

## APPENDIX D: CALIBRATION CERTIFICATE (S)

# Schmid & Partner Engineering AG

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

## Calibration Certificate

### Dosimetric E-Field Probe

Type:

**ET3DV6**

Serial Number:

**1504**

Place of Calibration:

**Zurich**

Date of Calibration:

**July 26, 2002**

Calibration Interval:

**12 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:

*U. Vella*

Approved by:

*Philip Kutz*

Probe ET3DV6

SN:1504

Manufactured:	October 24, 1999
Last calibration:	January 10, 2002
Recalibrated:	July 26, 2002

Calibrated for System DASY3

## DASY3 - Parameters of Probe: ET3DV6 SN:1504

### Sensitivity in Free Space

NormX	<b>2.02</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	<b>1.78</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	<b>1.73</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	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\% \text{ mho/m}$
Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
ConvF X	<b>6.5</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>6.5</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.39</b>
ConvF Z	<b>6.5</b> $\pm 9.5\%$ (k=2)	Depth	<b>2.42</b>
Head	1880 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
ConvF X	<b>5.4</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>5.4</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.53</b>
ConvF Z	<b>5.4</b> $\pm 9.5\%$ (k=2)	Depth	<b>2.44</b>

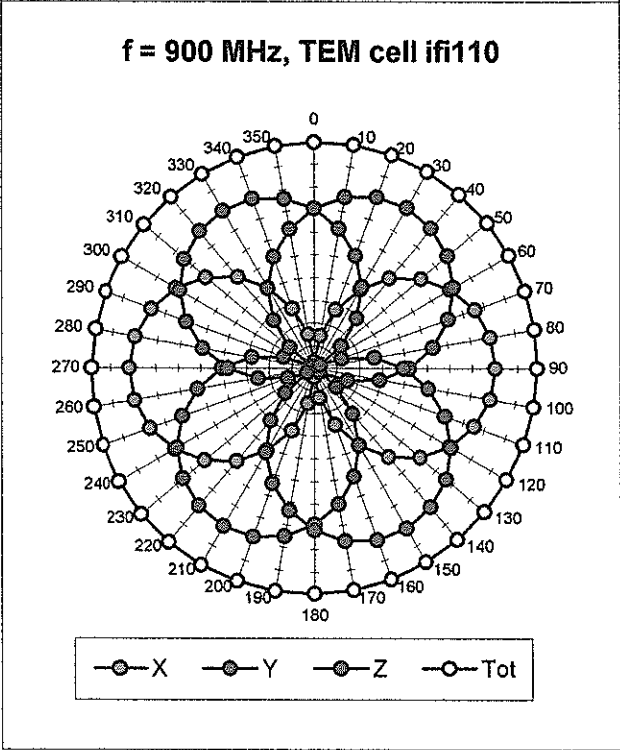
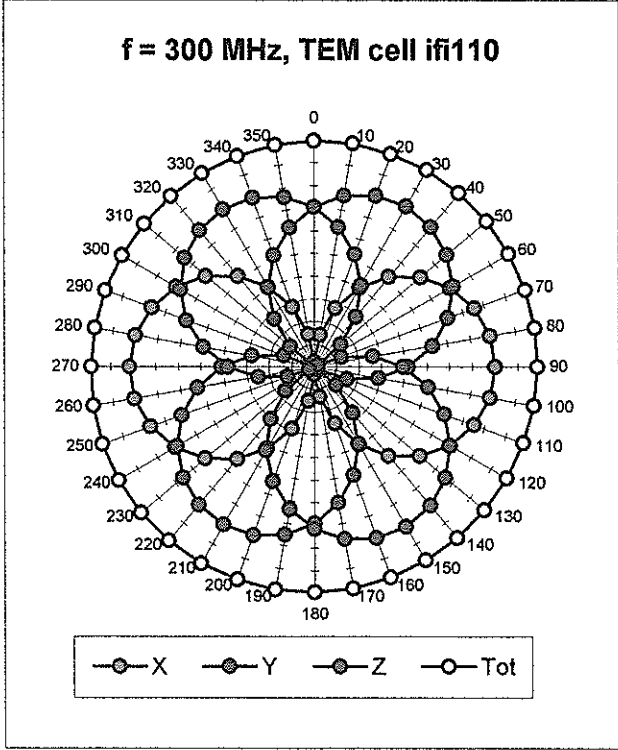
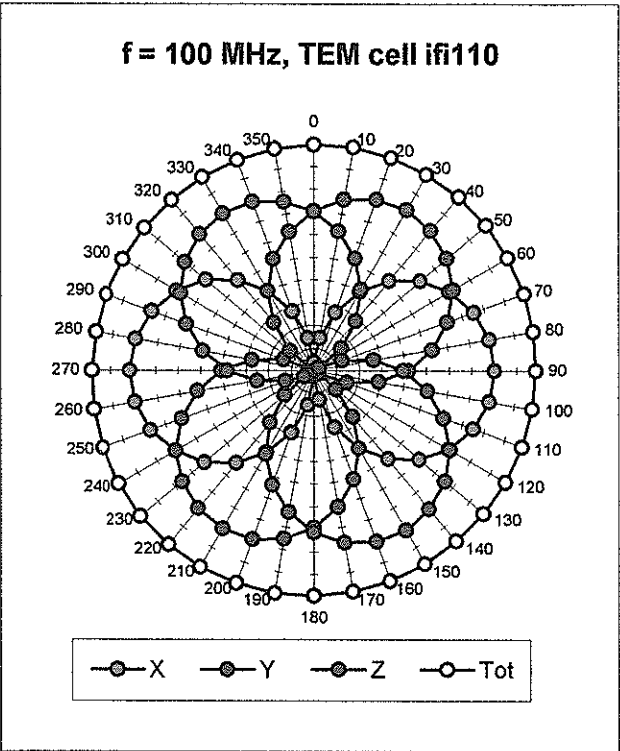
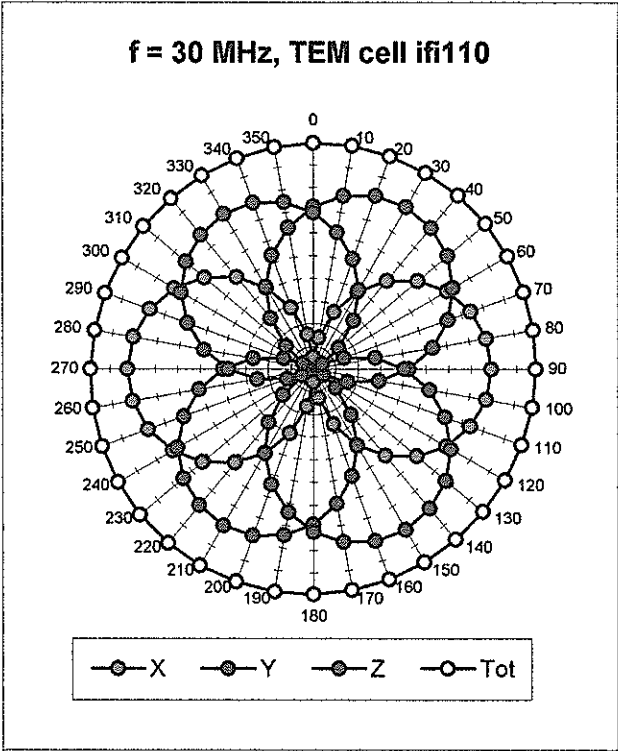
### Boundary Effect

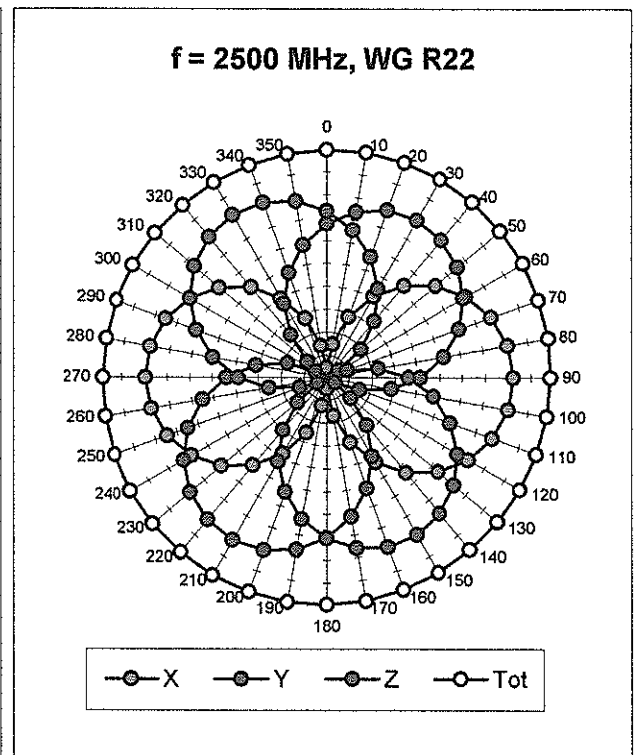
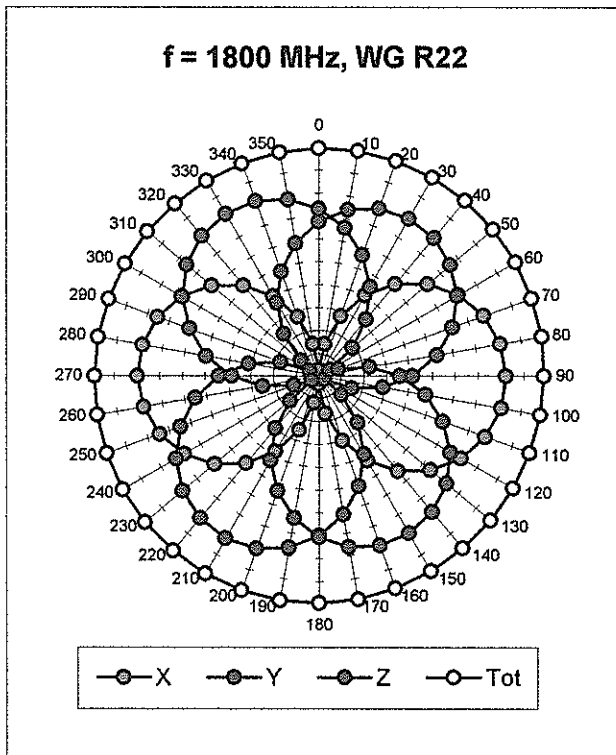
Head	835 MHz	Typical SAR gradient: 5 % per mm	
Probe Tip to Boundary		<b>1 mm</b>	<b>2 mm</b>
SAR <sub>be</sub> [%]	Without Correction Algorithm	9.6	5.3
SAR <sub>be</sub> [%]	With Correction Algorithm	0.3	0.5
Head	1880 MHz	Typical SAR gradient: 10 % per mm	
Probe Tip to Boundary		<b>1 mm</b>	<b>2 mm</b>
SAR <sub>be</sub> [%]	Without Correction Algorithm	13.0	8.5
SAR <sub>be</sub> [%]	With Correction Algorithm	0.2	0.2

### Sensor Offset

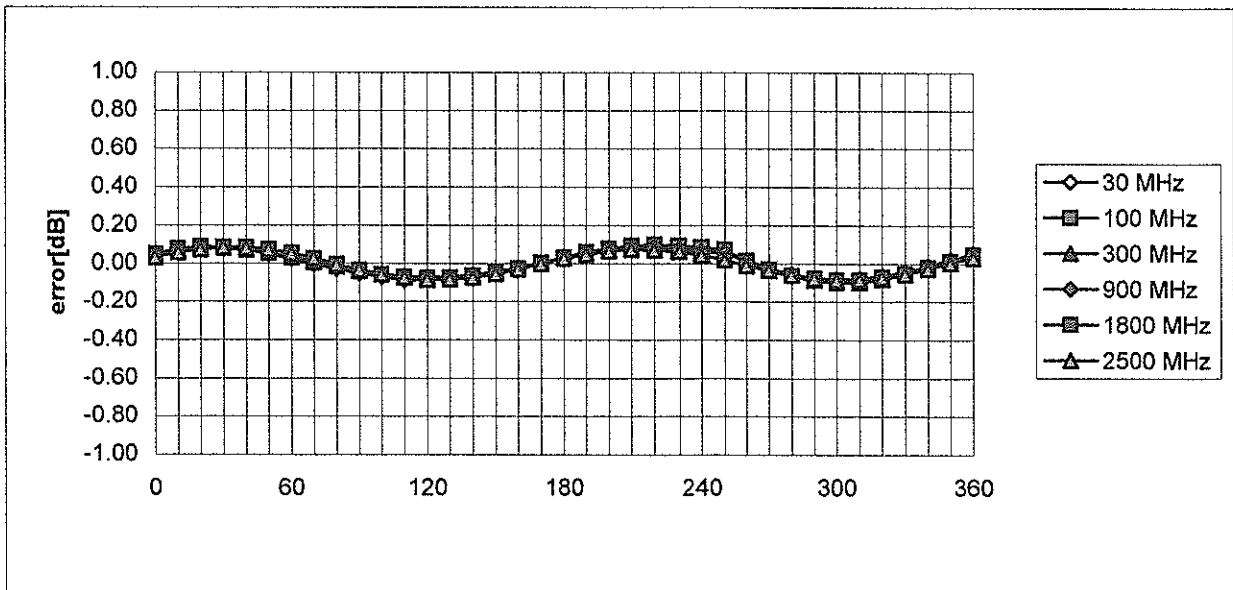
Probe Tip to Sensor Center	<b>2.7</b>	mm
Optical Surface Detection	<b>1.4 <math>\pm</math> 0.2</b>	mm

