

Appendix C – Dipole Calibration

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

Client

Auden

CALIBRATION CERTIFICATE

Object(s) **D5GHzV2 - SN:1021**

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

Calibration date: **March 23, 2004**

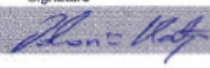
Condition of the calibrated item **In Tolerance (according to the specific calibration document)**

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
Power meter EPM E4419B	GB41293874	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor E4412A	MY41495277	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor HP 8481A	MY41092317	18-Oct-02 (Agilent, No. 20021018)	Oct-04
RF generator R&S SMT06	100058	23-May-01 (SPEAG, in house check May-03)	In house check: May-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-03)	In house check: Oct 05

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Laboratory Director	
Approved by:	Fin Bombolt	R&Q Director	

Date issued: March 25, 2004

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>

DASY

Dipole Validation Kit

Type: D5GHzV2

Serial: 1021

Manufactured: February 5, 2004

Calibrated: March 23, 2004

March 2004

D5GHzV2 – SN:1021

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:

Frequency:	5200 MHz	
Relative Dielectricity	36.3	$\pm 5\%$
Conductivity	4.57 mho/m	$\pm 5\%$
Frequency:	5800 MHz	
Relative Dielectricity	35.4	$\pm 5\%$
Conductivity	5.20 mho/m	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe EX3DV3 - SN:3503 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. Lossless spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 10mm was aligned with the dipole. Special 8x8x8 fine cube was chosen for cube integration (dx=dy=4.3mm, dz=3mm). Distance between probe sensors and phantom surface was set to 2.5 mm. The dipole input power (forward power) was 250 mW $\pm 3\%$. The results are normalized to 1W input power.

2. SAR Measurement with DASY System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figures supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured at **5200 MHz (Head Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm ³ (1 g) of tissue:	81.2 mW/g $\pm 20.3\%$ (k=2)¹
averaged over 10 cm ³ (10 g) of tissue:	23.1 mW/g $\pm 19.8\%$ (k=2)¹

The resulting averaged SAR-values measured at **5800 MHz (Head Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm ³ (1 g) of tissue:	81.2 mW/g $\pm 20.3\%$ (k=2)²
averaged over 10 cm ³ (10 g) of tissue:	22.6 mW/g $\pm 19.8\%$ (k=2)²

¹ Target dipole values determined by FDTD (feedpoint impedance set to 50 Ohm). The values are SAR_1g=76.5 mW/g, SAR_10g=21.6 mW/g and SAR_peak=310.3 mW/g.

² Target dipole values determined by FDTD (feedpoint impedance set to 50 Ohm). The values are SAR_1g=78.0 mW/g, SAR_10g=21.9 mW/g and SAR_peak=340.9 mW/g.

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3. Dipole Transformation Parameters

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint (please refer to the graphics attached to this document). The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	1.200 ns	(one direction)
Transmission factor:	0.950	(voltage transmission, one direction)

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:

Frequency:	5200 MHz	
Relative Dielectricity	49.7	± 5%
Conductivity	5.18 mho/m	± 5%
Frequency:	5800 MHz	
Relative Dielectricity	48.5	± 5%
Conductivity	6.01 mho/m	± 5%

The DASY3 System with a dosimetric E-field probe EX3DV3 - SN:3503 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. Lossless spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 10mm was aligned with the dipole. The 8x8x8 fine cube was chosen for cube integration (dx=dy=4.3mm, dz=3mm). Distance between probe sensors and phantom surface was set to 2.5 mm. The dipole input power (forward power) was 250 mW ± 3 %. The results are normalized to 1W input power.

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5. SAR Measurement with DASY System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. The results (see figures supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured at **5200 MHz (Body Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm³ (1 g) of tissue: **76.4 mW/g ± 20.3 % (k=2)³**

averaged over 10 cm³ (10 g) of tissue: **21.6 mW/g ± 19.8 % (k=2)³**

The resulting averaged SAR-values measured at **5800 MHz (Body Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm³ (1 g) of tissue: **72.0 mW/g ± 20.3 % (k=2)⁴**

averaged over 10 cm³ (10 g) of tissue: **20.0 mW/g ± 19.8 % (k=2)⁴**

6. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with **head and body simulating solution** of the following electrical parameters:

Frequency:	5500 MHz (Head)
Relative Dielectricity	35.5 ± 5%
Conductivity	5.03 mho/m ± 5%

Frequency:	5500 MHz (Body)
Relative Dielectricity	49.1 ± 5%
Conductivity	5.59 mho/m ± 5%

The DASY3 System with a dosimetric E-field probe EX3DV3 - SN:3503 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. Lossless spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 10mm was aligned with the dipole. The 8x8x8 fine cube was chosen for cube integration (dx=dy=4.3mm, dz=3mm). Distance between probe sensors and phantom surface was set to 2.5 mm. The dipole input power (forward power) was 250 mW ± 3 %. The results are normalized to 1W input power.

³ Target dipole values determined by FDTD (feedpoint impedance set to 50 Ohm). The values are SAR_{1g}=71.8 mW/g, SAR_{10g}=20.1 mW/g and SAR_{peak}=284.7 mW/g.

⁴ Target dipole values determined by FDTD (feedpoint impedance set to 50 Ohm). The values are SAR_{1g}=74.1 mW/g, SAR_{10g}=20.5 mW/g and SAR_{peak}=324.7 mW/g.

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7. SAR Measurement with DASY System

Standard SAR-measurements were performed according to the measurement conditions described in section 6. The results (see figures supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured at **5500 MHz (Head Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm³ (1 g) of tissue: **95.2 mW/g ± 20.3 % (k=2)**

averaged over 10 cm³ (10 g) of tissue: **26.3 mW/g ± 19.8 % (k=2)**

The resulting averaged SAR-values measured at **5500 MHz (Body Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm³ (1 g) of tissue: **79.6 mW/g ± 20.3 % (k=2)**

averaged over 10 cm³ (10 g) of tissue: **21.9 mW/g ± 19.8 % (k=2)**

8. 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.

9. 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 increase frequency bandwidth at the position as explained in Sections 1,4 and 6.

