## 1.1. Probe Calibration Certificate

**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

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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 108**

Client **CIQ (Auden)**

Certificate No: **ES3-3292_Aug17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | ES3DV3 - SN:3292 |
| Calibration procedure(s) | QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | August 15, 2017 |

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 E4419B | GB41293874 | 03-Apr-17 (No. 217-01911) | Apr-18 |
| Power sensor E4412A | MY41498087 | 03-Apr-17 (No. 217-01911) | Apr-18 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 03-Apr-17 (No. 217-01915) | Apr-18 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-17 (No. 217-01919) | Apr-18 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 03-Apr-17 (No. 217-01920) | Apr-18 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-16 (No. ES3-3013_Dec16) | Dec-17 |
| DAE4 | SN: 660 | 13-Dec-16 (No. DAE4-660_Dec16) | Dec-17 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-16) | In house check: Apr-17 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-16) | In house check: Oct-17 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: August 15, 2017



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## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,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., ϑ = 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) 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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

## Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,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*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). 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
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,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 ≤ 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 *NORMx,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 *NORMx* (no uncertainty required).

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# Probe ES3DV3

## SN:3292

Manufactured: July 6, 2010
Calibrated: August 15, 2017

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.89 | 0.95 | 1.46 | ± 10.1 % |
| DCP (mV)[B] | 107.1 | 106.1 | 103.9 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB$\sqrt{\mu V}$ | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 209.7 | ±3.8 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 218.8 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 198.5 | |

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 NormX,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 450 | 43.5 | 0.87 | 6.71 | 6.71 | 6.71 | 0.18 | 1.80 | ± 13.3 % |
| 835 | 41.5 | 0.90 | 6.23 | 6.23 | 6.23 | 0.80 | 1.11 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 6.71 | 6.71 | 6.10 | 6.71 | 1.17 | ± 12.0 % |
| 1810 | 40.0 | 1.40 | 5.07 | 5.07 | 5.07 | 0.61 | 1.36 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.03 | 5.03 | 5.03 | 0.45 | 1.55 | ± 12.0 % |
| 2100 | 39.8 | 1.49 | 5.04 | 5.04 | 5.04 | 0.77 | 1.17 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.43 | 4.43 | 4.43 | 0.73 | 1.23 | ± 12.0 % |

[C] Frequency validity above 300 MHz of ± 100 MHz 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. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[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.

# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292

## Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 450 | 56.7 | 0.94 | 7.10 | 7.10 | 7.10 | 0.13 | 1.00 | ± 13.3 % |
| 835 | 55.2 | 0.97 | 6.11 | 6.11 | 6.11 | 0.36 | 1.78 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 5.97 | 5.97 | 5.97 | 0.73 | 1.22 | ± 12.0 % |
| 1810 | 53.3 | 1.52 | 4.79 | 4.79 | 4.79 | 0.59 | 1.45 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.66 | 4.66 | 4.66 | 0.41 | 1.79 | ± 12.0 % |
| 2100 | 53.2 | 1.62 | 4.77 | 4.77 | 4.77 | 0.63 | 1.42 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.23 | 4.23 | 4.23 | 0.66 | 0.98 | ± 12.0 % |

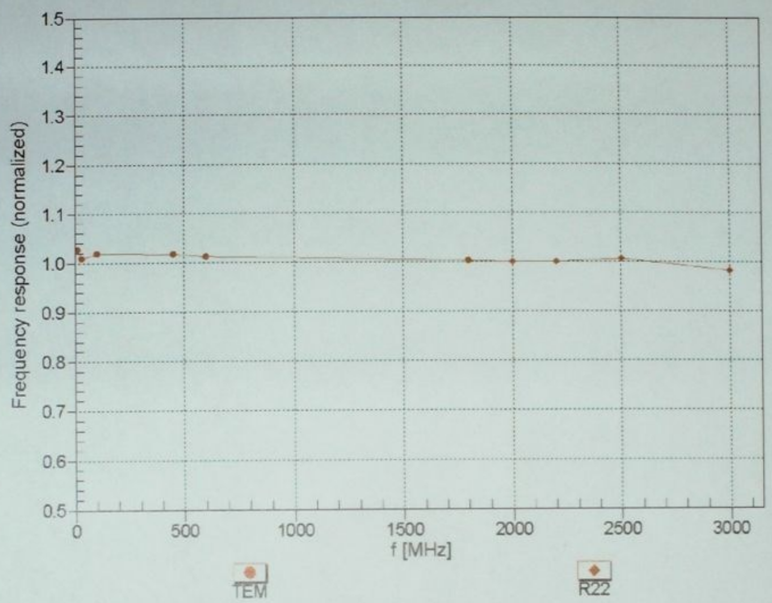
[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[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.

