

## SAR TEST REPORT

**SAMSUNG Electronics Co., Ltd.**

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**Date of Issue: Jul. 15, 2015**

**Test Report No.: HCT-A-1507-F003**

**Test Site: HCT CO., LTD.**

**FCC ID:**

**A3LSMJ110F**

**Equipment Type:**

**Model Name:**

**Additional Model Name:**

**Mobile Phone**

**SM-J110F**

**SM-J110F/DS**

**Testing has been carried out in accordance with:**

**47CFR §2.1093**

**ANSI/ IEEE C95.1 – 1992**

**IEEE 1528-2003**

**Date of Test:**

**July 10 ~ July 14, 2015**

This device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in FCC KDB procedures and had been tested in accordance with the measurement procedures specified in FCC KDB procedures.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

**Tested By**



**Yun-Jeang Heo**  
**Test Engineer / SAR Team**  
**Certification Division**

**Reviewed By**



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**Certification Division**

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## Version

| Rev.            | DATE         | DESCRIPTION           |
|-----------------|--------------|-----------------------|
| HCT-A-1507-F003 | Jul 15, 2015 | First Approval Report |

# Table of Contents

|                                                                   |              |
|-------------------------------------------------------------------|--------------|
| <b>1. INTRODUCTION .....</b>                                      | <b>4</b>     |
| <b>2. TEST METHODOLOGY .....</b>                                  | <b>5</b>     |
| <b>3. DESCRIPTION OF DEVICE.....</b>                              | <b>6</b>     |
| <b>4. DESCRIPTION OF TEST EQUIPMENT .....</b>                     | <b>8</b>     |
| <b>5. SAR MEASUREMENT PROCEDURE.....</b>                          | <b>1 6</b>   |
| <b>6. DESCRIPTION OF TEST POSITION.....</b>                       | <b>1 8</b>   |
| <b>7. MEASUREMENT UNCERTAINTY .....</b>                           | <b>2 0</b>   |
| <b>8. ANSI/ IEEE C95.1 - 1992 RF EXPOSURE LIMITS .....</b>        | <b>2 1</b>   |
| <b>9. SAR SYSTEM VALIDATION.....</b>                              | <b>2 2</b>   |
| <b>10. SYSTEM VERIFICATION.....</b>                               | <b>2 3</b>   |
| <b>11. RF CONDUCTED POWER MEASUREMENT .....</b>                   | <b>2 5</b>   |
| <b>11.6 SAR Test Exclusions Applied .....</b>                     | <b>3 6</b>   |
| <b>12. SAR Test configuration &amp; Antenna Information .....</b> | <b>3 8</b>   |
| <b>13. SAR TEST DATA SUMMARY .....</b>                            | <b>3 9</b>   |
| 13.1-1 Measurement Results (GSM850 Head SAR) .....                | 3 9          |
| 13.1-2 Measurement Results (GSM1900 Head SAR) .....               | 3 9          |
| 13.1-3 Measurement Results (WCDMA850 Head SAR).....               | 3 9          |
| 13.1-4 Measurement Results (LTE Band 5 10MHz Head SAR) .....      | 4 0          |
| 13.1-5 Measurement Results (DTS Head SAR) .....                   | 4 0          |
| 13.2-1 Measurement Results (GSM850 Hotspot SAR).....              | 4 1          |
| 13.2-2 Measurement Results (GSM1900 Hotspot SAR).....             | 4 1          |
| 13.2-3 Measurement Results (WCDMA850 Hotspot SAR).....            | 4 1          |
| 13.2-4 Measurement Results (LTE Band 5 10MHz Hotspot SAR) .....   | 4 2          |
| 13.2-5 Measurement Results (WLAN Hotspot SAR) .....               | 4 2          |
| 13.3-1 Measurement Results (DTS Body-worn SAR).....               | 4 3          |
| 13.3-2 Measurement Results (Body-worn SAR) .....                  | 4 3          |
| 13.3 SAR Test Notes .....                                         | 4 4          |
| <b>14. SAR Measurement Variability and Uncertainty .....</b>      | <b>4 7</b>   |
| <b>15. SAR Summation Scenario .....</b>                           | <b>4 8</b>   |
| <b>16. CONCLUSION.....</b>                                        | <b>5 2</b>   |
| <b>17. REFERENCES .....</b>                                       | <b>5 3</b>   |
| <b>Attachment 1. – SAR Test Plots .....</b>                       | <b>5 4</b>   |
| <b>Attachment 2. – Dipole Verification Plots.....</b>             | <b>6 8</b>   |
| <b>Attachment 3. – Probe Calibration Data .....</b>               | <b>7 6</b>   |
| <b>Attachment 4. – Dipole Calibration Data .....</b>              | <b>1 1 0</b> |

# 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

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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 3G SAR Procedures v03
- FCC KDB Publication 941225 D06 Hot Spot SAR v02
- FCC KDB Publication 941225 D05 SAR for LTE Devices v02r03
- FCC KDB Publication 248227 D01 802.11 Wi-Fi SAR v02r01
- FCC KDB Publication 447498 D01 General SAR Guidance v05r02
- 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)
- April 2015 TCB Workshop Notes (Simultaneous transmission summation clarified)

### 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:                                 | A3LSMJ110F                                                               |                  |                 |                        |           |         |
| Model:                                  | SM-J110F                                                                 |                  |                 |                        |           |         |
| Additional Model Name:                  | SM-J110F/DS                                                              |                  |                 |                        |           |         |
| Trade Name:                             | SAMSUNG Electronics Co., Ltd.                                            |                  |                 |                        |           |         |
| Application Type:                       | Certification                                                            |                  |                 |                        |           |         |
| Hardware Version:                       | REV1.0                                                                   |                  |                 |                        |           |         |
| Software Version :                      | J110F.001                                                                |                  |                 |                        |           |         |
| Wireless Technologies                   | GSM 850/1900, WCDMA 850, LTE 5, BT 3.0/LE, 802.11 b/g/n                  |                  |                 |                        |           |         |
| GPRS/EDGE Class                         | Multi-slot Class 12, Mode Class B                                        |                  |                 |                        |           |         |
| WCDMA                                   | Band 5 : UMTS Rel.99 (Voice & Data) HSDPA (Rel.7 Cat .14) ,HSUPA (Rel.6) |                  |                 |                        |           |         |
| LTE (FDD)                               | Band 5 ( Rel.9)                                                          |                  |                 |                        |           |         |
| Production Unit or Identical Prototype: |                                                                          | Prototype        |                 |                        |           |         |
| Max. SAR:                               | Band                                                                     | Tx. Frequency    | Equipment Class | Reported 1g SAR (W/Kg) |           |         |
|                                         |                                                                          | (MHz)            |                 | Head                   | Body-Worn | Hotspot |
|                                         | GSM/GPRS/EDGE 850                                                        | 824.2 - 848.8    | PCE             | 0.80                   | 0.89      | 0.65    |
|                                         | GSM/GPRS/EDGE 1900                                                       | 1 850.2 -1 909.8 | PCE             | 0.75                   | 0.60      | 0.54    |
|                                         | WCDMA 850                                                                | 826.4 - 846.6    | PCE             | 0.58                   | 0.65      | 0.65    |
|                                         | LTE 5                                                                    | 824.7 - 843      | PCE             | 0.58                   | 0.62      | 0.62    |
|                                         | 802.11b                                                                  | 2 412 ~ 2 462    | DTS             | 0.33                   | 0.04      | 0.07    |
|                                         | Bluetooth                                                                | 2 402 ~ 2 480    | DSS/DTS         | -                      | 0.10*     | -       |
|                                         | Simultaneous SAR per KDB 690783 D01v01r03                                |                  |                 | 1.12                   | 0.99      |         |
| Date(s) of Tests:                       | July 10, 2015 ~ July 14, 2015                                            |                  |                 |                        |           |         |

Note :

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

### 3.1 LTE information

| Item.                                                                                                                                             |             | Description                                                                                                                              |             |                                                                  |             |        |             |
|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------------------------------------------------------------|-------------|--------|-------------|
| Frequency Range:                                                                                                                                  |             | Band 5: 824.7 MHz ~ 848.3 MHz                                                                                                            |             |                                                                  |             |        |             |
| Channel Bandwidths                                                                                                                                |             | Band 5: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz                                                                                                    |             |                                                                  |             |        |             |
| Channel Number s& Frequencies(MHz):                                                                                                               |             |                                                                                                                                          |             |                                                                  |             |        |             |
| Band 5                                                                                                                                            |             |                                                                                                                                          |             |                                                                  |             |        |             |
| 1.4 MHz                                                                                                                                           |             | 3 MHz                                                                                                                                    |             | 5 MHz                                                            |             | 10 MHz |             |
| Ch.                                                                                                                                               | Freq. (MHz) | Ch.                                                                                                                                      | Freq. (MHz) | Ch.                                                              | Freq. (MHz) | Ch.    | Freq. (MHz) |
| 20407                                                                                                                                             | 824.7       | 20415                                                                                                                                    | 825.5       | 20425                                                            | 826.5       | 20450  | 829.0       |
| 20525                                                                                                                                             | 836.5       | 20525                                                                                                                                    | 836.5       | 20525                                                            | 836.5       | 20525  | 836.5       |
| 20643                                                                                                                                             | 848.3       | 20635                                                                                                                                    | 847.5       | 20625                                                            | 846.5       | 20600  | 844.0       |
| UE Category                                                                                                                                       |             | UE Category 4                                                                                                                            |             |                                                                  |             |        |             |
| Modulations Supported in UL                                                                                                                       |             | QPSK, 16QAM                                                                                                                              |             |                                                                  |             |        |             |
| Description of the LTE Transmitter & antenna                                                                                                      |             | This model has two Tx. paths.                                                                                                            |             |                                                                  |             |        |             |
|                                                                                                                                                   |             | One is for GSM and WCDMA and LTE. It can not transmit simultaneously.                                                                    |             |                                                                  |             |        |             |
|                                                                                                                                                   |             | The other is for BT & WLAN. It can not transmit simultaneously.                                                                          |             |                                                                  |             |        |             |
|                                                                                                                                                   |             | For Antenna description, please find the section 12.1 for antenna information.                                                           |             |                                                                  |             |        |             |
| LTE voice/data requirements                                                                                                                       |             | Data Only,                                                                                                                               |             |                                                                  |             |        |             |
|                                                                                                                                                   |             | LTE voice is available via VoIP.<br>Considering the users may install 3rd party software to enable VoIP, LTE Head SAR is also evaluated. |             |                                                                  |             |        |             |
| Identify if MPR is optional or mandatory optional or mandatory                                                                                    |             | The EUT incorporates MPR as per 3GPP TS 36.101 sec. 6.2.3 ~ 6.2.5                                                                        |             |                                                                  |             |        |             |
|                                                                                                                                                   |             | The MPR is permanently built-in by design as a mandatory.                                                                                |             |                                                                  |             |        |             |
|                                                                                                                                                   |             | A-MPR is not implemented in the DUT.                                                                                                     |             |                                                                  |             |        |             |
|                                                                                                                                                   |             | See section 11.4 RF output power measurements in the SAR report.                                                                         |             |                                                                  |             |        |             |
| Maximum average conducted output power(dBm) Identify all other U.S. wireless operating modes, device exposure configurations and frequency bands. |             |                                                                                                                                          |             | GSM850/ GSM1900, WCDMA850 ,LTE 5                                 |             |        |             |
|                                                                                                                                                   |             |                                                                                                                                          |             | Head & Body SAR are required.                                    |             |        |             |
| Maximum average conducted output power for other Wireless mode and frequency                                                                      |             |                                                                                                                                          |             | See section 11.4 RF output power measurements in the SAR report. |             |        |             |
| Simultaneous Transmission condition                                                                                                               |             | This device supports simultaneous transmission. Please find the section 15.                                                              |             |                                                                  |             |        |             |
| Power reduction explanation                                                                                                                       |             | This device doesn't implements power reduction.                                                                                          |             |                                                                  |             |        |             |
| Description of the test equipment, software, etc.                                                                                                 |             | LTE SAR Testing was performed using a CMW500.<br>UE transmits with maximum output power during SAR testing.                              |             |                                                                  |             |        |             |

## 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.

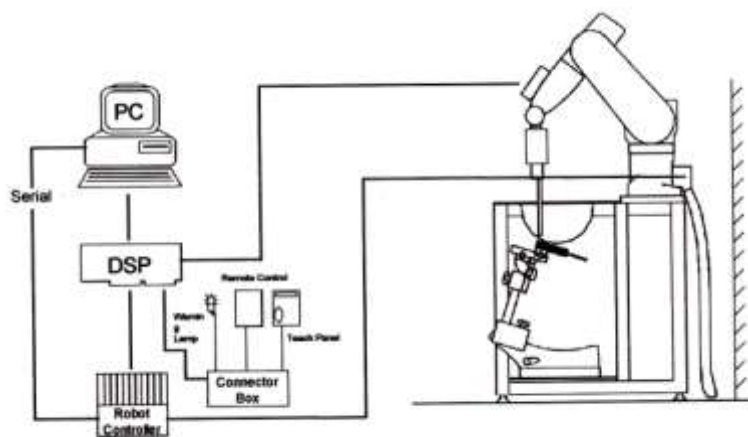


Figure 2. HCT SAR Lab. Test Measurement Set-up

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

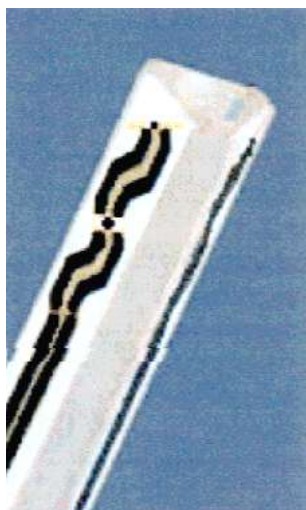


Figure 4. ET3DV6 E-field Probe

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 multiter 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)

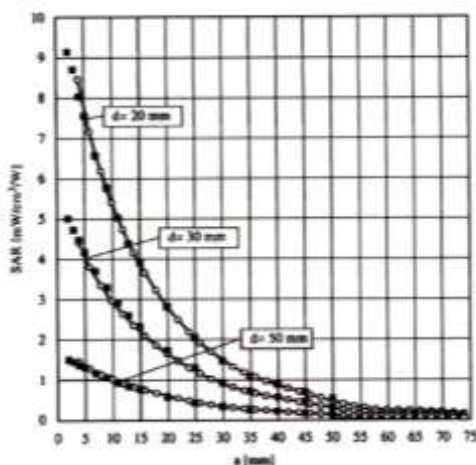


Figure 7. E-Field and Temperature measurements at 900 MHz

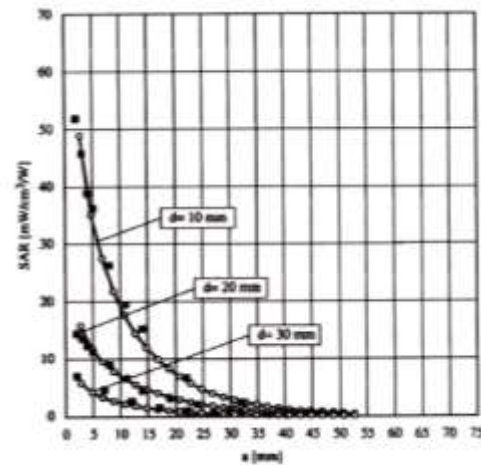


Figure 8. E-Field and temperature measurements at 1.8 GHz

### 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.

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

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   | alib.Interval | Calib.Due     |
|--------------|-------------------------------|-----------------|---------------|---------------|---------------|
| SPEAG        | SAM Phantom                   | -               | N/A           | N/A           | N/A           |
| SPEAG        | Triple Modular Phantom        | -               | N/A           | N/A           | N/A           |
| Staubli      | Robot TX90 XLspeag            | F13/5R4XF1/A/01 | N/A           | N/A           | N/A           |
| Staubli      | CS8Cspeag-TX90                | F13/5R4XF1/C/01 | N/A           | N/A           | N/A           |
| HP           | Pavilion t000_puffer          | KRJ51201TV      | N/A           | N/A           | N/A           |
| SPEAG        | Light Alignment Sensor        | 273             | N/A           | N/A           | N/A           |
| Staubli      | Teach Pendant (Joystick)      | D22134001 1     | N/A           | N/A           | N/A           |
| SPEAG        | DAE3                          | 446             | Jan. 21, 2015 | Annual        | Jan. 21, 2016 |
| SPEAG        | DAE4                          | 648             | Apr. 28, 2015 | Annual        | Apr. 28, 2016 |
| SPEAG        | DAE4                          | 869             | Sep. 18, 2014 | Annual        | Sep. 18, 2015 |
| SPEAG        | E-Field Probe EX3DV4          | 3797            | Nov. 19, 2014 | Annual        | Nov. 19, 2015 |
| SPEAG        | E-Field Probe EX3DV4          | 3967            | Dec. 22, 2014 | Annual        | Dec. 22, 2015 |
| SPEAG        | E-Field Probe EX3DV4          | 3968            | Jun. 18, 2015 | Annual        | Jun. 18, 2016 |
| SPEAG        | Dipole D835V2                 | 441             | Jan. 23, 2015 | Annual        | Jan. 23, 2016 |
| SPEAG        | Dipole D1900V2                | 5d032           | May 20, 2015  | Annual        | May 20, 2016  |
| SPEAG        | Dipole D2450V2                | 743             | May 19, 2015  | Annual        | May 19, 2016  |
| Agilent      | Power Meter(F) E4419B         | MY41291386      | Oct. 27, 2014 | Annual        | Oct. 27, 2015 |
| Agilent      | Power Sensor(G) 8481          | MY41090680      | Oct. 27, 2014 | Annual        | Oct. 27, 2015 |
| SPEAG        | DAKS 3.5                      | 1038            | May 26, 2015  | Annual        | May 26, 2016  |
| HP           | Dual Directional Coupler 778D | 16072           | Oct. 27, 2014 | Annual        | Oct. 27, 2015 |
| Agilent      | Base Station E5515C           | GB44400269      | Feb. 09, 2015 | Annual        | Feb. 09, 2016 |
| HP           | Signal Generator 8664A        | 3744A02069      | Oct. 27, 2014 | Annual        | Oct. 27, 2015 |
| Agilent      | N9020A/ SIGNAL ANALYZER       | MY50510407      | Mar. 23, 2015 | Annual        | Mar. 23, 2016 |
| HP           | Network Analyzer 8753ES       | JP39240221      | Mar. 23, 2015 | Annual        | Mar. 23, 2016 |
| R&S          | Base Station CMW500           | 100990          | Dec. 05, 2014 | Annual        | Dec. 05, 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 DAKS 3.5 to determine the conductivity and permittivity (dielectric constant) of the brain/body-equivalent material.

## 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.

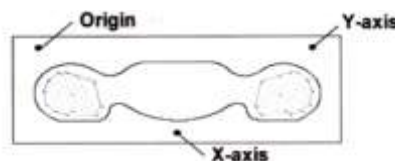


Figure 12. SAR Measurement Point in Area Scan

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: $\Delta z_{Zoom}(n)$                                                                                                                                                                                                                                     |                                                                                      | $3 - 4$ 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 | $3 - 4$ 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.

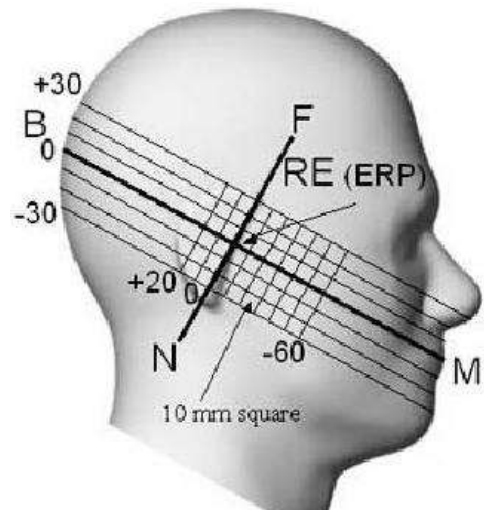


Figure 13. Side view of the phantom

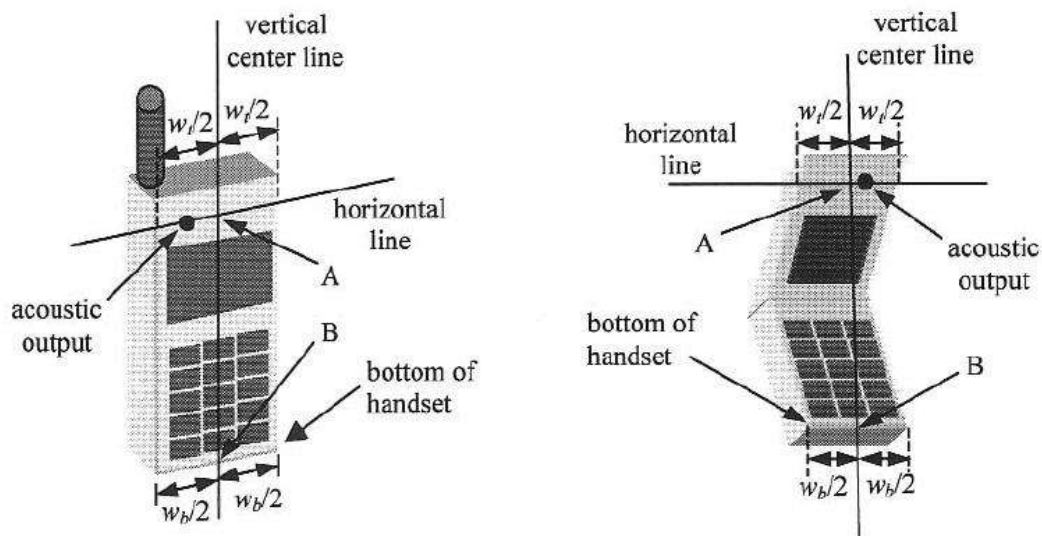


Figure 14. Handset vertical and horizontal reference lines

## **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>(± %) | Prob.<br>dist. | Div. | $c_i$ | Standard<br>Uncertainty<br>(± %) | $V_{eff}$ |
|-------------------------------------|--------------|----------------|------|-------|----------------------------------|-----------|
| <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.)          | 2.50         | N              | 1    | 0.64  | 1.60                             | $\infty$  |
| Liquid Permittivity(target)         | 5.00         | R              | 1.73 | 0.6   | 1.73                             | $\infty$  |
| Liquid Permittivity(meas.)          | 2.50         | N              | 1    | 0.6   | 1.50                             | $\infty$  |
| <b>Combine Standard Uncertainty</b> |              |                |      |       | 10.85                            |           |
| <b>Coverage Factor for 95 %</b>     |              |                |      |       | $k=2$                            |           |
| <b>Expanded STD Uncertainty</b>     |              |                |      |       | 21.70                            |           |

Table 7.1 Uncertainty (800MHz- 2450 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  |
| 9            | 3968  | EX3DV4     | Head                    | 835  | 441    | 2015.6.29 | 41.4                  | 0.9                   | PASS          | PASS            | PASS           | GMSK                  | PASS        | N/A  |
| 9            | 3968  | EX3DV4     | Head                    | 835  | 441    | 2015.6.29 | 41.4                  | 0.9                   | PASS          | PASS            | PASS           | N/A                   | N/A         | N/A  |
| 3            | 3797  | EX3DV4     | Body                    | 835  | 441    | 2015.2.11 | 55.4                  | 0.97                  | PASS          | PASS            | PASS           | GMSK                  | PASS        | N/A  |
| 8            | 3967  | EX3DV4     | Body                    | 835  | 441    | 2015.2.11 | 55.4                  | 0.97                  | PASS          | PASS            | PASS           | N/A                   | N/A         | N/A  |
| 8            | 3967  | EX3DV4     | Body                    | 835  | 441    | 2015.2.11 | 55.4                  | 0.97                  | PASS          | PASS            | PASS           | GMSK                  | PASS        | N/A  |
| 3            | 3797  | EX3DV4     | Head                    | 1900 | 5d032  | 2015.5.28 | 40.1                  | 1.39                  | PASS          | PASS            | PASS           | GMSK                  | PASS        | N/A  |
| 3            | 3797  | EX3DV4     | Body                    | 1900 | 5d032  | 2015.5.29 | 52.4                  | 1.51                  | PASS          | PASS            | PASS           | GMSK                  | PASS        | N/A  |
| 8            | 3967  | EX3DV4     | Head                    | 2450 | 743    | 2015.6.2  | 38.5                  | 1.81                  | PASS          | PASS            | PASS           | OFDM                  | N/A         | PASS |
| 8            | 3967  | EX3DV4     | Body                    | 2450 | 743    | 2015.6.3  | 53.5                  | 1.92                  | PASS          | PASS            | PASS           | OFDM                  | N/A         | PASS |

**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 Temp.<br>[°C] | Parameters   | Target Value | Measured Value | Deviation<br>[%] | Limit<br>[%] |
|----------------|---------------|-------|--------|--------|----------------------|--------------|--------------|----------------|------------------|--------------|
| 820            | Jul. 10, 2015 | 3968  | 441    | Head   | 21.4                 | $\epsilon_r$ | 41.578       | 40.55          | -2.47            | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 0.899        | 0.9046         | 0.62             | $\pm 5$      |
| 835            |               |       |        |        |                      | $\epsilon_r$ | 41.50        | 40.4           | -2.65            | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 0.90         | 0.918          | 2.00             | $\pm 5$      |
| 850            |               |       |        |        |                      | $\epsilon_r$ | 41.50        | 40.18          | -3.18            | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 0.916        | 0.9338         | 1.94             | $\pm 5$      |
| 820            | Jul.10, 2015  | 3797  | 441    | Body   | 21.3                 | $\epsilon_r$ | 55.258       | 56.57          | 2.37             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 0.969        | 0.9399         | -3.00            | $\pm 5$      |
| 835            |               |       |        |        |                      | $\epsilon_r$ | 55.20        | 56.416         | 2.20             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 0.97         | 0.955          | -1.55            | $\pm 5$      |
| 850            |               |       |        |        |                      | $\epsilon_r$ | 55.154       | 56.32          | 2.11             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 0.988        | 0.9718         | -1.64            | $\pm 5$      |
| 820            | Jul. 13 2015  | 3967  | 441    | Body   | 21.8                 | $\epsilon_r$ | 55.258       | 54.2           | -1.91            | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 0.969        | 0.9567         | -1.27            | $\pm 5$      |
| 835            |               |       |        |        |                      | $\epsilon_r$ | 55.20        | 54.179         | -1.85            | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 0.97         | 0.969          | -0.10            | $\pm 5$      |
| 850            |               |       |        |        |                      | $\epsilon_r$ | 55.154       | 54.16          | -1.80            | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 0.988        | 0.9795         | -0.86            | $\pm 5$      |
| 1850           | Jul. 10, 2015 | 3797  | 5d032  | Head   | 21.8                 | $\epsilon_r$ | 40.000       | 38.82          | -2.95            | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.400        | 1.366          | -2.43            | $\pm 5$      |
| 1880           |               |       |        |        |                      | $\epsilon_r$ | 40.000       | 38.685         | -3.29            | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.400        | 1.409          | 0.64             | $\pm 5$      |
| 1 910          |               |       |        |        |                      | $\epsilon_r$ | 40.0         | 38.68          | -3.30            | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.40         | 1.415          | 1.07             | $\pm 5$      |
| 1850           | Jul. 10, 2015 | 3797  | 5d032  | Body   | 21.8                 | $\epsilon_r$ | 53.300       | 55.03          | 3.25             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.520        | 1.5            | -1.32            | $\pm 5$      |
| 1880           |               |       |        |        |                      | $\epsilon_r$ | 53.300       | 54.907         | 3.02             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.520        | 1.554          | 2.24             | $\pm 5$      |
| 1 910          |               |       |        |        |                      | $\epsilon_r$ | 53.30        | 54.9           | 3.00             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.52         | 1.564          | 2.89             | $\pm 5$      |
| 2 401          | Jul. 14, 2015 | 3967  | 743    | Head   | 20.2                 | $\epsilon_r$ | 39.287       | 40.44          | 2.93             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.756        | 1.762          | 0.34             | $\pm 5$      |
| 2 450          |               |       |        |        |                      | $\epsilon_r$ | 39.20        | 40.27          | 2.73             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.80         | 1.822          | 1.22             | $\pm 5$      |
| 2 499          |               |       |        |        |                      | $\epsilon_r$ | 39.138       | 40.08          | 2.41             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.853        | 1.878          | 1.35             | $\pm 5$      |
| 2 401          | Jul. 14, 2015 | 3967  | 743    | Body   | 20.2                 | $\epsilon_r$ | 52.765       | 53.23          | 0.88             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.903        | 1.928          | 1.31             | $\pm 5$      |
| 2 450          |               |       |        |        |                      | $\epsilon_r$ | 52.70        | 52.971         | 0.51             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 1.95         | 1.985          | 1.79             | $\pm 5$      |
| 2 499          |               |       |        |        |                      | $\epsilon_r$ | 52.638       | 52.89          | 0.48             | $\pm 5$      |
|                |               |       |        |        |                      | $\sigma$     | 2.019        | 2.049          | 1.49             | $\pm 5$      |

