

# TEST REPORT

**KCTL Inc.**

65, Sinwon-ro, Yeongtong-gu,  
Suwon-si, Gyeonggi-do, 16677, Korea  
TEL: 82 70 5008 1021  
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Report No.: KCTL16-SFA0005

Page( 1 ) / ( 56 ) Pages

**KCTL**  
<http://www.kctl.co.kr>

## 1. Applicant

Name: E-TECH Co., Ltd.  
Address: 655, Pyeongcheon-ro, Wonmi-gu, Bucheon-si, Gyeonggi-do, Korea

## 2. Manufacturer

Name: E-TECH Co., Ltd.  
Address: 655, Pyeongcheon-ro, Wonmi-gu, Bucheon-si, Gyeonggi-do, Korea

## 3. Sample Description:

Type of equipment: FM Handheld Transceiver(VHF)  
Model: NEP100

4. Date of Receipt: April 22, 2015

5. Date of Test: April 22 ~ April 23, 2015

6. FCC ID: R72NEP100

7. FCC Rule Part: CFR §2.1093



8. Test method used: IEEE 1528-2003, ANSI/IEEE C95.1, KDB Publication

9. Testing Environment: Temperature:(22 ± 2) °C

## 10. Test Results

Result: Complied (Refer to page 20 ~ page 21)  
Measurement Uncertainty: Refer to test result

This result shown in this report refer only to the sample(s) tested unless otherwise stated.

|             |  |   |
|-------------|--|---|
| Affirmation | Tested by<br><br>Name: KIM DONG KYU | Technical Manager<br><br>Name: CHOI, CHEON SIG |
|-------------|--|---|

2016. 04. 26

**KCTL Inc.** Testing Laboratory

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## 1. Applicant information

**Applicant:** E-TECH Co., Ltd.  
**Address:** 655, Pyeongcheon-ro, Wonmi-gu, Bucheon-si, Gyeonggi-do, Korea  
**Telephone:** +82-32-328-3184  
**Fax:** +82-32-328-3186  
**E-mail:** pico76@etech2004.co.kr  
**Contact name:** Kim Jae-Hyeon

**Manufacturer:** E-TECH Co., Ltd.  
**Address:** 655, Pyeongcheon-ro, Wonmi-gu, Bucheon-si, Gyeonggi-do, Korea

## 2. Laboratory information

### Address

#### **KCTL Inc.**

65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea

TEL: 82 70 5008 1021 FAX: 82 505 299 8311

### Certificate

KOLAS No.: KT231

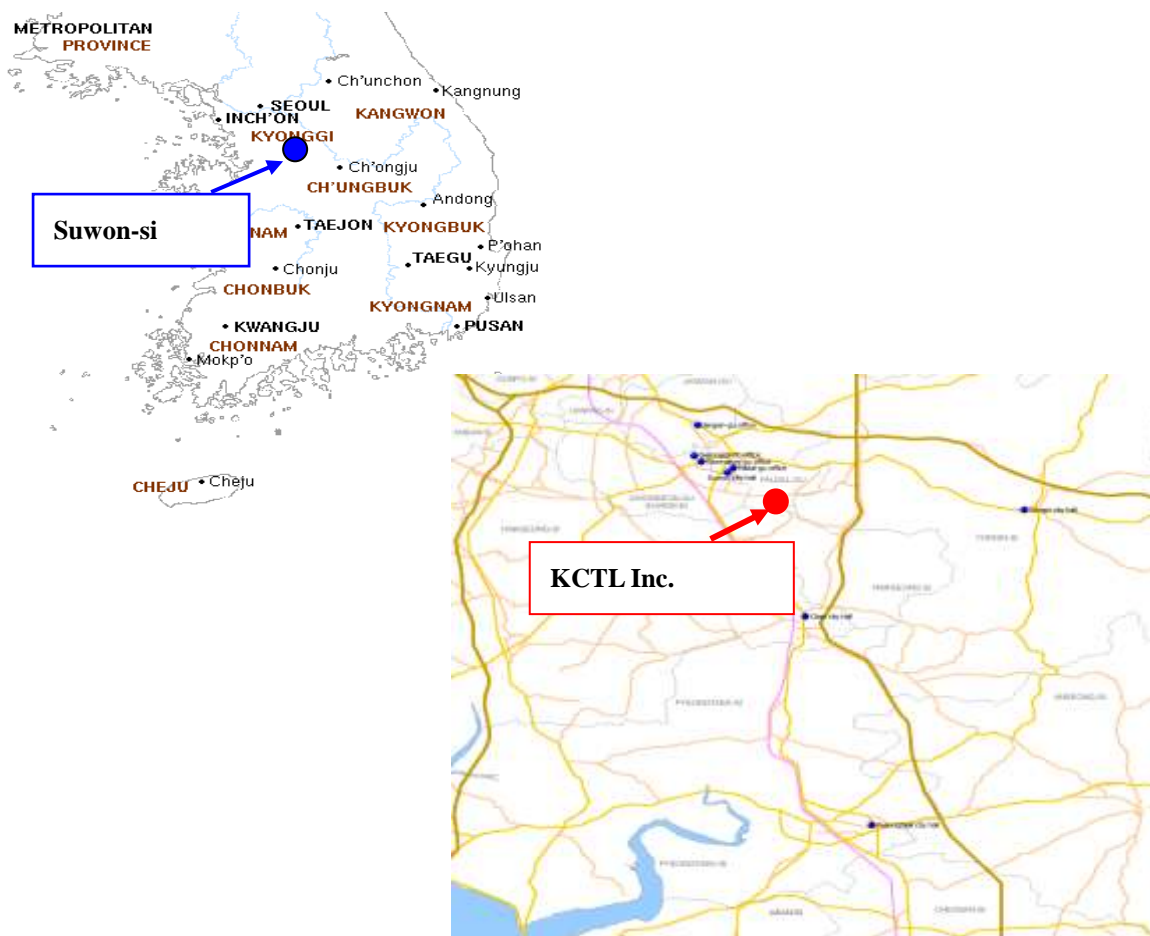
FCC Site Designation No.: KR0040

FCC Site Registration No.: 687132

VCCI Site Registration No.: R-3327, G-198, C-3706, T-1849

IC Site Registration No.: 8035A-2

### SITE MAP



#### **KCTL Inc.**

65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea

TEL: 82 70 5008 1021 FAX: 82 505 299 8311

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### 3. Identification of Sample

|                   |                               |
|-------------------|-------------------------------|
| EUT Type          | FM Handheld Transceiver (VHF) |
| Brand Name        | E-TECH Co., Ltd.              |
| Mode of Operation | FM                            |
| Model Number      | NEP100                        |
| Serial Number     | N/A                           |
| Max. Power        | 37.99 dBm                     |
| Tx Freq.Range     | 136.025 ~ 173.975 MHz         |
| Rx Freq.Range     | 136.025 ~ 173.975 MHz         |
| Antenna Type      | Whip Type                     |
| Normal Voltage    | DC 7.4 V                      |
| H/W Version       | V1.0                          |
| S/W Version       | V1.0                          |

## 4. Test Result Summary

### 4.1 FM Head SAR

| Frequency |         | Average Power (dBm) | Max. tune up power (dBm) | Scaling Factor | EUT Position | Distance (mm) | Measured 1 g SAR (W/kg) Duty 100 % | Measured 1 g SAR (W/kg) Duty 50 % | Scaled 1 g SAR (W/kg) |
|-----------|---------|---------------------|--------------------------|----------------|--------------|---------------|------------------------------------|-----------------------------------|-----------------------|
| MHz       | Channel |                     |                          |                |              |               |                                    |                                   |                       |
| 155.025   | 2       | 37.12               | 37.99                    | 1.023          | Front        | 25            | 1.11                               | 0.555                             | 0.568                 |

\* Contain the results of the worst test SAR including battery.

### 4.2 FM Body SAR

| Frequency |         | Average Power (dBm) | Max. tune up power (dBm) | Scaling Factor | EUT Position | Distance (mm) | Measured 1 g SAR (W/kg) Duty 100 % | Measured 1 g SAR (W/kg) Duty 50 % | Scaled 1 g SAR (W/kg) |
|-----------|---------|---------------------|--------------------------|----------------|--------------|---------------|------------------------------------|-----------------------------------|-----------------------|
| MHz       | Channel |                     |                          |                |              |               |                                    |                                   |                       |
| 155.025   | 2       | 37.12               | 37.99                    | 1.023          | Back         | 0             | 2.13                               | 1.07                              | 1.095                 |

\* Contain the results of the worst test SAR including battery.

## 5. Report Overview

This report details the results of testing carried out on the samples listed in section 3, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

This report may only be reproduced and distributed in full. If the product in this test report is used in any configuration other than that detailed in the test report, the manufacturer must ensure the new configuration complies with all relevant standards and certification requirements. Any mention of KCTL Inc. Wireless lab or testing done by KCTL Inc. Wireless lab made in connection with the distribution or use of the tested product must be approved in writing by KCTL Inc. Wireless lab.

## 6. Test Lab Declaration or Comments

None

## 7. Applicant Declaration or Comments

None

## 8. Measurement Uncertainty

All measurements and results are recorded and maintained at the laboratory performing the tests and measurement uncertainties are taken into account when comparing measurements to pass/ fail criteria.

