

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3814

### Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 2300                 | 52.9                               | 1.81                            | 7.38    | 7.38    | 7.38    | 0.22               | 1.09                    | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 7.07    | 7.07    | 7.07    | 0.38               | 0.80                    | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 6.84    | 6.84    | 6.84    | 0.31               | 1.00                    | ± 12.0 %    |
| 3700                 | 51.0                               | 3.55                            | 6.27    | 6.27    | 6.27    | 0.22               | 2.14                    | ± 13.1 %    |
| 5200                 | 49.0                               | 5.30                            | 4.38    | 4.38    | 4.38    | 0.50               | 1.90                    | ± 13.1 %    |
| 5300                 | 48.9                               | 5.42                            | 4.18    | 4.18    | 4.18    | 0.50               | 1.90                    | ± 13.1 %    |
| 5500                 | 48.6                               | 5.65                            | 3.97    | 3.97    | 3.97    | 0.50               | 1.90                    | ± 13.1 %    |
| 5600                 | 48.5                               | 5.77                            | 3.79    | 3.79    | 3.79    | 0.50               | 1.90                    | ± 13.1 %    |
| 5800                 | 48.2                               | 6.00                            | 4.06    | 4.06    | 4.06    | 0.50               | 1.90                    | ± 13.1 %    |

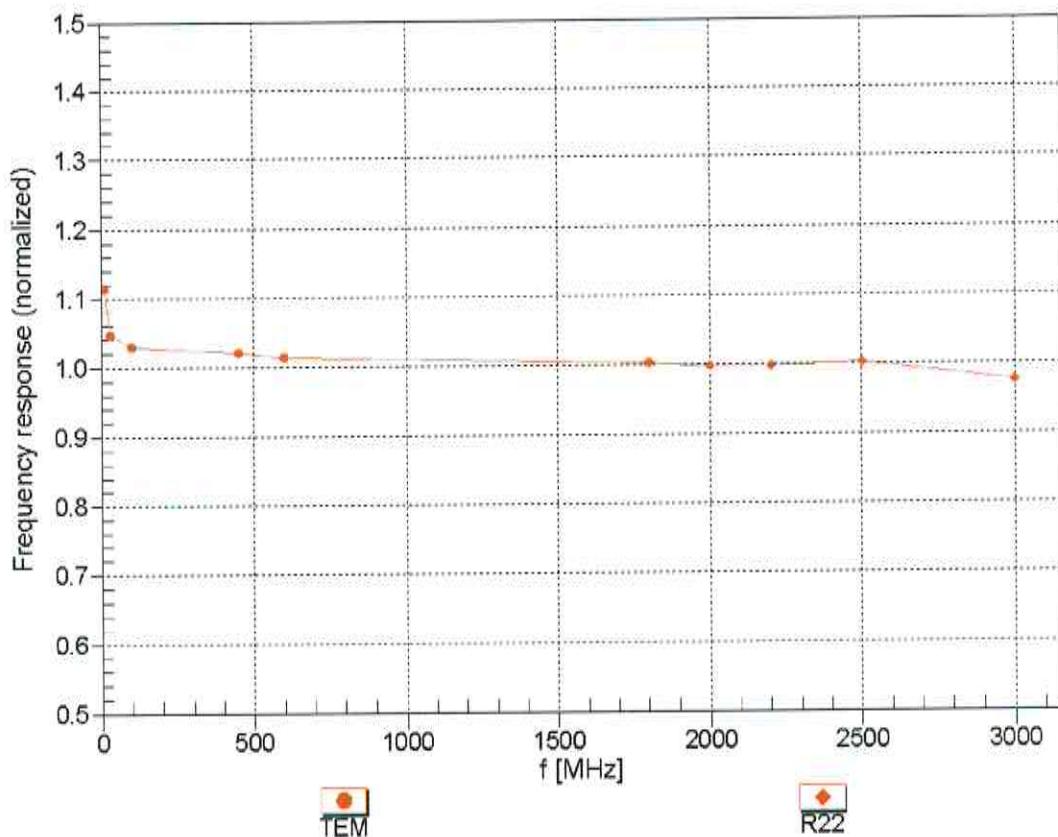
<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

## Frequency Response of E-Field

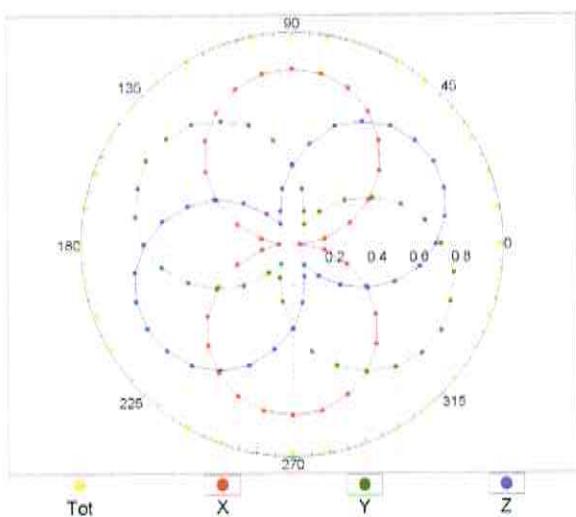
(TEM-Cell:ifi110 EXX, Waveguide: R22)



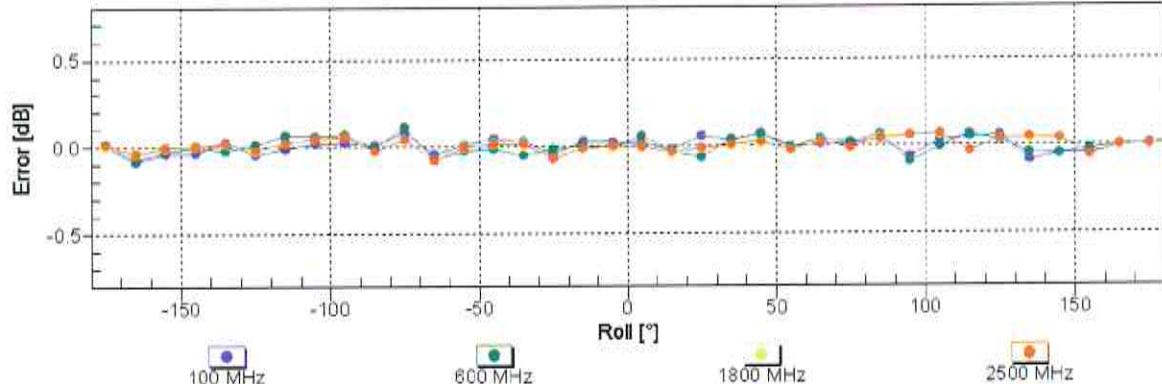
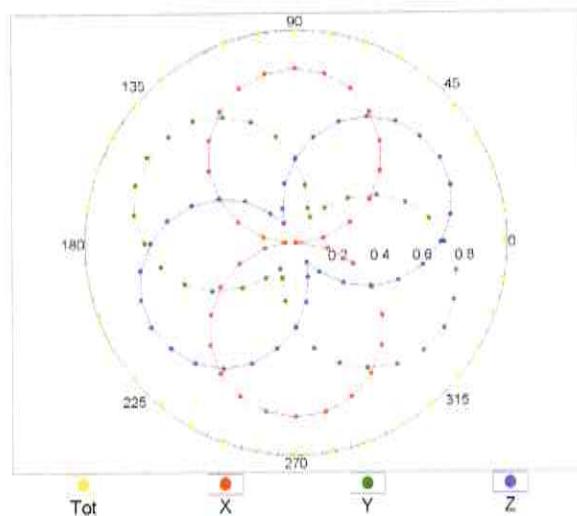
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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

f=600 MHz, TEM

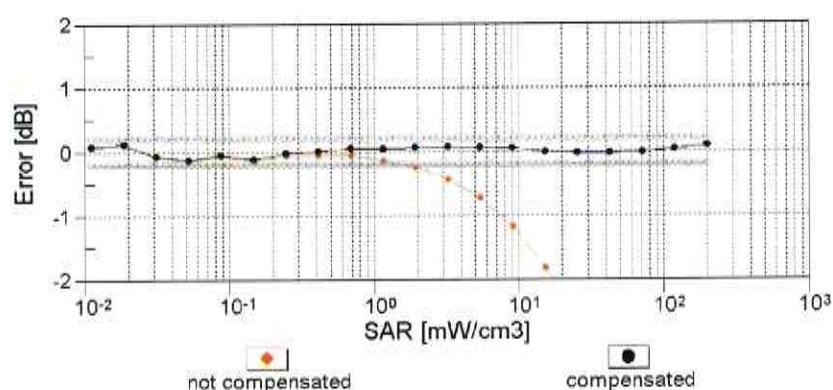
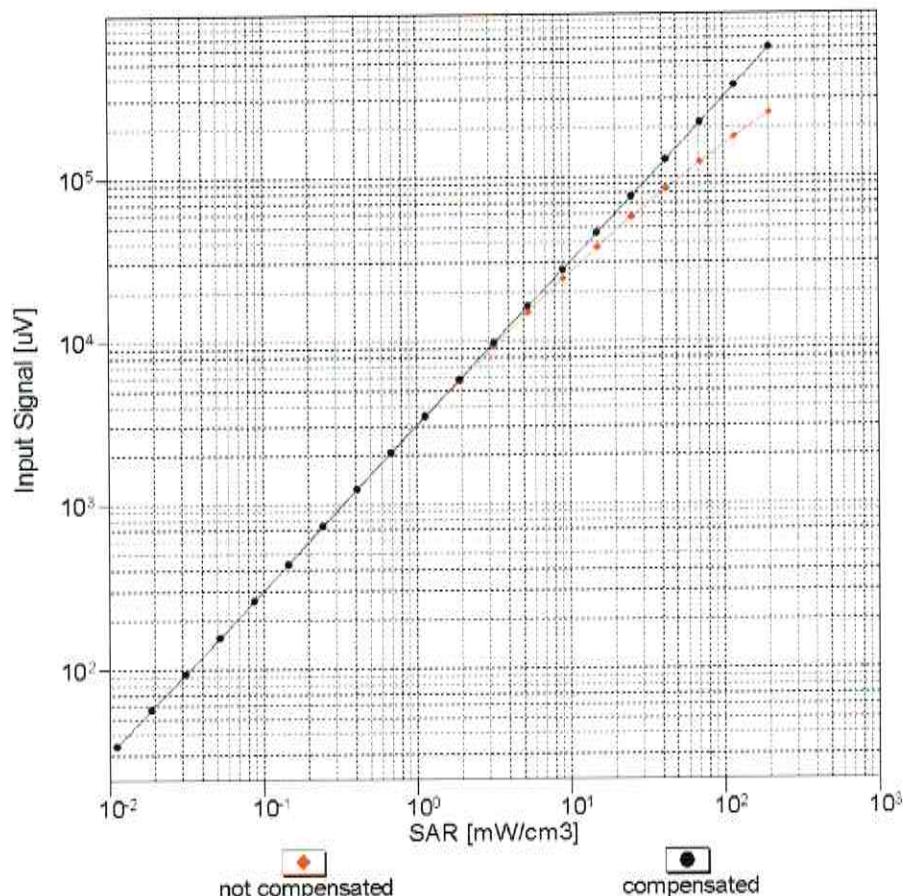


