

# SAR TEST REPORT

**Applicant Name:**

LG Electronics, MobileComm U.S.A., Inc.

1000 Sylvan Avenue, Englewood Cliffs NJ 07632

**Date of Issue:** 02. 15, 2016

**Test Report No.:** HCT-A-1602-F001-1

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

**FCC ID:**

**ZNFK520**

**Equipment Type:**

GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n (2.4GHz), NFC, VoIP, Hotspot support

**Model Name:**

LG-K520

**Additional Model Name:**

LGK520, K520

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

47CFR §2.1093  
ANSI/ IEEE C95.1 – 1992  
IEEE 1528-2013

**Date of Test:**

01/18/2016 ~ 01/21/2016

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**



**Young-Soo Jang**  
Test Engineer / SAR Team  
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**Reviewed By**



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Certification Division

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## Version

| <b>Rev.</b>       | <b>DATE</b>  | <b>DESCRIPTION</b>      |
|-------------------|--------------|-------------------------|
| HCT-A-1602-F001   | 02. 03, 2016 | First Approval Report   |
| HCT-A-1602-F001-1 | 02. 15, 2016 | Revised sec. 2.2 (Typo) |

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# 1. Attestation of Test Result of Device Under Test

| Test Laboratory |  |
|-----------------|--|
| Company Name:   | HCT Co., LTD   |
| Address         | 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of Korea |
| Telephone       | +82 31 645 6300  |
| Fax.            | +82 31 645 6400  |

| Attestation of SAR test result |   |
|--------------------------------|---|
| Trade Name:                    | LG Electronics, MobileComm U.S.A., Inc.   |
| FCC ID:                        | ZNFK520   |
| Model:                         | LG-K520   |
| Additional Model Name:         | LGK520, K520  |
| EUT Type                       | GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support |
| Application Type:              | Certification   |

| The Highest Reported SAR (W/Kg)           |                         |                 |                        |                     |         |
|---|-------------------------|-----------------|------------------------|---------------------|---------|
| Band                                      | Tx. Frequency           | Equipment Class | Reported 1g SAR (W/kg) |                     |         |
|   | (MHz)                   |                 | Head                   | Body-Worn           | Hotspot |
| GSM/GPRS/EDGE 850                         | 824.2 - 848.8           | PCE             | 0.31                   | 0.47                | 0.47    |
| GSM/GPRS/EDGE 1900                        | 1 850.2 -1 909.8        | PCE             | 0.25                   | 0.37                | 0.37    |
| UMTS 850                                  | 826.4 - 846.6           | PCE             | 0.15                   | 0.39                | 0.39    |
| UMTS 1900                                 | 1 852.4 – 1 907.6       | PCE             | 0.42                   | 0.57                | 0.57    |
| 802.11b                                   | 2 412 - 2 462           | DTS             | 0.97                   | 0.24                | 0.24    |
| Bluetooth                                 | 2 402 - 2 480           | DSS/DTS         |                        | 0.17 <sup>*1)</sup> |         |
| Simultaneous SAR per KDB 690783 D01v01r03 |                         |                 | 1.38                   | 0.81                | 0.81    |
| Date(s) of Tests:                         | 01/18/2016 ~ 01/21/2016 |                 |                        |                     |         |

Note :

\*1) BT Body-worn SAR value is estimated SAR value that should not be reported standalone SAR on grants of equipment approval.

## 2. Device Under Test Description

### 2.1 DUT specification

| Device Wireless specification overview |  |                       |
|--|--|-----------------------|
| Band & Mode                            | Operating Mode   | Tx Frequency          |
| GSM/GPRS/EDGE 850                      | Voice / Data   | 824.2 – 848.8 MHz     |
| GSM/GPRS/EDGE 1900                     | Voice / Data   | 1 850.2 – 1 909.8 MHz |
| UMTS 850                               | Voice / Data   | 826.4 – 846.6 MHz     |
| UMTS 1900                              | Voice / Data   | 1 852.4 – 1 907.6 MHz |
| 2.4 GHz WLAN                           | Data   | 2 412.0 – 2 462.0 MHz |
| Bluetooth                              | Data   | 2 402.0 – 2 480.0 MHz |
| NFC                                    | Data   | 13.56 MHz             |
| Device Description                     |  |                       |
| Device Dimension                       | Overall (Length x Width) : 155.2 mm x 77.2 mm  |                       |
| Back Cover                             | Normal Battery cover   |                       |
| Battery Options                        | Standard   |                       |
| Device Serial Numbers                  | Mode   | Serial Number/IMEI    |
|  | GSM850, GSM1900, UMTS850, UMTS 1900  | 512KPQJ980796         |
|  | 2.4 GHz WLAN   | 601KPXU842322         |
|  | Several samples with identical hardware were used to SAR testing. The manufacturer has confirmed that the devices tested have the same physical, mechanical and thermal characteristics are within operational tolerances expected for production units. |                       |

### 2.2 DUT Wireless mode

| Wireless Modulation | Band             | Operating Mode  |  | Duty Cycle  |
|---------------------|------------------|---|--|---|
| GSM                 | 850<br>1900      | Voice(GMSK)<br>GPRS (GMSK)<br>EGPRS (8PSK)  | GPRS/ EDGE<br>Multi-Slot Class:<br>Class 12 – 4 Up, 4 Down<br>Mode class B | GSM Voice: 12.5%<br>GPRS 1 Slot: 12.5%<br>2 Slots : 25%<br>3 Slots : 37.5%<br>4 Slots : 50% |
| WCDMA (UMTS)        | Band 5<br>Band 2 | UMTS Rel.99 (Voice / DATA)<br>HSDPA (Rel. 5)<br>HSUPA (Rel. 6)<br>HSPA+ (Rel. 7) (Uplink QPSK Only)<br>DC-HSDPA (Rel.8) |  | 100 %   |
| 2.4 GHz WLAN        |                  | Data  | 802.11 b, 802.11 g, 802.11 n (HT20)  | 99.27 %   |
| Bluetooth           |                  | Data  | 4.1 LE   | N/A   |

## 2.4 TEST METHODOLOGY and Procedures

The tests documented in this report were performed in accordance with IEEE Standard 1528-2013 & IEEE 1528-2005 and the following published KDB procedures.

- FCC KDB Publication 941225 D01 3G SAR Procedures v03r01
- FCC KDB Publication 941225 D06 Hot Spot SAR v02r01
- FCC KDB Publication 248227 D01 802.11 Wi-Fi SAR v02r02
- FCC KDB Publication 447498 D01 General SAR Guidance v06
- FCC KDB Publication 648474 D04 Handset SAR v01r03
- FCC KDB Publication 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- FCC KDB Publication 865664 D02 SAR Reporting v01r02
- October 2013 TCB Workshop Notes (GPRS testing criteria)
- April 2015 TCB Workshop Notes (Simultaneous transmission summation clarified)

## 2.5 Nominal and Maximum 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 D01v06.

| Mode / Band        |         | Voice (dBm) | Burst Average GMSK (dBm) |           |           |           | Burst Average 8-PSK (dBm) |           |           |           |
|--------------------|---------|-------------|--------------------------|-----------|-----------|-----------|---------------------------|-----------|-----------|-----------|
|                    |         | 1 Tx Slot   | 1 Tx Slot                | 2 Tx Slot | 3 Tx Slot | 4 Tx Slot | 1 Tx Slot                 | 2 Tx Slot | 3 Tx Slot | 4 Tx Slot |
| GSM/GPRS/EDGE 850  | Maximum | 33.7        | 33.7                     | 32.2      | 30.2      | 29.2      | 27.2                      | 26.2      | 24.2      | 23.2      |
|                    | Nominal | 33.2        | 33.2                     | 31.7      | 29.7      | 28.7      | 26.7                      | 25.7      | 23.7      | 22.7      |
| GSM/GPRS/EDGE 1900 | Maximum | 30.7        | 30.7                     | 29.2      | 27.7      | 26.2      | 26.7                      | 25.2      | 23.7      | 22.2      |
|                    | Nominal | 30.2        | 30.2                     | 28.7      | 27.2      | 25.7      | 26.2                      | 24.7      | 23.2      | 21.7      |

| Mode / Band            |         | 3GPP WCDMA | 3GPP HSDPA(dBm) |           |           |           | 3GPP HSUPA(dBm) |           |           |           |           | DC-HSDPA(dBm) |           |           |           |
|------------------------|---------|------------|-----------------|-----------|-----------|-----------|-----------------|-----------|-----------|-----------|-----------|---------------|-----------|-----------|-----------|
|                        |         |            | Sub test1       | Sub test2 | Sub test3 | Sub test4 | Sub test1       | Sub test2 | Sub test3 | Sub test4 | Sub Test5 | Sub test1     | Sub test2 | Sub test3 | Sub test4 |
| UMTS Band 5 (850 MHz)  | Maximum | 23.7       | 23.7            | 23.7      | 23.2      | 23.2      | 23.7            | 21.7      | 22.7      | 21.7      | 23.7      | 23.7          | 23.7      | 23.2      | 23.2      |
|                        | Nominal | 23.2       | 23.2            | 23.2      | 22.7      | 22.7      | 23.2            | 21.2      | 22.2      | 21.2      | 23.2      | 23.2          | 23.2      | 22.7      | 22.7      |
| UMTS Band 2 (1900 MHz) | Maximum | 23.7       | 23.7            | 23.7      | 23.2      | 23.2      | 23.7            | 21.7      | 22.7      | 21.7      | 23.7      | 23.7          | 23.7      | 23.2      | 23.2      |
|                        | Nominal | 23.2       | 23.2            | 23.2      | 22.7      | 22.7      | 23.2            | 21.2      | 22.2      | 21.2      | 23.2      | 23.2          | 23.2      | 22.7      | 22.7      |

| Mode / Band            |         | Modulated Average (dBm) |     |
|------------------------|---------|-------------------------|-----|
| IEE 802.11b (2.4 GHz)  | Maximum | 17.0                    |     |
|                        | Nominal | 16.0                    |     |
| IEEE 802.11g (2.4 GHz) | Maximum | 15.0                    |     |
|                        | Nominal | 14.0                    |     |
| IEEE 802.11n (2.4 GHz) | Maximum | 14.0                    |     |
|                        | Nominal | 13.0                    |     |
| Bluetooth              | DH5     | Maximum                 | 9.0 |
|                        |         | Nominal                 | 8.0 |
|                        | 2-DH5   | Maximum                 | 7.0 |
|                        |         | Nominal                 | 6.0 |
|                        | 3-DH5   | Maximum                 | 7.0 |
|                        |         | Nominal                 | 6.0 |
|                        | LE      | Maximum                 | 0   |
|                        |         | Nominal                 | -1  |

## 2.6 DUT Antenna Locations

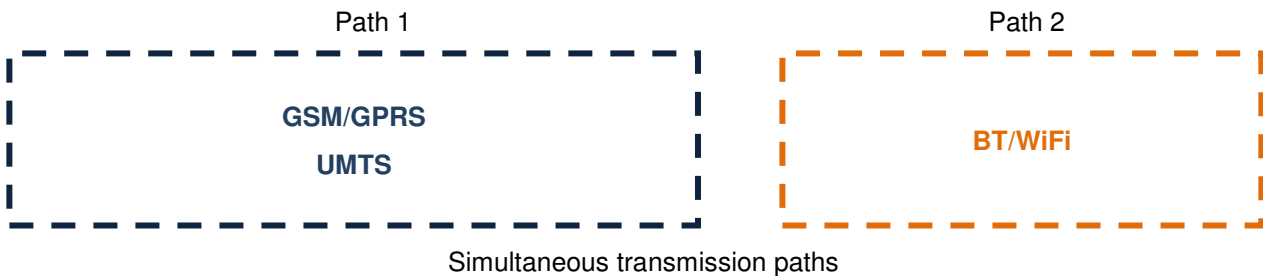
| Device Edges / Sides for SAR Testing |      |       |      |       |        |     |
|--------------------------------------|------|-------|------|-------|--------|-----|
| Mode                                 | Rear | Front | Left | Right | Bottom | Top |
| GSM/GPRS 850                         | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| GSM/GPRS 1900                        | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| UMTS 850                             | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| UMTS 1900                            | Yes  | Yes   | Yes  | Yes   | Yes    | No  |
| 2.4 GHz WLAN                         | Yes  | Yes   | No   | Yes   | No     | Yes |

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 941225 D06v02r01 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. A diagram showing device antenna can be found in SAR\_setup\_photos. Since the diagonal dimension of this device is > 160 mm and < 200 mm, it is considered a “phablet”.

\* Note: All test configurations are based on front view position.

## 2.7 SAR Summation Scenario

According to FCC KDB 447498 D01v06, 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 D01v06.



| Simultaneous Transmission Scenarios |      |           |         |
|-------------------------------------|------|-----------|---------|
| 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/EDGE + 2.4 GHz WiFi            | Yes  | Yes       | Yes     |
| GPRS/EDGE + 2.4 GHz Bluetooth       | N/A  | Yes       | N/A     |
| UMTS + 2.4 GHz WiFi                 | Yes  | Yes       | Yes     |
| UMTS + 2.4 GHz Bluetooth            | N/A  | Yes       | N/A     |

1. 2.4 GHz WLAN, and 2.4GHz Bluetooth share antenna path and cannot transmit simultaneously.
2. All licensed modes share the same antenna path and cannot transmit simultaneously.
3. UMTS +WLAN scenario also represents the UMTS Voice/DATA + WLAN hotspot scenario.
4. The highest reported SAR for each exposure condition is used for SAR summation purpose.

## 2.8 SAR Test Exclusions Applied

### (A) BT & LE

Per FCC KDB 447498 D01v06, 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     | 8                     | 10                  | 1.26  |
| Bluetooth LE | 2 480     | 1                     | 10                  | 0.16  |

Based on the maximum conducted power of Bluetooth and antenna to use separation distance, Bluetooth SAR was not required  $[(8/10)*\sqrt{2.480}] = 1.26 < 3.0$ .

Based on the maximum conducted power of Bluetooth LE and antenna to use separation distance, Bluetooth LE SAR was not required  $[(1/10)*\sqrt{2.480}] = 0.16 < 3.0$ .

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v06 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 D01v06 4.3.22, the following equation must be used to estimate the standalone 1-g SAR for simultaneous transmission assessment involving that transmitter.

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

| Mode         | Frequency | Maximum Allowed Power | Separation Distance (Body) | Estimated SAR (Body) |
|--------------|-----------|-----------------------|----------------------------|----------------------|
|              | [MHz]     | [mW]                  | [mm]                       | [W/kg]               |
| Bluetooth    | 2 480     | 8                     | 10                         | 0.17                 |
| Bluetooth LE | 2 480     | 1                     | 10                         | 0.02                 |

**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 D01v06.

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

## (B) Licensed Transmitter(s)

GSM/GPRS/EDGE DTM is not supported for US bands. Therefore, the GSM Voice modes in this report do not transmit simultaneously with GPRS/EDGE Data.

This device is only capable of QPSK HSUPA in the uplink. Therefore, no additional SAR tests are required beyond that described for devices with HSUPA in KDB 941225 D01v03r01.

Per FCC KDB 648474 D04v01r03, this device is considered a "Phablet" since the diagonal dimension is greater than 160 mm and less than 200 mm. Therefore, extremity SAR tests are required when wireless router mode does not apply or if wireless router 1g SAR >1.2 W/kg. When hotspot mode applies, 10g SAR required only for the surfaces and edges with hotspot mode scaled to the maximum output power (including tolerance) is 1g SAR > 1.2 W/kg.

Per FCC KDB 941225 D01v03r01, 12.2 kbps RMC is the primary mode and HSPA (HSUPA/HSDPA with RMC) is the secondary mode.

Per FCC KDB 941225 D01v03r01, The SAR test exclusion is applied to the secondary mode by the following equation.

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

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

$$[0.572 * (234/234)] = 0.572 \text{ W/kg} \leq 1.2 \text{ W/kg}$$

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

### 3. 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 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 (r). 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.

## 4. DESCRIPTION OF TEST EQUIPMENT

### 4.1 SAR MEASUREMENT SETUP

These measurements are performed using the DASY4 & DASY5 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 with Windows XP or Windows 7 is working with SAR Measurement system DASY4 & DASY5, 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.

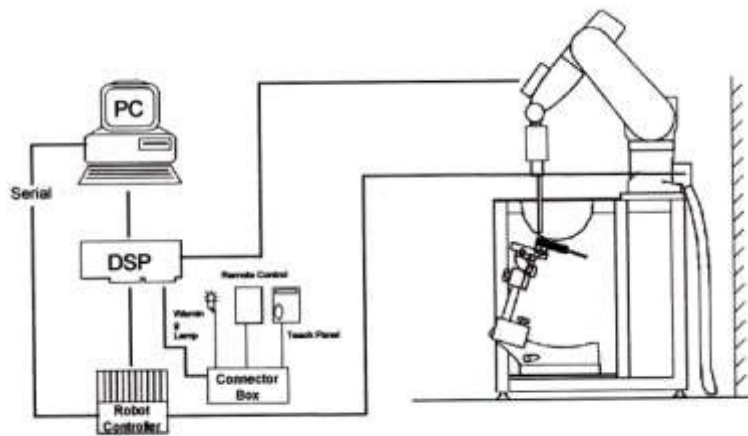







Figure 2. HCT SAR Lab. Test Measurement Set-up

The DAE 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

| Isotropic SAR Probe   |   |  |  |
|---|---|--|--|
| Probe type  | ET3DV6  | ES3DV3   | EX3DV4   |
| Appearance  |    |    |   |
| 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   | IEEE 1528-2013, IEC 62209-1, IEC 62209-2, KDB 865664  |  |  |
| Frequency   | 10 MHz to 2.3 GHz<br>Linearity: $\pm 0.2$ dB<br>(30 MHz to 2.3 GHz)   | 10 MHz to 4 GHz<br>Linearity: $\pm 0.2$ dB<br>(30 MHz to 4 GHz)  | 10 MHz to 6 GHz<br>Linearity: $\pm 0.2$ dB<br>(30 MHz to 6 GHz)  |
| Directivity   | $\pm 0.2$ dB in TSL<br>(rotation around probe axis)<br>$\pm 0.4$ dB in TSL<br>(rotation normal to probe axis)   | $\pm 0.2$ dB in TSL<br>(rotation around probe axis)<br>$\pm 0.3$ dB in TSL<br>(rotation normal to probe axis)                        | $\pm 0.3$ dB in TSL<br>(rotation around probe axis)<br>$\pm 0.5$ dB in TSL<br>(rotation normal to probe axis)                        |
| Dynamic Range   | 5 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB  | 5 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB   | 10 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB  |
| Dimensions  | Overall length: 337 mm<br>(Tip: 16 mm)<br>Tip diameter: 6.8 mm<br>(Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.7 mm  | Overall length: 337 mm<br>(Tip: 20 mm)<br>Tip diameter: 3.9 mm<br>(Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.0 mm | Overall length: 337 mm<br>(Tip: 20 mm)<br>Tip diameter: 2.5 mm<br>(Body: 12 mm)<br>Distance from probe tip to dipole centers: 1.0 mm |
| Application   | General dosimetry up to 2.3 GHz<br>Dosimetry in strong gradient fields<br>Compliance tests of mobile phones   | General dosimetry up to 4 GHz<br>Dosimetry in strong gradient fields<br>Compliance tests of mobile phones                            | General dosimetry up to 6 GHz<br>Dosimetry in strong gradient fields<br>Compliance tests of mobile phones                            |
| <p>The SAR measurements were conducted with the dosimetric probe ET3DV6, ES3DV3 and EX3DV4 (depending on the frequency), 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 DASY 4 &amp; 5 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.</p> |   |  |  |

### 4.3 SAM Phantom


| SAR PHANTOMS                        |                             |   |
|-------------------------------------|-----------------------------|---|
| T<br>W<br>I<br>N<br><br>S<br>A<br>M | <b>Name</b>                 | Twin SAM  |
|                                     | <b>Appearance</b>           |    |
|                                     | <b>Material</b>             | Vinyl ester, Fiberglass reinforced (VE-GF)  |
|                                     | <b>Liquid Compatibility</b> | Compatible with all DGBE Type liquid  |
|                                     | <b>Shell Thickness</b>      | 2±0.2 mm (6±0.2 mm at ear point)  |
|                                     | <b>Dimensions</b>           | Length : 1000 mm<br>Width : 500 mm<br>Height : adjustable feet                      |
| <b>Filling Volume</b>               |                             | Approx. 25 liters   |
| M<br>F<br>P                         | <b>Name</b>                 | MFP – Triple Modular Phantom  |
|                                     | <b>Appearance</b>           |   |
|                                     | <b>Material</b>             | Vinyl ester, Fiberglass reinforced (VE-GF)  |
|                                     | <b>Liquid Compatibility</b> | Compatible with all DGBE Type liquid  |
|                                     | <b>Shell Thickness</b>      | 2±0.2 mm  |
|                                     | <b>Dimensions</b>           | Length : 292 mm<br>Width : 178 mm<br>Height : 178 mm<br>Useable area : 280 x 175 mm |
| <b>Filling Volume</b>               |                             | Approx. 8.1 liters<br>(filling height 155 mm)                                       |

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.

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.


Applicable for system performance check from 700 MHz – 6 GHz as well as dosimetric evaluations of body-worn devices.

## 4.4 Device Holder for Transmitters

| Device Holder – Mounting Device  |   |
|--|---|
| <p>In combination with the SAM Phantom, the Mounting Device 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 repeatable positioned according to the EN 50360:2001/A:2001 and FCC KDB specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).</p> <p>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.</p> |  |

## 4.5 Validation Dipole

The reference dipole should have a return loss better than -20 dB (measured in the setup) at the resonant frequency to reduce the uncertainty in the power measurement.

| System Validation Dipole |  |   |
|--------------------------|--|---|
| Description              | Symmetrical dipole with $\lambda/4$ balun. Enables measurement of feedpoint impedance with network analyzer (NWA). Matched for use near flat phantoms filled with tissue simulating liquids.   |  |
| Frequency                | 750,835,1900, 2000, 2300, 2450, 2600, 5000 MHz   |   |
| Return Loss              | > 20 dB at specified validation position   |   |
| Power Capability         | > 100 W ( f < 1GHz), >40 W ( f > 1 GHz)  |   |
| Dimension                | D750V3: dipole length : 179.0 mm ; overall height : 330.0 mm<br>D835V2: dipole length : 158.0 mm ; overall height : 340.0 mm<br>D1900V2: dipole length : 67.7 mm ; overall height : 300.0 mm<br>D2300V2: dipole length : 56.3 mm ; overall height : 290.0 mm<br>D2450V2: dipole length : 52.0 mm ; overall height : 290.0 mm<br>D2600V1: dipole length : 49.2 mm ; overall height : 290.0 mm<br>D5GHzV2: dipole length : 20.6 mm ; overall height : 300.0 mm |   |



## 5. SAR MEASUREMENT PROCEDURE

The evaluation was performed with the following procedure:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no more than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the DUT's head and body area and the horizontal grid resolution was depending on the FCC KDB 865664 D01v01r04 table 4-1 & IEEE 1528-2013.
2. Based on step, the area of the maximum absorption was determined by sophisticated interpolations routines implemented in DASY software. When an Area Scan has measured all reachable point. DASY system computes the field maximal found in the scanned are, within a range of the maximum. SAR at this fixed point was measured and used as a reference value.
3. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB 865664 D01v01r04 table 4-1 and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (reference from the DASY manual.)
  - a. The data at the surface were extrapolated, since the center of the dipoles is no more than 2.7 mm away from the tip of the probe (it is different from the probe type) 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 reference value, at the same location as step 2, was re-measured after the zoom scan. If the value changed by more than 5 %, the SAR evaluation and drift measurements were repeated.

