

## Appendix C

### Tissue Parameters

#### Recipe for all liquids:

52-75% water  
25-48% DGBE  
<1% Sodium Chloride

SAR measurements were made within 24 hours of the measurement of liquid parameters.

#### **850MHz Body Liquid:**

| Date       | Freq.<br>(MHz) | Rel.<br>Perm. | Condy<br>(S/m) |
|------------|----------------|---------------|----------------|
| 2011-02-05 | 824.2          | 55.16         | 0.979          |
| 2011-02-05 | 835            | 54.9          | 0.991          |
| 2011-02-05 | 836.6          | 54.86         | 0.992          |
| 2011-02-05 | 848.8          | 54.53         | 1.006          |
| 2011-02-07 | 824.2          | 55.71         | 0.977          |
| 2011-02-07 | 835            | 55.5          | 0.993          |
| 2011-02-07 | 836.6          | 55.47         | 0.992          |
| 2011-02-07 | 848.8          | 55.26         | 1.002          |
| 2011-02-08 | 824.2          | 55.33         | 0.975          |
| 2011-02-08 | 835            | 55.17         | 0.985          |
| 2011-02-08 | 836.6          | 55.14         | 0.991          |
| 2011-02-08 | 848.8          | 54.94         | 1.001          |
| 2011-02-19 | 824.2          | 55.33         | 0.975          |
| 2011-02-19 | 835            | 55.17         | 0.985          |
| 2011-02-19 | 836.6          | 55.14         | 0.991          |
| 2011-02-19 | 848.8          | 54.94         | 1.001          |

#### **1900MHz Body Liquid:**

| Date       | Freq.<br>(MHz) | Rel.<br>Perm. | Condy<br>(S/m) |
|------------|----------------|---------------|----------------|
| 2011-02-06 | 1880           | 52.97         | 1.587          |
| 2011-02-06 | 1900           | 52.66         | 1.589          |
| 2011-02-07 | 1880           | 53.21         | 1.521          |
| 2011-02-07 | 1900           | 52.94         | 1.524          |
| 2011-02-19 | 1880           | 53.27         | 1.539          |
| 2011-02-19 | 1900           | 52.97         | 1.569          |

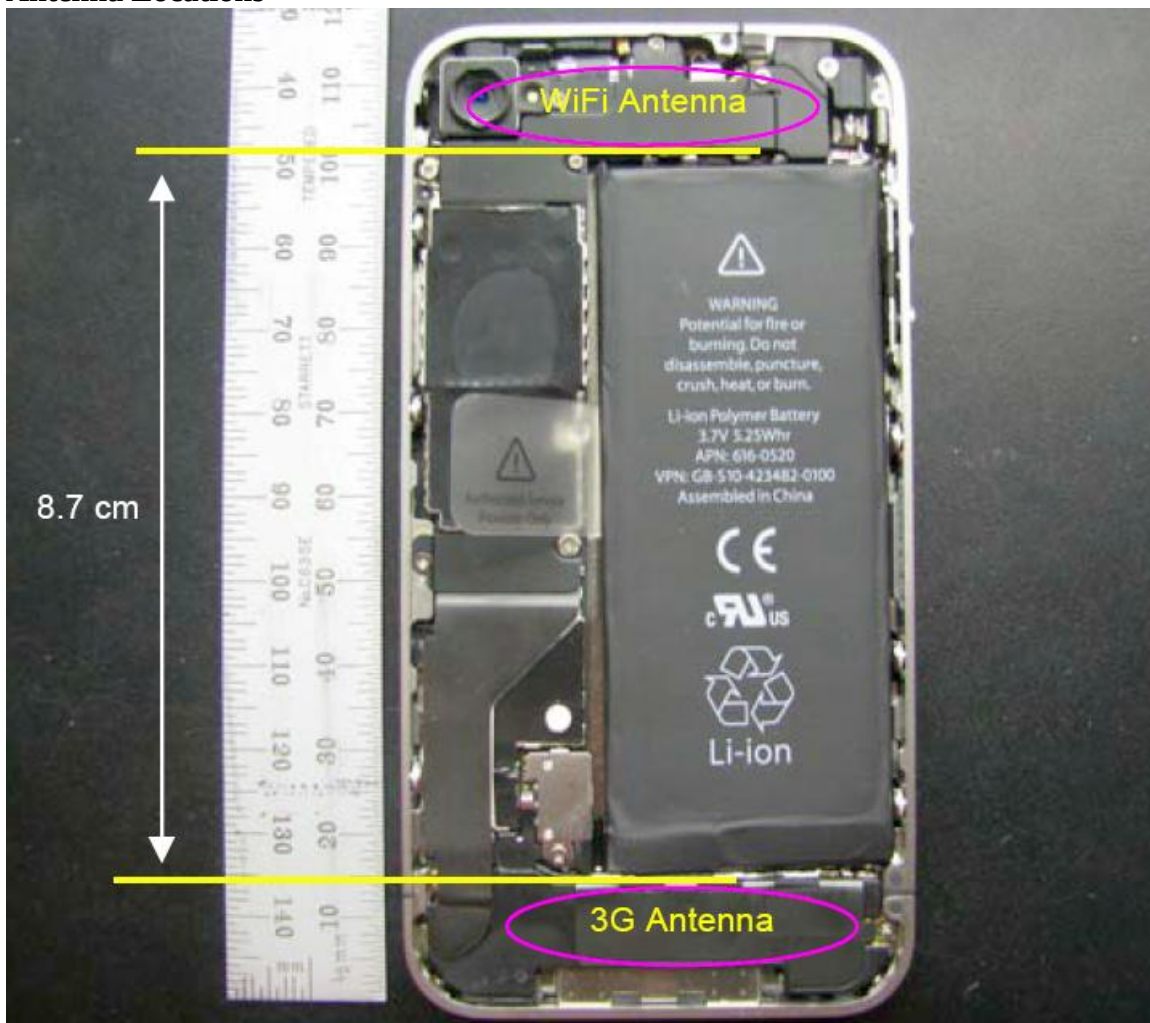
## Appendix C

### 2450MHz Body Liquid:

| Date       | Freq.<br>(MHz) | Rel.<br>Perm. | Condy<br>(S/m) |
|------------|----------------|---------------|----------------|
| 2011-02-08 | 2437           | 50.32         | 1.972          |
| 2011-02-08 | 2450           | 50.25         | 1.993          |
| 2011-02-21 | 2437           | 50.18         | 1.942          |
| 2011-02-21 | 2450           | 50.08         | 1.968          |

