

DASY5 Validation Report for Head TSL

Date: 19.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

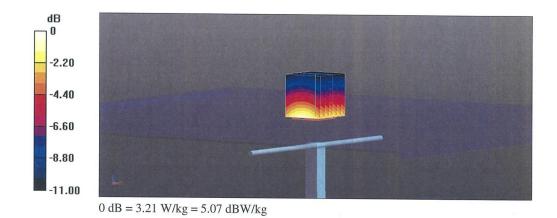
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d069

Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz; σ = 0.91 S/m; ϵ_r = 40.8; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(10.07, 10.07, 10.07); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

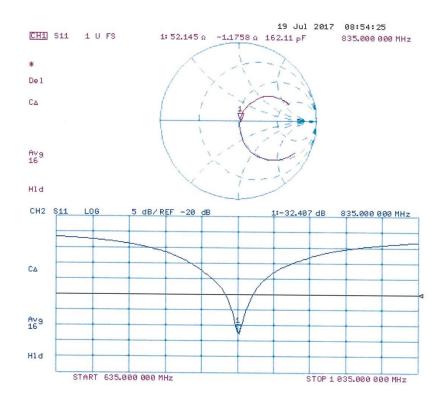
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 62.08 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 3.65 W/kg SAR(1 g) = 2.37 W/kg; SAR(10 g) = 1.53 W/kg Maximum value of SAR (measured) = 3.21 W/kg



Certificate No: D835V2-4d069_Jul17



Impedance Measurement Plot for Head TSL



Certificate No: D835V2-4d069_Jul17

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DASY5 Validation Report for Body TSL

Date: 19.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

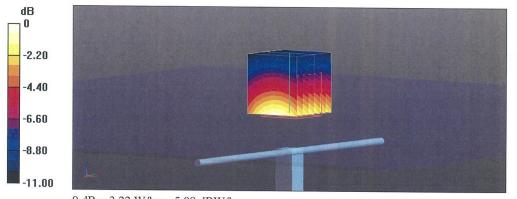
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d069

Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz; σ = 1.01 S/m; ϵ_r = 54.8; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(10.2, 10.2, 10.2); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 59.35 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 3.67 W/kg SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.57 W/kg Maximum value of SAR (measured) = 3.22 W/kg

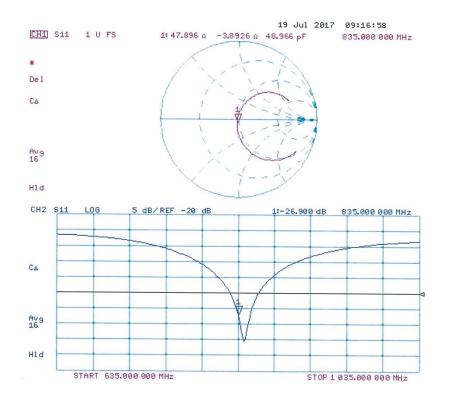


0 dB = 3.22 W/kg = 5.08 dBW/kg

Certificate No: D835V2-4d069_Jul17



Impedance Measurement Plot for Body TSL



Certificate No: D835V2-4d069_Jul17

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1750 MHz Dipole Calibration Certificate

