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# **Appendix for the Report**

## **Dosimetric Assessment of the Mirae MGH 900 (FCC ID: PLUMGH-900) According to the FCC Requirements**

### **Calibration Data**

February 05, 2004  
**IMST GmbH**  
**Carl-Friedrich-Gauß-Str. 2**  
**D-47475 Kamp-Lintfort**

Customer  
7 Layers AG  
Borsigstrasse 11  
D-40880-Ratingen

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Client **IMST**

## CALIBRATION CERTIFICATE

Object(s) **ET3DV6 - SN:1669**

Calibration procedure(s) **QA CAL-01.v2  
Calibration procedure for dosimetric E-field probes**

Calibration date: **March 21, 2003**

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

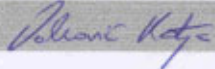
This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

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	Scheduled Calibration
RF generator HP 8684C	US3642U01700	4-Aug-99 (in house check Aug-02)	In house check: Aug-05
Power sensor E4412A	MY41495277	Mar-02	Mar-03
Power sensor HP 8481A	MY41092180	18-Sep-02	Sep-03
Power meter EPM E4419B	GB41293874	13-Sep-02	Sep-03
Network Analyzer HP 8753E	US38432426	3-May-00	In house check: May 03
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01	Sep-03

Calibrated by:	Name <b>Nico Vetterli</b>	Function <b>Technician</b>	Signature 
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Approved by:	<b>Katja Pokovic</b>	<b>Laboratory Director</b>	
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Date issued: March 21, 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.

Schmid & Partner Engineering AG

**s p e a g**

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info@speag.com, <http://www.speag.com>

# Probe ET3DV6

SN:1669

Manufactured:	February 8, 2002
Last calibration:	March 7, 2002
Recalibrated:	March 21, 2003

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

**DASY - Parameters of Probe: ET3DV6 SN:1669****Sensitivity in Free Space**

NormX	<b>1.75</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	<b>1.84</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	<b>1.72</b> $\mu\text{V}/(\text{V}/\text{m})^2$

**Diode Compression**

DCP X	<b>97</b>	mV
DCP Y	<b>97</b>	mV
DCP Z	<b>97</b>	mV

**Sensitivity in Tissue Simulating Liquid**

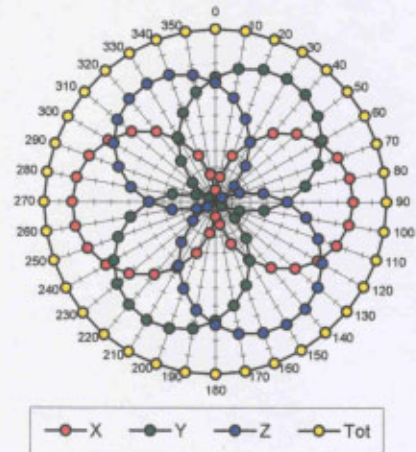
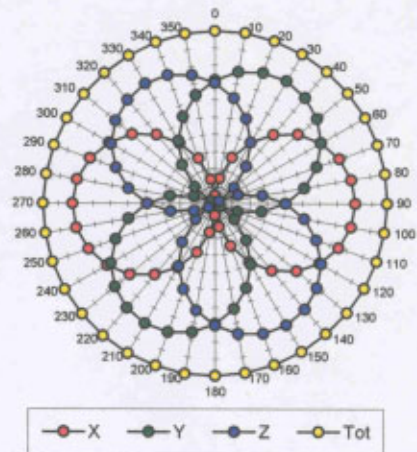
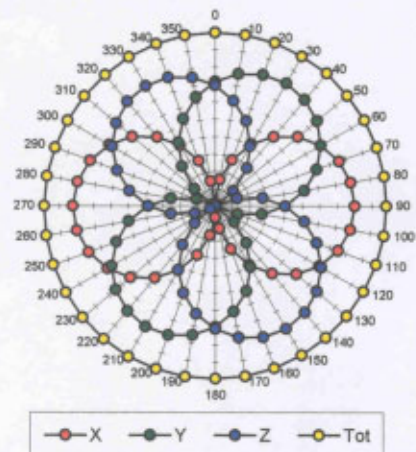
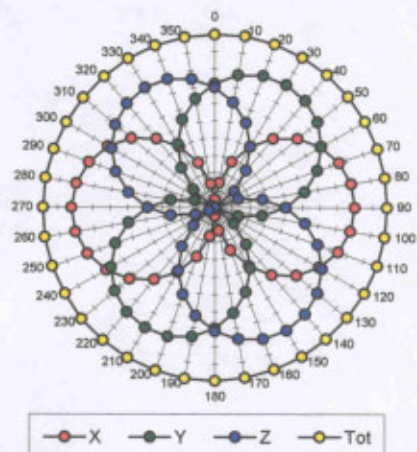
Head	835 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.90 \pm 5\%$ mho/m
Head	900 MHz	$\epsilon_r = 41.5 \pm 5\%$	$\sigma = 0.97 \pm 5\%$ mho/m
ConvF X	<b>6.8</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>6.8</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.44</b>
ConvF Z	<b>6.8</b> $\pm 9.5\%$ (k=2)	Depth	<b>2.20</b>
Head	1900 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>5.2</b> $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	<b>5.2</b> $\pm 9.5\%$ (k=2)	Alpha	<b>0.48</b>
ConvF Z	<b>5.2</b> $\pm 9.5\%$ (k=2)	Depth	<b>2.73</b>

