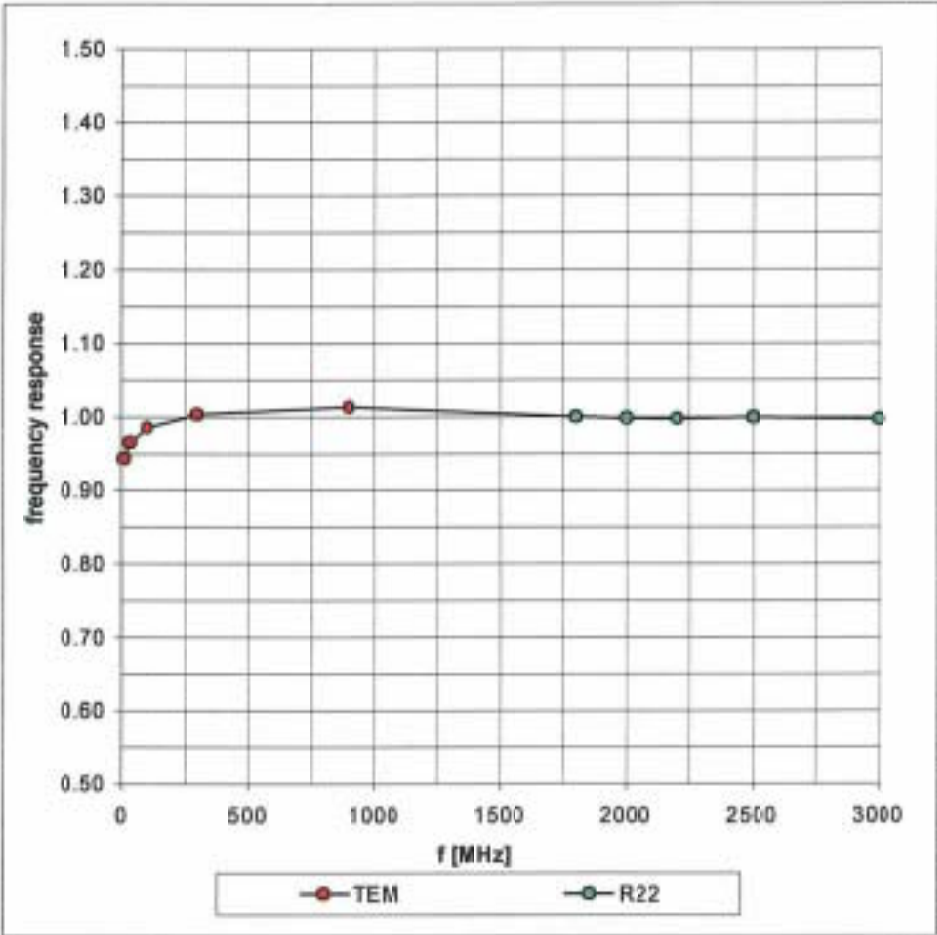
