

## Calibration Certificate

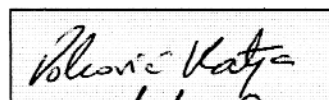
### Dosimetric E-Field Probe

Type:	<b>ET3DV6</b>
Serial Number:	<b>1578</b>
Place of Calibration:	<b>Zurich</b>
Date of Calibration:	<b>February 22, 2002</b>
Calibration Interval:	<b>12 months</b>

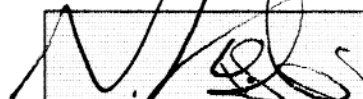
Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

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:



Approved by:



# Probe ET3DV6

## SN:1578

Manufactured:	April 6, 2001
Last calibration:	April 20, 2001
Recalibrated:	February 22, 2002

Calibrated for System DASY3

## DASY3 - Parameters of Probe: ET3DV6 SN:1578

### Sensitivity in Free Space

NormX	<b>1.72</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	<b>1.83</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	<b>1.68</b> $\mu\text{V}/(\text{V}/\text{m})^2$

### Diode Compression

DCP X	<b>99</b>	mV
DCP Y	<b>99</b>	mV
DCP Z	<b>99</b>	mV

### Sensitivity in Tissue Simulating Liquid

Head	<b>900 MHz</b>	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
Head	<b>835 MHz</b>	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\%$ mho/m
ConvF X	<b>7.0</b> $\pm 9.5\%$ (k=2)		Boundary effect:
ConvF Y	<b>7.0</b> $\pm 9.5\%$ (k=2)		Alpha <b>0.33</b>
ConvF Z	<b>7.0</b> $\pm 9.5\%$ (k=2)		Depth <b>2.34</b>
Head	<b>1800 MHz</b>	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
Head	<b>1900 MHz</b>	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
ConvF X	<b>5.5</b> $\pm 9.5\%$ (k=2)		Boundary effect:
ConvF Y	<b>5.5</b> $\pm 9.5\%$ (k=2)		Alpha <b>0.47</b>
ConvF Z	<b>5.5</b> $\pm 9.5\%$ (k=2)		Depth <b>2.20</b>

### Boundary Effect

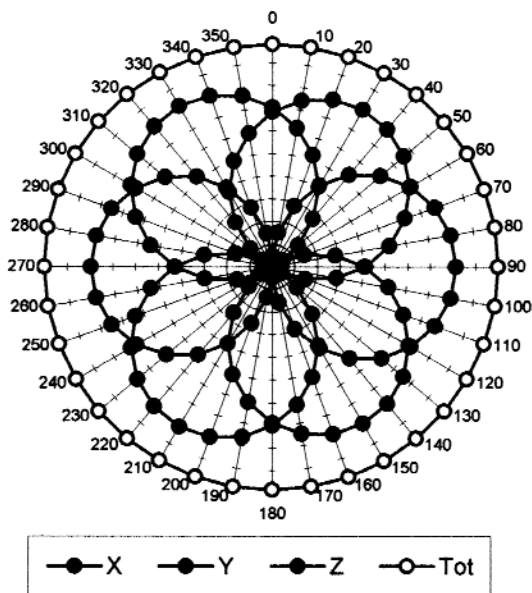
Head	<b>900 MHz</b>	<b>Typical SAR gradient: 5 % per mm</b>	
	Probe Tip to Boundary	<b>1 mm</b>	<b>2 mm</b>
	SAR <sub>be</sub> [%] Without Correction Algorithm	<b>7.6</b>	<b>4.3</b>
	SAR <sub>be</sub> [%] With Correction Algorithm	<b>0.2</b>	<b>0.4</b>
Head	<b>1800 MHz</b>	<b>Typical SAR gradient: 10 % per mm</b>	
	Probe Tip to Boundary	<b>1 mm</b>	<b>2 mm</b>
	SAR <sub>be</sub> [%] Without Correction Algorithm	<b>9.5</b>	<b>6.3</b>
	SAR <sub>be</sub> [%] With Correction Algorithm	<b>0.2</b>	<b>0.3</b>

### Sensor Offset

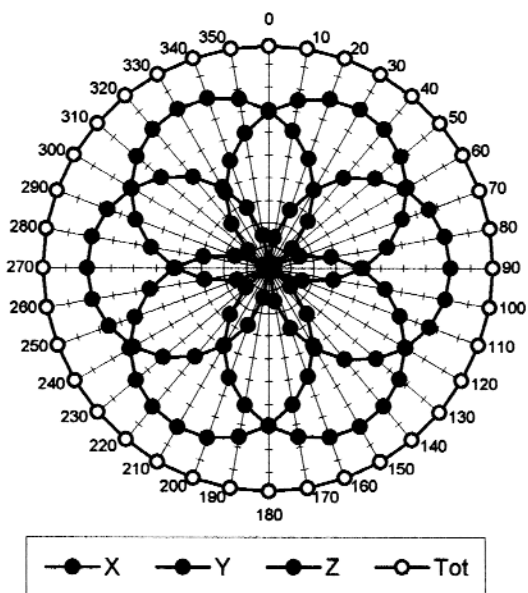
Probe Tip to Sensor Center	<b>2.7</b>	mm
Optical Surface Detection	<b>1.5 <math>\pm</math> 0.2</b>	mm

