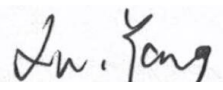


| | | | |
|-----------------|-----------------|-------------|---|
| Project No. | SHT2404077201W | | |
| Test sample No. | YPHT24040772002 | Model No. | Q368 |
| Start test date | 2024/5/14 | Finish date | 2024/5/14 |
| Temperature | 22.5°C | Humidity | 54% |
| Test Engineer | Xiaodong Zhao | Auditor |  |

| Appendix clause | Test Item | Result |
|-----------------|-------------------------|--------|
| A | ERP Measurement Results | PASS |
| B | SAR Measurement Results | PASS |

Appendix A:ERP Measurement Results

| ERP | | | | | |
|--------|--------------------|-----------|----------|-----------|---------------------|
| Mode | Channel Separation | Frequency | | ERP (dBm) | Tune up limit (dBm) |
| | | Channel | MHz | | |
| Analog | 12.5kHz | CH4 | 462.6375 | 25.99 | 27.00 |
| | | CH11 | 467.6375 | 25.87 | 27.00 |

Appendix B:SAR Measurement Results

| Front-of-face | | | | | | | | | | | |
|-------------------|--------------------|-----------|----------|-----------|---------------------|------------------------|-----------------|-------------------------|-----------------------|-------------------------|----------|
| Mode | Test Position | Frequency | | ERP (dBm) | Tune up limit (dBm) | Tune up scaling factor | Power Drift(dB) | Measured SAR(1g) (W/kg) | Report SAR(1g) (W/kg) | 75% Duty SAR(1g) (W/kg) | Plot No. |
| | | CH | MHz | | | | | | | | |
| Analog 12.5kHz | Front dis.=25mm | CH4 | 462.6375 | 25.99 | 27.00 | 1.262 | -0.06 | 0.482 | 0.608 | 0.456 | 1 |
| | | CH11 | 467.6375 | 25.87 | 27.00 | 1.297 | -0.14 | 0.465 | 0.603 | 0.452 | - |

| Body-worn | | | | | | | | | | | |
|-------------------|--------------------|-----------|----------|-----------|---------------------|------------------------|-----------------|-------------------------|-----------------------|-------------------------|----------|
| Mode | Test Position | Frequency | | ERP (dBm) | Tune up limit (dBm) | Tune up scaling factor | Power Drift(dB) | Measured SAR(1g) (W/kg) | Report SAR(1g) (W/kg) | 75% Duty SAR(1g) (W/kg) | Plot No. |
| | | CH | MHz | | | | | | | | |
| Analog 12.5kHz | Front dis.=10mm | CH4 | 462.6375 | 25.99 | 27.00 | 1.262 | -0.10 | 1.300 | 1.640 | 1.230 | - |
| | | CH11 | 467.6375 | 25.87 | 27.00 | 1.297 | -0.09 | 1.240 | 1.609 | 1.206 | - |
| | Back dis.=10mm | CH4 | 462.6375 | 25.99 | 27.00 | 1.262 | -0.16 | 1.470 | 1.855 | 1.391 | 2 |
| | | CH11 | 467.6375 | 25.87 | 27.00 | 1.297 | -0.14 | 1.400 | 1.816 | 1.362 | - |

Analog-12.5kHz Front-of-face

Communication System: UID 0, Analog (0); Frequency: 462.637 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 463$ MHz; $\sigma = 0.883$ S/m; $\epsilon_r = 44.284$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient Temperature: 22.5°C; Liquid Temperature: 22.0°C

DASY Configuration:

- Probe: EX3DV4 - SN7494; ConvF(11.69, 11.69, 11.69) @ 462.637 MHz; Calibrated: 10/24/2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1549; Calibrated: 4/16/2024
- Phantom: ELI V8.0 ; Type: QD OVA 004 AA ; Serial: 2078
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Front 25mm/CH4/Area Scan (51x101x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.653 W/kg