**NOTE:**

The Head /body simulating material is calibrated by HCT using the DAKS 3.5 to determine the conductivity and permittivity

## 10.2 System Verification

Prior to assessment, the system is verified to the  $\pm 10\%$  of the specifications at / 835 MHz / 1 900 MHz / 2 450 MHz by using the system Verification kit. (Graphic Plots Attached)

### System Verification Results

| Freq. | Date          | Probe (S/N) | Dipole (S/N) | Liquid | Amb. Temp. | Liquid Temp. | 1 W Target SAR <sub>1g</sub> (SPEAG) | Measured SAR <sub>1g</sub> | 1 W Normalized SAR <sub>1g</sub> | Deviation | Limit [%] |
|-------|---------------|-------------|--------------|--------|------------|--------------|--------------------------------------|----------------------------|----------------------------------|-----------|-----------|
| [MHz] |               |             |              |        | [°C]       | [°C]         | [mW/g]                               | [mW/g]                     | [mW/g]                           | [%]       | [%]       |
| 835   | Jul. 10, 2015 | 3968        | 441          | Head   | 21.6       | 21.4         | 9.21                                 | 0.958                      | 9.58                             | 4.02      | $\pm 10$  |
| 835   | Jul. 10, 2015 | 3797        |              | Body   | 21.5       | 21.3         | 9.34                                 | 0.945                      | 9.45                             | 1.18      | $\pm 10$  |
| 835   | Jul. 13, 2015 | 3967        |              | Body   | 22.0       | 21.8         | 9.34                                 | 0.964                      | 9.64                             | 3.21      | $\pm 10$  |
| 1 900 | Jul. 10, 2015 | 3797        | 5d032        | Head   | 22.0       | 21.8         | 41.1                                 | 4.04                       | 40.4                             | -1.70     | $\pm 10$  |
| 1 900 | Jul. 10, 2015 | 3797        |              | Body   | 22.0       | 21.8         | 40.9                                 | 4.03                       | 40.3                             | -1.47     | $\pm 10$  |
| 2 450 | Jul. 14, 2015 | 3967        | 743          | Head   | 20.4       | 20.2         | 53.4                                 | 5.48                       | 54.8                             | 2.62      | $\pm 10$  |
| 2 450 | Jul. 14, 2015 | 3967        |              | Body   | 20.4       | 20.2         | 52.1                                 | 5.30                       | 53                               | 1.73      | $\pm 10$  |

## 10.3 System Verification Procedur

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 865664 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 : 32.5 dBm                   | Target Power : 29.5dBm                    |
| GPRS850                                   | PCS1900                                   |
| GPRS 1tx : 32.5 dBm / EDGE 1tx : 27.5 dBm | GPRS 1tx : 29.5dBm / EDGE 1tx : 25.5 dBm  |
| GPRS 2tx : 29.0 dBm / EDGE 2tx : 25.5 dBm | GPRS 2tx : 27.0 dBm / EDGE 2tx : 24.0 dBm |
| GPRS 3tx : 27.0 dBm / EDGE 3tx : 23.5 dBm | GPRS 3tx : 24.2 dBm / EDGE 3tx : 22.0 dBm |
| GPRS 4tx : 25.0 dBm / EDGE 4tx : 21.5 dBm | GPRS 4tx : 22.5 dBm / EDGE 4tx : 20.0 dBm |
| Tune-up Tolerance : -1.5 dB/ +0.5 dB      |                                           |

#### WCDMA

| WCDMA850                             |                         |
|--------------------------------------|-------------------------|
| 3GPP RMC Rel-99                      | Target Power : 22.5 dBm |
| HSDPA 3GPP Rel.7                     | Target Power : 22.5 dBm |
| HSUPA 3GPP Rel.6                     | Target Power : 22.5 dBm |
| Tune-up Tolerance : -1.5 dB/ +0.5 dB |                         |

#### LTE

| Mode / Band                          | LTE Band 5 |
|--------------------------------------|------------|
| Target Power                         | 22.5 dBm   |
| Tune-up Tolerance : -1.5 dB/ +0.5 dB |            |

## WLAN

| Mode / Band                       | IEEE 802.11 (in dBm) |          |          |          |           |
|-----------------------------------|----------------------|----------|----------|----------|-----------|
|                                   | 802.11 a             | 802.11 b | 802.11 g | 802.11 n | 802.11 ac |
| 2.4 GHz WI-FI                     | N/A                  | 15       | 13       | 11       | N/A       |
| Upper Tune-up Tolerance : +0.5 dB |                      |          |          |          |           |

## Bluetooth

|                                   | Target power (dBm) |
|-----------------------------------|--------------------|
| Bluetooth (in dBm)                | 8                  |
| Bluetooth LE (in dBm)             | 1                  |
| Upper Tune-up Tolerance : +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 worn SAR
- GPRS Multi-slots : Body SAR with GPRS/EDGE Multi-slot Class 12 with CS 1 (GMSK)

### Note;

This EUT'S GSM, GPRS and EDGE device class is B. Per KDB 941225 D01v03, GMSK GPRS and EDGE mode is the primary mode. CS1/MCS7 coding scheme was used in GPRS/EDGE output power measurements and SAR Testing, as a condition where GMSK/8PSK modulation was ensured. Investigation has shown that CS1 - CS4/ MCS5 – MCS9 settings do not have any impact on the output levels in the GPRS/EDGE modes.

GSM Conducted output powers (Burst-Average)

| Band     | Channel | Voice     | GPRS(GMSK) Data – CS1 |                      |                      |                      | EDGE Data            |                      |                      |                      |
|----------|---------|-----------|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|          |         | GSM (dBm) | GPRS 1 TX Slot (dBm)  | GPRS 2 TX Slot (dBm) | GPRS 3 TX Slot (dBm) | GPRS 4 TX Slot (dBm) | EDGE 1 TX Slot (dBm) | EDGE 2 TX Slot (dBm) | EDGE 3 TX Slot (dBm) | EDGE 4 TX Slot (dBm) |
| GSM 850  | 128     | 31.26     | 31.32                 | 27.94                | 26.54                | 24.53                | 27.07                | 25.45                | 23.31                | 21.08                |
|          | 190     | 31.40     | 31.52                 | 28.09                | 26.68                | 24.66                | 26.89                | 25.34                | 22.95                | 20.87                |
|          | 251     | 31.41     | 31.53                 | 28.14                | 26.66                | 24.66                | 27.38                | 25.78                | 23.69                | 21.53                |
| GSM 1900 | 512     | 29.01     | 29.19                 | 26.29                | 24.59                | 22.27                | 25.08                | 23.63                | 21.65                | 19.51                |
|          | 661     | 28.98     | 29.09                 | 26.16                | 24.53                | 22.17                | 24.89                | 23.39                | 21.61                | 19.62                |
|          | 810     | 28.45     | 28.52                 | 25.55                | 23.96                | 21.65                | 24.07                | 22.67                | 20.78                | 18.70                |

GSM Conducted output powers (Frame-Average)

| Band     | Channel | Voice     | GPRS(GMSK) Data – CS1 |                      |                      |                      | EDGE Data            |                      |                      |                      |
|----------|---------|-----------|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|          |         | GSM (dBm) | GPRS 1 TX Slot (dBm)  | GPRS 2 TX Slot (dBm) | GPRS 3 TX Slot (dBm) | GPRS 4 TX Slot (dBm) | EDGE 1 TX Slot (dBm) | EDGE 2 TX Slot (dBm) | EDGE 3 TX Slot (dBm) | EDGE 4 TX Slot (dBm) |
| GSM 850  | 128     | 22.23     | 22.29                 | 21.92                | 22.28                | 21.52                | 18.04                | 19.43                | 19.05                | 18.07                |
|          | 190     | 22.37     | 22.49                 | 22.07                | <b>22.42</b>         | 21.65                | 17.86                | 19.32                | 18.69                | 17.86                |
|          | 251     | 22.38     | 22.50                 | 22.12                | 22.40                | 21.65                | 18.35                | 19.76                | 19.43                | 18.52                |
| GSM 1900 | 512     | 19.98     | 20.16                 | 20.27                | <b>20.33</b>         | 19.26                | 16.05                | 17.61                | 17.39                | 16.50                |
|          | 661     | 19.95     | 20.06                 | 20.14                | 20.27                | 19.16                | 15.86                | 17.37                | 17.35                | 16.61                |
|          | 810     | 19.42     | 19.49                 | 19.53                | 19.70                | 18.64                | 15.04                | 16.65                | 16.52                | 15.69                |

### 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 WCDMA

Body SAR is not required for handsets with HSDPA/HSUPA capabilities when the maximum average output of each RF channel with HSDPA active is less than ¼ dB higher than that measured without HSDPA using 12.2 kbps RMC and the maximum SAR for 12.2 kbps RMC is ≤ 75 % of the SAR limit. Otherwise, SAR is Measured for HSDPA, using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, using the highest body SAR configuration in 12.2 kbps RMC without HSDPA, on the maximum output channel with the body exposure configuration that results in the highest SAR in 12.2 kbps RMC for that RF channel.

### 11.3.1 Output Power Verification

Maximum output power is verified on the High, Middle and Low channels according to the general descriptions in section 5.2 of 3 GPP TS 34.121, using the appropriate RMC or AMR with TPC(transmit power control) set to all “1s”. Maximum output power is verified by applying the applicable versions of 3GPP TS 34.121.

#### Release 99 Setup Procedures used to establish the test signals

The following tests were completed according to the test requirements outlined in section 5.2 of the 3GPP TS34.121-1 specification. The DUT supports power Class 3, which has a nominal maximum output power of 24 dBm (+1.7/-3.7)

| Mode                   | Subtest                 | Rel99        |
|------------------------|-------------------------|--------------|
| WCDMA General Settings | Loopback Mode           | Test Mode 2  |
|                        | Rel99 RMC               | 12.2kbps RMC |
|                        | Power Control Algorithm | Algorithm2   |
|                        | βc/βd                   | 8/15         |
|                        |                         |              |

#### HSDPA Setup Procedures used to establish the test signals

The following 4 Sub-tests were completed according to Release 7 procedures in section 5.2 of 3GPP TS34.121. A summary of these settings are illustrated below:

|                         | Mode                                 | HSDPA        |       |       |       |
|-------------------------|--------------------------------------|--------------|-------|-------|-------|
|                         | Subtest                              | 1            | 2     | 3     | 4     |
| WCDMA General Settings  | Loopback Mode                        | Test Mode 1  |       |       |       |
|                         | Rel99 RMC                            | 12.2kbps RMC |       |       |       |
|                         | HSDPA FRC                            | H-Set 1      |       |       |       |
|                         | Power Control Algorithm              | Algorithm 2  |       |       |       |
|                         | βc                                   | 2/15         | 11/15 | 15/15 | 15/15 |
|                         | βd                                   | 15/15        | 15/15 | 8/15  | 4/15  |
|                         | Bd (SF)                              | 64           |       |       |       |
|                         | βc/βd                                | 2/15         | 12/15 | 15/8  | 15/4  |
|                         | βhs                                  | 4/15         | 24/15 | 30/15 | 30/15 |
|                         | MPR (dB)                             | 0            | 0     | 0.5   | 0.5   |
| HSDPA Specific Settings | DACK                                 | 8            |       |       |       |
|                         | DNAK                                 | 8            |       |       |       |
|                         | DCQI                                 | 8            |       |       |       |
|                         | Ack-Nack repetition factor           | 3            |       |       |       |
|                         | CQI Feedback (Table 5.2B.4)          | 4ms          |       |       |       |
|                         | CQI Repetition Factor (Table 5.2B.4) | 2            |       |       |       |
|                         | Ahs=βhs/βc                           | 30/15        |       |       |       |

### **HSPA (HSDPA & HSUPA) Setup Procedures used to establish the test signals**

The following 5 Sub-tests were completed according to Release 6 procedures in section 5.2 of 3GPP TS34.121. A summary of these settings are illustrated below:

|                         | mode                                 | HSPA          |       |       |       |             |
|-------------------------|--------------------------------------|---------------|-------|-------|-------|-------------|
|                         | Subtest                              | 1             | 2     | 3     | 4     | 5           |
| WCDMA General Settings  | Loopback Mode                        | Test Mode 1   |       |       |       |             |
|                         | Rel99 RMC                            | 12.2 kbps RMC |       |       |       |             |
|                         | HSDPA FRC                            | H-Set 1       |       |       |       |             |
|                         | HSUPA Test                           | HSPA          |       |       |       |             |
|                         | Power Control Algorithm              | Algorithm 2   |       |       |       | Algorithm 1 |
|                         | $\beta_c$                            | 11/15         | 6/15  | 15/15 | 2/15  | 15/15       |
|                         | $\beta_d$                            | 15/15         | 15/15 | 9/15  | 15/15 | 0           |
|                         | $\beta_{ec}$                         | 209/225       | 12/15 | 30/15 | 2/15  | 5/15        |
|                         | $\beta_c/\beta_d$                    | 11/15         | 6/15  | 15/9  | 2/15  | 15/1        |
|                         | $\beta_{hs}$                         | 22/15         | 12/15 | 30/15 | 4/15  | 5/15        |
|                         | $\beta_{ed}$                         | 1309/225      | 94/75 | 47/15 | 56/75 | 47/15       |
|                         | CM (dB)                              | 1             | 3     | 2     | 3     | 1           |
|                         | MPR (dB)                             | 0             | 2     | 1     | 2     | 0           |
| HSDPA Specific Settings | DACK                                 | 8             |       |       |       | 0           |
|                         | DNAK                                 | 8             |       |       |       | 0           |
|                         | DCQI                                 | 8             |       |       |       | 0           |
|                         | Ack-Nack repetition factor           | 3             |       |       |       |             |
|                         | CQI Feedback (Table 5.2B.4)          | 4ms           |       |       |       |             |
|                         | CQI Repetition Factor (Table 5.2B.4) | 2             |       |       |       |             |
|                         | $A_{hs} = \beta_{hs}/\beta_c$        | 30/15         |       |       |       |             |
| HSUPA Specific Settings | E-DPDCCH                             | 6             | 8     | 8     | 5     | 7           |
|                         | DHARQ                                | 0             | 0     | 0     | 0     | 0           |
|                         | AG Index                             | 20            | 12    | 15    | 17    | 21          |
|                         | ETFCI (from 34.121 Table C.11.1.3)   | 75            | 67    | 92    | 71    | 81          |
|                         | Associated Max UL Data Rate kbps     | 242.1         | 174.9 | 482.8 | 205.8 | 308.9       |
|                         | Reference E-TFCIs                    | 5             | 5     | 2     | 5     | 1           |
|                         | Reference E-TFCI                     | 11            | 11    | 11    | 11    | 67          |
|                         | Reference E-TFCI PO                  | 4             | 4     | 4     | 4     | 18          |
|                         | Reference E-TFCI                     | 67            | 67    | 92    | 67    | 67          |
|                         | Reference E-TFCI PO                  | 18            | 18    | 18    | 18    | 18          |
|                         | Reference E-TFCI                     | 71            | 71    | 71    | 71    | 71          |
|                         | Reference E-TFCI PO                  | 23            | 23    | 23    | 23    | 23          |
|                         | Reference E-TFCI                     | 75            | 75    | 75    | 75    | 75          |
|                         | Reference E-TFCI PO                  | 26            | 26    | 26    | 26    | 26          |
|                         | Reference E-TFCI                     | 81            | 81    | 81    | 81    | 81          |
|                         | Reference E-TFCI PO                  | 27            | 27    | 27    | 27    | 27          |
|                         | Maximum Channelization Codes         | 2xSF2         |       |       |       | SF4         |

## 11.3.2 Head SAR Measurements

SAR for head exposure configurations is measured using the 12.2 kbps RMC with TPC bits configured to all "1s". SAR in AMR configurations is not required when the maximum average output of each RF channel for 12.2 kbps AMR is less than ¼ dB higher than that measured in 12.2 kbps RMC. Otherwise, SAR is measured on the maximum output channel in 12.2 AMR with a 3.4 kbps SRB (signaling radio bearer) using the exposure configuration that results in the highest SAR for that RF channel in 12.2 RMC.

## 11.3.3 Body SAR Measurement

SAR for body exposure configurations is measured using the 12.2 kbps RMC with the TPC bits all "1s".

### KDB 941225 D01 SAR test for 3G devices:

Body SAR is also measured for HSPA when the maximum average output of each RF channel with HSPA active is at least ¼ dB higher than that measured without HSPA using 12.2 kbps RMC or the maximum SAR for 12.2 kbps RMC is above 75% of the SAR limit. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 with power control algorithm 2.

#### WCDMA850

| 3GPP    | Mode  | 3GPP 34.121   | WCDMA Band V [dBm] |                    |                    |
|---------|-------|---------------|--------------------|--------------------|--------------------|
| Release |       | Subtest       |                    |                    |                    |
| Version |       |               | UL 4132<br>DL 4357 | UL 4183<br>DL 4408 | UL 4233<br>DL 4458 |
| 99      | WCDMA | 12.2 kbps RMC | 22.55              | 22.54              | 22.64              |
| 99      | WCDMA | 12.2 kbps AMR | 21.62              | 21.63              | 21.75              |
| 7       | HSDPA | Subtest 1     | 21.75              | 22.48              | 22.55              |
| 7       |       | Subtest 2     | 22.20              | 22.22              | 22.31              |
| 7       |       | Subtest 3     | 20.81              | 20.83              | 20.94              |
| 7       |       | Subtest 4     | 20.86              | 20.88              | 20.98              |
| 6       | HSUPA | Subtest 1     | 21.83              | 21.81              | 21.91              |
| 6       |       | Subtest 2     | 19.42              | 19.45              | 19.56              |
| 6       |       | Subtest 3     | 21.76              | 21.77              | 21.89              |
| 6       |       | Subtest 4     | 19.57              | 19.61              | 19.71              |
| 6       |       | Subtest 5     | 21.18              | 21.64              | 21.60              |

WCDMA Average Conducted output powers

## 11.4 LTE

SAR testing was performed according to the FCC KDB 941225 D05v02r03 publication.

This DUT is developed base on MPR. The MPR is mandatory.

The device will not operate with any other MPR setting than that stated in the table as indicated.

SAR Testing was performed using a CMW500. UE transmits with Maximum output power during SAR testing.

A-MPR has been disabled for all SAR tests by setting NS=01 on the R&S CMW500.

### - LTE Band 5

| Bandwidth | Modulation | RB Size | RB Offset | Max.Average Power (dBm) |           |           | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|-----------|------------|---------|-----------|-------------------------|-----------|-----------|---------------------------|----------|
|           |            |         |           | 20407                   | 20525     | 20643     |                           |          |
|           |            |         |           | 824.7 MHz               | 836.5 MHz | 848.3 MHz |                           |          |
| 1.4 MHz   | QPSK       | 1       | 0         | 22.11                   | 22.33     | 22.15     | 0                         | 0        |
|           |            | 1       | 3         | 22.12                   | 22.33     | 22.19     | 0                         | 0        |
|           |            | 1       | 5         | 22.14                   | 22.32     | 22.15     | 0                         | 0        |
|           |            | 3       | 0         | 22.2                    | 22.3      | 22.18     | 0                         | 0        |
|           |            | 3       | 1         | 22.23                   | 22.36     | 22.19     | 0                         | 0        |
|           |            | 3       | 3         | 22.18                   | 22.33     | 22.16     | 0                         | 0        |
|           |            | 6       | 0         | 20.18                   | 20.33     | 20.34     | 0-1                       | 1        |
|           | 16QAM      | 1       | 0         | 21.69                   | 21.93     | 21.49     | 0-1                       | 1        |
|           |            | 1       | 3         | 21.65                   | 21.91     | 21.48     | 0-1                       | 1        |
|           |            | 1       | 5         | 21.71                   | 21.93     | 21.54     | 0-1                       | 1        |
|           |            | 3       | 0         | 21.35                   | 21.51     | 21.57     | 0-1                       | 1        |
|           |            | 3       | 1         | 21.33                   | 21.47     | 21.62     | 0-1                       | 1        |
|           |            | 3       | 3         | 21.33                   | 21.46     | 21.56     | 0-1                       | 1        |
|           |            | 6       | 0         | 19.51                   | 19.44     | 19.66     | 0-2                       | 2        |

| Bandwidth | Modulation | RB Size | RB Offset | Max.Average Power (dBm) |           |           | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|-----------|------------|---------|-----------|-------------------------|-----------|-----------|---------------------------|----------|
|           |            |         |           | 20415                   | 20525     | 20635     |                           |          |
|           |            |         |           | 825.5 MHz               | 836.5 MHz | 847.5 MHz |                           |          |
| 3 MHz     | QPSK       | 1       | 0         | 22.19                   | 22.23     | 22.22     | 0                         | 0        |
|           |            | 1       | 7         | 22.21                   | 22.20     | 22.17     | 0                         | 0        |
|           |            | 1       | 14        | 22.24                   | 22.20     | 22.19     | 0                         | 0        |
|           |            | 8       | 0         | 20.13                   | 20.29     | 20.23     | 0-1                       | 1        |
|           |            | 8       | 3         | 20.16                   | 20.30     | 20.26     | 0-1                       | 1        |
|           |            | 8       | 7         | 20.18                   | 20.26     | 20.27     | 0-1                       | 1        |
|           |            | 15      | 0         | 20.05                   | 20.29     | 20.26     | 0-1                       | 1        |
|           | 16QAM      | 1       | 0         | 21.80                   | 21.58     | 21.43     | 0-1                       | 1        |
|           |            | 1       | 7         | 21.85                   | 21.52     | 21.41     | 0-1                       | 1        |
|           |            | 1       | 14        | 21.89                   | 21.55     | 21.36     | 0-1                       | 1        |
|           |            | 8       | 0         | 19.51                   | 19.5      | 19.51     | 0-2                       | 2        |
|           |            | 8       | 3         | 19.50                   | 19.57     | 19.54     | 0-2                       | 2        |
|           |            | 8       | 7         | 19.51                   | 19.56     | 19.49     | 0-2                       | 2        |
|           |            | 15      | 0         | 19.30                   | 19.38     | 19.40     | 0-2                       | 2        |

| Bandwidth | Modulation | RB Size | RB Offset | Max.Average Power (dBm) |           |           | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|-----------|------------|---------|-----------|-------------------------|-----------|-----------|---------------------------|----------|
|           |            |         |           | 20425                   | 20525     | 20625     |                           |          |
|           |            |         |           | 826.5 MHz               | 836.5 MHz | 846.5 MHz |                           |          |
| 5 MHz     | QPSK       | 1       | 0         | 22.15                   | 22.20     | 22.23     | 0                         | 0        |
|           |            | 1       | 12        | 22.21                   | 22.18     | 22.21     | 0                         | 0        |
|           |            | 1       | 24        | 22.19                   | 22.21     | 22.16     | 0                         | 0        |
|           |            | 12      | 0         | 20.10                   | 20.31     | 20.27     | 0-1                       | 1        |
|           |            | 12      | 6         | 20.14                   | 20.25     | 20.25     | 0-1                       | 1        |
|           |            | 12      | 11        | 20.12                   | 20.26     | 20.23     | 0-1                       | 1        |
|           |            | 25      | 0         | 20.08                   | 20.26     | 20.20     | 0-1                       | 1        |
|           | 16QAM      | 1       | 0         | 21.38                   | 21.71     | 21.59     | 0-1                       | 1        |
|           |            | 1       | 12        | 21.42                   | 21.76     | 21.59     | 0-1                       | 1        |
|           |            | 1       | 24        | 21.47                   | 21.70     | 21.59     | 0-1                       | 1        |
|           |            | 12      | 0         | 19.33                   | 19.54     | 19.36     | 0-2                       | 2        |
|           |            | 12      | 6         | 19.34                   | 19.55     | 19.33     | 0-2                       | 2        |
|           |            | 12      | 11        | 19.37                   | 19.53     | 19.33     | 0-2                       | 2        |
|           |            | 25      | 0         | 19.23                   | 19.42     | 19.29     | 0-2                       | 2        |

| Bandwidth | Modulation | RB Size | RB Offset | Max.Average Power (dBm) | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|-----------|------------|---------|-----------|-------------------------|---------------------------|----------|
|           |            |         |           | 20525                   |                           |          |
|           |            |         |           | 836.5 MHz               |                           |          |
| 10 MHz    | QPSK       | 1       | 0         | 22.31                   | 0                         | 0        |
|           |            | 1       | 24        | 22.35                   | 0                         | 0        |
|           |            | 1       | 49        | <b>22.37</b>            | 0                         | 0        |
|           |            | 25      | 0         | 20.23                   | 0-1                       | 1        |
|           |            | 25      | 12        | 20.22                   | 0-1                       | 1        |
|           |            | 25      | 24        | <b>20.25</b>            | 0-1                       | 1        |
|           |            | 50      | 0         | 20.25                   | 0-1                       | 1        |
|           | 16QAM      | 1       | 0         | 21.86                   | 0-1                       | 1        |
|           |            | 1       | 24        | 21.88                   | 0-1                       | 1        |
|           |            | 1       | 49        | 21.90                   | 0-1                       | 1        |
|           |            | 25      | 0         | 19.37                   | 0-2                       | 2        |
|           |            | 25      | 12        | 19.42                   | 0-2                       | 2        |
|           |            | 25      | 24        | 19.41                   | 0-2                       | 2        |
|           |            | 50      | 0         | 19.36                   | 0-2                       | 2        |

**Note:** LTE Band 5 at 10 MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r03, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

## **11.5 WiFi**

### **11.5.1 SAR Testing for 802.11 Transmitters**

#### **General Device Setup**

Normal Network operating configurations are not suitable for measuring the SAR of 802.11 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.

A periodic duty factor is required for current generation SAR systems to measure SAR. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 – 96% is typically achievable in most test mode configurations. A minimum transmission duty factor 85 % is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

#### **Initial Test Position Procedure**

For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is  $\leq 0.4$  W/kg, no additional testing for the remaining test positions is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is  $\leq 0.8$  W/kg or all test positions are measured.

### **2.4 GHz SAR Test Requirements**

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

- 1) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is  $\leq 0.8$  W/kg, no further SAR testing is required for 802.11b DSSS is that exposure configuration.
- 2) When the reported SAR is  $> 0.8$  W/kg, SAR is required for that position using the next highest measured output power channel. When any reported SAR is  $> 1.2$  W/kg, SAR is required for the third channel; i.e., all channels require testing.

2.4 GHz 802.11 g/n OFDM are additionally evaluated for SAR if the highest reported SAR for 802.11b, adjusted by the ratio of the OFDM to DSSS specified maximum output power, is  $> 1.2$  W/kg. When SAR is required for OFDM modes in 2.4 GHz band, the Initial Test Configuration Procedures should be followed.

## OFDM Transmission Mode and SAR Test Channel Selection

For the 2.4 GHz, when the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated bands, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations; for example, 802.11a, 802.11n and 802.11 ac or 802.11 g and 802.11 n with the same channel and 802.11 ac or 802.11g then 802.11n, is used for SAR measurement. When the maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

## Initial Test configuration procedure

For OFDM, 2.4 GHZ, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, and lowest data rate. If the average RF output powers of the highest identical transmission modes are within 0.25 dB of each other, mid channel of the transmission mode with highest average RF output power is the initial test channel. Otherwise, the channel of the transmission mode with the highest average RF output conducted power will be the initial test configuration.

