
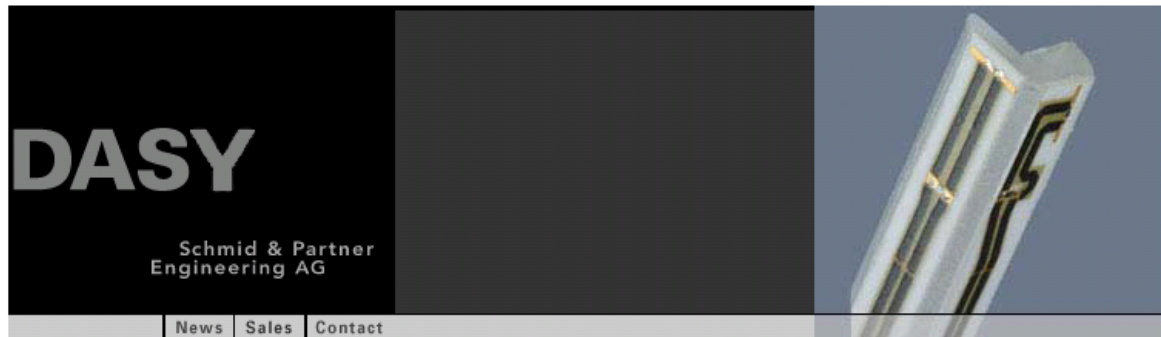
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<b>Daoud Attayi</b>	<b>July 03, Aug 11, 2009</b>	<b>RTS-1689-0908-37</b>	<b>L6ARCM70UW</b>

## **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




- Applications**
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- Products**
  - DASY4 Packages
  - EASY4
  - Probes
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    - 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
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  - Phantoms
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  - Validation Kits & Calibration Dipoles
    - Hearing Aid Compatibility (HAC) Ext
    - Tissue Simulating Liquids
- SPEAG Home**

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

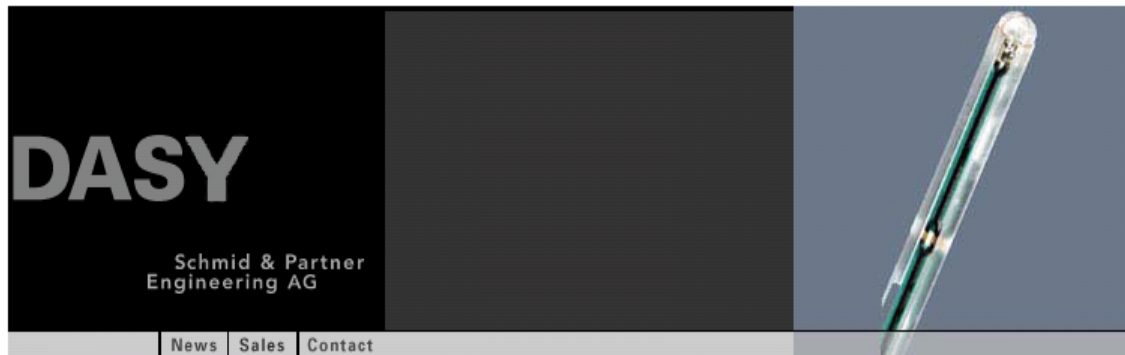
 [Download Product Flyer \(PDF, 192kB\)](#)

- 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:  $\pm 0.2$  dB (100 MHz to 3 GHz)
- Directivity**  $\pm 0.2$  dB in air (rotation around probe axis)  
 $\pm 0.4$  dB in air (rotation normal to probe axis)
- Dynamic Range** 2 V/m to > 1000 V/m; Linearity:  $\pm 0.2$  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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DASY Dosimetric Assessment System by Schmid & Partner Engineering AG




<b>Applications</b>
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<b>Products</b>
<ul style="list-style-type: none"> <li>▪ DASY4 Packages</li> <li>▪ EASY4</li> <li>▪ Probes <ul style="list-style-type: none"> <li>ET3DV6 - Isotropic Dos-Probe</li> <li>ES3DV3 - Isotropic Dos-Probe</li> <li>EX3DV4 - Isotropic Dos-Probe</li> <li>ET1DV3 - D-Probe</li> <li>ER3DV6 - Isotropic E-Probe</li> <li>EUV3 - Universal Vector E-Probe</li> </ul> </li> <li>HUV4 - Universal Vector H-Probe</li> <li>T1V3 - Temp-Probe</li> <li>DP1 - Dummy-Probe</li> <li>▪ Data Acquisition System</li> <li>▪ Software</li> <li>▪ Phantoms</li> <li>▪ Robots</li> <li>▪ Validation Kits &amp; Calibration Dipoles <ul style="list-style-type: none"> <li>▪ Hearing Aid Compatibility (HAC) Ext</li> <li>▪ Tissue Simulating Liquids</li> </ul> </li> </ul>
<b>SPEAG Home</b>

