

**RADIO FREQUENCY INVESTIGATION LTD.**

**Operations Department**

**Test Of:** **Sendo Ltd.**

**M551 Dual Band Mobile Handset with PHF and Case Accessory**

**To:** **OET Bulletin 65 Supplement C: (2001-01)**

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**TEST REPORT**

**S.No. RFI/SARB2/RP45446JD06A**

**Page 39 of 70**

**Issue Date: 26 January 2004**

#### **Appendix 4. Calibration Data**

This appendix contains the calibration data and certificates.

**RADIO FREQUENCY INVESTIGATION LTD.**

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**TEST REPORT**

**S.No. RFI/SARB2/RP45446JD06A**

**Page 40 of 70**

**Issue Date: 26 January 2004**

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Calibration Laboratory of  
Schmid & Partner  
Engineering AG  
Zeughausstrasse 43, 8004 Zurich, Switzerland

*J. W. D. Adams*  
Curved  
n/06/03

Client

RFI

## CALIBRATION CERTIFICATE

Object(s)	D1900V2 - SN 540		
Calibration procedure(s)	QA CAL-05 v2 Calibration procedure for dipole validation kits		
Calibration date:	June 4, 2003		
Condition of the calibrated item	In Tolerance (according to the specific calibration document)		
<p>This calibration statement documents traceability of M&amp;TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity &lt; 75%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p>			
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
Calibrated by:	Name Judith Mueller	Function Technician	Signature <i>J. W. D. Adams</i>
Approved by:	Name Kolja Pekovic	Function Laboratory Director	Signature <i>J. W. D. Adams</i>
Date issued: June 4, 2003			
<p>This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid &amp; Partner Engineering AG is completed.</p>			

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# DASY

## Dipole Validation Kit

Type: D1900V2

Serial: 540

Manufactured: July 26, 2001

Calibrated: June 4, 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 1900 MHz:

Relative Dielectricity	<b>38.8</b>	$\pm 5\%$
Conductivity	<b>1.44 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  $250 \text{ mW} \pm 3\%$ . 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: **41.2 mW/g  $\pm 16.8\%$  (k=2)**<sup>1</sup>

averaged over  $10 \text{ cm}^3$  (10 g) of tissue: **21.2 mW/g  $\pm 16.2\%$  (k=2)**<sup>1</sup>

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<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>1.196 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 1900 MHz:  $\text{Re}\{Z\} = 50.3 \Omega$

$\text{Im}\{Z\} = 3.8 \Omega$

Return Loss at 1900 MHz **-28.5 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.

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.

### **6. Power Test**

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

Date/Time: 06/04/03 18:39:25

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN540\_SN1507\_HSL1900\_040603.da4

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN540**  
**Program: Dipole Calibration**

Communication System: CW-1900; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: HSL 1900 MHz ( $\sigma = 1.44 \text{ mho/m}$ ,  $\epsilon_r = 38.78$ ,  $\rho = 1000 \text{ kg/m}^3$ )

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5.2, 5.2, 5.2); 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 = 10 mm/Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm

Reference Value = 94.4 V/m

Power Drift = 0.01 dB

Maximum value of SAR = 11.4 mW/g

**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

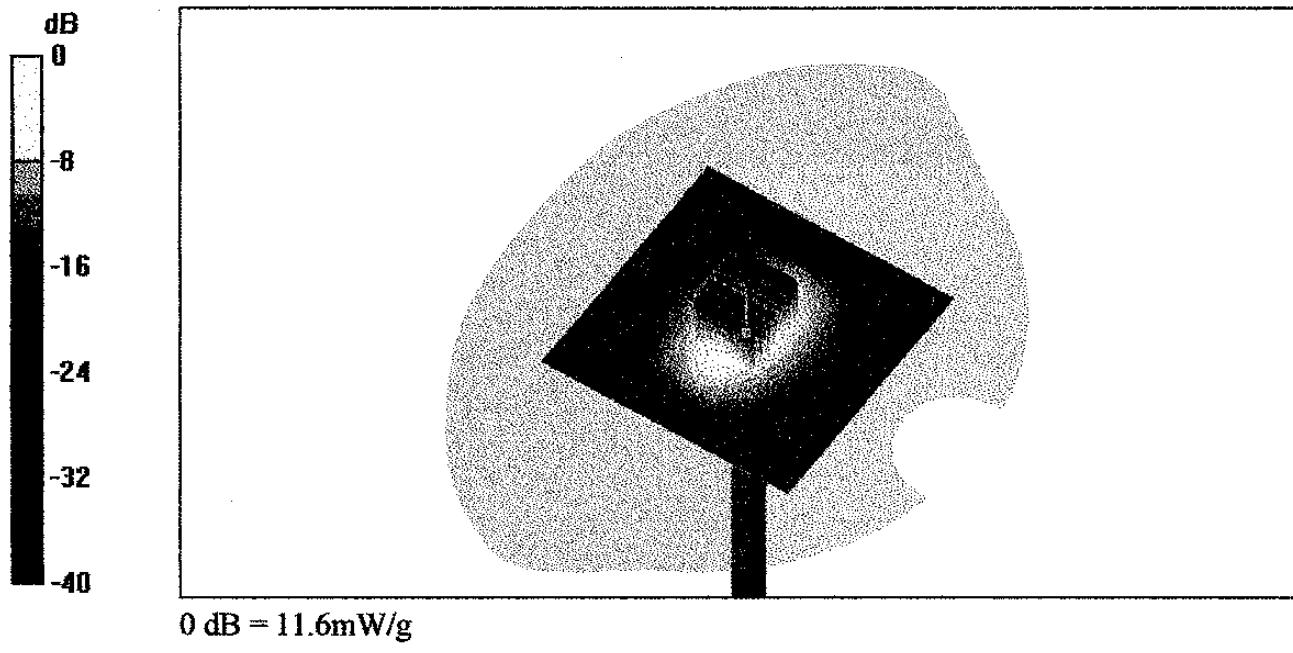
Peak SAR (extrapolated) = 18 W/kg

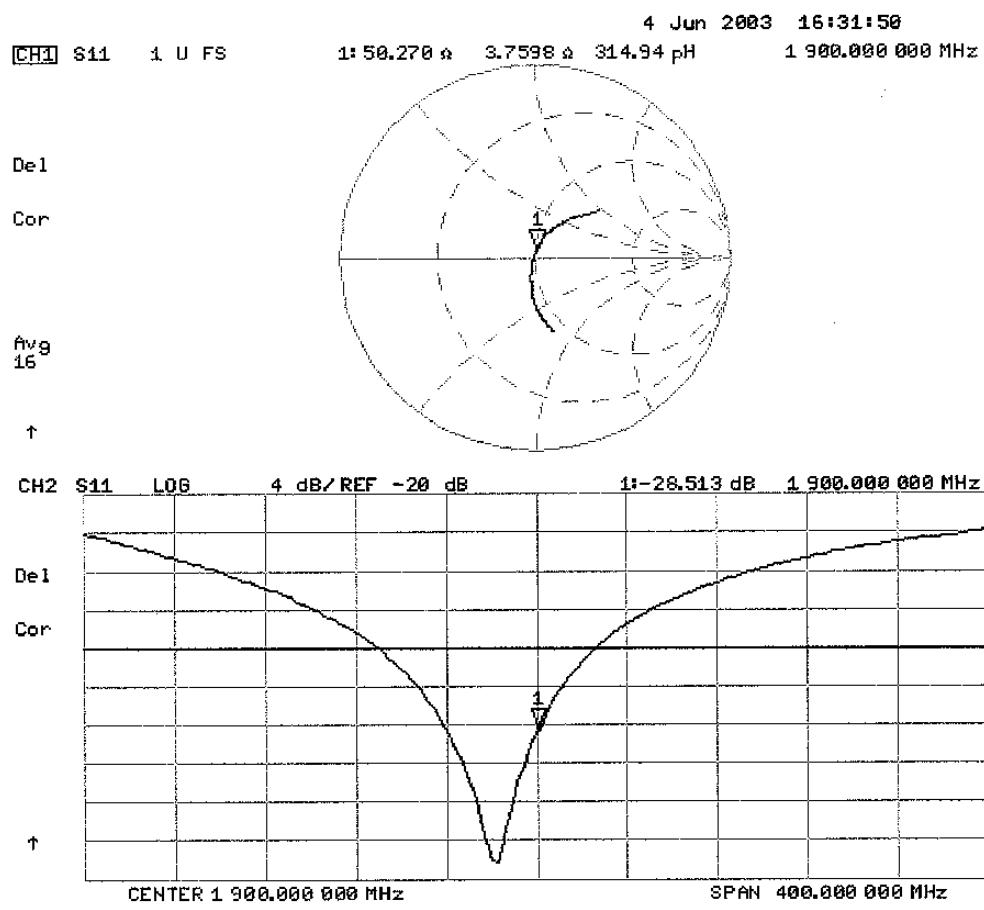
SAR(1 g) = 10.3 mW/g; SAR(10 g) = 5.29 mW/g

Reference Value = 94.4 V/m

Power Drift = 0.01 dB

Maximum value of SAR = 11.6 mW/g





*J. M. Di Adamo*  
Cuscuso  
23/05/03

**Calibration Laboratory of**  
Schmid & Partner  
Engineering AG  
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client

RFI

## CALIBRATION CERTIFICATE

Object(s)	D1800V2 - SN 2d009
Calibration procedure(s)	QA-CAL-05.v2 Calibration procedure for dipole validation kits
Calibration date:	May 14, 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

Calibrated by:	Name	Function	Signature
	Judith Mueller	Technician	<i>J. Mueller</i>
Approved by:	Katja Pokovic	Laboratory Director	<i>K. Pokovic</i>

Date issued: May 14, 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.

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Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, http://www.speag.com

# DASY

## Dipole Validation Kit

Type: D1800V2

Serial: 2d009

Manufactured: July 23, 2001  
Calibrated: May 14, 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 1800 MHz:

Relative Dielectricity	<b>39.2</b>	$\pm 5\%$
Conductivity	<b>1.36 mho/m</b>	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 5.3 at 1800 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  $250 \text{ mW} \pm 3\%$ . 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:  **$38.2 \text{ mW/g} \pm 16.8\% \text{ (k=2)}$** <sup>1</sup>

averaged over  $10 \text{ cm}^3$  (10 g) of tissue:  **$20.1 \text{ mW/g} \pm 16.2\% \text{ (k=2)}$** <sup>1</sup>

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<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>1.184 ns</b>	(one direction)
Transmission factor:	<b>0.998</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 1800 MHz:  $\text{Re}\{Z\} = 47.2 \Omega$

$\text{Im}\{Z\} = -8.4 \Omega$

Return Loss at 1800 MHz **-20.8 dB**

### 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 1800 MHz:

Relative Dielectricity	<b>51.6</b>	$\pm 5\%$
Conductivity	<b>1.49 mho/m</b>	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 5.0 at 1800 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  $250 \text{ mW} \pm 3\%$ . 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>36.7 mW/g ± 16.8 % (k=2)</b> <sup>2</sup>
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	<b>19.6 mW/g ± 16.2 % (k=2)</b> <sup>2</sup>

## 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 1800 MHz:	<b>Re{Z} = 43.4 Ω</b>
	<b>Im {Z} = -8.8 Ω</b>
Return Loss at 1800 MHz	<b>-18.7 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.

