

CERTIFICATE OF CALIBRATION

ISSUED BY UL INTERNATIONAL (UK) LTD

DATE OF ISSUE: 09/Mar/2022

CERTIFICATE NUMBER : 12345678JD01B



5772

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APPROVED SIGNATORY

Harmohan Sahota

Customer :

UL VS Inc
47173 Benicia Street
Fremont, CA 94538, USA

Equipment Details:

| | | | |
|--------------------|--------------------------------------|------------------|-------------|
| Description: | Dipole Validation Kit | Date of Receipt: | 07/Mar/2022 |
| Manufacturer: | Speag | | |
| Type/Model Number: | D1640V2 | | |
| Serial Number: | 324 | | |
| Calibration Date: | 08/Mar/2022 | | |
| Calibrated By: | Gizem Kodal Laboratory Technician | | |
| Signature: | | | |

All Calibration have been conducted in the closed laboratory facility: Lab Temperature (22±3) °C and humidity < 70%

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025:2017 has been independently assessed.

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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The calibration methods and procedures used were as detailed in:

1. **IEC 62209-1:2016**: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)
2. **IEC 62209-2:2010**: 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)
3. **IEEE 1528-2013**: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques
4. **IEC/IEEE 62209-1528:2020**: 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)
5. FCC KDB Publication Number: “**KDB865664 D01 SAR Measurement 100 MHz to 6 GHz**”
6. **DASY 6 System Handbook**
7. **Dipole Calibration Procedure V1.2**: Calibration performed as per internal procedure

The measuring equipment used to perform the calibration, documented in this certificate has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

| UL No. | Instrument | Manufacturer | Type No. | Serial No. | Date Last Calibrated | Cal. Interval (Months) |
|------------|------------------------------|-----------------|---------------|------------|-----------------------|------------------------|
| PRE0135115 | Data Acquisition Electronics | SPEAG | DAE4 | 1438 | 12 Apr 2021 | 12 |
| PRE0135113 | Probe | SPEAG | ES3DV3 | 3995 | 23 Jul 2021 | 12 |
| PRE0176086 | Dipole | SPEAG | D1640V2 | 501 | 11 Feb 2022 | 12 |
| PRE0151451 | Power Monitoring Kit | Art-Fi | ART 100850-01 | 0001 | Cal as part of System | - |
| PRE0151441 | Power Sensor | Rhode & Schwarz | NRP8S | 102481 | 22 Mar 2021 | 12 |
| PRE0151154 | Vector Network Analyser | Rohde & Schwarz | ZND | 100151 | 23 Mar 2021 | 12 |
| 212645 | Calibration Kit | Rohde & Schwarz | ZN-Z135 | 101005 | 22 Oct 2021 | 12 |
| M1838 | Signal Generator | Rohde & Schwarz | SME 06 | 831377/005 | 29 Mar 2021 | 12 |

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SAR System Specification

| | |
|--------------------------|--|
| Robot System Positioner: | Stäubli Unimation Corp. Robot Model: TX60L |
| Robot Serial Number: | F17/5ENYG1/A/01 |
| DASY Version: | cDASY6.14.0.959 |
| Phantom: | Flat section of SAM Twin Phantom |
| Distance Dipole Centre: | 10 mm (with spacer) |
| Frequency: | 1640 MHz |

Dielectric Property Measurements – Head Simulating Liquid (HSL)

| Simulant Liquid | Frequency (MHz) | Room Temp | | Liquid Temp | | Parameters | Target Value | Measured Value | Uncertainty (%) |
|-----------------|-----------------|-----------|---------|-------------|---------|--------------|--------------|----------------|-----------------|
| | | Start | End | Start | End | | | | |
| Head | 1640 | 20.8 °C | 21.0 °C | 21.0 °C | 21.2 °C | ϵ_r | 40.2 | 40.5 | ± 5% |
| | | | | | | σ | 1.31 | 1.29 | ± 5% |

SAR Results – Head Simulating Liquid (HSL)

| Simulant Liquid | SAR Measured | 250 mW input Power | Normalised to 1.00 W | Uncertainty (%) |
|-----------------|-----------------------|--------------------|----------------------|-----------------|
| Head | SAR averaged over 1g | 8.560 W/Kg | 34.08 W/Kg | +18.70 / -18.48 |
| | SAR averaged over 10g | 4.690 W/Kg | 18.67 W/Kg | +18.62 / -18.43 |

Antenna Parameters – Head Simulating Liquid (HSL)

| Simulant Liquid | Parameter | Measured Level | Uncertainty |
|-----------------|-------------|------------------------|-------------|
| Head | Impedance | 50.62 + 1.41j Ω | ± 10.83 % |
| | Return Loss | 36.29 | ± 1.37 dB |

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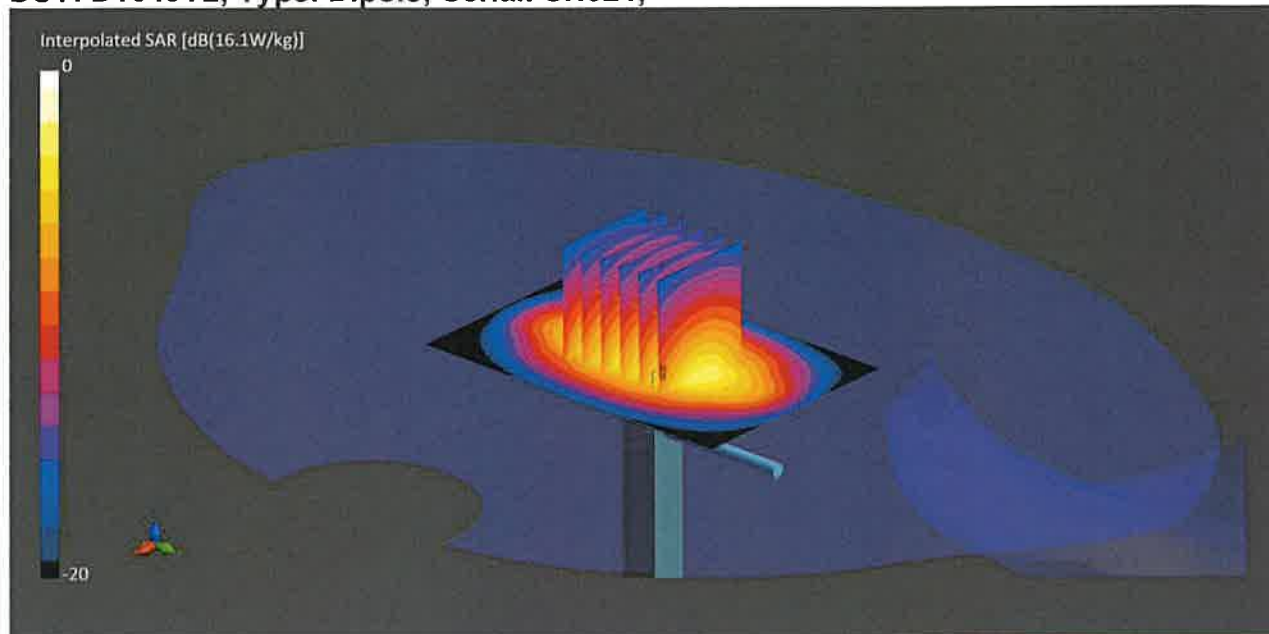
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DASY Validation Scan for Head Stimulating Liquid (HSL)

Date: 08 Mar 2022

DUT: D1640V2; Type: Dipole; Serial: SN324;



Communication System: CW UID: 0; Frequency: 1640.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_08Mar2022_080208_Head - 750 900 1450 1640 1800 1900 5%;
Medium parameters used: $f = 1640.0$ MHz; $\sigma = 1.28$ S/m; $\epsilon_r = 40.5$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = 0.63$ %; $\Delta\sigma = -1.97$ %; No correction

Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN3995; ConvF(8.71, 8.71, 8.71); Calibrated: 23 Jul 2021
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 12 Apr 2021
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1945
- Measurement SW: cDASY6.14.0.959

Area Scan (60x90): Interpolated grid: dx=15 mm, dy=15 mm

Zoom Scan1(30x30x30): Measurement grid: dx=6 mm, dy=6 mm, dz=1.5 mm; Grading Ratio: 1.5; Reference Value = 10.650 V/m; Power Drift = 0.02 dB

Minimum horizontal 3dB distance: 10.8 mm;

Vertical M2/M1 Ratio: 81.8 %;

SAR(1 g) = 8.560 W/kg; SAR(10 g) = 4.690 W/kg

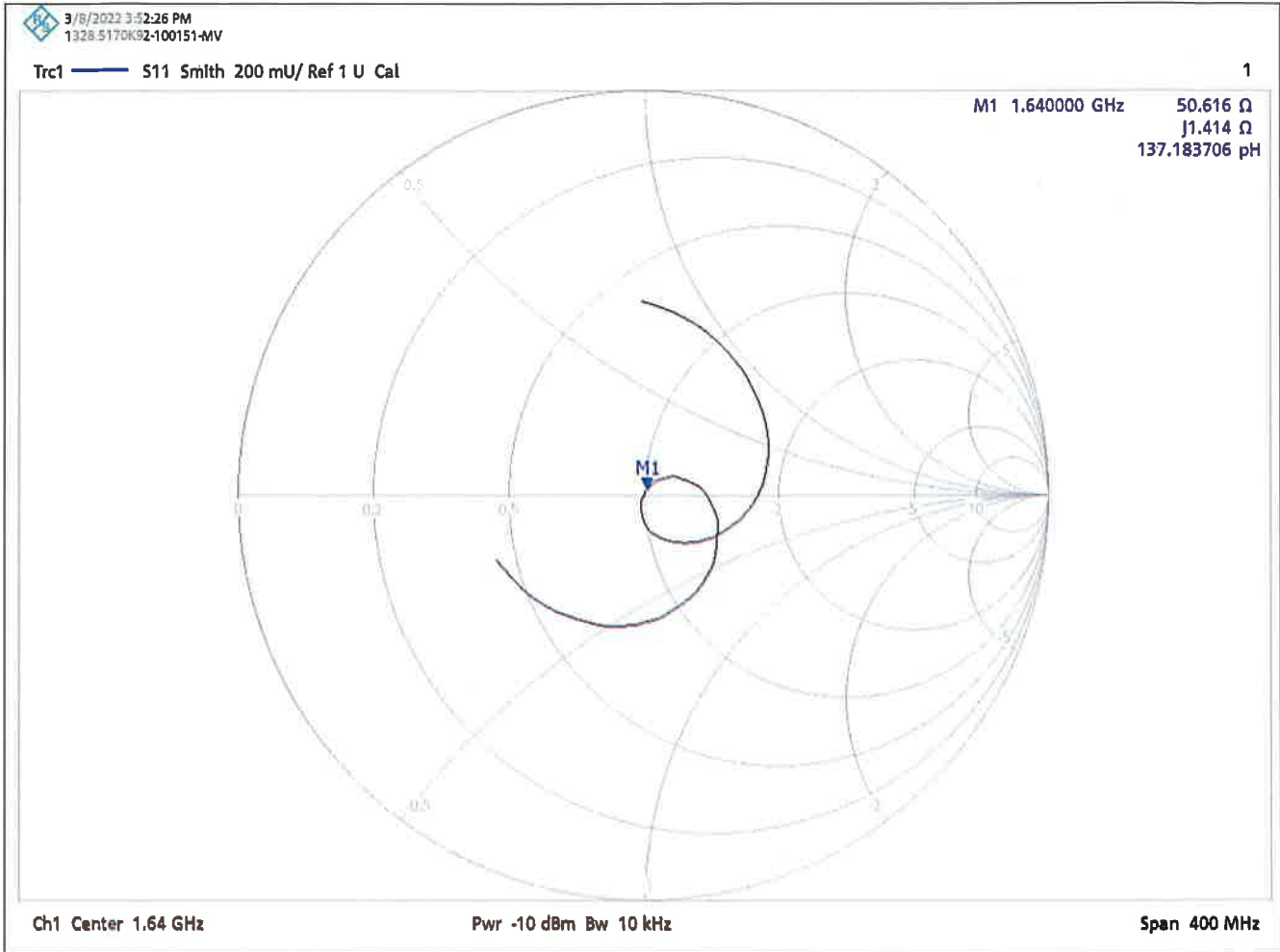
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Impedance Measurement Plot for Head Stimulating Liquid (HSL)



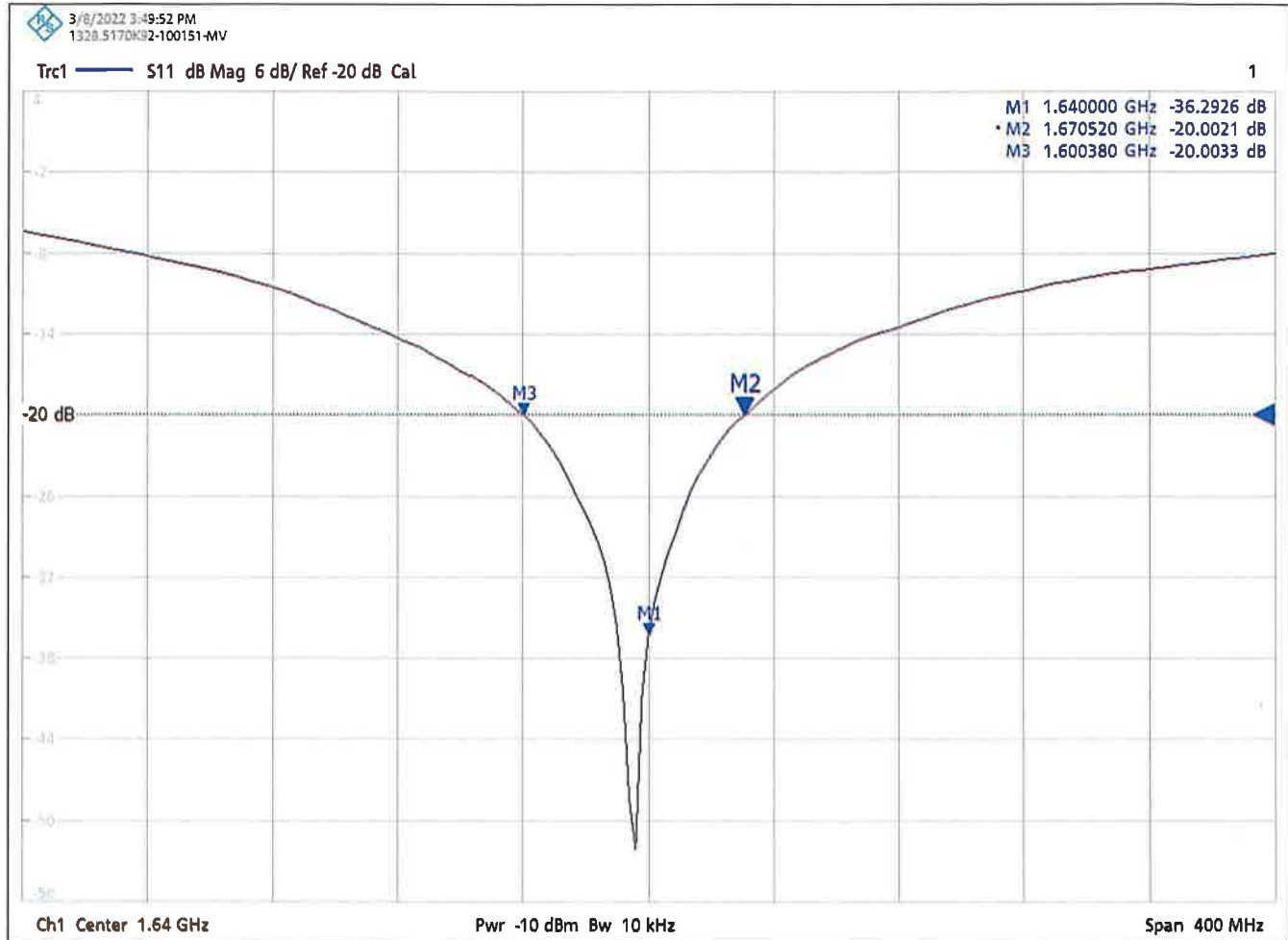
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NUMBER :
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)



