

**DASY - Parameters of Probe: EX3DV4 SN:3578**Sensitivity in Free Space<sup>A</sup>Diode Compression<sup>B</sup>

NormX	0.520 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP X	98 mV
NormY	0.500 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP Y	90 mV
NormZ	0.540 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP Z	93 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		2.0 mm	3.0 mm
SAR <sub>be</sub> [%]	Without Correction Algorithm	11.3	5.6
SAR <sub>be</sub> [%]	With Correction Algorithm	0.6	0.2

TSL                      1810 MHz      Typical SAR gradient: 10 % per mm

Sensor Center to Phantom Surface Distance		2.0 mm	3.0 mm
SAR <sub>be</sub> [%]	Without Correction Algorithm	9.2	4.6
SAR <sub>be</sub> [%]	With Correction Algorithm	0.5	0.2

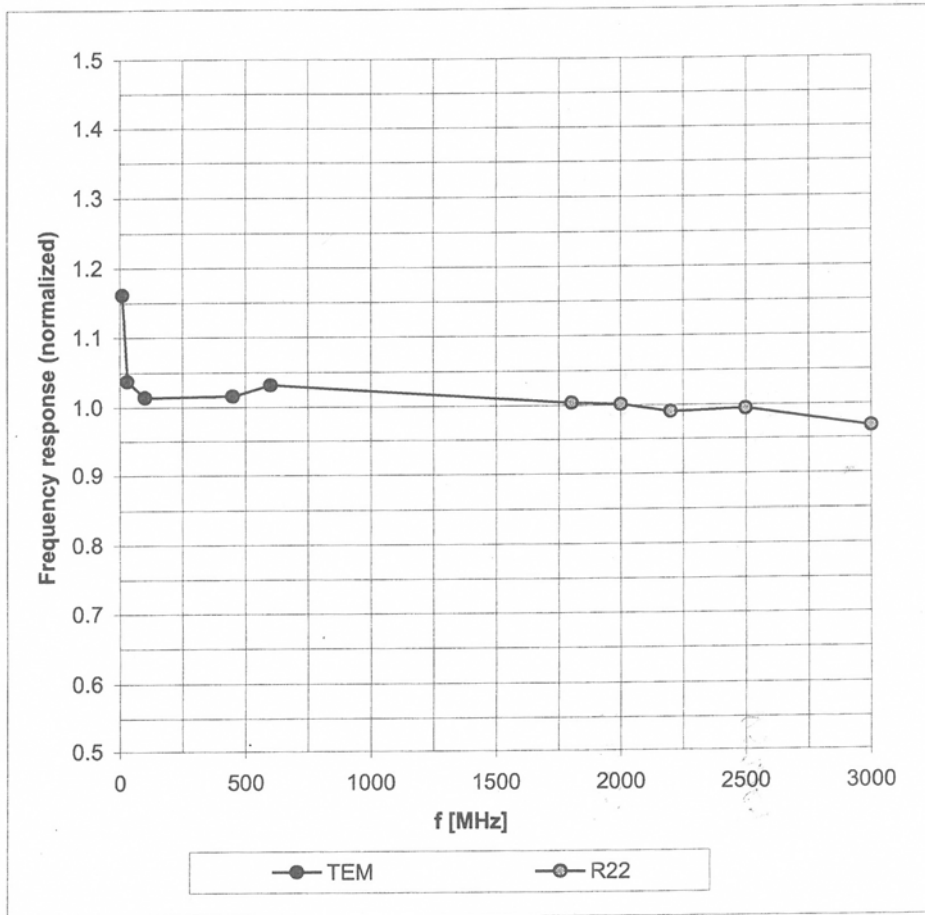
## Sensor Offset

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%.