## 9. Power Test

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

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<sup>2</sup> validation uncertainty

Date/Time: 05/12/03 17:38:29

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN2d009 SN1507 HSL1800 120503.da4

**DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN2d009**  
**Program: Dipole Calibration**

Communication System: CW-1800; Frequency: 1800 MHz; Duty Cycle: 1:1

Medium: HSL 1800 MHz ( $\sigma = 1.36 \text{ mho/m}$ ,  $\epsilon_r = 39.22$ ,  $\rho = 1000 \text{ kg/m}^3$ )

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5.3, 5.3, 5.3); 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 = 10 mm/Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm

Reference Value = 93.7 V/m

Power Drift = -0.01 dB

Maximum value of SAR = 10.7 mW/g

**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

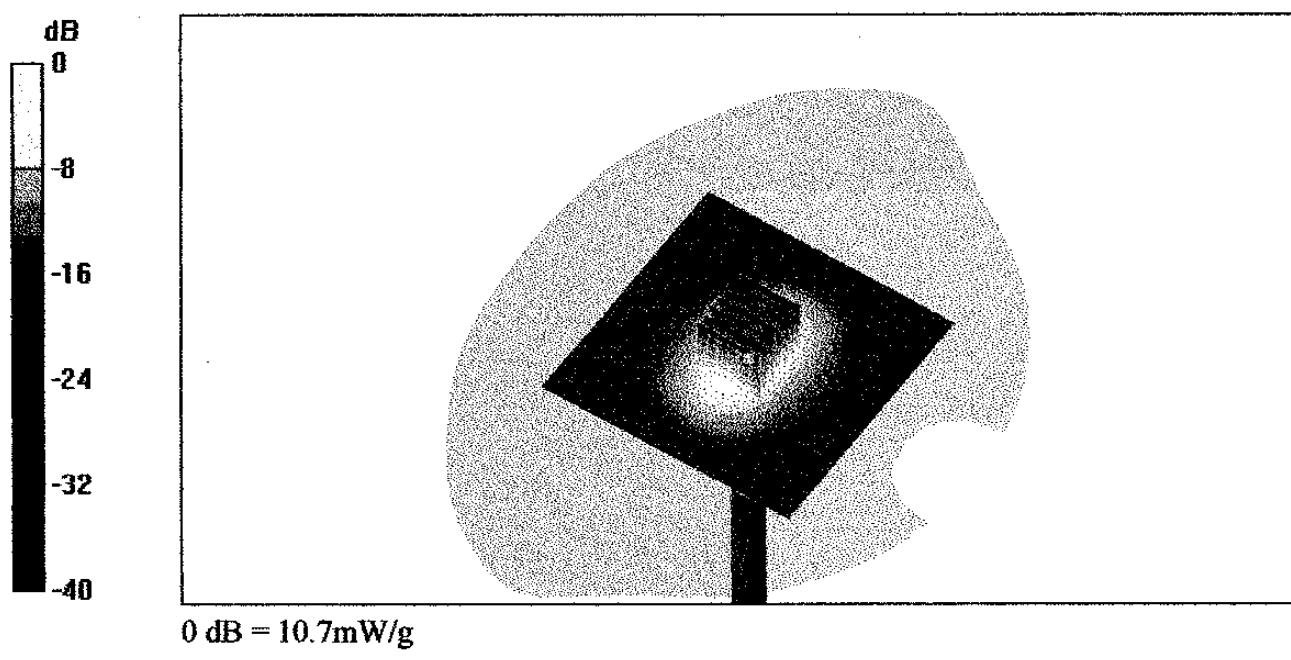
Peak SAR (extrapolated) = 16.5 W/kg

SAR(1 g) = 9.56 mW/g; SAR(10 g) = 5.03 mW/g

Reference Value = 93.7 V/m

Power Drift = -0.01 dB

Maximum value of SAR = 10.7 mW/g



2d009

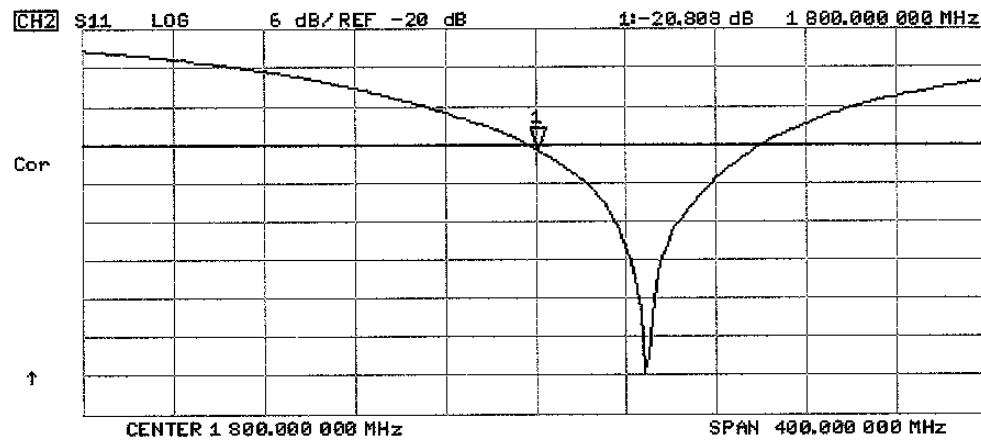
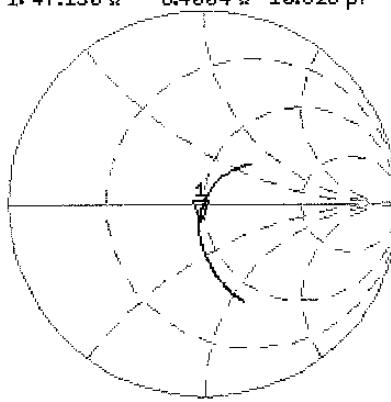
12 May 2003 12:13:43  
CH1 S11 1 U FS 1: 47.150  $\Omega$  -8.4004  $\Omega$  10.526 pF 1 800.000 000 MHz

Del

Cor

Avg  
16

↑



Date/Time: 05/14/03 12:55:22

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN2d009 SN1507 M1800 140503da4.da4

**DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN2d009**  
**Program: Dipole Calibration**

Communication System: CW-1800; Frequency: 1800 MHz; Duty Cycle: 1:1

Medium: Muscle 1800 MHz ( $\sigma = 1.49 \text{ mho/m}$ ,  $\epsilon_r = 51.55$ ,  $\rho = 1000 \text{ kg/m}^3$ )

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(5, 5, 5); 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 = 10 mm/Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm

Reference Value = 89.6 V/m

Power Drift = 0.02 dB

Maximum value of SAR = 10.3 mW/g

**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

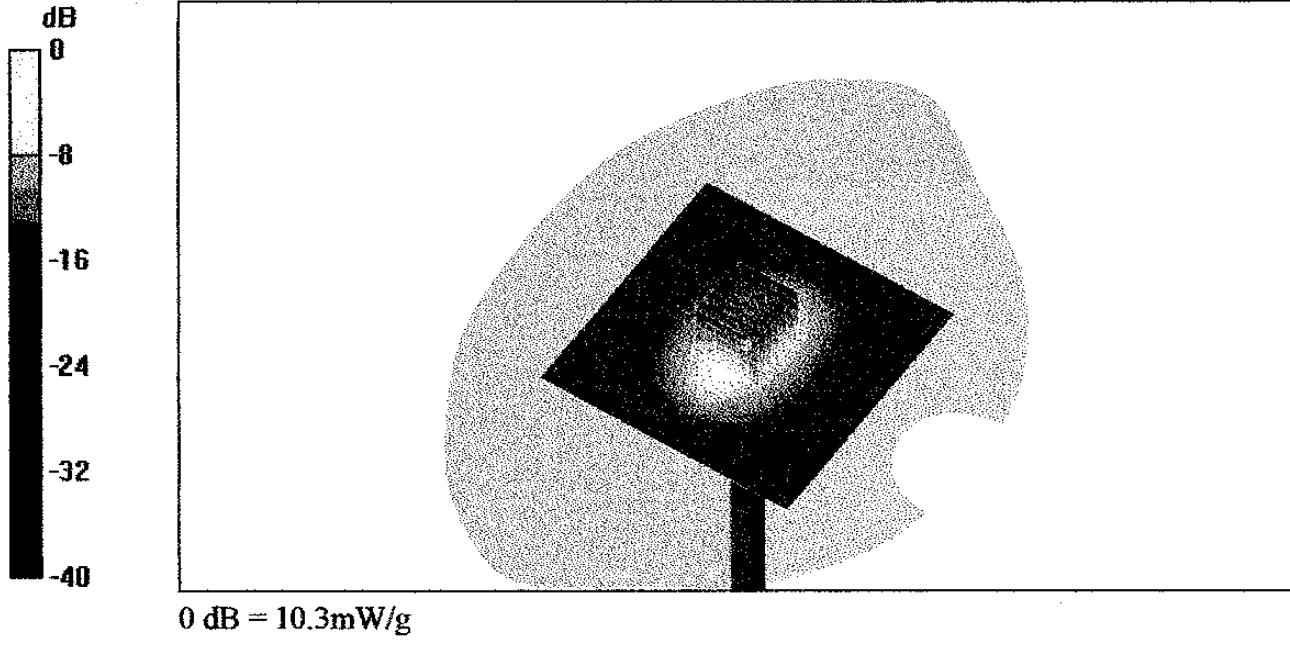
Peak SAR (extrapolated) = 15.1 W/kg

SAR(1 g) = 9.17 mW/g; SAR(10 g) = 4.9 mW/g

Reference Value = 89.6 V/m

Power Drift = 0.02 dB

Maximum value of SAR = 10.3 mW/g



2d003  
Body

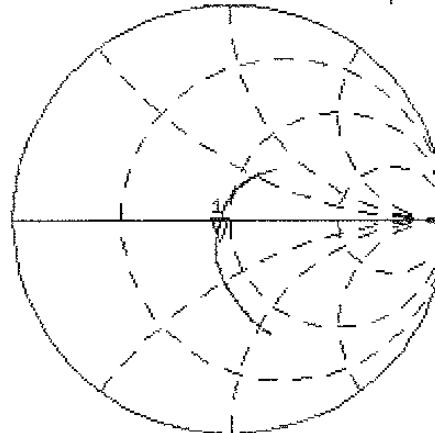
CH1 S11 1 U FS

14 May 2003 10:12:49  
1: 43.441  $\Delta$  -8.7715  $\Delta$  10.830 pF 1 000.000 000 MHz

De1

PRM

Cor  
Avg  
16



↑

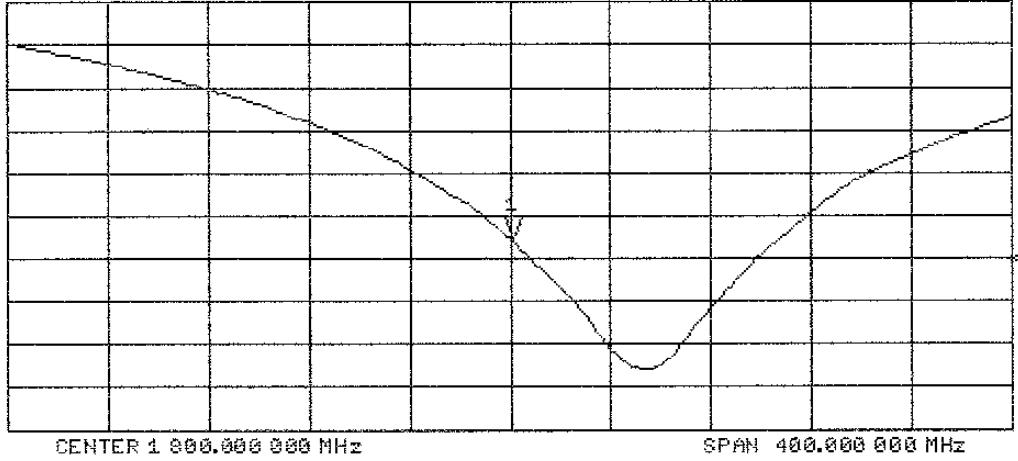
CH2 S11 LOG 3 dB/REF -20 dB

1:-18.693 dB 1 000.000 000 MHz

PRM

Cor

↑



CENTER 1 000.000 000 MHz

SPAN 400.000 000 MHz

*Jeff D Adams*  
Circus 20  
23/05/03

**Calibration Laboratory of**  
**Schmid & Partner**  
**Engineering AG**  
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client

RFI

## CALIBRATION CERTIFICATE

Object(s)	D900V2 - SN: 124
Calibration procedure(s)	QA CAL-05 v2 Calibration procedure for dipole validation kits
Calibration date:	May 13, 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	GB37460704	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

Calibrated by:	Name	Function	Signature
	Judith Mueller	Technician	<i>Judith Mueller</i>
Approved by:	Katja Pokovic	Laboratory Director	<i>Katja Pokovic</i>

Date issued: May 13, 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.

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**DASY**

**Dipole Validation Kit**

**Type: D900V2**

**Serial: 124**

**Manufactured: July 4, 2001**  
**Calibrated: May 13, 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 900 MHz:

Relative Dielectricity	<b>42.1</b>	$\pm 5\%$
Conductivity	<b>0.95 mho/m</b>	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.6 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 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:  **$10.6\text{ mW/g} \pm 16.8\% (k=2)$** <sup>1</sup>

averaged over  $10\text{ cm}^3$  (10 g) of tissue:  **$6.76\text{ mW/g} \pm 16.2\% (k=2)$** <sup>1</sup>

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<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>1.381 ns</b>	(one direction)
Transmission factor:	<b>0.989</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:  $\text{Re}\{Z\} = 50.3 \Omega$

$\text{Im}\{Z\} = -6.4 \Omega$

Return Loss at 900 MHz **-24.0 dB**

### 4. Measurement Conditions

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

Relative Dielectricity	<b>53.5</b>	$\pm 5\%$
Conductivity	<b>1.03 mho/m</b>	$\pm 5\%$

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

## 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: **11.0 mW/g ± 16.8 % (k=2)**<sup>2</sup>

averaged over 10 cm<sup>3</sup> (10 g) of tissue: **7.12 mW/g ± 16.2 % (k=2)**<sup>2</sup>

## 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 900 MHz: **Re{Z} = 46.2 Ω**

**Im {Z} = -8.2 Ω**

Return Loss at 900 MHz **-20.6 dB**

## 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.

## 9. Power Test

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

---

<sup>2</sup> validation uncertainty

Date/Time: 05/09/03 15:50:49

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN0124 SN1507 HSL900 090503da4.da4

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN124**  
**Program: Dipole Calibration**

Communication System: CW-900; Frequency: 900 MHz; Duty Cycle: 1:1

Medium: HSL 900 MHz ( $\sigma = 0.95 \text{ mho/m}$ ,  $\epsilon_r = 42.07$ ,  $\rho = 1000 \text{ kg/m}^3$ )

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.6, 6.6, 6.6); 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 = 57.1 V/m

Power Drift = 0.02 dB

Maximum value of SAR = 2.82 mW/g

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

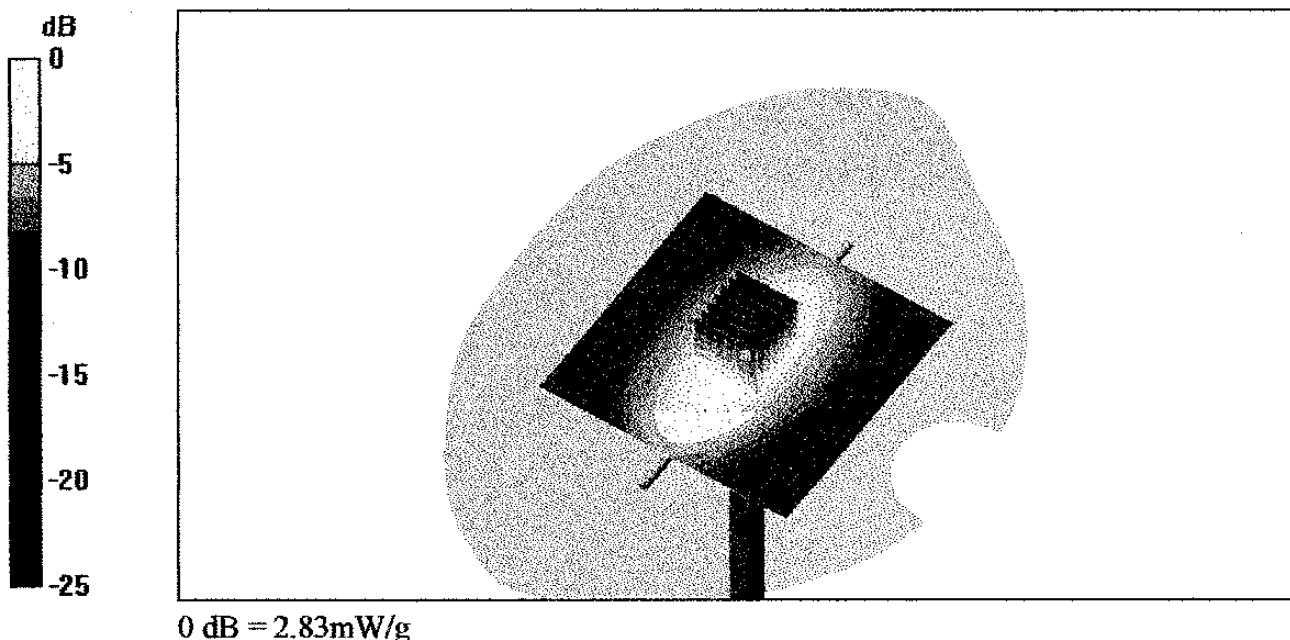
Peak SAR (extrapolated) = 3.88 W/kg

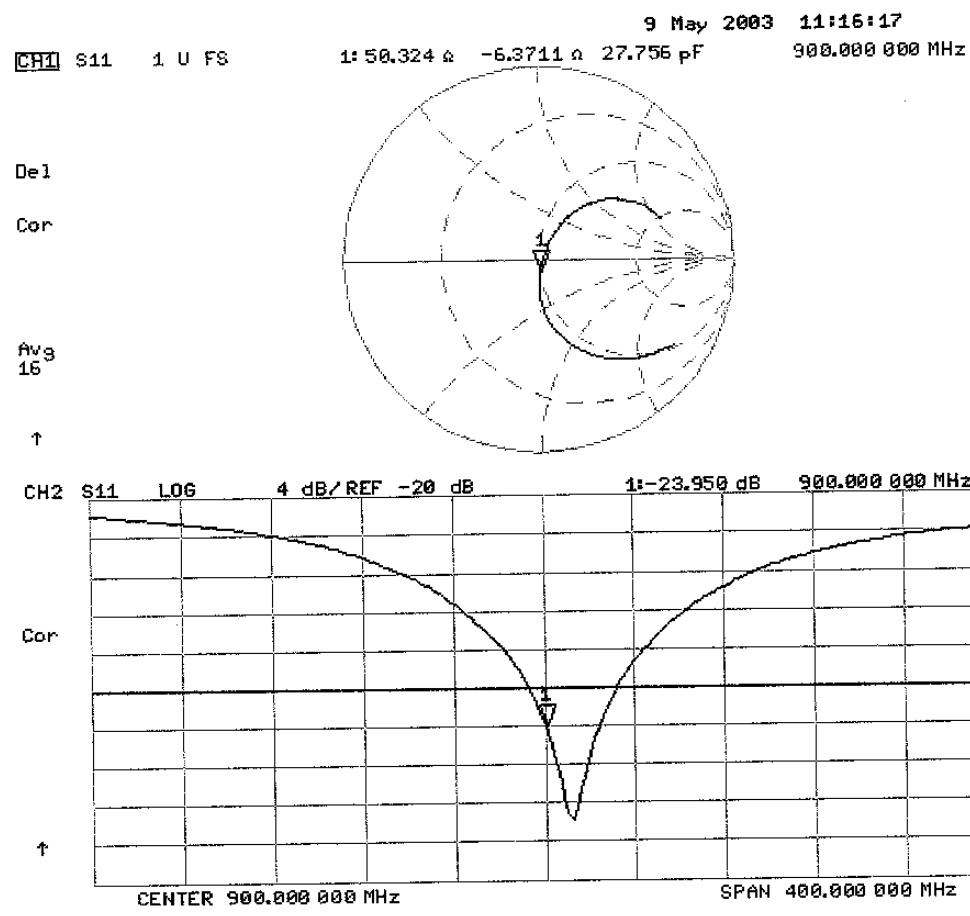
SAR(1 g) = 2.64 mW/g; SAR(10 g) = 1.69 mW/g