Calibration Certificate Label:

| | |
|---|---|
|  | <p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 12345678JD01B</p> <p>Instrument ID: 324</p> <p>Calibration Date: 09/Mar/2022</p> <p>Calibration Due Date:</p> |
|---|---|

| | |
|---|---|
|  | <p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 12345678JD01B</p> <p>Instrument ID: 324</p> <p>Calibration Date: 09/Mar/2022</p> <p>Calibration Due Date:</p> |
|---|---|

| | |
|---|---|
|  | <p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312000</p> <p>Certificate Number: 12345678JD01B</p> <p>Instrument ID: 324</p> <p>Calibration Date: 09/Mar/2022</p> <p>Calibration Due Date:</p> |
|---|---|



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Multilateral Agreement for the recognition of calibration certificates**

Accreditation No.: **SCS 0108**

Client **UL USA**

Certificate No: **D2450V2-706_Jan22**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN:706**

Calibration procedure(s) **QA CAL-05.v11
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **January 13, 2022**

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 | 09-Apr-21 (No. 217-03291/03292) | Apr-22 |
| Power sensor NRP-Z91 | SN: 103244 | 09-Apr-21 (No. 217-03291) | Apr-22 |
| Power sensor NRP-Z91 | SN: 103245 | 09-Apr-21 (No. 217-03292) | Apr-22 |
| Reference 20 dB Attenuator | SN: BH9394 (20k) | 09-Apr-21 (No. 217-03343) | Apr-22 |
| Type-N mismatch combination | SN: 310982 / 06327 | 09-Apr-21 (No. 217-03344) | Apr-22 |
| Reference Probe EX3DV4 | SN: 7349 | 31-Dec-21 (No. EX3-7349_Dec21) | Dec-22 |
| DAE4 | SN: 601 | 01-Nov-21 (No. DAE4-601_Nov21) | Nov-22 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---------------------------------|----------------|-----------------------------------|------------------------|
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Oct-20) | In house check: Oct-22 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-20) | In house check: Oct-22 |
| Power sensor HP 8481A | SN: MY41093315 | 07-Oct-15 (in house check Oct-20) | In house check: Oct-22 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-20) | In house check: Oct-22 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-20) | In house check: Oct-22 |

| | | | |
|----------------|------------------------------|--|---------------|
| Calibrated by: | Name Michael Weber | Function Laboratory Technician | Signature |
| Approved by: | Name Sven Kühn | Deputy Manager | |

Issued: January 14, 2022

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Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:** This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

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

Measurement Conditions

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

| | | |
|-------------------------------------|------------------------|-------------|
| DASY Version | DASY52 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 2450 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|---------------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.2 | 1.80 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 38.2 \pm 6 % | 1.85 mho/m \pm 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 13.7 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 53.8 W/kg \pm 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 6.32 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 25.0 W/kg \pm 16.5 % (k=2) |

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.4 Ω + 3.9 j Ω |
| Return Loss | - 27.1 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.143 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: 13.01.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:706

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.85$ S/m; $\epsilon_r = 38.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 117.3 V/m; Power Drift = 0.07 dB