### Uncertainty of SAR equipments for measurement Head

| <i>A</i>   | <i>b</i>                  | <i>c</i>                           | <i>D</i>                    | <i>e = f(d,k)</i> | <i>g</i> | <i>i = c x g / e</i>    | <i>k</i>         |
|--|---------------------------|------------------------------------|-----------------------------|-------------------|----------|-------------------------|------------------|
| Source of Uncertainty  | Description<br>IEEE P1528 | Tolerance/<br>Uncertainty<br>value | Probability<br>Distribution | Div.              | CI       | Standard<br>uncertainty | Vt<br>or<br>Veff |
|  | (0.3 ~ 3 GHz)             | ± %                                |                             |                   | (1 g)    | ± %, (1 g)              |                  |
| Measurement System   |                           |                                    |                             |                   |          |                         |                  |
| Probe calibration(k=1)   | E.2.1                     | 6.30                               | N                           | 1                 | 1        | 6.30                    | ∞                |
| Axial isotropy   | E.2.2                     | 0.50                               | R                           | 1.73              | 0.71     | 0.20                    | ∞                |
| Hemispherical isotropy   | E.2.2                     | 2.60                               | R                           | 1.73              | 0.71     | 1.06                    | ∞                |
| Linearity  | E.2.4                     | 0.60                               | R                           | 1.73              | 1        | 0.35                    | ∞                |
| Boundary effect  | E.2.3                     | 1.00                               | R                           | 1.73              | 1        | 0.58                    | ∞                |
| System detection limits  | E.2.5                     | 1.00                               | R                           | 1.73              | 1        | 0.58                    | ∞                |
| Readout electronics  | E.2.6                     | 0.30                               | N                           | 1                 | 1        | 0.30                    | ∞                |
| Response time  | E.2.7                     | 0.80                               | R                           | 1.73              | 1        | 0.46                    | ∞                |
| Integration time   | E.2.8                     | 2.60                               | R                           | 1.73              | 1        | 1.50                    | ∞                |
| RF ambient conditions-noise  | E.6.1                     | 3.00                               | R                           | 1.73              | 1        | 1.73                    | ∞                |
| RF ambient conditions-reflections  | E.6.1                     | 3.00                               | R                           | 1.73              | 1        | 1.73                    | ∞                |
| Probe positioner mechanical tolerance  | E.6.2                     | 0.40                               | R                           | 1.73              | 1        | 0.23                    | ∞                |
| Probe positioning with respect to phantom shell                                  | E.6.3                     | 2.90                               | R                           | 1.73              | 1        | 1.67                    | ∞                |
| Extrapolation, interpolation, and integration algorithms for max. SAR evaluation | E.5                       | 2.00                               | R                           | 1.73              | 1        | 1.15                    | ∞                |
| Test Sample Related  |                           |                                    |                             |                   |          |                         |                  |
| Test sample positioning  | E.4.2                     | 4.71                               | N                           | 1                 | 1        | 4.71                    | 9                |
| Device holder uncertainty  | E.4.1                     | 3.60                               | N                           | 1                 | 1        | 3.60                    | 5                |
| Output power variation--SAR drift measurement                                    | 6.6.2                     | 5.00                               | R                           | 1.73              | 1        | 2.89                    | ∞                |
| Phantom and Tissue Parameters  |                           |                                    |                             |                   |          |                         |                  |
| Phantom uncertainty (shape and thickness tolerances)                             | E.3.1                     | 6.10                               | R                           | 1.73              | 1        | 3.52                    | ∞                |
| Liquid conductivity-measurement uncertainty                                      | E.3.3                     | 1.53                               | N                           | 1                 | 0.64     | 0.98                    | 5                |
| Liquid permittivity-measurement uncertainty                                      | E.3.3                     | 3.07                               | N                           | 1                 | 0.6      | 1.84                    | 5                |
| Liquid conductivity-deviation from target values                                 | E.3.2                     | 5.00                               | R                           | 1.73              | 0.64     | 1.85                    | ∞                |
| Liquid permittivity-deviation from target values                                 | E.3.2                     | 5.00                               | R                           | 1.73              | 0.6      | 1.73                    | ∞                |
| Combined standard uncertainty  |                           |                                    |                             | RSS               |          | 11.00                   | 165              |
| Expanded uncertainty   |                           |                                    |                             | K=2               |          | 22.00                   |                  |
| (95% CONFIDENCE INTERVAL)  |                           |                                    |                             |                   |          |                         |                  |

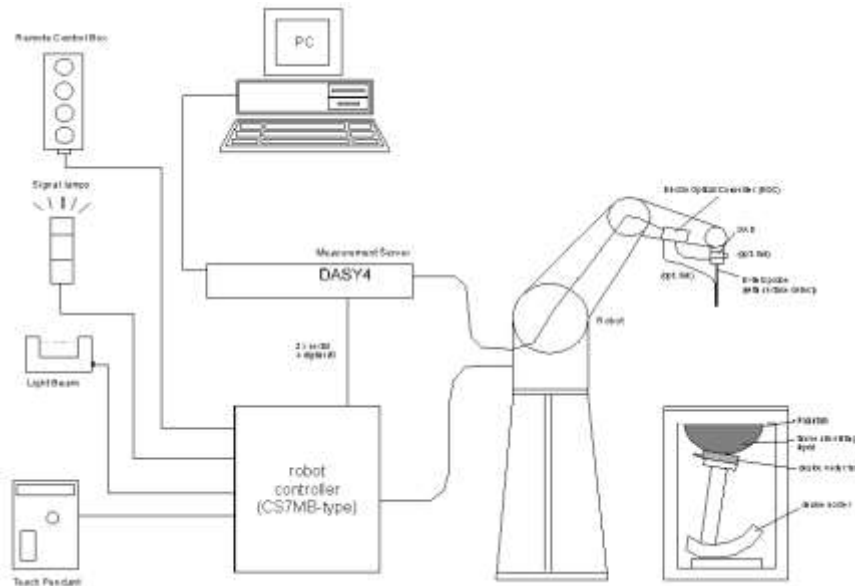


## Uncertainty of SAR equipments for measurement Body

| <i>A</i>   | <i>b</i>                  | <i>c</i>                           | <i>D</i>                    | <i>e = f(d,k)</i> | <i>g</i> | <i>i = c x g / e</i>    | <i>k</i>         |
|--|---------------------------|------------------------------------|-----------------------------|-------------------|----------|-------------------------|------------------|
| Source of Uncertainty  | Description<br>IEEE P1528 | Tolerance/<br>Uncertainty<br>value | Probability<br>Distribution | Div.              | Ci       | Standard<br>uncertainty | Vi<br>or<br>Veff |
|  | (0.3 ~ 3 GHz)             | ± %                                |                             |                   | (1 g)    | ± %, (1 g)              |                  |
| Measurement System   |                           |                                    |                             |                   |          |                         |                  |
| Probe calibration(k=1)   | E.2.1                     | 6.30                               | N                           | 1                 | 1        | 6.30                    | ∞                |
| Axial isotropy   | E.2.2                     | 0.50                               | R                           | 1.73              | 0.71     | 0.20                    | ∞                |
| Hemispherical isotropy   | E.2.2                     | 2.60                               | R                           | 1.73              | 0.71     | 1.06                    | ∞                |
| Linearity  | E.2.4                     | 0.60                               | R                           | 1.73              | 1        | 0.35                    | ∞                |
| Boundary effect  | E.2.3                     | 1.00                               | R                           | 1.73              | 1        | 0.58                    | ∞                |
| System detection limits  | E.2.5                     | 1.00                               | R                           | 1.73              | 1        | 0.58                    | ∞                |
| Readout electronics  | E.2.6                     | 0.30                               | N                           | 1                 | 1        | 0.30                    | ∞                |
| Response time  | E.2.7                     | 0.80                               | R                           | 1.73              | 1        | 0.46                    | ∞                |
| Integration time   | E.2.8                     | 2.60                               | R                           | 1.73              | 1        | 1.50                    | ∞                |
| RF ambient conditions—noise  | E.6.1                     | 3.00                               | R                           | 1.73              | 1        | 1.73                    | ∞                |
| KF ambient conditions—<br>reflections  | E.6.1                     | 3.00                               | R                           | 1.73              | 1        | 1.73                    | ∞                |
| Probe positioner mechanical<br>tolerance   | E.6.2                     | 0.40                               | R                           | 1.73              | 1        | 0.23                    | ∞                |
| Probe positioning with respect to<br>phantom shell                                     | E.6.3                     | 2.90                               | R                           | 1.73              | 1        | 1.67                    | ∞                |
| Extrapolation, interpolation, and<br>integration algorithms for max.<br>SAR evaluation | E.5                       | 2.00                               | R                           | 1.73              | 1        | 1.15                    | ∞                |
| Test Sample Related  |                           |                                    |                             |                   |          |                         |                  |
| Test sample positioning  | E.4.2                     | 4.71                               | N                           | 1                 | 1        | 4.71                    | 9                |
| Device holder uncertainty  | E.4.1                     | 3.60                               | N                           | 1                 | 1        | 3.60                    | 5                |
| Output power variation—SAR<br>drift measurement  | 6.6.2                     | 5.00                               | R                           | 1.73              | 1        | 2.89                    | ∞                |
| Phantom and Tissue Parameters  |                           |                                    |                             |                   |          |                         |                  |
| Phantom uncertainty<br>(shape and thickness tolerances)                                | E.3.1                     | 7.50                               | R                           | 1.73              | 1        | 4.33                    | ∞                |
| Liquid conductivity-measurement<br>uncertainty   | E.3.3                     | 1.53                               | N                           | 1                 | 0.64     | 0.98                    | 5                |
| Liquid permittivity-measurement<br>uncertainty   | E.3.3                     | 3.07                               | N                           | 1                 | 0.6      | 1.84                    | 5                |
| Liquid conductivity-deviation<br>from target values                                    | E.3.2                     | 5.00                               | R                           | 1.73              | 0.64     | 1.85                    | ∞                |
| Liquid permittivity-deviation<br>from target values                                    | E.3.2                     | 5.00                               | R                           | 1.73              | 0.6      | 1.73                    | ∞                |
| Combined standard uncertainty  |                           |                                    |                             | RSS               |          | 11.29                   | 183              |
| Expanded uncertainty   |                           |                                    |                             | K=2               |          | 22.57                   |                  |
| (95% CONFIDENCE<br>INTERVAL)   |                           |                                    |                             |                   |          |                         |                  |



## 9. The SAR Measurement System




### <SAR System Configuration>

- A standard high precision 6-axis robot (Staubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

## 9.1 Isotropic E-field Probe

| <b>ES3DV3</b><br><b>Isotropic E-Field Probe for Dosimetric Measurements</b>       |  |
|---|--|
|  | Symmetrical design with triangular core<br>Interleaved sensors<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| Calibration   | ISO/IEC 17025 <a href="#">calibration service</a> available.   |
| Frequency   | 10 MHz to 4 GHz;<br>Linearity: $\pm 0.2$ dB (30 MHz to 4 GHz)  |
| Directivity   | $\pm 0.2$ dB in TSL (rotation around probe axis)<br>$\pm 0.3$ dB in TSL (rotation normal to probe axis)  |
| Dynamic Range   | 5 $\mu$ W/g to > 100 mW/g;<br>Linearity: $\pm 0.2$ dB  |
| Dimensions  | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 3.9 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.0 mm   |
| Application   | General dosimetry up to 4 GHz<br>Dosimetry in strong gradient fields<br>Compliance tests of mobile phones  |
| Compatibility   | DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI   |

| <b>EX3DV4</b><br><b>Smallest Isotropic E-Field Probe for Dosimetric Measurements</b><br><b>(Preliminary Specifications)</b> |   |
|---|---|
|    | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE)   |
| Calibration   | ISO/IEC 17025 <a href="#">calibration service</a> available.  |
| Frequency   | 10 MHz to > 6 GHz<br>Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)  |
| Directivity   | $\pm 0.3$ dB in TSL (rotation around probe axis)<br>$\pm 0.5$ dB in TSL (rotation normal to probe axis)   |
| Dynamic Range   | 10 $\mu$ W/g to > 100 mW/g<br>Linearity: $\pm 0.2$ dB (noise: typically < 1 $\mu$ W/g)  |
| Dimensions  | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm  |
| Application   | High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields); the only probe that enables compliance testing for frequencies up to 6 GHz with precision of better 30%. |
| Compatibility   | DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI  |