Reference Value = 57.1 V/m

Power Drift = 0.02 dB

Maximum value of SAR = 2.83 mW/g





Date/Time: 05/13/03 11:27:28

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN124 SN1507 M900 130503.da4

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN124**  
**Program: Dipole Calibration**

Communication System: CW-900; Frequency: 900 MHz; Duty Cycle: 1:1

Medium: Muscle 900 MHz ( $\sigma = 1.03 \text{ mho/m}$ ,  $\epsilon_r = 53.48$ ,  $\rho = 1000 \text{ kg/m}^3$ )

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 = 56 V/m

Power Drift = 0.007 dB

Maximum value of SAR = 2.94 mW/g

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

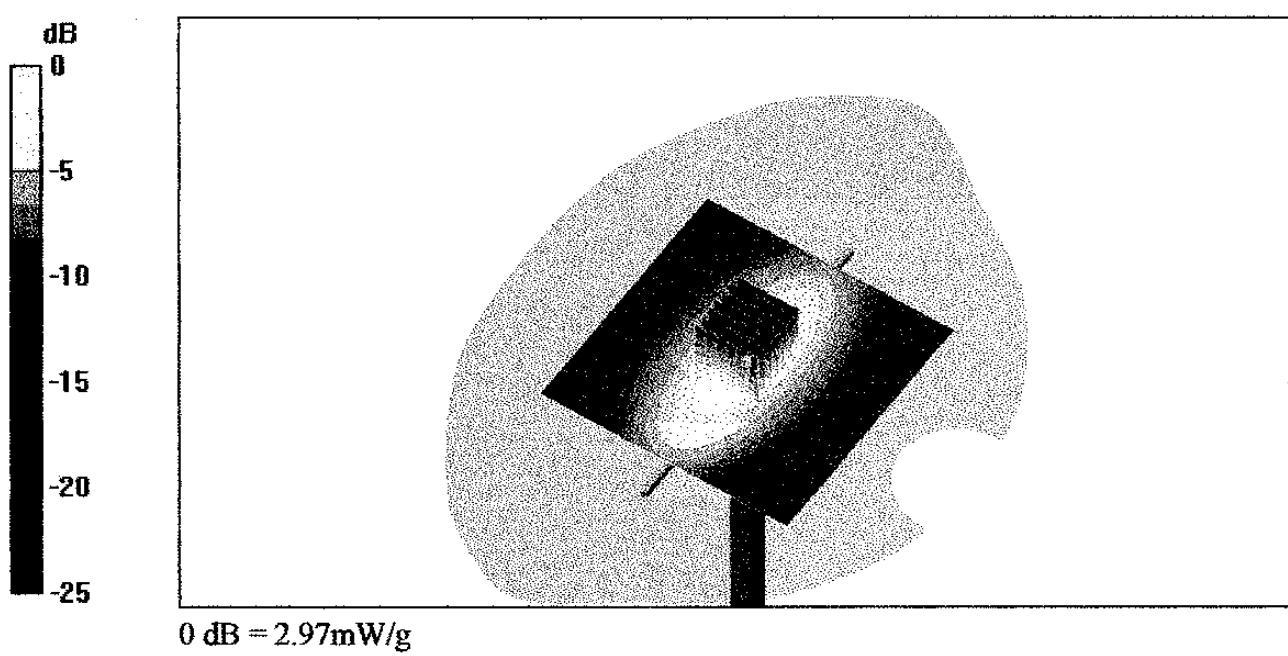
Peak SAR (extrapolated) = 3.97 W/kg

SAR(1 g) = 2.75 mW/g; SAR(10 g) = 1.78 mW/g

Reference Value = 56 V/m

Power Drift = 0.007 dB

Maximum value of SAR = 2.97 mW/g



124  
Body

CH1 S11 1 U FS 1: 46.223  $\Omega$  -8.1541  $\Omega$  21.661 pF 900.000 000 MHz

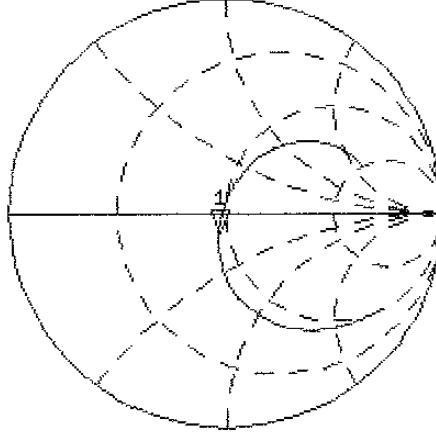
13 May 2003 09:21:44

De1

PRm

Cor  
Avg  
16

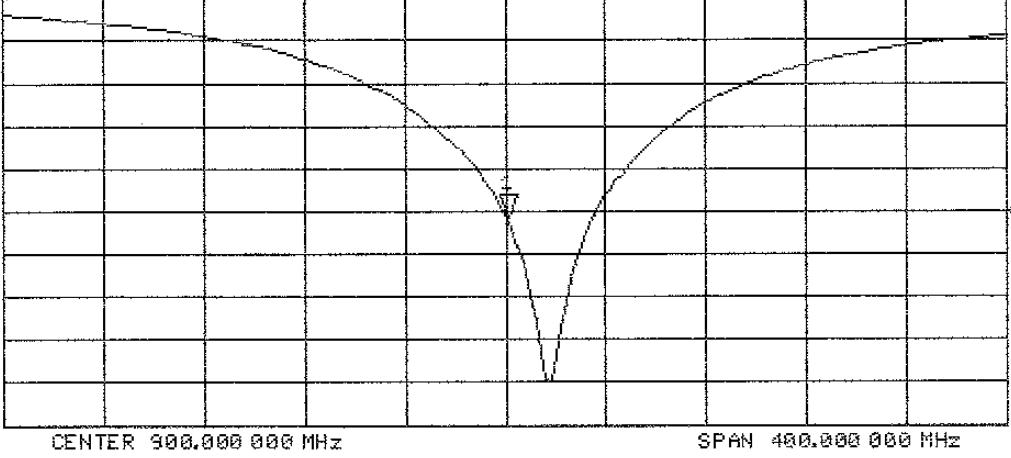
↑



CH2 S11 LOG 4 dB/REF -20 dB 1: -20.646 dB 900.000 000 MHz

PRm  
Cor

↑



CENTER 900.000 000 MHz

SPAN 400.000 000 MHz

A1234

Calibration Laboratory of  
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 Engineering AG  
 Zeughausstrasse 43, 8004 Zurich, Switzerland

*Hand of H. H. Schmid  
 Checked  
 23/05/03*

Client

RFI

## CALIBRATION CERTIFICATE

Object(s)	DAE3-SN:450		
Calibration procedure(s)	QA-CAL-06.v2 Calibration procedure for the data acquisition unit (DAE)		
Calibration date:	May 19, 2003		
Condition of the calibrated item	In Tolerance (according to the specific calibration document)		
<p>This calibration statement documents traceability of M&amp;TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity &lt; 75%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p>			
Model Type	ID #	Cal Date	Scheduled Calibration
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01	Sep-03
Calibrated by:	Name Eric Hainfeld	Function Technician	
Approved by:	Name Fin. Bombelt	Function R&D Director	
Date issued: May 19, 2003			
<p>This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid &amp; Partner Engineering AG is completed.</p>			

## 1. DC Voltage Measurement

DA - Converter Values from DAE

High Range: 1LSB =  $6.1\mu\text{V}$ , full range =  $400\text{ mV}$   
 Low Range: 1LSB =  $61\text{nV}$ , full range =  $4\text{ mV}$

Software Set-up: Calibration time: 3 sec Measuring time: 3 sec

Setup	X	Y	Z
High Range	405.5951302	405.2833984	405.4842344
Low Range	3.97291	3.94768	3.97214
Connector Position		75 °	

High Range	Input	Reading in $\mu\text{V}$	% Error
Channel X + Input	200mV	199999	0.00
	20mV	20002.4	0.01
Channel X - Input	20mV	-19998.8	-0.01
Channel Y + Input	200mV	200001	0.00
	20mV	19996.9	-0.02
Channel Y - Input	20mV	-20005	0.03
Channel Z + Input	200mV	200001	0.00
	20mV	20002.2	0.01
Channel Z - Input	20mV	-20001.1	0.01

Low Range	Input	Reading in $\mu\text{V}$	% Error
Channel X + Input	2mV	2000.1	0.00
	0.2mV	200.09	0.05
Channel X - Input	0.2mV	-200.44	0.22
Channel Y + Input	2mV	2000.2	0.01
	0.2mV	199.19	-0.41
Channel Y - Input	0.2mV	-200.64	0.32
Channel Z + Input	2mV	2000	0.00
	0.2mV	199.03	-0.48
Channel Z - Input	0.2mV	-201.51	0.75

## 2. Common mode sensitivity

Software Set-up

Calibration time: 3 sec, Measuring time: 3 sec  
High/Low Range

in $\mu$ V	Common mode Input Voltage	High Range Reading	Low Range Reading
<b>Channel X</b>	200mV	0.77918	-0.79661
	- 200mV	0.070618	0.74578
<b>Channel Y</b>	200mV	-7.4139	-7.8046
	- 200mV	6.277	6.1409
<b>Channel Z</b>	200mV	-0.18007	-1.493
	- 200mV	-1.7404	-0.80548

## 3. Channel separation

Software Set-up

Calibration time: 3 sec, Measuring time: 3 sec  
High Range

in $\mu$ V	Input Voltage	Channel X	Channel Y	Channel Z
<b>Channel X</b>	200mV	-	0.754	-0.74565
<b>Channel Y</b>	200mV	0.47052	-	3.2555
<b>Channel Z</b>	200mV	-2.397	-0.54072	-

## 4. AD-Converter Values with inputs shorted

in LSB	Low Range	High Range
<b>Channel X</b>	16211	15939
<b>Channel Y</b>	16815	16418
<b>Channel Z</b>	16584	16099

## 5. Input Offset Measurement

Measured after 15 min warm-up time of the Data Acquisition Electronic.  
Every Measurement is preceded by a calibration cycle.

