

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



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3287_Nov12**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3287**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes**

Calibration date: **November 15, 2012**

*✓ KOK
11/2012*

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 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-11 (No. ES3-3013_Dec11) | Dec-12 |
| DAE4 | SN: 660 | 20-Jun-12 (No. DAE4-660_Jun12) | Jun-13 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

| | | | |
|----------------|--------------------------------|--|---------------|
| Calibrated by: | Name Claudio Leubler | Function Laboratory Technician | Signature |
| Approved by: | Name Katja Pokovic | Function Technical Manager | Signature |

Issued: November 16, 2012

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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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Multilateral Agreement for the recognition of calibration certificates

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 |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C | modulation dependent linearization parameters |
| Polarization φ | φ rotation around probe axis |
| Polarization ϑ | ϑ 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 affect the E²-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 with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}**: A, B, C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- 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 ± 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 ES3DV3

SN:3287

Manufactured: June 7, 2010
Calibrated: November 15, 2012

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 1.31 | 1.25 | 1.25 | $\pm 10.1\%$ |
| DCP (mV) ^B | 102.9 | 103.6 | 101.6 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 0 | CW | 0.00 | X | 0.0 | 0.0 | 1.0 | 116.8 | $\pm 3.5\%$ |
| | | | Y | 0.0 | 0.0 | 1.0 | 118.5 | |
| | | | Z | 0.0 | 0.0 | 1.0 | 154.1 | |

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 Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 41.9 | 0.89 | 6.40 | 6.40 | 6.40 | 0.20 | 2.54 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.17 | 6.17 | 6.17 | 0.34 | 1.68 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.16 | 5.16 | 5.16 | 0.63 | 1.30 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 4.96 | 4.96 | 4.96 | 0.48 | 1.55 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.30 | 4.30 | 4.30 | 0.79 | 1.31 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.19 | 4.19 | 4.19 | 0.80 | 1.31 | ± 12.0 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

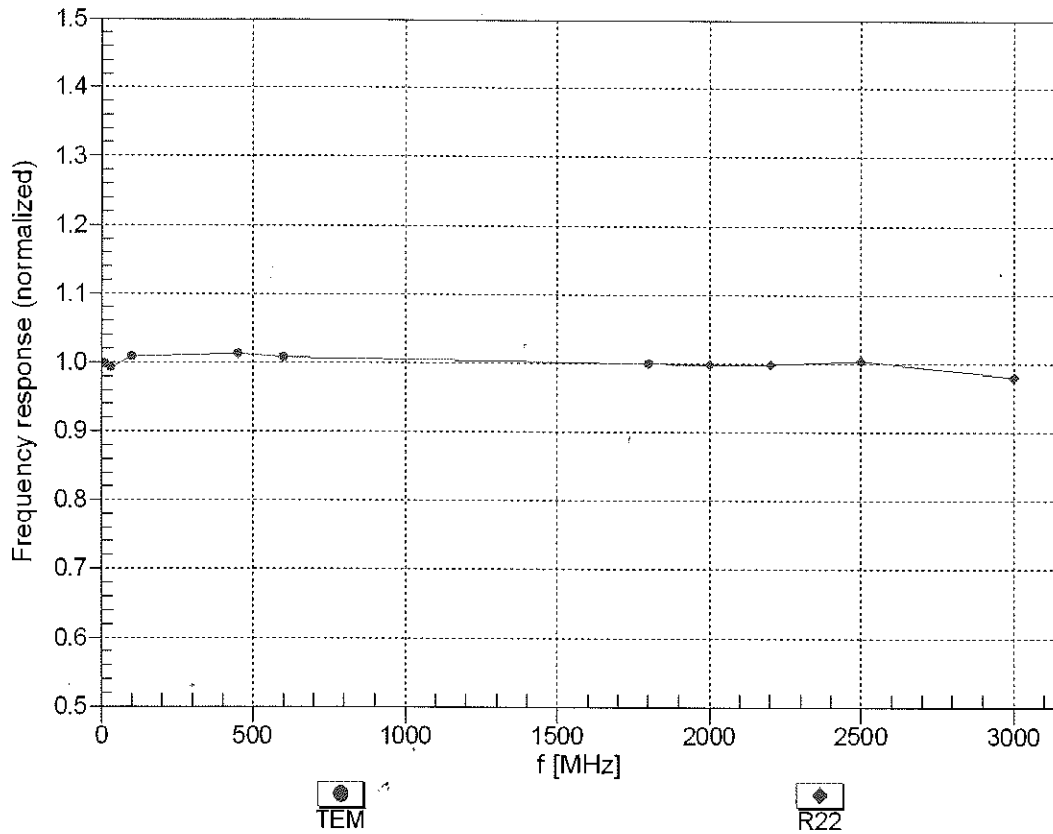
Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 6.14 | 6.14 | 6.14 | 0.28 | 2.06 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.06 | 6.06 | 6.06 | 0.42 | 1.63 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.86 | 4.86 | 4.86 | 0.43 | 1.64 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.69 | 4.69 | 4.69 | 0.56 | 1.54 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.29 | 4.29 | 4.29 | 0.80 | 1.02 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.12 | 4.12 | 4.12 | 0.64 | 0.92 | ± 12.0 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

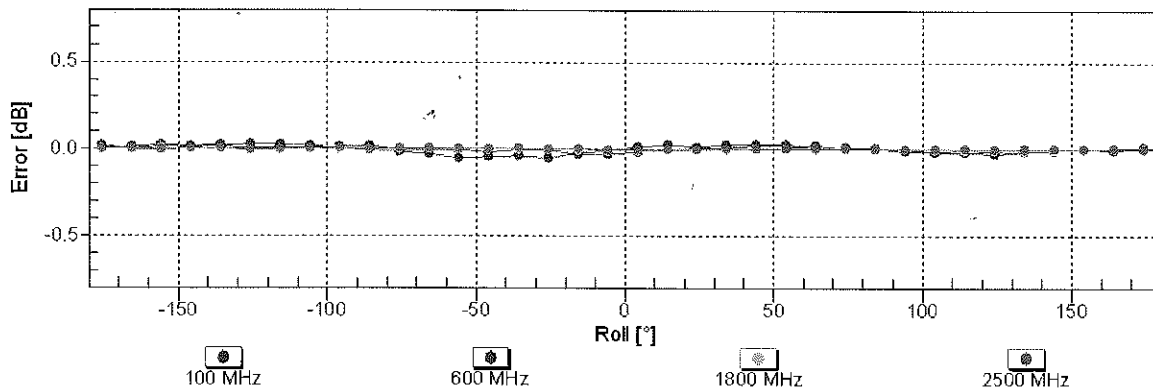
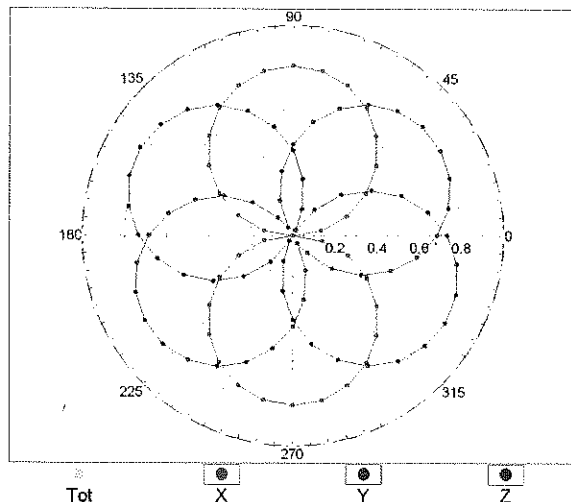
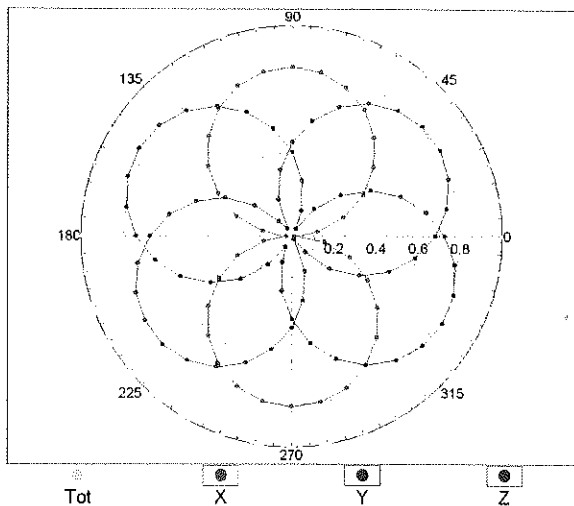


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

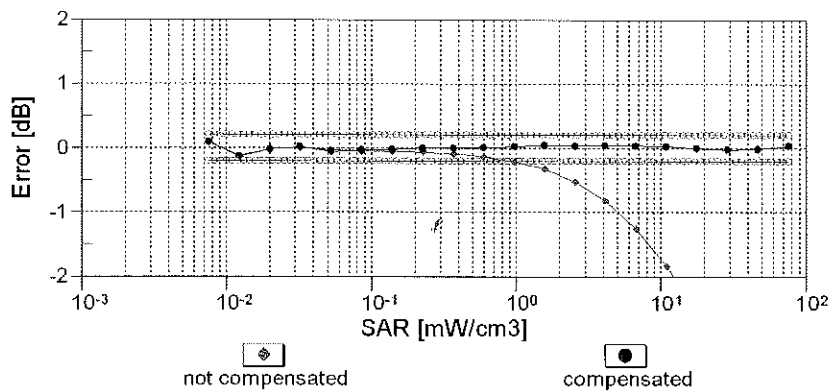
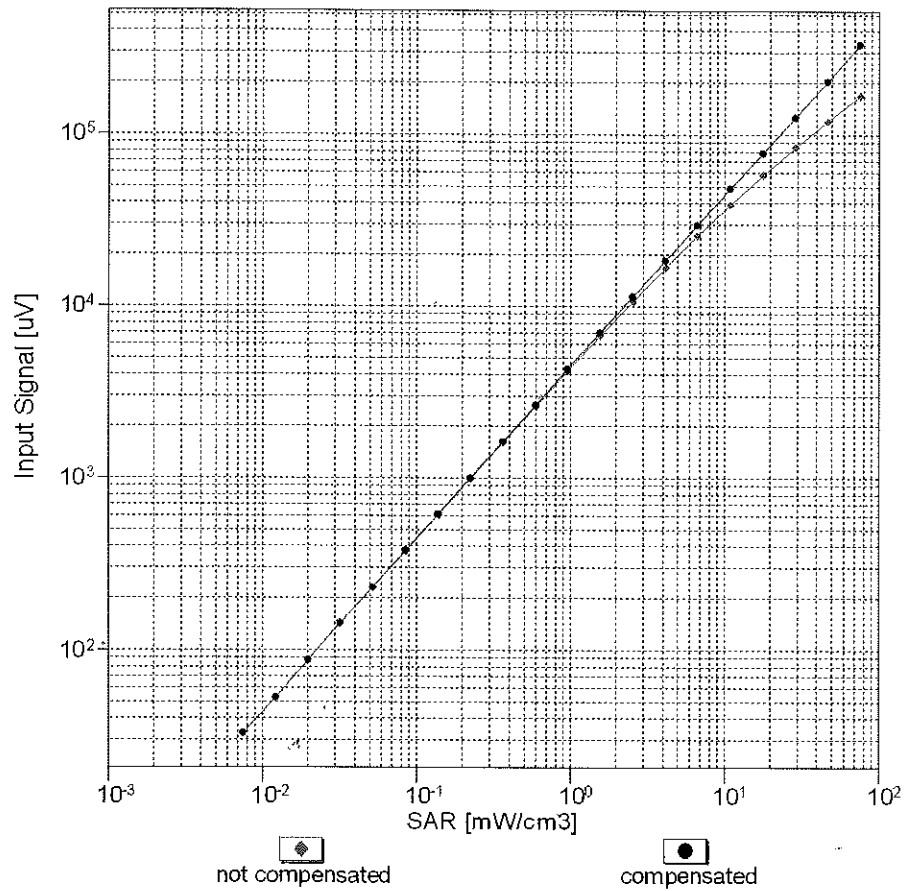
f=600 MHz,TEM

f=1800 MHz,R22



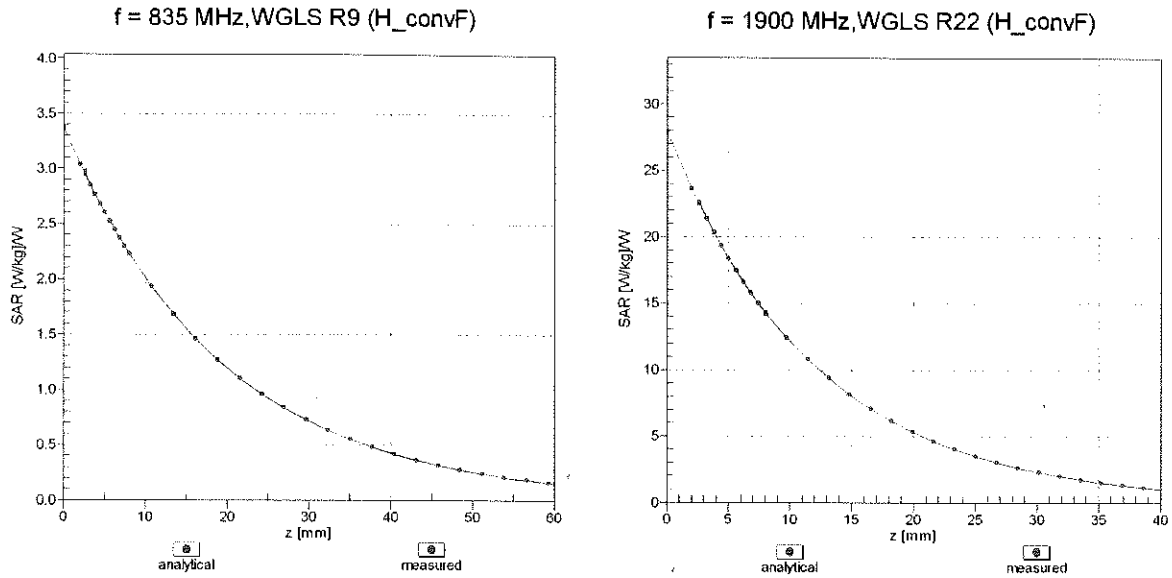
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)

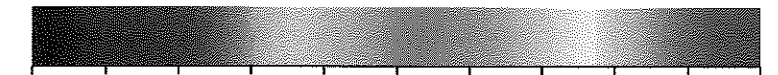
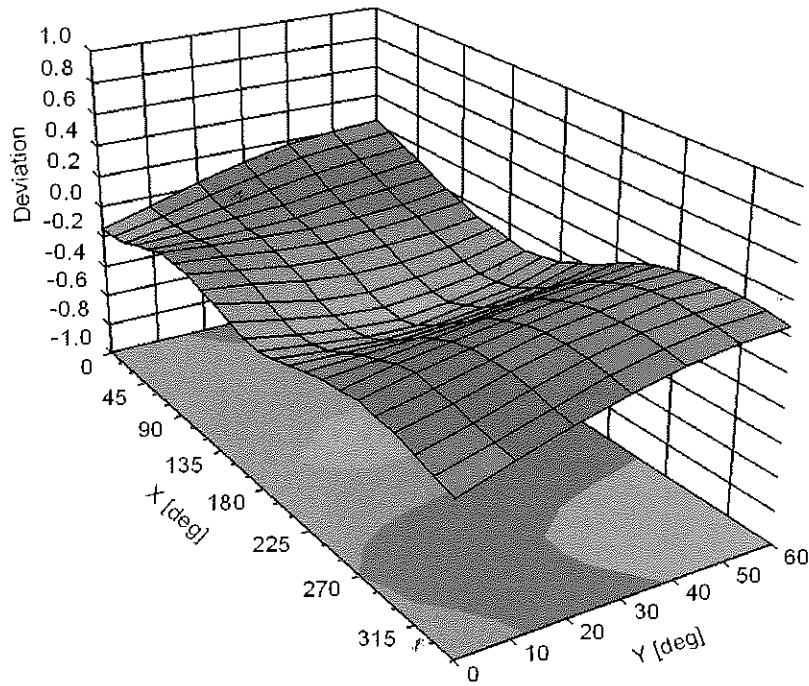


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ (k=2)

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3287

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -15.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |

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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3288_Sep12**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3288**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes**

Calibration date: **September 20, 2012**

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.

