

# CALIBRATION DATA PROBE CALIBRATION DATA

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client **AGC-CERT**  
Shenzhen

Certificate No. **ES-3337\_Oct23**

## CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3337**

Calibration procedure(s) **QA CAL-01.v10, QA CAL-12.v10, QA CAL-23.v6, QA CAL-25.v8**  
**Calibration procedure for dosimetric E-field probes**

Calibration date **October 14, 2023**

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 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                |
| OCP DAK-3.5 (weighted)     | SN: 1249         | 20-Oct-22 (OCP-DAK3.5-1249_Oct22) | Oct-23                |
| OCP DAK-12                 | SN: 1016         | 20-Oct-22 (OCP-DAK12-1016_Oct22)  | Oct-23                |
| Reference 20 dB Attenuator | SN: CC2552 (20x) | 30-Mar-23 (No. 217-03809)         | Mar-24                |
| DAE4                       | SN: 660          | 16-Mar-23 (No. DAE4-660_Mar23)    | Mar-24                |
| Reference Probe ES3DV2     | SN: 3013         | 06-Jan-23 (No. ES3-3013_Jan23)    | Jan-24                |

| Secondary Standards     | ID               | Check Date (in house)             | Scheduled Check        |
|-------------------------|------------------|-----------------------------------|------------------------|
| Power meter E4419B      | SN: GB41293874   | 06-Apr-16 (in house check Jun-22) | In house check: Jun-24 |
| Power sensor E4412A     | SN: MY41498087   | 06-Apr-16 (in house check Jun-22) | In house check: Jun-24 |
| Power sensor E4412A     | SN: 000110210    | 06-Apr-16 (in house check Jun-22) | In house check: Jun-24 |
| RF generator HP 8648C   | SN: US3642U01700 | 04-Aug-99 (in house check Jun-22) | In house check: Jun-24 |
| Network Analyzer E8358A | SN: US41080477   | 31-Mar-14 (in house check Oct-22) | In house check: Oct-24 |

|                                                                                                                 | Name           | Function              | Signature                                                                            |
|-----------------------------------------------------------------------------------------------------------------|----------------|-----------------------|--------------------------------------------------------------------------------------|
| Calibrated by                                                                                                   | Jeton Kastrati | Laboratory Technician |  |
| Approved by                                                                                                     | Sven Kühn      | Technical Manager     |  |
| Issued: October 16, 2023                                                                                        |                |                       |                                                                                      |
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Certificate No: ES-3337\_Oct23

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## Glossary

|                          |                                                                                                                                                      |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                      | tissue simulating liquid                                                                                                                             |
| NORM <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                            |
| ConvF                    | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                           |
| DCP                      | diode compression point                                                                                                                              |
| CF                       | crest factor (1/duty_cycle) of the RF signal                                                                                                         |
| A, B, C, D               | modulation dependent linearization parameters                                                                                                        |
| Polarization $\varphi$   | $\varphi$ rotation around probe axis                                                                                                                 |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis |
| Connector Angle          | information used in DASY system to align probe sensor X to the robot coordinate system                                                               |

## Calibration is Performed According to the Following Standards:

- 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.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM( $f$ )<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

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ES3DV3 - SN:3337

October 14, 2023

### Parameters of Probe: ES3DV3 - SN:3337

#### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k = 2)  |
|-----------------------------------------------------------|----------|----------|----------|--------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 1.24     | 1.28     | 1.33     | $\pm 10.1\%$ |
| DCP (mV) <sup>B</sup>                                     | 107.6    | 106.3    | 107.0    | $\pm 4.7\%$  |

