

## **ATTACHMENT R – PROBE CALIBRATION DATA**

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

**Client** **Hanwha (Dymstec)**

## CALIBRATION CERTIFICATE

Object(s) **ET3DV6 - SN:1607**

Calibration procedure(s) **QA CAL-01.v2**  
**Calibration procedure for dosimetric E-field probes**

Calibration date: **April 28, 2004**

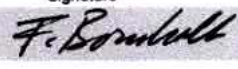
Condition of the calibrated item **In Tolerance (according to the specific calibration document)**

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 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

| Model Type                        | ID #         | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration  |
|-----------------------------------|--------------|-------------------------------------------|------------------------|
| Power meter EPM E442              | GB37480704   | 6-Nov-03 (METAS, No. 252-0254)            | Nov-04                 |
| Power sensor HP 8481A             | US37292783   | 6-Nov-03 (METAS, No. 252-0254)            | Nov-04                 |
| Fluke Process Calibrator Type 702 | SN: 6295803  | 8-Sep-03 (Sintrel SCS No. E-030020)       | Sep-04                 |
| Power sensor HP 8481A             | MY41092180   | 18-Sep-02 (SPEAG, in house check Oct-03)  | In house check: Oct 05 |
| RF generator HP 8684C             | US3642U01700 | 4-Aug-99 (SPEAG, in house check Aug-02)   | In house check: Aug-05 |
| Network Analyzer HP 8753E         | US37390585   | 18-Oct-01 (SPEAG, in house check Oct-03)  | In house check: Oct 05 |

|                |               |                     |                                                                                       |
|----------------|---------------|---------------------|---------------------------------------------------------------------------------------|
|                | Name          | Function            | Signature                                                                             |
| Calibrated by: | Nico Vetterli | Technician          |  |
| Approved by:   | Katja Pokovic | Laboratory Director |  |

Date issued: April 28, 2004

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

# Probe ET3DV6

## SN:1607

|                  |                |
|------------------|----------------|
| Manufactured:    | July 27, 2001  |
| Last calibrated: | August 7, 2001 |
| Recalibrated:    | April 28, 2004 |

**Calibrated for DASY Systems**

(Note: non-compatible with DASY2 system!)

ET3DV6 SN:1607

April 28, 2004

## DASY - Parameters of Probe: ET3DV6 SN:1607

### Sensitivity in Free Space

|       |                                          |
|-------|------------------------------------------|
| NormX | 1.74 $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormY | 1.80 $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormZ | 1.74 $\mu\text{V}/(\text{V}/\text{m})^2$ |

### Diode Compression<sup>A</sup>

|       |    |    |
|-------|----|----|
| DCP X | 90 | mV |
| DCP Y | 90 | mV |
| DCP Z | 90 | mV |

### Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 7.

### Boundary Effect

Head                      900 MHz              Typical SAR gradient: 5 % per mm

|                                           |                              |        |        |
|-------------------------------------------|------------------------------|--------|--------|
| Sensor Center to Phantom Surface Distance |                              | 3.7 mm | 4.7 mm |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 8.8    | 4.4    |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.0    | 0.1    |

Head                      1800 MHz              Typical SAR gradient: 10 % per mm

|                                           |                              |        |        |
|-------------------------------------------|------------------------------|--------|--------|
| Sensor Center to Phantom Surface Distance |                              | 3.7 mm | 4.7 mm |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 14.5   | 9.8    |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.2    | 0.2    |

### Sensor Offset

|                            |              |
|----------------------------|--------------|
| Probe Tip to Sensor Center | 2.7 mm       |
| Optical Surface Detection  | in tolerance |

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%.

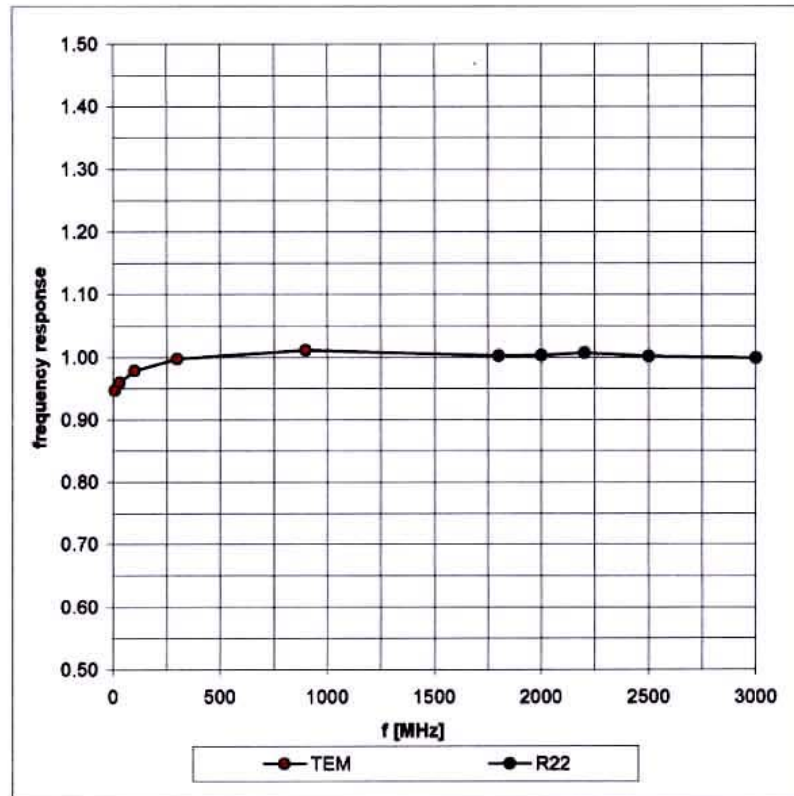
<sup>A</sup> numerical linearization parameter; uncertainty not required