*KOK
10/2/12*

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 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-11 (No. ES3-3013_Dec11) | Dec-12 |
| DAE4 | SN: 660 | 20-Jun-12 (No. DAE4-660_Jun12) | Jun-13 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

| | | | |
|----------------|-------------------------------|--|---------------|
| Calibrated by: | Name Jeton Kastrati | Function Laboratory Technician | Signature |
| Approved by: | Name Katja Pokovic | Technical Manager | |

Issued: September 20, 2012

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Accreditation No.: **SCS 108**

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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 |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C | modulation dependent linearization parameters |
| Polarization ϕ | ϕ rotation around probe axis |
| Polarization ϑ | ϑ 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 affect the E²-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 with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}; A, B, C** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- 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 ± 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 ES3DV3

SN:3288

Manufactured: July 6, 2010
Calibrated: September 20, 2012

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3288

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.87 | 0.97 | 0.75 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 101.3 | 102.4 | 103.9 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 0 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 168.6 | $\pm 3.3 \%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 132.2 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 156.8 | |

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 Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3288

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^c | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 41.9 | 0.89 | 6.67 | 6.67 | 6.67 | 0.80 | 1.14 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.41 | 6.41 | 6.41 | 0.76 | 1.18 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.51 | 5.51 | 5.51 | 0.70 | 1.28 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.28 | 5.28 | 5.28 | 0.80 | 1.22 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.61 | 4.61 | 4.61 | 0.80 | 1.26 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.45 | 4.45 | 4.45 | 0.80 | 1.31 | ± 12.0 % |

^c Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3288

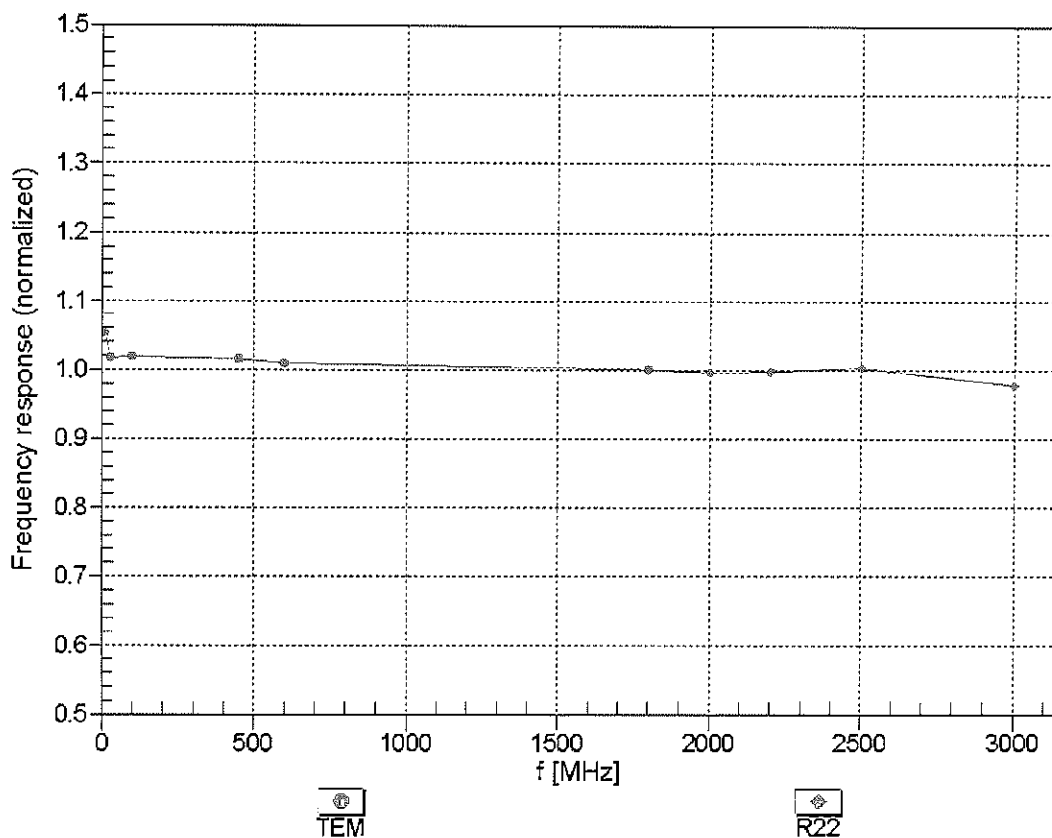
Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 6.44 | 6.44 | 6.44 | 0.62 | 1.31 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.31 | 6.31 | 6.31 | 0.38 | 1.78 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 5.18 | 5.18 | 5.18 | 0.64 | 1.43 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.89 | 4.89 | 4.89 | 0.50 | 1.64 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.35 | 4.35 | 4.35 | 0.74 | 1.23 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.09 | 4.09 | 4.09 | 0.80 | 1.07 | ± 12.0 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

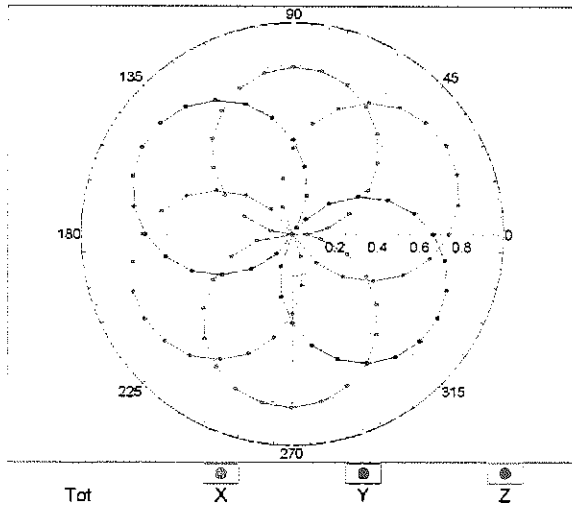
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



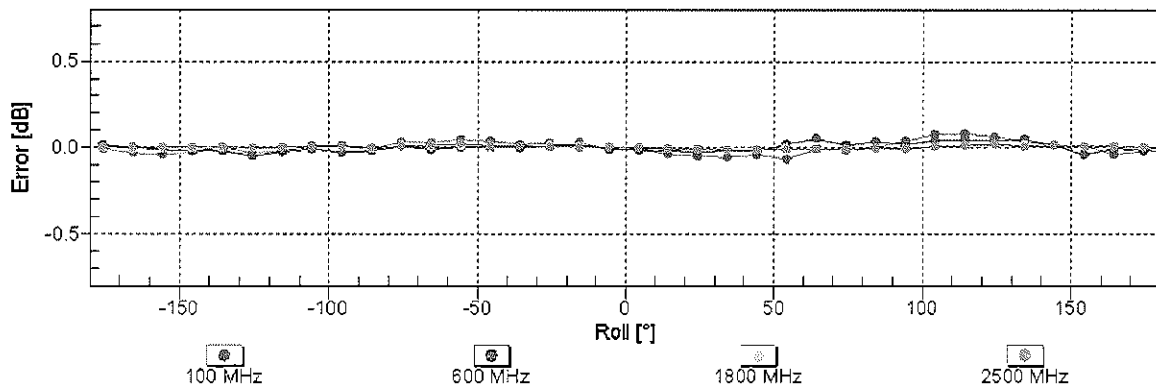
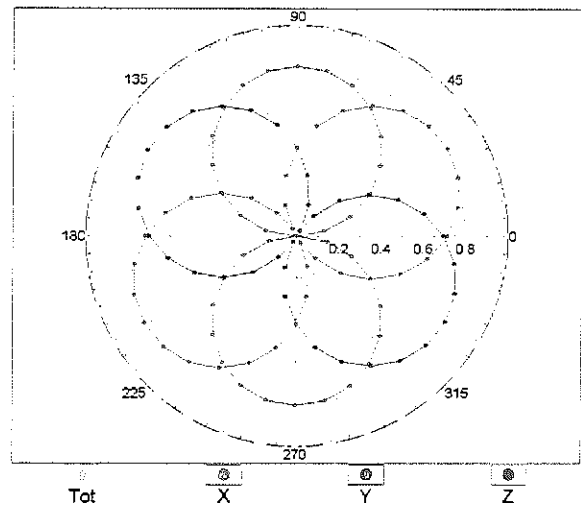
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM

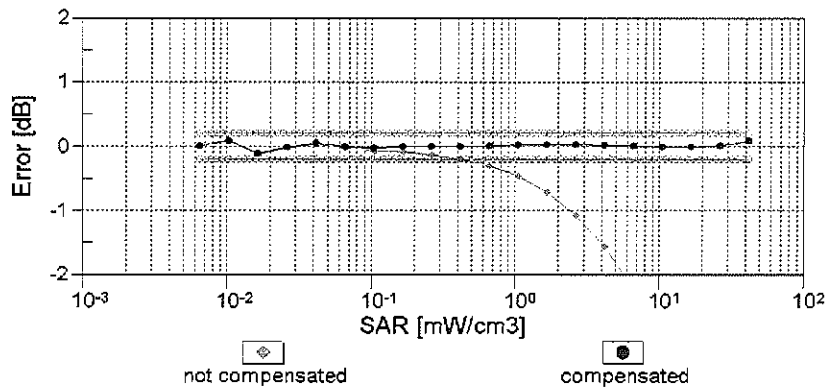
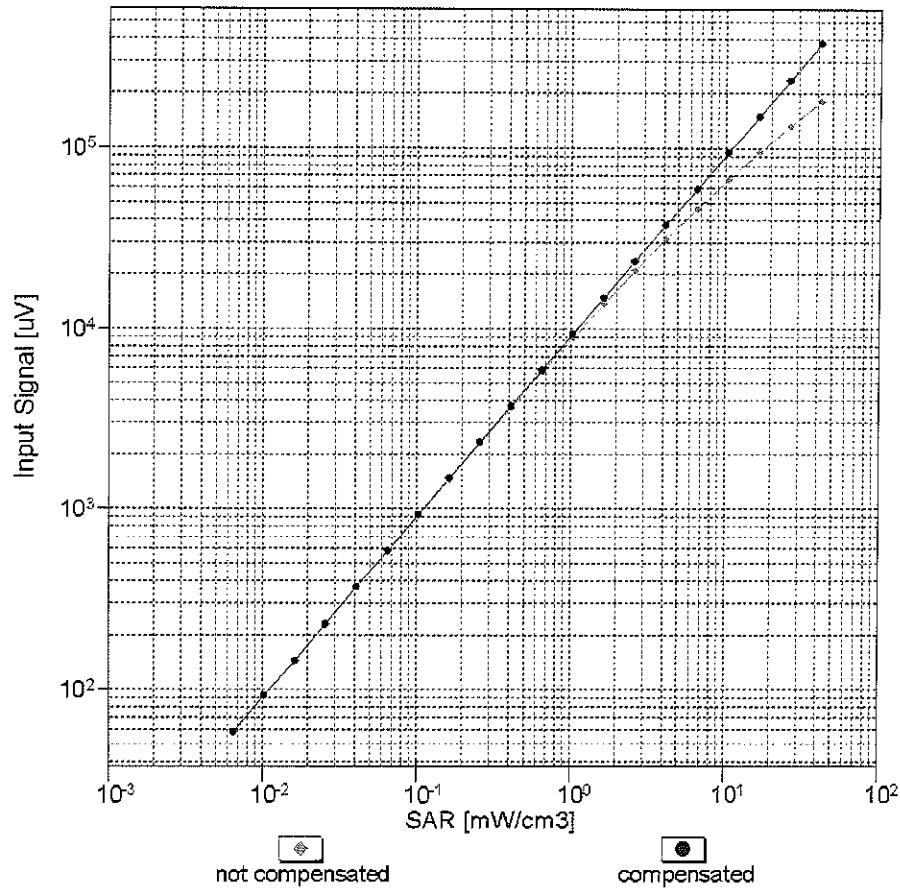


f=1800 MHz, R22



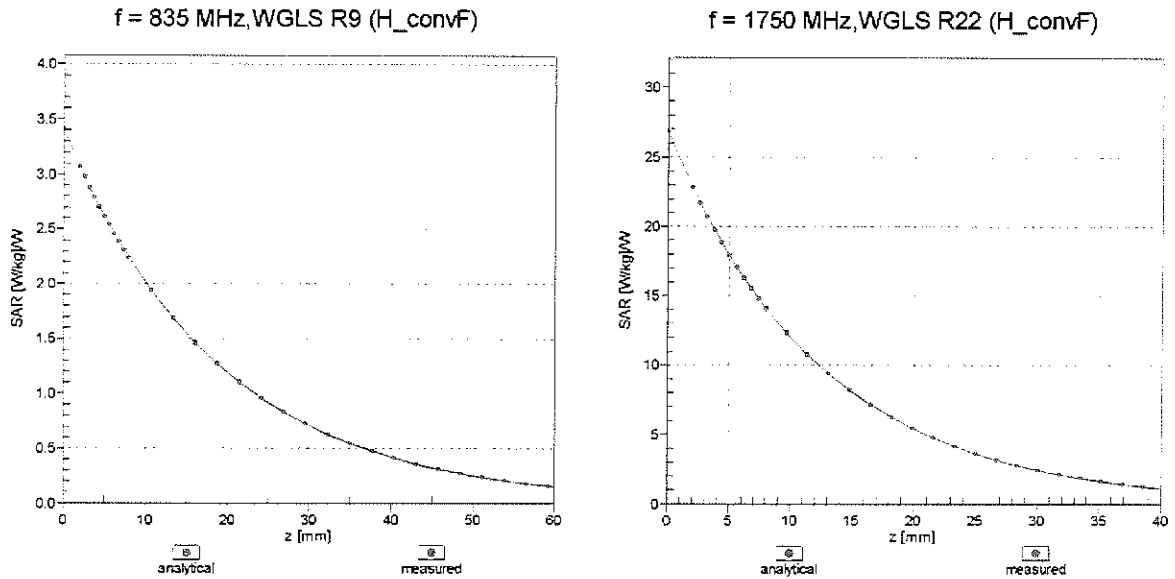
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)



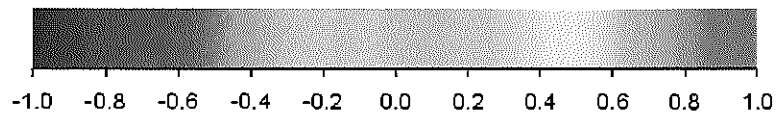
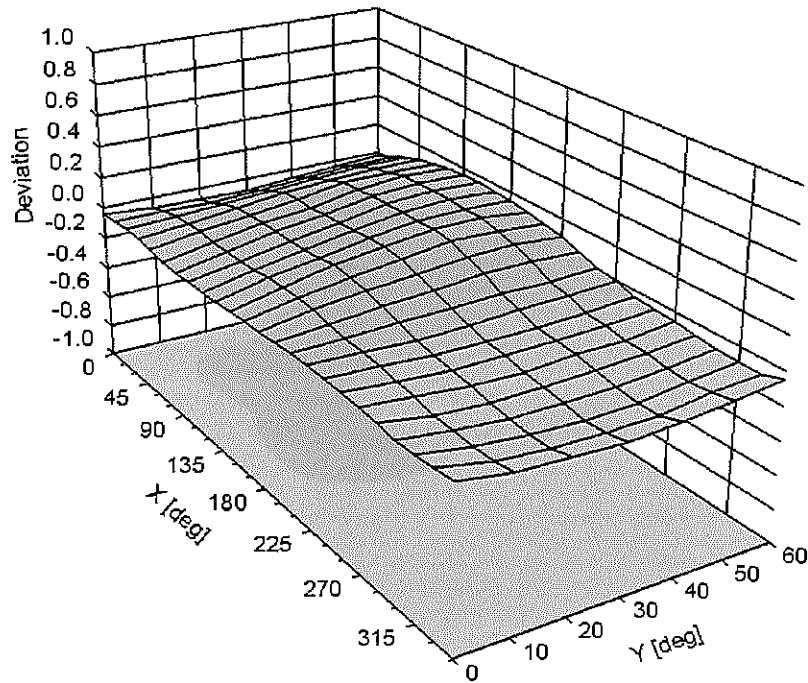
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ (k=2)

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3288**Other Probe Parameters**

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 54.3 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **EX3-3920_Feb13/2**

CALIBRATION CERTIFICATE (Replacement of No: EX3-3920_Feb13)

Object **EX3DV4 - SN:3920**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes**

Calibration date: **February 27, 2013**

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%.

