



Appendix C. Calibration Certificate for Probe and Dipole

The SPEAG calibration certificates are shown as follows.



Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **B.V. ADT (Auden)**

Certificate No: **D835V2-4d021_Mar11**

CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d021**

Calibration procedure(s) **QA CAL-05.v8
Calibration procedure for dipole validation kits**

Calibration date: **March 23, 2011**

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 EPM-442A | GB37480704 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Power sensor HP 8481A | US37292783 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Reference 20 dB Attenuator | SN: 5086 (20g) | 30-Mar-10 (No. 217-01158) | Mar-11 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 30-Mar-10 (No. 217-01162) | Mar-11 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Apr-10 (No. ES3-3205_Apr10) | Apr-11 |
| DAE4 | SN: 601 | 10-Jun-10 (No. DAE4-601_Jun10) | Jun-11 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-09) | In house check: Oct-11 |
| RF generator R&S SMT-06 | 100005 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

Calibrated by: **Dimce Iliev** Name: **Dimce Iliev** Function: **Laboratory Technician**

Approved by: **Katja Pokovic** Name: **Katja Pokovic** Function: **Technical Manager**

Signature

Issued: March 23, 2011

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

Measurement Conditions

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

| | | |
|-------------------------------------|---------------------------|-------------|
| DASY Version | DASY5 | V52.6.2 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom V4.9 | |
| Distance Dipole Center - TSL | 15 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 835 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 41.5 | 0.90 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 41.0 \pm 6 % | 0.89 mho/m \pm 6 % |
| Head TSL temperature during test | (21.8 \pm 0.2) °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
|---|--------------------|---|
| SAR measured | 250 mW input power | 2.40 mW / g |
| SAR normalized | normalized to 1W | 9.60 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 9.65 mW /g \pm 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|---|
| SAR measured | 250 mW input power | 1.57 mW / g |
| SAR normalized | normalized to 1W | 6.28 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 6.31 mW /g \pm 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 55.2 | 0.97 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 54.3 ± 6 % | 0.99 mho/m ± 6 % |
| Body TSL temperature during test | (21.7 ± 0.2) °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 2.56 mW / g |
| SAR normalized | normalized to 1W | 10.2 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 10.1 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 1.68 mW / g |
| SAR normalized | normalized to 1W | 6.72 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 6.63 mW / g ± 16.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.0 Ω - 2.0 j Ω |
| Return Loss | - 31.0 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 47.9 Ω - 4.2 j Ω |
| Return Loss | - 26.4 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.393 ns |
|----------------------------------|----------|

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

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

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

Design Modification by End User

The dipole has been modified with Teflon Rings (TR) placed within identified markings close to the end of each dipole arm. Calibration has been performed with TR attached to the dipole.

Additional EUT Data

| | |
|-----------------|----------------|
| Manufactured by | SPEAG |
| Manufactured on | April 22, 2004 |

DASY5 Validation Report for Head TSL

Date/Time: 18.03.2011 11:51:13

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d021

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: HSL900

Medium parameters used: $f = 835$ MHz; $\sigma = 0.89$ mho/m; $\epsilon_r = 40.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.03, 6.03, 6.03); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY52, V52.6.2 Build (424)
- Postprocessing SW: SEMCAD X, V14.4.4 Build (2829)

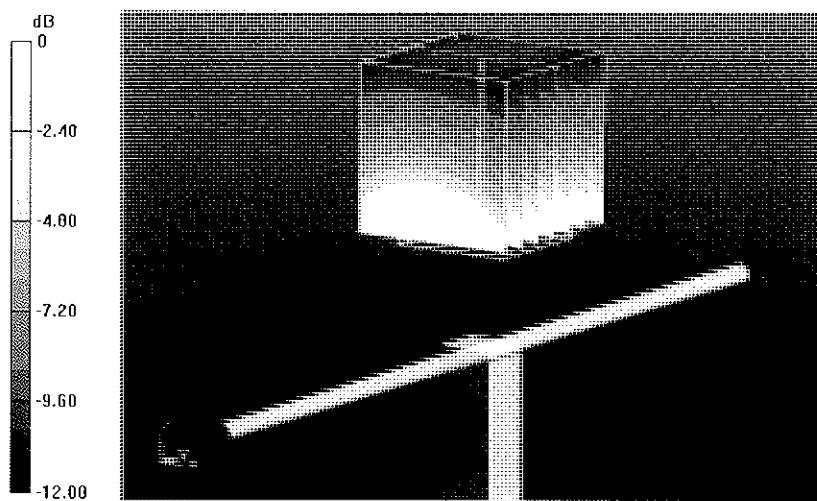
Pin=250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.571 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.583 W/kg

SAR(1 g) = 2.4 mW/g; SAR(10 g) = 1.57 mW/g

Maximum value of SAR (measured) = 2.792 mW/g

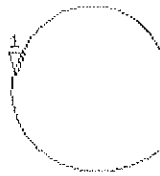


0 dB = 2.790mW/g

Impedance Measurement Plot for Head TSL

18 Mar 2011 10:32:43
S11 1 U FS 1: 51.996 ω -2.0469 ω 93.120 μ F 835.000 000 MHz

8
De1
Cor

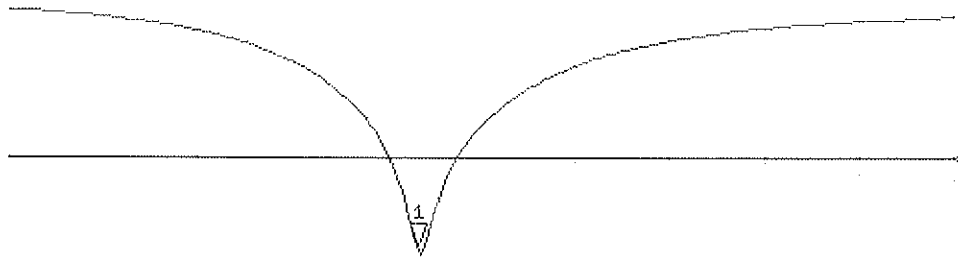


avg
1.6

↑

CH2 S11 L06 5 dB/REF -20 dB 1: -31.025 dB 835.000 000 MHz

Cor



avg
1.6

↑

START 835.000 000 MHz

STOP 1.188.000 000 MHz

DASY5 Validation Report for Body TSL

Date/Time: 23.03.2011 10:45:49

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d021

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: MSL900

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.99 \text{ mho/m}$; $\epsilon_r = 54.3$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.86, 5.86, 5.86); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY52, V52.6.2 Build (424)
- Postprocessing SW: SEMCAD X, V14.4.4 Build (2829)

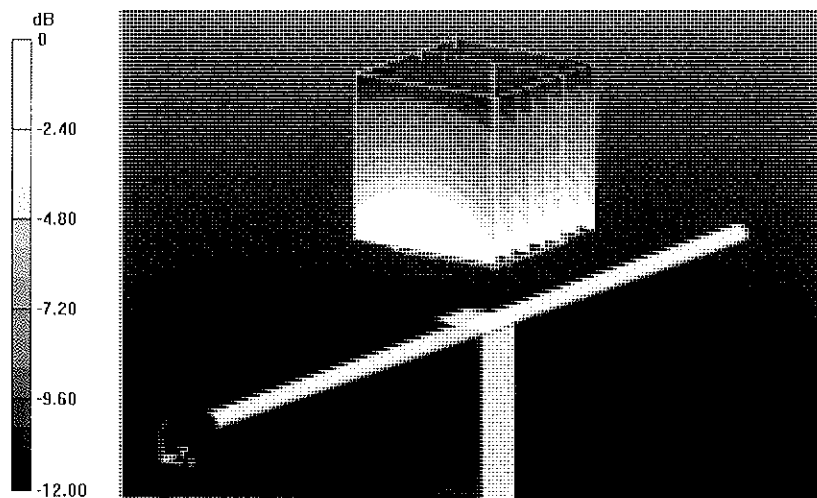
Pin=250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 56.615 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.794 W/kg

SAR(1 g) = 2.56 mW/g; SAR(10 g) = 1.68 mW/g

Maximum value of SAR (measured) = 2.981 mW/g

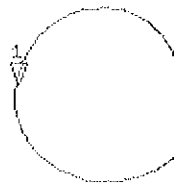


0 dB = 2.980mW/g

Impedance Measurement Plot for Body TSL

23 Mar 2011 10:18:11
[CH1] S11 1 U FS 1: 47.865 Ω -4.1953 Ω 45.433 pF 835.000 000 MHz

*
De1
Cor

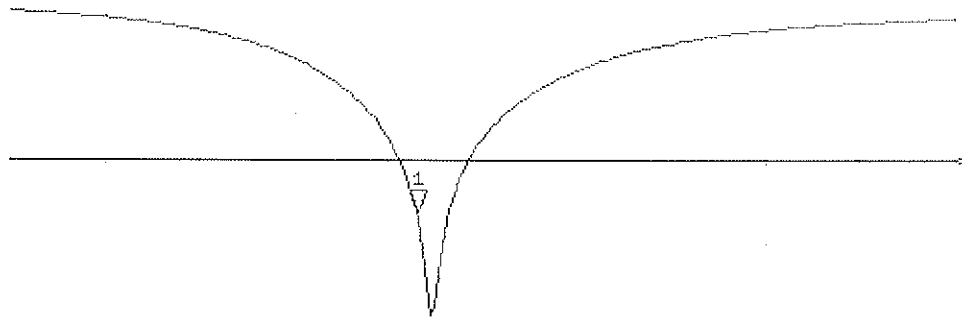


Avg
16

↑

CH2 S11 LOG 5 dB/REF -20 dB 1: -25.372 dB 835.000 000 MHz

Cor



Avg
16

↑

START 635.000 000 MHz

STOP 1 100.000 000 MHz



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Accreditation No.: **SCS 108**

Client **B.V. ADT (Auden)**

Certificate No: **D1900V2-5d022_Jan11**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d022**

Calibration procedure(s) **QA CAL-05.v8
Calibration procedure for dipole validation kits**

Calibration date: **January 26, 2011**

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 EPM-442A | GB37480704 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Power sensor HP 8481A | US37292783 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Reference 20 dB Attenuator | SN: 5086 (20g) | 30-Mar-10 (No. 217-01158) | Mar-11 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 30-Mar-10 (No. 217-01162) | Mar-11 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Apr-10 (No. ES3-3205_Apr10) | Apr-11 |
| DAE4 | SN: 601 | 10-Jun-10 (No. DAE4-601_Jun10) | Jun-11 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-09) | In house check: Oct-11 |
| RF generator R&S SMT-06 | 100005 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

Calibrated by: **Dimce Iliev** **Dimce Iliev** **Laboratory Technician**

Approved by: **Katja Pokovic** **Katja Pokovic** **Technical Manager**

Dimce Iliev

Katja Pokovic

Issued: January 27, 2011

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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- 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
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

Measurement Conditions

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

| | | |
|------------------------------|---------------------------|-------------|
| DASY Version | DASY5 | V52.6 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom V5.0 | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 1900 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|----------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 40.0 | 1.40 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 38.5 \pm 6 % | 1.43 mho/m \pm 6 % |
| Head TSL temperature during test | (20.5 \pm 0.2) °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|---|
| SAR measured | 250 mW input power | 10.4 mW / g |
| SAR normalized | normalized to 1W | 41.6 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 40.9 mW /g \pm 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|---|
| SAR measured | 250 mW input power | 5.37 mW / g |
| SAR normalized | normalized to 1W | 21.5 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 21.3 mW /g \pm 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 53.3 | 1.52 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 52.9 ± 6 % | 1.56 mho/m ± 6 % |
| Body TSL temperature during test | (20.8 ± 0.2) °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 10.4 mW / g |
| SAR normalized | normalized to 1W | 41.6 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 40.9 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 5.48 mW / g |
| SAR normalized | normalized to 1W | 21.9 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 21.7 mW / g ± 16.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.5 Ω + 4.0 j Ω |
| Return Loss | - 27.6 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 46.2 Ω + 4.0 j Ω |
| Return Loss | - 24.9 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.193 ns |
|----------------------------------|----------|

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

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

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

Additional EUT Data

| | |
|-----------------|-----------------|
| Manufactured by | SPEAG |
| Manufactured on | August 29, 2002 |

DASY5 Validation Report for Head TSL

Date/Time: 24.01.2011 11:20:43

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d022

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: HSL U12 BB

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.42$ mho/m; $\epsilon_r = 38.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.09, 5.09, 5.09); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY52, V52.6.1 Build (408)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

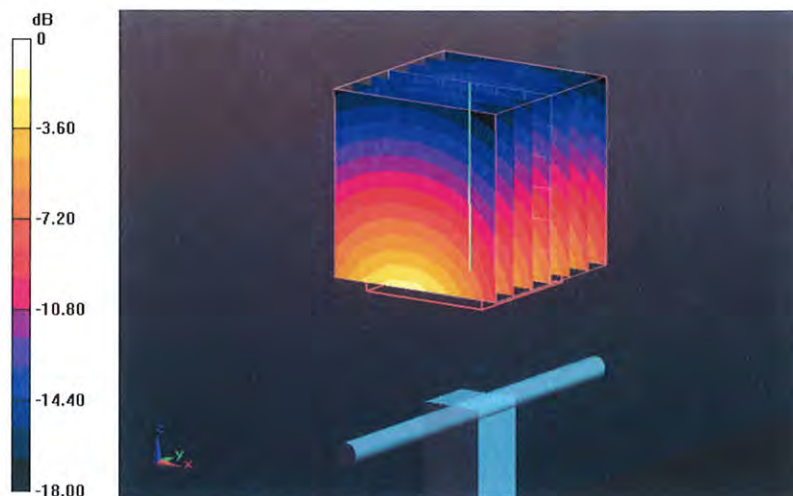
Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.002 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 19.131 W/kg