Area scan and zoom scan resolution setting follow KDB 865664 D01v01r04 quoted below.

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

Figure 6-2 shows the front, back and side views of the SAM phantom. The center-of-mouth reference point is labeled “M”, the left ear reference point (ERP) is marked “LE”, and the right ERP is marked “RE.” Each ERP is on the B-M (back-mouth) line located 15 mm behind the entrance-to-ear-canal (EEC) point, as shown in Figure 6-1. The Reference Plane is defined as passing through the two ear reference point and point M. The line N-F (Neck-Front), also called the Reference Pivoting Line, is not perpendicular to the reference plane (See Figure 5-1), Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning.

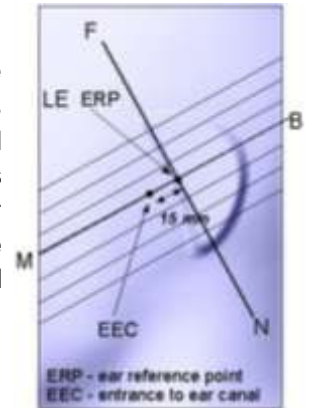


Figure 6-1  
Close-up side view of ERP

### 6.1 HEAD POSITION

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The device under test was placed in a normal operating position with the acoustic output located along the “vertical centerline” on the front of the device aligned to the “ear reference point”(see Figure 6-3). The acoustic output was then located at the same level as the center of the ear reference point. The device under test was positioned so that the “vertical centerline” was bisecting the front surface of the handset at its top and bottom edges, positioning the “ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point.



Figure 6-2  
Front, back and side views of SAM Twin Phantom

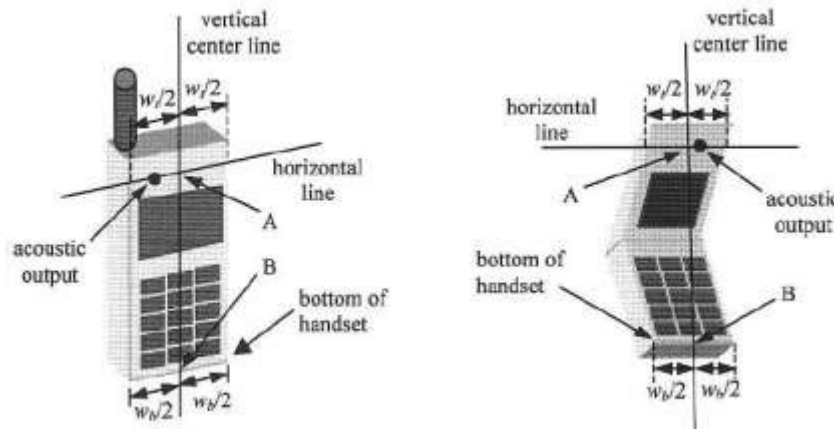


Figure 6-3. Handset vertical and horizontal reference lines

## 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 accessories 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.

## 6.3 Body-Worn Accessory Configurations

Body-Worn operating configurations are tested with the belt-dips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 6-4). Per FCC KDB Publication 648474 D04v01r03 Body-Worn accessory exposure is typically related to voice mode operations when handsets are carried in body-Worn accessories. The body-Worn accessory procedures in FCC KDB Publication 447498 D01v06 should be used to test for body-Worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-Worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body- Worn accessory, measured without a headset connected to the handset, is  $> 1.2$  W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body- Worn accessory with a headset attached to the handset.



Figure 6-4  
Sample Body-Worn Diagram

Accessories for Body-Worn operation configurations are divided into two categories: those that do not contain metallic components and those that do 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 the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-dip 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. Test position spacing was documented.

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 in head fluid. For devices that are carried next to the body such as a shoulder, waist or chest-Worn transmitters. SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

## 6.4 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06v02r01 where SAR test considerations for handsets ( $L \times W \geq 9\text{cm} \times 5\text{cm}$ ) are based on a composite test separation distance of 10 mm from the front back and edges of the device containing transmitting antennas within 2.5 cm of their edges, determined from general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-Worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-Worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset actual operations include simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes. Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WIFI transmitter according to FCC KDB Publication 447498 D01v06 publication procedures. The "Portable Hotspot\*" feature on the handset was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.

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

| HUMAN EXPOSURE   | UNCONTROLLED ENVIRONMENT<br>General Population | CONTROLLED ENVIRONMENT<br>Occupational |
|--|--|--|
|  | (W/kg) or (mW/g)                               | (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. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be mad fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

**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). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

## 8. FCC SAR GENERAL MEASUREMENT PROCEDURES

### 8.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v06, when SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as Reported SAR. The highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

### 8.2 3G SAR Test Reduction Procedure

#### 8.2.1 GSM, GPRS AND EDGE

The following procedures may be considered for each frequency band to determine SAR test reduction for devices operating in GSM/GPRS/EDGE modes to demonstrate RF exposure compliance. GSM voice mode transmits with 1 time slot. GPRS and EDGE may transmit up to 4 time slots in the 8 time-slot frame according to the multi-slot class implemented in a device.

#### 8.2.2 SAR Test Reduction

In FCC KDB 941225 D01v03r01, certain transmission modes within a frequency band and wireless mode evaluated for SAR are defined as primary modes. The equivalent modes considered for SAR test reduction are denoted as secondary modes. When the maximum output power including tune-up tolerance specified for production units in a secondary mode is  $\leq 0.25$  dB higher than the primary mode or when the highest reported SAR of the primary mode, scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode, is  $\leq 1.2$  W/kg, SAR measurements are not required for the secondary mode. These criteria are referred to as the 3G SAR test reduction procedure. When the 3G SAR test reduction procedure is not satisfied, SAR measurements are additionally required for the secondary mode.

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested

### 8.3 Procedures Used to Establish RF Signal for SAR

The following procedures are according to FCC KDB 941225 D01v03r01 - 3G SAR Measurement Procedures. 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 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.

## 8.4 SAR Measurement Conditions for UMTS

### 8.4.1 Output Power Verification

Maximum output power is verified on the High, Middle and Low channels according to the general descriptions in sec. 5.2 of 3GPP TS 34.121, using the appropriate RMC with TPC (transmit power control) set to all "1s" or applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HS-DPCCH etc) are tabulated in this test report. All configurations that are not supported by the DUT or cannot be measured due to technical or equipment limitations are identified.

### 8.4.2 Head SAR Measurements

SAR for next to the ear head exposure is measured using a 12.2 kbps RMC with TPC bits configured to all "1s". The 3G SAR test reduction procedure is applied to AMR configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for 12.2 kbps AMR in 3.4 kbps SRB (signaling radio bearer) using the highest reported SAR configuration in 12.2 kbps RMC for head exposure.

### 8.4.3 Body SAR measurements

SAR for body exposure configurations is measured using the 12.2kbps RMC with the TPC bits all "1s". the 3G SAR test reduction procedure is applied to other spreading codes and multiple DPDCHn configurations supported by the handset with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured using and applicable RMC configuration with the corresponding spreading code or DPDCHn, for the highest reported SAR configuration in 12.2kbps RMC.

### 8.4.4 SAR Measurements with Rel. 5 HSDPA

The 3G SAR test reduction procedure is applied to HSDPA body configurations with 12.2 kbps RMC as the primary mode. Otherwise, Body SAR for HSDPA is measured using and FRC with H-SET 1 in Sub-test and a 12.2 kbps RMC without HSDPA. Handsets with both HSDPA and HSUPA are tested according to release 6 HSPA test procedures. 8.4.5 SAR Measurement with Rel 6 HSUPA The 3G SAR test Reduction Procedure is applied to HSPA (HSUPA/HSDPA with RMC) body configurations with 12.2 kbps RMC as the primary mode. Otherwise, Body SAR for HSPA is measured with E-DCH Sub-test 5, Using H-Set 1 and QPSK for FRC and a 12.2kbps RMC configured in Test Loop Mode 1 and Power Control algorithm 2, according to the highest reported body SAR configuration in 12.2 kbps RMC without HSPA. When VOIP applies to head exposure, the 3G SAR test reduction procedure is applied with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body SAR measurements are applied to head exposure testing.

### 8.4.5 SAR Measurements with Rel. 6 HSUPA

The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body configurations with 12.2 kbps RMC as the primary mode. Otherwise, Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 and power control algorithm 2, according to the highest reported body SAR configuration in 12.2 kbps RMC without HSPA.



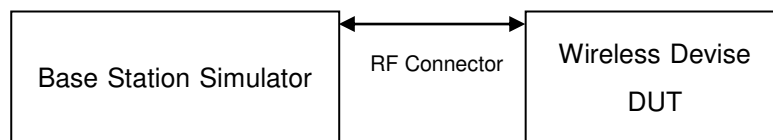
### 8.4.6 DC-HSDPA

UMTS SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB publication 941225 D01v03r01. 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.

DC-HSDPA Considerations:

- 3GPP Specification 34.121-1 Release 8 Ver 8.10.0 was used for DC-HSDPA guidance
- H-Set 12(QPSK) was confirmed to be used during DC-HSDPA measurements
- Measured maximum output powers for DC-HSDPA were not greater than 1/4 dB higher than the WCDMA 12.2 kbps RMC maximum output and as a result, SAR is not required for DC-HSDPA
- The DUT supports UE category 24 for HSDPA.

It is expected by the manufacturer that MPR for some HSUPA subtests may be up to 1 dB more than specified by 3GPP, but also as low as 0 dB according to the chipset implementation in this model.



## 8.5 SAR Testing with 802.11 Transmitters

The normal network operating configurations of 802.11 transmitters are not suitable for SAR measurements. 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. See KDB Publication 248227 D01v02r02 for more details.

### 8.5.1 General Device Setup

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 system 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 of 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.

### 8.5.2 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 test 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 for 1g SAR and  $\leq 1.0$  W/kg for 10g SAR, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is  $\leq 0.8$  W/kg for 1g SAR and  $\leq 2.0$  W/kg for 10g SAR or all test positions are measured.

### 8.5.3 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.

### 8.5.4 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 band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate and lowest order 802.11 g/n mode. When the maximum output power of a channel is the same for equivalent OFDM configurations; for example, 802.11g and 802.11n with the same channel bandwidth, modulation and data rate etc., the lower order 802.11 mode i.e., 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.

### 8.5.5 Initial Test configuration Procedure

For OFDM, in both 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.

### 8.5.6 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 on 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 for 1g SAR and  $\leq 3.0$  W/kg for 10g SAR, no additional SAR tests for the subsequent test configurations are required.

## 9. 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 D01v06.

### 9.1 GSM

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     | 33.60     | 33.57                 | 31.94                | 29.97                | 28.93                | 26.97                | 26.12                | 23.93                | 22.94                |
|          | 190     | 33.66     | 33.64                 | 32.01                | 29.95                | 28.98                | 26.95                | 26.08                | 23.89                | 22.89                |
|          | 251     | 33.33     | 33.29                 | 32.06                | 29.65                | 29.00                | 26.93                | 26.03                | 23.85                | 22.86                |
| GSM 1900 | 512     | 30.47     | 30.49                 | 28.97                | 27.58                | 26.03                | 26.57                | 24.99                | 23.60                | 21.56                |
|          | 661     | 30.55     | 30.56                 | 29.07                | 27.29                | 25.92                | 26.46                | 24.89                | 23.49                | 21.56                |
|          | 810     | 30.62     | 30.62                 | 29.04                | 27.24                | 25.98                | 26.48                | 24.87                | 23.48                | 21.49                |

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     | 24.57     | 24.54                 | 25.92                | 25.71                | 25.92                | 17.94                | 20.10                | 19.67                | 19.93                |
|          | 190     | 24.63     | 24.61                 | 25.99                | 25.69                | 25.97                | 17.92                | 20.06                | 19.63                | 19.88                |
|          | 251     | 24.30     | 24.26                 | 26.04                | 25.39                | 25.99                | 17.90                | 20.01                | 19.59                | 19.85                |
| GSM 1900 | 512     | 21.44     | 21.46                 | 22.95                | 23.32                | 23.02                | 17.54                | 18.97                | 19.34                | 18.55                |
|          | 661     | 21.52     | 21.53                 | 23.05                | 23.03                | 22.91                | 17.43                | 18.87                | 19.23                | 18.55                |
|          | 810     | 21.59     | 21.59                 | 23.02                | 22.98                | 22.97                | 17.45                | 18.85                | 19.22                | 18.48                |

**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

GSM Class : B  
 GSM voice/GPRS VOIP: Head SAR , Body worn SAR  
 GPRS/EDGE Multi-slots 12 : Hotspot SAR with GPRS/EDGE  
 Multi-slot Class 12 with CS 1 (GMSK)



## 9.2 UMTS

### 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   |
|                        | $\beta_c/\beta_d$       | 8/15         |

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

The following 4 Sub-tests were completed according to Release 5 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  |       |       |       |
|                         | $\beta_c$                            | 2/15         | 11/15 | 15/15 | 15/15 |
|                         | $\beta_d$                            | 15/15        | 15/15 | 8/15  | 4/15  |
|                         | Bd (SF)                              | 64           |       |       |       |
|                         | $\beta_c/\beta_d$                    | 2/15         | 12/15 | 15/8  | 15/4  |
|                         | $\beta_{hs}$                         | 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            |       |       |       |
|                         | $A_{hs}=\beta_{hs}/\beta_c$          | 30/15        |       |       |       |

### HSPA+

This DUT is only capable of QPSK HSPA+ in uplink. Therefore, the RF conducted power is not measured according to 941225 D01 3G SAR.

**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                                 |       |       |             |       |       |
|------------------------------|--------------------------------------|-------|-------|-------------|-------|-------|
|                              | 1                                    | 2     | 3     | 4           | 5     |       |
| Subtest                      |                                      |       |       |             |       |       |
| 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   |       |

**WCDMA850**

| 3GPP Release Version | Mode     | 3GPP 34.121   | WCDMA Band 5 [dBm] |                    |                    |
|----------------------|----------|---------------|--------------------|--------------------|--------------------|
|                      |          | Subtest       | UL 4132<br>DL 4357 | UL 4183<br>DL 4408 | UL 4233<br>DL 4458 |
| 99                   | WCDMA    | 12.2 kbps RMC | 23.63              | 23.56              | 23.51              |
| 99                   | WCDMA    | 12.2 kbps AMR | 23.60              | 23.52              | 23.48              |
| 5                    | HSDPA    | Subtest 1     | 23.39              | 23.33              | 23.30              |
| 5                    |          | Subtest 2     | 23.38              | 23.27              | 23.21              |
| 5                    |          | Subtest 3     | 22.98              | 22.89              | 22.99              |
| 5                    |          | Subtest 4     | 22.98              | 22.91              | 22.98              |
| 6                    | HSUPA    | Subtest 1     | 23.06              | 23.04              | 23.05              |
| 6                    |          | Subtest 2     | 21.42              | 21.48              | 21.45              |
| 6                    |          | Subtest 3     | 22.19              | 22.11              | 22.12              |
| 6                    |          | Subtest 4     | 22.29              | 22.24              | 22.27              |
| 6                    |          | Subtest 5     | 23.06              | 23.08              | 23.07              |
| 8                    | DC-HSDPA | Subtest 1     | 23.41              | 23.32              | 23.13              |
| 8                    |          | Subtest 2     | 23.39              | 23.26              | 23.16              |
| 8                    |          | Subtest 3     | 23.10              | 22.87              | 22.76              |
| 8                    |          | Subtest 4     | 23.10              | 22.87              | 22.76              |

WCDMA Average Conducted output powers

**WCDMA1900**

| 3GPP Release Version | Mode     | 3GPP 34.121   | WCDMA Band 2 [dBm] |                    |                    |
|----------------------|----------|---------------|--------------------|--------------------|--------------------|
|                      |          | Subtest       | UL 9262<br>DL 9662 | UL 9400<br>DL 9800 | UL 9538<br>DL 9938 |
| 99                   | WCDMA    | 12.2 kbps RMC | 23.43              | 23.46              | 23.59              |
| 99                   | WCDMA    | 12.2 kbps AMR | 23.44              | 23.40              | 23.57              |
| 5                    | HSDPA    | Subtest 1     | 23.38              | 23.29              | 23.49              |
| 5                    |          | Subtest 2     | 23.35              | 23.36              | 23.56              |
| 5                    |          | Subtest 3     | 23.04              | 22.96              | 23.14              |
| 5                    |          | Subtest 4     | 23.02              | 23.01              | 23.15              |
| 6                    | HSUPA    | Subtest 1     | 22.62              | 22.78              | 23.16              |
| 6                    |          | Subtest 2     | 21.96              | 21.92              | 21.69              |
| 6                    |          | Subtest 3     | 22.38              | 22.26              | 22.49              |
| 6                    |          | Subtest 4     | 22.04              | 22.02              | 22.02              |
| 6                    |          | Subtest 5     | 22.64              | 22.80              | 23.16              |
| 8                    | DC-HSDPA | Subtest 1     | 23.25              | 23.14              | 23.31              |
| 8                    |          | Subtest 2     | 23.20              | 23.08              | 23.38              |
| 8                    |          | Subtest 3     | 22.82              | 22.71              | 23.03              |
| 8                    |          | Subtest 4     | 22.90              | 22.70              | 23.03              |

WCDMA Average Conducted output powers

## 9.4 WiFi

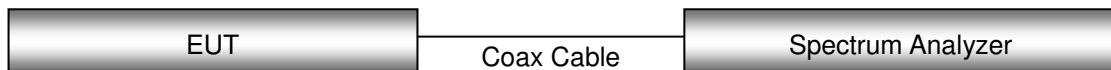
**IEEE 802.11 Average RF Power**

| Mode              | Freq. | Channel | IEEE 802.11 (2.4 GHz)<br>Conducted Power |
|-------------------|-------|---------|--|
|                   | [MHz] |         | [dBm]                                    |
| 802.11b           | 2 412 | 1       | 16.03                                    |
|                   | 2 437 | 6       | 16.29                                    |
|                   | 2 462 | 11      | 15.96                                    |
| 802.11g           | 2 412 | 1       | 13.44                                    |
|                   | 2 437 | 6       | 13.80                                    |
|                   | 2 462 | 11      | 13.33                                    |
| 802.11n<br>(HT20) | 2 412 | 1       | 12.65                                    |
|                   | 2 437 | 6       | 13.01                                    |
|                   | 2 462 | 11      | 12.54                                    |

Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02:

- 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



## 10. SYSTEM VERIFICATION

### 10.1 Tissue Verification

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

**Table for Head Tissue Verification**

| Date of Tests | Tissue Temp. (°C) | Tissue Type | Freq. (MHz) | Measured Conductivity $\sigma$ (S/m) | Measured Dielectric Constant, $\epsilon$ | Target Conductivity $\sigma$ (S/m) | Target Dielectric Constant, $\epsilon$ | % dev $\sigma$ | % dev $\epsilon$ |
|---------------|-------------------|-------------|-------------|--------------------------------------|--|------------------------------------|--|----------------|------------------|
| 01/18/2016    | 19.8              | 835H        | 820         | 0.907                                | 40.517                                   | 0.899                              | 41.578                                 | 0.89%          | -2.55%           |
|               |                   |             | 835         | 0.918                                | 40.300                                   | 0.900                              | 41.500                                 | 2.00%          | -2.89%           |
|               |                   |             | 850         | 0.932                                | 40.124                                   | 0.916                              | 41.500                                 | 1.75%          | -3.32%           |
| 01/20/2016    | 20.6              | 1900H       | 1850        | 1.354                                | 39.517                                   | 1.400                              | 40.000                                 | -3.29%         | -1.21%           |
|               |                   |             | 1900        | 1.410                                | 39.300                                   | 1.400                              | 40.000                                 | 0.71%          | -1.75%           |
|               |                   |             | 1910        | 1.414                                | 39.330                                   | 1.400                              | 40.000                                 | 1.00%          | -1.68%           |
| 01/20/2016    | 21.3              | 2450H       | 2400        | 1.773                                | 38.012                                   | 1.756                              | 39.290                                 | 0.97%          | -3.25%           |
|               |                   |             | 2450        | 1.830                                | 37.800                                   | 1.800                              | 39.200                                 | 1.67%          | -3.57%           |
|               |                   |             | 2500        | 1.893                                | 37.572                                   | 1.855                              | 39.140                                 | 2.05%          | -4.01%           |

**Table for Body Tissue Verification**

| Date of Tests | Tissue Temp. (°C) | Tissue Type | Freq. (MHz) | Measured Conductivity $\sigma$ (S/m) | Measured Dielectric Constant, $\epsilon$ | Target Conductivity $\sigma$ (S/m) | Target Dielectric Constant, $\epsilon$ | % dev $\sigma$ | % dev $\epsilon$ |
|---------------|-------------------|-------------|-------------|--------------------------------------|--|------------------------------------|--|----------------|------------------|
| 01/19/2016    | 21.2              | 835B        | 820         | 0.935                                | 56.755                                   | 0.969                              | 55.258                                 | -3.51%         | 2.71%            |
|               |                   |             | 835         | 0.95                                 | 56.600                                   | 0.970                              | 55.200                                 | -2.06%         | 2.54%            |
|               |                   |             | 850         | 0.956                                | 56.535                                   | 0.988                              | 55.154                                 | -3.24%         | 2.50%            |
| 01/21/2016    | 20.2              | 1900B       | 1850        | 1.491                                | 55.116                                   | 1.520                              | 53.300                                 | -1.91%         | 3.41%            |
|               |                   |             | 1900        | 1.540                                | 54.900                                   | 1.520                              | 53.300                                 | 1.32%          | 3.00%            |
|               |                   |             | 1910        | 1.554                                | 54.999                                   | 1.520                              | 53.300                                 | 2.24%          | 3.19%            |
| 01/20/2016    | 21.3              | 2450B       | 2400        | 1.872                                | 51.716                                   | 1.902                              | 52.770                                 | -1.58%         | -2.00%           |
|               |                   |             | 2450        | 1.920                                | 51.600                                   | 1.950                              | 52.700                                 | -1.54%         | -2.09%           |
|               |                   |             | 2500        | 1.995                                | 51.517                                   | 2.021                              | 52.640                                 | -1.29%         | -2.13%           |



## 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]         | [W/kg]                               | [W/kg]                     | [W/kg]                           | [%]       | [%]       |
| 835   | 01/18/2016 | 3967        | 4d165        | Head   | 20.0       | 19.8         | 9.06                                 | 0.955                      | 9.55                             | + 5.41    | $\pm 10$  |
| 835   | 01/19/2016 | 3967        |              | Body   | 21.4       | 21.2         | 9.47                                 | 0.953                      | 9.53                             | + 0.63    | $\pm 10$  |
| 1 900 | 01/20/2016 | 3967        | 5d032        | Head   | 20.8       | 20.6         | 41.1                                 | 4.21                       | 42.1                             | + 2.43    | $\pm 10$  |
| 1 900 | 01/21/2016 | 3967        |              | Body   | 20.5       | 20.2         | 40.9                                 | 4.18                       | 41.8                             | + 2.20    | $\pm 10$  |
| 2 450 | 01/20/2016 | 3968        | 743          | Head   | 21.5       | 21.3         | 53.4                                 | 5.4                        | 54                               | + 1.12    | $\pm 10$  |
| 2 450 | 01/20/2016 | 3968        |              | Body   | 21.5       | 21.3         | 52.1                                 | 5.2                        | 52                               | - 0.19    | $\pm 10$  |

## 10.3 System Verification Procedure

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

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

NOTE;

SAR Verification was performed according to the FCC KDB 865664 D01v01r04.

