Dipole Setup

8.0 SIMULATED EQUIVALENT TISSUES

The 835MHz and 900MHz 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	**900MHz Brain (System Check)**	**835MHz Brain (EUT Evaluation)**	**835MHz Body (EUT Evaluation)**
Water	40.71 %	40.71 %	53.70 %
Sugar	56.63 %	56.63 %	45.10 %
Salt	1.48 %	1.48 %	0.97 %
HEC	1.00 %	1.00 %	0.13%
Bactericide	0.18 %	0.18 %	0.10 %

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 1 g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	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 mm ± 0.1 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

Type:	SAM V4.0C
Shell Material:	Fiberglass
Thickness:	2.0 ±0.1 mm
Volume:	Approx. 20 liters

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 ± 8%)
Frequency:	10 MHz to >6 GHz; Linearity: ±0.2 dB (30 MHz to 3 GHz)
Directivity:	±0.2 dB in brain tissue (rotation around probe axis) ±0.4 dB in brain tissue (rotation normal to probe axis)
Dynamic Range:	5 µW/g to >100 mW/g; Linearity: ±0.2 dB
Surface Detect.	±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 SAM PHANTOM V4.0C

The SAM phantom V4.0C is a fiberglass shell phantom with a 2.0 mm (+/-0.2 mm) shell thickness for left and right head and flat planar area integrated in a wooden table. The shape of the fiberglass shell corresponds to the phantom defined by SCC34-SC2. The device holder positions are adjusted to the standard measurement positions in the three sections (see Appendix F for specifications of the SAM phantom V4.0C).

SAM Phantom

13.0 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

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
-SAM Phantom V4.0C	1033	N/A
-Plexiglas Planar Phantom	161	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	√3	$(1-c_p)$	± 1.9	∞
Spherical isotropy of the probe	± 9.6	Rectangular	√3	(c_p)	± 3.9	∞
Spatial resolution	± 0.0	Rectangular	√3	1	± 0.0	∞
Boundary effects	± 5.5	Rectangular	√3	1	± 3.2	∞
Probe linearity	± 4.7	Rectangular	√3	1	± 2.7	∞
Detection limit	± 1.0	Rectangular	√3	1	± 0.6	∞
Readout electronics	± 1.0	Normal	1	1	± 1.0	∞
Response time	± 0.8	Rectangular	√3	1	± 0.5	∞
Integration time	± 1.4	Rectangular	√3	1	± 0.8	∞
RF ambient conditions	± 3.0	Rectangular	√3	1	± 1.7	∞
Mech. constraints of robot	± 0.4	Rectangular	√3	1	± 0.2	∞
Probe positioning	± 2.9	Rectangular	√3	1	± 1.7	∞
Extrapolation & integration	± 3.9	Rectangular	√3	1	± 2.3	∞
Test Sample Related						
Device positioning	± 6.0	Normal	√3	1	± 6.7	12
Device holder uncertainty	± 5.0	Normal	√3	1	± 5.9	8
Power drift	± 5.0	Rectangular	√3		± 2.9	∞
Phantom and Setup						
Phantom uncertainty	± 4.0	Rectangular	√3	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Liquid conductivity (measured)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Liquid permittivity (target)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Liquid permittivity (measured)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Combined Standard Uncertainty					**± 13.3**	
Expanded Uncertainty (k=2)					**± 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	√3	$(1-c_p)$	± 1.9	∞
Spherical isotropy of the probe	± 9.6	Rectangular	√3	(c_p)	± 3.9	∞
Spatial resolution	± 0.0	Rectangular	√3	1	± 0.0	∞
Boundary effects	± 5.5	Rectangular	√3	1	± 3.2	∞
Probe linearity	± 4.7	Rectangular	√3	1	± 2.7	∞
Detection limit	± 1.0	Rectangular	√3	1	± 0.6	∞
Readout electronics	± 1.0	Normal	1	1	± 1.0	∞
Response time	± 0.8	Rectangular	√3	1	± 0.5	∞
Integration time	± 1.4	Rectangular	√3	1	± 0.8	∞
RF ambient conditions	± 3.0	Rectangular	√3	1	± 1.7	∞
Mech. constraints of robot	± 0.4	Rectangular	√3	1	± 0.2	∞
Probe positioning	± 2.9	Rectangular	√3	1	± 1.7	∞
Extrapolation & integration	± 3.9	Rectangular	√3	1	± 2.3	∞
Dipole						
Dipole Axis to Liquid Distance	± 2.0	Rectangular	√3	1	± 1.2	∞
Input Power	± 4.7	Rectangular	√3	1	± 2.7	∞
Phantom and Setup						
Phantom uncertainty	± 4.0	Rectangular	√3	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Liquid conductivity (measured)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Liquid permittivity (target)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Liquid permittivity (measured)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Combined Standard Uncertainty					**± 9.9**	
Expanded Uncertainty (k=2)					**± 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”.

[6] W. Gander, *Computermathematick*, Birkhaeuser, Basel: 1992.

APPENDIX B - SYSTEM PERFORMANCE CHECK DATA

Date Tested: 10/15/03

DUT: Dipole 900 MHz; Model: D900V2; Type: System Performance Check; Serial: 054

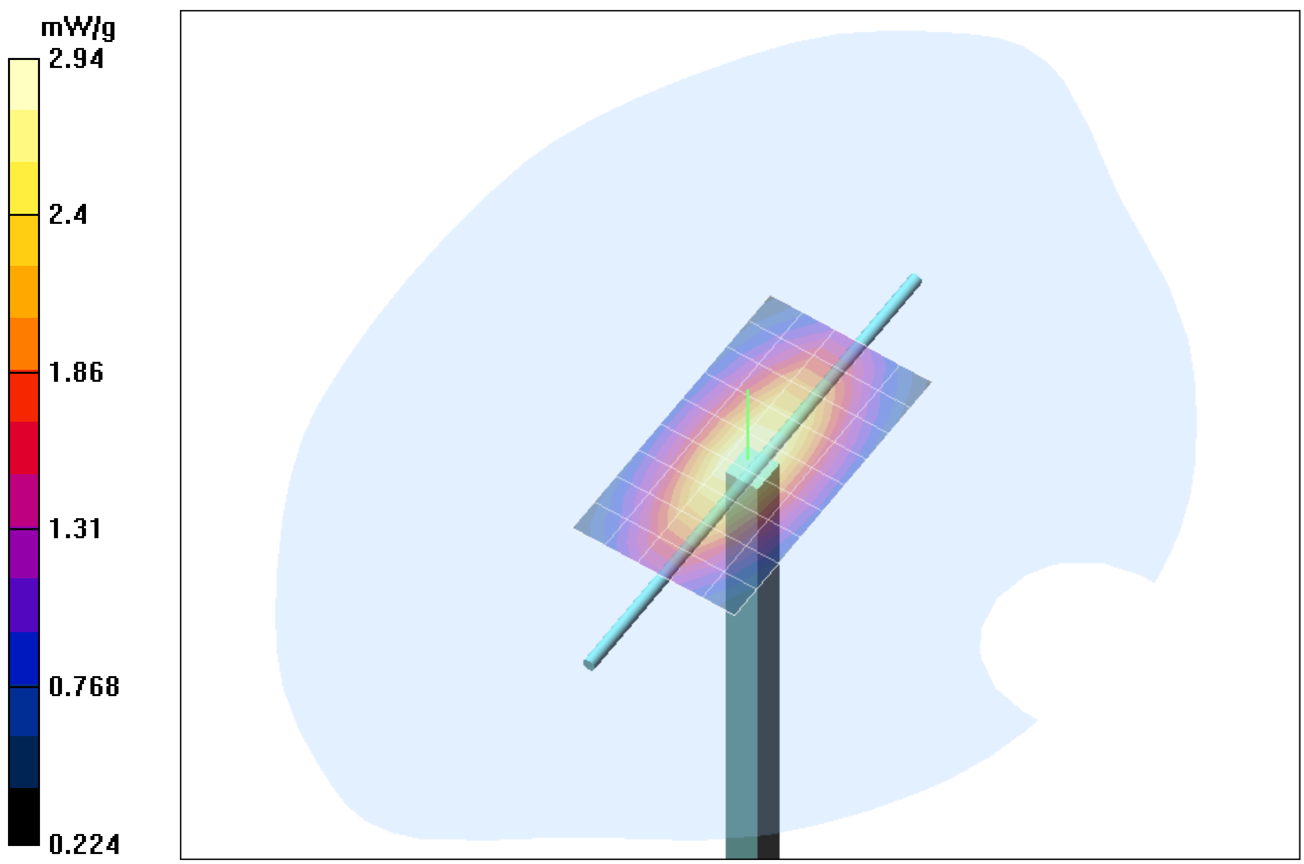
Ambient Temp: 20.5°C; Fluid Temp: 20.3°C; Barometric Pressure: 102.0 kPa; Humidity: 56%

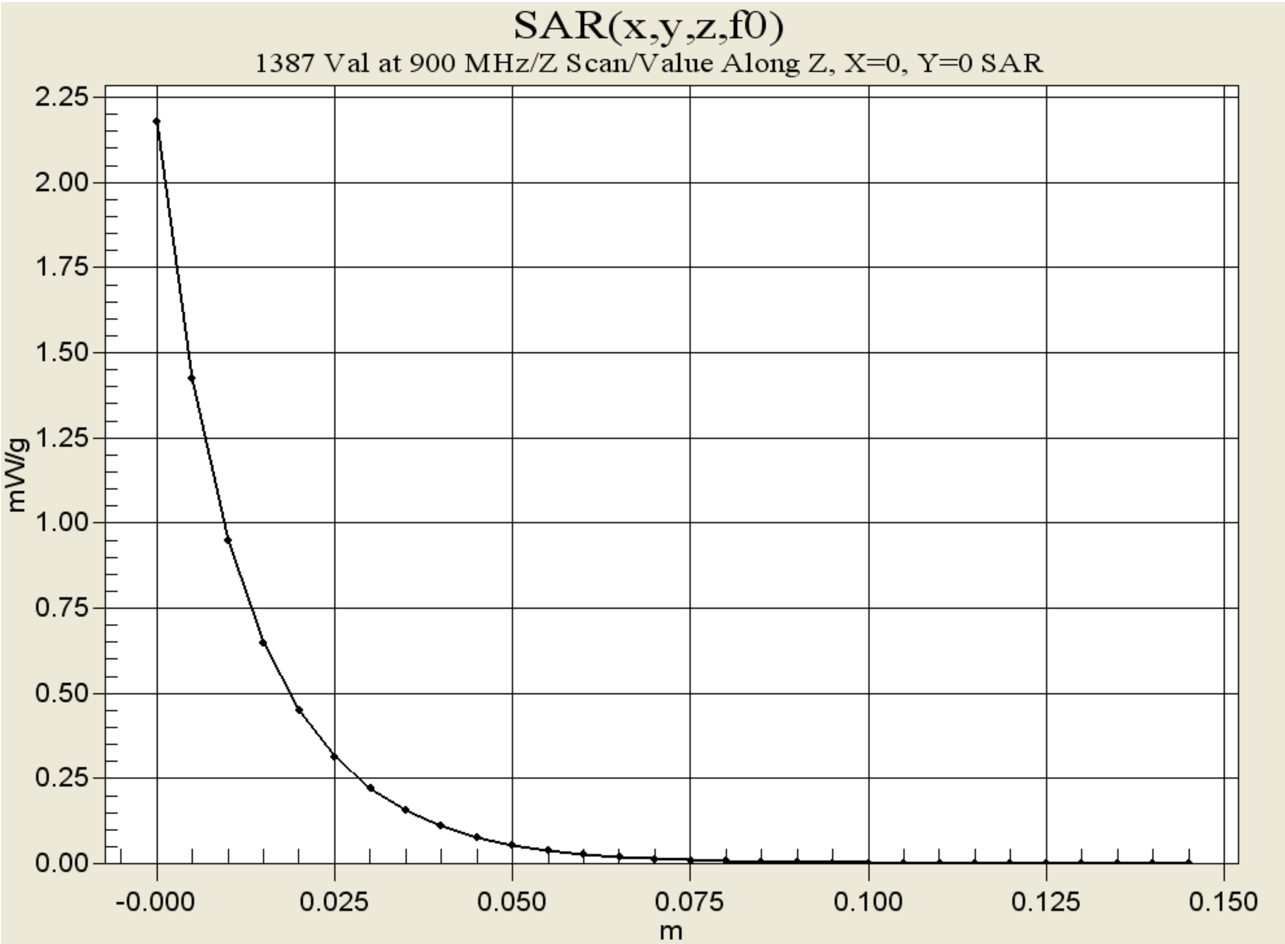
Communication System: CW
Forward Conducted Power: 250 mW
Frequency: 900 MHz; Duty Cycle: 1:1
Medium: HSL900 (σ = 0.98 mho/m, ε_r = 40.6, ρ = 1000 kg/m^3)

