# APPENDIX F - PROBE CALIBRATION


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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

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**Accreditation No.: SCS 108**

**Client** Celltech

**Certificate No: ET3-1590_May05**

# CALIBRATION CERTIFICATE

Object: ET3DV6 - SN:1590

Calibration procedure(s): QA CAL-01.v5
Calibration procedure for dosimetric E-field probes

Calibration date: May 20, 2005

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 E4419B | GB41293874 | 3-May-05 (METAS, No. 251-00466) | May-06 |
| Power sensor E4412A | MY41495277 | 3-May-05 (METAS, No. 251-00466) | May-06 |
| Power sensor E4412A | MY41498087 | 3-May-05 (METAS, No. 251-00466) | May-06 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 10-Aug-04 (METAS, No. 251-00403) | Aug-05 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 3-May-05 (METAS, No. 251-00467) | May-06 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 10-Aug-04 (METAS, No. 251-00404) | Aug-05 |
| Reference Probe ES3DV2 | SN: 3013 | 7-Jan-05 (SPEAG, No. ES3-3013_Jan05) | Jan-06 |
| DAE4 | SN: 617 | 19-Jan-05 (SPEAG, No. DAE4-617_Jan05) | Jan-06 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (SPEAG, in house check Dec-03) | In house check: Dec-05 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (SPEAG, in house check Nov-04) | In house check: Nov 05 |

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

Issued: May 21, 2005

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

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**Glossary:**

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConF | sensitivity in TSL / NORMx,y,z |
| 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 |

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

a) 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
b) 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

**Methods Applied and Interpretation of Parameters:**

- *NORMx,y,z:* Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

# Probe ET3DV6

# SN:1590

| | |
|---|---|
| Manufactured: | March 19, 2001 |
| Last calibrated: | May 24, 2004 |
| Recalibrated: | May 20, 2005 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

# DASY - Parameters of Probe: ET3DV6 SN:1590

## Sensitivity in Free Space[A]

| | | | | |
|---|---|---|---|---|
| NormX | **1.82** ± 10.1% | $\mu V/(V/m)^2$ | DCP X | **87** mV |
| NormY | **1.97** ± 10.1% | $\mu V/(V/m)^2$ | DCP Y | **87** mV |
| NormZ | **1.70** ± 10.1% | $\mu V/(V/m)^2$ | DCP Z | **87** mV |

## Diode Compression[B]

## Sensitivity in Tissue Simulating Liquid (Conversion Factors)

**Please see Page 8.**

## Boundary Effect

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

| Sensor Center to Phantom Surface Distance | | **3.7 mm** | **4.7 mm** |
|---|---|---|---|
| $SAR_{be}$ [%] | Without Correction Algorithm | 7.6 | 3.9 |
| $SAR_{be}$ [%] | With Correction Algorithm | 0.1 | 0.2 |

**TSL** **1810 MHz** **Typical SAR gradient: 10 % per mm**

| Sensor Center to Phantom Surface Distance | | **3.7 mm** | **4.7 mm** |
|---|---|---|---|
| $SAR_{be}$ [%] | Without Correction Algorithm | 11.8 | 8.3 |
| $SAR_{be}$ [%] | With Correction Algorithm | 0.6 | 0.1 |

