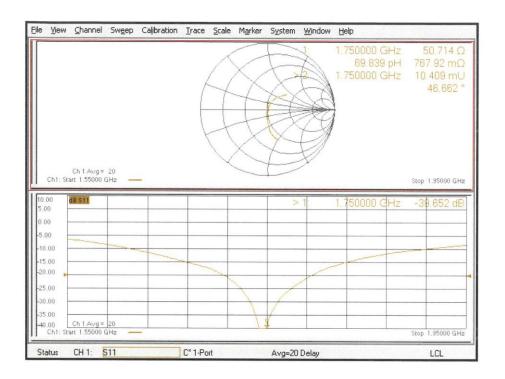


Impedance Measurement Plot for Head TSL



Certificate No: D1750V2-1003_Jul20





DASY5 Validation Report for Body TSL

Date: 24.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1003

Communication System: UID 0 - CW; Frequency: 1750 MHz

Medium parameters used: f = 1750 MHz; σ = 1.47 S/m; ϵ_r = 54; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.36, 8.36, 8.36) @ 1750 MHz; Calibrated: 29.06.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 102.6 V/m; Power Drift = -0.06 dB

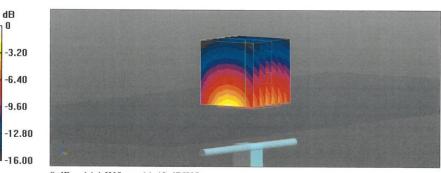
Peak SAR (extrapolated) = 16.7 W/kg

SAR(1 g) = 9.31 W/kg; SAR(10 g) = 4.95 W/kg

Smallest distance from peaks to all points 3 dB below = 9.8 mm

Ratio of SAR at M2 to SAR at M1 = 56.5%

Maximum value of SAR (measured) = 14.1 W/kg



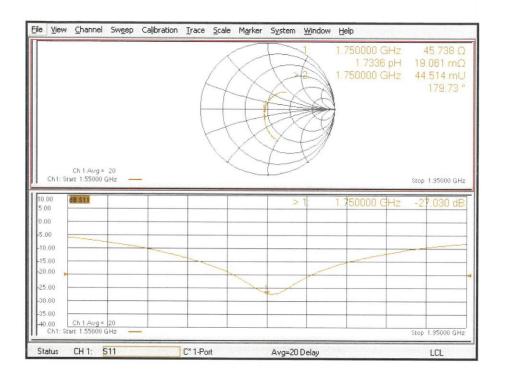
0 dB = 14.1 W/kg = 11.49 dBW/kg

Certificate No: D1750V2-1003_Jul20

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Impedance Measurement Plot for Body TSL



Certificate No: D1750V2-1003_Jul20





1900 MHz Dipole Calibration Certificate

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





- S 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

Client

CTTL-BJ (Auden)