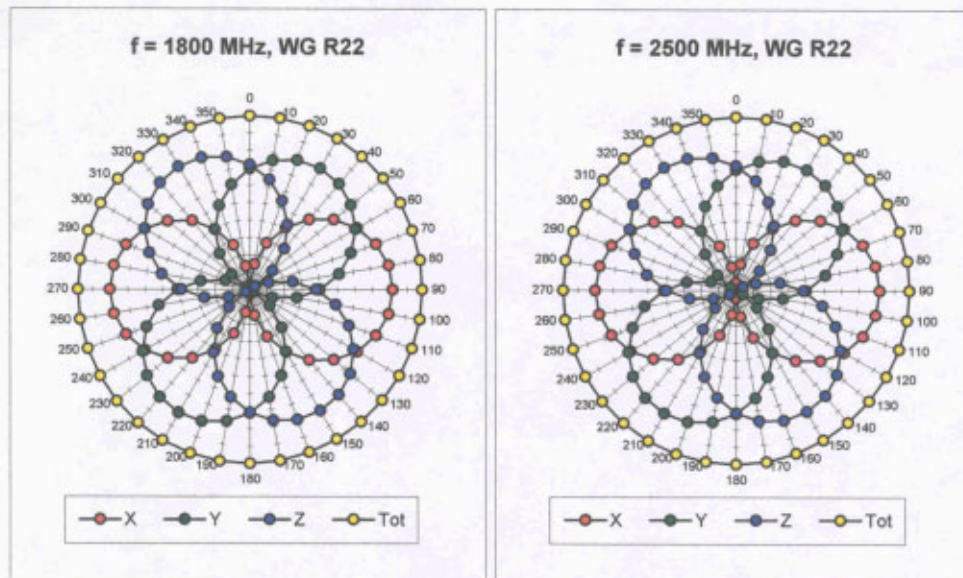
**Boundary Effect**

Head	835 MHz	Typical SAR gradient: 5 % per mm		
Probe Tip to Boundary		1 mm	2 mm	
SAR <sub>be</sub> [%]	Without Correction Algorithm	9.2	5.0	
SAR <sub>be</sub> [%]	With Correction Algorithm	0.2	0.5	
Head	1900 MHz	Typical SAR gradient: 10 % per mm		
Probe Tip to Boundary		1 mm	2 mm	
SAR <sub>be</sub> [%]	Without Correction Algorithm	13.8	9.7	
SAR <sub>be</sub> [%]	With Correction Algorithm	0.4	0.2	