SAR(1 g) = 10.4 mW/g; SAR(10 g) = 5.37 mW/g

Maximum value of SAR (measured) = 12.963 mW/g

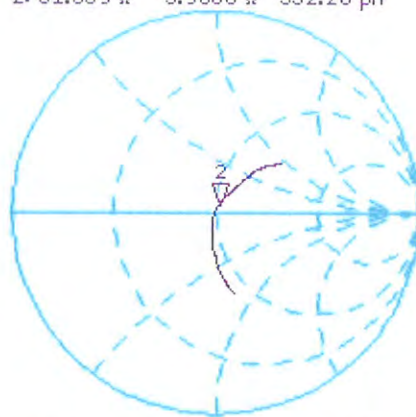


Impedance Measurement Plot for Head TSL

24 Jan 2011 10:16:09

CH1 S11 1 U FS 2: 51.539 \angle 3.9668 \angle 332.28 μ H 1 900.000 000 MHz

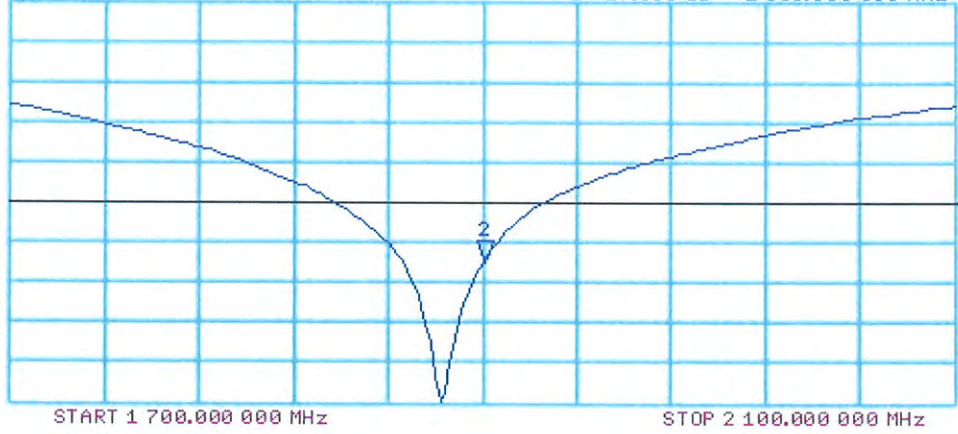
*
De 1
CA



Avg
16
↑

CH2 S11 LOG 5 dB/REF -20 dB 2: -27.558 dB 1 900.000 000 MHz

CA
Avg
16
↑



DASY5 Validation Report for Body TSL

Date/Time: 26.01.2011 12:06:07

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d022

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: MSL U12 BB

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.56$ mho/m; $\epsilon_r = 53.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.59, 4.59, 4.59); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY52, V52.6.1 Build (408)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

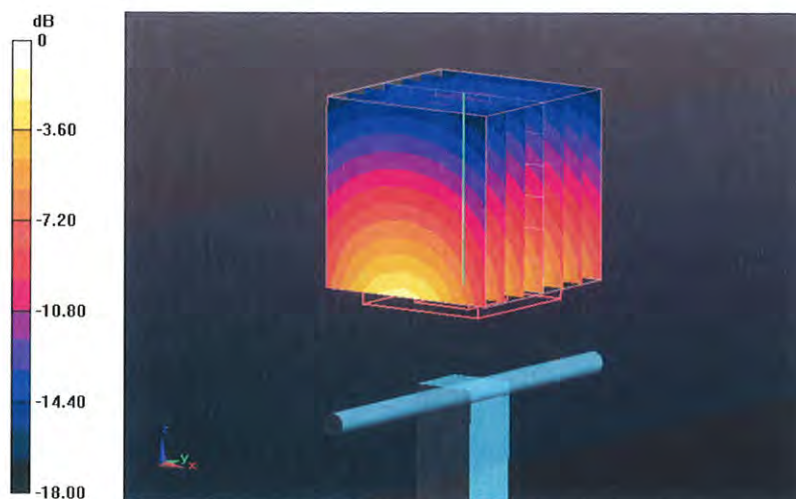
Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.936 V/m; Power Drift = -0.0021 dB

Peak SAR (extrapolated) = 17.774 W/kg

SAR(1 g) = 10.4 mW/g; SAR(10 g) = 5.48 mW/g

Maximum value of SAR (measured) = 13.186 mW/g

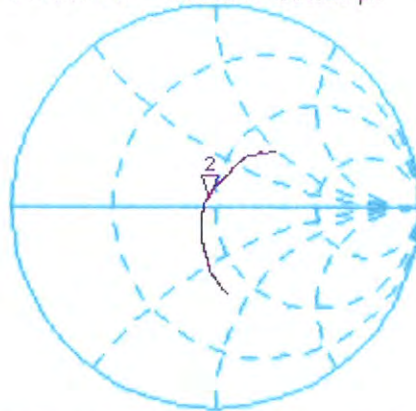


Impedance Measurement Plot for Body TSL

26 Jan 2011 10:44:12

CH1 S11 1 U FS 2: 46.244 Ω 4.0215 Ω 336.86 μH 1 900.000 000 MHz

*
De1
CA



Avg
16

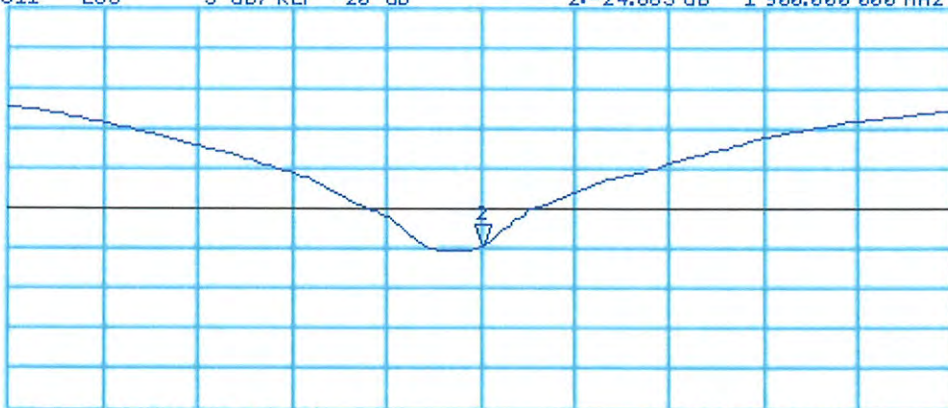
↑

CH2 S11 LOG 5 dB/REF -20 dB 2:-24.853 dB 1 900.000 000 MHz

CA

Avg
16

↑



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz



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Accreditation No.: **SCS 108**

Client **B.V.ADT (Auden)**

Certificate No: **D1900V2-5d036_Jan12**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d036**

Calibration procedure(s) **QA CAL-05.v8
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **January 26, 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 EPM-442A | GB37480704 | 05-Oct-11 (No. 217-01451) | Oct-12 |
| Power sensor HP 8481A | US37292783 | 05-Oct-11 (No. 217-01451) | Oct-12 |
| Reference 20 dB Attenuator | SN: 5086 (20g) | 29-Mar-11 (No. 217-01368) | Apr-12 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 29-Mar-11 (No. 217-01371) | Apr-12 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Dec-11 (No. ES3-3205_Dec11) | Dec-12 |
| DAE4 | SN: 601 | 04-Jul-11 (No. DAE4-601_Jul11) | Jul-12 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

| | | | |
|----------------|----------------------------|-----------------------------------|---------------|
| Calibrated by: | Name Dimce Iliev | Function Laboratory Technician | Signature |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 26, 2012

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- 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
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

Measurement Conditions

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

| | | |
|------------------------------|------------------------|-------------|
| DASY Version | DASY5 | V52.8.0 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 1900 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 40.0 | 1.40 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 40.8 \pm 6 % | 1.39 mho/m \pm 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 9.65 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 38.9 mW / g \pm 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 5.05 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 20.3 mW / g \pm 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---------------------|----------------|----------------------|
| Nominal Body TSL parameters | 22.0 °C | 53.3 | 1.52 mho/m |
| Measured Body TSL parameters | (22.0 \pm 0.2) °C | 52.9 \pm 6 % | 1.52 mho/m \pm 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 9.74 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 38.9 mW / g \pm 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 5.10 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 20.4 mW / g \pm 16.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.0 Ω + 4.9 j Ω |
| Return Loss | - 26.1 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 46.3 Ω + 5.6 j Ω |
| Return Loss | - 23.1 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.195 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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

Additional EUT Data

| | |
|-----------------|--------------|
| Manufactured by | SPEAG |
| Manufactured on | May 08, 2003 |

DASY5 Validation Report for Head TSL

Date: 26.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d036

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.39$ mho/m; $\epsilon_r = 40.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.850 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 17.7040

SAR(1 g) = 9.65 mW/g; SAR(10 g) = 5.05 mW/g

Maximum value of SAR (measured) = 12.055 mW/g



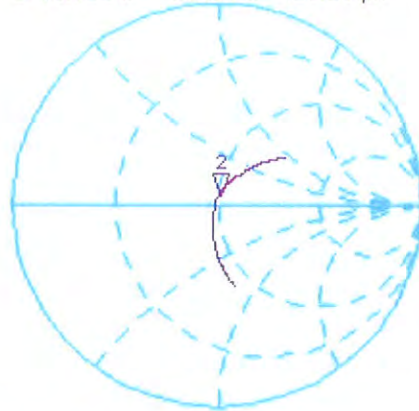
0 dB = 12.060mW/g = 21.63 dB mW/g

Impedance Measurement Plot for Head TSL

26 Jan 2012 11:20:39

CH1 S11 1 U FS 2: 50.012 Ω 4.9316 Ω 413.10 pF 1 900.000 000 MHz

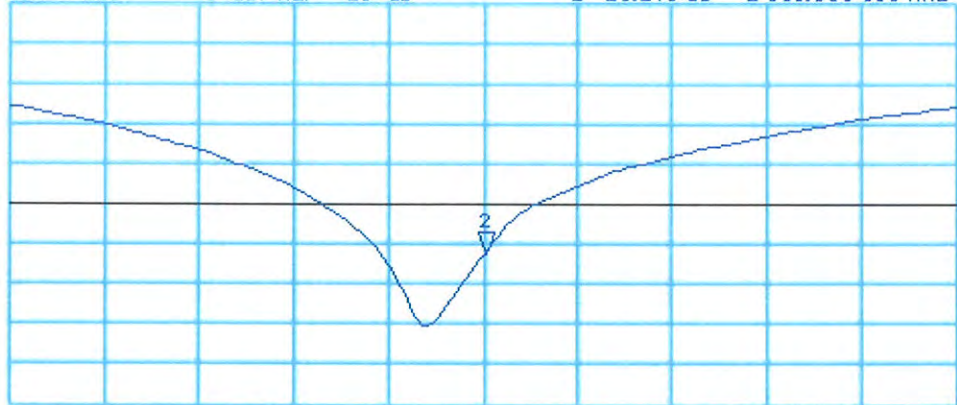
*
De1
Ca



Avg
16
H1d

CH2 S11 LOG 5 dB/REF -20 dB 2:-26.149 dB 1 900.000 000 MHz

Ca
Avg
16
H1d



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz

DASY5 Validation Report for Body TSL

Date: 26.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d036

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.52$ mho/m; $\epsilon_r = 52.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.62, 4.62, 4.62); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

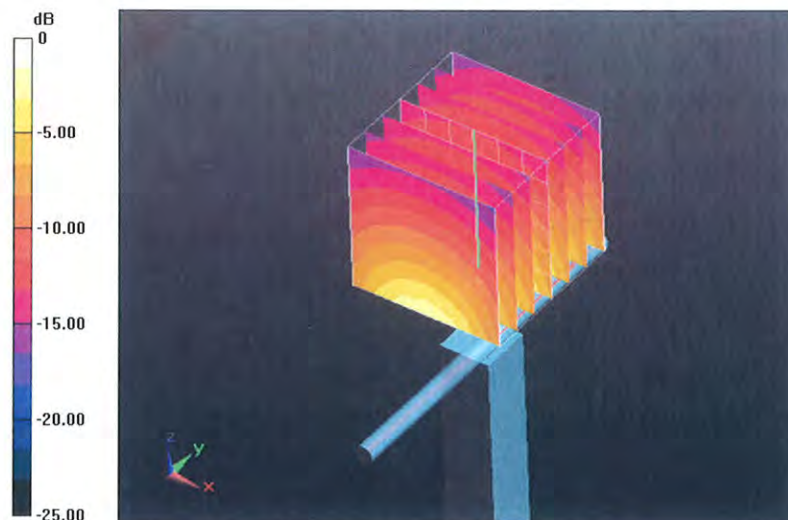
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.423 V/m; Power Drift = -0.0044 dB

Peak SAR (extrapolated) = 17.2700

SAR(1 g) = 9.74 mW/g; SAR(10 g) = 5.1 mW/g

Maximum value of SAR (measured) = 12.419 mW/g



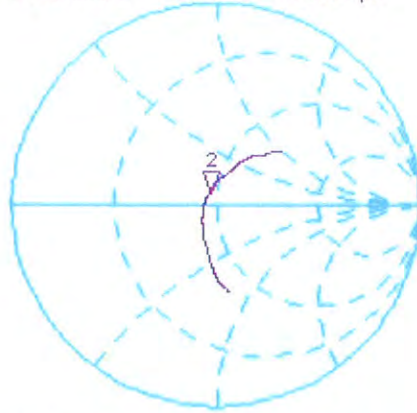
0 dB = 12.420mW/g = 21.88 dB mW/g

Impedance Measurement Plot for Body TSL

26 Jan 2012 11:19:41

[CH1] S11 1 U FS 2: 46.256 Ω 5.6113 Ω 470.04 μ H 1 900.000 000 MHz

*
De1
CA



Avg
16

H1d

CH2 S11 LOG 5 dB/REF -20 dB 2:-23.096 dB 1 900.000 000 MHz

CA

Avg
16

H1d





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Accreditation No.: **SCS 108**

Client **B.V. ADT (Auden)**

Certificate No: **D2450V2-716_Jan11**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 716**

Calibration procedure(s) **QA CAL-05.v8
Calibration procedure for dipole validation kits**

Calibration date: **January 26, 2011**

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 $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A | GB37480704 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Power sensor HP 8481A | US37292783 | 06-Oct-10 (No. 217-01266) | Oct-11 |
| Reference 20 dB Attenuator | SN: 5086 (20g) | 30-Mar-10 (No. 217-01158) | Mar-11 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 30-Mar-10 (No. 217-01162) | Mar-11 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Apr-10 (No. ES3-3205_Apr10) | Apr-11 |
| DAE4 | SN: 601 | 10-Jun-10 (No. DAE4-601_Jun10) | Jun-11 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-09) | In house check: Oct-11 |
| RF generator R&S SMT-06 | 100005 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

| | Name | Function | Signature |
|----------------|----------------------|-----------------------|-----------|
| Calibrated by: | Dimce Iliev | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 27, 2011

