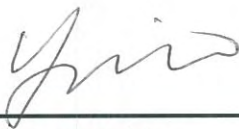


# SAR TEST REPORT

HCT CO., LTD

|                                                  |                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EUT Type:                                        | Mobile Phone                                                                                                                                                                                                                                                                                                                          |
| FCC ID:                                          | A3LSMG130H                                                                                                                                                                                                                                                                                                                            |
| Model:                                           | SM-G130H/DS                                                                                                                                                                                                                                                                                                                           |
| Date of Issue:                                   | May. 26, 2014                                                                                                                                                                                                                                                                                                                         |
| Test report No.:                                 | HCT-A-1405-F008                                                                                                                                                                                                                                                                                                                       |
| Test Laboratory:                                 | <b>HCT CO., LTD.</b><br>74, Seoicheon-ro 578 beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea 467-811<br>TEL: +82 31 645 6300 FAX: +82 31 645 6401                                                                                                                                                                               |
| Applicant :                                      | <b>SAMSUNG Electronics Co., Ltd.</b><br>129, Samsung-ro, Yeongtong-gu, Suwon-City, Gyeonggi-do, 443-742 Republic of Korea                                                                                                                                                                                                             |
| Testing has been carried out in accordance with: | RSS-102 Issue 4; Health Canada Safety Code 6<br>47CFR §2.1093<br>ANSI/ IEEE C95.1 – 1992<br>IEEE 1528-2003                                                                                                                                                                                                                            |
| Test result:                                     | The tested device complies with the requirements in respect of all parameters subject to the test. The test results and statements relate only to the items tested. The test report shall not be reproduced except in full, without written approval of the laboratory.                                                               |
| Signature                                        | <div><br/>Report prepared by<br/>: Yun-Jeang, Heo<br/>Test Engineer of SAR Part</div> <div><br/>Approved by<br/>: Kim Dong-seob<br/>Manager of SAR Part</div> |

## Version

| Rev.            | DATE          | DESCRIPTION           |
|-----------------|---------------|-----------------------|
| HCT-A-1405-F008 | May. 26, 2014 | First Approval Report |

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# 1. INTRODUCTION

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices.

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. The measurement procedure described in IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave is used for guidance in measuring SAR due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86 NCRP, 1986, Bethesda, MD 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

## SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative of the incremental electromagnetic energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density ( $\rho$ ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body.

$$SAR = \frac{d}{dt} \left( \frac{dU}{dm} \right) = \frac{d}{dt} \left( \frac{dU}{\rho dV} \right)$$

Figure 1. SAR Mathematical Equation

*SAR is expressed in units of Watts per Kilogram (W/kg)*

$$SAR = \sigma E^2 / \rho$$

Where:

$\sigma$  = conductivity of the tissue-simulant material (S/m)

$\rho$  = mass density of the tissue-simulant material (kg/m<sup>3</sup>)

$E$  = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.

## 2. TEST METHODOLOGY

---

The tests documented in this report were performed in accordance with IEEE Standard 1528-2003 & IEEE 1528-2005 and the following published KDB procedures.

- FCC KDB Publication 941225 D01 SAR test for 3G devices v02
- FCC KDB Publication 941225 D03 SAR Test Reduction GSM GPRS EDGE v01
- FCC KDB Publication 941225 D06 Hot Spot SAR v01r01
- FCC KDB Publication 248227 D01v01r02 (SAR Consideration for 802.11 Devices)
- FCC KDB Publication 447498 D01v05r02 (General SAR Guidance)
- FCC KDB Publication 648474 D04 Handset SAR v01r02
- FCC KDB Publication 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03
- FCC KDB Publication 865664 D02 SAR Reporting v01r01
- October 2013 TCB Workshop Notes (GPRS testing criteria)

### 3. DESCRIPTION OF DEVICE

Environmental evaluation measurements of specific absorption rate (SAR) distributions in emulated human head and body tissues exposed to radio frequency (RF) radiation from wireless portable devices for compliance with the rules and regulations of the U.S. Federal Communications Commission (FCC).

|                                           |                               |                    |                 |                         |           |         |
|-------------------------------------------|-------------------------------|--------------------|-----------------|-------------------------|-----------|---------|
| EUT Type                                  | Mobile Phone                  |                    |                 |                         |           |         |
| FCC ID:                                   | A3LSMG130H                    |                    |                 |                         |           |         |
| Model:                                    | SM-G130H/DS                   |                    |                 |                         |           |         |
| Trade Name                                | SAMSUNG Electronics Co., Ltd. |                    |                 |                         |           |         |
| Application Type                          | Certification                 |                    |                 |                         |           |         |
| Production Unit or Identical Prototype    | Prototype                     |                    |                 |                         |           |         |
| Max. SAR                                  | Band                          | Tx Frequency (MHz) | Equipment Class | Reported 1 g SAR (W/kg) |           |         |
|                                           |                               |                    |                 | Head                    | Body-worn | Hotspot |
|                                           | GSM/GPRS 850                  | 824.2 - 848.8      | PCE             | 0.52                    | 0.61      | 0.56    |
|                                           | GSM/GPRS1900                  | 1 850.2 - 1 909.8  | PCE             | 0.86                    | 0.50      | 0.50    |
|                                           | 802.11b                       | 2 412 - 2 462      | DTS             | 0.02                    | 0.08      | 0.11    |
|                                           | Bluetooth                     | 2 402 - 2 480      | DSS/DTS         | -                       | 0.33*     | -       |
| Simultaneous SAR per KDB 690783 D01v01r03 |                               |                    |                 | 0.94                    |           |         |
| Date(s) of Tests                          | May. 15, 2014 ~ May. 21, 2014 |                    |                 |                         |           |         |
| Antenna Type                              | Integral Antenna              |                    |                 |                         |           |         |
| Hardware Version :                        | REV1.1                        |                    |                 |                         |           |         |
| Software Version :                        | G130H.001                     |                    |                 |                         |           |         |
| EUT Description:                          | GPRS Class 12                 |                    |                 |                         |           |         |
| Key Feature(s)                            | Hotspot Support               |                    |                 |                         |           |         |

\* **Note:** BT Body-worn SAR value is estimate SAR value that should not be reported standalone SAR on grants of equipment approval.

## 4. DESCRIPTION OF TEST EQUIPMENT

### 4.1 SAR MEASUREMENT SETUP

These measurements are performed using the DASY4 automated dosimetric assessment system. It is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland. It consists of high precision robotics system (Staubli), robot controller, Pentium III computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Figure.2).

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The PC consists of the HP Pentium IV 3.0 GHz computer with Windows XP system and SAR Measurement Software DASY4, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

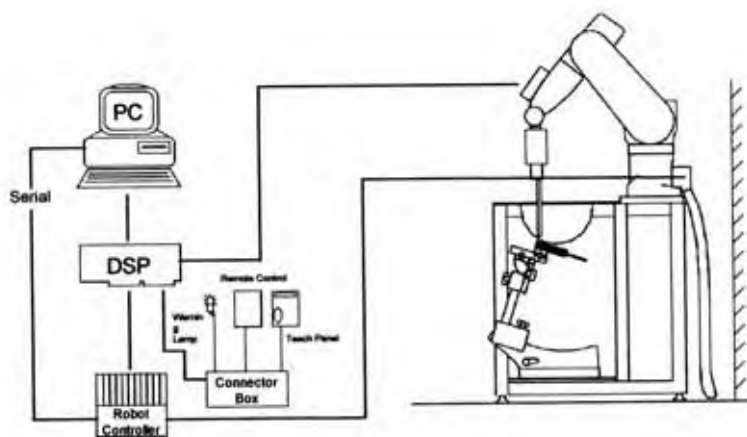


Figure 2. HCT SAR Lab. Test Measurement Set-up

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in.

## 4.2 DASY E-FIELD PROBE SYSTEM

### 4.2.1 ET3DV6 Probe Specification

|                      |                                                                                                                                                  |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction         | Symmetrical design with triangular core<br>Built-in optical fiber for surface detection System<br>Built-in shielding against static charges      |
| Calibration          | In air from 10 MHz to 2.5 GHz<br>In brain and muscle simulating tissue at<br>Frequencies of 450 MHz, 900 MHz and<br>1.8 GHz (accuracy: 8 %)      |
| Frequency            | 10 MHz to > 3 GHz; Linearity: $\pm 0.2$ dB<br>(30 MHz to 3 GHz)                                                                                  |
| Directivity          | $\pm 0.2$ dB in brain tissue (rotation around probe axis)<br>$\pm 0.4$ dB in brain tissue (rotation normal probe axis)                           |
| Dynamic              | 5 $\mu$ W/g to > 100 mW/g;                                                                                                                       |
| Range Linearity:     | $\pm 0.2$ dB                                                                                                                                     |
| Surface<br>Detection | $\pm 0.2$ mm repeatability in air and clear liquids<br>over diffuse reflecting surfaces.                                                         |
| Dimensions           | Overall length: 330 mm<br>Tip length: 16 mm<br>Body diameter: 12 mm<br>Tip diameter: 6.8 mm<br>Distance from probe tip to dipole centers: 2.7 mm |
| Application          | General dissymmetry up to 3 GHz<br>Compliance tests of WCDMA/LTE Phones<br>Fast automatic scanning in arbitrary phantoms                         |



Figure 3. Photograph of the probe and the Phantom

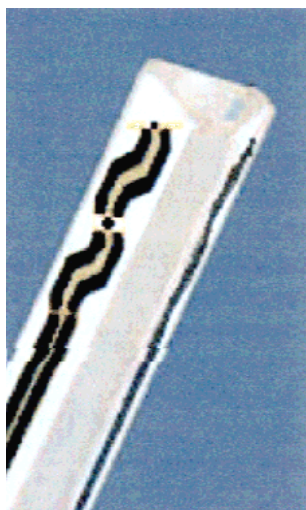


Figure 4. ET3DV6 E-field Probe

The SAR measurements were conducted with the dosimetric probe ET3DV6, designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches a maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2<sup>nd</sup> order fitting. The approach is stopped at reaching the maximum.

## 4.2.2 EX3DV4 Probe Specification

|               |                                                                                                                                                                                 |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction  | Symmetrical design with triangular core Interleaved sensors<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| Calibration   | Basic Broad Band Calibration in air<br>Conversion Factors (CF) for HSL 900 and HSL 1810<br>Additional CF for other liquids and frequencies upon request                         |
| Frequency     | 10 MHz to 4 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 4 GHz)                                                                                                                      |
| Directivity   | $\pm 0.2$ dB in HSL (rotation around probe axis)<br>$\pm 0.3$ dB in tissue material (rotation normal to probe axis)                                                             |
| Dynamic Range | 5 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB                                                                                                                              |
| Dimensions    | Overall length: 330 mm (Tip: 20 mm)<br>Tip diameter: 3.9 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.0 mm                                                  |
| Application   | General dosimetry up to 4 GHz<br>Dosimetry in strong gradient fields<br>Compliance tests of mobile phones                                                                       |



Figure 5. Photograph of the probe and the Phantom



Figure 6. EX3DV4 E-field Probe

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches a maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2<sup>nd</sup> order fitting. The approach is stopped at reaching the maximum.

## 4.3 PROBE CALIBRATION PROCESS

### 4.3.1 E-Probe Calibration

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

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

where:

$\Delta t$  = exposure time (30 seconds),

$C$  = heat capacity of tissue (brain or muscle),

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

SAR is proportional to  $\Delta T/\Delta t$ , the initial rate of tissue heating, before thermal diffusion takes place.

Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E-field;

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

where:

$\sigma$  = simulated tissue conductivity,

$\rho$  = Tissue density ( $1.25 \text{ g/cm}^3$  for brain tissue)

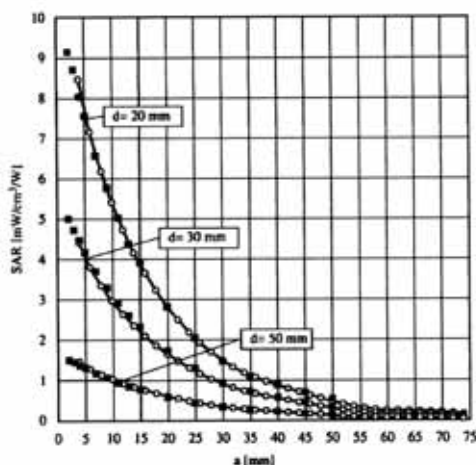


Figure 7. E-Field and Temperature measurements at 900 MHz

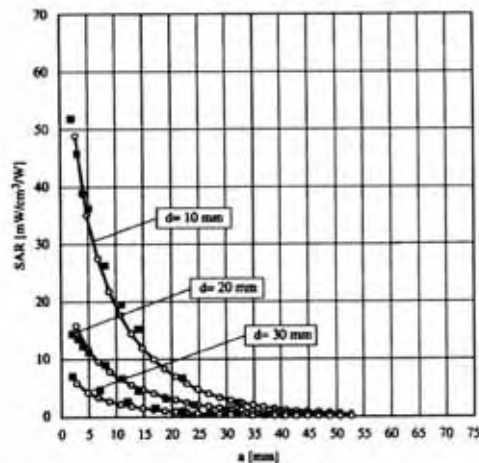


Figure 8. E-Field and temperature measurements at 1.8 GHz

### 4.3.2 Data Extrapolation

The DASY4 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given like below;

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i} \quad \text{with} \quad \begin{array}{ll} V_i & = \text{compensated signal of channel } i \quad (i=x,y,z) \\ U_i & = \text{input signal of channel } i \quad (i=x,y,z) \\ cf & = \text{crest factor of exciting field} \quad (\text{DASY parameter}) \\ dcp_i & = \text{diode compression poing} \quad (\text{DASY parameter}) \end{array}$$

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

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}} \quad \text{with} \quad \begin{array}{ll} V_i & = \text{compensated signal of channel } i \quad (i=x,y,z) \\ Norm_i & = \text{sensor sensitivity of channel } i \quad (i=x,y,z) \\ & \quad \mu V/(V/m)^2 \text{ for E-field probes} \\ ConvF & = \text{sensitivity of enhancement in solution} \\ E_i & = \text{electric field strength of channel } i \text{ in } V/m \end{array}$$

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

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

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000} \quad \text{with} \quad \begin{array}{ll} SAR & = \text{local specific absorption rate in } W/g \\ E_{tot} & = \text{total field strength in } V/m \\ \sigma & = \text{conductivity in } [mho/m] \text{ or } [Siemens/m] \\ \rho & = \text{equivalent tissue density in } g/cm^3 \end{array}$$

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

$$P_{pwe} = \frac{E_{tot}^2}{3770} \quad \text{with} \quad \begin{array}{ll} P_{pwe} & = \text{equivalent power density of a plane wave in } w/cm^2 \\ E_{tot} & = \text{total electric field strength in } V/m \end{array}$$

## 4.4 SAM Phantom

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.



Figure 9. SAM Phantom

|                 |                                                   |
|-----------------|---------------------------------------------------|
| Shell Thickness | 2.0 mm $\pm$ 0.2 mm (6 $\pm$ 0.2 mm at ear point) |
| Filling Volume  | about 25 L                                        |
| Dimensions      | 810 mm x 1 000 mm x 500 mm (H x L x W)            |

Triple Modular Phantom consists of three identical modules which can be installed and removed separately without emptying the liquid. It includes three reference points for phantom installation. Covers prevent evaporation of the liquid. Phantom material is resistant to DGBE based tissue simulating liquids. The MFP V5.1 will be delivered including wooden support only (non-standard SPEAG support).

Applicable for system performance check from 700 MHz to 6 GHz (MFP V5.1C) or 800 MHz - 6 GHz (MFP V5.1A) as well as dosimetric evaluations for body-worn operation.

|                 |                         |
|-----------------|-------------------------|
| Shell Thickness | 2.0 mm $\pm$ 0.2 mm     |
| Filling Volume  | approx. 9.2 L           |
| Dimensions      | 830 mm x 500 mm (L x W) |



Figure 10. MFP V5.1 Triple Modular Phantom

## 4.5 Device Holder for Transmitters

In combination with the SAM Phantom V 4.0, the Mounting Device (POM) enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatably positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produced infinite number of configurations. To produce the Worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.



Figure 11. Device Holder

## 4.6 Brain & Muscle Simulating Mixture Characterization

The brain and muscle mixtures consist of a viscous gel using hydrox-ethyl cellulose (HEC) gelling agent and saline solution (see Table 3.1). Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Hartsgrave.

| Ingredients<br>(% by weight)  | Frequency (MHz) |       |       |       |               |      |               |       |
|-------------------------------|-----------------|-------|-------|-------|---------------|------|---------------|-------|
|                               | 835             |       | 1 900 |       | 2 450 – 2 700 |      | 5 200 - 5 800 |       |
| Tissue Type                   | Head            | Body  | Head  | Body  | Head          | Body | Head          | Body  |
| Water                         | 40.45           | 53.06 | 54.9  | 70.17 | 71.88         | 73.2 | 65.52         | 78.66 |
| Salt (NaCl)                   | 1.45            | 0.94  | 0.18  | 0.39  | 0.16          | 0.1  | 0.0           | 0.0   |
| Sugar                         | 57.0            | 44.9  | 0.0   | 0     | 0.0           | 0.0  | 0.0           | 0.0   |
| HEC                           | 1.0             | 1.0   | 0.0   | 0     | 0.0           | 0.0  | 0.0           | 0.0   |
| Bactericide                   | 0.1             | 0.1   | 0.0   | 0     | 0.0           | 0.0  | 0.0           | 0.0   |
| Triton X-100                  | 0.0             | 0.0   | 0.0   | 0.0   | 19.97         | 0.0  | 17.24         | 10.67 |
| DGBE                          | 0.0             | 0.0   | 44.92 | 29.44 | 7.99          | 26.7 | 0.0           | 0.0   |
| Diethylene glycol hexyl ether | -               | -     | -     | -     | -             | -    | 17.24         | 10.67 |

|                           |                                                                    |        |                        |
|---------------------------|--------------------------------------------------------------------|--------|------------------------|
| Salt:                     | 99 % Pure Sodium Chloride                                          | Sugar: | 98 % Pure Sucrose      |
| Water:                    | De-ionized, 16M resistivity                                        | HEC:   | Hydroxyethyl Cellulose |
| DGBE:                     | 99 % Di(ethylene glycol) butyl ether,[2-(2-butoxyethoxy) ethanol]  |        |                        |
| Triton X-100(ultra pure): | Polyethylene glycol mono[4-(1,1,3,3-tetramethylbutyl)phenyl] ether |        |                        |

**Table 3.1 Composition of the Tissue Equivalent Matter**

## 4.7 SAR TEST EQUIPMENT

| Manufacturer    | Type / Model                  | S/N             | Calib. Date   | Calib. Interval | Calib. Due    |
|-----------------|-------------------------------|-----------------|---------------|-----------------|---------------|
| SPEAG           | SAM Phantom                   | -               | N/A           | N/A             | N/A           |
| SPEAG           | Triple Modular Phantom        | -               | N/A           | N/A             | N/A           |
| Staubli         | Robot TX60 Lspeag             | F10/5D1CA1/A/01 | N/A           | N/A             | N/A           |
| Staubli         | Robot ControllerCS7MB         | F10/5D1CA1/C/01 | N/A           | N/A             | N/A           |
| HP              | Pavilion t000_puffer          | KRJ51201TV      | N/A           | N/A             | N/A           |
| SPEAG           | Light Alignment Sensor        | SE UKS 030 AA   | N/A           | N/A             | N/A           |
| Staubli         | Teach Pendant (Joystick)      | D21142106       | N/A           | N/A             | N/A           |
| SPEAG           | D4E4                          | 1417            | Jan. 13, 2014 | Annual          | Jan. 13, 2015 |
| SPEAG           | D4E4                          | 869             | Sep. 30, 2013 | Annual          | Sep. 30, 2014 |
| SPEAG           | E-Field Probe EX3DV4          | 3968            | Jan. 08, 2014 | Annual          | Jan. 08, 2015 |
| SPEAG           | E-Field Probe EX3DV4          | 3863            | Jul. 31, 2013 | Annual          | Jul. 31, 2014 |
| SPEAG           | Dipole D835V2                 | 4d165           | Jan. 07, 2014 | Annual          | Jan. 07, 2015 |
| SPEAG           | Dipole D1900V2                | 5d032           | Jul. 29, 2013 | Annual          | Jul. 29, 2014 |
| SPEAG           | Dipole D2450V2                | 743             | Aug. 23, 2013 | Annual          | Aug. 23, 2014 |
| Agilent         | Power Meter(F) E4419B         | MY41291386      | Nov. 01, 2013 | Annual          | Nov. 01, 2014 |
| Agilent         | Power Sensor(G) 8481          | MY41090680      | Oct. 30, 2013 | Annual          | Oct. 30, 2014 |
| HP              | Dielectric Probe Kit 85070C   | 00721521        | CBT           |                 |               |
| HP              | Dual Directional Coupler 778D | 16072           | Oct. 31, 2013 | Annual          | Oct. 31, 2014 |
| Agilent         | Base Station E5515C           | GB44400269      | Feb. 10, 2014 | Annual          | Feb. 10, 2015 |
| HP              | Signal Generator 8664A        | 3744A02069      | Nov. 04, 2013 | Annual          | Nov. 04, 2014 |
| Hewlett Packard | 11636B/Power Divider          | 11377           | Nov. 10, 2013 | Annual          | Nov. 11, 2014 |
| Agilent         | N9020A/ SIGNAL ANALYZER       | MY50510407      | Mar. 25, 2014 | Annual          | Mar. 25, 2015 |
| TESCOM          | TC-3000C / BLUETOOTH          | 3000C000276     | Apr. 11, 2014 | Annual          | Apr. 11, 2015 |
| HP              | Network Analyzer 8753ES       | JP39240221      | Mar. 21, 2014 | Annual          | Mar. 21, 2015 |

### NOTE:

1. The E-field probe was calibrated by SPEAG, by the waveguide technique procedure. Dipole Verification measurement is performed by HCT Lab. before each test. The brain/body simulating material is calibrated by HCT using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain/body-equivalent material.

