### 1.4. D1900V2 Dipole Calibration Certificate

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





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

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

| CALIBRATION (AL               |   | and the second s | tificate No: D1900V2-5d226_Feb18       |
|-------------------------------|---|--|--|
| CALIBRATION (                 | ERTIFICAT   |  |  |
| Object                        | D1900V2 - SN:5  | 5d226  |  |
| Calibration procedure(s)      | QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz |  |  |
| Calibration date:             | February 22, 20   | 18   |  |
| The measurements and the unce | rtainties with confidence potential in the closed laborate                  | tional standards, which realize the phorobability are given on the following<br>ory facility: environment temperature  | pages and are part of the certificate. |
| Primary Standards             | ID#   | Cal Date (Certificate No.)   | Scheduled Calibration                  |
| Power meter NRP               | SN: 104778  | 04-Apr-17 (No. 217-02521/02522   |  |
| 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: 5058 (20k)  | 07-Apr-17 (No. 217-02528)  | Apr-18                                 |
| Гуре-N mismatch combination   | SN: 5047.2 / 06327  | 07-Apr-17 (No. 217-02529)  | Apr-18                                 |
| 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   | i) In house check: Oct-18              |
| Power sensor HP 8481A         | SN: US37292783  | 07-Oct-15 (in house check Oct-16   |  |
| Power sensor HP 8481A         | SN: MY41092317  | 07-Oct-15 (in house check Oct-16   |  |
| RF generator R&S SMT-06       | SN: 100972  | 15-Jun-15 (in house check Oct-16   | In house check: Oct-18                 |
| letwork Analyzer HP 8753E     | SN: US37390585  | 18-Oct-01 (in house check Oct-17   | ) In house check: Oct-18               |
|                               | Name  | Function   | Signature                              |
| Calibrated by:                | Michael Weber   | Laboratory Technician  | MIKES                                  |
| Approved by:                  | Katja Pokovic   | Technical Manager  | le us                                  |
|                               |   | full without written approval of the la  | Issued: February 22, 2018              |

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#### Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst Service suisse d'étalonnage

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#### Glossary:

TSL

tissue simulating liquid

ConvF N/A sensitivity in TSL / NORM x,y,z

not applicable or not measured

# Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "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
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### **Additional Documentation:**

e) 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%.

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#### **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 | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, $dy$ , $dz = 5 mm$ |             |
| Frequency                    | 1900 MHz ± 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 ± 0.2) °C | 40.7 ± 6 %   | 1.39 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 | 10.0 W/kg                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 40.3 W/kg ± 17.0 % (k=2) |

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

#### **Body TSL parameters**

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 53.3         | 1.52 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 55.2 ± 6 %   | 1.48 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 | 9.71 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 39.8 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Body TSL | condition          |                          |
|---|--------------------|--------------------------|
| SAR measured                                | 250 mW input power | 5.16 W/kg                |
| SAR for nominal Body TSL parameters         | normalized to 1W   | 20.9 W/kg ± 16.5 % (k=2) |

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

### Antenna Parameters with Head TSL

| 52 2 O + 6 0 iO |                              |
|-----------------|------------------------------|
| ,               |                              |
|                 | 52.2 Ω + 6.0 jΩ<br>- 24.0 dB |

### Antenna Parameters with Body TSL

| Impedance, transformed to feed point | $47.9 \Omega + 7.5 j\Omega$ |
|--------------------------------------|-----------------------------|
| Return Loss                          | - 22.0 dB                   |

# General Antenna Parameters and Design

| Electrical Delay (one direction)  |           |
|-----------------------------------|-----------|
| Liectifical Delay (one direction) | 1.195 ns  |
|                                   | 1.195 118 |

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 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 | April 16, 2015 |
|                 | April 16, 2015 |

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# **DASY5 Validation Report for Head TSL**

Date: 22.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d226

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

Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.39 S/m;  $\epsilon_r$  = 40.7;  $\rho$  = 1000 kg/m³

Phantom section: Flat Section

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

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.18, 8.18, 8.18); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