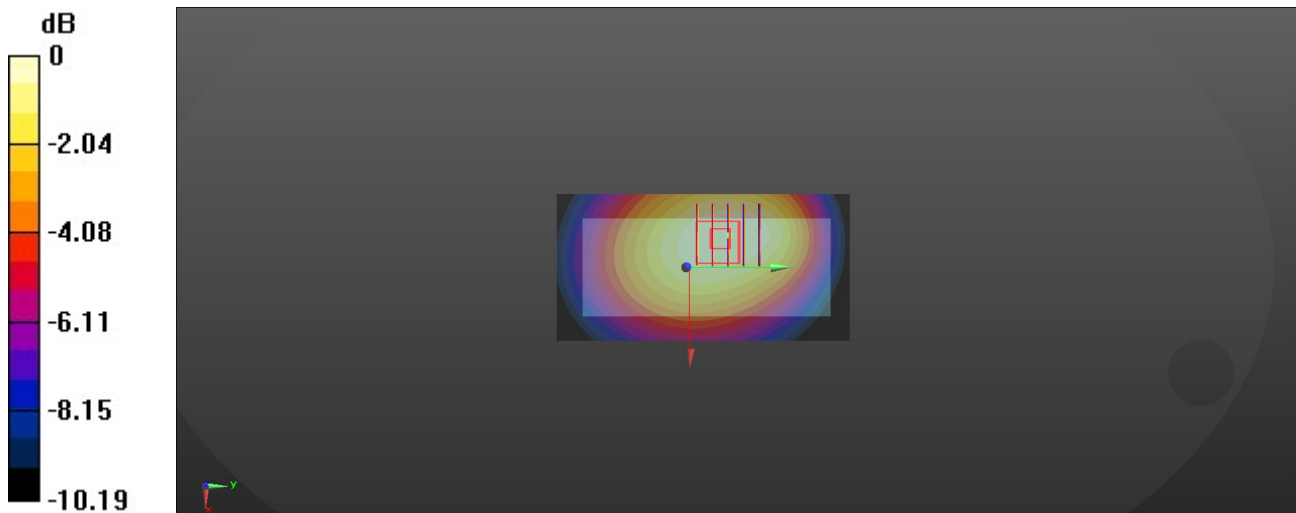
Front 25mm/CH4/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 26.06 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 0.787 W/kg

SAR(1 g) = 0.482 W/kg; SAR(10 g) = 0.343 W/kg

Maximum value of SAR (measured) = 0.645 W/kg



0 dB = 0.645 W/kg = -1.90 dBW/kg

Analog-12.5kHz Body-worn

Communication System: UID 0, Analog (0); Frequency: 462.637 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 463 \text{ MHz}$; $\sigma = 0.883 \text{ S/m}$; $\epsilon_r = 44.284$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Ambient Temperature: 22.5°C ; Liquid Temperature: 22.0°C

DASY Configuration:

- Probe: EX3DV4 - SN7494; ConvF(11.69, 11.69, 11.69) @ 462.637 MHz; Calibrated: 10/24/2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1549; Calibrated: 4/16/2024
- Phantom: ELI V8.0 ; Type: QD OVA 004 AA ; Serial: 2078
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Back 10mm/CH4/Area Scan (51x101x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$
 Maximum value of SAR (interpolated) = 2.33 W/kg

