CERTIFICATE OF COMPLIANCE
SAR EVALUATION

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Applicant Information:

EF JOHNSON
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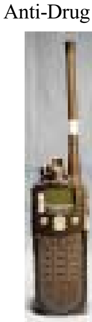
Waseca, MN 65093

FCC Rule Part(s):	**2.1093; ET Docket 96-326**
FCC ID:	**ATH2425110**
Model(s):	**242-5110 / 242-5111**
EUT Type:	**Portable VHF PTT Radio Transceiver**
Modulation:	**FM (VHF Band)**
Tx Frequency Range:	**136 - 174 MHz**
Conducted Power Tested:	**5.8 Watts**
Antenna Type(s):	**Helical Whip**
Antenna P/N(s):	**1. 501-0017-101 (136-151 MHz)**
	2: 501-0017-103 (151-162 MHz)
	3: 501-0017-105 (162-174 MHz)

This wireless portable device has been shown to be compliant for localized Specific Absorption Rate (SAR) for controlled environment / occupational exposure limits specified in ANSI/IEEE Std. C95.1-1992 and has been tested in accordance with the measurement procedures specified in ANSI/IEEE Std. C95.3-1999.

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.

Celltech Research Inc. certifies that no party to this application has been denied FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 853(a).



Shawn McMillen
General Manager
Celltech Research Inc.

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1.0 INTRODUCTION

This measurement report shows compliance of the EF JOHNSON Model: 242-5110/5111 Portable VHF PTT Radio Transceiver FCC ID: ATH2425110 with the regulations and procedures specified in FCC Part 2.1093, ET Docket 96-326 Rules for mobile and portable devices (controlled exposure). The test procedures, as described in American National Standards Institute C95.1-1992 (1), and FCC OET Bulletin 65, Supplement C (Edition 01-01) (2) 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 Equipment Under Test (EUT)

Rule Part(s)	FCC 2.1093; ET Docket 96.326	**Modulation**	FM (VHF Band)
EUT Type	Portable VHF PTT Radio Transceiver	**Tx Frequency Range**	136 - 174 MHz
FCC ID	ATH2425110	**Conducted Output Power Tested**	5.8 Watts
Model No.(s)	242-5110 / 242-5111	**Antenna P/N(s):**	1. 501-0017-101 (136-151 MHz) 2. 501-0017-103 (151-162 MHz) 3. 501-0017-105 (162-174 MHz)
Serial No.	Pre-production	**Battery Type**	7.5 VDC Ni-Cd


EUT with 136-151 MHz Whip Antenna


EUT with 151-162 MHz Whip Antenna


EUT with 162-174 MHz Whip Antenna


Left Side of EUT


Right Side of EUT


Back Side of EUT


EUT with Speaker/Mic

3.0 SAR MEASUREMENT SYSTEM

Celltech Research SAR measurement facility utilizes the Dosimetric Assessment System (DASY™) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland. The DASY system is comprised of the robot controller, computer, near-field probe, probe alignment sensor, SAM phantom, and various planar phantoms for brain 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 PC plug-in card. The DAE3 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 PC-card 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. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

DASY3 SAR Measurement System with small planar phantom

4.0 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.

Face-Held SAR Measurements

Freq. (MHz)	Chan.	Mode	Cond. Power Before (W)	Cond. Power After (W)	Antenna Position	Antenna P/N	Separation Distance (cm)	SAR (w/kg)	
								100% Duty Cycle	50% Duty Cycle
136.00	Low	CW	5.8	5.76	Fixed	501-0017-101	2.5	0.310	0.155
155.00	Mid	CW	5.8	5.72	Fixed	501-0017-103	2.5	1.54	0.770
174.00	High	CW	5.8	5.74	Fixed	501-0017-105	2.5	0.752	0.376
Mixture Type: Brain Dielectric Constant: 52.3 Conductivity: 0.76					**ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Controlled Exposure / Occupational BRAIN: 8.0 W/kg (averaged over 1 gram)**				

Notes:

1. The SAR values found were below the maximum limit of 8.0 w/kg (controlled exposure).
2. The highest face-held SAR value found was 1.54 w/kg (100% duty cycle).
3. The EUT was tested for face-held SAR with a 2.5cm separation distance between the front of the EUT and the outer surface of the planar phantom.
4. Ambient TEMPERATURE: 23.3 °C
   Relative HUMIDITY: 57.5 %
   Atmospheric PRESSURE: 100.4 kPa
5. Fluid Temperature 23.0 °C
6. During the entire test the conducted power was maintained to within 5% of the initial conducted power.

Face-held SAR Test Setup
2.5cm Separation Distance

Body-Worn SAR Measurements

Freq. (MHz)	Chan.	Mode	Cond. Power Before (W)	Cond. Power After (W)	Antenna Position	Antenna Type	Belt-Clip Separation Distance (cm)	SAR (w/kg)	
								100% Duty Cycle	50% Duty Cycle
136.00	Low	CW	5.8	5.78	Fixed	501-0017-101	1.3	1.55	0.775
155.00	Mid	CW	5.8	5.75	Fixed	501-0017-103	1.3	1.15	0.575
174.00	High	CW	5.8	5.76	Fixed	501-0017-105	1.3	1.28	0.640
Mixture Type: Body **Dielectric Constant: 61.9** **Conductivity: 0.80**					**ANSI / IEEE C95.1 1992 - SAFETY LIMIT** **Spatial Peak Controlled Exposure / Occupational** **BODY: 8.0 W/kg (averaged over 1 gram)**				

Notes:

1. The SAR values found were below the maximum limit of 8.0 w/kg (controlled exposure).
2. The highest body-worn SAR value found was 1.55 w/kg (100% duty cycle).
3. The EUT was tested for body-worn SAR with the attached belt-clip providing a 1.3cm separation distance between the back of the EUT and the outer surface of the planar phantom.
4. Ambient TEMPERATURE: 23.3 °C
   Relative HUMIDITY: 57.5 %
   Atmospheric PRESSURE: 100.4 kPa
5. Fluid Temperature 23.0 °C
6. During the entire test the conducted power was maintained to within 5% of the initial conducted power.

Body-worn SAR Test Setup
1.3cm Belt-Clip Separation

5.0 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.

6.0 DETAILS OF SAR EVALUATION

The EF JOHNSON Model: 242-5110/5111 Portable VHF PTT Radio Transceiver FCC ID: ATH2425110 was found to be compliant for localized Specific Absorption Rate (Controlled Exposure) based on the following test provisions and conditions:

1. The EUT was tested in a face-held configuration with the front of the device placed parallel to the outer surface of the small planar phantom and with a 2.5cm separation distance.
2. The EUT was tested in a body-worn configuration with the attached belt-clip touching the outer surface of the planar phantom and providing a 1.3cm separation distance between the back of the EUT and the outer surface of the small planar phantom.
3. The EUT was evaluated for SAR at maximum power and the unit was operated for an appropriate period prior to the evaluation in order to minimize drift. The conducted power levels were checked before and after each test. If the conducted power level dropped more than 5% of the initial power level, then the EUT was retested. Any unusual anomalies over the course of the test also warranted a re-evaluation.
4. The conducted power was measured according to the procedures described in FCC Part 2.1046.
5. The device was operated continuously in the transmit mode for the duration of the test.
6. The location of the maximum spatial SAR distribution (Hot Spot) was determined relative to the device and its antenna.
7. The EUT was tested with a fully charged battery.

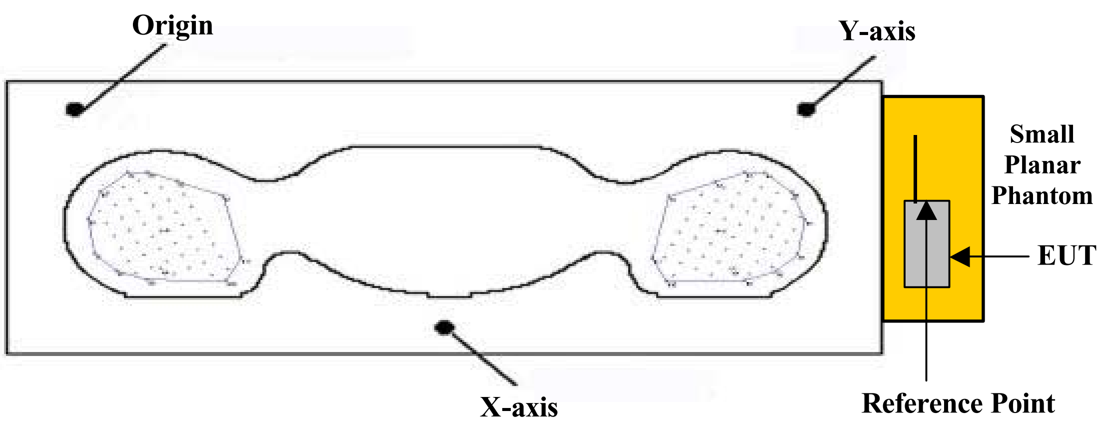
7.0 EVALUATION PROCEDURES

a. The evaluation was performed using the applicable type of 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 in accordance with FCC OET Bulletin 65, Supplement C (Edition 01-01) using the SAM phantom. For body-worn and face-held devices a planar phantom was used. Depending on the phantom used for the evaluation, all other phantoms were drained of fluid.

b. The SAR was determined by a pre-defined procedure within the DASY3 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 20mm x 20mm.

c. For frequencies below 500MHz a 4x4x7 matrix was performed around the greatest spatial SAR distribution found during the area scan of the applicable exposed region. For frequencies above 500MHz a 5x5x7 matrix was performed. SAR values were then calculated using a 3-D spline interpolation algorithm and averaged over spatial volumes of 1 and 10 grams.

d. The depth of the simulating tissue in the planar phantom used for the SAR evaluation was no less than 15.0cm.



Phantom Reference Point & EUT Positioning

8.0 SYSTEM VALIDATION

Prior to the assessment, the system was verified in a large planar phantom with a 300MHz dipole. A forward power of 250mW was applied to the dipole and the system was verified to a tolerance of $\pm$10%. The applicable verifications are as follows (see Appendix B for validation test plots and calibration information):

Dipole Validation Kit	Target SAR 1g (w/kg)	Measured SAR 1g (w/kg)	Validation Date
300MHz	0.878	0.898	October 24, 2001

VALIDATION TISSUE MIXTURE (300MHz Brain)	
INGREDIENT	**%**
Water	37.56
Sugar	55.32
Salt	5.95
HEC	0.98
Bactericide	0.19

VALIDATION TISSUE PARAMETERS (300MHz)			
Tissue Mixture	**Dielectric Constant ε_r**	**Conductivity σ (mho/m)**	**ρ (Kg/m^3)**
Brain	45.3 ± 5%	0.87 ± 5%	1000

9.0 EVALUATION SIMULATED TISSUES

The brain and body 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 (permitivity and conductivity).

INGREDIENT	MIXTURE %	
	150MHz Brain	150MHz Body
Water	38.35	46.6
Sugar	55.5	49.7
Salt	5.15	2.6
HEC	1.0	1.0
Bactericide	0.1	0.1

10.0 EVALUATION TISSUE PARAMETERS

The dielectric parameters of the fluids were verified prior to the SAR evaluation using an 85070C Dielectric Probe Kit and an 8753E Network Analyzer. The dielectric parameters of the fluid are as follows:

Equivalent Tissue 150MHz	Dielectric Constant ε_r	Conductivity σ (mho/m)	ρ (Kg/m^3)
Brain	52.3 ± 5%	0.76 ± 5%	1000
Body	61.9 ± 5%	0.80 ± 5%	1000

11.0 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:	Pentium III
Clock Speed:	450 MHz
Operating System:	Windows NT
Data Card:	DASY3 PC-Board

Data Converter

Features:	Signal Amplifier, multiplexer, A/D converter, and control logic
Software:	DASY3 software
Connecting Lines:	Optical downlink for data and status info. Optical uplink for commands and clock

PC Interface Card

Function:	24 bit (64 MHz) DSP for real time processing Link to DAE3 16-bit A/D converter for surface detection system serial link to robot direct emergency stop output for robot

E-Field Probe

Model:	ET3DV6
Serial No.:	1590
Construction:	Triangular core fiber optic detection system
Frequency:	10 MHz to 6 GHz
Linearity:	± 0.2 dB (30 MHz to 3 GHz)

Evaluation Phantom

Type:	Small Planar Phantom
Shell Material:	Plexiglas
Bottom Thickness:	2.0 mm ± 0.1mm
Dimensions:	Box: 36.5cm (L) x 22.5cm (W) x 20.3cm (H); Back Plane: 25.3cm (H)

Validation Phantom (≤ 450MHz)

Type:	Large Planar Phantom
Shell Material:	Plexiglas
Bottom Thickness:	6.2 mm ± 0.1mm
Dimensions:	86.0cm (L) x 39.5cm (W) x 21.8cm (H)

12.0 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)
Dynam. Rnge: 5 μW/g to > 100 mW/g; Linearity: ± 0.2 dB
Srfce. 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

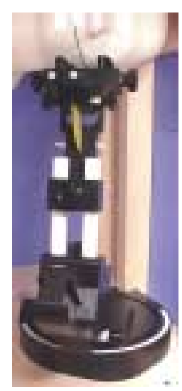
13.0 SMALL PLANAR PHANTOM

The small planar phantom is constructed of Plexiglas material with a 2.0mm shell thickness for face-held and body-worn SAR evaluations. The small planar phantom is mounted onto the outer left hand section of the DASY3 system.