ES3DV3– SN:3292

August 15, 2017

# Frequency Response of E-Field

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




Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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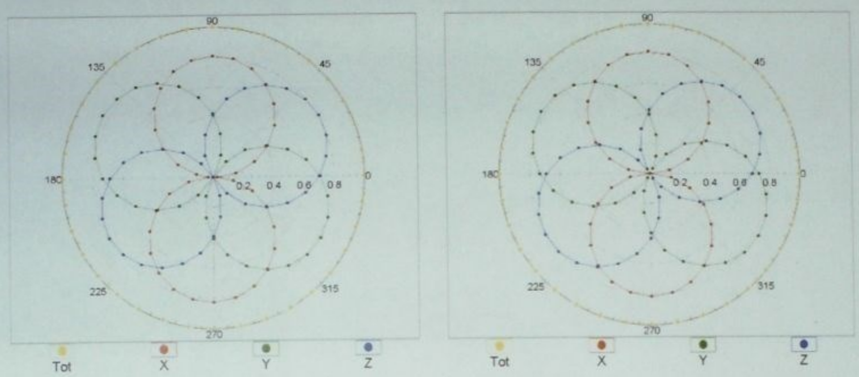
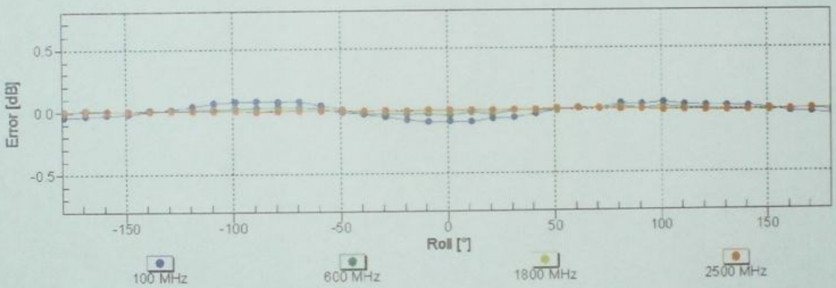
# Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM

f=1800 MHz,R22




**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

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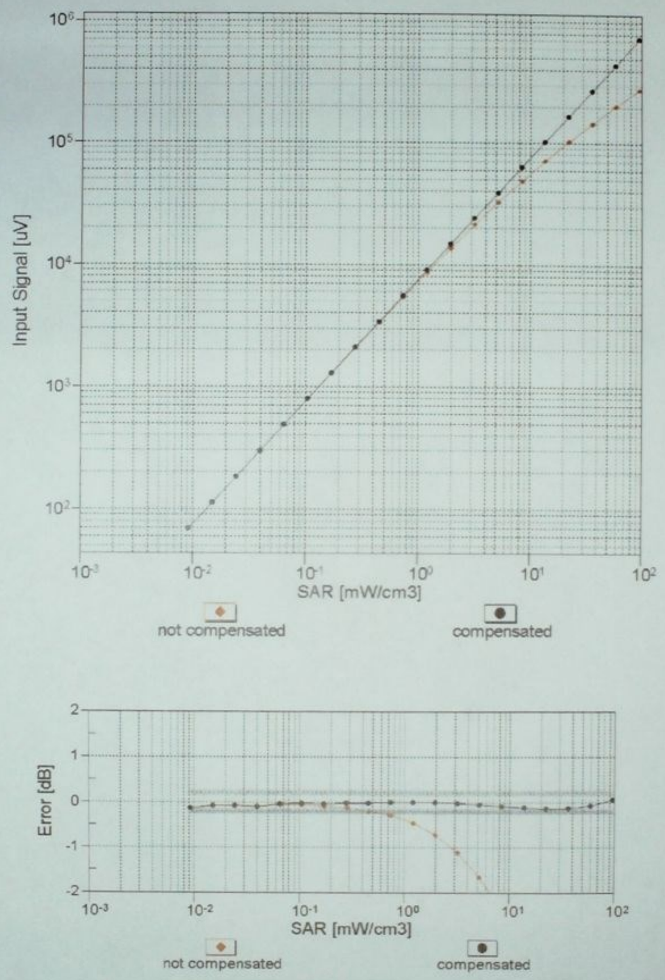
August 15, 2017