Certificate No: D1900V2-5d101_Jul20

| Alibration procedure(s) QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz Alibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI), ne measurements and the uncertainties with conflidence probability are given on the following pages and are part of the certificate. Il calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Alibration Equipment used (M&TE critical for calibration) Firmary Standards ID # Cal Date (Certificate No.) Scheduled Calibration Ower meter NRP SN: 104778 01-Apr-20 (No. 217-03100) Apr-21 Ower sensor NRP-Z91 SN: 103244 01-Apr-20 (No. 217-03100) Apr-21 Ower sensor NRP-Z91 SN: 103245 01-Apr-20 (No. 217-03101) Apr-21 Ower sensor NRP-Z91 SN: 103245 01-Apr-20 (No. 217-03101) Apr-21 Ower sensor NRP-Z91 SN: 103245 (20k) 31-Mar-20 (No. 217-03104) Apr-21 Eleference 20 dB Attenuator SN: BH9394 (20k) 31-Mar-20 (No. 217-03104) Apr-21 Ower sensor HP B481A SN: 10484 29-Jun-20 (No. 217-03104) Apr-21 Ower Sensor HP B481A SN: US37292783 07-Oct-19 (No. DAE4-601_Dec19) Dec-20 Election SN: 10972 15-Jun-15 (in house check Cot-18) In house check: Cot-2 Ower sensor HP B481A SN: W341092317 07-Oct-15 (in house check Oct-18) In house check: Cot-2 Ower Sensor HP B481A SN: US37292783 07-Oct-15 (in house check Oct-18) In house check: Cot-2 Ower Sensor HP B481A SN: US37292783 07-Oct-15 (in house check Oct-18) In house check: Cot-2 Ower Sensor HP B481A SN: US37292783 07-Oct-15 (in house check Oct-18) In house check: Cot-2 Ower Sensor HP B481A SN: US37292783 07-Oct-15 (in house check Oct-18) In house check: Cot-2 Ower Sensor HP B481A SN: US37292783 07-Oct-15 (in house check Oct-18) In house check: Cot-2 Ower Sensor HP B481A SN: US37292783 07-Oct-15 (in house check Oct-18) In house check: Cot-2 Ower Sensor HP B481A SN: US37292783 07-Oct-15 (in house check Oct-18) In house check: Cot-2 Ower Sensor HP B481A SN: US37292783 07-Oct-15 (in h | ALIBRATION CE | ERTIFICATE | | |
|--|-------------------------------------|--------------------------------|--|--------------------------------|
| Calibration Procedure for SAR Validation Sources between 0.7-3 GHz Calibration date: July 28, 2020 Calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards D# Cal Date (Certificate No.) Scheduled Calibration Scheduled Calibration Scheduled Calibration Apr-21 Sover sensor NRP-291 SN: 103244 O1-Apr-20 (No. 217-03100/03101) Apr-21 Power sensor NRP-291 SN: 103244 O1-Apr-20 (No. 217-03101) Apr-21 SREderence 20 dB Attenuator SN: BH9394 (20k) SN: 310982 (6827 SN: 309-20 (No. 217-03104) Apr-21 Apr-21 SAEderence Probe EX3DV4 SN: 601 27-Dec-19 (No. DAE4-601_Dec19) Dec-20 Sceondary Standards ID # Check Date (in house) Scheduled Check SN: 309972 SN: 109972 SN: 109972 SN: 109972 SN: 109972 SN: 109972 SN: 109972 SN: US41080477 31-Mar-14 (in house check Oct-18) In house check: Oct-2 Name Function Signature Approved by: Katja Pokovic Technical Manager | bject | D1900V2 - SN:5d | 101 | |
| Calibration Procedure for SAR Validation Sources between 0.7-3 GHz Calibration date: July 28, 2020 Calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID # Cal Date (Certificate No.) Scheduled Calibration Power meter NRP Power sensor NRP-Z91 SN: 104778 01-Apr-20 (No. 217-03100)03101) Apr-21 Power sensor NRP-Z91 SN: 103244 01-Apr-20 (No. 217-03100) Apr-21 Power sensor NRP-Z91 SN: 103244 01-Apr-20 (No. 217-03101) Apr-21 Reference 20 dB Attenuator SN: BH9394 (20k) SN: 310982 / 06327 31-Mar-20 (No. 217-03104) Apr-21 SN: 310982 / 06327 31-Mar-20 (No. 217-03104) Apr-21 SN: 601 SN: 601 Z7-Dec-19 (No. DAE4-601_Dec19) Dec-20 Secondary Standards ID # Check Date (in house) Scheduled Check Power sensor HP 8481A SN: US37292783 SN: US37292783 SN: US37292783 SN: US41080477 31-Mar-14 (in house check Oct-18) In house check: Oct-2 Name Function Signature Approved by: Katja Pokovic Technical Manager | alibration procedura(s) | OA CAL -05 v11 | | |
| This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID # | and and proceeding(e) | | dure for SAR Validation Sources | between 0.7-3 GHz |
| This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID # | alibration date: | July 28, 2020 | | |
