

APPENDIX 4 : System Validation Dipole (D2450V2,S/N: 713)

Schmid & Partner Engineering AG

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

Calibration Certificate

2450 MHz System Validation Dipole

Type:

D2450V2

Serial Number:

713

Place of Calibration:

Zurich

Date of Calibration:

November 15, 2002

Calibration Interval:

24 months

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

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

Calibrated by:

D. Vetter

Approved by:

Robert Kofe

UL Apex Co., Ltd.

Head Office EMC Lab.

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**Schmid & Partner
Engineering AG**

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DASY

Dipole Validation Kit

Type: D2450V2

Serial: 713

Manufactured: July 5, 2002
Calibrated: November 15, 2002

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 2450 MHz:

Relative permittivity	38.0	$\pm 5\%$
Conductivity	1.87 mho/m	$\pm 10\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.0 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.

The dipole input power (forward power) was 250mW $\pm 3\%$. 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 cm³ (1 g) of tissue: **54.4 mW/g**

averaged over 10 cm³ (10 g) of tissue: **24.2 mW/g**

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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: **1.158 ns** (one direction)
Transmission factor: **0.997** (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 2450 MHz: $\text{Re}\{Z\} = \mathbf{51.3\ \Omega}$

$\text{Im}\{Z\} = \mathbf{2.4\ \Omega}$

Return Loss at 2450 MHz **- 31.4 dB**

4. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with body simulating solution of the following electrical parameters at 2450 MHz:

Relative permittivity **51.2** $\pm 5\%$
Conductivity **1.96 mho/m** $\pm 10\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 4.5 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.

The dipole input power (forward power) was $250\text{mW} \pm 3\%$. The results are normalized to 1W input power.

Date/Time: 11/13/02 21:52:22

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: SN713_SN1507_HSL2450_131102.da4

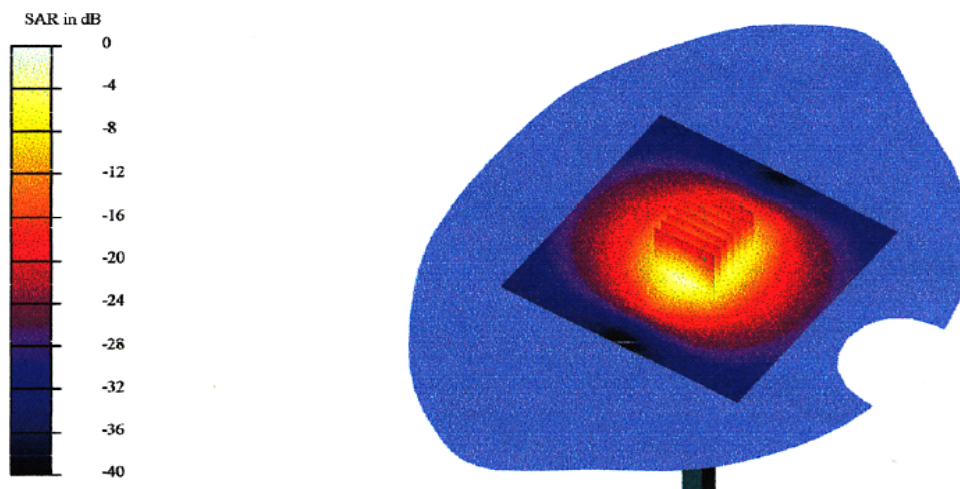
DUT: Dipole 2450 MHz Type & Serial Number: D2450V2 - SN713
Program: Dipole Calibration; Pin = 250 mW; d = 10 mm

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: HSL 2450 MHz ($\sigma = 1.87$ mho/m, $\epsilon = 38.03$, $\rho = 1000$ kg/m³)
Phantom section: FlatSection

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5, 5, 5); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 35

Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm
Reference Value = 94.4 V/m
Peak SAR = 29.6 mW/g
SAR(1 g) = 13.6 mW/g; SAR(10 g) = 6.04 mW/g
Power Drift = 0.01 dB