#### Calibration Results for Modulation Response

| UID   | Communication System Name     |   | A<br>dB | B<br>dB/ $\sqrt{\mu\text{V}}$ | C     | D<br>dB | VR<br>mV | Max<br>dev. | Max<br>Unc <sup>E</sup><br>k = 2 |
|-------|-------------------------------|---|---------|-------------------------------|-------|---------|----------|-------------|----------------------------------|
| 0     | CW                            | X | 0.00    | 0.00                          | 1.00  | 0.00    | 139.1    | $\pm 3.8\%$ | $\pm 4.7\%$                      |
|       |                               | Y | 0.00    | 0.00                          | 1.00  |         | 140.6    |             |                                  |
|       |                               | Z | 0.00    | 0.00                          | 1.00  |         | 147.0    |             |                                  |
| 10089 | MRI (Square, 1 ms, 0.4 ms)    | X | 0.50    | 60.70                         | 6.40  | 3.98    | 134.4    | $\pm 0.9\%$ | $\pm 4.7\%$                      |
|       |                               | Y | 0.58    | 59.70                         | 5.70  |         | 138.1    |             |                                  |
|       |                               | Z | 9.03    | 81.60                         | 14.40 |         | 144.7    |             |                                  |
| 10091 | MITS (2pi Sinc, 1 ms, 0.4 ms) | X | 3.35    | 68.30                         | 22.90 | 10.22   | 145.4    | $\pm 2.5\%$ | $\pm 4.7\%$                      |
|       |                               | Y | 5.08    | 76.80                         | 26.10 |         | 137.7    |             |                                  |
|       |                               | Z | 5.47    | 79.70                         | 28.30 |         | 146.0    |             |                                  |
| 10093 | MRI (Square, 10 ms, 0.4 ms)   | X | 0.40    | 56.20                         | 13.20 | 13.98   | 60.7     | $\pm 3.3\%$ | $\pm 4.7\%$                      |
|       |                               | Y | 1.52    | 61.10                         | 12.30 |         | 54.4     |             |                                  |
|       |                               | Z | 1.86    | 64.10                         | 14.40 |         | 74.5     |             |                                  |
| 10190 | MRI (Square, 100 ms, 5 ms)    | X | 0.34    | 47.90                         | 3.90  | 13.01   | 21.4     | $\pm 1.7\%$ | $\pm 4.7\%$                      |
|       |                               | Y | 0.50    | 50.30                         | 6.00  |         | 22.7     |             |                                  |
|       |                               | Z | 0.69    | 53.00                         | 7.70  |         | 20.7     |             |                                  |
| 10199 | MRI (Square, 5 ms, 2.5 ms)    | X | 0.35    | 58.90                         | 5.40  | 3.01    | 147.5    | $\pm 0.7\%$ | $\pm 4.7\%$                      |
|       |                               | Y | 0.47    | 60.10                         | 6.30  |         | 149.8    |             |                                  |
|       |                               | Z | 0.80    | 63.50                         | 8.00  |         | 134.8    |             |                                  |
| 10272 | MRI (Square, 20 ms, 1.0 ms)   | X | 0.40    | 53.80                         | 10.40 | 13.01   | 59.3     | $\pm 3.0\%$ | $\pm 4.7\%$                      |
|       |                               | Y | 1.44    | 61.60                         | 12.40 |         | 62.6     |             |                                  |
|       |                               | Z | 1.53    | 61.50                         | 12.40 |         | 63.3     |             |                                  |
| 10405 | MRI (Square, 1 ms, 0.5 ms)    | X | 0.39    | 59.80                         | 5.70  | 3.01    | 146.8    | $\pm 0.9\%$ | $\pm 4.7\%$                      |
|       |                               | Y | 0.47    | 59.20                         | 5.20  |         | 149.1    |             |                                  |
|       |                               | Z | 99.50   | 96.40                         | 16.80 |         | 134.6    |             |                                  |
| 10455 | MRI (Square, 50 ms, 10 ms)    | X | 0.27    | 53.50                         | 4.60  | 6.99    | 66.5     | $\pm 1.7\%$ | $\pm 4.7\%$                      |
|       |                               | Y | 0.38    | 54.50                         | 5.10  |         | 68.1     |             |                                  |
|       |                               | Z | 0.38    | 53.90                         | 4.60  |         | 70.3     |             |                                  |

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%.

<sup>A</sup> The uncertainties of Norm X,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Page 5).

<sup>B</sup> Linearization parameter uncertainty for maximum specified field strength.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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ES3DV3 - SN:3337

October 14, 2023

**Parameters of Probe: ES3DV3 - SN:3337****Other Probe Parameters**

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle                               | -91.1°     |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 10 mm      |
| Tip Diameter                                  | 4 mm       |
| Probe Tip to Sensor X Calibration Point       | 2 mm       |
| Probe Tip to Sensor Y Calibration Point       | 2 mm       |
| Probe Tip to Sensor Z Calibration Point       | 2 mm       |
| Recommended Measurement Distance from Surface | 3 mm       |

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ES3DV3 - SN:3337

October 14, 2023

### Parameters of Probe: ES3DV3 - SN:3337

#### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity <sup>F</sup> (S/m) | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unc (k = 2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 52.3                               | 0.76                            | 7.63    | 7.63    | 7.63    | 0.00               | 1.00                    | ±13.3%      |
| 450                  | 43.5                               | 0.87                            | 7.53    | 7.53    | 7.53    | 0.16               | 1.30                    | ±13.3%      |

<sup>C</sup> Frequency validity above 300 MHz of  $\pm 100$  MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to  $\pm 50$  MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is  $\pm 10$ , 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4–9 MHz, and ConvF assessed at 13 MHz is 9–19 MHz. Above 5 GHz frequency validity can be extended to  $\pm 110$  MHz.