# Dynamic Range f($SAR_{head}$)

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




**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

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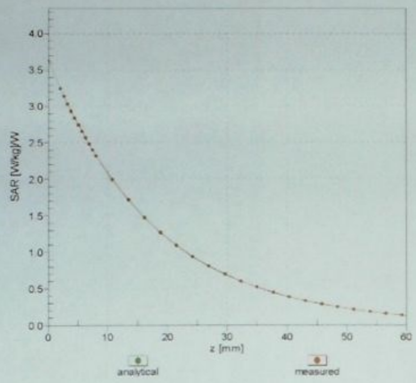
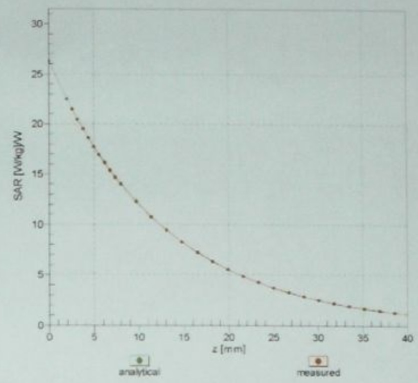
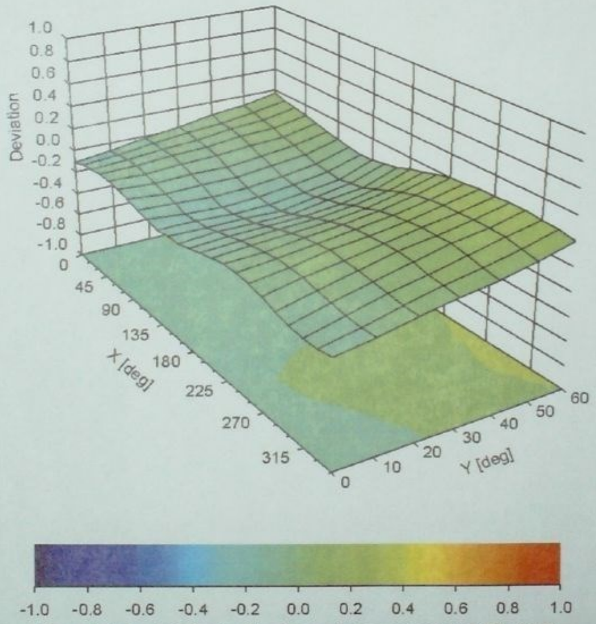
## Conversion Factor Assessment




## Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




**Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)**

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# DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -8.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |

## 1.2. D450V3 Dipole Calibration Certificate

**Calibration Laboratory of**
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**Accreditation No.: SCS 108**

Client **CIQ SZ (Auden)**

Certificate No: **D450V3-1079_Feb16**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D450V3 - SN: 1079 |
| Calibration procedure(s) | QA CAL-15.v6<br>Calibration procedure for dipole validation kits below 700 MHz |
| Calibration date: | February 28, 2016 |

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 E4419B | GB41293874 | 31-Mar-15 (No. 217-01372) | Apr-16 |
| Power sensor E4412A | MY41498087 | 31-Mar-15 (No. 217-01372) | Apr-16 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 29-Mar-15 (No. 217-01369) | Apr-16 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 29-Mar-15 (No. 217-01367) | Apr-16 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 29-Mar-15 (No. 217-01168) | Apr-16 |
| Reference Probe ET3DV6 | SN: 1507 | 30-Dec-15 (No. ET3-1507_Dec11) | Dec-16 |
| DAE4 | SN: 654 | 03-May-15 (No. DAE4-654_May11) | May-16 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-15) | In house check: Oct-16 |
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-15) | In house check: Oct-16 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

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

Issued: February 28, 2016

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

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Accreditation No.: **SCS 108**

**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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

d) 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.

