

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



Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura

S 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

Client DT&C (Dymstec)

Certificate No: D2450V2-920_Sep16

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| Dbject | D2450V2 - SN:92 | 20 | |
|---|--|--|---|
| Calibration procedure(s) | QA CAL-05.v9 Calibration proce | dure for dipole validation kits abc | ove 700 MHz |
| Calibration date: | September 23, 2 | 016 | |
| The measurements and the unce | rtainties with confidence p | onal standards, which realize the physical un robability are given on the following pages an ry facility: environment temperature (22 ± 3)°C | d are part of the certificate. |
| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
| Power meter NRP | SN: 104778 | 06-Apr-16 (No. 217-02288/02289) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103244 | 06-Apr-16 (No. 217-02288) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103245 | 06-Apr-16 (No. 217-02289) | Apr-17 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 05-Apr-16 (No. 217-02292) | Apr-17 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 05-Apr-16 (No. 217-02295) | Apr-17 |
| Reference Probe EX3DV4 | SN: 7349 | 15-Jun-16 (No. EX3-7349_Jun16) | Jun-17 |
| DAE4 | SN: 601 | 30-Dec-15 (No. DAE4-601_Dec15) | Dec-16 |
| | ID # | Check Date (in house) | Scheduled Check |
| Secondary Standards | | | In house check: Oct-16 |
| | SN: GB37480704 | 07-Oct-15 (No. 217-02222) | |
| Power meter EPM-442A | SN: GB37480704 SN: US37292783 | 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power meter EPM-442A Power sensor HP 8481A | | | In house check: Oct-16 In house check: Oct-16 |
| Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (No. 217-02222) | |
| Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 | SN: US37292783 SN: MY41092317 | 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02223) | In house check: Oct-16 |
| Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 | SN: US37292783 SN: MY41092317 SN: 100972 | 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02223) 15-Jun-15 (in house check Jun-15) | In house check: Oct-16 In house check: Oct-16 |
| Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E | SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585 | 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02223) 15-Jun-15 (in house check Jun-15) 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 In house check: Oct-16 In house check: Oct-16 Signature |
| Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by: Approved by: | SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585 Name | 07-Oct-15 (No. 217-02222) 07-Oct-15 (No. 217-02223) 15-Jun-15 (in house check Jun-15) 18-Oct-01 (in house check Oct-15) Function | In house check: Oct-16 In house check: Oct-16 In house check: Oct-16 |

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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) 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 | V52.8.8 |
|------------------------------|------------------------|-------------|
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2450 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.2 | 1.80 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 37.9 ± 6 % | 1.88 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C | | |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|--------------------------|
| SAR measured | 250 mW input power | 13.5 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 52.5 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|--------------------------|
| SAR measured | 250 mW input power | 6.28 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 24.7 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 | 51.6 ± 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 ³ (1 g) of Body TSL | Condition | |
|---|---------------------------------|--------------------------|
| SAR measured | 250 mW input power | 13.1 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 51.0 W/kg ± 17.0 % (k=2) |
| | | |
| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
| SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured | condition 250 mW input power | 6.12 W/kg |

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

| Impedance, transformed to feed point | 55.9 Ω + 2.3 jΩ |
|--------------------------------------|-----------------|
| Return Loss | - 24.5 dB |

Antenna Parameters with Body TSL

| Impedance, transformed to feed point | 52.3 Ω + 5.0 jΩ |
|--------------------------------------|-----------------|
| Return Loss | - 25.5 dB |

General Antenna Parameters and Design

| Electrical Delay (one direction) | 1.154 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 | December 19, 2012 |

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DASY5 Validation Report for Head TSL

Date: 23.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:920

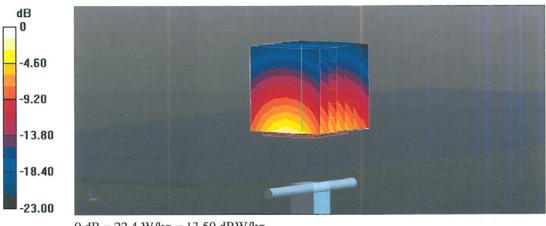
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 1.88 S/m; ϵ_r = 37.9; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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 = 114.0 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 27.5 W/kg SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.28 W/kg Maximum value of SAR (measured) = 22.4 W/kg



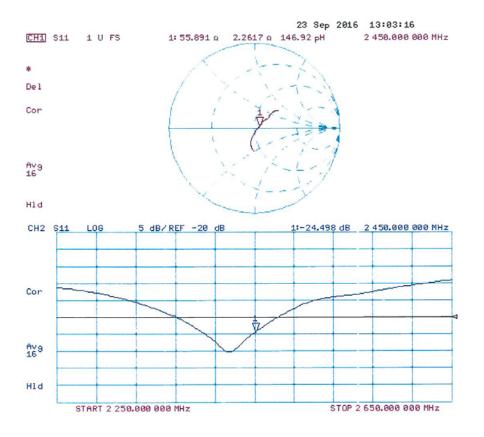
0 dB = 22.4 W/kg = 13.50 dBW/kg

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Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 23.09.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:920

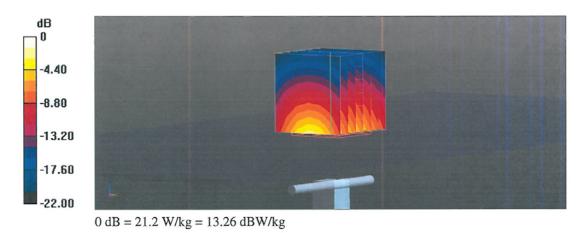
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 2.04 S/m; ϵ_r = 51.6; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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 = 106.3 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 26.0 W/kg SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.12 W/kgMaximum value of SAR (measured) = 21.2 W/kg

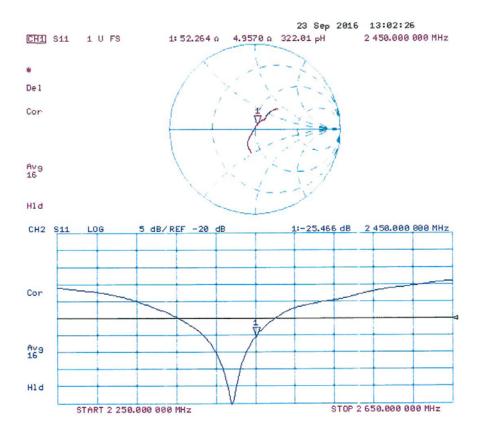


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Impedance Measurement Plot for Body TSL



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