

Page: 1 of 28

# **Appendix C**

# **Phantom Description**

Schmid & Partner Engineering AG

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Zeughausstrasse 43, 8004 Zurich, Switzerland Phone +41 44 245 9700, Fax +41 44 245 9779 info@speag.com, http://www.speag.com

#### Certificate of Conformity / First Article Inspection

Item	Oval Flat Phantom ELI 5.0
Type No	QD OVA 002 A
Series No	1108 and higher
Manufacturer	Untersee Composites
	Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

#### Tests

Complete tests were made on the prototype units QD OVA 001 A, pre-series units QD OVA 001 B as well as on some series units QD OVA 001 B. Some tests are made on all series units QD OVA 002 A.

Test	Requirement	Details	Units tested
Shape	Internal dimensions, depth and sagging are compatible with standards	Bottom elliptical 600 x 400 mm, Depth 190 mm, dimension compliant with [1] for f > 375 MHz	Prototypes
Material thickness	Bottom: 2.0mm +/- 0.2mm	dimension compliant with [3] for f > 800 MHz	all
Material parameters	rel. permittivity 2 – 5, loss tangent ≤ 0.05, at f ≤ 6 GHz	rel. permittivity 3.5 +/- 0.5 loss tangent ≤ 0.05	Material samples
Material resistivity	Compatibility with tissue simulating liquids .	Compatible with SPEAG liquids. **	Phantoms, Material sample
Sagging	Sagging of the flat section in tolerance when filled with tissue simulating liquid.	within tolerance for filling height up to 155 mm	Prototypes, samples

Note: Compatibility restrictions apply certain liquid components mentioned in the standard. containing e.g. DGBE, DGMHE or Triton X-100. Observe technical note on material compatibility

- OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01
   IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific
- Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003
- [3] IEC 62209-1 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close
- proximity to the ear (frequency range of 300 MHz to 3 GHz)", 2005-02-18
  [4] IEC 62209-2 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 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)", 2010-03-30

#### Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of body-worn SAR measurements and system performance checks as specified in [1 - 4] and further standards.

25.7.2011

Signature / Stamp

speag

Doc No 881 - QD OVA 002 A - A

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# **System Validation from Original Equipment Supplier**

Calibration Laboratory of Schmid & Partner Engineering AG eughausstrasse 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

Taoyuan City

Certificate No. D2450V2-727\_Apr24

	ERTIFICATI		
Object	D2450V2 - SN:727		
Calibration procedure(s)	QA CAL-05.v12	between 0.7-3 GHz	
	0411011411000	date to SATT validation Sources	between 0.7-3 GHZ
Calibration date:	April 22, 2024		
The measurements and the uncert	ainties with confidence pr	onal standards, which realize the physical uni robability are given on the following pages an	d are part of the certificate.
All calibrations have been conducte  Calibration Equipment used (M&TE		y facility: environment temperature (22 $\pm$ 3)°C	and humidity < 70%.
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP2	SN: 104778	26-Mar-24 (No. 217-04036/04037)	Mar-25
Power sensor NRP-Z91	SN: 103244	26-Mar-24 (No. 217-04036)	Mar-25
Power sensor NRP-Z91	SN: 103245	26-Mar-24 (No. 217-04037)	Mar-25
Reference 20 dB Attenuator	SN: BH9394 (20k)	26-Mar-24 (No. 217-04046)	Mar-25
Type-N mismatch combination	SN: 310982 / 06327	26-Mar-24 (No. 217-04047)	Mar-25
	SN: 7349	03-Nov-23 (No. EX3-7349_Nov23)	Nov-24
			A CONTRACTOR OF THE PARTY OF TH
Reference Probe EX3DV4	SN: 601	30-Jan-24 (No. DAE4-601_Jan24)	Jan-25
Reference Probe EX3DV4 DAE4	SN: 601	30-Jan-24 (No. DAE4-601_Jan24)  Check Date (in house)	Jan-25 Scheduled Check
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	M. Accessor	60-48-0-60-0-60-0-60-3-0-60-0-60-0-60-0-60-0	Scheduled Check
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	ID#	Check Date (in house)	Scheduled Check In house check: Oct-24
Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor HP 8481A	ID # SN: GB39512475	Check Date (in house) 30-Oct-14 (in house check Oct-22)	Scheduled Check
Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	ID # SN: GB39512475 SN: US37292783	Check Date (in house)  30-Oct-14 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)	Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	ID # SN: GB39512475 SN: US37292783 SN: MY41093315	Check Date (in house)  30-Oct-14 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)	Scheduled Check In house check: Oct-24 In house check: Oct-24
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	ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972	Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22)	Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22)	Scheduled Check In house check: Oct-24 Signature
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	ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	Check Date (in house) 30-Oct-14 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 07-Oct-15 (in house check Oct-22) 15-Jun-15 (in house check Oct-22) 31-Mar-14 (in house check Oct-22)	Scheduled Check In house check: Oct-24

