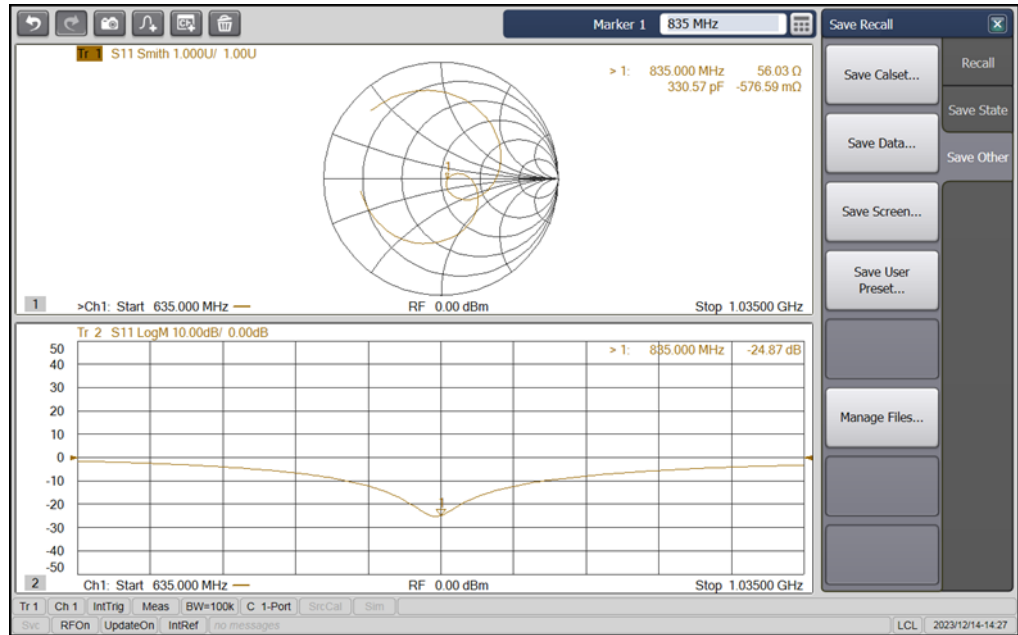


| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole835<br>Head TSL      | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 52.51        | -2.070 | 56.03         | -0.576 | 3.52       | 1.49   |
| Return loss(dB)            | -29.973      |        | -24.87        |        | -17.0%     |        |
| Measure Date               | 14-Dec-23    |        |               |        |            |        |





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UL

Certificate No: Z21-60529

## CALIBRATION CERTIFICATE

Object

D1800V2 - SN: 2d212

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

December 21, 2021

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(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| Power Meter NRP2        | 106277     | 24-Sep-21 (CTTL, No.J21X08326)           | Sep-22                |
| Power sensor NRP8S      | 104291     | 24-Sep-21 (CTTL, No.J21X08326)           | Sep-22                |
| ReferenceProbe EX3DV4   | SN 7307    | 26-May-21(SPEAG,No.EX3-7307_May21)       | May-22                |
| DAE4                    | SN 1556    | 15-Jan-21(SPEAG,No.DAE4-1556_Jan21)      | Jan-22                |
| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593)           | Jan-22                |
| NetworkAnalyzer E5071C  | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232)           | Jan-22                |

|                |             |                    |           |
|----------------|-------------|--------------------|-----------|
|                | Name        | Function           | Signature |
| Calibrated by: | Zhao Jing   | SAR Test Engineer  |           |
| Reviewed by:   | Lin Hao     | SAR Test Engineer  |           |
| Approved by:   | Qi Dianyuan | SAR Project Leader |           |

Issued: December 27, 2021

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**lossary:**

|       |                                            |
|-------|--------------------------------------------|
| TSL   | tissue simulating liquid                   |
| ConvF | sensitivity in TSL / NORM <sub>x,y,z</sub> |
| N/A   | not applicable or not measured             |

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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



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**Measurement Conditions**

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

|                                     |                          |             |
|-------------------------------------|--------------------------|-------------|
| <b>DASY Version</b>                 | DASY52                   | V52.10.4    |
| <b>Extrapolation</b>                | Advanced Extrapolation   |             |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                    | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm        |             |
| <b>Frequency</b>                    | 1800 MHz $\pm$ 1 MHz     |             |

**Head TSL parameters**

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 40.0           | 1.40 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 41.2 $\pm$ 6 % | 1.40 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             |                |                      |

**SAR result with Head TSL**

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 9.62 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>38.7 W/kg <math>\pm</math> 18.8 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 4.95 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>19.9 W/kg <math>\pm</math> 18.7 % (k=2)</b> |



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 49.4Ω- 3.43jΩ |
| Return Loss                          | - 29.1dB      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.118 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

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



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## DASY5 Validation Report for Head TSL

Date: 2021-12-21

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 2d212**

Communication System: UID 0, CW; Frequency: 1800 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 1800 \text{ MHz}$ ;  $\sigma = 1.402 \text{ S/m}$ ;  $\epsilon_r = 41.17$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(8.34, 8.34, 8.34) @ 1800 MHz; Calibrated: 2021-05-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:**

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

Reference Value = 100.7 V/m; Power Drift = -0.02 dB

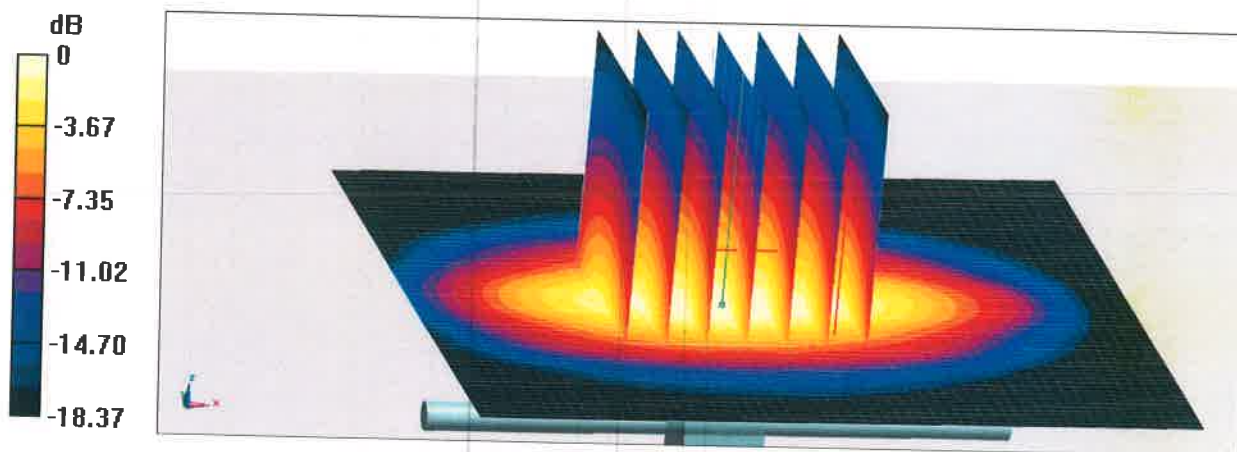
Peak SAR (extrapolated) = 18.8 W/kg

**SAR(1 g) = 9.62 W/kg; SAR(10 g) = 4.95 W/kg**

Smallest distance from peaks to all points 3 dB below = 10.2 mm

Ratio of SAR at M2 to SAR at M1 = 51.2%

Maximum value of SAR (measured) = 15.4 W/kg



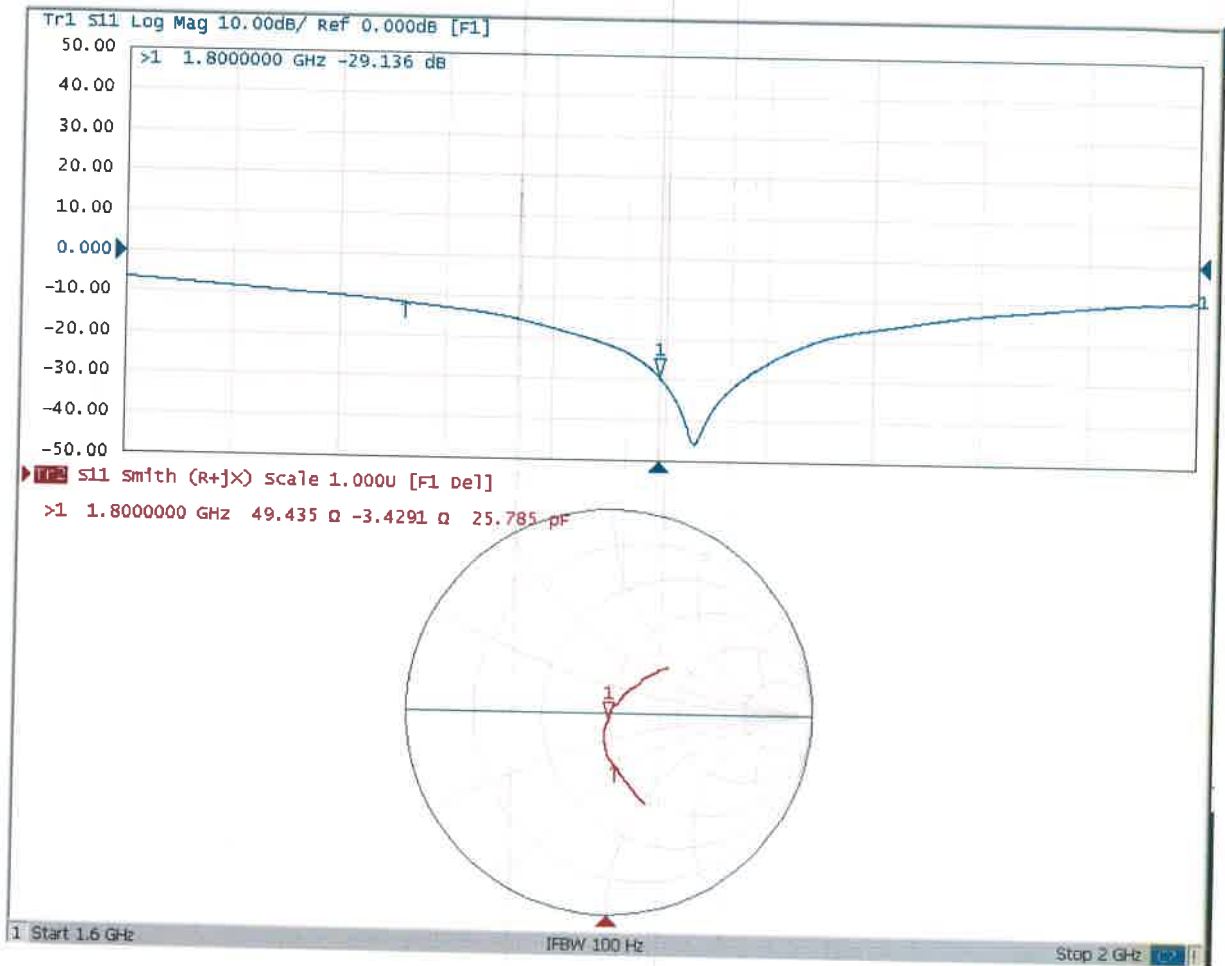
0 dB = 15.4 W/kg = 11.88 dBW/kg



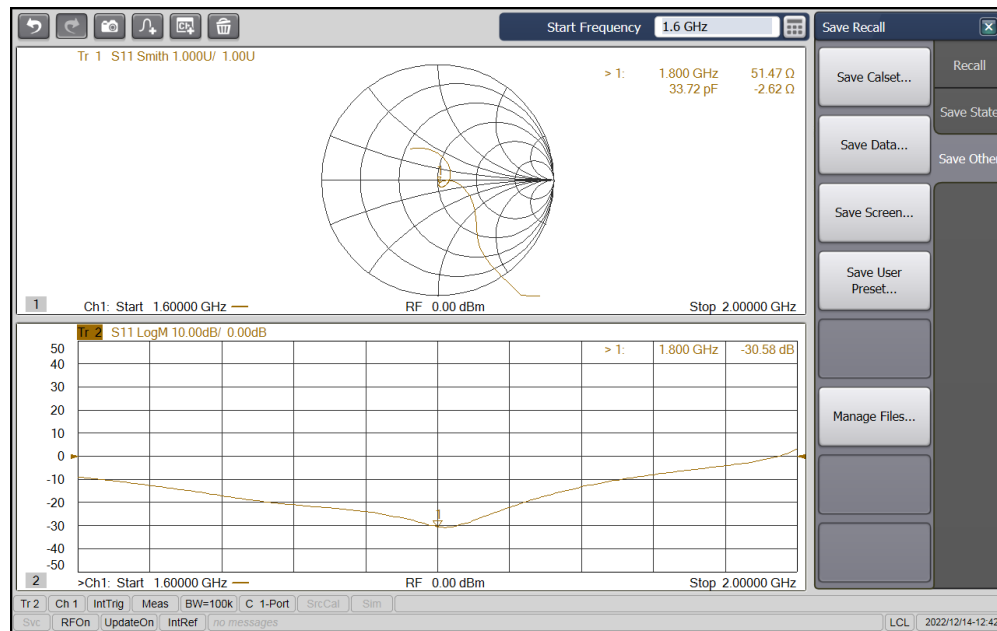
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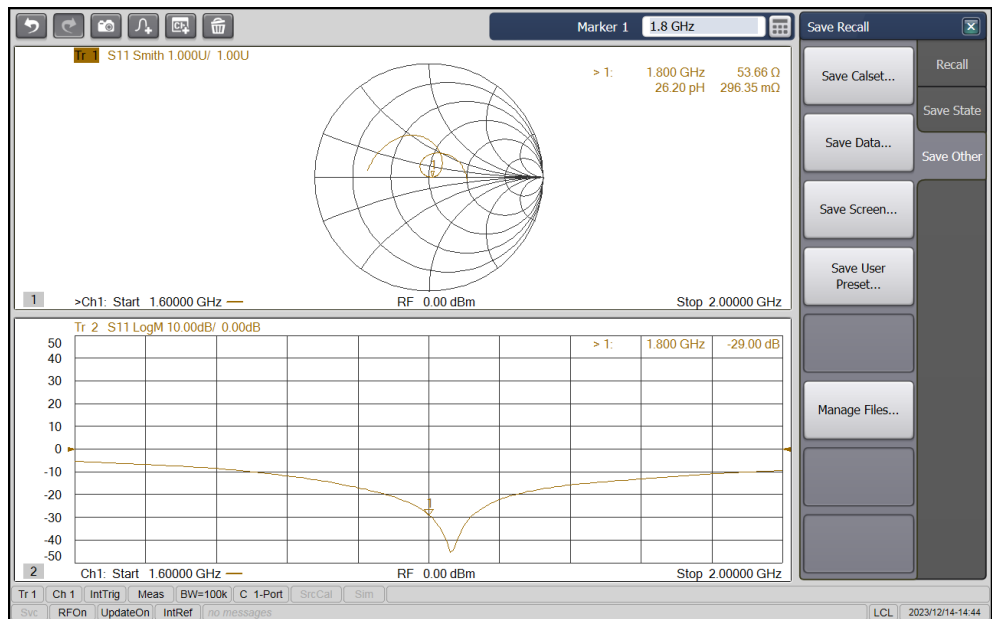
## Impedance Measurement Plot for Head TSL



| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole1800<br>Head TSL     | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 49.44        | -3.429 | 51.47         | -2.620 | 2.04       | 0.81   |
| Return loss(dB)            | -29.136      |        | -30.58        |        | 5.0%       |        |
| Measure Date               | 14-Dec-22    |        |               |        |            |        |



| Annual Verification Result |              |           |               |           |            |           |
|----------------------------|--------------|-----------|---------------|-----------|------------|-----------|
| Dipole1800<br>Head TSL     | Target Value |           | Measure Value |           | Difference |           |
|                            | R<br>(Ω)     | X<br>(jΩ) | R<br>(Ω)      | X<br>(jΩ) | R<br>(Ω)   | X<br>(jΩ) |
| Impedance                  | 49.44        | -3.429    | 53.66         | 0.296     | 4.22       | 3.73      |
| Return loss(dB)            | -29.136      |           | -29           |           | -0.5%      |           |
| Measure Date               | 14-Dec-23    |           |               |           |            |           |





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Client

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Certificate No: Z21-60530

## CALIBRATION CERTIFICATE

Object

D1900V2 - SN: 5d212

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

December 20, 2021

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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|-------------------------------------------|-----------------------|
| Power Meter NRP2        | 106277     | 24-Sep-21 (CTTL, No.J21X08326)            | Sep-22                |
| Power sensor NRP8S      | 104291     | 24-Sep-21 (CTTL, No.J21X08326)            | Sep-22                |
| Reference Probe EX3DV4  | SN 7307    | 26-May-21(SPEAG,No.EX3-7307_May21)        | May-22                |
| DAE4                    | SN 1556    | 15-Jan-21(SPEAG,No.DAE4-1556_Jan21)       | Jan-22                |
| Secondary Standards     | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593)            | Jan-22                |
| NetworkAnalyzer E5071C  | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232)            | Jan-22                |

|                | Name        | Function           | Signature |
|----------------|-------------|--------------------|-----------|
| Calibrated by: | Zhao Jing   | SAR Test Engineer  |           |
| Reviewed by:   | Lin Hao     | SAR Test Engineer  |           |
| Approved by:   | Qi Dianyuan | SAR Project Leader |           |

Issued: December 27, 2021

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#### **Glossary:**

|       |                                            |
|-------|--------------------------------------------|
| TSL   | tissue simulating liquid                   |
| ConvF | sensitivity in TSL / NORM <sub>x,y,z</sub> |
| N/A   | not applicable or not measured             |

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

#### **Additional Documentation:**

- DASY4/5 System Handbook

#### **Methods Applied and Interpretation of Parameters:**

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

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



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**Measurement Conditions**

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

|                                     |                          |             |
|-------------------------------------|--------------------------|-------------|
| <b>DASY Version</b>                 | DASY52                   | V52.10.4    |
| <b>Extrapolation</b>                | Advanced Extrapolation   |             |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                    | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm        |             |
| <b>Frequency</b>                    | 1900 MHz $\pm$ 1 MHz     |             |

**Head TSL parameters**

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 40.0           | 1.40 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 39.4 $\pm$ 6 % | 1.41 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             |                |                      |

**SAR result with Head TSL**

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 10.0 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>39.6 W/kg <math>\pm</math> 18.8 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 5.08 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>20.2 W/kg <math>\pm</math> 18.7 % (k=2)</b> |



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 53.2Ω+ 5.56jΩ |
| Return Loss                          | - 24.2dB      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.110 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

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



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## DASY5 Validation Report for Head TSL

Date: 2021-12-20

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d212**

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.414$  S/m;  $\epsilon_r = 39.36$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(8.32, 8.32, 8.32) @ 1900 MHz; Calibrated: 2021-05-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid:  
 $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 103.0 V/m; Power Drift = -0.01 dB

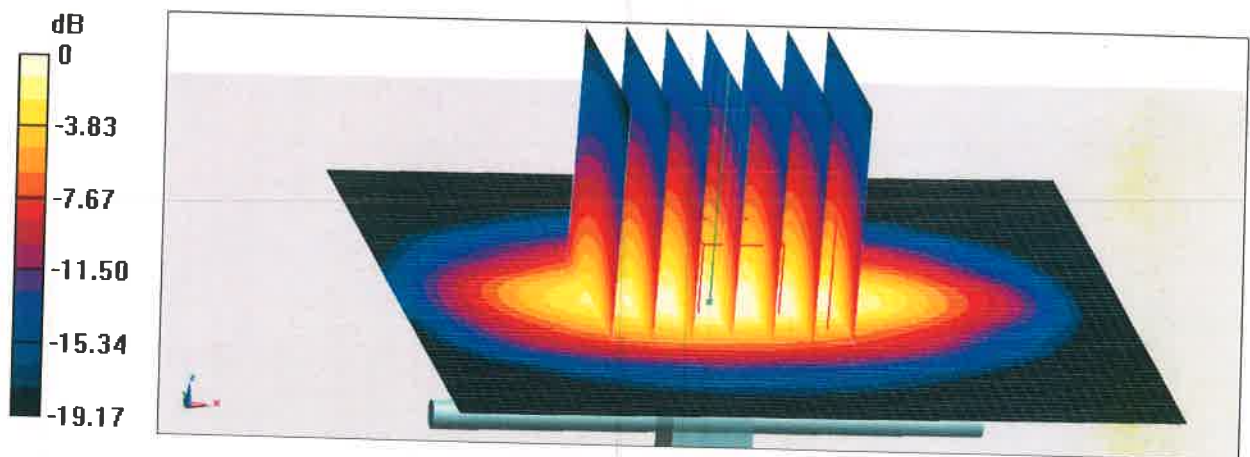
Peak SAR (extrapolated) = 19.7 W/kg

**SAR(1 g) = 10 W/kg; SAR(10 g) = 5.08 W/kg**

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 51%

Maximum value of SAR (measured) = 16.0 W/kg



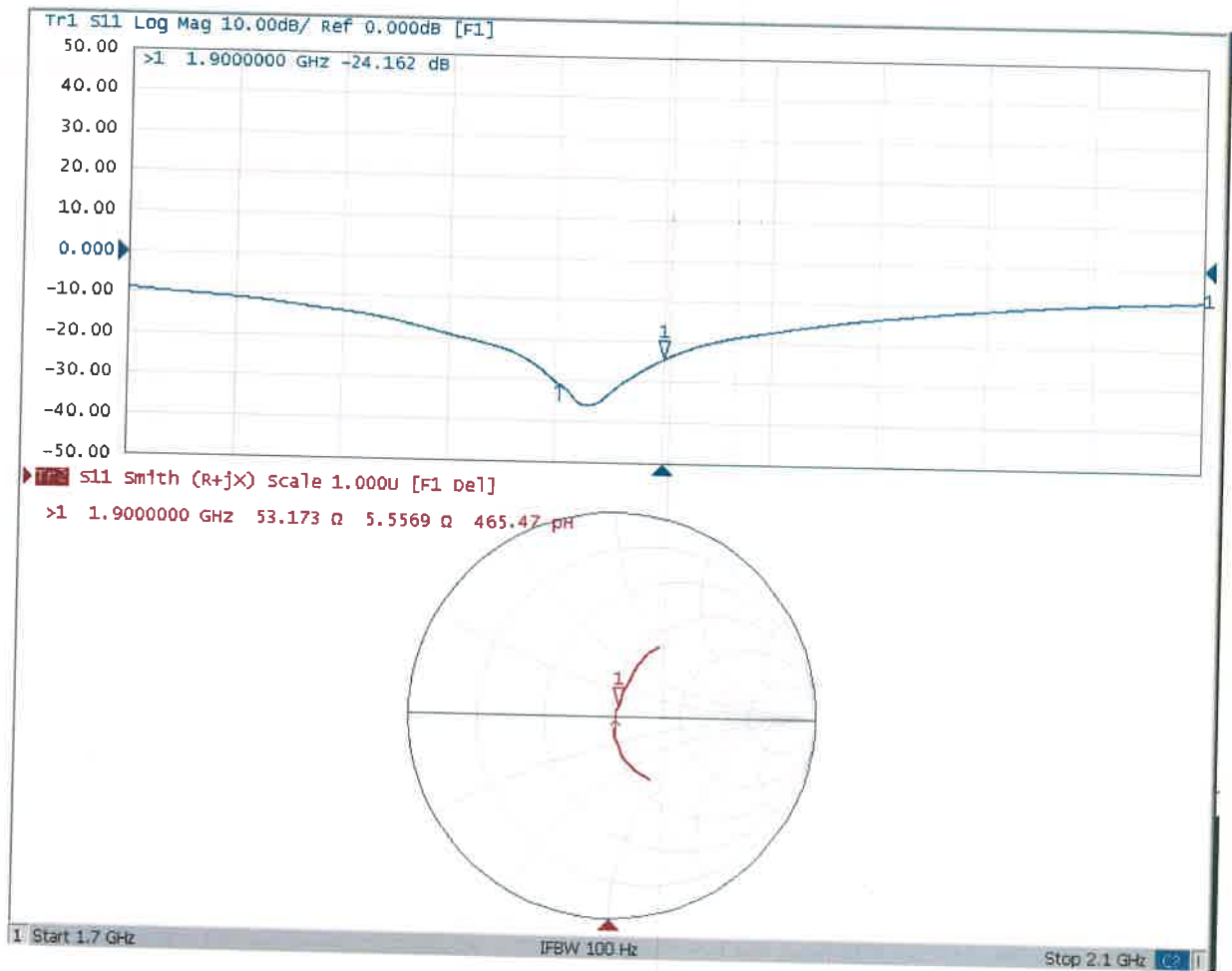
0 dB = 16.0 W/kg = 12.04 dBW/kg



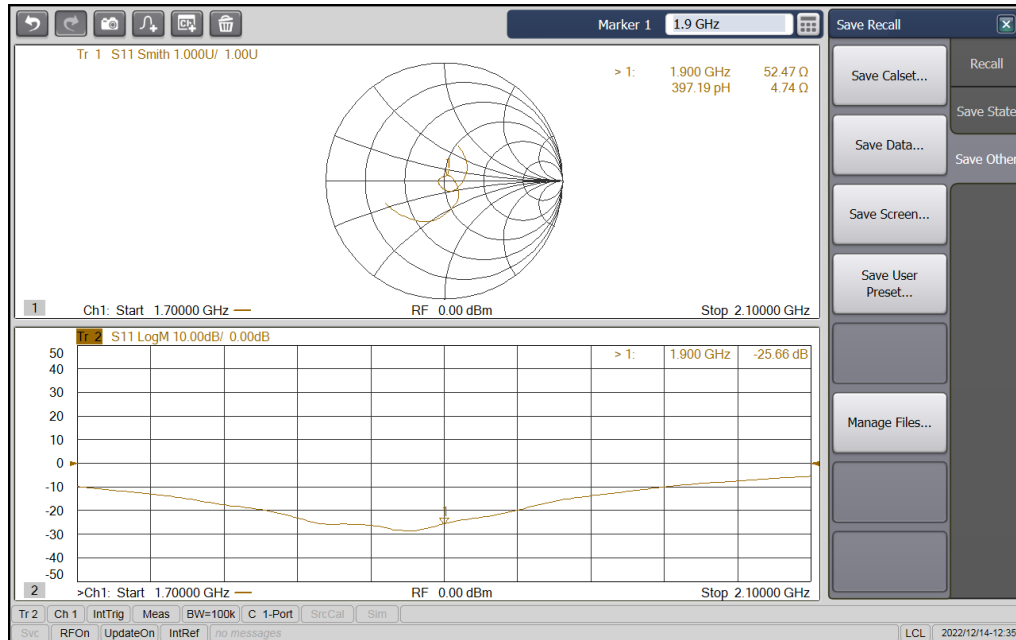
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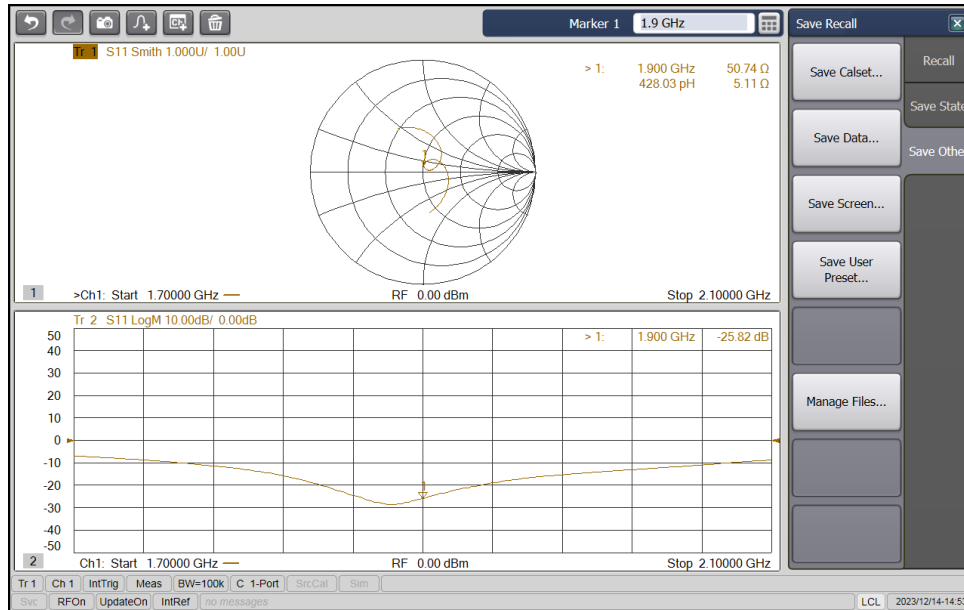
## Impedance Measurement Plot for Head TSL



| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole1900<br>Head TSL     | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 53.17        | 5.557  | 52.47         | 4.740  | -0.70      | -0.82  |
| Return loss(dB)            | -24.162      |        | -25.66        |        | 6.2%       |        |
| Measure Date               | 14-Dec-22    |        |               |        |            |        |



| Annual Verification Result |              |           |               |           |            |           |
|----------------------------|--------------|-----------|---------------|-----------|------------|-----------|
| Dipole1900<br>Head TSL     | Target Value |           | Measure Value |           | Difference |           |
|                            | R<br>(Ω)     | X<br>(jΩ) | R<br>(Ω)      | X<br>(jΩ) | R<br>(Ω)   | X<br>(jΩ) |
| Impedance                  | 53.17        | 5.557     | 50.74         | 5.110     | -2.43      | -0.45     |
| Return loss(dB)            | -24.162      |           | -25.82        |           | 6.9%       |           |
| Measure Date               | 14-Dec-23    |           |               |           |            |           |





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Client

UL

Certificate No: Z21-60532

## CALIBRATION CERTIFICATE

Object

D2450V2 - SN: 977

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

December 17, 2021

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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|-------------------------------------------|-----------------------|
| Power Meter NRP2        | 106277     | 24-Sep-21 (CTTL, No.J21X08326)            | Sep-22                |
| Power sensor NRP8S      | 104291     | 24-Sep-21 (CTTL, No.J21X08326)            | Sep-22                |
| Reference Probe EX3DV4  | SN 7307    | 26-May-21(SPEAG,No.EX3-7307_May21)        | May-22                |
| DAE4                    | SN 1556    | 15-Jan-21(SPEAG,No.DAE4-1556_Jan21)       | Jan-22                |
| Secondary Standards     | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593)            | Jan-22                |
| NetworkAnalyzer E5071C  | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232)            | Jan-22                |

|                | Name        | Function           | Signature |
|----------------|-------------|--------------------|-----------|
| Calibrated by: | Zhao Jing   | SAR Test Engineer  |           |
| Reviewed by:   | Lin Hao     | SAR Test Engineer  |           |
| Approved by:   | Qi Dianyuan | SAR Project Leader |           |

Issued: December 24, 2021

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### Glossary:

|       |                                            |
|-------|--------------------------------------------|
| TSL   | tissue simulating liquid                   |
| ConvF | sensitivity in TSL / NORM <sub>x,y,z</sub> |
| N/A   | not applicable or not measured             |

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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



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## Measurement Conditions

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

|                                     |                          |             |
|-------------------------------------|--------------------------|-------------|
| <b>DASY Version</b>                 | DASY52                   | V52.10.4    |
| <b>Extrapolation</b>                | Advanced Extrapolation   |             |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                    | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm        |             |
| <b>Frequency</b>                    | 2450 MHz $\pm$ 1 MHz     |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 39.9 $\pm$ 6 % | 1.79 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | ---            | ---                  |

## SAR result with Head TSL

| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| SAR measured                                                  | 250 mW input power | 13.2 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>53.2 W/kg <math>\pm</math> 18.8 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 6.02 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>24.2 W/kg <math>\pm</math> 18.7 % (k=2)</b> |



## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 56.4Ω+ 0.96jΩ |
| Return Loss                          | - 24.3dB      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.061 ns |
|----------------------------------|----------|

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

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

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

### Additional EUT Data

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



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## DASY5 Validation Report for Head TSL

Date: 2021-12-17

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 977**

Communication System: UID-0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.785$  S/m;  $\epsilon_r = 39.91$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(7.75, 7.75, 7.75) @ 2450 MHz; Calibrated: 2021-05-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 109.9 V/m; Power Drift = -0.01 dB