# 11. SAR TEST DATA SUMMARY

## 11.1 HEAD SAR Measurement Results

| GSM 850 Head SAR   |     |          |               |             |             |  |            |           |                |              |          |
|--|-----|----------|---------------|-------------|-------------|--|------------|-----------|----------------|--------------|----------|
| Frequency  |     | Mode     | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Meas. SAR | Scaling Factor | Scaled SAR   | Plot No. |
| MHz  | Ch. |          |               |             |             |  |            |           |                |              |          |
| 836.6  | 190 | GSM      | 33.7          | 33.66       | 0.140       | Left Cheek                               | 1:8.3      | 0.170     | 1.009          | 0.172        | -        |
| 836.6  | 190 | GSM      | 33.7          | 33.66       | 0.198       | Left Tilt                                | 1:8.3      | 0.097     | 1.009          | 0.098        | -        |
| 836.6  | 190 | GSM      | 33.7          | 33.66       | 0.066       | Right Cheek                              | 1:8.3      | 0.234     | 1.009          | 0.236        | -        |
| 836.6  | 190 | GSM      | 33.7          | 33.66       | 0.081       | Right Tilt                               | 1:8.3      | 0.111     | 1.009          | 0.112        | -        |
| 836.6  | 190 | GPRS 4Tx | 29.2          | 28.98       | 0.100       | Left Cheek                               | 1:2.075    | 0.236     | 1.052          | 0.248        | -        |
| 836.6  | 190 | GPRS 4Tx | 29.2          | 28.98       | 0.130       | Left Tilt                                | 1:2.075    | 0.245     | 1.052          | 0.258        | -        |
| 836.6  | 190 | GPRS 4Tx | 29.2          | 28.98       | 0.115       | Right Cheek                              | 1:2.075    | 0.297     | 1.052          | <b>0.312</b> | 1        |
| 836.6  | 190 | GPRS 4Tx | 29.2          | 28.98       | 0.196       | Right Tilt                               | 1:2.075    | 0.146     | 1.052          | 0.154        | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |          |               |             |             | Head<br>1.6 W/kg<br>Averaged over 1 gram |            |           |                |              |          |

| GSM 1900 Head SAR  |     |          |               |             |             |  |            |           |                |              |          |
|--|-----|----------|---------------|-------------|-------------|--|------------|-----------|----------------|--------------|----------|
| Frequency  |     | Mode     | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Meas. SAR | Scaling Factor | Scaled SAR   | Plot No. |
| MHz  | Ch. |          |               |             |             |  |            |           |                |              |          |
| 1880.0   | 661 | GSM      | 30.7          | 30.55       | -0.185      | Left Cheek                               | 1:8.3      | 0.163     | 1.035          | 0.169        | -        |
| 1880.0   | 661 | GSM      | 30.7          | 30.55       | 0.110       | Left Tilt                                | 1:8.3      | 0.071     | 1.035          | 0.073        | -        |
| 1880.0   | 661 | GSM      | 30.7          | 30.55       | 0.184       | Right Cheek                              | 1:8.3      | 0.087     | 1.035          | 0.090        | -        |
| 1880.0   | 661 | GSM      | 30.7          | 30.55       | 0.170       | Right Tilt                               | 1:8.3      | 0.077     | 1.035          | 0.080        | -        |
| 1880.0   | 661 | GPRS 3Tx | 27.7          | 27.29       | 0.052       | Left Cheek                               | 1:2.77     | 0.229     | 1.099          | <b>0.252</b> | 2        |
| 1880.0   | 661 | GPRS 3Tx | 27.7          | 27.29       | -0.121      | Left Tilt                                | 1:2.77     | 0.101     | 1.099          | 0.111        | -        |
| 1880.0   | 661 | GPRS 3Tx | 27.7          | 27.29       | 0.065       | Right Cheek                              | 1:2.77     | 0.118     | 1.099          | 0.130        | -        |
| 1880.0   | 661 | GPRS 3Tx | 27.7          | 27.29       | -0.114      | Right Tilt                               | 1:2.77     | 0.116     | 1.099          | 0.127        | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |          |               |             |             | Head<br>1.6 W/kg<br>Averaged over 1 gram |            |           |                |              |          |

**UMTS 850 Head SAR**

| Frequency  |      | Mode | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Meas. SAR | Scaling Factor | Scaled SAR   | Plot No. |
|--|------|------|---------------|-------------|-------------|--|------------|-----------|----------------|--------------|----------|
| MHz  | Ch.  |      | (dB)          | (dB)        | (dB)        |  |            | (W/kg)    |                | (W/kg)       |          |
| 836.6  | 4183 | RMC  | 23.7          | 23.56       | 0.185       | Left Cheek                               | 1:1        | 0.112     | 1.033          | 0.116        | -        |
| 836.6  | 4183 | RMC  | 23.7          | 23.56       | -0.197      | Left Tilt                                | 1:1        | 0.083     | 1.033          | 0.086        | -        |
| 836.6  | 4183 | RMC  | 23.7          | 23.56       | -0.117      | Right Cheek                              | 1:1        | 0.146     | 1.033          | <b>0.151</b> | 3        |
| 836.6  | 4183 | RMC  | 23.7          | 23.56       | -0.032      | Right Tilt                               | 1:1        | 0.075     | 1.033          | 0.077        | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |      |      |               |             |             | Head<br>1.6 W/kg<br>Averaged over 1 gram |            |           |                |              |          |

**UMTS 1900 Head SAR**

| Frequency   |      | Mode | Tune-Up Limit | Meas. Power | Power Drift | Test Position                                   | Duty Cycle | Meas. SAR | Scaling Factor | Scaled SAR   | Plot No. |
|---|------|------|---------------|-------------|-------------|---|------------|-----------|----------------|--------------|----------|
| MHz   | Ch.  |      | (dB)          | (dB)        | (dB)        |   |            | (W/kg)    |                | (W/kg)       |          |
| 1 880.0   | 9400 | RMC  | 23.7          | 23.46       | -0.135      | Left Cheek                                      | 1:1        | 0.395     | 1.057          | <b>0.417</b> | 4        |
| 1 880.0   | 9400 | RMC  | 23.7          | 23.46       | 0.111       | Left Tilt                                       | 1:1        | 0.179     | 1.057          | 0.189        | -        |
| 1 880.0   | 9400 | RMC  | 23.7          | 23.46       | -0.060      | Right Cheek                                     | 1:1        | 0.174     | 1.057          | 0.184        | -        |
| 1 880.0   | 9400 | RMC  | 23.7          | 23.46       | 0.088       | Right Tilt                                      | 1:1        | 0.189     | 1.057          | 0.200        | -        |
| ANSI/ IEEE C95.1 - 2005 - Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |      |      |               |             |             | Head<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram |            |           |                |              |          |

**DTS Head SAR**

| Frequency  |     | Mode    | Band width | Data Rate | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Area Scan | Meas. SAR | Scaling Factor | Scaling Factor | Scaled SAR   | Plot No. |
|--|-----|---------|------------|-----------|---------------|-------------|-------------|--|------------|-----------|-----------|----------------|----------------|--------------|----------|
| MHz  | Ch. |         |            |           | (dBm)         | (dBm)       | (dB)        |  |            | Peak SAR  | (W/kg)    |                |                | (W/kg)       |          |
| 2 412  | 1   | 802.11b | 22         | 1         | 17.0          | 16.03       | -0.120      | Left Cheek                               | 99.27      | 1.31      | 0.768     | 1.250          | 1.007          | <b>0.967</b> | 5        |
| 2 437  | 6   | 802.11b | 22         | 1         | 17.0          | 16.29       | 0.009       | Left Cheek                               | 99.27      | 1.02      | 0.689     | 1.178          | 1.007          | 0.817        | -        |
| 2 437  | 6   | 802.11b | 22         | 1         | 17.0          | 16.29       | -0.113      | Left Tilt                                | 99.27      | 0.906     | 0.611     | 1.178          | 1.007          | 0.725        | -        |
| 2 437  | 6   | 802.11b | 22         | 1         | 17.0          | 16.29       | 0.128       | Right Cheek                              | 99.27      | 0.396     | 0.250     | 1.178          | 1.007          | 0.297        | -        |
| 2 437  | 6   | 802.11b | 22         | 1         | 17.0          | 16.29       |             | Right Tilt                               | 99.27      | 0.384     |           | 1.178          | 1.007          |              | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |         |            |           |               |             |             | Head<br>1.6 W/kg<br>Averaged over 1 gram |            |           |           |                |                |              |          |

## 11.2 Body-worn SAR Measurement Results

| GSM/UMTS Body-Worn SAR   |      |           |          |               |             |             |  |            |          |           |                |              |          |
|--|------|-----------|----------|---------------|-------------|-------------|--|------------|----------|-----------|----------------|--------------|----------|
| Frequency  |      | Mode      |          | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Distance | Meas. SAR | Scaling Factor | Scaled SAR   | Plot No. |
| MHz  | Ch.  |           |          |               |             |             |  |            |          |           |                |              |          |
| 836.6  | 190  | GSM 850   | GSM      | 33.7          | 33.66       | 0.108       | Rear                                     | 1:8.3      | 10       | 0.349     | 1.009          | 0.352        | 6        |
| 836.6  | 190  | GSM 850   | GPRS 4Tx | 29.2          | 28.98       | -0.174      | Rear                                     | 1:2.075    | 10       | 0.442     | 1.052          | <b>0.465</b> | 7        |
| 1880.0   | 661  | GSM 1900  | GSM      | 30.7          | 30.55       | 0.107       | Rear                                     | 1:8.3      | 10       | 0.224     | 1.035          | 0.232        | 8        |
| 1 880.0  | 661  | GSM 1900  | GPRS 3Tx | 27.7          | 27.29       | -0.171      | Rear                                     | 1:2.77     | 10       | 0.333     | 1.099          | <b>0.366</b> | 9        |
| 836.6  | 4183 | UMTS 850  | RMC      | 23.7          | 23.56       | 0.080       | Rear                                     | 1:1        | 10       | 0.375     | 1.033          | <b>0.387</b> | 10       |
| 1 880.0  | 9400 | UMTS 1900 | RMC      | 23.7          | 23.46       | 0.067       | Rear                                     | 1:1        | 10       | 0.541     | 1.057          | <b>0.572</b> | 11       |
| ANSI/ IEEE C95.1 - 1992– Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |      |           |          |               |             |             | Body<br>1.6 W/kg<br>Averaged over 1 gram |            |          |           |                |              |          |

| DTS Body-Worn SAR  |     |         |            |           |               |             |             |  |            |          |                    |           |                |                       |              |          |
|--|-----|---------|------------|-----------|---------------|-------------|-------------|--|------------|----------|--------------------|-----------|----------------|-----------------------|--------------|----------|
| Frequency  |     | Mode    | Band width | Data Rate | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Distance | Area Scan Peak SAR | Meas. SAR | Scaling Factor | Scaling Factor (Duty) | Scaled SAR   | Plot No. |
| MHz  | Ch. |         |            |           |               |             |             |  |            |          |                    |           |                |                       |              |          |
| 2 437  | 6   | 802.11b | 22         | 1         | 17.0          | 16.29       | -0.130      | Rear                                     | 99.27      | 10       | 0.341              | 0.204     | 1.178          | 1.007                 | <b>0.242</b> | 12       |
| ANSI/ IEEE C95.1 - 1992– Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |         |            |           |               |             |             | Body<br>1.6 W/kg<br>Averaged over 1 gram |            |          |                    |           |                |                       |              |          |

### 11.3 Hotspot SAR Measurement Results

| GSM 850 Hotspot SAR  |     |          |               |             |             |  |            |          |           |                |              |          |
|--|-----|----------|---------------|-------------|-------------|--|------------|----------|-----------|----------------|--------------|----------|
| Frequency  |     | Mode     | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Distance | Meas. SAR | Scaling Factor | Scaled SAR   | Plot No. |
| MHz  | Ch. |          | (dB)          | (dB)        | (dB)        |  |            |          |           |                | (mm)         |          |
| 836.6  | 190 | GPRS 4Tx | 29.2          | 28.98       | -0.174      | Rear                                     | 1:2.075    | 10       | 0.442     | 1.052          | <b>0.465</b> | 7        |
| 836.6  | 190 | GPRS 4Tx | 29.2          | 28.98       | -0.168      | Front                                    | 1:2.075    | 10       | 0.265     | 1.052          | 0.279        | -        |
| 836.6  | 190 | GPRS 4Tx | 29.2          | 28.98       | -0.015      | Left                                     | 1:2.075    | 10       | 0.130     | 1.052          | 0.137        | -        |
| 836.6  | 190 | GPRS 4Tx | 29.2          | 28.98       | -0.161      | Right                                    | 1:2.075    | 10       | 0.331     | 1.052          | 0.348        | -        |
| 836.6  | 190 | GPRS 4Tx | 29.2          | 28.98       | -0.101      | Bottom                                   | 1:2.075    | 10       | 0.201     | 1.052          | 0.211        | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |          |               |             |             | Body<br>1.6 W/kg<br>Averaged over 1 gram |            |          |           |                |              |          |

| GSM 1900 Hotspot SAR   |     |          |               |             |             |  |            |          |           |                |              |          |
|--|-----|----------|---------------|-------------|-------------|--|------------|----------|-----------|----------------|--------------|----------|
| Frequency  |     | Mode     | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Distance | Meas. SAR | Scaling Factor | Scaled SAR   | Plot No. |
| MHz  | Ch. |          | (dB)          | (dB)        | (dB)        |  |            |          |           |                | (mm)         |          |
| 1 880.0  | 661 | GPRS 3Tx | 27.7          | 27.29       | -0.171      | Rear                                     | 1:2.77     | 10       | 0.333     | 1.099          | <b>0.366</b> | 9        |
| 1 880.0  | 661 | GPRS 3Tx | 27.7          | 27.29       | -0.141      | Front                                    | 1:2.77     | 10       | 0.185     | 1.099          | 0.203        | -        |
| 1 880.0  | 661 | GPRS 3Tx | 27.7          | 27.29       | 0.014       | Left                                     | 1:2.77     | 10       | 0.210     | 1.099          | 0.231        | -        |
| 1 880.0  | 661 | GPRS 3Tx | 27.7          | 27.29       | -0.110      | Right                                    | 1:2.77     | 10       | 0.055     | 1.099          | 0.060        | -        |
| 1 880.0  | 661 | GPRS 3Tx | 27.7          | 27.29       | 0.010       | Bottom                                   | 1:2.77     | 10       | 0.123     | 1.099          | 0.135        | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |          |               |             |             | Body<br>1.6 W/kg<br>Averaged over 1 gram |            |          |           |                |              |          |

| UMTS 850 Hotspot SAR   |      |      |               |             |             |  |            |          |           |                |              |          |
|--|------|------|---------------|-------------|-------------|--|------------|----------|-----------|----------------|--------------|----------|
| Frequency  |      | Mode | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Distance | Meas. SAR | Scaling Factor | Scaled SAR   | Plot No. |
| MHz  | Ch.  |      | (dB)          | (dB)        | (dB)        |  |            |          |           |                | (mm)         |          |
| 836.6  | 4183 | RMC  | 23.7          | 23.56       | 0.080       | Rear                                     | 1:1        | 10       | 0.375     | 1.033          | <b>0.387</b> | 10       |
| 836.6  | 4183 | RMC  | 23.7          | 23.56       | 0.018       | Front                                    | 1:1        | 10       | 0.132     | 1.033          | 0.136        | -        |
| 836.6  | 4183 | RMC  | 23.7          | 23.56       | -0.121      | Left                                     | 1:1        | 10       | 0.072     | 1.033          | 0.074        | -        |
| 836.6  | 4183 | RMC  | 23.7          | 23.56       | -0.140      | Right                                    | 1:1        | 10       | 0.182     | 1.033          | 0.188        | -        |
| 836.6  | 4183 | RMC  | 23.7          | 23.56       | 0.139       | Bottom                                   | 1:1        | 10       | 0.158     | 1.033          | 0.163        | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |      |      |               |             |             | Body<br>1.6 W/kg<br>Averaged over 1 gram |            |          |           |                |              |          |

**UMTS 1900 Hotspot SAR**

| Frequency  |      | Mode | Tune-Up Limit | Meas. Power | Power Drift | Test Position                            | Duty Cycle | Distance | Meas. SAR | Scaling Factor | Scaled SAR   | Plot No. |
|--|------|------|---------------|-------------|-------------|--|------------|----------|-----------|----------------|--------------|----------|
| MHz  | Ch.  |      |               |             |             |  |            |          |           |                |              |          |
| 1880.0   | 9400 | RMC  | 23.7          | 23.46       | 0.067       | Rear                                     | 1:1        | 10       | 0.541     | 1.057          | <b>0.572</b> | 11       |
| 1880.0   | 9400 | RMC  | 23.7          | 23.46       | 0.036       | Front                                    | 1:1        | 10       | 0.347     | 1.057          | 0.367        | -        |
| 1880.0   | 9400 | RMC  | 23.7          | 23.46       | 0.150       | Left                                     | 1:1        | 10       | 0.333     | 1.057          | 0.352        | -        |
| 1880.0   | 9400 | RMC  | 23.7          | 23.46       | 0.113       | Right                                    | 1:1        | 10       | 0.089     | 1.057          | 0.094        | -        |
| 1880.0   | 9400 | RMC  | 23.7          | 23.46       | 0.077       | Bottom                                   | 1:1        | 10       | 0.200     | 1.057          | 0.211        | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |      |      |               |             |             | Body<br>1.6 W/kg<br>Averaged over 1 gram |            |          |           |                |              |          |

**DTS Hotspot SAR**

| Frequency  |     | Mode    | Band width | Data Rate | Tune-Up Limit | Meas. Power                              | Power Drift | Test Position | Duty Cycle | Distance | Area Scan Peak SAR | Meas. SAR | Scaling Factor | Scaling Factor | Scaled SAR   | Plot No. |
|--|-----|---------|------------|-----------|---------------|--|-------------|---------------|------------|----------|--------------------|-----------|----------------|----------------|--------------|----------|
| MHz  | Ch. |         |            |           |               |  |             |               |            |          |                    |           |                |                |              |          |
| 2 437  | 6   | 802.11b | 22         | 1         | 17.0          | 16.29                                    | -0.130      | Rear          | 99.27      | 10       | 0.341              | 0.204     | 1.178          | 1.007          | <b>0.242</b> | 12       |
| 2 437  | 6   | 802.11b | 22         | 1         | 17.0          | 16.29                                    |             | Front         | 99.27      | 10       | 0.171              |           | 1.178          | 1.007          |              | -        |
| 2 437  | 6   | 802.11b | 22         | 1         | 17.0          | 16.29                                    |             | Right         | 99.27      | 10       | 0.148              |           | 1.178          | 1.007          |              | -        |
| 2 437  | 6   | 802.11b | 22         | 1         | 17.0          | 16.29                                    |             | Top           | 99.27      | 10       | 0.149              |           | 1.178          | 1.007          |              | -        |
| ANSI/ IEEE C95.1 - 1992- Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population |     |         |            |           |               | Body<br>1.6 W/kg<br>Averaged over 1 gram |             |               |            |          |                    |           |                |                |              |          |

## 11.4 SAR Test Notes

### General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2013, 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 D01v06.
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 D04v01r03, 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 D01v01r04, 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 13 for variability analysis information.
9. Per KDB 648474 D04v01r03, this device is considered a "Phablet" since the diagonal dimension is  $> 160$  mm and  $< 200$  mm. When hotspot mode applies, extremity SAR is required only for the surfaces and edges with hotspot mode scaled to the maximum output power (with tolerance) is 1 g SAR  $> 1.2$  W/kg.

### GSM/GPRS Test Notes:

1. This EUT'S GSM and GPRS device class is B.
2. This device supports GPRS VOIP in the head and the body-worn configurations therefore GPRS was additionally evaluated for head and body-worn compliance.
3. Body-Worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.
4. Justification for reduced test configurations per KDB 941225 D01v03r01: 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 including tolerance was evaluated for SAR.
5. Per FCC KDB 447498 D01v06, 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.
6. Justification for reduced test configurations per KDB Publication 941225 D01v03r01 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 per KDB 941225 D01v03r01.
2. UMTS mode in Body SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB 941225 D01v03r01. 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 D01v06, 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 D01v03r01. 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.

**WLAN Notes:**

1. For held-to-ear and hotspot operations, the initial test position procedures were applied. For initial test position, the highest extrapolated peak SAR will be used. When reported SAR for the initial test position is  $\leq 0.4$  W/kg for 1g SAR and  $\leq 1.0$  W/kg for 10g SAR, no additional testing for the remaining test positions was required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR results is  $\leq 0.8$  W/kg for 1g SAR and  $\leq 2.0$  W/kg for 10g SAR or all test position are measured.
2. Per KDB 248227 D01v02r02 justification for test configurations of 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.
3. 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.
4. 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.



## 12. Simultaneous SAR Analysis

### 12.1 Simultaneous Transmission Summation for Head

| Simultaneous Transmission Summation Scenario with 2.4 GHz WLAN |           |          |                  |                  |
|--|-----------|----------|------------------|------------------|
| Exposure condition   | Band      | WWAN SAR | 2.4 GHz WLAN SAR | $\Sigma$ 1-g SAR |
|  |           | (W/kg)   | (W/kg)           | (W/kg)           |
| Head SAR   | GSM 850   | 0.236    | 0.967            | 1.203            |
|  | GPRS 850  | 0.312    | 0.967            | 1.279            |
|  | GSM 1900  | 0.169    | 0.967            | 1.136            |
|  | GPRS 1900 | 0.252    | 0.967            | 1.219            |
|  | UMTS 850  | 0.151    | 0.967            | 1.118            |
|  | UMTS 1900 | 0.417    | 0.967            | <b>1.384</b>     |

### 12.2 Simultaneous Transmission Summation for Body-Worn

| Simultaneous Transmission Summation Scenario with 2.4 GHz WLAN |          |           |          |                  |                  |
|--|----------|-----------|----------|------------------|------------------|
| Exposure condition   | Distance | Band      | WWAN SAR | 2.4 GHz WLAN SAR | $\Sigma$ 1-g SAR |
|  | (mm)     |           | (W/kg)   | (W/kg)           | (W/kg)           |
| Body-worn  | 10       | GSM 850   | 0.352    | 0.242            | 0.594            |
|  |          | GPRS 850  | 0.465    | 0.242            | 0.707            |
|  |          | GSM 1900  | 0.232    | 0.242            | 0.474            |
|  |          | GPRS 1900 | 0.366    | 0.242            | 0.608            |
|  |          | UMTS 850  | 0.387    | 0.242            | 0.629            |
|  |          | UMTS 1900 | 0.572    | 0.242            | <b>0.814</b>     |

| Simultaneous Transmission Summation Scenario with Bluetooth |          |           |          |               |                  |
|---|----------|-----------|----------|---------------|------------------|
| Exposure condition  | Distance | Band      | WWAN SAR | Bluetooth SAR | $\Sigma$ 1-g SAR |
|   | (mm)     |           | (W/kg)   | (W/kg)        | (W/kg)           |
| Body-worn   | 10       | GSM 850   | 0.352    | 0.17          | 0.522            |
|   |          | GPRS 850  | 0.465    | 0.17          | 0.635            |
|   |          | GSM 1900  | 0.232    | 0.17          | 0.402            |
|   |          | GPRS 1900 | 0.366    | 0.17          | 0.536            |
|   |          | UMTS 850  | 0.387    | 0.17          | 0.557            |
|   |          | UMTS 1900 | 0.572    | 0.17          | 0.742            |

Note: Bluetooth SAR was not required to be measured per FCC KDB 447498 D01v06. Estimated SAR results were used for SAR summation for body-worn back side at 10 mm to determine simultaneous transmission SAR test exclusion.

