

**APPENDIX F – DIPOLE CALIBRATION**



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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Celltech**

Certificate No: **CLA150-4007\_Apr17**

## CALIBRATION CERTIFICATE

Object **CLA150 - SN: 4007**

Calibration procedure(s) **QA CAL-15.v8**  
**Calibration procedure for system validation sources below 700 MHz**

Calibration date: **April 27, 2017**

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 NRP             | SN: 104778         | 04-Apr-17 (No. 217-02521/02522)   | Apr-18                 |
| Power sensor NRP-Z91        | SN: 103244         | 04-Apr-17 (No. 217-02521)         | Apr-18                 |
| Power sensor NRP-Z91        | SN: 103245         | 04-Apr-17 (No. 217-02522)         | Apr-18                 |
| Reference 20 dB Attenuator  | SN: 5277 (20x)     | 07-Apr-17 (No. 217-02528)         | Apr-18                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529)         | Apr-18                 |
| Reference Probe EX3DV4      | SN: 3877           | 31-Dec-16 (No. EX3-3877_Dec16)    | Dec-17                 |
| DAE4                        | SN: 654            | 12-Aug-16 (No. DAE4-654_Aug16)    | Aug-17                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power meter E4419B          | SN: GB41293874     | 06-Apr-16 (No. 217-02285/02284)   | In house check: Jun-18 |
| Power sensor E4412A         | SN: MY41498087     | 06-Apr-16 (No. 217-02285)         | In house check: Jun-18 |
| Power sensor E4412A         | SN: 000110210      | 06-Apr-16 (No. 217-02284)         | In house check: Jun-18 |
| RF generator HP 8648C       | SN: US3642U01700   | 04-Aug-99 (in house check Jun-16) | In house check: Jun-18 |
| Network Analyzer HP 8753E   | SN: US37390585     | 18-Oct-01 (in house check Oct-16) | In house check: Oct-17 |

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

Issued: April 27, 2017

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Accreditation No.: **SCS 0108**

**Glossary:**

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. 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                            | V52.10.0                         |
| Extrapolation        | Advanced Extrapolation           |                                  |
| Phantom              | ELI4 Flat Phantom                | Shell thickness: $2 \pm 0.2$ mm  |
| EUT Positioning      | Touch Position                   |                                  |
| Zoom Scan Resolution | $dx, dy = 4.0$ mm, $dz = 1.4$ mm | Graded Ratio = 1.4 (Z direction) |
| Frequency            | 150 MHz $\pm$ 1 MHz              |                                  |

## Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity           |
|-----------------------------------------|---------------------|----------------|------------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 52.3           | 0.76 mho/m             |
| Measured Head TSL parameters            | $(22.0 \pm 0.2)$ °C | $50.5 \pm 6$ % | $0.76$ 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                                          | 1 W input power  | 3.90 W/kg                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W | <b>3.87 W/kg <math>\pm</math> 18.4 % (k=2)</b> |

|                                                         |                  |                                                |
|---------------------------------------------------------|------------------|------------------------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition        |                                                |
| SAR measured                                            | 1 W input power  | 2.58 W/kg                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W | <b>2.56 W/kg <math>\pm</math> 18.0 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity           |
|-----------------------------------------|---------------------|----------------|------------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 61.9           | 0.80 mho/m             |
| Measured Body TSL parameters            | $(22.0 \pm 0.2)$ °C | $62.2 \pm 6$ % | $0.82$ 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                                          | 1 W input power  | 4.08 W/kg                                      |
| SAR for nominal Body TSL parameters                   | normalized to 1W | <b>4.01 W/kg <math>\pm</math> 18.4 % (k=2)</b> |

|                                                         |                  |                                                |
|---------------------------------------------------------|------------------|------------------------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition        |                                                |
| SAR measured                                            | 1 W input power  | 2.70 W/kg                                      |
| SAR for nominal Body TSL parameters                     | normalized to 1W | <b>2.65 W/kg <math>\pm</math> 18.0 % (k=2)</b> |

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 44.5 $\Omega$ - 7.6 j $\Omega$ |
| Return Loss                          | - 20.1 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 47.6 $\Omega$ - 9.1 j $\Omega$ |
| Return Loss                          | - 20.3 dB                      |

### Additional EUT Data

|                 |                   |
|-----------------|-------------------|
| Manufactured by | SPEAG             |
| Manufactured on | December 12, 2013 |

## DASY5 Validation Report for Head TSL

Date: 27.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4007**

Communication System: UID 0 - CW; Frequency: 150 MHz

Medium parameters used:  $f = 150 \text{ MHz}$ ;  $\sigma = 0.76 \text{ S/m}$ ;  $\epsilon_r = 50.5$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(12.04, 12.04, 12.04); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 12.08.2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

**CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan**

**(81x81x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) =  $5.42 \text{ W/kg}$

**CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan,**

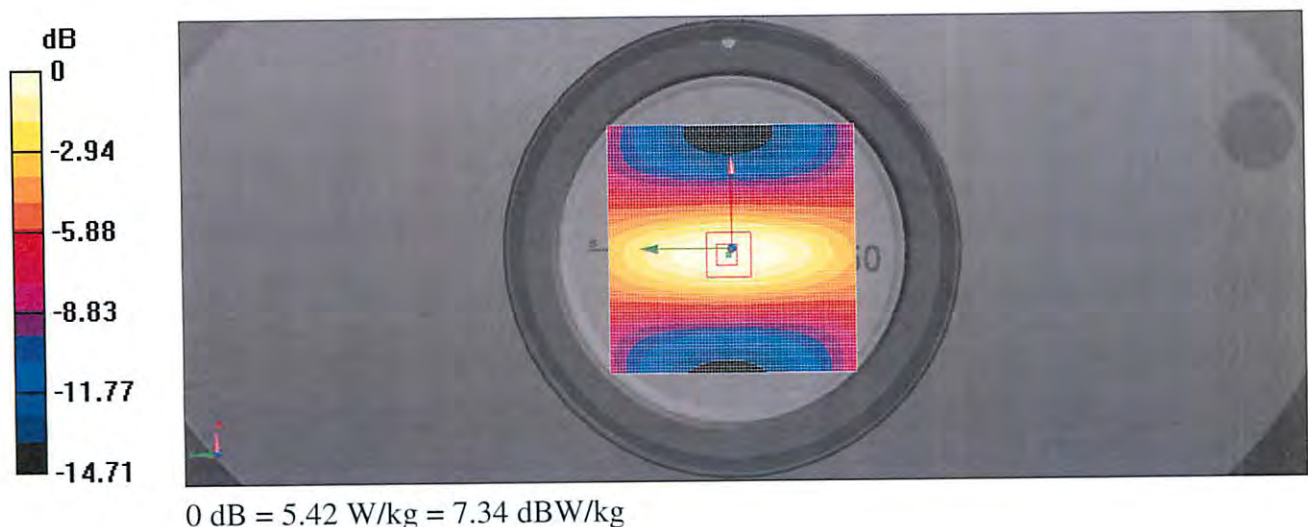
**dist=1.4mm (8x10x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value =  $74.83 \text{ V/m}$ ; Power Drift =  $0.02 \text{ dB}$

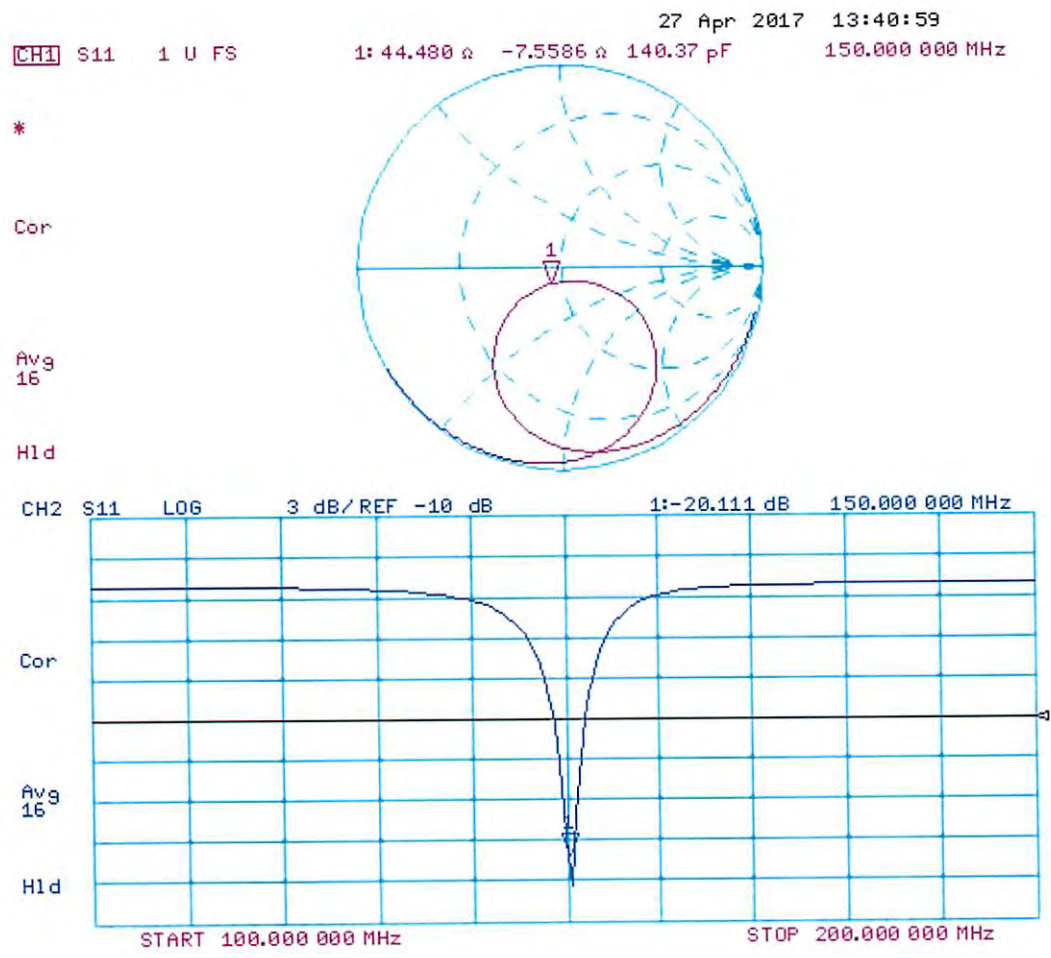
Peak SAR (extrapolated) =  $7.04 \text{ W/kg}$