- Probe: ET3DV6 - SN1387; ConvF(6.6, 6.6, 6.6); Calibrated: 26/02/2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn370; Calibrated: 19/05/2003
- Phantom: SAM front; Type: SAM 4.0; Serial: 1033
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

System Validation at 900 MHz/Area Scan (6x10x1): Measurement grid: dx=10mm, dy=10mm

System Validation at 900 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 4 W/kg
SAR(1 g) = 2.73 mW/g; SAR(10 g) = 1.74 mW/g
Reference Value = 57.1 V/m
Power Drift = 0.02 dB




SAR(x,y,z,f0)
1387 Val at 900 MHz/Z Scan/Value Along Z, X=0, Y=0 SAR
mW/g
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.000
0.025
0.050
0.075
0.100
0.125
0.150
m

Date Tested: 10/16/03

DUT: Dipole 900 MHz; Model: D900V2; Type: System Performance Check; Serial: 054

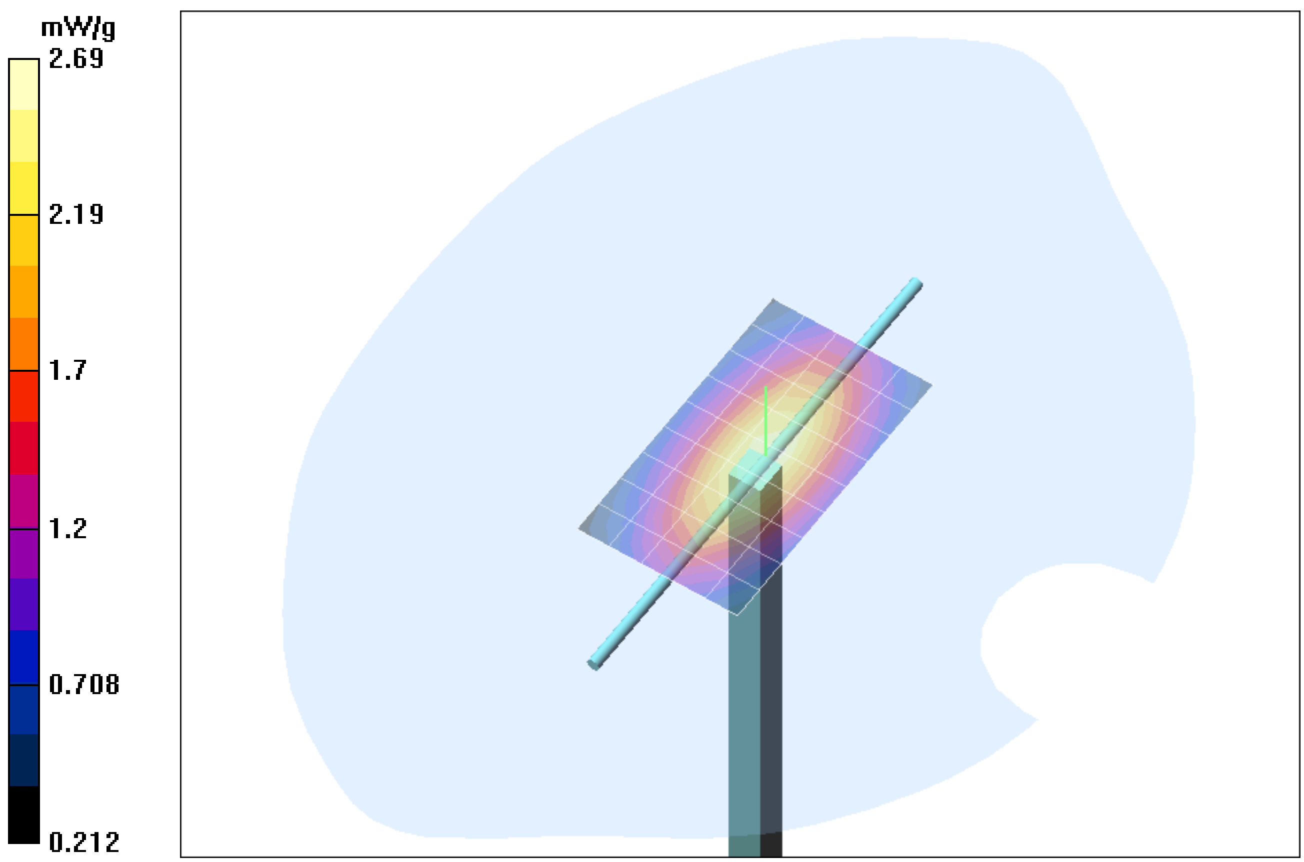
Ambient Temp: 20.4°C; Fluid Temp: 21.1°C; Barometric Pressure: 101.1 kPa; Humidity: 54%

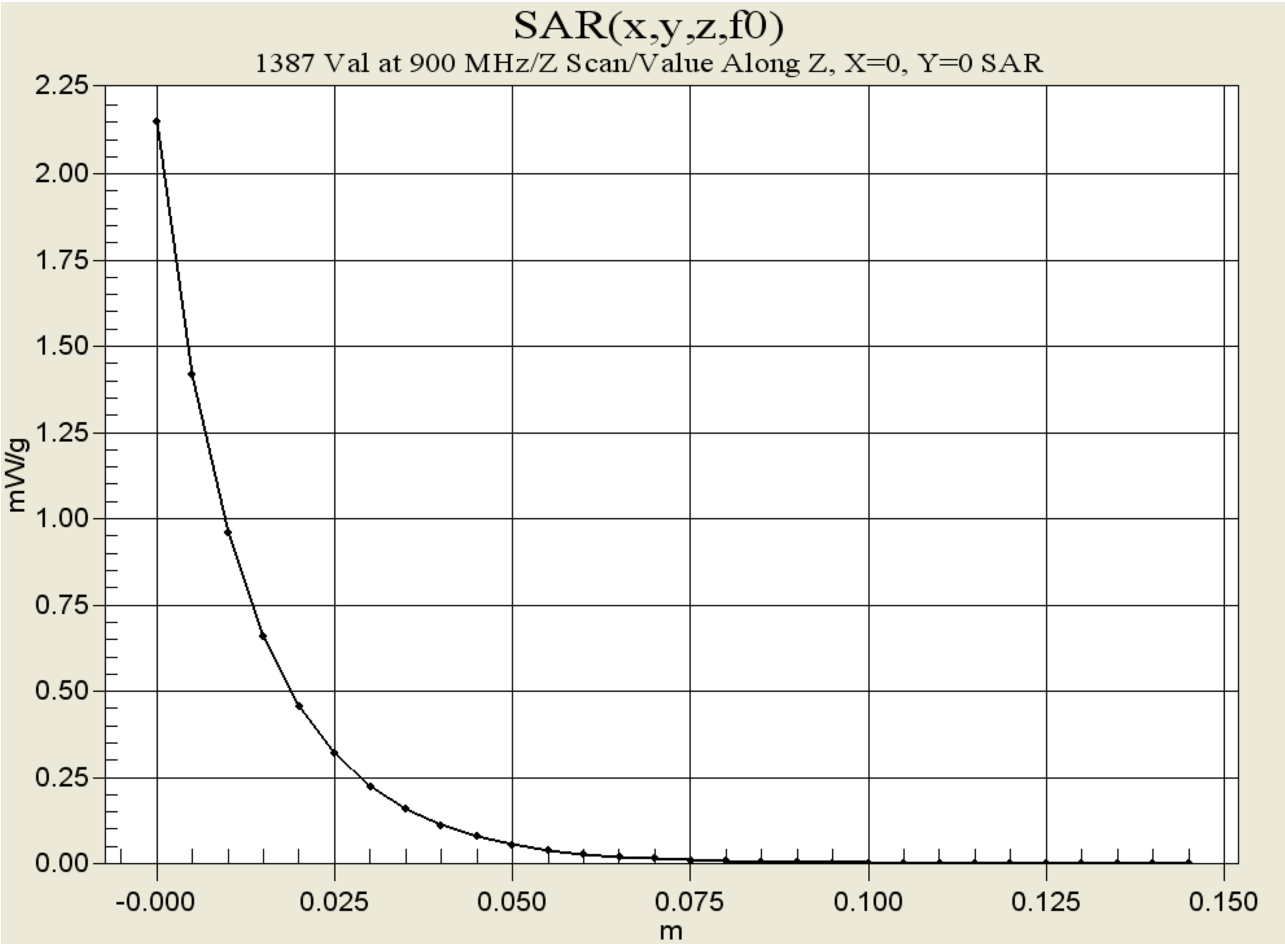
Communication System: CW
Forward Conducted Power: 250 mW
Frequency: 900 MHz; Duty Cycle: 1:1
Medium: HSL900 (σ = 0.98 mho/m, ε_r = 40.8, ρ = 1000 kg/m^3)

- Probe: ET3DV6 - SN1387; ConvF(6.6, 6.6, 6.6); Calibrated: 26/02/2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn370; Calibrated: 19/05/2003
- Phantom: SAM front; Type: SAM 4.0; Serial: 1033
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

System Validation at 900 MHz/Area Scan (6x10x1): Measurement grid: dx=10mm, dy=10mm

System Validation at 900 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 3.46 W/kg
SAR(1 g) = 2.48 mW/g; SAR(10 g) = 1.61 mW/g
Reference Value = 53.8 V/m
Power Drift = 0.07 dB




SAR(x,y,z,f0)
1387 Val at 900 MHz/Z Scan/Value Along Z, X=0, Y=0 SAR
mW/g
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.000
0.025
0.050
0.075
0.100
0.125
0.150
m

