

## FCC SAR TEST REPORT

### FOR

|                             |   |                                      |
|-----------------------------|---|--------------------------------------|
| <b>Applicant</b>            | : | VIEVU, LLC                           |
| <b>Address</b>              | : | 105W. John St, Seattle WA 98119, USA |
| <b>Equipment under Test</b> | : | Wearable Video Camera                |
| <b>Model No</b>             | : | LE4                                  |
| <b>FCC ID</b>               | : | 2ABBNLE4                             |
| <b>Trade Mark</b>           | : | VIEVU                                |
| <b>Manufacturer</b>         | : | VIEVU, LLC                           |
| <b>Address</b>              | : | 105W. John St, Seattle WA 98119, USA |

**Issued By: Dongguan Dongdian Testing Service Co., Ltd.**

**Add:** No. 17, Zongbu Road 2, Songshan Lake Sci&Tech, Industry Park, Dongguan City, Guangdong Province,  
China, 523808

**Tel:** +86-0769-22891499 [Http://www.dgddt.com](http://www.dgddt.com)

# REPORT

**TEST REPORT DECLARE**

|                             |   |                                      |
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**We Declare:**

The equipment described above is evaluation by Dongguan Dongdian Testing Service Co., Ltd and in the configuration tested the equipment complied with the standards specified above. The test results are contained in this test report and Dongguan Dongdian Testing Service Co., Ltd is assumed of full responsibility for the accuracy and completeness of these tests.

|                      |                              |                        |               |
|----------------------|------------------------------|------------------------|---------------|
| <b>Report No:</b>    | DDT-15Q00730-1E6             |                        |               |
| <b>Date of Test:</b> | Aug.12, 2015--- Aug.12, 2015 | <b>Date of Report:</b> | Aug. 18, 2015 |

**Prepared By:**

**Leo Liu/Engineer****Kevin Feng/EMC Manager**

Note: This report applies to above tested sample only. This report shall not be reproduced in parts without written approval of Dongguan Dongdian Testing Service Co., Ltd.

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## **1. TEST STANDARDS/PROCEDURES REFERENCE/FCC KDBs**

The tests were performed according to following standards:

[IEEE 1528-2003 \(2003-04\)](#): Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques:

[IEEE 1528-2013 \(2014-06\)](#): Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

[IEEE Std. C95-3 \(2002\)](#): IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave

[ANSI/IEEE Std. C95-1 \(1992\)](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[KDB941225D07v01r01](#): UMPC Mini Tablet

[KDB248227 D01v02r01](#): SAR Guidance for IEEE 802.11 Wi-Fi SAR v02r01

[KDB 865664D01v01r03 \(February 7, 2014\)](#): SAR Measurement Requirements for 100 MHz to 6 GHz

[KDB 865664D02v01r01 \(May 28, 2013\)](#): RF Exposure Compliance Reporting and Documentation Considerations

[KDB 447498D01v05r02 \(February 7, 2014\)](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

## 2. SUMMARY

### 2.1. General Remarks

|                             |   |                                                                                        |
|-----------------------------|---|----------------------------------------------------------------------------------------|
| EUT* Name                   | : | Wearable Video Camera                                                                  |
| Model Number                | : | LE4                                                                                    |
| EUTfunction description     | : | Please reference user manual of this device                                            |
| Power supply                | : | DC 5V from external power adapter input AC 120V/60Hz and DC 3.7V from built-in battery |
| Operation frequency range   | : | IEEE 802.11b: 2412MHz—2462MHz                                                          |
| Modulation type             | : | IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK)                                                    |
| Maximum Reported SAR Values | : | <b>Body worn: 0.228W/Kg (100% Duty Cycle)</b>                                          |
| Antenna Type                | : | Integrated                                                                             |
| Date of Receipt             | : | Aug.06,2015                                                                            |
| Sample Type                 | : | Series production                                                                      |
| Exposure category:          | : | General population / Uncontrolled environment                                          |

Note1: EUT is the ab.of equipment under test.

### 2.2. Accessories of EUT

| Description of Accessories | Manufacturer | Model number or Type | Serial No. | Other |
|----------------------------|--------------|----------------------|------------|-------|
| /                          | /            | /                    | /          | /     |

### 2.3. Short description of the Equipment under Test (EUT)

The spatial peak SAR values were assessed for systems. Battery and accessories shall be specified by the manufacturer. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output.

### 2.4. TEST Configuration

For WiFi SAR testing, a communication link is set up with the testing software for WiFi mode test. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. The RF signal utilized in SAR measurement has 100% duty cycle and its crest factor is 1. The test procedures in KDB 248227D01v02r01 are applied. (Refer to KDB 248227D01v02r01 for more details)

#### 1) Initial Test Position Procedure

For exposure condition with multiple test position, such as handsets operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all position in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is  $\leq 0.4 \text{ W/kg}$ , no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is  $\leq 0.8 \text{ W/kg}$  or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the *reported* SAR is  $> 0.8 \text{ W/kg}$ , SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is  $\leq 1.2 \text{ W/kg}$  or all required channels are tested.

#### 2) Initial Test Configuration Procedure

An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. SAR is measured using the highest measured maximum output power channel. For configurations with the same specified or measured maximum output power, additional transmission mode and test channel selection procedures are required (see section 5.3.2 of KDB 248227D01v02r01). SAR test reduction of subsequent highest output test channels is based on the reported SAR of the initial test configuration.

For next to the ear, hotspot mode and UMC mini-tablet exposure configurations where multiple test positions are required, the initial test position procedure is applied to minimize the number of test positions required for SAR measurement using the initial test configuration transmission mode. For fixed exposure conditions that do not have multiple SAR test positions, SAR is measured in the transmission mode determined by the initial test configuration. When the reported SAR of the initial test configuration is  $> 0.8 \text{ W/kg}$ , SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the reported SAR is  $\leq 1.2 \text{ W/kg}$  or all required channels are tested.

#### 3) Sub Test Configuration Procedure

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units.

When the highest reported SAR for the initial test configuration, according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is  $\leq 1.2 \text{ W/kg}$ , SAR is not required for that subsequent test configuration.

#### 4) WiFi 2.4G SAR Test Procedures

Separate SAR procedures are applied to DSSS and OFDM configurations in the 2.4 GHz band to simplify DSSS test requirements. For 802.11b DSSS SAR measurements, DSSS SAR procedure applies to fixed exposure test position and initial test position procedure applies to multiple exposure test positions.

##### A) 802.11b DSSS SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

- When the reported SAR of the highest measured maximum output power channel (section 3.1 of KDB 248227D01v02) for the exposure configuration is  $\leq 0.8 \text{ W/kg}$ , no further SAR testing is required for 802.11b DSSS in that exposure configuration.
- When the reported SAR is  $> 0.8 \text{ W/kg}$ , SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is  $> 1.2 \text{ W/kg}$ , SAR is required for the third channel;

i.e., all channels require testing.

#### B) 2.4GHz 802.11g/n OFDM SAR Test Exclusion Requirements

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied (section 5.3 of of KDB 248227D01v02r01). SAR is not required for the following 2.4 GHz OFDM conditions.

- When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
- When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg.

### 2.5. EUT operation mode

The EUT has been tested under typical operating condition and The Transmitter was operated in the normal operating mode. The TX frequency was fixed which was for the purpose of the measurements.

### 2.6. EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

- - supplied by the manufacturer
- - supplied by the lab

|   |             |                |   |
|---|-------------|----------------|---|
| ○ | Power Cable | Length (m) :   | / |
|   |             | Shield :       | / |
|   |             | Detachable :   | / |
| ○ | Multimeter  | Manufacturer : | / |
|   |             | Model No. :    | / |

**Battery1#:** Model: KEBT-650  
3XAA 4.5V-650mAh

## 3. TEST ENVIRONMENT

### 3.1. Address of the test laboratory

The test was subcontracted to The Testing and Technology Center for Industrial Products of Shenzhen Entry-Exit Inspection and Quarantine Bureau  
No.289, 8th Industry Road, Nanshan District, Shenzhen, Guangdong, China

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 (2009) and CISPR Publication 22.

### 3.2. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

|                       |              |
|-----------------------|--------------|
| Temperature:          | 18-25 ° C    |
|                       |              |
| Humidity:             | 40-65 %      |
|                       |              |
| Atmospheric pressure: | 950-1050mbar |

### 3.3. SAR Limits

FCC Limit (1g Tissue)

| EXPOSURE LIMITS                                                  | SAR (W/kg)                                                     |                                                        |
|------------------------------------------------------------------|----------------------------------------------------------------|--------------------------------------------------------|
|                                                                  | (General Population /<br>Uncontrolled Exposure<br>Environment) | (Occupational /<br>Controlled Exposure<br>Environment) |
| Spatial Average<br>(averaged over the whole body)                | 0.08                                                           | 0.4                                                    |
| Spatial Peak<br>(averaged over any 1 g of tissue)                | 1.60                                                           | 8.0                                                    |
| Spatial Peak<br>(hands/wrists/feet/ankles<br>averaged over 10 g) | 4.0                                                            | 20.0                                                   |

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).

### 3.4. Equipments Used during the Test

| Test Equipment                       | Manufacturer    | Type/Model | Serial Number | Calibration      |                      |
|--------------------------------------|-----------------|------------|---------------|------------------|----------------------|
|                                      |                 |            |               | Last Calibration | Calibration Interval |
| Data Acquisition Electronics DAEx    | SPEAG           | DAE4       | 1315          | 2014/11/25       | 1                    |
| E-field Probe                        | SPEAG           | ES3DV3     | 3292          | 2014/08/15       | 1                    |
| System Validation Dipole D450V3      | SPEAG           | D2450V3    | 860           | 2014/11/19       | 1                    |
| Network analyzer                     | Agilent         | 8753E      | US37390562    | 2014/12/25       | 1                    |
| Dielectric Probe Kit                 | Agilent         | 85070E     | US44020288    | /                | /                    |
| Power meter                          | Agilent         | E4417A     | GB41292254    | 2014/12/26       | 1                    |
| Power sensor                         | Agilent         | 8481H      | MY41095360    | 2014/12/26       | 1                    |
| Universal Radio Communication Tester | ROHDE & SCHWARZ | CMU200     | 112012        | 2014/10/23       | 1                    |

## 4. SAR Measurements System configuration

### 4.1.SAR Measurement Set-up

The DASY5 system for performing compliance tests consists of the following items:

A standard high precision 6-axis robot (Stäubli RX family) with controller 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 electronic (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.

A unit to operate the optical surface detector which is connected to the EOC.

The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.

The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows 2003.

DASY5 software and SEMCAD data evaluation software.