### H3DV6 3-DIMENSIONAL H-FIELD PROBE FOR SMALL BAND APPLICATIONS

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

<b>Construction</b>	Three concentric loop sensors with 3.8 mm loop diameters Resistively loaded detector diodes for linear response Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycoether)
<b>Frequency</b>	200 MHz to 3 GHz (absolute accuracy $\pm 6.0\%$ , $k=2$ ); Output linearized
<b>Directivity</b>	$\pm 0.25$ dB (spherical isotropy error)
<b>Dynamic Range</b>	10 mA/m to 2 A/m at 1 GHz
<b>E-Field Interference</b>	< 10% at 3 GHz (for plane wave)
<b>Dimensions</b>	Overall length: 330 mm (Tip: 40 mm) Tip diameter: 6 mm (Body: 12 mm) Distance from probe tip to dipole centers: 3 mm
<b>Application</b>	General magnetic near-field measurements up to 3 GHz Field component measurements Surface current measurements Measurements in air or liquids Low interaction with the measured field

<http://www.dasy4.com/h3d.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 DASY4 software so that the measurement was to the nearest element.

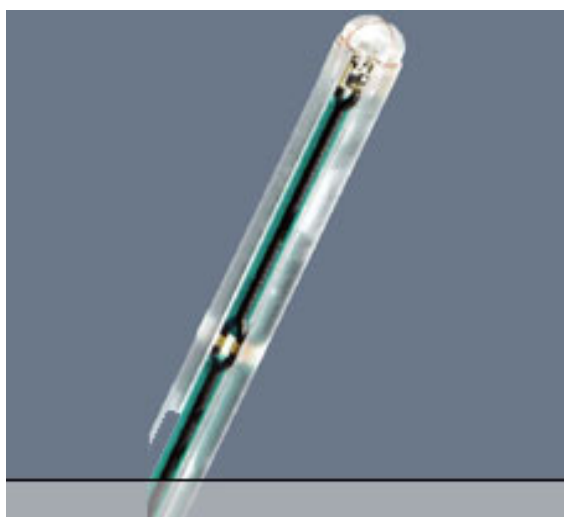
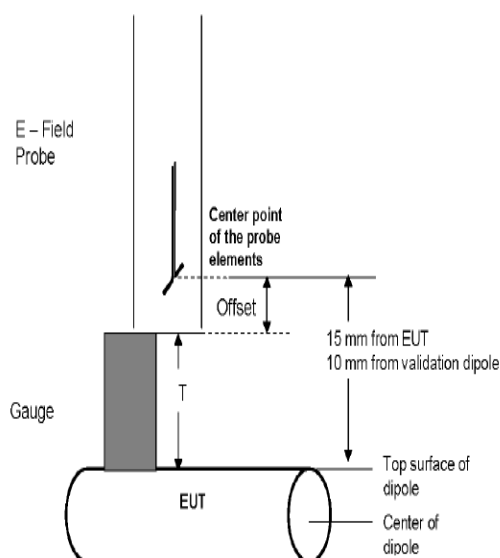
Figures 1 and 2, provided by the manufacturer, illustrate detail of the probe tip and its dimensions.

**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.

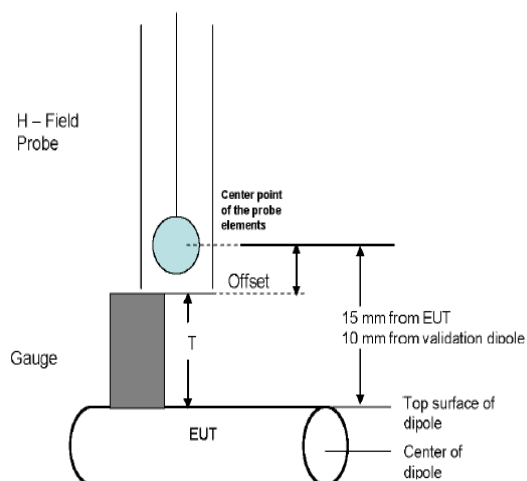
**H3DV6 H-Field probe:** The distance from the probe tip to the closest point of the X, Y and Z loop sensors is 1.1mm. From the probe tip to the center of the sensor is 3.00mm.