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

Measurement Conditions

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

| | | |
|------------------------------|---------------------------|-------------|
| DASY Version | DASY5 | V52.6 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom V5.0 | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2450 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|----------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.2 | 1.80 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 37.9 \pm 6 % | 1.74 mho/m \pm 6 % |
| Head TSL temperature during test | (20.5 \pm 0.2) °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 13.6 mW / g |
| SAR normalized | normalized to 1W | 54.4 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 54.8 mW / g \pm 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 6.37 mW / g |
| SAR normalized | normalized to 1W | 25.5 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 25.5 mW / g \pm 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 52.7 | 1.95 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 52.5 ± 6 % | 1.96 mho/m ± 6 % |
| Body TSL temperature during test | (20.8 ± 0.2) °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 13.4 mW / g |
| SAR normalized | normalized to 1W | 53.6 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 53.3 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 6.22 mW / g |
| SAR normalized | normalized to 1W | 24.9 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 24.8 mW / g ± 16.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 55.0 Ω + 2.1 j Ω |
| Return Loss | - 25.7 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.1 Ω + 4.4 j Ω |
| Return Loss | - 27.2 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.143 ns |
|----------------------------------|----------|

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

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

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

Additional EUT Data

| | |
|-----------------|--------------------|
| Manufactured by | SPEAG |
| Manufactured on | September 10, 2002 |

DASY5 Validation Report for Head TSL

Date/Time: 24.01.2011 13:05:38

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:716

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

Medium: HSL U12 BB

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.75$ mho/m; $\epsilon_r = 38.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY52, V52.6.1 Build (408)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

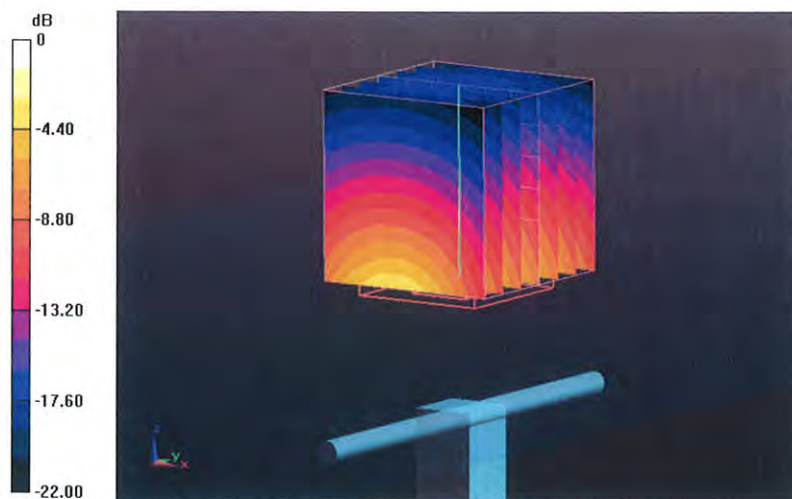
Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement
grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 103.2 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 27.976 W/kg

SAR(1 g) = 13.6 mW/g; SAR(10 g) = 6.37 mW/g

Maximum value of SAR (measured) = 17.366 mW/g

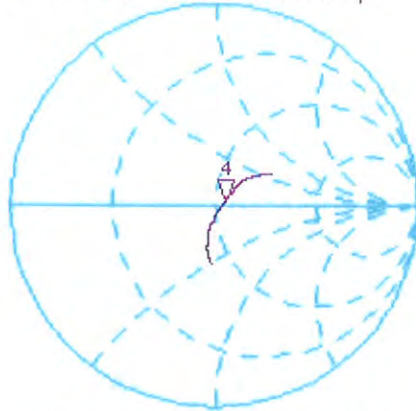


Impedance Measurement Plot for Head TSL

24 Jan 2011 10:25:33

CH1 S11 1 U FS 4: 55.020 Ω 2.0840 Ω 135.38 pF 2 450.000 000 MHz

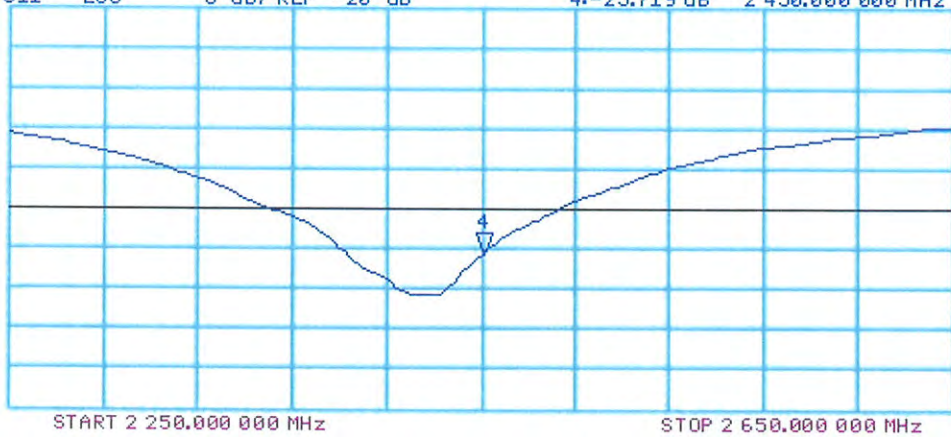
*
De l
CΔ



Avg
16
↑

CH2 S11 LOG 5 dB/REF -20 dB 4:-25.719 dB 2 450.000 000 MHz

CΔ
Avg
16
↑



DASY5 Validation Report for Body TSL

Date/Time: 26.01.2011 13:56:41

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:716

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

Medium: MSL U12 BB

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.97$ mho/m; $\epsilon_r = 52.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.31, 4.31, 4.31); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY52, V52.6.1 Build (408)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

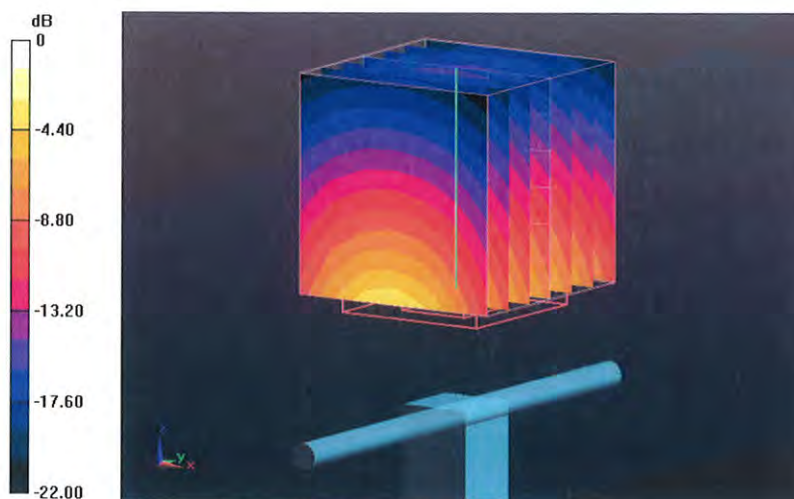
Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.445 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 28.276 W/kg

SAR(1 g) = 13.4 mW/g; SAR(10 g) = 6.22 mW/g

Maximum value of SAR (measured) = 17.680 mW/g



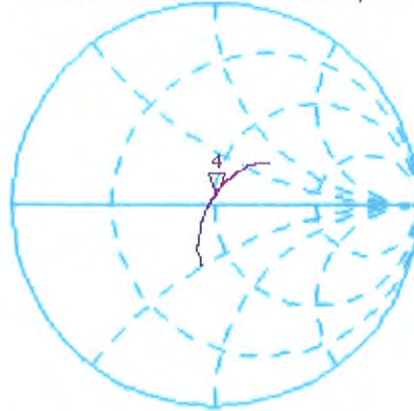
0 dB = 17.680mW/g

Impedance Measurement Plot for Body TSL

26 Jan 2011 10:53:07

[CH1] S11 1 U FS 4: 50.141 Ω 4.3887 Ω 285.09 μH 2 450.000 000 MHz

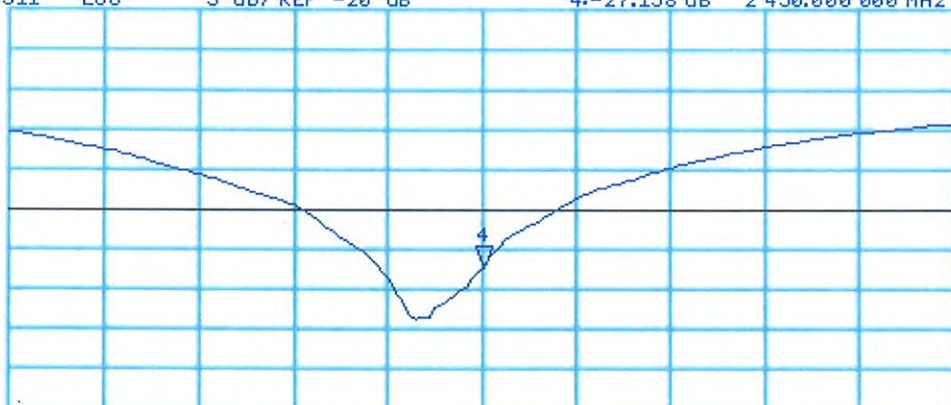
*
Del
CA



Avg
16
↑

CH2 S11 LOG 5 dB/REF -20 dB 4:-27.158 dB 2 450.000 000 MHz

CA
Avg
16
↑



START 2 250.000 000 MHz

STOP 2 650.000 000 MHz



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Accreditation No.: **SCS 108**

Client **B.V. ADT (Auden)**

Certificate No: **D2600V2_1003_Jan11**

CALIBRATION CERTIFICATE

Object **D2600V2 - SN: 1003**

Calibration procedure(s) **QA CAL-05.v8
Calibration procedure for dipole validation kits**

Calibration date: **January 27, 2011**

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 EPM-442A | GB37480704 | 06-Oct-09 (No. 217-01086) | Oct-10 |
| Power sensor HP 8481A | US37292783 | 06-Oct-09 (No. 217-01086) | Oct-10 |
| Reference 20 dB Attenuator | SN: 5086 (20g) | 30-Mar-10 (No. 217-01158) | Mar-11 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 30-Mar-10 (No. 217-01162) | Mar-11 |
| Reference Probe ES3DV3 | SN: 3205 | 30-Apr-10 (No. ES3-3205_Apr10) | Apr-11 |
| DAE4 | SN: 601 | 10-Jun-10 (No. DAE4-601_Jun10) | Jun-11 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-09) | In house check: Oct-11 |
| RF generator R&S SMT-06 | 100005 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

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

Issued: January 27, 2011

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



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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) 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
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

Measurement Conditions

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

| | | |
|------------------------------|---------------------------|-------------|
| DASY Version | DASY5 | V52.6 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom V5.0 | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2600 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.0 | 1.96 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 38.9 ± 6 % | 2.03 mho/m ± 6 % |
| Head TSL temperature during test | (21.5 ± 0.2) °C | ----- | ----- |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 15.0 mW / g |
| SAR normalized | normalized to 1W | 60.0 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 58.9 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 6.57 mW / g |
| SAR normalized | normalized to 1W | 26.3 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | 26.1 mW / g ± 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 52.5 | 2.16 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 52.3 ± 6 % | 2.10 mho/m ± 6 % |
| Body TSL temperature during test | (20.8 ± 0.2) °C | ----- | ----- |

SAR result with Body TSL

| SAR averaged over 1 cm ³ (1 g) of Body TSL | condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 14.4 mW / g |
| SAR normalized | normalized to 1W | 57.6 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 58.1 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|-----------------------------------|
| SAR measured | 250 mW input power | 6.41 mW / g |
| SAR normalized | normalized to 1W | 25.6 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | 25.7 mW / g ± 16.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.5 Ω - 0.4 j Ω |
| Return Loss | - 44.2 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 46.2 Ω + 0.0 j Ω |
| Return Loss | - 28.1 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.147 ns |
|----------------------------------|----------|

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

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

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

Additional EUT Data

| | |
|-----------------|-------------------|
| Manufactured by | SPEAG |
| Manufactured on | December 23, 2006 |

DASY5 Validation Report for Head TSL

Date/Time: 27.01.2011 15:40:46

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1003

Communication System: CW; Frequency: 2600 MHz; Duty Cycle: 1:1

Medium: HSL BB1.9

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.04$ mho/m; $\epsilon_r = 38.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.47, 4.47, 4.47); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY52, V52.6.1 Build (408)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

Pin=250 mW/d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 102.3 V/m; Power Drift = 0.00081 dB

Peak SAR (extrapolated) = 32.976 W/kg

SAR(1 g) = 15 mW/g; SAR(10 g) = 6.57 mW/g

Maximum value of SAR (measured) = 19.719 mW/g



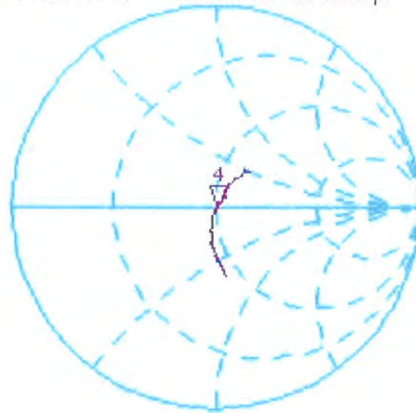
0 dB = 19.720mW/g

Impedance Measurement Plot for Head TSL

27 Jan 2011 11:29:59

CH1 S11 1 U FS 4: 50.467 Ω -408.20 m Ω 149.96 pF 2 500.000 000 MHz

*
De1
Ca



Avg
16

CH2 S11 LOG 5 dB/REF -20 dB 4:-44.187 dB 2 500.000 000 MHz

Ca
Avg
16



DASY5 Validation Report for Body TSL

Date/Time: 05.01.2011 14:25:38

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1003

Communication System: CW; Frequency: 2600 MHz; Duty Cycle: 1:1

Medium: MSL U12 BB

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.12$ mho/m; $\epsilon_r = 52.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.18, 4.18, 4.18); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY52, V52.6.1 Build (408)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

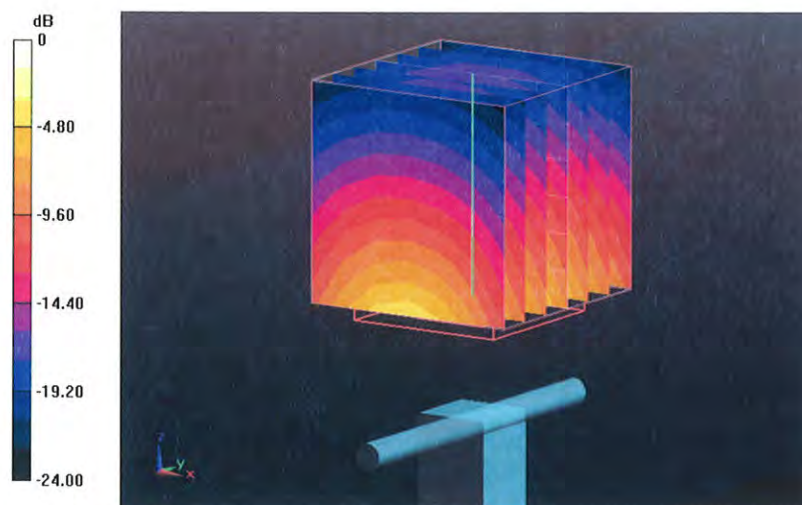
Pin=250 mW/d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.717 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 31.466 W/kg

