



APPENDIX D: SYSTEM CERTIFICATE & CALIBRATION

D1: SAM PHANTOM

Schmid & Partner Engineering AG

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Certificate of conformity / First Article Inspection

Item	SAM Twin Phantom V4.0
Type No	QD 000 P40 CA
Series No	TP-1150 and higher
Manufacturer / Origin	Untersee Composites Hauptstr. 69 CH-8559 Fruthwilen Switzerland

Tests

The series production process used allows the limitation to test of first articles.

Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

Test	Requirement	Details	Units tested
Shape	Compliance with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness	Compliant with the requirements according to the standards	2mm +/- 0.2mm in specific areas	First article, Samples
Material parameters	Dielectric parameters for required frequencies	200 MHz – 3 GHz Relative permittivity < 5 Loss tangent < 0.05.	Material sample TP 104-5
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards	Liquid type HSL 1800 and others according to the standard.	Pre-series, First article

Standards

- [1] CENELEC EN 50361
- [2] IEEE P1528-200x draft 6.5
- [3] IEC PT 62209 draft 0.9

(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

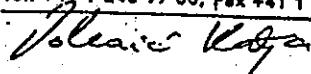
Date 28.02.2002

Signature / Stamp



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D2: DOSIMETRIC E-FIELD PROBE

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **ADT (Auden)**

Certificate No: **ET3-1687_Sep05**

CALIBRATION CERTIFICATE

Object **ET3DV6 - SN:1687**

Calibration procedure(s) **QA CAL-01.v5**
Calibration procedure for dosimetric E-field probes

Calibration date: **September 15, 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.

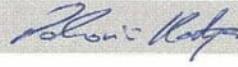
All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	3-May-05 (METAS, No. 251-00466)	May-06
Power sensor E4412A	MY41495277	3-May-05 (METAS, No. 251-00466)	May-06
Power sensor E4412A	MY41498087	3-May-05 (METAS, No. 251-00466)	May-06
Reference 3 dB Attenuator	SN: S5054 (3c)	11-Aug-05 (METAS, No. 251-00499)	Aug-06
Reference 20 dB Attenuator	SN: S5086 (20b)	3-May-05 (METAS, No. 251-00467)	May-06
Reference 30 dB Attenuator	SN: S5129 (30b)	11-Aug-05 (METAS, No. 251-00500)	Aug-06
Reference Probe ES3DV2	SN: 3013	7-Jan-05 (SPEAG, No. ES3-3013_Jan05)	Jan-06
DAE4	SN: 654	29-Nov-04 (SPEAG, No. DAE4-654_Nov04)	Nov-05

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Dec-03)	In house check: Dec-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov 05

Calibrated by:	Name	Function	Signature
	Nico Vetterli	Laboratory Technician	

Approved by:	Name	Function	Signature
	Katja Pokovic	Technical Manager	

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

Issued: September 16, 2005

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Glossary:

TS	tissue simulating liquid
NORM x,y,z	sensitivity in free space
ConF	sensitivity in TSL / NORM x,y,z
DCP	diode compression point
Polarization ϕ	ϕ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ 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
- CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz)", July 2001

Methods Applied and Interpretation of Parameters:

- $NORMx,y,z$: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). $NORMx,y,z$ are only intermediate values, i.e., the uncertainties of $NORMx,y,z$ does not effect the E^2 -field uncertainty inside TSL (see below *ConvF*).
- $NORM(f)x,y,z = NORMx,y,z * frequency_response$ (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*.
- $DCPx,y,z$: 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 $NORMx,y,z * ConvF$ 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 ± 50 MHz to ± 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.



ET3DV6 SN:1687

September 15, 2005

Probe ET3DV6

SN:1687

Manufactured:	May 28, 2002
Last calibrated:	August 26, 2004
Repaired:	September 2, 2005
Recalibrated:	September 15, 2005

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)



ET3DV6 SN:1687

September 15, 2005

DASY - Parameters of Probe: ET3DV6 SN:1687

Sensitivity in Free Space^A

NormX	1.99 \pm 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$
NormY	1.95 \pm 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	1.81 \pm 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression^B

DCP X	93 mV
DCP Y	93 mV
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	3.7 mm	4.7 mm
SAR _{be} [%] Without Correction Algorithm	7.3	3.8
SAR _{be} [%] With Correction Algorithm	0.1	0.2

TSL **1750 MHz** **Typical SAR gradient: 10 % per mm**

Sensor Center to Phantom Surface Distance	3.7 mm	4.7 mm
SAR _{be} [%] Without Correction Algorithm	12.4	8.7
SAR _{be} [%] With Correction Algorithm	0.7	0.1

Sensor Offset

Probe Tip to Sensor Center **2.7 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%.