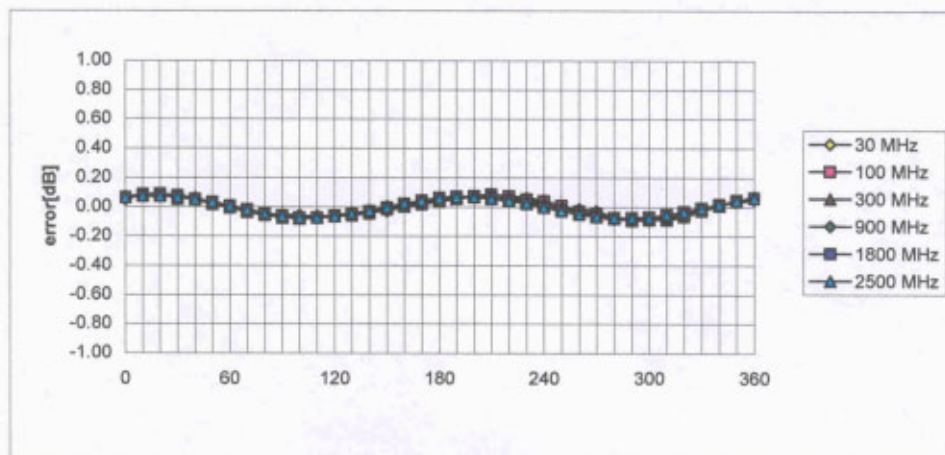
**Sensor Offset**

Probe Tip to Sensor Center	<b>2.7</b>	mm
Optical Surface Detection	<b>1.2 <math>\pm</math> 0.2</b>	mm

Receiving Pattern ( $\phi$ ),  $\theta = 0^\circ$  $f = 30 \text{ MHz}$ , TEM cell ifi110 $f = 100 \text{ MHz}$ , TEM cell ifi110 $f = 300 \text{ MHz}$ , TEM cell ifi110 $f = 900 \text{ MHz}$ , TEM cell ifi110