f=1800 MHz, R22



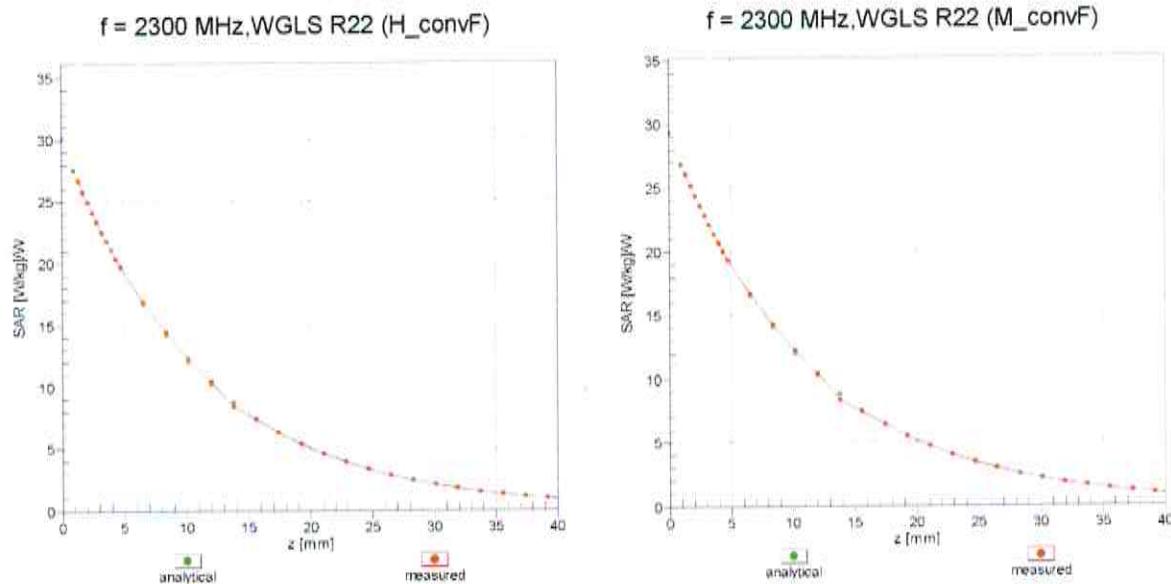
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

## Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f<sub>eval</sub>= 1900 MHz)



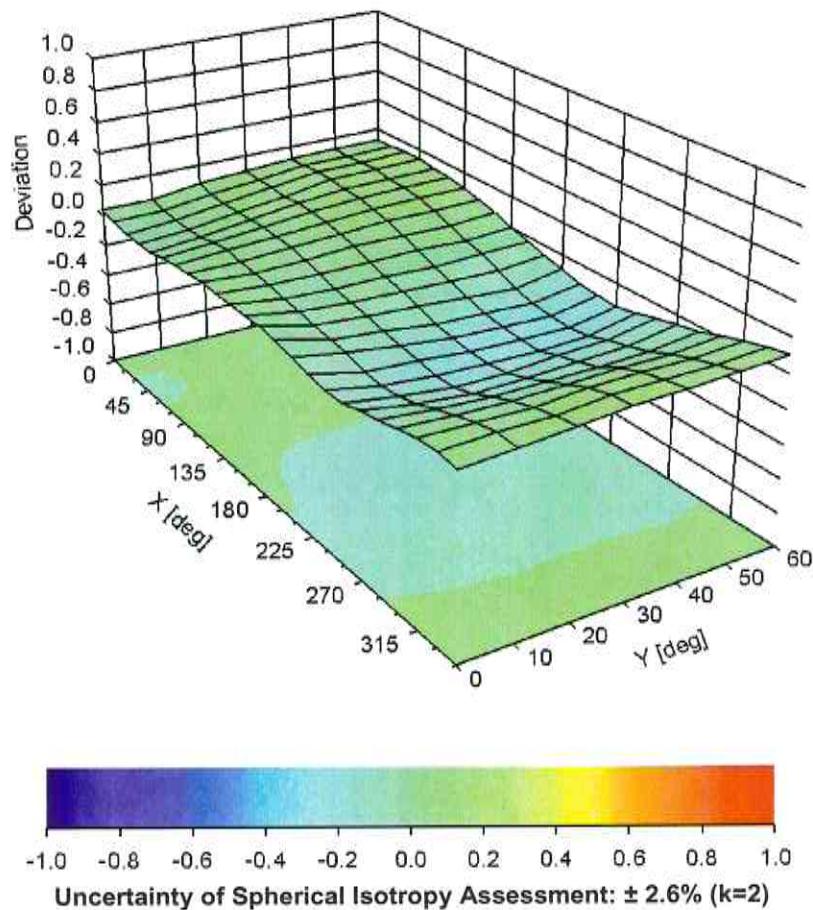
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

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



## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3814

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -65.1      |
| 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 | 1.4 mm     |

## 12.6. Calibration Certificate for Dipole

This sub-section contains Cal Certificates for Dipoles, and is not included in the total number of pages for this report.

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



Checked By  
 Sascha Weber  
 04.02.15

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

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

The Swiss Accreditation Service is one of the signatories to the EA  
 Multilateral Agreement for the recognition of calibration certificates

Client **UL RFI UK**

Certificate No: **D750V3-1011\_Jan15**

## CALIBRATION CERTIFICATE

Object **D750V3 - SN: 1011**

Calibration procedure(s) **QA CAL-05.v9**  
 Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **January 16, 2015**

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         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | US37292783         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | MY41092317         | 07-Oct-14 (No. 217-02021)         | Oct-15                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 03-Apr-14 (No. 217-01918)         | Apr-15                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921)         | Apr-15                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-14 (No. ES3-3205_Dec14)    | Dec-15                 |
| DAE4                        | SN: 601            | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

Calibrated by: Name **Michael Weber** Function **Laboratory Technician**

Signature

Approved by: **Katja Pokovic** Technical Manager

Issued: January 19, 2015

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 0108

### 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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### 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.

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%.

## Measurement Conditions

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

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.8     |
| <b>Extrapolation</b>                | Advanced Extrapolation |             |
| <b>Phantom</b>                      | Modular Flat Phantom   |             |
| <b>Distance Dipole Center - TSL</b> | 15 mm                  | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm      |             |
| <b>Frequency</b>                    | 750 MHz ± 1 MHz        |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature     | Permittivity | Conductivity     |
|------------------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C         | 41.9         | 0.89 mho/m       |
| <b>Measured Head TSL parameters</b>            | (22.0 ± 0.2) °C | 41.7 ± 6 %   | 0.91 mho/m ± 6 % |
| <b>Head TSL temperature change during test</b> | < 0.5 °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 | 2.06 W/kg                |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | 8.09 W/kg ± 17.0 % (k=2) |

|                                                               |                    |                          |
|---------------------------------------------------------------|--------------------|--------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                          |
| SAR measured                                                  | 250 mW input power | 1.35 W/kg                |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | 5.32 W/kg ± 16.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature     | Permittivity | Conductivity     |
|------------------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C         | 55.5         | 0.96 mho/m       |
| <b>Measured Body TSL parameters</b>            | (22.0 ± 0.2) °C | 56.0 ± 6 %   | 0.99 mho/m ± 6 % |
| <b>Body TSL temperature change during test</b> | < 0.5 °C        | ----         | ----             |

## SAR result with Body TSL

|                                                             |                    |                          |
|-------------------------------------------------------------|--------------------|--------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                          |
| SAR measured                                                | 250 mW input power | 2.18 W/kg                |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | 8.54 W/kg ± 17.0 % (k=2) |

|                                                               |                    |                          |
|---------------------------------------------------------------|--------------------|--------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                          |
| SAR measured                                                  | 250 mW input power | 1.44 W/kg                |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | 5.66 W/kg ± 16.5 % (k=2) |

## Appendix (Additional assessments outside the scope of SCS0108)

### Antenna Parameters with Head TSL

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 54.1 $\Omega$ + 1.5 $j\Omega$ |
| Return Loss                          | - 27.5 dB                     |

### Antenna Parameters with Body TSL

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 48.4 $\Omega$ - 1.8 $j\Omega$ |
| Return Loss                          | - 32.2 dB                     |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.038 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 | September 29, 2009 |

# DASY5 Validation Report for Head TSL

Date: 16.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1011**

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used:  $f = 750 \text{ MHz}$ ;  $\sigma = 0.91 \text{ S/m}$ ;  $\epsilon_r = 41.7$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.44, 6.44, 6.44); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

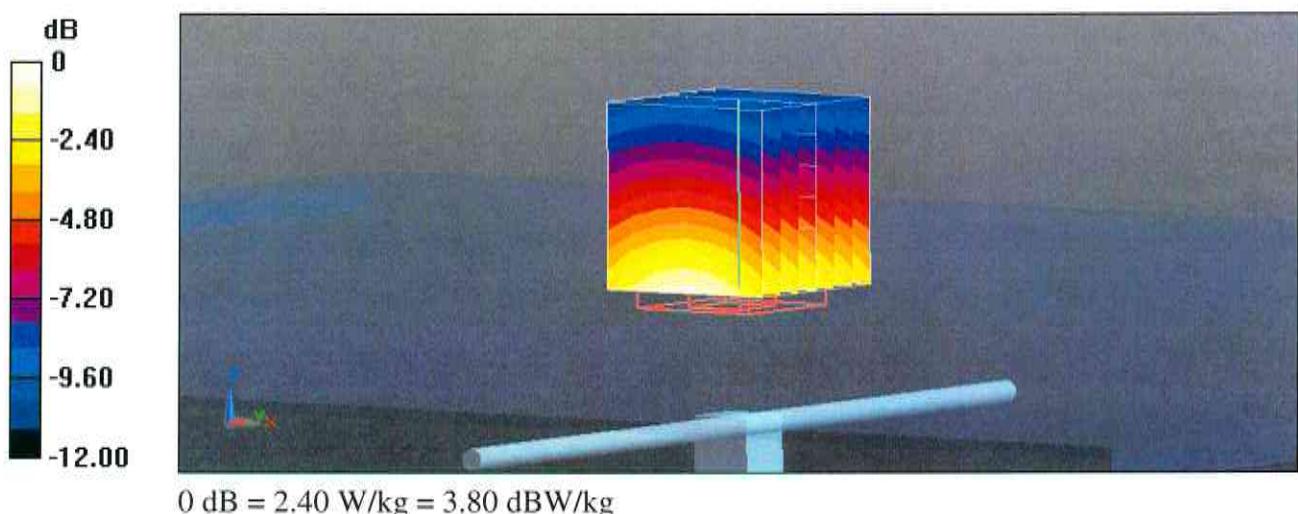
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 53.08 V/m; Power Drift = -0.00 dB

