







Appendix C. Probe Calibration Data:


In Collaboration with

CALIBRATION LABORATORY



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Client: **AUDEN**      Certificate No: **Z14-97115**

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**CALIBRATION CERTIFICATE**

Object: **ES3DV3 - SN:3028**

Calibration Procedure(s): **TMC-OS-E-02-195**  
**Calibration Procedures for Dosimetric E-field Probes**

Calibration date: **October 22, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

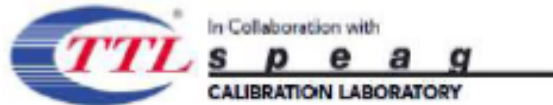
| Primary Standards       | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|--|-----------------------|
| Power Meter NRP2        | 101919     | 01-Jul-14 (CTTL, No.J14X02146)           | Jun-15                |
| Power sensor NRP-Z91    | 101547     | 01-Jul-14 (CTTL, No.J14X02146)           | Jun-15                |
| Power sensor NRP-Z91    | 101548     | 01-Jul-14 (CTTL, No.J14X02146)           | Jun-15                |
| Reference10dBAttenuator | BT0520     | 12-Dec-12(TMC,No.JZ12-867)               | Dec-14                |
| Reference20dBAttenuator | BT0267     | 12-Dec-12(TMC,No.JZ12-866)               | Dec-14                |
| Reference Probe EX3DV4  | SN 3617    | 28-Aug-14(SPEAG,No.EX3-3617_Aug14)       | Aug-15                |
| DAE4                    | SN 1331    | 23-Jan-14 (SPEAG, DAE4-1331_Jan14)       | Jan -15               |
| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| SignalGeneratorMG3700A  | 6201052605 | 01-Jul-14 (CTTL, No.J14X02145)           | Jun-15                |
| Network Analyzer E5071C | MY46110673 | 15-Feb-14 (TMC, No.JZ14-781)             | Feb-15                |

|                |             |                                   |           |
|----------------|-------------|-----------------------------------|-----------|
|                | Name        | Function                          | Signature |
| Calibrated by: | Yu Zongying | SAR Test Engineer                 |           |
| Reviewed by:   | Qi Dianyuan | SAR Project Leader                |           |
| Approved by:   | Lu Bingsong | Deputy Director of the laboratory |           |

Issued: October 23, 2014

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**Glossary:**

|                       |   |
|-----------------------|---|
| TSL                   | tissue simulating liquid  |
| NORM <sub>x,y,z</sub> | sensitivity in free space   |
| ConvF                 | sensitivity in TSL / NORM <sub>x,y,z</sub>  |
| DCP                   | diode compression point   |
| CF                    | crest factor (1/duty_cycle) of the RF signal  |
| A,B,C,D               | modulation dependent linearization parameters   |
| Polarization $\Phi$   | $\Phi$ rotation around probe axis   |
| Polarization $\theta$ | $\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e. $\theta=0$ 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 300MHz to 3GHz)", February 2005

**Methods Applied and Interpretation of Parameters:**

- NORM<sub>x,y,z</sub>: Assessed for E-field polarization  $\theta=0$  ( $f \leq 900$ MHz in TEM-cell;  $f > 1800$ MHz: waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* 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<sub>x,y,z</sub>: DCP are numerical linearization parameters assessed based on the data of power sweep (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.
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; VR<sub>x,y,z</sub>: A,B,C 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  $f \leq 900$ 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 valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* 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  $\pm 50$ MHz to  $\pm 100$ 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<sub>x</sub> (no uncertainty required).



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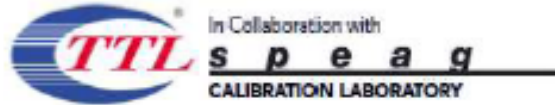
# Probe ES3DV3

## SN: 3028

Calibrated: October 22, 2014

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



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DASY – Parameters of Probe: ES3DV3 - SN: 3028

Basic Calibration Parameters

Table with 5 columns: Parameter, Sensor X, Sensor Y, Sensor Z, Unc (k=2). Rows include Norm(µV/(V/m)²) and DCP(mV).

Modulation Calibration Parameters

Table with 9 columns: UID, Communication System Name, A dB, B dB/µV, C, D dB, VR mV, Unc (k=2). Includes data for CW system across X, Y, Z axes.

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 and Page 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.



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DASY – Parameters of Probe: ES3DV3 - SN: 3028

Calibration Parameter Determined in Head Tissue Simulating Media

Table with 9 columns: f [MHz], Relative Permittivity, Conductivity (S/m), ConvF X, ConvF Y, ConvF Z, Alpha, Depth (mm), and Unct. (k=2). Rows include frequencies from 750 to 2600 MHz.

Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

At frequency below 3 GHz, the validity of tissue parameters (ε and σ) 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 (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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DASY – Parameters of Probe: ES3DV3 - SN: 3028

Calibration Parameter Determined in Body Tissue Simulating Media

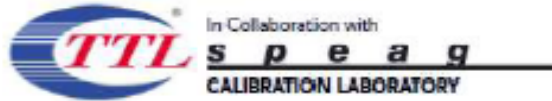
| f [MHz] <sup>c</sup> | Relative Permittivity <sup>f</sup> | Conductivity (S/m) <sup>f</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>g</sup> | Depth <sup>g</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 55.5                               | 0.96                            | 6.02    | 6.02    | 6.02    | 0.33               | 1.68                    | ± 12%       |
| 835                  | 55.2                               | 0.97                            | 6.02    | 6.02    | 6.02    | 0.34               | 1.79                    | ± 12%       |
| 1750                 | 53.4                               | 1.49                            | 4.69    | 4.69    | 4.69    | 0.63               | 1.30                    | ± 12%       |
| 1900                 | 53.3                               | 1.52                            | 4.48    | 4.48    | 4.48    | 0.60               | 1.34                    | ± 12%       |
| 2300                 | 52.9                               | 1.81                            | 4.37    | 4.37    | 4.37    | 0.74               | 1.25                    | ± 12%       |
| 2450                 | 52.7                               | 1.95                            | 4.14    | 4.14    | 4.14    | 0.68               | 1.35                    | ± 12%       |
| 2600                 | 52.5                               | 2.16                            | 4.02    | 4.02    | 4.02    | 0.84               | 1.16                    | ± 12%       |

<sup>c</sup> Frequency validity of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>f</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  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 ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

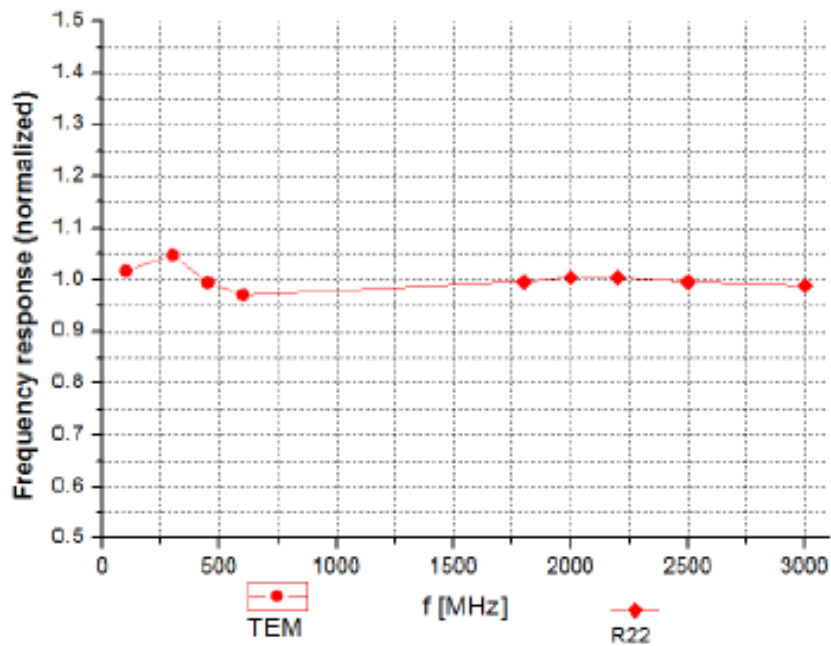
<sup>g</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip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





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### Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)



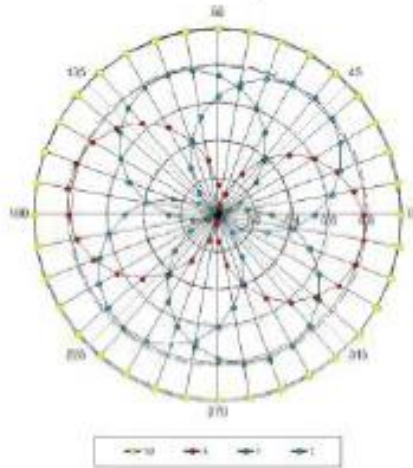
Uncertainty of Frequency Response of E-field:  $\pm 7.5\%$  (k=2)



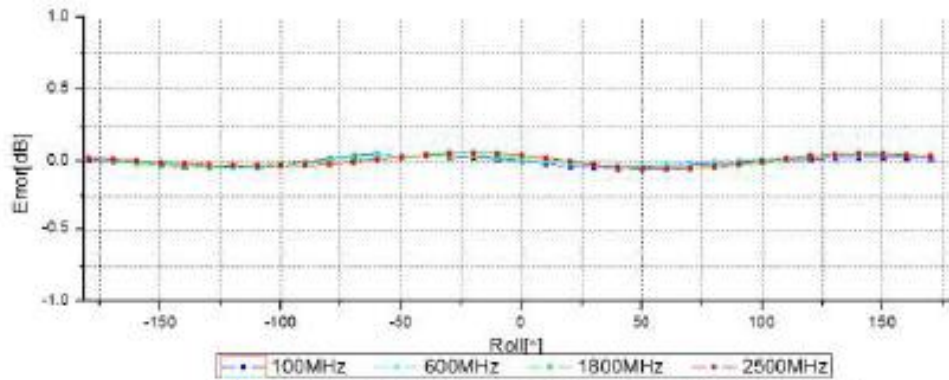
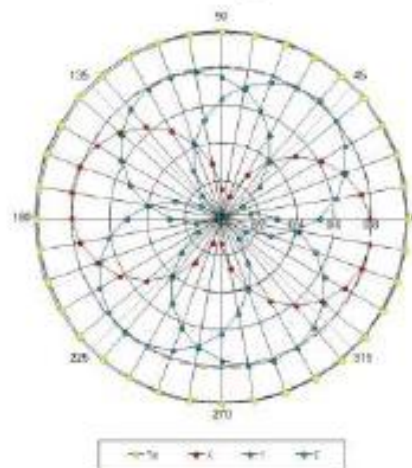
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Receiving Pattern ( $\Phi$ ),  $\theta=0^\circ$