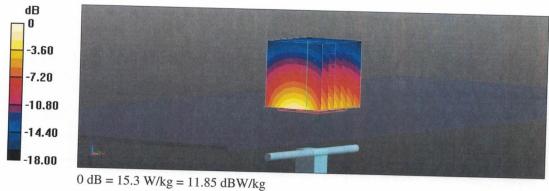
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 109.6 V/m; Power Drift = -0.09 dB

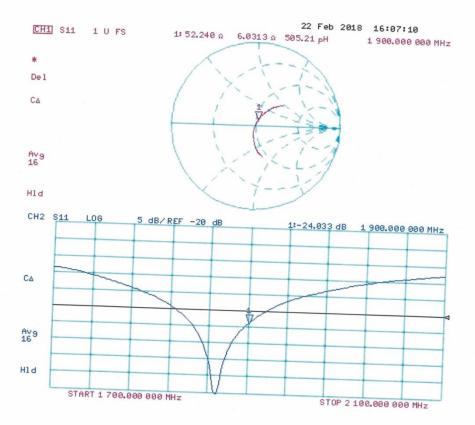
Peak SAR (extrapolated) = 18.5 W/kg

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

Maximum value of SAR (measured) = 15.3 W/kg



# Impedance Measurement Plot for Head TSL



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# **DASY5 Validation Report for Body TSL**

Date: 22.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d226

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

Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.48 S/m;  $\epsilon_r$  = 55.2;  $\rho$  = 1000 kg/m³

Phantom section: Flat Section

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

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.15, 8.15, 8.15); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

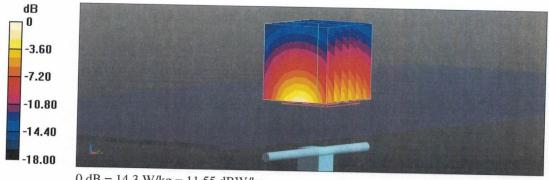
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 102.8 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 17.2 W/kg

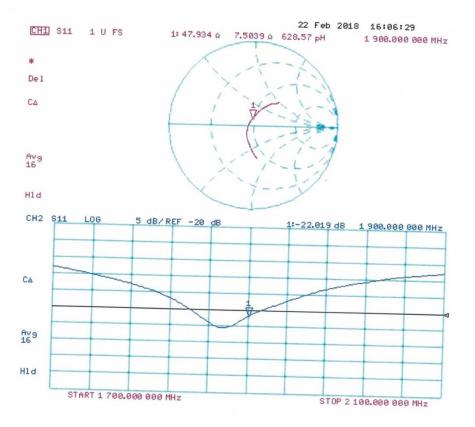
SAR(1 g) = 9.71 W/kg; SAR(10 g) = 5.16 W/kg

Maximum value of SAR (measured) = 14.3 W/kg



0 dB = 14.3 W/kg = 11.55 dBW/kg

# Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5d226\_Feb18

# **Extended Dipole Calibrations**

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| Head-1900   |                  |           |                |       |                 |       |
|-------------|------------------|-----------|----------------|-------|-----------------|-------|
| Date of     | Return-loss (dB) | Delta (%) | Real Impedance | Delta | Imaginary       | Delta |
| measurement | Return-1055 (ub) | Della (%) | (ohm)          | (ohm) | impedance (ohm) | (ohm) |
| 2018/2/22   | -24.0            |           | 52.2           |       | 6.0             |       |
| 2019/2/20   | -24.5            | 2.08%     | 52.6           | 0.4   | 6.5             | 0.5   |

| Body-1900   |                  |            |                |       |                 |       |
|-------------|------------------|------------|----------------|-------|-----------------|-------|
| Date of     | Poturn loop (dP) | Dolto (9/) | Real Impedance | Delta | Imaginary       | Delta |
| measurement | Return-loss (dB) | Delta (%)  | (ohm)          | (ohm) | impedance (ohm) | (ohm) |
| 2018/2/22   | -22.0            |            | 47.9           |       | 7.5             |       |
| 2019/2/20   | -22.3            | 1.36%      | 47.3           | 0.6   | 7.1             | 0.4   |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 50hm of prior calibration. Therefore the verification result should support extended calibration.