<sup>F</sup> The probes are calibrated using tissue simulating liquids (TSL) that deviate for  $\epsilon$  and  $\sigma$  by less than  $\pm 5\%$  from the target values (typically better than  $\pm 3\%$ ) and are valid for TSL with deviations of up to  $\pm 10\%$ . If TSL with deviations from the target of less than  $\pm 5\%$  are used, the calibration uncertainties are 11.1% for 0.7 - 3 GHz and 13.1% for 3 - 6 GHz.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than  $\pm 1\%$  for frequencies below 3 GHz and below  $\pm 2\%$  for frequencies between 3–6 GHz at any distance larger than half the probe tip diameter from the boundary.

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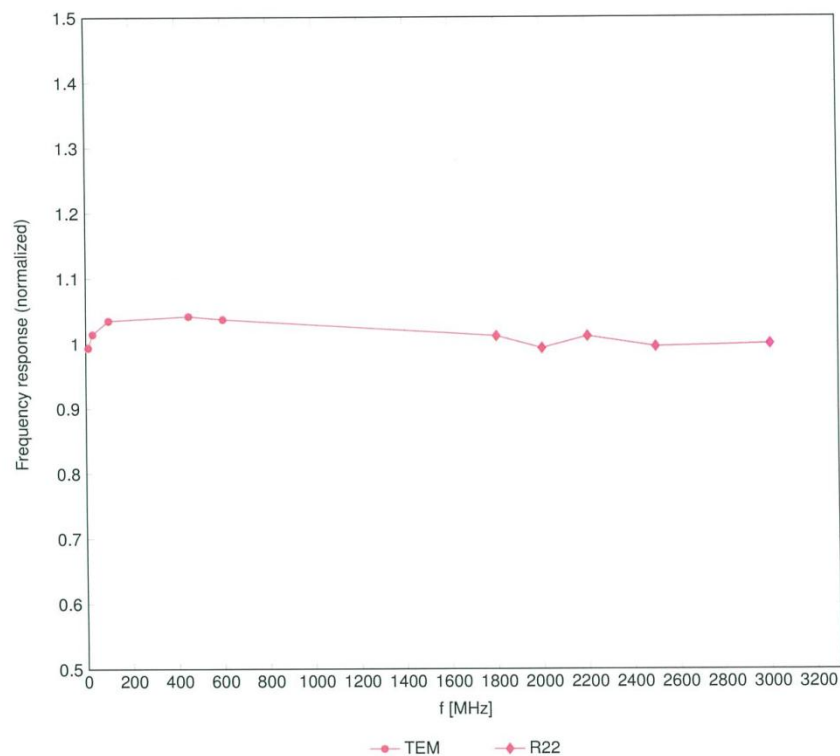
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ES3DV3 - SN:3337

October 14, 2023

### Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide:R22)