When the reported SAR is  $\leq 0.8$  W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is 1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurements.

## Subsequent Test configuration Procedures

For OFDM configurations in each frequency band and aggregated band, SAR is evaluated for initial test configuration using the fixed test position or the initial test position procedure. When the highest reported SAR (for the initial test configuration), adjusted by the ratio of the specified maximum output power of the subsequent test configuration to initial test configuration, is  $\leq 1.2$  W/kg, no additional SAR test for the subsequent test configurations are required.

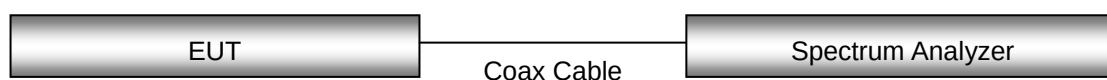
### IEEE 802.11 Average RF Power

| Mode    | Freq. | Channel | 802.11b (2.4 GHz) Conducted Power |
|---------|-------|---------|-----------------------------------|
|         | [MHz] |         | [dBm]                             |
| 802.11b | 2412  | 1       | 15.20                             |
|         | 2437  | 6       | 15.10                             |
|         | 2462  | 11      | 14.50                             |
| 802.11g | 2412  | 1       | 13.40                             |
|         | 2437  | 6       | 13.00                             |
|         | 2462  | 11      | 13.40                             |
| 802.11n | 2412  | 1       | 11.50                             |
|         | 2437  | 6       | 11.40                             |
|         | 2462  | 11      | 11.50                             |

Justification for test configurations for WLAN per KDB Publication 248227 D01v02r01:

- Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
- For transmission mode with the same maximum output power specification, powers were measured for the largest channel bandwidth, lowest order modulation and lowest data rate.
- For transmission modes with identical maximum specified output power, channel bandwidth, modulation and data rates, power measurements were required for all identical configurations.
- For each transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel(s) when there were at least 3 channels supported. For configurations with multiple mid-band channels, due to an even number of channels, both channels were measured.

## Test Configuration



## 11.6 SAR Test Exclusions Applied

### 11.6.1 WCDMA

Per FCC KDB 941225 D01V03, 12.2 kbps RMC is the primary mode and HSPA (HSUPA/HSDPA with RMC) is the secondary mode.

Per KDB 941225 D01V03, The SAR test exclusion is applied to the secondary mode by the following equation.

$$\text{Adjusted SAR} = \text{Highest Reported SAR} * \frac{\text{Secondary Max tune - up (mW)}}{\text{Primary Max tune tune - up(mW)}} \leq 1.2 \text{ W/kg.}$$

Based on the highest Reported SAR, the secondary mode is not required.

$$[0.647 * (200/200)] = 0.647 \text{ W/kg} \leq 1.2 \text{ W/kg}$$

And the maximum output power and tune-up tolerance in secondary mode is  $\leq 0.25$  dB higher than the primary mode.

## 11.6.2 BT & BT LE

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 | Separation Distance | ≤ 3.0 |
|--------------|-----------|-----------------------|---------------------|-------|
|              | [MHz]     | [mW]                  | [mm]                |       |
| Bluetooth    | 2 480     | 7                     | 15                  | 0.73  |
| Bluetooth LE | 2 480     | 1                     | 15                  | 0.10  |

Based on the maximum conducted power of Bluetooth and antenna to use separation distance, Bluetooth SAR was not required  $[(7/15)*\sqrt{2.480}] = 0.73 < 3.0$ .

Based on the maximum conducted power of Bluetooth LE and antenna to use separation distance, Bluetooth LE SAR was not required  $[(1/15)*\sqrt{2.480}] = 0.10 < 3.0$ .

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 | Separation Distance (Body) | Estimated SAR (Body) |
|--------------|-----------|-----------------------|----------------------------|----------------------|
|              | [MHz]     | [mW]                  | [mm]                       | [W/kg]               |
| Bluetooth    | 2 480     | 7                     | 15                         | 0.10                 |
| Bluetooth LE | 2 480     | 1                     | 15                         | 0.01                 |

### Note :

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

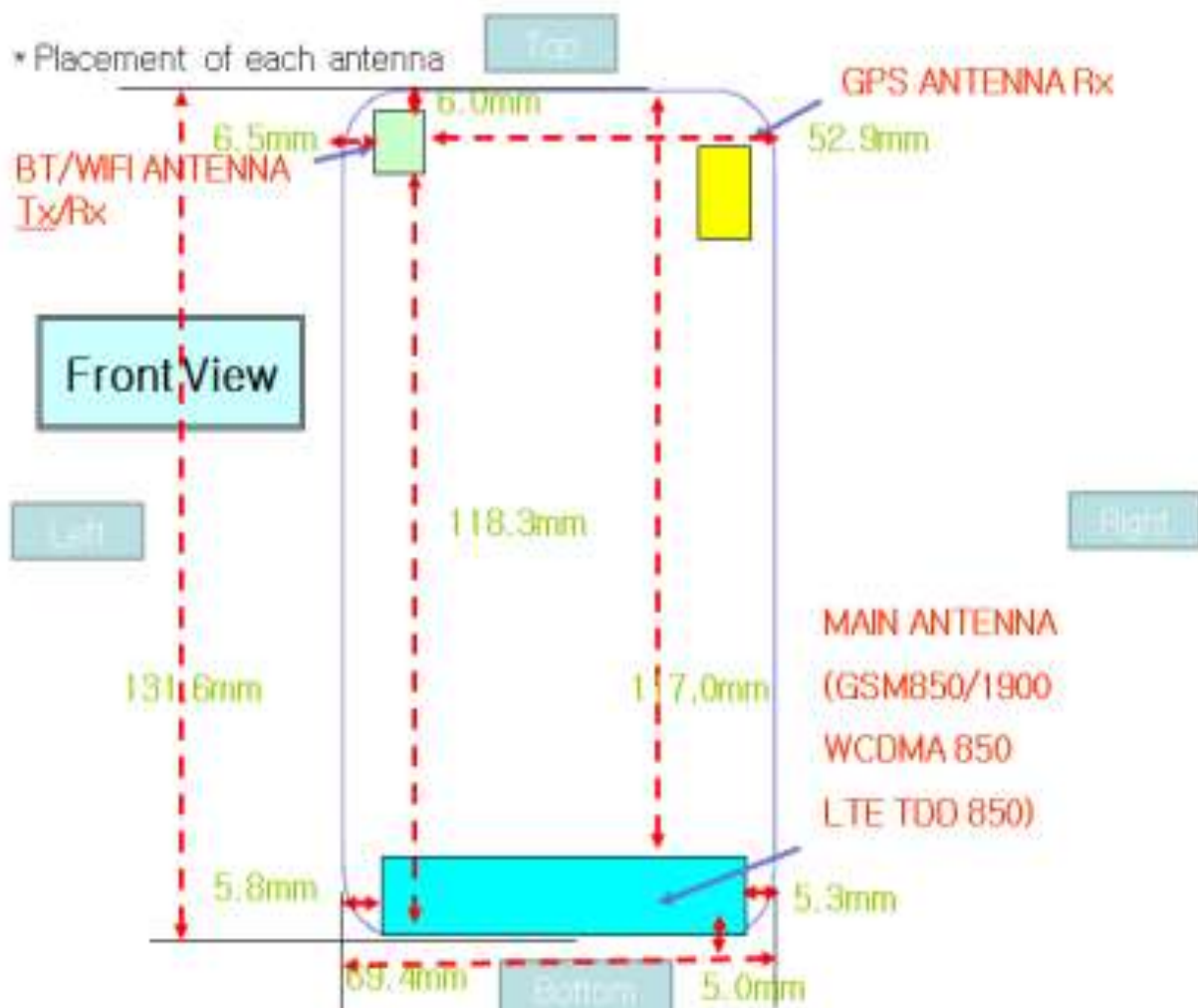
2) The frequency of Bluetooth and Bluetooth LE using for estimated SAR was selected highest channel of Bluetooth LE for highest estimated SAR.

## 12. SAR Test configuration & Antenna Information

| Mode          | Rear | Front | Left | Right | Bottom | Top |
|---------------|------|-------|------|-------|--------|-----|
| GSM/GPRS 850  | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| GSM/GPRS 1900 | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| WCDMA 850     | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| LTE Band 5    | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| 2.4 GHz WLAN  | Yes  | Yes   | Yes  | No    | No     | Yes |

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

### 12.1 Antenna and Device Information



※ The further information of the device antennas can be found in [SM-J110F]\_Ant\_distance\_150624 file. Particular EUT edges were not required to be evaluated for Wireless Router SAR if the edges were > 25 mm from the transmitting antenna according to FCC KDB 941225D06v01 on page 2. The distance between the transmit antennas and the edges of the device are included in the filing. The overall dimensions of this device are > 9 X 5 cm. The overall diagonal dimension of the device is < 160 mm and the diagonal display is < 150 mm.

## 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 | 33.0          | 31.40           | -0.010           | Standard | Left Ear                                        | 0.550              | 1.445          | 0.795             | 1       |
| 836.6                                                                                              | 190 |        | 33.0          | 31.40           | -0.012           | Standard | Left Tilt                                       | 0.295              | 1.445          | 0.426             | -       |
| 836.6                                                                                              | 190 |        | 33.0          | 31.40           | -0.041           | Standard | Right Ear                                       | 0.482              | 1.445          | 0.697             | -       |
| 836.6                                                                                              | 190 |        | 33.0          | 31.40           | 0.055            | Standard | Right Tilt                                      | 0.280              | 1.445          | 0.405             | -       |
| 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 | 30.0          | 28.98           | 0.11             | Standard | Left Ear                                        | 0.278              | 1.265          | 0.352             | -       |
| 1 880.0                                                                                            | 661 |         | 30.0          | 28.98           | 0.14             | Standard | Left Tilt                                       | 0.227              | 1.265          | 0.287             | -       |
| 1 880.0                                                                                            | 661 |         | 30.0          | 28.98           | 0.15             | Standard | Right Ear                                       | 0.596              | 1.265          | <b>0.754</b>      | 2       |
| 1 880.0                                                                                            | 661 |         | 30.0          | 28.98           | -0.06            | Standard | Right Tilt                                      | 0.215              | 1.265          | 0.272             | -       |
| 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 (WCDMA850 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                                                                                              | 4183 | WCDMA 850 | 23.0          | 22.54           | -0.150           | Standard | Left Ear                                        | 0.522              | 1.112          | 0.580             | 3        |
| 836.6                                                                                              | 4183 |           | 23.0          | 22.54           | 0.036            | Standard | Left Tilt                                       | 0.288              | 1.112          | 0.320             | -        |
| 836.6                                                                                              | 4183 |           | 23.0          | 22.54           | 0.167            | Standard | Right Ear                                       | 0.463              | 1.112          | 0.515             | -        |
| 836.6                                                                                              | 4183 |           | 23.0          | 22.54           | 0.074            | Standard | Right Tilt                                      | 0.269              | 1.112          | 0.299             | -        |
| 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 |                    |                |                   |          |

### 13.1-4 Measurement Results (LTE Band 5 10MHz Head SAR)

| Frequency                                                                                         |       | Mode | Power (dBm)   |                 | Power Drift (dB) | Battery  | Phantom Position | RB Size                                         | RB Offset | Measured SAR (mW/g) | Scaling Factor | Scaled SAR (mW/g) | Plot No |
|---------------------------------------------------------------------------------------------------|-------|------|---------------|-----------------|------------------|----------|------------------|-------------------------------------------------|-----------|---------------------|----------------|-------------------|---------|
| MHz                                                                                               | Ch.   |      | Tune-Up Limit | Conducted Power |                  |          |                  |                                                 |           |                     |                |                   |         |
| 836.5                                                                                             | 20525 | QPSK | 23.0          | 22.37           | 0.002            | Standard | Left Ear         | 1                                               | 49        | 0.504               | 1.156          | 0.583             | 4       |
| 836.5                                                                                             | 20525 |      | 22.0          | 20.25           | 0.045            | Standard | Left Ear         | 25                                              | 24        | 0.316               | 1.496          | 0.473             | -       |
| 836.5                                                                                             | 20525 |      | 23.0          | 22.37           | -0.128           | Standard | Left Tilt        | 1                                               | 49        | 0.265               | 1.156          | 0.306             | -       |
| 836.5                                                                                             | 20525 |      | 22.0          | 20.25           | 0.033            | Standard | Left Tilt        | 25                                              | 24        | 0.164               | 1.496          | 0.245             | -       |
| 836.5                                                                                             | 20525 |      | 23.0          | 22.37           | -0.072           | Standard | Right Ear        | 1                                               | 49        | 0.427               | 1.156          | 0.494             | -       |
| 836.5                                                                                             | 20525 |      | 22.0          | 20.25           | 0.043            | Standard | Right Ear        | 25                                              | 24        | 0.262               | 1.496          | 0.392             | -       |
| 836.5                                                                                             | 20525 |      | 23.0          | 22.37           | 0.039            | Standard | Right Tilt       | 1                                               | 49        | 0.255               | 1.156          | 0.295             | -       |
| 836.5                                                                                             | 20525 |      | 22.0          | 20.25           | 0.092            | Standard | Right Tilt       | 25                                              | 24        | 0.154               | 1.496          | 0.230             | -       |
| 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 |           |                     |                |                   |         |

### 13.1-5 Measurement Results (DTS Head SAR)

| Frequency                                                                                          |     | Mode     | Power (dBm)   |                 | Power Drift (dB) | Phantom Position | Data Rate                                       | Duty Cycle (%) | Peak SAR of Area Scan (W/kg) | Measured SAR (mW/g) | Scaling Factor (Power) | Scaling Factor (Duty Cycle) | Scaled SAR (mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|----------|---------------|-----------------|------------------|------------------|-------------------------------------------------|----------------|------------------------------|---------------------|------------------------|-----------------------------|-------------------|----------|
| MHz                                                                                                | Ch. |          | Tune-Up Limit | Conducted Power |                  |                  |                                                 |                |                              |                     |                        |                             |                   |          |
| 2412                                                                                               | 1   | 802.11 b | 15.5          | 15.2            |                  | Left Ear         | 1Mbps                                           | 100            | 0.234                        |                     |                        |                             |                   | -        |
|                                                                                                    |     |          | 15.5          | 15.2            |                  | Left Tilt        | 1Mbps                                           | 100            | 0.172                        |                     |                        |                             |                   | -        |
|                                                                                                    |     |          | 15.5          | 15.2            | -0.19            | Right Ear        | 1Mbps                                           | 100            | 0.528                        | 0.306               | 1.072                  | 1.0                         | 0.328             | 5        |
|                                                                                                    |     |          | 15.5          | 15.2            |                  | Right Tilt       | 1Mbps                                           | 100            | 0.231                        |                     |                        |                             |                   | -        |
| 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 3Tx | 27.5          | 26.68           | 0.08             | Rear          | 1.0 cm                                          | 0.539              | 1.208          | 0.651            | 6        |
| 836.6                                                                                              | 190 |          | 27.5          | 26.68           | -0.04            | Front         | 1.0 cm                                          | 0.433              | 1.208          | 0.523            | -        |
| 836.6                                                                                              | 190 |          | 27.5          | 26.68           | 0.00             | Left          | 1.0 cm                                          | 0.302              | 1.208          | 0.365            | -        |
| 836.6                                                                                              | 190 |          | 27.5          | 26.68           | 0.02             | Right         | 1.0 cm                                          | 0.236              | 1.208          | 0.285            | -        |
| 836.6                                                                                              | 190 |          | 27.5          | 26.68           | 0.05             | Bottom        | 1.0 cm                                          | 0.085              | 1.208          | 0.103            | -        |
| 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 3Tx | 24.7          | 24.53           | 0.07             | Rear          | 1.0 cm                                          | 0.392              | 1.040          | 0.408            | -        |
| 1 880.0                                                                                            | 661 |          | 24.7          | 24.53           | 0.11             | Front         | 1.0 cm                                          | 0.520              | 1.040          | <b>0.541</b>     | 7        |
| 1 880.0                                                                                            | 661 |          | 24.7          | 24.53           | 0.04             | Left          | 1.0 cm                                          | 0.054              | 1.040          | 0.056            | -        |
| 1 880.0                                                                                            | 661 |          | 24.7          | 24.53           | -0.06            | Right         | 1.0 cm                                          | 0.249              | 1.040          | 0.259            | -        |
| 1 880.0                                                                                            | 661 |          | 24.7          | 24.53           | 0.12             | Bottom        | 1.0 cm                                          | 0.144              | 1.040          | 0.150            | -        |
| 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 (WCDMA850 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                                                                                              | 4183 | WCDMA 850 | 23.0          | 22.54           | 0.06             | Rear          | 1.0 cm                                          | 0.582              | 1.112          | 0.647            | 8        |
| 836.6                                                                                              | 4183 |           | 23.0          | 22.54           | -0.02            | Front         | 1.0 cm                                          | 0.467              | 1.112          | 0.519            | -        |
| 836.6                                                                                              | 4183 |           | 23.0          | 22.54           | -0.04            | Left          | 1.0 cm                                          | 0.291              | 1.112          | 0.324            | -        |
| 836.6                                                                                              | 4183 |           | 23.0          | 22.54           | -0.02            | Right         | 1.0 cm                                          | 0.232              | 1.112          | 0.258            | -        |
| 836.6                                                                                              | 4183 |           | 23.0          | 22.54           | 0.02             | Bottom        | 1.0 cm                                          | 0.075              | 1.112          | 0.083            | -        |
| 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 |                    |                |                  |          |

## 13.2-4 Measurement Results (LTE Band 5 10MHz Hotspot SAR)

| Frequency                                                                                         |       | Mode | Power (dBm)   |                 | Power Drift (dB) | Configuration | RB Size                                         | RB Offset | Separation Distance | Measured SAR (mW/g) | Scaling Factor | Scaled SAR (mW/g) | Plot No. |
|---------------------------------------------------------------------------------------------------|-------|------|---------------|-----------------|------------------|---------------|-------------------------------------------------|-----------|---------------------|---------------------|----------------|-------------------|----------|
| MHz                                                                                               | Ch.   |      | Tune-Up Limit | Conducted Power |                  |               |                                                 |           |                     |                     |                |                   |          |
| 836.5                                                                                             | 20525 | QPSK | 23.0          | 22.37           | -0.03            | Rear          | 1                                               | 49        | 1.0 cm              | 0.534               | 1.156          | 0.617             | 9        |
| 836.5                                                                                             | 20525 |      | 22.0          | 20.25           | -0.01            | Rear          | 25                                              | 24        | 1.0 cm              | 0.343               | 1.496          | 0.513             | -        |
| 836.5                                                                                             | 20525 |      | 23.0          | 22.37           | -0.01            | Front         | 1                                               | 49        | 1.0 cm              | 0.429               | 1.156          | 0.496             | -        |
| 836.5                                                                                             | 20525 |      | 22.0          | 20.25           | -0.01            | Front         | 25                                              | 24        | 1.0 cm              | 0.276               | 1.496          | 0.413             | -        |
| 836.5                                                                                             | 20525 |      | 23.0          | 22.37           | -0.03            | Left          | 1                                               | 49        | 1.0 cm              | 0.276               | 1.156          | 0.319             | -        |
| 836.5                                                                                             | 20525 |      | 22.0          | 20.25           | -0.01            | Left          | 25                                              | 24        | 1.0 cm              | 0.182               | 1.496          | 0.272             | -        |
| 836.5                                                                                             | 20525 |      | 23.0          | 22.37           | -0.01            | Right         | 1                                               | 49        | 1.0 cm              | 0.247               | 1.156          | 0.286             | -        |
| 836.5                                                                                             | 20525 |      | 22.0          | 20.25           | -0.01            | Right         | 25                                              | 24        | 1.0 cm              | 0.164               | 1.496          | 0.245             | -        |
| 836.5                                                                                             | 20525 |      | 23.0          | 22.37           | -0.01            | Bottom        | 1                                               | 49        | 1.0 cm              | 0.074               | 1.156          | 0.086             | -        |
| 836.5                                                                                             | 20525 |      | 22.0          | 20.25           | 0.07             | Bottom        | 25                                              | 24        | 1.0 cm              | 0.045               | 1.496          | 0.067             | -        |
| 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 |           |                     |                     |                |                   |          |

## 13.2-5 Measurement Results (WLAN Hotspot SAR)

| Frequency                                                                                          |     | Mode            | Power (dBm)   |                 | Power Drift (dB) | Configuration | Separation Distance                             | Duty Cycle (%) | Peak SAR of Area Scan (W/kg) | Measured SAR (mW/g) | Scaling Factor | Scaling Factor (Duty Cycle) | Scaled SAR (mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|-----------------|---------------|-----------------|------------------|---------------|-------------------------------------------------|----------------|------------------------------|---------------------|----------------|-----------------------------|-------------------|----------|
| MHz                                                                                                | Ch. |                 | Tune-Up Limit | Conducted Power |                  |               |                                                 |                |                              |                     |                |                             |                   |          |
| 2412                                                                                               | 1   | 802.11b (1Mbps) | 15.5          | 15.2            |                  | Rear          | 1.0 cm                                          | 100            | 0.0560                       | 0.039               | 1.072          | 1.0                         | 0.042             | -        |
|                                                                                                    |     |                 | 15.5          | 15.2            | 0.13             | Front         | 1.0 cm                                          | 100            | 0.0575                       | 0.041               | 1.072          | 1.0                         | 0.044             | 10       |
|                                                                                                    |     |                 | 15.5          | 15.2            | 0.11             | Left          | 1.0 cm                                          | 100            | 0.0870                       | 0.061               | 1.072          | 1.0                         | 0.065             | 11       |
|                                                                                                    |     |                 | 15.5          | 15.2            |                  | Top           | 1.0 cm                                          | 100            | 0.0661                       |                     |                |                             |                   | -        |
| 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 (DTS Body-worn SAR)

| Frequency                                                                                          |     | Mode            | Power (dBm)   |                 | Power Drift (dB) | Configuration | Separation Distance                             | Duty Cycle (%) | Peak SAR of Area Scan (W/kg) | Measured SAR (mW/g) | Scaling Factor | Scaling Factor (Duty Cycle) | Scaled SAR (mW/g) | Plot No. |
|----------------------------------------------------------------------------------------------------|-----|-----------------|---------------|-----------------|------------------|---------------|-------------------------------------------------|----------------|------------------------------|---------------------|----------------|-----------------------------|-------------------|----------|
| MHz                                                                                                | Ch. |                 | Tune-Up Limit | Conducted Power |                  |               |                                                 |                |                              |                     |                |                             |                   |          |
| 2412                                                                                               | 1   | 802.11b (1Mbps) | 15.5          | 15.2            |                  | Rear          | 1.0 cm                                          | 100            | 0.0560                       | 0.039               | 1.072          | 1.0                         | 0.042             | -        |
|                                                                                                    |     |                 | 15.5          | 15.2            | 0.13             | Front         | 1.0 cm                                          | 100            | 0.0575                       | 0.041               | 1.072          | 1.0                         | 0.044             | 10       |
| 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 |                |                              |                     |                |                             |                   |          |

### 13.3-2 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 |                  |                         |                                                 |                     |                |                   |          |
| 824.2                                                                                              | 128   | GSM850    | 33.0          | 31.26           | -0.01            | Rear                    | 1.0 cm                                          | 0.589               | 1.493          | 0.879             | -        |
| 836.6                                                                                              | 190   | GSM850    | 33.0          | 31.40           | 0.01             | Rear                    | 1.0 cm                                          | 0.604               | 1.445          | 0.873             | -        |
| 848.8                                                                                              | 251   | GSM850    | 33.0          | 31.41           | 0.03             | Rear                    | 1.0 cm                                          | 0.614               | 1.442          | <b>0.885</b>      | 12       |
| 836.6                                                                                              | 190   | GSM850    | 33.0          | 31.40           | 0.05             | Front                   | 1.0 cm                                          | 0.489               | 1.445          | 0.707             | -        |
| 1 880.0                                                                                            | 661   | GSM1900   | 30.0          | 28.98           | -0.03            | Rear                    | 1.0 cm                                          | 0.378               | 1.265          | 0.478             | -        |
| 1 880.0                                                                                            | 661   | GSM1900   | 30.0          | 28.98           | 0.18             | Front                   | 1.0 cm                                          | 0.471               | 1.265          | <b>0.596</b>      | 13       |
| 836.6                                                                                              | 4183  | WCDMA 850 | 23.0          | 22.54           | 0.06             | Rear                    | 1.0 cm                                          | 0.582               | 1.112          | <b>0.647</b>      | 8        |
| 836.6                                                                                              | 4183  | WCDMA 850 | 23.0          | 22.54           | -0.02            | Front                   | 1.0 cm                                          | 0.467               | 1.112          | 0.519             | -        |
| 836.5                                                                                              | 20525 | LTE 5     | 23.0          | 22.37           | -0.03            | Rear (1RB, 49offset)    | 1.0 cm                                          | 0.534               | 1.156          | <b>0.617</b>      | 9        |
| 836.5                                                                                              | 20525 | LTE 5     | 22.0          | 20.25           | -0.01            | Rear (25RB, 24 offset)  | 1.0 cm                                          | 0.343               | 1.496          | 0.513             | -        |
| 836.5                                                                                              | 20525 | LTE 5     | 23.0          | 22.37           | -0.01            | Front (1RB, 49 offset)  | 1.0 cm                                          | 0.429               | 1.156          | 0.496             | -        |
| 836.5                                                                                              | 20525 | LTE 5     | 22.0          | 20.25           | -0.01            | Front (25RB, 24 offset) | 1.0 cm                                          | 0.276               | 1.496          | 0.413             | -        |
| 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 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 EUT'S GSM and GPRS device class is B.
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 D01v03: 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 D01v03 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.

**UMTS Notes:**

1. The 12.2 kbps RMC mode is the primary mode.
2. UMTS mode in Body SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB 941225 D01v03. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and Adjusted SAR value was less than 1.2 W/kg.
3. 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 channel highest output power channel was used.
4. UMTS SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB publication 941225 D01v03. HSPA SAR was not required since the average output power of the HSPA subtests was not more than 0.25 dB higher than the RMC level and SAR was less than 1.2 W/kg.

**LTE Notes:**

1. LTE Considerations: LTE test configurations are determined according to SAR Evaluation Consideration for LTE Devices in FCC KDB 941225 D05v02r03.
2. According to FCC KDB 941225 D05v02r01:  
When the reported SAR is  $\leq 0.8$  W/kg, testing of the 100%RB allocation and required test channels is not required. Otherwise, SAR is required for the remaining required test channels using the 1RB, 50%RB and 100%RB allocation with highest output power for that channel.  
Only one channel, and as reported SAR values for 1RB allocation and 50%RB allocation were less than 1.45W/Kg only the highest power RB offset for each allocation was required.
3. MPR is permanently implemented for this device by the manufacturer. The specific manufacturer target MPR is indicated alongside the SAR results. MPR is enabled for this device, according to target MPR is indicated alongside the SAR results.
4. A-MPR was dialed for all SAR tests by setting NS=01 on the base station simulator.
5. Pre-installed VOIP applications are considered.
6. SAR test reduction is applied using the following criteria:
7. Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB, and 50% RB allocation, using the RB offset and required test channel combination with the highest maximum output power among RB offsets at the upper edge, middle and lower edge of each required test channel.  
When the reported SAR is  $>0.8$  W/kg, testing for other Channels is performed at the highest output power level for 1RB, and 50% RB configuration for that channel.  
Testing for 100% RB configuration is performed at the highest output power level for 100% RB configuration across the Low, Mid and High Channel when the highest reported SAR for 1 RB and 50% RB are  $>0.8$  W/kg, Testing for the remaining required channels is not needed because the reported SAR for 100% RB Allocation  $<1.45$  W/kg.  
Testing for 16-QAM modulation is not required because the reported SAR for QPSK is  $<1.45$  W/kg and its output power is not more than 0.5 dB higher than that a QPSK.  
Testing for the other channel bandwidths is not required because the reported SAR for the highest channel bandwidth is  $<1.45$  W/kg and its

**WLAN Notes:**

1. Justification for test configurations for WLAN per KDB Publication 248227 D01 for 2.4 GHz WiFi single transmission chain operations, the highest measured maximum output power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4 GHz 802.11 g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR.
2. When the maximum reported 1g averaged SAR is  $\leq 0.8$  W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was  $\leq 1.20$  W/kg or all test channels were measured.
3. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools. The reported SAR was scaled to the 100% transmission duty factor to determine compliance. Procedures used to measure the duty factor are identical to that in the associated WLAN test reports.
4. According to KDB 248227 D01v02 Sec. 5.2 2.4GHz SAR procedures, for 802.11b DSSS SAR measurement of this device, SAR test procedures were applied to fixed exposure test position.