Small Planar Phantom

14.0 DEVICE HOLDER

The DASY3 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

SAR MEASUREMENT SYSTEM		
EQUIPMENT	***SERIAL NO.***	***CALIBRATION DATE***
DASY3 System -Robot -ET3DV6 E-Field Probe -DAE -300MHz Validation Dipole -900MHz Validation Dipole -1800MHz Validation Dipole -SAM Phantom V4.0C	 599396-01 1590 370 135 054 247 N/A	 N/A Mar 2001 Sept 1999 Oct 2001 June 2001 June 2001 N/A
85070C Dielectric Probe Kit	N/A	N/A
Gigatronics 8652A Power Meter -Power Sensor 80701A -Power Sensor 80701A	1835272 1833535 1833542	Oct 1999 Jan 2001 Feb 2001
E4408B Spectrum Analyzer	US39240170	Nov 1999
8594E Spectrum Analyzer	3543A02721	Mar 2000
8753E Network Analyzer	US38433013	Nov 1999
8648D Signal Generator	3847A00611	August 1999
5S1G4 Amplifier Research Power Amplifier	26235	N/A

16.0 MEASUREMENT UNCERTAINTIES

Uncertainty Description	Error	Distribution	Weight	Standard Deviation	Offset
Probe Uncertainty					
Axial isotropy	±0.2 dB	U-Shaped	0.5	±2.4 %	
Spherical isotropy	±0.4 dB	U-Shaped	0.5	±4.8 %	
Isotropy from gradient	±0.5 dB	U-Shaped	0	±	
Spatial resolution	±0.5 %	Normal	1	±0.5 %	
Linearity error	±0.2 dB	Rectangle	1	±2.7 %	
Calibration error	±3.3 %	Normal	1	±3.3 %	
SAR Evaluation Uncertainty					
Data acquisition error	±1 %	Rectangle	1	±0.6 %	
ELF and RF disturbances	±0.25 %	Normal	1	±0.25 %	
Conductivity assessment	±5 %	Rectangle	1	±5.8 %	
Spatial Peak SAR Evaluation Uncertainty					
Extrapolated boundary effect	±3 %	Normal	1	±3 %	±5 %
Probe positioning error	±0.1 mm	Normal	1	±1 %	
Integrated and cube orientation	±3 %	Normal	1	±3 %	
Cube Shape inaccuracies	±2 %	Rectangle	1	±1.2 %	
Device positioning	±6 %	Normal	1	±6 %	
Combined Uncertainties				±11.7 %	±5 %

Measurement uncertainties in SAR measurements are difficult to quantify due to several variables including biological, physiological, and environmental.

According to ANSI/IEEE C95.3, the overall uncertainties are difficult to assess and will vary with the type of meter and usage situation. However, accuracy's of ± 1 to 3 dB can be expected in practice, with greater uncertainties in near-field situations and at higher frequencies (shorter wavelengths), or areas where large reflecting objects are present. Under optimum measurement conditions, SAR measurement uncertainties of at least ± 2dB can be expected.

According to CENELEC, typical worst-case uncertainty of field measurements is ± 5 dB.
For well-defined modulation characteristics the uncertainty can be reduced to ± 3 dB.

17.0 REFERENCES

(1) ANSI, *ANSI/IEEE C95.1: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 Ghz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY: 1992.*

(2) 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. 20554: June 2001.

(3) Thomas Schmid, Oliver Egger, and Neils Kuster, "Automated E-field scanning system for dosimetric assessments", IEEE *Transaction on Microwave Theory and Techniques,* Vol. 44, pp. 105 – 113: January 1996.

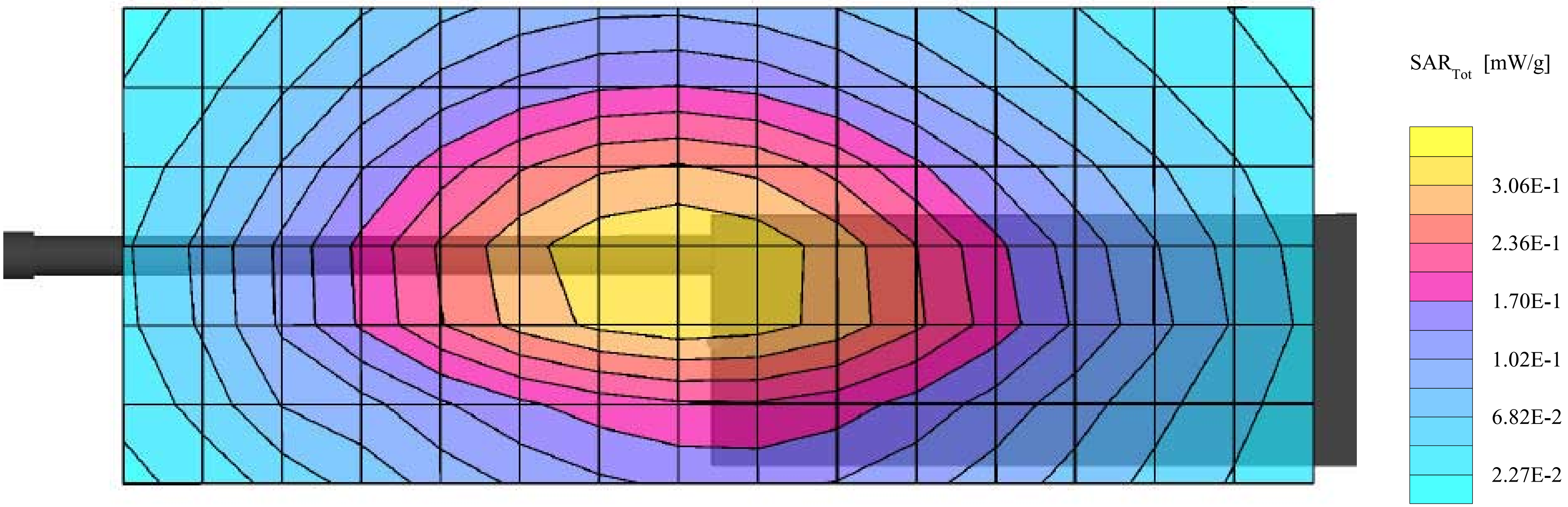
(4) Niels Kuster, Ralph Kastle, and Thomas Schmid, "Dosimetric evaluation of mobile communications equipment with know precision", IEICE Transactions of Communications, vol. E80-B, no. 5, pp. 645 – 652: May 1997.

APPENDIX A - SAR MEASUREMENT DATA

EF Johnson FCC ID: ALH2425110

Small Planar Phantom; Planar Section; Position: (90°,0°)
Probe: ET3DV6 - SN1590; ConvF(7.71,7.71,7.71); Crest factor: 1.0
150 MHz Brain : σ = 0.76 mho/m ε_r = 52.3 ρ = 1.00 g/cm³
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Cube 4x4x7
SAR (1g): 0.310 mW/g, SAR (10g): 0.236 mW/g

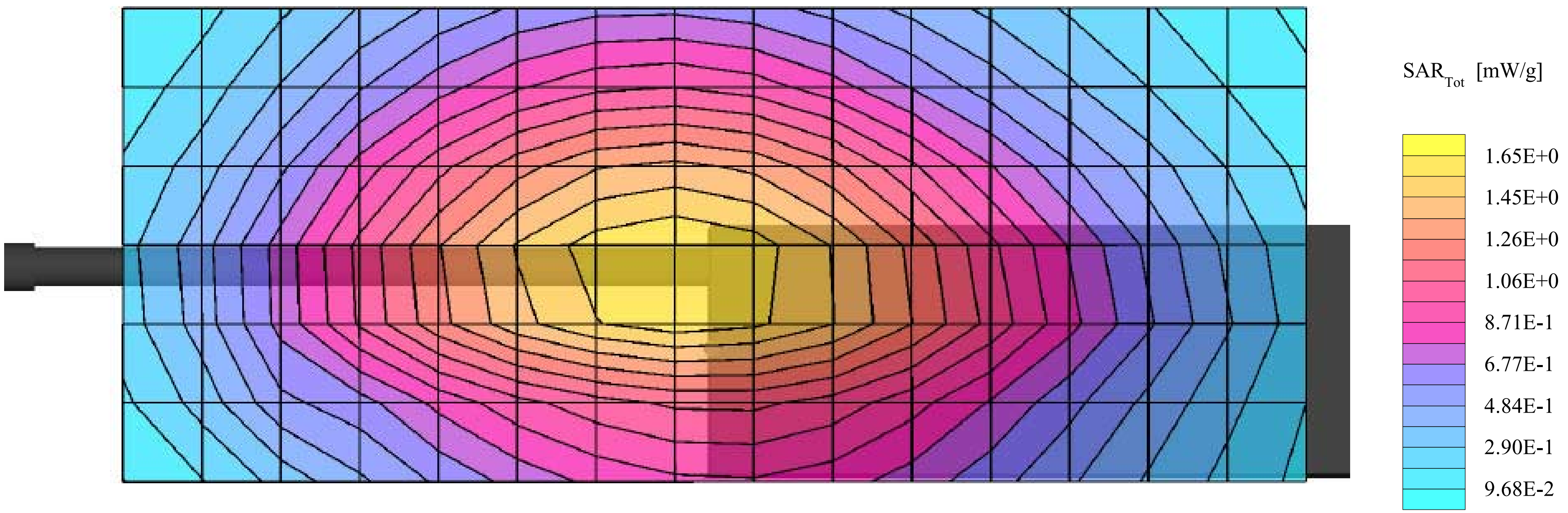
Face SAR at 2.5 cm Separation Distance
Portable VHF PTT Radio Transceiver
Antenna P/N: 501-0017-101
EF Johnson Model: 242-5110/5111
Continuous Wave Mode
Low Channel [136.000 Mhz]
Conducted Power: 5.80 Watts
Date Tested: October 24, 2001



EF Johnson FCC ID: ALH2425110

Small Planar Phantom; Planar Section; Position: (90°,0°)
Probe: ET3DV6 - SN1590; ConvF(7.71,7.71,7.71); Crest factor: 1.0
150 MHz Brain : σ = 0.76 mho/m ε_r = 52.3 ρ = 1.00 g/cm^3
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Cube 4x4x7
SAR (1g): 1.54 mW/g, SAR (10g): 1.24 mW/g

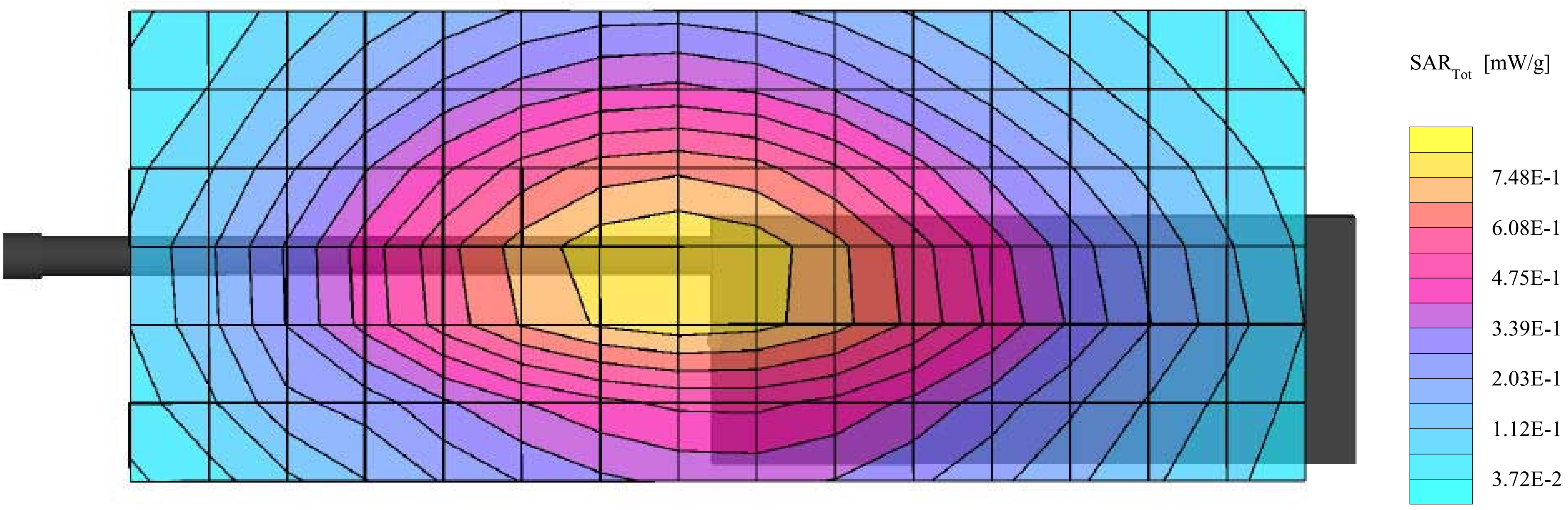
Face SAR at 2.5 cm Separation Distance
Portable VHF PTT Radio Transceiver
Antenna P/N: 501-0017-103
EF Johnson Model: 242-5110/5111
Continuous Wave Mode
Mid Channel [155.000 Mhz]
Conducted Power: 5.80 Watts
Date Tested: October 24, 2001



EF Johnson FCC ID: ALH2425110

Small Planar Phantom; Planar Section; Position: (90°,0°)
Probe: ET3DV6 - SN1590; ConvF(7.71,7.71,7.71); Crest factor: 1.0
150 MHz Brain : $\sigma = 0.76$ mho/m $\varepsilon_r = 52.3$ $\rho = 1.00$ g/cm³
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Cube 4x4x7
SAR (1g): 0.752 mW/g, SAR (10g): 0.405 mW/g

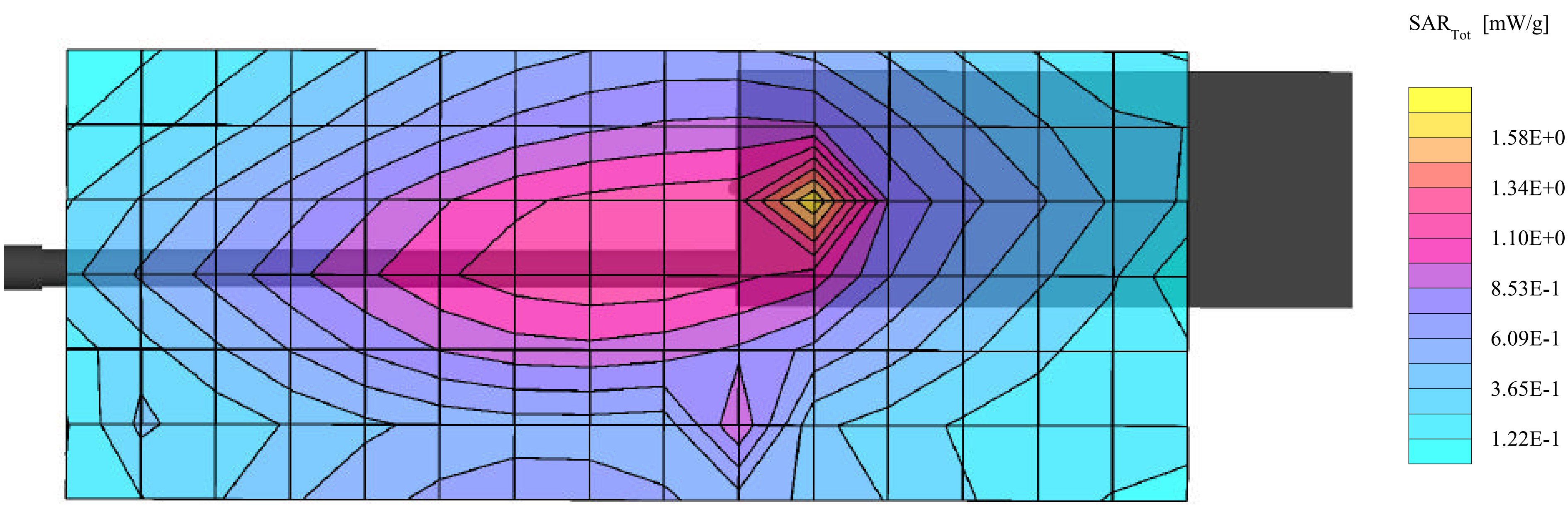
Face SAR at 2.5 cm Separation Distance
Portable VHF PTT Radio Transceiver
Antenna P/N: 501-0017-105
EF Johnson Model: 242-5110/5111
Continuous Wave Mode
High Channel [174.000 Mhz]
Conducted Power: 5.80 Watts
Date Tested: October 24, 2001