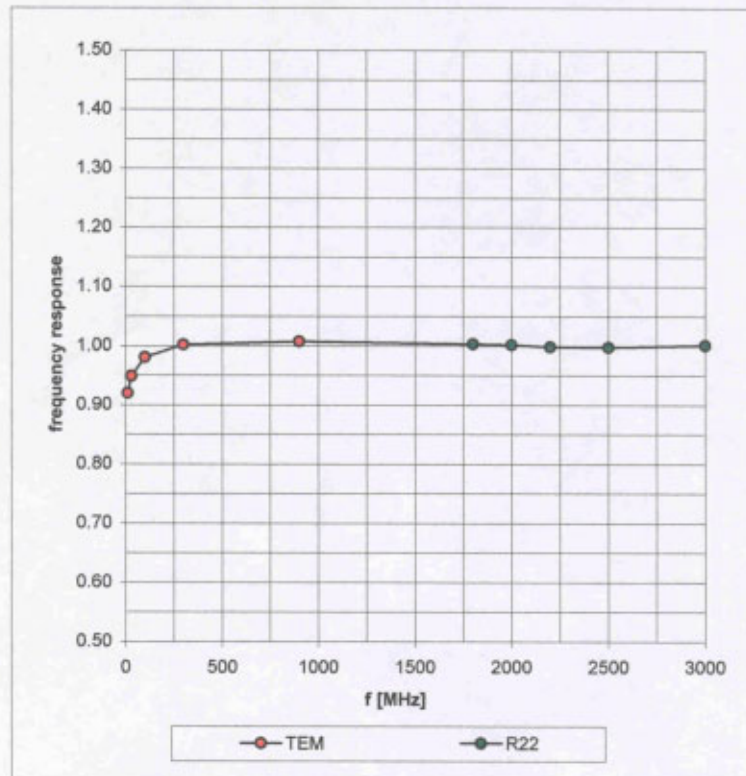


### Isotropy Error ( $\phi$ ), $\theta = 0^\circ$

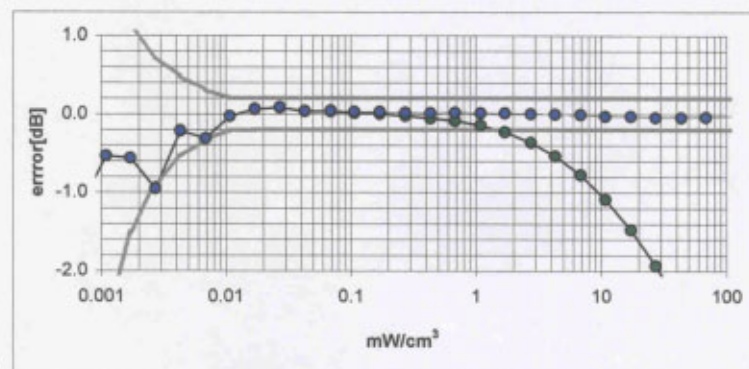
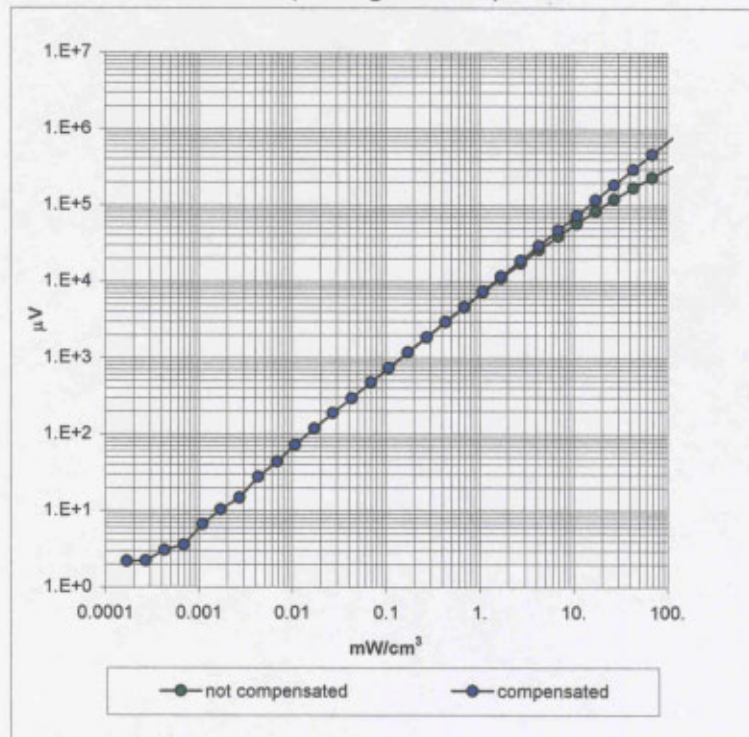


## Frequency Response of E-Field

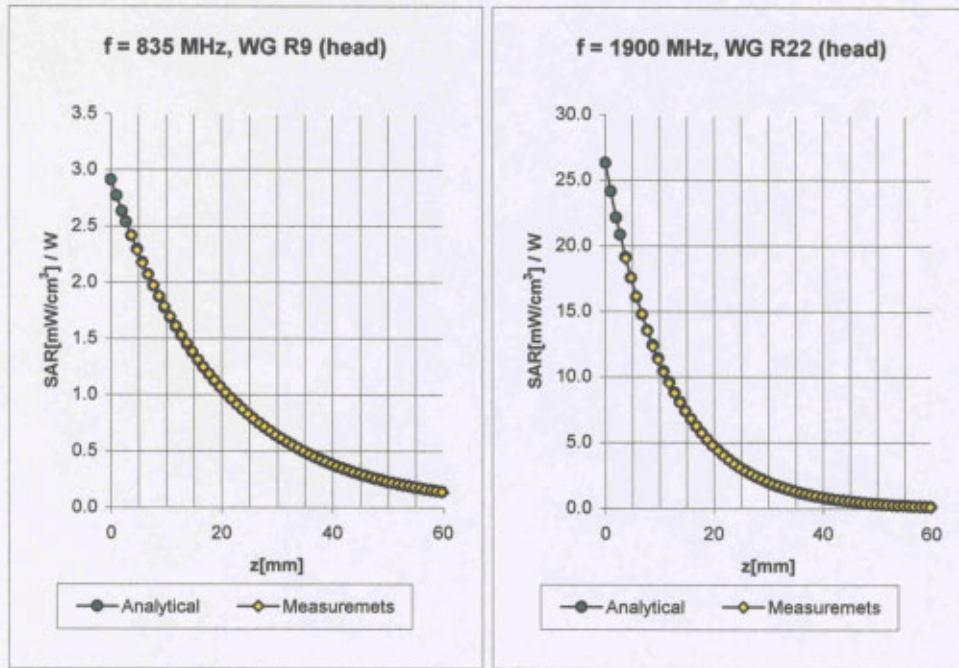
( TEM-Cell:ifi1110, Waveguide R22)