**SAR(1 g) =  $3.9 \text{ W/kg}$ ; SAR(10 g) =  $2.58 \text{ W/kg}$**

Maximum value of SAR (measured) =  $5.40 \text{ W/kg}$



Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 27.04.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4007**

Communication System: UID 0 - CW; Frequency: 150 MHz

Medium parameters used:  $f = 150$  MHz;  $\sigma = 0.82$  S/m;  $\epsilon_r = 62.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(11.54, 11.54, 11.54); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 12.08.2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7413)

### **CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan**

**(81x81x1):** Interpolated grid:  $dx=1.500$  mm,  $dy=1.500$  mm

Maximum value of SAR (interpolated) = 5.74 W/kg

### **CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan,**

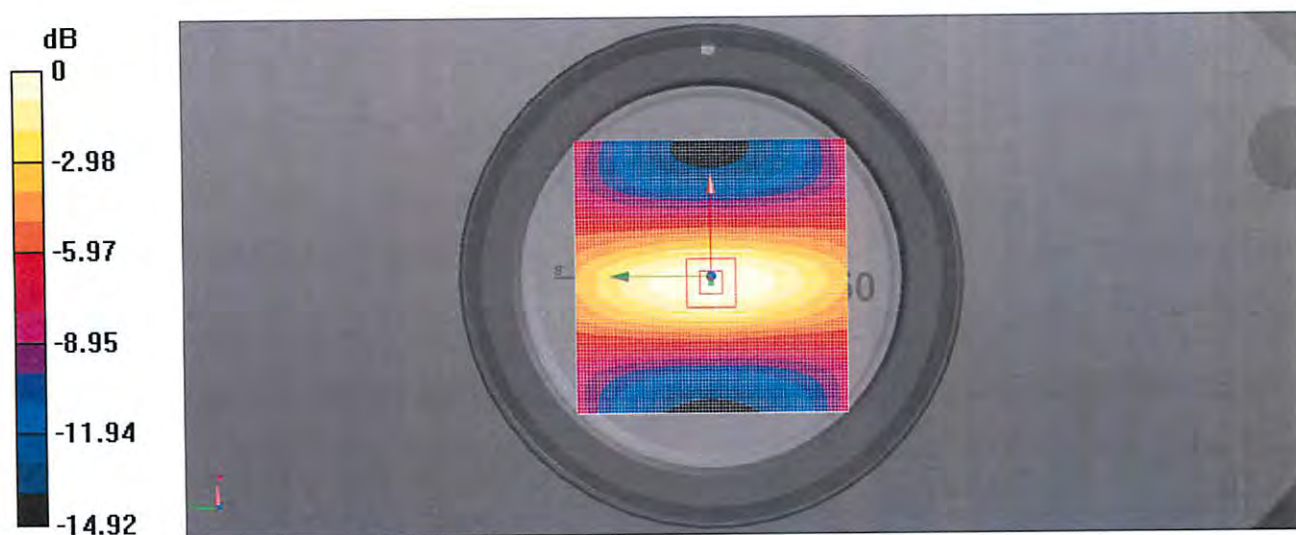
**dist=1.4mm (8x10x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 82.70 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 7.74 W/kg

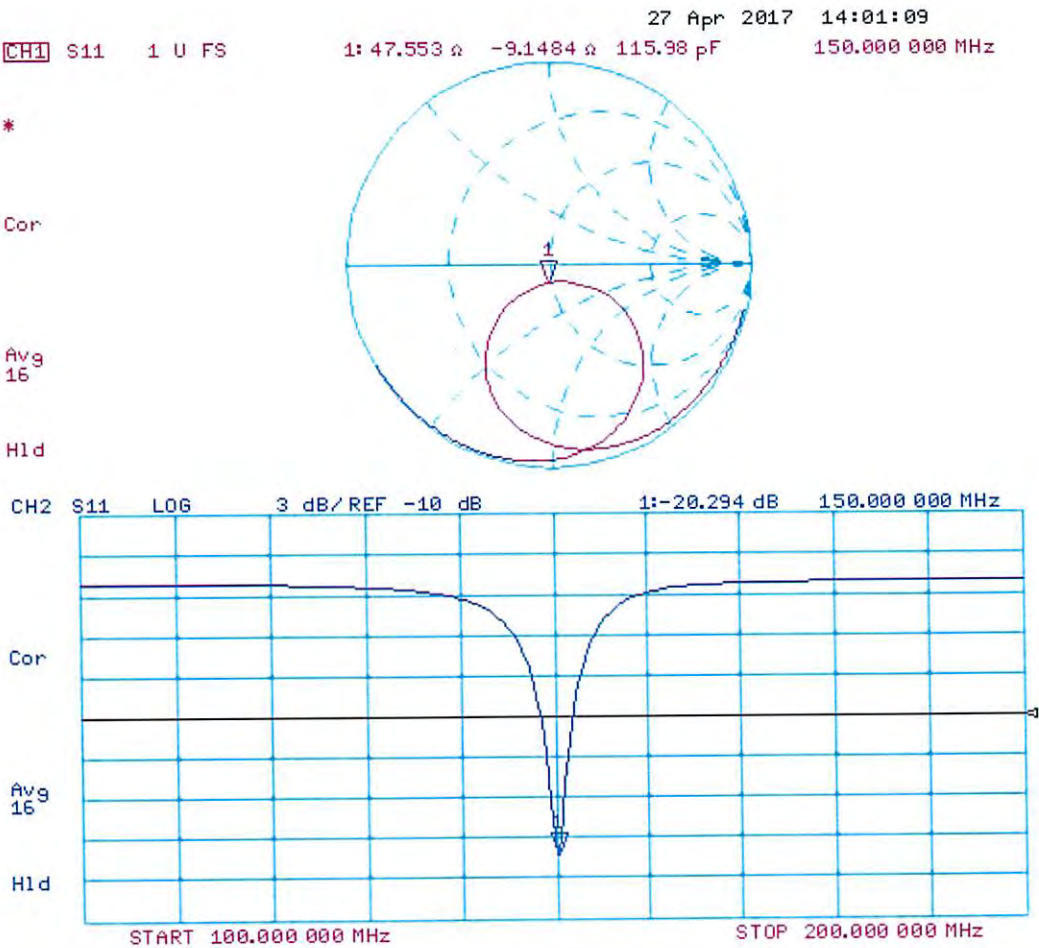
**SAR(1 g) = 4.08 W/kg; SAR(10 g) = 2.7 W/kg**

Maximum value of SAR (measured) = 5.74 W/kg



0 dB = 5.74 W/kg = 7.59 dBW/kg

Impedance Measurement Plot for Body TSL



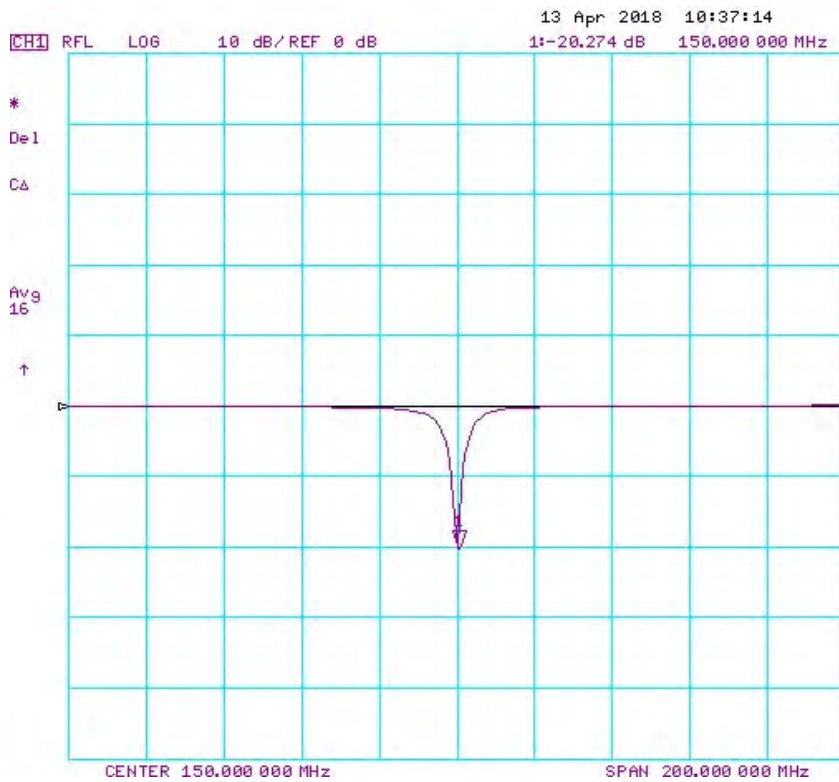
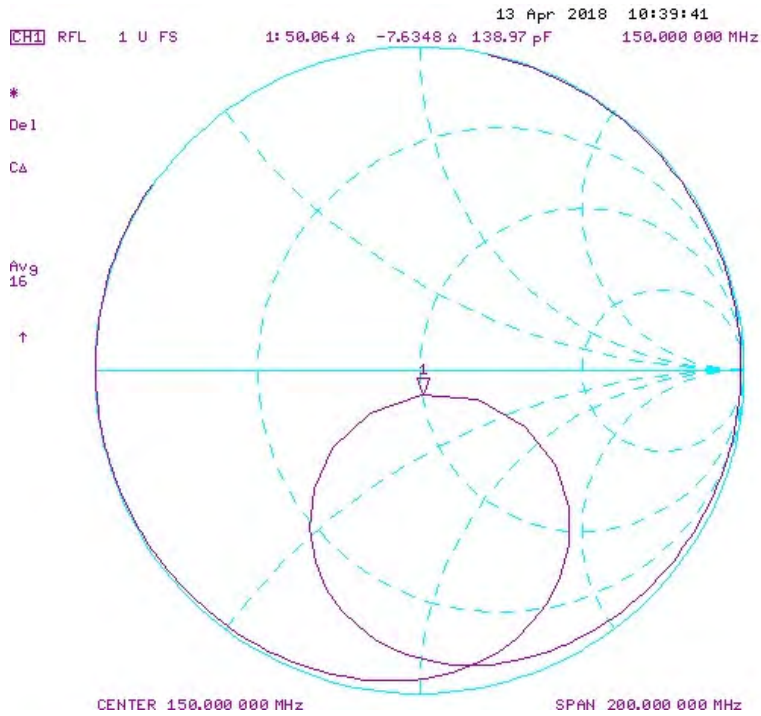
|                                                                                  |                                     |                                 |                                                                                                                        |
|----------------------------------------------------------------------------------|-------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------|
|  | <u>Date:</u><br>April 13, 2018      | <u>Revision No.</u><br>Rev. 1.0 | <br>Test Lab Certificate No. 2470.01 |
|                                                                                  | 150 MHz Dipole Extended Calibration |                                 |                                                                                                                        |

