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

- [1] OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01
   [2] 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

Client SGS

Certificate No. D5GHzV2-1023\_Jan24

| ALIBITATION   | ERTIFICATE   | PARTITION OF THE PROPERTY.   |  |
|---|--|--|--|
| Dbject  | D5GHzV2 - SN:1   | 023  |  |
| Calibration procedure(s)  | QA CAL-22.v7<br>Calibration Proce  | dure for SAR Validation Sources  | between 3-10 GHz   |
|   |  |  |  |
| Calibration date:   | January 24, 2024   |  |  |
|   | The state of the second | onal standards, which realize the physical uni   |  |
| ne measurements and the uncerta   | ainties with confidence pr   | obability are given on the following pages an  | d are part of the certificate.   |
| All calibrations have been conducted  | d in the closed laborator  | y facility: environment temperature (22 ± 3)°C   | and humidity < 70%.  |
| Calibration Equipment used (M&TE  | critical for calibration)  |  |  |
| rimary Standards  | ID#  | Cal Date (Certificate No.)   | Scheduled Calibration  |
| ower meter NRP2   | SN: 104778   | 30-Mar-23 (No. 217-03804/03805)  | Mar-24   |
| Power sensor NRP-Z91  | SN: 103244   | 30-Mar-23 (No. 217-03804)  | Mar-24   |
| ower sensor NRP-Z91   | SN: 103245   | 30-Mar-23 (No. 217-03805)  | Mar-24   |
| Reference 20 dB Attenuator  | SN: BH9394 (20k)   | 30-Mar-23 (No. 217-03809)  | Mar-24   |
| ype-N mismatch combination  | SN: 310982 / 06327   | 30-Mar-23 (No. 217-03810)  | Mar-24   |
| Reference Probe EX3DV4  | SN: 3503   | 07-Mar-23 (No. EX3-3503_Mar23)   | Mar-24   |
| DAE4  | SN: 601  | 03-Oct-23 (No. DAE4-601_Oct23)   | Oct-24   |
|   | ID#  | Check Date (in house)  | Scheduled Check  |
| secondary Standards   |  |  |  |
|   | SN: GB39512475   | 30-Oct-14 (in house check Oct-22)  | In house check: Oct-24   |
| Power meter E4419B  | SN: GB39512475<br>SN: US37292783   | 30-Oct-14 (in house check Oct-22)<br>07-Oct-15 (in house check Oct-22)   | In house check: Oct-24<br>In house check: Oct-24   |
| Power meter E4419B<br>Power sensor HP 8481A   |  |  |  |
| Power meter E4419B<br>Power sensor HP 8481A<br>Power sensor HP 8481A  | SN: US37292783   | 07-Oct-15 (in house check Oct-22)  | In house check: Oct-24   |
| Power meter E4419B<br>Power sensor HP 8481A<br>Power sensor HP 8481A<br>RF generator R&S SMT-06   | SN: US37292783<br>SN: MY41093315   | 07-Oct-15 (in house check Oct-22)<br>07-Oct-15 (in house check Oct-22)   | In house check: Oct-24<br>In house check: Oct-24   |
| Power meter E4419B<br>Power sensor HP 8481A<br>Power sensor HP 8481A<br>RF generator R&S SMT-06   | SN: US37292783<br>SN: MY41093315<br>SN: 100972   | 07-Oct-15 (in house check Oct-22)<br>07-Oct-15 (in house check Oct-22)<br>15-Jun-15 (in house check Oct-22)                                      | In house check: Oct-24<br>In house check: Oct-24<br>In house check: Oct-24                           |
| Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A                                    | SN: US37292783<br>SN: MY41093315<br>SN: 100972<br>SN: US41080477   | 07-Oct-15 (in house check Oct-22)<br>07-Oct-15 (in house check Oct-22)<br>15-Jun-15 (in house check Oct-22)<br>31-Mar-14 (in house check Oct-22) | In house check: Oct-24<br>In house check: Oct-24<br>In house check: Oct-24<br>In house check: Oct-24 |
| Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Aglient E8358A                                    | SN: US37292783<br>SN: MY41093315<br>SN: 100972<br>SN: US41080477   | 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) Function | In house check: Oct-24<br>In house check: Oct-24<br>In house check: Oct-24<br>In house check: Oct-24 |
| 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: US37292783<br>SN: MY41093315<br>SN: 100972<br>SN: US41080477   | 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) Function | In house check: Oct-24<br>In house check: Oct-24<br>In house check: Oct-24<br>In house check: Oct-24 |