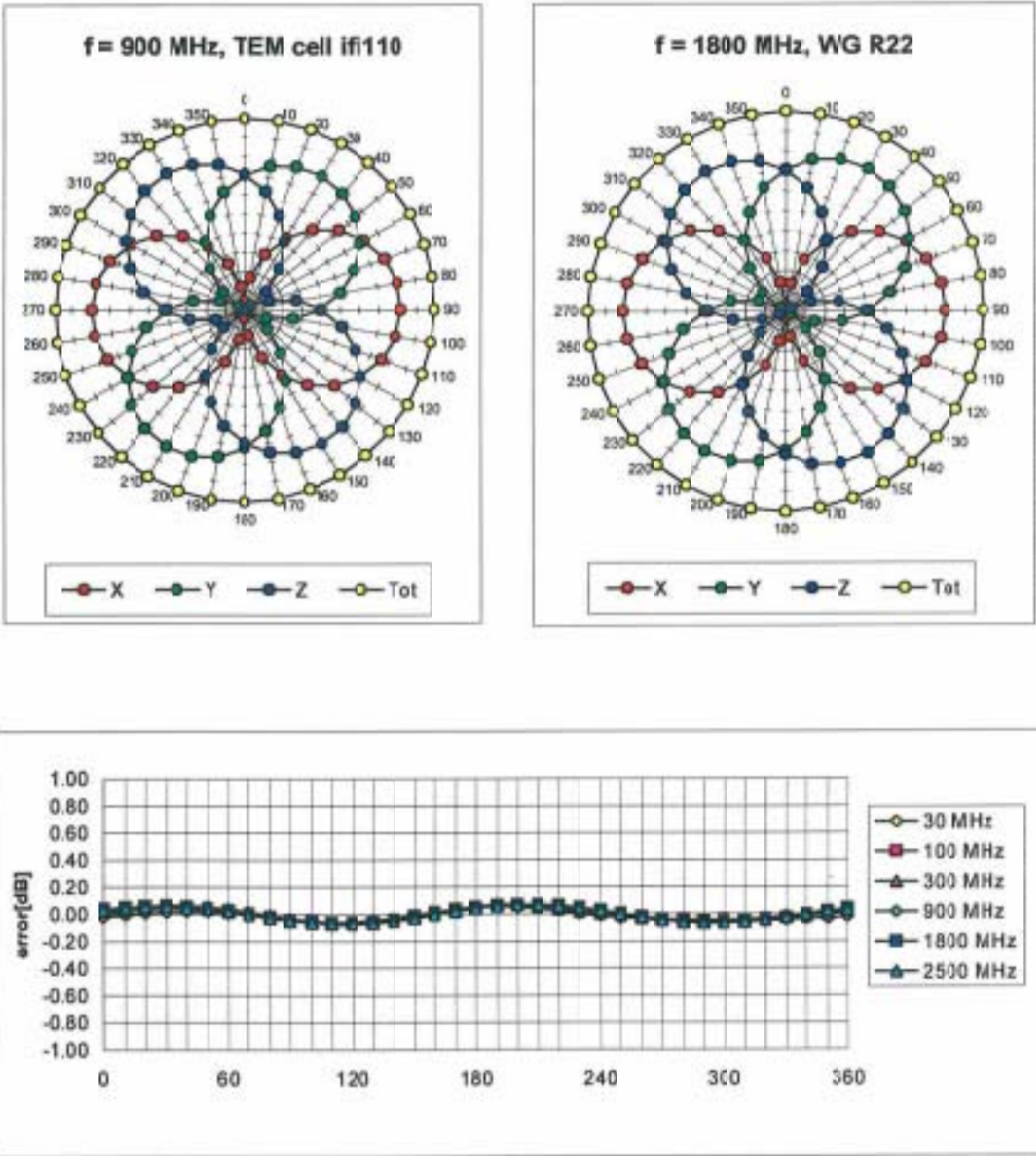