Dipole: CLA150  
Serial Number: 4007  
Last Calibrated: April 13 2018

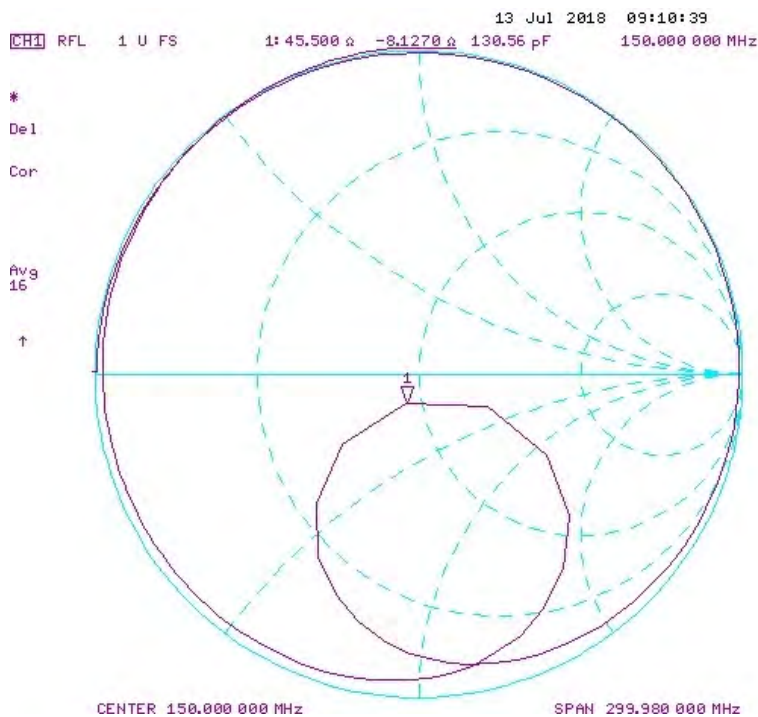
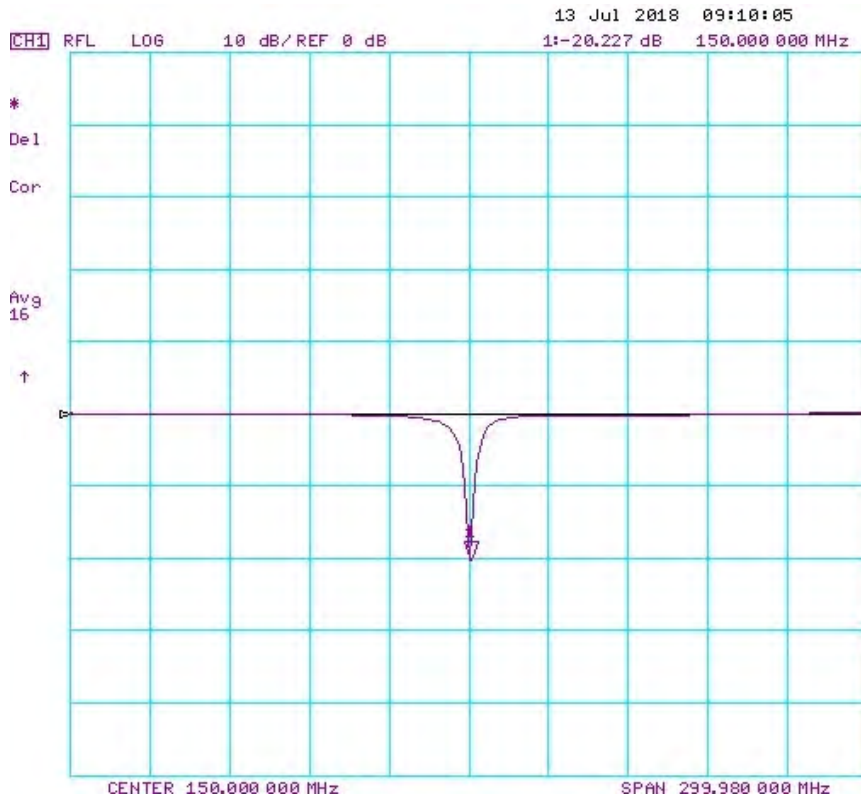
| Antenna Parameters with Body TSL       |                          |                                 |                                  |                                 |                     |                              |
|----------------------------------------|--------------------------|---------------------------------|----------------------------------|---------------------------------|---------------------|------------------------------|
|                                        | Impedance<br>Real (ohms) | Deviation<br>from cal<br>(ohms) | Impedance<br>Imaginary<br>(ohms) | Deviation<br>from cal<br>(ohms) | Return Loss<br>(dB) | Deviation<br>from Cal<br>(%) |
| <b>Last Calibration</b>                | 47.55                    | -                               | -9.15                            | -                               | -20.29              | -                            |
| <b>Extended Cal<br/>April 13, 2018</b> | 50.06                    | +2.51                           | -7.63                            | +1.52                           | -20.27              | +7.78%                       |

| Antenna Parameters with Head TSL      |                          |                                 |                                  |                                 |                     |                              |
|---------------------------------------|--------------------------|---------------------------------|----------------------------------|---------------------------------|---------------------|------------------------------|
|                                       | Impedance<br>Real (ohms) | Deviation<br>from cal<br>(ohms) | Impedance<br>Imaginary<br>(ohms) | Deviation<br>from cal<br>(ohms) | Return Loss<br>(dB) | Deviation<br>from Cal<br>(%) |
| <b>Last Calibration</b>               | 44.48                    | -                               | -7.56                            | -                               | -20.11              | -                            |
| <b>Extended Cal<br/>July 13, 2018</b> | 45.50                    | +1.02                           | -8.13                            | -0.57                           | -20.27              | -4.9%                        |