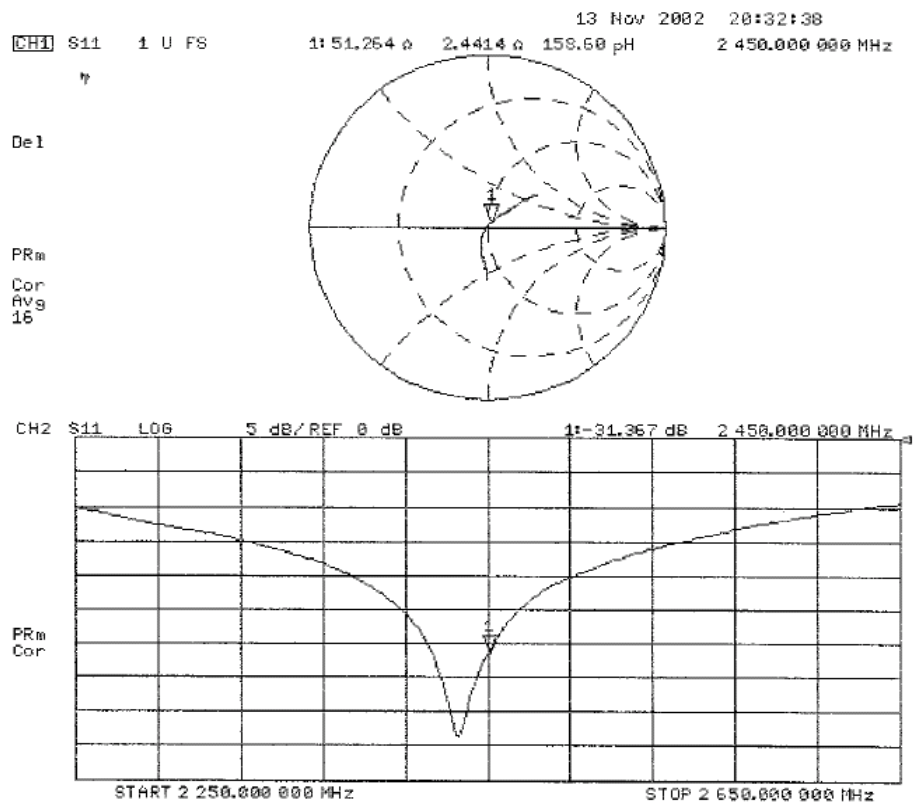
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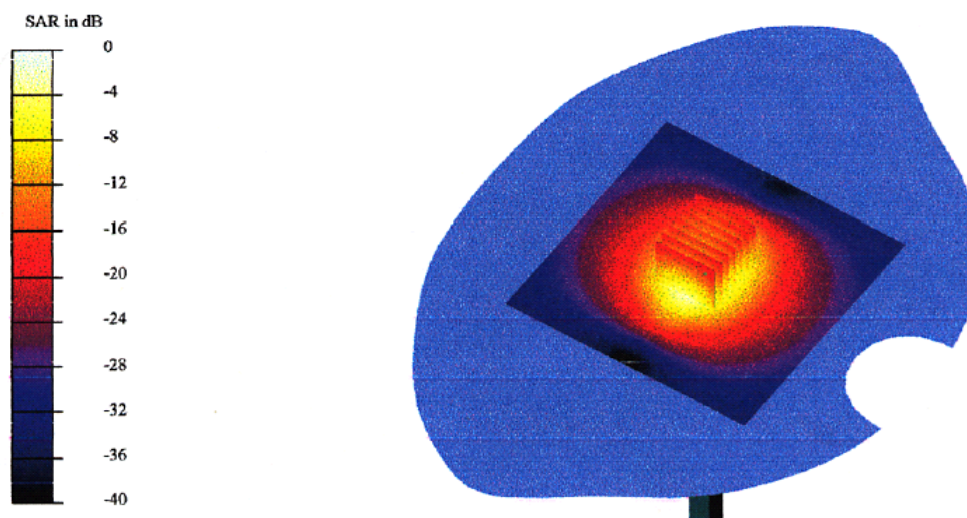
DUT: Dipole 2450 MHz Type & Serial Number: D2450V2 - SN713
Program: Dipole Calibration; Pin = 250 mW; d = 10 mm

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: Muscle 2450 MHz ($\sigma = 1.96$ mho/m, $\epsilon = 51.15$, $\rho = 1000$ kg/m³)
Phantom section: FlatSection

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(4.5, 4.5, 4.5); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 35

Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm
Reference Value = 95.2 V/m
Peak SAR = 25 mW/g
SAR(1 g) = 12.9 mW/g; SAR(10 g) = 5.99 mW/g
Power Drift = 0.02 dB