ET3DV6 SN:1607

April 28, 2004

## Frequency Response of E-Field

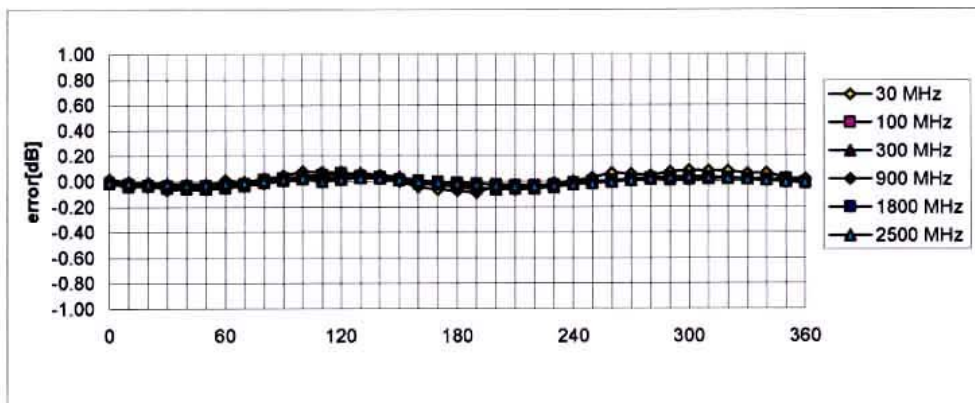
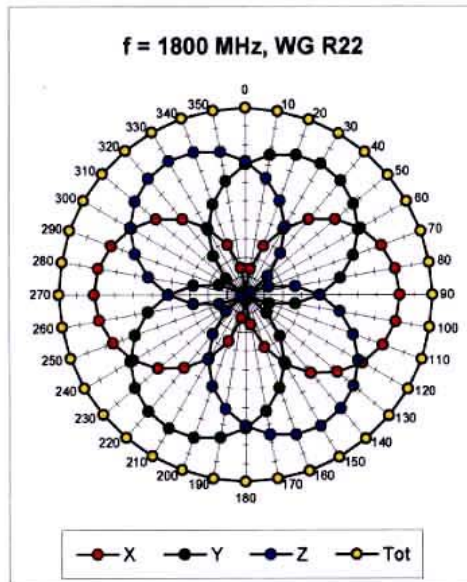
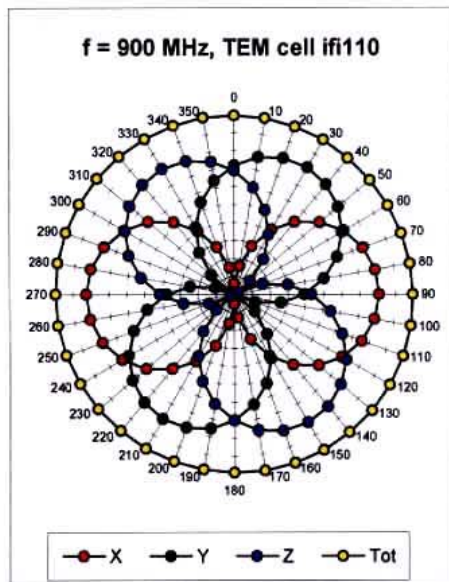
( TEM-Cell:ifi110, Waveguide R22)