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

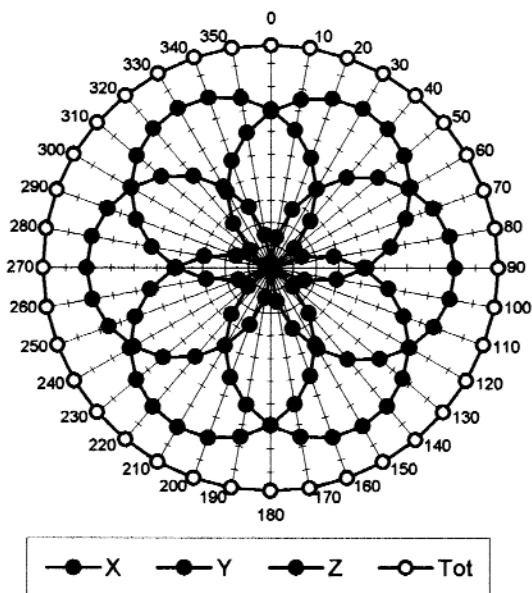
**f = 30 MHz, TEM cell ifi110**



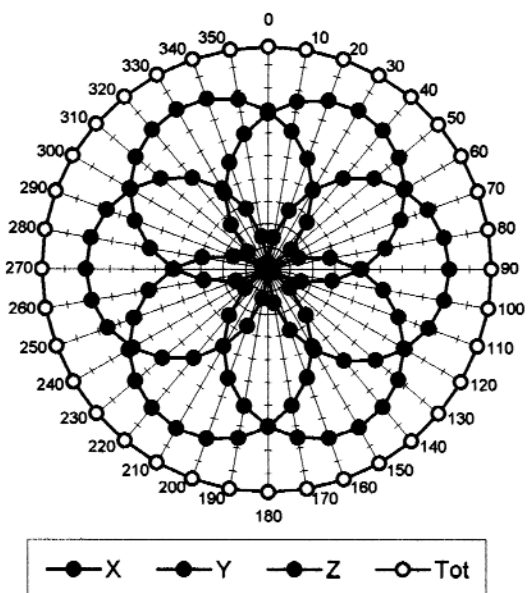
**f = 100 MHz, TEM cell ifi110**

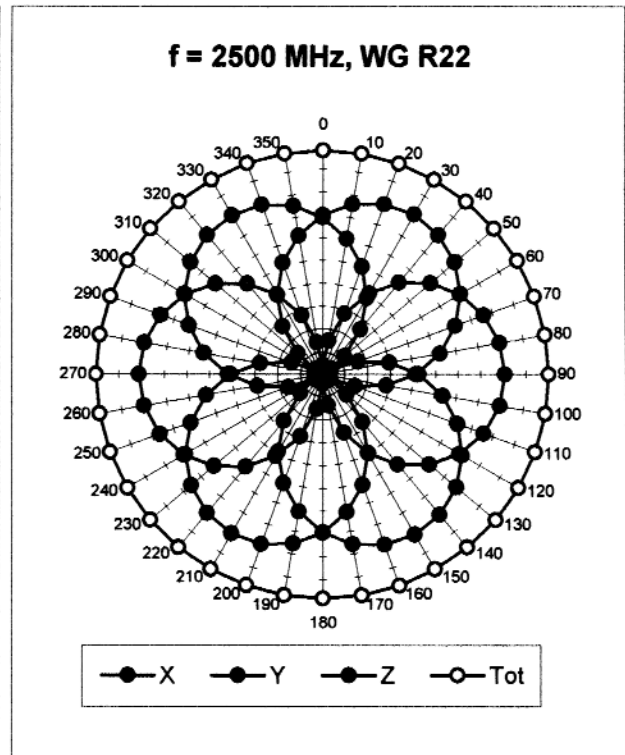
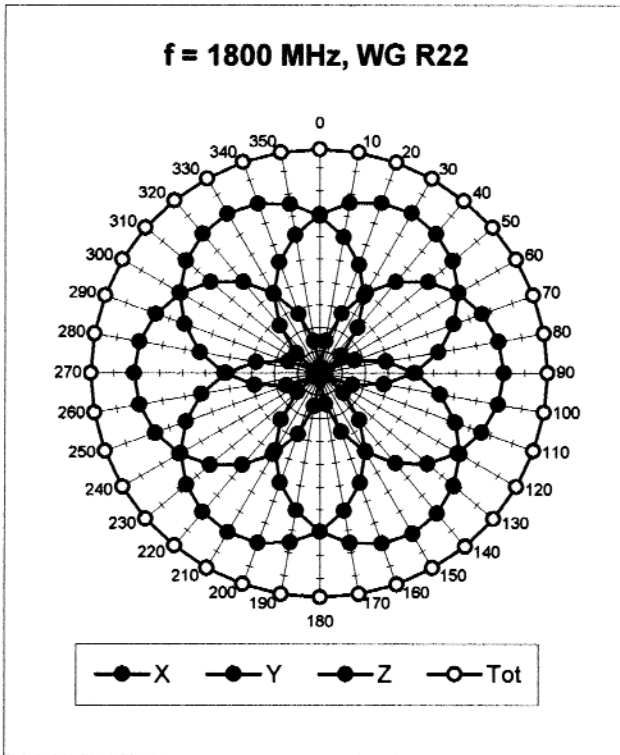


