# ANNEX C: DIPOLE CERTIFICATE

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

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**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 **ETC (Auden)**

**Certificate No: D1900V2-5d054_Oct06**

## CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN: 5d054 |
| Calibration procedure(s) | QA CAL-05.v6<br>Calibration procedure for dipole validation kits |
| Calibration date: | October 17, 2006 |
| 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-442A | GB37480704 | 03-Oct-06 (METAS, No. 217-00608) | Oct-07 |
| Power sensor HP 8481A | US37292783 | 03-Oct-06 (METAS, No. 217-00608) | Oct-07 |
| Reference 20 dB Attenuator | SN: 5086 (20g) | 10-Aug-06 (METAS, No 217-00591) | Aug-07 |
| Reference 10 dB Attenuator | SN: 5047.2 (10r) | 10-Aug-06 (METAS, No 217-00591) | Aug-07 |
| Reference Probe ET3DV6 | SN: 1507 | 28-Oct-05 (SPEAG, No. ET3-1507_Oct05) | Oct-06 |
| Reference Probe ES3DV3 | SN: 3025 | 28-Oct-05 (SPEAG, No. ES3-3025_Oct05) | Oct-06 |
| DAE4 | SN: 601 | 15-Dec-05 (SPEAG, No. DAE4-601_Dec05) | Dec-06 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (SPEAG, in house check Oct-05) | In house check: Oct-07 |
| RF generator Agilent E4421B | MY41000675 | 11-May-05 (SPEAG, in house check Nov-05) | In house check: Nov-07 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (SPEAG, in house check Nov-05) | In house check: Nov-06 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Mike Meili | Laboratory Technician | M. Meili |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: October 18, 2006

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

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**Calibration Laboratory of**
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**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:**

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
c) 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:**

d) 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 | V4.7 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom V5.0 | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1900 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.0 | 1.40 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 39.3 ± 6 % | 1.42 mho/m ± 6 % |
| **Head TSL temperature during test** | (20.5 ± 0.2) °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm$^3$ (1 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.56 mW / g |
| SAR normalized | normalized to 1W | 38.2 mW / g |
| SAR for nominal Head TSL parameters [1] | normalized to 1W | **37.6 mW / g ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm$^3$ (10 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.07 mW / g |
| SAR normalized | normalized to 1W | 20.3 mW / g |
| SAR for nominal Head TSL parameters [1] | normalized to 1W | **20.1 mW / g ± 16.5 % (k=2)** |

[1] 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 | 53.3 | 1.52 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 52.4 ± 6 % | 1.54 mho/m ± 6 % |
| **Body TSL temperature during test** | (22.0 ± 0.2) °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm$^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.60 mW / g |
| SAR normalized | normalized to 1W | 38.4 mW / g |
| SAR for nominal Body TSL parameters [2] | normalized to 1W | **37.7 mW / g ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm$^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.08 mW / g |
| SAR normalized | normalized to 1W | 20.3 mW / g |
| SAR for nominal Body TSL parameters [2] | normalized to 1W | **20.1 mW / g ± 16.5 % (k=2)** |

[2] Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

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## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 56.9 Ω + 3.5 jΩ |
| Return Loss | - 22.8 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 51.8 Ω + 5.1 jΩ |
| Return Loss | - 25.5 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.198 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 DC-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 | March 19, 2004 |