**E-Field Probe (ER3DV6)**



**H-Field Probe (H3DV6)**



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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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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **RTS (RIM Testing Services)**

Certificate No: ER3-2286\_Jan09

### CALIBRATION CERTIFICATE

Object: **ER3DV6 - SN:2286**

Calibration procedure(s): **QA CAL-02.v5**  
Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date: **January 8, 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). 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 E4419D	GD41293874	1-Apr-08 (No. 217-00780)	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)	1-Jul-08 (No. 217-00865)	Jul-09
Reference 20 dB Attenuator	SN: S5086 (20b)	31-Mar-08 (No. 217-00787)	Apr-09
Reference 30 dB Attenuator	SN: S5129 (30b)	1-Jul-08 (No. 217-00866)	Jul-09
Reference Probe ER3DV6	SN: 2328	1-Oct-08 (No. ER3-2328_Oct08)	Oct-09
DAE4	SN: 789	19-Dec-08 (No. DAE4-789_Dec08)	Dec-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-08)	In house check: Oct-09


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

Issued: January 12, 2009

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

Certificate No: ER3-2286\_Jan09

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Accreditation No.: SCS 108

**Glossary:**


NORM<sub>x,y,z</sub> sensitivity in free space  
DCP diode compression point  
Polarization  $\varphi$   $\varphi$  rotation around probe axis  
Polarization  $\vartheta$   $\vartheta$  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:**

- *NORM<sub>x,y,z</sub>*: 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)<sub>x,y,z</sub>* = *NORM<sub>x,y,z</sub>* \* *frequency\_response* (see Frequency Response Chart).
- *DCP<sub>x,y,z</sub>*: 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 *NORM<sub>x</sub>* (no uncertainty required).

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ER3DV6 SN:2286

January 8, 2009

# Probe ER3DV6


## SN:2286

Manufactured:	September 19, 2002
Last calibrated:	January 21, 2008
Recalibrated:	January 8, 2009

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)



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ER3DV6 SN:2286

January 8, 2009

**DASY - Parameters of Probe: ER3DV6 SN:2286**

Sensitivity in Free Space [ $\mu\text{V}/(\text{V}/\text{m})^2$ ]		Diode Compression <sup>A</sup>	
NormX	2.24 ± 10.1 % (k=2)	DCP X	95 mV
NormY	1.47 ± 10.1 % (k=2)	DCP Y	94 mV
NormZ	1.54 ± 10.1 % (k=2)	DCP Z	96 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 -10 °

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>A</sup> numerical linearization parameter: uncertainty not required

Author Data  
**Daoud Attayi**

Dates of Test  
**July 03, Aug 11, 2009**

Report No  
**RTS-1689-0908-37**

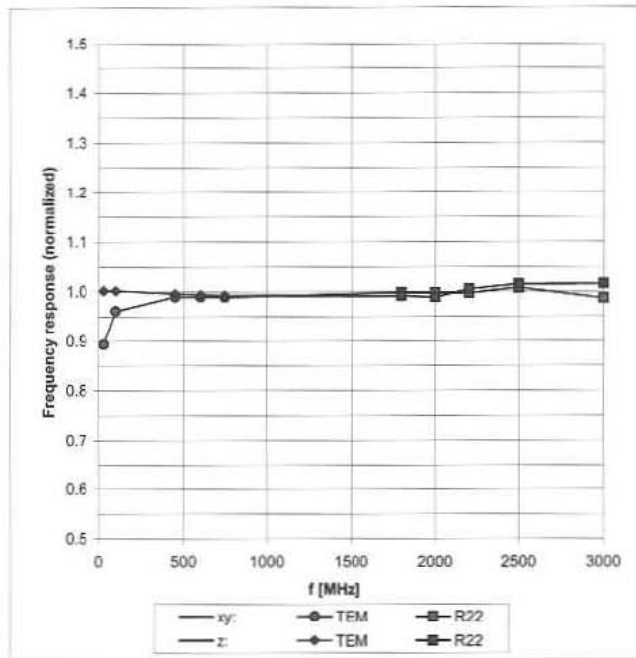
FCC ID  
**L6ARCM70UW**

ER3DV6 SN:2286

January 8, 2009

### Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide R22)

