

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

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## Schmid & Partner Engineering AG

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### 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. Vetterli*

Approved by:

*Poloni Kutz*

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**UL Apex Co., Ltd.**

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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	<b>38.0</b>	$\pm 5\%$
Conductivity	<b>1.87 mho/m</b>	$\pm 10\%$

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 cm <sup>3</sup> (1 g) of tissue:	<b>54.4 mW/g</b>
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	<b>24.2 mW/g</b>

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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 250mW  $\pm 3\%$ . The results are normalized to 1W input power.

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

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN713\_SN1507\_HSL2450\_131102.da4

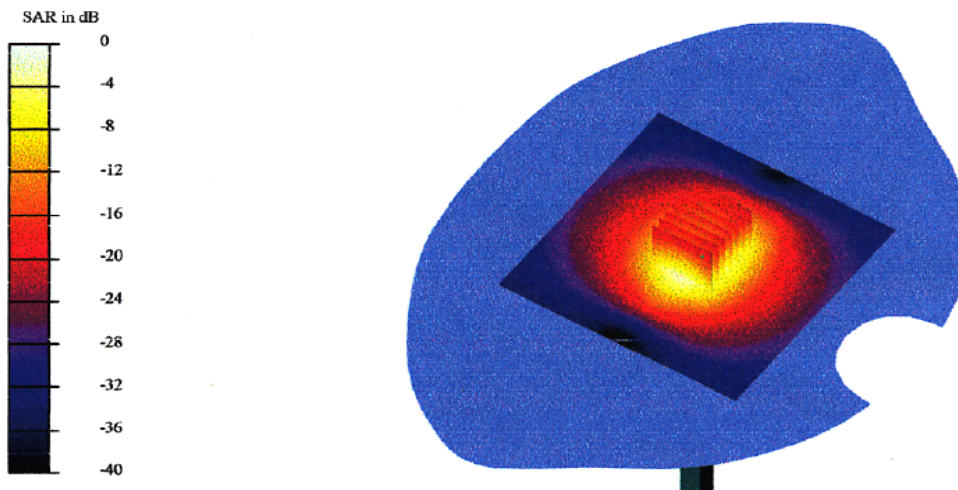
**DUT: Dipole 2450 MHz Type & Serial Number: D2450V2 - SN713**  
**Program: Dipole Calibration; Pin = 250 mW; d = 10 mm**

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/m<sup>3</sup>)  
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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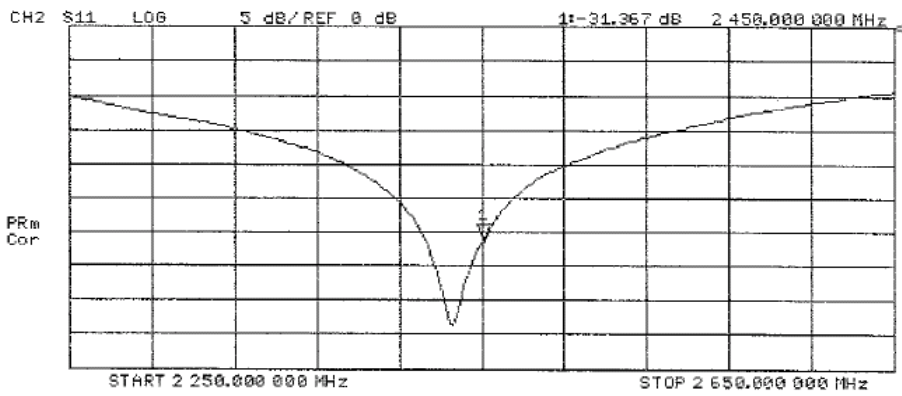
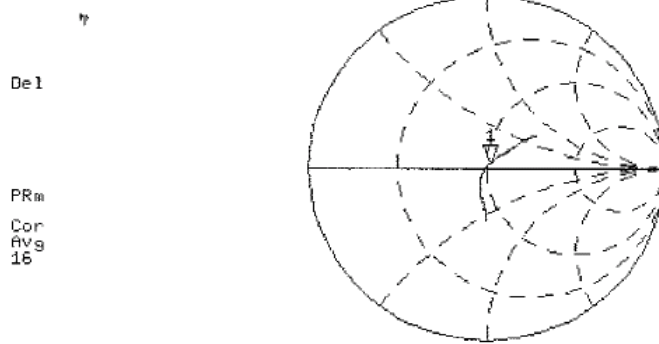
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13 Nov 2002 20:32:38  
CH1 S11 1 U FS 1: 51.254  $\alpha$  2.4414  $\alpha$  158.60 pH 2 450.000 000 MHz