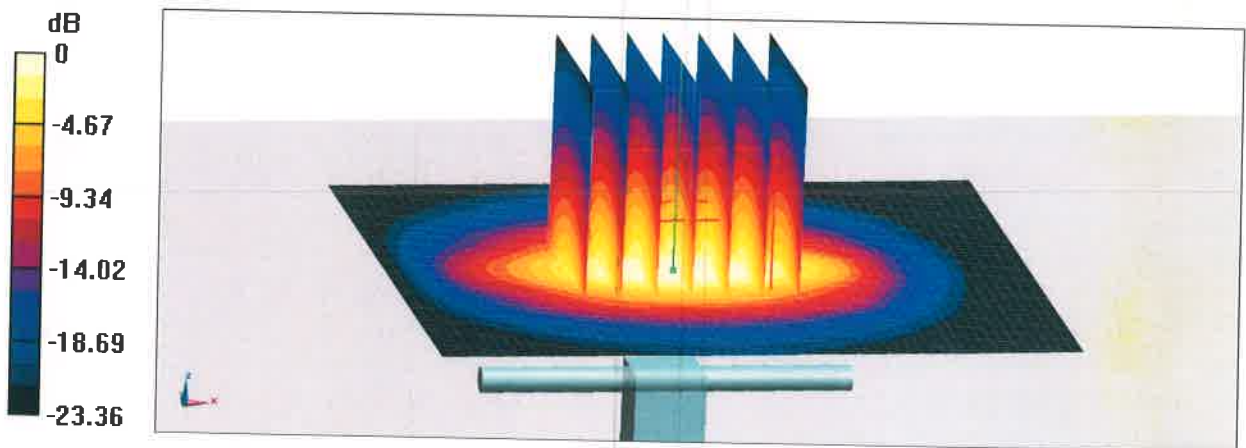
Peak SAR (extrapolated) = 28.2 W/kg

**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.02 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 46.4%

Maximum value of SAR (measured) = 22.6 W/kg

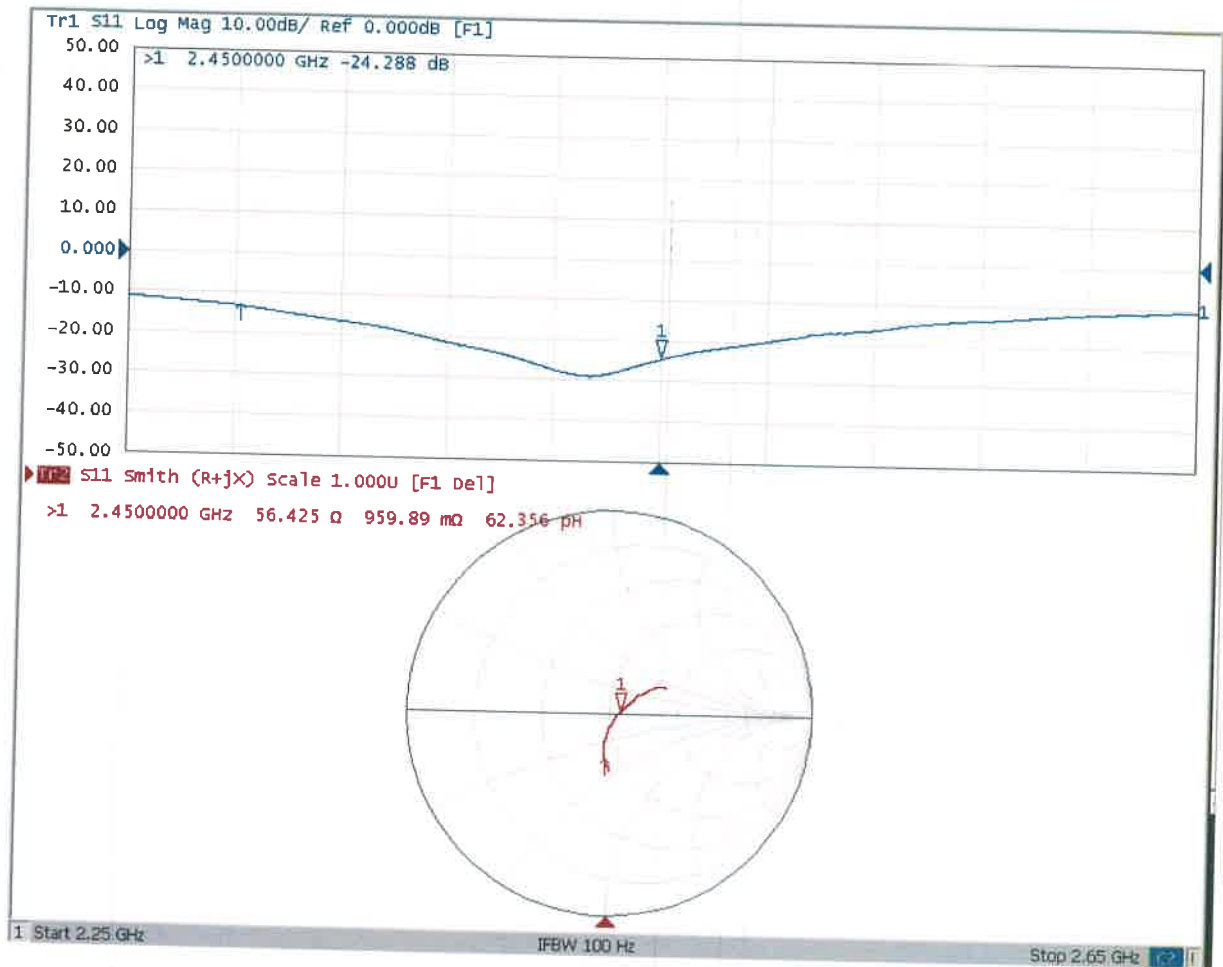


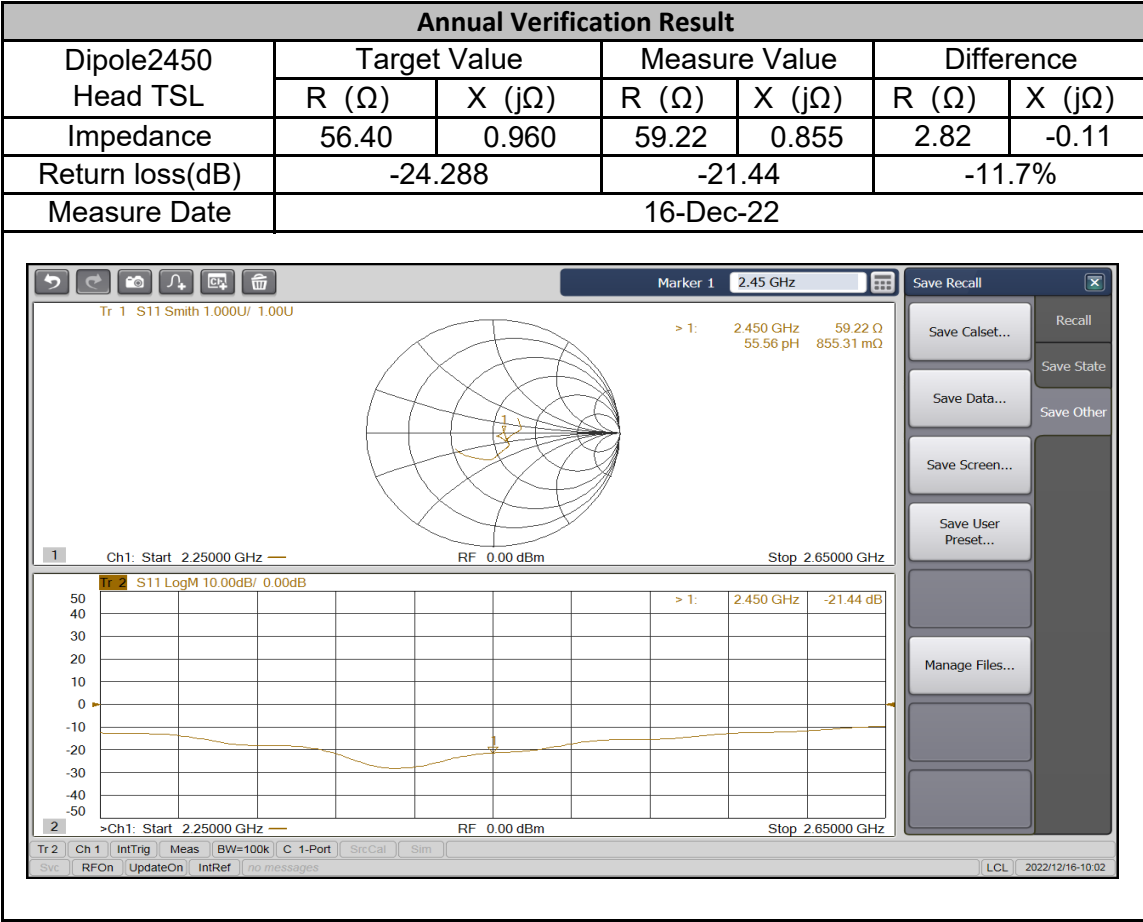


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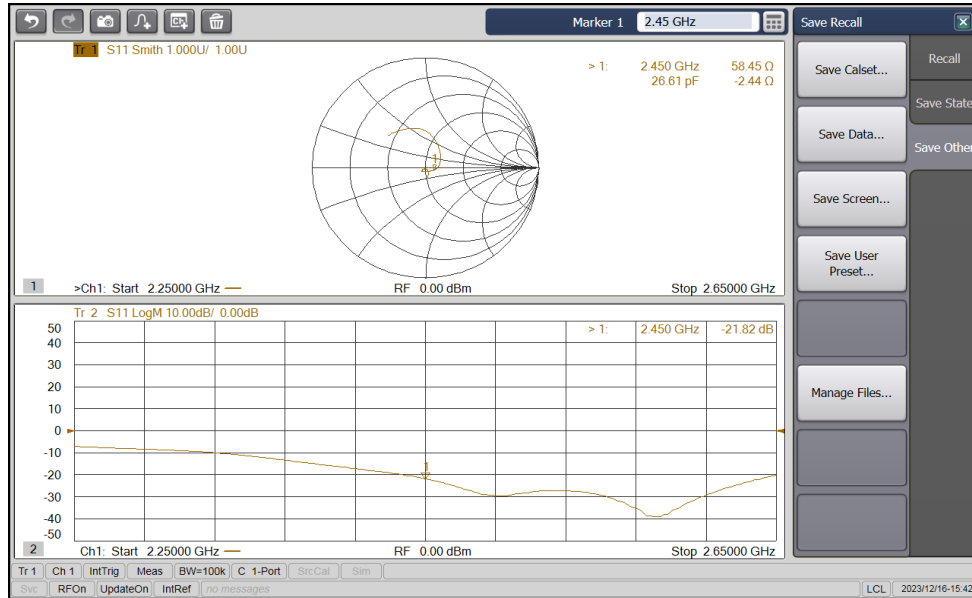
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## Impedance Measurement Plot for Head TSL





| Annual Verification Result |              |       |               |        |            |       |
|----------------------------|--------------|-------|---------------|--------|------------|-------|
| Dipole2450<br>Head TSL     | Target Value |       | Measure Value |        | Difference |       |
|                            | R            | X     | R             | X      | R          | X     |
|                            | (Ω)          | (jΩ)  | (Ω)           | (jΩ)   | (Ω)        | (jΩ)  |
| Impedance                  | 56.40        | 0.960 | 58.45         | -2.440 | 2.05       | -3.40 |
| Return loss(dB)            | -24.288      |       | -21.82        |        | -10.2%     |       |
| Measure Date               | 16-Dec-23    |       |               |        |            |       |





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Client

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Certificate No: Z21-60533

## CALIBRATION CERTIFICATE

Object

D2600V2 - SN: 1117

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

December 20, 2021

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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|-------------------------------------------|-----------------------|
| Power Meter NRP2        | 106277     | 24-Sep-21 (CTTL, No.J21X08326)            | Sep-22                |
| Power sensor NRP8S      | 104291     | 24-Sep-21 (CTTL, No.J21X08326)            | Sep-22                |
| Reference Probe EX3DV4  | SN 7307    | 26-May-21(SPEAG,No.EX3-7307_May21)        | May-22                |
| DAE4                    | SN 1556    | 15-Jan-21(SPEAG,No.DAE4-1556_Jan21)       | Jan-22                |
| Secondary Standards     | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593)            | Jan-22                |
| Network Analyzer E5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232)            | Jan-22                |

|                | Name        | Function           | Signature |
|----------------|-------------|--------------------|-----------|
| Calibrated by: | Zhao Jing   | SAR Test Engineer  |           |
| Reviewed by:   | Lin Hao     | SAR Test Engineer  |           |
| Approved by:   | Qi Dianyuan | SAR Project Leader |           |

Issued: December 27, 2021

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### Glossary:

|       |                                            |
|-------|--------------------------------------------|
| TSL   | tissue simulating liquid                   |
| ConvF | sensitivity in TSL / NORM <sub>x,y,z</sub> |
| N/A   | not applicable or not measured             |

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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



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### Measurement Conditions

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

|                                     |                          |             |
|-------------------------------------|--------------------------|-------------|
| <b>DASY Version</b>                 | DASY52                   | V52.10.4    |
| <b>Extrapolation</b>                | Advanced Extrapolation   |             |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                    | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm        |             |
| <b>Frequency</b>                    | 2600 MHz $\pm$ 1 MHz     |             |

### Head TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 39.0           | 1.96 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 40.1 $\pm$ 6 % | 1.97 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             |                |                      |

### SAR result with Head TSL

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 13.8 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>55.4 W/kg <math>\pm</math> 18.8 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 6.10 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>24.5 W/kg <math>\pm</math> 18.7 % (k=2)</b> |



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 50.7Ω- 6.70jΩ |
| Return Loss                          | - 23.5dB      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.051 ns |
|----------------------------------|----------|

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

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



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## DASY5 Validation Report for Head TSL

Date: 2021-12-20

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1117**

Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2600$  MHz;  $\sigma = 1.97$  S/m;  $\epsilon_r = 40.05$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(7.5, 7.5, 7.5) @ 2600 MHz; Calibrated: 2021-05-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 106.8 V/m; Power Drift = -0.03 dB

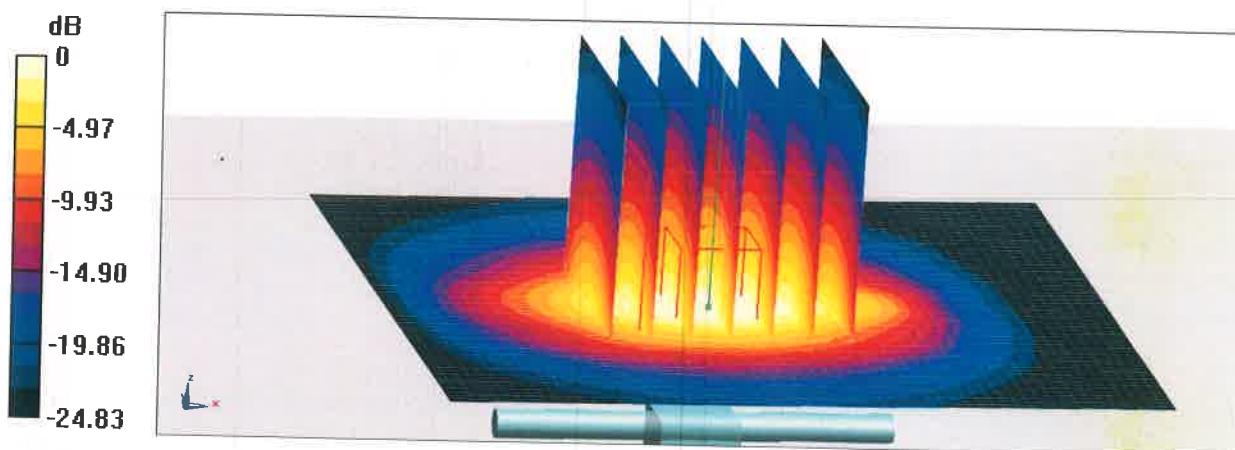
Peak SAR (extrapolated) = 30.3 W/kg

**SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.1 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 45.1%

Maximum value of SAR (measured) = 24.1 W/kg



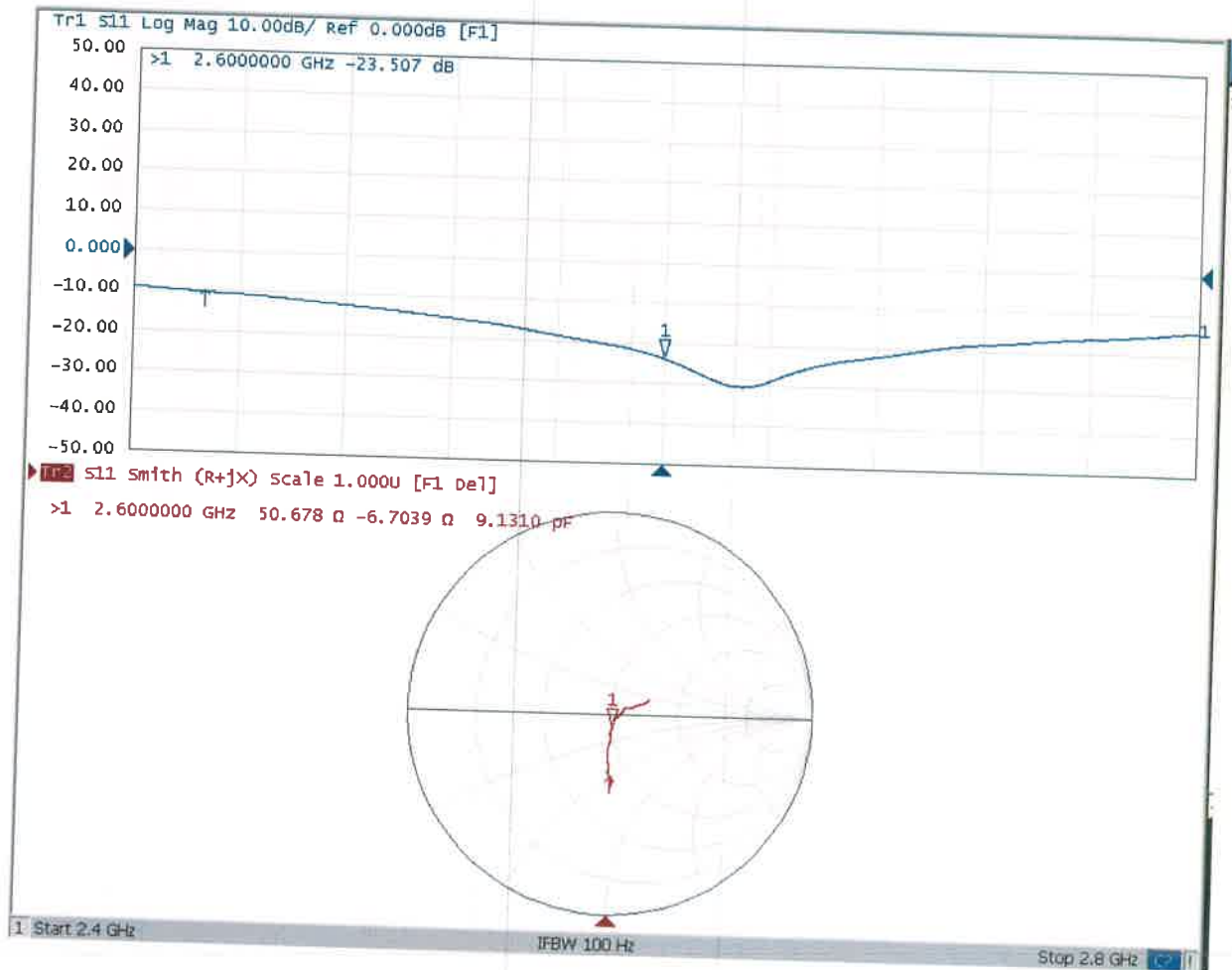
0 dB = 24.1 W/kg = 13.82 dBW/kg



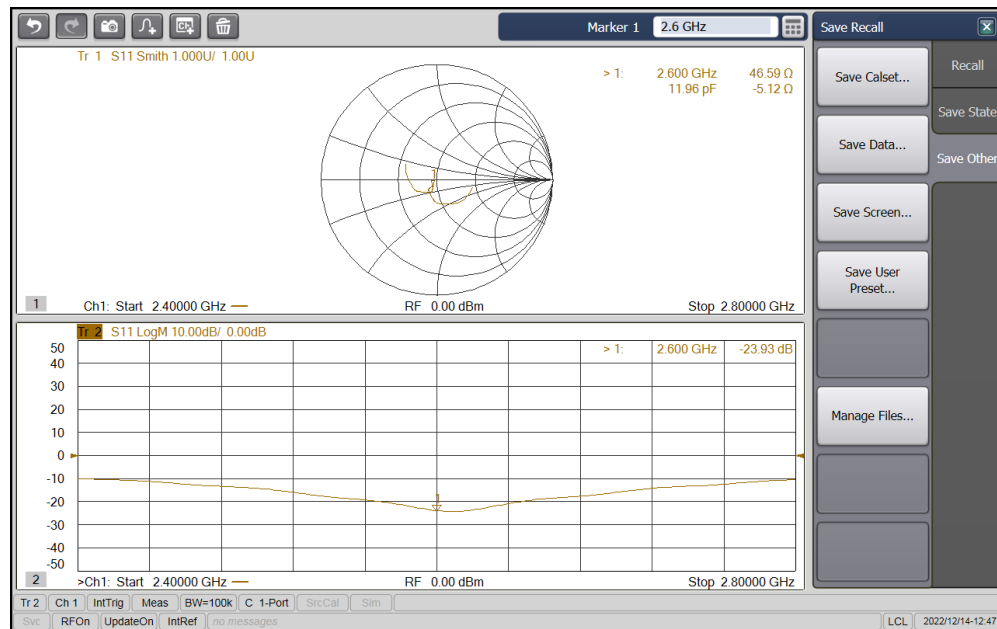
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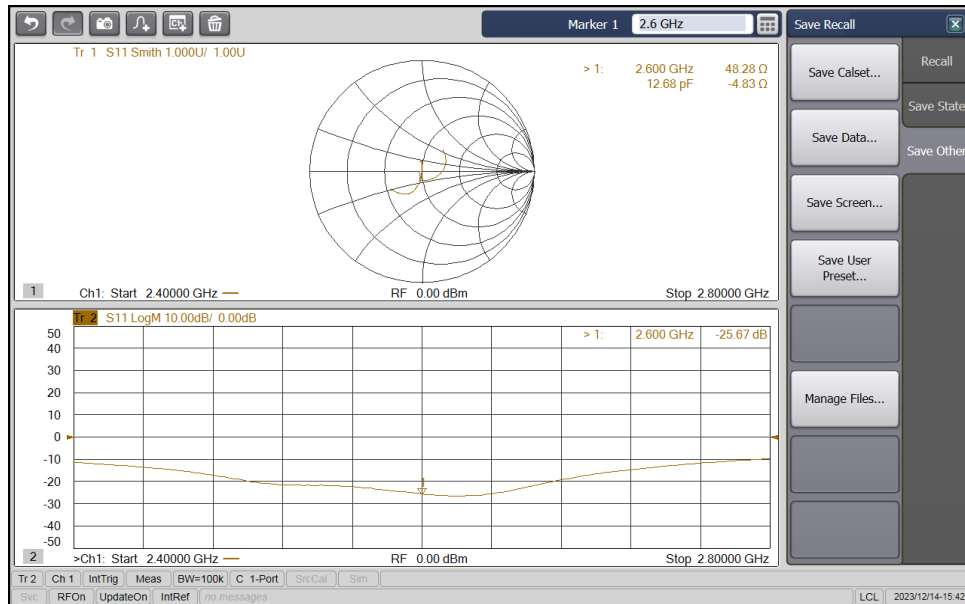
## Impedance Measurement Plot for Head TSL



| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole2600<br>Head TSL     | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 50.68        | -6.704 | 46.59         | -5.120 | -4.09      | 1.58   |
| Return loss(dB)            | -23.507      |        | -23.93        |        | 1.8%       |        |
| Measure Date               | 14-Dec-22    |        |               |        |            |        |



| Annual Verification Result |              |           |               |           |            |           |
|----------------------------|--------------|-----------|---------------|-----------|------------|-----------|
| Dipole2600<br>Head TSL     | Target Value |           | Measure Value |           | Difference |           |
|                            | R<br>(Ω)     | X<br>(jΩ) | R<br>(Ω)      | X<br>(jΩ) | R<br>(Ω)   | X<br>(jΩ) |
| Impedance                  | 50.68        | -6.704    | 48.28         | -4.830    | -2.40      | 1.87      |
| Return loss(dB)            | -23.507      |           | -25.67        |           | 9.2%       |           |
| Measure Date               | 14-Dec-23    |           |               |           |            |           |



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Certificate No: 24J02Z000024

## CALIBRATION CERTIFICATE

Object D3500V2 - SN: 1047

Calibration Procedure(s) FF-Z11-003-01  
Calibration Procedures for dipole validation kits

Calibration date: January 31, 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 (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|-------------------------------------------|-----------------------|
| Power Meter NRP2        | 106276     | 15-May-23 (CTTL, No.J23X04183)            | May-24                |
| Power sensor NRP6A      | 101369     | 15-May-23 (CTTL, No.J23X04183)            | May-24                |
| ReferenceProbe EX3DV4   | SN 3617    | 31-Mar-23(CTTL-SPEAG,No.Z23-60161)        | Mar-24                |
| DAE4                    | SN 1556    | 03-Jan-24(CTTL-SPEAG,No.24J02Z80002)      | Jan-25                |
| Secondary Standards     | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 25-Dec-23 (CTTL, No. J23X13426)           | Dec-24                |
| NetworkAnalyzer E5071C  | MY46110673 | 25-Dec-23 (CTTL, No. J23X13425)           | Dec-24                |

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

Issued: February 6, 2024

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### Glossary:

|       |                                            |
|-------|--------------------------------------------|
| TSL   | tissue simulating liquid                   |
| ConvF | sensitivity in TSL / NORM <sub>x,y,z</sub> |
| 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-mounted 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) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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



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## Measurement Conditions

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

|                                     |                                              |                                  |
|-------------------------------------|----------------------------------------------|----------------------------------|
| <b>DASY Version</b>                 | DASY52                                       | 52.10.4                          |
| <b>Extrapolation</b>                | Advanced Extrapolation                       |                                  |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C                     |                                  |
| <b>Distance Dipole Center - TSL</b> | 10 mm                                        | with Spacer                      |
| <b>Zoom Scan Resolution</b>         | dx, dy = 4 mm, dz = 1.4 mm                   | Graded Ratio = 1.4 (Z direction) |
| <b>Frequency</b>                    | 3400 MHz $\pm$ 1 MHz<br>3500 MHz $\pm$ 1 MHz |                                  |

## Head TSL parameters at 3400 MHz

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 38.0           | 2.81 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 38.4 $\pm$ 6 % | 2.82 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | —              | —                    |

## SAR result with Head TSL at 3400 MHz

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 6.68 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>66.9 W/kg <math>\pm</math> 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 2.56 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>25.6 W/kg <math>\pm</math> 24.2 % (k=2)</b> |

## Head TSL parameters at 3500 MHz

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 37.9           | 2.91 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 38.1 $\pm$ 6 % | 2.93 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | —              | —                    |

## SAR result with Head TSL at 3500 MHz

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 6.73 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>67.2 W/kg <math>\pm</math> 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 2.56 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>25.6 W/kg <math>\pm</math> 24.2 % (k=2)</b> |



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL at 3400 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 47.8Ω - 9.48jΩ |
| Return Loss                          | - 20.1dB       |

### Antenna Parameters with Head TSL at 3500 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 57.2Ω - 2.72jΩ |
| Return Loss                          | - 22.9dB       |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.045 ns |
|----------------------------------|----------|

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

### Additional EUT Data

|                 |       |
|-----------------|-------|
| Manufactured by | SPEAG |
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## **DASY5 Validation Report for Head TSL**

Date: 2024-01-31

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN: 1047**

Communication System: CW; Frequency: 3400 MHz, CW; Frequency: 3500 MHz,

Medium parameters used:  $f = 3400$  MHz;  $\sigma = 2.82$  S/m;  $\epsilon_r = 38.37$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 3500$  MHz;  $\sigma = 2.933$  S/m;  $\epsilon_r = 38.08$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

### **DASY5 Configuration:**

- Probe: EX3DV4 - SN3617; ConvF(7.19, 7.19, 7.19) @ 3400 MHz; ConvF(7.02, 7.02, 7.02) @ 3500 MHz; Calibrated: 2023-03-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2024-01-03
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

### **Dipole Calibration /Pin=100mW, d=10mm, f=3400 MHz/Zoom Scan,**

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

Reference Value = 68.86 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 17.3 W/kg

**SAR(1 g) = 6.68 W/kg; SAR(10 g) = 2.56 W/kg**

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 76.3%

Maximum value of SAR (measured) = 12.2 W/kg

### **Dipole Calibration /Pin=100mW, d=10mm, f=3500 MHz/Zoom Scan,**

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

Reference Value = 68.15 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 17.6 W/kg

**SAR(1 g) = 6.73 W/kg; SAR(10 g) = 2.56 W/kg**

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 76%

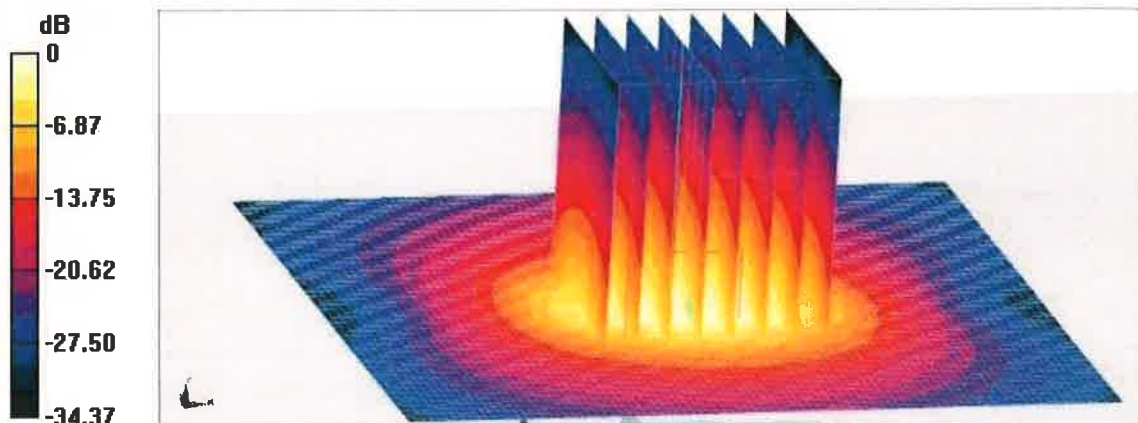
Maximum value of SAR (measured) = 12.3 W/kg

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0 dB = 12.3 W/kg = 10.90 dBW/kg



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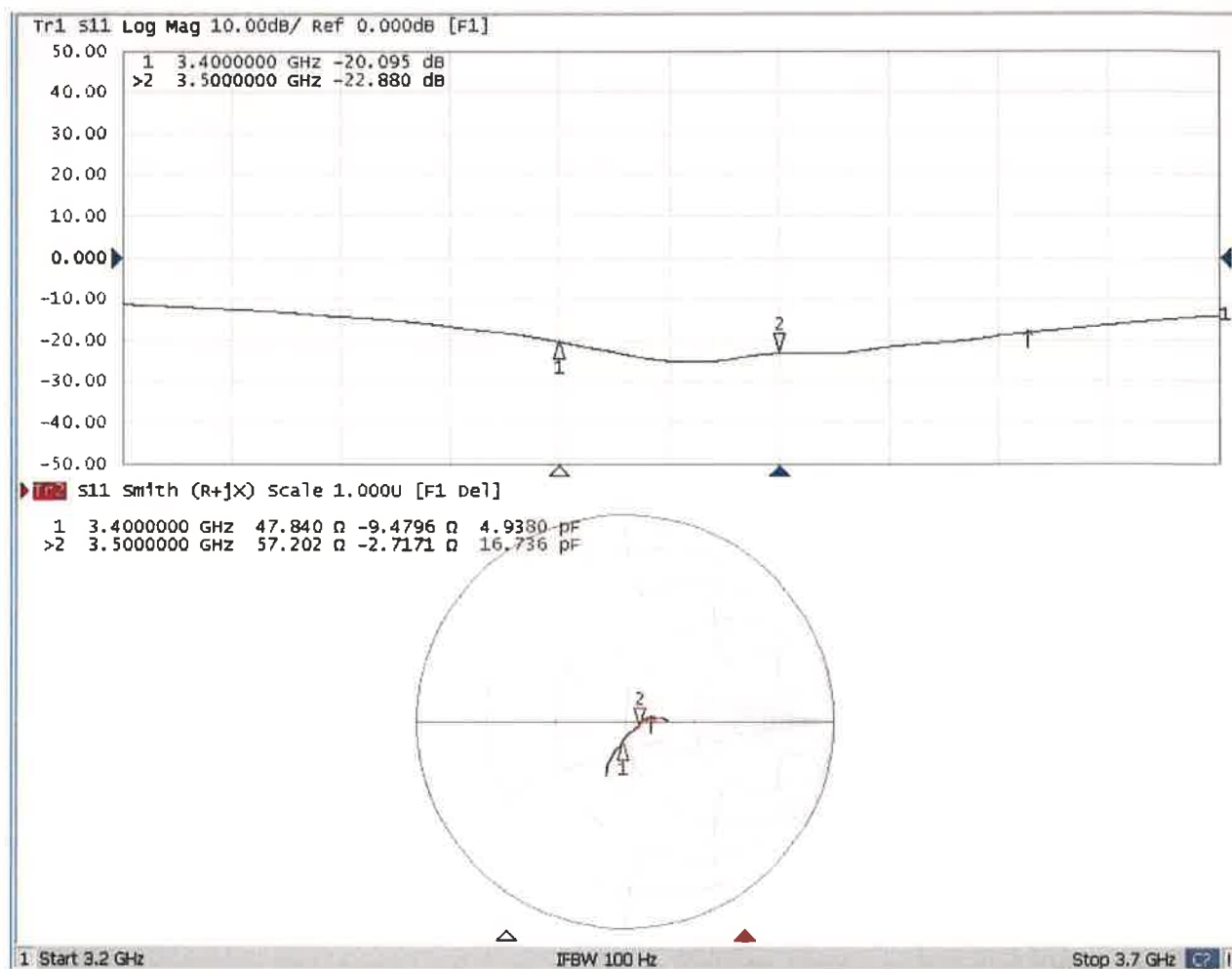
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## Impedance Measurement Plot for Head TSL



Client

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Certificate No: 24J02Z000102

## CALIBRATION CERTIFICATE

Object D3900V2 - SN: 1067

Calibration Procedure(s) FF-Z11-003-01  
Calibration Procedures for dipole validation kits

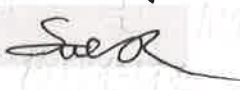
Calibration date: March 27, 2024

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 (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|-------------------------------------------|-----------------------|
| Power Meter NRP2        | 106276     | 15-May-23 (CTTL, No.J23X04183)            | May-24                |
| Power sensor NRP6A      | 101369     | 15-May-23 (CTTL, No.J23X04183)            | May-24                |
| ReferenceProbe EX3DV4   | SN 3617    | 31-Mar-23(CTTL-SPEAG,No.Z23-60161)        | Mar-24                |
| DAE4                    | SN 1556    | 03-Jan-24(CTTL-SPEAG,No.24J02Z80002)      | Jan-25                |
| Secondary Standards     | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 25-Dec-23 (CTTL, No. J23X13426)           | Dec-24                |
| NetworkAnalyzer E5071C  | MY46110673 | 25-Dec-23 (CTTL, No. J23X13425)           | Dec-24                |