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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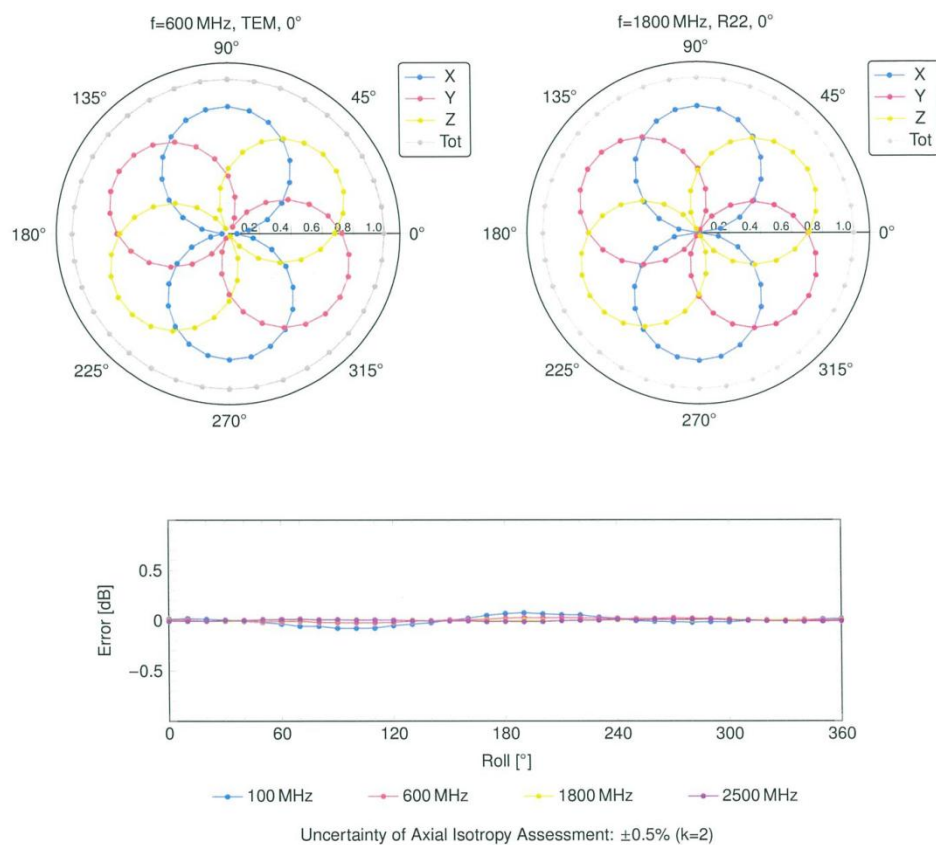
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### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



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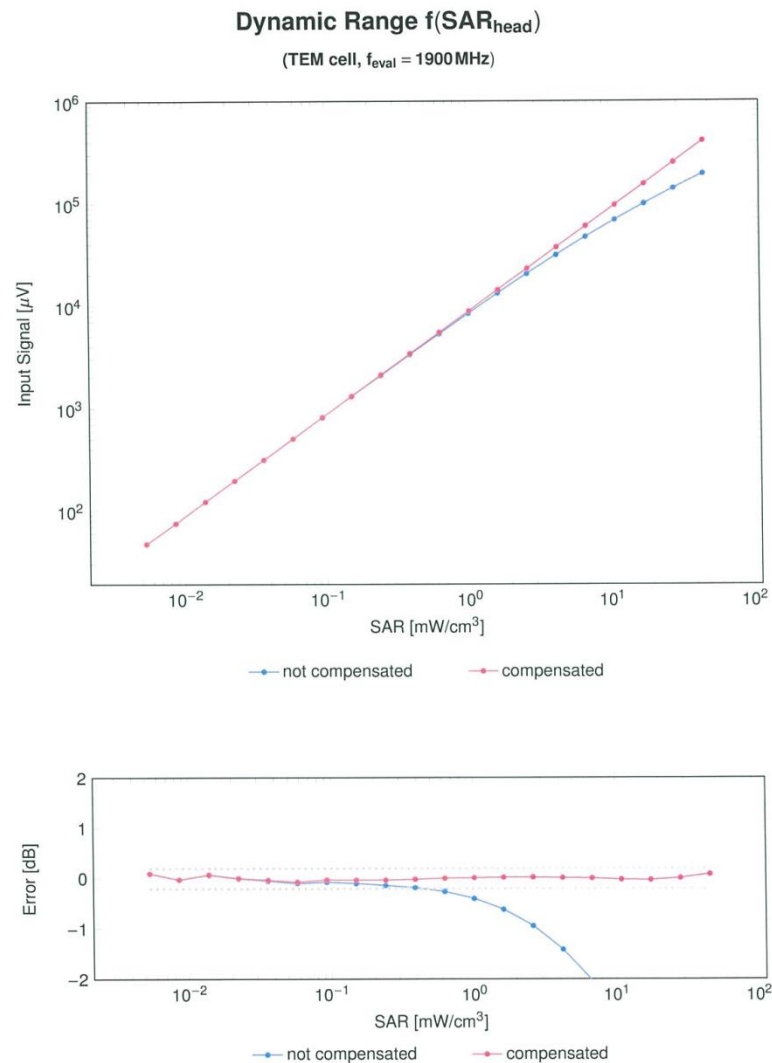
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October 14, 2023


