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

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

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

**Accreditation No.: SCS 0108**

**Client** Morlab (Auden)

**Certificate No: D3500V2-1104_Jun20**

# CALIBRATION CERTIFICATE

Object D3500V2 - SN:1104

Calibration procedure(s) QA CAL-22.v4
Calibration Procedure for SAR Validation Sources between 3-6 GHz

Calibration date: June 03, 2020

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 01-Apr-20 (No. 217-03100/03101) | Apr-21 |
| Power sensor NRP-Z91 | SN: 103244 | 01-Apr-20 (No. 217-03100) | Apr-21 |
| Power sensor NRP-Z91 | SN: 103245 | 01-Apr-20 (No. 217-03101) | Apr-21 |
| Reference 20 dB Attenuator | SN: BH9394 (20k) | 31-Mar-20 (No. 217-03106) | Apr-21 |
| Type-N mismatch combination | SN: 310982 / 06327 | 31-Mar-20 (No. 217-03104) | Apr-21 |
| Reference Probe EX3DV4 | SN: 3503 | 31-Dec-19 (No. EX3-3503_Dec19) | Dec-20 |
| DAE4 | SN: 601 | 27-Dec-19 (No. DAE4-601_Dec19) | Dec-20 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-19) | In house check: Oct-20 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: June 4, 2020

**Glossary:**

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

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

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

**Additional Documentation:**

e) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.10.4 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom V5.0 | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy = 4.0 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| **Frequency** | 3400 MHz ± 1 MHz<br>3500 MHz ± 1 MHz | |

## Head TSL parameters at 3400 MHz

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 38.0 | 2.81 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 37.9 ± 6 % | 2.82 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 3400 MHz

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 6.74 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **67.3 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.52 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **25.2 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 3500 MHz

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 37.9 | 2.91 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 37.7 ± 6 % | 2.90 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 3500 MHz

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 6.72 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **67.2 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.51 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **25.1 W/kg ± 19.5 % (k=2)** |

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

### Antenna Parameters with Head TSL at 3400 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 43.3 Ω - 2.3 jΩ |
| Return Loss | - 22.4 dB |

### Antenna Parameters with Head TSL at 3500 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 50.1 Ω + 0.7 jΩ |
| Return Loss | - 43.1 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.136 ns |

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

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

### Additional EUT Data

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

## DASY5 Validation Report for Head TSL

Date: 03.06.2020

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN: 1104**

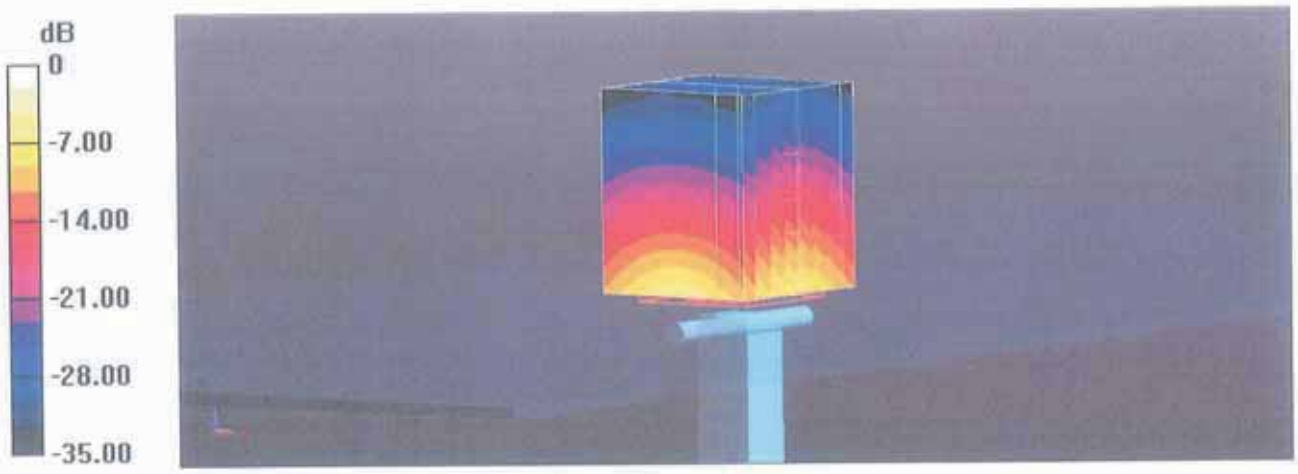
Communication System: UID 0 - CW; Frequency: 3500 MHz, Frequency: 3400 MHz
Medium parameters used: f = 3500 MHz; $\sigma$ = 2.9 S/m; $\varepsilon_r$ = 37.7; $\rho$ = 1000 kg/m$^3$,
Medium parameters used: f = 3400 MHz; $\sigma$ = 2.82 S/m; $\varepsilon_r$ = 37.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.91, 7.91, 7.91) @ 3500 MHz, ConvF(7.91, 7.91, 7.91) @ 3400 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

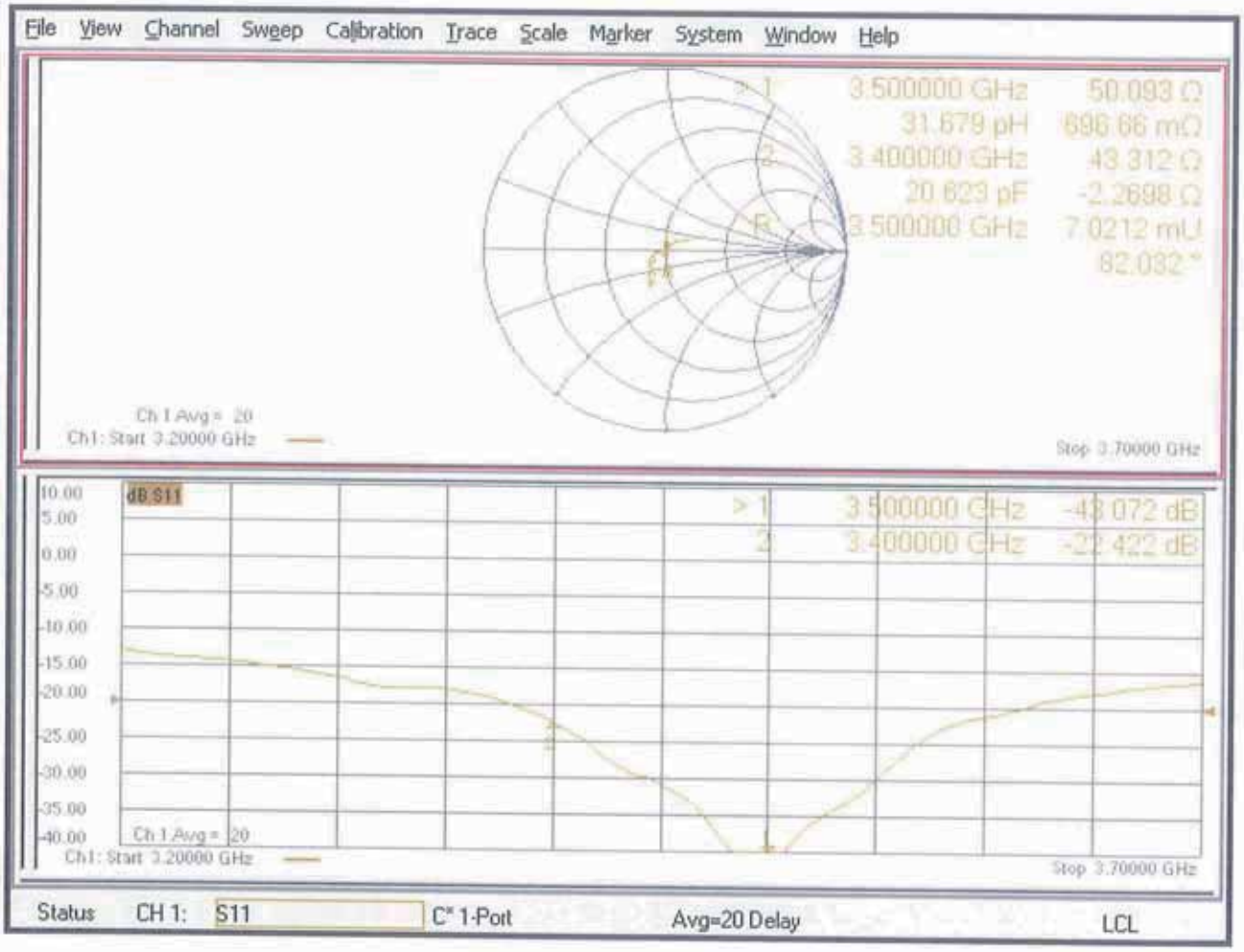
**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3500MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.56 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 18.5 W/kg
**SAR(1 g) = 6.72 W/kg; SAR(10 g) = 2.51 W/kg**
Smallest distance from peaks to all points 3 dB below = 8.2 mm
Ratio of SAR at M2 to SAR at M1 = 74.1%
Maximum value of SAR (measured) = 13.0 W/kg

**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3400MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 73.45 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 18.1 W/kg
**SAR(1 g) = 6.74 W/kg; SAR(10 g) = 2.52 W/kg**
Smallest distance from peaks to all points 3 dB below = 8.4 mm
Ratio of SAR at M2 to SAR at M1 = 75.1%
Maximum value of SAR (measured) = 13.0 W/kg




0 dB = 13.0 W/kg = 11.15 dBW/kg

## Impedance Measurement Plot for Head TSL



# Appendix Annual validation for Test Lab.

**General calibration information**

| | |
|---|---|
| Date | 2022.07.08 |
| Test Laboratory | ShenZhen Morlab Communications Technology Co., Ltd. |
| Antenna serial No. | D3500V2-SN:1104 |

**Antenna Parameters with Head TSL**

| | |
|---|---|
| Impedance, transformed to feed point | 43.32Ω-1.05jΩ |
| Return Loss | -22.80dB |

**General Antenna Parameters and Design**

| | |
|---|---|
| Electrical Delay (one direction) | 1.276 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 arm，because they might bend or the soldered connections near the feed point may be damaged.