## Appendix C

### Antenna Locations



## Appendix C



## Appendix C

### Test Equipment

| Instrument description        | Supplier / Manufacturer | Model         | Serial No.          | Calibration (date)         | Calibration Due (date) |
|-------------------------------|-------------------------|---------------|---------------------|----------------------------|------------------------|
| Robot                         | Staubli                 | TX90          | F10/5D3NA<br>1/A/01 | N/A                        | N/A                    |
| SAM Twin Phantom              | Speag                   | SM 000 T01 DA | 1592                | N/A                        | N/A                    |
| Elliptical Phantom            | Speag                   | QD OVA 001 BB | 1092                | N/A                        | N/A                    |
| Software                      | Speag                   | Dasy5         | N/A                 | N/A                        | N/A                    |
| Device Holder                 | Speag                   | SD 000H01     | N/A                 | N/A                        | N/A                    |
| Data Acquisition Electronics  | Speag                   | DAE4          | 1233                | 2010/10/13                 | 2011/10/13             |
| 850 MHz Body Tissue Simulant  | Speag                   | MSL 900       | N/A                 | 2011/02/04 –<br>2011/02/19 | N/A                    |
| 1900 MHz Body Tissue Simulant | Speag                   | MSL 1900      | N/A                 | 2011/02/04 –<br>2011/02/19 | N/A                    |
| 2450 MHz Body Tissue Simulant | Speag                   | MSL 2450      | N/A                 | 2011/02/04 –<br>2011/02/21 | N/A                    |
| 835 MHz Dipole                | Speag                   | D835V2        | 4D113               | 2011-01-10                 | 2012-01-10             |
| 1900 MHz Dipole               | Speag                   | D1900V2       | 5D135               | 2011-01-05                 | 2012-01-05             |
| 2450 MHz Dipole               | Speag                   | D2450V2       | 859                 | 2011-01-05                 | 2010-01-05             |
| Directional coupler           | Werlatone               | C6529         | 11249               | N/A                        | N/A                    |
| RF Amplifier                  | Vectawave               | VTL5400       | N/A                 | N/A                        | N/A                    |
| SAR Probe                     | Speag                   | ES3DV3        | 3244                | 2010-10-13                 | 2011-10-13             |
| Dielectric Measurement Kit    | IndexSAR                | Di-Line       | N/A                 | N/A                        | N/A                    |

## Appendix C

### **Equipment Calibration/Performance Documents:**

*Attached:*

*SAR Probe Calibration Report*

*835 MHz Dipole Calibration Report*

*1900 MHz Dipole Calibration Report*

*2450 MHz Dipole Calibration Report*



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Client **Cetecom USA**

Certificate No: **ES3-3244\_Oct10**

## CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3244**

Calibration procedure(s) **QA CAL-01.v6, QA CAL-23.v3 and QA CAL-25.v2**  
**Calibration procedure for dosimetric E-field probes**

Calibration date: **October 13, 2010**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID #            | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 1-Apr-10 (No. 217-01136)          | Apr-11                 |
| Power sensor E4412A        | MY41495277      | 1-Apr-10 (No. 217-01136)          | Apr-11                 |
| Power sensor E4412A        | MY41498087      | 1-Apr-10 (No. 217-01136)          | Apr-11                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 30-Mar-10 (No. 217-01159)         | Mar-11                 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 30-Mar-10 (No. 217-01161)         | Mar-11                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 30-Mar-10 (No. 217-01160)         | Mar-11                 |
| Reference Probe ES3DV2     | SN: 3013        | 30-Dec-09 (No. ES3-3013_Dec09)    | Dec-10                 |
| DAE4                       | SN: 660         | 20-Apr-10 (No. DAE4-660_Apr10)    | Apr-11                 |
| Secondary Standards        | ID #            | Check Date (in house)             | Scheduled Check        |
| RF generator HP 8648C      | US3642U01700    | 4-Aug-99 (in house check Oct-09)  | In house check: Oct-11 |
| Network Analyzer HP 8753E  | US37390585      | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

Calibrated by: **Katja Pokovic** Name **Technical Manager** Function  Signature

Approved by: **Fin Bomholt** Name **R&D Director** Function  Signature

Issued: October 13, 2010

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

## 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                  | modulation dependent linearization parameters                                                                                                           |
| Polarization $\phi$      | $\phi$ rotation around probe axis                                                                                                                       |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\vartheta = 0$ is normal to probe axis |

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 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<sup>2</sup>-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 with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- 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  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<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.

# Probe ES3DV3

## SN:3244

|               |                  |
|---------------|------------------|
| Manufactured: | May 5, 2009      |
| Calibrated:   | October 13, 2010 |

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

## DASY/EASY - Parameters of Probe: ES3DV3 SN:3244

### Basic Calibration Parameters

|                                                    | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|----------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V/m})^2$ ) <sup>A</sup> | 1.31     | 1.37     | 1.34     | ± 10.1%   |
| DCP (mV) <sup>B</sup>                              | 94.5     | 99.7     | 94.3     |           |

### Modulation Calibration Parameters

| UID   | Communication System Name                         | PAR  |   | A<br>dB | B<br>dBuV | C     | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-------|---------------------------------------------------|------|---|---------|-----------|-------|----------|---------------------------|
| 10000 | CW                                                | 0.00 | X | 0.00    | 0.00      | 1.00  | 140.4    | ± 2.6 %                   |
|       |                                                   |      | Y | 0.00    | 0.00      | 1.00  | 146.5    |                           |
|       |                                                   |      | Z | 0.00    | 0.00      | 1.00  | 141.5    |                           |
| 10021 | GSM-FDD (TDMA, GMSK)                              | 9.20 | X | 2.29    | 62.16     | 14.55 | 43.4     | ± 4.7 %                   |
|       |                                                   |      | Y | 2.62    | 65.02     | 15.26 | 44.5     |                           |
|       |                                                   |      | Z | 2.03    | 61.64     | 14.13 | 42.9     |                           |
| 10039 | CDMA2000 (1xRTT, RC1)                             | 5.30 | X | 3.61    | 58.73     | 15.04 | 47.3     | ± 2.9 %                   |
|       |                                                   |      | Y | 3.76    | 59.88     | 15.47 | 48.4     |                           |
|       |                                                   |      | Z | 3.68    | 59.18     | 15.22 | 47.7     |                           |
| 10072 | IEEE 802.11g WiFi 2.4 GHz<br>(DSSS/OFDM, 12 Mbps) | 9.75 | X | 7.42    | 59.79     | 16.86 | 45.2     | ± 3.1 %                   |
|       |                                                   |      | Y | 7.30    | 59.86     | 16.83 | 46.1     |                           |
|       |                                                   |      | Z | 7.39    | 59.85     | 16.90 | 45.4     |                           |

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%.

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the maximum deviation from linear response applying recatangular distribution and is expressed for the square of the field value.

## DASY/EASY - Parameters of Probe: ES3DV3 SN:3244

### Calibration Parameter Determined in Head Tissue Simulating Media

| f [MHz] | Validity [MHz] <sup>c</sup> | Permittivity | Conductivity | ConvF X | ConvF Y | ConvF Z | Alpha | Depth Unc (k=2) |
|---------|-----------------------------|--------------|--------------|---------|---------|---------|-------|-----------------|
| 835     | ± 50 / ± 100                | 41.5 ± 5%    | 0.90 ± 5%    | 6.09    | 6.09    | 6.09    | 0.97  | 1.07 ± 11.0%    |
| 900     | ± 50 / ± 100                | 41.5 ± 5%    | 0.97 ± 5%    | 6.02    | 6.02    | 6.02    | 0.95  | 1.08 ± 11.0%    |
| 1750    | ± 50 / ± 100                | 40.1 ± 5%    | 1.37 ± 5%    | 5.20    | 5.20    | 5.20    | 0.36  | 1.75 ± 11.0%    |
| 1900    | ± 50 / ± 100                | 40.0 ± 5%    | 1.40 ± 5%    | 5.02    | 5.02    | 5.02    | 0.40  | 1.72 ± 11.0%    |
| 1950    | ± 50 / ± 100                | 40.0 ± 5%    | 1.40 ± 5%    | 4.85    | 4.85    | 4.85    | 0.46  | 1.59 ± 11.0%    |
| 2450    | ± 50 / ± 100                | 39.2 ± 5%    | 1.80 ± 5%    | 4.48    | 4.48    | 4.48    | 0.41  | 1.78 ± 11.0%    |