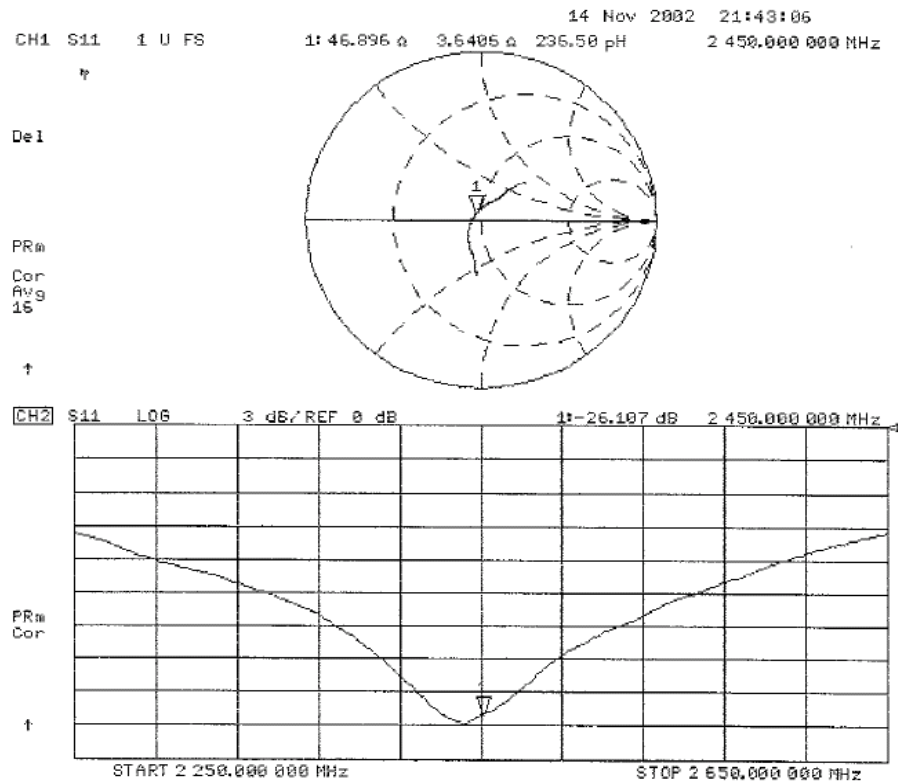
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APPENDIX 5 : Dosimetric E-Field Probe Calibration (ET3DV6,S/N: 1685)

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IMPORTANT NOTICE

USAGE OF PROBES IN ORGANIC SOLVENTS

Diethylene Glycol Monobuthy Ether (the basis for liquids above 1 GHz), as many other organic solvents, is a very effective softener for synthetic materials. These solvents can cause irreparable damage to certain SPEAG products, except those which are explicitly declared as compliant with organic solvents.

Compatible Probes:

- ET3DV6
- ET3DV6R
- ES3DV2
- ER3DV6
- H3DV6

Important Note for ET3DV6 Probes:

The ET3DV6 probes shall not be exposed to solvents longer than necessary for the measurements and shall be cleaned daily after use with warm water and stored dry.

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Technical Note 01.06.15-1

June 2002

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

Client **UL Apex (MTT)**

CALIBRATION CERTIFICATE			
Object(s)	ET3DV6 - SN:1685		
Calibration procedure(s)	QA CAL-01.v2 Calibration procedure for dosimetric E-field probes		
Calibration date:	October 10, 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
Power meter EPM E4419B	GB41293874	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor E4412A	MY41495277	2-Apr-03 (METAS, No 252-0250)	Apr-04
Reference 20 dB Attenuator	SN: 5086 (20b)	3-Apr-03 (METAS No. 251-0340)	Apr-04
Fluke Process Calibrator Type 702	SN: 6295803	8-Sep-03 (Sintrel SCS No. E-030020)	Sep-04
Power sensor HP 8481A	MY41092180	18-Sep-02 (Agilent, No. 20020918)	In house check: Oct 03
RF generator HP 8684C	US3642U01700	4-Aug-99 (SPEAG, in house check Aug-02)	In house check: Aug-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (Agilent, No. 24BR1033101)	In house check: Oct 03
Calibrated by:	Name Nico Vetterli	Function Technician	Signature 
Approved by:	Name Katja Pokovic	Function Laboratory Director	Signature 
Date issued: October 23, 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.			