| The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates Client CTL-BJ (Auden) Certificate No: D1750V2-1003_Jul1 CALIBRATION CERTIFICATE Object D1750V2 - SN:1003 Calibration procedure(s) QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz Calibration procedure(s) QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz Calibration date: July 21, 2017 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (S). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibration set with confidence probability are given on the following pages and are part of the certificate. All calibration Equipment used (M&TE critical for calibration) Primary Standards ID # Cal Date (Certificate No.) Scheduled Calibration Prover sensor NRP-291 SN: 103245 04-Apri-17 (No. 217-02521) Apri-18 Prover sensor NRP-291 SN: 103245 04-Apri-17 (No. 217-02522) Apri-18 Prover sensor NRP-291 SN: 103245 04-Apri-17 (No. 217-02529) Apri-18 Reference 20 dB Attenuator SN: 5054 (2082) 07-Apri-17 (No. 217-02529) Apri-18 Reference 20 dB Attenuator SN: 5054 (2082) 07-Apri-17 (No. 217-02529) Apri-18 Reference Probe EX3DV4 SN: 5058 (208) 07-Apri-17 (No. 217-02529) Apri-18 Reference Probe EX3DV4 SN: 5058 (208) 07-Apri-17 (No. 217-02529) Apri-18 Reference Probe EX3DV4 SN: 5058 (208) 07-Apri-17 (No. 217-02529) Apri-18 Reference Probe EX3DV4 SN: 5058 (208) 07-Apri-17 (No. 217-02529) Apri-18 Reference Probe EX3DV4 SN: 601 28-Mar-17 (No. 217-02529) Apri-18 Reference Probe EX3DV4 SN: 6037/20637 07-Cr:15 (in house check Oct-16) In house check: Oct-17 Power sensor HP 8481A SN: MV41082317 07-Oct-15 (in house check Oct-16) In house check: Oct-17 Power sensor HP 8481A SN: MV41082317 07-Oct-15 (in house check Oct-16) In house check: Oct-16 Network Analyzer HP 8473A | Calibration Laborator Schmid & Partner Engineering AG ^{Zeughausstrasse 43, 8004} Zuric | | | Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service |
|---|--|--|---|--|
| Multilateral Agreement for the recognition of calibration certificates Zitent CTLL-BJ (Auden) Carity Calibration CERTIFICATE Clipicet D1750V2 - SN:1003 Calibration procedure(s) QA CAL-05,v9 Calibration procedure for dipole validation kits above 700 MHz Calibration procedure(s) QA CAL-05,v9 Calibration procedure for dipole validation kits above 700 MHz Calibration date: UJU 21, 2017 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibration shave 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 10 # Cal Date (Cartificate No.) Scheduled Calibration Prower measor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-02521) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Primary Standards UB # Check Date (in house check Cot-16) In house check: Cot-18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover sensor NRP-Z91 SN: 103244 04 Apr 17 (No. 217-0252) Apr 18 Prover s | Accredited by the Swiss Accredita Fhe Swiss Accreditation Servic | ation Service (SAS) e is one of the signatori | es to the FA | Accreditation No.: SCS 0108 |
| CALIBRATION CERTIFICATE Object D1750V2 - SN:1003 Calibration procedure(s) QA CAL-05,v9 Calibration procedure for dipole validation kits above 700 MHz Calibration date: July 21, 2017 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibration Equipment used (M&TE critical for calibration) Primary Standards D # Cal Date (Certificate No.) Scheduled Calibration Proceedure 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID # Cal Date (Certificate No.) Scheduled Calibration Proceedure 70%. Power sensor NRP-291 SN: 103245 04-Apr-17 (No. 217-02521) Apr-18 Power sensor NRP-291 SN: 103245 04-Apr-17 (No. 217-02529) Apr-18 Power sensor NRP-291 SN: 103245 04-Apr-17 (No. 217-02529) Apr-18 Power sensor NRP-291 SN: 103245 04-Apr-17 (No. 217-02529) Apr-18 SN: 0547 2 / 05327 07-Apr-17 (No. 217-02529) Apr-18 SN: 0547 2 / 05327 07-Apr-17 (No. 217-02529) Apr-18 SN: 0547 2 / 05327 07-Apr-17 (N | Multilateral Agreement for the r | ecognition of calibration | n certificates | |
| Object D1750V2 - SN:1003 Calibration procedure(s) QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz Calibration date: July 21, 2017 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibration shave been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. | Client CTTL-BJ (Aud | en) | Certificate | No: D1750V2-1003_Jul17 |
| Calibration procedure(s) QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz Calibration date: July 21, 2017 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (S). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibration shave been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. | CALIBRATION O | CERTIFICAT | E | |