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



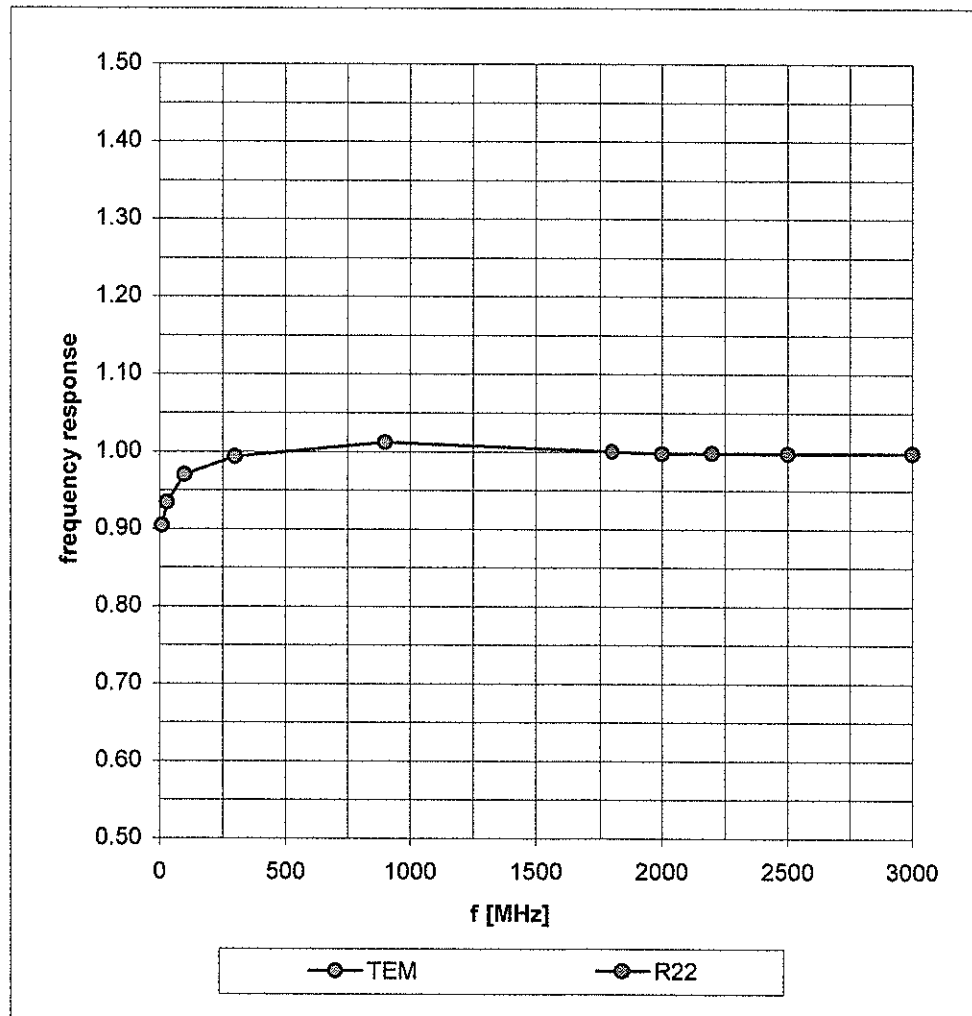


### Isotropy Error ( $\phi$ ), $\theta = 0^\circ$

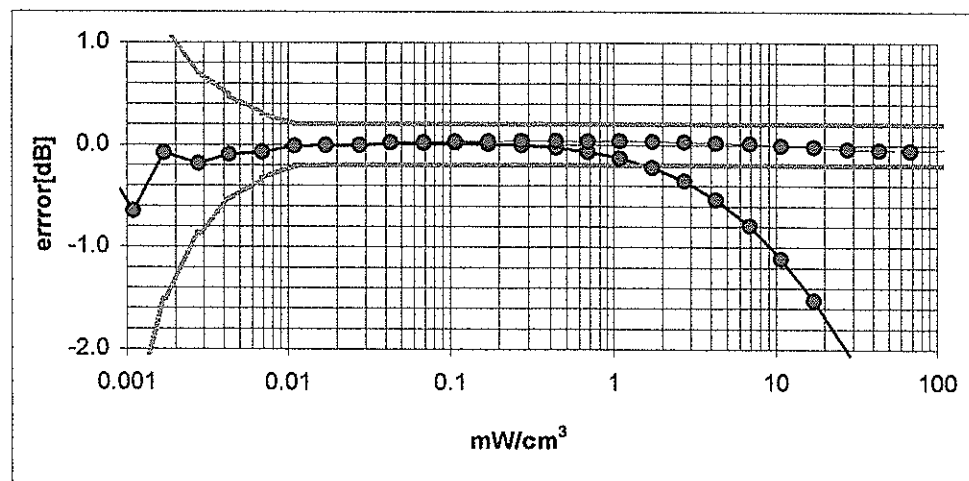
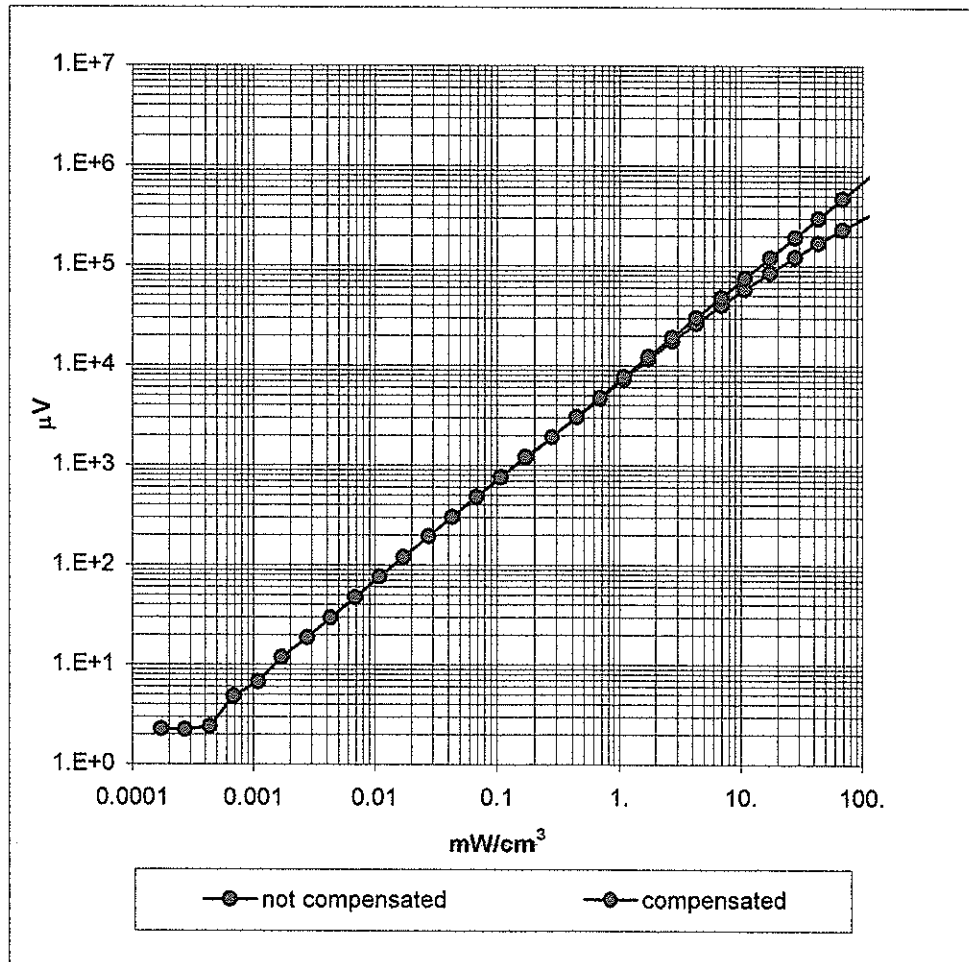


# Frequency Response of E-Field

( TEM-Cell:ifi110, Waveguide R22)

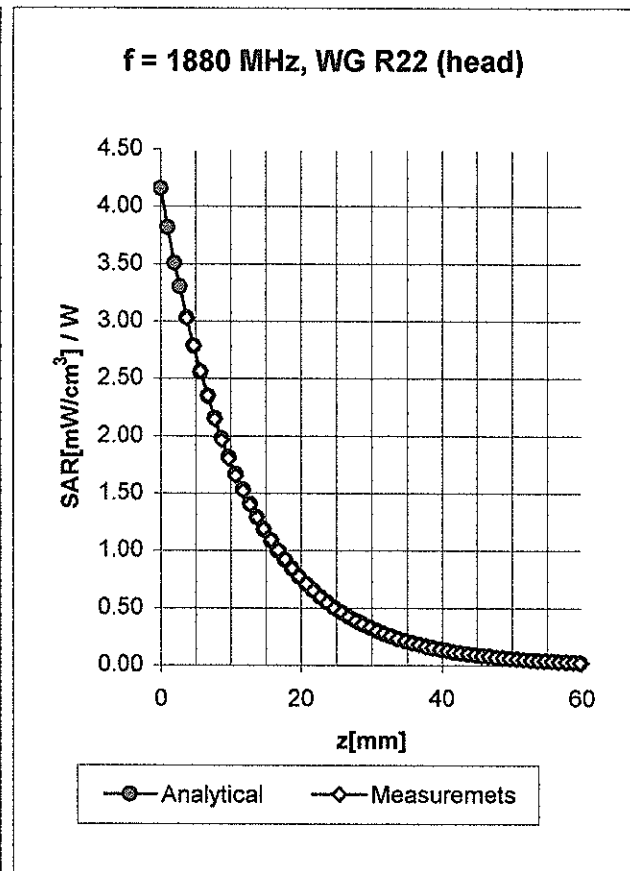
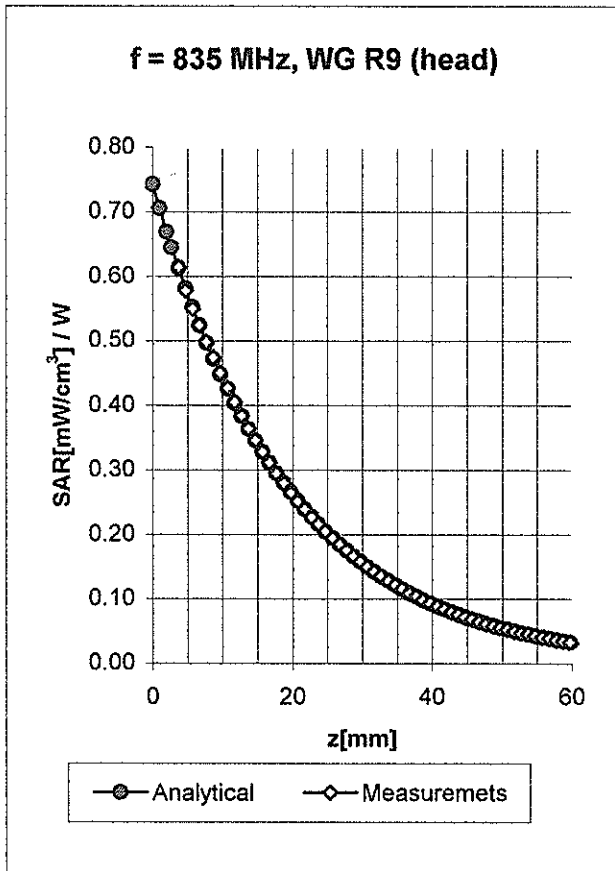


