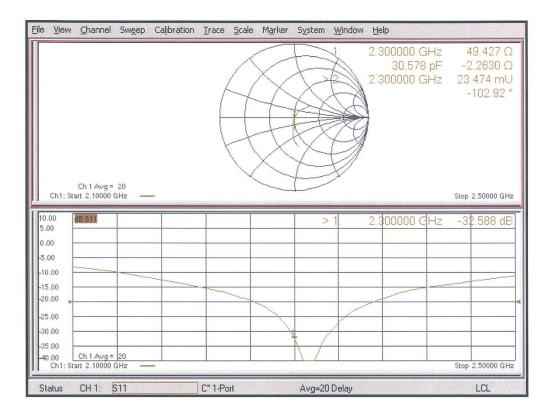




## Impedance Measurement Plot for Head TSL



Certificate No: D2300V2-1018\_Jul19

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

Date: 17.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

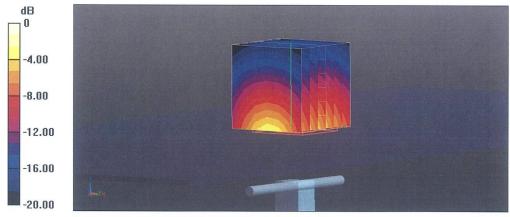
## DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN:1018

Communication System: UID 0 - CW; Frequency: 2300 MHz Medium parameters used: f = 2300 MHz;  $\sigma = 1.84$  S/m;  $\epsilon_r = 51.2$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.18, 8.18, 8.18) @ 2300 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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 = 107.4 V/m; Power Drift = -0.06 dB Peak SAR (extrapolated) = 22.6 W/kg SAR(1 g) = 12 W/kg; SAR(10 g) = 5.77 W/kg Maximum value of SAR (measured) = 18.9 W/kg



0 dB = 18.9 W/kg = 12.76 dBW/kg

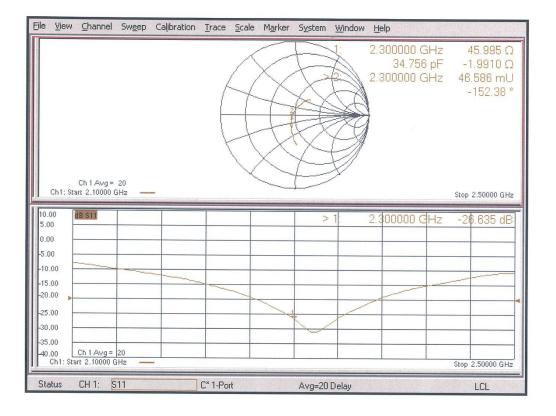
Certificate No: D2300V2-1018\_Jul19

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# Impedance Measurement Plot for Body TSL



Certificate No: D2300V2-1018\_Jul19

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# 2450 MHz Dipole Calibration Certificate

Calibration Laboratory Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich		The MEAN Store Store	<ul> <li>S Schweizerischer Kalibrierdienst</li> <li>Service suisse d'étalonnage</li> <li>Servizio svizzero di taratura</li> <li>Swiss Calibration Service</li> </ul>
Accredited by the Swiss Accreditati The Swiss Accreditation Service Multilateral Agreement for the red	is one of the signatorie		Accreditation No.: SCS 0108
Client CTTL (Auden)			No: D2450V2-853_Jul19
CALIBRATION C	ERTIFICATI		
Object	D2450V2 - SN:8	52	
	0240072 - 014.0	55	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	edure for SAR Validation Sourc	es between 0.7-3 GHz
Calibration date:	July 17, 2019		
All calibrations have been conducte Calibration Equipment used (M&TE Primary Standards	ed in the closed laborato E critical for calibration)	robability are given on the following pages ry facility: environment temperature (22 ± Cal Date (Certificate No.)	3)°C and humidity < 70%. Scheduled Calibration
Power meter NRP Power sensor NRP-Z91	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244 SN: 103245	03-Apr-19 (No. 217-02892)	Apr-20
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-19 (No. 217-02893)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02894) 04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 7349	29-May-19 (No. EX3-7349_May19)	Apr-20
DAE4	SN: 601	30-Apr-19 (No. DAE4-601_Apr19)	May-20 Apr-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-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19
	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M. Kees
Approved by:	Katja Pokovic	Technical Manager	Ally
This calibration certificate shall not	be reproduced except in	full without written approval of the laborat	Issued: July 17, 2019 ory.