| The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID # Cal Date (Certificate No.) Scheduled Calibration Prower sensor NRP SN: 104778 O1-Apr-20 (No. 217-03100/03101) Apr-21 Power sensor NRP-Z91 SN: 103244 Power sensor NRP-Z91 SN: 103245 O1-Apr-20 (No. 217-03100) Apr-21 Reference 20 dB Attenuator SN: BH9394 (20k) 31-Mar-20 (No. 217-03106) Apr-21 Reference Probe EX3DV4 SN: 310982 / 06327 SN: 310982 / 06327 SN: 349 29-Jun-20 (No. EX3-7349_Jun20) Jun-21 DAE4 SN: 601 27-Dec-19 (No. DAE4-601_Dec19) Dec-20 Secondary Standards ID # Check Date (in house) Scheduled Check Power sensor HP 8481A SN: US37292783 O7-Oct-15 (in house check Feb-19) Network Analyzer Agilent E8358A NE US37292783 O7-Oct-15 (in house check Oct-18) In house check: Oct-2 Network Analyzer Agilent E8358A Name Function Signature Approved by: Katja Pokovic Technical Manager | | | | |
| All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID # Cal Date (Certificate No.) Scheduled Calibration Power meter NRP SN: 104778 01-Apr-20 (No. 217-03100/03101) Apr-21 Power sensor NRP-Z91 SN: 103244 01-Apr-20 (No. 217-03100) Apr-21 Reference 20 dB Attenuator SN: BH9394 (20k) 31-Mar-20 (No. 217-03101) Apr-21 Type-N mismatch combination SN: 310982 / 06327 31-Mar-20 (No. 217-03104) Apr-21 Reference Probe EX3DV4 SN: 7349 29-Jun-20 (No. EX3-7349_Jun20) Jun-21 DAE4 SN: 601 27-Dec-19 (No. DAE4-601_Dec19) Dec-20 Secondary Standards ID # Check Date (in house) Scheduled Check Power meter E4419B SN: GB39512475 30-Oct-14 (in house check Feb-19) In house check: Oct-2 Power sensor HP 8481A SN: US37292783 07-Oct-15 (in house check Oct-18) In house check: Oct-2 Power sensor HP 8481A SN: MY41092317 07-Oct-15 (in house check Oct-18) In house check: Oct-2 RF generator R&S SMT-06 SN: 100972 15-Jun-15 (in house check Oct-18) In house check: Oct-2 Name Function Signature Calibrated by: Katja Pokovic Technician Approved by: Katja Pokovic Technical Manager | his calibration certificate documen | its the traceability to nation | onal standards, which realize the physical un | its of measurements (SI). |
| D# | he measurements and the uncerta | inties with confidence pr | robability are given on the following pages an | d are part of the certificate. |
| D # Cal Date (Certificate No.) Scheduled Calibration | Il calibrations have been conducte | ed in the closed laborator | y facility: environment temperature (22 ± 3)° | C and humidity < 70%. |
| Secondary Standards | Calibration Equipment used (M&TE | critical for calibration) | | |
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| SN: 103245 01-Apr-20 (No. 217-03101) Apr-21 | ower meter NRP | SN: 104778 | 01-Apr-20 (No. 217-03100/03101) | Apr-21 |
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| SN: 310982 / 06327 31-Mar-20 (No. 217-03104) Apr-21 | ower sensor NRP-Z91 | SN: 103245 | 01-Apr-20 (No. 217-03101) | Apr-21 |
| Seletrence Probe EX3DV4 | Reference 20 dB Attenuator | SN: BH9394 (20k) | 31-Mar-20 (No. 217-03106) | Apr-21 |
| SN: 7349 | vpe-N mismatch combination | SN: 310982 / 06327 | 31-Mar-20 (No. 217-03104) | Apr-21 |
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| Power meter E4419B Power meter E4419B SN: GB39512475 SN: CCt-14 (in house check Feb-19) In house check: Oct-2 | DAE4 | SN: 601 | 27-Dec-19 (No. DAE4-601_Dec19) | Dec-20 |
| Power sensor HP 8481A Power sensor HP 8481A SN: US37292783 O7-Oct-15 (in house check Oct-18) In house check: Oct-2 In house check: O | Secondary Standards | ID# | Check Date (in house) | Scheduled Check |
| Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A Name Calibrated by: SN: MY41092317 SN: 100972 SN: 100972 SN: 100972 SN: 100972 SN: 100972 SN: 100972 SN: US41080477 SN: 100972 SN: US41080477 SN: US41 | Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| RF generator R&S SMT-06 Network Analyzer Agillent E8358A SN: 100972 SN: 100972 SN: US41080477 S | Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A SN: US41080477 31-Mar-14 (in house check Oct-19) In house check: Oct-2 Name Function Jeffrey Katzman Laboratory Technician Approved by: Katja Pokovic Technical Manager | Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A SN: US41080477 31-Mar-14 (in house check Oct-19) In house check: Oct-2 Name Function Signature Calibrated by: Laboratory Technician Approved by: Katja Pokovic Technical Manager | RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Calibrated by: Jeffrey Katzman Laboratory Technician Approved by: Katja Pokovic Technical Manager | Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-19) | In house check: Oct-20 |
| Approved by: Katja Pokovic Technical Manager | | Name | Function | Signature |
| acres - | | Jeffrey Katzman | Laboratory Technician | of fifture |
| acres - | Calibrated by: | | | |
| Issued: July 29, 2020 | | Katja Pokovic | Technical Manager | min |
| | | Katja Pokovic | Technical Manager | Mill |