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

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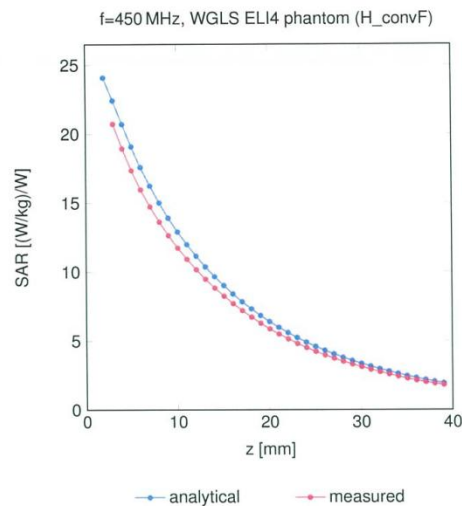
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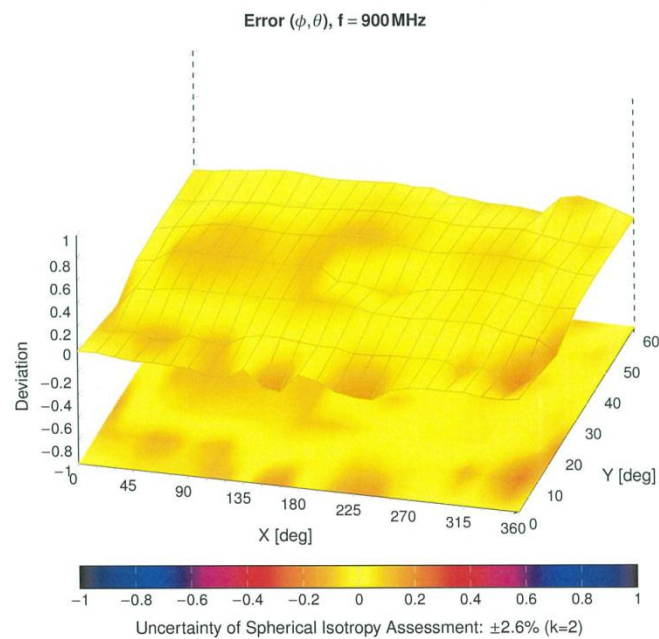
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### Conversion Factor Assessment



### Deviation from Isotropy in Liquid



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## DAE CALIBRATION DATA



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CALIBRATION  
CNAS L0570

Client : agc-cert

Certificate No: 24J02Z000265

## CALIBRATION CERTIFICATE

Object DAE4 - SN: 1398

Calibration Procedure(s) FF-Z11-002-01  
Calibration Procedure for the Data Acquisition Electronics (DAEx)

Calibration date: May 20, 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)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards      | ID #    | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|------------------------|---------|------------------------------------------|-----------------------|
| Process Calibrator 753 | 1971018 | 12-Jun-23 (CTTL, No.J23X05436)           | Jun-24                |

|                | Name        | Function           | Signature |
|----------------|-------------|--------------------|-----------|
| Calibrated by: | Yu Zongying | SAR Test Engineer  |           |
| Reviewed by:   | Lin Jun     | SAR Test Engineer  |           |
| Approved by:   | Qi Dianyuan | SAR Project Leader |           |

Issued: May 22, 2024

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**s p e a g**  
**CALIBRATION LABORATORY**


Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2117

E-mail: emf@caict.ac.cn

<http://www.caict.ac.cn>
**Glossary:**

DAE

data acquisition electronics

Connector angle

information used in DASY system to align probe sensor X to the robot coordinate system.

**Methods Applied and Interpretation of Parameters:**

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.

Certificate No: 24J02Z000265

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Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China  
 Tel: +86-10-62304633-2117  
 E-mail: emf@caict.ac.cn <http://www.caict.ac.cn>

### DC Voltage Measurement

A/D - Converter Resolution nominal  
 High Range: 1LSB = 6.1 $\mu$ V , full range = -100...+300 mV  
 Low Range: 1LSB = 61nV , full range = -1.....+3mV  
 DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 404.244 $\pm$ 0.15% (k=2) | 404.228 $\pm$ 0.15% (k=2) | 403.683 $\pm$ 0.15% (k=2) |
| Low Range           | 3.97446 $\pm$ 0.7% (k=2)  | 3.99237 $\pm$ 0.7% (k=2)  | 3.96950 $\pm$ 0.7% (k=2)  |

### Connector Angle

|                                           |                 |
|-------------------------------------------|-----------------|
| Connector Angle to be used in DASY system | 47.5° $\pm$ 1 ° |
|-------------------------------------------|-----------------|

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## DIPOLE CALIBRATION DATA

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



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

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

Accreditation No.: SCS 0108

Client **AGC-CERT**  
**Shenzhen, China**

Certificate No. **CLA150-4008\_Mar23**

## CALIBRATION CERTIFICATE

Object **CLA150 - SN: 4008**

Calibration procedure(s) **QA CAL-15.v10  
Calibration Procedure for SAR Validation Sources below 700 MHz**

