

**APPENDIX 4 : System Validation Dipole (D2450V2,S/N: 765)**

**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 Federal Office of Metrology and Accreditation  
 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 **MTT**

Certificate No: D2450V2-765\_Nov04

## CALIBRATION CERTIFICATE

Object: **D2450V2 - SN: 765**

Calibration procedure(s): **QA CAL-05.v6**  
 Calibration procedure for dipole validation kits

Calibration date: **November 15, 2004**

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 (Calibrated by, Certificate No.) | Scheduled Calibration  |
|----------------------------|------------------|-------------------------------------------|------------------------|
| Power meter EPM E442       | GB37480704       | 12-Oct-04 (METAS, No. 251-00412)          | Oct-05                 |
| Power sensor HP 8481A      | US37252783       | 12-Oct-04 (METAS, No. 251-00412)          | Oct-05                 |
| Reference 20 dB Attenuator | SN: 5086 (20g)   | 10-Aug-04 (METAS, No. 251-00402)          | Aug-05                 |
| Reference 10 dB Attenuator | SN: 5047.2 (10r) | 10-Aug-04 (METAS, No. 251-00402)          | Aug-05                 |
| Reference Probe ES3DV2     | SN 3025          | 29-Oct-04 (SPEAG, No. ES3-3025_Oct04)     | Oct-05                 |
| DAE4                       | SN 601           | 6-Nov-03 (SPEAG, No. DAE4-601_Jul04)      | Jul-05                 |
| Secondary Standards        | ID #             | Check Date (in house)                     | Scheduled Check        |
| Power sensor HP 8481A      | MY41092317       | 18-Oct-02 (SPEAG, in house check Oct-03)  | In house check: Oct-05 |
| RF generator R&S SML-03    | 100698           | 27-Mar-02 (SPEAG, in house check Dec-03)  | In house check: Dec-05 |
| Network Analyzer HP 8753E  | US37390585 S4206 | 18-Oct-01 (SPEAG, in house check Nov-03)  | In house check: Nov-04 |

|                |                              |                                   |               |
|----------------|------------------------------|-----------------------------------|---------------|
| Calibrated by: | Name<br><b>Mike Meili</b>    | Function<br>Laboratory Technician | Signature<br> |
| Approved by:   | Name<br><b>Katja Pokovic</b> | Technical Manager                 |               |

Issued: November 17, 2004

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

Certificate No: D2450V2-765\_Nov04

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Accreditation No.: **SCS 108**

**Glossary:**

|       |                                 |
|-------|---------------------------------|
| TSL   | tissue simulating liquid        |
| ConvF | sensitivity in TSL / NORM x,y,z |
| N/A   | not applicable or not measured  |

**Calibration is Performed According to the Following Standards:**

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz), July 2001
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- DASY4 System Handbook

**Methods Applied and Interpretation of Parameters:**

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

#### Measurement Conditions

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

|                              |                           |             |
|------------------------------|---------------------------|-------------|
| DASY Version                 | DASY4                     | V4.4        |
| Extrapolation                | Advanced Extrapolation    |             |
| Phantom                      | Modular Flat Phantom V5.0 |             |
| Distance Dipole Center - TSL | 10 mm                     | with Spacer |
| Area Scan resolution         | dx, dy = 15 mm            |             |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm         |             |
| Frequency                    | 2450 MHz $\pm$ 1 MHz      |             |

#### Head TSL parameters

The following parameters and calculations were applied.

|                                  | Temperature         | Permittivity   | Conductivity         |
|----------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters      | 22.0 °C             | 39.2           | 1.80 mho/m           |
| Measured Head TSL parameters     | (23.0 $\pm$ 0.2) °C | 38.3 $\pm$ 6 % | 1.86 mho/m $\pm$ 6 % |
| Head TSL temperature during test | (23.0 $\pm$ 0.2) °C | ----           | ----                 |

#### SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | condition          |                                |
|-------------------------------------------------------|--------------------|--------------------------------|
| SAR measured                                          | 250 mW input power | 13.5 mW / g                    |
| SAR normalized                                        | normalized to 1W   | 54.0 mW / g                    |
| SAR for nominal Head TSL parameters <sup>1</sup>      | normalized to 1W   | 52.7 mW / g $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                |
|---------------------------------------------------------|--------------------|--------------------------------|
| SAR measured                                            | 250 mW input power | 8.15 mW / g                    |
| SAR normalized                                          | normalized to 1W   | 24.6 mW / g                    |
| SAR for nominal Head TSL parameters <sup>1</sup>        | normalized to 1W   | 24.0 mW / g $\pm$ 16.5 % (k=2) |

<sup>1</sup> Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

**Body TSL parameters**

The following parameters and calculations were applied.

|                                  | Temperature     | Permittivity | Conductivity     |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters      | 22.0 °C         | 52.7         | 1.95 mho/m       |
| Measured Body TSL parameters     | (22.0 ± 0.2) °C | 51.7 ± 6 %   | 1.96 mho/m ± 6 % |
| Body TSL temperature during test | (22.0 ± 0.2) °C | ----         | ----             |

**SAR result with Body TSL**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | condition          |                            |
|-------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                          | 250 mW input power | 13.3 mW / g                |
| SAR normalized                                        | normalized to 1W   | 53.2 mW / g                |
| SAR for nominal Body TSL parameters <sup>2</sup>      | normalized to 1W   | 52.5 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                            |
|---------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                            | 250 mW input power | 6.12 mW / g                |
| SAR normalized                                          | normalized to 1W   | 24.5 mW / g                |
| SAR for nominal Body TSL parameters <sup>1</sup>        | normalized to 1W   | 24.1 mW / g ± 16.5 % (k=2) |

<sup>2</sup> Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

## Appendix

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $52.7 \Omega + j4.6 \Omega$ |
| Return Loss                          | - 25.8 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $48.9 \Omega + j6.3 \Omega$ |
| Return Loss                          | - 23.8 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.175 ns |
|----------------------------------|----------|

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for IDC-signals.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

|                 |                 |
|-----------------|-----------------|
| Manufactured by | SPEAG           |
| Manufactured on | August 10, 2004 |

#### DASY4 Validation Report for Head TSL

Date/Time: 11/17/04 10:57:18

Test Laboratory: SPEAG, Zürich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN765**

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: HSL 2450 MHz;

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.86$  mho/m;  $\epsilon_r = 38.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.4, 4.4, 4.4); Calibrated: 29.10.2004
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 22.07.2004
- Phantom: Flat Phantom quarter size -SN:1001; Type: QD000P50AA; Serial: SN:1001
- Measurement SW: DASY4, V4.4 Build 3; Postprocessing SW: SEMCAD, V1.8 Build 130

**Pin = 250 mW; d = 10 mm/Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (interpolated) = 15.6 mW/g

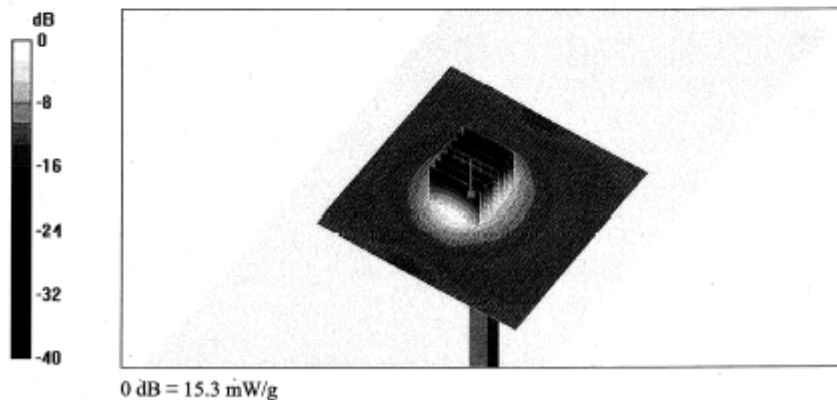
**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 79.7 V/m; Power Drift = 0.2 dB