Certificate No: D1900V2-5d101_Jul20

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





Schweizerischer Kalibrierdienst Service suisse d'étalonnage

C Service suisse d étalorimage Servizio svizzero di taratura S Swiss Calibration Service

Accreditation No.: SCS 0108

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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 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, "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: D1900V2-5d101_Jul20

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Measurement Conditions

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

| DASY Version | DASY5 | V52.10.4 |
|------------------------------|------------------------|-------------|
| 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.

| to following paramotors and salesiations were approximately | 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 | 41.0 ± 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 ³ (1 g) of Head TSL | Condition | |
|---|--------------------|--------------------------|
| SAR measured | 250 mW input power | 9.80 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 39.6 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|--------------------------|
| SAR measured | 250 mW input power | 5.13 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 20.6 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 | 53.8 ± 6 % | 1.49 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 | 9.73 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 39.5 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (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 | 20.8 W/kg ± 16.5 % (k=2) |

Certificate No: D1900V2-5d101_Jul20

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

| Impedance, transformed to feed point | $50.4 \Omega + 5.6 jΩ$ |
|--------------------------------------|------------------------|
| Return Loss | - 25.0 dB |

Antenna Parameters with Body TSL

| Impedance, transformed to feed point | 45.4 Ω + 5.7 jΩ |
|--------------------------------------|-----------------|
| Return Loss | - 22.3 dB |

General Antenna Parameters and Design

| Electrical Delay (one direction) | 1.202 ns |
|----------------------------------|----------|
| | |

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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

Additional EUT Data

| Manufactured by | SPEAG |
|-----------------|-------|
| | |

Certificate No: D1900V2-5d101_Jul20

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DASY5 Validation Report for Head TSL

Date: 28.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d101

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

Medium parameters used: f = 1900 MHz; σ = 1.39 S/m; ϵ_r = 41.0; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.26, 8.26, 8.26) @ 1900 MHz; Calibrated: 29.06.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 108.9 V/m; Power Drift = -0.04 dB

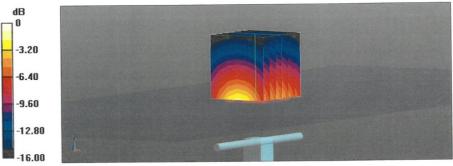
Peak SAR (extrapolated) = 18.2 W/kg

SAR(1 g) = 9.80 W/kg; SAR(10 g) = 5.13 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 54.5%

