

APPENDIX B: ADT SAR MEASUREMENT SYSTEM



APPENDIX C: PHOTOGRAPHS OF SYSTEM VALIDATION



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**

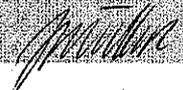
Condition of the calibrated item **In Tolerance (according to the specific calibration document)**

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 EPM E442	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	MY41092317	18-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	US37390585	18-Oct-01 (SPEAG, in house check Nov-03)	In house check: Oct 05

Calibrated by: **Name** **Function** **Signature**
 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 dosimetric 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: DAS4 (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: DAS4, 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

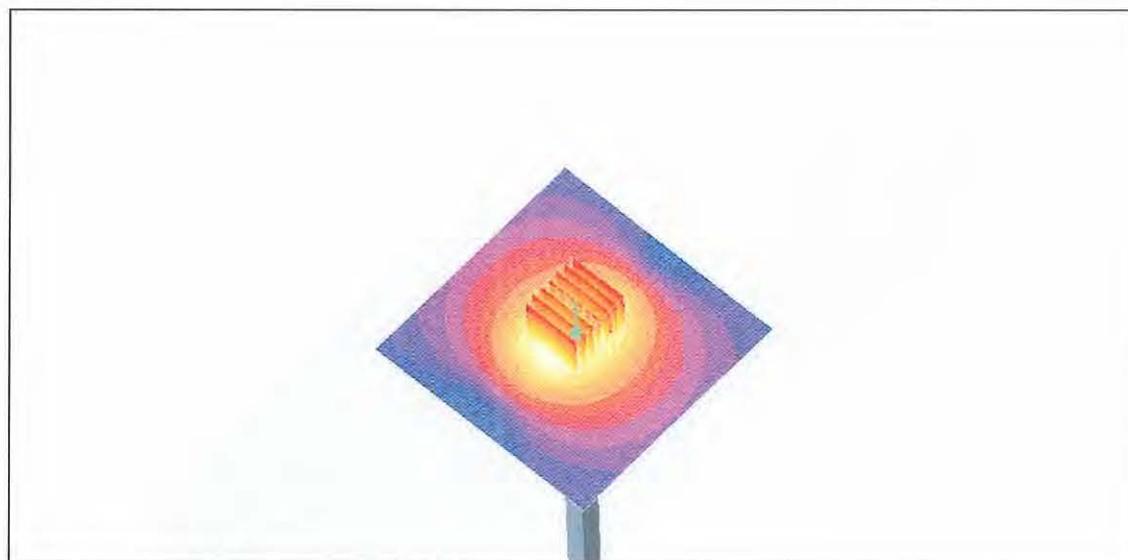
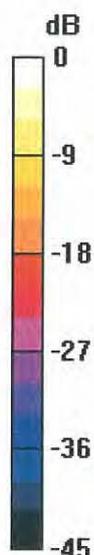
Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

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



0 dB = 14.8mW/g

716
Head

20 Aug 2004 14:02:08

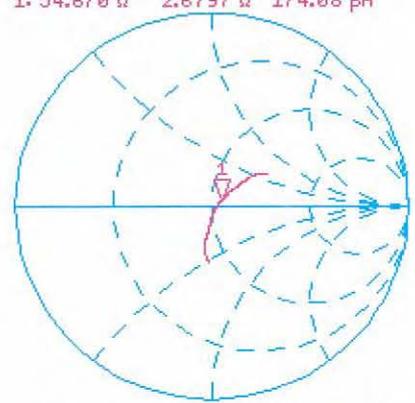
CH1 S11 1 U FS 1: 54.670 Ω 2.6797 Ω 174.08 μ H 2 450.000 000 MHz