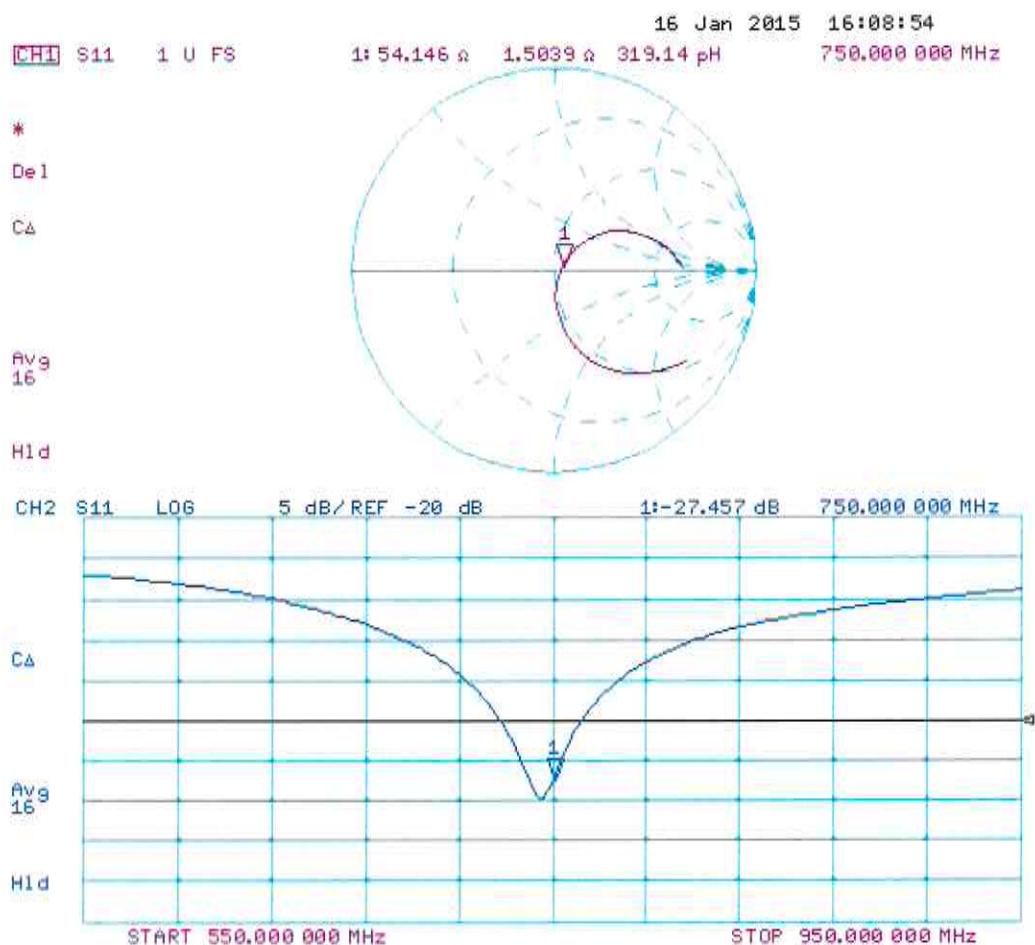
Peak SAR (extrapolated) = 3.05 W/kg

**SAR(1 g) = 2.06 W/kg; SAR(10 g) = 1.35 W/kg**

Maximum value of SAR (measured) = 2.40 W/kg



## Impedance Measurement Plot for Head TSL



# DASY5 Validation Report for Body TSL

Date: 16.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1011**

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used:  $f = 750 \text{ MHz}$ ;  $\sigma = 0.99 \text{ S/m}$ ;  $\epsilon_r = 56$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.21, 6.21, 6.21); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

## Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

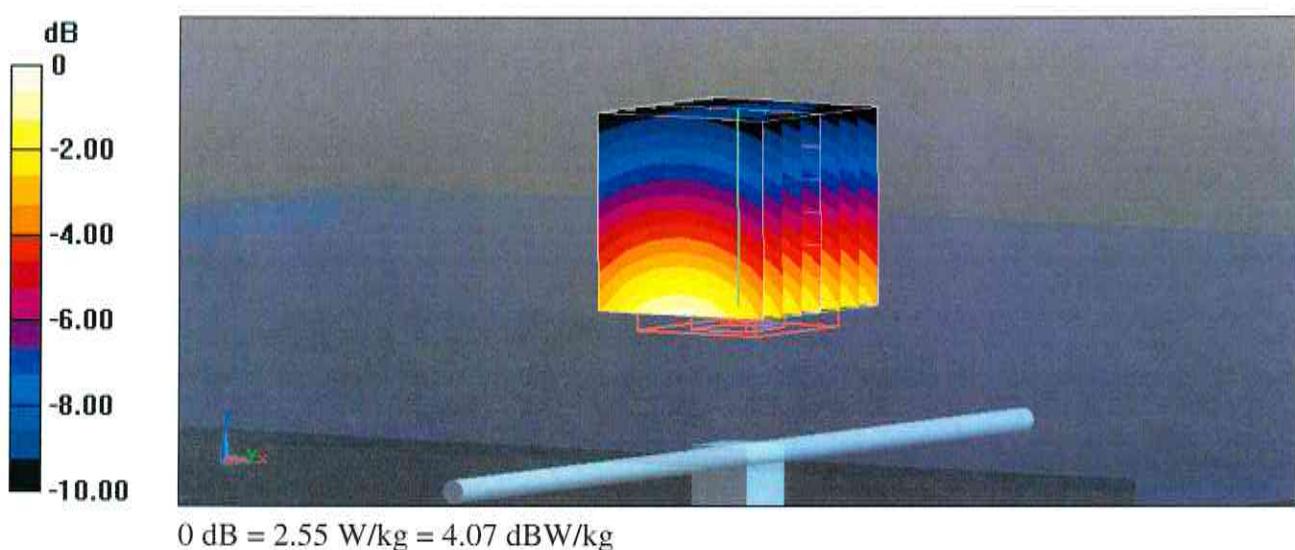
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 52.46 V/m; Power Drift = 0.01 dB

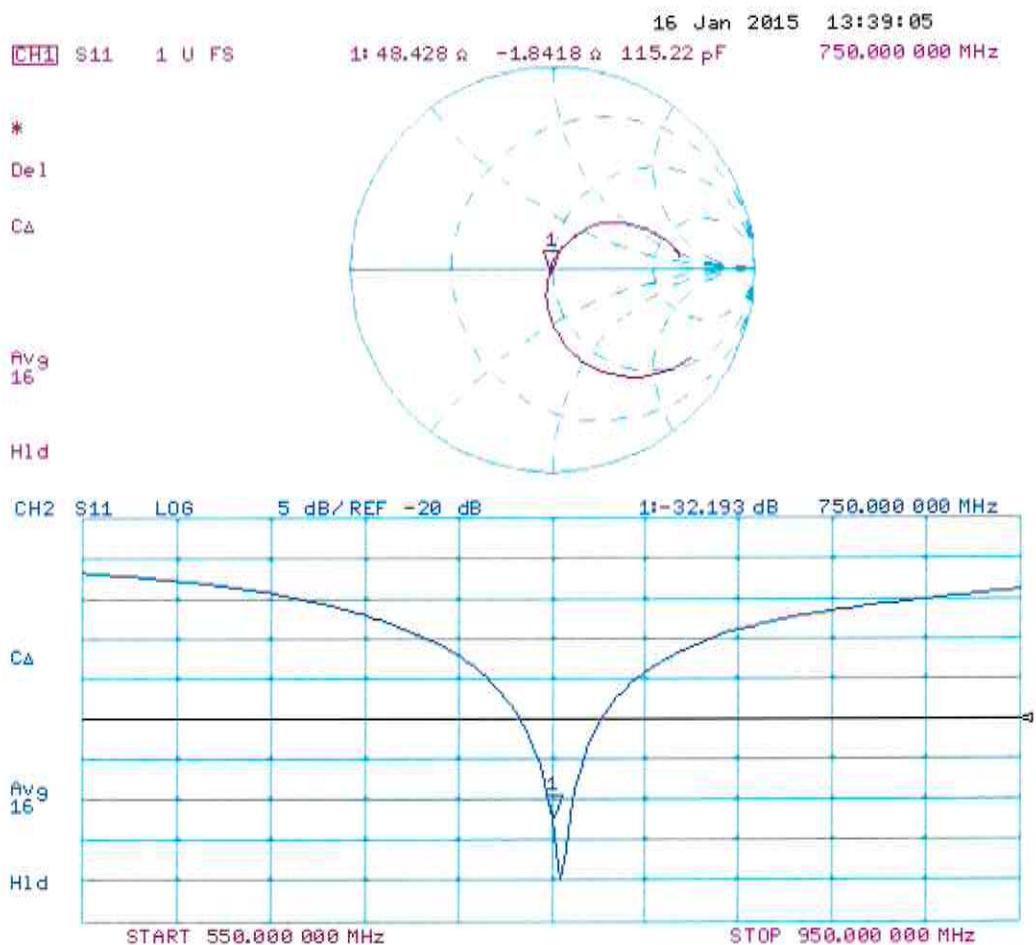
Peak SAR (extrapolated) = 3.19 W/kg

**SAR(1 g) = 2.18 W/kg; SAR(10 g) = 1.44 W/kg**

Maximum value of SAR (measured) = 2.55 W/kg



## Impedance Measurement Plot for Body TSL



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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)

Accreditation No.: SCS 108

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Multilateral Agreement for the recognition of calibration certificates

Client UL RFI UK

Certificate No: D900V2-1d168\_May14

## CALIBRATION CERTIFICATE

Object D900V2 - SN: 1d168

Calibration procedure(s) QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: May 14, 2014

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         | 09-Oct-13 (No. 217-01827)         | Oct-14                 |
| Power sensor HP 8481A       | US37292783         | 09-Oct-13 (No. 217-01827)         | Oct-14                 |
| Power sensor HP 8481A       | MY41092317         | 09-Oct-13 (No. 217-01828)         | Oct-14                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 03-Apr-14 (No. 217-01918)         | Apr-15                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921)         | Apr-15                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-13 (No. ES3-3205_Dec13)    | Dec-14                 |
| DAE4                        | SN: 601            | 30-Apr-14 (No. DAE4-601_Apr14)    | Apr-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

Calibrated by: Name Jeton Kastrati Function Laboratory Technician Signature

Approved by: Katja Pokovic Technical Manager

Issued: May 14, 2014

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#### Glossary:

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

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### 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.

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%.

## Measurement Conditions

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

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.8     |
| <b>Extrapolation</b>                | Advanced Extrapolation |             |
| <b>Phantom</b>                      | Modular Flat Phantom   |             |
| <b>Distance Dipole Center - TSL</b> | 15 mm                  | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm      |             |
| <b>Frequency</b>                    | 900 MHz ± 1 MHz        |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature     | Permittivity | Conductivity     |
|------------------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C         | 41.5         | 0.97 mho/m       |
| <b>Measured Head TSL parameters</b>            | (22.0 ± 0.2) °C | 40.0 ± 6 %   | 0.96 mho/m ± 6 % |
| <b>Head TSL temperature change during test</b> | < 0.5 °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 | 2.58 W/kg                |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | 10.3 W/kg ± 17.0 % (k=2) |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                          |
| SAR measured                                                  | 250 mW input power | 1.65 W/kg                |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | 6.60 W/kg ± 16.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature     | Permittivity | Conductivity     |
|------------------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C         | 55.0         | 1.05 mho/m       |
| <b>Measured Body TSL parameters</b>            | (22.0 ± 0.2) °C | 56.5 ± 6 %   | 1.05 mho/m ± 6 % |
| <b>Body TSL temperature change during test</b> | < 0.5 °C        | ---          | ---              |

## SAR result with Body TSL

|                                                               |                    |                          |
|---------------------------------------------------------------|--------------------|--------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>   | Condition          |                          |
| SAR measured                                                  | 250 mW input power | 2.64 W/kg                |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | 10.6 W/kg ± 17.0 % (k=2) |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                          |
| SAR measured                                                  | 250 mW input power | 1.71 W/kg                |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | 6.87 W/kg ± 16.5 % (k=2) |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 53.2 $\Omega$ - 0.3 $j\Omega$ |
| Return Loss                          | - 30.2 dB                     |

### Antenna Parameters with Body TSL

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 47.7 $\Omega$ - 2.3 $j\Omega$ |
| Return Loss                          | - 29.5 dB                     |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.402 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 | March 27, 2013 |

# DASY5 Validation Report for Head TSL

Date: 14.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 1d168**

Communication System: UID 0 - CW; Frequency: 900 MHz

Medium parameters used:  $f = 900 \text{ MHz}$ ;  $\sigma = 0.96 \text{ S/m}$ ;  $\epsilon_r = 40$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.09, 6.09, 6.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