EF Johnson FCC ID: ALH2425110

Small Planar Phantom; Planar Section; Position: (270°,0°)
Probe: ET3DV6 - SN1590; ConvF(7.71,7.71,7.71); Crest factor: 1.0
150 MHz Muscle: σ = 0.80 mho/m ε_r = 61.9 ρ = 1.00 g/cm³
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Cube 4x4x7
SAR (1g): 1.55 mW/g, SAR (10g): 0.988 mW/g

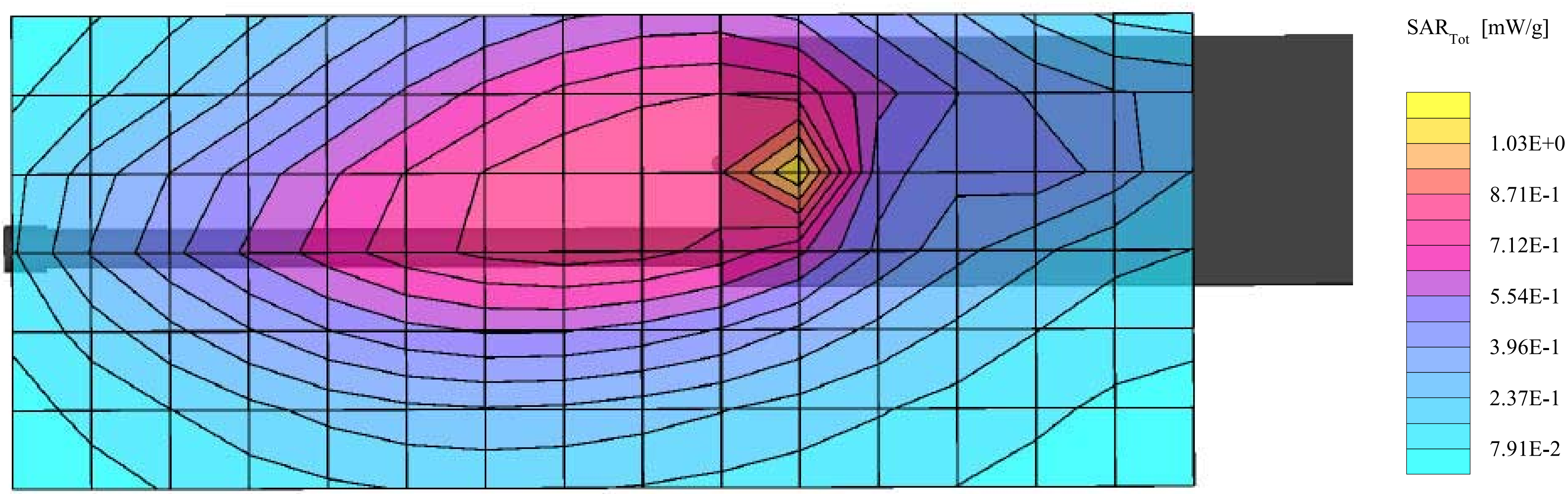
Body-Worn SAR with 1.3 cm Belt-Clip Separation
Portable VHF PTT Radio Transceiver
Antenna P/N: 501-0017-101
EF Johnson Model: 242-5110/5111
Continuous Wave Mode
Low Channel [136.000 Mhz]
Conducted Power: 5.80 Watts
Date Tested: October 24, 2001



EF Johnson FCC ID: ALH2425110

Small Planar Phantom; Planar Section; Position: (270°,0°)
Probe: ET3DV6 - SN1590; ConvF(7.71,7.71,7.71); Crest factor: 1.0
150 MHz Muscle: $\sigma = 0.80$ mho/m $\varepsilon_r = 61.9$ $\rho = 1.00$ g/cm³
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Cube 4x4x7
SAR (1g): 1.15 mW/g, SAR (10g): 0.756 mW/g

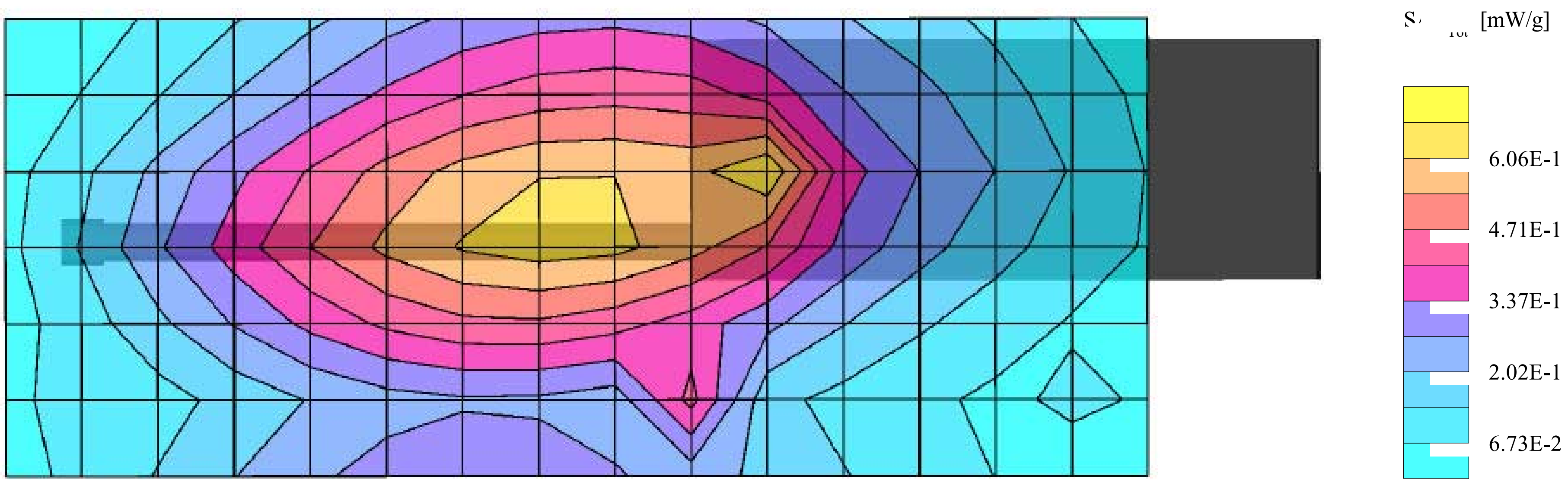
Body-Worn SAR with 1.3 cm Belt-Clip Separation
Portable VHF PTT Radio Transceiver
Antenna P/N: 501-0017-103
EF Johnson Model: 242-5110/5111
Continuous Wave Mode
Mid Channel [155.000 Mhz]
Conducted Power: 5.80 Watts
Date Tested: October 24, 2001



EF Johnson FCC ID: ALH2425110

Small Planar Phantom; Planar Section; Position: (270°,0°)
Probe: ET3DV6 - SN1590; ConvF(7.71,7.71,7.71); Crest factor: 1.0
150 MHz Muscle: σ = 0.80 mho/m ε_r = 61.9 ρ = 1.00 g/cm^3
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Cube 4x4x7
SAR (1g): 1.28 mW/g, SAR (10g): 0.869 mW/g

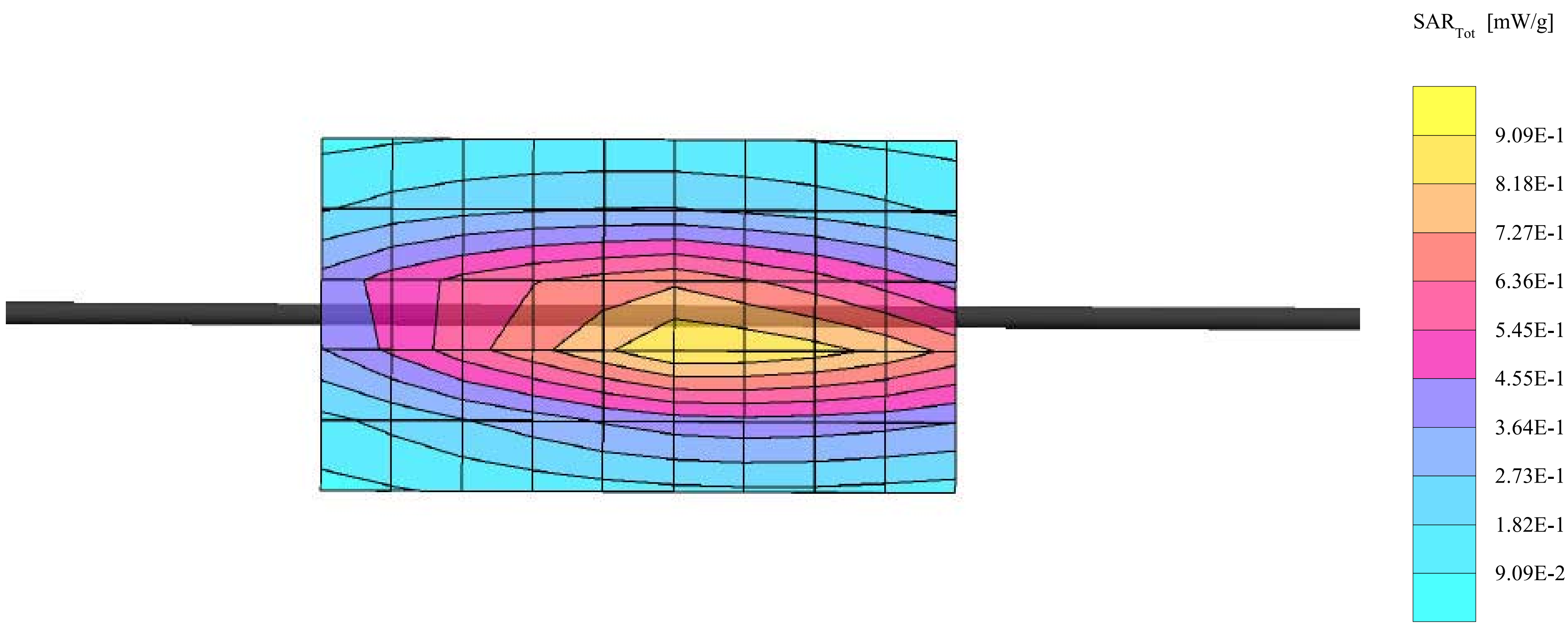
Body-Worn SAR with 1.3 cm Belt-Clip Separation
Portable VHF PTT Radio Transceiver
Antenna P/N: 501-0017-105
EF Johnson Model: 242-5110/5111
Continuous Wave Mode
High Channel [174.000 Mhz]
Conducted Power: 5.80 Watts
Date Tested: October 24, 2001



APPENDIX B - DIPOLE VALIDATION

Dipole 300 MHz

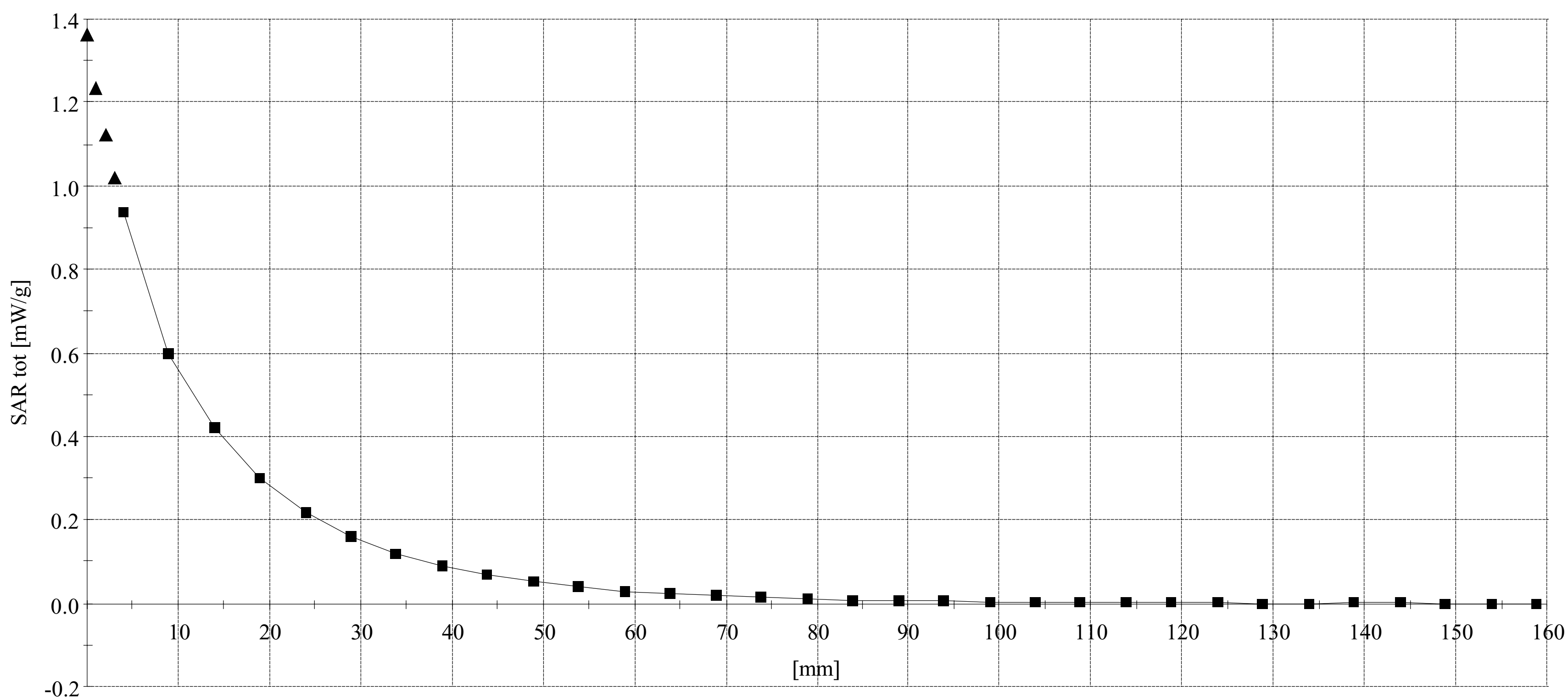
Frequency: 300 MHz; Conducted Input Power: 250 [mW]
Flat Phantom; Planar Section
Probe: ET3DV6 - SN1590; ConvF(7.54,7.54,7.54); Crest factor: 1.0; 300 MHz Brain: σ = 0.87 mho/m ε_r = 45.3 ρ = 1.00 g/cm³
Cube 5x5x7: Peak: 1.43 mW/g, SAR (1g): 0.898 mW/g, SAR (10g): 0.592 mW/g, (Worst-case extrapolation)
Penetration depth: 12.4 (10.5, 14.7) [mm]
Powerdrift: -0.03 dB
Calibration Date: Oct. 24, 2001