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Probe ET3DV6

SN:1685

Manufactured:	April 3, 2002
Last calibration:	May 10, 2002
Recalibrated:	October 10, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

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ET3DV6 SN:1685

October 10, 2003

DASY - Parameters of Probe: ET3DV6 SN:1685

Sensitivity in Free Space

NormX	1.60 $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	1.65 $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	1.56 $\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression

DCP X	95	mV
DCP Y	95	mV
DCP Z	95	mV

Sensitivity in Tissue Simulating Liquid

Head **900 MHz** $\epsilon_r = 41.5 \pm 5\%$ $\sigma = 0.97 \pm 5\%$ mho/m
Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	6.6 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	6.6 $\pm 9.5\%$ (k=2)	Alpha 0.26
ConvF Z	6.6 $\pm 9.5\%$ (k=2)	Depth 3.07

Head **1800 MHz** $\epsilon_r = 40.0 \pm 5\%$ $\sigma = 1.40 \pm 5\%$ mho/m
Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	5.2 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	5.2 $\pm 9.5\%$ (k=2)	Alpha 0.41
ConvF Z	5.2 $\pm 9.5\%$ (k=2)	Depth 2.77

Boundary Effect

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

Probe Tip to Boundary	1 mm	2 mm
SAR _{pe} [%] Without Correction Algorithm	8.9	5.4
SAR _{pe} [%] With Correction Algorithm	0.4	0.5

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

Probe Tip to Boundary	1 mm	2 mm
SAR _{pe} [%] Without Correction Algorithm	11.8	8.4
SAR _{pe} [%] With Correction Algorithm	0.4	0.2

Sensor Offset

Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.6 $\pm$ 0.2	mm

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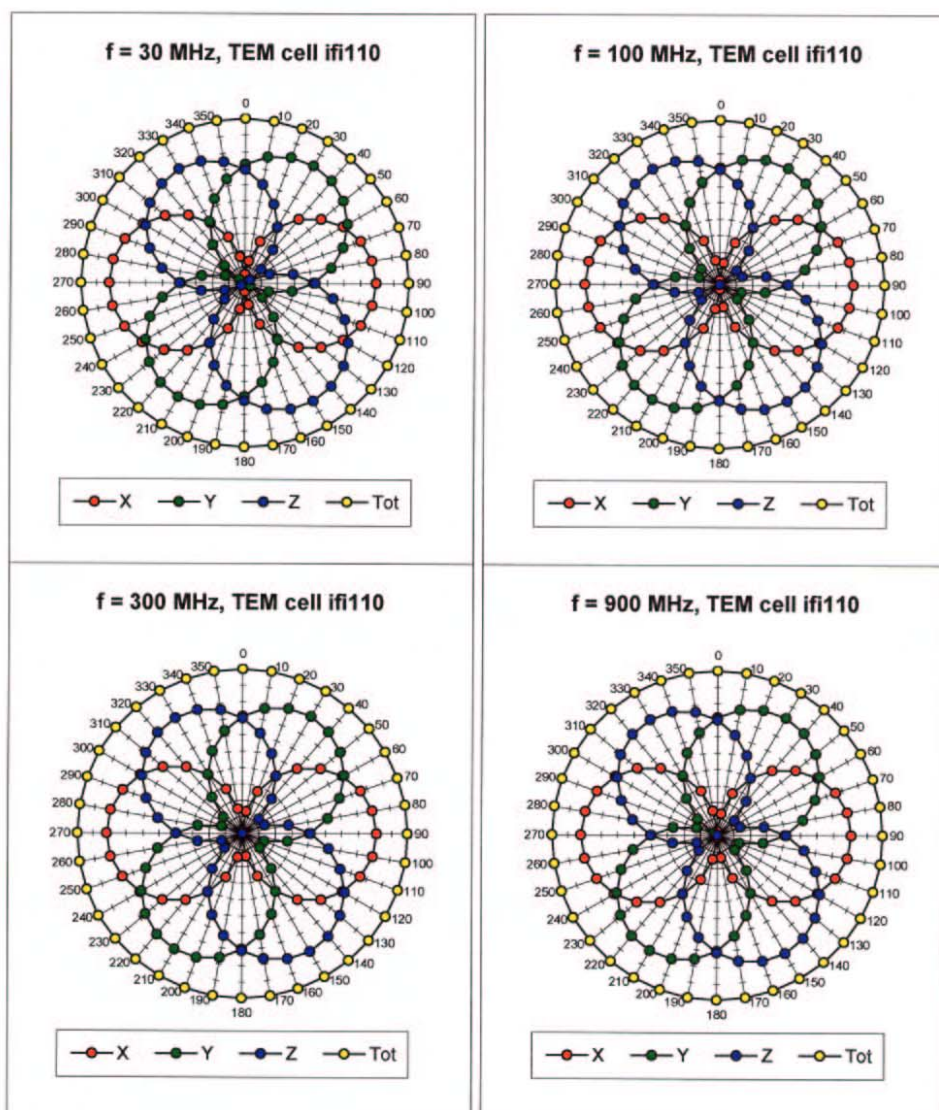
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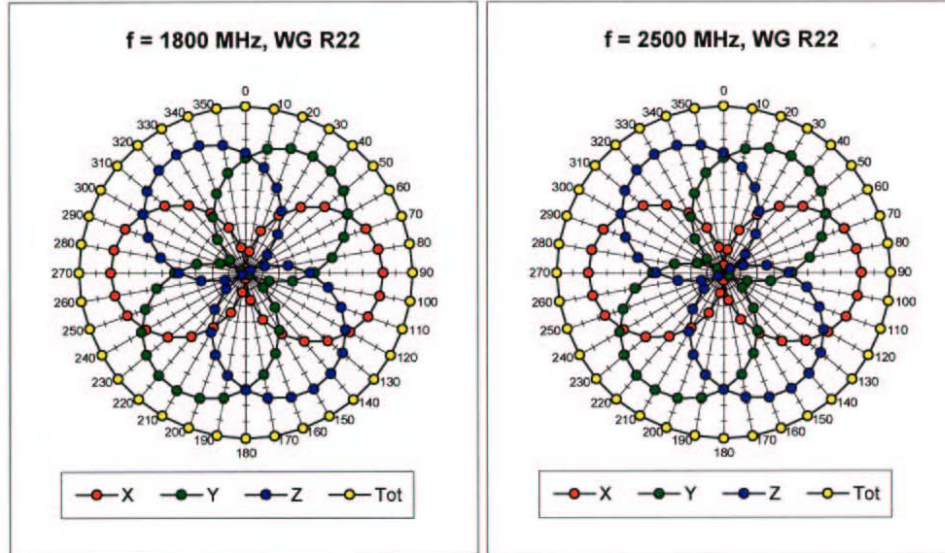
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Receiving Pattern ($\phi, \theta = 0^\circ$)