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

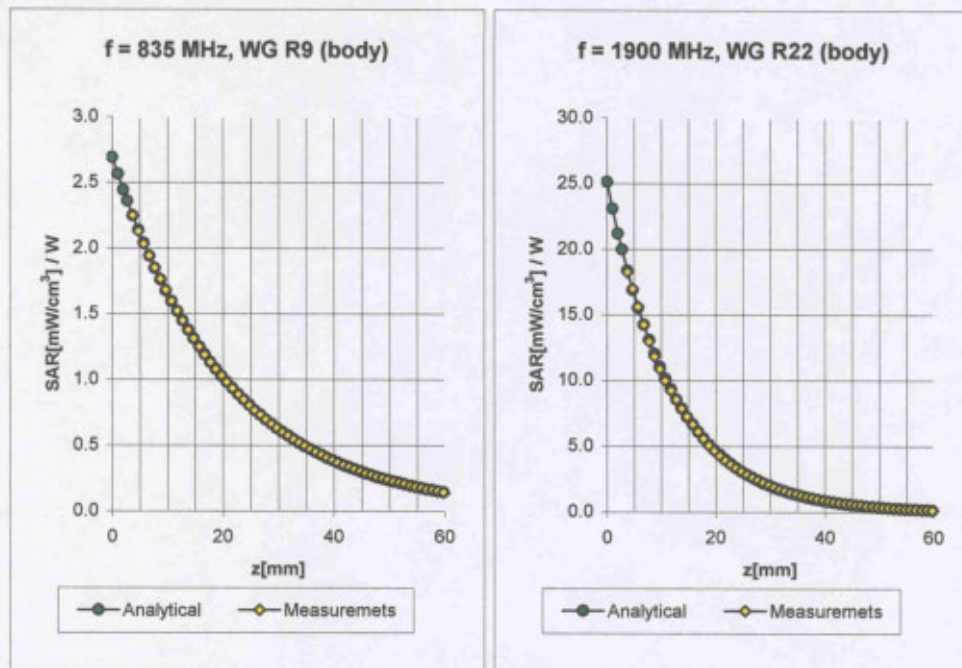


## Conversion Factor Assessment



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	$6.8 \pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	$6.8 \pm 9.5\%$ (k=2)	Alpha 0.44
	ConvF Z	$6.8 \pm 9.5\%$ (k=2)	Depth 2.20
Head	1900 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	$5.2 \pm 9.5\%$ (k=2)	Boundary effect:
	ConvF Y	$5.2 \pm 9.5\%$ (k=2)	Alpha 0.48
	ConvF Z	$5.2 \pm 9.5\%$ (k=2)	Depth 2.73