| Calibration procedure for dipole validation kits above 700 MHz Calibration date: July 21, 2017 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)*C and humidity < 70%. | Object | D1750V2 - SN:1 | 003 | |
| 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 procedure(s) | | edure for dipole validation kits ab | pove 700 MHz |
| Primary StandardsID #Cal Date (Certificate No.)Scheduled CalibrationPower meter NRPSN: 10477804-Apr-17 (No. 217-02521/02522)Apr-18Power sensor NRP-Z91SN: 10324404-Apr-17 (No. 217-02521)Apr-18Power sensor NRP-Z91SN: 10324504-Apr-17 (No. 217-02522)Apr-18Reference 20 dB AttenuatorSN: 5058 (20k)07-Apr-17 (No. 217-02528)Apr-18Type-N mismatch combinationSN: 5047.2 / 0632707-Apr-17 (No. 217-02529)Apr-18Reference Probe EX3DV4SN: 60128-Mar-17 (No. 237-349_May17)May-18DAE4SN: 60128-Mar-17 (No. DAE4-601_Mar17)Mar-18Secondary StandardsID #Check Date (in house)Scheduled CheckPower sensor HP 8481ASN: GB3748070407-Oct-15 (in house check Oct-16)In house check: Oct-18Power sensor HP 8481ASN: 10937215-Jun-15 (in house check Oct-16)In house check: Oct-18RF generator R&S SMT-06SN: 10097215-Jun-15 (in house check Oct-16)In house check: Oct-18Network Analyzer HP 8753ENameFunctionSignature | Calibration date: | July 21, 2017 | | |
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| 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 Type-N mismatch combination SN: 5047.2 / 06327 07-Apr-17 (No. 217-02529) Apr-18 Reference Probe EX3DV4 SN: 601 28-Mar-17 (No. 237-349_May17) May-18 DAE4 SN: 601 28-Mar-17 (No. DAE4-601_Mar17) Mar-18 Secondary Standards ID # Check Date (in house) Scheduled Check Power sensor HP 8481A SN: US37292783 07-Oct-15 (in house check Oct-16) In house check: Oct-18 Power sensor HP 8481A SN: 100972 15-Jun-15 (in house check Oct-16) In house check: Oct-18 RF generator R&S SMT-06 SN: 100972 15-Jun-15 (in house check Oct-16) In house check: Oct-17 Name Function Signature | Power meter NRP | SN: 104778 | | |
| Reference 20 dB AttenuatorSN: 5058 (20k)07-Apr-17 (No. 217-02528)Apr-18Type-N mismatch combinationSN: 5047.2 / 0632707-Apr-17 (No. 217-02528)Apr-18Reference Probe EX3DV4SN: 5047.2 / 0632707-Apr-17 (No. 217-02529)Apr-18DAE4SN: 60128-Mar-17 (No. DAE4-601_Mar17)May-18Secondary StandardsID #Check Date (in house)Scheduled CheckPower meter EPM-442ASN: GB3748070407-Oct-15 (in house check Oct-16)In house check: Oct-18Power sensor HP 8481ASN: US3729278307-Oct-15 (in house check Oct-16)In house check: Oct-18Power sensor HP 8481ASN: 10097215-Jun-15 (in house check Oct-16)In house check: Oct-18RF generator R&S SMT-06SN: 10097215-Jun-15 (in house check Oct-16)In house check: Oct-18Network Analyzer HP 8753ESN: US3739058518-Oct-01 (in house check Oct-16)In house check: Oct-17NameFunctionSignature | | SN: 103244 | 04-Apr-17 (No. 217-02521) | |
| Type-N mismatch combination Reference Probe EX3DV4SN: 5047.2 / 06327 SN: 734907-Apr-17 (No. 217-02529) SN: 7349 28-Mar-17 (No. 217-02529)Apr-18 Apr-18OAE4SN: 60128-Mar-17 (No. 247-02529) SN: 601May-18 SN: 601Secondary StandardsID # Check Date (in house)Scheduled CheckPower meter EPM-442A Power sensor HP 8481ASN: US37292783 SN: US3729278307-Oct-15 (in house check Oct-16) (in house check Oct-16)In house check: Oct-18 In house check: Oct-18 SN: 100972SF generator R&S SMT-06 Jetwork Analyzer HP 8753ESN: US3739058518-Oct-01 (in house check Oct-16)In house check: Oct-17 In house check: Oct-17NameFunctionSignature | | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference Probe EX3DV4SN: 734931-May-17 (No. EX3-7349_May17)May-18DAE4SN: 60128-Mar-17 (No. DAE4-601_Mar17)Mar-18Secondary StandardsID #Check Date (in house)Scheduled CheckPower meter EPM-442ASN: GB3748070407-Oct-15 (in house check Oct-16)In house check: Oct-18Power sensor HP 8481ASN: US3729278307-Oct-15 (in house check Oct-16)In house check: Oct-18Power sensor HP 8481ASN: MY4109231707-Oct-15 (in house check Oct-16)In house check: Oct-18Power sensor HP 8481ASN: 10097215-Jun-15 (in house check Oct-16)In house check: Oct-18RF generator R&S SMT-06SN: 10097215-Jun-15 (in house check Oct-16)In house check: Oct-17NameFunctionSignature | | and a second second second second second | 07-Apr-17 (No. 217-02528) | Apr-18 |
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| Network Analyzer HP 8753E SN: US37390585 18-Oct-01 (in house check Oct-16) In house check: Oct-17 Name Function Signature | | | | |
| Name Function Signature | | | | |
| i diodon Signature | TOTOL ANALYZEL HE 0/33E | | 18-Oct-01 (In nouse check Oct-16) | In house check: Oct-17 |
| Laboratory Technician | Dellineted by | NUMBER OF THE REAL PROPERTY OF THE PROPERTY OF | | Signature |
| | Calibrated by: | Michael Weber | Laboratory Technician | Milles |
| Approved by: Katja Pokovic Technical Manager | Approved by: | Katja Pokovic | Technical Manager | DIN |