De1

Cor

Avg
16

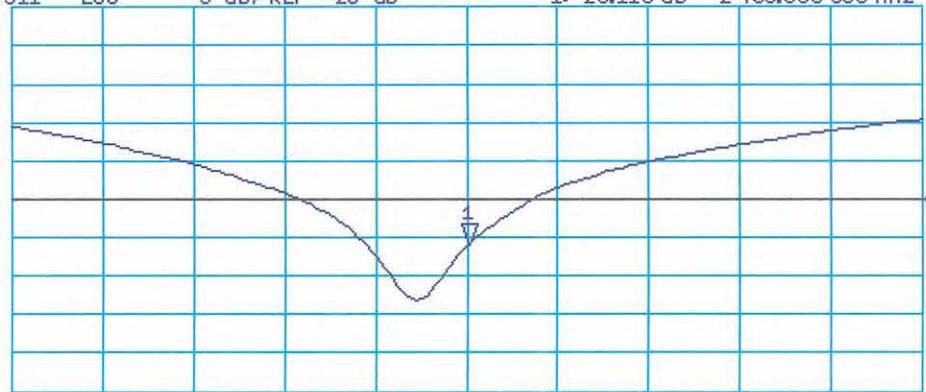
↑



CH2 S11 LOG 5 dB/REF -20 dB 1:-26.110 dB 2 450.000 000 MHz

Cor

↑



CENTER 2 450.000 000 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: DASYS4 (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: DASYS4, 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

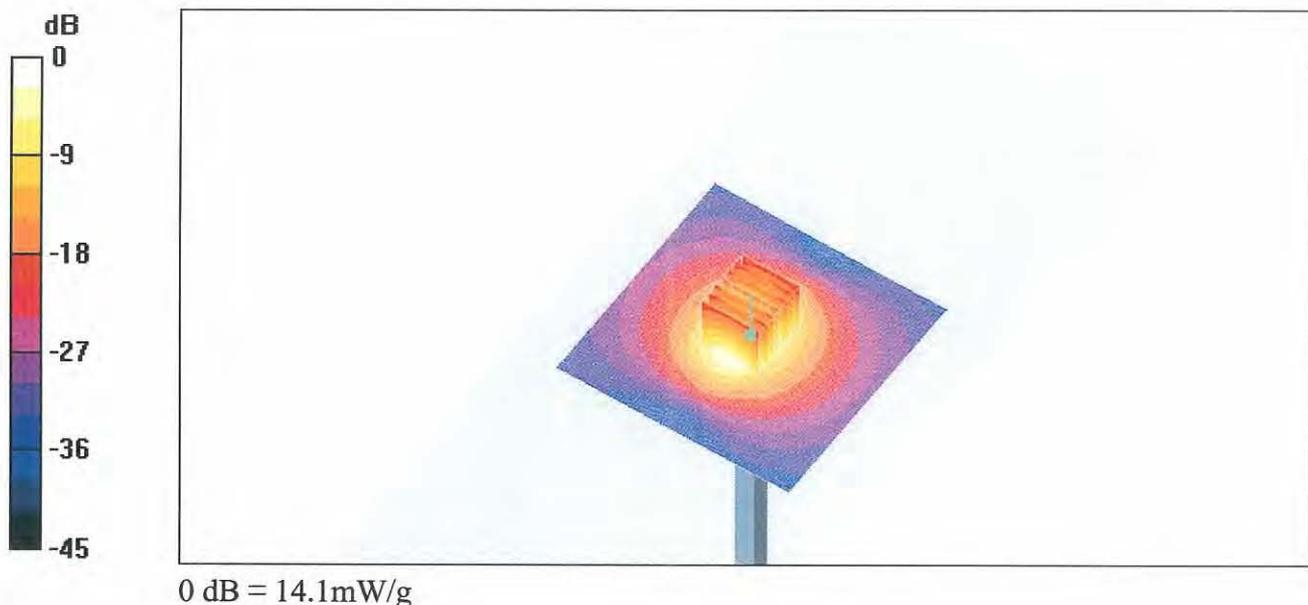
Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