## Sensor Offset

| | |
|---|---|
| Probe Tip to Sensor Center | **2.7** mm |

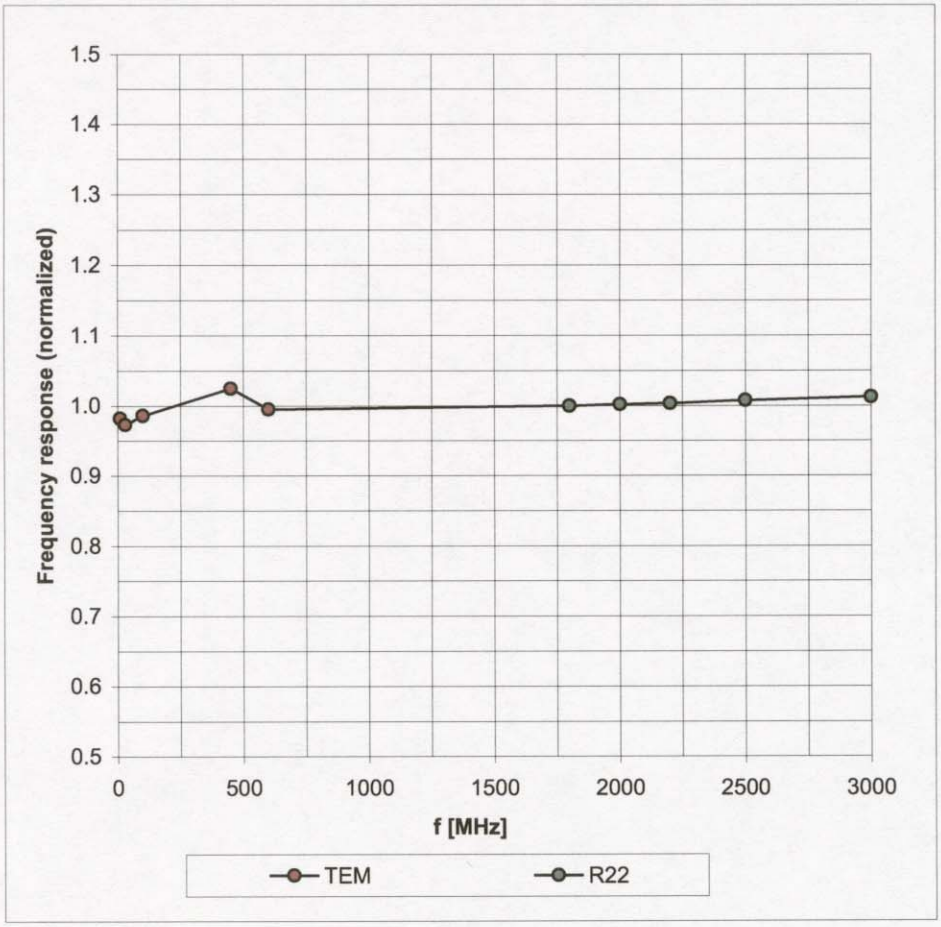
**The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.**

[A] The uncertainties of NormX,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Page 8).

[B] Numerical linearization parameter: uncertainty not required.

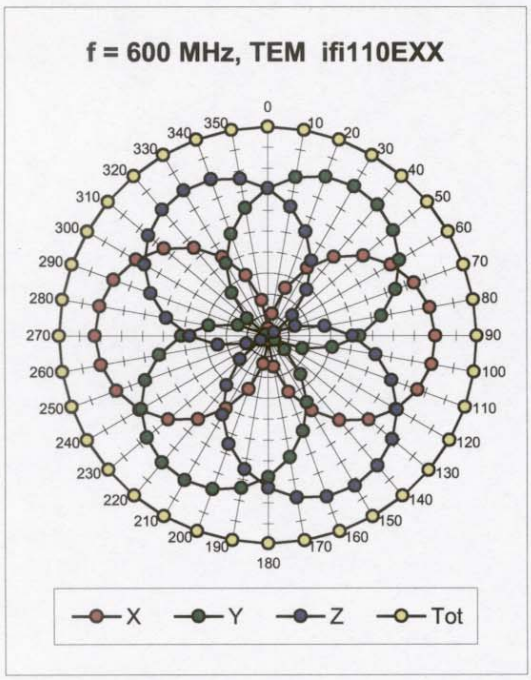
# Frequency Response of E-Field

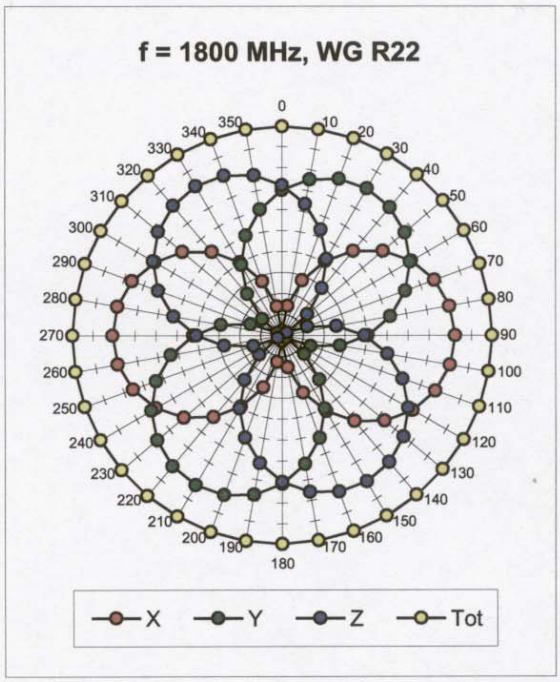
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**

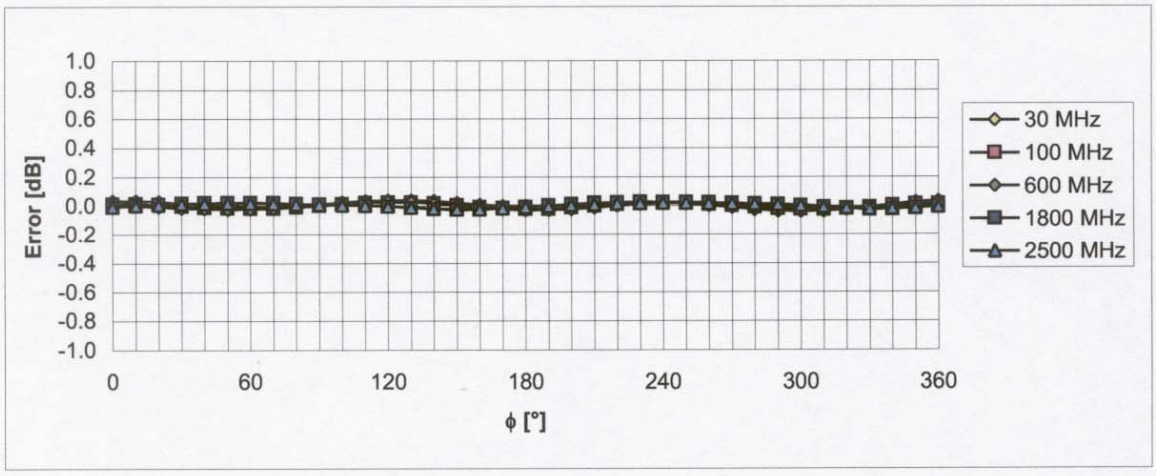



**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

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



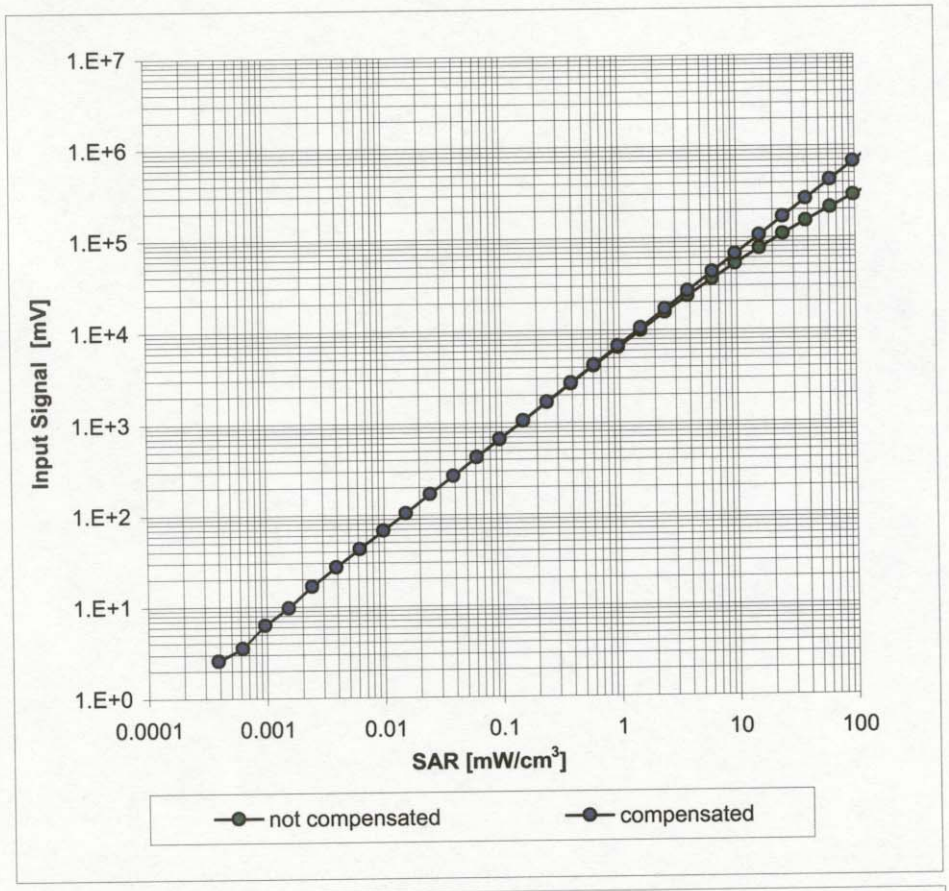



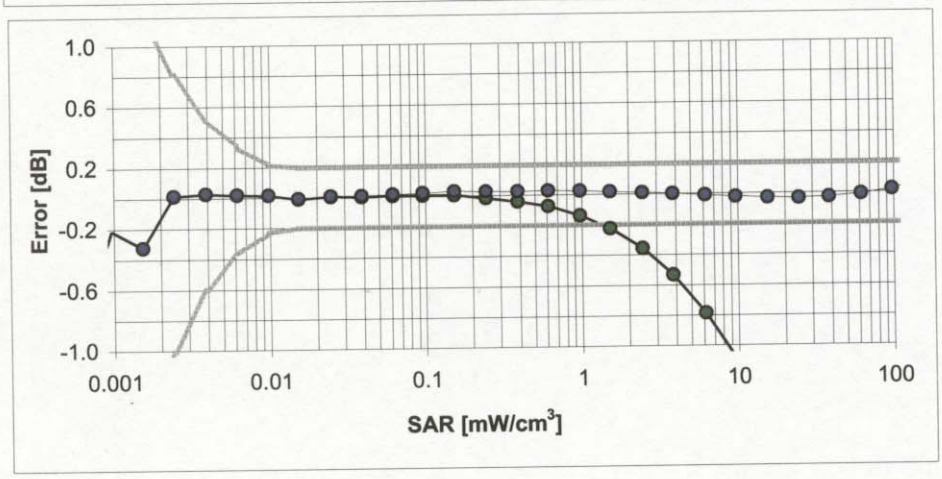




**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

# Dynamic Range f($SAR_{head}$)

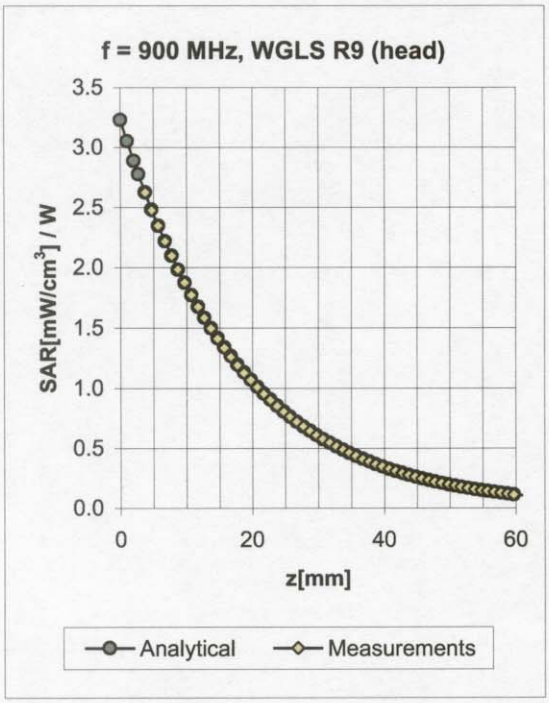
**(Waveguide R22, f = 1800 MHz)**

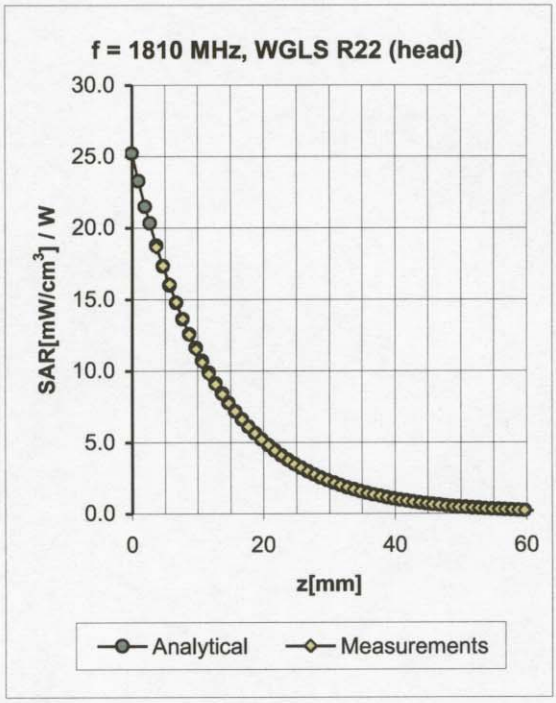



**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment



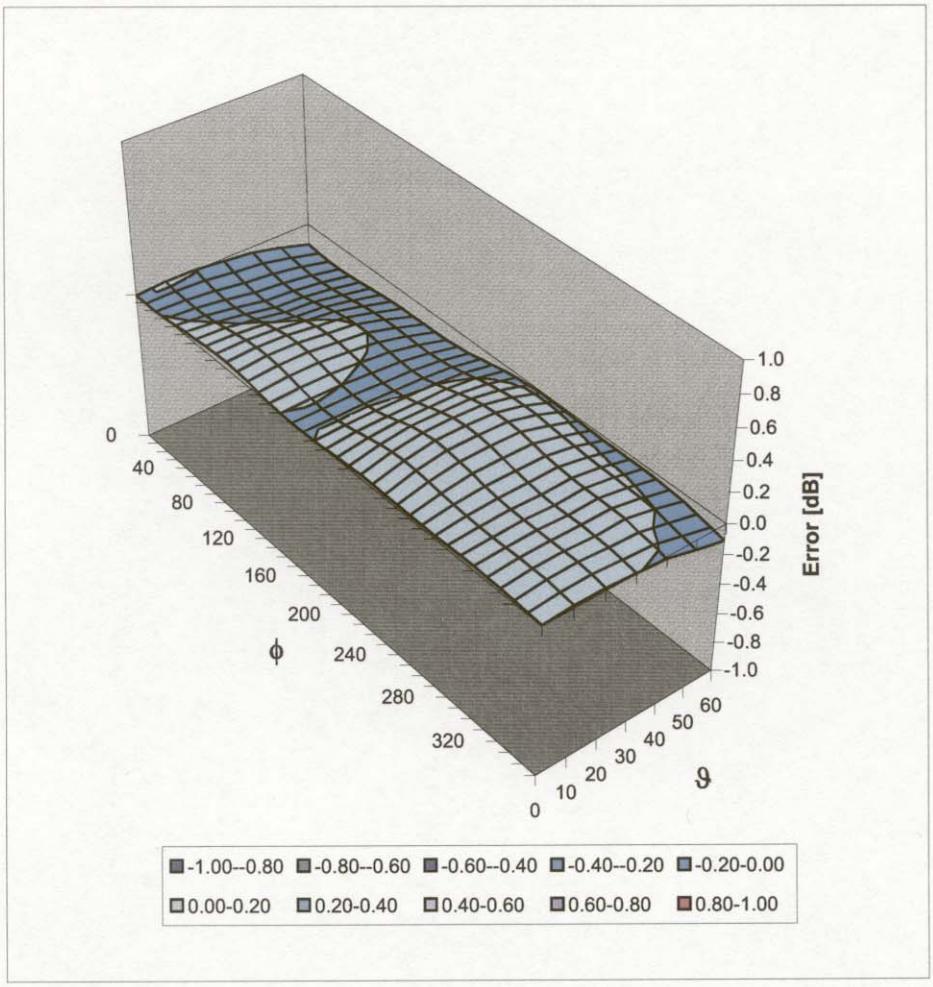




| f [MHz] | Validity [MHz][C] | TSL | Permittivity | Conductivity | Alpha | Depth | ConvF Uncertainty |
|---|---|---|---|---|---|---|---|
| 900 | ± 50 / ± 100 | Head | 41.5 ± 5% | 0.97 ± 5% | 0.54 | 1.81 | 6.67 ± 11.0% (k=2) |
| 1810 | ± 50 / ± 100 | Head | 40.0 ± 5% | 1.40 ± 5% | 0.46 | 2.62 | 5.44 ± 11.0% (k=2) |
| 2450 | ± 50 / ± 100 | Head | 39.2 ± 5% | 1.80 ± 5% | 0.50 | 2.53 | 4.56 ± 11.8% (k=2) |
| 900 | ± 50 / ± 100 | Body | 55.0 ± 5% | 1.05 ± 5% | 0.46 | 2.09 | 6.47 ± 11.0% (k=2) |
| 1810 | ± 50 / ± 100 | Body | 53.3 ± 5% | 1.52 ± 5% | 0.44 | 3.00 | 4.85 ± 11.0% (k=2) |
| 2450 | ± 50 / ± 100 | Body | 52.7 ± 5% | 1.95 ± 5% | 0.50 | 2.42 | 4.22 ± 11.8% (k=2) |

[C] **The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.**

# Deviation from Isotropy in HSL

**Error ($\phi$, $\vartheta$), f = 900 MHz**




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

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s p e a g

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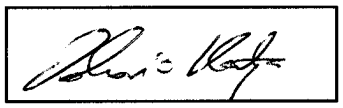
# Additional Conversion Factors

**for Dosimetric E-Field Probe**

| | |
|---|---|
| Type: | **ET3DV6** |
| Serial Number: | **1590** |
| Place of Assessment: | **Zurich** |
| Date of Assessment: | **May 23, 2005** |
| Probe Calibration Date: | **May 20, 2005** |