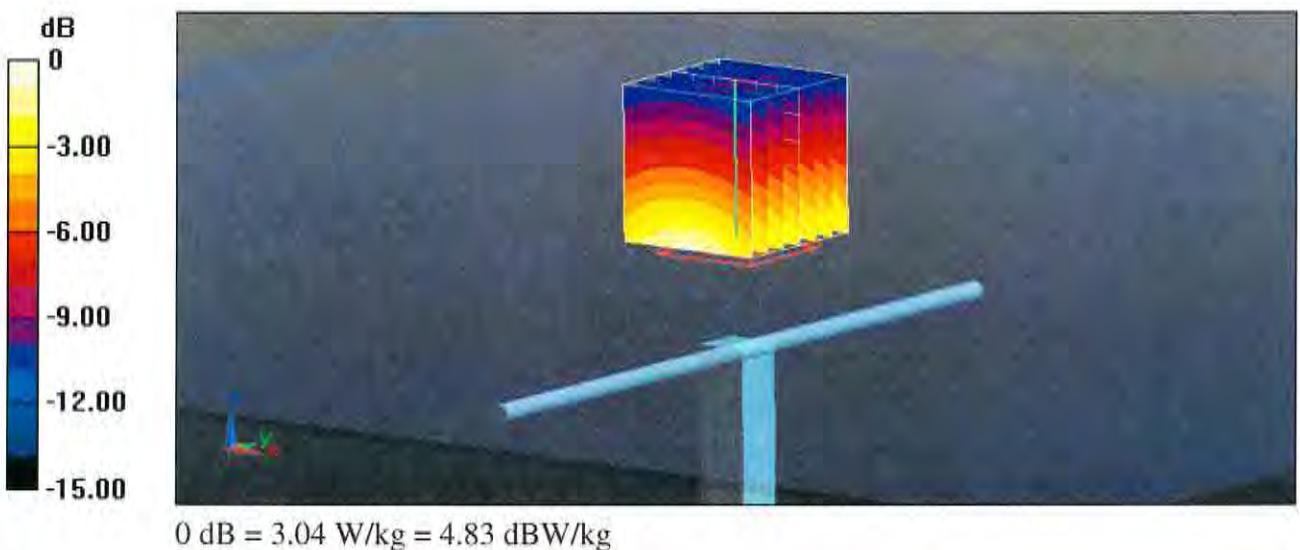
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 58.10 V/m; Power Drift = 0.01 dB

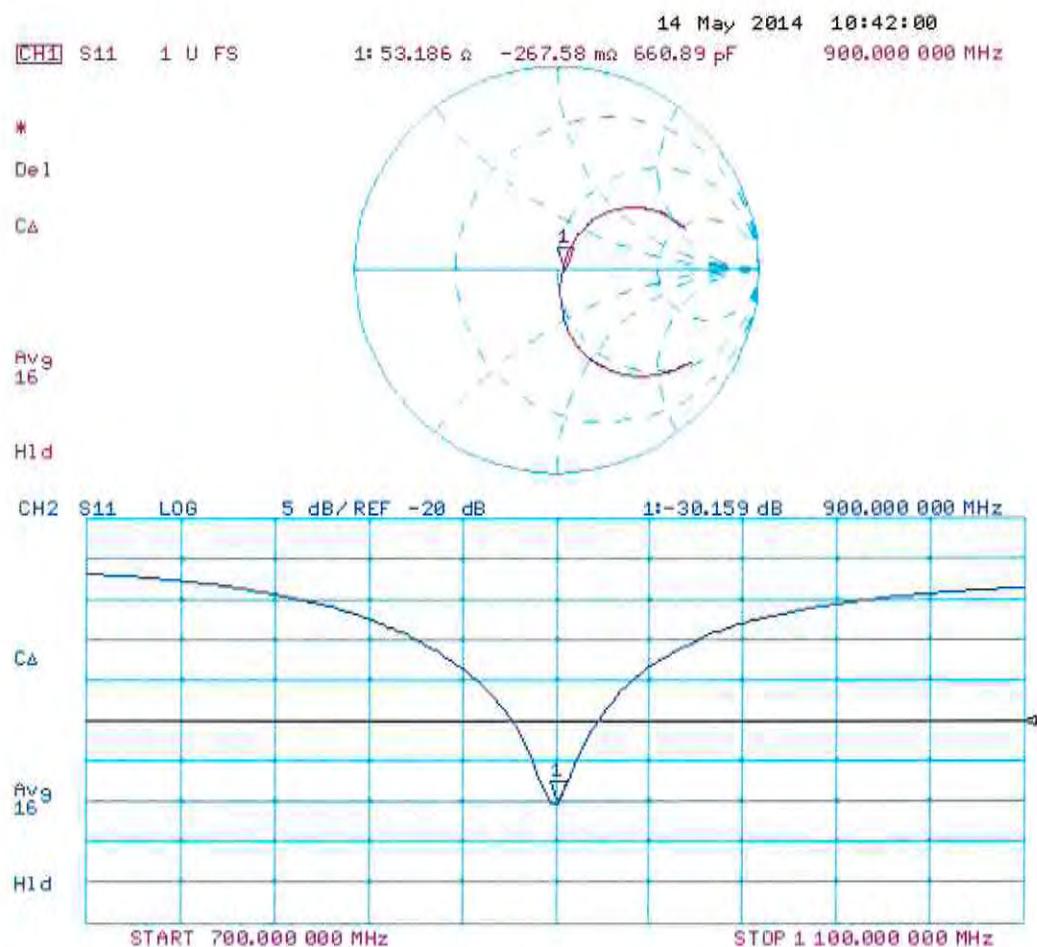
Peak SAR (extrapolated) = 3.91 W/kg

**SAR(1 g) = 2.58 W/kg; SAR(10 g) = 1.65 W/kg**

Maximum value of SAR (measured) = 3.04 W/kg



## Impedance Measurement Plot for Head TSL



# DASY5 Validation Report for Body TSL

Date: 06.05.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 1d168**

Communication System: UID 0 - CW; Frequency: 900 MHz

Medium parameters used:  $f = 900 \text{ MHz}$ ;  $\sigma = 1.05 \text{ S/m}$ ;  $\epsilon_r = 56.5$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.98, 5.98, 5.98); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

## Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

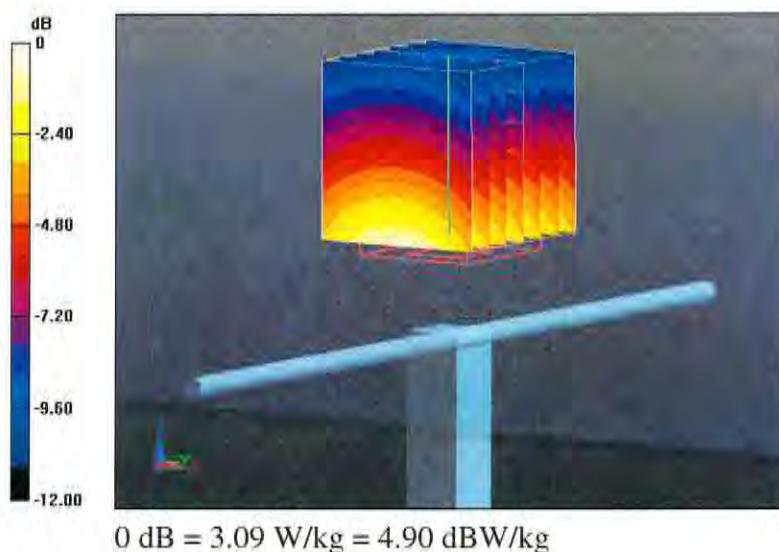
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 56.08 V/m; Power Drift = 0.01 dB

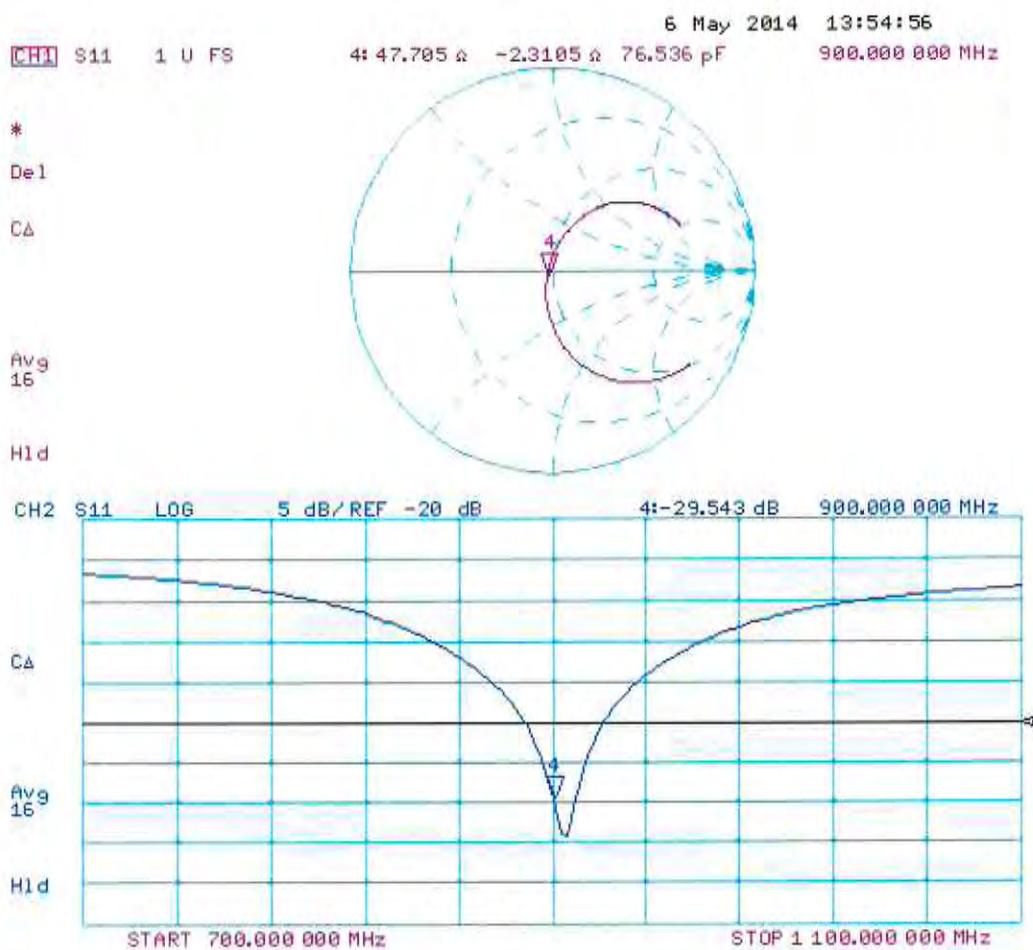
Peak SAR (extrapolated) = 3.92 W/kg

**SAR(1 g) = 2.64 W/kg; SAR(10 g) = 1.71 W/kg**

Maximum value of SAR (measured) = 3.09 W/kg



## Impedance Measurement Plot for Body TSL



A1190

*Checked  
M. Naser 26/8/11*

**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)

Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA  
 Multilateral Agreement for the recognition of calibration certificates

Client **UL RFI UK**

Certificate No: **D1800V2-264\_Aug14**

## CALIBRATION CERTIFICATE

Object **D1800V2 - SN: 264**

Calibration procedure(s) **QA CAL-05.v9**  
 Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **August 18, 2014**

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         | 09-Oct-13 (No. 217-01827)         | Oct-14                 |
| Power sensor HP 8481A       | US37292783         | 09-Oct-13 (No. 217-01827)         | Oct-14                 |
| Power sensor HP 8481A       | MY41092317         | 09-Oct-13 (No. 217-01828)         | Oct-14                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 03-Apr-14 (No. 217-01918)         | Apr-15                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921)         | Apr-15                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-13 (No. ES3-3205_Dec13)    | Dec-14                 |
| DAE4                        | SN: 601            | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

Calibrated by: Name **Michael Weber** Function **Laboratory Technician**

Signature

*M. Weber*

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

*K. Pokovic*

Issued: August 20, 2014

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        |
| 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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### 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.