## **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 for 1g SAR or  $< 2.0$  W/kg for 10g SAR ; steps 2) through 4) do not apply.

2) When the original highest measured 1g SAR is  $\geq 0.80$  W/kg or 10g SAR  $\geq 2.0$  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 for 1g SAR or  $\geq 3.625$  W/kg for 10g SAR (~ 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 for 1g SAR or  $\geq 3.75$  W/kg for 10g SAR and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .

## 15. SAR Summation Scenario

According to FCC KDB 447498 D01v05r02, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds. Possible transmission paths for the EUT are shown below paths and are mode in same rectangle to indicate communication modes which share the same path. Modes which share the same transmission path cannot transmit simultaneously with one another.



This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB 447498 D01v05r02.

| Applicable Combination        | Head | Body-Worn | Hotspot |
|-------------------------------|------|-----------|---------|
| GSM Voice + 2.4 GHz WiFi      | Yes  | Yes       | N/A     |
| GSM Voice + 2.4 GHz Bluetooth | N/A  | Yes       | N/A     |
| GPRS + 2.4 GHz WiFi           | N/A  | N/A       | Yes     |
| UMTS + 2.4 GHz WiFi           | Yes  | Yes       | Yes     |
| UMTS + 2.4 GHz Bluetooth      | N/A  | Yes       | N/A     |
| LTE+ 2.4 GHz WiFi             | Yes  | Yes       | Yes     |
| LTE+ 2.4 GHz Bluetooth        | N/A  | Yes       | N/A     |

- 2.4 GHz WLAN and 2.4 GHz Bluetooth share antenna path and cannot transmit simultaneously
- All licensed modes share the same antenna path and cannot transmit simultaneously.
- UMTS +WLAN scenario also represents the UMTS Voice/DATA + WLAN hotspot scenario.
- Per the manufacturer, GPRS does not support VOIP service.
- Per the manufacturer, WiFi Direct is not expected to be used in conjunction with a held-to-ear or body-worn accessory voice call. Therefore, there are no simultaneous transmission scenarios involving WiFi direct beyond that listed in the above table.
- This device does not support VoLTE.
- LTE is considered pre-installed VOIP applications.
- The highest reported SAR for each exposure condition is used for SAR summation purpose.

## 15.1 Simultaneous Transmission Summation for Head

**Simultaneous Transmission Summation with 2.4 GHz WIFI**

| Band       | Scaled SAR | 2.4 GHz WIFI Scaled SAR | $\sum$ 1-g SAR |
|------------|------------|-------------------------|----------------|
|            | (W/kg)     | (W/kg)                  | (W/kg)         |
| GSM 850    | 0.795      | 0.328                   | <b>1.123</b>   |
| GSM 1900   | 0.754      | 0.328                   | 1.082          |
| UMTS 850   | 0.580      | 0.328                   | 0.908          |
| LTE Band 5 | 0.583      | 0.328                   | 0.911          |

## 15.2 Simultaneous Transmission Summation for Body-Worn

### Simultaneous Transmission Summation with Wifi (1.5 cm)

| Band       | Scaled SAR | 2.4 GHz WIFI Scaled SAR | $\Sigma$ 1-g SAR |
|------------|------------|-------------------------|------------------|
|            | (W/kg)     | (W/kg)                  | (W/kg)           |
| GSM 850    | <0.885     | <0.044                  | <0.929           |
| GSM 1900   | <0.596     | <0.044                  | <0.64            |
| UMTS 850   | <0.647     | <0.044                  | <0.691           |
| LTE Band 5 | <0.617     | <0.044                  | <0.661           |

### Simultaneous Transmission Summation with Bluetooth (1.5 cm)

| Band       | Scaled SAR | 2.4 GHz BT Estimated SAR | $\Sigma$ 1-g SAR |
|------------|------------|--------------------------|------------------|
|            | (W/kg)     | (W/kg)                   | (W/kg)           |
| GSM 850    | <0.885     | 0.10                     | <b>&lt;0.985</b> |
| GSM 1900   | <0.596     | 0.10                     | <0.696           |
| UMTS 850   | <0.647     | 0.10                     | <0.747           |
| LTE Band 5 | <0.617     | 0.10                     | <0.717           |

Note:

1. For SAR summation for body-worn back side at 15mm, the SAR values at 10 mm for some transmission mode were used since the 10mm test distance was more conservative. "<" denotes that the 10mm SAR values were used for summation purposes.

## 15.3 Simultaneous Transmission Summation for Hotspot

**Simultaneous Transmission Summation with 2.4 GHz WIFI (1.0 cm)**

| Band       | Scaled SAR | 2.4 GHz WIFI Scaled SAR | $\Sigma$ 1-g SAR |
|------------|------------|-------------------------|------------------|
|            | (W/kg)     | (W/kg)                  | (W/kg)           |
| GPRS 850   | 0.651      | 0.065                   | 0.716            |
| GPRS 1900  | 0.541      | 0.065                   | 0.606            |
| UMTS 850   | 0.647      | 0.065                   | 0.712            |
| LTE Band 5 | 0.617      | 0.065                   | 0.682            |

## 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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## Attachment 1. – SAR Test Plots

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.4 °C  
Ambient Temperature: 21.6 °C  
Test Date: Jul. 10, 2015  
Plot No.: 1

### DUT: SM-J110F; Type: Bar

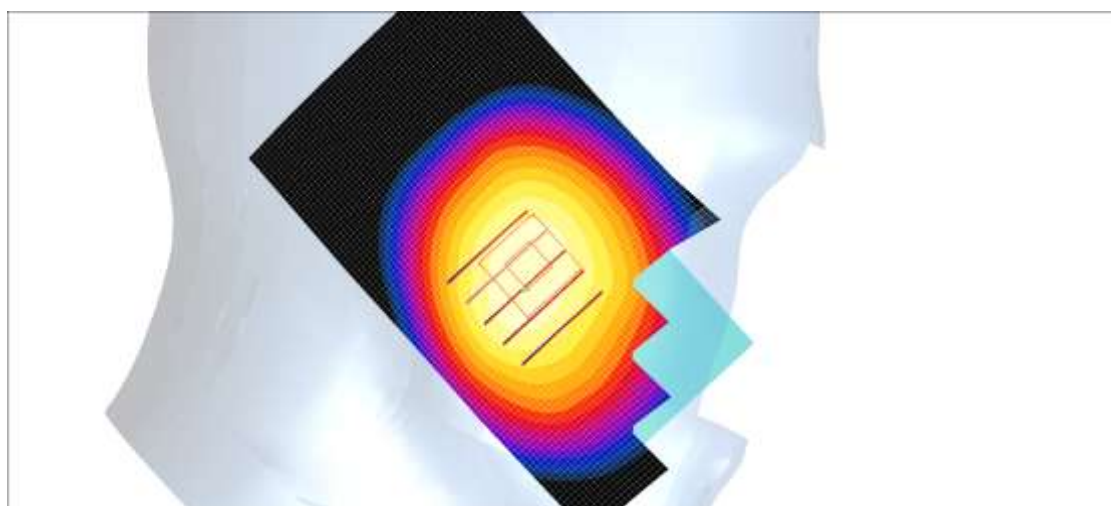
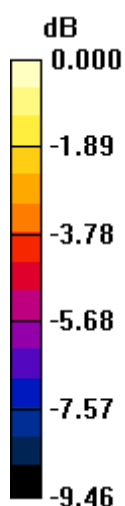
Communication System: GSM 850; Frequency: 836.6 MHz; Duty Cycle: 1:8.3  
Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.919 \text{ mho/m}$ ;  $\epsilon_r = 40.4$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Left Section

### DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.6, 9.6, 9.6); Calibrated: 2015-06-18
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2015-01-21
- Phantom: 835/900 Phantom; Type: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**GSM850 Left Touch 190ch/Area Scan (61x101x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
Maximum value of SAR (interpolated) = 0.627 mW/g

**GSM850 Left Touch 190ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 5.31 V/m; Power Drift = -0.010 dB  
Peak SAR (extrapolated) = 0.676 W/kg  
**SAR(1 g) = 0.550 mW/g; SAR(10 g) = 0.417 mW/g**  
Maximum value of SAR (measured) = 0.618 mW/g



0 dB = 0.618mW/g

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.8 °C  
Ambient Temperature: 22.0 °C  
Test Date: Jul. 10, 2015  
Plot No.: 2

# DUT: SM-J110F; Type: Bar

Communication System: UID 0, GSM 1900 (0); Frequency: 1880 MHz; Duty Cycle: 1:8.30042  
Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.397 \text{ S/m}$ ;  $\epsilon_r = 38.727$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Right Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3797; ConvF(7.58, 7.58, 7.58); Calibrated: 2014-11-19;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2014-09-18
- Phantom: SAM with CRP v5.0\_R
- Measurement SW: DASY52, Version 52.8 (8);

**GSM1900 Head Right Touch 661ch/Area Scan (61x101x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.816 W/kg

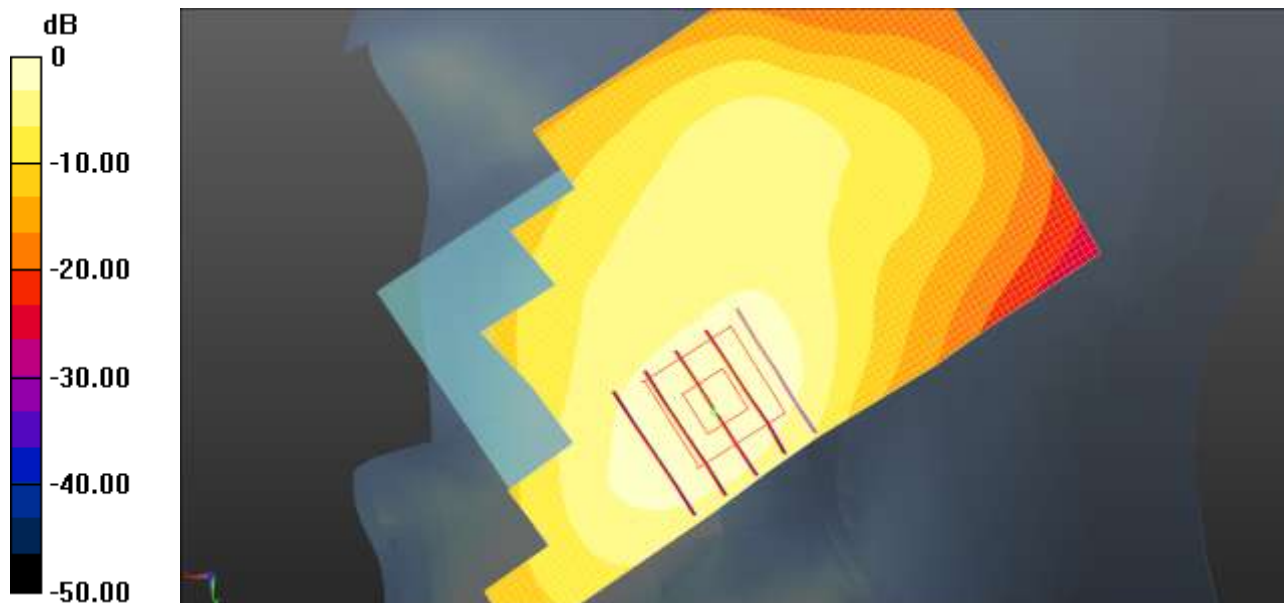
**GSM1900 Head Right Touch 661ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 6.138 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 0.953 W/kg

**SAR(1 g) = 0.596 W/kg; SAR(10 g) = 0.361 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.788 W/kg



0 dB = 0.816 W/kg = -0.88 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.6 °C  
Ambient Temperature: 21.8 °C  
Test Date: Jul. 10, 2015  
Plot No.: 3

### DUT: SM-J110F; Type: Bar

Communication System: WCDMA850; Frequency: 836.6 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.919 \text{ mho/m}$ ;  $\epsilon_r = 40.4$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Left Section

### DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.6, 9.6, 9.6); Calibrated: 2015-06-18
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2015-01-21
- Phantom: 835/900 Phantom; Type: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**WCDMA850 Left Touch 4183ch/Area Scan (61x101x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
Maximum value of SAR (interpolated) = 0.600 mW/g

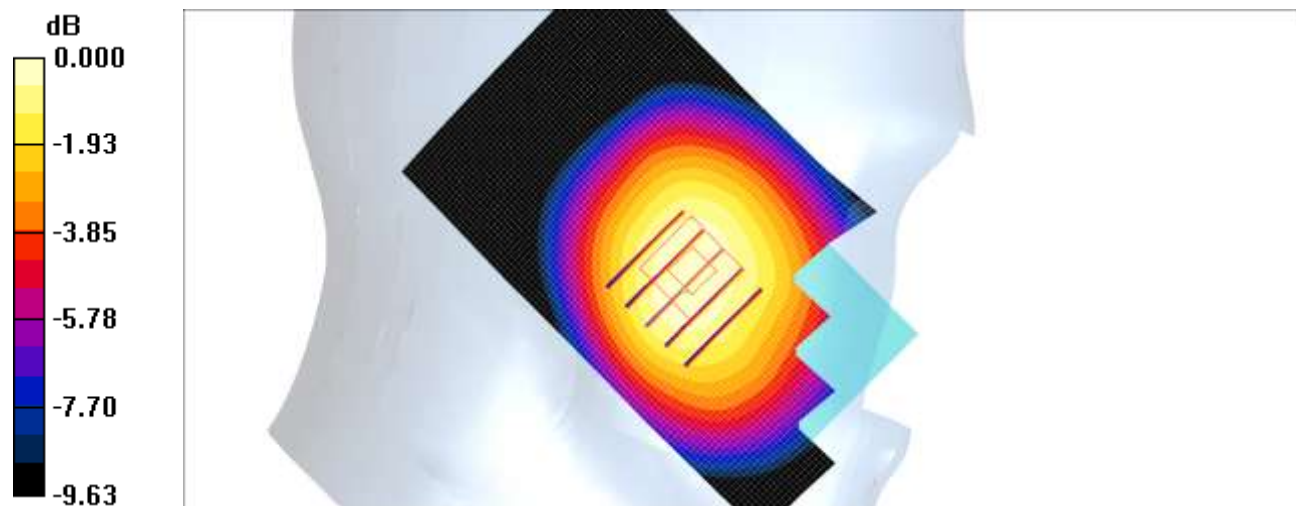
**WCDMA850 Left Touch 4183ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 5.03 V/m; Power Drift = -0.150 dB

Peak SAR (extrapolated) = 0.642 W/kg

**SAR(1 g) = 0.522 mW/g; SAR(10 g) = 0.394 mW/g**

Maximum value of SAR (measured) = 0.590 mW/g



0 dB = 0.590mW/g

Test Laboratory: HCT CO., LTD  
 EUT Type: Mobile Phone  
 Liquid Temperature: 21.6 °C  
 Ambient Temperature: 21.8 °C  
 Test Date: Jul. 10, 2015  
 Plot No.: 4

### DUT: SM-J110F; Type: Bar

Communication System: LTE Band 5; Frequency: 836.5 MHz; Duty Cycle: 1:1  
 Medium parameters used (interpolated):  $f = 836.5 \text{ MHz}$ ;  $\sigma = 0.919 \text{ mho/m}$ ;  $\epsilon_r = 40.4$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Left Section

### DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.6, 9.6, 9.6); Calibrated: 2015-06-18
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2015-01-21
- Phantom: 835/900 Phantom; Type: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**LTE Band 5 Left Touch 10MHz 1RB 49offset 20525/Area Scan (61x101x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$

Maximum value of SAR (interpolated) = 0.577 mW/g

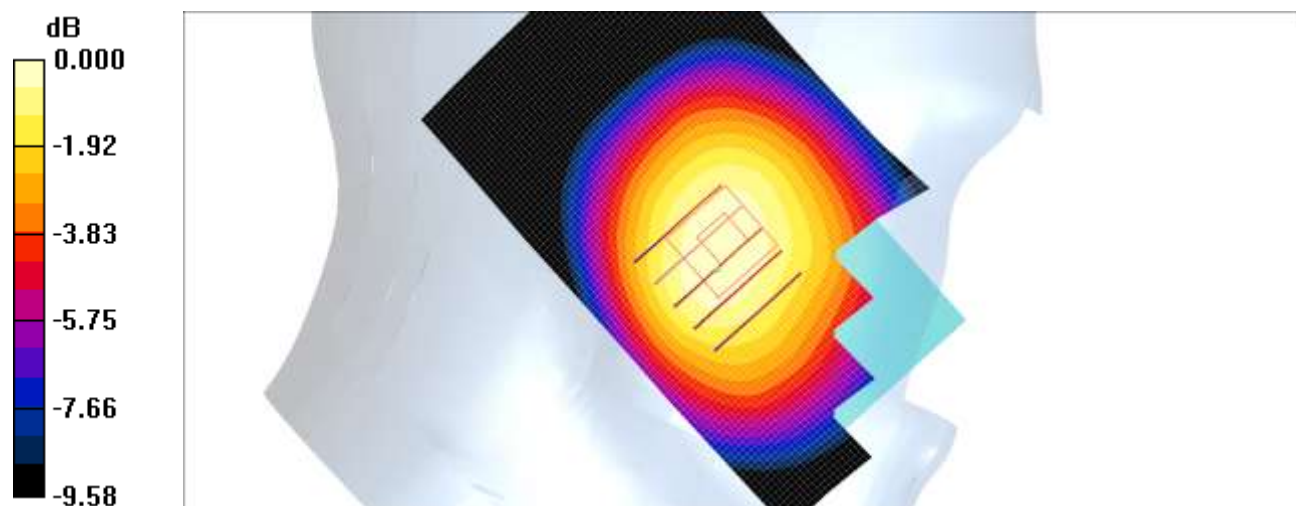
**LTE Band 5 Left Touch 10MHz 1RB 49offset 20525/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 5.04 V/m; Power Drift = 0.002 dB

Peak SAR (extrapolated) = 0.626 W/kg

**SAR(1 g) = 0.504 mW/g; SAR(10 g) = 0.380 mW/g**

Maximum value of SAR (measured) = 0.570 mW/g



0 dB = 0.570mW/g

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 20.2 °C  
Ambient Temperature: 20.4 °C  
Test Date: Jul. 14, 2015  
Plot No.: 5

# DUT: SM-J110F; Type: Bar

Communication System: UID 0, 2450MHz FCC (0); Frequency: 2412 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 2412 \text{ MHz}$ ;  $\sigma = 1.777 \text{ S/m}$ ;  $\epsilon_r = 40.392$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Right Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(7.16, 7.16, 7.16); Calibrated: 2014-12-22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn648; Calibrated: 2015-04-28
- Phantom: SAM with CRP v5.0\_F
- Measurement SW: DASY52, Version 52.8 (8);

**802.11b Head Right Touch 1Mbps 1ch/Area Scan (71x121x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$

Maximum value of SAR (interpolated) = 0.528 W/kg

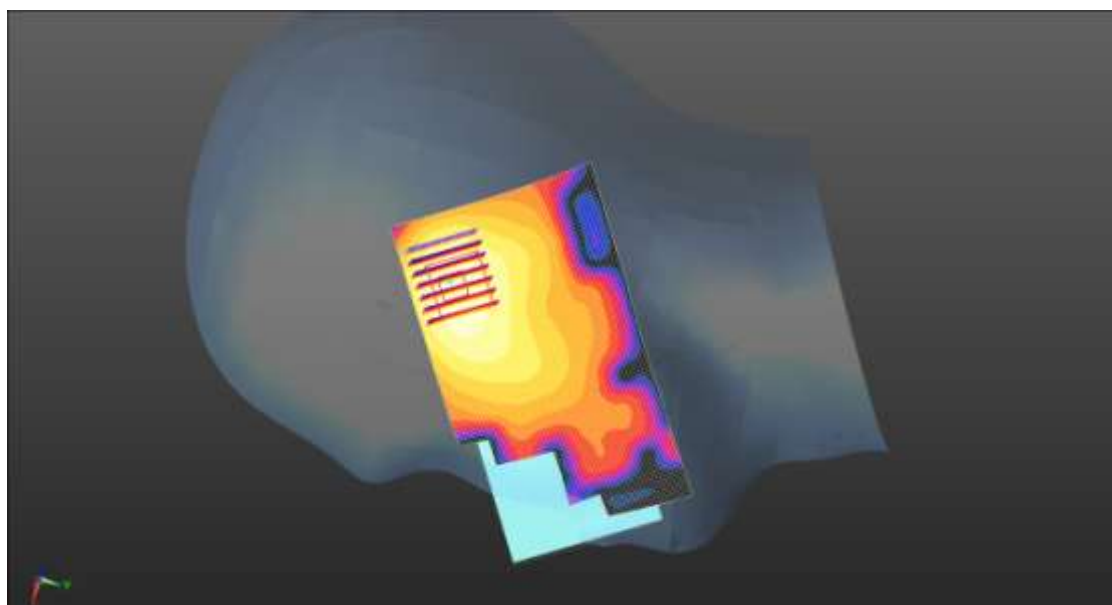
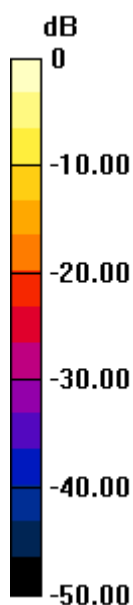
**802.11b Head Right Touch 1Mbps 1ch/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 7.264 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 0.643 W/kg

**SAR(1 g) = 0.306 W/kg; SAR(10 g) = 0.159 W/kg** (SAR corrected for target medium).

Maximum value of SAR (measured) = 0.451 W/kg



0 dB = 0.528 W/kg = -2.77 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.8 °C  
Ambient Temperature: 22.0 °C  
Test Date: Jul. 13, 2015  
Plot No.: 6

**DUT: SM-J110F; Type: Bar**

Communication System: UID 0, GSM850 GPRS 3TX (0); Frequency: 836.6 MHz; Duty Cycle: 1:2.77013  
Medium parameters used (interpolated):  $f = 836.6$  MHz;  $\sigma = 0.97$  S/m;  $\epsilon_r = 54.179$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Center Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.55, 9.55, 9.55); Calibrated: 2014-12-22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn648; Calibrated: 2015-04-28
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**GSM850 Body Rear Side GPRS 3Tx 190ch/Area Scan (61x101x1):** Interpolated grid:  $dx=1.500$  mm,  $dy=1.500$  mm

Maximum value of SAR (interpolated) = 0.618 W/kg

**GSM850 Body Rear Side GPRS 3Tx 190ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8$ mm,  $dy=8$ mm,  $dz=5$ mm

Reference Value = 22.12 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.691 W/kg

**SAR(1 g) = 0.539 W/kg; SAR(10 g) = 0.404 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.625 W/kg

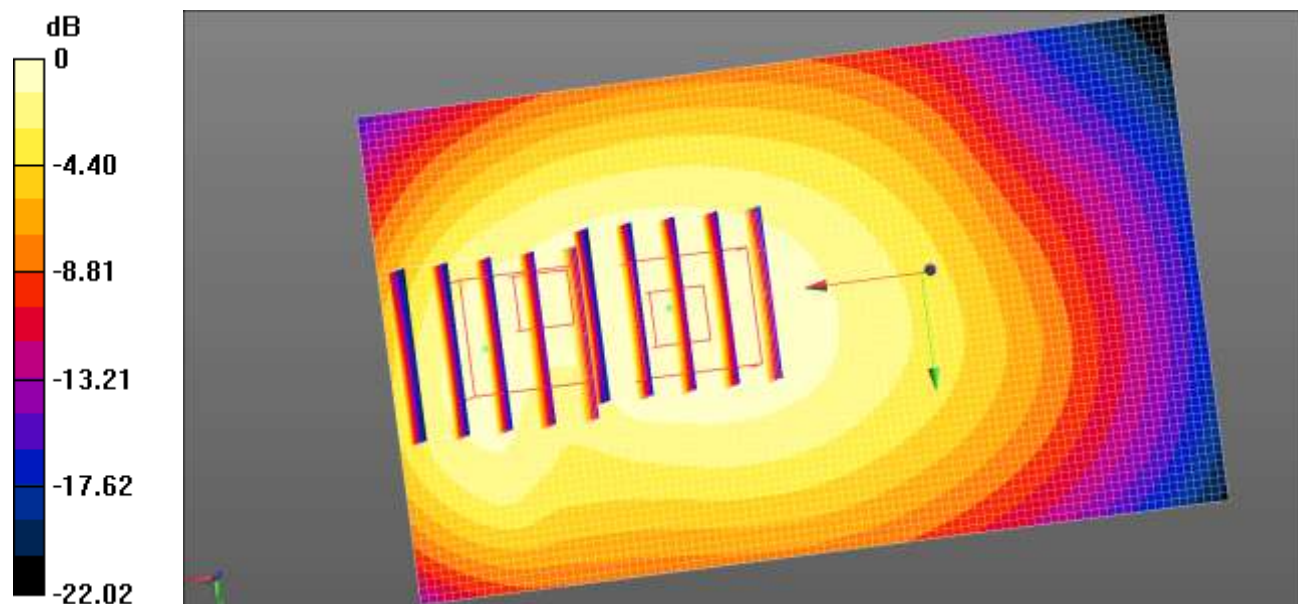
**GSM850 Body Rear Side GPRS 3Tx 190ch/Zoom Scan (5x5x7)/Cube 1:** Measurement grid:  $dx=8$ mm,  $dy=8$ mm,  $dz=5$ mm

Reference Value = 22.12 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.695 W/kg

**SAR(1 g) = 0.414 W/kg; SAR(10 g) = 0.279 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.543 W/kg



0 dB = 0.618 W/kg = -2.09 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 22.0 °C  
Ambient Temperature: 21.8 °C  
Test Date: Jul. 10, 2015  
Plot No.: 7

### DUT: SM-J110F; Type: Bar

Communication System: UID 0, GSM 1900 3TX (0); Frequency: 1880 MHz; Duty Cycle: 1:2.77013  
Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.539 \text{ S/m}$ ;  $\epsilon_r = 54.929$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

### DASY5 Configuration:

- Probe: EX3DV4 - SN3797; ConvF(7.23, 7.23, 7.23); Calibrated: 2014-11-19;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2014-09-18
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**GSM1900 Body Front GPRS 3Tx 661ch/Area Scan (61x101x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$  Maximum value of SAR (interpolated) = 0.549 W/kg

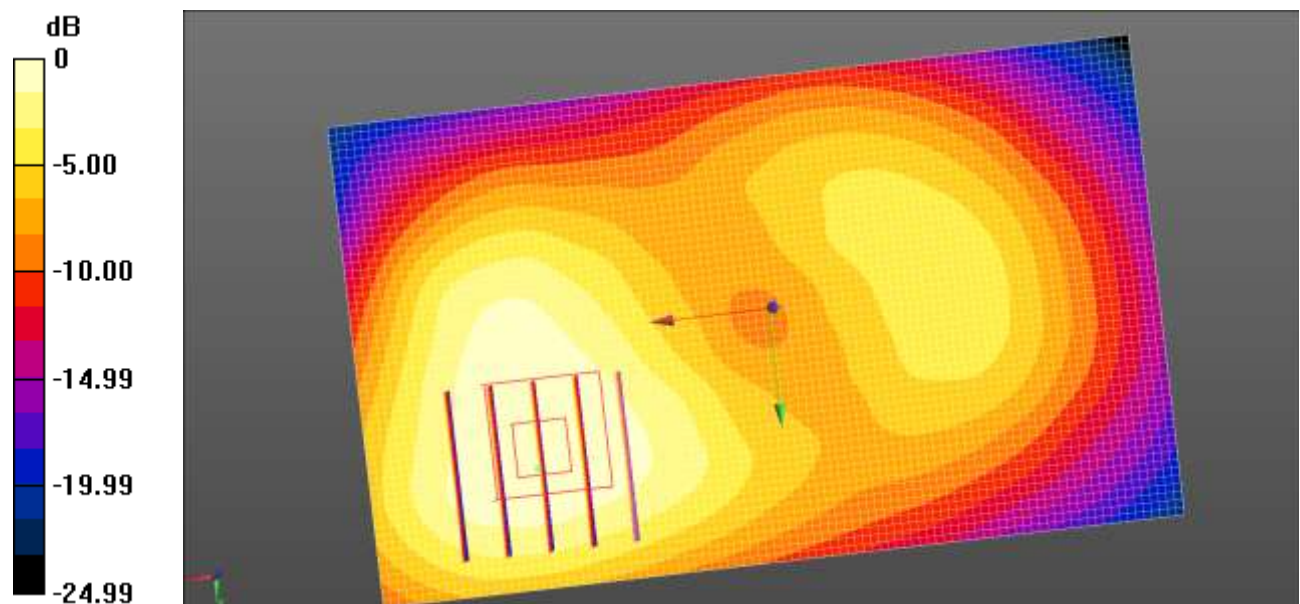
**GSM1900 Body Front GPRS 3Tx 661ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 7.395 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 0.816 W/kg

