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Accreditation No.: **SCS 108**

Client **ATL (Auden)**

Certificate No: **D5GHzV2-1021\_Mar08**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1021**

Calibration procedure(s) **QA CAL-22.v1  
Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **March 11, 2008**

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
Power meter EPM-442A	GB37480704	04-Oct-07 (METAS, No. 217-00736)	Oct-08
Power sensor HP 8481A	US37292783	04-Oct-07 (METAS, No. 217-00736)	Oct-08
Reference 20 dB Attenuator	SN: S5072.1 (20g)	07-Aug-07 (METAS, No 217-00718)	Aug-08
Reference Probe EX3DV4	SN: 3503	8-Mar-08 (SPEAG, No. EX3-3503_Mar08)	Mar-09
DAE4	SN 909	3-Sep-07 (SPEAG, No. DAE4-909_Sep08)	Sep-08

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	4-Aug-99 (SPEAG, in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (SPEAG, in house check Oct-07)	In house check: Oct-08
Power meter E4419B	GB43310788	13-Aug-03 (SPEAG, in house check Oct-07)	In house check: Oct-08
Power sensor HP 8481A	MY41093315	10-Aug-03 (SPEAG, in house check Oct-07)	In house check: Oct-08

Calibrated by: **Marcel Fehr** Laboratory Technician

Signature

Approved by: **Katja Pokovic** Technical Manager

Issued: March 12, 2008

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**Glossary:**

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

**Calibration is Performed According to the Following Standards:**

- a) IEC Std 62209 Part 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", Draft Version 0.9, December 2004
- b) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- c) DASY4 System Handbook

**Methods Applied and Interpretation of Parameters:**

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

## Measurement Conditions

DASY system configuration, as far as not given on page 1.

<b>DASY Version</b>	DASY4	V4.7
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom V5.0	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Area Scan resolution</b>	dx, dy = 10 mm	
<b>Zoom Scan Resolution</b>	dx, dy = 4.0 mm, dz = 2.5 mm	
<b>Frequency</b>	5200 MHz ± 1 MHz 5500 MHz ± 1 MHz 5800 MHz ± 1 MHz	

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	36.0	4.66 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	35.6 ± 6 %	4.47 mho/m ± 6 %
<b>Head TSL temperature during test</b>	(21.2 ± 0.2) °C	---	---

## SAR result with Head TSL at 5200 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	condition	
SAR measured	100 mW input power	8.28 mW / g
SAR normalized	normalized to 1W	82.8 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	<b>82.5 mW / g ± 19.9 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	100 mW input power	2.33 mW / g
SAR normalized	normalized to 1W	23.3 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	<b>23.1 mW / g ± 19.5 % (k=2)</b>

<sup>1</sup> Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

### Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.0 ± 6 %	4.75 mho/m ± 6 %
Head TSL temperature during test	(21.0 ± 0.2) °C	----	----

### SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	condition	
SAR measured	100 mW input power	8.71 mW / g
SAR normalized	normalized to 1W	87.1 mW / g
SAR for nominal Head TSL parameters <sup>2</sup>	normalized to 1W	<b>86.5 mW / g ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.43 mW / g
SAR normalized	normalized to 1W	24.3 mW / g
SAR for nominal Head TSL parameters <sup>2</sup>	normalized to 1W	<b>24.1 mW / g ± 19.5 % (k=2)</b>

### Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	5.02 mho/m ± 6 %
Head TSL temperature during test	(21.0 ± 0.2) °C	----	----

### SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	condition	
SAR measured	100 mW input power	8.45 mW / g
SAR normalized	normalized to 1W	84.5 mW / g
SAR for nominal Head TSL parameters <sup>2</sup>	normalized to 1W	<b>83.8 mW / g ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.36 mW / g
SAR normalized	normalized to 1W	23.6 mW / g
SAR for nominal Head TSL parameters <sup>2</sup>	normalized to 1W	<b>23.3 mW / g ± 19.5 % (k=2)</b>

<sup>2</sup> Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

### Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.7 ± 6 %	5.33 mho/m ± 6 %
Body TSL temperature during test	(21.0 ± 0.2) °C	---	---

### SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	condition	
SAR measured	100 mW input power	8.04 mW / g
SAR normalized	normalized to 1W	80.4 mW / g
SAR for nominal Body TSL parameters <sup>3</sup>	normalized to 1W	<b>79.7 mW / g ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.25 mW / g
SAR normalized	normalized to 1W	22.5 mW / g
SAR for nominal Body TSL parameters <sup>3</sup>	normalized to 1W	<b>22.3 mW / g ± 19.5 % (k=2)</b>

### Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.7 ± 6 %	5.70 mho/m ± 6 %
Body TSL temperature during test	(20.9 ± 0.2) °C	---	---

### SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	condition	
SAR measured	100 mW input power	8.49 mW / g
SAR normalized	normalized to 1W	84.9 mW / g
SAR for nominal Body TSL parameters <sup>3</sup>	normalized to 1W	<b>83.9 mW / g ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.37 mW / g
SAR normalized	normalized to 1W	23.7 mW / g
SAR for nominal Body TSL parameters <sup>3</sup>	normalized to 1W	<b>23.5 mW / g ± 19.5 % (k=2)</b>