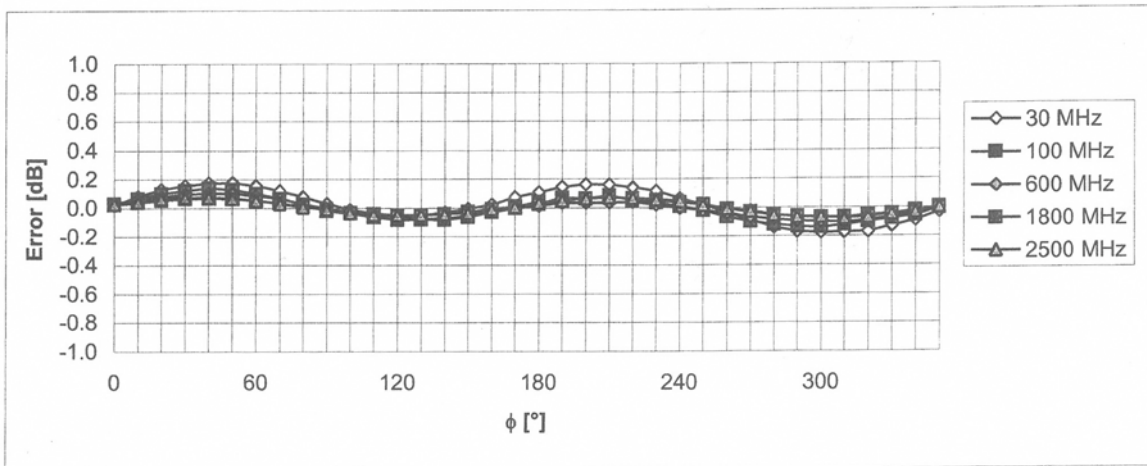
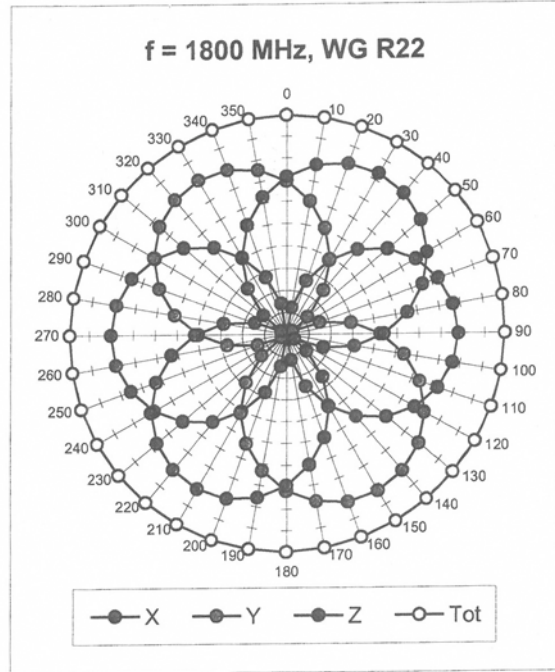
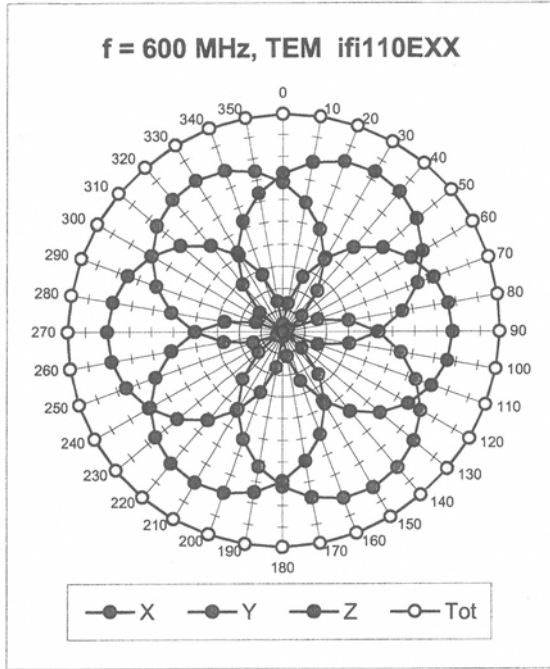
<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 8).<sup>B</sup> Numerical linearization parameter: uncertainty not required.

