

## APPENDIX C: PROBE CALIBRATION



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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 **PC Test**

Certificate No: **D750V3-1003\_Jan12**

## CALIBRATION CERTIFICATE

Object **D750V3 - SN: 1003**

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

Calibration date: **January 27, 2012**

*KOK  
21/6/12*

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

Calibrated by: **Jeton Kastrati** (Name) **Laboratory Technician** (Function)  (Signature)

Approved by: **Katja Pokovic** (Name) **Technical Manager** (Function)  (Signature)

Issued: January 27, 2012

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



### Glossary:

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

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

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

## Measurement Conditions

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.0     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 15 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 750 MHz $\pm$ 1 MHz    |             |

## Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 41.9           | 0.89 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 42.3 $\pm$ 6 % | 0.92 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 2.15 mW / g                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 8.40 mW / g $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 1.40 mW / g                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 5.49 mW / g $\pm$ 16.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 55.5           | 0.96 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 55.6 $\pm$ 6 % | 0.96 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 2.18 mW / g                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 8.72 mW / g $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 1.45 mW / g                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 5.80 mW / g $\pm$ 16.5 % (k=2) |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.3 $\Omega$ - 1.5 j $\Omega$ |
| Return Loss                          | - 27.1 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.5 $\Omega$ - 2.8 j $\Omega$ |
| Return Loss                          | - 31.1 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.044 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 | January 21, 2009 |

## DASY5 Validation Report for Head TSL

Date: 27.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

~~DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1003~~

Communication System: CW; Frequency: 750 MHz

Medium parameters used:  $f = 750$  MHz;  $\sigma = 0.92$  mho/m;  $\epsilon_r = 42.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.33, 6.33, 6.33); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

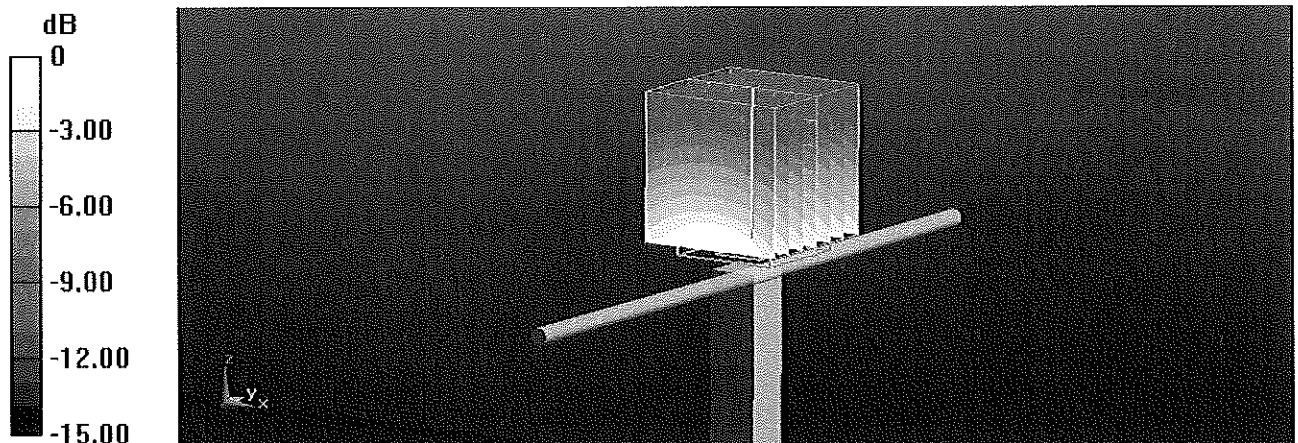
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 53.564 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.2610

**SAR(1 g) = 2.15 mW/g; SAR(10 g) = 1.4 mW/g**

Maximum value of SAR (measured) = 2.510 mW/g



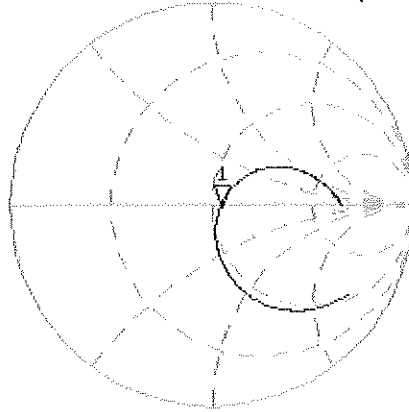
0 dB = 2.510mW/g = 7.99 dB mW/g

# Impedance Measurement Plot for Head TSL

27 Jan 2012 13:38:24

CH1 S11 1-U-FC 1:54.2424 -1.48224 142.59 pF 750.000 000 MHz

\*  
Del  
Cor



Avg  
16

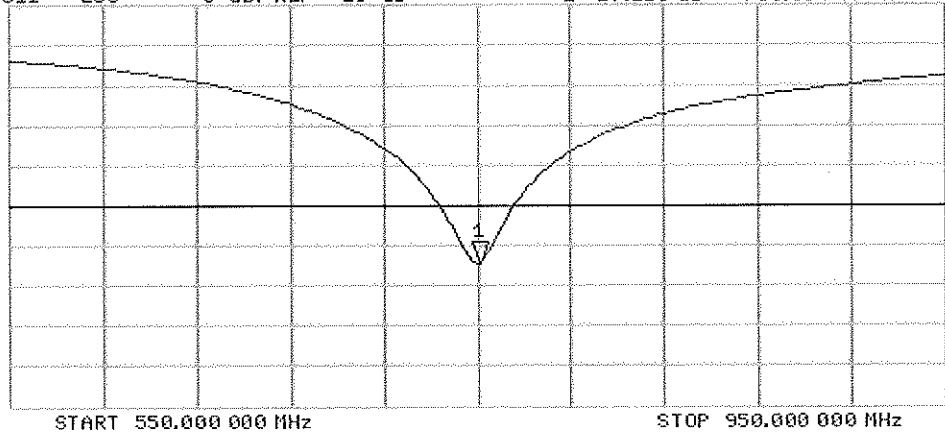
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-27.125 dB 750.000 000 MHz

Cor

Avg  
16

H1d



# DASY5 Validation Report for Body TSL

Date: 27.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

~~DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1003~~

Communication System: CW; Frequency: 750 MHz

Medium parameters used:  $f = 750 \text{ MHz}$ ;  $\sigma = 0.96 \text{ mho/m}$ ;  $\epsilon_r = 55.6$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.12, 6.12, 6.12); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

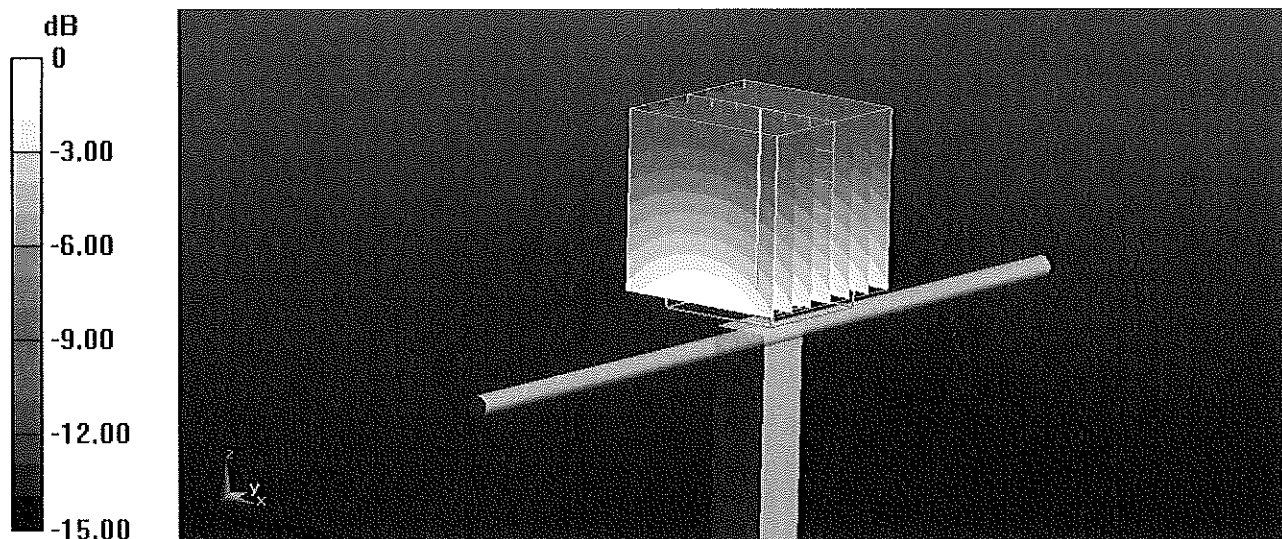
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 52.545 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 3.2460

**SAR(1 g) = 2.18 mW/g; SAR(10 g) = 1.45 mW/g**

Maximum value of SAR (measured) = 2.548 mW/g



0 dB = 2.550mW/g = 8.13 dB mW/g

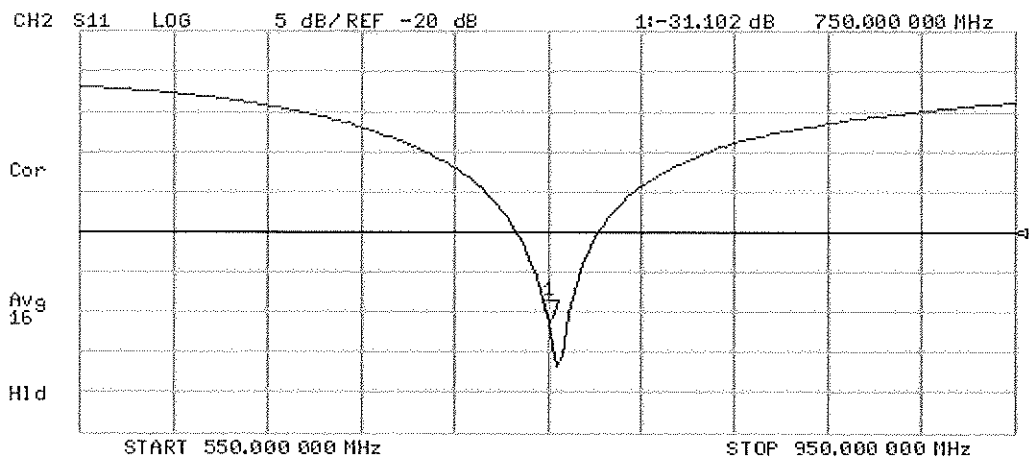
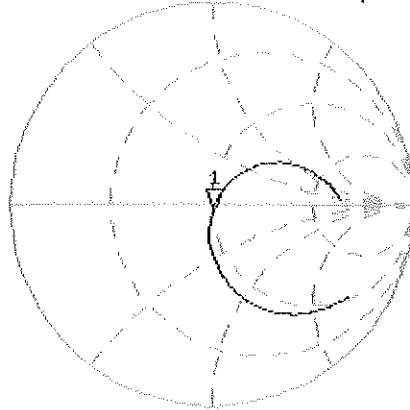


# Impedance Measurement Plot for Body TSL

27 Jan 2012 10:10:56

[S11] S11 1 U FS 1:50.527 A -2.7500 A 27.166 pF 750.000 000 MHz

\*  
De1  
Cor  
Avg  
16  
H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D750V3-1054\_Feb12**

**CALIBRATION CERTIFICATE**

Object **D750V3 - SN: 1054**

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

Calibration date: **February 09, 2012**

*✓  
KOK  
5/11/12*

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

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

Calibrated by: **Israe El-Naouq**      **Israe El-Naouq**      **Laboratory Technician**      *Israe El-Naouq*

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

Issued: February 9, 2012

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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.