f=600 MHz, TEM



f=1800 MHz, R22



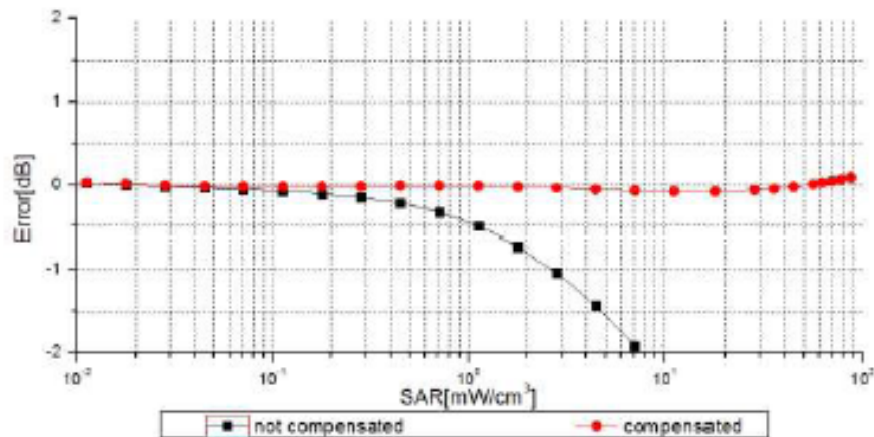
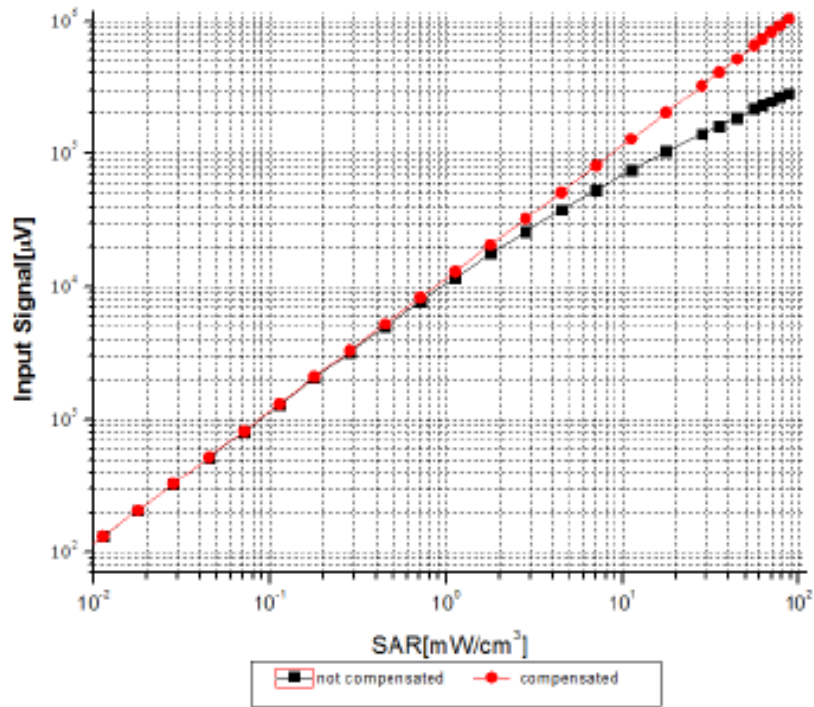
Uncertainty of Axial Isotropy Assessment:  $\pm 0.9\%$  (k=2)





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### Dynamic Range f(SAR<sub>head</sub>) (TEM cell, f = 900 MHz)



Uncertainty of Linearity Assessment: ±0.9% (k=2)

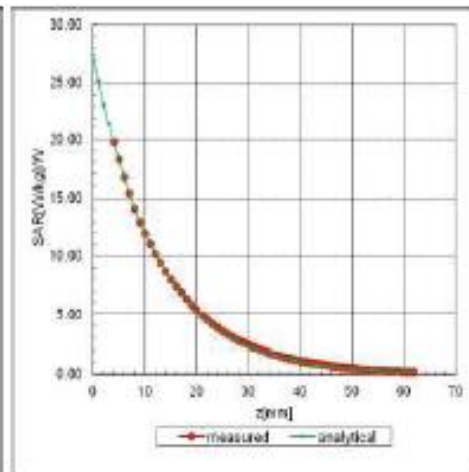
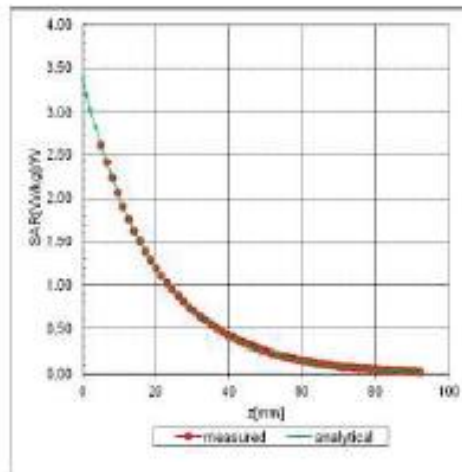


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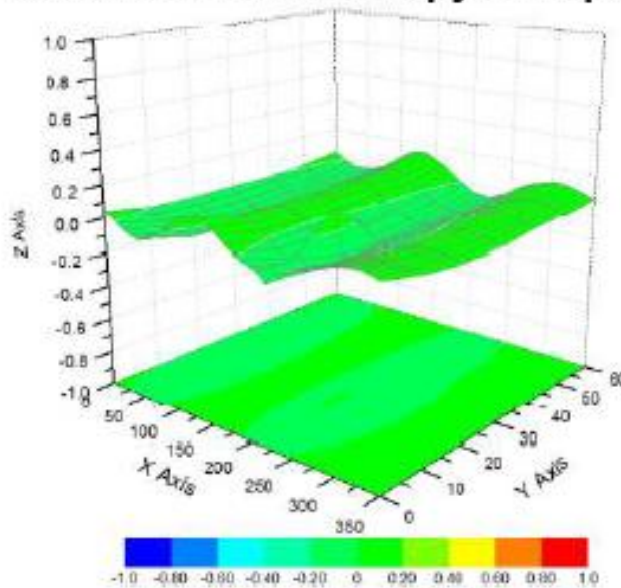
### Conversion Factor Assessment

f=835 MHz, WGLS R9(H\_convF)

f=1750 MHz, WGLS R22(H\_convF)



### Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.8\%$  (K=2)

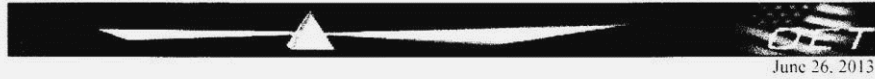


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**DASY - Parameters of Probe: ES3DV3 - SN: 3208**

**Other Probe Parameters**

|   |            |
|---|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 54.8       |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disable    |
| Probe Overall Length                          | 337mm      |
| Probe Body Diameter                           | 10mm       |
| Tip Length                                    | 10mm       |
| Tip Diameter                                  | 4mm        |
| Probe Tip to Sensor X Calibration Point       | 2mm        |
| Probe Tip to Sensor Y Calibration Point       | 2mm        |
| Probe Tip to Sensor Z Calibration Point       | 2mm        |
| Recommended Measurement Distance from Surface | 3mm        |



**Acceptable Conditions for SAR Measurements Using Probes and Dipoles  
Calibrated under the SPEAG-TMC Dual-Logo Calibration Program to  
Support FCC Equipment Certification**

The acceptable conditions for SAR measurements using probes, dipoles and DAEs calibrated by TMC (*Telecommunication Metrology Center of MITT in Beijing, China*), under the Dual-Logo Calibration Certificate program and quality assurance (QA) protocols established between SPEAG (*Schmid & Partner Engineering AG, Switzerland*) and TMC, to support FCC (*U.S. Federal Communications Commission*) equipment certification are defined and described in the following.

- 1) The agreement established between SPEAG and TMC is only applicable to calibration services performed by TMC where its clients (companies and divisions of such companies) are headquartered in the Greater China Region, including Taiwan and Hong Kong. This agreement is subject to renewal at the end of each calendar year between SPEAG and TMC. TMC shall inform the FCC of any changes or early termination to the agreement.
- 2) Only a subset of the calibration services specified in the SPEAG-TMC agreement, while it remains valid, are applicable to SAR measurements performed using such equipment for supporting FCC equipment certification. These are identified in the following.
  - a) Calibration of dosimetric (SAR) probes EX3DVx, ET3DVx and ES3DVx.
    - i) Free-space E-field and H-field probes, including those used for HAC (hearing aid compatibility) evaluation, temperature probes, other probes or equipment not identified in this document, when calibrated by TMC, are excluded and cannot be used for measurements to support FCC equipment certification.
    - ii) Signal specific and bundled probe calibrations based on PMR (probe modulation response) characteristics are handled according to the requirements of KDB 865664; that is, "Until standardized procedures are available to make such determination, the applicability of a signal specific probe calibration for testing specific wireless modes and technologies is determined on a case-by-case basis through KDB inquiries, including SAR system verification requirements."
  - b) Calibration of SAR system validation dipoles, excluding HAC dipoles.
  - c) Calibration of data acquisition electronics DAE3Vx, DAE4Vx and DAEasyVx.
  - d) For FCC equipment certification purposes, the frequency range of SAR probe and dipole calibrations is limited to 700 MHz - 6 GHz and provided it is supported by the equipment identified in the TMC QA protocol (a separate attachment to this document).
  - e) The identical system and equipment setup, measurement configurations, hardware, evaluation algorithms, calibration and QA protocols, including the format of calibration certificates and reports used by SPEAG shall be applied by TMC.
  - f) The calibrated items are only applicable to SPEAG DASY 4 and DASY 5 or higher version systems.