Test Laboratory: Shenzhen Morlab Communications Technology Co., Ltd. Date: 2022.07.08

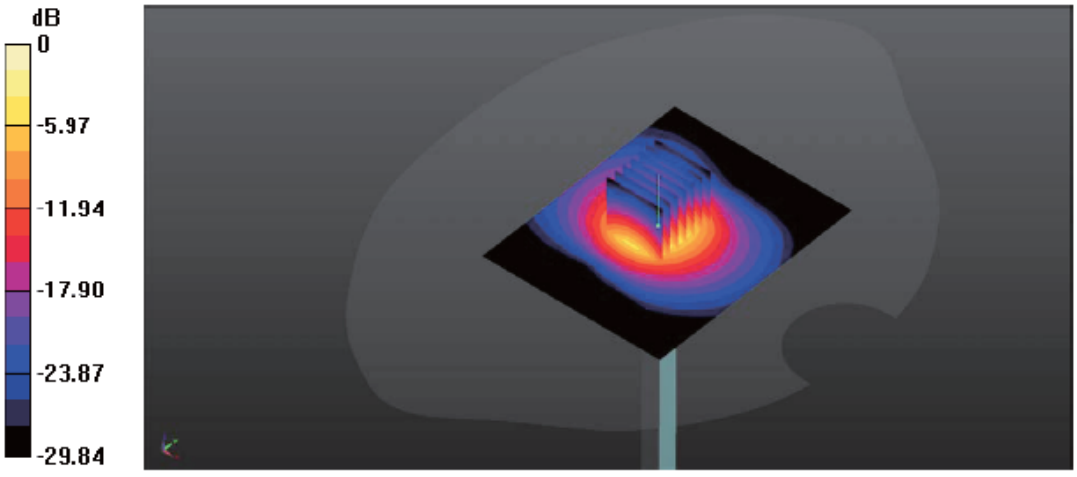
## System Check_3500MHz_Head

Communication System: UID 0, CW (0); Frequency: 3500 MHz;Duty Cycle: 1:1
Medium: HSL_3500 Medium parameters used: f = 3500 MHz; $\sigma$ = 2.839 S/m; $\varepsilon_r$ = 38.906; $\rho$ = 1000 kg/$m^3$
Ambient Temperature : 23.2 ℃; Liquid Temperature : 22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7608; ConvF(6.61, 6.61, 6.61) @ 3500 MHz; Calibrated: 2022.01.12
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1643; Calibrated: 2021.12.30
- Phantom: Twin-SAM; Type: QD 000 P41 Ax; Serial: 2020
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

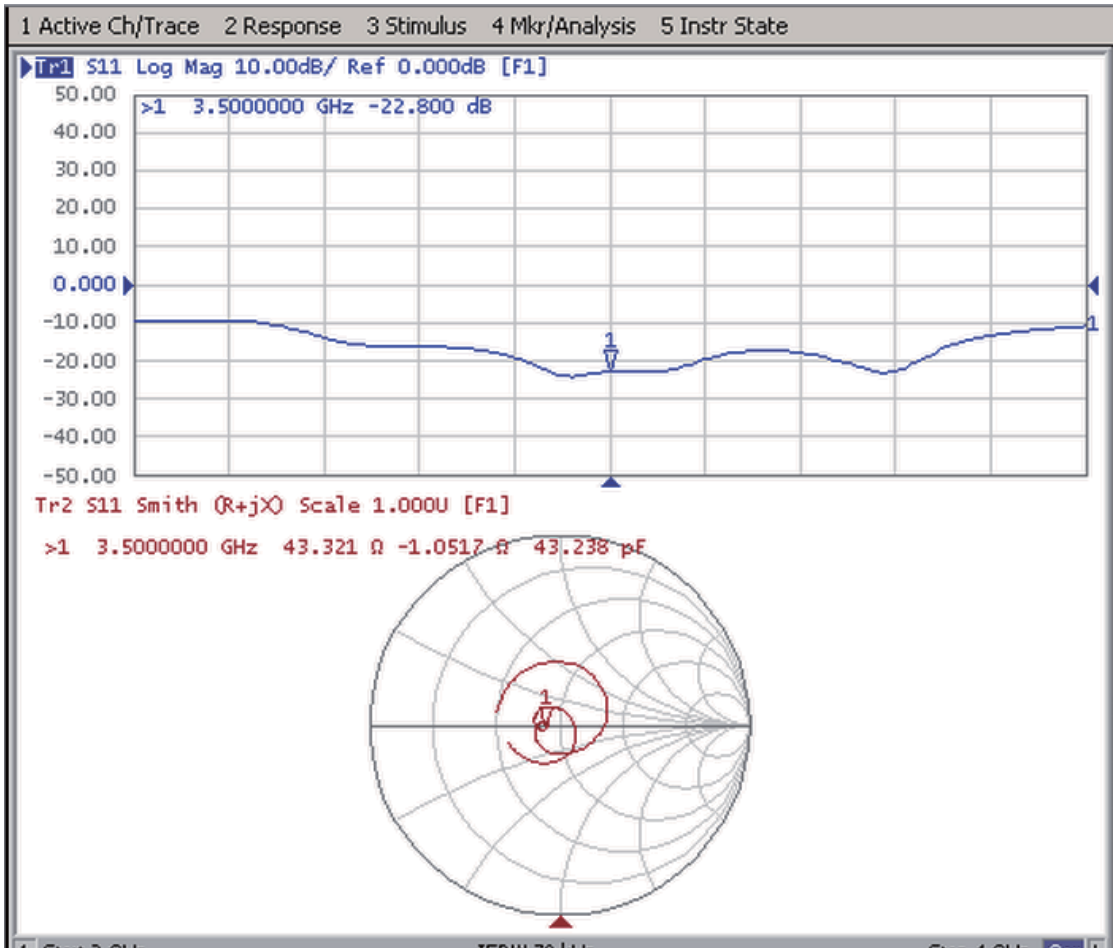
**CW3500/Area Scan (81x101x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 8.99 W/kg

**CW3500/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 53.73 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 18.1 W/kg
**SAR(1 g) = 7.04 W/kg; SAR(10 g) = 2.64 W/kg**
Maximum value of SAR (measured) = 8.28 W/kg




0 dB = 8.28 W/kg

## Appendix Impedance Measurement Plot for Head TSL



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

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

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

**Accreditation No.: SCS 0108**

**Client** Morlab (Auden)

**Certificate No: D3700V2-1076_Jun20**

# CALIBRATION CERTIFICATE

Object: D3700V2 - SN:1076

Calibration procedure(s): QA CAL-22.v4
Calibration Procedure for SAR Validation Sources between 3-6 GHz

Calibration date: June 03, 2020

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 01-Apr-20 (No. 217-03100/03101) | Apr-21 |
| Power sensor NRP-Z91 | SN: 103244 | 01-Apr-20 (No. 217-03100) | Apr-21 |
| Power sensor NRP-Z91 | SN: 103245 | 01-Apr-20 (No. 217-03101) | Apr-21 |
| Reference 20 dB Attenuator | SN: BH9394 (20k) | 31-Mar-20 (No. 217-03106) | Apr-21 |
| Type-N mismatch combination | SN: 310982 / 06327 | 31-Mar-20 (No. 217-03104) | Apr-21 |
| Reference Probe EX3DV4 | SN: 3503 | 31-Dec-19 (No. EX3-3503_Dec19) | Dec-20 |
| DAE4 | SN: 601 | 27-Dec-19 (No. DAE4-601_Dec19) | Dec-20 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-19) | In house check: Oct-20 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: June 3, 2020

**Glossary:**

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

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

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

**Additional Documentation:**

e) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.10.4 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy = 4 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| **Frequency** | 3700 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 37.7 | 3.12 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 37.5 ± 6 % | 3.05 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 6.72 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **67.5 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.42 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.2 W/kg ± 19.5 % (k=2)** |

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

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 47.0 Ω + 1.2 jΩ |
| Return Loss | - 29.5 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.133 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 |