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.0 |
| **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 ± 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 ± 0.2) °C | 43.6 ± 6 % | 0.85 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 | 398 mW input power | 1.81 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **4.63 mW /g ± 18.1 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 398 mW input power | 1.21 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **3.09 mW /g ± 17.6 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 56.7 | 0.94 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 55.0 ± 6 % | 0.91 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 398 mW input power | 1.74 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **4.45 mW / g ± 18.1 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 398 mW input power | 1.16 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **2.97 mW / g ± 17.6 % (k=2)** |

## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 59.8 Ω - 0.5 jΩ |
| Return Loss | - 21.0 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 56.4 Ω - 5.9 jΩ |
| Return Loss | - 21.7 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.350 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 |
| Manufactured on | March 03, 2013 |

**DASY5 Validation Report for Head TSL**

Date/Time: 28.02.2016

Test Laboratory: SPEAG

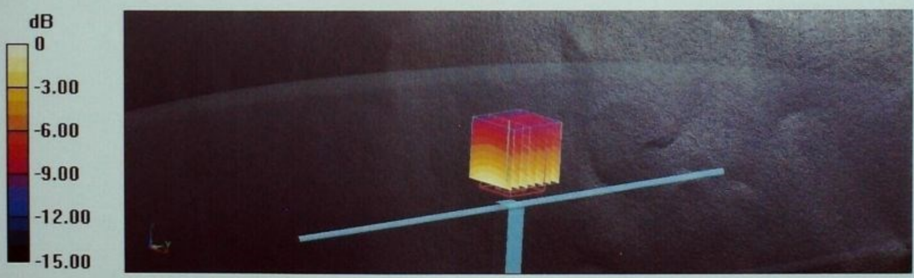
**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1079**

Communication System: CW; Frequency: 450 MHz
Medium parameters used: f = 450 MHz; $\sigma$ = 0.85 mho/m; $\varepsilon_r$ = 43.6; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.59, 6.59, 6.59); Calibrated: 30.12.2015
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 03.05.2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1003
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

**Dipole Calibration for Head Tissue/d=15mm, Pin=398mW/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 49.699 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 2.7560
**SAR(1 g) = 1.81 mW/g; SAR(10 g) = 1.21 mW/g**
Maximum value of SAR (measured) = 1.936 mW/g




0 dB = 1.940mW/g = 5.76 dB mW/g

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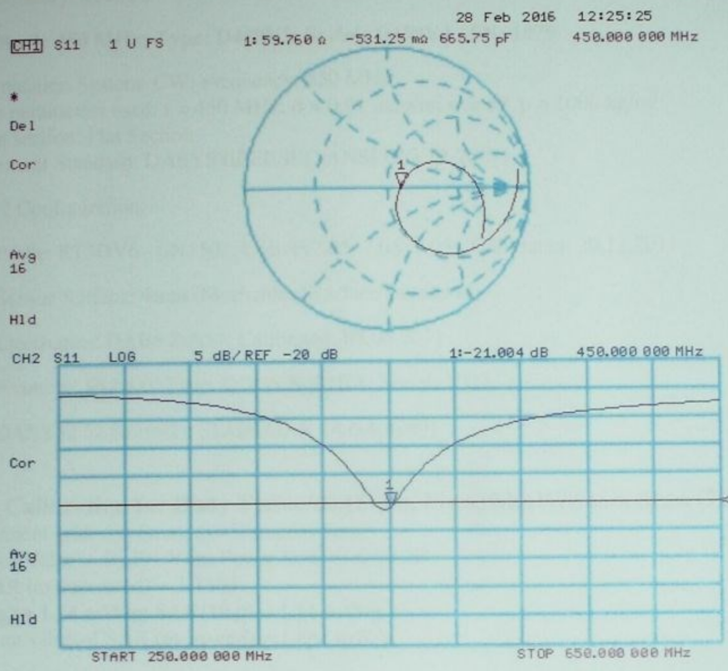
**Impedance Measurement Plot for Head TSL**

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**DASY5 Validation Report for Body TSL**

Date/Time: 28.02.2016

Test Laboratory: SPEAG

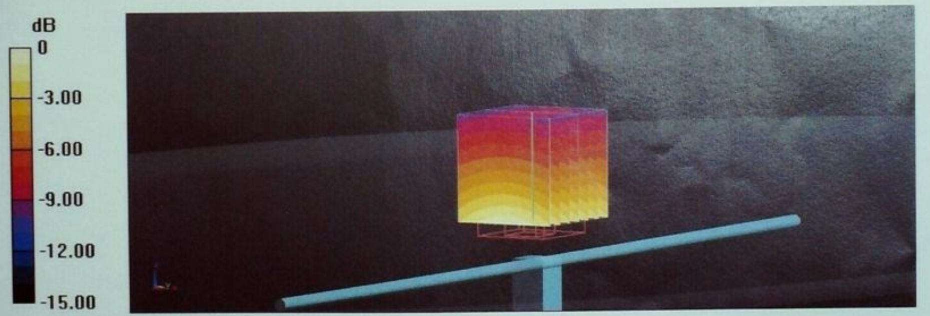
**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1079**