*✓
KOK
3/27/13*

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B | GB41293874 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 28-Dec-12 (No. ES3-3013_Dec12) | Dec-13 |
| DAE4 | SN: 660 | 31-Jan-13 (No. DAE4-660_Jan13) | Jan-14 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

| | | | |
|----------------|--------------------------------|-----------------------------------|---------------|
| Calibrated by: | Name Claudio Leubler | Function Laboratory Technician | Signature |
| Approved by: | Name Katja Pokovic | Function Technical Manager | Signature |

Issued: March 5, 2013

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Accreditation No.: **SCS 108**

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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 |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C, D | modulation dependent linearization parameters |
| Polarization φ | φ rotation around probe axis |
| Polarization ϑ | ϑ 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 affect the E²-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 with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- 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 ± 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:3920

Manufactured: December 18, 2012
Calibrated: February 27, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3920

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.34 | 0.50 | 0.50 | $\pm 10.1\%$ |
| DCP (mV) ^B | 101.2 | 101.0 | 99.1 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 134.3 | $\pm 3.3\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 164.7 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 161.4 | |

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 Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3920

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 41.9 | 0.89 | 9.86 | 9.86 | 9.86 | 0.19 | 1.39 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 9.58 | 9.58 | 9.58 | 0.77 | 0.54 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 7.97 | 7.97 | 7.97 | 0.57 | 0.69 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.73 | 7.73 | 7.73 | 0.54 | 0.73 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.04 | 7.04 | 7.04 | 0.40 | 0.82 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 6.80 | 6.80 | 6.80 | 0.49 | 0.76 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 4.87 | 4.87 | 4.87 | 0.35 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.73 | 4.73 | 4.73 | 0.37 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.52 | 4.52 | 4.52 | 0.39 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.17 | 4.17 | 4.17 | 0.50 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.02 | 4.02 | 4.02 | 0.45 | 1.80 | ± 13.1 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3920

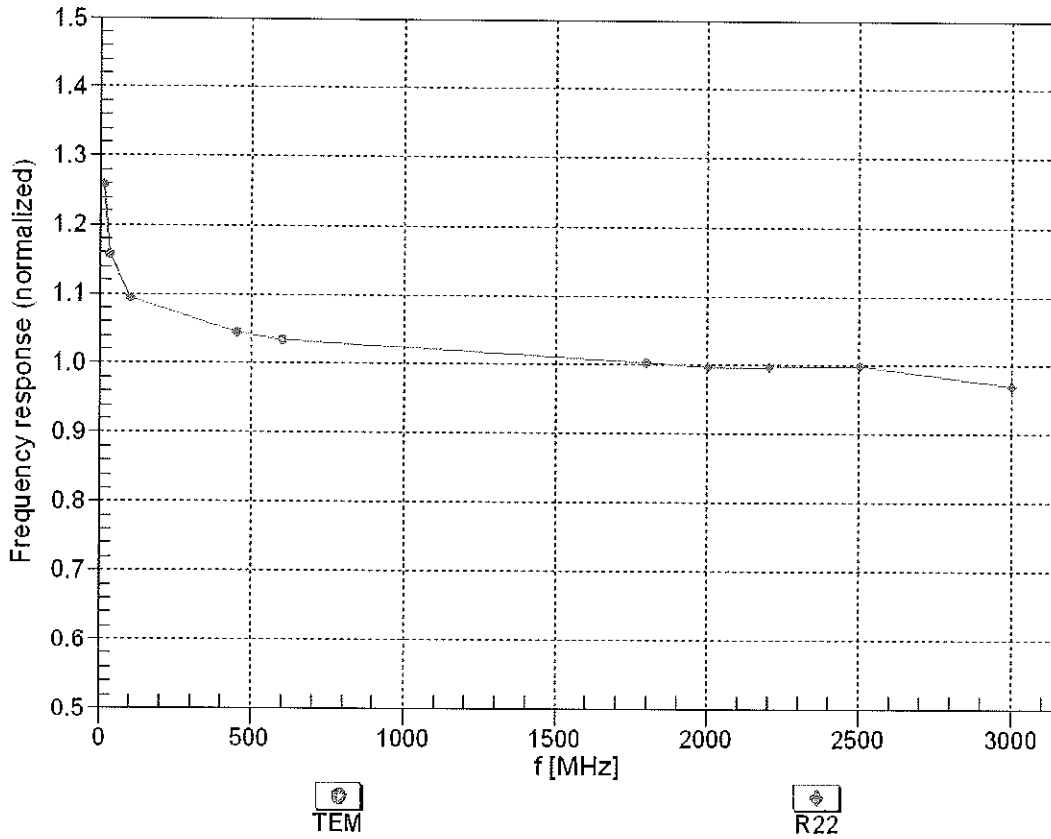
Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 9.57 | 9.57 | 9.57 | 0.43 | 0.83 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 9.42 | 9.42 | 9.42 | 0.36 | 0.98 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.59 | 7.59 | 7.59 | 0.43 | 0.78 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.38 | 7.38 | 7.38 | 0.33 | 0.91 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.07 | 7.07 | 7.07 | 0.80 | 0.55 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.73 | 6.73 | 6.73 | 0.80 | 0.56 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 4.23 | 4.23 | 4.23 | 0.51 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.13 | 4.13 | 4.13 | 0.49 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 3.63 | 3.63 | 3.63 | 0.52 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.62 | 3.62 | 3.62 | 0.49 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 3.91 | 3.91 | 3.91 | 0.54 | 1.90 | ± 13.1 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

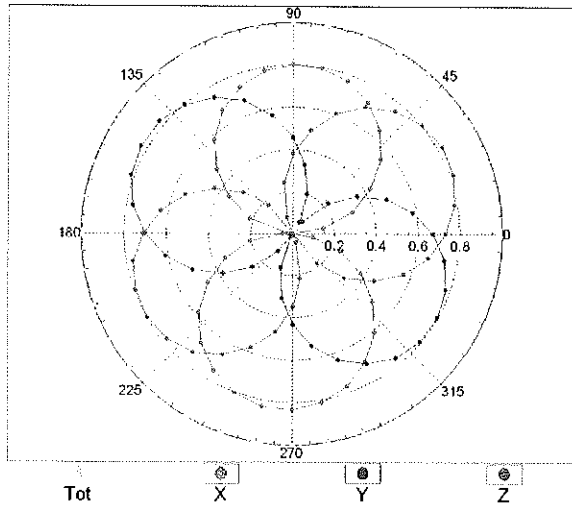
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



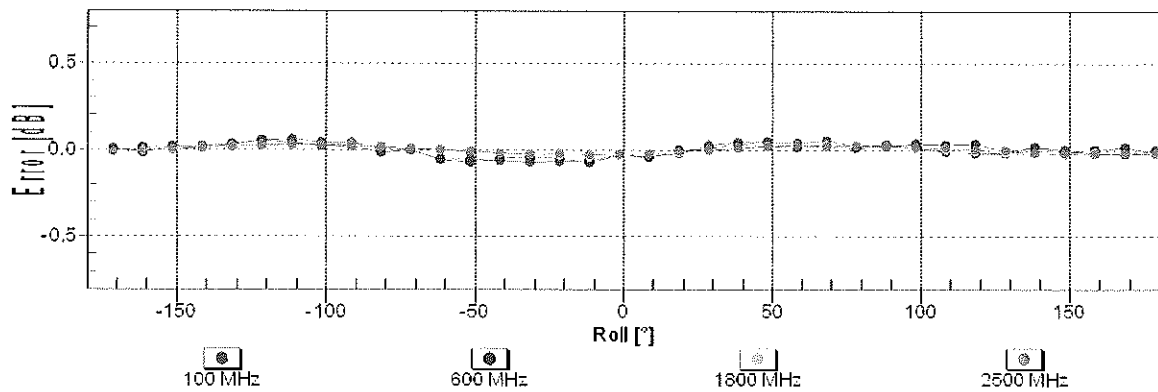
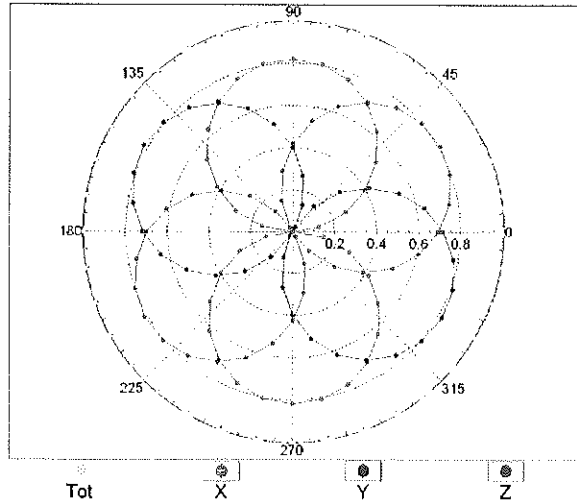
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

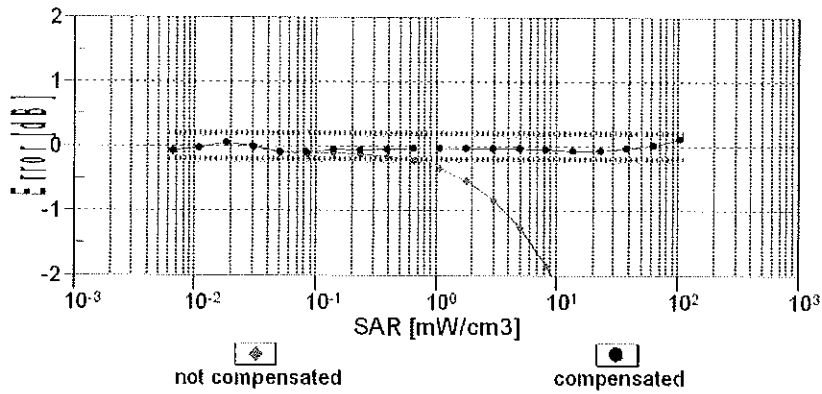
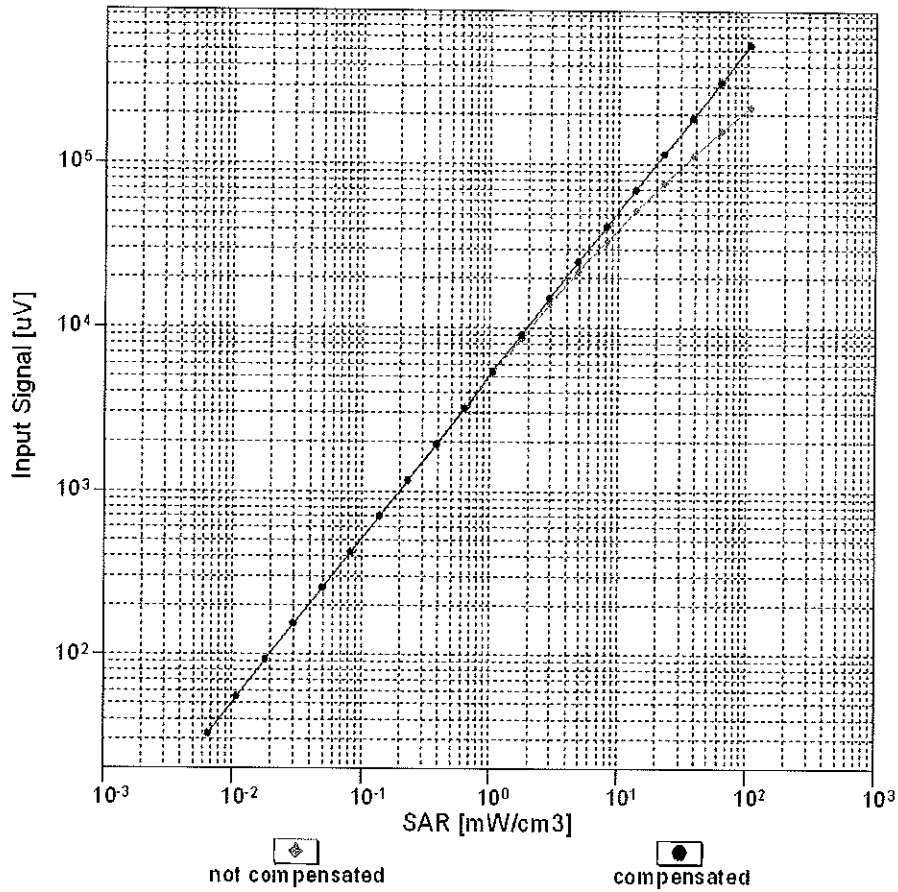


f=1800 MHz,R22



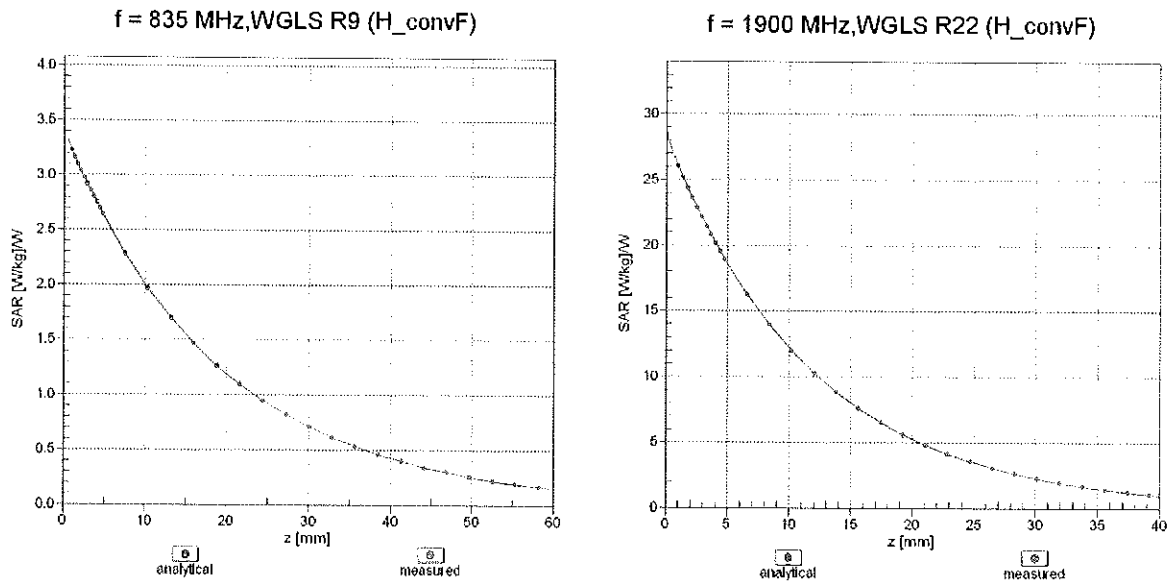
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)

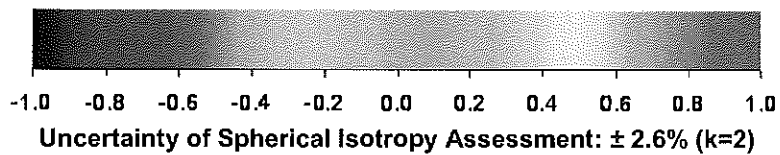
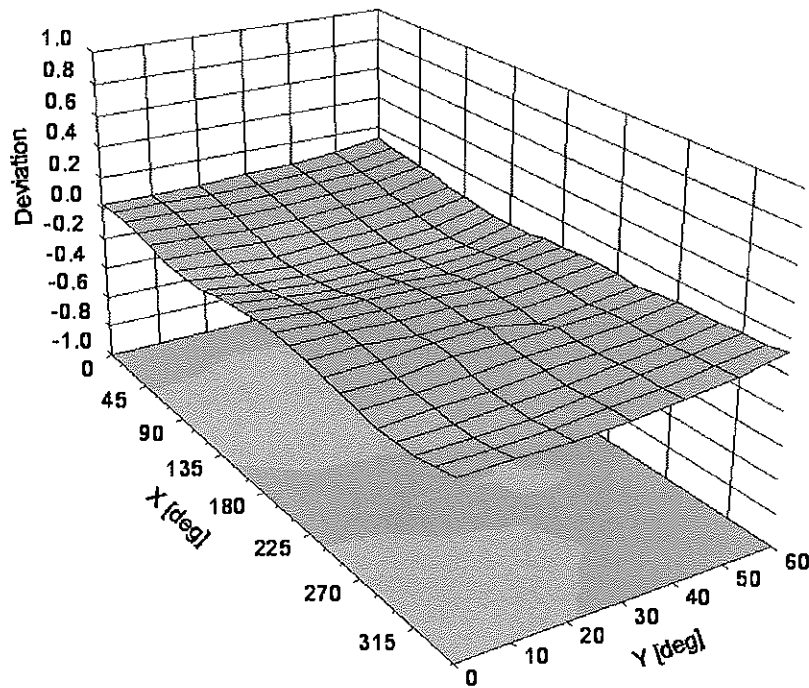


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), $f = 900$ MHz



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3920

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -21.6 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 2 mm |



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3209_Mar13**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3209**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes**

Calibration date: **March 15, 2013**

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%.