## 9.2 Phantom

| Twin SAM  |  |
|---|--|
|  | <p>The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.</p> <p>Twin SAM V5.0 has the same shell geometry and is manufactured from the same material as Twin SAM V4.0, but has reinforced top structure.</p> |
|   |  |
| <b>Material</b>   | Vinylester, glass fiber reinforced (VE-GF)   |
| <b>Liquid Compatibility</b>   | Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)  |
| <b>Shell Thickness</b>  | 2 ± 0.2 mm (6 ± 0.2 mm at ear point)   |
| <b>Dimensions</b><br>(incl. Wooden Support)                                       | Length: 1000 mm<br>Width: 500 mm<br>Height: adjustable feet  |
| <b>Filling Volume</b>   | approx. 25 liters  |
| <b>Wooden Support</b>   | SPEAG standard phantom table   |
| <b>Accessories</b>  | <a href="#">Mounting Device and Adaptors</a>   |

| ELI   |  |
|---|--|
|  | <p>Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.</p> <p>ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure. ELI V6.0, released in August 2014, has the same shell geometry as ELI4 but offers increased longterm stability.</p> |
|   |  |
| <b>Material</b>   | Vinylester, glass fiber reinforced (VE-GF)   |
| <b>Liquid Compatibility</b>   | Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)  |
| <b>Shell Thickness</b>  | 2.0 ± 0.2 mm (bottom plate)  |
| <b>Dimensions</b>   | Major axis: 600 mm<br>Minor axis: 400 mm   |
| <b>Filling Volume</b>   | approx. 30 liters  |
| <b>Wooden Support</b>   | SPEAG standard phantom table   |
| <b>Accessories</b>  | <a href="#">Mounting Device and Adaptors</a>   |

### 9.3 Device Holder for Transmitters

#### Mounting Devices and Adaptors



Mounting Device for Hand-Held Transmitters

##### **MD4HHTV5 - Mounting Device for Hand-Held Transmitters**

In combination with the Twin SAM V5.0/V5.0c or ELI Phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).

**Material:** Polyoxymethylene (POM)



Mounting Device for Laptops

##### **MD4LAPV5 - Mounting Device for Laptops and other Body-Worn Transmitters**

In combination with the Twin SAM V5.0/V5.0c or ELI Phantoms, the Mounting Device (Body-Worn) enables testing of transmitter devices according to IEC 62209-2 specifications. The device holder can be locked for positioning at flat phantom section.

**Material:** Polyoxymethylene (POM), PET-G, Foam



## 10. System Verification

### 10.1 Tissue Verification

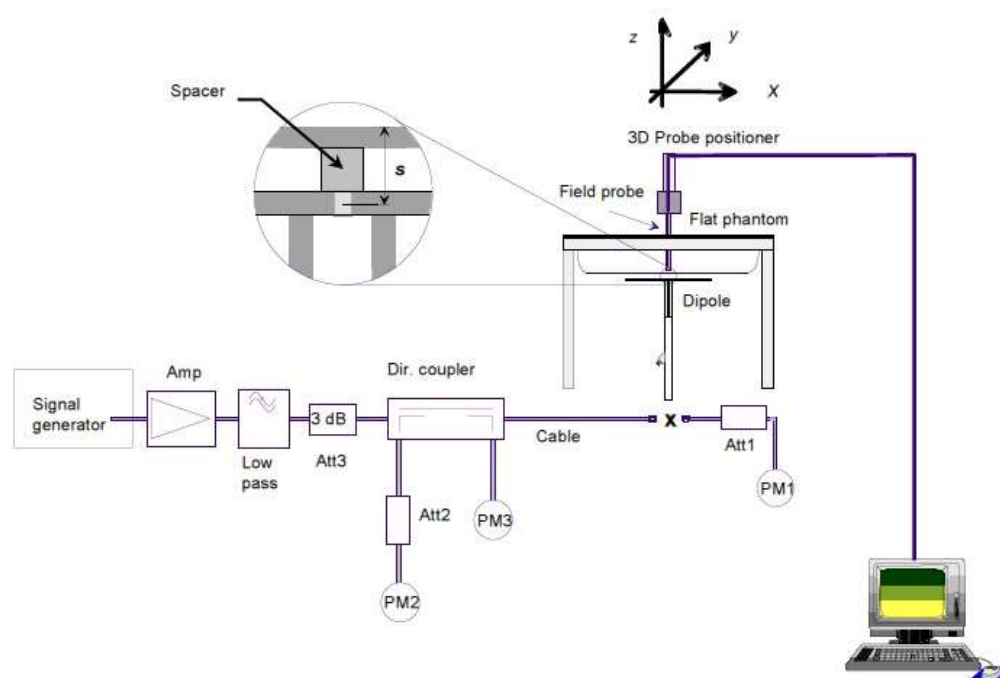
The dielectric properties for this Tissue Simulant Liquids were measured by using the SPEAG Model DAK3.5 Dielectric Probe in conjunction with Agilent E5071B Network Analyzer (300 kHz – 8 500 MHz). The Conductivity ( $\sigma$ ) and Permittivity ( $\rho$ ) are listed in Table 1. For the SAR measurement given in this report. The temperature variation of the Tissue Simulant Liquids was  $(22 \pm 2) ^\circ\text{C}$ .

| Freq. (MHz) | Tissue Type | Limit/Measured       | Permittivity ( $\rho$ )           | Conductivity ( $\sigma$ )      | Temp ( $^\circ\text{C}$ ) |
|-------------|-------------|----------------------|-----------------------------------|--------------------------------|---------------------------|
| 136.025     | HSL         | Recommended Limit    | $52.95 \pm 5 \%$<br>(50.30~55.60) | $0.75 \pm 5 \%$<br>(0.71~0.79) | $22 \pm 2$                |
|             |             | Measured, 2015-04-22 | 51.30                             | 0.78                           | 22.21                     |
| 150         | HSL         | Recommended Limit    | $52.30 \pm 5 \%$<br>(48.75~53.87) | $0.76 \pm 5 \%$<br>(0.72~0.80) | $22 \pm 2$                |
|             |             | Measured, 2015-04-22 | 50.49                             | 0.78                           | 22.21                     |
| 155.025     | HSL         | Recommended Limit    | $52.07 \pm 5 \%$<br>(49.47~54.67) | $0.76 \pm 5 \%$<br>(0.72~0.80) | $22 \pm 2$                |
|             |             | Measured, 2015-04-22 | 50.44                             | 0.77                           | 22.21                     |
| 173.975     | HSL         | Recommended Limit    | $51.23 \pm 5 \%$<br>(48.67~53.79) | $0.78 \pm 5 \%$<br>(0.74~0.82) | $22 \pm 2$                |
|             |             | Measured, 2015-04-22 | 50.70                             | 0.76                           | 22.21                     |
| 136.025     | MSL         | Recommended Limit    | $62.25 \pm 5 \%$<br>(59.14~65.36) | $0.79 \pm 5 \%$<br>(0.75~0.83) | $22 \pm 2$                |
|             |             | Measured, 2015-04-23 | 65.24                             | 0.82                           | 22.08                     |
| 150         | MSL         | Recommended Limit    | $61.90 \pm 5 \%$<br>(58.81~65.00) | $0.80 \pm 5 \%$<br>(0.76~0.84) | $22 \pm 2$                |
|             |             | Measured, 2015-04-23 | 64.17                             | 0.83                           | 22.08                     |
| 155.025     | MSL         | Recommended Limit    | $61.78 \pm 5 \%$<br>(58.69~64.87) | $0.80 \pm 5 \%$<br>(0.76~0.84) | $22 \pm 2$                |
|             |             | Measured, 2015-04-23 | 63.91                             | 0.82                           | 22.08                     |
| 173.975     | MSL         | Recommended Limit    | $61.38 \pm 5 \%$<br>(58.31~64.45) | $0.82 \pm 5 \%$<br>(0.78~0.86) | $22 \pm 2$                |
|             |             | Measured, 2015-04-23 | 63.07                             | 0.80                           | 22.08                     |

<Table 1.Measurement result of Tissue electric parameters>

## 10.2 Test System Verification

The microwave circuit arrangement for system verification is sketched below picture. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within  $\pm 10\%$  from the target SAR values. These tests were done at 150 MHz. The tests were conducted on the same days as the measurement of the EUT. The obtained results from the system accuracy verification are displayed in the table Table 2 (A power level of 250mW was input to the dipole antenna). During the tests, the ambient temperature of the laboratory was in the range  $(22 \pm 2)^\circ\text{C}$ , the relative humidity was in the range  $(50 \pm 20)\%$  and the liquid depth above the ear/grid reference points was above 15 cm in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.



| Validation Kit | Dipole Ant. S/N | Frequency (MHz) | Tissue Type | Limit/Measurement (Normalized to 1 W) |                                |                                |
|----------------|-----------------|-----------------|-------------|---------------------------------------|--------------------------------|--------------------------------|
|                |                 |                 |             |                                       | 1 g                            | 10 g                           |
| CLA150         | 4014            | 150             | HSL         | Recommended Limit (Normalized)        | $3.72 \pm 10\%$<br>(3.35~4.09) | $2.48 \pm 10\%$<br>(2.23~2.73) |
|                |                 |                 |             | Measured, 2015-04-22                  | 3.72                           | 2.31                           |
| CLA150         | 4014            | 150             | MSL         | Recommended Limit (Normalized)        | $3.81 \pm 10\%$<br>(3.43~4.19) | $2.56 \pm 10\%$<br>(2.30~2.82) |
|                |                 |                 |             | Measured, 2015-04-23                  | 3.99                           | 2.65                           |

<Table 2. Test System Verification Result>



---

## 11. Operation Configurations

Measurements were performed at the lowest, middle and highest channels of the operating band. The EUT was set to maximum power level during all tests and at the beginning of each test the battery was fully charged.

