

**Appendix 3-11: Calibration certificate: Dipole (D2450V2) (sn:822)**

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
**S** Swiss Calibration Service

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **UL Japan (PTT)**

Certificate No: **D2450V2-822\_Jan11**

**CALIBRATION CERTIFICATE**

Object: **D2450V2 - SN: 822**

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

Calibration date: **January 05, 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: **Jeton Kastrati** **Laboratory Technician**

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

Signature

Issued: January 5, 2011

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**Appendix 3-11: Calibration certificate: Dipole (D2450V2) (sn:822) (cont'd)**

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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:**

- 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.

**Appendix 3-11: Calibration certificate: Dipole (D2450V2) (sn:822) (cont'd)**

**Measurement Conditions**

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

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

**Head TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>      | 22.0 °C             | 39.2           | 1.80 mho/m           |
| <b>Measured Head TSL parameters</b>     | (22.0 $\pm$ 0.2) °C | 37.9 $\pm$ 6 % | 1.74 mho/m $\pm$ 6 % |
| <b>Head TSL temperature during test</b> | (21.0 $\pm$ 0.2) °C | ----           | ----                 |

**SAR result with Head TSL**

| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                                  |
|-------------------------------------------------------------|--------------------|--------------------------------------------------|
| SAR measured                                                | 250 mW input power | 13.5 mW / g                                      |
| SAR normalized                                              | normalized to 1W   | 54.0 mW / g                                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>54.4 mW / g <math>\pm</math> 17.0 % (k=2)</b> |

| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                                                  |
|---------------------------------------------------------------|--------------------|--------------------------------------------------|
| SAR measured                                                  | 250 mW input power | 6.33 mW / g                                      |
| SAR normalized                                                | normalized to 1W   | 25.3 mW / g                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>25.3 mW / g <math>\pm</math> 16.5 % (k=2)</b> |

**Appendix 3-11: Calibration certificate: Dipole (D2450V2) (sn:822) (cont'd)**

**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 | (21.0 ± 0.2) °C | ----         | -----            |

**SAR result with Body TSL**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                            |
|-------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                          | 250 mW input power | 12.8 mW / g                |
| SAR normalized                                        | normalized to 1W   | 51.2 mW / g                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 50.9 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                            |
|---------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                            | 250 mW input power | 5.91 mW / g                |
| SAR normalized                                          | normalized to 1W   | 23.6 mW / g                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 23.6 mW / g ± 16.5 % (k=2) |

**Appendix 3-11: Calibration certificate: Dipole (D2450V2) (sn:822) (cont'd)**

**Appendix**

**Antenna Parameters with Head TSL**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.3 $\Omega$ + 3.6 j $\Omega$ |
| Return Loss                          | - 25.4 dB                      |

**Antenna Parameters with Body TSL**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.7 $\Omega$ + 5.2 j $\Omega$ |
| Return Loss                          | - 25.6 dB                      |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.159 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 11, 2008 |

**Appendix 3-11: Calibration certificate: Dipole (D2450V2) (sn:822) (cont'd)**

**DASY5 Validation Report for Head TSL**

Date/Time: 04.01.2011 14:12:13

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:822**

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/m<sup>3</sup>

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 Build (401)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

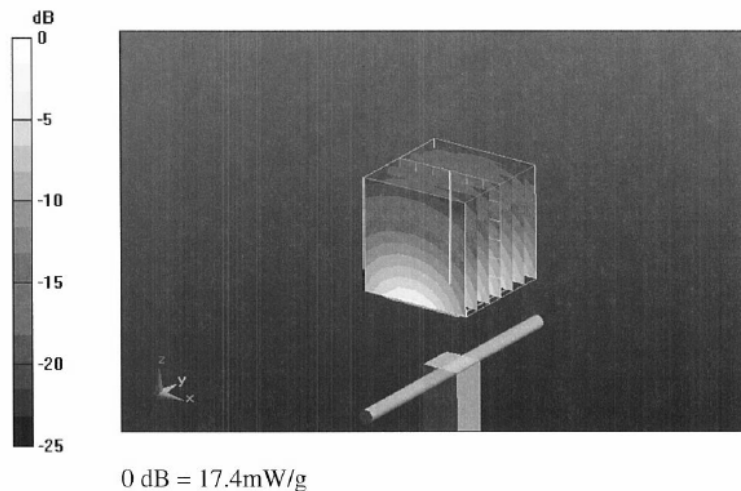
**Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement**  
grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 103.5 V/m; Power Drift = 0.039 dB

Peak SAR (extrapolated) = 27.7 W/kg

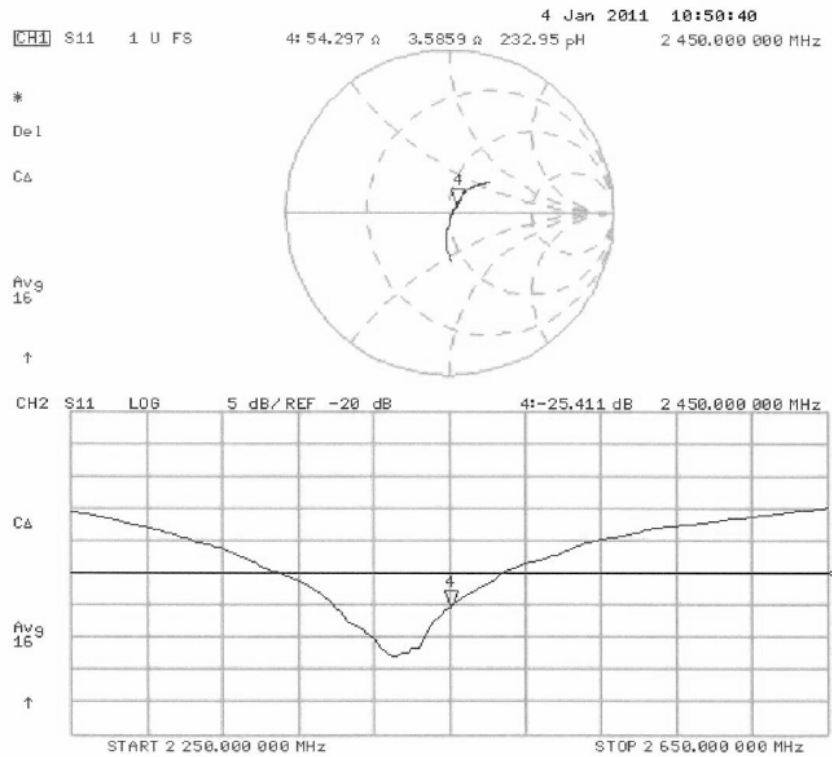
**SAR(1 g) = 13.5 mW/g; SAR(10 g) = 6.33 mW/g**