# Dynamic Range $f(\text{SAR}_{\text{brain}})$ ( Waveguide R22 )



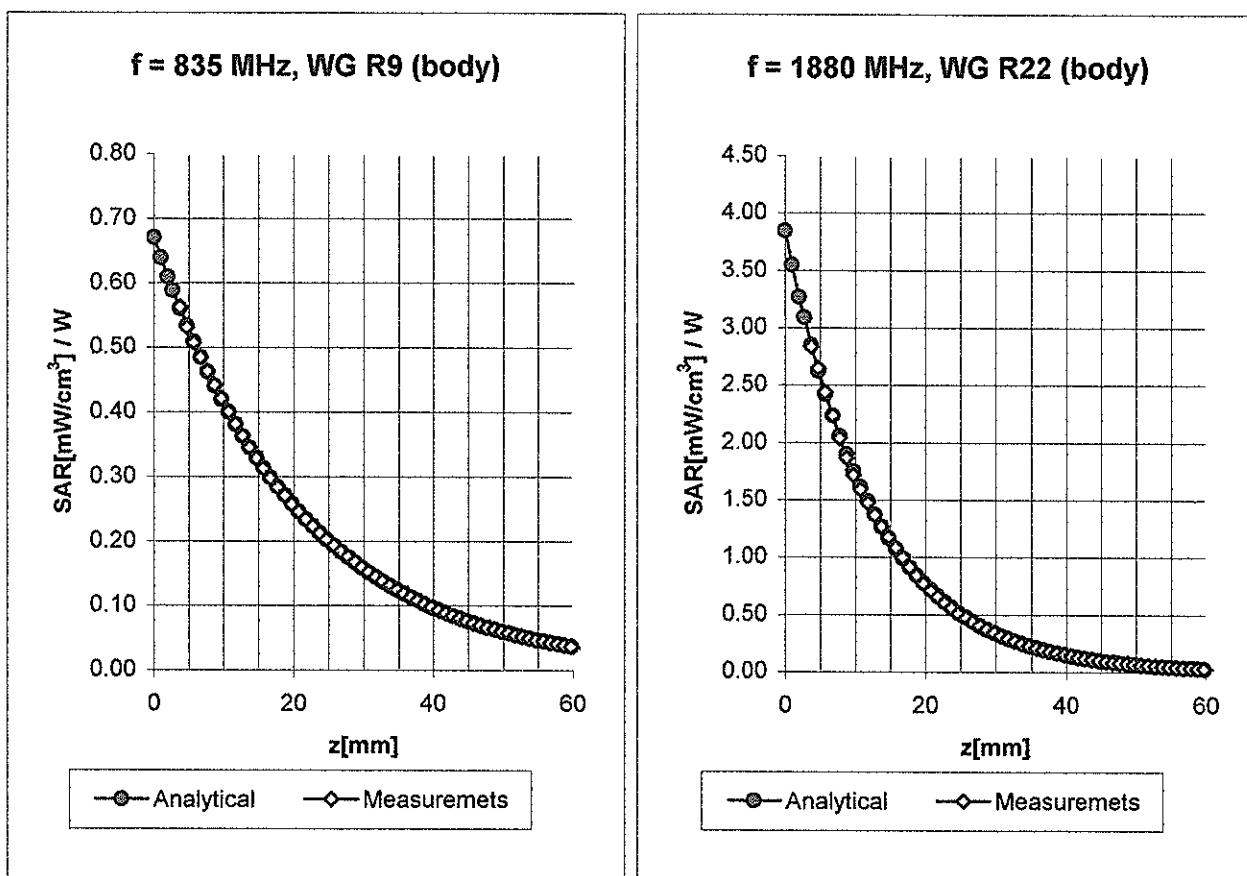


## Conversion Factor Assessment



Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\%$ mho/m
Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
	ConvF X	<b>6.5</b> $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	<b>6.5</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.39</b>
	ConvF Z	<b>6.5</b> $\pm 9.5\%$ (k=2)	Depth <b>2.42</b>
Head	1880 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
	ConvF X	<b>5.4</b> $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	<b>5.4</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.53</b>
	ConvF Z	<b>5.4</b> $\pm 9.5\%$ (k=2)	Depth <b>2.44</b>

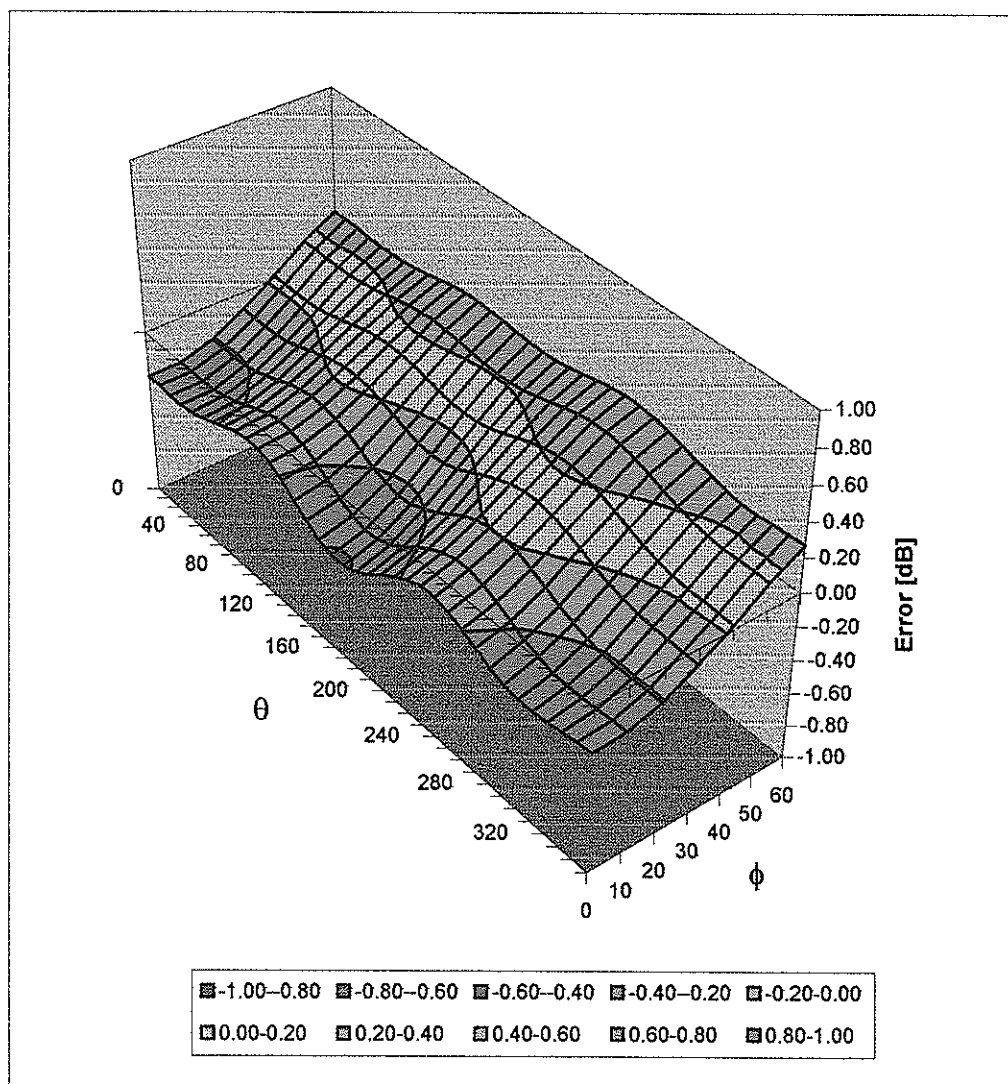
## Conversion Factor Assessment



Body	835 MHz	$\epsilon_r = 55.2 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
Body	900 MHz	$\epsilon_r = 55.0 \pm 5\%$	$\sigma = 1.05 \pm 5\%$ mho/m
	ConvF X	<b>6.5</b> $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	<b>6.5</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.42</b>
	ConvF Z	<b>6.5</b> $\pm 9.5\%$ (k=2)	Depth <b>2.38</b>
Body	1880 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\%$ mho/m
Body	1800 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\%$ mho/m
	ConvF X	<b>5.0</b> $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	<b>5.0</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.74</b>
	ConvF Z	<b>5.0</b> $\pm 9.5\%$ (k=2)	Depth <b>2.06</b>

## Deviation from Isotropy in HSL

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



# Schmid & Partner Engineering AG

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

## Calibration Certificate

### Dosimetric E-Field Probe

Type:

**ET3DV6**

Serial Number:

**1505**

Place of Calibration:

**Zurich**

Date of Calibration:

**September 7, 2002**

Calibration Interval:

**12 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:

*N. Vetter*

Approved by:

*Alain Kaya*

# Probe ET3DV6

## SN:1505

Manufactured:	October 24, 1999
Last calibration:	May 22, 2002
Repaired:	August 29, 2002
Recalibrated:	September 7, 2002

**Calibrated for DASY Systems**

(Note: non-compatible with DASY2 system!)

## DASY - Parameters of Probe: ET3DV6 SN:1505

### Sensitivity in Free Space

NormX	<b>1.67</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	<b>1.69</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>94</b>	mV
DCP Y	<b>94</b>	mV
DCP Z	<b>94</b>	mV

### Sensitivity in Tissue Simulating Liquid

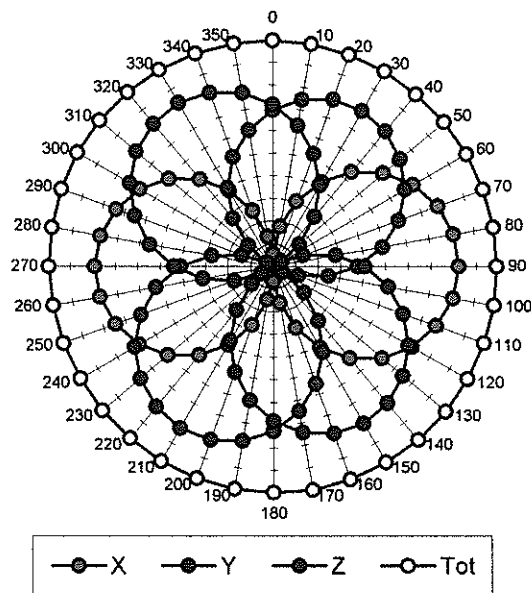
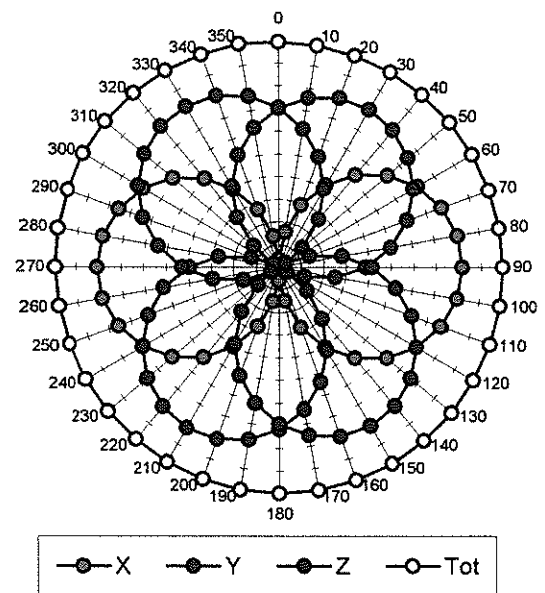
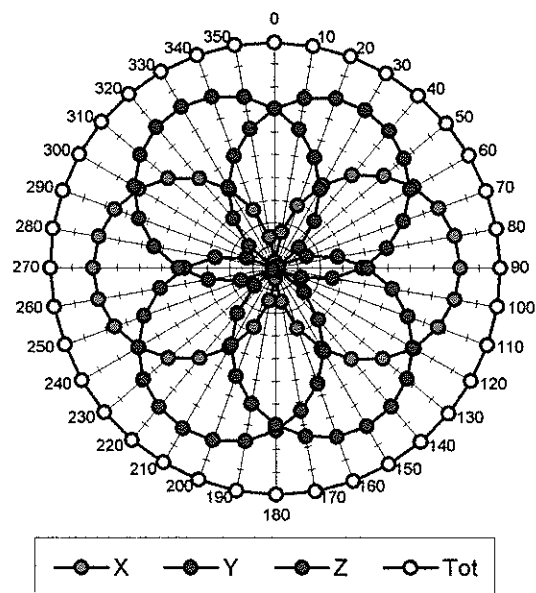
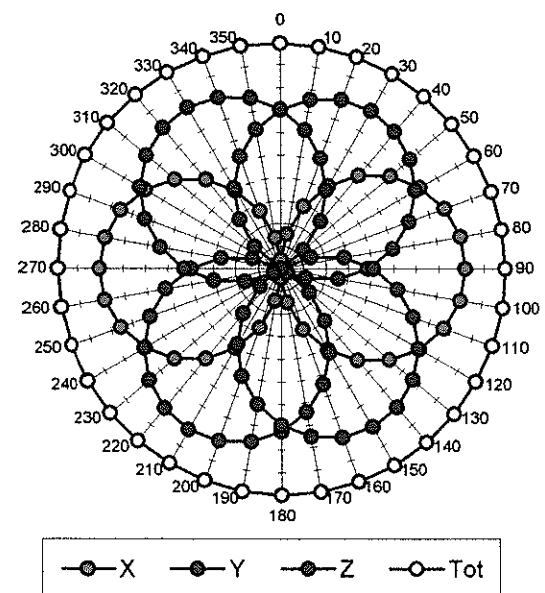
Head	<b>835 MHz</b>	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\% \text{ mho/m}$
Head	<b>900 MHz</b>	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
ConvF X	<b>7.0</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>7.0</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.21</b>
ConvF Z	<b>7.0</b> $\pm 9.5\%$ (k=2)	Depth	<b>3.66</b>
Head	<b>1880 MHz</b>	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
Head	<b>1800 MHz</b>	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\% \text{ mho/m}$
ConvF X	<b>5.6</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>5.6</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.43</b>
ConvF Z	<b>5.6</b> $\pm 9.5\%$ (k=2)	Depth	<b>2.63</b>