Date/Time: 11/15/02 14:25:17

Test Laboratory: SPEAG, Zurich, Switzerland  
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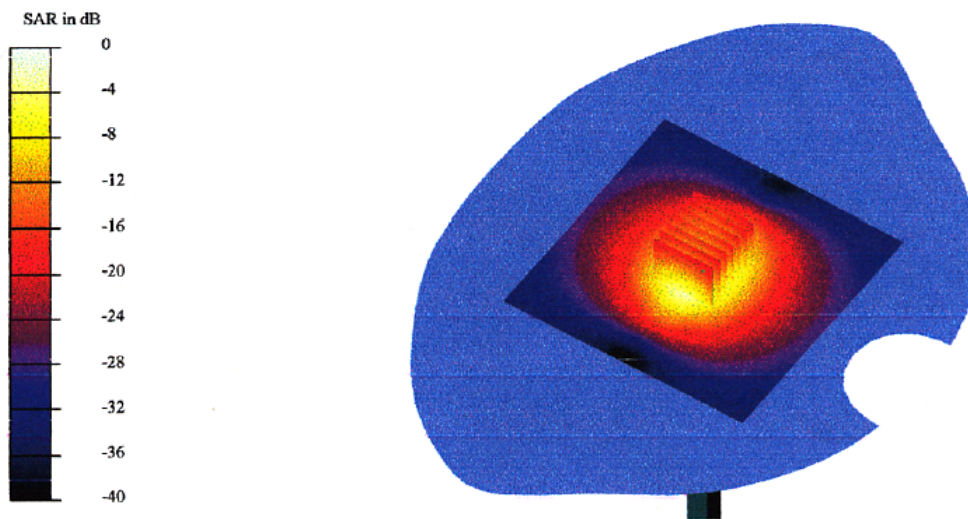
**DUT: Dipole 2450 MHz Type & Serial Number: D2450V2 - SN713**  
**Program: Dipole Calibration; Pin = 250 mW; d = 10 mm**

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/m<sup>3</sup>)  
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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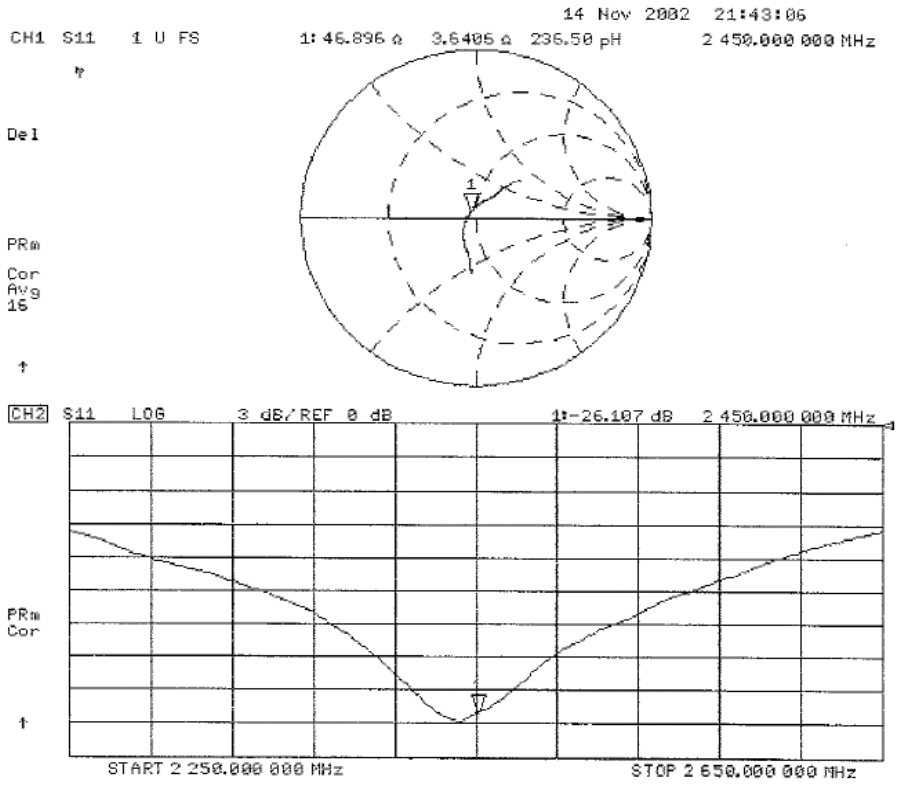
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**APPENDIX 5 : Dosimetric E-Field Probe Calibration (ET3DV6,S/N: 1685)**