Maximum value of SAR (measured) = 17.4 mW/g



**Appendix 3-11: Calibration certificate: Dipole (D2450V2) (sn:822) (cont'd)**

**Impedance Measurement Plot for Head TSL**



**Appendix 3-11: Calibration certificate: Dipole (D2450V2) (sn:822) (cont'd)**

**DASY5 Validation Report for Body**

Date/Time: 05.01.2011 12:40:53

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:822**

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

Medium: MSL U12 BB

Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 1.97 \text{ mho/m}$ ;  $\epsilon_r = 52.7$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(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 Build (401)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

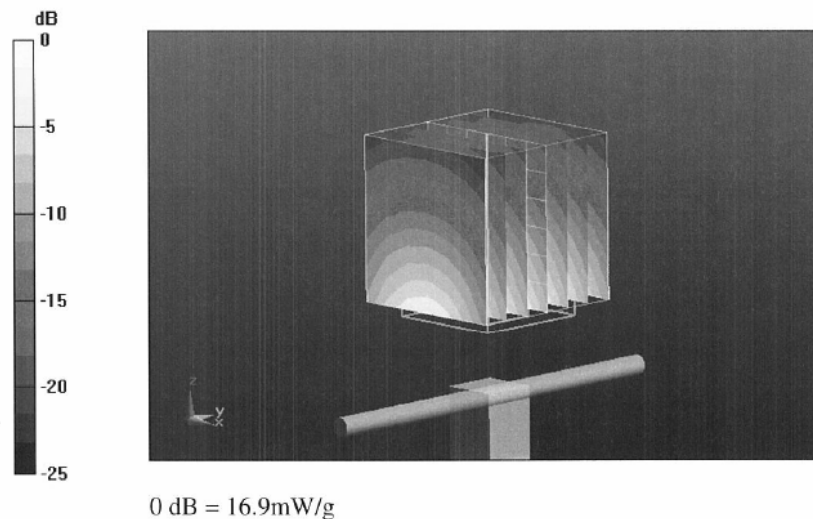
**Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 95.7 V/m; Power Drift = -0.024 dB

Peak SAR (extrapolated) = 27.1 W/kg

**SAR(1 g) = 12.8 mW/g; SAR(10 g) = 5.91 mW/g**

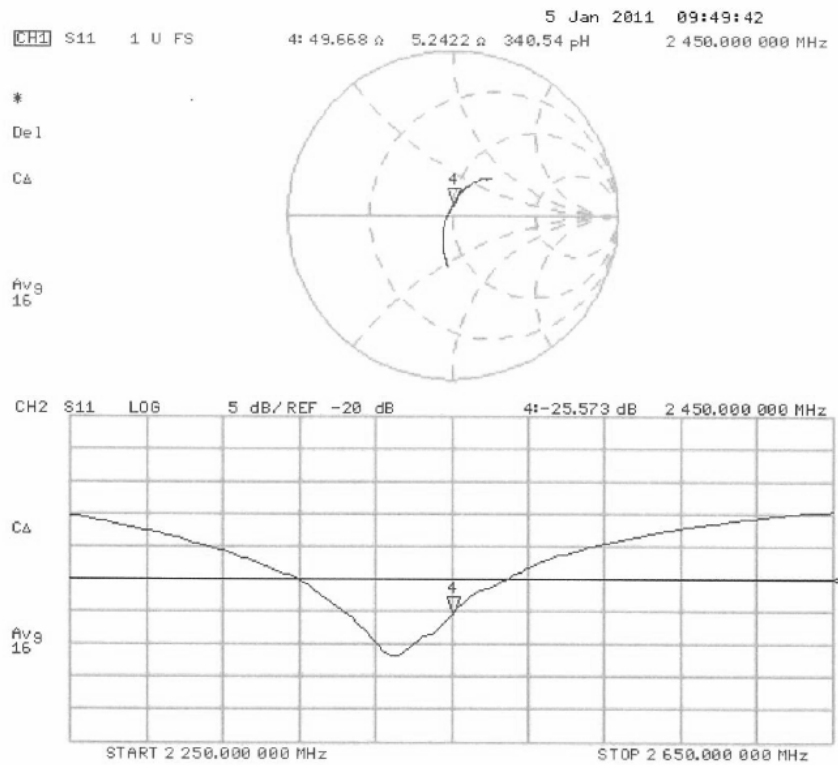
Maximum value of SAR (measured) = 16.9 mW/g





**Appendix 3-11: Calibration certificate: Dipole (D2450V2) (sn:822) (cont'd)**

**Impedance Measurement Plot for Body TSL**



**Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070)**

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Accreditation No.: **SCS 108**

Client **UL Japan (PTT)**

Certificate No: **D5GHzV2-1070\_Feb11**

**CALIBRATION CERTIFICATE**

Object **D5GHzV2 - SN: 1070**

Calibration procedure(s) **QA CAL-22.v1  
Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **February 16, 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 ( $22 \pm 3$ )°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 EX3DV4      | SN: 3503           | 05-Mar-10 (No. EX3-3503_Mar10)    | Mar-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: February 16, 2011

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**Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)**

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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) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010
- b) 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:**

- c) 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.

**Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)**

**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 |
| Area Scan resolution         | dx, dy = 10 mm                                                       |             |
| Zoom Scan Resolution         | dx, dy = 4.0 mm, dz = 2.0 mm                                         |             |
| Frequency                    | 5200 MHz $\pm$ 1 MHz<br>5500 MHz $\pm$ 1 MHz<br>5800 MHz $\pm$ 1 MHz |             |

**Head TSL parameters at 5200 MHz**

The following parameters and calculations were applied.

|                                  | Temperature         | Permittivity   | Conductivity         |
|----------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters      | 22.0 °C             | 36.0           | 4.66 mho/m           |
| Measured Head TSL parameters     | (22.0 $\pm$ 0.2) °C | 35.3 $\pm$ 6 % | 4.50 mho/m $\pm$ 6 % |
| Head TSL temperature during test | (22.0 $\pm$ 0.2) °C | ----           | ----                 |

**SAR result with Head TSL at 5200 MHz**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | condition          |                                |
|-------------------------------------------------------|--------------------|--------------------------------|
| SAR measured                                          | 100 mW input power | 8.24 mW / g                    |
| SAR normalized                                        | normalized to 1W   | 82.4 mW / g                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 82.1 mW / g $\pm$ 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                |
|---------------------------------------------------------|--------------------|--------------------------------|
| SAR measured                                            | 100 mW input power | 2.34 mW / g                    |
| SAR normalized                                          | normalized to 1W   | 23.4 mW / g                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 23.3 mW / g $\pm$ 19.5 % (k=2) |

Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)

**Head TSL parameters at 5500 MHz**

The following parameters and calculations were applied.

|                                  | Temperature     | Permittivity | Conductivity     |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Head TSL parameters      | 22.0 °C         | 35.6         | 4.96 mho/m       |
| Measured Head TSL parameters     | (22.0 ± 0.2) °C | 36.2 ± 6 %   | 4.86 mho/m ± 6 % |
| Head TSL temperature during test | (22.0 ± 0.2) °C | ----         | ----             |

**SAR result with Head TSL at 5500 MHz**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | condition          |                            |
|-------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                          | 100 mW input power | 8.92 mW / g                |
| SAR normalized                                        | normalized to 1W   | 89.2 mW / g                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 89.4 mW / g ± 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                            |
|---------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                            | 100 mW input power | 2.50 mW / g                |
| SAR normalized                                          | normalized to 1W   | 25.0 mW / g                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 25.0 mW / g ± 19.5 % (k=2) |

**Head TSL parameters at 5800 MHz**

The following parameters and calculations were applied.

|                                  | Temperature     | Permittivity | Conductivity     |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Head TSL parameters      | 22.0 °C         | 35.3         | 5.27 mho/m       |
| Measured Head TSL parameters     | (22.0 ± 0.2) °C | 35.6 ± 6 %   | 5.17 mho/m ± 6 % |
| Head TSL temperature during test | (22.1 ± 0.2) °C | ----         | ----             |

**SAR result with Head TSL at 5800 MHz**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | condition          |                            |
|-------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                          | 100 mW input power | 8.25 mW / g                |
| SAR normalized                                        | normalized to 1W   | 82.5 mW / g                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 82.6 mW / g ± 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                            |
|---------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                            | 100 mW input power | 2.32 mW / g                |
| SAR normalized                                          | normalized to 1W   | 23.2 mW / g                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 23.2 mW / g ± 19.5 % (k=2) |

Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)

**Body TSL parameters at 5200 MHz**

The following parameters and calculations were applied.

|                                  | Temperature     | Permittivity | Conductivity     |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters      | 22.0 °C         | 49.0         | 5.30 mho/m       |
| Measured Body TSL parameters     | (22.0 ± 0.2) °C | 47.2 ± 6 %   | 5.37 mho/m ± 6 % |
| Body TSL temperature during test | (21.5 ± 0.2) °C | ----         | ----             |

**SAR result with Body TSL at 5200 MHz**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | condition          |                            |
|-------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                          | 100 mW input power | 7.77 mW / g                |
| SAR normalized                                        | normalized to 1W   | 77.7 mW / g                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 77.1 mW / g ± 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                            |
|---------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                            | 100 mW input power | 2.15 mW / g                |
| SAR normalized                                          | normalized to 1W   | 21.5 mW / g                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.3 mW / g ± 19.5 % (k=2) |

**Body TSL parameters at 5500 MHz**

The following parameters and calculations were applied.

|                                  | Temperature     | Permittivity | Conductivity     |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters      | 22.0 °C         | 48.6         | 5.65 mho/m       |
| Measured Body TSL parameters     | (22.0 ± 0.2) °C | 46.6 ± 6 %   | 5.75 mho/m ± 6 % |
| Body TSL temperature during test | (21.5 ± 0.2) °C | ----         | ----             |

**SAR result with Body TSL at 5500 MHz**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | condition          |                            |
|-------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                          | 100 mW input power | 8.34 mW / g                |
| SAR normalized                                        | normalized to 1W   | 83.4 mW / g                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 82.7 mW / g ± 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                            |
|---------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                            | 100 mW input power | 2.29 mW / g                |
| SAR normalized                                          | normalized to 1W   | 22.9 mW / g                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 22.7 mW / g ± 19.5 % (k=2) |

**Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)**

**Body TSL parameters at 5800 MHz**

The following parameters and calculations were applied.

|                                  | Temperature     | Permittivity | Conductivity     |
|----------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters      | 22.0 °C         | 48.2         | 6.00 mho/m       |
| Measured Body TSL parameters     | (22.0 ± 0.2) °C | 46.2 ± 6 %   | 6.16 mho/m ± 6 % |
| Body TSL temperature during test | (22.0 ± 0.2) °C | ----         | ----             |

**SAR result with Body TSL at 5800 MHz**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | condition          |                                   |
|-------------------------------------------------------|--------------------|-----------------------------------|
| SAR measured                                          | 100 mW input power | 7.30 mW / g                       |
| SAR normalized                                        | normalized to 1W   | 73.0 mW / g                       |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>72.4 mW / g ± 19.9 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                   |
|---------------------------------------------------------|--------------------|-----------------------------------|
| SAR measured                                            | 100 mW input power | 2.00 mW / g                       |
| SAR normalized                                          | normalized to 1W   | 20.0 mW / g                       |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>19.8 mW / g ± 19.5 % (k=2)</b> |

Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)

**Appendix**

**Antenna Parameters with Head TSL at 5200 MHz**

|                                      |                                 |
|--------------------------------------|---------------------------------|
| Impedance, transformed to feed point | 52.5 $\Omega$ - 10.2 j $\Omega$ |
| Return Loss                          | -19.9 dB                        |

**Antenna Parameters with Head TSL at 5500 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.3 $\Omega$ - 8.2 j $\Omega$ |
| Return Loss                          | -21.8 dB                       |

**Antenna Parameters with Head TSL at 5800 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.0 $\Omega$ - 5.6 j $\Omega$ |
| Return Loss                          | -23.6 dB                       |