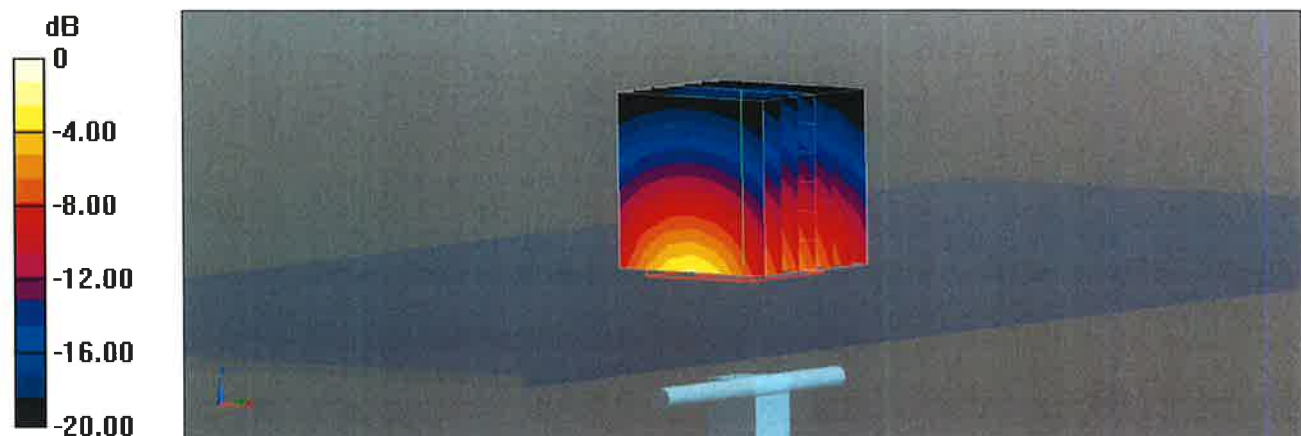
Peak SAR (extrapolated) = 27.3 W/kg

SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.32 W/kg

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

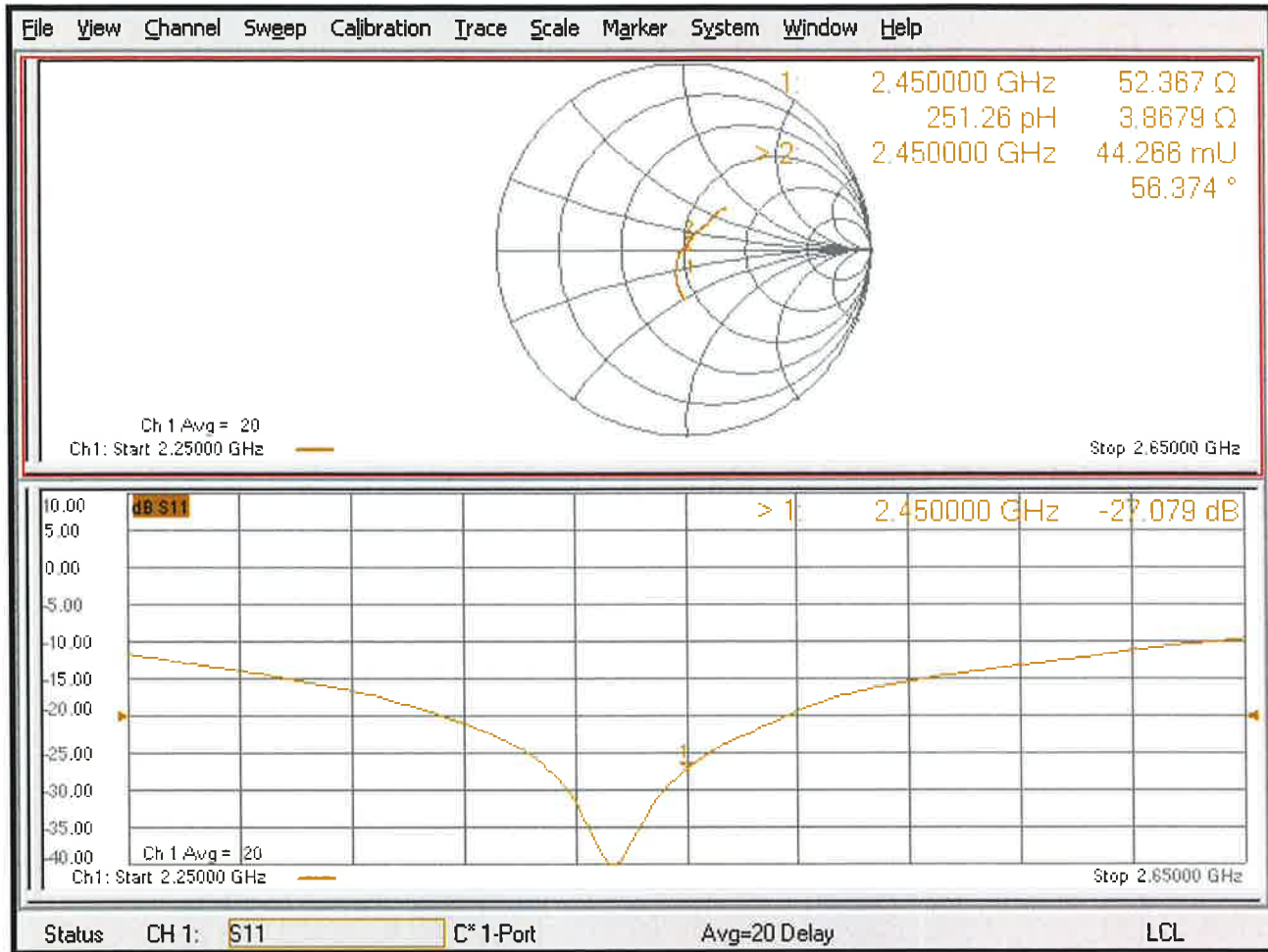
Ratio of SAR at M2 to SAR at M1 = 50.3%

Maximum value of SAR (measured) = 22.4 W/kg



0 dB = 22.4 W/kg = 13.50 dBW/kg

Impedance Measurement Plot for Head TSL





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Accreditation No.: **SCS 0108**

Client **UL USA**

Certificate No: **D3500V2-1060_Feb22**

CALIBRATION CERTIFICATE

Object **D3500V2 - SN:1060**

Calibration procedure(s) **QA CAL-22.v6
Calibration Procedure for SAR Validation Sources between 3-10 GHz**

Calibration date: **February 25, 2022**

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 | 09-Apr-21 (No. 217-03291/03292) | Apr-22 |
| Power sensor NRP-Z91 | SN: 103244 | 09-Apr-21 (No. 217-03291) | Apr-22 |
| Power sensor NRP-Z91 | SN: 103245 | 09-Apr-21 (No. 217-03292) | Apr-22 |
| Reference 20 dB Attenuator | SN: BH9394 (20k) | 09-Apr-21 (No. 217-03343) | Apr-22 |
| Type-N mismatch combination | SN: 310982 / 06327 | 09-Apr-21 (No. 217-03344) | Apr-22 |
| Reference Probe EX3DV4 | SN: 3503 | 31-Dec-21 (No. EX3-3503_Dec21) | Dec-22 |
| DAE4 | SN: 601 | 01-Nov-21 (No. DAE4-601_Nov21) | Nov-22 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Oct-20) | In house check: Oct-22 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-20) | In house check: Oct-22 |
| Power sensor HP 8481A | SN: MY41093315 | 07-Oct-15 (in house check Oct-20) | In house check: Oct-22 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-20) | In house check: Oct-22 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-20) | In house check: Oct-22 |

Calibrated by: **Michael Weber** Function: **Laboratory Technician** Signature:

Approved by: **Niels Kuster** Quality Manager

Issued: March 1, 2022

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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:* The source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:* SAR measured at the stated antenna input power.
- SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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

Measurement Conditions

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

| | | |
|-------------------------------------|----------------------------|----------------------------------|
| DASY Version | DASY52 | 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 | 3500 MHz ± 1 MHz | |

Head TSL parameters

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 | 37.4 ± 6 % | 2.93 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 6.65 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 66.2 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.47 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 24.7 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 | 52.3 Ω - 7.4 j Ω |
| Return Loss | - 22.4 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.132 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: 25.02.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1060

Communication System: UID 0 - CW; Frequency: 3500 MHz

Medium parameters used: $f = 3500$ MHz; $\sigma = 2.93$ S/m; $\epsilon_r = 37.4$; $\rho = 1000$ kg/m³

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; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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 = 71.72 V/m; Power Drift = -0.07 dB