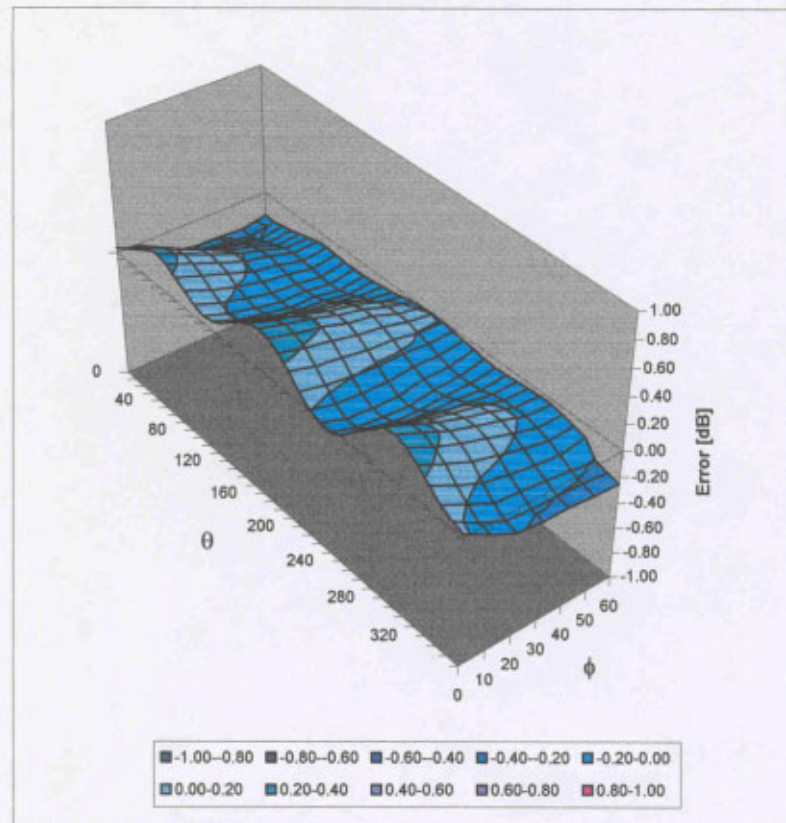
## Conversion Factor Assessment



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	6.6 $\pm$ 9.5% (k=2)	Boundary effect:
	ConvF Y	6.6 $\pm$ 9.5% (k=2)	Alpha 0.48
	ConvF Z	6.6 $\pm$ 9.5% (k=2)	Depth 2.16
Body	1900 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	4.8 $\pm$ 9.5% (k=2)	Boundary effect:
	ConvF Y	4.8 $\pm$ 9.5% (k=2)	Alpha 0.63
	ConvF Z	4.8 $\pm$ 9.5% (k=2)	Depth 2.45

# Deviation from Isotropy in HSL

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



# Schmid & Partner Engineering AG

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## Calibration Certificate

### 1900 MHz System Validation Dipole

Type:

D1900V2

Serial Number:

535

Place of Calibration:

Zurich

Date of Calibration:

November 14, 2002

Calibration Interval:

24 months

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

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

Calibrated by:

D. Vetter

Approved by:

René Kästli

**DASY**

**Dipole Validation Kit**

**Type: D1900V2**

**Serial: 535**

Manufactured: March 22, 2001  
Calibrated: November 14, 2002

## **1. Measurement Conditions**

The measurements were performed in the flat section of the SAM twin phantom filled with head simulating glycol solution of the following electrical parameters at 1900 MHz:

Relative Dielectricity	<b>39.8</b>	$\pm 5\%$
Conductivity	<b>1.45 mho/m</b>	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 5.2 at 1900 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 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>40.8 mW/g</b>
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	<b>20.7 mW/g</b>

### 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>1.2184 ns</b>	(one direction)
Transmission factor:	<b>0.995</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 1900 MHz:	$\text{Re}\{Z\} = 50.9 \Omega$
	$\text{Im}\{Z\} = 3.6 \Omega$
Return Loss at 1900 MHz	<b>-28.6 dB</b>

### 4. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with body simulating glycol solution of the following electrical parameters at 1900 MHz:

Relative Dielectricity	<b>52.2</b>	$\pm 5\%$
Conductivity	<b>1.57 mho/m</b>	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 4.9 at 1900 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 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.

## **5. 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:	<b>41.2 mW/g</b>
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	<b>21.0 mW/g</b>

## **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 1900 MHz:	$\text{Re}\{Z\} = 46.5 \Omega$
	$\text{Im}\{Z\} = 3.4 \Omega$
Return Loss at 1900 MHz	<b>-26.0 dB</b>

## **7. 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.

## **8. 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.

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.