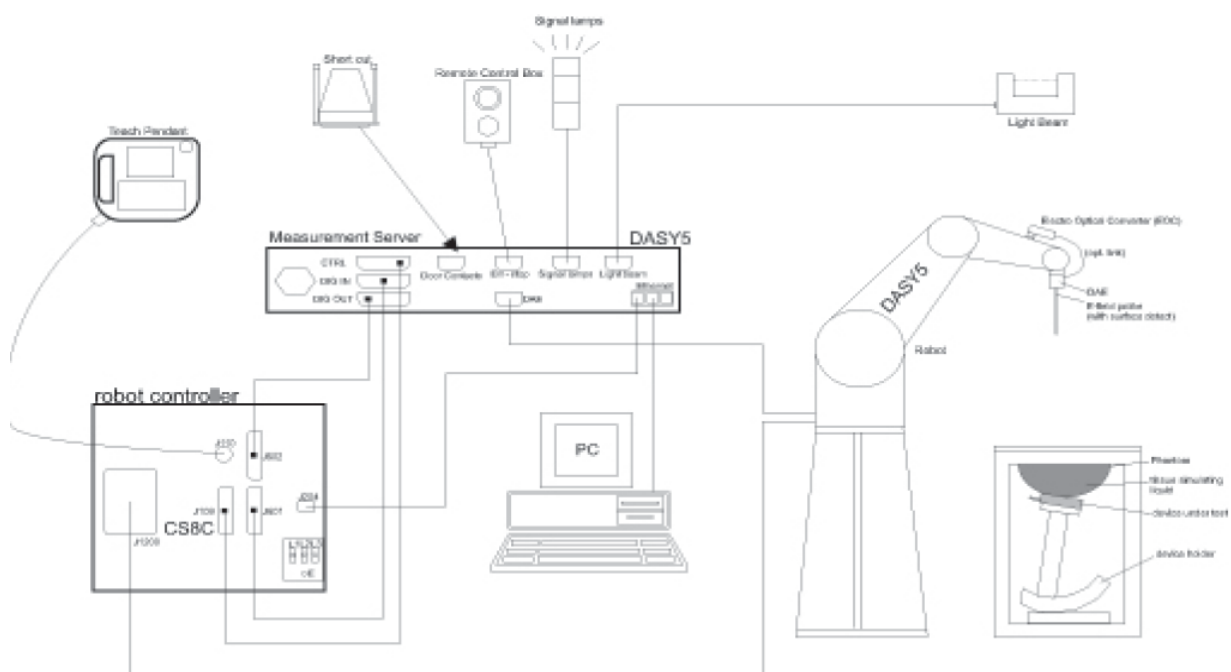
Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.

The generic twin phantom enabling the testing of left-hand and right-hand usage.

The device holder for handheld mobile phones.

Tissue simulating liquid mixed according to the given recipes.

System validation dipoles allowing to validate the proper functioning of the system.



## 4.2.DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe ES3DV3 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

### Probe Specification

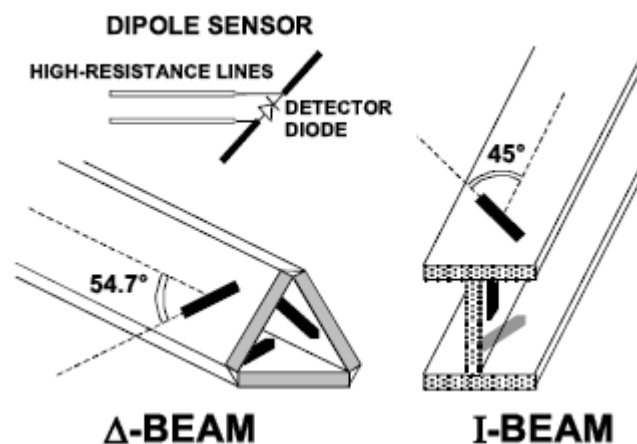
|               |                                                                                                                                                                                    |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction  | 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 calibration service available.                                                                                                                                       |
| Frequency     | 10 MHz to 4 GHz;<br>Linearity: $\pm 0.2$ dB (30 MHz to 4 GHz)                                                                                                                      |
| Directivity   | $\pm 0.2$ dB in HSL (rotation around probe axis)<br>$\pm 0.3$ dB in tissue material (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                                                                                                                                     |



### Isotropic E-Field Probe

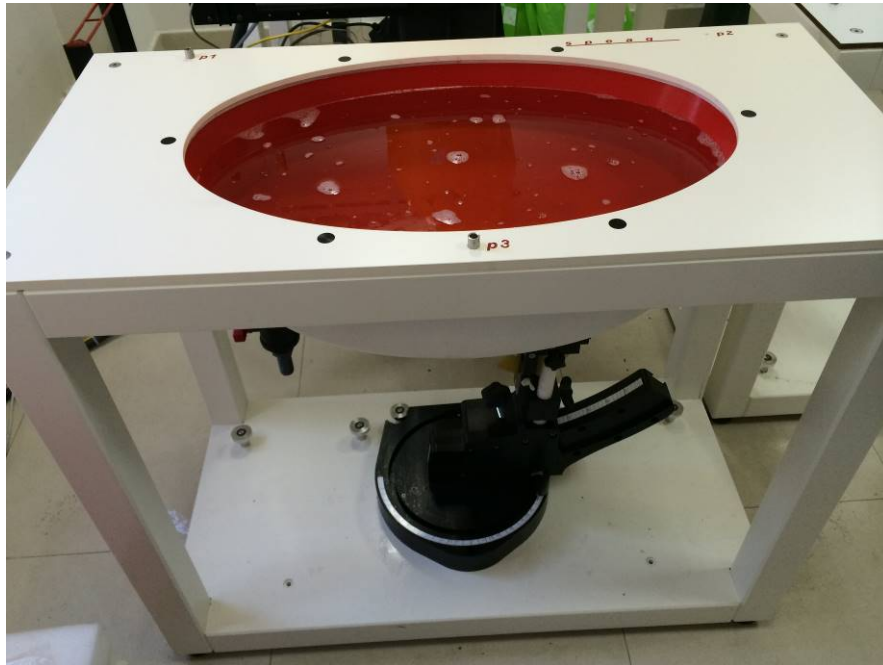
The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



### 4.3. Phantoms

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.

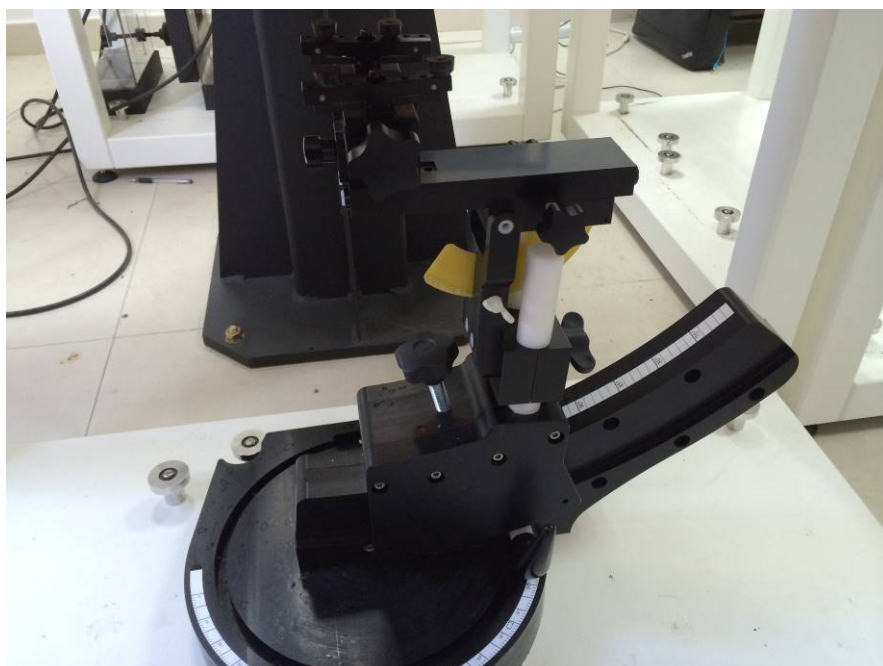


ELI4 Phantom

### 4.4. Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the DASY system.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.



Device holder supplied by SPEAG

## 4.5. Scanning Procedure

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max.  $\pm 5\%$ .

The “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above  $\pm 0.1\text{mm}$ ). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe (It does not depend on the surface reflectivity or the probe angle to the surface within  $\pm 30^\circ$ .)

### Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values before running a detailed measurement around the hot spot. Before starting the area scan a grid spacing of 15 mm x 15 mm is set. During the scan the distance of the probe to the phantom remains unchanged. After finishing area scan, the field maxima within a range of 2 dB will be ascertained.

### Zoom Scan

Zoom Scans are used to estimate the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan is done by 7x7x7 points within a cube whose base is centered around the maxima found in the preceding area scan.

### Spatial Peak Detection

The procedure for spatial peak SAR evaluation has been implemented and can determine values of masses of 1g and 10g, as well as for user-specific masses. The DASY5 system allows evaluations that combine measured data and robot positions, such as: • maximum search • extrapolation • boundary correction • peak search for averaged SAR. During a maximum search, global and local maxima searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard’s method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation. Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Zoom Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard’s method for extrapolation. For a grid using 7x7x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1g and 10g cubes.

A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube 7x7x7 scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 5mm steps.

## 4.6. Data Storage and Evaluation

### Data Storage

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension “DA4”. The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm<sup>2</sup>], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform

the evaluation with other software packages.

#### Data Evaluation

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

|                    |                           |                      |
|--------------------|---------------------------|----------------------|
| Probe parameters:  | - Sensitivity             | Normi, ai0, ai1, ai2 |
|                    | - Conversion factor       | ConvFi               |
|                    | - Diode compression point | Dcpi                 |
| Device parameters: | - Frequency               | f                    |
|                    | - Crest factor            | cf                   |
| Media parameters:  | - Conductivity            | $\sigma$             |
|                    | - Density                 | $\rho$               |

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

With  $V_i$  = compensated signal of channel i (i = x, y, z)  
 $U_i$  = input signal of channel i (i = x, y, z)  
 cf = crest factor of exciting field (DASY parameter)  
 dcp<sub>i</sub> = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$\text{E - fieldprobes : } E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$\text{H - fieldprobes : } H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

With  $V_i$  = compensated signal of channel i (i = x, y, z)  
 Norm<sub>i</sub> = sensor sensitivity of channel i (i = x, y, z)  
           [mV/(V/m)<sup>2</sup>] for E-field Probes  
 ConvF = sensitivity enhancement in solution  
 a<sub>ij</sub> = sensor sensitivity factors for H-field probes  
 f = carrier frequency [GHz]  
 E<sub>i</sub> = electric field strength of channel i in V/m  
 H<sub>i</sub> = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

with SAR = local specific absorption rate in mW/g  
 E<sub>tot</sub> = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

## 4.7.SAR Measurement System

The SAR measurement system being used is the DASY5 system, the system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

In operation, the system first does an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom. When the maximum SAR point has been found, the system will then carry out a 3D scan centred at that point to determine volume averaged SAR level.

#### 4.7.1 Tissue Dielectric Parameters for Head and Body Phantoms

The liquid is consisted of water,salt,Glycol,Sugar,Preventol and Cellulose.The liquid has previously been proven to be suited for worst-case. It's satisfying the latest tissue dielectric parameters requirements proposed by the KDB865664.

| Target Frequency | Head         |                | Body         |                |
|------------------|--------------|----------------|--------------|----------------|
| (MHz)            | $\epsilon_r$ | $\sigma$ (S/m) | $\epsilon_r$ | $\sigma$ (S/m) |
| 150              | 52.3         | 0.76           | 61.9         | 0.80           |
| 300              | 45.3         | 0.87           | 58.2         | 0.92           |
| 450              | 43.5         | 0.87           | 56.7         | 0.94           |
| 835              | 41.5         | 0.90           | 55.2         | 0.97           |
| 900              | 41.5         | 0.97           | 55.0         | 1.05           |
| 915              | 41.5         | 0.98           | 55.0         | 1.06           |
| 1450             | 40.5         | 1.20           | 54.0         | 1.30           |
| 1610             | 40.3         | 1.29           | 53.8         | 1.40           |
| 1800-2000        | 40.0         | 1.40           | 53.3         | 1.52           |
| 2450             | 39.2         | 1.80           | 52.7         | 1.95           |
| 3000             | 38.5         | 2.40           | 52.0         | 2.73           |
| 5800             | 35.3         | 5.27           | 48.2         | 6.00           |

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho = 1000 \text{ kg/m}^3$ )

#### 4.8.Tissue equivalent liquid properties

Dielectric performance of Body tissue simulating liquid.