<sup>3</sup> Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

## Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.1 ± 6 %	6.06 mho/m ± 6 %
Body TSL temperature during test	(20.9 ± 0.2) °C	---	---

## SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	condition	
SAR measured	100 mW input power	7.82 mW / g
SAR normalized	normalized to 1W	78.2 mW / g
SAR for nominal Body TSL parameters <sup>4</sup>	normalized to 1W	<b>77.1 mW / g ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.18 mW / g
SAR normalized	normalized to 1W	21.8 mW / g
SAR for nominal Body TSL parameters <sup>4</sup>	normalized to 1W	<b>21.6 mW / g ± 19.5 % (k=2)</b>

<sup>4</sup> Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	50.7 $\Omega$ - 8.5 j $\Omega$
Return Loss	-21.4 dB

### Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	51.1 $\Omega$ - 3.0 j $\Omega$
Return Loss	-30.1 dB

### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	56.7 $\Omega$ - 0.8 j $\Omega$
Return Loss	-24.0 dB

### Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	50.6 $\Omega$ - 6.6 j $\Omega$
Return Loss	-23.7 dB

### Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	51.6 $\Omega$ - 1.5 j $\Omega$
Return Loss	-33.2 dB

### Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	58.0 $\Omega$ + 0.9 j $\Omega$
Return Loss	-22.6 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	1.200 ns
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After long term use with 40 W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

## Additional EUT Data

Manufactured by	SPEAG
Manufactured on	February 05, 2004

## DASY4 Validation Report for Head TSL

Date/Time: 11.03.2008 12:15:00

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1021

Communication System: CW-5GHz; Frequency: 5200 MHz; Frequency: 5500 MHz; Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: HSL 5800 MHz;

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.47$  mho/m;  $\epsilon_r = 35.6$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.75$  mho/m;  $\epsilon_r = 35$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.04$  mho/m;  $\epsilon_r = 34.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

### DASY4 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.63, 5.63, 5.63)ConvF(5.24, 5.24, 5.24)ConvF(5.04, 5.04, 5.04); Calibrated: 08.03.2008
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 03.09.2007
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; ;
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

### **d=10mm, Pin=100mW, f=5200 MHz/Area Scan (61x61x1):**

Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 17.6 mW/g

### **d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan (8x8x10), dist=2mm**

**(8x8x10)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 53.6 V/m; Power Drift = 0.033 dB

Peak SAR (extrapolated) = 32.1 W/kg

**SAR(1 g) = 8.28 mW/g; SAR(10 g) = 2.33 mW/g**

Maximum value of SAR (measured) = 17.1 mW/g

### **d=10mm, Pin=100mW, f=5500 MHz/Zoom Scan (8x8x10), dist=2mm**

**(8x8x10)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 52.9 V/m; Power Drift = 0.004 dB

Peak SAR (extrapolated) = 35.0 W/kg

**SAR(1 g) = 8.71 mW/g; SAR(10 g) = 2.43 mW/g**

Maximum value of SAR (measured) = 17.9 mW/g

### **d=10mm, Pin=100mW, f=5800 MHz/Zoom Scan (8x8x10), dist=2mm**

**(8x8x10)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 50.6 V/m; Power Drift = -0.020 dB

Peak SAR (extrapolated) = 35.6 W/kg

**SAR(1 g) = 8.45 mW/g; SAR(10 g) = 2.36 mW/g**

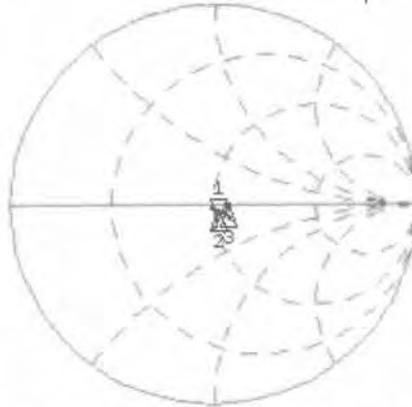
Maximum value of SAR (measured) = 17.4 mW/g

# Impedance Measurement Plot for Head TSL

11 Mar 2008 10:32:06

CH1 S11 1 U FS 1: 50.668  $\Omega$  -8.5410  $\Omega$  3.5835 pF 5 200.000 000 MHz

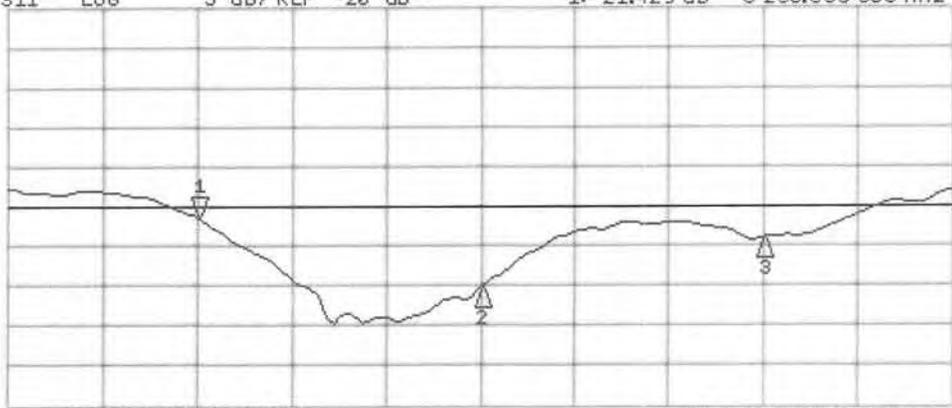
\*  
Del  
Cor  
Avg  
16  
↑



CH1 Markers  
2: 51.051  $\Omega$   
-2.9727  $\Omega$   
5.50000 GHz  
3: 55.684  $\Omega$   
-798.83 m $\Omega$   
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -21.429 dB 5 200.000 000 MHz