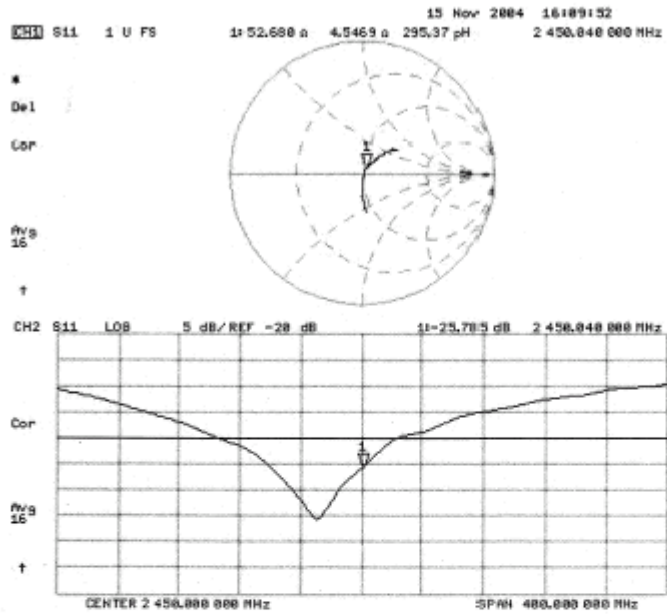
Peak SAR (extrapolated) = 29 W/kg

**SAR(1 g) = 13.5 mW/g; SAR(10 g) = 6.15 mW/g**

Maximum value of SAR (measured) = 15.3 mW/g



Impedance Measurement Plot for Head TSL



#### DASY4 Validation Report for Body TSL

Date/Time: 11/17/04 10:57:37

Test Laboratory: SPEAG, Zürich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN765**

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: MSL 2450 MHz;

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.96$  mho/m;  $\epsilon_r = 51.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.13, 4.13, 4.13); Calibrated: 29.10.2004
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 22.07.2004
- Phantom: SAM with CRP - TP1006; Type: SAM 4.0; Serial: TP:1006
- Measurement SW: DASY4, V4.4 Build 3; Postprocessing SW: SEMCAD, V1.8 Build 130

**Pin = 250 mW; d = 10 mm/Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 15.3 mW/g

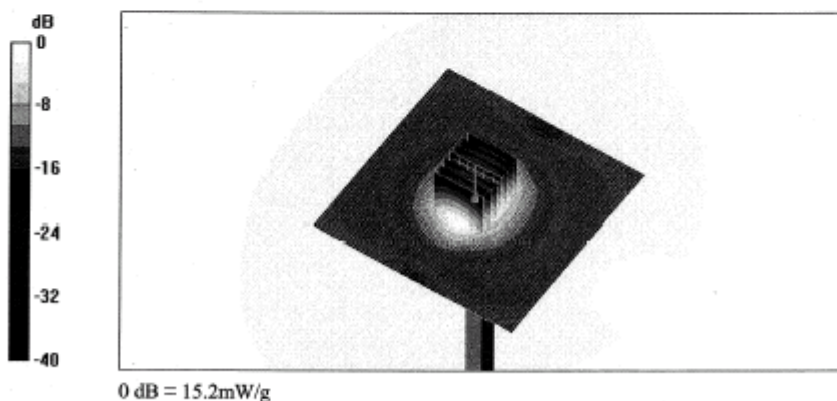
**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 88.6 V/m; Power Drift = 0.1 dB