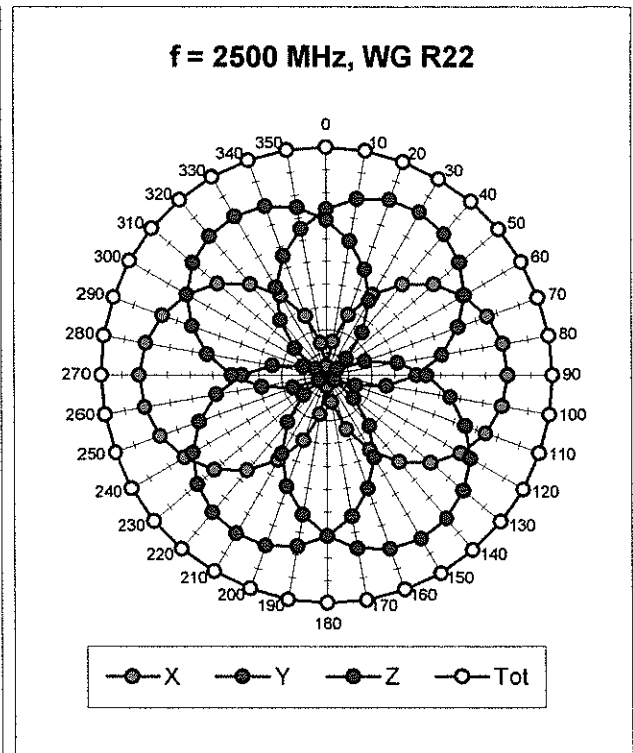
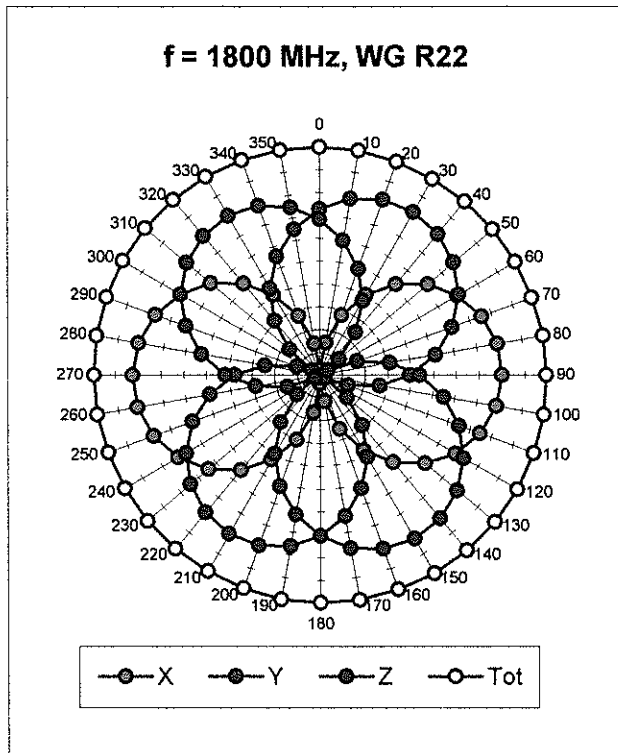
### Boundary Effect

Head	<b>835 MHz</b>	Typical SAR gradient: 5 % per mm	
Probe Tip to Boundary		<b>1 mm</b>	<b>2 mm</b>
SAR <sub>be</sub> [%]	Without Correction Algorithm	9.2	5.6
SAR <sub>be</sub> [%]	With Correction Algorithm	0.6	0.6
Head	<b>1880 MHz</b>	Typical SAR gradient: 10 % per mm	
Probe Tip to Boundary		<b>1 mm</b>	<b>2 mm</b>
SAR <sub>be</sub> [%]	Without Correction Algorithm	11.4	8.1
SAR <sub>be</sub> [%]	With Correction Algorithm	0.3	0.3

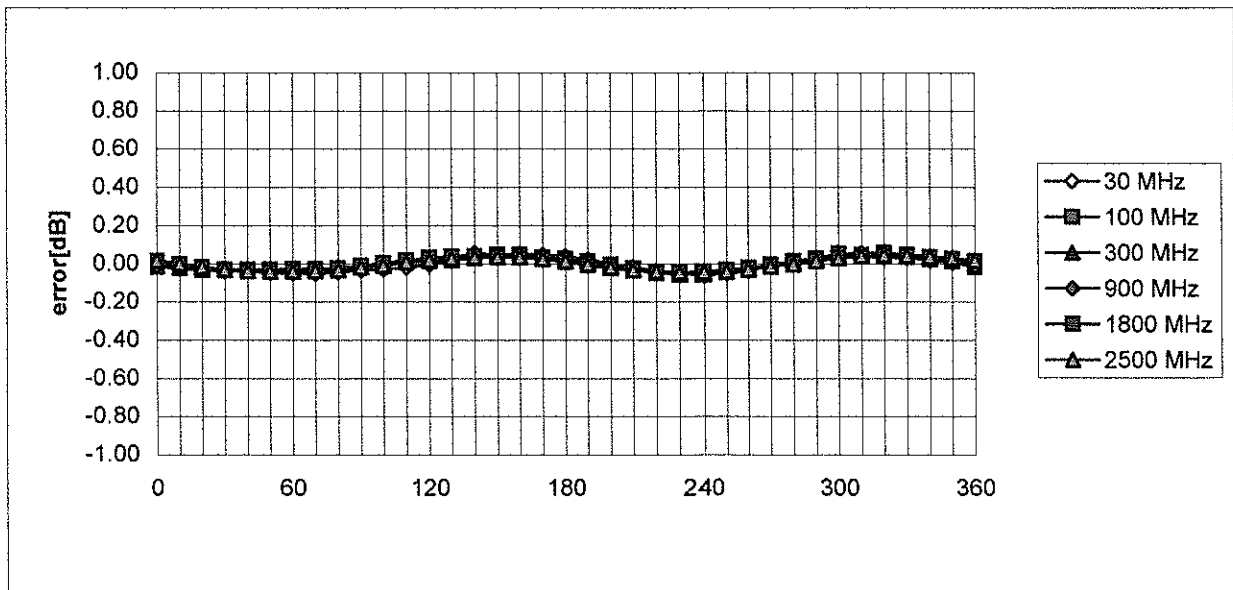
### Sensor Offset

Probe Tip to Sensor Center	<b>2.7</b>	mm
Optical Surface Detection	<b>1.4 <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**



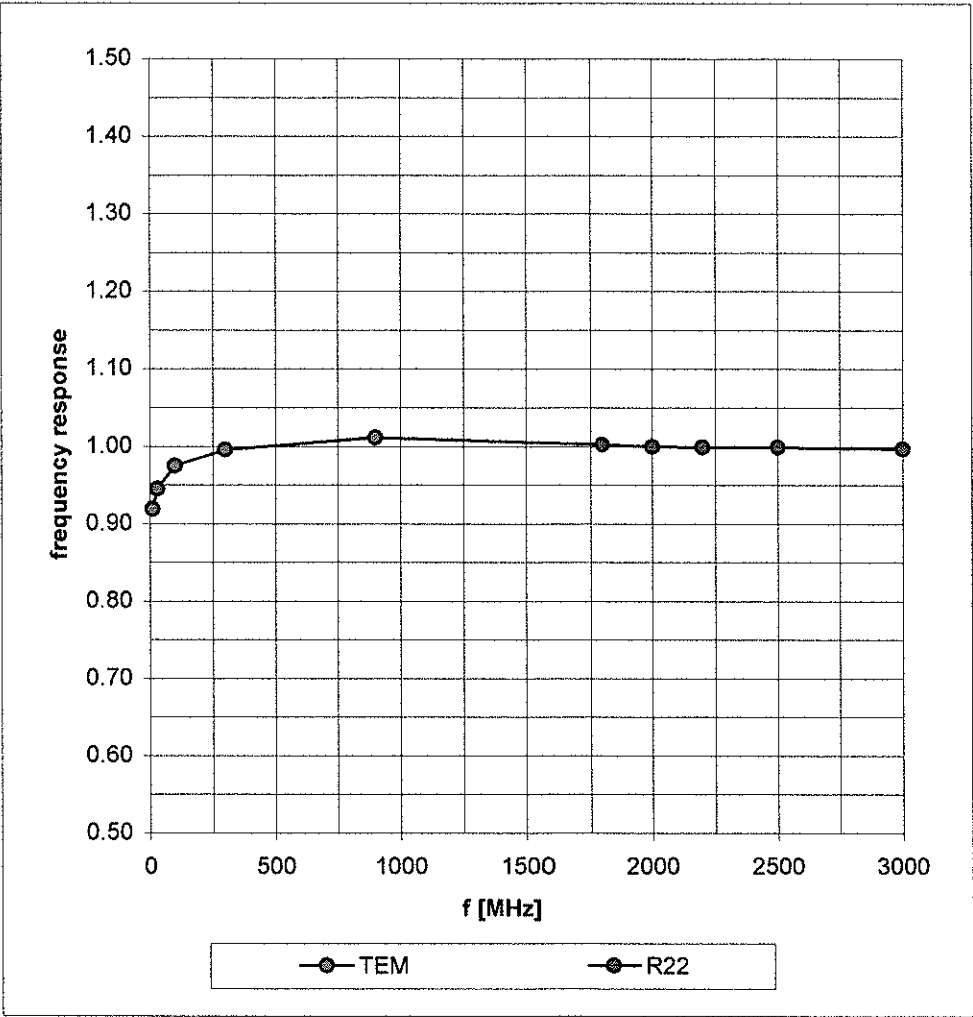
### Isotropy Error ( $\phi$ ), $\theta = 0^\circ$



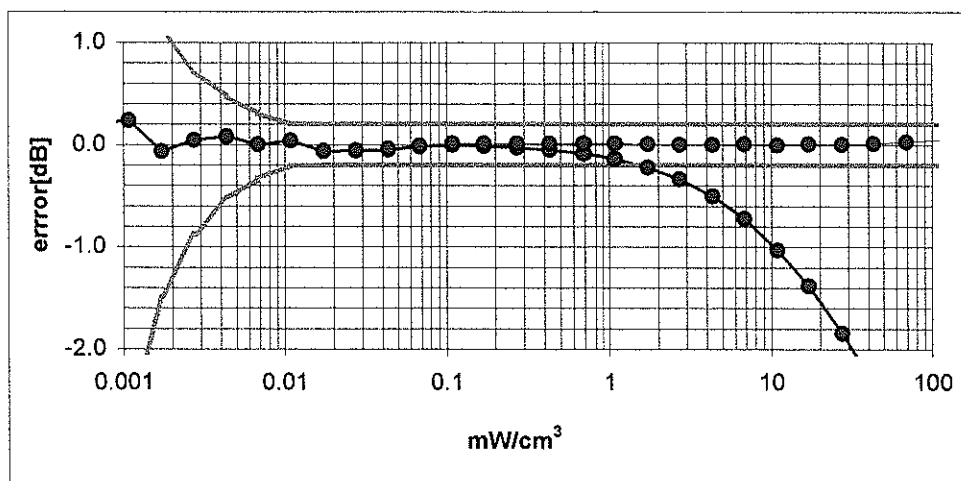
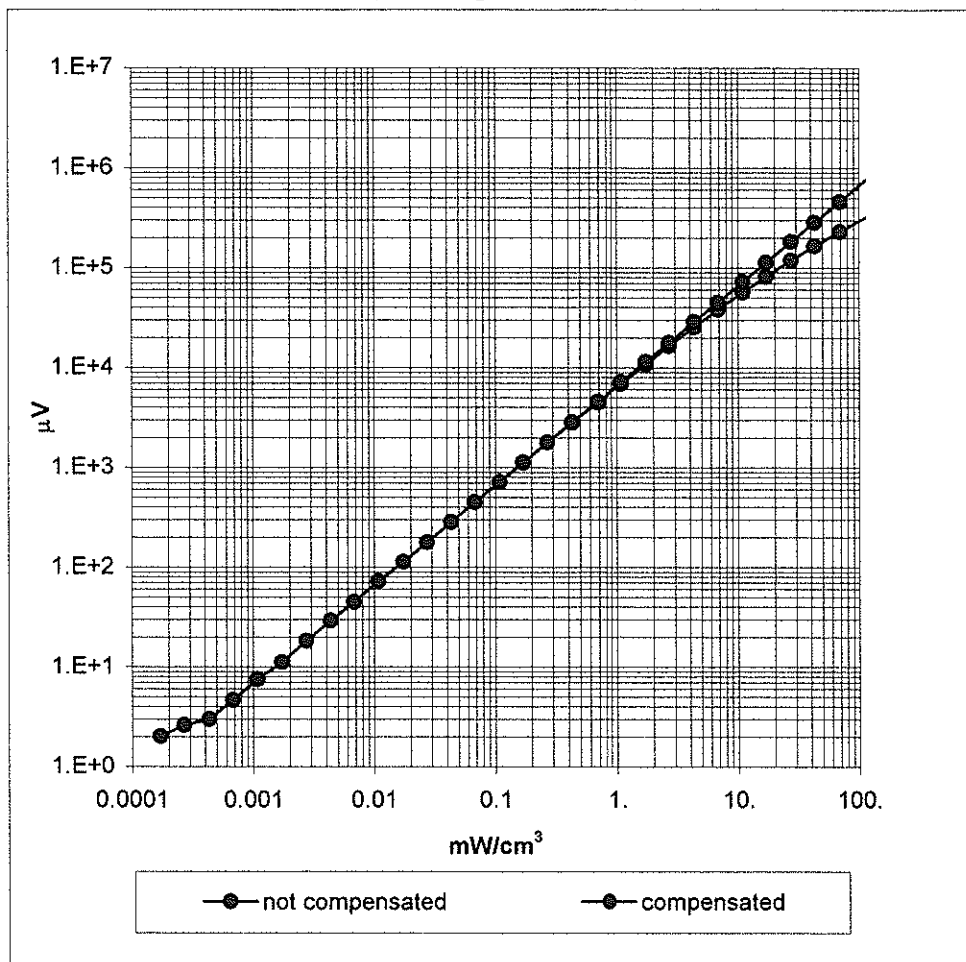