Dipole 300 MHz

Flat Phantom; Section; Position:
Probe: ET3DV6 - SN1590; ConvF(7.54,7.54,7.54); Crest factor: 1.0
300 MHz Brain: σ = 0.87 mho/m ε_r = 45.3 ρ = 1.00 g/cm³
Z-Axis: Dx = 0.0, Dy = 0.0, Dz = 5.0

Conducted Power: 250 mW
Date Tested:October 24, 2001



APPENDIX C - DIPOLE CALIBRATION

Celltech
Testing and Engineering Services Lab

300MHz SYSTEM VALIDATION DIPOLE

Type:	**300MHz Validation Dipole**
Serial Number:	**135**
Place of Calibration:	**Celltech Research Inc.**
Date of Calibration:	**October 15, 2001**

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

Calibrated by:

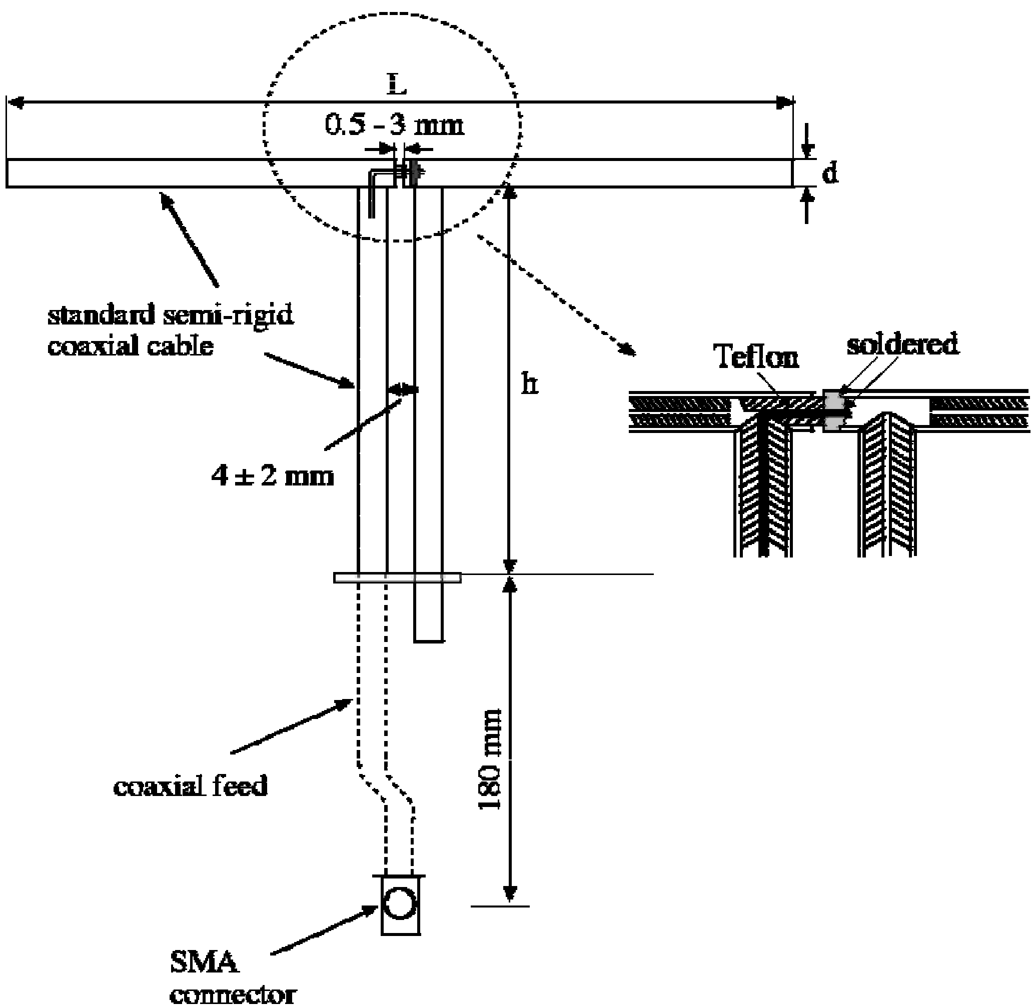
Approved by:

Celltech Research Inc. 1955 Moss Court, Kelowna, B.C. Canada V1Y 9L3
Tel. 250-860-3130 • Fax. 250-860-3110 • e-mail: info@celltechlabs.com
www.celltechlabs.com

1. Dipole Construction

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	Re{Z} = 45.789Ù
	Im{Z} = 1.2598Ù
Return Loss at 300MHz	-26.394dB



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

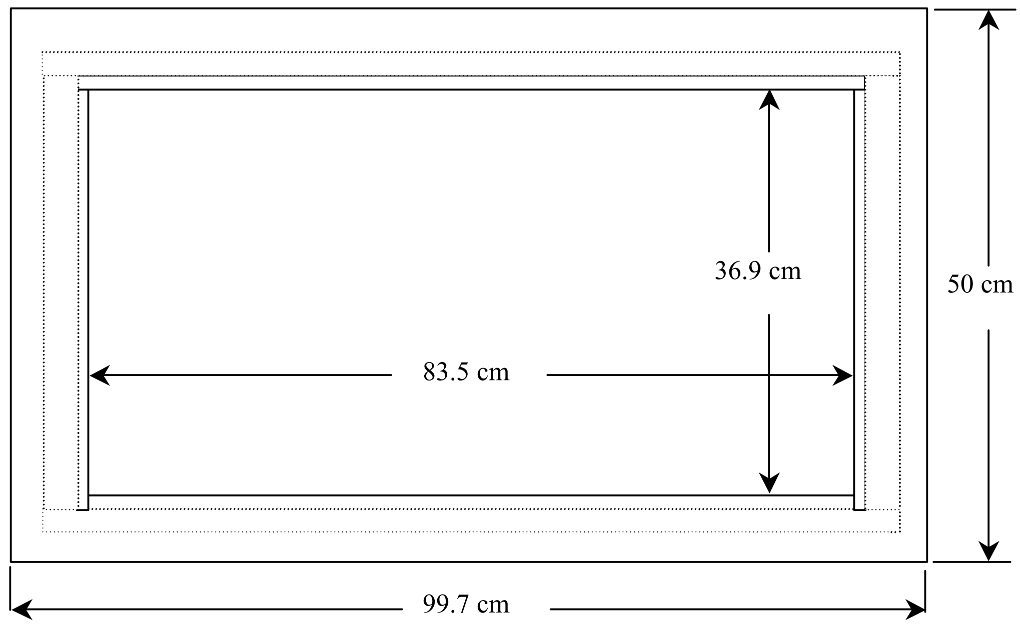
2. Validation Phantom

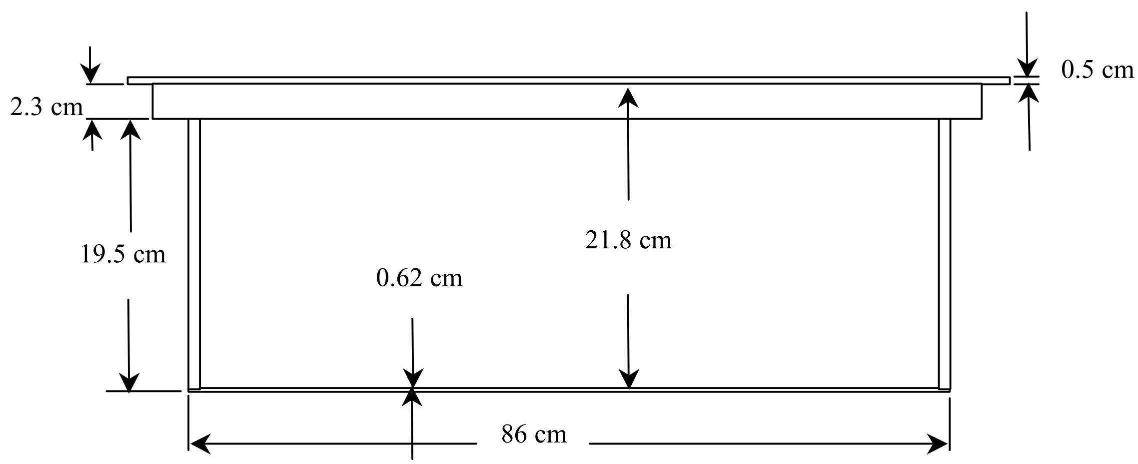
The validation phantom was constructed using relatively low-loss tangent Plexiglas material. The dimensions of the phantom are as follows:

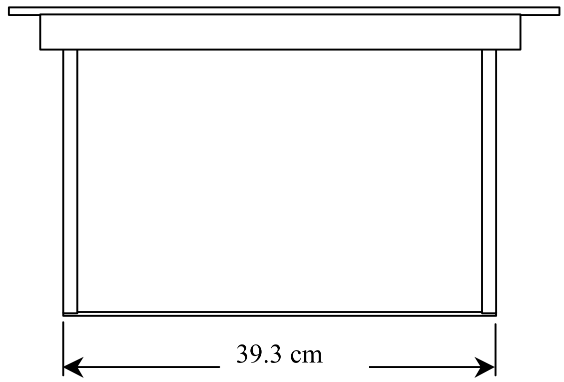
Length: 83.5 cm
Width: 36.9 cm
Height: 21.8 cm

