
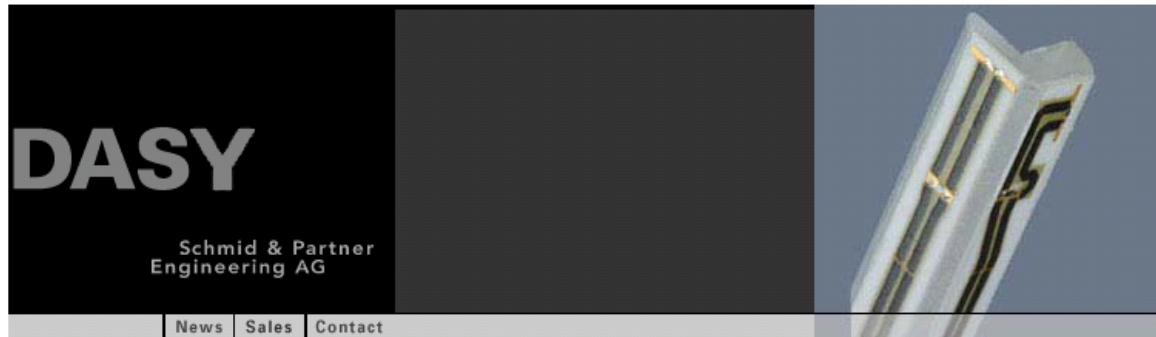


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Annex B: Probe and dipole description and calibration certificates

B.1 Probe, measurement chain description, specification and calibration certificate

DASY Dosimetric Assessment System by Schmid & Partner Engineering AG



- Applications**
- Support & Downloads**
- Products**
 - DASY4 Packages
 - EASY4
 - Probes
 - ET3DV6 - Isotropic Dos-Probe
 - ES3DV3 - Isotropic Dos-Probe
 - EX3DV4 - Isotropic Dos-Probe
 - ET1DV3 - D-Probe
 - EUV3 - Universal Vector E-Probe
 - H3DV6 - Isotropic H-Probe
 - HUV4 - Universal Vector H-Probe
 - T1V3 - Temp-Probe
 - DP1 - Dummy-Probe
 - Data Acquisition System
 - Software
 - Phantoms
 - Robots
 - Validation Kits & Calibration Dipoles
 - Hearing Aid Compatibility (HAC) Ext
 - Tissue Simulating Liquids
- SPEAG Home**

ER3DV6 ISOTROPIC E-FIELD PROBE FOR GENERAL NEAR-FIELD MEASUREMENTS

 [Download Product Flyer](#) (PDF, 192kB)

Construction One dipole parallel, two dipoles normal to probe axis
 Built-in shielding against static charges
 PEEK enclosure material (resistant to organic solvents, e.g., glycoether)

Calibration In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$, $k=2$)

Frequency 100 MHz to > 6 GHz; Linearity: ± 0.2 dB (100 MHz to 3 GHz)


Directivity ± 0.2 dB in air (rotation around probe axis)
 ± 0.4 dB in air (rotation normal to probe axis)

Dynamic Range 2 V/m to > 1000 V/m; Linearity: ± 0.2 dB

Dimensions Overall length: 330 mm (Tip: 16 mm)
 Tip diameter: 8 mm (Body: 12 mm)
 Distance from probe tip to dipole centers: 2.5 mm

Application General near-field measurements up to 6 GHz
 Field component measurements
 Fast automatic scanning in phantoms

<http://www.dasy4.com/er3.htm>

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All measurements were performed to the nearest element point as per the C63.19 standard. Offset distances were entered in the DASY5 software so that the measurement was to the nearest element.

Figures 1, provided by the manufacturer, illustrate detail of the probe tip and its dimensions.

ER3DV6 E-Field probe: The distances from the probe tip to the closest points on the dipole sensors are 1.45mm for X and Y and 1.25mm for Z. From the probe tip to the center of the sensors is 2.5mm.