10. Power Test

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

March 2004

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Serial: D5GHzV2 - SN:1021

Communication System: CW-5GHz; Duty Cycle: 1:1; Medium: MSL5800

Medium parameters used: $f = 5500$ MHz; $\sigma = 5.59$ mho/m; $\epsilon_r = 49.1$; $\rho = 1000$ kg/m³

Phantom: SAM with CRP - TP:1312; Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV3 - SN3503; ConvF(4.8, 4.8, 4.8);
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE4 600; Calibrated: 9/30/2003
- Measurement SW: DASY4, V4.2 Build 44;

d=10mm, Pin=250mW, f=5500 MHz/Area Scan (31x31x1): Measurement grid: dx=10mm, dy=10mm

Reference Value = 73.6 V/m; Power Drift = 0.001 dB

Maximum value of SAR (interpolated) = 37.9 mW/g

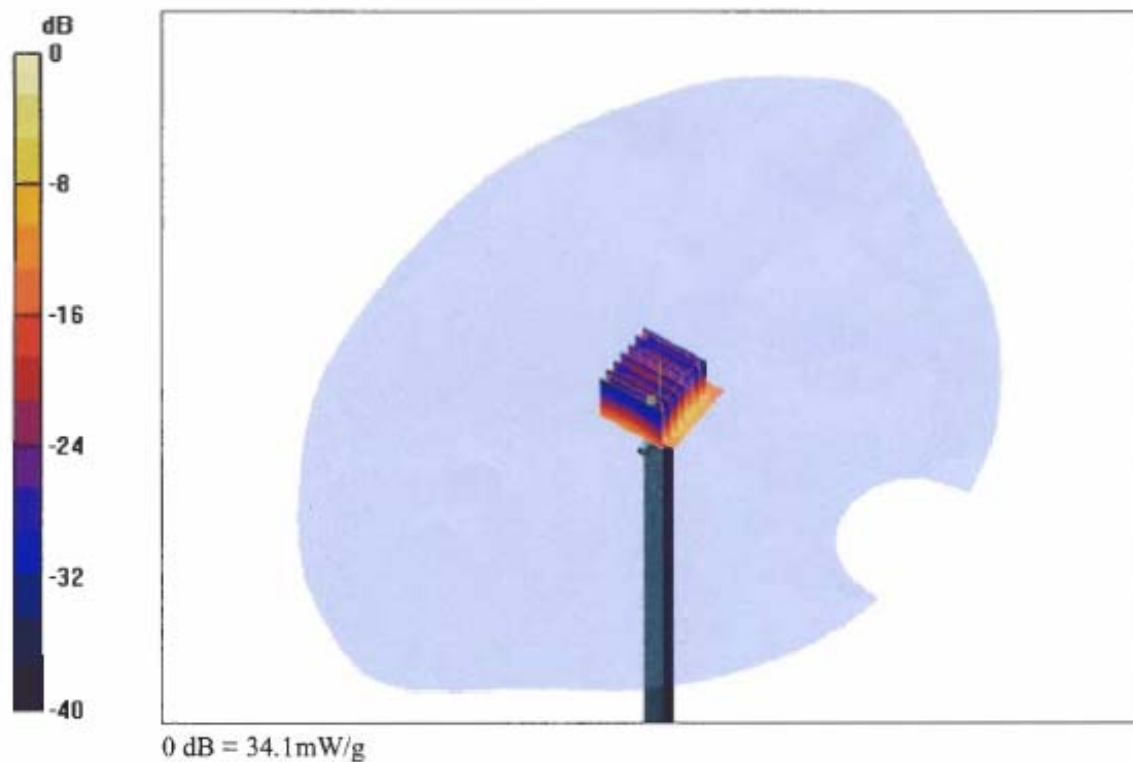
d=10mm, Pin=250mW, f=5500 MHz/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 73.6 V/m; Power Drift = 0.001 dB

Peak SAR (extrapolated) = 75.9 W/kg

SAR(1 g) = 19.9 mW/g; SAR(10 g) = 5.48 mW/g



Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Serial: D5GHzV2 - SN:1021

Communication System: CW-5GHz; Duty Cycle: 1:1; Medium: HSL5800

Medium parameters used: $f = 5200$ MHz; $\sigma = 4.57$ mho/m; $\epsilon_r = 36.3$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5800$ MHz; $\sigma = 5.2$ mho/m; $\epsilon_r = 35.4$; $\rho = 1000$ kg/m³

Phantom: SAM with CRP - TP:1312; Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV3 - SN3503; ConvF(5.7, 5.7, 5.7), ConvF(5, 5, 5);
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE4 600; Calibrated: 9/30/2003
- Measurement SW: DASY4, V4.2 Build 44;

d=10mm, Pin=250mW, f=5200 MHz/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm

Reference Value = 91.2 V/m; Power Drift = -0.002 dB

Maximum value of SAR (interpolated) = 37 mW/g

d=10mm, Pin=250mW, f=5800 MHz/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 85.8 V/m; Power Drift = -0.0 dB

Peak SAR (extrapolated) = 87.3 W/kg

SAR(1 g) = 20.3 mW/g; SAR(10 g) = 5.66 mW/g

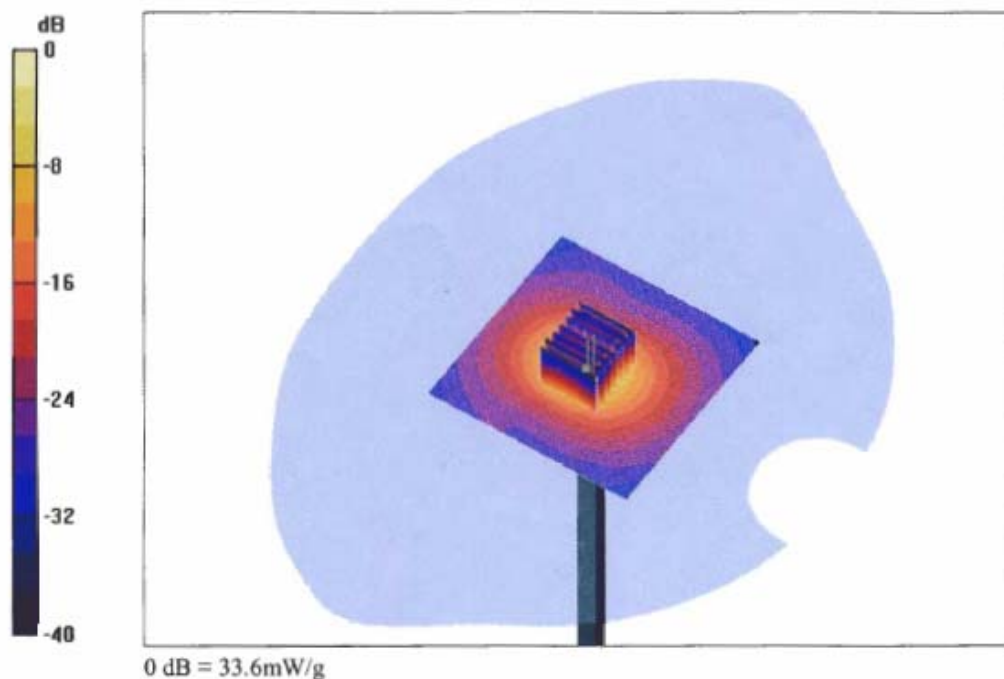
d=10mm, Pin=250mW, f=5200 MHz/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 91.2 V/m; Power Drift = -0.002 dB