## 12. SAR Measurement Procedures

### Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

### Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04.

|  | ≤ 3 GHz   | > 3 GHz  |
|--|---|--|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | 5 ± 1 mm  | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location              | 30° ± 1°  | 20° ± 1°   |
| Maximum area scan spatial resolution: $\Delta x_{Area}$ , $\Delta y_{Area}$                            | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm  | 3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm           |
|  | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |  |

### Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures 5x5x7 points within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Zoom Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04

|   |                         |  | ≤ 3 GHz   | > 3 GHz  |
|---|-------------------------|--|---|--|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface  |                         |  | 5 mm ± 1 mm   | $\frac{1}{2} \cdot \delta \cdot \ln(2)$ mm 0.5 mm              |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location   |                         |  | 30° ± 1°  | 20° ± 1°   |
| Maximum area scan spatial resolution: ΔxArea, ΔyArea  |                         |  | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm  | 3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm                       |
|   |                         |  | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |  |
| Maximum zoom scan spatial resolution: ΔxZoom, ΔyZoom  |                         |  | ≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm*   | 3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm*                       |
| Maximum zoom scan spatial resolution, normal to phantom surface   | uniform grid: ΔzZoom(n) |  | ≤ 5 mm  | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm    |
|   | graded grid             | ΔzZoom(1): between 1st two points closest to phantom surface | ≤ 4 mm  | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm  |
|   |                         | ΔzZoom(n>1): between subsequent points                       | ≤ 1.5 · ΔzZoom(n-1) mm  |  |
| Minimum zoom scan volume  | x, y, z                 |  | ≥ 30 mm   | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |
| Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.  |                         |  |   |  |
| * When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. |                         |  |   |  |

### Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

### Step 5: Z-Scan

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

\* Z Scan Report on Liquid Measure the height Annex A.4 Liquid Depth photo to replace

### 13. Test Equipment Information

|                                   |   |                 |                     |                              |
|-----------------------------------|---|-----------------|---------------------|------------------------------|
| Test Platform                     | SPEAG DASY4 System                            |                 |                     |                              |
| Description                       | SAR Test System                               |                 |                     |                              |
| Software Reference                | DASY4: V4.7,Build80<br>SEMCAD: V1.8,Build 186 |                 |                     |                              |
| Hardware Reference                |   |                 |                     |                              |
| Equipment                         | Model   | Serial Number   | Date of Calibration | Due date of next Calibration |
| Shield Room                       | Shield Room                                   | None            | N/A                 | N/A                          |
| DASY4 Robot                       | RX90BL Speag                                  | F05/51E0A1/A01  | N/A                 | N/A                          |
| DASY4 Controller                  | RX90BL Speag                                  | F05/51E0A1/C/01 | N/A                 | N/A                          |
| Phantom                           | 2mm Oval Phantom ELI5                         | 1220            | N/A                 | N/A                          |
| Mounting Device                   | Mounting Device                               | None            | N/A                 | N/A                          |
| DAE                               | DAE4  | 911             | 2015-02-20          | 2016-02-20                   |
| Probe                             | ES3DV3  | 3302            | 2014-05-20          | 2015-05-20                   |
| System Validation Sources         | CLA150  | 4014            | 2014-09-04          | 2015-09-04                   |
| Network Analyzer                  | E5071B  | MY42403524      | 2014-07-15          | 2015-07-15                   |
| Dual Directional Coupler          | 778D  | 16059           | 2014-08-29          | 2015-08-29                   |
| Signal Generator                  | E4438C  | MY42080486      | 2015-01-19          | 2016-01-19                   |
| Power Amplifier                   | GRF5039                                       | 1062            | 2014-07-17          | 2015-07-17                   |
| LP Filter                         | LA-15N  | 36543           | 2014-08-28          | 2015-08-28                   |
| Dual Power Meter                  | E4419B  | GB43312301      | 2014-07-17          | 2015-07-17                   |
| Power Sensor                      | 8481H   | 3318A19377      | 2014-08-30          | 2015-08-30                   |
| Dielectric Assessment Kit         | DAK-3.5                                       | 1078            | 2014-08-19          | 2015-08-19                   |
| Humidity/Baro/Temp. Data Recorder | MHB-382SD                                     | 14036           | 2014-08-26          | 2015-08-26                   |

## 14. RF Average Conducted Output Power

### 14.1 Average Conducted Output Power

| Band | Power      | Conducted Power (dBm) |             |             |
|------|------------|-----------------------|-------------|-------------|
|      |            | 136.025 MHz           | 155.025 MHz | 173.975 MHz |
| FM   | 1 W - Low  | 30.68                 | 30.05       | 30.08       |
|      | 5 W - High | 37.14                 | 37.12       | 37.13       |

### 14.2 Max. tune up power

| Band | Power      | Target Power (dBm) | Tolerance (dBm) | Max. Allowed Power (dBm) |
|------|------------|--------------------|-----------------|--------------------------|
| FM   | 1 W - Low  | 30.00              | ± 1.50          | 31.50                    |
|      | 5 W - High | 36.99              | ± 1.00          | 37.99                    |

## 15. SAR Test Results

### 15.1 Head SAR Test Results

| Frequency |         | Average Power (dBm) | Max. tune up power (dBm) | Scaling Factor | EUT Position | Distance (mm) | Measured 1 g SAR (W/kg) Duty 100 % | Measured 1 g SAR (W/kg) Duty 50 % | Scaled 1 g SAR (W/kg) |
|-----------|---------|---------------------|--------------------------|----------------|--------------|---------------|------------------------------------|-----------------------------------|-----------------------|
| MHz       | Channel |                     |                          |                |              |               |                                    |                                   |                       |
| 155.025   | 2       | 37.12               | 37.99                    | 1.023          | Front        | 25            | 1.11                               | 0.555                             | <b>0.568</b>          |

<Note>

1.FCC KDB Publication 643646D01v01r03.

I) When the head SAR of an antenna test

- a)  $\leq 3.5$  W/kg, testing of all other required channels is not necessary for that antenna
- b)  $> 3.5$  W/kg and  $\leq 4.0$  W/kg, testing of the required immediately adjacent channel(s) is not necessary; testing of the other required channels may still be required
- c)  $> 4.0$  W/kg and  $\leq 6.0$  W/kg, head SAR should be measured for that antenna on the required immediately adjacent channels; testing of the other required channels still needs consideration
- d)  $> 6.0$  W/kg, test all required channels for that antenna
- e) for the remaining channels that cannot be excluded in b) and c), which still require consideration, the 3.5 W/kg exclusion in a) and 4.0 W/kg exclusion in b) may be applied recursively with respect to the highest output power channel among the remaining channels; measure the SAR for the remaining channels that cannot be excluded
- i) if an immediately adjacent channel measured in c) or a remaining channel

2. FCC KDB Publication 447498D01v06

I) The operating configurations of handheld PTT two-way radios generally require SAR testing for in-front-of the face and body-worn accessory exposure conditions. A duty factor of 50% should be applied to determine compliance for radios with maximum operating duty factors  $\leq 50\%$ .



## 15.2 Body SAR Test Results

| Frequency |         | Average Power (dBm) | Max. tune up power (dBm) | Scaling Factor | EUT Position | Distance (mm) | Measured 1 g SAR (W/kg) Duty 100 % | Measured 1 g SAR (W/kg) Duty 50 % | Scaled 1 g SAR (W/kg) |
|-----------|---------|---------------------|--------------------------|----------------|--------------|---------------|------------------------------------|-----------------------------------|-----------------------|
| MHz       | Channel |                     |                          |                |              |               |                                    |                                   |                       |
| 155.025   | 2       | 37.12               | 37.99                    | 1.023          | Back         | 0             | 2.13                               | 1.07                              | <b>1.095</b>          |

<Note>

1.FCC KDB Publication 643646D01v01r03.

I) When the body SAR of an antenna test

- a)  $\leq 3.5$  W/kg, testing of all other required channels is not necessary for that antenna
- b)  $> 3.5$  W/kg and  $\leq 4.0$  W/kg, testing of the required immediately adjacent channel(s) is not necessary; testing of the other required channels may still be required
- c)  $> 4.0$  W/kg and  $\leq 6.0$  W/kg, body SAR should be measured for that antenna on the required immediately adjacent channels; testing of the other required channels still needs consideration
- d)  $> 6.0$  W/kg, test all required channels for that antenna
- e) for the remaining channels that cannot be excluded in b) and c), which still require consideration, the 3.5 W/kg exclusion in a) and 4.0 W/kg exclusion in b) may be applied recursively with respect to the highest output power channel among the remaining channels; measure the SAR of the remaining channels that cannot be excluded
- i) if an immediately adjacent channel measured in c) or a remaining channel measured in e) is  $> 6.0$  W/kg, test all required channels for that antenna

2. FCC KDB Publication 447498D01v06

I) The operating configurations of handheld PTT two-way radios generally require SAR testing for in-front-of the face and body-worn accessory exposure conditions. A duty factor of 50% should be applied to determine compliance for radios with maximum operating duty factors  $\leq 50\%$ .