Software set-up:

Calibration time: 3 sec  
Measuring time: 3 sec  
Number of measurements: 100, Low Range

Input  $10M\Omega$

in $\mu$ V	Average	min. Offset	max. Offset	Std. Deviation
Channel X	-0.71	-2.07	-0.11	0.33
Channel Y	-0.26	-1.20	0.30	0.24
Channel Z	-1.18	-2.39	-0.06	0.28

Input shorted

in $\mu$ V	Average	min. Offset	max. Offset	Std. Deviation
Channel X	0.00	-0.96	0.56	0.26
Channel Y	-0.71	-1.98	0.16	0.23
Channel Z	-0.94	-1.18	-0.53	0.14

## 6. Input Offset Current

in fA	Input Offset Current
Channel X	< 25
Channel Y	< 25
Channel Z	< 25

## 7. Input Resistance

	Calibrating	Measuring
Channel X	200 k $\Omega$	200.4 M $\Omega$
Channel Y	200 k $\Omega$	199.7 M $\Omega$
Channel Z	199.9 k $\Omega$	198.9 M $\Omega$

## 8. Low Battery Alarm Voltage

in V	Alarm Level
Supply (+ Vcc)	7.62 V
Supply (- Vcc)	-7.65 V

## 9. Power Consumption

in mA	Switched off	Stand by	Transmitting
Supply (+ Vcc)	0.000	5.59	13.8
Supply (- Vcc)	-0.010	-7.76	-9.07

## 10. Functional test

Touch async pulse 1	ok
Touch async pulse 2	ok
Touch status bit 1	ok
Touch status bit 2	ok
Remote power off	ok
Remote analog Power control	ok
Modification Status	B – C

Calibration Laboratory of  
Schmid & Partner  
Engineering AG  
Zeughausstrasse 43, 8004 Zurich, Switzerland

*YHD*  
CAL2CK 20  
06/08/03

Client

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## CALIBRATION CERTIFICATE

Object(s)	ET3DV6 - SN 1528		
Calibration procedure(s)	QA CAL-01 v2 Calibration procedure for dosimetric E-field probes		
Calibration date:	July 29, 2003		
Condition of the calibrated item	In Tolerance (according to the specific calibration document)		
<p>This calibration statement documents traceability of M&amp;TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity &lt; 75%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p>			
Model	Type	ID #	Cal Date (Calibrated by, Certificate No.)
RF generator HP 8684C		US3642U01700	4-Aug-99 (SPEAG, in house check Aug-02)
Power sensor E4412A		MY41495277	2-Apr-03 (METAS, No 252-0250)
Power sensor HP 8481A		MY41092180	18-Sep-02 (Agilent, No. 20020918)
Power meter EPM E4419B		GB41293874	2-Apr-03 (METAS, No 252-0250)
Network Analyzer HP 8753E		US37390585	18-Oct-01 (Agilent, No. 24BR1033101)
Fluke Process Calibrator Type 702		SN: 6295803	3-Sep-01 (ELCAL, No.2360)
Calibrated by:	Name	Function	Signature
	Nicu Vetterli	Technician	<i>N. Vetterli</i>
Approved by:	Name	Function	Signature
	Katja Pokornic	Laboratory Director	<i>K. Pokornic</i>
Date issued: July 29, 2003			
<p>This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid &amp; Partner Engineering AG is completed.</p>			

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Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, http://www.speag.com

# Probe ET3DV6

**SN:1528**

<b>Manufactured:</b>	March 21, 2000
<b>Last calibration:</b>	February 6, 2003
<b>Recalibrated:</b>	July 29, 2003

**Calibrated for DASY Systems**

(Note: non-compatible with DASY2 system!)

## DASY - Parameters of Probe: ET3DV6 SN:1528

### Sensitivity in Free Space

NormX	<b>1.51</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	<b>1.28</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	<b>1.34</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** **900 MHz**  $\epsilon_r = 41.5 \pm 5\%$   $\sigma = 0.97 \pm 5\% \text{ mho/m}$

Valid for f=855-945 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	<b>6.3</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>6.3</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.41</b>
ConvF Z	<b>6.3</b> $\pm 9.5\%$ (k=2)	Depth <b>2.46</b>

**Head** **1800 MHz**  $\epsilon_r = 40.0 \pm 5\%$   $\sigma = 1.40 \pm 5\% \text{ mho/m}$

Valid for f=1710-1890 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

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>0.51</b>
ConvF Z	<b>5.0</b> $\pm 9.5\%$ (k=2)	Depth <b>2.62</b>

### Boundary Effect

**Head** **900 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	10.2	6.0
SAR <sub>be</sub> [%] With Correction Algorithm	0.3	0.3

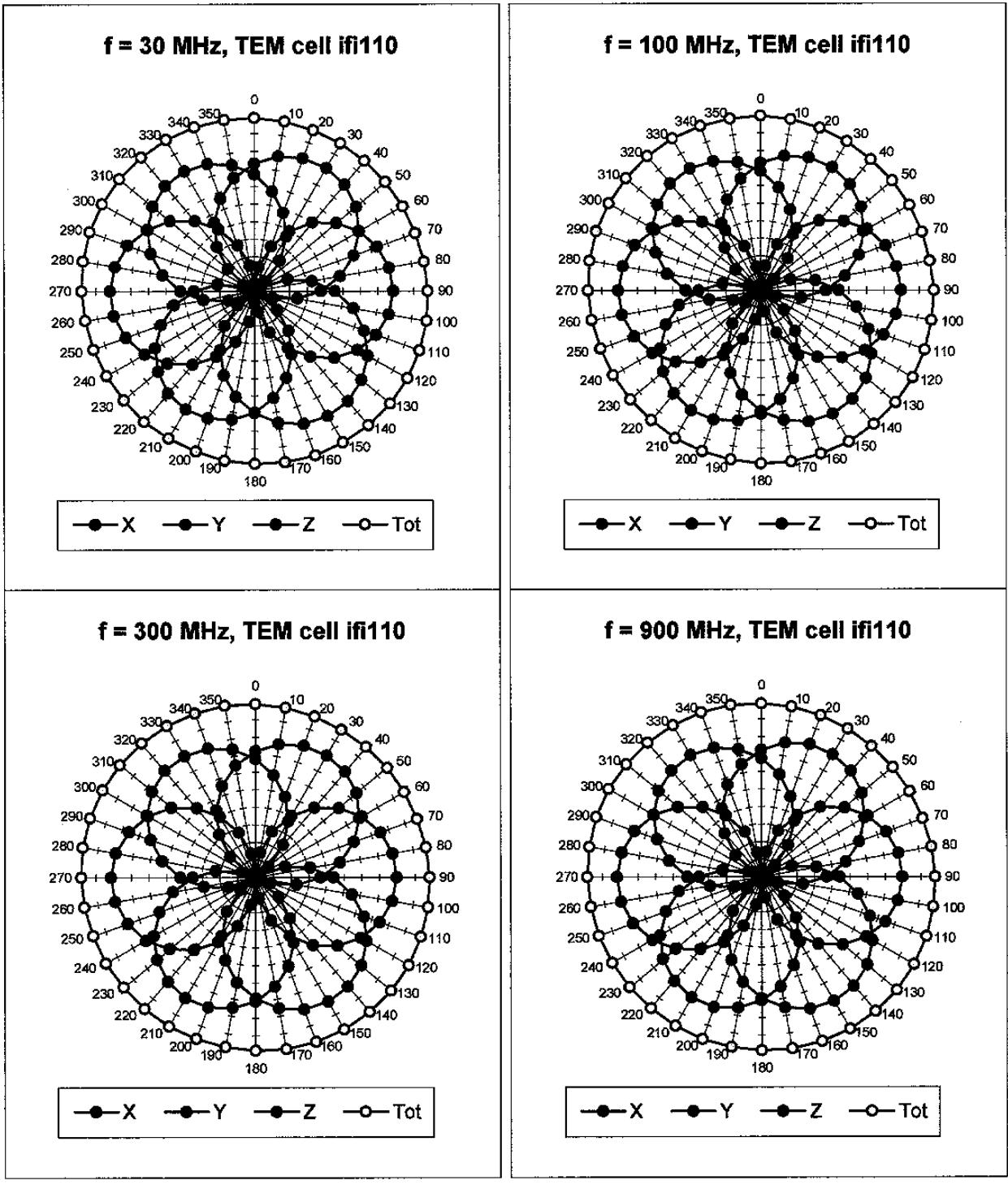
**Head** **1800 MHz** Typical SAR gradient: 10 % per mm

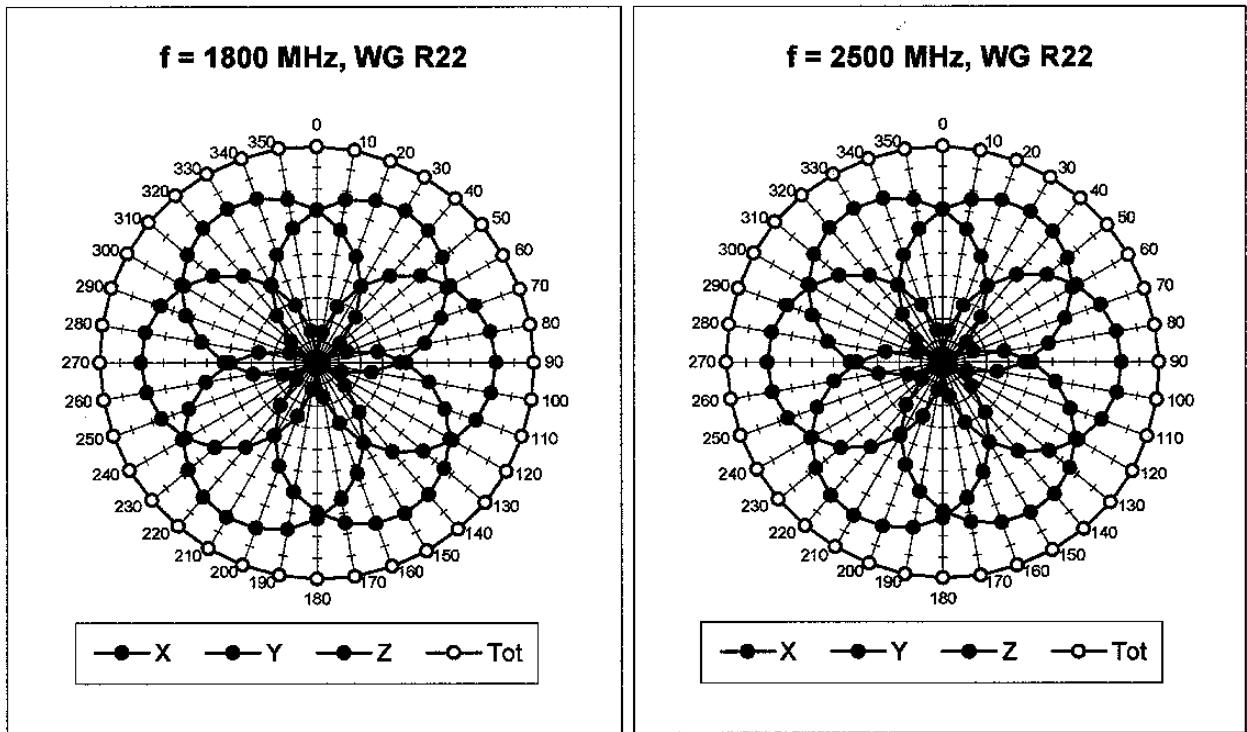
Probe Tip to Boundary	<b>1 mm</b>	<b>2 mm</b>
SAR <sub>be</sub> [%] Without Correction Algorithm	13.9	9.2
SAR <sub>be</sub> [%] With Correction Algorithm	0.2	0.0