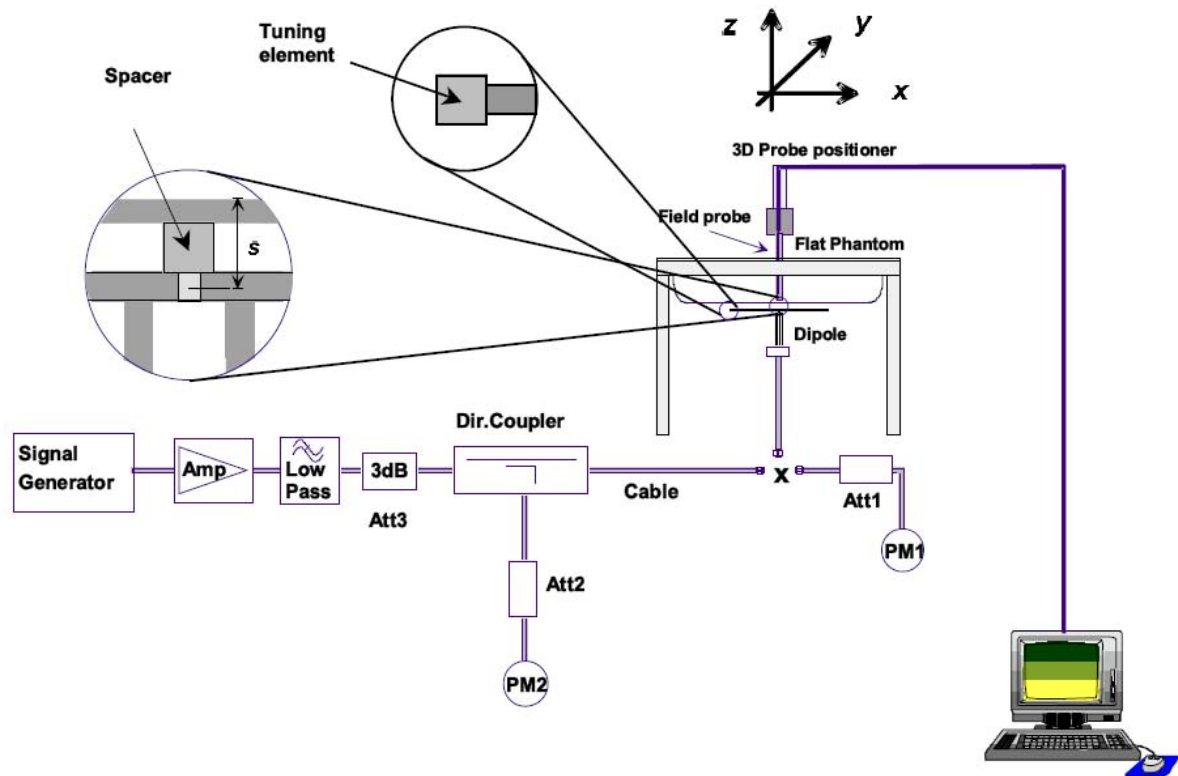
| Tissue Type | Measured Frequency (MHz) | Target Tissue |          | Measured Tissue |        |          |        | Liquid Temp. | Test Data  |
|-------------|--------------------------|---------------|----------|-----------------|--------|----------|--------|--------------|------------|
|             |                          | $\epsilon_r$  | $\sigma$ | $\epsilon_r$    | Dev. % | $\sigma$ | Dev. % |              |            |
| 2450B       | 2450                     | 52.7          | 1.95     | 53.51           | 1.5%   | 1.91     | -2.1%  | 22.3 degree  | 2015-08-12 |

#### 4.9.System Check

The purpose of the system check is to verify that the system operates within its specifications at the device test frequency.The system check is simple check of repeatability to make sure that the system works correctly at the time of the compliance test;

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system ( $\pm 10\%$ ).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.



System Validation of Body

| Measurement is made at temperature 22.4 °C and relative humidity 52%. |                 |                                   |                  |                                     |                  |           |                  |
|-----------------------------------------------------------------------|-----------------|-----------------------------------|------------------|-------------------------------------|------------------|-----------|------------------|
| Tissue temperature 22.3 °C                                            |                 |                                   |                  |                                     |                  |           |                  |
| Measurement Date: 2015/08/12                                          |                 |                                   |                  |                                     |                  |           |                  |
| Verification results                                                  | Frequency (MHz) | Target value<br>1 g Average(W/kg) |                  | Measured value<br>1 g Average(W/kg) |                  | Deviation |                  |
|                                                                       |                 | 250mW                             | Normalized to 1W | 250mW                               | Normalized to 1W | 250mW     | Normalized to 1W |
|                                                                       | 2450            | 13.2                              | 51.4             | 13.9                                | 55.6             | 5.3%      | 8.2%             |

## 4.10. SAR measurement procedure

### 4.10.1 Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in Picture 11.1.

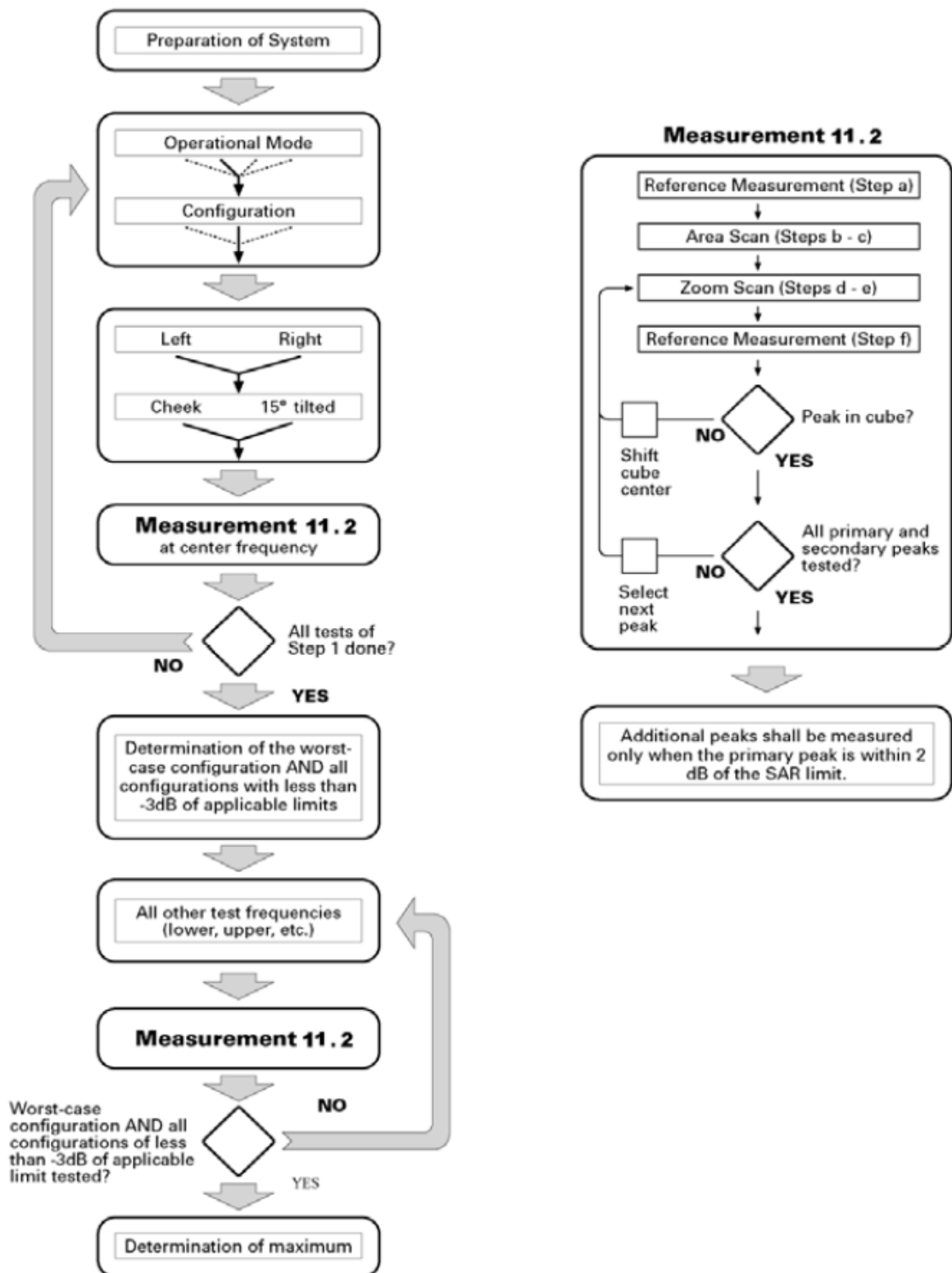
Step 1: The tests described in 11.2 shall be performed at the channel that is closest to the centre of the transmit frequency band ( $f_c$ ) for:

- all device positions (cheek and tilt, for both left and right sides of the SAM phantom;
- all configurations for each device position in a), e.g., antenna extended and retracted, and
- all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e.,  $N_c > 3$ ), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

Step 2: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 11.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

Step 3: Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.



Picture 10.1 Block diagram of the tests to be performed

#### 4.10.2 General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2003. The results should be documented as part of the system validation records and may be requested to support test results when all the measurement parameters in the following table are not satisfied.

|                                                                                                                                                                                                                                                                                                                                    |                                    |                                                                                      | $\leq 3\text{ GHz}$                                                                                                                                                                                                                                                    | $> 3\text{ GHz}$                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface                                                                                                                                                                                                                             |                                    |                                                                                      | $5 \pm 1\text{ mm}$                                                                                                                                                                                                                                                    | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5\text{ mm}$                                                                  |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location                                                                                                                                                                                                                                          |                                    |                                                                                      | $30^\circ \pm 1^\circ$                                                                                                                                                                                                                                                 | $20^\circ \pm 1^\circ$                                                                                                     |
| Maximum area scan spatial resolution: $\Delta x_{Area}$ , $\Delta y_{Area}$                                                                                                                                                                                                                                                        |                                    |                                                                                      | $\leq 2\text{ GHz: } \leq 15\text{ mm}$<br>$2 - 3\text{ GHz: } \leq 12\text{ mm}$                                                                                                                                                                                      | $3 - 4\text{ GHz: } \leq 12\text{ mm}$<br>$4 - 6\text{ GHz: } \leq 10\text{ mm}$                                           |
|                                                                                                                                                                                                                                                                                                                                    |                                    |                                                                                      | 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 $\leq$ 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: $\Delta x_{Zoom}$ , $\Delta y_{Zoom}$                                                                                                                                                                                                                                                        |                                    |                                                                                      | $\leq 2\text{ GHz: } \leq 8\text{ mm}$<br>$2 - 3\text{ GHz: } \leq 5\text{ mm}^*$                                                                                                                                                                                      | $3 - 4\text{ GHz: } \leq 5\text{ mm}^*$<br>$4 - 6\text{ GHz: } \leq 4\text{ mm}^*$                                         |
| Maximum zoom scan spatial resolution, normal to phantom surface                                                                                                                                                                                                                                                                    | uniform grid: $\Delta z_{Zoom}(n)$ |                                                                                      | $\leq 5\text{ mm}$                                                                                                                                                                                                                                                     | $3 - 4\text{ GHz: } \leq 4\text{ mm}$<br>$4 - 5\text{ GHz: } \leq 3\text{ mm}$<br>$5 - 6\text{ GHz: } \leq 2\text{ mm}$    |
|                                                                                                                                                                                                                                                                                                                                    | graded grid                        | $\Delta z_{Zoom}(1)$ : between 1 <sup>st</sup> two points closest to phantom surface | $\leq 4\text{ mm}$                                                                                                                                                                                                                                                     | $3 - 4\text{ GHz: } \leq 3\text{ mm}$<br>$4 - 5\text{ GHz: } \leq 2.5\text{ mm}$<br>$5 - 6\text{ GHz: } \leq 2\text{ mm}$  |
|                                                                                                                                                                                                                                                                                                                                    |                                    | $\Delta z_{Zoom}(n>1)$ : between subsequent points                                   | $\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$                                                                                                                                                                                                                                  |                                                                                                                            |
| Minimum zoom scan volume                                                                                                                                                                                                                                                                                                           | x, y, z                            |                                                                                      | $\geq 30\text{ mm}$                                                                                                                                                                                                                                                    | $3 - 4\text{ GHz: } \geq 28\text{ mm}$<br>$4 - 5\text{ GHz: } \geq 25\text{ mm}$<br>$5 - 6\text{ GHz: } \geq 22\text{ mm}$ |
| Note: $\delta$ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.                                                                                                                                                                                  |                                    |                                                                                      |                                                                                                                                                                                                                                                                        |                                                                                                                            |
| * When zoom scan is required and the <i>reported</i> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is $\leq 1.4\text{ W/kg}$ , $\leq 8\text{ mm}$ , $\leq 7\text{ mm}$ and $\leq 5\text{ mm}$ zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. |                                    |                                                                                      |                                                                                                                                                                                                                                                                        |                                                                                                                            |