Date: 03.06.2020

Test Laboratory: SPEAG, Zurich, Switzerland

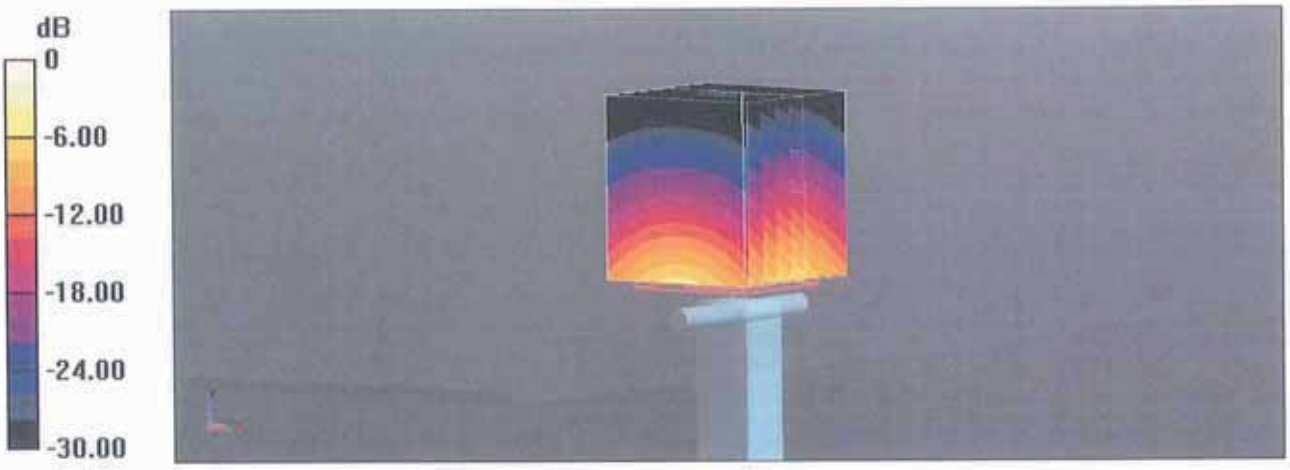
**DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN: 1076**

Communication System: UID 0 - CW; Frequency: 3700 MHz
Medium parameters used: f = 3700 MHz; $\sigma$ = 3.05 S/m; $\varepsilon_r$ = 37.5; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

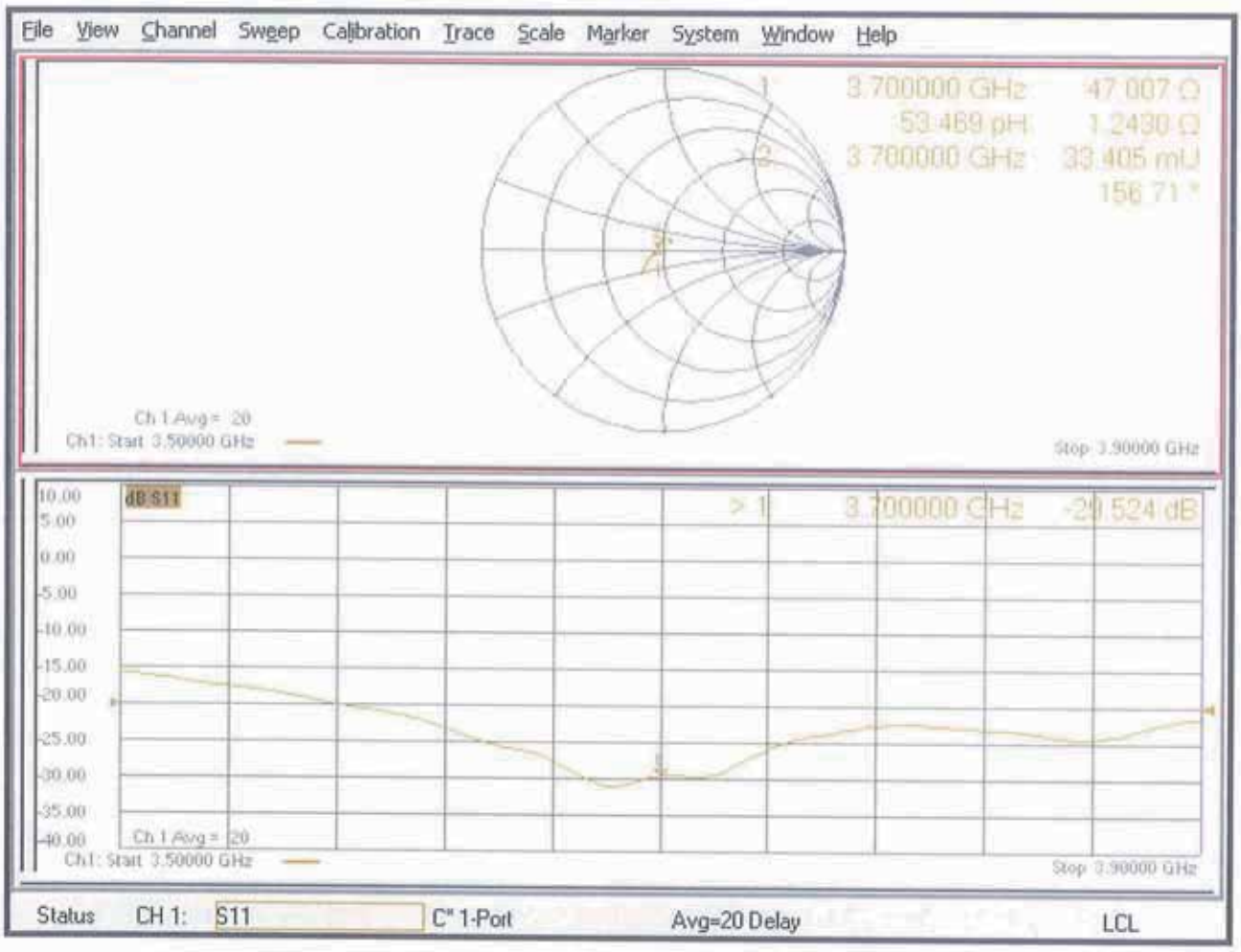
- Probe: EX3DV4 - SN3503; ConvF(7.73, 7.73, 7.73) @ 3700 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3700MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 71.10 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 19.3 W/kg
**SAR(1 g) = 6.72 W/kg; SAR(10 g) = 2.42 W/kg**
Smallest distance from peaks to all points 3 dB below = 7.9 mm
Ratio of SAR at M2 to SAR at M1 = 73.2%
Maximum value of SAR (measured) = 13.0 W/kg




0 dB = 13.0 W/kg = 11.15 dBW/kg

## Impedance Measurement Plot for Head TSL



# Appendix Annual validation for Test Lab.

**General calibration information**

| | |
|---|---|
| Date | 2022.07.08 |
| Test Laboratory | ShenZhen Morlab Communications Technology Co., Ltd. |
| Antenna serial No. | D3700V2-SN:1076 |

**Antenna Parameters with Head TSL**

| | |
|---|---|
| Impedance, transformed to feed point | 47.01Ω+1.36jΩ |
| Return Loss | -29.41dB |

**General Antenna Parameters and Design**

| | |
|---|---|
| Electrical Delay (one direction) | 1.276 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 arm，because they might bend or the soldered connections near the feed point may be damaged.

Test Laboratory: Shenzhen Morlab Communications Technology Co., Ltd. Date: 2022.07.08

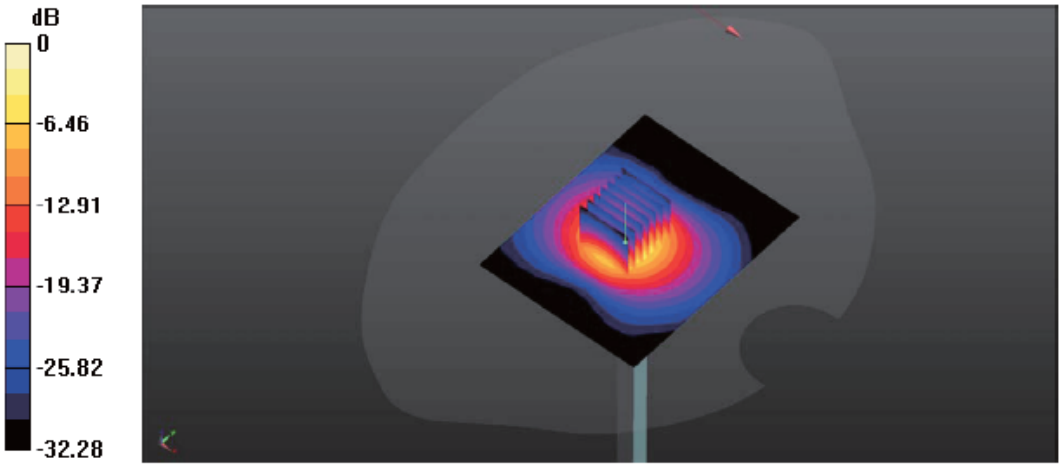
## System Check_3700MHz_Head

Communication System: UID 0, CW (0); Frequency: 3700 MHz;Duty Cycle: 1:1
Medium: HSL_3700 Medium parameters used: f = 3700 MHz; $\sigma$ = 2.999 S/m; $\varepsilon_r$ = 37.552; $\rho$ = 1000 kg/m$^3$
Ambient Temperature : 23.2 ℃; Liquid Temperature : 22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7608; ConvF(6.31, 6.31, 6.31) @ 3700 MHz; Calibrated: 2022.01.12
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1643; Calibrated: 2021.12.30
- Phantom: Twin-SAM; Type: QD 000 P41 Ax; Serial: 2020
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