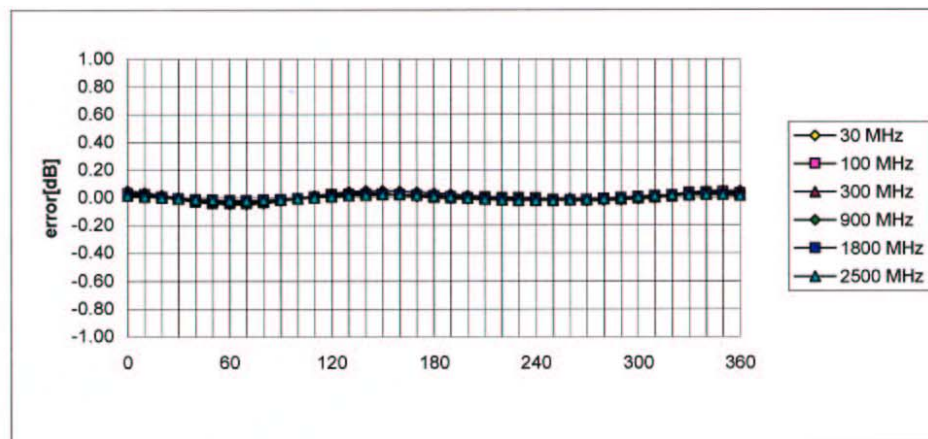


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Isotropy Error (ϕ), $\theta = 0^\circ$



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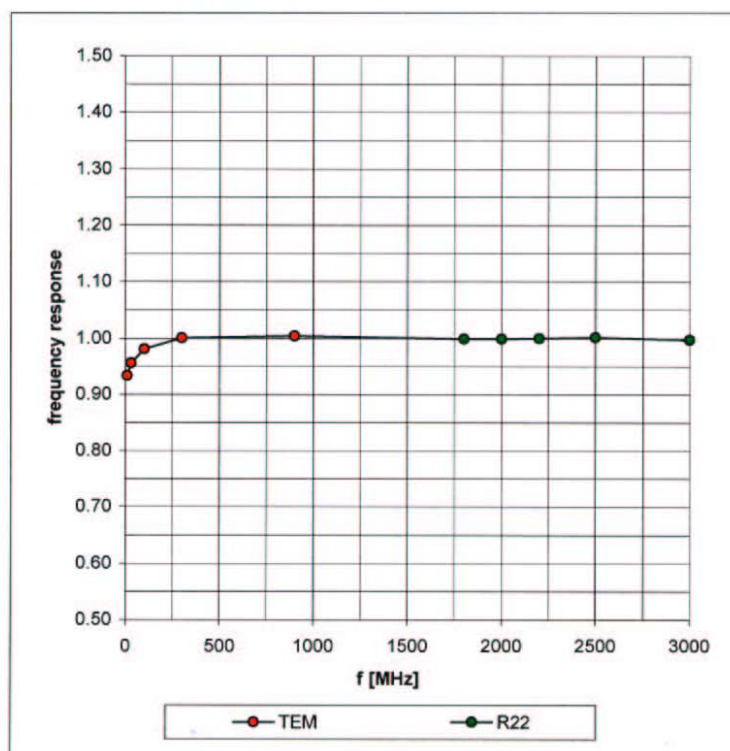
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Frequency Response of E-Field