### 1.5. D2450V2 Dipole Calibration Certificate

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





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

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

Accreditation No.: SCS 0108

|  | CERTIFICAT   |  |   |
|--|--|--|---|
| Object   | D2450V2 - SN   | :1009  |   |
| Calibration procedure(s)   | QA CAL-05.v9<br>Calibration prod   | cedure for dipole validation kits  | above 700 MHz   |
| Calibration date:  | February 05, 20  | 018  |   |
|  | lucted in the closed laborat   | ational standards, which realize the physica<br>probability are given on the following pages<br>ory facility: environment temperature (22 ±  | s and are part of the certificate.  |
| Primary Standards  | ID#  | Cal Data (Cartification)   |   |
| Power meter NRP  | SN: 104778   | Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522)   | Scheduled Calibration   |
|  | The state of the s |  |   |
|  | SN: 103244   | 04-Apr-17 (No. 217-02521/02522)  | Apr-18  |
| Power sensor NRP-Z91   | SN: 103244<br>SN: 103245   | 04-Apr-17 (No. 217-02521)  | Apr-18  |
| Power sensor NRP-Z91<br>Reference 20 dB Attenuator   | ESTABLISHED CONTROL CO | 04-Apr-17 (No. 217-02521)<br>04-Apr-17 (No. 217-02522)   | Apr-18<br>Apr-18  |
| Power sensor NRP-Z91<br>Reference 20 dB Attenuator<br>Type-N mismatch combination  | SN: 103245   | 04-Apr-17 (No. 217-02521)<br>04-Apr-17 (No. 217-02522)<br>07-Apr-17 (No. 217-02528)  | Apr-18<br>Apr-18<br>Apr-18  |
| Power sensor NRP-Z91<br>Reference 20 dB Attenuator<br>Type-N mismatch combination<br>Reference Probe EX3DV4  | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349   | 04-Apr-17 (No. 217-02521)<br>04-Apr-17 (No. 217-02522)<br>07-Apr-17 (No. 217-02528)<br>07-Apr-17 (No. 217-02529)   | Apr-18<br>Apr-18<br>Apr-18<br>Apr-18  |
| Power sensor NRP-Z91<br>Reference 20 dB Attenuator<br>Type-N mismatch combination<br>Reference Probe EX3DV4  | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327   | 04-Apr-17 (No. 217-02521)<br>04-Apr-17 (No. 217-02522)<br>07-Apr-17 (No. 217-02528)<br>07-Apr-17 (No. 217-02529)<br>30-Dec-17 (No. EX3-7349_Dec17)   | Apr-18<br>Apr-18<br>Apr-18<br>Apr-18<br>Dec-18  |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 NAE4  | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601  | 04-Apr-17 (No. 217-02521)<br>04-Apr-17 (No. 217-02522)<br>07-Apr-17 (No. 217-02528)<br>07-Apr-17 (No. 217-02529)<br>30-Dec-17 (No. EX3-7349_Dec17)<br>26-Oct-17 (No. DAE4-601_Oct17)   | Apr-18<br>Apr-18<br>Apr-18<br>Apr-18  |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4  | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601  | 04-Apr-17 (No. 217-02521)<br>04-Apr-17 (No. 217-02522)<br>07-Apr-17 (No. 217-02528)<br>07-Apr-17 (No. 217-02529)<br>30-Dec-17 (No. EX3-7349_Dec17)<br>26-Oct-17 (No. DAE4-601_Oct17)<br>Check Date (in house)  | Apr-18<br>Apr-18<br>Apr-18<br>Apr-18<br>Dec-18  |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Tower meter EPM-442A Ower sensor HP 8481A  | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601<br>ID #<br>SN: GB37480704  | 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16)   | Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18  |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 PAE4 Recondary Standards Ower meter EPM-442A Ower sensor HP 8481A Ower sensor HP 8481A  | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601<br>ID #<br>SN: GB37480704<br>SN: US37292783  | 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)   | Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18   |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Rewer meter EPM-442A Rower sensor HP 8481A Regenerator R&S SMT-06  | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601<br>ID #<br>SN: GB37480704  | 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)   | Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18  |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 AE4  econdary Standards ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A F generator R&S SMT-06  | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601<br>ID #<br>SN: GB37480704<br>SN: US37292783<br>SN: MY41092317  | 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16)   | Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18  Scheduled Check  In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18   |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 AE4  econdary Standards ower meter EPM-442A ower sensor HP 8481A ower sensor HP 8481A F generator R&S SMT-06  | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601<br>ID #<br>SN: GB37480704<br>SN: US37292783<br>SN: MY41092317<br>SN: 100972  | 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)   | Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18  |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 PAE4 Recondary Standards Ower meter EPM-442A Ower sensor HP 8481A Ower sensor HP 8481A F generator R&S SMT-06 Retwork Analyzer HP 8753E   | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601<br>ID #<br>SN: GB37480704<br>SN: US37292783<br>SN: MY41092317<br>SN: 100972  | 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16)   | Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Oct-18 Scheduled Check In house check: Oct-18                             |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 PAE4 Recondary Standards Ower meter EPM-442A Ower sensor HP 8481A Ower sensor HP 8481A F generator R&S SMT-06 Retwork Analyzer HP 8753E   | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601<br>ID #<br>SN: GB37480704<br>SN: US37292783<br>SN: MY41092317<br>SN: 100972<br>SN: US37390585  | 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)  Function | Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18  Scheduled Check  In house check: Oct-18 Signature |
| Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Re | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601<br>ID #<br>SN: GB37480704<br>SN: US37292783<br>SN: MY41092317<br>SN: 100972<br>SN: US37390585  | 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)           | Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18  Scheduled Check  In house check: Oct-18 Signature |
| Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Description of the Secondary Standards Reference Probe EX3DV4 DAE4 | SN: 103245<br>SN: 5058 (20k)<br>SN: 5047.2 / 06327<br>SN: 7349<br>SN: 601<br>ID #<br>SN: GB37480704<br>SN: US37292783<br>SN: MY41092317<br>SN: 100972<br>SN: US37390585  | 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)  Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)  Function | Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Oct-18 Scheduled Check In house check: Oct-18                             |