# Frequency Response of E-Field

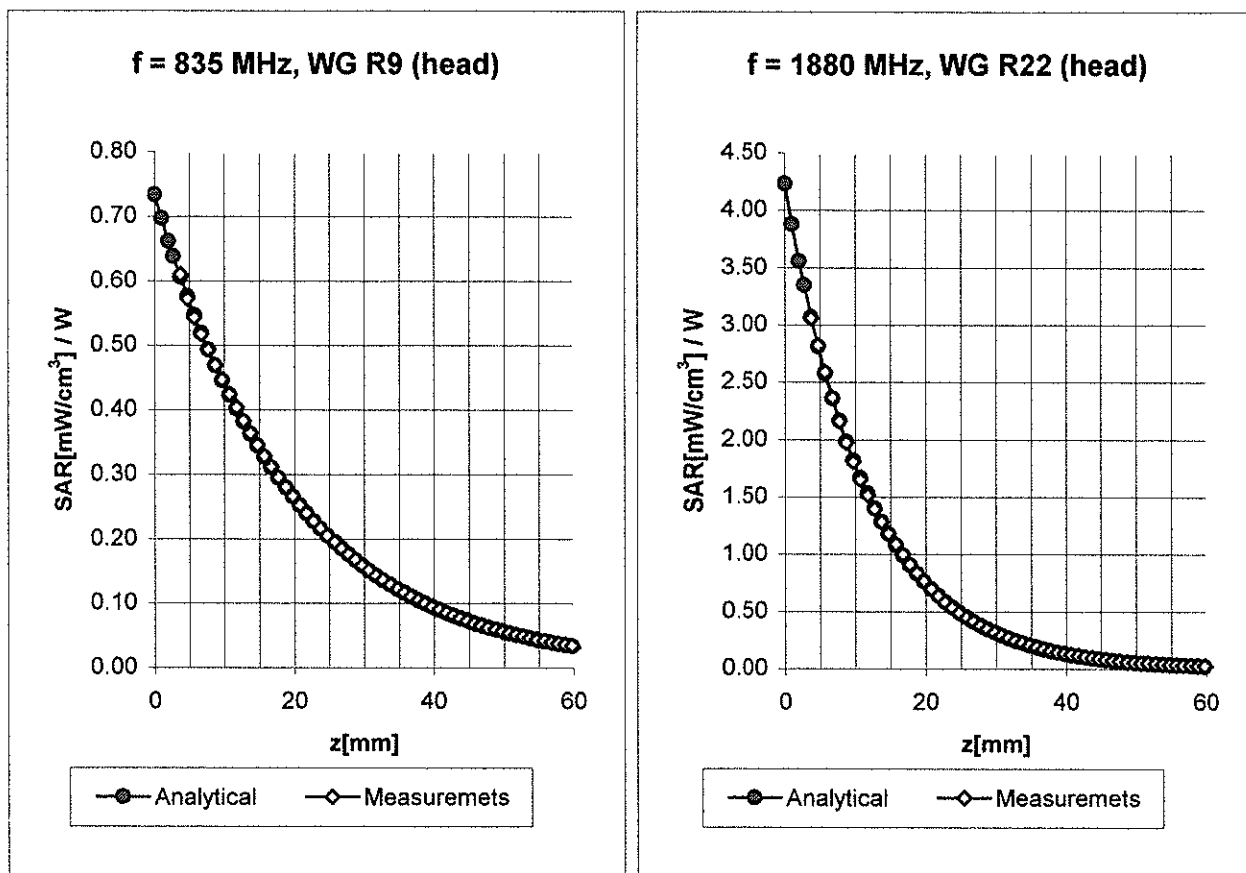
( TEM-Cell:ifi110, Waveguide R22)



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

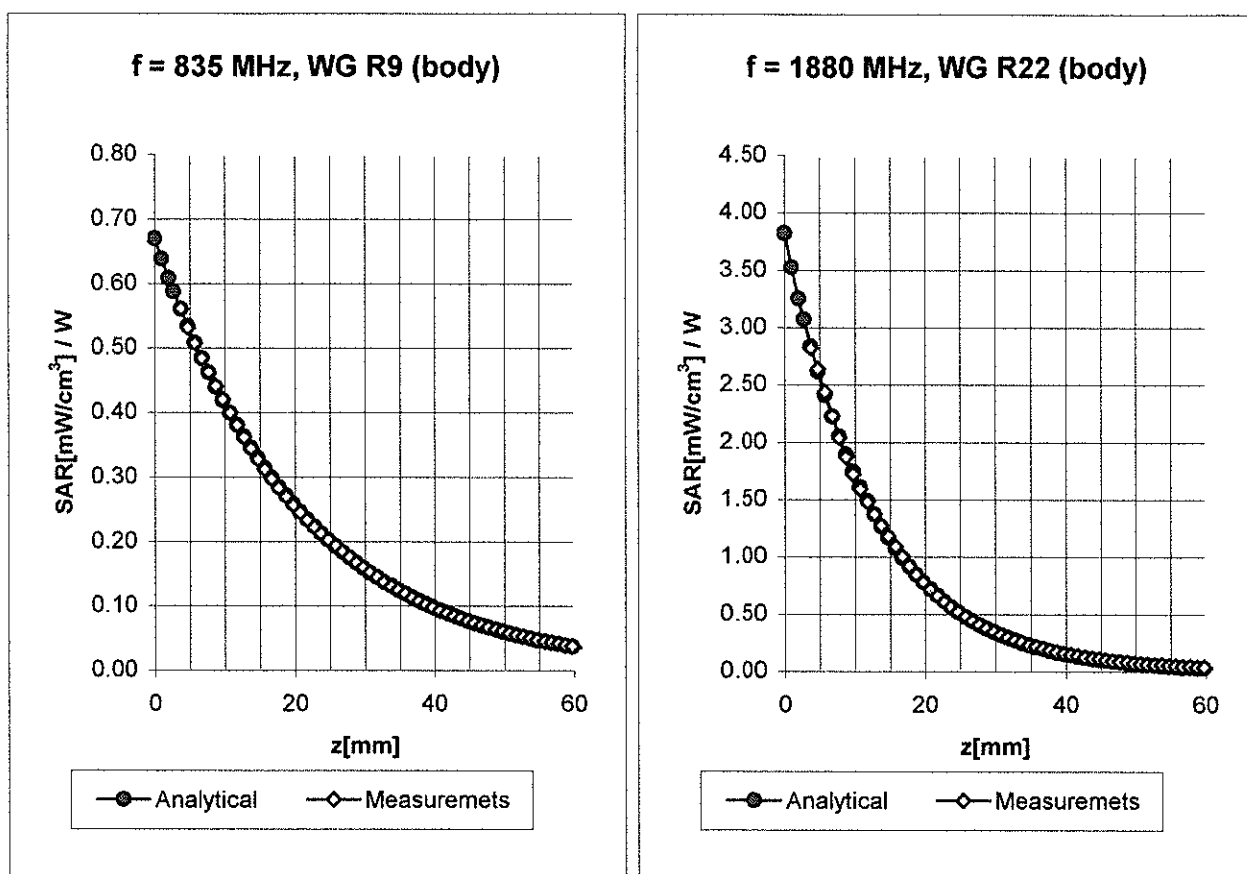


## Conversion Factor Assessment



Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\%$ mho/m
Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
	ConvF X	$7.0 \pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	$7.0 \pm 9.5\%$ (k=2)	Alpha <b>0.21</b>
	ConvF Z	$7.0 \pm 9.5\%$ (k=2)	Depth <b>3.66</b>
Head	1880 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
Head	1800 MHz	$\epsilon_r = 40.0 \pm 5\%$	$\sigma = 1.40 \pm 5\%$ mho/m
	ConvF X	$5.6 \pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	$5.6 \pm 9.5\%$ (k=2)	Alpha <b>0.43</b>
	ConvF Z	$5.6 \pm 9.5\%$ (k=2)	Depth <b>2.63</b>

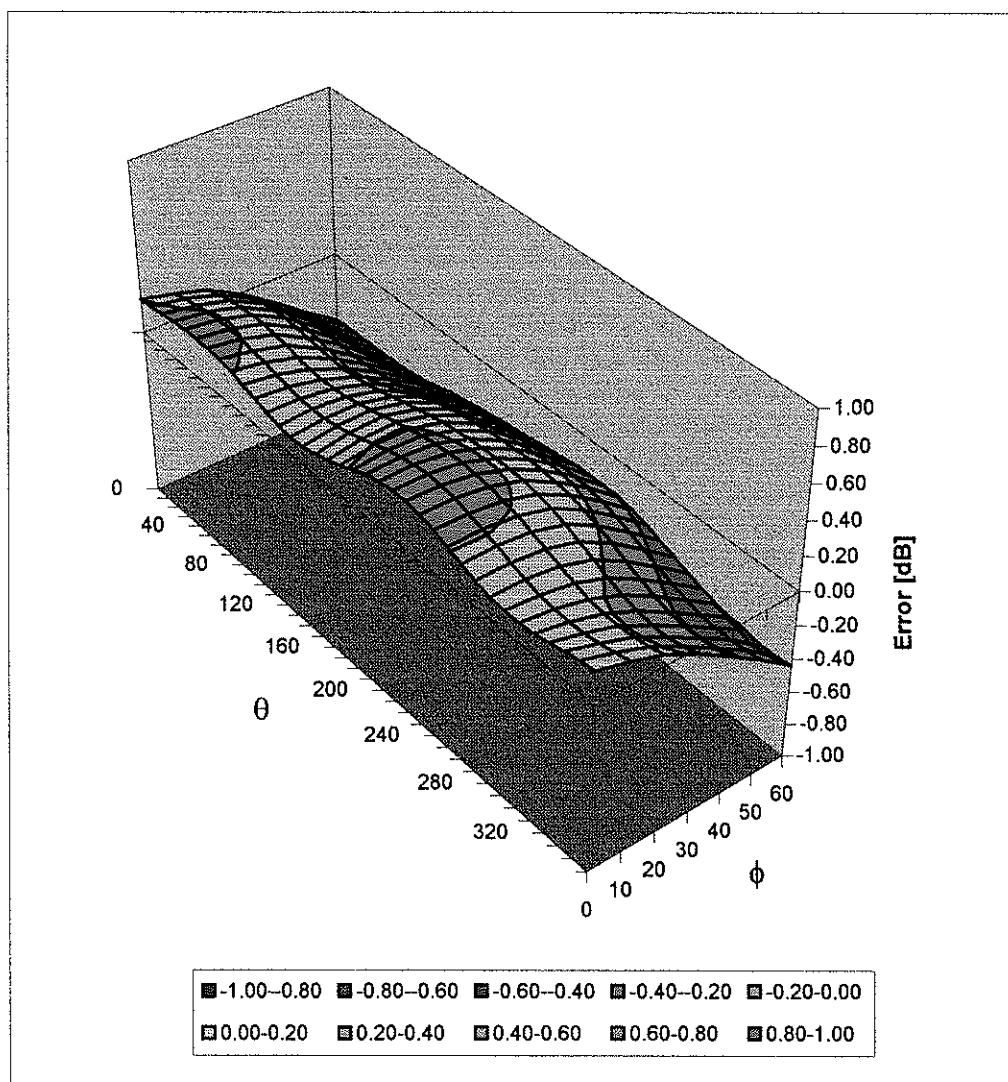
## Conversion Factor Assessment



Body	835 MHz	$\epsilon_r = 55.2 \pm 5\%$	$\sigma = 0.97 \pm 5\% \text{ mho/m}$
Body	900 MHz	$\epsilon_r = 55.0 \pm 5\%$	$\sigma = 1.05 \pm 5\% \text{ mho/m}$
	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>0.30</b>
	ConvF Z	<b>6.7</b> $\pm 9.5\%$ (k=2)	Depth <b>2.69</b>
Body	1880 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$
Body	1800 MHz	$\epsilon_r = 53.3 \pm 5\%$	$\sigma = 1.52 \pm 5\% \text{ mho/m}$
	ConvF X	<b>5.0</b> $\pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	<b>5.0</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.58</b>
	ConvF Z	<b>5.0</b> $\pm 9.5\%$ (k=2)	Depth <b>2.32</b>

## Deviation from Isotropy in HSL

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



## Calibration Certificate

### 835 MHz System Validation Dipole

Type:

**D835V2**

Serial Number:

**455**

Place of Calibration:

**Zurich**

Date of Calibration:

**July 16, 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:

*N. Vetter*

Approved by:

*Alconio Klatza*

**DASY**

**Dipole Validation Kit**

**Type: D835V2**

**Serial: 455**

Manufactured: January 31, 2002  
Calibrated: July 16, 2002

## **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 835 MHz:

Relative Dielectricity	<b>42.5</b>	$\pm 5\%$
Conductivity	<b>0.90 mho/m</b>	$\pm 5\%$

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.6 at 835 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 20mm 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  $250\text{mW} \pm 3\%$ . The results are normalized to 1W input power.

### **2.1. SAR Measurement with DASY3 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 worst-case extrapolation are:

averaged over  $1\text{ cm}^3$  (1 g) of tissue: **9.84 mW/g**

averaged over  $10\text{ cm}^3$  (10 g) of tissue: **6.32 mW/g**

### **2.2 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  $1\text{ cm}^3$  (1 g) of tissue: **9.20 mW/g**

averaged over  $10\text{ cm}^3$  (10 g) of tissue: **6.08 mW/g**



### 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>1.375 ns</b>	(one direction)
Transmission factor:	<b>0.992</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 835 MHz:	$\text{Re}\{Z\} = 49.6 \Omega$
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$\text{Im}\{Z\} = -1.8 \Omega$
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Return Loss at 835 MHz	<b>-34.7 dB</b>
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### 4. Measurement Conditions

The measurements were performed in the flat section of the new generic twin phantom filled with body simulating solution of the following electrical parameters at 835 MHz:

Relative Dielectricity	<b>55.3</b>	$\pm 5\%$
Conductivity	<b>0.95 mho/m</b>	$\pm 5\%$

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.2 at 835 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 20mm 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.