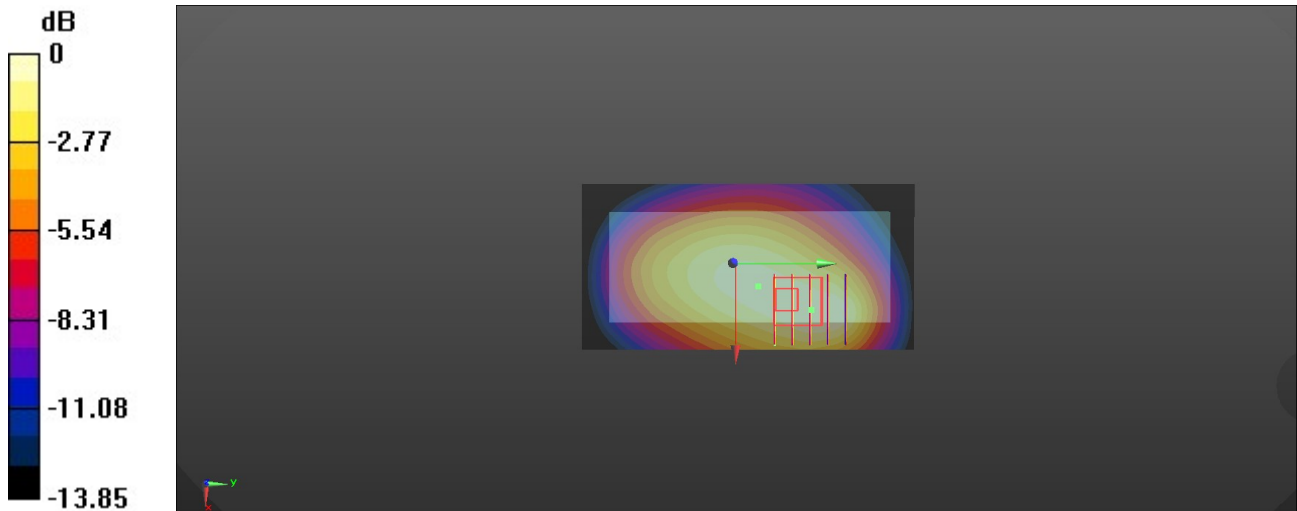
Back 10mm/CH4/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 47.51 V/m ; Power Drift = -0.16 dB

Peak SAR (extrapolated) = 3.33 W/kg

SAR(1 g) = 1.47 W/kg ; SAR(10 g) = 0.975 W/kg

Maximum value of SAR (measured) = 2.23 W/kg



0 dB = $2.23 \text{ W/kg} = 3.48 \text{ dBW/kg}$

1.1.1. DAE4 Calibration Certificate



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



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 国际互认
 校准
CAICT
 CALIBRATION
 CNAS L0570

Client : **HTW**

Certificate No: **24J02Z000159**

| CALIBRATION CERTIFICATE | | | |
|--|--|--|-----------------------|
| Object | DAE4 - SN: 1549 | | |
| Calibration Procedure(s) | FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx) | | |
| Calibration date: | April 16, 2024 | | |
| <p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p> | | | |
| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Process Calibrator 753 | 1971018 | 12-Jun-23 (CTTL, No.J23X05436) | Jun-24 |
| Calibrated by: | Name Yu Zongying | Function SAR Test Engineer | Signature |
| Reviewed by: | Name Lin Jun | Function SAR Test Engineer | Signature |
| Approved by: | Name Qi Dianyuan | Function SAR Project Leader | Signature |
| Issued: April 17, 2024 | | | |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. | | | |



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

Glossary:

DAE data acquisition electronics
Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters:

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



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DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 μ V, full range = -100...+300 mV

Low Range: 1LSB = 61nV, full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

| Calibration Factors | X | Y | Z |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range | 406.369 \pm 0.15% (k=2) | 406.051 \pm 0.15% (k=2) | 406.200 \pm 0.15% (k=2) |
| Low Range | 3.98561 \pm 0.7% (k=2) | 3.99305 \pm 0.7% (k=2) | 3.99389 \pm 0.7% (k=2) |

Connector Angle

| | |
|---|----------------|
| Connector Angle to be used in DASY system | 17.5° \pm 1° |
|---|----------------|

1.2. Probe Calibration Certificate

Calibration Laboratory of
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 Zeughausstrasse 43, 8004 Zurich, Switzerland



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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HTW**
 Shenzhen

Certificate No. **EX-7494_Oct23**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:7494**

