Calibration Laboratory of
Schmid & Partner
 Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

ilac-MRA

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Auden**

Certificate No: **ER3-2302_May08**

CALIBRATION CERTIFICATE

Object	ER3DV6 - SN:2302
Calibration procedure(s)	QA CAL-02.v5 Calibration procedure for E-field probes optimized for close near field evaluations in air
Calibration date:	May 19, 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 (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	1-Apr-08 (No. 217-00788)	Apr-09
Power sensor E4412A	MY41495277	1-Apr-08 (No. 217-00788)	Apr-09
Power sensor E4412A	MY41498087	1-Apr-08 (No. 217-00788)	Apr-09
Reference 3 dB Attenuator	SN: S5054 (3c)	8-Aug-07 (No. 217-00719)	Aug-08
Reference 20 dB Attenuator	SN: S5086 (20b)	31-Mar-08 (No. 217-00787)	Apr-09
Reference 30 dB Attenuator	SN: S5129 (30b)	8-Aug-07 (No. 217-00720)	Aug-08
Reference Probe ER3DV6	SN: 2328	2-Oct-07 (No. ER3-2328_Oct07)	Oct-08
DAE4	SN: 654	24-Apr-08 (No. DAE4-654_Apr08)	Apr-09

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

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Technical Manager	
Approved by:	Niels Kuster	Quality Manager	

Issued: May 20, 2008

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Accreditation No.: **SCS 108**

Glossary:

NORMx,y,z	sensitivity in free space
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
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1309-2005, " IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005.

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z*: Assessed for E-field polarization $\vartheta = 0$ for XY sensors and $\vartheta = 90$ for Z sensor (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide).

- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart).

- *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.

- *Spherical isotropy (3D deviation from isotropy)*: in a locally homogeneous field realized using an open waveguide setup.

- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

- *Connector Angle*: The angle is assessed using the information gained by determining the NORMx (no uncertainty required).

Probe ER3DV6

SN:2302

Manufactured:	November 6, 2002
Last calibrated:	March 21, 2007
Recalibrated:	May 19, 2008

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ER3DV6 SN:2302

Sensitivity in Free Space [μV/(V/m)^2]

NormX	**1.45** ± 10.1 % (k=2)
NormY	**1.32** ± 10.1 % (k=2)
NormZ	**1.45** ± 10.1 % (k=2)

Diode Compression^A

DCP X	**95** mV
DCP Y	**95** mV
DCP Z	**98** mV

Frequency Correction

X	**0.0**
Y	**0.0**
Z	**0.0**

Sensor Offset   (Probe Tip to Sensor Center)

X	**2.5** mm
Y	**2.5** mm
Z	**2.5** mm

Connector Angle   **0** °

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%.

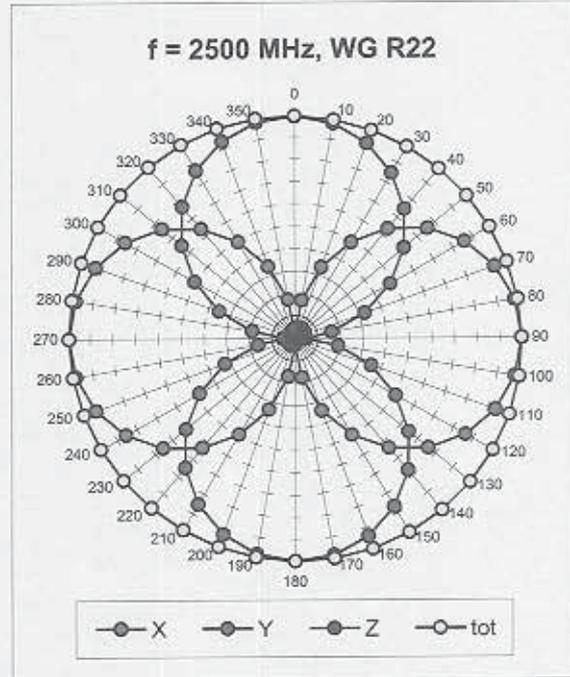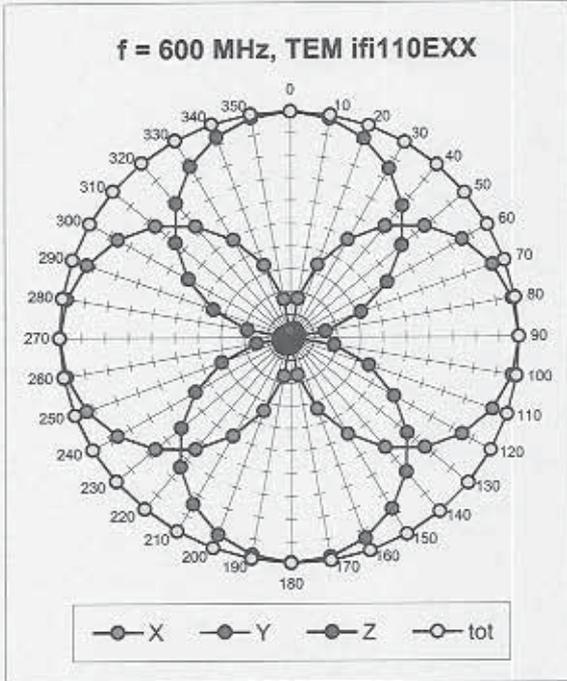^{A} numerical linearization parameter: uncertainty not required

Frequency Response of E-Field
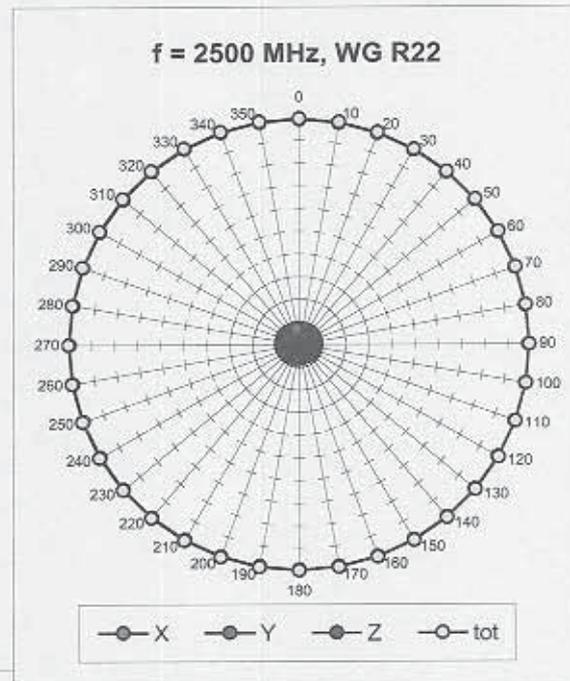
(TEM-Cell:ifi110 EXX, Waveguide R22)
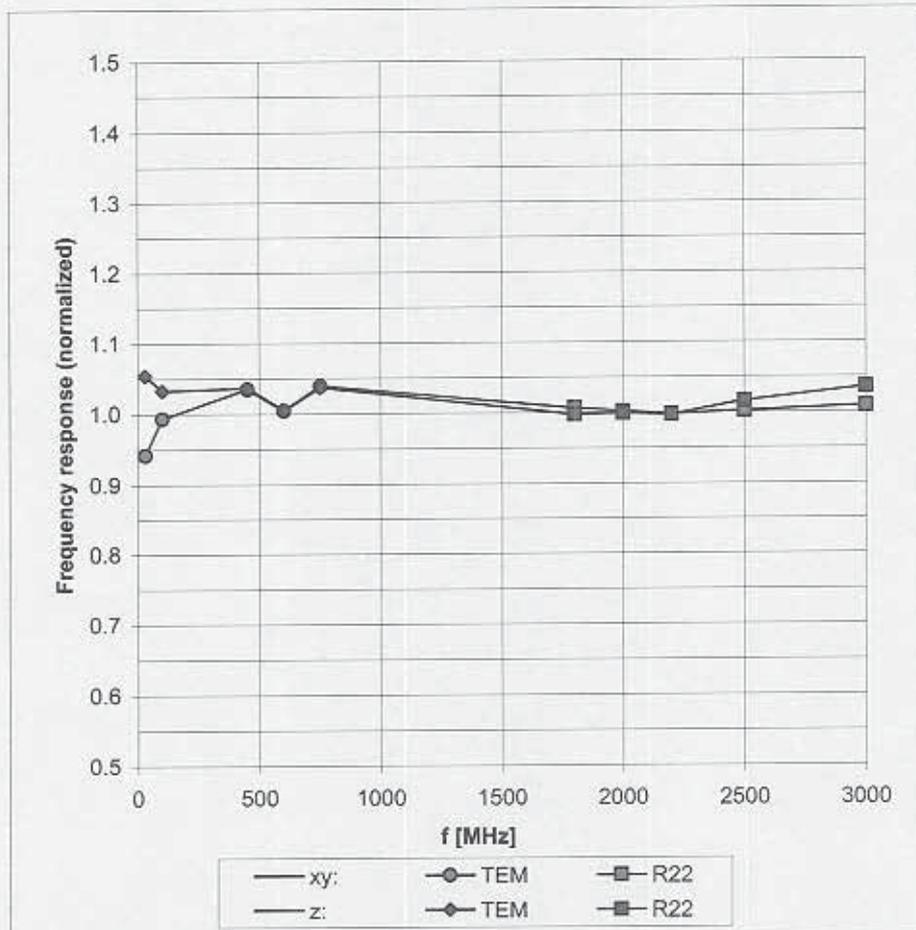
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

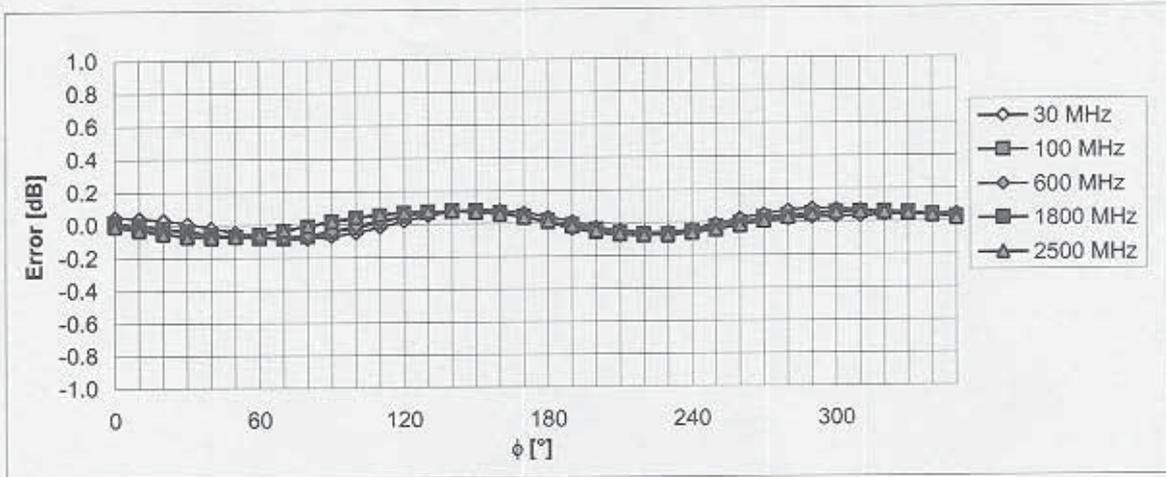# Receiving Pattern (φ), ϑ = 0°

f = 600 MHz, TEM ifi110EXX

f = 2500 MHz, WG R22

Receiving Pattern (φ), ϑ = 90°

f = 600 MHz, TEM ifi110EXX

f = 2500 MHz, WG R22
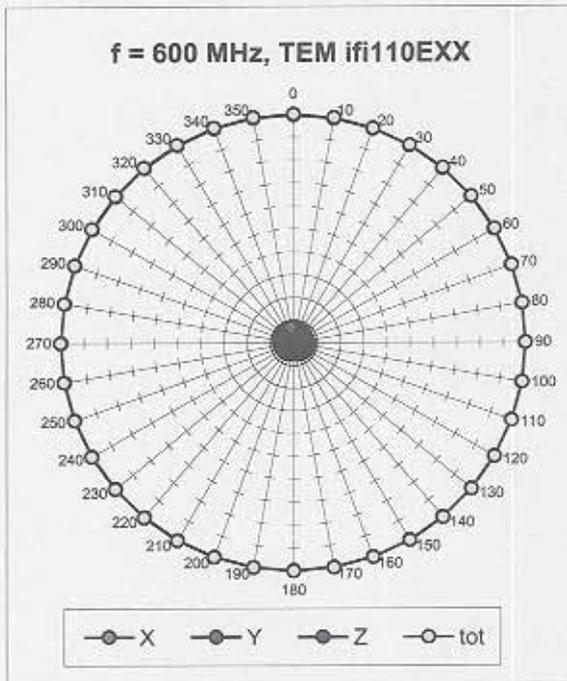
Receiving Pattern (φ), ϑ = 0°

Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Receiving Pattern (φ), ϑ = 90°
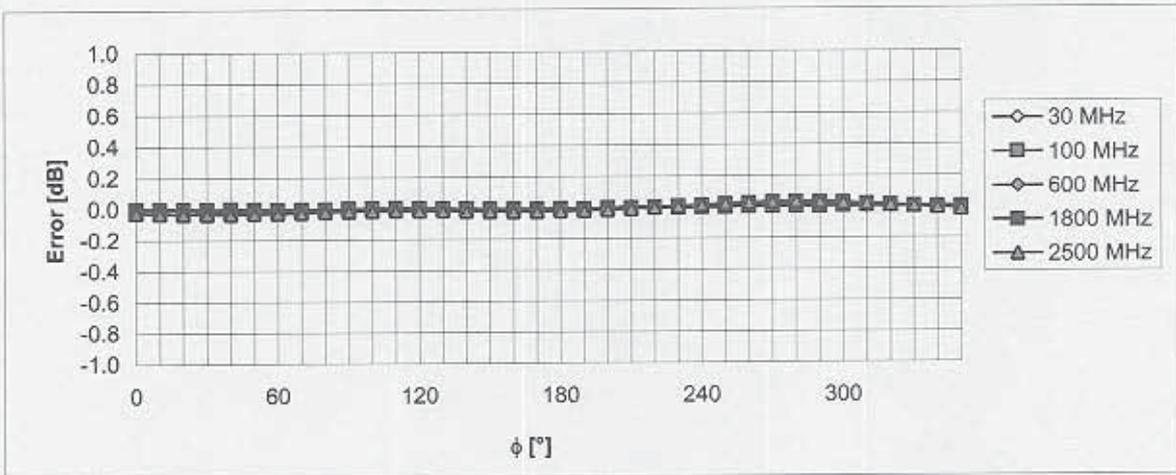
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(E-field)
(Waveguide R22, f = 1800 MHz)
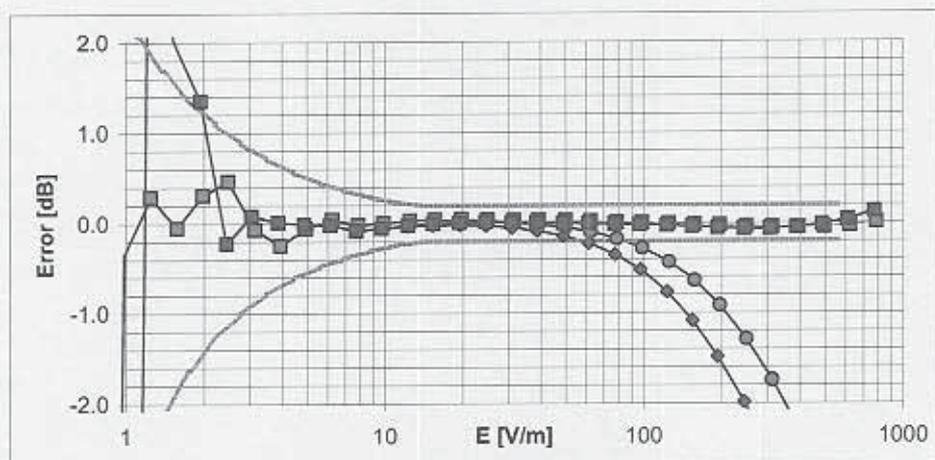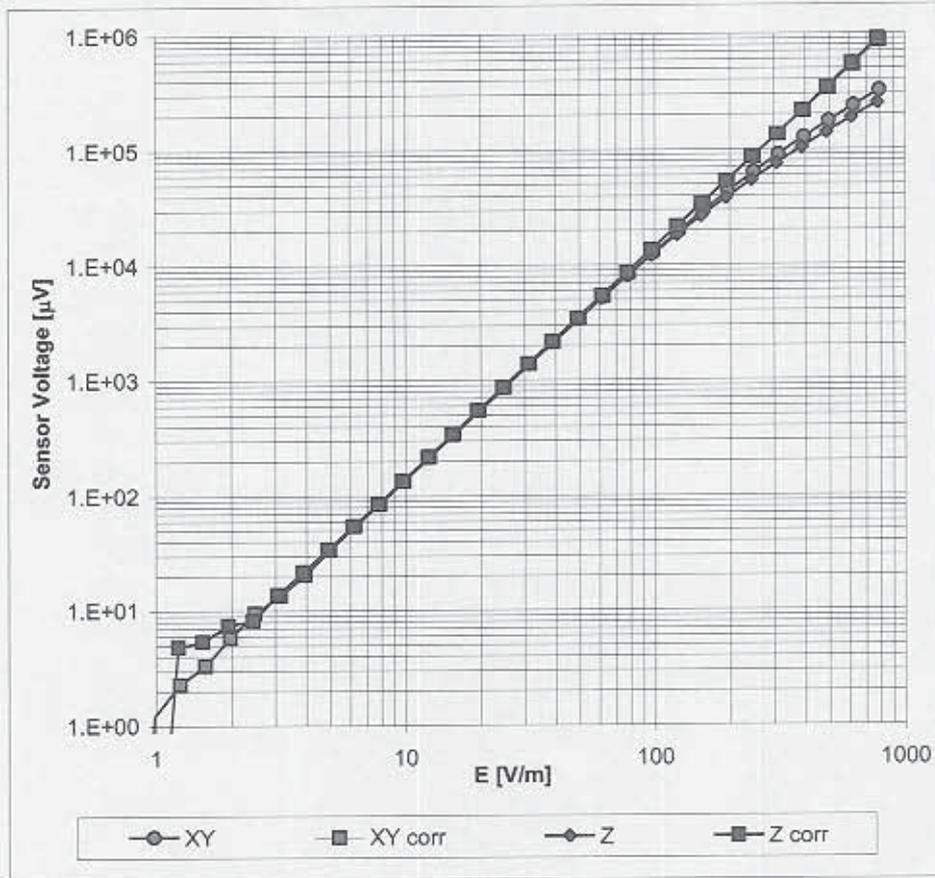
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Deviation from Isotropy in Air
Error (ϕ, ϑ), f = 900 MHz

| ■-1.00--0.80 | ■-0.80--0.60 | ■-0.60--0.40 | ■-0.40--0.20 | ■-0.20-0.00 |
| □0.00-0.20 | □0.20-0.40 | □0.40-0.60 | ■0.60-0.80 | ■0.80-1.00 |

Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

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Accreditation No.: **SCS 108**
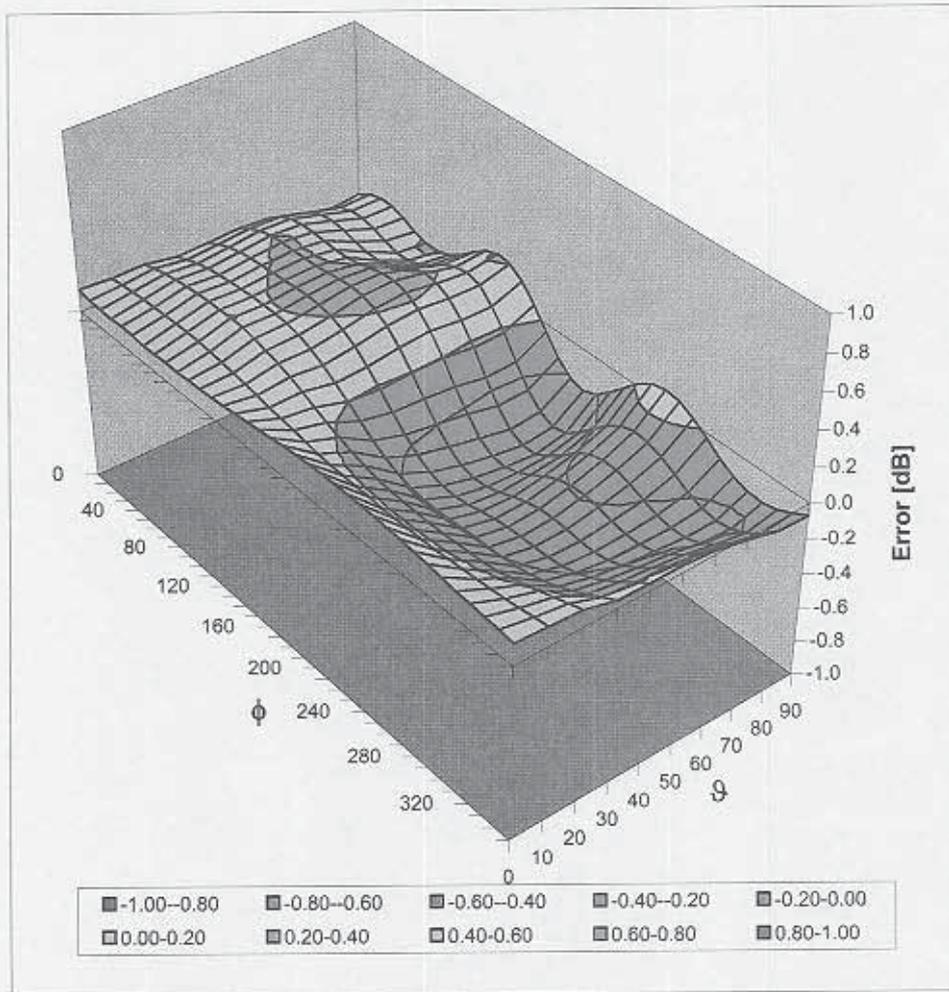
Client **Auden**

Certificate No: **H3-6187_May08**

CALIBRATION CERTIFICATE

Object	H3DV6 - SN:6187
Calibration procedure(s)	QA CAL-03.v5 Calibration procedure for H-field probes optimized for close near field evaluations in air
Calibration date:	May 19, 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 (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	1-Apr-08 (No. 217-00788)	Apr-09
Power sensor E4412A	MY41495277	1-Apr-08 (No. 217-00788)	Apr-09
Power sensor E4412A	MY41498087	1-Apr-08 (No. 217-00788)	Apr-09
Reference 3 dB Attenuator	SN: S5054 (3c)	8-Aug-07 (No. 217-00719)	Aug-08
Reference 20 dB Attenuator	SN: S5086 (20b)	31-Mar-08 (No. 217-00787)	Apr-09
Reference 30 dB Attenuator	SN: S5129 (30b)	8-Aug-07 (No. 217-00720)	Aug-08
Reference Probe H3DV6	SN: 6182	2-Oct-07 (No. H3-6182_Oct07)	Oct-08
DAE4	SN: 654	24-Apr-08 (No. DAE4-654_Apr08)	Apr-09

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

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Technical Manager	
Approved by:	Niels Kuster	Quality Manager	

Issued: May 20, 2008

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Glossary:

NORMx,y,z	sensitivity in free space
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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
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1309-2005, " IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005.

Methods Applied and Interpretation of Parameters:

- *X,Y,Z_a0a1a2:* Assessed for E-field polarization $\vartheta = 90$ for XY sensors and $\vartheta = 0$ for Z sensor (f $\leq$ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide).

- *X,Y,Z(f)_a0a1a2= X,Y,Z_a0a1a2* frequency_response* (see Frequency Response Chart).

- *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.

- *Spherical isotropy (3D deviation from isotropy):* in a locally homogeneous field realized using an open waveguide setup.

- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

- *Connector Angle:* The angle is assessed using the information gained by determining the *X_a0a1a2* (no uncertainty required).

Probe H3DV6

SN:6187

Manufactured: June 8, 2004
Last calibrated: March 21, 2007
Recalibrated: May 19, 2008

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: H3DV6 SN:6187

Sensitivity in Free Space [A/m / $\sqrt{(\mu V)}$]

	a0	a1	a2
X	3.157E-3	2.508E-5	3.858E-6 ± 5.1 % (k=2)
Y	2.435E-3	9.642E-5	3.239E-6 ± 5.1 % (k=2)
Z	2.952E-3	2.920E-5	4.880E-5 ± 5.1 % (k=2)

Diode Compression[1]

DCP X	91 mV
DCP Y	91 mV
DCP Z	85 mV

Sensor Offset   (Probe Tip to Sensor Center)

X	3.0 mm
Y	3.0 mm
Z	3.0 mm

| Connector Angle	66 °

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%.

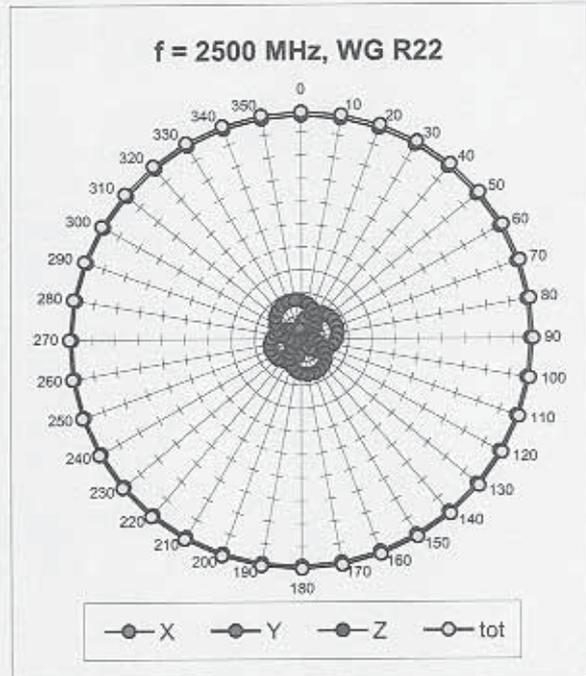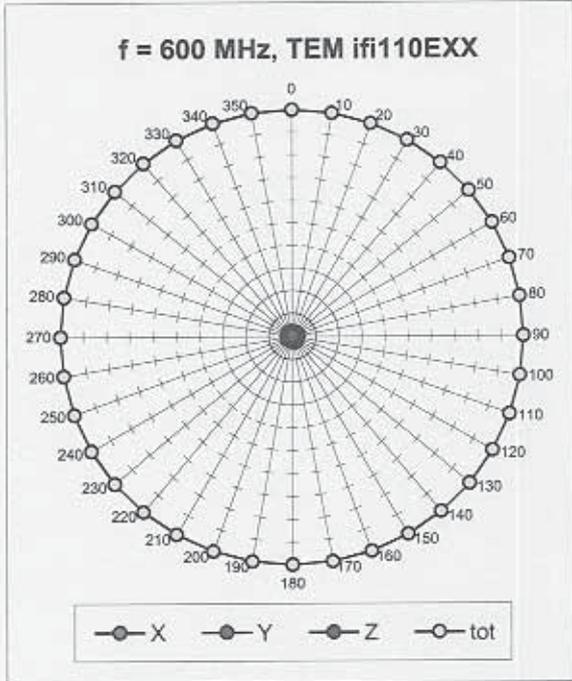[1] numerical linearization parameter: uncertainty not required

Frequency Response of H-Field

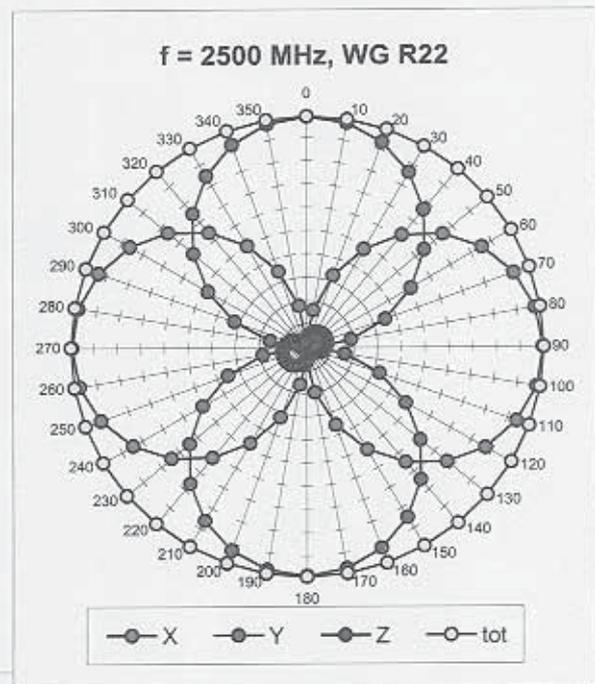## (TEM-Cell:ifi110 EXX, Waveguide R22)
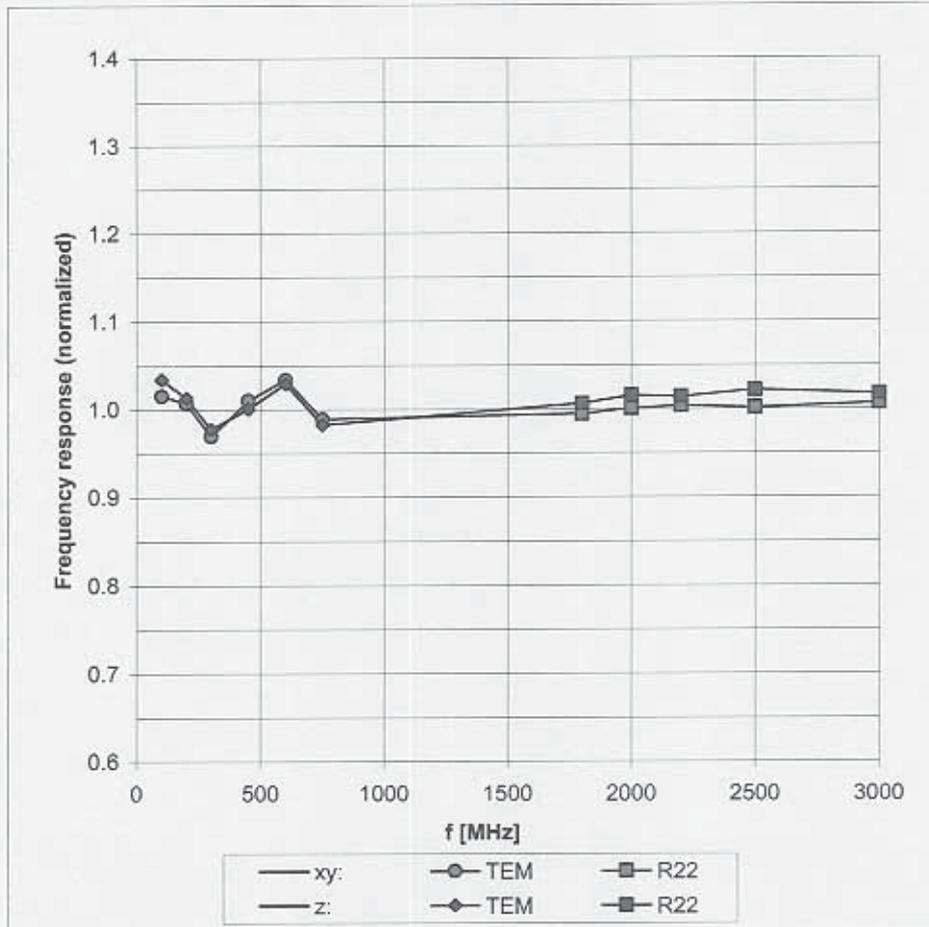
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (ϕ), $\vartheta = 0°$

f = 600 MHz, TEM ifi110EXX

f = 2500 MHz, WG R22

Receiving Pattern (ϕ), $\vartheta = 90°$

f = 600 MHz, TEM ifi110EXX

f = 2500 MHz, WG R22
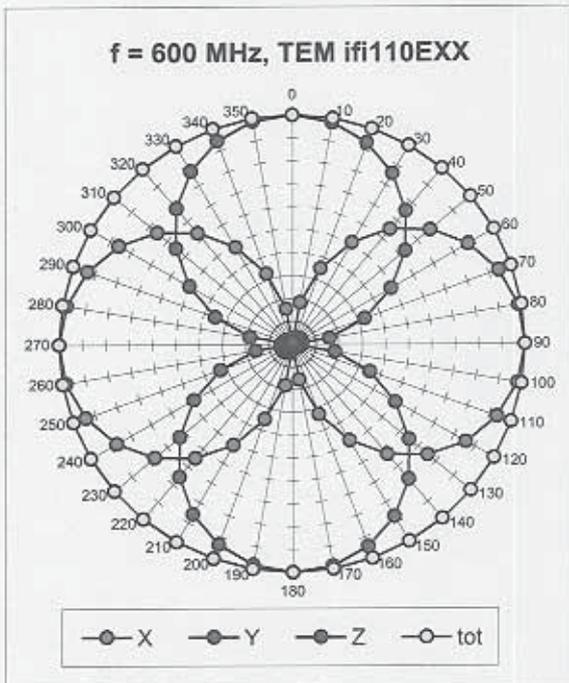
Receiving Pattern (φ), θ = 0°
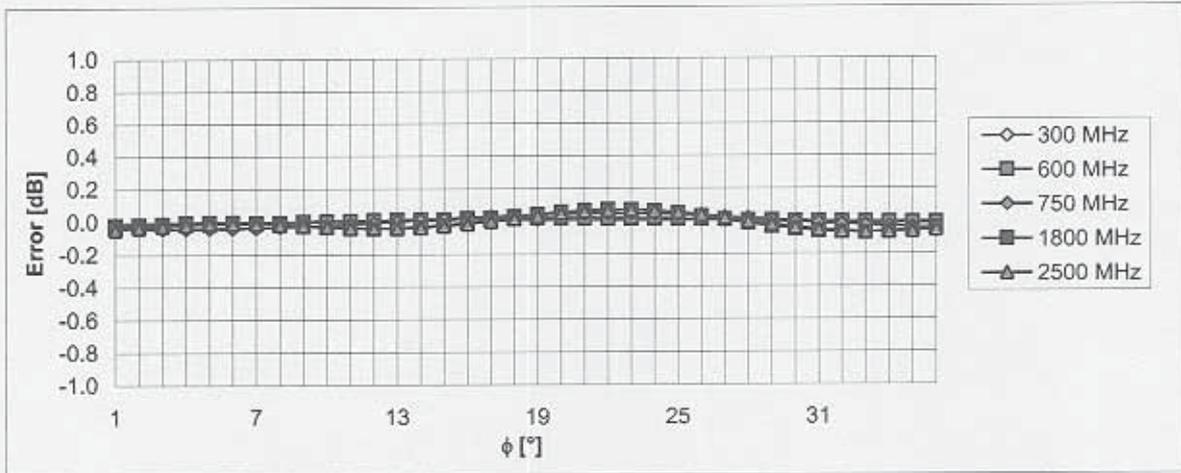
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Receiving Pattern (φ), θ = 90°
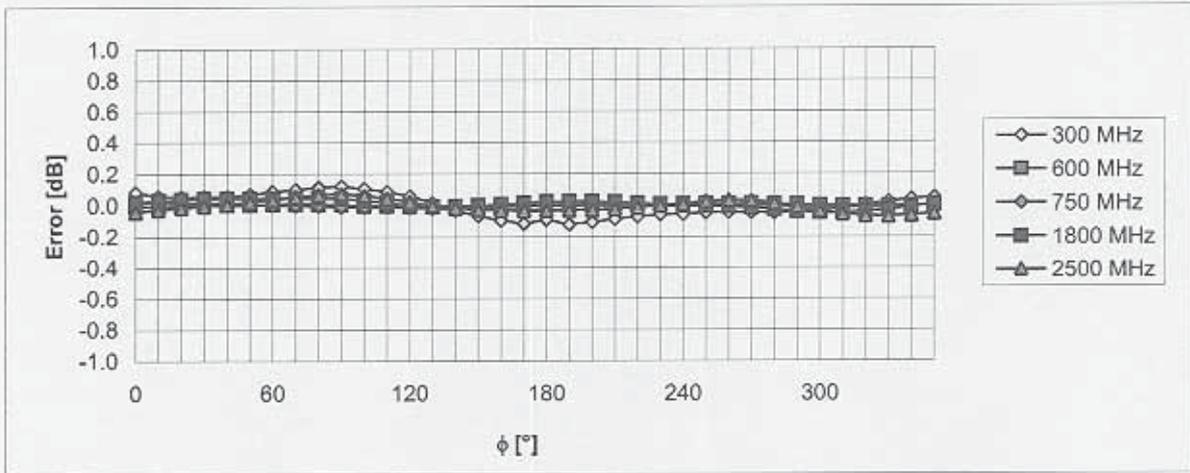
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(H-field)
(Waveguide R22, f = 1800 MHz)
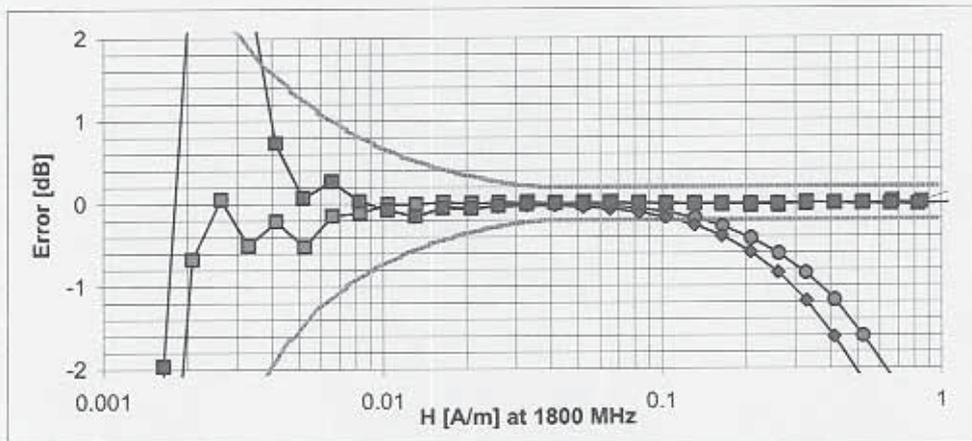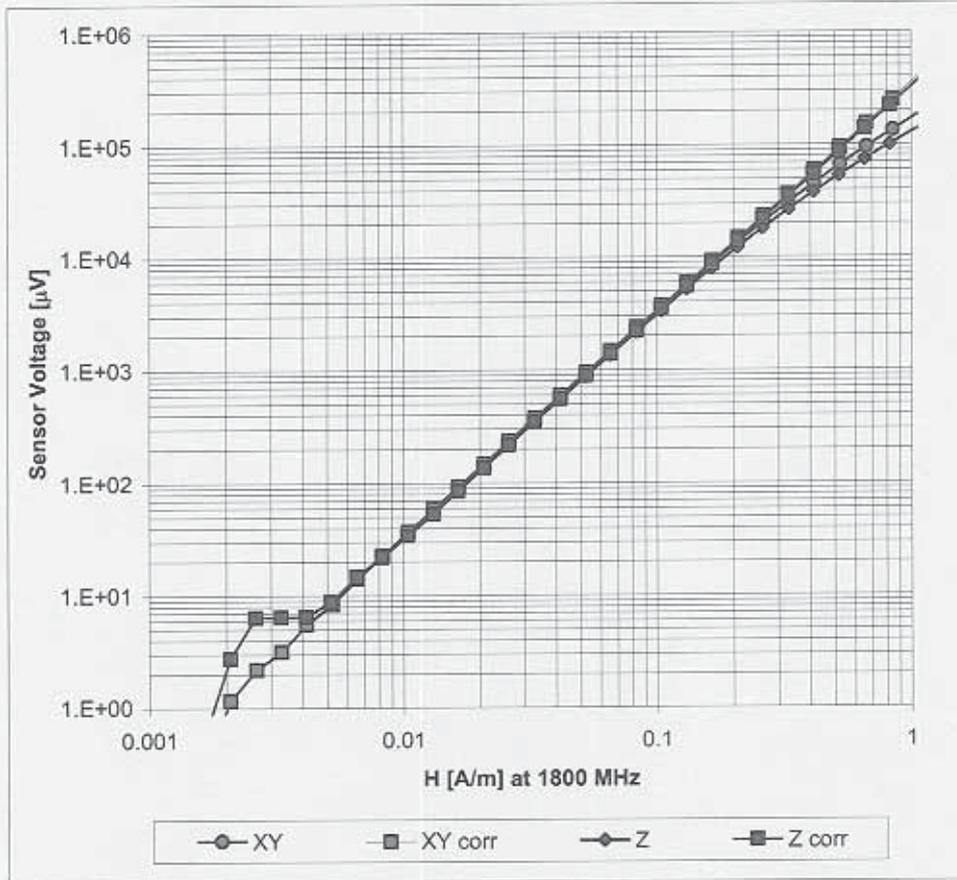
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

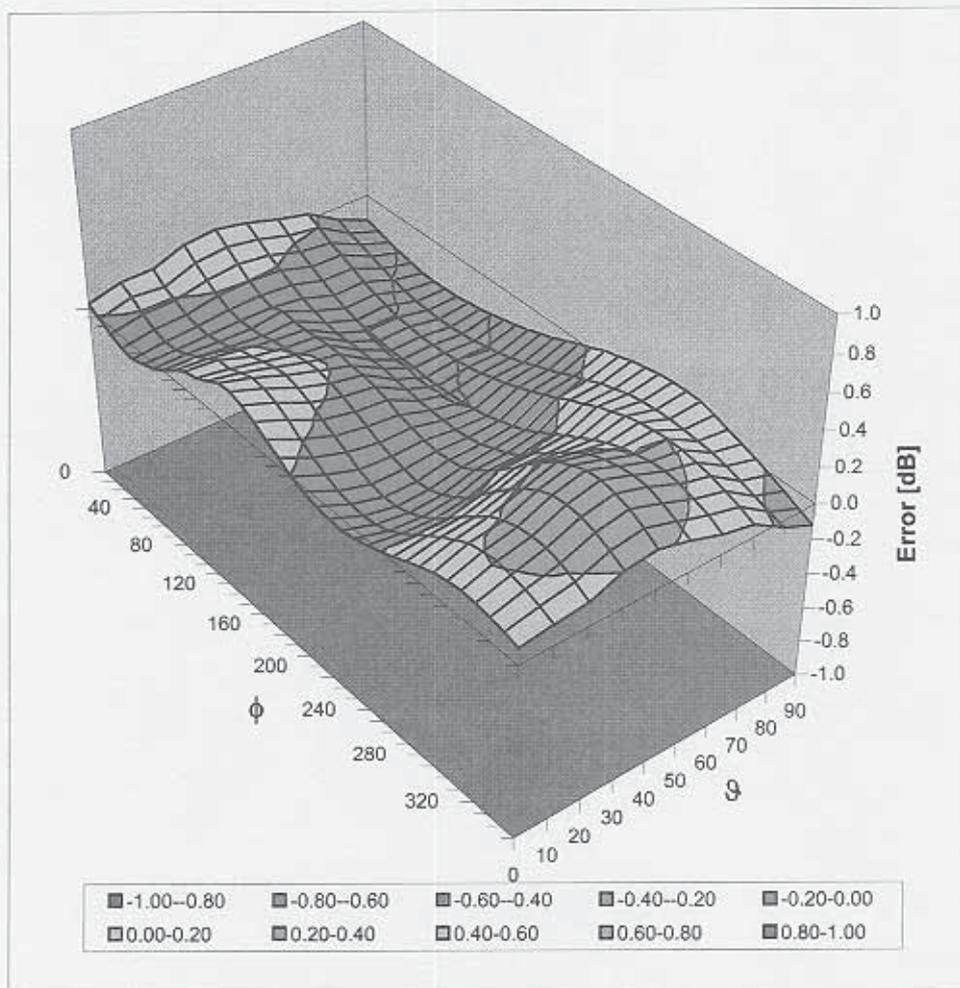# Deviation from Isotropy in Air
Error (ϕ, ϑ) ,   f = 900 MHz

Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

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S	Swiss Calibration Service

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 ± 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

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	R&D Director	i.V.

Issued: November 30, 2007

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S   Swiss Calibration Service

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 =	6.1µV ,	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 ± 0.1% (k=2)	403.591 ± 0.1% (k=2)	403.822 ± 0.1% (k=2)
Low Range	3.97765 ± 0.7% (k=2)	3.96449 ± 0.7% (k=2)	3.98429 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	83 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Input (µV)	Reading (µV)	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 (µV)	Reading (µV)	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 (µV)	Low Range Average Reading (µV)
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 (µV)	Channel Y (µV)	Channel Z (µV)
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 10MΩ

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
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