#### 4.10.3 Power Drift

To control the output power stability during the SAR test, DASY5 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Table 14.1 to Table 14.11 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

#### 4.10.4 Area Scan Based 1-g SAR

##### 4.10.4.1 Requirement of KDB

According to the KDB447498 D01 v05, when the implementation is based the specific polynomial fit algorithm as presented at the 29th Bioelectromagnetics Society meeting (2007) and the estimated 1-g SAR is  $\leq 1.2$  W/kg, a zoom scan measurement is not required provided it is also not needed for any other purpose; for example, if the peak SAR location required for simultaneous transmission SAR test exclusion can be determined accurately by the SAR system or manually to discriminate between distinctive peaks and scattered noisy SAR distributions from area scans.

There must not be any warning or alert messages due to various measurement concerns identified by the SAR system; for example, noise in measurements, peaks too close to scan boundary, peaks are too sharp, spatial resolution and uncertainty issues etc. The SAR system verification must also demonstrate that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR (See Annex B). When all the SAR results for each exposure condition in a frequency band and wireless mode are based on estimated 1-g SAR, the 1-g SAR for the highest SAR configuration must be determined by a zoom scan.

## 5. TEST CONDITIONS AND RESULTS

### 5.1. Conducted Power Results

According KDB 447498 D01 General RF Exposure Guidance v05r02Section 4.1 2) states that “Unless it is specified differently in the published RF exposure KDB procedures, these requirements also apply to test reduction and test exclusion considerations. Time-averaged maximum conducted output power applies to SAR and, as required by § 2.1091(c), time-averaged ERP applies to MPE. When an antenna port is not available on the device to support conducted power measurement

| Mode: 11b |         |              |
|-----------|---------|--------------|
| CH        | Type    | Result (dBm) |
| CH1       | PK      | 17.33        |
|           | Average | 13.71        |
| CH6       | PK      | 18.03        |
|           | Average | 14.79        |
| CH11      | PK      | 19.14        |
|           | Average | 15.73        |

#### Manufacturing tolerance

| 802.11b                              |       |       |       |
|--------------------------------------|-------|-------|-------|
| Test Frequency(MHz)                  | 2412  | 2437  | 2462  |
| Target average conducted power (dBm) | 14.0  | 14.0  | 14.0  |
| Tolerance ±(dB)                      | ±2.00 | ±2.00 | ±2.00 |

### 5.2. Test reduction procedure

The maximum power level,  $P_{\max,m}$ , that can be transmitted by a device before the SAR averaged over a mass,  $m$ , exceeds a given limit,  $SAR_{\lim}$ , can be defined. Any device transmitting at power levels below  $P_{\max,m}$  can then be excluded from SAR testing. The lowest possible value for  $P_{\max,m}$  is:  $P_{\max,m} = SAR_{\lim} * m$ .

### 5.3. SAR Measurement Results

#### SAR Values –Body worn

| Test Frequency |      | Mode/<br>Band | Maximum<br>Allowed<br>Power<br>(dBm) | ERP<br>(dBm) | Test<br>Config. | Measurement<br>SAR over<br>1g(W/kg) | Power<br>drift | Scaling<br>Factor | Reported SAR<br>over 1g<br>(W/kg) | SAR<br>limit<br>1g<br>(W/kg) | Ref.<br>Plot<br># |
|----------------|------|---------------|--------------------------------------|--------------|-----------------|-------------------------------------|----------------|-------------------|-----------------------------------|------------------------------|-------------------|
| Chann.         | MHz  |               |                                      |              |                 | 100% Duty Cycle                     |                |                   | 100% Duty<br>Cycle                |                              |                   |
| 11             | 2462 | 802.11b       | 16                                   | 15.73        | front           | 0.214                               | -0.13          | 1.064             | 0.228                             | 1.60                         | 1                 |
| 11             | 2462 | 802.11b       | 16                                   | 15.73        | back            | 0.183                               | 0.08           | 1.064             | 0.195                             | 1.60                         | /                 |
| 11             | 2462 | 802.11b       | 16                                   | 15.73        | Left            | 0.192                               | 0.12           | 1.064             | 0.204                             | 1.60                         | /                 |
| 11             | 2462 | 802.11b       | 16                                   | 15.73        | Right           | 0.0814                              | 0.11           | 1.064             | 0.087                             | 1.60                         | /                 |
| 11             | 2462 | 802.11b       | 16                                   | 15.73        | bottom          | 0.0123                              | 0.16           | 1.064             | 0.013                             | 1.60                         | /                 |

### 5.4. SAR Measurement Variability

SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. The following procedures are applied to determine if repeated measurements are required.

- 1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.

- 2) When the original highest measured SAR is  $\geq 0.80$  W/kg, repeat that measurement once.
- 3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$  or when the original or repeated measurement is  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .

### 5.5.Measurement Uncertainty(300MHz-3GHz)

| According to IEEE 1528/2011 and IEC62209-1/2011 |                                                 |      |                   |                       |            |         |          |                |                 |                   |
|-------------------------------------------------|-------------------------------------------------|------|-------------------|-----------------------|------------|---------|----------|----------------|-----------------|-------------------|
| No.                                             | Error Description                               | Type | Uncertainty Value | Probably Distribution | Div.       | (Ci) 1g | (Ci) 10g | Std. Unc. (1g) | Std. Unc. (10g) | Degree of freedom |
| Measurement System                              |                                                 |      |                   |                       |            |         |          |                |                 |                   |
| 1                                               | Probe calibration                               | B    | 5.50%             | N                     | 1          | 1       | 1        | 5.50%          | 5.50%           | $\infty$          |
| 2                                               | Axial isotropy                                  | B    | 4.70%             | R                     | $\sqrt{3}$ | 0.7     | 0.7      | 1.90%          | 1.90%           | $\infty$          |
| 3                                               | Hemispherical isotropy                          | B    | 9.60%             | R                     | $\sqrt{3}$ | 0.7     | 0.7      | 3.90%          | 3.90%           | $\infty$          |
| 4                                               | Boundary Effects                                | B    | 1.00%             | R                     | $\sqrt{3}$ | 1       | 1        | 0.60%          | 0.60%           | $\infty$          |
| 5                                               | Probe Linearity                                 | B    | 4.70%             | R                     | $\sqrt{3}$ | 1       | 1        | 2.70%          | 2.70%           | $\infty$          |
| 6                                               | Detection limit                                 | B    | 1.00%             | R                     | $\sqrt{3}$ | 1       | 1        | 0.60%          | 0.60%           | $\infty$          |
| 7                                               | RF ambient conditions-noise                     | B    | 0.00%             | R                     | $\sqrt{3}$ | 1       | 1        | 0.00%          | 0.00%           | $\infty$          |
| 8                                               | RF ambient conditions-reflection                | B    | 0.00%             | R                     | $\sqrt{3}$ | 1       | 1        | 0.00%          | 0.00%           | $\infty$          |
| 9                                               | Response time                                   | B    | 0.80%             | R                     | $\sqrt{3}$ | 1       | 1        | 0.50%          | 0.50%           | $\infty$          |
| 10                                              | Integration time                                | B    | 5.00%             | R                     | $\sqrt{3}$ | 1       | 1        | 2.90%          | 2.90%           | $\infty$          |
| 11                                              | RF ambient                                      | B    | 3.00%             | R                     | $\sqrt{3}$ | 1       | 1        | 1.70%          | 1.70%           | $\infty$          |
| 12                                              | Probe positioned mech. restrictions             | B    | 0.40%             | R                     | $\sqrt{3}$ | 1       | 1        | 0.20%          | 0.20%           | $\infty$          |
| 13                                              | Probe positioning with respect to phantom shell | B    | 2.90%             | R                     | $\sqrt{3}$ | 1       | 1        | 1.70%          | 1.70%           | $\infty$          |
| 14                                              | Max.SAR evaluation                              | B    | 3.90%             | R                     | $\sqrt{3}$ | 1       | 1        | 2.30%          | 2.30%           | $\infty$          |
| Test Sample Related                             |                                                 |      |                   |                       |            |         |          |                |                 |                   |
| 15                                              | Test sample positioning                         | A    | 1.86%             | N                     | 1          | 1       | 1        | 1.86%          | 1.86%           | $\infty$          |
| 16                                              | Device holder uncertainty                       | A    | 1.70%             | N                     | 1          | 1       | 1        | 1.70%          | 1.70%           | $\infty$          |
| 17                                              | Drift of output power                           | B    | 5.00%             | R                     | $\sqrt{3}$ | 1       | 1        | 2.90%          | 2.90%           | $\infty$          |
| Phantom and Set-up                              |                                                 |      |                   |                       |            |         |          |                |                 |                   |
| 18                                              | Phantom uncertainty                             | B    | 4.00%             | R                     | $\sqrt{3}$ | 1       | 1        | 2.30%          | 2.30%           | $\infty$          |
| 19                                              | Liquid conductivity (target)                    | B    | 5.00%             | R                     | $\sqrt{3}$ | 0.64    | 0.43     | 1.80%          | 1.20%           | $\infty$          |
| 20                                              | Liquid conductivity (meas.)                     | A    | 0.50%             | N                     | 1          | 0.64    | 0.43     | 0.32%          | 0.26%           | $\infty$          |
| 21                                              | Liquid                                          | B    | 5.00%             | R                     | $\sqrt{3}$ | 0.64    | 0.43     | 1.80%          | 1.20%           | $\infty$          |

|                                                                |                                            |   |       |   |     |      |      |        |        |          |
|----------------------------------------------------------------|--------------------------------------------|---|-------|---|-----|------|------|--------|--------|----------|
|                                                                | permittivity<br>(target)                   |   |       |   |     |      |      |        |        |          |
| 22                                                             | Liquid<br>permittivity<br>(meas.)          | A | 0.16% | N | 1   | 0.64 | 0.43 | 0.10%  | 0.07%  | $\infty$ |
| Combined<br>standard<br>uncertainty                            | $u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$ |   | /     | / | /   | /    | /    | 10.20% | 10.00% | $\infty$ |
| Expanded<br>uncertainty<br>(confidence<br>interval of<br>95 %) | $u_e = 2u_c$                               |   | /     | R | K=2 | /    | /    | 20.40% | 20.00% | $\infty$ |