Calibration date: **March 21, 2023**

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 meter NRP                 | SN: 104778         | 04-Apr-22 (No. 217-03525/03524)   | Apr-23                 |
| Power sensor NRP-Z91            | SN: 103244         | 04-Apr-22 (No. 217-03524)         | Apr-23                 |
| Power sensor NRP-Z91            | SN: 103245         | 04-Apr-22 (No. 217-03525)         | Apr-23                 |
| Reference 20 dB Attenuator      | SN: CC2552 (20x)   | 04-Apr-22 (No. 217-03527)         | Apr-23                 |
| Type-N mismatch combination     | SN: 310982 / 06327 | 04-Apr-22 (No. 217-03528)         | Apr-23                 |
| Reference Probe EX3DV4          | SN: 3877           | 06-Jan-23 (No. EX3-3877_Jan23)    | Jan-24                 |
| DAE4                            | SN: 654            | 27-Jan-23 (No. DAE4-654_Jan23)    | Jan-24                 |
| Secondary Standards             | ID #               | Check Date (in house)             | Scheduled Check        |
| Power meter NRP2                | SN: 107193         | 08-Nov-21 (in house check Dec-22) | In house check: Dec-24 |
| Power sensor NRP-Z91            | SN: 100922         | 15-Dec-09 (in house check Dec-22) | In house check: Dec-24 |
| Power sensor NRP-Z91            | SN: 100418         | 01-Jan-04 (in house check Dec-22) | In house check: Dec-24 |
| RF generator HP 8648C           | SN: US3642U01700   | 04-Aug-99 (in house check Jun-22) | In house check: Jun-24 |
| Network Analyzer Agilent E8358A | SN: US41080477     | 31-Mar-14 (in house check Oct-22) | In house check: Oct-24 |

|                |                         |                                   |               |
|----------------|-------------------------|-----------------------------------|---------------|
| Calibrated by: | Name<br>Jeffrey Katzman | Function<br>Laboratory Technician | Signature<br> |
| Approved by:   | Sven Kühn               | Technical Manager                 |               |

Issued: March 21, 2023

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: CLA150-4008\_Mar23

Page 1 of 6

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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

#### 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:

- 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.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

- 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%.

### Measurement Conditions

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

|                      |                                  |                                  |
|----------------------|----------------------------------|----------------------------------|
| DASY Version         | DASY5                            | V52.10.4                         |
| Extrapolation        | Advanced Extrapolation           |                                  |
| Phantom              | ELI4 Flat Phantom                | Shell thickness: $2 \pm 0.2$ mm  |
| EUT Positioning      | Touch Position                   |                                  |
| Zoom Scan Resolution | $dx, dy = 4.0$ mm, $dz = 1.4$ mm | Graded Ratio = 1.4 (Z direction) |
| Frequency            | $150$ MHz $\pm 1$ MHz            |                                  |

### Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity           |
|-----------------------------------------|---------------------|----------------|------------------------|
| Nominal Head TSL parameters             | $22.0$ °C           | 52.3           | $0.76$ mho/m           |
| Measured Head TSL parameters            | $(22.0 \pm 0.2)$ °C | $51.4 \pm 6$ % | $0.78$ mho/m $\pm 6$ % |
| 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                                            | 1 W input power  | $4.06$ W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W | $3.96$ W/kg $\pm 18.4$ % (k=2) |

| SAR averaged over $10$ cm <sup>3</sup> (10 g) of Head TSL | condition        |                                |
|-----------------------------------------------------------|------------------|--------------------------------|
| SAR measured                                              | 1 W input power  | $2.72$ W/kg                    |
| SAR for nominal Head TSL parameters                       | normalized to 1W | $2.66$ W/kg $\pm 18.0$ % (k=2) |

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

## Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 43.0 $\Omega$ - 6.0 j $\Omega$ |
| Return Loss                          | - 20.1 dB                      |

## Additional EUT Data

|                 |       |
|-----------------|-------|
| Manufactured by | SPEAG |
|-----------------|-------|

## DASY5 Validation Report for Head TSL

Date: 21.03.2023

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4008**

Communication System: UID 0 - CW; Frequency: 150 MHz

Medium parameters used:  $f = 150 \text{ MHz}$ ;  $\sigma = 0.78 \text{ S/m}$ ;  $\epsilon_r = 51.4$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(12.51, 12.51, 12.51) @ 150 MHz; Calibrated: 06.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 27.01.2023
- Phantom: ELI v6.0; Type: QDOVA003AA; Serial: TP:2034
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan, dist=1.4mm (8x10x8)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$ 