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%.

## Measurement Conditions

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

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.8     |
| <b>Extrapolation</b>                | Advanced Extrapolation |             |
| <b>Phantom</b>                      | Modular Flat Phantom   |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                  | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm      |             |
| <b>Frequency</b>                    | 1800 MHz ± 1 MHz       |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature     | Permittivity | Conductivity     |
|------------------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C         | 40.0         | 1.40 mho/m       |
| <b>Measured Head TSL parameters</b>            | (22.0 ± 0.2) °C | 39.1 ± 6 %   | 1.41 mho/m ± 6 % |
| <b>Head TSL temperature change during test</b> | < 0.5 °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 | 9.75 W/kg                       |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>38.6 W/kg ± 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 | 5.10 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>20.3 W/kg ± 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature     | Permittivity | Conductivity     |
|------------------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C         | 53.3         | 1.52 mho/m       |
| <b>Measured Body TSL parameters</b>            | (22.0 ± 0.2) °C | 51.8 ± 6 %   | 1.53 mho/m ± 6 % |
| <b>Body TSL temperature change during test</b> | < 0.5 °C        | ----         | ----             |

## SAR result with Body TSL

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                 |
| SAR measured                                                | 250 mW input power | 9.56 W/kg                       |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>37.8 W/kg ± 17.0 % (k=2)</b> |

|                                                               |                    |                                 |
|---------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                 |
| SAR measured                                                  | 250 mW input power | 5.05 W/kg                       |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>20.1 W/kg ± 16.5 % (k=2)</b> |

## **Appendix (Additional assessments outside the scope of SCS108)**

### **Antenna Parameters with Head TSL**

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 47.2 $\Omega$ - 5.2 $j\Omega$ |
| Return Loss                          | - 24.3 dB                     |

### **Antenna Parameters with Body TSL**

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 43.7 $\Omega$ - 5.5 $j\Omega$ |
| Return Loss                          | - 21.0 dB                     |

### **General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.201 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 | March 05, 2000 |

# DASY5 Validation Report for Head TSL

Date: 18.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 264**

Communication System: UID 0 - CW; Frequency: 1800 MHz

Medium parameters used:  $f = 1800 \text{ MHz}$ ;  $\sigma = 1.41 \text{ S/m}$ ;  $\epsilon_r = 39.1$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.09, 5.09, 5.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

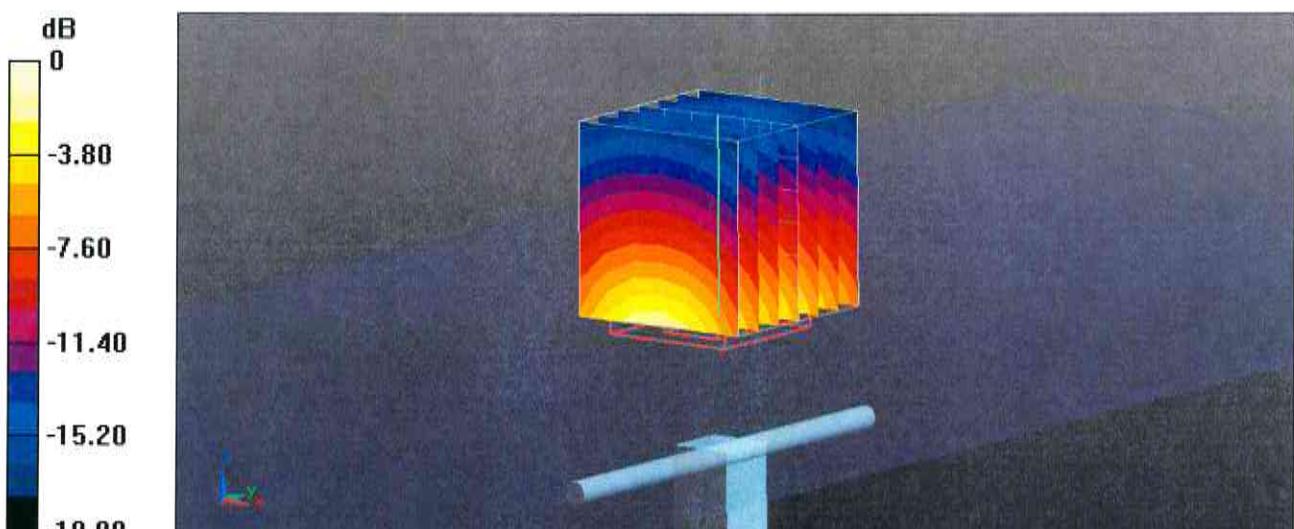
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 96.76 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 18.0 W/kg

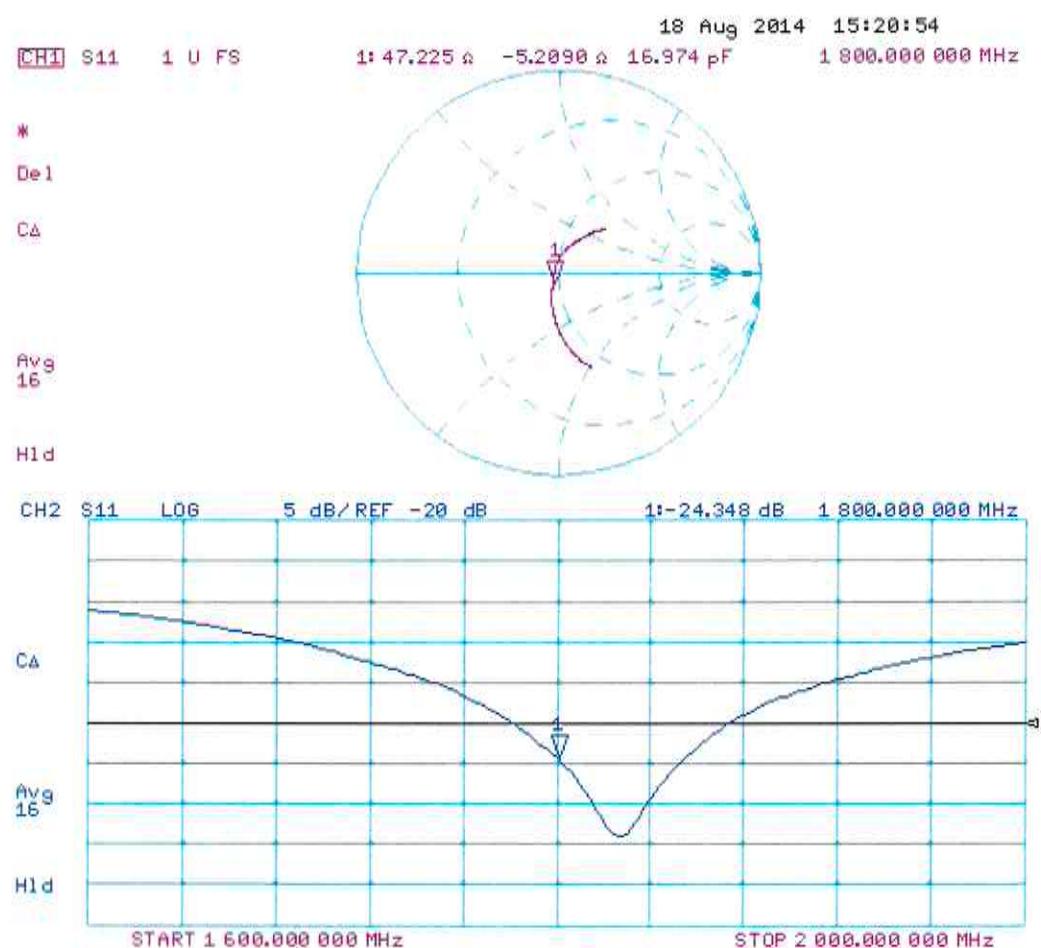
**SAR(1 g) = 9.75 W/kg; SAR(10 g) = 5.1 W/kg**

Maximum value of SAR (measured) = 12.4 W/kg



0 dB = 12.4 W/kg = 10.93 dBW/kg

## Impedance Measurement Plot for Head TSL



# DASY5 Validation Report for Body TSL

Date: 18.08.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 264**

Communication System: UID 0 - CW; Frequency: 1800 MHz

Medium parameters used:  $f = 1800 \text{ MHz}$ ;  $\sigma = 1.53 \text{ S/m}$ ;  $\epsilon_r = 51.8$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.86, 4.86, 4.86); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

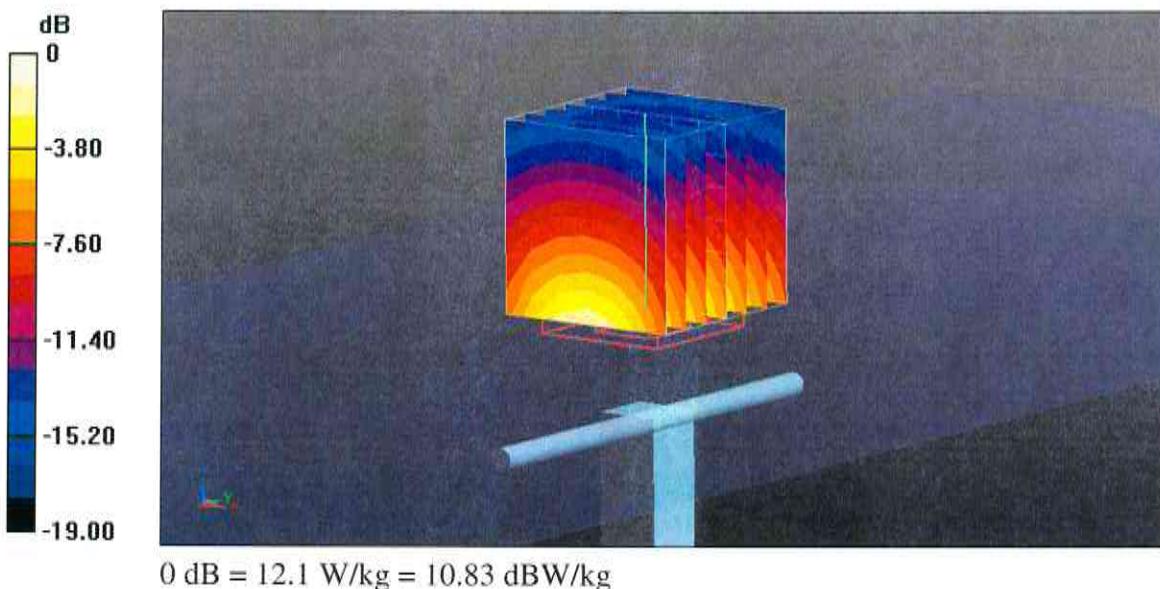
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 92.70 V/m; Power Drift = 0.02 dB