Maximum value of SAR (measured) = 15.2 W/kg



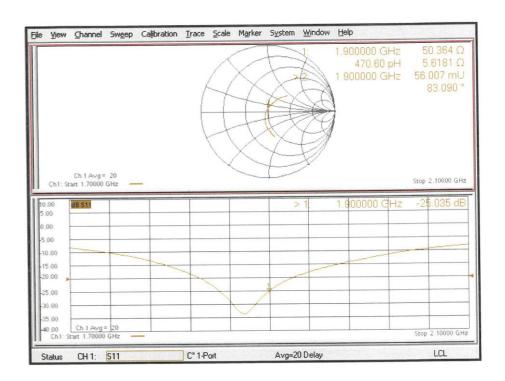
0 dB = 15.2 W/kg = 11.82 dBW/kg

Certificate No: D1900V2-5d101_Jul20

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Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d101_Jul20

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DASY5 Validation Report for Body TSL

Date: 24.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d101

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

Medium parameters used: f = 1900 MHz; $\sigma = 1.49$ S/m; $\epsilon_r = 53.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(8.21, 8.21, 8.21) @ 1900 MHz; Calibrated: 29.06.2020

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 27.12.2019

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

• DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 103.4 V/m; Power Drift = -0.09 dB

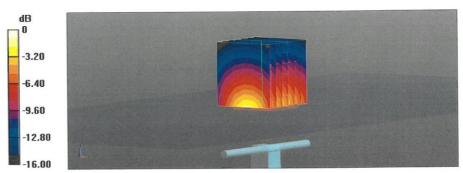
Peak SAR (extrapolated) = 16.8 W/kg

SAR(1 g) = 9.73 W/kg; SAR(10 g) = 5.16 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 59.5%

Maximum value of SAR (measured) = 14.2 W/kg



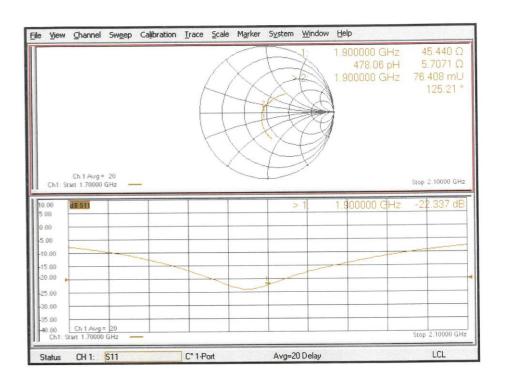
0 dB = 14.2 W/kg = 11.52 dBW/kg

Certificate No: D1900V2-5d101_Jul20

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Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5d101_Jul20

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2450 MHz Dipole Calibration Certificate

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





S Schweizerischer Kalibrierdienst
C 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 CTTL-BJ (Auden)