Date Tested: 10/17/03

DUT: Dipole 900 MHz; Model: D900V2; Type: System Performance Check; Serial: 054

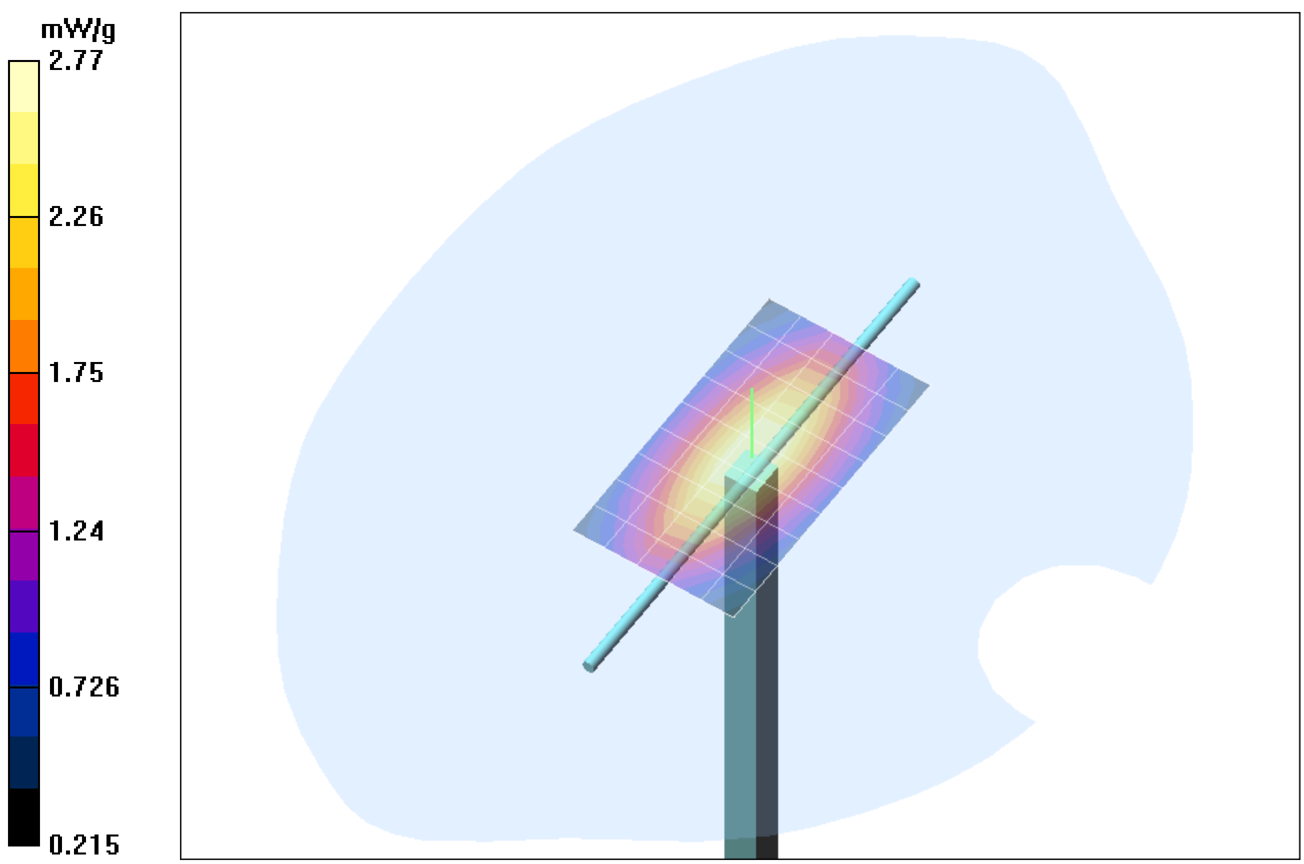
Ambient Temp: 20.7°C; Fluid Temp: 21.5°C; Barometric Pressure: 101.0 kPa; Humidity: 64%

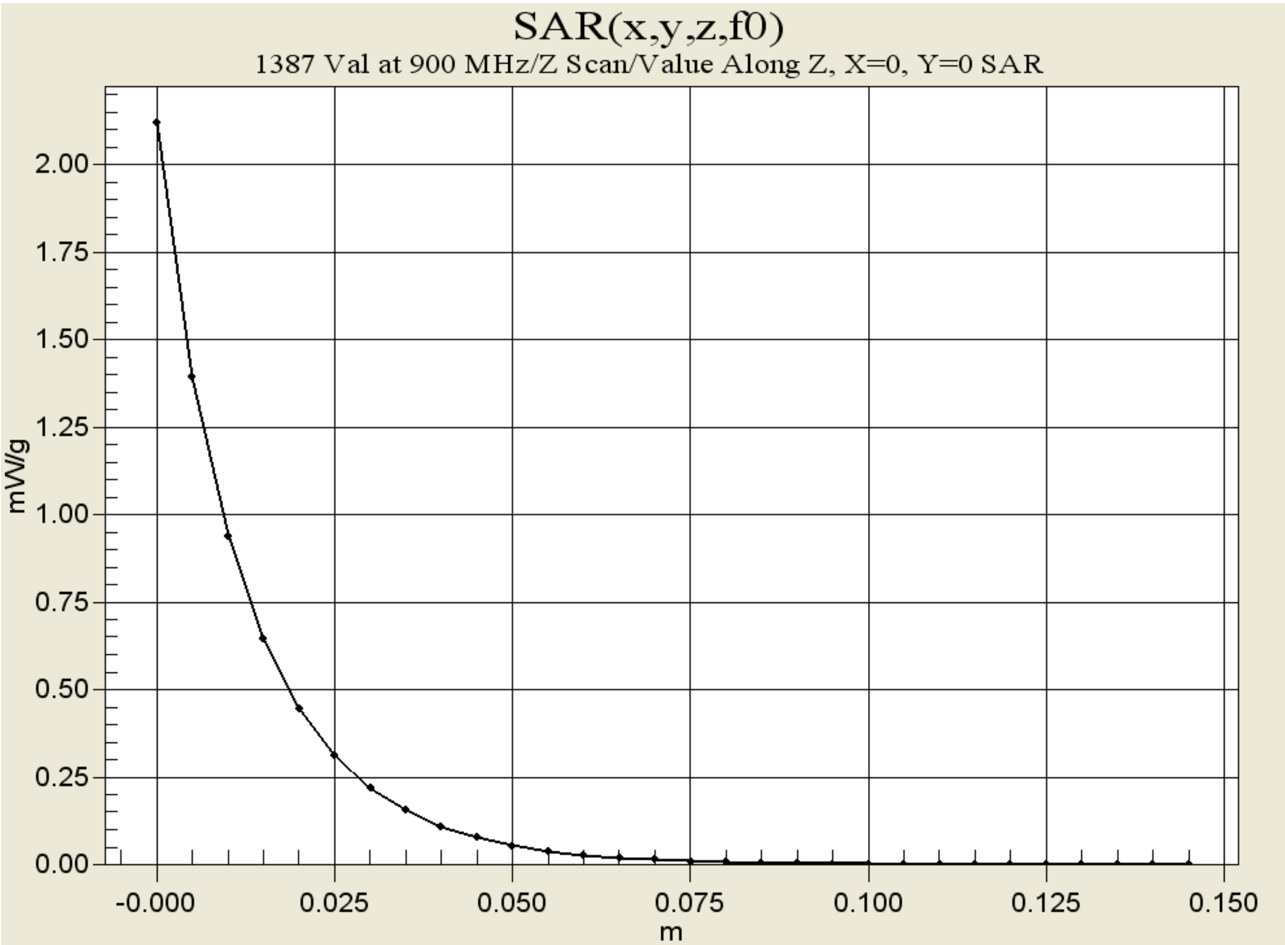
Communication System: CW
Forward Conducted Power: 250 mW
Frequency: 900 MHz; Duty Cycle: 1:1
Medium: HSL900 (σ = 0.98 mho/m, ε_r = 40.7, ρ = 1000 kg/m^3)

- Probe: ET3DV6 - SN1387; ConvF(6.6, 6.6, 6.6); Calibrated: 26/02/2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn370; Calibrated: 19/05/2003
- Phantom: SAM front; Type: SAM 4.0; Serial: 1033
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

System Validation at 900 MHz/Area Scan (6x10x1): Measurement grid: dx=10mm, dy=10mm

System Validation at 900 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 3.67 W/kg
SAR(1 g) = 2.55 mW/g; SAR(10 g) = 1.63 mW/g
Reference Value = 56.3 V/m
Power Drift = 0.1 dB




SAR(x,y,z,f0)
1387 Val at 900 MHz/Z Scan/Value Along Z, X=0, Y=0 SAR
mW/g
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.000
0.025
0.050
0.075
0.100
0.125
0.150
m

Date Tested: 10/20/03

DUT: Dipole 900 MHz; Model: D900V2; Type: System Performance Check; Serial: 054

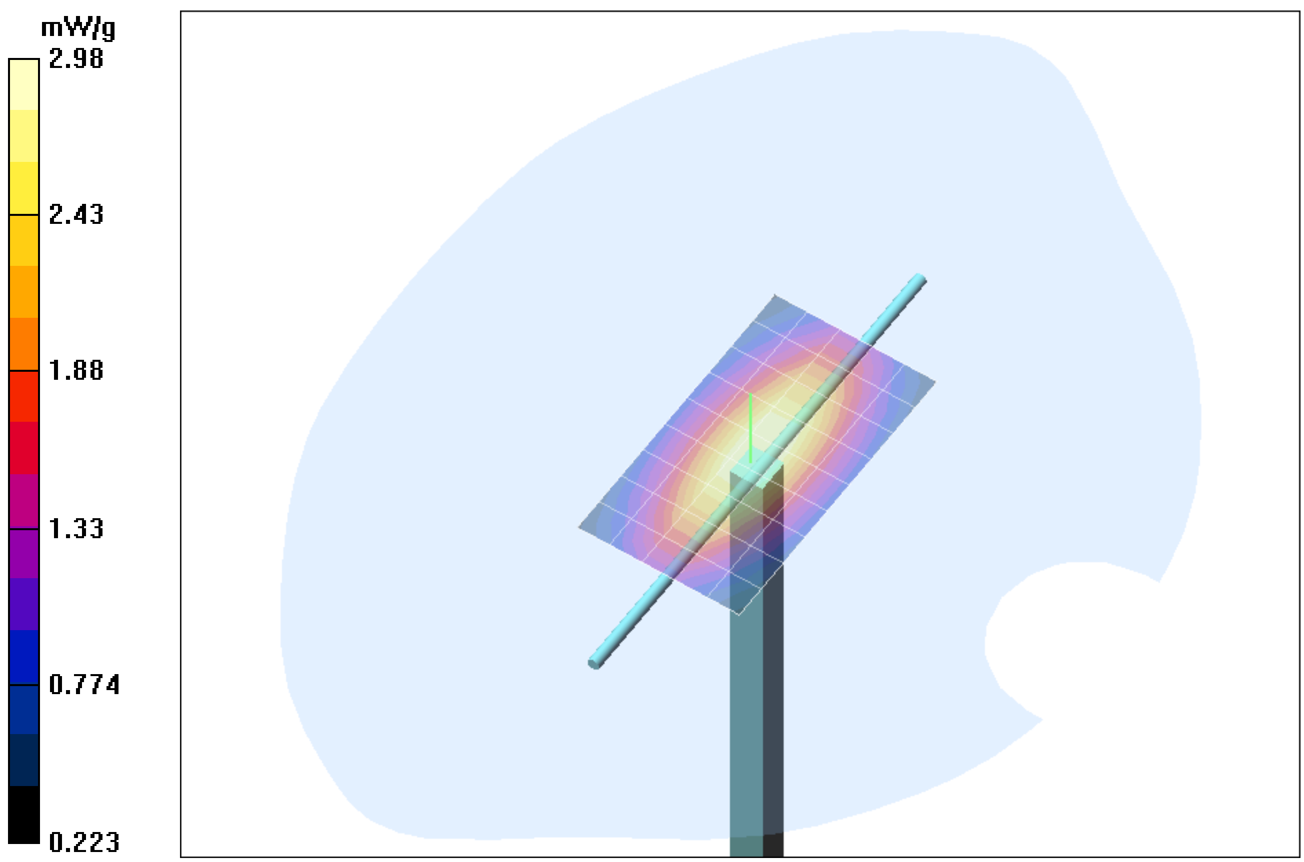
Ambient Temp: 20.0°C; Fluid Temp: 22.0°C; Barometric Pressure: 101.4 kPa; Humidity: 62%