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## IMPORTANT NOTICE

### USAGE OF PROBES IN ORGANIC SOLVENTS

Diethylene Glycol Monobutyl 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)																																		
<p>This calibration statement documents traceability of M&amp;TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity &lt; 75%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p> <table border="1"> <thead> <tr> <th>Model Type</th> <th>ID #</th> <th>Cal Date (Calibrated by, Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power meter EPM E4419B</td> <td>GB41293874</td> <td>2-Apr-03 (METAS, No 252-0250)</td> <td>Apr-04</td> </tr> <tr> <td>Power sensor E4412A</td> <td>MY41495277</td> <td>2-Apr-03 (METAS, No 252-0250)</td> <td>Apr-04</td> </tr> <tr> <td>Reference 20 dB Attenuator</td> <td>SN: 5086 (20b)</td> <td>3-Apr-03 (METAS No. 251-0340)</td> <td>Apr-04</td> </tr> <tr> <td>Fluke Process Calibrator Type 702</td> <td>SN: 6295803</td> <td>8-Sep-03 (Sintrel SCS No. E-030020)</td> <td>Sep-04</td> </tr> <tr> <td>Power sensor HP 8481A</td> <td>MY41092180</td> <td>18-Sep-02 (Agilent, No. 20020918)</td> <td>In house check: Oct 03</td> </tr> <tr> <td>RF generator HP 8684C</td> <td>US3642U01700</td> <td>4-Aug-99 (SPEAG, in house check Aug-02)</td> <td>In house check: Aug-05</td> </tr> <tr> <td>Network Analyzer HP 8753E</td> <td>US37390585</td> <td>18-Oct-01 (Agilent, No. 24BR1033101)</td> <td>In house check: Oct 03</td> </tr> </tbody> </table>				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
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Calibrated by:	Name Nico Vetterli	Function Technician	Signature 																																
Approved by:	Name Katja Pokovic	Function Laboratory Director	Signature 																																
Date issued: October 23, 2003																																			
<p>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 &amp; Partner Engineering AG is completed.</p>																																			

ET3DV6 SN:1685

October 10, 2003

## DASY - Parameters of Probe: ET3DV6 SN:1685

### Sensitivity in Free Space

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

### Diode Compression

DCP X	<b>95</b>	mV
DCP Y	<b>95</b>	mV
DCP Z	<b>95</b>	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	<b>6.6</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>6.6</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.26</b>
ConvF Z	<b>6.6</b> $\pm 9.5\%$ (k=2)	Depth <b>3.07</b>

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

### Boundary Effect

Head	<b>900 MHz</b>	Typical SAR gradient: 5 % per mm	
	Probe Tip to Boundary	<b>1 mm</b>	<b>2 mm</b>
	SAR <sub>pe</sub> [%] Without Correction Algorithm	8.9	5.4
	SAR <sub>pe</sub> [%] With Correction Algorithm	0.4	0.5

Head	<b>1800 MHz</b>	Typical SAR gradient: 10 % per mm	
	Probe Tip to Boundary	<b>1 mm</b>	<b>2 mm</b>
	SAR <sub>pe</sub> [%] Without Correction Algorithm	11.8	8.4
	SAR <sub>pe</sub> [%] With Correction Algorithm	0.4	0.2

### Sensor Offset

Probe Tip to Sensor Center	<b>2.7</b>	mm
Optical Surface Detection	<b>1.6 <math>\pm</math> 0.2</b>	mm