SAR(1 g) = 14.4 mW/g; SAR(10 g) = 6.41 mW/g

Maximum value of SAR (measured) = 19.133 mW/g

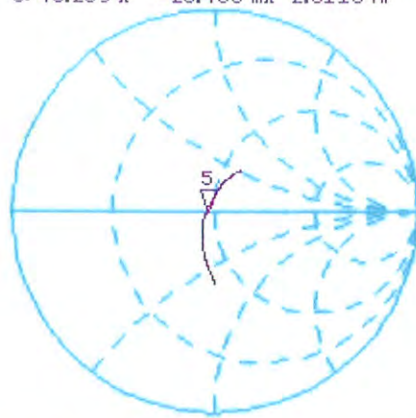


Impedance Measurement Plot for Body TSL

26 Jan 2011 11:00:19

CH1 S11 1 U FS 5: 46.209 Ω -23.438 $m\Omega$ 2.6118 nF 2 600.000 000 MHz

*
De1
CA



Avg
16

↑

CH2 S11 LOG 5 dB/REF -20 dB 5:-28.086 dB 2 600.000 000 MHz

CA

Avg
16

↑





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Accreditation No.: **SCS 108**

Client **Nokia China (Auden)**

Certificate No: **ES3-3280_Nov11**

CALIBRATION CERTIFICATE

Object: **ES3DV3 - SN:3280**

Calibration procedure(s): **DA CAL-01 V8, DA CAL-02 V8, DA CAL-25 V8
Calibration procedure for Document: E-Field 02/08**

Calibration date: **November 29, 2011**

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 | 31-Mar-11 (No. 217-01372) | Apr-12 |
| Power sensor E4412A | MY41498087 | 31-Mar-11 (No. 217-01372) | Apr-12 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 29-Mar-11 (No. 217-01369) | Apr-12 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 29-Mar-11 (No. 217-01367) | Apr-12 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 29-Mar-11 (No. 217-01370) | Apr-12 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-10 (No. ES3-3013_Dec10) | Dec-11 |
| DAE4 | SN: 654 | 3-May-11 (No. DAE4-654_May11) | May-12 |
| 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 Kastrioti | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: November 29, 2011

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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:3280

Manufactured: June 7, 2010
Calibrated: November 29, 2011

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3280

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|-----------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 1.26 | 1.31 | 1.33 | ± 10.1 % |
| DCP (mV) ^B | 102.1 | 99.8 | 100.9 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-------|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 114.8 | ±3.0 % |
| | | | Y | 0.00 | 0.00 | 1.00 | 115.1 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 120.0 | |

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:3280

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 | 6.34 | 6.34 | 6.34 | 0.80 | 1.00 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.09 | 6.09 | 6.09 | 0.80 | 1.00 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 6.01 | 6.01 | 6.01 | 0.80 | 1.00 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.23 | 5.23 | 5.23 | 0.80 | 1.24 | ± 12.0 % |
| 1950 | 40.0 | 1.40 | 4.89 | 4.89 | 4.89 | 0.80 | 1.23 | ± 12.0 % |
| 2100 | 39.8 | 1.49 | 5.08 | 5.08 | 5.08 | 0.80 | 1.27 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 4.68 | 4.68 | 4.68 | 0.80 | 1.28 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.41 | 4.41 | 4.41 | 0.80 | 1.28 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.26 | 4.26 | 4.26 | 0.80 | 1.29 | ± 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:3280

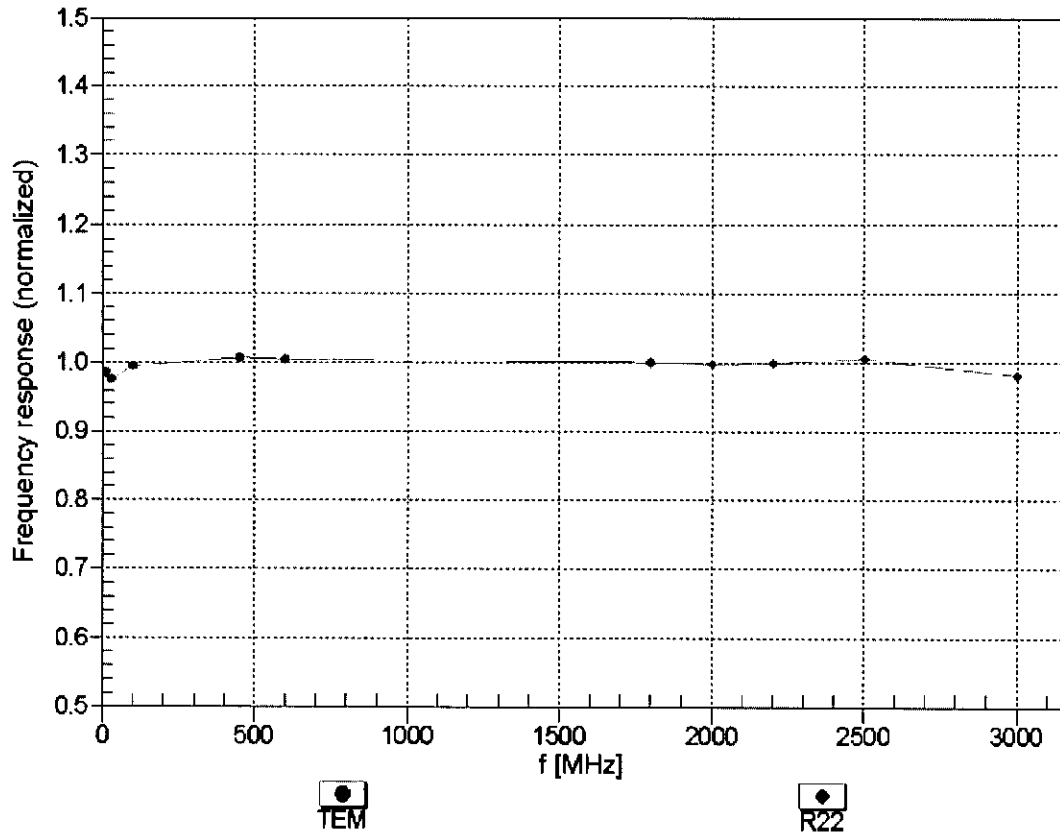
Calibration Parameter Determined in Body Tissue Simulating Media

| 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 | 0.80 | 1.33 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.08 | 6.08 | 6.08 | 0.80 | 1.00 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 6.01 | 6.01 | 6.01 | 0.80 | 1.00 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.93 | 4.93 | 4.93 | 0.80 | 1.39 | ± 12.0 % |
| 1950 | 53.3 | 1.52 | 4.80 | 4.80 | 4.80 | 0.80 | 1.31 | ± 12.0 % |
| 2100 | 53.2 | 1.62 | 4.78 | 4.78 | 4.78 | 0.80 | 1.38 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 4.43 | 4.43 | 4.43 | 0.80 | 1.29 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.31 | 4.31 | 4.31 | 0.80 | 1.00 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.12 | 4.12 | 4.12 | 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.

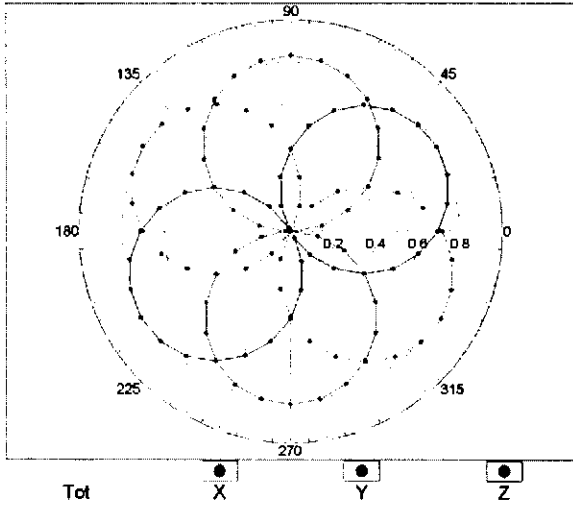
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



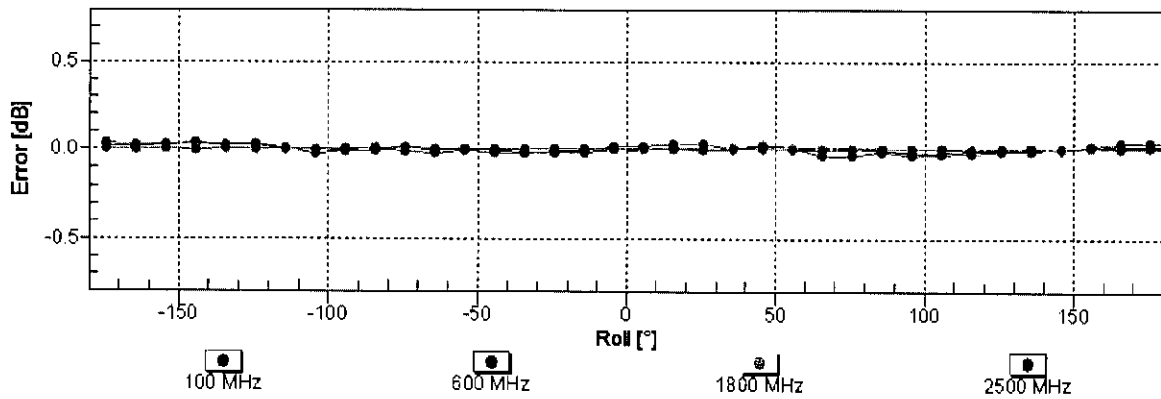
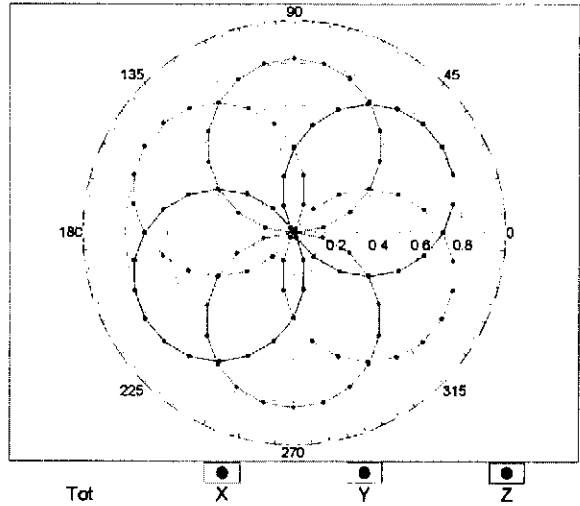
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

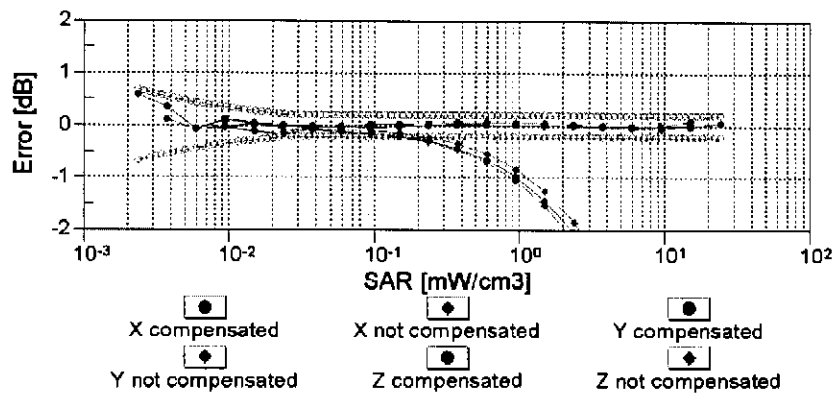
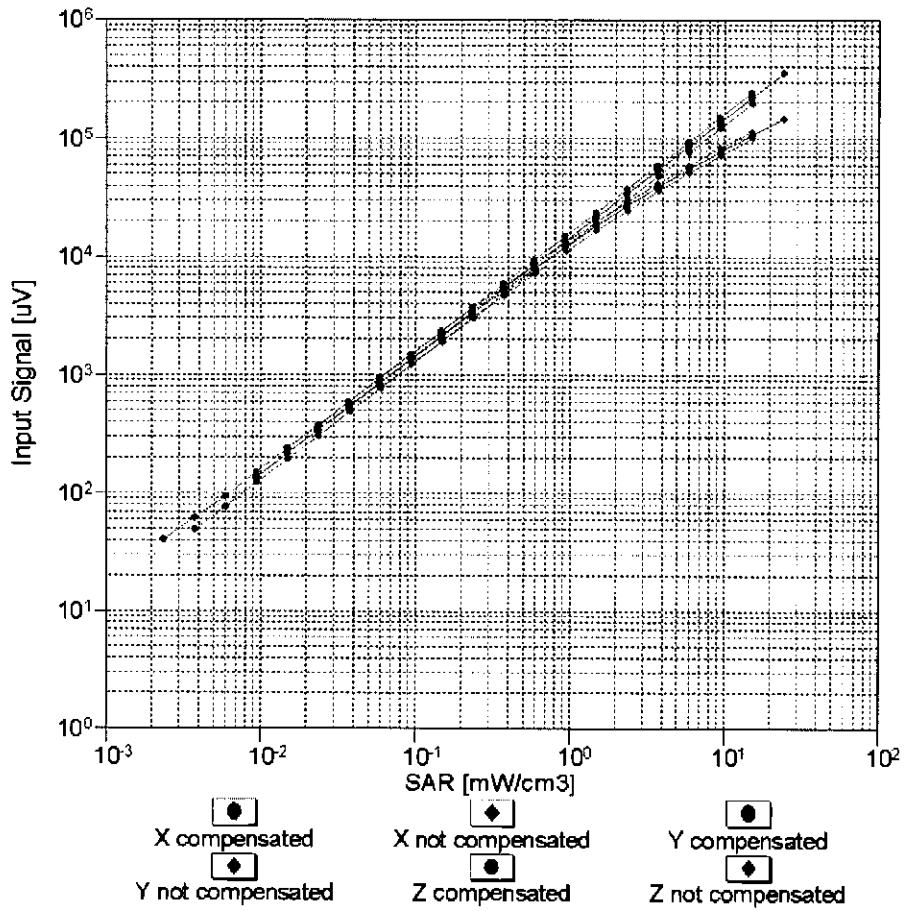


