Appendix C: probe and dipole calibration parameters

Schmid & Partner Engineering AG

s p e a g

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Probe ET3DV6

SN:1618

Manufactured:	January 25, 2002
Last calibration:	March 24, 2003
Repaired:	September 26, 2003
Recalibrated:	October 10, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ET3DV6 SN:1618

Sensitivity in Free Space

NormX	**1.59**	$\mu V/(V/m)^2$
NormY	**1.77**	$\mu V/(V/m)^2$
NormZ	**1.85**	$\mu V/(V/m)^2$

Diode Compression

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

Sensitivity in Tissue Simulating Liquid

Head 900 MHz ε_r = 41.5 ± 5% σ = 0.97 ± 5% mho/m

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

ConvF X	6.9	± 9.5% (k=2)	Boundary effect:	
ConvF Y	6.9	± 9.5% (k=2)	Alpha	**0.25**
ConvF Z	6.9	± 9.5% (k=2)	Depth	**3.72**

Head 1800 MHz ε_r = 40.0 ± 5% σ = 1.40 ± 5% mho/m

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

ConvF X	5.3	± 9.5% (k=2)	Boundary effect:	
ConvF Y	5.3	± 9.5% (k=2)	Alpha	**0.45**
ConvF Z	5.3	± 9.5% (k=2)	Depth	**2.81**

Boundary Effect

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

Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	11.1	7.0
SAR_{be} [%]	With Correction Algorithm	0.7	0.7

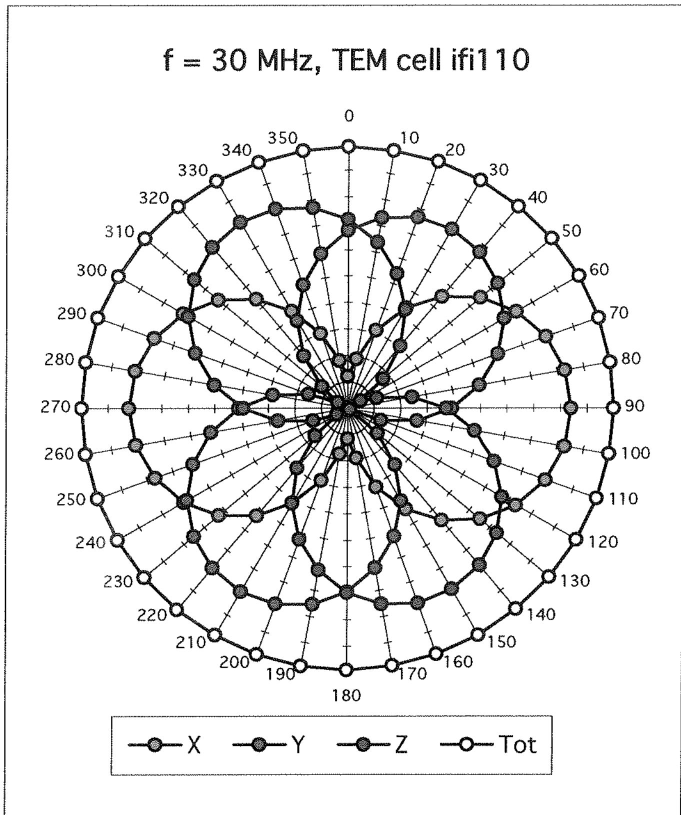
Head **1800** MHz **Typical SAR gradient: 10 % per mm**

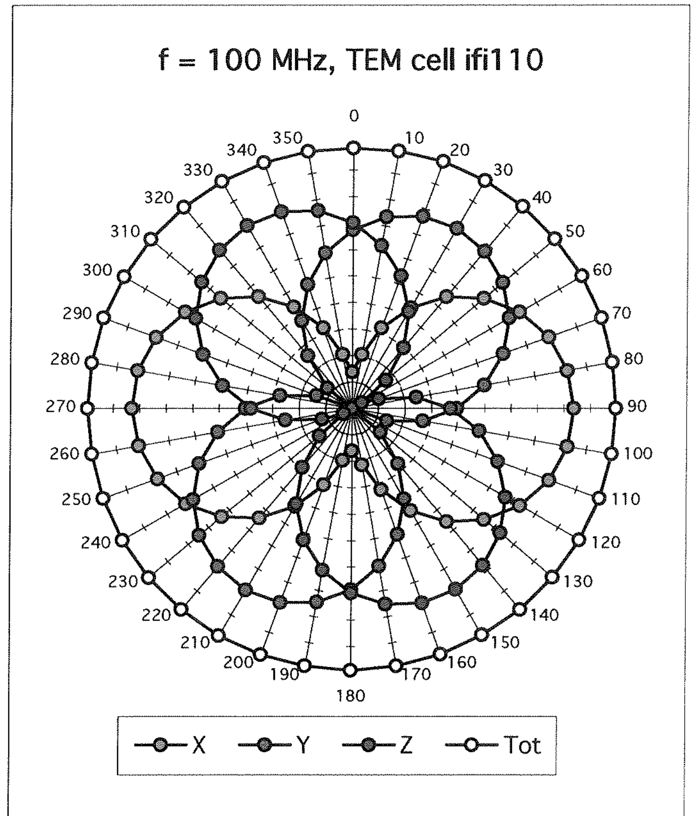
Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	13.3	9.3
SAR_{be} [%]	With Correction Algorithm	0.2	0.2