✓ KOK 3/22/13

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B | GB41293874 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 28-Dec-12 (No. ES3-3013_Dec12) | Dec-13 |
| DAE4 | SN: 660 | 31-Jan-13 (No. DAE4-660_Jan13) | Jan-14 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

| | Name | Function | Signature |
|----------------|----------------|-----------------------|-----------------------|
| Calibrated by: | Israe El-Naouq | Laboratory Technician | <i>Israe El-Naouq</i> |
| Approved by: | Katja Pokovic | Technical Manager | <i>Katja Pokovic</i> |

Issued: March 15, 2013

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Accreditation No.: **SCS 108**

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 Multilateral Agreement for the recognition of calibration certificates

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 |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C, D | modulation dependent linearization parameters |
| Polarization φ | φ rotation around probe axis |
| Polarization ϑ | ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 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:

- NORM_{x,y,z}: Assessed for E-field polarization ϑ = 0 (f ≤ 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 affect the E²-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 with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z; A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 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 ± 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 ES3DV3

SN:3209

Manufactured: October 14, 2008
Calibrated: March 15, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 1.35 | 1.33 | 1.14 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 99.2 | 97.8 | 98.3 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 163.6 | $\pm 3.5 \%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 170.3 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 158.7 | |

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 E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 41.9 | 0.89 | 6.74 | 6.74 | 6.74 | 0.76 | 1.18 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.46 | 6.46 | 6.46 | 0.31 | 1.81 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.39 | 5.39 | 5.39 | 0.80 | 1.21 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.21 | 5.21 | 5.21 | 0.78 | 1.26 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.57 | 4.57 | 4.57 | 0.65 | 1.43 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.43 | 4.43 | 4.43 | 0.75 | 1.36 | ± 12.0 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

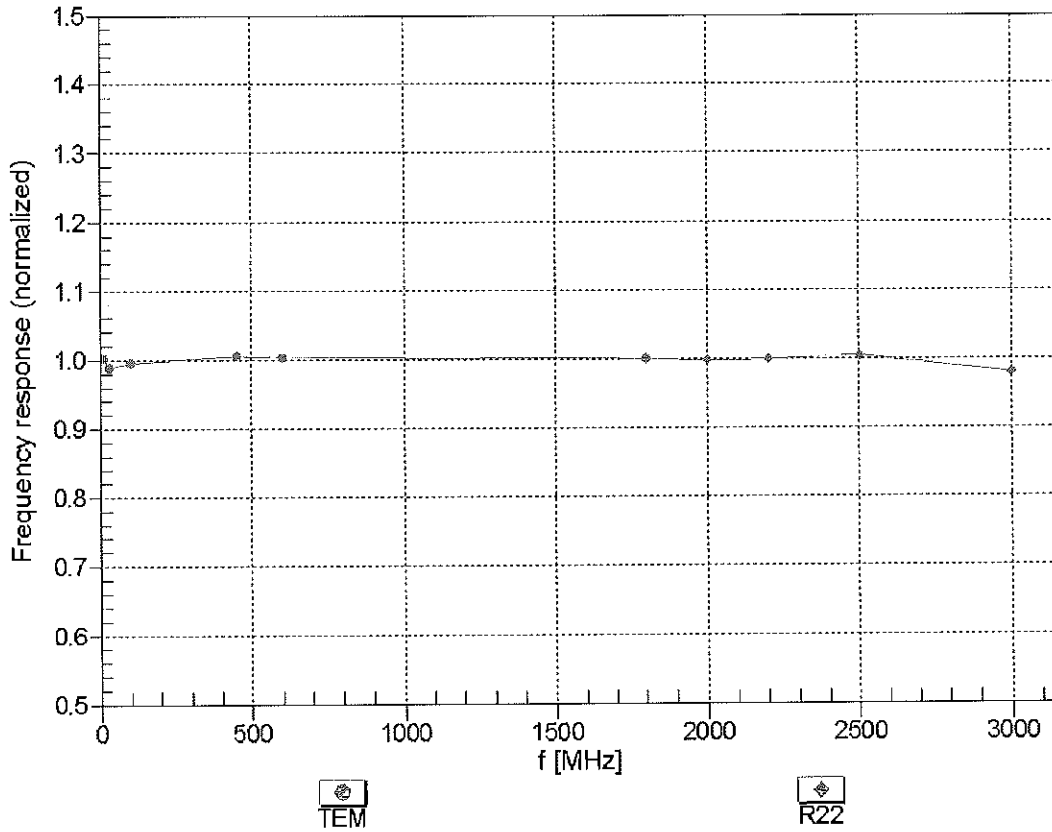
Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 6.38 | 6.38 | 6.38 | 0.80 | 1.16 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.28 | 6.28 | 6.28 | 0.52 | 1.45 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 5.03 | 5.03 | 5.03 | 0.58 | 1.45 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.77 | 4.77 | 4.77 | 0.70 | 1.36 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.34 | 4.34 | 4.34 | 0.80 | 1.15 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.11 | 4.11 | 4.11 | 0.80 | 1.00 | ± 12.0 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

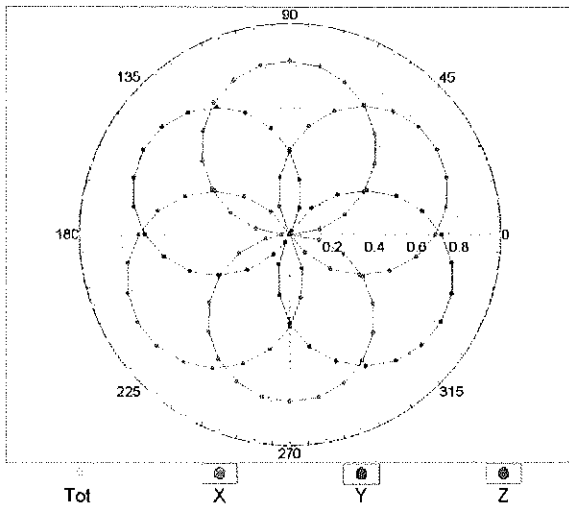
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



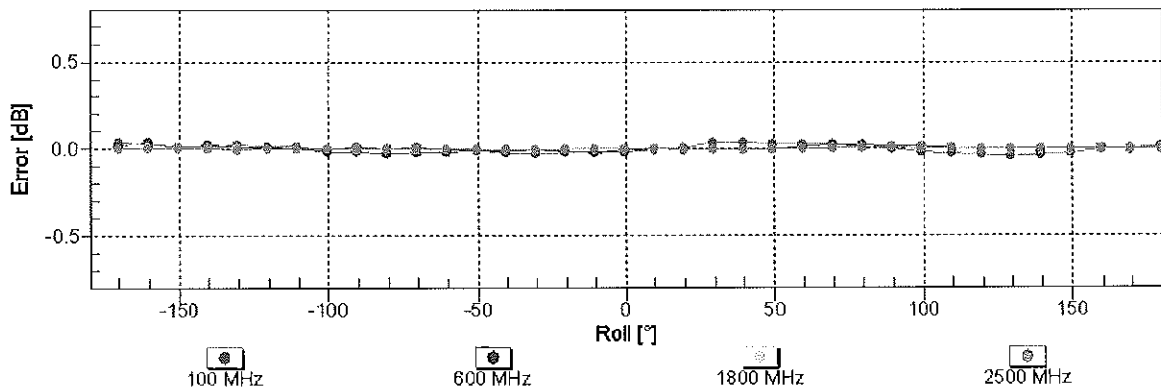
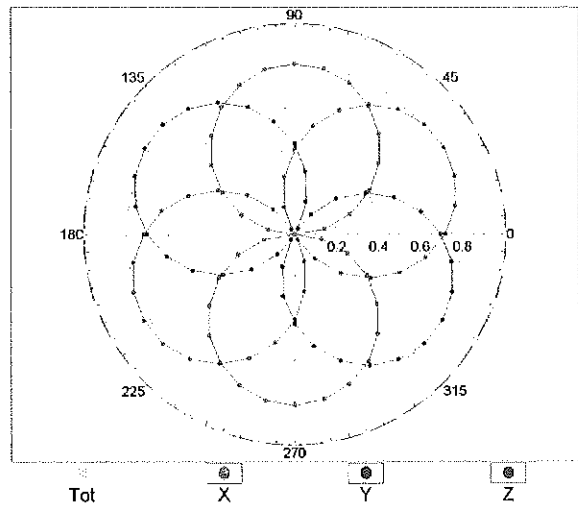
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

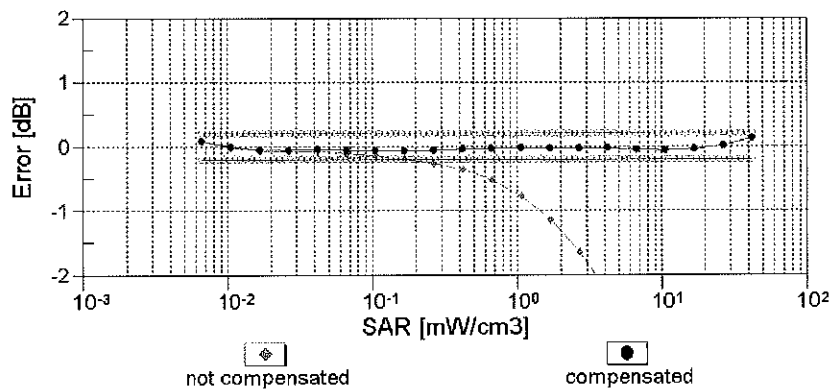
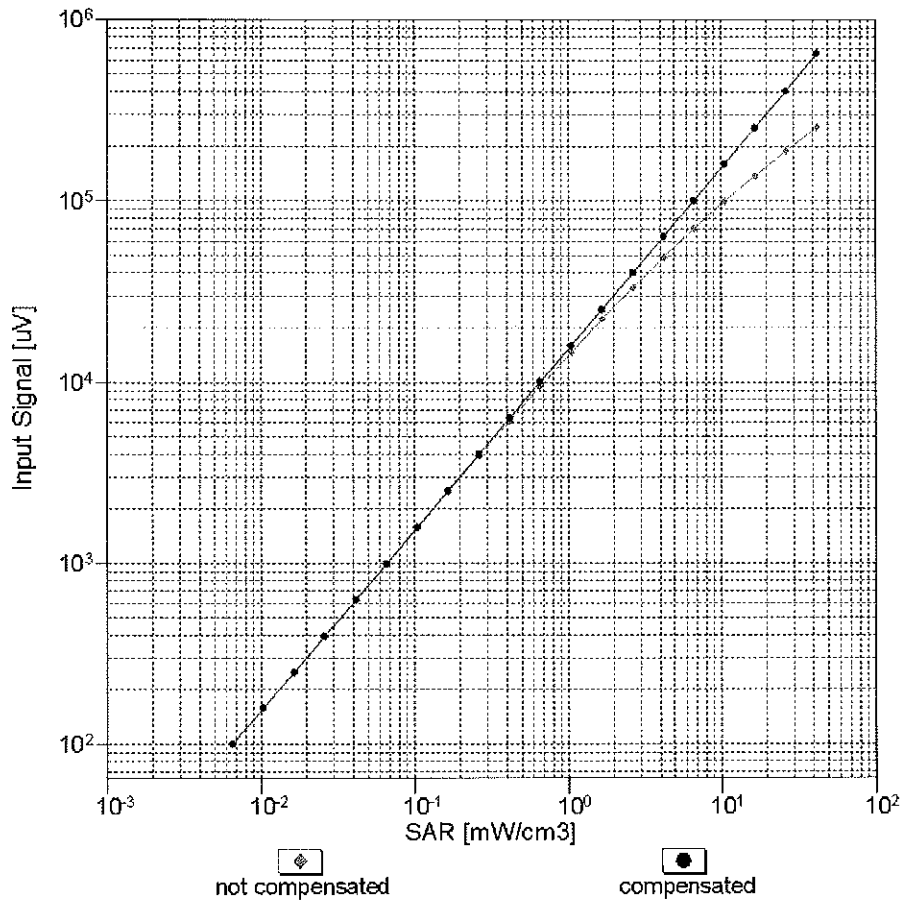


f=1800 MHz,R22



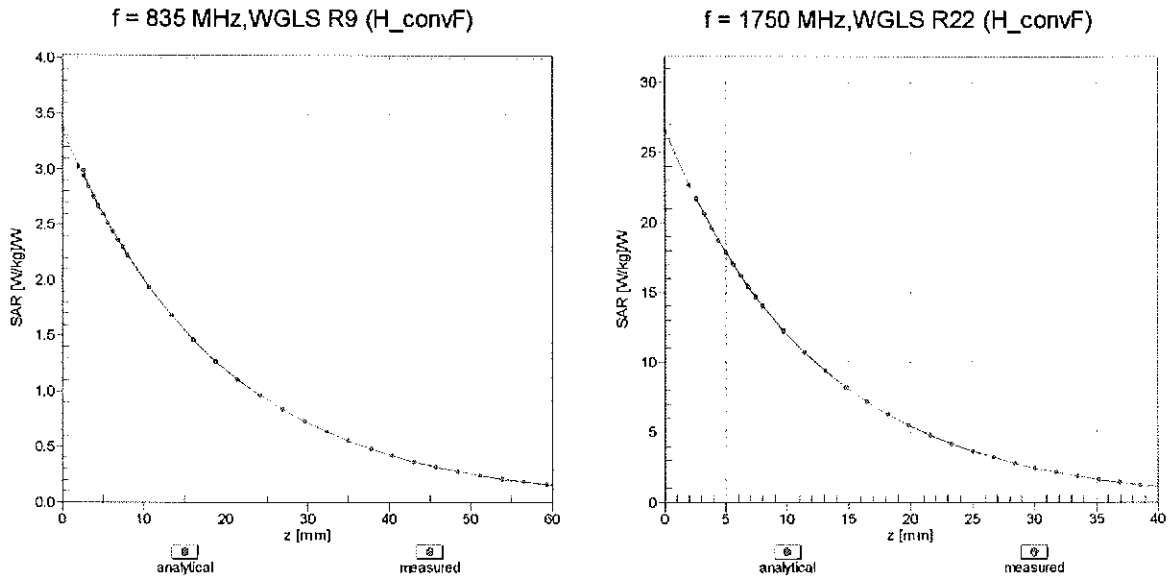
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(SAR_{head})$ (TEM cell , $f = 900$ MHz)