Frequency Response of E-Field
(TEM-Cell:ifi110, Waveguide R22)

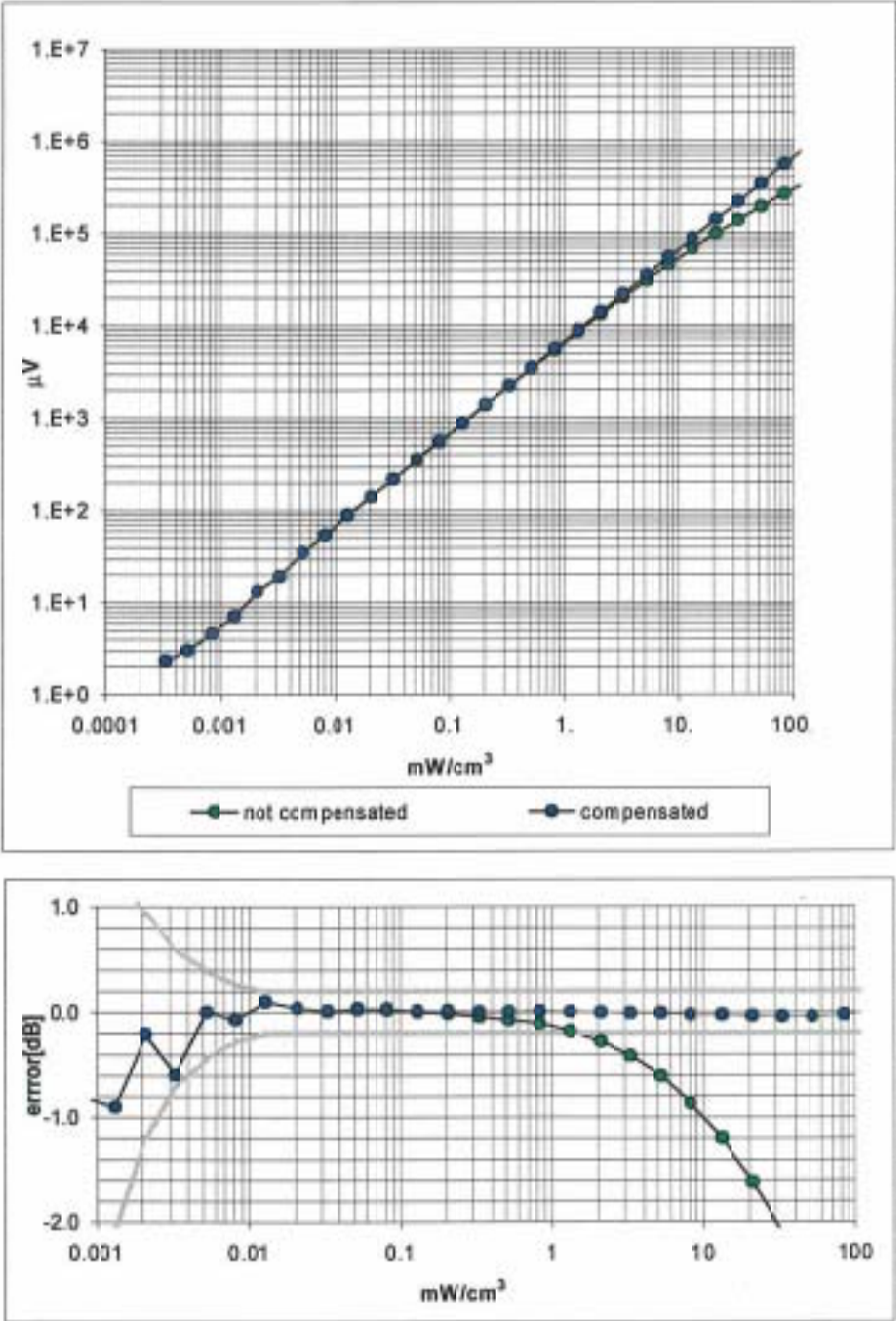


Receiving Pattern (ϕ), $\theta = 0^\circ$



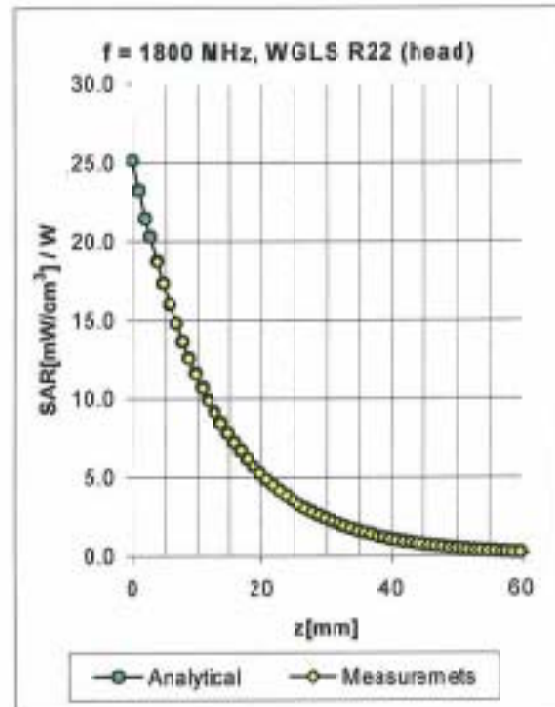
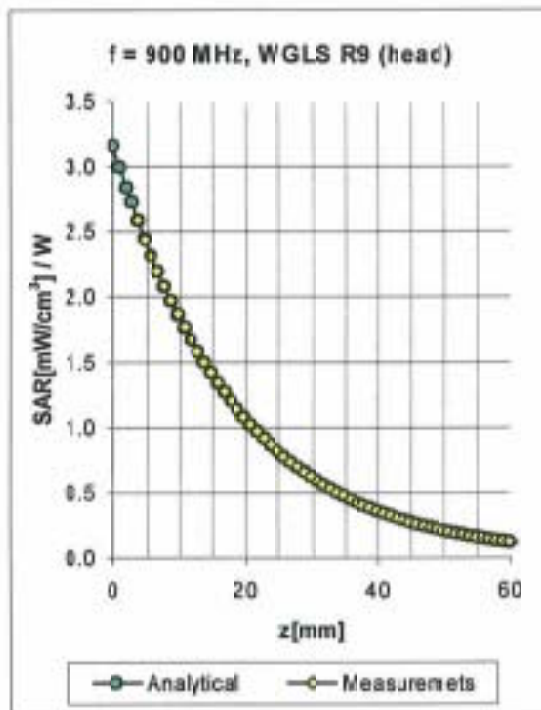
Axial Isotropy Error < ± 0.2 dB