**f = 300 MHz, TEM cell ifi110**

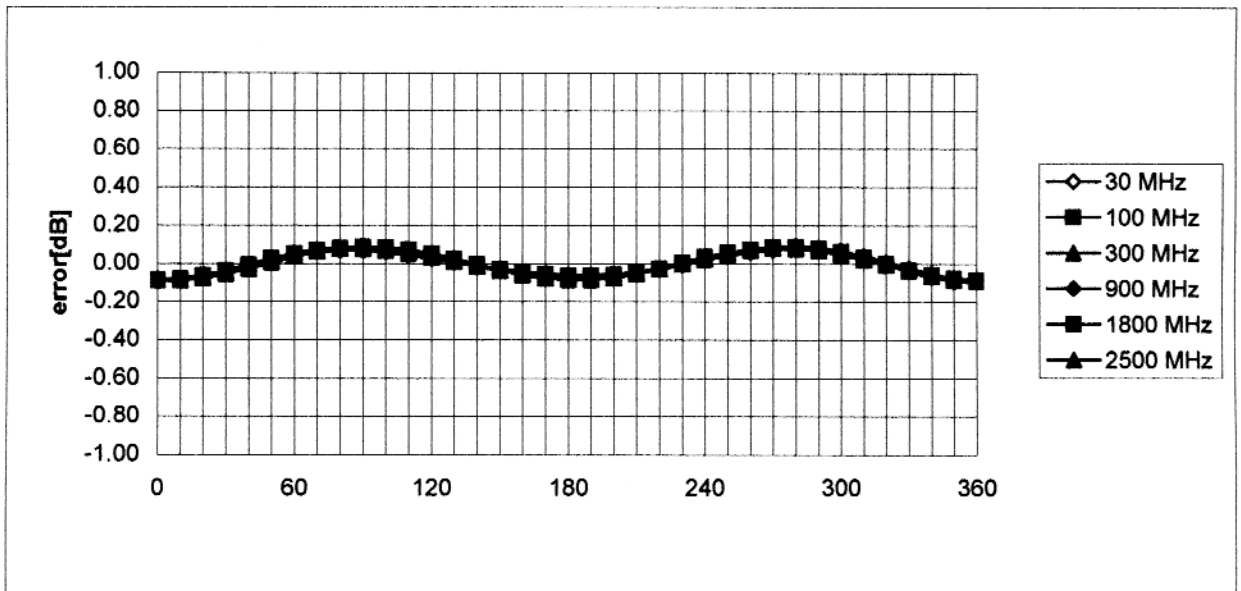


**f = 900 MHz, TEM cell ifi110**



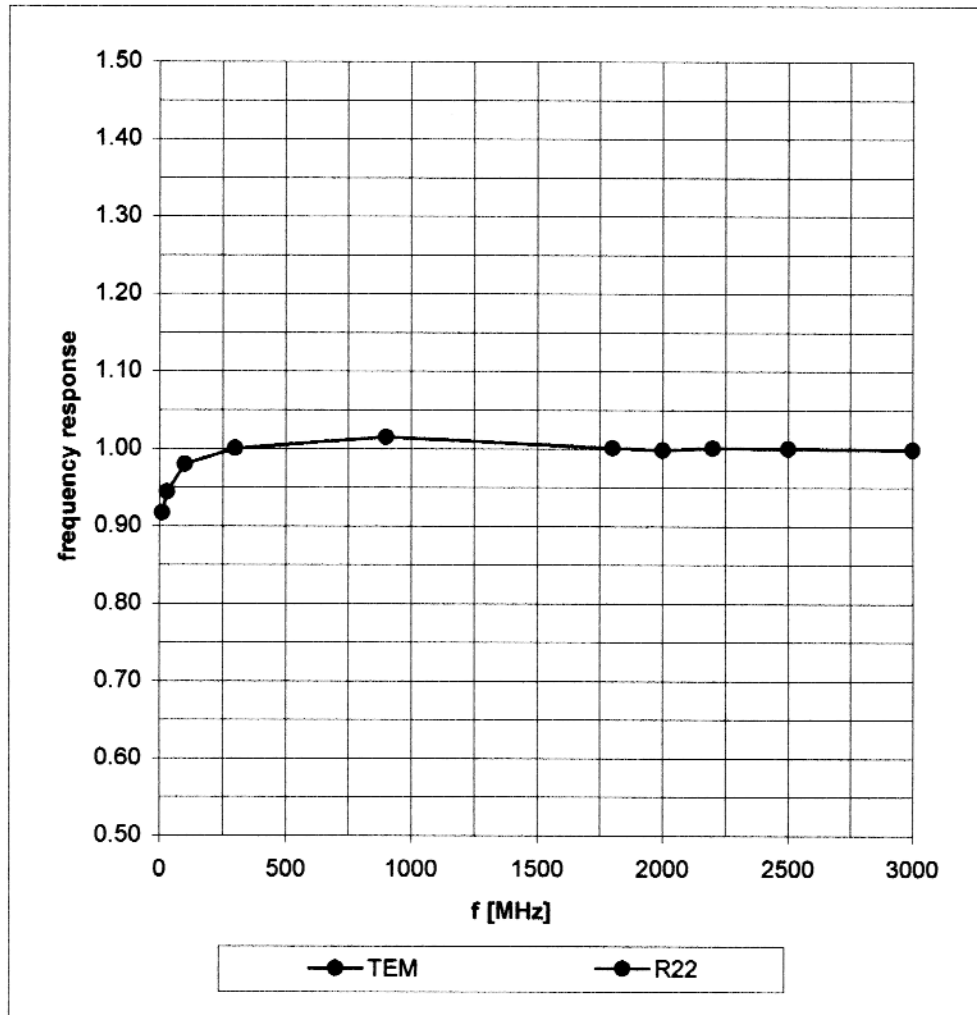


### Isotropy Error ( $\phi$ ), $\theta = 0^\circ$

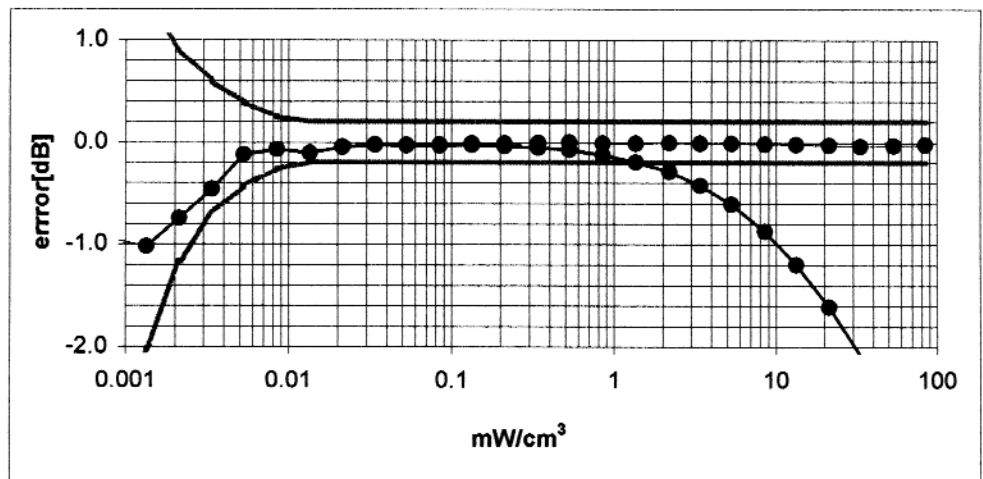
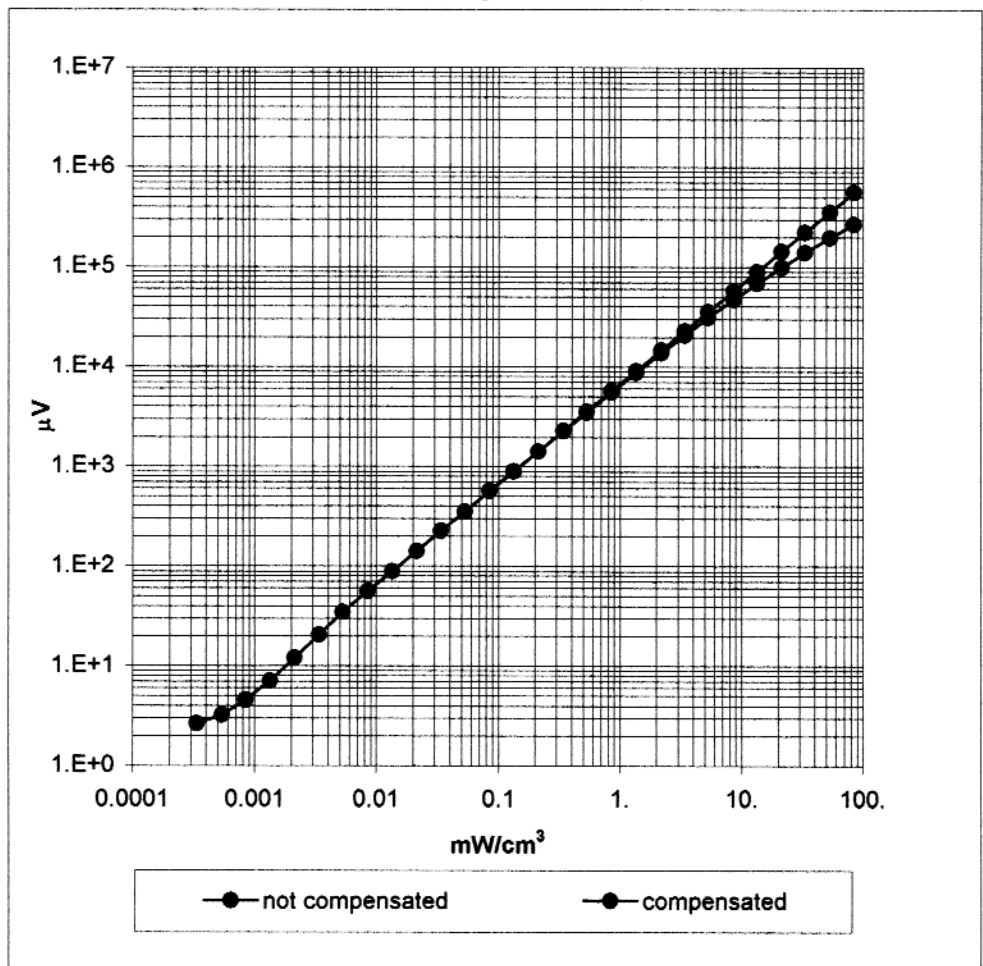