## Antenna VSWR with Body TSL



## Antenna VSWR with Head TSL

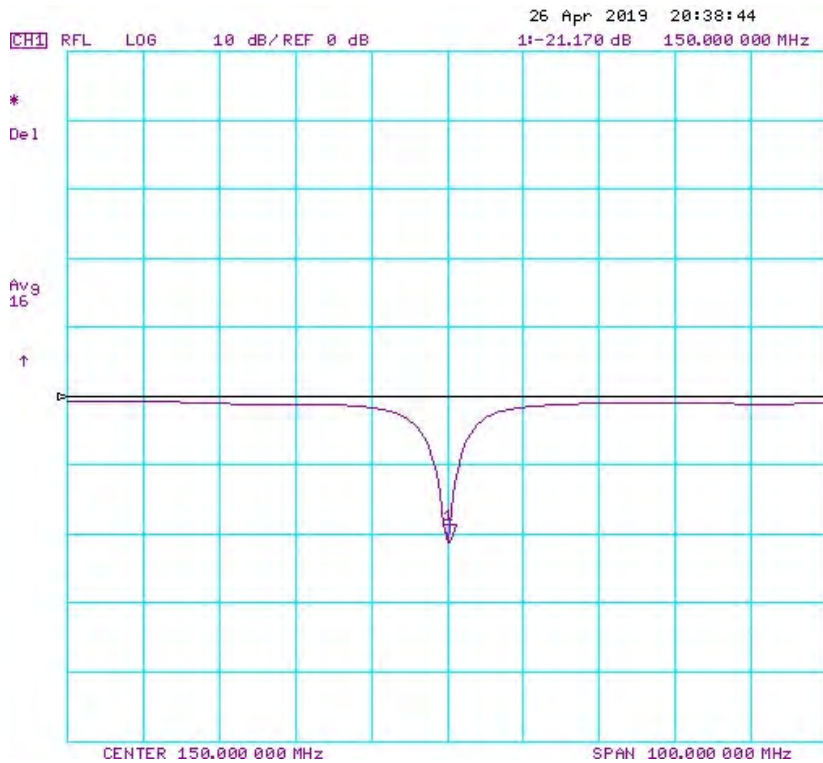
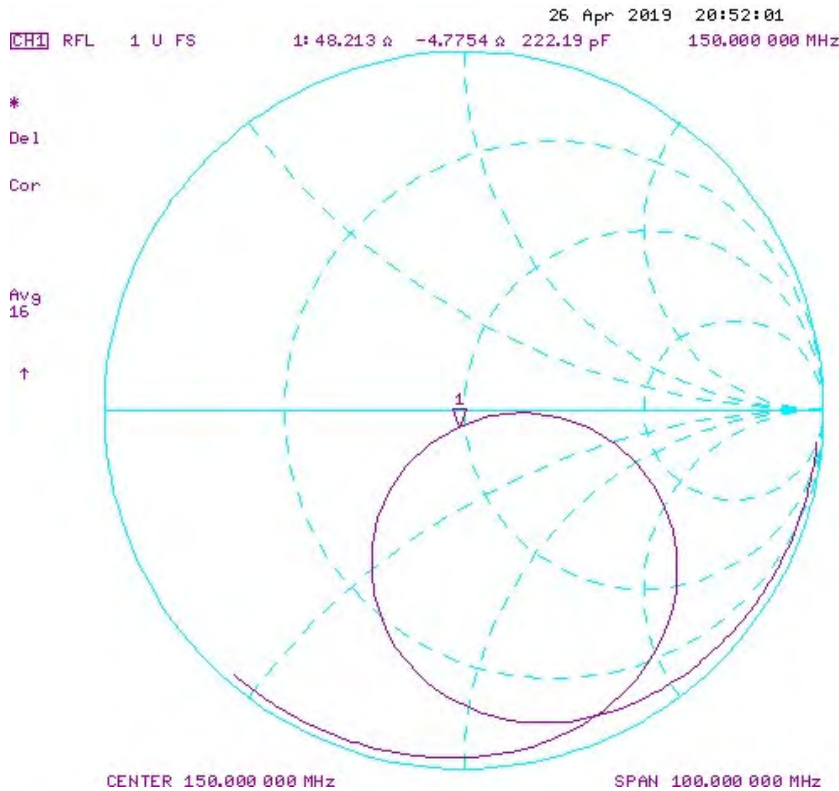


|                                                                                  |                                     |                                 |                                                                                                                        |
|----------------------------------------------------------------------------------|-------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------|
|  | <u>Date:</u><br>April 26, 2019      | <u>Revision No.</u><br>Rev. 1.0 | <br>Test Lab Certificate No. 2470.01 |
|                                                                                  | 150 MHz Dipole Extended Calibration |                                 |                                                                                                                        |

Dipole: CLA150  
 Serial Number: 4007  
 Last Calibrated: April 27, 2017

| Antenna Parameters with Head TSL       |                          |                                 |                                  |                                 |                     |                              |
|----------------------------------------|--------------------------|---------------------------------|----------------------------------|---------------------------------|---------------------|------------------------------|
|                                        | Impedance<br>Real (ohms) | Deviation<br>from cal<br>(ohms) | Impedance<br>Imaginary<br>(ohms) | Deviation<br>from cal<br>(ohms) | Return Loss<br>(dB) | Deviation<br>from Cal<br>(%) |
| <b>Extended Cal<br/>July 13, 2018</b>  | 45.50                    | -                               | -8.13                            | -                               | -20.27              | -                            |
| <b>Extended Cal<br/>April 26, 2019</b> | 48.21                    | +2.71                           | -4.78                            | +3.35                           | -21.17              | -4.25                        |

## Antenna VSWR with Head TSL





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Celltech**

Certificate No: **D450V3-1068\_Apr18**

## CALIBRATION CERTIFICATE

Object **D450V3 - SN:1068**

Calibration procedure(s) **QA CAL-15.v8  
Calibration procedure for dipole validation kits below 700 MHz**

Calibration date: **April 23, 2018**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter NRP             | SN: 104778         | 04-Apr-18 (No. 217-02672/02673)   | Apr-19                 |
| Power sensor NRP-Z91        | SN: 103244         | 04-Apr-18 (No. 217-02672)         | Apr-19                 |
| Power sensor NRP-Z91        | SN: 103245         | 04-Apr-18 (No. 217-02673)         | Apr-19                 |
| Reference 20 dB Attenuator  | SN: 5277 (20x)     | 04-Apr-18 (No. 217-02682)         | Apr-19                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683)         | Apr-19                 |
| Reference Probe EX3DV4      | SN: 3877           | 30-Dec-17 (No. EX3-3877_Dec17)    | Dec-18                 |
| DAE4                        | SN: 654            | 24-Jul-17 (No. DAE4-654_Jul17)    | Jul-18                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power meter E4419B          | SN: GB41293874     | 06-Apr-16 (No. 217-02285/02284)   | In house check: Jun-18 |
| Power sensor E4412A         | SN: MY41498087     | 06-Apr-16 (No. 217-02285)         | In house check: Jun-18 |
| Power sensor E4412A         | SN: 000110210      | 06-Apr-16 (No. 217-02284)         | In house check: Jun-18 |
| RF generator HP 8648C       | SN: US3642U01700   | 04-Aug-99 (in house check Jun-16) | In house check: Jun-18 |
| Network Analyzer HP 8753E   | SN: US37390585     | 18-Oct-01 (in house check Oct-17) | In house check: Oct-18 |

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

Signature

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

Issued: April 25, 2018

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



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Accreditation No.: **SCS 0108**

### Glossary:

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### 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                  | V52.10.0                        |
| Extrapolation                | Advanced Extrapolation |                                 |
| Phantom                      | ELI4 Flat Phantom      | Shell thickness: $2 \pm 0.2$ mm |
| Distance Dipole Center - TSL | 15 mm                  | with Spacer                     |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |                                 |
| Frequency                    | 450 MHz $\pm$ 1 MHz    |                                 |

## Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 43.5           | 0.87 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 44.1 $\pm$ 6 % | 0.87 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 | 1.13 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 4.53 W/kg $\pm$ 18.1 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 0.753 W/kg                   |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 3.02 W/kg $\pm$ 17.6 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 56.7           | 0.94 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 56.2 $\pm$ 6 % | 0.93 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 | 1.12 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 4.51 W/kg $\pm$ 18.1 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 0.752 W/kg                   |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 3.03 W/kg $\pm$ 17.6 % (k=2) |

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 57.8 $\Omega$ - 4.6 j $\Omega$ |
| Return Loss                          | - 21.6 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 53.8 $\Omega$ - 8.7 j $\Omega$ |
| Return Loss                          | - 20.8 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.347 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 16, 2009 |

## DASY5 Validation Report for Head TSL

Date: 23.04.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 450 MHz D450V3; Type: D450V3; Serial: D450V3 - SN:1068**

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used:  $f = 450$  MHz;  $\sigma = 0.87$  S/m;  $\epsilon_r = 44.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.5, 10.5, 10.5); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 24.07.2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

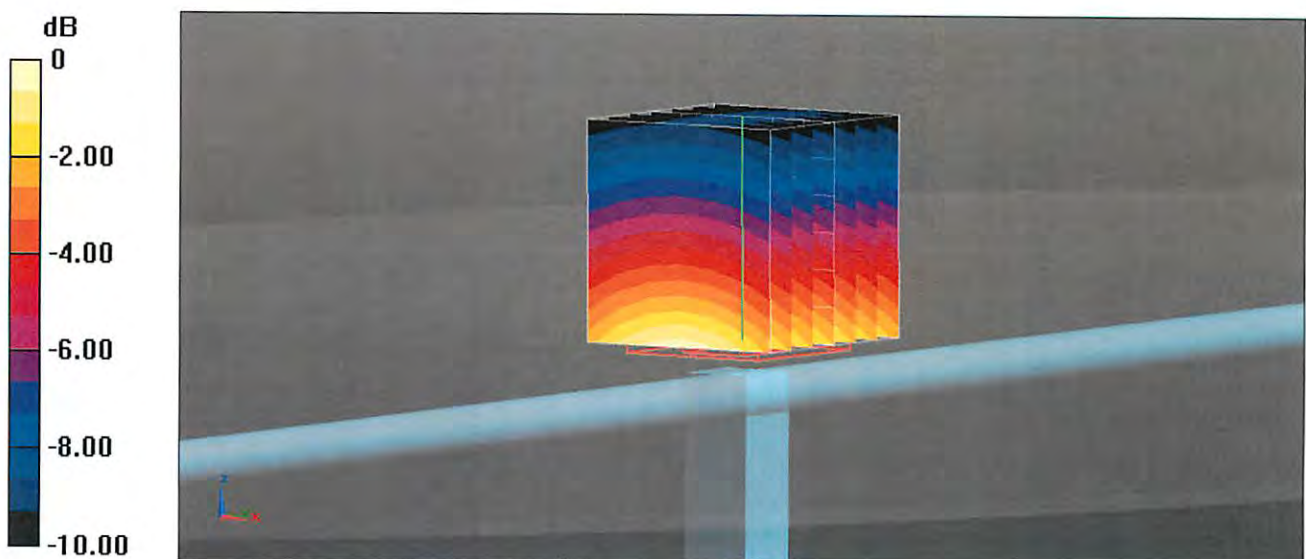
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 43.17 V/m; Power Drift = -0.02 dB