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

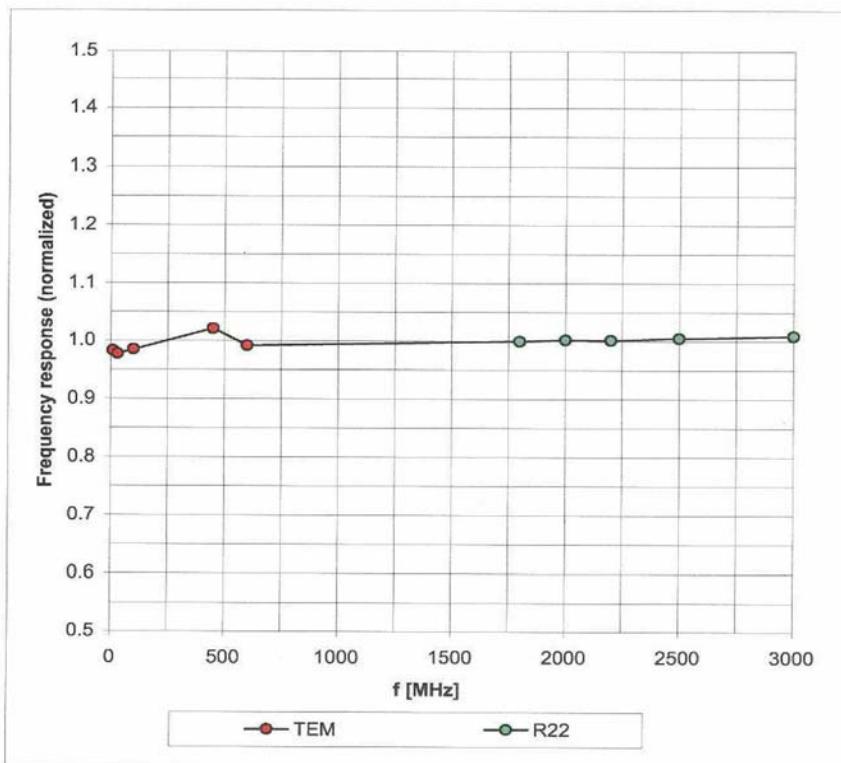
^B Numerical linearization parameter: uncertainty not required.

ET3DV6 SN:1687

September 15, 2005

Frequency Response of E-Field

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

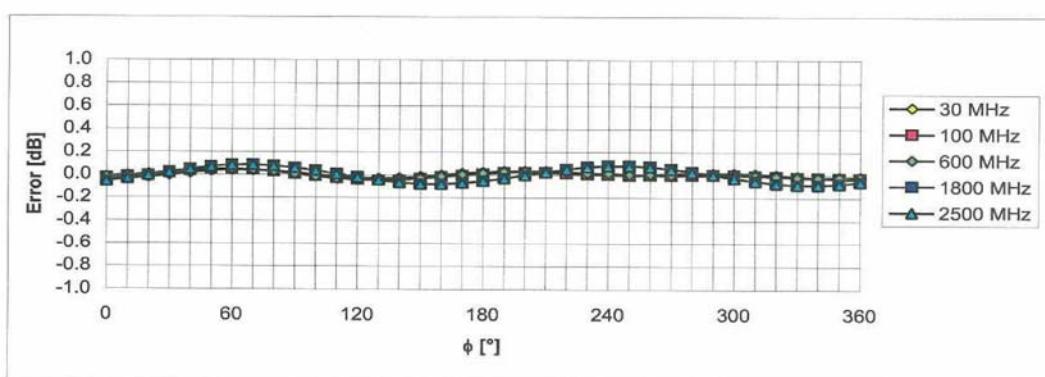
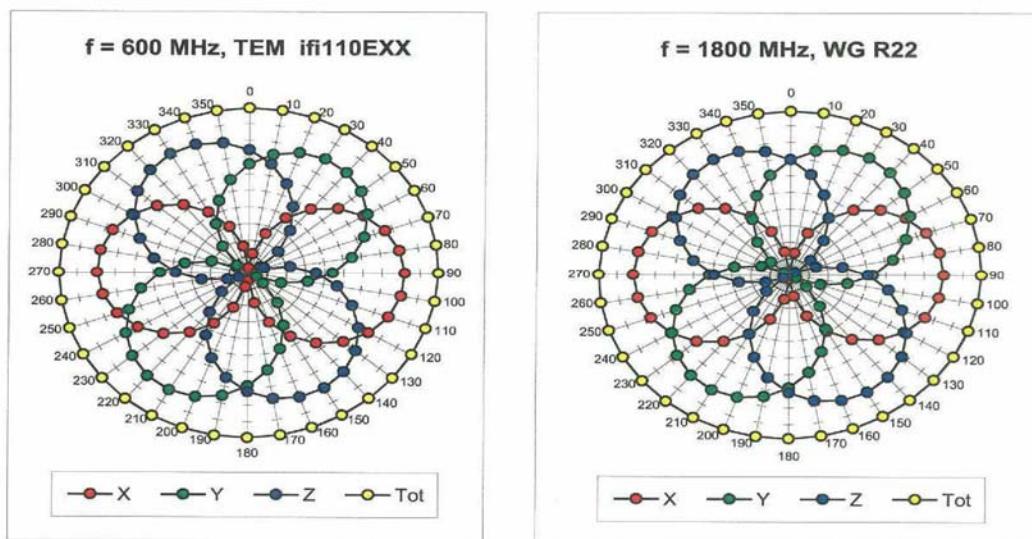