Certificate No: D2450V2-853\_Jul19

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



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

TSLtissue simulating liquidConvFsensitivity in TSL / NORM x,y,zN/Anot 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\_Jul19

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## **Measurement Conditions**

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

DASY Version	DASY5	V52.10.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.6 ± 6 %	1.85 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.6 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	6.13 W/kg

### **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	50.8 ± 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 <sup>3</sup> (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	52.3 W/kg ± 17.0 % (k=2)

SAR averaged over 10 $\text{cm}^3$ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.23 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.5 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	54.5 Ω + 2.7 jΩ	
Return Loss	- 25.9 dB	

## Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.6 Ω + 5.6 jΩ	
Return Loss	- 25.0 dB	

## General Antenna Parameters and Design

Electrical Delay (one direction)	1.162 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: D2450V2-853\_Jul19

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

Date: 16.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

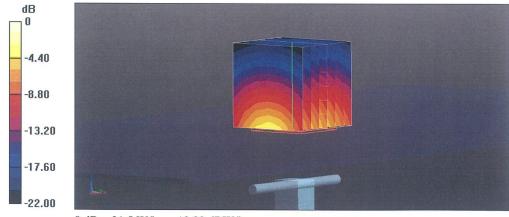
## DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:853

Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.85 S/m;  $\epsilon_r$  = 37.6;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.9, 7.9, 7.9) @ 2450 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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 = 115.6 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 25.7 W/kg SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.13 W/kg Maximum value of SAR (measured) = 21.5 W/kg



0 dB = 21.5 W/kg = 13.32 dBW/kg

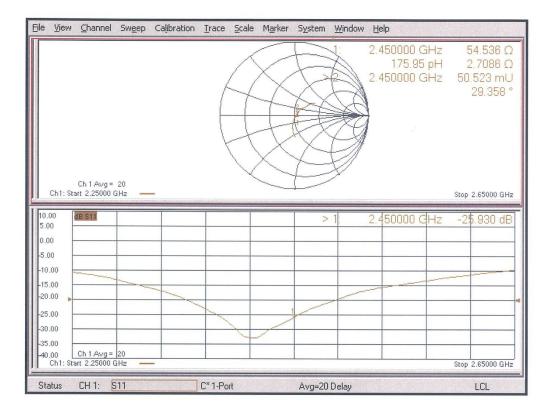
Certificate No: D2450V2-853\_Jul19

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## Impedance Measurement Plot for Head TSL



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

Date: 17.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

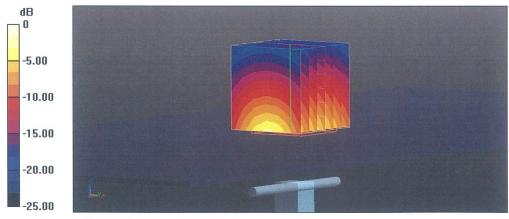
#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:853

Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 50.8$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.94, 7.94, 7.94) @ 2450 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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 = 110.2 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 26.3 W/kg SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.23 W/kg Maximum value of SAR (measured) = 21.8 W/kg



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

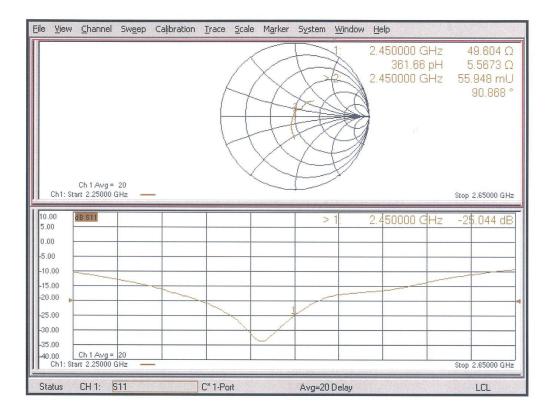
Certificate No: D2450V2-853\_Jul19

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## Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-853\_Jul19

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## 2600 MHz Dipole Calibration Certificate