ET3DV6 SN:1607

April 28, 2004

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

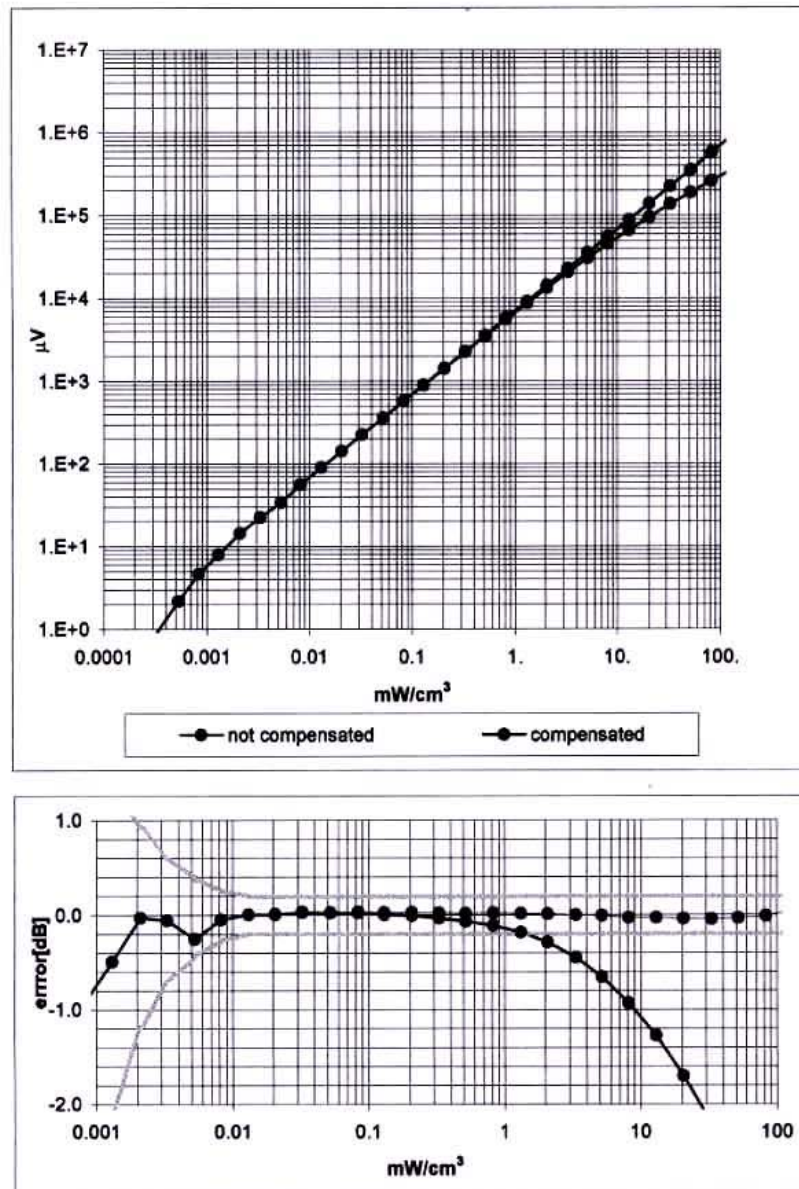


**Axial Isotropy Error <  $\pm 0.2$  dB**

ET3DV6 SN:1607

April 28, 2004

### Dynamic Range f(SAR<sub>head</sub>) ( Waveguide R22 )

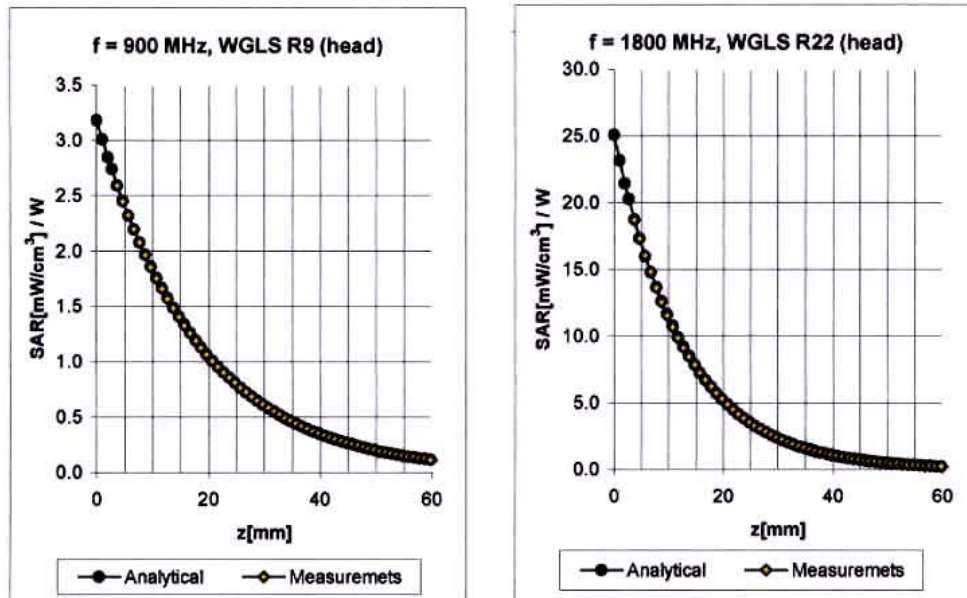


Probe Linearity  $< \pm 0.2$  dB

ET3DV6 SN:1607

April 28, 2004

## Conversion Factor Assessment



| f [MHz] | Validity [MHz] <sup>B</sup> | Tissue | Permittivity | Conductivity | Alpha | Depth | ConvF        | Uncertainty |
|---------|-----------------------------|--------|--------------|--------------|-------|-------|--------------|-------------|
| 900     | 800-1000                    | Head   | 41.5 ± 5%    | 0.97 ± 5%    | 0.81  | 1.60  | 6.22 ± 11.3% | (k=2)       |
| 1800    | 1710-1910                   | Head   | 40.0 ± 5%    | 1.40 ± 5%    | 0.53  | 2.60  | 5.10 ± 11.7% | (k=2)       |
| 835     | 750-950                     | Body   | 55.2 ± 5%    | 0.97 ± 5%    | 0.62  | 1.90  | 6.26 ± 11.9% | (k=2)       |
| 1900    | 1800-2000                   | Body   | 53.3 ± 5%    | 1.52 ± 5%    | 0.63  | 2.67  | 4.54 ± 11.3% | (k=2)       |