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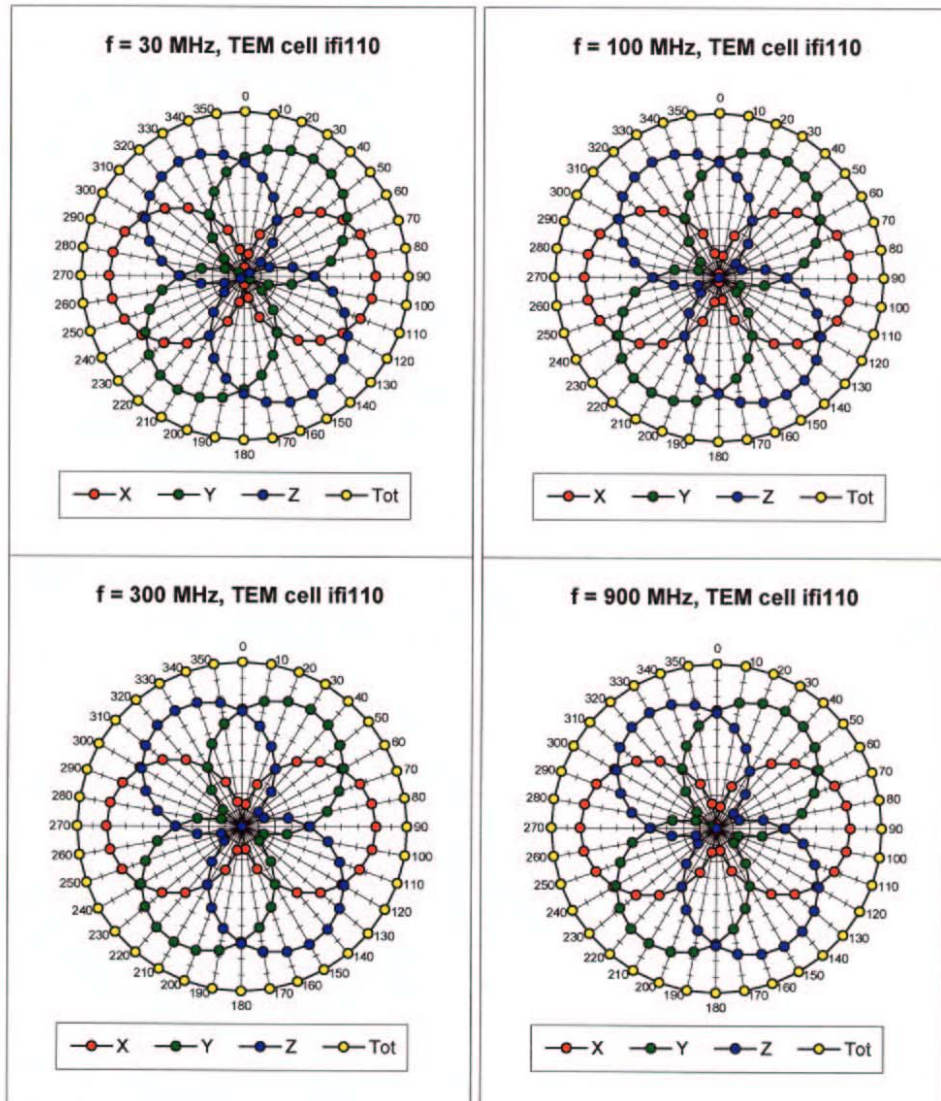
Telephone: +81 596 24 8116

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ET3DV6 SN:1685

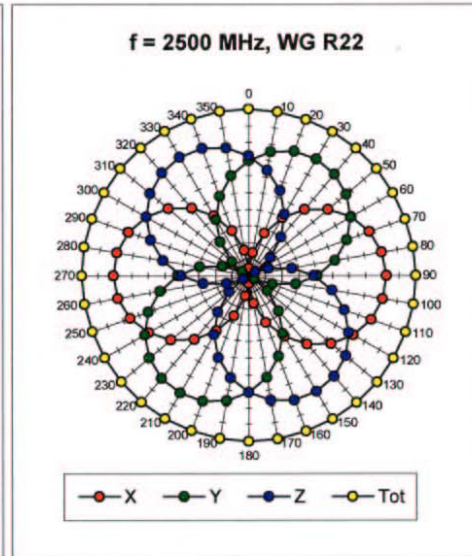
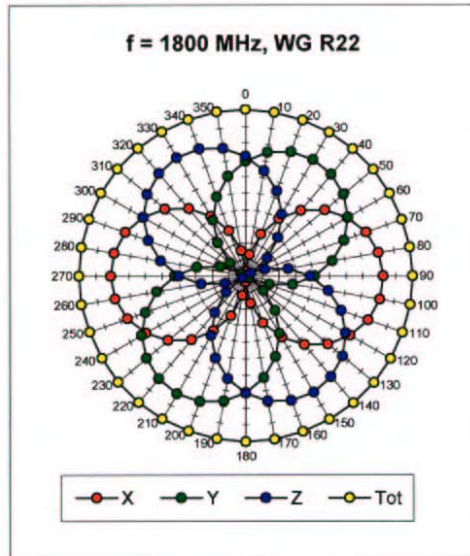
October 10, 2003