Reference Value = 84.39 V/m; Power Drift = -0.07 dB

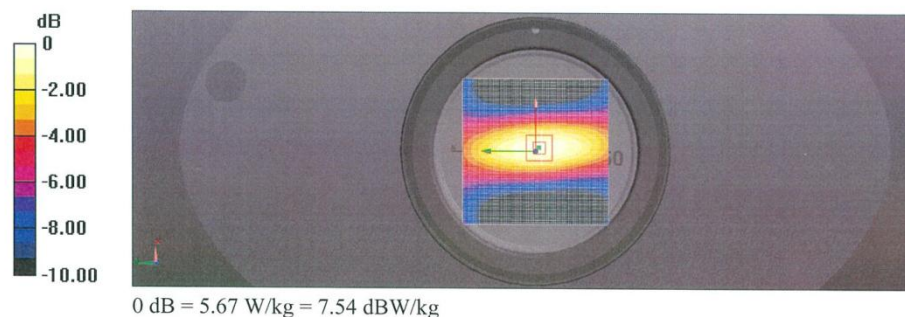
Peak SAR (extrapolated) = 7.52 W/kg

**SAR(1 g) = 4.06 W/kg; SAR(10 g) = 2.72 W/kg**

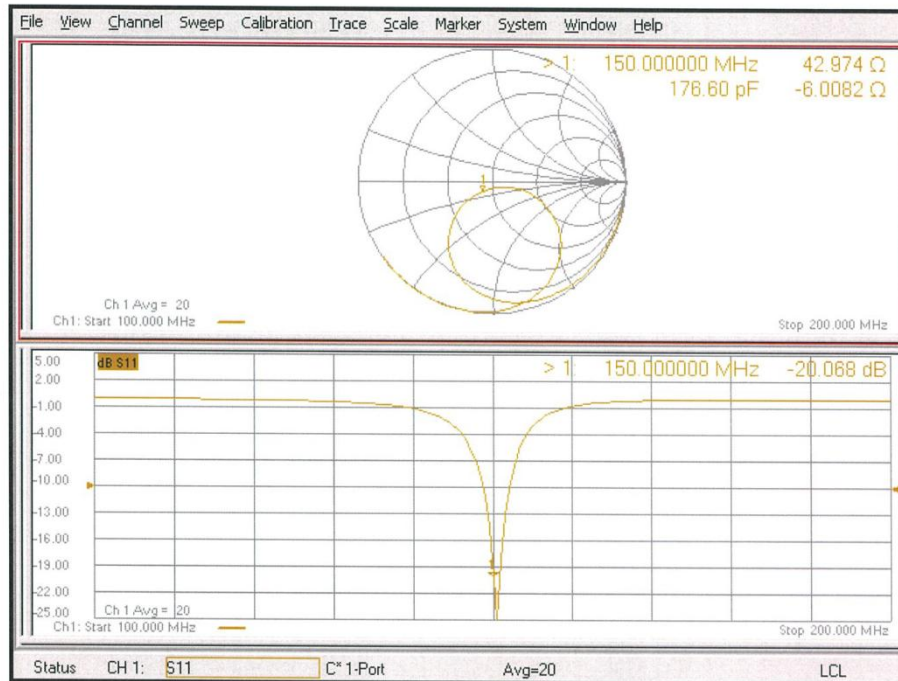
Smallest distance from peaks to all points 3 dB below: Larger than measurement grid ( $> 14 \text{ mm}$ )

Ratio of SAR at M2 to SAR at M1 = 81%

Maximum value of SAR (measured) = 5.67 W/kg



### Impedance Measurement Plot for Head TSL



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Client **AGC-CERT**  
**Shenzhen**

Certificate No. **D450V3-1113\_Feb24**

## CALIBRATION CERTIFICATE

Object **D450V3 - SN:1113**

Calibration procedure(s) **QA CAL-15.v11**  
**Calibration Procedure for SAR Validation Sources below 700 MHz**