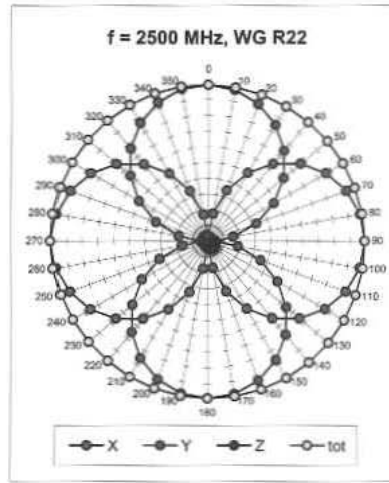
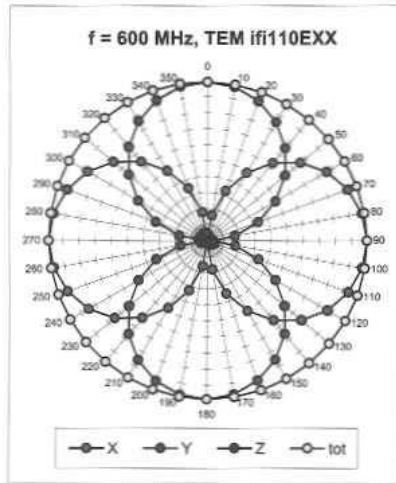


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

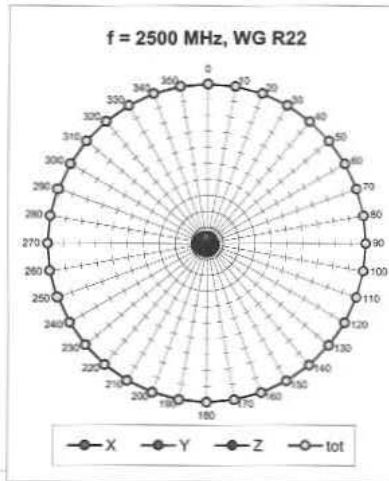
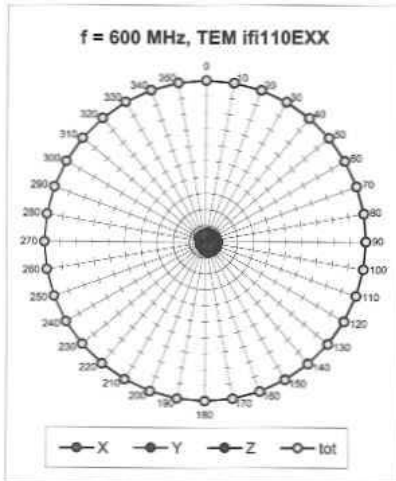
ER3DV6 SN:2286

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



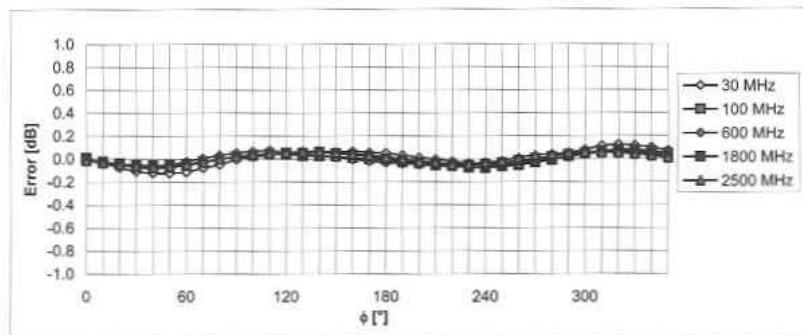
**Receiving Pattern ( $\phi$ ),  $\vartheta = 90^\circ$**