Certificate No: D2450V2-727\_Apr24

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### Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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#### Glossary:

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

- Calibration is Performed According to the Following Standards:
  a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.

  b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

c) DASY 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss: This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. 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: D2450V2-727 Apr24 Page 2 of 6

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#### **Measurement Conditions**

DASY Version	DASY52	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	38.0 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.7 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.6 W/kg ± 16.5 % (k=2)

Certificate No: D2450V2-727 Apr24 Page 3 of 6

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	56.5 Ω + 0.4 jΩ	-11120-
Return Loss	- 24.2 dB	

# General Antenna Parameters and Design

Electrical Delay (one direction)	1.148 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**

ELEVANO DE SE LEGIS DE LA CONTRACTOR DE	
Manufactured by	SPEAG

Certificate No: D2450V2-727\_Apr24 Page 4 of 6

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

Date: 22.04.2024

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:727

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

Medium parameters used: f = 2450 MHz;  $\sigma = 1.87 \text{ S/m}$ ;  $\varepsilon_r = 38$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

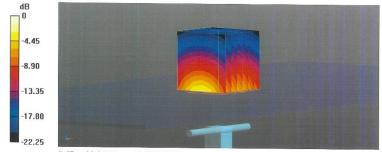
#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 03.11.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2024
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

# 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 = 117.9 V/m; Power Drift = 0.05 dB Peak SAR (extrapolated) = 27.0 W/kg SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.24 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 49.9%

Maximum value of SAR (measured) = 22.3 W/kg



0 dB = 22.3 W/kg = 13.49 dBW/kg

Certificate No: D2450V2-727 Apr24

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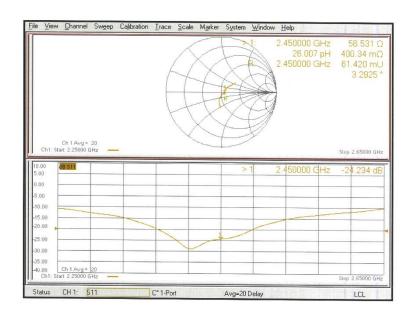
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#### Impedance Measurement Plot for Head TSL