2. CBT(Calibrating Before Testing). Prior to testing, the dielectric probe kit was calibrated via the network analyzer, with the specified procedure(calibrated in pure water) and calibration kit(standard) short circuit, before the dielectric measurement. The specific procedure and calibration kit are provided by Agilent

## 5. SAR MEASUREMENT PROCEDURE

The evaluation was performed with the following procedure:

1. The SAR value at a fixed location above the ear point was measured and was used as a reference value for assessing the power drop.
2. The SAR distribution at the exposed side of the head was measured at a distance of 3.9 mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 15 mm x 15 mm. Based on this data, the area of the maximum absorption was determined by spline interpolation.
3. Around this point, a volume of 32 mm x 32 mm x 30 mm was assessed by measuring 5 x 5 x 7 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:
  - a. The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
  - b. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed using the 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 integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.
  - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR value, at the same location as procedure #1, was re-measured. If the value changed by more than 5 %, the evaluation is repeated.

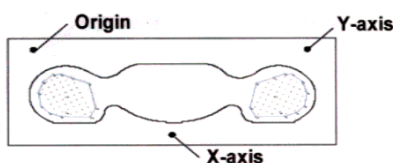


Figure 12. SAR Measurement Point in Area Scan

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extend, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SASR-distribution over 10g.

Area scan and zoom scan resolution setting follow KDB 865664 D01v01r03 quoted below.

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

## 6. DESCRIPTION OF TEST POSITION

### 6.1 HEAD POSITION

The device was placed in a normal operating position with the Point A on the device, as illustrated in following drawing, aligned with the location of the RE(ERP) on the phantom. With the ear-piece pressed against the head, the vertical center line of the body of the handset was aligned with an imaginary plane consisting of the RE, LE and M. While maintaining these alignments, the body of the handset was gradually moved towards the cheek until any point on the mouth-piece or keypad contacted the cheek. This is a cheek/touch position. For ear/tilt position, while maintain the device aligned with the BM and FN lines, the device was pivot against ERP back for 15° or until the device antenna touch the phantom. Please refer to IEEE 1528-2003 illustration below.

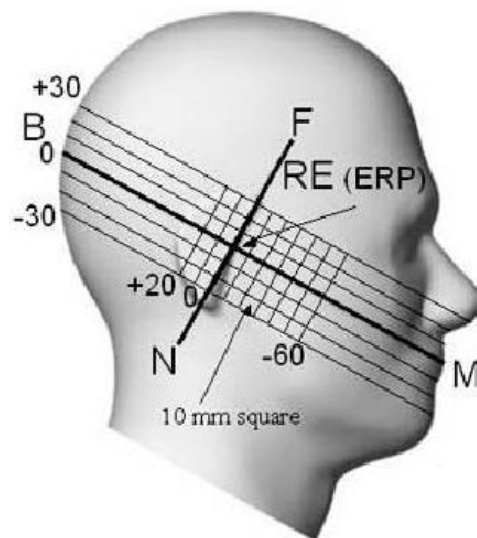


Figure 13. Side view of the phantom

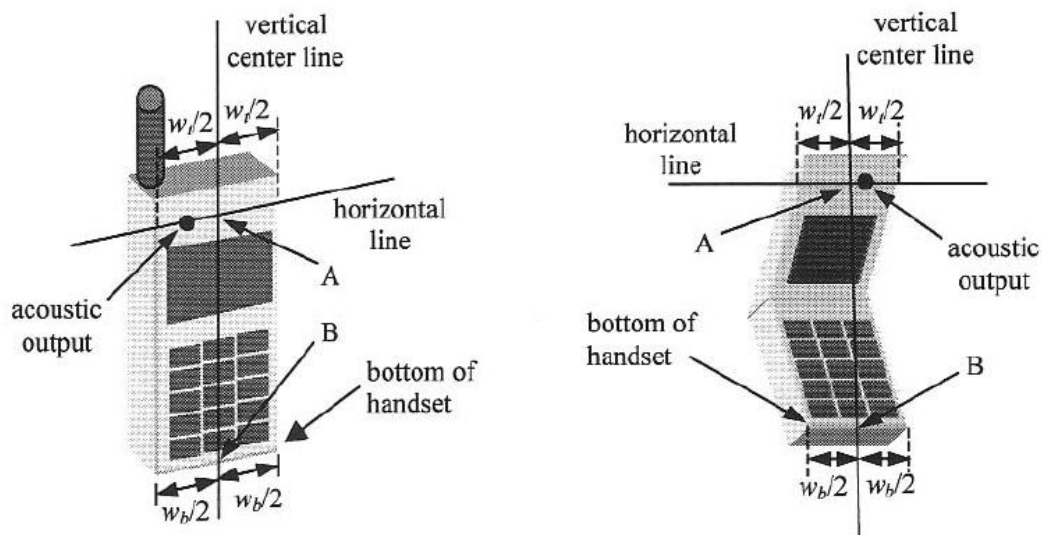


Figure 14. Handset vertical and horizontal reference lines

## **6.2 Body Holster/Belt Clip Configurations**

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. A device with a headset output is tested with a headset connected to the device. Body dielectric parameters are used.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are tested with each accessory. If multiple accessory share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some Devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used.

Since this EUT does not supply any body worn accessory to the end user a distance of 1.0 cm from the EUT back surface to the liquid interface is configured for the generic test.

"See the Test SET-UP Photo"

Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessory(ies), Including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

In all cases SAR measurements are performed to investigate the worst-case positioning. Worstcase positioning is then documented and used to perform Body SAR testing.

## 7. MEASUREMENT UNCERTAINTY

| Error Description                   | Tol<br>( $\pm$ %) | Prob.<br>dist. | Div. | $c_i$ | Standard<br>Uncertainty<br>( $\pm$ %) | $V_{eff}$ |
|-------------------------------------|-------------------|----------------|------|-------|---------------------------------------|-----------|
| <b>1. Measurement System</b>        |                   |                |      |       |                                       |           |
| Probe Calibration                   | 6.00              | N              | 1    | 1     | 6.00                                  | $\infty$  |
| Axial Isotropy                      | 4.70              | R              | 1.73 | 0.7   | 1.90                                  | $\infty$  |
| Hemispherical Isotropy              | 9.60              | R              | 1.73 | 0.7   | 3.88                                  | $\infty$  |
| Boundary Effects                    | 1.00              | R              | 1.73 | 1     | 0.58                                  | $\infty$  |
| Linearity                           | 4.70              | R              | 1.73 | 1     | 2.71                                  | $\infty$  |
| System Detection Limits             | 1.00              | R              | 1.73 | 1     | 0.58                                  | $\infty$  |
| Readout Electronics                 | 0.30              | N              | 1.00 | 1     | 0.30                                  | $\infty$  |
| Response Time                       | 0.8               | R              | 1.73 | 1     | 0.46                                  | $\infty$  |
| Integration Time                    | 2.6               | R              | 1.73 | 1     | 1.50                                  | $\infty$  |
| RF Ambient Conditions               | 3.00              | R              | 1.73 | 1     | 1.73                                  | $\infty$  |
| Probe Positioner                    | 0.40              | R              | 1.73 | 1     | 0.23                                  | $\infty$  |
| Probe Positioning                   | 2.90              | R              | 1.73 | 1     | 1.67                                  | $\infty$  |
| Max SAR Eval                        | 1.00              | R              | 1.73 | 1     | 0.58                                  | $\infty$  |
| <b>2. Test Sample Related</b>       |                   |                |      |       |                                       |           |
| Device Positioning                  | 2.90              | N              | 1.00 | 1     | 2.90                                  | 145       |
| Device Holder                       | 3.60              | N              | 1.00 | 1     | 3.60                                  | 5         |
| Power Drift                         | 5.00              | R              | 1.73 | 1     | 2.89                                  | $\infty$  |
| <b>3. Phantom and Setup</b>         |                   |                |      |       |                                       |           |
| Phantom Uncertainty                 | 4.00              | R              | 1.73 | 1     | 2.31                                  | $\infty$  |
| Liquid Conductivity(target)         | 5.00              | R              | 1.73 | 0.64  | 1.85                                  | $\infty$  |
| Liquid Conductivity(meas.)          | 2.07              | N              | 1    | 0.64  | 1.32                                  | 9         |
| Liquid Permittivity(target)         | 5.00              | R              | 1.73 | 0.6   | 1.73                                  | $\infty$  |
| Liquid Permittivity(meas.)          | 5.02              | N              | 1    | 0.6   | 3.01                                  | 9         |
| <b>Combine Standard Uncertainty</b> |                   |                |      |       | 11.13                                 |           |
| <b>Coverage Factor for 95 %</b>     |                   |                |      |       | $k=2$                                 |           |
| <b>Expanded STD Uncertainty</b>     |                   |                |      |       | 22.25                                 |           |

Table 7.1 Uncertainty (800 MHz- 2 450 MHz)

## 8. ANSI/ IEEE C95.1 - 1992 RF EXPOSURE LIMITS

| HUMAN EXPOSURE                                         | UNCONTROLLED ENVIRONMENT<br>General Population<br>(W/kg) or (mW/g) | CONTROLLED ENVIRONMENT<br>Occupational<br>(W/kg) or (mW/g) |
|--------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------------|
| SPATIAL PEAK SAR *<br>(Brain)                          | 1.60                                                               | 8.00                                                       |
| SPATIAL AVERAGE SAR **<br>(Whole Body)                 | 0.08                                                               | 0.40                                                       |
| SPATIAL PEAK SAR ***<br>(Hands / Feet / Ankle / Wrist) | 4.00                                                               | 20.00                                                      |

**Table 8.1 Safety Limits for Partial Body Exposure**

### NOTES:

\* The Spatial Peak value of the SAR averaged over any 1 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

\*\* The Spatial Average value of the SAR averaged over the whole-body.

\*\*\* The Spatial Peak value of the SAR averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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

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

## 9. SAR SYSTEM VALIDATION

Per FCC KCB 865664 D02v01r01, SAR system validation status should be document to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01v01r03. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

| SAR System # | Probe | Probe Type | Probe Calibration Point |      | Dipole | Date         | Dielectric Parameters |                       | CW Validation |                 |                | Modulation Validation |             |      |
|--------------|-------|------------|-------------------------|------|--------|--------------|-----------------------|-----------------------|---------------|-----------------|----------------|-----------------------|-------------|------|
|              |       |            |                         |      |        |              | Measured Permittivity | Measured Conductivity | Sensitivity   | Probe Linearity | Probe Isotropy | MOD. Type             | Duty Factor | PAR  |
| 1            | 3863  | EX3DV4     | Head                    | 835  | 4d165  | Jan. 16,2014 | 41.2                  | 0.91                  | PASS          | PASS            | PASS           | GMSK                  | PASS        | N/A  |
| 9            | 3968  | EX3DV4     | Body                    | 835  | 4d165  | Jan. 21,2014 | 55.1                  | 0.99                  | PASS          | PASS            | PASS           | GMSK                  | PASS        | N/A  |
| 1            | 3863  | EX3DV4     | Head                    | 1900 | 5d032  | Aug.07,2013  | 39.8                  | 1.4                   | PASS          | PASS            | PASS           | GMSK                  | PASS        | N/A  |
| 9            | 3968  | EX3DV4     | Body                    | 1900 | 5d032  | Jan. 23,2014 | 53.6                  | 1.53                  | PASS          | PASS            | PASS           | GMSK                  | PASS        | N/A  |
| 9            | 3968  | EX3DV4     | Head                    | 2450 | 743    | Jan. 22,2014 | 39.5                  | 1.79                  | PASS          | PASS            | PASS           | OFDM                  | N/A         | PASS |
| 9            | 3968  | EX3DV4     | Body                    | 2450 | 743    | Jan. 23,2014 | 53.2                  | 1.94                  | PASS          | PASS            | PASS           | OFDM                  | N/A         | PASS |

**Table 9.1 SAR System Validation Summary**

**Note;**

All measurement were performed using probes calibrated for CW signal only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01r03. SAR system were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664 D01v01r03.

## 10. SYSTEM VERIFICATION

### 10.1 Tissue Verification

| Freq.<br>[MHz] | Date             | Probe | Dipole | Liquid | Liquid<br>Temp<br>.[°C] | Parameters   | Target<br>Value | Measured<br>Value | Deviation<br>[%] | Limit<br>[%] |
|----------------|------------------|-------|--------|--------|-------------------------|--------------|-----------------|-------------------|------------------|--------------|
| 835            | May. 19,<br>2014 | 3863  | 4d165  | Head   | 21.0                    | $\epsilon_r$ | 41.5            | 42.014            | + 1.24           | ± 5          |
|                |                  |       |        |        |                         | $\sigma$     | 0.90            | 0.875             | - 2.78           | ± 5          |
| 835            | May. 21,<br>2014 | 3968  |        | Body   | 21.1                    | $\epsilon_r$ | 55.2            | 54.12             | - 1.96           | ± 5          |
|                |                  |       |        |        |                         | $\sigma$     | 0.97            | 0.983             | + 1.34           | ± 5          |
| 1 900          | May. 20,<br>2014 | 3863  | 5d032  | Head   | 20.3                    | $\epsilon_r$ | 40.0            | 38.883            | - 2.79           | ± 5          |
|                |                  |       |        |        |                         | $\sigma$     | 1.40            | 1.437             | + 2.64           | ± 5          |
| 1 900          | May. 21,<br>2014 | 3968  |        | Body   | 21.1                    | $\epsilon_r$ | 53.3            | 52.299            | - 1.88           | ± 5          |
|                |                  |       |        |        |                         | $\sigma$     | 1.52            | 1.504             | - 1.05           | ± 5          |
| 2 450          | May. 21,<br>2014 | 3968  | 743    | Head   | 21.1                    | $\epsilon_r$ | 39.2            | 40.26             | + 2.70           | ± 5          |
|                |                  |       |        |        |                         | $\sigma$     | 1.80            | 1.822             | + 1.22           | ± 5          |
| 2 450          | May. 15,<br>2014 | 3968  |        | Body   | 19.9                    | $\epsilon_r$ | 52.7            | 52.961            | + 0.50           | ± 5          |
|                |                  |       |        |        |                         | $\sigma$     | 1.95            | 1.985             | + 1.79           | ± 5          |

The Tissue dielectric parameters were measured prior to the SAR evaluation using an Agilent 85070C Dielectric Probe Kit and Agilent Network Analyzer.

### 10.2 System Verification

Prior to assessment, the system is verified to the  $\pm 10\%$  of the specifications at 850 MHz / 1 900 MHz / 2 450 MHz by using the system Verification kit. (Graphic Plots Attached)

| Freq. [MHz] | Date          | Probe (SN) | Dipole (SN) | Liquid | Amb. Temp. [°C] | Liquid Temp. [°C] | 1 W Target SAR <sub>1g</sub> (SPEAG) (mW/g) | Measured SAR <sub>1g</sub> (mW/g) | 1 W Normalized SAR <sub>1g</sub> (mW/g) | Deviation [%] | Limit [%] |
|-------------|---------------|------------|-------------|--------|-----------------|-------------------|---------------------------------------------|-----------------------------------|-----------------------------------------|---------------|-----------|
| 835         | May. 19, 2014 | 3863       | 4d165       | Head   | 21.2            | 21.0              | 9.24                                        | 0.948                             | 9.48                                    | + 2.60        | $\pm 10$  |
| 835         | May. 21, 2014 | 3968       |             | Body   | 21.3            | 21.1              | 9.58                                        | 0.979                             | 9.79                                    | + 2.19        | $\pm 10$  |
| 1 900       | May. 20, 2014 | 3863       | 5d032       | Head   | 20.5            | 20.3              | 40.1                                        | 3.94                              | 39.4                                    | - 1.75        | $\pm 10$  |
| 1 900       | May. 21, 2014 | 3968       |             | Body   | 21.3            | 21.1              | 40.5                                        | 3.98                              | 39.8                                    | - 1.73        | $\pm 10$  |
| 2 450       | May. 21, 2014 | 3968       | 743         | Head   | 21.3            | 21.1              | 52.8                                        | 5.46                              | 54.6                                    | + 3.41        | $\pm 10$  |
| 2 450       | May. 15, 2014 | 3968       |             | Body   | 20.1            | 19.9              | 50.5                                        | 5.1                               | 51                                      | + 0.99        | $\pm 10$  |

## **10.3 System Verification Procedure**

SAR measurement was prior to assessment, the system is verified to the  $\pm 10\%$  of the specifications at each frequency band by using the system Verification kit. (Graphic Plots Attached)

- Cabling the system, using the Verification kit equipments.
- Generate about 100 mW Input Level from the Signal generator to the Dipole Antenna.
- Dipole Antenna was placed below the Flat phantom.
- The measured one-gram SAR at the surface of the phantom above the dipole feed-point should be within 10 % of the target reference value.
- The results are normalized to 1 W input power.

NOTE;

SAR Verification was performed according to the FCC KDB D01v01r03.

## 11. RF CONDUCTED POWER MEASUREMENT

Power measurements were performed using a base station simulator under digital average power. The handset was placed into a simulated call using a base station simulator in a shielded chamber. Such test signals offer a consistent means for testing SAR and are recommended for evaluation SAR. SAR measurements were taken with a fully charged battery. In order to verify that the device was tested and maintained at full power, this was configured with the base station simulator. The SAR measurement Software calculates a reference point at the start and end of the test to check for power drifts. If conducted Power deviations of more than 5 % occurred, the tests were repeated.

### 11.1 Output Power Specifications.

This device operates using the following maximum output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB publication 447498 D01v05r02.

#### GSM

| GSM850                               | GSM1900                 |
|--------------------------------------|-------------------------|
| Target Power : 32.0 dBm              | Target Power : 28.8 dBm |
| GPRS850                              | PCS1900                 |
| GPRS 1tx : 32.0 dBm                  | GPRS 1tx : 28.8 dBm     |
| GPRS 2tx : 29.7 dBm                  | GPRS 2tx : 27.0 dBm     |
| GPRS 3tx : 27.9 dBm                  | GPRS 3tx : 25.2 dBm     |
| GPRS 4tx : 26.7 dBm                  | GPRS 4tx : 24.0 dBm     |
| Tune-up Tolerance : -1.5 dB/ +0.5 dB |                         |

#### Wifi

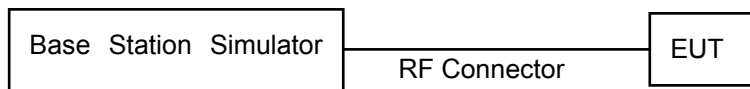
| Mode / Band                          | IEEE 802.11 (in dBm) |    |    |    |     |
|--------------------------------------|----------------------|----|----|----|-----|
|                                      | a                    | b  | g  | N  | ac  |
| 2.4 GHz WIFI                         | N/A                  | 16 | 13 | 12 | N/A |
| Tune-up Tolerance : -1.5 dB/ +0.5 dB |                      |    |    |    |     |

#### BT.

| Bluetooth (in dBm)                   | Target power(dBm)    |      |
|--------------------------------------|----------------------|------|
|                                      | GFSK(DH5)            | 11.5 |
|                                      | $\pi/4$ DQPSK(2-DH5) | 9.5  |
|                                      | 8DPSK(3-DH5)         | 9.5  |
|                                      | Bluetooth LE         | 8    |
| Tune-up Tolerance : -1.5 dB/ +0.5 dB |                      |      |

## 11.2 GSM

Conducted output power measurements were performed using a base station simulator under digital average power.



SAR Test for WWAN were performed with a base station simulator Agilent E5515C. Communication between the device and the emulator was established by air link. Set base station emulator to allow DUT to radiate maximum output power during all tests. Please refer to the below worst case SAR operation setup.

- GSM voice: Head SAR, Body SAR
- GPRS Multi-slots : Hotspot Body SAR with GPRS Multi-slot Class12 with CS 1 (GMSK)

### Note;

CS1/MCS7 coding scheme was used in GPRS output power measurements and SAR Testing, as a condition where GMSK modulation was ensured. Investigation has shown that CS1 - CS4 settings do not have any impact on the output levels in the GPRS modes.