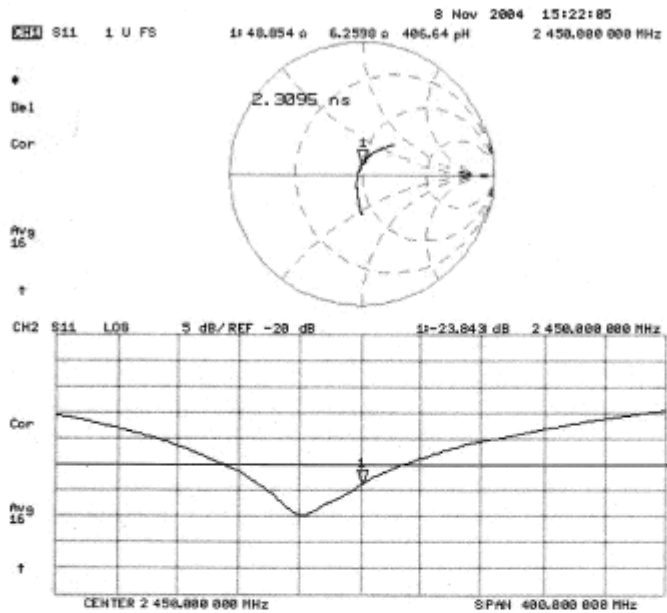
Peak SAR (extrapolated) = 27.4 W/kg

**SAR(1 g) = 13.3 mW/g; SAR(10 g) = 6.12 mW/g**

Maximum value of SAR (measured) = 15.2 mW/g



Impedance Measurement Plot for Body TSL



**APPENDIX 5 : Dosimetric E-Field Probe Calibration (ET3DV6,S/N: 1684)**

Schmid & Partner Engineering AG

**s p e a g**

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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.

**s p e a g**

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Technical Note 01.06.15-1

June 2002

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**Client** **UL A-Pax (MITT)**

## CALIBRATION CERTIFICATE

**Object(s)** **ET3DV6 - SN 1684**

**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 |

**Calibrated by:** **Name** **Function** **Signature**  
**Nico Veseli** **Technician** 

**Approved by:** **Name** **Function** **Signature**  
**Karla 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:1684

|                  |                   |
|------------------|-------------------|
| Manufactured:    | April 3, 2002     |
| Last calibrated: | November 20, 2002 |
| Recalibrated:    | September 2, 2004 |

**Calibrated for DASY Systems**

(Note: non-compatible with DASY2 system!)

ET3DV6 SN:1684

September 2, 2004

## DASY - Parameters of Probe: ET3DV6 SN:1684

### Sensitivity in Free Space

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

|       |                                          |       |    |    |
|-------|------------------------------------------|-------|----|----|
| NormX | 1.58 $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP X | 96 | mV |
| NormY | 1.58 $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP Y | 96 | mV |
| NormZ | 1.62 $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP Z | 96 | 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 | 7.2    | 3.6    |
| 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 | 11.6   | 8.2    |
| 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%.

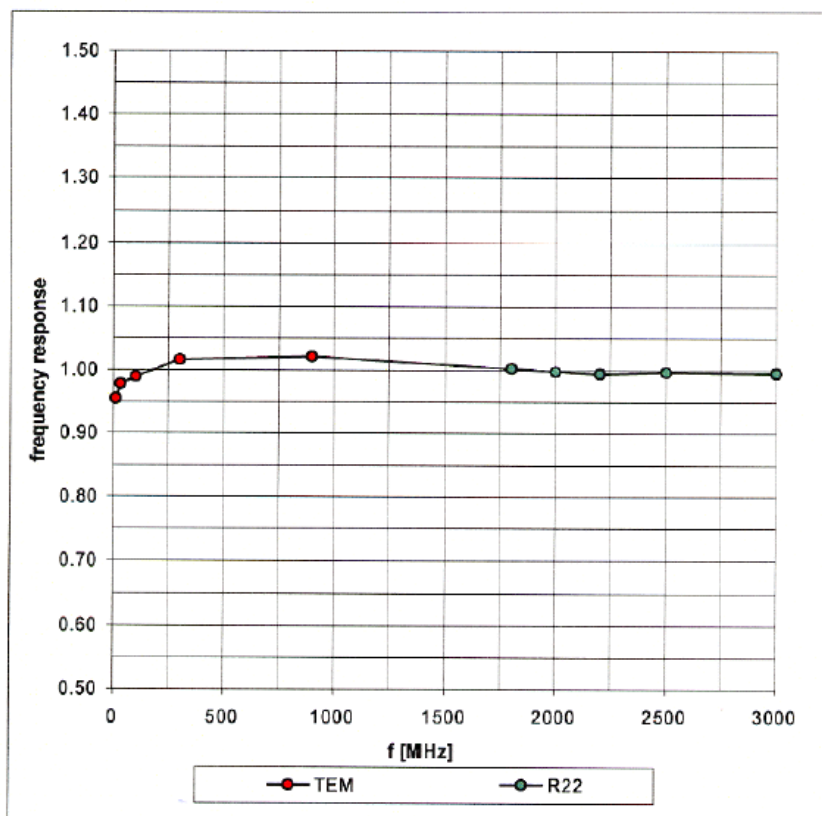
<sup>A</sup> numerical linearization parameter: uncertainty not required

