



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

Date: 22.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

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

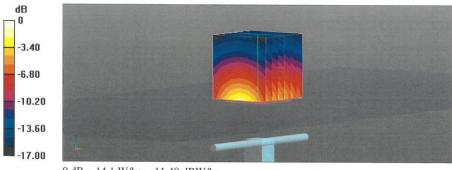
Communication System: UID 0 - CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma$  = 1.35 S/m;  $\epsilon_r$  = 40.4;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.58, 8.58, 8.58) @ 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 (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=5mmReference Value = 106.1 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 16.8 W/kg SAR(1 g) = 9.02 W/kg; SAR(10 g) = 4.75 W/kg Smallest distance from peaks to all points 3 dB below = 10 mm Ratio of SAR at M2 to SAR at M1 = 54.1% Maximum value of SAR (measured) = 14.1 W/kg



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

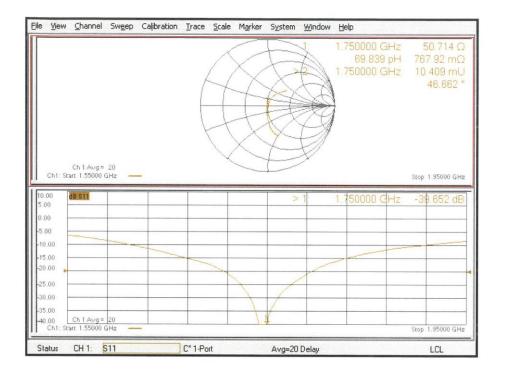
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### Impedance Measurement Plot for Head TSL



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### 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

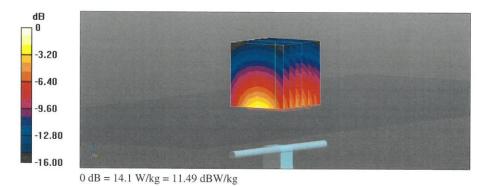
 $\begin{array}{l} \mbox{Communication System: UID 0 - CW; Frequency: 1750 MHz} \\ \mbox{Medium parameters used: } f = 1750 MHz; \mbox{$\sigma$} = 1.47 \mbox{ S/m}; \mbox{$\epsilon$}_r = 54; \mbox{$\rho$} = 1000 \mbox{ kg/m}^3 \\ \mbox{Phantom section: Flat Section} \\ \mbox{Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)} \\ \end{array}$ 

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



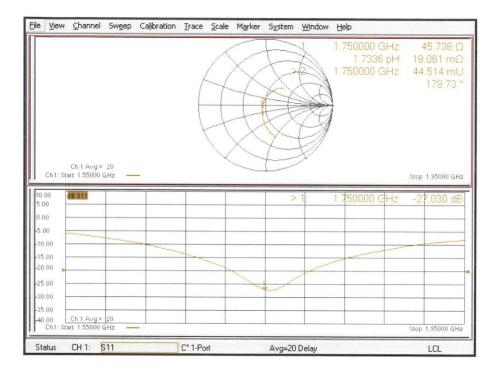
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### Impedance Measurement Plot for Body TSL



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### 1900 MHz Dipole Calibration Certificate

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



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

Accreditation No.: SCS 0108

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

Client CTTL-BJ (Auden)

Certificate No: D1900V2-5d101\_Jul20

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bject	D1900V2 - SN:5d	101	
	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	between 0.7-3 GHz
Calibration date:	July 28, 2020		
he measurements and the uncerta	ainties with confidence pr	onal standards, which realize the physical uni robability are given on the following pages an y facility: environment temperature (22 ± 3)°C	d are part of the certificate.
Calibration Equipment used (M&TE	1		Out-out-of Calibration
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21 Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245 SN: BH9394 (20k)	01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k) SN: 310982 / 06327	31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104)	Apr-21
Type-N mismatch combination 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-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A RF generator R&S SMT-06	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20
RF generator R&S SMT-06	Name	Function	Signature
RF generator R&S SMT-06	Name Jeffrey Katzman	Function Laboratory Technician	Signature
RF generator R&S SMT-06 Network Analyzer Agilent E8358A			Signature Hifus Allh

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 Servizio svizzero di taratura
- Swiss Calibration Service

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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	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	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 <sup>3</sup> (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 <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	5.13 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	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 <sup>3</sup> (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 <sup>3</sup> (10 g) of Body TSL	condition	