## Measurement Conditions

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.0     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 15 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 750 MHz ± 1 MHz        |             |

## Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters             | 22.0 °C         | 41.9         | 0.89 mho/m       |
| Measured Head TSL parameters            | (22.0 ± 0.2) °C | 42.3 ± 6 %   | 0.92 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

## SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                                   |
|---|--------------------|-----------------------------------|
| SAR measured  | 250 mW input power | 2.18 mW / g                       |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>8.52 mW / g ± 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                   |
|---|--------------------|-----------------------------------|
| SAR measured  | 250 mW input power | 1.42 mW / g                       |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>5.57 mW / g ± 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 55.5         | 0.96 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 55.6 ± 6 %   | 0.96 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 2.21 mW / g                       |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>8.84 mW / g ± 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                   |
|---|--------------------|-----------------------------------|
| SAR measured  | 250 mW input power | 1.46 mW / g                       |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>5.84 mW / g ± 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.0 $\Omega$ - 1.5 j $\Omega$ |
| Return Loss                          | - 27.8 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.6 $\Omega$ - 3.4 j $\Omega$ |
| Return Loss                          | - 29.2 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.041 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 | November 08, 2011 |

## DASY5 Validation Report for Head TSL

Date: 09.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1054**

Communication System: CW; Frequency: 750 MHz

Medium parameters used:  $f = 750$  MHz;  $\sigma = 0.92$  mho/m;  $\epsilon_r = 42.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.33, 6.33, 6.33); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

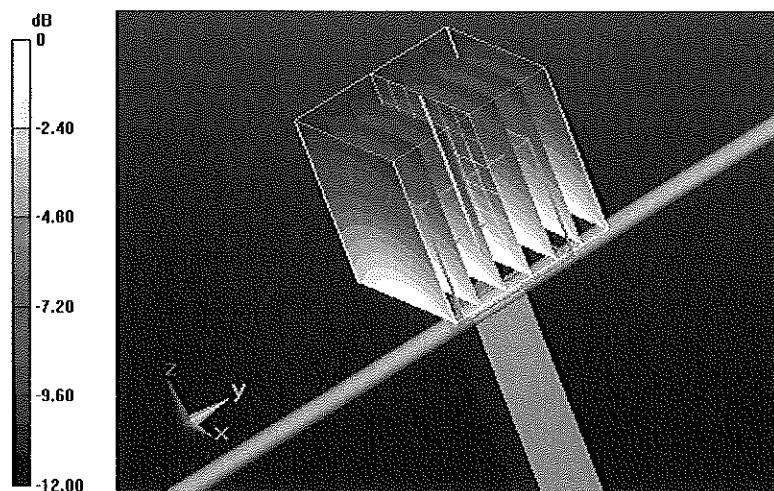
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 53.659 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.2940

**SAR(1 g) = 2.18 mW/g; SAR(10 g) = 1.42 mW/g**

Maximum value of SAR (measured) = 2.552 mW/g

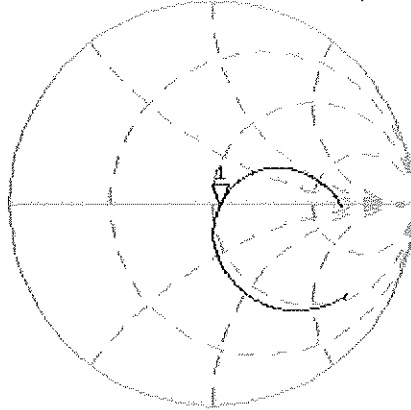


0 dB = 2.550mW/g = 8.13 dB mW/g

# Impedance Measurement Plot for Head TSL

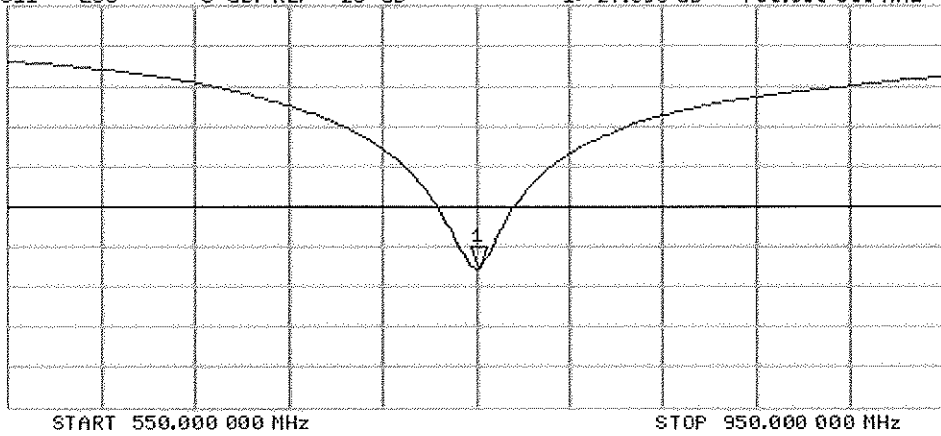
9 Feb 2012 15:46:54  
[CH1] S11 1 U FS 1: 53.955  $\Omega$  -1.4746  $\Omega$  143.91 pF 750.000 000 MHz

\*  
De1  
Cor  
Avg  
0  
HI d



CH2 S11 LOG 5 dB/REF -20 dB 1:-27.835 dB 750.000 000 MHz

Cor  
Avg  
0  
HI d



## DASY5 Validation Report for Body TSL

Date: 09.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1054**

Communication System: CW; Frequency: 750 MHz

Medium parameters used:  $f = 750$  MHz;  $\sigma = 0.96$  mho/m;  $\epsilon_r = 55.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.12, 6.12, 6.12); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

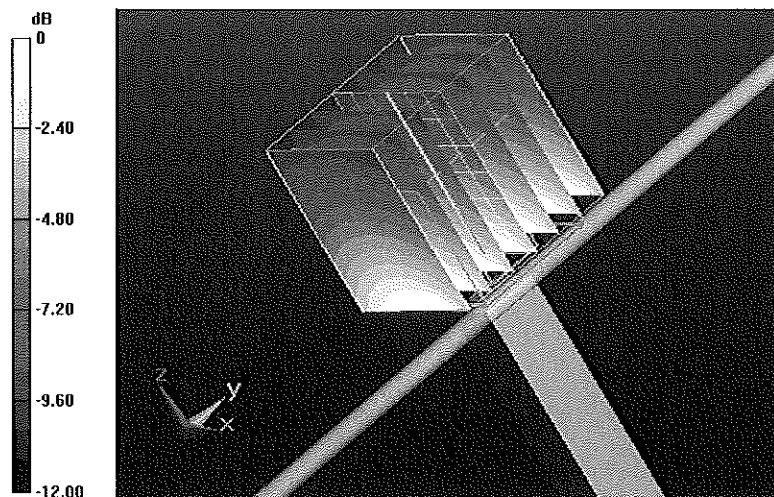
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 53.016 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.2860

**SAR(1 g) = 2.21 mW/g; SAR(10 g) = 1.46 mW/g**

Maximum value of SAR (measured) = 2.576 mW/g



0 dB = 2.580mW/g = 8.23 dB mW/g

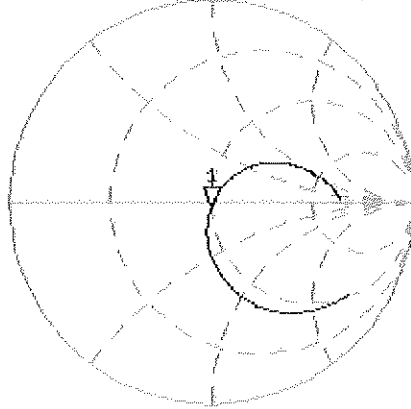


# Impedance Measurement Plot for Body TSL

9 Feb 2012 12:59:08

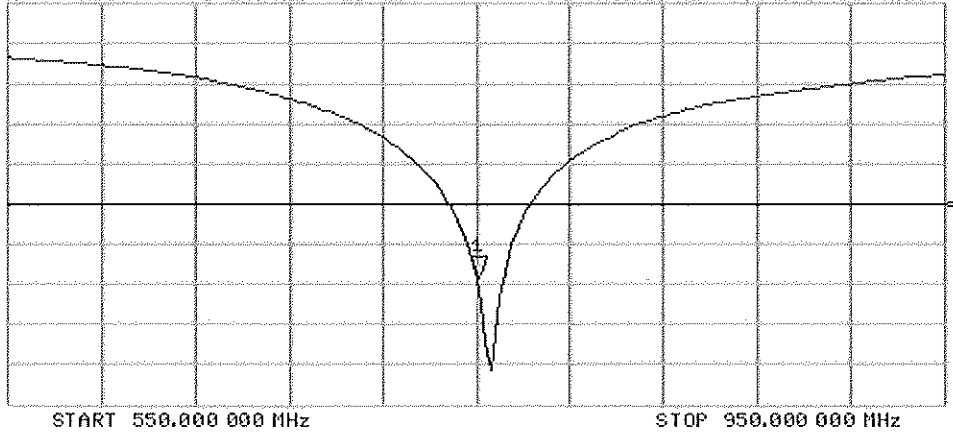
[CH1] S11 1 U FS 1: 49.650  $\Omega$  -3.4414  $\Omega$  61.663  $\mu$ F 750.000 000 MHz

\*  
De1  
Cor  
Avg  
16  
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1:-29.187 dB 750.000 000 MHz

Cor  
Avg  
16  
H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D835V2-4d132\_Feb12**

**CALIBRATION CERTIFICATE**

Object **D835V2 - SN: 4d132**

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

Calibration date: **February 03, 2012**

*✓ FOK  
5/14/12*

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: February 3, 2012

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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.

## Measurement Conditions

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

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.0     |
| <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>                    | 835 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         | 0.90 mho/m       |
| <b>Measured Head TSL parameters</b>            | (22.0 ± 0.2) °C | 41.8 ± 6 %   | 0.89 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 | 2.34 mW / g                       |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>9.45 mW / g ± 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 | 1.53 mW / g                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>6.17 mW / g ± 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         | 55.2         | 0.97 mho/m       |
| <b>Measured Body TSL parameters</b>            | (22.0 ± 0.2) °C | 53.3 ± 6 %   | 0.98 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 | 2.39 mW / g                       |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>9.41 mW / g ± 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 | 1.57 mW / g                       |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>6.21 mW / g ± 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.7 $\Omega$ - 2.3 j $\Omega$ |
| Return Loss                          | - 29.2 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 48.9 $\Omega$ - 3.5 j $\Omega$ |
| Return Loss                          | - 28.7 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.392 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 22, 2011 |

## DASY5 Validation Report for Head TSL

Date: 03.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d132**

Communication System: CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.89$  mho/m;  $\epsilon_r = 41.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.07, 6.07, 6.07); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

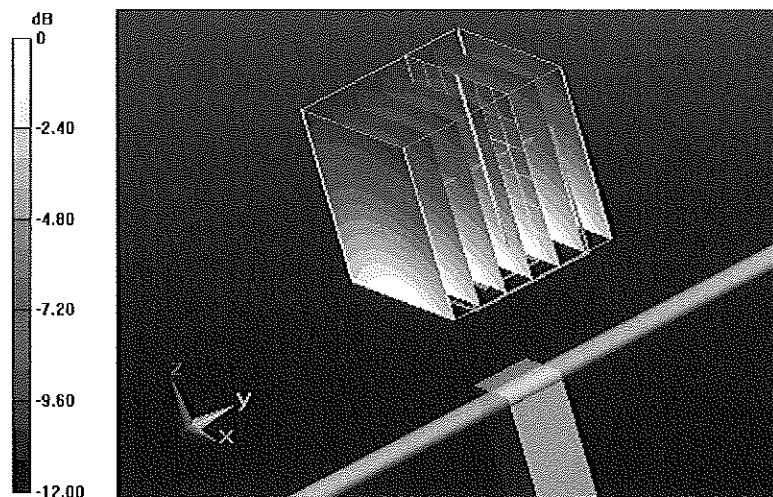
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.867 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 3.4300

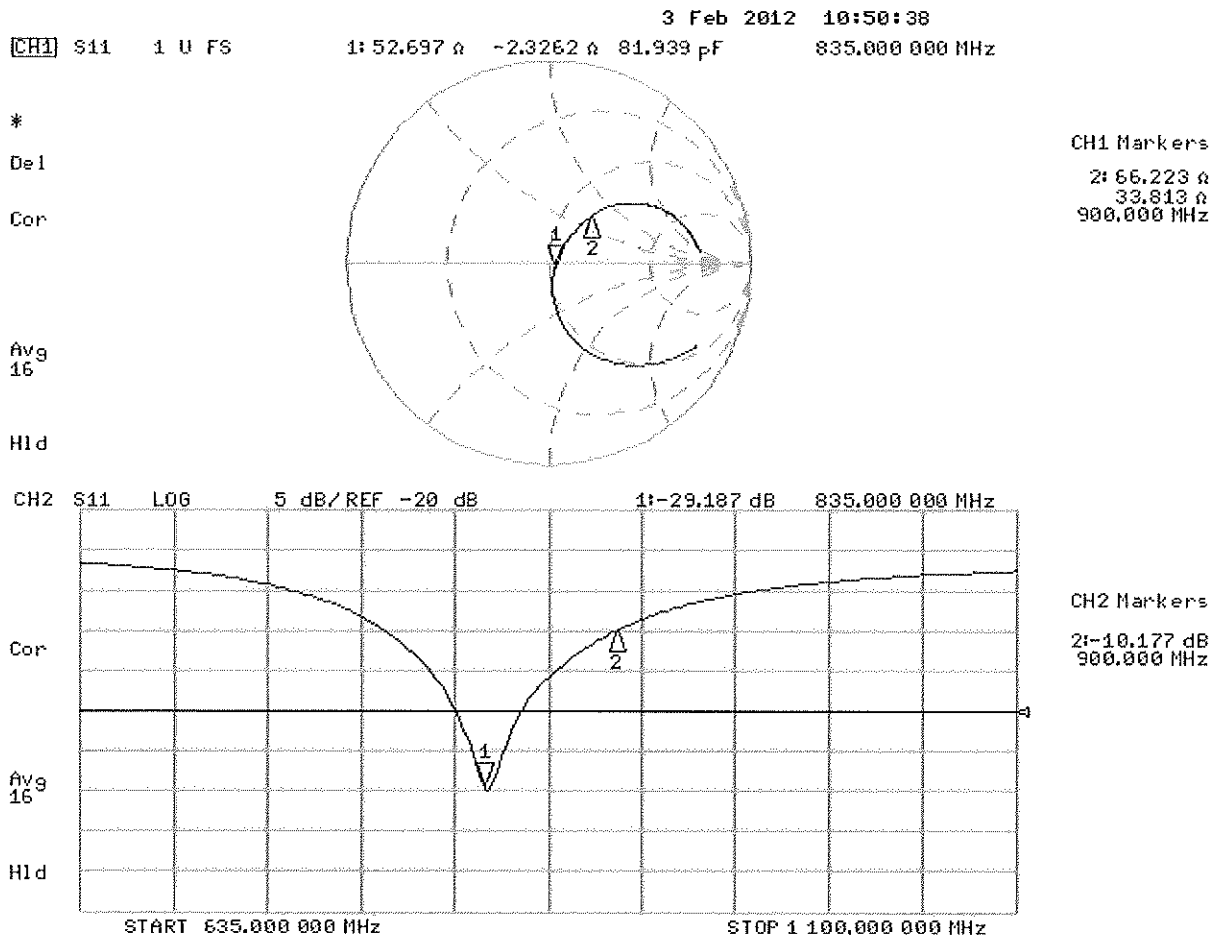
**SAR(1 g) = 2.34 mW/g; SAR(10 g) = 1.53 mW/g**

