



# SAR TEST REPORT

**Product Name** RFID Handheld Reader

**Model Name** T550

**Brand Name** Zoko

**FCC ID** 2AA7IT550-WIFI

**Applicant** Shenzhen Zokon Industry Development Co., Ltd

**Manufacturer** Shenzhen Zoko Industry Development Company Limited

**Date of issue** August 7, 2015

**TA Technology (Shanghai) Co., Ltd.**

**TA Technology (Shanghai) Co., Ltd.**  
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**GENERAL SUMMARY**

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Reference Standard(s)</b> | <p><b>FCC 47CFR §2.1093</b> Radiofrequency Radiation Exposure Evaluation: Portable Devices</p> <p><b>ANSI C95.1- 1992:</b> Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.(IEEE Std C95.1-1991)</p> <p><b>IEEE Std 1528™-2003:</b> IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.</p> <p><b>KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03:</b> SAR Measurement Requirements for 100 MHz to 6 GHz</p> <p><b>KDB 447498 D01 Mobile Portable RF Exposure v05r02:</b> Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies</p> |
| <b>Conclusion</b>            | <p>This portable wireless equipment has been measured in all cases requested by the relevant standards. Test results in Chapter 7 of this test report are below limits specified in the relevant standards for the tested bands only.</p> <p>General Judgment: <b>Pass</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Comment</b>               | <p>The test result only responds to the measured sample.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

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## 1. General Information

### 1.1. Notes of the Test Report

**TA Technology (Shanghai) Co., Ltd.** has obtained the accreditation of China National Accreditation Service for Conformity Assessment (CNAS), and accreditation number: L2264.

**TA Technology (Shanghai) Co., Ltd.** guarantees the reliability of the data presented in this test report, which is the results of measurements and tests performed for the items under test on the date and under the conditions stated in this test report and is based on the knowledge and technical facilities available at TA Technology (Shanghai) Co., Ltd. at the time of execution of the test.

**TA Technology (Shanghai) Co., Ltd.** is liable to the client for the maintenance by its personnel of the confidentiality of all information related to the items under test and the results of the test. The sample under test was selected by the Client. This report only refers to the item that has undergone the test.

This report alone does not constitute or imply by its own an approval of the product by the certification Bodies or competent Authorities. This report cannot be used partially or in full for publicity and/or promotional purposes without previous written approval of **TA Technology (Shanghai) Co., Ltd.** and the Accreditation Bodies, if it applies.

If the electronic report is inconsistent with the printed one, it should be subject to the latter.

### 1.2. Testing Laboratory

|            |                                                                     |
|------------|---------------------------------------------------------------------|
| Company:   | TA Technology (Shanghai) Co., Ltd.                                  |
| Address:   | No.145, Jintang Rd, Tangzhen Industry Park, Pudong Shanghai, China  |
| City:      | Shanghai                                                            |
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### 1.3. Applicant Information

Company: Shenzhen Zokon Industry Development Co., Ltd  
Address: 5F, Administration Building, Jinxing Industry District, Dongbing Road,  
Nanshan, Shenzhen, China

### 1.4. Manufacturer Information

Company: Zoko Industry Development Company Limited  
Address: 5/F, Administration Building, Jinxing Industry District, Dongbin Road,  
Nanshan, Shenzhen, China

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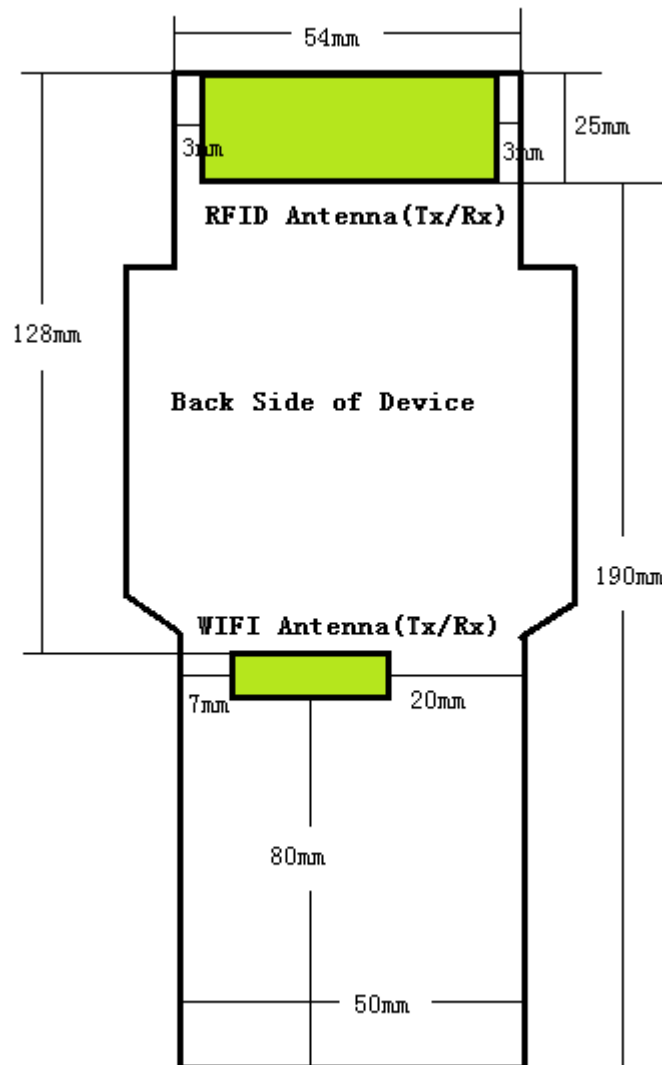
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**1.5. Information of EUT**  
**General Information**

|                                   |                                               |                 |
|-----------------------------------|-----------------------------------------------|-----------------|
| Device Type:                      | Portable Device                               |                 |
| Exposure Category:                | Uncontrolled Environment / General Population |                 |
| State of Sample:                  | Prototype Unit                                |                 |
| Product SN:                       | 14080201                                      |                 |
| Hardware Version:                 | ZKT960-V2.1                                   |                 |
| Software Version:                 | V1.06                                         |                 |
| Antenna Type:                     | Internal Antenna                              |                 |
| Device Operating Configurations : |                                               |                 |
| Test Mode(s):                     | RFID 900MHz                                   |                 |
| Test Modulation:                  | DSB-ASK                                       |                 |
| Operating Frequency Range(s):     | Mode                                          | Tx (MHz)        |
|                                   | RFID 900MHz                                   | 902.75 ~ 927.25 |
|                                   | WiFi                                          | 2412 ~ 2462     |
| Power Level set:                  | RFID 900MHz: 21dBm                            |                 |

## 1.6. EUT Antenna Locations



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**1.7. The Maximum Reported SAR<sub>10g</sub>**

**Body SAR Configuration**

| Mode        | Test Position | Channel<br>/Frequency(MHz) | Limit SAR <sub>10g</sub> 4 W/kg       |                                       |
|-------------|---------------|----------------------------|---------------------------------------|---------------------------------------|
|             |               |                            | Measured SAR <sub>10g</sub><br>(W/kg) | Reported SAR <sub>10g</sub><br>(W/kg) |
| RFID 900MHz | Top Edge      | 1/902.75                   | 1.430                                 | 2.086                                 |

**1.8. Test Date**

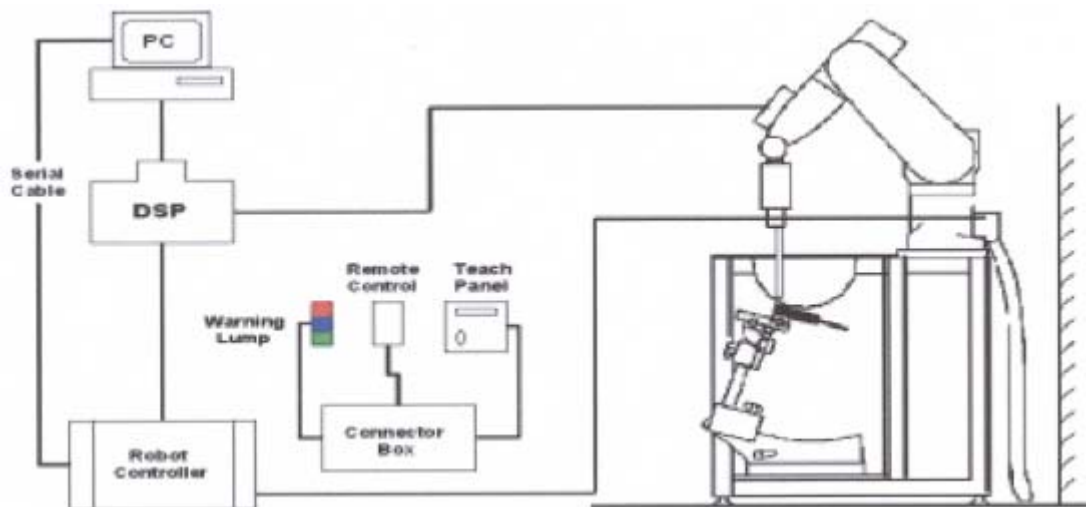
The test performed on January 25, 2015.

## 2. SAR Measurements System Configuration

### 2.1. 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.



**Figure 1 SAR Lab Test Measurement Set-up**

## 2.2. DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe EX3DV4(manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

### 2.2.1. EX3DV4 Probe Specification

|               |                                                                                                                                                                                                               |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction  | Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)                                                         |
| Calibration   | ISO/IEC 17025 calibration service available                                                                                                                                                                   |
| Frequency     | 10 MHz to > 6 GHz<br>Linearity: $\pm 0.2$ dB<br>(30 MHz to 6 GHz)                                                                                                                                             |
| Directivity   | $\pm 0.3$ dB in HSL (rotation around probe axis) $\pm 0.5$ dB in tissue material (rotation normal to probe axis)                                                                                              |
| Dynamic Range | 10 $\mu$ W/g to > 100 mW/g Linearity:<br><br>$\pm 0.2$ dB (noise: typically < 1 $\mu$ W/g)                                                                                                                    |
| Dimensions    | Overall length: 330 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm                                                                          |
| Application   | High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields).<br>Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%. |



**Figure 2.EX3DV4 E-field Probe**



**Figure 3. EX3DV4 E-field probe**

### 2.2.2. E-field Probe Calibration

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than  $\pm 10\%$ . The spherical isotropy was evaluated and found to be better than  $\pm 0.25\text{dB}$ . The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$\text{SAR} = C \frac{\Delta T}{\Delta t}$$

Where:  $\Delta t$  = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

$\Delta T$  = Temperature increase due to RF exposure.

Or

$$\text{SAR} = \frac{|E|^2 \sigma}{\rho}$$

Where:

$\sigma$  = Simulated tissue conductivity,

$\rho$  = Tissue density ( $\text{kg/m}^3$ ).

## 2.3. Other Test Equipment

### 2.3.1. Device Holder for Transmitters

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.

The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.



**Figure 4 Device Holder**

### 2.3.2. Phantom

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.

Shell Thickness  $2 \pm 0.2$  mm

Filling Volume Approx. 30 liters

Dimensions 190×600×400 mm (H×L×W)



**Figure 5. ELI4 Phantom**

### 2.4. 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  $\pm 0.1$  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

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before running a detailed measurement around the hot spot. Before starting the area scan a grid spacing is set according to FCC KDB Publication 865664. During 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

After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm.