Calibration procedure(s) **QA CAL-01.v10, QA CAL-12.v10, QA CAL-14.v7, QA CAL-23.v6,
 QA CAL-25.v8
 Calibration procedure for dosimetric E-field probes**

Calibration date **October 24, 2023**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
 The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.
 All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3) °C and humidity < 70%.
 Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|----------------------------|------------------|-----------------------------------|-----------------------|
| Power meter NRP2 | SN: 104778 | 30-Mar-23 (No. 217-03804/03805) | Mar-24 |
| Power sensor NRP-Z91 | SN: 103244 | 30-Mar-23 (No. 217-03804) | Mar-24 |
| OCP DAK-3.5 (weighted) | SN: 1249 | 05-Oct-23 (OCP-DAK3 5-1249_Oct23) | Oct-24 |
| OCP DAK-12 | SN: 1016 | 05-Oct-23 (OCP-DAK12-1016_Oct23) | Oct-24 |
| Reference 20 dB Attenuator | SN: CC2552 (20x) | 30-Mar-23 (No. 217-03809) | Mar-24 |
| DAE4 | SN: 660 | 16-Mar-23 (No. DAE4-660_Mar23) | Mar-24 |
| Reference Probe ES3DV2 | SN: 3013 | 06-Jan-23 (No. ES3-3013_Jan23) | Jan-24 |

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

| | Name | Function | Signature |
|---------------|----------------|-----------------------|-----------|
| Calibrated by | Jeton Kastrati | Laboratory Technician | |
| Approved by | Sven Kühn | Technical Manager | |

Issued: October 26, 2023

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

Calibration Laboratory of

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**The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates**

Accreditation No.: **SCS 0108**

Glossary

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

Calibration is Performed According to the Following Standards:

- 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"

Methods Applied and Interpretation of Parameters:

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

Appendix E: DAE and Probe Calibration Certificate

EX3DV4 - SN:7494

October 24, 2023

Parameters of Probe: EX3DV4 - SN:7494

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k = 2) |
|---|----------|----------|----------|-------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.40 | 0.47 | 0.39 | ±10.1% |
| DCP (mV) ^B | 96.8 | 98.4 | 99.9 | ±4.7% |

Calibration Results for Modulation Response

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Max dev. | Max Unc ^E k = 2 |
|-----|---------------------------|---|---------|------------------------------|------|---------|----------|-------------|----------------------------------|
| 0 | CW | X | 0.00 | 0.00 | 1.00 | 0.00 | 141.5 | ±3.8% | ±4.7% |
| | | Y | 0.00 | 0.00 | 1.00 | | 132.2 | | |
| | | Z | 0.00 | 0.00 | 1.00 | | 144.7 | | |

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%.

^A The uncertainties of Norm X,Y,Z do not affect the E²-field uncertainty inside TSL (see Page 5).

^B Linearization parameter uncertainty for maximum specified field strength.

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

EX3DV4 - SN:7494

October 24, 2023

Parameters of Probe: EX3DV4 - SN:7494

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle | 21.7° |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 1.4 mm |

Note: Measurement distance from surface can be increased to 3-4 mm for an *Area Scan* job.

EX3DV4 - SN:7494

October 24, 2023

Parameters of Probe: EX3DV4 - SN:7494

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity ^F (S/m) | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unc (k = 2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150 | 52.3 | 0.76 | 13.40 | 13.40 | 13.40 | 0.00 | 1.00 | ±13.3% |
| 450 | 43.5 | 0.87 | 11.69 | 11.69 | 11.69 | 0.16 | 1.30 | ±13.3% |

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

^F The probes are calibrated using tissue simulating liquids (TSL) that deviate for ϵ and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10%. If TSL with deviations from the target of less than ±5% are used, the calibration uncertainties are 11.1% for 0.7 - 3 GHz and 13.1% for 3 - 6 GHz.