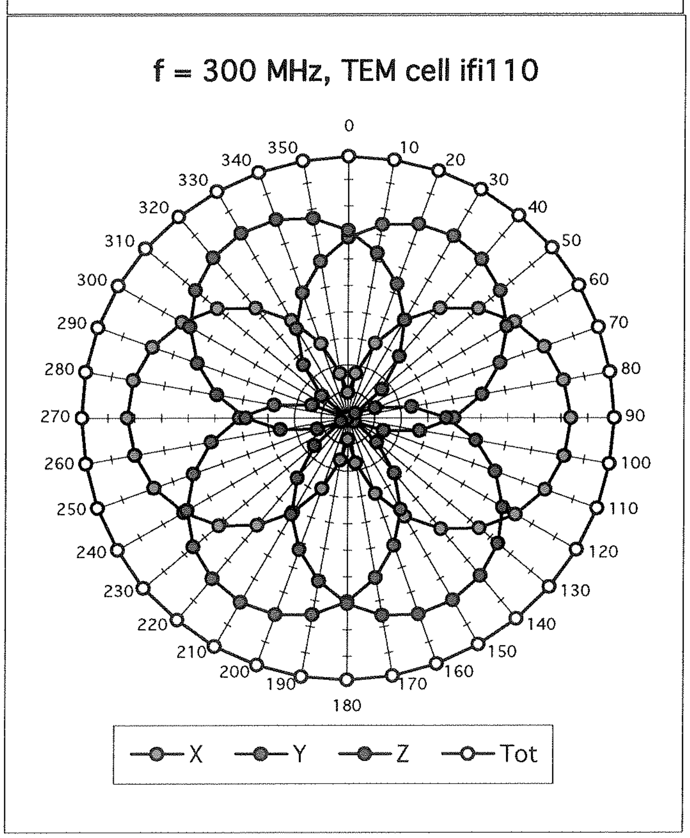
Sensor Offset

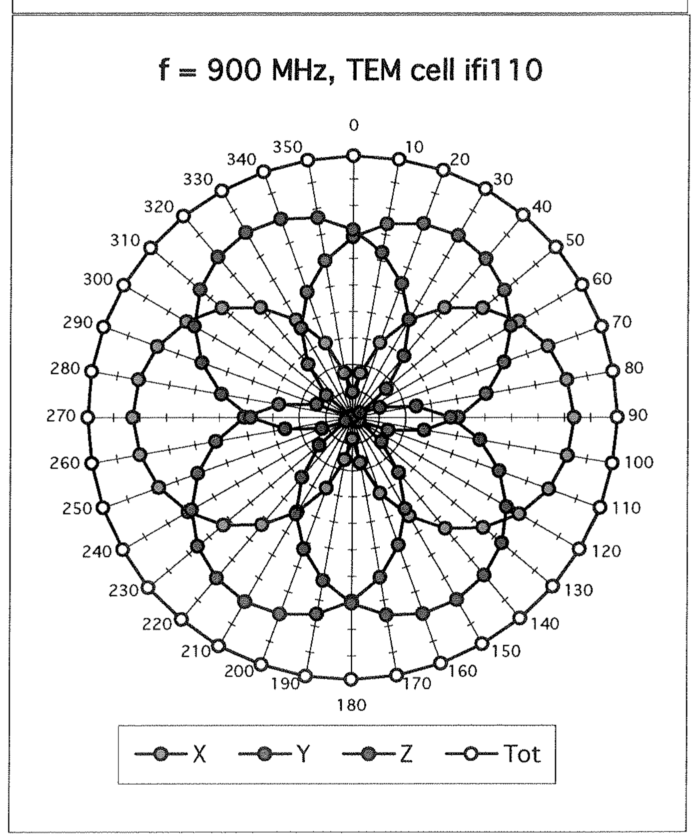
Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.6 ± 0.2**	mm

