



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

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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

Certificate No: D1900V2-5d101_Jul20 CTTL-BJ (Auden) Client CALIBRATION CERTIFICATE Object D1900V2 - SN:5d101 QA CAL-05.v11 Calibration procedure(s) Calibration Procedure for SAR Validation Sources between 0.7-3 GHz July 28, 2020 Calibration date: 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) Cal Date (Certificate No.) Scheduled Calibration ID # Primary Standards SN: 104778 01-Apr-20 (No. 217-03100/03101) Apr-21 Power meter NRP Power sensor NRP-Z91 SN: 103244 01-Apr-20 (No. 217-03100) Apr-21 Power sensor NRP-Z91 SN: 103245 01-Apr-20 (No. 217-03101) Apr-21 SN: BH9394 (20k) 31-Mar-20 (No. 217-03106) Apr-21 Reference 20 dB Attenuator SN: 310982 / 06327 31-Mar-20 (No. 217-03104) Apr-21 Type-N mismatch combination SN: 7349 29-Jun-20 (No. EX3-7349_Jun20) Jun-21 Reference Probe EX3DV4 DAE4 SN: 601 27-Dec-19 (No. DAE4-601_Dec19) Dec-20 Scheduled Check Check Date (in house) Secondary Standards ID # In house check: Oct-20 SN: GB39512475 30-Oct-14 (in house check Feb-19) Power meter E4419B 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-19) Name Function Sign ature Jeffrey Katzman Laboratory Technician Calibrated by: Technical Manager Katja Pokovic Approved by: Issued: July 29, 2020 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "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 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

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.0 ± 6 %	1.39 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.80 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	39.6 W/kg ± 17.0 % (k=2)
- A Contraction of the second s		
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
	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 ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.73 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	39.5 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured	condition 250 mW input power	5.16 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	50.4 Ω + 5.6 jΩ	
Return Loss	- 25.0 dB	

Antenna Parameters with Body TSL

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

General Antenna Parameters and Design

Electrical Delay (one direction)	1.202 ns

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

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

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

Additional EUT Data

1	Manufactured by	SPEAG
	Waltaractured by	

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DASY5 Validation Report for Head TSL

Date: 28.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

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

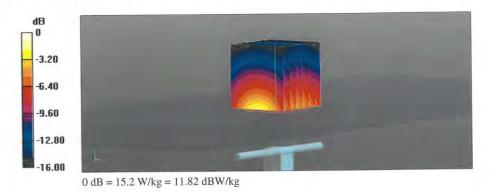
Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz; σ = 1.39 S/m; ε_r = 41.0; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

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

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 108.9 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 18.2 W/kg SAR(1 g) = 9.80 W/kg; SAR(10 g) = 5.13 W/kg Smallest distance from peaks to all points 3 dB below = 10 mm Ratio of SAR at M2 to SAR at M1 = 54.5% Maximum value of SAR (measured) = 15.2 W/kg



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File View Channel Sweep Calibration Trace Scale Marker System Window Help 50.364 Ω 1.900000 GHz 470.60 pH 5.6181 Q 1 900000 GHz 56.007 mU 83.090 * Ch 1 Avg = 20 Ch1: Start 1,70000 GHz Stop 2.10000 GHz dB \$11 0.00 5.00 900000 00.0 5.00 10.00 15.00 20.00 25.00 38 60 15.00 40.00 Ch1 Ch I Awg = 20 Stop 2.10000 GHz Start LCL Avg=20 Delay CH 1: 511 C* 1-Port Status

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

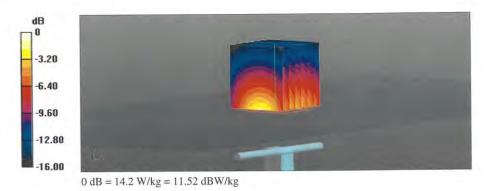
Communication System: UID 0 - CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz; $\sigma = 1.49$ S/m; $\epsilon_r = 53.8$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.21, 8.21, 8.21) @ 1900 MHz; Calibrated: 29.06.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 103.4 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 16.8 W/kg SAR(1 g) = 9.73 W/kg; SAR(10 g) = 5.16 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 59.5% Maximum value of SAR (measured) = 14.2 W/kg



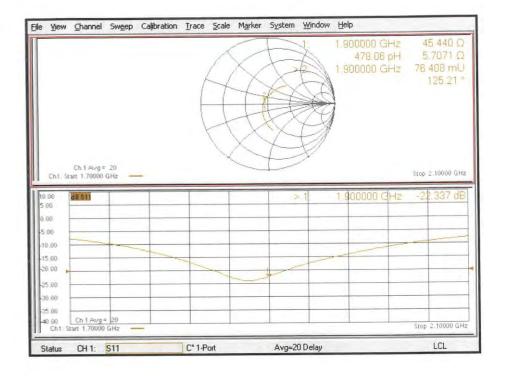
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Impedance Measurement Plot for Body TSL