**SAR(1 g) = 0.520 W/kg; SAR(10 g) = 0.327 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.553 W/kg



$$0 \text{ dB} = 0.549 \text{ W/kg} = -2.61 \text{ dBW/kg}$$

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.3 °C  
Ambient Temperature: 21.5 °C  
Test Date: Jul. 10, 2015  
Plot No.: 8

# DUT: SM-J110F; Type: Bar

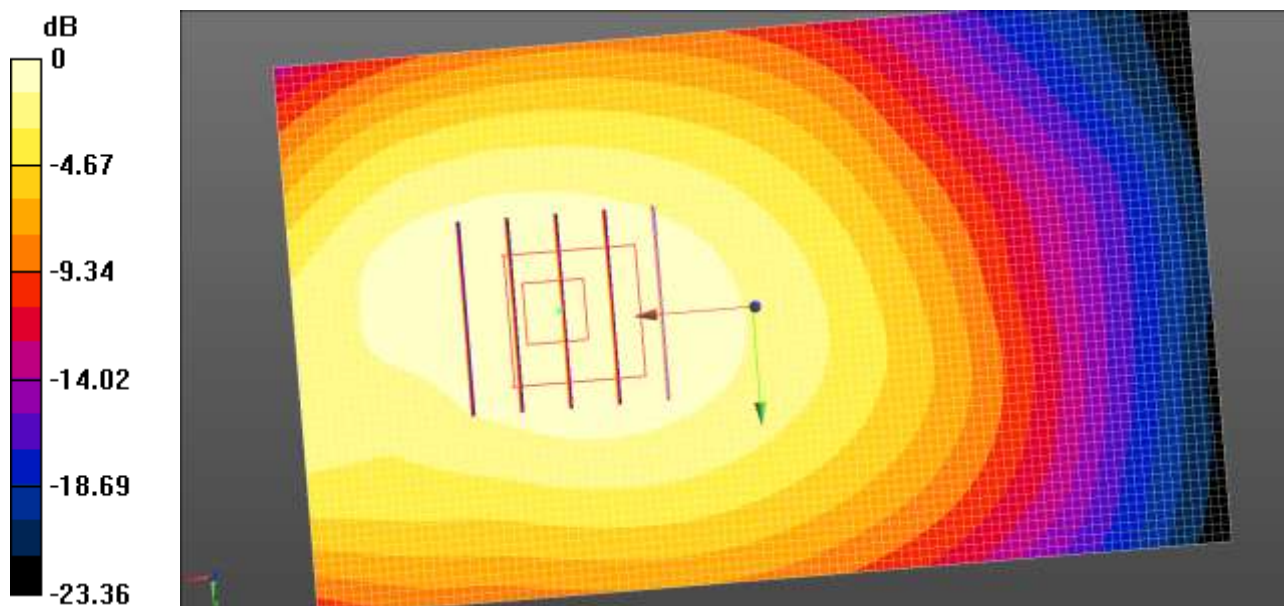
Communication System: UID 0, WCDMA850 (0); Frequency: 836.6 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.957 \text{ S/m}$ ;  $\epsilon_r = 56.392$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3797; ConvF(9.15, 9.15, 9.15); Calibrated: 2014-11-19;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2014-09-18
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**WCDMA850 Body Rear 4183ch/Area Scan (61x101x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.600 W/kg

**WCDMA850 Body Rear 4183ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 22.14 V/m; Power Drift = 0.06 dB  
Peak SAR (extrapolated) = 0.727 W/kg  
**SAR(1 g) = 0.582 W/kg; SAR(10 g) = 0.431 W/kg** (SAR corrected for target medium)  
Maximum value of SAR (measured) = 0.602 W/kg



$$0 \text{ dB} = 0.600 \text{ W/kg} = -2.22 \text{ dBW/kg}$$

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 21.8 °C  
Ambient Temperature: 22.0 °C  
Test Date: Jul. 13, 2015  
Plot No.: 9

# DUT: SM-J110F; Type: Bar

Communication System: UID 0, LTE Band 5 (0); Frequency: 836.5 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 836.5 \text{ MHz}$ ;  $\sigma = 0.97 \text{ S/m}$ ;  $\epsilon_r = 54.179$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.55, 9.55, 9.55); Calibrated: 2014-12-22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn648; Calibrated: 2015-04-28
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**LTE Band 5 Body Rear QPSK 10MHz 1RB 49offset 20525ch/Area Scan (61x101x1):** Interpolated grid:  
 $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 0.622 W/kg

**LTE Band 5 Body Rear QPSK 10MHz 1RB 49offset 20525ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 22.29 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 0.682 W/kg

**SAR(1 g) = 0.534 W/kg; SAR(10 g) = 0.403 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.616 W/kg

**SM-J110F/LTE Band 5 Body Rear QPSK 10MHz 1RB 49offset 20525ch/Zoom Scan (5x5x7)/Cube 1:**

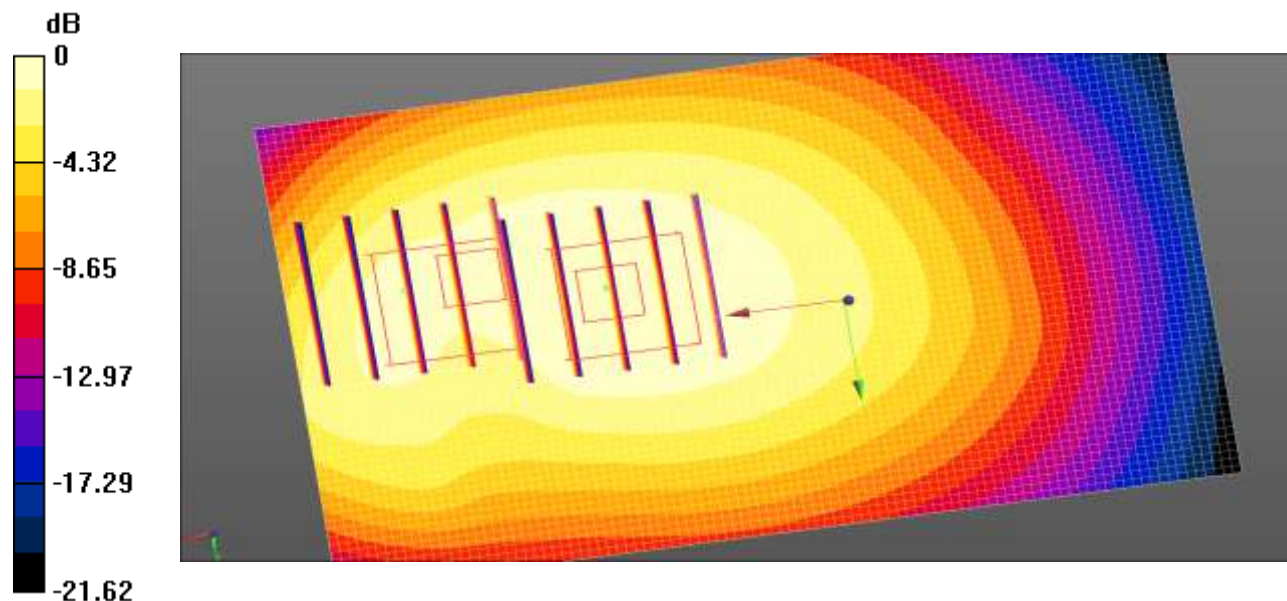
Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 22.29 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 0.659 W/kg

**SAR(1 g) = 0.422 W/kg; SAR(10 g) = 0.281 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.556 W/kg



0 dB = 0.622 W/kg = -2.06 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 20.2 °C  
Ambient Temperature: 20.4 °C  
Test Date: Jul. 14, 2015  
Plot No.: 10

# DUT: SM-J110F; Type: Bar

Communication System: UID 0, 2450MHz FCC (0); Frequency: 2412 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 2412 \text{ MHz}$ ;  $\sigma = 1.936 \text{ S/m}$ ;  $\epsilon_r = 53.189$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(7.1, 7.1, 7.1); Calibrated: 2014-12-22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn648; Calibrated: 2015-04-28
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**802.11b Body Front 1ch 1Mbps/Area Scan (71x121x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.0575 W/kg

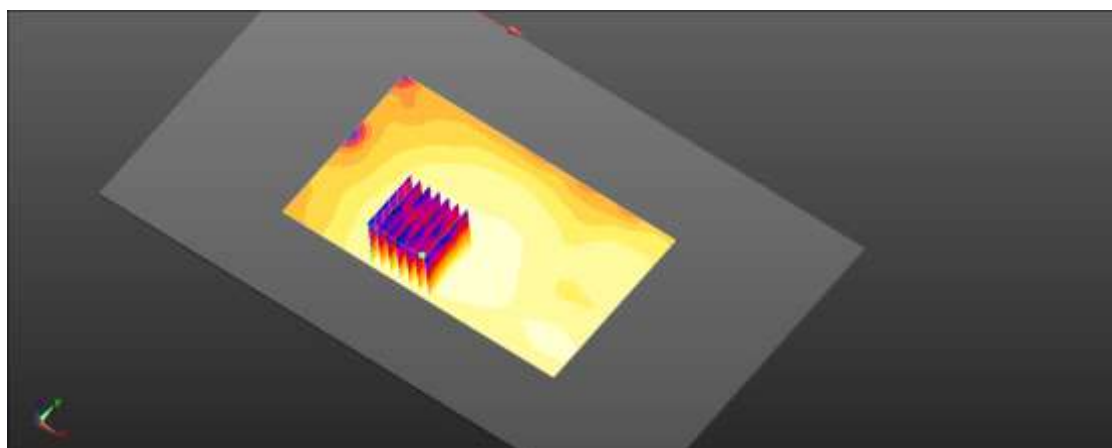
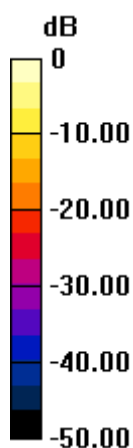
**802.11b Body Front 1ch 1Mbps/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 3.795 V/m; Power Drift = 0.13 dB

Peak SAR (extrapolated) = 0.0730 W/kg

**SAR(1 g) = 0.041 W/kg; SAR(10 g) = 0.023 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.0564 W/kg



0 dB = 0.0575 W/kg = -12.40 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 20.2 °C  
Ambient Temperature: 20.4 °C  
Test Date: Jul. 14, 2015  
Plot No.: 11

### DUT: SM-J110F; Type: Bar

Communication System: UID 0, 2450MHz FCC (0); Frequency: 2412 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 2412 \text{ MHz}$ ;  $\sigma = 1.936 \text{ S/m}$ ;  $\epsilon_r = 53.189$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

### DASY5 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(7.1, 7.1, 7.1); Calibrated: 2014-12-22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn648; Calibrated: 2015-04-28
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**802.11b Body Left 1ch 1Mbps/Area Scan (61x121x1):** Interpolated grid:  $dx=1.200 \text{ mm}$ ,  $dy=1.200 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.0870 W/kg

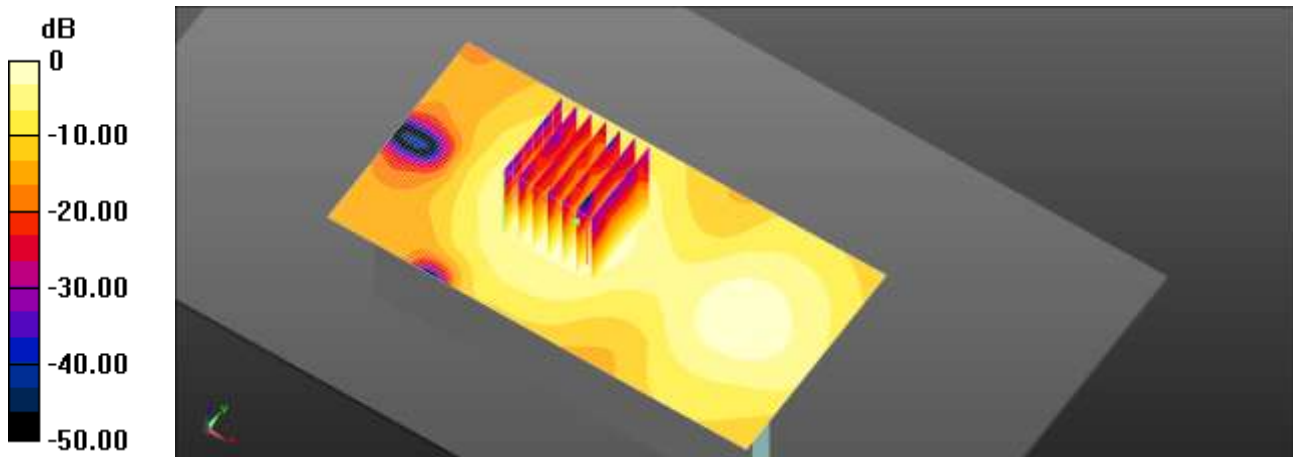
**802.11b Body Left 1ch 1Mbps/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 5.808 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 0.111 W/kg

**SAR(1 g) = 0.061 W/kg; SAR(10 g) = 0.034 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.0864 W/kg



0 dB = 0.0870 W/kg = -10.61 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 22.0 °C  
Ambient Temperature: 21.8 °C  
Test Date: Jul. 13, 2015  
Plot No.: 12

# DUT: SM-J110F; Type: Bar

Communication System: UID 0, GSM 850 (0); Frequency: 848.8 MHz; Duty Cycle: 1:8.30042  
Medium parameters used (interpolated):  $f = 848.8 \text{ MHz}$ ;  $\sigma = 0.979 \text{ S/m}$ ;  $\epsilon_r = 54.158$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.55, 9.55, 9.55); Calibrated: 2014-12-22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn648; Calibrated: 2015-04-28
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**GSM850 Body Worn Voice Rear 251ch/Area Scan (61x101x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 0.699 W/kg

**GSM850 Body Worn Voice Rear 251ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 23.98 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.787 W/kg

**SAR(1 g) = 0.614 W/kg; SAR(10 g) = 0.462 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.710 W/kg

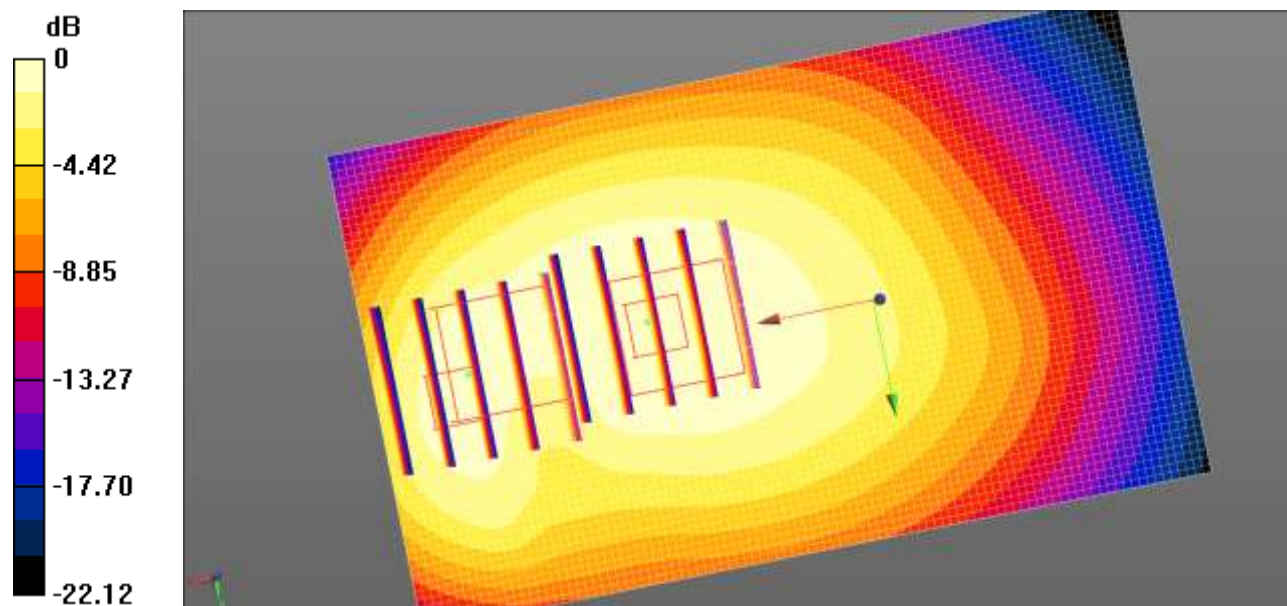
**GSM850 Body Worn Voice Rear 251ch/Zoom Scan (5x5x7)/Cube 1:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 23.98 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.836 W/kg

**SAR(1 g) = 0.483 W/kg; SAR(10 g) = 0.314 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.631 W/kg



0 dB = 0.699 W/kg = -1.55 dBW/kg

Test Laboratory: HCT CO., LTD  
EUT Type: Mobile Phone  
Liquid Temperature: 22.0 °C  
Ambient Temperature: 21.8 °C  
Test Date: Jul. 10, 2015  
Plot No.: 13

# DUT: SM-J110F; Type: Bar

Communication System: UID 0, GSM 1900 (0); Frequency: 1880 MHz; Duty Cycle: 1:8.30042  
Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.539 \text{ S/m}$ ;  $\epsilon_r = 54.929$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

## DASY5 Configuration:

- Probe: EX3DV4 - SN3797; ConvF(7.23, 7.23, 7.23); Calibrated: 2014-11-19;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2014-09-18
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**GSM1900 Body Worn Front 661ch/Area Scan (61x101x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$   
Maximum value of SAR (interpolated) = 0.507 W/kg

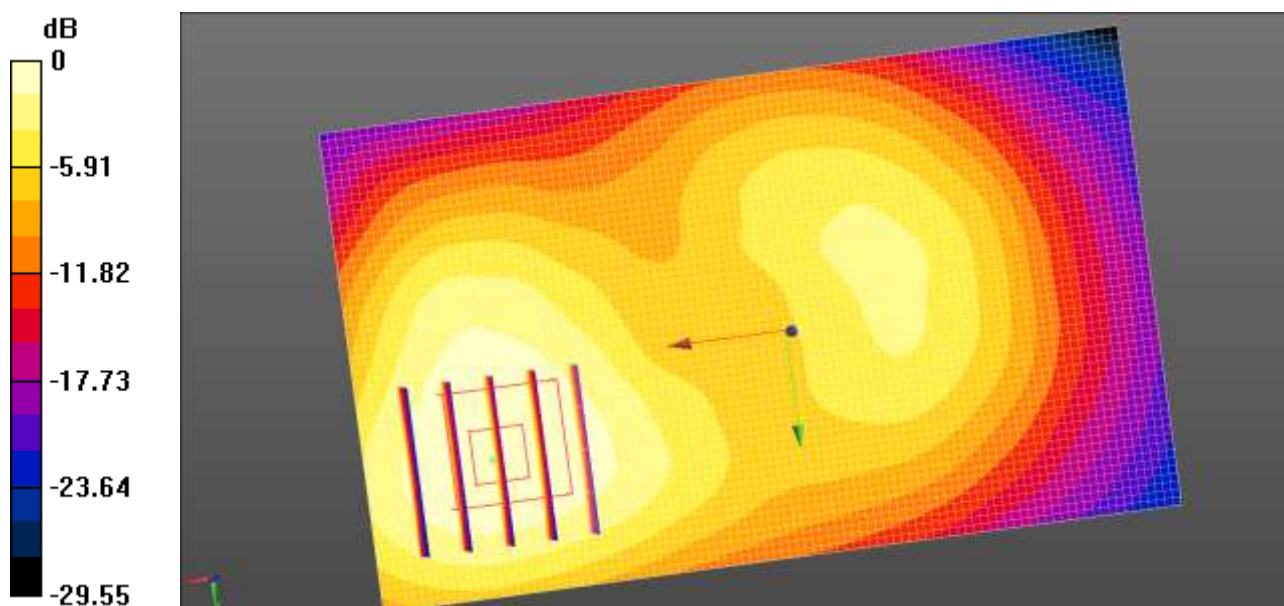
**GSM1900 Body Worn Front 661ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 7.204 V/m; Power Drift = 0.18 dB

Peak SAR (extrapolated) = 0.724 W/kg

**SAR(1 g) = 0.471 W/kg; SAR(10 g) = 0.296 W/kg** (SAR corrected for target medium)

Maximum value of SAR (measured) = 0.507 W/kg



0 dB = 0.507 W/kg = -2.95 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: 21.4 °C  
Test Date: Jul. 10, 2015

### DUT: Dipole 835 MHz; Type: D835V2

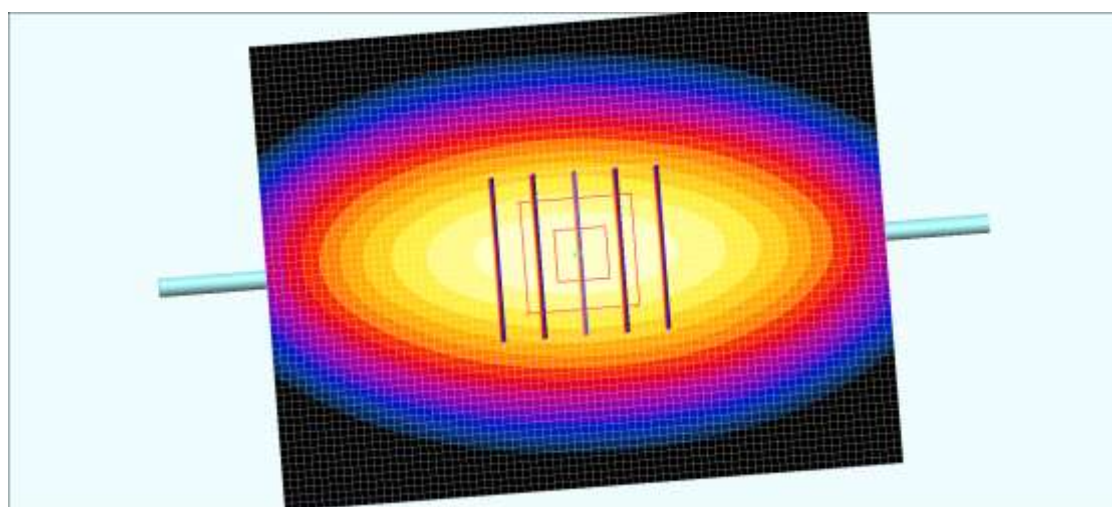
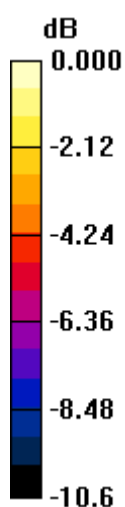
Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 835$  MHz;  $\sigma = 0.918$  mho/m;  $\epsilon_r = 40.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.6, 9.6, 9.6); Calibrated: 2015-06-18
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2015-01-21
- Phantom: 835/900 Phantom; Type: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**Verification 835 MHz Head/Area Scan (61x81x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (interpolated) = 1.03 mW/g

**Verification 835 MHz Head/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 33.8 V/m; Power Drift = -0.031 dB  
Peak SAR (extrapolated) = 1.38 W/kg  
**SAR(1 g) = 0.958 mW/g; SAR(10 g) = 0.632 mW/g**  
Maximum value of SAR (measured) = 1.04 mW/g



0 dB = 1.04mW/g

## ■ Verification Data (835 MHz Body)

Test Laboratory: HCT CO., LTD  
Input Power 100 mW (20 dBm)  
Liquid Temp: 21.3 °C  
Test Date: Jul. 10, 2015

### DUT: Dipole 835 MHz D835V2; Type: D835V2

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 835$  MHz;  $\sigma = 0.955$  S/m;  $\epsilon_r = 56.416$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3797; ConvF(9.15, 9.15, 9.15); Calibrated: 2014-11-19;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2014-09-18
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**835MHz Verification /Area Scan (61x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 1.02 W/kg

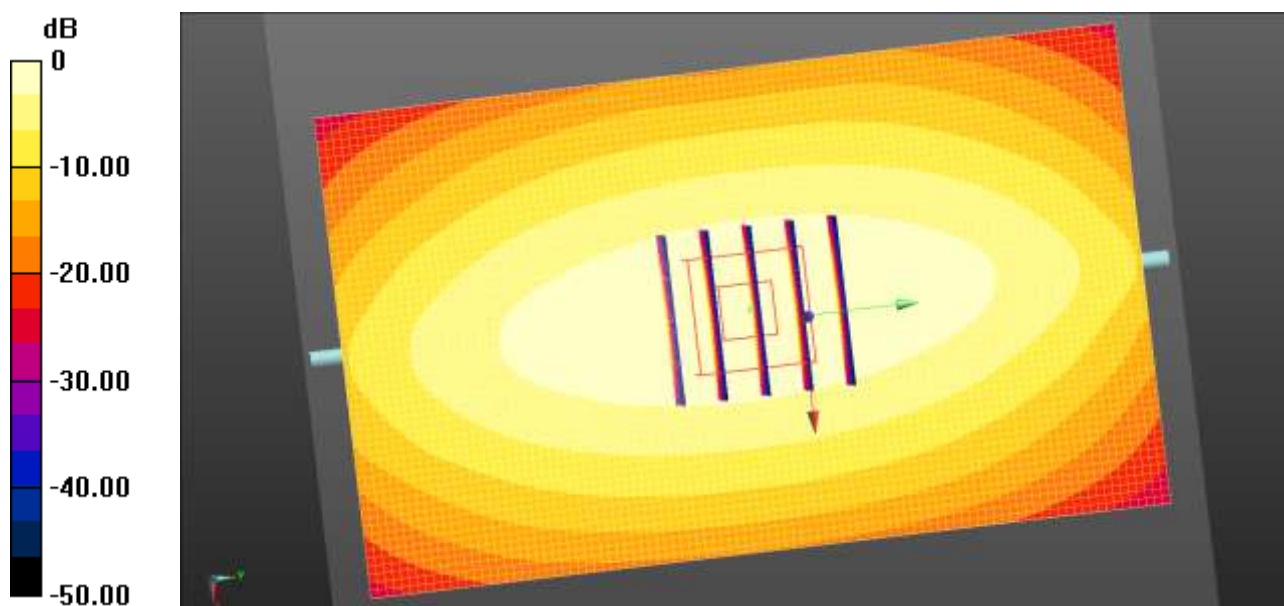
**835MHz Verification /Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 32.47 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 1.28 W/kg

**SAR(1 g) = 0.945 W/kg; SAR(10 g) = 0.682 W/kg**

Maximum value of SAR (measured) = 1.01 W/kg



0 dB = 1.02 W/kg = 0.07 dBW/kg

## ■ Verification Data (835 MHz Body)

Test Laboratory: HCT CO., LTD  
Input Power: 100 mW (20 dBm)  
Liquid Temp: 21.8 °C  
Test Date: Jul. 13, 2015

### DUT: Dipole 835 MHz D835V2; Type: D835V2

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.969 \text{ S/m}$ ;  $\epsilon_r = 54.179$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Center Section