Maximum value of SAR (measured) = 2.701 mW/g



0 dB = 2.700mW/g = 8.63 dB mW/g

# Impedance Measurement Plot for Head TSL



# DASY5 Validation Report for Body TSL

Date: 02.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d132**

Communication System: CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.98$  mho/m;  $\epsilon_r = 53.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.02, 6.02, 6.02); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

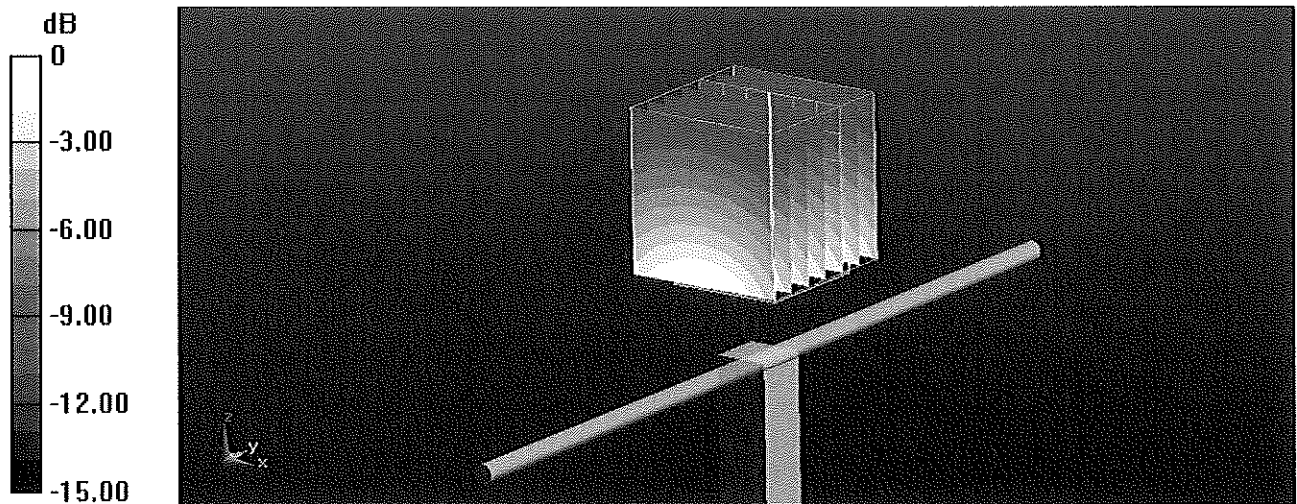
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 55.137 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.4770

**SAR(1 g) = 2.39 mW/g; SAR(10 g) = 1.57 mW/g**

Maximum value of SAR (measured) = 2.781 mW/g



0 dB = 2.780mW/g = 8.88 dB mW/g

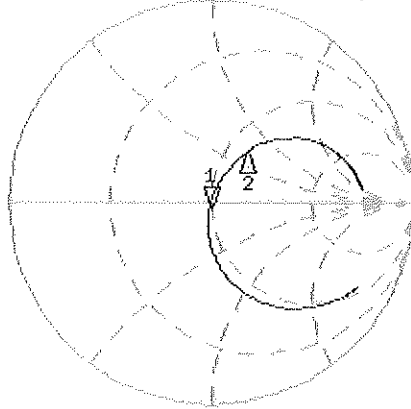


# Impedance Measurement Plot for Body TSL

2 Feb 2012 17:18:48

CH1 S11 1 U FS 1: 48.902  $\Omega$  -3.4570  $\Omega$  55.135 pF 835.000 000 MHz

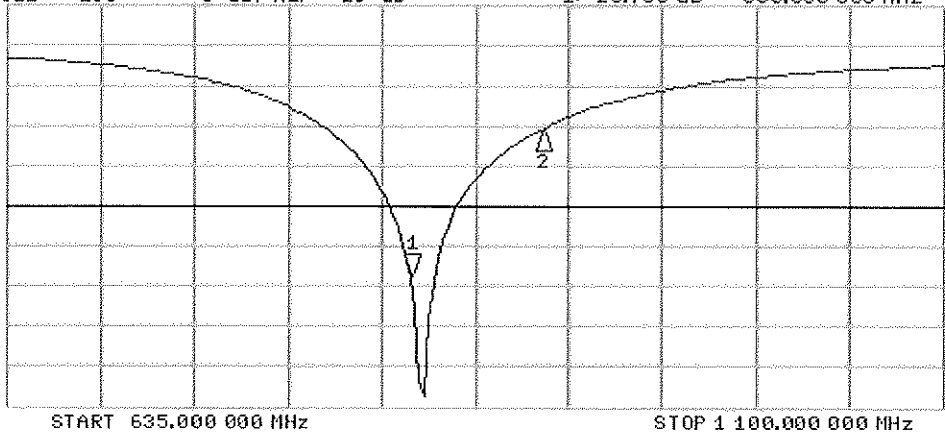
\*  
De1  
Cor  
Avg  
16  
H1d



CH1 Markers  
2: 61.023  $\Omega$   
32.770  $\Omega$   
900.000 MHz

CH2 S11 LOG 5 dB/REF -20 dB 1:-28.730 dB 835.000 000 MHz

Cor  
Avg  
16  
H1d



CH2 Markers  
2: -10.497 dB  
900.000 MHz



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D835V2-4d119\_Apr12**

## CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d119**

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

Calibration date: **April 20, 2012**

*✓ KOK  
5/4/12*

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | GB37480704         | 05-Oct-11 (No. 217-01451)         | Oct-12                 |
| Power sensor HP 8481A       | US37292783         | 05-Oct-11 (No. 217-01451)         | Oct-12                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 27-Mar-12 (No. 217-01530)         | Apr-13                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 27-Mar-12 (No. 217-01533)         | Apr-13                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-11 (No. ES3-3205_Dec11)    | Dec-12                 |
| DAE4                        | SN: 601            | 04-Jul-11 (No. DAE4-601_Jul11)    | Jul-12                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power sensor HP 8481A       | MY41092317         | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

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

Issued: April 20, 2012

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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.

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.

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.1     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 15 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 835 MHz $\pm$ 1 MHz    |             |

## Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 41.5           | 0.90 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 41.1 $\pm$ 6 % | 0.90 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 2.36 mW / g                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>9.42 mW / g <math>\pm</math> 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 1.55 mW / g                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>6.19 mW / g <math>\pm</math> 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 55.2           | 0.97 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 54.5 $\pm$ 6 % | 1.01 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 2.47 mW / g                                      |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>9.56 mW / g <math>\pm</math> 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 1.62 mW / g                                      |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>6.31 mW / g <math>\pm</math> 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.3 $\Omega$ - 2.2 j $\Omega$ |
| Return Loss                          | - 32.1 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 46.8 $\Omega$ - 4.3 j $\Omega$ |
| Return Loss                          | - 25.2 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.386 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 | June 29, 2010 |

## DASY5 Validation Report for Head TSL

Date: 20.04.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d119**

Communication System: CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.9$  mho/m;  $\epsilon_r = 41.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.07, 6.07, 6.07); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

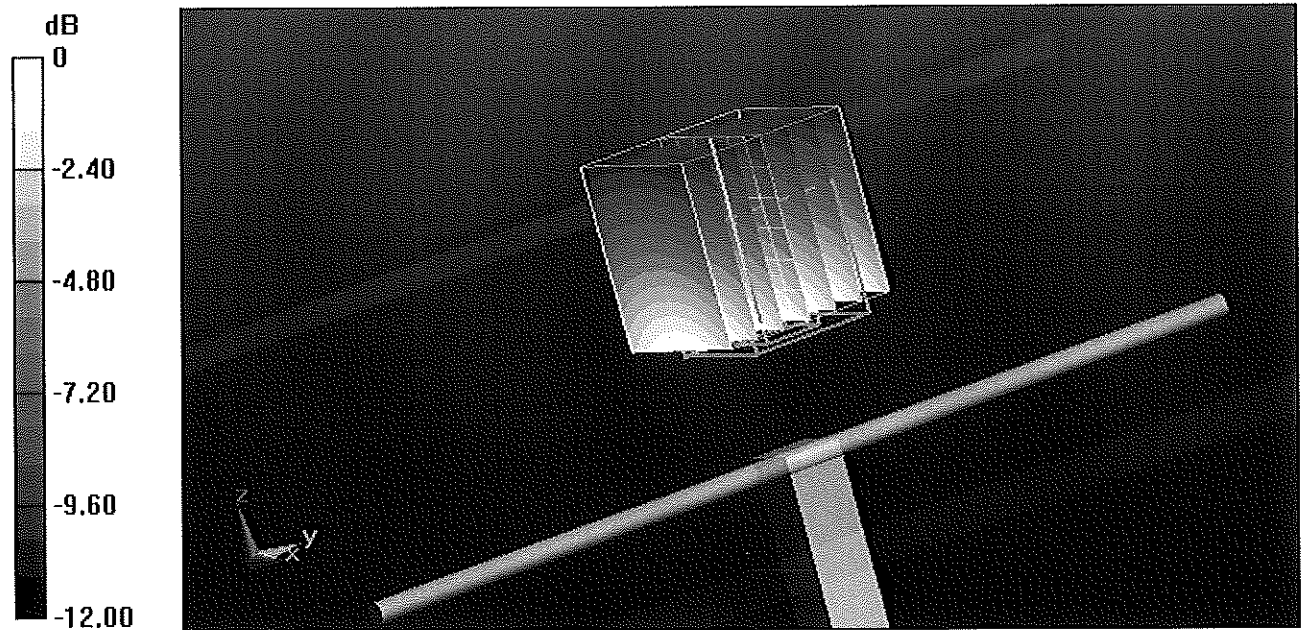
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.041 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 3.480 mW/g

**SAR(1 g) = 2.36 mW/g; SAR(10 g) = 1.55 mW/g**

Maximum value of SAR (measured) = 2.75 mW/g

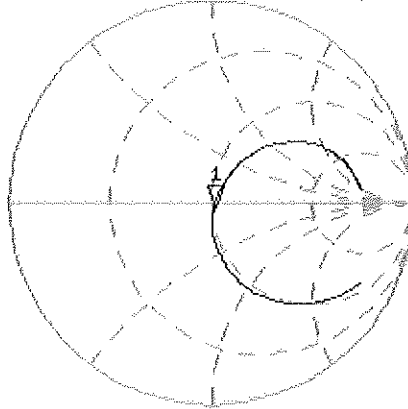


0 dB = 2.75 mW/g = 8.79 dB mW/g

# Impedance Measurement Plot for Head TSL

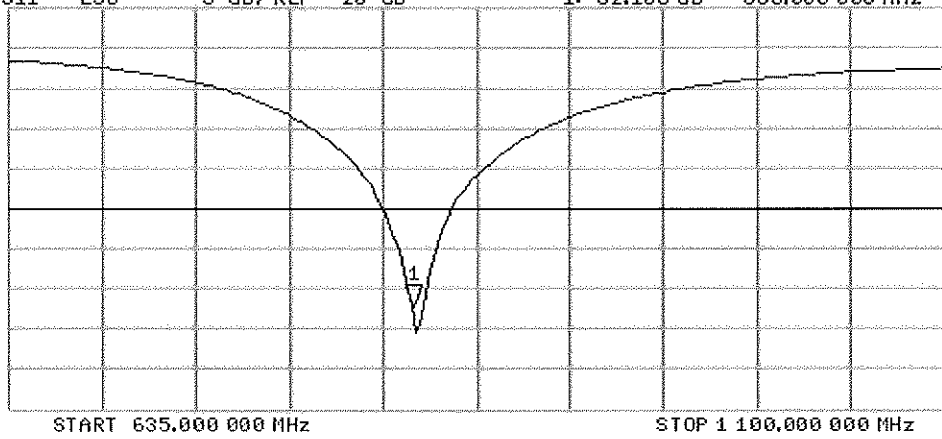
20 Apr 2012 09:34:14  
[CH1] S11 1 U FS 1: 51.279  $\Omega$  -2.1582  $\Omega$  88.316  $\mu\text{F}$  835.000 000 MHz