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2450 MHz Dipole Calibration Certificate

Accredited by the Swiss Accreditati The Swiss Accreditation Service Multilateral Agreement for the red Client CTTL-BJ (Auder CALIBRATION C Object Calibration procedure(s)	is one of the signatorie cognition of calibration n)	s to the EA certificates Certificate N	ccreditation No.: SCS 0108 o: D2450V2-853_Jul20
CALIBRATION C	ERTIFICATE		o: D2450V2-853_Jul20
Object			
	D2450V2 - SN:8		
Calibration procedure(s)		53	
	QA CAL-05.v11 Calibration Proce	dure for SAR Validation Sources	s between 0.7-3 GHz
Calibration date:	July 21, 2020		
All calibrations have been conducte Calibration Equipment used (M&TE Primary Standards		y facility: environment temperature (22 \pm 3)°	C and humidity < 70%.
Power meter NRP	SN: 104778		
		Cal Date (Certificate No.)	Scheduled Calibration
	SN: 104778 SN: 103244	01-Apr-20 (No. 217-03100/03101)	Apr-21
ower sensor NRP-Z91		01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100)	Apr-21 Apr-21
Power sensor NRP-Z91 Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	SN: 103244 SN: 103245	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101)	Apr-21 Apr-21 Apr-21 Apr-21
² ower sensor NRP-Z91 ² ower sensor NRP-Z91 Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe EX3DV4	SN: 103244 SN: 103245 SN: BH9394 (20k)	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106)	Apr-21 Apr-21 Apr-21
² ower sensor NRP-Z91 ² ower sensor NRP-Z91 Reference 20 dB Attenuator Fype-N mismatch combination Reference Probe EX3DV4	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104)	Apr-21 Apr-21 Apr-21 Apr-21 Apr-21
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 AAE4	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20)	Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Power meter E4419B	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19)	Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18)	Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: WY41092317	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	Apr-21 Apr-21 Apr-21 Apr-21 Jur-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A RF generator R&S SMT-06	SN: 103244 SN: 103245 SN: BH3394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house check Feb-19) 07-Oct-15 (in house check Feb-19) 07-Oct-15 (in house check Cot-18) 15-Jun-15 (in house check Oct-18)	Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A RF generator R&S SMT-06	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: WY41092317	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	Apr-21 Apr-21 Apr-21 Apr-21 Jur-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310962 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: US3100972 SN: US41080477 Name	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03104) 29-Jun-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 Feb-19) 07-Oct-15 (in house check Cot-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-19) Function	Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A Calibrated by:	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310962 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03100) 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) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Cot-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-19)	Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20

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

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ConvF	sensitivity in TSL / NORM x,y,z
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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:

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- 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 ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.5 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (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 ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	52.4 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR averaged over 10 cm ³ (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	
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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	SPEAG
	SILAU

Certificate No: D2450V2-853_Jul20

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DASY5 Validation Report for Head TSL

Date: 21.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

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

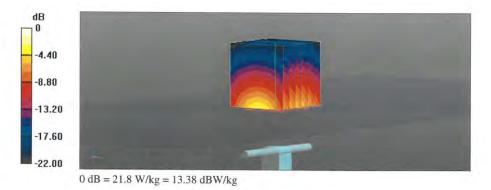
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 1.84 S/m; ϵ_r = 38.5; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

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

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 118.2 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 26.2 W/kg SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.17 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 51.1% Maximum value of SAR (measured) = 21.8 W/kg



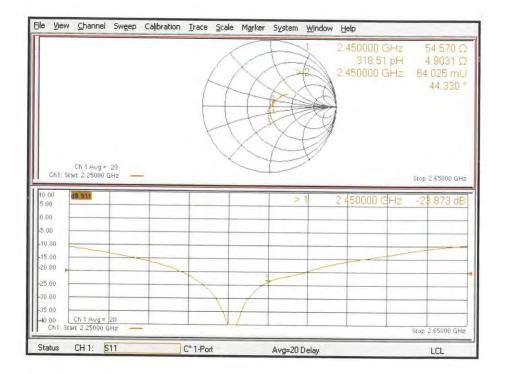
Certificate No: D2450V2-853_Jul20

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Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-853_Jul20

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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

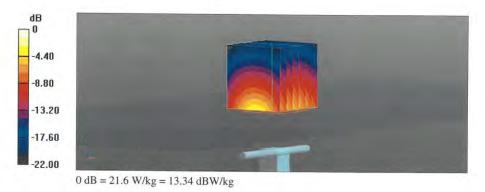
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz; σ = 2.02 S/m; ϵ_r = 51.4; p = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.82, 7.82, 7.82) @ 2450 MHz; Calibrated: 29.06.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=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