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

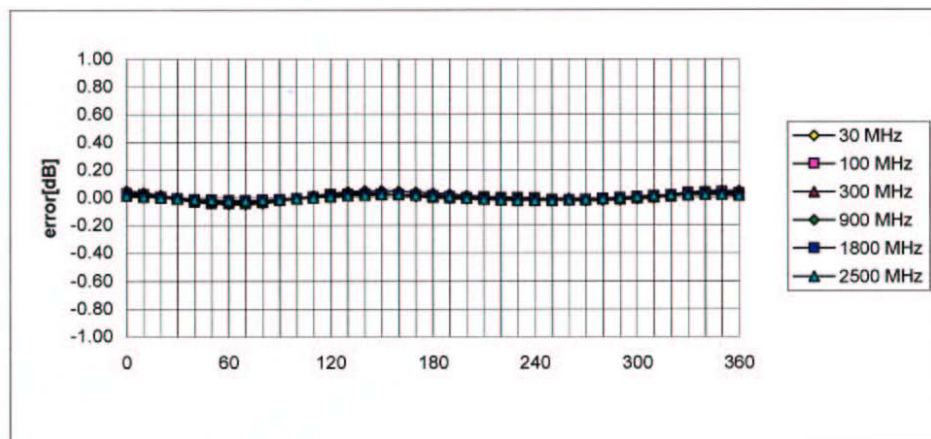


ET3DV6 SN:1685

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

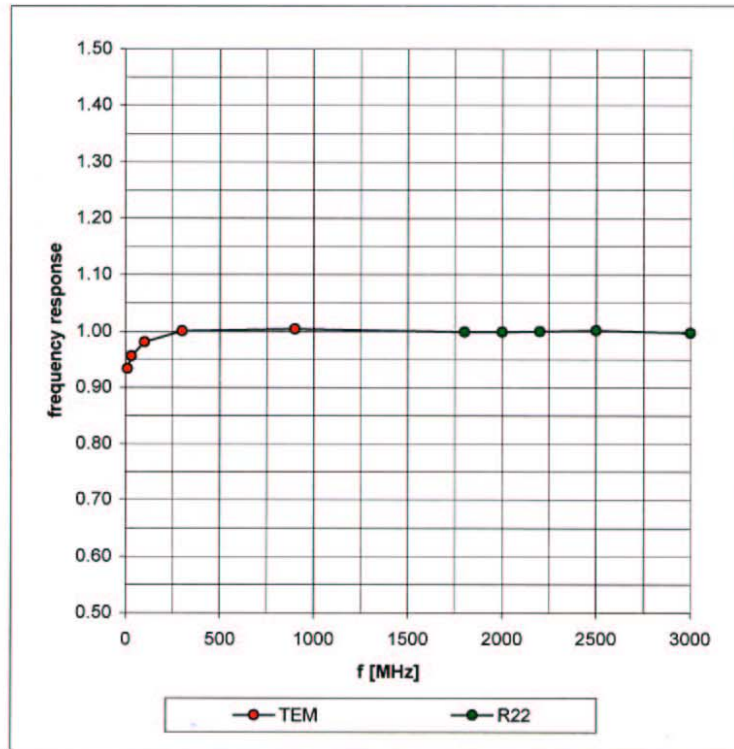


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## Frequency Response of E-Field

( TEM-Cell:ifi110, Waveguide R22)