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

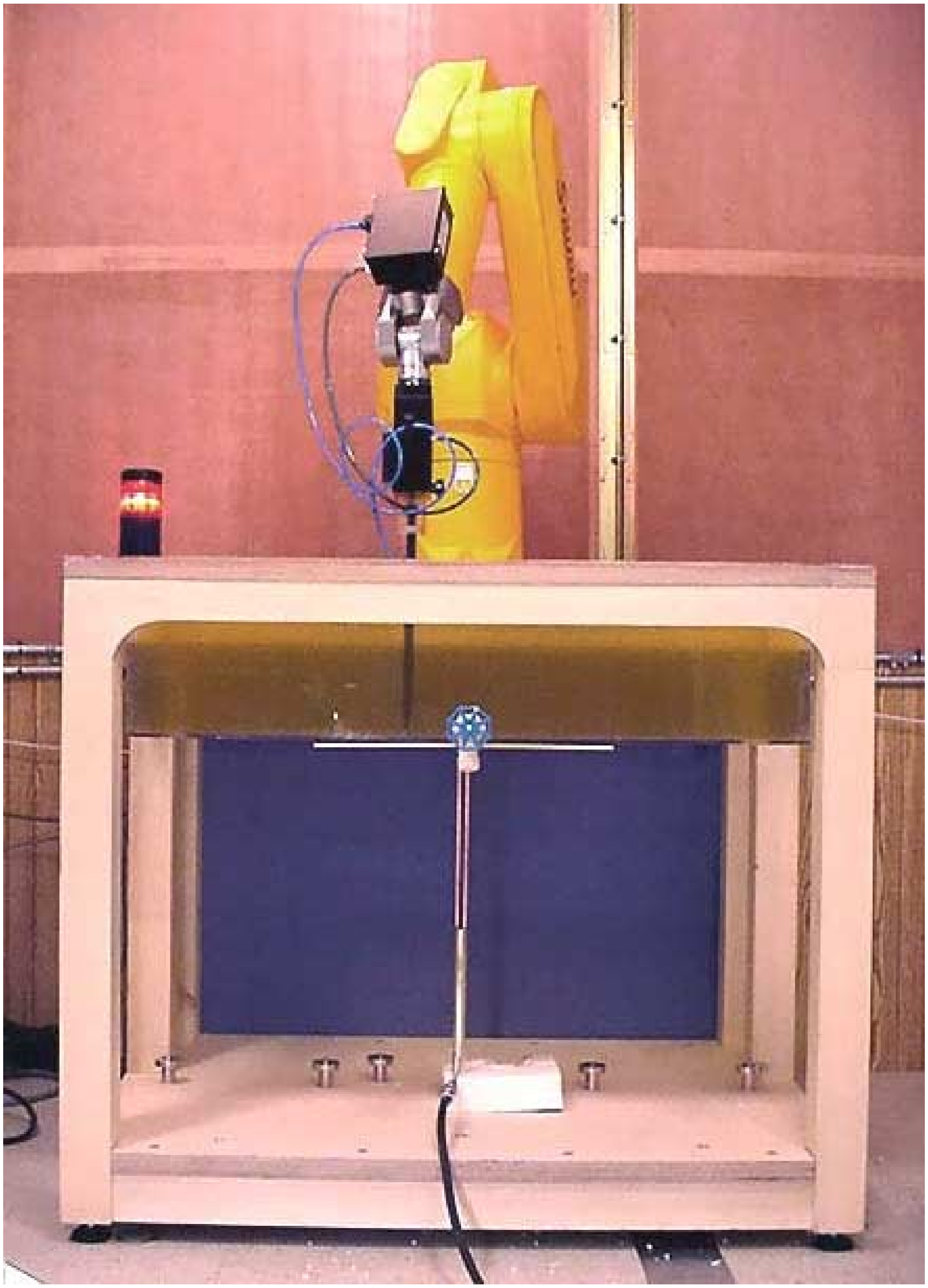
Dimensions of Plexiglas Planar Phantom







300MHz Dipole Calibration Photo



300MHz Dipole Calibration Photo

3. Measurement Conditions

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

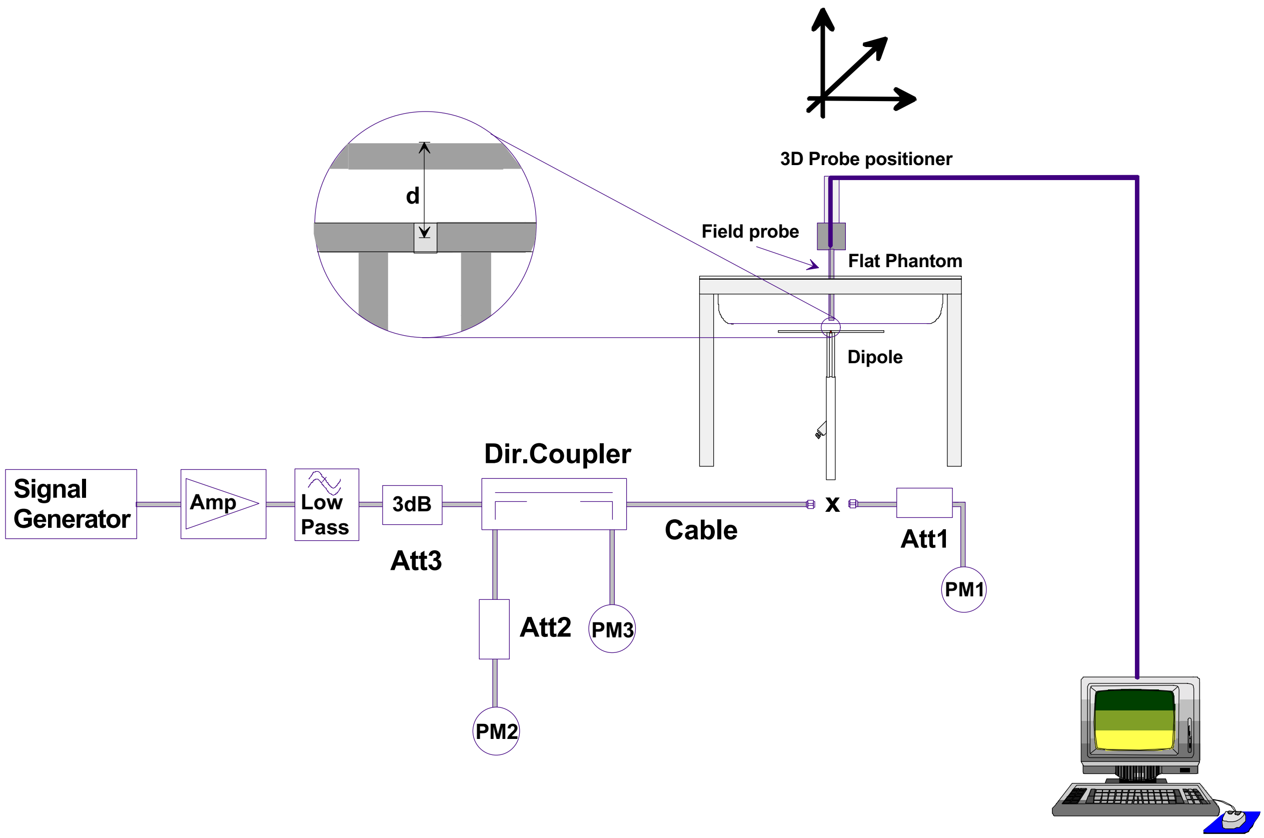
Relative Permitivity:	45.7	± 5%
Conductivity:	0.86 mho/m	± 5%
Temperature:	22.5°C	

The 300MHz simulating tissue 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%
Target Dielectric Parameters at 22°C	å$_r$ = 45.3 ó = 0.87 S/m

4. 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.

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

Validation Dipole SAR Test Results

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	0.872	3.488	0.579	2.316	1.38
Test 2	0.876	3.504	0.580	2.320	1.39
Test 3	0.876	3.504	0.581	2.324	1.39
Test 4	0.878	3.512	0.583	2.332	1.39
Test 5	0.881	3.524	0.581	2.324	1.39
Test 6	0.875	3.500	0.580	2.320	1.38
Test 7	0.884	3.536	0.582	2.328	1.40
Test 8	0.879	3.516	0.581	2.324	1.39
Test 9	0.876	3.504	0.580	2.320	1.39
Test10	0.873	3.492	0.579	2.316	1.39
Average Value	0.877	3.508	0.581	2.322	1.39

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

Averaged over 1cm (1g) of tissue: 3.51 mW/g

Averaged over 10cm (10g) of tissue: 2.32 mW/g

Note: If the liquid parameters are slightly different then the target values, the SAR can be adjusted using the following table “SAR Sensitivities”

Application Note: SAR Sensitivities

Introduction

The measured SAR-values in homogeneous phantoms depend strongly on the electrical parameters of the liquid. Liquids with exactly matching parameters are difficult to produce; there is always a small error involved in the production or measurement of the liquid parameters. The following sensitivities allow the estimation of the influence of small parameter errors on the measured SAR values. The calculations are based on an approximation formula [1] for the SAR of an electrical dipole near the phantom surface and a adapted plane wave approximation for the penetration depth. The sensitivities are given in percent SAR change per percent change in the controlling parameter:

$$S(x) = \frac{d\,SAR / SAR}{d\,x / x}$$

The controlling parameters x are:

- ε : permitivity
- σ : conductivity
- ρ : brain density (= one over integration volume)

For example: If The liquid permitivity increases by 2 percent and the sensitivity of the SAR to permitivity is -0.6 then the SAR will decrease by 1.2 percent.

The sensitivities are given for surface SAR values and averaged SAR values for 1 g and 10 g cubes and for dipole distances d of 10mm (for frequencies below 1000 MHz) and 15mm (for frequencies above 1000 MHz) from the liquid surface.

Liquid parameters are as proposed in the new standards (e.g., IEEE 1528).

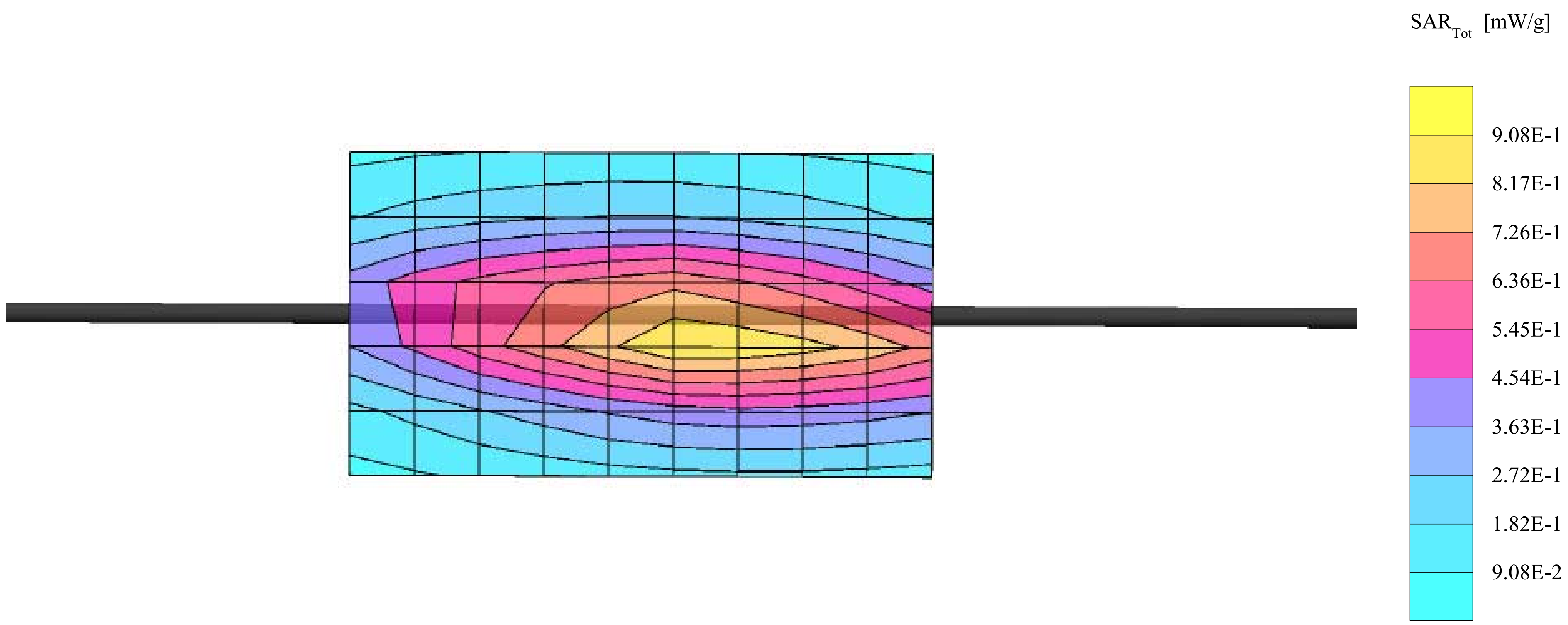
References

[1] N. Kuster and Q. Balzano, "Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300 MHz", *IEEE Transacions on Vehicular Technology*, vol. 41(1), pp. 17-23, 1992.

Parameter	ε	σ	ρ
f=300 MHz (εr=45.3, σ=0.87S/m, ρ=1g/cm³)			
d=15mm: Surface	- 0.41	+ 0.48	—
1 g	- 0.33	+ 0.28	0.08
10 g	- 0.26	+ 0.09	0.16
f=450 MHz (εr=43.5, σ=0.87S/m, ρ=1g/cm³)			
d=15mm: Surface	- 0.56	+ 0.67	—
1 g	- 0.46	+ 0.43	0.09
10 g	- 0.37	+ 0.22	0.17
f=835 MHz (εr=41.5, σ=0.90S/m, ρ=1g/cm³)			
d=15mm: Surface	- 0.70	+ 0.86	—
1 g	- 0.57	+ 0.59	0.10
10 g	- 0.45	+ 0.35	0.18
f=900 MHz (εr=41.5, σ=0.97S/m, ρ=1g/cm³)			
d=15mm: Surface	- 0.69	+ 0.86	—
1 g	- 0.55	+ 0.57	0.10
10 g	- 0.44	+ 0.32	0.19
f=1450 MHz (εr=40.5, σ=1.20/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.73	+ 0.91	—
1 g	- 0.55	+ 0.55	0.12
10 g	- 0.42	+ 0.27	0.22
f=1800 MHz (εr=40.0, σ=1.40S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.73	+ 0.92	—
1 g	- 0.52	+ 0.51	0.14
10 g	- 0.38	+ 0.21	0.24
f=1900 MHz (εr=40.0, σ=1.40S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.73	+ 0.93	—
1 g	- 0.53	+ 0.51	0.14
10 g	- 0.39	+ 0.22	0.24
f=2000 MHz (εr=40.0, σ=1.40S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.74	+ 0.94	—
1 g	- 0.53	+ 0.52	0.14
10 g	- 0.39	+ 0.22	0.24
f=2450 MHz (εr=39.2, σ=1.80S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.74	+ 0.93	—
1 g	- 0.49	+ 0.41	0.17
10 g	- 0.34	+ 0.12	0.28
f=3000 MHz (εr=38.5, σ=2.40S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.75	+ 0.90	—
1 g	- 0.45	+ 0.28	0.21
10 g	- 0.32	+ 0.02	0.31

Dipole 300 MHz

Frequency: 300 MHz; Conducted Input Power: 250 [mW]
Flat Phantom; Planar Section
Probe: ET3DV6 - SN1590; ConvF(7.54,7.54,7.54); Crest factor: 1.0; 300 MHz Brain: σ = 0.87 mho/m ε_r = 45.3 ρ = 1.00 g/cm^3
Cube 5x5x7: Peak: 1.43 mW/g, SAR (1g): 0.899 mW/g, SAR (10g): 0.592 mW/g, (Worst-case extrapolation)
Penetration depth: 12.4 (10.6, 14.7) [mm]
Powerdrift: -0.08 dB
Calibration Date: Oct. 15, 2001



Dipole 300 MHz

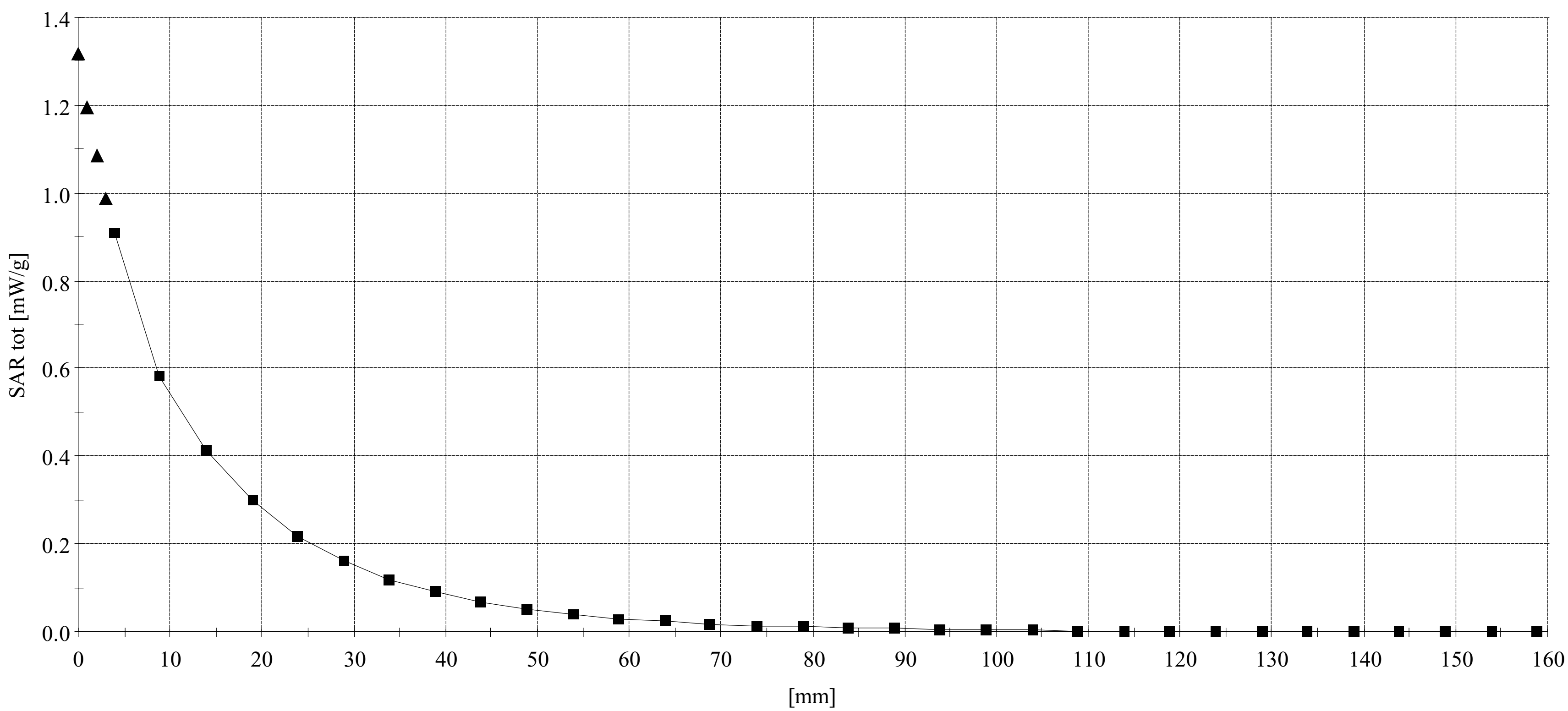
Flat Phantom; Section; Position:

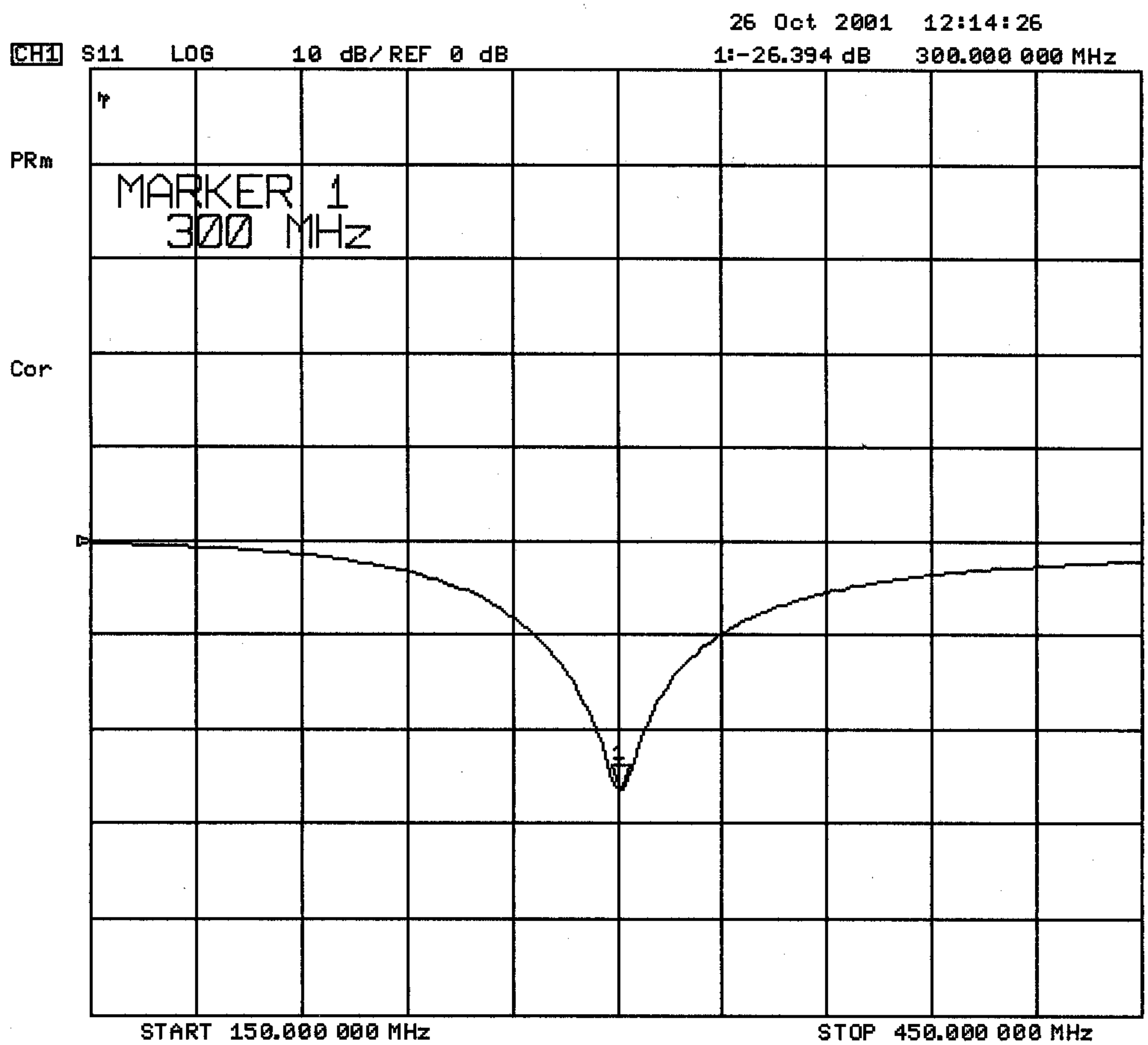
Probe: ET3DV6 - SN1590; ConvF(7.54,7.54,7.54); Crest factor: 1.0

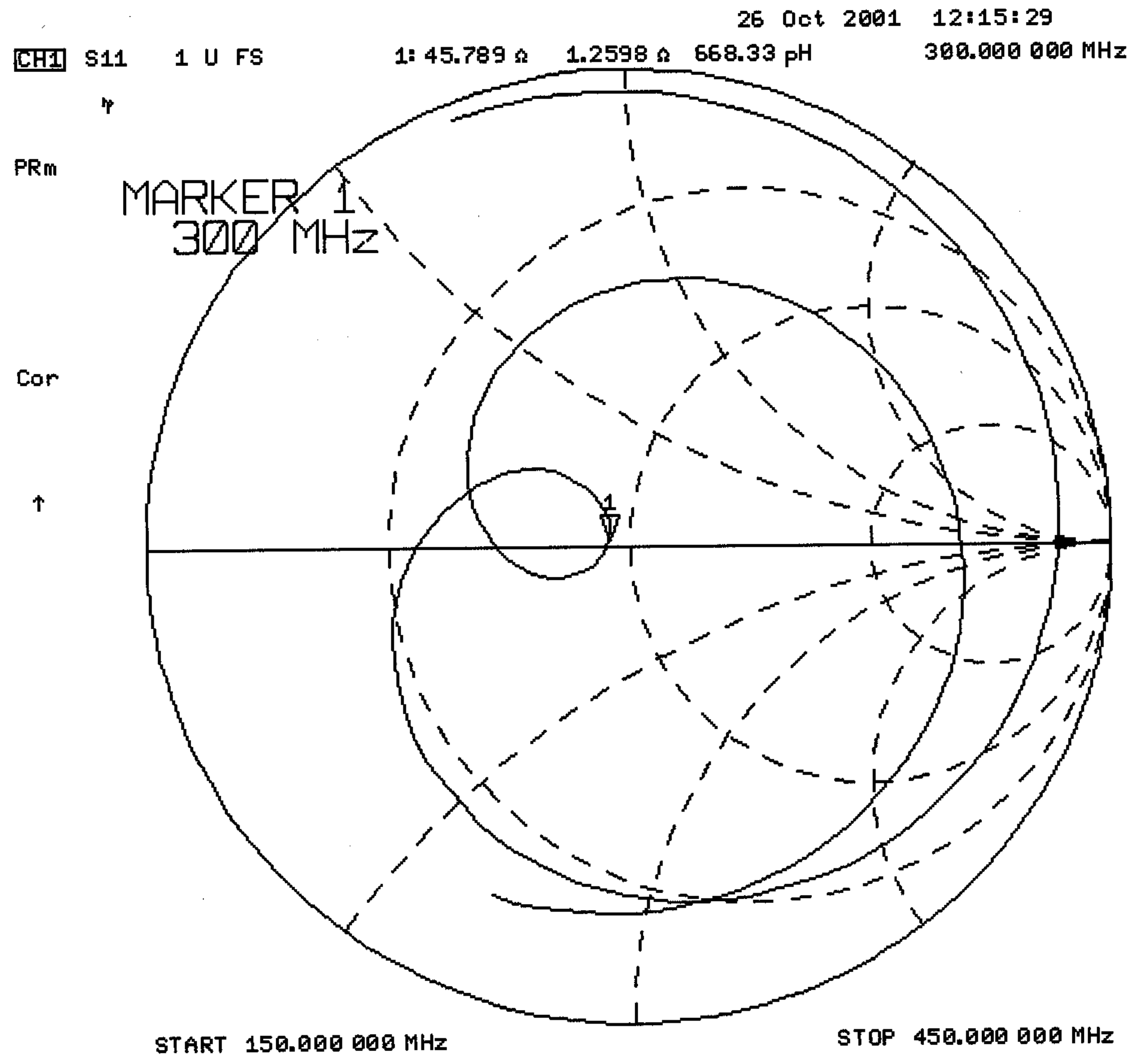
300 MHz Brain: $\sigma = 0.87$ mho/m $\epsilon_r = 45.3$ $\rho = 1.00$ g/cm³

Z-Axis: Dx = 0.0, Dy = 0.0, Dz = 5.0

Date of Calibration: October 15, 2001




26 Oct 2001 12:14:26
CH1 S11 LOG 10 dB/ REF 0 dB
1:-26.394 dB 300.000 000 MHz
PRm
Cor
MARKER 1
300 MHz
START 150.000 000 MHz
STOP 450.000 000 MHz


26 Oct 2001 12:15:29
CH1 S11 1 U FS
1: 45.789 Ω 1.2598 Ω 668.33 pH
300.000 000 MHz
PRm
Cor
MARKER 1
300 MHz
START 150.000 000 MHz
STOP 450.000 000 MHz

APPENDIX D - PROBE CALIBRATION

Probe ET3DV6

SN:1590

Manufactured: March 19, 2001
Calibrated: March 26, 2001

Calibrated for System DASY3

DASY3 - Parameters of Probe: ET3DV6 SN:1590

Sensitivity in Free Space

NormX	**1.77**	$\mu V/(V/m)^2$
NormY	**1.91**	$\mu V/(V/m)^2$
NormZ	**1.67**	$\mu V/(V/m)^2$

Diode Compression

DCP X	**100**	mV
DCP Y	**100**	mV
DCP Z	**100**	mV

Sensitivity in Tissue Simulating Liquid

Head 450 MHz ε_r **= 43.5 ± 5%** σ **= 0.87 ± 10% mho/m**

ConvF X	**7.36**	extrapolated	Boundary effect:	
ConvF Y	**7.36**	extrapolated	Alpha	**0.29**
ConvF Z	**7.36**	extrapolated	Depth	**2.72**

Head 900 MHz ε_r **= 42 ± 5%** σ **= 0.97 ± 10% mho/m**

ConvF X	**6.83**	± 7% (k=2)	Boundary effect:	
ConvF Y	**6.83**	± 7% (k=2)	Alpha	**0.37**
ConvF Z	**6.83**	± 7% (k=2)	Depth	**2.48**

Head 1500 MHz ε_r **= 40.4 ± 5%** σ **= 1.23 ± 10% mho/m**

ConvF X	**6.13**	interpolated	Boundary effect:	
ConvF Y	**6.13**	interpolated	Alpha	**0.47**
ConvF Z	**6.13**	interpolated	Depth	**2.17**

Head 1800 MHz ε_r **= 40 ± 5%** σ **= 1.40 ± 10% mho/m**

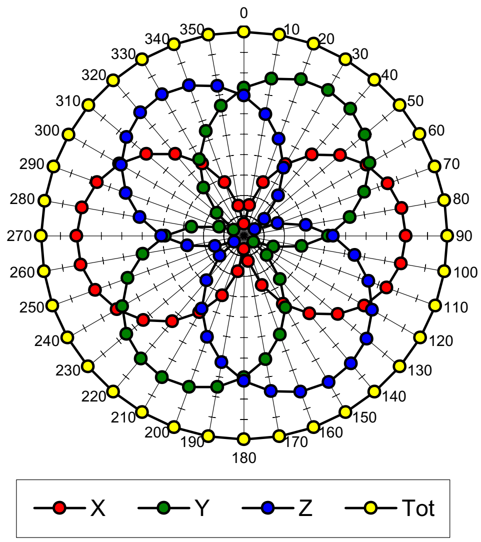
ConvF X	**5.78**	± 7% (k=2)	Boundary effect:	
ConvF Y	**5.78**	± 7% (k=2)	Alpha	**0.53**
ConvF Z	**5.78**	± 7% (k=2)	Depth	**2.01**

Sensor Offset

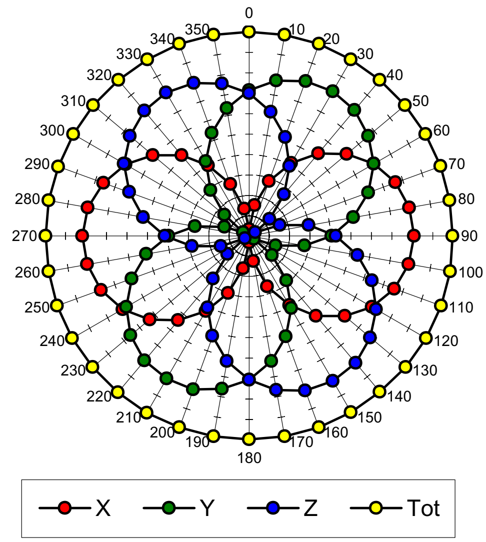
Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.2 ± 0.2**	mm

Receiving Pattern (ϕ, θ = 0°)