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



Probe Linearity Error $< \pm 0.2$ dB

Conversion Factor Assessment

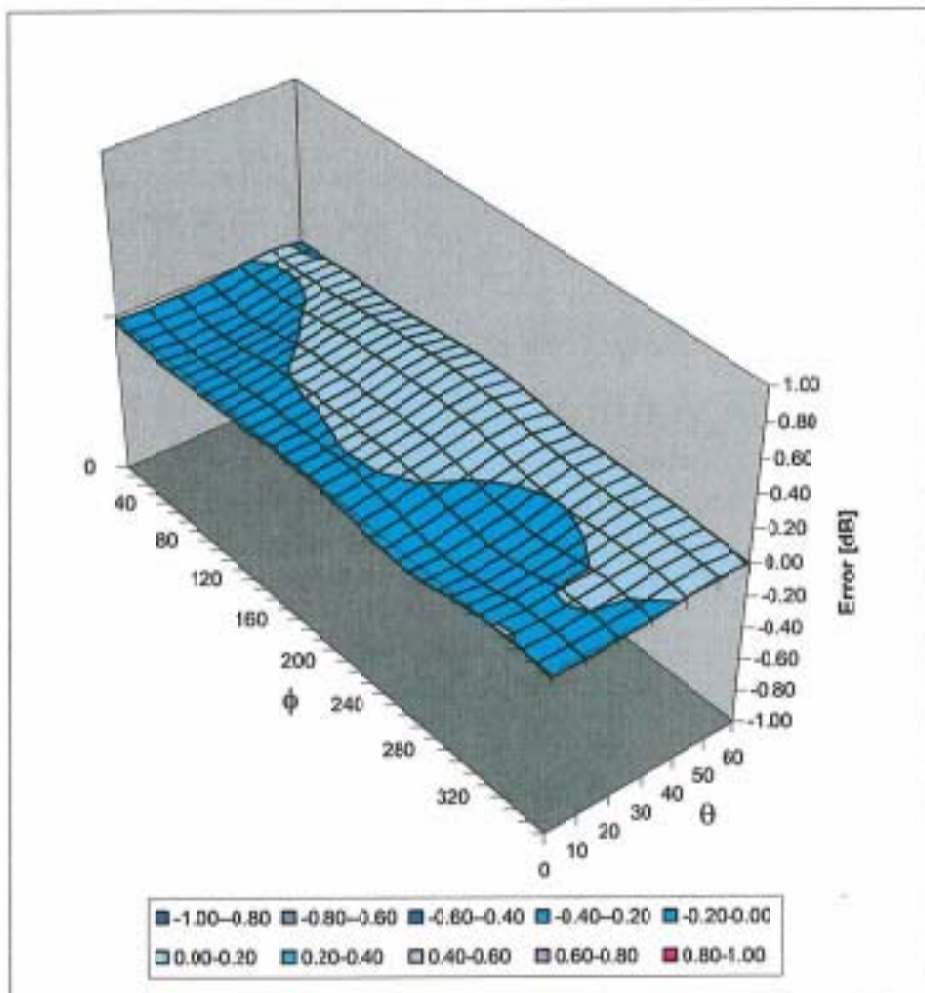


f [MHz]	Validity [MHz] ^a	Tissue	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	800-1000	Head	41.5 ± 5%	0.97 ± 5%	0.38	2.58	6.34 ± 11.3% (k=2)
1800	1710-1910	Head	40.0 ± 5%	1.40 ± 5%	0.46	2.71	5.16 ± 11.7% (k=2)
2450	2400-2500	Head	39.2 ± 5%	1.80 ± 5%	0.90	1.93	4.41 ± 9.7% (k=2)
900	800-1000	Body	55.0 ± 5%	1.05 ± 5%	0.52	2.10	6.06 ± 11.3% (k=2)
1800	1710-1910	Body	53.3 ± 5%	1.52 ± 5%	0.52	2.88	4.54 ± 11.7% (k=2)
2450	2400-2500	Body	52.7 ± 5%	1.95 ± 5%	1.04	1.62	4.23 ± 9.7% (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.