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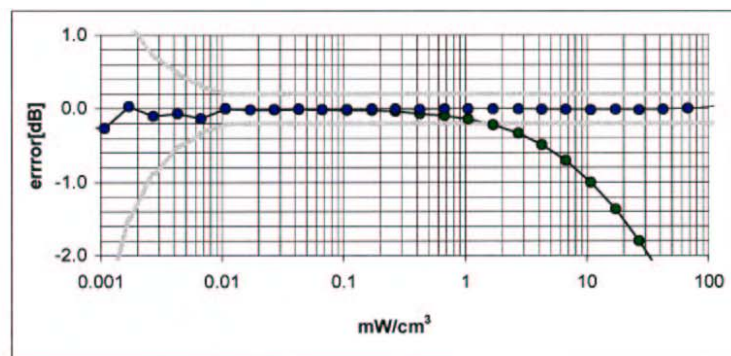
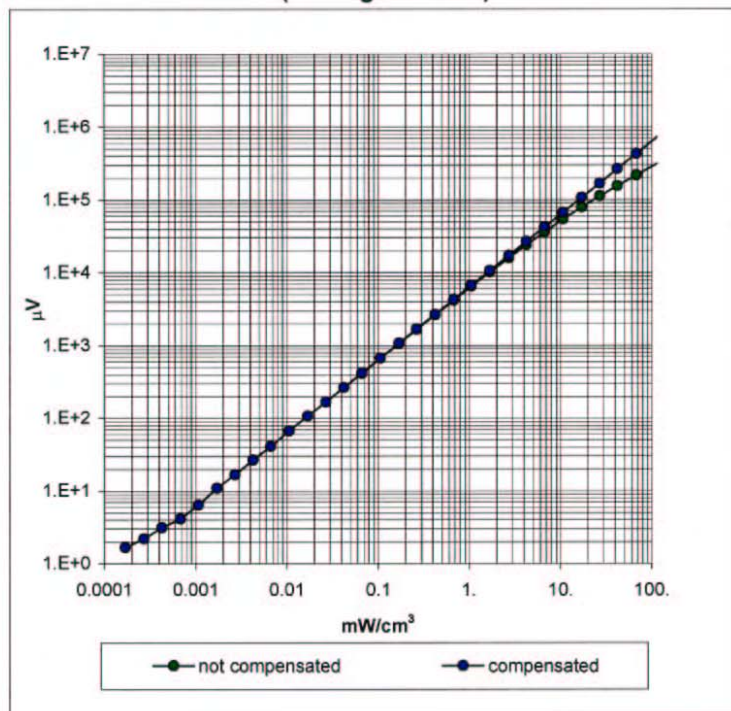
Facsimile: +81 596 24 8124



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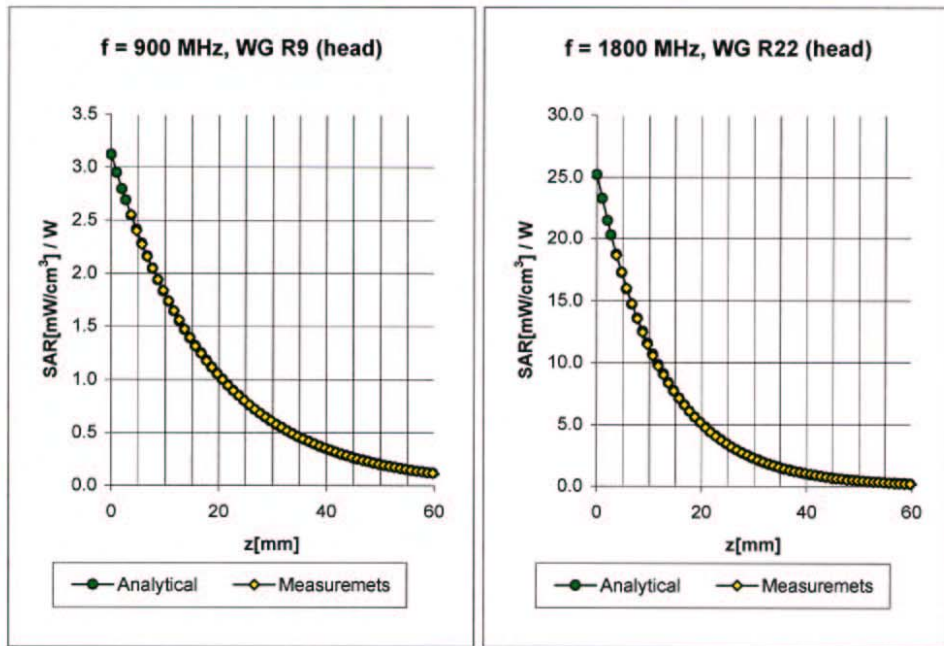
### Dynamic Range $f(\text{SAR}_{\text{brain}})$ ( Waveguide R22 )