E-Field Probe (ER3DV6)

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The following information is from the system manufacturer user manual describing the process chain:

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i} \quad (20.1)$$

with V_i = compensated signal of channel i (i = x, y, z)
 U_i = input signal of channel i (i = x, y, z)
 cf = crest factor of exciting field (DASY parameter)
 dcp_i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$\text{E - fieldprobes : } E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$\text{H - fieldprobes : } H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

with V_i = compensated signal of channel i (i = x, y, z)
 $Norm_i$ = sensor sensitivity of channel i (i = x, y, z)
 $\mu V / (V/m)^2$ for E-field Probes
 $ConvF$ = sensitivity enhancement in solution
 a_{ij} = sensor sensitivity factors for H-field probes
 f = carrier frequency [GHz]
 E_i = electric field strength of channel i in V/m
 H_i = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2} \quad (20.2)$$

The measurement / integration time per point is > 500 ms, as per the system manufacturer:

The time response of the field probes has been assessed by exposing the probe to a well-controlled field producing signals larger than HAC E- and H-fields of class M4. The signal response time is evaluated as the time required by the system to reach 90% of the expected final value after an on/off switch of the power source with an integration time of 500 ms and a probe response time of <5 ms. In the current implementation, DASY4 waits longer than 100ms after having reached the grid point before starting a measurement, i.e., the response time uncertainty is negligible.

If the device under test does not emit a CW signal, the integration time applied to measure the electric field at a specific point may introduce additional uncertainties due to the discretization. The tolerances for the different systems had the worst-case of 2.6%.

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



S Schweizerischer Kalibrierdienst
S Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
 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 **RTS (RTM Testing Services)**

Certificate No: **ER3-2286_Jan13**

CALIBRATION CERTIFICATE

Object: **ER3DV6 - SN:2286**

Calibration procedure(s): **QA CAL-02.v6, QA CAL-25.v4
 Calibration procedure for E-field probes optimized for close near field
 evaluations in air**


Calibration date: **January 11, 2013**


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 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ER3DV6 | SN: 2328 | 12-Oct-12 (No. ER3-2328 Oct12) | Oct-13 |
| DAE4 | SN: 789 | 18-Sep-12 (No. DAE4-789 Sep12) | Sep-13 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

Calibrated by: **Jeton Kasirali** Laboratory Technician 

Approved by: **Katja Pokovic** Technical Manager 

Issued: January 11, 2013

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

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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 Accreditation Service (SAS)
 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:

| | |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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, D | 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
- CTIA Test Plan for Hearing Aid Compatibility, April 2010.

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.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D 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).



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ER3DV6 – SN:2286

January 11, 2013

Probe ER3DV6

SN:2286

Manufactured: September 18, 2002
Calibrated: January 11, 2013

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



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DASY/EASY - Parameters of Probe: ER3DV6 - SN:2286

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---------------------------------------|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V/m})^2$) | 2.20 | 1.47 | 1.51 | $\pm 10.1\%$ |
| DCP (mV) ^B | 98.4 | 100.5 | 99.6 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 194.1 | $\pm 2.5\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 197.9 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 176.0 | |

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%.

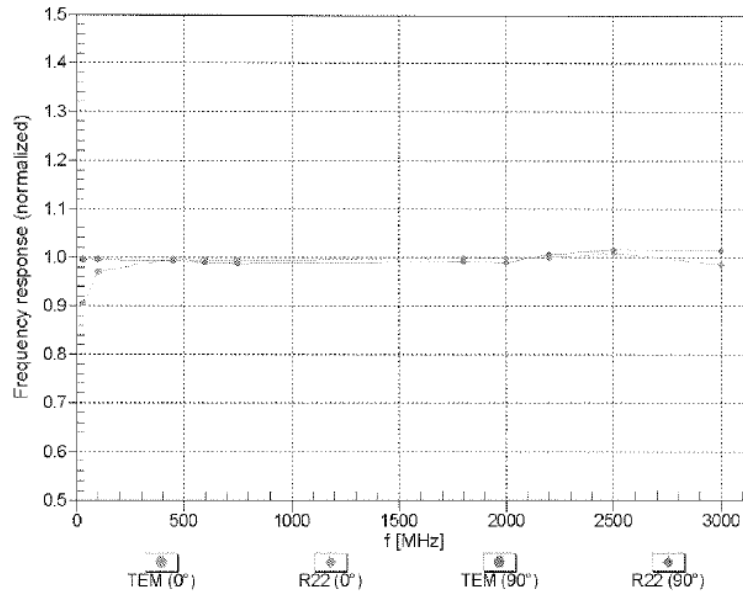
^B Numerical linearization parameter; uncertainty not required.