Appendix D. DAE Calibration Data:



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Client : Auden

Certificate No: Z15-97093

| CALIBRATION CERTIFICATE  |  |  |                       |
|--|--|--|-----------------------|
| Object   | DAE4 - SN: 905   |  |                       |
| Calibration Procedure(s)   | FD-Z11-2-002-01<br>Calibration Procedure for the Data Acquisition Electronics (DAEx) |  |                       |
| Calibration date:  | July 16, 2015  |  |                       |
| <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&lt;70%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p> |  |  |                       |
| Primary Standards  | ID #   | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Process Calibrator 753   | 1971018  | 06-July-15 (CTTL, No:J15X04257)          | July-16               |
| Calibrated by:   | Name<br>Yu Zongying  | Function<br>SAR Test Engineer            | Signature<br>         |
| Reviewed by:   | Qi Dianyuan  | SAR Project Leader                       |                       |
| Approved by:   | Lu Bingsong  | Deputy Director of the laboratory        |                       |
| Issued: July 17, 2015  |  |  |                       |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory.  |  |  |                       |





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**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          | 404.672 ± 0.15% (k=2) | 405.235 ± 0.15% (k=2) | 404.825 ± 0.15% (k=2) |
| Low Range           | 3.98116 ± 0.7% (k=2)  | 4.00286 ± 0.7% (k=2)  | 3.99735 ± 0.7% (k=2)  |

Connector Angle

|   |            |
|---|------------|
| Connector Angle to be used in DASY system | 269° ± 1 ° |
|---|------------|



Appendix E. Dipole Calibration Data:



**TMC**

In Collaboration with



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校准  
CNAS L0442

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Client **Sunway** Certificate No: **J13-2-2185**

CALIBRATION CERTIFICATE

Object: **D900V2 - SN: 1d086**

Calibration Procedure(s): **TMC-OS-E-02-194**  
Calibration procedure for dipole validation kits

Calibration date: **August 9, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|--|-----------------------|
| Power Meter NRVD        | 102083     | 11-Sep-12 (TMC, No.JZ12-443)             | Sep-13                |
| Power sensor NRV-Z5     | 100595     | 11-Sep-12 (TMC, No. JZ12-443)            | Sep -13               |
| Reference Probe EX3DV4  | SN 3846    | 20- Dec-12 (SPEAG, No.EX3-3846_Dec12)    | Dec-13                |
| DAE4                    | SN 777     | 22-Feb-13 (SPEAG, DAE4-777_Feb13)        | Feb -14               |
| Signal Generator E4438C | MY49070393 | 13-Nov-12 (TMC, No.JZ12-394)             | Nov-13                |
| Network Analyzer E8362B | MY43021135 | 19-Oct-12 (TMC, No.JZ13-278)             | Oct-13                |

|                | Name        | Function                          | Signature   |
|----------------|-------------|-----------------------------------|---|
| Calibrated by: | Zhao Jing   | SAR Test Engineer                 |  |
| Reviewed by:   | Qi Dianyuan | SAR Project Leader                |  |
| Approved by:   | Xiao Li     | Deputy Director of the laboratory |  |

Issued: August 11, 2013

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Certificate No: J13-2-2185

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CALIBRATION LABORATORY

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**Glossary:**

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

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

- a) 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 300MHz to 3GHz)", February 2005
- c) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**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.

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





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Measurement Conditions

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

Table with 3 columns: Parameter, Value, and Note. Rows include DASY Version (DASY52, 52.8.7.1137), Extrapolation (Advanced Extrapolation), Phantom (Twin Phantom), Distance Dipole Center - TSL (15 mm, with Spacer), Zoom Scan Resolution (dx, dy, dz = 5 mm), and Frequency (900 MHz ± 1 MHz).

Head TSL parameters

The following parameters and calculations were applied.

Table with 4 columns: Parameter, Temperature, Permittivity, and Conductivity. Rows include Nominal Head TSL parameters (22.0 °C, 41.5, 0.97 mho/m), Measured Head TSL parameters ((22.0 ± 0.2) °C, 42.6 ± 6 %, 0.98 mho/m ± 6 %), and Head TSL temperature change during test (<0.5 °C, ---, ---).

SAR result with Head TSL

Table with 3 columns: SAR averaged over 1 cm³ (1 g) of Head TSL, Condition, and SAR measured. Rows include SAR measured (250 mW input power, 2.67 mW / g), SAR for nominal Head TSL parameters (normalized to 1W, 10.7 mW / g ± 20.8 % (k=2)), SAR averaged over 10 cm³ (10 g) of Head TSL, SAR measured (250 mW input power, 1.72 mW / g), and SAR for nominal Head TSL parameters (normalized to 1W, 6.87 mW / g ± 20.4 % (k=2)).

Body TSL parameters

The following parameters and calculations were applied.

Table with 4 columns: Parameter, Temperature, Permittivity, and Conductivity. Rows include Nominal Body TSL parameters (22.0 °C, 55.0, 1.05 mho/m), Measured Body TSL parameters ((22.0 ± 0.2) °C, 54.2 ± 6 %, 1.02 mho/m ± 6 %), and Body TSL temperature change during test (<0.5 °C, ---, ---).

SAR result with Body TSL

Table with 3 columns: SAR averaged over 1 cm³ (1 g) of Body TSL, Condition, and SAR measured. Rows include SAR measured (250 mW input power, 2.63 mW / g), SAR for nominal Body TSL parameters (normalized to 1W, 10.7mW / g ± 20.8 % (k=2)), SAR averaged over 10 cm³ (10 g) of Body TSL, SAR measured (250 mW input power, 1.71 mW / g), and SAR for nominal Body TSL parameters (normalized to 1W, 6.94 mW / g ± 20.4 % (k=2)).



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**Appendix**

**Antenna Parameters with Head TSL**

|                                      |              |
|--------------------------------------|--------------|
| Impedance, transformed to feed point | 49.1Ω-8.85jΩ |
| Return Loss                          | - 22.3dB     |

**Antenna Parameters with Body TSL**

|                                      |              |
|--------------------------------------|--------------|
| Impedance, transformed to feed point | 42.1Ω+0.52jΩ |
| Return Loss                          | - 21.3dB     |

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

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

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

**Additional EUT Data**

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



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### DASY5 Validation Report for Head TSL

Date: 02.08.2013

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 1d086**

Communication System: CW; Frequency: 900 MHz

Medium parameters used:  $f = 900 \text{ MHz}$ ;  $\sigma = 0.982 \text{ mho/m}$ ;  $\epsilon_r = 42.66$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(9.01,9.01,9.01); Calibrated:20,12,2012
- Sensor-Surface: 2mm (Mechanical Surface Detection); 1.0, 31.0
- Electronics: DAE4 Sn777; Calibrated: 22/2/2013
- Phantom: Flat Phantom; Type: QD000P40CC;
- DASY52 52.8.7(1137); SEMCAD X Version 14.6.10 (7164)

#### Dipole Calibration for Head Tissue/Pin=250mW, d=15mm/Zoom Scan

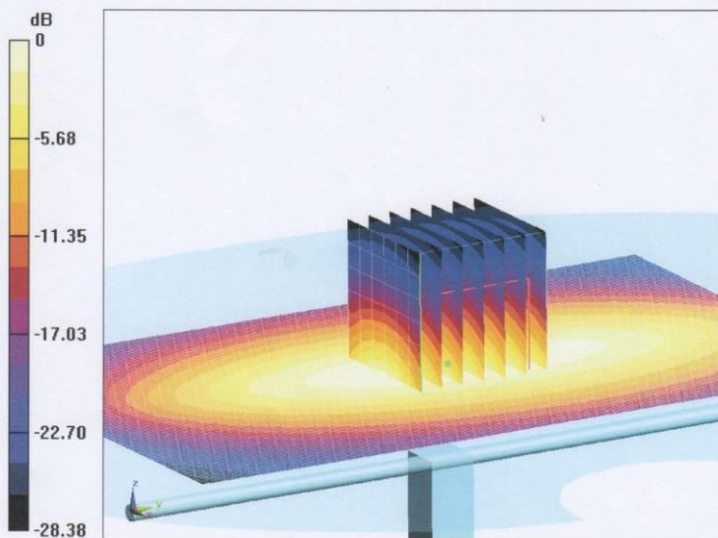
(7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 59.910 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 4.11 W/kg

**SAR(1 g) = 2.67 W/kg; SAR(10 g) = 1.72 W/kg**

Maximum value of SAR (measured) = 3.43 W/kg

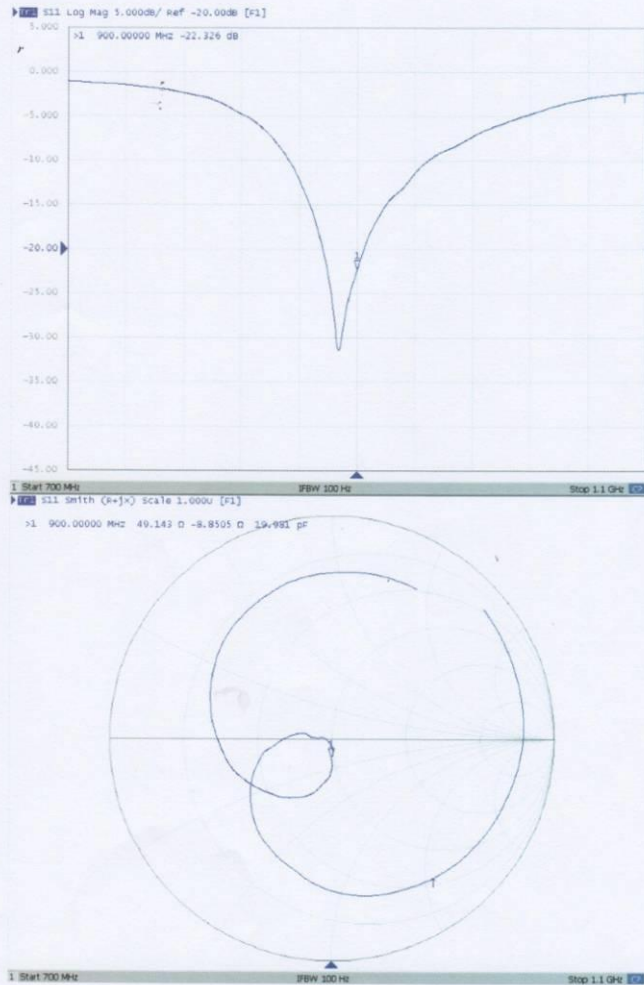






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Impedance Measurement Plot for Head TSL





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### DASY5 Validation Report for Body TSL

Date: 02.08.2013

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 1d086**

Communication System: CW; Frequency: 900 MHz;

Medium parameters used:  $f = 900 \text{ MHz}$ ;  $\sigma = 1.023 \text{ mho/m}$ ;  $\epsilon_r = 54.207$ ;  $\rho = 1000 \text{ kg/m}^3$ .