## 16. Test System Verification Results

### System check for 150 MHz-Body(2015-04-22)

**Procedure Name: d=0 mm, Pin=250 mW, f=150**

Frequency: 150 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 150$  MHz;  $\sigma = 0.777$  mho/m;  $\epsilon_r = 50.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3302; ConvF(6.77, 6.77, 6.77); Calibrated: 2014-05-20
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn911; Calibrated: 2015-02-20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1220
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**d=0 mm, Pin=250 mW, f=150/Area Scan (201x201x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 1.12 mW/g

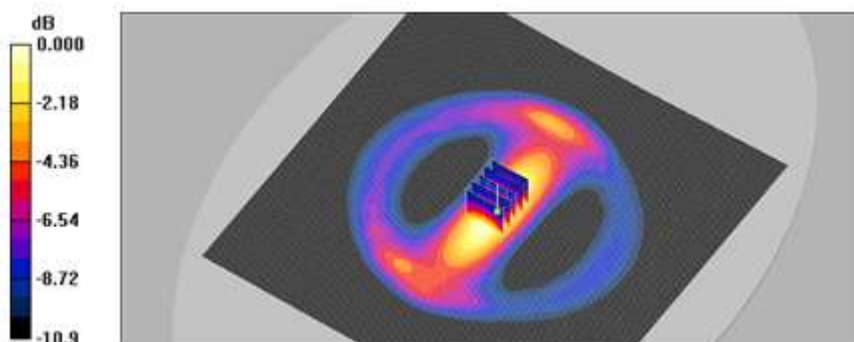
**d=0 mm, Pin=250 mW, f=150/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 38.7 V/m; Power Drift = -0.085 dB

Peak SAR (extrapolated) = 1.67 W/kg

**SAR(1 g) = 0.930 mW/g; SAR(10 g) = 0.578 mW/g**

Maximum value of SAR (measured) = 1.11 mW/g



---

**System check for 150 MHz-Body(2015-04-23)**

**Procedure Name: d=0 mm, Pin=250 mW, f=150**

Frequency: 150 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated):  $f = 150$  MHz;  $\sigma = 0.826$  mho/m;  $\epsilon_r = 64.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3302; ConvF(6.45, 6.45, 6.45); Calibrated: 2014-05-20
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn911; Calibrated: 2015-02-20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1220
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**d=0 mm, Pin=250 mW, f=150/Area Scan (201x201x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 1.24 mW/g

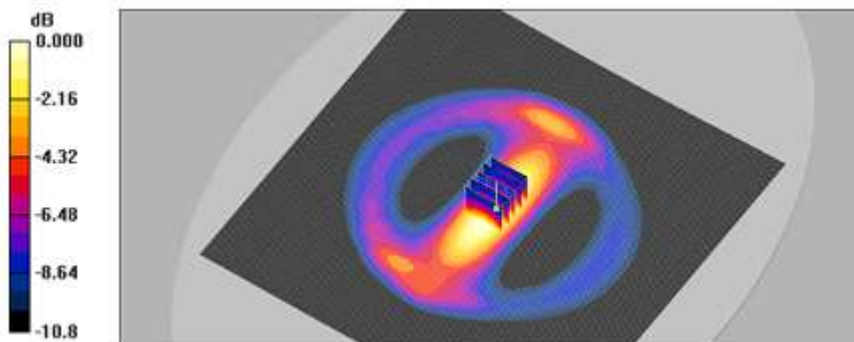
**d=0 mm, Pin=250 mW, f=150/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 38.8 V/m; Power Drift = 0.018 dB

Peak SAR (extrapolated) = 1.78 W/kg

**SAR(1 g) = 0.997 mW/g; SAR(10 g) = 0.622 mW/g**

Maximum value of SAR (measured) = 1.19 mW/g



## 17. Test Results

#1 FM Head SAR

**Procedure Name: FM\_Ch.1\_f.155.025\_Head Front\_Gap 25 mm**

Frequency: 155.025 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 155.025$  MHz;  $\sigma = 0.775$  mho/m;  $\epsilon_r = 50.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3302; ConvF(6.77, 6.77, 6.77); Calibrated: 2014-05-20
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn911; Calibrated: 2015-02-20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1220
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**FM\_Ch.1\_f.155.025\_Head Front\_Gap 25 mm/Area Scan (71x191x1):** Measurement grid:

$dx=15$ mm,  $dy=15$ mm

Maximum value of SAR (interpolated) = 1.32 mW/g

**FM\_Ch.1\_f.155.025\_Head Front\_Gap 25 mm/Zoom Scan (5x5x7)/Cube 0:** Measurement

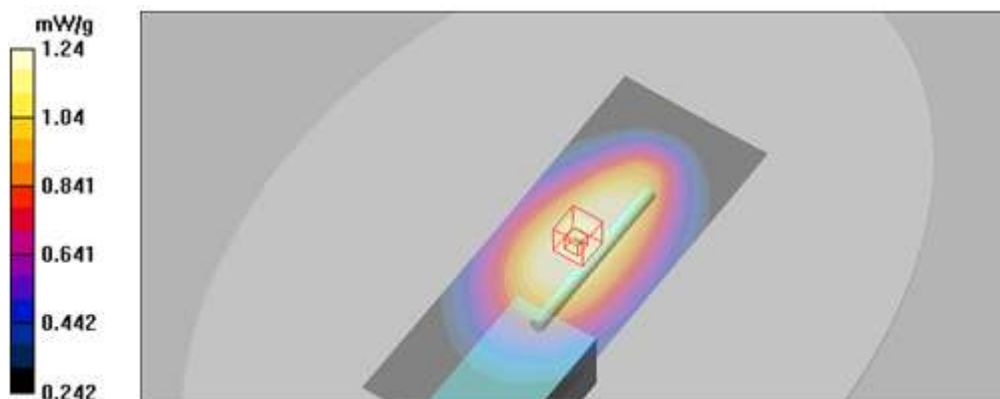
grid:  $dx=8$ mm,  $dy=8$ mm,  $dz=5$ mm

Reference Value = 40.5 V/m; Power Drift = -0.001 dB

Peak SAR (extrapolated) = 1.61 W/kg

**SAR(1 g) = 1.11 mW/g; SAR(10 g) = 0.835 mW/g**

Maximum value of SAR (measured) = 1.24 mW/g



#2 FM Body SAR

**Procedure Name: FM\_Ch.2\_f.155.025\_Body Back\_Gap 0 mm**

Frequency: 155.025 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 155.025$  MHz;  $\sigma = 0.822$  mho/m;  $\epsilon_r = 63.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ES3DV3 - SN3302; ConvF(6.45, 6.45, 6.45); Calibrated: 2014-05-20
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn911; Calibrated: 2015-02-20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:1220
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**FM\_Ch.2\_f.155.025\_Body Back\_Gap 0 mm/Area Scan (81x191x1):** Measurement grid:  
dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 2.44 mW/g

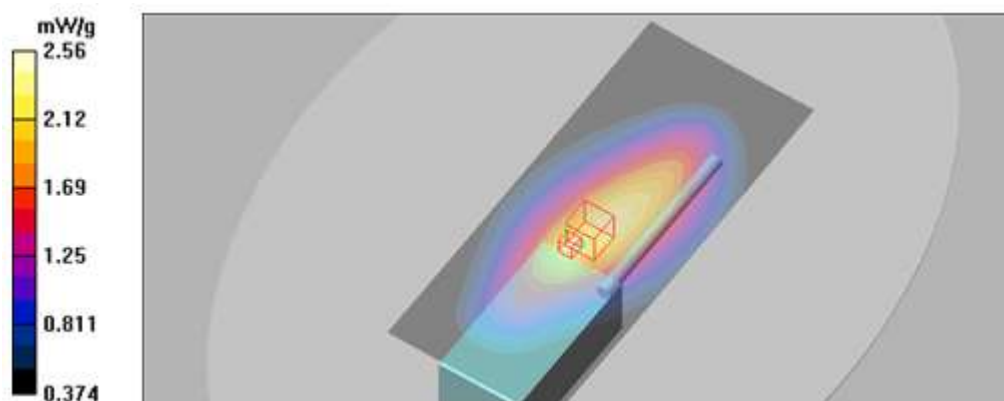
**FM\_Ch.2\_f.155.025\_Body Back\_Gap 0 mm/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 55.6 V/m; Power Drift = -0.038 dB