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

Issued: March 31, 2024

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### Glossary:

|       |                                            |
|-------|--------------------------------------------|
| TSL   | tissue simulating liquid                   |
| ConvF | sensitivity in TSL / NORM <sub>x,y,z</sub> |
| 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-mounted 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) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

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## Measurement Conditions

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

|                                     |                                              |                                  |
|-------------------------------------|----------------------------------------------|----------------------------------|
| <b>DASY Version</b>                 | DASY52                                       | 52.10.4                          |
| <b>Extrapolation</b>                | Advanced Extrapolation                       |                                  |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C                     |                                  |
| <b>Distance Dipole Center - TSL</b> | 10 mm                                        | with Spacer                      |
| <b>Zoom Scan Resolution</b>         | dx, dy = 4 mm, dz = 1.4 mm                   | Graded Ratio = 1.4 (Z direction) |
| <b>Frequency</b>                    | 3900 MHz $\pm$ 1 MHz<br>4100 MHz $\pm$ 1 MHz |                                  |

## Head TSL parameters at 3900MHz

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 37.5           | 3.32 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 37.0 $\pm$ 6 % | 3.34 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | —              | —                    |

## SAR result with Head TSL at 3900MHz

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 6.83 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>68.0 W/kg <math>\pm</math> 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 2.37 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>23.6 W/kg <math>\pm</math> 24.2 % (k=2)</b> |

## Head TSL parameters at 4100MHz

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 37.2           | 3.53 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 36.6 $\pm$ 6 % | 3.53 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | —              | —                    |

## SAR result with Head TSL at 4100MHz

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 6.77 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>67.4 W/kg <math>\pm</math> 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 2.34 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>23.3 W/kg <math>\pm</math> 24.2 % (k=2)</b> |



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL at 3900MHz

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 46.6Ω- 3.09jΩ |
| Return Loss                          | - 26.5dB      |

### Antenna Parameters with Head TSL at 4100MHz

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 58.0Ω+ 3.71jΩ |
| Return Loss                          | - 21.8dB      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.010 ns |
|----------------------------------|----------|

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

### Additional EUT Data

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



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

Date: 2024-03-27

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN: 1067**

Communication System: UID 0, CW; Frequency: 3900 MHz; Frequency: 4100 MHz;

Medium parameters used:  $f = 3900$  MHz;  $\sigma = 3.34$  S/m;  $\epsilon_r = 37.02$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Medium parameters used:  $f = 4100$  MHz;  $\sigma = 3.531$  S/m;  $\epsilon_r = 36.55$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(6.76, 6.76, 6.76) @ 3900 MHz; ConvF(6.68, 6.68, 6.68) @ 4100 MHz; Calibrated: 2023-03-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2024-01-03
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration /Pin=100mW, d=10mm, f=3900 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm**

Reference Value = 62.49 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 19.9 W/kg

**SAR(1 g) = 6.83 W/kg; SAR(10 g) = 2.37 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.6 mm

Ratio of SAR at M2 to SAR at M1 = 73.5%

Maximum value of SAR (measured) = 13.2 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=4100 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm**

Reference Value = 61.20 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 20.1 W/kg

**SAR(1 g) = 6.77 W/kg; SAR(10 g) = 2.34 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.9 mm

Ratio of SAR at M2 to SAR at M1 = 72.5%

Maximum value of SAR (measured) = 13.5 W/kg



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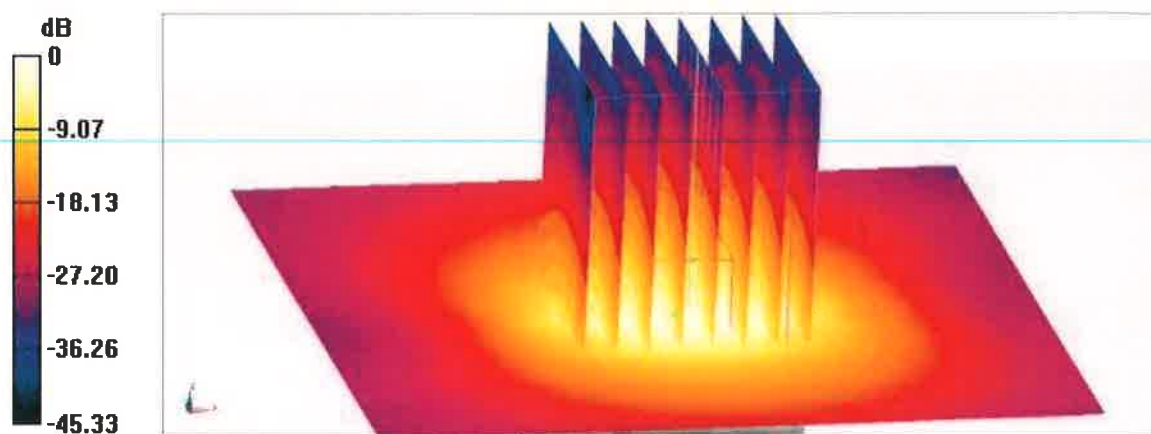


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0 dB = 13.5 W/kg = 11.30 dBW/kg



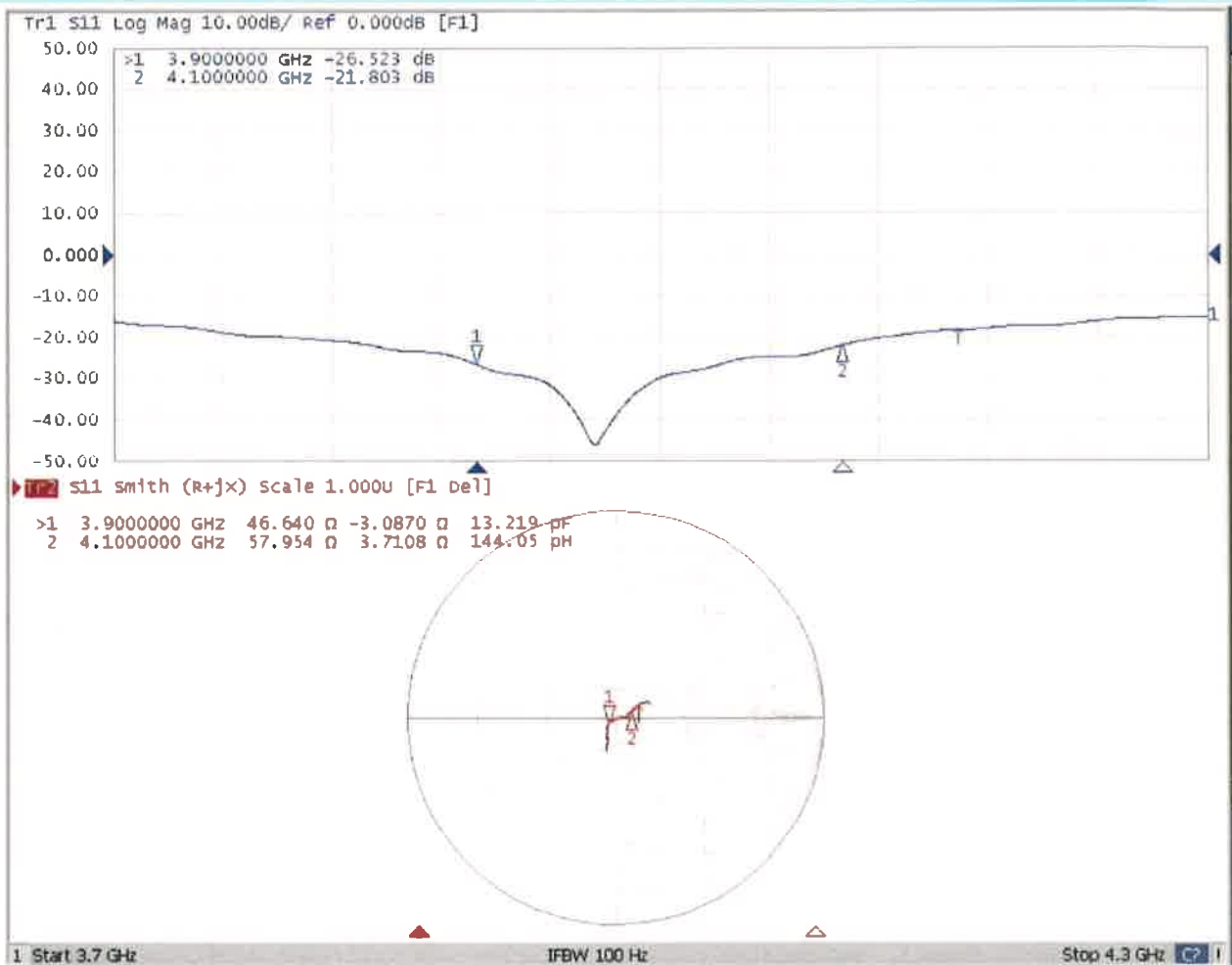
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## Impedance Measurement Plot for Head TSL





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Client

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Certificate No: Z21-60534

## CALIBRATION CERTIFICATE

Object

D5GHzV2 - SN: 1231

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

December 16, 2021

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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|-------------------------------------------|-----------------------|
| Power Meter NRP2        | 106277     | 24-Sep-21 (CTTL, No.J21X08326)            | Sep-22                |
| Power sensor NRP8S      | 104291     | 24-Sep-21 (CTTL, No.J21X08326)            | Sep-22                |
| ReferenceProbe EX3DV4   | SN 3617    | 27-Jan-21(SPEAG,No.EX3-3617_Jan21)        | Jan-22                |
| DAE4                    | SN 1556    | 15-Jan-21(SPEAG,No.DAE4-1556_Jan21)       | Jan-22                |
| Secondary Standards     | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593)            | Jan-22                |
| NetworkAnalyzerE5071C   | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232)            | Jan-22                |

|                | Name        | Function           | Signature |
|----------------|-------------|--------------------|-----------|
| Calibrated by: | Zhao Jing   | SAR Test Engineer  |           |
| Reviewed by:   | Lin Hao     | SAR Test Engineer  |           |
| Approved by:   | Qi Dianyuan | SAR Project Leader |           |

Issued: December 24, 2021

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### Glossary:

|       |                                            |
|-------|--------------------------------------------|
| TSL   | tissue simulating liquid                   |
| ConvF | sensitivity in TSL / NORM <sub>x,y,z</sub> |
| N/A   | not applicable or not measured             |

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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



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### Measurement Conditions

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

|                              |                                                                      |                                  |
|------------------------------|----------------------------------------------------------------------|----------------------------------|
| DASY Version                 | DASY52                                                               | V52.10.4                         |
| Extrapolation                | Advanced Extrapolation                                               |                                  |
| Phantom                      | Triple Flat Phantom 5.1C                                             |                                  |
| Distance Dipole Center - TSL | 10 mm                                                                | with Spacer                      |
| Zoom Scan Resolution         | dx, dy = 4 mm, dz = 1.4 mm                                           | Graded Ratio = 1.4 (Z direction) |
| Frequency                    | 5250 MHz $\pm$ 1 MHz<br>5600 MHz $\pm$ 1 MHz<br>5750 MHz $\pm$ 1 MHz |                                  |

### Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 35.9           | 4.71 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 35.7 $\pm$ 6 % | 4.69 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | <1.0 °C             |                |                      |

### SAR result with Head TSL at 5250 MHz

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL   | Condition          |                              |
| SAR measured                                            | 100 mW input power | 7.80 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 77.9 W/kg $\pm$ 24.4 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                              |
| SAR measured                                            | 100 mW input power | 2.26 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 22.6 W/kg $\pm$ 24.2 % (k=2) |



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**Head TSL parameters at 5600 MHz**

The following parameters and calculations were applied.

|                                                | Temperature     | Permittivity | Conductivity     |
|------------------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C         | 35.5         | 5.07 mho/m       |
| <b>Measured Head TSL parameters</b>            | (22.0 ± 0.2) °C | 35.1 ± 6 %   | 5.07 mho/m ± 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C         | ----         | ----             |

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

|                                                               |                    |                                 |
|---------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                 |
| SAR measured                                                  | 100 mW input power | 8.11 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>80.9 W/kg ± 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                 |
| SAR measured                                                  | 100 mW input power | 2.34 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>23.3 W/kg ± 24.2 % (k=2)</b> |

**Head TSL parameters at 5750 MHz**

The following parameters and calculations were applied.

|                                                | Temperature     | Permittivity | Conductivity     |
|------------------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C         | 35.4         | 5.22 mho/m       |
| <b>Measured Head TSL parameters</b>            | (22.0 ± 0.2) °C | 34.9 ± 6 %   | 5.23 mho/m ± 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C         | ----         | ----             |

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

|                                                               |                    |                                 |
|---------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                 |
| SAR measured                                                  | 100 mW input power | 7.85 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>78.3 W/kg ± 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                 |
| SAR measured                                                  | 100 mW input power | 2.25 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>22.4 W/kg ± 24.2 % (k=2)</b> |



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL at 5250 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 49.0Ω - 5.89jΩ |
| Return Loss                          | - 24.4dB       |

### Antenna Parameters with Head TSL at 5600 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 50.6Ω - 1.18jΩ |
| Return Loss                          | - 37.7dB       |

### Antenna Parameters with Head TSL at 5750 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 54.7Ω + 0.03jΩ |
| Return Loss                          | - 26.9dB       |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.102 ns |
|----------------------------------|----------|