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



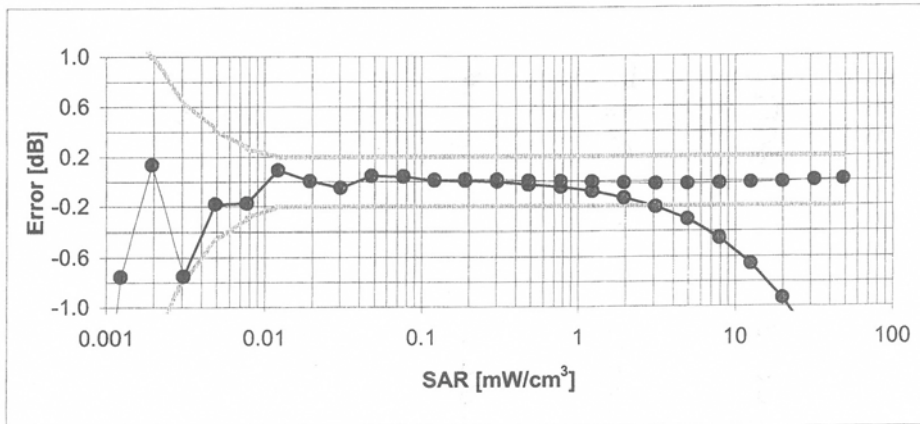
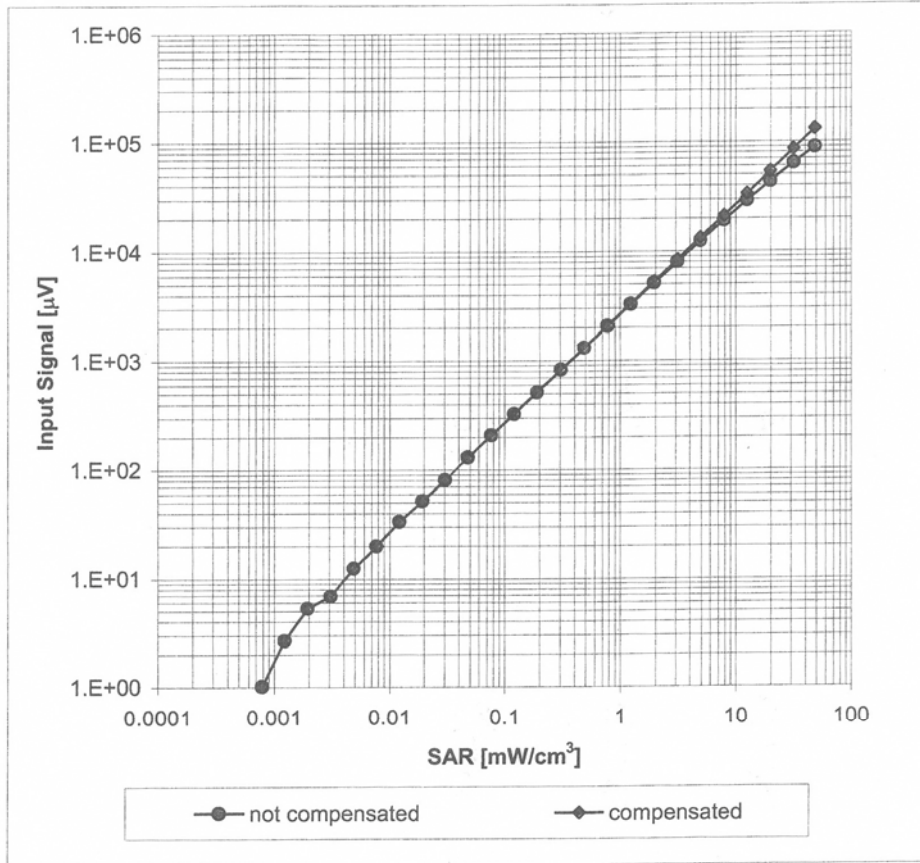
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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



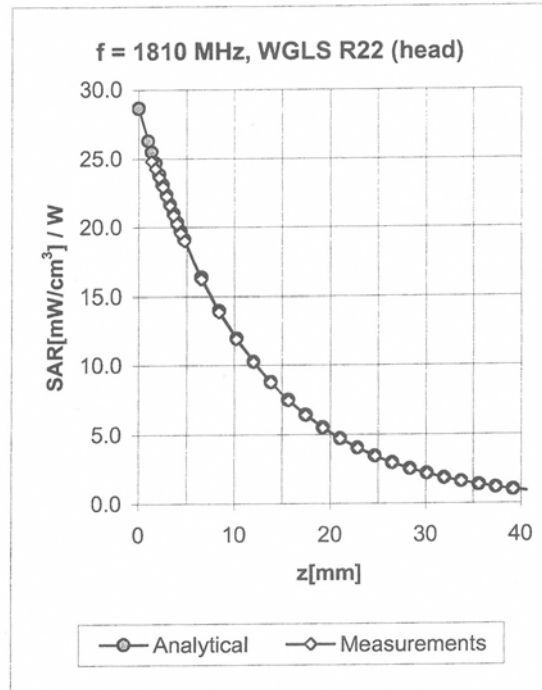
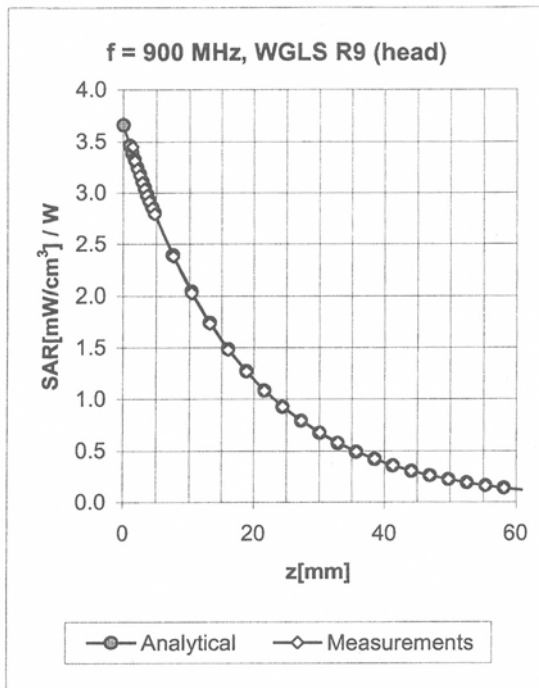
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