Peak SAR (extrapolated) = 3.69 W/kg

**SAR(1 g) = 2.13 mW/g; SAR(10 g) = 1.5 mW/g**

Maximum value of SAR (measured) = 2.56 mW/g



## Annex A. Photographs

### Annex A.1 EUT

Front View



Back View





**Right side View**



**Left side View**



**Top side View**



**Bottom side View**



---

## Annex A.2 Photographs of Test Setup



**Photograph of the SAR measurement System**

### Annex A.3 Test Position



(a) Head\_Front



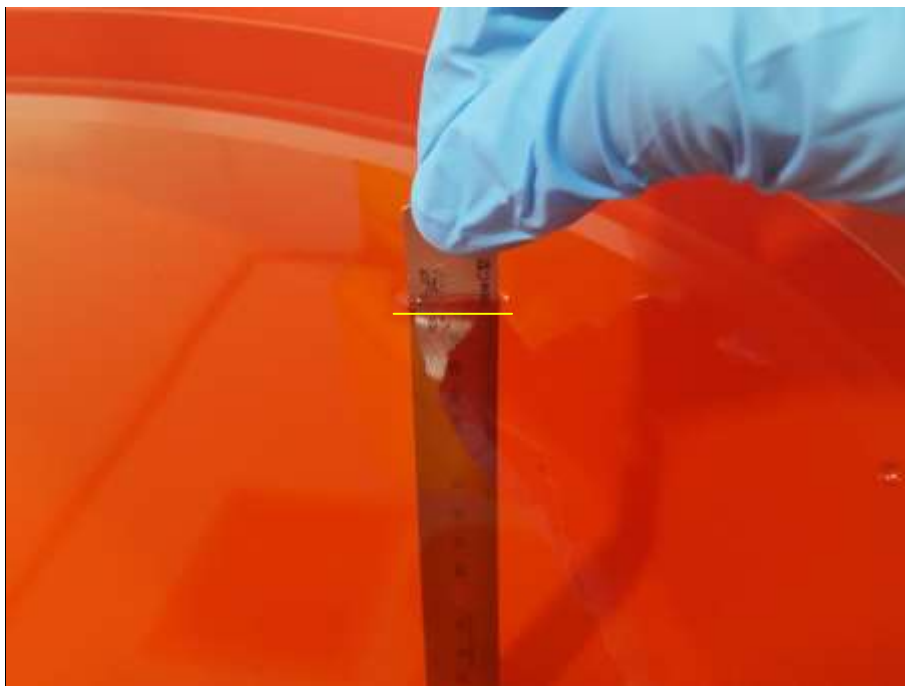
(b) Body\_Back



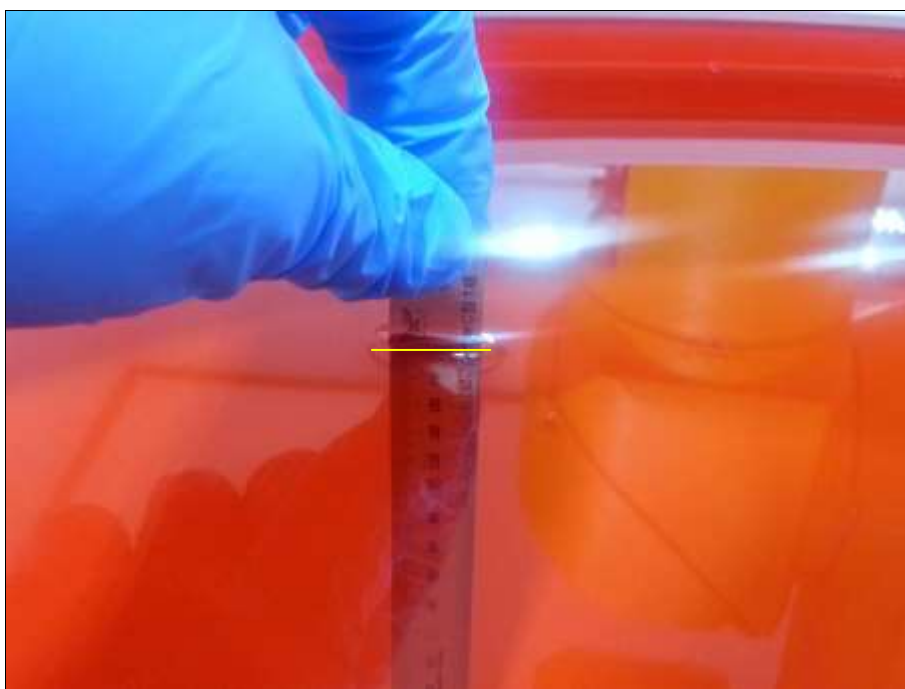
(c) System Check 150 MHz

---

Annex A.4 Liquid Depth



**HSL150**



**MSL150**



## Annex B. Calibration certificate

### Annex B.1 Probe Calibration certificate

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

Schweizerischer Kalibrierdienst  
Service suisse d'étalonnage  
Servizio svizzero di taratura  
Swiss Calibration Service

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: **EMC Compliance (Dymstec)** Certificate No.: **ES3-3302\_May14**

### CALIBRATION CERTIFICATE

Object: **ES3DV3 - SN:3302**

Calibration procedure(s): **QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6**  
Calibration procedure for dosimetric E-field probes

Calibration date: **May 20, 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&E critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41283874      | 03-Apr-14 (No. 217-01911)         | Apr-15                 |
| Power sensor E4412A        | MY41498087      | 03-Apr-14 (No. 217-01911)         | Apr-15                 |
| Reference 3 dB Attenuator  | SN: 55054 (3c)  | 03-Apr-14 (No. 217-01915)         | Apr-15                 |
| Reference 20 dB Attenuator | SN: 55277 (20x) | 03-Apr-14 (No. 217-01919)         | Apr-15                 |
| Reference 30 dB Attenuator | SN: 55129 (30b) | 03-Apr-14 (No. 217-01920)         | Apr-15                 |
| Reference Probe ES3DV2     | SN: 3013        | 30-Dec-13 (No. ES3-3013_Dec13)    | Dec-14                 |
| DAE4                       | SN: 660         | 13-Dec-13 (No. DAE4-660_Dec13)    | Dec-14                 |
| Secondary Standards        | ID              | Check Date (in house)             | Scheduled Check        |
| RF generator HP 8648C      | US3642U01700    | 4-Aug-95 (in house check Apr-13)  | In house check: Apr-16 |
| Network Analyzer HP 8753E  | US37390585      | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

Calibrated by: **Jeton Kastrell** (Name), **Laboratory Technician** (Function),  (Signature)

Approved by: **Katja Pokovic** (Name), **Technical Manager** (Function),  (Signature)

Issued: May 22, 2014.

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

|   |   |   |    |     |
|---|---|---|----|-----|
| 결 | 제 | X | HA | 506 |
|---|---|---|----|-----|

Certificate No: ES3-3302\_May14

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
Swiss Calibration Service

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  |
| 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).<br>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:**

- 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

**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: 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 affect 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.
- 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>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>:** A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters:** Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<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).

ES3DV3 - SN:3302

May 20, 2014

# Probe ES3DV3

SN:3302

Manufactured: August 27, 2010  
Calibrated: May 20, 2014

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

ES3DV3- SN:3302

May 20, 2014

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3302

### Basic Calibration Parameters

|   | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|---|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 1.18     | 1.38     | 1.32     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                                     | 103.0    | 102.0    | 101.0    |               |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>C</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 247.9    | $\pm 4.1 \%$              |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 231.8    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 227.1    |                           |

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 Norm X,Y,Z do not effect the E<sup>2</sup> field uncertainty inside TSL (see Page 5).

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

<sup>C</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ES3DV3- SN:3302

May 20, 2014

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3302

### Calibration Parameter Determined in Head 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>h</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 52.3                               | 0.76                            | 6.77    | 6.77    | 6.77    | 0.05               | 1.10                    | ± 13.3 %    |
| 300                  | 45.3                               | 0.87                            | 6.63    | 6.63    | 6.63    | 0.15               | 1.20                    | ± 13.3 %    |
| 450                  | 43.5                               | 0.87                            | 6.46    | 6.46    | 6.46    | 0.20               | 2.25                    | ± 13.3 %    |
| 850                  | 41.5                               | 0.92                            | 5.94    | 5.94    | 5.94    | 0.60               | 1.35                    | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 5.88    | 5.88    | 5.88    | 0.48               | 1.47                    | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 5.06    | 5.06    | 5.06    | 0.77               | 1.24                    | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 4.91    | 4.91    | 4.91    | 0.80               | 1.19                    | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 4.34    | 4.34    | 4.34    | 0.73               | 1.26                    | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 4.16    | 4.16    | 4.16    | 0.80               | 1.30                    | ± 12.0 %    |

<sup>c</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), also it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Above 5 GHz frequency validity can be extended to ± 110 MHz. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively.

<sup>f</sup> At frequencies 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>h</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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



ES3DV3- SN:3302

May 20, 2014

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3302

### 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>H</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 61.9                               | 0.80                            | 6.45    | 6.45    | 6.45    | 0.08               | 1.10                    | ± 13.3 %    |
| 300                  | 58.2                               | 0.92                            | 6.39    | 6.39    | 6.39    | 0.16               | 1.50                    | ± 13.3 %    |

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Above 5 GHz frequency validity can be extended to ± 110 MHz. Frequency validity below 300 MHz is ± 10, 25, 40, 60 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively.

<sup>F</sup> At frequencies 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.

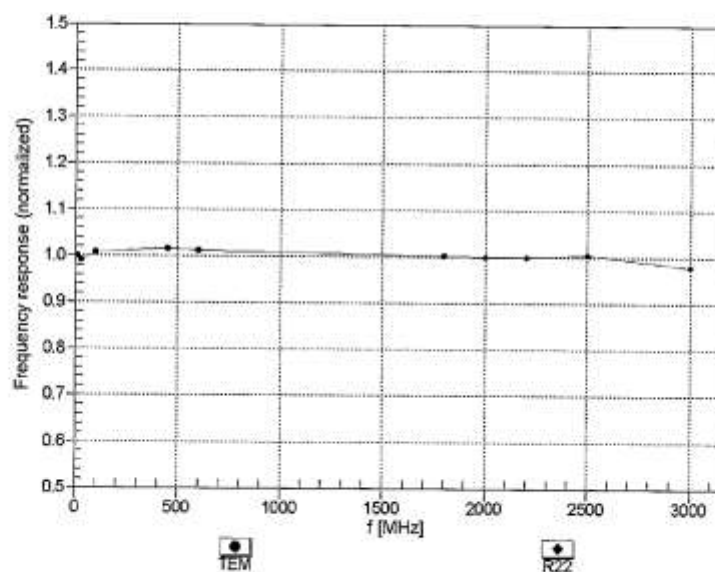
<sup>H</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter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



ES3DV3- SN:3302

May 20, 2014

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

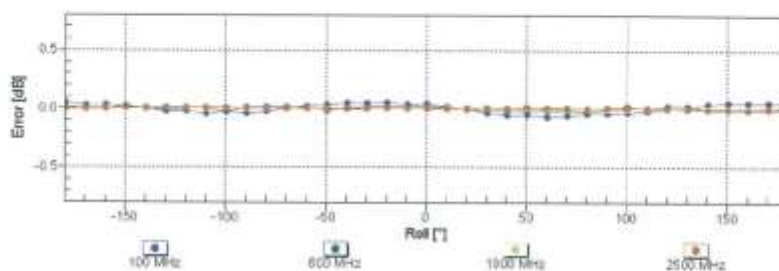
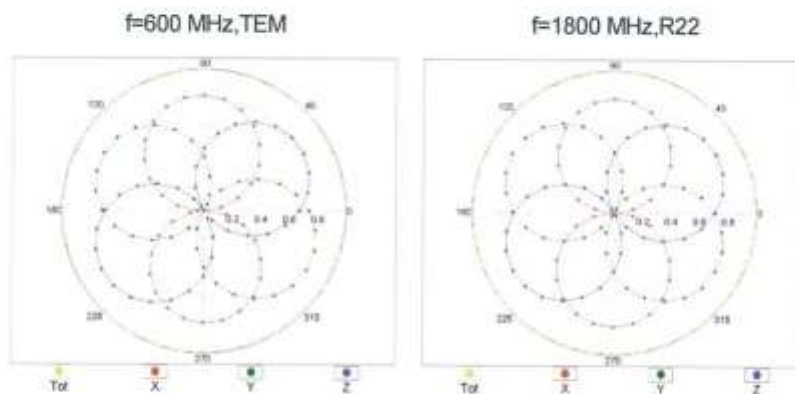


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

ES3DV3- SN:3302

May 20, 2014

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

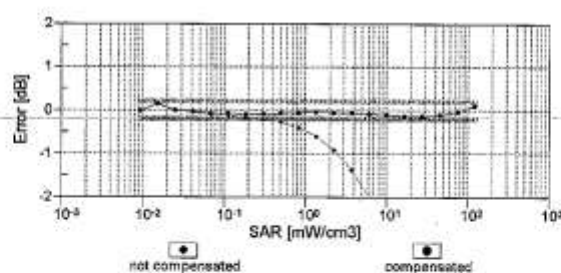
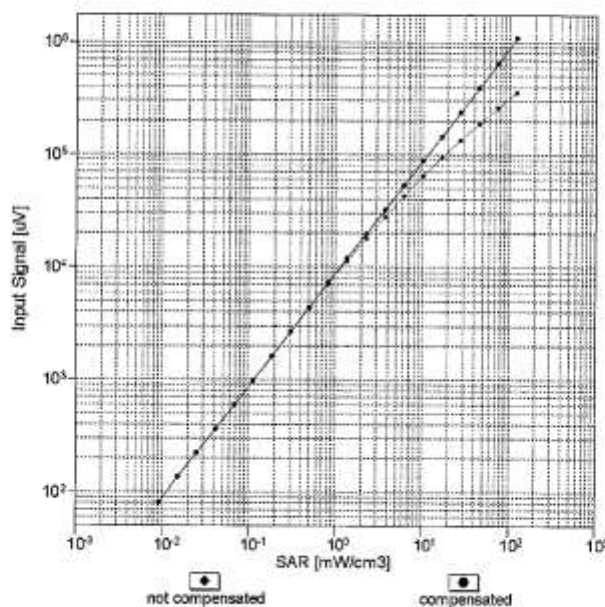