Peak SAR (extrapolated) = 78 W/kg

SAR(1 g) = 20.3 mW/g; SAR(10 g) = 5.77 mW/g



Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Serial: D5GHzV2 - SN:1021

Communication System: CW-5GHz; Duty Cycle: 1:1; Medium: MSL5800

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.18$ mho/m; $\epsilon_r = 49.7$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5800$ MHz; $\sigma = 6.01$ mho/m; $\epsilon_r = 48.5$; $\rho = 1000$ kg/m³

Phantom: SAM with CRP - TP:1312; Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV3 - SN3503; ConvF(5, 5, 5), ConvF(4.6, 4.6, 4.6);
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE4 600; Calibrated: 9/30/2003
- Measurement SW: DASY4, V4.2 Build 44;

d=10mm, Pin=250mW, f=5200 MHz/Area Scan (31x31x1): Measurement grid: dx=10mm, dy=10mm

Reference Value = 79.4 V/m; Power Drift = 0.0 dB

Maximum value of SAR (interpolated) = 36 mW/g

d=10mm, Pin=250mW, f=5800 MHz/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 68.1 V/m; Power Drift = -0.0 dB

Peak SAR (extrapolated) = 73.9 W/kg

SAR(1 g) = 18 mW/g; SAR(10 g) = 5.01 mW/g

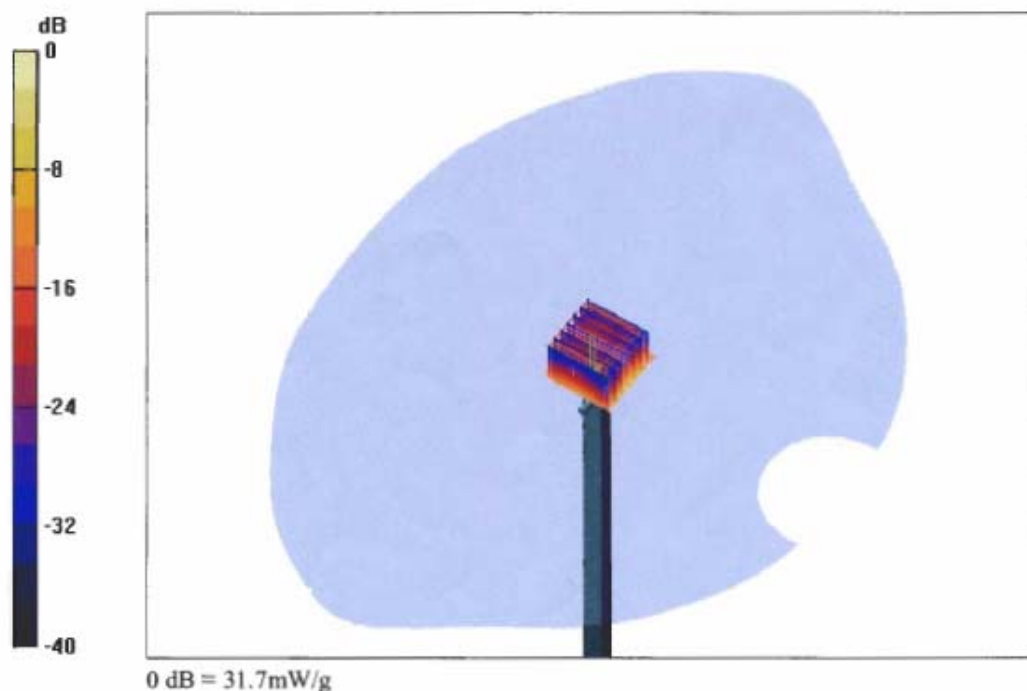
d=10mm, Pin=250mW, f=5200 MHz/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:

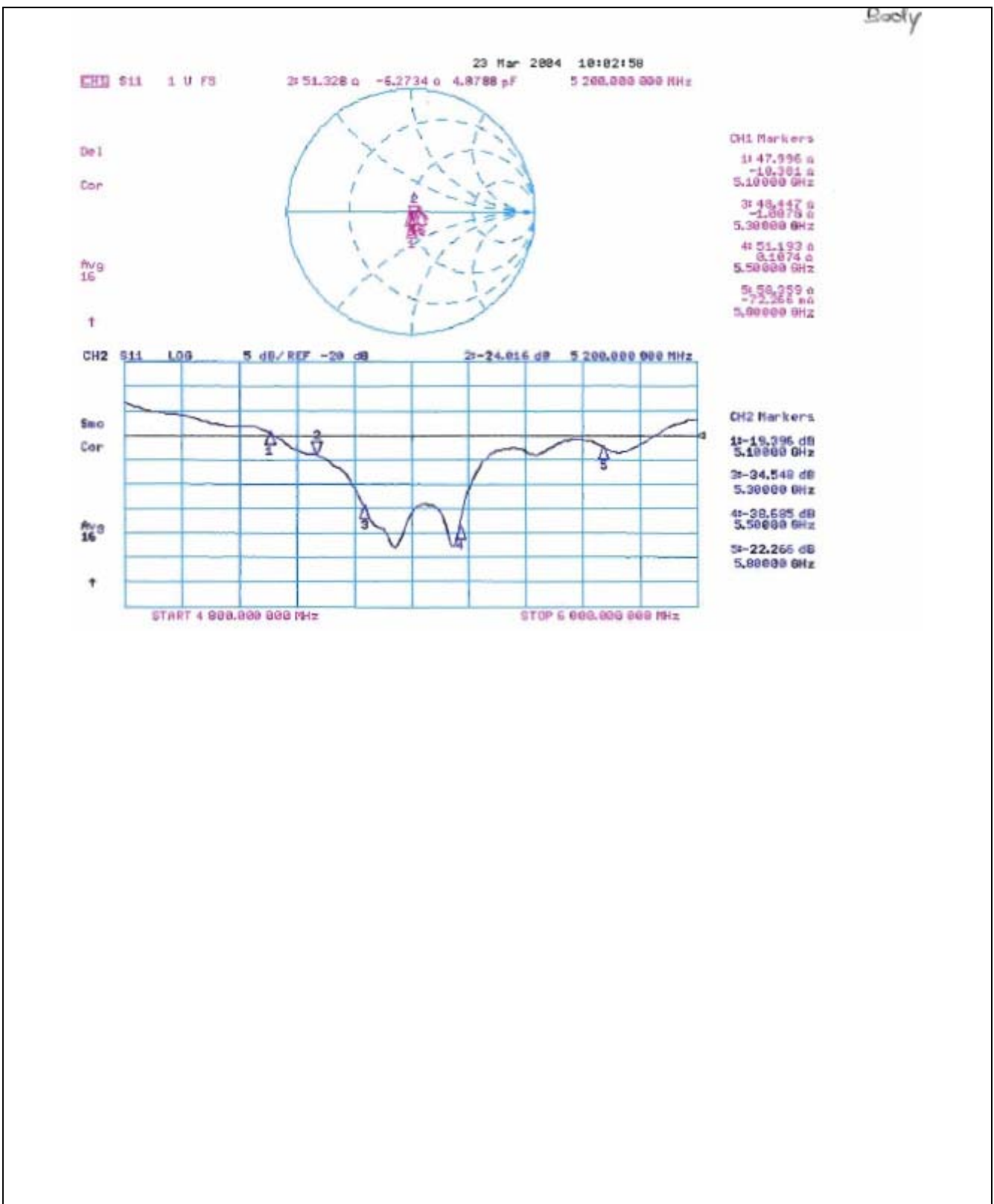
Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 79.4 V/m; Power Drift = 0.0 dB

Peak SAR (extrapolated) = 67.7 W/kg

SAR(1 g) = 19.1 mW/g; SAR(10 g) = 5.41 mW/g





Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Serial: D5GHzV2 - SN:1021

Communication System: CW-5GHz; Duty Cycle: 1:1; Medium: HSL5800

Medium parameters used: $f = 5500$ MHz; $\sigma = 5.03$ mho/m; $\epsilon_r = 35.5$; $\rho = 1000$ kg/m³

Phantom: SAM with CRP - TP:1312; Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV3 - SN3503; ConvF(5, 5, 5);
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE4 600; Calibrated: 9/30/2003
- Measurement SW: DASY4, V4.2 Build 44;

d=10mm, Pin=250mW, f=5500 MHz/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm

Reference Value = 97.3 V/m; Power Drift = 0.0 dB

Maximum value of SAR (interpolated) = 44.6 mW/g

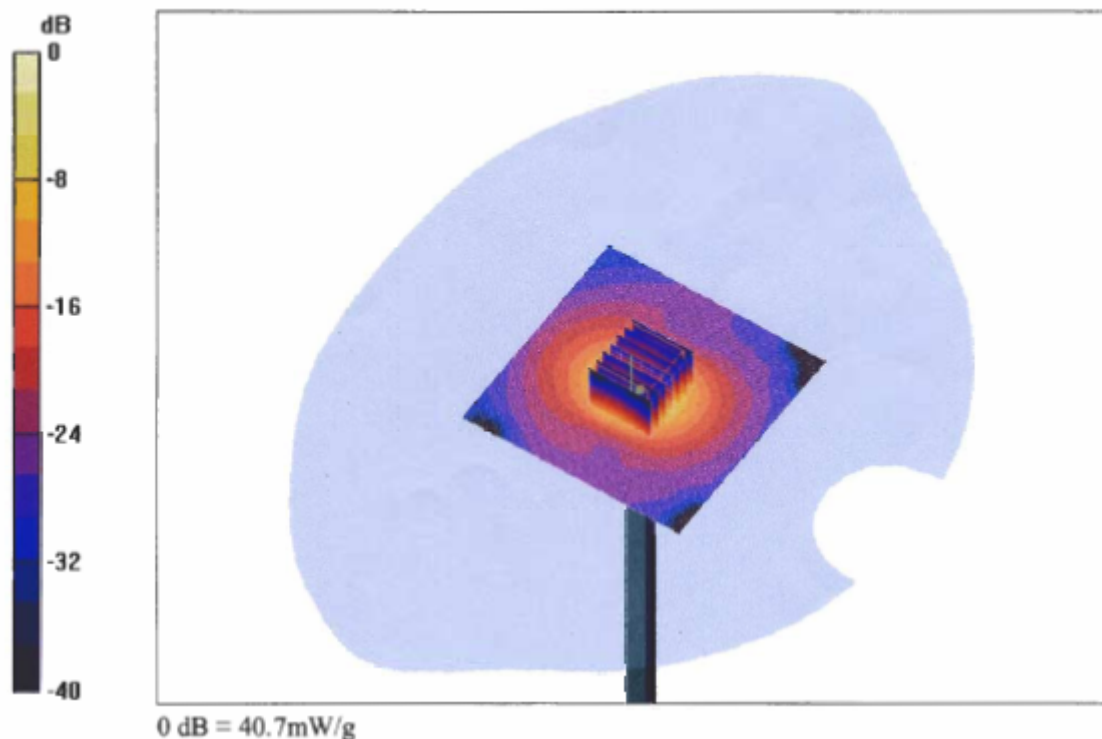
d=10mm, Pin=250mW, f=5500 MHz/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:

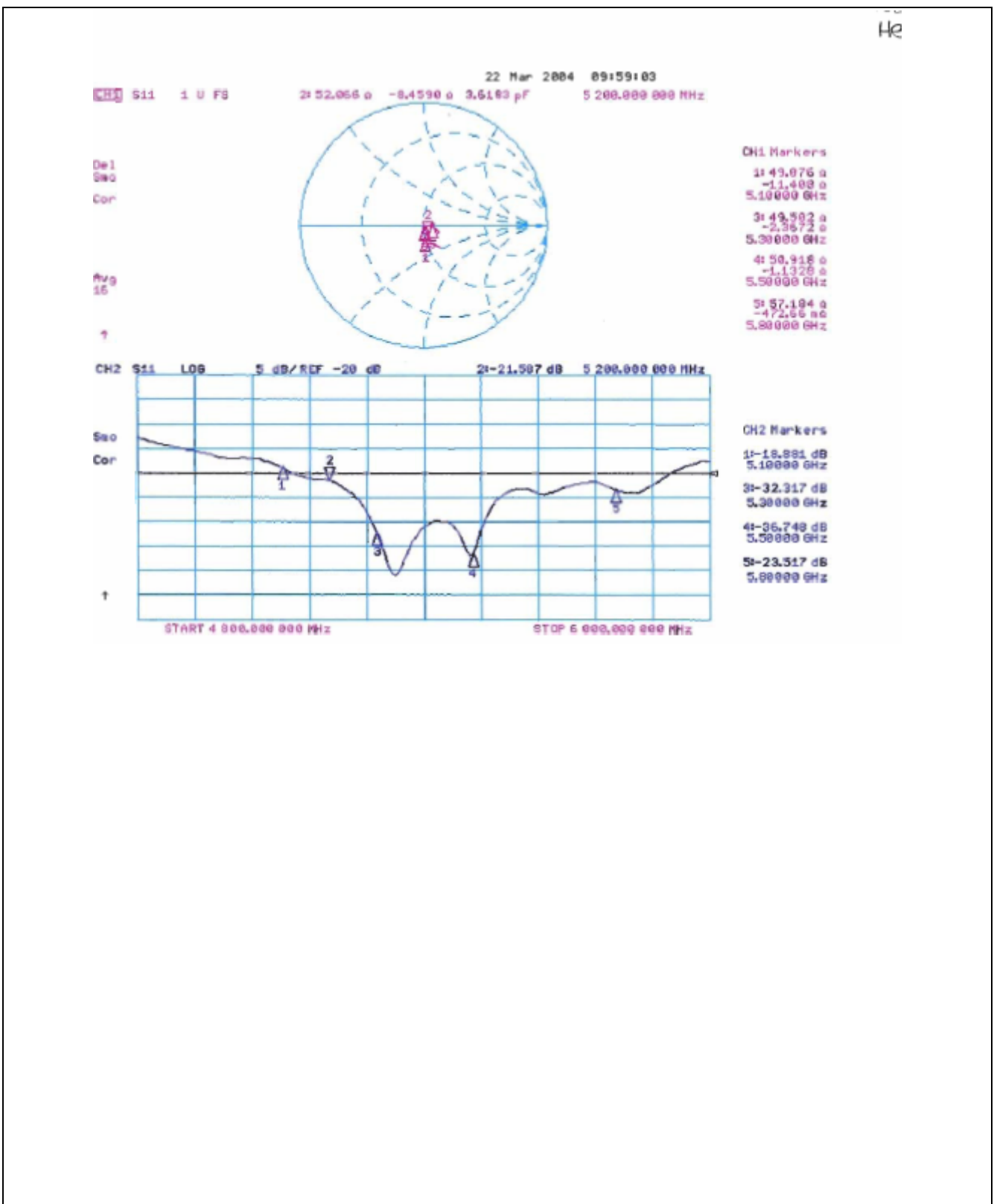
Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 97.3 V/m; Power Drift = 0.0 dB

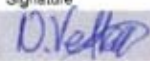
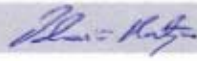
Peak SAR (extrapolated) = 95.3 W/kg

SAR(1 g) = 23.8 mW/g; SAR(10 g) = 6.58 mW/g





Appendix D – Probe Calibration

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland			
Client		Auden	
CALIBRATION CERTIFICATE			
Object(s)	EX3DV3 - SN:3519		
Calibration procedure(s)	QA CAL-01.v2 Calibration procedure for dosimetric E-field probes		
Calibration date:	March 19, 2004		
Condition of the calibrated item	In Tolerance (according to the specific calibration document)		
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. 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
Power meter EPM E4419B	GB41293874	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor E4412A	MY41495277	2-Apr-03 (METAS, No 252-0250)	Apr-04
Reference 20 dB Attenuator	SN: 5086 (20b)	3-Apr-03 (METAS, No. 251-0340)	Apr-04
Fluke Process Calibrator Type 702	SN: 6295803	8-Sep-03 (Sintrel SCS No. E-030020)	Sep-04
Power sensor HP 8481A	MY41092180	18-Sep-02 (SPEAG, in house check Oct-03)	In house check: Oct 05
RF generator HP 8684C	US3642U01700	4-Aug-99 (SPEAG, in house check Aug-02)	In house check: Aug-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Oct-03)	In house check: Oct 05
Calibrated by:	Name Nico Vetterli	Function Technician	Signature 
Approved by:	Kaşa Pekovic	Laboratory Director	
Date issued: March 25, 2004			
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.			

Probe EX3DV3

SN:3519

Manufactured:	March 8, 2004
Last calibrated:	March 19, 2004

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

EX3DV3 SN:3519

March 19, 2004

DASY - Parameters of Probe: EX3DV3 SN:3519**Sensitivity in Free Space****Diode Compression^A**

NormX	0.78 $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	0.79 $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	0.73 $\mu\text{V}/(\text{V}/\text{m})^2$

DCP X	96	mV
DCP Y	96	mV
DCP Z	96	mV

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 7.