# Frequency Response of E-Field

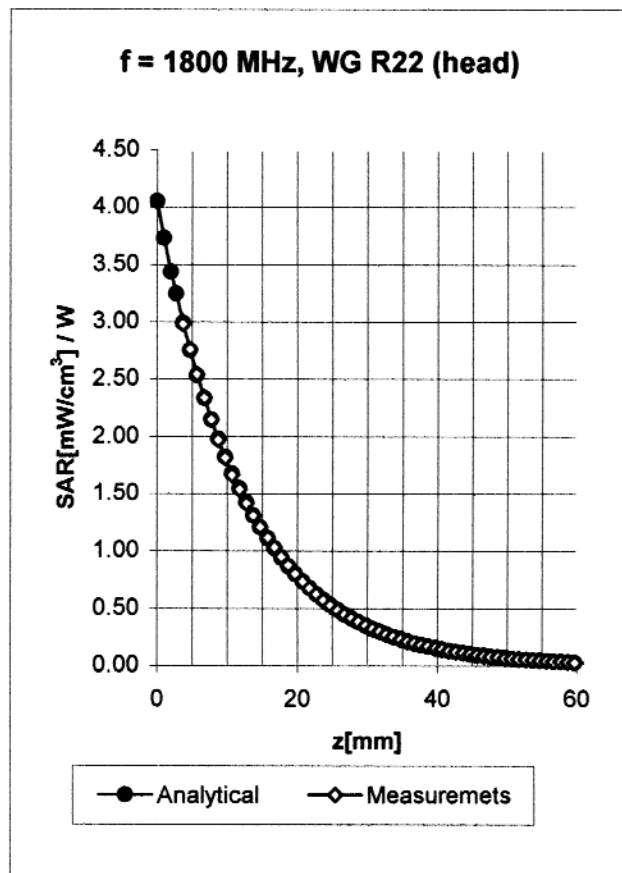
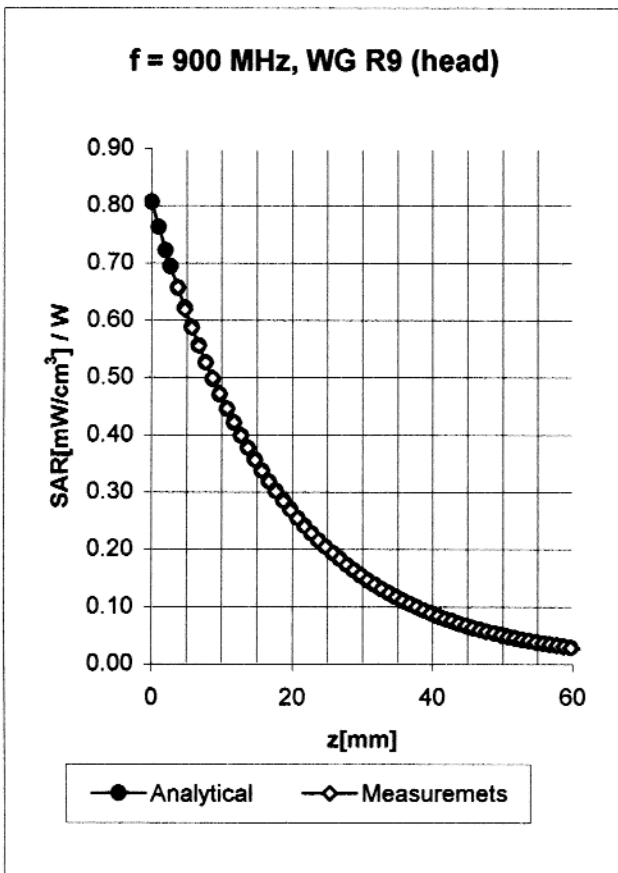
( TEM-Cell:ifi110, Waveguide R22)