### 12.3 Simultaneous Transmission Summation for Hotspot

| Simultaneous Transmission Summation Scenario with 2.4 GHz WLAN |          |           |          |                  |                  |
|--|----------|-----------|----------|------------------|------------------|
| Exposure condition   | Distance | Band      | WWAN SAR | 2.4 GHz WLAN SAR | $\Sigma$ 1-g SAR |
|  | (mm)     |           | (W/kg)   | (W/kg)           | (W/kg)           |
| Hotspot  | 10       | GSM 850   | 0.465    | 0.242            | 0.707            |
|  |          | GSM 1900  | 0.366    | 0.242            | 0.608            |
|  |          | UMTS 850  | 0.387    | 0.242            | 0.629            |
|  |          | UMTS 1900 | 0.572    | 0.242            | <b>0.814</b>     |

### 12.4 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 D01v06 and IEEE 1528-2013.

## 13. SAR Measurement Variability and Uncertainty

In accordance with KDB procedure 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz, SAR 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.

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

- 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  $> 1.20$ .

# 14. MEASUREMENT UNCERTAINTY

| Uncertainty (700 MHz ~ 2600 MHz)    |       |       |      |                |                               |                  |  |
|-------------------------------------|-------|-------|------|----------------|-------------------------------|------------------|--|
| Error Description                   | Tol   | Prob. | Div. | c <sub>i</sub> | Standard Uncertainty<br>(± %) | v <sub>eff</sub> |  |
|                                     | (± %) | dist. |      |                |                               |                  |  |
| <b>1. Measurement System</b>        |       |       |      |                |                               |                  |  |
| Probe Calibration                   | 6.00  | N     | 1    | 1              | 6.00                          | ∞                |  |
| Axial Isotropy                      | 4.70  | R     | 1.73 | 0.7            | 1.90                          | ∞                |  |
| Hemispherical Isotropy              | 9.60  | R     | 1.73 | 0.7            | 3.88                          | ∞                |  |
| Boundary Effects                    | 1.00  | R     | 1.73 | 1              | 0.58                          | ∞                |  |
| Linearity                           | 4.70  | R     | 1.73 | 1              | 2.71                          | ∞                |  |
| System Detection Limits             | 1.00  | R     | 1.73 | 1              | 0.58                          | ∞                |  |
| Readout Electronics                 | 0.30  | N     | 1.00 | 1              | 0.30                          | ∞                |  |
| Response Time                       | 0.8   | R     | 1.73 | 1              | 0.46                          | ∞                |  |
| Integration Time                    | 2.6   | R     | 1.73 | 1              | 1.50                          | ∞                |  |
| RF Ambient Conditions               | 3.00  | R     | 1.73 | 1              | 1.73                          | ∞                |  |
| Probe Positioner                    | 0.40  | R     | 1.73 | 1              | 0.23                          | ∞                |  |
| Probe Positioning                   | 2.90  | R     | 1.73 | 1              | 1.67                          | ∞                |  |
| Max SAR Eval                        | 1.00  | R     | 1.73 | 1              | 0.58                          | ∞                |  |
| <b>2. Test Sample Related</b>       |       |       |      |                |                               |                  |  |
| Device Positioning                  | 2.25  | N     | 1.00 | 1              | 2.25                          | 9                |  |
| Device Holder                       | 3.60  | N     | 1.00 | 1              | 3.60                          | ∞                |  |
| Power Drift                         | 5.00  | R     | 1.73 | 1              | 2.89                          | ∞                |  |
| <b>3. Phantom and Setup</b>         |       |       |      |                |                               |                  |  |
| Phantom Uncertainty                 | 4.00  | R     | 1.73 | 1              | 2.31                          | ∞                |  |
| Liquid Conductivity(target)         | 5.00  | R     | 1.73 | 0.64           | 1.85                          | ∞                |  |
| Liquid Conductivity(meas.)          | 2.70  | N     | 1    | 0.64           | 1.73                          | ∞                |  |
| Liquid Permittivity(target)         | 5.00  | R     | 1.73 | 0.6            | 1.73                          | ∞                |  |
| Liquid Permittivity(meas.)          | 1.90  | N     | 1    | 0.6            | 1.14                          | ∞                |  |
| <b>Combind Standard Uncertainty</b> |       |       |      |                |                               | 10.67            |  |
| <b>Coverage Factor for 95 %</b>     |       |       |      |                |                               | k=2              |  |
| <b>Expanded STD Uncertainty</b>     |       |       |      |                |                               | 21.34            |  |

## 15. SAR TEST EQUIPMENT

| Manufacturer     | Type / Model               | S/N             | Calib. Date | Calib.Interval | Calib.Due  |
|------------------|----------------------------|-----------------|-------------|----------------|------------|
| SPEAG            | SAM Phantom                | -               | N/A         | N/A            | N/A        |
| SPEAG            | Triple Modular Phantom     | -               | N/A         | N/A            | N/A        |
| HP               | SAR System Control PC      | -               | N/A         | N/A            | N/A        |
| Staubli          | Robot RX90B L              | F01/5K09A1/A/01 | N/A         | N/A            | N/A        |
| Staubli          | Robot ControllerCS7MB      | F01/5K09A1/C/01 | N/A         | N/A            | N/A        |
| SCHMID & PARTNER | Light Alignment Sensor     | 265             | N/A         | N/A            | N/A        |
| Staubli          | Teach Pendant (Joystick)   | D221340.01      | N/A         | N/A            | N/A        |
| SPEAG            | DAE4                       | 614             | 09/29/2015  | Annual         | 09/29/2016 |
| SPEAG            | DAE4                       | 1225            | 03/18/2015  | Annual         | 03/18/2016 |
| SPEAG            | E-Field Probe EX3DV4       | 3968            | 06/18/2015  | Annual         | 06/18/2016 |
| SPEAG            | E-Field Probe EX3DV4       | 3967            | 12/16/2015  | Annual         | 12/16/2016 |
| SPEAG            | Dipole D835V2              | 4d165           | 11/24/2015  | Annual         | 11/24/2016 |
| SPEAG            | Dipole D1900V2             | 5d032           | 05/20/2015  | Annual         | 05/20/2016 |
| SPEAG            | Dipole D2450V2             | 743             | 05/19/2015  | Annual         | 05/19/2016 |
| Agilent          | Power Meter N1991A         | MY45101406      | 10/03/2015  | Annual         | 10/03/2016 |
| Agilent          | Power Sensor N1921A        | MY55220026      | 08/19/2015  | Annual         | 08/19/2016 |
| SPEAG            | DAKS 3.5                   | 1038            | 05/26/2015  | Annual         | 05/26/2016 |
| HP               | Directional Bridge         | 86205A          | 05/20/2015  | Annual         | 05/20/2016 |
| Agilent          | Base Station E5515C        | GB44400269      | 02/09/2015  | Annual         | 02/09/2016 |
| HP               | Signal Generator N5182A    | MY4770230       | 05/13/2015  | Annual         | 05/13/2016 |
| Agilent          | MXA Signal Analyzer N9020A | MY50510407      | 03/23/2015  | Annual         | 03/23/2016 |
| HP               | Network Analyzer 8753ES    | JP39240221      | 03/23/2015  | Annual         | 03/23/2016 |
| Hewlett Packard  | 11636B/Power Divider       | 58698           | 03/02/2015  | Annual         | 03/02/2016 |

**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.

## 16. CONCLUSION

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.

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the FCC and Industry Canada. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

## 17. REFERENCES

- [1] IEEE Standards Coordinating Committee 34 – IEEE Std. 1528-2013, IEEE Recommended Practice or Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body from Wireless Communications Devices.
- [2] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radio frequency Radiation, Aug. 1996.
- [3] ANSI/IEEE C95.1 - 1991, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300 kHz to 100 GHz, New York: IEEE, Aug. 1992
- [4] ANSI/IEEE C 95.1 - 2005, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz, New York: IEEE, 2006.
- [5] ANSI/IEEE C95.3 - 1991, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave, New York: IEEE, 1992.
- [6] NCRP, National Council on Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radio Frequency Electromagnetic Fields, NCRP Report No. 86, 1986. Reprinted Feb. 1995.
- [7] T. Schmid, O. Egger, N. Kuster, Automated E-field scanning system for dosimetric assessments, IEEE Transaction on Microwave Theory and Techniques, vol. 44, Jan. 1996, pp. 105-113.
- [8] K. Pokovic, T. Schmid, N. Kuster, Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies, ICECOM97, Oct. 1997, pp. 120-124.
- [9] K. Pokovic, T. Schmid, and N. Kuster, E-field Probe with improved isotropy in brain simulating liquids, Proceedings of the ELMAR, Zadar, Croatia, June 23-25, 1996, pp. 172-175.
- [10] Schmid & Partner Engineering AG, Application Note: Data Storage and Evaluation, June 1998, p2.
- [11] V. Hombach, K. Meier, M. Burkhardt, E. Kuhn, N. Kuster, The Dependence of EM Energy Absorption upon Human Head Modeling at 900 MHz, IEEE Transaction on Microwave Theory and Techniques, vol. 44 no. 10, Oct. 1996, pp. 1865-1873.
- [12] N. Kuster and Q. Balzano, Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300 MHz, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.
- [13] G. Hartsgrrove, A. Kraszewski, A. Surowiec, Simulated Biological Materials for Electromagnetic Radiation Absorption Studies, University of Ottawa, Bioelectro magnetics, Canada: 1987, pp. 29-36.
- [14] Q. Balzano, O. Garay, T. Manning Jr., Electromagnetic Energy Exposure of Simulated Users of Portable Cellular Telephones, IEEE Transactions on Vehicular Technology, vol. 44, no.3, Aug. 1995.
- [15] W. Gander, Computer mathematick, Birkhaeuser, Basel, 1992.
- [16] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second edition, Cambridge University Press, 1992.
- [17] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.
- [18] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), Human Exposure to Electromagnetic Fields High-frequency: 10 kHz-300 GHz, Jan. 1995.
- [19] Prof. Dr. Niels Kuster, ETH, EidgenØssische Technische Hoschsschule ZØrich, Dosimetric Evaluation of the Cellular Phone.

- [20] IEC 62209-1, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation and procedures – Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz), Feb. 2005.
- [21] IEC 62209-2, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz) Mar. 2010.
- [22] Industry Canada RSS-102 Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Band) Issue 5, March 2015.
- [23] Health Canada Safety Code 6 Limits of Human Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range from 3 kHz – 300 GHz, 2009
- [24] FCC SAR Test procedures for 2G-3G Devices, Mobile Hotspot and UMPC Device KDB 941225 D01.
- [25] SAR Measurement Guidance for IEEE 802.11 transmitters, KDB 248227 D01.
- [26] SAR Evaluation of Handsets with Multiple Transmitters and Antennas KDB 648474 D03, D04.
- [27] SAR Evaluation for Laptop, Notebook, Netbook and Tablet computers KDB 616217 D04.
- [28] SAR Measurement and Reporting Requirements for 100 MHz – 6 GHz, KDB 865664 D01, D02.
- [29] FCC General RF Exposure Guidance and SAR procedures for Dongles, KDB 447498 D01, D02.



## Attachment 1. – SAR Test Plots

|                      |   |
|----------------------|---|
| Test Laboratory:     | HCT CO., LTD  |
| EUT Type:            | GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support |
| Liquid Temperature:  | 19.8 °C   |
| Ambient Temperature: | 20.0 °C   |
| Test Date:           | 01/18/2016  |
| Plot No.:            | 1   |

**DUT: LG-K520; Type: Bar**

Communication System: GSM 850; Frequency: 836.6 MHz; Duty Cycle: 1:2.075  
 Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.919 \text{ mho/m}$ ;  $\epsilon_r = 40.3$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Right Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.87, 9.87, 9.87); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**GSM850 4Tx Right touch 190ch/Area Scan (71x121x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
 Maximum value of SAR (interpolated) = 0.337 mW/g

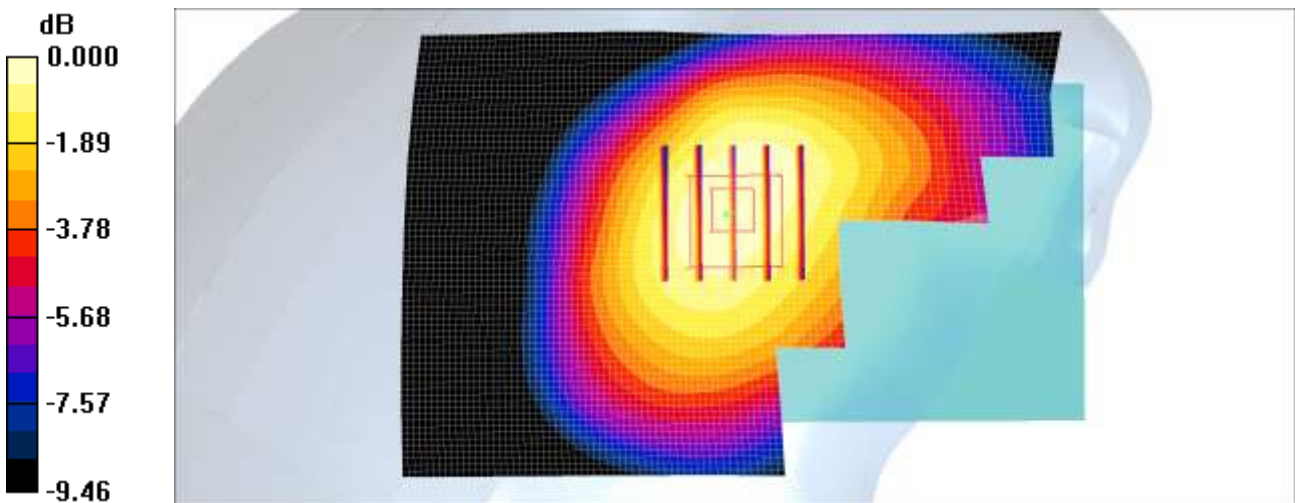
**GSM850 4Tx Right touch 190ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 3.55 V/m; Power Drift = 0.115 dB

Peak SAR (extrapolated) = 0.376 W/kg

**SAR(1 g) = 0.297 mW/g; SAR(10 g) = 0.227 mW/g**

Maximum value of SAR (measured) = 0.338 mW/g



0 dB = 0.338mW/g

Test Laboratory: HCT CO., LTD  
 EUT Type: GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support  
 Liquid Temperature: 20.6 °C  
 Ambient Temperature: 20.8 °C  
 Test Date: 01/20/2016  
 Plot No.: 2

**DUT: LG-K520; Type: Bar**

Communication System: GSM 1900; Frequency: 1880 MHz; Duty Cycle: 1:2.77  
 Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.39 \text{ mho/m}$ ;  $\epsilon_r = 39.4$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Left Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(8.11, 8.11, 8.11); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**GSM1900 Left touch 3Tx 661ch/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 0.290 mW/g

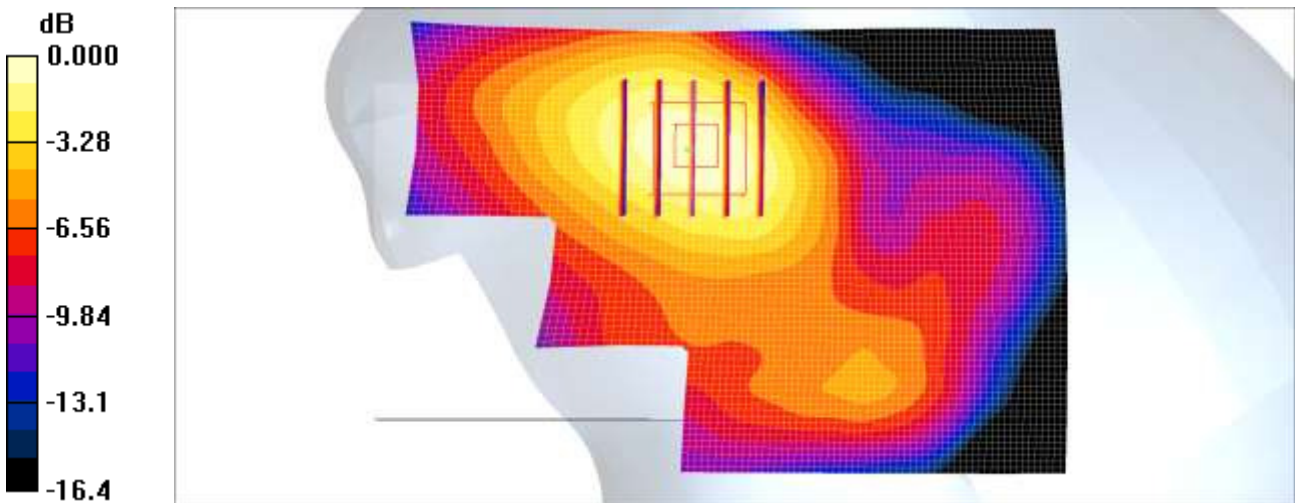
**GSM1900 Left touch 3Tx 661ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 5.53 V/m; Power Drift = 0.052 dB

Peak SAR (extrapolated) = 0.366 W/kg

**SAR(1 g) = 0.229 mW/g; SAR(10 g) = 0.140 mW/g**

Maximum value of SAR (measured) = 0.295 mW/g



0 dB = 0.295mW/g

Test Laboratory: HCT CO., LTD  
 EUT Type: GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support  
 Liquid Temperature: 19.8 °C  
 Ambient Temperature: 20.0 °C  
 Test Date: 01/18/2016  
 Plot No.: 3

**DUT: LG-K520; Type: Bar**

Communication System: WCDMA850; Frequency: 836.6 MHz;Duty Cycle: 1:1  
 Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.919 \text{ mho/m}$ ;  $\epsilon_r = 40.3$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Right Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.87, 9.87, 9.87); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**WCDMA850 Right touch 4183ch/Area Scan (71x121x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
 Maximum value of SAR (interpolated) = 0.169 mW/g

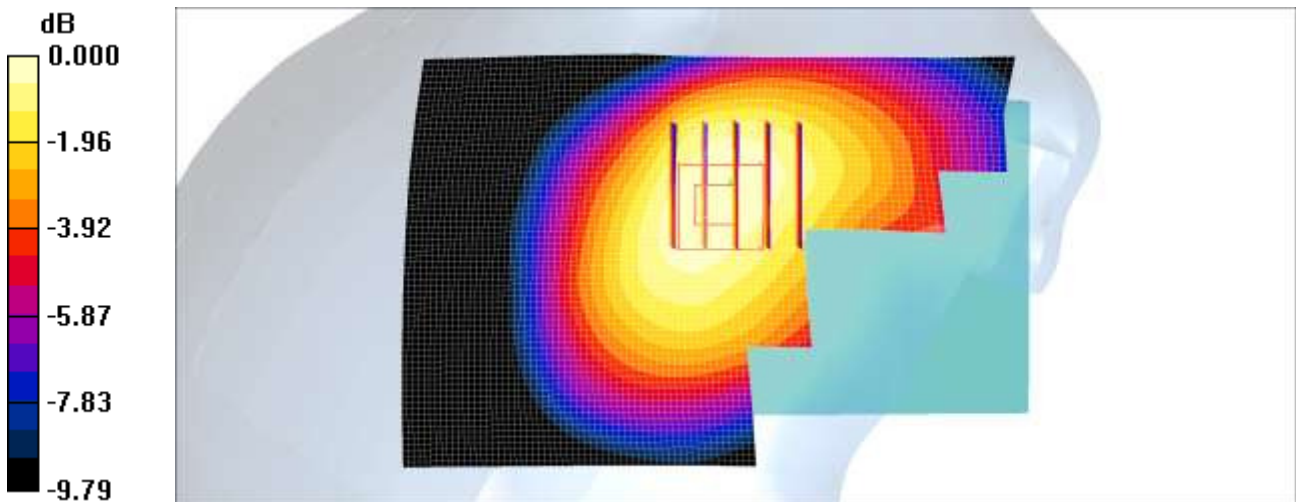
**WCDMA850 Right touch 4183ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 2.75 V/m; Power Drift = -0.117 dB

Peak SAR (extrapolated) = 0.187 W/kg

**SAR(1 g) = 0.146 mW/g; SAR(10 g) = 0.110 mW/g**

Maximum value of SAR (measured) = 0.167 mW/g



0 dB = 0.167mW/g

Test Laboratory: HCT CO., LTD  
EUT Type: GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support  
Liquid Temperature: 20.6 °C  
Ambient Temperature: 20.8 °C  
Test Date: 01/20/2016  
Plot No.: 4

**DUT: LG-K520; Type: Bar**

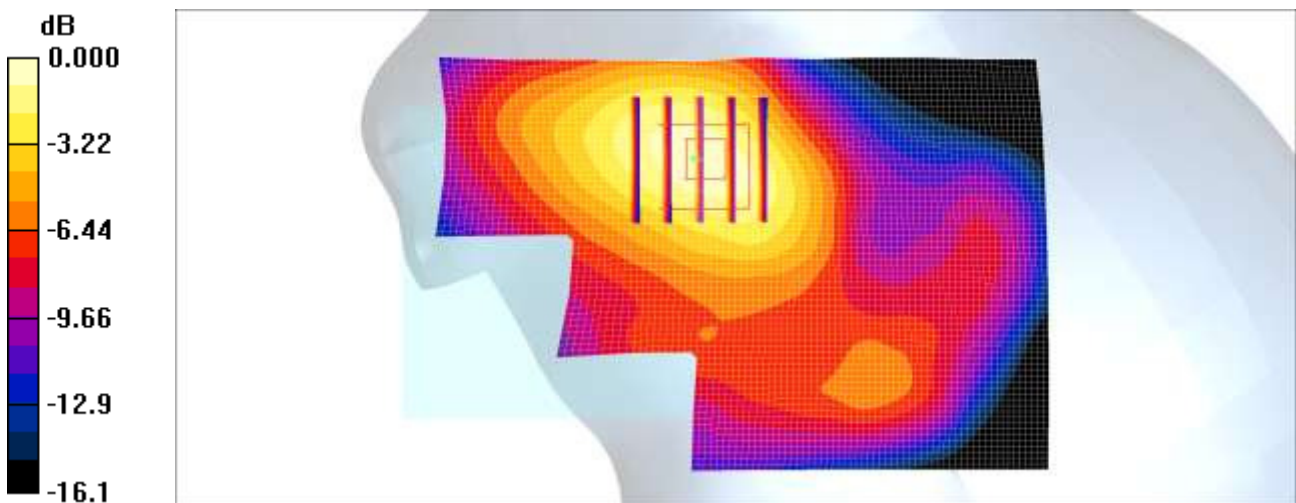
Communication System: WCDMA1900; Frequency: 1880 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.39 \text{ mho/m}$ ;  $\epsilon_r = 39.4$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Left Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(8.11, 8.11, 8.11); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**WCDMA Left touch 9400ch/Area Scan (71x121x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
Maximum value of SAR (interpolated) = 0.470 mW/g