(TEM-Cell:ifi110, Waveguide R22)



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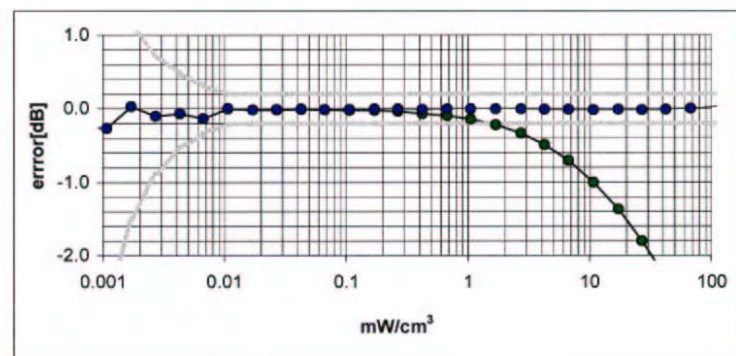
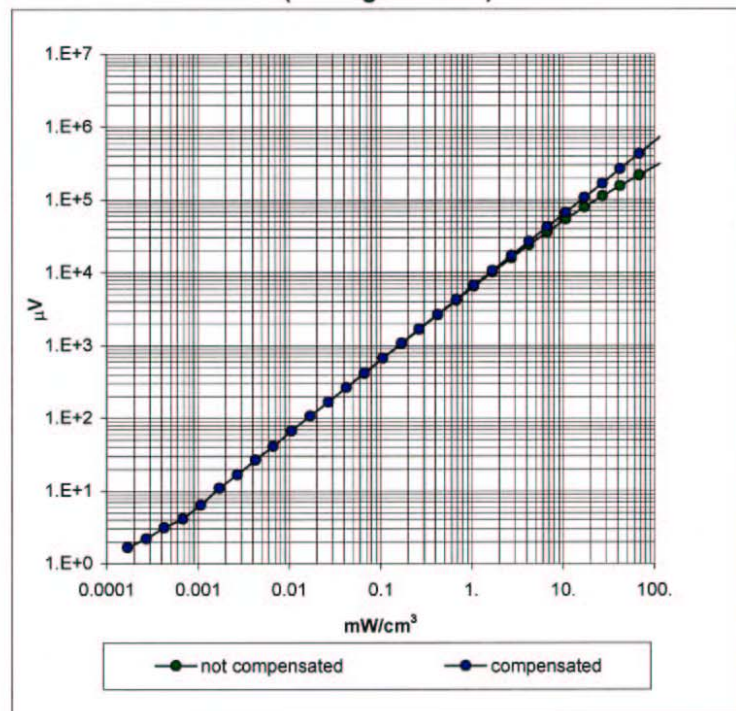
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Dynamic Range f(SAR_{brain})
(Waveguide R22)



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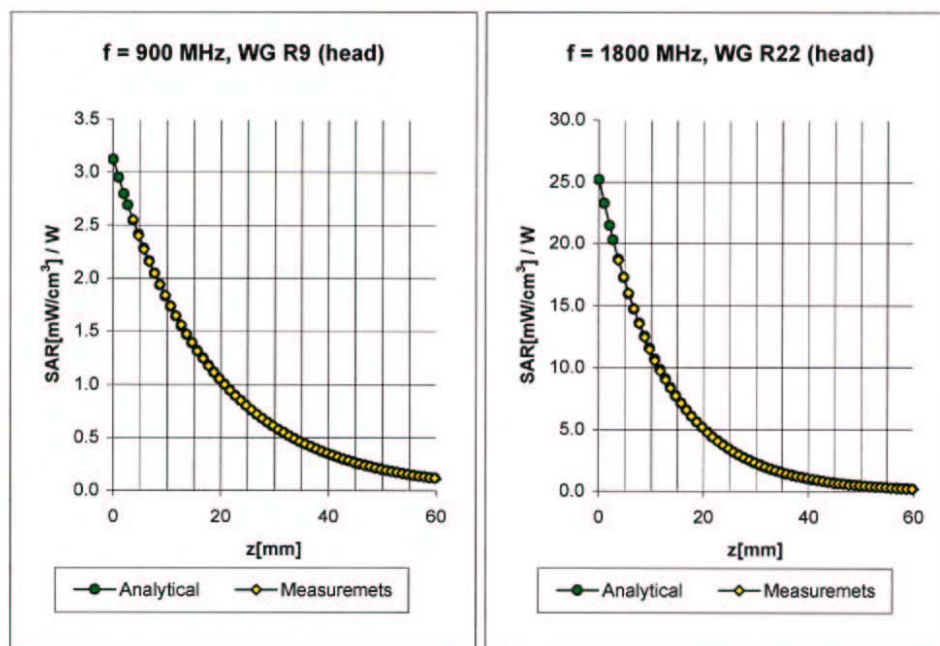
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Conversion Factor Assessment