Phantom section: ELI 4.0

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

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(9.01,9.01,9.01) ; Calibrated:20.12.2012
- Sensor-Surface: 2mm (Mechanical Surface Detection); 1.0, 31.0
- Electronics: DAE4 Sn777; Calibrated: 22/2/2013
- Phantom: ELI 4.0; Type: QDOVA001DB;
- DASY52 52.8.7(1137); SEMCAD X Version 14.6.10 (7164)

#### Dipole Calibration for Body Tissue/Pin=250mW, d=15mm/Zoom Scan

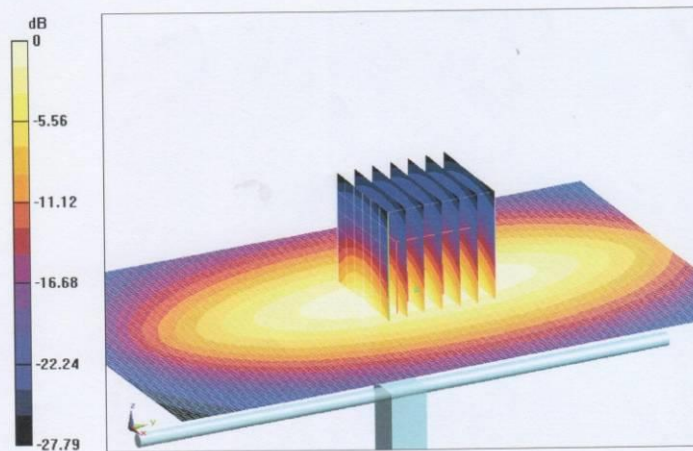
(7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.362 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 3.90 W/kg

**SAR(1 g) = 2.63 W/kg; SAR(10 g) = 1.71 W/kg**

Maximum value of SAR (measured) = 3.33 W/kg

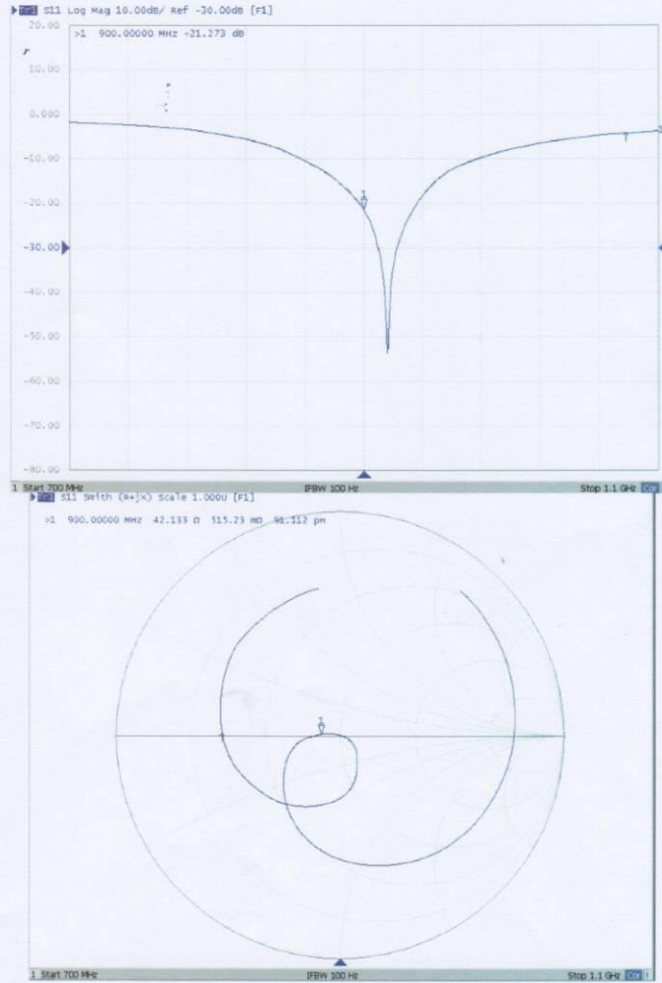


0 dB = 3.31 W/kg = 5.19 dBW/kg



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Impedance Measurement Plot for Body TSL







**Acceptable Conditions for SAR Measurements Using Probes and Dipoles  
Calibrated under the SPEAG-TMC Dual-Logo Calibration Program to  
Support FCC Equipment Certification**

The acceptable conditions for SAR measurements using probes, dipoles and DAEs calibrated by TMC (*Telecommunication Metrology Center of MITT in Beijing, China*), under the Dual-Logo Calibration Certificate program and quality assurance (QA) protocols established between SPEAG (*Schmid & Partner Engineering AG, Switzerland*) and TMC, to support FCC (*U.S. Federal Communications Commission*) equipment certification are defined and described in the following.

- 1) The agreement established between SPEAG and TMC is only applicable to calibration services performed by TMC where its clients (companies and divisions of such companies) are headquartered in the Greater China Region, including Taiwan and Hong Kong. This agreement is subject to renewal at the end of each calendar year between SPEAG and TMC. TMC shall inform the FCC of any changes or early termination to the agreement.
- 2) Only a subset of the calibration services specified in the SPEAG-TMC agreement, while it remains valid, are applicable to SAR measurements performed using such equipment for supporting FCC equipment certification. These are identified in the following.
  - a) Calibration of dosimetric (SAR) probes EX3DVx, ET3DVx and ES3DVx.
    - i) Free-space E-field and H-field probes, including those used for HAC (hearing aid compatibility) evaluation, temperature probes, other probes or equipment not identified in this document, when calibrated by TMC, are excluded and cannot be used for measurements to support FCC equipment certification.
    - ii) Signal specific and bundled probe calibrations based on PMR (probe modulation response) characteristics are handled according to the requirements of KDB 865664; that is, "Until standardized procedures are available to make such determination, the applicability of a signal specific probe calibration for testing specific wireless modes and technologies is determined on a case-by-case basis through KDB inquiries, including SAR system verification requirements."
  - b) Calibration of SAR system validation dipoles, excluding HAC dipoles.
  - c) Calibration of data acquisition electronics DAE3Vx, DAE4Vx and DAEasyVx.
  - d) For FCC equipment certification purposes, the frequency range of SAR probe and dipole calibrations is limited to 700 MHz - 6 GHz and provided it is supported by the equipment identified in the TMC QA protocol (a separate attachment to this document).
  - e) The identical system and equipment setup, measurement configurations, hardware, evaluation algorithms, calibration and QA protocols, including the format of calibration certificates and reports used by SPEAG shall be applied by TMC.
  - f) The calibrated items are only applicable to SPEAG DASY 4 and DASY 5 or higher version systems.



- 3) The SPEAG-TMC agreement includes specific protocols identified in the following to ensure the quality of calibration services provided by TMC under this SPEAG-TMC Dual-Logo calibration agreement are equivalent to the calibration services provided by SPEAG. TMC shall, upon request, provide copies of documentation to the FCC to substantiate program implementation.
  - a) The Inter-laboratory Calibration Evaluation (ILCE) stated in the TMC QA protocol shall be performed between SPEAG and TMC at least once every 12 months. The ILCE acceptance criteria defined in the TMC QA protocol shall be satisfied for the TMC, SPEAG and FCC agreements to remain valid.
  - b) Check of Calibration Certificate (CCC) shall be performed by SPEAG for all calibrations performed by TMC. Written confirmation from SPEAG is required for TMC to issue calibration certificates under the SPEAG-TMC Dual-Logo calibration program. Quarterly reports for all calibrations performed by TMC under the program are also issued by SPEAG.
  - c) The calibration equipment and measurement system used by TMC shall be verified before each calibration service according to the specific reference SAR probes, dipoles, and DAE calibrated by SPEAG. The results shall be reproducible and within the defined acceptance criteria specified in the TMC QA protocol before each actual calibration can commence. TMC shall maintain records of the measurement and calibration system verification results for all calibrations.
  - d) Quality Check of Calibration (QCC) certificates shall be performed by SPEAG at least once every 12 months. SPEAG shall visit TMC facilities to verify the laboratory, equipment, applied procedures and plausibility of randomly selected certificates.
- 4) A copy of this document, to be updated annually, shall be provided to TMC clients that accept calibration services according to the SPEAG-TMC Dual-Logo calibration program, which should be presented to a TCB (*Telecommunication Certification Body*), to facilitate FCC equipment approval.
- 5) TMC shall address any questions raised by its clients or TCBs relating to the SPEAG-TMC Dual-Logo calibration program and inform the FCC and SPEAG of any critical issues.

Change Note: Revised on June 26 to clarify the applicability of PMR and Bundled probe calibrations according to the requirements of KDB 865664.



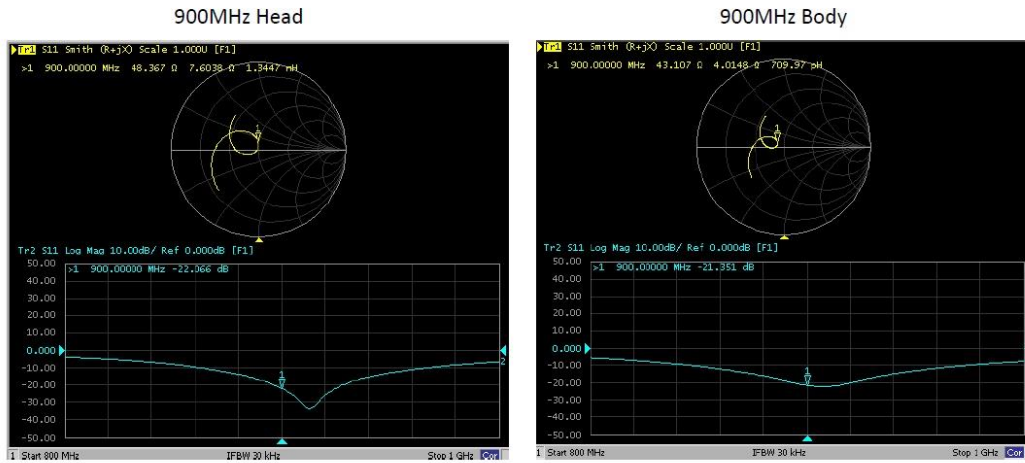
D900V2, serial no. 1d086 Extended Dipole Calibrations

Referring to KDB 865664D01V01r03, 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.