Cor  
Avg  
16  
↑



CH2 Markers  
2: -30.123 dB  
5.50000 GHz  
3: -23.998 dB  
5.80000 GHz

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz

## DASY4 Validation Report for Body TSL

Date/Time: 11.03.2008 16:42:45

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1021**

Communication System: CW-5GHz; Frequency: 5200 MHz; Frequency: 5500 MHz; Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: MSL 5800 MHz;

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.41$  mho/m;  $\epsilon_r = 47.7$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.79$  mho/m;  $\epsilon_r = 46.6$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.16$  mho/m;  $\epsilon_r = 46.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.95, 4.95, 4.95)ConvF(4.61, 4.61, 4.61)ConvF(4.74, 4.74, 4.74); Calibrated: 08.03.2008
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 03.09.2007
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; ;
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

**d=10mm, Pin=100mW, f=5200 MHz/Area Scan (61x61x1):**

Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 17.7 mW/g

**d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan (8x8x10), dist=2mm**

**(8x8x10)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 50.6 V/m; Power Drift = -0.062 dB

Peak SAR (extrapolated) = 30.6 W/kg

**SAR(1 g) = 8.04 mW/g; SAR(10 g) = 2.25 mW/g**

Maximum value of SAR (measured) = 15.9 mW/g

**d=10mm, Pin=100mW, f=5500 MHz/Zoom Scan (8x8x10), dist=2mm**

**(8x8x10)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 49.3 V/m; Power Drift = -0.046 dB

Peak SAR (extrapolated) = 34.3 W/kg

**SAR(1 g) = 8.49 mW/g; SAR(10 g) = 2.37 mW/g**

Maximum value of SAR (measured) = 17.1 mW/g

**d=10mm, Pin=100mW, f=5800 MHz/Zoom Scan (8x8x10), dist=2mm**

**(8x8x10)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 46.3 V/m; Power Drift = -0.054 dB

Peak SAR (extrapolated) = 32.8 W/kg

**SAR(1 g) = 7.82 mW/g; SAR(10 g) = 2.18 mW/g**

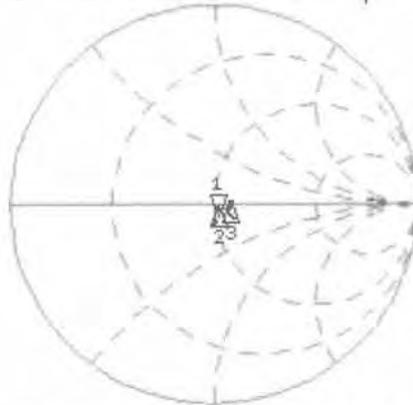
Maximum value of SAR (measured) = 15.8 mW/g

# Impedance Measurement Plot for Body TSL

11 Mar 2008 10:33:37

CH1 S11 1 U FS 1: 50.613  $\Omega$  -6.5801  $\Omega$  4.6514 pF 5 200.000 000 MHz

\*  
Del  
Cor

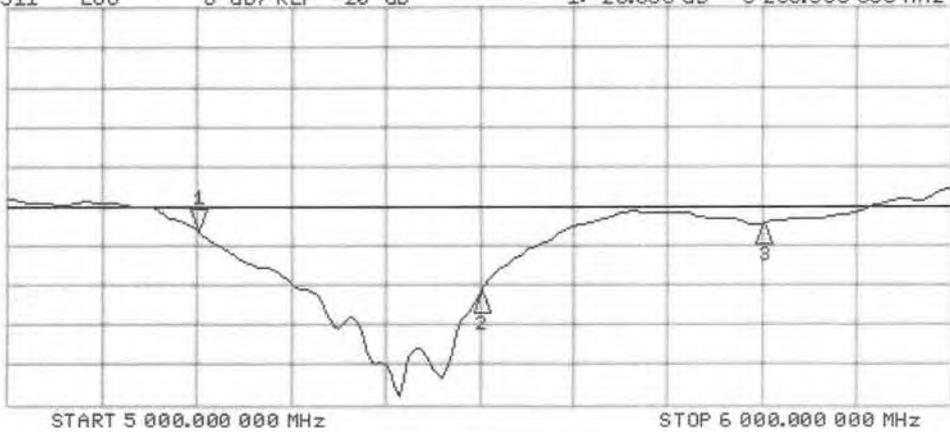


CH1 Markers  
2: 51.578  $\Omega$   
-1.5449  $\Omega$   
5.50000 GHz  
3: 57.955  $\Omega$   
0.8887  $\Omega$   
5.80000 GHz