Head 900 MHz $\epsilon_r = 41.5 \pm 5\%$ $\sigma = 0.97 \pm 5\%$ mho/m

Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	6.6 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	6.6 $\pm 9.5\%$ (k=2)	Alpha 0.26
ConvF Z	6.6 $\pm 9.5\%$ (k=2)	Depth 3.07

Head 1800 MHz $\epsilon_r = 40.0 \pm 5\%$ $\sigma = 1.40 \pm 5\%$ mho/m

Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	5.2 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	5.2 $\pm 9.5\%$ (k=2)	Alpha 0.41
ConvF Z	5.2 $\pm 9.5\%$ (k=2)	Depth 2.77

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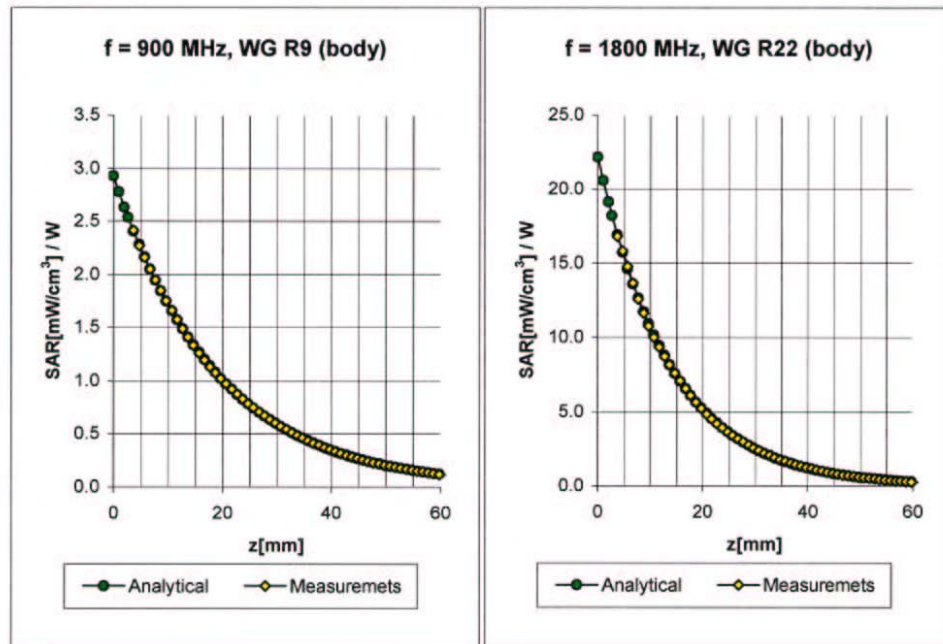
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Conversion Factor Assessment



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

Valid for f=800-1000 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	6.4 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	6.4 $\pm 9.5\%$ (k=2)	Alpha 0.27
ConvF Z	6.4 $\pm 9.5\%$ (k=2)	Depth 3.22

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

Valid for f=1710-1910 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	4.7 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	4.7 $\pm 9.5\%$ (k=2)	Alpha 0.48
ConvF Z	4.7 $\pm 9.5\%$ (k=2)	Depth 2.94