## 5.6.System Check Results

### System Performance Check at 2450 MHz Body TSL

DUT: Dipole2450 MHz; Type: D2450V2; Serial: 860

Date/Time: 08/13/2015 08:45:27 AM

Communication System: WI-FI(2.4GHz); Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated):  $f=2450$  MHz;  $\sigma = 1.91$  S/m;  $\epsilon_r = 53.51$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 - SN3292; ConvF(4.23, 4.23, 4.23); Calibrated: 08/15/2014;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 25/11/2014

Phantom: SAM; Type: Triple Modular;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

**Area Scan (12x15x1):** Measurement grid:  $dx=12.00$  mm,  $dy=12.00$  mm

Maximum value of SAR (interpolated) = 14.6 W/kg

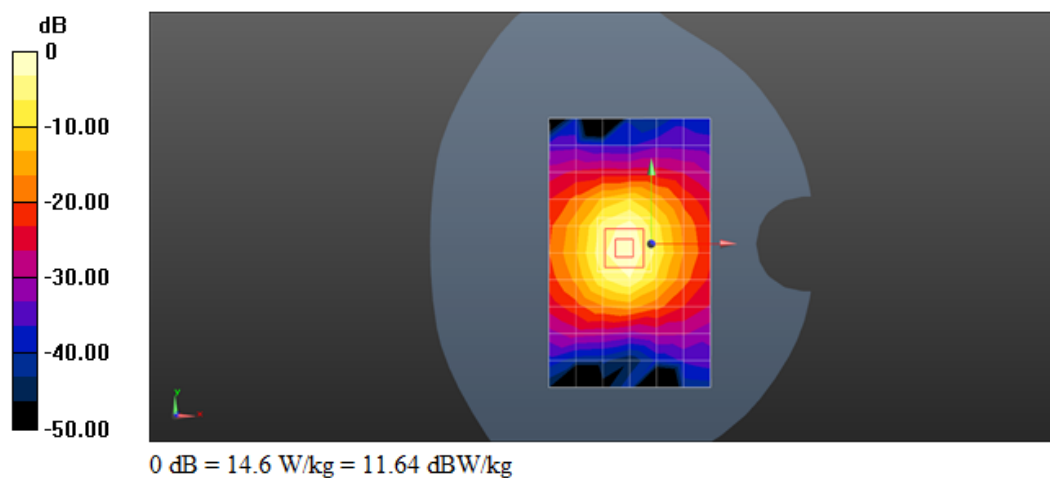
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 92.32 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 31.81 mW/g

**SAR(1 g) = 13.9 mW/g; SAR(10 g) = 6.21 mW/ g**

Maximum value of SAR (measured) =15.6 W/kg



System Performance Check 2450MHz 250mW

## 5.7.SAR Test Graph Results

### LE4 Front towards Phantom 2462 MHz

Communication System: WI-FI(2.4GHz); Frequency: 2462 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated):2462MHz;  $\sigma = 1.98$  S/m;  $\epsilon_r = 53.12$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 - SN3292; ConvF(4.23, 4.23, 4.23); Calibrated: 08/15/2014;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 25/11/2014

Phantom: SAM; Type: Triple Modular;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

**Area Scan (9x16x1):** Measurement grid: dx=12.00 mm, dy=12.00 mm

Maximum value of SAR (interpolated) =0.215 W/kg

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

Reference Value = 3.0234 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 0.389 mW/g

**SAR(1 g) = 0.214 mW/g; SAR(10 g) = 0.111 mW/g**

Maximum value of SAR (measured) = 0.215 W/kg

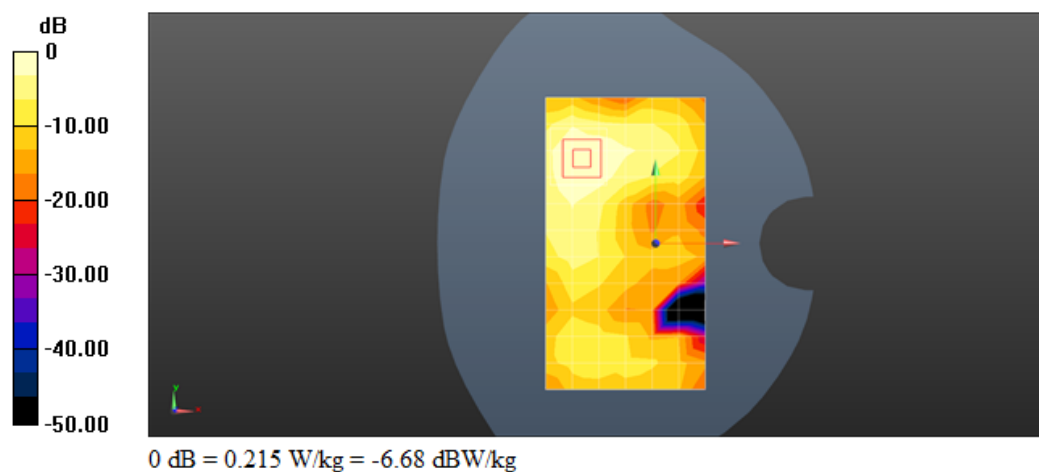


Figure 1: LE4 Front towards Phantom 2462MHz

## 6. Calibration Certificate

### 6.1. Probe Calibration Certificate

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
**S** 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 **CIQ (Auden)**

Certificate No: **ES3-3292\_Aug14**

### CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3292**

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

Calibration date: **August 15, 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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 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: S5054 (3c)  | 03-Apr-14 (No. 217-01915)         | Apr-15                 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-14 (No. 217-01919)         | Apr-15                 |
| Reference 30 dB Attenuator | SN: S5129 (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-99 (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: | Name<br>Claudio Leubler | Function<br>Laboratory Technician | Signature<br> |
| Approved by:   | Katja Pokovic           | Technical Manager                 |               |

Issued: August 15, 2014

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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 $\varphi$   | $\varphi$ rotation around probe axis                                                                                                                    |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\vartheta = 0$ is normal to probe axis |
| 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  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>:** DCP are numerical linearization parameters assessed based on the data of power sweep 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:3292

August 15, 2014

# Probe ES3DV3

## SN:3292

|               |                 |
|---------------|-----------------|
| Manufactured: | July 6, 2010    |
| Repaired:     | July 28, 2014   |
| Calibrated:   | August 15, 2014 |

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

ES3DV3- SN:3292

August 15, 2014

**DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292****Basic Calibration Parameters**

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|-----------------------------------------------------------|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.89     | 0.95     | 1.46     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                                     | 107.1    | 106.1    | 103.9    |               |

**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>E</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 209.7    | $\pm 3.8 \%$              |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 218.8    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 198.5    |                           |

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

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

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

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

ES3DV3- SN:3292

August 15, 2014

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

### 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>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 450                  | 43.5                               | 0.87                            | 6.71    | 6.71    | 6.71    | 0.18               | 1.80                    | ± 13.3 %    |
| 835                  | 41.5                               | 0.90                            | 6.23    | 6.23    | 6.23    | 0.80               | 1.11                    | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 6.71    | 6.71    | 6.10    | 6.71               | 1.17                    | ± 12.0 %    |
| 1810                 | 40.0                               | 1.40                            | 5.07    | 5.07    | 5.07    | 0.61               | 1.36                    | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 5.03    | 5.03    | 5.03    | 0.45               | 1.55                    | ± 12.0 %    |
| 2100                 | 39.8                               | 1.49                            | 5.04    | 5.04    | 5.04    | 0.77               | 1.17                    | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 4.43    | 4.43    | 4.43    | 0.73               | 1.23                    | ± 12.0 %    |

<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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

ES3DV3- SN:3292

August 15, 2014

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

### Calibration Parameter Determined in Body Tissue Simulating Media

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

<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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<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.

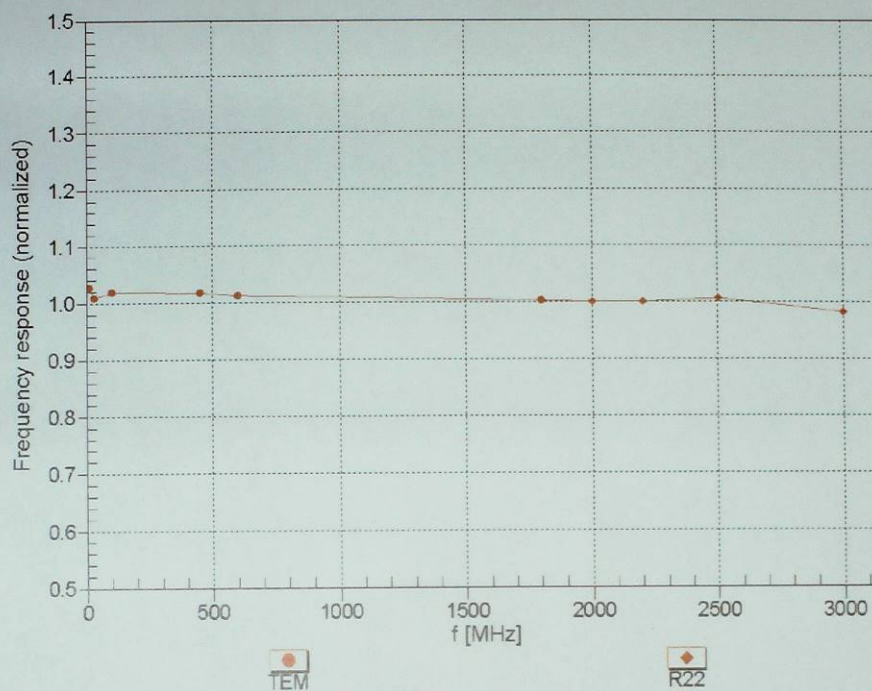
<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter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