## **9. Power Test**

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

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN535caps\_SN1507\_HSL1900\_141102.da4

**DUT: Dipole 1900 MHz Type & Serial Number: D1900V2 - SN535**  
**Program: Dipole Calibration; Pin = 250 mW; d = 10 mm**

Communication System: CW-1900; Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium: HSL 1900 MHz ( $\sigma = 1.45$  mho/m,  $\epsilon = 39.75$ ,  $\rho = 1000$  kg/m<sup>3</sup>)  
Phantom section: FlatSection

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5.2, 5.2, 5.2); 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

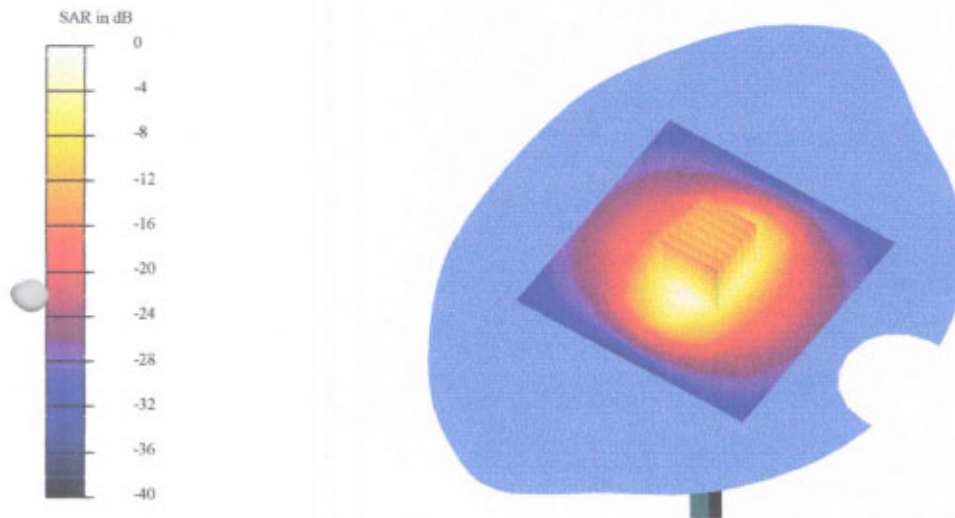
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm

Reference Value = 94 V/m

Peak SAR = 18.5 mW/g

SAR(1 g) = 10.2 mW/g; SAR(10 g) = 5.18 mW/g

Power Drift = -0.01 dB



14 Nov 2002 16:58:38  
 CH1 S11 1 U FS 1:50.945  $\alpha$  3.6445  $\alpha$  305.29  $\mu$ H 1 900.000 000 MHz

Y

Del

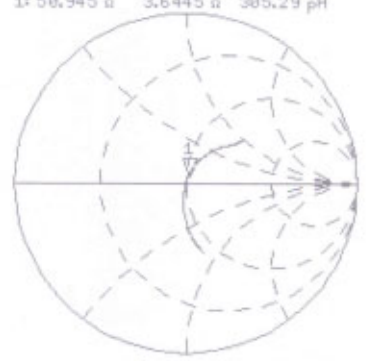
PRn

Cor

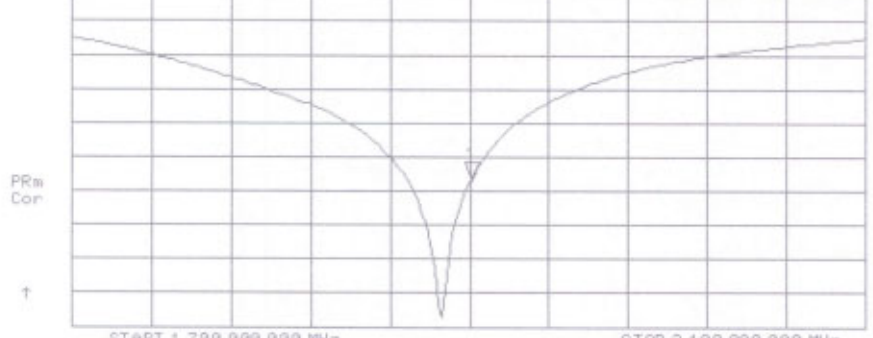
Avg

16

↑



CH2 S11 LOG 5 dB/REF 0 dB 1:-20.617 dB 1 900.000 000 MHz



PRn

Cor

↑

START 1 700.000 000 MHz STOP 2 100.000 000 MHz

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN535\_SN1507\_M1900\_141102.da4

**DUT: Dipole 1900 MHz Type & Serial Number: D1900V2 - SN535**  
**Program: Dipole Calibration; Pin = 250 mW; d = 10 mm**