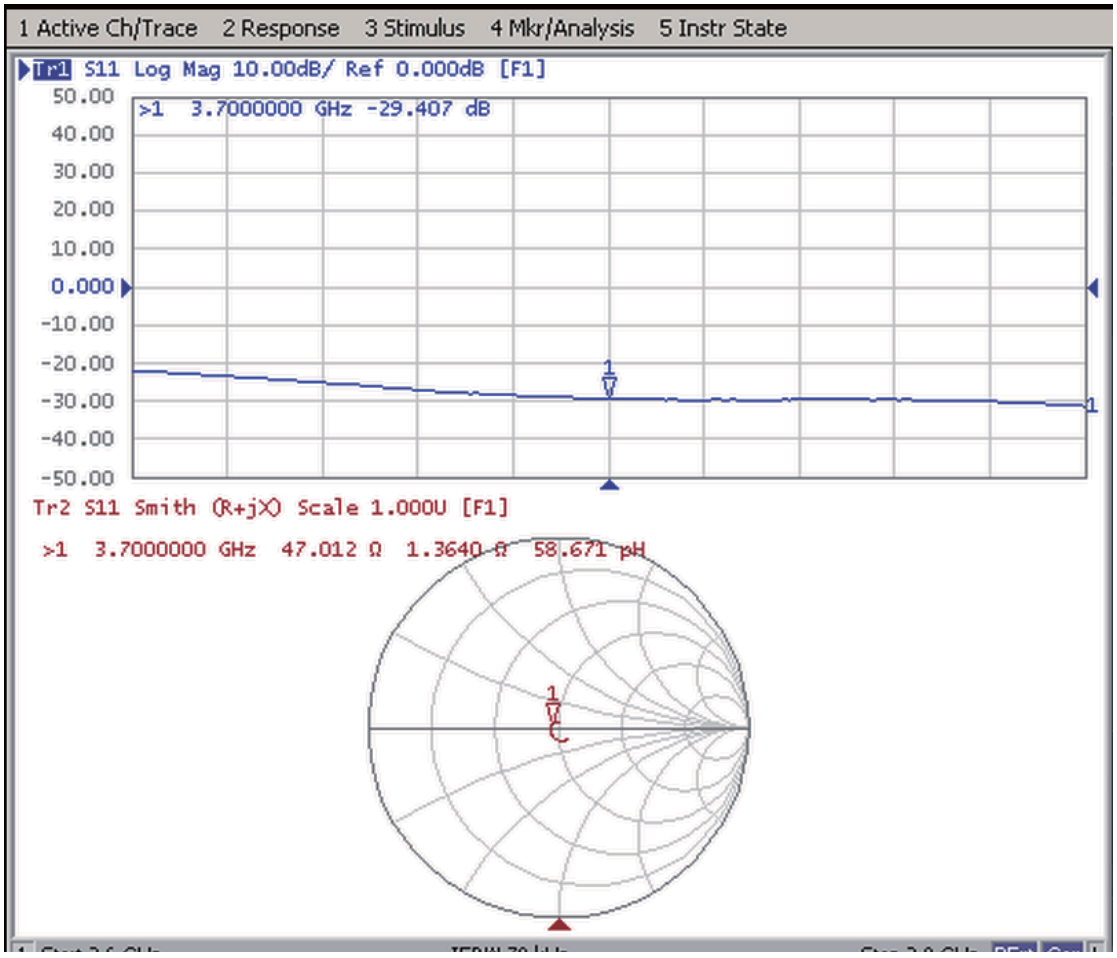
**CW3700/Area Scan (81x101x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 14.6 W/kg

**CW3700/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 54.74 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 20.0 W/kg
**SAR(1 g) = 7.01 W/kg; SAR(10 g) = 2.55 W/kg**
Maximum value of SAR (measured) = 13.2 W/kg




0 dB = 13.2 W/kg

## Appendix Impedance Measurement Plot for Head TSL



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

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

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

**Accreditation No.: SCS 0108**

**Client** **Morlab (Auden)**

**Certificate No: D3900V2-1046_Jun20**

# CALIBRATION CERTIFICATE

Object: D3900V2 - SN:1046

Calibration procedure(s): QA CAL-22.v4
Calibration Procedure for SAR Validation Sources between 3-6 GHz

Calibration date: June 02, 2020

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 01-Apr-20 (No. 217-03100/03101) | Apr-21 |
| Power sensor NRP-Z91 | SN: 103244 | 01-Apr-20 (No. 217-03100) | Apr-21 |
| Power sensor NRP-Z91 | SN: 103245 | 01-Apr-20 (No. 217-03101) | Apr-21 |
| Reference 20 dB Attenuator | SN: BH9394 (20k) | 31-Mar-20 (No. 217-03106) | Apr-21 |
| Type-N mismatch combination | SN: 310982 / 06327 | 31-Mar-20 (No. 217-03104) | Apr-21 |
| Reference Probe EX3DV4 | SN: 3503 | 31-Dec-19 (No. EX3-3503_Dec19) | Dec-20 |
| DAE4 | SN: 601 | 27-Dec-19 (No. DAE4-601_Dec19) | Dec-20 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-19) | In house check: Oct-20 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: June 2, 2020

**Glossary:**

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

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

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

**Additional Documentation:**

e) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.10.4 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom V5.0 | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy = 4.0 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| **Frequency** | 3900 MHz ± 1 MHz<br>4100 MHz ± 1 MHz | |

## Head TSL parameters at 3900 MHz

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 37.5 | 3.32 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 37.2 ± 6 % | 3.22 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 3900 MHz

| **SAR averaged over 1 cm$^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 6.96 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **69.9 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 cm$^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.42 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.1 W/kg ± 19.5 % (k=2)** |

## Head TSL parameters at 4100 MHz

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 37.2 | 3.53 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 37.0 ± 6 % | 3.39 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL at 4100 MHz

| **SAR averaged over 1 cm$^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 6.90 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **69.3 W/kg ± 19.9 % (k=2)** |

| **SAR averaged over 10 cm$^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 100 mW input power | 2.38 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **23.8 W/kg ± 19.5 % (k=2)** |

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

### Antenna Parameters with Head TSL at 3900 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 48.0 Ω - 5.4 jΩ |
| Return Loss | - 24.6 dB |

### Antenna Parameters with Head TSL at 4100 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 58.0 Ω - 0.3 jΩ |
| Return Loss | - 22.6 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.099 ns |

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

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

### Additional EUT Data

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

## DASY5 Validation Report for Head TSL

Date: 02.06.2020

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN: 1046**

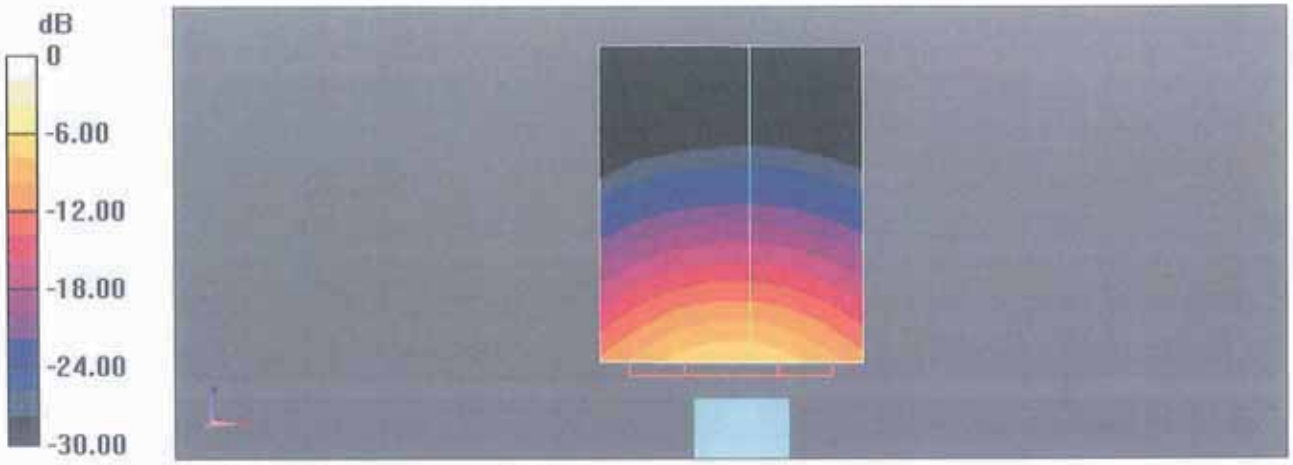
Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz
Medium parameters used: f = 3900 MHz; $\sigma$ = 3.22 S/m; $\varepsilon_r$ = 37.2; $\rho$ = 1000 kg/m$^3$ ,
Medium parameters used: f = 4100 MHz; $\sigma$ = 3.39 S/m; $\varepsilon_r$ = 37; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.39, 7.39, 7.39) @ 3900 MHz, ConvF(7.26, 7.26, 7.26) @ 4100 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