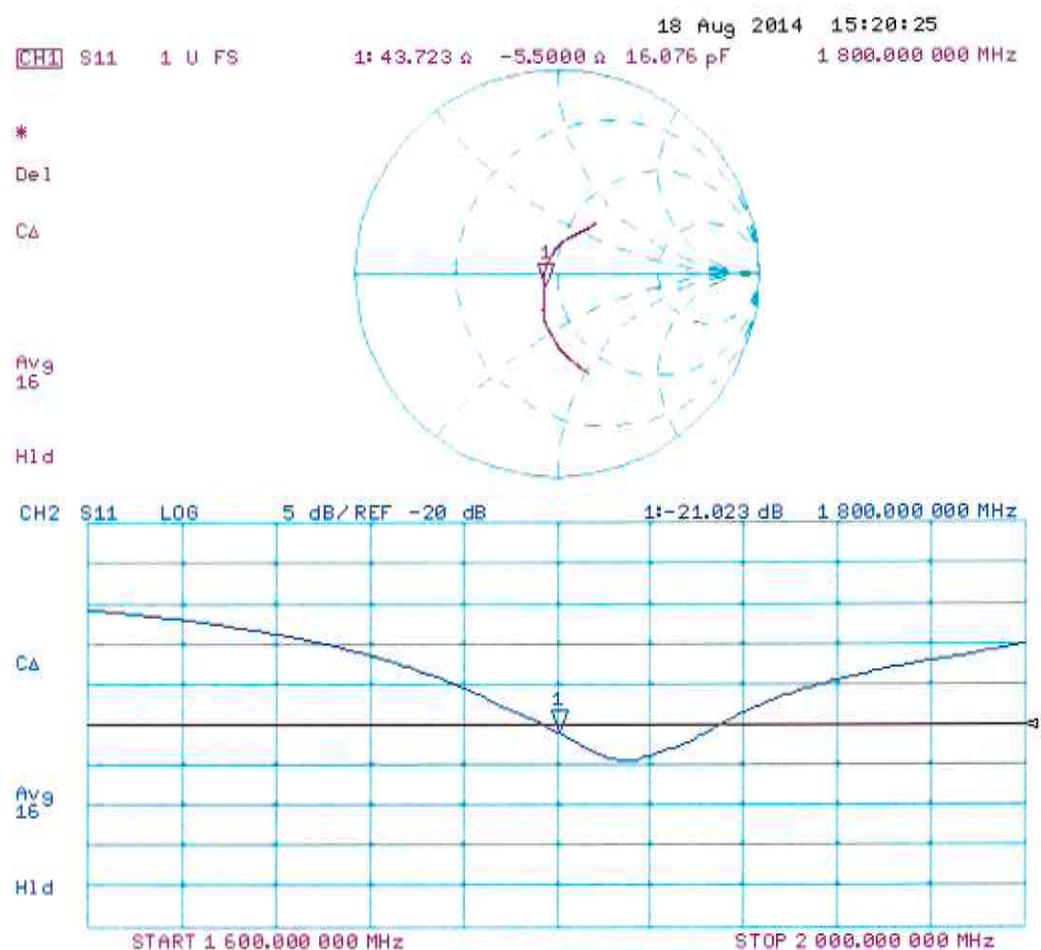
Peak SAR (extrapolated) = 16.8 W/kg

**SAR(1 g) = 9.56 W/kg; SAR(10 g) = 5.05 W/kg**

Maximum value of SAR (measured) = 12.1 W/kg



## Impedance Measurement Plot for Body TSL



A1237

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



*Checked by  
Schmid & Partner  
A1237 2014*

**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

Client **UL RFI UK**

Accreditation No.: **SCS 108**

Certificate No: **D1900V2-540\_Dec14**

## CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 540**

Calibration procedure(s) **QA CAL-05.v9**  
 Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **December 08, 2014**

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         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | US37292783         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | MY41092317         | 07-Oct-14 (No. 217-02021)         | Oct-15                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 03-Apr-14 (No. 217-01918)         | Apr-15                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921)         | Apr-15                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-13 (No. ES3-3205_Dec13)    | Dec-14                 |
| DAE4                        | SN: 601            | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

Calibrated by: Name **Michael Weber** Function **Laboratory Technician**

Signature

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

Issued: December 9, 2014

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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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### 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.

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%.

## Measurement Conditions

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

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.8     |
| <b>Extrapolation</b>                | Advanced Extrapolation |             |
| <b>Phantom</b>                      | Modular Flat Phantom   |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                  | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm      |             |
| <b>Frequency</b>                    | 1900 MHz ± 1 MHz       |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                                | <b>Temperature</b> | <b>Permittivity</b> | <b>Conductivity</b> |
|------------------------------------------------|--------------------|---------------------|---------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C            | 40.0                | 1.40 mho/m          |
| <b>Measured Head TSL parameters</b>            | (22.0 ± 0.2) °C    | 39.6 ± 6 %          | 1.38 mho/m ± 6 %    |
| <b>Head TSL temperature change during test</b> | < 0.5 °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 | 9.97 W/kg                |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | 40.1 W/kg ± 17.0 % (k=2) |

|                                                               |                    |                          |
|---------------------------------------------------------------|--------------------|--------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                          |
| SAR measured                                                  | 250 mW input power | 5.21 W/kg                |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | 20.9 W/kg ± 16.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|                                                | <b>Temperature</b> | <b>Permittivity</b> | <b>Conductivity</b> |
|------------------------------------------------|--------------------|---------------------|---------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C            | 53.3                | 1.52 mho/m          |
| <b>Measured Body TSL parameters</b>            | (22.0 ± 0.2) °C    | 53.3 ± 6 %          | 1.50 mho/m ± 6 %    |
| <b>Body TSL temperature change during test</b> | < 0.5 °C           | ----                | ----                |

## SAR result with Body TSL

|                                                             |                    |                          |
|-------------------------------------------------------------|--------------------|--------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                          |
| SAR measured                                                | 250 mW input power | 9.91 W/kg                |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | 40.0 W/kg ± 17.0 % (k=2) |

|                                                               |                    |                          |
|---------------------------------------------------------------|--------------------|--------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                          |
| SAR measured                                                  | 250 mW input power | 5.25 W/kg                |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | 21.1 W/kg ± 16.5 % (k=2) |

## **Appendix (Additional assessments outside the scope of SCS108)**

### **Antenna Parameters with Head TSL**

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $53.3 \Omega + 4.9 j\Omega$ |
| Return Loss                          | - 24.9 dB                   |

### **Antenna Parameters with Body TSL**

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $48.7 \Omega + 5.7 j\Omega$ |
| Return Loss                          | - 24.6 dB                   |

### **General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.199 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 | July 26, 2001 |

# DASY5 Validation Report for Head TSL

Date: 08.12.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 540**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.38 \text{ S/m}$ ;  $\epsilon_r = 39.6$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.06, 5.06, 5.06); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

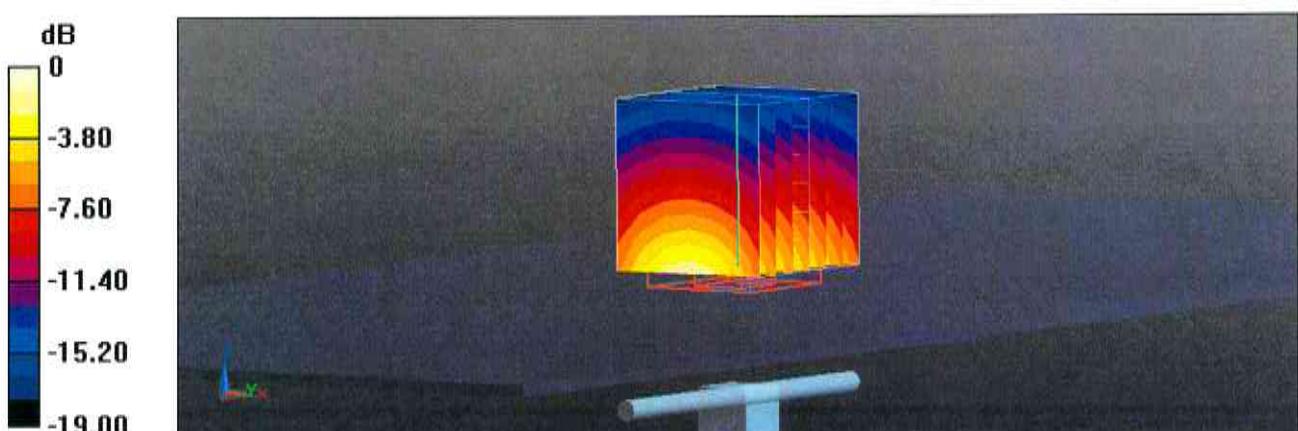
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 98.55 V/m; Power Drift = 0.01 dB

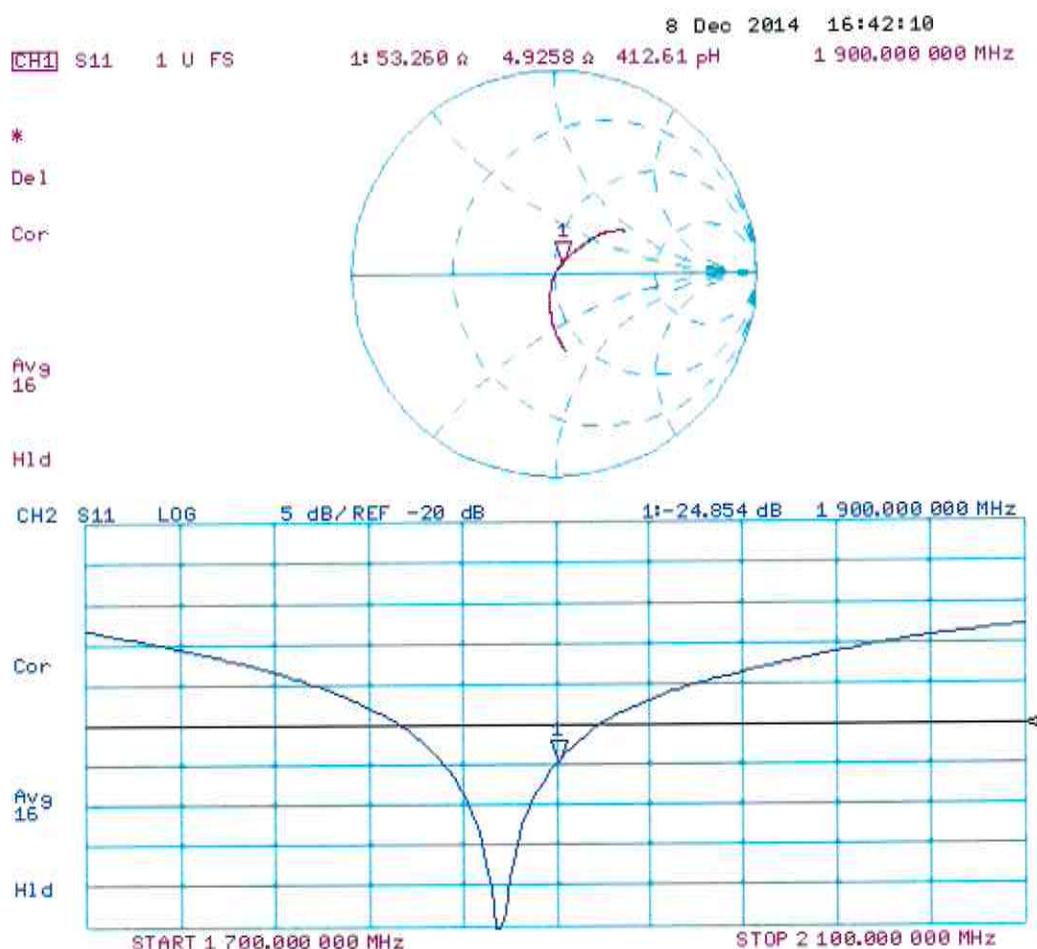
Peak SAR (extrapolated) = 18.4 W/kg

**SAR(1 g) = 9.97 W/kg; SAR(10 g) = 5.21 W/kg**

Maximum value of SAR (measured) = 12.7 W/kg



## Impedance Measurement Plot for Head TSL



# DASY5 Validation Report for Body TSL

Date: 08.12.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 540**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.5 \text{ S/m}$ ;  $\epsilon_r = 53.3$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.76, 4.76, 4.76); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