Communication System: CW-1900; Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium: Muscle 1900 MHz ( $\sigma = 1.57$  mho/m,  $\epsilon = 52.15$ ,  $\rho = 1000$  kg/m<sup>3</sup>)  
Phantom section: FlatSection

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(4.9, 4.9, 4.9); 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

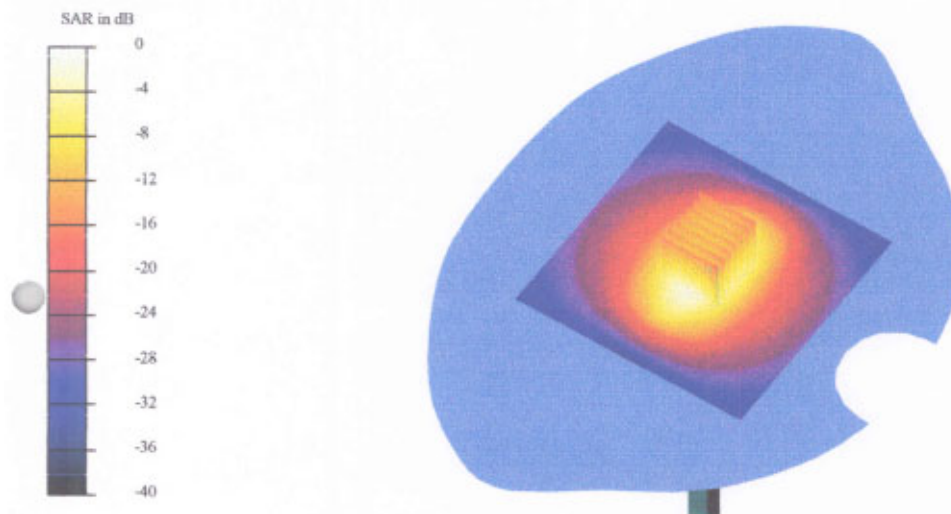
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm

Reference Value = 90.7 V/m

Peak SAR = 18.8 mW/g

SAR(1 g) = 10.3 mW/g; SAR(10 g) = 5.26 mW/g

Power Drift = -0.03 dB



Muscle

14 Nov 2002 18:07:45  
CH1 S11 1 U FS 1: 46.463  $\Omega$  3.3906  $\Omega$  284.82  $\mu$ H 1 900.000 000 MHz

$\gamma$

De1

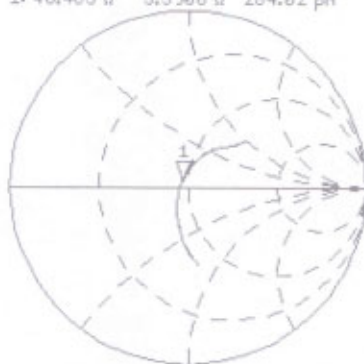
PRm

Cor

Avg

16

↑

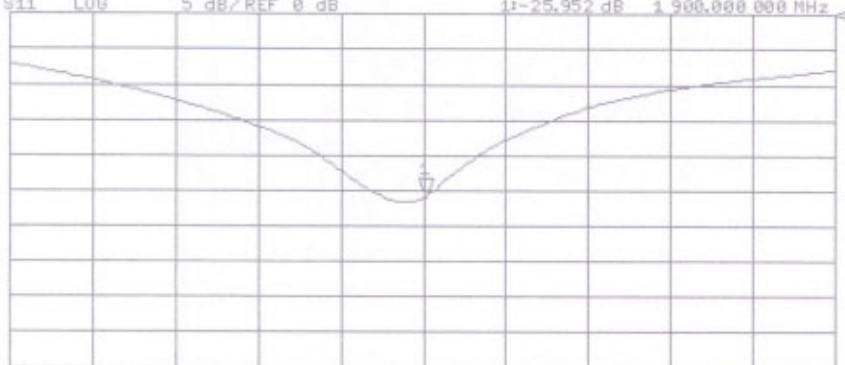


CH2 S11 LOG 5 dB/REF 0 dB 1:-25.952 dB 1 900.000 000 MHz

PRm

Cor

↑



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz