



## APPENDIX D: SYSTEM CERTIFICATE & CALIBRATION

D1: PHANTOM

DRAFT

## Certificate of Conformity / First Article Inspection

|              |  |
|--------------|--|
| Item         | SAM Twin Phantom V4.0  |
| Type No      | QD 000 P40 C   |
| Series No    | TP-1150 and higher   |
| Manufacturer | SPEAG<br>Zeughausstrasse 43<br>CH-8004 Zürich<br>Switzerland |

### Tests

The series production process used allows the limitation to test of first articles. Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series items (called samples) or are tested at each item.

| Test                        | Requirement  | Details  | Units tested                                |
|-----------------------------|--|--|---|
| Dimensions                  | Compliant with the geometry according to the CAD model.  | IT'IS CAD File (*)   | First article, Samples                      |
| Material thickness of shell | Compliant with the requirements according to the standards   | 2mm +/- 0.2mm in flat and specific areas of head section                 | First article, Samples, TP-1314 ff.         |
| Material thickness at ERP   | Compliant with the requirements according to the standards   | 6mm +/- 0.2mm at ERP   | First article, All items                    |
| Material parameters         | Dielectric parameters for required frequencies   | 300 MHz – 6 GHz:<br>Relative permittivity < 5,<br>Loss tangent < 0.05    | Material samples                            |
| Material resistivity        | The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions. Observe technical Note for material compatibility. | DEGMBE based simulating liquids  | Pre-series, First article, Material samples |
| Sagging                     | Compliant with the requirements according to the standards. Sagging of the flat section when filled with tissue simulating liquid.   | < 1% typical < 0.8% if filled with 155mm of HSL900 and without DUT below | Prototypes, Sample testing                  |

### Standards

- [1] CENELEC EN 50361
- [2] IEEE Std 1528-2003
- [3] IEC 62209 Part I
- [4] FCC OET Bulletin 65, Supplement C, Edition 01-01

(\*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

### Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standards [1] to [4].

**Date** 07.07.2005

**Signature / Stamp**



## D2: DOSIMETRIC E-FIELD PROBE

DRAFT



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

Accreditation No.: **SCS 108**

Client **ADT (Auden)**

Certificate No: **EX3-3590\_Apr09**

## CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3590**

Calibration procedure(s): **QA CAL-01.v6, QA CAL-14.v3 and QA CAL-23.v3  
Calibration procedure for dosimetric E-field probes**

Calibration date: **April 28, 2009**

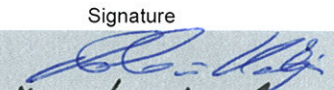
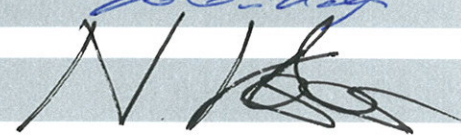
Condition of the calibrated item: **In Tolerance**

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         | GB41293874      | 1-Apr-09 (No. 217-01030)          | Apr-10                 |
| Power sensor E4412A        | MY41495277      | 1-Apr-09 (No. 217-01030)          | Apr-10                 |
| Power sensor E4412A        | MY41498087      | 1-Apr-09 (No. 217-01030)          | Apr-10                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 31-Mar-09 (No. 217-01026)         | Mar-10                 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 31-Mar-09 (No. 217-01028)         | Mar-10                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 31-Mar-09 (No. 217-01027)         | Mar-10                 |
| Reference Probe ES3DV2     | SN: 3013        | 2-Jan-09 (No. ES3-3013_Jan09)     | Jan-10                 |
| DAE4                       | SN: 660         | 9-Sep-08 (No. DAE4-660_Sep08)     | Sep-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 |

|                |                              |                                      |  |
|----------------|------------------------------|--------------------------------------|--|
| Calibrated by: | Name<br><b>Katja Pokovic</b> | Function<br><b>Technical Manager</b> | Signature<br> |
| Approved by:   | Name<br><b>Niels Kuster</b>  | Function<br><b>Quality Manager</b>   |               |

Issued: April 28, 2009

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



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Accreditation No.: **SCS 108**

### Glossary:

|                          |  |
|--------------------------|--|
| TSL                      | tissue simulating liquid   |
| $NORM_{x,y,z}$           | sensitivity in free space  |
| ConvF                    | sensitivity in TSL / $NORM_{x,y,z}$  |
| 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:

- 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
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

### Methods Applied and Interpretation of Parameters:

- $NORM_{x,y,z}$ : Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).  $NORM_{x,y,z}$  are only intermediate values, i.e., the uncertainties of  $NORM_{x,y,z}$  does not effect the  $E^2$ -field uncertainty inside TSL (see below *ConvF*).
- $NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency\_response$  (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*.
- $DCP_{x,y,z}$ : DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency 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  $NORM_{x,y,z} * ConvF$  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  $\pm 50$  MHz to  $\pm 100$  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 EX3DV4

## SN:3590

|               |                |
|---------------|----------------|
| Manufactured: | March 23, 2009 |
| Calibrated:   | April 28, 2009 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

## DASY - Parameters of Probe: EX3DV4 SN:3590

### Sensitivity in Free Space<sup>A</sup>

|       |                     |                                     |
|-------|---------------------|-------------------------------------|
| NormX | <b>0.49</b> ± 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormY | <b>0.48</b> ± 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormZ | <b>0.50</b> ± 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ |

### Diode Compression<sup>B</sup>

|       |              |
|-------|--------------|
| DCP X | <b>85</b> mV |
| DCP Y | <b>87</b> mV |
| DCP Z | <b>88</b> mV |

### 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 |                              | <b>2.0 mm</b> | <b>3.0 mm</b> |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 9.3           | 5.6           |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.8           | 0.4           |

**TSL**                      **1750 MHz**      **Typical SAR gradient: 10 % per mm**

|   |                              |               |               |
|---|------------------------------|---------------|---------------|
| Sensor Center to Phantom Surface Distance |                              | <b>2.0 mm</b> | <b>3.0 mm</b> |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 8.0           | 5.0           |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.9           | 0.5           |

### Sensor Offset

Probe Tip to Sensor Center                      **1.0 mm**

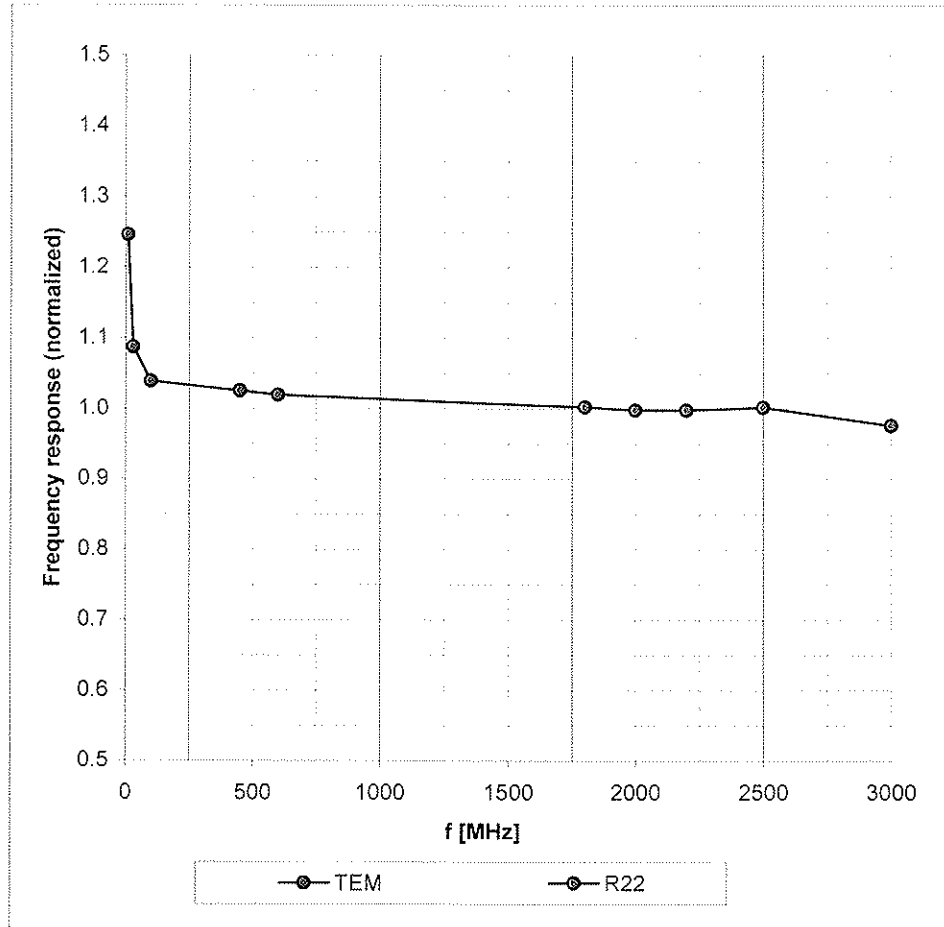
**The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.**

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 8).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

# Frequency Response of E-Field

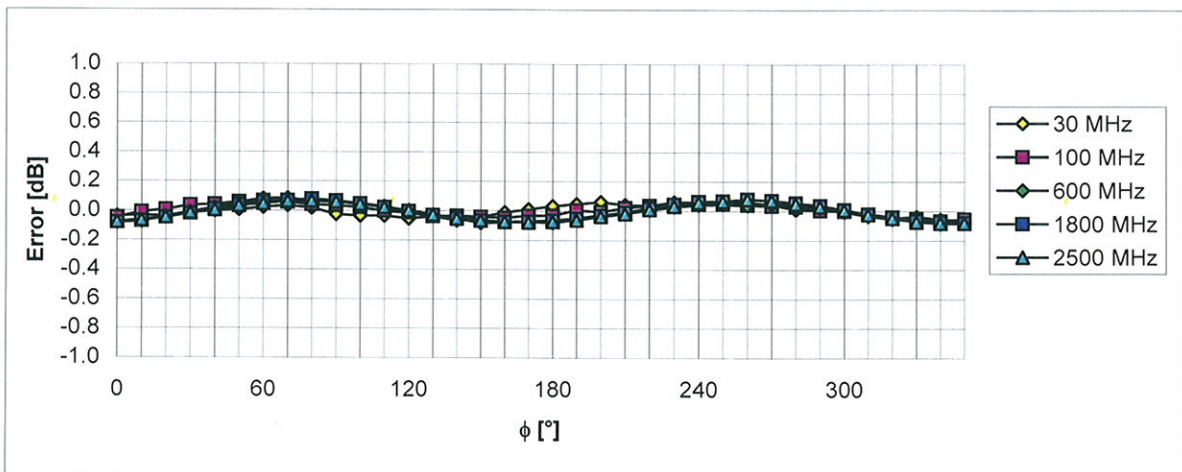
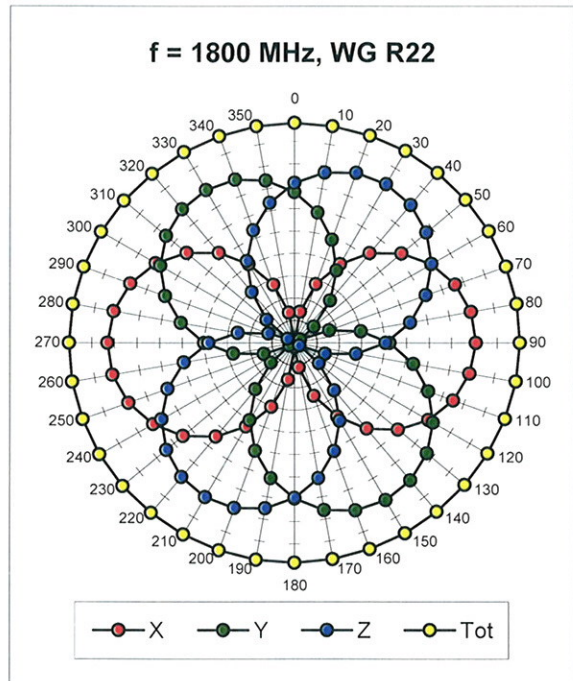
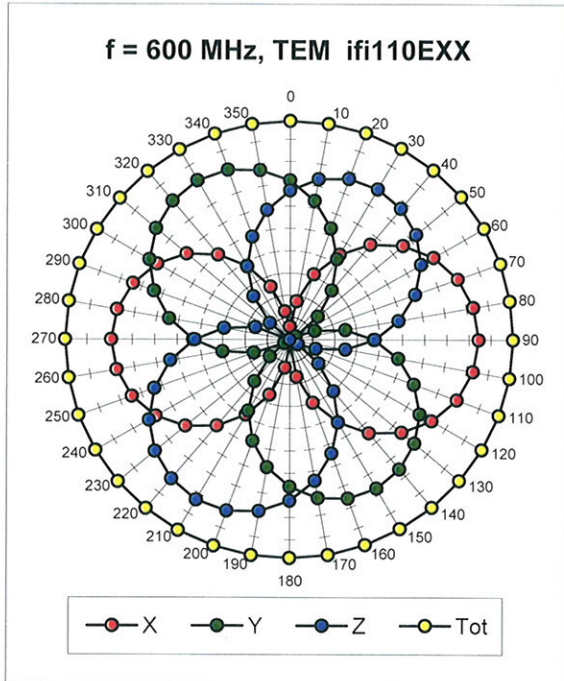
(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

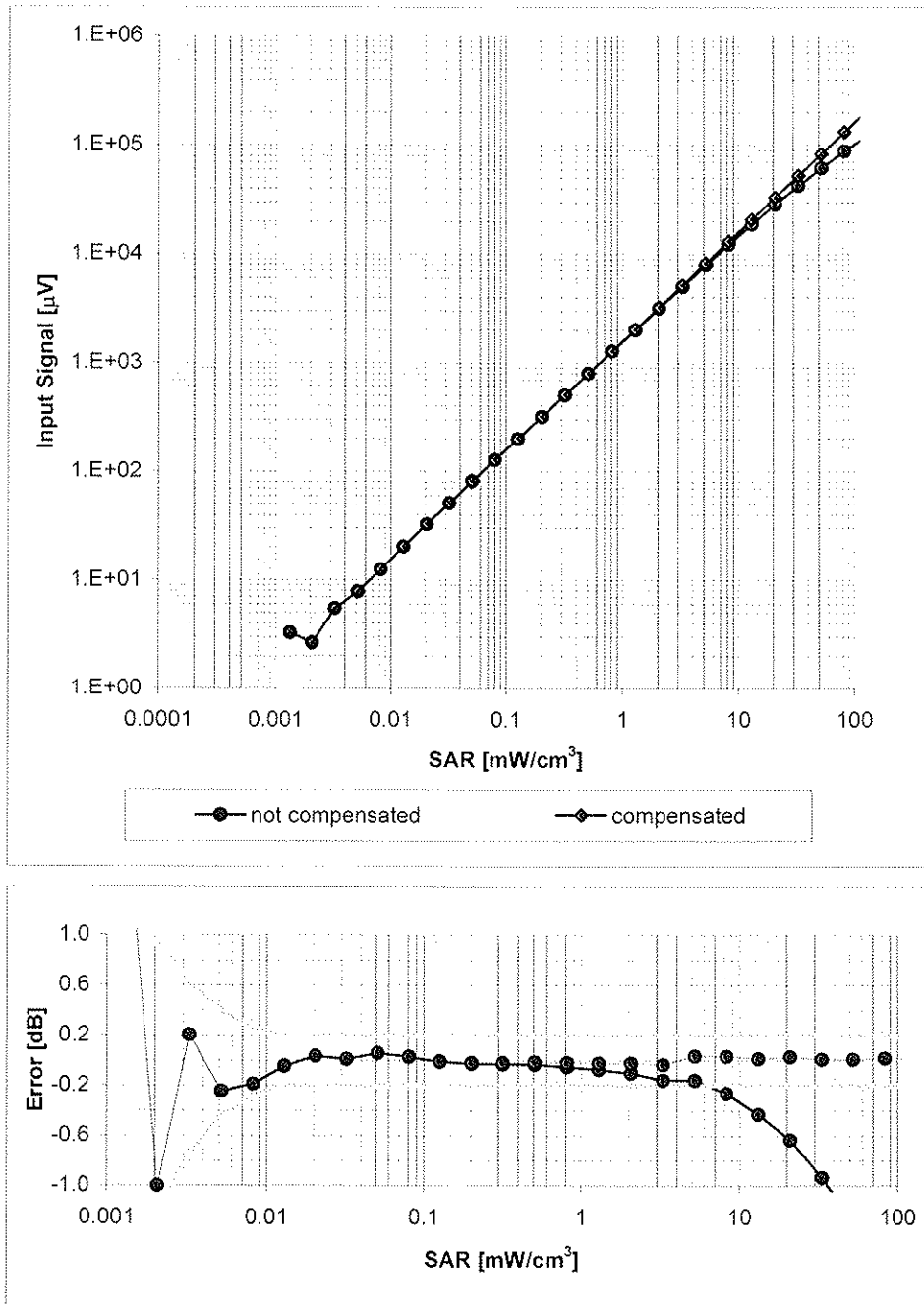


### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



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

### Dynamic Range $f(SAR_{head})$ (Waveguide R22, $f = 1800$ MHz)



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

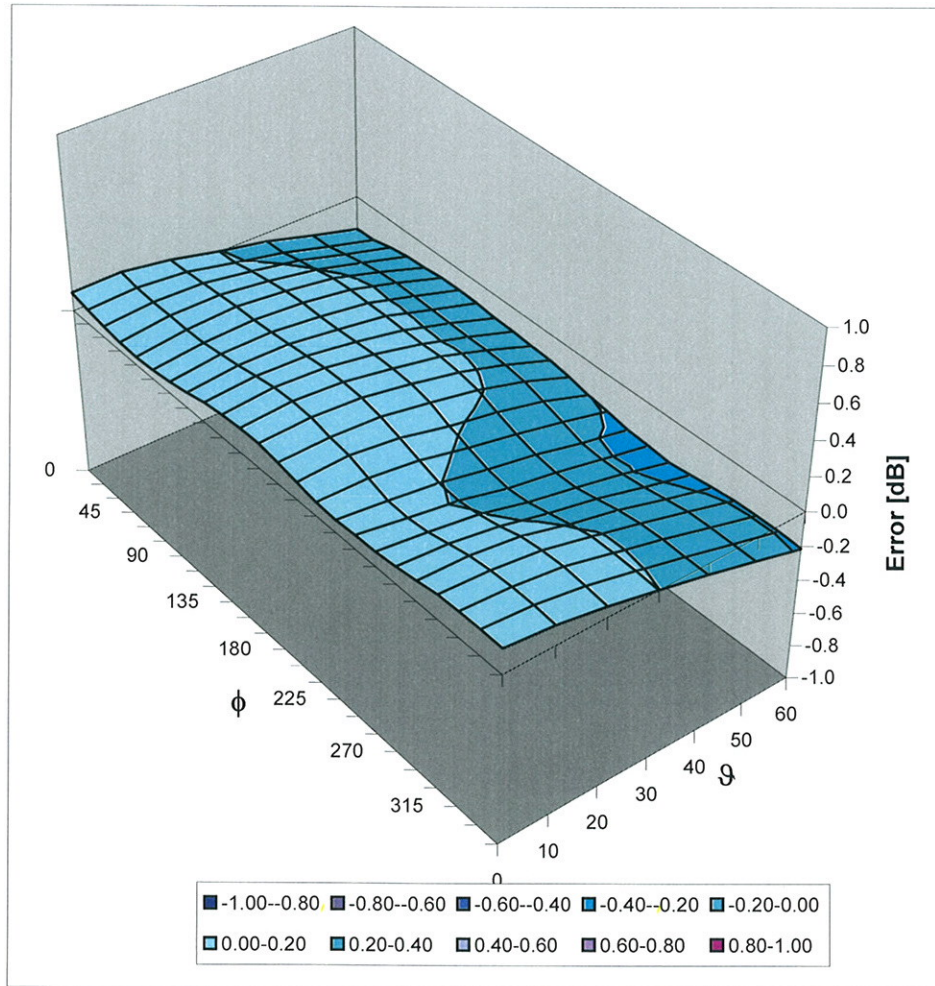
## Conversion Factor Assessment

| f [MHz] | Validity [MHz] <sup>c</sup> | TSL  | Permittivity | Conductivity | Alpha | Depth | ConvF Uncertainty  |
|---------|-----------------------------|------|--------------|--------------|-------|-------|--------------------|
| 900     | ± 50 / ± 100                | Head | 41.5 ± 5%    | 0.97 ± 5%    | 0.72  | 0.63  | 9.79 ± 11.0% (k=2) |
| 1750    | ± 50 / ± 100                | Head | 40.1 ± 5%    | 1.37 ± 5%    | 0.70  | 0.58  | 8.82 ± 11.0% (k=2) |
| 1950    | ± 50 / ± 100                | Head | 40.0 ± 5%    | 1.40 ± 5%    | 0.63  | 0.61  | 8.39 ± 11.0% (k=2) |
| 2300    | ± 50 / ± 100                | Head | 39.5 ± 5%    | 1.67 ± 5%    | 0.70  | 0.57  | 8.28 ± 11.0% (k=2) |
| 2450    | ± 50 / ± 100                | Head | 39.2 ± 5%    | 1.80 ± 5%    | 0.61  | 0.61  | 7.88 ± 11.0% (k=2) |
| 2600    | ± 50 / ± 100                | Head | 39.0 ± 5%    | 1.96 ± 5%    | 0.40  | 0.76  | 7.85 ± 11.0% (k=2) |
| 3500    | ± 50 / ± 100                | Head | 37.9 ± 5%    | 2.91 ± 5%    | 0.33  | 1.10  | 7.15 ± 13.1% (k=2) |
| 4950    | ± 50 / ± 100                | Head | 36.3 ± 5%    | 4.40 ± 5%    | 0.42  | 1.70  | 5.43 ± 13.1% (k=2) |
| 5200    | ± 50 / ± 100                | Head | 36.0 ± 5%    | 4.66 ± 5%    | 0.45  | 1.70  | 5.34 ± 13.1% (k=2) |
| 5300    | ± 50 / ± 100                | Head | 35.9 ± 5%    | 4.76 ± 5%    | 0.45  | 1.70  | 4.90 ± 13.1% (k=2) |
| 5500    | ± 50 / ± 100                | Head | 35.6 ± 5%    | 4.96 ± 5%    | 0.50  | 1.70  | 4.79 ± 13.1% (k=2) |
| 5600    | ± 50 / ± 100                | Head | 35.5 ± 5%    | 5.07 ± 5%    | 0.50  | 1.70  | 4.61 ± 13.1% (k=2) |
| 5800    | ± 50 / ± 100                | Head | 35.3 ± 5%    | 5.27 ± 5%    | 0.50  | 1.70  | 4.60 ± 13.1% (k=2) |
|         |                             |      |              |              |       |       |                    |
| 900     | ± 50 / ± 100                | Body | 55.0 ± 5%    | 1.05 ± 5%    | 0.49  | 0.74  | 9.93 ± 11.0% (k=2) |
| 1750    | ± 50 / ± 100                | Body | 53.4 ± 5%    | 1.49 ± 5%    | 0.59  | 0.68  | 8.62 ± 11.0% (k=2) |
| 1950    | ± 50 / ± 100                | Body | 53.3 ± 5%    | 1.52 ± 5%    | 0.47  | 0.77  | 8.39 ± 11.0% (k=2) |
| 2300    | ± 50 / ± 100                | Body | 52.8 ± 5%    | 1.85 ± 5%    | 0.38  | 0.86  | 8.05 ± 11.0% (k=2) |
| 2450    | ± 50 / ± 100                | Body | 52.7 ± 5%    | 1.95 ± 5%    | 0.40  | 0.77  | 7.96 ± 11.0% (k=2) |
| 2600    | ± 50 / ± 100                | Body | 52.5 ± 5%    | 2.16 ± 5%    | 0.34  | 0.86  | 7.84 ± 11.0% (k=2) |
| 3500    | ± 50 / ± 100                | Body | 51.3 ± 5%    | 3.31 ± 5%    | 0.33  | 1.26  | 6.75 ± 13.1% (k=2) |
| 4950    | ± 50 / ± 100                | Body | 49.4 ± 5%    | 5.01 ± 5%    | 0.40  | 1.80  | 5.13 ± 13.1% (k=2) |
| 5200    | ± 50 / ± 100                | Body | 49.0 ± 5%    | 5.30 ± 5%    | 0.50  | 1.80  | 5.01 ± 13.1% (k=2) |
| 5300    | ± 50 / ± 100                | Body | 48.5 ± 5%    | 5.42 ± 5%    | 0.50  | 1.80  | 4.72 ± 13.1% (k=2) |
| 5500    | ± 50 / ± 100                | Body | 48.6 ± 5%    | 5.65 ± 5%    | 0.56  | 1.80  | 4.42 ± 13.1% (k=2) |
| 5600    | ± 50 / ± 100                | Body | 48.5 ± 5%    | 5.77 ± 5%    | 0.55  | 1.80  | 4.07 ± 13.1% (k=2) |
| 5800    | ± 50 / ± 100                | Body | 48.2 ± 5%    | 6.00 ± 5%    | 0.60  | 1.80  | 4.62 ± 13.1% (k=2) |

<sup>c</sup> 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:  $\pm 2.6\%$  ( $k=2$ )