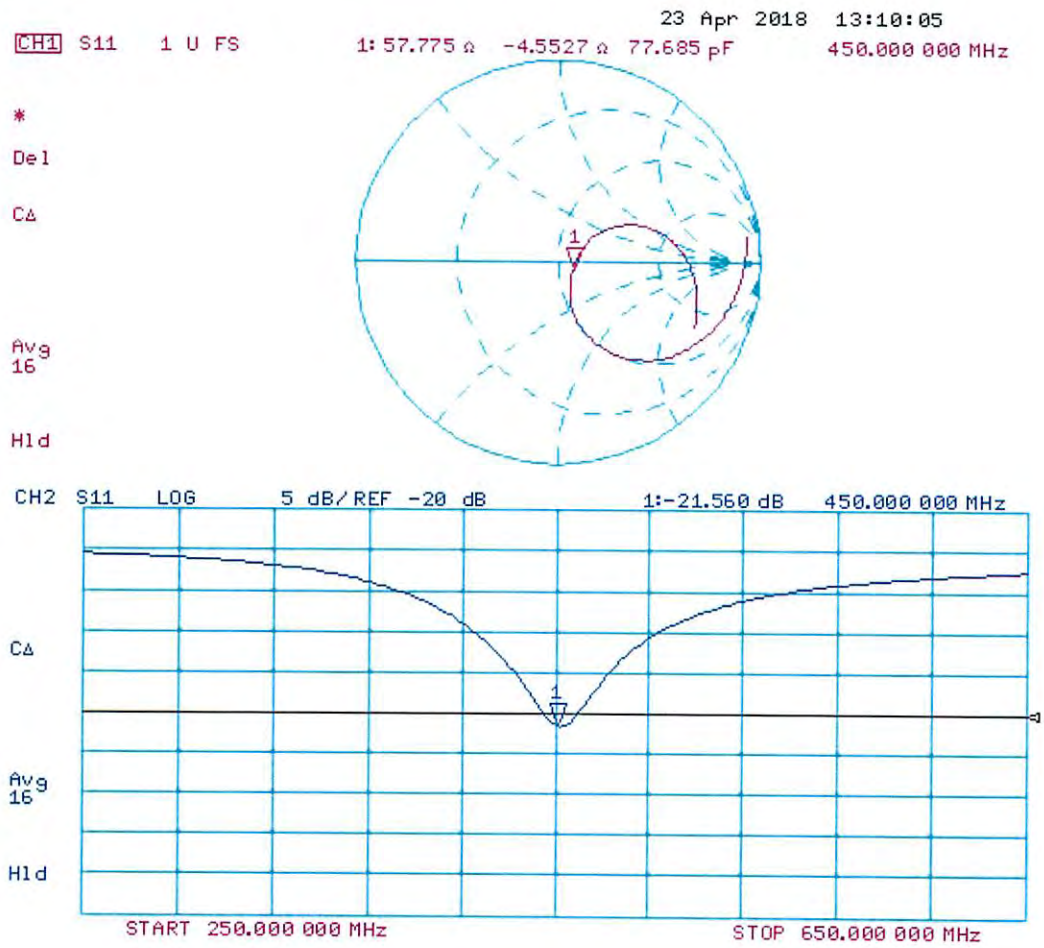
Peak SAR (extrapolated) = 1.73 W/kg

**SAR(1 g) = 1.13 W/kg; SAR(10 g) = 0.753 W/kg**

Maximum value of SAR (measured) = 1.52 W/kg



## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 23.04.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 450 MHz D450V3; Type: D450V3; Serial: D450V3 - SN:1068**

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used:  $f = 450 \text{ MHz}$ ;  $\sigma = 0.93 \text{ S/m}$ ;  $\epsilon_r = 56.2$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.8, 10.8, 10.8); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 24.07.2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

### Dipole Calibration for Body Tissue/ $d=15\text{mm}$ , $P_{in}=250\text{mW}$ /Zoom Scan (7x7x7)/Cube 0:

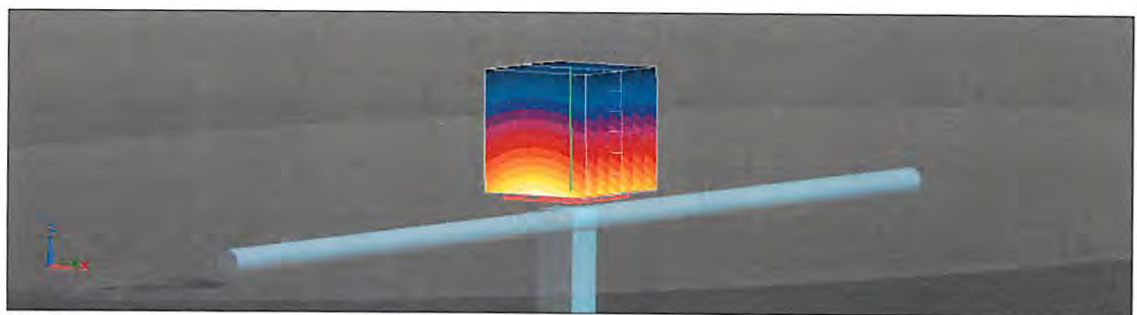
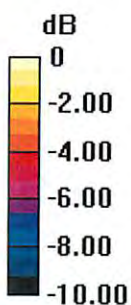
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $41.30 \text{ V/m}$ ; Power Drift =  $-0.02 \text{ dB}$

Peak SAR (extrapolated) =  $1.71 \text{ W/kg}$

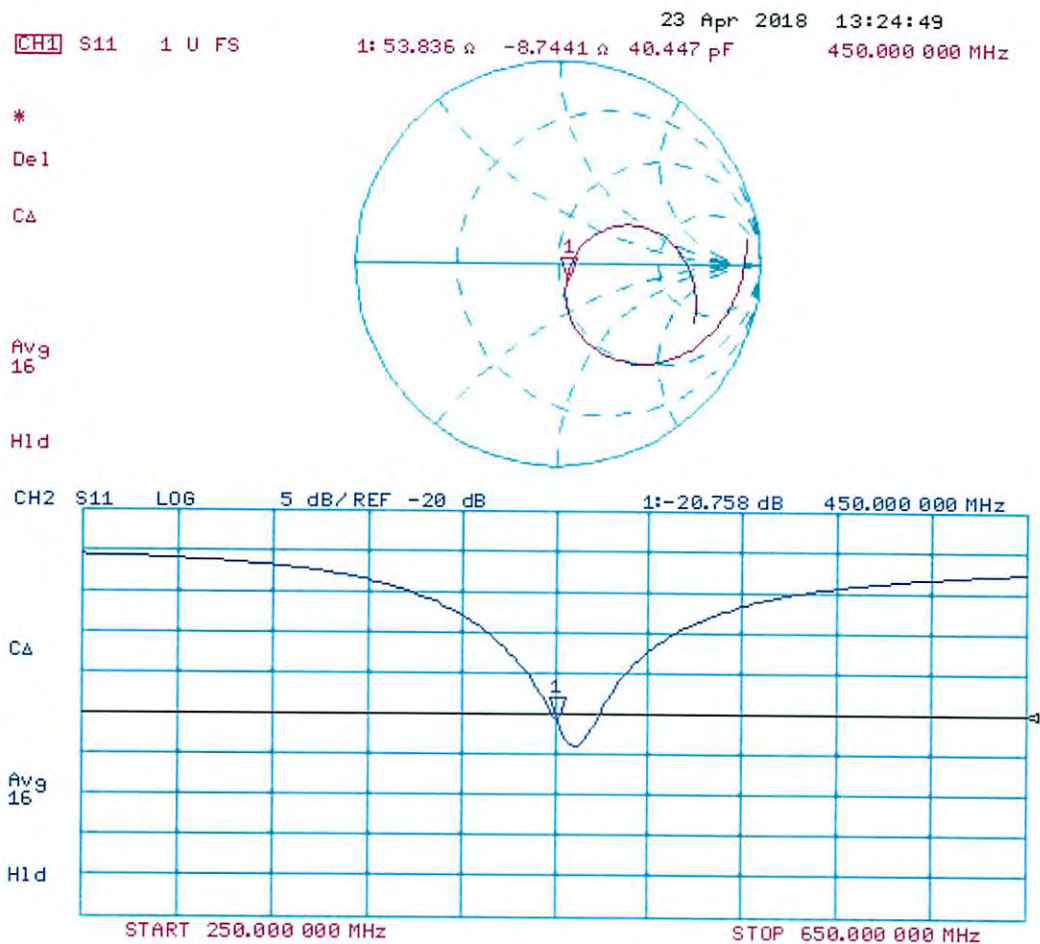
**SAR(1 g) =  $1.12 \text{ W/kg}$ ; SAR(10 g) =  $0.752 \text{ W/kg}$**