f=1800 MHz,R22



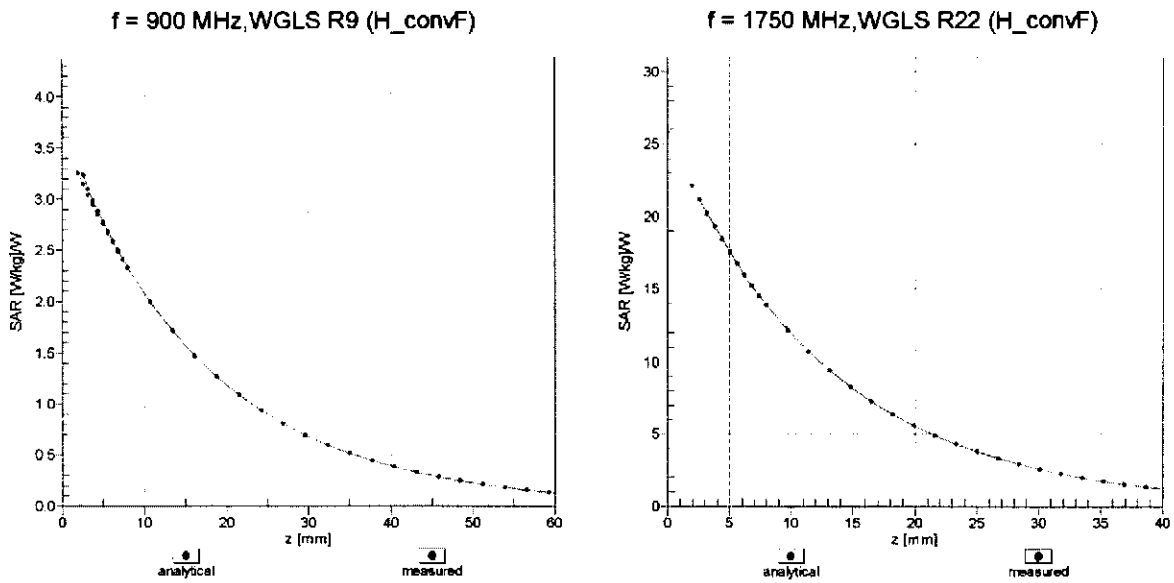
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

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

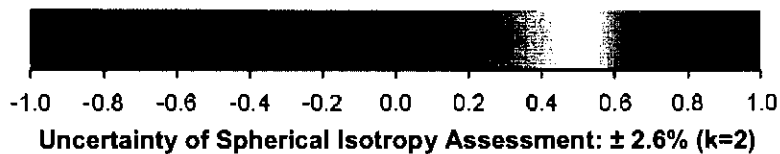
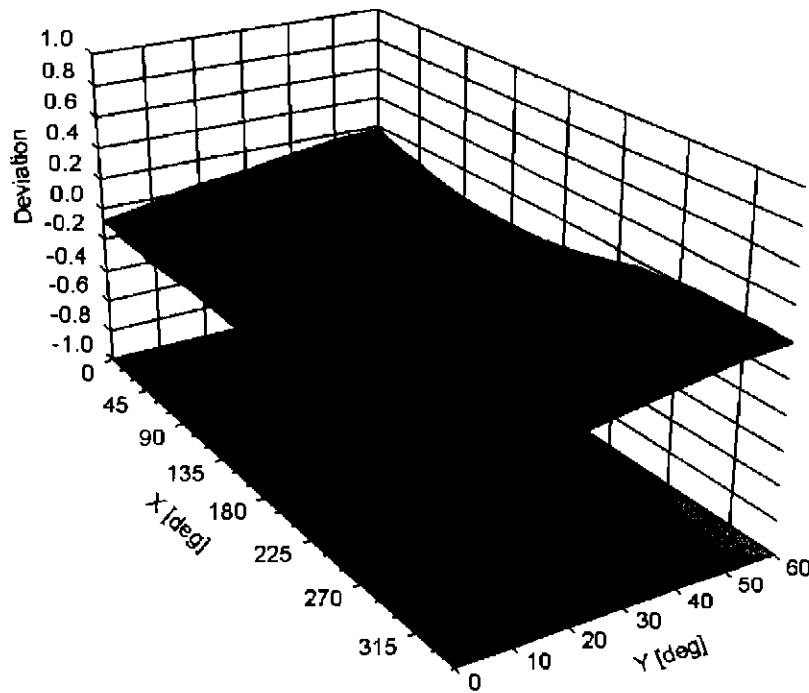


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



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



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3280

Other Probe Parameters

| | |
|---|----------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | Not applicable |
| 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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The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **BV ADT (Auden)**

Certificate No: **EX3-3590_Feb11**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3590**

Calibration procedure(s) **QA CAL-01.v7, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v3
Calibration procedure for dosimetric E-field probes**

Calibration date: **February 25, 2011**

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 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41495277 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Power sensor E4412A | MY41498087 | 01-Apr-10 (No. 217-01136) | Apr-11 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 30-Mar-10 (No. 217-01159) | Mar-11 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 30-Mar-10 (No. 217-01161) | Mar-11 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 30-Mar-10 (No. 217-01160) | Mar-11 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-10 (No. ES3-3013_Dec10) | Dec-11 |
| DAE4 | SN: 654 | 23-Apr-10 (No. DAE4-654_Apr10) | Apr-11 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

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

Issued: February 25, 2011

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



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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 E^2 -field uncertainty inside TSL (see below *ConvF*).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * *frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep 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}** are numerical linearization parameters in dB assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media.
- VR**: VR is the validity range of the calibration related to the average diode voltage or DAE voltage in mV.
- 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:3590

Manufactured: March 23, 2009
Calibrated: February 25, 2011

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3590

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V/m})^2$) ^A | 0.51 | 0.48 | 0.51 | $\pm 10.1\%$ |
| DCP (mV) ^B | 94.6 | 95.5 | 92.8 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-------|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 119.0 | $\pm 2.7\%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 141.4 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 115.0 | |

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:3590

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) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 835 | 41.5 | 0.90 | 10.21 | 10.21 | 10.21 | 0.56 | 0.68 | ± 12.0 % |
| 1640 | 40.3 | 1.29 | 9.25 | 9.25 | 9.25 | 0.68 | 0.60 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 9.03 | 9.03 | 9.03 | 0.79 | 0.58 | ± 12.0 % |
| 1950 | 40.0 | 1.40 | 8.45 | 8.45 | 8.45 | 0.55 | 0.66 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 8.14 | 8.14 | 8.14 | 0.40 | 0.80 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.73 | 7.73 | 7.73 | 0.29 | 1.00 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 7.53 | 7.53 | 7.53 | 0.28 | 1.06 | ± 12.0 % |
| 3500 | 37.9 | 2.91 | 7.55 | 7.55 | 7.55 | 0.36 | 1.03 | ± 13.1 % |
| 5200 | 36.0 | 4.66 | 5.51 | 5.51 | 5.51 | 0.30 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 5.17 | 5.17 | 5.17 | 0.30 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 5.00 | 5.00 | 5.00 | 0.40 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.52 | 4.52 | 4.52 | 0.50 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.53 | 4.53 | 4.53 | 0.50 | 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:3590

Calibration Parameter Determined in Body Tissue Simulating Media

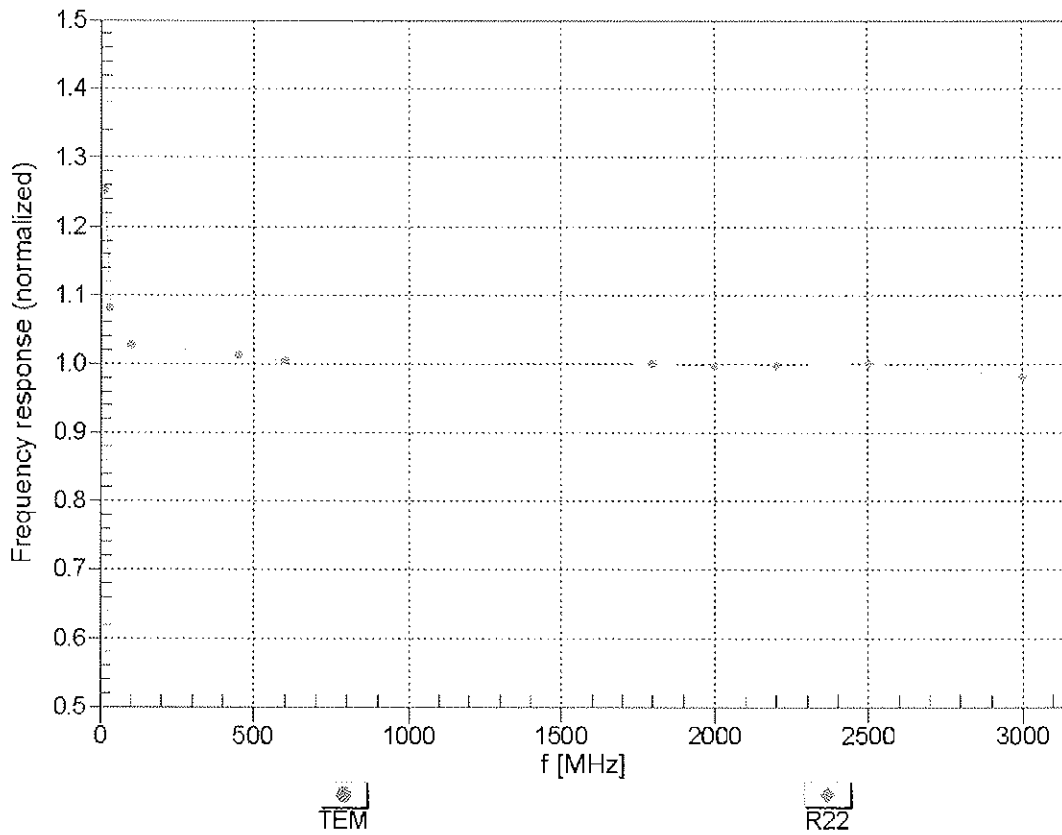
| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 835 | 55.2 | 0.97 | 10.32 | 10.32 | 10.32 | 0.38 | 0.82 | ± 12.0 % |
| 1640 | 53.8 | 1.40 | 9.72 | 9.72 | 9.72 | 0.51 | 0.79 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 8.77 | 8.77 | 8.77 | 0.37 | 0.92 | ± 12.0 % |
| 1950 | 53.3 | 1.52 | 8.49 | 8.49 | 8.49 | 0.60 | 0.67 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 8.08 | 8.08 | 8.08 | 0.30 | 1.00 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.91 | 7.91 | 7.91 | 0.42 | 0.82 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 7.78 | 7.78 | 7.78 | 0.25 | 1.17 | ± 12.0 % |
| 3500 | 51.3 | 3.31 | 7.14 | 7.14 | 7.14 | 0.43 | 0.96 | ± 13.1 % |
| 5200 | 49.0 | 5.30 | 4.81 | 4.81 | 4.81 | 0.50 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.56 | 4.56 | 4.56 | 0.50 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 4.32 | 4.32 | 4.32 | 0.50 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 4.01 | 4.01 | 4.01 | 0.60 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 4.55 | 4.55 | 4.55 | 0.50 | 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

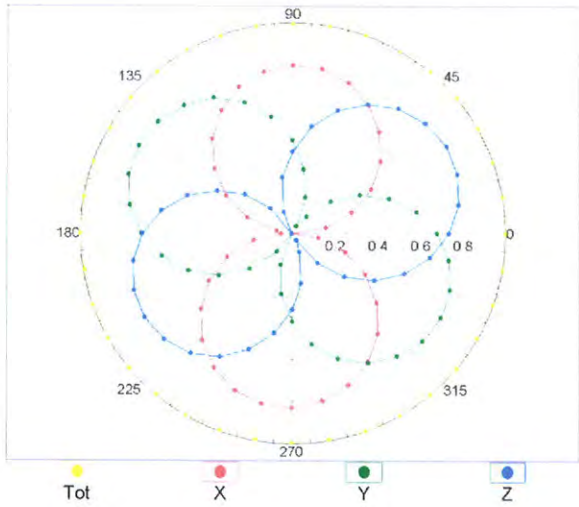
(TEM-Cell:ifi110 EXX, Waveguide: R22)



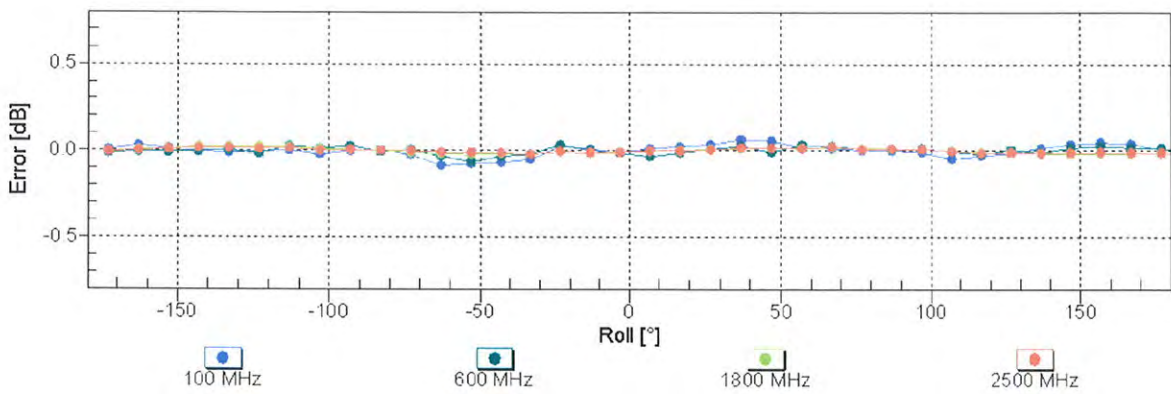
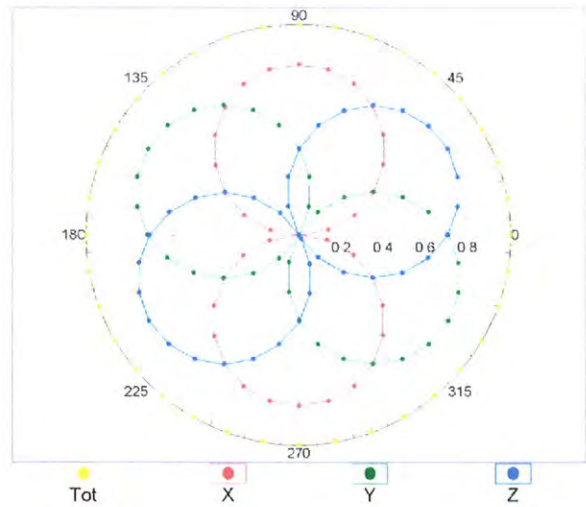
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM

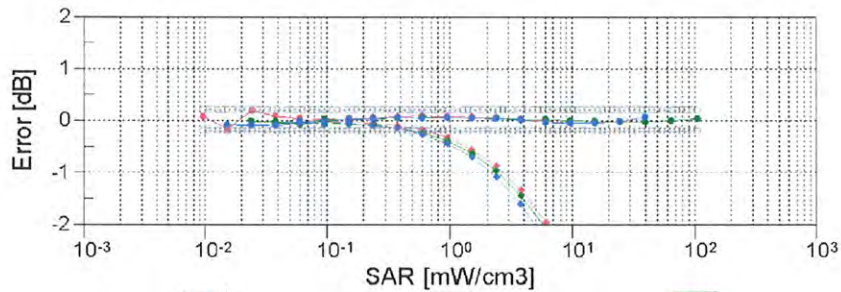
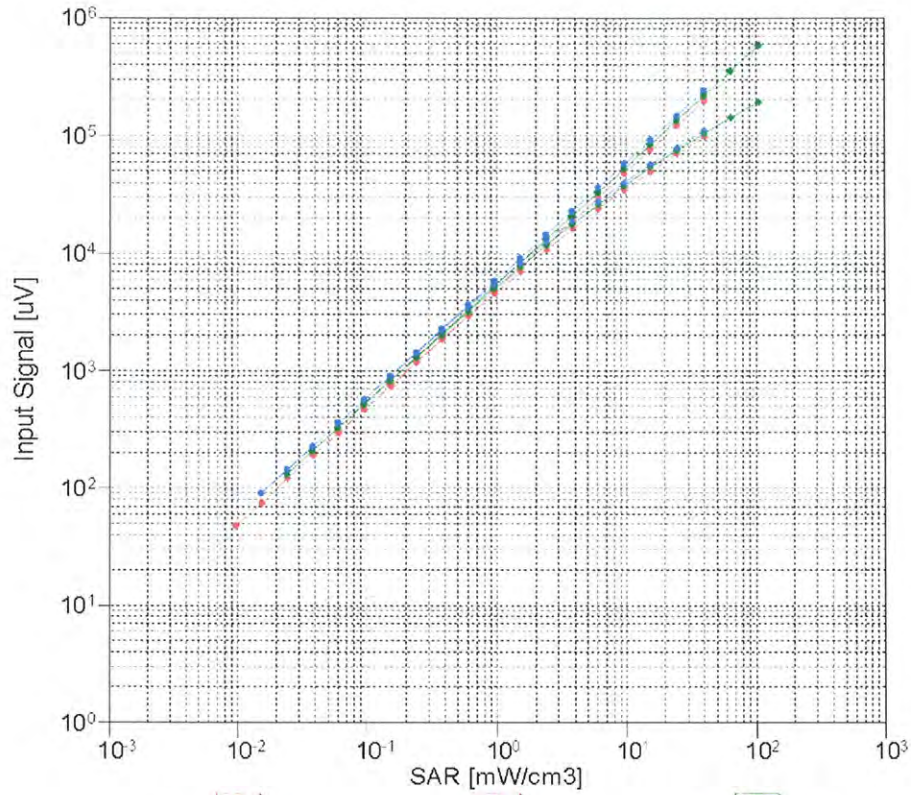


f=1800 MHz, R22



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

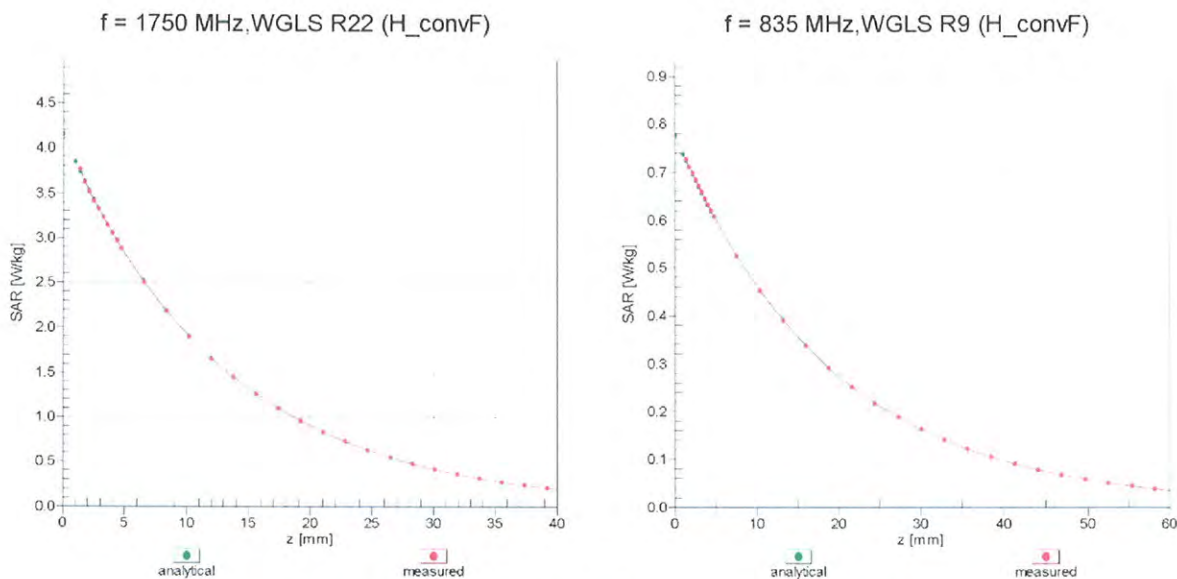
Dynamic Range f(SAR_{head}) (TEM cell , f = 900 MHz)



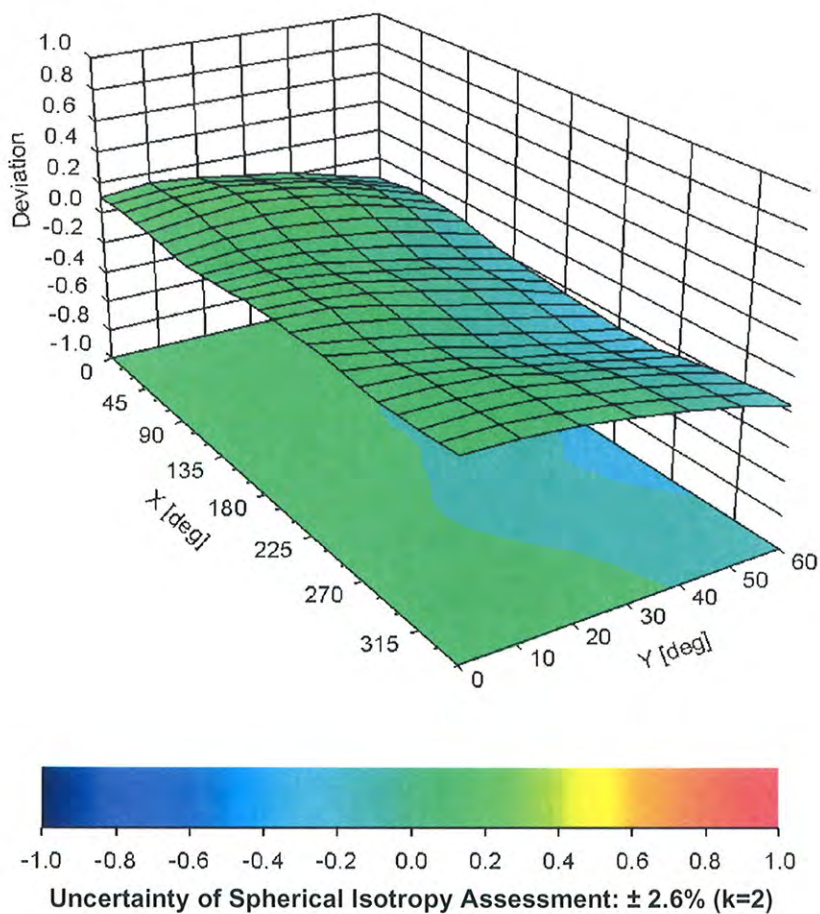
X compensated X not compensated Y compensated
Y not compensated Z compensated Z not compensated

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

Conversion Factor Assessment



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



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3590

Other Probe Parameters

| | |
|---|----------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | Not applicable |
| 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 |

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



S Schweizerischer Kalibrierdienst
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S Swiss Calibration Service

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **B.V. ADT (Auden)**

Certificate No: **EX3-3650_Oct11**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3650**

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: **October 26, 2011**

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 | 31-Mar-11 (No. 217-01372) | Apr-12 |
| Power sensor E4412A | MY41498087 | 31-Mar-11 (No. 217-01372) | Apr-12 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 29-Mar-11 (No. 217-01369) | Apr-12 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 29-Mar-11 (No. 217-01367) | Apr-12 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 29-Mar-11 (No. 217-01370) | Apr-12 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-10 (No. ES3-3013_Dec10) | Dec-11 |
| DAE4 | SN: 654 | 3-May-11 (No. DAE4-654_May11) | May-12 |
| 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: October 27, 2011

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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA
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 EX3DV4

SN:3650

Manufactured: March 18, 2008
Calibrated: October 26, 2011

Calibrated for DASYS/EASY Systems
(Note: non-compatible with DASYS2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3650

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.36 | 0.37 | 0.46 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 98.5 | 94.0 | 98.2 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-------|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 94.9 | $\pm 2.5 \%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 90.7 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 114.0 | |

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:3650

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 | 9.20 | 9.20 | 9.20 | 0.79 | 0.69 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 8.87 | 8.87 | 8.87 | 0.79 | 0.69 | ± 12.0 % |
| 1450 | 40.5 | 1.20 | 8.32 | 8.32 | 8.32 | 0.79 | 0.65 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 7.92 | 7.92 | 7.92 | 0.70 | 0.63 | ± 12.0 % |
| 1950 | 40.0 | 1.40 | 7.40 | 7.40 | 7.40 | 0.79 | 0.54 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 6.80 | 6.80 | 6.80 | 0.59 | 0.62 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 6.68 | 6.68 | 6.68 | 0.50 | 0.74 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 5.05 | 5.05 | 5.05 | 0.35 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.71 | 4.71 | 4.71 | 0.40 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.56 | 4.56 | 4.56 | 0.45 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.42 | 4.42 | 4.42 | 0.45 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.30 | 4.30 | 4.30 | 0.50 | 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:3650

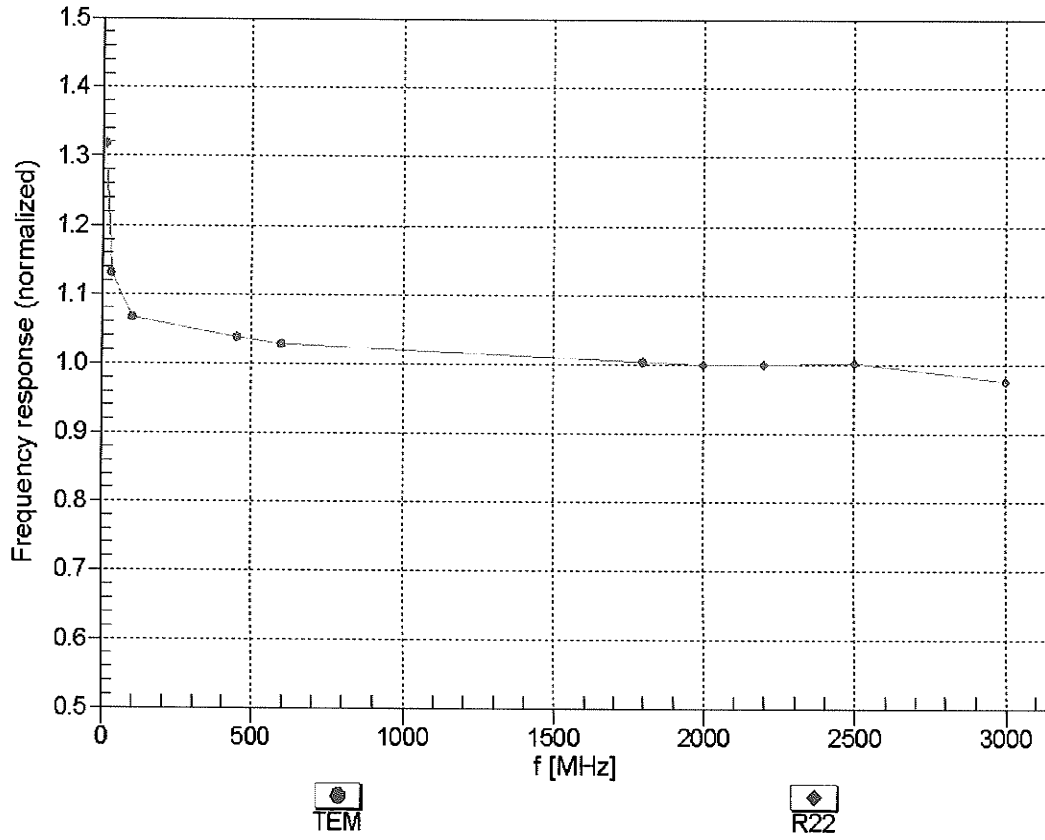
Calibration Parameter Determined in Body Tissue Simulating Media

| 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 | 9.21 | 9.21 | 9.21 | 0.78 | 0.69 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 9.12 | 9.12 | 9.12 | 0.79 | 0.67 | ± 12.0 % |
| 1450 | 54.0 | 1.30 | 8.09 | 8.09 | 8.09 | 0.79 | 0.63 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.49 | 7.49 | 7.49 | 0.79 | 0.64 | ± 12.0 % |
| 1950 | 53.3 | 1.52 | 7.46 | 7.46 | 7.46 | 0.79 | 0.65 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 6.89 | 6.89 | 6.89 | 0.79 | 0.60 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.79 | 6.79 | 6.79 | 0.72 | 0.58 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 4.28 | 4.28 | 4.28 | 0.50 | 1.95 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.11 | 4.11 | 4.11 | 0.50 | 1.95 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 3.73 | 3.73 | 3.73 | 0.60 | 1.95 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.57 | 3.57 | 3.57 | 0.60 | 1.95 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 3.81 | 3.81 | 3.81 | 0.60 | 1.95 | ± 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.