**WCDMA Left touch 9400ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
Reference Value = 8.09 V/m; Power Drift = -0.135 dB  
Peak SAR (extrapolated) = 0.628 W/kg  
**SAR(1 g) = 0.395 mW/g; SAR(10 g) = 0.240 mW/g**  
Maximum value of SAR (measured) = 0.512 mW/g



0 dB = 0.512mW/g

Test Laboratory: HCT CO., LTD  
 EUT Type: GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support  
 Liquid Temperature: 21.3 °C  
 Ambient Temperature: 21.5 °C  
 Test Date: 01/20/2016  
 Plot No.: 5

**DUT: LG-K520; Type: Bar**

Communication System: 2450MHz FCC; Frequency: 2412 MHz;Duty Cycle: 1:1  
 Medium parameters used (interpolated):  $f = 2412 \text{ MHz}$ ;  $\sigma = 1.8 \text{ mho/m}$ ;  $\epsilon_r = 38$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Left Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.21, 7.21, 7.21); Calibrated: 2015-06-18
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1225; Calibrated: 2015-03-18
- Phantom: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**802.11b Head left touch 1Mbps 1ch/Area Scan (81x151x1):** Measurement grid:  $dx=12\text{mm}$ ,  $dy=12\text{mm}$   
 Maximum value of SAR (interpolated) = 1.31 mW/g

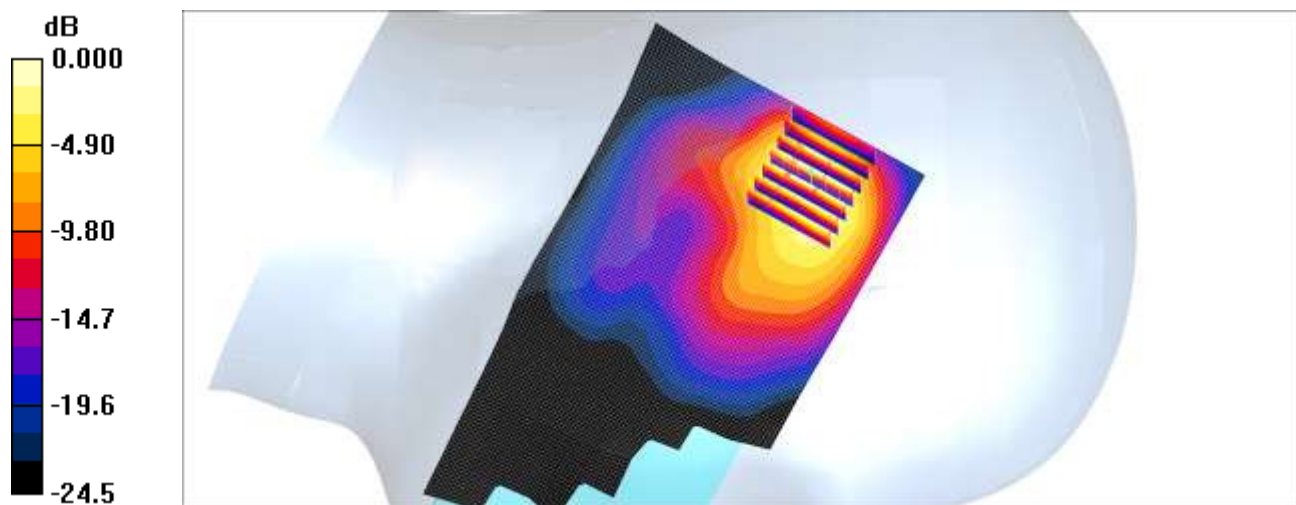
**802.11b Head left touch 1Mbps 1ch/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 14.1 V/m; Power Drift = -0.120 dB

Peak SAR (extrapolated) = 2.00 W/kg

**SAR(1 g) = 0.768 mW/g; SAR(10 g) = 0.351 mW/g**

Maximum value of SAR (measured) = 1.34 mW/g



0 dB = 1.34mW/g

|                      |   |
|----------------------|---|
| Test Laboratory:     | HCT CO., LTD  |
| EUT Type:            | GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support |
| Liquid Temperature:  | 21.2 °C   |
| Ambient Temperature: | 21.4 °C   |
| Test Date:           | 01/19/2016  |
| Plot No.:            | 6   |

**DUT: LG-K520; Type: Bar**

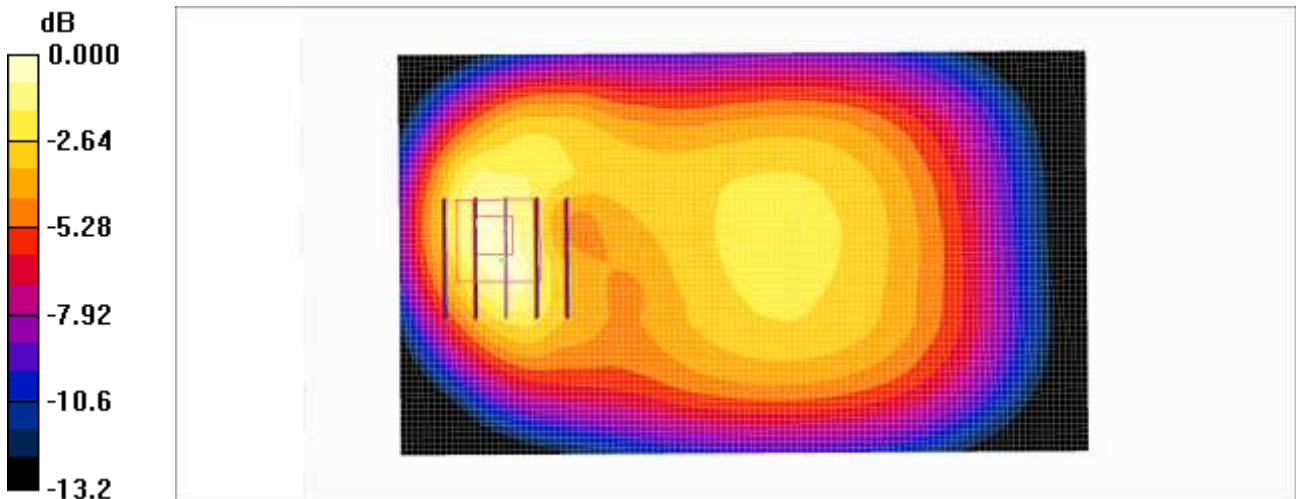
Communication System: GSM 850; Frequency: 836.6 MHz; Duty Cycle: 1:8.3  
 Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.952 \text{ mho/m}$ ;  $\epsilon_r = 56.6$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Center Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.76, 9.76, 9.76); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**GSM850 body rear 190ch/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 0.428 mW/g

**GSM850 body rear 190ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
 Reference Value = 16.5 V/m; Power Drift = 0.108 dB  
 Peak SAR (extrapolated) = 0.591 W/kg  
**SAR(1 g) = 0.349 mW/g; SAR(10 g) = 0.203 mW/g**  
 Maximum value of SAR (measured) = 0.464 mW/g



0 dB = 0.464mW/g

|                      |   |
|----------------------|---|
| Test Laboratory:     | HCT CO., LTD  |
| EUT Type:            | GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support |
| Liquid Temperature:  | 21.2 °C   |
| Ambient Temperature: | 21.4 °C   |
| Test Date:           | 01/19/2016  |
| Plot No.:            | 7   |

**DUT: LG-K520; Type: Bar**

Communication System: GSM 850; Frequency: 836.6 MHz; Duty Cycle: 1:2.075

Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.952 \text{ mho/m}$ ;  $\epsilon_r = 56.6$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Center Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.76, 9.76, 9.76); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**GSM850 body rear 4Tx 190ch/Area Scan (71x121x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$

Maximum value of SAR (interpolated) = 0.566 mW/g

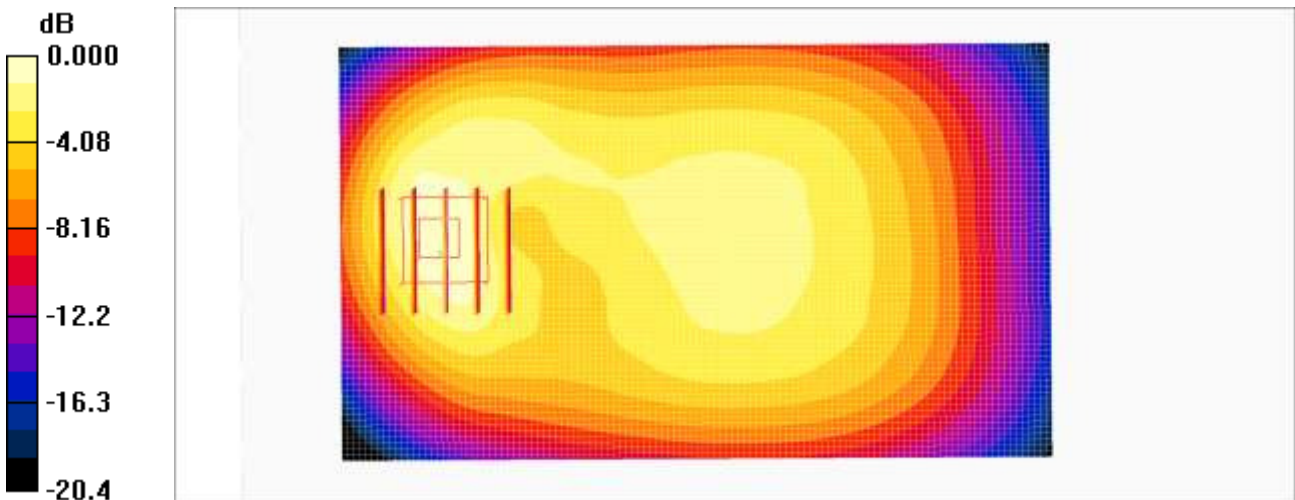
**GSM850 body rear 4Tx 190ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 20.1 V/m; Power Drift = -0.174 dB

Peak SAR (extrapolated) = 0.750 W/kg

**SAR(1 g) = 0.442 mW/g; SAR(10 g) = 0.258 mW/g**

Maximum value of SAR (measured) = 0.599 mW/g



0 dB = 0.599mW/g



Test Laboratory: HCT CO., LTD  
 EUT Type: GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support  
 Liquid Temperature: 20.2 °C  
 Ambient Temperature: 20.5 °C  
 Test Date: 01/21/2016  
 Plot No.: 8

**DUT: LG-K520; Type: Bar**

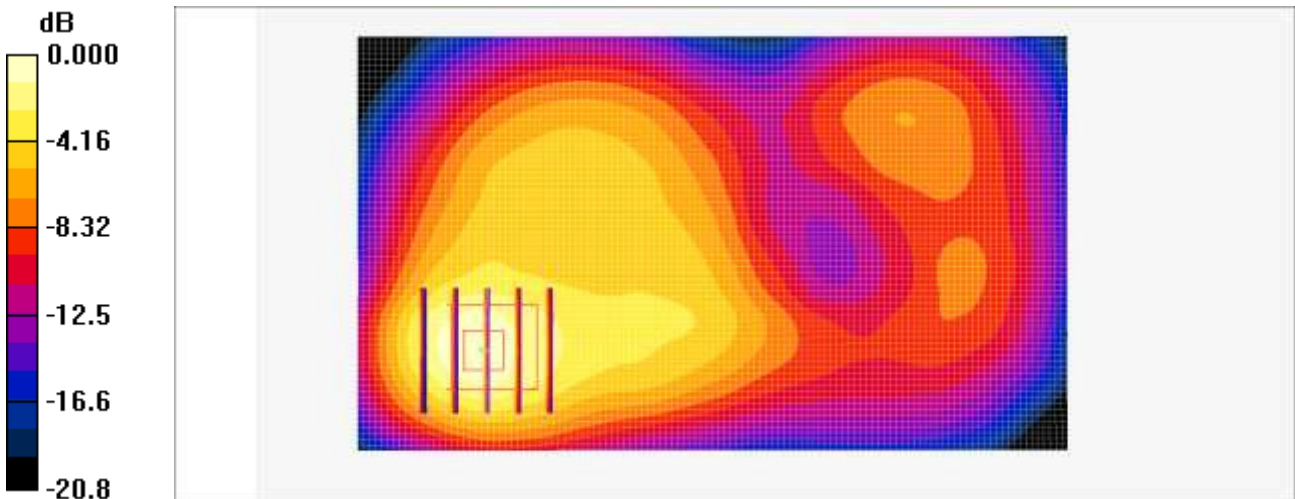
Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3  
 Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.52 \text{ mho/m}$ ;  $\epsilon_r = 55$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Center Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(7.95, 7.95, 7.95); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**GSM1900 body rear 661ch/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 0.308 mW/g

**GSM1900 body rear 661ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
 Reference Value = 3.08 V/m; Power Drift = 0.107 dB  
 Peak SAR (extrapolated) = 0.417 W/kg  
**SAR(1 g) = 0.224 mW/g; SAR(10 g) = 0.120 mW/g**  
 Maximum value of SAR (measured) = 0.322 mW/g



0 dB = 0.322mW/g

Test Laboratory: HCT CO., LTD  
 EUT Type: GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support  
 Liquid Temperature: 20.2 °C  
 Ambient Temperature: 20.5 °C  
 Test Date: 01/21/2016  
 Plot No.: 9

**DUT: LG-K520; Type: Bar**

Communication System: GSM 1900; Frequency: 1880 MHz; Duty Cycle: 1:2.77  
 Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.52 \text{ mho/m}$ ;  $\epsilon_r = 55$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Center Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(7.95, 7.95, 7.95); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**GSM1900 body rear 3Tx 661ch/Area Scan (71x121x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
 Maximum value of SAR (interpolated) = 0.469 mW/g

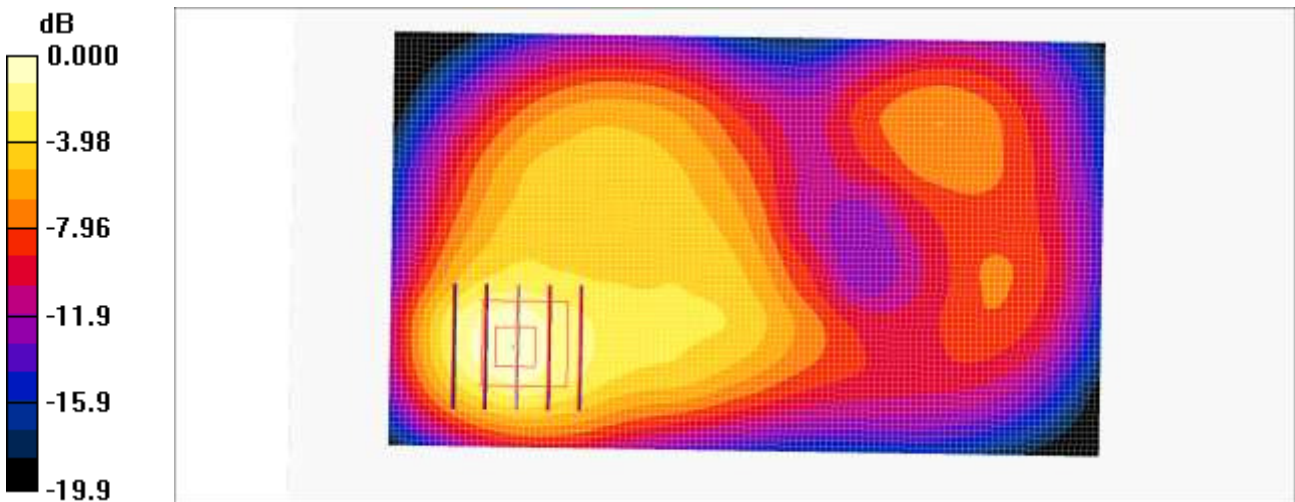
**GSM1900 body rear 3Tx 661ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 4.04 V/m; Power Drift = -0.171 dB

Peak SAR (extrapolated) = 0.621 W/kg

**SAR(1 g) = 0.333 mW/g; SAR(10 g) = 0.178 mW/g**

Maximum value of SAR (measured) = 0.479 mW/g



0 dB = 0.479mW/g

Test Laboratory: HCT CO., LTD  
 EUT Type: GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support  
 Liquid Temperature: 21.2 °C  
 Ambient Temperature: 21.4 °C  
 Test Date: 01/19/2016  
 Plot No.: 10

**DUT: LG-K520; Type: Bar**

Communication System: WCDMA850; Frequency: 836.6 MHz;Duty Cycle: 1:1  
 Medium parameters used (interpolated):  $f = 836.6 \text{ MHz}$ ;  $\sigma = 0.952 \text{ mho/m}$ ;  $\epsilon_r = 56.6$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Center Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.76, 9.76, 9.76); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**WCDMA850 body rear 4183ch/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 0.501 mW/g

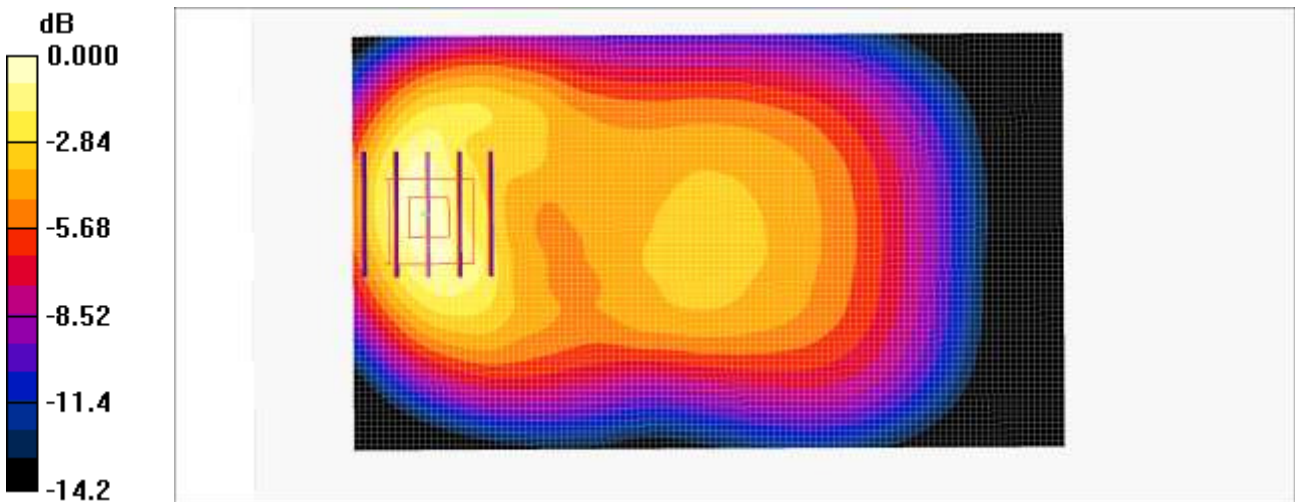
**WCDMA850 body rear 4183ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 14.1 V/m; Power Drift = 0.080 dB

Peak SAR (extrapolated) = 0.630 W/kg

**SAR(1 g) = 0.375 mW/g; SAR(10 g) = 0.222 mW/g**

Maximum value of SAR (measured) = 0.512 mW/g



0 dB = 0.512mW/g

Test Laboratory: HCT CO., LTD  
 EUT Type: GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support  
 Liquid Temperature: 20.5 °C  
 Ambient Temperature: 20.7 °C  
 Test Date: 01/21/2016  
 Plot No.: 11

**DUT: LG-K520; Type: Bar**

Communication System: WCDMA1900; Frequency: 1880 MHz;Duty Cycle: 1:1  
 Medium parameters used:  $f = 1880 \text{ MHz}$ ;  $\sigma = 1.52 \text{ mho/m}$ ;  $\epsilon_r = 55$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Center Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(7.95, 7.95, 7.95); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**WCDMA1900 body rear 9400ch/Area Scan (71x121x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (interpolated) = 0.748 mW/g

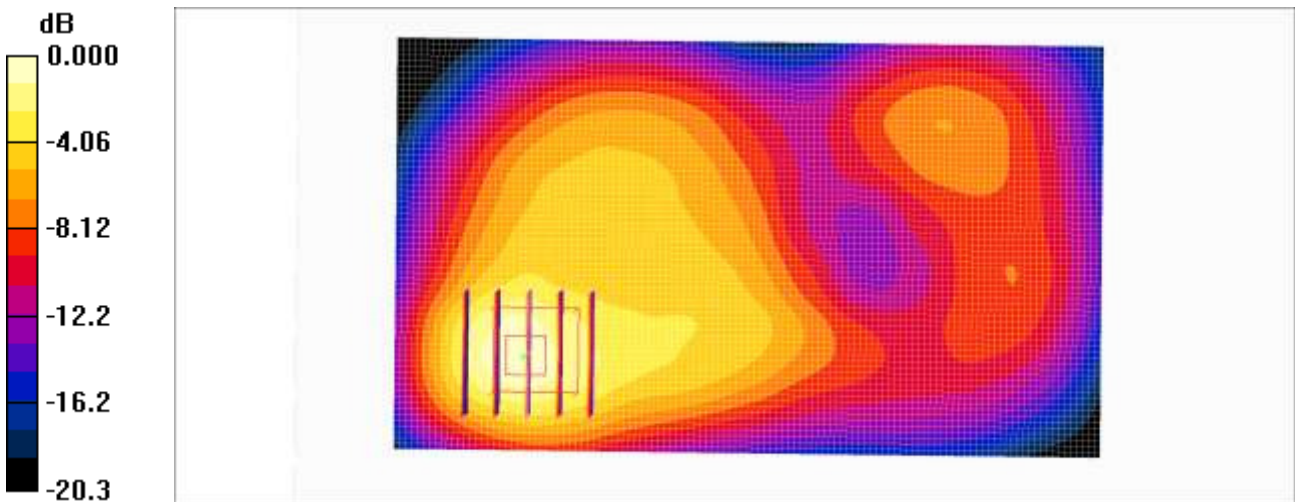
**WCDMA1900 body rear 9400ch/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 5.18 V/m; Power Drift = 0.067 dB

Peak SAR (extrapolated) = 1.01 W/kg

**SAR(1 g) = 0.541 mW/g; SAR(10 g) = 0.288 mW/g**

Maximum value of SAR (measured) = 0.782 mW/g



0 dB = 0.782mW/g

Test Laboratory: HCT CO., LTD  
EUT Type: GSM/WCDMA/LTE Phone with Bluetooth4.1LE, WIFI802.11 b/g/n(2.4GHz), NFC, VoIP, Hotspot support  
Liquid Temperature: 21.3 °C  
Ambient Temperature: 21.5 °C  
Test Date: 01/20/2016  
Plot No.: 12