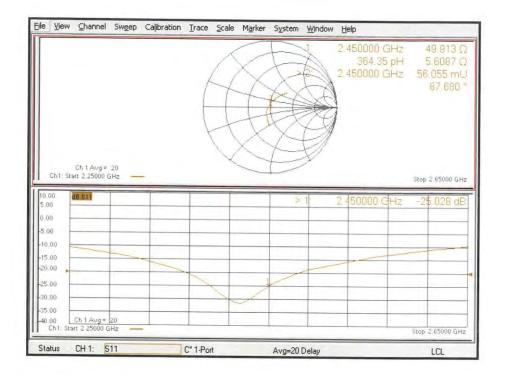
Certificate No: D2450V2-853_Jul20

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Impedance Measurement Plot for Body TSL



Certificate No: D2450V2-853_Jul20

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2600 MHz Dipole Calibration Certificate

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



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: D2600V2-1012_Jul20

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С

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Object	D2600V2 - SN:1	1012	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proc	edure for SAR Validation Source	es between 0.7-3 GHz
Calibration date:	July 21, 2020		
and the drive	ted in the closed laborato	tional standards, which realize the physical u probability are given on the following pages a ry facility: environment temperature (22 ± 3)	and are part of the certificate.
Primary Standards	D #		
minary Standards	10 #	Gal Date (Certificate No.)	Cabadulad Oath at
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	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) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19)	Scheduled Calibration Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20
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	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19)	Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20)	Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 VAE4 Recondary Standards Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A Figenerator R&S SMT-06 Retwork Analyzer Agilent E8358A	SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: 100972	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03101) 31-Mar-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house check Feb-19) 07-Oct-15 (in house check Feb-19) 07-Oct-15 (in house check Cot-18) 07-Oct-15 (in house check Cot-18)	Apr-21 Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20
Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Peference 20 dB Attenuator Type-N mismatch combination Peference Probe EX3DV4 PAE4 Power sensor HP 8481A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 104778 SN: 103244 SN: 103245 SN: 8H9394 (20k) SN: 310982 / 06327 SN: 7349 SN: 601 ID # SN: GB39512475 SN: US37292783 SN: V10972 SN: US41080477	01-Apr-20 (No. 217-03100/03101) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03100) 01-Apr-20 (No. 217-03106) 31-Mar-20 (No. 217-03104) 29-Jun-20 (No. EX3-7349_Jun20) 27-Dec-19 (No. DAE4-601_Dec19) Check Date (in house) 30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-19)	Apr-21 Apr-21 Apr-21 Apr-21 Jun-21 Dec-20 Scheduled Check In house check: Oct-20 In house check: Oct-20

Certificate No: D2600V2-1012_Jul20

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



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

Accreditation No.: SCS 0108

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Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

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Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.9 ± 6 %	2.01 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	14.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	57.0 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL SAR measured	condition 250 mW input power	6.40 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	51.0 ± 6 %	2.20 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	14.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	55.1 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR averaged over 10 cm ³ (10 g) of Body TSL SAR measured	condition 250 mW input power	6.20 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	47.0 Ω - 5.6 ίΩ
Return Loss	- 23.7 dB

Antenna Parameters with Body TSL

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

General Antenna Parameters and Design

Electrical Delay (one direction)	1.152 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufacture	
Manufactured by	SPEAC
	SPEAG

Certificate No: D2600V2-1012_Jul20

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DASY5 Validation Report for Head TSL

Date: 21.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

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

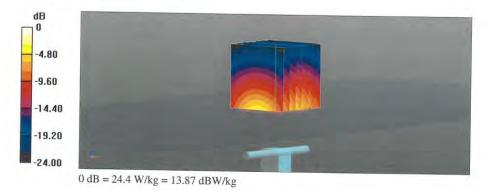
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz; σ = 2.01 S/m; ε_r = 37.9; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.54, 7.54, 7.54) @ 2600 MHz; Calibrated: 29.06.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 121.2 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 29.3 W/kg SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.40 W/kg Smallest distance from peaks to all points 3 dB below = 8.9 mm Ratio of SAR at M2 to SAR at M1 = 49.4% Maximum value of SAR (measured) = 24.4 W/kg

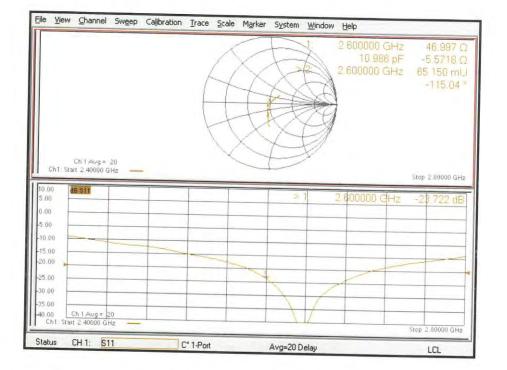


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Impedance Measurement Plot for Head TSL

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