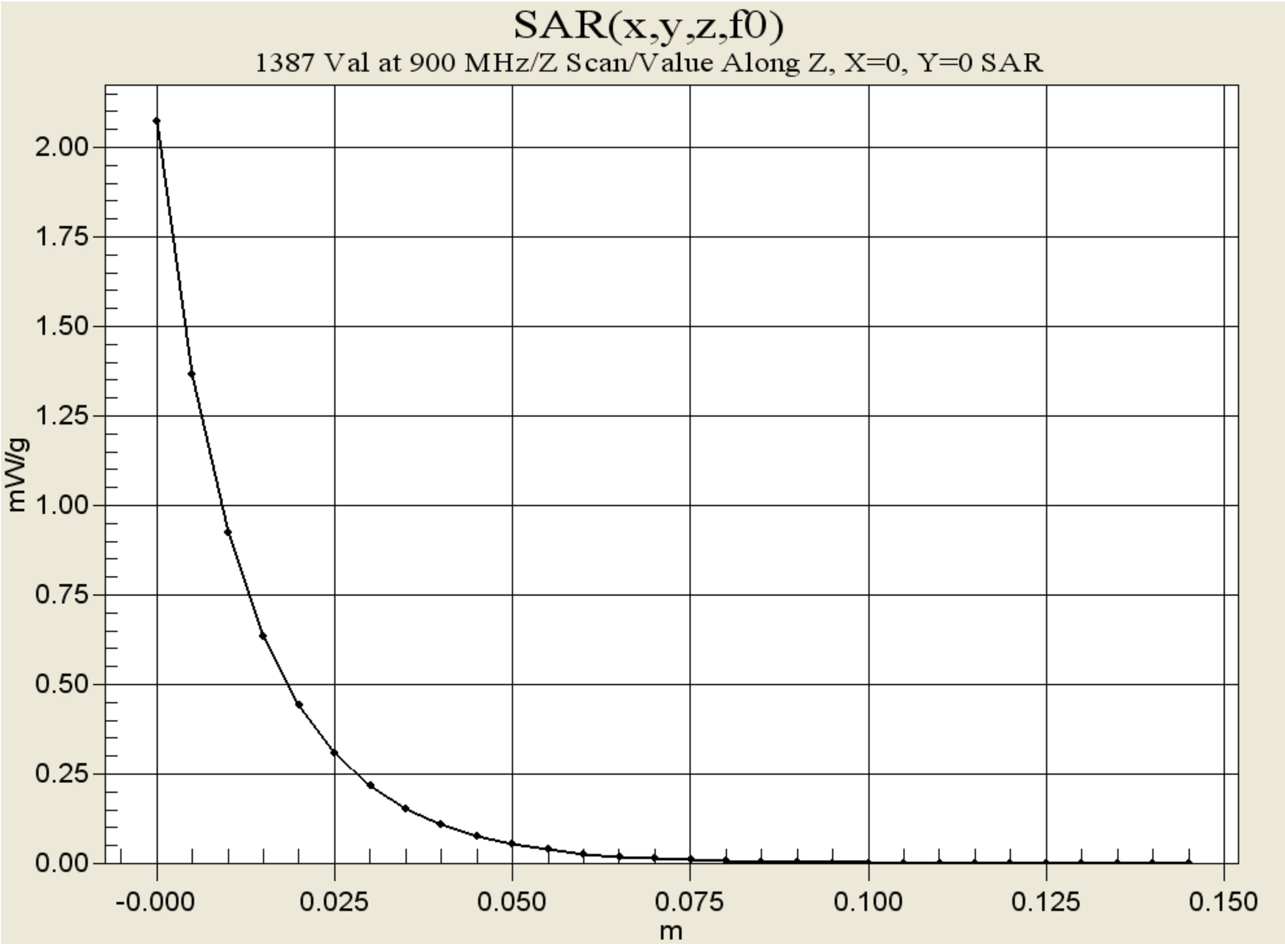
Communication System: CW
Forward Conducted Power: 250 mW
Frequency: 900 MHz; Duty Cycle: 1:1
Medium: HSL900 (σ = 0.99 mho/m, ε_r = 40.7, ρ = 1000 kg/m^3)

- Probe: ET3DV6 - SN1387; ConvF(6.6, 6.6, 6.6); Calibrated: 26/02/2003
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn370; Calibrated: 19/05/2003
- Phantom: SAM front; Type: SAM 4.0; Serial: 1033
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 116

System Validation at 900 MHz/Area Scan (6x10x1): Measurement grid: dx=10mm, dy=10mm

System Validation at 900 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 4.09 W/kg
SAR(1 g) = 2.77 mW/g; SAR(10 g) = 1.75 mW/g
Reference Value = 57.3 V/m
Power Drift = -0.03 dB




SAR(x,y,z,f0)
1387 Val at 900 MHz/Z Scan/Value Along Z, X=0, Y=0 SAR
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
mW/g
-0.000
0.025
0.050
0.075
0.100
0.125
0.150
m

APPENDIX C - SYSTEM VALIDATION

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

Client Celltech Labs

CALIBRATION CERTIFICATE

Object(s)	D900V2 - SN:054
Calibration procedure(s)	QA CAL-05.v2 Calibration procedure for dipole validation kits
Calibration date:	June 3, 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 (Calibrated by, Certificate No.)	Scheduled Calibration
RF generator R&S SML-03	100698	27-Mar-2002 (R&S, No. 20-92389)	In house check: Mar-05
Power sensor HP 8481A	MY41092317	18-Oct-02 (Agilent, No. 20021018)	Oct-04
Power sensor HP 8481A	US37292783	30-Oct-02 (METAS, No. 252-0236)	Oct-03
Power meter EPM E442	GB37480704	30-Oct-02 (METAS, No. 252-0236)	Oct-03
Network Analyzer HP 8753E	US37390585	18-Oct-01 (Agilent, No. 24BR1033101)	In house check: Oct 03

	Name	Function	Signature
Calibrated by:	Judith Mueller	Technician	
Approved by:	Katja Pokovic	Laboratory Director	

Date issued: June 3, 2003

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

Schmid & Partner Engineering AG

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

DASY

Dipole Validation Kit

Type: D900V2

Serial: 054

Manufactured: August 25, 1999
Calibrated: June 3, 2003

1. Measurement Conditions

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

Relative Dielectricity	**42.1**	± 5%
Conductivity	**0.95 mho/m**	± 5%

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.6 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 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.
The dipole input power (forward power) was 250 mW ± 3 %. The results are normalized to 1W input power.

2. SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue:	**10.6 mW/g** ± 16.8 % (k=2)[1]
averaged over 10 cm^3 (10 g) of tissue:	**6.84 mW/g** ± 16.2 % (k=2)[1]

[1] validation uncertainty

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:	**1.397 ns**	(one direction)
Transmission factor:	**0.991**	(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} = **49.9 Ω**
	Im {Z} = **-2.0 Ω**
Return Loss at 900 MHz	**-33.9 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.

Date/Time: 06/03/03 12:00:32

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN054_SN1507_HSL900_030603.da4

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN054
Program: Dipole Calibration

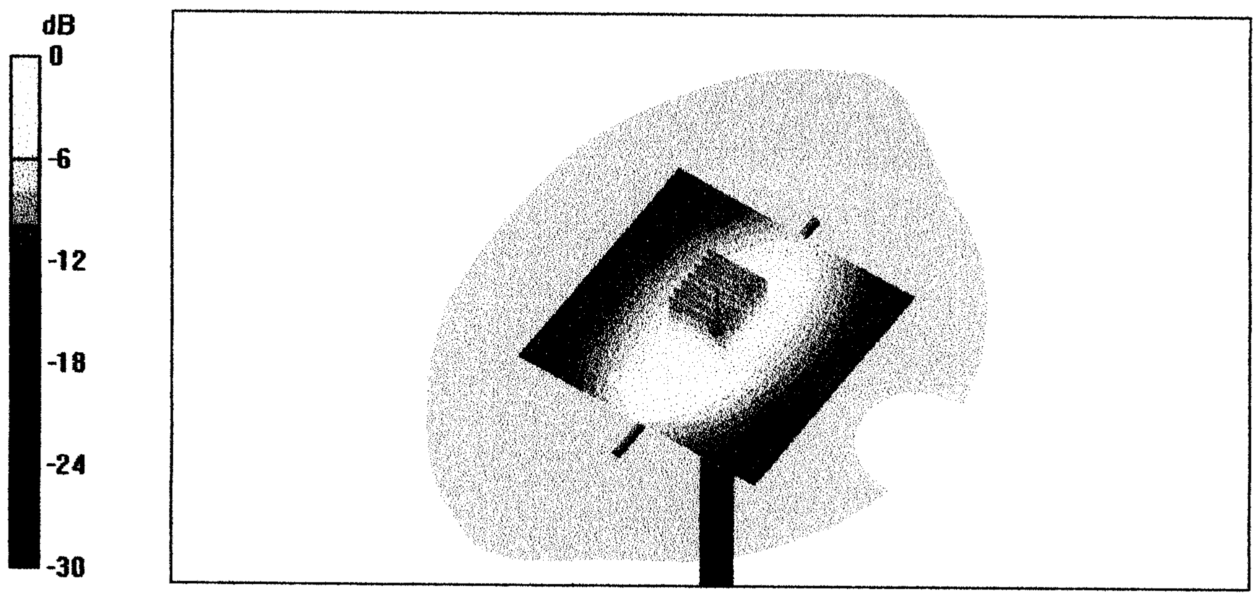
Communication System: CW-900; Frequency: 900 MHz;Duty Cycle: 1:1
Medium: HSL 900 MHz (σ = 0.95 mho/m, ε_r = 42.07, ρ = 1000 kg/m^3)
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

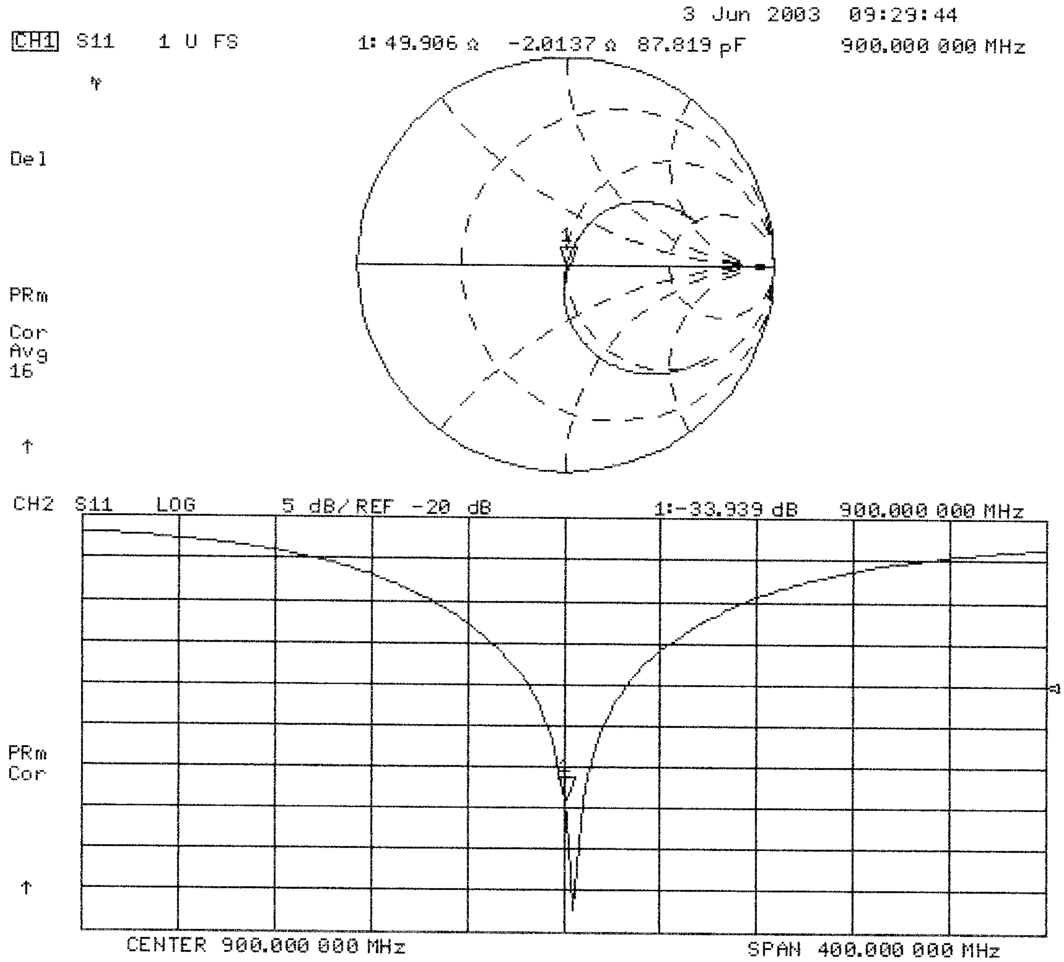
- Probe: ET3DV6 - SN1507; ConvF(6.6, 6.6, 6.6); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN411; Calibrated: 1/16/2003
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

Pin = 250 mW; d = 15 mm/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Reference Value = 56.9 V/m
Power Drift = 0.0004 dB
Maximum value of SAR = 2.84 mW/g

Pin = 250 mW; d = 15 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 3.92 W/kg
SAR(1 g) = 2.66 mW/g; SAR(10 g) = 1.71 mW/g
Reference Value = 56.9 V/m
Power Drift = 0.0004 dB
Maximum value of SAR = 2.85 mW/g



0 dB = 2.85mW/g


3 Jun 2003 09:29:44
CH1 S11 1 U FS
1: 49.906 Ω -2.0137 Ω 87.819 pF 900.000 000 MHz
Del
PRm
Cor
Avg
16
CH2 S11 LOG 5 dB/ REF -20 dB
1:-33.939 dB 900.000 000 MHz
PRm
Cor
CENTER 900.000 000 MHz
SPAN 400.000 000 MHz

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

	Name	Function	Signature
Calibrated by:	Nico Vetterli	Technician	N. Vetterli
Approved by:	Katja Pokovic	Laboratory Director	

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.