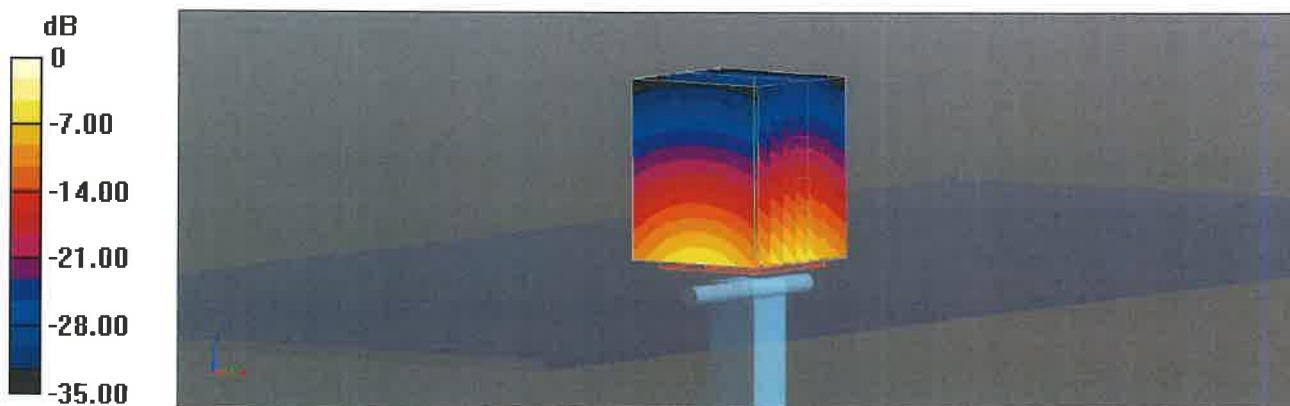
Peak SAR (extrapolated) = 18.0 W/kg

SAR(1 g) = 6.65 W/kg; SAR(10 g) = 2.47 W/kg

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

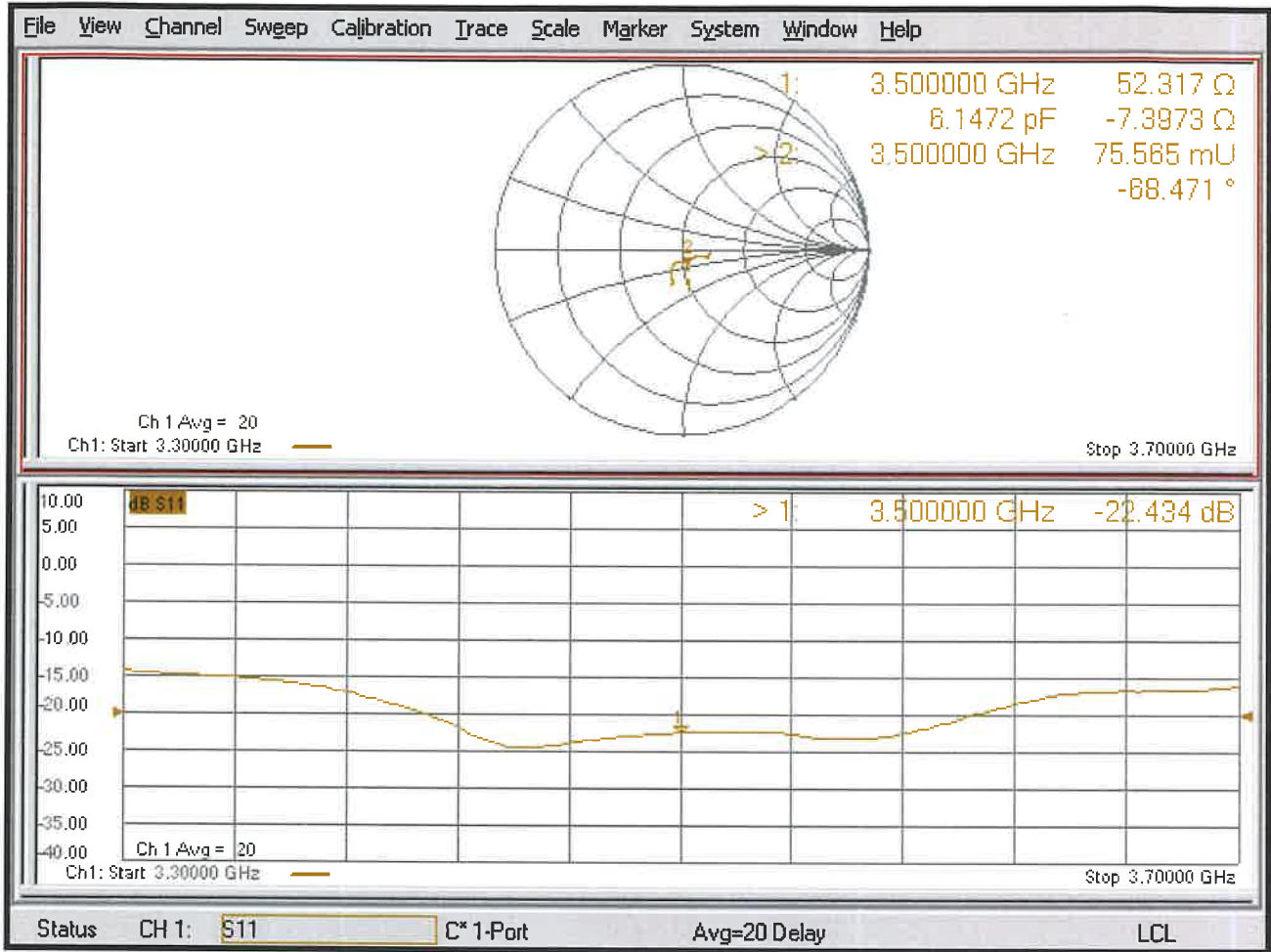
Ratio of SAR at M2 to SAR at M1 = 74.3%

Maximum value of SAR (measured) = 12.8 W/kg



0 dB = 12.8 W/kg = 11.08 dBW/kg

Impedance Measurement Plot for Head TSL





Accreditation No.: **SCS 0108**

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

Client **UL USA**

Certificate No: **D3500V2-1011_Apr22**

CALIBRATION CERTIFICATE

Object **D3500V2 - SN:1011**

Calibration procedure(s) **QA CAL-22.v6
Calibration Procedure for SAR Validation Sources between 3-10 GHz**

Calibration date: **April 21, 2022**

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 (Certificate No.) | Scheduled Calibration |
|-----------------------------|--------------------|---------------------------------|-----------------------|
| Power meter NRP | SN: 104778 | 04-Apr-22 (No. 217-03525/03524) | Apr-23 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-22 (No. 217-03524) | Apr-23 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-22 (No. 217-03525) | Apr-23 |
| Reference 20 dB Attenuator | SN: BH9394 (20k) | 04-Apr-22 (No. 217-03527) | Apr-23 |
| Type-N mismatch combination | SN: 310982 / 06327 | 04-Apr-22 (No. 217-03528) | Apr-23 |
| Reference Probe EX3DV4 | SN: 3503 | 08-Mar-22 (No. EX3-3503_Mar22) | Mar-23 |
| DAE4 | SN: 601 | 01-Nov-21 (No. DAE4-601_Nov21) | Nov-22 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---------------------------------|----------------|-----------------------------------|------------------------|
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Oct-20) | In house check: Oct-22 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-20) | In house check: Oct-22 |
| Power sensor HP 8481A | SN: MY41093315 | 07-Oct-15 (in house check Oct-20) | In house check: Oct-22 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-20) | In house check: Oct-22 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-20) | In house check: Oct-22 |

Calibrated by: **Michael Weber** Function: **Laboratory Technician** Signature: *M. Weber*

Approved by: **Sven Kühn** Deputy Manager *S. Kühn*

Issued: April 28, 2022

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



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Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- c) DASY System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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

Measurement Conditions

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

| | | |
|-------------------------------------|----------------------------|----------------------------------|
| DASY Version | DASY52 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy = 4 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| Frequency | 3500 MHz ± 1 MHz | |

Head TSL parameters

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 | 37.0 ± 6 % | 2.93 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 6.70 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 66.5 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 | 24.9 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 | $53.5 \Omega + 0.4 j\Omega$ |
| Return Loss | - 29.4 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.137 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: 21.04.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1011

Communication System: UID 0 - CW; Frequency: 3500 MHz

Medium parameters used: $f = 3500$ MHz; $\sigma = 2.93$ S/m; $\epsilon_r = 37.0$; $\rho = 1000$ kg/m³

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; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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 = 70.08 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 18.2 W/kg