Calibration date: **February 14, 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 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                 |
| Power 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                 |
| Type-N mismatch combination     | SN: 310982 / 06327 | 30-Mar-23 (No. 217-03810)         | Mar-24                 |
| Reference Probe EX3DV4          | SN: 3877           | 10-Jan-24 (No. EX3-3877_Jan24)    | Jan-25                 |
| DAE4                            | SN: 908            | 03-Jul-23 (No. DAE4-908_Jul23)    | Jul-24                 |
| Secondary Standards             | ID #               | Check Date (in house)             | Scheduled Check        |
| Power meter NRP2                | SN: 107193         | 08-Nov-21 (in house check Dec-22) | In house check: Dec-24 |
| Power sensor NRP-Z91            | SN: 100922         | 15-Dec-09 (in house check Dec-22) | In house check: Dec-24 |
| Power sensor NRP-Z91            | SN: 100418         | 01-Jan-04 (in house check Dec-22) | In house check: Dec-24 |
| RF generator HP 8648C           | SN: US3642U01700   | 04-Aug-99 (in house check Jun-22) | In house check: Jun-24 |
| Network Analyzer Agilent E8358A | SN: US41080477     | 31-Mar-14 (in house check Oct-22) | In house check: Oct-24 |

|                |                          |                                   |               |
|----------------|--------------------------|-----------------------------------|---------------|
| Calibrated by: | Name<br>Krešimir Franjić | Function<br>Laboratory Technician | Signature<br> |
| Approved by:   | Sven Kühn                | Technical Manager                 |               |

Issued: February 15, 2024

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Certificate No: D450V3-1113\_Feb24

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

#### 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:

- 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.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

- 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 impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

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

### Measurement Conditions

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

|                              |                        |                                 |
|------------------------------|------------------------|---------------------------------|
| DASY Version                 | DASY5                  | V52.10.4                        |
| Extrapolation                | Advanced Extrapolation |                                 |
| Phantom                      | ELI4 Flat Phantom      | Shell thickness: $2 \pm 0.2$ mm |
| Distance Dipole Center - TSL | 15 mm                  | with Spacer                     |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |                                 |
| Frequency                    | 450 MHz $\pm$ 1 MHz    |                                 |

### Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 43.5           | 0.87 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 45.0 $\pm$ 6 % | 0.87 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | -----                |

### SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                          | 250 mW input power | 1.16 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 4.67 W/kg $\pm$ 18.1 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                            | 250 mW input power | 0.772 W/kg                   |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 3.10 W/kg $\pm$ 17.6 % (k=2) |

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

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 59.2 $\Omega$ - 0.9 j $\Omega$ |
| Return Loss                          | - 21.5 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.346 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 |
|-----------------|-------|

## DASY5 Validation Report for Head TSL

Date: 14.02.2024

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1113**

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used:  $f = 450 \text{ MHz}$ ;  $\sigma = 0.87 \text{ S/m}$ ;  $\epsilon_r = 45$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.64, 10.64, 10.64) @ 450 MHz; Calibrated: 10.01.2024
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn908; Calibrated: 03.07.2023
- Phantom: ELI v6.0; Type: QDOVA003AA; Serial: TP:2034
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

### Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ 

Reference Value = 38.84 V/m; Power Drift = 0.02 dB

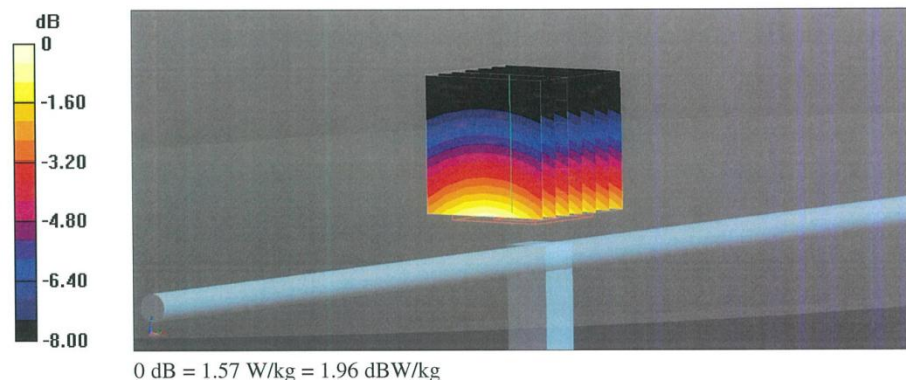
Peak SAR (extrapolated) = 1.82 W/kg

**SAR(1 g) = 1.16 W/kg; SAR(10 g) = 0.772 W/kg**

Smallest distance from peaks to all points 3 dB below: Larger than measurement grid ( $> 15 \text{ mm}$ )

Ratio of SAR at M2 to SAR at M1 = 63.6%

Maximum value of SAR (measured) = 1.57 W/kg



### Impedance Measurement Plot for Head TSL