### Sensor Offset

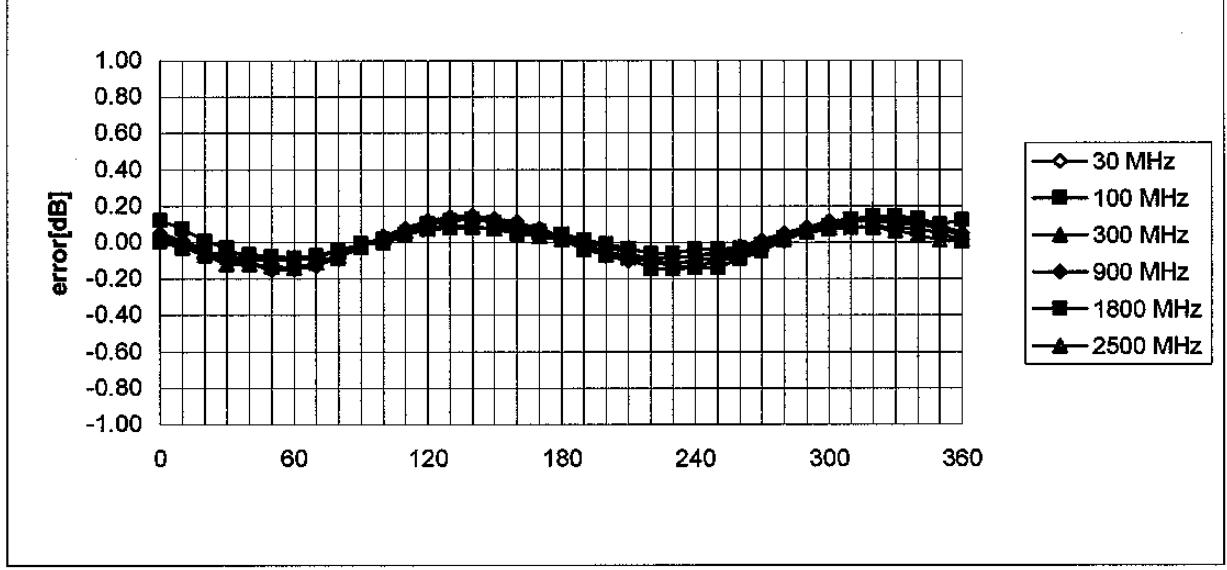
Probe Tip to Sensor Center	<b>2.7</b>	mm
Optical Surface Detection	<b>1.6 <math>\pm</math> 0.2</b>	mm

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



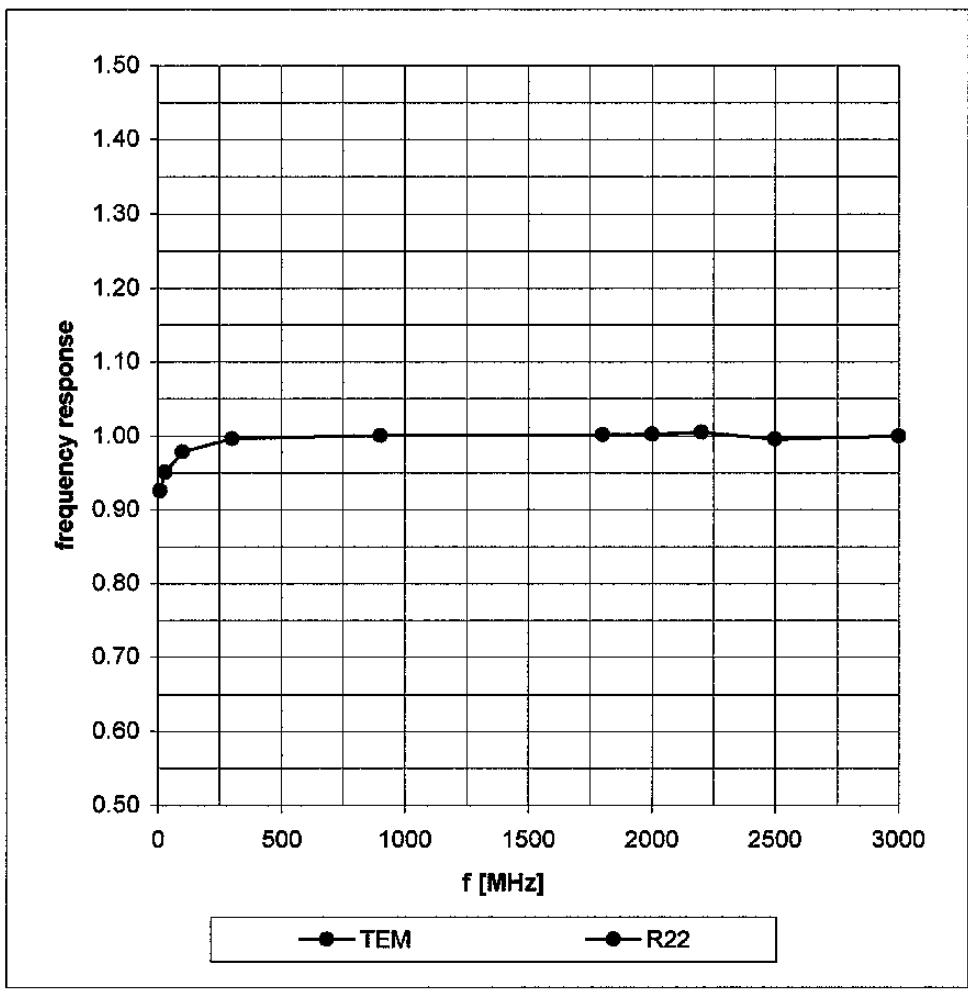


### Isotropy Error ( $\phi$ ), $\theta = 0^\circ$

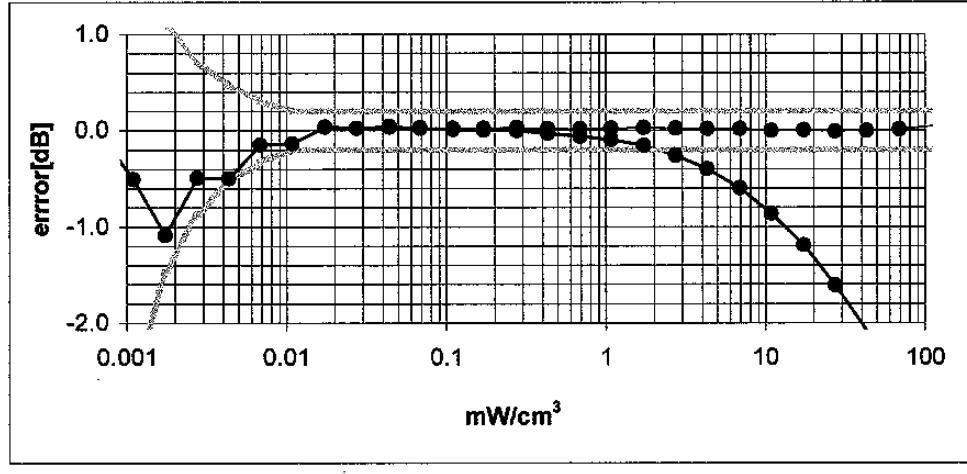
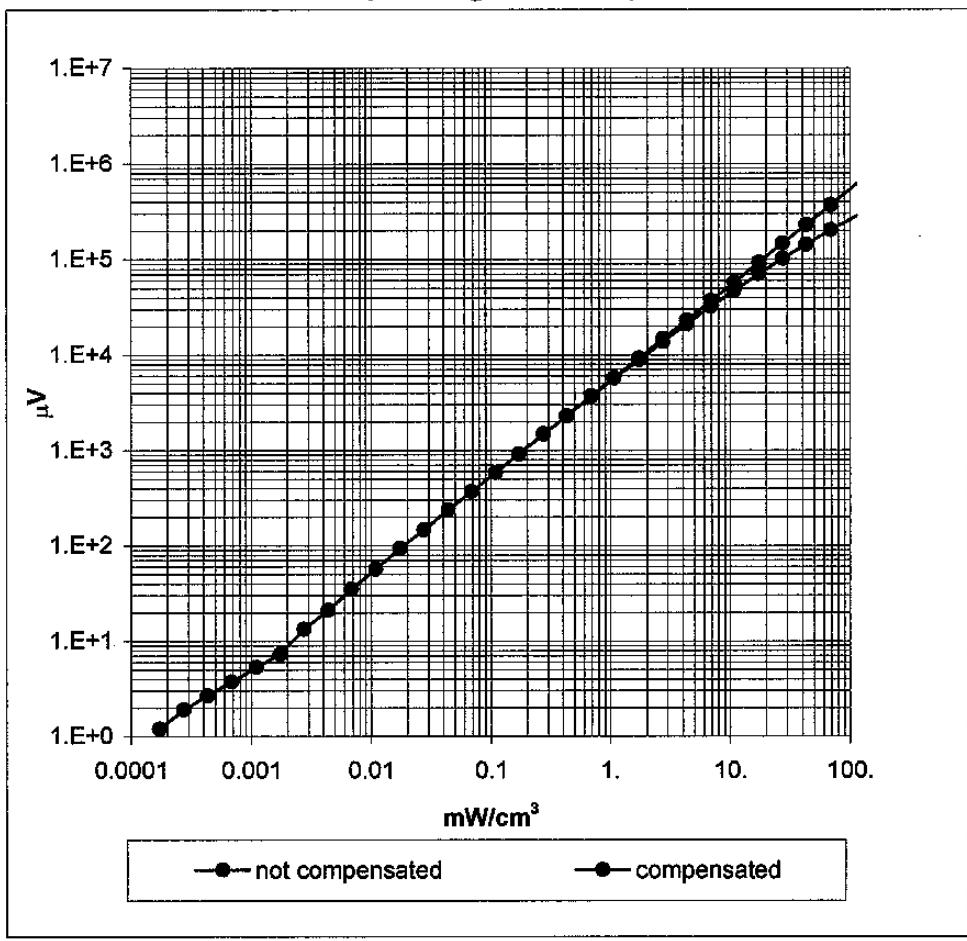