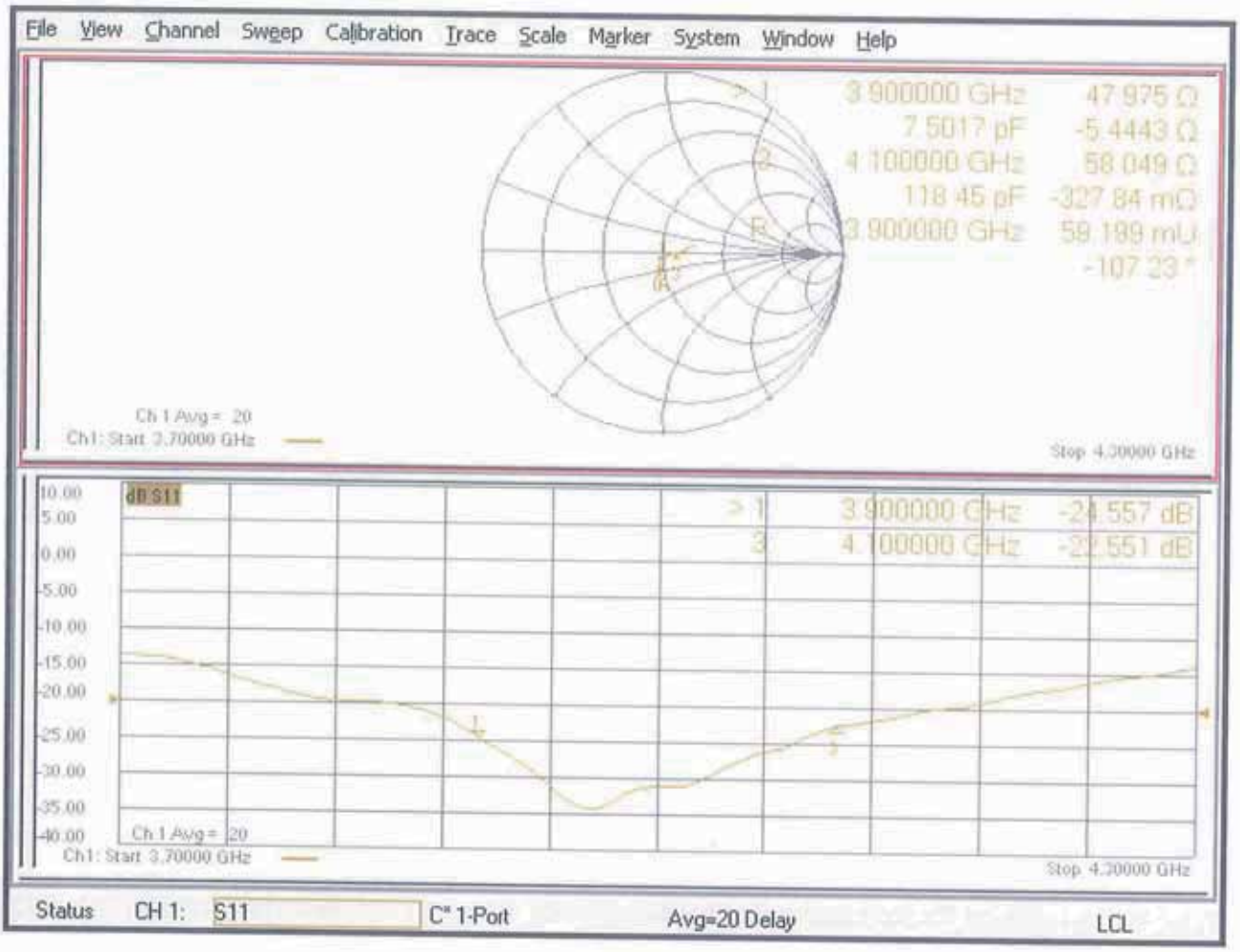
**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3900MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 74.03 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 20.2 W/kg
**SAR(1 g) = 6.96 W/kg; SAR(10 g) = 2.42 W/kg**
Smallest distance from peaks to all points 3 dB below = 8 mm
Ratio of SAR at M2 to SAR at M1 = 73.1%
Maximum value of SAR (measured) = 13.9 W/kg

**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=4100MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 71.80 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 20.3 W/kg
**SAR(1 g) = 6.9 W/kg; SAR(10 g) = 2.38 W/kg**
Smallest distance from peaks to all points 3 dB below = 8 mm
Ratio of SAR at M2 to SAR at M1 = 72.7%
Maximum value of SAR (measured) = 14.0 W/kg




0 dB = 14.0 W/kg = 11.46 dBW/kg

## Impedance Measurement Plot for Head TSL



# Appendix Annual validation for Test Lab.

**General calibration information**

| | |
|---|---|
| Date | 2022.07.08 |
| Test Laboratory | ShenZhen Morlab Communications Technology Co., Ltd. |
| Antenna serial No. | D3900V2-SN:1046 |

**Antenna Parameters with Head TSL**

| | |
|---|---|
| Impedance, transformed to feed point | 49.66Ω-1.29jΩ |
| Return Loss | -37.43dB |

**General Antenna Parameters and Design**

| | |
|---|---|
| Electrical Delay (one direction) | 1.276 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 arm，because they might bend or the soldered connections near the feed point may be damaged.

Test Laboratory: Shenzhen Morlab Communications Technology Co., Ltd. Date: 2022.07.08

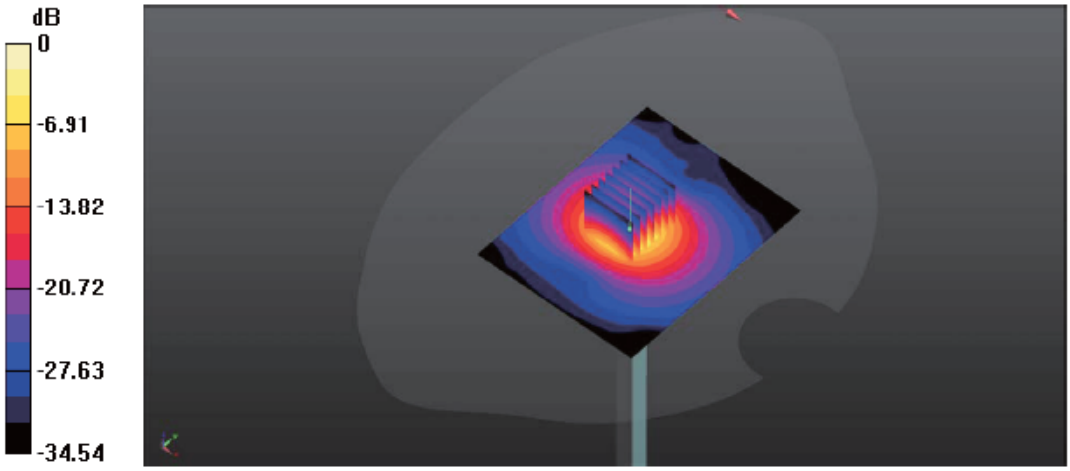
## System Check_3900MHz_Head

Communication System: UID 0, CW (0); Frequency: 3900 MHz;Duty Cycle: 1:1
Medium: HSL_3900 Medium parameters used: f = 3900 MHz; $\sigma$ = 3.233 S/m; $\varepsilon_r$ = 39.264; $\rho$ = 1000 kg/m$^3$
Ambient Temperature : 23.2 °C; Liquid Temperature : 22.1 °C

DASY5 Configuration:
- Probe: EX3DV4 - SN7608; ConvF(6.22, 6.22, 6.22) @ 3900 MHz; Calibrated: 2022.01.12
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1643; Calibrated: 2021.12.30
- Phantom: Twin-SAM; Type: QD 000 P41 Ax; Serial: 2020
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

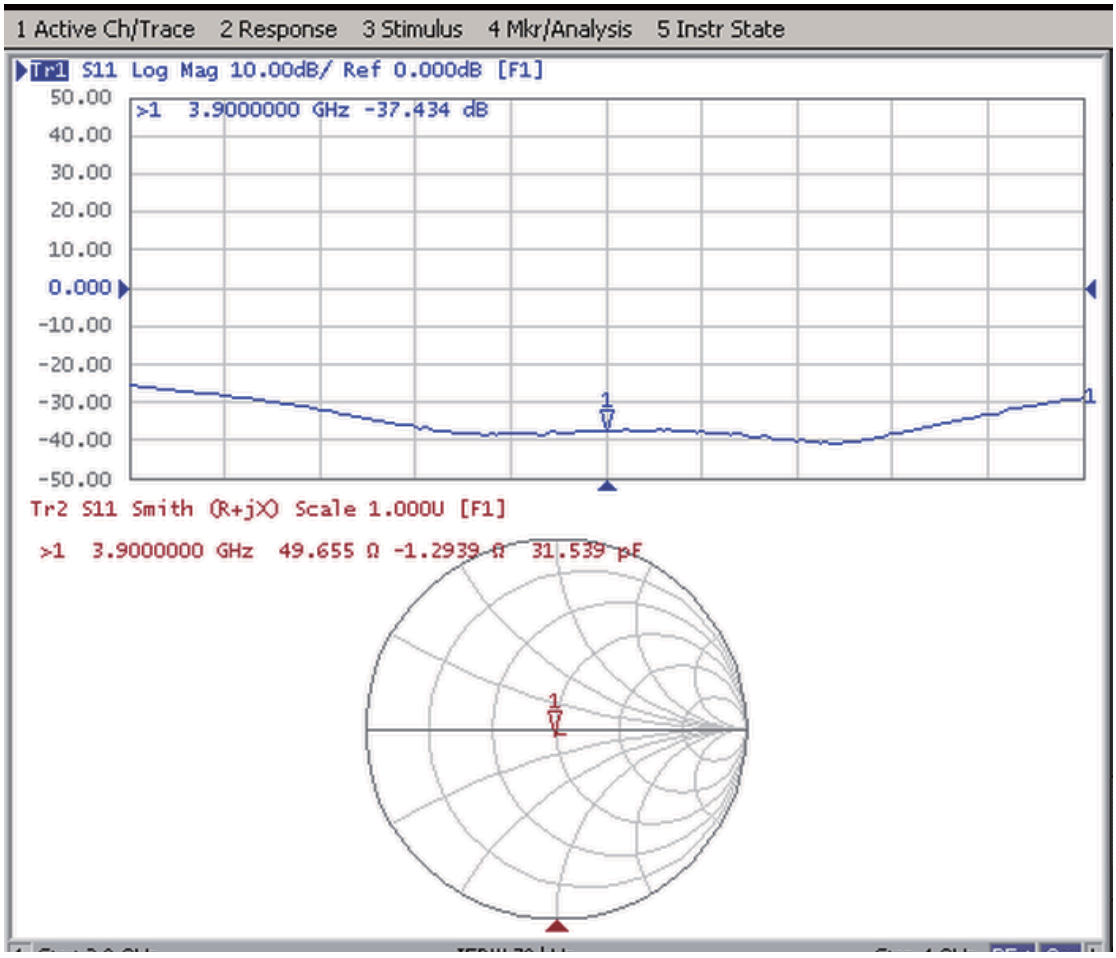
**CW3900/Area Scan (81x101x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 14.5 W/kg