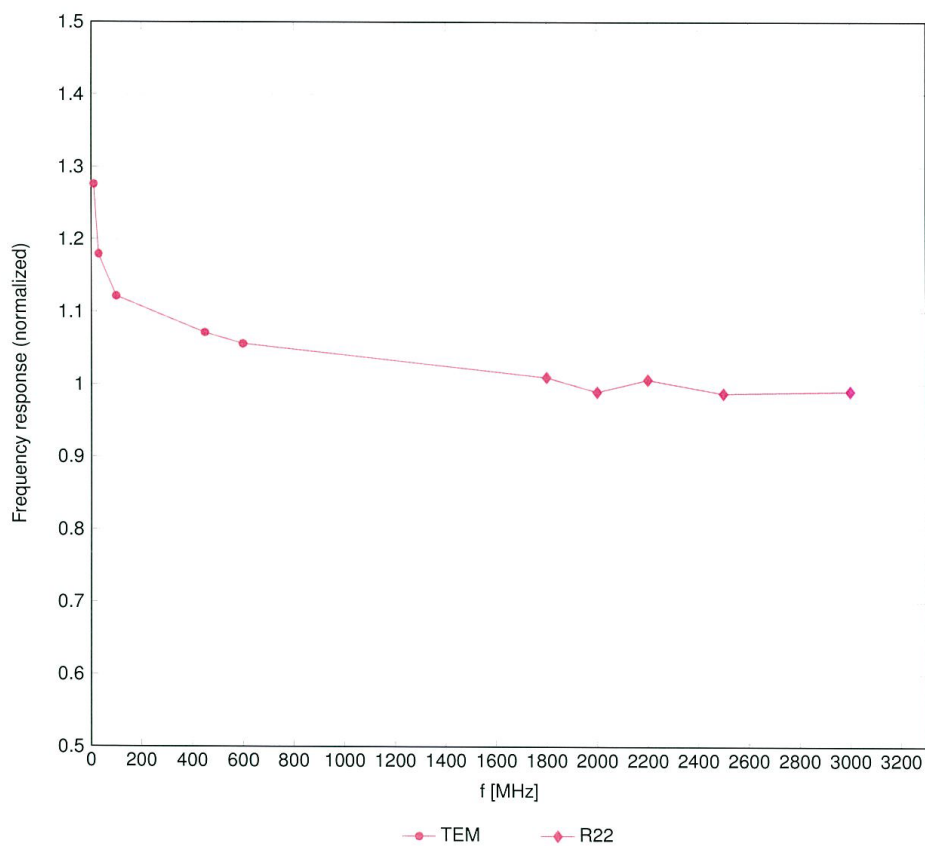
^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ±1% for frequencies below 3 GHz and below ±2% for frequencies between 3–6 GHz at any distance larger than half the probe tip diameter from the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