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

ER3DV6- SN:2286

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



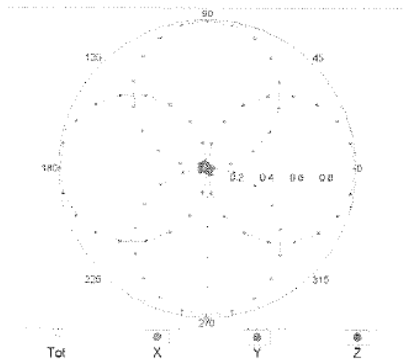
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

ER3DV6-- SN:2286

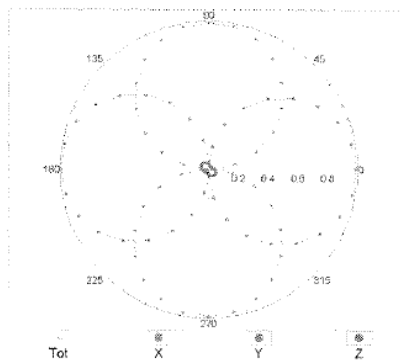
January 11, 2013

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

f=600 MHz, TEM, 0°

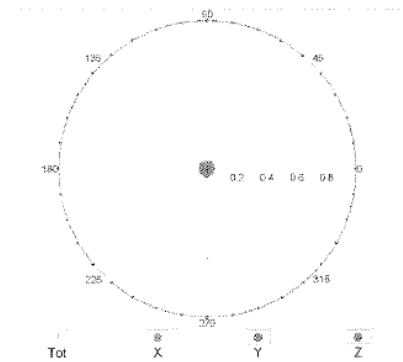


f=2500 MHz, R22, 0°

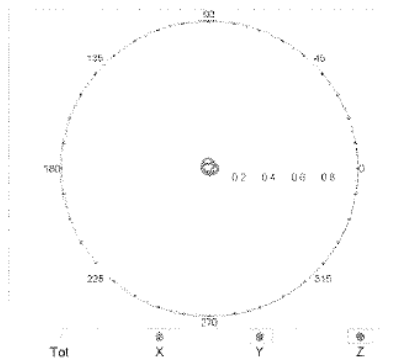


Receiving Pattern (ϕ), $\theta = 90^\circ$

f=600 MHz, TEM, 90°



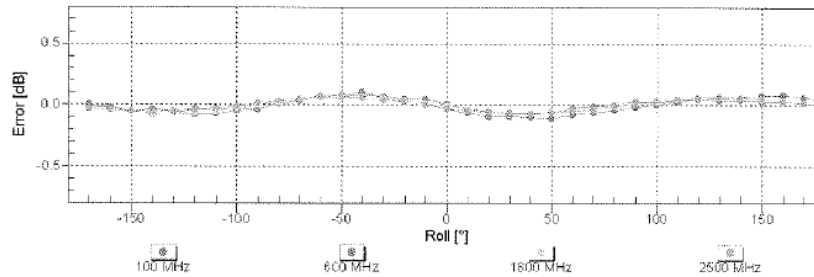
f=2500 MHz, R22, 90°



ER3DV6- SN:2286

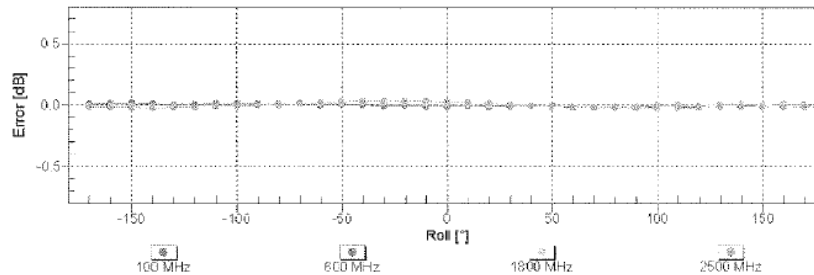
January 11, 2013

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



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