Avg  
16  
↑

CH2 S11 LOG 6 dB/REF -20 dB 1: -23.665 dB 5 200.000 000 MHz

Cor  
Avg  
16  
↑



CH2 Markers  
2: -33.237 dB  
5.50000 GHz  
3: -22.599 dB  
5.80000 GHz



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **ATL (Auden)**

Certificate No: **EX3-3519\_Mar08**

## CALIBRATION CERTIFICATE

Object **EX3DV3 - SN:3519**

Calibration procedure(s) **QA CAL-01.v6 and QA CAL-14.v3  
Calibration procedure for dosimetric E-field probes**

Calibration date: **March 21, 2008**

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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	29-Mar-07 (METAS, No. 217-00670)	Mar-08
Power sensor E4412A	MY41495277	29-Mar-07 (METAS, No. 217-00670)	Mar-08
Power sensor E4412A	MY41498087	29-Mar-07 (METAS, No. 217-00670)	Mar-08
Reference 3 dB Attenuator	SN: S5054 (3c)	8-Aug-07 (METAS, No. 217-00719)	Aug-08
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-07 (METAS, No. 217-00671)	Mar-08
Reference 30 dB Attenuator	SN: S5129 (30b)	8-Aug-07 (METAS, No. 217-00720)	Aug-08
Reference Probe ES3DV2	SN: 3013	2-Jan-08 (SPEAG, No. ES3-3013_Jan08)	Jan-09
DAE4	SN: 654	20-Apr-07 (SPEAG, No. DAE4-654_Apr07)	Apr-08

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Oct-07)	In house check: Oct-08

Calibrated by:	Name	Function	Signature
	Katja Pokovic	Technical Manager	

Approved by:	Niels Kuster	Quality Manager	
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Issued: March 21, 2008

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Accreditation No.: **SCS 108**

### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis

### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the E<sup>2</sup>-field uncertainty inside TSL (see below *ConvF*).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* *frequency\_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* *ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

# Probe EX3DV3

## SN:3519

Manufactured:	March 8, 2004
Last calibrated:	March 20, 2007
Recalibrated:	March 21, 2008

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

## DASY - Parameters of Probe: EX3DV3 SN:3519

### Sensitivity in Free Space<sup>A</sup>

NormX	<b>0.810</b> ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$
NormY	<b>0.700</b> ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	<b>0.730</b> ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$

### Diode Compression<sup>B</sup>

DCP X	<b>92</b> mV
DCP Y	<b>92</b> mV
DCP Z	<b>93</b> mV

### Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 8.

### Boundary Effect

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

Sensor Center to Phantom Surface Distance		<b>2.0 mm</b>	<b>3.0 mm</b>
SAR <sub>be</sub> [%]	Without Correction Algorithm	10.4	6.2
SAR <sub>be</sub> [%]	With Correction Algorithm	0.8	0.7

**TSL**                      **1810 MHz**      **Typical SAR gradient: 10 % per mm**

Sensor Center to Phantom Surface Distance		<b>2.0 mm</b>	<b>3.0 mm</b>
SAR <sub>be</sub> [%]	Without Correction Algorithm	8.0	5.2
SAR <sub>be</sub> [%]	With Correction Algorithm	0.7	0.6

### Sensor Offset

Probe Tip to Sensor Center                      **1.0 mm**

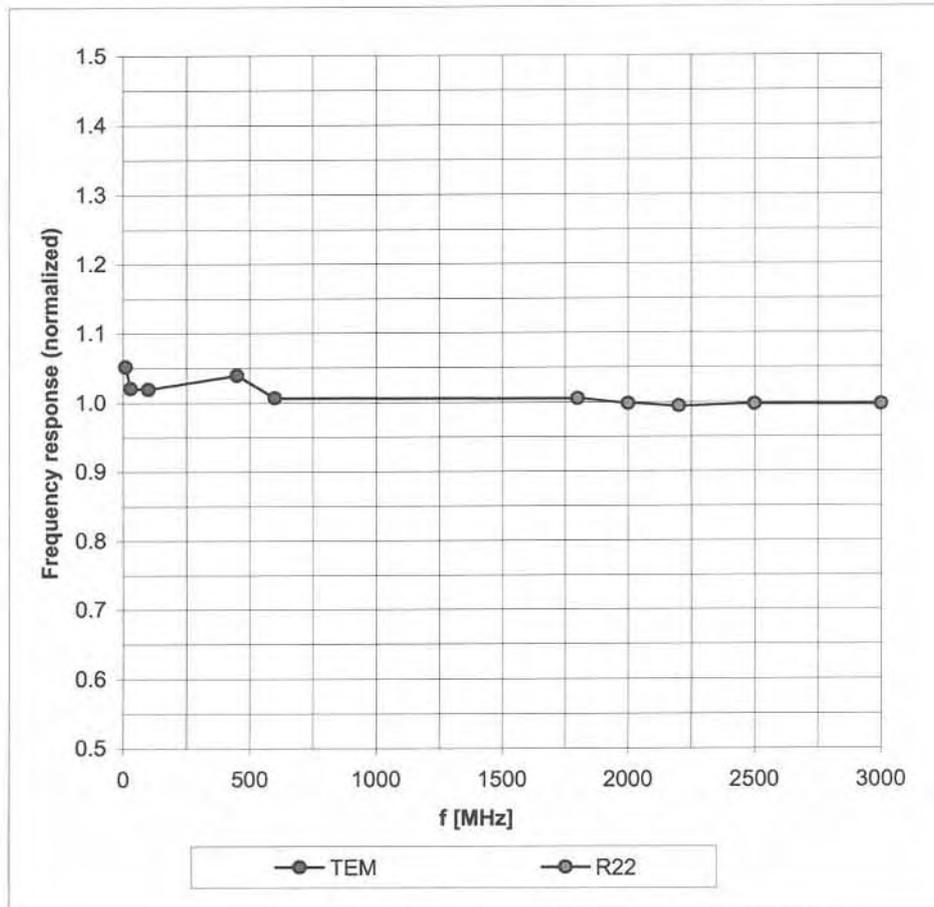
**The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.**