Boundary Effect

Head	900 MHz	Typical SAR gradient: 5 % per mm
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Sensor Cener to Phantom Surface Distance	2.0 mm	3.0 mm
SAR _{be} [%] Without Correction Algorithm	2.4	0.3
SAR _{be} [%] With Correction Algorithm	0.1	0.4

Head	1800 MHz	Typical SAR gradient: 10 % per mm
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Sensor to Surface Distance	2.0 mm	3.0 mm
SAR _{be} [%] Without Correction Algorithm	4.6	2.6
SAR _{be} [%] With Correction Algorithm	0.2	0.5

Sensor Offset

Probe Tip to Sensor Center	1.0	mm
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The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

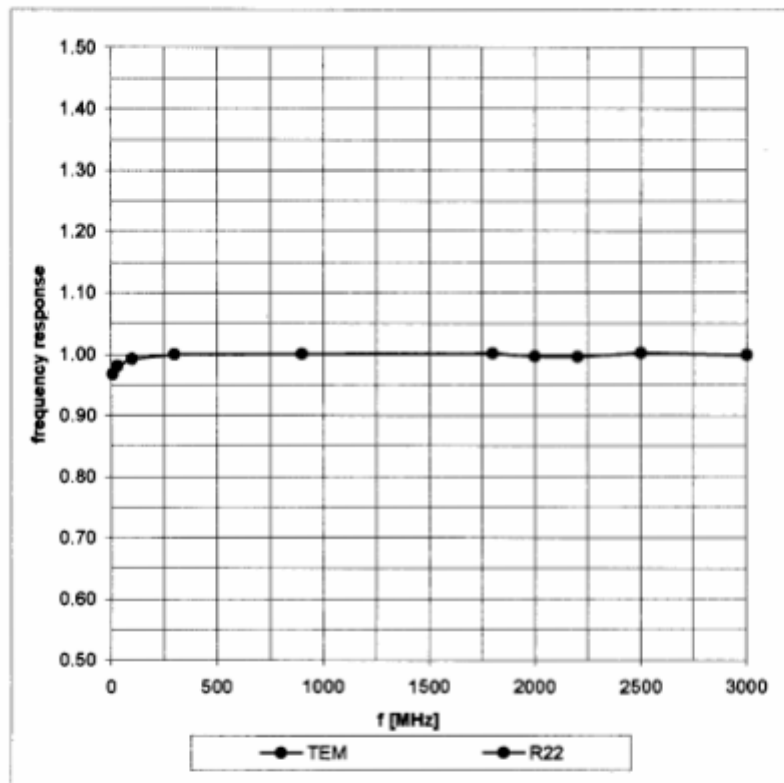
^A numerical linearization parameter: uncertainty not required

EX3DV3 SN:3519

March 19, 2004

Frequency Response of E-Field

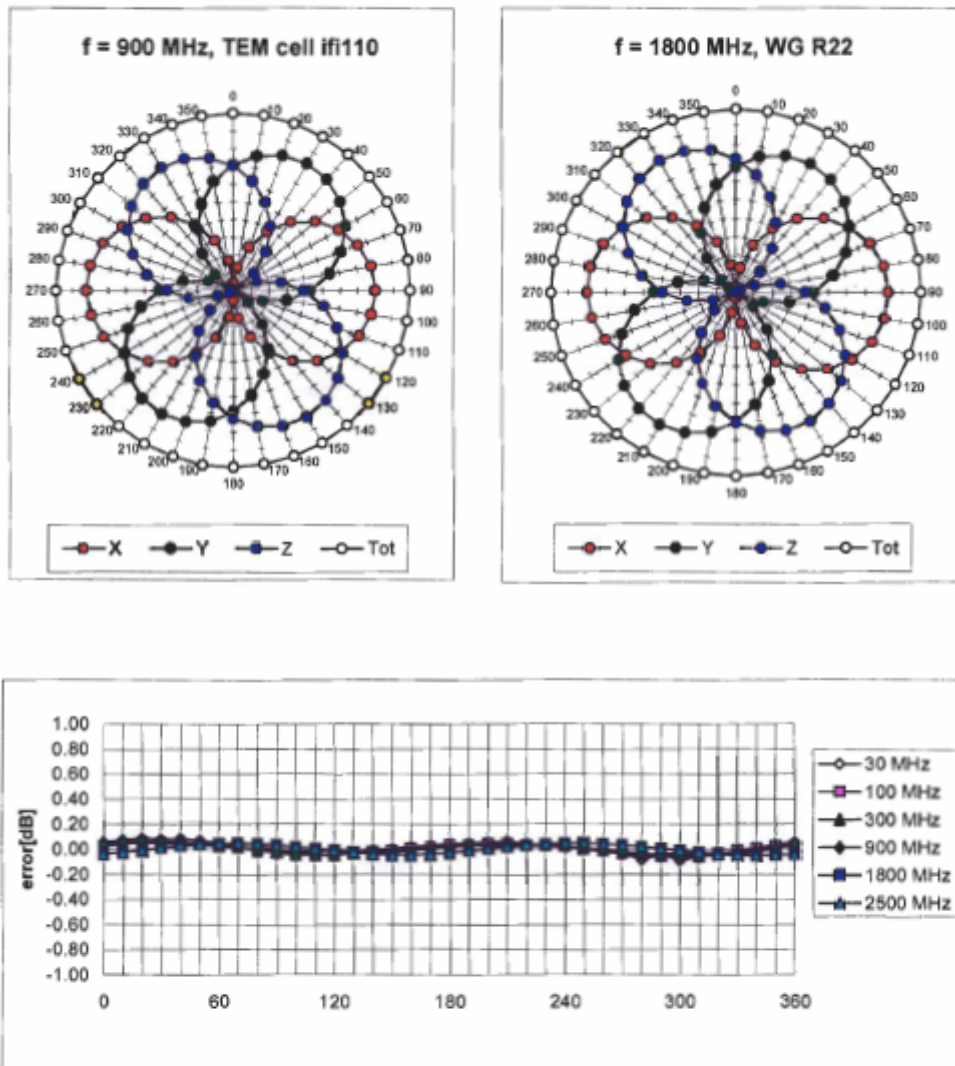
(TEM-Cell:If1110, Waveguide R22)