Schmid & Partner Engineering AG
s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

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**	$\mu V/(V/m)^2$
NormY	**1.65**	$\mu V/(V/m)^2$
NormZ	**1.64**	$\mu V/(V/m)^2$

Diode Compression

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

Sensitivity in Tissue Simulating Liquid

Head 900 MHz ε_r **= 41.5 ± 5%** σ **= 0.97 ± 5% mho/m**
Head 835 MHz ε_r **= 41.5 ± 5%** σ **= 0.90 ± 5% mho/m**

ConvF X	**6.6**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.6**	± 9.5% (k=2)	Alpha	**0.37**
ConvF Z	**6.6**	± 9.5% (k=2)	Depth	**2.61**

Head 1800 MHz ε_r **= 40.0 ± 5%** σ **= 1.40 ± 5% mho/m**
Head 1900 MHz ε_r **= 40.0 ± 5%** σ **= 1.40 ± 5% mho/m**

ConvF X	**5.2**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.2**	± 9.5% (k=2)	Alpha	**0.50**
ConvF Z	**5.2**	± 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

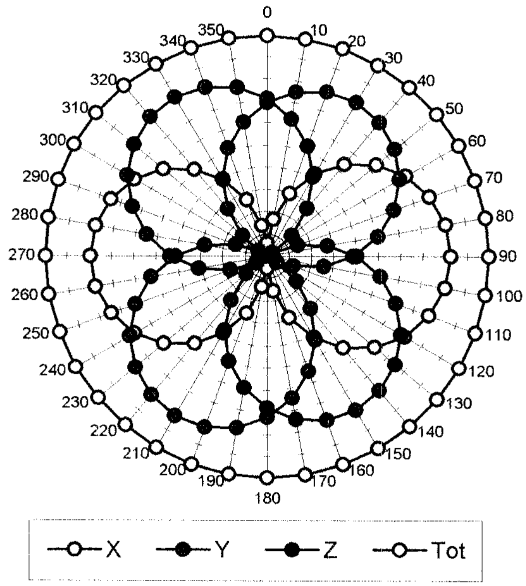
Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	14.6	9.8
SAR_{be} [%]	With Correction Algorithm	0.2	0.0

Sensor Offset

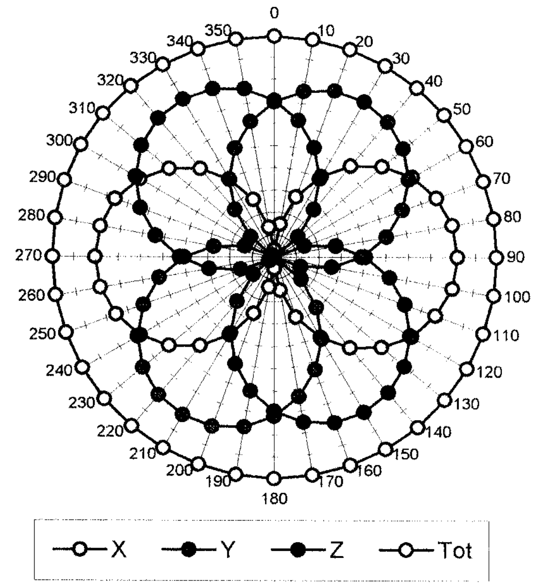
Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.4 ± 0.2**	mm