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 8).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

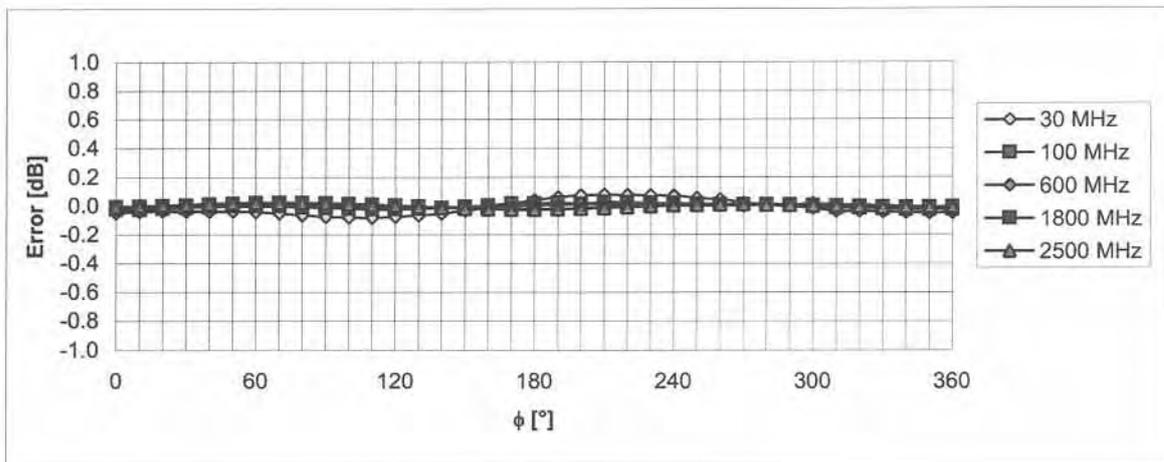
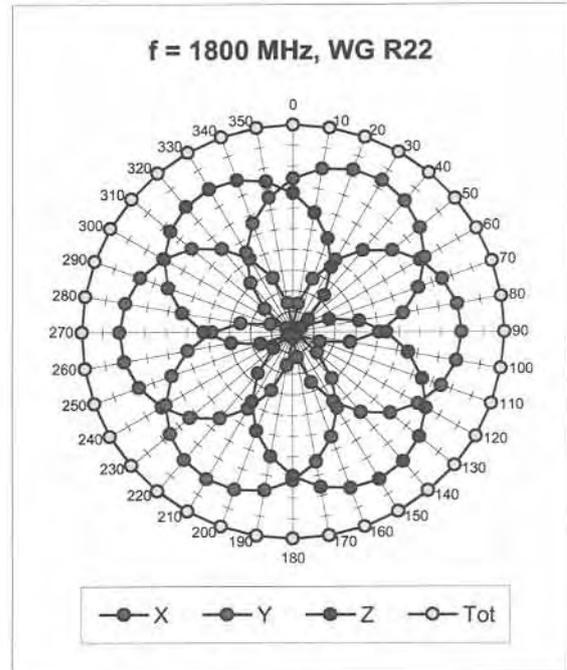
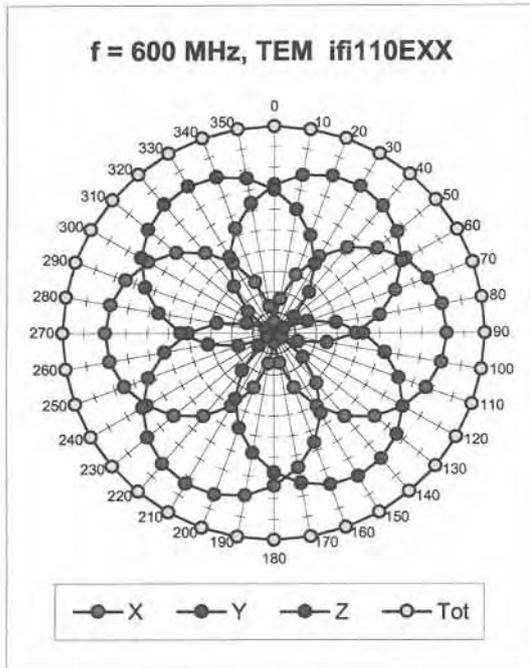
## Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