| D900V2, serial no. 1d086 |                  |           |                      |             |                  |           |                      |             |
|--------------------------|------------------|-----------|----------------------|-------------|------------------|-----------|----------------------|-------------|
| Date of Measurement      | 900 Head         |           |                      |             | 900 Body         |           |                      |             |
|                          | Return-Loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Return-Loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) |
| 2013-8-9                 | -22.3            |           | 49.2                 |             | -21.3            |           | 42.1                 |             |
| 2014-8-8                 | -22.21           | 0.41      | 49.12                | -0.08       | -21.1            | 0.94      | 42.25                | -0.15       |
| 2015-8-4                 | -22.1            | 0.9       | 48.4                 | -0.8        | -21.4            | -0.5      | 43.1                 | 1.0         |

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

<Dipole Verification Data>- D900V2, serial no. 1d086







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Client **Sunway**

Certificate No: **J13-2-2184**

**CALIBRATION CERTIFICATE**

Object: **D1750V2 - SN: 1021**

Calibration Procedure(s): **TMC-OS-E-02-194  
Calibration procedure for dipole validation kits**

Calibration date: **August 2, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-----------------------------|------------|--|-----------------------|
| Power Meter NRVD            | 102083     | 11-Sep-12 (TMC, No.JZ12-443)             | Sep-13                |
| Power sensor NRV-Z5         | 100595     | 11-Sep-12 (TMC, No. JZ12-443)            | Sep -13               |
| Reference Probe EX3DV4 DAE4 | SN 3846    | 20- Dec-12 (SPEAG, No.EX3-3846_Dec12)    | Dec-13                |
|                             | SN 777     | 22-Feb-13 (SPEAG, DAE4-777_Feb13)        | Feb -14               |
| Signal Generator E4438C     | MY49070393 | 13-Nov-12 (TMC, No.JZ12-394)             | Nov-13                |
| Network Analyzer E8362B     | MY43021135 | 19-Oct-12 (TMC, No.JZ13-278)             | Oct-13                |

|                | Name        | Function                          | Signature |
|----------------|-------------|-----------------------------------|-----------|
| Calibrated by: | Zhao Jing   | SAR Test Engineer                 |           |
| Reviewed by:   | Qi Dianyuan | SAR Project Leader                |           |
| Approved by:   | Xiao Li     | Deputy Director of the laboratory |           |

Issued: August 6, 2013

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



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**Glossary:**

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

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

- a) 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 300MHz to 3GHz)", February 2005
- c) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**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.

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



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Measurement Conditions

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

Table with 3 columns: Parameter, Value, and Note. Rows include DASY Version (DASY52, 52.8.7.1137), Extrapolation (Advanced Extrapolation), Phantom (Twin Phantom), Distance Dipole Center - TSL (10 mm, with Spacer), Zoom Scan Resolution (dx, dy, dz = 5 mm), and Frequency (1750 MHz ± 1 MHz).

Head TSL parameters

The following parameters and calculations were applied.

Table with 4 columns: Parameter, Temperature, Permittivity, and Conductivity. Rows include Nominal Head TSL parameters (22.0 °C, 40.1, 1.37 mho/m), Measured Head TSL parameters ((22.0 ± 0.2) °C, 40.6 ± 6 %, 1.35 mho/m ± 6 %), and Head TSL temperature change during test (<0.5 °C, ---, ---).

SAR result with Head TSL

Table with 3 columns: SAR averaged over 1 cm³ (1g) of Head TSL, Condition, and SAR measured. Rows include SAR measured (250 mW input power, 8.54 mW / g), SAR for nominal Head TSL parameters (normalized to 1W, 34.6 mW /g ± 20.8 % (k=2)), SAR averaged over 10 cm³ (10g) of Head TSL, SAR measured (250 mW input power, 4.55 mW / g), and SAR for nominal Head TSL parameters (normalized to 1W, 18.3 mW /g ± 20.4 % (k=2)).

Body TSL parameters

The following parameters and calculations were applied.

Table with 4 columns: Parameter, Temperature, Permittivity, and Conductivity. Rows include Nominal Body TSL parameters (22.0 °C, 53.4, 1.49 mho/m), Measured Body TSL parameters ((22.0 ± 0.2) °C, 53.4 ± 6 %, 1.52 mho/m ± 6 %), and Body TSL temperature change during test (<0.5 °C, ---, ---).

SAR result with Body TSL

Table with 3 columns: SAR averaged over 1 cm³ (1g) of Body TSL, Condition, and SAR measured. Rows include SAR measured (250 mW input power, 9.52mW / g), SAR for nominal Body TSL parameters (normalized to 1W, 37.5 mW /g ± 20.8 % (k=2)), SAR averaged over 10 cm³ (10g) of Body TSL, SAR measured (250 mW input power, 5.06 mW / g), and SAR for nominal Body TSL parameters (normalized to 1W, 20.1 mW /g ± 20.4 % (k=2)).





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**Appendix**

**Antenna Parameters with Head TSL**

|                                      |              |
|--------------------------------------|--------------|
| Impedance, transformed to feed point | 46.3Ω-0.22jΩ |
| Return Loss                          | - 31.0dB     |

**Antenna Parameters with Body TSL**

|                                      |              |
|--------------------------------------|--------------|
| Impedance, transformed to feed point | 49.5Ω-2.36jΩ |
| Return Loss                          | - 27.5dB     |

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

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

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

**Additional EUT Data**

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



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### DASY5 Validation Report for Head TSL

Date: 02.08.2013

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1021**

Communication System: CW; Frequency: 1750 MHz

Medium parameters used:  $f = 1750$  MHz;  $\sigma = 1.35$  mho/m;  $\epsilon_r = 40.554$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(8.39, 8.39,8.39); Calibrated:20,12,2012
- Sensor-Surface: 2mm (Mechanical Surface Detection);1.0, 31.0
- Electronics: DAE4 Sn777; Calibrated: 22/2/2013
- Phantom: Flat Phantom; Type: QD000P40CC;
- DASY52 52.8.7(1137); SEMCAD X Version 14.6.10 (7164)

#### Dipole Calibration for Head Tissue/Pin=250mW, d=10mm/Zoom Scan

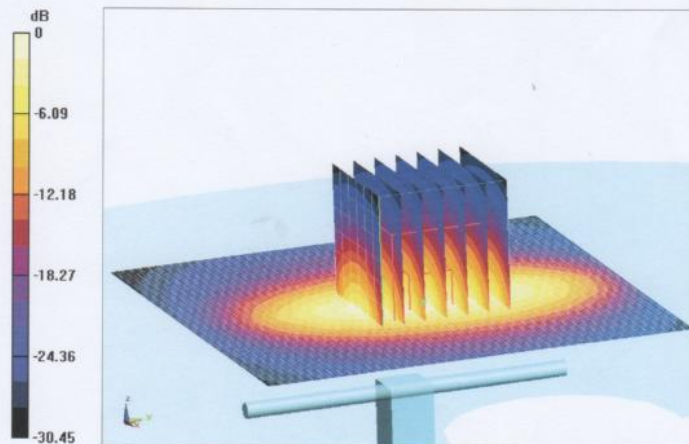
(7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 92.999 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 15.5 W/kg

**SAR(1 g) = 8.54 W/kg; SAR(10 g) = 4.55 W/kg**

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



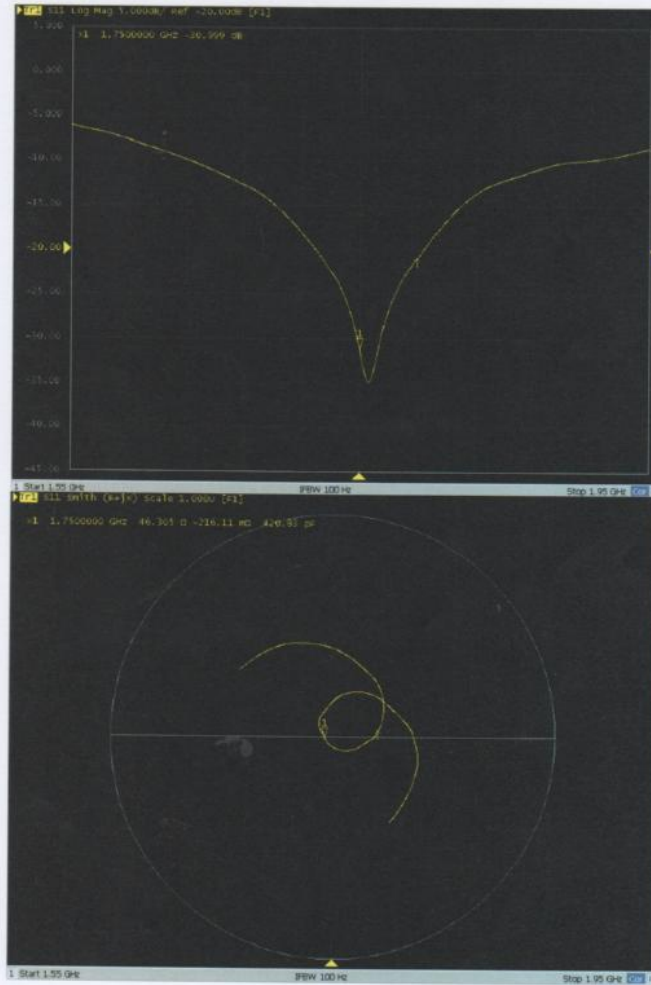
0 dB = 12.1 W/kg = 10.81 dBW/kg





Add: No.52 Huayuanbei Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
E-mail: Info@emcite.com [Http://www.emcite.com](http://www.emcite.com)

Impedance Measurement Plot for Head TSL





Add: No.52 Huayuanbei Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
E-mail: Info@emcite.com [Http://www.emcite.com](http://www.emcite.com)

**DASY5 Validation Report for Body TSL**

Date: 02.08.2013

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1021**

Communication System: CW; Frequency: 1750 MHz;

Medium parameters used:  $f = 1750 \text{ MHz}$ ;  $\sigma = 1.524 \text{ mho/m}$ ;  $\epsilon_r = 53.401$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Phantom

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

**DASY5 Configuration:**

- Probe: EX3DV4 - SN3846; ConvF(7.63,7.63,7.63) ; Calibrated:20.12.2012
- Sensor-Surface: 2mm (Mechanical Surface Detection); 1.0, 31.0
- Electronics: DAE4 Sn777; Calibrated: 22/2/2013
- Phantom: ELI v4.0 1033;Type: QDOVA001BB;
- DASY52 52.8.7(1137); SEMCAD X Version 14.6.10 (7164)