**CW3900/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 54.58 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 21.0 W/kg
**SAR(1 g) = 7.45 W/kg; SAR(10 g) = 2.61 W/kg**
Maximum value of SAR (measured) = 13.7 W/kg




0 dB = 13.7 W/kg

## Appendix Impedance Measurement Plot for Head TSL



In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, Chi
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Client **Morlab** **Certificate No: Z21-60478**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D5GHzV2 - SN: 1176 |
| Calibration Procedure(s) | FF-Z11-003-01<br>Calibration Procedures for dipole validation kits |
| Calibration date: | December 19, 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)℃ 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 |
| 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 27, 2021

In Collaboration with
s p e a g
CALIBRATION LABORATORY
Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

**Glossary:**

| | |
|---|---|
| TSL | tissue simulating liquid |
| ConvF | sensitivity in TSL / NORMx,y,z |
| N/A | not applicable or not measured |

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

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for 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
c) 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
d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

e) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

## 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 ± 1 MHz<br>5600 MHz ± 1 MHz<br>5750 MHz ± 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 ± 0.2) °C | 34.9 ± 6 % | 4.72 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | --- | --- |

## SAR result with Head TSL at 5250 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.71 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **76.7 W/kg ± 24.4 % (*k*=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 2.23 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **22.1 W/kg ± 24.2 % (*k*=2)** |

In Collaboration with
s p e a g
CALIBRATION LABORATORY
Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

## Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.5 | 5.07 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.5 ± 6 % | 5.10 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL at 5600 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.12 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **80.8 W/kg ± 24.4 % (*k*=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 2.35 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **23.3 W/kg ± 24.2 % (*k*=2)** |

## Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.4 | 5.22 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.4 ± 6 % | 5.27 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL at 5750 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.91 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **78.7 W/kg ± 24.4 % (*k*=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 2.27 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **22.5 W/kg ± 24.2 % (*k*=2)** |

In Colleboration with
s p e a g
CALIBRATION LABORATORY
Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

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

### Antenna Parameters with Head TSL at 5250 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 49.3Ω - 7.38jΩ |
| Return Loss | - 22.6dB |

### Antenna Parameters with Head TSL at 5600 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 53.7Ω - 0.82jΩ |
| Return Loss | - 28.8dB |

### Antenna Parameters with Head TSL at 5750 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 52.2Ω - 3.36jΩ |
| Return Loss | - 28.2dB |

### 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 |

In Collaboration with
s p e a g
CALIBRATION LABORATORY
Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

**DASY5 Validation Report for Head TSL**
Test Laboratory: CTTL, Beijing, China Date: 2021-11-19
**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1176**
Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz,
Medium parameters used: f = 5250 MHz; $\sigma$ = 4.722 S/m; $\varepsilon_r$ = 34.9; $\rho$ = 1000 kg/m$^3$, Medium parameters used: f = 5600 MHz; $\sigma$ = 5.103 S/m; $\varepsilon_r$ = 34.47; $\rho$ = 1000 kg/m$^3$, Medium parameters used: f = 5750 MHz; $\sigma$ = 5.268 S/m; $\varepsilon_r$ = 34.35; $\rho$ = 1000 kg/m$^3$,
Phantom section: Right Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration:

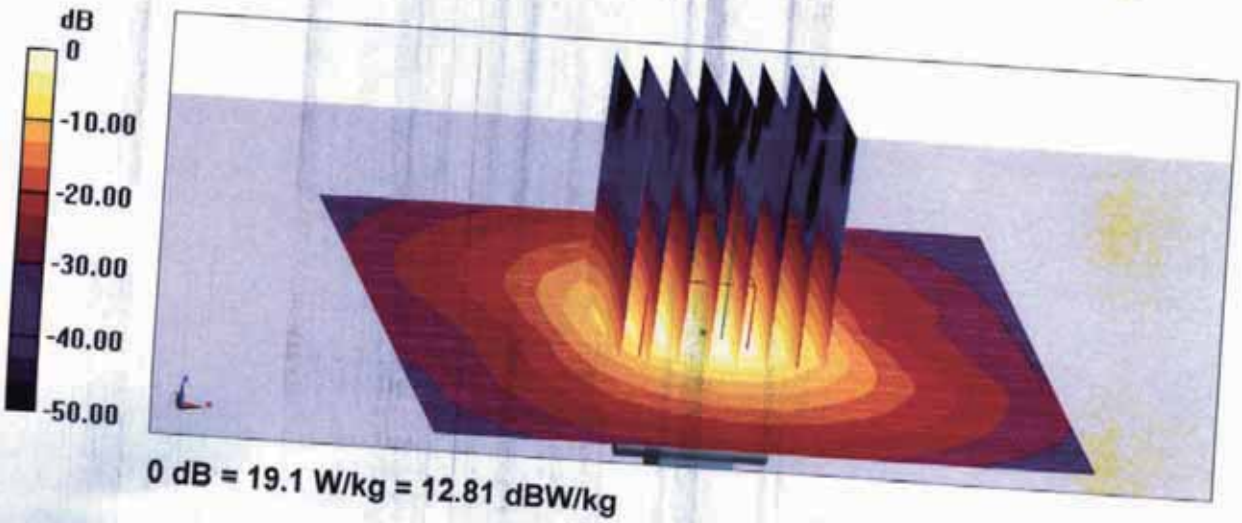
- Probe: EX3DV4 - SN7307; ConvF(5.69, 5.69, 5.69) @ 5250 MHz; ConvF(5.1, 5.1, 5.1) @ 5600 MHz; ConvF(5.05, 5.05, 5.05) @ 5750 MHz; Calibrated: 2021-05-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration /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 = 70.50 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 30.5 W/kg
**SAR(1 g) = 7.71 W/kg; SAR(10 g) = 2.23 W/kg**
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 65.4%
Maximum value of SAR (measured) = 17.6 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 = 70.77 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 34.6 W/kg
**SAR(1 g) = 8.12 W/kg; SAR(10 g) = 2.35 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%
Maximum value of SAR (measured) = 19.1 W/kg

In Collaboration with
s p e a g
CALIBRATION LABORATORY
Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

**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 = 69.00 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 35.4 W/kg
**SAR(1 g) = 7.91 W/kg; SAR(10 g) = 2.27 W/kg**
Smallest distance from peaks to all points 3 dB below = 7.5 mm
Ratio of SAR at M2 to SAR at M1 = 61.8%
Maximum value of SAR (measured) = 19.1 W/kg