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### Calibration Laboratory of

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





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Swiss Calibration Service

Accreditation No.: SCS 0108

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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<br>5600 MHz ± 1 MHz<br>5750 MHz ± 1 MHz<br>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        |              | 1,4100           |

### SAR result with Head TSL at 5250 MHz

| SAR averaged over 1 cm3 (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 cm³ (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 Ω - 4.9 jΩ |  |
|--------------------------------------|-----------------|--|
| Return Loss                          | - 26.2 dB       |  |

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

| Impedance, transformed to feed point | 54.5 Ω - 0.4 jΩ |  |
|--------------------------------------|-----------------|--|
| 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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|                               |             |  |
| ficate No: D5GHzV2-1023_Jan24 | Page 6 of 9 |  |

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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

Certificate No: D5GHzV2-1023\_Jan24

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No.134,Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan/新北市五股區新北產業園區五工路 134 號

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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

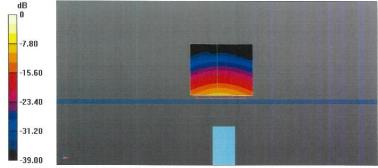
Reference Value = 69.49 V/m; Power Drift = 0.03 dB

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



0 dB = 19.3 W/kg = 12.87 dBW/kg

Certificate No: D5GHzV2-1023\_Jan24

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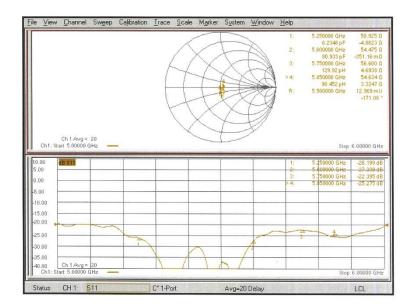
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### Impedance Measurement Plot for Head TSL



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





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Accreditation No.: SCS 0108

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C

Certificate No. D6.5GHzV2-1006\_Aug24

#### **Taoyuan City CALIBRATION CERTIFICATE** D6.5GHzV2 - SN:1006 Object Calibration procedure(s) **QA CAL-22.v7** Calibration Procedure for SAR Validation Sources between 3-10 GHz Calibration date: August 15, 2024 This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. Calibration Equipment used (M&TE critical for calibration) Primary Standards ID# Cal Date (Certificate No.) Scheduled Calibration Power 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 DAE4 SN: 908 27-Mar-24 (No. DAE4-908 Mar24) Mar-25 ID# Secondary Standards Check Date (in house) Scheduled Check RF generator Anapico APSIN20G SN: 827 18-Dec-18 (in house check Jan-24) In house check: Jan-25 Power sensor NRP-Z23 SN: 100169 10-Jan-19 (in house check Jan-24) 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 Name Function Calibrated by: Aidonia Georgiadou Laboratory Technician Approved by: Sven Kühn Technical Manager

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Issued: August 16, 2024

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## Calibration Laboratory of Schmid & Partner

Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Accreditation No.: SCS 0108

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#### Glossarv:

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.