- 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.

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

**Table 1: Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01**

| Frequency | Maximum Area Scan Resolution (mm)<br>( $\Delta x_{\text{area}}, \Delta y_{\text{area}}$ ) | Maximum Zoom Scan Resolution (mm)<br>( $\Delta x_{\text{zoom}}, \Delta y_{\text{zoom}}$ ) | Maximum Zoom Scan Spatial Resolution (mm)<br>$\Delta z_{\text{zoom}}(n)$ | Minimum Zoom Scan Volume (mm)<br>(x,y,z) |
|-----------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------|
| ≤ 2 GHz   | ≤ 15                                                                                      | ≤ 8                                                                                       | ≤ 5                                                                      | ≥ 30                                     |
| 2-3 GHz   | ≤ 12                                                                                      | ≤ 5                                                                                       | ≤ 5                                                                      | ≥ 30                                     |
| 3-4 GHz   | ≤ 12                                                                                      | ≤ 5                                                                                       | ≤ 4                                                                      | ≥ 28                                     |
| 4-5 GHz   | ≤ 10                                                                                      | ≤ 4                                                                                       | ≤ 3                                                                      | ≥ 25                                     |
| 5-6 GHz   | ≤ 10                                                                                      | ≤ 4                                                                                       | ≤ 2                                                                      | ≥ 22                                     |

## **2.5. Data Storage and Evaluation**

### **2.5.1. 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 “.DAE4”. 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/cm²], [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.

### **2.5.2. Data Evaluation by SEMCAD**

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, $a_{i0}$ , $a_{i1}$ , $a_{i2}$ |
|                    | - Conversion factor       | ConvF <sub>i</sub>                    |
|                    | - Diode compression point | Dcp <sub>i</sub>                      |
| Device parameters: | - Frequency               | f                                     |
|                    | - Crest factor            | cf                                    |
| Media parameters:  | - Conductivity            |                                       |
|                    | - Density                 |                                       |

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.

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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:

$$V_i = U_i + U_i^2 \cdot c f / d c p_i$$

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)

$dcp_i$  = diode compression point (DASY parameter)

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

E-field probes:  $E_i = (V_i / Norm_i \cdot ConvF)^{1/2}$

H-field probes:  $H_i = (V_i)^{1/2} \cdot (a_{i0} + a_{i1}f + a_{i2}f^2) / f$

With  $V_i$  = compensated signal of channel i (i = x, y, z)

$Norm_i$  = sensor sensitivity of channel i (i = x, y, z)  
[mV/(V/m)<sup>2</sup>] for E-field Probes

$ConvF$  = sensitivity enhancement in solution

$a_{ij}$  = sensor sensitivity factors for H-field probes

$f$  = carrier frequency [GHz]

$E_i$  = electric field strength of channel i in V/m

$H_i$  = magnetic field strength of channel i in A/m

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

$$E_{tot} = (E_x^2 + E_y^2 + E_z^2)^{1/2}$$

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

$$SAR = (E_{tot})^2 \cdot \sigma / (\rho \cdot 1000)$$

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with **SAR** = local specific absorption rate in mW/g

**$E_{tot}$**  = total field strength in V/m

= conductivity in [mho/m]

or [Siemens/m]

= 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. The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = E_{tot}^2 / 3770 \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

with  $P_{pwe}$  = equivalent power density of a plane wave in mW/cm<sup>2</sup>

**$E_{tot}$**  = total electric field strength in V/m

**$H_{tot}$**  = total magnetic field strength in A/m

### 3. Laboratory Environment

**Table 2: The Requirements of the Ambient Conditions**

|                                                                                                 |                           |
|-------------------------------------------------------------------------------------------------|---------------------------|
| Temperature                                                                                     | Min. = 18°C, Max. = 25 °C |
| Relative humidity                                                                               | Min. = 30%, Max. = 70%    |
| Ground system resistance                                                                        | < 0.5 $\Omega$            |
| Ambient noise is checked and found very low and in compliance with requirement of standards.    |                           |
| Reflection of surrounding objects is minimized and in compliance with requirement of standards. |                           |

## **4. Tissue-equivalent Liquid**

### **4.1. Tissue-equivalent Liquid Ingredients**

The liquid is consisted of water, salt, Glycol, Sugar, Preventol and Cellulose. The liquid has previously been proven to be suited for worst-case. The table 3 show the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the KDB 865664 D01.

**Table 3: Composition of the Body Tissue Equivalent Matter**

| <b>MIXTURE%</b>                               | <b>FREQUENCY(Body) 835MHz</b> |                                   |                                 |
|-----------------------------------------------|-------------------------------|-----------------------------------|---------------------------------|
| <b>Water</b>                                  | <b>52.5</b>                   |                                   |                                 |
| <b>Sugar</b>                                  | <b>45</b>                     |                                   |                                 |
| <b>Salt</b>                                   | <b>1.4</b>                    |                                   |                                 |
| <b>Preventol</b>                              | <b>0.1</b>                    |                                   |                                 |
| <b>Cellulose</b>                              | <b>1.0</b>                    |                                   |                                 |
| <b>Dielectric Parameters<br/>Target Value</b> | <b>f=835MHz</b>               | <b><math>\epsilon=55.2</math></b> | <b><math>\sigma=0.97</math></b> |

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**4.2. Tissue-equivalent Liquid Properties**

**Table 4: Dielectric Performance of Tissue Simulating Liquid**

| Frequency        | Test Date | Temp<br>℃ | Measured Dielectric<br>Parameters |                      | Target Dielectric<br>Parameters |                      | Limit<br>(Within ±5%)   |                     |
|------------------|-----------|-----------|-----------------------------------|----------------------|---------------------------------|----------------------|-------------------------|---------------------|
|                  |           |           | $\epsilon_r$                      | $\sigma(\text{s/m})$ | $\epsilon_r$                    | $\sigma(\text{s/m})$ | Dev<br>$\epsilon_r(\%)$ | Dev<br>$\sigma(\%)$ |
| 835MHz<br>(body) | 2015-1-25 | 21.5      | 55.9                              | 0.99                 | 55.2                            | 0.97                 | 1.27                    | 2.06                |
| 915MHz<br>(body) | 2015-1-25 | 21.5      | 55.5                              | 1.09                 | 55.0                            | 1.06                 | 0.87                    | 2.83                |

## 5. System Check

### 5.1. Description of System Check

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulates were measured every day using the dielectric probe kit and the network analyzer. A system check measurement was made following the determination of the dielectric parameters of the simulates, using the dipole validation kit. A power level of 250 mW was supplied to the dipole antenna, which was placed under the flat section of the twin SAM phantom. The system check results (dielectric parameters and SAR values) are given in the table 5.

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.

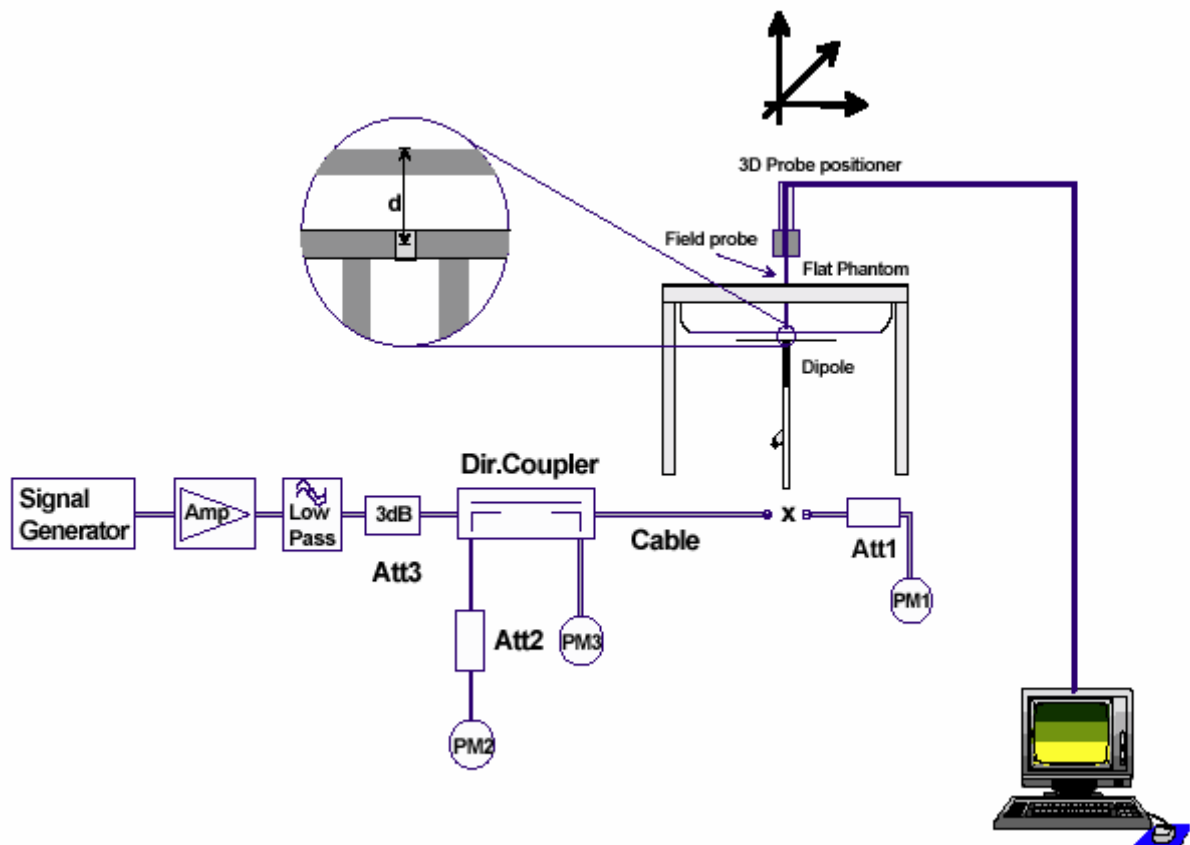


Figure 6 System Check Set-up

| Frequency | Test Date | Dielectric Parameters |        | 250mW Measured SAR <sub>10g</sub> | 1W Normalized SAR <sub>10g</sub> | 1W Target SAR <sub>10g</sub> | Limit (±10% Deviation) |
|-----------|-----------|-----------------------|--------|-----------------------------------|----------------------------------|------------------------------|------------------------|
|           |           | ε <sub>r</sub>        | σ(s/m) | (W/kg)                            |                                  |                              |                        |
| 835MHz    | 2015-1-25 | 55.9                  | 0.99   | 1.60                              | 6.40                             | 6.31                         | 1.43                   |

Note: 1. The graph results see ANNEX B.  
2. Target Values used derive from the calibration certificate

## **6. Operational Conditions during Test**

### **6.1. General Description of Test Procedures**

The product use RFID technology. It can support 902-928MHz with duty cycle 100%, It has no voice call function.

For RFID SAR testing, RFID engineering testing software installed on the EUT can provide continuous transmitting RF signal with maximum output power.