Certificate No: D1750V2-1003_Jul17

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Calibration Laboratory of

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



S Schweizerischer Kalibrierdienst

C Service suisse d'étalonnage

Accreditation No.: SCS 0108

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

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: D1750V2-1003_Jul17

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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 | at at any |
| Frequency | 1750 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 40.1 | 1.37 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 39.0 ± 6 % | 1.35 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 | 9.15 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 36.7 W/kg ± 17.0 % (k=2) |
| | | |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
| SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured | condition 250 mW input power | 4.84 W/kg |

Body TSL parameters The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 53.4 | 1.49 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 53.3 ± 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 | 9.29 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 37.1 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 | 4.94 W/kg |

Certificate No: D1750V2-1003_Jul17



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

| Impedance, transformed to feed point | 50.9 Ω + 1.1 jΩ |
|--------------------------------------|-----------------|
| Return Loss | - 37.1 dB |

Antenna Parameters with Body TSL

| Impedance, transformed to feed point | 47.0 Ω + 0.1 jΩ |
|--------------------------------------|-----------------|
| Return Loss | - 30.2 dB |

General Antenna Parameters and Design

| Electrical Delay (one direction) | 1.213 ns |
|----------------------------------|----------|
|----------------------------------|----------|

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

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

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

Additional EUT Data

| Manufactured by | SPEAG | |
|-----------------|---------------|--|
| Manufactured on | July 30, 2008 | |

Certificate No: D1750V2-1003_Jul17

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DASY5 Validation Report for Head TSL

Date: 21.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

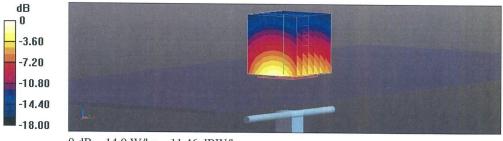
DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1003