**Dipole Calibration for Body Tissue/Pin=250mW, d=10mm/Zoom Scan**

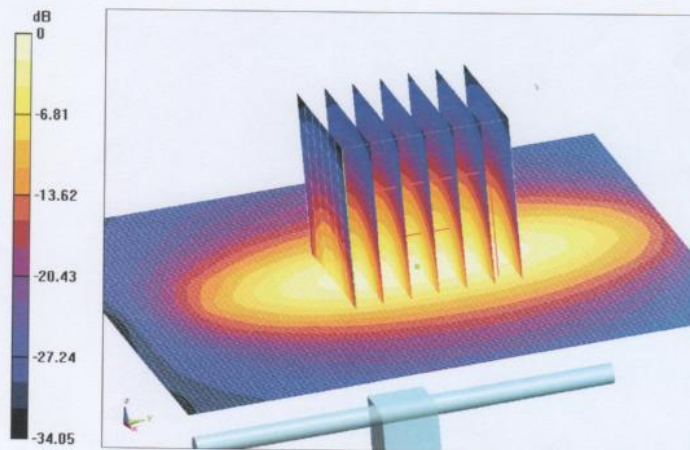
(7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.233 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 16.9 W/kg

**SAR(1 g) = 9.52 W/kg; SAR(10 g) = 5.06 W/kg**

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

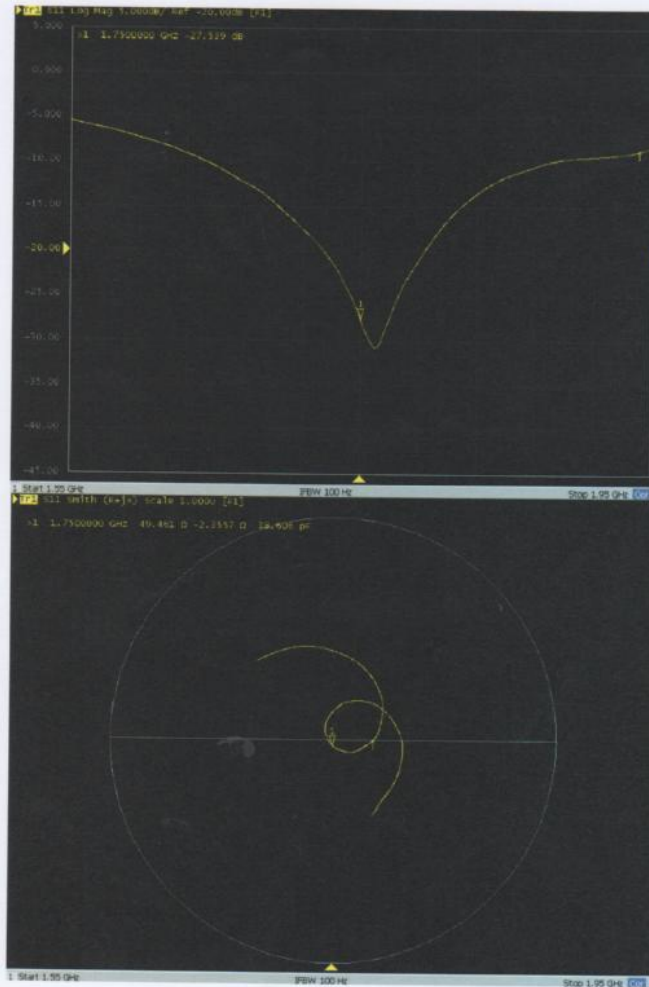


0 dB = 13.6 W/kg = 11.33 dBW/kg



Add: No.52 Huayuanbei Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
E-mail: Info@emcite.com [Http://www.emcite.com](http://www.emcite.com)

Impedance Measurement Plot for Body TSL





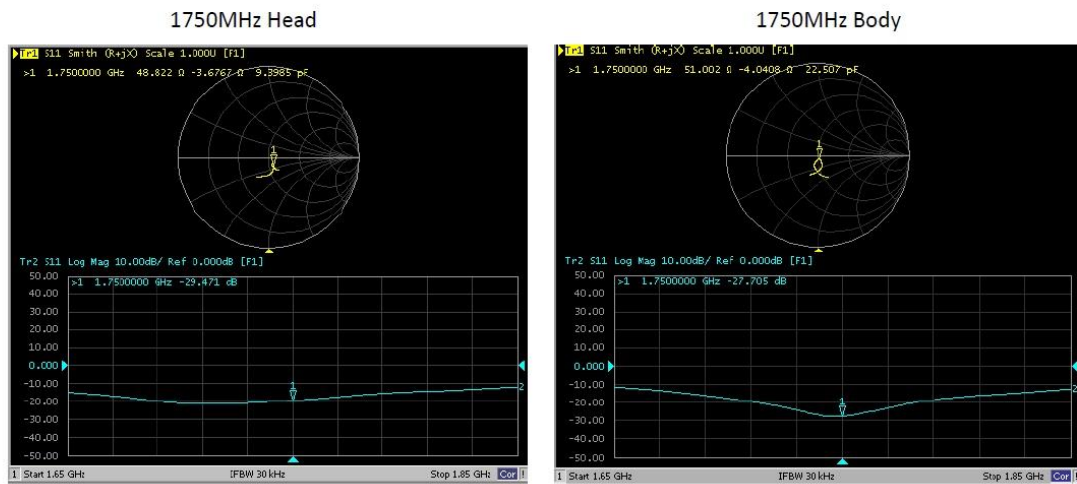
D1750V2, serial no. 1021 Extended Dipole Calibrations

Referring to KDB 865664D01V01r03, 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.

| D1750V2, serial no. 1021 |                  |           |                      |             |                  |           |                      |             |
|--------------------------|------------------|-----------|----------------------|-------------|------------------|-----------|----------------------|-------------|
| Date of Measurement      | 1750 Head        |           |                      |             | 1750 Body        |           |                      |             |
|                          | Return-Loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Return-Loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) |
| 2013-8-2                 | -31.0            |           | 46.3                 |             | -27.5            |           | 49.5                 |             |
| 2014-8-1                 | -28.7            | 7.4       | 49.9                 | 3.6         | -25.5            | 7.3       | 49.1                 | -0.4        |
| 2015-7-31                | -29.5            | 4.8       | 48.8                 | 2.5         | -27.7            | -0.7      | 51.0                 | 1.5         |

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

<Dipole Verification Data>- D1750V2, serial no. 1021







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



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Accreditation No.: SCS 0108

Client SMQ (Auden)

Certificate No: D1900V2-5d194\_Jan15

CALIBRATION CERTIFICATE

Object D1900V2 - SN: 5d194
Calibration procedure(s) QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz
Calibration date: January 07, 2015

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)

Table with 4 columns: Standards, ID #, Cal Date (Certificate No.), Scheduled Calibration. Includes Primary Standards (Power meter, Power sensor, Reference 20 dB Attenuator, Type-N mismatch combination, Reference Probe, DAE4) and Secondary Standards (RF generator, Network Analyzer).

Calibrated by: Claudio Leubler, Laboratory Technician
Approved by: Katja Pokovic, Technical Manager

Issued: January 7, 2015

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



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Zeughausstrasse 43, 8004 Zurich, Switzerland



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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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



### Measurement Conditions

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.8     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 1900 MHz ± 1 MHz       |             |

### Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters             | 22.0 °C         | 40.0         | 1.40 mho/m       |
| Measured Head TSL parameters            | (22.0 ± 0.2) °C | 40.1 ± 6 %   | 1.39 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                                 |
|---|--------------------|---------------------------------|
| SAR measured  | 250 mW input power | 10.1 W/kg                       |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>40.6 W/kg ± 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                 |
|---|--------------------|---------------------------------|
| SAR measured  | 250 mW input power | 5.32 W/kg                       |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>21.3 W/kg ± 16.5 % (k=2)</b> |

### Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 53.3         | 1.52 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 53.3 ± 6 %   | 1.50 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                                 |
|---|--------------------|---------------------------------|
| SAR measured  | 250 mW input power | 9.95 W/kg                       |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>40.1 W/kg ± 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                 |
|---|--------------------|---------------------------------|
| SAR measured  | 250 mW input power | 5.31 W/kg                       |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>21.3 W/kg ± 16.5 % (k=2)</b> |



**Appendix (Additional assessments outside the scope of SCS108)**

**Antenna Parameters with Head TSL**

|                                      |                                 |
|--------------------------------------|---------------------------------|
| Impedance, transformed to feed point | 53.7 $\Omega$ + 4.9 $\mu\Omega$ |
| Return Loss                          | - 24.5 dB                       |

**Antenna Parameters with Body TSL**

|                                      |                                 |
|--------------------------------------|---------------------------------|
| Impedance, transformed to feed point | 48.9 $\Omega$ + 5.1 $\mu\Omega$ |
| Return Loss                          | - 25.6 dB                       |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.201 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 | May 06, 2014 |





**DASY5 Validation Report for Head TSL**

Date: 07.12.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d194**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.39$  S/m;  $\epsilon_r = 40.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5, 5, 5); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

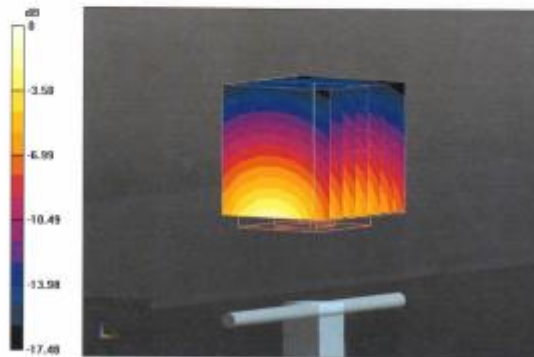
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.35 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 18.5 W/kg

**SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.32 W/kg**

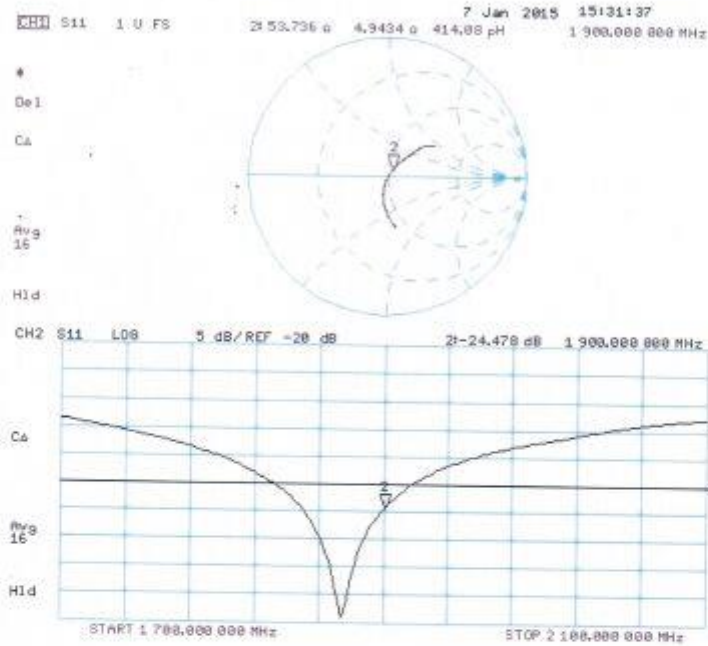
Maximum value of SAR (measured) = 12.7 W/kg