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

ES3DV3- SN:3302

May 20, 2014

**Dynamic Range  $f(\text{SAR}_{\text{head}})$**   
(TEM cell,  $f_{\text{eval}} = 1900 \text{ MHz}$ )



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

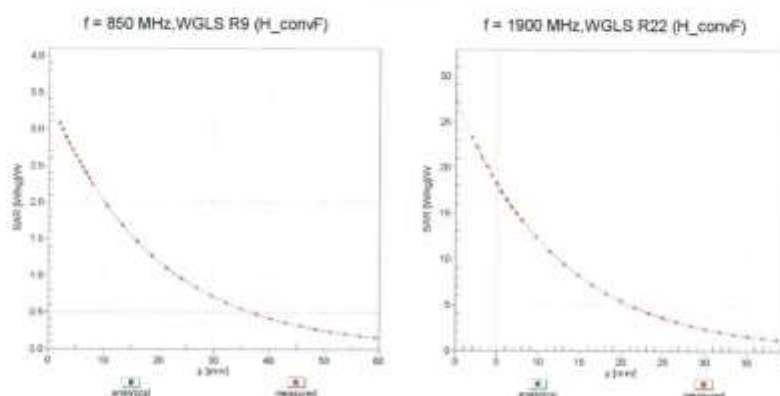
Certificate No: ES3-3302\_May14

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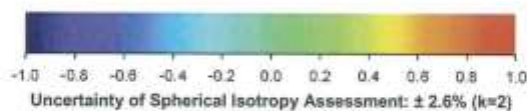
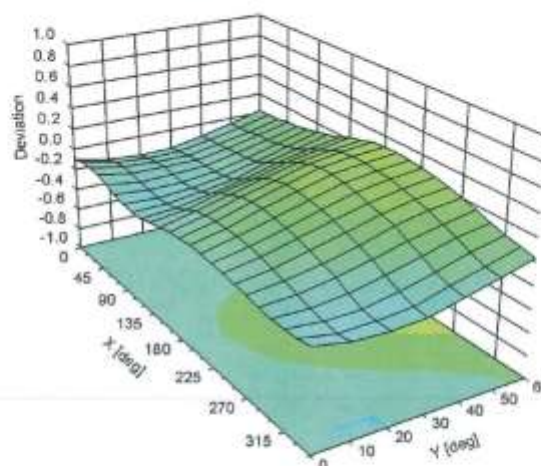
ES3DV3- SN:3302

May 20, 2014

### Conversion Factor Assessment



### Deviation from Isotropy in Liquid Error ( $\phi$ , $\theta$ ), $f = 900 \text{ MHz}$



ES3DV3- SN:3302

May 20, 2014

**DASY/EASY - Parameters of Probe: ES3DV3 - SN:3302**

**Other Probe Parameters**

|   |            |
|---|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -129.6     |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 10 mm      |
| Tip Diameter                                  | 4 mm       |
| Probe Tip to Sensor X Calibration Point       | 2 mm       |
| Probe Tip to Sensor Y Calibration Point       | 2 mm       |
| Probe Tip to Sensor Z Calibration Point       | 2 mm       |
| Recommended Measurement Distance from Surface | 3 mm       |

Annex B.2 DAE Calibration certification

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Dymstec**

Certificate No: **DAE4-911\_Feb15**

**CALIBRATION CERTIFICATE**

Object **DAE4 - SD 000 D04 BK - SN: 911**

Calibration procedure(s) **QA CAL-06.v29  
Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **February 20, 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)

| Primary Standards             | ID #               | Cal Date (Certificate No.) | Scheduled Calibration  |
|-------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278        | 03-Oct-14 (No:15573)       | Oct-15                 |
| Secondary Standards           | ID #               | Check Date (in house)      | Scheduled Check        |
| Auto DAE Calibration Unit     | SE UWS 053 AA 1001 | 06-Jan-15 (in house check) | In house check: Jan-16 |
| Calibrator Box V2.1           | SE UMS 006 AA 1002 | 06-Jan-15 (in house check) | In house check: Jan-16 |

|                |                           |                          |               |
|----------------|---------------------------|--------------------------|---------------|
| Calibrated by: | Name<br>Dominique Steffen | Function<br>Technician   | Signature<br> |
| Approved by:   | Fin Bornholt              | Deputy Technical Manager |               |

Issued: February 20, 2015

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

Certificate No: DAE4-911\_Feb15

Page 1 of 5



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

### 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 following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - **DC Voltage Measurement Linearity:** Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - **Common mode sensitivity:** Influence of a positive or negative common mode voltage on the differential measurement.
  - **Channel separation:** Influence of a voltage on the neighbor channels not subject to an input voltage.
  - **AD Converter Values with inputs shorted:** Values on the internal AD converter corresponding to zero input voltage
  - **Input Offset Measurement:** Output voltage and statistical results over a large number of zero voltage measurements.
  - **Input Offset Current:** Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - **Input resistance:** Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - **Low Battery Alarm Voltage:** Typical value for information. Below this voltage, a battery alarm signal is generated.
  - **Power consumption:** Typical value for information. Supply currents in various operating modes.

#### DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 $\mu$ V, full range = -100...+300 mV  
Low Range: 1LSB = 61nV, full range = -1.....+3mV

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 405.170 $\pm$ 0.02% (k=2) | 404.879 $\pm$ 0.02% (k=2) | 404.758 $\pm$ 0.02% (k=2) |
| Low Range           | 4.00112 $\pm$ 1.50% (k=2) | 3.96552 $\pm$ 1.50% (k=2) | 3.96381 $\pm$ 1.50% (k=2) |

#### Connector Angle

|   |                 |
|---|-----------------|
| Connector Angle to be used in DASY system | 230.5° $\pm$ 1° |
|---|-----------------|

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

**1. DC Voltage Linearity**

| High Range        | Reading ( $\mu$ V) | Difference ( $\mu$ V) | Error (%) |
|-------------------|--------------------|-----------------------|-----------|
| Channel X + Input | 200037.32          | 1.46                  | 0.00      |
| Channel X + Input | 20004.28           | 0.78                  | 0.00      |
| Channel X - Input | -20004.64          | 1.68                  | -0.01     |
| Channel Y + Input | 200033.09          | -1.68                 | -0.00     |
| Channel Y + Input | 20002.35           | -1.20                 | -0.01     |
| Channel Y - Input | -20008.45          | -1.96                 | 0.01      |
| Channel Z + Input | 200034.70          | 0.03                  | 0.00      |
| Channel Z + Input | 20002.39           | -1.05                 | -0.01     |
| Channel Z - Input | -20004.67          | 1.87                  | -0.01     |

| Low Range         | Reading ( $\mu$ V) | Difference ( $\mu$ V) | Error (%) |
|-------------------|--------------------|-----------------------|-----------|
| Channel X + Input | 1999.99            | -0.06                 | -0.00     |
| Channel X + Input | 200.20             | 0.16                  | 0.08      |
| Channel X - Input | -199.85            | 0.08                  | -0.04     |
| Channel Y + Input | 1999.61            | -0.30                 | -0.02     |
| Channel Y + Input | 198.82             | -1.01                 | -0.50     |
| Channel Y - Input | -200.06            | 0.06                  | -0.03     |
| Channel Z + Input | 1998.51            | -1.46                 | -0.07     |
| Channel Z + Input | 198.92             | -0.93                 | -0.46     |
| Channel Z - Input | -201.66            | -1.46                 | 0.73      |

**2. Common mode sensitivity**

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

|           | Common mode Input Voltage (mV) | High Range Average Reading ( $\mu$ V) | Low Range Average Reading ( $\mu$ V) |
|-----------|--------------------------------|---------------------------------------|--------------------------------------|
| Channel X | 200                            | -10.84                                | -12.46                               |
|           | - 200                          | 15.93                                 | 14.84                                |
| Channel Y | 200                            | 20.13                                 | 19.14                                |
|           | - 200                          | -20.31                                | -20.62                               |
| Channel Z | 200                            | -20.75                                | -20.21                               |
|           | - 200                          | 17.28                                 | 17.42                                |

**3. Channel separation**

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

|           | Input Voltage (mV) | Channel X ( $\mu$ V) | Channel Y ( $\mu$ V) | Channel Z ( $\mu$ V) |
|-----------|--------------------|----------------------|----------------------|----------------------|
| Channel X | 200                | -                    | 0.34                 | -5.35                |
| Channel Y | 200                | 6.51                 | -                    | 0.09                 |
| Channel Z | 200                | 9.54                 | 4.62                 | -                    |

#### 4. AD-Converter Values with inputs shorted

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

|           | High Range (LSB) | Low Range (LSB) |
|-----------|------------------|-----------------|
| Channel X | 15852            | 16154           |
| Channel Y | 15998            | 16109           |
| Channel Z | 16437            | 14961           |

#### 5. Input Offset Measurement

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

Input 10MΩ

|           | Average (μV) | min. Offset (μV) | max. Offset (μV) | Std. Deviation (μV) |
|-----------|--------------|------------------|------------------|---------------------|
| Channel X | 0.94         | -1.06            | 3.07             | 0.63                |
| Channel Y | 0.10         | -1.29            | 1.79             | 0.60                |
| Channel Z | -0.37        | -2.17            | 1.01             | 0.56                |

#### 6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

#### 7. Input Resistance (Typical values for information)

|           | Zeroing (kΩ) | Measuring (MΩ) |
|-----------|--------------|----------------|
| Channel X | 200          | 200            |
| Channel Y | 200          | 200            |
| Channel Z | 200          | 200            |

#### 8. Low Battery Alarm Voltage (Typical values for information)

| Typical values | Alarm Level (VDC) |
|----------------|-------------------|
| Supply (+ Vcc) | +7.9              |
| Supply (- Vcc) | -7.6              |