SAR(1 g) = 6.70 W/kg; SAR(10 g) = 2.51 W/kg

Smallest distance from peaks to all points 3 dB below = 8.6 mm

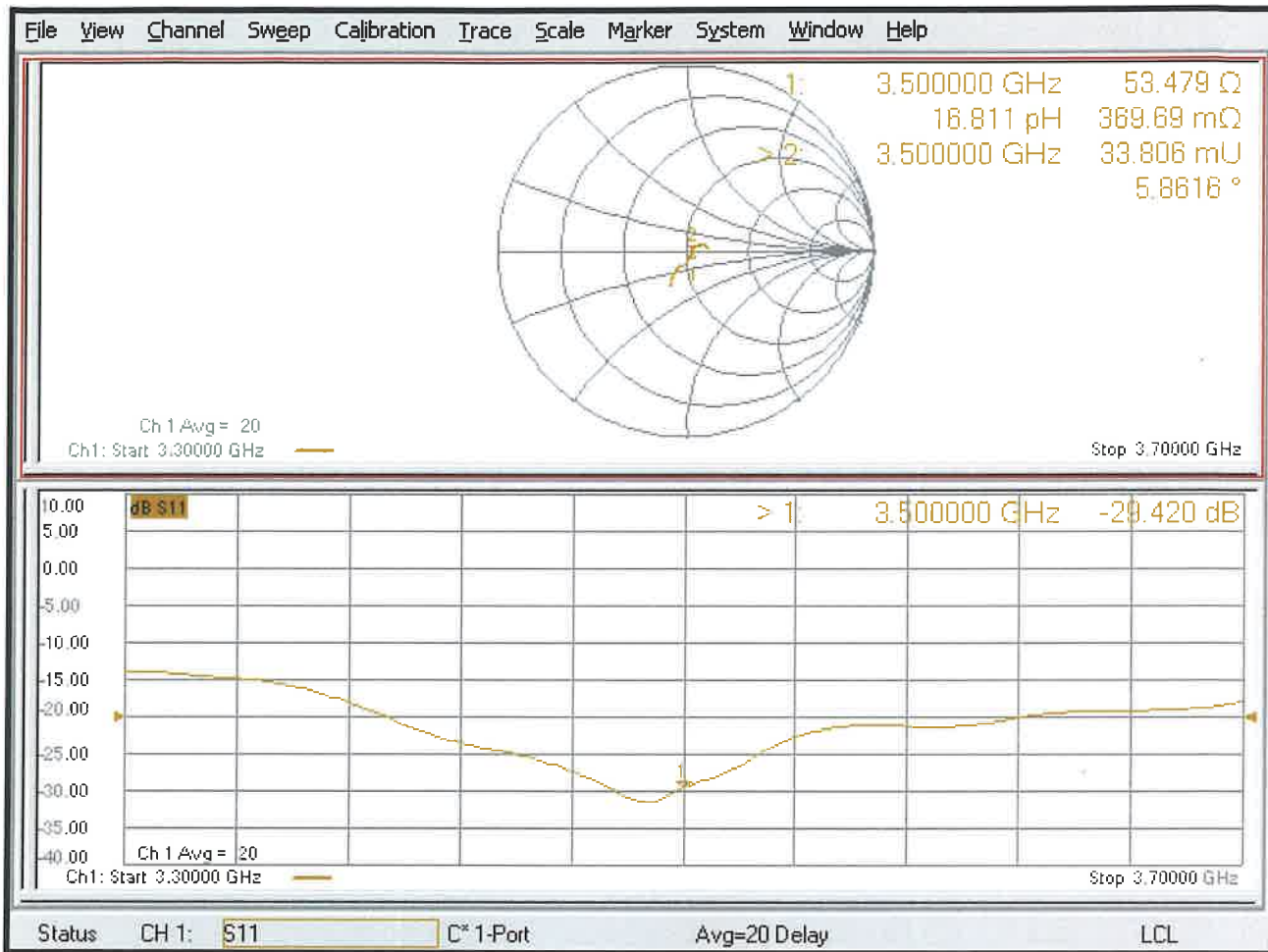
Ratio of SAR at M2 to SAR at M1 = 75%

Maximum value of SAR (measured) = 12.7 W/kg



0 dB = 12.7 W/kg = 11.03 dBW/kg

Impedance Measurement Plot for Head TSL



CERTIFICATE OF CALIBRATION

ISSUED BY **UL INTERNATIONAL (UK) LTD**

DATE OF ISSUE: 29/Nov/2021 CERTIFICATE NUMBER : 13685241JD01E



5772

UL INTERNATIONAL (UK) LTD
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BASINGSTOKE, HAMPSHIRE
RG24 8AH, UK
TEL: +44 (0) 1256 312100
FAX: +44 (0) 1256 312001
Email: LST.UK.Calibration@ul.com



Page 1 of 9

APPROVED SIGNATORY

A handwritten signature in black ink, appearing to read 'M. Naseer'.

.....
Naseer Mirza

Customer :

UL VS Inc
47173 Benicia Street
Fremont, CA 94538, USA

Equipment Details:

| | | | |
|--------------------|--|------------------|-------------|
| Description: | Dipole Validation Kit | Date of Receipt: | 19/Nov/2021 |
| Manufacturer: | SPEAG | | |
| Type/Model Number: | D5GHZV2 | | |
| Serial Number: | 1168 | | |
| Calibration Date: | 24/Nov/2021 | | |
| Calibrated By: | Masood Khan Test Engineer | | |
| Signature: | A handwritten signature in black ink, appearing to read 'Masood Khan'. | | |

All Calibration have been conducted in the closed laboratory facility: Lab Temperature (22±3) °C and humidity < 70%

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Use of the UKAS mark demonstrates that compliance with the requirements of BS/EN/ISO/IEC 17025 has been independently assessed.

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The calibration methods and procedures used were as detailed in:

1. **IEC 62209-1:2016**: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)
2. **IEC 62209-2:2010**: 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)
3. **IEEE 1528: 2013**: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques
4. FCC KDB Publication Number: **"KDB865664 D01 SAR Measurement 100 MHz to 6 GHz"**
5. **DASY 6 System Handbook**
6. **Dipole Calibration Procedure V1.2**: Calibration performed as per internal procedure

The measuring equipment used to perform the calibration, documented in this certificate has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

| UL No. | Instrument | Manufacturer | Type No. | Serial No. | Date Last Calibrated | Cal. Interval (Months) |
|-------------|------------------------------|-----------------|---------------------|------------|-----------------------|------------------------|
| PRE0135115 | Data Acquisition Electronics | SPEAG | DAE4 | 1438 | 12 Apr 2021 | 12 |
| PRE0178314 | Probe | SPEAG | EX3DV4 | 7496 | 16 Mar 2021 | 12 |
| PRE0132081 | Dipole | SPEAG | D5GHzV2 | SN1016 | 9 Feb 2021 | 12 |
| PRE0151451 | Power Monitoring Kit | Art-Fi | ART 100850-01 | 0001 | Cal as part of System | - |
| PRE0151441 | Power Sensor | Rhode & Schwarz | NRP8S | 102481 | 22 Mar 2021 | 12 |
| PRE0151154 | Vector Network Analyser | Rhode & Schwarz | ZND 1328.5170K92 | 100151 | 23 Mar 2021 | 12 |
| ULEID212645 | Calibration Kit | Rhode & Schwarz | ZN-Z135 (f) | 101005 | 22 Oct 2021 | 12 |
| PRE0178154 | Signal Generator | Rhode & Schwarz | SMB 100A | 175325 | 25 Mar 2021 | 12 |

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SAR System Specification

| | |
|--------------------------|--|
| Robot System Positioner: | Stäubli Unimation Corp. Robot Model: TX60L |
| Robot Serial Number: | F17/5ENYG1/A/01 |
| DASY Version: | cDASY16.0.0.116 |
| Phantom: | Flat section of SAM Twin Phantom |
| Distance Dipole Centre: | 10 mm (with spacer) |

Frequency: 5250 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

| Simulant Liquid | Frequency (MHz) | Room Temp | | Liquid Temp | | Parameters | Target Value | Measured Value | Uncertainty (%) |
|-----------------|-----------------|-----------|-------|-------------|-------|--------------|--------------|----------------|-----------------|
| | | Start | End | Start | End | | | | |
| Head | 5250 | 21.2 °C | 21 °C | 21.1 °C | 21 °C | ϵ_r | 35.93 | 35.83 | ± 5% |
| | | | | | | σ | 4.71 | 4.66 | ± 5% |

SAR Results – Head Simulating Liquid (HSL)

| Simulant Liquid | SAR Measured | 250 mW input Power | Normalised to 1.00 W | Uncertainty (%) |
|-----------------|-----------------------|--------------------|----------------------|------------------|
| Head | SAR averaged over 1g | 7.36 W/Kg | 73.6 W/Kg | +16.77 / -16.70% |
| | SAR averaged over 10g | 2.12 W/Kg | 21.2 W/Kg | ±16.70% |

Antenna Parameters – Head Simulating Liquid (HSL)

| Simulant Liquid | Parameter | Measured Level | Uncertainty (%) |
|-----------------|-------------|------------------------|-----------------|
| Head | Impedance | 60.19 + 3.72j Ω | ± 3.01 |
| | Return Loss | 20.19 | ± 2.93 |

Frequency: 5600 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

| Simulant Liquid | Frequency (MHz) | Room Temp | | Liquid Temp | | Parameters | Target Value | Measured Value | Uncertainty (%) |
|-----------------|-----------------|-----------|-------|-------------|-------|--------------|--------------|----------------|-----------------|
| | | Start | End | Start | End | | | | |
| Head | 5600 | 21.2 °C | 21 °C | 21.1 °C | 21 °C | ϵ_r | 35.53 | 35.15 | ± 5% |
| | | | | | | σ | 5.065 | 5.059 | ± 5% |