ET3DV6 SN:1685

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### Conversion Factor Assessment



<b>Head</b>	<b>900 MHz</b>	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
Valid for f=800-1000 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X			
ConvF X	<b>6.6</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>6.6</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.26</b>
ConvF Z	<b>6.6</b> $\pm 9.5\%$ (k=2)	Depth	<b>3.07</b>

<b>Head</b>	<b>1800 MHz</b>	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
Valid for f=1710-1910 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X			
ConvF X	<b>5.2</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>5.2</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.41</b>
ConvF Z	<b>5.2</b> $\pm 9.5\%$ (k=2)	Depth	<b>2.77</b>

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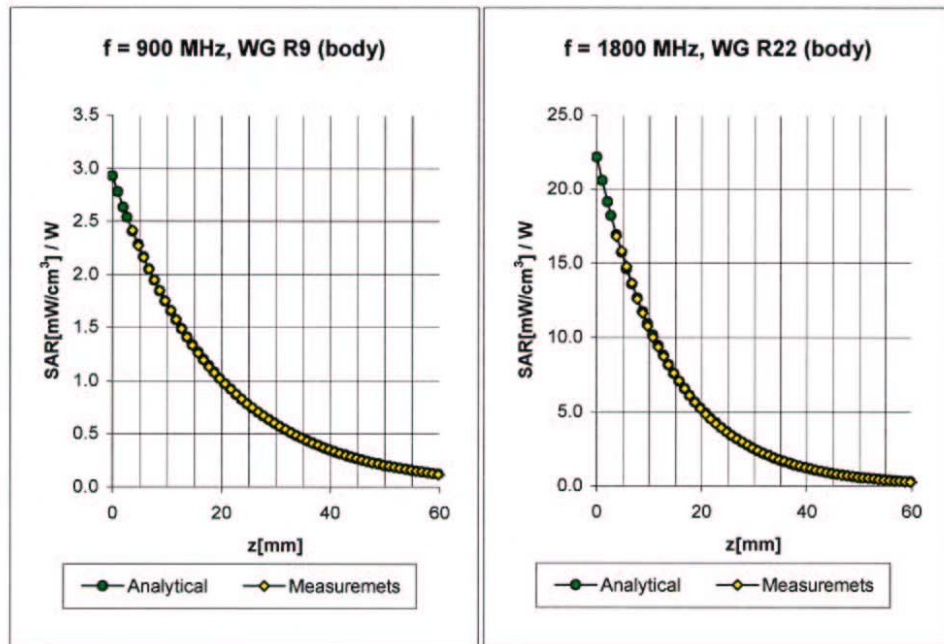
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ET3DV6 SN:1685