## Dynamic Range f(SAR<sub>brain</sub>) ( Waveguide R22 )



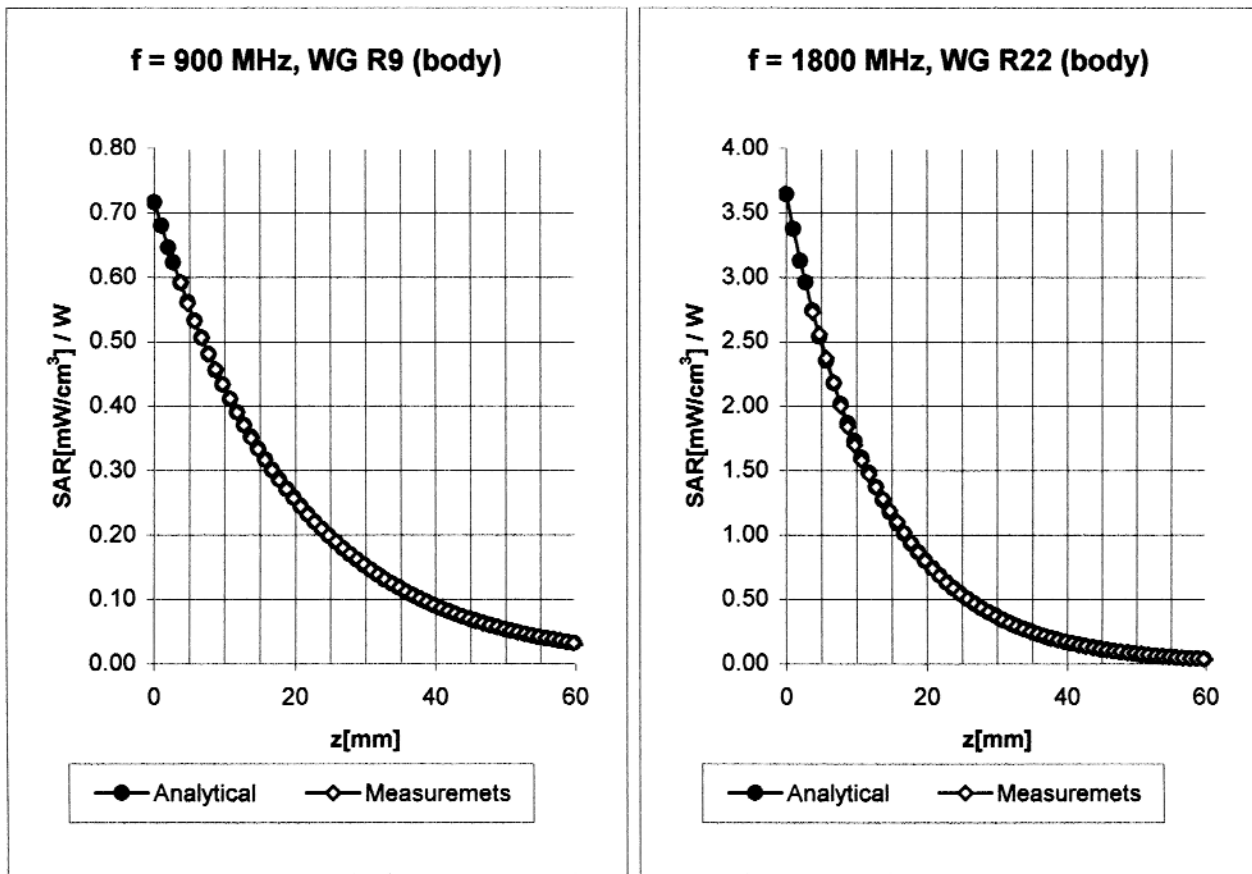
## Conversion Factor Assessment



<b>Head</b>	<b>900 MHz</b>	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
<b>Head</b>	<b>835 MHz</b>	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\% \text{ mho/m}$
	ConvF X	<b>7.0</b> $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	<b>7.0</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.33</b>
	ConvF Z	<b>7.0</b> $\pm 9.5\%$ (k=2)	Depth <b>2.34</b>
<b>Head</b>	<b>1800 MHz</b>	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
<b>Head</b>	<b>1900 MHz</b>	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
	ConvF X	<b>5.5</b> $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	<b>5.5</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.47</b>
	ConvF Z	<b>5.5</b> $\pm 9.5\%$ (k=2)	Depth <b>2.20</b>



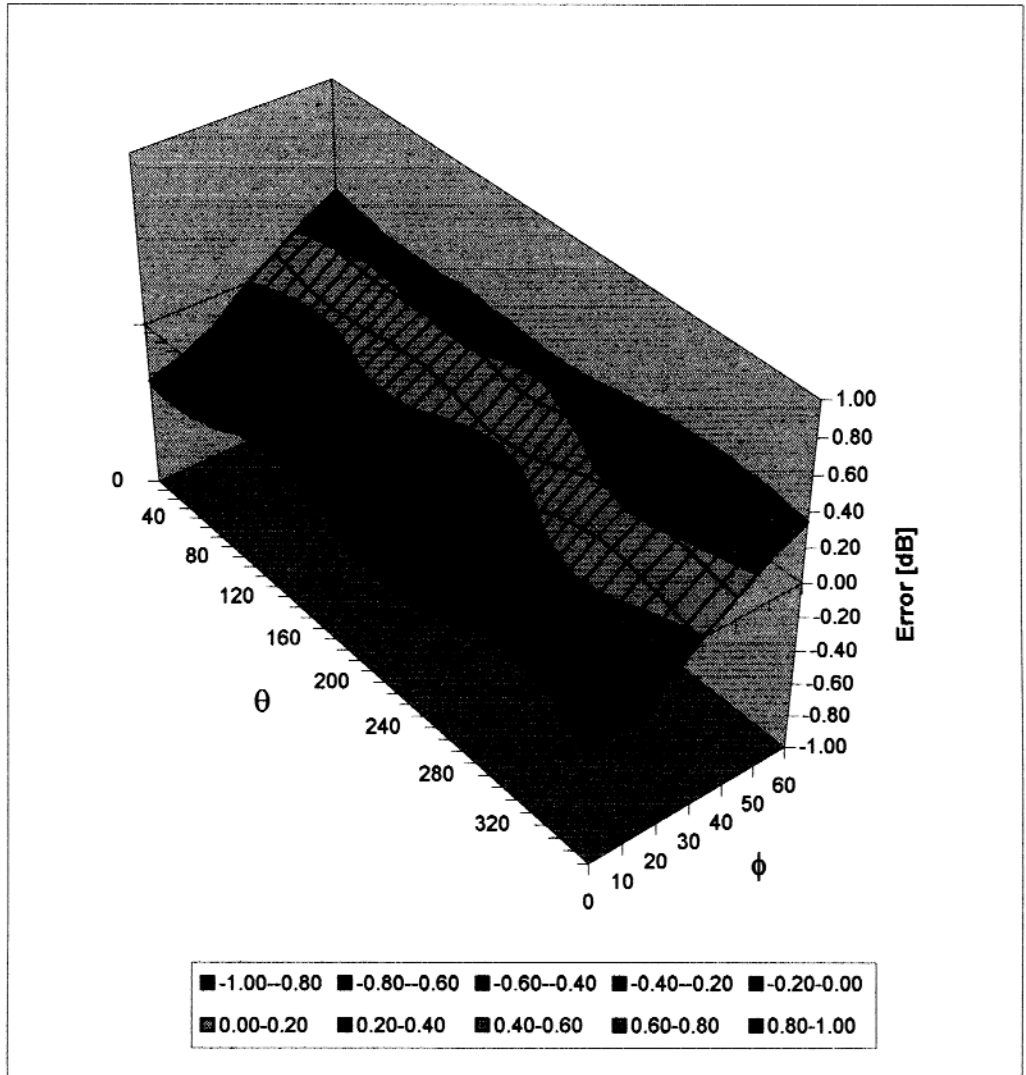
## Conversion Factor Assessment



<b>Body</b>	<b>900 MHz</b>	$\epsilon_r = 55.0 \pm 5\%$	$\sigma = 1.05 \pm 5\% \text{ mho/m}$
<b>Body</b>	<b>835 MHz</b>	$\epsilon_r = 55.2 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
	ConvF X	<b>6.7</b> $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	<b>6.7</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.29</b>
	ConvF Z	<b>6.7</b> $\pm 9.5\%$ (k=2)	Depth <b>2.76</b>
<b>Body</b>	<b>1800 MHz</b>	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$
<b>Body</b>	<b>1900 MHz</b>	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$
	ConvF X	<b>5.1</b> $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	<b>5.1</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.58</b>
	ConvF Z	<b>5.1</b> $\pm 9.5\%$ (k=2)	Depth <b>2.19</b>