SAR averaged over 10 cm <sup>3</sup> (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)

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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 Ω + 5.6 jΩ
Return Loss	- 25.0 dB

### Antenna Parameters with Body TSL

45.4 Ω + 5.7 jΩ	
- 22.3 dB	

### General Antenna Parameters and Design

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

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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

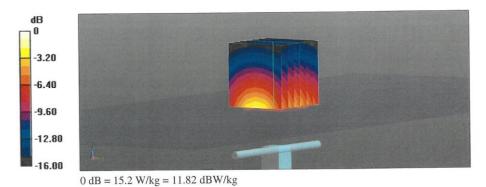
Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.39 S/m;  $\varepsilon_r$  = 41.0;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.26, 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



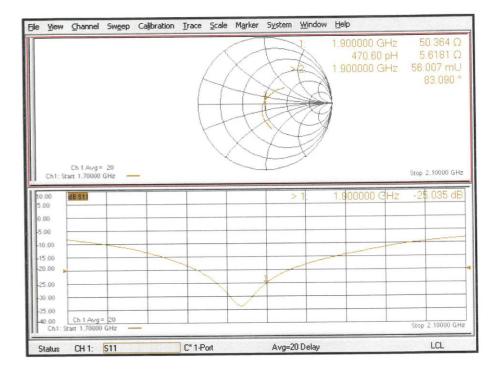
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### Impedance Measurement Plot for Head TSL



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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

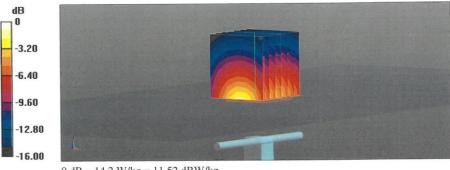
Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma = 1.49$  S/m;  $\varepsilon_r = 53.8$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(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=5mmReference 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

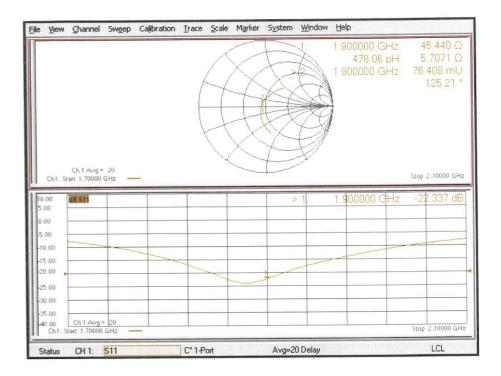
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### Impedance Measurement Plot for Body TSL



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### 2300 MHz Dipole Calibration Certificate