Communication System: UID 0 - CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz; $\sigma = 1.35$ S/m; $\varepsilon_r = 39$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.73, 8.73, 8.73); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- 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 = 104.4 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 17.0 W/kg SAR(1 g) = 9.15 W/kg; SAR(10 g) = 4.84 W/kg Maximum value of SAR (measured) = 14.0 W/kg

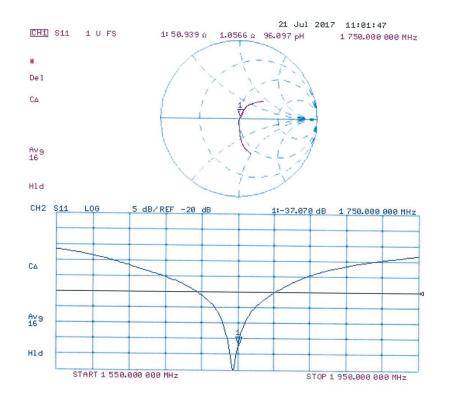


0 dB = 14.0 W/kg = 11.46 dBW/kg

Certificate No: D1750V2-1003_Jul17



Impedance Measurement Plot for Head TSL



Certificate No: D1750V2-1003_Jul17

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DASY5 Validation Report for Body TSL

Date: 20.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

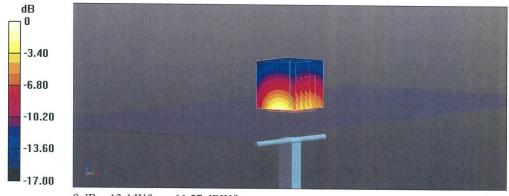
DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1003

Communication System: UID 0 - CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz; σ = 1.49 S/m; ϵ_r = 53.3; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.46, 8.46, 8.46); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- 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 = 99.34 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 16.4 W/kg SAR(1 g) = 9.29 W/kg; SAR(10 g) = 4.94 W/kg Maximum value of SAR (measured) = 13.4 W/kg



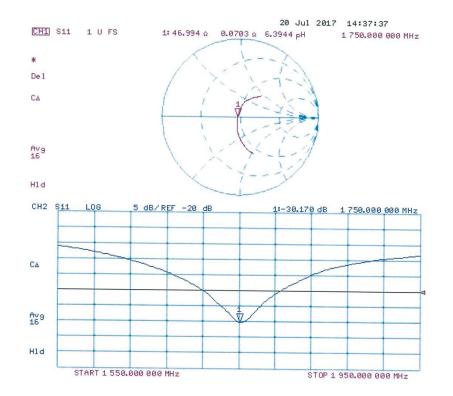
0 dB = 13.4 W/kg = 11.27 dBW/kg

Certificate No: D1750V2-1003_Jul17

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Impedance Measurement Plot for Body TSL



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Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

Servizio svizzero di taratura

Swiss Calibration Service

Accreditation No.: SCS 0108

Certificate No: D1900V2-5d101_Jul17

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1900 MHz Dipole Calibration Certificate

| Schmie Engi | ation Laboratory of d & Partner neering AG sstrasse 43, 8004 Zurich, Switzerland | |
|----------------|--|--|
| The Swis | ed by the Swiss Accreditation Service (SAS) ss Accreditation Service is one of the signatories to the EA ral Agreement for the recognition of calibration certificates | |
| Client | CTTL-BJ (Auden) | |
| CAL | IBRATION CERTIFICATE | |
| Object | D1900V2 - SN:5d101 | |

ERTIFICATE D1900V2 - SN:5d101 QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz

Calibration date:

Calibration procedure(s)

July 26, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter NRP | SN: 104778 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 7349 | 31-May-17 (No. EX3-7349_May17) | May-18 |
| DAE4 | SN: 601 | 28-Mar-17 (No. DAE4-601_Mar17) | Mar-18 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter EPM-442A | SN: GB37480704 | 07-Oct-15 (in house check Oct-16) | In house check: Oct-18 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-16) | In house check: Oct-18 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-16) | In house check: Oct-18 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-16) | In house check: Oct-18 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-16) | In house check: Oct-17 |
| | Name | Function | Signature |
| Calibrated by: | Johannes Kurikka | Laboratory Technician | you la |
| Approved by: | Katja Pokovic | Technical Manager | Alles |