ES3DV3- SN:3292

August 15, 2014

### Frequency Response of E-Field

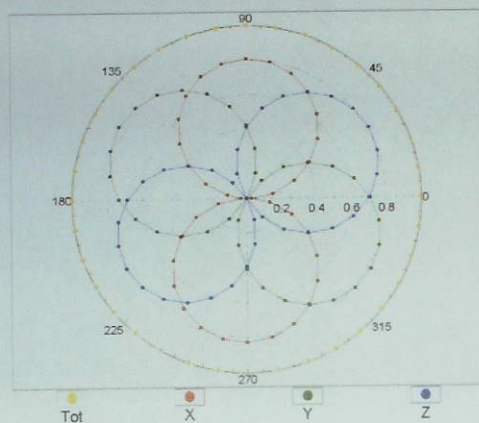
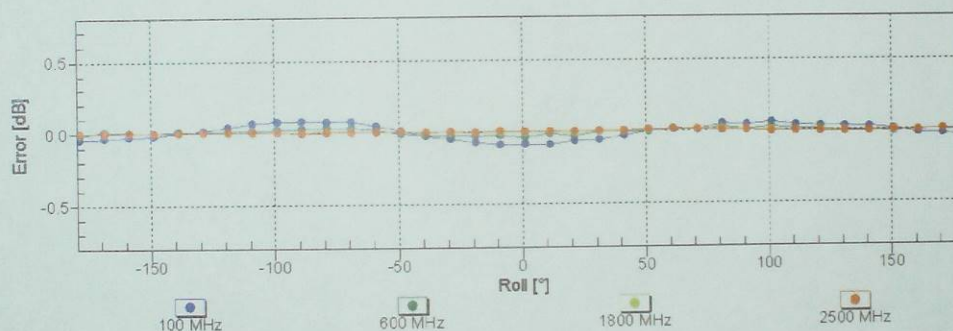
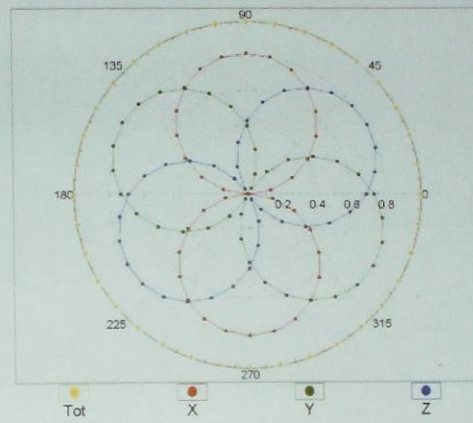
(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

ES3DV3- SN:3292

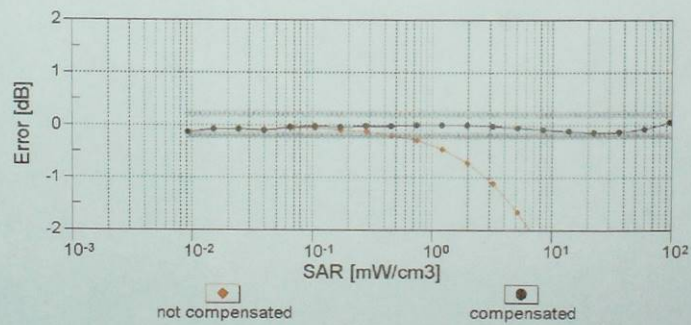
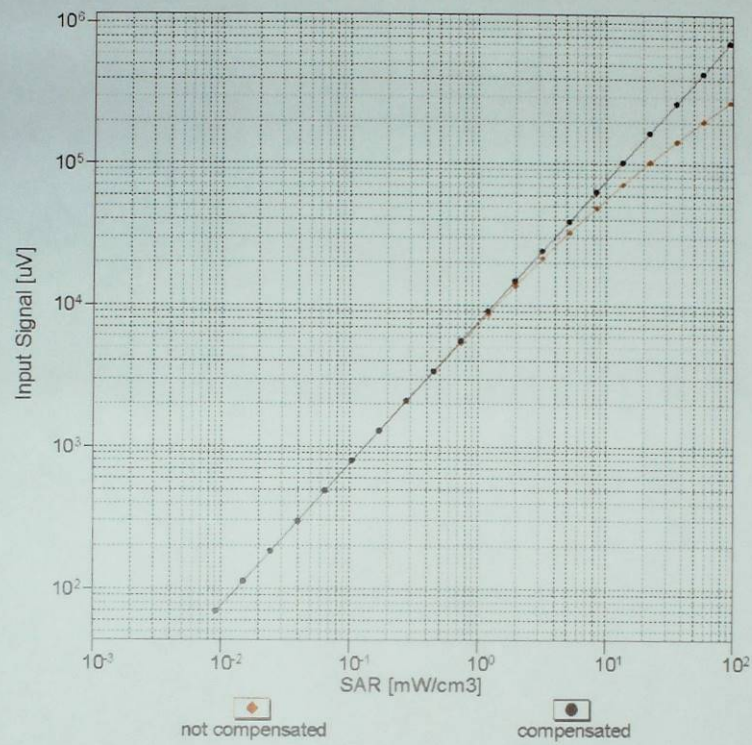
August 15, 2014

**Receiving Pattern ( $\phi$ ),  $\vartheta = 0^\circ$** **f=600 MHz, TEM****f=1800 MHz, R22****Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )**

ES3DV3- SN:3292

August 15, 2014

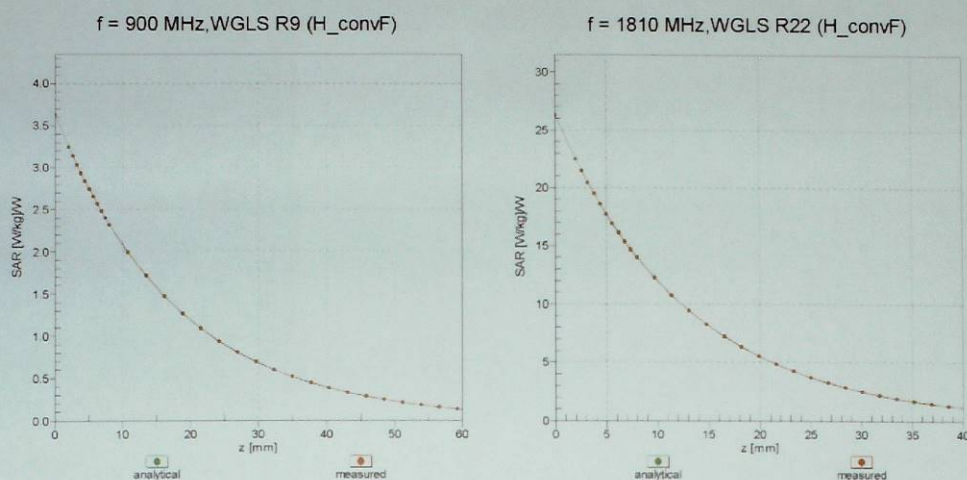
### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f_{\text{eval}} = 1900 \text{ MHz}$ )

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

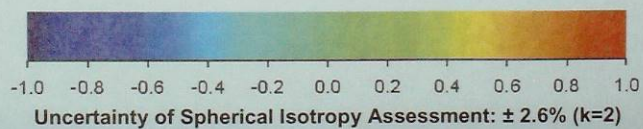
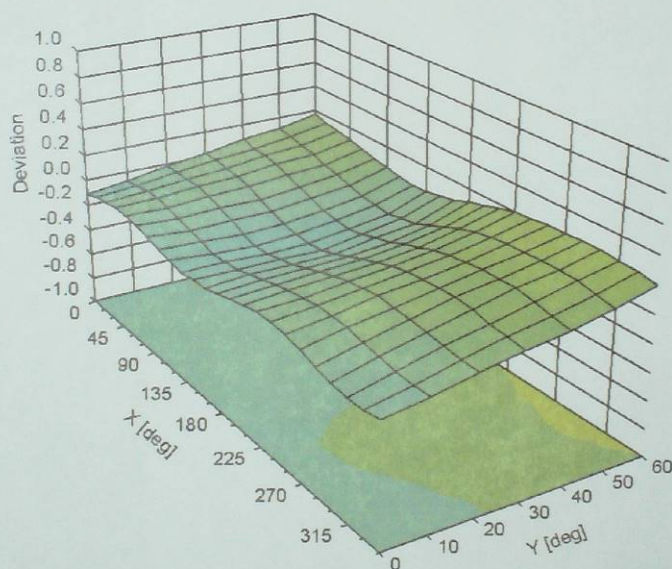
ES3DV3- SN:3292

August 15, 2014

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

Error ( $\phi, \theta$ ),  $f = 900 \text{ MHz}$ 

ES3DV3- SN:3292

August 15, 2014

**DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292****Other Probe Parameters**

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

## 6.2.D2450V2 Dipole Calibration Certificate

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Accreditation No.: SCS 108

Client **Auden**

Certificate No: **D2450V2-860\_Nov14**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 860**

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

Calibration date: **November 19, 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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (NIST critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | G897480704         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | US37292793         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | MY41082317         | 07-Oct-14 (No. 217-02021)         | Oct-15                 |
| Reference 20 dB Attenuator  | SN: 5058 (20x)     | 08-Apr-14 (No. 217-01818)         | Apr-15                 |
| Type-N mismatch combination | SN: 5047.2 / 05027 | 08-Apr-14 (No. 217-01821)         | Apr-15                 |
| Reference Probe ES30V3      | SN: 3205           | 30-Dec-13 (No. ES3-3205_Dec13)    | Dec-14                 |
| DAE4                        | SN: 601            | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | in house check: Oct-16 |
| Network Analyzer HP 8753E   | US37290585 S4206   | 18-Oct-01 (in house check Oct-14) | in house check: Oct-15 |

|                |               |                       |           |
|----------------|---------------|-----------------------|-----------|
|                | Name          | Function              | Signature |
| Calibrated by: | Michael Weber | Laboratory Technician |           |
| Approved by:   | Katja Pokovic | Technical Manager     |           |

Issued: November 19, 2014

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Accreditation No.: **SCS 108**

#### Glossary:

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

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

- DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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

**Measurement Conditions**

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.6.6     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 2450 MHz $\pm$ 1 MHz   |             |

**Head TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 39.0 $\pm$ 6 % | 1.86 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                                          | 250 mW input power | 13.3 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 52.3 W/kg $\pm$ 17.0 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 6.18 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.5 W/kg $\pm$ 16.5 % (k=2) |

**Body TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 52.7           | 1.95 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 50.9 $\pm$ 6 % | 2.03 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                                          | 250 mW input power | 13.2 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 51.4 W/kg $\pm$ 17.0 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 6.06 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 23.9 W/kg $\pm$ 16.5 % (k=2) |

**Appendix (Additional assessments outside the scope of SCS108)****Antenna Parameters with Head TSL**

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $54.4 \Omega + 2.5 j\Omega$ |
| Return Loss                          | -28.3 dB                    |

**Antenna Parameters with Body TSL**

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $49.5 \Omega + 3.7 j\Omega$ |
| Return Loss                          | -28.5 dB                    |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.164 ns |
|----------------------------------|----------|

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

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

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

**Additional EUT Data**

|                 |                |
|-----------------|----------------|
| Manufactured by | SPEAG          |
| Manufactured on | April 23, 2010 |

**DASY5 Validation Report for Head TSL**

Date: 18.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 860**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.86$  S/m;  $\epsilon_r = 39$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

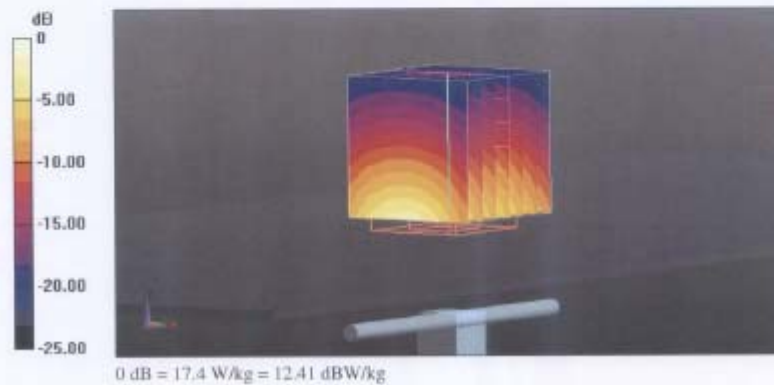
Measurement grid: dx=5mm, dy=5mm, dz=5mm