ER3DV6 SN:2286

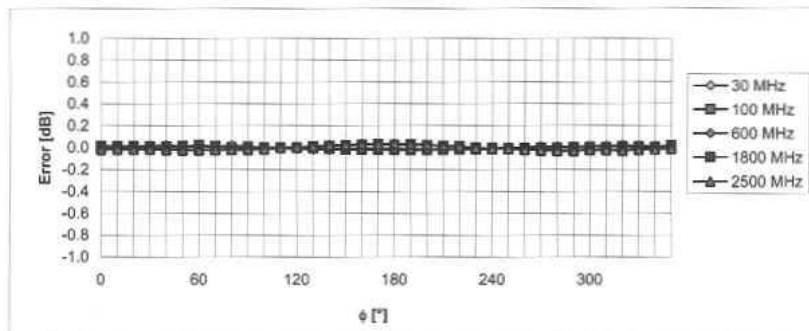
January 8, 2009

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



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

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

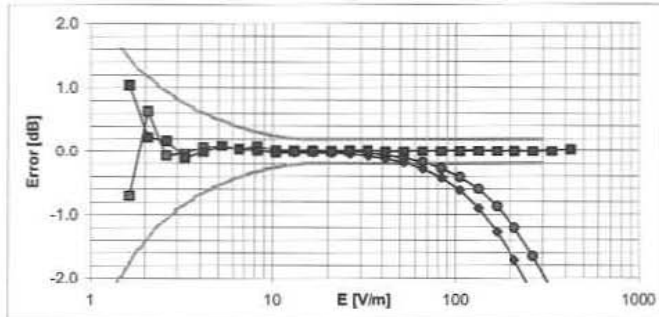
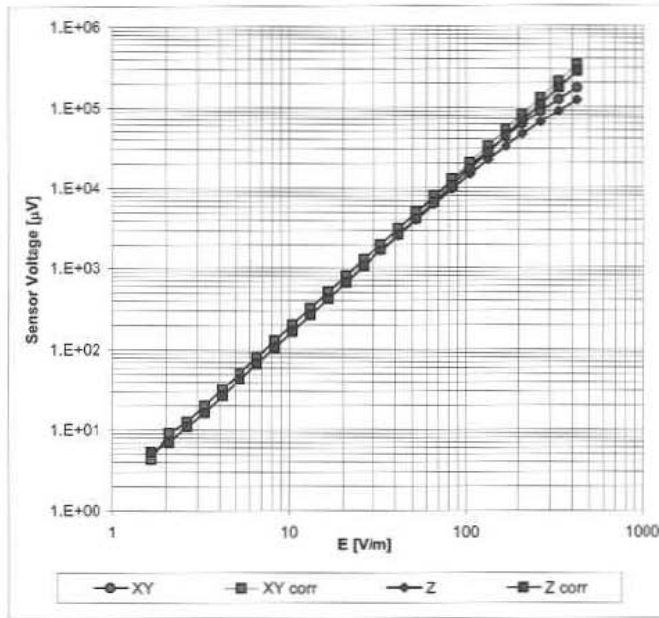


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)


ER3DV6 SN:2286

January 8, 2009

**Dynamic Range f(E-field)**  
 (Waveguide R22, f = 1800 MHz)



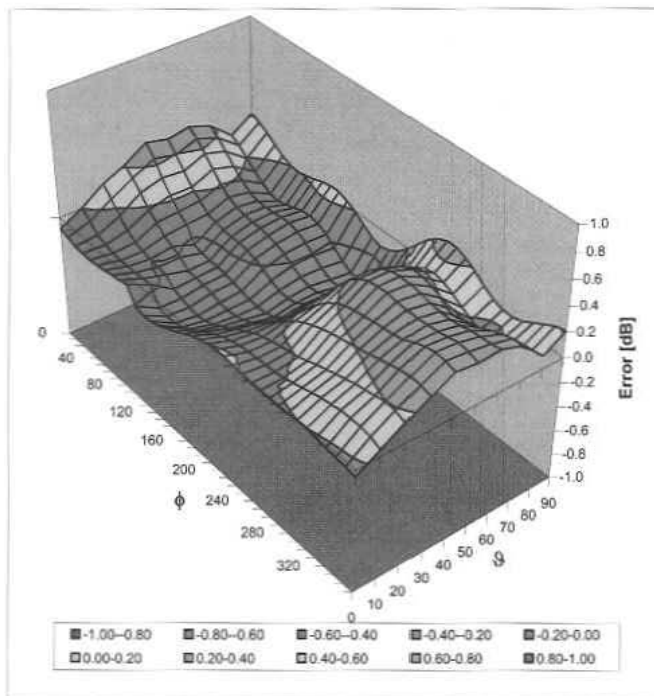
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  (k=2)

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ER3DV6 SN:2286

January 8, 2009

**Deviation from Isotropy in Air  
Error ( $\phi, \vartheta$ ),  $f = 900$  MHz**



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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **RTS (RIM Testing Services)**

Certificate No: H3-6168\_Mar09

### CALIBRATION CERTIFICATE

Object: **H3DV6 - SN:6168**

Calibration procedure(s): **QA CAL-03.v5  
Calibration procedure for H-field probes optimized for close near field evaluations in air**