# Deviation from Isotropy in HSL

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



## Additional Conversion Factors for Dosimetric E-Field Probe

Type:

**ET3DV6**

Serial Number:

**1578**

Place of Assessment:

**Zurich**

Date of Assessment:

**February 25, 2002**

Probe Calibration Date:

**February 22, 2002**

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:

*Johnie Katz*

# Dosimetric E-Field Probe ET3DV6 SN:1578

Conversion factor ( $\pm$  standard deviation)

<b>450 MHz</b>	ConvF	<b>8.0<math>\pm</math> 8%</b>	$\epsilon_r = 43.5$ $\sigma = 0.87$ mho/m (head tissue)
<b>450 MHz</b>	ConvF	<b>8.1 <math>\pm</math> 8%</b>	$\epsilon_r = 56.7$ $\sigma = 0.94$ mho/m (body tissue)
<b>2450 MHz</b>	ConvF	<b>4.5 <math>\pm</math> 8%</b>	$\epsilon_r = 39.2$ $\sigma = 1.80$ mho/m (head tissue)
<b>2450 MHz</b>	ConvF	<b>4.1 <math>\pm</math> 8%</b>	$\epsilon_r = 52.7$ $\sigma = 1.95$ mho/m (body tissue)

# DASY

## Dipole Validation Kit

**Type: D900V2**

**Serial: 108**

**Manufactured: March 15, 2001**

**Calibrated: April 17, 2001**

## Calibration Certificate

### 900 MHz System Validation Dipole

Type:

**D900V2**

Serial Number:

**108**

Place of Calibration:

**Zurich**

Date of Calibration:

**Apr. 17, 2001**

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:

*Volker Kahle*

Approved by:

*[Signature]*

## 1. Measurement Conditions

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

Relative Dielectricity	<b>41.2</b>	$\pm 5\%$
Conductivity	<b>0.95 mho/m</b>	$\pm 5\%$

The DASY3 System (Software version 3.1c) with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.27 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 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 90° turned probe orientations and averaging.

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

## 2. SAR Measurement

Standard SAR-measurements were performed with the phantom according to the measurement conditions described in section 1. The results have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

averaged over 1 cm <sup>3</sup> (1 g) of tissue:	<b>11.2 mW/g</b>
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	<b>7.08 mW/g</b>

Note: If the liquid parameters for validation are slightly different from the ones used for initial calibration, the SAR-values will be different as well.

### **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:	<b>1.416 ns</b>	(one direction)
Transmission factor:	<b>0.987</b>	(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:	$\text{Re}\{Z\} = 55.4 \Omega$
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	$\text{Im}\{Z\} = 1.1 \Omega$
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Return Loss at 900 MHz	<b>-25.6 dB</b>
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### **4. Handling**

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.

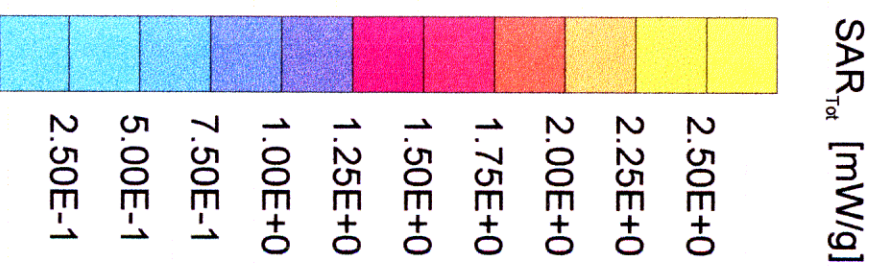
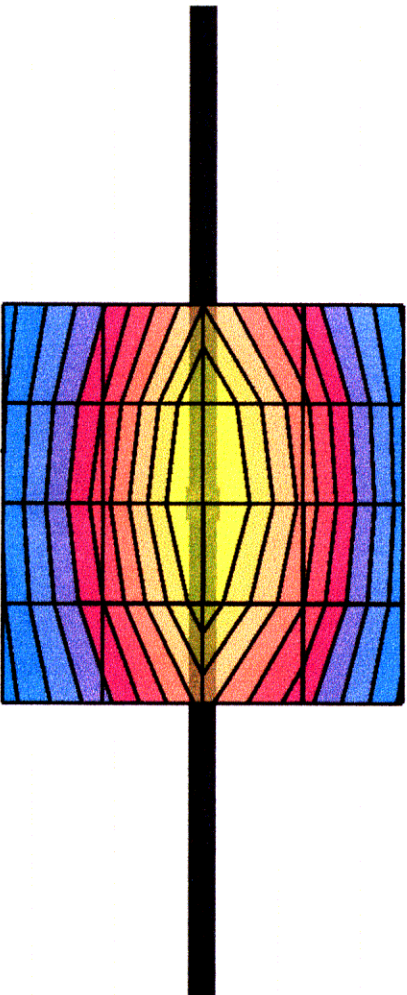
Do not apply excessive force to the dipole arms, because they might bend. If the dipole arms have to be bent back, take care to release stress to the soldered connections near the feedpoint; they might come off.

After prolonged use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.