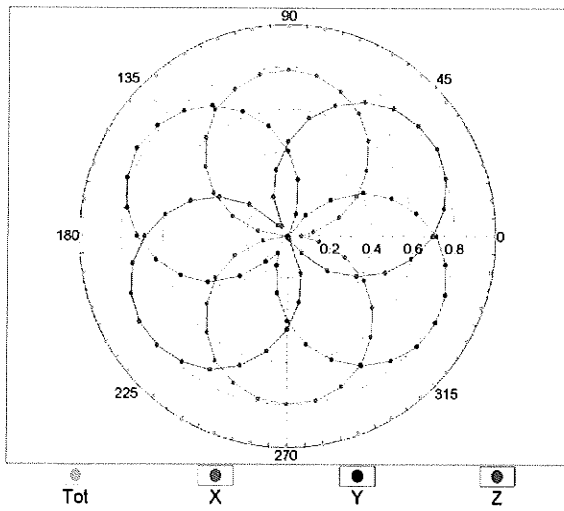
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



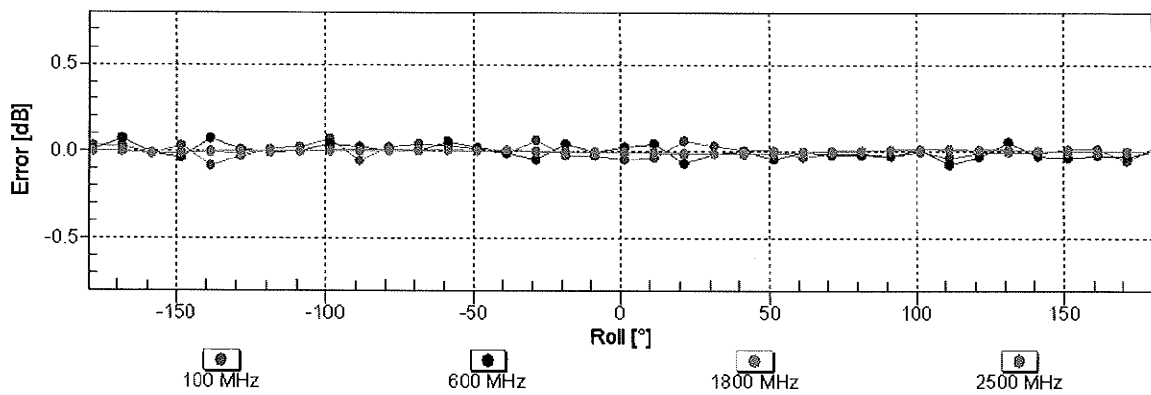
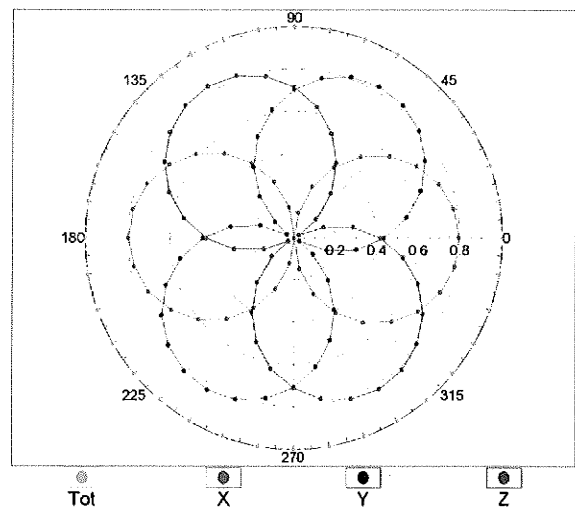
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM

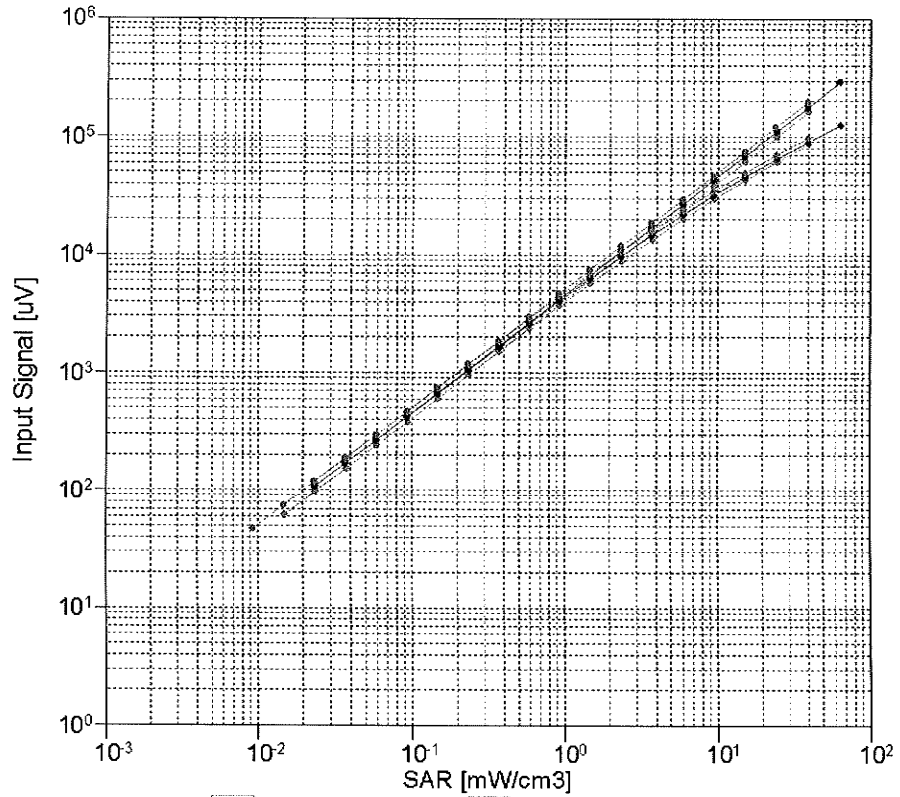


f=1800 MHz, R22

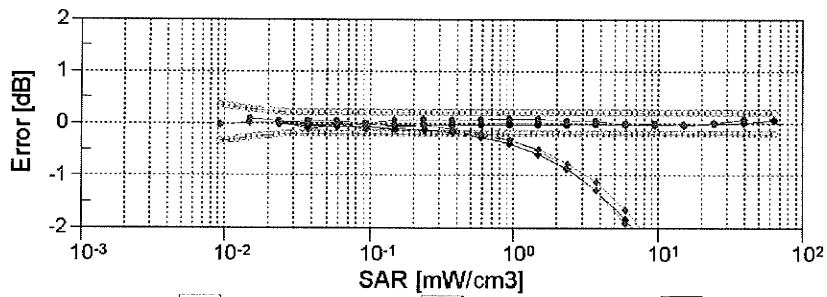


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

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



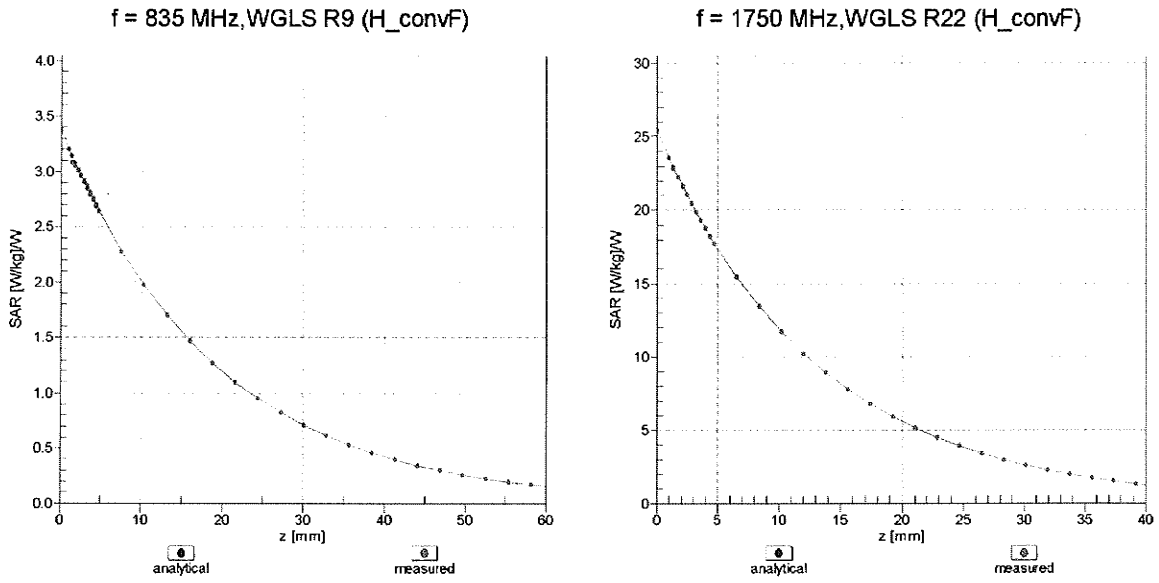
| | | |
|-------------------|-------------------|-------------------|
| | | |
| X compensated | X not compensated | Y compensated |
| | | |
| Y not compensated | Z compensated | Z not compensated |



| | | |
|-------------------|-------------------|-------------------|
| | | |
| X compensated | X not compensated | Y compensated |
| | | |
| Y not compensated | Z compensated | Z not compensated |

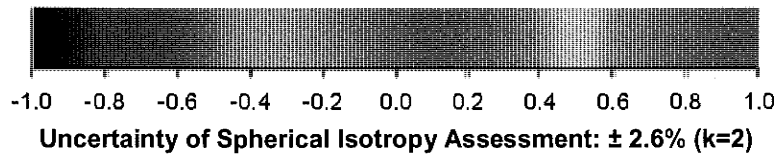
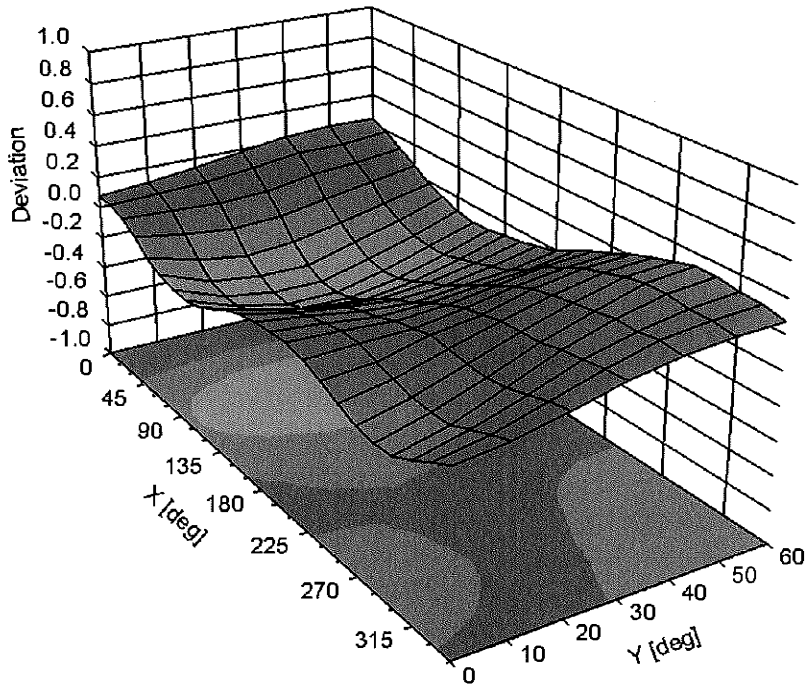
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

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: EX3DV4 - SN:3650**Other Probe Parameters**

| | |
|---|----------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | Not applicable |
| 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 |



Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **B.V. ADT (Auden)**

Certificate No: **EX3-3800_Aug11**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3800**

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 5, 2011**

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 | 31-Mar-11 (No. 217-01372) | Apr-12 |
| Power sensor E4412A | MY41498087 | 31-Mar-11 (No. 217-01372) | Apr-12 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 29-Mar-11 (No. 217-01369) | Apr-12 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 29-Mar-11 (No. 217-01367) | Apr-12 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 29-Mar-11 (No. 217-01370) | Apr-12 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-10 (No. ES3-3013_Dec10) | Dec-11 |
| DAE4 | SN: 654 | 3-May-11 (No. DAE4-654_May11) | May-12 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

| | | | |
|---|------------------------------|--------------------------------------|------------------------|
| Calibrated by: | Name Katja Pokovic | Function Technical Manager | Signature |
| Approved by: | Name Fin Bornholt | Function R&D Director | Signature |
| | | | Issued: August 8, 2011 |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. | | | |



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA
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 EX3DV4

SN:3800

Manufactured: April 5, 2011
Calibrated: August 5, 2011

Calibrated for DASYS/EASY Systems
(Note: non-compatible with DASYS2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3800

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.42 | 0.58 | 0.55 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 100.6 | 96.7 | 98.8 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-------|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 10000 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 102.6 | $\pm 3.0 \%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 124.9 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 120.1 | |

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 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:3800

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 | 9.02 | 9.02 | 9.02 | 0.15 | 1.41 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 8.70 | 8.70 | 8.70 | 0.24 | 1.03 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 8.51 | 8.51 | 8.51 | 0.13 | 1.52 | ± 12.0 % |
| 1640 | 40.3 | 1.29 | 7.95 | 7.95 | 7.95 | 0.15 | 1.37 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 7.79 | 7.79 | 7.79 | 0.13 | 1.56 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.46 | 7.46 | 7.46 | 0.45 | 0.76 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 6.71 | 6.71 | 6.71 | 0.32 | 0.89 | ± 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: EX3DV4- SN:3800