Calibration date: **March 3, 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).  
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	GB41293674	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)	1-Jul-08 (No. 217-00865)	Jul-09
Reference 20 dB Attenuator	SN: S5086 (20b)	31-Mar-08 (No. 217-00787)	Apr-09
Reference 30 dB Attenuator	SN: S5129 (30b)	1-Jul-08 (No. 217-00866)	Jul-09
Reference Probe H3DV6	SN: 6162	1-Oct-08 (No. H3-6162_Oct08)	Oct-09
DAE4	SN: 789	19-Dec-08 (No. DAE4-789_Dec08)	Dec-09
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642J01700	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-08)	In house check: Oct-09


Calibrated by:	Name	Function	Signature
	Marcel Fehr	Laboratory Technician	
Approved by:	Katja Polkovic	Technical Manager	

Issued: March 9, 2009

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Certificate No: H3-6168\_Mar09

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Accreditation No.: SCS 108

**Glossary:**

NORM<sub>x,y,z</sub> sensitivity in free space  
DCP diode compression point  
Polarization  $\varphi$   $\varphi$  rotation around probe axis  
Polarization  $\vartheta$   $\vartheta$  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:**

- $X, Y, Z_{a0a1a2}$ : 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).
- $X, Y, Z(f)_{a0a1a2} = X, Y, Z_{a0a1a2} \cdot \text{frequency\_response}$  (see Frequency Response Chart).
- $DCP_{x,y,z}$ : DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency.
- 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).



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Author Data	Dates of Test	Report No	FCC ID
<b>Daoud Attayi</b>	<b>July 03, Aug 11, 2009</b>	<b>RTS-1689-0908-37</b>	<b>L6ARCM70UW</b>

H3DV6 SN:6168

March 3, 2009

# Probe H3DV6

## SN:6168

Manufactured:	July 9, 2003
Last calibrated:	March 7, 2008
Recalibrated:	March 3, 2009

Calibrated for DASYS Systems

(Note: non-compatible with DASYS2 system!)



Author Data  
**Daoud Attayi**

Dates of Test  
**July 03, Aug 11, 2009**

Report No  
**RTS-1689-0908-37**

FCC ID  
**L6ARCM70UW**

H3DV6 SN:6168

March 3, 2009

**DASY - Parameters of Probe: H3DV6 SN:6168**

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

	a0	a1	a2
X	2.751E-03	-1.544E-4	-2.207E-5 ± 5.1 % (k=2)
Y	2.647E-03	-1.290E-4	-3.117E-5 ± 5.1 % (k=2)
Z	3.184E-03	-2.570E-4	3.903E-5 ± 5.1 % (k=2)

Diode Compression<sup>1</sup>

DCP X	90 mV
DCP Y	82 mV
DCP Z	83 mV

Sensor Offset (Probe Tip to Sensor Center)

X	3.0 mm
Y	3.0 mm
Z	3.0 mm

Connector Angle -234 °

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%.

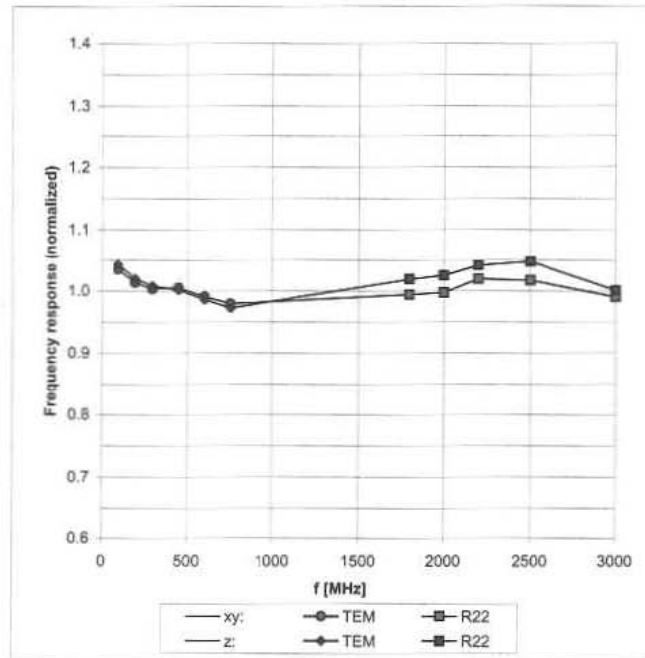
<sup>1</sup> numerical linearization parameter: uncertainty not required

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### Frequency Response of H-Field