\*  
Del  
Cor  
Avg  
16  
H1 d



CH2 S11 LOG 5 dB/REF -20 dB 1: -32.106 dB 835.000 000 MHz

Cor  
Avg  
16  
H1 d



## DASY5 Validation Report for Body TSL

Date: 19.04.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d119**

Communication System: CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 1.01$  mho/m;  $\epsilon_r = 54.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.02, 6.02, 6.02); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

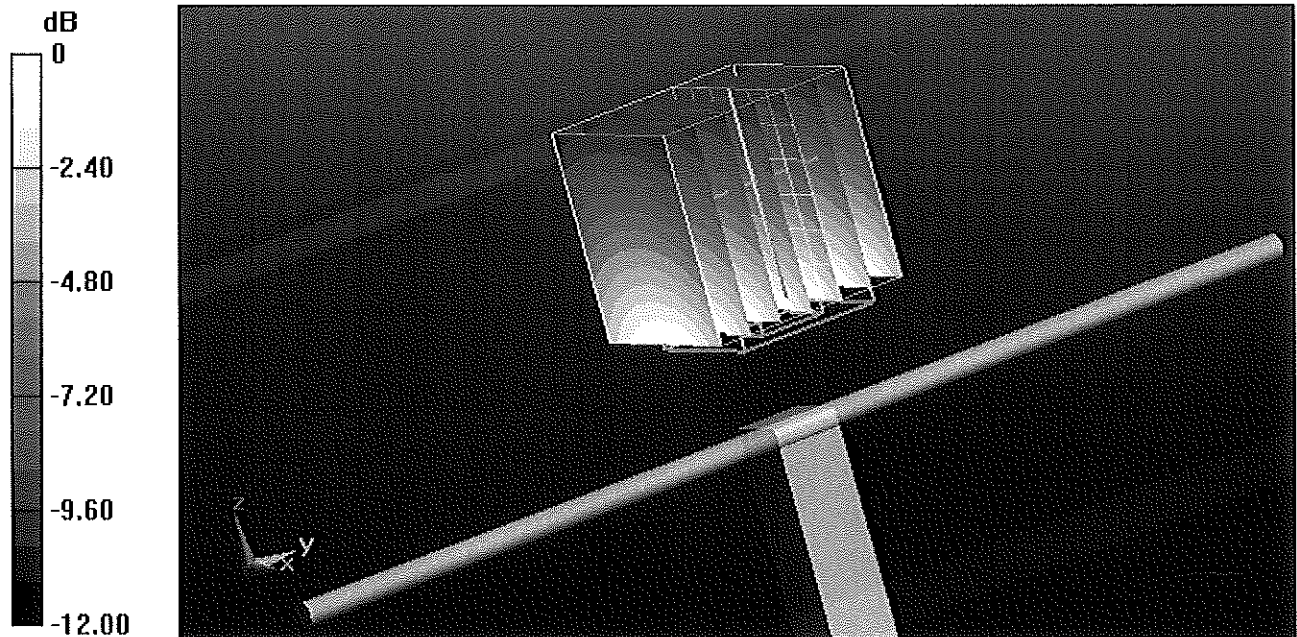
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 55.253 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.571 mW/g

**SAR(1 g) = 2.47 mW/g; SAR(10 g) = 1.62 mW/g**

Maximum value of SAR (measured) = 2.87 mW/g



0 dB = 2.87 mW/g = 9.16 dB mW/g



# Impedance Measurement Plot for Body TSL

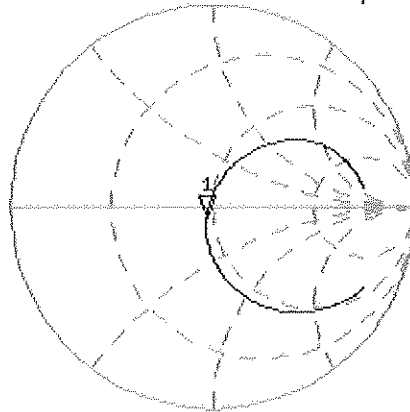
19 Apr 2012 10:20:53  
[CH1] S11 1 U FS 1: 46.836  $\Omega$  -4.3203  $\Omega$  44.118  $\mu\text{F}$  835.000 000 MHz

\*  
De1

Cor

Avg  
16

H1 d

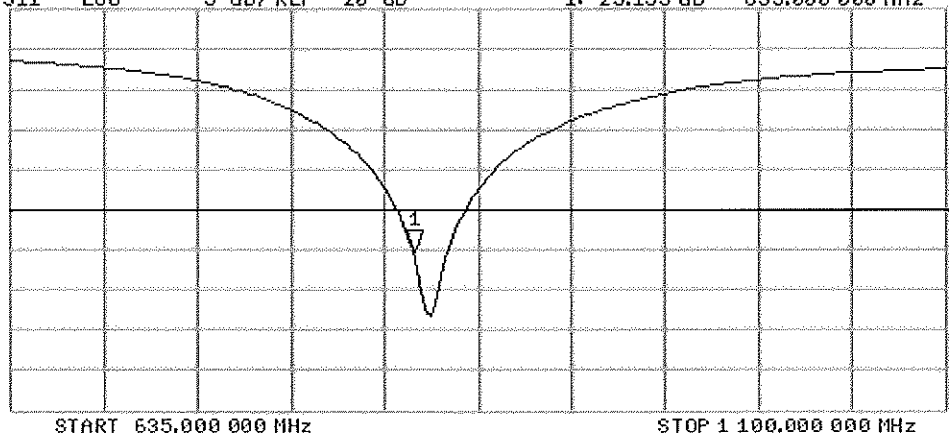


CH2 S11 LOG 5 dB/REF -20 dB 1:-25.155 dB 835.000 000 MHz

Cor

AVG  
16

H1 d





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Multilateral Agreement for the recognition of calibration certificates

Client **PC Test**

Certificate No: **D835V2-4d047\_Jan12**

**CALIBRATION CERTIFICATE**

Object **D835V2 - SN: 4d047**

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

Calibration date: **January 25, 2012** ✓ KOK  
2/6/12

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

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

Calibrated by: **Israe El-Naouq**      Function: **Laboratory Technician**      Signature: *Israe El-Naouq*

Approved by: **Katja Pokovic**      Technical Manager      *[Signature]*

Issued: January 25, 2012

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Accreditation No.: **SCS 108**

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Multilateral Agreement for the recognition of calibration certificates

**Glossary:**

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

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

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

## Measurement Conditions

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.0     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 15 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 835 MHz $\pm$ 1 MHz    |             |

## Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 41.5           | 0.90 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 41.8 $\pm$ 6 % | 0.89 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 2.33 mW / g                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 9.41 mW / g $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 1.53 mW / g                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 6.17 mW / g $\pm$ 16.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 55.2           | 0.97 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 53.3 $\pm$ 6 % | 0.98 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 2.39 mW / g                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 9.41 mW / g $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 1.57 mW / g                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 6.21 mW / g $\pm$ 16.5 % (k=2) |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.7 $\Omega$ - 3.0 j $\Omega$ |
| Return Loss                          | - 29.4 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 47.8 $\Omega$ - 5.0 j $\Omega$ |
| Return Loss                          | - 25.0 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.386 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 | August 16, 2006 |

# DASY5 Validation Report for Head TSL

Date: 25.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d047**

---

Communication System: CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.89$  mho/m;  $\epsilon_r = 41.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.07, 6.07, 6.07); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

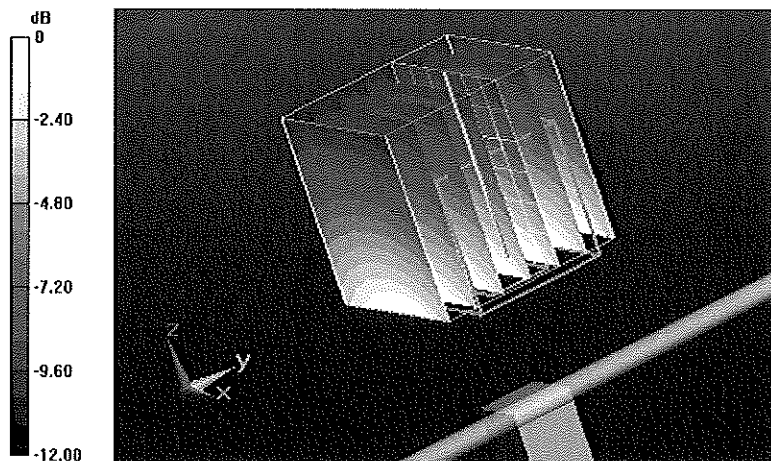
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.752 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.4130

**SAR(1 g) = 2.33 mW/g; SAR(10 g) = 1.53 mW/g**

Maximum value of SAR (measured) = 2.709 mW/g



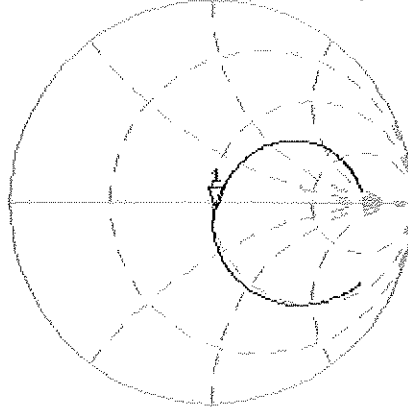
0 dB = 2.710mW/g = 8.66 dB mW/g

# Impedance Measurement Plot for Head TSL

25 Jan 2012 15:57:44

[CH1] S11 1 U ES 1: 51.688  $\Omega$  -3.0098  $\Omega$  53.329 pF 835.000 000 MHz

\*  
Del  
Cor



Avg  
16

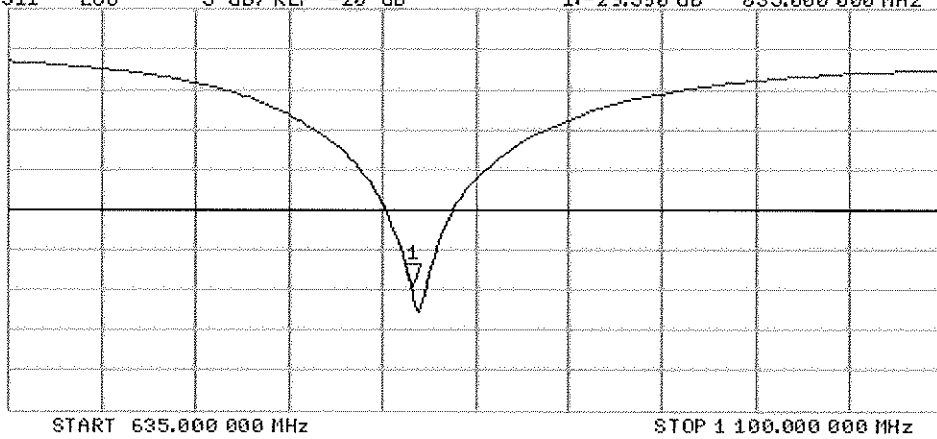
HI d

CH2 S11 LOG 5 dB/REF -20 dB 1:-29.390 dB 835.000 000 MHz

Cor

Avg  
16

HI d



# DASY5 Validation Report for Body TSL

Date: 25.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d047**

---

Communication System: CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.98$  mho/m;  $\epsilon_r = 53.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.02, 6.02, 6.02); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

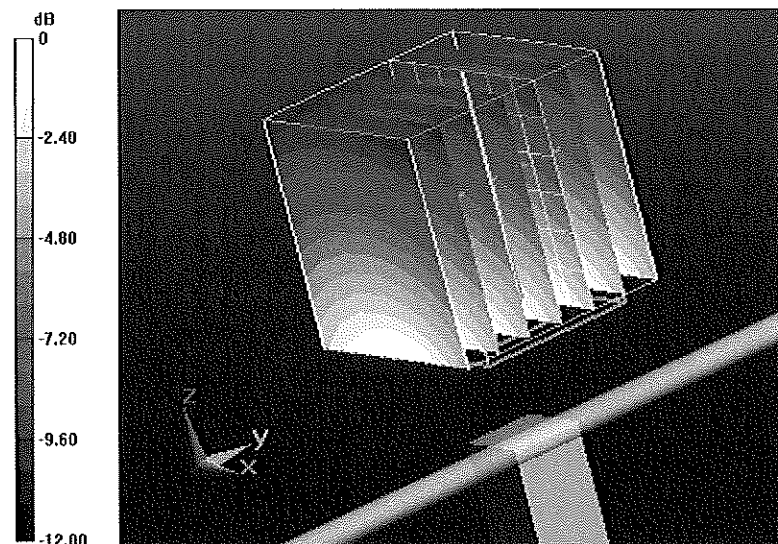
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 54.995 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.4790