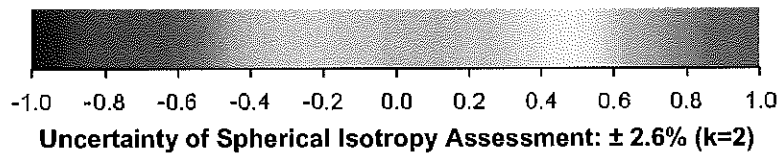
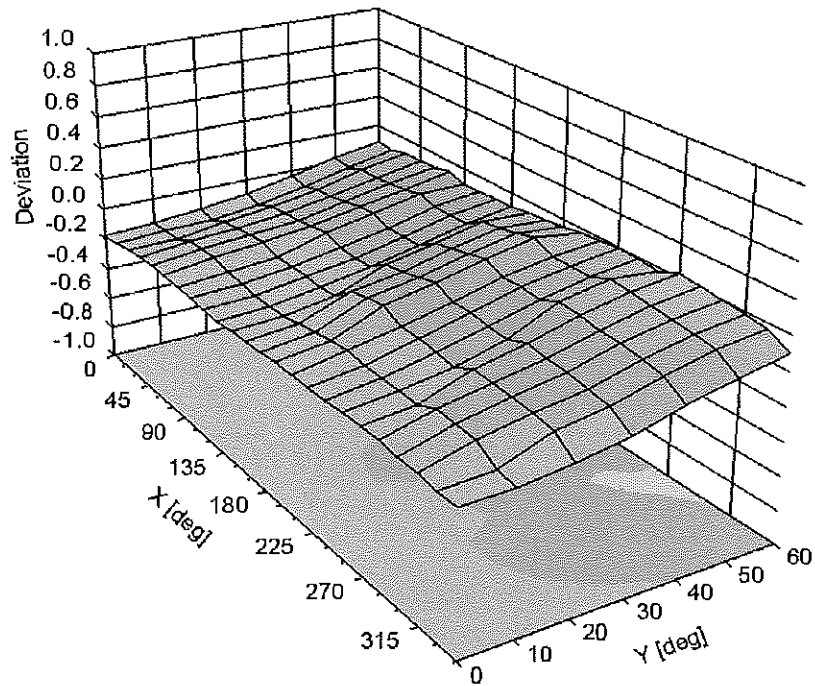


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -40.6 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3022_Aug12**

CALIBRATION CERTIFICATE

Object **ES3DV2 - SN:3022**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes**

Calibration date: **August 28, 2012**

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)

✓
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| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B | GB41293874 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-11 (No. ES3-3013_Dec11) | Dec-12 |
| DAE4 | SN: 660 | 20-Jun-12 (No. DAE4-660_Jun12) | Jun-13 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

| | Name | Function | Signature |
|----------------|----------------|-----------------------|-----------|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: August 28, 2012

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Accreditation No.: **SCS 108**

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Multilateral Agreement for the recognition of calibration certificates

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 |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C | modulation dependent linearization parameters |
| Polarization ϕ | ϕ rotation around probe axis |
| Polarization ϑ | ϑ 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 affect the E²-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 with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}**: A, B, C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- 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 ± 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 ES3DV2

SN:3022

Manufactured: April 15, 2003
Calibrated: August 28, 2012

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 1.00 | 1.04 | 0.99 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 98.3 | 99.5 | 101.3 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 0 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 133.3 | $\pm 2.7 \%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 140.3 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 178.9 | |

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 E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 41.9 | 0.89 | 6.30 | 6.30 | 6.30 | 0.30 | 1.72 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.03 | 6.03 | 6.03 | 0.35 | 1.63 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.07 | 5.07 | 5.07 | 0.32 | 1.89 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 4.86 | 4.86 | 4.86 | 0.40 | 1.57 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.23 | 4.23 | 4.23 | 0.59 | 1.44 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.10 | 4.10 | 4.10 | 0.67 | 1.37 | ± 12.0 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

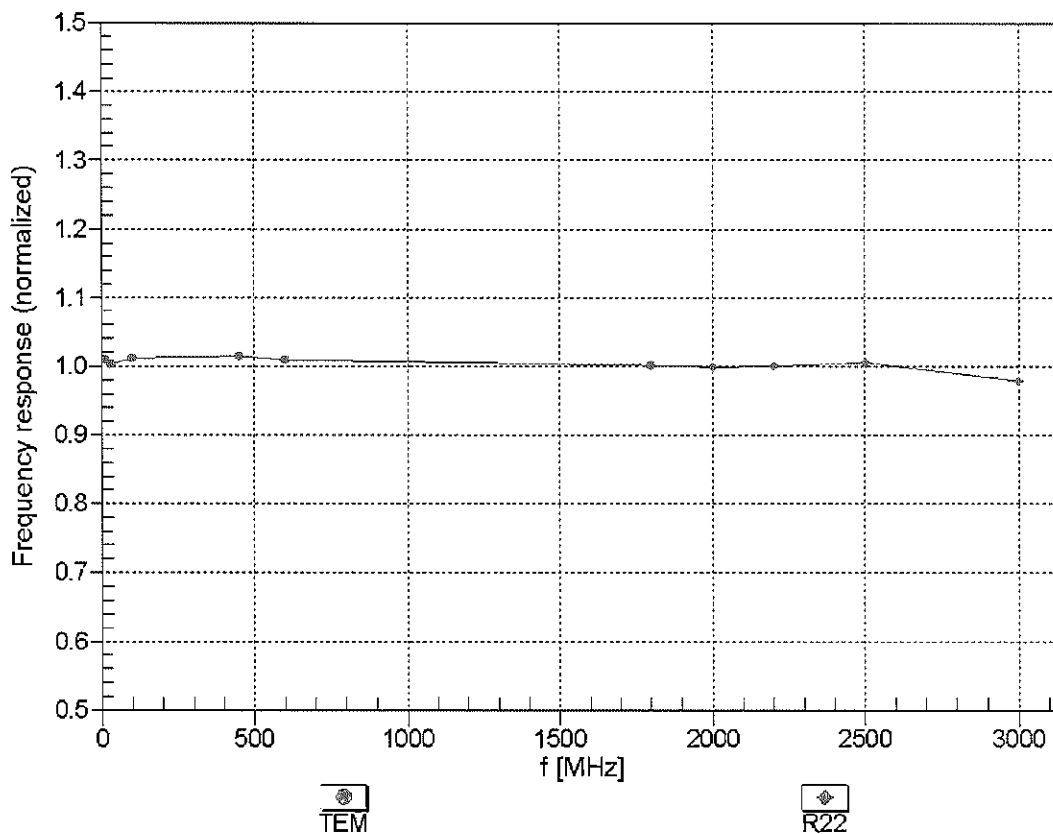
Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 6.07 | 6.07 | 6.07 | 0.23 | 2.09 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.02 | 6.02 | 6.02 | 0.47 | 1.44 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.70 | 4.70 | 4.70 | 0.46 | 1.55 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.43 | 4.43 | 4.43 | 0.36 | 1.87 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 3.97 | 3.97 | 3.97 | 0.65 | 1.06 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 3.80 | 3.80 | 3.80 | 0.54 | 0.75 | ± 12.0 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

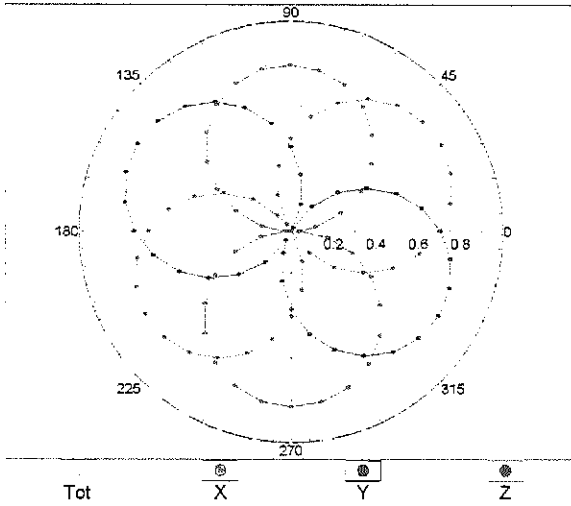
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



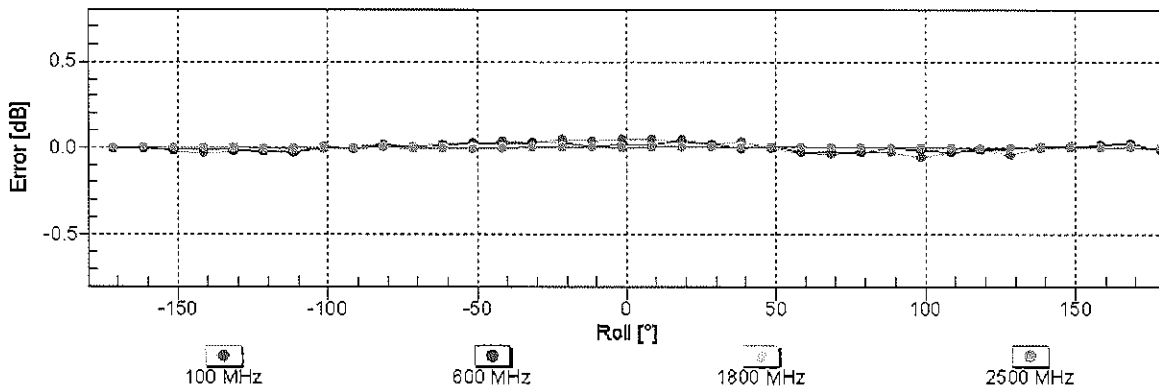
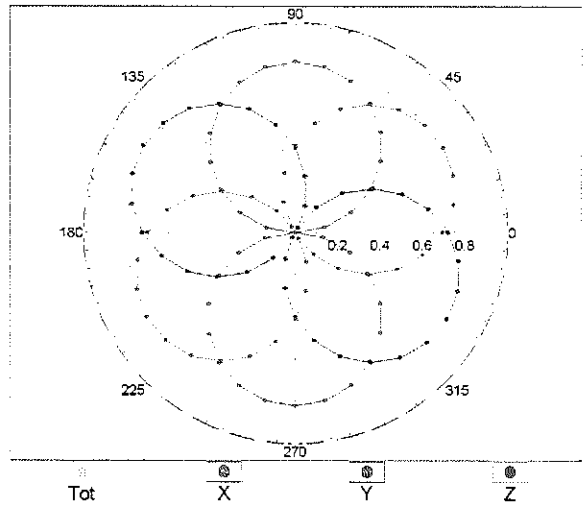
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM

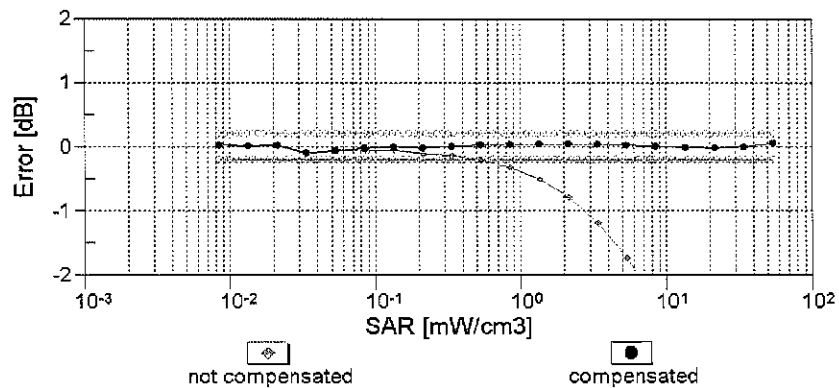
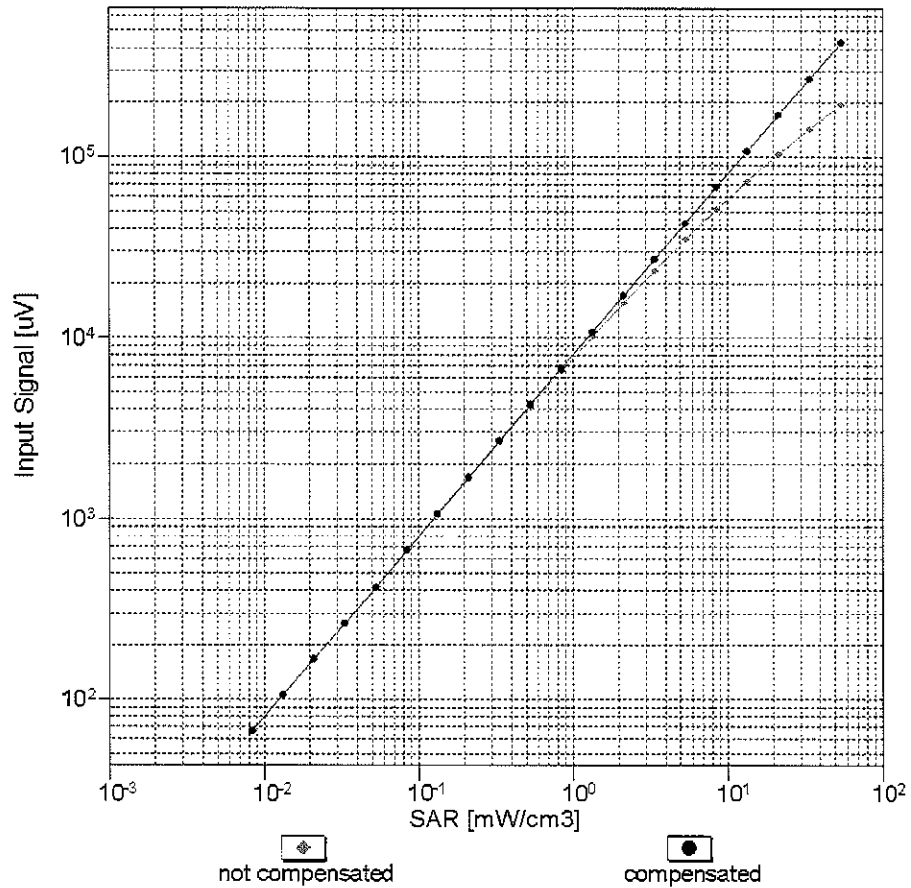


f=1800 MHz, R22



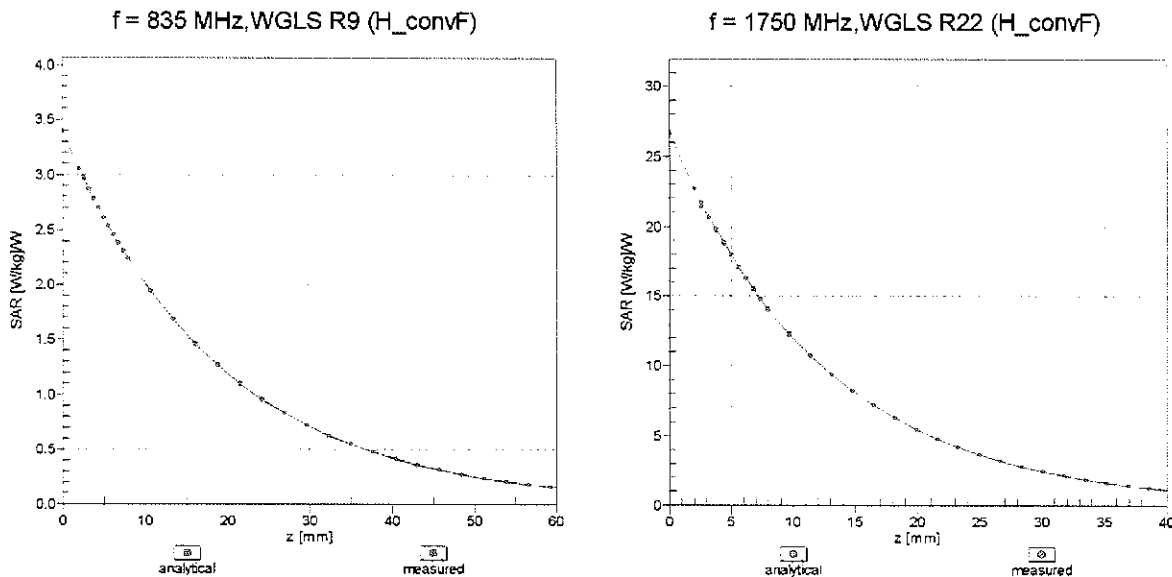
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$)