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



716
Body

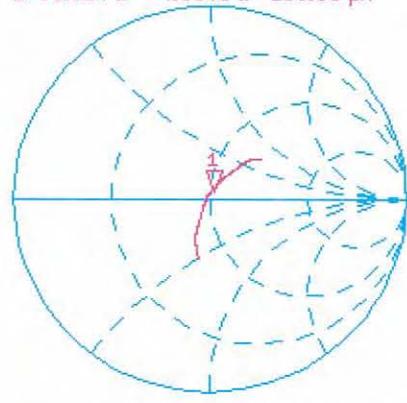
23 Aug 2004 08:51:35

CH1 S11 1 U FS 1: 50.824 Ω 4.0840 Ω 265.30 pH 2 450.000 000 MHz

De1

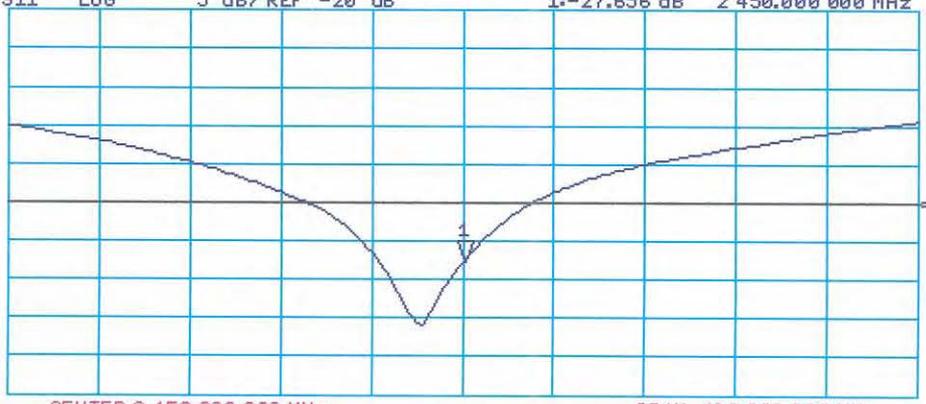
Cor

Avg
16



CH2 S11 LOG 5 dB/REF -20 dB 1: -27.656 dB 2 450.000 000 MHz

Cor



CENTER 2 450.000 000 MHz

SPAN 400.000 000 MHz

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info@speag.com, <http://www.speag.com>

IMPORTANT NOTICE

USAGE OF PROBES IN ORGANIC SOLVENTS

Diethylene Glycol Monobuthy Ether (the basis for liquids above 1 GHz), as many other organic solvents, is a very effective softener for synthetic materials. These solvents can cause irreparable damage to certain SPEAG products, except those which are explicitly declared as compliant with organic solvents.

Compatible Probes:

- ET3DV6
- ET3DV6R
- ES3DVx
- ER3DV6
- H3DV6

Important Note for ET3DV6 Probes:

The ET3DV6 probes shall not be exposed to solvents longer than necessary for the measurements and shall be cleaned daily after use with warm water and stored dry.

s p e a g

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INTRODUCTION OF NEW PROBE CONFIGURATION FILES (*.cf5)

Dear Customer,

Please be informed that as of November 2004, probe configuration files have been change to the new version, i.e., *.cf5 configuration files. Together with the DASY4 v4.4 Build 3 software version, the frequency compensation is applied to measured data providing extension of frequency validity of the probe *ConvF* from ± 50 MHz to ± 100 MHz with the same accuracy.

SOFTWARE INSTALLATION

The new software is available for download from the DASY4 homepage
<http://www.dasy4.com/updates/updates.html>
(via: DASY4 / Support & Downloads / Downloads / Software Updates)

The two new executable files:

DASY4.4 B3 EXE (item 3 within the DASY 4.4 Upgrade section)

SEMCAD V1.8 B130 EXE (item 4 within the DASY 4.4 Upgrade section)

To access and download the files, please use:

Username: **dasy4**

Password: **wowcool**

Please download the two executable files and replace the existing DASY4/SEMCAD software versions located in your DASY4 directory on your PC with these new releases at your earliest convenience.

Best regards

Your SPEAG DASY4 support team

s p e a g

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Schmid & Partner Engineering AG



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 **ADT (Auden)**

Certificate No. **ET3-1790_Dec04**

CALIBRATION CERTIFICATE

Object **ET3DV6 - SN:1790**

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

Calibration date: **December 20, 2004**

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	5-May-04 (METAS, No. 251-00388)	May-05
Power sensor E4412A	MY41495277	5-May-04 (METAS, No. 251-00388)	May-05
Reference 3 dB Attenuator	SN: S5054 (3c)	10-Aug-04 (METAS, No. 251-00403)	Aug-05
Reference 20 dB Attenuator	SN: S5086 (20b)	3-May-04 (METAS, No. 251-00389)	May-05
Reference 30 dB Attenuator	SN: S5129 (30b)	10-Aug-04 (METAS, No. 251-00404)	Aug-05
Reference Probe ES3DV2	SN: 3013	8-Jan-04 (SPEAG, No. ES3-3013_Jan04)	Jan-05
DAE4	SN: 617	26-May-04 (SPEAG, No. DAE4-617_May04)	May-05