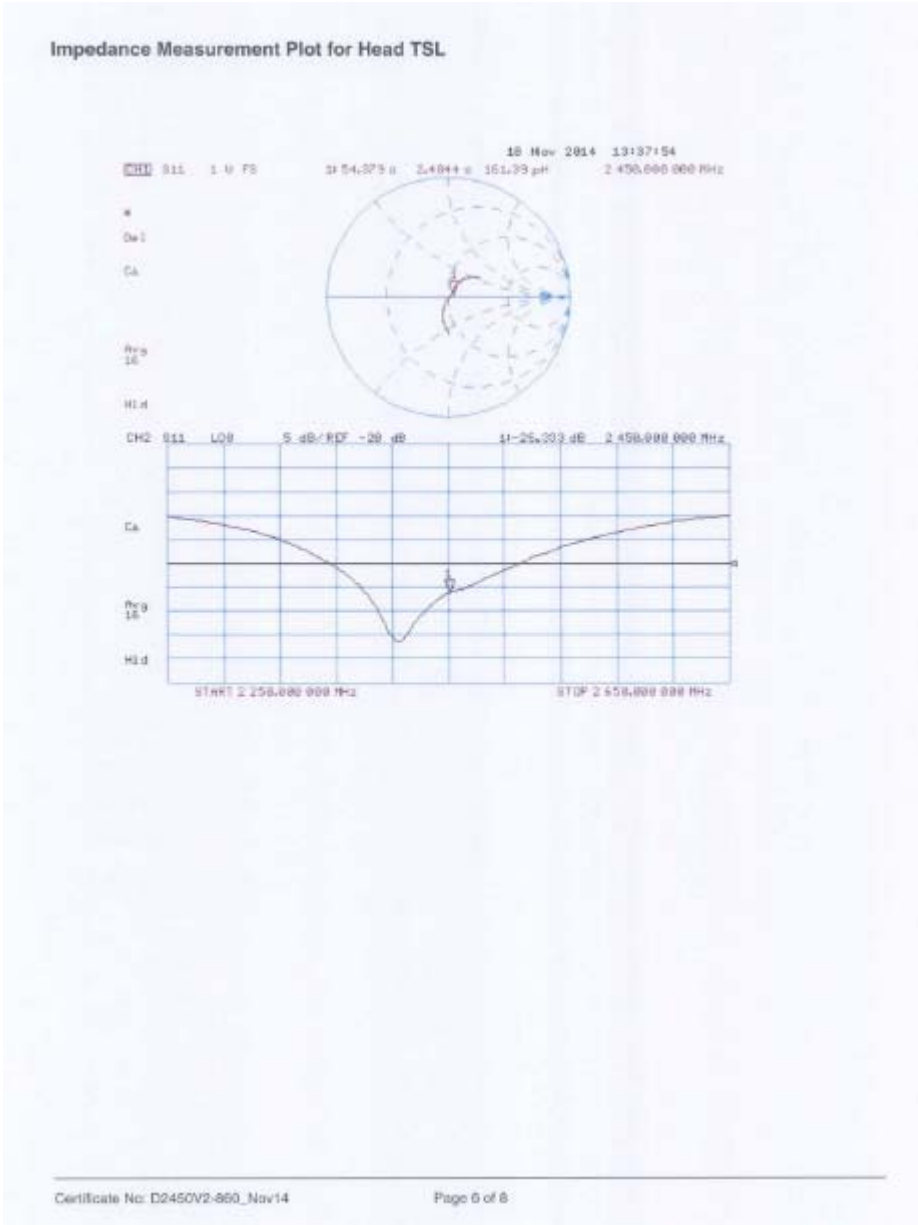
Reference Value = 100.6 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 27.4 W/kg

**SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.18 W/kg**

Maximum value of SAR (measured) = 17.4 W/kg





## DASY5 Validation Report for Body TSL

Date: 19.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 860**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 50.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

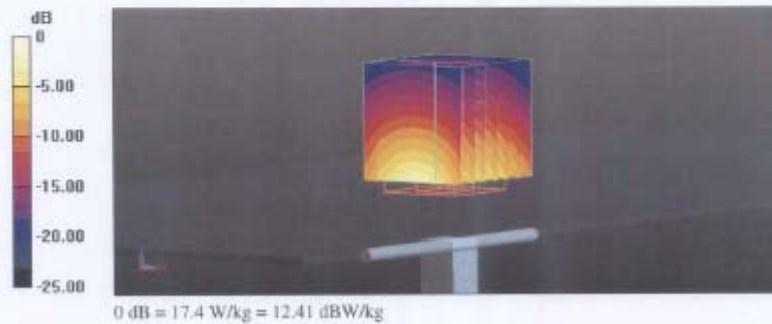
Measurement grid: dx=5mm, dy=5mm, dz=5mm

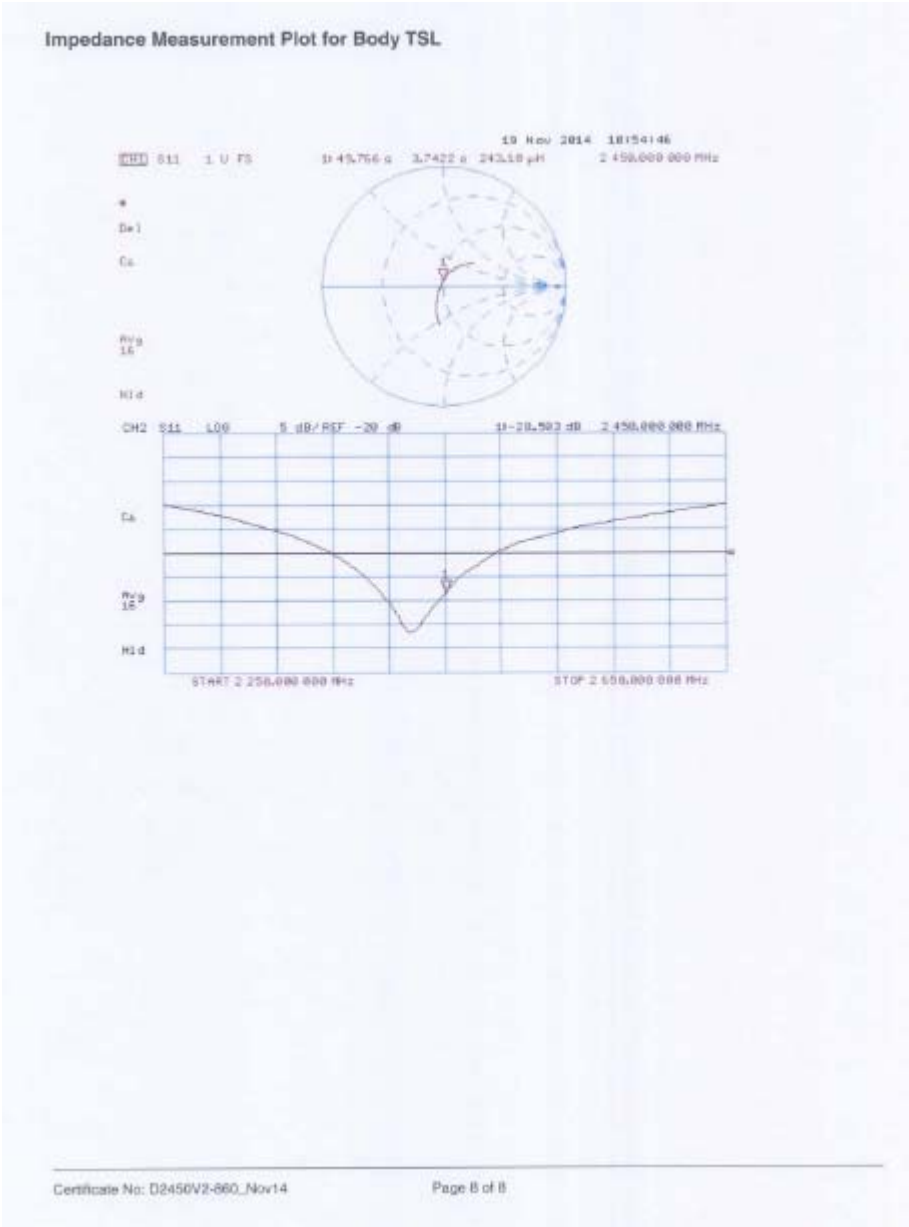
Reference Value = 95.14 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 27.8 W/kg

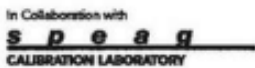
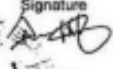
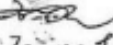
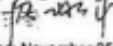
**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.06 W/kg**

Maximum value of SAR (measured) = 17.4 W/kg





## 6.3.DAE4 Calibration Certificate

|                                                                                                                                                                                                                                                                           |         |                                                                                                            |                                   |                                                                                       |                       |                                                                                     |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------------------------------------------------------------------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------|--|
|                                                                                                                                                                                          |         | In Collaboration with<br> |                                   |     |                       |  |  |
| Add: No.52 Huangzui Road, Haitian District, Beijing, 100191, China<br>Tel: +86-10-62304633-2079<br>E-mail: info@tmc.cn                                                                                                                                                    |         | Fax: +86-10-62304633-2504<br>Http://www.tmc.cn                                                             |                                   |                                                                                       |                       |                                                                                     |  |
| Client : CIQ SZ (Auden)                                                                                                                                                                                                                                                   |         |                                                                                                            |                                   | Certificate No: J14-2-3048                                                            |                       |                                                                                     |  |
| <b>CALIBRATION CERTIFICATE</b>                                                                                                                                                                                                                                            |         |                                                                                                            |                                   |                                                                                       |                       |                                                                                     |  |
| Object                                                                                                                                                                                                                                                                    |         | DAE4 - SN: 1315                                                                                            |                                   |                                                                                       |                       |                                                                                     |  |
| Calibration Procedure(s)                                                                                                                                                                                                                                                  |         | TMC-OS-E-01-198<br>Calibration Procedure for the Data Acquisition Electronics (DAEx)                       |                                   |                                                                                       |                       |                                                                                     |  |
| Calibration date:                                                                                                                                                                                                                                                         |         | November 25, 2014                                                                                          |                                   |                                                                                       |                       |                                                                                     |  |
| This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. |         |                                                                                                            |                                   |                                                                                       |                       |                                                                                     |  |
| All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.                                                                                                                                                 |         |                                                                                                            |                                   |                                                                                       |                       |                                                                                     |  |
| Calibration Equipment used (M&TE critical for calibration)                                                                                                                                                                                                                |         |                                                                                                            |                                   |                                                                                       |                       |                                                                                     |  |
| Primary Standards                                                                                                                                                                                                                                                         | ID #    | Cal Date(Calibrated by, Certificate No.)                                                                   |                                   |                                                                                       | Scheduled Calibration |                                                                                     |  |
| Documenting<br>Process Calibrator 753                                                                                                                                                                                                                                     | 1971018 | 01-July-14 (TMC, No.JW14-049)                                                                              |                                   |                                                                                       | July-15               |                                                                                     |  |
| Calibrated by:                                                                                                                                                                                                                                                            |         | Name                                                                                                       | Function                          | Signature                                                                             |                       |                                                                                     |  |
|                                                                                                                                                                                                                                                                           |         | Yu zongying                                                                                                | SAR Test Engineer                 |  |                       |                                                                                     |  |
| Reviewed by:                                                                                                                                                                                                                                                              |         | Qi Dianyuan                                                                                                | SAR Project Leader                |  |                       |                                                                                     |  |
| Approved by:                                                                                                                                                                                                                                                              |         | Lu Bingsong                                                                                                | Deputy Director of the laboratory |  |                       |                                                                                     |  |
| Issued: November 25, 2014<br>This calibration certificate shall not be reproduced except in full without written approval of the laboratory.                                                                                                                              |         |                                                                                                            |                                   |                                                                                       |                       |                                                                                     |  |