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

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

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

### Additional EUT Data

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



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

Date: 2021-12-16

Test Laboratory: CCTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1231**

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz,

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.692$  S/m;  $\epsilon_r = 35.68$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.071$  S/m;  $\epsilon_r = 35.08$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.234$  S/m;  $\epsilon_r = 34.86$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

### **DASY5 Configuration:**

- Probe: EX3DV4 - SN3617; ConvF(5.4, 5.4, 5.4) @ 5250 MHz; ConvF(5, 5, 5) @ 5600 MHz; ConvF(5.12, 5.12, 5.12) @ 5750 MHz; Calibrated: 2021-01-27
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

### **Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan,**

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

Reference Value = 71.60 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 30.6 W/kg

**SAR(1 g) = 7.8 W/kg; SAR(10 g) = 2.26 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 65.4%

Maximum value of SAR (measured) = 17.9 W/kg

### **Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan,**

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

Reference Value = 70.58 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 34.6 W/kg

**SAR(1 g) = 8.11 W/kg; SAR(10 g) = 2.34 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 63.1%

Maximum value of SAR (measured) = 20.0 W/kg



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**Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan,**  
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 68.78 V/m; Power Drift = 0.00 dB

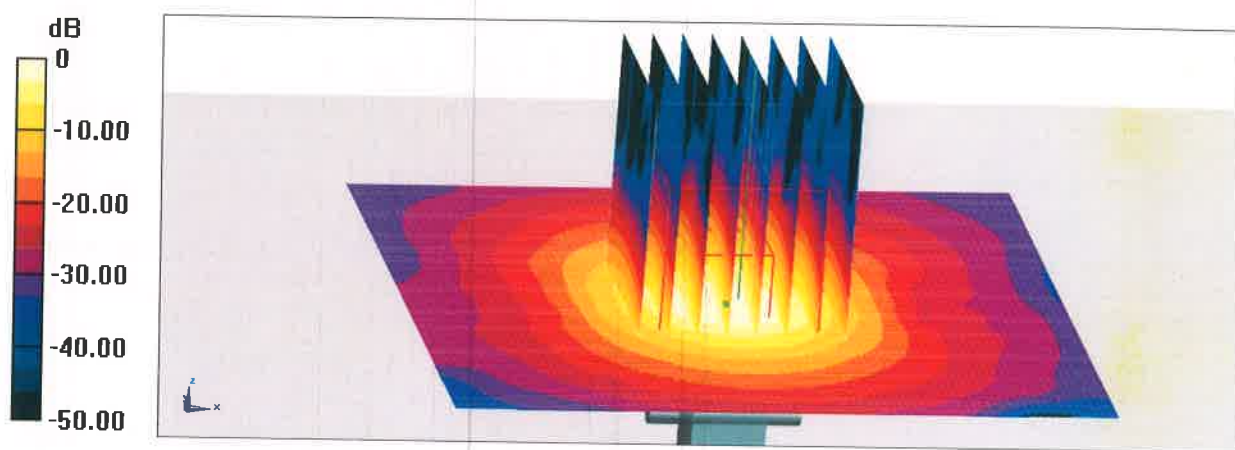
Peak SAR (extrapolated) = 34.7 W/kg

**SAR(1 g) = 7.85 W/kg; SAR(10 g) = 2.25 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 62%

Maximum value of SAR (measured) = 18.9 W/kg

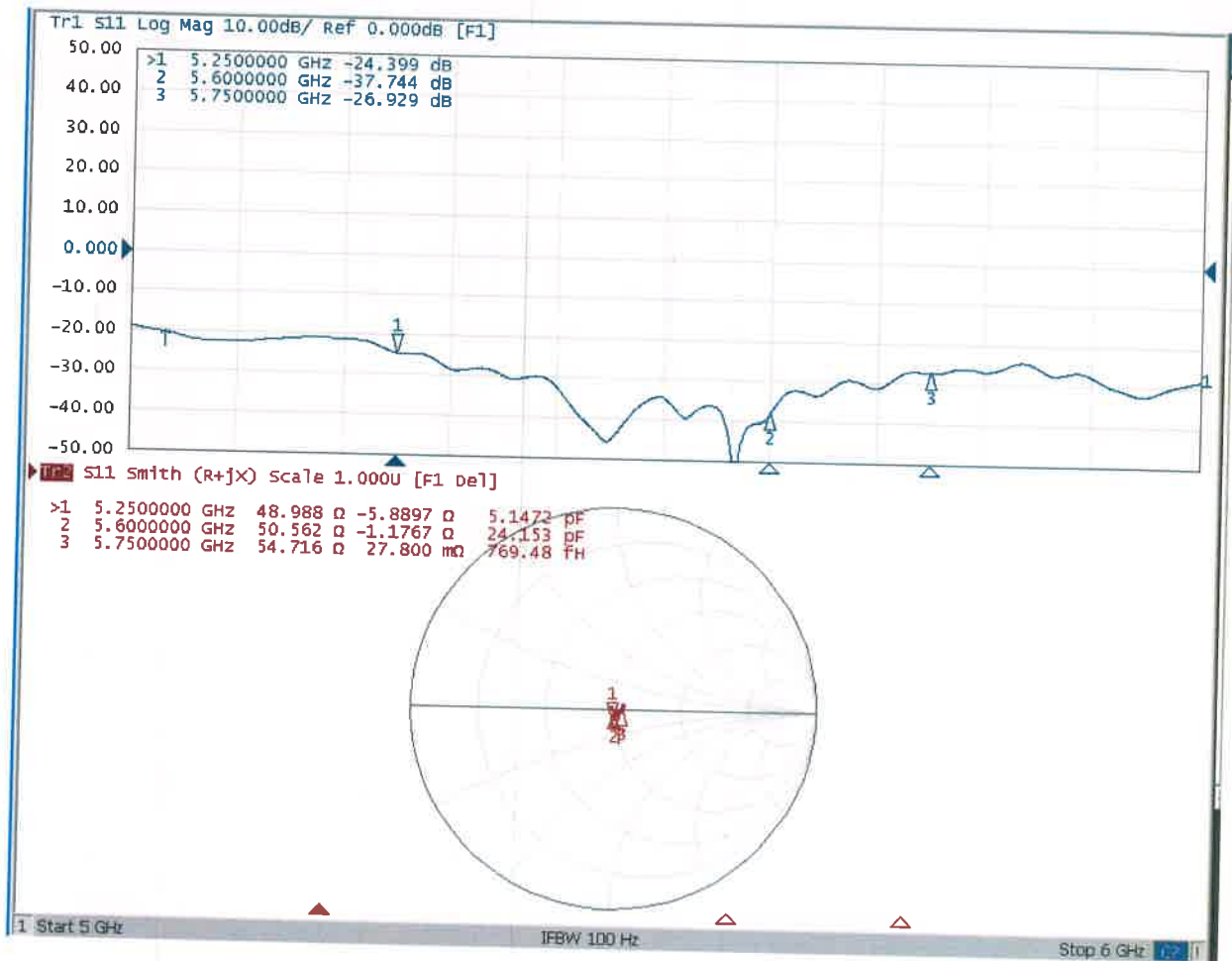




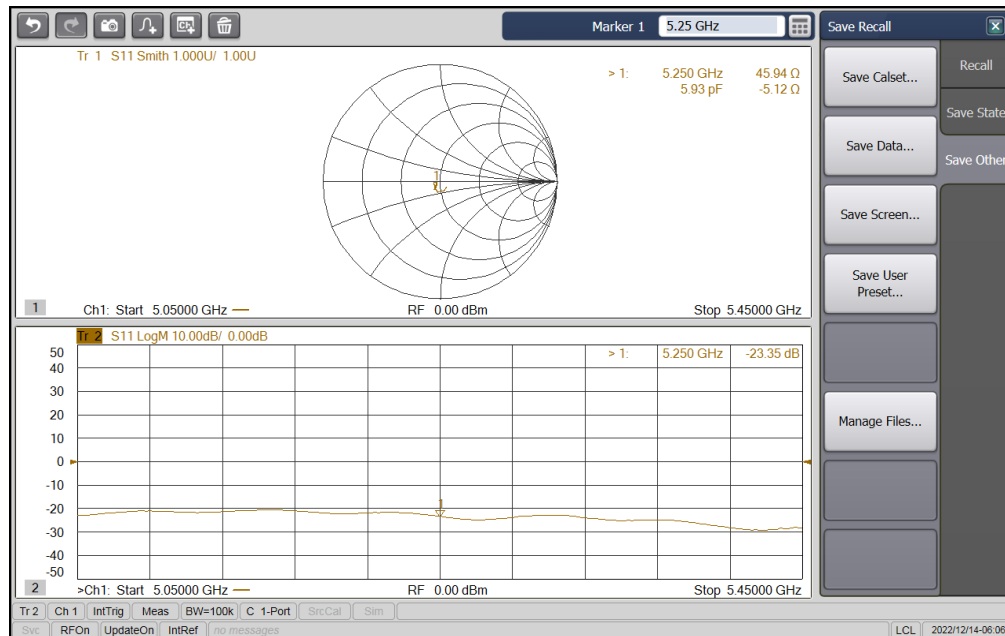
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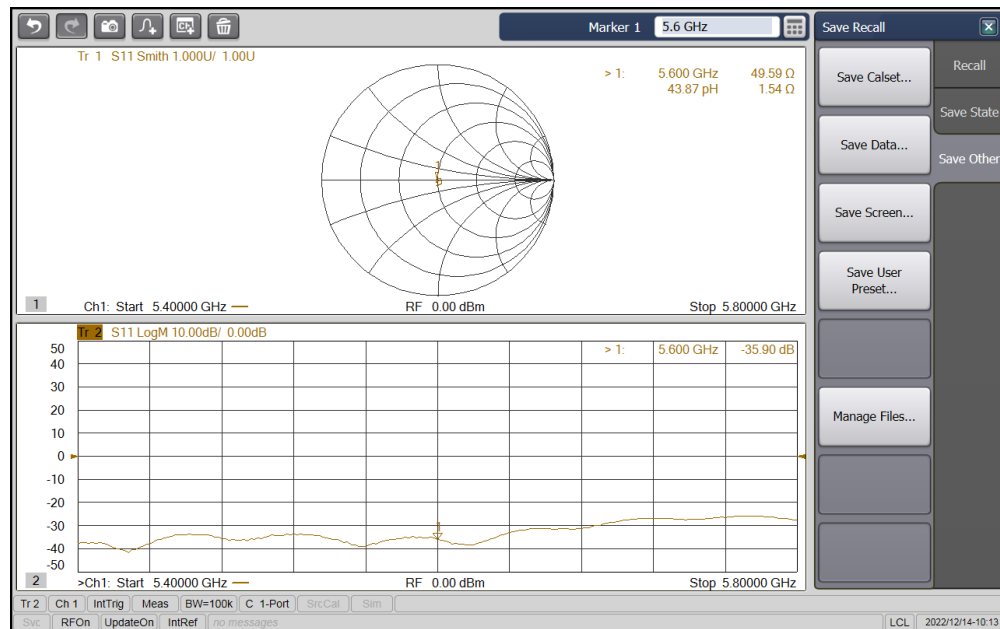
## Impedance Measurement Plot for Head TSL



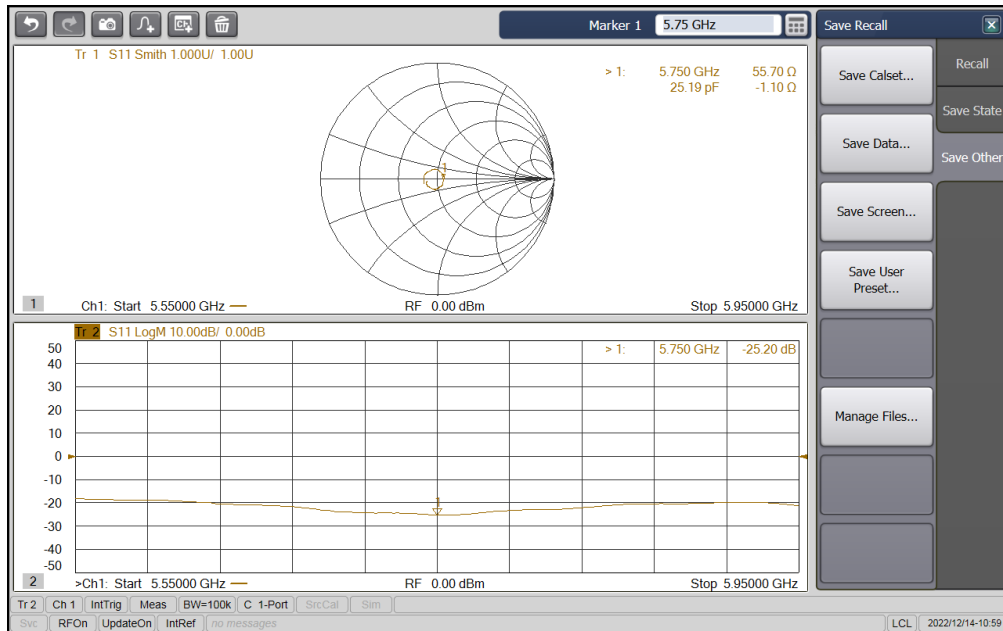
| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole5250<br>Head TSL     | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 48.99        | -5.890 | 45.94         | -5.120 | -3.05      | 0.77   |
| Return loss(dB)            | -24.399      |        | -23.35        |        | -4.3%      |        |
| Measure Date               | 14-Dec-22    |        |               |        |            |        |