## DASY4 Validation Report for Head TSL

Date/Time: 11.10.2006 15:17:05

Test Laboratory: SPEAG, Zurich, Switzerland

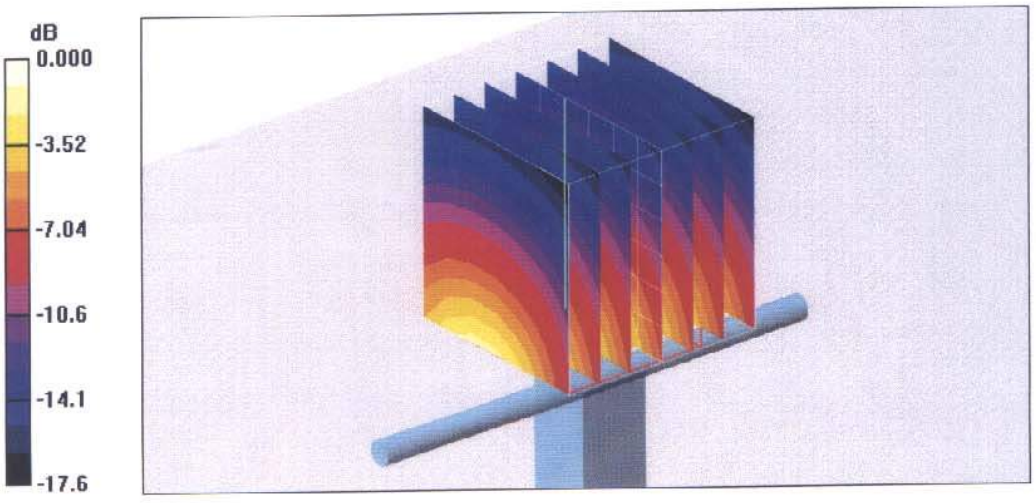
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d054**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: HSL U10 BB;
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.42 mho/m; $\varepsilon_r$ = 39.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

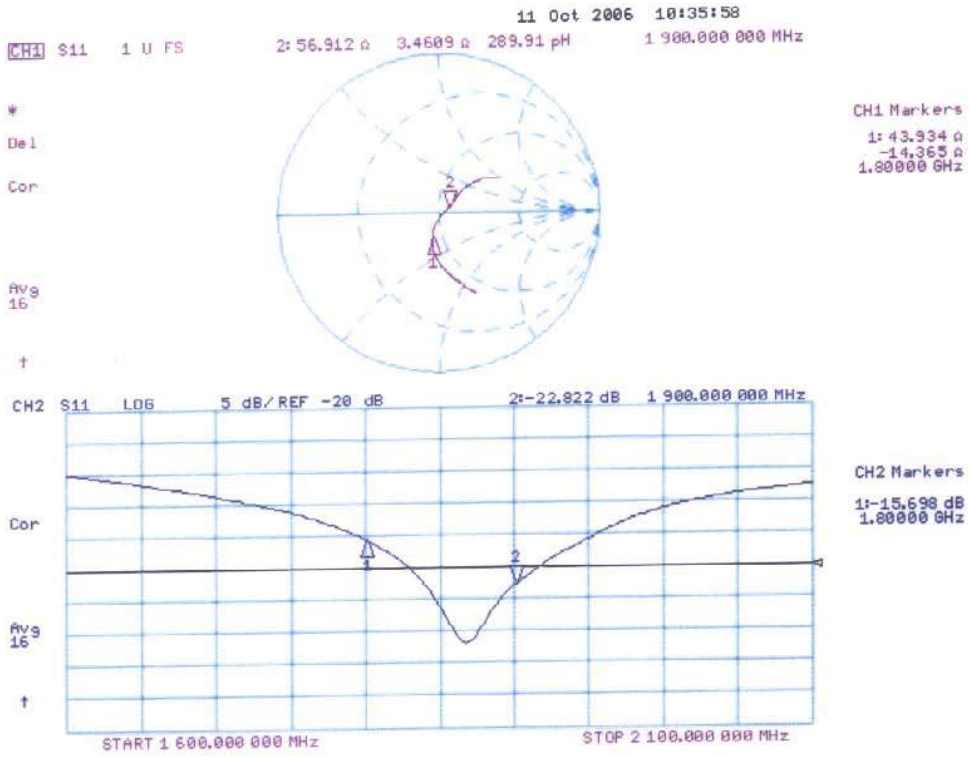
- Probe: ET3DV6 - SN1507 (HF); ConvF(4.74, 4.74, 4.74); Calibrated: 28.10.2005
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 15.12.2005
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA
- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 90.1 V/m; Power Drift = 0.042 dB
Peak SAR (extrapolated) = 16.3 W/kg
**SAR(1 g) = 9.56 mW/g; SAR(10 g) = 5.07 mW/g**
Maximum value of SAR (measured) = 10.7 mW/g