**Glossary:**

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

**Methods Applied and Interpretation of Parameters:**

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



DC Voltage Measurement

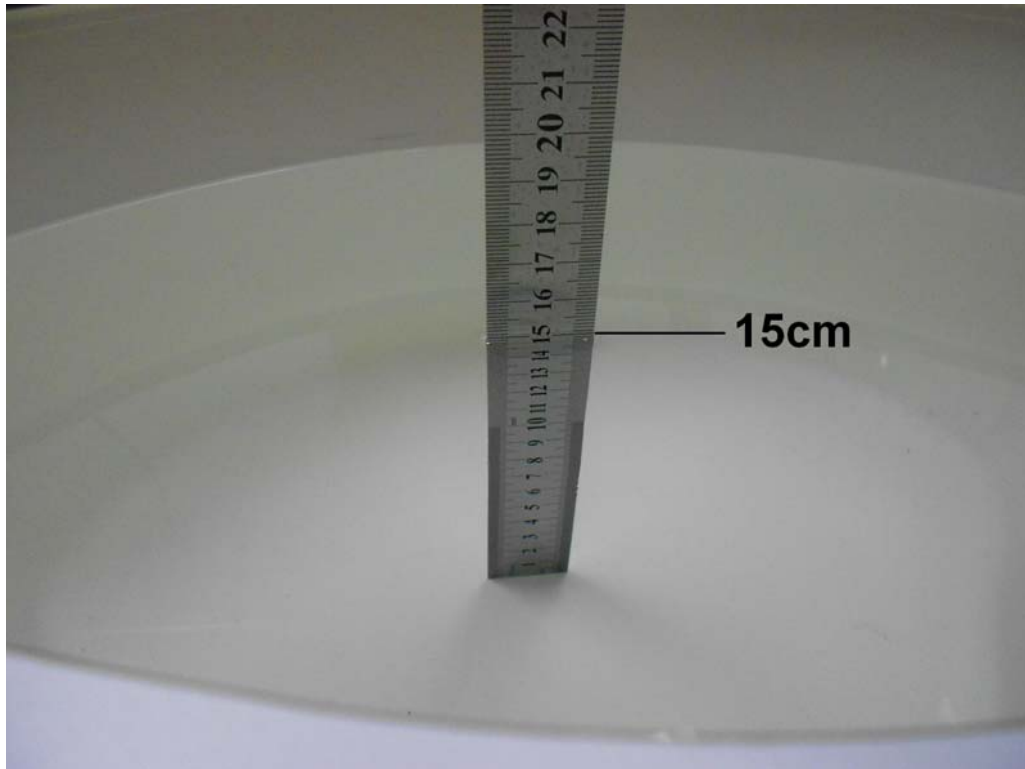
A/D - Converter Resolution nominal  
 High Range: 1LSB = 6.1μV , full range = -100...+300 mV  
 Low Range: 1LSB = 61nV , full range = -1.....+3mV  
 DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

| Calibration Factors | X                     | Y                     | Z                     |
|---------------------|-----------------------|-----------------------|-----------------------|
| High Range          | 403.915 ± 0.15% (k=2) | 405.171 ± 0.15% (k=2) | 404.667 ± 0.15% (k=2) |
| Low Range           | 3.98903 ± 0.7% (k=2)  | 3.94180 ± 0.7% (k=2)  | 3.93862 ± 0.7% (k=2)  |

Connector Angle

|                                           |              |
|-------------------------------------------|--------------|
| Connector Angle to be used in DASY system | 162.5° ± 1 ° |
|-------------------------------------------|--------------|

## **7. Test Setup Photos**



**Photograph of the depth in the Body Phantom (2450MHz)**



**the front of the EUT towards phantom (The distance was 0mm)**



**the Back of the EUT towards phantom (The distance was 0mm)**



**the Left of the EUT towards phantom (The distance was 0mm)**



**the Right of the EUT towards phantom (The distance was 0mm)**



**the Bottom of the EUT towards phantom (The distance was 0mm)**

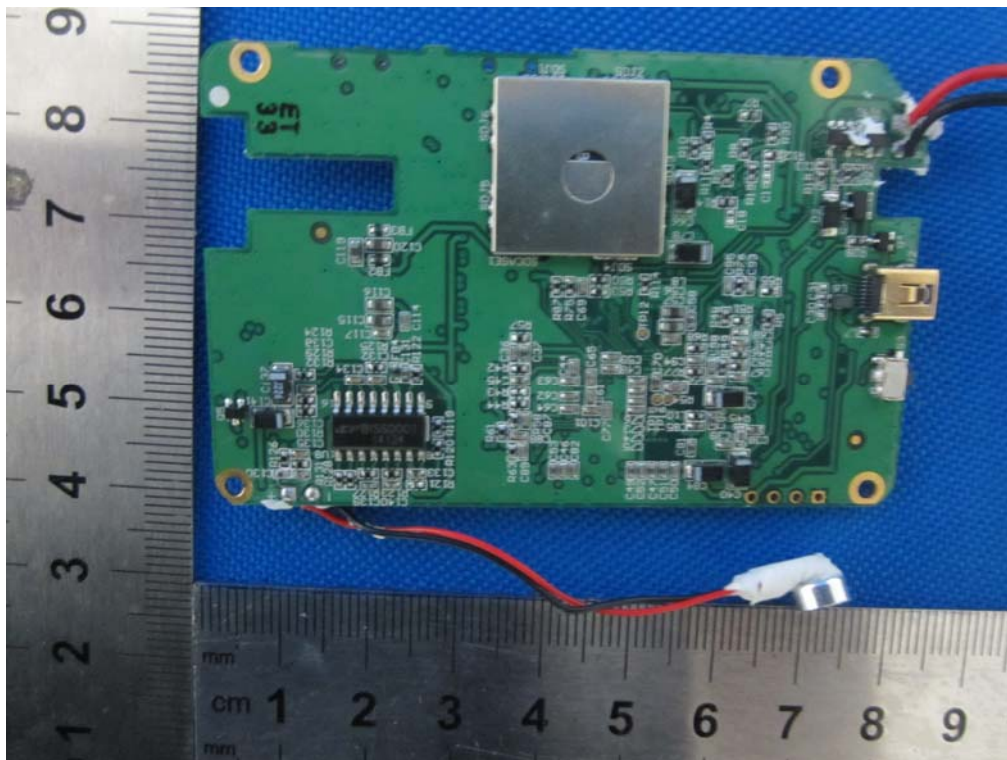
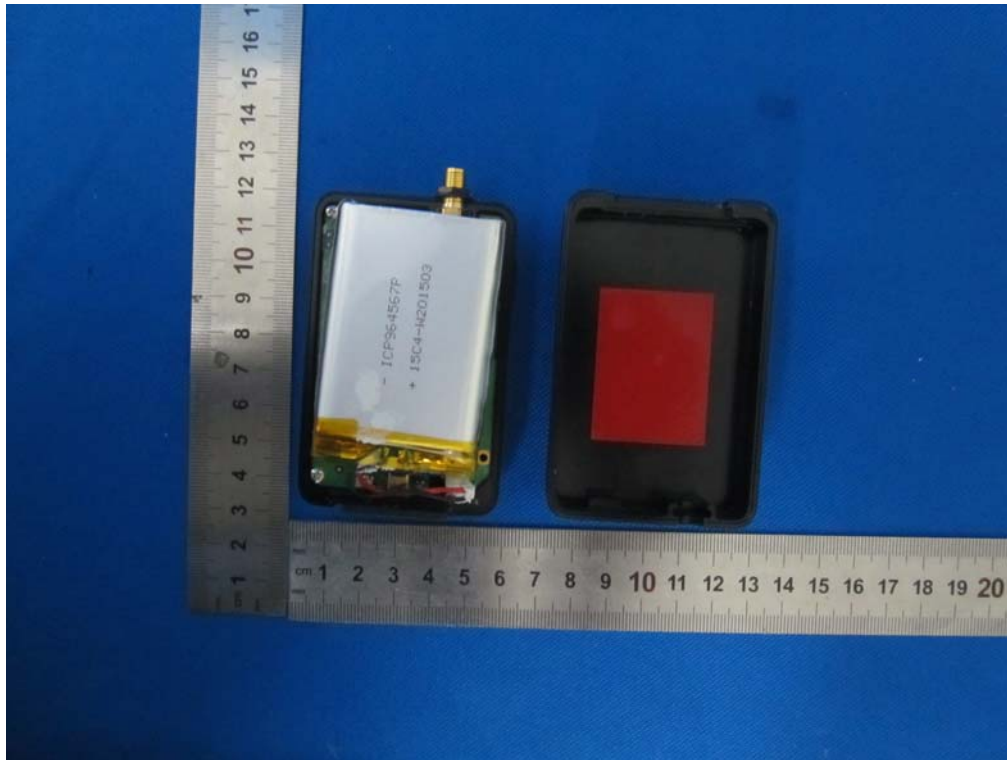
## 8. Photos of the EUT

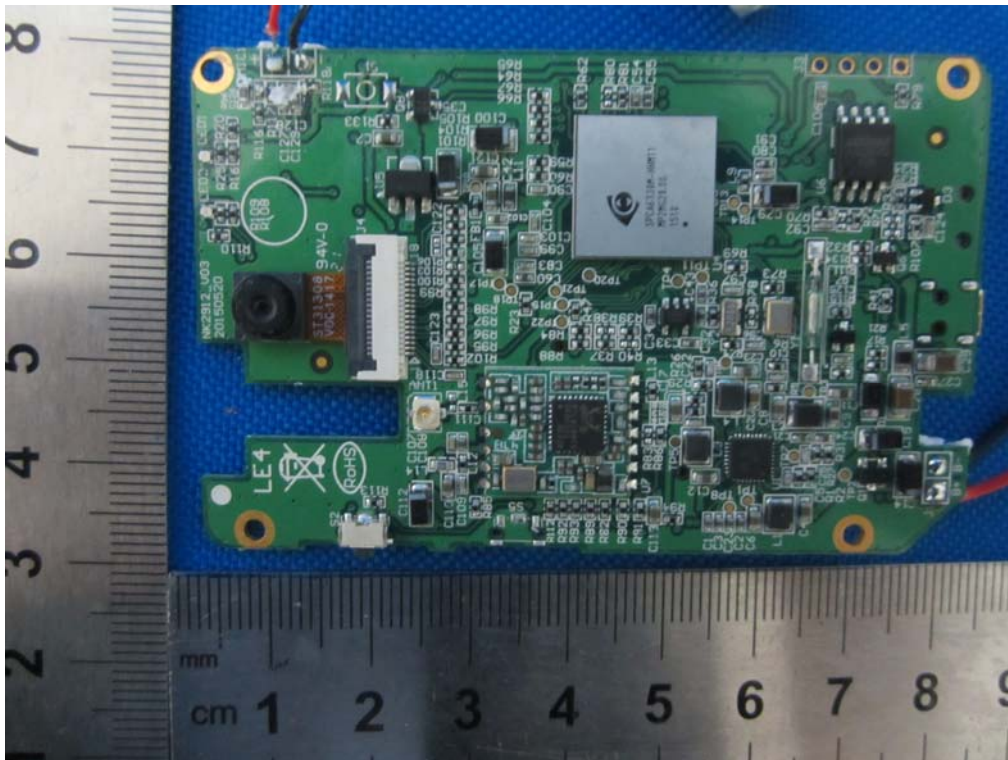












.....End of Report.....