EX3DV4 - SN:7494

October 24, 2023

Frequency Response of E-Field

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

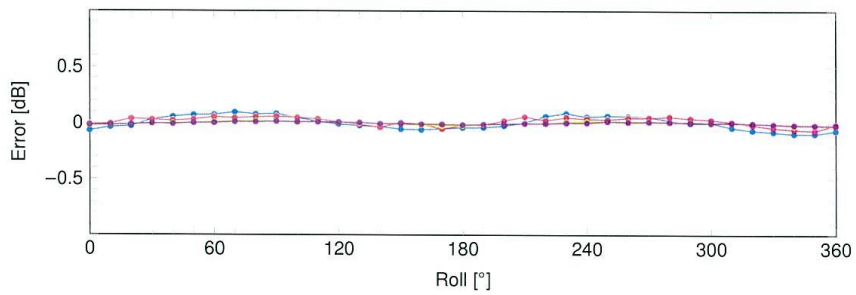
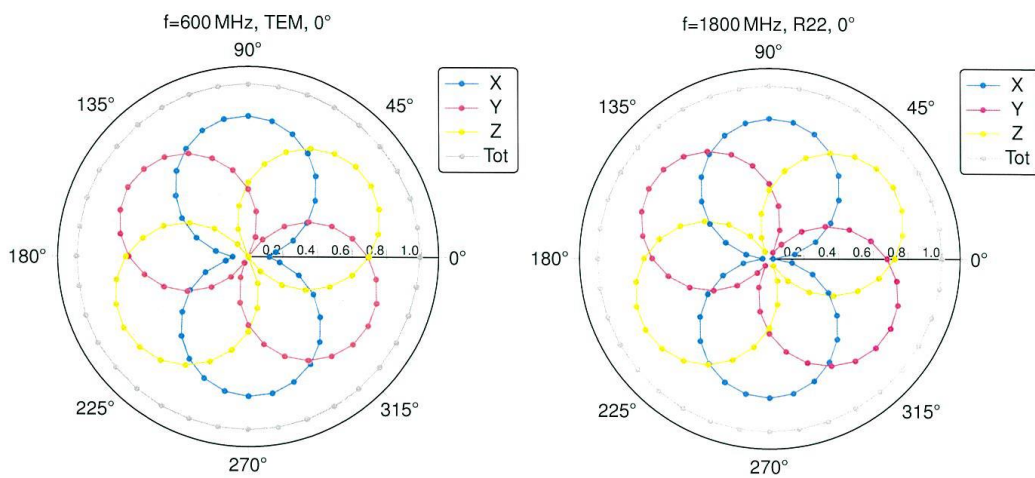


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

EX3DV4 - SN:7494

October 24, 2023

Receiving Pattern (ϕ), $\theta = 0^\circ$



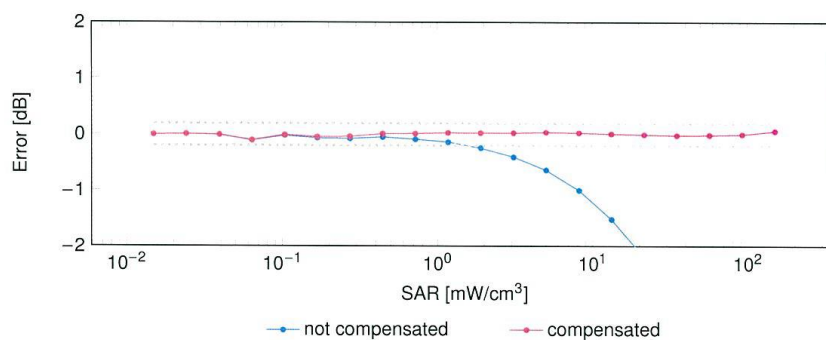
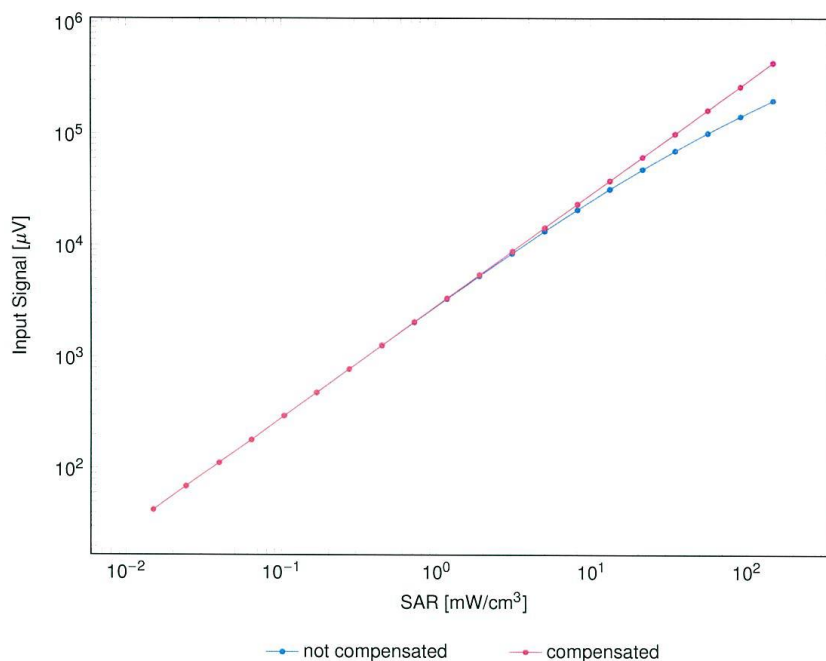
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