### **6.2. Test Positions**

According to a KDB inquiry, The EUT is tested at the following four test positions:

- Test Position 1: The back side of the EUT towards to the bottom of the flat phantom. The distance is 0mm. (ANNEX G Picture 4)
- Test Position 2: The left edge of the EUT towards to the bottom of the flat phantom. The distance is 0mm. (ANNEX G Picture 5)
- Test Position 3: The right edge of the EUT towards to the bottom of the flat phantom. The distance is 0mm. (ANNEX G Picture 6)
- Test Position 4: The top edge of the EUT towards to the bottom of the flat phantom. The distance is 0mm. (ANNEX G Picture 7)
- Test Position 5: The back side of the EUT antenna towards to the bottom of the flat phantom. The distance is 0mm. (ANNEX G Picture 8)

### **6.3. Measurement Variability**

Per FCC KDB Publication 865664 D01, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:

- 1) When the original highest measured SAR is  $\geq 0.80$  W/kg, the measurement was repeated once.
- 2) A second repeated measurement was performed only if the ratio of largest to smallest SAR for the original and first repeated measurements was  $> 1.20$  or when the original or repeated measurement was  $\geq 1.45$  W/kg (~ 10% from the 1-g SAR limit).
- 3) A third repeated measurement was performed only if the original, first or second repeated measurement was  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .
- 4) Repeated measurements are not required when the original highest measured SAR is  $< 0.80$  W/kg

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

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## 7. Test Results

### 7.1. Conducted Power Results

Table 6: Conducted Power Measurement Results

| RFID 900MHz  | Average power(dBm)     |           |           |
|--------------|------------------------|-----------|-----------|
|              | Channel/Frequency(MHz) |           |           |
|              | 1/902.75               | 26/914.75 | 51/927.25 |
| Test results | 21.86                  | 21.66     | 21.51     |

| Mode | Channel/<br>Frequency(MHz) | Data rate<br>(Mbps) | AV Power (dBm) |
|------|----------------------------|---------------------|----------------|
| 11b  | 1                          | 1                   | 2.5            |
|      |                            | 2                   | 2.3            |
|      |                            | 5.5                 | 2.0            |
|      |                            | 11                  | 2.1            |
|      | 6                          | 1                   | 1.8            |
|      |                            | 2                   | 1.9            |
|      |                            | 5.5                 | 1.7            |
|      |                            | 11                  | 1.8            |
|      | 11                         | 1                   | 2.4            |
|      |                            | 2                   | 2.3            |
|      |                            | 5.5                 | 2.4            |
|      |                            | 11                  | 2.3            |
| 11g  | 1                          | 6                   | -3.9           |
|      |                            | 9                   | -4.0           |
|      |                            | 12                  | -4.0           |
|      |                            | 18                  | -4.1           |
|      |                            | 24                  | -4.5           |
|      |                            | 36                  | -4.2           |
|      |                            | 48                  | -4.1           |
|      |                            | 54                  | -4.3           |
|      | 6                          | 6                   | -4.3           |
|      |                            | 9                   | -4.6           |
|      |                            | 12                  | -4.5           |
|      |                            | 18                  | -4.5           |
|      |                            | 24                  | -4.6           |
|      |                            | 36                  | -4.3           |
|      |                            | 48                  | -4.8           |
|      |                            | 54                  | -4.0           |
|      | 11                         | 6                   | -5.0           |
|      |                            | 9                   | -5.1           |

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|          |    |       |      |
|----------|----|-------|------|
|          |    | 12    | -4.8 |
|          |    | 18    | -4.6 |
|          |    | 24    | -4.6 |
|          |    | 36    | -4.5 |
|          |    | 48    | -4.3 |
|          |    | 54    | -4.4 |
| 11n HT20 | 1  | MCS 0 | -1.4 |
|          |    | MCS 1 | -1.6 |
|          |    | MCS 2 | -1.8 |
|          |    | MCS 3 | -1.9 |
|          |    | MCS 4 | -1.6 |
|          |    | MCS 5 | -1.5 |
|          |    | MCS 6 | -1.5 |
|          |    | MCS 7 | -1.6 |
|          | 6  | MCS 0 | -1.5 |
|          |    | MCS 1 | -1.8 |
|          |    | MCS 2 | -1.6 |
|          |    | MCS 3 | -1.7 |
|          |    | MCS 4 | -1.8 |
|          |    | MCS 5 | -1.8 |
|          |    | MCS 6 | -1.7 |
|          |    | MCS 7 | -1.6 |
|          | 11 | MCS 0 | -1.5 |
|          |    | MCS 1 | -1.8 |
|          |    | MCS 2 | -1.8 |
|          |    | MCS 3 | -1.9 |
|          |    | MCS 4 | -1.5 |
|          |    | MCS 5 | -1.6 |
|          |    | MCS 6 | -1.4 |
|          |    | MCS 7 | -1.5 |
| 11n HT40 | 3  | MCS 0 | -2.1 |
|          |    | MCS 1 | -2.2 |
|          |    | MCS 2 | -2.4 |
|          |    | MCS 3 | -2.6 |
|          |    | MCS 4 | -2.8 |
|          |    | MCS 5 | -2.9 |
|          |    | MCS 6 | -2.5 |
|          |    | MCS 7 | -2.6 |
|          | 6  | MCS 0 | -2.7 |
|          |    | MCS 1 | -2.5 |
|          |    | MCS 2 | -2.3 |
|          |    | MCS 3 | -2.1 |
|          |    | MCS 4 | -2.2 |

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|  |   |       |      |
|--|---|-------|------|
|  |   | MCS 5 | -2.4 |
|  |   | MCS 6 | -2.5 |
|  |   | MCS 7 | -2.1 |
|  | 9 | MCS 0 | -2.3 |
|  |   | MCS 1 | -2.4 |
|  |   | MCS 2 | -2.6 |
|  |   | MCS 3 | -2.7 |
|  |   | MCS 4 | -2.5 |
|  |   | MCS 5 | -2.4 |
|  |   | MCS 6 | -2.1 |
|  |   | MCS 7 | -2.2 |

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**7.2. Standalone SAR Test Exclusion Considerations**

Per FCC KDB 447498 D01, the SAR exclusion threshold for distances <50mm is defined by the following equation:

$$\frac{(\text{max. power of channel, including tune-up tolerance, mW})}{(\text{min. test separation distance, mm})} * \sqrt{\text{Frequency (GHz)}} \leq 7.5$$

| Band | Configuration | Frequency (MHz) | Maximum Power (dBm) | Separation Distance (mm) | Calculation Result | SAR Exclusion Thresholds | Standalone SAR |
|------|---------------|-----------------|---------------------|--------------------------|--------------------|--------------------------|----------------|
| Wifi | Body          | 2462            | 3                   | 5                        | 0.63               | 7.5                      | No             |

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| Test Position                                                                                                    | Channel/<br>Frequency<br>(MHz) | Service | Duty Cycle | Maximum<br>Allowed<br>Power<br>(dBm) | Conducted<br>Power<br>(dBm) | Drift<br>$\pm 0.21\text{dB}$ | Limit SAR <sub>10g</sub> 4 W/kg          |                   |                                          |                  |
|------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------------|--------------------------------------|-----------------------------|------------------------------|------------------------------------------|-------------------|------------------------------------------|------------------|
|                                                                                                                  |                                |         |            |                                      |                             | Drift<br>(dB)                | Measured<br>SAR <sub>10g</sub><br>(W/kg) | Scaling<br>Factor | Reported<br>SAR <sub>10g</sub><br>(W/kg) | Graph<br>Results |
| Test position of Body (Distance 0mm)                                                                             |                                |         |            |                                      |                             |                              |                                          |                   |                                          |                  |
| Back Side                                                                                                        | 1/902.75                       | DSB-ASK | 1:1        | 23.5                                 | 21.86                       | -0.037                       | 0.330                                    | 1.46              | 0.481                                    | /                |
| Front Side                                                                                                       | NA                             | NA      | NA         | NA                                   | NA                          | NA                           | NA                                       | NA                | NA                                       | NA               |
| Left Edge                                                                                                        | 1/902.75                       | DSB-ASK | 1:1        | 23.5                                 | 21.86                       | 0.090                        | 0.744                                    | 1.46              | 1.085                                    | /                |
| Right Edge                                                                                                       | 1/902.75                       | DSB-ASK | 1:1        | 23.5                                 | 21.86                       | 0.033                        | 0.581                                    | 1.46              | 0.848                                    | /                |
| Top Edge                                                                                                         | 51/927.25                      | DSB-ASK | 1:1        | 23.5                                 | 21.51                       | 0.010                        | 0.660                                    | 1.58              | 1.044                                    | /                |
|                                                                                                                  | 26/914.75                      | DSB-ASK | 1:1        | 23.5                                 | 21.66                       | -0.010                       | 0.954                                    | 1.53              | 1.457                                    | /                |
|                                                                                                                  | 1/902.75                       | DSB-ASK | 1:1        | 23.5                                 | 21.86                       | 0.020                        | 1.430                                    | 1.46              | 2.086                                    | Figure 8         |
| Bottom Edge                                                                                                      | NA                             | NA      | NA         | NA                                   | NA                          | NA                           | NA                                       | NA                | NA                                       | NA               |
| Position Antenna                                                                                                 | 1/902.75                       | DSB-ASK | 1:1        | 23.5                                 | 21.86                       | -0.070                       | 0.654                                    | 1.46              | 0.954                                    | Figure 9         |
| Note: 1.The value with blue color is the maximum SAR Value of each test band.<br>EUT has no voice call function. |                                |         |            |                                      |                             |                              |                                          |                   |                                          |                  |

#### **7.4. Simultaneous Transmission Conditions**

RFID and WiFi antenna can not transmit simultaneously.

| No.                 | source                                                                           | Type | Uncertainty Value (%) | Probability Distribution | k  | c <sub>i</sub> | Standard Uncertainty u <sub>i</sub> (%) | Degree of freedom V <sub>eff</sub> or v <sub>i</sub> |
|---------------------|----------------------------------------------------------------------------------|------|-----------------------|--------------------------|----|----------------|-----------------------------------------|------------------------------------------------------|
| 1                   | System repetivity                                                                | A    | 0.5                   | N                        | 1  | 1              | 0.5                                     | 9                                                    |
| Measurement system  |                                                                                  |      |                       |                          |    |                |                                         |                                                      |
| 2                   | -probe calibration                                                               | B    | 6.0                   | N                        | 1  | 1              | 6.0                                     | ∞                                                    |
| 3                   | -axial isotropy of the probe                                                     | B    | 4.7                   | R                        | √3 | √0.5           | 1.9                                     | ∞                                                    |
| 4                   | - Hemispherical isotropy of the probe                                            | B    | 9.4                   | R                        | √3 | √0.5           | 3.9                                     | ∞                                                    |
| 5                   | -boundary effect                                                                 | B    | 1.9                   | R                        | √3 | 1              | 1.1                                     | ∞                                                    |
| 6                   | -probe linearity                                                                 | B    | 4.7                   | R                        | √3 | 1              | 2.7                                     | ∞                                                    |
| 7                   | - System detection limits                                                        | B    | 1.0                   | R                        | √3 | 1              | 0.6                                     | ∞                                                    |
| 8                   | -readout Electronics                                                             | B    | 1.0                   | N                        | 1  | 1              | 1.0                                     | ∞                                                    |
| 9                   | -response time                                                                   | B    | 0.8                   | R                        | √3 | 1              | 0.5                                     | ∞                                                    |
| 10                  | -integration time                                                                | B    | 4.3                   | R                        | √3 | 1              | 2.5                                     | ∞                                                    |
| 11                  | -RF Ambient noise                                                                | B    | 3.0                   | R                        | √3 | 1              | 1.7                                     | ∞                                                    |
| 12                  | -RF Ambient Conditions                                                           | B    | 3.0                   | R                        | √3 | 1              | 1.7                                     | ∞                                                    |
| 13                  | -Probe Positioner Mechanical Tolerance                                           | B    | 0.4                   | R                        | √3 | 1              | 0.2                                     | ∞                                                    |
| 14                  | -Probe Positioning with respect to Phantom Shell                                 | B    | 2.9                   | R                        | √3 | 1              | 1.7                                     | ∞                                                    |
| 15                  | -Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation | B    | 3.9                   | R                        | √3 | 1              | 2.3                                     | ∞                                                    |
| Test sample Related |                                                                                  |      |                       |                          |    |                |                                         |                                                      |
| 16                  | -Test Sample Positioning                                                         | A    | 2.9                   | N                        | 1  | 1              | 2.9                                     | 71                                                   |
| 17                  | -Device Holder Uncertainty                                                       | A    | 4.1                   | N                        | 1  | 1              | 4.1                                     | 5                                                    |
| 18                  | - Power drift                                                                    | B    | 5.0                   | R                        | √3 | 1              | 2.9                                     | ∞                                                    |
| Physical parameter  |                                                                                  |      |                       |                          |    |                |                                         |                                                      |