# Validation Dipole D900V2 SN:108, d = 15 mm

Frequency: 900 MHz; Antenna Input Power: 250 [mW]  
Generic Twin Phantom; Flat Section; Grid Spacing: Dx = 15.0, Dy = 15.0, Dz = 10.0  
Probe: ET3DVG - SN1507; ConvF(6.27,6.27,6.27) at 900 MHz; IEEE1528 900 MHz;  $\sigma = 0.95$  mho/m  $\epsilon_r = 41.2$   $\rho = 1.00$  g/cm<sup>3</sup>  
Cubes (2): Peak: 4.52 mW/g  $\pm 0.03$  dB; SAR (1g): 2.80 mW/g  $\pm 0.02$  dB, SAR (10g): 1.77 mW/g  $\pm 0.02$  dB, (Worst-case extrapolation)  
Penetration depth: 11.5 (10.3, 13.1) [mm]  
Powerdrift: 0.01 dB

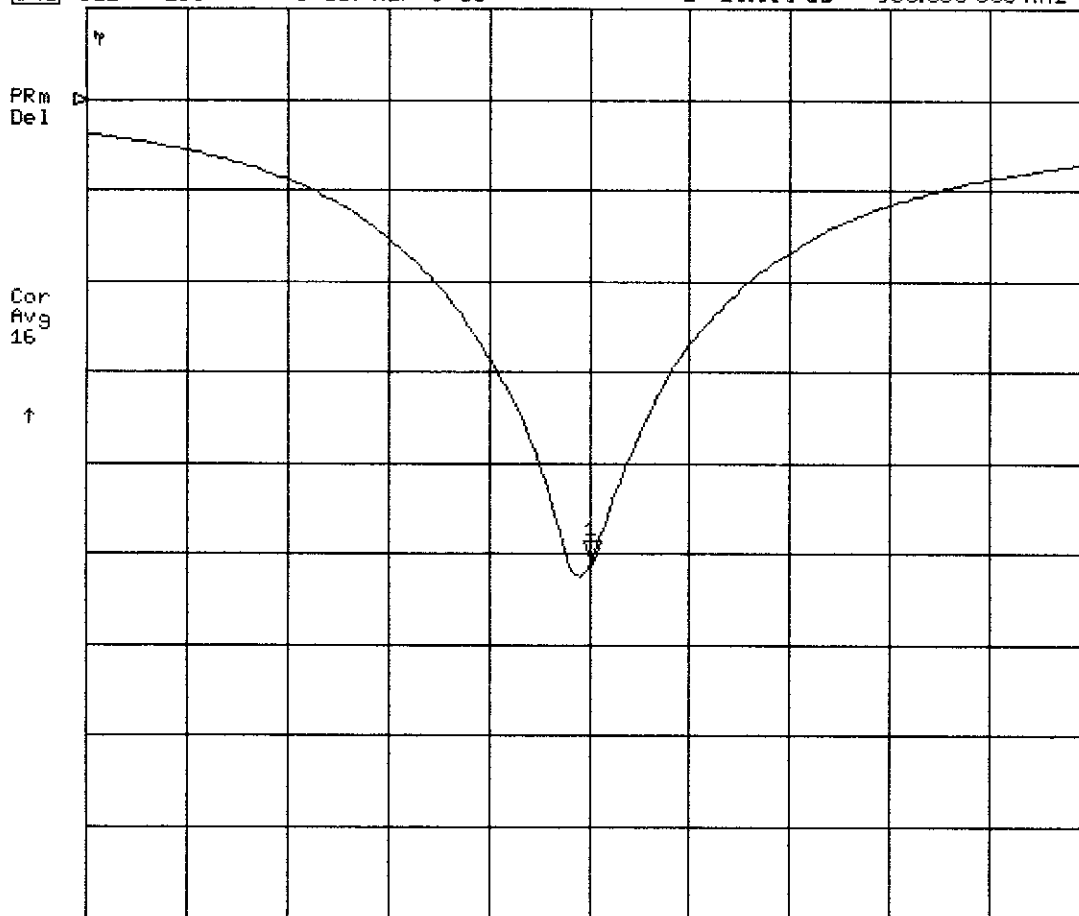




14 Apr 2001 13:51:00

[CH1] S11 LOG 5 dB/REF 0 dB

1:-25.555 dB 900.000 000 MHz



START 700.000 000 MHz

STOP 1 1000.000 000 MHz

# DASY3

## Dipole Validation Kit

Type: D1800V2

Serial: 294

Manufactured: March 22, 2001

Calibrated: April 19, 2001

# Schmid & Partner Engineering AG

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

## Calibration Certificate

### 1800 MHz System Validation Dipole

Type:

**D1800V2**

Serial Number:

**294**

Place of Calibration:

**Zurich**

Date of Calibration:

**Apr. 19, 2001**

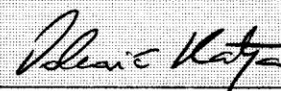
Calibration Interval:

**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:



Approved by:



## 1. Measurement Conditions

The measurements were performed in the flat section of the new generic twin phantom filled with head simulating sugar solution of the following electrical parameters at 1800 MHz:

Relative permittivity	<b>39.7</b>	$\pm 5\%$
Conductivity	<b>1.36 mho/m</b>	$\pm 10\%$

The DASY3 System (Software version 3.1c) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.57 at 1800 MHz) was used for the measurements.

The dipole feedpoint was positioned below the centre marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole centre 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 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 90° turned probe orientations and averaging. The dipole input power (forward power) was 250mW  $\pm 3\%$ . The results are normalised to 1W input power.

## 2. SAR Measurement

Standard SAR-measurements were performed with the head phantom according to the measurement conditions described in section 1. The results (see figure) have been normalised to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

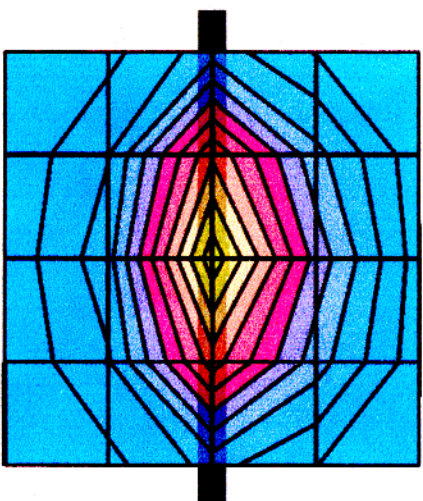
averaged over 1 cm <sup>3</sup> (1 g) of tissue:	<b>38.4 mW/g</b>
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	<b>20.0 mW/g</b>

Note: If the liquid parameters for validation are slightly different from the ones used for initial calibration, the SAR-values will be different as well. The estimated sensitivities of SAR-values and penetration depths to the liquid parameters are listed in the DASY Application Note 4: 'SAR Sensitivities'.