(TEM-Cell: ifi110 EXX, Waveguide R22)

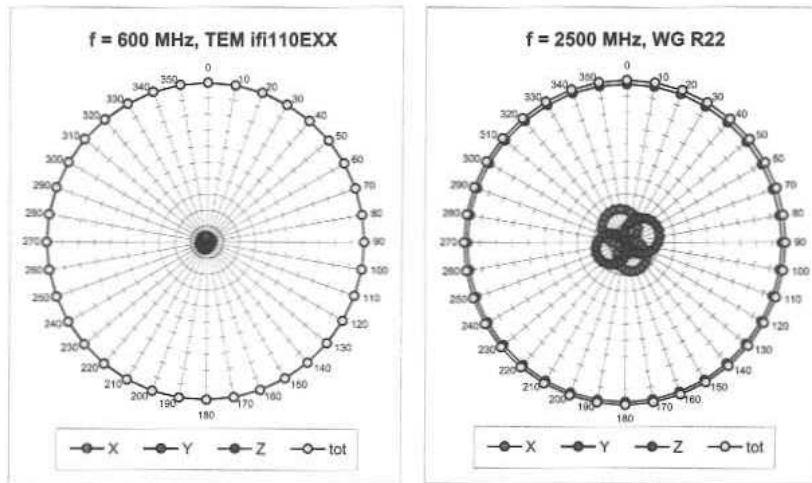


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

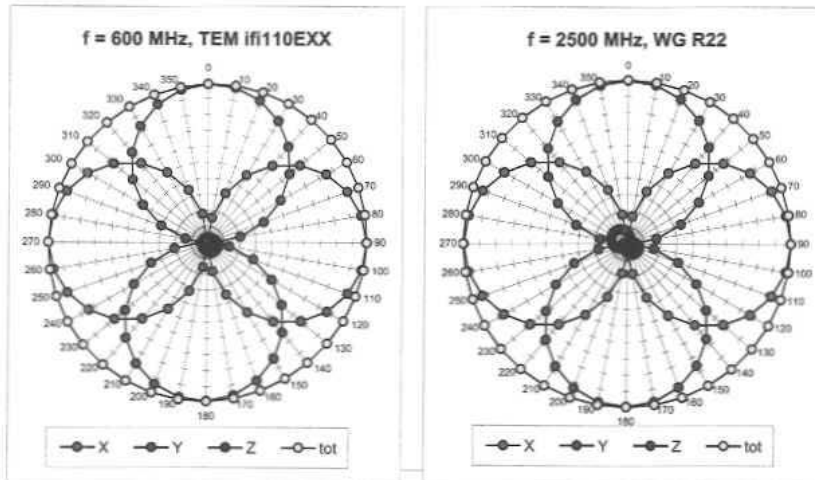
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**Receiving Pattern ( $\phi$ ),  $\vartheta = 90^\circ$**



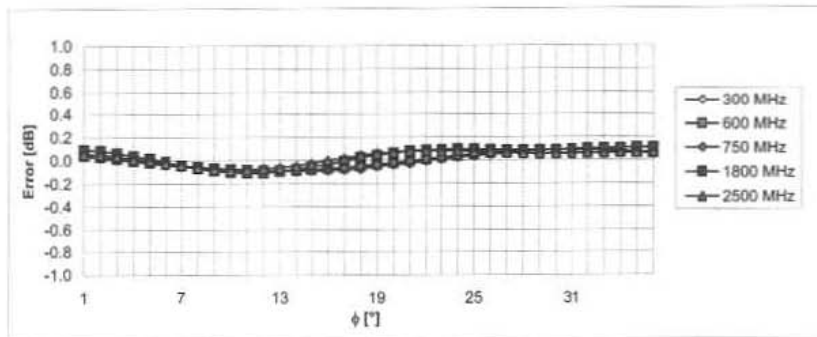
**Receiving Pattern ( $\phi$ ),  $\vartheta = 0^\circ$**



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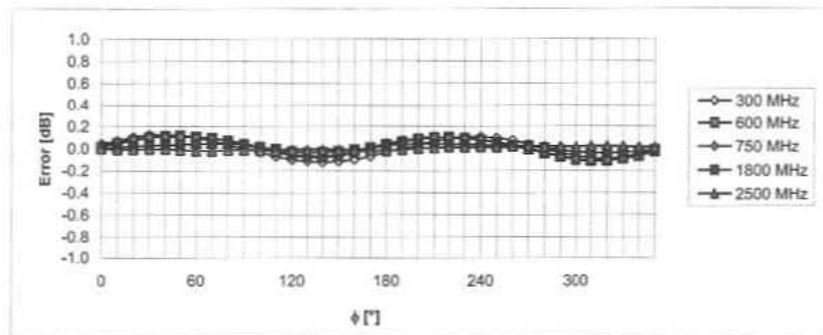
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### Receiving Pattern ( $\phi$ ), $\theta = 90^\circ$