GSM Conducted output powers (Burst-Average)

| Band     | Channel | Voice     | GPRS(GMSK) Data – CS1 |                      |                      |                      |
|----------|---------|-----------|-----------------------|----------------------|----------------------|----------------------|
|          |         | GSM (dBm) | GPRS 1 TX Slot (dBm)  | GPRS 2 TX Slot (dBm) | GPRS 3 TX Slot (dBm) | GPRS 4 TX Slot (dBm) |
| GSM 850  | 128     | 31.84     | 31.84                 | 28.40                | 26.56                | 25.50                |
|          | 190     | 31.85     | 31.84                 | 28.39                | 26.55                | 25.49                |
|          | 251     | 31.85     | 31.85                 | 28.37                | 26.53                | 25.47                |
| GSM 1900 | 512     | 29.10     | 29.07                 | 26.34                | 24.60                | 23.38                |
|          | 661     | 29.11     | 29.09                 | 26.34                | 24.61                | 23.39                |
|          | 810     | 29.11     | 29.08                 | 26.32                | 24.59                | 23.38                |

GSM Conducted output powers (Frame-Average)

| Band     | Channel | Voice     | GPRS(GMSK) Data – CS1 |                      |                      |                      |
|----------|---------|-----------|-----------------------|----------------------|----------------------|----------------------|
|          |         | GSM (dBm) | GPRS 1 TX Slot (dBm)  | GPRS 2 TX Slot (dBm) | GPRS 3 TX Slot (dBm) | GPRS 4 TX Slot (dBm) |
| GSM 850  | 128     | 22.81     | 22.81                 | 22.38                | 22.30                | 22.49                |
|          | 190     | 22.82     | 22.81                 | 22.37                | 22.29                | 22.48                |
|          | 251     | 22.82     | 22.82                 | 22.35                | 22.27                | 22.46                |
| GSM 1900 | 512     | 20.07     | 20.04                 | 20.32                | 20.34                | 20.37                |
|          | 661     | 20.08     | 20.06                 | 20.32                | 20.35                | 20.38                |
|          | 810     | 20.08     | 20.05                 | 20.30                | 20.33                | 20.37                |

### Note:

Time slot average factor is as follows:

1 Tx slot = 9.03 dB, Frame-Average output power = Burst-Average output power – 9.03 dB

2 Tx slot = 6.02 dB, Frame-Average output power = Burst-Average output power – 6.02 dB

3 Tx slot = 4.26 dB, Frame-Average output power = Burst-Average output power – 4.26 dB

4 Tx slot = 3.01 dB, Frame-Average output power = Burst-Average output power – 3.01 dB

## 11.3 WiFi

### 11.3.1 SAR Testing for 802.11b/g/n modes

#### General Device Setup

Normal Network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

#### Frequency Channel Configurations

802.11 a/b/g and 4.9 GHz operating modes are tested independently according to the service requirements in each frequency band. 802.11 b/g modes are tested on channels 1, 6 and 11. 802.11a is tested for UNII operations on channels 36 and 48 in the 5.15-5.25 GHz band; channels 52 and 64 in the 5.25-5.35 GHz band; Channels 104, 116, 124 and 136 in the 5.470-5.725 GHz band; and channels 149 and 161 in the 5.8 GHz band. When 5.8 GHz § 15.247 is also available, channels 149, 157 and 165 should be tested instead of the UNII channels. 4.9 GHz is tested on channels 1, 10 and 5 or 6, whichever has the higher output power, for 5 MHz channels; channels 11, 15 and 19 for 10 MHz channels; and channels 21 and 25 for 20 MHz channels.

These are referred to as the “default test channels”. 802.11g mode was evaluated only if the output power was 0.25 dB higher than the 802.11b mode.

| Mode      | GHz   | Channel | Turbo Channel  | “Default Test Channels” |         |      |   |
|-----------|-------|---------|----------------|-------------------------|---------|------|---|
|           |       |         |                | §15.247                 |         | UNII |   |
|           |       |         |                | 802.11b                 | 802.11g |      |   |
| 802.11b/g | 2.412 | 1#      |                | √                       | √       |      |   |
|           | 2.437 | 6       | 6              | √                       | √       |      |   |
|           | 2.462 | 11#     |                | √                       | √       |      |   |
| 802.11a   | 5.18  | 36      |                |                         |         | √    |   |
|           | 5.20  | 40      | 42 (5.21 GHz)  |                         |         |      | * |
|           | 5.22  | 44      |                |                         |         |      | * |
|           | 5.24  | 48      | 50 (5.25 GHz)  |                         |         | √    |   |
|           | 5.26  | 52      |                |                         |         | √    |   |
|           | 5.28  | 56      | 58 (5.29 GHz)  |                         |         |      | * |
|           | 5.30  | 60      |                |                         |         |      | * |
|           | 5.32  | 64      |                |                         |         | √    |   |
|           | 5.500 | 100     | Unknown        |                         |         |      | * |
|           | 5.520 | 104     |                |                         |         | √    |   |
|           | 5.540 | 108     |                |                         |         |      | * |
|           | 5.560 | 112     |                |                         |         |      | * |
|           | 5.580 | 116     |                |                         |         | √    |   |
|           | 5.600 | 120     |                |                         |         |      | * |
|           | 5.620 | 124     |                |                         |         | √    |   |
|           | 5.640 | 128     |                |                         |         |      | * |
|           | 5.660 | 132     |                |                         |         |      | * |
|           | 5.680 | 136     |                |                         |         | √    |   |
|           | 5.700 | 140     |                |                         |         |      | * |
|           | 5.745 | 149     |                | √                       |         | √    |   |
|           | 5.765 | 153     | 152 (5.76 GHz) |                         | *       |      | * |
|           | 5.785 | 157     |                | √                       |         |      | * |
|           | 5.805 | 161     | 160 (5.80 GHz) |                         | *       | √    |   |
|           | 5.825 | 165     |                | √                       |         |      |   |

802.11 Test Channels per FCC Requirements

# TEST RESULTS-Average

## IEEE 802.11b Average RF Power

| Mode    | Freq.<br>[MHz] | Channel | 802.11b (2.4 GHz) Conducted Power [dBm] |       |       |       |
|---------|----------------|---------|-----------------------------------------|-------|-------|-------|
|         |                |         | Data Rate (Mbps)                        |       |       |       |
|         |                |         | 1                                       | 2     | 5.5   | 11    |
| 802.11b | 2412           | 1       | 15.56                                   | 15.80 | 15.75 | 15.73 |
|         | 2437           | 6       | 15.82                                   | 15.89 | 15.99 | 15.88 |
|         | 2462           | 11      | 15.88                                   | 16.02 | 16.06 | 16.09 |

## IEEE 802.11g Average RF Power

| Mode    | Freq.<br>[MHz] | Channel | 802.11g (2.4 GHz) Conducted Power [dBm] |       |       |       |       |       |       |       |
|---------|----------------|---------|-----------------------------------------|-------|-------|-------|-------|-------|-------|-------|
|         |                |         | Data Rate (Mbps)                        |       |       |       |       |       |       |       |
|         |                |         | 6                                       | 9     | 12    | 18    | 24    | 36    | 48    | 54    |
| 802.11g | 2412           | 1       | 13.93                                   | 14.01 | 13.91 | 13.99 | 14.12 | 14.01 | 13.96 | 13.96 |
|         | 2437           | 6       | 13.94                                   | 13.99 | 13.95 | 14.04 | 14.09 | 14.08 | 14.07 | 14.00 |
|         | 2462           | 11      | 14.08                                   | 14.06 | 14.18 | 14.04 | 14.22 | 14.14 | 14.11 | 14.15 |

## IEEE 802.11n Average RF Power

| Mode    | Freq.<br>[MHz] | Channel | 802.11n (2.4 GHz) Conducted Power [dBm] |       |       |       |       |       |       |       |
|---------|----------------|---------|-----------------------------------------|-------|-------|-------|-------|-------|-------|-------|
|         |                |         | Data Rate (Mbps)                        |       |       |       |       |       |       |       |
|         |                |         | 6.5                                     | 13    | 19.5  | 26    | 39    | 52    | 58.5  | 65    |
| 802.11n | 2412           | 1       | 11.88                                   | 12.09 | 11.92 | 11.89 | 12.10 | 11.97 | 12.12 | 12.00 |
|         | 2437           | 6       | 12.13                                   | 12.09 | 11.87 | 12.15 | 12.22 | 12.09 | 12.16 | 12.08 |
|         | 2462           | 11      | 12.18                                   | 12.22 | 12.12 | 12.27 | 12.28 | 12.23 | 12.23 | 12.17 |

## 11.4 SAR Test Exclusions Applied

### 11.4.1 BT

Per FCC KDB 447498 D01v05r02, The SAR exclusion threshold for distance < 50mm is defined by the following equation:

$$\frac{\text{Max Power of Channel(mW)}}{\text{Test Separation Distance (mm)}} * \sqrt{\text{Frequency(GHz)}} \leq 3.0$$

| . Mode    | Frequency | Maximum Allowed Power | Separatuin Distance | ≤ 3.0 |
|-----------|-----------|-----------------------|---------------------|-------|
|           | [MHz]     | [mW]                  | [mm]                |       |
| Bluetooth | 2441      | 16                    | 10                  | 2.50  |

Based on the maximum conducted power of Bluetooth and antenna to use separation distance, Bluetooth SAR was not required  $[(16/10)*\sqrt{2.441}] = 2.50 < 3.0$ .

this device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v05r02 IV.C.1iii, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤ 1.6W/kg. When standalone SAR is not required to be measured per FCC KDB 447498 D01v05r02 4.3.22, the following equation must be used to estimate the standalone 1-g SAR for simultaneous transmission assessment involving that transmitter

$$\text{Estimated SAR} = \frac{\sqrt{f(\text{GHZ})}}{7.5} * \frac{(\text{Max Power of channel mW})}{\text{Min Seperation Distance}}$$

| . Mode    | Frequency | Maximum Allowed Power | Separatuin Distance (Body) | Estimated SAR (Body) |
|-----------|-----------|-----------------------|----------------------------|----------------------|
|           | [MHz]     | [mW]                  | [mm]                       | [W/kg]               |
| Bluetooth | 2441      | 16                    | 10                         | 0.33                 |

**Note :** Held-to ear configurations are not applicable to Bluetooth operations and therefore were not considered for simultaneous transmission. The Estimated SAR results were determined according to FCC KDB447498 D01v05r02

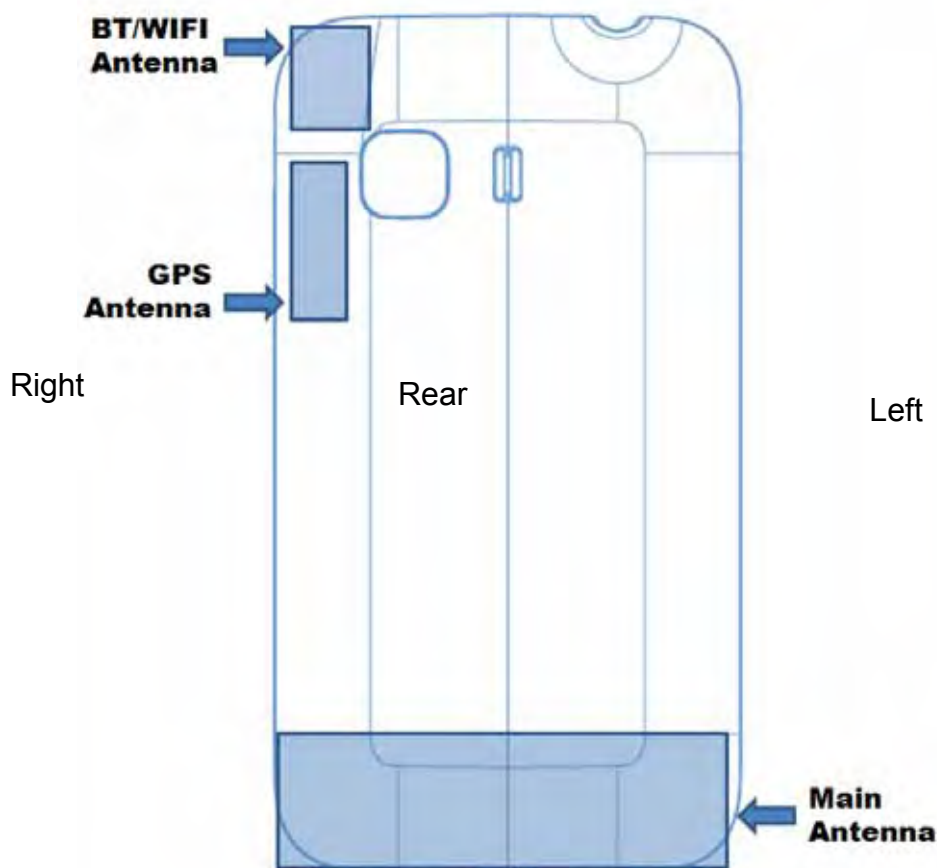
**Note:** Bluetooth LE conducted Power is not calculated on the SAR test exclusions table. Because Bluetooth LE conducted power is lower than Bluetooth conducted Power.

## 12. SAR Test configuration & Antenna Information

| Mode         | Back | Front | Left | Right | Bottom | Top |
|--------------|------|-------|------|-------|--------|-----|
| GSM850       | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| GSM1900      | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| 2.4 GHz WLAN | Yes  | Yes   | No   | Yes   | No     | Yes |

**Note;** All test configurations are based on front view.

### 12.1 Antenna and Device Information



※ Please see SM-G130H/DS\_ A3LSMG130H\_ Antenna location file for further information.

## 13. SAR TEST DATA SUMMARY

### 13.1-1 Measurement Results (GSM850 Head SAR)

| Frequency                                                                                          |     | Mode     | Power (dBm)   |                 | Power Drift (dB) | Battery  | Phantom Position                                | Measured SAR(mW/g) | Scaling Factor | Scaled SAR(mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|----------|---------------|-----------------|------------------|----------|-------------------------------------------------|--------------------|----------------|------------------|----------|
| MHz                                                                                                | Ch. |          | Tune-Up Limit | Conducted Power |                  |          |                                                 |                    |                |                  |          |
| 836.6                                                                                              | 190 | GSM850   | 32.5          | 31.85           | 0.10             | Standard | Left Ear                                        | 0.444              | 1.161          | 0.516            | 1        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.85           | 0.06             | Standard | Left Tilt                                       | 0.241              | 1.161          | 0.280            | -        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.85           | -0.01            | Standard | Right Ear                                       | 0.409              | 1.161          | 0.475            | -        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.85           | -0.01            | Standard | Right Tilt                                      | 0.226              | 1.161          | 0.262            | -        |
| 836.6                                                                                              | 190 | GPRS 1Tx | 32.5          | 31.84           | 0.10             | Standard | Left Ear                                        | 0.390              | 1.164          | 0.454            | -        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.84           | -0.13            | Standard | Left Tilt                                       | 0.238              | 1.164          | 0.277            | -        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.84           | -0.16            | Standard | Right Ear                                       | 0.377              | 1.164          | 0.439            | -        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.84           | -0.01            | Standard | Right Tilt                                      | 0.217              | 1.164          | 0.253            | -        |
| ANSI/ IEEE C95.1 - 1992– Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |          |               |                 |                  |          | Head<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram |                    |                |                  |          |

### 13.1-2 Measurement Results (GSM1900 Head SAR)

| Frequency                                                                                          |     | Mode     | Power (dBm)   |                 | Power Drift (dB) | Battery  | Phantom Position                                | Measured SAR (mW/g) | Scaling Factor | Scaled SAR (mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|----------|---------------|-----------------|------------------|----------|-------------------------------------------------|---------------------|----------------|-------------------|----------|
| MHz                                                                                                | Ch. |          | Tune-Up Limit | Conducted Power |                  |          |                                                 |                     |                |                   |          |
| 1 880.0                                                                                            | 661 | GSM1900  | 29.3          | 29.11           | -0.18            | Standard | Left Ear                                        | 0.392               | 1.045          | 0.410             | -        |
| 1 880.0                                                                                            | 661 |          | 29.3          | 29.11           | 0.08             | Standard | Left Tilt                                       | 0.243               | 1.045          | 0.254             | -        |
| 1 880.0                                                                                            | 661 |          | 29.3          | 29.11           | 0.14             | Standard | Right Ear                                       | 0.696               | 1.045          | 0.727             | 2        |
| 1 880.0                                                                                            | 661 |          | 29.3          | 29.11           | -0.03            | Standard | Right Tilt                                      | 0.209               | 1.045          | 0.218             | -        |
| 1 880.0                                                                                            | 661 | GPRS 4Tx | 24.5          | 23.39           | -0.11            | Standard | Left Ear                                        | 0.344               | 1.291          | 0.444             | -        |
| 1 880.0                                                                                            | 661 |          | 24.5          | 23.39           | 0.10             | Standard | Left Tilt                                       | 0.226               | 1.291          | 0.292             | -        |
| 1 850.2                                                                                            | 512 |          | 24.5          | 23.38           | -0.15            | Standard | Right Ear                                       | 0.644               | 1.294          | 0.833             |          |
| 1 880.0                                                                                            | 661 |          | 24.5          | 23.39           | -0.02            | Standard | Right Ear                                       | 0.668               | 1.291          | <b>0.863</b>      | -        |
| 1 909.8                                                                                            | 810 |          | 24.5          | 23.38           | 0.08             | Standard | Right Ear                                       | 0.653               | 1.294          | 0.845             |          |
| 1 880.0                                                                                            | 661 |          | 24.5          | 23.39           | -0.02            | Standard | Right Tilt                                      | 0.194               | 1.291          | 0.250             | -        |
| ANSI/ IEEE C95.1 - 1992– Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |          |               |                 |                  |          | Head<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram |                     |                |                   |          |

### 13.1-3 Measurement Results (DTS Head SAR)

| Frequency                                                                                          |     | Mode     | Power (dBm)   |                 | Power Drift (dB) | Battery  | Phantom Position                                | Data Rate | Measured SAR (mW/g) | Scaling Factor | Scaled SAR (mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|----------|---------------|-----------------|------------------|----------|-------------------------------------------------|-----------|---------------------|----------------|-------------------|----------|
| MHz                                                                                                | Ch. |          | Tune-Up Limit | Conducted Power |                  |          |                                                 |           |                     |                |                   |          |
| 2462                                                                                               | 11  | 802.11 b | 16.5          | 15.88           | -0.08            | Standard | Left Ear                                        | 1Mbps     | 0.019               | 1.153          | 0.022             | 3        |
|                                                                                                    |     |          | 16.5          | 15.88           | -0.02            | Standard | Left Tilt                                       | 1Mbps     | 0.0091              | 1.153          | 0.010             | -        |
|                                                                                                    |     |          | 16.5          | 15.88           | 0.01             | Standard | Right Ear                                       | 1Mbps     | 0.00867             | 1.153          | 0.010             | -        |
|                                                                                                    |     |          | 16.5          | 15.88           | 0.08             | Standard | Right Tilt                                      | 1Mbps     | 0.000186            | 1.153          | 0.000             | -        |
| ANSI/ IEEE C95.1 - 1992– Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |          |               |                 |                  |          | Head<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram |           |                     |                |                   |          |

### 13.2-1 Measurement Results (GSM850 Hotspot SAR)

| Frequency                                                                                          |     | Mode     | Power (dBm)   |                 | Power Drift (dB) | Configuration | Separation Distance                             | Measured SAR(mW/g) | Scaling Factor | Scaled SAR(mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|----------|---------------|-----------------|------------------|---------------|-------------------------------------------------|--------------------|----------------|------------------|----------|
| MHz                                                                                                | Ch. |          | Tune-Up Limit | Conducted Power |                  |               |                                                 |                    |                |                  |          |
| 836.6                                                                                              | 190 | GPRS 1Tx | 32.5          | 31.84           | -0.03            | Rear          | 1.0 cm                                          | 0.484              | 1.164          | 0.563            | 4        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.84           | -0.07            | Front         | 1.0 cm                                          | 0.392              | 1.164          | 0.456            | -        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.84           | -0.02            | Left          | 1.0 cm                                          | 0.276              | 1.164          | 0.321            | -        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.84           | -0.04            | Right         | 1.0 cm                                          | 0.272              | 1.164          | 0.317            | -        |
| 836.6                                                                                              | 190 |          | 32.5          | 31.84           | 0.05             | Bottom        | 1.0 cm                                          | 0.044              | 1.164          | 0.051            | -        |
| ANSI/ IEEE C95.1 - 1992– Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |          |               |                 |                  |               | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram |                    |                |                  |          |