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

## DASY/EASY - Parameters of Probe: ES3DV3 SN:3244

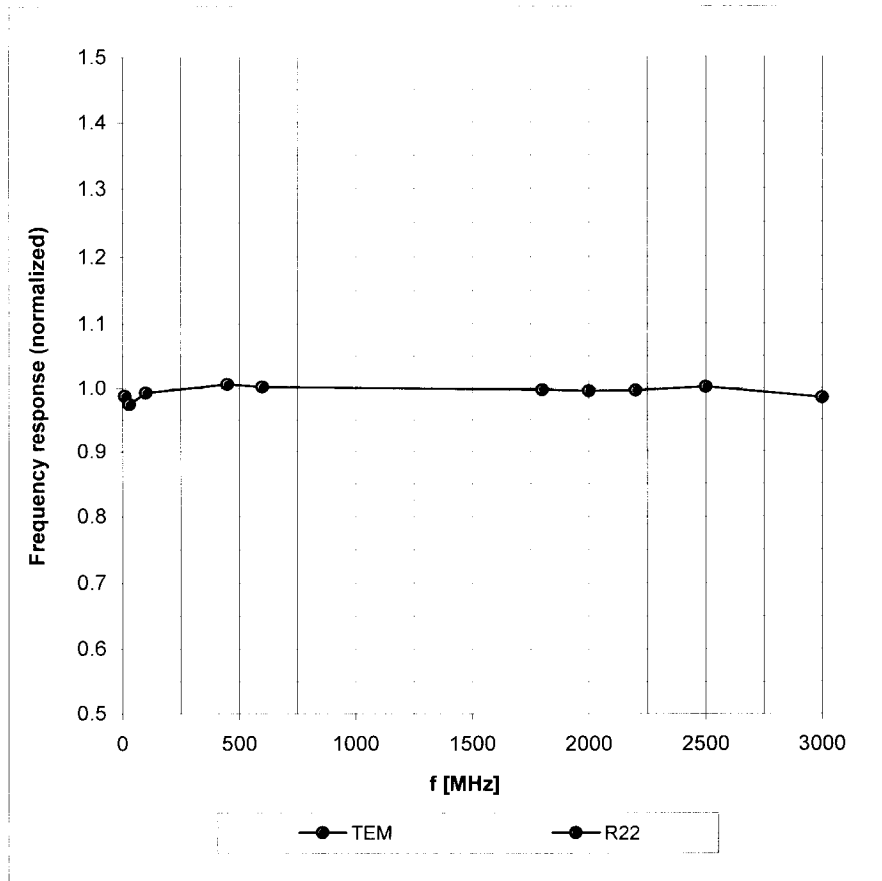
### Calibration Parameter Determined in Body Tissue Simulating Media

| f [MHz] | Validity [MHz] <sup>c</sup> | Permittivity | Conductivity | ConvF X | ConvF Y | ConvF Z | Alpha | Depth Unc (k=2) |
|---------|-----------------------------|--------------|--------------|---------|---------|---------|-------|-----------------|
| 835     | ± 50 / ± 100                | 55.2 ± 5%    | 0.97 ± 5%    | 6.05    | 6.05    | 6.05    | 0.80  | 1.18 ± 11.0%    |
| 900     | ± 50 / ± 100                | 55.0 ± 5%    | 1.05 ± 5%    | 5.96    | 5.96    | 5.96    | 0.79  | 1.19 ± 11.0%    |
| 1750    | ± 50 / ± 100                | 53.4 ± 5%    | 1.49 ± 5%    | 4.85    | 4.85    | 4.85    | 0.31  | 2.22 ± 11.0%    |
| 1900    | ± 50 / ± 100                | 53.3 ± 5%    | 1.52 ± 5%    | 4.62    | 4.62    | 4.62    | 0.35  | 2.21 ± 11.0%    |
| 1950    | ± 50 / ± 100                | 53.3 ± 5%    | 1.52 ± 5%    | 4.75    | 4.75    | 4.75    | 0.35  | 2.18 ± 11.0%    |
| 2450    | ± 50 / ± 100                | 52.7 ± 5%    | 1.95 ± 5%    | 4.24    | 4.24    | 4.24    | 0.75  | 1.24 ± 11.0%    |

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

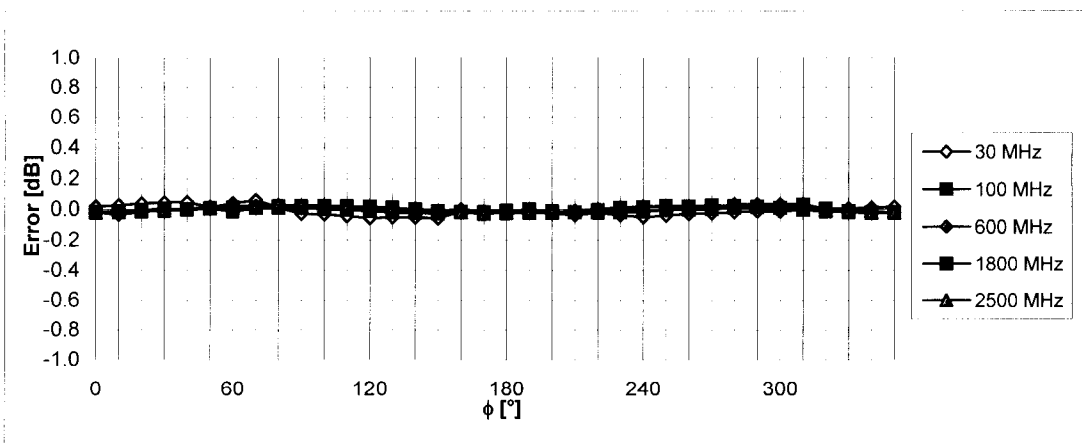
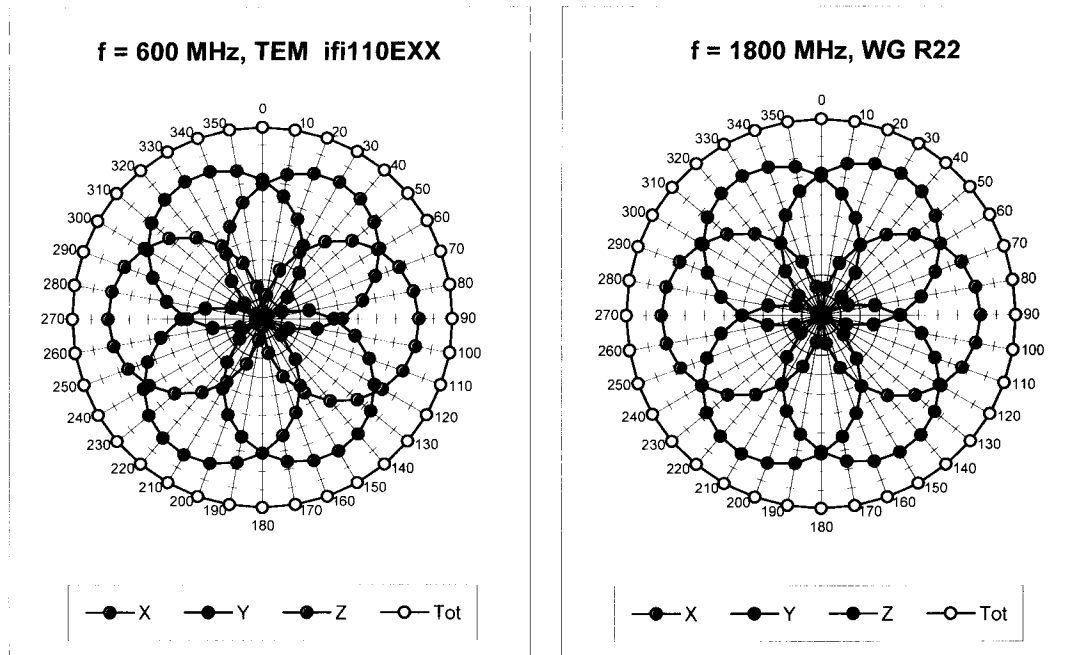
## Frequency Response of E-Field