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|                                                    |                                                                              |                                             |     |   |            |      |       |          |
|----------------------------------------------------|------------------------------------------------------------------------------|---------------------------------------------|-----|---|------------|------|-------|----------|
| 19                                                 | -phantom Uncertainty                                                         | B                                           | 4.0 | R | $\sqrt{3}$ | 1    | 2.3   | $\infty$ |
| 20                                                 | Algorithm for correcting SAR for deviations in permittivity and conductivity | B                                           | 1.9 | N | 1          | 0.84 | 0.9   | $\infty$ |
| 21                                                 | -Liquid conductivity (measurement uncertainty)                               | B                                           | 2.5 | N | 1          | 0.71 | 1.8   | 9        |
| 22                                                 | -Liquid permittivity (measurement uncertainty )                              | B                                           | 2.5 | N | 1          | 0.26 | 0.7   | 9        |
| 23                                                 | -Liquid conductivity -temperature uncertainty                                | B                                           | 1.7 | R | $\sqrt{3}$ | 0.71 | 0.7   | $\infty$ |
| 24                                                 | -Liquid permittivity -temperature uncertainty                                | B                                           | 0.3 | R | $\sqrt{3}$ | 0.26 | 0.05  | $\infty$ |
| Combined standard uncertainty                      |                                                                              | $u_c' = \sqrt{\sum_{i=1}^{24} c_i^2 u_i^2}$ |     |   |            |      | 11.34 |          |
| Expanded uncertainty (confidence interval of 95 %) |                                                                              | $u_e = 2u_c$                                |     | N | k=2        |      | 22.68 |          |

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## 9. Main Test Instruments

**Table 8: List of Main Instruments**

| No. | Name                                | Type           | Serial Number | Calibration Date         | Expiration Time | Valid Period |
|-----|-------------------------------------|----------------|---------------|--------------------------|-----------------|--------------|
| 01  | Network analyzer                    | E5071B         | MY42404014    | 2014-05-26               | 2015-05-25      | 1 year       |
| 02  | Dielectric Probe Kit                | Agilent 85070E | US44020115    | No Calibration Requested |                 |              |
| 03  | Power meter                         | Agilent E4417A | GB41291714    | 2014-03-09               | 2015-03-08      | 1 year       |
| 04  | Power sensor                        | Agilent N8481H | MY50350004    | 2014-09-24               | 2015-09-23      | 1 year       |
| 05  | Power sensor                        | E9327A         | US40441622    | 2015-01-20               | 2016-01-19      | 1 year       |
| 06  | Signal Generator                    | HP 8341B       | 2730A00804    | 2014-09-02               | 2015-09-01      | 1 year       |
| 07  | Dual directional coupler            | 778D-012       | 50519         | 2014-03-24               | 2015-03-23      | 1 year       |
| 08  | Amplifier                           | IXA-020        | 0401          | No Calibration Requested |                 |              |
| 09  | Wideband radio communication tester | E5515C         | MY48360957    | 2014-12-18               | 2015-12-17      | 1 year       |
| 10  | E-field Probe                       | EX3DV4         | 3977          | 2014-02-17               | 2015-02-16      | 1 year       |
| 11  | DAE                                 | DAE4           | 1291          | 2014-11-14               | 2015-11-13      | 1 year       |
| 12  | Validation Kit 835MHz               | D835V2         | 4d020         | 2014-08-28               | 2017-08-27      | 3 years      |
| 13  | Temperature Probe                   | JM222          | AA1009129     | 2014-03-13               | 2015-03-12      | 1 year       |
| 14  | Hygrothermograph                    | WS-1           | 64591         | 2014-09-25               | 2015-09-24      | 1 year       |

\*\*\*\*\*END OF REPORT \*\*\*\*\*

## ANNEX A: Test Layout



Picture 1: Specific Absorption Rate Test Layout



Picture 2: Liquid depth in the flat Phantom (835MHz, 15.4cm depth)

## ANNEX B: System Check Results

### System Performance Check at 835 MHz Body TSL

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d020**

Date: 1/25/2015

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

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.99 \text{ mho/m}$ ;  $\epsilon_r = 55.9$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.3^\circ\text{C}$       Liquid Temperature:  $21.5^\circ\text{C}$

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3977; ConvF(9.74, 9.74, 9.74); Calibrated: 2/17/2014;

Electronics: DAE4 Sn1291; Calibrated: 11/14/2014

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7164)

**d=15mm, Pin=250mW/Area Scan (41x121x1):** Measurement grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) =  $2.58 \text{ mW/g}$

**d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $51.9 \text{ V/m}$ ; Power Drift =  $-0.058 \text{ dB}$

Peak SAR (extrapolated) =  $3.5 \text{ W/kg}$

**SAR(1 g) =  $2.41 \text{ mW/g}$ ; SAR(10 g) =  $1.6 \text{ mW/g}$**

Maximum value of SAR (measured) =  $2.6 \text{ mW/g}$

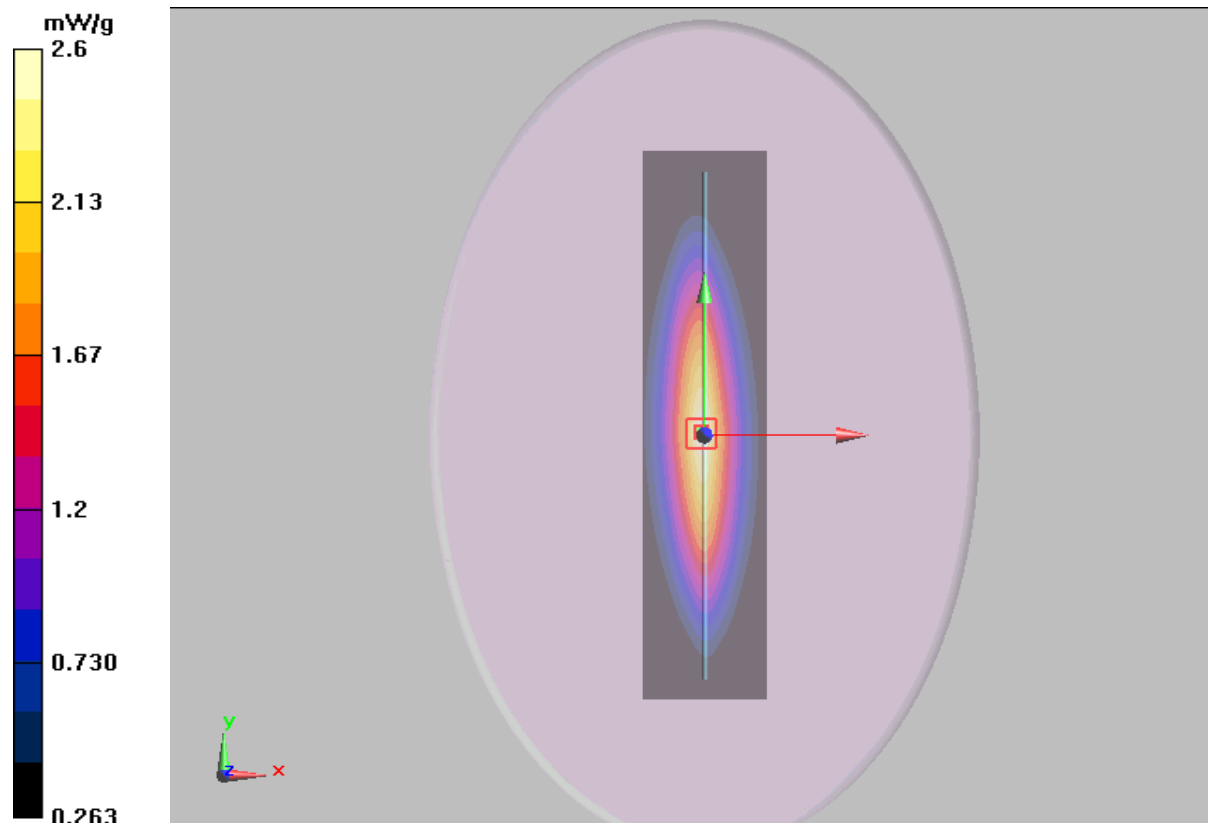


Figure 7 System Performance Check 835MHz 250mW

## ANNEX C: Highest Graph Results

### RFID 900MHz Top Edge Low

Date: 1/25/2015

Communication System: UID 0, Frequency: 902.75 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 903 \text{ MHz}$ ;  $\sigma = 1.06 \text{ S/m}$ ;  $\epsilon_r = 55.059$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.3^\circ\text{C}$       Liquid Temperature:  $21.5^\circ\text{C}$

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3977; ConvF(9.74, 9.74, 9.74); Calibrated: 2/17/2014;

Electronics: DAE4 Sn1291; Calibrated: 11/14/2014

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Top Edge Low /Area Scan (51x91x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) =  $2.71 \text{ W/kg}$