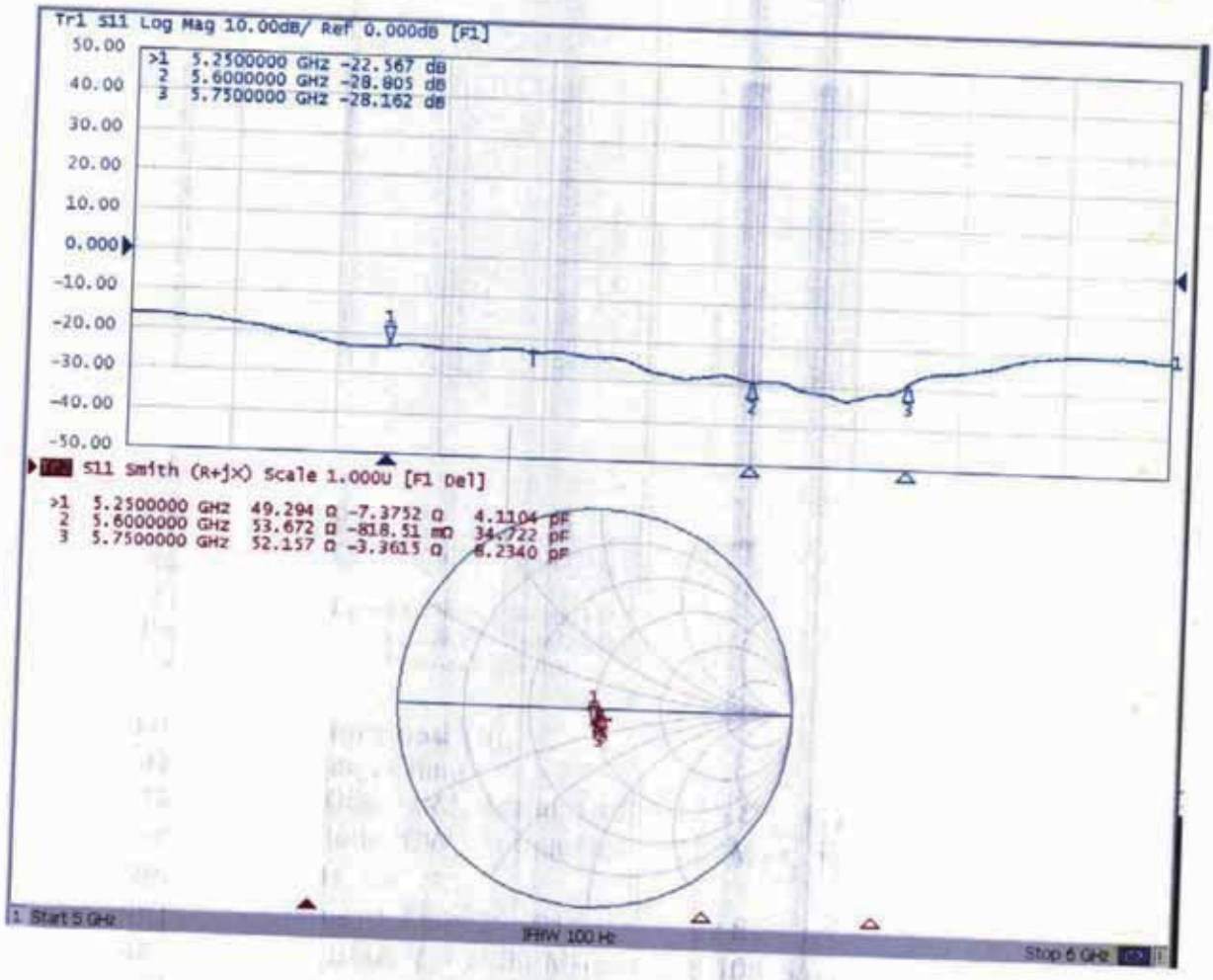



**0 dB = 19.1 W/kg = 12.81 dBW/kg**

In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

## Impedance Measurement Plot for Head TSL



# Appendix Annual validation for Test Lab.

**General calibration information**

| | |
|---|---|
| Date | 2022.12.15 |
| Test Laboratory | ShenZhen Morlab Communications Technology Co., Ltd. |
| Antenna serial No. | D5250V2-SN: 1176 |

**Antenna Parameters with Head TSL**

| | |
|---|---|
| Impedance, transformed to feed point | 51.068Ω +1.05jΩ |
| Return Loss | -32.818dB |

**General Antenna Parameters and Design**

| | |
|---|---|
| Electrical Delay (one direction) | 1.276 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 arm，because they might bend or the soldered connections near the feed point may be damaged.

Test Laboratory: Shenzhen Morlab Communications Technology Co., Ltd. Date: 2022.12.15

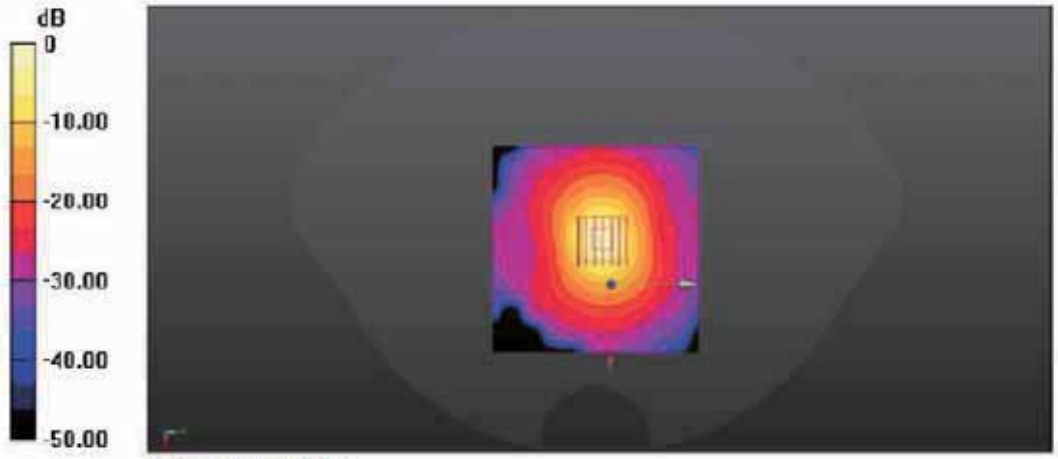
**System Check_5250MHz_Head**

Communication System: UID 0, CW (0); Frequency: 5250 MHz;Duty Cycle: 1:1
Medium: HSL_5250 Medium parameters used: f = 5250 MHz; $\sigma$ = 4.714 S/m; $\varepsilon_r$ = 36.322; $\rho$ = 1000 kg/m$^3$
Ambient Temperature : 23.2 ℃; Liquid Temperature : 22.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7608; ConvF(5.16, 5.16, 5.16) @ 5250 MHz; Calibrated: 2022.01.12
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1643; Calibrated: 2021.12.30
- Phantom: Twin-SAM; Type: QD 000 P41 Ax; Serial: 2020
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

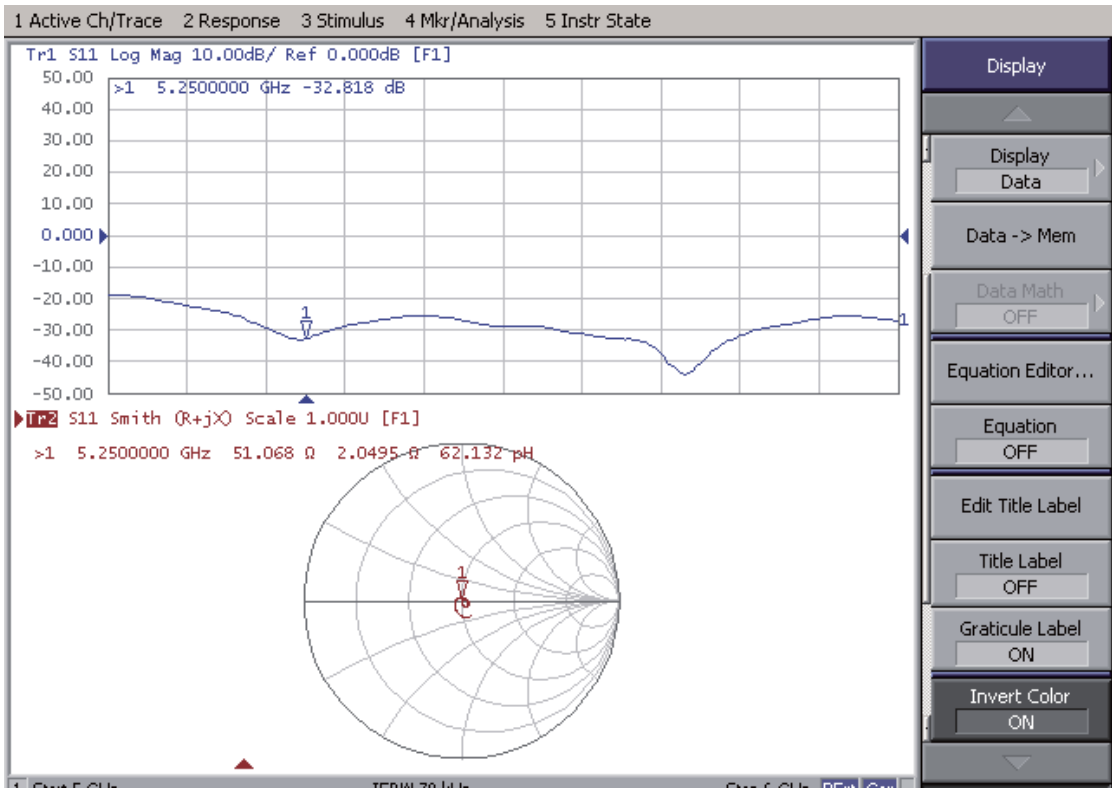
**CW5250/Area Scan (101x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 13.52 W/kg

**CW5250/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 55.31 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 21.2 W/kg
**SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.25 W/kg**
Maximum value of SAR (measured) = 13.06 W/kg




0 dB = 13.06 W/kg

## Appendix Impedance Measurement Plot for Head TSL



# Appendix Annual validation for Test Lab.

**General calibration information**

| | |
|---|---|
| Date | 2022.12.15 |
| Test Laboratory | ShenZhen Morlab Communications Technology Co., Ltd. |
| Antenna serial No. | D5600V2-SN: 1176 |

**Antenna Parameters with Head TSL**

| | |
|---|---|
| Impedance, transformed to feed point | 50.89Ω -2.58jΩ |
| Return Loss | -31.355dB |

**General Antenna Parameters and Design**

| | |
|---|---|
| Electrical Delay (one direction) | 1.276 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 arm，because they might bend or the soldered connections near the feed point may be damaged.