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

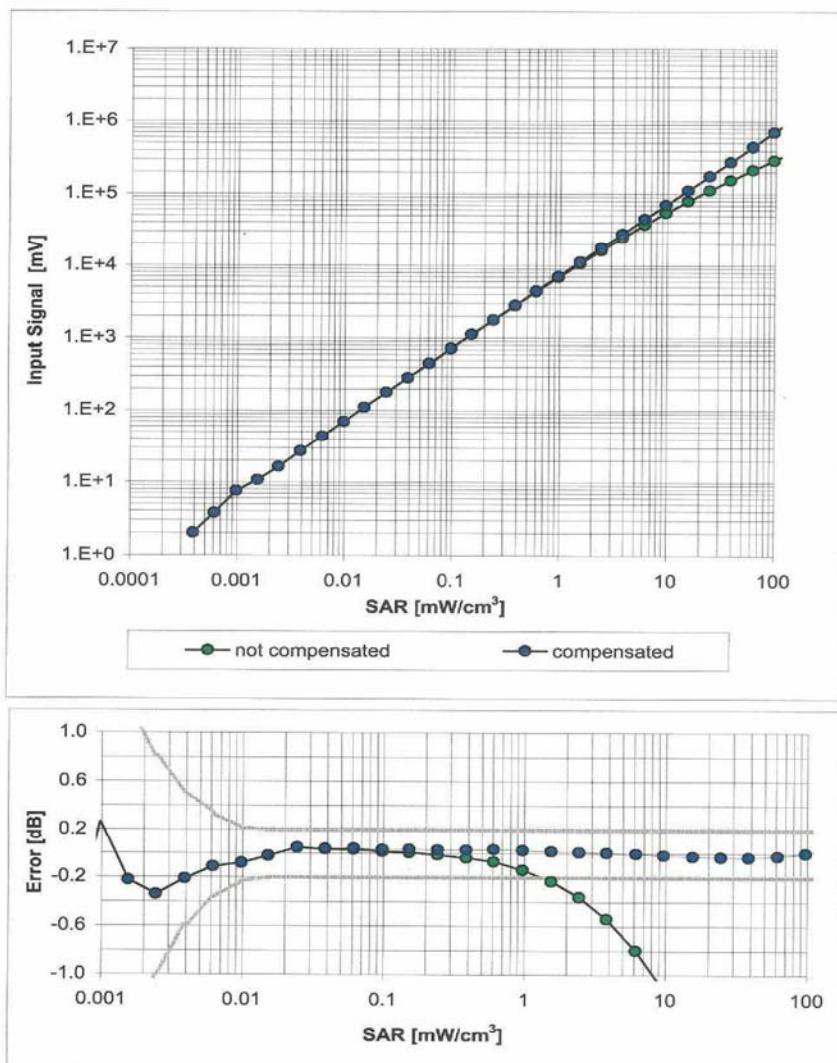


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

ET3DV6 SN:1687

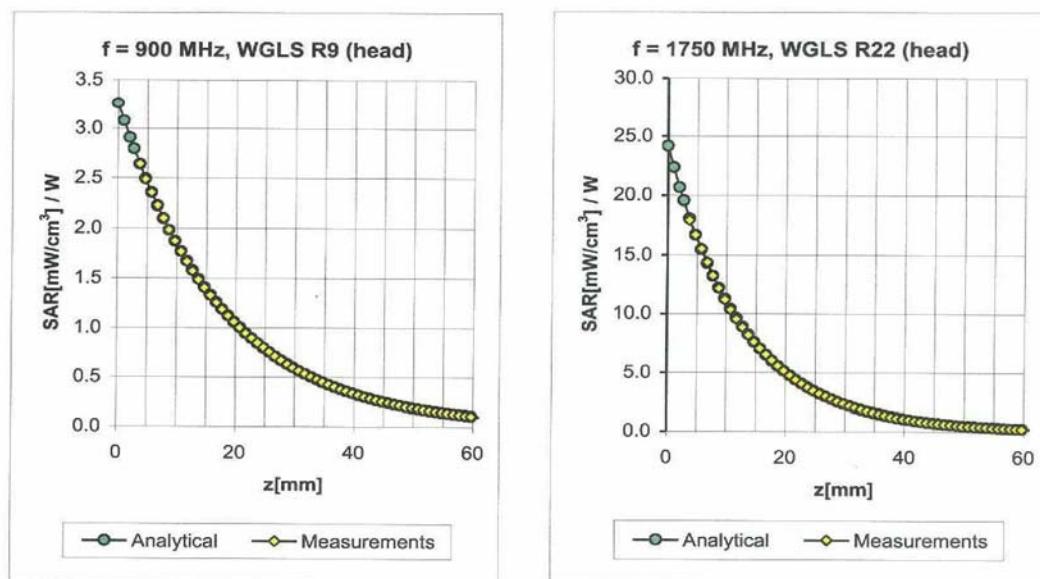
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Dynamic Range f(SAR_{head})
(Waveguide R22, f = 1800 MHz)



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

Conversion Factor Assessment



f [MHz]	Validity [MHz] ^c	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF	Uncertainty
900	$\pm 50 / \pm 100$	Head	$41.5 \pm 5\%$	$0.97 \pm 5\%$	0.50	1.84	6.34	$\pm 11.0\% (k=2)$
1750	$\pm 50 / \pm 100$	Head	$40.1 \pm 5\%$	$1.37 \pm 5\%$	0.49	2.57	5.18	$\pm 11.0\% (k=2)$
