# Annex B: Probe and dipole description and calibration certificates

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

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DASY Dosimetric Assessment System by Schmid & Partner Engineering AG

DASY Schmid & Partner Engineering AG News Sales Contact		A CONTRACT OF A
Applications	ER3DV6 ISOTRO MEASUREMENTS	PIC E-FIELD PROBE FOR GENERAL NEAR-FIELD
Support & Downloads Products DASY4 Packages	Download Produ	<u>zt Flyer</u> (PDF, 192kB)
EASY4     Probes     ET3DV6 - Isotropic Dos-Probe     ES3DV3 - Isotropic Dos-Probe	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., glycolether)
EX3DV4 - Isotropic Dos-Probe ET1DV3 - D-Probe	Calibration	In air from 100 MHz to 3.0 GHz (absolute accuracy ±6.0%, k=2)
EUV3 - Universal Vector E-Probe H3DV6 - Isotropic H-Probe	Frequency	100 MHz to > 6 GHz; Linearity: $\pm$ 0.2 dB (100 MHz to 3 GHz)
HUV4 - Universal Vector H-Probe T1V3 - Temp-Probe DP1 - Dummy-Probe	Directivity	± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis)
Data Acquisition System	Dynamic Range	2 V/m to > 1000 V/m; Linearity: $\pm$ 0.2 dB
Software     Phantoms     Robots	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
<ul> <li>Validation Kits &amp; Calibration Dipoles</li> <li>Hearing Aid Compatibility (HAC) Ext</li> <li>Tissue Simulating Liquids</li> <li>SPEAG Home</li> </ul>	Application	General near-field measurements up to 6 GHz Field component measurements Fast automatic scanning in phantoms

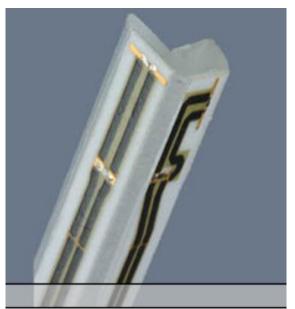
http://www.dasy4.com/er3.htm

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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:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$
(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:

	$\mathrm{E-field probes}$ :	$E_i = \sqrt{\frac{V_i}{Norm_i \cdot C}}$	ConvF
	$\mathbf{H}-\mathbf{fieldprobes}$ :	$H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}}{V_i}$	$\frac{f + a_{i2}f^2}{f}$
with	= compensated signal of $\alpha$ = sensor sensitivity of cha $\mu V/(V/m)^2$ for E-field = sensitivity enhancement = sensor sensitivity factor = carrier frequency [GHz] = electric field strength of = magnetic field strength	nnel i I Probes t in solution s for H-field probes f channel i in V/m	$\begin{array}{l} (i=x,y,z) \\ (i=x,y,z) \end{array}$

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

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$
(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 100 ms 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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<sup>Data</sup> ud Attayi	Dates of Te March	18-24, July	14-15, 2014	Report No RTS-6058-1407-08	FCC ID L6AI	RHB120L
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Object		ER3DV6 - SN:22	86			
Calibration procedur	re(s)		dure for E-field probes opt	imized for close near field		
		evaluations in air				
Calibration date:		January 17, 2014				
This calibration certi	ficate documen	January 17, 2014	4 onal standards, which realize the phy	vsical units of measurements (SI).		
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



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

Accreditation No.: SCS 108

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

### Glossary:

NORMx,y,z	sensitivity in free space
DCP	diode compression point
ĆF	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 9	9 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

b) CTIA Test Plan for Hearing Aid Compatibility, April 2010.

### Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 0 for XY sensors and 9 = 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 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
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,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 8 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).