Certificate No: D2450V2-853 Jul20

| | ERTIFICATE | | |
|---|---|--|--|
| Object | D2450V2 - SN:8 | 53 | |
| Calibration procedure(s) | QA CAL-05.v11 Calibration Proce | edure for SAR Validation Sources | s between 0.7-3 GHz |
| Calibration date: | July 21, 2020 | | |
| The measurements and the uncert | tainties with confidence p | ional standards, which realize the physical unrobability are given on the following pages arry facility: environment temperature $(22 \pm 3)^{\circ}$ | nd are part of the certificate. |
| Calibration Equipment used (M&TE | critical for calibration) | | |
| | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
| Primary Standards | | Cal Date (Certificate No.) 01-Apr-20 (No. 217-03100/03101) | Scheduled Calibration |
| rimary Standards ower meter NRP | ID# | Cal Date (Certificate No.) 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) | Apr-21 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 | ID # SN: 104778 | 01-Apr-20 (No. 217-03100/03101) | |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 | ID # SN: 104778 SN: 103244 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) | Apr-21 Apr-21 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator | ID # SN: 104778 SN: 103244 SN: 103245 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) | Apr-21 Apr-21 Apr-21 |
| Primary Standards Prower meter NRP Prower sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Rype-N mismatch combination Reference Probe EX3DV4 | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) | Apr-21 Apr-21 Apr-21 Apr-21 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 |
| Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Power meter E4419B | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03104) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Peference 20 dB Attenuator Fype-N mismatch combination Reference Probe EX3DV4 DAE4 Decondary Standards Power meter E4419B Power sensor HP 8481A RF generator R&S SMT-06 | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310962 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03101) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Peference 20 dB Attenuator Fype-N mismatch combination Reference Probe EX3DV4 DAE4 Decondary Standards Power meter E4419B Power sensor HP 8481A RF generator R&S SMT-06 | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03104) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A RF generator R&S SMT-06 | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310962 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03101) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Power meter E4419B Power sensor HP 8481A RF generator R&S SMT-06 Retwork Analyzer Agilent E8358A | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477 | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03101) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-19) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 |
| Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 | ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477 Name | 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03101) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-19) | Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 |

Certificate No: D2450V2-853_Jul20

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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

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, "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: D2450V2-853_Jul20



Measurement Conditions

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

| DASY Version | DASY5 | V52.10.4 |
|------------------------------|------------------------|-------------|
| 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 | |

| | 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 | 38.5 ± 6 % | 1.84 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 | 13.3 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 | 6.17 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 24.5 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 % | 2.02 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 | 13.4 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 52.4 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|--------------------------|
| SAR measured | 250 mW input power | 6.22 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 24.6 W/kg ± 16.5 % (k=2) |

Certificate No: D2450V2-853_Jul20

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Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

| Impedance, transformed to feed point | 54.6 Ω + 4.9 jΩ | |
|--------------------------------------|-----------------|--|
| Return Loss | - 23.9 dB | |

Antenna Parameters with Body TSL

| Impedance, transformed to feed point | 49.9 Ω + 5.6 jΩ | |
|--------------------------------------|-----------------|--|
| Return Loss | - 25.0 dB | |

General Antenna Parameters and Design

| Electrical Delay (one direction) | 1.162 ns |
|----------------------------------|-----------|
| | 1.102 115 |

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 |
|-----------------|-------|
|-----------------|-------|

Certificate No: D2450V2-853_Jul20

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DASY5 Validation Report for Head TSL

Date: 21.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:853

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

Medium parameters used: f = 2450 MHz; $\sigma = 1.84$ S/m; $\epsilon_r = 38.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.74, 7.74, 7.74) @ 2450 MHz; Calibrated: 29.06.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 118.2 V/m; Power Drift = -0.05 dB

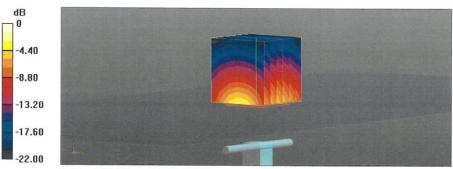
Peak SAR (extrapolated) = 26.2 W/kg

SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.17 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 51.1%

Maximum value of SAR (measured) = 21.8 W/kg

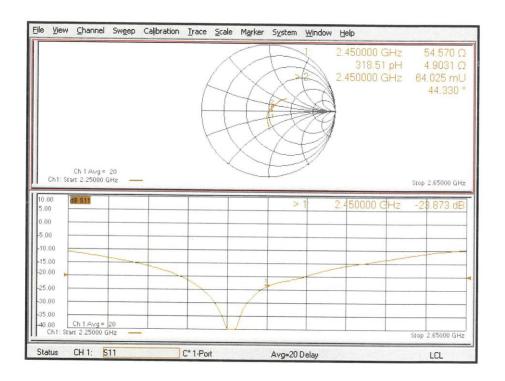


0 dB = 21.8 W/kg = 13.38 dBW/kg

Certificate No: D2450V2-853_Jul20



Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-853_Jul20





DASY5 Validation Report for Body TSL

Date: 21.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:853

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

Medium parameters used: f = 2450 MHz; $\sigma = 2.02$ 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(7.82, 7.82, 7.82) @ 2450 MHz; Calibrated: 29.06.2020