Test Laboratory: Shenzhen Morlab Communications Technology Co., Ltd. Date: 2022.12.15

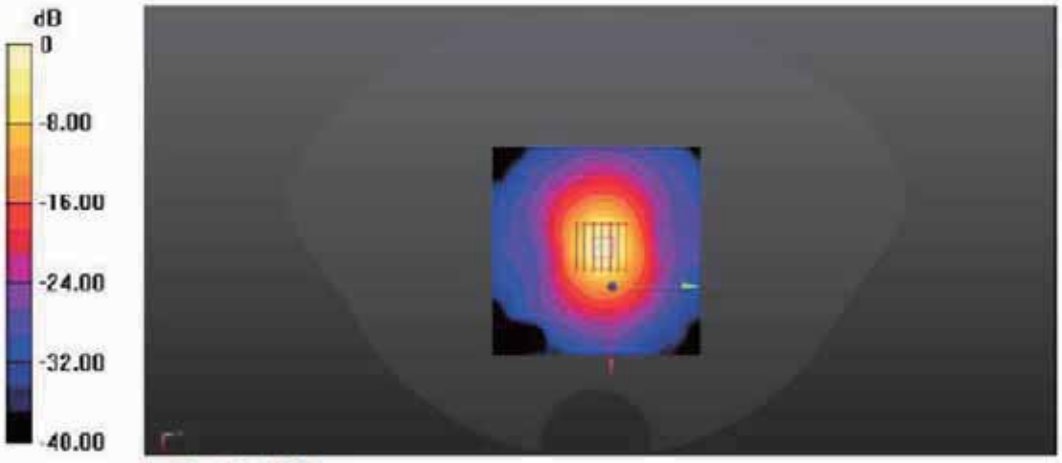
## System Check_5600MHz_Head

Communication System: UID 0, CW (0); Frequency: 5600 MHz;Duty Cycle: 1:1
Medium: HSL_5600 Medium parameters used: f = 5600 MHz; $\sigma$ = 5.11 S/m; $\varepsilon_r$ = 35.521; $\rho$ = 1000 kg/m$^3$
Ambient Temperature : 23.2 ℃; Liquid Temperature : 22.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN7608; ConvF(4.74, 4.74, 4.74) @ 5600 MHz; Calibrated: 2022.01.12
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1643; Calibrated: 2021.12.30
- Phantom: Twin-SAM; Type: QD 000 P41 Ax; Serial: 2020
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

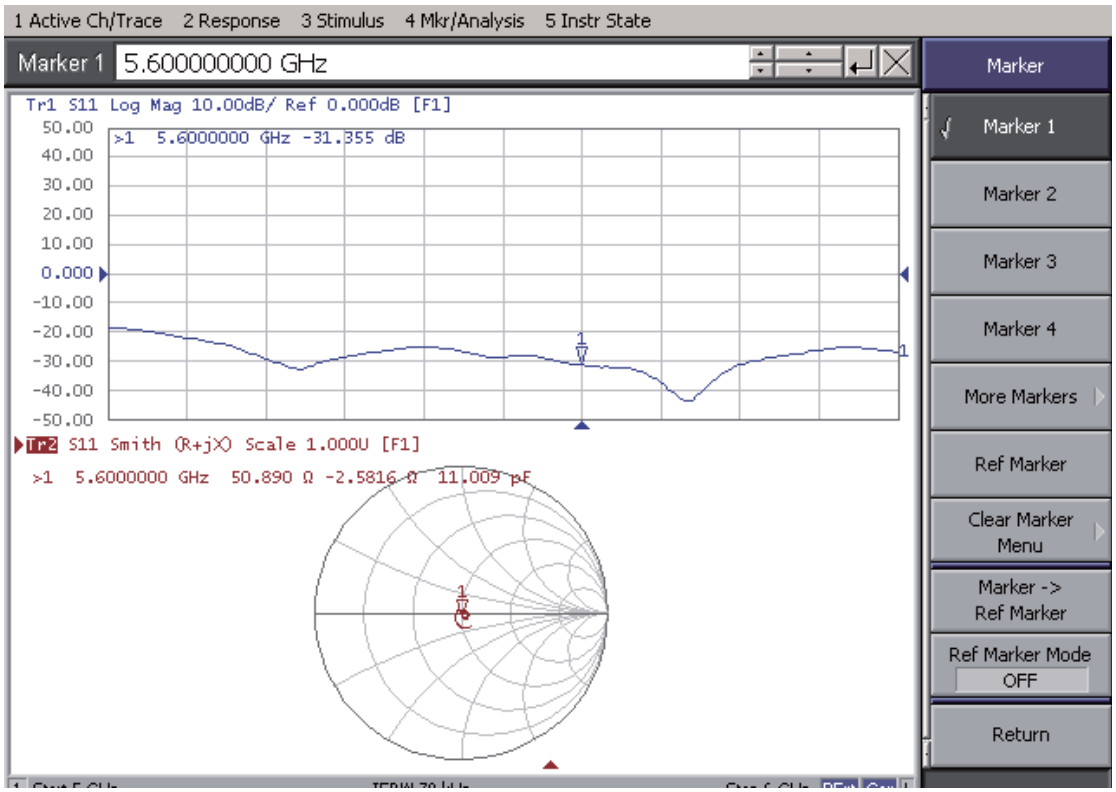
**CW5600/Area Scan (101x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 19.24 W/kg

**CW5600/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 49.70 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 21.0 W/kg
**SAR(1 g) = 8.05 W/kg; SAR(10 g) = 2.37 W/kg**
Maximum value of SAR (measured) = 19.1 W/kg




0 dB = 19.1 W/kg

## Appendix Impedance Measurement Plot for Head TSL



# Appendix Annual validation for Test Lab.

**General calibration information**

| | |
|---|---|
| Date | 2022.12.15 |
| Test Laboratory | ShenZhen Morlab Communications Technology Co., Ltd. |
| Antenna serial No. | D5750V2-SN: 1176 |

**Antenna Parameters with Head TSL**

| | |
|---|---|
| Impedance, transformed to feed point | 50.962Ω +1.96jΩ |
| Return Loss | -40.247dB |

**General Antenna Parameters and Design**

| | |
|---|---|
| Electrical Delay (one direction) | 1.276 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 arm，because they might bend or the soldered connections near the feed point may be damaged.

Test Laboratory: Shenzhen Morlab Communications Technology Co., Ltd. Date: 2022.12.15

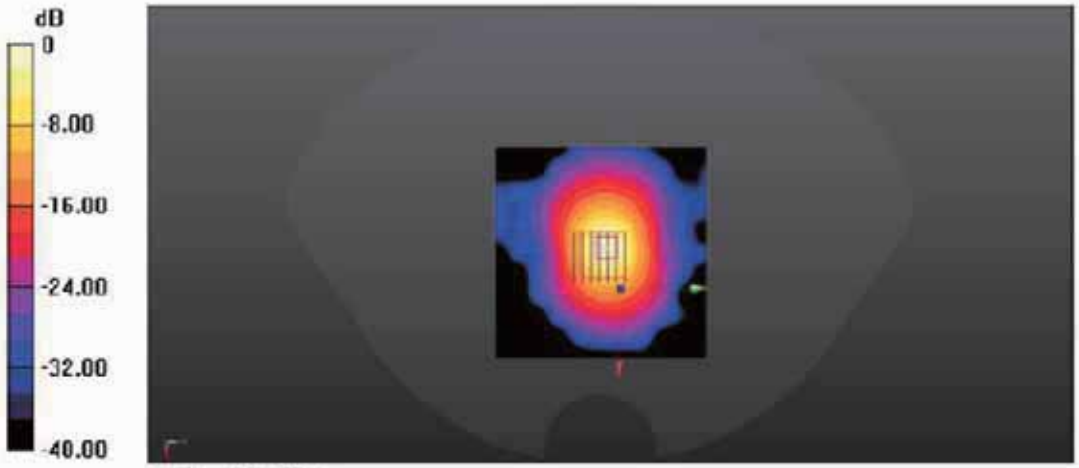
## System Check_5750MHz_Head

Communication System: UID 0, CW (0); Frequency: 5750 MHz;Duty Cycle: 1:1
Medium: HSL_5750 Medium parameters used: f = 5750 MHz; $\sigma$ = 5.355 S/m; $\varepsilon_r$ = 35.127; $\rho$ = 1000 kg/m$^3$
Ambient Temperature : 23.2 ℃; Liquid Temperature : 22.4 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(4.45, 4.45, 4.45) @ 5750 MHz; Calibrated: 2022.03.04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1643; Calibrated: 2021.12.30
- Phantom: Twin-SAM; Type: QD 000 P41 Ax; Serial: 2020
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**CW5750/Area Scan (101x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 21.6 W/kg

**CW5750/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 56.28 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 36.5 W/kg
**SAR(1 g) = 7.98 W/kg; SAR(10 g) = 2.35 W/kg**
Maximum value of SAR (measured) = 21.1 W/kg




0 dB = 21.1 W/kg

## Appendix Impedance Measurement Plot for Head TSL