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

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



Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura

Swiss Calibration Service

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Accreditation No.: SCS 0108

allbration procedure(s)       QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz         allbration date:       July 17, 2019         his calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). he measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.         Il calibration shave been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.         allbration Equipment used (M&TE critical for calibration)         timary Standards       ID #         Ower meter NIP       SN: 104778       03-Apr-19 (No. 217-02892)       Apr-20         swer sensor NIP-Z91       SN: 10244       03-Apr-19 (No. 217-02892)       Apr-20         swer sensor NIP-Z91       SN: 103244       03-Apr-19 (No. 217-02893)       Apr-20         swer sensor NIP-Z91       SN: 103245       03-Apr-19 (No. 217-02893)       Apr-20         swer sensor NIP-Z91       SN: 5047.27.08327       04-Apr-19 (No. 217-02893)       Apr-20         swer sensor NIP-Z91       SN: 103245       03-Apr-19 (No. 217-02895)       Apr-20         swer sensor NP-Z91       SN: 5047.27.08327       04-Apr-19 (No. 217-02893)       Apr-20         swer sensor NP-281       SN: 5047.27.08327       04-Apr-19 (No. 217-02895)       Apr-20         sw	ALIBRATION C	ERTIFICATI	E	
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz         Calibration date:       July 17, 2019         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.         NII calibration Equipment used (M&TE critical for calibration)         Primary Standards       D #         Ower sensor NRP-Z91       SN: 104778         SN: 103244       03-Apr-19 (No. 217-02892)(2893)         Yower sensor NRP-Z91       SN: 103244         SN: 103245       03-Apr-19 (No. 217-02893)         Yower sensor NRP-Z91       SN: 103244         SN: 103245       03-Apr-19 (No. 217-02893)         Yower sensor NRP-Z91       SN: 103245         SN: 103245       03-Apr-19 (No. 217-02893)         Yower sensor NRP-Z91       SN: 103245         SN: 103245       03-Apr-19 (No. 217-02893)         Yower sensor NRP-Z91       SN: 104778         SN: 501       30-Apr-19 (No. 217-02893)         Apr-20       SN: 501         SN: 501       30-Apr-19 (No. 217-02893)         Apr-20       SN: 501         SN: 501       30-Apr-19 (No. 217-02893)         Apr-20       SN: 501         SN:	Dbject	D2600V2 - SN:1	012	¢
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz         Calibration date:       July 17, 2019         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 Equipment used (M&TE critical for calibration)       Scheduled Calibration         Primary Standards       ID #       Cal Date (Certificate No.)       Scheduled Calibration         Prower sensor NRP-Z91       SN: 104778       03-Apr-19 (No. 217-02893)(2893)       Apr-20         Power sensor NRP-Z91       SN: 103244       03-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 103244       03-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 103244       03-Apr-19 (No. 217-02893)       Apr-20         SN: 103245       03-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 103244       03-Apr-19 (No. 217-02893)       Apr-20         SN: 1047 Z (05827)       04-Apr-19 (No. 217-02893)       Apr-20         SN: 601       30-Apr-19 (No. 217-02893)       Apr-20         SN: 601       30-Apr-19 (No. 217-02893)       Apr-20         SN: 601       30-Apr-19 (No. 217-02893)       Apr-20		04.041.05.44		
Calibration date:       July 17, 2019         This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.         All calibration Equipment used (M&TE critical for calibration)       Scheduled Calibration         Power meter NRP       SN: 104778       O3-Apr-19 (No. 217-02892/02893)       Apr-20         Power meter NRP       SN: 104778       O3-Apr-19 (No. 217-02892/02893)       Apr-20         Power sensor NRP-Z91       SN: 104728       O3-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 104778       O3-Apr-19 (No. 217-02894)       Apr-20         Reference 20 dB Attenuator       SN: 5047.2 / 06327       O4-Apr-19 (No. 217-02894)       Apr-20         SN: 5067.2 / 06327       O4-Apr-19 (No. 217-02894)       Apr-20         SN: 5067.2 / 06327       O4-Apr-19 (No. 217-02894)       Apr-20         SN: 5067.2 / 06327       O4-Apr-19 (No. 217-02894)       Apr-20         SN: 601       30-Apr-19 (No. 217-02894)       Apr-20         SN: 601       30-Apr-19 (No. DAE4-601_Apr19)       Apr-20         SN: 053292783       O7-Cot-15 (in house check Cot-18)       In house check: Cot-22         SN: 0537292728       O7-Cot-15 (in house check Cot-18) </td <td>Calibration procedure(s)</td> <td></td> <td>adura for SAR Validation Source</td> <td>a batwaan 0 7 0 OUL</td>	Calibration procedure(s)		adura for SAR Validation Source	a batwaan 0 7 0 OUL
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 1100	edure for SAIT validation Source	s 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 calibration certificate documents 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       03-Apr-19 (No. 217-02892)       Apr-20         Power sensor NRP-Z91       SN: 103244       03-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 103245       03-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 5058 (20k)       04-Apr-19 (No. 217-02895)       Apr-20         Power sensor NRP-Z91       SN: 5058 (20k)       04-Apr-19 (No. 217-02895)       Apr-20         SN: 601       30-Apr-19 (No. 217-02895)       Apr-20         SN: 601       30-Apr-19 (No. 217-02895)       Apr-20         SN: 601       30-Apr-19 (No. DAE4-601_Apr19)       May-20         SN: 601       30-Apr-19 (No. 217-02895)       Apr-20         Secondary Standards       ID #       Check				
D#       Cal Date (Certificate No.)       Scheduled Calibration         Primary Standards       ID #       Cal Date (Certificate No.)       Scheduled Calibration         Power meter NRP       SN: 104778       03-Apr-19 (No. 217-02892/02893)       Apr-20         Power sensor NRP-Z91       SN: 104778       03-Apr-19 (No. 217-02892/02893)       Apr-20         Power sensor NRP-Z91       SN: 103244       03-Apr-19 (No. 217-02892)       Apr-20         Power sensor NRP-Z91       SN: 103245       03-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 103245       03-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 103245       03-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 5058 (20k)       04-Apr-19 (No. 217-02895)       Apr-20         SN: 5047.2 / 06327       04-Apr-19 (No. 217-02895)       Apr-20         SN: 601       30-Apr-19 (No. 217-02895)       Apr-20         SN: 601       30-Apr-19 (No. 217-02895)       Apr-20         SN: 601       30-Apr-19 (No. 217-02895)       Apr-20         Swer meter E4419B       SN: US37282783       07-Oct-14 (in house check Cot-18)       In house check: Oct-22         Power sensor HP 8481A       SN: 109217       30-Oct-14 (in house check Oct-				
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 date:	July 17, 2019		
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%.				
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%.				
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       03-Apr-19 (No. 217-02892/02893)       Apr-20         Power sensor NRP-Z91       SN: 103244       03-Apr-19 (No. 217-02892)       Apr-20         Power sensor NRP-Z91       SN: 103245       03-Apr-19 (No. 217-02893)       Apr-20         Power sensor NRP-Z91       SN: 5058 (20k)       04-Apr-19 (No. 217-02893)       Apr-20         Second B Attenuator       SN: 5058 (20k)       04-Apr-19 (No. 217-02895)       Apr-20         SN: 5047.2 / 06327       04-Apr-19 (No. 217-02895)       Apr-20         SN: 5047.2 / 06327       04-Apr-19 (No. 217-02895)       Apr-20         SN: 5047.2 / 06327       SN: 5047.2 / 06327       SN: 504/2 / 06327       SN: 504/2 / 06327         SN: 5047.2 / 06327       SN: 504/2 / 06327       SN: 504/2 / 06327       SN: 504/2 / 06327       SN: 504/2 / 06327         SN: 601       30-Apr-19 (No. 2T-02895)       Apr-20       SN: 601       SN: 602       SN: 602         Sweer sensor HP 8481A       SN: US37292783       07-Oct-15 (in house check Oct-18)       In house check: Oct-20<	This calibration certificate docume	nts the traceability to nat	ional standards, which realize the physical u	nits of measurements (SI).
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Name     Function     Signature       Calibrated by:     Michael Weber     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
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Issued: July 17, 2019				Ally
Issued: July 17, 2019				
his calibration certificate shall not be reproduced except in full without written approval of the laboratory.				Issued: July 17, 2019