**DUT: LG-K520; Type: Bar**

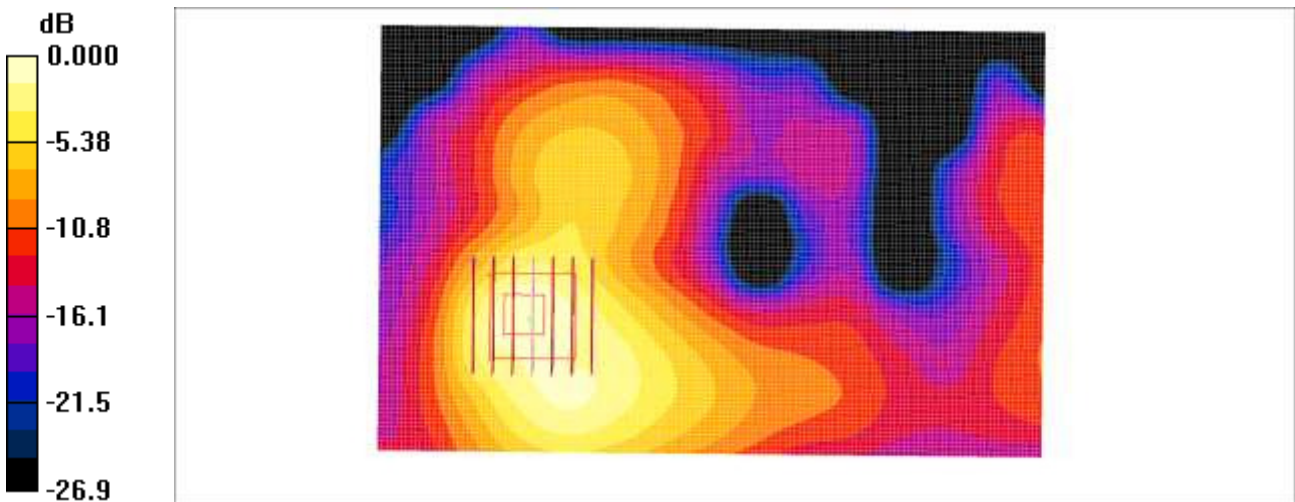
Communication System: 2450MHz FCC; Frequency: 2437 MHz;Duty Cycle: 1:1  
Medium parameters used (interpolated):  $f = 2437$  MHz;  $\sigma = 1.9$  mho/m;  $\epsilon_r = 51.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Center Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.25, 7.25, 7.25); Calibrated: 2015-06-18
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1225; Calibrated: 2015-03-18
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**802.11b Body Rear 1Mbps 6ch/Area Scan (91x141x1):** Measurement grid: dx=12mm, dy=12mm  
Maximum value of SAR (interpolated) = 0.341 mW/g

**802.11b Body Rear 1Mbps 6ch/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 5.01 V/m; Power Drift = -0.130 dB  
Peak SAR (extrapolated) = 0.428 W/kg  
**SAR(1 g) = 0.204 mW/g; SAR(10 g) = 0.097 mW/g**  
Maximum value of SAR (measured) = 0.306 mW/g



0 dB = 0.306mW/g

## Attachment 2. – Dipole Verification Plots

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

Test Laboratory: HCT CO., LTD  
 Input Power 100 mW (20 dBm)  
 Liquid Temp: 19.8 °C  
 Test Date: 01/18/2016

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

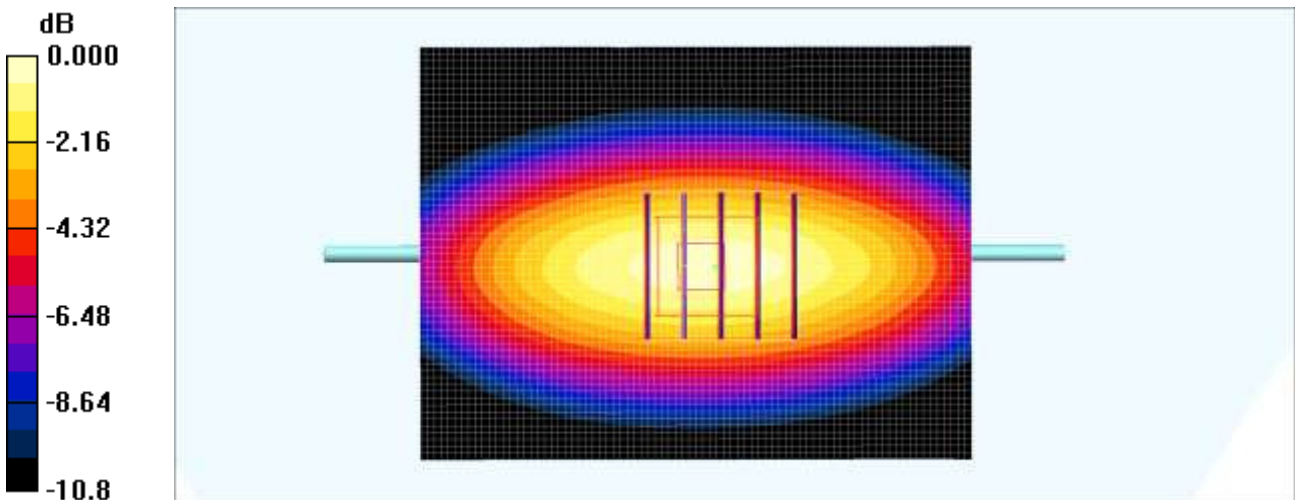
Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1  
 Medium parameters used (interpolated):  $f = 835 \text{ MHz}$ ;  $\sigma = 0.918 \text{ mho/m}$ ;  $\epsilon_r = 40.3$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.87, 9.87, 9.87); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**Verification Head 835 MHz/Area Scan (61x81x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
 Maximum value of SAR (interpolated) = 1.13 mW/g

**Verification Head 835 MHz/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
 Reference Value = 35.5 V/m; Power Drift = -0.036 dB  
 Peak SAR (extrapolated) = 1.39 W/kg  
**SAR(1 g) = 0.955 mW/g; SAR(10 g) = 0.627 mW/g**  
 Maximum value of SAR (measured) = 1.20 mW/g



0 dB = 1.20mW/g

**■ Verification Data (835 MHz Body)**

Test Laboratory: HCT CO., LTD  
 Input Power 100 mW (20 dBm)  
 Liquid Temp: 21.2 °C  
 Test Date: 01/19/2016

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

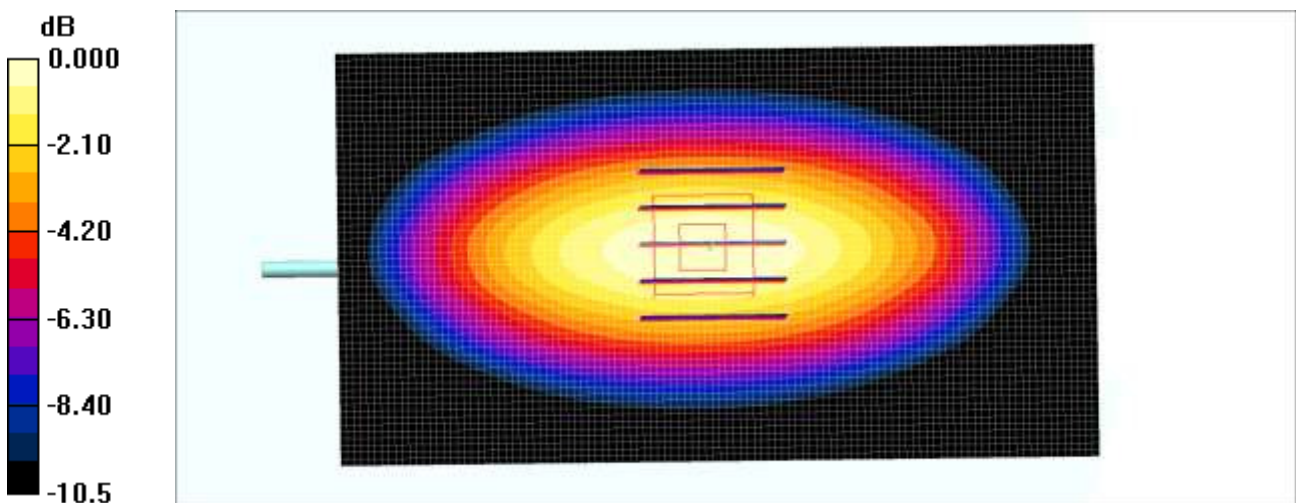
Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1  
 Medium parameters used (interpolated):  $f = 835 \text{ MHz}$ ;  $\sigma = 0.95 \text{ mho/m}$ ;  $\epsilon_r = 56.6$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(9.76, 9.76, 9.76); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**Verification Body 835 MHz/Area Scan (111x61x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
 Maximum value of SAR (interpolated) = 1.04 mW/g

**Verification Body 835 MHz/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$   
 Reference Value = 32.9 V/m; Power Drift = 0.027 dB  
 Peak SAR (extrapolated) = 1.41 W/kg  
**SAR(1 g) = 0.953 mW/g; SAR(10 g) = 0.623 mW/g**  
 Maximum value of SAR (measured) = 1.03 mW/g



0 dB = 1.03mW/g



**■ Verification Data (1 900 MHz Head)**

Test Laboratory: HCT CO., LTD  
 Input Power 100 mW (20 dBm)  
 Liquid Temp: 20.6 °C  
 Test Date: 01/20/2016

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

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.41 \text{ mho/m}$ ;  $\epsilon_r = 39.3$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(8.11, 8.11, 8.11); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**Dipole 1900MHz Verification /Area Scan (61x61x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$   
 Maximum value of SAR (interpolated) = 6.58 mW/g

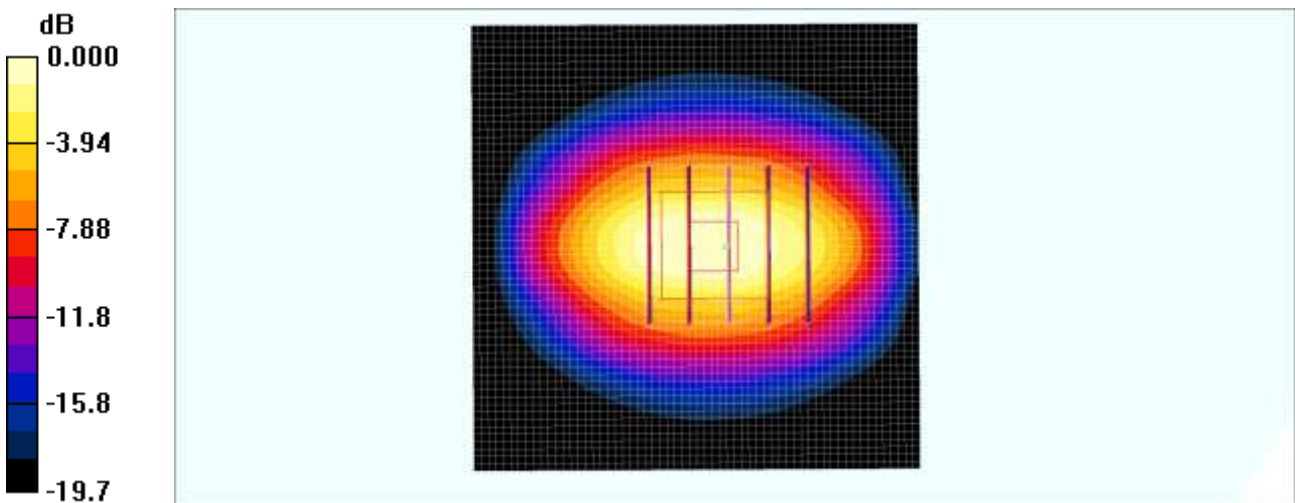
**Dipole 1900MHz Verification /Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 66.9 V/m; Power Drift = 0.007 dB

Peak SAR (extrapolated) = 7.97 W/kg

**SAR(1 g) = 4.21 mW/g; SAR(10 g) = 2.14 mW/g**

Maximum value of SAR (measured) = 6.09 mW/g



0 dB = 6.09mW/g

## ■ Verification Data (1 900 MHz Body)

Test Laboratory: HCT CO., LTD  
Input Power 100 mW (20 dBm)  
Liquid Temp: 20.2 °C  
Test Date: 01/21/2016

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

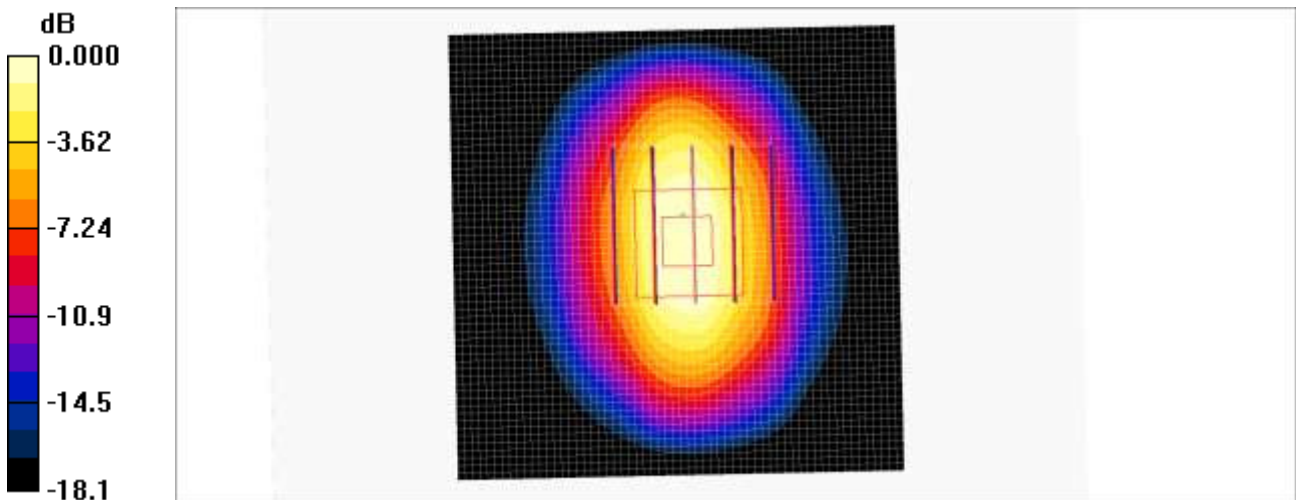
Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.54$  mho/m;  $\epsilon_r = 54.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Center Section

#### DASY4 Configuration:

- Probe: EX3DV4 - SN3967; ConvF(7.95, 7.95, 7.95); Calibrated: 2015-12-16
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2015-09-29
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**Verification Body 1900 MHz/Area Scan (61x61x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (interpolated) = 5.05 mW/g

**Verification Body 1900 MHz/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 54.3 V/m; Power Drift = -0.006 dB  
Peak SAR (extrapolated) = 7.53 W/kg  
**SAR(1 g) = 4.18 mW/g; SAR(10 g) = 2.2 mW/g**  
Maximum value of SAR (measured) = 4.58 mW/g



0 dB = 4.58mW/g

## ■ Verification Data (2 450 MHz Head)

Test Laboratory: HCT CO., LTD  
 Input Power 100 mW (20 dBm)  
 Liquid Temp: 21.3 °C  
 Test Date: 01/20/2016

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

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 1.83 \text{ mho/m}$ ;  $\epsilon_r = 37.8$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section

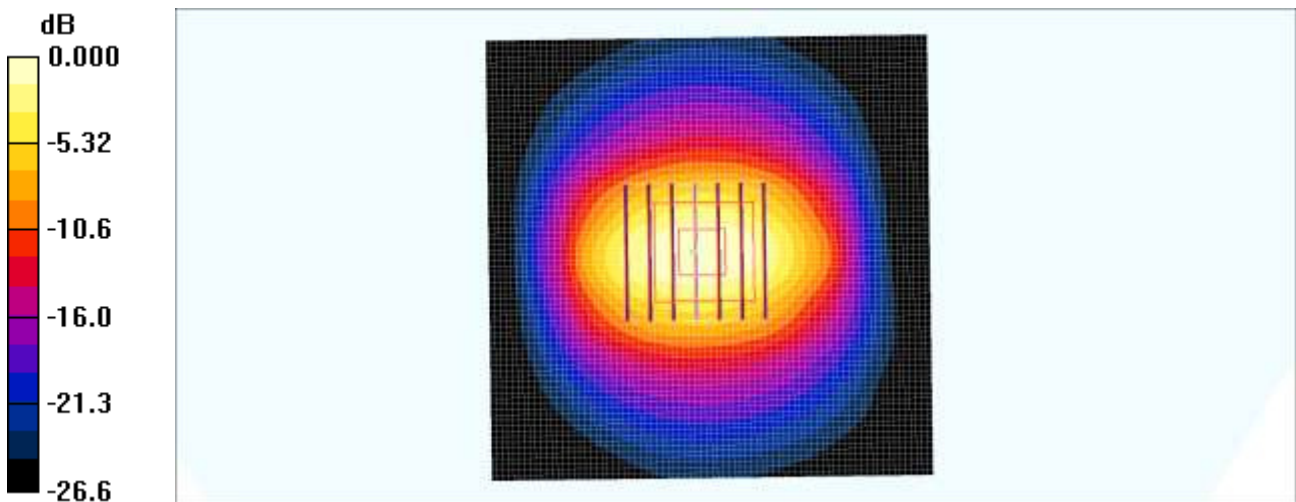
#### DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.21, 7.21, 7.21); Calibrated: 2015-06-18
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1225; Calibrated: 2015-03-18
- Phantom: SAM
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**Verification 2450MHz/Area Scan (81x81x1):** Measurement grid:  $dx=12\text{mm}$ ,  $dy=12\text{mm}$   
 Maximum value of SAR (interpolated) = 8.66 mW/g

**Verification 2450MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$   
 Reference Value = 57.5 V/m; Power Drift = -0.048 dB

Peak SAR (extrapolated) = 12.5 W/kg  
**SAR(1 g) = 5.4 mW/g; SAR(10 g) = 2.36 mW/g**  
 Maximum value of SAR (measured) = 8.66 mW/g



0 dB = 8.66mW/g

## ■ Verification Data (2 450 MHz Body)

Test Laboratory: HCT CO., LTD  
 Input Power 100 mW (20 dBm)  
 Liquid Temp: 21.3 °C  
 Test Date: 01/20/2016

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

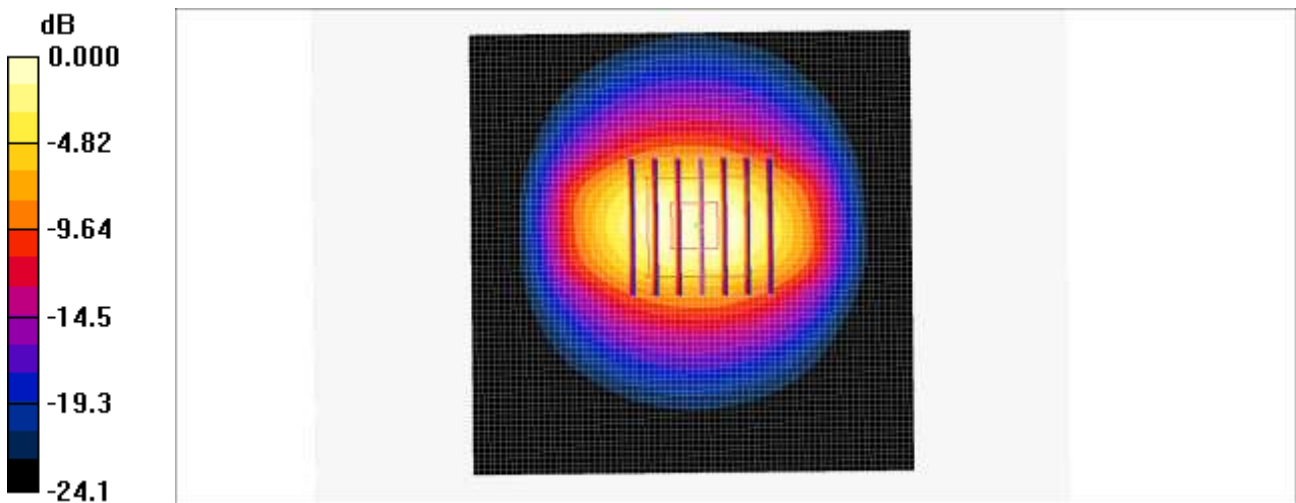
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.92$  mho/m;  $\epsilon_r = 51.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Center Section

### DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(7.25, 7.25, 7.25); Calibrated: 2015-06-18
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1225; Calibrated: 2015-03-18
- Phantom: Triple Flat Phantom
- Measurement SW: DASY4, V4.7 Build 80
- Postprocessing SW: SEMCAD, V1.8 Build 186

**Verification Body 2450MHz/Area Scan (81x81x1):** Measurement grid: dx=12mm, dy=12mm  
 Maximum value of SAR (interpolated) = 8.24 mW/g

**Verification Body 2450MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 48.2 V/m; Power Drift = -0.106 dB  
 Peak SAR (extrapolated) = 11.4 W/kg  
**SAR(1 g) = 5.2 mW/g; SAR(10 g) = 2.32 mW/g**  
 Maximum value of SAR (measured) = 8.18 mW/g



0 dB = 8.18mW/g

## 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 0108**

Client: **HCT (Dymstec)**

Certificate No: **EX3-3967\_Dec15**

**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 16, 2015**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 01-Apr-15 (No. 217-02128)         | Mar-16                 |
| Power sensor E4412A        | MY41499067      | 01-Apr-15 (No. 217-02128)         | Mar-16                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 01-Apr-15 (No. 217-02129)         | Mar-16                 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 01-Apr-15 (No. 217-02132)         | Mar-16                 |
| Reference 30 dB Attenuator | SN: S5129 (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 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-15) | In house check: Oct-16 |

|                | Name           | Function              | Signature |
|----------------|----------------|-----------------------|-----------|
| Calibrated by: | Jeton Kastrell | Laboratory Technician |           |
| Approved by:   | Katja Pokovic  | Technical Manager     |           |

Issued: December 16, 2015

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

**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  |
| 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 $\beta$   | $\beta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\beta = 0$ 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:**

- a) 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
- b) 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
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Methods Applied and Interpretation of Parameters:**

- **NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\beta = 0$  ( $f \leq 900$  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).

EX3DV4 – SN:3967

December 16, 2015

# Probe EX3DV4

## SN:3967

Manufactured: September 30, 2013  
Calibrated: December 16, 2015

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



EX3DV4- SN:3967

December 16, 2015

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

### Basic Calibration Parameters

|  | Sensor X | Sensor Y | Sensor Z | Unc (k=2)    |
|--|----------|----------|----------|--------------|
| Norm ( $\mu\text{V}/(\text{V/m})^2$ ) <sup>A</sup> | 0.54     | 0.38     | 0.48     | $\pm 10.1\%$ |
| DCP (mV) <sup>B</sup>                              | 101.3    | 97.8     | 101.0    |              |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>C</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 145.0    | $\pm 3.5\%$               |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 143.7    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 138.2    |                           |

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

<sup>A</sup> The uncertainties of Norm X,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside T5L (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.