Certificate No: D2450V2-1009\_Feb18

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#### Calibration Laboratory of

Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

C Service suisse d'étalonnage

Accreditation No.: SCS 0108

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Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

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

#### Glossary:

**TSL** 

tissue simulating liquid

ConvF N/A

sensitivity in TSL / NORM x,y,z

not applicable or not measured

# Calibration is Performed According to the Following Standards:

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

b) IEC 62209-1, "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

c) 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

d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### **Additional Documentation:**

e) 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%.

Certificate No: D2450V2-1009\_Feb18

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# **Measurement Conditions**

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

| DASY Version                 | DASY5                  |             |
|------------------------------|------------------------|-------------|
| Extrapolation                | Advanced Extrapolation | V52.10.0    |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, $dy$ , $dz = 5 mm$ | with Spacer |
| 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 | 37.9 ± 6 %   | 1.87 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        |              |                  |

### SAR result with Head TSL

| Condition          |   |
|--------------------|---|
| 250 mW input power | 13.2 W/kg                                     |
|                    | 51.5 W/kg ± 17.0 % (k=2)                      |
|                    | Condition 250 mW input power normalized to 1W |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                          |
|---|--------------------|--------------------------|
| SAR measured  | 250 mW input power | 6.13 W/kg                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.1 W/kg ± 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 | 51.4 ± 6 %   | 2.04 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 | 12.7 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 49.4 W/kg ± 17.0 % (k=2) |

| mW input power |                          |
|----------------|--------------------------|
| mipat power    | 5.92 W/kg                |
|                | 23.3 W/kg ± 16.5 % (k=2) |
|                | rmalized to 1W           |

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

# Antenna Parameters with Head TSL

| Impedance, transformed to feed point | 50.0                        |  |
|--------------------------------------|-----------------------------|--|
| Return Loss                          | $53.8 \Omega + 2.2 j\Omega$ |  |
| 2000                                 | - 27.4 dB                   |  |

# Antenna Parameters with Body TSL

| Impedance, transformed to feed point | 10.0.0                      |  |
|--------------------------------------|-----------------------------|--|
| Return Loss                          | $49.9 \Omega + 4.6 j\Omega$ |  |
| Totalii 2000                         | - 26.7 dB                   |  |

# General Antenna Parameters and Design

| Electrical Delay (one direction) | 1.152 ns  |
|----------------------------------|-----------|
|                                  | 11102 118 |

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 according to the Standard.