Deviation from Isotropy in HSL

Error (θ, ϕ), $f = 900$ MHz



Spherical Isotropy Error $< \pm 0.4$ dB

D3: DAE

IMPORTANT NOTICE

USAGE OF THE DAE 3

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Battery Exchange: The battery cover of the DAE3 unit is connected to a fragile 3-pin battery connector. Customer is responsible to apply utmost caution not to bend or damage the connector when changing batteries.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration Customer shall remove the batteries and pack the DAE in an antistatic bag. The packaging shall protect the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, Customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

Important Note:

Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:

Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.

Client **Auden ADT**

CALIBRATION CERTIFICATE

Object(s) **DAE3 - SD 000 D03 AA - SN: 510**

Calibration procedure(s) **QA CAL-06.v7**
Calibration procedure for the data acquisition unit (DAE)

Calibration date: **17.08.2004**

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	Scheduled Calibration
Fluke Process Calibrator Type 702	SN: 6295303	8-Sep-03	Sep-04

	Name	Function	Signature
Calibrated by:	Philipp Storchenegger	Technician	
Approved by:	Fin Bornholt	R&D Director	

Date issued: 17.08.2004

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.

1. 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	403.405	403.470	403.344
Low Range	3.95588	3.93301	3.95923
Connector Angle to be used	in DASY System 43 °		

High Range	Input (μ V)	Reading (μ V)	Error (%)
Channel X + Input	200000	199999.5	0.00
Channel X + Input	20000	20004.1	0.02
Channel X - Input	20000	-19988.8	-0.06
Channel Y + Input	200000	199999.9	0.00
Channel Y + Input	20000	19999.3	0.00
Channel Y - Input	20000	-19993.8	-0.03
Channel Z + Input	200000	199999.6	0.00
Channel Z + Input	20000	20005.6	0.03
Channel Z - Input	20000	-19995.4	-0.02

Low Range	Input (μ V)	Reading (μ V)	Error (%)
Channel X + Input	2000	1999.96	0.00
Channel X + Input	200	200.00	0.00
Channel X - Input	200	-200.34	0.17
Channel Y + Input	2000	2000.03	0.00
Channel Y + Input	200	199.39	-0.31
Channel Y - Input	200	-200.81	-0.41
Channel Z + Input	2000	2000.07	0.00
Channel Z + Input	200	199.29	-0.36
Channel Z - Input	200	-201.07	0.53

2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Reading (μ V)	Low Range Reading (μ V)
Channel X	200	17.42	16.88
	- 200	-17.00	-17.10
Channel Y	200	14.86	14.26
	- 200	-15.53	-16.14
Channel Z	200	-8.63	-8.44
	- 200	7.15	7.51

3. Channel separation

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

	Input Voltage (mV)	Channel X (μ V)	Channel Y (μ V)	Channel Z (μ V)
Channel X	200	-	2.45	1.22
Channel Y	200	0.25	-	4.38
Channel Z	200	-1.29	0.37	-

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	15983	16854
Channel Y	16210	16793
Channel Z	16173	16131

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	0.46	-0.28	1.02	0.27
Channel Y	-1.06	-1.87	-0.38	0.25
Channel Z	-0.15	-1.01	0.88	0.36

6. Input Offset Current

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

7. Input Resistance

	Zeroing (MOhm)	Measuring (MOhm)
Channel X	0.2001	201.3
Channel Y	0.2001	199.6
Channel Z	0.2001	200.7

8. Low Battery Alarm Voltage

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

9. Power Consumption

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



D4: 2450MHz SYSTEM VALIDATION DIPOLE

Client **ADT (Auden)**

CALIBRATION CERTIFICATE

Object(s) D2450V2 - SN:716

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

Calibration date: August 23, 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 EPME442	GB37480704	6-Nov-03 (METAS, No. 252-0254)	Nov-04
Power sensor HP 8481A	US37292783	6-Nov-03 (METAS, No. 252-0254)	Nov-04
Power sensor HP 8481A	MY41052317	13-Oct-02 (Agilent, No. 20021018)	Oct-04
RF generator R&S SML-03	100698	27-Mar-2002 (R&S, No. 20-92389)	In house check: Mar-05
Network Analyzer HP 8753E	US37390586	13-Oct-01 (SPEAG, in house check: Nov-03)	In house check: Oct 05

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

Date issued: August 26, 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.