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



Uncertainty of Linearity Assessment:  $\pm 0.6\%$  (k=2)

### Conversion Factor Assessment

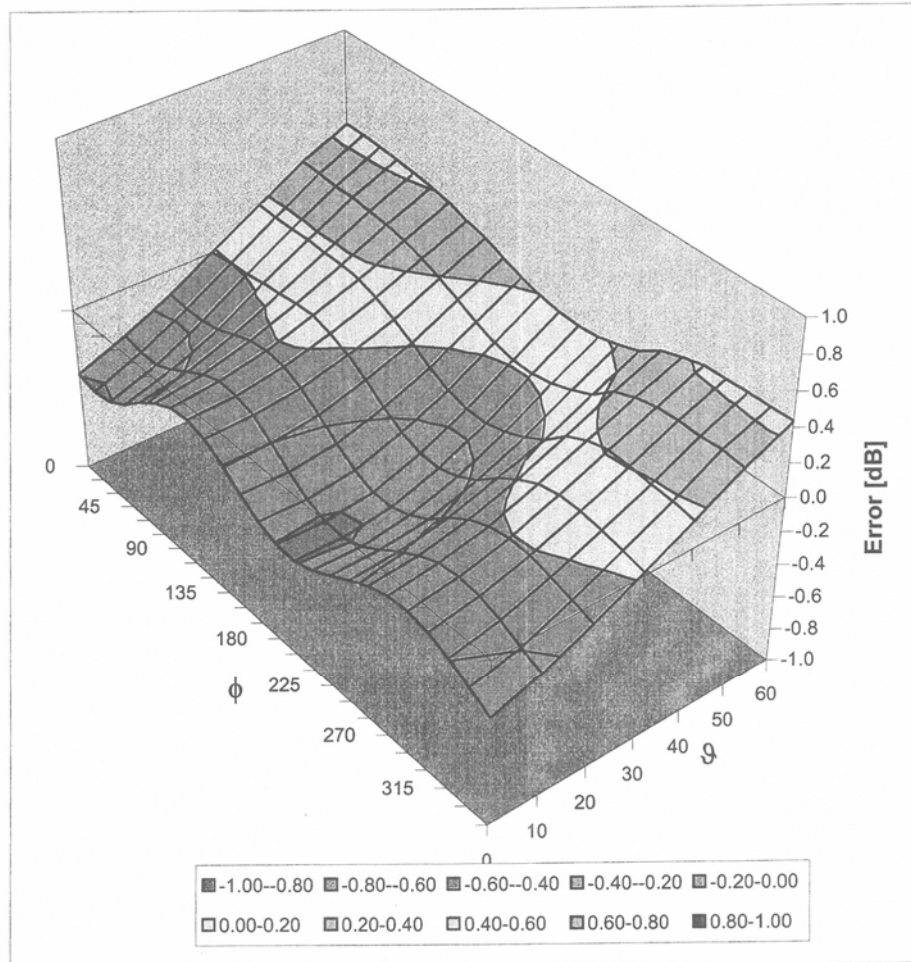


f [MHz]	Validity [MHz] <sup>c</sup>	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	± 50 / ± 100	Head	41.5 ± 5%	0.97 ± 5%	0.48	0.80	8.55 ± 11.0% (k=2)
1810	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.51	0.75	7.28 ± 11.0% (k=2)
2000	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.48	0.77	7.10 ± 11.0% (k=2)
2450	± 50 / ± 100	Head	39.2 ± 5%	1.80 ± 5%	0.40	0.87	6.66 ± 11.0% (k=2)
5200	± 50 / ± 100	Head	36.0 ± 5%	4.66 ± 5%	0.43	1.70	4.65 ± 13.1% (k=2)
5500	± 50 / ± 100	Head	35.6 ± 5%	4.96 ± 5%	0.48	1.70	4.30 ± 13.1% (k=2)
5800	± 50 / ± 100	Head	35.3 ± 5%	5.27 ± 5%	0.50	1.70	4.22 ± 13.1% (k=2)
900	± 50 / ± 100	Body	55.0 ± 5%	1.05 ± 5%	0.45	0.80	8.42 ± 11.0% (k=2)
1810	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.49	0.80	7.41 ± 11.0% (k=2)
2000	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.43	0.87	7.08 ± 11.0% (k=2)
2450	± 50 / ± 100	Body	52.7 ± 5%	1.95 ± 5%	0.55	0.80	6.55 ± 11.0% (k=2)
5200	± 50 / ± 100	Body	49.0 ± 5%	5.30 ± 5%	0.47	1.75	3.84 ± 13.1% (k=2)
5500	± 50 / ± 100	Body	48.6 ± 5%	5.65 ± 5%	0.35	1.75	4.12 ± 13.1% (k=2)
5800	± 50 / ± 100	Body	48.2 ± 5%	6.00 ± 5%	0.46	1.75	3.92 ± 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 ( $\phi, \vartheta$ ),  $f = 900$  MHz



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



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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.



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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



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Client **ATL (Auden)**

Certificate No: **DAE4-779\_Nov08**

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Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **November 11, 2008**

Condition of the calibrated item **In Tolerance**

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Keithley Multimeter Type 2001	SN: 0810278	30-Sep-08 (No: 7670)	Sep-09