ET3DV6 SN:1684

September 2, 2004

## Frequency Response of E-Field

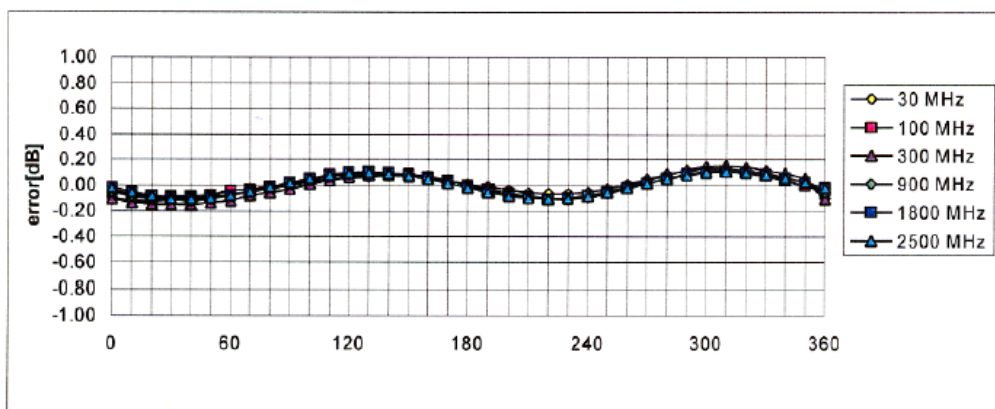
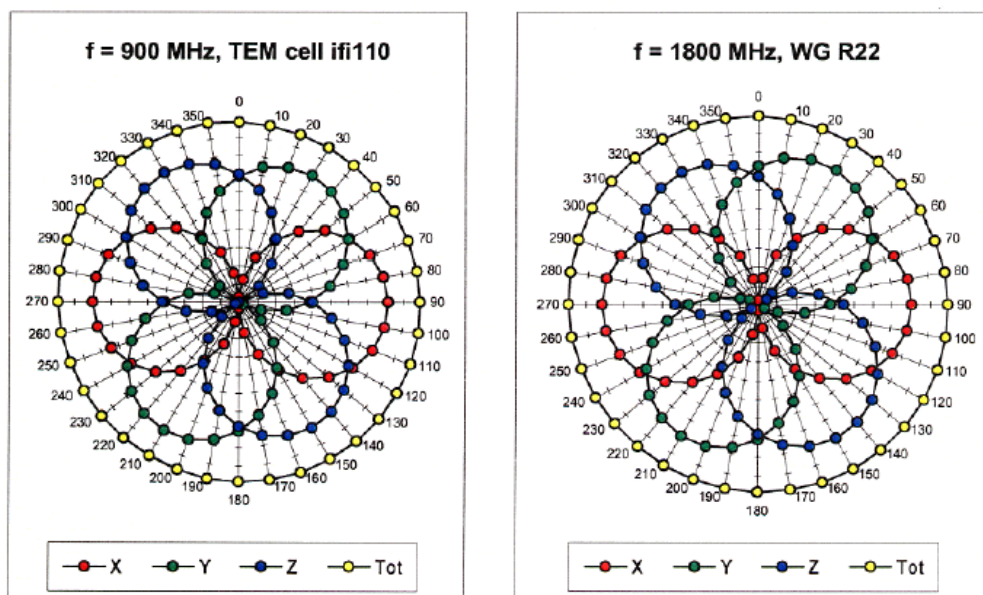
( TEM-Cell:ifi110, Waveguide R22)