DASY

Dipole Validation Kit

Type: D2450V2

Serial: 716

Manufactured:	September 10, 2002
Calibrated:	August 23, 2004

1. Measurement Conditions

The measurements were performed in the quarter size flat phantom filled with **head simulating solution** of the following electrical parameters at 2450 MHz:

Relative Dielectricity	38.3	$\pm 5\%$
Conductivity	1.86 mho/m	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe ES3DV2 (SN:3025, Conversion factor 4.55 at 2450 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 quarter size flat phantom 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 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 ES3DV2 SN:3025 and applying the advanced extrapolation are:

averaged over: 1 cm ³ (1 g) of tissue:	52.4 mW/g $\pm 16.8\%$ (k=2)¹
averaged over: 10 cm ³ (10 g) of tissue:	23.8 mW/g $\pm 16.2\%$ (k=2)¹

¹ 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:	1.147 ns	(one direction)
Transmission factor:	0.983	(voltage transmission, one direction)

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

Feedpoint impedance at 2450 MHz:	$\text{Re}\{Z\} = 54.7 \Omega$
	$\text{Im}\{Z\} = 2.7 \Omega$
Return Loss at 2450 MHz	-26.1 dB

4. Measurement Conditions

The measurements were performed in the quarter size flat phantom filled with **body simulating solution** of the following electrical parameters at 2450 MHz:

Relative Dielectricity	51.7	$\pm 5\%$
Conductivity	1.96 mho/m	$\pm 5\%$

The DASY4 System with a dosimetric E-field probe ES3DV2 (SN:3025, Conversion factor 4.22 at 2450 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 quarter size flat phantom 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 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 desimetric probe ES3DV2 SN:3025 and applying the advanced extrapolation are:

averaged over 1 cm³ (1 g) of tissue: **48.8 mW/g ± 16.8 % (k=2)²**

averaged over 10 cm³ (10 g) of tissue: **22.6 mW/g ± 16.2 % (k=2)²**

6. Dipole Impedance and Return Loss

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

Feedpoint impedance at 2450 MHz: **Re{Z} = 50.8 Ω**

Im {Z} = 4.1 Ω

Return Loss at 2450 MHz **-27.7 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.

Small end caps have been added to the dipole arms in order to improve matching when loaded according to the position as explained in Sections 1 and 4. 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.

² validation uncertainty

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN716

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: HSL 2450 MHz;

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.86$ mho/m; $\epsilon_r = 38.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.55, 4.55, 4.55); Calibrated: 9/29/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 7/22/2004
- Phantom: Flat Phantom quarter size; Type: QD000P50AA; Serial: SN:1001;
- Measurement SW: DASY4, V4.3 Build 16; Postprocessing SW: SEMCAD, V1.8 Build 123

Pin = 250 mW; d = 10 mm/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 14.9 mW/g

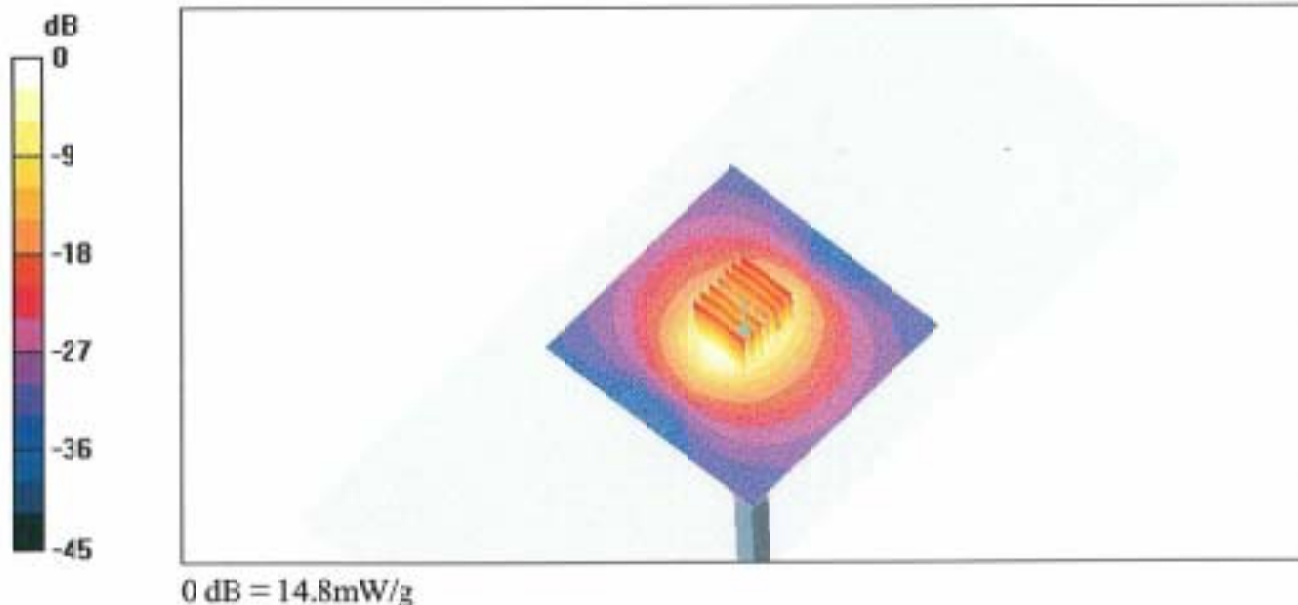
Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 91.1 V/m; Power Drift = 0.1 dB