Certificate No: D1900V2-5d101_Jul17

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



S Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura S wiss 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 | V52.10.0 |
|------------------------------|------------------------|---------------|
| Extrapolation | Advanced Extrapolation | 420- 1420- |
| 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 ³ (1 g) of Head TSL | Condition | 5005 5000 STORE |
|---|---------------------------------|--------------------------|
| SAR measured | 250 mW input power | 9.93 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 40.0 W/kg ± 17.0 % (k=2) |
| - Patricia - Fatricia | | |
| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
| SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured | condition 250 mW input power | 5.23 W/kg |

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 | 54.1 ± 6 % | 1.50 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 | 10.0 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 40.5 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 | 5.33 W/kg |

Certificate No: D1900V2-5d101_Jul17



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

| Impedance, transformed to feed point | 51.7 Ω + 5.8 jΩ |
|--------------------------------------|-----------------|
| Return Loss | - 24.5 dB |

Antenna Parameters with Body TSL

| Impedance, transformed to feed point | 46.2 Ω + 6.6 jΩ | |
|--------------------------------------|-----------------|--|
| Return Loss | - 22.0 dB | |

General Antenna Parameters and Design

| | Electrical Delay (one direction) | 1.203 ns |
|--|----------------------------------|----------|
|--|----------------------------------|----------|

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

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

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

Additional EUT Data

| Manufactured by | SPEAG |
|-----------------|----------------|
| Manufactured on | March 28, 2008 |

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DASY5 Validation Report for Head TSL

Date: 26.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

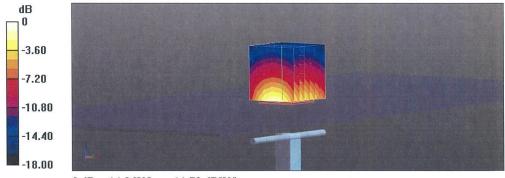
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d101

Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz; σ = 1.39 S/m; ϵ_r = 40.7; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.43, 8.43, 8.43); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- 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 = 106.3 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 18.4 W/kg SAR(1 g) = 9.93 W/kg; SAR(10 g) = 5.23 W/kg Maximum value of SAR (measured) = 14.9 W/kg

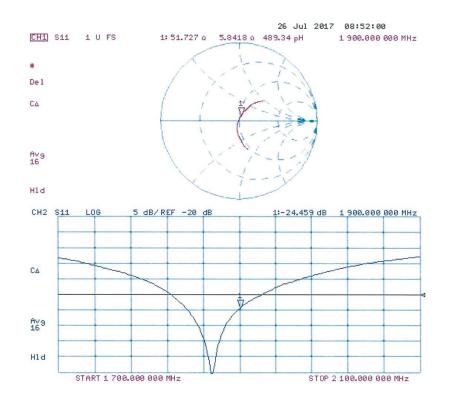


0 dB = 14.9 W/kg = 11.73 dBW/kg

Certificate No: D1900V2-5d101_Jul17



Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d101_Jul17

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DASY5 Validation Report for Body TSL

Date: 26.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

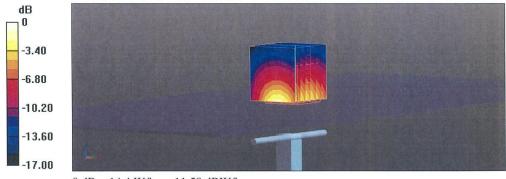
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d101

Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz; σ = 1.5 S/m; ϵ_r = 54.1; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.2, 8.2, 8.2); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- 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 = 101.8 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 17.6 W/kg SAR(1 g) = 10 W/kg; SAR(10 g) = 5.33 W/kg Maximum value of SAR (measured) = 14.4 W/kg



0 dB = 14.4 W/kg = 11.58 dBW/kg

Certificate No: D1900V2-5d101_Jul17

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