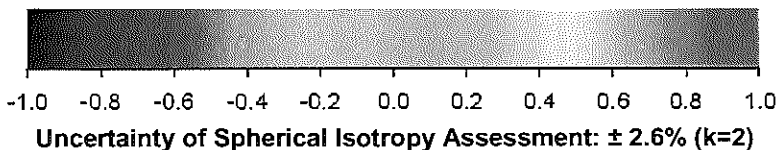
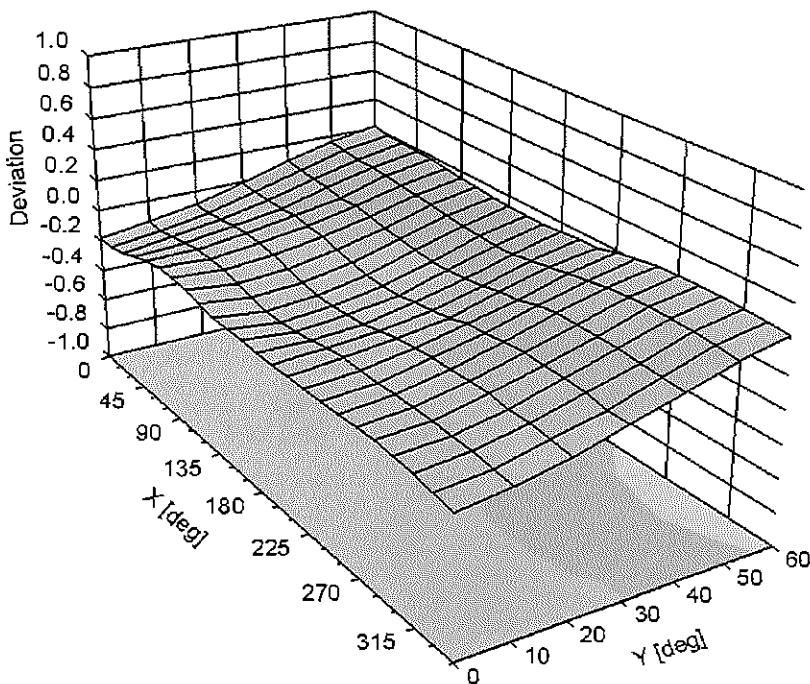


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ (k=2)

DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 98.5 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **EX3-3589_Jan13**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3589**

Calibration procedure(s) **QA CAL-01 v3, QA CAL-14 v3, QA CAL-23 v4, QA CAL-25 v4
Calibration procedure for dosimetric E-field probes**

Calibration date: **January 17, 2013**

✓
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1/28/13

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 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 28-Dec-12 (No. ES3-3013_Dec12) | Dec-13 |
| DAE4 | SN: 660 | 20-Jun-12 (No. DAE4-660_Jun12) | Jun-13 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

| | Name | Function | Signature |
|----------------|----------------|-----------------------|-----------|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 17, 2013

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Accreditation No.: **SCS 108**

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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 |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C, D | modulation dependent linearization parameters |
| Polarization φ | φ rotation around probe axis |
| Polarization ϑ | ϑ 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 affect the E²-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 with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- 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 ± 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:3589

Manufactured: March 30, 2006
Calibrated: January 17, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.46 | 0.40 | 0.40 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 100.5 | 103.8 | 99.6 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 165.8 | $\pm 3.3 \%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 134.3 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 140.5 | |

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 E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 41.9 | 0.89 | 8.70 | 8.70 | 8.70 | 0.39 | 0.96 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 8.40 | 8.40 | 8.40 | 0.52 | 0.74 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 7.34 | 7.34 | 7.34 | 0.45 | 0.93 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.09 | 7.09 | 7.09 | 0.80 | 0.65 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 6.37 | 6.37 | 6.37 | 0.39 | 0.97 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 6.19 | 6.19 | 6.19 | 0.30 | 1.12 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 4.48 | 4.48 | 4.48 | 0.45 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.27 | 4.27 | 4.27 | 0.45 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.14 | 4.14 | 4.14 | 0.50 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 3.81 | 3.81 | 3.81 | 0.55 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 3.85 | 3.85 | 3.85 | 0.55 | 1.80 | ± 13.1 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589

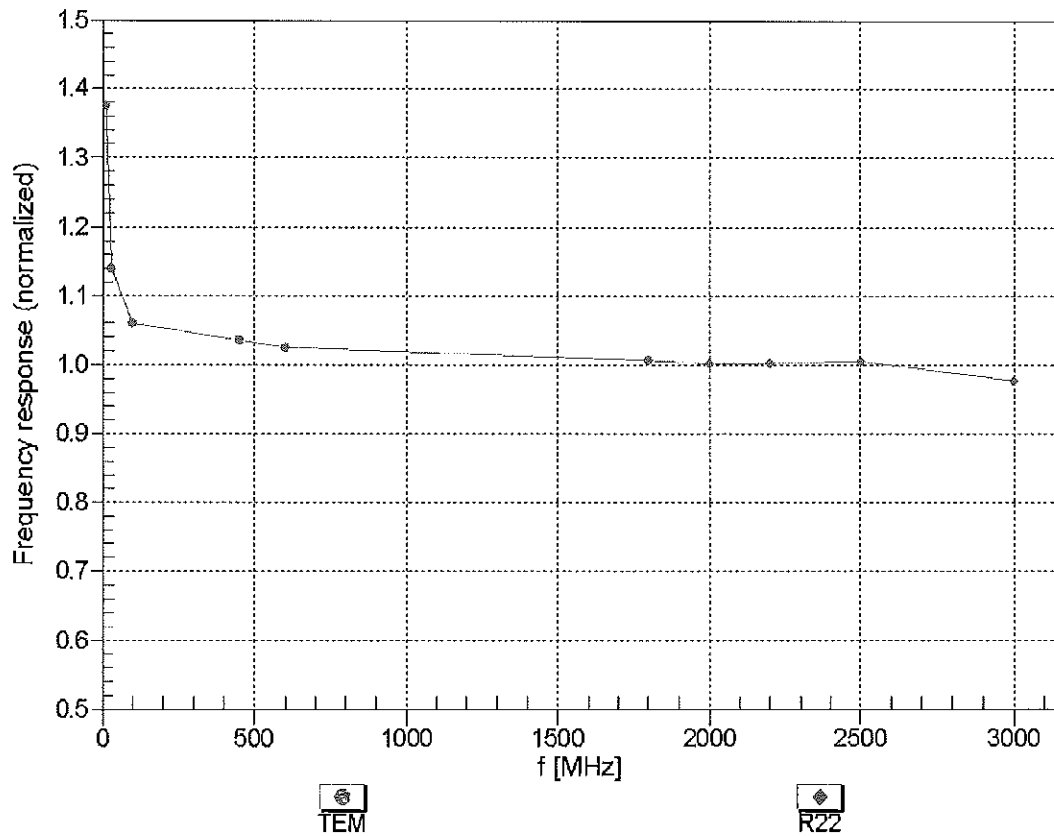
Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 8.59 | 8.59 | 8.59 | 0.49 | 0.86 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 8.43 | 8.43 | 8.43 | 0.38 | 1.05 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.87 | 7.87 | 7.87 | 0.44 | 0.89 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.46 | 7.46 | 7.46 | 0.58 | 0.75 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.07 | 7.07 | 7.07 | 0.80 | 0.50 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.68 | 6.68 | 6.68 | 0.80 | 0.50 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 3.99 | 3.99 | 3.99 | 0.50 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 3.81 | 3.81 | 3.81 | 0.50 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 3.52 | 3.52 | 3.52 | 0.55 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.32 | 3.32 | 3.32 | 0.60 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 3.66 | 3.66 | 3.66 | 0.60 | 1.90 | ± 13.1 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

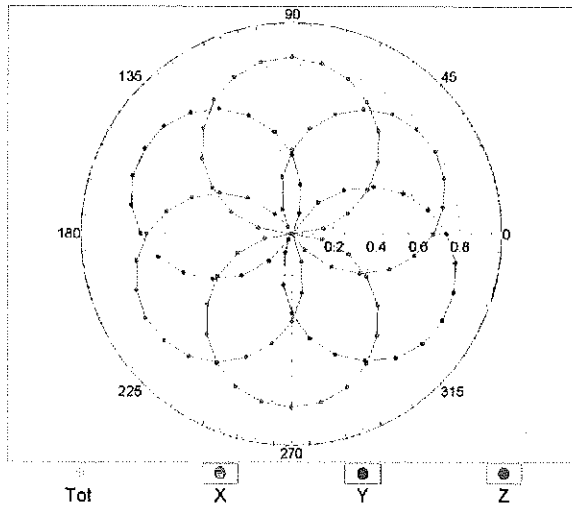
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



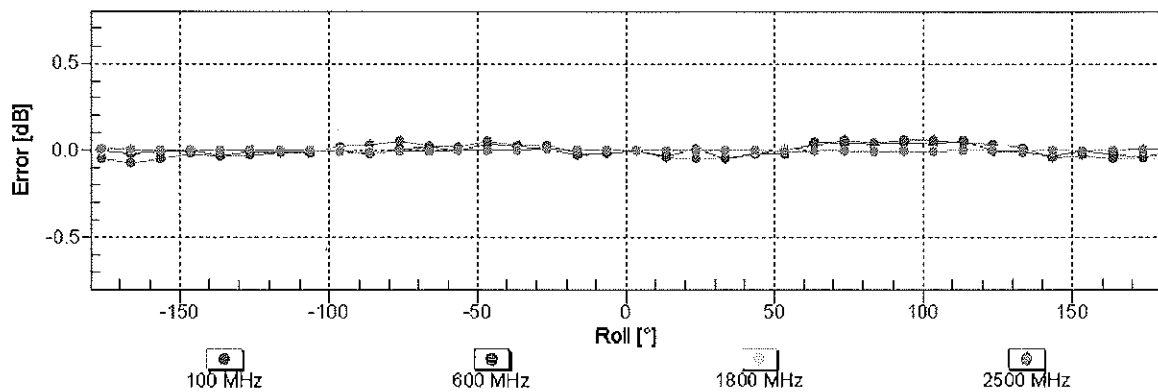
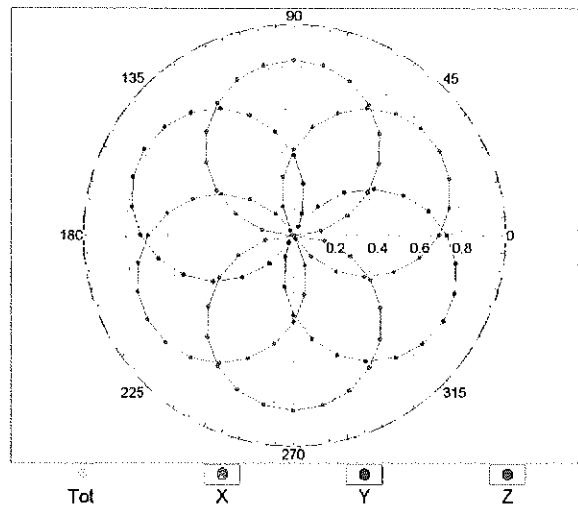
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM

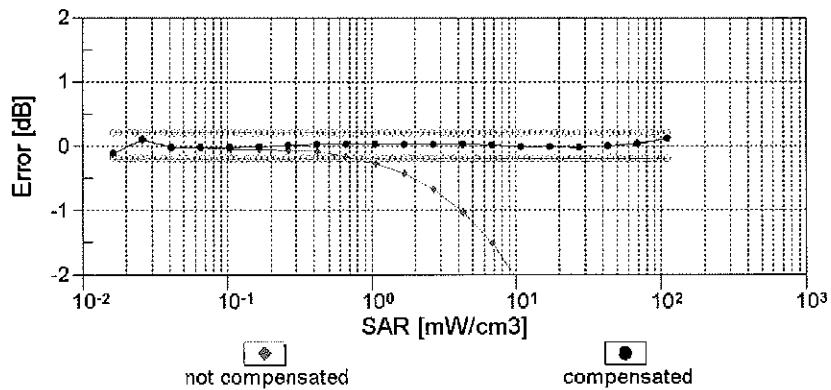
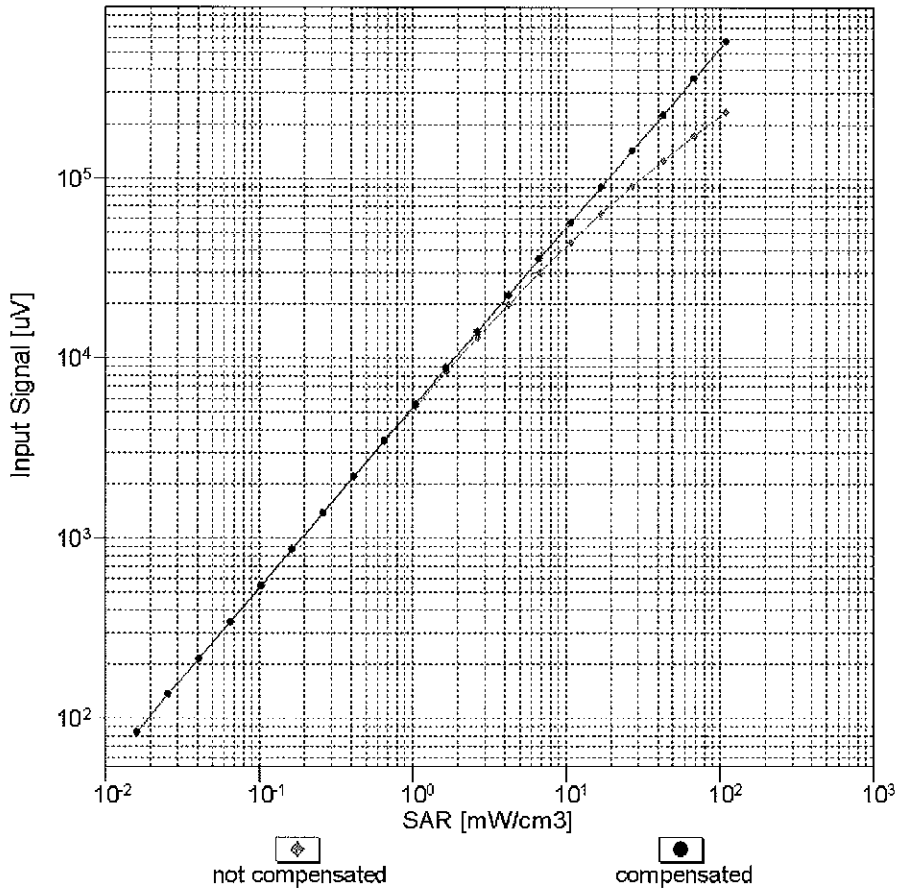


f=1800 MHz, R22



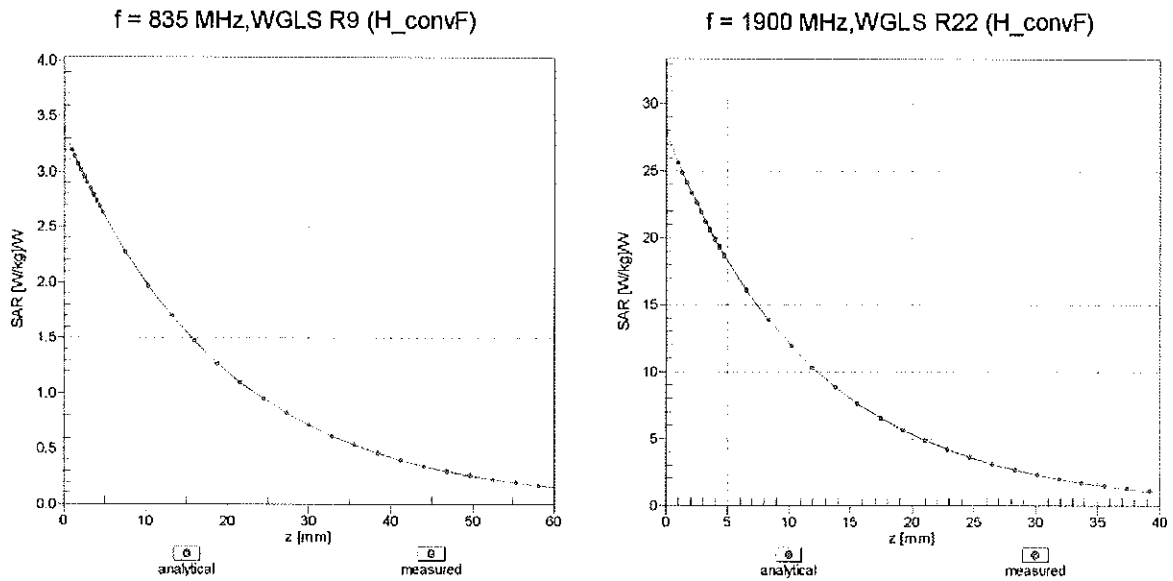
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$)