### 13. 2-2 Measurement Results (GSM1900 Hotspot SAR)

| Frequency                                                                                          |     | Mode     | Power (dBm)   |                 | Power Drift (dB) | Configuration | Separation Distance                             | Measured SAR (mW/g) | Scaling Factor | Scaled SAR (mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|----------|---------------|-----------------|------------------|---------------|-------------------------------------------------|---------------------|----------------|-------------------|----------|
| MHz                                                                                                | Ch. |          | Tune-Up Limit | Conducted Power |                  |               |                                                 |                     |                |                   |          |
| 1 880.0                                                                                            | 661 | GPRS 4Tx | 24.5          | 23.39           | -0.03            | Rear          | 1.0 cm                                          | 0.389               | 1.291          | 0.502             | 5        |
| 1 880.0                                                                                            | 661 |          | 24.5          | 23.39           | 0.00             | Front         | 1.0 cm                                          | 0.323               | 1.291          | 0.417             | -        |
| 1 880.0                                                                                            | 661 |          | 24.5          | 23.39           | -0.19            | Left          | 1.0 cm                                          | 0.044               | 1.291          | 0.057             | -        |
| 1 880.0                                                                                            | 661 |          | 24.5          | 23.39           | -0.00            | Right         | 1.0 cm                                          | 0.167               | 1.291          | 0.216             | -        |
| 1 880.0                                                                                            | 661 |          | 24.5          | 23.39           | 0.06             | Bottom        | 1.0 cm                                          | 0.120               | 1.291          | 0.155             | -        |
| ANSI/ IEEE C95.1 - 1992– Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |          |               |                 |                  |               | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram |                     |                |                   |          |

### 13. 2-3 Measurement Results (WLAN Hotspot SAR)

| Frequency                                                                                          |     | Mode    | Power (dBm)   |                 | Power Drift (dB) | Configuration | Data Rate                                       | Separation Distance | Measured SAR (mW/g) | Scaling Factor | Scaled SAR (mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|---------|---------------|-----------------|------------------|---------------|-------------------------------------------------|---------------------|---------------------|----------------|-------------------|----------|
| MHz                                                                                                | Ch. |         | Tune-Up Limit | Conducted Power |                  |               |                                                 |                     |                     |                |                   |          |
| 2462                                                                                               | 11  | 802.11b | 16.5          | 15.88           | 0.17             | Rear          | 1Mbps                                           | 1.0 cm              | 0.070               | 1.153          | 0.081             | 6        |
|                                                                                                    |     |         | 16.5          | 15.88           | -0.15            | Front         | 1Mbps                                           | 1.0 cm              | 0.040               | 1.153          | 0.046             | -        |
|                                                                                                    |     |         | 16.5          | 15.88           | 0.06             | Right         | 1Mbps                                           | 1.0 cm              | 0.099               | 1.153          | 0.114             | 7        |
|                                                                                                    |     |         | 16.5          | 15.88           | -0.10            | Top           | 1Mbps                                           | 1.0 cm              | 0.017               | 1.153          | 0.020             | -        |
| ANSI/ IEEE C95.1 - 1992– Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |         |               |                 |                  |               | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram |                     |                     |                |                   |          |

### 13.3-1 Measurement Results (Body-worn SAR)

| Frequency                                                                                          |     | Mode            | Power (dBm)   |                 | Power Drift (dB) | Configuration | Separation Distance                             | Measured SAR (mW/g) | Scaling Factor | Scaled SAR (mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|-----------------|---------------|-----------------|------------------|---------------|-------------------------------------------------|---------------------|----------------|-------------------|----------|
| MHz                                                                                                | Ch. |                 | Tune-Up Limit | Conducted Power |                  |               |                                                 |                     |                |                   |          |
| 836.6                                                                                              | 190 | GSM850          | 32.5          | 31.85           | -0.06            | Rear          | 1.0 cm                                          | 0.529               | 1.161          | <b>0.614</b>      | 8        |
| 836.6                                                                                              | 190 | GSM850          | 32.5          | 31.85           | -0.07            | Front         | 1.0 cm                                          | 0.415               | 1.161          | 0.482             | -        |
| 836.6                                                                                              | 190 | GPRS 1Tx        | 32.5          | 31.84           | -0.03            | Rear          | 1.0 cm                                          | 0.484               | 1.164          | 0.563             | 4        |
| 836.6                                                                                              | 190 | GPRS 1Tx        | 32.5          | 31.84           | -0.07            | Front         | 1.0 cm                                          | 0.392               | 1.164          | 0.456             | -        |
| 1 880.0                                                                                            | 661 | GSM1900         | 29.3          | 29.11           | 0.05             | Rear          | 1.0 cm                                          | 0.414               | 1.045          | 0.433             | 9        |
| 1 880.0                                                                                            | 661 | GSM1900         | 29.3          | 29.11           | 0.03             | Front         | 1.0 cm                                          | 0.341               | 1.045          | 0.356             | -        |
| 1 880.0                                                                                            | 661 | GPRS 4Tx        | 24.5          | 23.39           | -0.03            | Rear          | 1.0 cm                                          | 0.389               | 1.291          | <b>0.502</b>      | 5        |
| 1 880.0                                                                                            | 661 | GPRS 4Tx        | 24.5          | 23.39           | 0.00             | Front         | 1.0 cm                                          | 0.323               | 1.291          | 0.417             | -        |
| 2462                                                                                               | 11  | 802.11b (1Mbps) | 16.5          | 15.88           | 0.17             | Rear          | 1.0 cm                                          | 0.070               | 1.153          | 0.081             | 6        |
| 2462                                                                                               | 11  | 802.11b (1Mbps) | 16.5          | 15.88           | -0.15            | Front         | 1.0 cm                                          | 0.040               | 1.153          | 0.046             | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |                 |               |                 |                  |               | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram |                     |                |                   |          |

## **13.4 SAR Test Notes**

### **General Notes:**

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, FCC KDB Procedure.
2. Batteries are fully charged at the beginning of the SAR measurements. A standard battery was used for all SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB 447498 D01v05r02.
6. Device was tested using a fixed spacing for body-worn accessory testing. A separation distance of 10 mm was considered because the manufacturer has determined that there will be body-worn accessories available in the marketplace for users to support this separation distance.
7. Per FCC KDB 648474 D04v01r02, SAR was evaluated without a headset connected to the device. Since the standalone reported SAR was  $\leq 1.2$  W/kg, no additional SAR evaluation using a headset cable were required.
8. Per FCC KDB 865664 D01v01r03, variability SAR tests were not performed since the measured SAR results for all frequency bands were less than 0.8 W/kg. Please see Section 14 for variability analysis information.

### **GSM/GPRS Test Notes:**

1. This device supports GSM VOIP in the head and the body-worn configurations therefore GPRS was additionally evaluated for head and body-worn compliance.
2. Body-Worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.
3. Justification for reduced test configurations per KDB 941225 D03v01: The source-based time-averaged output power was evaluated for all multi-slot operations. The multi-slot configuration with the highest frame averaged output power was evaluated for SAR.
4. Per FCC KDB 447498 D01v05r02, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is  $\leq 0.8$  W/kg then testing at the other channels is not required for such test configuration(s). When the maximum output power variation across the required test channels is 1/2 dB, instead of the middle channel, the highest output power channel must be used.
5. Justification for reduced test configurations per KDB Publication 941225 D03v01 and October 2013 TCB Workshop Notes: The source-based frame-averaged output power was evaluated for all GPRS/EDGE slot configurations. The configuration with the highest target frame averaged output power was evaluated for hotspot SAR. When the maximum frame-averaged powers are equivalent across two or more slots (within 0.25 dB), the configuration with the most number of time slots was tested.

### **WLAN Notes:**

1. Justification for reduced test configurations for WIFI channels per KDB 248227 D01v01r02 and Oct. 2012 FCC/TCB Meeting Notes for 2.4 GHz WIFI: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11b. Other IEEE 802.11 modes (including 802.11 g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
2. Since the maximum extrapolated peak SAR of the zoom scan for the maximum output channel was  $\leq 1.6$  W/kg and the reported 1g averaged SAR was  $< 0.8$  W/kg, SAR testing on other default channels was not required.

## **14. SAR Measurement Variability and Uncertainty**

In accordance with published RF Exposure KDB procedure 865664 D01v01r03 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

- 1) Repeated measurement is not required when the original highest measured SAR is  $< 0.80$  W/kg; steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is  $\geq 0.80$  W/kg, repeat that measurement once.
- 3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$  or when the original or repeated measurement is  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .

## 15. SAR Summation Scenario

|                                                  | Position  | Applicable Combination            | Note |
|--------------------------------------------------|-----------|-----------------------------------|------|
| Simultaneous Transmission                        | Head      | GSM 850 Voice + 2.4 GHz WiFi      |      |
|                                                  |           | GPRS 850 Voice + 2.4 GHz WiFi     |      |
|                                                  |           | GSM 1900 Voice + 2.4 GHz WiFi     |      |
|                                                  |           | GPRS 1900 Voice + 2.4 GHz WiFi    |      |
|                                                  | Hotspot   | GPRS 850 Data + 2.4 GHz WiFi      |      |
|                                                  |           | GPRS 1900 Data + 2.4 GHz WiFi     |      |
|                                                  | Body-worn | GSM 850 Voice + 2.4 GHz WiFi      |      |
|                                                  |           | GPRS 850 Data + 2.4 GHz WiFi      |      |
|                                                  |           | GSM 1900 Voice + 2.4 GHz WiFi     |      |
|                                                  |           | GPRS 1900 Data + 2.4 GHz WiFi     |      |
|                                                  |           | GSM 850 Voice + 2.4 GHz Bluetooth |      |
|                                                  |           | GPRS VoIP 850 + 2.4 GHz Bluetooth |      |
| GSM 1900 Voice + 2.4 GHz Bluetooth               |           |                                   |      |
| GPRS VoIP 1900 + 2.4 GHz Bluetooth               |           |                                   |      |
| * BT and WLAN are not simultaneous transmission. |           |                                   |      |

## 15.1 Simultaneous Transmission Summation for Head

Simultaneous Transmission Summation with Wifi

| Band      | configuration | Scaled SAR (W/kg) | 2.4 GHz WIFI Scaled SAR (W/kg) | $\Sigma$ 1-g SAR (W/kg) |
|-----------|---------------|-------------------|--------------------------------|-------------------------|
| GSM 850   | Left Cheek    | 0.516             | 0.022                          | 0.538                   |
|           | Left Tilt     | 0.280             | 0.010                          | 0.290                   |
|           | Right Cheek   | 0.475             | 0.010                          | 0.485                   |
|           | Right Tilt    | 0.262             | 0.000                          | 0.262                   |
| GPRS 850  | Left Cheek    | 0.454             | 0.022                          | 0.476                   |
|           | Left Tilt     | 0.277             | 0.010                          | 0.287                   |
|           | Right Cheek   | 0.439             | 0.010                          | 0.449                   |
|           | Right Tilt    | 0.253             | 0.000                          | 0.253                   |
| GSM 1900  | Left Cheek    | 0.410             | 0.022                          | 0.432                   |
|           | Left Tilt     | 0.254             | 0.010                          | 0.264                   |
|           | Right Cheek   | 0.727             | 0.010                          | 0.737                   |
|           | Right Tilt    | 0.218             | 0.000                          | 0.218                   |
| GPRS 1900 | Left Cheek    | 0.444             | 0.022                          | 0.466                   |
|           | Left Tilt     | 0.292             | 0.010                          | 0.302                   |
|           | Right Cheek   | 0.863             | 0.010                          | 0.873                   |
|           | Right Tilt    | 0.250             | 0.000                          | 0.250                   |

## 15.2 Simultaneous Transmission Summation for Body-Worn

**Simultaneous Transmission Summation with Wifi (1 cm)**

| Band      | configuration | Scaled SAR (W/kg) | 2.4 GHz WIFI Scaled SAR (W/kg) | $\Sigma$ 1-g SAR (W/kg) |
|-----------|---------------|-------------------|--------------------------------|-------------------------|
| GSM 850   | Rear          | 0.614             | 0.081                          | 0.695                   |
| GSM 850   | Front         | 0.482             | 0.046                          | 0.528                   |
| GPRS 850  | Rear          | 0.563             | 0.081                          | 0.644                   |
| GPRS 850  | Front         | 0.456             | 0.046                          | 0.502                   |
| GSM 1900  | Rear          | 0.433             | 0.081                          | 0.514                   |
| GSM 1900  | Front         | 0.356             | 0.046                          | 0.402                   |
| GPRS 1900 | Rear          | 0.502             | 0.081                          | 0.583                   |
| GPRS 1900 | Front         | 0.417             | 0.046                          | 0.463                   |

**Simultaneous Transmission Summation with Bluetooth (1 cm)**

| Band      | configuration | Scaled SAR (W/kg) | BT SAR (W/kg) | $\Sigma$ 1-g SAR (W/kg) |
|-----------|---------------|-------------------|---------------|-------------------------|
| GSM 850   | Rear          | 0.614             | 0.33          | 0.944                   |
| GSM 850   | Front         | 0.482             | 0.33          | 0.812                   |
| GPRS 850  | Rear          | 0.563             | 0.33          | 0.893                   |
| GPRS 850  | Front         | 0.456             | 0.33          | 0.786                   |
| GSM 1900  | Rear          | 0.433             | 0.33          | 0.763                   |
| GSM 1900  | Front         | 0.356             | 0.33          | 0.686                   |
| GPRS 1900 | Rear          | 0.502             | 0.33          | 0.832                   |
| GPRS 1900 | Front         | 0.417             | 0.33          | 0.747                   |

## 15.3 Simultaneous Transmission Summation for Hotspot

Simultaneous Transmission Summation for Hotspot (1 cm)

| Band     | configuration | Scaled SAR(W/kg) | 2.4 GHz WIFI Scaled SAR (W/kg) | $\Sigma$ 1-g SAR (W/kg) |
|----------|---------------|------------------|--------------------------------|-------------------------|
| GSM 850  | Rear          | 0.563            | 0.081                          | 0.644                   |
|          | Front         | 0.456            | 0.046                          | 0.502                   |
|          | Left          | 0.321            |                                | 0.321                   |
|          | Right         | 0.317            | 0.114                          | 0.431                   |
|          | Bottom        | 0.051            |                                | 0.051                   |
|          | Top           |                  | 0.020                          | 0.020                   |
| GSM 1900 | Rear          | 0.502            | 0.081                          | 0.583                   |
|          | Front         | 0.417            | 0.046                          | 0.463                   |
|          | Left          | 0.057            |                                | 0.057                   |
|          | Right         | 0.216            | 0.114                          | 0.330                   |
|          | Bottom        | 0.155            |                                | 0.155                   |
|          | Top           |                  | 0.020                          | 0.020                   |

## 15.4 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit. And therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v05r02.

## 16. CONCLUSION

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The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the ANSI/IEEE C95.1 1992.

These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests.

## 17. REFERENCES

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- [20] SAR Measurement Procedure for 802.11 a/b/g Transmitters #KDB 248227.

## Attachment 1. – SAR Test Plots

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.0 °C  
Ambient Temperature: 21.2 °C  
Test Date: May. 19, 2014  
Plot No.: 1

# DUT: SM-G130H/DS; Type: Bar; Serial: #1

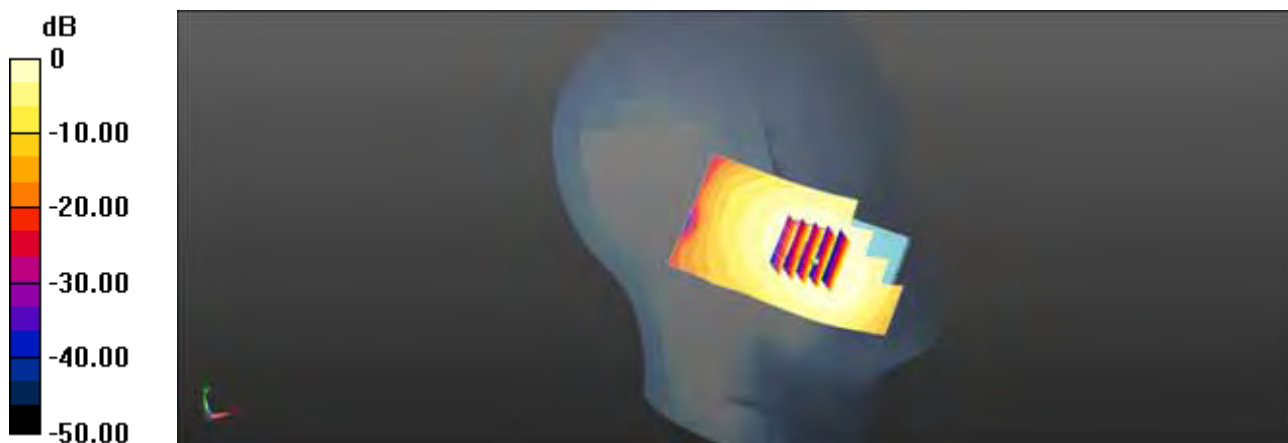
Communication System: UID 0, GSM 850 (0); Frequency: 836.6 MHz; Duty Cycle: 1:8.30042  
Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.876 \text{ S/m}$ ;  $\epsilon_r = 42.002$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Left Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3863; ConvF(9.46, 9.46, 9.46); Calibrated: 2013-07-31;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2014-01-03
- Phantom: SAM\_Front\_2014\_03\_03; Type: SAM; Serial: TP-1573
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**SM-G130H/DS /Left Touch GSM 850 190ch/Area Scan (51x91x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.541 W/kg

**SM-G130H/DS /Left Touch GSM 850 190ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 6.979 V/m; Power Drift = 0.10 dB  
Peak SAR (extrapolated) = 0.612 W/kg  
**SAR(1 g) = 0.444 W/kg; SAR(10 g) = 0.315 W/kg**  
Maximum value of SAR (measured) = 0.535 W/kg



$$0 \text{ dB} = 0.541 \text{ W/kg} = -2.66 \text{ dBW/kg}$$

Test Laboratory: HCT CO., LTD  
 EUT Type: Mobile Phone  
 Liquid Temperature: 20.3 °C  
 Ambient Temperature: 20.5 °C  
 Test Date: May. 20, 2014  
 Plot No.: 2

# DUT: SM-G130H/DS; Type: Bar; Serial: #1

Communication System: UID 0, GSM 1900 (0); Frequency: 1880 MHz; Duty Cycle: 1:8.30042  
 Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.416 \text{ S/m}$ ;  $\epsilon_r = 38.95$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Right Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY4 Configuration:

- Probe: EX3DV4 - SN3863; ConvF(7.86, 7.86, 7.86); Calibrated: 2013-07-31;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2014-01-03
- Phantom: SAM\_Front\_2014\_03\_03; Type: SAM; Serial: TP-1573
- ; SEMCAD X Version 14.6.10 (7331)

**SM-G130H/DS /Right Touch GSM 1900 661ch/Area Scan (51x91x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
 Maximum value of SAR (interpolated) = 0.898 W/kg

**SM-G130H/DS /Right Touch GSM 1900 661ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
 Reference Value = 7.776 V/m; Power Drift = 0.14 dB  
 Peak SAR (extrapolated) = 1.03 W/kg  
**SAR(1 g) = 0.696 W/kg; SAR(10 g) = 0.408 W/kg**  
 Maximum value of SAR (measured) = 0.889 W/kg



$$0 \text{ dB} = 0.898 \text{ W/kg} = -0.47 \text{ dBW/kg}$$

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.1 °C  
Ambient Temperature: 21.3 °C  
Test Date: May. 21, 2014  
Plot No.: 3

# DUT: SM-G130H/DS; Type: Bar; Seril: #1

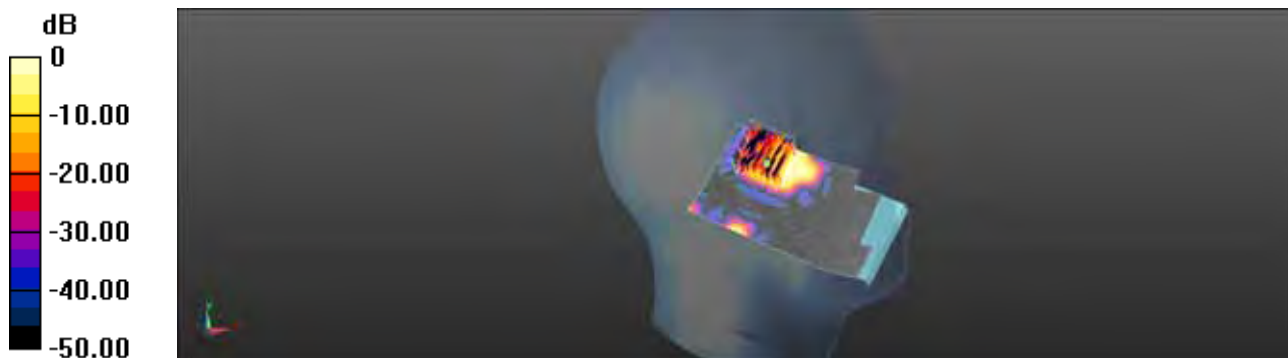
Communication System: UID 0, 2450MHz FCC (0); Frequency: 2462 MHz;Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 2462 \text{ MHz}$ ;  $\sigma = 1.835 \text{ S/m}$ ;  $\epsilon_r = 40.207$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Left Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.1, 7.1, 7.1); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: SAM (20deg probe tilt) with CRP v5.0\_Right\_2014\_02\_25; Type: QD000P40CD; Serial: TP:1804
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7331)