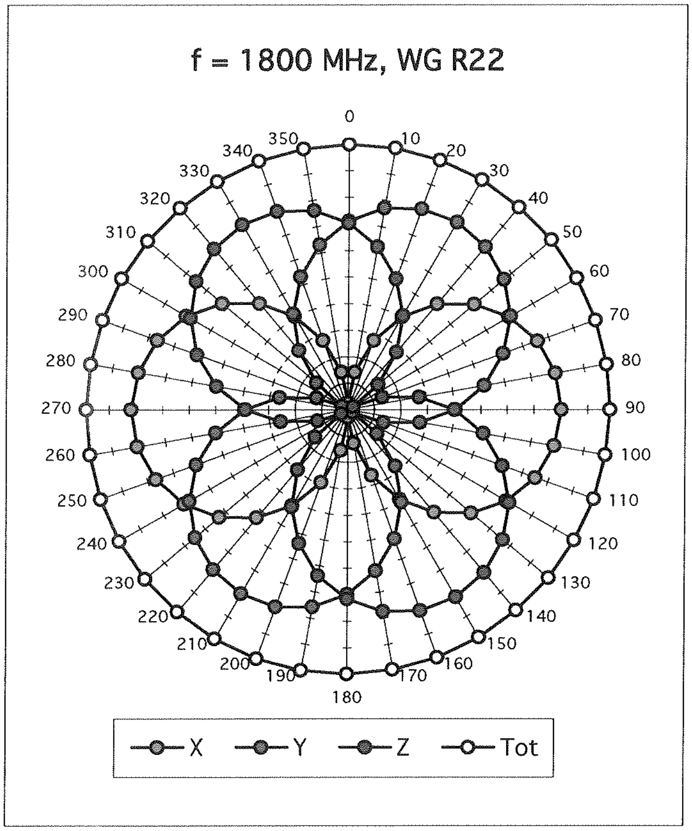
Receiving Pattern (ϕ), θ = 0°

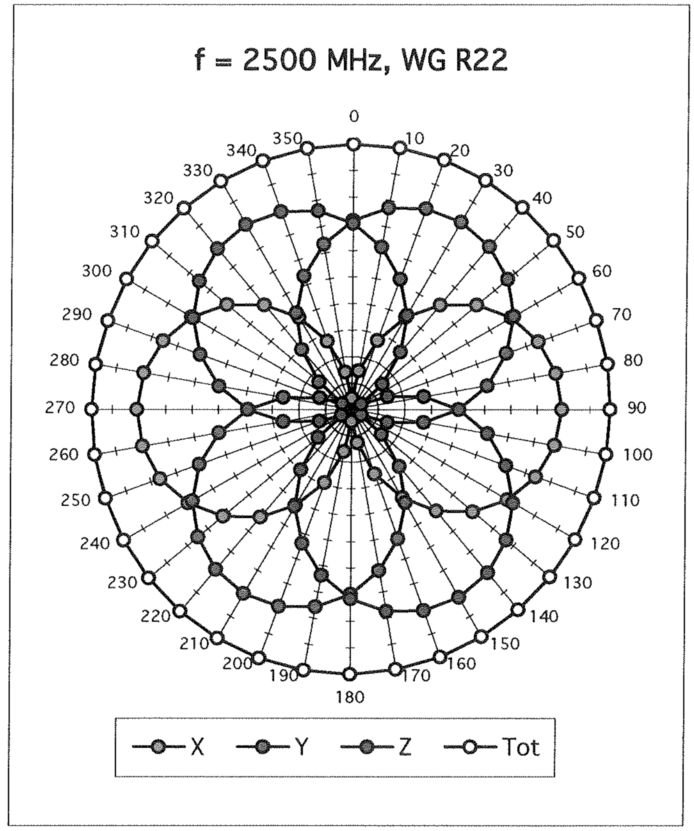




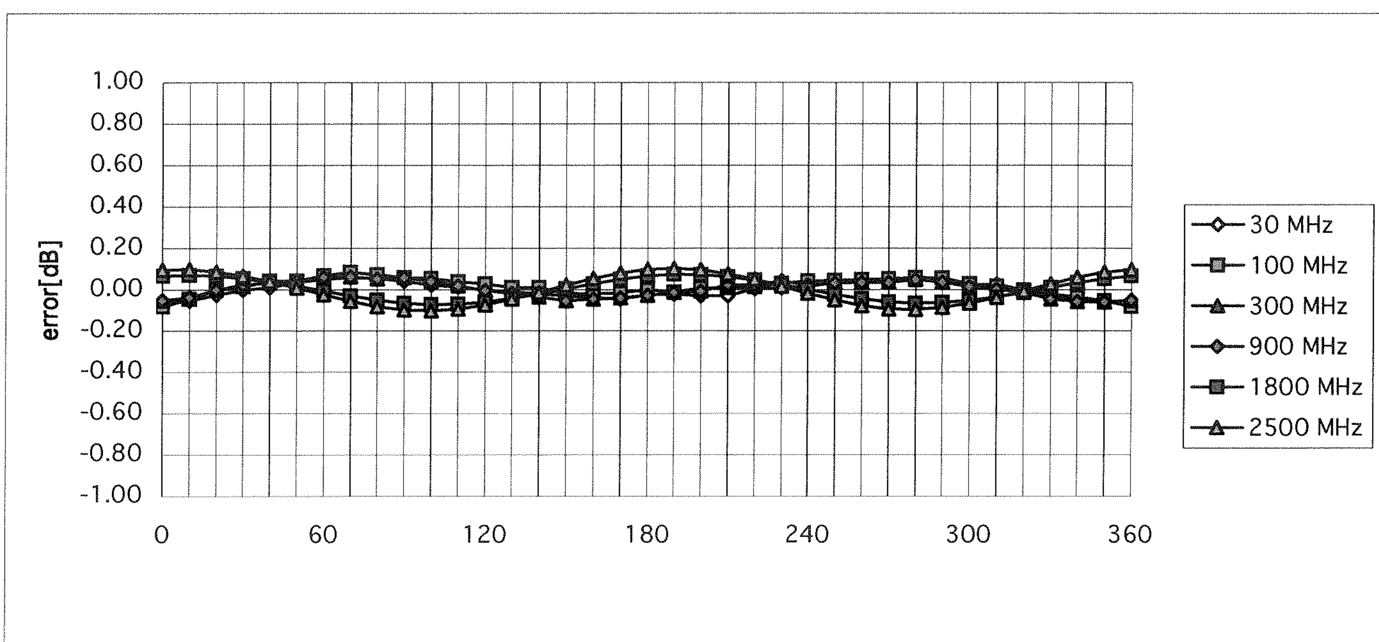






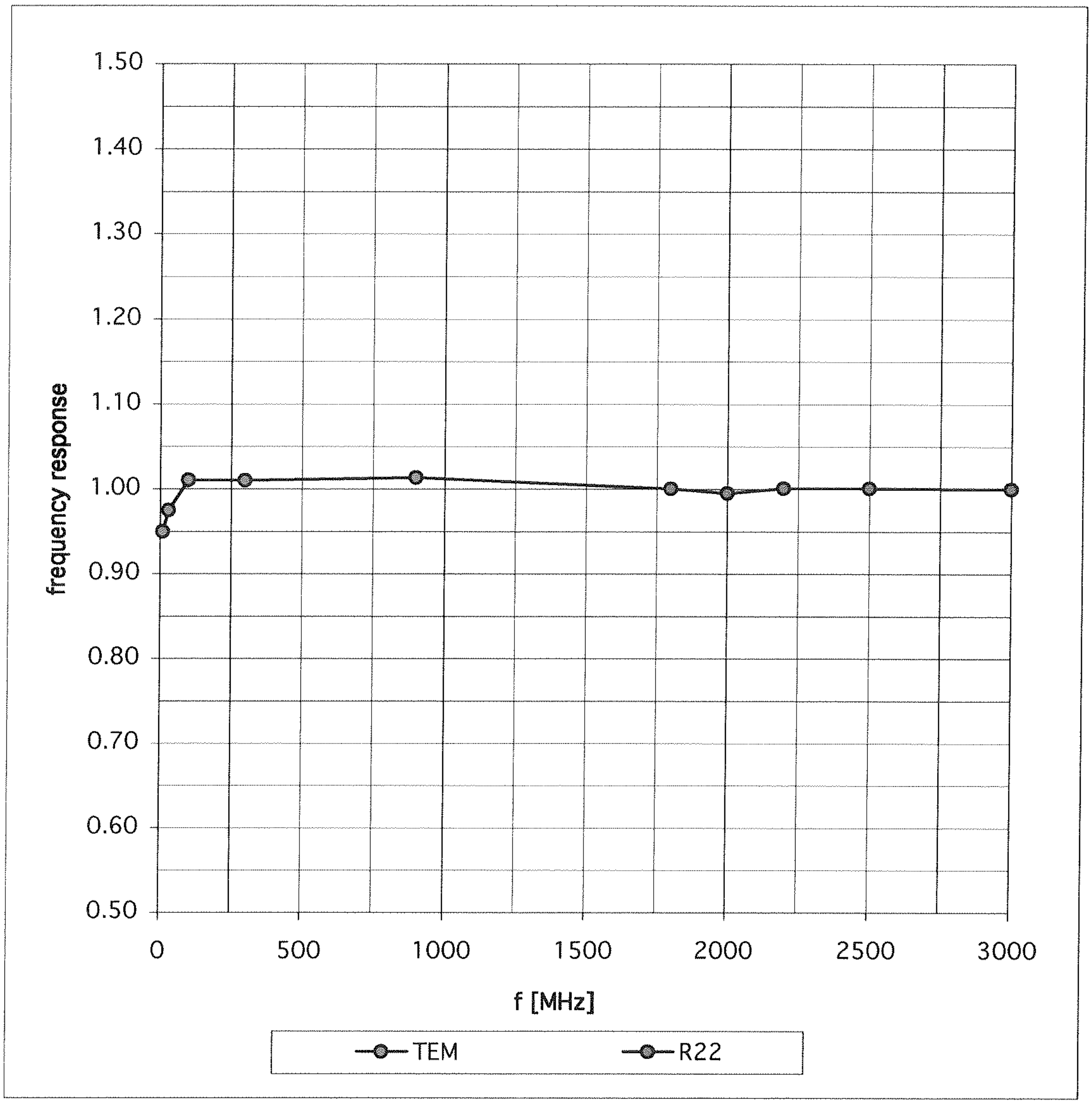


Isotropy Error (ϕ), θ = 0°