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:



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# Dosimetric E-Field Probe ET3DV6 SN:1590

Conversion factor (± standard deviation)

| | | | |
|---|---|---|---|
| **f = 150 MHz** | ConvF | **9.1 ± 10%** | **$\varepsilon_r$ = 52.3 ± 5%**<br>**$\sigma$ = 0.76 ± 5% mho/m**<br>(head tissue) |
| **f = 300 MHz** | ConvF | **8.1 ± 9%** | **$\varepsilon_r$ = 45.3 ± 5%**<br>**$\sigma$ = 0.87 ± 5% mho/m**<br>(head tissue) |
| **f = 450 MHz** | ConvF | **7.8 ± 8%** | **$\varepsilon_r$ = 43.5 ± 5%**<br>**$\sigma$ = 0.87 ± 5% mho/m**<br>(head tissue) |
| **f = 150 MHz** | ConvF | **8.6 ± 10%** | **$\varepsilon_r$ = 61.9 ± 5%**<br>**$\sigma$ = 0.80 ± 5% mho/m**<br>(body tissue) |
| **f = 450 MHz** | ConvF | **7.7 ± 8%** | **$\varepsilon_r$ = 56.7 ± 5%**<br>**$\sigma$ = 0.94 ± 5% mho/m**<br>(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.**