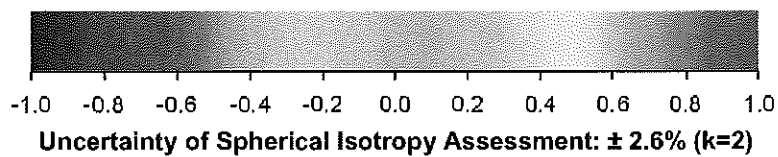
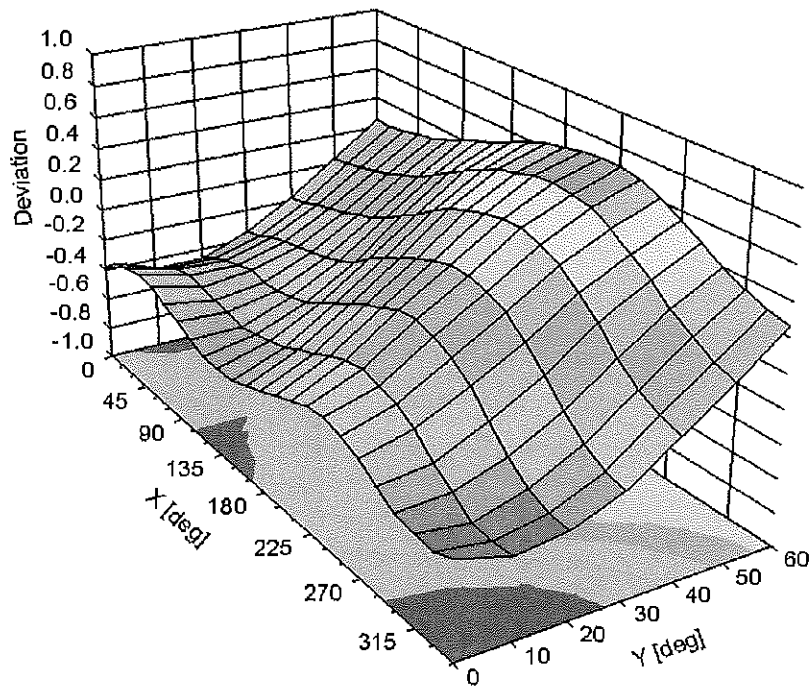


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, ϑ), f = 900 MHz



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3589**Other Probe Parameters**

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -26.4 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 2 mm |

APPENDIX 8 : SAR T=GGI 9 GD97 = 7 5 H=CBG

APPENDIX D: SAR TISSUE SPECIFICATIONS

Measurement Procedure for Tissue Verification:

- 1) The network analyzer and probe system was configured and calibrated.
- 2) The probe was immersed in the tissue. The tissue was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
- 3) The complex admittance with respect to the probe aperture was measured
- 4) The complex relative permittivity ϵ can be calculated from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\epsilon_r'\epsilon_0)^{1/2}]}{r} d\phi' d\rho' d\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho' \cos\phi'$, ω is the angular frequency, and $j = \sqrt{-1}$.

**Table D-I
Composition of the Tissue Equivalent Matter**

| Frequency (MHz) | 750 | 750 | 835 | 835 | 1750 | 1750 | 1900 | 1900 | 2450 | 2450 | 5200-5800 | 5200-5800 |
|---------------------------|------------------|---------------|-------|-------|------|------|-------|-------|---------------|---------------|-----------|-----------|
| Tissue | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body |
| Ingredients (% by weight) | | | | | | | | | | | | |
| Bactericide | See Pages 2-3 | See Page 2 | 0.1 | 0.1 | | | | | See Page 4 | See Page 5 | | |
| DGBE | | | | | 47 | 31 | 44.92 | 29.44 | | | 26.7 | |
| HEC | | | 1 | 1 | | | | | | | | |
| NaCl | | | 1.45 | 0.94 | 0.4 | 0.2 | 0.18 | 0.39 | | | 0.1 | |
| Sucrose | | | 57 | 44.9 | | | | | | | | |
| Polysorbate (Tween) 80 | | | | | | | | | | | | 20 |
| Water | | | 40.45 | 53.06 | 52.6 | 68.8 | 54.9 | 70.17 | | | | 80 |

| | | | | |
|------------------------------------|--|------------------------------|--|---------------------------------|
| FCC ID: ZNFD800 | PCTEST <small>ENGINEERING LABORATORY, INC.</small> | SAR EVALUATION REPORT | | Reviewed by: Quality Manager |
| Test Dates: 06/26/13 - 07/15/13 | DUT Type: Portable Handset | | | APPENDIX D: Page 1 of 5 |

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

| | |
|------------------------|---|
| H ₂ O | Water, 35 – 58% |
| Sucrose | Sugar, white, refined, 40 – 60% |
| NaCl | Sodium Chloride, 0 – 6% |
| Hydroxyethyl-cellulose | Medium Viscosity (CAS# 9004-62-0), <0.3% |
| Preventol-D7 | Preservative: aqueous preparation, (CAS# 55965-84-9), containing 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyl-3(2H)-isothiazolone, 0.1 – 0.7% |

Relevant for safety; Refer to the respective Safety Data Sheet*.

**Figure D-1
Composition of 750 MHz Head and Body Tissue Equivalent Matter**

Note: 750MHz liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

| | |
|--------------|--|
| Item Name | Body Tissue Simulating Liquid (MSL750) |
| Product No. | SL AAM 075 AA (Charge: 111130-3) |
| Manufacturer | SPEAG |

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe (type DAK).

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

Test Condition

Ambient Condition 22°C ; 30% humidity

TSL Temperature 22°C

Test Date 7-Dec-11

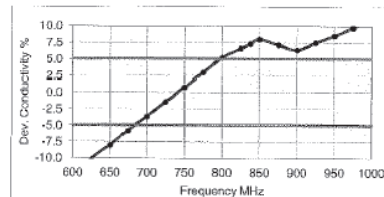
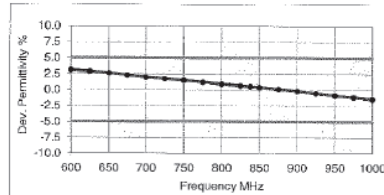
Additional Information

TSL Density 1.212 g/cm³



TSL Heat-capacity 3.006 kJ/(kg*K)

Results

| f [MHz] | Measured | | | Target | | Diff. to Target (%) | |
|---------|----------|--------|-------|--------|-------|---------------------|---------|
| | HP-e' | HP-e'' | sigma | eps | sigma | Δ-eps | Δ-sigma |
| 600 | 57.9 | 25.01 | 0.83 | 56.1 | 0.95 | 3.1 | -12.3 |
| 625 | 57.6 | 24.66 | 0.86 | 56.0 | 0.95 | 2.9 | -10.1 |
| 650 | 57.4 | 24.31 | 0.88 | 55.9 | 0.96 | 2.6 | -8.0 |
| 675 | 57.1 | 24.02 | 0.90 | 55.8 | 0.96 | 2.3 | -5.8 |
| 700 | 56.8 | 23.74 | 0.92 | 55.7 | 0.96 | 2.0 | -3.7 |
| 725 | 56.6 | 23.50 | 0.95 | 55.6 | 0.96 | 1.7 | -1.5 |
| 750 | 56.4 | 23.26 | 0.97 | 55.5 | 0.96 | 1.5 | 0.8 |
| 775 | 56.1 | 23.06 | 0.99 | 55.4 | 0.97 | 1.2 | 3.0 |
| 800 | 55.8 | 22.86 | 1.02 | 55.3 | 0.97 | 0.9 | 5.2 |
| 825 | 55.6 | 22.72 | 1.04 | 55.2 | 0.98 | 0.6 | 6.6 |
| 838 | 55.5 | 22.64 | 1.05 | 55.2 | 0.98 | 0.5 | 7.3 |
| 850 | 55.4 | 22.57 | 1.07 | 55.2 | 0.99 | 0.4 | 8.0 |
| 875 | 55.1 | 22.44 | 1.09 | 55.1 | 1.02 | 0.1 | 7.2 |
| 900 | 54.9 | 22.31 | 1.12 | 55.0 | 1.05 | -0.2 | 6.4 |
| 925 | 54.7 | 22.20 | 1.14 | 55.0 | 1.08 | -0.5 | 7.5 |
| 950 | 54.5 | 22.09 | 1.17 | 54.9 | 1.08 | -0.9 | 8.5 |
| 975 | 54.3 | 21.99 | 1.19 | 54.9 | 1.09 | -1.2 | 9.7 |
| 1000 | 54.1 | 21.89 | 1.22 | 54.8 | 1.10 | -1.4 | 10.9 |



**Figure D-2
750MHz Body Tissue Equivalent Matter**

| | | | | |
|------------------------------------|--|-----------------------|--|---------------------------------|
| FCC ID: ZNFD800 |  PCTEST ENGINEERING LABORATORY, INC. | SAR EVALUATION REPORT |  LG | Reviewed by: Quality Manager |
| Test Dates: 06/26/13 - 07/15/13 | DUT Type: Portable Handset | | | APPENDIX D: Page 2 of 5 |

Measurement Certificate / Material Test

| | |
|--------------|---|
| Item Name | Head Tissue Simulating Liquid (HSL 750) |
| Product No. | SL AAH 075 (Charge: 111208-2) |
| Manufacturer | SPEAG |

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe (type DAK).

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

Test Condition

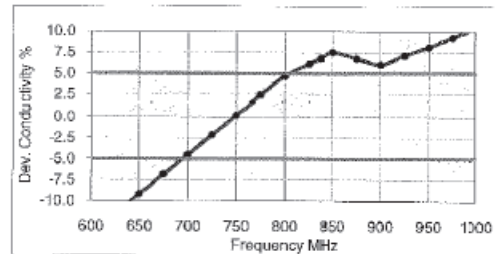
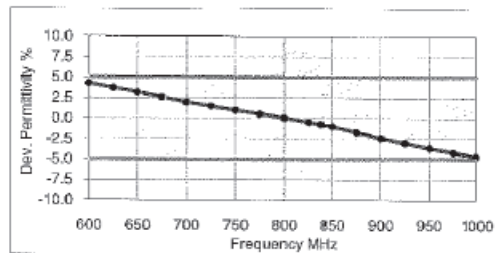
Ambient Condition 22°C ; 30% humidity
 TSL Temperature 22°C
 Test Date 14-Dec-11

Additional Information



TSL Density 1.284 g/cm³
 TSL Heat-capacity 2.701 kJ/(kg*K)

Results

| f [MHz] | Measured | | | Target | | Diff.to Target [%] | |
|---------|----------|--------|-------|--------|-------|--------------------|---------|
| | HP-e' | HP-e'' | sigma | eps | sigma | Δ-eps | Δ-sigma |
| 600 | 44.5 | 22.77 | 0.76 | 42.7 | 0.88 | 4.2 | -13.8 |
| 625 | 44.2 | 22.50 | 0.78 | 42.6 | 0.88 | 3.7 | -11.5 |
| 650 | 43.8 | 22.24 | 0.80 | 42.5 | 0.89 | 3.1 | -9.2 |
| 675 | 43.4 | 22.03 | 0.83 | 42.3 | 0.89 | 2.5 | -6.8 |
| 700 | 43.0 | 21.82 | 0.85 | 42.2 | 0.89 | 1.9 | -4.5 |
| 725 | 42.7 | 21.64 | 0.87 | 42.1 | 0.89 | 1.4 | -2.1 |
| 750 | 42.3 | 21.45 | 0.89 | 41.9 | 0.89 | 1.0 | 0.2 |
| 775 | 42.0 | 21.28 | 0.92 | 41.8 | 0.90 | 0.5 | 2.4 |
| 800 | 41.7 | 21.11 | 0.94 | 41.7 | 0.90 | 0.0 | 4.7 |
| 825 | 41.4 | 20.97 | 0.96 | 41.6 | 0.91 | -0.5 | 6.1 |
| 838 | 41.2 | 20.90 | 0.97 | 41.5 | 0.91 | -0.7 | 6.8 |
| 850 | 41.1 | 20.83 | 0.98 | 41.5 | 0.92 | -1.0 | 7.5 |
| 875 | 40.8 | 20.69 | 1.01 | 41.5 | 0.94 | -1.7 | 6.8 |
| 900 | 40.5 | 20.55 | 1.03 | 41.5 | 0.97 | -2.4 | 6.1 |
| 925 | 40.2 | 20.45 | 1.05 | 41.5 | 0.98 | -3.0 | 7.1 |
| 950 | 39.9 | 20.34 | 1.08 | 41.4 | 0.99 | -3.6 | 8.1 |
| 975 | 39.7 | 20.24 | 1.10 | 41.4 | 1.00 | -4.2 | 9.3 |
| 1000 | 39.4 | 20.14 | 1.12 | 41.3 | 1.01 | -4.7 | 10.4 |



**Figure D-3
 750MHz Head Tissue Equivalent Matter**

| | | | | |
|------------------------------------|--|-----------------------|---|---------------------------------|
| FCC ID: ZNFD800 |  PCTEST Engineering Laboratory, Inc. | SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 06/26/13 - 07/15/13 | DUT Type: Portable Handset | | | APPENDIX D: Page 3 of 5 |

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

| | |
|---------|---|
| H2O | Water, 52 – 75% |
| C8H18O3 | Diethylene glycol monobutyl ether (DGBE), 25 – 48% (CAS-No. 112-34-5, EC-No. 203-961-6, EC-index-No. 603-096-00-8) Relevant for safety; Refer to the respective Safety Data Sheet*. |
| NaCl | Sodium Chloride, <1.0% |

Figure D-4
Composition of 2.4 GHz Head Tissue Equivalent Matter

Note: 2.4 GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

| | |
|--------------|--|
| Item Name | Head Tissue Simulating Liquid (HSL 2450) |
| Product No. | SL AAH 245 BA (Charge: 120112-4) |
| Manufacturer | SPEAG |

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe (type DAK).