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 27.12.2019

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

DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 111.1 V/m; Power Drift = -0.09 dB

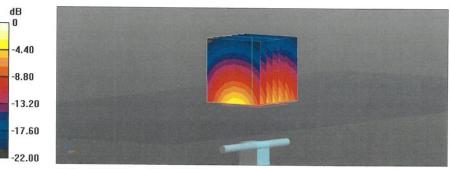
Peak SAR (extrapolated) = 25.7 W/kg

SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.22 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 52.9%

Maximum value of SAR (measured) = 21.6 W/kg



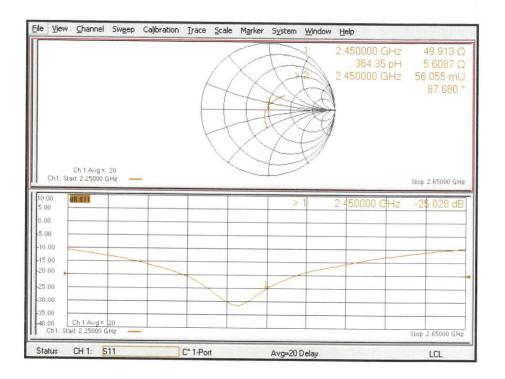
0 dB = 21.6 W/kg = 13.34 dBW/kg

Certificate No: D2450V2-853_Jul20

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Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-853_Jul20

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2600 MHz Dipole Calibration Certificate

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





S Schweizerischer Kalibrierdienst
C 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

CTTL-BJ (Auden)

Certificate No: D2600V2-1012 Jul20

| | CERTIFICAT | | |
|--|---|---|---|
| Object | D2600V2 - SN:1 | 012 | |
| Calibration procedure(s) | QA CAL-05.v11 | oduro for SAD Volidation O | |
| | Sanstation 1 100 | edure for SAR Validation Source | s between 0.7-3 GHz |
| Calibration date: | July 21, 2020 | | |
| his calibration cortificate docum | anta tha tanan 1999 | | |
| he measurements and the uncer | ents the traceability to nat rtainties with confidence p | ional standards, which realize the physical u probability are given on the following pages a | nits of measurements (SI). nd are part of the certificate. |
| | | ry facility: environment temperature (22 ± 3)° | |
| alibration Equipment used (M&T | | | , |
| rimary Standards | ID# | Cal Date (Certificate No.) | Scheduled Calibration |
| ower meter NRP | SN: 104778 | 01-Apr-20 (No. 217-03100/03101) | Apr-21 |
| ower sensor NRP-Z91 | SN: 103244 | 01-Apr-20 (No. 217-03100) | Apr-21 |
| ower sensor NRP-Z91 | SN: 103245 | 01-Apr-20 (No. 217-03101) | Apr-21 |
| eference 20 dB Attenuator | SN: BH9394 (20k) | 31-Mar-20 (No. 217-03106) | |
| pe-N mismatch combination | SN: 310982 / 06327 | 31-Mar-20 (No. 217-03104) | Apr-21 |
| Reference Probe EX3DV4 | SN: 7349 | 29-Jun-20 (No. EX3-7349_Jun20) | Apr-21 Jun-21 |
| | SN: 601 | 27-Dec-19 (No. DAE4-601_Dec19) | Dec-20 |
| DAE4 | | | |
| Secondary Standards | ID# | Check Date (in house) | Scheduled Cheek |
| econdary Standards ower meter E4419B | ID # SN: GB39512475 | Check Date (in house) 30-Oct-14 (in house check Feb-19) | Scheduled Check |
| secondary Standards lower meter E4419B lower sensor HP 8481A | | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| decondary Standards Tower meter E4419B Tower sensor HP 8481A Tower sensor HP 8481A | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 In house check: Oct-20 |
| econdary Standards ower meter E4419B ower sensor HP 8481A ower sensor HP 8481A F generator R&S SMT-06 | SN: GB39512475 SN: US37292783 | 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 |
| iecondary Standards fower meter E4419B fower sensor HP 8481A fower sensor HP 8481A figenerator R&S SMT-06 | SN: GB39512475 SN: US37292783 SN: MY41092317 | 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 |
| Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A Figenerator R&S SMT-06 Fielwork Analyzer Agilent E8358A | SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 | 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 |
| Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A | SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477 | 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-19) | In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 Signature |
| Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A F generator R&S SMT-06 letwork Analyzer Agilent E8358A | SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477 Name Jeffrey Katzman | 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-19) Function | In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 Signature |
| econdary Standards ower meter E4419B ower sensor HP 8481A ower sensor HP 8481A F generator R&S SMT-06 etwork Analyzer Agilent E8358A | SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477 | 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-19) Function | In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 |