### **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%.

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### **Measurement Conditions**

nfiguration, 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, $dy = 3.4$ mm, $dz = 1.4$ mm | Graded Ratio = 1.4 (Z direction) |
| Frequency                    | 6500 MHz ± 1 MHz                 |                                  |

### **Head TSL parameters**

The following 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/m²                             |
| 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 |
|-----------------|-------|
|-----------------|-------|

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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** 

| Name, Manufacturer | Dimensions [mm]    | IMEI     | DUT Type |
|--------------------|--------------------|----------|----------|
| De ECUa            | 16 0 v 6 0 v 200 0 | CN: 1006 |          |

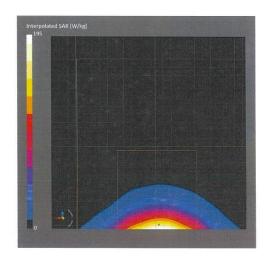
Exposure Conditions

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

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, 11:31 |
| Grid Steps [mm]     | 3.4 x 3.4 x 1.4    | psSAR1g [W/Kg]      | 29.7              |
| Sensor Surface [mm] | 1.4                | psSAR8g [W/Kg]      | 6.63              |
| Graded Grid         | Yes                | psSAR10g [W/Kg]     | 5.43              |
| Grading Ratio       | 1.4                | Power Drift [dB]    | -0.00             |
| MAIA                | N/A                | Power Scaling       | Disabled          |
| Surface Detection   | VMS + 6p           | Scaling Factor [dB] |                   |
| Scan Method         | Measured           | TSL Correction      | No correction     |
|                     |                    | M2/M1 [%]           | 49.4              |
|                     |                    | Dist 3dB Peak [mm]  | 4.8               |



Certificate No: D6.5GHzV2-1006 Aug24

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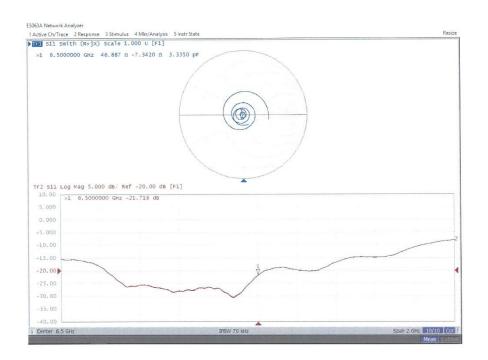
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### Impedance Measurement Plot for Head TSL



Certificate No: D6.5GHzV2-1006 Aug24

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Certificate No. D7GHzV2-1007\_Aug24