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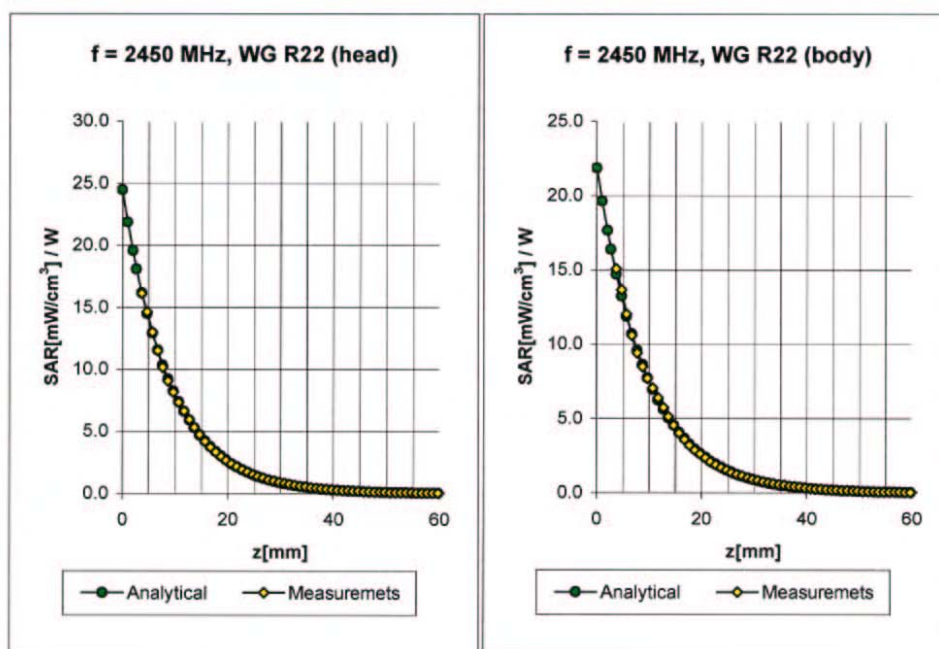
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Conversion Factor Assessment



Head	2450 MHz	$\epsilon_r = 39.2 \pm 5\%$	$\sigma = 1.80 \pm 5\% \text{ mho/m}$
Valid for f=2400-2500 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X			
ConvF X	4.7 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	4.7 $\pm 9.5\%$ (k=2)	Alpha	0.78
ConvF Z	4.7 $\pm 9.5\%$ (k=2)	Depth	2.04
Body	2450 MHz	$\epsilon_r = 52.7 \pm 5\%$	$\sigma = 1.95 \pm 5\% \text{ mho/m}$
Valid for f=2400-2500 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C			
ConvF X	4.3 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	4.3 $\pm 9.5\%$ (k=2)	Alpha	0.80
ConvF Z	4.3 $\pm 9.5\%$ (k=2)	Depth	1.89

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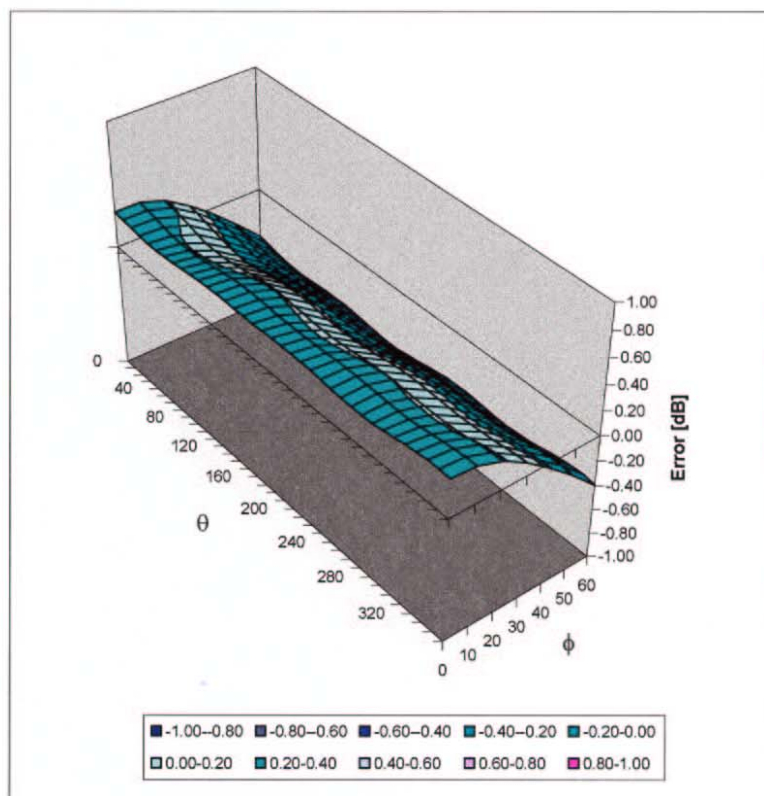
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Deviation from Isotropy in HSL

Error ($\theta\phi$), $f = 900$ MHz



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