**SM-G130H/DS/Left Touch 802.11b 11ch 1Mbps/Area Scan (61x111x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.0578 W/kg

**SM-G130H/DS/Left Touch 802.11b 11ch 1Mbps/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 1.914 V/m; Power Drift = -0.08 dB  
Peak SAR (extrapolated) = 0.0450 W/kg  
**SAR(1 g) = 0.019 W/kg; SAR(10 g) = 0.008 W/kg**  
Maximum value of SAR (measured) = 0.0321 W/kg



$$0 \text{ dB} = 0.0578 \text{ W/kg} = -12.38 \text{ dBW/kg}$$

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.1 °C  
Ambient Temperature: 21.3 °C  
Test Date: May. 21, 2014  
Plot No.: 4

# DUT: SM-G130H/DS; Type: Bar; Serial: #1

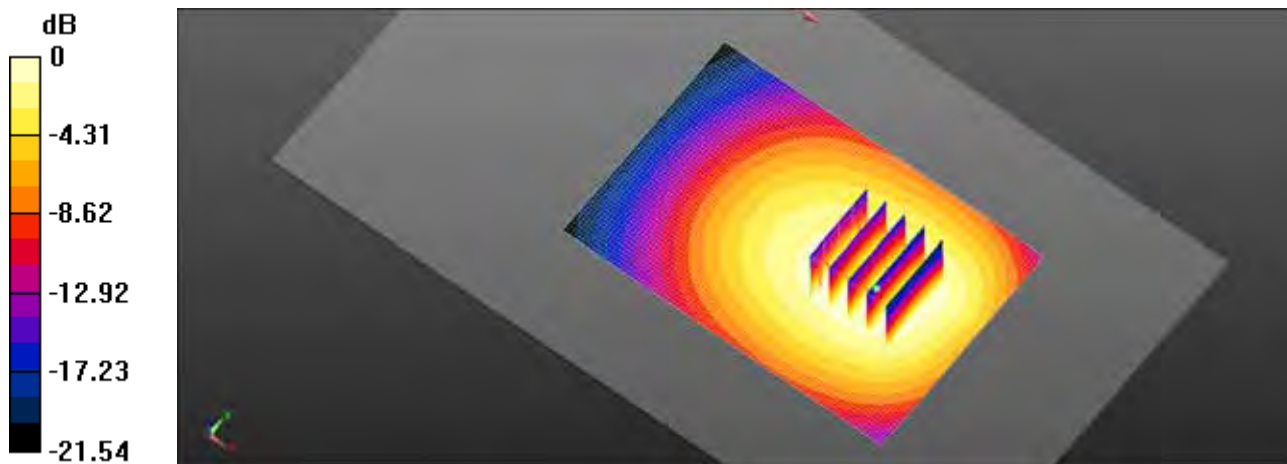
Communication System: UID 0, GSM 850 (0); Frequency: 836.6 MHz; Duty Cycle: 1:8.30042  
Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.985 \text{ S/m}$ ;  $\epsilon_r = 54.116$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.66, 9.66, 9.66); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: Triple Flat Phantom 5.1C-2014-02-21; Type: QD 000 P51 CA; Serial: xxxx
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7331)

**SM-G130H/DS /GPRS850 Body Rear 190ch 1Tx/Area Scan (61x91x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.573 W/kg

**SM-G130H/DS /GPRS850 Body Rear 190ch 1Tx/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 13.19 V/m; Power Drift = -0.03 dB  
Peak SAR (extrapolated) = 0.682 W/kg  
**SAR(1 g) = 0.484 W/kg; SAR(10 g) = 0.352 W/kg**  
Maximum value of SAR (measured) = 0.572 W/kg



0 dB = 0.573 W/kg = -2.42 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.1 °C  
Ambient Temperature: 21.3 °C  
Test Date: May. 21, 2014  
Plot No.: 5

# DUT: SM-G130H/DS; Type: Bar; Serial: #1

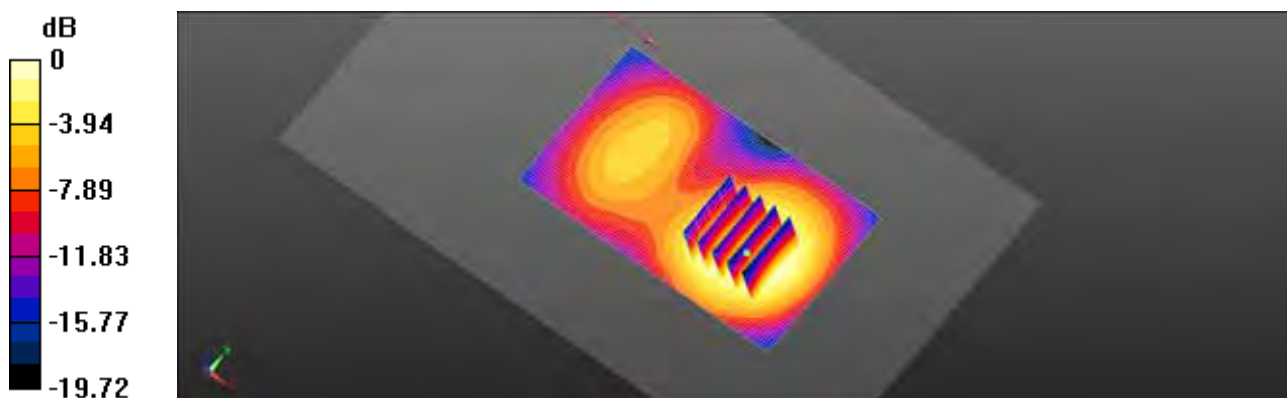
Communication System: UID 0, GSM 1900 4TX (0); Frequency: 1880 MHz; Duty Cycle: 1:2.07491  
Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.482 \text{ S/m}$ ;  $\epsilon_r = 52.383$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section  
Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

## DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.59, 7.59, 7.59); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: Triple Flat Phantom 5.1C-2014-02-21; Type: QD 000 P51 CA; Serial: xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**SM-G130H/DS /GSM1900 Body Rear 661ch GPRS 4Tx/Area Scan (51x91x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.523 W/kg

**SM-G130H/DS /GSM1900 Body Rear 661ch GPRS 4Tx/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 8.838 V/m; Power Drift = -0.03 dB  
Peak SAR (extrapolated) = 0.615 W/kg  
**SAR(1 g) = 0.389 W/kg; SAR(10 g) = 0.239 W/kg**  
Maximum value of SAR (measured) = 0.501 W/kg



0 dB = 0.523 W/kg = -2.81 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 19.9 °C  
Ambient Temperature: 20.1 °C  
Test Date: May. 15, 2014  
Plot No.: 6

# DUT: SM-G130H/DS; Type: Bar; Serial: #1

Communication System: UID 0, 2450MHz FCC (0); Frequency: 2462 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 2462 \text{ MHz}$ ;  $\sigma = 2.006 \text{ S/m}$ ;  $\epsilon_r = 52.941$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.31, 7.31, 7.31); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: Triple Flat Phantom 5.1C-2014-02-21; Type: QD 000 P51 CA; Serial: xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**SM-G130H/DS /802.11b Body Rear 11ch 1Mbps/Area Scan (81x111x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$

Reference Value = 4.348 V/m; Power Drift = 0.17 dB

**Fast SAR: SAR(1 g) = 0.071 W/kg; SAR(10 g) = 0.039 W/kg**

Maximum value of SAR (interpolated) = 0.104 W/kg

**SM-G130H/DS /802.11b Body Rear 11ch 1Mbps/Area Scan (81x111x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$

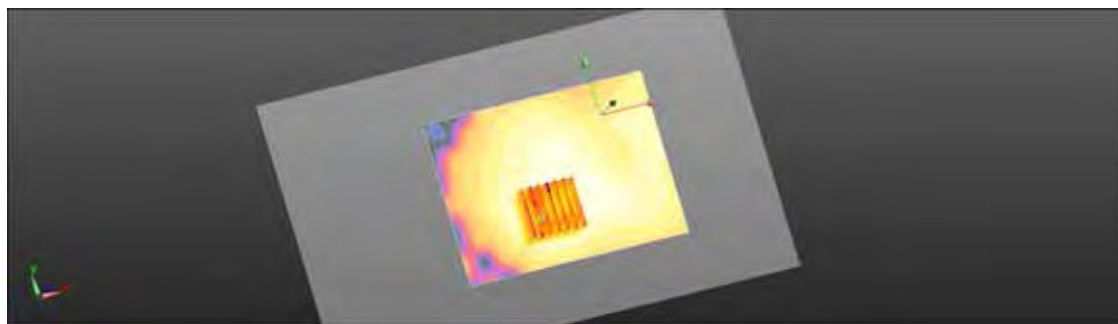
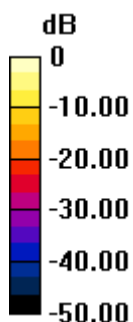
**SM-G130H/DS /802.11b Body Rear 11ch 1Mbps/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 4.348 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 0.139 W/kg

**SAR(1 g) = 0.070 W/kg; SAR(10 g) = 0.036 W/kg**

Maximum value of SAR (measured) = 0.103 W/kg



0 dB = 0.104 W/kg = -9.81 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 19.9 °C  
Ambient Temperature: 20.1 °C  
Test Date: May. 15, 2014  
Plot No.: 7

# DUT: SM-G130H/DS; Type: Bar; Serial: #1

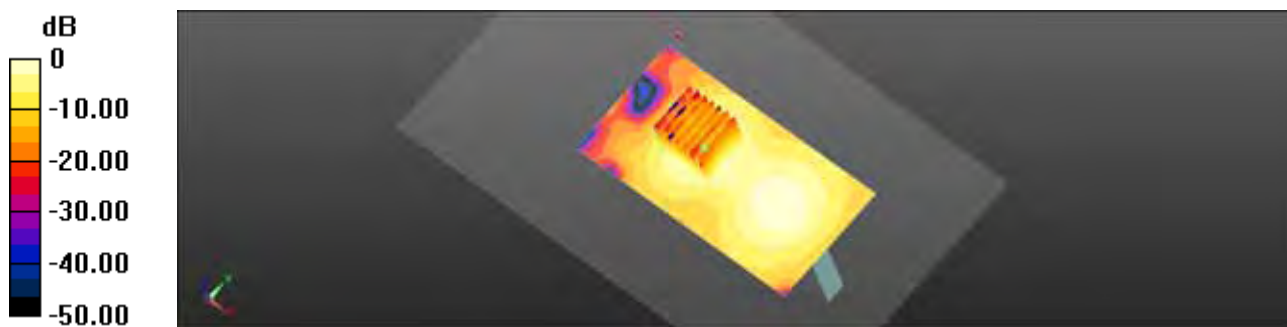
Communication System: UID 0, 2450MHz FCC (0); Frequency: 2462 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 2462 \text{ MHz}$ ;  $\sigma = 2.006 \text{ S/m}$ ;  $\epsilon_r = 52.941$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.31, 7.31, 7.31); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: Triple Flat Phantom 5.1C-2014-02-21; Type: QD 000 P51 CA; Serial: xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**SM-G130H/DS /802.11b Body Right 11ch 1Mbps/Area Scan (61x121x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.152 W/kg

**SM-G130H/DS /802.11b Body Right 11ch 1Mbps/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 7.039 V/m; Power Drift = 0.06 dB  
Peak SAR (extrapolated) = 0.196 W/kg  
**SAR(1 g) = 0.099 W/kg; SAR(10 g) = 0.049 W/kg**  
Maximum value of SAR (measured) = 0.146 W/kg



0 dB = 0.152 W/kg = -8.19 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.1 °C  
Ambient Temperature: 21.3 °C  
Test Date: May. 21, 2014  
Plot No.: 8

# DUT: SM-G130H/DS; Type: Bar; Serial: #1

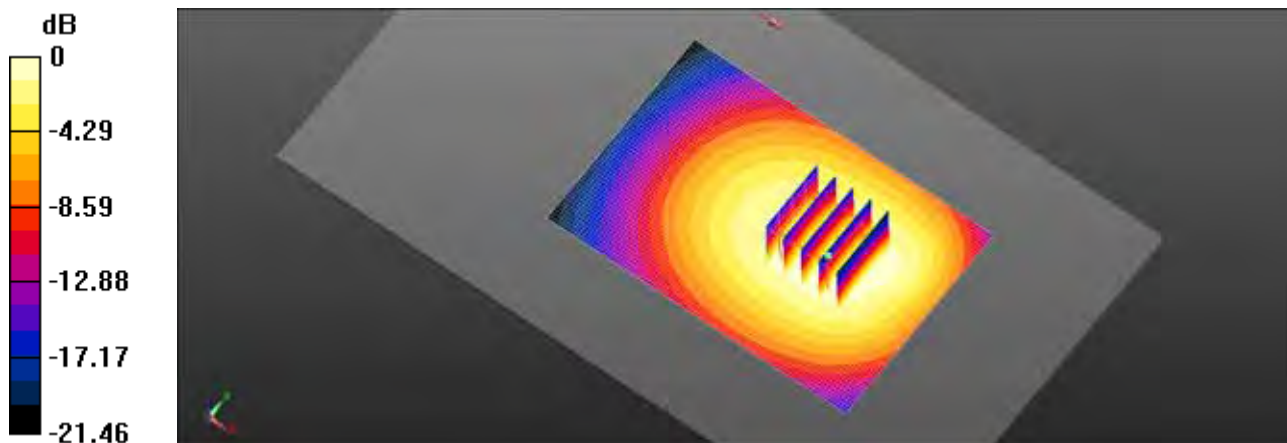
Communication System: UID 0, GSM 850 (0); Frequency: 836.6 MHz; Duty Cycle: 1:8.30042  
Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.985 \text{ S/m}$ ;  $\epsilon_r = 54.116$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.66, 9.66, 9.66); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: Triple Flat Phantom 5.1C-2014-02-21; Type: QD 000 P51 CA; Serial: xxxx
- Measurement SW: DASY52, Version 52.8 (7); SEMCAD X Version 14.6.10 (7331)

**SM-G130H/DS /GSM850 Body-worn Rear 190ch/Area Scan (61x91x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.624 W/kg

**SM-G130H/DS /GSM850 Body-worn Rear 190ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 14.71 V/m; Power Drift = -0.06 dB  
Peak SAR (extrapolated) = 0.677 W/kg  
**SAR(1 g) = 0.529 W/kg; SAR(10 g) = 0.383 W/kg**  
Maximum value of SAR (measured) = 0.616 W/kg



0 dB = 0.624 W/kg = -2.05 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.1 °C  
Ambient Temperature: 21.3 °C  
Test Date: May. 21, 2014  
Plot No.: 9

# DUT: SM-G130H/DS; Type: Bar; Serial: #1

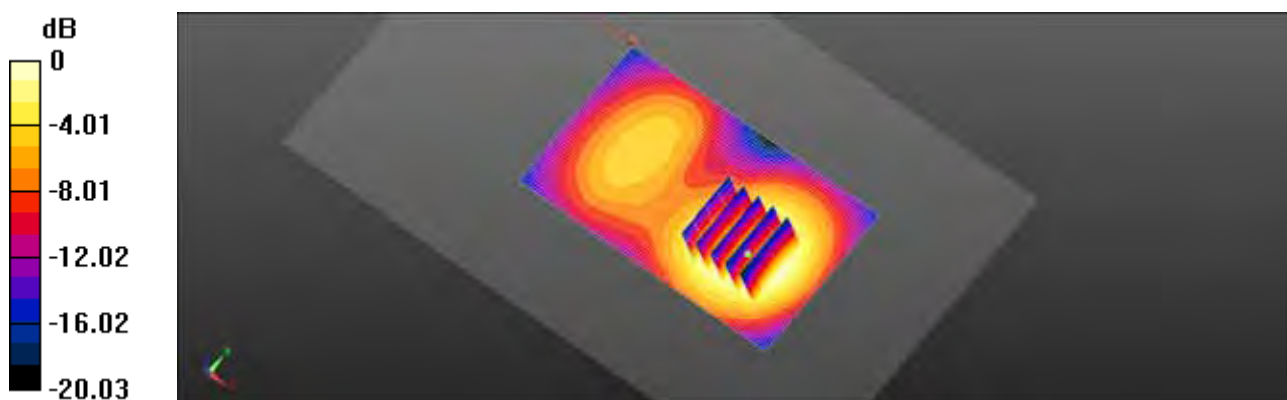
Communication System: UID 0, GSM 1900 (0); Frequency: 1880 MHz; Duty Cycle: 1:8.30042  
Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.482 \text{ S/m}$ ;  $\epsilon_r = 52.383$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.59, 7.59, 7.59); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: Triple Flat Phantom 5.1C-2014-02-21; Type: QD 000 P51 CA; Serial: xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**SM-G130H/DS /GSM1900 Body Rear 661ch body worn/Area Scan (51x91x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.553 W/kg

**SM-G130H/DS /GSM1900 Body Rear 661ch body worn/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 9.521 V/m; Power Drift = 0.05 dB  
Peak SAR (extrapolated) = 0.666 W/kg  
**SAR(1 g) = 0.414 W/kg; SAR(10 g) = 0.254 W/kg**  
Maximum value of SAR (measured) = 0.540 W/kg



$$0 \text{ dB} = 0.553 \text{ W/kg} = -2.57 \text{ dBW/kg}$$

## Attachment 2. – Dipole Verification Plots

## **Verification Data (835 MHz Head)**

Test Laboratory: HCT CO., LTD  
 Input Power: 100 mW (20 dBm)  
 Liquid Temp: 21.0 °C  
 Test Date: May. 19, 2014

**DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: D835V2 - SN:4d0165**

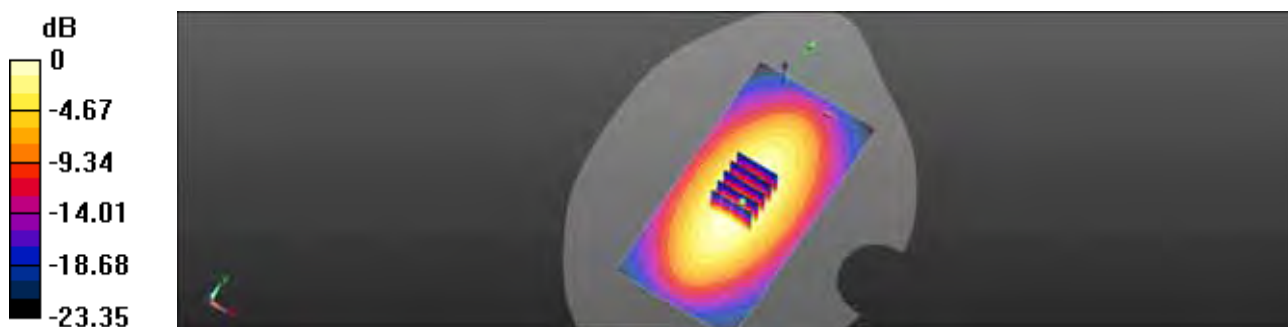
Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.875 \text{ S/m}$ ;  $\epsilon_r = 42.014$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY4 Configuration:

- Probe: EX3DV4 - SN3863; ConvF(9.46, 9.46, 9.46); Calibrated: 2013-07-31;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2014-01-03
- Phantom: SAM with CRP v5.0\_Front\_20120517; Type: QD000P40CD; Serial: TP:xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**Verification 835MHz/Area Scan (61x121x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
 Maximum value of SAR (interpolated) = 1.02 W/kg

**Verification 835MHz/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
 Reference Value = 34.16 V/m; Power Drift = -0.02 dB  
 Peak SAR (extrapolated) = 1.42 W/kg  
**SAR(1 g) = 0.948 W/kg; SAR(10 g) = 0.621 W/kg**  
 Maximum value of SAR (measured) = 1.02 W/kg



0 dB = 1.02 W/kg = 0.08 dBW/kg

## ■ Verification Data (835 MHz Body)

Test Laboratory: HCT CO., LTD  
Input Power 100 mW (20 dBm)  
Liquid Temp: 21.1 °C  
Test Date: May. 21, 2014

**DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: D835V2 - SN:4d165**

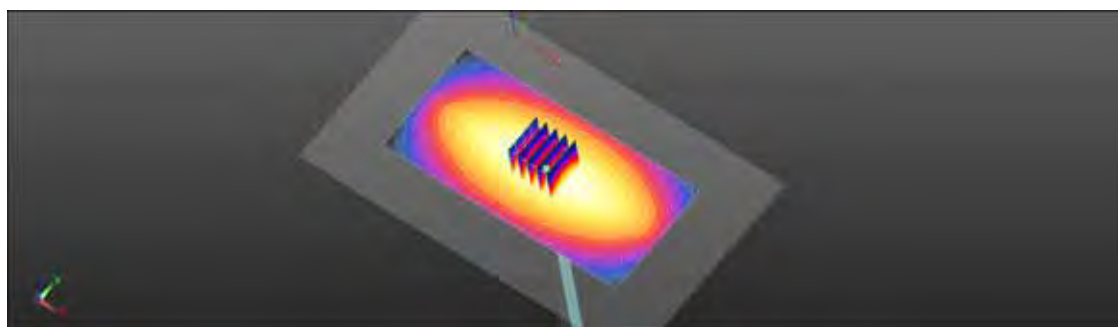
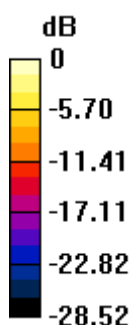
Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.983 \text{ S/m}$ ;  $\epsilon_r = 54.12$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section  
Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.66, 9.66, 9.66); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: Triple Flat Phantom 5.1C-2014-02-21; Type: QD 000 P51 CA; Serial: xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**Verification 835MHz/Area Scan (61x131x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 1.22 W/kg

**Verification 835MHz/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 32.47 V/m; Power Drift = 0.02 dB  
Peak SAR (extrapolated) = 1.44 W/kg  
**SAR(1 g) = 0.979 W/kg; SAR(10 g) = 0.647 W/kg**  
Maximum value of SAR (measured) = 1.24 W/kg



0 dB = 1.22 W/kg = 0.87 dBW/kg

## ■ Verification Data (1 900 MHz Head)

Test Laboratory: HCT CO., LTD  
Input Power 100 mW (20 dBm)  
Liquid Temp: 20.3 °C  
Test Date: May. 20, 2014

**DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d032**

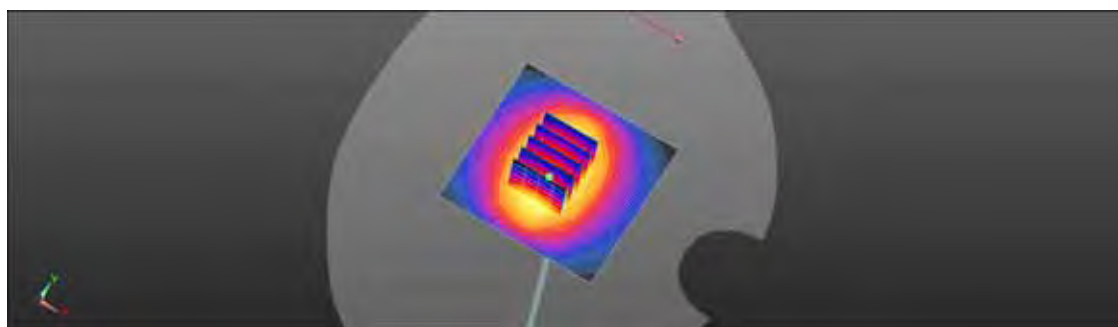
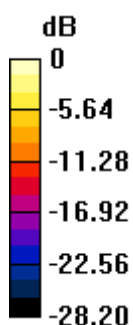
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.437$  S/m;  $\epsilon_r = 38.883$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY4 Configuration:

- Probe: EX3DV4 - SN3863; ConvF(7.86, 7.86, 7.86); Calibrated: 2013-07-31;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1417; Calibrated: 2014-01-03
- Phantom: SAM with CRP v5.0\_Front\_20120517; Type: QD000P40CD; Serial: TP:xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**Verification 1900MHz/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm  
Maximum value of SAR (interpolated) = 4.46 W/kg

**Verification 1900MHz/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 53.95 V/m; Power Drift = 0.03 dB  
Peak SAR (extrapolated) = 8.02 W/kg  
**SAR(1 g) = 3.94 W/kg; SAR(10 g) = 1.94 W/kg**  
Maximum value of SAR (measured) = 4.34 W/kg



0 dB = 4.46 W/kg = 6.49 dBW/kg

## ■ Verification Data (1 900 MHz Body)

Test Laboratory: HCT CO., LTD  
Input Power 100 mW (20 dBm)  
Liquid Temp: 21.1 °C  
Test Date: May. 21, 2014

**DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d032**

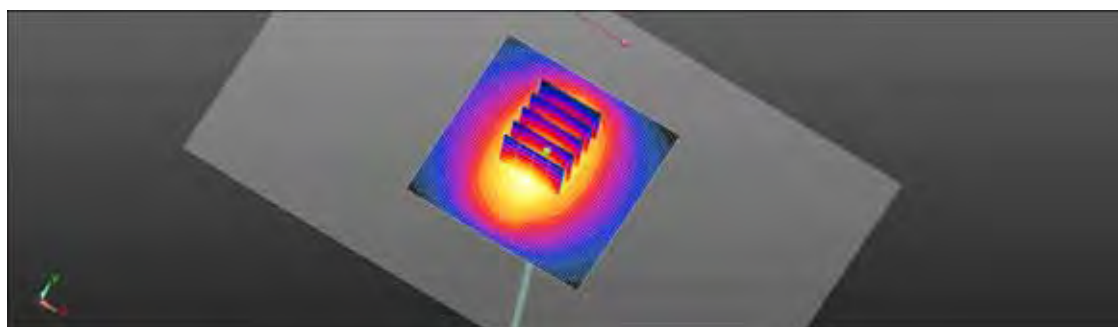
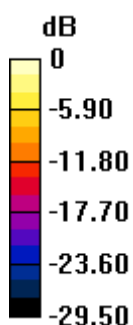
Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.504$  S/m;  $\epsilon_r = 52.299$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Center Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.59, 7.59, 7.59); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**Verification 1900MHz/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm  
Maximum value of SAR (interpolated) = 4.55 W/kg

**Verification 1900MHz/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 53.96 V/m; Power Drift = 0.01 dB  
Peak SAR (extrapolated) = 7.25 W/kg  
**SAR(1 g) = 3.98 W/kg; SAR(10 g) = 2.06 W/kg**  
Maximum value of SAR (measured) = 4.41 W/kg



0 dB = 4.55 W/kg = 6.58 dBW/kg

## **Verification Data (2 450 MHz Head)**

Test Laboratory: HCT CO., LTD  
 Input Power: 100 mW (20 dBm)  
 Liquid Temp: 21.1°C  
 Test Date: May. 21, 2014

**DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:743**

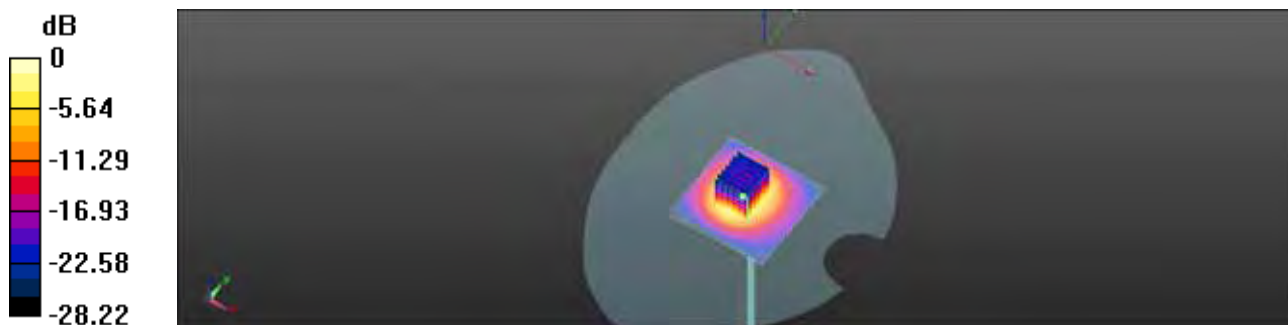
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.822$  S/m;  $\epsilon_r = 40.26$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.1, 7.1, 7.1); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: SAM Front (20deg probe tilt) with CRP v5.0; Type: QD000P40CD; Serial: TP:xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**Verification 2450MHz/Area Scan (71x71x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm  
 Maximum value of SAR (interpolated) = 6.77 W/kg

**Verification 2450MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 62.94 V/m; Power Drift = -0.16 dB  
 Peak SAR (extrapolated) = 11.9 W/kg  
**SAR(1 g) = 5.46 W/kg; SAR(10 g) = 2.55 W/kg**  
 Maximum value of SAR (measured) = 6.06 W/kg



0 dB = 6.77 W/kg = 8.31 dBW/kg

## **Verification Data (2 450 MHz Body)**

Test Laboratory: HCT CO., LTD  
 Input Power: 100 mW (20 dBm)  
 Liquid Temp: 19.9 °C  
 Test Date: May. 15, 2014

**DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:743**

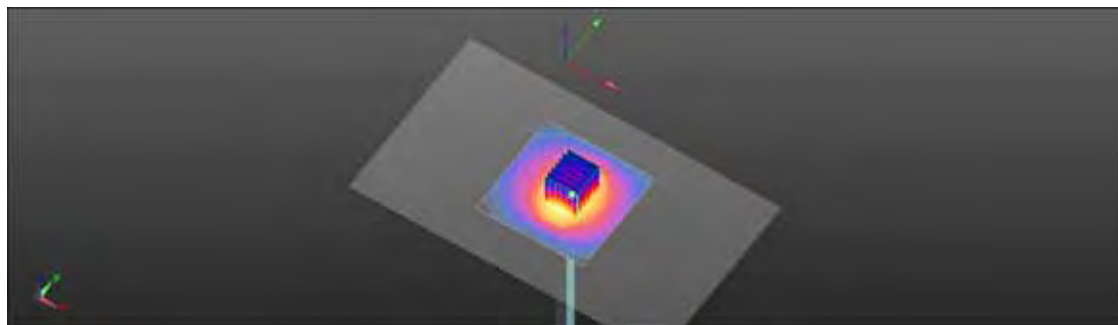
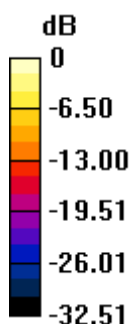
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.985$  S/m;  $\epsilon_r = 52.961$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Center Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.31, 7.31, 7.31); Calibrated: 2014-01-08;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2013-09-30
- Phantom: Triple Flat Phantom 5.1C-2014-02-21; Type: QD 000 P51 CA; Serial: xxxx
- ; SEMCAD X Version 14.6.10 (7331)

**Verification 2450MHz/Area Scan (81x81x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm  
 Maximum value of SAR (interpolated) = 5.90 W/kg

**Verification 2450MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 49.13 V/m; Power Drift = -0.05 dB  
 Peak SAR (extrapolated) = 10.9 W/kg  
**SAR(1 g) = 5.1 W/kg; SAR(10 g) = 2.33 W/kg**  
 Maximum value of SAR (measured) = 7.07 W/kg



0 dB = 5.90 W/kg = 7.71 dBW/kg

## Attachment 3. – Probe Calibration Data

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 HCT (Dymstec)

Certificate No: EX3-3863\_Jul13

## CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3863

Calibration procedure(s) QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4  
Calibration procedure for dosimetric E-field probes

Calibration date: July 31, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter 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. 217-01736)         | Apr-14                 |
| Reference Probe ES3DV2     | SN: 3013        | 28-Dec-12 (No. ES3-3013, Dec12)   | Dec-13                 |
| DAE4                       | SN: 660         | 31-Jan-13 (No. DAE4-660, Jan13)   | Jan-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-15 |
| Network Analyzer HP 8753E  | US37390585      | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

|                       |                         |                                   |               |
|-----------------------|-------------------------|-----------------------------------|---------------|
| Calibrated by:        | Name<br>Claudio Leubler | Function<br>Laboratory Technician | Signature<br> |
| Approved by:          | Katja Pokovic           | Technical Manager                 |               |
| Issued: July 31, 2013 |                         |                                   |               |

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

Certificate No: EX3-3863\_Jul13

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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)

Accreditation No.: SCS 108

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

#### Glossary:

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

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

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

#### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>:** Assessed for E-field polarization  $\theta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCPx,y,z:** 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.

EX3DV4 – SN:3863

July 31, 2013

# Probe EX3DV4

## SN:3863

Manufactured: February 2, 2012

Calibrated: July 31, 2013

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3863

July 31, 2013

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

### Basic Calibration Parameters

|                                                    | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|----------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V/m})^2$ ) <sup>A</sup> | 0.36     | 0.35     | 0.45     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                              | 105.0    | 102.2    | 97.9     |           |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 134.8    | ±2.7 %                    |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 134.1    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 152.6    |                           |

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

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

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

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

EX3DV4- SN:3863

July 31, 2013

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

### 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 | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750                  | 41.9                               | 0.89                            | 9.77    | 9.77    | 9.77    | 0.30  | 0.98       | ± 12.0 %    |
| 835                  | 41.5                               | 0.90                            | 9.46    | 9.46    | 9.46    | 0.48  | 0.74       | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 9.29    | 9.29    | 9.29    | 0.18  | 1.31       | ± 12.0 %    |
| 1450                 | 40.5                               | 1.20                            | 8.40    | 8.40    | 8.40    | 0.19  | 1.21       | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 8.10    | 8.10    | 8.10    | 0.43  | 0.73       | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 7.86    | 7.86    | 7.86    | 0.45  | 0.75       | ± 12.0 %    |
| 1950                 | 40.0                               | 1.40                            | 7.70    | 7.70    | 7.70    | 0.39  | 0.80       | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 7.08    | 7.08    | 7.08    | 0.38  | 0.80       | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 6.82    | 6.82    | 6.82    | 0.25  | 1.13       | ± 12.0 %    |
| 5200                 | 36.0                               | 4.66                            | 5.11    | 5.11    | 5.11    | 0.33  | 1.80       | ± 13.1 %    |
| 5300                 | 35.9                               | 4.76                            | 4.83    | 4.83    | 4.83    | 0.37  | 1.80       | ± 13.1 %    |
| 5500                 | 35.6                               | 4.96                            | 4.81    | 4.81    | 4.81    | 0.37  | 1.80       | ± 13.1 %    |
| 5600                 | 35.5                               | 5.07                            | 4.44    | 4.44    | 4.44    | 0.44  | 1.80       | ± 13.1 %    |
| 5800                 | 35.3                               | 5.27                            | 4.70    | 4.70    | 4.70    | 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.

EX3DV4- SN:3863

July 31, 2013

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

### 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 | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750                  | 55.5                               | 0.96                            | 9.57    | 9.57    | 9.57    | 0.19  | 1.54       | ± 12.0 %    |
| 835                  | 55.2                               | 0.97                            | 9.59    | 9.59    | 9.59    | 0.34  | 0.99       | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 7.84    | 7.84    | 7.84    | 0.27  | 0.99       | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 7.49    | 7.49    | 7.49    | 0.27  | 1.02       | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 7.04    | 7.04    | 7.04    | 0.77  | 0.56       | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 6.79    | 6.79    | 6.79    | 0.80  | 0.50       | ± 12.0 %    |
| 5200                 | 49.0                               | 5.30                            | 4.49    | 4.49    | 4.49    | 0.38  | 1.90       | ± 13.1 %    |
| 5300                 | 48.9                               | 5.42                            | 4.14    | 4.14    | 4.14    | 0.48  | 1.90       | ± 13.1 %    |
| 5500                 | 48.6                               | 5.65                            | 3.91    | 3.91    | 3.91    | 0.51  | 1.90       | ± 13.1 %    |
| 5600                 | 48.5                               | 5.77                            | 3.60    | 3.60    | 3.60    | 0.58  | 1.90       | ± 13.1 %    |
| 5800                 | 48.2                               | 6.00                            | 3.95    | 3.95    | 3.95    | 0.53  | 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.

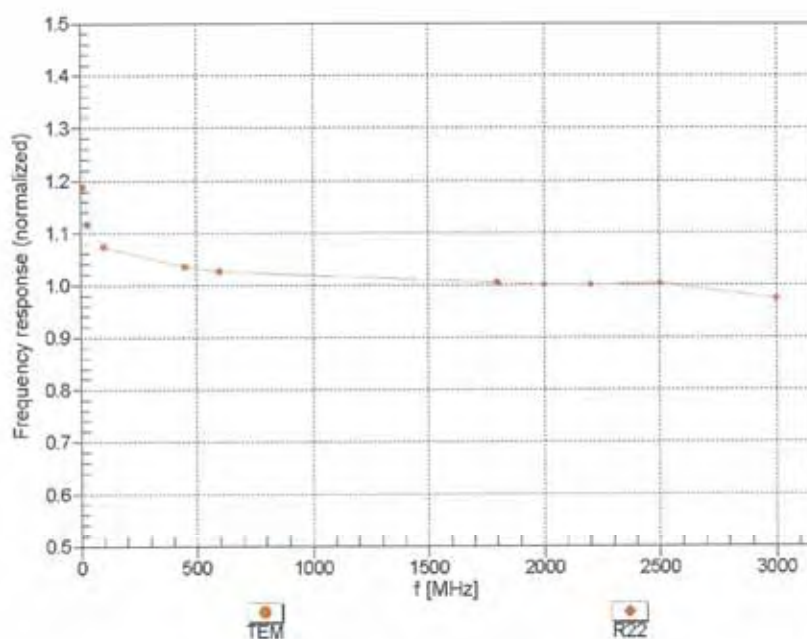
<sup>f</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

EX3DV4- SN:3863

July 31, 2013

## Frequency Response of E-Field

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



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

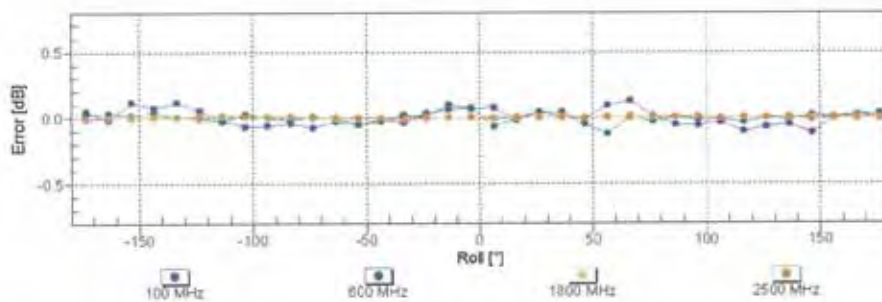
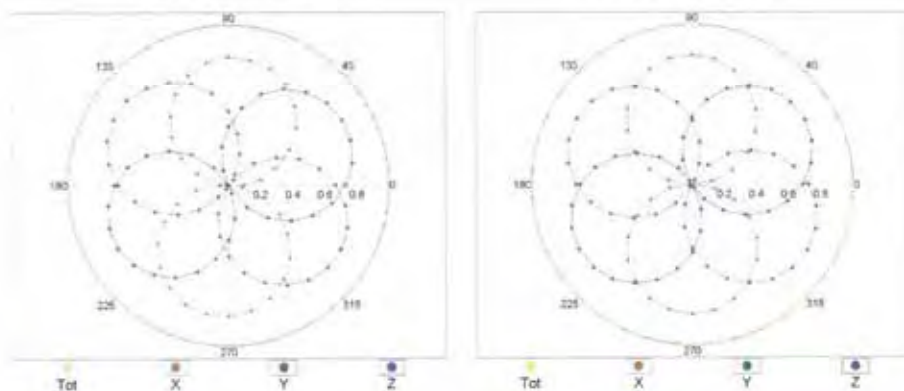
EX3DV4- SN-3863

July 31, 2013

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

f=600 MHz, TEM

f=1800 MHz, R22



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

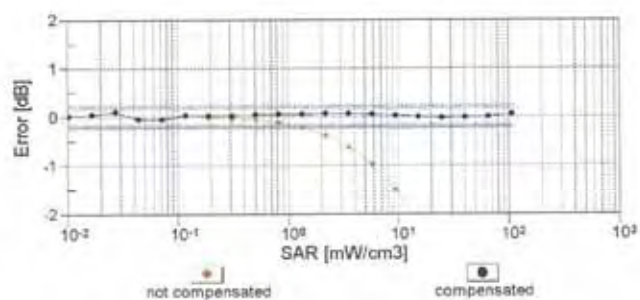
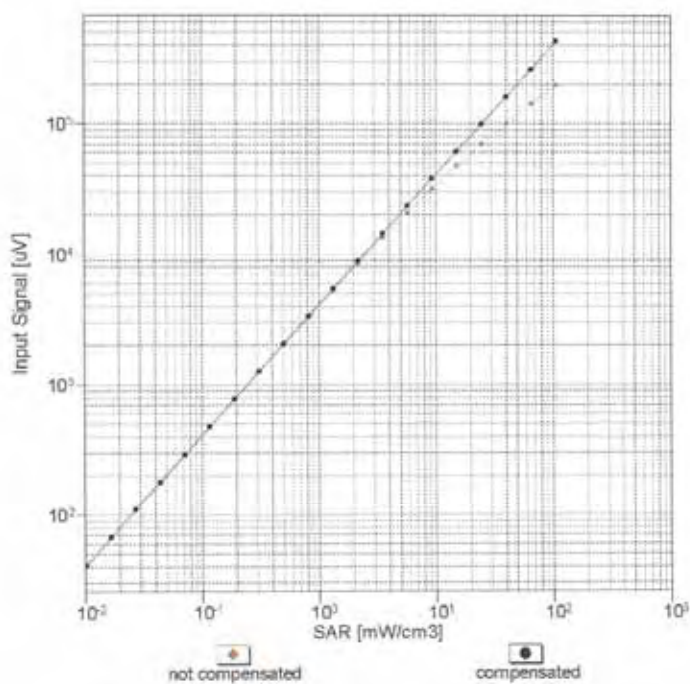
Certificate No: EX3-3863\_Jul13