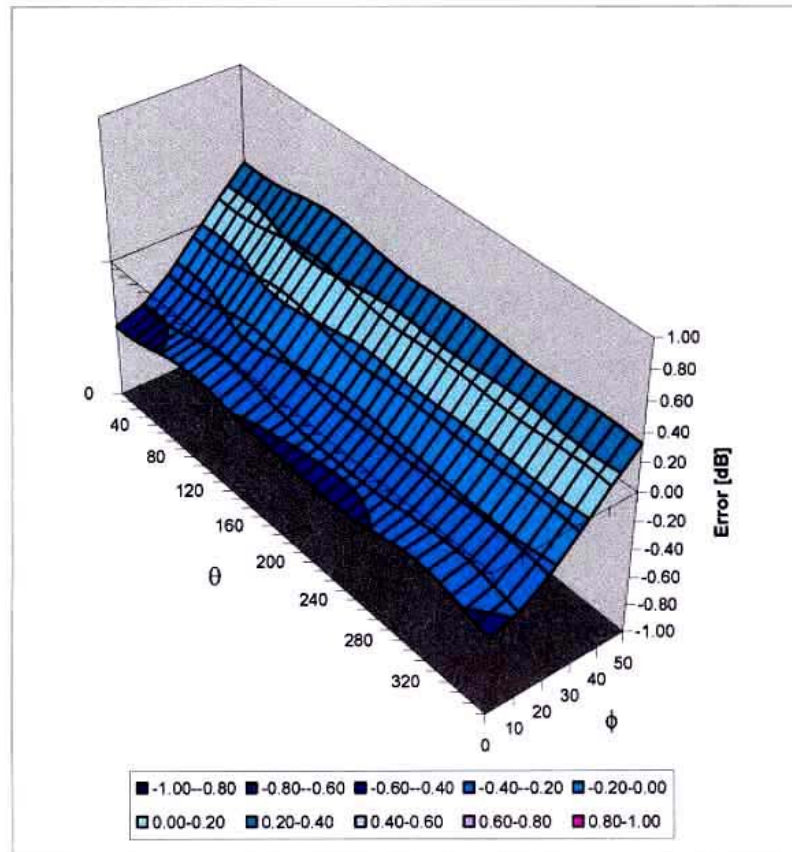
<sup>B</sup> The total standard uncertainty is calculated as root-sum-square of standard uncertainty of the Conversion Factor at calibration frequency and the standard uncertainty for the indicated frequency band.

ET3DV6 SN:1607

April 28, 2004

## Deviation from Isotropy in HSL

Error ( $\theta, \phi$ ),  $f = 900$  MHz



Spherical Isotropy Error <  $\pm 0.4$  dB

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## Additional Conversion Factors

for Dosimetric E-Field Probe

Type:

**ET3DV6**

Serial Number:

**1607**

Place of Assessment:

**Zurich**

Date of Assessment:

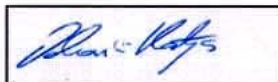
**May 1, 2004**

Probe Calibration Date:

**April 28, 2004**

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. Since the evaluation is coupled with measured conversion factors, it has to be recalculated yearly, i.e., following the re-calibration schedule of the probe. The uncertainty of the numerical assessment is based on the extrapolation from measured value at 900 MHz or at 1800 MHz.

Assessed by:



ET3DV6-SN:1607

Page 1 of 2

May 1, 2004

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**Dosimetric E-Field Probe ET3DV6 SN:1607**Conversion factor ( $\pm$  standard deviation)**450 MHz**      ConvF       **$7.3 \pm 8\%$** 

$\epsilon_r = 43.5 \pm 5\%$   
 $\sigma = 0.87 \pm 5\%$  mho/m  
(head tissue)

**450 MHz**      ConvF       **$7.1 \pm 8\%$** 

$\epsilon_r = 56.7 \pm 5\%$   
 $\sigma = 0.94 \pm 5\%$  mho/m  
(body tissue)

**Important Note:**

For numerically assessed probe conversion factors, parameters Alpha and Delta in the DASY software must have the following entries: Alpha = 0 and Delta = 1.

Please see also Section 4.7 of the DASY4 Manual.

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

**Client**      **H-CT (Dymstec)**

## CALIBRATION CERTIFICATE

**Object(s)**      **ET3DV6 - SN:1609**

**Calibration procedure(s)**      **QA CAL-01.v2**  
**Calibration procedure for dosimetric E-field probes**

**Calibration date:**      **September 2, 2004**

**Condition of the calibrated item**      **In Tolerance (according to the specific calibration document)**

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 +/- 2 degrees Celsius and humidity < 75%.

**Calibration Equipment used (M&TE critical for calibration)**

| Model Type                        | ID #           | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration  |
|-----------------------------------|----------------|-------------------------------------------|------------------------|
| Power meter EPM E4419B            | GB41293874     | 5-May-04 (METAS, No 251-00388)            | May-05                 |
| Power sensor E4412A               | MY41495277     | 5-May-04 (METAS, No 251-00388)            | May-05                 |
| Reference 20 dB Attenuator        | SN: 5086 (20b) | 3-May-04 (METAS, No 251-00389)            | May-05                 |
| Fluke Process Calibrator Type 702 | SN: 6295803    | 8-Sep-03 (Sintrel SCS No. E030020)        | Sep-04                 |
| Power sensor HP 8481A             | MY41092180     | 18-Sep-02 (SPEAG, in house check Oct03)   | In house check: Oct 05 |
| RF generator HP 8684C             | US3642U01700   | 4-Aug-99 (SPEAG, in house check Aug02)    | In house check: Aug05  |
| Network Analyzer HP 8753E         | US37390585     | 18-Oct-01 (SPEAG, in house check Oct03)   | In house check: Oct 05 |

|                       |               |                     |                                                                                       |
|-----------------------|---------------|---------------------|---------------------------------------------------------------------------------------|
|                       | <b>Name</b>   | <b>Function</b>     | <b>Signature</b>                                                                      |
| <b>Calibrated by:</b> | Nico Vetterli | Technician          |  |
| <b>Approved by:</b>   | Katja Pokovic | Laboratory Director |  |

Date issued: September 2, 2004

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

# Probe ET3DV6

## SN:1609

|                  |                   |
|------------------|-------------------|
| Manufactured:    | July 27, 2001     |
| Last calibrated: | January 22, 2004  |
| Repaired:        | August 18, 2004   |
| Recalibrated:    | September 2, 2004 |

**Calibrated for DASY Systems**

(Note: non-compatible with DASY2 system!)