0 dB = 10.7mW/g

## Impedance Measurement Plot for Head TSL

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## DASY4 Validation Report for Body TSL

Date/Time: 17.10.2006 15:56:11

Test Laboratory: SPEAG, Zurich, Switzerland

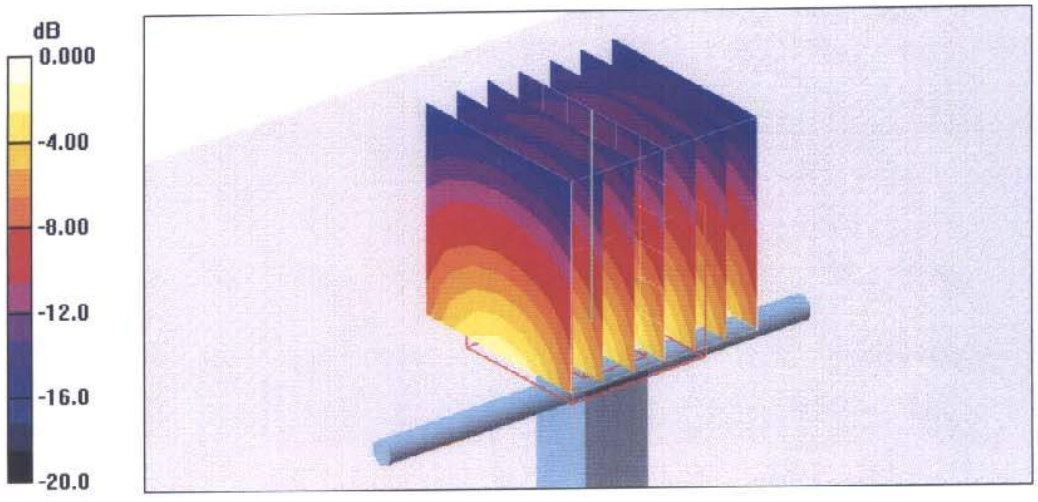
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d054**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: MSL U10;
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.54 mho/m; $\varepsilon_r$ = 52.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

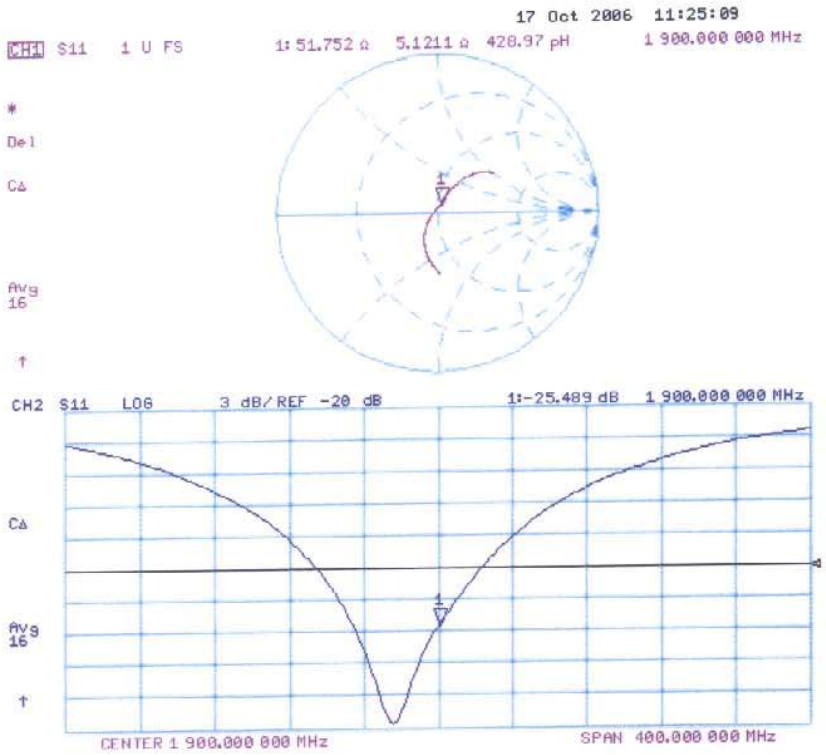
- Probe: ET3DV6 - SN1507 (HF); ConvF(4.3, 4.3, 4.3); Calibrated: 28.10.2005
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 15.12.2005
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA
- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 90.4 V/m; Power Drift = -0.027 dB
Peak SAR (extrapolated) = 16.8 W/kg
**SAR(1 g) = 9.6 mW/g; SAR(10 g) = 5.08 mW/g**
Maximum value of SAR (measured) = 10.9 mW/g