1900	$\pm 50 / \pm 100$	Head	$40.0 \pm 5\%$	$1.40 \pm 5\%$	0.49	2.67	4.96	$\pm 11.0\% (k=2)$
2450	$\pm 50 / \pm 100$	Head	$39.2 \pm 5\%$	$1.80 \pm 5\%$	0.59	2.30	4.41	$\pm 11.8\% (k=2)$

900	$\pm 50 / \pm 100$	Body	$55.0 \pm 5\%$	$1.05 \pm 5\%$	0.39	2.27	6.21	$\pm 11.0\% (k=2)$
1750	$\pm 50 / \pm 100$	Body	$53.4 \pm 5\%$	$1.49 \pm 5\%$	0.50	2.88	4.46	$\pm 11.0\% (k=2)$
1900	$\pm 50 / \pm 100$	Body	$53.3 \pm 5\%$	$1.52 \pm 5\%$	0.51	2.79	4.39	$\pm 11.0\% (k=2)$
2450	$\pm 50 / \pm 100$	Body	$52.7 \pm 5\%$	$1.95 \pm 5\%$	0.63	1.99	4.13	$\pm 11.8\% (k=2)$

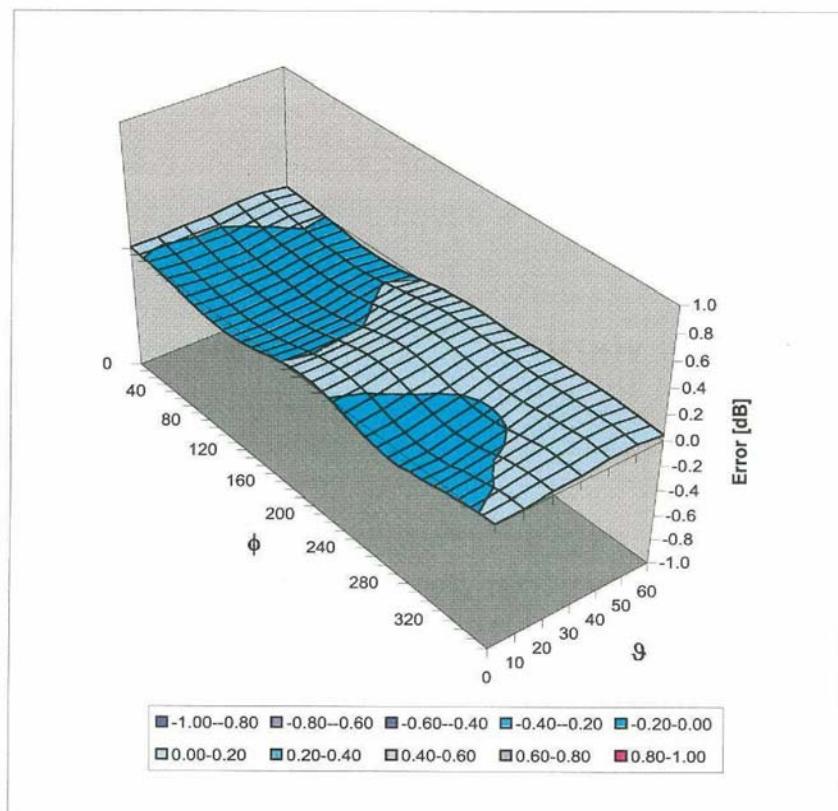
^c The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