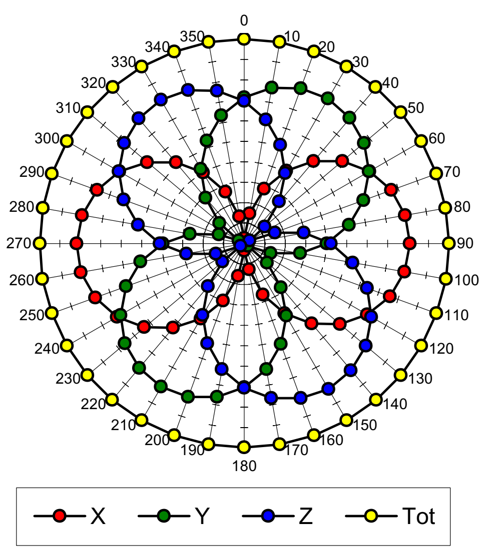
f = 30 MHz, TEM cell ifi110



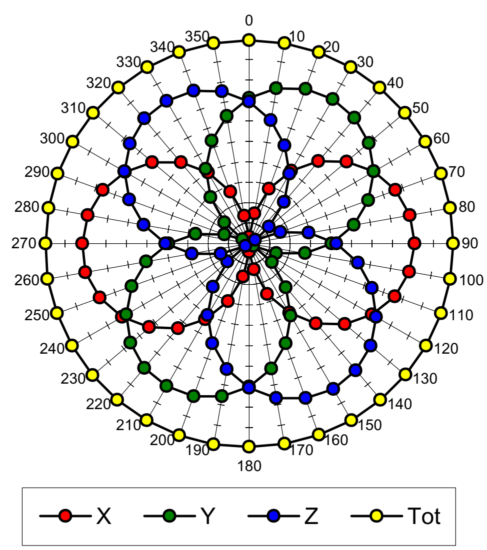
f = 100 MHz, TEM cell ifi110

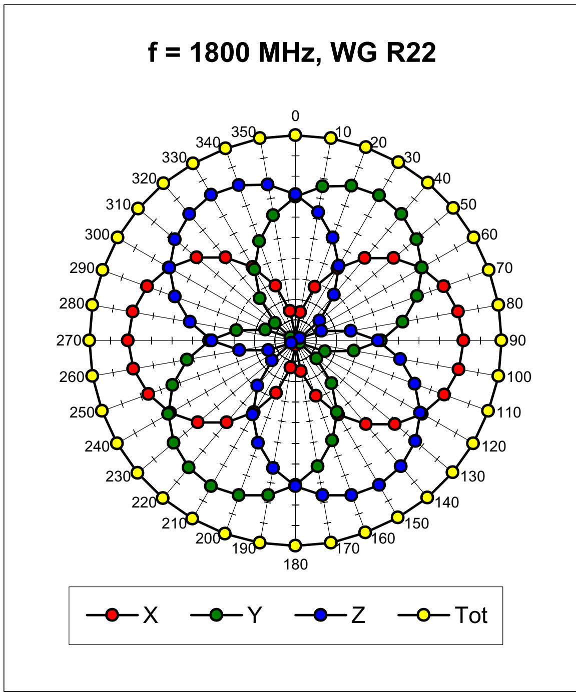


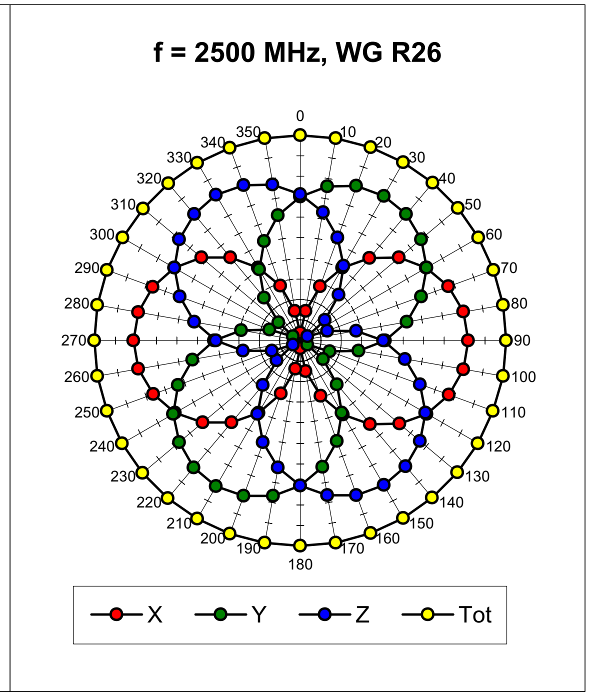
f = 300 MHz, TEM cell ifi110



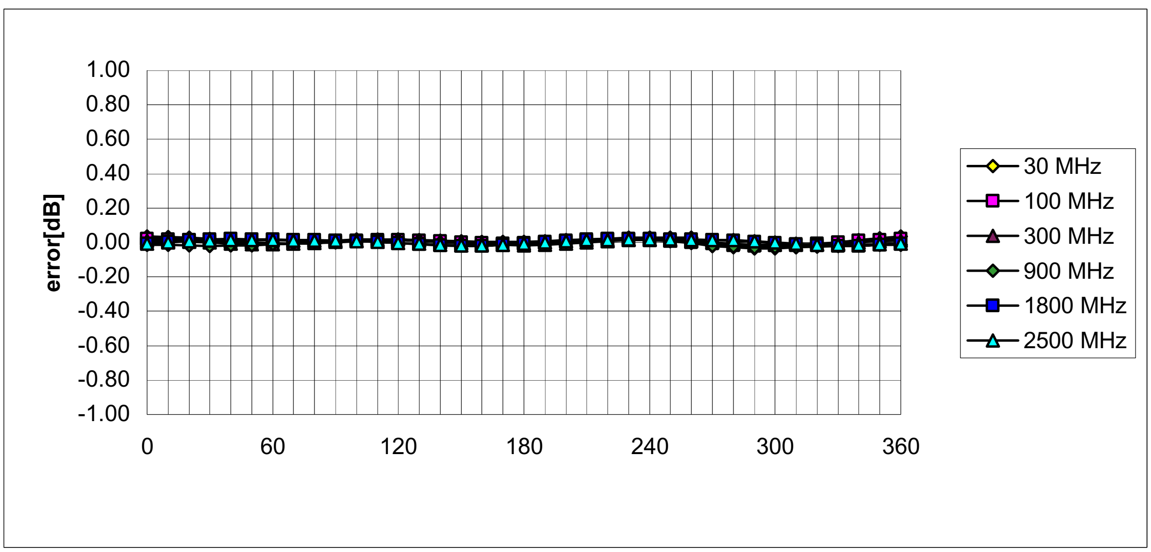
f = 900 MHz, TEM cell ifi110





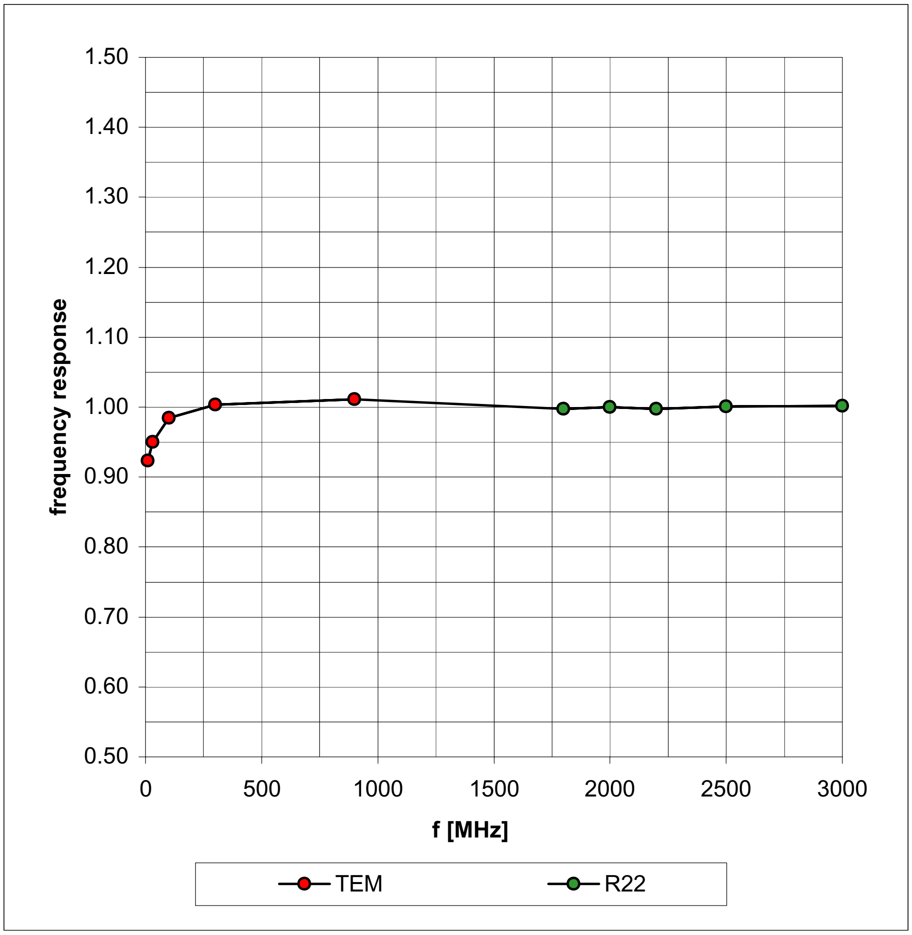


Isotropy Error (φ), θ = 0°



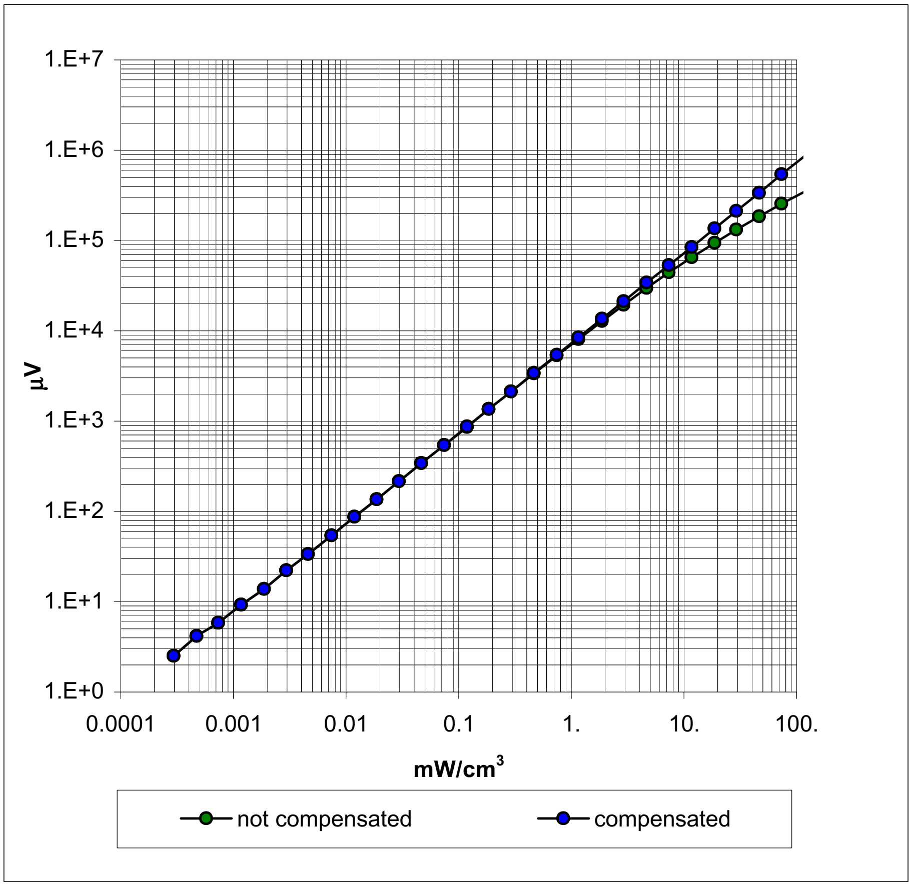
Frequency Response of E-Field

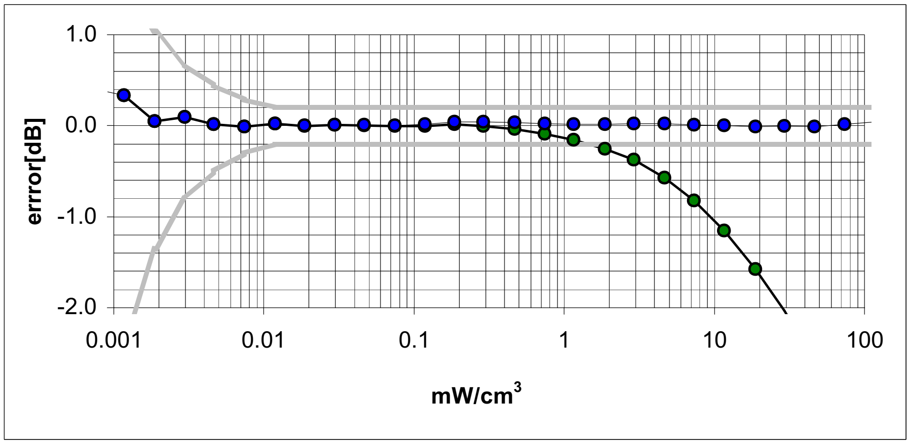
(TEM-Cell:ifi110, Waveguide R22)



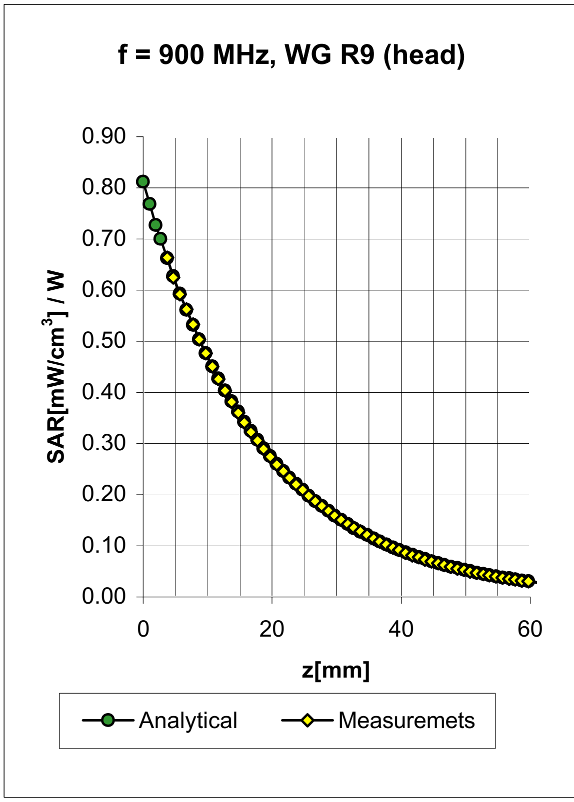
Dynamic Range f(SAR_{brain})