0 dB = 10.9mW/g

## Impedance Measurement Plot for Body TSL




Certificate No: D1900V2-5d054_Oct06 Page 9 of 9

# ANNEX D: PROBE CERTIFICATE

**Calibration Laboratory of**
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**Accreditation No.: SCS 108**

Client **ETC (Auden)** Certificate No: **EX3-3555_Sep07**

## CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3555 |
| Calibration procedure(s) | QA CAL-01.v6<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | September 26, 2007 |
| 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 | 29-Mar-07 (METAS, No. 217-00670) | Mar-08 |
| Power sensor E4412A | MY41495277 | 29-Mar-07 (METAS, No. 217-00670) | Mar-08 |
| Power sensor E4412A | MY41498087 | 29-Mar-07 (METAS, No. 217-00670) | Mar-08 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 8-Aug-07 (METAS, No. 217-00719) | Aug-08 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 29-Mar-07 (METAS, No. 217-00671) | Mar-08 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 8-Aug-07 (METAS, No. 217-00720) | Aug-08 |
| Reference Probe ES3DV2 | SN: 3013 | 4-Jan-07 (SPEAG, No. ES3-3013_Jan07) | Jan-08 |
| DAE4 | SN: 654 | 20-Apr-07 (SPEAG, No. DAE4-654_Apr07) | Apr-08 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (SPEAG, in house check Nov-05) | In house check: Nov-07 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (SPEAG, in house check Oct-06) | In house check: Oct-07 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Katja Pokovic | Technical Manager | |
| Approved by: | Niels Kuster | Quality Manager | |

Issued: September 27, 2007



Certificate No: EX3-3555_Sep07 Page 1 of 9

**Calibration Laboratory of**
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**Accreditation No.: SCS 108**

**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) 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:**

- *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 EX3DV4

## SN:3555

| | |
|---|---|
| Manufactured: | July 13, 2004 |
| Last calibrated: | November 5, 2004 |
| Recalibrated: | September 26, 2007 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

**EX3DV4 SN:3555** **September 26, 2007**

# DASY - Parameters of Probe: EX3DV4 SN:3555

## Sensitivity in Free Space[A] Diode Compression[B]

| | | | | |
|---|---|---|---|---|
| NormX | **0.420** ± 10.1% | $\mu V/(V/m)^2$ | DCP X | **92** mV |
| NormY | **0.390** ± 10.1% | $\mu V/(V/m)^2$ | DCP Y | **100** mV |
| NormZ | **0.420** ± 10.1% | $\mu V/(V/m)^2$ | DCP Z | **92** 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 | | **2.0 mm** | **3.0 mm** |
|---|---|---|---|
| $SAR_{be}$ [%] | Without Correction Algorithm | 1.3 | 0.2 |
| $SAR_{be}$ [%] | With Correction Algorithm | 0.5 | 0.0 |

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

| Sensor Center to Phantom Surface Distance | | **2.0 mm** | **3.0 mm** |
|---|---|---|---|
| $SAR_{be}$ [%] | Without Correction Algorithm | 1.8 | 0.2 |
| $SAR_{be}$ [%] | With Correction Algorithm | 0.1 | |