### DASY5 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.55, 9.55, 9.55); Calibrated: 2014-12-22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn648; Calibrated: 2015-04-28
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**835MHz Verification/Area Scan (61x121x1):** Interpolated grid:  $dx=1.500 \text{ mm}$ ,  $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 1.04 W/kg

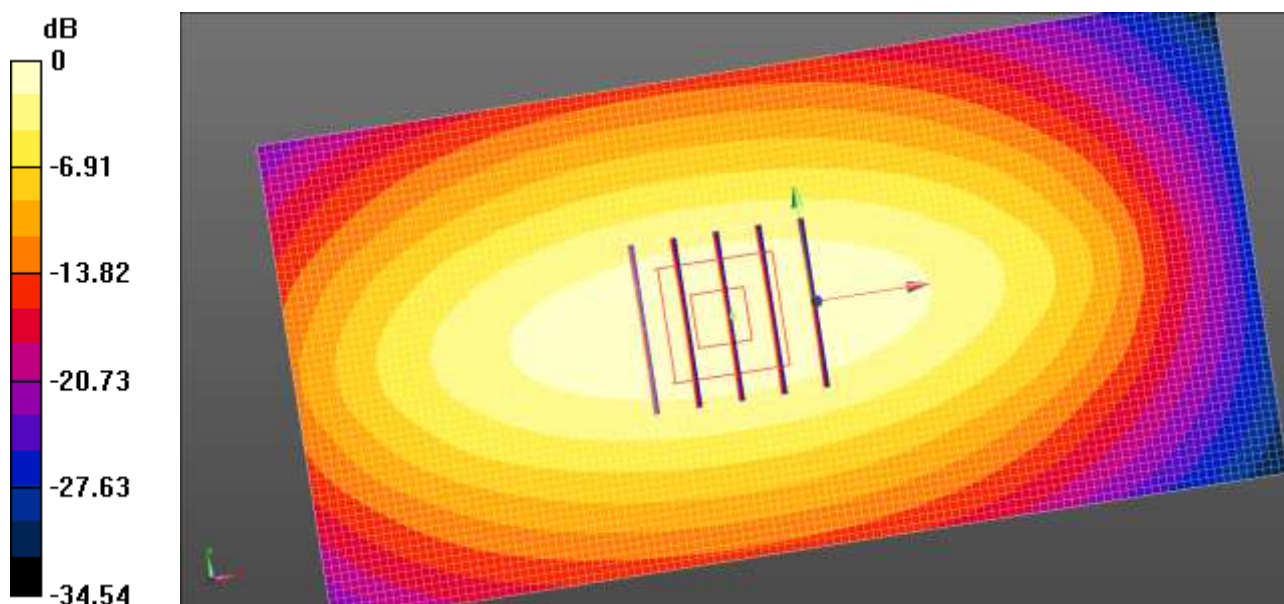
**835MHz Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 32.53 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 1.44 W/kg

**SAR(1 g) = 0.964 W/kg; SAR(10 g) = 0.633 W/kg**

Maximum value of SAR (measured) = 1.04 W/kg



0 dB = 1.04 W/kg = 0.17 dBW/kg

## ■ Verification Data (1 900 MHz Head)

Test Laboratory: HCT CO., LTD  
Input Power: 100 mW (20 dBm)  
Liquid Temp: 21.8 °C  
Test Date: Jul. 10, 2015

### DUT: Dipole 1900 MHz D1900V2; Type: D1900V2

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.409$  S/m;  $\epsilon_r = 38.685$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3797; ConvF(7.33, 7.33, 7.33); Calibrated: 2014-11-19;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2014-09-18
- Phantom: SAM with CRP v5.0\_Front\_20120517
- Measurement SW: DASY52, Version 52.8 (8);

**1900MHz Head Verification/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 4.71 W/kg

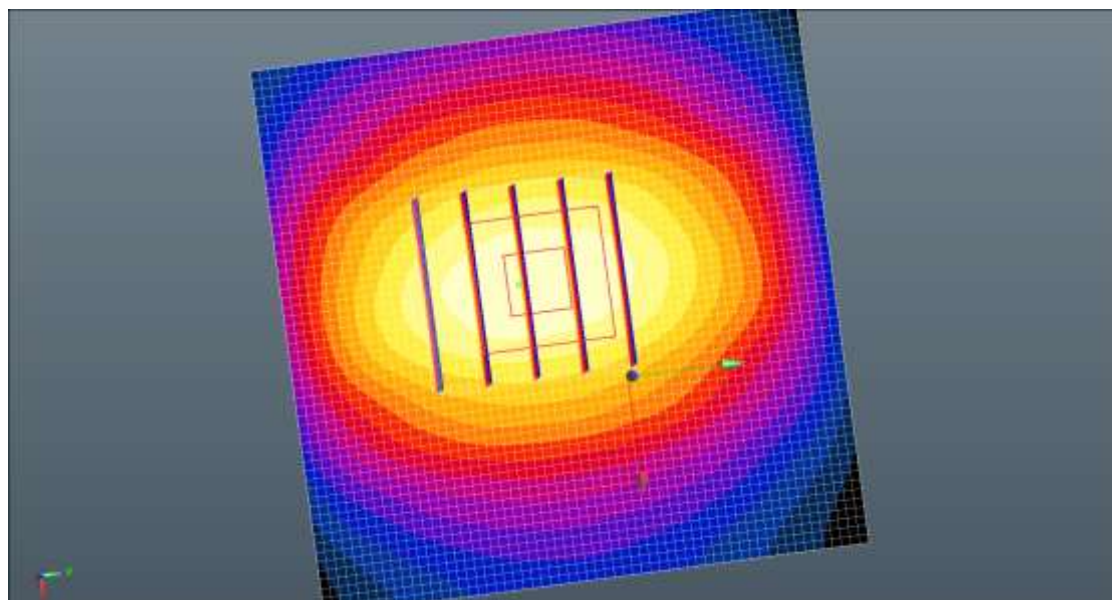
**1900MHz Head Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 52.89 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 8.04 W/kg

**SAR(1 g) = 4.04 W/kg; SAR(10 g) = 2.03 W/kg**

Maximum value of SAR (measured) = 4.48 W/kg



0 dB = 4.71 W/kg = 6.73 dBW/kg

## ■ Verification Data (1 900 MHz Body)

Test Laboratory: HCT CO., LTD  
Input Power 100 mW (20 dBm)  
Liquid Temp: 21.8 °C  
Test Date: Jul. 10, 2015

### DUT: Dipole 1900 MHz D1900V2; Type: D1900V2

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.554$  S/m;  $\epsilon_r = 54.907$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3797; ConvF(7.23, 7.23, 7.23); Calibrated: 2014-11-19;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2014-09-18
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**1900MHz Verification /Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 4.56 W/kg

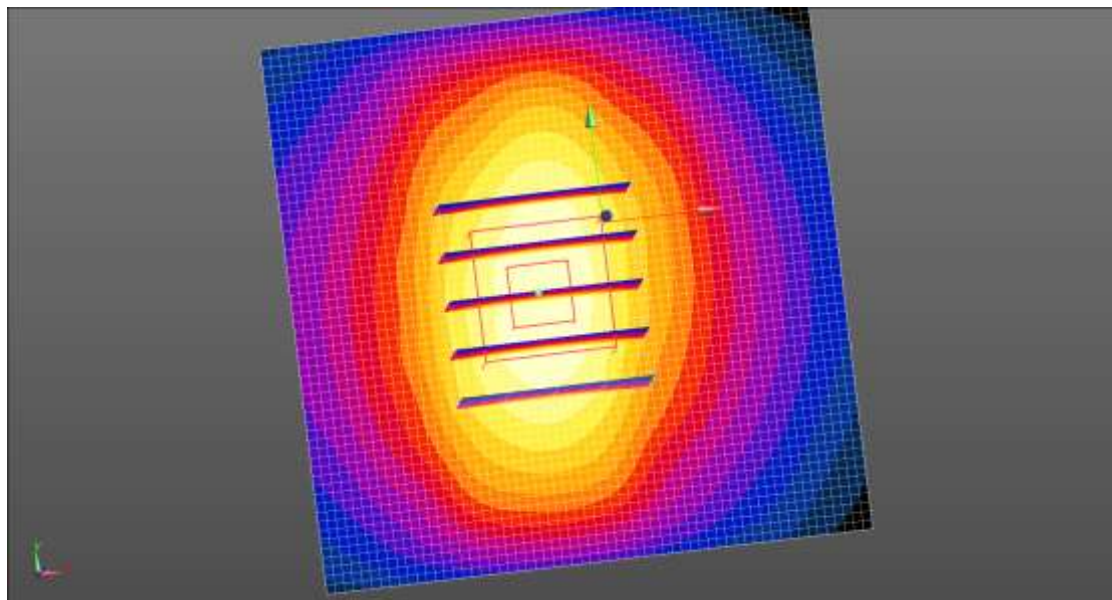
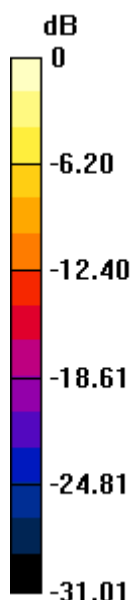
**1900MHz Verification /Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 50.87 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 7.60 W/kg

**SAR(1 g) = 4.03 W/kg; SAR(10 g) = 2.05 W/kg**

Maximum value of SAR (measured) = 4.54 W/kg



0 dB = 4.56 W/kg = 6.59 dBW/kg

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

Test Laboratory: HCT CO., LTD  
 Input Power: 100 mW (20 dBm)  
 Liquid Temp: 20.2 °C  
 Test Date: Jul. 14, 2015

### **DUT: Dipole 2450 MHz D2450V2; Type: D2450V2**

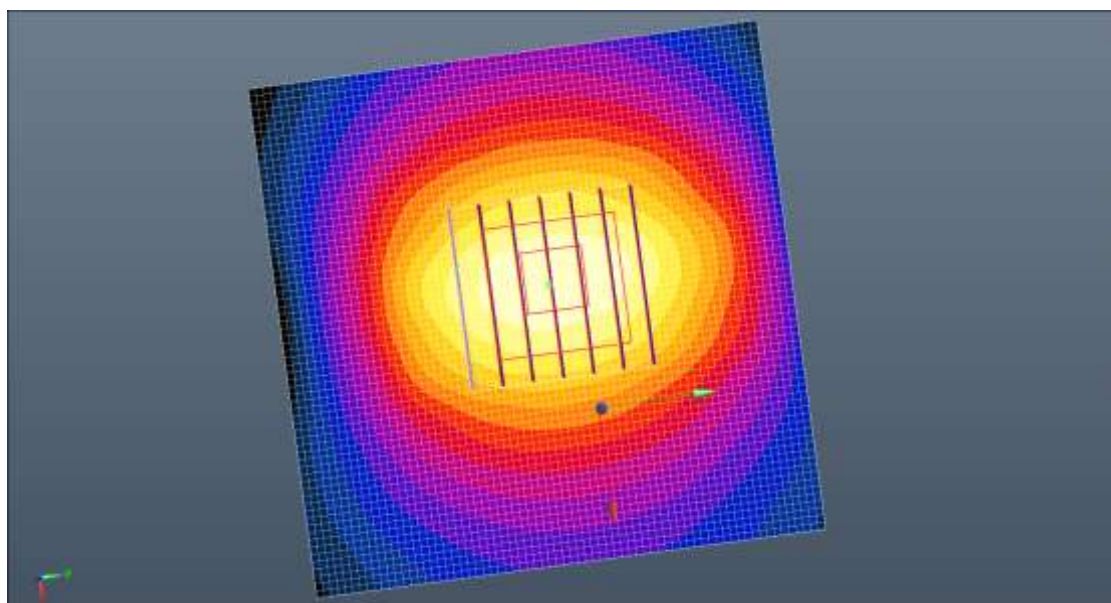
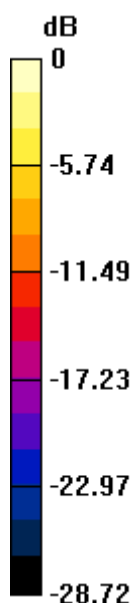
Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.822$  S/m;  $\epsilon_r = 40.27$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(7.16, 7.16, 7.16); Calibrated: 2014-12-22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn648; Calibrated: 2015-04-28
- Phantom: SAM with CRP v5.0\_F
- Measurement SW: DASY52, Version 52.8 (8);

**Verification/2450MHz Head/Area Scan (71x71x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm  
 Maximum value of SAR (interpolated) = 8.61 W/kg

**Verification/2450MHz Head/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm  
 Reference Value = 69.16 V/m; Power Drift = 0.08 dB  
 Peak SAR (extrapolated) = 11.9 W/kg  
**SAR(1 g) = 5.48 W/kg; SAR(10 g) = 2.51 W/kg**  
 Maximum value of SAR (measured) = 8.55 W/kg



0 dB = 8.61 W/kg = 9.35 dBW/kg

## ■ Verification Data (2 450 MHz Body)

Test Laboratory: HCT CO., LTD  
Input Power: 100 mW (20 dBm)  
Liquid Temp: 20.2 °C  
Test Date: Jul. 14, 2015

### DUT: Dipole 2450 MHz D2450V2; Type: D2450V2

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.985$  S/m;  $\epsilon_r = 52.971$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Center Section

#### DASY5 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(7.1, 7.1, 7.1); Calibrated: 2014-12-22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn648; Calibrated: 2015-04-28
- Phantom: Triple Flat Phantom 5.1C
- Measurement SW: DASY52, Version 52.8 (8);

**2450MHz Body Verification/Area Scan (81x81x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 6.19 W/kg

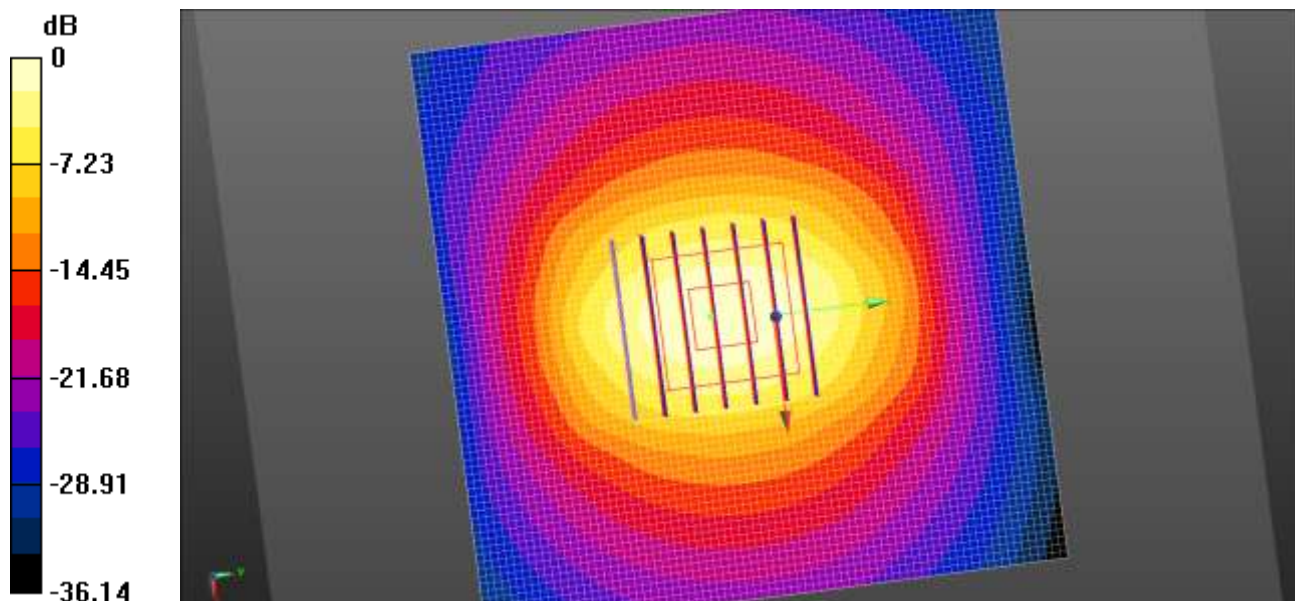
**2450MHz Body Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 54.47 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 10.5 W/kg

**SAR(1 g) = 5.3 W/kg; SAR(10 g) = 2.54 W/kg**

Maximum value of SAR (measured) = 7.13 W/kg



0 dB = 6.19 W/kg = 7.91 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: **EX3-3797\_Nov14**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3797**

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

Calibration date: **November 19, 2014**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 03-Apr-14 (No. 217-01911)         | Apr-15                 |
| Power sensor E4412A        | MY41498087      | 03-Apr-14 (No. 217-01911)         | Apr-15                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 03-Apr-14 (No. 217-01915)         | Apr-15                 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-14 (No. 217-01919)         | Apr-15                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 03-Apr-14 (No. 217-01920)         | Apr-15                 |
| Reference Probe ES3DV2     | SN: 3013        | 30-Dec-13 (No. ES3-3013_Dec13)    | Dec-14                 |
| DAE4                       | SN: 660         | 13-Dec-13 (No. DAE4-660_Dec13)    | Dec-14                 |
| Secondary Standards        | ID              | Check Date (in house)             | Scheduled Check        |
| RF generator HP 8648C      | US3642U01700    | 4-Aug-99 (in house check Apr-13)  | In house check: Apr-16 |
| Network Analyzer HP 8753E  | US37390585      | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

|                                                                                                                 | Name          | Function              | Signature |
|-----------------------------------------------------------------------------------------------------------------|---------------|-----------------------|-----------|
| Calibrated by:                                                                                                  | Jeton Kasrati | Laboratory Technician |           |
| Approved by:                                                                                                    | Katja Pokovic | Technical Manager     |           |
| Issued: November 20, 2014                                                                                       |               |                       |           |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |               |                       |           |

Certificate No: EX3-3797\_Nov14

Page 1 of 11

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



S Schweizerischer Kalibrierdienst  
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S Servizio svizzero di taratura  
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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#### Glossary:

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

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

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

#### Methods Applied and Interpretation of Parameters:

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

EX3DV4 – SN:3797

November 19, 2014

# Probe EX3DV4

## SN:3797

Manufactured: April 5, 2011  
Calibrated: November 19, 2014

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

EX3DV4- SN:3797

November 19, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3797

### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|-----------------------------------------------------------|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.63     | 0.58     | 0.57     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                                     | 97.9     | 97.3     | 95.4     |               |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>C</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 154.4    | $\pm 3.0 \%$              |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 168.7    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 171.4    |                           |

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

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

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

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

EX3DV4- SN:3797

November 19, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3797

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>c</sup> | Relative Permittivity <sup>f</sup> | Conductivity (S/m) <sup>f</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>g</sup> | Depth (mm) <sup>g</sup> | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 52.3                               | 0.76                            | 11.03   | 11.03   | 11.03   | 0.00               | 1.00                    | ± 13.3 %    |
| 835                  | 41.5                               | 0.90                            | 9.22    | 9.22    | 9.22    | 0.51               | 0.78                    | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 8.96    | 8.96    | 8.96    | 0.66               | 0.68                    | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 7.71    | 7.71    | 7.71    | 0.64               | 0.63                    | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 7.58    | 7.58    | 7.58    | 0.46               | 0.74                    | ± 12.0 %    |
| 1950                 | 40.0                               | 1.40                            | 7.33    | 7.33    | 7.33    | 0.45               | 0.76                    | ± 12.0 %    |
| 2300                 | 39.5                               | 1.67                            | 7.23    | 7.23    | 7.23    | 0.52               | 0.69                    | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 6.86    | 6.86    | 6.86    | 0.51               | 0.70                    | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 6.70    | 6.70    | 6.70    | 0.43               | 0.79                    | ± 12.0 %    |
| 5200                 | 36.0                               | 4.66                            | 4.86    | 4.86    | 4.86    | 0.35               | 1.80                    | ± 13.1 %    |
| 5300                 | 35.9                               | 4.76                            | 4.71    | 4.71    | 4.71    | 0.35               | 1.80                    | ± 13.1 %    |
| 5500                 | 35.6                               | 4.96                            | 4.62    | 4.62    | 4.62    | 0.40               | 1.80                    | ± 13.1 %    |
| 5600                 | 35.5                               | 5.07                            | 4.50    | 4.50    | 4.50    | 0.40               | 1.80                    | ± 13.1 %    |
| 5800                 | 35.3                               | 5.27                            | 4.42    | 4.42    | 4.42    | 0.40               | 1.80                    | ± 13.1 %    |

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

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

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

EX3DV4- SN:3797

November 19, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3797

### Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 61.9                               | 0.80                            | 10.65   | 10.65   | 10.65   | 0.00               | 1.00                    | ± 13.3 %    |
| 835                  | 55.2                               | 0.97                            | 9.15    | 9.15    | 9.15    | 0.65               | 0.72                    | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 7.54    | 7.54    | 7.54    | 0.37               | 0.85                    | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 7.23    | 7.23    | 7.23    | 0.73               | 0.61                    | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 6.86    | 6.86    | 6.86    | 0.80               | 0.50                    | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 6.68    | 6.68    | 6.68    | 0.80               | 0.50                    | ± 12.0 %    |
| 5200                 | 49.0                               | 5.30                            | 4.36    | 4.36    | 4.36    | 0.45               | 1.90                    | ± 13.1 %    |
| 5300                 | 48.9                               | 5.42                            | 4.17    | 4.17    | 4.17    | 0.45               | 1.90                    | ± 13.1 %    |
| 5500                 | 48.6                               | 5.65                            | 3.89    | 3.89    | 3.89    | 0.50               | 1.90                    | ± 13.1 %    |
| 5600                 | 48.5                               | 5.77                            | 3.73    | 3.73    | 3.73    | 0.50               | 1.90                    | ± 13.1 %    |
| 5800                 | 48.2                               | 6.00                            | 4.12    | 4.12    | 4.12    | 0.50               | 1.90                    | ± 13.1 %    |

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

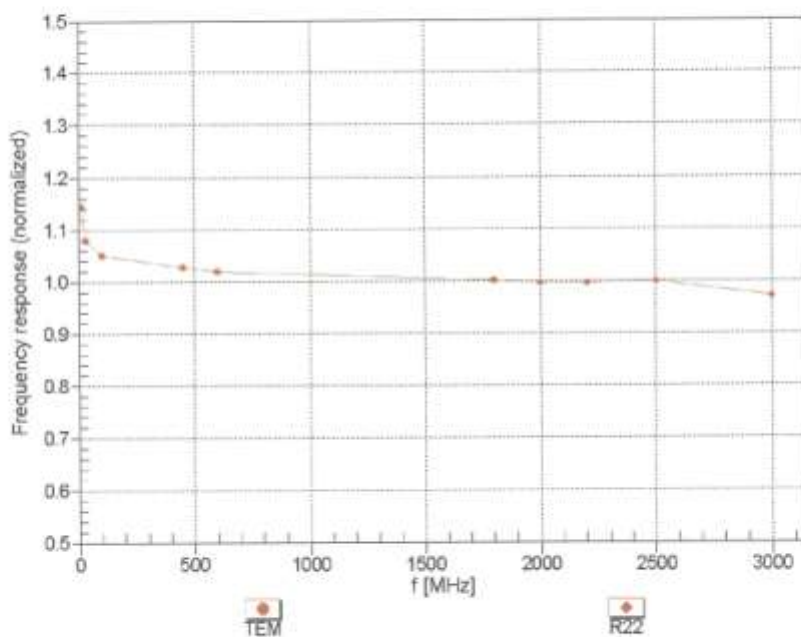
<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted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

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

EX3DV4- SN:3797

November 19, 2014

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

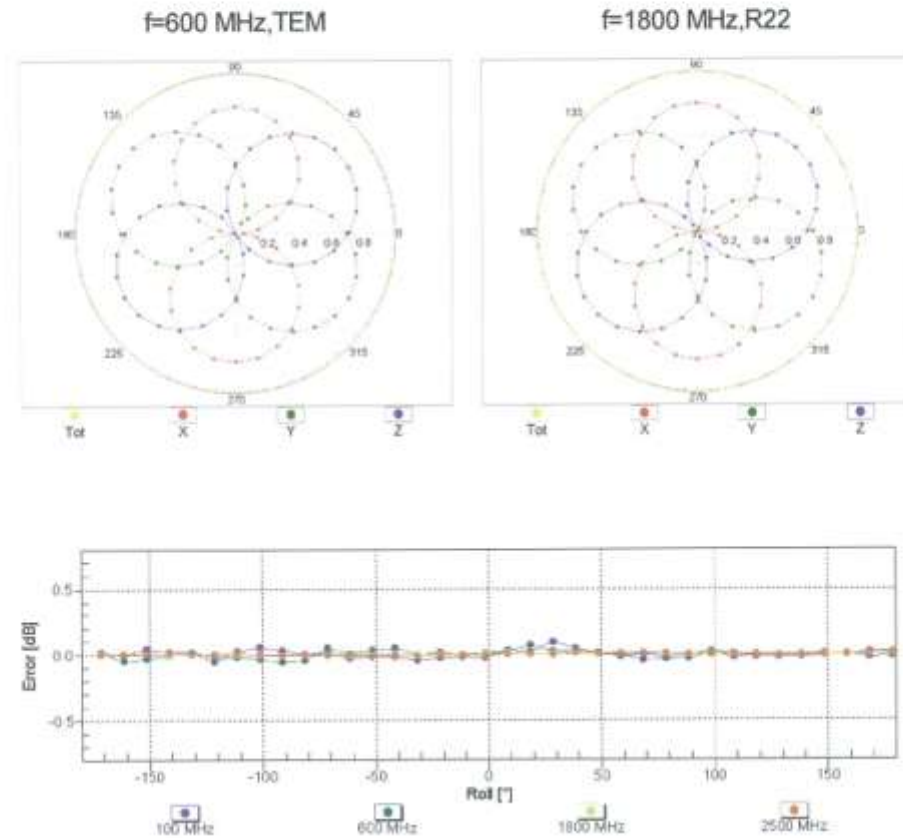


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

EX3DV4- SN:3797

November 19, 2014

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

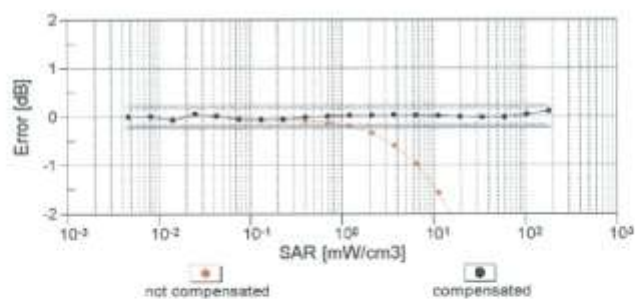
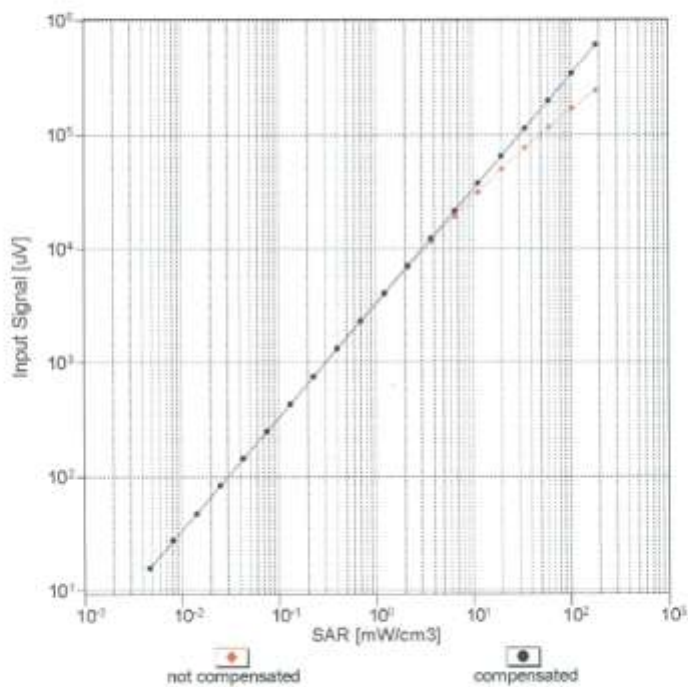