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

#### **Additional EUT Data**

| Manufactured by | SPEAG            |
|-----------------|------------------|
| Manufactured on |                  |
|                 | October 17, 2017 |

# **DASY5 Validation Report for Head TSL**

Date: 05.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:1009

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

Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.87 S/m;  $\epsilon_r$  = 37.9;  $\rho$  = 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(7.88, 7.88, 7.88); Calibrated: 30.12.2017;

- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

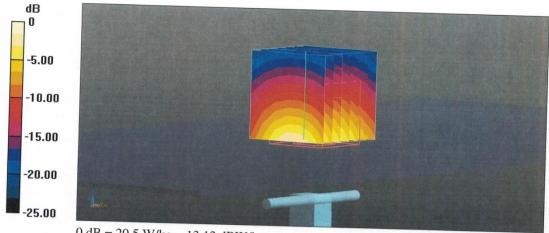
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 111.8 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 26.6 W/kg

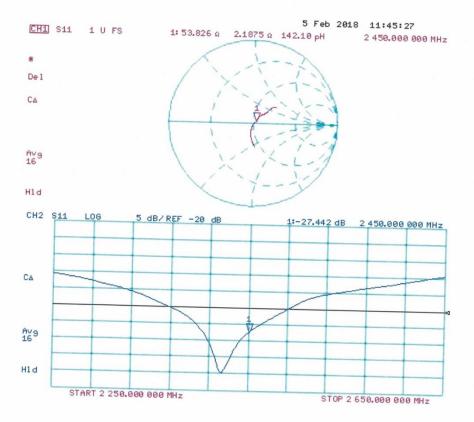
SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.13 W/kg

Maximum value of SAR (measured) = 20.5 W/kg



0 dB = 20.5 W/kg = 13.12 dBW/kg

# Impedance Measurement Plot for Head TSL



# **DASY5 Validation Report for Body TSL**

Date: 05.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:1009

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

Medium parameters used: f = 2450 MHz;  $\sigma$  = 2.04 S/m;  $\epsilon_r$  = 51.4;  $\rho$  = 1000 kg/m³

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(8.01, 8.01, 8.01); Calibrated: 30.12.2017;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 26.10.2017

Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002

DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

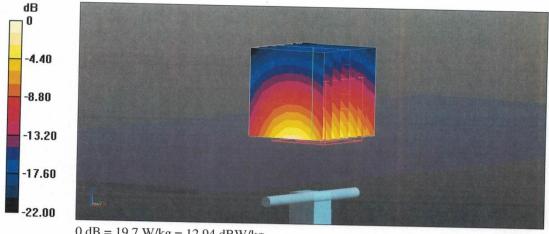
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 104.2 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 25.5 W/kg

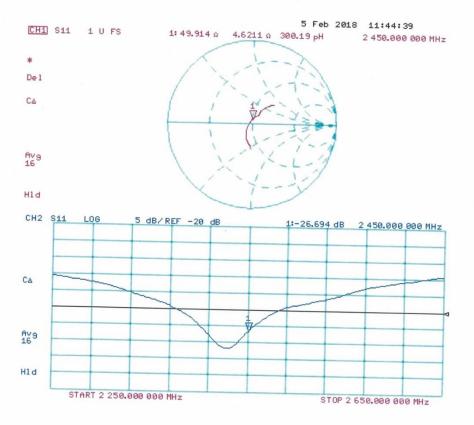
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.92 W/kg