Receiving Pattern (ϕ), $\theta = 0°$

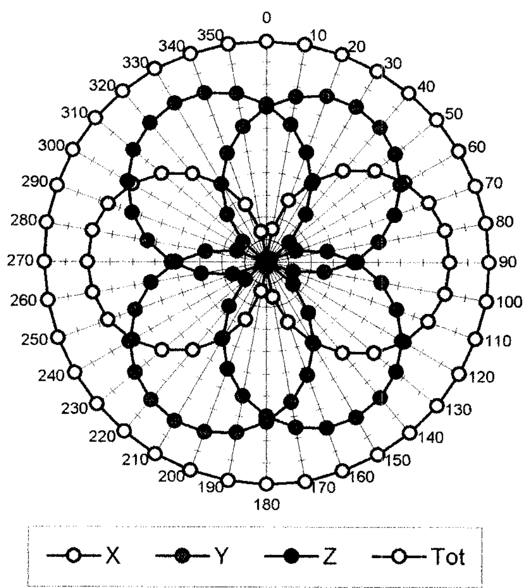
f = 30 MHz, TEM cell ifi110



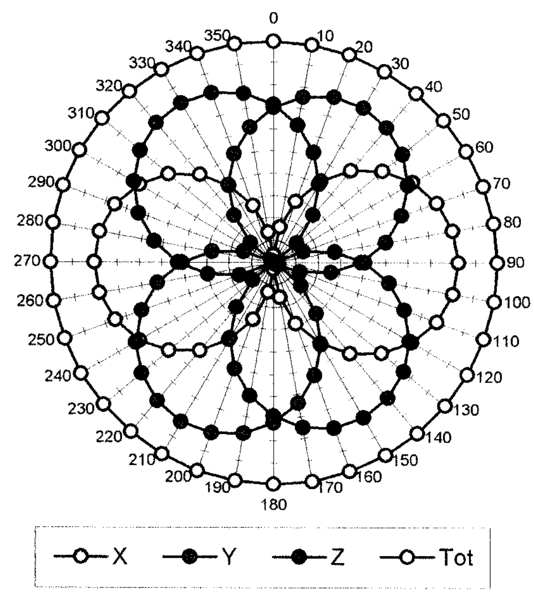
f = 100 MHz, TEM cell ifi110

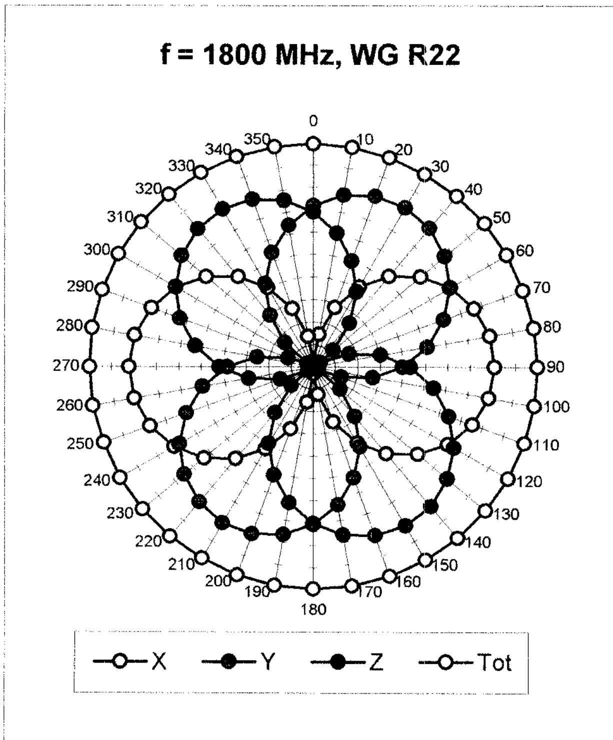


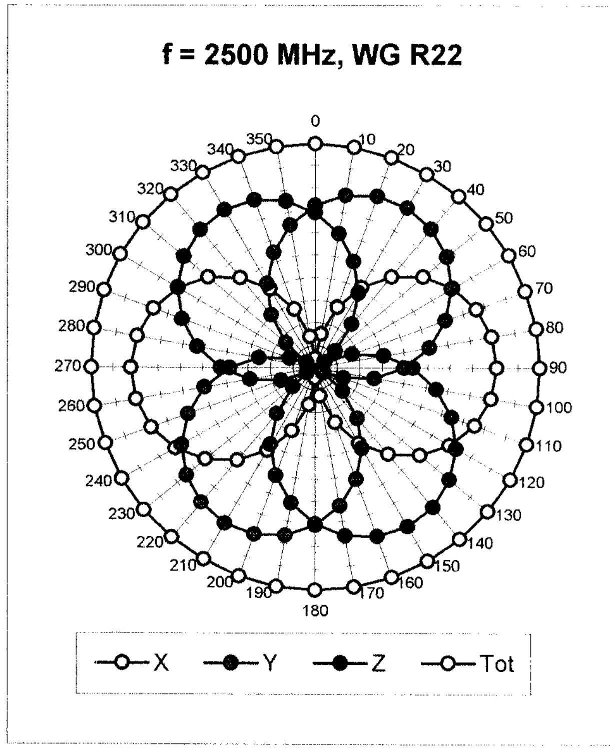
f = 300 MHz, TEM cell ifi110



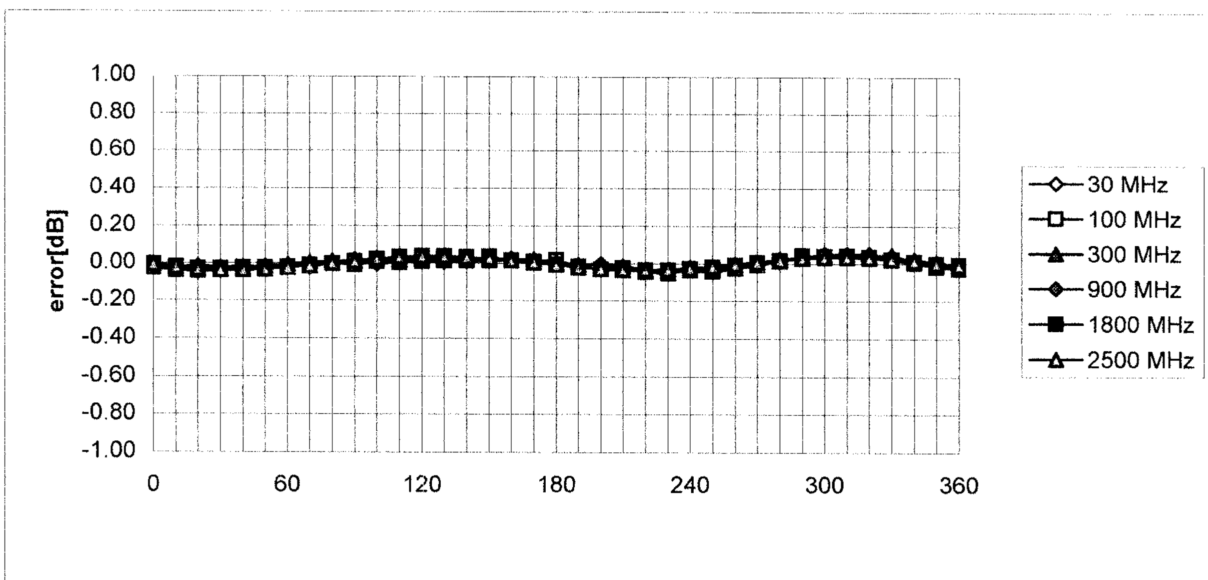
f = 900 MHz, TEM cell ifi110





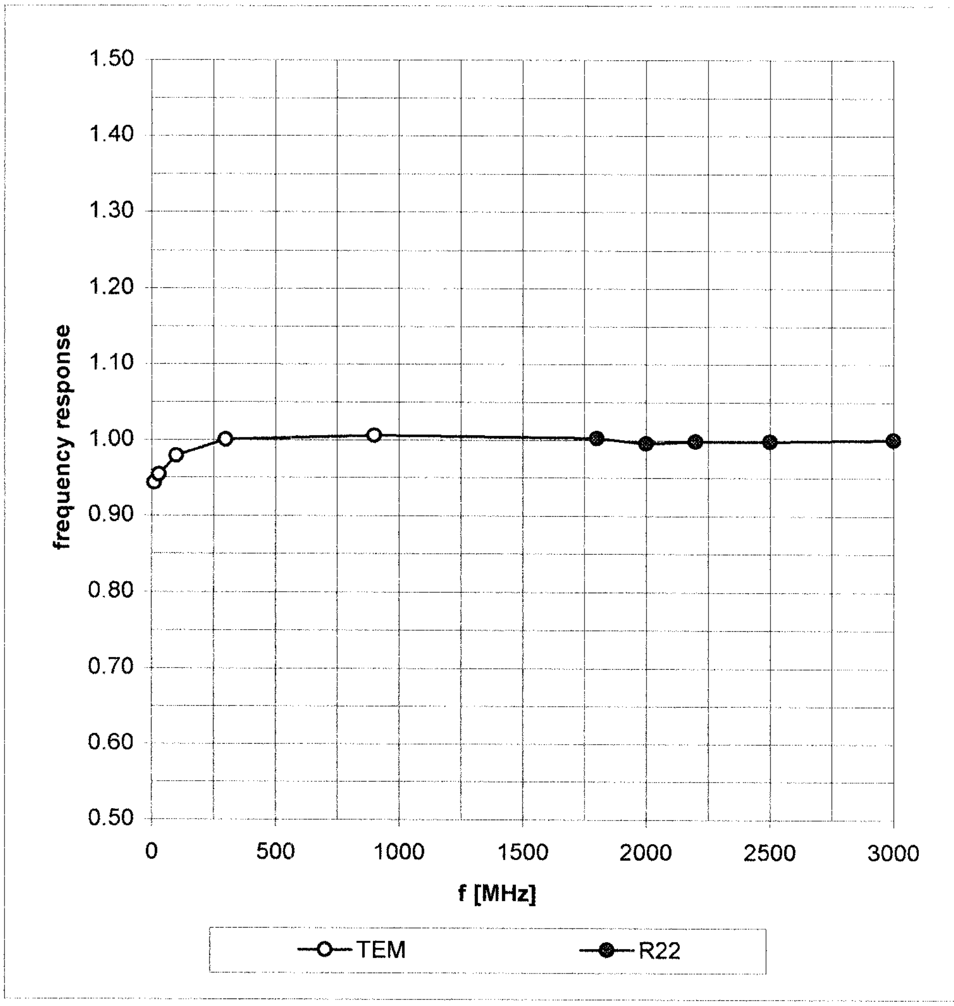


Isotropy Error (ϕ), θ = 0°



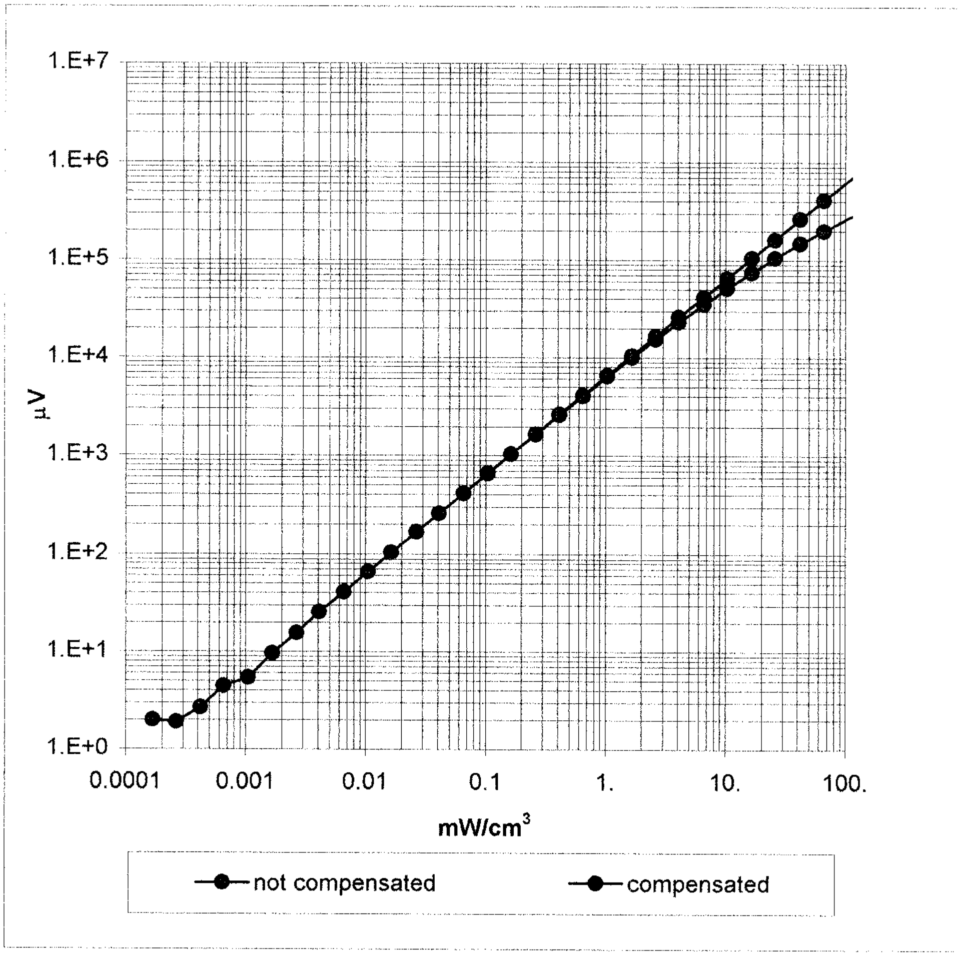
Frequency Response of E-Field

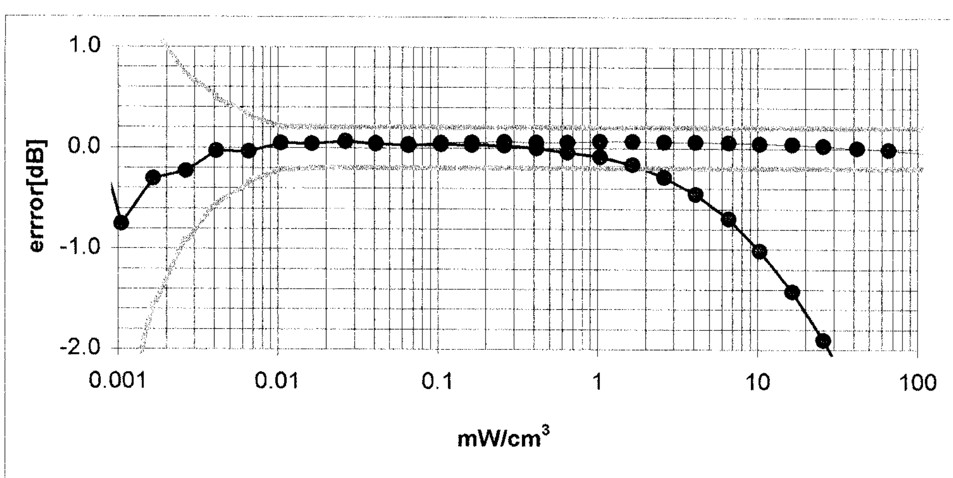
(TEM-Cell:ifi110, Waveguide R22)



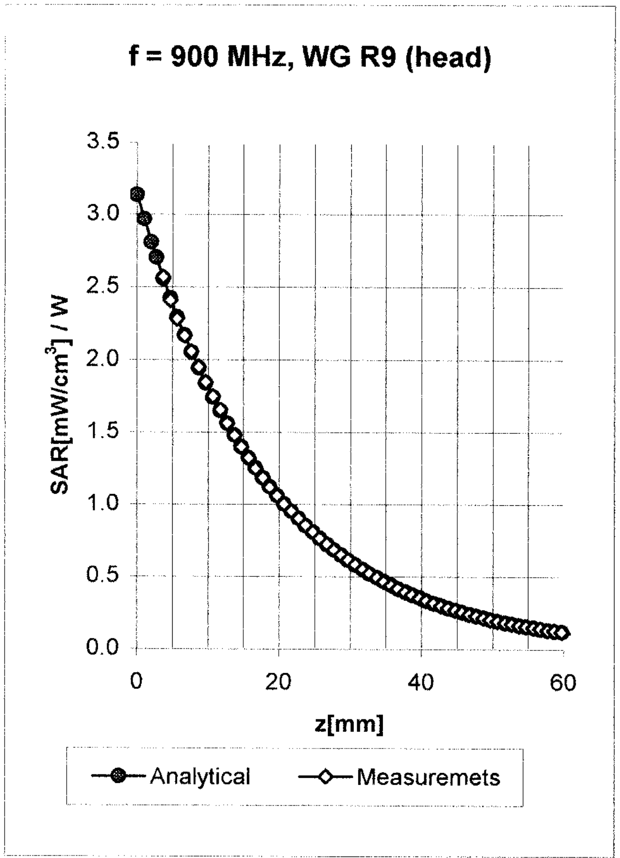
Dynamic Range f(SAR_{brain})

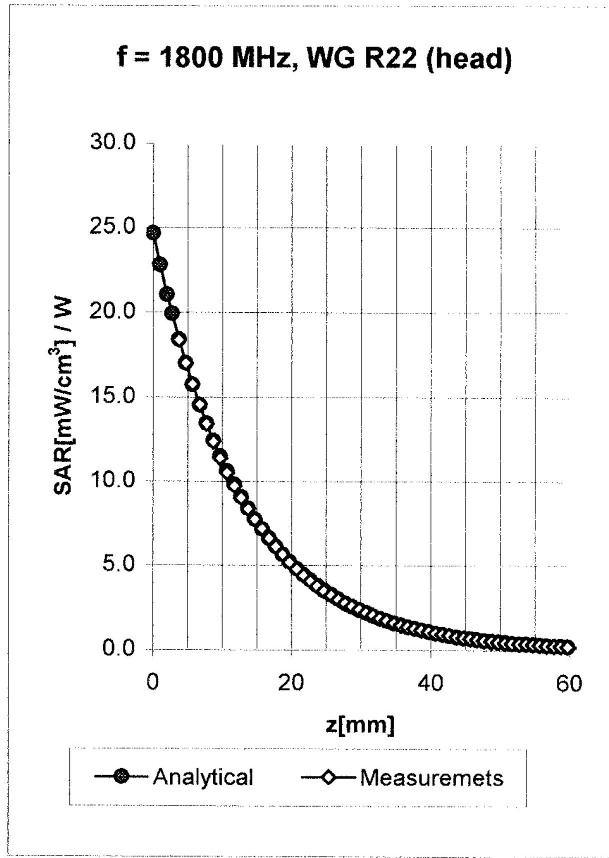
(Waveguide R22)