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

EX3DV4- SN:3797

November 19, 2014

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



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

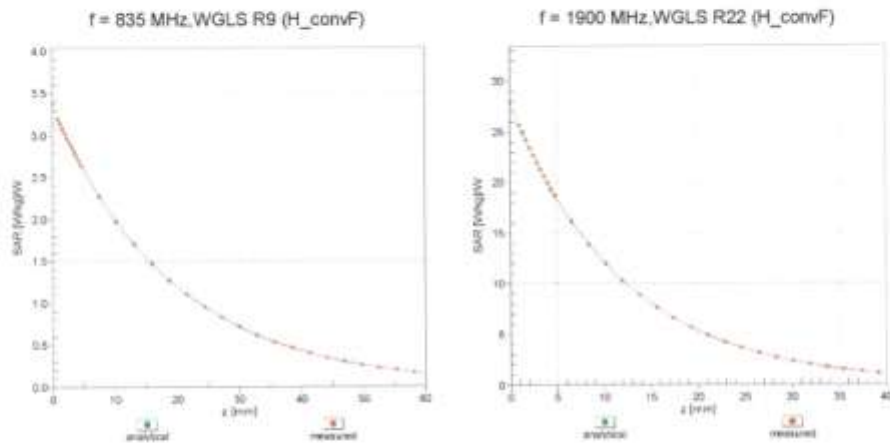
Certificate No: EX3-3797\_Nov14

Page 9 of 11

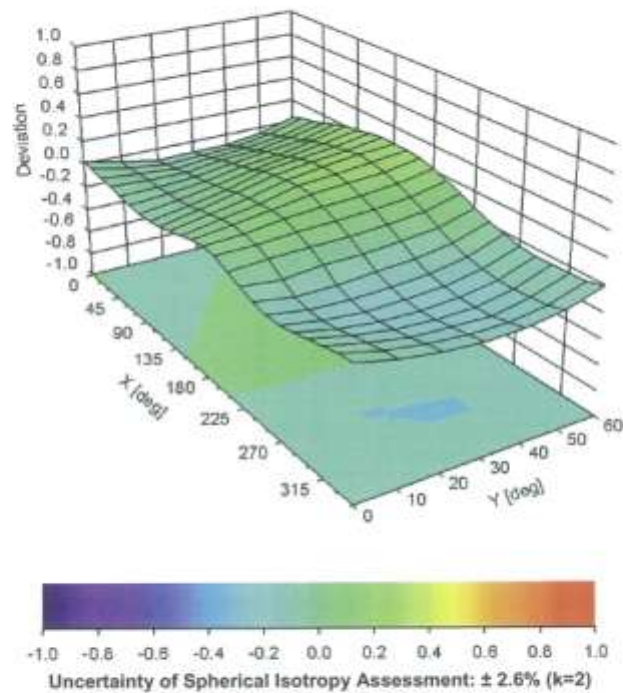
EX3DV4- SN:3797

November 19, 2014

## Conversion Factor Assessment



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



EX3DV4- SN:3797

November 19, 2014

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3797****Other Probe Parameters**

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -111.5     |
| 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 | 1.4 mm     |

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

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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: EX3-3967\_Dec14

## CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3967

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: December 22, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 03-Apr-14 (No. 217-01911)         | Apr-15                 |
| Power sensor E4412A        | MY41498087      | 03-Apr-14 (No. 217-01911)         | Apr-15                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 03-Apr-14 (No. 217-01915)         | Apr-15                 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-14 (No. 217-01919)         | Apr-15                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 03-Apr-14 (No. 217-01920)         | Apr-15                 |
| Reference Probe ES3DV2     | SN: 3013        | 30-Dec-13 (No. ES3-3013_Dec13)    | Dec-14                 |
| DAE4                       | SN: 789         | 30-Apr-14 (No. DAE4-789_Apr14)    | Apr-15                 |
| 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-14) | In house check: Oct-15 |

|                                                                                                                 |                         |                                   |               |
|-----------------------------------------------------------------------------------------------------------------|-------------------------|-----------------------------------|---------------|
| Calibrated by:                                                                                                  | Name<br>Claudio Leubler | Function<br>Laboratory Technician | Signature<br> |
| Approved by:                                                                                                    | Name<br>Kaija Pokovic   | Function<br>Technical Manager     | Signature<br> |
| Issued: December 22, 2014                                                                                       |                         |                                   |               |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |                         |                                   |               |

Certificate No: EX3-3967\_Dec14

Page 1 of 11

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**S** Schweizerischer Kalibrierdienst  
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**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 |
| 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 is diode compression point 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: EX3-3967\_Dec14

Page 2 of 11

EX3DV4 – SN:3967

December 22, 2014

# Probe EX3DV4

## SN:3967

Manufactured: September 30, 2013

Calibrated: December 22, 2014

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3967

December 22, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3967

### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|-----------------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.53     | 0.44     | 0.49     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                                     | 93.9     | 96.2     | 102.2    |           |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>C</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 148.0    | ±3.0 %                    |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 134.9    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 138.3    |                           |

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

EX3DV4-SN:3967

December 22, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3967

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>c</sup> | Relative Permittivity <sup>f</sup> | Conductivity (S/m) <sup>f</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>g</sup> | Depth <sup>h</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 41.9                               | 0.89                            | 10.18   | 10.18   | 10.18   | 0.80               | 0.61                    | ± 12.0 %    |
| 835                  | 41.5                               | 0.90                            | 9.75    | 9.75    | 9.75    | 0.80               | 0.61                    | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 9.56    | 9.56    | 9.56    | 0.39               | 0.89                    | ± 12.0 %    |
| 1450                 | 40.5                               | 1.20                            | 8.40    | 8.40    | 8.40    | 0.32               | 0.91                    | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 8.59    | 8.59    | 8.59    | 0.64               | 0.70                    | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 8.13    | 8.13    | 8.13    | 0.69               | 0.68                    | ± 12.0 %    |
| 1950                 | 40.0                               | 1.40                            | 7.81    | 7.81    | 7.81    | 0.69               | 0.60                    | ± 12.0 %    |
| 2300                 | 39.5                               | 1.67                            | 7.57    | 7.57    | 7.57    | 0.51               | 0.76                    | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 7.16    | 7.16    | 7.16    | 0.50               | 0.77                    | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 6.86    | 6.86    | 6.86    | 0.40               | 0.92                    | ± 12.0 %    |
| 3500                 | 37.9                               | 2.91                            | 7.10    | 7.10    | 7.10    | 0.41               | 0.95                    | ± 13.1 %    |
| 5200                 | 36.0                               | 4.66                            | 5.07    | 5.07    | 5.07    | 0.35               | 1.80                    | ± 13.1 %    |
| 5300                 | 35.9                               | 4.76                            | 4.88    | 4.88    | 4.88    | 0.35               | 1.80                    | ± 13.1 %    |
| 5500                 | 35.6                               | 4.96                            | 4.84    | 4.84    | 4.84    | 0.40               | 1.80                    | ± 13.1 %    |
| 5600                 | 35.5                               | 5.07                            | 4.70    | 4.70    | 4.70    | 0.40               | 1.80                    | ± 13.1 %    |
| 5800                 | 35.3                               | 5.27                            | 4.64    | 4.64    | 4.64    | 0.40               | 1.80                    | ± 13.1 %    |

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

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

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

EX3DV4- SN:3967

December 22, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3967

### Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) <sup>c</sup> | Relative Permittivity <sup>f</sup> | Conductivity (S/m) <sup>f</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>g</sup> | Depth <sup>g</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 55.5                               | 0.96                            | 9.68    | 9.68    | 9.68    | 0.58               | 0.71                    | ± 12.0 %    |
| 835                  | 55.2                               | 0.97                            | 9.55    | 9.55    | 9.55    | 0.80               | 0.58                    | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 7.90    | 7.90    | 7.90    | 0.78               | 0.63                    | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 7.58    | 7.58    | 7.58    | 0.49               | 0.82                    | ± 12.0 %    |
| 2300                 | 52.9                               | 1.81                            | 7.37    | 7.37    | 7.37    | 0.80               | 0.63                    | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 7.10    | 7.10    | 7.10    | 0.73               | 0.66                    | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 6.97    | 6.97    | 6.97    | 0.80               | 0.57                    | ± 12.0 %    |
| 5200                 | 49.0                               | 5.30                            | 4.59    | 4.59    | 4.59    | 0.45               | 1.90                    | ± 13.1 %    |
| 5300                 | 48.9                               | 5.42                            | 4.43    | 4.43    | 4.43    | 0.45               | 1.90                    | ± 13.1 %    |
| 5500                 | 48.6                               | 5.65                            | 4.02    | 4.02    | 4.02    | 0.50               | 1.90                    | ± 13.1 %    |
| 5600                 | 48.5                               | 5.77                            | 3.85    | 3.85    | 3.85    | 0.50               | 1.90                    | ± 13.1 %    |
| 5800                 | 48.2                               | 6.00                            | 4.12    | 4.12    | 4.12    | 0.50               | 1.90                    | ± 13.1 %    |

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

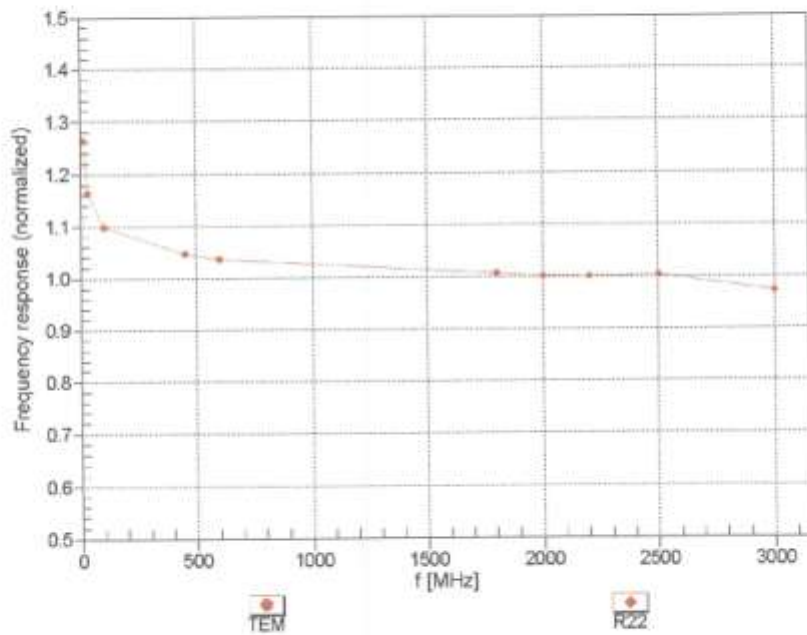
<sup>f</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted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

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

EX3DV4-SN:3957

December 22, 2014

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

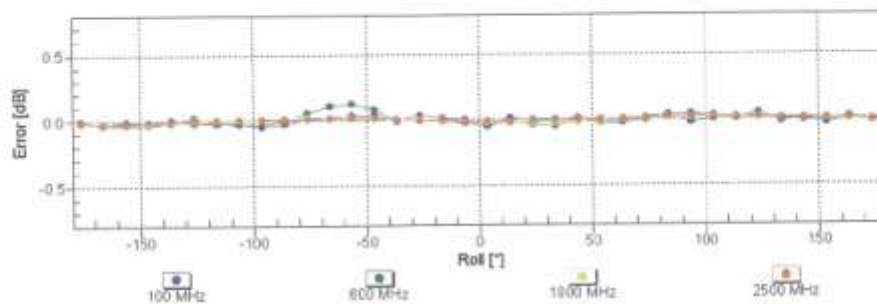
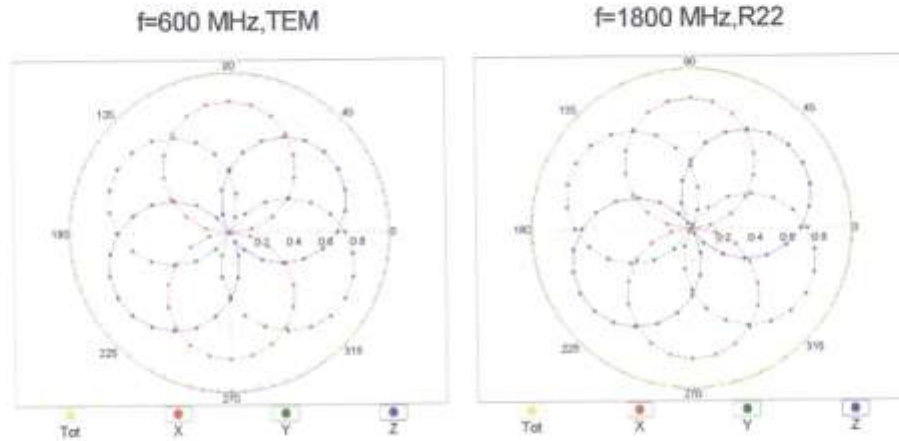


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

EX3DV4- SN:3967

December 22, 2014

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

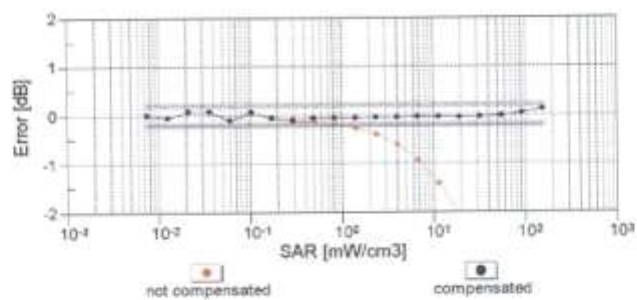
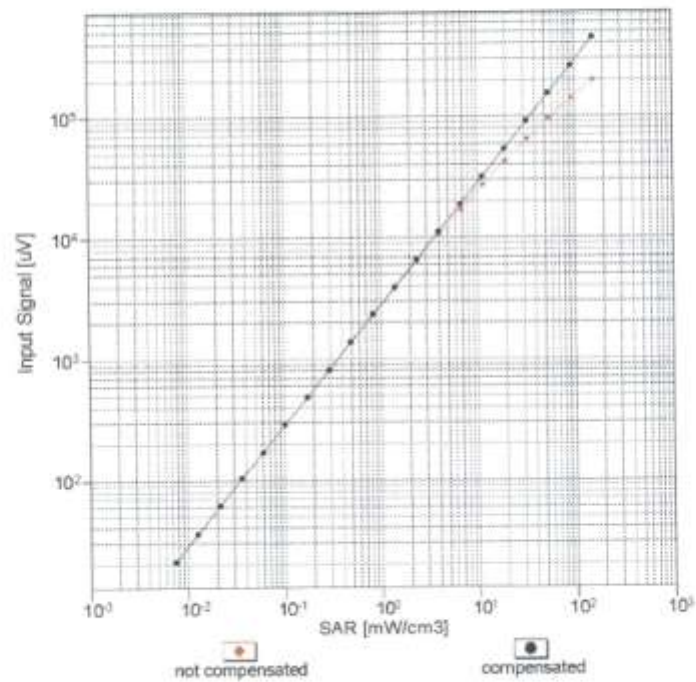


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

EX3DV4- SN:3967

December 22, 2014

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



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

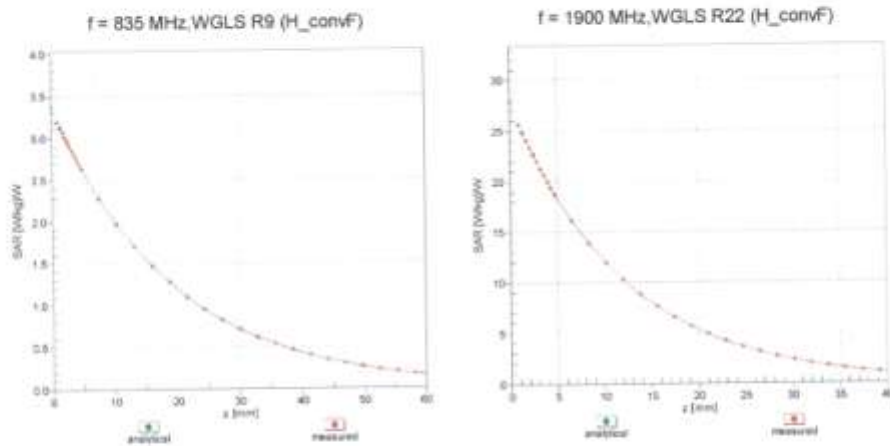
Certificate No: EX3-3967\_Dec14

Page 9 of 11

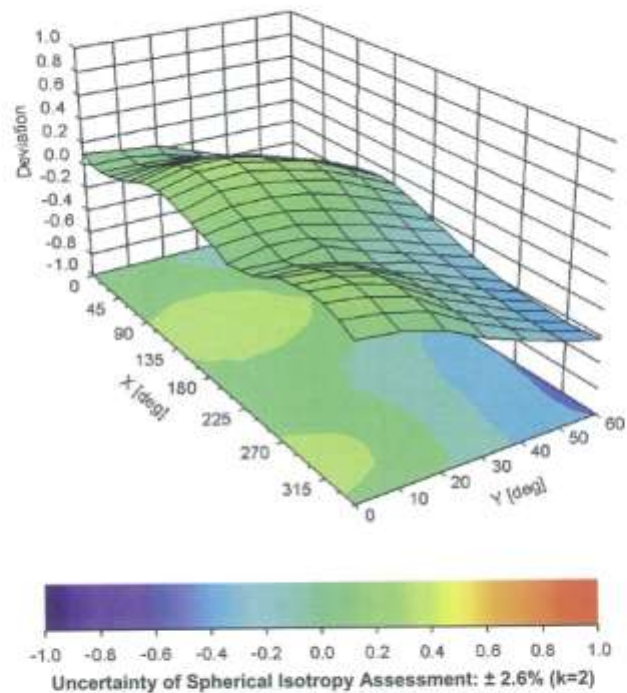
EX3DV4- SN:3967

December 22, 2014

## Conversion Factor Assessment



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



Certificate No: EX3-3967\_Dec14

Page 10 of 11

EX3DV4- SN:3967

December 22, 2014

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3967

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -16,4      |
| 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 | 1.4 mm     |

Calibration Laboratory of  
Schmid & Partner  
Engineering AG  
Zaughausstrasse 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 0108

Client HCT (Dymstec)

Certificate No: EX3-3968\_Jun15

## CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3968

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

Calibration date: June 18, 2015

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 01-Apr-15 (No. 217-02128)         | Mar-16                 |
| Power sensor E4412A        | MY41498087      | 01-Apr-15 (No. 217-02128)         | Mar-16                 |
| Reference 3 dB Attenuator  | SN: 55054 (3c)  | 01-Apr-15 (No. 217-02129)         | Mar-16                 |
| Reference 20 dB Attenuator | SN: 55277 (20x) | 01-Apr-15 (No. 217-02132)         | Mar-16                 |
| Reference 30 dB Attenuator | SN: 55129 (30b) | 01-Apr-15 (No. 217-02133)         | Mar-16                 |
| Reference Probe ES3DV2     | SN: 3013        | 30-Dec-14 (No. ES3-3013_Dec14)    | Dec-15                 |
| DAE4                       | SN: 660         | 14-Jan-15 (No. DAE4-660_Jan15)    | Jan-16                 |
| Secondary Standards        | ID              | Check Date (in house)             | Scheduled Check        |
| RF generator HP 8548C      | 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-14) | In house check: Oct-15 |

|                                                                                                                 | Name           | Function              | Signature |
|-----------------------------------------------------------------------------------------------------------------|----------------|-----------------------|-----------|
| Calibrated by:                                                                                                  | Jeton Kastrati | Laboratory Technician |           |
| Approved by:                                                                                                    | Katja Pokrovic | Technical Manager     |           |
| Issued: June 18, 2015                                                                                           |                |                       |           |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |                |                       |           |

Certificate No: EX3-3968\_Jun15

Page 1 of 11

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Accreditation No.: SCS 0108

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 $\phi$   | $\phi$ rotation around probe axis                                                                                                                 |
| Polarization $\theta$ | $\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\theta = 0$ is normal to probe axis |
| Connector Angle       | information used in DASY system to align probe sensor X to the robot coordinate system                                                            |

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

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

#### Methods Applied and Interpretation of Parameters:

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

Certificate No: EX3-3968\_Jun15

Page 2 of 11

EX3DV4 – SN:3968

June 18, 2015

# Probe EX3DV4

## SN:3968

Manufactured: September 30, 2013

Calibrated: June 18, 2015

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

Certificate No: EX3-3968\_Jun15

Page 3 of 11

EX3DV4- SN:3968

June 18, 2015

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

### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|-----------------------------------------------------------|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.36     | 0.35     | 0.42     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                                     | 103.1    | 102.8    | 96.8     |               |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>C</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 130.3    | $\pm 3.0 \%$              |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 129.8    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 142.3    |                           |

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

EX3DV4- SN:3968

June 18, 2015

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

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 52.3                               | 0.76                            | 13.09   | 13.09   | 13.09   | 0.00               | 1.00                    | ± 13.3 %    |
| 300                  | 45.3                               | 0.87                            | 12.28   | 12.28   | 12.28   | 0.10               | 1.20                    | ± 13.3 %    |
| 450                  | 43.5                               | 0.87                            | 10.61   | 10.61   | 10.61   | 0.18               | 1.20                    | ± 13.3 %    |
| 750                  | 41.9                               | 0.89                            | 9.92    | 9.92    | 9.92    | 0.18               | 1.57                    | ± 12.0 %    |
| 835                  | 41.5                               | 0.90                            | 9.60    | 9.60    | 9.60    | 0.21               | 1.64                    | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 9.45    | 9.45    | 9.45    | 0.22               | 1.25                    | ± 12.0 %    |
| 1450                 | 40.5                               | 1.20                            | 8.28    | 8.28    | 8.28    | 0.26               | 1.02                    | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 8.23    | 8.23    | 8.23    | 0.31               | 0.80                    | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 7.95    | 7.95    | 7.95    | 0.30               | 0.80                    | ± 12.0 %    |
| 1950                 | 40.0                               | 1.40                            | 7.66    | 7.66    | 7.66    | 0.38               | 0.80                    | ± 12.0 %    |
| 2300                 | 39.5                               | 1.67                            | 7.51    | 7.51    | 7.51    | 0.37               | 0.80                    | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 7.21    | 7.21    | 7.21    | 0.36               | 0.80                    | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 7.06    | 7.06    | 7.06    | 0.39               | 0.89                    | ± 12.0 %    |
| 3500                 | 37.9                               | 2.91                            | 6.82    | 6.82    | 6.82    | 0.29               | 1.33                    | ± 13.1 %    |
| 5200                 | 36.0                               | 4.66                            | 5.26    | 5.26    | 5.26    | 0.30               | 1.80                    | ± 13.1 %    |
| 5300                 | 35.9                               | 4.76                            | 5.09    | 5.09    | 5.09    | 0.35               | 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                            | 4.59    | 4.59    | 4.59    | 0.40               | 1.80                    | ± 13.1 %    |
| 5800                 | 35.3                               | 5.27                            | 4.68    | 4.68    | 4.68    | 0.40               | 1.80                    | ± 13.1 %    |

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

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

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

EX3DV4- SN:3968

June 18, 2015

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

### Calibration Parameter Determined in Body 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) <sup>g</sup> | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 61.9                               | 0.80                            | 12.40   | 12.40   | 12.40   | 0.00               | 1.00                    | ± 13.3 %    |
| 300                  | 58.2                               | 0.92                            | 11.34   | 11.34   | 11.34   | 0.05               | 1.10                    | ± 13.3 %    |
| 450                  | 56.7                               | 0.94                            | 10.86   | 10.86   | 10.86   | 0.12               | 1.20                    | ± 13.3 %    |
| 750                  | 55.5                               | 0.96                            | 9.49    | 9.49    | 9.49    | 0.34               | 1.03                    | ± 12.0 %    |
| 835                  | 55.2                               | 0.97                            | 9.55    | 9.55    | 9.55    | 0.50               | 0.80                    | ± 12.0 %    |
| 900                  | 55.0                               | 1.05                            | 9.34    | 9.34    | 9.34    | 0.42               | 0.93                    | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 7.87    | 7.87    | 7.87    | 0.42               | 0.80                    | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 7.60    | 7.60    | 7.60    | 0.33               | 0.95                    | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 7.25    | 7.25    | 7.25    | 0.36               | 0.80                    | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 7.10    | 7.10    | 7.10    | 0.24               | 0.80                    | ± 12.0 %    |
| 5200                 | 49.0                               | 5.30                            | 4.71    | 4.71    | 4.71    | 0.40               | 1.90                    | ± 13.1 %    |
| 5300                 | 48.9                               | 5.42                            | 4.44    | 4.44    | 4.44    | 0.40               | 1.90                    | ± 13.1 %    |
| 5500                 | 48.6                               | 5.65                            | 4.14    | 4.14    | 4.14    | 0.45               | 1.90                    | ± 13.1 %    |
| 5600                 | 48.5                               | 5.77                            | 3.93    | 3.93    | 3.93    | 0.45               | 1.90                    | ± 13.1 %    |
| 5800                 | 48.2                               | 6.00                            | 4.27    | 4.27    | 4.27    | 0.45               | 1.90                    | ± 13.1 %    |

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

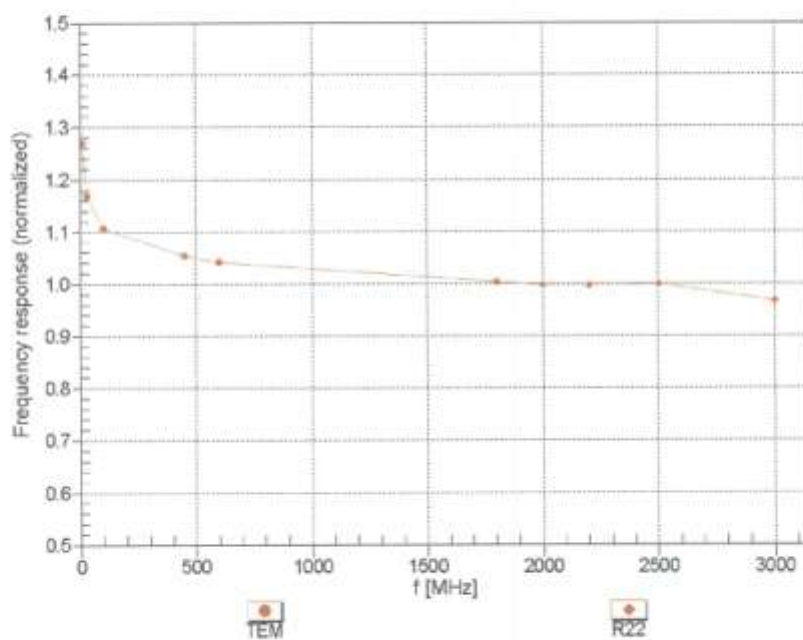
<sup>e</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted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

June 18, 2015

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

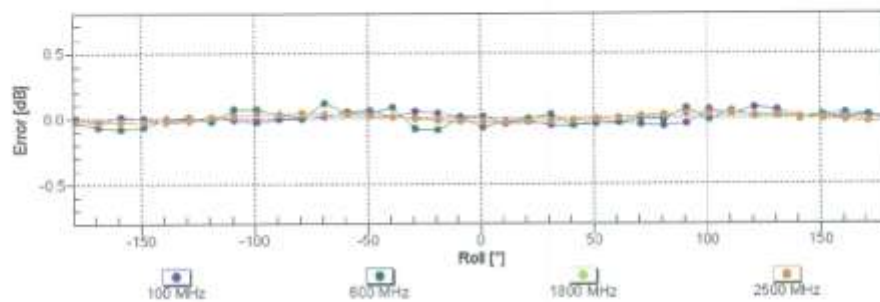
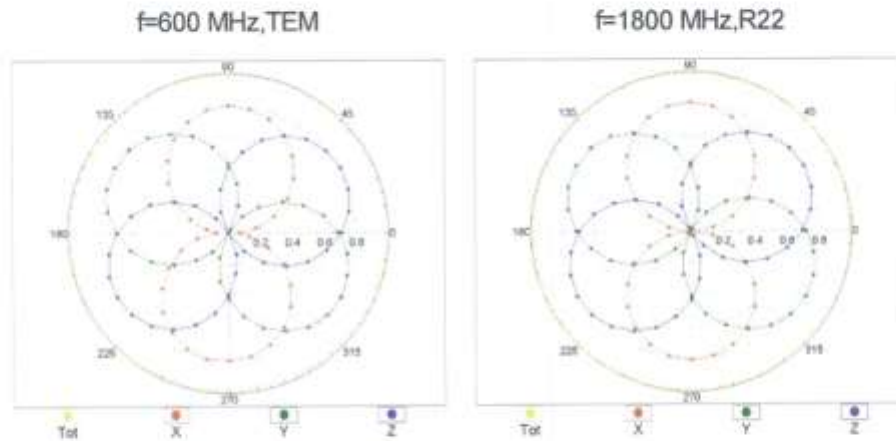