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# Calibration Laboratory of

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





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Client SGS

Certificate No. D5GHzV2-1023\_Jan24

ALIBNATION	ERTIFICATE		
Dbject	D5GHzV2 - SN:1023		
Calibration procedure(s)	QA CAL-22.v7 Calibration Procedure for SAR Validation Sources between 3-10 GHz		
Calibration date:	January 24, 2024		
The measurements and the uncerta	inties with confidence pr	anal standards, which realize the physical unitrobability are given on the following pages and y facility: environment temperature $(22 \pm 3)^{\circ}$ C	d are part of the certificate.
Calibration Equipment used (M&TE	en e		
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24
Power sensor NRP-Z91 Power sensor NRP-Z91	SN: 103244 SN: 103245	30-Mar-23 (No. 217-03804)	Mar-24
		30-Mar-23 (No. 217-03805)	Mar-24
Reference 20 dB Attenuator  Type-N mismatch combination	SN: BH9394 (20k) SN: 310982 / 06327	30-Mar-23 (No. 217-03809)	Mar-24 Mar-24
		30-Mar-23 (No. 217-03810) 07-Mar-23 (No. EX3-3503_Mar23)	
Reference Probe EX3DV4	SN: 3503 SN: 601	03-Oct-23 (No. DAE4-601_Oct23)	Mar-24 Oct-24
Reference Probe EX3DV4 DAE4			
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter E4419B	SN: 601 ID # SN: GB39512475	03-Oct-23 (No. DAE4-601_Oct23)  Check Date (in house)  30-Oct-14 (in house check Oct-22)	Oct-24
Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor HP 8481A	SN: 601 ID # SN: GB39512475 SN: US37292783	03-Oct-23 (No. DAE4-601_Oct23)  Check Date (in house)  30-Oct-14 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)	Oct-24  Scheduled Check In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	ID # SN: GB39512475 SN: US37292783 SN: MY41093315	03-Oct-23 (No. DAE4-601_Oct23)  Check Date (in house)  30-Oct-14 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)	Oct-24  Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E44198 Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972	03-Oct-23 (No. DAE4-601_Oct23)  Check Date (in house)  30-Oct-14 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)  17-Oct-15 (in house check Oct-22)  15-Jun-15 (in house check Oct-22)	Oct-24  Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
Reference Probe EX3DV4 DAE4  Secondary Standards Power meter E44198 Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	ID # SN: GB39512475 SN: US37292783 SN: MY41093315	03-Oct-23 (No. DAE4-601_Oct23)  Check Date (in house)  30-Oct-14 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)	Oct-24  Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
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 Agillent E8358A	SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	03-Oct-23 (No. DAE4-601_Oct23)  Check Date (in house)  30-Oct-14 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)  17-Oct-15 (in house check Oct-22)  15-Jun-15 (in house check Oct-22)  31-Mar-14 (in house check Oct-22)	Oct-24  Scheduled Check In house check: Oct-24 In house check: Oct-24 In house check: Oct-24 In house check: Oct-24
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: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477	03-Oct-23 (No. DAE4-601_Oct23)  Check Date (in house)  30-Oct-14 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)  15-Jun-15 (in house check Oct-22)  31-Mar-14 (in house check Oct-22)	Oct-24  Scheduled Check In house check: Oct-24 Signature
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 Agillent E8358A	SN: 601 ID # SN: GB39512475 SN: US37292783 SN: MY41093315 SN: 100972 SN: US41080477 Name	03-Oct-23 (No. DAE4-601_Oct23)  Check Date (in house)  30-Oct-14 (in house check Oct-22)  07-Oct-15 (in house check Oct-22)  17-Oct-15 (in house check Oct-22)  15-Jun-15 (in house check Oct-22)  31-Mar-14 (in house check Oct-22)	Oct-24  Scheduled Check In house check: Oct-24

Certificate No: D5GHzV2-1023 Jan24

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## Calibration Laboratory of

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





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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) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
  - b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Additional Documentation:

c) DASY 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss: This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. 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	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5850 MHz ± 1 MHz	

#### Head TSL parameters at 5250 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.8 ± 6 %	4.57 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		0.000

#### SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.90 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 W/kg ± 19.5 % (k=2)

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#### Head TSL parameters at 5600 MHz

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.5 ± 6 %	4.97 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	2222	

#### SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.13 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.3 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.4 ± 6 %	5.11 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	2777	

#### SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.81 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.1 W/kg ± 19.5 % (k=2)