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July 31, 2013

### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f = 900 \text{ MHz}$ )



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

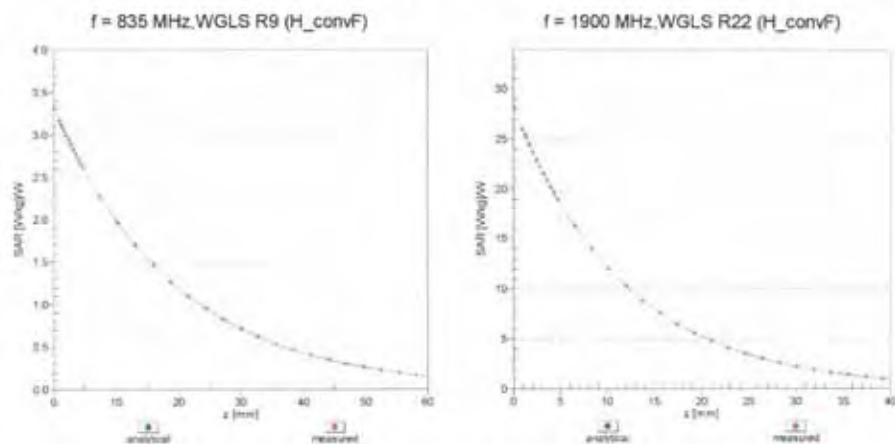
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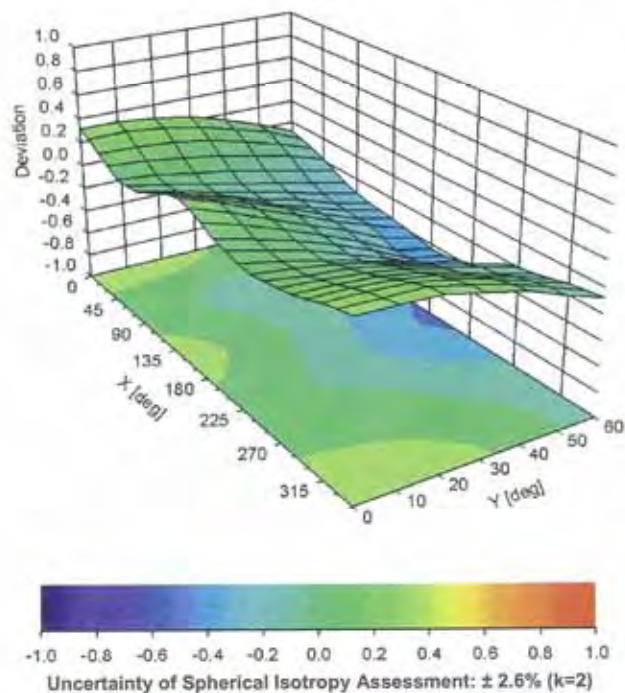
July 31, 2013

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

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



Certificate No: EX3-3863\_Jul13

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July 31, 2013

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -73.5      |
| 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       |

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



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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 HCT (Dymstec)

Certificate No: EX3-3968\_Jan14

## CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3968

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

Calibration date: January 8, 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:                                                                                                  | Leif Klysner  | Laboratory Technician |           |
| Approved by:                                                                                                    | Katja Pokovic | Technical Manager     |           |
| Issued: January 8, 2014                                                                                         |               |                       |           |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |               |                       |           |

Certificate No: EX3-3968\_Jan14

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**S** Servizio svizzero di taratura  
 Swiss Calibration Service

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Accreditation No.: **SCS 108**

#### Glossary:

|                        |                                                                                                                                                |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                    | tissue simulating liquid                                                                                                                       |
| NORM <sub>x,y,z</sub>  | sensitivity in free space                                                                                                                      |
| ConvF                  | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                     |
| DCP                    | diode compression point                                                                                                                        |
| CF                     | crest factor (1/duty_cycle) of the RF signal                                                                                                   |
| A, B, C, D             | modulation dependent linearization parameters                                                                                                  |
| Polarization $\varphi$ | $\varphi$ rotation around probe axis                                                                                                           |
| Polarization $\theta$  | $\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis |
| Connector Angle        | information used in DASY system to align probe sensor X to the robot coordinate system                                                         |

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

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

#### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\theta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

Certificate No: EX3-3968\_Jan14

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EX3DV4 – SN:3968

January 8, 2014

# Probe EX3DV4

## SN:3968

Manufactured: September 30, 2013  
Calibrated: January 8, 2014

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

EX3DV4- SN:3968

January 8, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3968

### Basic Calibration Parameters

|                                                    | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|----------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V/m})^2$ ) <sup>A</sup> | 0.36     | 0.35     | 0.42     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                              | 105.5    | 102.2    | 97.1     |           |

### 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    | 133.2    | ±2.7 %                    |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 135.7    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 142.2    |                           |

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

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

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

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

EX3DV4- SN:3968

January 8, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3968

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>c</sup> | Relative Permittivity <sup>e</sup> | Conductivity (S/m) <sup>f</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>g</sup> | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|------------|-------------|
| 750                  | 41.9                               | 0.89                            | 10.28   | 10.28   | 10.28   | 0.33               | 0.94       | ± 12.0 %    |
| 835                  | 41.5                               | 0.90                            | 9.87    | 9.87    | 9.87    | 0.32               | 1.03       | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 9.71    | 9.71    | 9.71    | 0.47               | 0.81       | ± 12.0 %    |
| 1450                 | 40.5                               | 1.20                            | 8.58    | 8.58    | 8.58    | 0.68               | 0.64       | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 8.15    | 8.15    | 8.15    | 0.80               | 0.59       | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 7.91    | 7.91    | 7.91    | 0.76               | 0.59       | ± 12.0 %    |
| 1950                 | 40.0                               | 1.40                            | 7.69    | 7.69    | 7.69    | 0.80               | 0.50       | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 7.10    | 7.10    | 7.10    | 0.39               | 0.81       | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 7.04    | 7.04    | 7.04    | 0.23               | 1.19       | ± 12.0 %    |
| 5200                 | 36.0                               | 4.66                            | 5.14    | 5.14    | 5.14    | 0.40               | 1.80       | ± 13.1 %    |
| 5300                 | 35.9                               | 4.76                            | 4.89    | 4.89    | 4.89    | 0.40               | 1.80       | ± 13.1 %    |
| 5500                 | 35.6                               | 4.96                            | 4.86    | 4.86    | 4.86    | 0.40               | 1.80       | ± 13.1 %    |
| 5600                 | 35.5                               | 5.07                            | 4.52    | 4.52    | 4.52    | 0.40               | 1.80       | ± 13.1 %    |
| 5800                 | 35.3                               | 5.27                            | 4.58    | 4.58    | 4.58    | 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>e</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.

EX3DV4- SN:3968

January 8, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3968

### 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 (mm) <sup>G</sup> | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 55.5                               | 0.96                            | 9.74    | 9.74    | 9.74    | 0.54               | 0.79                    | ± 12.0 %    |
| 835                  | 55.2                               | 0.97                            | 9.66    | 9.66    | 9.66    | 0.24               | 1.35                    | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 7.93    | 7.93    | 7.93    | 0.63               | 0.68                    | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 7.59    | 7.59    | 7.59    | 0.28               | 1.07                    | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 7.31    | 7.31    | 7.31    | 0.76               | 0.56                    | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 6.96    | 6.96    | 6.96    | 0.65               | 0.50                    | ± 12.0 %    |
| 5200                 | 49.0                               | 5.30                            | 4.66    | 4.66    | 4.66    | 0.45               | 1.90                    | ± 13.1 %    |
| 5300                 | 48.9                               | 5.42                            | 4.28    | 4.28    | 4.28    | 0.50               | 1.90                    | ± 13.1 %    |
| 5500                 | 48.6                               | 5.65                            | 4.01    | 4.01    | 4.01    | 0.50               | 1.90                    | ± 13.1 %    |
| 5600                 | 48.5                               | 5.77                            | 4.17    | 4.17    | 4.17    | 0.40               | 1.90                    | ± 13.1 %    |
| 5800                 | 48.2                               | 6.00                            | 4.11    | 4.11    | 4.11    | 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.

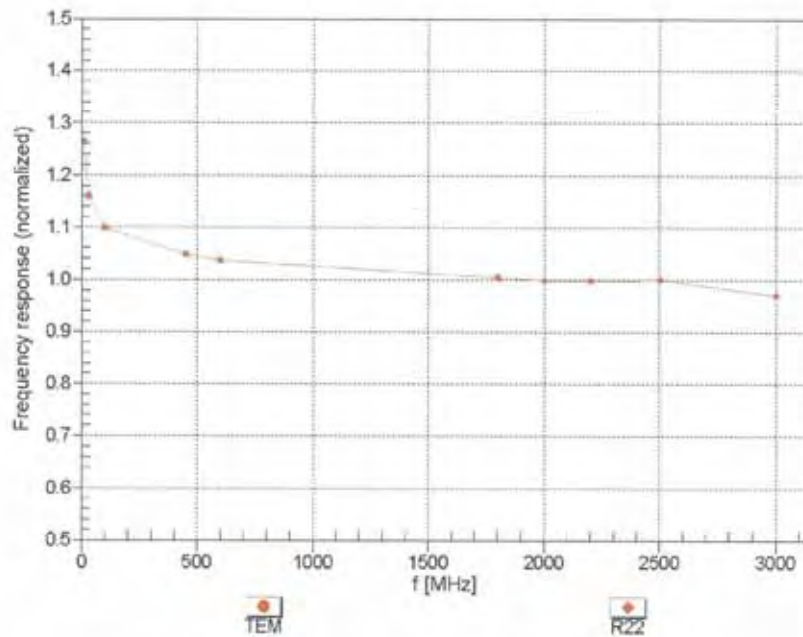
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted 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.

EX3DV4- SN:3968

January 8, 2014

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

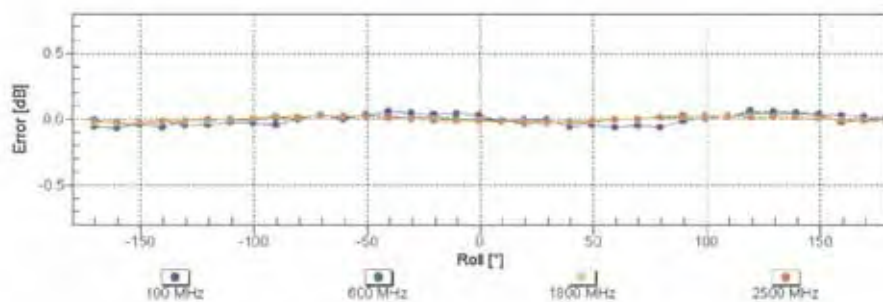
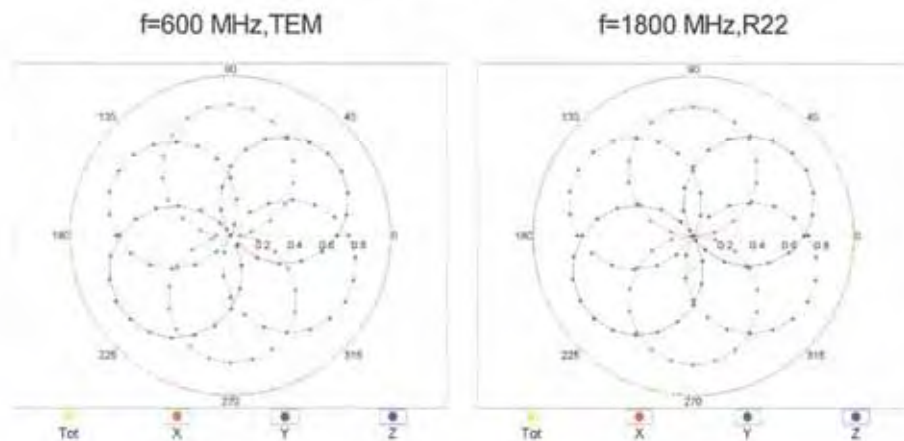


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

EX3DV4- SN:3968

January 8, 2014

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

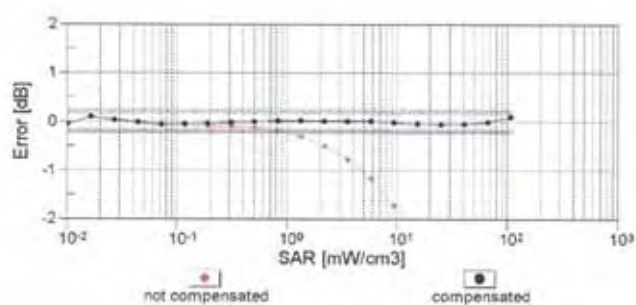
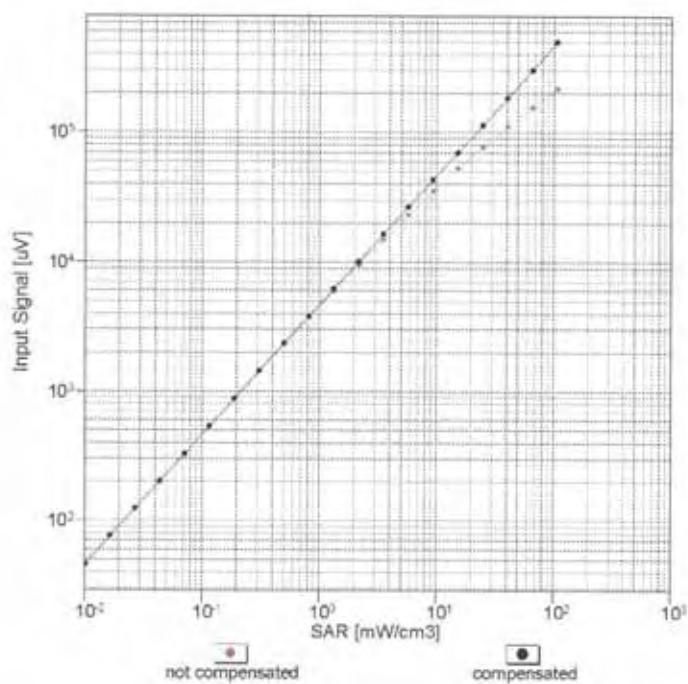


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

EX3DV4- SN:3968

January 8, 2014

### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f = 900 \text{ MHz}$ )



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

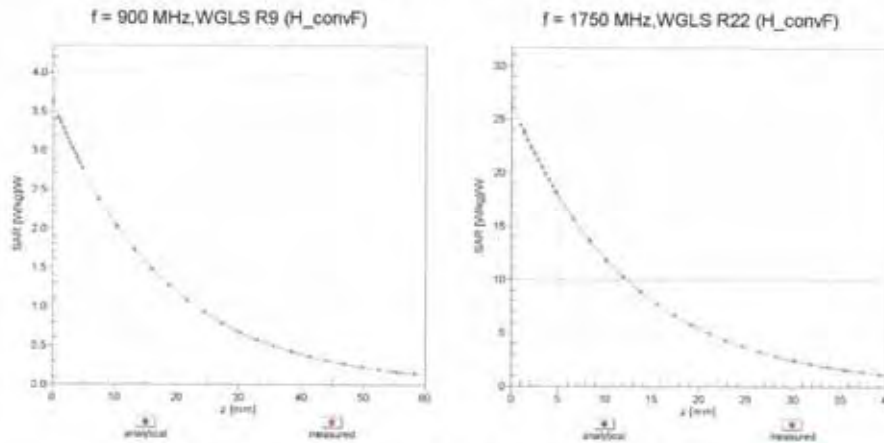
Certificate No: EX3-3968\_Jan14

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EX3DV4- SN:3968

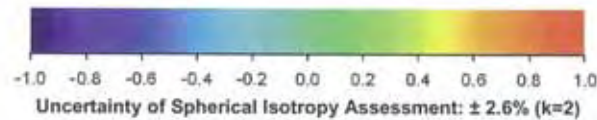
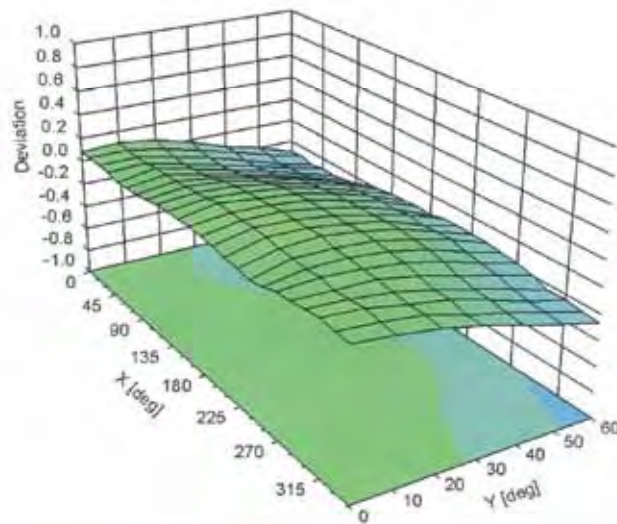
January 8, 2014

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

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



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

EX3DV4- SN:3968

January 8, 2014

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3968****Other Probe Parameters**

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -120.5     |
| 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       |

## Attachment 4. – Dipole Calibration Data

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client HCT (Dymstec)

Certificate No: D835V2-4d165\_Jan14

## CALIBRATION CERTIFICATE

Object D835V2 - SN: 4d165

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

Calibration date: January 07, 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 EPM-442A        | GB37480704         | 09-Oct-13 (No. 217-01827)         | Oct-14                 |
| Power sensor HP 8481A       | US37292783         | 09-Oct-13 (No. 217-01827)         | Oct-14                 |
| Power sensor HP 8481A       | MY41092317         | 09-Oct-13 (No. 217-01828)         | Oct-14                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 04-Apr-13 (No. 217-01736)         | Apr-14                 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 04-Apr-13 (No. 217-01739)         | Apr-14                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-13 (No. ES3-3205_Dec13)    | Dec-14                 |
| DAE4                        | SN: 601            | 25-Apr-13 (No. DAE4-601_Apr13)    | Apr-14                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

|                |                        |                                   |               |
|----------------|------------------------|-----------------------------------|---------------|
| Calibrated by: | Name<br>Jeton Kastrati | Function<br>Laboratory Technician | Signature<br> |
| Approved by:   | Name<br>Kolja Pokovic  | Function<br>Technical Manager     | Signature<br> |

Issued: January 9, 2014

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

Certificate No: D835V2-4d165\_Jan14

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Accreditation No.: SCS 108

**Glossary:**

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

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

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

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

**Measurement Conditions**

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.7     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| 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 | 40.7 $\pm$ 6 % | 0.91 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

**SAR result with Head TSL**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                          | 250 mW input power | 2.34 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 9.24 W/kg $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                            | 250 mW input power | 1.52 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 6.02 W/kg $\pm$ 16.5 % (k=2) |

**Body TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 55.2           | 0.97 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 56.8 $\pm$ 6 % | 1.01 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

**SAR result with Body TSL**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                          | 250 mW input power | 2.46 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 9.58 W/kg $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                            | 250 mW input power | 1.60 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 6.26 W/kg $\pm$ 16.5 % (k=2) |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 50.6 $\Omega$ - 3.8 $j\Omega$ |
| Return Loss                          | - 28.4 dB                     |

### Antenna Parameters with Body TSL

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 47.2 $\Omega$ - 5.7 $j\Omega$ |
| Return Loss                          | - 23.7 dB                     |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.440 ns |
|----------------------------------|----------|

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

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

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

### Additional EUT Data

|                 |                   |
|-----------------|-------------------|
| Manufactured by | SPEAG             |
| Manufactured on | December 28, 2012 |

**DASY5 Validation Report for Head TSL**

Date: 07.01.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d165**

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.91$  S/m;  $\epsilon_r = 40.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.22, 6.22, 6.22); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:**

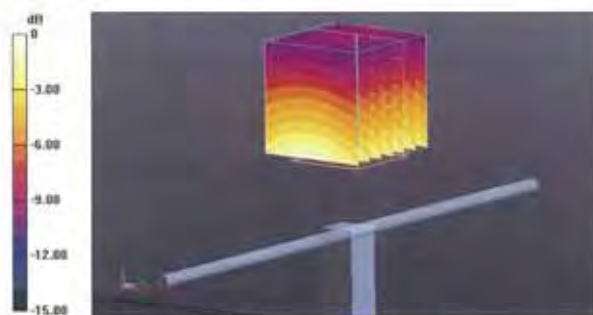
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 60.874 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 3.54 W/kg