ET3DV6 SN:1687

September 15, 2005

Deviation from Isotropy in HSL

Error (ϕ, θ), $f = 900$ MHz



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



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Accreditation No.: SCS 108

Client **ADT (Auden)**

Certificate No: DAE3-510_Aug05

CALIBRATION CERTIFICATE

Object **DAE3 - SD 000 D03 AA - SN: 510**

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

Calibration date: **August 17, 2005**

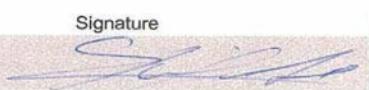
Condition of the calibrated item **In Tolerance**

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
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	29-Jun-05 (SPEAG, in house check)	In house check Jun-06

Calibrated by:	Name Eric Hainfeld	Function Technician	Signature 
Approved by:	Fin Bomholt	R&D Director	

Issued: August 17, 2005

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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 = $6.1\mu\text{V}$, full range = $-100...+300\text{ mV}$

Low Range: 1LSB = 61nV , full range = $-1.....+3\text{mV}$

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

Calibration Factors	X	Y	Z
High Range	$403.415 \pm 0.1\% \text{ (k=2)}$	$403.485 \pm 0.1\% \text{ (k=2)}$	$403.851 \pm 0.1\% \text{ (k=2)}$
Low Range	$3.95575 \pm 0.7\% \text{ (k=2)}$	$3.93409 \pm 0.7\% \text{ (k=2)}$	$3.95875 \pm 0.7\% \text{ (k=2)}$

Connector Angle

Connector Angle to be used in DASY system	$44^\circ \pm 1^\circ$
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Appendix

1. DC Voltage Linearity

High Range		Input (µV)	Reading (µV)	Error (%)
Channel X	+ Input	200000	200000.5	0.00
Channel X	+ Input	20000	20004.73	0.02
Channel X	- Input	20000	-19990.82	-0.05
Channel Y	+ Input	200000	200000.4	0.00
Channel Y	+ Input	20000	20002.02	0.01
Channel Y	- Input	20000	-19995.68	-0.02
Channel Z	+ Input	200000	200000.2	0.00
Channel Z	+ Input	20000	20006.25	0.03
Channel Z	- Input	20000	-19996.09	-0.02

Low Range		Input (µV)	Reading (µV)	Error (%)
Channel X	+ Input	2000	2000.1	0.00
Channel X	+ Input	200	200.36	0.18
Channel X	- Input	200	-200.01	0.00
Channel Y	+ Input	2000	1999.9	0.00
Channel Y	+ Input	200	199.23	-0.38
Channel Y	- Input	200	-200.56	0.28
Channel Z	+ Input	2000	2000	0.00
Channel Z	+ Input	200	199.08	-0.46
Channel Z	- Input	200	-200.99	0.50

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	17.56	16.61
	-200	-15.84	-17.03
Channel Y	200	14.35	14.26
	-200	-15.35	-15.86
Channel Z	200	-8.76	-8.81
	-200	7.41	7.46

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	-	3.17	0.64
Channel Y	200	0.23	-	3.72
Channel Z	200	-0.73	-0.05	-

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	15976	16467
Channel Y	16203	16387
Channel Z	16171	16268

5. Input Offset Measurement

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

Input 10MΩ

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	0.21	-0.66	0.72	0.27
Channel Y	-1.17	-3.01	0.16	0.33
Channel Z	-1.42	-2.98	-0.81	0.29

6. Input Offset Current

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

7. Input Resistance

	Zeroing (MΩ)	Measuring (MΩ)
Channel X	0.2001	201.1
Channel Y	0.2001	199.6
Channel Z	0.2000	200.5

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