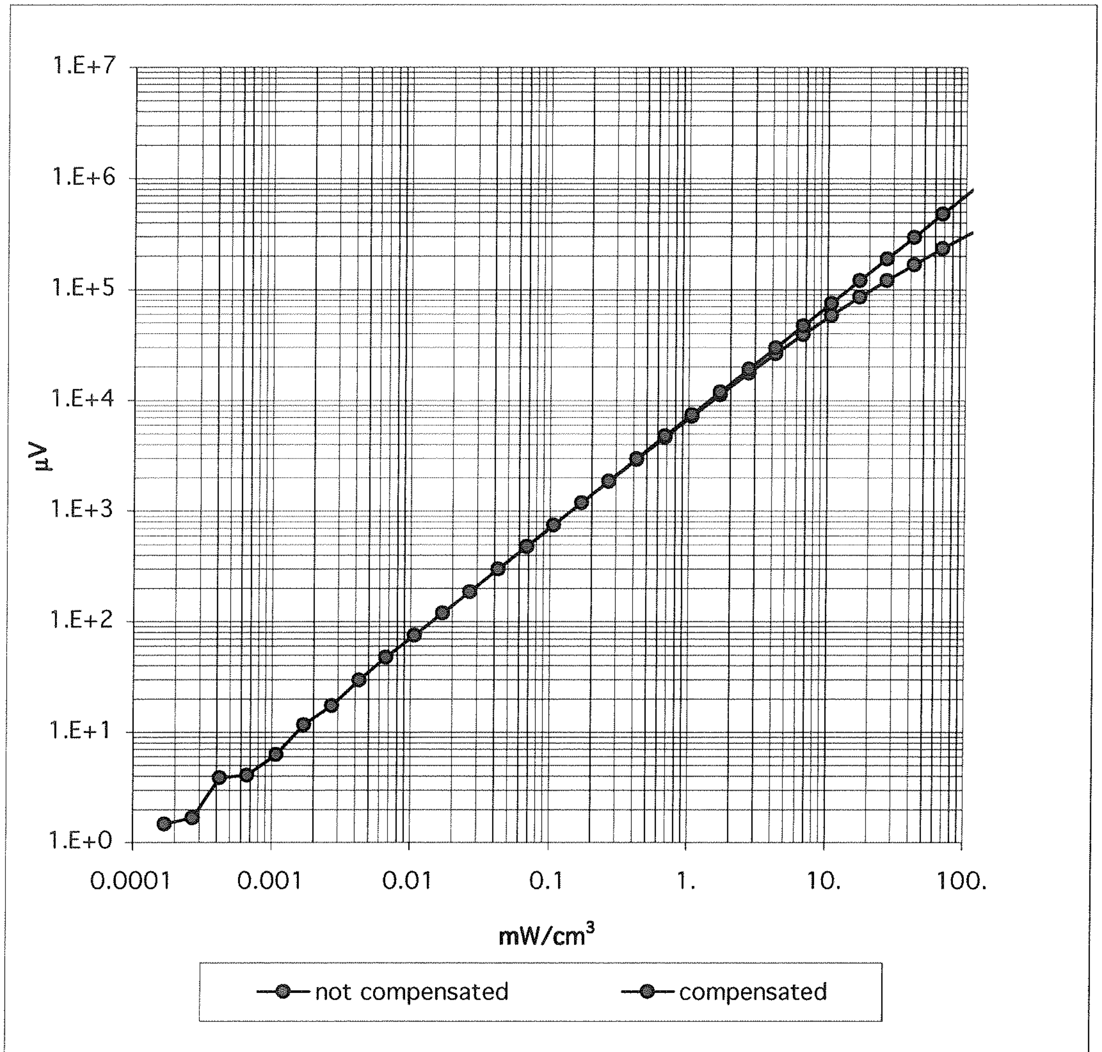
Frequency Response of E-Field

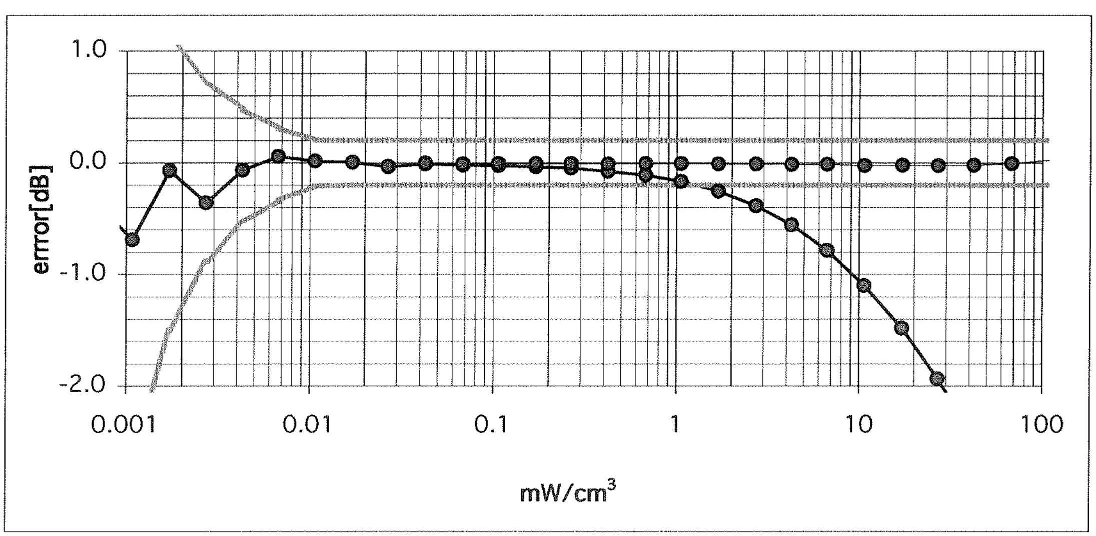
(TEM-Cell:ifi110, Waveguide R22)



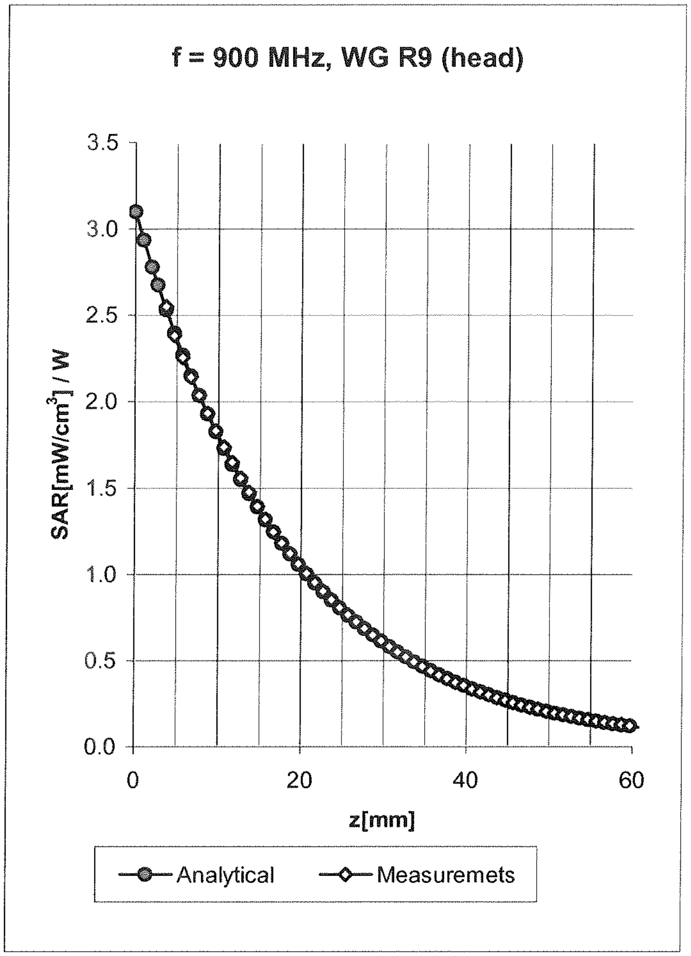
Dynamic Range f(SARhead)

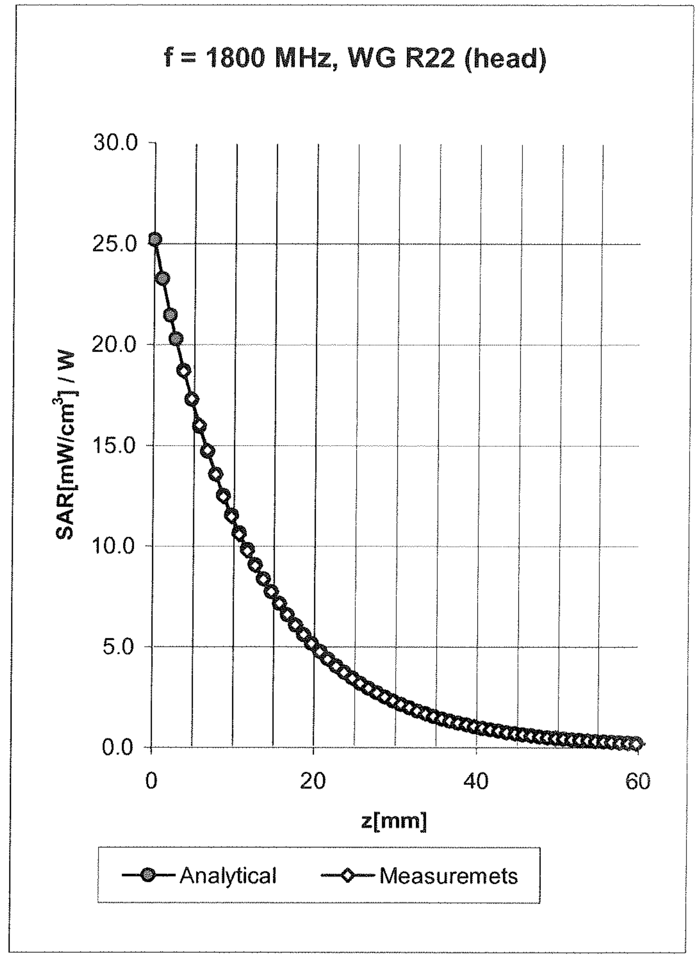
(Waveguide R22)