**SAR(1 g) = 2.39 mW/g; SAR(10 g) = 1.57 mW/g**

Maximum value of SAR (measured) = 2.767 mW/g



0 dB = 2.770mW/g = 8.85 dB mW/g

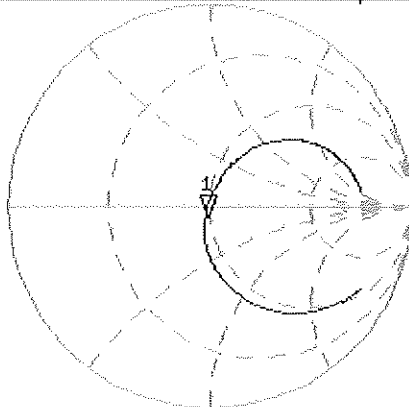


# Impedance Measurement Plot for Body TSL

25 Jan 2012 11:09:13

[CH1] S11 1 U FS 1:47.283  $\angle$  -5.0176  $\angle$  37.987  $\mu$ F 835.000 000 MHz

\*  
De1  
Cor



Avg  
16

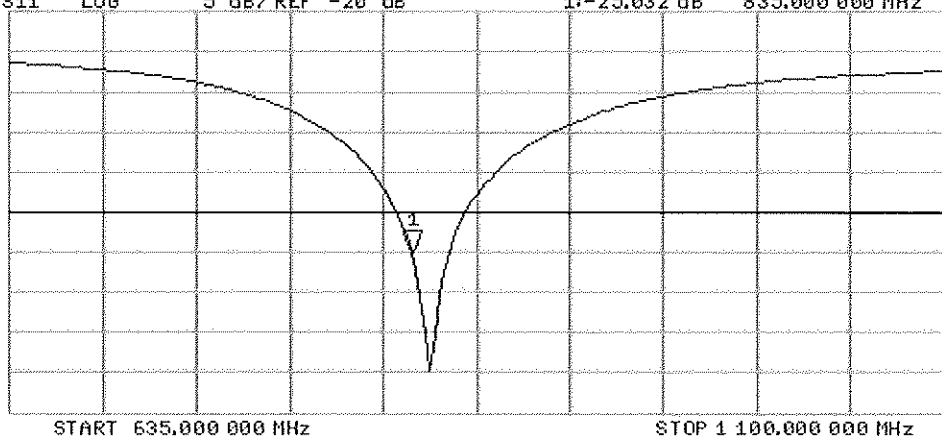
H1 d

CH2 S11 LOG 5 dB/REF -20 dB 1:-25.032 dB 835.000 000 MHz

Cor

Avg  
16

H1 d





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Client **PC Test**

Certificate No: **D1900V2-502\_Feb12**

## CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 502**

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

Calibration date: **February 22, 2012**

*KOK  
2/27/12*

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: February 22, 2012

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**Glossary:**

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

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

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- d) DAS4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

## Measurement Conditions

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

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

## Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 40.0           | 1.40 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 40.4 $\pm$ 6 % | 1.40 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 9.79 mW / g                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>39.2 mW / g <math>\pm</math> 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 5.17 mW / g                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>20.7 mW / g <math>\pm</math> 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 53.3           | 1.52 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 53.0 $\pm$ 6 % | 1.56 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 9.88 mW / g                                      |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>38.9 mW / g <math>\pm</math> 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 5.17 mW / g                                      |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>20.5 mW / g <math>\pm</math> 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.7 $\Omega$ + 7.2 j $\Omega$ |
| Return Loss                          | - 22.8 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 47.2 $\Omega$ + 7.6 j $\Omega$ |
| Return Loss                          | - 21.6 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.206 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 | November 14, 1998 |

# DASY5 Validation Report for Head TSL

Date: 22.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 502**

Communication System: CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.4$  mho/m;  $\epsilon_r = 40.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

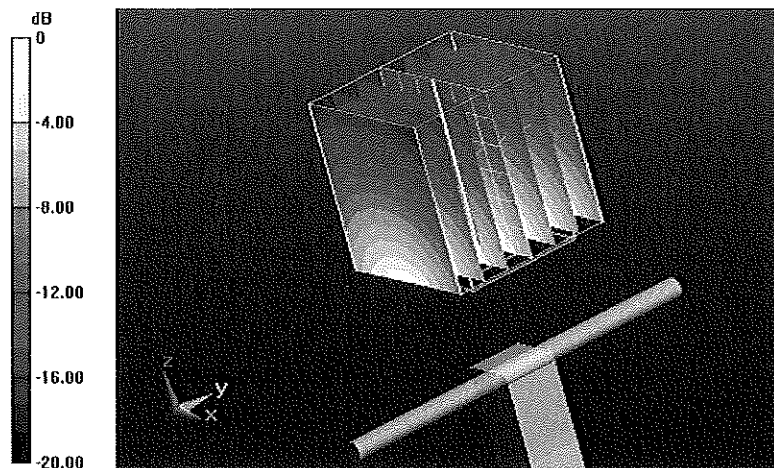
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.315 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 17.4000

**SAR(1 g) = 9.79 mW/g; SAR(10 g) = 5.17 mW/g**

Maximum value of SAR (measured) = 12.015 mW/g



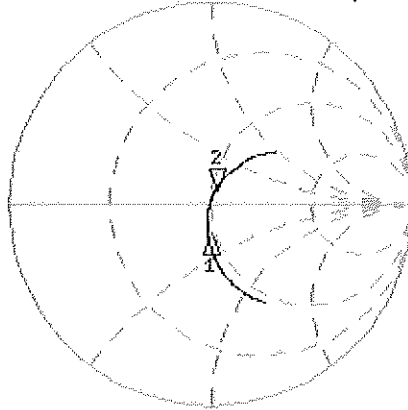
0 dB = 12.020mW/g = 21.60 dB mW/g

# Impedance Measurement Plot for Head TSL

22 Feb 2012 09:44:49

CH1 S11 1 u FS 2: 51.697  $\Omega$  7.1936  $\Omega$  601.74  $\mu$ H 1 900.000 000 MHz

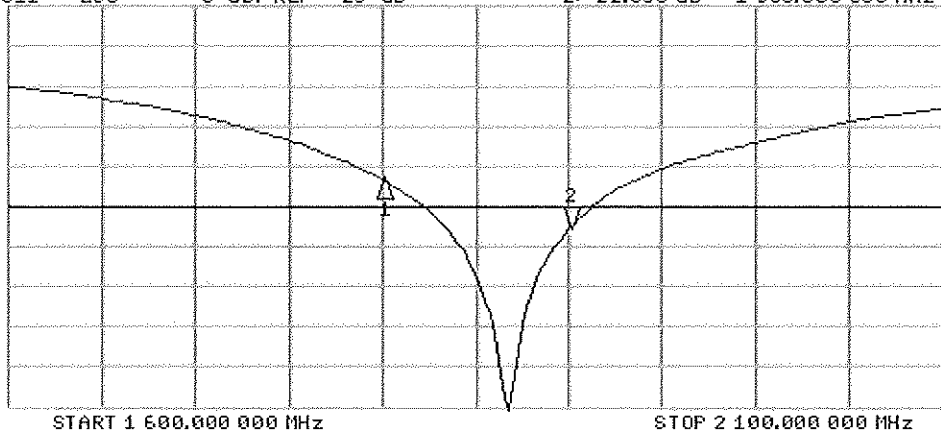
\*  
De1  
Cor  
Avg  
9  
H1d



CH1 Markers  
1: 46.764  $\Omega$   
-14.023  $\Omega$   
1.00000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 2:-22.806 dB 1 900.000 000 MHz

Cor  
Avg  
9  
H1d



CH2 Markers  
1:-16.642 dB  
1.00000 GHz

## DASY5 Validation Report for Body TSL

Date: 22.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 502**

---

Communication System: CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.56$  mho/m;  $\epsilon_r = 53$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

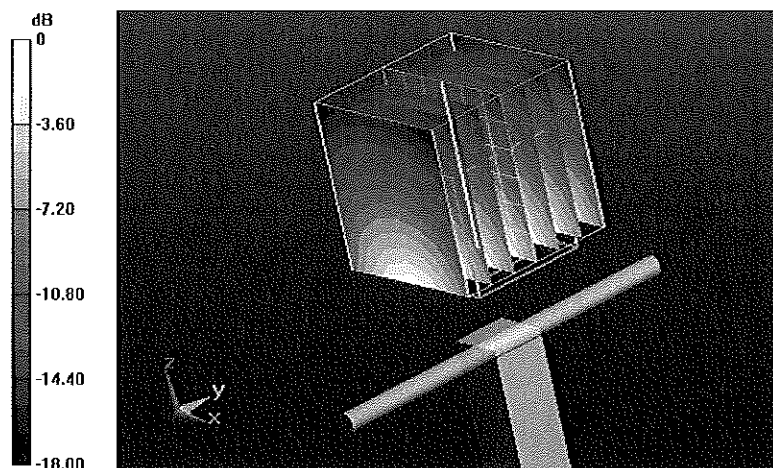
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.607 V/m; Power Drift = 0.0093 dB

Peak SAR (extrapolated) = 17.4260

**SAR(1 g) = 9.88 mW/g; SAR(10 g) = 5.17 mW/g**

Maximum value of SAR (measured) = 12.532 mW/g



0 dB = 12.530mW/g = 21.96 dB mW/g

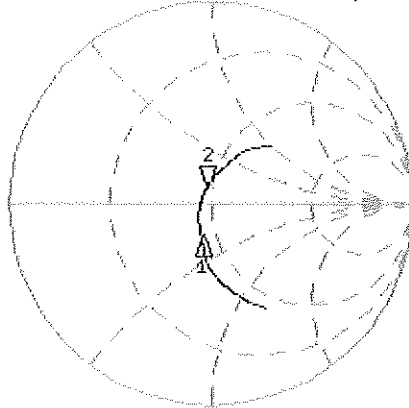


# Impedance Measurement Plot for Body TSL

22 Feb 2012 09:44:23

[CH1] S11 1 U FS 2:47.184  $\Omega$  2:6.133  $\Omega$  -637.73  $\mu$ H 1.900.000.000 MHz

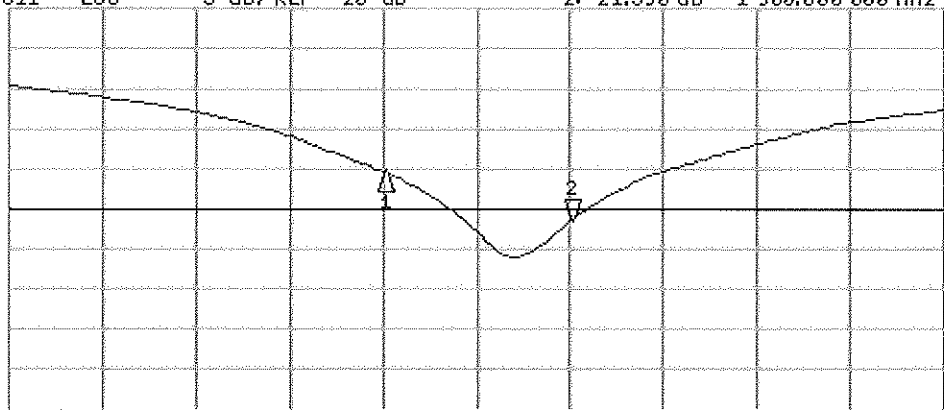
\*  
Del  
Cor  
Avg  
16  
H1d



CH1 Markers  
1: 43.225  $\Omega$   
-14.492  $\Omega$   
1.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 2:-21.590 dB 1.900.000.000 MHz

Cor  
Avg  
16  
H1d



CH2 Markers  
1:-15.413 dB  
1.80000 GHz

START 1.600.000.000 MHz

STOP 2.000.000.000 MHz



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D1900V2-5d149\_Feb12**

**CALIBRATION CERTIFICATE**

Object: **D1900V2 - SN: 5d149**

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

Calibration date: **February 22, 2012**

*✓ KOK  
4/11/12*

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

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

Calibrated by: **Israe El-Naouq** (Name), **Laboratory Technician** (Function), *Israe El-Naouq* (Signature)

Approved by: **Katja Pokovic** (Name), **Technical Manager** (Function), *Katja Pokovic* (Signature)

Issued: February 23, 2012

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

**Glossary:**

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

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

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

## Measurement Conditions

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

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.0     |
| <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 $\pm$ 1 MHz   |             |