ET3DV6 SN:1684

September 2, 2004

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

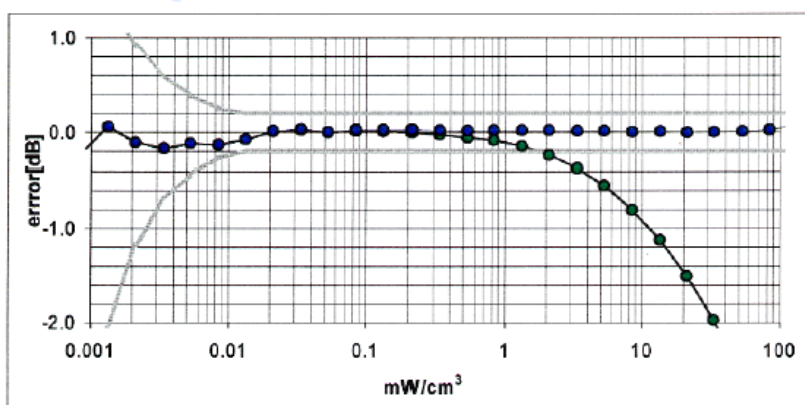
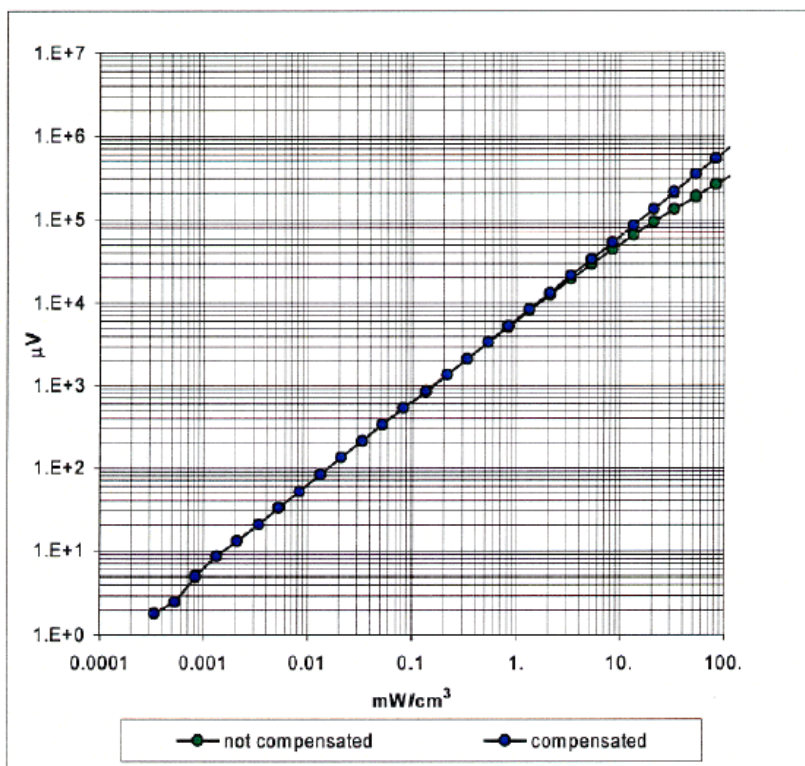


Axial Isotropy Error  $< \pm 0.2$  dB

ET3DV6 SN:1684

September 2, 2004

## Dynamic Range $f(\text{SAR}_{\text{head}})$ ( Waveguide R22 )

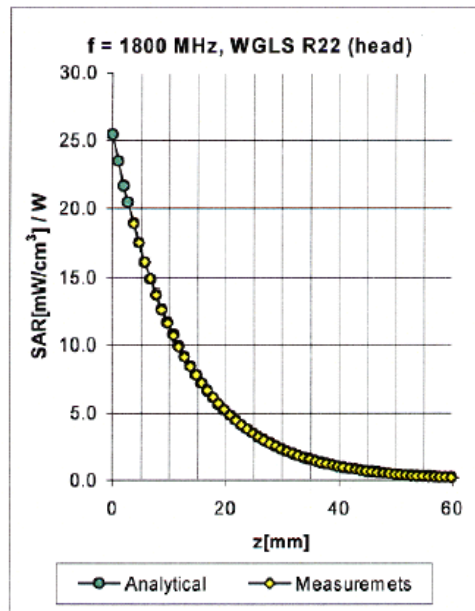
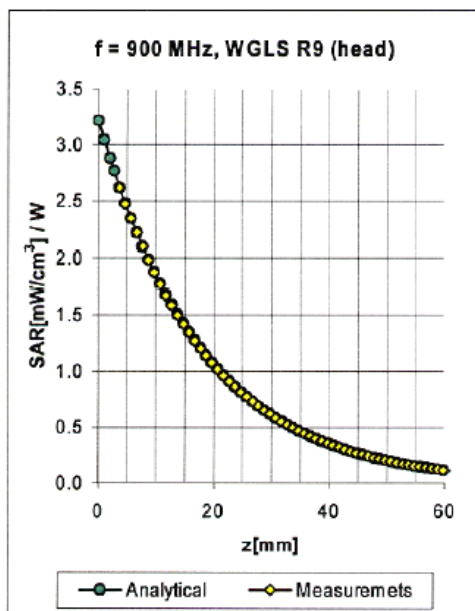