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### Head TSL parameters at 5850 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.2	5.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	5.19 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 5850 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.87 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.2 W/kg ± 19.5 % (k=2)

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

#### Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	$50.9~\Omega$ - $4.9~\mathrm{j}\Omega$	
Return Loss	- 26.2 dB	

#### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	$54.5~\Omega$ - $0.4~j\Omega$	
Return Loss	- 27.3 dB	

### Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	56.6 Ω + 4.7 jΩ	
Return Loss	- 22.4 dB	

#### Antenna Parameters with Head TSL at 5850 MHz

Impedance, transformed to feed point	54.6 Ω - 3.3 jΩ	
Return Loss	- 25.3 dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.200 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: 24.01.2024

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1023

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750

MHz, Frequency: 5850 MHz

Medium parameters used: f = 5250 MHz;  $\sigma = 4.57 \text{ S/m}$ ;  $\varepsilon_r = 35.8$ ;  $\rho = 1000 \text{ kg/m}^3$ Medium parameters used: f = 5600 MHz;  $\sigma = 4.97$  S/m;  $\varepsilon_r = 35.5$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used: f = 5750 MHz;  $\sigma = 5.11$  S/m;  $\epsilon_r = 35.4$ ;  $\rho = 1000$  kg/m Medium parameters used: f = 5850 MHz;  $\sigma = 5.19$  S/m;  $\epsilon_r = 35.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.08, 5.08, 5.08) @ 5750 MHz, ConvF(4.99, 4.99, 4.99) @ 5850 MHz; Calibrated: 07.03.2023
- · Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 03.10.2023
- · Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

#### Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.22 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 26.5 W/kg

SAR(1 g) = 7.90 W/kg; SAR(10 g) = 2.28 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 71%

Maximum value of SAR (measured) = 18.1 W/kg

#### Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.82 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 29.4 W/kg SAR(1 g) = 8.13 W/kg; SAR(10 g) = 2.33 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 68.5%

Maximum value of SAR (measured) = 18.7 W/kg

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#### Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 70.20 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 29.6 W/kg

SAR(1 g) = 7.81 W/kg; SAR(10 g) = 2.22 W/kg

Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 66.9%

Maximum value of SAR (measured) = 18.3 W/kg

#### Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5850 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

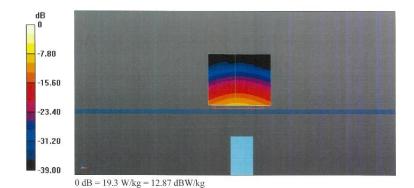
Reference Value = 69.49 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 30.9 W/kg

SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.23 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mmRatio of SAR at M2 to SAR at M1 = 66%

Maximum value of SAR (measured) = 19.3 W/kg



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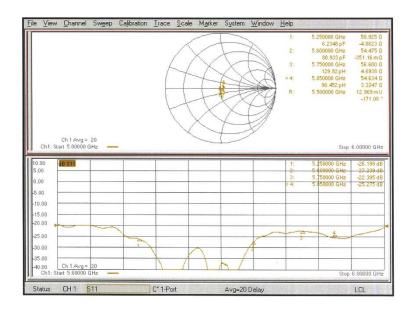
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#### Impedance Measurement Plot for Head TSL



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Certificate No. D6.5GHzV2-1006\_Aug24