## 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%.**

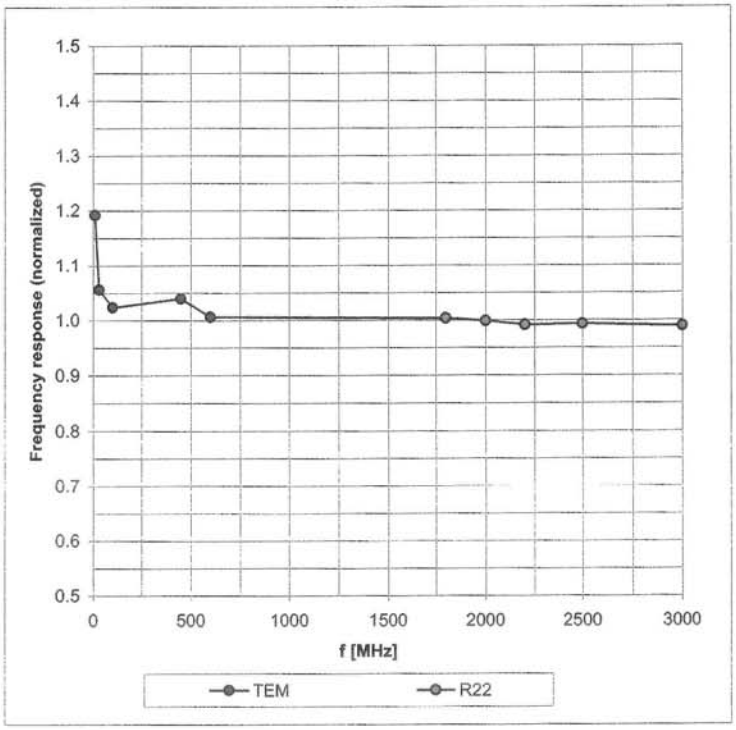
[A] The uncertainties of NormX,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Page 8).

[B] Numerical linearization parameter: uncertainty not required.

EX3DV4 SN:3555 September 26, 2007

## Frequency Response of E-Field

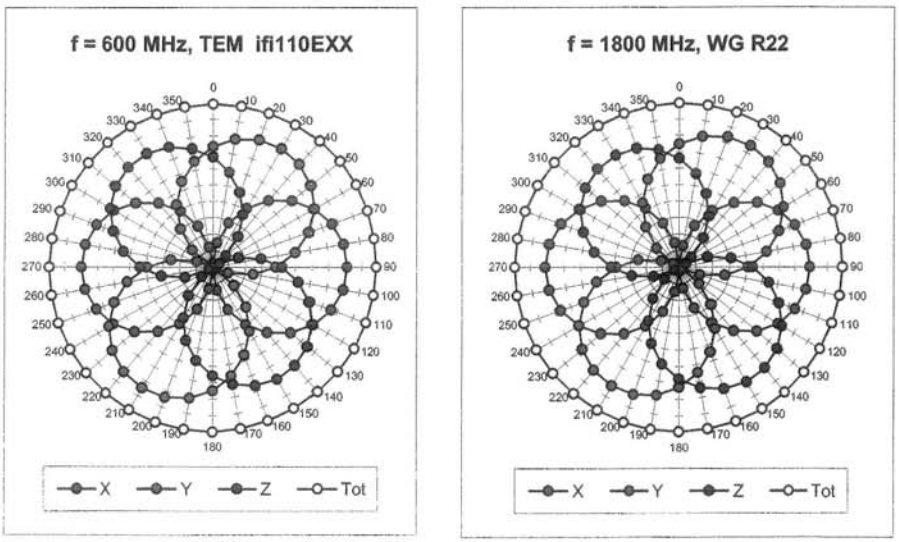
(TEM-Cell:ifi110 EXX, Waveguide: R22)