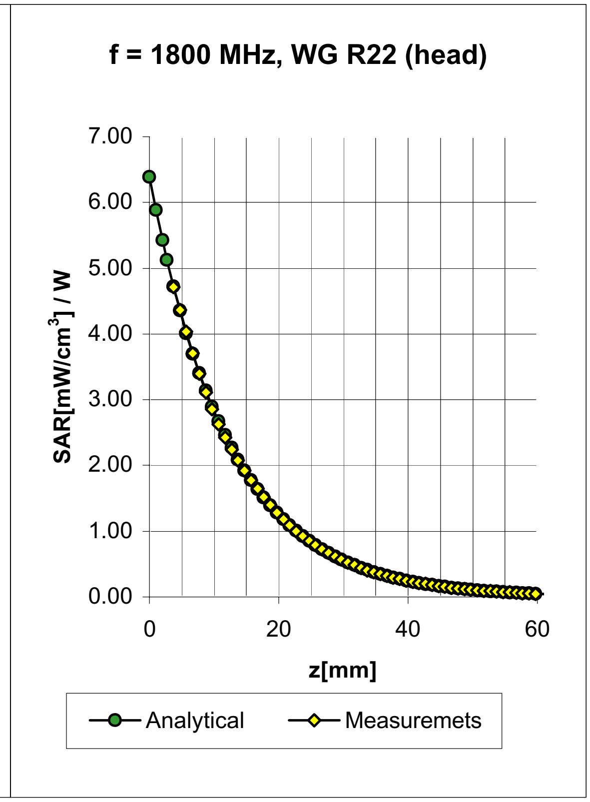
(TEM-Cell:ifi110)





Conversion Factor Assessment





Head **900 MHz** **ε_r = 42 ± 5%** **σ = 0.97 ± 10% mho/m**

ConvF X	**6.83**	± 7% (k=2)	Boundary effect:	
ConvF Y	**6.83**	± 7% (k=2)	Alpha	**0.37**
ConvF Z	**6.83**	± 7% (k=2)	Depth	**2.48**

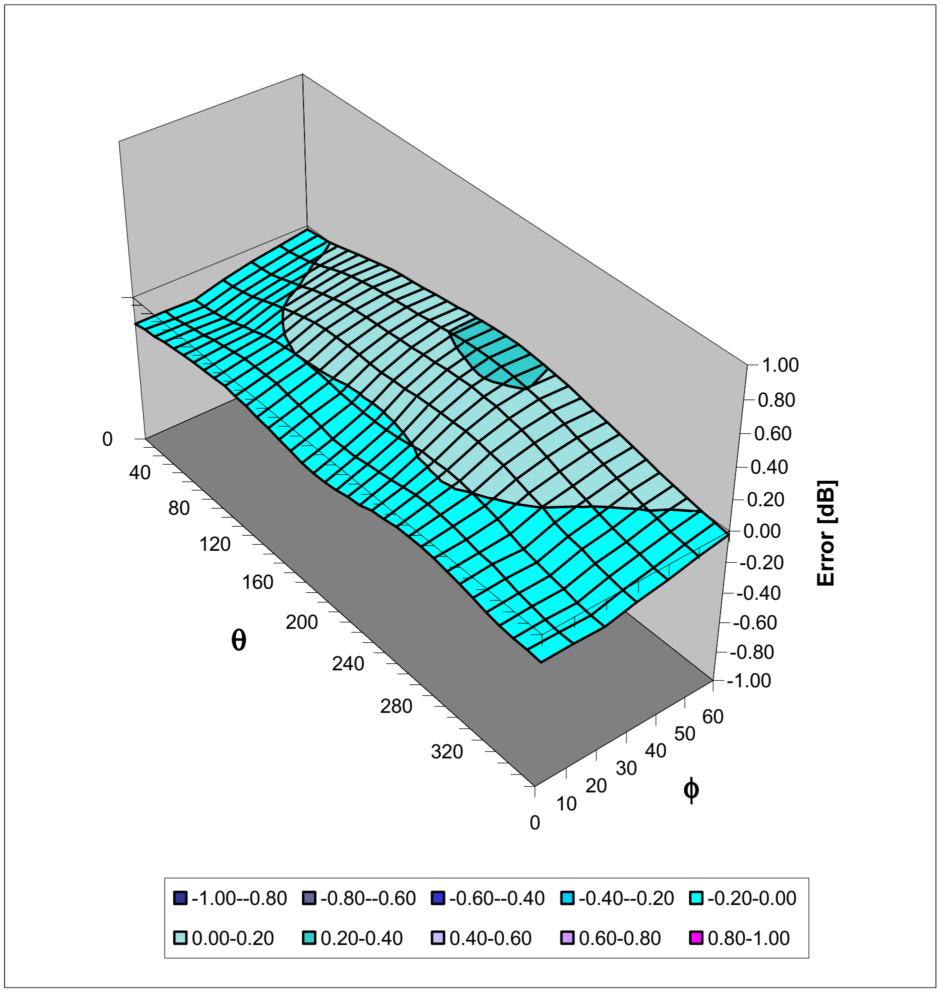
Head **1800 MHz** **ε_r = 40 ± 5%** **σ = 1.40 ± 10% mho/m**

ConvF X	**5.78**	± 7% (k=2)	Boundary effect:	
ConvF Y	**5.78**	± 7% (k=2)	Alpha	**0.53**
ConvF Z	**5.78**	± 7% (k=2)	Depth	**2.01**

ET3DV6 SN:1590

Deviation from Isotropy in HSL

Error (θϕ), f = 900 MHz



APPENDIX E - DETERMINATION OF ELECTRIC FIELD PROBE CONVERSION NUMBERS

The E-field probe conversion numbers, outside the calibrated data points, were determined by the system manufacturer's recommended linear extrapolation routine. The extrapolation and interpolation was based on the two calibrated data points of 900 and 1800MHz in head simulating tissue. Attached is an example of an identical calibrated E-probe from the same system manufacturer showing the derived conversion numbers outside the two calibration reference points using numerical modeling methods. The graph and tables indicate the linearity of this E-field probe across several frequency bands with the associated uncertainty. The graph also shows that for frequencies below 800MHz the slope of the derived conversion numbers is slightly steeper. Since the E-field probe used in this SAR evaluation was based on two data points, 900 and 1800MHz, a linear extrapolation down to lower frequencies such as 150MHz would generate a lower than expected conversion number. For this particular system the conversion numbers are inversely proportional to the total SAR value determined, therefore, the lower conversion numbers translates to an overestimation of the SAR. The magnitude of the overestimation has not yet been determined. The conversion numbers for body parameters have not yet been established, since at this time the only method available from the system manufacturer in determining these numbers is through numerical modeling. Until such time as the conversion numbers can be determined through experimental techniques, the accuracy of the conversion numbers are in question.

Dosimetric E-Field Probe ET3DV6 **EXAMPLE**

Head Tissue Conversion Factor (± standard deviation)

400 MHz	ConvF	7.64 ± 8%	ε_r = 44.4 σ = 0.87 mho/m CENELEC Head Tissue
835 MHz	ConvF	6.54 ± 8%	ε_r = 42.5 σ = 0.98 mho/m CENELEC Head Tissue
900 MHz	ConvF	6.41 ± 8%	ε_r = 42.3 σ = 0.99 mho/m CENELEC Head Tissue
350 MHz	ConvF	7.76 ± 8%	ε_r = 44.7 σ = 0.87 mho/m IEEE Head Tissue
450 MHz	ConvF	7.52 ± 8%	ε_r = 43.5 σ = 0.87 mho/m IEEE Head Tissue
835 MHz	ConvF	6.53 ± 8%	ε_r = 41.5 σ = 0.90 mho/m IEEE Head Tissue
925 MHz	ConvF	6.37 ± 8%	ε_r = 41.45 σ = 0.98 mho/m IEEE Head Tissue
1500 MHz	ConvF	6.04 ± 8%	ε_r = 40.43 σ = 1.23 mho/m IEEE Head Tissue
1900 MHz	ConvF	5.41 ± 8%	ε_r = 40.0 σ = 1.40 mho/m IEEE Head Tissue
2450 MHz	ConvF	5.18 ± 8%	ε_r = 39.2 σ = 1.8 mho/m IEEE Head Tissue
2450 MHz	ConvF	5.40 ± 8%	ε_r = 37.2 σ = 2.09 mho/m H1800 at 2450 MHz

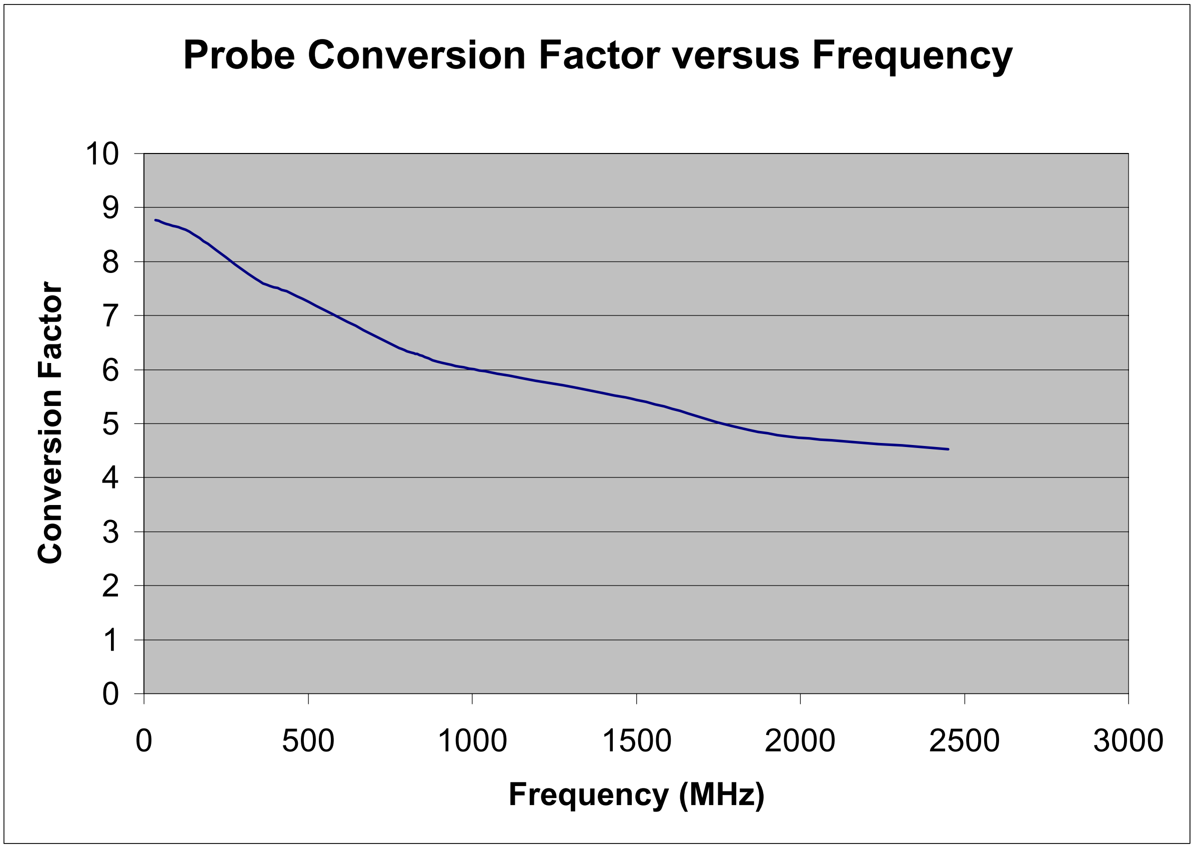
Dosimetric E-Field Probe ET3DV6

EXAMPLE

Muscle Tissue Conversion Factor (± standard deviation)

Frequency		ConvF	Tissue parameters
35 MHz	ConvF	8.77 ± 15%	ε_r = 85.19 σ = 0.69 mho/m FCC Muscle Tissue
75 MHz	ConvF	8.68 ± 10%	ε_r = 69.93 σ = 0.72 mho/m FCC Muscle Tissue
150 MHz	ConvF	8.51 ± 8%	ε_r = 62.68 σ = 0.75 mho/m FCC Muscle Tissue
350 MHz	ConvF	7.64 ± 8%	ε_r = 58.41 σ = 0.80 mho/m FCC Muscle Tissue
450 MHz	ConvF	7.40 ± 8%	ε_r = 57.62 σ = 0.83 mho/m FCC Muscle Tissue
784 MHz	ConvF	6.38 ± 8%	ε_r = 56.25 σ = 0.93 mho/m FCC Muscle Tissue
835 MHz	ConvF	6.28 ± 8%	ε_r = 56.11 σ = 0.95 mho/m FCC Muscle Tissue
925 MHz	ConvF	6.10 ± 8%	ε_r = 55.9 σ = 0.98 mho/m FCC Muscle Tissue
1500 MHz	ConvF	5.44 ± 8%	ε_r = 54.87 σ = 1.23 mho/m FCC Muscle Tissue
1900 MHz	ConvF	4.82 ± 8%	ε_r = 54.3 σ = 1.45 mho/m FCC Muscle Tissue
2450 MHz	ConvF	4.53 ± 8%	ε_r = 53.57 σ = 1.81 mho/m FCC Muscle Tissue

EXAMPLE



Probe Conversion Factor versus Frequency
10
9
8
7
6
5
4
3
2
1
0
Conversion Factor
0
500
1000
1500
2000
2500
3000
Frequency (MHz)

APPENDIX F - SAR TEST SETUP PHOTOGRAPHS

**FACE-HELD SAR TEST SETUP PHOTOGRAPHS
WITH ANTENNA P/N: 501-0017-101 (136-151MHz)
2.5cm Separation Distance**

FACE-HELD SAR TEST SETUP PHOTOGRAPHS
WITH ANTENNA P/N: 501-0017-103 (151-162MHz)
2.5cm Separation Distance

FACE-HELD SAR TEST SETUP PHOTOGRAPHS
WITH ANTENNA P/N: 501-0017-105 (162-174MHz)
2.5cm Separation Distance

BODY-WORN SAR TEST SETUP PHOTOGRAPHS
WITH ANTENNA P/N: 501-0017-101 (136-151MHz)
1.3cm Belt-Clip Separation Distance

BODY-WORN SAR TEST SETUP PHOTOGRAPHS
WITH ANTENNA P/N: 501-0017-103 (151-162MHz)
1.3cm Belt-Clip Separation Distance

**BODY-WORN SAR TEST SETUP PHOTOGRAPHS
WITH ANTENNA P/N: 501-0017-103 (151-162MHz)
1.3cm Belt-Clip Separation Distance**

ANTENNA PHOTOGRAPHS

Antenna P/N: 501-0017-101 (136-151 MHz)

Antenna P/N: 501-0017-103 (151-162 MHz)

Antenna P/N: 501-0017-105 (162-174 MHz)