ET3DV6 SN:1609

September 2, 2004

## DASY - Parameters of Probe: ET3DV6 SN:1609

### Sensitivity in Free Space

|       |                                                 |
|-------|-------------------------------------------------|
| NormX | <b>1.86</b> $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormY | <b>1.79</b> $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormZ | <b>1.78</b> $\mu\text{V}/(\text{V}/\text{m})^2$ |

### Diode Compression<sup>A</sup>

|       |           |    |
|-------|-----------|----|
| DCP X | <b>96</b> | mV |
| DCP Y | <b>96</b> | mV |
| DCP Z | <b>96</b> | mV |

### Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 7.

### Boundary Effect

**Head**                      **900 MHz**      **Typical SAR gradient: 5 % per mm**

|                                           |                              |               |               |
|-------------------------------------------|------------------------------|---------------|---------------|
| Sensor Center to Phantom Surface Distance |                              | <b>3.7 mm</b> | <b>4.7 mm</b> |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 8.8           | 4.3           |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.0           | 0.1           |

**Head**                      **1800 MHz**      **Typical SAR gradient: 10 % per mm**

|                                           |                              |               |               |
|-------------------------------------------|------------------------------|---------------|---------------|
| Sensor Center to Phantom Surface Distance |                              | <b>3.7 mm</b> | <b>4.7 mm</b> |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 13.6          | 9.0           |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.2           | 0.0           |

### Sensor Offset

|                            |                     |
|----------------------------|---------------------|
| Probe Tip to Sensor Center | <b>2.7</b> mm       |
| Optical Surface Detection  | <b>in tolerance</b> |

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%.

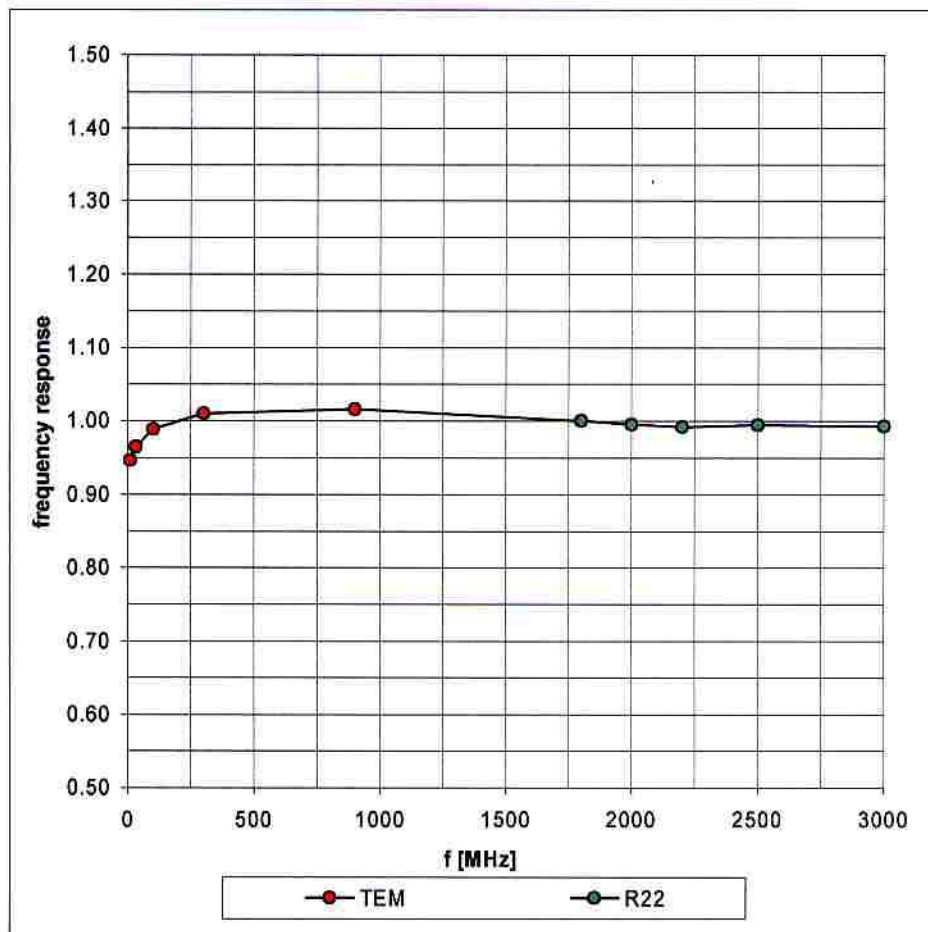
<sup>A</sup> numerical linearization parameter: uncertainty not required