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

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

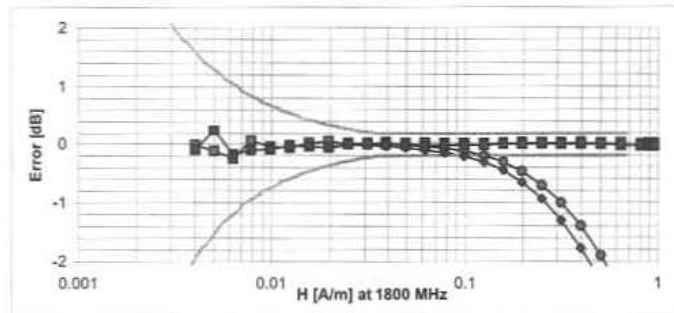
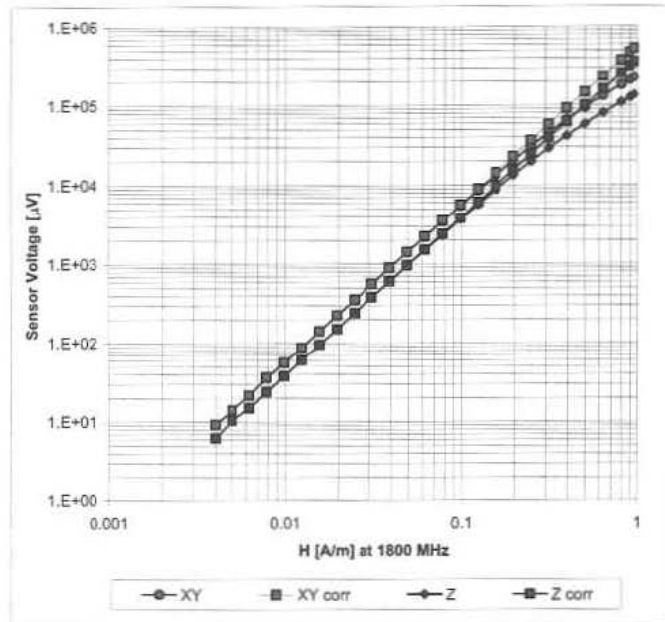


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

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**Dynamic Range f(H-field)**  
 (Waveguide R22, f = 1800 MHz)

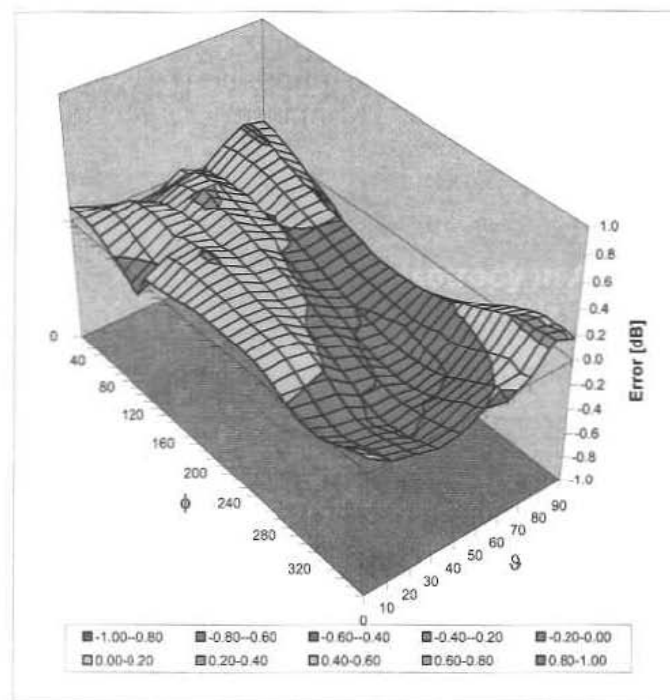


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  (k=2)

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**Deviation from Isotropy in Air**  
**Error ( $\phi, \theta$ ),  $f = 900$  MHz**



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.5\%$  ( $k=2$ )