



Appendix C. DASY Calibration Certificate

The DASY calibration certificates are shown as follows.



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



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Accreditation No.: SCS 108

Client Sporton (Auden)

Certificate No: CD835V3-1045_Sep09

CALIBRATION CERTIFICATE

Object CD835V3 - SN: 1045
Calibration procedure(s) QA CAL-20.v4 Calibration procedure for dipoles in air
Calibration date: September 17, 2009
Condition of the calibrated item In Tolerance

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). 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)

Table with 4 columns: Primary Standards, ID #, Cal Date (Certificate No.), Scheduled Calibration. Includes items like Power meter EPM-442A, Power sensor HP 8481A, Probe ER3DV6, etc.

Calibrated by: Claudio Leubler, Laboratory Technician
Approved by: Katja Pokovic, Technical Manager

Issued: September 17, 2009

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Calibration Laboratory of
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Accreditation No.: **SCS 108**

References

- [1] ANSI-C63.19-2006
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
- [2] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1, 2], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the top edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY4 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1, 2], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (in z) above the top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, 10mm above the dipole surface.
- **H-field distribution:** H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.



1 Measurement Conditions

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

| | | |
|------------------------------------|------------------------|----------------------|
| DASY Version | DASY5 | V5.0 B127 |
| DASY PP Version | SEMCAD X | V13.4 B125 |
| Phantom | HAC Test Arch | SD HAC P01 BA, #1070 |
| Distance Dipole Top - Probe Center | 10 mm | |
| Scan resolution | dx, dy = 5 mm | area = 20 x 180 mm |
| Frequency | 835 MHz ± 1 MHz | |
| Forward power at dipole connector | 20.0 dBm = 100mW | |
| Input power drift | < 0.05 dB | |

2 Maximum Field values

| H-field 10 mm above dipole surface | condition | interpolated maximum |
|------------------------------------|----------------------|----------------------|
| Maximum measured | 100 mW forward power | 0.457 A/m |

Uncertainty for H-field measurement: 8.2% (k=2)

| E-field 10 mm above dipole surface | condition | Interpolated maximum |
|------------------------------------|----------------------|----------------------|
| Maximum measured above high end- | 100 mW forward power | 170.6 V/m |
| Maximum measured above low end | 100 mW forward power | 169.8 V/m |
| Averaged maximum above arm | 100 mW forward power | 170.2 V/m |

Uncertainty for E-field measurement: 12.8% (k=2)

3 Appendix

3.1 Antenna Parameters

| Frequency | Return Loss | Impedance |
|----------------|----------------|----------------------------|
| 800 MHz | 15.7 dB | (44.9 – j14.9) Ohm |
| 835 MHz | 40.5 dB | (49.2 - j0.5) Ohm |
| 900 MHz | 17.4 dB | (53.0 – j13.7) Ohm |
| 950 MHz | 20.2 dB | (47.5 + j9.2) Ohm |
| 960 MHz | 14.8 dB | (53.9 + j18.8) Ohm |

3.2 Antenna Design and Handling

The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

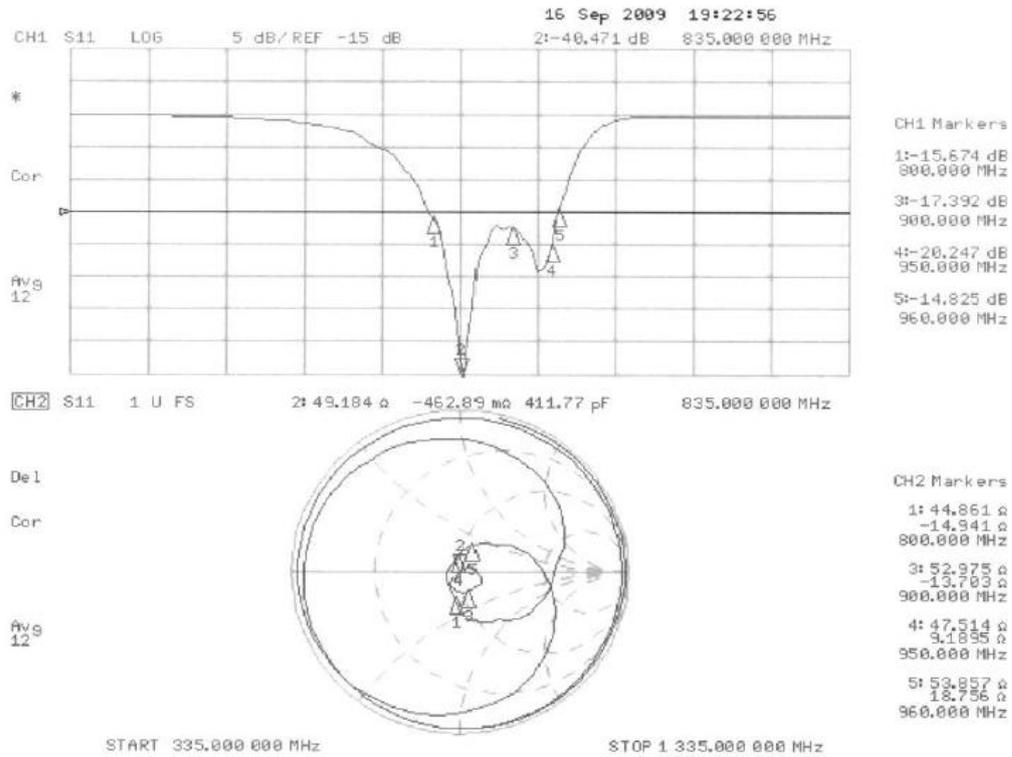
Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.



3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart



3.3.2 DASYS4 H-field Result

Date/Time: 16.09.2009 10:26:07

Test Laboratory: SPEAG Lab2

H_CD835_1045_090916.da5

DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1045

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: RF Section

Measurement Standard: DASYS5 (IEEE/IEC)

DASYS5 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 22.12.2008
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.02.2009
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASYS5, V5.0 Build 127; SEMCAD X Version 13.4 Build 125

H Scan - measurement distance from the probe sensor center to CD835 Dipole = 10mm/Hearing Aid Compatibility Test (41x361x1):

Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.457 A/m

Probe Modulation Factor = 1

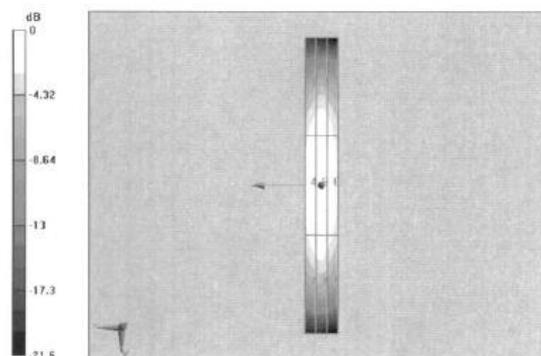
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 0.487 A/m; Power Drift = 0.00195 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

| | | |
|-------------------------------------|-------------------------------------|-------------------------------------|
| Grid 1 0.384 M4 | Grid 2 0.410 M4 | Grid 3 0.385 M4 |
| Grid 4 0.431 M4 | Grid 5 0.457 M4 | Grid 6 0.429 M4 |
| Grid 7 0.383 M4 | Grid 8 0.401 M4 | Grid 9 0.369 M4 |



0 dB = 0.457A/m

3.3.3 DASYS4 E-field Result

Date/Time: 17.09.2009 09:59:19

Test Laboratory: SPEAG Lab2

E_CD835_1045_090917.da5

DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1045

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: RF Section

Measurement Standard: DASYS5 (IEEE/IEC)

DASYS5 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 22.12.2008
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.02.2009
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASYS5, V5.0 Build 127; SEMCAD X Version 13.4 Build 125

E Scan - measurement distance from the probe sensor center to CD835 Dipole = 10mm/Hearing Aid Compatibility Test (41x361x1):

Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 170.6 V/m

Probe Modulation Factor = 1

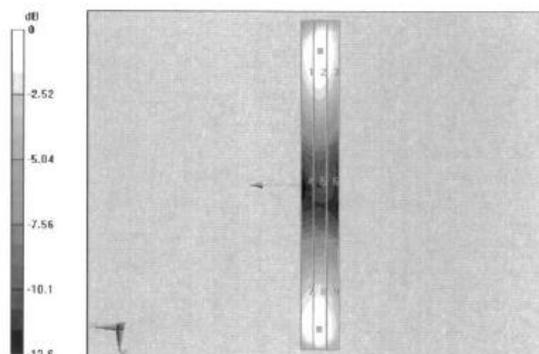
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 109.7 V/m; Power Drift = -0.035 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

| | | |
|-------------------------------------|-------------------------------------|-------------------------------------|
| Grid 1 164.9 M4 | Grid 2 170.6 M4 | Grid 3 164.4 M4 |
| Grid 4 87.7 M4 | Grid 5 89.9 M4 | Grid 6 86.1 M4 |
| Grid 7 165.1 M4 | Grid 8 169.8 M4 | Grid 9 159.4 M4 |



0 dB = 170.6V/m



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Multilateral Agreement for the recognition of calibration certificates
Client **Sporton-TW (Auden)**

Accreditation No.: **SCS 108**

Certificate No: **AM1DV2- 1038_Jan11**

CALIBRATION CERTIFICATE

Object **AM1DV2 - SN: 1038**

Calibration procedure(s) **QA CAL-24.v2
Calibration procedure for AM1D magnetic field probes and TMFS in the
audio range**

Calibration date: **January 18, 2011**

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 |
|-------------------------------|-------------|-----------------------------------|-----------------------|
| Keithley Multimeter Type 2001 | SN: 0810278 | 28-Sep-10 (No:10376) | Sep-11 |
| Reference Probe AM1DV2 | SN: 1008 | 18-Jan-11 (No. AM1D-1008_Jan11) | Jan-12 |
| DAE4 | SN: 781 | 20-Oct-10 (No. DAE4-781_Oct10) | Oct-11 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| AMCC | 1050 | 15-Oct-09 (in house check Oct-09) | Oct-11 |

| | | | |
|----------------|-------------|-----------------------|------------------|
| | Name | Function | Signature |
| Calibrated by: | Mike Meili | Laboratory Technician | |

| | | |
|--------------|--------------|-----------------|
| | Name | Function |
| Approved by: | Fin Bornholt | R&D Director |

Issued: January 19, 2011

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References

- [1] ANSI C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
- [2] DASY4 manual, Chapter: Hearing Aid Compatibility (HAC) T-Coil Extension

Description of the AM1D probe

The AM1D Audio Magnetic Field Probe is a fully shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The pickup coil is compliant with the dimensional requirements of [1]. The probe includes a symmetric low noise amplifier for the signal available at the shielded 3 pin connector at the side. Power is supplied via the same connector (phantom power supply) and monitored via the LED near the connector. The 7 pin connector at the end of the probe does not carry any signals, but determines the angle of the sensor when mounted on the DAE. The probe supports mechanical detection of the surface.

The single sensor in the probe is arranged in a tilt angle allowing measurement of 3 orthogonal field components when rotating the probe by 120° around its axis. It is aligned with the perpendicular component of the field, if the probe axis is tilted nominally 35.3° above the measurement plane, using the connector rotation and sensor angle stated below.

The probe is fully RF shielded when operated with the matching signal cable (shielded) and allows measurement of audio magnetic fields in the close vicinity of RF emitting wireless devices according to [1] without additional shielding.

Handling of the item

The probe is manufactured from stainless steel. In order to maintain the performance and calibration of the probe, it must not be opened. The probe is designed for operation in air and shall not be exposed to humidity or liquids. For proper operation of the surface detection and emergency stop functions in a DASY system, the probe must be operated with the special probe cup provided (larger diameter).

Methods Applied and Interpretation of Parameters

- *Coordinate System:* The AM1D probe is mounted in the DASY system for operation with a HAC Test Arch phantom with AMCC Helmholtz calibration coil according to [2], with the tip pointing to “southwest” orientation.
- *Functional Test:* The functional test preceding calibration includes test of Noise level
RF immunity (1kHz AM modulated signal). The shield of the probe cable must be well connected. Frequency response verification from 100 Hz to 10 kHz.
- *Connector Rotation:* The connector at the end of the probe does not carry any signals and is used for fixation to the DAE only. The probe is operated in the center of the AMCC Helmholtz coil using a 1 kHz magnetic field signal. Its angle is determined from the two minima at nominally +120° and –120° rotation, so the sensor in the tip of the probe is aligned to the vertical plane in z-direction, corresponding to the field maximum in the AMCC Helmholtz calibration coil.
- *Sensor Angle:* The sensor tilting in the vertical plane from the ideal vertical direction is determined from the two minima at nominally +120° and –120°. DASY system uses this angle to align the sensor for radial measurements to the x and y axis in the horizontal plane.
- *Sensitivity:* With the probe sensor aligned to the z-field in the AMCC, the output of the probe is compared to the magnetic field in the AMCC at 1 kHz. The field in the AMCC Helmholtz coil is given by the geometry and the current through the coil, which is monitored on the precision shunt resistor of the coil.

AM1D probe identification and configuration data

| | |
|-----------|---|
| Item | AM1DV2 Audio Magnetic 1D Field Probe |
| Type No | SP AM1 001 AF |
| Serial No | 1038 |

| | |
|--------------------|------------------------------------|
| Overall length | 296 mm |
| Tip diameter | 6.0 mm (at the tip) |
| Sensor offset | 3.0 mm (centre of sensor from tip) |
| Internal Amplifier | 40 dB |

| | |
|-----------------------|--|
| Manufacturer / Origin | Schmid & Partner Engineering AG, Zurich, Switzerland |
| Manufacturing date | Sep-2006 |
| Last calibration date | January 21, 2010 |

Calibration data

| | | | |
|--------------------------|------------------|-------------------------|-----------------|
| Connector rotation angle | (in DASY system) | 39.1 ° | +/- 3.6 ° (k=2) |
| Sensor angle | (in DASY system) | 2.83 ° | +/- 0.5 ° (k=2) |
| Sensitivity at 1 kHz | (in DASY system) | 0.0664 V / (A/m) | +/- 2.2 % (k=2) |

IMPORTANT NOTICE

USAGE OF THE DAE 4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is closed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.

Important Note:

Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:

Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.

Important Note:

To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.



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Accreditation No.: **SCS 108**

Client: **Fujitsu Research Institute (Aachen)**

Certificate No: **DAE4-1249_Feb11**

CALIBRATION CERTIFICATE

Object: **DAE4 - SD 000 D04 BJ - SN: 1249**

Calibration procedure(s): **QA CAL-06.v22
Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **February 21, 2011**

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 |
|-------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278 | 28-Sep-10 (No:10376) | Sep-11 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Calibrator Box V1.1 | SE UMS 006 AB 1004 | 07-Jun-10 (in house check) | In house check: Jun-11 |

Calibrated by: **Dominique Steffen** (Name), **Technician** (Function),  (Signature)

Approved by: **Fin Bomhoff** (Name), **R&D Director** (Function),  (Signature)

Issued: February 23, 2011

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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:* Typical value for information: 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 | 403.884 \pm 0.1% (k=2) | 403.606 \pm 0.1% (k=2) | 404.329 \pm 0.1% (k=2) |
| Low Range | 3.95010 \pm 0.7% (k=2) | 3.97181 \pm 0.7% (k=2) | 3.99227 \pm 0.7% (k=2) |

Connector Angle

| | |
|---|-------------------------------------|
| Connector Angle to be used in DASY system | 264.5 $^{\circ}$ \pm 1 $^{\circ}$ |
|---|-------------------------------------|

Appendix

1. DC Voltage Linearity

| High Range | | Reading (μV) | Difference (μV) | Error (%) |
|------------|---------|---------------------------|------------------------------|-----------|
| Channel X | + Input | 200003.1 | -0.44 | -0.00 |
| Channel X | + Input | 19999.46 | -0.74 | -0.00 |
| Channel X | - Input | -19998.91 | 1.59 | -0.01 |
| Channel Y | + Input | 200003.6 | 1.31 | 0.00 |
| Channel Y | + Input | 19999.42 | -0.78 | -0.00 |
| Channel Y | - Input | -20001.30 | -1.80 | 0.01 |
| Channel Z | + Input | 200013.4 | 12.01 | 0.01 |
| Channel Z | + Input | 20000.65 | 0.65 | 0.00 |
| Channel Z | - Input | -20000.97 | -1.47 | 0.01 |

| Low Range | | Reading (μV) | Difference (μV) | Error (%) |
|-----------|---------|---------------------------|------------------------------|-----------|
| Channel X | + Input | 2001.3 | 1.22 | 0.06 |
| Channel X | + Input | 199.82 | -0.08 | -0.04 |
| Channel X | - Input | -200.39 | -0.39 | 0.20 |
| Channel Y | + Input | 1999.2 | -0.95 | -0.05 |
| Channel Y | + Input | 199.20 | -0.70 | -0.35 |
| Channel Y | - Input | -201.25 | -1.35 | 0.67 |
| Channel Z | + Input | 2001.0 | 0.98 | 0.05 |
| Channel Z | + Input | 198.82 | -0.98 | -0.49 |
| Channel Z | - Input | -201.67 | -1.67 | 0.84 |

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 | -2.81 | -4.67 |
| | - 200 | 6.20 | 4.41 |
| Channel Y | 200 | 5.96 | 5.63 |
| | - 200 | -7.15 | -7.01 |
| Channel Z | 200 | -24.87 | -24.52 |
| | - 200 | 27.23 | 27.09 |

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 | - | 3.80 | 0.28 |
| Channel Y | 200 | 2.77 | - | 4.40 |
| Channel Z | 200 | 1.74 | -1.02 | - |

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 | 16365 | 16336 |
| Channel Y | 15884 | 16495 |
| Channel Z | 16086 | 16313 |

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 | 0.25 | -1.50 | 1.93 | 0.63 |
| Channel Y | -0.72 | -1.94 | 0.63 | 0.43 |
| Channel Z | -0.87 | -2.04 | 0.55 | 0.50 |

6. Input Offset Current

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

7. Input Resistance (Typical values for information)

| | Zeroing (kOhm) | Measuring (MOhm) |
|-----------|----------------|------------------|
| Channel X | 200 | 200 |
| Channel Y | 200 | 200 |
| Channel Z | 200 | 200 |

8. Low Battery Alarm Voltage (Typical values for information)

| Typical values | Alarm Level (VDC) |
|----------------|-------------------|
| Supply (+ Vcc) | +7.9 |
| Supply (- Vcc) | -7.6 |

9. Power Consumption (Typical values for information)

| Typical values | Switched off (mA) | Stand by (mA) | Transmitting (mA) |
|----------------|-------------------|---------------|-------------------|
| Supply (+ Vcc) | +0.01 | +6 | +14 |
| Supply (- Vcc) | -0.01 | -8 | -9 |



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Client **Sporton-TW (Auden)**

Certificate No: **H3-6184_Jan11**

CALIBRATION CERTIFICATE

Object **H3DV6 - SN:6184**

Calibration procedure(s) **QA CAL-03.v6, QA CAL-25.v3
Calibration procedure for H-field probes optimized for close near field
evaluations in air**

Calibration date: **January 25, 2011**

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 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41495277 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41498087 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 30-Mar-10 (No. 217-01159) | Mar-11 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 30-Mar-10 (No. 217-01161) | Mar-11 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 30-Mar-10 (No. 217-01160) | Mar-11 |
| Reference Probe H3DV6 | SN: 6182 | 4-Oct-10 (No. H3-6182_Oct10) | Oct-11 |
| DAE4 | SN: 789 | 31-Aug-10 (No. DAE4-789_Aug10) | Aug-11 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

| | | | |
|---|----------------------------|--|--------------------------|
| Calibrated by: | Name Marcel Fehr | Function Laboratory Technician | Signature |
| Approved by: | Katja Pokovic | Technical Manager | |
| | | | Issued: January 25, 2011 |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. | | | |



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Glossary:

| | |
|--------------------------|---|
| NORM _{x,y,z} | sensitivity in free space |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C | modulation dependent linearization parameters |
| 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:

- 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:

- NORM_{x,y,z}*: Assessed for E-field polarization $\vartheta = 0$ for XY sensors and $\vartheta = 90$ 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).
- DCP_{x,y,z}*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}*: *A, B, C* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- 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:6184

Manufactured: June 8, 2004
Calibrated: January 25, 2011

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: H3DV6 - SN:6184

Basic Calibration Parameters

| | | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|----------------------------------|----|------------|------------|------------|--------------|
| Norm (A/m / $\sqrt{\text{mV}}$) | a0 | 2.53E-003 | 2.58E-003 | 3.00E-003 | $\pm 5.1 \%$ |
| Norm (A/m / $\sqrt{\text{mV}}$) | a1 | -2.60E-005 | -9.54E-005 | -1.07E-004 | $\pm 5.1 \%$ |
| Norm (A/m / $\sqrt{\text{mV}}$) | a2 | 1.54E-005 | 2.86E-006 | 6.42E-005 | $\pm 5.1 \%$ |
| DCP (mV) ^B | | 91.0 | 90.6 | 91.7 | |

Modulation Calibration Parameters

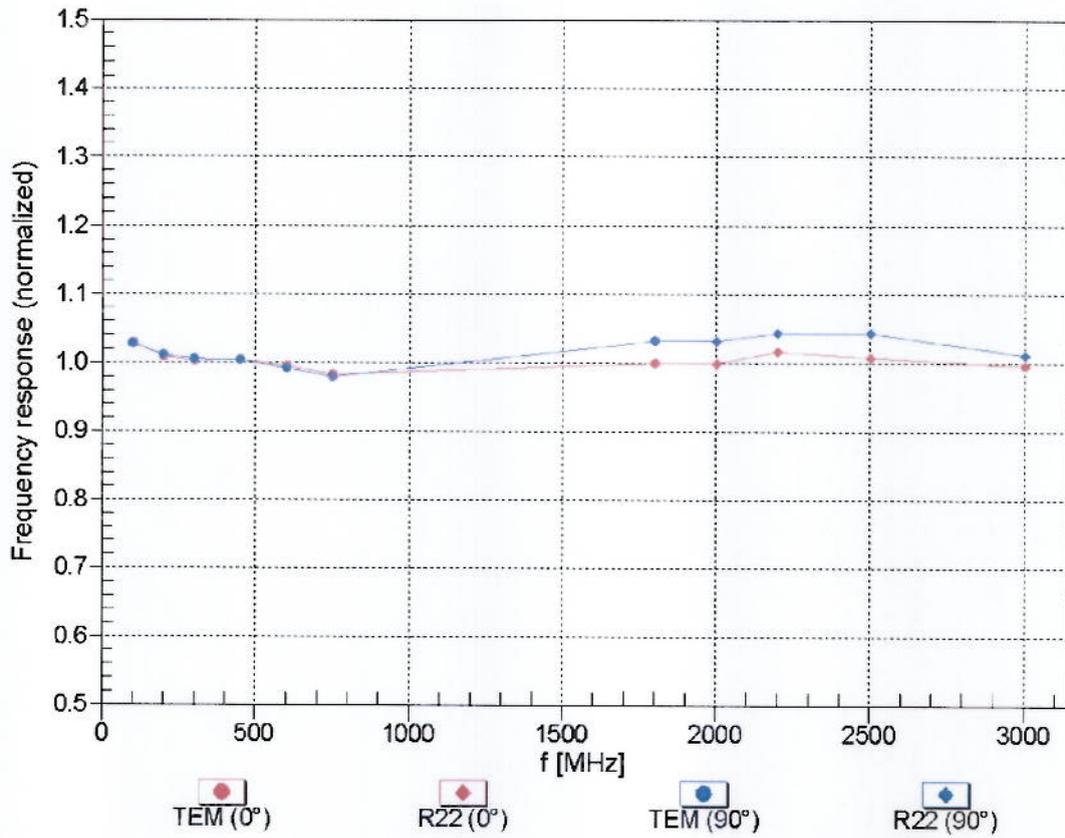
| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-------|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 251.5 | $\pm 1.6 \%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 252.0 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 238.8 | |

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%.

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

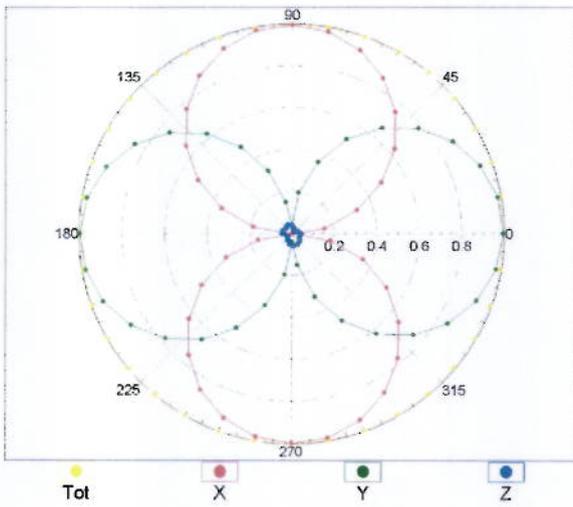
Frequency Response of H-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



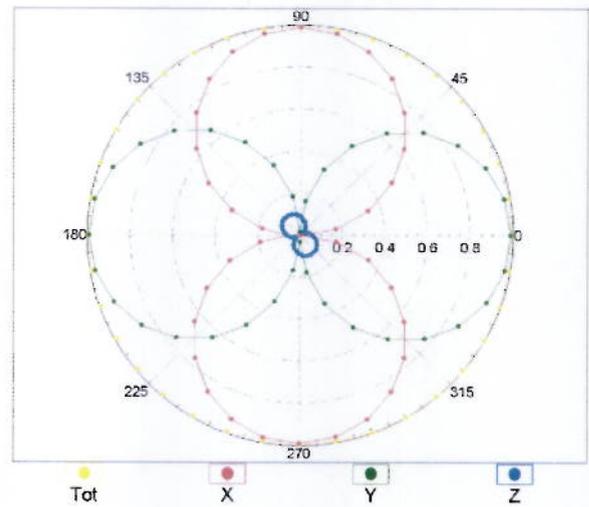
Uncertainty of Frequency Response of H-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM, 0°

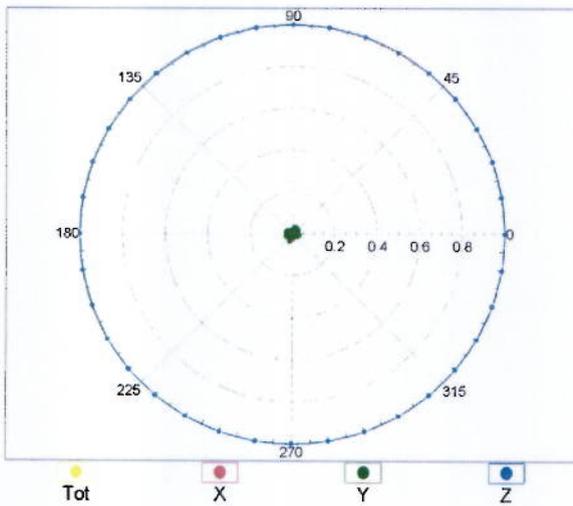


f=2500 MHz, R22, 0°

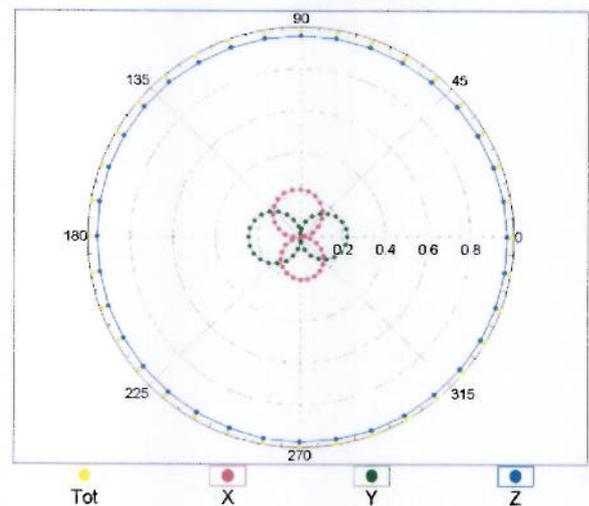


Receiving Pattern (ϕ), $\vartheta = 90^\circ$

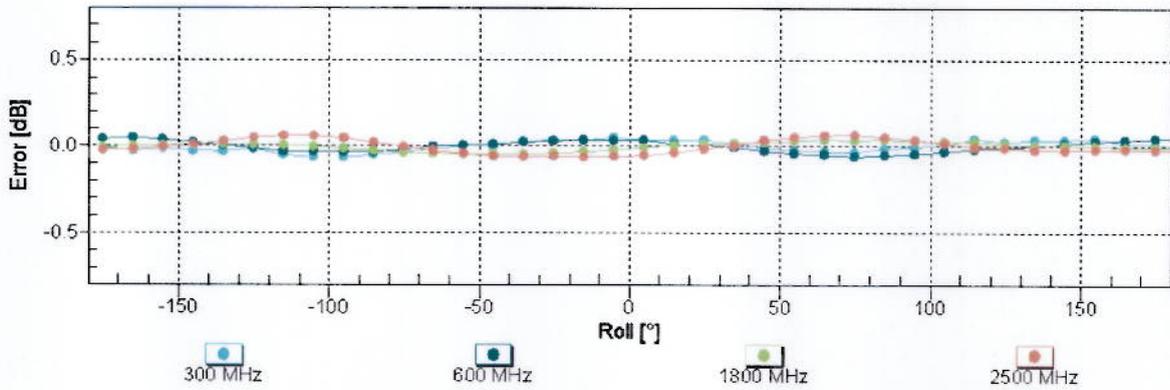
f=600 MHz, TEM, 90°



f=2500 MHz, R22, 90°

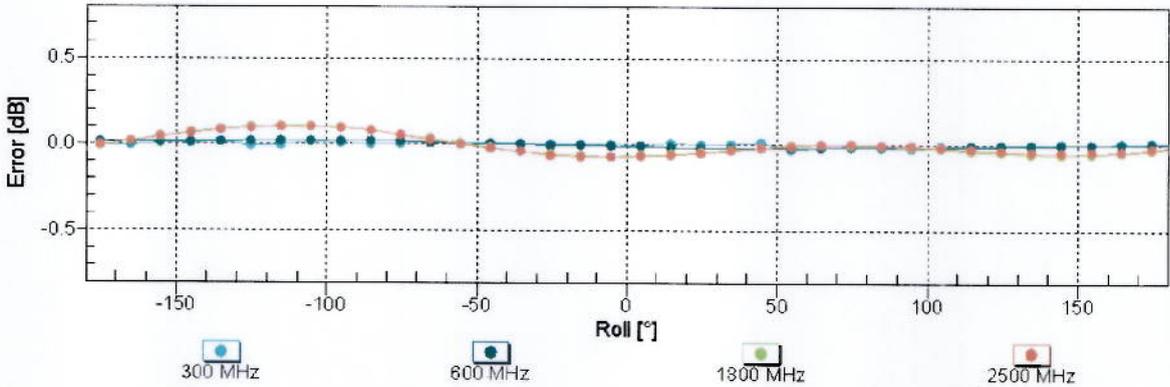


Receiving Pattern (ϕ), $\vartheta = 0^\circ$



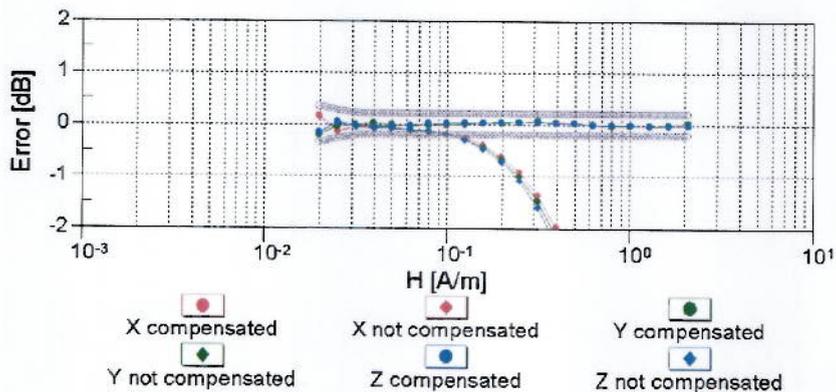
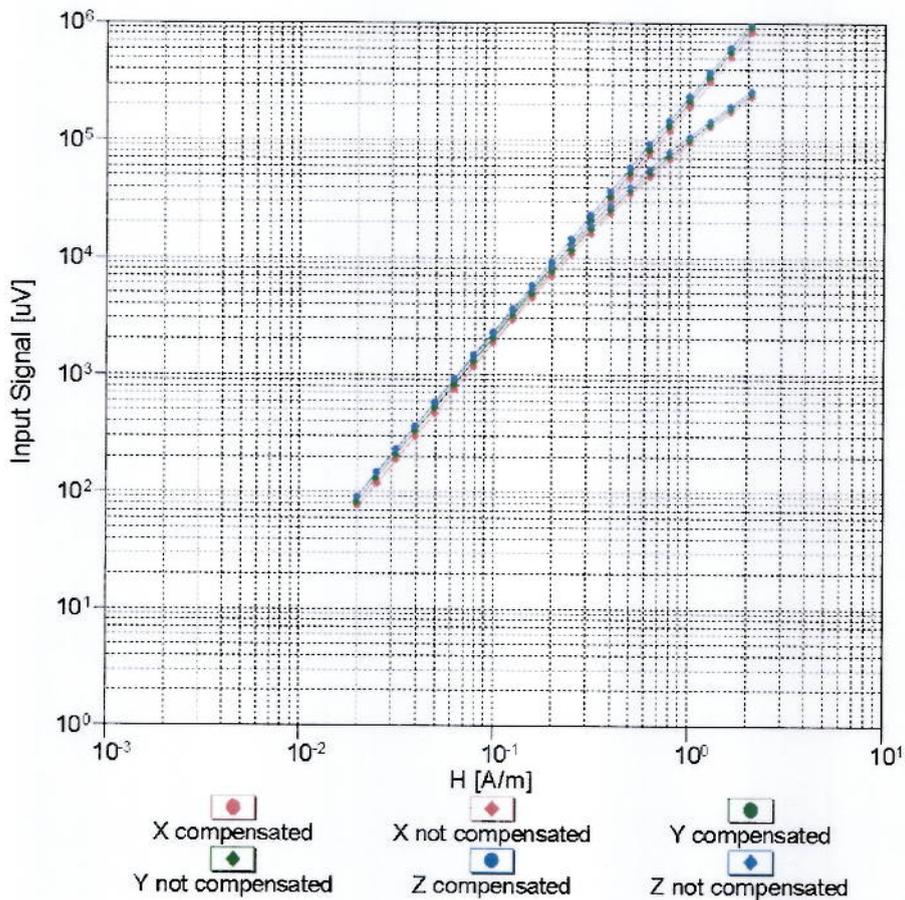
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Receiving Pattern (ϕ), $\vartheta = 90^\circ$



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

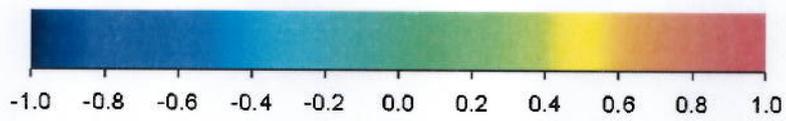
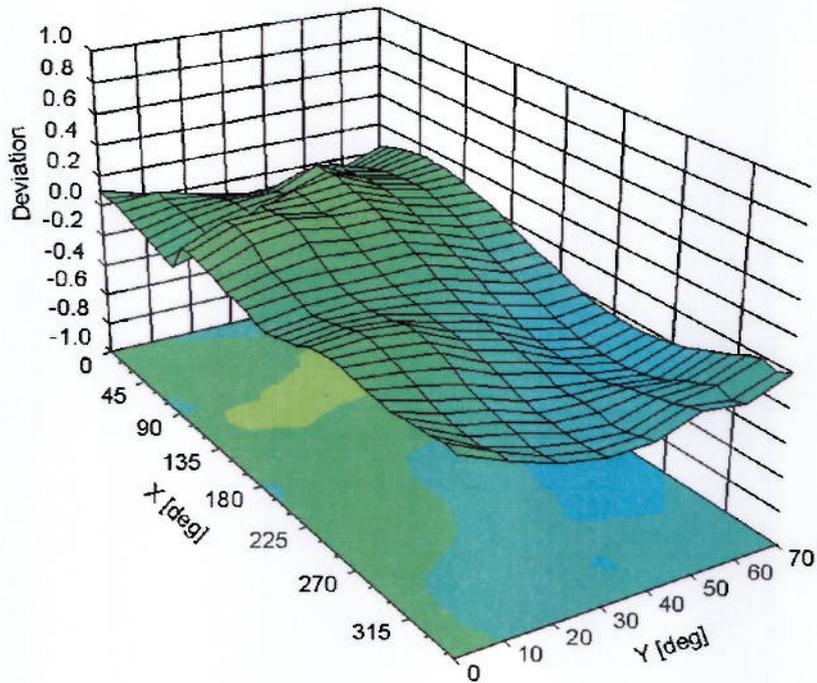
Dynamic Range f(H-field) (TEM cell, f = 900 MHz)



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

Deviation from Isotropy in Air

Error (ϕ , ϑ), $f = 900$ MHz



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

DASY/EASY - Parameters of Probe: H3DV6 - SN:6184

Other Probe Parameters

| | |
|---|-------------|
| Sensor Arrangement | Rectangular |
| Connector Angle (°) | -65.4 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 20 mm |
| Tip Diameter | 6 mm |
| Probe Tip to Sensor X Calibration Point | 3 mm |
| Probe Tip to Sensor Y Calibration Point | 3 mm |
| Probe Tip to Sensor Z Calibration Point | 3 mm |



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Client **Sporton-TW (Auden)**

Certificate No: **ER3-2358_Jan11**

CALIBRATION CERTIFICATE

Object **ER3DV6 - SN:2358**

Calibration procedure(s) **QA CAL-02.v6, QA CAL-25.v3**
Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date: **January 14, 2011**

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 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41495277 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41498087 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 30-Mar-10 (No. 217-01159) | Mar-11 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 30-Mar-10 (No. 217-01161) | Mar-11 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 30-Mar-10 (No. 217-01160) | Mar-11 |
| Reference Probe ER3DV6 | SN: 2328 | 4-Oct-10 (No. ER3-2328_Oct10) | Oct-11 |
| DAE4 | SN: 789 | 31-Aug-10 (No. DAE4-789_Aug10) | Aug-11 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

| | | | |
|---|----------------------------|-----------------------------------|--------------------------|
| Calibrated by: | Name Marcel Fehr | Function Laboratory Technician | Signature |
| Approved by: | Katja Pokovic | Technical Manager | |
| | | | Issued: January 25, 2011 |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. | | | |



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Glossary:

| | |
|--------------------------|---|
| NORM _{x,y,z} | sensitivity in free space |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C | modulation dependent linearization parameters |
| 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:

- 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:

- NORM_{x,y,z}*: Assessed for E-field polarization $\vartheta = 0$ for XY sensors and $\vartheta = 90$ for Z sensor ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide).
- NORM(f)_{x,y,z}* = *NORM_{x,y,z}* * *frequency_response* (see Frequency Response Chart).
- DCP_{x,y,z}*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}*: A, B, C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- 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 *NORM_x* (no uncertainty required).

Probe ER3DV6

SN:2358

Manufactured: July 7, 2005
Calibrated: January 14, 2011

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2358

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) | 1.72 | 1.56 | 1.59 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 98.6 | 97.8 | 99.6 | |

Modulation Calibration Parameters

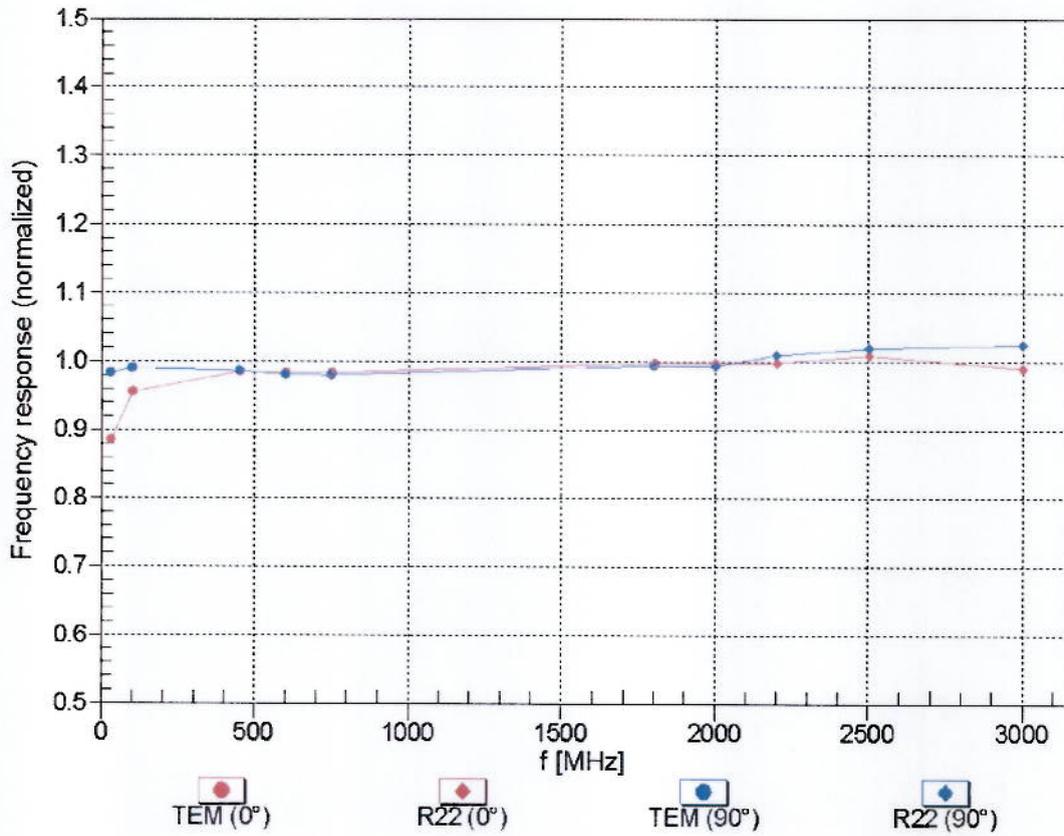
| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-------|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 151.8 | $\pm 1.6 \%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 153.3 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 138.4 | |

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%.

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

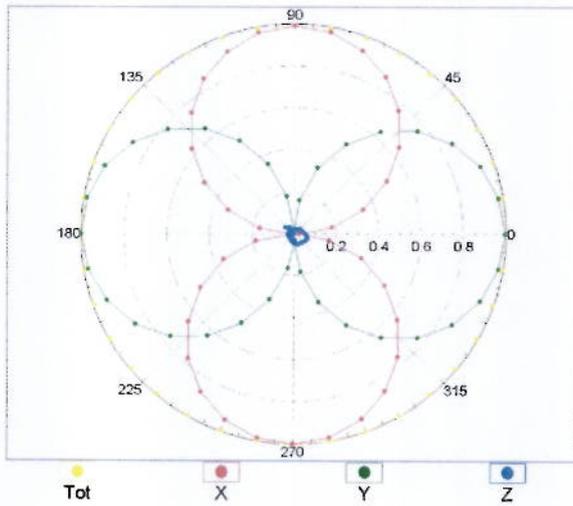
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



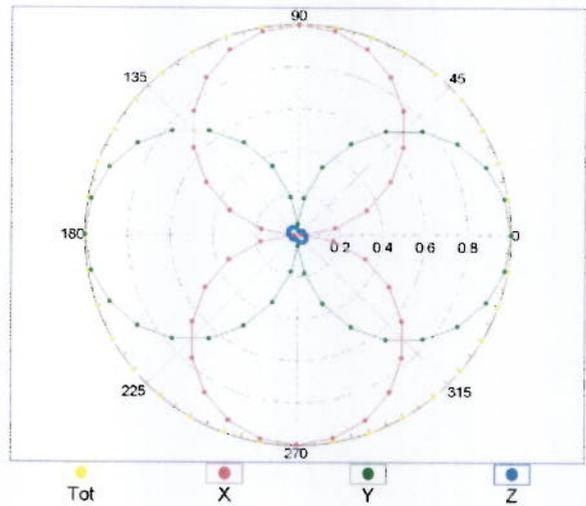
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM,0°

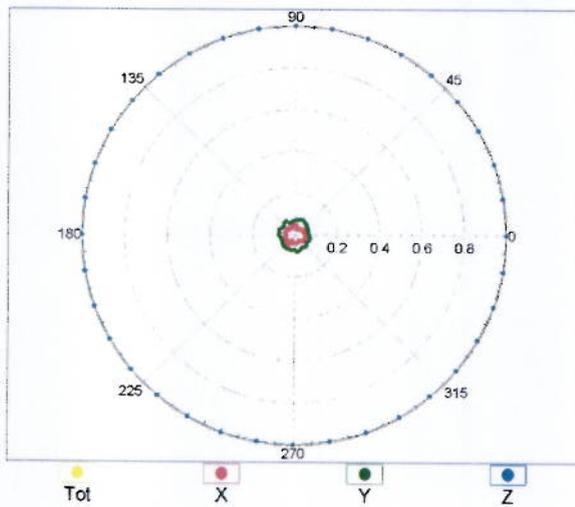


f=2500 MHz,R22,0°

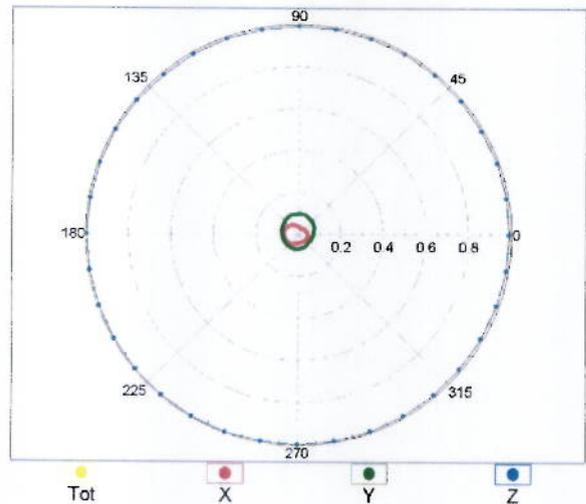


Receiving Pattern (ϕ), $\vartheta = 90^\circ$

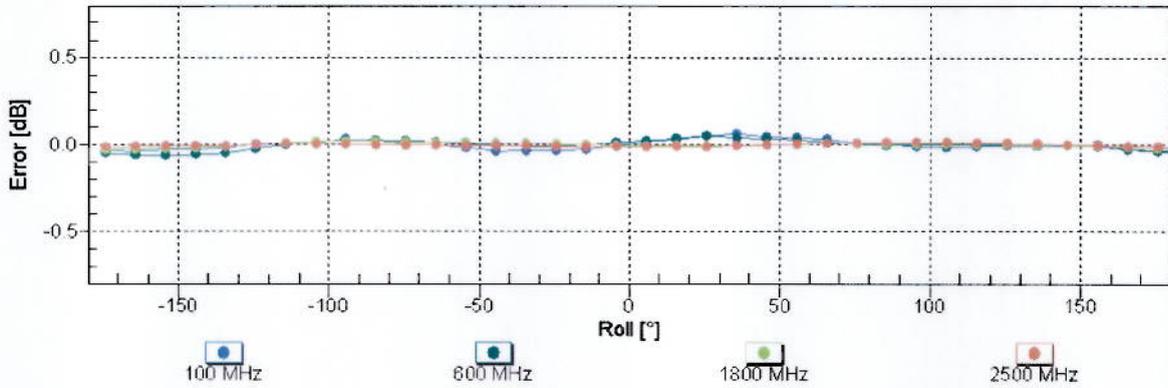
f=600 MHz,TEM,90°



f=2500 MHz,R22,90°

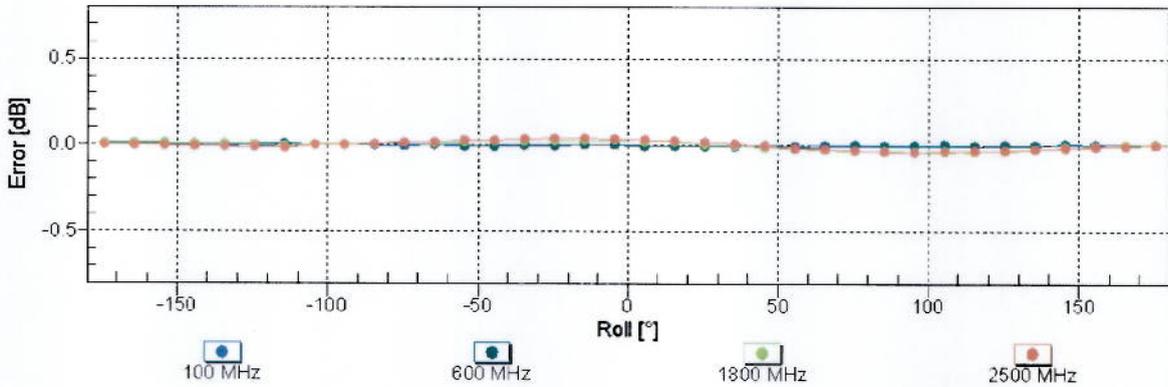


Receiving Pattern (ϕ), $\vartheta = 0^\circ$



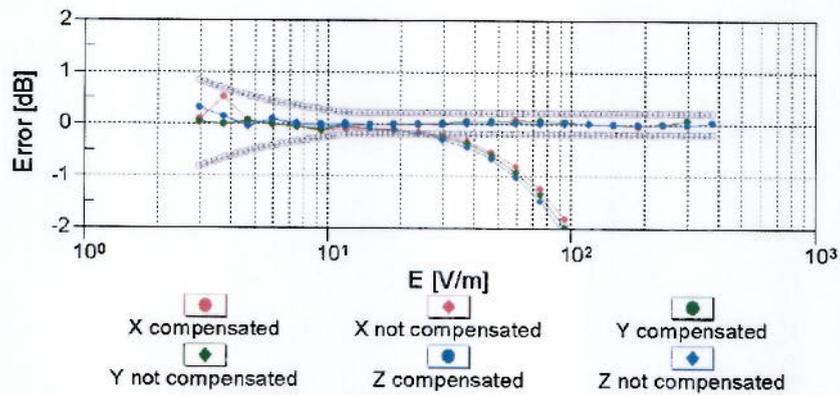
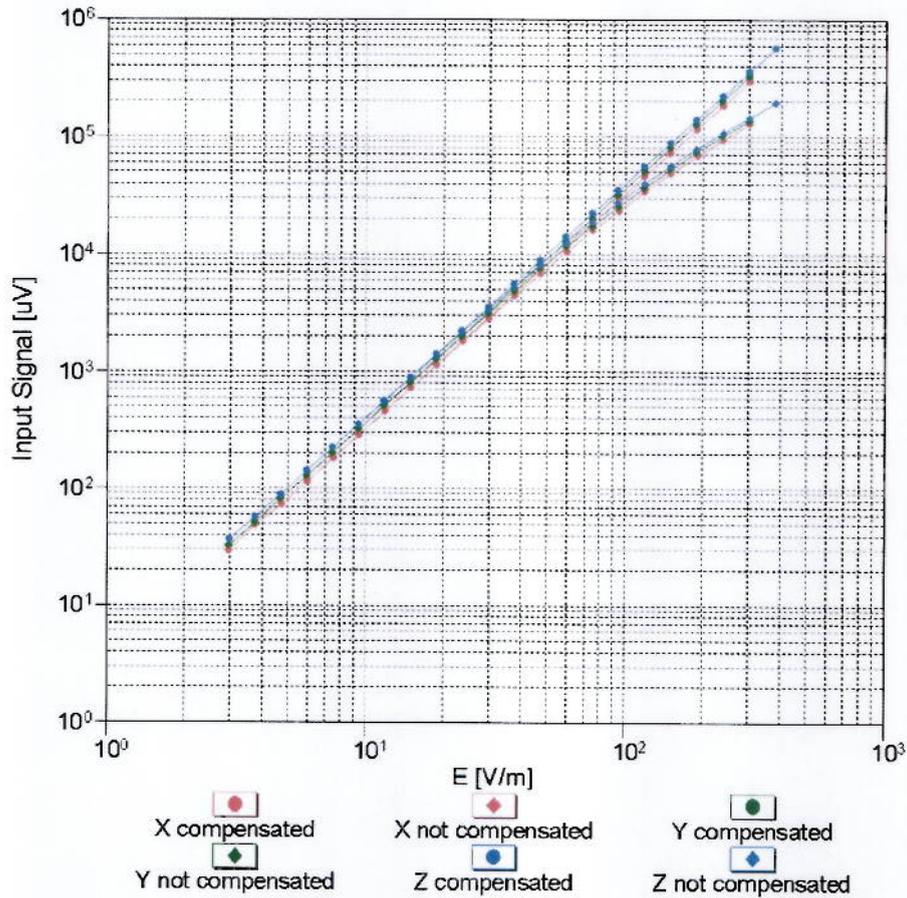
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Receiving Pattern (ϕ), $\vartheta = 90^\circ$



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

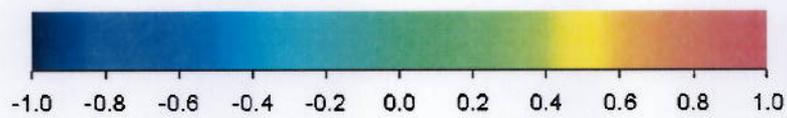
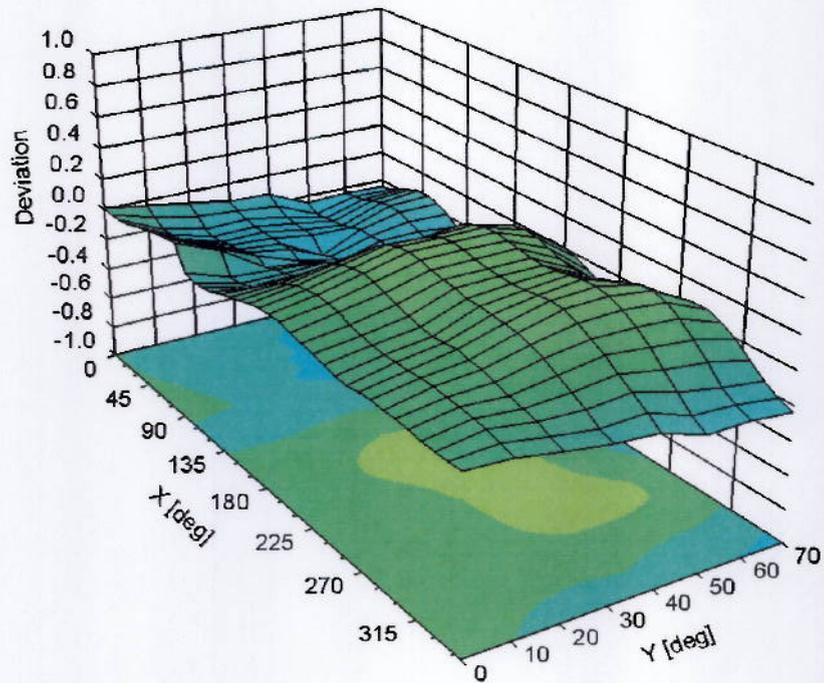
Dynamic Range f(E-field) (TEM cell , f = 900 MHz)



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

Deviation from Isotropy in Air

Error (ϕ , θ), $f = 900$ MHz



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

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2358**Other Probe Parameters**

| | |
|---|-------------|
| Sensor Arrangement | Rectangular |
| Connector Angle (°) | 115.6 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 8 mm |
| Probe Tip to Sensor X Calibration Point | 2.5 mm |
| Probe Tip to Sensor Y Calibration Point | 2.5 mm |
| Probe Tip to Sensor Z Calibration Point | 2.5 mm |