EX3DV3 SN:3519

March 19, 2004

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

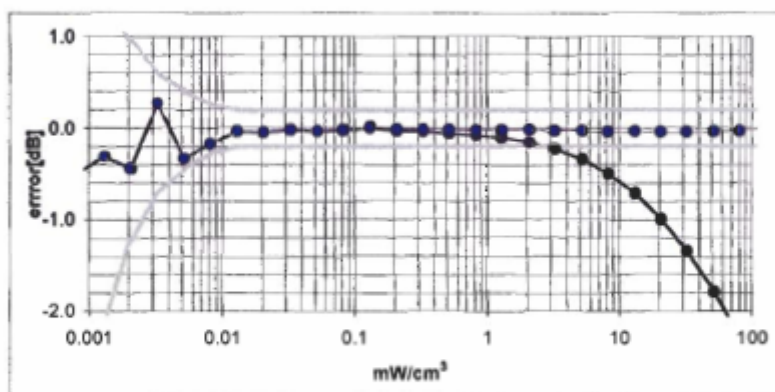
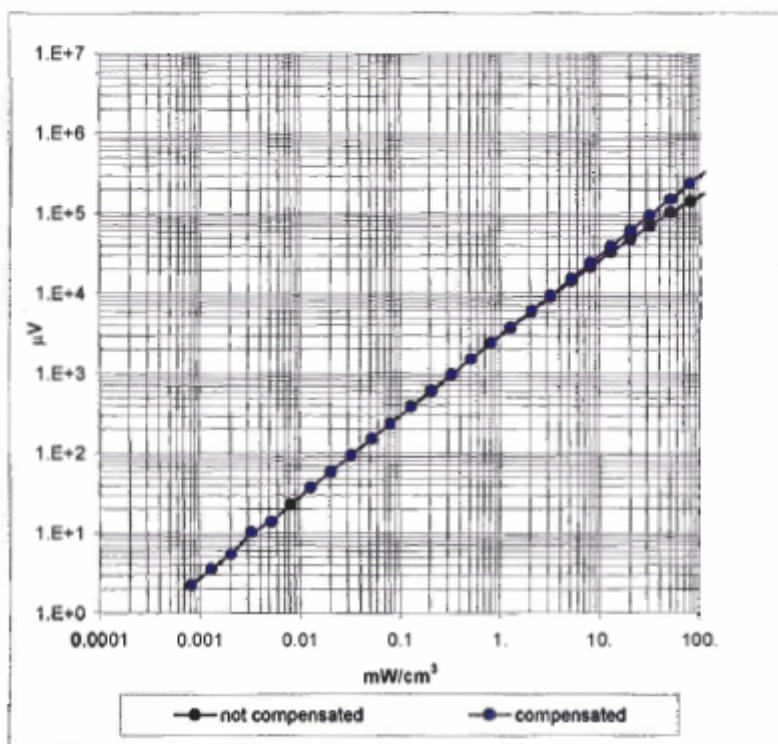


Axial Isotropy Error $< \pm 0.2 \text{ dB}$

EX3DV3 SN:3519

March 19, 2004

Dynamic Range f(SAR_{head}) (Waveguide R22)



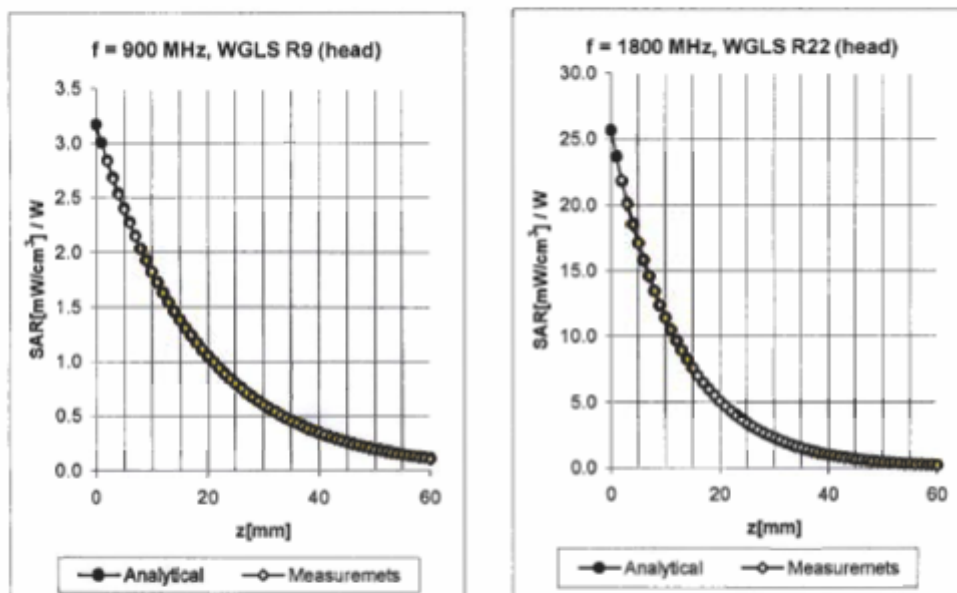
Probe Linearity < ± 0.2 dB

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EX3DV3 SN:3519

March 19, 2004

Conversion Factor Assessment



f [MHz]	Validity [MHz] ^a	Tissue	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	800-1000	Head	41.5 ± 5%	0.97 ± 5%	0.30	0.80	10.3 ± 11.3% (k=2)
1800	1710-1910	Head	40.0 ± 5%	1.40 ± 5%	0.08	3.04	8.84 ± 11.7% (k=2)
5200	4940-5460	Head	36.0 ± 5%	4.66 ± 5%	0.45	1.80	4.80 ± 21.8% (k=2)
5500	5225-5775	Head	35.6 ± 5%	4.96 ± 5%	0.45	1.80	4.40 ± 22.6% (k=2)
5800	5510-6090	Head	35.3 ± 5%	5.27 ± 5%	0.45	1.80	4.34 ± 23.4% (k=2)
5200	4940-5460	Body	49.0 ± 5%	5.30 ± 5%	0.45	1.90	4.21 ± 21.8% (k=2)
5500	5225-5775	Body	48.6 ± 5%	5.65 ± 5%	0.43	1.90	4.00 ± 22.6% (k=2)
5800	5510-6090	Body	48.2 ± 5%	6.00 ± 5%	0.43	1.90	3.82 ± 23.4% (k=2)