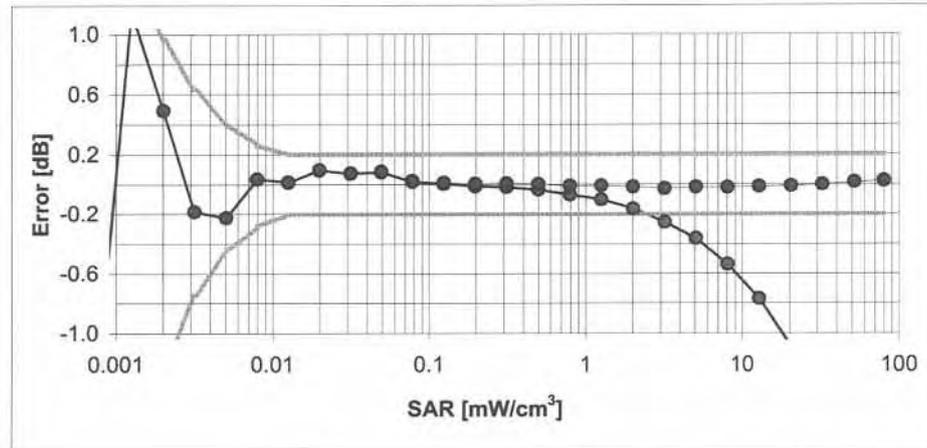
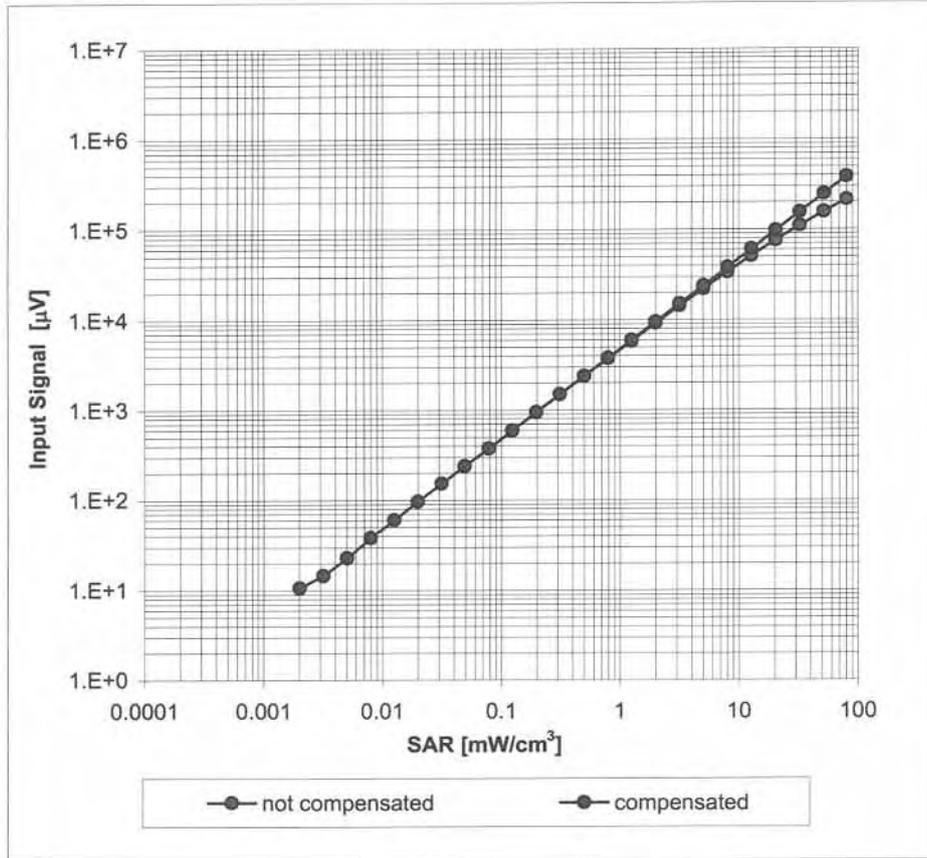
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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