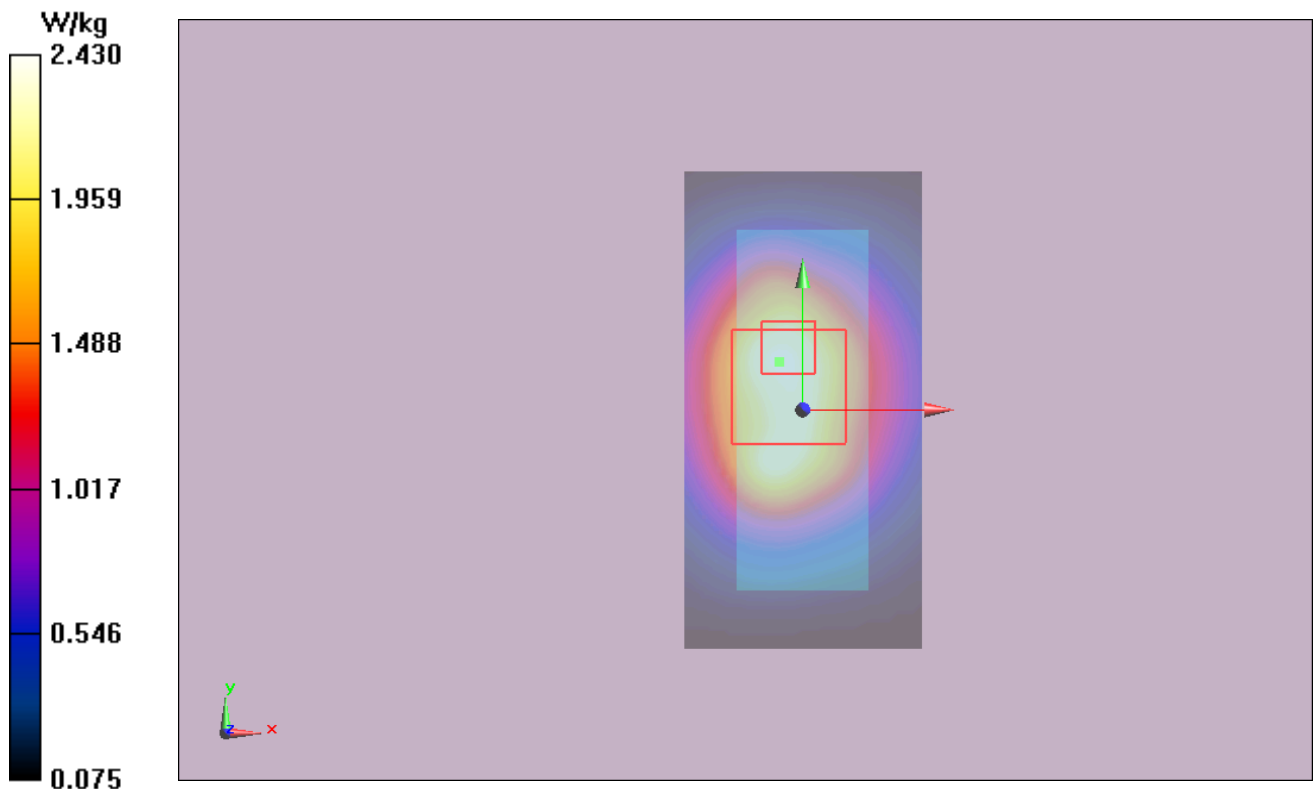
**Top Edge Low /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $50.06 \text{ V/m}$ ; Power Drift =  $0.02 \text{ dB}$

Peak SAR (extrapolated) =  $4.18 \text{ W/kg}$

**SAR(1 g) =  $2.31 \text{ W/kg}$ ; SAR(10 g) =  $1.43 \text{ W/kg}$**

Maximum value of SAR (measured) =  $2.43 \text{ W/kg}$



**Figure 8 Body, Top Edge, RFID 900M Channel 1**

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### RFID 900MHz Position Antenna Low

Date: 1/25/2015

Communication System: UID 0, Frequency: 902.75 MHz; Duty Cycle: 1:1.21955

Medium parameters used:  $f = 903 \text{ MHz}$ ;  $\sigma = 1.06 \text{ S/m}$ ;  $\epsilon_r = 55.059$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.3^\circ\text{C}$  Liquid Temperature:  $21.5^\circ\text{C}$

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3977; ConvF(9.74, 9.74, 9.74); Calibrated: 2/17/2014;

Electronics: DAE4 Sn1291; Calibrated: 11/14/2014

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Position Antenna Low /Area Scan (51x91x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) =  $0.969 \text{ W/kg}$

**Position Antenna Low /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $0.2970 \text{ V/m}$ ; Power Drift =  $-0.07 \text{ dB}$

Peak SAR (extrapolated) =  $1.19 \text{ W/kg}$

**SAR(1 g) =  $0.863 \text{ W/kg}$ ; SAR(10 g) =  $0.654 \text{ W/kg}$**

Maximum value of SAR (measured) =  $0.911 \text{ W/kg}$

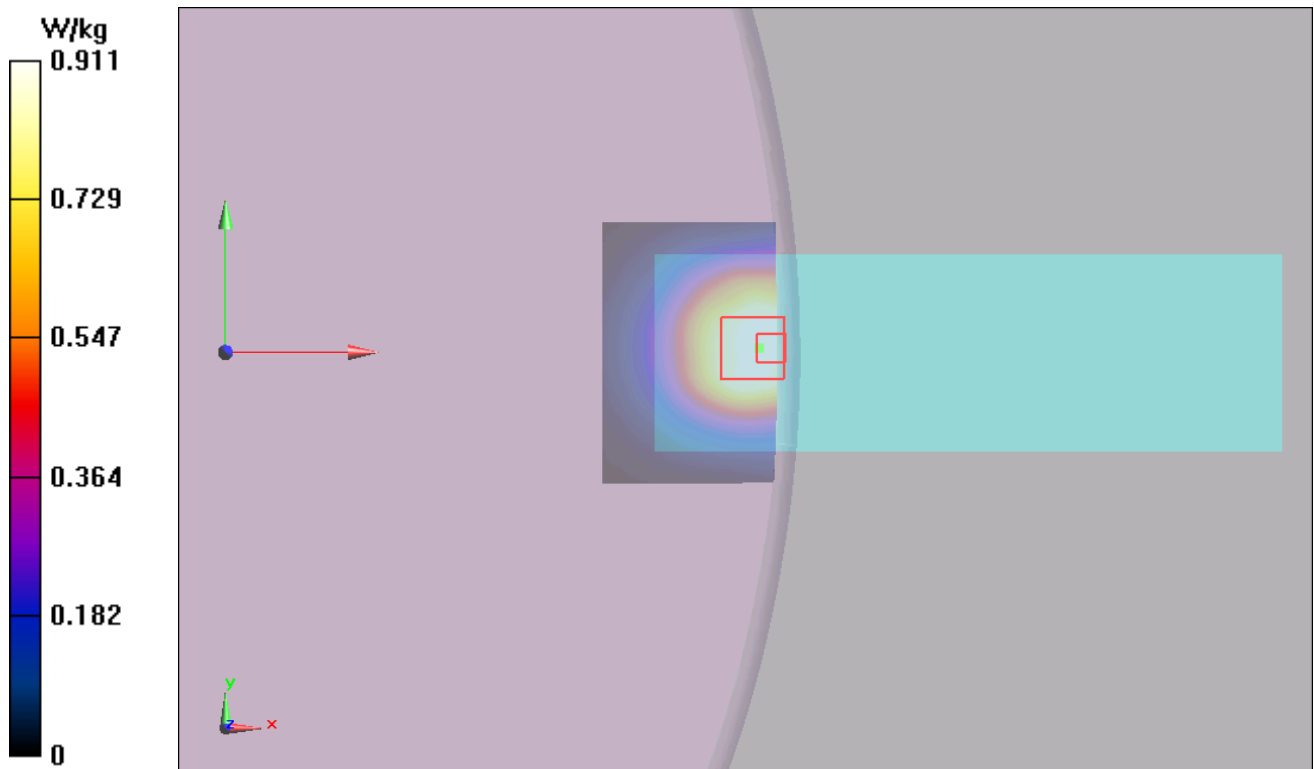


Figure 9 Body, Top Edge, RFID 900M Channel 1

# TA Technology (Shanghai) Co., Ltd.

## Test Report

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### ANNEX D: 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 **ATL (Auden)**

Certificate No: **EX3-3977\_Feb14**

#### CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3977**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5,  
QA CAL-25.v6  
Calibration procedure for dosimetric E-field probes**

Calibration date: **February 17, 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      | 04-Apr-13 (No. 217-01733)         | Apr-14                 |
| Power sensor E4412A        | MY41498087      | 04-Apr-13 (No. 217-01733)         | Apr-14                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 04-Apr-13 (No. 217-01737)         | Apr-14                 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 04-Apr-13 (No. 217-01735)         | Apr-14                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 04-Apr-13 (No. 217-01738)         | Apr-14                 |
| 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 |

|                                                                                                                 | Name           | Function              | Signature |
|-----------------------------------------------------------------------------------------------------------------|----------------|-----------------------|-----------|
| Calibrated by:                                                                                                  | Jeton Kastrati | Laboratory Technician |           |
| Approved by:                                                                                                    | Katja Pokovic  | Technical Manager     |           |
| Issued: February 19, 2014                                                                                       |                |                       |           |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |                |                       |           |

Certificate No: EX3-3977\_Feb14

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



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

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

Accreditation No.: **SCS 108**

### Glossary:

|                          |                                                                                                                                                         |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                      | tissue simulating liquid                                                                                                                                |
| NORM <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                               |
| ConvF                    | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                              |
| DCP                      | diode compression point                                                                                                                                 |
| CF                       | crest factor (1/duty_cycle) of the RF signal                                                                                                            |
| A, B, C, D               | modulation dependent linearization parameters                                                                                                           |
| Polarization $\varphi$   | $\varphi$ 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<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>; A, B, C, D** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

**TA Technology (Shanghai) Co., Ltd.**  
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EX3DV4 – SN:3977

February 17, 2014

**Probe EX3DV4**

**SN:3977**

Manufactured: November 5, 2013  
Calibrated: February 17, 2014

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

# TA Technology (Shanghai) Co., Ltd.

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EX3DV4-- SN:3977

February 17, 2014

### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3977

#### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|-----------------------------------------------------------|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.54     | 0.57     | 0.54     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                                     | 99.5     | 100.0    | 99.7     |               |

#### 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    | 133.3    | $\pm 3.3 \%$              |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 134.9    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 146.5    |                           |

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.

# TA Technology (Shanghai) Co., Ltd.

## Test Report

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EX3DV4- SN:3977

February 17, 2014

### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3977

#### 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                            | 11.72   | 11.72   | 11.72   | 0.18               | 1.10                    | ± 13.3 %    |
| 750                  | 41.9                               | 0.89                            | 9.98    | 9.98    | 9.98    | 0.36               | 0.88                    | ± 12.0 %    |
| 835                  | 41.5                               | 0.90                            | 9.62    | 9.62    | 9.62    | 0.61               | 0.69                    | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 9.48    | 9.48    | 9.48    | 0.77               | 0.63                    | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 8.14    | 8.14    | 8.14    | 0.78               | 0.60                    | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 7.97    | 7.97    | 7.97    | 0.48               | 0.75                    | ± 12.0 %    |
| 2000                 | 40.0                               | 1.40                            | 7.93    | 7.93    | 7.93    | 0.69               | 0.63                    | ± 12.0 %    |
| 2300                 | 39.5                               | 1.67                            | 7.59    | 7.59    | 7.59    | 0.37               | 0.83                    | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 7.24    | 7.24    | 7.24    | 0.27               | 1.10                    | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 7.07    | 7.07    | 7.07    | 0.41               | 0.84                    | ± 12.0 %    |
| 5200                 | 36.0                               | 4.66                            | 5.09    | 5.09    | 5.09    | 0.35               | 1.80                    | ± 13.1 %    |
| 5300                 | 35.9                               | 4.76                            | 4.82    | 4.82    | 4.82    | 0.35               | 1.80                    | ± 13.1 %    |
| 5500                 | 35.6                               | 4.96                            | 4.76    | 4.76    | 4.76    | 0.35               | 1.80                    | ± 13.1 %    |
| 5600                 | 35.5                               | 5.07                            | 4.55    | 4.55    | 4.55    | 0.40               | 1.80                    | ± 13.1 %    |
| 5800                 | 35.3                               | 5.27                            | 4.52    | 4.52    | 4.52    | 0.40               | 1.80                    | ± 13.1 %    |

<sup>C</sup> Frequency validity 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.