## Frequency Response of E-Field

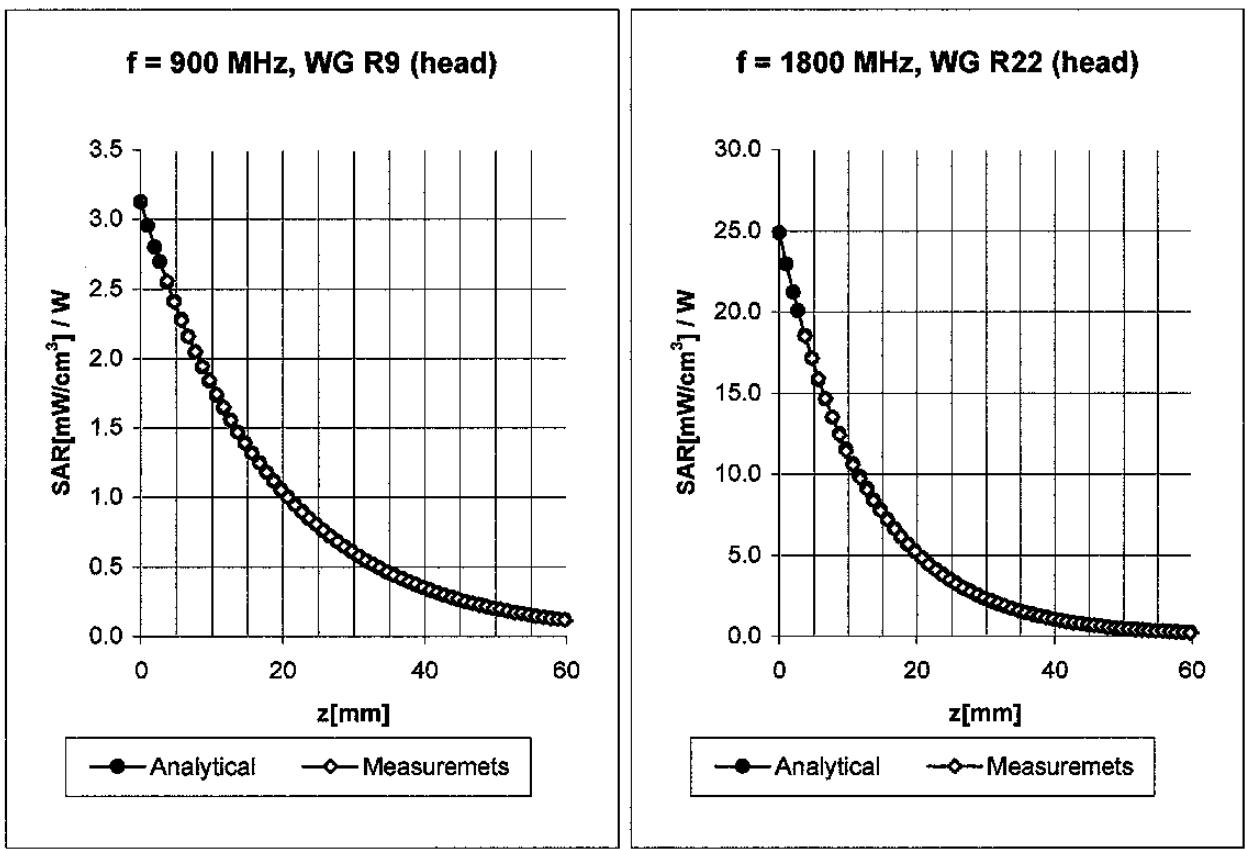
( TEM-Cell:ifi110, Waveguide R22)



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



## Conversion Factor Assessment



Head 900 MHz  $\varepsilon_r = 41.5 \pm 5\%$   $\sigma = 0.97 \pm 5\% \text{ mho/m}$

Valid for f=855-945 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

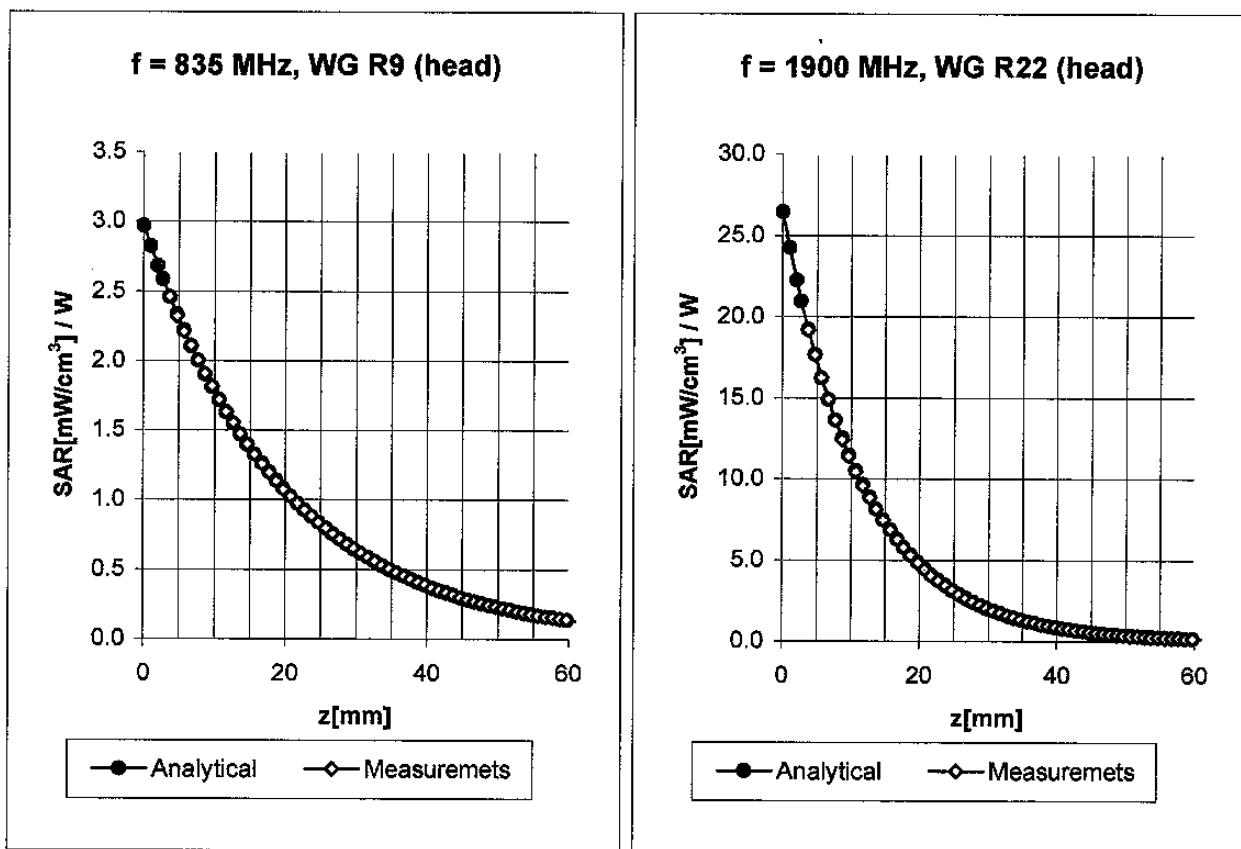
ConvF X	<b>6.3</b> $\pm$ 9.5% (k=2)	Boundary effect:	
ConvF Y	<b>6.3</b> $\pm$ 9.5% (k=2)	Alpha	<b>0.41</b>
ConvF Z	<b>6.3</b> $\pm$ 9.5% (k=2)	Depth	<b>2.46</b>

Head 1800 MHz  $\varepsilon_r = 40.0 \pm 5\%$   $\sigma = 1.40 \pm 5\% \text{ mho/m}$

Valid for f=1710-1890 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

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>0.51</b>
ConvF Z	<b>5.0</b> $\pm$ 9.5% (k=2)	Depth	<b>2.62</b>

## Conversion Factor Assessment



Head 835 MHz  $\epsilon_r = 41.5 \pm 5\%$   $\sigma = 0.90 \pm 5\%$  mho/m

**Valid for f=793-877 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X**

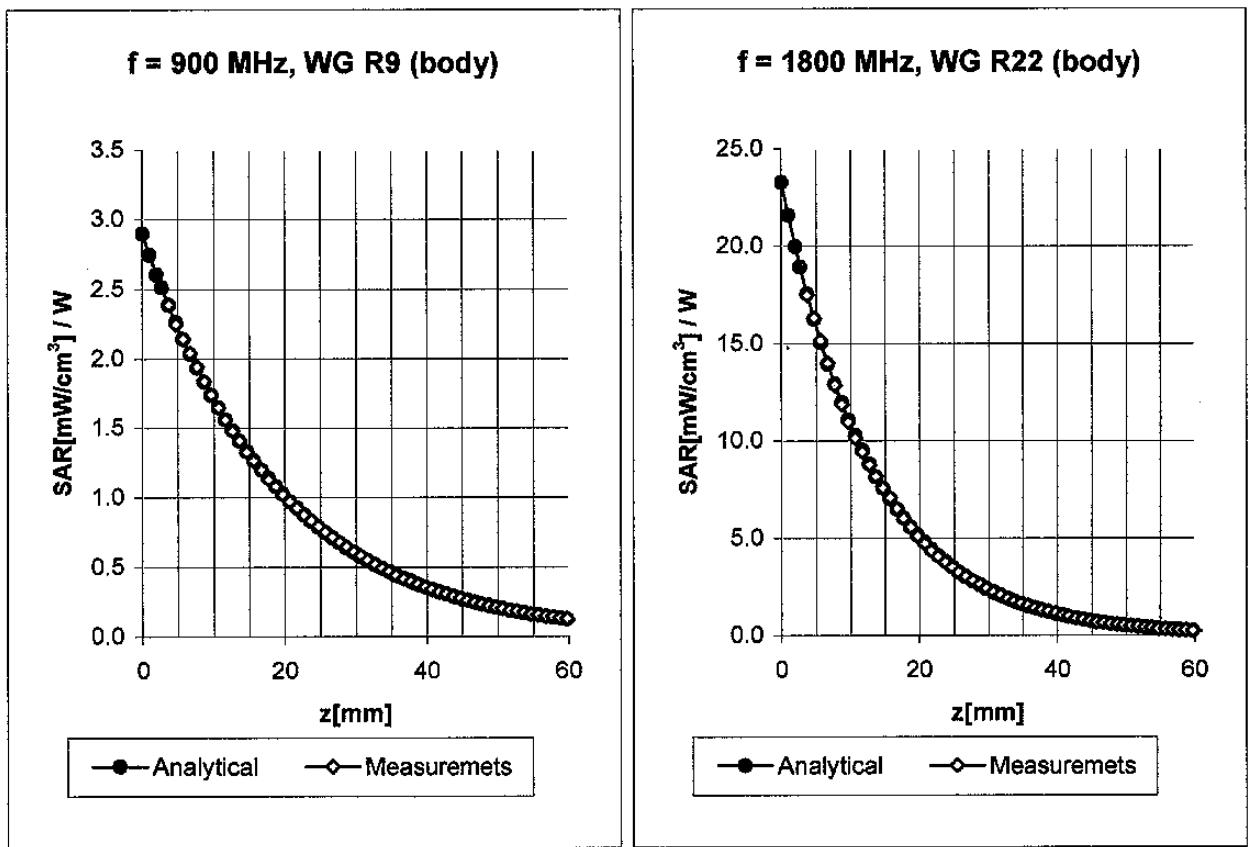
ConvF X	<b>6.4</b> $\pm$ 9.5% (k=2)	Boundary effect:	
ConvF Y	<b>6.4</b> $\pm$ 9.5% (k=2)	Alpha	<b>0.46</b>
ConvF Z	<b>6.4</b> $\pm$ 9.5% (k=2)	Depth	<b>2.20</b>