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

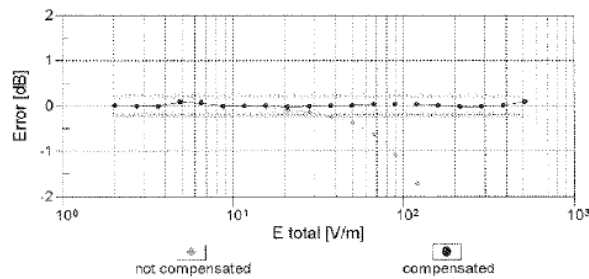
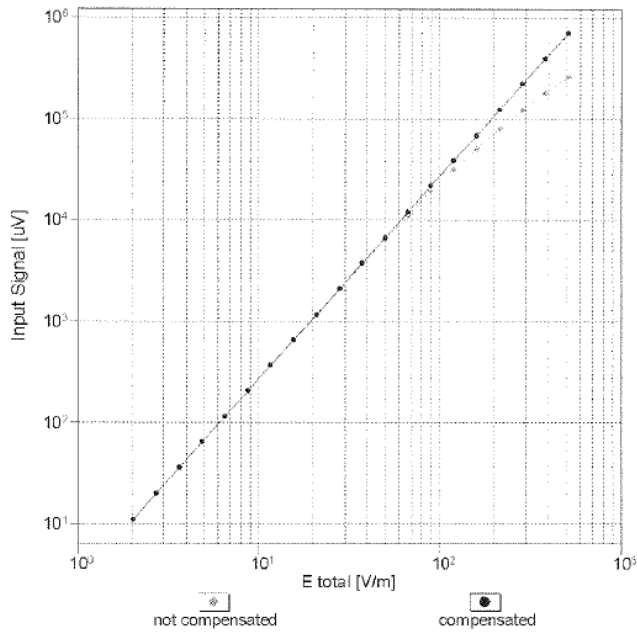


Uncertainty of Axial isotropy Assessment: $\pm 0.5\%$ (k=2)

ER3DV6- SN:2286

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

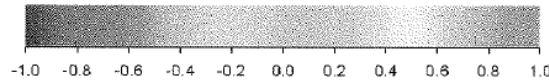
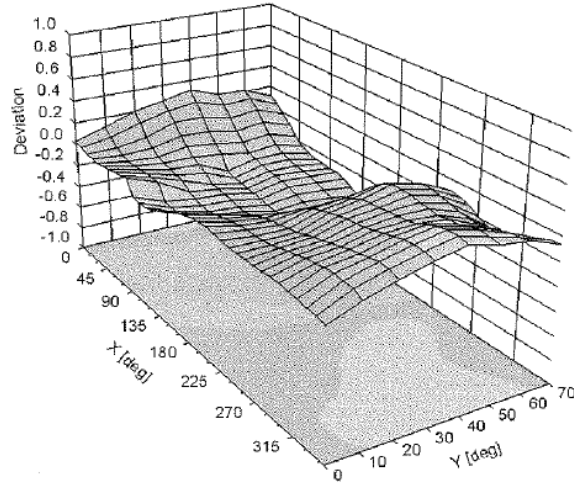


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

ER3DV6-SN:2286

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



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



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DASY/EASY - Parameters of Probe: ER3DV6 - SN:2286

Other Probe Parameters

| | |
|-----------------------------------------|-------------|
| Sensor Arrangement | Rectangular |
| Connector Angle (°) | -10.1 |
| 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 |