<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.

# TA Technology (Shanghai) Co., Ltd.

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EX3DV4- SN:3977

February 17, 2014

### DASY/EASY - Parameters of Probe: EX3DV4 - SN:3977

#### 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                            | 12.47   | 12.47   | 12.47   | 0.11               | 1.10                    | ± 13.3 %    |
| 750                  | 55.5                               | 0.96                            | 9.78    | 9.78    | 9.78    | 0.45               | 0.86                    | ± 12.0 %    |
| 835                  | 55.2                               | 0.97                            | 9.74    | 9.74    | 9.74    | 0.48               | 0.83                    | ± 12.0 %    |
| 900                  | 55.0                               | 1.05                            | 9.46    | 9.46    | 9.46    | 0.41               | 0.89                    | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 7.69    | 7.69    | 7.69    | 0.41               | 0.88                    | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 7.37    | 7.37    | 7.37    | 0.34               | 0.89                    | ± 12.0 %    |
| 2000                 | 53.3                               | 1.52                            | 7.41    | 7.41    | 7.41    | 0.24               | 1.14                    | ± 12.0 %    |
| 2300                 | 52.9                               | 1.81                            | 7.12    | 7.12    | 7.12    | 0.66               | 0.64                    | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 6.97    | 6.97    | 6.97    | 0.80               | 0.50                    | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 6.68    | 6.68    | 6.68    | 0.80               | 0.50                    | ± 12.0 %    |
| 5200                 | 49.0                               | 5.30                            | 4.50    | 4.50    | 4.50    | 0.45               | 1.90                    | ± 13.1 %    |
| 5300                 | 48.9                               | 5.42                            | 4.28    | 4.28    | 4.28    | 0.45               | 1.90                    | ± 13.1 %    |
| 5500                 | 48.6                               | 5.65                            | 4.02    | 4.02    | 4.02    | 0.45               | 1.90                    | ± 13.1 %    |
| 5600                 | 48.5                               | 5.77                            | 3.87    | 3.87    | 3.87    | 0.45               | 1.90                    | ± 13.1 %    |
| 5800                 | 48.2                               | 6.00                            | 4.12    | 4.12    | 4.12    | 0.50               | 1.90                    | ± 13.1 %    |

<sup>C</sup> Frequency validity 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.

<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.

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Test Report

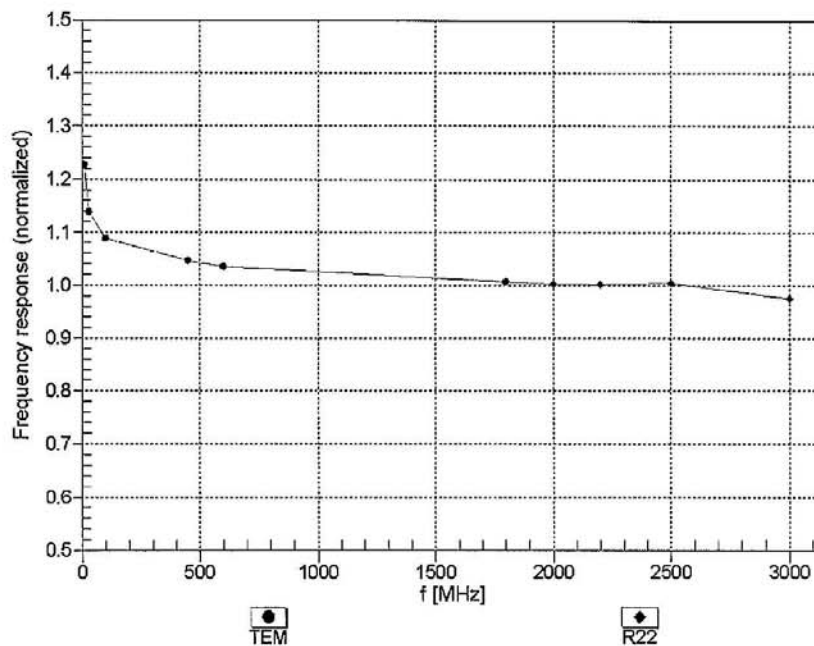
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February 17, 2014

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



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

# TA Technology (Shanghai) Co., Ltd.

## Test Report

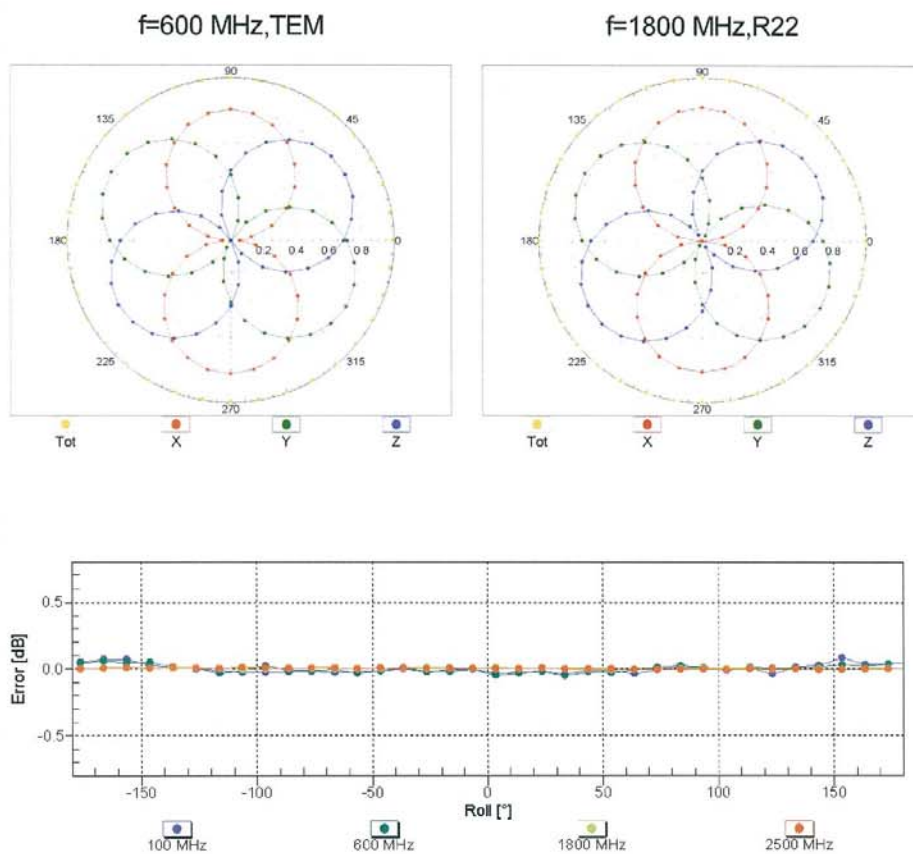
Report No.: RXA1411-0260SAR01R1

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



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

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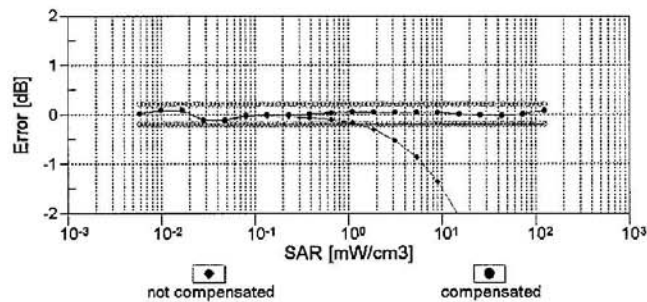
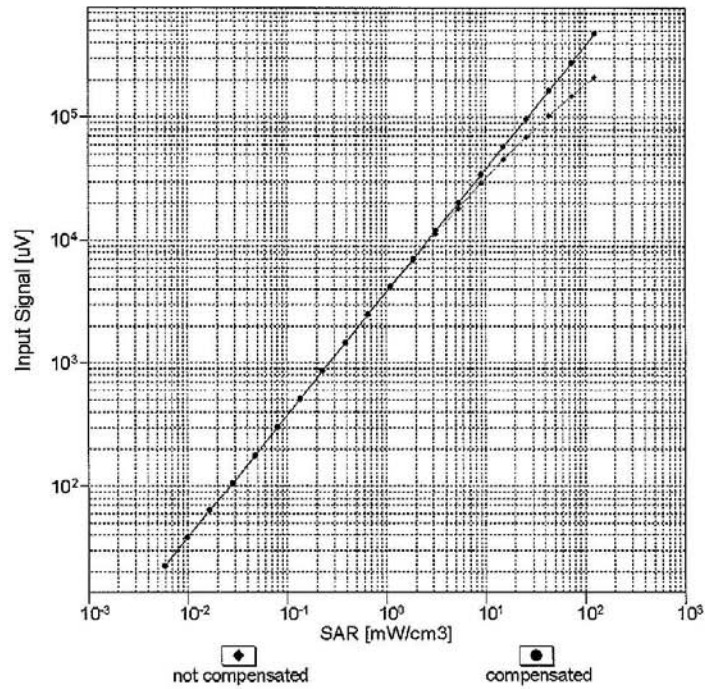
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**Dynamic Range  $f(\text{SAR}_{\text{head}})$**   
(TEM cell ,  $f_{\text{eval}} = 1900 \text{ MHz}$ )