0 dB = 12.7 W/kg = 11.04 dBW/kg



Impedance Measurement Plot for Head TSL





**DASY5 Validation Report for Body TSL**

Date: 07.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d194**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.5$  S/m;  $\epsilon_r = 53.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.65, 4.65, 4.65); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

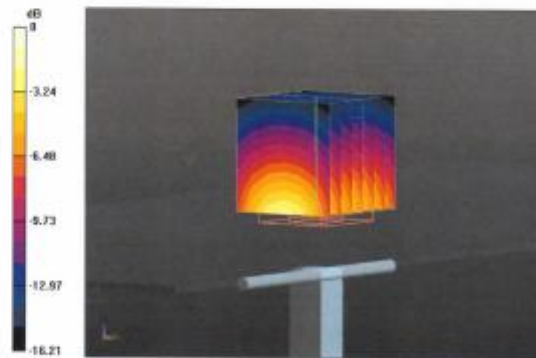
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.88 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 16.8 W/kg

**SAR(1 g) = 9.95 W/kg; SAR(10 g) = 5.31 W/kg**

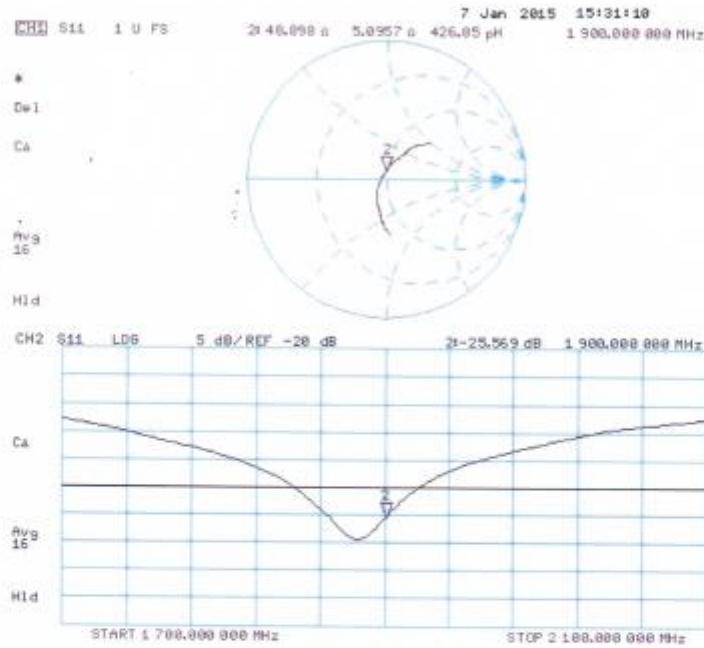
Maximum value of SAR (measured) = 12.6 W/kg



0 dB = 12.6 W/kg = 11.00 dBW/kg



Impedance Measurement Plot for Body TSL







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Accreditation No.: SCS 0108

Client SMQ (Auden)

Certificate No: D2450V2-955\_Jan15/2

CALIBRATION CERTIFICATE (Replacement of No: D2450V2-955\_Jan15)

Object: D2450V2 - SN: 955
Calibration procedure(s): QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz
Calibration date: January 08, 2015

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)

Table with 4 columns: Primary Standards, ID #, Cal Date (Certificate No.), Scheduled Calibration. Lists equipment like Power meter EPM-442A, Power sensor HP 8481A, Reference 20 dB Attenuator, etc.

Table with 4 columns: Secondary Standards, ID #, Check Date (in house), Scheduled Check. Lists equipment like RF generator R&S SMT-06, Network Analyzer HP 8753E.

Calibrated by: Claudio Leubler, Laboratory Technician
Approved by: Katja Pokovic, Technical Manager
Includes handwritten signatures.

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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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



Measurement Conditions

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.8     |
| 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 ± 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 ± 0.2) °C | 39.7 ± 6 %   | 1.84 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                          |
|---|--------------------|--------------------------|
| SAR measured  | 250 mW input power | 13.2 W/kg                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 52.4 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                          |
|---|--------------------|--------------------------|
| SAR measured  | 250 mW input power | 6.12 W/kg                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.4 W/kg ± 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 52.7         | 1.95 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 51.0 ± 6 %   | 2.03 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

SAR result with Body TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                          |
|---|--------------------|--------------------------|
| SAR measured  | 250 mW input power | 13.8 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 53.7 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
|---|--------------------|--------------------------|
| SAR measured  | 250 mW input power | 6.36 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 25.0 W/kg ± 16.5 % (k=2) |



**Appendix (Additional assessments outside the scope of SCS108)**

**Antenna Parameters with Head TSL**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.8 $\Omega$ + 3.5 j $\Omega$ |
| Return Loss                          | - 24.9 dB                      |

**Antenna Parameters with Body TSL**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.2 $\Omega$ + 4.9 j $\Omega$ |
| Return Loss                          | - 26.0 dB                      |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.165 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 | August 05, 2014 |





**DASY5 Validation Report for Head TSL**

Date: 08.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 955**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.84$  S/m;  $\epsilon_r = 39.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

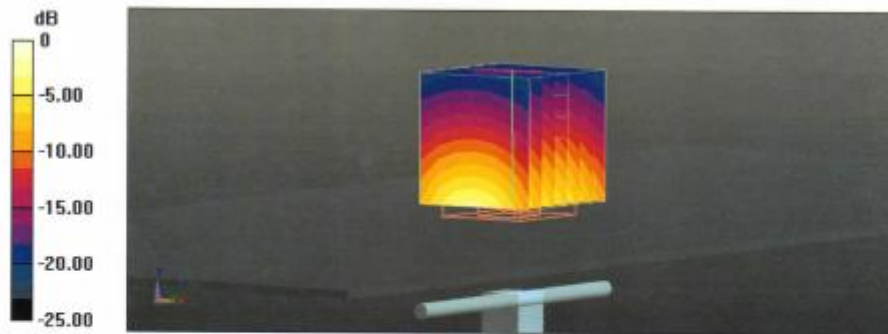
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.2 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 27.5 W/kg

**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.12 W/kg**

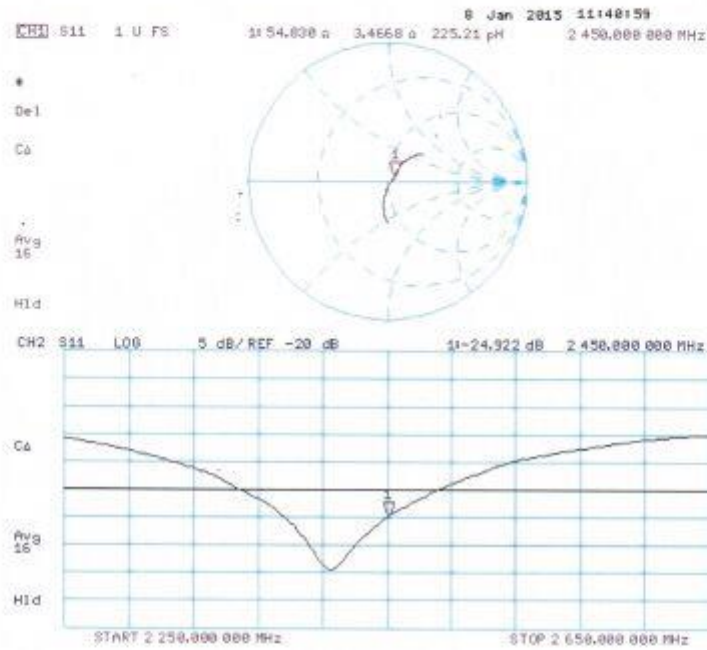
Maximum value of SAR (measured) = 17.5 W/kg



0 dB = 17.5 W/kg = 12.43 dBW/kg



Impedance Measurement Plot for Head TSL





**DASY5 Validation Report for Body TSL**

Date: 08.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 955**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 51$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.17, 4.17, 4.17); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

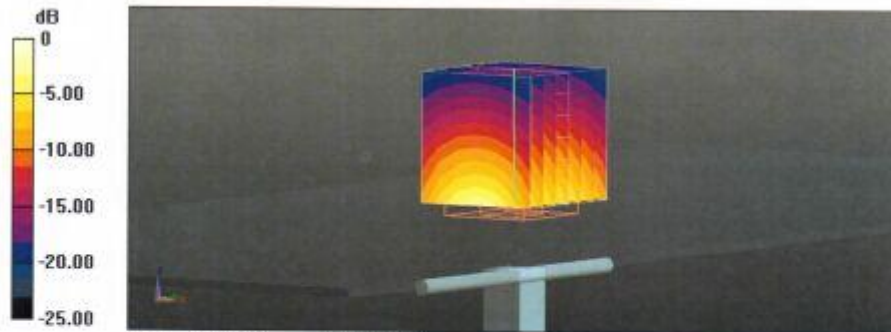
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.96 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 28.8 W/kg

**SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.36 W/kg**

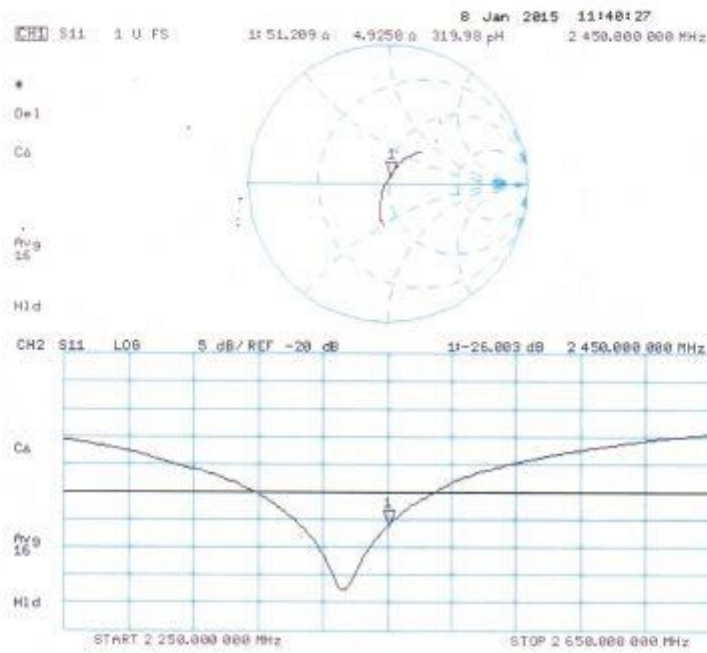
Maximum value of SAR (measured) = 18.3 W/kg