EX3DV4 - SN:7494

October 24, 2023

Dynamic Range $f(SAR_{head})$

(TEM cell, $f_{eval} = 1900\text{ MHz}$)

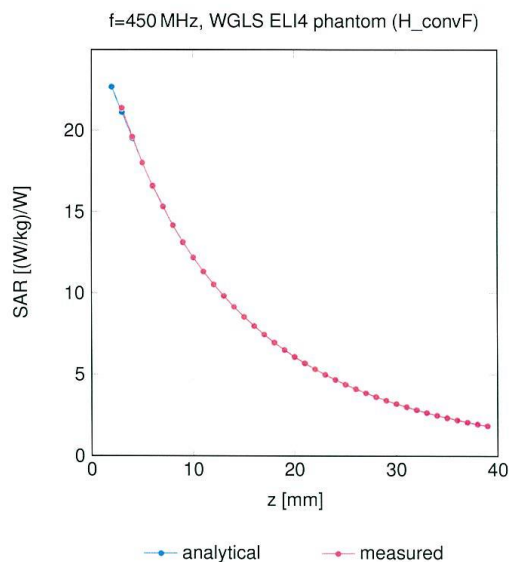


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

EX3DV4 - SN:7494

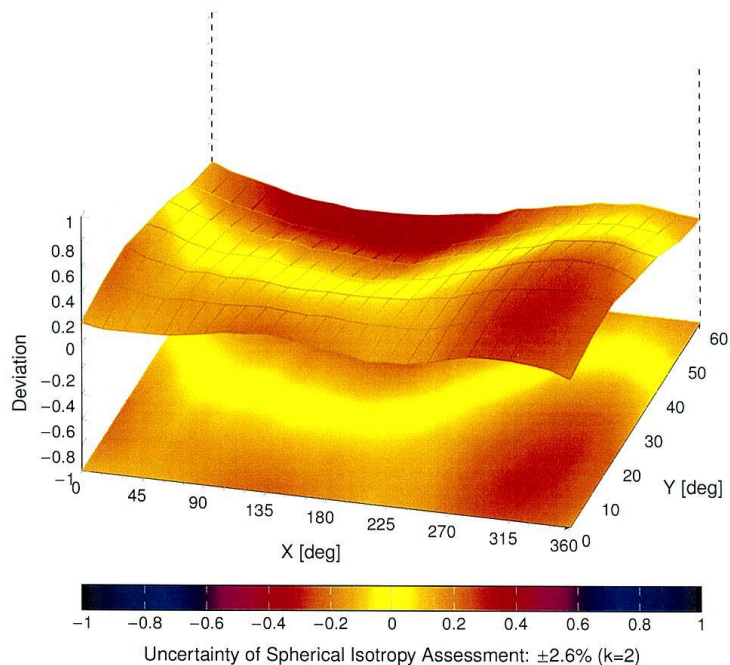
October 24, 2023

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), f = 900 MHz



1.1. D450V3 Dipole Calibration Certificate

**Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HTW**
Shenzhen

Certificate No. **D450V3-1102_Jan24**

| CALIBRATION CERTIFICATE | | | |
|---|---|-----------------------------------|------------------------------|
| Object | D450V3 - SN:1102 | | |
| Calibration procedure(s) | QA CAL-15.v10 Calibration Procedure for SAR Validation Sources below 700 MHz | | |
| Calibration date: | January 24, 2024 | | |
| This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. | | | |
| All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. | | | |
| Calibration Equipment used (M&TE critical for calibration) | | | |
| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
| Power meter NRP2 | SN: 104778 | 30-Mar-23 (No. 217-03804/03805) | Mar-24 |
| Power sensor NRP-Z91 | SN: 103244 | 30-Mar-23 (No. 217-03804) | Mar-24 |
| Power sensor NRP-Z91 | SN: 103245 | 30-Mar-23 (No. 217-03805) | Mar-24 |
| Reference 20 dB Attenuator | SN: BH9394 (20k) | 30-Mar-23 (No. 217-03809) | Mar-24 |
| Type-N mismatch combination | SN: 310982 / 06327 | 30-Mar-23 (No. 217-03810) | Mar-24 |
| Reference Probe EX3DV4 | SN: 3877 | 10-Jan-24 (No. EX3-3877_Jan24) | Jan-25 |
| DAE4 | SN: 654 | 15-Jan-24 (No. DAE4-654_Jan24) | Jan-25 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter NRP2 | SN: 107193 | 08-Nov-21 (in house check Dec-22) | In house check: Dec-24 |
| Power sensor NRP-Z91 | SN: 100922 | 15-Dec-09 (in house check Dec-22) | In house check: Dec-24 |
| Power sensor NRP-Z91 | SN: 100418 | 01-Jan-04 (in house check Dec-22) | In house check: Dec-24 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-22) | In house check: Jun-24 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-22) | In house check: Oct-24 |
| Calibrated by: | Name Krešimir Franjić | Function Laboratory Technician | Signature |