SGS Taoyuan City **CALIBRATION CERTIFICATE** D6.5GHzV2 - SN:1006 QA CAL-22.v7 Calibration procedure(s) Calibration Procedure for SAR Validation Sources between 3-10 GHz August 15, 2024 Calibration date: This calibration certificate documents the traceability to national standards, which realize the physical units of meas The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70% Calibration Equipment used (M&TE critical for calibration) Primary Standards Cal Date (Certificate No.) Scheduled Calibration Power sensor R&S NRP33T SN: 100967 28-Mar-24 (No. 217-04038) Mar-25 Reference 20 dB Attenuator SN: BH9394 (20k) 26-Mar-24 (No. 217-04046) Mar-25 Mismatch combination Reference Probe EX3DV4 SN: 84224 / 360D SN: 7405 28-Mar-24 (No. 217-04050) Mar-25 01-Jul-24 (No. EX3-7405 Jul24) Jul-25 DAE4 SN: 908 27-Mar-24 (No. DAE4-908\_Mar24) Secondary Standards Check Date (in house) Scheduled Check RF generator Anapico APSIN20G 18-Dec-18 (in house check Jan-24) 10-Jan-19 (in house check Jan-24) SN: 827 In house check: Jan-25 Power sensor NRP-Z23 In house check: Jan-25 Power sensor NRP-18T SN: 100950 28-Sep-22 (in house check Jan-24) In house check: Jan-25 Network Analyzer Keysight E5063A SN:MY54504221 31-Oct-19 (in house check Oct-22) In house check: Oct-25 Function Calibrated by: Aidonia Georgiadou Laboratory Technician Approved by: Technical Manager This calibration certificate shall not be reproduced except in full without written approval of the laboratory

Certificate No: D6.5GHzV2-1006 Aug24

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Glossary:

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

### Calibration is Performed According to the Following Standards:

 a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate
Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range Of 4 MHz To 10 GHz)", October 2020.

#### **Additional Documentation:**

b) DASY 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 Return Loss ensures low reflected power. No uncertainty
- 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 absorbed power density (APD): The absorbed power density is evaluated according to Samaras T, Christ A, Kuster N, "Compliance assessment of the epithelial or absorbed power density above 6 GHz using SAR measurement systems", Bioelectromagnetics, 2021 (submitted). The additional evaluation uncertainty of 0.55 dB (rectangular distribution) is considered.

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: D6.5GHzV2-1006 Aug24 Page 2 of 6

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#### Measurement Conditions

ASY system configuration, as far as not g		
DASY Version	DASY6	V16.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	5 mm	with Spacer
Zoom Scan Resolution	dx, dy = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	6500 MHz ± 1 MHz	

#### Head TSL parameters

ng parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	34.5	6.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.9 ± 6 %	6.32 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	100 mW input power	29.7 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	297 W/kg ± 24.7 % (k=2)

SAR averaged over 8 cm <sup>3</sup> (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.63 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.4 W/kg ± 24.4 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	54.5 W/kg ± 24.4 % (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	46.9 Ω - 7.3 jΩ	
Return Loss	- 21.7 dB	

### APD (Absorbed Power Density)

APD averaged over 1 cm <sup>2</sup>	Condition	
APD measured	100 mW input power	297 W/m <sup>2</sup>
APD measured	normalized to 1W	2970 W/m <sup>2</sup> ± 29.2 % (k=2)

APD averaged over 4 cm <sup>2</sup>	condition	
APD measured	100 mW input power	133 W/m <sup>2</sup>
APD measured	normalized to 1W	1330 W/m <sup>2</sup> ± 28.9 % (k=2)

<sup>\*</sup>The reported APD values have been derived using the psSAR1g and psSAR8g.

#### General Antenna Parameters and Design

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
	<u> </u>

Certificate No: D6.5GHzV2-1006\_Aug24

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#### DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1006, UID 0 -, Channel 6500 (6500.0MHz)

**Device under Test Properties** 

DUT Type Name, Manufacturer Dimensions [mm] IMEI D6.5GHz 16.0 x 6.0 x 300.0 SN: 1006

Evnosure Conditions

Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.14	6.32	34.9

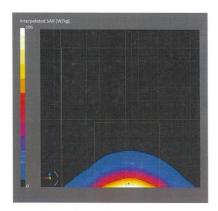
Hardware Setup DAE, Calibration Date Probe, Calibration Date Phantom MFP V8.0 Center - 1182 HBBL600-10000V6 EX3DV4 - SN7405, 2024-07-01 DAE4 Sn908, 2024-03-27