|   |   | 007  |   |
|---|---|--|---|
|   | QA CAL-22.v7<br>Calibration Proce   | dure for SAR Validation Sources  | between 3-10 GHz  |
| Calibration date:   | August 15, 2024   |  |   |
| The measurements and the uncertain  | nties with confidence pro   | nal standards, which realize the physical unitobability are given on the following pages and facility: environment temperature (22 ± 3)°C  | d are part of the certificate.  |
|   | ID#   | Cal Date (Certificate No.)   | Scheduled Calibration   |
| Primary Standards   |   |  |   |
| Primary Standards Power sensor R&S NRP33T   | SN: 100967  | 28-Mar-24 (No. 217-04038)  | Mar-25  |
| Power sensor R&S NRP33T   | SN: 100967<br>SN: BH9394 (20k)  |  |   |
| Power sensor R&S NRP33T<br>Reference 20 dB Attenuator   |   | 28-Mar-24 (No. 217-04038)<br>26-Mar-24 (No. 217-04046)   | Mar-25  |
| Power sensor R&S NRP33T<br>Reference 20 dB Attenuator<br>Mismatch combination   | SN: BH9394 (20k)  | 28-Mar-24 (No. 217-04038)  | Mar-25<br>Mar-25  |
|   | SN: BH9394 (20k)<br>SN: 84224 / 360D  | 28-Mar-24 (No. 217-04038)<br>26-Mar-24 (No. 217-04046)<br>28-Mar-24 (No. 217-04050)  | Mar-25<br>Mar-25<br>Mar-25  |
| Power sensor R&S NRP33T<br>Reference 20 dB Attenuator<br>Mismatch combination<br>Reference Probe EX3DV4<br>DAE4   | SN: BH9394 (20k)<br>SN: 84224 / 360D<br>SN: 7405  | 28-Mar-24 (No. 217-04038)<br>26-Mar-24 (No. 217-04046)<br>28-Mar-24 (No. 217-04050)<br>01-Jul-24 (No. EX3-7405_Jul/24)<br>27-Mar-24 (No. DAE4-908_Mar/24)  | Mar-25<br>Mar-25<br>Mar-25<br>Jul-25<br>Mar-25  |
| Power sensor R&S NRP33T<br>Reference 20 dB Attenuator<br>Mismatch combination<br>Reference Probe EX3DV4   | SN: BH9394 (20k)<br>SN: 84224 / 360D<br>SN: 7405<br>SN: 908   | 28-Mar-24 (No. 217-04038)<br>26-Mar-24 (No. 217-04046)<br>28-Mar-24 (No. 217-04050)<br>01-Jul-24 (No. EX3-7405_Jul24)  | Mar-25<br>Mar-25<br>Mar-25<br>Jul-25  |
| Power sensor R&S NRP33T<br>Reference 20 dB Attenuator<br>Mismatch combination<br>Reference Probe EX3DV4<br>DAE4   | SN: BH9394 (20k)<br>SN: 84224 / 360D<br>SN: 7405<br>SN: 908   | 28-Mar-24 (No. 217-04038)<br>26-Mar-24 (No. 217-04046)<br>28-Mar-24 (No. 217-04050)<br>01-Jul-24 (No. EX3-7405_Jul/24)<br>27-Mar-24 (No. DAE4-908_Mar/24)<br>Check Date (in house)   | Mar-25<br>Mar-25<br>Mar-25<br>Jul-25<br>Mar-25<br>Scheduled Check   |
| Power sensor R&S NRP33T Reference 20 dB Attenuator Mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards RF generator Anapico APSIN20G  | SN: BH9394 (20k)<br>SN: 84224 / 360D<br>SN: 7405<br>SN: 908   | 28-Mar-24 (No. 217-04038)<br>26-Mar-24 (No. 217-04046)<br>28-Mar-24 (No. 217-04050)<br>01-Jul-24 (No. EX3-7405 Jul24)<br>27-Mar-24 (No. DAE4-908_Mar24)<br>Check Date (in house)<br>18-Dec-18 (in house check Jan-24)  | Mar-25<br>Mar-25<br>Jul-25<br>Mar-25<br>Mar-25<br>Scheduled Check<br>In house check: Jan-25   |
| Power sensor R&S NRP33T Reference 20 dB Attenuator Mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards RF generator Anapico APSIN20G Power sensor NRP-Z23   | SN: BH9394 (20k)<br>SN: 84224 / 360D<br>SN: 7405<br>SN: 908<br>ID#<br>SN: 827<br>SN: 100169                                 | 28-Mar-24 (No. 217-04038) 26-Mar-24 (No. 217-04046) 28-Mar-24 (No. 217-04046) 01-Jul-24 (No. EX3-7405_Jul24) 27-Mar-24 (No. DAE4-908_Mar24) Check Date (in house) 18-Dec-18 (in house check Jan-24) 10-Jan-19 (in house check Jan-24)  | Mar-25<br>Mar-25<br>Jul-25<br>Mar-25<br>Scheduled Check<br>In house check: Jan-25<br>In house check: Jan-25                                     |
| Power sensor R&S NRP33T Reference 20 dB Attenuator Mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards RF generator Anapico APSIN20G Power sensor NRP-223 Power sensor NRP-18T                                  | SN: BH9394 (20k)<br>SN: 84224 / 360D<br>SN: 7405<br>SN: 908<br>ID#<br>SN: 827<br>SN: 100169<br>SN: 100950                   | 28-Mar-24 (No. 217-04038) 26-Mar-24 (No. 217-04046) 28-Mar-24 (No. 217-04050) 01-Jul-24 (No. EX3-7405_Jul/24) 27-Mar-24 (No. DAE4-908_Mar/24) Check Date (in house) 18-Dec-18 (in house check Jan-24) 19-Jan-19 (in house check Jan-24) 28-Sep-22 (in house check Jan-24)                                    | Mar-25 Mar-25 Jul-25 Mar-25 Mar-25 Scheduled Check In house check: Jan-25 In house check: Jan-25 In house check: Jan-25 In house check: Oct-25  |
| Power sensor R&S NRP33T Reference 20 dB Attenuator Mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards RF generator Anapico APSIN20G Power sensor NRP-223 Power sensor NRP-18T                                  | SN: BH9394 (20k)<br>SN: 84224 / 360D<br>SN: 7405<br>SN: 908<br>ID#<br>SN: 827<br>SN: 100169<br>SN: 100950<br>SN: MY54504221 | 28-Mar-24 (No. 217-04038) 26-Mar-24 (No. 217-04046) 28-Mar-24 (No. 217-04050) 01-Jul-24 (No. EX3-7405_Jul/24) 27-Mar-24 (No. DAE4-908_Mar/24)  Check Date (in house) 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 Jan-24) | Mar-25<br>Mar-25<br>Jul-25<br>Mar-25<br>Mar-25<br>Scheduled Check<br>In house check: Jan-25<br>In house check: Jan-25<br>In house check: Jan-25 |
| Power sensor R&S NRP33T Reference 20 dB Attenuator Mismatch combination Reference Probe EX3DV4 DAE4  Secondary Standards RF generator Anapico APSIN20G Power sensor NRP-Z23 Power sensor NRP-18T Network Analyzer Keysight E5063A | SN: BH9394 (20k) SN: 84224 / 360D SN: 7405 SN: 908  ID # SN: 827 SN: 100169 SN: 100950 SN:MY54504221  Name                  | 28-Mar-24 (No. 217-04038) 26-Mar-24 (No. 217-04046) 28-Mar-24 (No. 217-04046) 01-Jul-24 (No. EX3-7405_Jul24) 27-Mar-24 (No. DAE4-908_Mar24)  Check Date (in house) 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)   | Mar-25 Mar-25 Jul-25 Mar-25 Mar-25 Scheduled Check In house check: Jan-25 In house check: Jan-25 In house check: Jan-25 In house check: Oct-25  |