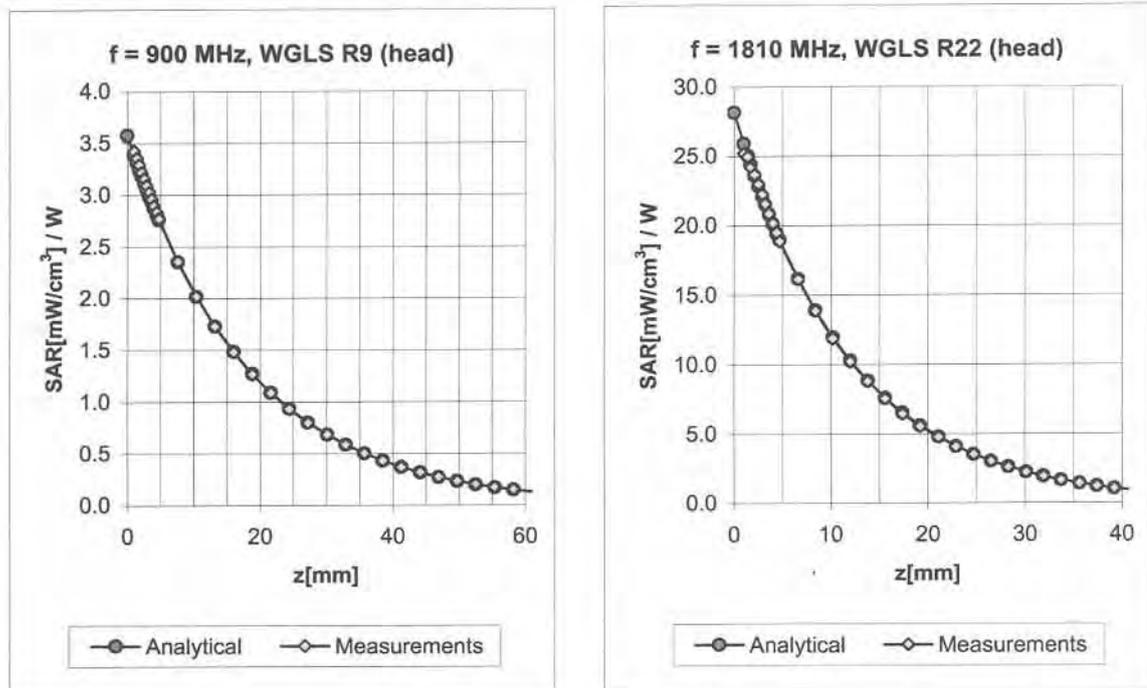
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

### Dynamic Range f(SAR<sub>head</sub>) (Waveguide R22, f = 1800 MHz)



Uncertainty of Linearity Assessment: ± 0.6% (k=2)