**Antenna Parameters with Body TSL at 5200 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.3 $\Omega$ - 9.3 j $\Omega$ |
| Return Loss                          | -20.2 dB                       |

**Antenna Parameters with Body TSL at 5500 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.8 $\Omega$ - 8.6 j $\Omega$ |
| Return Loss                          | -21.3 dB                       |

**Antenna Parameters with Body TSL at 5800 MHz**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 53.8 $\Omega$ - 3.9 j $\Omega$ |
| Return Loss                          | -25.6 dB                       |



**Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)**

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.202 ns |
|----------------------------------|----------|

After long term use with 40 W 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 26, 2008 |

Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)

**DASY5 Validation Report for Head TSL**

Date/Time: 11.02.2011 15:14:35

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1070**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: HSL 5000

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.5$  mho/m;  $\epsilon_r = 35.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.86$  mho/m;  $\epsilon_r = 36.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.17$  mho/m;  $\epsilon_r = 35.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.36, 5.36, 5.36), ConvF(4.85, 4.85, 4.85), ConvF(4.74, 4.74, 4.74); Calibrated: 05.03.2010
- Sensor-Surface: 2mm (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=100mW/d=10mm, f=5200 MHz/Zoom Scan (4x4x2mm), dist=2mm (8x8x6)/Cube 0:Measurement**  
grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 65.848 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 31.362 W/kg

**SAR(1 g) = 8.24 mW/g; SAR(10 g) = 2.34 mW/g**

Maximum value of SAR (measured) = 16.014 mW/g

**Pin=100mW/d=10mm, f=5500 MHz/Zoom Scan (4x4x2mm), dist=2mm (8x8x6)/Cube 0:Measurement**  
grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 66.309 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 36.103 W/kg

**SAR(1 g) = 8.92 mW/g; SAR(10 g) = 2.5 mW/g**

Maximum value of SAR (measured) = 17.730 mW/g

**Pin=100mW/d=10mm, f=5800 MHz/Zoom Scan (4x4x2mm), dist=2mm (8x8x6)/Cube 0: Measurement**  
grid: dx=4mm, dy=4mm, dz=2mm

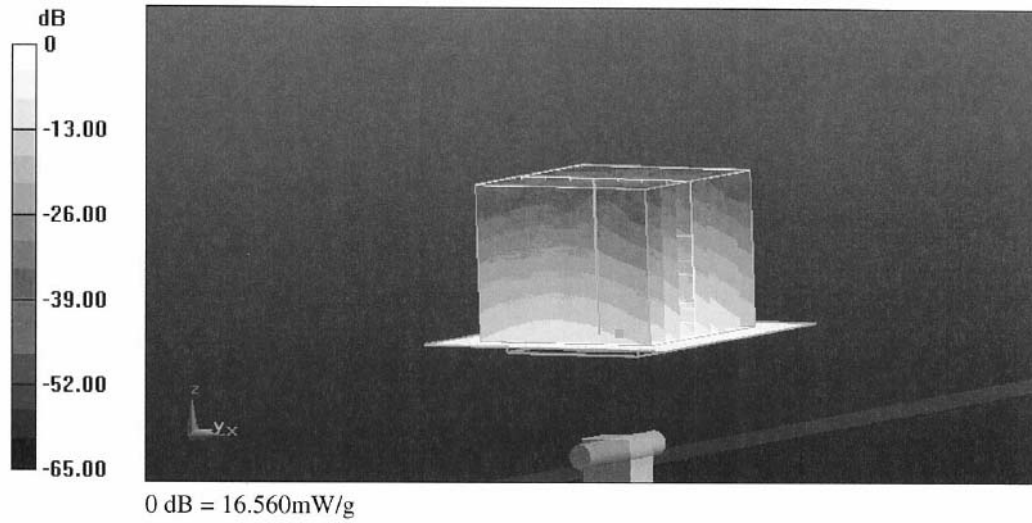
Reference Value = 63.058 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 35.384 W/kg

**SAR(1 g) = 8.25 mW/g; SAR(10 g) = 2.32 mW/g**

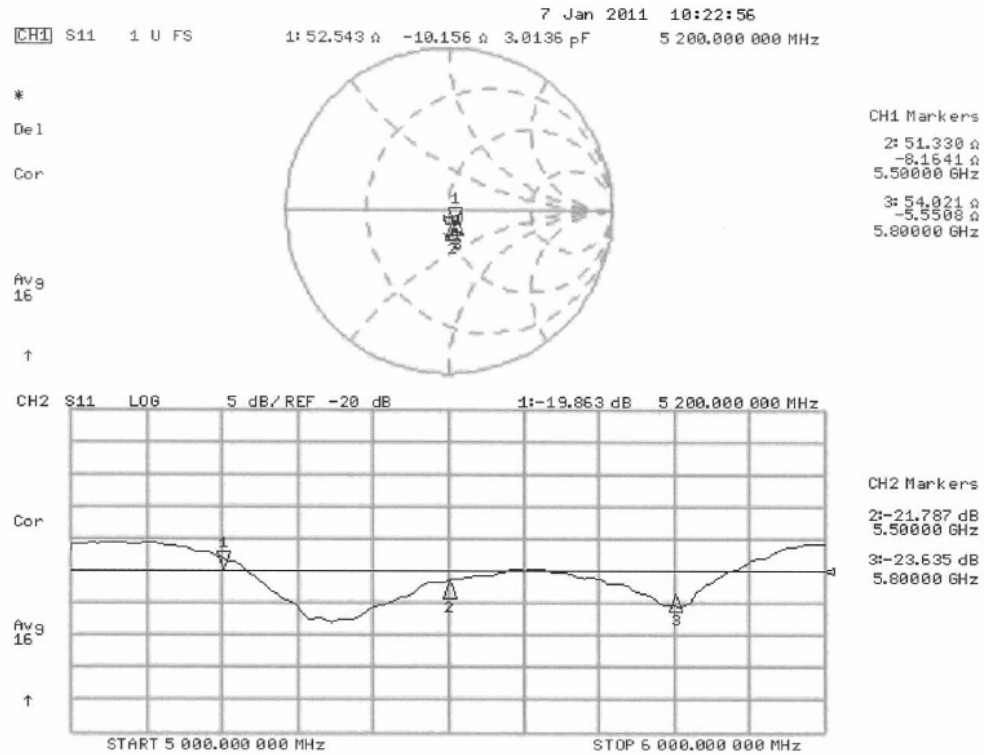
Maximum value of SAR (measured) = 16.408 mW/g

Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)



Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)

**Impedance Measurement Plot for Head TSL**



Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)

**DASY5 Validation Report for Body TSL**

Date/Time: 16.02.2011 15:22:06

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1070**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: MSL 5000 MHz

Medium parameters used:  $f = 5200 \text{ MHz}$ ;  $\sigma = 5.4 \text{ mho/m}$ ;  $\epsilon_r = 47.2$ ;  $\rho = 1000 \text{ kg/m}^3$ ,

Medium parameters used:  $f = 5500 \text{ MHz}$ ;  $\sigma = 5.78 \text{ mho/m}$ ;  $\epsilon_r = 46.6$ ;  $\rho = 1000 \text{ kg/m}^3$ ,

Medium parameters used:  $f = 5800 \text{ MHz}$ ;  $\sigma = 6.16 \text{ mho/m}$ ;  $\epsilon_r = 46.2$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.88, 4.88, 4.88), ConvF(4.37, 4.37, 4.37), ConvF(4.57, 4.57, 4.57); Calibrated: 05.03.2010
- Sensor-Surface: 2mm (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=100mW/d=10mm, f=5200 MHz/Zoom Scan (4x4x2mm), dist=2mm (8x8x6)/Cube 0:Measurement grid: dx=4mm, dy=4mm, dz=2mm**

Reference Value = 60.047 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 31.080 W/kg

**SAR(1 g) = 7.77 mW/g; SAR(10 g) = 2.15 mW/g**

Maximum value of SAR (measured) = 15.512 mW/g

**Pin=100mW/d=10mm, f=5500 MHz/Zoom Scan (4x4x2mm), dist=2mm (8x8x6)/Cube 0:Measurement grid: dx=4mm, dy=4mm, dz=2mm**

Reference Value = 60.794 V/m; Power Drift = 0.0024 dB

Peak SAR (extrapolated) = 35.594 W/kg

**SAR(1 g) = 8.34 mW/g; SAR(10 g) = 2.29 mW/g**

Maximum value of SAR (measured) = 16.750 mW/g

**Pin=100mW/d=10mm, f=5800 MHz/Zoom Scan (4x4x2mm), dist=2mm (8x8x6)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm**

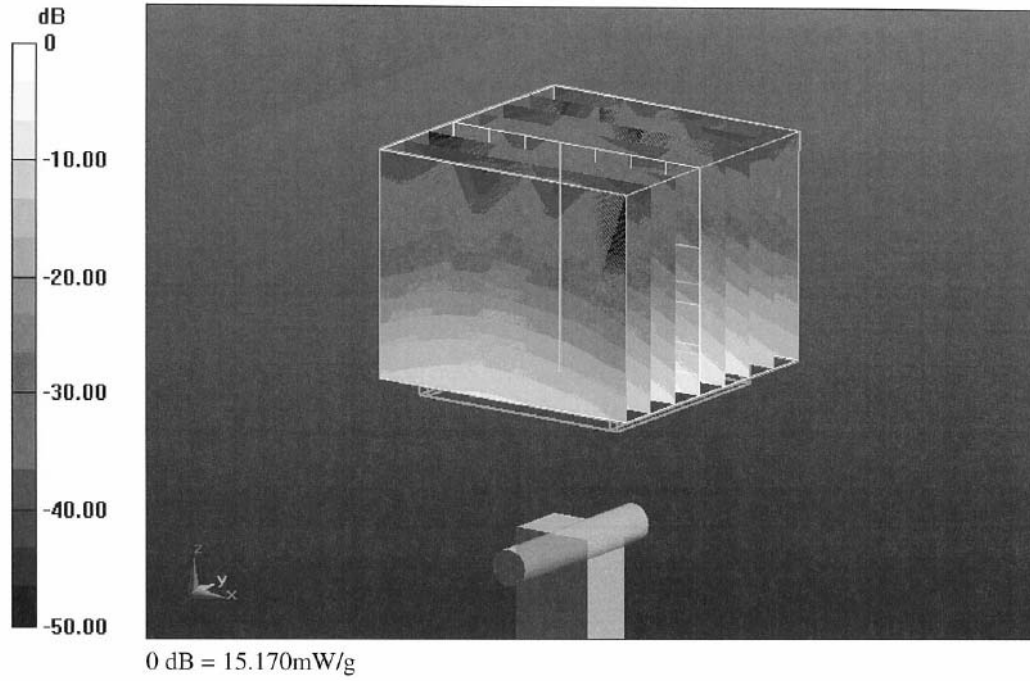
Reference Value = 54.748 V/m; Power Drift = -0.0008 dB

Peak SAR (extrapolated) = 33.007 W/kg

**SAR(1 g) = 7.3 mW/g; SAR(10 g) = 2 mW/g**

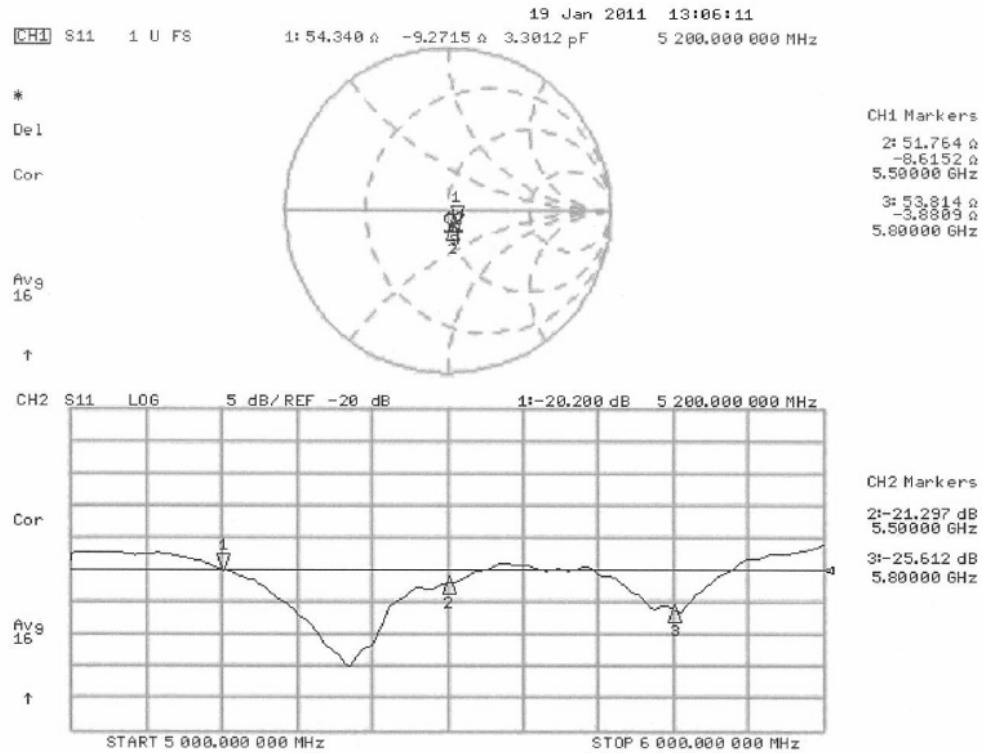
Maximum value of SAR (measured) = 14.959 mW/g

Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)



Appendix 3-12: Calibration certificate: Dipole (D5GHzV2) (sn:1070) (cont'd)

Impedance Measurement Plot for Body TSL



**Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540)**

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
**S** Swiss Calibration Service

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 **PTT**

Certificate No: **EX3-3540\_Jul10**

**CALIBRATION CERTIFICATE**

Object **EX3DV4 - SN:3540**

Calibration procedure(s) **QA CAL-01.v6, QA CAL-14.v3, QA CAL-23.v3 and QA CAL-25.v2**  
**Calibration procedure for dosimetric E-field probes**

Calibration date: **July 13, 2010**

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 E4419B         | GB41293874      | 1-Apr-10 (No. 217-01136)          | Apr-11                 |
| Power sensor E4412A        | MY41495277      | 1-Apr-10 (No. 217-01136)          | Apr-11                 |
| Power sensor E4412A        | MY41498087      | 1-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        | 30-Dec-09 (No. ES3-3013_Dec09)    | Dec-10                 |
| DAE4                       | SN: 660         | 20-Apr-10 (No. DAE4-660_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-09) | In house check: Oct10  |

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

Issued: July 14, 2010

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

Certificate No: EX3-3540\_Jul10

Page 1 of 11



**Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)**

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
**S** Swiss Calibration Service

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**

**Glossary:**

|                       |                                                                                                                                                   |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                   | tissue simulating liquid                                                                                                                          |
| NORM <sub>x,y,z</sub> | sensitivity in free space                                                                                                                         |
| ConvF                 | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                        |
| DCP                   | diode compression point                                                                                                                           |
| CF                    | crest factor (1/duty_cycle) of the RF signal                                                                                                      |
| A, B, C               | modulation dependent linearization parameters                                                                                                     |
| Polarization $\phi$   | $\phi$ rotation around probe axis                                                                                                                 |
| Polarization $\theta$ | $\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\theta = 0$ 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<sub>x,y,z</sub>:** Assessed for E-field polarization  $\theta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the  $E^2$ -field uncertainty inside TSL (see below *ConvF*).
- NORM( $f$ )<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* 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<sub>x,y,z</sub>:** 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.
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; VR<sub>x,y,z</sub>:** 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<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy):** in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset:** The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)

EX3DV4 SN:3540

July 13, 2010

# Probe EX3DV4

## SN:3540

|                  |                 |
|------------------|-----------------|
| Manufactured:    | August 23, 2005 |
| Last calibrated: | June 26, 2009   |
| Recalibrated:    | July 13, 2010   |

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

**Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)**

EX3DV4 SN:3540

July 13, 2010

**DASY/EASY - Parameters of Probe: EX3DV4 SN:3540**

**Basic Calibration Parameters**

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|-----------------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.45     | 0.50     | 0.59     | ± 10.1%   |
| DCP (mV) <sup>B</sup>                                     | 94.7     | 92.0     | 86.8     |           |

**Modulation Calibration Parameters**

| UID   | Communication System Name | PAR  |   | A<br>dB | B<br>dBuV | C    | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-------|---------------------------|------|---|---------|-----------|------|----------|---------------------------|
| 10000 | CW                        | 0.00 | X | 0.00    | 0.00      | 1.00 | 300      | ± 1.5%                    |
|       |                           |      | Y | 0.00    | 0.00      | 1.00 | 300      |                           |
|       |                           |      | Z | 0.00    | 0.00      | 1.00 | 300      |                           |

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

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 8).

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

<sup>E</sup> Uncertainty is determined using the maximum deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

**Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)**

**EX3DV4 SN:3540**

**July 13, 2010**

**DASY/EASY - Parameters of Probe: EX3DV4 SN:3540**

**Calibration Parameter Determined in Head Tissue Simulating Media**

| f [MHz] | Validity [MHz] <sup>c</sup> | Permittivity | Conductivity | ConvF X | ConvF Y | ConvF Z | Alpha | Depth Unc (k=2) |
|---------|-----------------------------|--------------|--------------|---------|---------|---------|-------|-----------------|
| 2450    | ± 50 / ± 100                | 39.2 ± 5%    | 1.80 ± 5%    | 7.81    | 7.81    | 7.81    | 0.27  | 0.85 ± 11.0%    |
| 2600    | ± 50 / ± 100                | 39.0 ± 5%    | 1.96 ± 5%    | 7.79    | 7.79    | 7.79    | 0.16  | 1.39 ± 11.0%    |
| 5200    | ± 50 / ± 100                | 36.0 ± 5%    | 4.66 ± 5%    | 4.74    | 4.74    | 4.74    | 0.40  | 1.80 ± 13.1%    |
| 5300    | ± 50 / ± 100                | 35.9 ± 5%    | 4.76 ± 5%    | 4.44    | 4.44    | 4.44    | 0.40  | 1.80 ± 13.1%    |
| 5500    | ± 50 / ± 100                | 35.6 ± 5%    | 4.96 ± 5%    | 4.45    | 4.45    | 4.45    | 0.45  | 1.80 ± 13.1%    |
| 5600    | ± 50 / ± 100                | 35.5 ± 5%    | 5.07 ± 5%    | 4.23    | 4.23    | 4.23    | 0.45  | 1.80 ± 13.1%    |
| 5800    | ± 50 / ± 100                | 35.3 ± 5%    | 5.27 ± 5%    | 4.15    | 4.15    | 4.15    | 0.50  | 1.80 ± 13.1%    |