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





S Schweizerischer Kalibrierdienst
C 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

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, "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%.

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|------------------------------------|-------------|--|
| | | |



Measurement Conditions

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

| DASY Version | DASY5 | V52.10.4 |
|------------------------------|------------------------|-------------|
| 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.

| | 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 | 37.9 ± 6 % | 2.01 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 | 14.5 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 57.0 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|--------------------------|
| SAR measured | 250 mW input power | 6.40 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 25.3 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 | 52.5 | 2.16 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 51.0 ± 6 % | 2.20 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 | 14.0 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 55.1 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|--------------------------|
| SAR measured | 250 mW input power | 6.20 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 24.6 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 | 47.0 Ω - 5.6 jΩ | |
|--------------------------------------|-----------------|--|
| Return Loss | - 23.7 dB | |

Antenna Parameters with Body TSL

| Impedance, transformed to feed point | 44.6 Ω - 4.4 ϳΩ |
|--------------------------------------|-----------------|
| Return Loss | - 22.7 dB |

General Antenna Parameters and Design

| - 1 | | |
|-----|----------------------------------|----------|
| | Electrical Delay (one direction) | 1.152 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 |
|-----------------|-------|

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DASY5 Validation Report for Head TSL

Date: 21.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1012

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

Medium parameters used: f = 2600 MHz; σ = 2.01 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(7.54, 7.54, 7.54) @ 2600 MHz; Calibrated: 29.06.2020

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 27.12.2019

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

DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 121.2 V/m; Power Drift = -0.04 dB

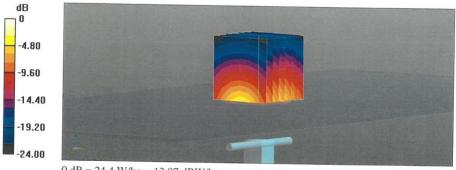
Peak SAR (extrapolated) = 29.3 W/kg

SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.40 W/kg

Smallest distance from peaks to all points 3 dB below = 8.9 mm

Ratio of SAR at M2 to SAR at M1 = 49.4%

Maximum value of SAR (measured) = 24.4 W/kg



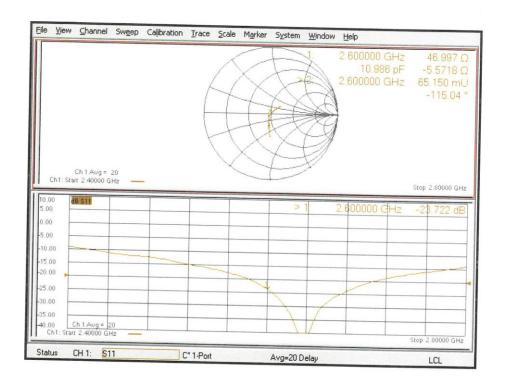
0 dB = 24.4 W/kg = 13.87 dBW/kg

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Impedance Measurement Plot for Head TSL



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