Head 1900 MHz  $\varepsilon_r = 40.0 \pm 5\%$   $\sigma = 1.40 \pm 5\%$  mho/m

Valid for f=1805-1995 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	<b>4.8</b> $\pm$ 9.5% (k=2)	Boundary effect:	
ConvF Y	<b>4.8</b> $\pm$ 9.5% (k=2)	Alpha	<b>0.54</b>
ConvF Z	<b>4.8</b> $\pm$ 9.5% (k=2)	Depth	<b>2.58</b>

## Conversion Factor Assessment



**Body**                    **900 MHz**                     $\epsilon_r = 55.0 \pm 5\%$                      $\sigma = 1.05 \pm 5\% \text{ mho/m}$

Valid for  $f=855-945 \text{ MHz}$  with Body Tissue Simulating Liquid according to OET 65 Suppl. C

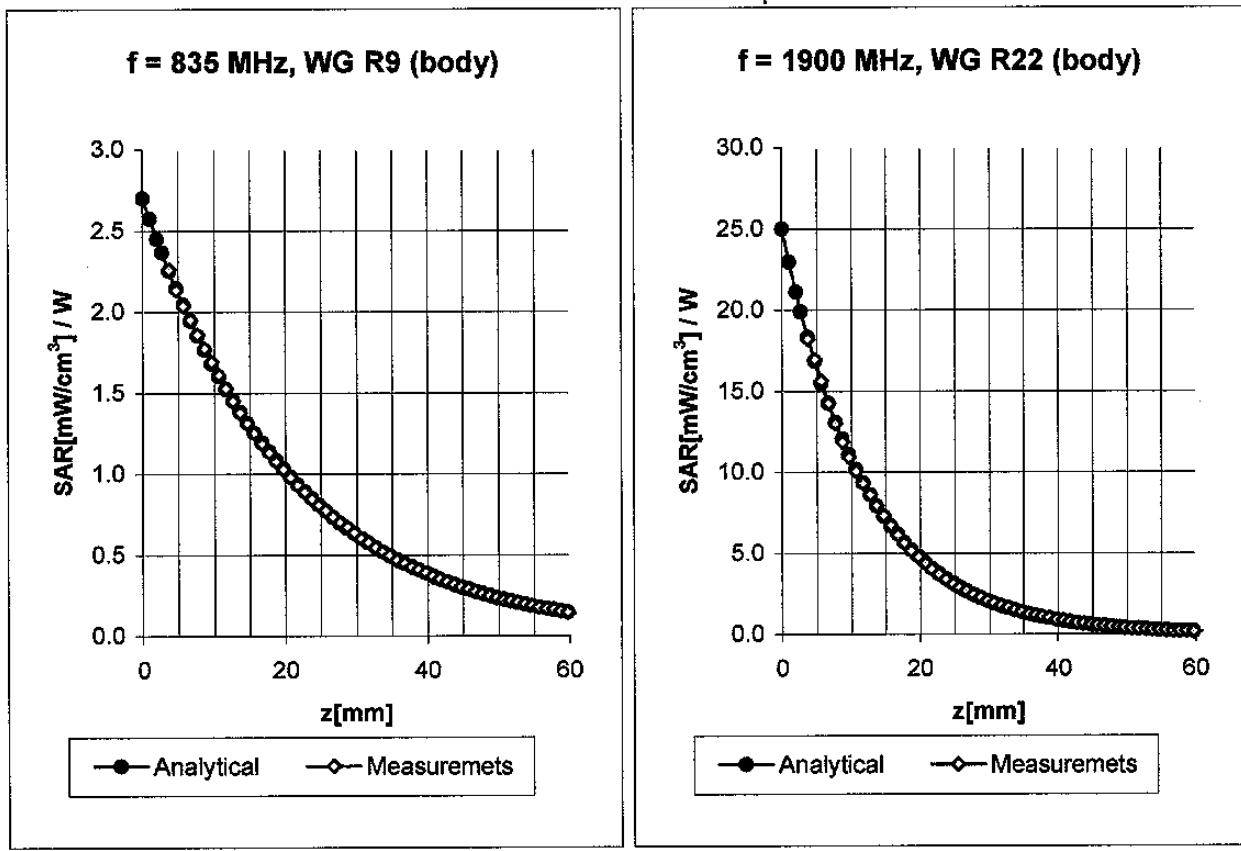
ConvF X	<b>6.2</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>6.2</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.56</b>
ConvF Z	<b>6.2</b> $\pm 9.5\%$ (k=2)	Depth <b>2.08</b>

**Body**                    **1800 MHz**                     $\epsilon_r = 53.3 \pm 5\%$                      $\sigma = 1.52 \pm 5\% \text{ mho/m}$

Valid for  $f=1710-1890 \text{ MHz}$  with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	<b>4.7</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>4.7</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.62</b>
ConvF Z	<b>4.7</b> $\pm 9.5\%$ (k=2)	Depth <b>2.59</b>

## Conversion Factor Assessment



**Body                    835 MHz                     $\epsilon_r = 55.2 \pm 5\%$                      $\sigma = 0.97 \pm 5\% \text{ mho/m}$**

Valid for f=793-877 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

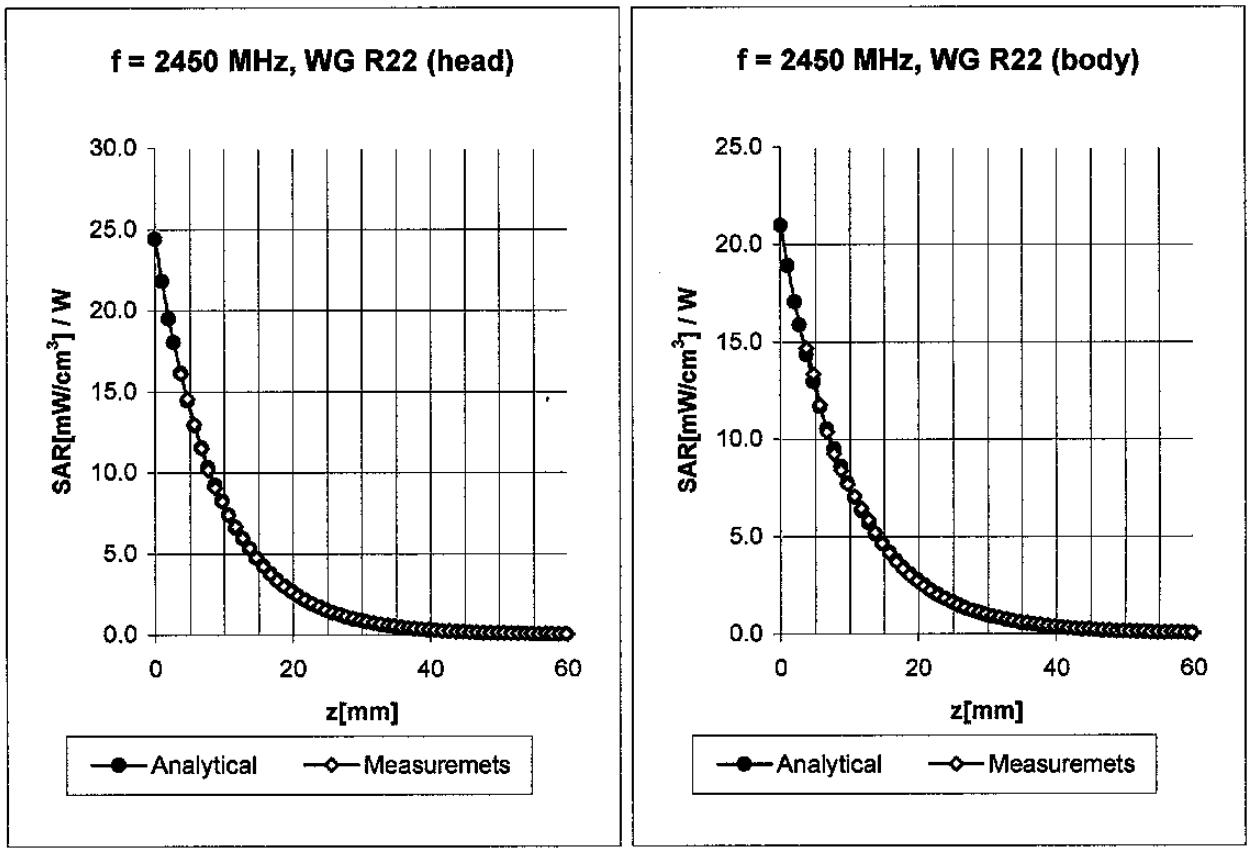
ConvF X	<b>6.3</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>6.3</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.44</b>
ConvF Z	<b>6.3</b> $\pm 9.5\%$ (k=2)	Depth <b>2.40</b>

**Body                    1900 MHz                     $\epsilon_r = 53.3 \pm 5\%$                      $\sigma = 1.52 \pm 5\% \text{ mho/m}$**

Valid for f=1805-1995 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	<b>4.6</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>4.6</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.65</b>
ConvF Z	<b>4.6</b> $\pm 9.5\%$ (k=2)	Depth <b>2.48</b>

## Conversion Factor Assessment



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

Valid for f=2328-2573 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	<b>4.6</b> $\pm 8.9\%$ (k=2)	Boundary effect:
ConvF Y	<b>4.6</b> $\pm 8.9\%$ (k=2)	Alpha <b>1.04</b>
ConvF Z	<b>4.6</b> $\pm 8.9\%$ (k=2)	Depth <b>1.85</b>

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

Valid for f=2328-2573 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	<b>4.3</b> $\pm 8.9\%$ (k=2)	Boundary effect:
ConvF Y	<b>4.3</b> $\pm 8.9\%$ (k=2)	Alpha <b>1.10</b>
ConvF Z	<b>4.3</b> $\pm 8.9\%$ (k=2)	Depth <b>1.75</b>

## Deviation from Isotropy in HSL

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