Conversion Factor Assessment





Head	900 MHz	ε_r = 41.5 ± 5%	σ = 0.97 ± 5% mho/m

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

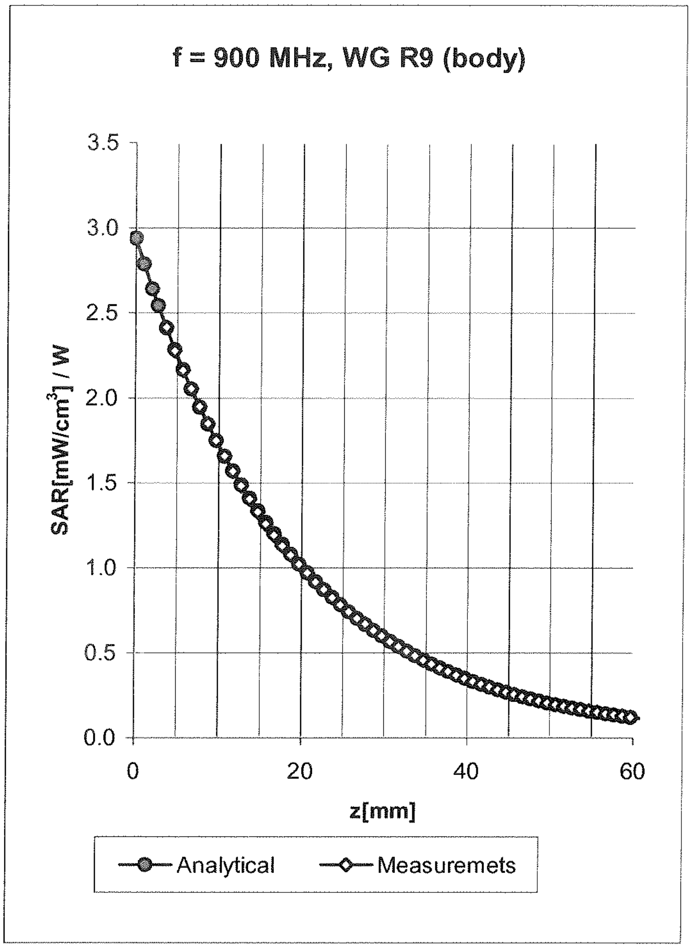
ConvF X	**6.9**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.9**	± 9.5% (k=2)	Alpha	**0.25**
ConvF Z	**6.9**	± 9.5% (k=2)	Depth	**3.72**

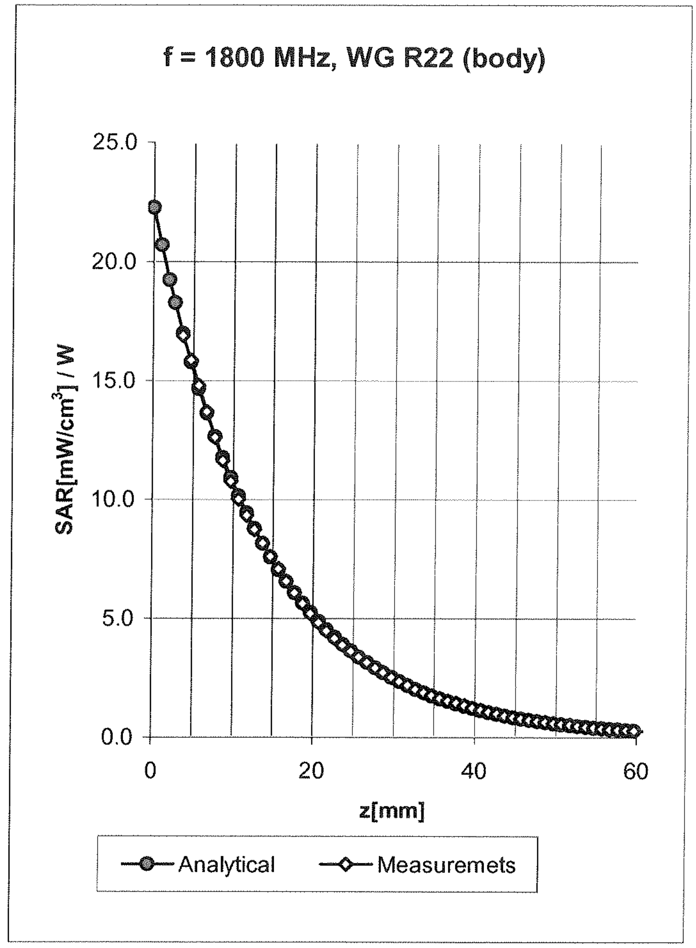
Head	1800 MHz	ε_r = 40.0 ± 5%	σ = 1.40 ± 5% mho/m

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

ConvF X	**5.3**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.3**	± 9.5% (k=2)	Alpha	**0.45**
ConvF Z	**5.3**	± 9.5% (k=2)	Depth	**2.81**

Conversion Factor Assessment





Body	900 MHz	ε_r = 55.0 ± 5%	σ = 1.05 ± 5% mho/m

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

ConvF X	**6.6**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.6**	± 9.5% (k=2)	Alpha	**0.38**
ConvF Z	**6.6**	± 9.5% (k=2)	Depth	**2.52**