| Approved by: | Sven Kühn | Technical Manager | |
| | | | Issued: January 25, 2024 |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. | | | |

Appendix F: Dipole Calibration Certificate

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Engineering AG
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S Swiss Calibration Service

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The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Appendix F: Dipole Calibration Certificate

Measurement Conditions

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

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

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 43.5 | 0.87 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 43.9 \pm 6 % | 0.87 mho/m \pm 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 1.15 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 4.61 W/kg \pm 18.1 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 0.768 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 3.08 W/kg \pm 17.6 % (k=2) |

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 58.4 Ω - 3.5 j Ω |
| Return Loss | - 21.5 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.344 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: 24.01.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1102

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

Medium parameters used: $f = 450$ MHz; $\sigma = 0.87$ S/m; $\epsilon_r = 43.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.64, 10.64, 10.64) @ 450 MHz; Calibrated: 10.01.2024
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 15.01.2024
- Phantom: ELI v6.0; Type: QDOVA003AA; Serial: TP:2034
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7501)

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

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

Reference Value = 39.01 V/m; Power Drift = 0.00 dB

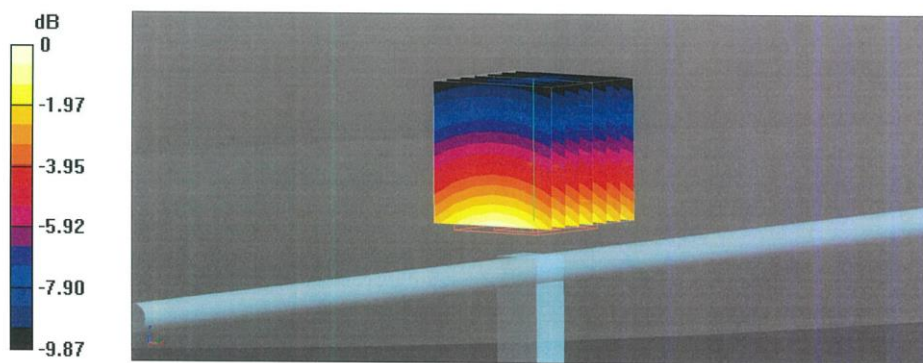
Peak SAR (extrapolated) = 1.82 W/kg

SAR(1 g) = 1.15 W/kg; SAR(10 g) = 0.768 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 63.3%

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



0 dB = 1.57 W/kg = 1.96 dBW/kg

Impedance Measurement Plot for Head TSL