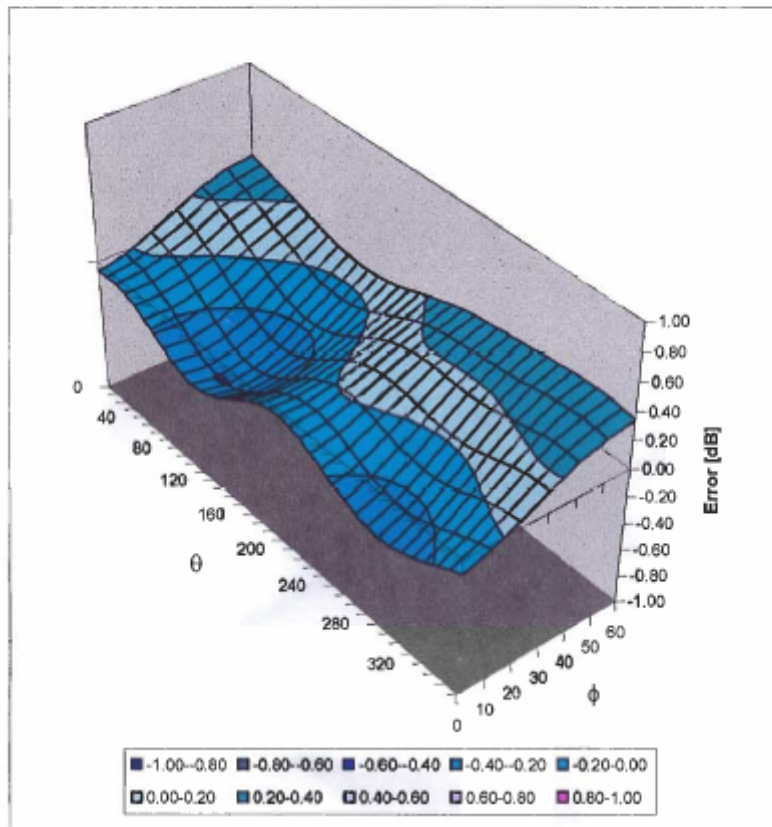
^a The total standard uncertainty is calculated as root-sum-square of standard uncertainty of the Conversion Factor at calibration frequency and the standard uncertainty for the indicated frequency band.

EX3DV3 SN:3519

March 19, 2004

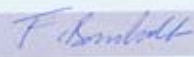
Deviation from Isotropy in HSL

Error (θ, ϕ), $f = 900$ MHz



Spherical Isotropy Error < ± 0.4 dB

Appendix E – Data Acquisition Electronic (DAE) Calibration

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland		 S Schweizerischer Kalibrierdienst C Service suisse d'étalonnage S Servizio svizzero di taratura S Swiss Calibration Service	
Accredited by the Swiss Federal Office of Metrology and Accreditation The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates		Accreditation No.: SCS 108	
Client Auden		Certificate No: DAE3-393_Apr05	
CALIBRATION CERTIFICATE			
Object	DAE3 - SD 000 D03 AA - SN: 393		
Calibration procedure(s)	QA CAL-06.v11 Calibration procedure for the data acquisition unit (DAE)		
Calibration date:	April 25, 2005		
Condition of the calibrated item	In Tolerance		
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.			
All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.			
Calibration Equipment used (M&TE critical for calibration)			
Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Fluke Process Calibrator Type 702	SN: 6295803	7-Sep-04 (Sintrel, No.E-040073)	Sep-05
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V1.1	SE UMS 006 AB 1002	16-Jul-04 (SPEAG, in house check)	In house check Jul-05
Calibrated by:	Name Daniel Steinacher	Function Technician	Signature 
Approved by:	Name Fin Bornholt	Function R&D Director	Signature 
			Issued: April 25, 2005
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Certificate No: DAE3-393_Apr05		Page 1 of 5	

**Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
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Accreditation No.: **SCS 108**

Glossary

DAE digital acquisition electronics
Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- **DC Voltage Measurement:** Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- **Connector angle:** The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters contain technical information as a result from the performance test and require no uncertainty.
- **DC Voltage Measurement Linearity:** Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
- **Common mode sensitivity:** Influence of a positive or negative common mode voltage on the differential measurement.
- **Channel separation:** Influence of a voltage on the neighbor channels not subject to an input voltage.
- **AD Converter Values with inputs shorted:** Values on the internal AD converter corresponding to zero input voltage
- **Input Offset Measurement:** Output voltage and statistical results over a large number of zero voltage measurements.
- **Input Offset Current:** Typical value for information; Maximum channel input offset current, not considering the input resistance.
- **Input resistance:** DAE input resistance at the connector, during internal auto-zeroing and during measurement.
- **Low Battery Alarm Voltage:** Typical value for information. Below this voltage, a battery alarm signal is generated.
- **Power consumption:** Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 μ V , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.034 $\pm$ 0.1% (k=2)	404.290 $\pm$ 0.1% (k=2)	404.188 $\pm$ 0.1% (k=2)
Low Range	3.97015 $\pm$ 0.7% (k=2)	3.95219 $\pm$ 0.7% (k=2)	3.95274 $\pm$ 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	18 $^{\circ}$ $\pm$ 1 $^{\circ}$
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Appendix

1. DC Voltage Linearity

High Range	Input (μV)	Reading (μV)	Error (%)
Channel X + Input	200000	200000.3	0.00
Channel X + Input	20000	19997.98	-0.01
Channel X - Input	20000	-19991.49	-0.04
Channel Y + Input	200000	199999.8	0.00
Channel Y + Input	20000	19995.58	-0.02
Channel Y - Input	20000	-19991.04	-0.04
Channel Z + Input	200000	200000.5	0.00
Channel Z + Input	20000	19996.71	-0.02
Channel Z - Input	20000	-20001.13	0.01

Low Range	Input (μV)	Reading (μV)	Error (%)
Channel X + Input	2000	1999.9	0.00
Channel X + Input	200	199.99	0.00
Channel X - Input	200	-200.44	0.22
Channel Y + Input	2000	1999.9	0.00
Channel Y + Input	200	199.28	-0.36
Channel Y - Input	200	-200.86	0.43
Channel Z + Input	2000	1999.9	0.00
Channel Z + Input	200	199.22	-0.39
Channel Z - Input	200	-201.08	0.54

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	12.51	11.50
	- 200	-10.12	-11.21
Channel Y	200	9.52	9.45
	- 200	-10.88	-11.19
Channel Z	200	3.35	2.94
	- 200	-4.99	-5.03

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	3.00	-0.31
Channel Y	200	1.48	-	5.95
Channel Z	200	-0.82	1.03	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16144	16008
Channel Y	16013	16872
Channel Z	16448	16957

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	1.00	0.39	2.17	0.24
Channel Y	-1.33	-2.17	-0.42	0.26
Channel Z	-0.62	-2.27	1.61	0.40

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance

	Zeroing (MOhm)	Measuring (MOhm)
Channel X	0.1999	200.6
Channel Y	0.2001	200.4
Channel Z	0.1999	200.1

8. Low Battery Alarm Voltage (verified during pre test)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (verified during pre test)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.0	+6	+14
Supply (- Vcc)	-0.01	-8	-9

10. Common Mode Bit Generation (verified during pre test)

Typical values	Bit set to High at Common Mode Error (V _{DC})
Channel X, Y, Z	+1.25