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092180	18-Sep-02 (SPEAG, in house check Oct-03)	In house check: Oct 05
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:	Katja Pokovic	Technical Manager	
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Issued: December 29, 2004

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:

TSL	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., $\vartheta = 0$ 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
- 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:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not effect the E^2 -field uncertainty inside TSL (see below *ConvF*).
- NORM(f)_{x,y,z}** = NORM_{x,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*.
- DCP_{x,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 NORM_{x,y,z} * *ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY 4.3 B17 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.

Probe ET3DV6

SN:1790

Manufactured:	May 28, 2003
Last calibrated:	August 29, 2003
Repaired:	October 5, 2004
Recalibrated:	December 20, 2004

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ET3DV6 SN:1790**Sensitivity in Free Space^A****Diode Compression^B**

NormX	2.07 ± 9.9%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP X	94 mV
NormY	2.04 ± 9.9%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP Y	94 mV
NormZ	1.78 ± 9.9%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP Z	94 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	9.2	4.9
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	12.6	8.4
SAR _{be} [%]	With Correction Algorithm	0.5	0.0

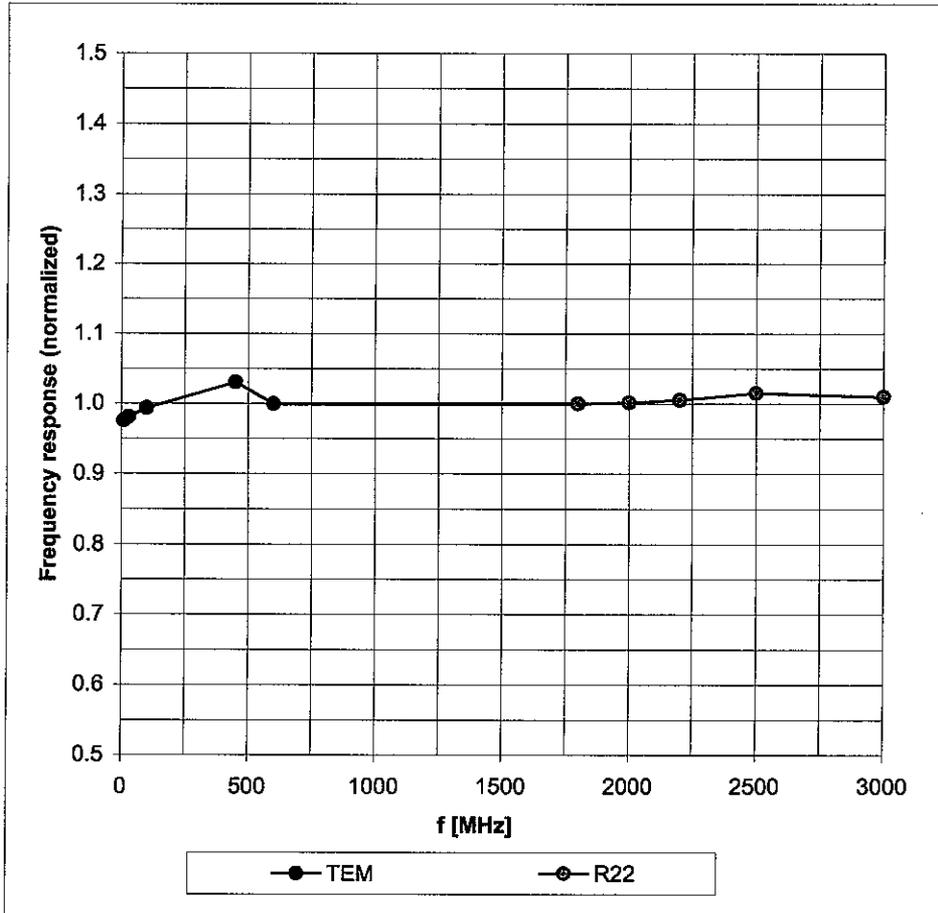
Sensor OffsetProbe Tip to Sensor Center **2.7 mm**

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 E²-field uncertainty inside TSL (see Page 8).^B Numerical linearization parameter: uncertainty not required.