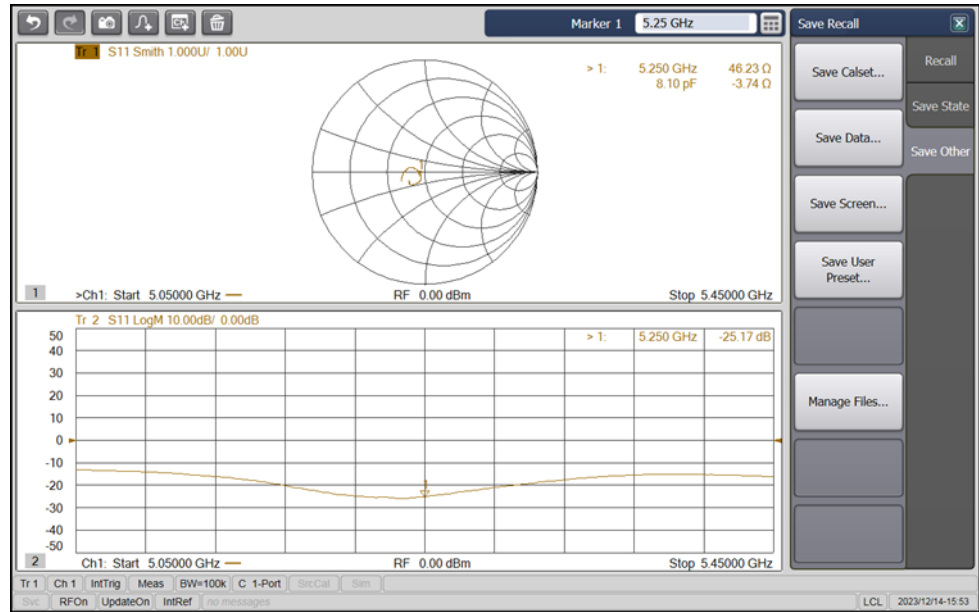
| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole5600<br>Head TSL     | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 50.56        | -1.177 | 49.59         | 1.540  | -0.97      | 2.72   |
| Return loss(dB)            | -37.744      |        | -35           |        | -7.3%      |        |
| Measure Date               | 14-Dec-22    |        |               |        |            |        |



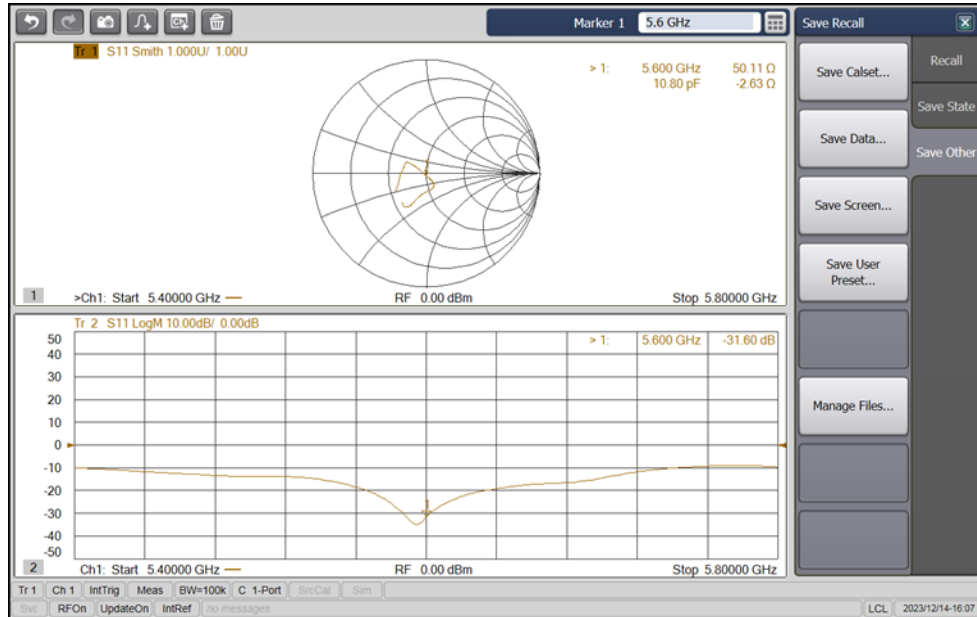
| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole5750<br>Head TSL     | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 54.72        | 0.028  | 55.70         | -1.100 | 0.98       | -1.13  |
| Return loss(dB)            | -26.929      |        | -25.2         |        | -6.4%      |        |
| Measure Date               | 14-Dec-22    |        |               |        |            |        |



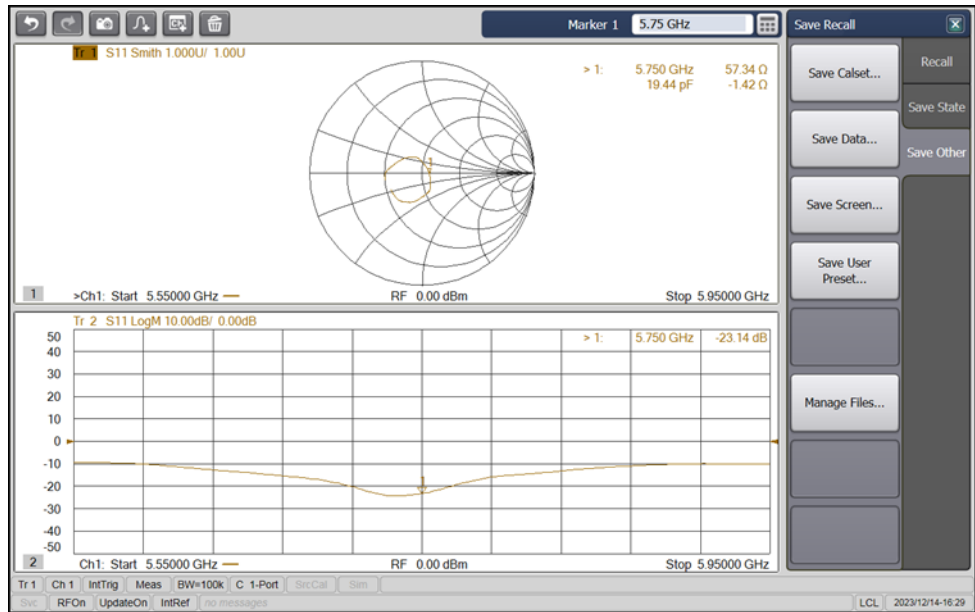
| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole5250<br>Head TSL     | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 48.99        | -5.890 | 46.23         | -3.740 | -2.76      | 2.15   |
| Return loss(dB)            | -24.399      |        | -25.17        |        | 3.2%       |        |
| Measure Date               | 14-Dec-23    |        |               |        |            |        |



| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole5600<br>Head TSL     | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 50.56        | -1.177 | 50.11         | -2.630 | -0.45      | -1.45  |
| Return loss(dB)            | -37.744      |        | -31.6         |        | -16.3%     |        |
| Measure Date               | 14-Dec-23    |        |               |        |            |        |



| Annual Verification Result |              |        |               |        |            |        |
|----------------------------|--------------|--------|---------------|--------|------------|--------|
| Dipole5750<br>Head TSL     | Target Value |        | Measure Value |        | Difference |        |
|                            | R (Ω)        | X (jΩ) | R (Ω)         | X (jΩ) | R (Ω)      | X (jΩ) |
| Impedance                  | 54.72        | 0.028  | 57.34         | -1.420 | 2.62       | -1.45  |
| Return loss(dB)            | -26.929      |        | -23.14        |        | -14.1%     |        |
| Measure Date               | 14-Dec-23    |        |               |        |            |        |



Client

UL

Certificate No: 24J02Z000102

## CALIBRATION CERTIFICATE

Object D3900V2 - SN: 1067

Calibration Procedure(s) FF-Z11-003-01  
Calibration Procedures for dipole validation kits

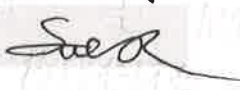
Calibration date: March 27, 2024

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 (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|-------------------------------------------|-----------------------|
| Power Meter NRP2        | 106276     | 15-May-23 (CTTL, No.J23X04183)            | May-24                |
| Power sensor NRP6A      | 101369     | 15-May-23 (CTTL, No.J23X04183)            | May-24                |
| ReferenceProbe EX3DV4   | SN 3617    | 31-Mar-23(CTTL-SPEAG,No.Z23-60161)        | Mar-24                |
| DAE4                    | SN 1556    | 03-Jan-24(CTTL-SPEAG,No.24J02Z80002)      | Jan-25                |
| Secondary Standards     | ID #       | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 25-Dec-23 (CTTL, No. J23X13426)           | Dec-24                |
| NetworkAnalyzer E5071C  | MY46110673 | 25-Dec-23 (CTTL, No. J23X13425)           | Dec-24                |

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

Issued: March 31, 2024

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### Glossary:

|       |                                            |
|-------|--------------------------------------------|
| TSL   | tissue simulating liquid                   |
| ConvF | sensitivity in TSL / NORM <sub>x,y,z</sub> |
| 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-mounted 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) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

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E-mail: emf@caict.ac.cn <http://www.caict.ac.cn>

## Measurement Conditions

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

|                                     |                                              |                                  |
|-------------------------------------|----------------------------------------------|----------------------------------|
| <b>DASY Version</b>                 | DASY52                                       | 52.10.4                          |
| <b>Extrapolation</b>                | Advanced Extrapolation                       |                                  |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C                     |                                  |
| <b>Distance Dipole Center - TSL</b> | 10 mm                                        | with Spacer                      |
| <b>Zoom Scan Resolution</b>         | dx, dy = 4 mm, dz = 1.4 mm                   | Graded Ratio = 1.4 (Z direction) |
| <b>Frequency</b>                    | 3900 MHz $\pm$ 1 MHz<br>4100 MHz $\pm$ 1 MHz |                                  |

## Head TSL parameters at 3900MHz

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 37.5           | 3.32 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 37.0 $\pm$ 6 % | 3.34 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | —              | —                    |

## SAR result with Head TSL at 3900MHz

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 6.83 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>68.0 W/kg <math>\pm</math> 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 2.37 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>23.6 W/kg <math>\pm</math> 24.2 % (k=2)</b> |

## Head TSL parameters at 4100MHz

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 37.2           | 3.53 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 36.6 $\pm$ 6 % | 3.53 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | —              | —                    |

## SAR result with Head TSL at 4100MHz

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 6.77 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>67.4 W/kg <math>\pm</math> 24.4 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 100 mW input power | 2.34 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>23.3 W/kg <math>\pm</math> 24.2 % (k=2)</b> |



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL at 3900MHz

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 46.6Ω- 3.09jΩ |
| Return Loss                          | - 26.5dB      |

### Antenna Parameters with Head TSL at 4100MHz

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 58.0Ω+ 3.71jΩ |
| Return Loss                          | - 21.8dB      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.010 ns |
|----------------------------------|----------|

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

### Additional EUT Data

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



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

Date: 2024-03-27

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN: 1067**

Communication System: UID 0, CW; Frequency: 3900 MHz; Frequency: 4100 MHz;

Medium parameters used:  $f = 3900$  MHz;  $\sigma = 3.34$  S/m;  $\epsilon_r = 37.02$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Medium parameters used:  $f = 4100$  MHz;  $\sigma = 3.531$  S/m;  $\epsilon_r = 36.55$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(6.76, 6.76, 6.76) @ 3900 MHz; ConvF(6.68, 6.68, 6.68) @ 4100 MHz; Calibrated: 2023-03-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2024-01-03
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration /Pin=100mW, d=10mm, f=3900 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm**

Reference Value = 62.49 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 19.9 W/kg

**SAR(1 g) = 6.83 W/kg; SAR(10 g) = 2.37 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.6 mm

Ratio of SAR at M2 to SAR at M1 = 73.5%

Maximum value of SAR (measured) = 13.2 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=4100 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm**

Reference Value = 61.20 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 20.1 W/kg

**SAR(1 g) = 6.77 W/kg; SAR(10 g) = 2.34 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.9 mm

Ratio of SAR at M2 to SAR at M1 = 72.5%

Maximum value of SAR (measured) = 13.5 W/kg



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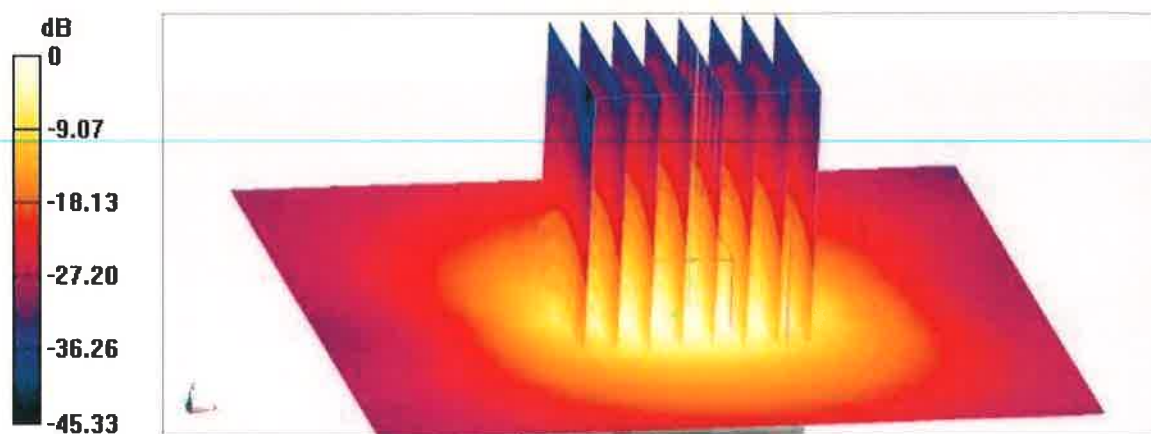


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0 dB = 13.5 W/kg = 11.30 dBW/kg



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## Impedance Measurement Plot for Head TSL