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

Test Condition

Ambient Condition 22°C; 30% humidity
TSL Temperature 23°C
Test Date 18-Jan-12

Additional Information

TSL Density 0.988 g/cm³
TSL Heat-capacity 3.680 kJ/(kg*K)

Results

| f [MHz] | Measured | | | | Target | | Diff.to Target [%] | |
|---------|----------|--------|-------|------|--------|-------|--------------------|--|
| | HP-e' | HP-e'' | sigma | eps | sigma | Δ-eps | Δ-sigma | |
| 1900 | 40.5 | 11.99 | 1.27 | 40.0 | 1.40 | 1.1 | -9.5 | |
| 1925 | 40.3 | 12.08 | 1.29 | 40.0 | 1.40 | 0.9 | -7.6 | |
| 1950 | 40.2 | 12.17 | 1.32 | 40.0 | 1.40 | 0.6 | -5.7 | |
| 1975 | 40.1 | 12.26 | 1.35 | 40.0 | 1.40 | 0.3 | -3.8 | |
| 2000 | 40.0 | 12.35 | 1.37 | 40.0 | 1.40 | 0.0 | -1.9 | |
| 2025 | 39.9 | 12.44 | 1.40 | 40.0 | 1.42 | -0.1 | -1.5 | |
| 2050 | 39.8 | 12.53 | 1.43 | 39.9 | 1.44 | -0.3 | -1.1 | |
| 2075 | 39.7 | 12.60 | 1.46 | 39.9 | 1.47 | -0.4 | -0.8 | |
| 2100 | 39.6 | 12.68 | 1.48 | 39.8 | 1.49 | -0.6 | -0.5 | |
| 2125 | 39.5 | 12.76 | 1.51 | 39.8 | 1.51 | -0.7 | -0.2 | |
| 2150 | 39.4 | 12.84 | 1.54 | 39.7 | 1.53 | -0.8 | 0.2 | |
| 2175 | 39.3 | 12.93 | 1.56 | 39.7 | 1.56 | -1.0 | 0.6 | |
| 2200 | 39.2 | 13.02 | 1.59 | 39.6 | 1.58 | -1.1 | 1.0 | |
| 2225 | 39.1 | 13.09 | 1.62 | 39.6 | 1.60 | -1.3 | 1.3 | |
| 2250 | 39.0 | 13.17 | 1.65 | 39.6 | 1.62 | -1.4 | 1.6 | |
| 2275 | 38.9 | 13.25 | 1.68 | 39.5 | 1.64 | -1.5 | 2.0 | |
| 2300 | 38.8 | 13.33 | 1.71 | 39.5 | 1.67 | -1.7 | 2.3 | |
| 2325 | 38.7 | 13.40 | 1.73 | 39.4 | 1.69 | -1.8 | 2.7 | |
| 2350 | 38.6 | 13.48 | 1.76 | 39.4 | 1.71 | -2.0 | 3.0 | |
| 2375 | 38.5 | 13.56 | 1.79 | 39.3 | 1.73 | -2.1 | 3.3 | |
| 2400 | 38.4 | 13.63 | 1.82 | 39.3 | 1.76 | -2.3 | 3.7 | |
| 2425 | 38.3 | 13.71 | 1.85 | 39.2 | 1.78 | -2.4 | 4.0 | |
| 2450 | 38.2 | 13.78 | 1.88 | 39.2 | 1.80 | -2.6 | 4.4 | |
| 2475 | 38.1 | 13.85 | 1.91 | 39.2 | 1.83 | -2.7 | 4.4 | |
| 2500 | 38.0 | 13.93 | 1.94 | 39.1 | 1.85 | -2.9 | 4.4 | |
| 2525 | 37.9 | 13.99 | 1.97 | 39.1 | 1.88 | -3.1 | 4.4 | |
| 2550 | 37.8 | 14.06 | 1.99 | 39.1 | 1.91 | -3.3 | 4.4 | |
| 2575 | 37.7 | 14.13 | 2.02 | 39.0 | 1.94 | -3.5 | 4.5 | |
| 2600 | 37.6 | 14.20 | 2.05 | 39.0 | 1.96 | -3.7 | 4.6 | |
| 2625 | 37.5 | 14.28 | 2.08 | 39.0 | 1.99 | -3.8 | 4.6 | |
| 2650 | 37.4 | 14.32 | 2.11 | 38.9 | 2.02 | -4.0 | 4.6 | |
| 2675 | 37.3 | 14.39 | 2.14 | 38.9 | 2.05 | -4.3 | 4.7 | |
| 2700 | 37.1 | 14.46 | 2.17 | 38.9 | 2.07 | -4.5 | 4.8 | |

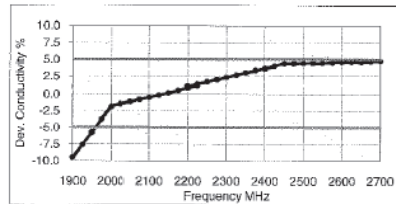
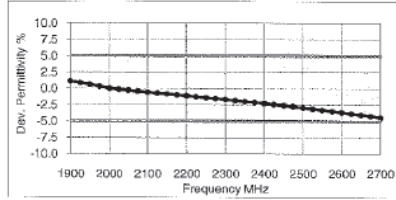




Figure D-5
2.4 GHz Head Tissue Equivalent Matter

| | | | | |
|------------------------------------|---|-----------------------|---|---------------------------------|
| FCC ID: ZNFD800 |  | SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 06/26/13 - 07/15/13 | DUT Type: Portable Handset | | | APPENDIX D: Page 4 of 5 |

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

| | |
|-------------|----------|
| Water | 50 – 65% |
| Mineral oil | 10 – 30% |
| Emulsifiers | 8 – 25% |
| Sodium salt | 0 – 1.5% |

Figure D-6
Composition of 5 GHz Head Tissue Equivalent Matter

Note: 5GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

| | |
|--------------|---|
| Item Name | Head Tissue Simulating Liquid (HBBL3500-5800V5) |
| Product No. | SL AAH 502 AB (Charge: 120402-2) |
| Manufacturer | SPEAG |

Measurement Method

| |
|---|
| TSL dielectric parameters measured using calibrated OCP probe (type DAK). |
|---|

Target Parameters

| |
|---|
| Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards. |
|---|

Test Condition

| | |
|-------------------|---------------------|
| Ambient Condition | 22°C ; 30% humidity |
| TSL Temperature | 22°C |
| Test Date | 4-Apr-12 |

Additional Information

| | |
|-------------------|-------------------------|
| TSL Density | 0.985 g/cm ³ |
| TSL Heat-capacity | 3.383 kJ/(kg*K) |

Results

| f [MHz] | Measured | | | Target | | Diff. to Target [%] | |
|---------|----------|--------|-------|--------|-------|---------------------|---------|
| | HP-ε' | HP-ε'' | sigma | eps | sigma | Δ-eps | Δ-sigma |
| 3400 | 38.7 | 14.96 | 2.83 | 38.0 | 2.81 | 1.8 | 0.7 |
| 3500 | 38.6 | 14.91 | 2.90 | 37.9 | 2.91 | 1.7 | -0.3 |
| 3600 | 38.5 | 14.92 | 2.99 | 37.8 | 3.02 | 1.7 | -0.9 |
| 3700 | 38.3 | 14.92 | 3.07 | 37.7 | 3.12 | 1.7 | -1.5 |
| 3800 | 38.2 | 14.94 | 3.16 | 37.6 | 3.22 | 1.7 | -1.9 |
| 3900 | 38.1 | 14.95 | 3.24 | 37.5 | 3.32 | 1.7 | -2.4 |
| 4000 | 38.0 | 15.00 | 3.34 | 37.4 | 3.43 | 1.8 | -2.5 |
| 4100 | 37.9 | 15.04 | 3.43 | 37.2 | 3.53 | 1.8 | -2.6 |
| 4200 | 37.8 | 15.08 | 3.52 | 37.1 | 3.63 | 1.8 | -2.9 |
| 4300 | 37.7 | 15.14 | 3.62 | 37.0 | 3.73 | 1.8 | -3.0 |
| 4400 | 37.5 | 15.18 | 3.71 | 36.9 | 3.84 | 1.7 | -3.1 |
| 4500 | 37.4 | 15.20 | 3.81 | 36.8 | 3.94 | 1.6 | -3.3 |
| 4600 | 37.3 | 15.29 | 3.91 | 36.7 | 4.04 | 1.6 | -3.2 |
| 4700 | 37.1 | 15.34 | 4.01 | 36.6 | 4.14 | 1.5 | -3.2 |
| 4800 | 37.0 | 15.39 | 4.11 | 36.4 | 4.25 | 1.4 | -3.2 |
| 4850 | 36.9 | 15.43 | 4.16 | 36.4 | 4.30 | 1.3 | -3.1 |
| 4900 | 36.8 | 15.45 | 4.21 | 36.3 | 4.35 | 1.3 | -3.1 |
| 4950 | 36.7 | 15.47 | 4.26 | 36.3 | 4.40 | 1.2 | -3.1 |
| 5000 | 36.7 | 15.50 | 4.31 | 36.2 | 4.45 | 1.2 | -3.1 |
| 5050 | 36.6 | 15.55 | 4.37 | 36.2 | 4.50 | 1.1 | -3.0 |
| 5100 | 36.5 | 15.60 | 4.43 | 36.1 | 4.55 | 1.1 | -2.8 |
| 5150 | 36.4 | 15.62 | 4.48 | 36.0 | 4.60 | 1.0 | -2.8 |
| 5200 | 36.4 | 15.65 | 4.53 | 36.0 | 4.66 | 1.0 | -2.8 |
| 5250 | 36.3 | 15.67 | 4.58 | 35.9 | 4.71 | 1.0 | -2.8 |
| 5300 | 36.2 | 15.70 | 4.63 | 35.9 | 4.76 | 1.0 | -2.7 |
| 5350 | 36.1 | 15.70 | 4.67 | 35.8 | 4.81 | 0.9 | -2.9 |
| 5400 | 36.1 | 15.74 | 4.73 | 35.8 | 4.86 | 0.8 | -2.7 |
| 5450 | 36.0 | 15.75 | 4.77 | 35.7 | 4.91 | 0.9 | -2.8 |
| 5500 | 35.9 | 15.78 | 4.82 | 35.6 | 4.96 | 0.8 | -2.9 |
| 5550 | 35.9 | 15.80 | 4.88 | 35.6 | 5.01 | 0.8 | -2.7 |
| 5600 | 35.8 | 15.82 | 4.93 | 35.5 | 5.07 | 0.7 | -2.7 |
| 5650 | 35.7 | 15.86 | 4.98 | 35.5 | 5.12 | 0.7 | -2.6 |
| 5700 | 35.7 | 15.88 | 5.03 | 35.4 | 5.17 | 0.7 | -2.6 |
| 5750 | 35.6 | 15.90 | 5.08 | 35.4 | 5.22 | 0.6 | -2.6 |
| 5800 | 35.5 | 15.94 | 5.14 | 35.3 | 5.27 | 0.6 | -2.4 |
| 5850 | 35.4 | 15.98 | 5.20 | 35.3 | 5.34 | 0.4 | -2.5 |
| 5900 | 35.4 | 16.02 | 5.26 | 35.3 | 5.40 | 0.2 | -2.6 |

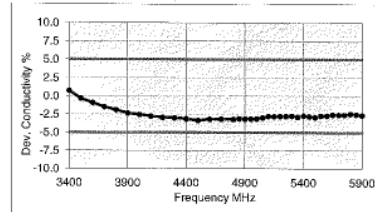
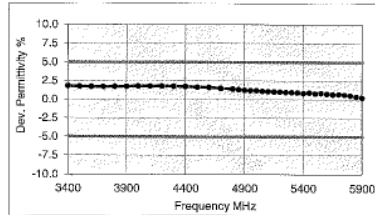


Figure D-7
5GHz Head Tissue Equivalent Matter

| | | | | |
|------------------------------------|--|-----------------------|----|---------------------------------|
| FCC ID: ZNFD800 | PCTEST ENGINEERING LABORATORY, INC. | SAR EVALUATION REPORT | LG | Reviewed by: Quality Manager |
| Test Dates: 06/26/13 - 07/15/13 | DUT Type: Portable Handset | | | APPENDIX D: Page 5 of 5 |

APPENDIX 9: G5 F SYSTEM V5 @-8 5 H=C B

APPENDIX E: SAR SYSTEM VALIDATION



Per FCC KDB 865664 D02v01, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01 v01. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

Table E-I
SAR System Validation Summary

| SAR SYSTEM # | FREQ. [MHz] | DATE | PROBE SN | PROBE TYPE | PROBE CAL. POINT | | COND. | PERM. | CW VALIDATION | | | MOD. VALIDATION | | |
|--------------|-------------|------------|----------|------------|------------------|------|-------|-------|---------------|-----------------|----------------|-----------------|-------------|------|
| | | | | | | | (σ) | (ε) | SENSI-TIVITY | PROBE LINEARITY | PROBE ISOTROPY | MOD. TYPE | DUTY FACTOR | PAR |
| B | 750 | 1/30/2013 | 3287 | ES3DV3 | 750 | Head | 0.894 | 40.58 | PASS | PASS | PASS | N/A | N/A | N/A |
| D | 835 | 10/17/2012 | 3288 | ES3DV3 | 835 | Head | 0.899 | 42.07 | PASS | PASS | PASS | GMSK | PASS | N/A |
| E | 1750 | 3/13/2013 | 3920 | EX3DV4 | 1750 | Head | 1.386 | 38.47 | PASS | PASS | PASS | N/A | N/A | N/A |
| G | 1900 | 3/27/2013 | 3209 | ES3DV3 | 1900 | Head | 1.449 | 39.10 | PASS | PASS | PASS | GMSK | PASS | N/A |
| E | 1900 | 3/5/2013 | 3920 | EX3DV4 | 1900 | Head | 1.410 | 38.62 | PASS | PASS | PASS | GMSK | PASS | N/A |
| C | 2450 | 11/9/2012 | 3022 | ES3DV2 | 2450 | Head | 1.874 | 38.23 | PASS | PASS | PASS | OFDM | N/A | PASS |
| E | 5200 | 3/21/2013 | 3920 | EX3DV4 | 5200 | Head | 4.529 | 35.64 | PASS | PASS | PASS | OFDM | N/A | PASS |
| E | 5300 | 3/21/2013 | 3920 | EX3DV4 | 5300 | Head | 4.638 | 35.52 | PASS | PASS | PASS | OFDM | N/A | PASS |
| E | 5500 | 3/28/2013 | 3920 | EX3DV4 | 5500 | Head | 4.813 | 34.07 | PASS | PASS | PASS | OFDM | N/A | PASS |
| E | 5800 | 3/22/2013 | 3920 | EX3DV4 | 5800 | Head | 5.108 | 34.76 | PASS | PASS | PASS | OFDM | N/A | PASS |
| B | 750 | 1/30/2013 | 3287 | ES3DV3 | 750 | Body | 0.981 | 54.40 | PASS | PASS | PASS | N/A | N/A | N/A |
| G | 835 | 3/26/2013 | 3209 | ES3DV3 | 835 | Body | 1.006 | 54.42 | PASS | PASS | PASS | GMSK | PASS | N/A |
| E | 1750 | 3/16/2013 | 3920 | EX3DV4 | 1750 | Body | 1.491 | 52.88 | PASS | PASS | PASS | N/A | N/A | N/A |
| D | 1750 | 10/16/2012 | 3288 | ES3DV3 | 1750 | Body | 1.524 | 52.04 | PASS | PASS | PASS | N/A | N/A | N/A |
| B | 1900 | 1/29/2013 | 3287 | ES3DV3 | 1900 | Body | 1.570 | 51.00 | PASS | PASS | PASS | GMSK | PASS | N/A |
| B | 2450 | 1/30/2013 | 3287 | ES3DV3 | 2450 | Body | 1.985 | 51.49 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5200 | 1/23/2013 | 3589 | EX3DV4 | 5200 | Body | 5.292 | 47.85 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5300 | 1/23/2013 | 3589 | EX3DV4 | 5300 | Body | 5.477 | 47.47 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5500 | 1/23/2013 | 3589 | EX3DV4 | 5500 | Body | 5.729 | 47.03 | PASS | PASS | PASS | OFDM | N/A | PASS |
| A | 5800 | 1/23/2013 | 3589 | EX3DV4 | 5800 | Body | 6.233 | 46.20 | PASS | PASS | PASS | OFDM | N/A | PASS |

NOTE: All measurements were performed using probes calibrated for CW signals only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01. SAR systems were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664.

| | | | | |
|------------------------------------|--|-----------------------|---|---------------------------------|
| FCC ID: ZNFD800 |  PCTEST ENGINEERING LABORATORY, INC. | SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 06/26/13 - 07/15/13 | DUT Type: Portable Handset | | | APPENDIX E: Page 1 of 1 |