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December 16, 2015

## 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>G</sup> (mm) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750                  | 41.9                               | 0.89                            | 10.27   | 10.27   | 10.27   | 0.21               | 1.39                    | ± 12.0 %  |
| 835                  | 41.5                               | 0.90                            | 9.87    | 9.87    | 9.87    | 0.20               | 1.38                    | ± 12.0 %  |
| 900                  | 41.5                               | 0.97                            | 9.70    | 9.70    | 9.70    | 0.25               | 1.15                    | ± 12.0 %  |
| 1450                 | 40.5                               | 1.20                            | 8.19    | 8.19    | 8.19    | 0.29               | 0.92                    | ± 12.0 %  |
| 1750                 | 40.1                               | 1.37                            | 8.39    | 8.39    | 8.39    | 0.25               | 0.88                    | ± 12.0 %  |
| 1900                 | 40.0                               | 1.40                            | 8.11    | 8.11    | 8.11    | 0.39               | 0.80                    | ± 12.0 %  |
| 1950                 | 40.0                               | 1.40                            | 7.90    | 7.90    | 7.90    | 0.38               | 0.86                    | ± 12.0 %  |
| 2300                 | 39.5                               | 1.67                            | 7.73    | 7.73    | 7.73    | 0.37               | 0.84                    | ± 12.0 %  |
| 2450                 | 39.2                               | 1.80                            | 7.42    | 7.42    | 7.42    | 0.40               | 0.80                    | ± 12.0 %  |
| 2600                 | 39.0                               | 1.96                            | 7.17    | 7.17    | 7.17    | 0.41               | 0.83                    | ± 12.0 %  |
| 3500                 | 37.9                               | 2.91                            | 7.69    | 7.69    | 7.69    | 0.94               | 0.63                    | ± 13.1 %  |
| 5200                 | 36.0                               | 4.66                            | 5.37    | 5.37    | 5.37    | 0.35               | 1.80                    | ± 13.1 %  |
| 5300                 | 35.9                               | 4.76                            | 5.04    | 5.04    | 5.04    | 0.40               | 1.80                    | ± 13.1 %  |
| 5500                 | 35.6                               | 4.96                            | 4.87    | 4.87    | 4.87    | 0.45               | 1.80                    | ± 13.1 %  |
| 5600                 | 35.5                               | 5.07                            | 4.65    | 4.65    | 4.65    | 0.50               | 1.80                    | ± 13.1 %  |
| 5800                 | 35.3                               | 5.27                            | 4.69    | 4.69    | 4.69    | 0.50               | 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.

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## 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>h</sup> (mm) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750                  | 55.5                               | 0.96                            | 9.92    | 9.92    | 9.92    | 0.22               | 1.41                    | ± 12.0 %  |
| 835                  | 55.2                               | 0.97                            | 9.76    | 9.76    | 9.76    | 0.24               | 1.28                    | ± 12.0 %  |
| 1750                 | 53.4                               | 1.49                            | 8.04    | 8.04    | 8.04    | 0.40               | 0.85                    | ± 12.0 %  |
| 1900                 | 53.3                               | 1.52                            | 7.95    | 7.95    | 7.95    | 0.35               | 0.92                    | ± 12.0 %  |
| 2450                 | 52.7                               | 1.95                            | 7.31    | 7.31    | 7.31    | 0.40               | 0.86                    | ± 12.0 %  |
| 2600                 | 52.5                               | 2.16                            | 7.19    | 7.19    | 7.19    | 0.25               | 1.05                    | ± 12.0 %  |
| 3500                 | 51.3                               | 3.31                            | 6.86    | 6.86    | 6.86    | 0.36               | 1.14                    | ± 13.1 %  |
| 5200                 | 49.0                               | 5.30                            | 4.32    | 4.32    | 4.32    | 0.55               | 1.90                    | ± 13.1 %  |
| 5300                 | 48.9                               | 5.42                            | 4.23    | 4.23    | 4.23    | 0.55               | 1.90                    | ± 13.1 %  |
| 5500                 | 48.6                               | 5.65                            | 3.80    | 3.80    | 3.80    | 0.60               | 1.90                    | ± 13.1 %  |
| 5600                 | 48.5                               | 5.77                            | 3.70    | 3.70    | 3.70    | 0.60               | 1.90                    | ± 13.1 %  |
| 5800                 | 48.2                               | 6.00                            | 3.82    | 3.82    | 3.82    | 0.60               | 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.

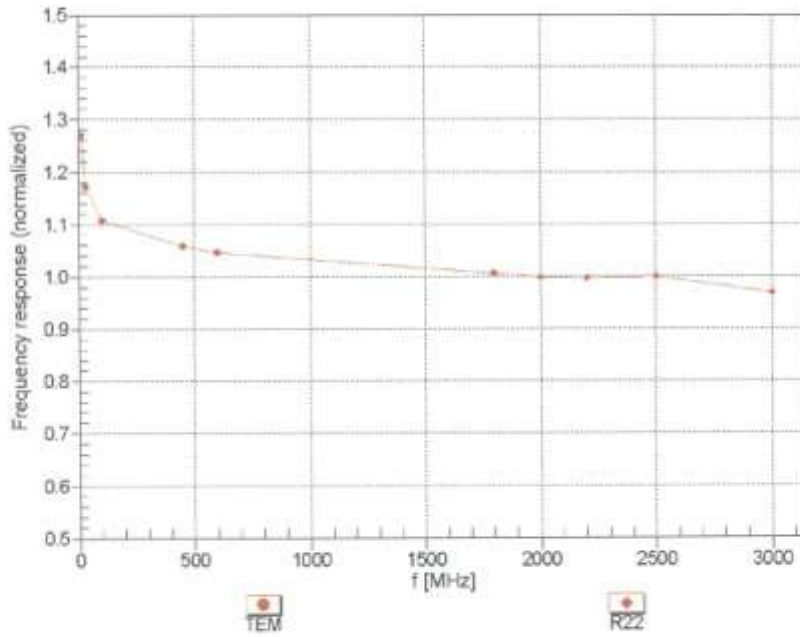
<sup>f</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted 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:3967

December 16, 2015

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

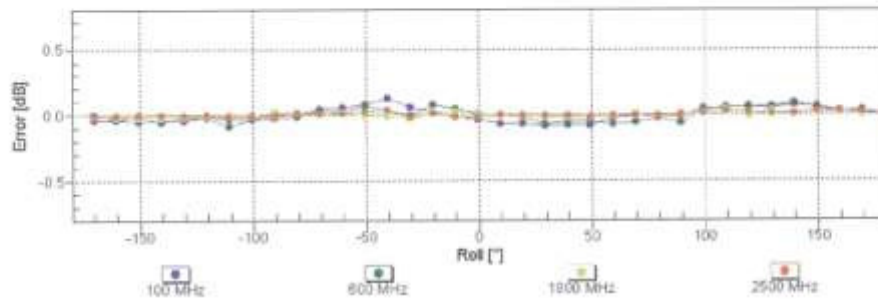
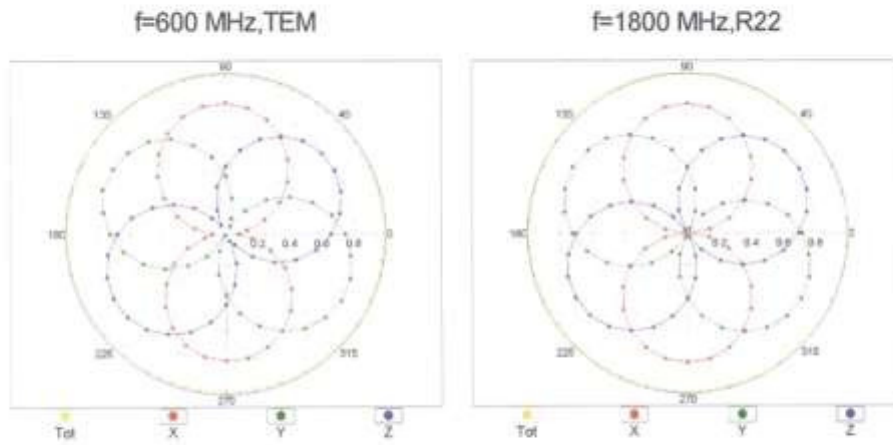


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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December 16, 2015

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

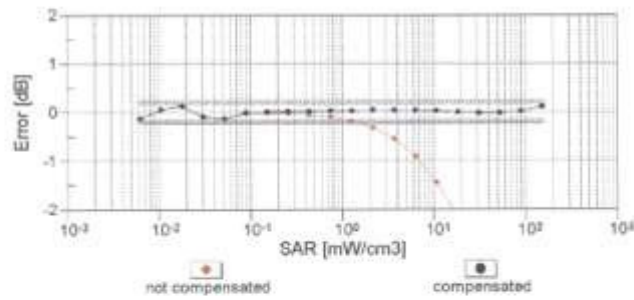
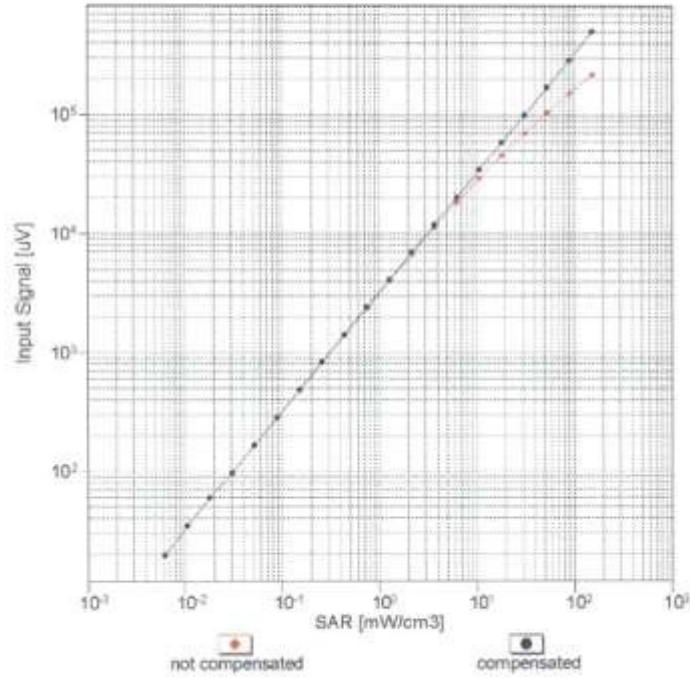


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

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December 16, 2015

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

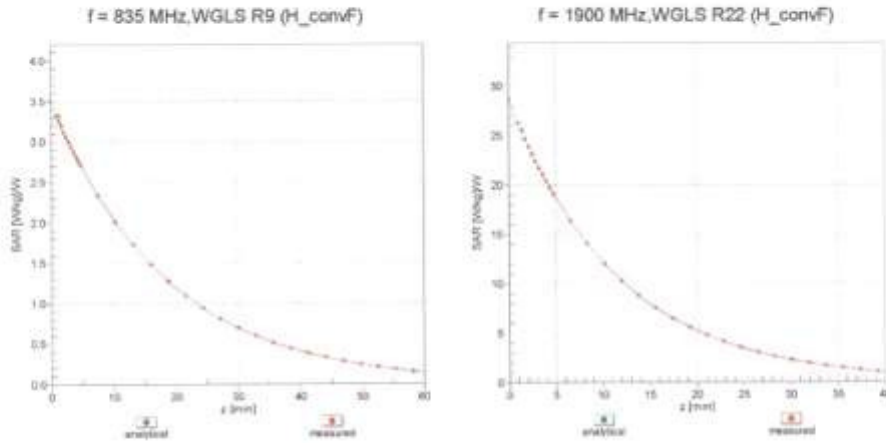


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

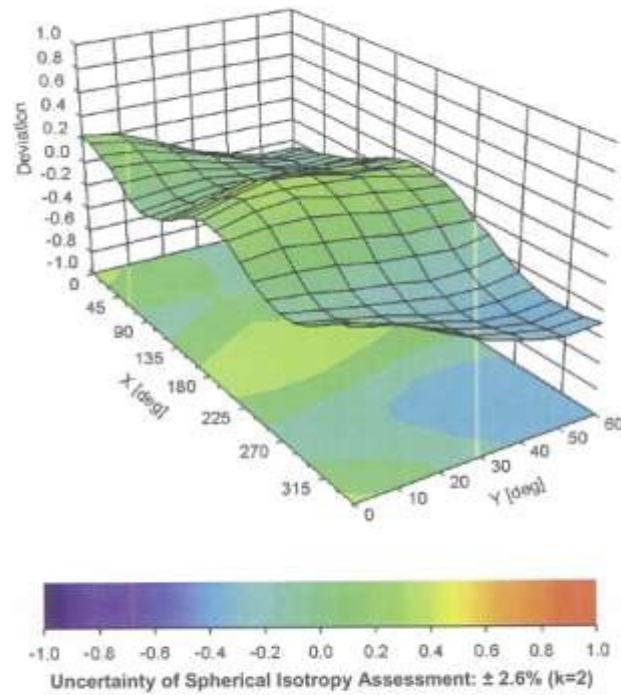
EX3DV4- SN:3967

December 16, 2015

### Conversion Factor Assessment



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



EX3DV4- SN:3967

December 16, 2015

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

### Other Probe Parameters

|   |            |
|---|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -20.6      |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 9 mm       |
| Tip Diameter                                  | 2.5 mm     |
| Probe Tip to Sensor X Calibration Point       | 1 mm       |
| Probe Tip to Sensor Y Calibration Point       | 1 mm       |
| Probe Tip to Sensor Z Calibration Point       | 1 mm       |
| Recommended Measurement Distance from Surface | 1.4 mm     |



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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 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 ± 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      | 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: S5054 (3c)  | 01-Apr-15 (No. 217-02129)         | Mar-16                 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 01-Apr-15 (No. 217-02132)         | Mar-16                 |
| Reference 30 dB Attenuator | SN: S5129 (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 8649C      | 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 Pkovic   | Technical Manager     |           |

Issued: June 18, 2015

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

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
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Accreditation No.: **SCS 0108**

**Glossary:**

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|------------------------|---|
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| 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  |
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- **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.
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- **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: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!)

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>D</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>D</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>f</sup> | Conductivity (Sim) <sup>f</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>g</sup> | Depth <sup>h</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 61.9                               | 0.80                            | 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, 125, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

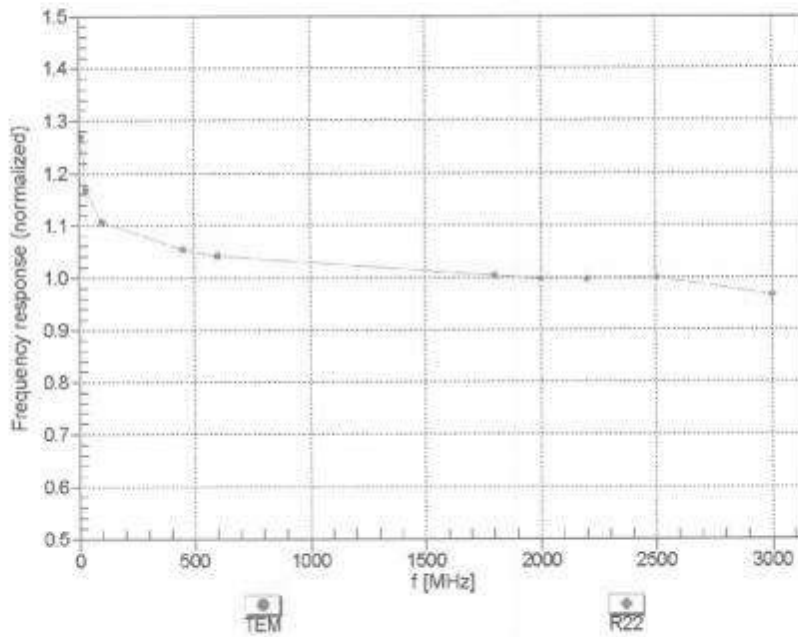
<sup>f</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted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

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



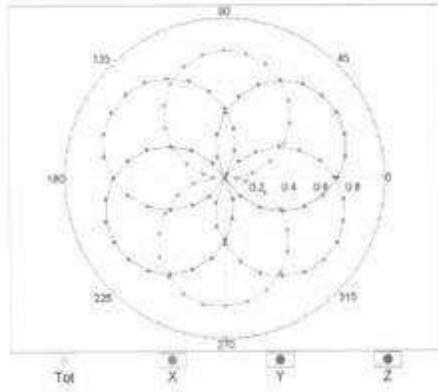
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

EX3DV4- SN:3968

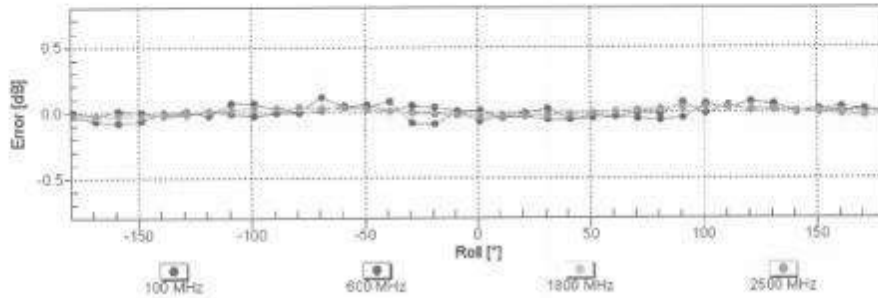
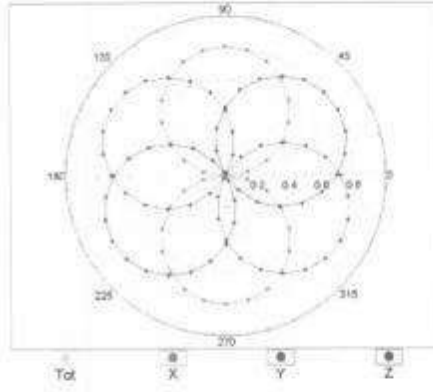
June 18, 2015

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

f=600 MHz,TEM



f=1800 MHz,R22



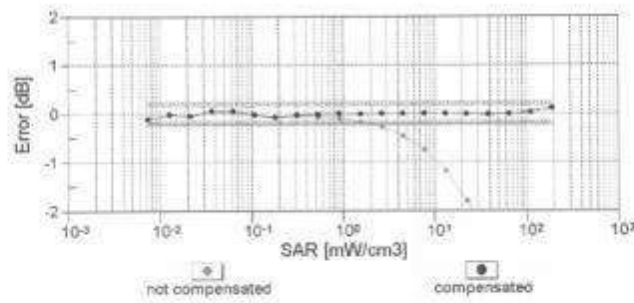
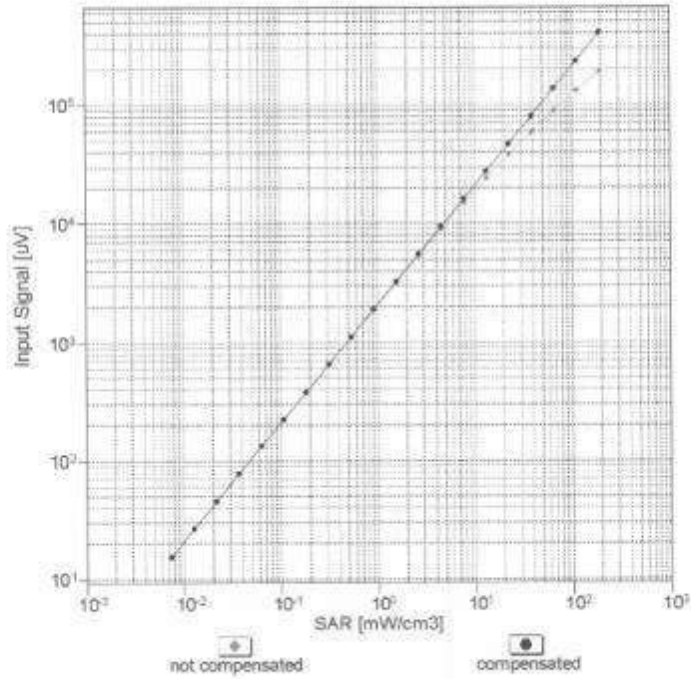
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)



EX3DV4- SN:3968

June 18, 2015

**Dynamic Range  $f(SAR_{head})$**   
(TEM cell,  $f_{eval}=1900$  MHz)

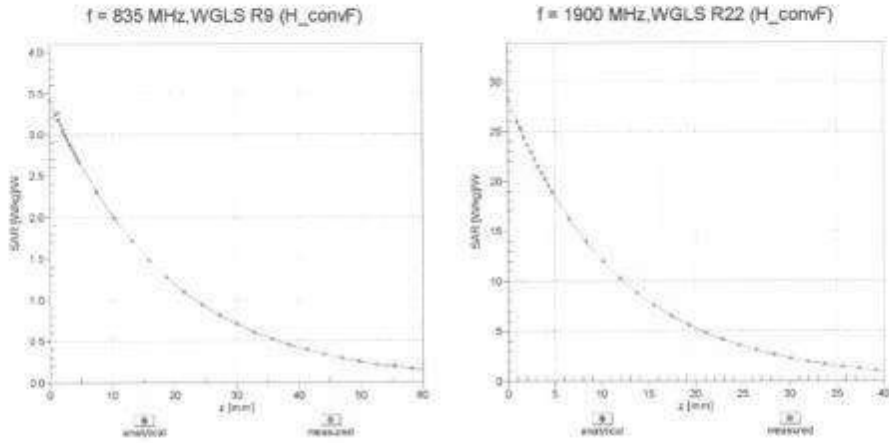


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

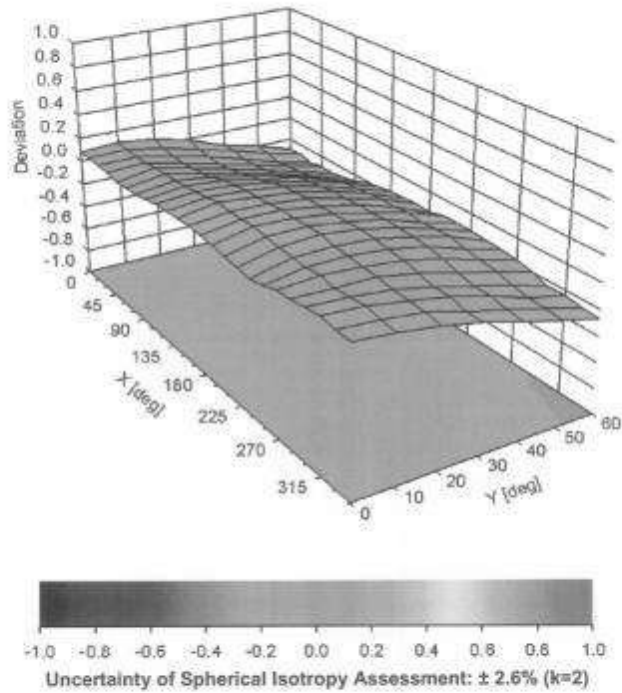
EX3DV4- SN:3968

June 18, 2015

### Conversion Factor Assessment



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



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

**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**

Client **HCT (Dymstec)**

Certificate No: **D835V2-4d165\_Nov15**

**CALIBRATION CERTIFICATE**

Object: **D835V2 - SN: 4d165**

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

Calibration date: **November 24, 2015**

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

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

Calibration Equipment used (M&E critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)     | Scheduled Calibration |
|-----------------------------|--------------------|--------------------------------|-----------------------|
| Power meter EPM-442A        | GB37480704         | 07-Oct-15 (No. 217-02222)      | Oct-16                |
| Power sensor HP 8481A       | US37292783         | 07-Oct-15 (No. 217-02222)      | Oct-16                |
| Power sensor HP 8481A       | MY41092317         | 07-Oct-15 (No. 217-02223)      | Oct-16                |
| 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 EX3QV4      | SN: 7349           | 30-Dec-14 (No. EK3-7349_Dec14) | Dec-15                |
| DAE4                        | SN: 601            | 17-Aug-15 (No. DAE4-601_Aug15) | Aug-16                |

| Secondary Standards       | ID #             | Check Date (in house)             | Scheduled Check        |
|---------------------------|------------------|-----------------------------------|------------------------|
| RF generator R&S SMT-06   | 100972           | 15-Jun-15 (in house check Jun-15) | In house check: Jun-16 |
| Network Analyzer HP 8753E | US37390565 S4206 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