Maximum value of SAR (measured) = 19.7 W/kg



0 dB = 19.7 W/kg = 12.94 dBW/kg

# Impedance Measurement Plot for Body TSL



# **Extended Dipole Calibrations**

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| Head-2450   |                  |           |                |       |                 |       |
|-------------|------------------|-----------|----------------|-------|-----------------|-------|
| Date of     | Return-loss (dB) | Delta (%) | Real Impedance | Delta | Imaginary       | Delta |
| measurement | Return-1055 (db) | Della (%) | (ohm)          | (ohm) | impedance (ohm) | (ohm) |
| 2018-02-05  | -27.4            |           | 53.8           |       | 2.2             |       |
| 2019-02-03  | -26.8            | -2.19%    | 52.9           | 0.9   | 1.9             | 0.3   |

| Body-2450   |                  |            |                |       |                 |       |
|-------------|------------------|------------|----------------|-------|-----------------|-------|
| Date of     | Return-loss (dB) | Dolto (9/) | Real Impedance | Delta | Imaginary       | Delta |
| measurement | Return-1055 (db) | Delta (%)  | (ohm)          | (ohm) | impedance (ohm) | (ohm) |
| 2018-02-05  | -26.7            |            | 49.9           |       | 4.6             |       |
| 2019-02-03  | -26.1            | -2.25%     | 49.1           | 0.8   | 4.2             | 0.4   |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 50hm of prior calibration. Therefore the verification result should support extended calibration.

#### 1.6. D2600V2 Dipole Calibration Certificate

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





Schweizerischer Kalibrierdienst Service suisse d'étalonnage C Servizio svizzero di taratura

**Swiss Calibration Service** 

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

| Calibration procedure(s)  Calibration procedure(s)  Calibration date:  Febr  This calibration certificate documents the transport of the measurements and the uncertainties of th | DOV2 - SN:115 CAL-05.v9 pration proced ruary 05, 2018 traceability to nation with confidence pro- | ure for dipole validation  and standards, which realize the bability are given on the following | e physical units of measurements (SI). Ing pages and are part of the certificate. |
|--|---|---|---|
| Calibration procedure(s)  Calibration procedure(s)  Calibration date:  Febr  This calibration certificate documents the first the example of the conducted in the calibrations have been conducted in the calibration Equipment used (M&TE critical primary Standards  Primary Standards  Power meter NRP  Power meter NRP  Power sensor NRP-Z91  Power sensor NRP-Z91  Reference 20 dB Attenuator  Type-N mismatch combination  Reference Probe EX3DV4  SN:   | CAL-05.v9 pration proced ruary 05, 2018 traceability to nation with confidence pro-               | ure for dipole validation  and standards, which realize the bability are given on the following | e physical units of measurements (SI). Ing pages and are part of the certificate. |
| Calibration date:  Febr  This calibration certificate documents the transport of the measurements and the uncertainties of the uncertainties of the measurements and the uncertainties of the uncertai | traceability to nation with confidence pro  | nal standards, which realize the<br>obability are given on the followin                         | e physical units of measurements (SI). Ing pages and are part of the certificate. |
| This calibration certificate documents the transfer of the measurements and the uncertainties. The measurements and the uncertainties of the measurements and the uncertainties. The measurements and the uncertainties of the uncertainties of the measurements and the uncertainties. The measurements have been conducted in the Calibration Equipment used (M&TE critical Primary Standards   ID #   Power meter NRP   SN: Power sensor NRP-Z91   SN: Power sensor NRP-Z91   SN: Reference 20 dB Attenuator   SN: Type-N mismatch combination   SN: Reference Probe EX3DV4   SN:   | traceability to nation with confidence pro  | nal standards, which realize the  | ing pages and are part of the certificate.  |
| Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 SN: Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 SN:   | with confidence pro   | bbability are given on the following  | ing pages and are part of the certificate.  |
| Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 SN: Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 SN:   |   |   |   |
| Power meter NRP SN: Power sensor NRP-Z91 SN: Power sensor NRP-Z91 SN: Reference 20 dB Attenuator SN: Type-N mismatch combination SN: Reference Probe EX3DV4 SN:  |   | Cal Date (Certificate No.)  | Scheduled Calibration   |
| Power sensor NRP-Z91 SN: Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 SN:   | 104778  | 04-Apr-17 (No. 217-02521/025  |   |
| Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 SN:  | 103244  | 04-Apr-17 (No. 217-02521)   | Apr-18  |
| Type-N mismatch combination SN: Reference Probe EX3DV4 SN:   | 103245  | 04-Apr-17 (No. 217-02522)   | Apr-18  |
| Reference Probe EX3DV4 SN:   | 5058 (20k)  | 07-Apr-17 (No. 217-02528)   | Apr-18  |
| Titoloronoo i robo Erica i   | 5047.2 / 06327  | 07-Apr-17 (No. 217-02529)   | Apr-18  |
| DAE4 SN:   | 7349  | 30-Dec-17 (No. EX3-7349_De  |   |
|  | 601   | 26-Oct-17 (No. DAE4-601_Oc  | ct17) Oct-18  |
| Secondary Standards ID #   |   | Check Date (in house)   | Scheduled Check   |
| Secondary Standards  | GB37480704  | 07-Oct-15 (in house check Oc  |   |
| 1 Ower motor Er in Tient   | US37292783  | 07-Oct-15 (in house check Oc  |   |
| Tower seriour in Groth   | MY41092317  | 07-Oct-15 (in house check Oc  |   |
| 1 Ower concern and   | 100972  | 15-Jun-15 (in house check Or  |   |
| Hi generator riaco civir co  | US37390585  | 18-Oct-01 (in house check Oc  | 1 1 O-t 10  |
| Nar  |   | Function  | Signature   |
| Calibrated by: Leif  | ne  |   |   |