Measurement Results

Scan Setup

Zoom Scan Grid Extents [mm] 22.0 x 22.0 x 22.0 Grid Steps [mm] 3.4 x 3.4 x 1.4 Sensor Surface [mm] 1.4 Graded Grid Yes Grading Ratio MAIA 1.4 N/A Surface Detection VMS + 6p Scan Method Measured

Zoom Scan Date psSAR1g [W/Kg] 2024-08-15, 11:31 29.7 psSAR8g [W/Kg] psSAR10g [W/Kg] 6.63 5.43 Power Drift [dB] Power Scaling -0.00 Disabled Scaling Factor [dB] TSL Correction No correction M2/M1 [%] Dist 3dB Peak [mm] 49.4 4.8



Certificate No: D6.5GHzV2-1006\_Aug24

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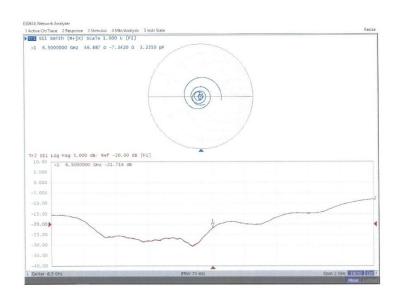
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#### Impedance Measurement Plot for Head TSL



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Certificate No. D7GHzV2-1007\_Aug24

Object	D7GHzV2 - SN:1	007	
	QA CAL-22.v7 Calibration Proce	dure for SAR Validation Sources	between 3-10 GHz
Calibration date:	August 15, 2024		
The measurements and the uncertain	nties with confidence pr	onal standards, which realize the physical uni obability are given on the following pages an	d are part of the certificate.
All calibrations have been conducted  Calibration Equipment used (M&TE of		y facility: environment temperature $(22\pm3)^\circ$ C	and humidity < 70%.
Primary Standards	ID#	Cal Date (Certificate No.)	Scheduled Calibration
Power sensor R&S NRP33T	SN: 100967	28-Mar-24 (No. 217-04038)	Mar-25
Reference 20 dB Attenuator	SN: BH9394 (20k)	26-Mar-24 (No. 217-04046)	Mar-25
Mismatch combination	SN: 84224 / 360D	28-Mar-24 (No. 217-04050)	Mar-25
Reference Probe EX3DV4	SN: 7405	01-Jul-24 (No. EX3-7405_Jul24)	Jul-25
Kelelelice i lobe EV3D 44	SN: 908	27-Mar-24 (No. DAE4-908_Mar24)	Mar-25
DAE4		Charle Date (in house)	Cabadilad Obad
DAE4 Secondary Standards	ID#	Check Date (in house)	Scheduled Check
DAE4 Secondary Standards RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Jan-24)	In house check: Jan-25
DAE4 Secondary Standards RF generator Anapico APSIN20G Power sensor NRP-Z23	SN: 827 SN: 100169	18-Dec-18 (in house check Jan-24) 10-Jan-19 (in house check Jan-24)	In house check: Jan-25 In house check: Jan-25
	SN: 827	18-Dec-18 (in house check Jan-24)	In house check: Jan-25
DAE4 Secondary Standards RF generator Anapico APSIN20G Power sensor NRP-223 Power sensor NRP-18T	SN: 827 SN: 100169 SN: 100950 SN:MY54504221	18-Dec-18 (in house check Jan-24) 10-Jan-19 (in house check Jan-24) 28-Sep-22 (in house check Jan-24) 31-Oct-19 (in house check Oct-22)	In house check: Jan-25 In house check: Jan-25 In house check: Jan-25 In house check: Oct-25
DAE4  Secondary Standards  RF generator Anapico APSIN20G  Power sensor NRP-223  Power sensor NRP-18T  Network Analyzer Keysight E5063A	SN: 827 SN: 100169 SN: 100950 SN:MY54504221	18-Dec-18 (in house check Jan-24) 10-Jan-19 (in house check Jan-24) 28-Sep-22 (in house check Jan-24) 31-Oct-19 (in house check Oct-22)	In house check: Jan-25 In house check: Jan-25 In house check: Jan-25
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Certificate No: D7GHzV2-1007 Aug24 Page 2 of 6