#### 9. Power Consumption (Typical values for information)

| Typical values | Switched off (mA) | Stand by (mA) | Transmitting (mA) |
|----------------|-------------------|---------------|-------------------|
| Supply (+ Vcc) | +0.01             | +6            | +14               |
| Supply (- Vcc) | -0.01             | -8            | -9                |

Annex B.3 Dipole Calibration certification

CLA150

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Accreditation No.: SCS 108

Client: HCT (Dymstec)

Certificate No: CLA150-4014\_Sep14

**CALIBRATION CERTIFICATE**

Object: CLA150 - SN: 4014

Calibration procedure(s): QA CAL-15.v8  
Calibration procedure for system validation sources below 700 MHz

Calibration date: September 04, 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 E4419B          | GBM1293874         | 03-Apr-14 (No. 217-01911)      | Apr-15                |
| Power sensor E4412A         | MY41499087         | 03-Apr-14 (No. 217-01911)      | Apr-15                |
| Reference 3 dB Attenuator   | SN: S5054 (3c)     | 03-Apr-14 (No. 217-01915)      | Apr-15                |
| Reference 20 dB Attenuator  | SN: S5058 (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 EX3DV4      | SN: 3877           | 06-Jan-14 (No. EX3-3877_Jan14) | Jan-15                |
| DAE4                        | SN: 654            | 30-Jun-14 (No. DAE4-654_Jun14) | Jun-15                |

| Secondary Standards       | ID #             | Check Date (in house)             | Scheduled Check        |
|---------------------------|------------------|-----------------------------------|------------------------|
| RF generator HP 8640C     | US3642U01700     | 04-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

|                |                      |                                 |            |
|----------------|----------------------|---------------------------------|------------|
| Calibrated by: | Name: Jeteri Kasrati | Function: Laboratory Technician | Signature: |
| Approved by:   | Name: Katja Pokovic  | Function: Technical Manager     | Signature: |

Issued: September 11, 2014

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Certificate No: CLA150-4014\_Sep14

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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:**

- IEC 62209-2, "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 2013
- 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:* SAR measured at the stated antenna input power.
- SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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



### Measurement Conditions

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

|                      |                                  |                                 |
|----------------------|----------------------------------|---------------------------------|
| DASY Version         | DASY5                            | V52.8.8                         |
| Extrapolation        | Advanced Extrapolation           |                                 |
| Phantom              | ELI4 Flat Phantom                | Shell thickness: $2 \pm 0.2$ mm |
| EUT Positioning      | Touch Position                   |                                 |
| Zoom Scan Resolution | $dx, dy = 4.0$ mm, $dz = 1.4$ mm |                                 |
| Frequency            | $150$ MHz $\pm 1$ MHz            |                                 |

### Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity           |
|---|---------------------|----------------|------------------------|
| Nominal Head TSL parameters             | $22.0$ °C           | 52.3           | 0.76 mho/m             |
| Measured Head TSL parameters            | $(22.0 \pm 0.2)$ °C | $51.5 \pm 6$ % | $0.76$ mho/m $\pm 6$ % |
| 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  | 1 W input power  | 3.77 W/kg                          |
| SAR for nominal Head TSL parameters                       | normalized to 1W | $3.72$ W/kg $\pm 18.4$ % ( $k=2$ ) |
| SAR averaged over $10$ cm <sup>3</sup> (10 g) of Head TSL | condition        |                                    |
| SAR measured  | 1 W input power  | 2.51 W/kg                          |
| SAR for nominal Head TSL parameters                       | normalized to 1W | $2.48$ W/kg $\pm 18.0$ % ( $k=2$ ) |

### Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity           |
|---|---------------------|----------------|------------------------|
| Nominal Body TSL parameters             | $22.0$ °C           | 61.9           | 0.80 mho/m             |
| Measured Body TSL parameters            | $(22.0 \pm 0.2)$ °C | $61.1 \pm 6$ % | $0.81$ mho/m $\pm 6$ % |
| 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  | 1 W input power  | 3.86 W/kg                          |
| SAR for nominal Body TSL parameters                       | normalized to 1W | $3.81$ W/kg $\pm 18.4$ % ( $k=2$ ) |
| SAR averaged over $10$ cm <sup>3</sup> (10 g) of Body TSL | condition        |                                    |
| SAR measured  | 1 W input power  | 2.59 W/kg                          |
| SAR for nominal Body TSL parameters                       | normalized to 1W | $2.56$ W/kg $\pm 18.0$ % ( $k=2$ ) |

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $46.6 \Omega - 5.9 j\Omega$ |
| Return Loss                          | - 23.0 dB                   |

Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $48.4 \Omega + 6.7 j\Omega$ |
| Return Loss                          | - 23.2 dB                   |

Additional EUT Data

|                 |               |
|-----------------|---------------|
| Manufactured by | SPEAG         |
| Manufactured on | June 30, 2014 |

**DASY5 Validation Report for Head TSL**

Date: 05.09.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4014**

Communication System: UID 0 - CW; Frequency: 150 MHz

Medium parameters used:  $f = 150$  MHz;  $\sigma = 0.77$  S/m;  $\epsilon_r = 51.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(11.76, 11.76, 11.76); Calibrated: 06.01.2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 30.06.2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan**

**(81x81x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 4.74 W/kg

**CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan,**

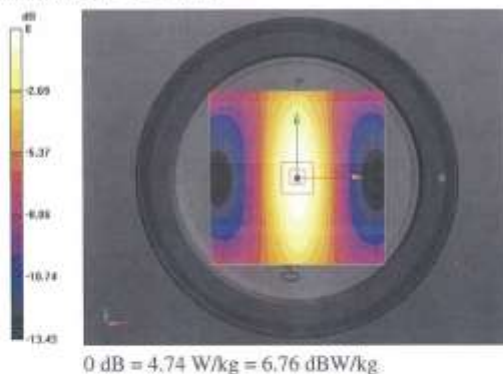
**dist=1.4mm (8x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 78.54 V/m; Power Drift = -0.04 dB

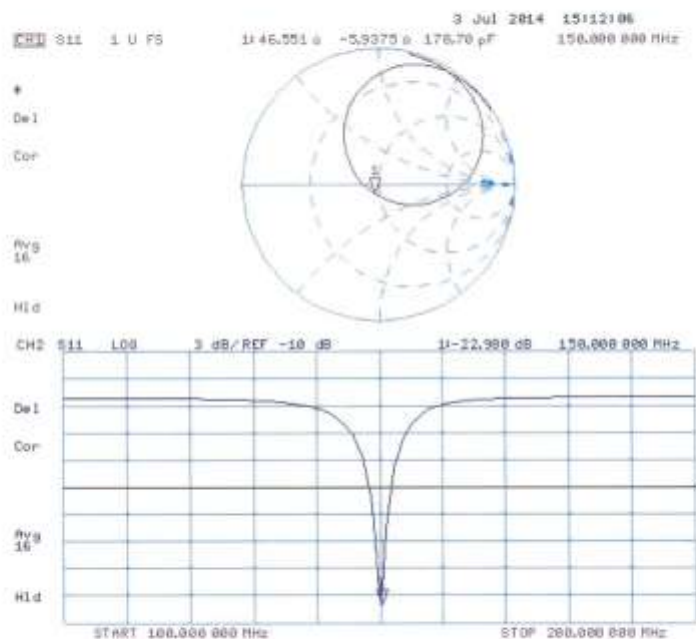
Peak SAR (extrapolated) = 7.09 W/kg

**SAR(1 g) = 3.77 W/kg; SAR(10 g) = 2.51 W/kg**

Maximum value of SAR (measured) = 5.24 W/kg



Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 04.09.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: CLA-150; Type: CLA-150; Serial: 4014**

Communication System: UID 0 - CW; Frequency: 150 MHz

Medium parameters used:  $f = 150$  MHz;  $\sigma = 0.81$  S/m;  $\epsilon_r = 61.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

**DASY52 Configuration:**

- Probe: EX3DV4 - SN3877; ConvF(11.45, 11.45, 11.45); Calibrated: 06.01.2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection), Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 30.06.2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan**

(81x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 4.83 W/kg

**CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan,**

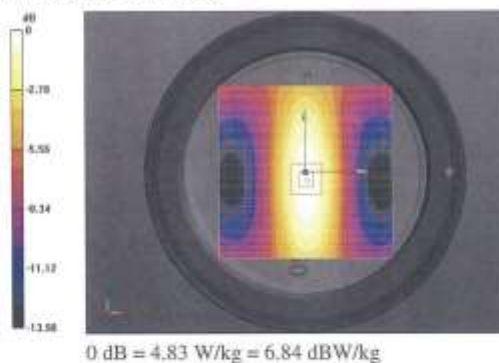
**dist=1.4mm (8x9x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 77.28 V/m; Power Drift = -0.02 dB

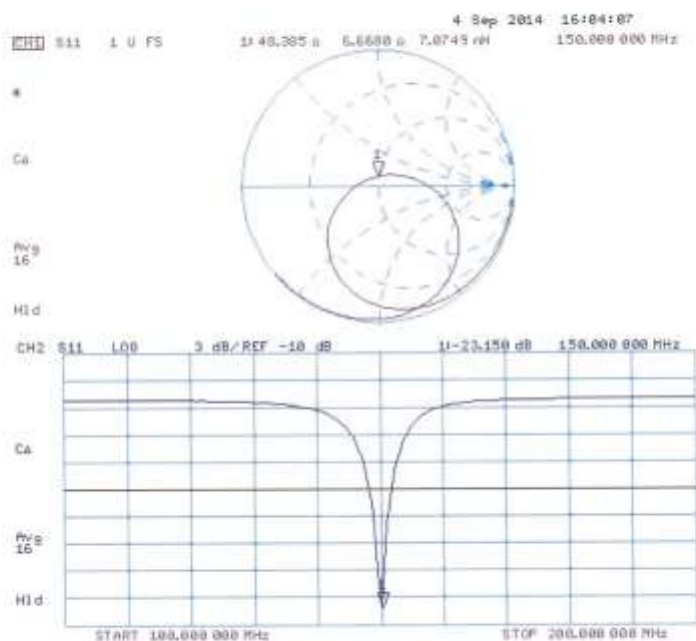
Peak SAR (extrapolated) = 7.09 W/kg

**SAR(1 g) = 3.86 W/kg; SAR(10 g) = 2.59 W/kg**

Maximum value of SAR (measured) = 5.36 W/kg



Impedance Measurement Plot for Body TSL



**-END OF REPORT -**