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



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

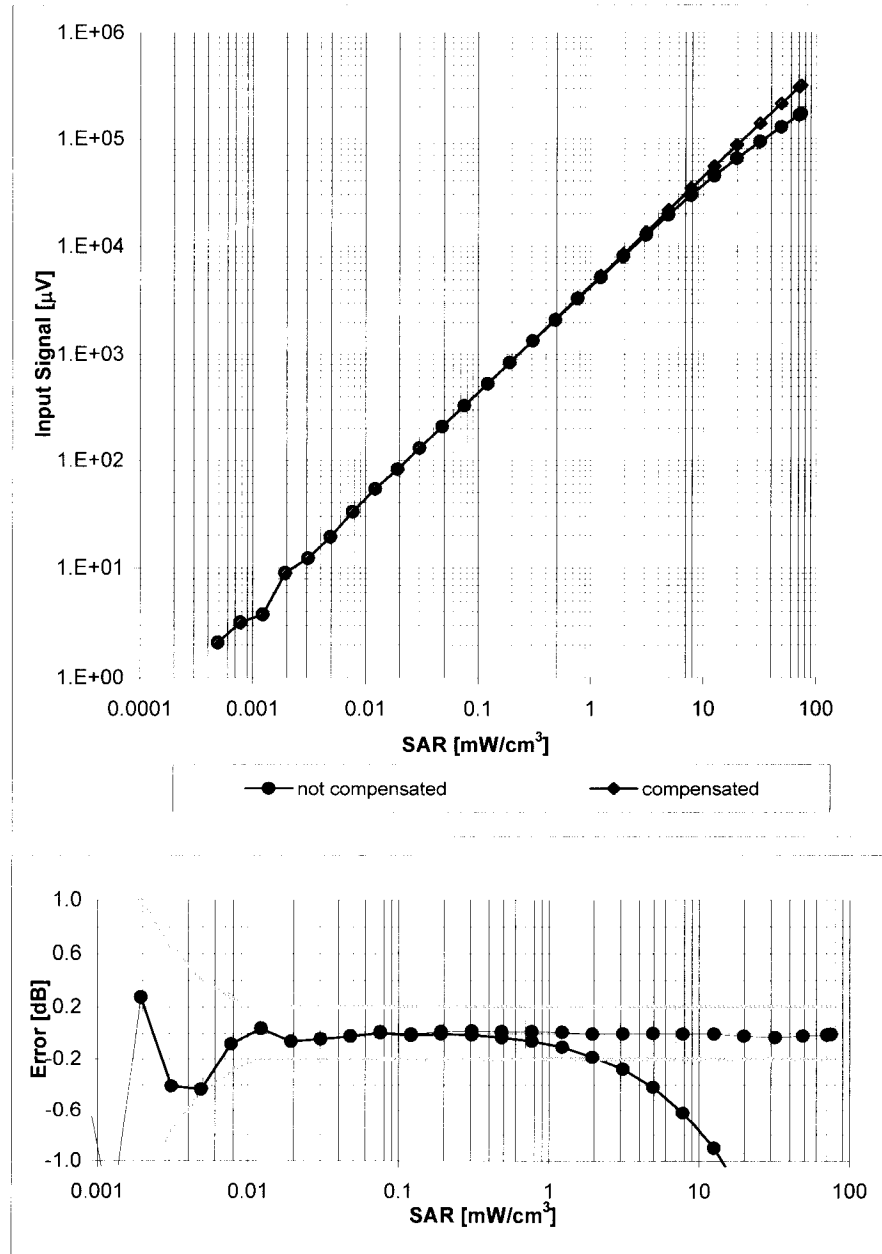
## Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



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

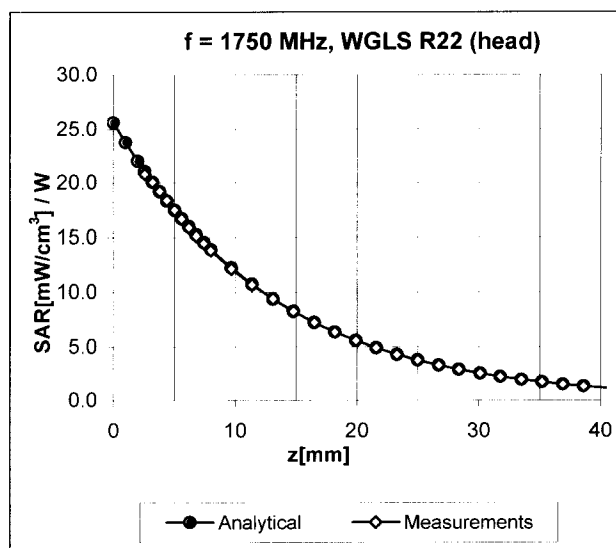
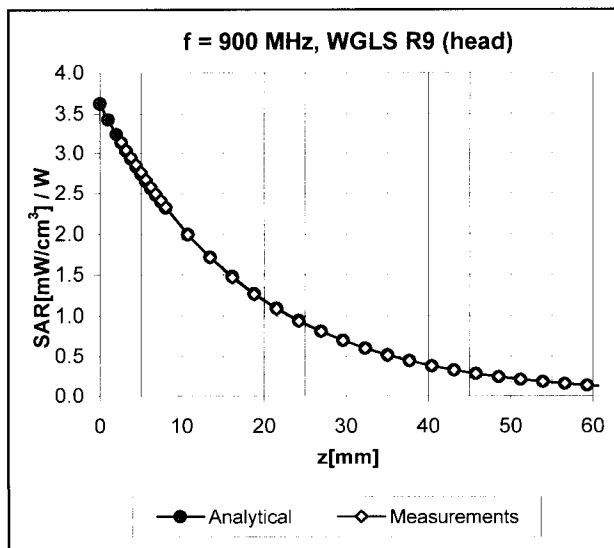
## Dynamic Range f(SAR<sub>head</sub>)

(Waveguide R22, f = 1800 MHz)



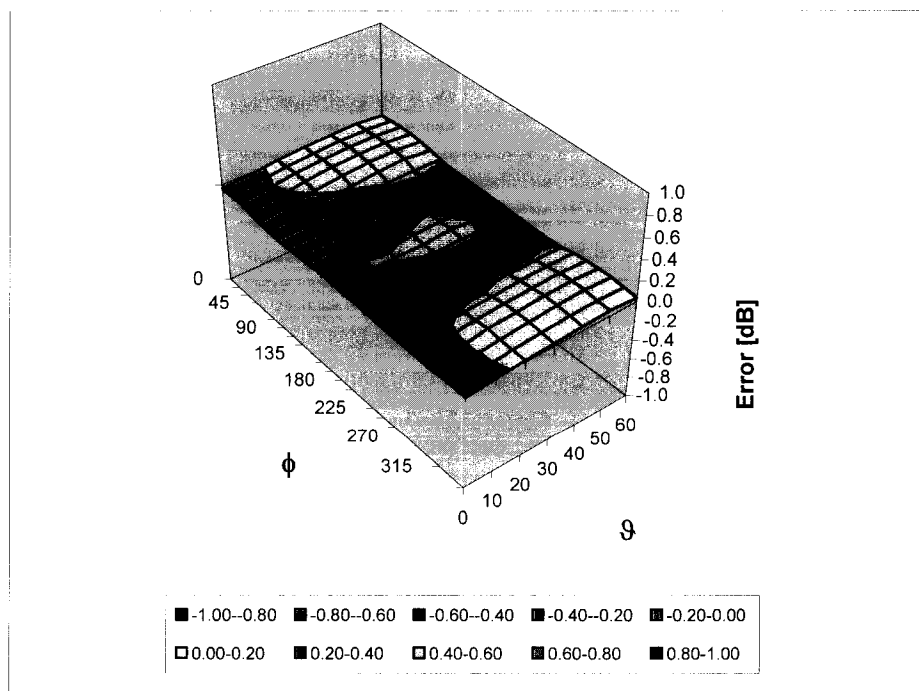
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment



## Deviation from Isotropy in HSL

Error ( $\phi$ ,  $\vartheta$ ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  (k=2)

## Other Probe Parameters

|                                               |                |
|-----------------------------------------------|----------------|
| Sensor Arrangement                            | Triangular     |
| Connector Angle (°)                           | Not applicable |
| Mechanical Surface Detection Mode             | enabled        |
| Optical Surface Detection Mode                | disabled       |
| Probe Overall Length                          | 337 mm         |
| Probe Body Diameter                           | 10 mm          |
| Tip Length                                    | 10 mm          |
| Tip Diameter                                  | 4.0 mm         |
| Probe Tip to Sensor X Calibration Point       | 2 mm           |
| Probe Tip to Sensor Y Calibration Point       | 2 mm           |
| Probe Tip to Sensor Z Calibration Point       | 2 mm           |
| Recommended Measurement Distance from Surface | 3 mm           |



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

Accreditation No.: **SCS 108**

Client **Cetecom USA**

Certificate No: **D835V2-4d113\_Jan11**

## CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d113**

Calibration procedure(s) **QA CAL-05.v8**  
**Calibration procedure for dipole validation kits**

Calibration date: **January 10, 2011**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature ( $22 \pm 3$ )°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         | 06-Oct-10 (No. 217-01266)         | Oct-11                 |
| Power sensor HP 8481A       | US37292783         | 06-Oct-10 (No. 217-01266)         | Oct-11                 |
| Reference 20 dB Attenuator  | SN: 5086 (20g)     | 30-Mar-10 (No. 217-01158)         | Mar-11                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 30-Mar-10 (No. 217-01162)         | Mar-11                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Apr-10 (No. ES3-3205_Apr10)    | Apr-11                 |
| DAE4                        | SN: 601            | 10-Jun-10 (No. DAE4-601_Jun10)    | Jun-11                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power sensor HP 8481A       | MY41092317         | 18-Oct-02 (in house check Oct-09) | In house check: Oct-11 |
| RF generator R&S SMT-06     | 100005             | 4-Aug-99 (in house check Oct-09)  | In house check: Oct-11 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

Calibrated by: **Jeton Kastrati** **Function**  
**Laboratory Technician**

Approved by: **Katja Pokovic** **Technical Manager**

Signature

Issued: January 10, 2011

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



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

Accreditation No.: **SCS 108**

**Glossary:**

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

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

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

## Measurement Conditions

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

|                                     |                           |             |
|-------------------------------------|---------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                     | V52.6       |
| <b>Extrapolation</b>                | Advanced Extrapolation    |             |
| <b>Phantom</b>                      | Modular Flat Phantom V4.9 |             |
| <b>Distance Dipole Center - TSL</b> | 15 mm                     | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm         |             |
| <b>Frequency</b>                    | 835 MHz $\pm$ 1 MHz       |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                         | <b>Temperature</b>  | <b>Permittivity</b> | <b>Conductivity</b>  |
|-----------------------------------------|---------------------|---------------------|----------------------|
| <b>Nominal Head TSL parameters</b>      | 22.0 °C             | 41.5                | 0.90 mho/m           |
| <b>Measured Head TSL parameters</b>     | (22.0 $\pm$ 0.2) °C | 41.3 $\pm$ 6 %      | 0.89 mho/m $\pm$ 6 % |
| <b>Head TSL temperature during test</b> | (21.0 $\pm$ 0.2) °C | ----                | ----                 |

## SAR result with Head TSL

|                                                             |                    |                                                 |
|-------------------------------------------------------------|--------------------|-------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                                 |
| SAR measured                                                | 250 mW input power | 2.41 mW / g                                     |
| SAR normalized                                              | normalized to 1W   | 9.64 mW / g                                     |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>9.69 mW /g <math>\pm</math> 17.0 % (k=2)</b> |

|                                                               |                    |                                                 |
|---------------------------------------------------------------|--------------------|-------------------------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                                                 |
| SAR measured                                                  | 250 mW input power | 1.57 mW / g                                     |
| SAR normalized                                                | normalized to 1W   | 6.28 mW / g                                     |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>6.31 mW /g <math>\pm</math> 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         | 55.2         | 0.97 mho/m       |
| Measured Body TSL parameters     | (22.0 ± 0.2) °C | 54.1 ± 6 %   | 0.99 mho/m ± 6 % |
| Body TSL temperature during test | (21.6 ± 0.2) °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 | 2.54 mW / g                       |
| SAR normalized                                        | normalized to 1W   | 10.2 mW / g                       |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>9.96 mW / g ± 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 | 1.67 mW / g                       |
| SAR normalized                                          | normalized to 1W   | 6.68 mW / g                       |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>6.59 mW / g ± 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.3 $\Omega$ - 2.2 j $\Omega$ |
| Return Loss                          | - 30.1 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 48.1 $\Omega$ - 4.1 j $\Omega$ |
| Return Loss                          | - 26.8 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.394 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.

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 26, 2010 |

## DASY5 Validation Report for Head TSL

Date/Time: 03.01.2011 14:35:06

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d113**

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: HSL900

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.89 \text{ mho/m}$ ;  $\epsilon_r = 40.9$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.03, 6.03, 6.03); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY52, V52.6.1 Build (408)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

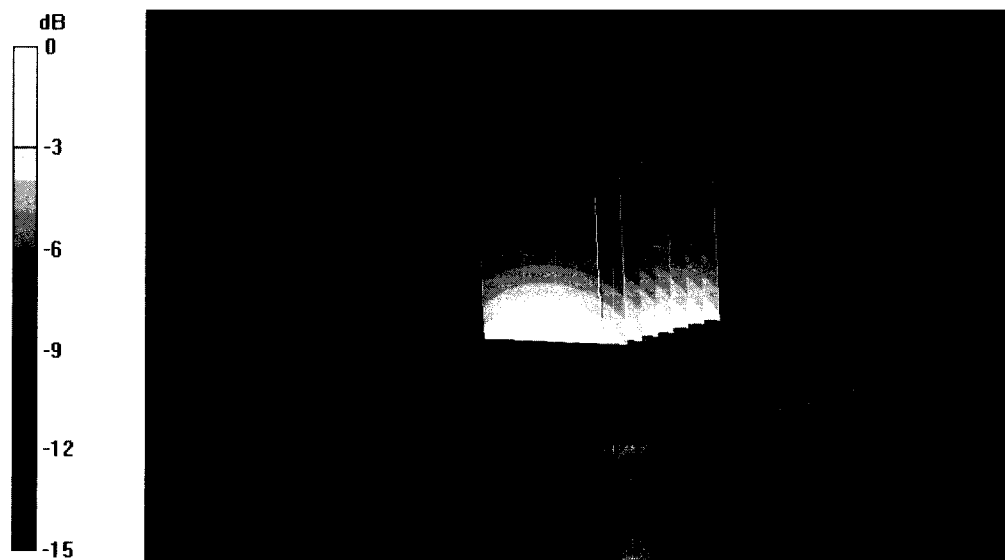
**Pin=250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.6 V/m; Power Drift = 0.00506 dB