## Head TSL parameters

The following parameters and calculations were applied.

|  | Temperature         | Permittivity   | Conductivity         |
|--|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 40.0           | 1.40 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 40.4 $\pm$ 6 % | 1.40 mho/m $\pm$ 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 | 9.80 mW / g                                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>39.3 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 | 5.18 mW / g                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>20.7 mW / g <math>\pm</math> 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 $\pm$ 0.2) °C | 53.0 $\pm$ 6 % | 1.56 mho/m $\pm$ 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 | 9.99 mW / g                                      |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>39.3 mW / g <math>\pm</math> 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 | 5.23 mW / g                                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>20.7 mW / g <math>\pm</math> 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.4 $\Omega$ + 5.5 j $\Omega$ |
| Return Loss                          | - 24.6 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 48.0 $\Omega$ + 6.7 j $\Omega$ |
| Return Loss                          | - 23.0 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 | March 11, 2011 |

# DASY5 Validation Report for Head TSL

Date: 22.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d149**

Communication System: CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.4$  mho/m;  $\epsilon_r = 40.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

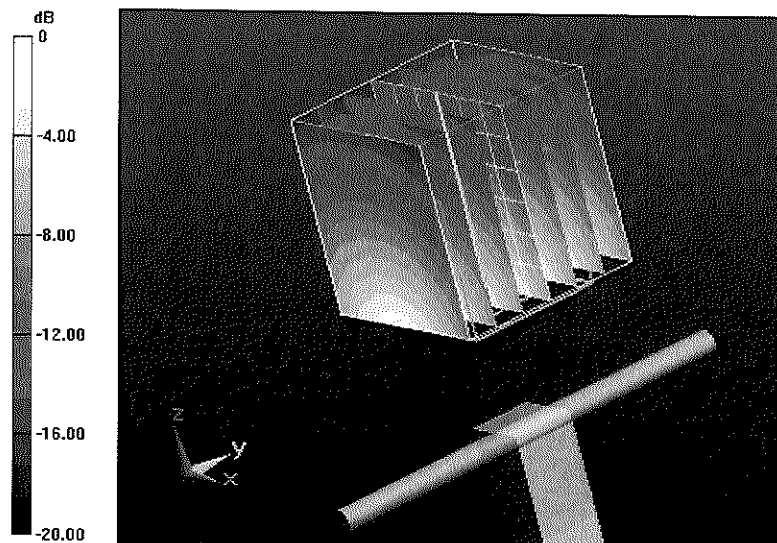
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.685 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 17.4710

**SAR(1 g) = 9.8 mW/g; SAR(10 g) = 5.18 mW/g**

Maximum value of SAR (measured) = 12.114 mW/g



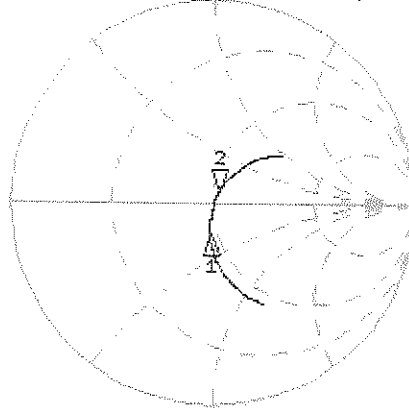
0 dB = 12.110mW/g = 21.66 dB mW/g

# Impedance Measurement Plot for Head TSL

22 Feb 2012 09:56:56

CH1 S11 1 U FS 2: 52.387  $\Omega$  5.5859  $\Omega$  461.20  $\mu$ H 1 900.000 000 MHz

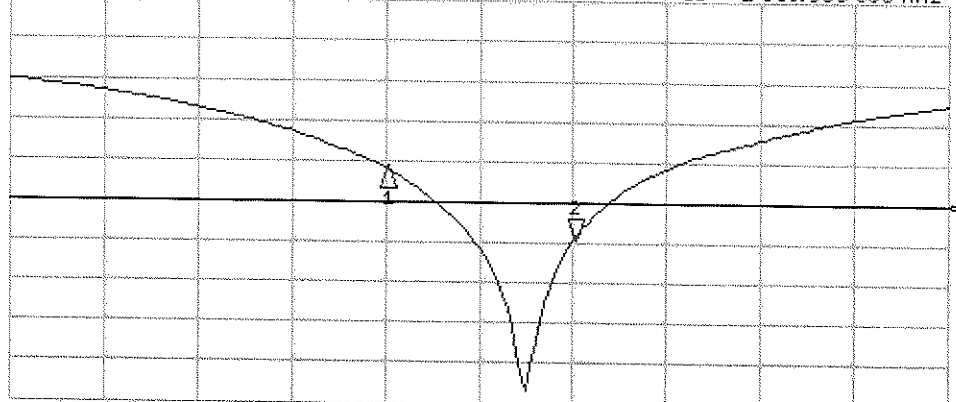
\*  
Del  
Cor  
Avg  
16  
H1 d



CH1 Markers  
1: 46.287  $\Omega$   
-15.180  $\Omega$   
1.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 2: -24.647 dB 1 900.000 000 MHz

Cor  
Avg  
16  
H1 d



CH2 Markers  
1: -15.901 dB  
1.80000 GHz

START 1 600.000 000 MHz STOP 2 100.000 000 MHz

# DASY5 Validation Report for Body TSL

Date: 06.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d149**

Communication System: CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.56$  mho/m;  $\epsilon_r = 53$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

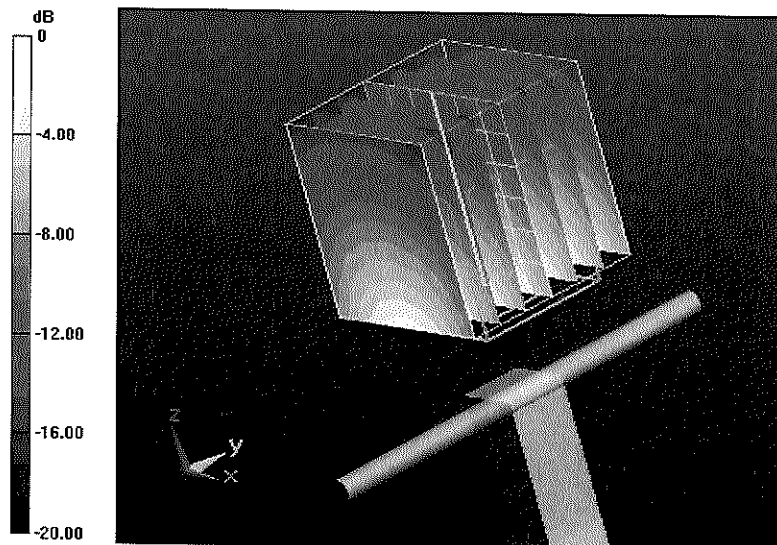
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.047 V/m; Power Drift = 0.0017 dB

Peak SAR (extrapolated) = 18.1310

**SAR(1 g) = 9.99 mW/g; SAR(10 g) = 5.23 mW/g**

Maximum value of SAR (measured) = 12.672 mW/g



0 dB = 12.670mW/g = 22.06 dB mW/g

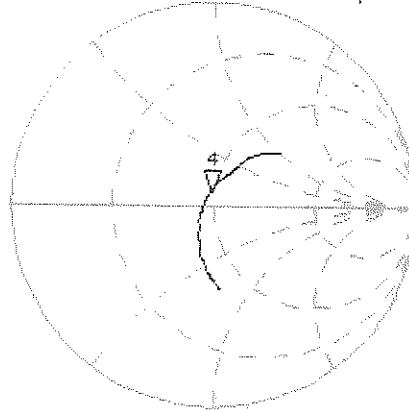


# Impedance Measurement Plot for Body TSL

6 Feb 2012 12:15:29

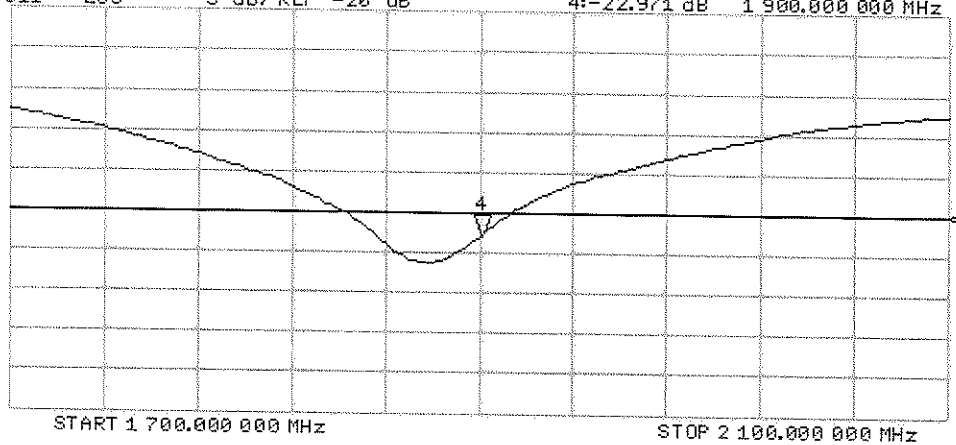
CH1 S11 1 U FS 4: 47.961  $\Omega$  6.8680  $\Omega$  558.55  $\mu$ H 1 900.000 000 MHz

\*  
Del  
Ca  
Avg  
15  
H1 d



CH2 S11 LOG 5 dB/REF -20 dB 4:-22.971 dB 1 900.000 000 MHz

Ca  
Avg  
15  
H1 d





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Accreditation No.: **SCS 108**

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Client **PC Test**

Certificate No: **D2450V2-797\_Jan12**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 797**

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

Calibration date: **January 24, 2012**

*✓/KOK  
2/6/2012*

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: January 24, 2012

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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:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

## Measurement Conditions

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.0     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 2450 MHz ± 1 MHz       |             |

## Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters             | 22.0 °C         | 39.2         | 1.80 mho/m       |
| Measured Head TSL parameters            | (22.0 ± 0.2) °C | 39.2 ± 6 %   | 1.85 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

## SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                            |
|---|--------------------|----------------------------|
| SAR measured  | 250 mW input power | 13.2 mW / g                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 52.1 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                            |
|---|--------------------|----------------------------|
| SAR measured  | 250 mW input power | 6.12 mW / g                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.3 mW / g ± 16.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 52.7         | 1.95 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 50.6 ± 6 %   | 2.01 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 13.0 mW / g                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 50.8 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 | 6.01 mW / g                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 23.7 mW / g ± 16.5 % (k=2) |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.0 $\Omega$ + 4.7 j $\Omega$ |
| Return Loss                          | - 24.6 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.1 $\Omega$ + 5.4 j $\Omega$ |
| Return Loss                          | - 25.3 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.151 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 | January 24, 2006 |

# DASY5 Validation Report for Head TSL

Date: 24.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 797**

Communication System: CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.85$  mho/m;  $\epsilon_r = 39.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

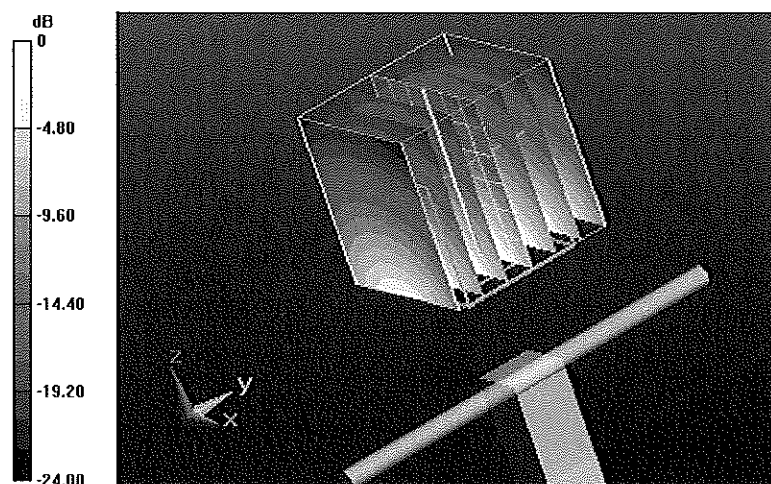
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.248 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.3550