## Validation Dipole D1800V2 SN:294, d = 10 mm

Frequency: 1800 MHz; Antenna Input Power: 250 [mW]  
 Generic Twin Phantom; Flat Section; Grid Spacing: Dx = 15.0, Dy = 15.0, Dz = 10.0  
 Probe: ET3DV6 - SN1507; ConvF(5.57,5.57,5.57) at 1800 MHz; IEEE1528 1800 MHz;  $\sigma = 1.36$  mho/m  $\epsilon_r = 39.7$   $\rho = 1.00$  g/cm<sup>3</sup>  
 Cubes (2): Peak: 18.0 mW/g  $\pm 0.04$  dB, SAR (1g): 9.59 mW/g  $\pm 0.04$  dB, SAR (10g): 4.99 mW/g  $\pm 0.04$  dB, (Worst-case extrapolation)  
 Penetration depth: 8.3 (7.7, 9.4) [mm]  
 Powerdrift: -0.04 dB





CH1 S11 1 U FS

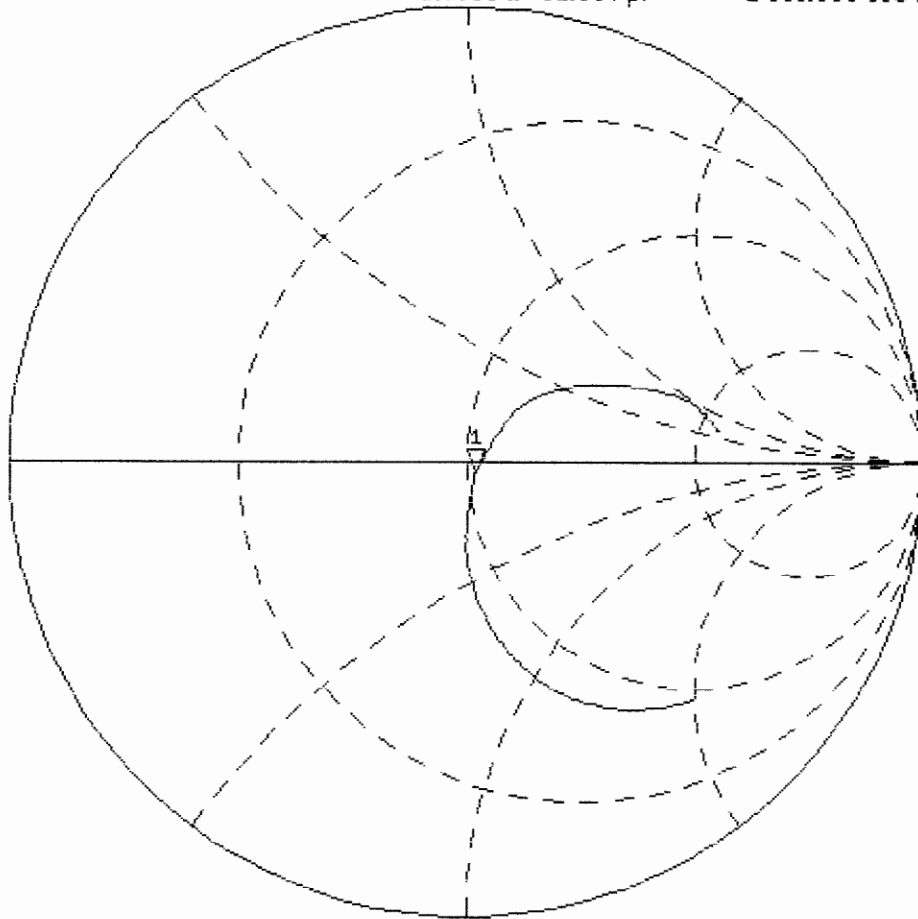
1: 51.816  $\Omega$  -2.8066  $\Omega$  31.504 pF

1 800.000 000 MHz

PRm  
Del

Cor  
Avg  
16

↑



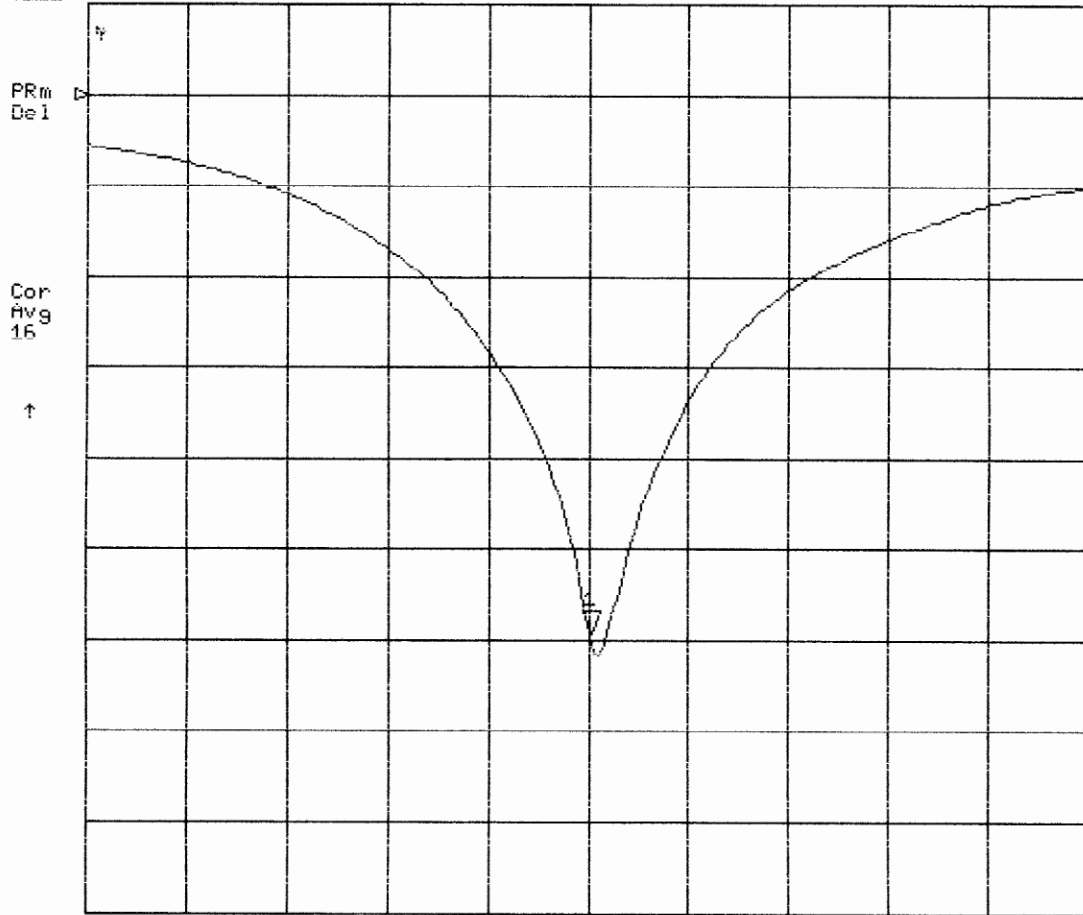
START 1 400.000 000 MHz

STOP 2 200.000 000 MHz

17 Apr 2001 15:51:14

[CH1] S11 LOG 5 dB/REF 0 dB

1:-29.661 dB 1 800.000 000 MHz



START 1 400.000 000 MHz

STOP 2 2000.000 000 MHz