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#### Measurement Conditions

as far as not given on page 1

DASY Version	DASY6	V16.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	5 mm	with Spacer
Zoom Scan Resolution	dx, dy = 3.0 mm, dz = 1.2 mm	Graded Ratio = 1.2 (Z direction)
Frequency	7000 MHz ± 1 MHz	

#### Head TSL parameters

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	33.9	6.65 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.0 ± 6 %	6.94 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		2000

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	28.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	286 W/kg ± 24.7 % (k=2)

SAR averaged over 8 cm <sup>3</sup> (8 g) of Head TSL	condition	
SAR measured	100 mW input power	6.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	61.6 W/kg ± 24.4 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.03 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	50.4 W/kg ± 24.4 % (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	54.1 Ω - 4.9 jΩ
Return Loss	- 24.3 dB

#### APD (Absorbed Power Density)

APD averaged over 1 cm <sup>2</sup>	Condition	
APD measured	100 mW input power	286 W/m <sup>2</sup>
APD measured	normalized to 1W	2860 W/m2 ± 29.2 % (k=2)

APD averaged over 4 cm <sup>2</sup>	condition		
APD measured	100 mW input power	123 W/m <sup>2</sup>	
APD measured	normalized to 1W	1230 W/m2 ± 28.9 % (k=2)	

<sup>\*</sup> The reported APD values have been derived using the psSAR1g and psSAR8g

#### General Antenna Parameters and Design

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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#### **DASY6 Validation Report for Head TSL**

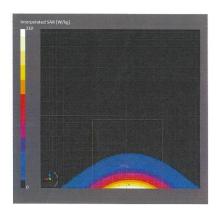
Measurement Report for D7GHz-1007, UID 0 -, Channel 7000 (7000.0MHz)

**Device under Test Properties** Name, Manufacturer Dimensions [mm] IMEI DUT Type SN: 1007 D7GHz 14.0 x 6.0 x 297.0

Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	7000	5.80	6.94	34.0

Hardware Setup Phantom TSL Probe, Calibration Date DAE, Calibration Date MFP V8.0 Center - 1182 HBBL600-10000V6 EX3DV4 - SN7405, 2024-07-01 DAE4 Sn908, 2024-03-27

Scan Setup		Measurement Results	
	Zoom Scan	Zoom Scan	
Grid Extents [mm]	22.0 x 22.0 x 22.0	Date	2024-08-15, 12:48
Grid Steps [mm]	3.0 x 3.0 x 1.2	psSAR1g [W/Kg]	28.6
Sensor Surface [mm]	1.4	psSAR8g [W/Kg]	6.16
Graded Grid	Yes	psSAR10g [W/Kg]	5.03
Grading Ratio	1.2	Power Drift [dB]	0.07
MAIA	N/A	Power Scaling	Disabled
Surface Detection	VMS + 6p	Scaling Factor [dB]	
Scan Method	Measured	TSL Correction	No correction
		M2/M1 [%]	46.1
		Dist 3dB Peak [mm]	4.3



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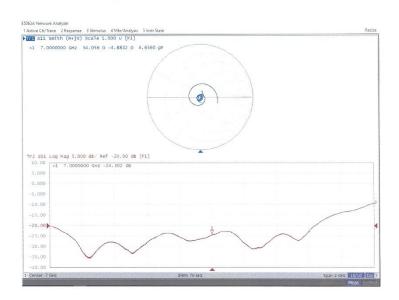
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#### Impedance Measurement Plot for Head TSL



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# - End of report -

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