Communication System: CW; Frequency: 450 MHz
Medium parameters used: f = 450 MHz; $\sigma = 0.91$ mho/m; $\varepsilon_r = 55$; $\rho = 1000$ kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(7.05, 7.05, 7.05); Calibrated: 30.12.2015
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 03.05.2015
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1003
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

**Dipole Calibration for Body Tissue/d=15mm, Pin=398mW/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 46.491 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 2.7360
**SAR(1 g) = 1.74 mW/g; SAR(10 g) = 1.16 mW/g**
Maximum value of SAR (measured) = 1.861 mW/g




0 dB = 1.860mW/g = 5.39 dB mW/g

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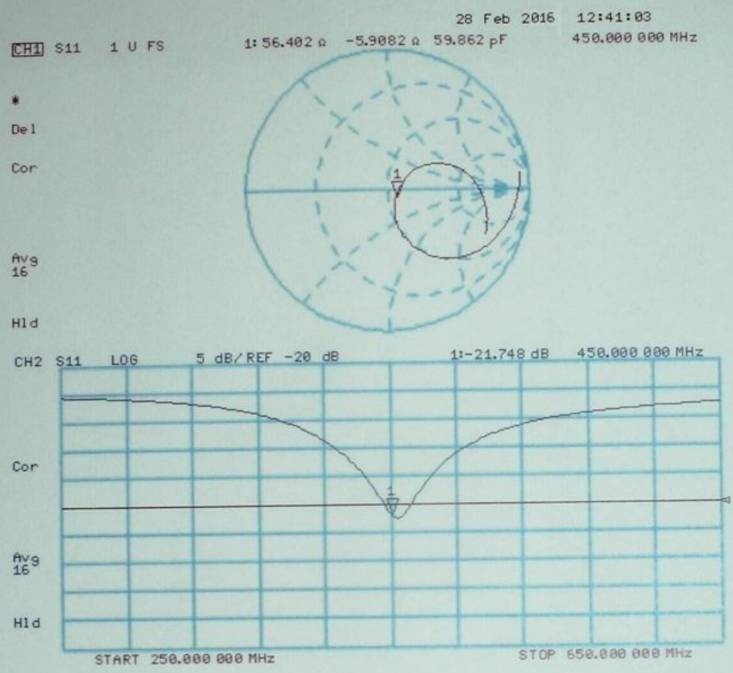
**Impedance Measurement Plot for Body TSL**

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# Extended Dipole Calibrations

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| **Head** | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2016-02-28 | -21.0 | | 59.8 | | 0.5 | |
| 2017-02-27 | -20.5 | 5.93 | 58.9 | -0.9 | 0.8 | 0.3 |

| **Body** | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2016-02-28 | -21.7 | | 56.4 | | 5.9 | |
| 2017-02-27 | -22.6 | -9.84 | 55.7 | -0.7 | 5.2 | -0.7 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5ohm of prior calibration. Therefore the verification result should support extended calibration.

## 1.2. DAE4 Calibration Certificate

In Collaboration with s p e a g CALIBRATION LABORATORY

中国认可 国际互认 校准 CALIBRATION CNAS L0570

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Client : CIQ(Shenzhen) Certificate No: Z17-97109

### CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE4 - SN: 1315 |
| Calibration Procedure(s) | FF-Z11-002-01<br>Calibration Procedure for the Data Acquisition Electronics (DAEx) |
| Calibration date: | August 15, 2017 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Process Calibrator 753 | 1971018 | 27-Jun-17 (CTTL, No.J17X05859) | June-18 |

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

Issued: August 16, 2017



Certificate No: Z17-97109 Page 1 of 3

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E-mail: cttl@chinattl.com Http://www.chinattl.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 = 6.1μV , 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 | 405.175 ± 0.15% (k=2) | 405.013 ± 0.15% (k=2) | 404.971 ± 0.15% (k=2) |
| Low Range | 3.99087 ± 0.7% (k=2) | 3.98644 ± 0.7% (k=2) | 3.98913 ± 0.7% (k=2) |

## Connector Angle

| | |
|---|---|
| Connector Angle to be used in DASY system | 20.5° ± 1 ° |



------End------