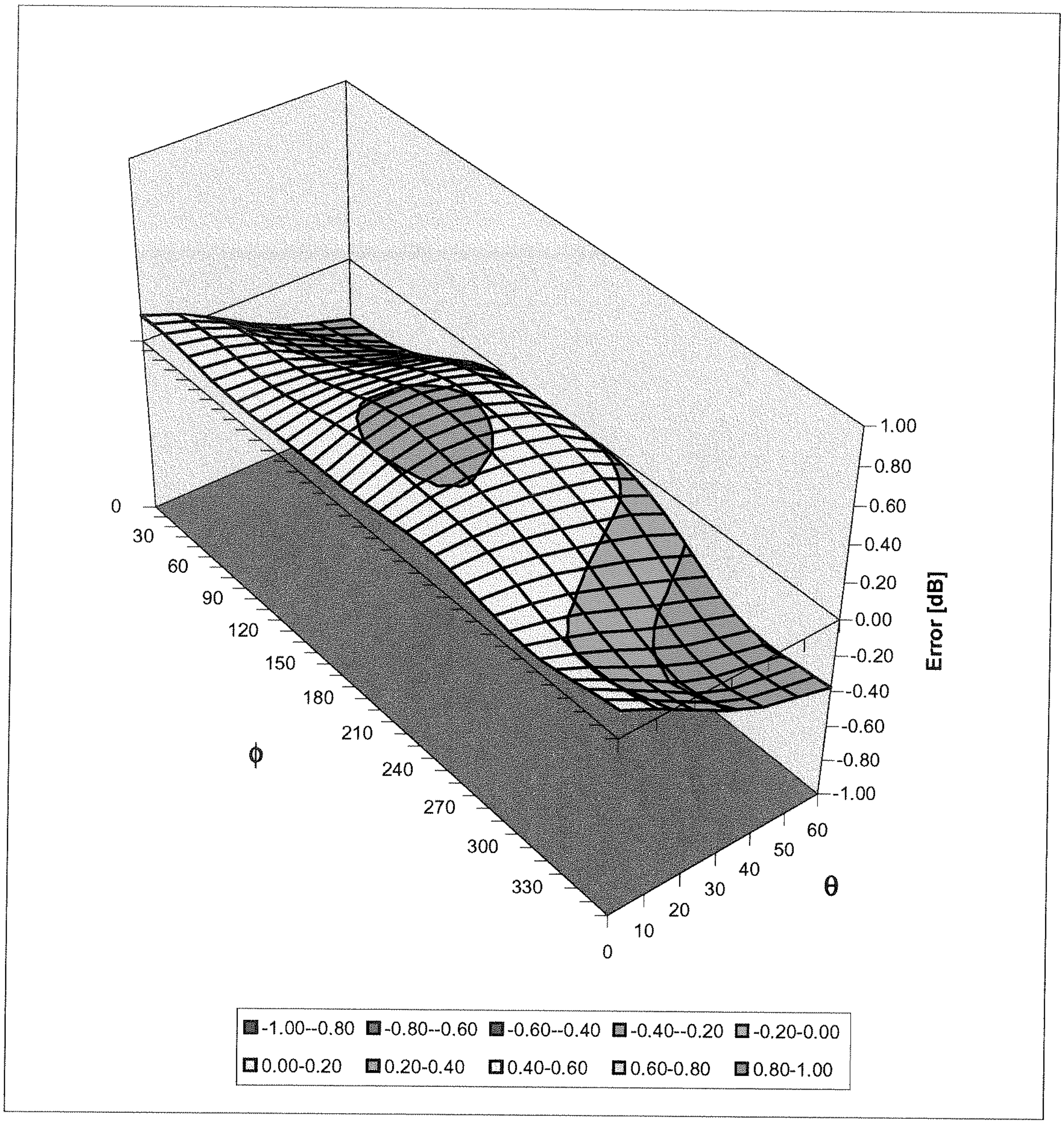
Body	1800 MHz	ε_r = 53.3 ± 5%	σ = 1.52 ± 5% mho/m

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

ConvF X	**4.9**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**4.9**	± 9.5% (k=2)	Alpha	**0.52**
ConvF Z	**4.9**	± 9.5% (k=2)	Depth	**2.76**

Deviation from Isotropy in HSL

Error (θ,φ), f = 900 MHz



Schmid & Partner
Engineering AG

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Calibration Certificate

1900 MHz System Validation Dipole

Type:	**D1900V2**
Serial Number:	**5d005**
Place of Calibration:	**Zurich**
Date of Calibration:	**February 20, 2002**
Calibration Interval:	**24 months**

asset#
039930

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 Nico

Approved by: [signature]

Schmid & Partner
Engineering AG

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

DASY3

Dipole Validation Kit

Type: D1900V2

Serial: 5d005

Manufactured: February 14, 2002
Calibrated: February 20, 2002

1. Measurement Conditions

The measurements were performed in the flat section of the new generic twin phantom filled with brain simulating sugar solution of the following electrical parameters at 1900 MHz:

Relative permitivity	**39.1**	± 5%
Conductivity	**1.47 mho/m**	± 10%

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.3) 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 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 ± 3 %. The results are normalized 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 normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

averaged over 1 cm^3 (1 g) of tissue:	**45.6 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**23.1 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. The estimated sensitivities of SAR-values and penetration depths to the liquid parameters are listed in the DASY Application Note 4: 'SAR Sensitivities'.

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:	**1.182 ns**	(one direction)
Transmission factor:	**0.996**	(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 1900 MHz:	Re{Z} = **50.9 Ω**
	Im {Z} = **2.4 Ω**
Return Loss at 1900 MHz	**- 32.0 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.

Small end caps have been added to the dipole arms in order to improve matching when loaded according to the position as explained in Section 1. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

5. Design

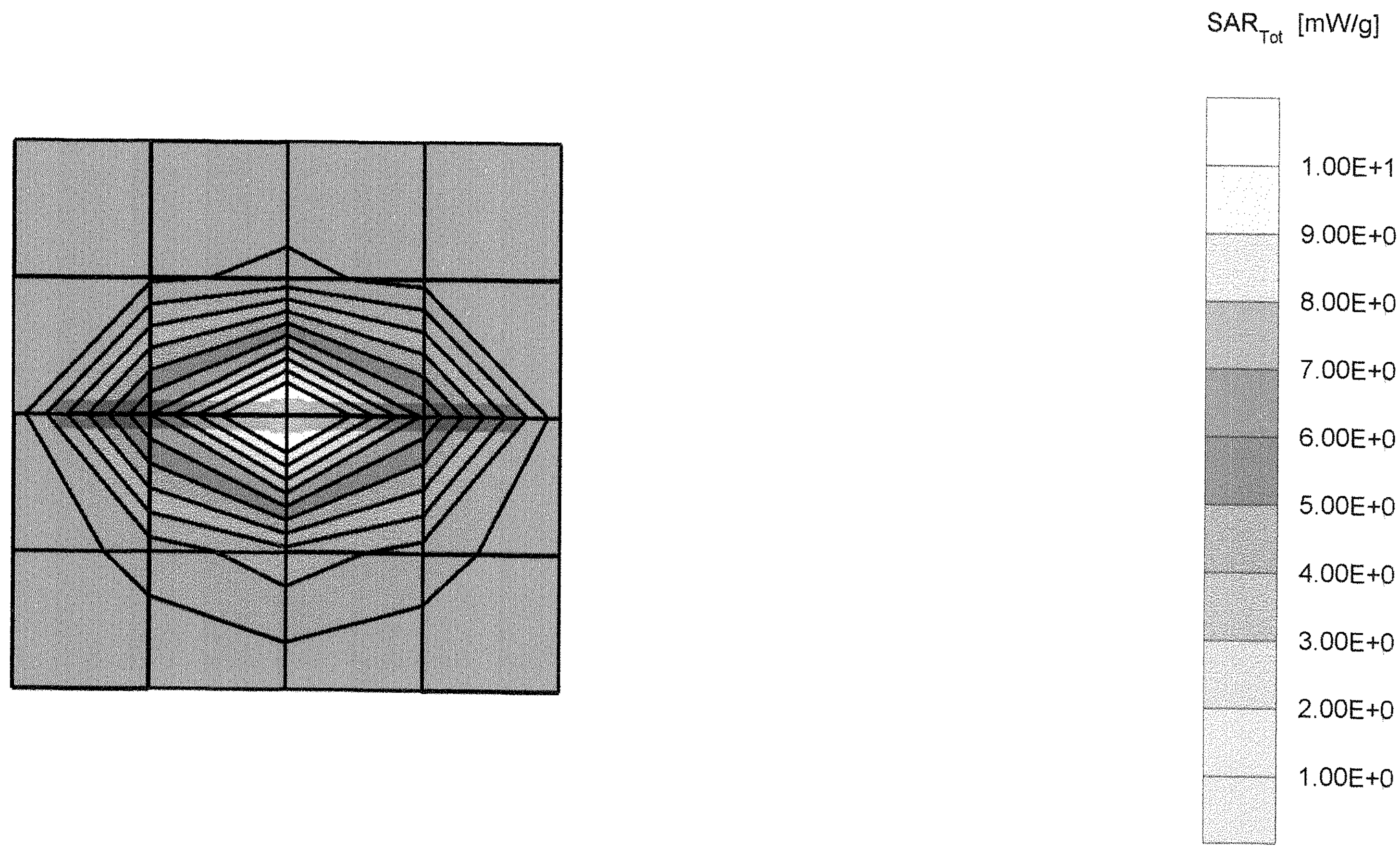
The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

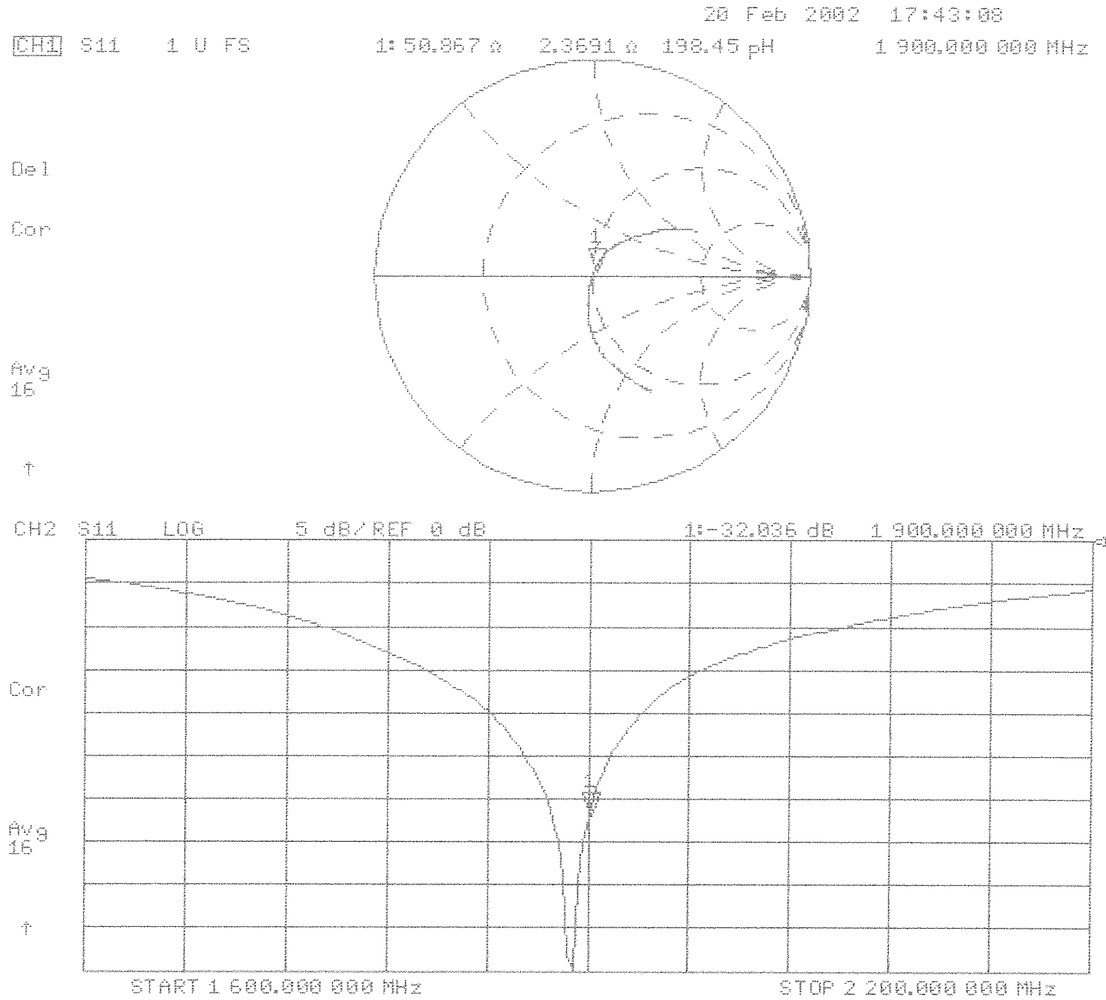
6. Power Test

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

idation Dipole D1900V2 SN:5d005, d = 10 mm

uency: 1900 MHz; Antenna Input Power: 250 [mW]
Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
e: ET3DV6 - SN1507; ConvF(5.30,5.30,5.30) at 1800 MHz; IEEE1528 1900 MHz ; σ = 1.47 mho/m ε_r = 39.1 ρ = 1.00 g/cm^3
s (2): Peak: 21.9 mW/g ± 0.03 dB, SAR (1g): 11.4 mW/g ± 0.03 dB, SAR (10g): 5.78 mW/g ± 0.02 dB, (Worst-case extrapolation)
tration depth: 7.8 (7.4, 8.7) [mm]
rdrift: -0.02 dB





20 Feb 2002 17:43:08
CH1 S11 1 U FS
1: 50.867 Ω 2.3691 Ω 198.45 pH
1 900.000 000 MHz
Del
Cor
Avg
16
CH2 S11 LOG 5 dB/ REF 0 dB
1:-32.036 dB 1 900.000 000 MHz
Cor
Avg
16
START 1 600.000 000 MHz
STOP 2 200.000 000 MHz

Schmid & Partner Engineering AG

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Calibration Certificate

835 MHz System Validation Dipole

Type:	**D835V2**
Serial Number:	**453**
Place of Calibration:	**Zurich**
Date of Calibration:	**February 11, 2002**
Calibration Interval:	**24 months**

asset # 039931

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: [signature]

Approved by: [signature]

Schmid & Partner
Engineering AG

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

DASY

Dipole Validation Kit

Type: D835V2

Serial: 453

Manufactured: January 31, 2002
Calibrated: February 11, 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 835 MHz:

Relative Dielectricity	**41.9**	± 5%
Conductivity	**0.89 mho/m**	± 5%

The DASY3 System (Software version 3.1c) with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.5 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 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 ± 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^3 (1 g) of tissue:	**10.4 mW/g**
averaged over 10 cm^3 (10 g) of tissue:	**6.64 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:	**1.375 ns**	(one direction)
Transmission factor:	**0.987**	(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:	Re{Z} = **49.4 Ω**
	Im {Z} = **-3.8 Ω**
Return Loss at 835 MHz	**-28.4 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