<sup>c</sup> The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

**Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)**

**EX3DV4 SN:3540**

**July 13, 2010**

**DASY/EASY - Parameters of Probe: EX3DV4 SN:3540**

**Calibration Parameter Determined in Body Tissue Simulating Media**

| f [MHz] | Validity [MHz] <sup>c</sup> | Permittivity | Conductivity | ConvF X | ConvF Y | ConvF Z | Alpha | Depth Unc (k=2) |
|---------|-----------------------------|--------------|--------------|---------|---------|---------|-------|-----------------|
| 2450    | ± 50 / ± 100                | 52.7 ± 5%    | 1.95 ± 5%    | 8.05    | 8.05    | 8.05    | 0.29  | 0.91 ± 11.0%    |
| 2600    | ± 50 / ± 100                | 52.5 ± 5%    | 2.16 ± 5%    | 7.96    | 7.96    | 7.96    | 0.32  | 0.84 ± 11.0%    |
| 5200    | ± 50 / ± 100                | 49.0 ± 5%    | 5.30 ± 5%    | 4.16    | 4.16    | 4.16    | 0.50  | 1.90 ± 13.1%    |
| 5300    | ± 50 / ± 100                | 48.5 ± 5%    | 5.42 ± 5%    | 3.80    | 3.80    | 3.80    | 0.55  | 1.90 ± 13.1%    |
| 5500    | ± 50 / ± 100                | 48.6 ± 5%    | 5.65 ± 5%    | 3.70    | 3.70    | 3.70    | 0.55  | 1.90 ± 13.1%    |
| 5600    | ± 50 / ± 100                | 48.5 ± 5%    | 5.77 ± 5%    | 3.45    | 3.45    | 3.45    | 0.55  | 1.95 ± 13.1%    |
| 5800    | ± 50 / ± 100                | 48.2 ± 5%    | 6.00 ± 5%    | 3.50    | 3.50    | 3.50    | 0.55  | 1.90 ± 13.1%    |

<sup>c</sup> The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

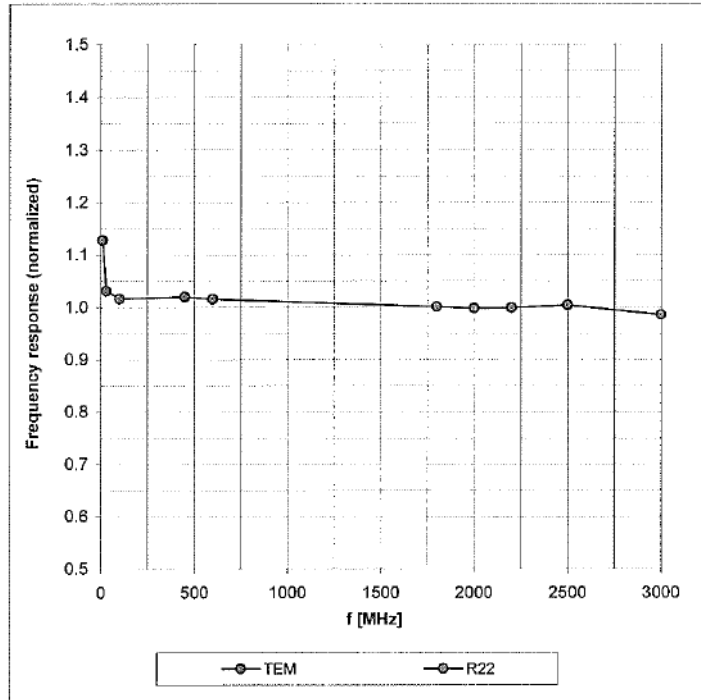
Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)

EX3DV4 SN:3540

July 13, 2010

## Frequency Response of E-Field

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



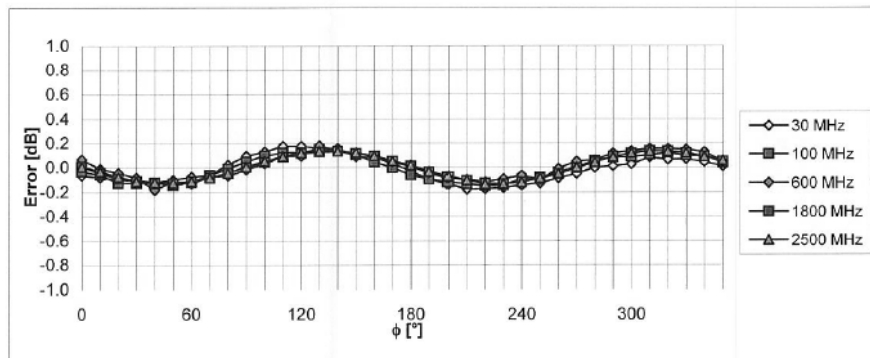
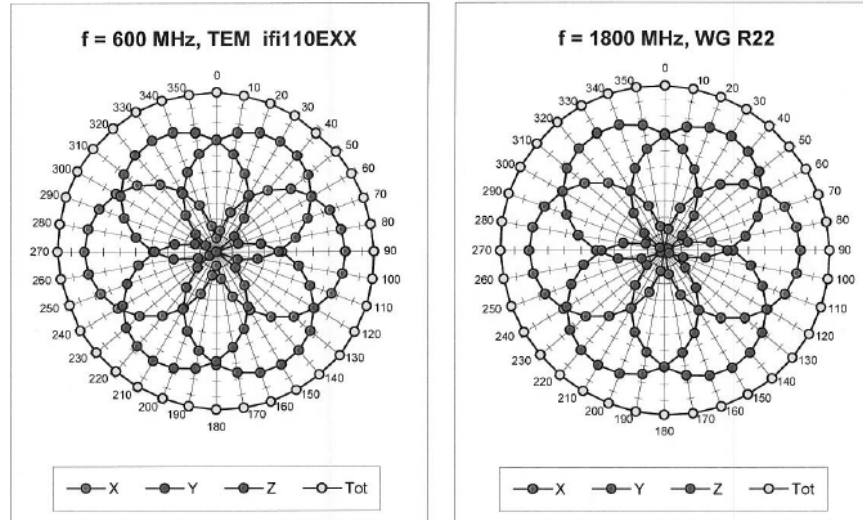
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)