0 dB = 18.3 W/kg = 12.62 dBW/kg



Impedance Measurement Plot for Body TSL







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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Auden**

Certificate No: **D2600V2-1058\_Jun14**

## CALIBRATION CERTIFICATE

Object **D2600V2 - SN: 1058**

Calibration procedure(s) **QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **June 23, 2014**

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 EPM-442A        | GB37480704         | 09-Oct-13 (No. 217-01827)         | Oct-14                 |
| Power sensor HP 8481A       | US37292783         | 09-Oct-13 (No. 217-01827)         | Oct-14                 |
| Power sensor HP 8481A       | MY41092317         | 09-Oct-13 (No. 217-01828)         | Oct-14                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 03-Apr-14 (No. 217-01918)         | Apr-15                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921)         | Apr-15                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-13 (No. ES3-3205_Dec13)    | Dec-14                 |
| DAE4                        | SN: 601            | 30-Apr-14 (No. DAE4-601_Apr14)    | Apr-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

|                |                              |  |               |
|----------------|------------------------------|--|---------------|
| Calibrated by: | Name<br><b>Michael Weber</b> | Function<br><b>Laboratory Technician</b> | Signature<br> |
| Approved by:   | Name<br><b>Katja Pokovic</b> | Function<br><b>Technical Manager</b>     | Signature<br> |

Issued: June 23, 2014

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



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



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**S** Servizio svizzero di taratura  
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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:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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



### Measurement Conditions

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.8     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 2600 MHz ± 1 MHz       |             |

### Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Head TSL parameters             | 22.0 °C         | 39.0         | 1.96 mho/m       |
| Measured Head TSL parameters            | (22.0 ± 0.2) °C | 38.0 ± 6 %   | 2.00 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                                 |
|---|--------------------|---------------------------------|
| SAR measured  | 250 mW input power | 14.7 W/kg                       |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>57.9 W/kg ± 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                 |
|---|--------------------|---------------------------------|
| SAR measured  | 250 mW input power | 6.60 W/kg                       |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>26.2 W/kg ± 16.5 % (k=2)</b> |

### Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature     | Permittivity | Conductivity     |
|---|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 52.5         | 2.16 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 50.8 ± 6 %   | 2.19 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                                 |
|---|--------------------|---------------------------------|
| SAR measured  | 250 mW input power | 14.4 W/kg                       |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>56.8 W/kg ± 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                 |
|---|--------------------|---------------------------------|
| SAR measured  | 250 mW input power | 6.37 W/kg                       |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>25.3 W/kg ± 16.5 % (k=2)</b> |



**Appendix (Additional assessments outside the scope of SCS108)**

**Antenna Parameters with Head TSL**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.2 $\Omega$ - 6.3 j $\Omega$ |
| Return Loss                          | - 24.0 dB                      |

**Antenna Parameters with Body TSL**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 45.7 $\Omega$ - 4.6 j $\Omega$ |
| Return Loss                          | - 23.7 dB                      |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.150 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 | August 14, 2012 |





**DASY5 Validation Report for Head TSL**

Date: 18.06.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1058**

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used:  $f = 2600$  MHz;  $\sigma = 2$  S/m;  $\epsilon_r = 38$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.46, 4.46, 4.46); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

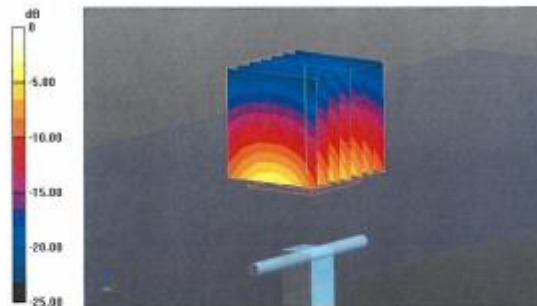
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 103,4 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 30.9 W/kg

**SAR(1 g) = 14.7 W/kg; SAR(10 g) = 6.6 W/kg**

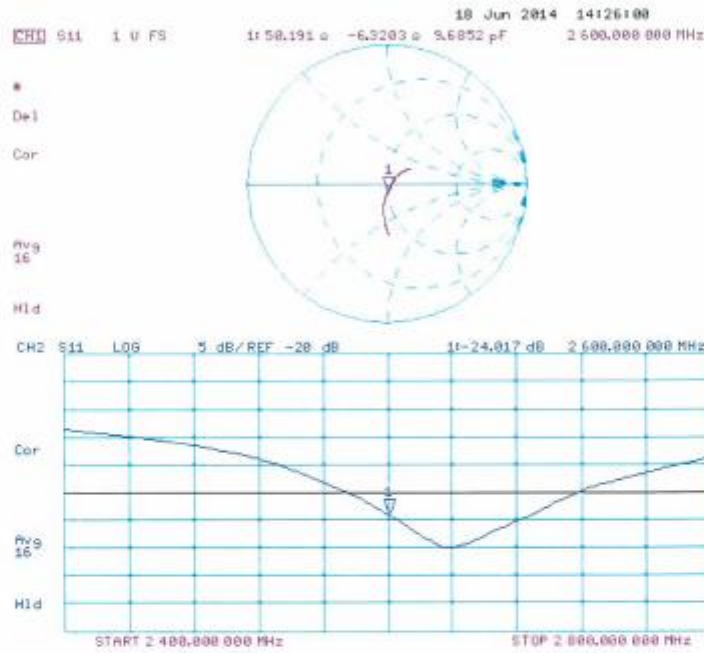
Maximum value of SAR (measured) = 19.6 W/kg



0 dB = 19.6 W/kg = 12.92 dBW/kg



Impedance Measurement Plot for Head TSL





**DASY5 Validation Report for Body TSL**

Date: 23.06.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1058**

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used:  $f = 2600$  MHz;  $\sigma = 2.19$  S/m;  $\epsilon_r = 50.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.24, 4.24, 4.24); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

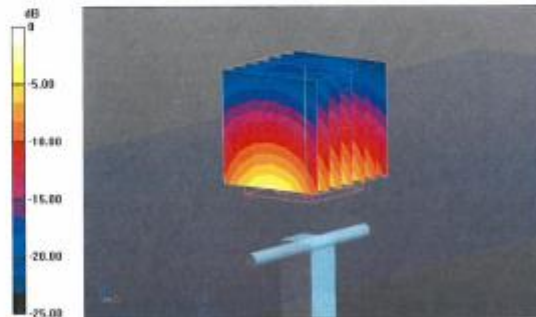
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.00 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 30.8 W/kg

**SAR(1 g) = 14.4 W/kg; SAR(10 g) = 6.37 W/kg**

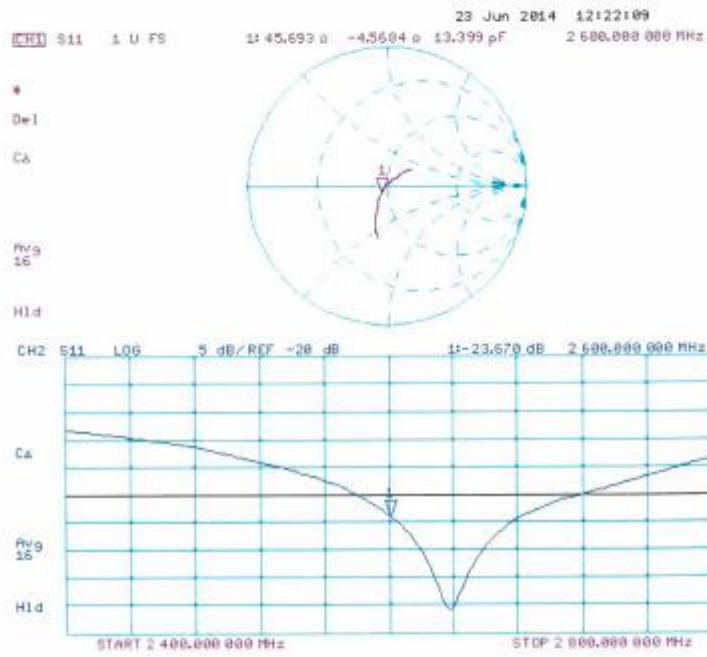
Maximum value of SAR (measured) = 19.2 W/kg



0 dB = 19.2 W/kg = 12.83 dBW/kg



Impedance Measurement Plot for Body TSL







### D2600V2, serial no. 1058 Extended Dipole Calibrations

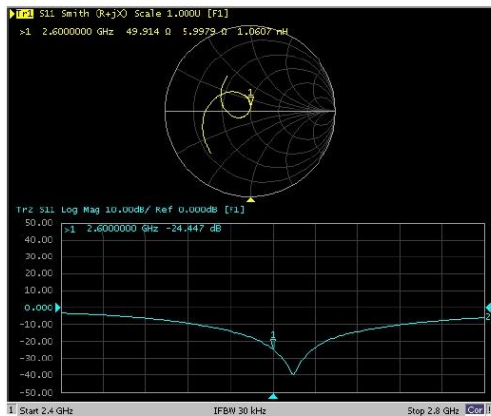
Referring to KDB 865664D01V01r03, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| D2600V2, serial no. 1058 |                  |           |                      |             |                  |           |                      |             |
|--------------------------|------------------|-----------|----------------------|-------------|------------------|-----------|----------------------|-------------|
| Date of Measurement      | 2600 Head        |           |                      |             | 2600 Body        |           |                      |             |
|                          | Return-Loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Return-Loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) |
| 2014-6-23                | -24.0            |           | 50.2                 |             | -23.7            |           | 45.7                 |             |
| 2015-6-21                | -24.4            | -1.6      | 49.9                 | -0.3        | -23.2            | 2.1       | 44.2                 | 1.5         |

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

#### <Dipole Verification Data>- D2600V2, serial no. 1058

2600MHz Head



2600MHz Body