ET3DV6 SN:1609

September 2, 2004

## Frequency Response of E-Field

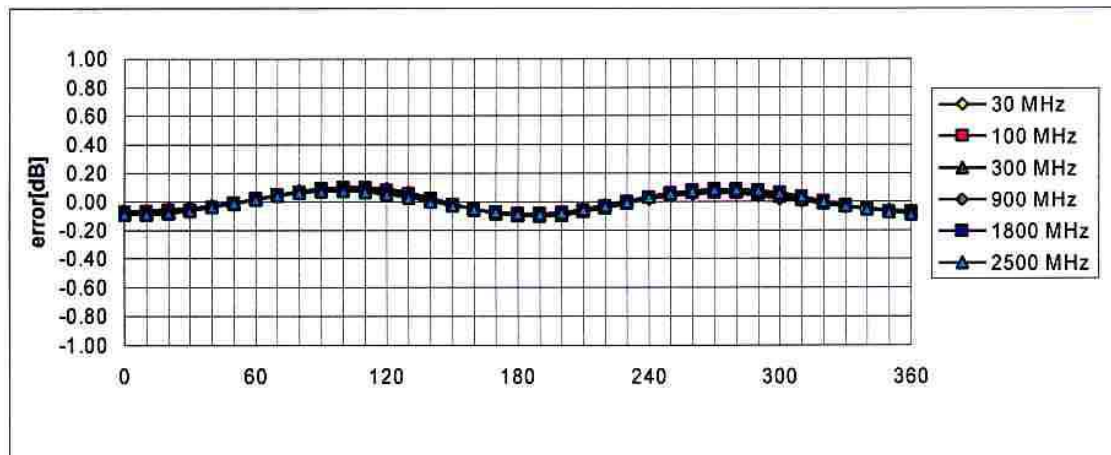
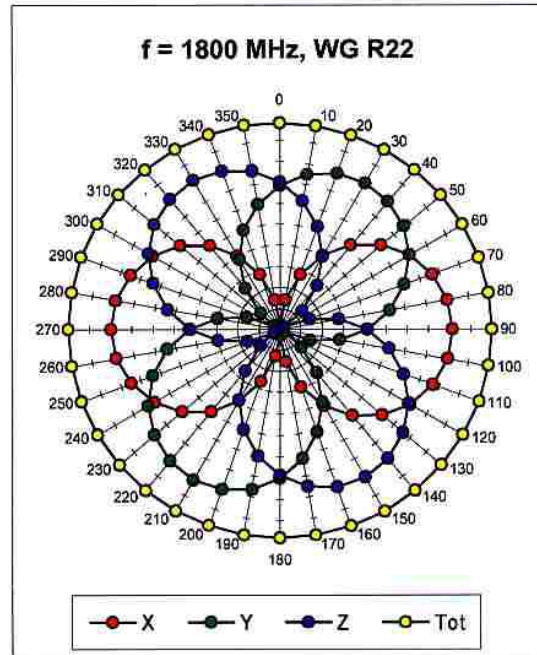
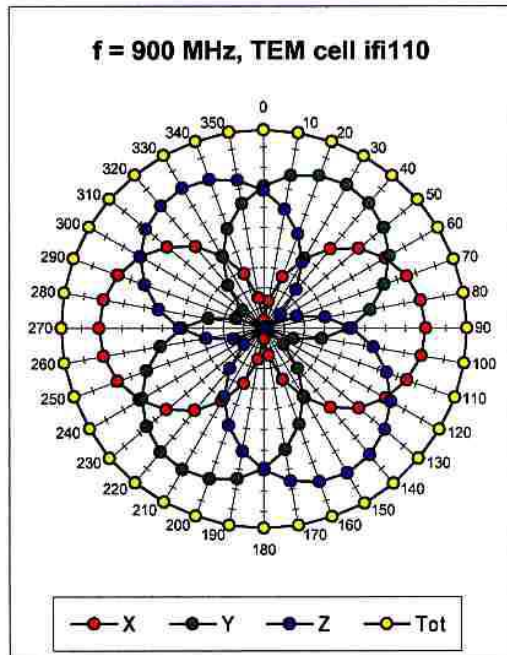
( TEM-Cell:ifi110, Waveguide R22)