### **5.1. SAR Measurement with DASY3 System**

Standard SAR-measurements were performed according to the measurement conditions described in section 4. 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 worst-case extrapolation are:

averaged over 1 cm<sup>3</sup> (1 g) of tissue:            **10.1 mW/g**

averaged over 10 cm<sup>3</sup> (10 g) of tissue:            **6.60 mW/g**

### **5.2 SAR Measurement with DASY4 System**

Standard SAR-measurements were performed according to the measurement conditions described in section 4. 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:            **9.24 mW/g**

averaged over 10 cm<sup>3</sup> (10 g) of tissue:            **6.20 mW/g**

## **6. Dipole Impedance and Return Loss**

The dipole was positioned at the flat phantom sections according to section 4 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 835 MHz:             $\text{Re}\{Z\} = 45.6 \Omega$

$\text{Im}\{Z\} = -4.3 \Omega$

Return Loss at 835 MHz                        **-23.7 dB**

#### **4. Handling**

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

#### **5. Design**

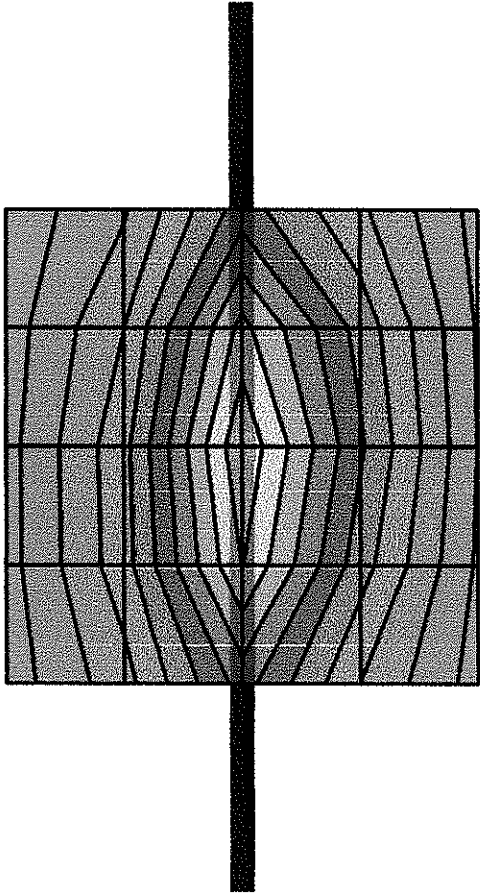
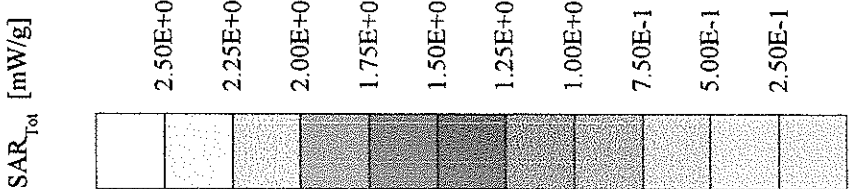
The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

#### **6. Power Test**

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

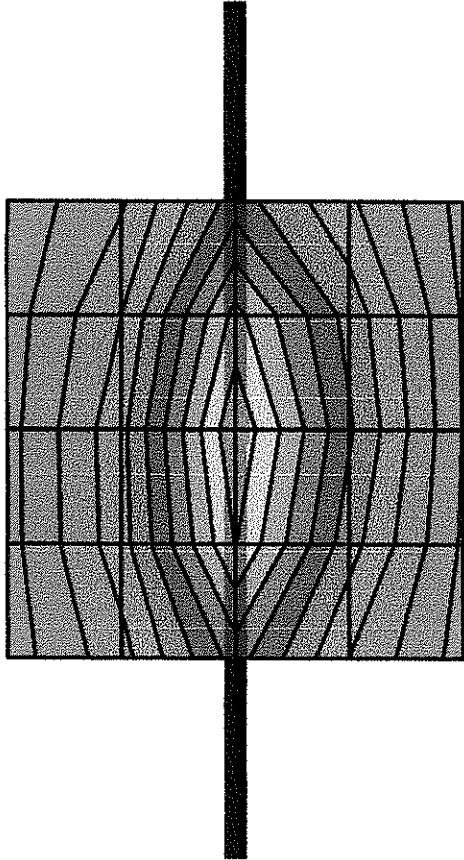
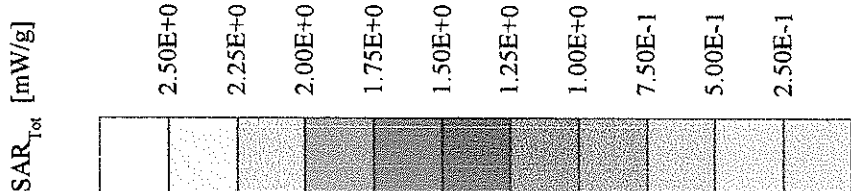
### Validation Dipole D835V2 SN455, d = 15 mm

Frequency: 835 MHz; Antenna Input Power: 250 [mW]  
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0  
Probe: ET3DV6 - SN1507; ConvF(6.60,6.60,6.60) at 835 MHz; IEEE1528 835 MHz:  $\sigma = 0.90 \text{ mho/m}$ ,  $\epsilon_r = 42.5$ ,  $\rho = 1.00 \text{ g/cm}^3$   
Cubes (2): Peak: 3.84 mW/g  $\pm$  0.02 dB, SAR (1g): 2.46 mW/g  $\pm$  0.02 dB, SAR (10g): 1.58 mW/g  $\pm$  0.01 dB, (Worst-case extrapolation)  
Penetration depth: 12.1 (11.1, 13.5) [mm]  
Powerdrift: 0.00 dB



### Validation Dipole D835V2 SN455, d = 15 mm

Frequency: 835 MHz; Antenna Input Power: 250 [mW]  
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0  
Probe: ET3DV6 - SN1507; ConvF(6.60,6.60) at 835 MHz; IEEE1528 835 MHz:  $\sigma = 0.90$  mho/m  $\epsilon_r = 42.5$   $\rho = 1.00$  g/cm<sup>3</sup>  
Cubes (2): Peak: 3.40 mW/g  $\pm 0.02$  dB, SAR (1g): 2.30 mW/g  $\pm 0.02$  dB, SAR (10g): 1.52 mW/g  $\pm 0.01$  dB, (Advanced extrapolation)  
Penetration depth: 13.1 (12.8, 13.6) [mm]  
Powerdrift: 0.00 dB



Del

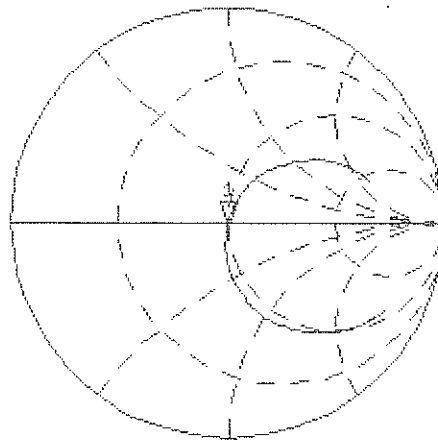
PRM

Cor

Avg

15

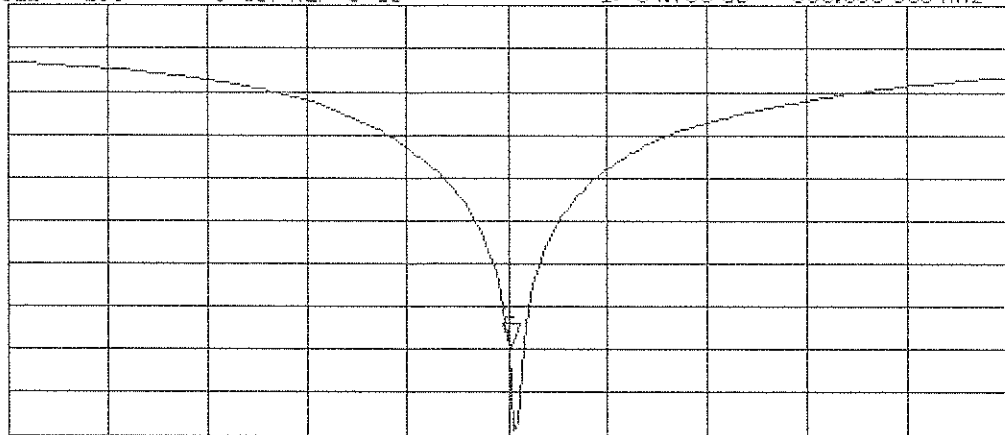
↑



CH2 S11 LOG 5 dB/REF 0 dB 1:-34.736 dB 835.000 000 MHz

PRM  
Cor

↑

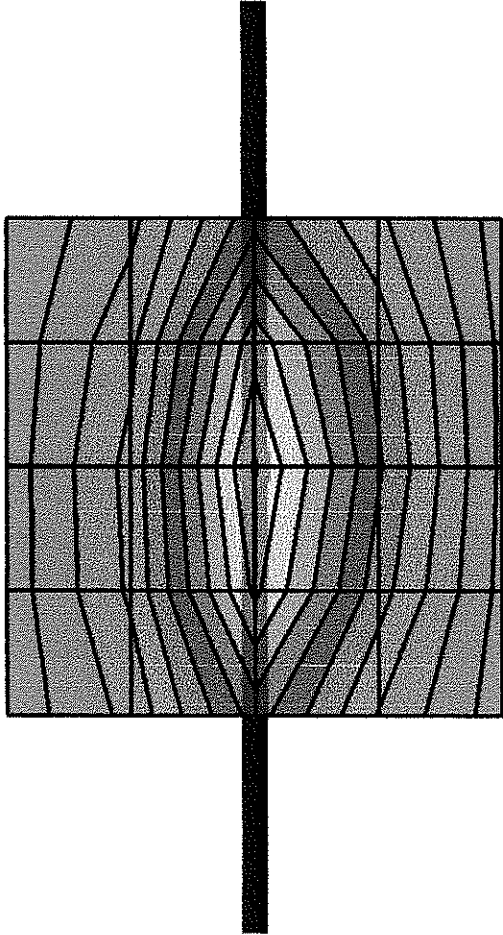
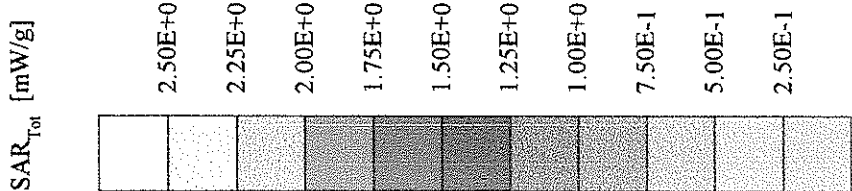


START 535.000 000 MHz

STOP 1 035.000 000 MHz

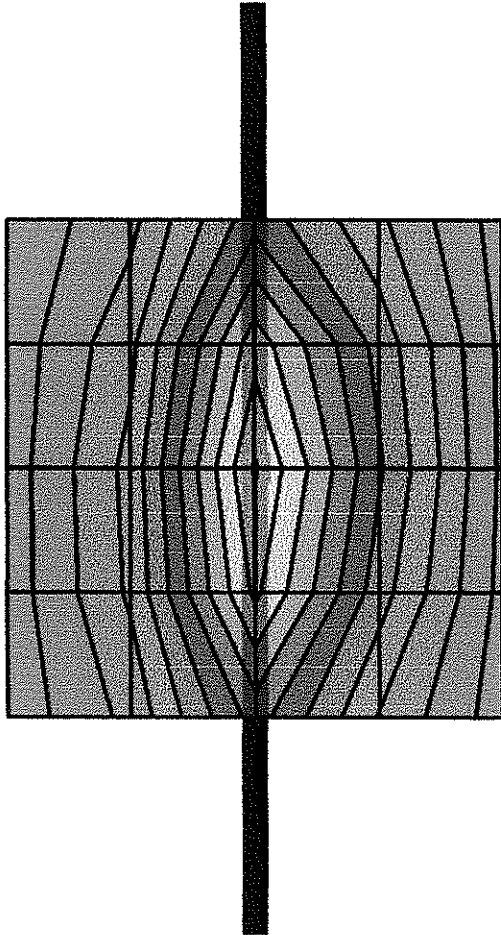
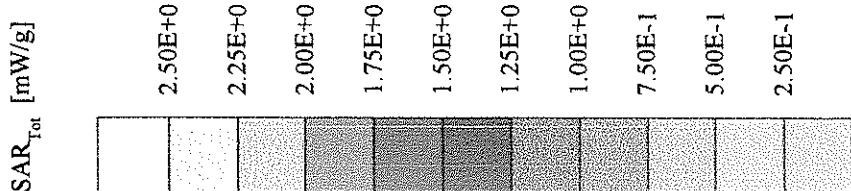
# Validation Dipole D835V2 SN455, d = 15 mm

Frequency: 835 MHz; Antenna Input Power: 250 [mW]  
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0  
Probe: ET3DV6 - SN1507; ConvF(6.20,6.20) at 835 MHz; IEEE1528 835 MHz:  $\sigma = 0.95$  mho/m  $\epsilon_r = 55.3$   $\rho = 1.00$  g/cm<sup>3</sup>  
Cubes (2): Peak: 3.91 mW/g  $\pm 0.01$  dB, SAR (1g): 2.53 mW/g  $\pm 0.01$  dB, SAR (10g): 1.65 mW/g  $\pm 0.01$  dB, (Worst-case extrapolation)  
Penetration depth: 12.7 (11.6, 14.2) [mm]  
Powerdrift: 0.01 dB