**SAR(1 g) = 13.2 mW/g; SAR(10 g) = 6.12 mW/g**

Maximum value of SAR (measured) = 17.017 mW/g



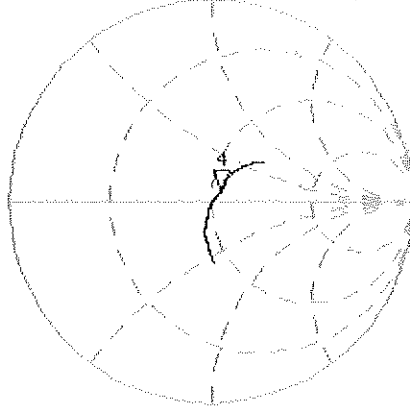
0 dB = 17.020mW/g = 24.62 dB mW/g

# Impedance Measurement Plot for Head TSL

24 Jan 2012 11:11:23

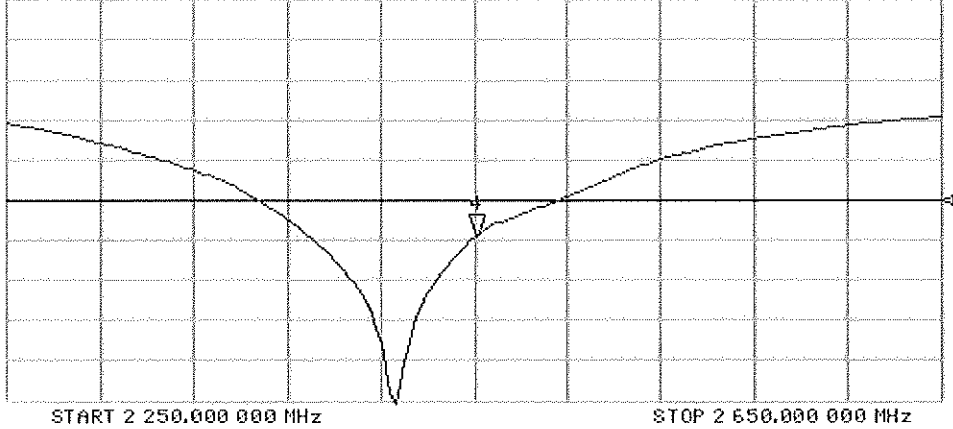
[CH1] S11 1 U FS 4:53.992 n 4:6563 n 382.40 pH 2 450.000 000 MHz

\*  
De1  
CA  
Avg  
16  
H1d



CH2 S11 LOG 5 dB/REF -20 dB 4:-24.593 dB 2 450.000 000 MHz

CA  
Avg  
16  
H1d



START 2 250.000 000 MHz

STOP 2 550.000 000 MHz

## DASY5 Validation Report for Body TSL

Date: 23.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 797**

---

Communication System: CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.01$  mho/m;  $\epsilon_r = 50.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

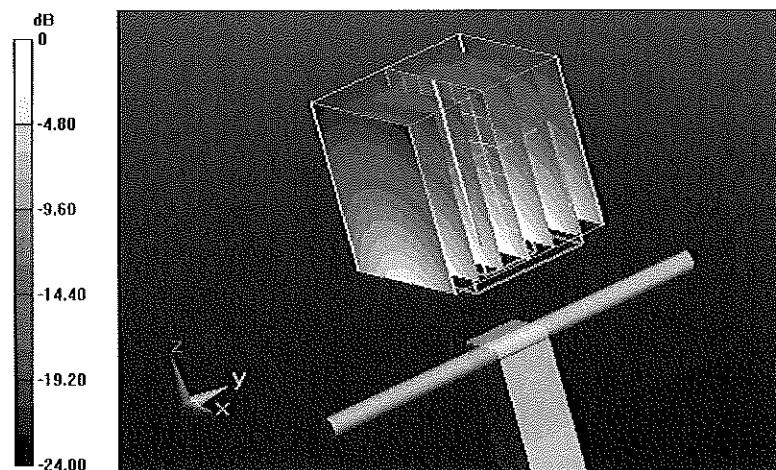
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.727 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 26.9680

**SAR(1 g) = 13 mW/g; SAR(10 g) = 6.01 mW/g**

Maximum value of SAR (measured) = 17.222 mW/g



0 dB = 17.220mW/g = 24.72 dB mW/g

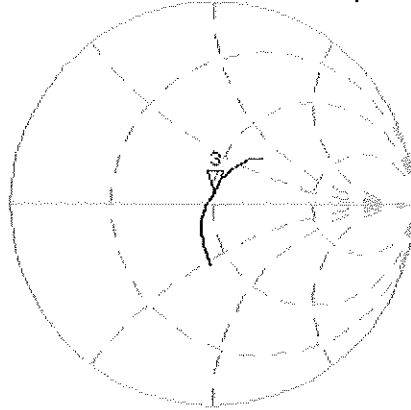


# Impedance Measurement Plot for Body TSL

23 Jan 2012 11:15:12

[CH2] S11 1 U FS 3: 50.423 4 5.4316 4 352.05  $\mu$ H 2 450.000 000 MHz

\*  
De1  
CA



Avg  
16

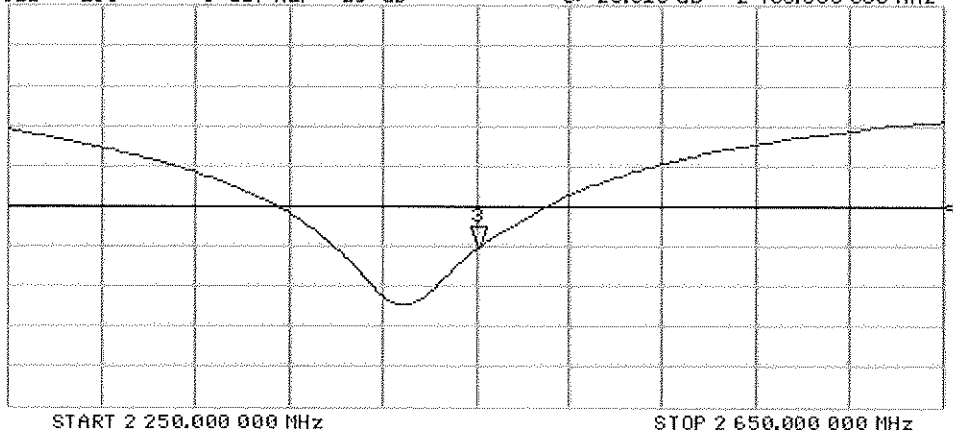
H1d

CH2 S11 LOG 5 dB/ REF -20 dB 3:-25.315 dB 2 450.000 000 MHz

CA

Avg  
16

H1d





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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 **PC Test**

Certificate No: **D5GHzV2-1057\_Jan12**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1057**

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

Calibration date: **January 19, 2012**

*✓KOK  
2/6/12*

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)     | Scheduled Calibration |
|-----------------------------|--------------------|--------------------------------|-----------------------|
| Power meter EPM-442A        | GB37480704         | 05-Oct-11 (No. 217-01451)      | Oct-12                |
| Power sensor HP 8481A       | US37292783         | 05-Oct-11 (No. 217-01451)      | Oct-12                |
| Reference 20 dB Attenuator  | SN: 5086 (20g)     | 29-Mar-11 (No. 217-01368)      | Apr-12                |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 29-Mar-11 (No. 217-01371)      | Apr-12                |
| Reference Probe EX3DV4      | SN: 3503           | 30-Dec-11 (No. EX3-3503_Dec11) | Dec-12                |
| DAE4                        | SN: 601            | 04-Jul-11 (No. DAE4-601_Jul11) | Jul-12                |

| Secondary Standards       | ID #             | Check Date (in house)             | Scheduled Check        |
|---------------------------|------------------|-----------------------------------|------------------------|
| Power sensor HP 8481A     | MY41092317       | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06   | 100005           | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

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

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

Issued: January 19, 2012

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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

## Measurement Conditions

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

|                              |  |                                  |
|------------------------------|--|----------------------------------|
| DASY Version                 | DASY5  | V52.8.0                          |
| Extrapolation                | Advanced Extrapolation                                   |                                  |
| Phantom                      | Modular Flat Phantom V5.0                                |                                  |
| Distance Dipole Center - TSL | 10 mm  | with Spacer                      |
| Zoom Scan Resolution         | dx, dy = 4.0 mm, dz = 1.4 mm                             | Graded Ratio = 1.4 (Z direction) |
| Frequency                    | 5200 MHz ± 1 MHz<br>5500 MHz ± 1 MHz<br>5800 MHz ± 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 ± 0.2) °C | 36.3 ± 6 %   | 4.60 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °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 | 7.90 mW / g                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 79.1 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                            |
|---|--------------------|----------------------------|
| SAR measured  | 100 mW input power | 2.26 mW / g                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 22.6 mW / g ± 16.5 % (k=2) |

## 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 | 35.8 ± 6 %   | 4.90 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °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 | 8.49 mW / g                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 84.9 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                            |
|---|--------------------|----------------------------|
| SAR measured  | 100 mW input power | 2.42 mW / g                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.2 mW / g ± 16.5 % (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 | 35.3 ± 6 %   | 5.22 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °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 | 7.95 mW / g                       |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>79.5 mW / g ± 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                   |
|---|--------------------|-----------------------------------|
| SAR measured  | 100 mW input power | 2.26 mW / g                       |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>22.6 mW / g ± 16.5 % (k=2)</b> |

### 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 | 49.2 ± 6 %   | 5.46 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 7.33 mW / g                       |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>73.4 mW / g ± 18.1 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                   |
|---|--------------------|-----------------------------------|
| SAR measured  | 100 mW input power | 2.05 mW / g                       |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>20.6 mW / g ± 17.6 % (k=2)</b> |

### 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 | 48.7 ± 6 %   | 5.86 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 7.87 mW / g                       |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>78.9 mW / g ± 18.1 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                   |
|---|--------------------|-----------------------------------|
| SAR measured  | 100 mW input power | 2.19 mW / g                       |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>21.9 mW / g ± 17.6 % (k=2)</b> |

### 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 | 48.2 ± 6 %   | 6.28 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 7.42 mW / g                       |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>74.3 mW / g ± 18.1 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                   |
|---|--------------------|-----------------------------------|
| SAR measured  | 100 mW input power | 2.06 mW / g                       |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>20.6 mW / g ± 17.6 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.6 $\Omega$ - 8.0 j $\Omega$ |
| Return Loss                          | - 21.9 dB                      |

### Antenna Parameters with Head TSL at 5500 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.5 $\Omega$ - 3.8 j $\Omega$ |
| Return Loss                          | - 27.8 dB                      |

### Antenna Parameters with Head TSL at 5800 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.4 $\Omega$ - 3.9 j $\Omega$ |
| Return Loss                          | - 27.0 dB                      |

### Antenna Parameters with Body TSL at 5200 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.6 $\Omega$ - 5.7 j $\Omega$ |
| Return Loss                          | - 24.9 dB                      |

### Antenna Parameters with Body TSL at 5500 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.9 $\Omega$ - 2.7 j $\Omega$ |
| Return Loss                          | - 31.4 dB                      |

### Antenna Parameters with Body TSL at 5800 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 48.1 $\Omega$ - 3.3 j $\Omega$ |
| Return Loss                          | - 28.2 dB                      |

## General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.202 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 | November 27, 2006 |



## DASY5 Validation Report for Head TSL

Date: 19.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1057**

---

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz  
Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.6$  mho/m;  $\epsilon_r = 36.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.9$  mho/m;  $\epsilon_r = 35.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.22$  mho/m;  $\epsilon_r = 35.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

### DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41), ConvF(4.91, 4.91, 4.91), ConvF(4.81, 4.81, 4.81); Calibrated: 30.12.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

### **Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:**

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.590 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 29.4530

**SAR(1 g) = 7.9 mW/g; SAR(10 g) = 2.26 mW/g**

Maximum value of SAR (measured) = 18.158 mW/g

### **Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:**

Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 64.129 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 33.6870