ET3DV6 SN:1609

September 2, 2004

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

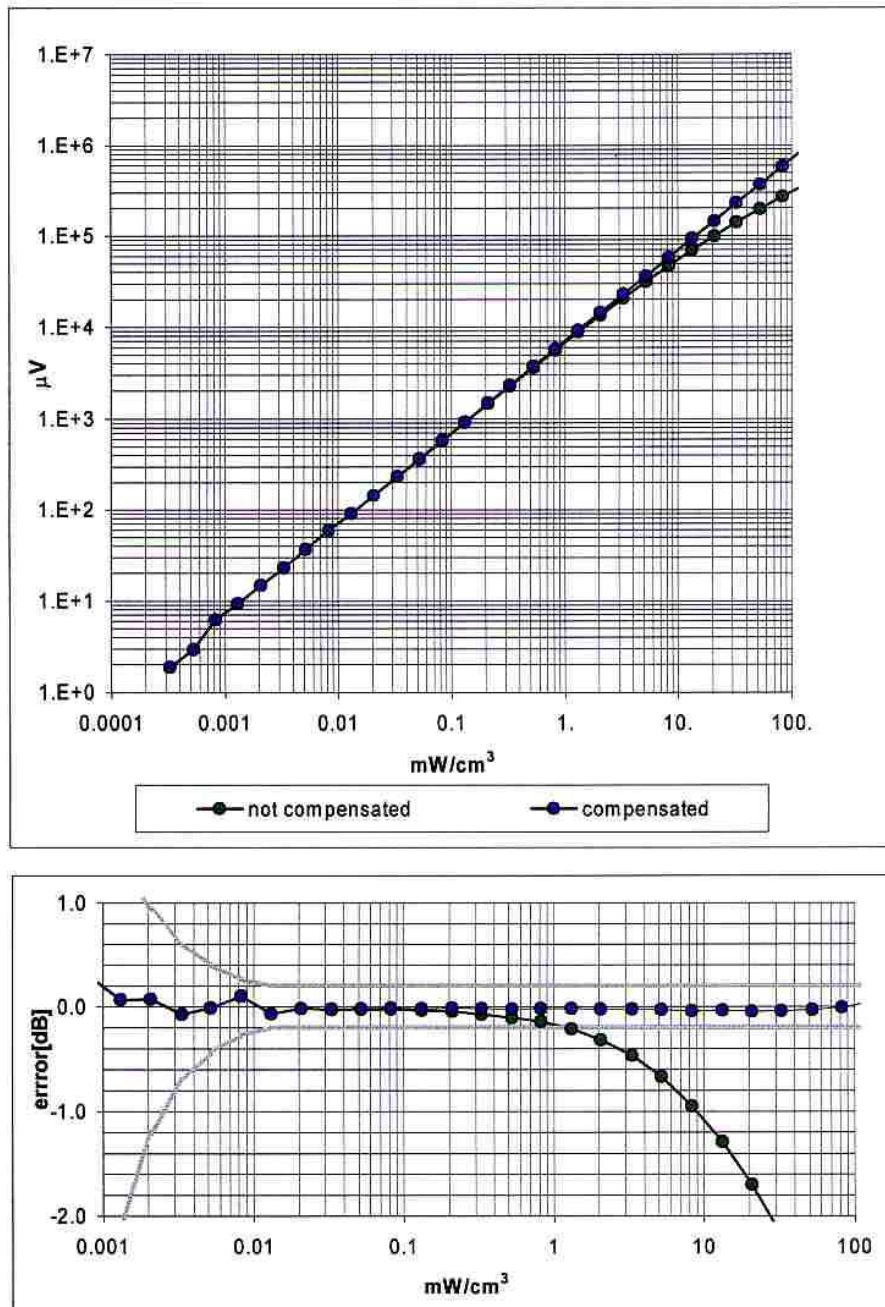


**Axial Isotropy Error  $< \pm 0.2$  dB**

ET3DV6 SN:1609

September 2, 2004

## Dynamic Range f(SAR<sub>head</sub>) ( Waveguide R22 )

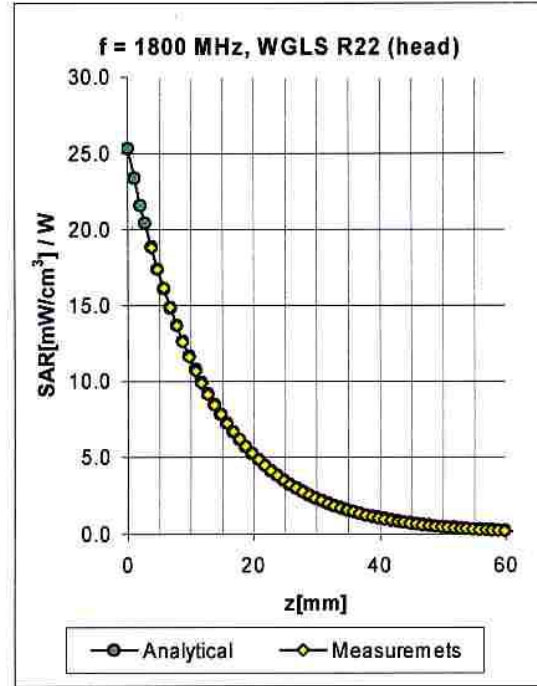
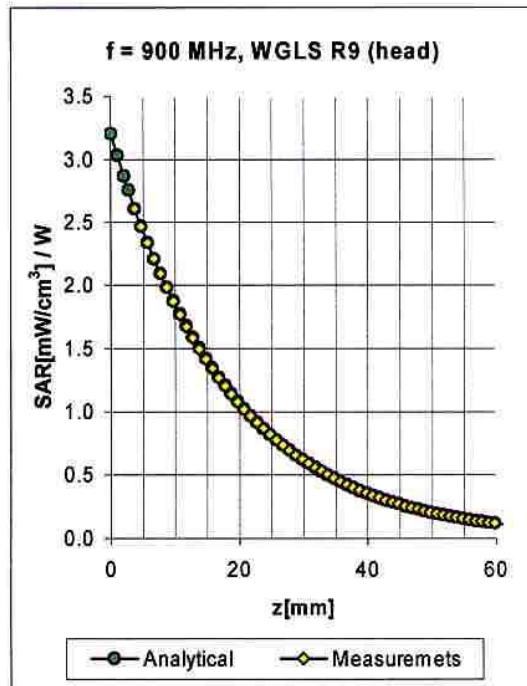