October 10, 2003

### Conversion Factor Assessment



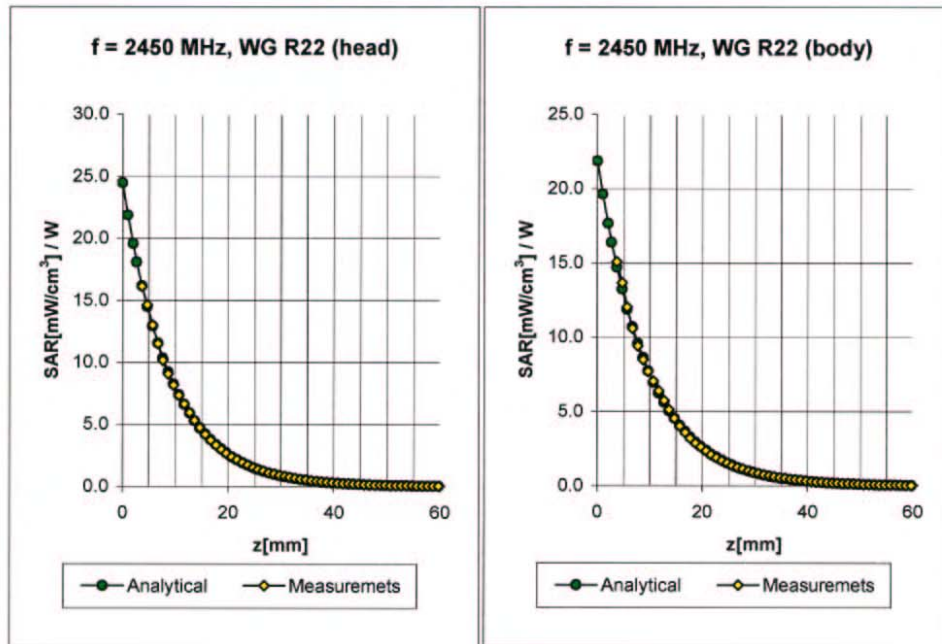
<b>Body</b>	<b>900 MHz</b>	$\epsilon_r = 55.0 \pm 5\%$	$\sigma = 1.05 \pm 5\% \text{ mho/m}$
Valid for f=800-1000 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C			
ConvF X	<b>6.4</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>6.4</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.27</b>
ConvF Z	<b>6.4</b> $\pm 9.5\%$ (k=2)	Depth	<b>3.22</b>

<b>Body</b>	<b>1800 MHz</b>	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$
Valid for f=1710-1910 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C			
ConvF X	<b>4.7</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>4.7</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.48</b>
ConvF Z	<b>4.7</b> $\pm 9.5\%$ (k=2)	Depth	<b>2.94</b>

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### Conversion Factor Assessment



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

Valid for f=2400-2500 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	<b>4.7</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>4.7</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.78</b>
ConvF Z	<b>4.7</b> $\pm 9.5\%$ (k=2)	Depth <b>2.04</b>

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

Valid for f=2400-2500 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

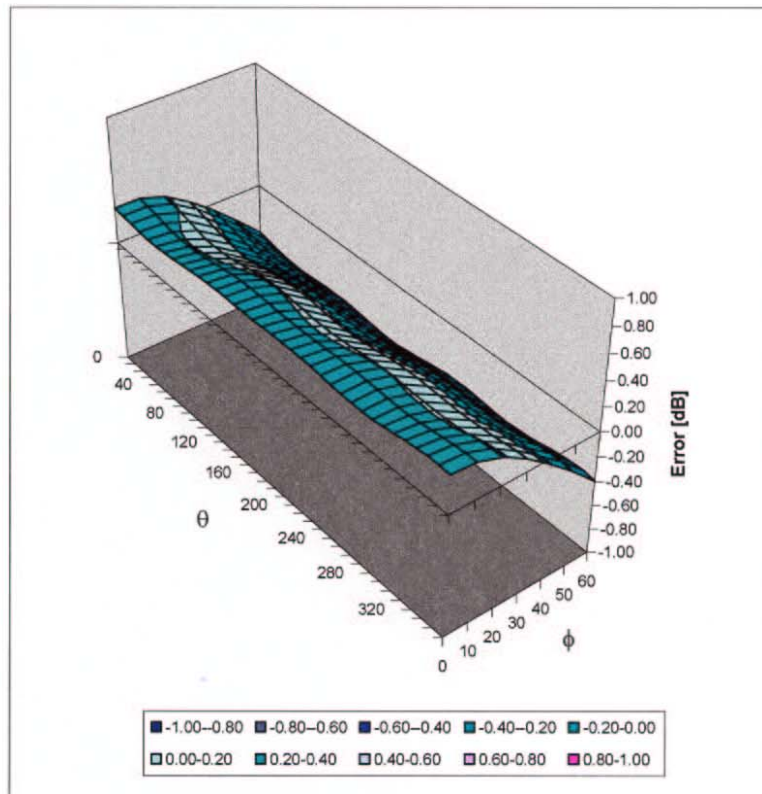
ConvF X	<b>4.3</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>4.3</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.80</b>
ConvF Z	<b>4.3</b> $\pm 9.5\%$ (k=2)	Depth <b>1.89</b>

ET3DV6 SN:1685

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### Deviation from Isotropy in HSL

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



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