Issued: February 6, 2018

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

Katja Pokovic

Certificate No: D2600V2-1150\_Feb18

Approved by:

Page 1 of 8

Technical Manager

#### **Calibration Laboratory of**

Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland





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#### Glossary:

TSL

tissue simulating liquid

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "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
- c) 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
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### **Additional Documentation:**

e) 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%.

Certificate No: D2600V2-1150\_Feb18

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#### **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 | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 2600 MHz ± 1 MHz       |             |

Head TSL parameters

The following parameters and calculations were applied.

| ne following parameters and calculations were appli | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters                         | 22.0 °C         | 39.0         | 1.96 mho/m       |
| Measured Head TSL parameters                        | (22.0 ± 0.2) °C | 37.3 ± 6 %   | 2.04 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 | 14.3 W/kg                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 55.6 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |   |
|---|--------------------|---|
| SAR measured  | 250 mW input power | 6.36 W/kg                                     |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | $25.0 \text{ W/kg} \pm 16.5 \% \text{ (k=2)}$ |

#### **Body TSL parameters**

| he following parameters and calculations were appli | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters                         | 22.0 °C         | 52.5         | 2.16 mho/m       |
| Measured Body TSL parameters                        | (22.0 ± 0.2) °C | 51.0 ± 6 %   | 2.22 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      | 13.9 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W        | 54.6 W/kg ± 17.0 % (k=2) |
| SAR for nominal body 13L parameters                   | Horrical and the second |                          |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
|---|--------------------|--------------------------|
| SAR measured  | 250 mW input power | 6.16 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 24.4 W/kg ± 16.5 % (k=2) |

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

#### Antenna Parameters with Head TSL

| Impedance, transformed to feed point | 49.4 Ω - 7.1 jΩ |  |  |
|--------------------------------------|-----------------|--|--|
| Return Loss                          | - 22.9 dB       |  |  |

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

| Impedance, transformed to feed point | 46.9 Ω - 4.4 jΩ |  |  |
|--------------------------------------|-----------------|--|--|
| Return Loss                          | - 25.1 dB       |  |  |

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

| Electrical Delay (one direction) | 1.141 ns |
|----------------------------------|----------|
| Licotrical Boldy (ever and every |          |

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 29, 2017 |  |  |

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#### **DASY5 Validation Report for Head TSL**

Date: 05.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1150

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: f = 2600 MHz;  $\sigma = 2.04$  S/m;  $\epsilon_r = 37.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(7.7, 7.7, 7.7); Calibrated: 30.12.2017;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 26.10.2017

Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001

DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

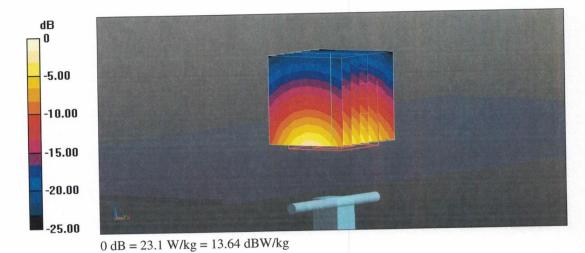
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 116.4 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 28.9 W/kg