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

# TA Technology (Shanghai) Co., Ltd.

## Test Report

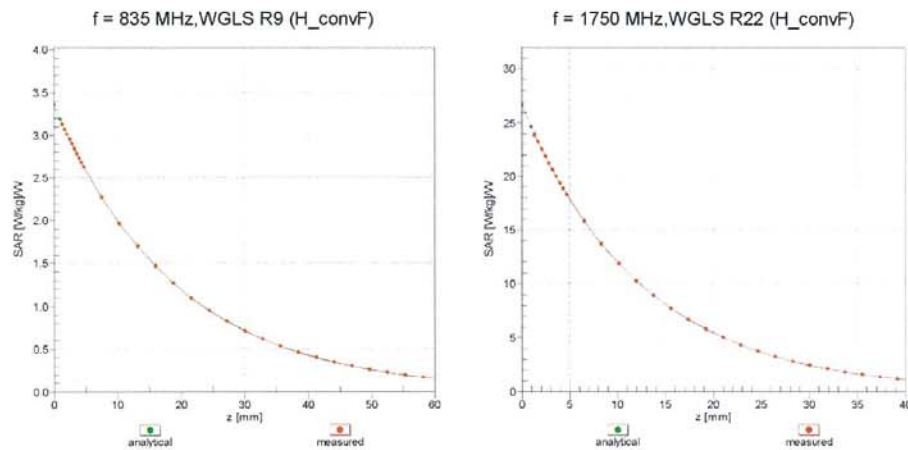
Report No.: RXA1411-0260SAR01R1

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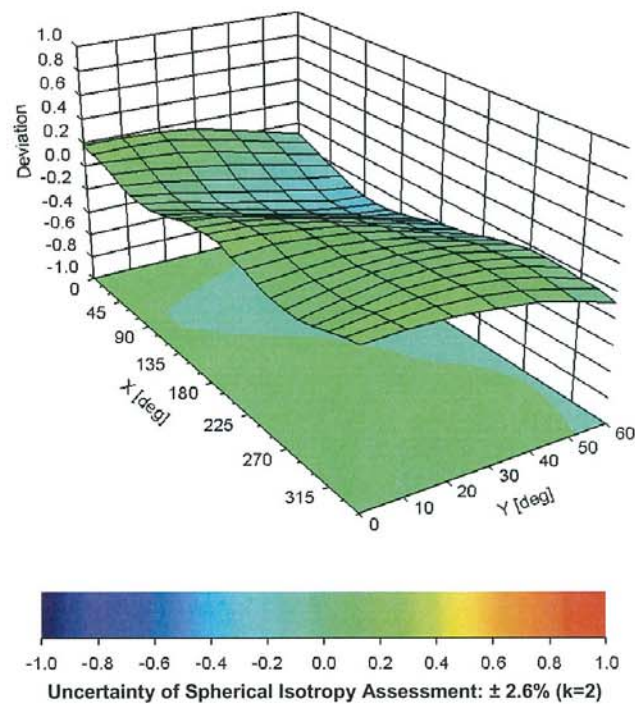
February 17, 2014

### Conversion Factor Assessment



### Deviation from Isotropy in Liquid

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



**TA Technology (Shanghai) Co., Ltd.**  
**Test Report**

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February 17, 2014

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3977**

**Other Probe Parameters**

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 23.6       |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 9 mm       |
| Tip Diameter                                  | 2.5 mm     |
| Probe Tip to Sensor X Calibration Point       | 1 mm       |
| Probe Tip to Sensor Y Calibration Point       | 1 mm       |
| Probe Tip to Sensor Z Calibration Point       | 1 mm       |
| Recommended Measurement Distance from Surface | 2 mm       |

TA Technology (Shanghai) Co., Ltd.  
Test Report

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ANNEX E: D835V2 Dipole Calibration Certificate



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
E-mail: cttl@chinattl.com Http://www.chinattl.cn



Client **TA(Shanghai)** Certificate No: **Z14-97073**

**CALIBRATION CERTIFICATE**

Object **D835V2 - SN: 4d020**

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

Calibration date: **August 28, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| Power Meter NRVD        | 102083     | 11-Sep-13 (TMC, No.JZ13-443)             | Sep-14                |
| Power sensor NRV-Z5     | 100595     | 11-Sep-13 (TMC, No. JZ13-443)            | Sep -14               |
| Reference Probe ES3DV3  | SN 3149    | 5- Sep-13 (SPEAG, No.ES3-3149_Sep13)     | Sep-14                |
| DAE3                    | SN 536     | 23-Jan-14 (SPEAG, DAE3-536_Jan14)        | Jan -15               |
| Signal Generator E4438C | MY49070393 | 13-Nov-13 (TMC, No.JZ13-394)             | Nov-14                |
| Network Analyzer E8362B | MY43021135 | 19-Oct-13 (TMC, No.JZ13-278)             | Oct-14                |

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

Issued: September 4, 2014

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

Certificate No: Z14-97073

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# TA Technology (Shanghai) Co., Ltd.

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Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
E-mail: cttd@chinattl.com Http://www.chinattl.cn



### Glossary:

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

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

- 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 300MHz to 3GHz)", February 2005
- KDB865664, 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%.

# TA Technology (Shanghai) Co., Ltd.

## Test Report

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Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
E-mail: cttl@chinattl.com Http://www.chinattl.cn



### Measurement Conditions

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

|                              |                          |             |
|------------------------------|--------------------------|-------------|
| DASY Version                 | DASY52                   | 52.8.8.1222 |
| Extrapolation                | Advanced Extrapolation   |             |
| Phantom                      | Triple Flat Phantom 5.1C |             |
| Distance Dipole Center - TSL | 15 mm                    | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm        |             |
| Frequency                    | 835 MHz $\pm$ 1 MHz      |             |

### Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 41.5           | 0.90 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 42.5 $\pm$ 6 % | 0.91 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | <1.0 °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 | 2.39 mW / g                  |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 9.54 mW/g $\pm$ 20.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                              |
| SAR measured                                            | 250 mW input power | 1.57 mW / g                  |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 6.26 mW/g $\pm$ 20.4 % (k=2) |

### Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 55.2           | 0.97 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 56.7 $\pm$ 6 % | 0.97 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | <1.0 °C             | ----           | ----                 |

### SAR result with Body TSL

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL   | Condition          |                              |
| SAR measured                                            | 250 mW input power | 2.37 mW / g                  |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 9.54 mW/g $\pm$ 20.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | Condition          |                              |
| SAR measured                                            | 250 mW input power | 1.57 mW / g                  |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 6.31 mW/g $\pm$ 20.4 % (k=2) |

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In Collaboration with  
**s p e a g**  
CALIBRATION LABORATORY

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E-mail: cttl@chinatl.com Http://www.chinatl.cn



### Appendix

#### Antenna Parameters with Head TSL

|                                      |                            |
|--------------------------------------|----------------------------|
| Impedance, transformed to feed point | $48.6\Omega + 2.75j\Omega$ |
| Return Loss                          | - 30.1dB                   |

#### Antenna Parameters with Body TSL

|                                      |                            |
|--------------------------------------|----------------------------|
| Impedance, transformed to feed point | $54.0\Omega + 5.88j\Omega$ |
| Return Loss                          | - 23.3dB                   |

#### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.242 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

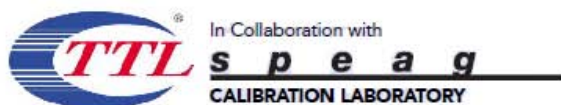
|                 |       |
|-----------------|-------|
| Manufactured by | SPEAG |
|-----------------|-------|

# TA Technology (Shanghai) Co., Ltd.

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### DASY5 Validation Report for Head TSL

Date: 28.08.2014

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d020**

Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.909 \text{ S/m}$ ;  $\epsilon_r = 42.49$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Left Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3149; ConvF(6.21, 6.21, 6.21); Calibrated: 2013-09-05;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 2014-01-23
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:**

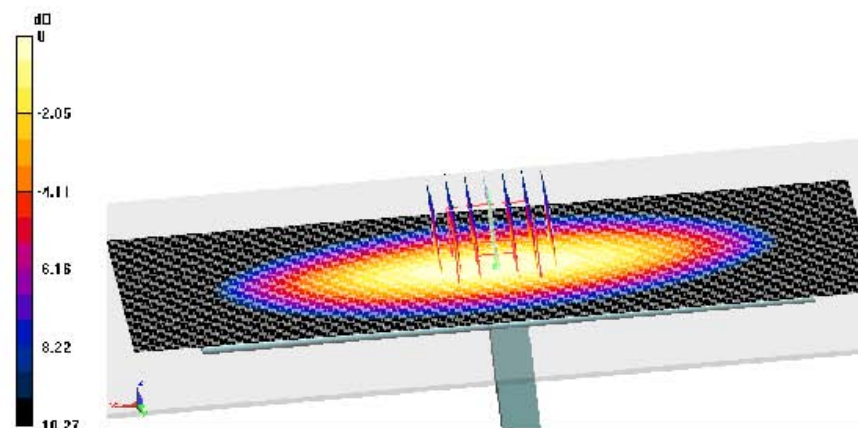
$dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 55.88 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.54 W/kg

**SAR(1 g) = 2.39 W/kg; SAR(10 g) = 1.57 W/kg**

Maximum value of SAR (measured) = 2.79 W/kg



**0 dB = 2.79 W/kg = 4.46 dBW/kg**

# TA Technology (Shanghai) Co., Ltd.

## Test Report

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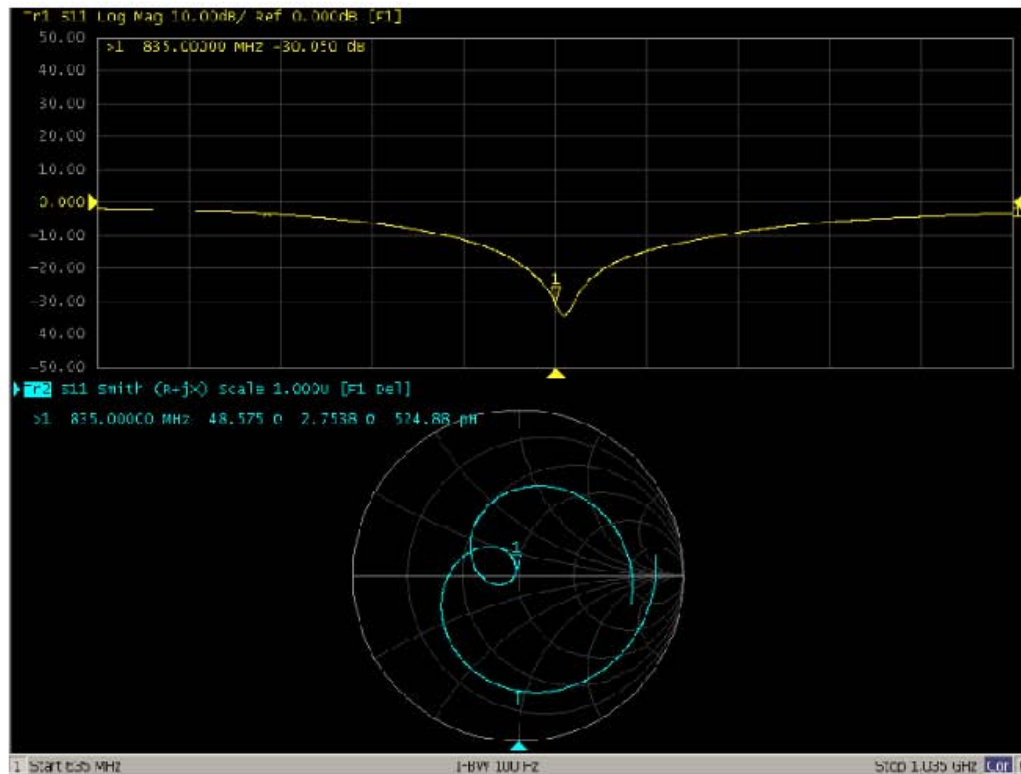
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### Impedance Measurement Plot for Head TSL



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### DASY5 Validation Report for Body TSL

Date: 28.08.2014

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d020**

Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.97 \text{ S/m}$ ;  $\epsilon_r = 56.745$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3149; ConvF(5.98, 5.98, 5.98); Calibrated: 2013-09-05;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 2014-01-23
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/2
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