Calibration Parameter Determined in Body Tissue Simulating Media

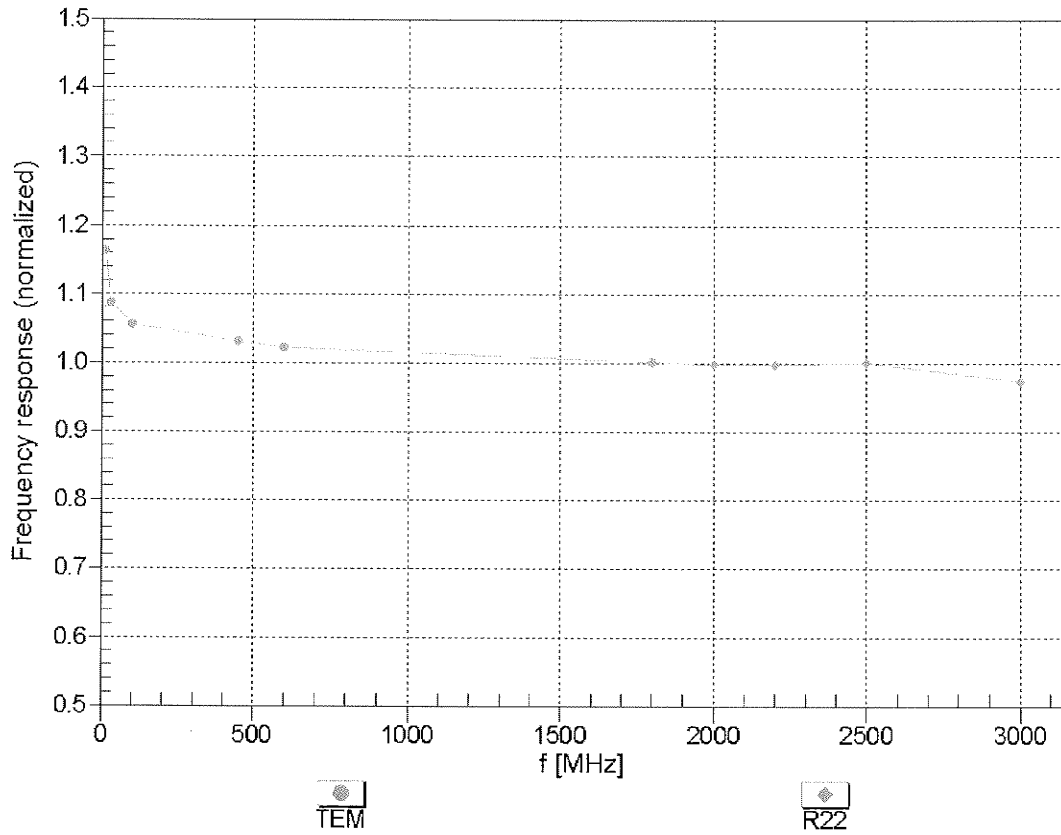
| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 9.34 | 9.34 | 9.34 | 0.10 | 2.61 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 8.94 | 8.94 | 8.94 | 0.11 | 2.46 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 8.67 | 8.67 | 8.67 | 0.13 | 2.08 | ± 12.0 % |
| 1640 | 53.8 | 1.40 | 8.07 | 8.07 | 8.07 | 0.16 | 1.57 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.43 | 7.43 | 7.43 | 0.15 | 1.76 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 6.97 | 6.97 | 6.97 | 0.13 | 1.56 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 6.75 | 6.75 | 6.75 | 0.80 | 0.53 | ± 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

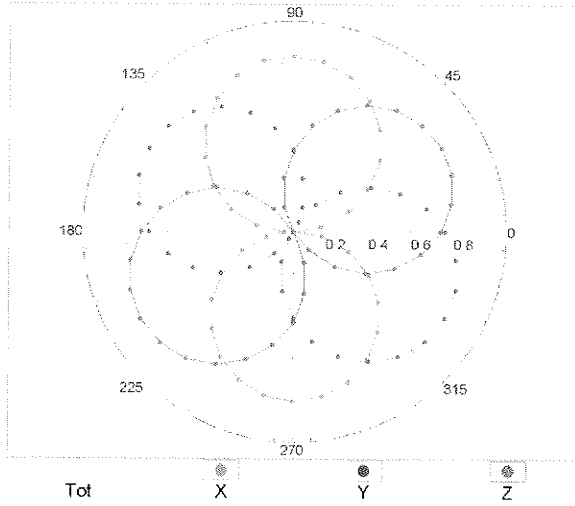
(TEM-Cell:ifi110 EXX, Waveguide: R22)



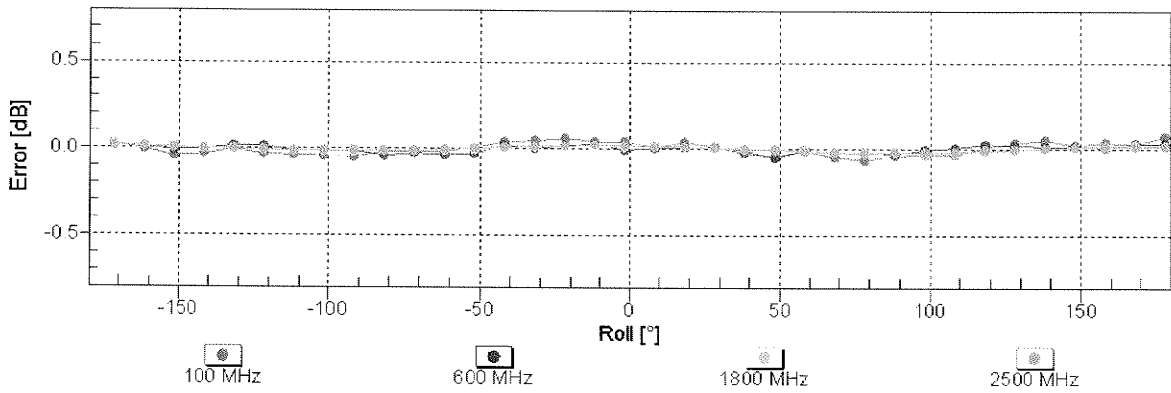
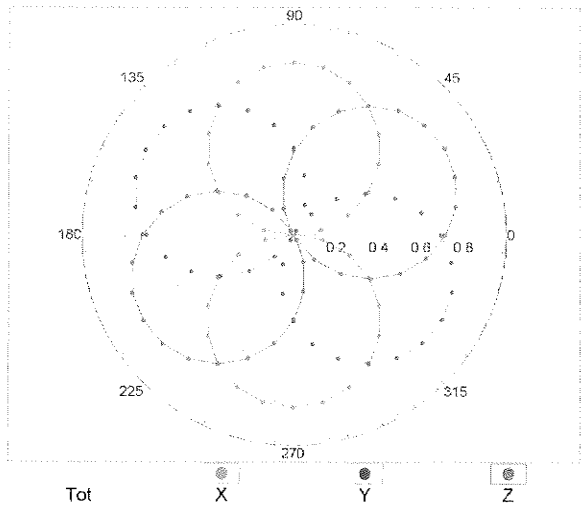
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

f=600 MHz,TEM

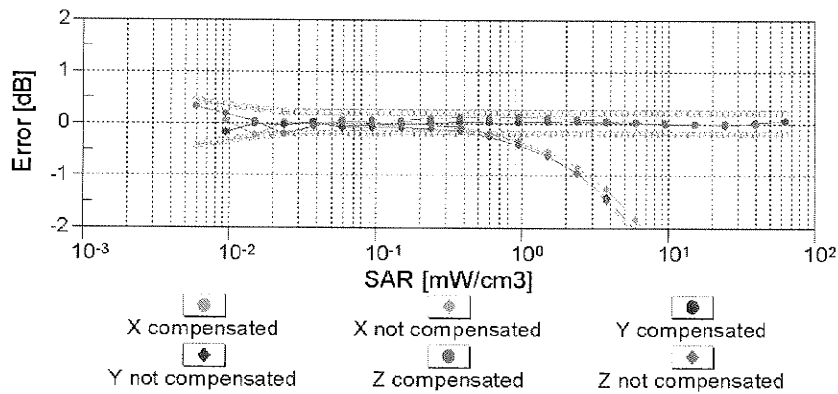
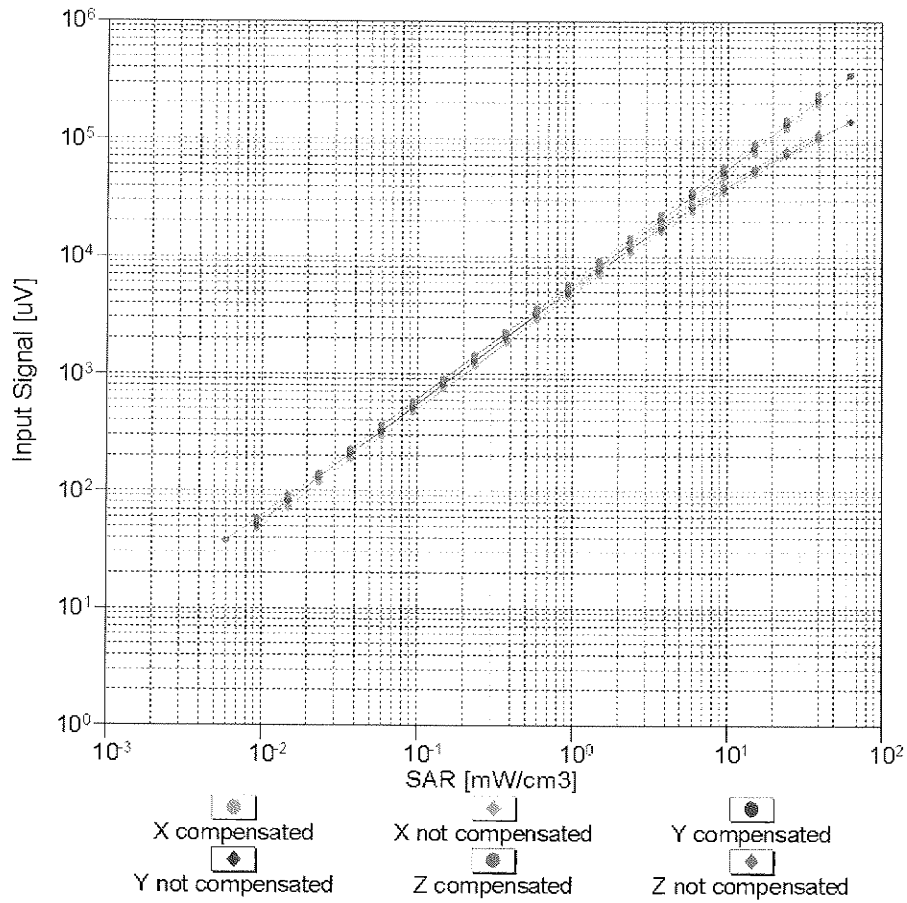


f=1800 MHz,R22



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

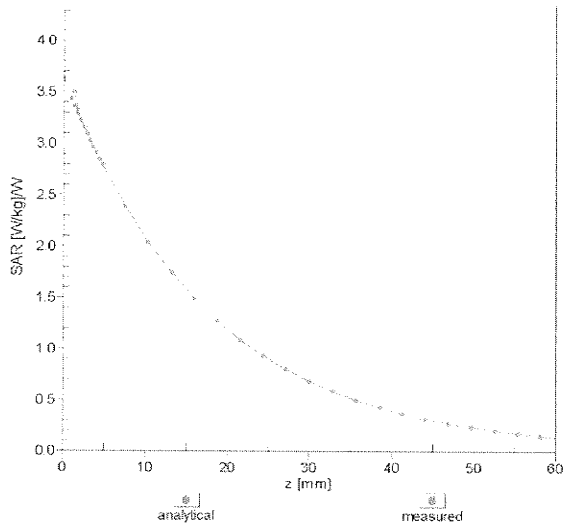
Dynamic Range $f(SAR_{head})$ (TEM cell , $f = 900$ MHz)



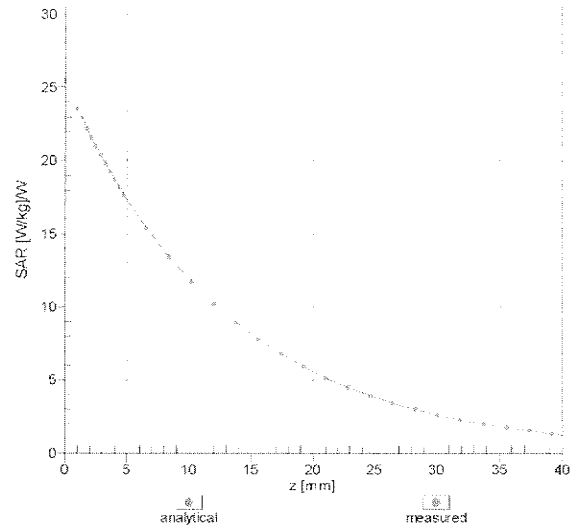
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment

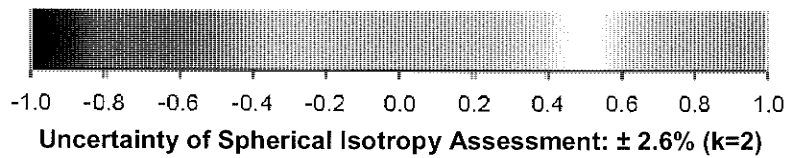
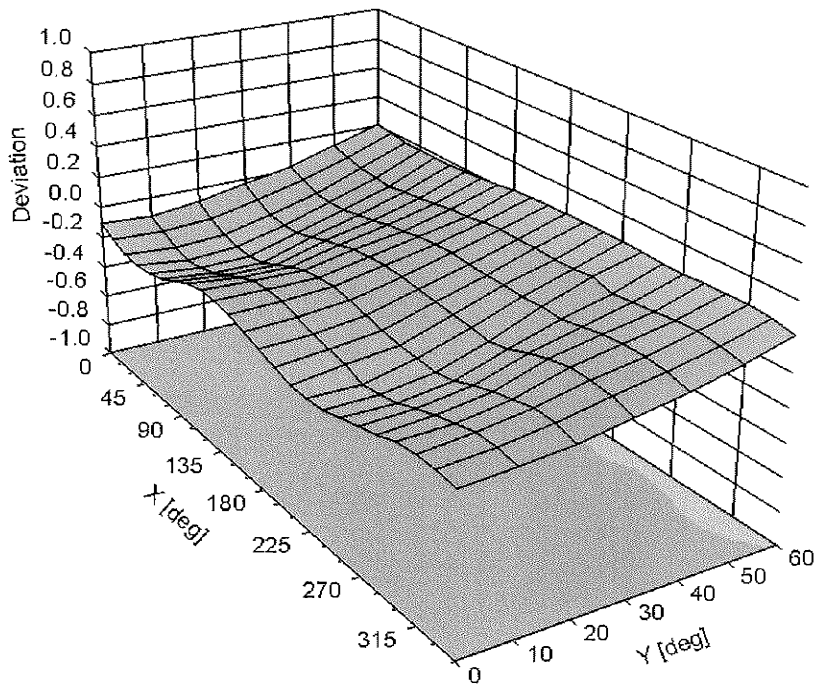
f = 900 MHz, WGLS R9 (H_convF)



f = 1750 MHz, WGLS R22 (H_convF)



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



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3800

Other Probe Parameters

| | |
|---|----------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | Not applicable |
| 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 |