Engineering AG Zeughausstrasse 43, 8004 Zur	Dry of		S Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura S Swiss Calibration Service
Accredited by the Swiss Accredit The Swiss Accreditation Servi Multilateral Agreement for the	ce is one of the signato	ries to the EA on certificates	Accreditation No.: SCS 0108
Client CTTL-BJ (Auc	len)	Certifica	ate No: D2300V2-1018_Jul20
CALIBRATION	CERTIFICAT	E	
Object	D2300V2 - SN:	1018	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proc	edure for SAR Validation Sour	rces between 0.7-3 GHz
Calibration date:	July 21, 2020		
	cted in the closed laborate	tional standards, which realize the physics probability are given on the following page pry facility: environment temperature (22 ±	is and are part of the certificate.
All calibrations have been conduc Calibration Equipment used (M&T Primary Standards	cted in the closed laborate FE critical for calibration)	Cal Date (Certificate No.)	s and are part of the certificate. 3)°C and humidity < 70%.
All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter NRP	ted in the closed laborate rE critical for calibration) ID # SN: 104778	Cal Date (Certificate No.) 01-Apr-20 (No. 217-03100/03101)	is and are part of the certificate.
All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter NRP Power sensor NRP-Z91	cted in the closed laborate rE critical for calibration) ID # SN: 104778 SN: 103244	Cal Date (Certificate No.) 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100)	s and are part of the certificate. 3)°C and humidity < 70%. Scheduled Calibration
All calibrations have been conduct Calibration Equipment used (M&T Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91	ID # SN: 104778 SN: 103244 SN: 103245	Cal Date (Certificate No.)           01-Apr-20 (No. 217-03100/03101)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03100)	s and are part of the certificate. 3)°C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21
All calibrations have been conduc Calibration Equipment used (M&T <u>Primary Standards</u> Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k)	Cal Date (Certificate No.)           01-Apr-20 (No. 217-03100/03101)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03106)	s and are part of the certificate. 3)°C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21 Apr-21
All calibrations have been conduc Calibration Equipment used (M&T <u>Primary Standards</u> Power meter NRP Power sensor NRP-291 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	ID # SN: 104778 SN: 103244 SN: 103245	Cal Date (Certificate No.) 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104)	s and are part of the certificate. 3)°C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Apr-21
All calibrations have been conduc Calibration Equipment used (M&T <u>Primary Standards</u> Power meter NRP Power sensor NRP-291 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	ID #         SN: 104778         SN: 103244         SN: 103245         SN: 819394 (20k)         SN: 310982 / 06327         SN: 310982	Cal Date (Certificate No.)           01-Apr-20 (No. 217-03100/03101)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03106)	s and are part of the certificate. 3)°C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21 Apr-21
All calibrations have been conduc Calibration Equipment used (M&T <u>Primary Standards</u> 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: 103824 (20k)         SN: 310982 / 06327           SN: 7349         SN: 7349	Cal Date (Certificate No.)           01-Apr-20 (No. 217-03100/03101)           01-Apr-20 (No. 217-03100)           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)	s and are part of the certificate. 3)°C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Jun-21 Dec-20
All calibrations have been conduct Calibration Equipment used (M&T Primary Standards Power meter NRP Power sensor NRP-291 Power sensor NRP-291 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	ID #           SN: 104778           SN: 103244           SN: 103245           SN: 8H9394 (20k)           SN: 310982 / 06327           SN: 601	Cal Date (Certificate No.)           01-Apr-20 (No. 217-03100/03101)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03100)           01-Apr-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)	s and are part of the certificate. 3)°C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Jun-21 Jun-21 Dec-20 Scheduled Check
All calibrations have been conduc Calibration Equipment used (M&T Primary Standards Power meter NRP Power sensor NRP-291 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards 20wer meter E4419B 20wer sensor HP 8481A	ID #           SN: 104778           SN: 103244           SN: 103245           SN: 819394 (20k)           SN: 310982 / 06327           SN: 7349           SN: 601           ID #           SN: 6B39512475           SN: US37292783	Cal Date (Certificate No.)           01-Apr-20 (No. 217-03100/03101)           01-Apr-20 (No. 217-03100)           01-Apr-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)	s and are part of the certificate. 3)°C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20
All calibrations have been conduc Calibration Equipment used (M&T 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 meter E4419B Power sensor HP 8481A	ID #           SN: 104778           SN: 103245           SN: 103245           SN: 103245           SN: 8H9394 (20k)           SN: 310982 / 06327           SN: 601           ID #           SN: 0537292783           SN: WY41092317	Cal Date (Certificate No.)           01-Apr-20 (No. 217-03100/03101)           01-Apr-20 (No. 217-03100)           01-Apr-20 (No. 217-03101)           01-Apr-20 (No. 217-03101)           01-Apr-20 (No. 217-03101)           01-Apr-20 (No. 217-03101)           01-Apr-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)	s and are part of the certificate. 3)°C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check 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



Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura 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 ConvF N/A	tissue simulating liquid sensitivity in TSL / NORM x,y,z
	not applicable or not measured

## Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

e) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the

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.

	V52.10.4
Advanced Extrapolation	
Modular Flat Phantom	
10 mm	with Spacer
dx, dy, dz = 5 mm	
2300 MHz ± 1 MHz	
	10 mm dx, dy, dz = 5 mm

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.5	1.67 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.0 ± 6 %	1.68 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	12.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	49.7 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	

	condition	
SAR measured	250 mW input power	5.97 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.8 W/kg ± 16.5 % (k=2)
		23.8 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	52.9	1.81 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.8 ± 6 %	1.84 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	48.2 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	5.85 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	
Return Loss	50.1 Ω - 3.4 jΩ
	- 29.5 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	
Return Loss	46.7 Ω - 2.4 jΩ
	- 27.5 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	
(one direction)	
	1.169 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 according to the Standard. No excessive force must be capitad and the second are not affected by this change. The overall dipole length is still

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: D2300V2-1018\_Jul20

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### DASY5 Validation Report for Head TSL