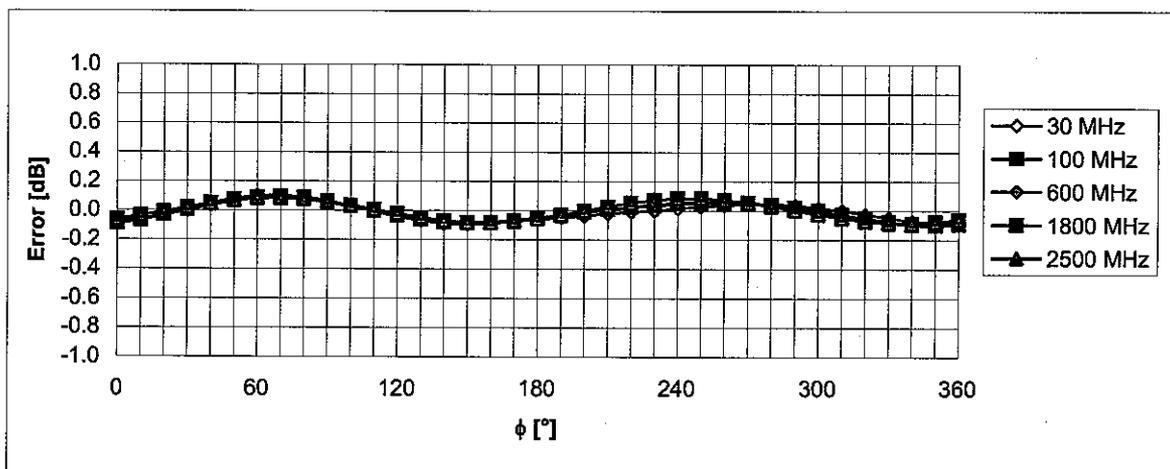
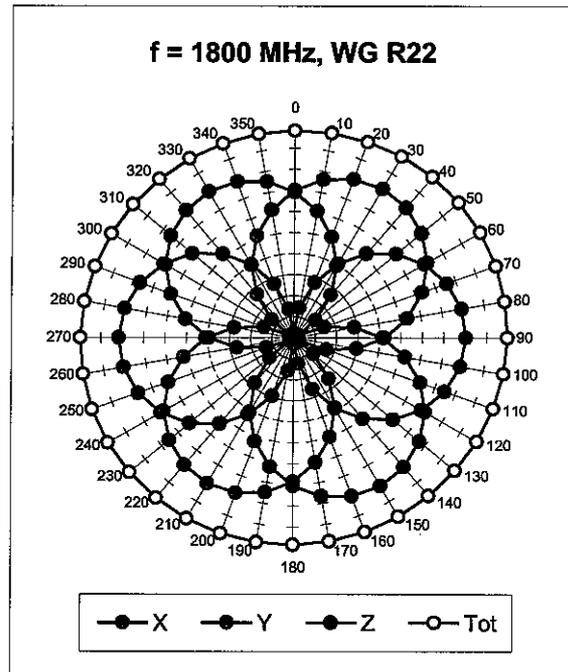
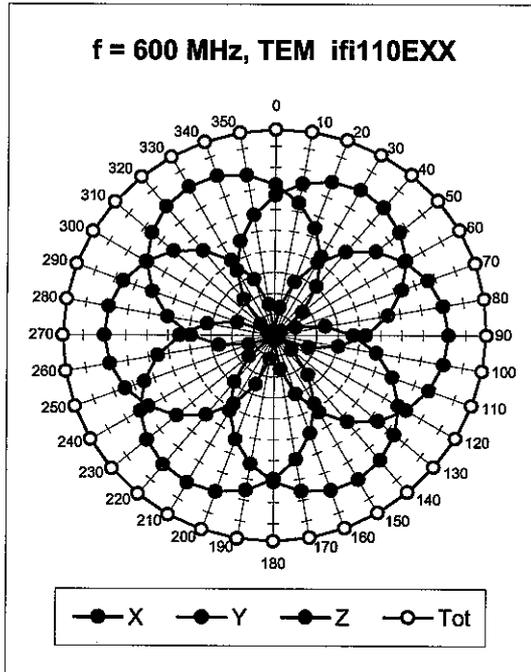
Frequency Response of E-Field

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



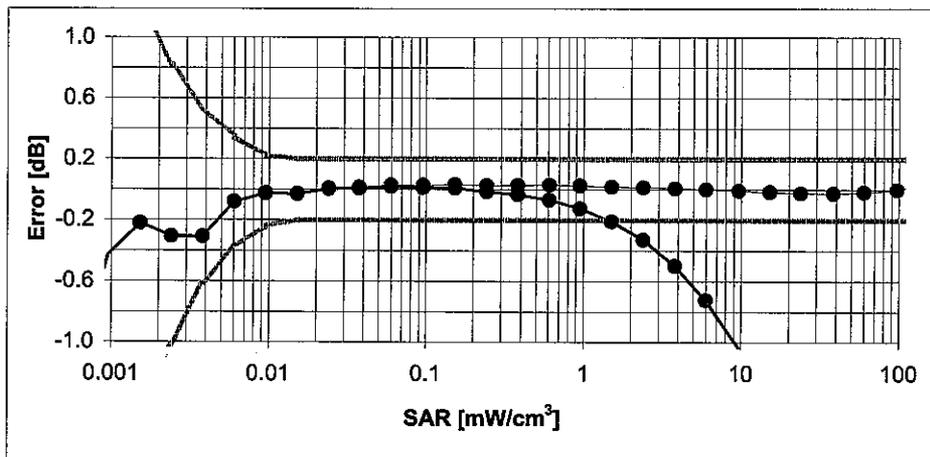
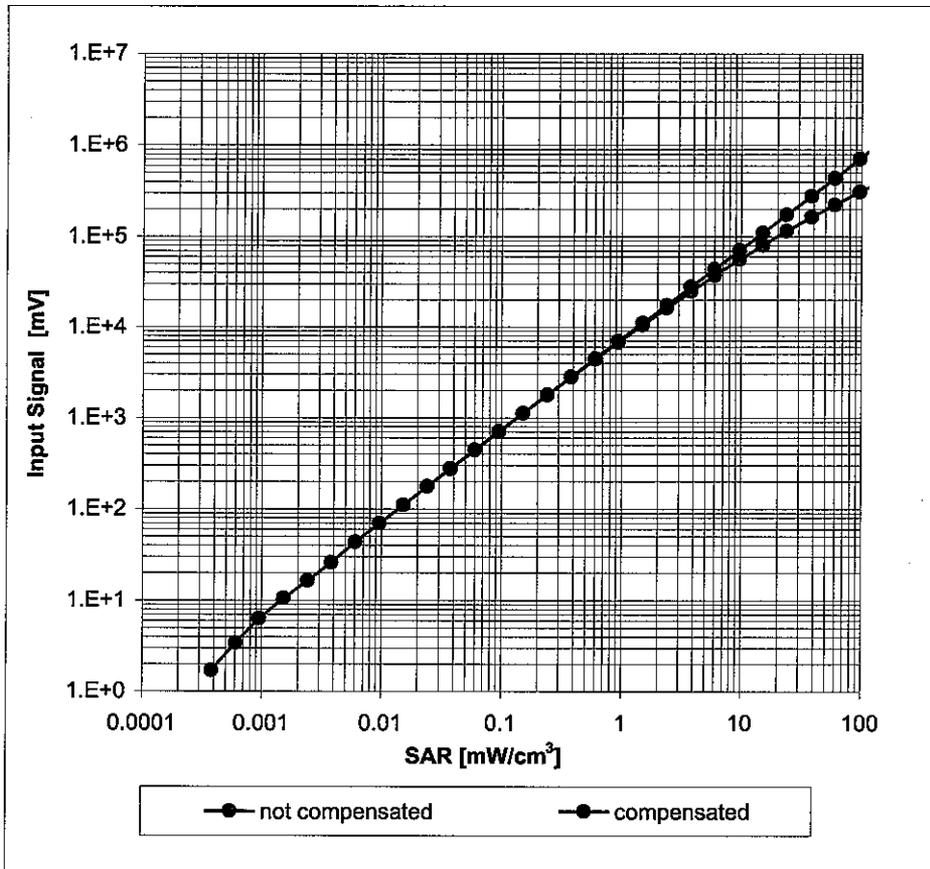
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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