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

EX3DV4- SN:3968

June 18, 2015

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

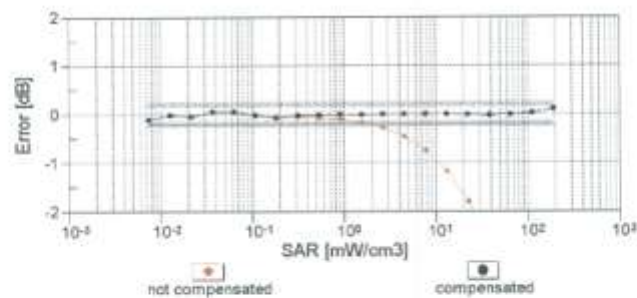
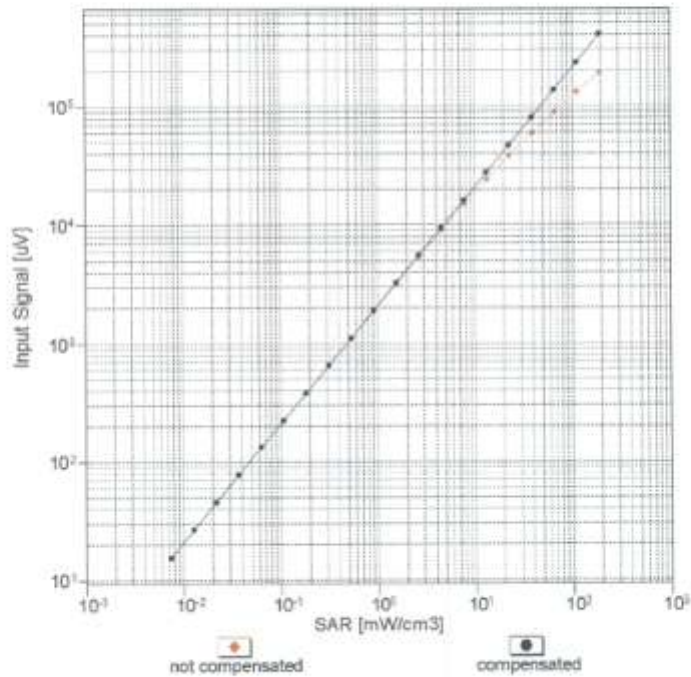


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

EX3DV4- SN:3968

June 18, 2015

### Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f<sub>eval</sub>= 1900 MHz)



Uncertainty of Linearity Assessment: ± 0.6% (k=2)

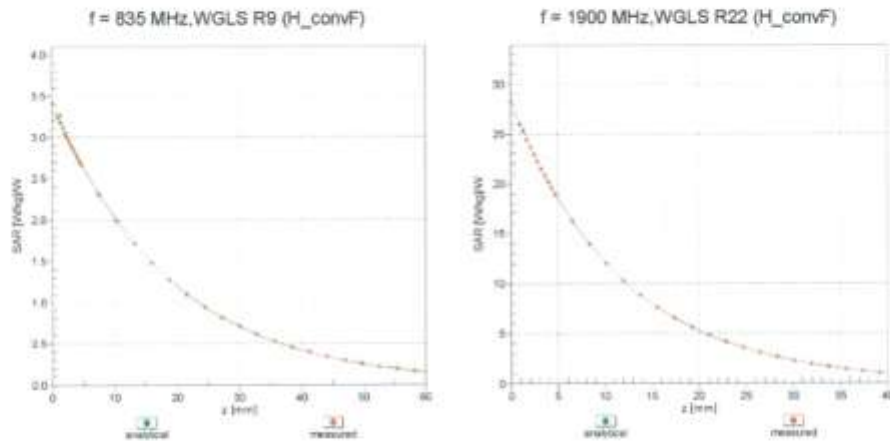
Certificate No: EX3-3968\_Jun15

Page 9 of 11

EX3DV4- SN:3968

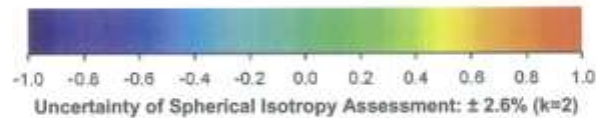
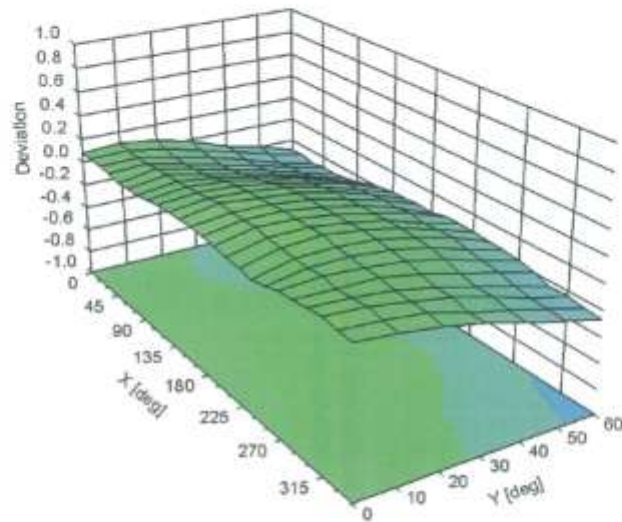
June 18, 2015

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

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



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

EX3DV4-- SN:3968

June 18, 2015

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

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 61.1       |
| 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 | 1.4 mm     |

## Attachment 4. – Dipole Calibration Data

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Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accreditation No.: SCS 0108

Client HCT (Dymstec)

Certificate No: D835V2-441\_Jan15

## CALIBRATION CERTIFICATE

Object D835V2 - SN: 441

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

Calibration date: January 23, 2015

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  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         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | US37292783         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | MY41092317         | 07-Oct-14 (No. 217-02021)         | Oct-15                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 03-Apr-14 (No. 217-01918)         | Apr-15                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921)         | Apr-15                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-14 (No. ES3-3205_Dec14)    | Dec-15                 |
| DAE4                        | SN: 601            | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-09 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

Calibrated by: Name Michael Weber Function Laboratory Technician

Signature

Approved by: Katja Pokovic Technical Manager

Issued: January 26, 2015

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

Certificate No: D835V2-441\_Jan15

Page 1 of 8

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

#### 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                  | V52.8.8     |
| 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 | 41.5 $\pm$ 6 % | 0.93 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 | 2.36 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 9.21 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 | 1.54 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 6.04 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 | 55.8 $\pm$ 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 | 2.40 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 9.34 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 | 1.57 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 6.14 W/kg $\pm$ 16.5 % (k=2) |

## Appendix (Additional assessments outside the scope of SCS0108)

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 51.7 $\Omega$ - 1.0 j $\Omega$ |
| Return Loss                          | - 34.0 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 47.2 $\Omega$ - 2.7 j $\Omega$ |
| Return Loss                          | - 27.9 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.369 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 09, 2001 |

## DASY5 Validation Report for Head TSL

Date: 22.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 441**

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

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.93 \text{ S/m}$ ;  $\epsilon_r = 41.5$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.2, 6.2, 6.2); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

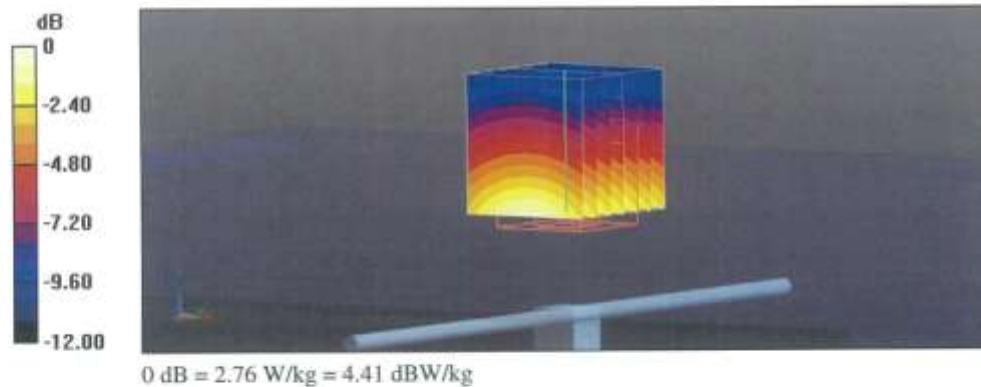
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.43 V/m; Power Drift = -0.04 dB

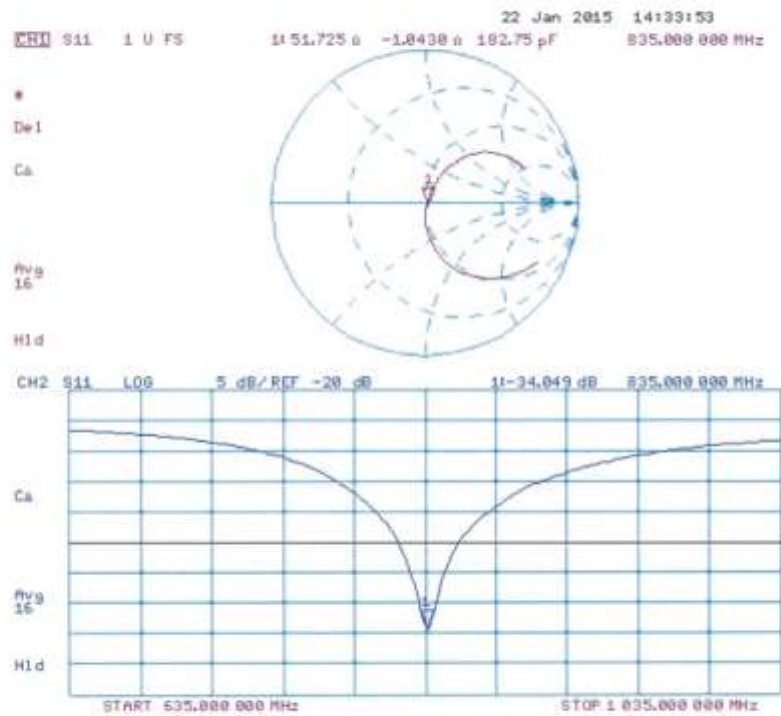
Peak SAR (extrapolated) = 3.49 W/kg

**SAR(1 g) = 2.36 W/kg; SAR(10 g) = 1.54 W/kg**

Maximum value of SAR (measured) = 2.76 W/kg



# Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 23.01.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 441**

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

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 1.01 \text{ S/m}$ ;  $\epsilon_r = 55.8$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.17, 6.17, 6.17); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

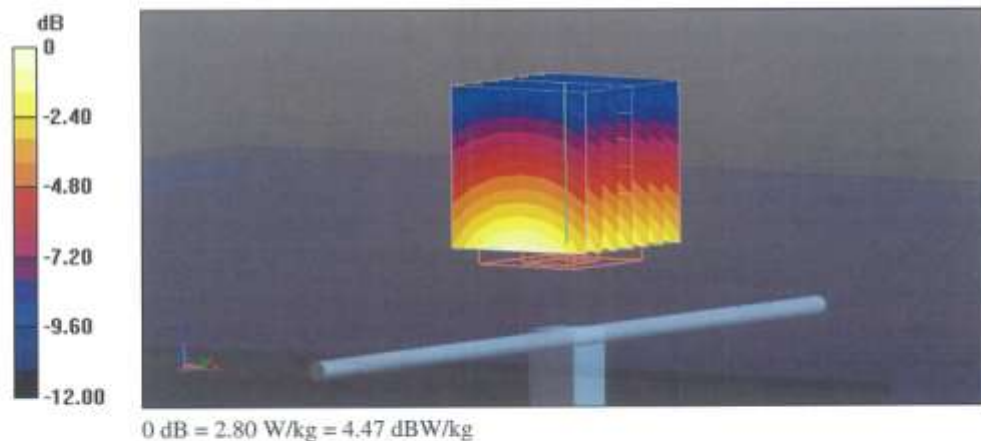
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ 

Reference Value = 54.59 V/m; Power Drift = -0.02 dB

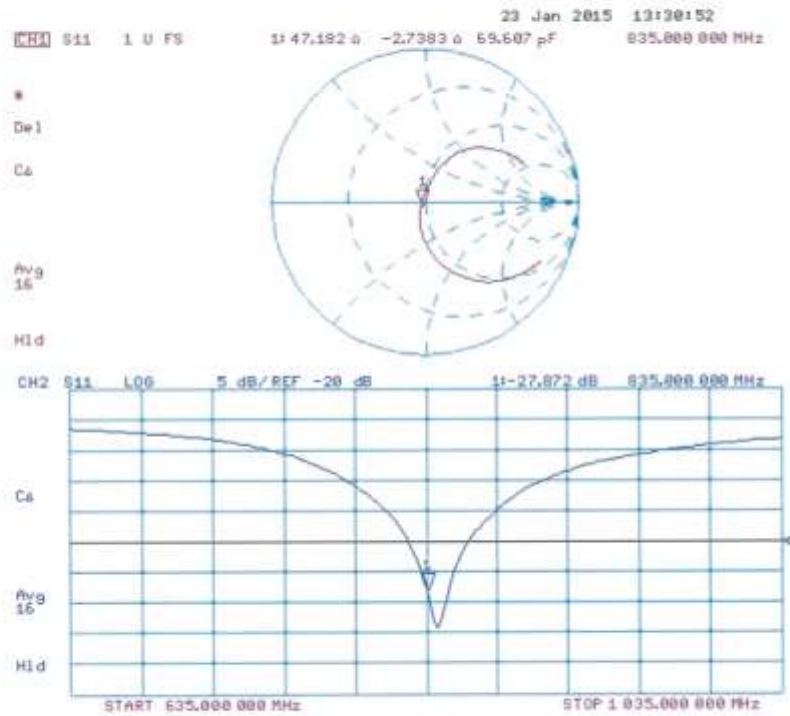
Peak SAR (extrapolated) = 3.53 W/kg

**SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.57 W/kg**

Maximum value of SAR (measured) = 2.80 W/kg



### Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 0108

Client HCT (Dymstec)

Certificate No: D1900V2-5d032\_May15

## CALIBRATION CERTIFICATE

Object D1900V2 - SN: 5d032

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

Calibration date: May 20, 2015

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^\circ\text{C}$  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         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | US37292783         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | MY41092317         | 07-Oct-14 (No. 217-02021)         | Oct-15                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 01-Apr-15 (No. 217-02131)         | Mar-16                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 01-Apr-15 (No. 217-02134)         | Mar-16                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-14 (No. ES3-3205_Dec14)    | Dec-15                 |
| DAE4                        | SN: 601            | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

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

Issued: May 20, 2015

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Certificate No: D1900V2-5d032\_May15

Page 1 of 8

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Accreditation No.: SCS 0108

#### 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                  | V52.8.8     |
| 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 % | 1.37 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 | 10.2 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 41.1 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 | 5.33 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 21.4 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 | 52.7 $\pm$ 6 % | 1.51 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 | 10.2 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 40.9 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 | 5.41 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.7 W/kg $\pm$ 16.5 % (k=2) |

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $51.3 \Omega + 5.2 j\Omega$ |
| Return Loss                          | - 25.5 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $47.4 \Omega + 5.5 j\Omega$ |
| Return Loss                          | - 24.2 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.195 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: 20.05.2015

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;  $\sigma = 1.37$  S/m;  $\epsilon_r = 38.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

### DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5, 5, 5); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

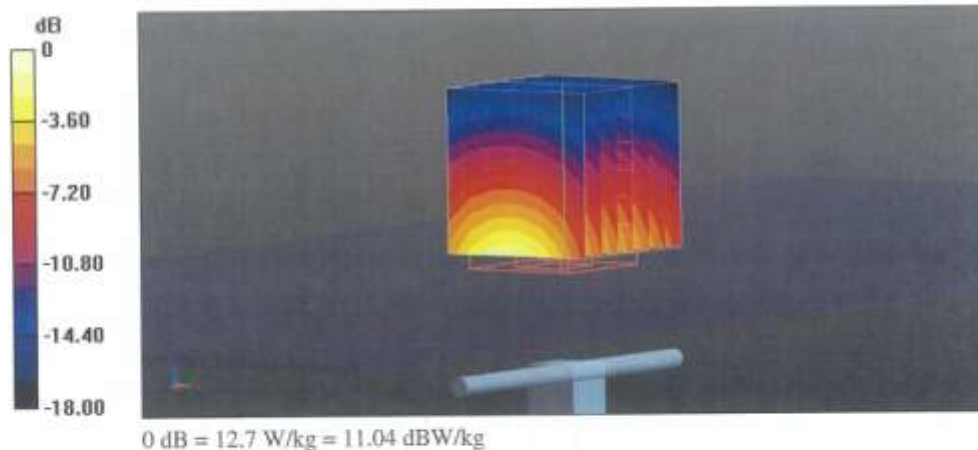
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.00 V/m; Power Drift = 0.04 dB

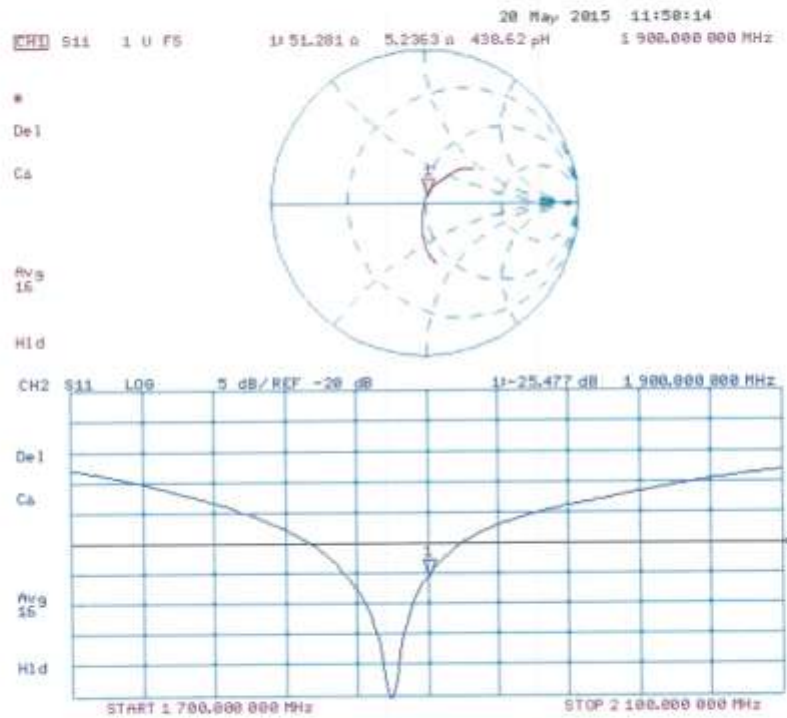
Peak SAR (extrapolated) = 18.6 W/kg

**SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.33 W/kg**

Maximum value of SAR (measured) = 12.7 W/kg



### Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 20.05.2015

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;  $\sigma = 1.51$  S/m;  $\epsilon_r = 52.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.65, 4.65, 4.65); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

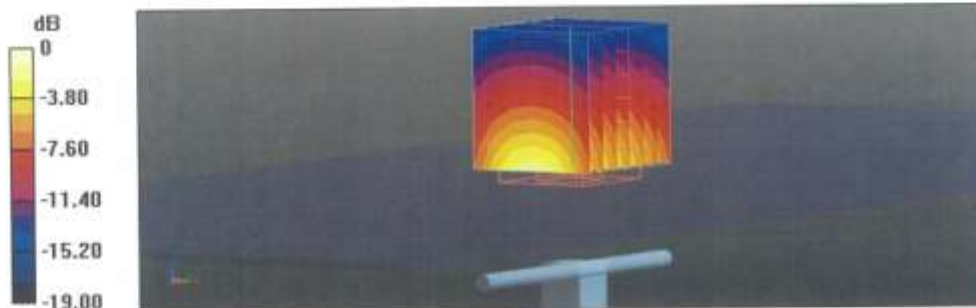
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.54 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 17.3 W/kg

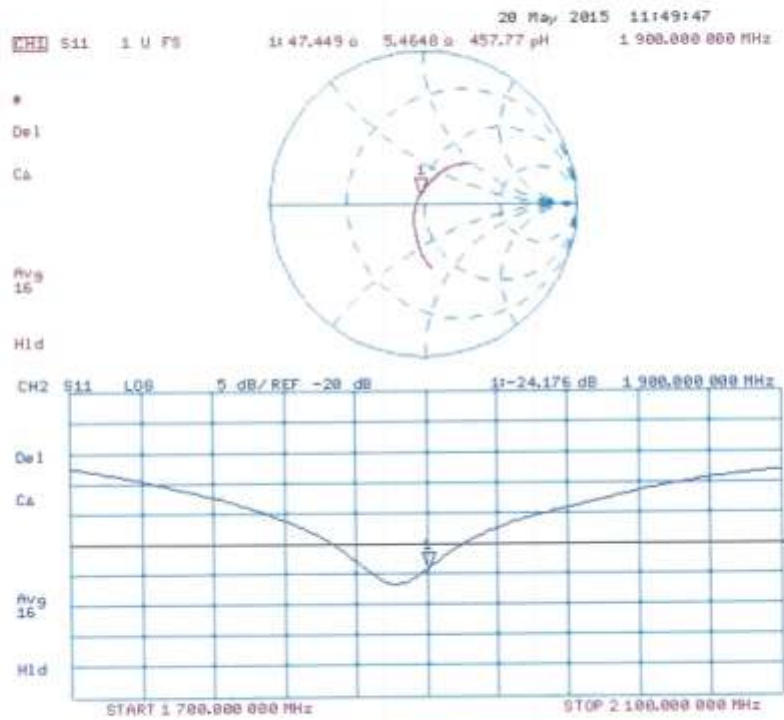
SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.41 W/kg

Maximum value of SAR (measured) = 12.8 W/kg



0 dB = 12.8 W/kg = 11.07 dBW/kg

### Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 0108

Client HCT (Dymstec)

Certificate No: D2450V2-743\_May15

## CALIBRATION CERTIFICATE

Object D2450V2 - SN: 743

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

Calibration date: May 19, 2015

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^\circ\text{C}$  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         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | US37292783         | 07-Oct-14 (No. 217-02020)         | Oct-15                 |
| Power sensor HP 8481A       | MY41092317         | 07-Oct-14 (No. 217-02021)         | Oct-15                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 01-Apr-15 (No. 217-02131)         | Mar-16                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 01-Apr-15 (No. 217-02134)         | Mar-16                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-14 (No. ES3-3205_Dec14)    | Dec-15                 |
| DAE4                        | SN: 601            | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

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

Issued: May 20, 2015

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

Certificate No: D2450V2-743\_May15

Page 1 of 8

**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 0108

#### 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                  | V52.8.8     |
| 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 | 37.9 $\pm$ 6 % | 1.84 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 | 13.6 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 53.4 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 | 6.32 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 25.0 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             | 52.7           | 1.95 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 50.7 $\pm$ 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 | 13.4 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 52.1 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 | 6.20 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 24.4 W/kg $\pm$ 16.5 % (k=2) |

**Appendix (Additional assessments outside the scope of SCS 0108)****Antenna Parameters with Head TSL**

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $54.2 \Omega + 4.4 j\Omega$ |
| Return Loss                          | - 24.6 dB                   |

**Antenna Parameters with Body TSL**

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $51.4 \Omega + 6.1 j\Omega$ |
| Return Loss                          | - 24.2 dB                   |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.160 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: 19.05.2015

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;  $\sigma = 1.84$  S/m;  $\epsilon_r = 37.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

### DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.54, 4.54, 4.54); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

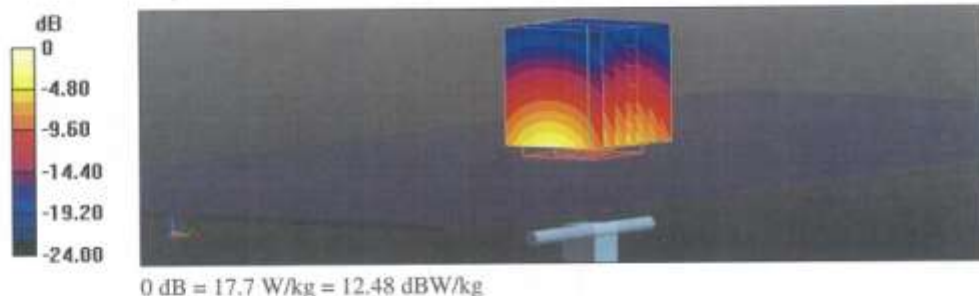
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.4 V/m; Power Drift = 0.04 dB

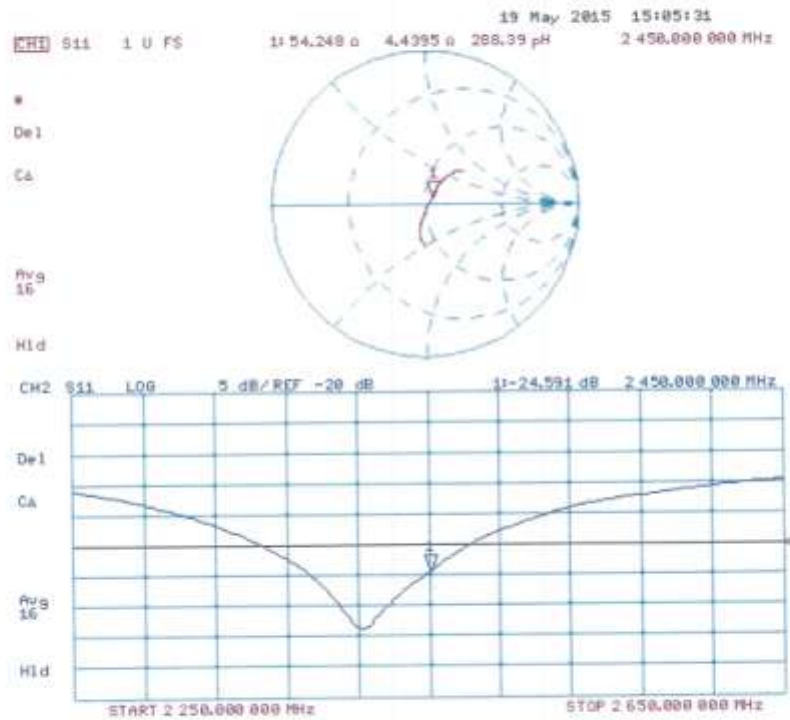
Peak SAR (extrapolated) = 28.0 W/kg

**SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.32 W/kg**

Maximum value of SAR (measured) = 17.7 W/kg



### Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 19.05.2015

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;  $\epsilon_r = 50.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.32, 4.32, 4.32); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

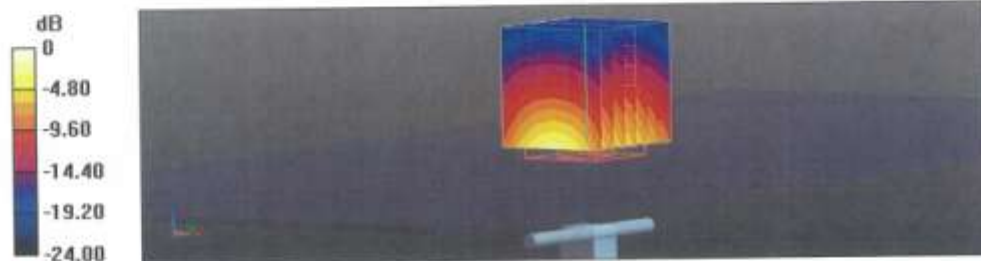
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.12 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 27.9 W/kg

**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.2 W/kg**

Maximum value of SAR (measured) = 17.7 W/kg



0 dB = 17.7 W/kg = 12.48 dBW/kg

### Impedance Measurement Plot for Body TSL