**SAR(1 g) = 8.49 mW/g; SAR(10 g) = 2.42 mW/g**

Maximum value of SAR (measured) = 20.088 mW/g

### **Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:**

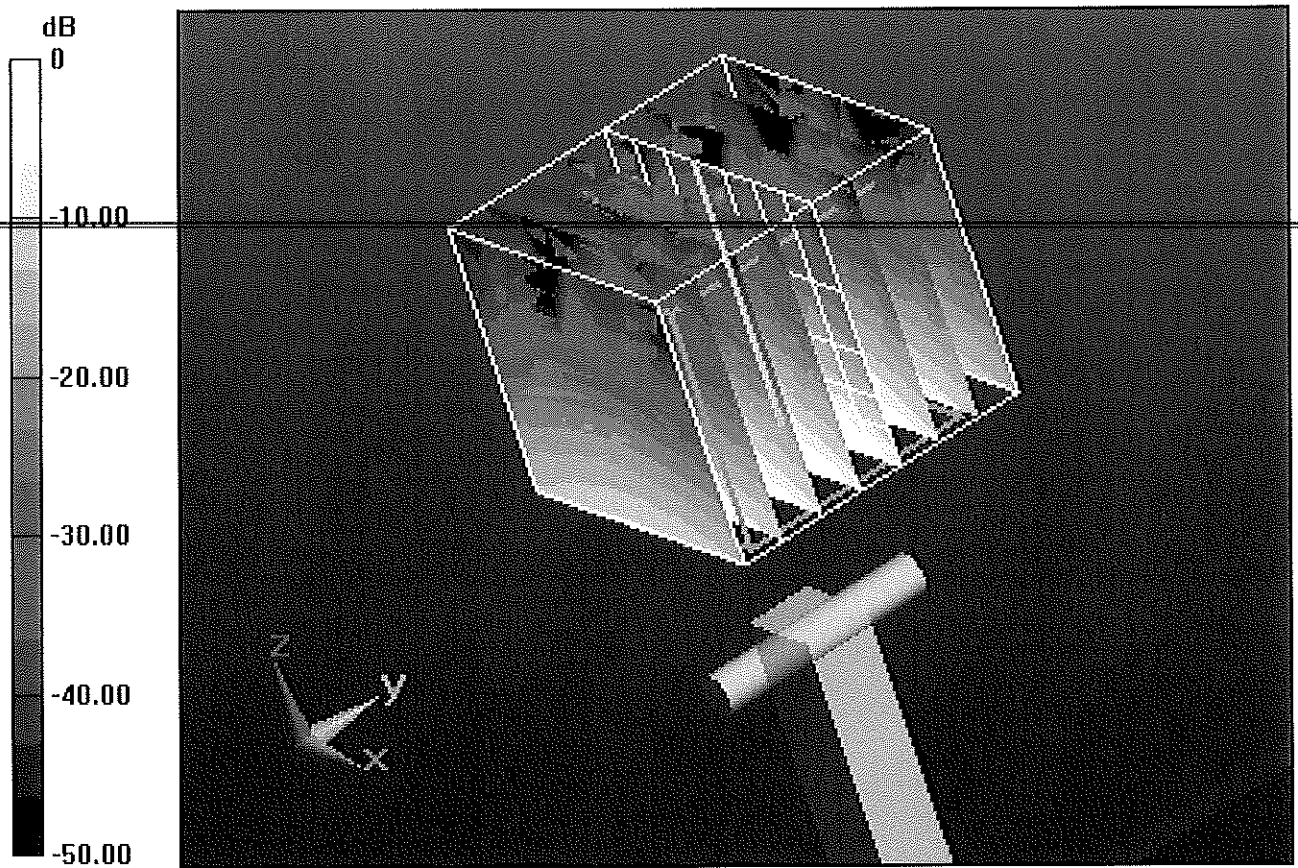
Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 60.728 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 33.3080

**SAR(1 g) = 7.95 mW/g; SAR(10 g) = 2.26 mW/g**

Maximum value of SAR (measured) = 19.277 mW/g



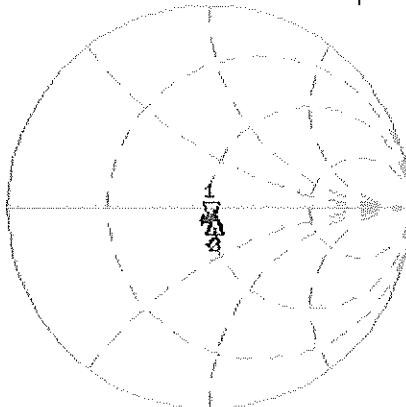
0 dB = 19.280mW/g = 25.70 dB mW/g

# Impedance Measurement Plot for Head TSL

19 Jan 2012 10:41:39

[CH1] S11 4 U EG 1: 49.551  $\Omega$  0.0020  $\Omega$  3.9249 pF 5 200.000 000 MHz

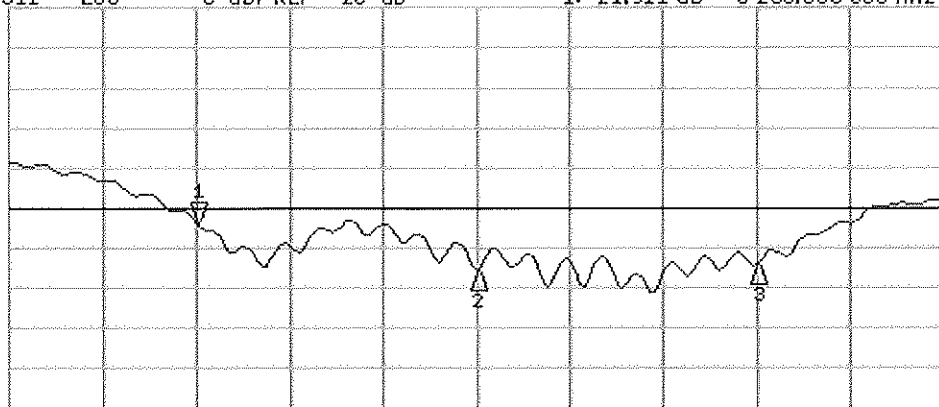
\*  
De1  
Cor  
Avg  
16  
H1 d



CH1 Markers  
2: 51.461  $\Omega$   
-3.8457  $\Omega$   
5.50000 GHz  
3: 52.420  $\Omega$   
-3.9121  $\Omega$   
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -21.911 dB 5 200.000 000 MHz

Cor  
Avg  
16  
H1 d



CH2 Markers  
2: -27.845 dB  
5.50000 GHz  
3: -26.962 dB  
5.80000 GHz

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz

## DASY5 Validation Report for Body TSL

Date: 18.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1057**

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Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz  
Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.46$  mho/m;  $\epsilon_r = 49.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.86$  mho/m;  $\epsilon_r = 48.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.28$  mho/m;  $\epsilon_r = 48.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91), ConvF(4.43, 4.43, 4.43), ConvF(4.38, 4.38, 4.38); Calibrated: 30.12.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 57.280 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 28.9110

**SAR(1 g) = 7.33 mW/g; SAR(10 g) = 2.05 mW/g**

Maximum value of SAR (measured) = 17.276 mW/g

**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 57.884 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 33.5680

**SAR(1 g) = 7.87 mW/g; SAR(10 g) = 2.19 mW/g**

Maximum value of SAR (measured) = 19.055 mW/g

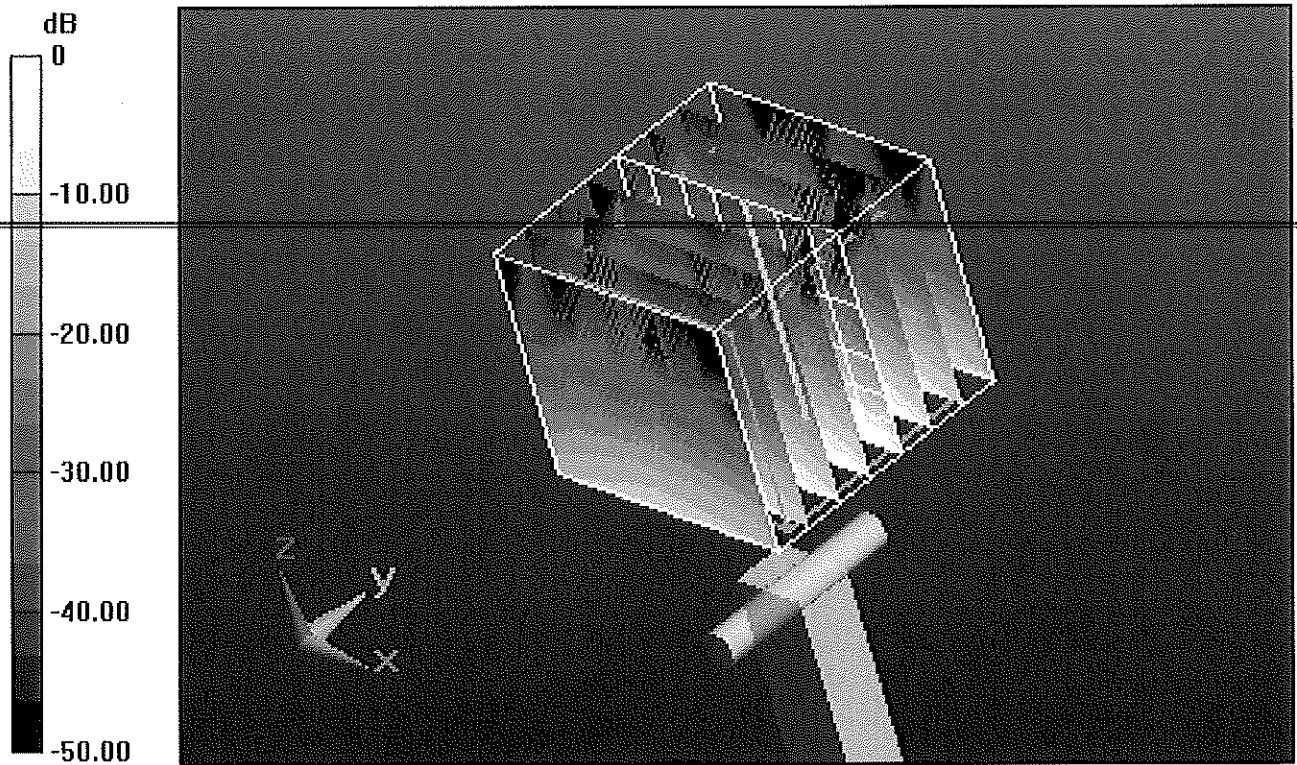
**Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 54.430 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 34.4850

**SAR(1 g) = 7.42 mW/g; SAR(10 g) = 2.06 mW/g**

Maximum value of SAR (measured) = 18.495 mW/g



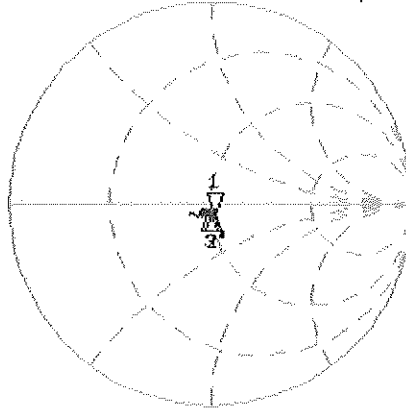
0 dB = 18.500mW/g = 25.34 dB mW/g

# Impedance Measurement Plot for Body TSL

18 Jan 2012 11:08:23

[CH1] S11 1 U FS 1: 50.562  $\Omega$  5: 216.2  $\Omega$  5: 3538 pF 5: 200.000 000 MHz

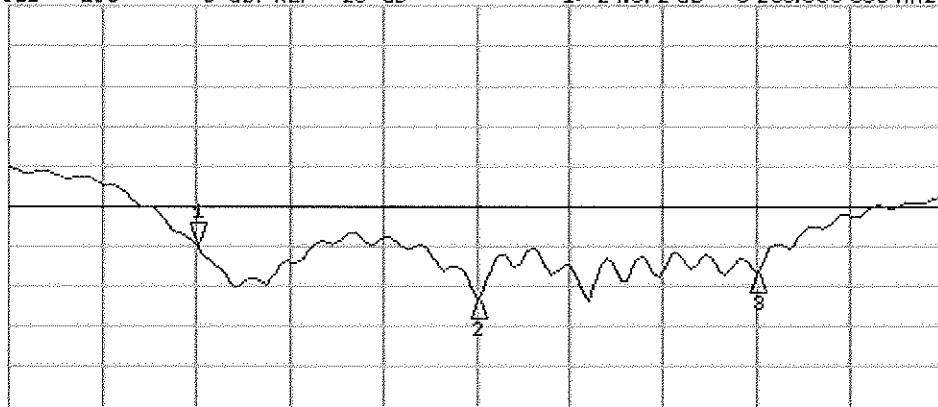
\*  
Del  
Cor  
Avg  
16  
H1d



CH1 Markers  
2: 49.947  $\Omega$   
-2.6934  $\Omega$   
5.50000 GHz  
3: 48.137  $\Omega$   
-3.3438  $\Omega$   
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1: -24.872 dB 5: 200.000 000 MHz

Cor  
Avg  
16  
H1d



CH2 Markers  
2: -31.393 dB  
5.50000 GHz  
3: -28.173 dB  
5.80000 GHz

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D5GHzV2-1120\_Feb12**

**CALIBRATION CERTIFICATE**

Object **D5GHzV2 - SN: 1120**

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

Calibration date: **February 01, 2012**

*KOK  
5/14/12*

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | GB37480704         | 05-Oct-11 (No. 217-01451)         | Oct-12                 |
| Power sensor HP 8481A       | US37292783         | 05-Oct-11 (No. 217-01451)         | Oct-12                 |
| Reference 20 dB Attenuator  | SN: 5086 (20g)     | 29-Mar-11 (No. 217-01368)         | Apr-12                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 29-Mar-11 (No. 217-01371)         | Apr-12                 |
| Reference Probe EX3DV4      | SN: 3503           | 30-Dec-11 (No. EX3-3503_Dec11)    | Dec-12                 |
| DAE4                        | SN: 601            | 04-Jul-11 (No. DAE4-601_Jul11)    | Jul-12                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power sensor HP 8481A       | MY41092317         | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

Calibrated by: **Name: Jeton Kastrati, Function: Laboratory Technician, Signature: [Signature]**

Approved by: **Name: Katja Pokovic, Function: Technical Manager, Signature: [Signature]**

Issued: February 6, 2012

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



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Accreditation No.: **SCS 108**

**Glossary:**

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

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

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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