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V1.1	SE UMS 006 AB 1004	06-Jun-08 (in house check)	In house check: Jun-09

	Name	Function	Signature
Calibrated by:	Daniel Hess	Technician	
Approved by:	Fin Bornholt	R&D Director	

Issued: November 11, 2008

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

Calibration Factors	X	Y	Z
High Range	404.449 $\pm$ 0.1% (k=2)	403.679 $\pm$ 0.1% (k=2)	403.906 $\pm$ 0.1% (k=2)
Low Range	3.97989 $\pm$ 0.7% (k=2)	3.96584 $\pm$ 0.7% (k=2)	3.96834 $\pm$ 0.7% (k=2)

## Connector Angle

Connector Angle to be used in DASY system	88 $^{\circ}$ $\pm$ 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	200000.2	0.00
Channel X + Input	20000	20004.76	0.02
Channel X - Input	20000	-20000.46	0.00
Channel Y + Input	200000	199999.9	0.00
Channel Y + Input	20000	20004.23	0.02
Channel Y - Input	20000	-20000.37	0.00
Channel Z + Input	200000	200000.1	0.00
Channel Z + Input	20000	20003.22	0.02
Channel Z - Input	20000	-20000.98	0.00

Low Range	Input ( $\mu\text{V}$ )	Reading ( $\mu\text{V}$ )	Error (%)
Channel X + Input	2000	1999.9	0.00
Channel X + Input	200	199.15	-0.43
Channel X - Input	200	-200.23	0.11
Channel Y + Input	2000	2000	0.00
Channel Y + Input	200	198.78	-0.61
Channel Y - Input	200	-199.84	-0.08
Channel Z + Input	2000	2000.1	0.00
Channel Z + Input	200	199.55	-0.22
Channel Z - Input	200	-201.30	0.65

### 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	-4.34	-5.11
	- 200	5.57	5.20
Channel Y	200	13.81	13.35
	- 200	-14.32	-13.88
Channel Z	200	2.61	2.32
	- 200	-4.14	-4.46

### 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	-	2.09	0.14
Channel Y	200	-0.49	-	2.40
Channel Z	200	-1.47	0.22	-

#### 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	15617	15330
Channel Y	15810	15565
Channel Z	16216	15563

#### 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	-0.13	-2.92	1.64	0.57
Channel Y	-0.83	-2.41	0.83	0.63
Channel Z	-1.03	-2.84	-0.06	0.42

#### 6. Input Offset Current

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

#### 7. Input Resistance

	Zeroing (MOhm)	Measuring (MOhm)
Channel X	0.1999	202.2
Channel Y	0.1999	201.5
Channel Z	0.2000	201.5

#### 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