Peak SAR (extrapolated) = 3.63 W/kg

**SAR(1 g) = 2.41 mW/g; SAR(10 g) = 1.57 mW/g**

Maximum value of SAR (measured) = 2.59 mW/g



0 dB = 2.59mW/g

# Impedance Measurement Plot for Head TSL

3 Jan 2011 12:04:11

CH1 S11 1 U FS 1: 52.295  $\Omega$  -2.2363  $\Omega$  85.231 pF 835.000 000 MHz

\*

De1

Cor

Avg  
16

↑

CH2 S11 LOG 5 dB/REF -20 dB 1: -30.066 dB 835.000 000 MHz

Cor

Avg  
16

↑

START 635.000 000 MHz

STOP 1 100.000 000 MHz

CH1 Markers

2: 64.754  $\Omega$   
33.477  $\Omega$   
900.000 MHz

CH2 Markers

2: -10.284 dB  
900.000 MHz

## DASY5 Validation Report for Body

Date/Time: 10.01.2011 10:33:12

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d113**

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: MSL900

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.99$  mho/m;  $\epsilon_r = 54.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.86, 5.86, 5.86); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY52, V52.6.1 Build (408)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

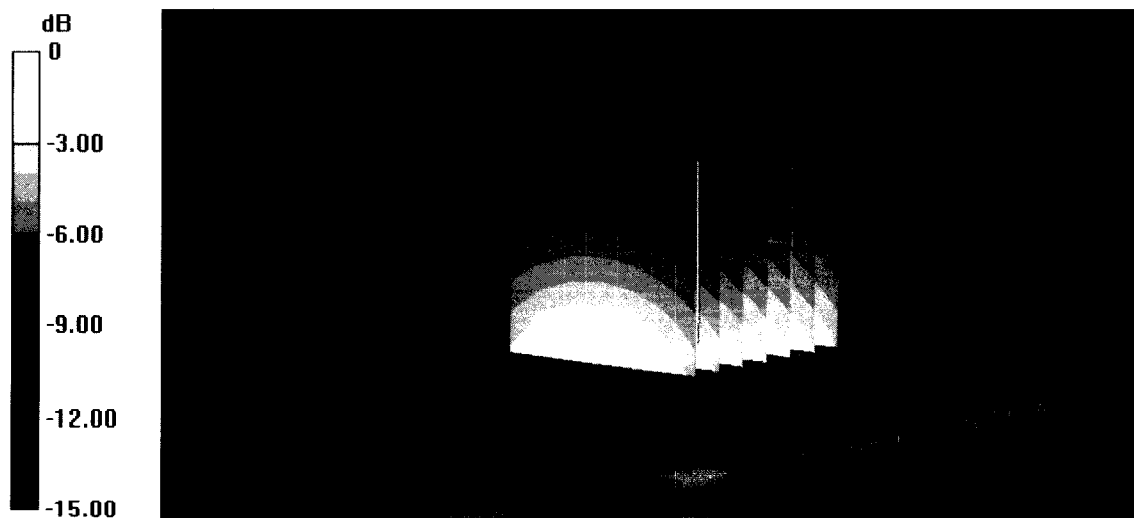
**Pin=250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.484 V/m; Power Drift = -0.0072 dB

Peak SAR (extrapolated) = 3.752 W/kg

**SAR(1 g) = 2.54 mW/g; SAR(10 g) = 1.67 mW/g**

Maximum value of SAR (measured) = 2.963 mW/g



0 dB = 2.960mW/g

# Impedance Measurement Plot for Body TSL

10 Jan 2011 10:28:12  
 CH1 S11 1 U FS 1: 48.055  $\Omega$  -4.0527  $\Omega$  47.031 pF 835.000 000 MHz

\*

Del

Cor

Avg  
16

↑

CH2 S11 LOG 5 dB/REF -20 dB 1:-26.788 dB 835.000 000 MHz

Cor

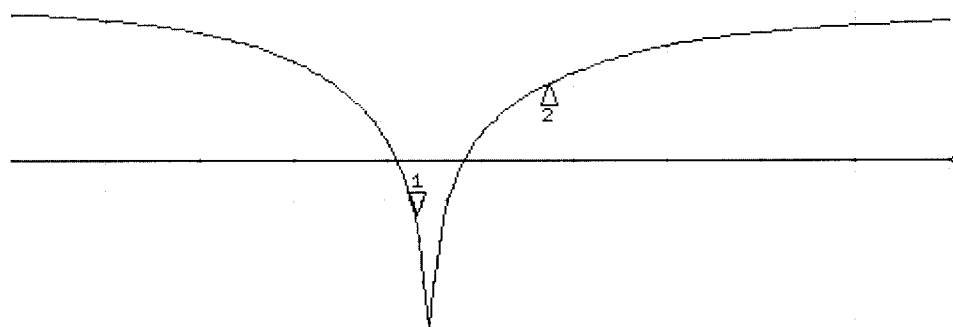
Avg  
16

↑



CH1 Markers

2: 60.053  $\Omega$   
 32.367  $\Omega$   
 900.000 MHz



CH2 Markers

2:-10.589 dB  
 900.000 MHz

START 635.000 000 MHz

STOP 1 100.000 000 MHz



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

Accreditation No.: **SCS 108**

Client **Cetecom USA**

Certificate No: **D1900V2-5d135\_Jan11**

## CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d135**

Calibration procedure(s) **QA CAL-05.v8**  
**Calibration procedure for dipole validation kits**

Calibration date: **January 05, 2011**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | GB37480704         | 06-Oct-10 (No. 217-01266)         | Oct-11                 |
| Power sensor HP 8481A       | US37292783         | 06-Oct-10 (No. 217-01266)         | Oct-11                 |
| Reference 20 dB Attenuator  | SN: 5086 (20g)     | 30-Mar-10 (No. 217-01158)         | Mar-11                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 30-Mar-10 (No. 217-01162)         | Mar-11                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Apr-10 (No. ES3-3205_Apr10)    | Apr-11                 |
| DAE4                        | SN: 601            | 10-Jun-10 (No. DAE4-601_Jun10)    | Jun-11                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power sensor HP 8481A       | MY41092317         | 18-Oct-02 (in house check Oct-09) | In house check: Oct-11 |
| RF generator R&S SMT-06     | 100005             | 4-Aug-99 (in house check Oct-09)  | In house check: Oct-11 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

Calibrated by: **Jeton Kastrati** Name **Laboratory Technician** Function **Signature**

Approved by: **Katja Pokovic** Technical Manager

Issued: January 5, 2011

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



Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: **SCS 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 1528-2003, "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
- 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
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

## Measurement Conditions

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

|                                     |                           |             |
|-------------------------------------|---------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                     | V52.6       |
| <b>Extrapolation</b>                | Advanced Extrapolation    |             |
| <b>Phantom</b>                      | Modular Flat Phantom V5.0 |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                     | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm         |             |
| <b>Frequency</b>                    | 1900 MHz $\pm$ 1 MHz      |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                         | <b>Temperature</b>  | <b>Permittivity</b> | <b>Conductivity</b>  |
|-----------------------------------------|---------------------|---------------------|----------------------|
| <b>Nominal Head TSL parameters</b>      | 22.0 °C             | 40.0                | 1.40 mho/m           |
| <b>Measured Head TSL parameters</b>     | (22.0 $\pm$ 0.2) °C | 38.5 $\pm$ 6 %      | 1.43 mho/m $\pm$ 6 % |
| <b>Head TSL temperature during test</b> | (20.6 $\pm$ 0.2) °C | ----                | ----                 |