Calibrated by: **Name: Michael Weber, Function: Laboratory Technician, Signature: M. Weber**

Approved by: **Name: Katja Pokovic, Function: Technical Manager, Signature: K. Pokovic**

Issued: November 24, 2015

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

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



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**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
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- 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 ± 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 ± 0.2) °C | 42.6 ± 6 %   | 0.92 mho/m ± 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 | 2.29 W/kg                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 9.06 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                          |
|---|--------------------|--------------------------|
| SAR measured  | 250 mW input power | 1.49 W/kg                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 5.90 W/kg ± 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 ± 0.2) °C | 55.6 ± 6 %   | 0.99 mho/m ± 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   | 9.47 W/kg ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
|---|--------------------|--------------------------|
| SAR measured  | 250 mW input power | 1.58 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 6.25 W/kg ± 16.5 % (k=2) |

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

**Antenna Parameters with Head TSL**

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 52.1 $\Omega$ - 4.7 $j\Omega$ |
| Return Loss                          | - 26.0 dB                     |

**Antenna Parameters with Body TSL**

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 47.8 $\Omega$ - 6.8 $j\Omega$ |
| Return Loss                          | - 22.7 dB                     |

**General Antenna Parameters and Design**

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

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

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

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

**Additional EUT Data**

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



**DASY5 Validation Report for Head TSL**

Date: 24.11.2015

Test Laboratory: SPEAG, Zurich, Switzerland

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

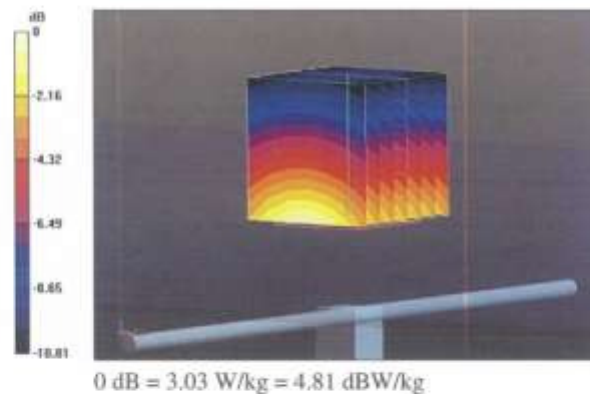
Communication System: UID 0 - CW; Frequency: 835 MHz  
Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.92$  S/m;  $\epsilon_r = 42.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

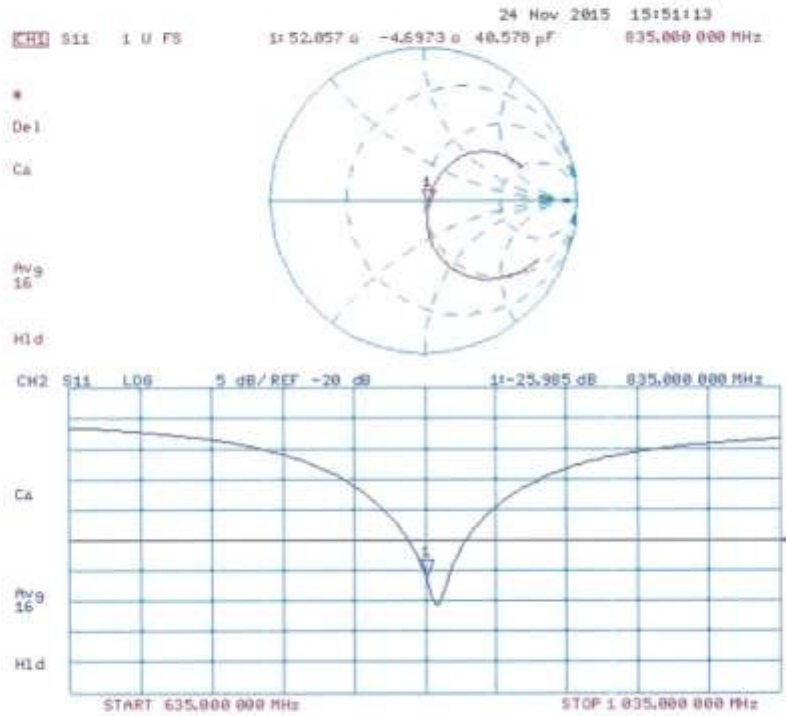
- Probe: EX3DV4 - SN7349; ConvF(9.77, 9.77, 9.77); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm  
Reference Value = 60.39 V/m; Power Drift = 0.02 dB  
Peak SAR (extrapolated) = 3.40 W/kg  
**SAR(1 g) = 2.29 W/kg; SAR(10 g) = 1.49 W/kg**  
Maximum value of SAR (measured) = 3.03 W/kg



Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 24.11.2015

Test Laboratory: SPEAG, Zurich, Switzerland

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

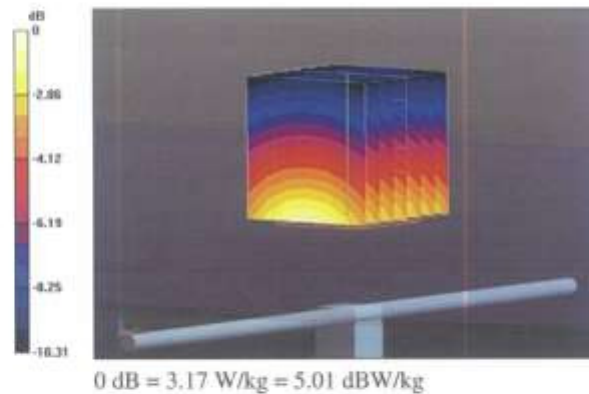
Communication System: UID 0 - CW; Frequency: 835 MHz  
Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.99$  S/m;  $\epsilon_r = 55.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

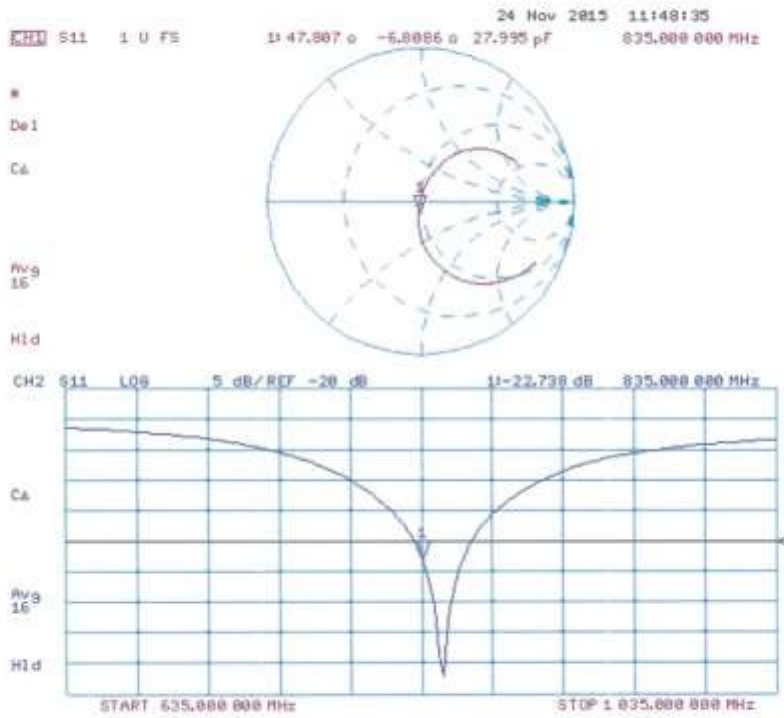
- Probe: EX3DV4 - SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 61.95 V/m; Power Drift = -0.02 dB  
Peak SAR (extrapolated) = 3.54 W/kg  
**SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.58 W/kg**  
Maximum value of SAR (measured) = 3.17 W/kg



Impedance Measurement Plot for Body TSL



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



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**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**

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 ± 3)°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-15 |
| Network Analyzer HP 8753E   | US37390595 S4206   | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

|                | Name          | Function              | Signature |
|----------------|---------------|-----------------------|-----------|
| Calibrated by: | Leif Klyzner  | Laboratory Technician |           |
| Approved by:   | Katja Pokovic | Technical Manager     |           |

Issued: May 20, 2015

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

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Engineering AG**  
Zeughausstrasse 43, 8004 Zurich, Switzerland



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**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 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:**

- a) 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
- b) 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
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- d) 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 ± 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 ± 0.2) °C | 38.9 ± 6 %   | 1.37 mho/m ± 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 ± 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 ± 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 ± 0.2) °C | 52.7 ± 6 %   | 1.51 mho/m ± 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 ± 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 ± 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:**

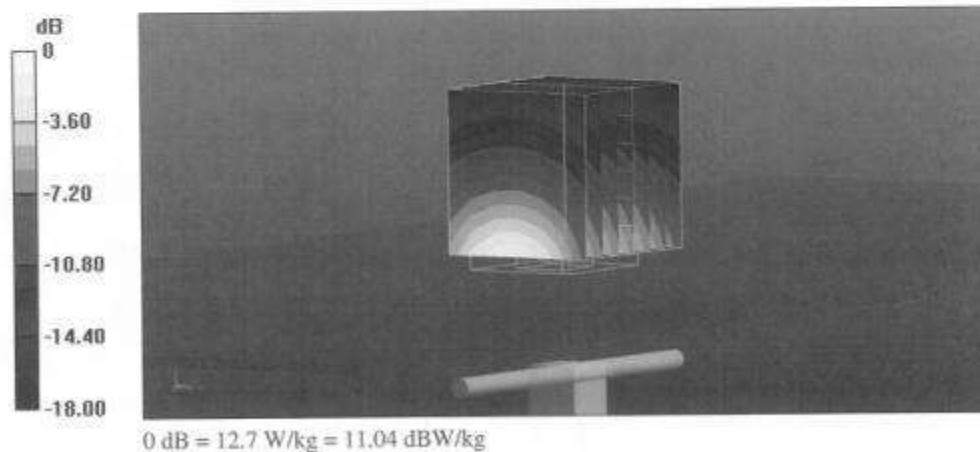
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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

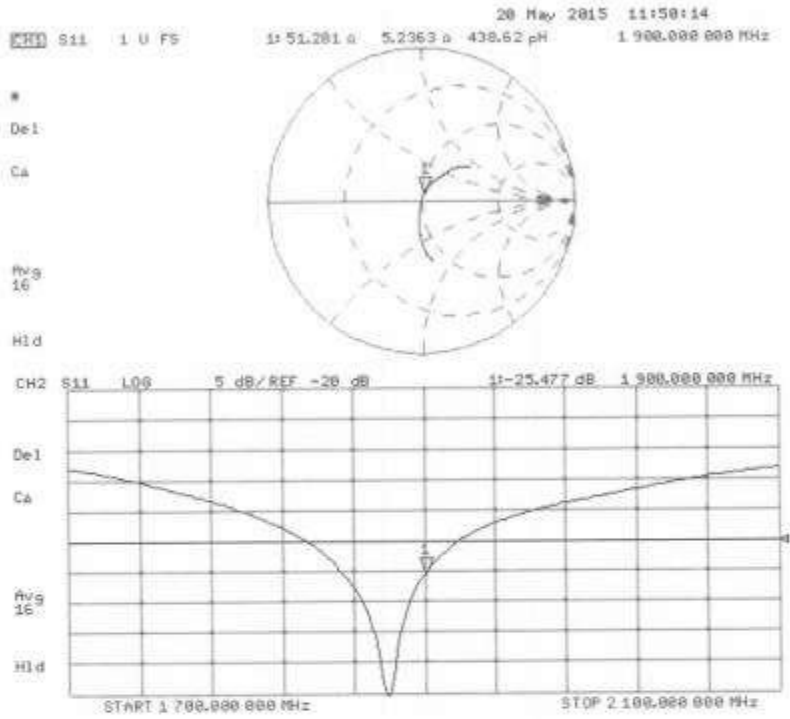
Peak SAR (extrapolated) = 18.6 W/kg

**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**

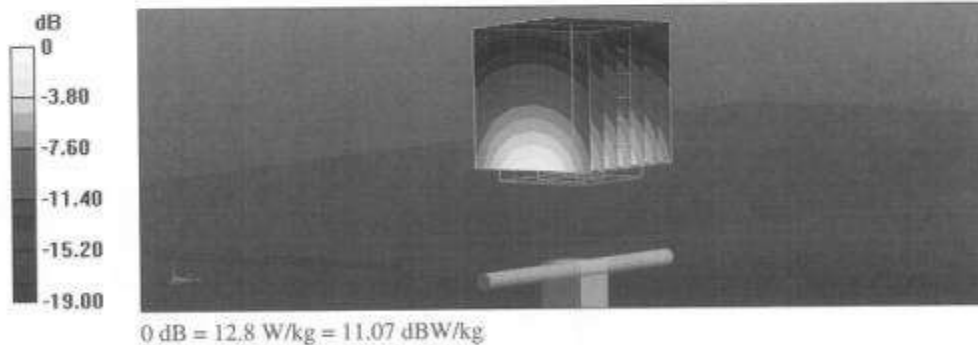
Communication System: UID 0 - CW; Frequency: 1900 MHz  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.51$  S/m;  $\epsilon_r = 52.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

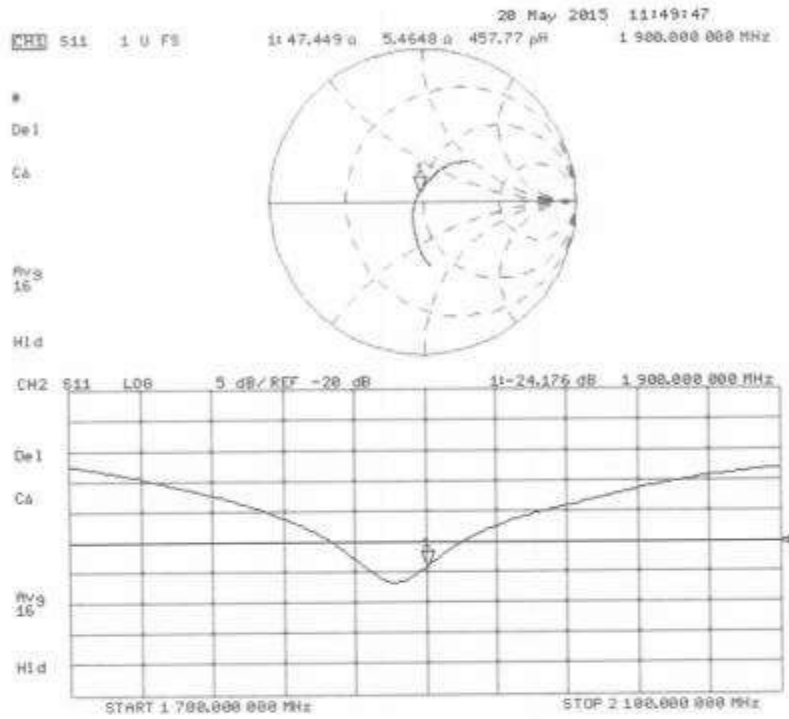
- Probe: ES3DV3 - SN3205; ConvF(4.65, 4.65, 4.65); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**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



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 ± 3)°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 / 05327 | 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: Michael Weber, Function: Laboratory Technician, Signature: M. Weber**

Approved by: **Name: Katja Pokovic, Function: Technical Manager, Signature: K. Pokovic**

Issued: May 20, 2015

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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:**

- a) 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
- b) 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
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- d) 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 ± 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 ± 0.2) °C | 37.9 ± 6 %   | 1.84 mho/m ± 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 ± 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 ± 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 ± 0.2) °C | 50.7 ± 6 %   | 2.03 mho/m ± 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 ± 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 ± 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**

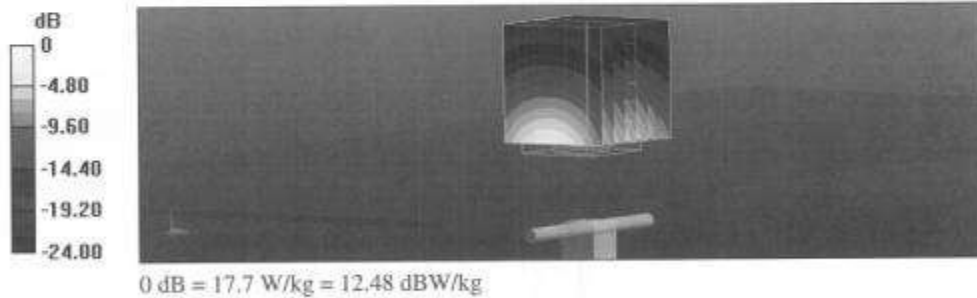
Communication System: UID 0 - CW; Frequency: 2450 MHz  
Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.84$  S/m;  $\epsilon_r = 37.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

**DASY52 Configuration:**

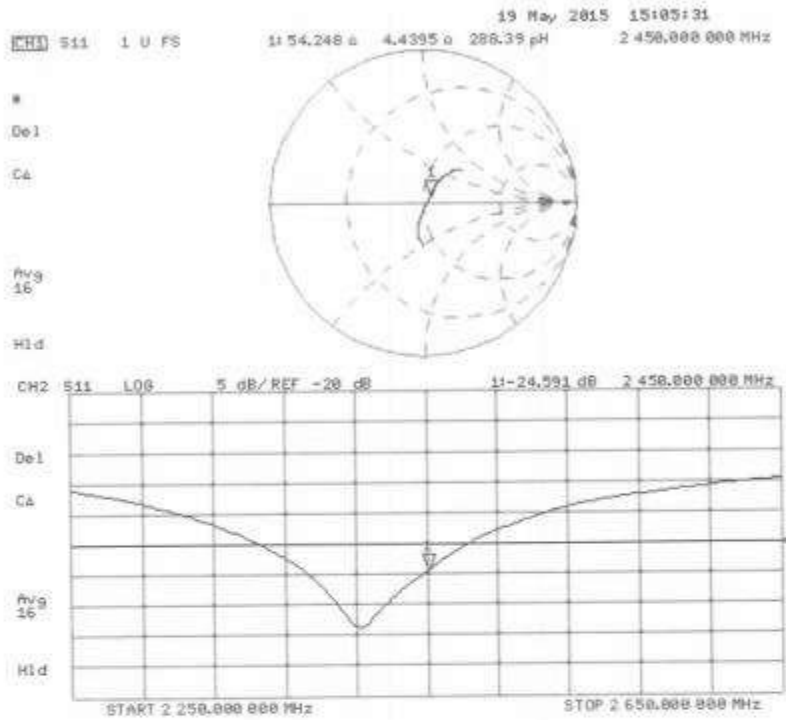
- Probe: ES3DV3 - SN3205; ConvF(4.54, 4.54, 4.54); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**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**

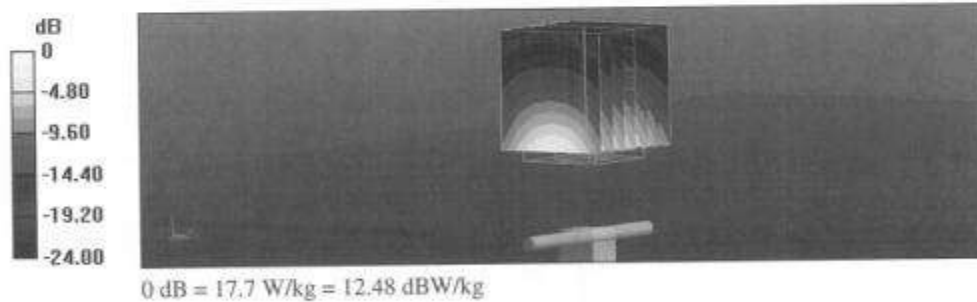
Communication System: UID 0 - CW; Frequency: 2450 MHz  
Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 50.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

**DASY52 Configuration:**

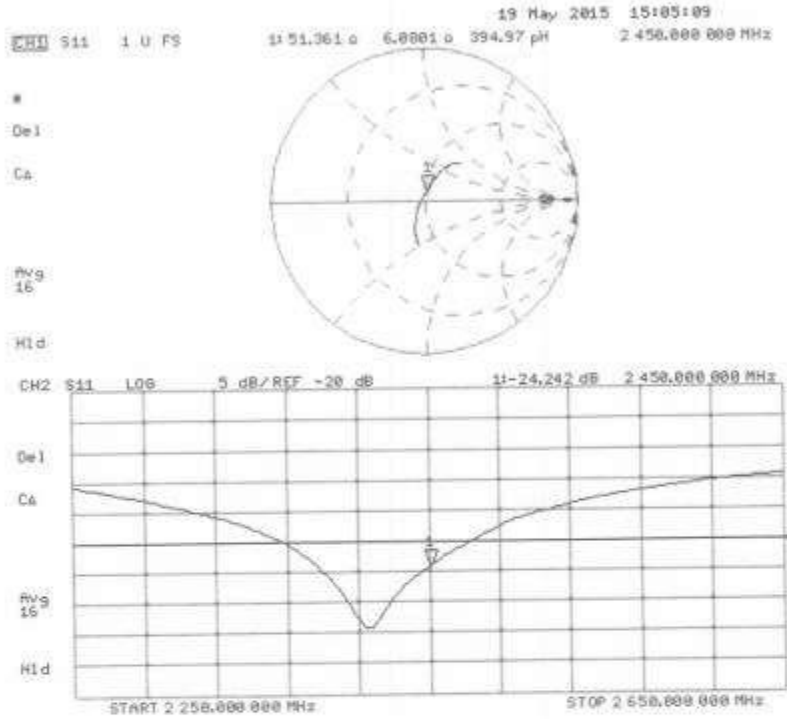
- Probe: ES3DV3 - SN3205; ConvF(4.32, 4.32, 4.32); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**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



**Impedance Measurement Plot for Body TSL**



## Attachment 5. – SAR Tissue 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. Hartsgrove.

| 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 |        |                        |

### Composition of the Tissue Equivalent Matter

## Attachment 6. – SAR SYSTEM VALIDATION

Per FCC KCB 865664 D02v01r02, 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 1528-2013 and FCC KDB 865664 D01v01r04. 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 No. | 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 |
| 8              | 3967  | EX3DV4     | Head                    | 835  | 4d165 | 12/28/2015 | 41.2 | 0.9                   | PASS                  | PASS          | PASS            | GMSK           | PASS                  | N/A         |
| 8              | 3967  | EX3DV4     | Body                    | 835  | 4d165 | 12/30/2015 | 55.1 | 0.98                  | PASS                  | PASS          | PASS            | GMSK           | PASS                  | N/A         |
| 8              | 3967  | EX3DV4     | Head                    | 1900 | 5d032 | 12/28/2015 | 40.3 | 1.41                  | PASS                  | PASS          | PASS            | GMSK           | PASS                  | N/A         |
| 8              | 3967  | EX3DV4     | Body                    | 1900 | 5d032 | 12/30/2015 | 53.1 | 1.53                  | PASS                  | PASS          | PASS            | GMSK           | PASS                  | N/A         |
| 9              | 3968  | EX3DV4     | Head                    | 2450 | 743   | 06/29/2015 | 38.8 | 1.81                  | PASS                  | PASS          | PASS            | OFDM           | N/A                   | PASS        |
| 9              | 3968  | EX3DV4     | Body                    | 2450 | 743   | 07/01/2015 | 52.9 | 1.98                  | PASS                  | PASS          | PASS            | OFDM           | N/A                   | PASS        |

**SAR System Validation Summary 1g**

**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 D01v01r04. 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 D01v01r04.