# Validation Dipole D835V2 SN455, d = 15 mm

Frequency: 835 MHz; Antenna Input Power: 250 [mW]  
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0  
Probe: ET3DV6 - SN1507; ConvF(6.20,6.20,6.20) at 835 MHz; IEEE1528 835 MHz:  $\sigma = 0.95 \text{ mho/m}$   $\epsilon_r = 55.3$   $\rho = 1.00 \text{ g/cm}^3$   
Cubes (2): Peak: 3.30 mW/g  $\pm 0.01 \text{ dB}$ , SAR (1g): 2.31 mW/g  $\pm 0.01 \text{ dB}$ , SAR (10g): 1.55 mW/g  $\pm 0.01 \text{ dB}$ , (Advanced extrapolation)  
Penetration depth: 14.3 (14.2, 14.5) [mm]  
Powerdrift: 0.01 dB

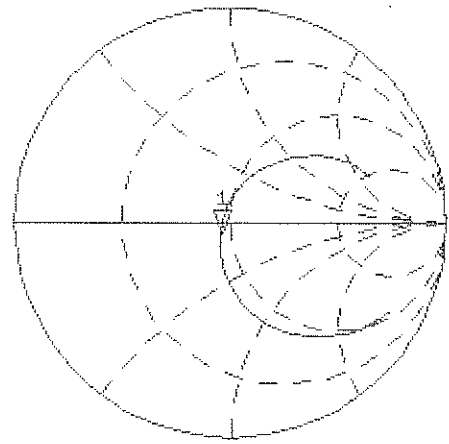




Del

PRm  
Cor  
Avg  
16

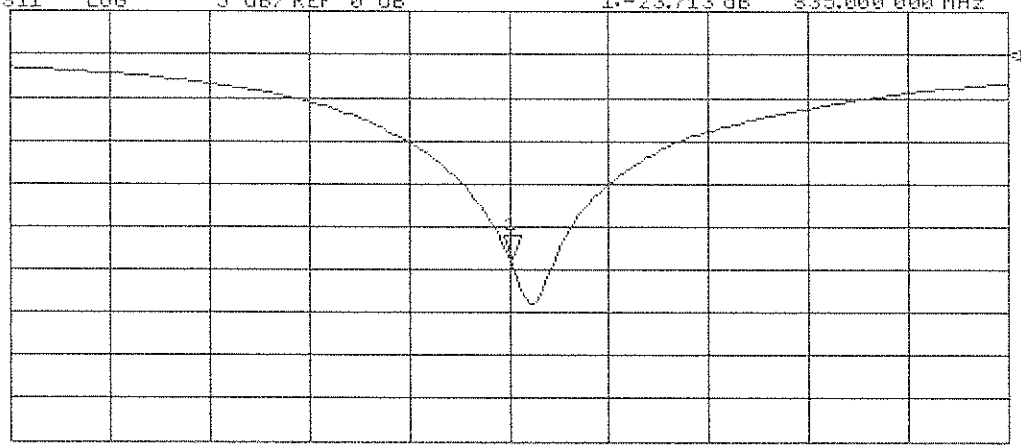
↑



CH2 S11 LOG 5 dB/REF 0 dB 1:-23.713 dB 835.000 000 MHz

PRm  
Cor

↑



START 635.000 000 MHz

STOP 1 835.000 000 MHz

**Client**      **Nokia Inc. Texas**

## CALIBRATION CERTIFICATE

Object(s)      **D835V2 - SN:487**

Calibration procedure(s)      **QA CAL-05.v2  
Calibration procedure for dipole validation kits**

Calibration date:      **May 26, 2003**



Condition of the calibrated item      **In Tolerance (according to the specific calibration document)**

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
RF generator R&S SML-03	100698	27-Mar-2002 (R&S, No. 20-92389)	In house check: Mar-05
Power sensor HP 8481A	MY41092317	18-Oct-02 (Agilent, No. 20021018)	Oct-04
Power sensor HP 8481A	US37292783	30-Oct-02 (METAS, No. 252-0236)	Oct-03
Power meter EPM E442	GB37480704	30-Oct-02 (METAS, No. 252-0236)	Oct-03
Network Analyzer HP 8753E	US38432426	3-May-00 (Agilent, No. 8702K064602)	In house check: May 03

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

Date issued: May 26, 2003

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

# DASY

## Dipole Validation Kit

Type: D835V2

Serial: 487

Manufactured: May 19, 2003

Calibrated: May 26, 2003

## **1. Measurement Conditions**

The measurements were performed in the flat section of the SAM twin phantom filled with head simulating solution of the following electrical parameters at 835 MHz:

Relative Dielectricity	<b>42.8</b>	$\pm 5\%$
Conductivity	<b>0.89 mho/m</b>	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.7 at 835 MHz) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

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

The dipole input power (forward power) was  $250 \text{ mW} \pm 3 \%$ . 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 $1 \text{ cm}^3$ (1 g) of tissue:	<b>9.80 mW/g <math>\pm 16.8 \%</math> (k=2)<sup>1</sup></b>
averaged over $10 \text{ cm}^3$ (10 g) of tissue:	<b>6.40 mW/g <math>\pm 16.2 \%</math> (k=2)<sup>1</sup></b>

---

<sup>1</sup> validation uncertainty

### **3. Dipole Impedance and Return Loss**

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	<b>1.387 ns</b>	(one direction)
Transmission factor:	<b>0.990</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 835 MHz:	$\text{Re}\{Z\} = 51.4 \Omega$
---------------------------------	--------------------------------

$\text{Im}\{Z\} = -0.6 \Omega$
--------------------------------

Return Loss at 835 MHz	<b>-36.6 dB</b>
------------------------	-----------------

### **4. Handling**

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

### **5. Design**

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

### **6. Power Test**

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

Date/Time: 05/26/03 17:53:50

Test Laboratory: SPEAG, Zurich, Switzerland  
 File Name: SN487\_SN1507\_HSL835\_260503.da4

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN487**  
**Program: Dipole Calibration**

Communication System: CW-835; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: HSL 835 MHz ( $\sigma = 0.89$  mho/m,  $\epsilon_r = 42.8$ ,  $\rho = 1000$  kg/m<sup>3</sup>)

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.7, 6.7, 6.7); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN411; Calibrated: 1/16/2003
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

**Pin = 250 mW; d = 15 mm/Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm

Reference Value = 56.4 V/m

Power Drift = 0.004 dB

Maximum value of SAR = 2.63 mW/g

**Pin = 250 mW; d = 15 mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

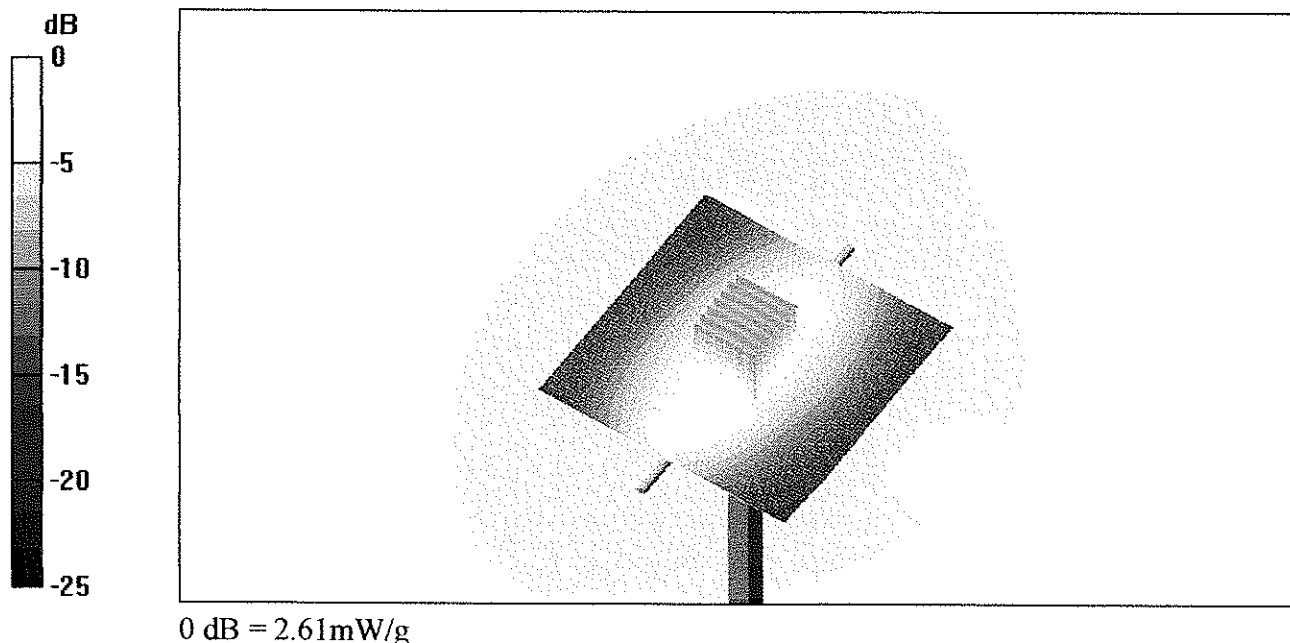
Peak SAR (extrapolated) = 3.57 W/kg

SAR(1 g) = 2.45 mW/g; SAR(10 g) = 1.6 mW/g

Reference Value = 56.4 V/m

Power Drift = 0.004 dB

Maximum value of SAR = 2.61 mW/g



26 May 2003 14:35:27

CH1 S11 1 U FS 1: 51.393  $\Omega$  -552.73 m $\Omega$  344.84 pF 835.000 000 MHz

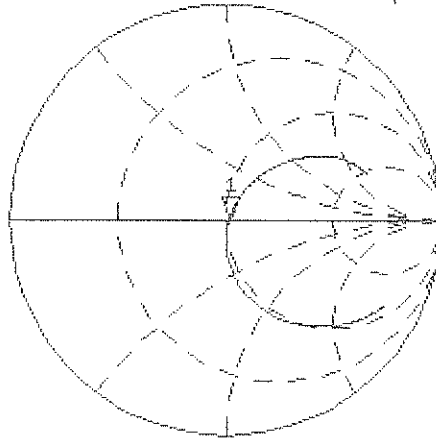
$\gamma$

Del

PRm

Cor  
Avg  
16

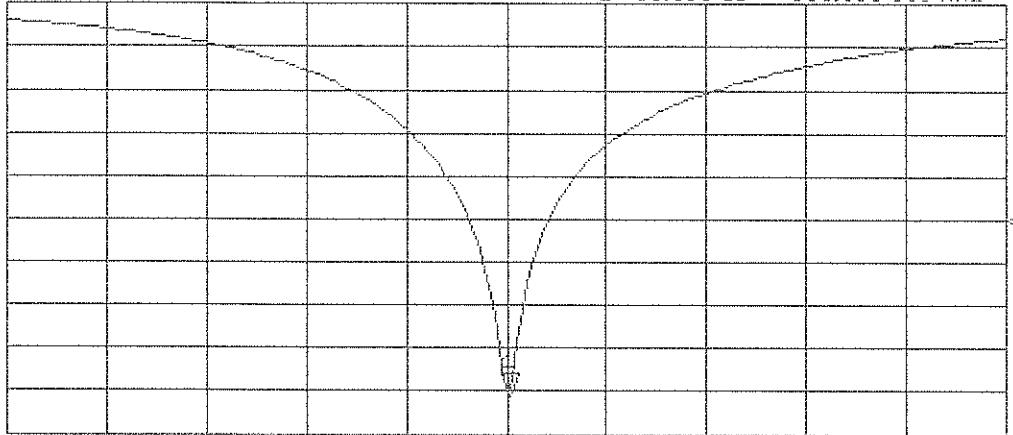
↑



CH2 S11 LOG 4 dB/REF -20 dB 1: -36.638 dB 835.000 000 MHz

PRm  
Cor

↑



CENTER 835.000 000 MHz

SPAN 400.000 000 MHz

Client

Nokia Inc. Texas

## CALIBRATION CERTIFICATE

Object(s) D835V2 - SN:487

Calibration procedure(s) QA CAL-05 v2  
Calibration procedure for dipole validation kits

Calibration date: July 17, 2003



Condition of the calibrated item In Tolerance (according to the specific calibration document)

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
RF generator R&S SML-03	100698	27-Mar-2002 (R&S, No. 20-92389)	In house check: Mar-05
Power sensor HP 8481A	MY41092317	18-Oct-02 (Agilent, No. 20021018)	Oct-04
Power sensor HP 8481A	US37292783	30-Oct-02 (METAS, No. 252-0236)	Oct-03
Power meter EPM E442	GB37480704	30-Oct-02 (METAS, No. 252-0236)	Oct-03
Network Analyzer HP 8753E	US37390585	18-Oct-01 (Agilent, No. 24BR1033101)	In house check: Oct 03

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

Date issued: July 17, 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.



# DASY

## Dipole Validation Kit

Type: D835V2

Serial: 487

Manufactured: May 19, 2003

Calibrated: July 17, 2003

## 1. 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 835 MHz:

Relative Dielectricity	<b>54.03</b>	$\pm 5\%$
Conductivity	<b>0.96 mho/m</b>	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.3 at 835 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 spacer 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.