Maximum value of SAR (measured) =  $1.50 \text{ W/kg}$



0 dB =  $1.50 \text{ W/kg}$  =  $1.76 \text{ dBW/kg}$

Impedance Measurement Plot for Body TSL



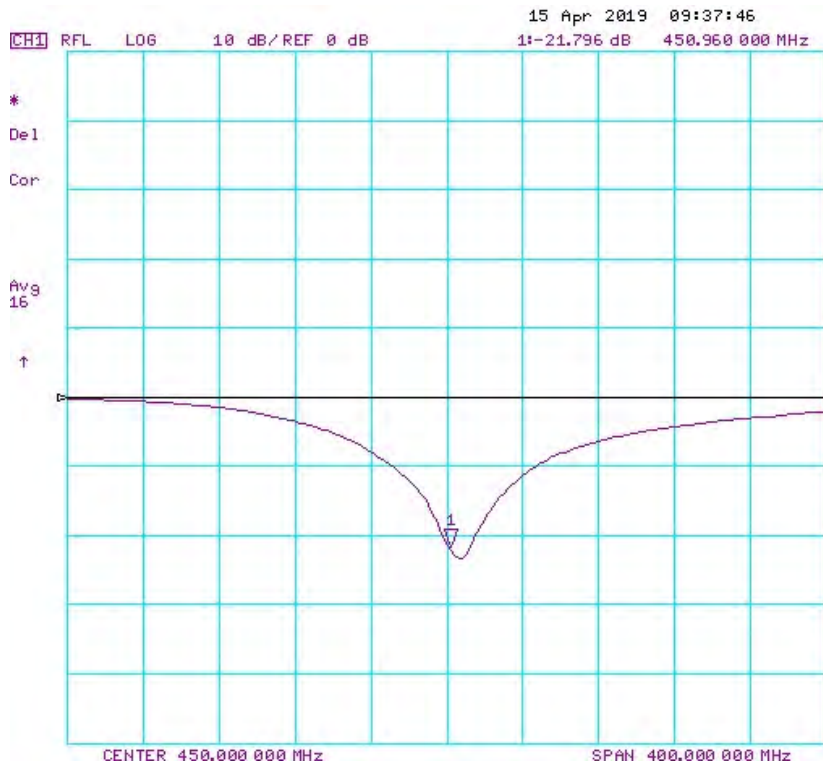
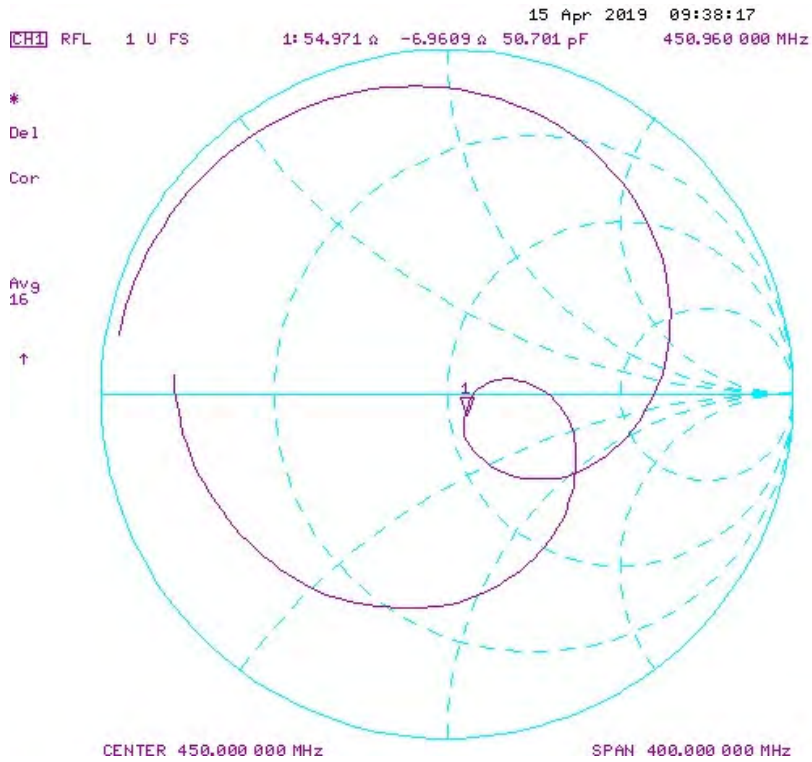
|                                                                                  |                                     |                                 |                                                                                                                        |
|----------------------------------------------------------------------------------|-------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------|
|  | <u>Date:</u><br>April 15, 2019      | <u>Revision No.</u><br>Rev. 1.0 | <br>Test Lab Certificate No. 2470.01 |
|                                                                                  | 450 MHz Dipole Extended Calibration |                                 |                                                                                                                        |

Dipole: D450V3  
 Serial Number: 1068  
 Last Calibrated: Apr 23, 2018

| Antenna Parameters with Head TSL     |                          |                                |                                  |                                |                     |                             |
|--------------------------------------|--------------------------|--------------------------------|----------------------------------|--------------------------------|---------------------|-----------------------------|
|                                      | Impedance<br>Real (ohms) | Deviation<br>from<br>cal(ohms) | Impedance<br>Imaginary<br>(ohms) | Deviation<br>from<br>cal(ohms) | Return Loss<br>(dB) | Deviation<br>from<br>Cal(%) |
| <b>Last Calibration</b>              | 57.775                   | -                              | -4.553                           | -                              | -21.560             | -                           |
| <b>Extended Cal<br/>Apr 15, 2019</b> | 54.971                   | -2.804                         | -6.961                           | -2.408                         | -21.796             | +1.08                       |

Per KDB 865664 D01 3.2.2 §2 C, D

## Antenna VSWR with Head TSL





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Celltech**

Certificate No: **D750V3-1061\_Mar19**

## CALIBRATION CERTIFICATE

Object **D750V3 - SN:1061**

Calibration procedure(s) **QA CAL-05.v11  
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **March 21, 2019**

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 NRP             | SN: 104778         | 04-Apr-18 (No. 217-02672/02673) | Apr-19                |
| Power sensor NRP-Z91        | SN: 103244         | 04-Apr-18 (No. 217-02672)       | Apr-19                |
| Power sensor NRP-Z91        | SN: 103245         | 04-Apr-18 (No. 217-02673)       | Apr-19                |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 04-Apr-18 (No. 217-02682)       | Apr-19                |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683)       | Apr-19                |
| Reference Probe EX3DV4      | SN: 7349           | 31-Dec-18 (No. EX3-7349_Dec18)  | Dec-19                |
| DAE4                        | SN: 601            | 04-Oct-18 (No. DAE4-601_Oct18)  | Oct-19                |

| Secondary Standards             | ID #           | Check Date (in house)             | Scheduled Check        |
|---------------------------------|----------------|-----------------------------------|------------------------|
| Power meter E4419B              | SN: GB39512475 | 07-Oct-15 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A           | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A           | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06         | SN: 100972     | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |

Calibrated by: **Manu Seitz**      Name: **Manu Seitz**      Function: **Laboratory Technician**

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

Issued: March 21, 2019

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

**Glossary:**

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**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.

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.10.2    |
| <b>Extrapolation</b>                | Advanced Extrapolation |             |
| <b>Phantom</b>                      | Modular Flat Phantom   |             |
| <b>Distance Dipole Center - TSL</b> | 15 mm                  | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm      |             |
| <b>Frequency</b>                    | 750 MHz $\pm$ 1 MHz    |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 41.9           | 0.89 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 42.1 $\pm$ 6 % | 0.89 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 | 2.08 W/kg                                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>8.33 W/kg <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 | 1.37 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>5.48 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.1 $\Omega$ - 1.0 j $\Omega$ |
| Return Loss                          | - 27.9 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.037 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 |
|-----------------|-------|

## DASY5 Validation Report for Head TSL

Date: 21.03.2019

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1061**

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

Medium parameters used:  $f = 750 \text{ MHz}$ ;  $\sigma = 0.89 \text{ S/m}$ ;  $\epsilon_r = 42.1$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.32, 10.32, 10.32) @ 750 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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

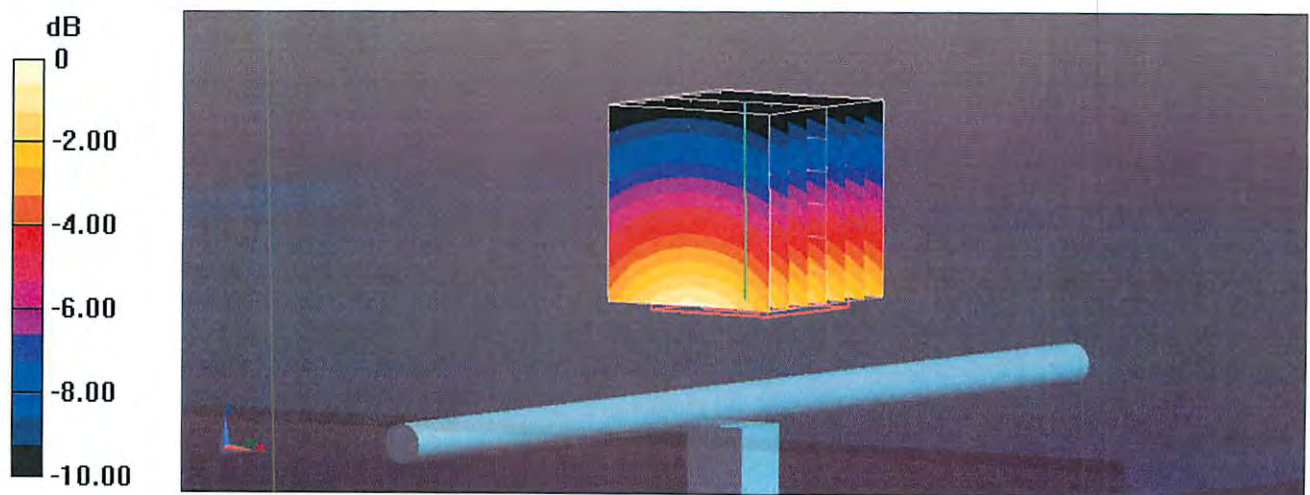
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 59.13 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 3.10 W/kg