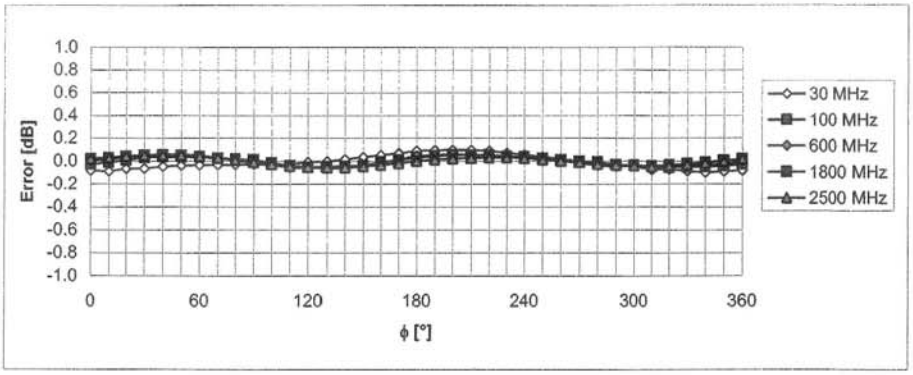



Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

**EX3DV4 SN:3555** **September 26, 2007**

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



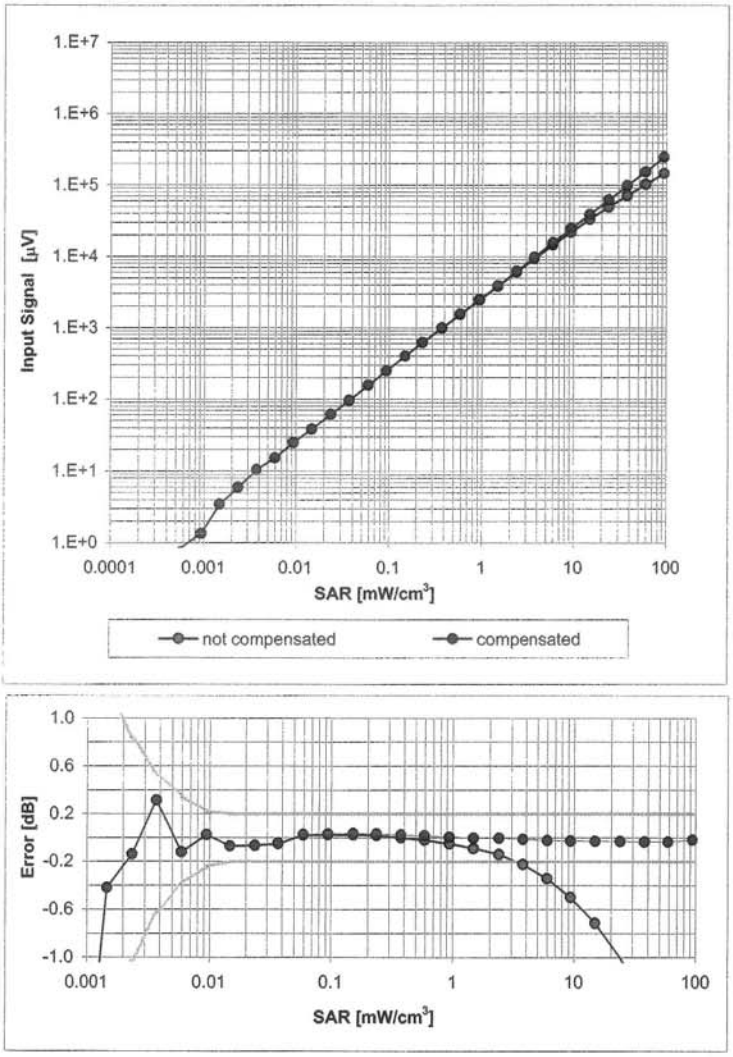




**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

**EX3DV4 SN:3555** **September 26, 2007**

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

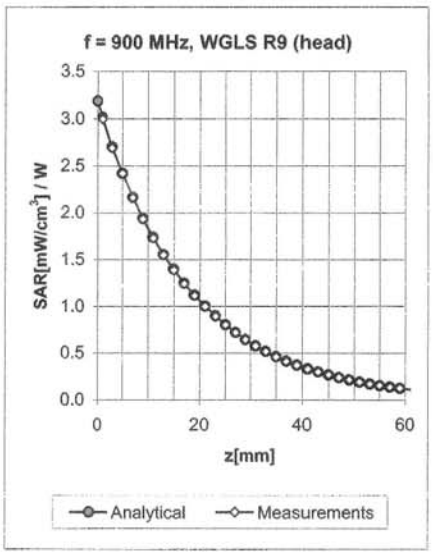
**(Waveguide R22, f = 1800 MHz)**

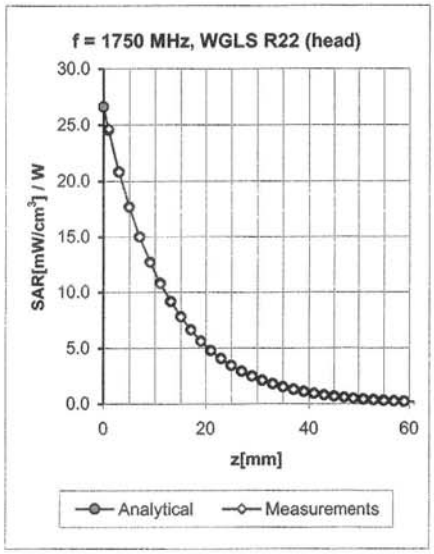



**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

**EX3DV4 SN:3555** **September 26, 2007**

# 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% | 0.50 | 0.90 | 8.10 ± 11.0% (k=2) |
| 1750 | ± 50 / ± 100 | Head | 40.1 ± 5% | 1.37 ± 5% | 0.39 | 0.75 | 6.86 ± 11.0% (k=2) |
| 1950 | ± 50 / ± 100 | Head | 40.0 ± 5% | 1.40 ± 5% | 0.44 | 0.70 | 6.61 ± 11.0% (k=2) |