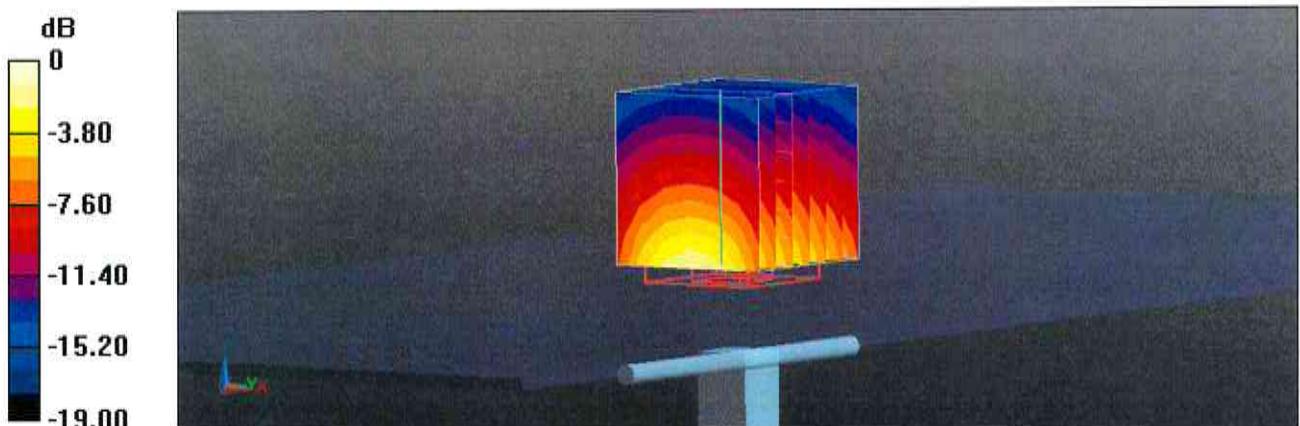
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 94.59 V/m; Power Drift = -0.00 dB

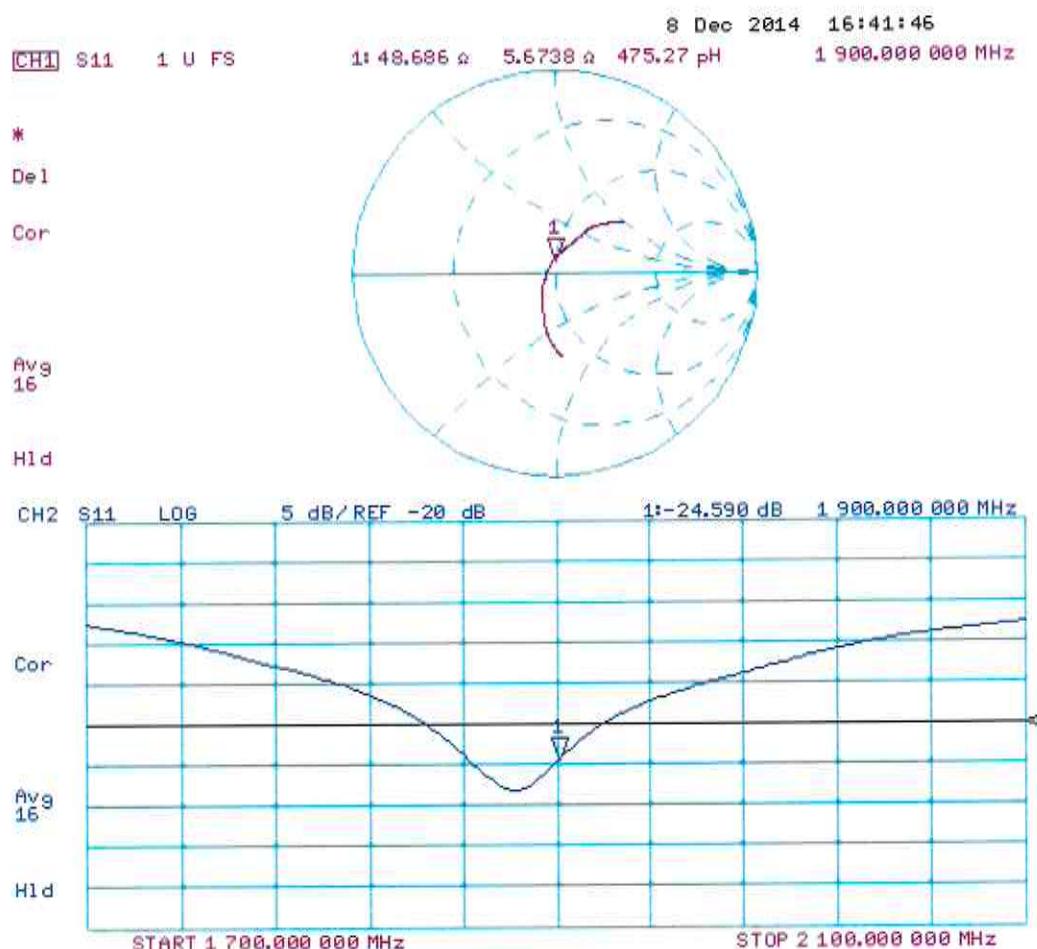
Peak SAR (extrapolated) = 17.2 W/kg

**SAR(1 g) = 9.91 W/kg; SAR(10 g) = 5.25 W/kg**

Maximum value of SAR (measured) = 12.4 W/kg

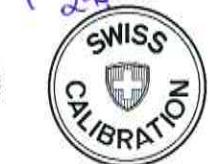


## Impedance Measurement Plot for Body TSL



A1322

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



Checked By  
 Parathyra  
 1-2012/2014

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

Accredited by the Swiss Accreditation Service (SAS)

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 Multilateral Agreement for the recognition of calibration certificates

Client **UL RFI UK**Accreditation No.: **SCS 108**Certificate No: **D2450V2-725\_Dec14**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 725**

Calibration procedure(s) **QA CAL-05.v9**  
 Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **December 08, 2014**

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         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | US37292783         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | MY41092317         | 07-Oct-14 (No. 217-02021)         | Oct-15                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 03-Apr-14 (No. 217-01918)         | Apr-15                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921)         | Apr-15                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-13 (No. ES3-3205_Dec13)    | Dec-14                 |
| DAE4                        | SN: 601            | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

Calibrated by: Name **Michael Weber** Function **Laboratory Technician**

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

Issued: December 8, 2014

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#### Glossary:

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

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### 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.

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%.

## Measurement Conditions

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

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.8     |
| <b>Extrapolation</b>                | Advanced Extrapolation |             |
| <b>Phantom</b>                      | Modular Flat Phantom   |             |
| <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 ± 1 MHz       |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                                | <b>Temperature</b> | <b>Permittivity</b> | <b>Conductivity</b> |
|------------------------------------------------|--------------------|---------------------|---------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C            | 39.2                | 1.80 mho/m          |
| <b>Measured Head TSL parameters</b>            | (22.0 ± 0.2) °C    | 39.7 ± 6 %          | 1.84 mho/m ± 6 %    |
| <b>Head TSL temperature change during test</b> | < 0.5 °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 | 12.8 W/kg                       |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>50.8 W/kg ± 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 | 5.95 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>23.7 W/kg ± 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|                                                | <b>Temperature</b> | <b>Permittivity</b> | <b>Conductivity</b> |
|------------------------------------------------|--------------------|---------------------|---------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C            | 52.7                | 1.95 mho/m          |
| <b>Measured Body TSL parameters</b>            | (22.0 ± 0.2) °C    | 51.0 ± 6 %          | 2.03 mho/m ± 6 %    |
| <b>Body TSL temperature change during test</b> | < 0.5 °C           | ----                | ----                |

## SAR result with Body TSL

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                 |
| SAR measured                                                | 250 mW input power | 12.8 W/kg                       |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>49.9 W/kg ± 17.0 % (k=2)</b> |

|                                                               |                    |                                 |
|---------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                 |
| SAR measured                                                  | 250 mW input power | 5.89 W/kg                       |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>23.2 W/kg ± 16.5 % (k=2)</b> |

## **Appendix (Additional assessments outside the scope of SCS108)**

### **Antenna Parameters with Head TSL**

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $54.2 \Omega + 9.5 j\Omega$ |
| Return Loss                          | - 20.0 dB                   |

### **Antenna Parameters with Body TSL**

|                                      |                              |
|--------------------------------------|------------------------------|
| Impedance, transformed to feed point | $50.6 \Omega + 10.0 j\Omega$ |
| Return Loss                          | - 20.1 dB                    |

### **General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.153 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 | October 16, 2002 |

# DASY5 Validation Report for Head TSL

Date: 08.12.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 725**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 1.84 \text{ S/m}$ ;  $\epsilon_r = 39.7$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

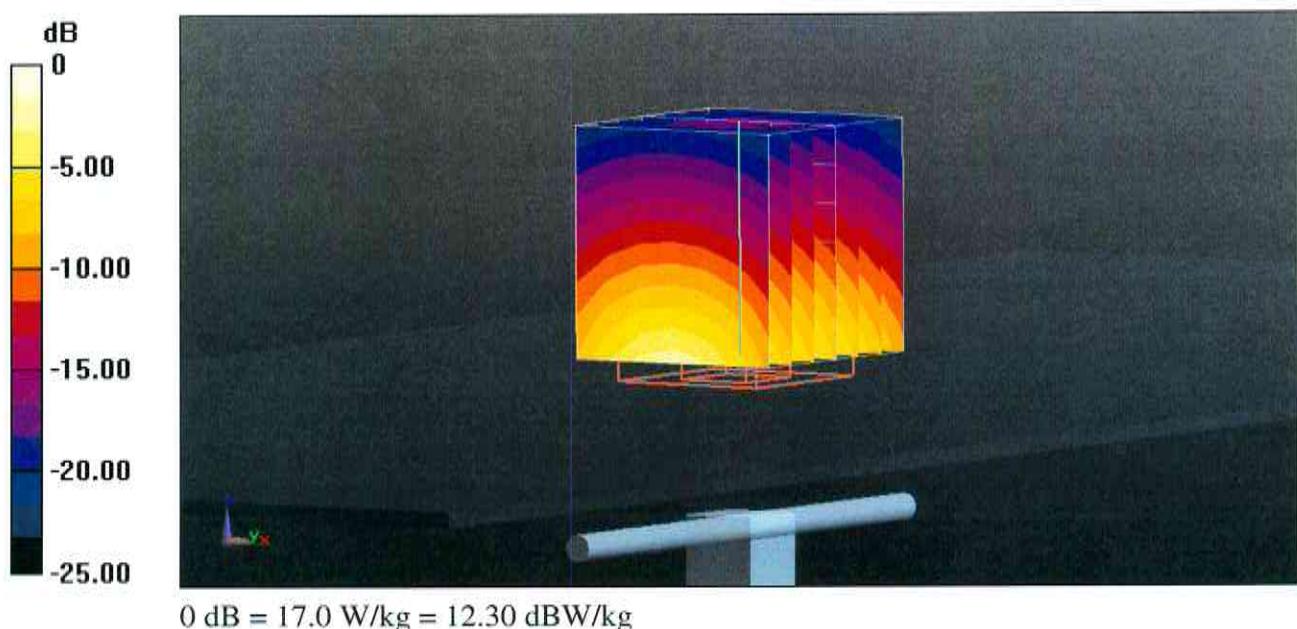
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 99.87 V/m; Power Drift = 0.03 dB