Test Laboratory: SPEAG, Zurich, Switzerland

Date: 21.07.2020

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

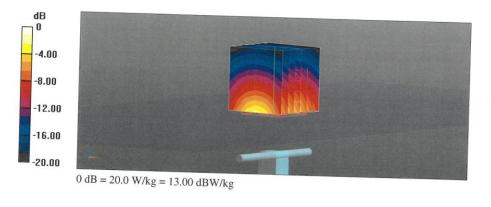
Communication System: UID 0 - CW; Frequency: 2300 MHz Medium parameters used: f = 2300 MHz;  $\sigma = 1.68 \text{ S/m}$ ;  $\varepsilon_r = 39$ ;  $\rho = 1000 \text{ kg/m}^3$ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.82, 7.82, 7.82) @ 2300 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 = 117.7 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 23.8 W/kg SAR(1 g) = 12.5 W/kg; SAR(10 g) = 5.97 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) = 20.0 W/kg



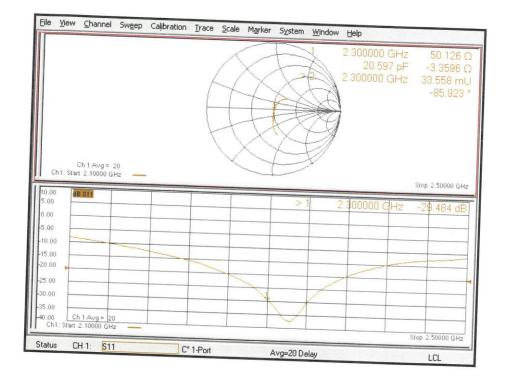
Certificate No: D2300V2-1018\_Jul20

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## Impedance Measurement Plot for Head TSL



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### DASY5 Validation Report for Body TSL

Test Laboratory: SPEAG, Zurich, Switzerland

Date: 21.07.2020

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

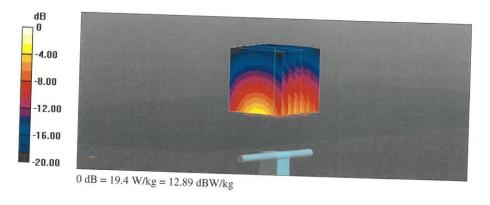
Communication System: UID 0 - CW; Frequency: 2300 MHz Medium parameters used: f = 2300 MHz;  $\sigma$  = 1.84 S/m;  $\epsilon_r$  = 51.8;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.93, 7.93, 7.93) @ 2300 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 = 109.4 V/m; Power Drift = -0.08 dB Peak SAR (extrapolated) = 23.4 W/kg SAR(1 g) = 12.2 W/kg; SAR(10 g) = 5.85 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 53.6% Maximum value of SAR (measured) = 19.4 W/kg



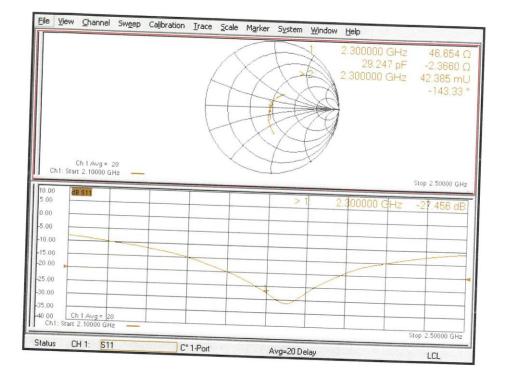
Certificate No: D2300V2-1018\_Jul20

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## Impedance Measurement Plot for Body TSL



Certificate No: D2300V2-1018\_Jul20

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### 2450 MHz Dipole Calibration Certificate