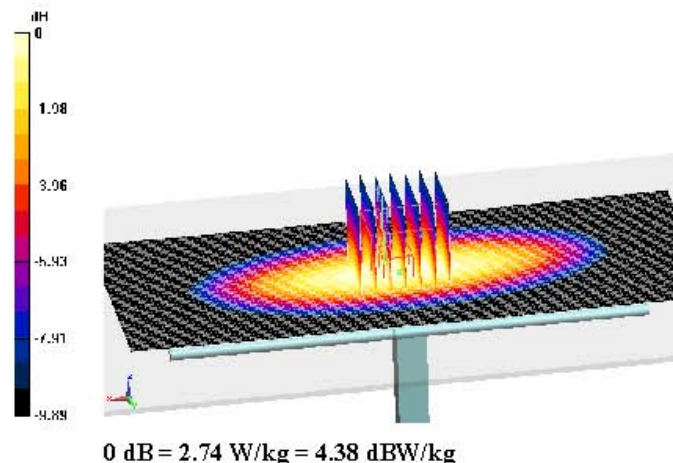
**System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm**

Reference Value = 53.515 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.45 W/kg

**SAR(1 g) = 2.37 W/kg; SAR(10 g) = 1.57 W/kg**

Maximum value of SAR (measured) = 2.74 W/kg

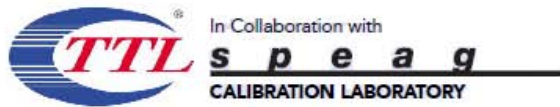


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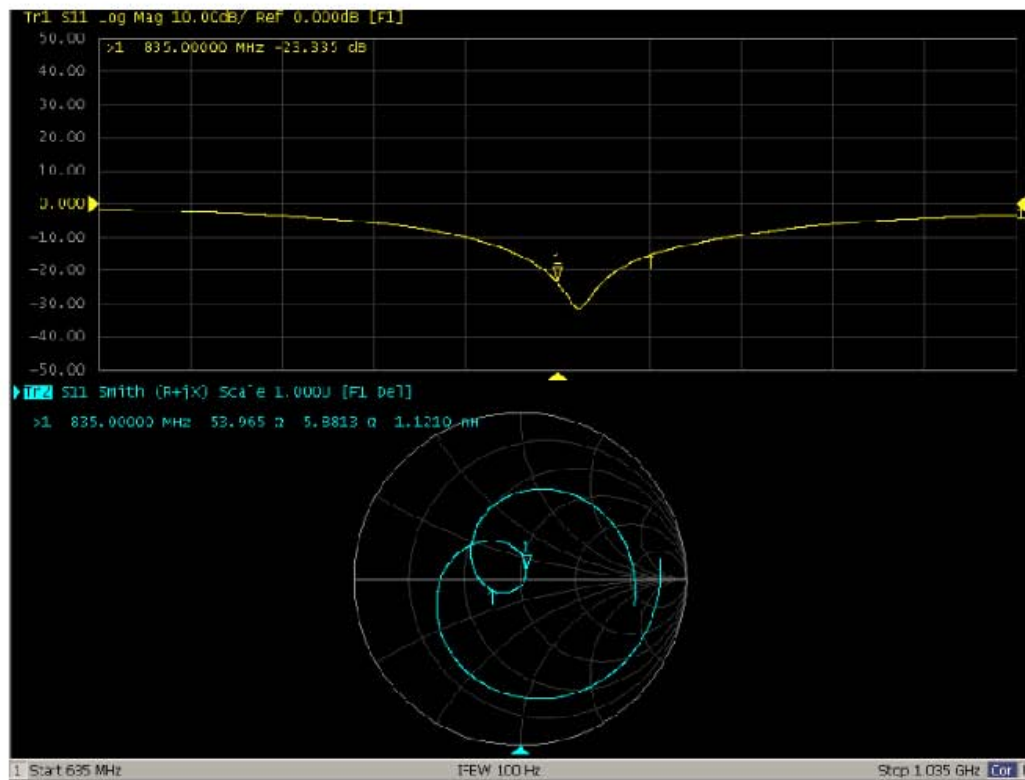
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### Impedance Measurement Plot for Body TSL



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ANNEX F: DAE4 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 TA-Shanghai (Auden)

Certificate No: DAE4-1291\_Nov14

CALIBRATION CERTIFICATE

Object DAE4 - SD 000 D04 BM - SN: 1291

Calibration procedure(s) QA CAL-06.v28  
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: November 14, 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  |
|-------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278        | 03-Oct-14 (No:15573)       | Oct-15                 |
| Secondary Standards           | ID #               | Check Date (in house)      | Scheduled Check        |
| Auto DAE Calibration Unit     | SE UWS 053 AA 1001 | 07-Jan-14 (in house check) | In house check: Jan-15 |
| Calibrator Box V2.1           | SE UMS 006 AA 1002 | 07-Jan-14 (in house check) | In house check: Jan-15 |

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

Issued: November 14, 2014

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

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



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

### Glossary

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

### Methods Applied and Interpretation of Parameters

- **DC Voltage Measurement:** Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- **Connector angle:** The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - **DC Voltage Measurement Linearity:** Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - **Common mode sensitivity:** Influence of a positive or negative common mode voltage on the differential measurement.
  - **Channel separation:** Influence of a voltage on the neighbor channels not subject to an input voltage.
  - **AD Converter Values with inputs shorted:** Values on the internal AD converter corresponding to zero input voltage
  - **Input Offset Measurement:** Output voltage and statistical results over a large number of zero voltage measurements.
  - **Input Offset Current:** Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - **Input resistance:** Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - **Low Battery Alarm Voltage:** Typical value for information. Below this voltage, a battery alarm signal is generated.
  - **Power consumption:** Typical value for information. Supply currents in various operating modes.

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### DC Voltage Measurement

A/D - Converter Resolution nominal

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

Low Range: 1LSB = 61nV , full range = -1.....+3mV

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 402.613 $\pm$ 0.02% (k=2) | 403.293 $\pm$ 0.02% (k=2) | 403.205 $\pm$ 0.02% (k=2) |
| Low Range           | 3.97544 $\pm$ 1.50% (k=2) | 3.93356 $\pm$ 1.50% (k=2) | 3.99377 $\pm$ 1.50% (k=2) |

### Connector Angle

|                                           |                   |
|-------------------------------------------|-------------------|
| Connector Angle to be used in DASY system | 308.5 ° $\pm$ 1 ° |
|-------------------------------------------|-------------------|

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

#### 1. DC Voltage Linearity

| High Range        | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 200033.82                 | -3.10                        | -0.00     |
| Channel X + Input | 20004.15                  | -0.02                        | -0.00     |
| Channel X - Input | -20004.31                 | 1.85                         | -0.01     |
| Channel Y + Input | 200033.24                 | -3.41                        | -0.00     |
| Channel Y + Input | 20003.47                  | -0.54                        | -0.00     |
| Channel Y - Input | -20006.08                 | 0.19                         | -0.00     |
| Channel Z + Input | 200036.05                 | -0.73                        | -0.00     |
| Channel Z + Input | 20001.26                  | -2.68                        | -0.01     |
| Channel Z - Input | -20007.69                 | -1.47                        | 0.01      |

| Low Range         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2000.57                   | -0.08                        | -0.00     |
| Channel X + Input | 200.57                    | -0.14                        | -0.07     |
| Channel X - Input | -199.31                   | -0.00                        | 0.00      |
| Channel Y + Input | 1999.81                   | -0.79                        | -0.04     |
| Channel Y + Input | 200.05                    | -0.62                        | -0.31     |
| Channel Y - Input | -199.06                   | 0.30                         | -0.15     |
| Channel Z + Input | 2001.14                   | 0.56                         | 0.03      |
| Channel Z + Input | 199.16                    | -1.42                        | -0.71     |
| Channel Z - Input | -200.73                   | -1.23                        | 0.62      |

#### 2. Common mode sensitivity

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

|           | Common mode Input Voltage (mV) | High Range Average Reading ( $\mu\text{V}$ ) | Low Range Average Reading ( $\mu\text{V}$ ) |
|-----------|--------------------------------|----------------------------------------------|---------------------------------------------|
| Channel X | 200                            | 9.64                                         | 7.77                                        |
|           | - 200                          | -6.77                                        | -8.44                                       |
| Channel Y | 200                            | 13.71                                        | 13.30                                       |
|           | - 200                          | -14.01                                       | -14.19                                      |
| Channel Z | 200                            | -16.88                                       | -16.56                                      |
|           | - 200                          | 13.70                                        | 13.86                                       |

#### 3. Channel separation

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

|           | Input Voltage (mV) | Channel X ( $\mu\text{V}$ ) | Channel Y ( $\mu\text{V}$ ) | Channel Z ( $\mu\text{V}$ ) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200                | -                           | 3.91                        | -4.26                       |
| Channel Y | 200                | 8.88                        | -                           | 3.64                        |
| Channel Z | 200                | 10.51                       | 7.45                        | -                           |

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

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

|           | High Range (LSB) | Low Range (LSB) |
|-----------|------------------|-----------------|
| Channel X | 16003            | 13374           |
| Channel Y | 15805            | 15470           |
| Channel Z | 16035            | 14317           |

#### 5. Input Offset Measurement

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

Input 10M $\Omega$

|           | Average ( $\mu$ V) | min. Offset ( $\mu$ V) | max. Offset ( $\mu$ V) | Std. Deviation ( $\mu$ V) |
|-----------|--------------------|------------------------|------------------------|---------------------------|
| Channel X | 0.37               | -1.17                  | 1.61                   | 0.49                      |
| Channel Y | 0.25               | -0.91                  | 1.56                   | 0.48                      |
| Channel Z | -0.62              | -1.83                  | 0.60                   | 0.47                      |

#### 6. Input Offset Current

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

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

|           | Zeroing (kOhm) | Measuring (MOhm) |
|-----------|----------------|------------------|
| Channel X | 200            | 200              |
| Channel Y | 200            | 200              |
| Channel Z | 200            | 200              |

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

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

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

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

## ANNEX G: The EUT Appearances and Test Configuration



a: EUT

Picture 3: Constituents of EUT

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Picture 4: Back Side, the distance from EUT to the bottom of the Phantom is 0mm



Picture 5: Left Edge, the distance from EUT to the bottom of the Phantom is 0mm

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Picture 6: Right Edge, the distance from EUT to the bottom of the Phantom is 0mm



Picture 7: Top Edge, the distance from EUT to the bottom of the Phantom is 0mm

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Picture 8: Back Side, the distance from EUT antenna to the bottom of the Phantom is 0mm

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### ANNEX K: System Validation

The SAR system must be validated against its performance specifications before it is deployed. When SAR probes, system components or software are changed, upgraded or recalibrated, these must be validated with the SAR system(s) that operates with such components.

**Table 9: System Validation Part 1**

| System No. | Probe SN. | Liquid Name   | Validation Date   | Frequency Point | Permittivity $\epsilon$ | Conductivity $\sigma$ (s/m) |
|------------|-----------|---------------|-------------------|-----------------|-------------------------|-----------------------------|
| 1          | 3977      | 835MHz (body) | February 17, 2014 | 835MHz          | 55.2                    | 0.97                        |

**Table 10: System Validation Part 2**

|                          |                 |      |      |
|--------------------------|-----------------|------|------|
| <b>CW<br/>Validation</b> | Sensitivity     | PASS | PASS |
|                          | Probe Linearity | PASS | PASS |
|                          | Probe Isotropy  | PASS | PASS |
|                          | MOD. Type       | OFDM | OFDM |
|                          | Duty Factor     | PASS | PASS |
|                          | PAR             | PASS | PASS |