## Conversion Factor Assessment

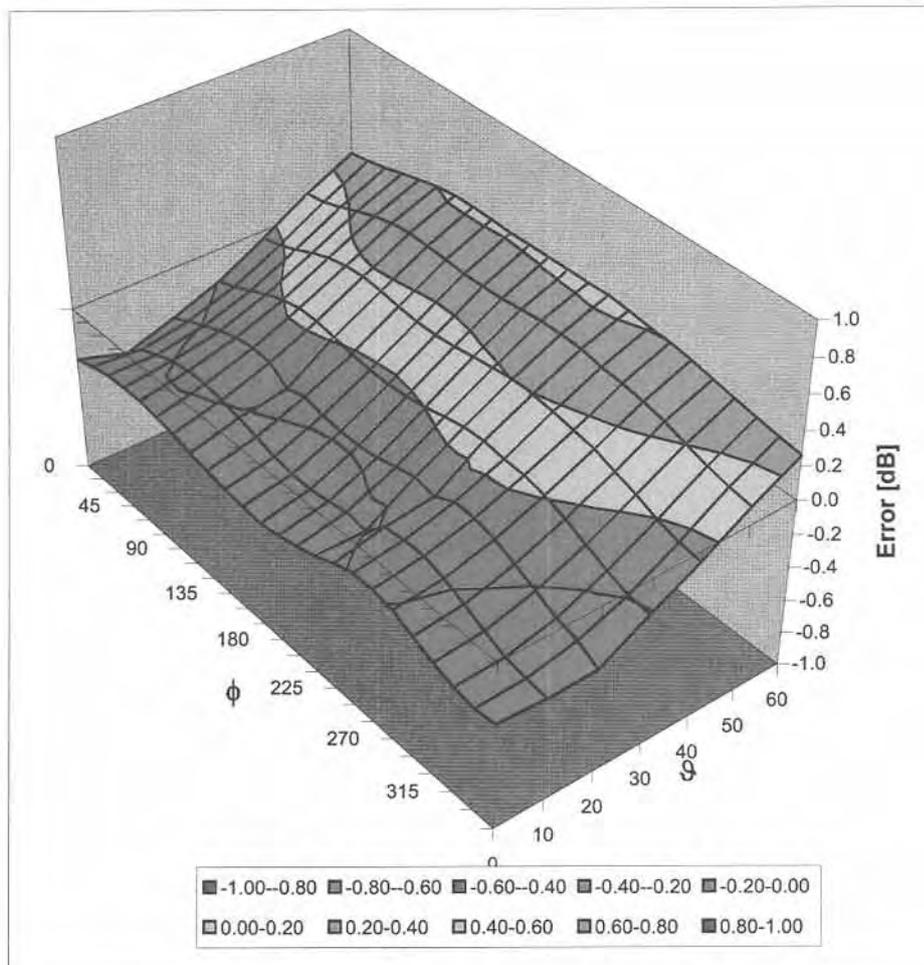


f [MHz]	Validity [MHz] <sup>c</sup>	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	± 50 / ± 100	Head	41.5 ± 5%	0.97 ± 5%	0.84	0.60	10.43 ± 11.0% (k=2)
1810	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.83	0.56	8.87 ± 11.0% (k=2)
5200	± 50 / ± 100	Head	36.0 ± 5%	4.66 ± 5%	0.38	1.75	5.07 ± 13.1% (k=2)
5500	± 50 / ± 100	Head	35.6 ± 5%	4.96 ± 5%	0.40	1.75	4.73 ± 13.1% (k=2)
5800	± 50 / ± 100	Head	35.3 ± 5%	5.27 ± 5%	0.44	1.75	4.46 ± 13.1% (k=2)
900	± 50 / ± 100	Body	55.0 ± 5%	1.05 ± 5%	0.93	0.56	9.87 ± 11.0% (k=2)
1810	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.82	0.57	9.17 ± 11.0% (k=2)
2300	± 50 / ± 100	Body	52.8 ± 5%	1.85 ± 5%	0.54	0.77	8.07 ± 11.8% (k=2)
2600	± 50 / ± 100	Body	52.5 ± 5%	2.16 ± 5%	0.52	0.83	7.60 ± 11.8% (k=2)
3500	± 50 / ± 100	Body	51.3 ± 5%	3.31 ± 5%	0.46	1.06	6.77 ± 13.1% (k=2)
5200	± 50 / ± 100	Body	49.0 ± 5%	5.30 ± 5%	0.38	1.80	4.65 ± 13.1% (k=2)
5500	± 50 / ± 100	Body	48.6 ± 5%	5.65 ± 5%	0.45	1.80	4.10 ± 13.1% (k=2)
5800	± 50 / ± 100	Body	48.2 ± 5%	6.00 ± 5%	0.50	1.80	3.88 ± 13.1% (k=2)

<sup>c</sup> The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

### Deviation from Isotropy in HSL

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



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )



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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

ATL (Auden)

Certificate No: **DAE4-779\_Nov07**

## CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BG - SN: 779**

Calibration procedure(s) **QA CAL-06.v12  
Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **November 30, 2007**

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 ( $22 \pm 3$ )°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	04-Oct-07 (Elcal AG, No: 6467)	Oct-08
Keithley Multimeter Type 2001	SN: 0810278	03-Oct-07 (Elcal AG, No: 6465)	Oct-08
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V1.1	SE UMS 006 AB 1004	25-Jun-07 (SPEAG, in house check)	In house check Jun-08

Calibrated by: **Dominique Steffen**      Function: **Technician**      Signature: *D. Steffen*

Approved by: **Fin Bomholt**      R&D Director      *F. Bomholt*

Issued: November 30, 2007

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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**

## Glossary

**DAE** data 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 as documented in the Appendix 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 $\mu$ 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	404.367 $\pm$ 0.1% (k=2)	403.591 $\pm$ 0.1% (k=2)	403.822 $\pm$ 0.1% (k=2)
Low Range	3.97765 $\pm$ 0.7% (k=2)	3.96449 $\pm$ 0.7% (k=2)	3.98429 $\pm$ 0.7% (k=2)

## Connector Angle

Connector Angle to be used in DASY system	83 $^{\circ}$ $\pm$ 1 $^{\circ}$
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## Appendix

### 1. DC Voltage Linearity

High Range	Input ( $\mu\text{V}$ )	Reading ( $\mu\text{V}$ )	Error (%)
Channel X + Input	200000	200000.1	0.00
Channel X + Input	20000	20006.71	0.03
Channel X - Input	20000	-20000.39	0.00
Channel Y + Input	200000	200000.5	0.00
Channel Y + Input	20000	20003.40	0.02
Channel Y - Input	20000	-19997.93	-0.01
Channel Z + Input	200000	200000.1	0.00
Channel Z + Input	20000	20004.76	0.02
Channel Z - Input	20000	-20002.27	0.01

Low Range	Input ( $\mu\text{V}$ )	Reading ( $\mu\text{V}$ )	Error (%)
Channel X + Input	2000	2000.1	0.00
Channel X + Input	200	200.18	0.09
Channel X - Input	200	-200.54	0.27
Channel Y + Input	2000	1999.9	0.00
Channel Y + Input	200	200.20	0.10
Channel Y - Input	200	-200.13	0.06
Channel Z + Input	2000	2000.1	0.00
Channel Z + Input	200	198.86	-0.57
Channel Z - Input	200	-200.95	0.47

### 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 ( $\mu\text{V}$ )	Low Range Average Reading ( $\mu\text{V}$ )
Channel X	200	-4.93	-6.03
	- 200	6.78	5.47
Channel Y	200	13.74	12.68
	- 200	-14.43	-14.38
Channel Z	200	2.46	1.41
	- 200	-3.80	-4.27

### 3. Channel separation

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

	Input Voltage (mV)	Channel X ( $\mu\text{V}$ )	Channel Y ( $\mu\text{V}$ )	Channel Z ( $\mu\text{V}$ )
Channel X	200	-	2.10	-0.74
Channel Y	200	0.76	-	2.81
Channel Z	200	-1.70	-0.57	-

#### 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	15628	16435
Channel Y	15822	16748
Channel Z	16264	16116

#### 5. Input Offset Measurement

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

Input 10M $\Omega$

	Average ( $\mu$ V)	min. Offset ( $\mu$ V)	max. Offset ( $\mu$ V)	Std. Deviation ( $\mu$ V)
Channel X	-0.15	-1.88	1.72	0.52
Channel Y	-1.21	-3.52	1.65	0.67
Channel Z	-1.21	-2.77	-0.09	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	201.5
Channel Y	0.1999	201.2
Channel Z	0.2000	201.4

#### 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