SAR Results – Head Simulating Liquid (HSL)

| Simulant Liquid | SAR Measured | 250 mW input Power | Normalised to 1.00 W | Uncertainty (%) |
|-----------------|-----------------------|--------------------|----------------------|------------------|
| Head | SAR averaged over 1g | 8.17 W/Kg | 81.7 W/Kg | +16.77 / -16.70% |
| | SAR averaged over 10g | 2.33 W/Kg | 23.3 W/Kg | ±16.70% |

Antenna Parameters – Head Simulating Liquid (HSL)

| Simulant Liquid | Parameter | Measured Level | Uncertainty (%) |
|-----------------|-------------|------------------------|-----------------|
| Head | Impedance | 45.95 + 4.75j Ω | ± 3.01 |
| | Return Loss | 23.66 | ± 2.93 |

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Frequency: 5750 MHz

Dielectric Property Measurements – Head Simulating Liquid (HSL)

| Simulant Liquid | Frequency (MHz) | Room Temp | | Liquid Temp | | Parameters | Target Value | Measured Value | Uncertainty (%) |
|-----------------|-----------------|-----------|-------|-------------|-------|--------------|--------------|----------------|-----------------|
| | | Start | End | Start | End | | | | |
| Head | 5750 | 21.2 °C | 21 °C | 21.1 °C | 21 °C | ϵ_r | 35.36 | 34.85 | ± 5% |
| | | | | | | σ | 5.22 | 5.23 | ± 5% |

SAR Results – Head Simulating Liquid (HSL)

| Simulant Liquid | SAR Measured | 250 mW input Power | Normalised to 1.00 W | Uncertainty (%) |
|-----------------|-----------------------|--------------------|----------------------|------------------|
| Head | SAR averaged over 1g | 7.7 W/Kg | 77.0 W/Kg | +16.77 / -16.70% |
| | SAR averaged over 10g | 2.21 W/Kg | 22.1 W/Kg | ±16.70% |

Antenna Parameters – Head Simulating Liquid (HSL)

| Simulant Liquid | Parameter | Measured Level | Uncertainty (%) |
|-----------------|-------------|------------------------|-----------------|
| Head | Impedance | 59.36 – 4.05j Ω | ± 3.01 |
| | Return Loss | 20.64 | ± 2.93 |

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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHZV2; Type: Dipole; Serial: SN1168;



Communication System: CW UID: 0; Frequency: 5250.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_24Nov2021_001812_Head - 5GHz 5%; Medium parameters used: $f = 5250.0$ MHz; $\sigma = 4.66$ S/m; $\epsilon_r = 35.8$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -0.28$ %; $\Delta\sigma = -1.02$ %; No correction
Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(5.24, 5.24, 5.24); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 12 Apr 2021
- Phantom: Twin-SAM V5.0 (30deg probe tilt); Serial: 1818
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: $dx=10$ mm, $dy=10$ mm

Zoom Scan1(22x22x22): Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=1.4$ mm; Grading Ratio: 1.4; Reference Value = 11.240 V/m; Power Drift = 0.03 dB

Minimum horizontal 3dB distance: 7.5 mm;

Vertical M2/M1 Ratio: 65.8 %;

SAR(1 g) = 7.360 W/kg; SAR(10 g) = 2.120 W/kg

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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHZV2; Type: Dipole; Serial: SN1168;



Communication System: CW UID: 0; Frequency: 5600.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_24Nov2021_001812_Head - 5GHz 5%; Medium parameters used: $f = 5600.0$ MHz; $\sigma = 5.06$ S/m; $\epsilon_r = 35.1$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -1.07$ %; $\Delta\sigma = -0.10$ %; No correction
Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(4.7, 4.7, 4.7); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 12 Apr 2021
- Phantom: Twin-SAM V5.0 (30deg probe tilt); Serial: 1818
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: dx=10 mm, dy=10 mm

Zoom Scan1(22x22x22): Measurement grid: dx=4 mm, dy=4 mm, dz=1.4 mm; Grading Ratio: 1.4; Reference Value = 12.360 V/m; Power Drift = 0.00 dB

Minimum horizontal 3dB distance: 7.2 mm;

Vertical M2/M1 Ratio: 62.7 %;

SAR(1 g) = 8.170 W/kg; SAR(10 g) = 2.330 W/kg

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DASY Validation Scan for Head Stimulating Liquid (HSL)

DUT: D5GHZV2; Type: Dipole; Serial: SN1168;



Communication System: CW UID: 0; Frequency: 5750.0 MHz; Duty Cycle: 1;
Medium: HSL; Site65_24Nov2021_001812_Head - 5GHz 5%; Medium parameters used: $f = 5750.0$ MHz; $\sigma = 5.23$ S/m; $\epsilon_r = 34.9$; $\rho = 1000$ kg/m³; $\Delta\epsilon_r = -1.43$ %; $\Delta\sigma = 0.30$ %; No correction
Phantom section: Flat;

DASY 6 Configuration:

- Laboratory Name: Site65;
- Probe: EX3DV4 - SN7496; ConvF(4.79, 4.79, 4.79); Calibrated: 16 Mar 2021
- Sensor-Surface: 1.4 mm; VMS + 6p
- Electronics: DAE4 - SN1438; Calibrated: 12 Apr 2021
- Phantom: Twin-SAM V5.0 (30deg probe tilt); Serial: 1818
- Measurement SW: cDASY6.14.0.959

Area Scan (40x80): Interpolated grid: $dx=10$ mm, $dy=10$ mm

Zoom Scan1(22x22x22): Measurement grid: $dx=4$ mm, $dy=4$ mm, $dz=1.4$ mm; Grading Ratio: 1.4; Reference Value = 11.980 V/m; Power Drift = -0.01 dB

Minimum horizontal 3dB distance: 7.5 mm;

Vertical M2/M1 Ratio: 61.8 %;