## 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 $1 \text{ cm}^3$ (1 g) of tissue:	<b>10.1 mW/g</b> $\pm 16.8 \%$ (k=2) <sup>1</sup>
averaged over $10 \text{ cm}^3$ (10 g) of tissue:	<b>6.64 mW/g</b> $\pm 16.2 \%$ (k=2) <sup>1</sup>

### **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>1.387 ns</b>	(one direction)
Transmission factor:	<b>0.990</b>	(voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance spacer was in place during impedance measurements.

Feedpoint impedance at 835 MHz:	$\text{Re}\{Z\} = 48.4 \, \Omega$
---------------------------------	-----------------------------------

	$\text{Im}\{Z\} = -4.0 \, \Omega$
--	-----------------------------------

Return Loss at 835 MHz	<b>-27.2 dB</b>
------------------------	-----------------

### **4. Handling**

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

### **5. Design**

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

### **6. Power Test**

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

Date/Time: 07/17/03 17:15:44

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN487\_SN1507\_M835\_170703.da4

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN487**  
**Program: Dipole Calibration**

Communication System: CW-835; Frequency: 835 MHz; Duty Cycle: 1:1  
Medium: Muscle 835 MHz ( $\sigma = 0.96$  mho/m,  $\epsilon_r = 54.03$ ,  $\rho = 1000$  kg/m<sup>3</sup>)  
Phantom section: Flat Section  
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.3, 6.3, 6.3); Calibrated: 1/18/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN411; Calibrated: 1/16/2003
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

**Pin = 250 mW; d = 15 mm/Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm

Reference Value = 55.2 V/m

Power Drift = 0.009 dB

Maximum value of SAR = 2.7 mW/g

**Pin = 250 mW; d = 15 mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

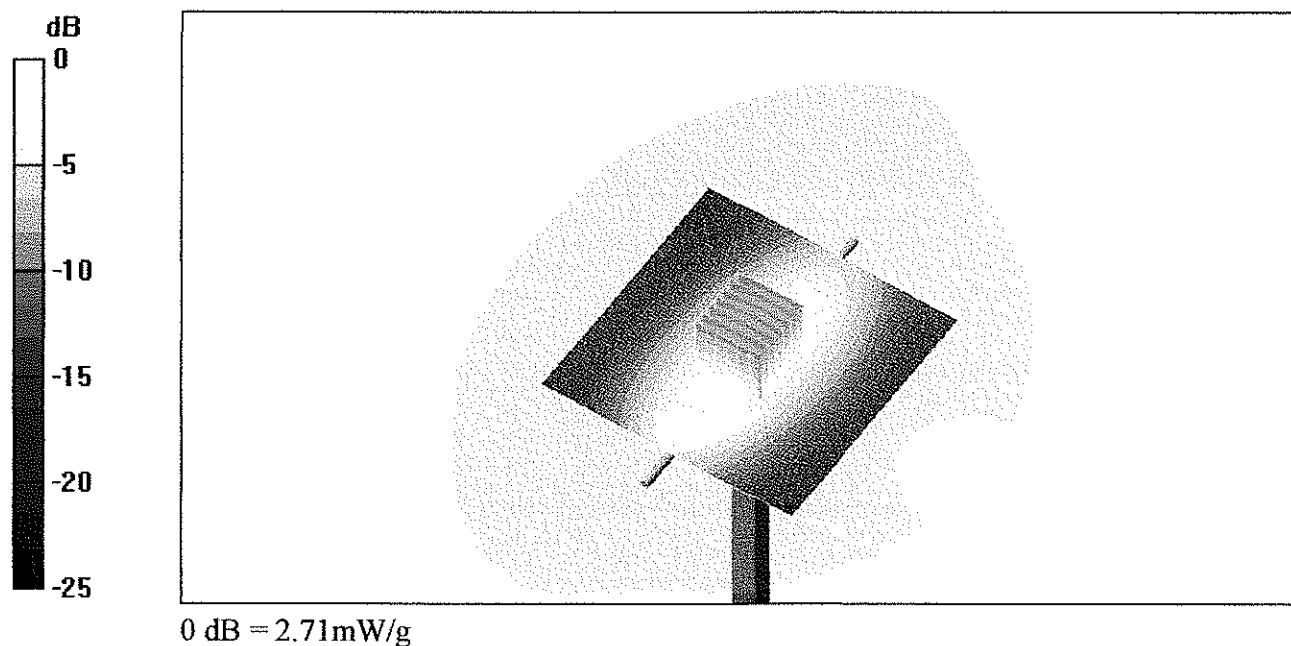
Peak SAR (extrapolated) = 3.62 W/kg

SAR(1 g) = 2.52 mW/g; SAR(10 g) = 1.66 mW/g

Reference Value = 55.2 V/m

Power Drift = 0.009 dB

Maximum value of SAR = 2.71 mW/g



487

Body

CH1 S11 1 U FS 17 Jul 2003 15:28:37  
1: 48.363  $\Omega$  -4.0430  $\Omega$  47.145 pF 835.000 000 MHz

De1

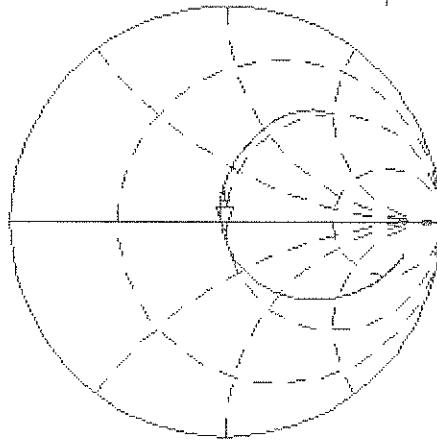
PRm

Cor

Avg

16

↑

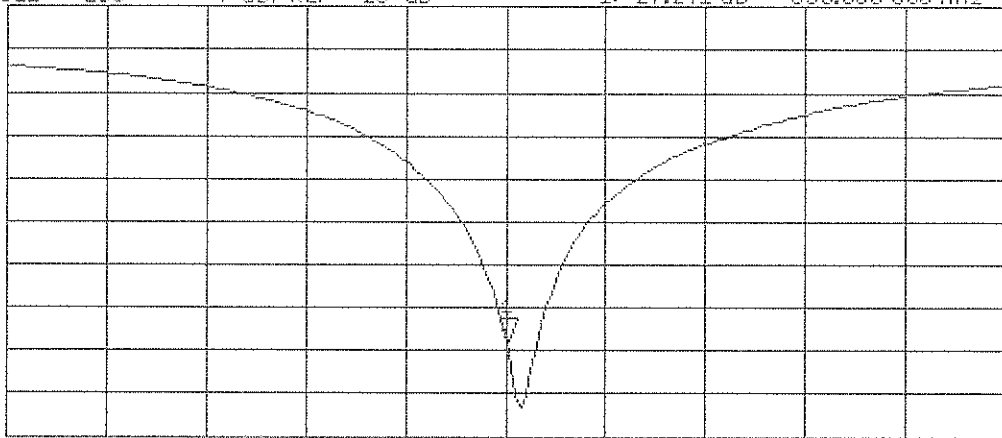


CH2 S11 LOG 4 dB/REF -20 dB 1:-27.241 dB 835.000 000 MHz

PRm

Cor

↑



# Schmid & Partner Engineering AG

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

## Calibration Certificate

### 900 MHz System Validation Dipole

Type:

**D900V2**

Serial Number:

**025**

Place of Calibration:

**Zurich**

Date of Calibration:

**October 23, 2001**

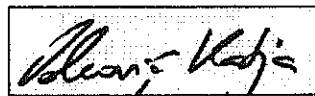
Calibration Interval:

**24 months**

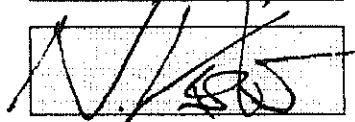
Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

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:



**Schmid & Partner  
Engineering AG**

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

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**DASY**

**Dipole Validation Kit**

**Type: D900V2**

**Serial: 025**

**Manufactured: November 12, 1997**  
**Calibrated: October 23, 2001**

## **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>41.5</b>	$\pm 5\%$
Conductivity	<b>0.97 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:      **11.36 mW/g**

averaged over 10 cm<sup>3</sup> (10 g) of tissue:      **7.20 mW/g**

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>1.401 ns</b>	(one direction)
Transmission factor:	<b>0.993</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:	$\text{Re}\{Z\} = 49.2 \, \Omega$
---------------------------------	-----------------------------------

$\text{Im}\{Z\} = -3.6 \, \Omega$
-----------------------------------

Return Loss at 900 MHz	<b>-28.7 dB</b>
------------------------	-----------------

### **4. Handling**

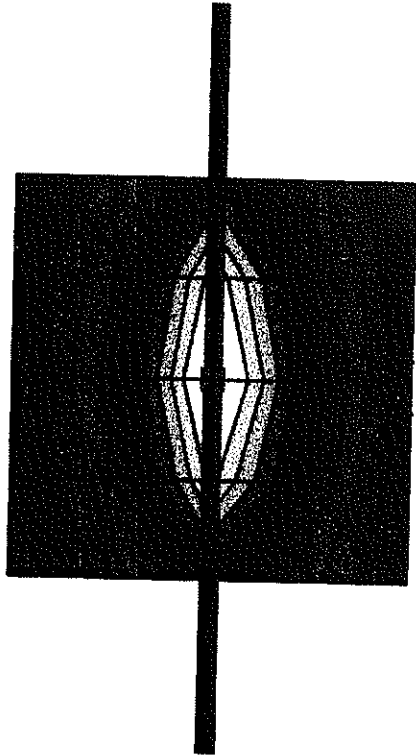
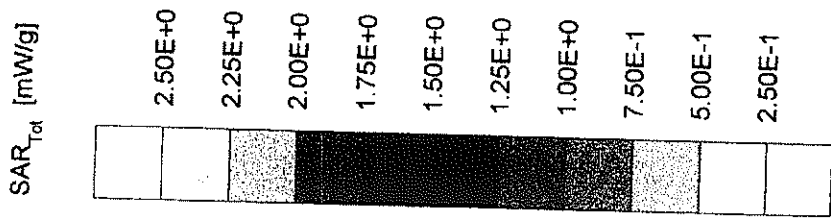
The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

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:025, d = 15 mm

Frequency: 900 MHz; Antenna Input Power: 250 [mW]  
AM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0  
Probe: ET3DV6 - SN1507; ConvF(6.27,6.27,6.27) at 900 MHz; IEEE1528 900 MHz;  $\sigma = 0.97 \text{ mho/m}$   $\epsilon_r = 41.5$   $\rho = 1.00 \text{ g/cm}^3$   
Tubes (2): Peak: 4.59 mW/g  $\pm 0.00 \text{ dB}$ , SAR (1g): 2.84 mW/g  $\pm 0.00 \text{ dB}$ , SAR (10g): 1.80 mW/g  $\pm 0.00 \text{ dB}$ , (Worst-case extrapolation)  
Penetration depth: 11.5 (10.3, 13.2) [mm]  
Overdrift: 0.03 dB



CH1 S11 1 U FS

23 Oct 2001 11:33:53

1: 49.238  $\Omega$  -3.6133  $\Omega$  48.341 pF

900.000 000 MHz

De1

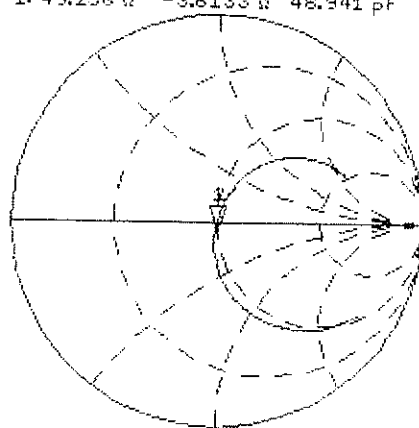
PRM

Cor

Avg

16

↑



CH2 S11 LOG

5 dB/REF 0 dB

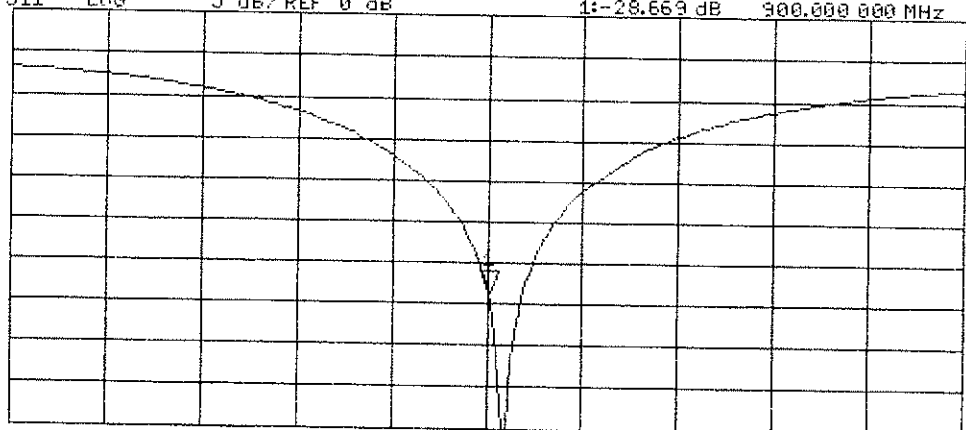
1:-28.663 dB

900.000 000 MHz

PRM

Cor

↑



START 700.000 000 MHz

STOP 1 1100.000 000 MHz