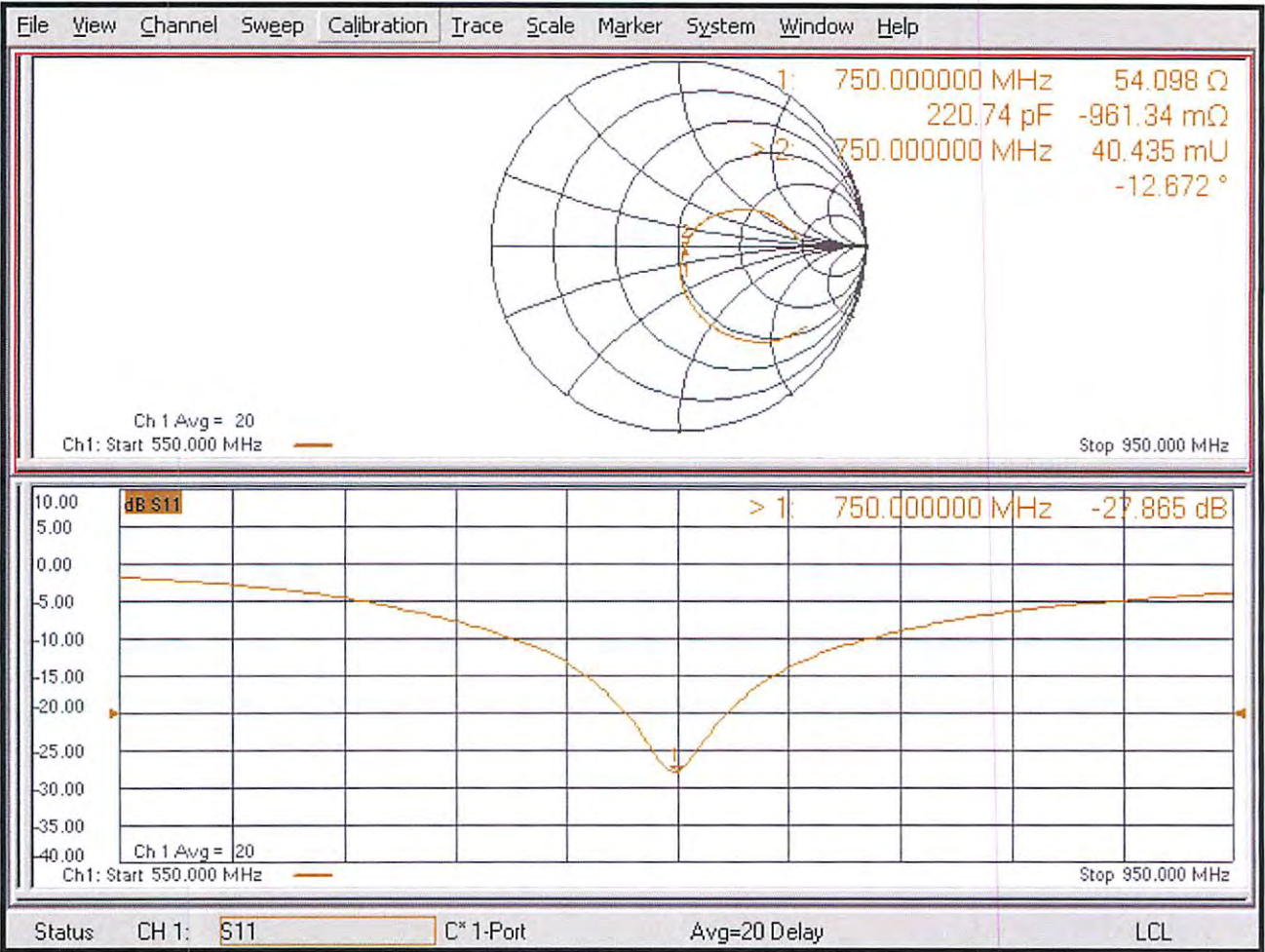
**SAR(1 g) = 2.08 W/kg; SAR(10 g) = 1.37 W/kg**

Maximum value of SAR (measured) = 2.76 W/kg



0 dB = 2.76 W/kg = 4.41 dBW/kg

Impedance Measurement Plot for Head TSL





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Accreditation No.: **SCS 0108**

Client **Celltech**

Certificate No: **D835V2-4d075\_Apr18**

## CALIBRATION CERTIFICATE

Object **D835V2 - SN:4d075**

Calibration procedure(s) **QA CAL-05.v10**  
**Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **April 20, 2018**

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 NRP             | SN: 104778         | 04-Apr-18 (No. 217-02672/02673)   | Apr-19                 |
| Power sensor NRP-Z91        | SN: 103244         | 04-Apr-18 (No. 217-02672)         | Apr-19                 |
| Power sensor NRP-Z91        | SN: 103245         | 04-Apr-18 (No. 217-02673)         | Apr-19                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 04-Apr-18 (No. 217-02682)         | Apr-19                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683)         | Apr-19                 |
| Reference Probe EX3DV4      | SN: 7349           | 30-Dec-17 (No. EX3-7349_Dec17)    | Dec-18                 |
| DAE4                        | SN: 601            | 26-Oct-17 (No. DAE4-601_Oct17)    | Oct-18                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power meter EPM-442A        | SN: GB37480704     | 07-Oct-15 (in house check Oct-16) | In house check: Oct-18 |
| Power sensor HP 8481A       | SN: US37292783     | 07-Oct-15 (in house check Oct-16) | In house check: Oct-18 |
| Power sensor HP 8481A       | SN: MY41092317     | 07-Oct-15 (in house check Oct-16) | In house check: Oct-18 |
| RF generator R&S SMT-06     | SN: 100972         | 15-Jun-15 (in house check Oct-16) | In house check: Oct-18 |
| Network Analyzer HP 8753E   | SN: US37390585     | 18-Oct-01 (in house check Oct-17) | In house check: Oct-18 |

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

Signature

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

Issued: April 23, 2018

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Accreditation No.: **SCS 0108**

### Glossary:

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### 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                  | V52.10.0    |
| 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 | 40.9 $\pm$ 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 | 2.41 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 9.45 W/kg $\pm$ 17.0 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 1.55 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 6.11 W/kg $\pm$ 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 | 53.8 $\pm$ 6 % | 0.99 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 | 2.43 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 9.52 W/kg $\pm$ 17.0 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 1.58 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 6.22 W/kg $\pm$ 16.5 % (k=2) |

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.6 $\Omega$ - 1.8 j $\Omega$ |
| Return Loss                          | - 30.2 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 48.7 $\Omega$ - 3.4 j $\Omega$ |
| Return Loss                          | - 28.6 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.414 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 09, 2007 |

## DASY5 Validation Report for Head TSL

Date: 20.04.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d075**

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.92$  S/m;  $\epsilon_r = 40.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.9, 9.9, 9.9); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

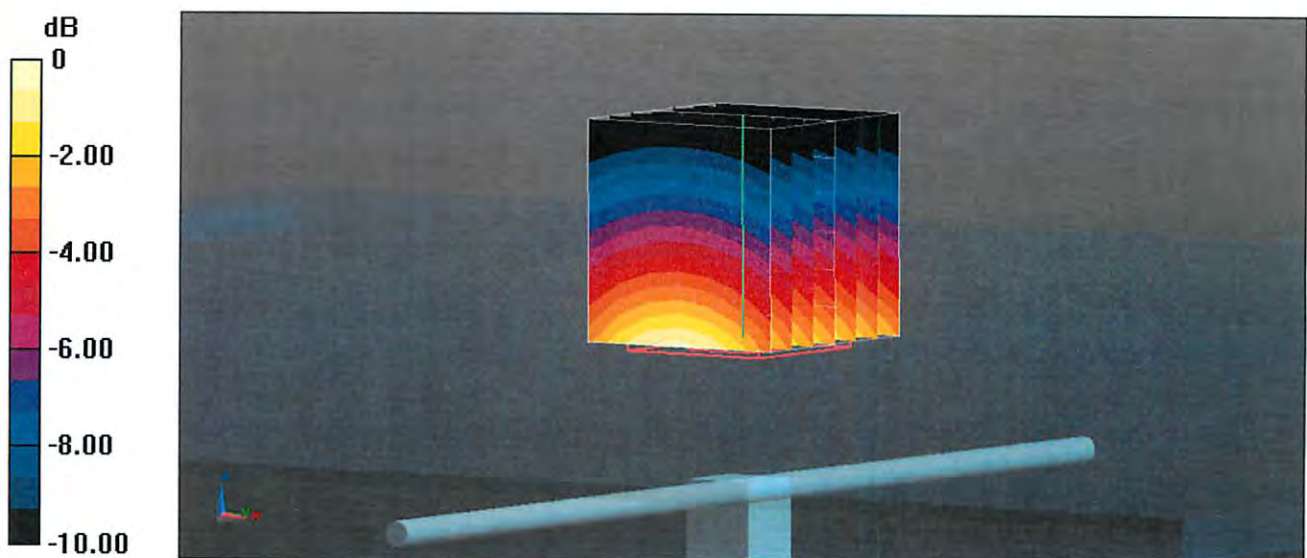
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 63.00 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.72 W/kg