Conversion Factor Assessment

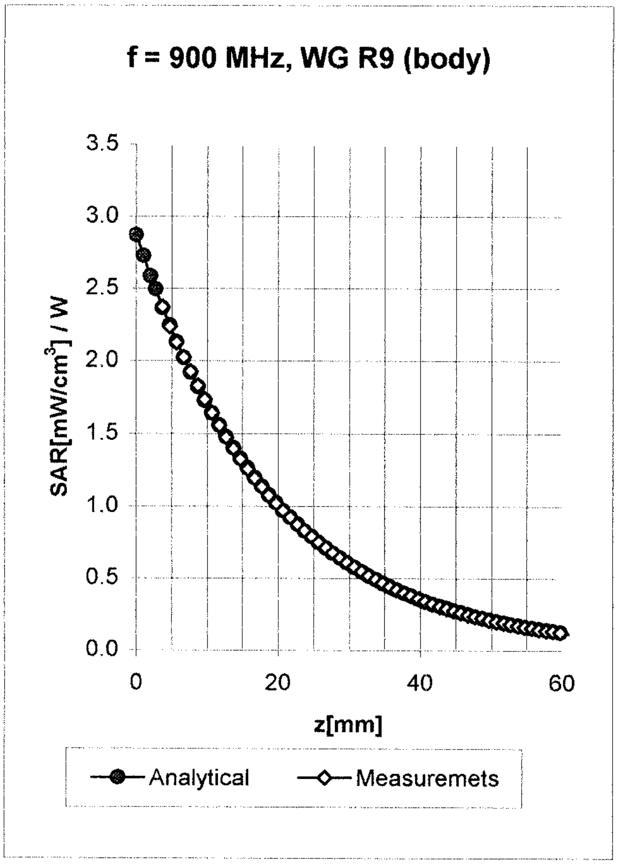


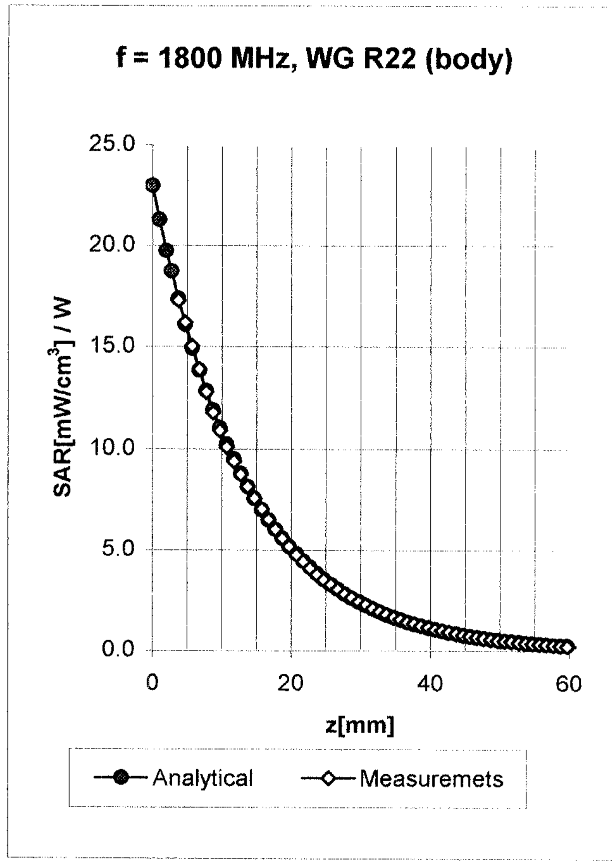


Head	**900 MHz**		ε_r = **41.5 ± 5%**		σ = **0.97 ± 5% mho/m**	
Head	**835 MHz**		ε_r = **41.5 ± 5%**		σ = **0.90 ± 5% mho/m**	
	ConvF X	**6.6**	± 9.5% (k=2)		Boundary effect:	
	ConvF Y	**6.6**	± 9.5% (k=2)		Alpha	**0.37**
	ConvF Z	**6.6**	± 9.5% (k=2)		Depth	**2.61**

Head	**1800 MHz**		ε_r = **40.0 ± 5%**		σ = **1.40 ± 5% mho/m**	
Head	**1900 MHz**		ε_r = **40.0 ± 5%**		σ = **1.40 ± 5% mho/m**	
	ConvF X	**5.2**	± 9.5% (k=2)		Boundary effect:	
	ConvF Y	**5.2**	± 9.5% (k=2)		Alpha	**0.50**
	ConvF Z	**5.2**	± 9.5% (k=2)		Depth	**2.73**

Conversion Factor Assessment

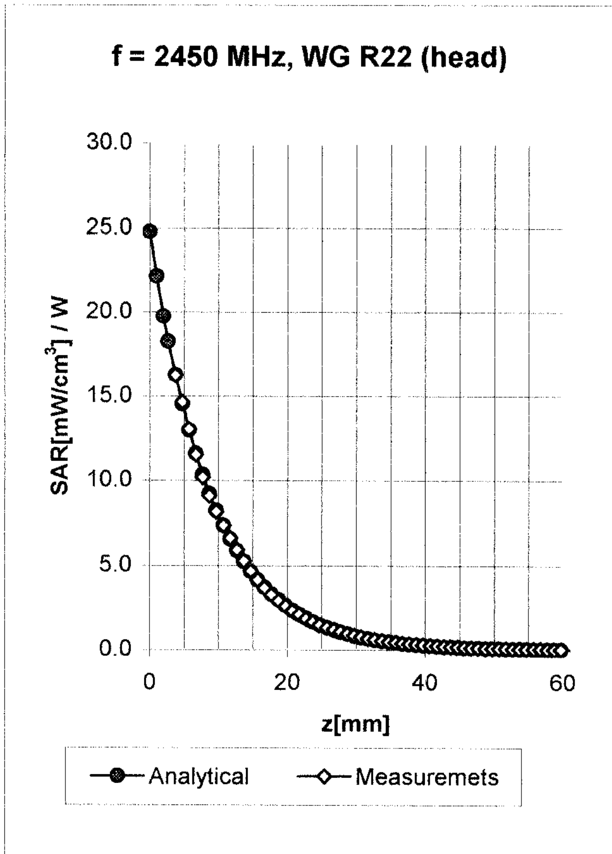


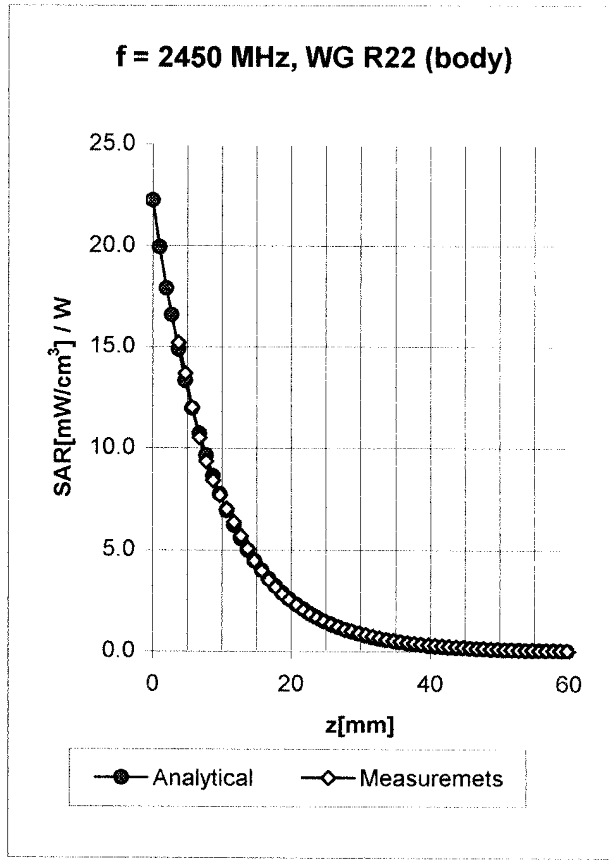


Body	**900 MHz**		ε_r **= 55.0 ± 5%**	σ **= 1.05 ± 5% mho/m**	
Body	**835 MHz**		ε_r **= 55.2 ± 5%**	σ **= 0.97 ± 5% mho/m**	
	ConvF X	**6.4**	± 9.5% (k=2)	Boundary effect:	
	ConvF Y	**6.4**	± 9.5% (k=2)	Alpha	**0.45**
	ConvF Z	**6.4**	± 9.5% (k=2)	Depth	**2.35**

Body	**1800 MHz**		ε_r **= 53.3 ± 5%**	σ **= 1.52 ± 5% mho/m**	
Body	**1900 MHz**		ε_r **= 53.3 ± 5%**	σ **= 1.52 ± 5% mho/m**	
	ConvF X	**4.9**	± 9.5% (k=2)	Boundary effect:	
	ConvF Y	**4.9**	± 9.5% (k=2)	Alpha	**0.60**
	ConvF Z	**4.9**	± 9.5% (k=2)	Depth	**2.59**

Conversion Factor Assessment



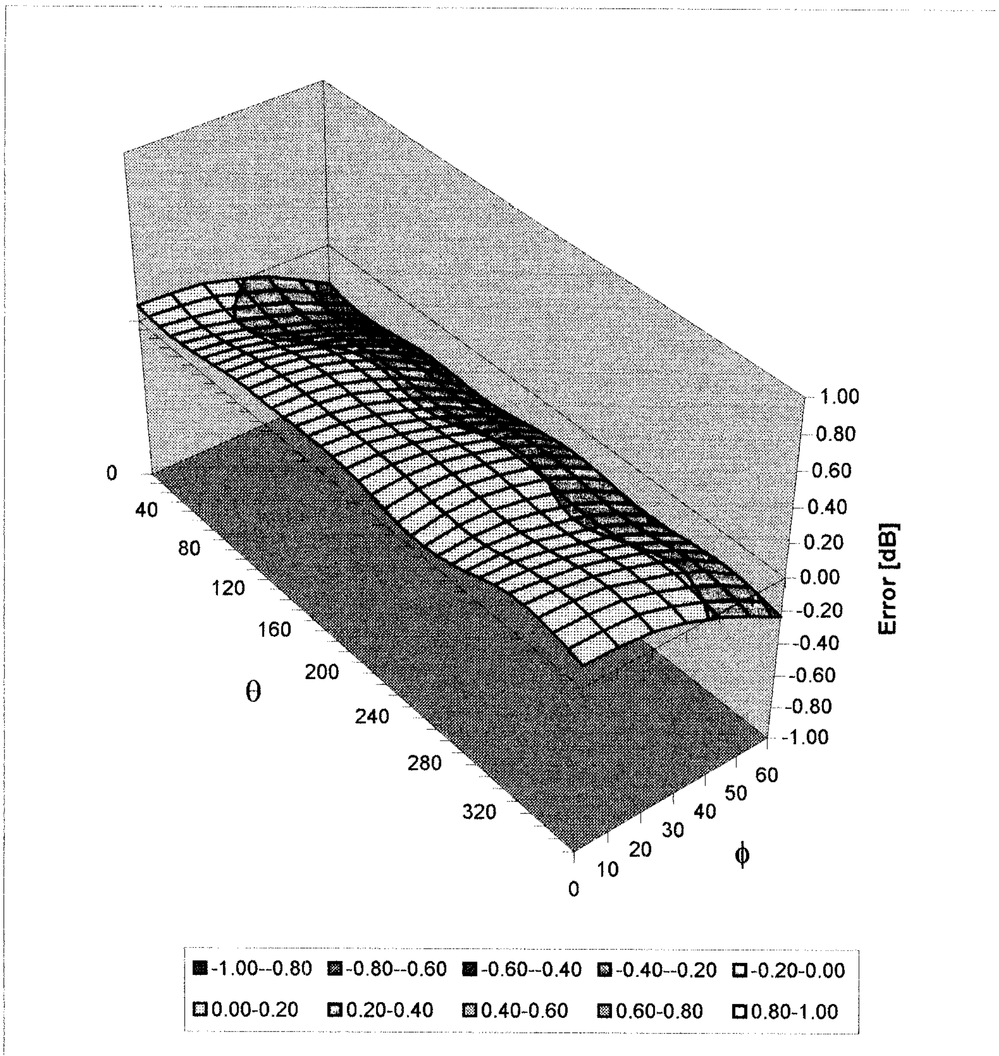


Head	**2450**	**MHz**	ε_r = **39.2 ± 5%**	σ = **1.80 ± 5% mho/m**
	ConvF X	**5.0** ± 8.9% (k=2)		Boundary effect:
	ConvF Y	**5.0** ± 8.9% (k=2)		Alpha **1.04**
	ConvF Z	**5.0** ± 8.9% (k=2)		Depth **1.85**