Peak SAR (extrapolated) = 27.6 W/kg

SAR(1 g) = 13.1 mW/g; SAR(10 g) = 5.95 mW/g

Maximum value of SAR (measured) = 14.8 mW/g



716
Head

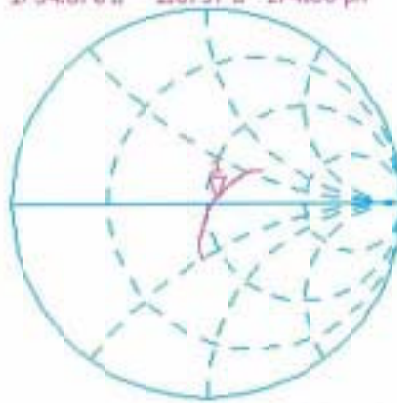
20 Aug 2004 14:02:00
[CH1] S11 1 U FS 1: 54.670 α 2: 6797 α 174.00 μ H 2 456.000 000 MHz

Del

Cor

avg
25

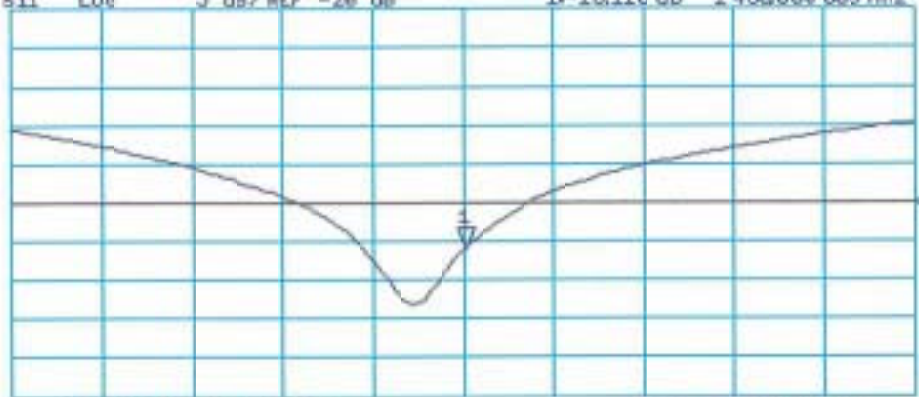
↑



CH2 S11 LOG 5 dB/REF -20 dB 1: -26.110 dB 2 456.000 000 MHz

Cor

↑



CENTER 2 456.000 000 MHz

SPAN 400.000 000 MHz

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN716

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: Muscle 2450 MHz;

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.96$ mho/m; $\epsilon_r = 51.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.22, 4.22, 4.22); Calibrated: 9/29/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 7/22/2004
- Phantom: Flat Phantom quarter size; Type: QD000P50AA; Serial: SN:1001;
- Measurement SW: DASY4, V4.3 Build 17; Postprocessing SW: SEMCAD, V1.8 Build 124

Pin = 250 mW; d = 10 mm/Area Scan (81x81x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 14.2 mW/g