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# Probe ER3DV6

## SN:2286

Manufactured: Calibrated: September 18, 2002 January 17, 2014

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 (μV/(V/m) <sup>2</sup> )	2.24	1.46	1.50	± 10.1 %
DCP (mV) <sup>B</sup>	98.6	100.7	100.5	

### **Modulation Calibration Parameters**

UID	Communication System Name		A	В	С	D	VR	Unc
			dB	dBõV		dB	mV	(k=2)
0	CW	Х	0.0	0.0	1.0	0.00	181.8	±3.5 %
		Y	0.0	0.0	1.0		196.2	
		Z	0.0	0.0	1.0		175.8	

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%.

<sup>8</sup> Numerical linearization parameter: uncertainty not required. <sup>e</sup> Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

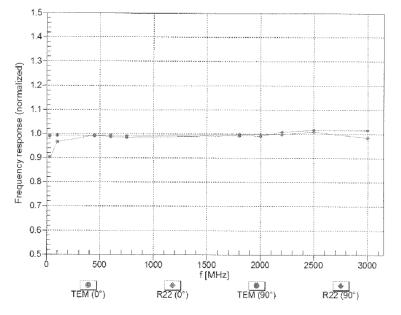
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### Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)





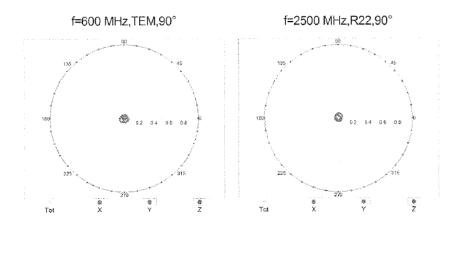
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January 17, 2014

# $Peceering Pattern (\phi), \theta = 0^{\circ}$ $f=600 \text{ MHz, TEM, 0^{\circ}}$ $f=2500 \text{ MHz, R22, 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ} 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ}}$ $f=0^{\circ} 0^{\circ} 0^{\circ}$



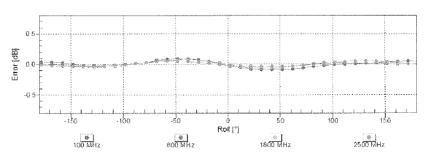
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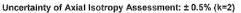
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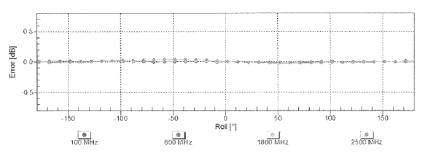
January 17, 2014

Receiving Pattern ( $\phi$ ),  $\vartheta = 0^{\circ}$ 





Receiving Pattern ( $\phi$ ),  $\vartheta = 90^{\circ}$ 



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

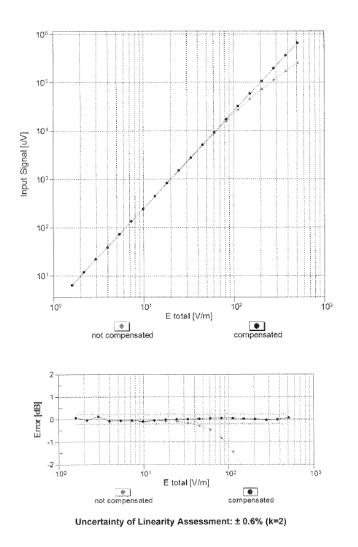
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### Dynamic Range f(E-field) (TEM cell , f = 900 MHz)

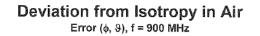


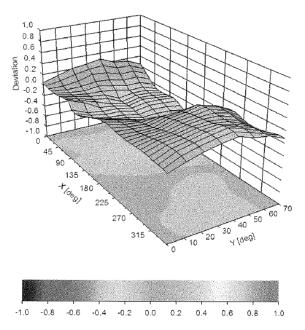
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Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

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Daoud Attavi	March 1	8-24, July 14-15, 2014	RTS-6058-1407-08	L6A	RHB120LW

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

### Other Probe Parameters

Rectangular
-8.1
enabled
disabled
337 mm
10 mm
10 mm
8 mm
2.5 mm
2.5 mm
2.5 mm

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