Certificate No: D2600V2-1012\_Jul19

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



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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

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	V52.10.2	
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	37.1 ± 6 %	2.02 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

# SAR result with Head TSL

-

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition		
SAR measured	250 mW input power	14.3 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	55.8 W/kg ± 17.0 % (k=2)	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition		
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition 250 mW input power	6.38 W/kg	

# **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	50.4 ± 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 <sup>3</sup> (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	55.0 W/kg ± 17.0 % (k=2)	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition		
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	6.26 W/kg	

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

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	47.5 Ω - 6.3 jΩ	
Return Loss	- 23.2 dB	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	43.8 Ω - 4.7 jΩ	
Return Loss	- 21.6 dB	

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

Electrical Delay (one direction)	1.153 ns
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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	540	SPEAG

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

Date: 16.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

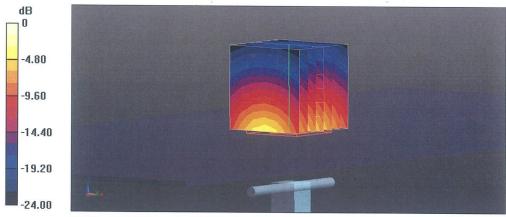
## DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1012

Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma$  = 2.02 S/m;  $\epsilon_r$  = 37.1;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.69, 7.69, 7.69) @ 2600 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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 = 118.6 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 28.8 W/kg SAR(1 g) = 14.3 W/kg; SAR(10 g) = 6.38 W/kg Maximum value of SAR (measured) = 24.0 W/kg



0 dB = 24.0 W/kg = 13.80 dBW/kg

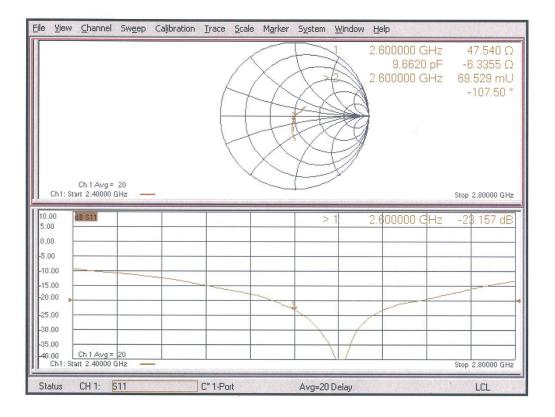
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# Impedance Measurement Plot for Head TSL



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