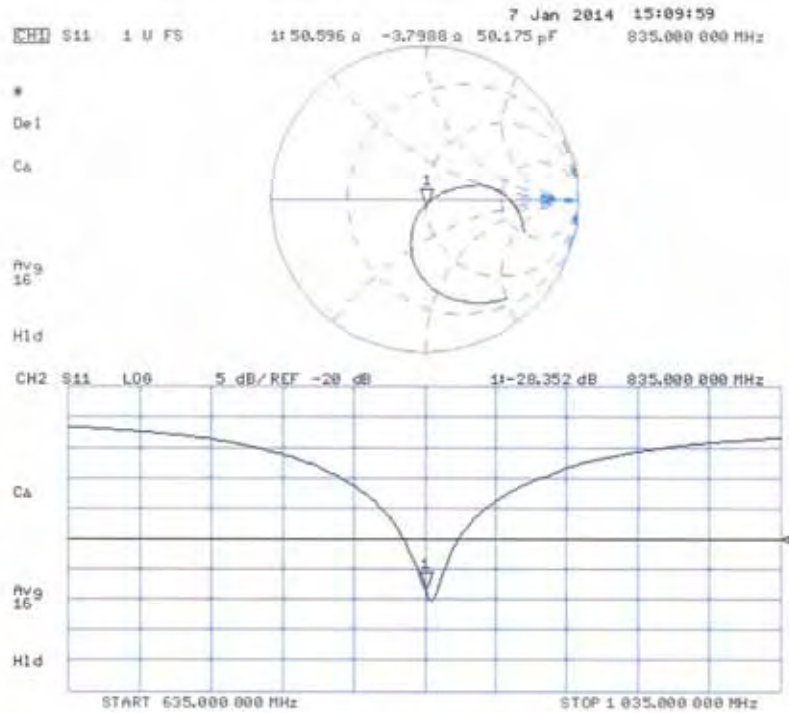
**SAR(1 g) = 2.34 W/kg; SAR(10 g) = 1.52 W/kg**

Maximum value of SAR (measured) = 2.73 W/kg



0 dB = 2.73 W/kg = 4.36 dBW/kg

### Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 07.01.2014

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d165**

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 1.013$  S/m;  $\epsilon_r = 56.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.09, 6.09, 6.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:**

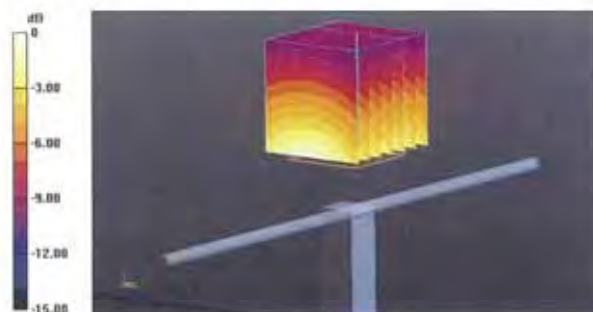
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 60.874 V/m; Power Drift = -0.00 dB

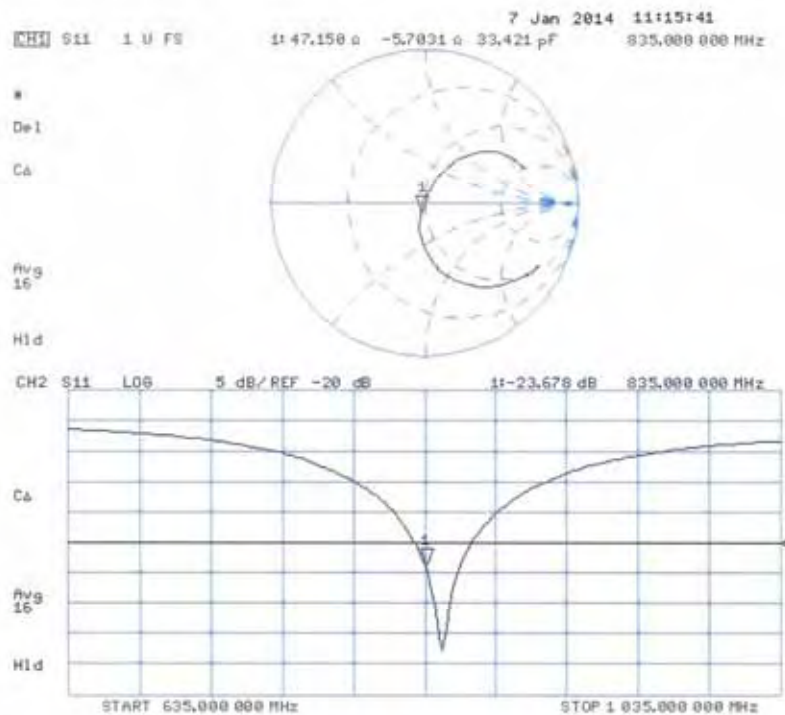
Peak SAR (extrapolated) = 3.66 W/kg

**SAR(1 g) = 2.46 W/kg; SAR(10 g) = 1.6 W/kg**

Maximum value of SAR (measured) = 2.86 W/kg



### Impedance Measurement Plot for Body TSL



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Client HCT (Dymstec)

Certificate No: D1900V2-5d032\_Jul13

## CALIBRATION CERTIFICATE

Object D1900V2 - SN: 5d032

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

Calibration date: July 29, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | GB37480704         | 01-Nov-12 (No. 217-01640)         | Oct-13                 |
| Power sensor HP 8481A       | US37292783         | 01-Nov-12 (No. 217-01640)         | Oct-13                 |
| Reference 20 dB Attenuator  | SN: 5058 (20K)     | 04-Apr-13 (No. 217-01736)         | Apr-14                 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 04-Apr-13 (No. 217-01739)         | Apr-14                 |
| Reference Probe ES3DV3      | SN: 3205           | 28-Dec-12 (No. ES3-3205_Dec12)    | Dec-13                 |
| DAE4                        | SN: 601            | 25-Apr-13 (No. DAE4-601_Apr13)    | Apr-14                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power sensor HP 8481A       | MY41092317         | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

|                |                |                       |           |
|----------------|----------------|-----------------------|-----------|
|                | Name           | Function              | Signature |
| Calibrated by: | Israa El-Naouq | Laboratory Technician |           |
| Approved by:   | Katja Pokovic  | Technical Manager     |           |

Issued: July 30, 2013

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Certificate No: D1900V2-5d032\_Jul13

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Accreditation No.: SCS 108

**Glossary:**

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

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

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

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

**Measurement Conditions**

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.7     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 1900 MHz $\pm$ 1 MHz   |             |

**Head TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 40.0           | 1.40 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 38.9 $\pm$ 6 % | 1.36 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

**SAR result with Head TSL**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                          | 250 mW input power | 9.91 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 40.1 W/kg $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                            | 250 mW input power | 5.21 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 21.0 W/kg $\pm$ 16.5 % (k=2) |

**Body TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 53.3           | 1.52 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 53.4 $\pm$ 6 % | 1.49 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

**SAR result with Body TSL**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                          | 250 mW input power | 10.0 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 40.5 W/kg $\pm$ 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                            | 250 mW input power | 5.34 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.5 W/kg $\pm$ 16.5 % (k=2) |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $51.1 \Omega + 5.3 j\Omega$ |
| Return Loss                          | - 25.5 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $46.8 \Omega + 5.4 j\Omega$ |
| Return Loss                          | - 23.7 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.193 ns |
|----------------------------------|----------|

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

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

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

### Additional EUT Data

|                 |                |
|-----------------|----------------|
| Manufactured by | SPEAG          |
| Manufactured on | March 17, 2003 |

## DASY5 Validation Report for Head TSL

Date: 29.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d032**

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

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.36$  S/m;  $\epsilon_r = 38.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.98, 4.98, 4.98); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

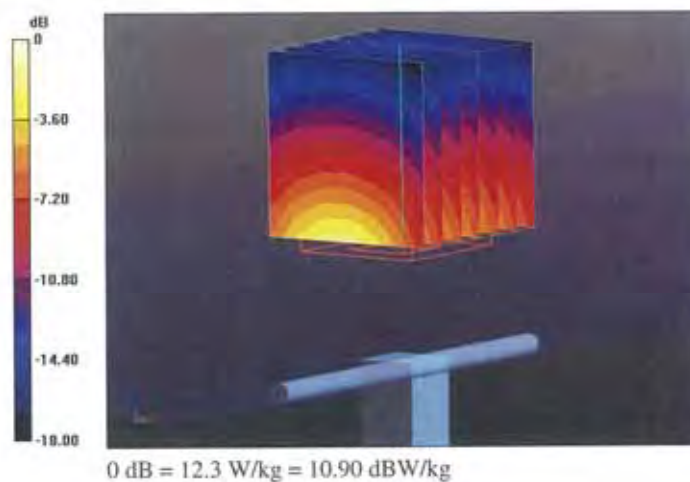
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.191 V/m; Power Drift = 0.04 dB

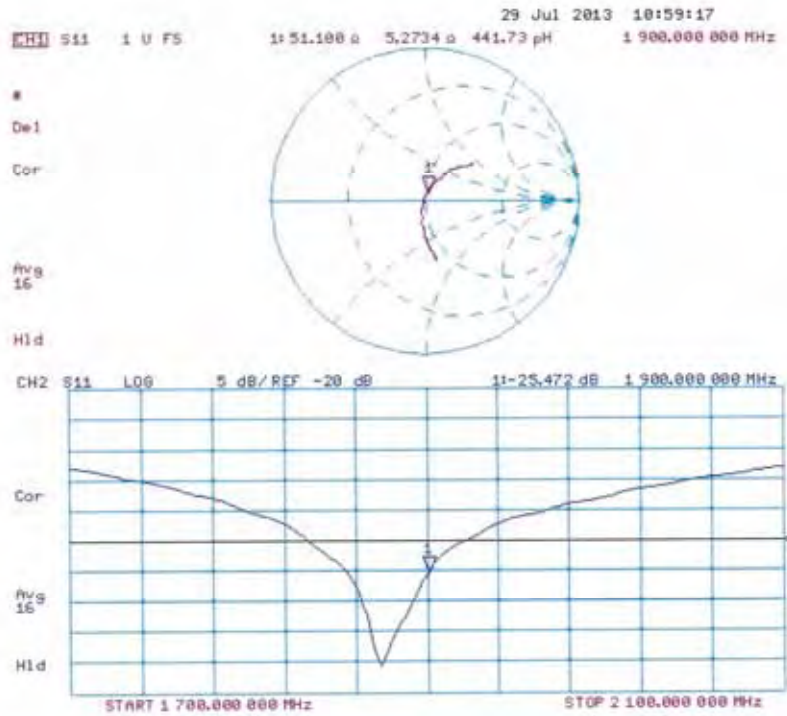
Peak SAR (extrapolated) = 17.9 W/kg

**SAR(1 g) = 9.91 W/kg; SAR(10 g) = 5.21 W/kg**

Maximum value of SAR (measured) = 12.3 W/kg



### Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 29.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d032**

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

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.49$  S/m;  $\epsilon_r = 53.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

**DASY52 Configuration:**

- Probe: ES3DV3 - SN3205; ConvF(4.6, 4.6, 4.6); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

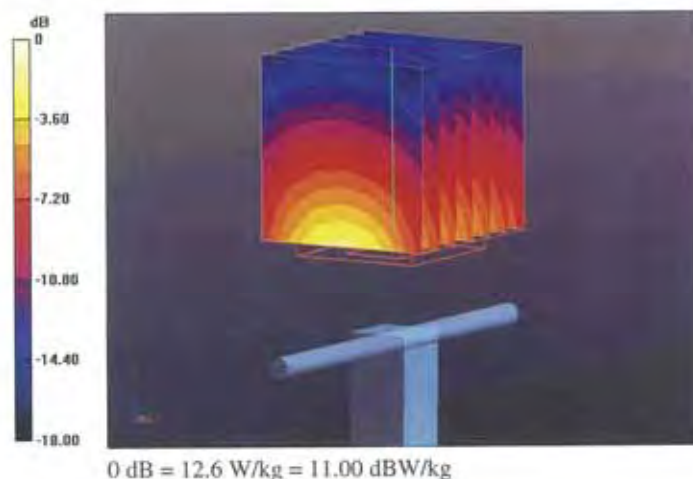
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.191 V/m; Power Drift = 0.01 dB

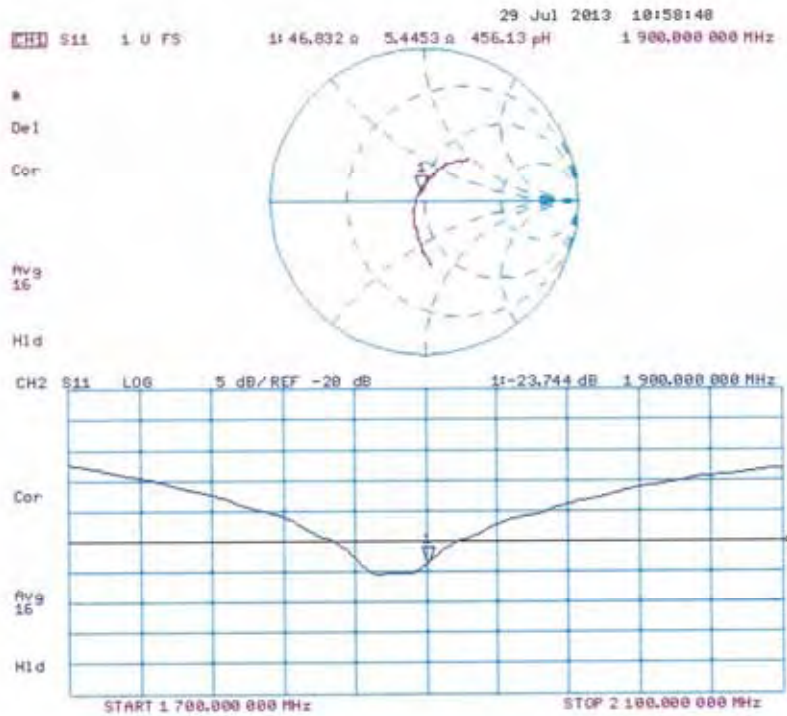
Peak SAR (extrapolated) = 17.1 W/kg

**SAR(1 g) = 10 W/kg; SAR(10 g) = 5.34 W/kg**

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



### Impedance Measurement Plot for Body TSL



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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client HCT (Dymstec)

Certificate No: D2450V2-743\_Aug13

## CALIBRATION CERTIFICATE

Object D2450V2 - SN: 743

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

Calibration date: August 23, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | GB37480704         | 01-Nov-12 (No. 217-01640)         | Oct-13                 |
| Power sensor HP 8481A       | US37292783         | 01-Nov-12 (No. 217-01640)         | Oct-13                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 04-Apr-13 (No. 217-01736)         | Apr-14                 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 04-Apr-13 (No. 217-01739)         | Apr-14                 |
| Reference Probe ES3DV3      | SN: 3205           | 28-Dec-12 (No. ES3-3205_Dec12)    | Dec-13                 |
| DAE4                        | SN: 601            | 25-Apr-13 (No. DAE4-601_Apr13)    | Apr-14                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power sensor HP 8481A       | MY41092317         | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

|                |                        |                                   |               |
|----------------|------------------------|-----------------------------------|---------------|
| Calibrated by: | Name<br>Jeton Kastrati | Function<br>Laboratory Technician | Signature<br> |
| Approved by:   | Name<br>Katja Pokovic  | Function<br>Technical Manager     | Signature<br> |

Issued: August 23, 2013

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

Certificate No: D2450V2-743\_Aug13

Page 1 of 8

Calibration Laboratory of  
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Accreditation No.: SCS 108

#### Glossary:

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

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

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

- DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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

### Measurement Conditions

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.7     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 2450 MHz $\pm$ 1 MHz   |             |

### Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 37.8 $\pm$ 6 % | 1.80 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

### SAR result with Head TSL

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL   | Condition          |                              |
| SAR measured                                            | 250 mW input power | 13.3 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 52.8 W/kg $\pm$ 17.0 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 6.18 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.6 W/kg $\pm$ 16.5 % (k=2) |

### Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 52.7           | 1.95 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 50.6 $\pm$ 6 % | 2.03 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

### SAR result with Body TSL

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL   | Condition          |                              |
| SAR measured                                            | 250 mW input power | 13.0 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 50.5 W/kg $\pm$ 17.0 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 6.01 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 23.6 W/kg $\pm$ 16.5 % (k=2) |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $53.9 \Omega + 4.2 j\Omega$ |
| Return Loss                          | - 25.1 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $50.0 \Omega + 5.5 j\Omega$ |
| Return Loss                          | - 25.2 dB                   |

### General Antenna Parameters and Design

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

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

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

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

### Additional EUT Data

|                 |                   |
|-----------------|-------------------|
| Manufactured by | SPEAG             |
| Manufactured on | December 01, 2003 |

**DASY5 Validation Report for Head TSL**

Date: 22.08.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 743**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.8$  S/m;  $\epsilon_r = 37.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

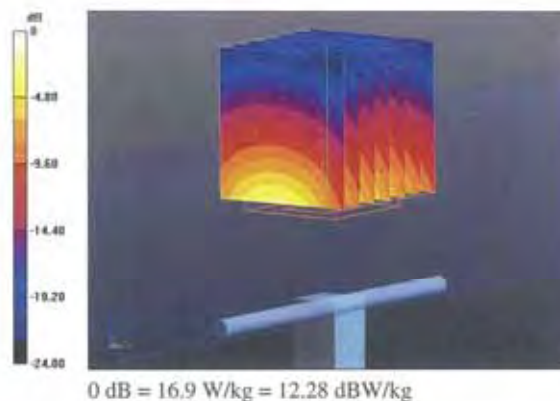
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.4 V/m; Power Drift = 0.06 dB

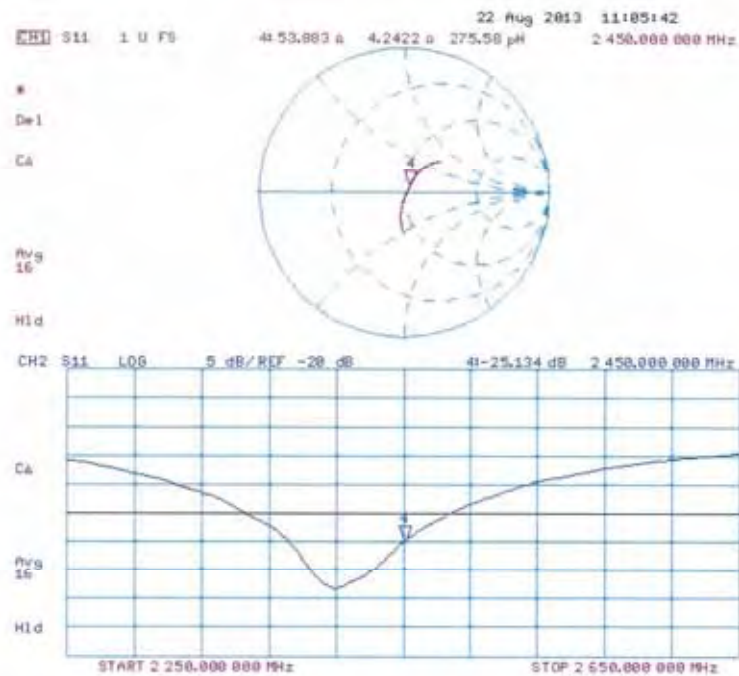
Peak SAR (extrapolated) = 27.8 W/kg

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

Maximum value of SAR (measured) = 16.9 W/kg



Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 23.08.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 743**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 50.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

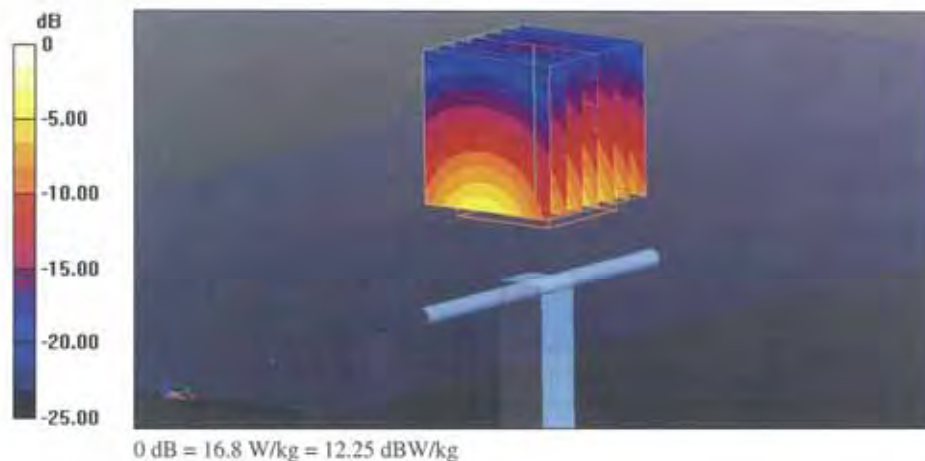
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.835 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.3 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 6.01 W/kg

Maximum value of SAR (measured) = 16.8 W/kg



Impedance Measurement Plot for Body TSL