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#### Glossary:

tissue simulating liquid TSL 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.

#### 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 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
- 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", Bloelectromagnetics, 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%.

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### **Measurement Conditions**

| 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

ers and calculations were applied

|   | 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        |              |                  |

#### 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          | 18-32 DATE OF THE STREET |
|---|--------------------|--------------------------|
| 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

|  | · |  |  |
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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** Dimensions [mm] Name, Manufacturer IMEI DUT Type SN: 1007 D7GHz 14.0 x 6.0 x 297.0

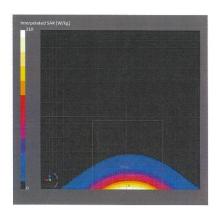
| Phantom<br>Section, TSL | Position, Test<br>Distance<br>[mm] | Band | Group,<br>UID | Frequency<br>[MHz] | Conversion<br>Factor | TSL Cond.<br>[S/m] | TSL<br>Permittivity |
|-------------------------|------------------------------------|------|---------------|--------------------|----------------------|--------------------|---------------------|
| 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

Measurement Results

Scan Setup

|                     | 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               |



Certificate No: D7GHzV2-1007\_Aug24

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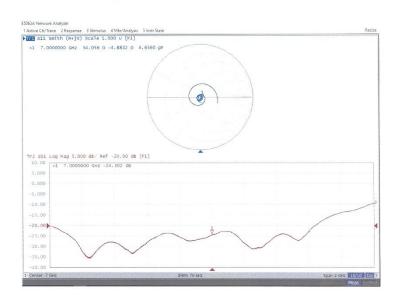
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### Impedance Measurement Plot for Head TSL



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# - End of report -

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