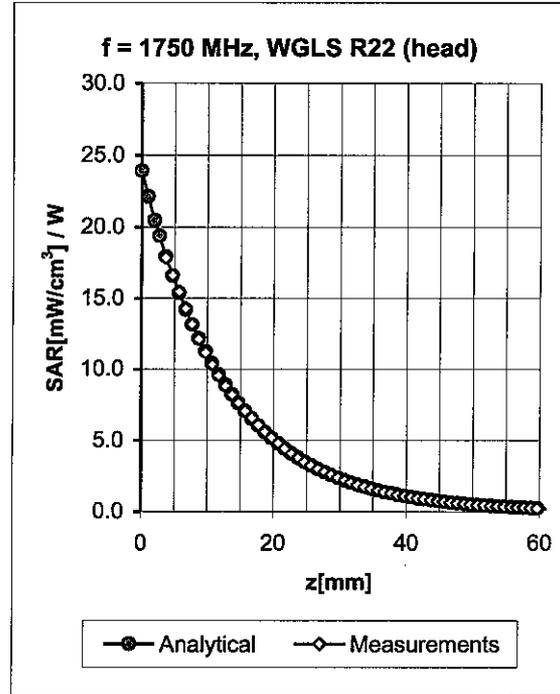
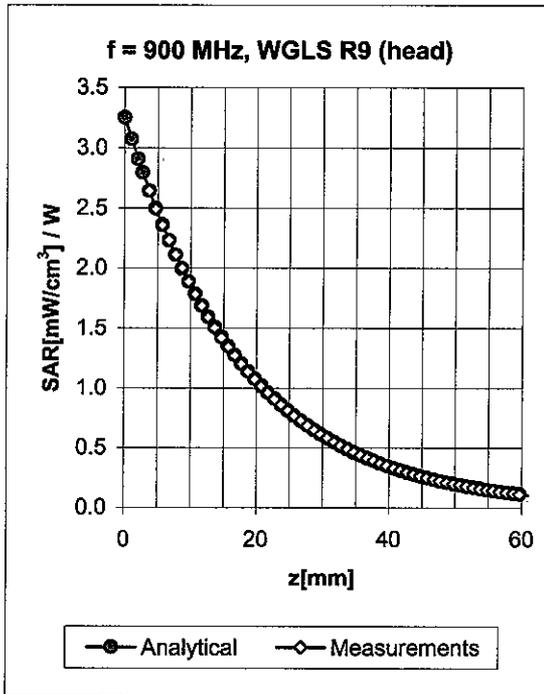
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (Waveguide R22, $f = 1800 \text{ MHz}$)