Body	**2450**	**MHz**	ε_r = **52.7 ± 5%**	σ = **1.95 ± 5% mho/m**
	ConvF X	**4.6** ± 8.9% (k=2)		Boundary effect:
	ConvF Y	**4.6** ± 8.9% (k=2)		Alpha **1.20**
	ConvF Z	**4.6** ± 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 (± standard deviation)

150 MHz	ConvF	**9.1 ± 8%**	**ε_r = 52.3** **σ = 0.76 mho/m** (head tissue)
300 MHz	ConvF	**7.9 ± 8%**	**ε_r = 45.3** **σ = 0.87 mho/m** (head tissue)
450 MHz	ConvF	**7.5 ± 8%**	**ε_r = 43.5** **σ = 0.87 mho/m** (head tissue)
150 MHz	ConvF	**8.8 ± 8%**	**ε_r = 61.9** **σ = 0.80 mho/m** (body tissue)
300 MHz	ConvF	**8.0 ± 8%**	**ε_r = 58.2** **σ = 0.92 mho/m** (body tissue)
450 MHz	ConvF	**7.7 ± 8%**	**ε_r = 56.7** **σ = 0.94 mho/m** (body tissue)

APPENDIX E - MEASURED FLUID DIELECTRIC PARAMETERS

900 MHz System Performance Check

Measured Fluid Dielectric Parameters (Brain)

October 15, 2003

Frequency	e'	e"
800.000000 MHz	41.8270	19.8860
810.000000 MHz	41.7651	19.8452
820.000000 MHz	41.6023	19.8169
830.000000 MHz	41.4896	19.7604
840.000000 MHz	41.3371	19.7745
850.000000 MHz	41.2046	19.7316
860.000000 MHz	41.0257	19.6933
870.000000 MHz	40.9191	19.6770
880.000000 MHz	40.7974	19.6660
890.000000 MHz	40.6925	19.6309
900.000000 MHz	40.6276	19.5357
910.000000 MHz	40.5143	19.4862
920.000000 MHz	40.4346	19.4573
930.000000 MHz	40.3283	19.3794
940.000000 MHz	40.1964	19.3974
950.000000 MHz	40.1009	19.3668
960.000000 MHz	39.9759	19.3228
970.000000 MHz	39.8477	19.3186
980.000000 MHz	39.7465	19.3302
990.000000 MHz	39.6268	19.3020
1.000000000 GHz	39.5169	19.2809

835 MHz EUT Evaluation (Body)

Measured Fluid Dielectric Parameters (Muscle)

October 15, 2003

Frequency	e'	e"
735.000000 MHz	55.4441	21.9125
745.000000 MHz	55.3274	21.8416
755.000000 MHz	55.2190	21.7456
765.000000 MHz	55.1157	21.7210
775.000000 MHz	55.0480	21.6496
785.000000 MHz	54.9396	21.6167
795.000000 MHz	54.9012	21.6059
805.000000 MHz	54.8077	21.5574
815.000000 MHz	54.7065	21.5070
825.000000 MHz	54.5947	21.4617
835.000000 MHz	54.4671	21.4511
845.000000 MHz	54.3129	21.4293
855.000000 MHz	54.1950	21.3736
865.000000 MHz	54.0624	21.3250
875.000000 MHz	53.9593	21.3416
885.000000 MHz	53.8979	21.2891
895.000000 MHz	53.8481	21.1908
905.000000 MHz	53.7716	21.1513
915.000000 MHz	53.7064	21.0925
925.000000 MHz	53.6318	21.0538
935.000000 MHz	53.5183	21.0367

900 MHz System Performance Check

Measured Fluid Dielectric Parameters (Brain)

October 16, 2003

Frequency	e'	e"
800.000000 MHz	42.0626	20.0300
810.000000 MHz	41.9642	19.9801
820.000000 MHz	41.8123	19.9572
830.000000 MHz	41.6569	19.9048
840.000000 MHz	41.5197	19.9018
850.000000 MHz	41.3733	19.8504
860.000000 MHz	41.2338	19.8092
870.000000 MHz	41.0944	19.7900
880.000000 MHz	41.0139	19.7853
890.000000 MHz	40.9164	19.7459
900.000000 MHz	40.8219	19.6224
910.000000 MHz	40.7439	19.5802
920.000000 MHz	40.6386	19.5522
930.000000 MHz	40.5821	19.5153
940.000000 MHz	40.4341	19.5168
950.000000 MHz	40.3247	19.5073
960.000000 MHz	40.1880	19.4599
970.000000 MHz	40.0596	19.4584
980.000000 MHz	39.9320	19.4483
990.000000 MHz	39.8345	19.4204
1.000000000 GHz	39.7150	19.3869

835 MHz EUT Evaluation (Body)

Measured Fluid Dielectric Parameters (Muscle)

October 16, 2003

Frequency	e'	e"
735.000000 MHz	55.7442	22.1550
745.000000 MHz	55.6320	22.1020
755.000000 MHz	55.5283	22.0235
765.000000 MHz	55.4185	21.9487
775.000000 MHz	55.3137	21.9091
785.000000 MHz	55.2208	21.8896
795.000000 MHz	55.1558	21.8376
805.000000 MHz	55.0860	21.7936
815.000000 MHz	54.9700	21.7670
825.000000 MHz	54.8600	21.7281
835.000000 MHz	54.7410	21.6824
845.000000 MHz	54.6005	21.6407
855.000000 MHz	54.5007	21.6069
865.000000 MHz	54.3528	21.5493
875.000000 MHz	54.2628	21.5463
885.000000 MHz	54.1936	21.5037
895.000000 MHz	54.1369	21.4305
905.000000 MHz	54.0623	21.3706
915.000000 MHz	53.9916	21.3258
925.000000 MHz	53.9056	21.3240
935.000000 MHz	53.7905	21.3038

900 MHz System Performance Check

Measured Fluid Dielectric Parameters (Brain)

October 17, 2003

Frequency	e'	e''
800.000000 MHz	41.9128	19.9611
810.000000 MHz	41.7930	19.9079
820.000000 MHz	41.6798	19.8651
830.000000 MHz	41.4988	19.8320
840.000000 MHz	41.3604	19.8204
850.000000 MHz	41.1865	19.7783
860.000000 MHz	41.0774	19.7301
870.000000 MHz	40.9205	19.7174
880.000000 MHz	40.8229	19.7192
890.000000 MHz	40.7005	19.6586
900.000000 MHz	40.6822	19.5692
910.000000 MHz	40.5729	19.5180
920.000000 MHz	40.4749	19.4941
930.000000 MHz	40.4020	19.4635
940.000000 MHz	40.2596	19.4165
950.000000 MHz	40.1623	19.4430
960.000000 MHz	40.0259	19.3780
970.000000 MHz	39.8886	19.3901
980.000000 MHz	39.7539	19.3835
990.000000 MHz	39.6538	19.3440
1.000000000 GHz	39.5207	19.3071

835 MHz EUT Evaluation (Body)

Measured Fluid Dielectric Parameters (Muscle)

October 17, 2003

Frequency	e'	e"
735.000000 MHz	55.8725	22.2836
745.000000 MHz	55.7557	22.2178
755.000000 MHz	55.6546	22.1482
765.000000 MHz	55.5898	22.0676
775.000000 MHz	55.4585	21.9879
785.000000 MHz	55.3911	21.9110
795.000000 MHz	55.3316	21.8786
805.000000 MHz	55.2587	21.8455
815.000000 MHz	55.1456	21.7993
825.000000 MHz	55.0357	21.7643
835.000000 MHz	54.9163	21.7062
845.000000 MHz	54.7923	21.7119
855.000000 MHz	54.6727	21.6291
865.000000 MHz	54.5623	21.5882
875.000000 MHz	54.4668	21.5749
885.000000 MHz	54.3738	21.5293
895.000000 MHz	54.3539	21.4188
905.000000 MHz	54.2627	21.3746
915.000000 MHz	54.1983	21.3103
925.000000 MHz	54.1288	21.2644
935.000000 MHz	54.0223	21.2703

900 MHz System Performance Check

Measured Fluid Dielectric Parameters (Brain)

October 20, 2003

Frequency	e'	e''
800.000000 MHz	41.9670	20.1214
810.000000 MHz	41.8529	20.1080
820.000000 MHz	41.7242	20.0458
830.000000 MHz	41.5589	20.0487
840.000000 MHz	41.4316	20.0001
850.000000 MHz	41.2586	19.9972
860.000000 MHz	41.1056	19.9384
870.000000 MHz	40.9705	19.9276
880.000000 MHz	40.8488	19.9141
890.000000 MHz	40.7613	19.9015
900.000000 MHz	40.7048	19.7811
910.000000 MHz	40.5894	19.7394
920.000000 MHz	40.5002	19.7255
930.000000 MHz	40.4077	19.6746
940.000000 MHz	40.2764	19.6608
950.000000 MHz	40.1862	19.6450
960.000000 MHz	40.0464	19.6123
970.000000 MHz	39.9181	19.6055
980.000000 MHz	39.8058	19.6086
990.000000 MHz	39.6998	19.5920
1.000000000 GHz	39.5818	19.5573

835 MHz EUT Evaluation (Face)

Measured Fluid Dielectric Parameter (Brain)

October 20, 2003

Frequency	e'	e''
735.000000 MHz	43.3157	20.4864
745.000000 MHz	43.1768	20.4210
755.000000 MHz	43.0430	20.3795
765.000000 MHz	42.9032	20.3411
775.000000 MHz	42.7892	20.2974
785.000000 MHz	42.6690	20.2568
795.000000 MHz	42.5689	20.2342
805.000000 MHz	42.4742	20.1783
815.000000 MHz	42.3380	20.1354
825.000000 MHz	42.2095	20.1240
835.000000 MHz	42.0650	20.0970
845.000000 MHz	41.9284	20.0272
855.000000 MHz	41.7904	20.0118
865.000000 MHz	41.6323	19.9830
875.000000 MHz	41.5189	19.9528
885.000000 MHz	41.3905	19.9282
895.000000 MHz	41.3378	19.8424
905.000000 MHz	41.2367	19.7875
915.000000 MHz	41.1517	19.7440
925.000000 MHz	41.0592	19.6990
935.000000 MHz	40.9499	19.6846

APPENDIX F - SAM PHANTOM CERTIFICATE OF CONFORMITY

Schmid & Partner
Engineering AG

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

Certificate of conformity / First Article Inspection

Item	SAM Twin Phantom V4.0
Type No	QD 000 P40 BA
Series No	TP-1002 and higher
Manufacturer / Origin	Untersee Composites Hauptstr. 69 CH-8559 Fruthwilen Switzerland

Tests

The series production process used allows the limitation to test of first articles.
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

Test	Requirement	Details	Units tested
Shape	Compliance with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness	Compliant with the requirements according to the standards	2mm +/- 0.2mm in specific areas	First article, Samples
Material parameters	Dielectric parameters for required frequencies	200 MHz – 3 GHz Relative permittivity < 5 Loss tangent < 0.05.	Material sample TP 104-5
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards	Liquid type HSL 1800 and others according to the standard.	Pre-series, First article

Standards

[1] CENELEC EN 50361
[2] IEEE P1528-200x draft 6.5
[3] IEC PT 62209 draft 0.9
(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

Date 18.11.2001

Signature / Stamp

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