SAR(1 g) = 7.700 W/kg; SAR(10 g) = 2.210 W/kg

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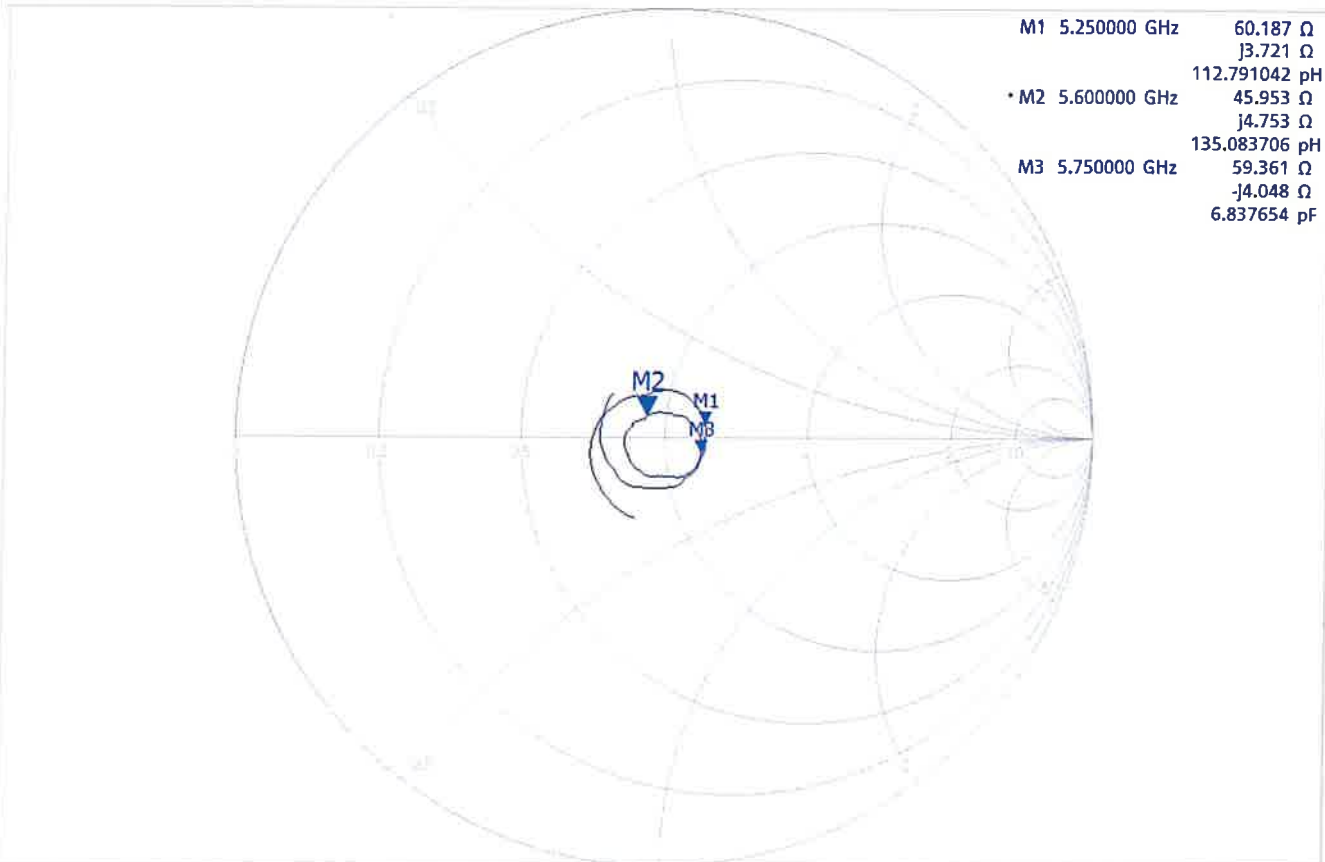
Impedance Measurement Plot for Head Stimulating Liquid (HSL)



11/24/2021 4:56:54 PM
1328.5170K92-100151-MV

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal

1



| | | | |
|----|--------------|-----------------|------------------|
| M1 | 5.250000 GHz | 60.187 Ω | j3.721 Ω |
| | | | 112.791042 pF |
| M2 | 5.600000 GHz | 45.953 Ω | j4.753 Ω |
| | | | 135.083706 pF |
| M3 | 5.750000 GHz | 59.361 Ω | -j4.048 Ω |
| | | | 6.837654 pF |

Ch1 Start 5 GHz

Pwr -10 dBm Bw 10 kHz

Stop 6 GHz

CERTIFICATE OF CALIBRATION

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NUMBER :
13685241JD01E

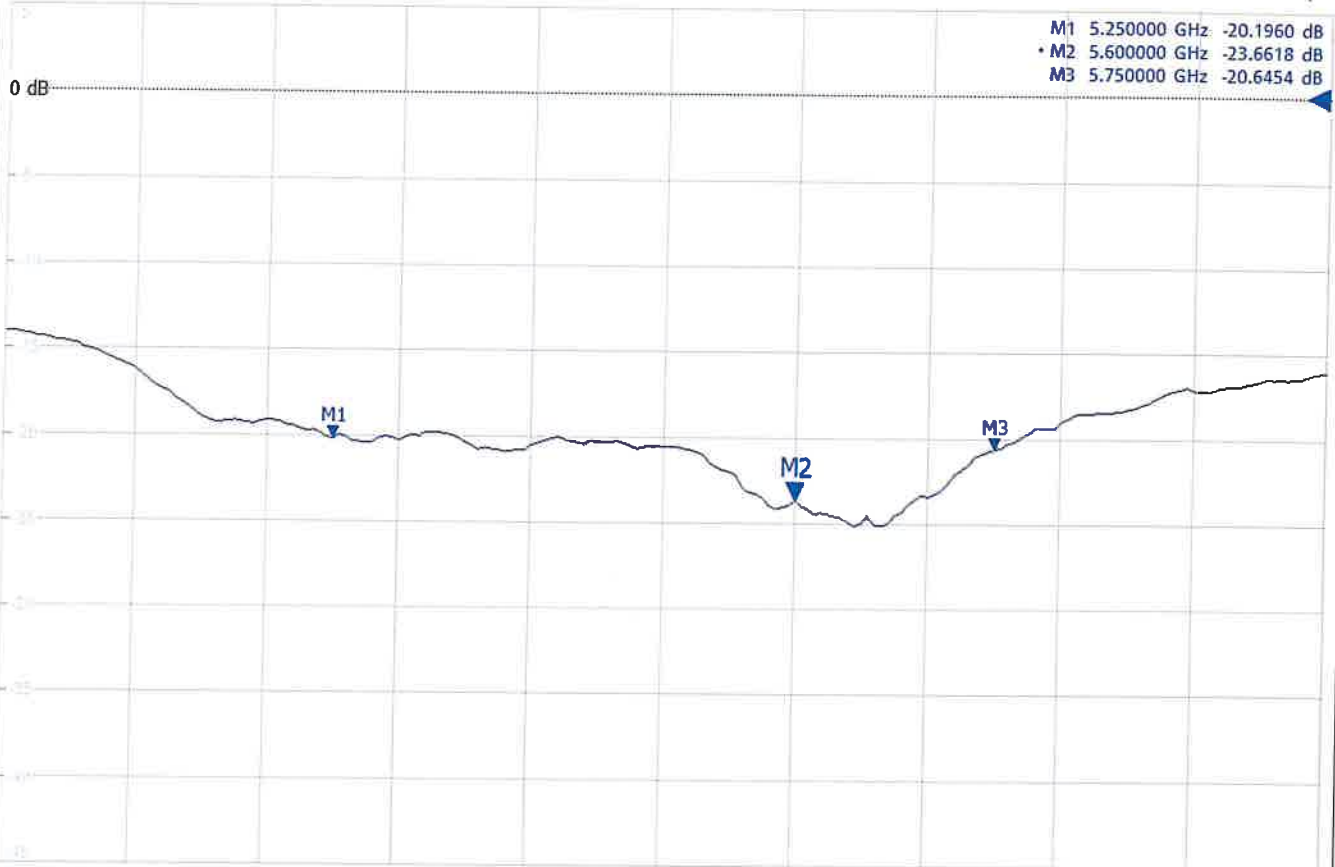
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Return Loss Measurement Plot for Head Stimulating Liquid (HSL)

11/24/2021 4:55:54 PM
1328.5170K92-100151-MV

Trc1 — S11 dB Mag 5 dB/ Ref 0 dB Cal

1





Ch1 Start 5 GHz


Pwr -10 dBm Bw 10 kHz

Stop 6 GHz

Calibration Certificate Label:

| | |
|---|--|
|  | <p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 13685241JD01E</p> <p>Instrument ID: 1168</p> <p>Calibration Date: 24/Nov/2021</p> <p>Calibration Due Date:</p> |
|---|--|

| | |
|---|--|
|  | <p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 13685241JD01E</p> <p>Instrument ID: 1168</p> <p>Calibration Date: 24/Nov/2021</p> <p>Calibration Due Date:</p> |
|---|--|

| | |
|---|--|
|  | <p>UL INTERNATIONAL (UK) LTD Tel: +44 (0) 1256312100</p> <p>Certificate Number: 13685241JD01E</p> <p>Instrument ID: 1168</p> <p>Calibration Date: 24/Nov/2021</p> <p>Calibration Due Date:</p> |
|---|--|