Probe Linearity Error  $< \pm 0.2$  dB

ET3DV6 SN:1684

September 2, 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%    | 0.72  | 1.56  | 6.75 ± 11.3% (k=2) |
| 1800    | 1710-1910                   | Head   | 40.0 ± 5%    | 1.40 ± 5%    | 0.40  | 2.81  | 5.27 ± 11.7% (k=2) |
| 2450    | 2400-2500                   | Head   | 39.2 ± 5%    | 1.80 ± 5%    | 0.77  | 2.07  | 4.39 ± 9.7% (k=2)  |
| 900     | 800-1000                    | Body   | 55.0 ± 5%    | 1.05 ± 5%    | 0.40  | 2.32  | 6.28 ± 11.3% (k=2) |
| 1800    | 1710-1910                   | Body   | 53.3 ± 5%    | 1.52 ± 5%    | 0.47  | 3.00  | 4.57 ± 11.7% (k=2) |
| 2450    | 2400-2500                   | Body   | 52.7 ± 5%    | 1.95 ± 5%    | 0.82  | 1.85  | 4.14 ± 9.7% (k=2)  |

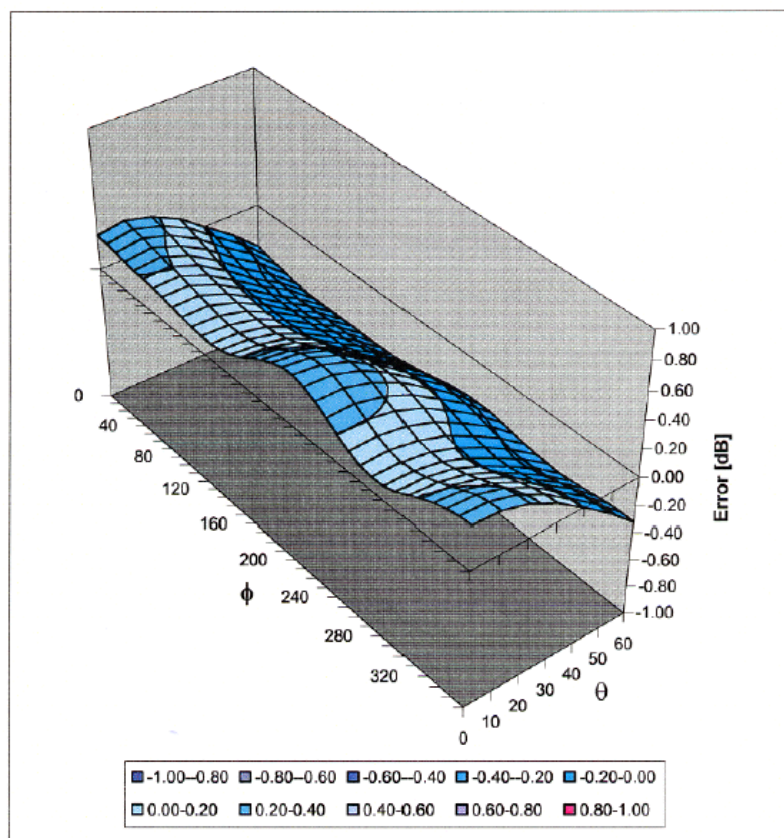
<sup>B</sup> The total standard uncertainty is calculated as root-sum-square of standard uncertainty of the Conversion Factor at calibration frequency and the standard uncertainty for the indicated frequency band.

ET3DV6 SN:1684

September 2, 200

## Deviation from Isotropy in HSL

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



Spherical Isotropy Error  $< \pm 0.4$  dB