SAR(1 g) = 14.3 W/kg; SAR(10 g) = 6.36 W/kg

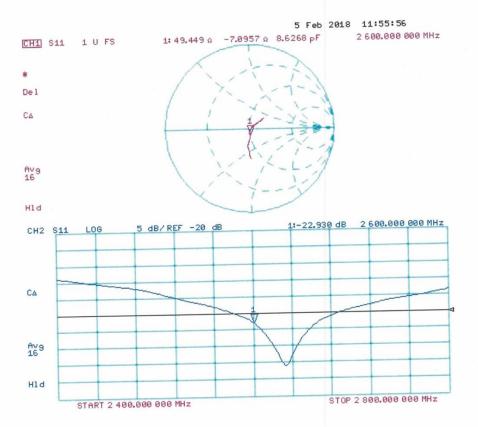
Maximum value of SAR (measured) = 23.1 W/kg



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# Impedance Measurement Plot for Head TSL



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### **DASY5 Validation Report for Body TSL**

Date: 05.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1150

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used: f = 2600 MHz;  $\sigma = 2.22$  S/m;  $\epsilon_r = 51$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.81, 7.81, 7.81); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

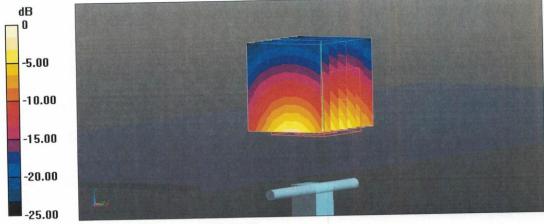
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.5 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 29.0 W/kg

SAR(1 g) = 13.9 W/kg; SAR(10 g) = 6.16 W/kg

Maximum value of SAR (measured) = 22.2 W/kg

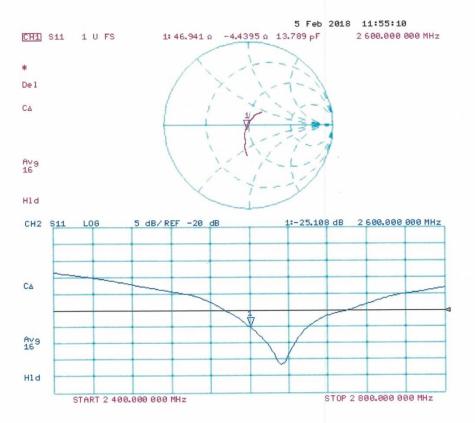


0 dB = 22.2 W/kg = 13.46 dBW/kg

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#### Impedance Measurement Plot for Body TSL



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# **Extended Dipole Calibrations**

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| Head-750    |                  |            |                |       |                 |       |
|-------------|------------------|------------|----------------|-------|-----------------|-------|
| Date of     | Poturo Jose (dP) | Dolto (9/) | Real Impedance | Delta | Imaginary       | Delta |
| measurement | Return-loss (dB) | Delta (%)  | (ohm)          | (ohm) | impedance (ohm) | (ohm) |
| 2018/2/5    | -22.9            |            | 49.4           |       | -7.1            |       |
| 2019/2/3    | -23.4            | 2.18%      | 48.8           | 0.6   | -6.7            | 0.4   |

| Body-750    |                  |            |                |       |                 |       |
|-------------|------------------|------------|----------------|-------|-----------------|-------|
| Date of     | Poturn logo (dP) | Dolto (9/) | Real Impedance | Delta | Imaginary       | Delta |
| measurement | Return-loss (dB) | Delta (%)  | (ohm)          | (ohm) | impedance (ohm) | (ohm) |
| 2018/2/5    | -25.1            |            | 46.9           |       | -4.4            |       |
| 2019/2/3    | -25.7            | 2.39%      | 46.2           | 0.7   | -3.9            | 0.5   |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 50hm of prior calibration. Therefore the verification result should support extended calibration.