## SAR result with Head TSL

|                                                             |                    |                                                 |
|-------------------------------------------------------------|--------------------|-------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                                 |
| SAR measured                                                | 250 mW input power | 10.3 mW / g                                     |
| SAR normalized                                              | normalized to 1W   | 41.2 mW / g                                     |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>40.5 mW /g <math>\pm</math> 17.0 % (k=2)</b> |

|                                                               |                    |                                                 |
|---------------------------------------------------------------|--------------------|-------------------------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                                                 |
| SAR measured                                                  | 250 mW input power | 5.33 mW / g                                     |
| SAR normalized                                                | normalized to 1W   | 21.3 mW / g                                     |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>21.1 mW /g <math>\pm</math> 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 | 52.9 ± 6 %   | 1.56 mho/m ± 6 % |
| Body TSL temperature during test | (21.2 ± 0.2) °C | ----         | ----             |

## SAR result with Body TSL

|                                                             |                    |                                   |
|-------------------------------------------------------------|--------------------|-----------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                   |
| SAR measured                                                | 250 mW input power | 10.2 mW / g                       |
| SAR normalized                                              | normalized to 1W   | 40.8 mW / g                       |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>40.1 mW / g ± 17.0 % (k=2)</b> |

|                                                               |                    |                                   |
|---------------------------------------------------------------|--------------------|-----------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                   |
| SAR measured                                                  | 250 mW input power | 5.36 mW / g                       |
| SAR normalized                                                | normalized to 1W   | 21.4 mW / g                       |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>21.3 mW / g ± 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $52.8 \Omega + 7.6 j\Omega$ |
| Return Loss                          | - 22.2 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $47.3 \Omega + 7.3 j\Omega$ |
| Return Loss                          | - 22.0 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.205 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.

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 | April 14, 2010 |

## DASY5 Validation Report for Head TSL

Date/Time: 04.01.2011 11:41:00

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d135**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: HSL U12 BB

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.42$  mho/m;  $\epsilon_r = 38.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.09, 5.09, 5.09); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY52, V52.6 Build (401)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

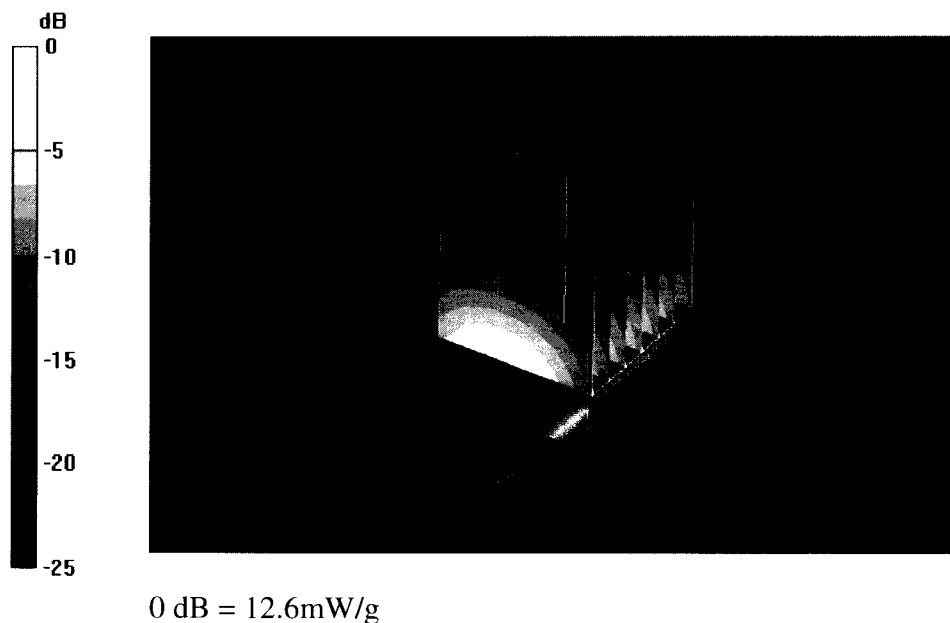
**Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement**  
grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.6 V/m; Power Drift = 0.031 dB

Peak SAR (extrapolated) = 18.9 W/kg

**SAR(1 g) = 10.3 mW/g; SAR(10 g) = 5.33 mW/g**

Maximum value of SAR (measured) = 12.6 mW/g



# Impedance Measurement Plot for Head TSL

4 Jan 2011 10:40:28  
 CH1 S11 1 U FS 2: 52.752  $\omega$  7.5566  $\omega$  632.99  $\mu$ H 1 900.000 000 MHz

\*

Del

C&



Avg  
16

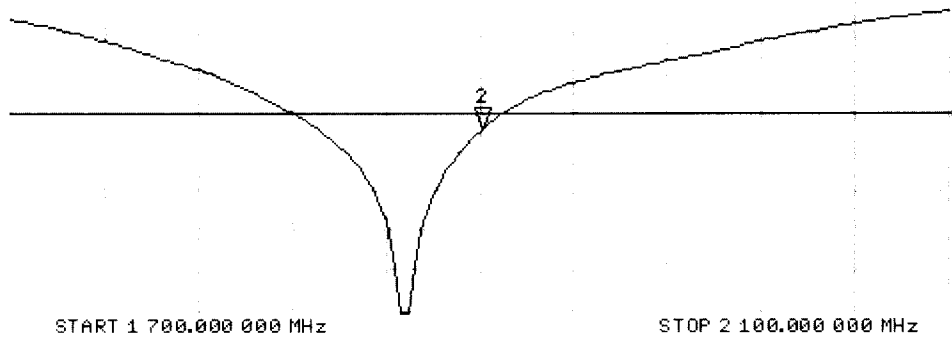
↑

CH2 S11 LOG 5 dB/REF -20 dB 2:-22.147 dB 1 900.000 000 MHz

C&

Avg  
16

↑



## DASY5 Validation Report for Body

Date/Time: 05.01.2011 10:23:19

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d135**

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: MSL U12 BB

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.56$  mho/m;  $\epsilon_r = 53$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.59, 4.59, 4.59); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY52, V52.6 Build (401)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

**Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.6 V/m; Power Drift = -0.042 dB

Peak SAR (extrapolated) = 17.5 W/kg

**SAR(1 g) = 10.2 mW/g; SAR(10 g) = 5.36 mW/g**

Maximum value of SAR (measured) = 12.9 mW/g



# Impedance Measurement Plot for Body TSL

5 Jan 2011 09:39:56

CH1 S11 1 U FS 2: 47.324  $\omega$  7.2852  $\omega$  610.25  $\mu$ H 1 900.000 000 MHz

\*

De1

CΔ

Avg  
16

↑

CH2 S11 LOG 5 dB/REF -20 dB 2:-21.990 dB 1 900.000 000 MHz

CΔ

Avg  
16

↑

START 1 700.000 000 MHz

STOP 2 100.000 000 MHz



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

Accreditation No.: **SCS 108**

Client **Cetecom USA**

Certificate No: **D2450V2-859\_Jan11**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 859**

Calibration procedure(s) **QA CAL-05.v8**  
**Calibration procedure for dipole validation kits**

Calibration date: **January 05, 2011**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | GB37480704         | 06-Oct-10 (No. 217-01266)         | Oct-11                 |
| Power sensor HP 8481A       | US37292783         | 06-Oct-10 (No. 217-01266)         | Oct-11                 |
| Reference 20 dB Attenuator  | SN: 5086 (20g)     | 30-Mar-10 (No. 217-01158)         | Mar-11                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 30-Mar-10 (No. 217-01162)         | Mar-11                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Apr-10 (No. ES3-3205_Apr10)    | Apr-11                 |
| DAE4                        | SN: 601            | 10-Jun-10 (No. DAE4-601_Jun10)    | Jun-11                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power sensor HP 8481A       | MY41092317         | 18-Oct-02 (in house check Oct-09) | In house check: Oct-11 |
| RF generator R&S SMT-06     | 100005             | 4-Aug-99 (in house check Oct-09)  | In house check: Oct-11 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-10) | In house check: Oct-11 |

|                |                               |                                          |               |
|----------------|-------------------------------|------------------------------------------|---------------|
| Calibrated by: | Name<br><b>Jeton Kastrati</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: January 5, 2011