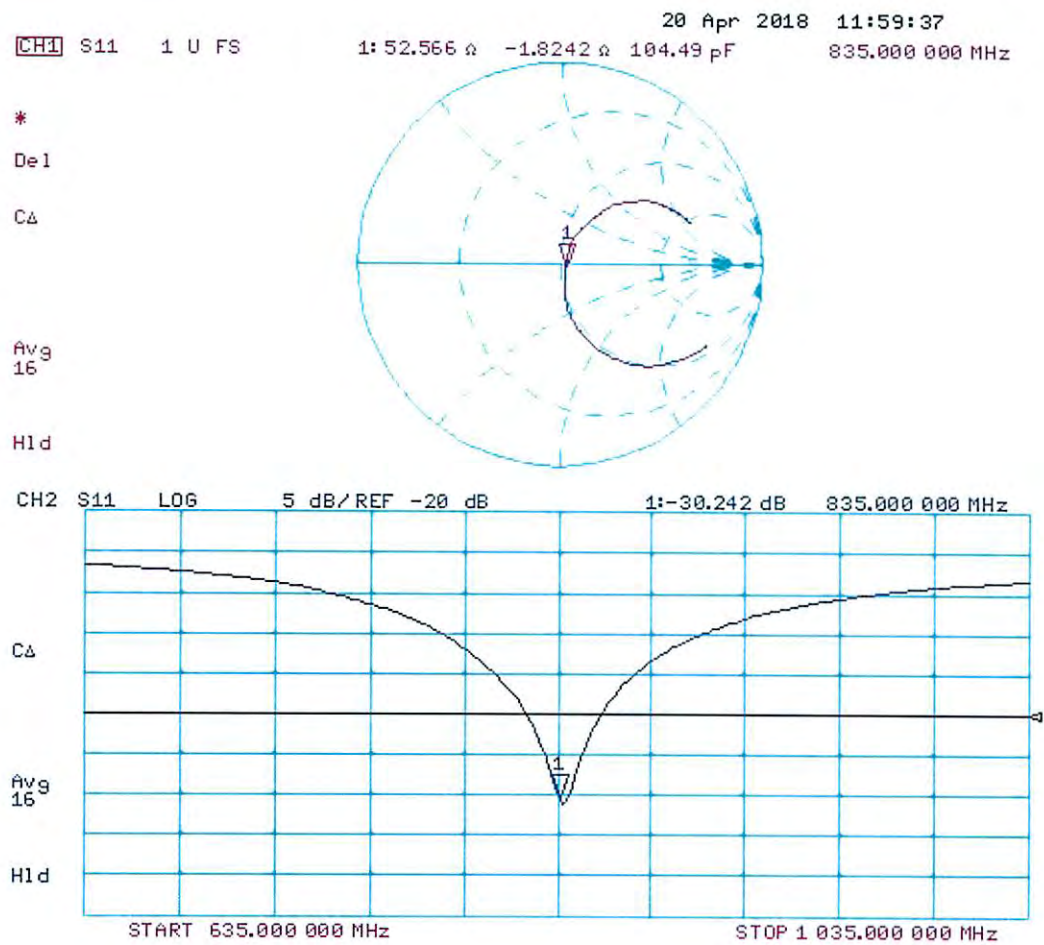
**SAR(1 g) = 2.41 W/kg; SAR(10 g) = 1.55 W/kg**

Maximum value of SAR (measured) = 3.27 W/kg



0 dB = 3.27 W/kg = 5.15 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 20.04.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d075**

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.99 \text{ S/m}$ ;  $\epsilon_r = 53.8$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.05, 10.05, 10.05); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

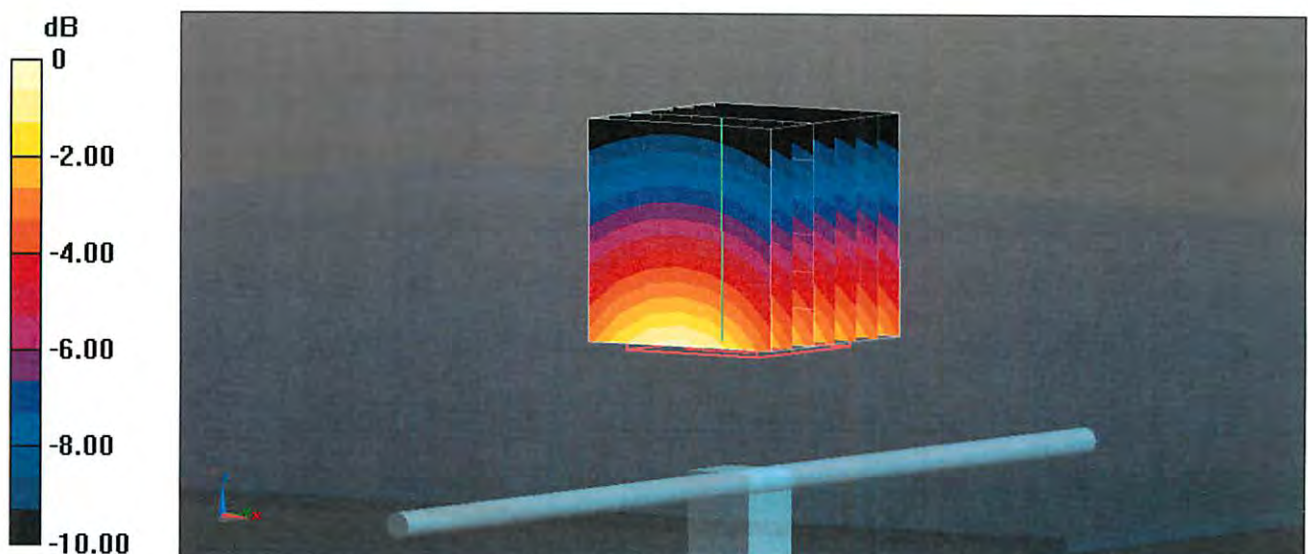
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 60.78 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.65 W/kg

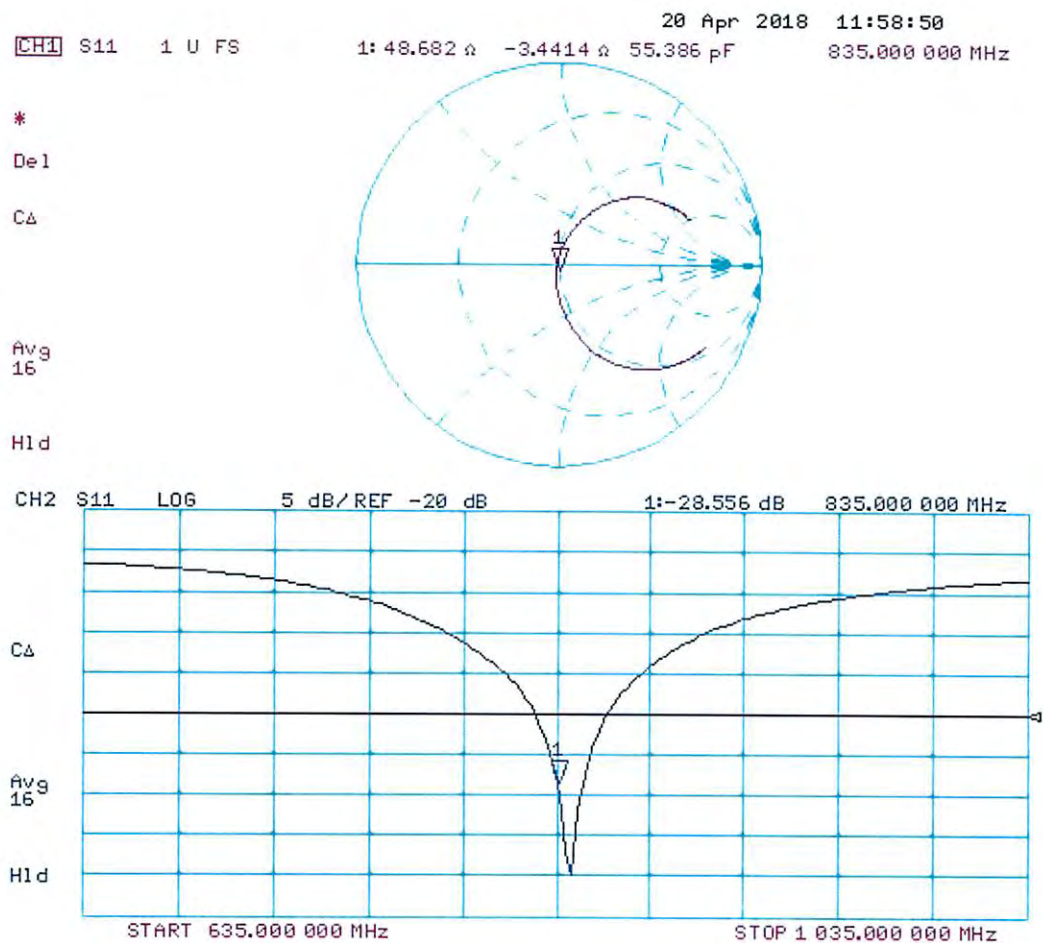
**SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.58 W/kg**

Maximum value of SAR (measured) = 3.24 W/kg



0 dB = 3.24 W/kg = 5.11 dBW/kg

## Impedance Measurement Plot for Body TSL



|                                                                                  |                                     |                                 |                                                                                                                        |
|----------------------------------------------------------------------------------|-------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------|
|  | <u>Date:</u><br>November 26, 2016   | <u>Revision No.</u><br>Rev. 1.0 | <br>Test Lab Certificate No. 2470.01 |
|                                                                                  | 835 MHz Dipole Extended Calibration |                                 |                                                                                                                        |

Dipole: D835V2  
Serial Number: 825  
Last Calibrated: Apr. 20, 2018

| Antenna Parameters with Head TSL       |                          |                                |                                  |                                 |                     |                              |
|----------------------------------------|--------------------------|--------------------------------|----------------------------------|---------------------------------|---------------------|------------------------------|
|                                        | Impedance<br>Real (ohms) | Deviation<br>from<br>cal(ohms) | Impedance<br>Imaginary<br>(ohms) | Deviation<br>from cal<br>(Ohms) | Return Loss<br>(dB) | Deviation<br>from Cal<br>(%) |
| <b>Last Calibration<br/>April 2018</b> | 52.57                    | -                              | -1.824                           | -                               | -30.24              | -                            |
| <b>Extended Cal<br/>Apr 19, 2019</b>   | 53.91                    | +1.34                          | -3.961                           | -2.14                           | -25.64              | 15.2%                        |

Per KDB 865664 D01 3.2.2 §2 C, D

## Antenna VSWR with Head TSL