Probe Linearity Error  $< \pm 0.2$  dB

ET3DV6 SN:1609

September 2, 2004

## Conversion Factor Assessment



| f [MHz] | Validity [MHz] <sup>B</sup> | Tissue | Permittivity | Conductivity | Alpha | Depth | ConvF Uncertainty  |
|---------|-----------------------------|--------|--------------|--------------|-------|-------|--------------------|
| 450     | 400-500                     | Head   | 43.5 ± 5%    | 0.87 ± 5%    | 0.19  | 2.72  | 7.69 ± 15.5% (k=2) |
| 900     | 800-1000                    | Head   | 41.5 ± 5%    | 0.97 ± 5%    | 0.90  | 1.53  | 6.63 ± 11.3% (k=2) |
| 1800    | 1710-1910                   | Head   | 40.0 ± 5%    | 1.40 ± 5%    | 0.50  | 2.61  | 5.34 ± 11.7% (k=2) |
| 1950    | 1900-2000                   | Head   | 40.0 ± 5%    | 1.40 ± 5%    | 0.57  | 2.70  | 4.89 ± 9.7% (k=2)  |
| 2450    | 2400-2500                   | Head   | 39.2 ± 5%    | 1.80 ± 5%    | 0.99  | 1.92  | 4.57 ± 9.7% (k=2)  |
| 450     | 400-500                     | Body   | 56.7 ± 5%    | 0.94 ± 5%    | 0.14  | 2.69  | 7.40 ± 15.5% (k=2) |
| 835     | 750-950                     | Body   | 55.2 ± 5%    | 0.97 ± 5%    | 0.58  | 1.95  | 6.47 ± 11.9% (k=2) |
| 1900    | 1800-2000                   | Body   | 53.3 ± 5%    | 1.52 ± 5%    | 0.59  | 2.76  | 4.60 ± 11.3% (k=2) |
| 2450    | 2400-2500                   | Body   | 52.7 ± 5%    | 1.95 ± 5%    | 1.21  | 1.63  | 4.44 ± 9.7% (k=2)  |

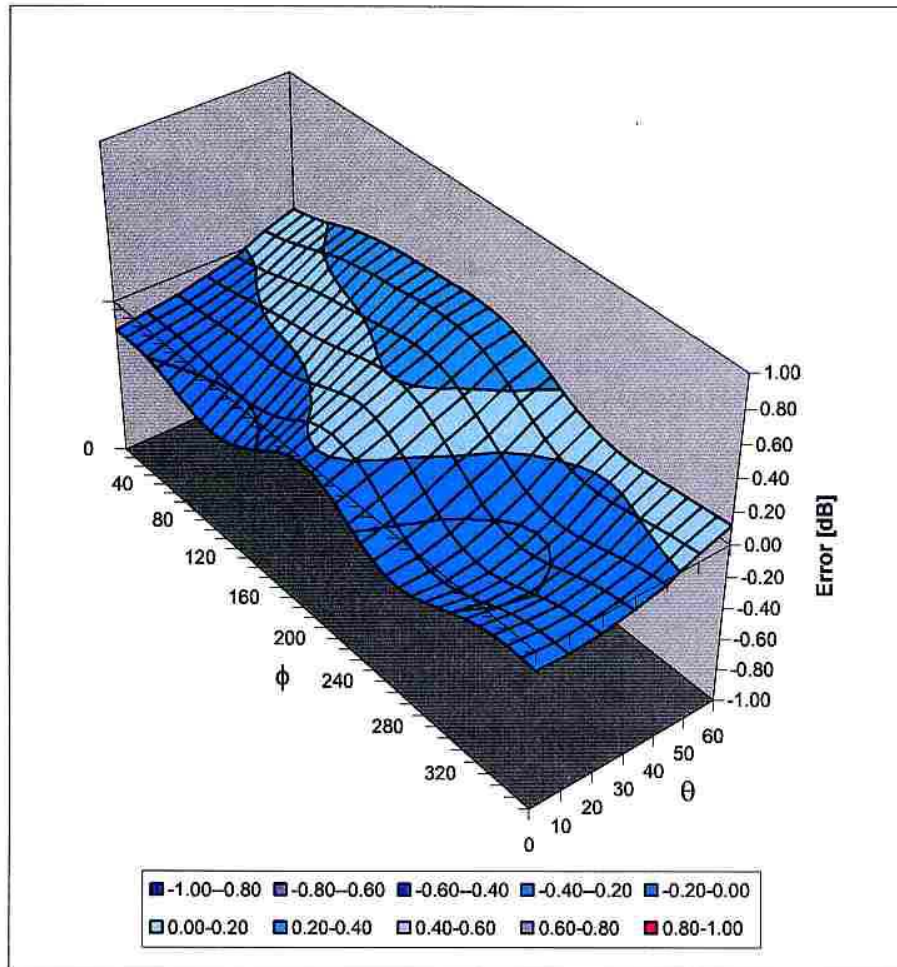
<sup>B</sup> The total standard uncertainty is calculated as root-sum-square of standard uncertainty of the Conversion Factor at calibration frequency and the standard uncertainty for the indicated frequency band.

ET3DV6 SN:1609

September 2, 2004

## Deviation from Isotropy in HSL

Error ( $\theta, \phi$ ),  $f = 900$  MHz



Spherical Isotropy Error  $< \pm 0.4$  dB

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## IMPORTANT NOTICE

### USAGE OF PROBES IN ORGANIC SOLVENTS

Diethylene Glycol Monobuthy Ether (the basis for liquids above 1 GHz), as many other organic solvents, is a very effective softener for synthetic materials. These solvents can cause irreparable damage to certain SPEAG products, except those which are explicitly declared as compliant with organic solvents.

#### Compatible Probes:

- ET3DV6
- ET3DV6R
- ES3DVx
- ER3DV6
- H3DV6

#### Important Note for ET3DV6 Probes:

**The ET3DV6 probes shall not be exposed to solvents longer than necessary for the measurements and shall be cleaned daily after use with warm water and stored dry.**

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