| 2450 | ± 50 / ± 100 | Head | 39.2 ± 5% | 1.80 ± 5% | 0.68 | 0.62 | 6.30 ± 11.8% (k=2) |
| 900 | ± 50 / ± 100 | Body | 55.0 ± 5% | 1.05 ± 5% | 0.48 | 0.90 | 7.91 ± 11.0% (k=2) |
| 1750 | ± 50 / ± 100 | Body | 53.4 ± 5% | 1.49 ± 5% | 0.40 | 0.73 | 6.86 ± 11.0% (k=2) |
| 1950 | ± 50 / ± 100 | Body | 53.3 ± 5% | 1.52 ± 5% | 0.22 | 1.03 | 6.50 ± 11.0% (k=2) |
| 2450 | ± 50 / ± 100 | Body | 52.7 ± 5% | 1.95 ± 5% | 0.64 | 0.69 | 6.17 ± 11.8% (k=2) |

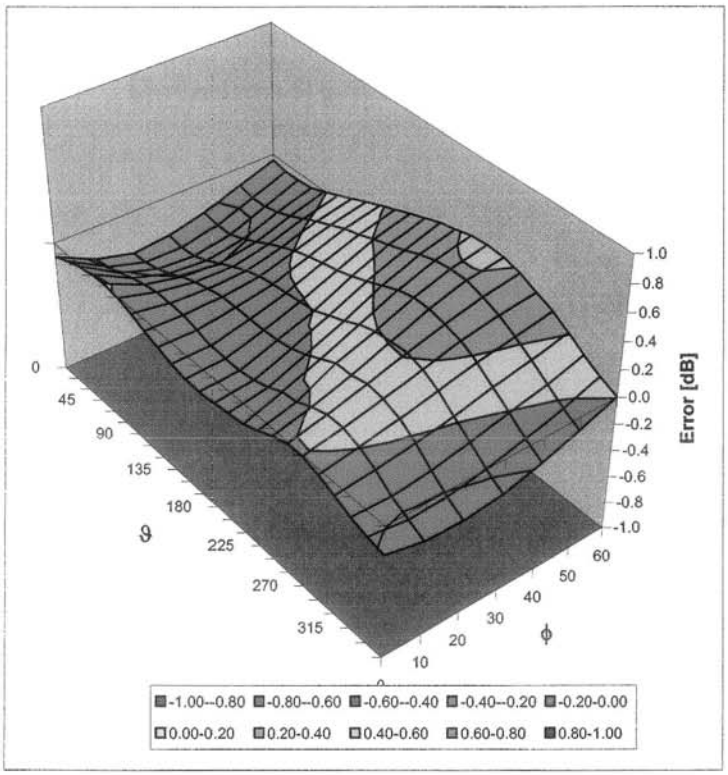
[C] The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

Certificate No: EX3-3555_Sep07 Page 8 of 9

EX3DV4 SN:3555 September 26, 2007

## Deviation from Isotropy in HSL

Error (ϕ, ϑ), f = 900 MHz




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

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