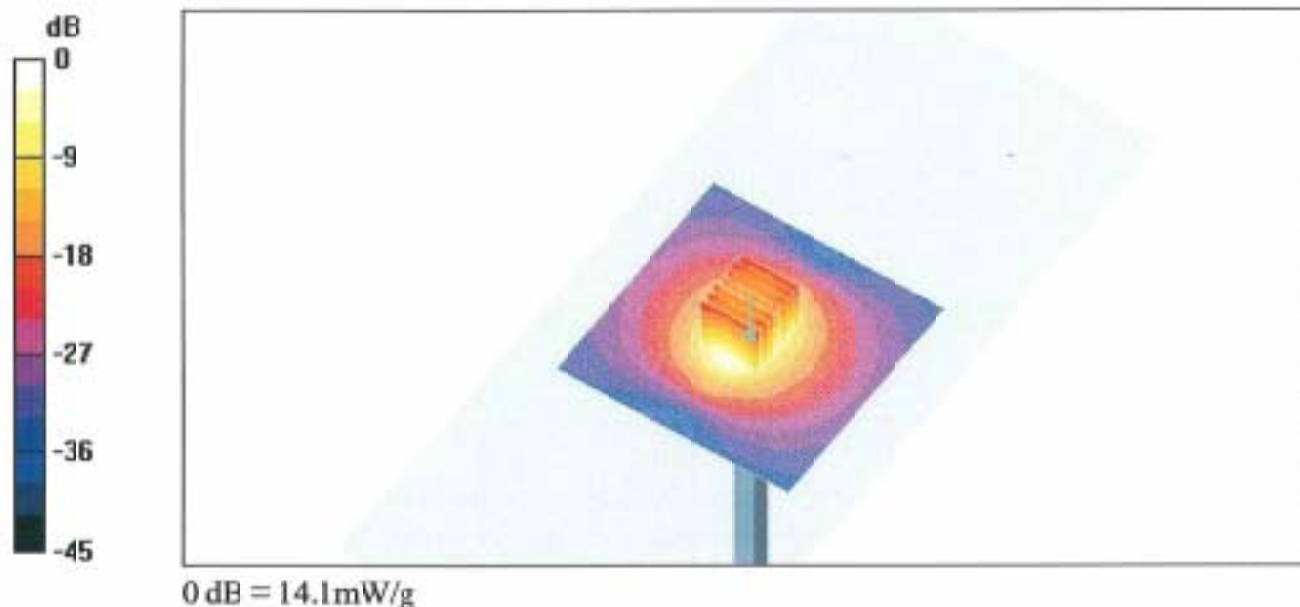
Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

Peak SAR (extrapolated) = 24.9 W/kg

SAR(1 g) = 12.2 mW/g; SAR(10 g) = 5.64 mW/g

Maximum value of SAR (measured) = 14.1 mW/g

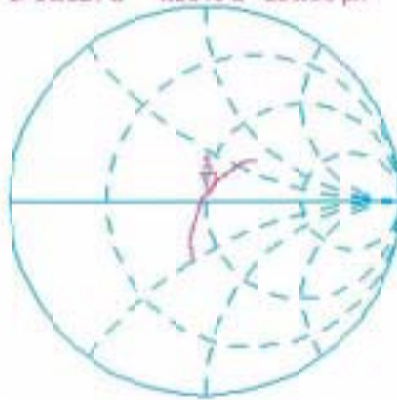


23 Aug 2004 08:51:35
CH1 S11 1.0 FS 11 56.824 a 4.8848 a 265.30 pH 2 458.000 000 MHz

De1

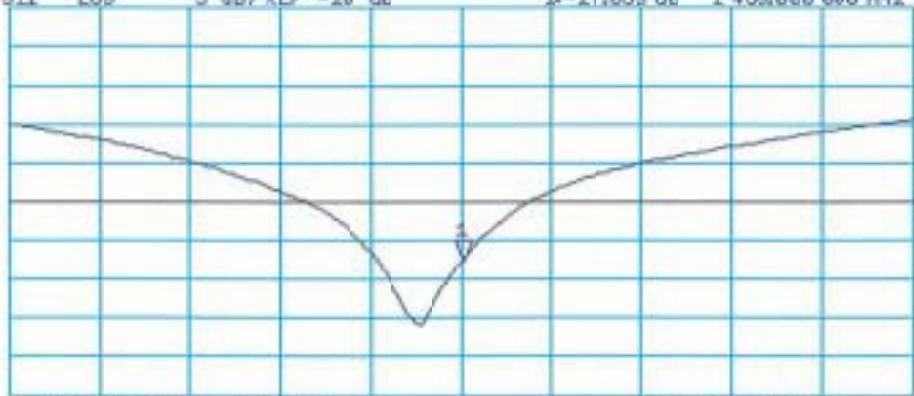
Cor

avg
16



CH2 S11 LOS 5 dB/REF -20 dB 11-27.655 dB 2 458.000 000 MHz

Cor



CENTER 2 458.000 000 MHz

SPAN 400.000 000 MHz