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

Conversion Factor Assessment

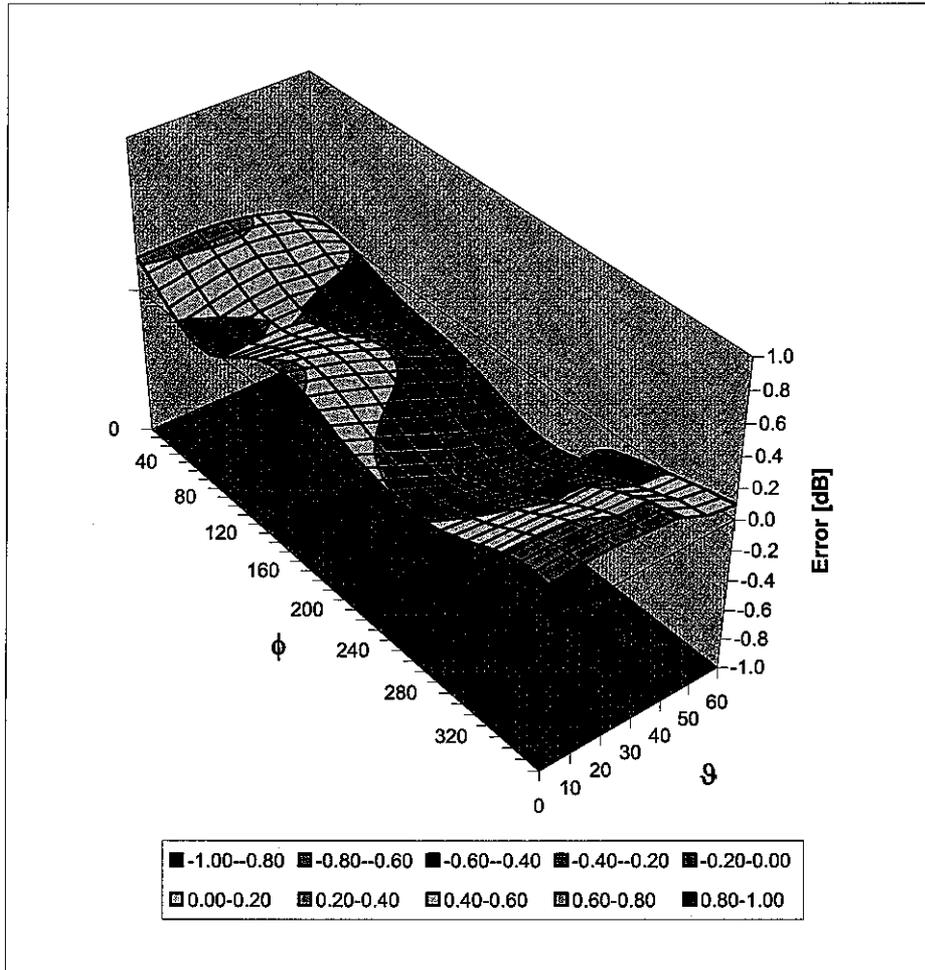


f [MHz]	Validity [MHz] ^c	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
835	± 50 / ± 100	Head	41.5 ± 5%	0.90 ± 5%	0.72	1.69	6.94 ± 11.0% (k=2)
900	± 50 / ± 100	Head	41.5 ± 5%	0.97 ± 5%	0.63	1.84	6.68 ± 11.0% (k=2)
1750	± 50 / ± 100	Head	40.1 ± 5%	1.37 ± 5%	0.55	2.40	5.51 ± 11.0% (k=2)
1900	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.53	2.51	5.26 ± 11.0% (k=2)
2450	± 50 / ± 100	Head	39.2 ± 5%	1.80 ± 5%	0.63	2.30	4.74 ± 11.8% (k=2)
835	± 50 / ± 100	Body	55.2 ± 5%	0.97 ± 5%	0.50	2.07	6.65 ± 11.0% (k=2)
900	± 50 / ± 100	Body	55.0 ± 5%	1.05 ± 5%	0.50	2.13	6.35 ± 11.0% (k=2)
1750	± 50 / ± 100	Body	53.4 ± 5%	1.49 ± 5%	0.52	2.81	4.83 ± 11.0% (k=2)
1900	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.52	2.96	4.71 ± 11.0% (k=2)
2450	± 50 / ± 100	Body	52.7 ± 5%	1.95 ± 5%	0.59	2.33	4.35 ± 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.

Deviation from Isotropy in HSL

Error (ϕ , θ), $f = 900$ MHz



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



D4 : DAE3 (Cal Date : August 17.2005)

**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 **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**

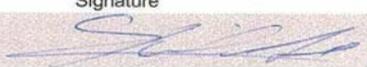
Condition of the calibrated item **In Tolerance**

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 ± 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	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

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

**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**

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	403.415 \pm 0.1% (k=2)	403.485 \pm 0.1% (k=2)	403.851 \pm 0.1% (k=2)
Low Range	3.95575 \pm 0.7% (k=2)	3.93409 \pm 0.7% (k=2)	3.95875 \pm 0.7% (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 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
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 (MOhm)	Measuring (MOhm)
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



APPENDIX D: SYSTEM CERTIFICATE & CALIBRATION

D1: SAM PHANTOM

Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

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

F. Bombault

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