EX3DV4 SN:3540

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



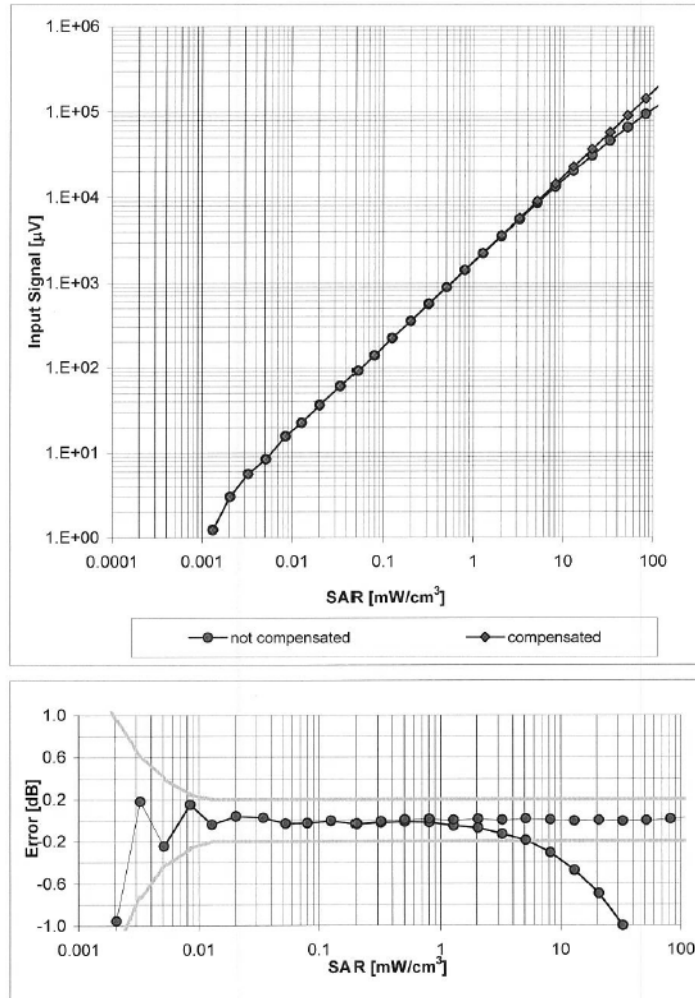
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)

EX3DV4 SN:3540

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**Dynamic Range f(SAR<sub>head</sub>)**  
(Waveguide R22, f = 1800 MHz)



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

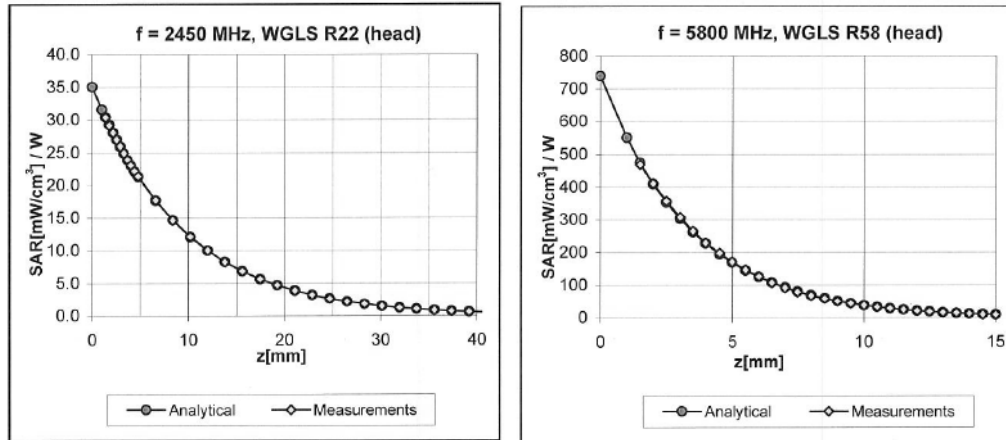


Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)

EX3DV4 SN:3540

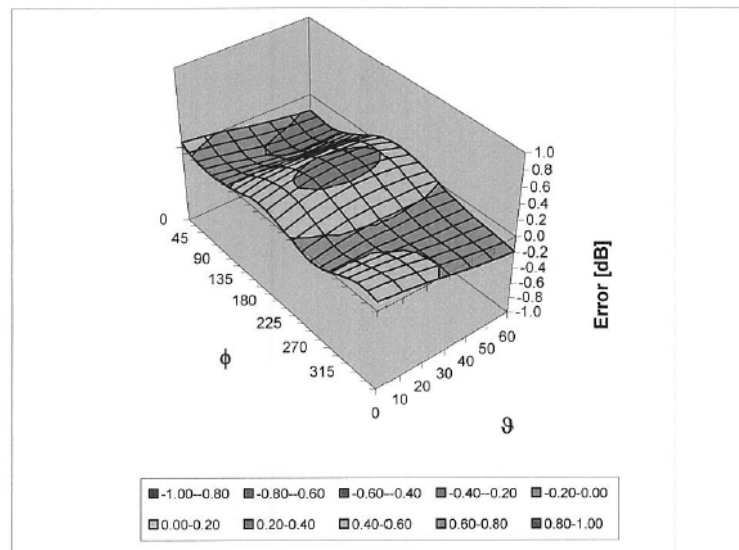
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## Conversion Factor Assessment



## Deviation from Isotropy in HSL

Error ( $\phi$ ,  $\theta$ ), f = 900 MHz



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

**Appendix 3-13: Calibration certificate: E-Field Probe (EX3DV4) (sn:3540) (cont'd)**

**EX3DV4 SN:3540**

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**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           |

### **Appendix 3-13: Reference**

- [1] ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
- [2] Katja Pokovic, Thomas Schmid, and Niels Kuster, "Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM '97, Dubrovnik, October 15-17, 1997, pp. 120-124.
- [3] Katja Pokovic, Thomas Schmid, and Niels Kuster, "E-field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23-25 June, 1996, pp.172-175.
- [4] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.
- [5] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992.
- [6] SPEAG uncertainty document for DASY 4 System from SPEAG (Schmid & Partner Engineering AG).