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



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

Accreditation No.: **SCS 108**

### Glossary:

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

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

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

### Additional Documentation:

- d) DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

## Measurement Conditions

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

|                                     |                           |             |
|-------------------------------------|---------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                     | V52.6       |
| <b>Extrapolation</b>                | Advanced Extrapolation    |             |
| <b>Phantom</b>                      | Modular Flat Phantom V5.0 |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                     | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm         |             |
| <b>Frequency</b>                    | 2450 MHz $\pm$ 1 MHz      |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                         | <b>Temperature</b>  | <b>Permittivity</b> | <b>Conductivity</b>  |
|-----------------------------------------|---------------------|---------------------|----------------------|
| <b>Nominal Head TSL parameters</b>      | 22.0 °C             | 39.2                | 1.80 mho/m           |
| <b>Measured Head TSL parameters</b>     | (22.0 $\pm$ 0.2) °C | 37.9 $\pm$ 6 %      | 1.74 mho/m $\pm$ 6 % |
| <b>Head TSL temperature during test</b> | (21.0 $\pm$ 0.2) °C | ----                | ----                 |

## SAR result with Head TSL

|                                                             |                    |                                                  |
|-------------------------------------------------------------|--------------------|--------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                                  |
| SAR measured                                                | 250 mW input power | 13.5 mW / g                                      |
| SAR normalized                                              | normalized to 1W   | 54.0 mW / g                                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>54.4 mW / g <math>\pm</math> 17.0 % (k=2)</b> |

|                                                               |                    |                                                  |
|---------------------------------------------------------------|--------------------|--------------------------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                                                  |
| SAR measured                                                  | 250 mW input power | 6.32 mW / g                                      |
| SAR normalized                                                | normalized to 1W   | 25.3 mW / g                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>25.3 mW / g <math>\pm</math> 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         | 52.7         | 1.95 mho/m       |
| Measured Body TSL parameters     | (22.0 ± 0.2) °C | 52.5 ± 6 %   | 1.96 mho/m ± 6 % |
| Body TSL temperature during test | (21.0 ± 0.2) °C | ----         | ----             |

## SAR result with Body TSL

|                                                             |                    |                                   |
|-------------------------------------------------------------|--------------------|-----------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                   |
| SAR measured                                                | 250 mW input power | 12.7 mW / g                       |
| SAR normalized                                              | normalized to 1W   | 50.8 mW / g                       |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>50.5 mW / g ± 17.0 % (k=2)</b> |

|                                                               |                    |                                   |
|---------------------------------------------------------------|--------------------|-----------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                   |
| SAR measured                                                  | 250 mW input power | 5.84 mW / g                       |
| SAR normalized                                                | normalized to 1W   | 23.4 mW / g                       |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>23.3 mW / g ± 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $52.7 \Omega + 3.3 j\Omega$ |
| Return Loss                          | - 27.7 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $48.7 \Omega + 4.5 j\Omega$ |
| Return Loss                          | - 26.5 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.159 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.

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 | April 23, 2010 |

## DASY5 Validation Report for Head TSL

Date/Time: 04.01.2011 14:51:47

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:859**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: HSL U12 BB

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.75$  mho/m;  $\epsilon_r = 38.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY52, V52.6 Build (401)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

**Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 103.5 V/m; Power Drift = 0.042 dB

Peak SAR (extrapolated) = 27.7 W/kg

**SAR(1 g) = 13.5 mW/g; SAR(10 g) = 6.32 mW/g**

Maximum value of SAR (measured) = 17.4 mW/g



0 dB = 17.4mW/g

# Impedance Measurement Plot for Head TSL

4 Jan 2011 10:53:34

[CH1] S11 1 U FS 4: 52.723  $\Omega$  3.2656  $\Omega$  212.14  $\mu\text{H}$  2 450.000 000 MHz

\*

De l

CA

Avg

16

CH2 S11 LOG 5 dB/REF -20 dB 4:-27.665 dB 2 450.000 000 MHz

CA

Avg

16

START 2 250.000 000 MHz

STOP 2 650.000 000 MHz

## DASY5 Validation Report for Body

Date/Time: 05.01.2011 13:26:59

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:859**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: MSL U12 BB

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.97$  mho/m;  $\epsilon_r = 52.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.31, 4.31, 4.31); Calibrated: 30.04.2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 10.06.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY52, V52.6 Build (401)
- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

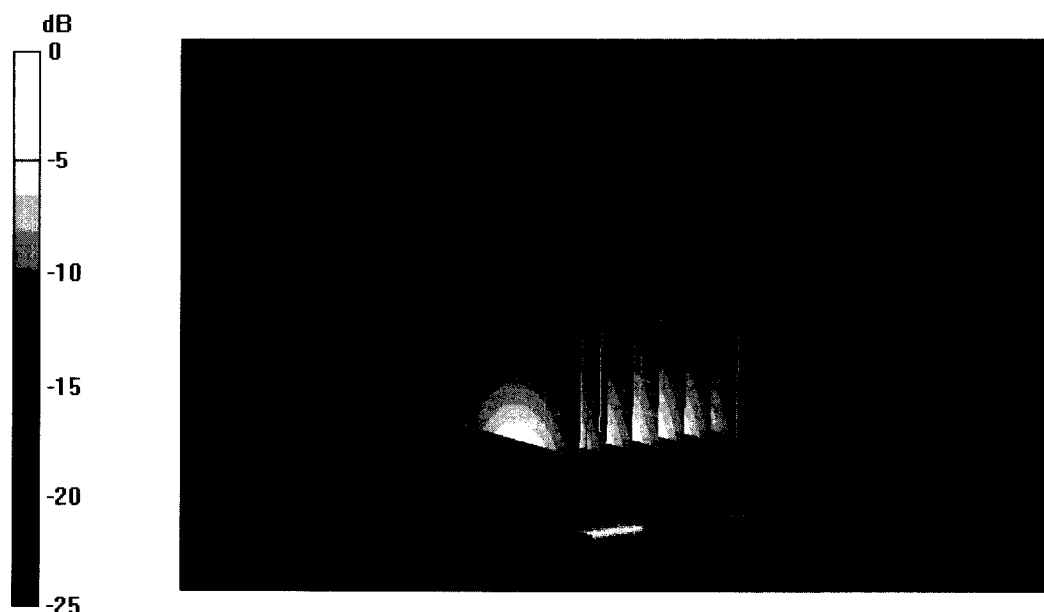
**Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.9 V/m; Power Drift = 0.00316 dB

Peak SAR (extrapolated) = 26.8 W/kg

**SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.84 mW/g**

Maximum value of SAR (measured) = 16.7 mW/g



0 dB = 16.7mW/g

# Impedance Measurement Plot for Body TSL

5 Jan 2011 09:52:47  
 [CH1] S11 1 U FS 4: 48.678  $\Omega$  4.4609  $\Omega$  289.79  $\mu$ H 2 450.000 000 MHz

\*

De1

CΔ

4

avg  
16

↑

CH2 S11 LOG 5 dB/REF -20 dB 4:-26.534 dB 2 450.000 000 MHz

CΔ

avg  
16

↑

START 2 250.000 000 MHz

STOP 2 650.000 000 MHz