Schmid & Partner Engineering AG eughausstrasse 43, 8004 Zurich	/ Of , Switzerland		S Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service
Accredited by the Swiss Accreditati The Swiss Accreditation Service Multilateral Agreement for the red	is one of the signatorie	es to the EA	Accreditation No.: SCS 0108
Client CTTL-BJ (Aude			No: D2450V2-853_Jul20
CALIBRATION C	ERTIFICATI		
Object	D2450V2 - SN:8	53	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	edure for SAR Validation Source	es between 0.7-3 GHz
Calibration date:	July 21, 2020		
The measurements and the uncert	ainties with confidence p ed in the closed laborato	ional standards, which realize the physical ι robability are given on the following pages a ry facility: environment temperature (22 ± 3)	and are part of the certificate.
The measurements and the uncert All calibrations have been conduct Calibration Equipment used (M&TE	ainties with confidence p ed in the closed laborato E critical for calibration)	robability are given on the following pages a ry facility: environment temperature $(22 \pm 3)$	and are part of the certificate. °C and humidity < 70%.
The measurements and the uncert All calibrations have been conduct Calibration Equipment used (M&TE Primary Standards	ainties with confidence p ed in the closed laborato	robability are given on the following pages and the fo	and are part of the certificate. °C and humidity < 70%. Scheduled Calibration
The measurements and the uncert All calibrations have been conducte Calibration Equipment used (M&TE Primary Standards Power meter NRP	ainties with confidence p ed in the closed laborato E critical for calibration) ID #	robability are given on the following pages a ry facility: environment temperature $(22 \pm 3)$	and are part of the certificate. °C and humidity < 70%.
The measurements and the uncert All calibrations have been conductor Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91	ainties with confidence p ed in the closed laborato E critical for calibration) ID # SN: 104778	robability are given on the following pages a ry facility: environment temperature (22 ± 3) Cal Date (Certificate No.) 01-Apr-20 (No. 217-03100/03101)	and are part of the certificate. °C and humidity < 70%. Scheduled Calibration Apr-21
The measurements and the uncert All calibrations have been conductor Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	ainties with confidence p ed in the closed laborato E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k)	robability are given on the following pages a ry facility: environment temperature (22 ± 3) Cal Date (Certificate No.) 01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100)	and are part of the certificate. °C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21
The measurements and the uncert All calibrations have been conducts Calibration Equipment used (M&TE Primary Standards Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	ainties with confidence p ed in the closed laborato E critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 103245 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	robability are given on the following pages a ry facility: environment temperature (22 ± 3) Cal Date (Certificate No.) 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)	and are part of the certificate. °C and humidity < 70%. Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21 Apr-21
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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

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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	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	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 <sup>3</sup> (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 <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	6.17 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	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 <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	52.4 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm³ (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	6.22 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	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
----------------------------------	----------

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
indianation by	SPEAG

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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

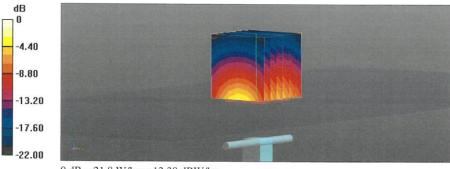
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 1.84 S/m;  $\epsilon_r$  = 38.5;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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=5mmReference 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

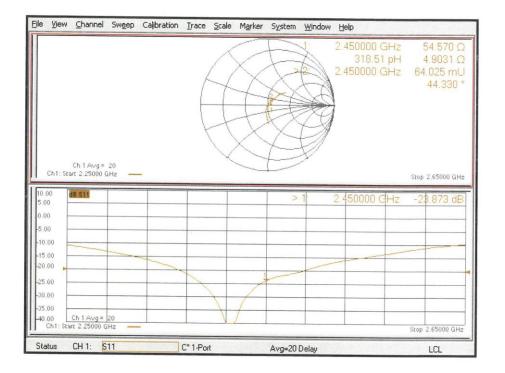
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### Impedance Measurement Plot for Head TSL



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### 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

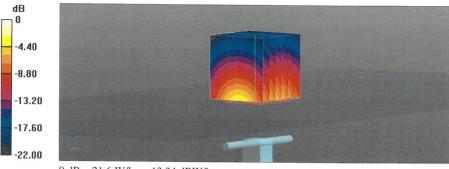
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma$  = 2.02 S/m;  $\varepsilon_r$  = 51.4;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.82, 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=5mmReference 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

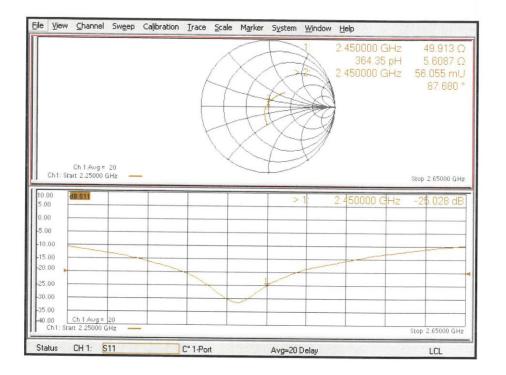
Certificate No: D2450V2-853\_Jul20

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### Impedance Measurement Plot for Body TSL



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