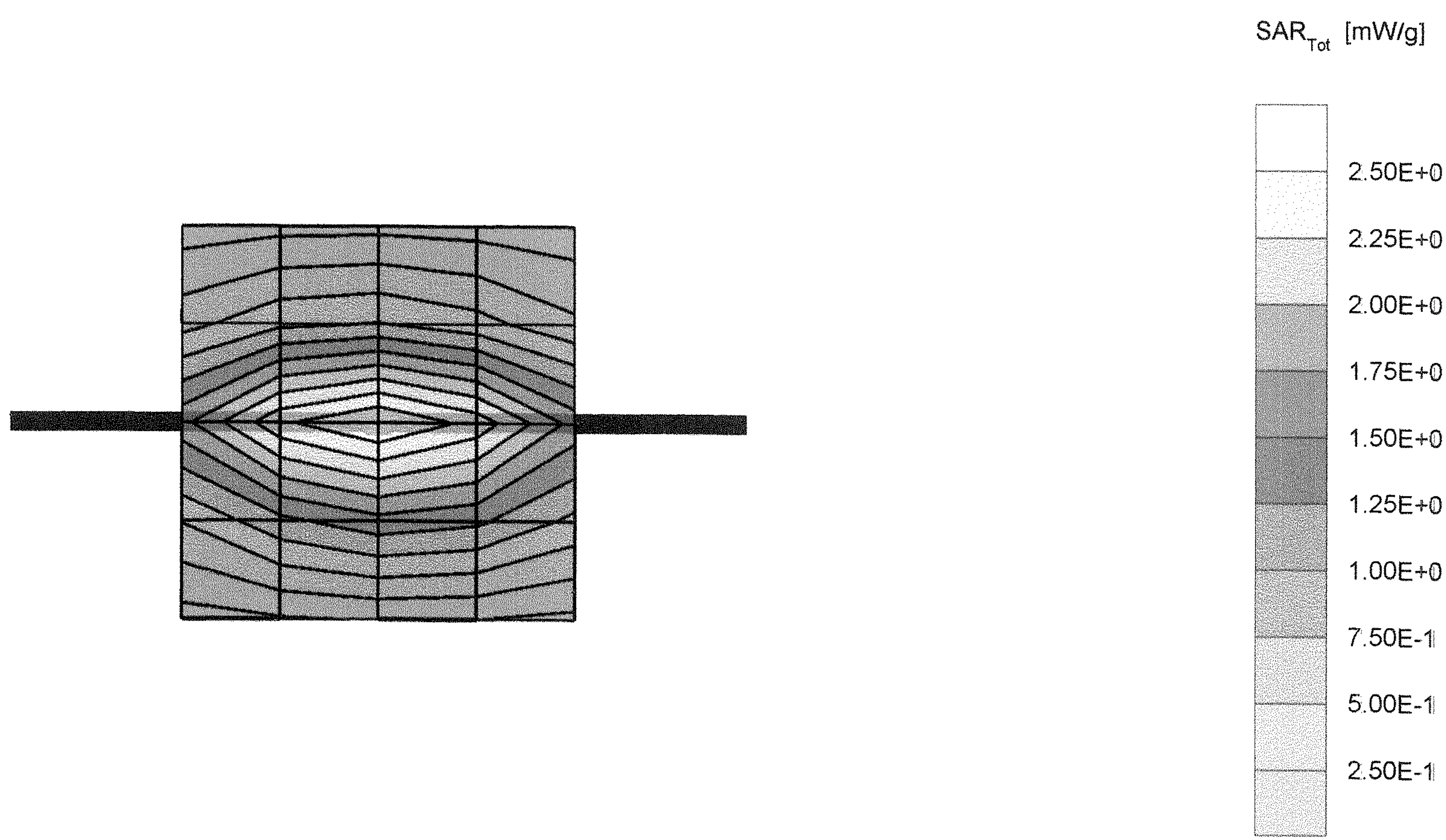
The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

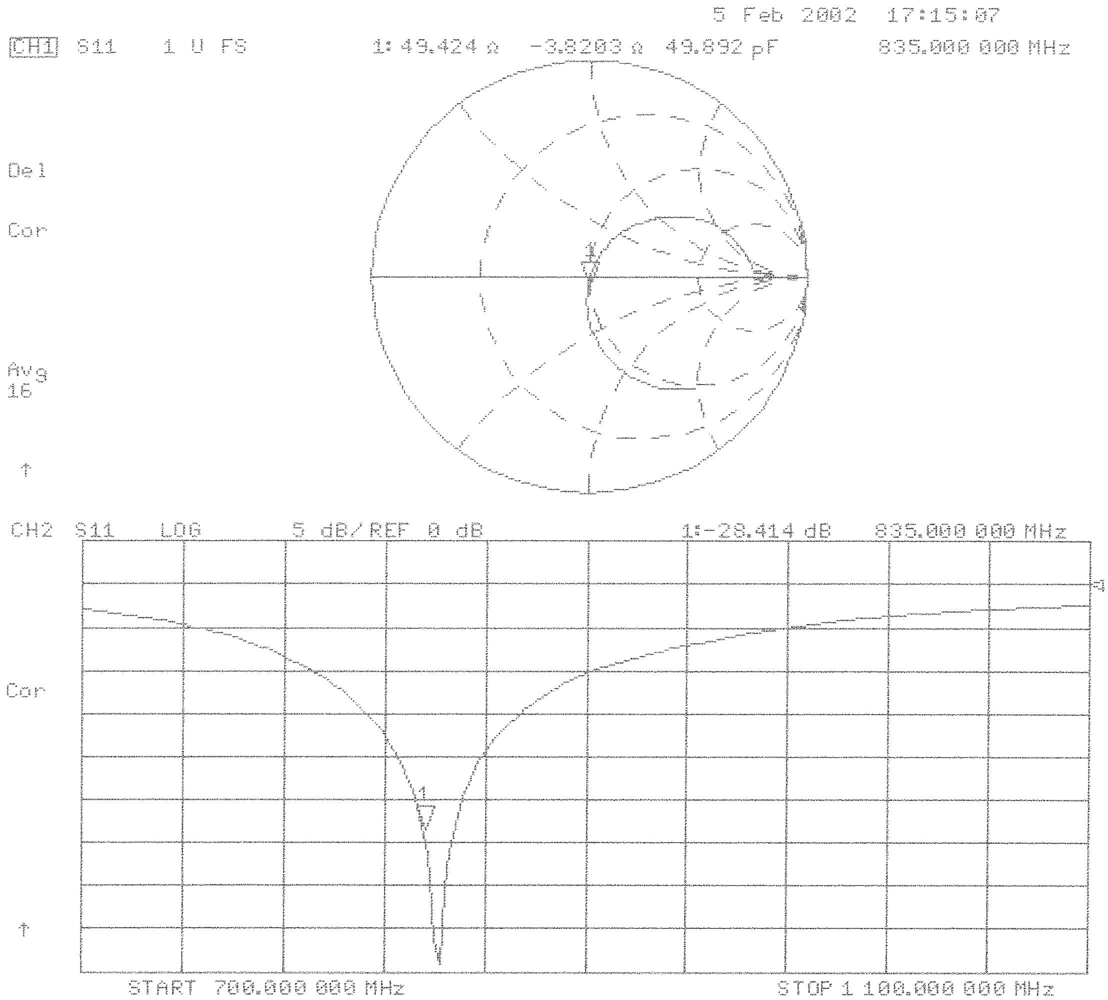
6. Power Test

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

dation Dipole D835V2 SN:453, d = 15 mm

ıency: 835 MHz; Antenna Input Power: 250 [mW]
Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
ɜ: ET3DV6 - SN1507; ConvF(6.50,6.50,6.50) at 900 MHz; IEEE1528 835 MHz; σ = 0.89 mho/m ε_r = 41.9 ρ = 1.00 g/cm³
s (2): Peak: 4.16 mW/g ± 0.00 dB, SAR (1g): 2.60 mW/g ± 0.01 dB, SAR (10g): 1.66 mW/g ± 0.02 dB, (Worst-case extrapolation)
tration depth: 12.0 (10.6, 13.8) [mm]
rdrift: -0.00 dB




5 Feb 2002 17:15:07
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Del
Cor
Avg
16
CH2 S11 LOG 5 dB/REF 0 dB
1:-28.414 dB 835.000 000 MHz
Cor
START 700.000 000 MHz
STOP 1 100.000 000 MHz