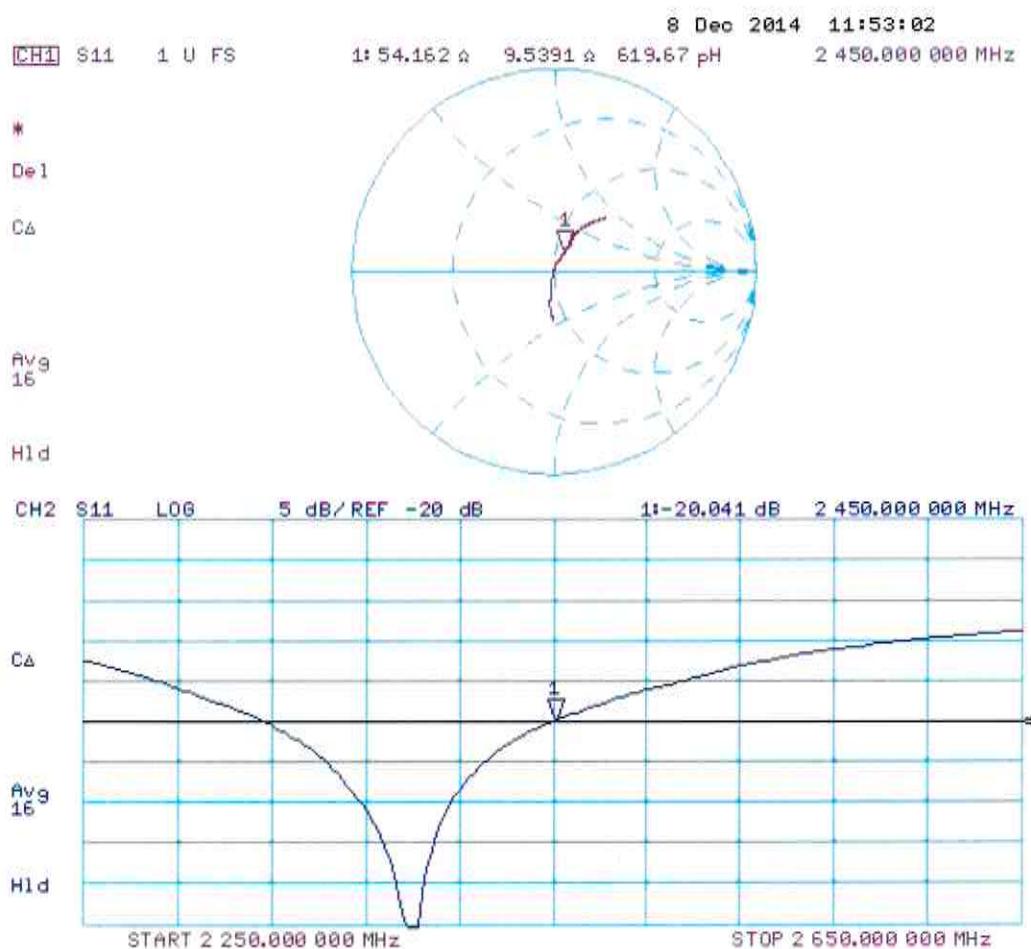
Peak SAR (extrapolated) = 26.6 W/kg

**SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.95 W/kg**

Maximum value of SAR (measured) = 17.0 W/kg



## Impedance Measurement Plot for Head TSL



# DASY5 Validation Report for Body TSL

Date: 08.12.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 725**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 2.03 \text{ S/m}$ ;  $\epsilon_r = 51$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

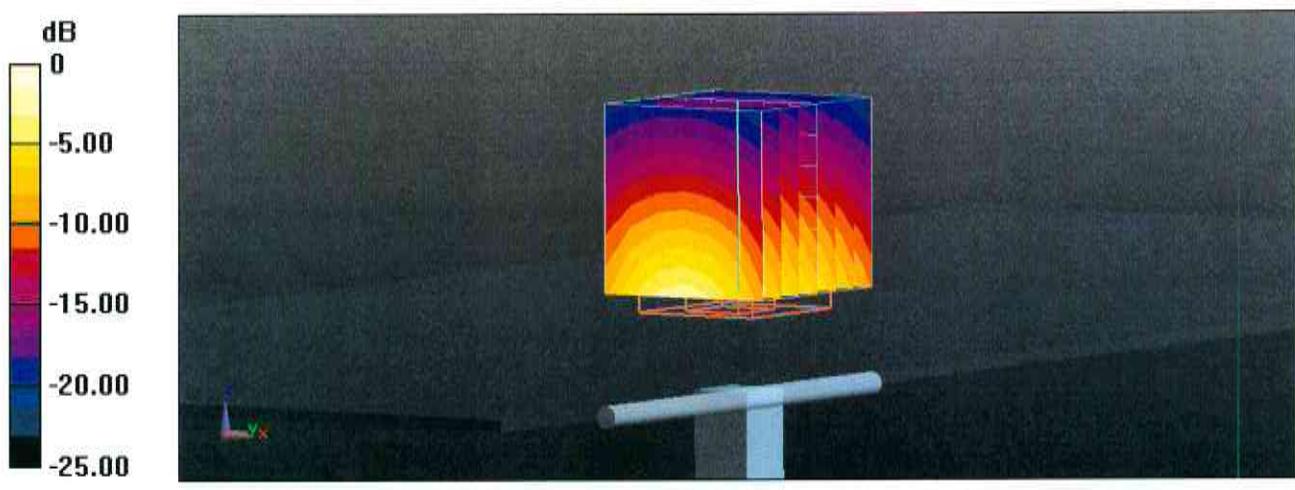
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 93.99 V/m; Power Drift = 0.02 dB

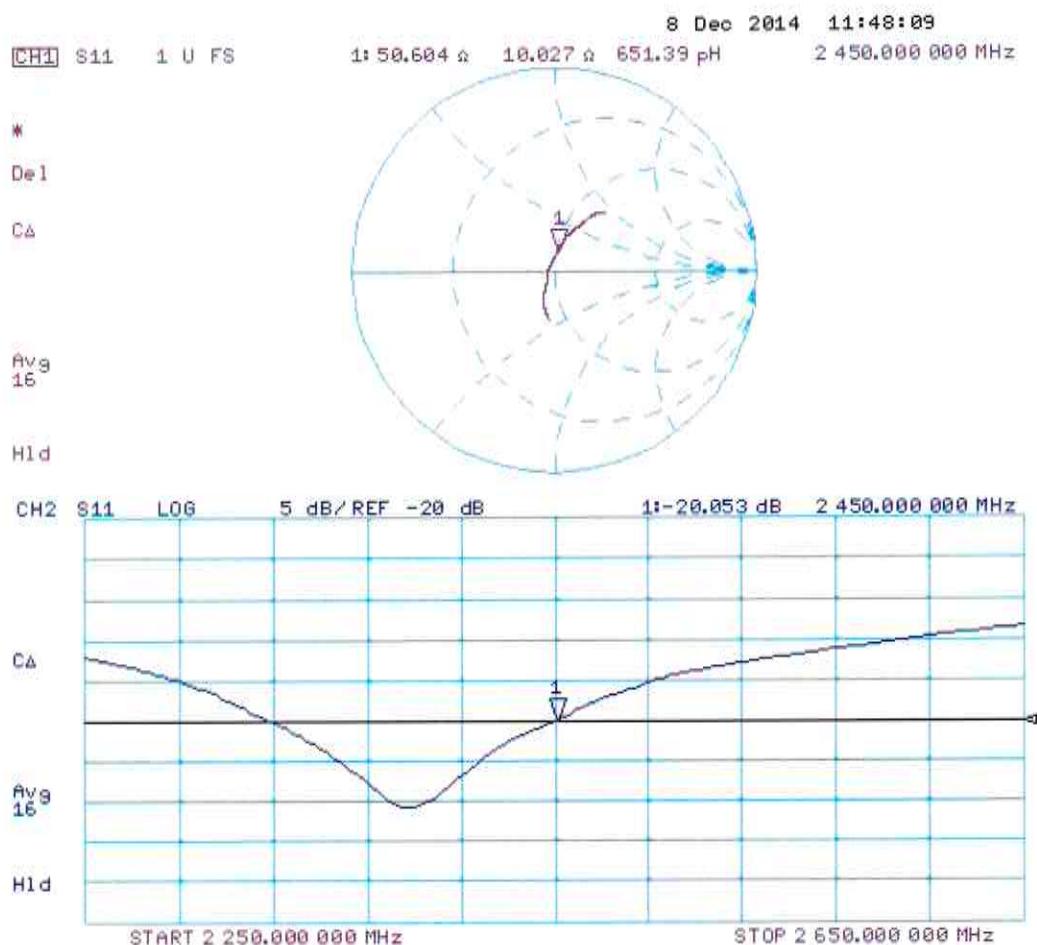
Peak SAR (extrapolated) = 26.7 W/kg

**SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.89 W/kg**

Maximum value of SAR (measured) = 16.9 W/kg



## Impedance Measurement Plot for Body TSL



A1377

Checked  
M. Nowak 03/3/2015

**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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Accreditation No.: **SCS 0108**Client **UL RFI UK**Certificate No: **D5GHzV2-1016\_Feb15**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1016**

Calibration procedure(s) **QA CAL-22.v2**  
 Calibration procedure for dipole validation kits between 3-6 GHz

Calibration date: **February 24, 2015**

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&amp;TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | GB37480704         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | US37292783         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | MY41092317         | 07-Oct-14 (No. 217-02021)         | Oct-15                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 03-Apr-14 (No. 217-01918)         | Apr-15                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921)         | Apr-15                 |
| Reference Probe EX3DV4      | SN: 3503           | 30-Dec-14 (No. EX3-3503_Dec14)    | Dec-15                 |
| DAE4                        | SN: 601            | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

Calibrated by: Name **Leif Klysner** Function **Laboratory Technician**

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

Issued: February 25, 2015

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Accreditation No.: SCS 0108

#### 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) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
- c) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

#### 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.

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%.

## Measurement Conditions

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

|                                     |                                                                      |                                  |
|-------------------------------------|----------------------------------------------------------------------|----------------------------------|
| <b>DASY Version</b>                 | DASY5                                                                | V52.8.8                          |
| <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>         | $dx, dy = 4.0 \text{ mm}, dz = 1.4 \text{ mm}$                       | Graded Ratio = 1.4 (Z direction) |
| <b>Frequency</b>                    | 5250 MHz $\pm 1$ MHz<br>5600 MHz $\pm 1$ MHz<br>5750 MHz $\pm 1$ MHz |                                  |

## Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

|                                                | Temperature          | Permittivity   | Conductivity         |
|------------------------------------------------|----------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C              | 35.9           | 4.71 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm 0.2$ ) °C | 35.3 $\pm 6$ % | 4.58 mho/m $\pm 6$ % |
| <b>Head TSL temperature change during test</b> | < 0.5 °C             | ----           | ----                 |

## SAR result with Head TSL at 5250 MHz

|                                                             |                    |                              |
|-------------------------------------------------------------|--------------------|------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                              |
| SAR measured                                                | 100 mW input power | 7.94 W/kg                    |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | 79.0 W/kg $\pm 19.9$ % (k=2) |

|                                                               |                    |                              |
|---------------------------------------------------------------|--------------------|------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                              |
| SAR measured                                                  | 100 mW input power | 2.28 W/kg                    |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | 22.7 W/kg $\pm 19.5$ % (k=2) |

## Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

|                                                | Temperature          | Permittivity   | Conductivity         |
|------------------------------------------------|----------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C              | 35.5           | 5.07 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm 0.2$ ) °C | 34.8 $\pm 6$ % | 4.94 mho/m $\pm 6$ % |
| <b>Head TSL temperature change during test</b> | < 0.5 °C             | ----           | ----                 |

## SAR result with Head TSL at 5600 MHz

|                                                             |                    |                                |
|-------------------------------------------------------------|--------------------|--------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                |
| SAR measured                                                | 100 mW input power | 8.13 W/kg                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | 80.9 W / kg $\pm 19.9$ % (k=2) |

|                                                               |                    |                              |
|---------------------------------------------------------------|--------------------|------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                              |
| SAR measured                                                  | 100 mW input power | 2.32 W/kg                    |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | 23.0 W/kg $\pm 19.5$ % (k=2) |