# FCC SAR TEST REPORT

**Test File No : F690501/RF-SAR002194-A1**

| | |
|---|---|
| **Equipment Under Test** | Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN |
| **Model No.** | LG-D724 |
| **Alternative models** | LGD724, D724, LG-D723, LGD723, D723, LG-D723AR, LGD723AR, D723AR |
| **Applicant** | LG Electronics MobileComm U.S.A., Inc. |
| **Address of Applicant** | 10101 Old Grove Road, San Diego, CA 92131 |
| **FCC ID** | ZNFD724 |
| **Device Category** | Portable Device |
| **Exposure Category** | General Population/Uncontrolled Exposure |
| **Standards** | FCC 47 CFR Part 2 (2.1093)<br>IEEE 1528, 2003<br>ANSI/IEEE C95.1, C95.3 |
| **Date of Test(s)** | 2014-05-22 ~ 2014-07-03 |
| **Date of Issue** | 2014-07-04 |

In the configuration tested, the EUT complied with the standards specified above.

**Remarks:**

This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.
This report may only be reproduced and distributed in full. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS Korea Co., Ltd. or testing done by SGS Korea Co., Ltd. in connection with distribution or use of the product described in this report must be approved by SGS Korea Co., Ltd. in writing.

**Report prepared by /**
**Jongwon Ma**
**Test Engineer**

**Approved by /**
**Nicky You**
**Technical Manager**

# Revision history

| Revision | Date of issue | Revisions | Revised By |
|---|---|---|---|
| - | June 27, 2014 | Initial issue | - |
| A1 | July 04, 2014 | - Section 14. Added to the note.<br>- Added SAR test the GPRS850 3-slot data (head and hotspot).<br>- SAR exclusions table updated.<br>- Section 23.4 and 23.5 Simultaneous Transmission updated.<br>- Section 21.2 WCDMA1900 data table updated.. | Jongwon Ma |

# Contents

## 1. Testing Laboratory

| | |
|---|---|
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| **Homepage** | All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at http://www.sgs.com/en/Terms-and-Conditions.aspx |

## 2. Details of Manufacturer

| | |
|---|---|
| **Applicant** | LG Electronics MobileComm U.S.A., Inc. |
| **Address** | 10101 Old Grove Road, San Diego, CA 92131 |
| **Contact Person** | Smyung-Lee |
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## 3. Description of EUT(s)

| | |
|---|---|
| **EUT Type** | Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN |
| **Model** | LG-D724 |
| **Alternative models** | LGD724, D724, LG-D723, LGD723, D723, LG-D723AR, LGD723AR, D723AR |
| **Serial Number** | 404KPCA642467 |
| **Mode of Operation** | GSM850 / GSM1900 / WCDMA850 / WCDMA1900 / WLAN / Bluetooth |
| **Duty Cycle** | 8.3(GPRS 1Tx Slot), 4.15(GPRS 2Tx Slot), 2.77 (GPRS 3Tx Slot),<br>2.075 (GPRS 4Tx Slot), 1 (WCDMA, WLAN) |
| **Body worn Accessory** | None |
| **Tx Frequency Range** | GSM850 (824.20 MHz ~ 848.80 MHz)<br>GSM1900 (1850.20 MHz ~ 1909.80 MHz)<br>WCDMA 850 (826.40 MHz ~ 846.60 MHz)<br>WCDMA 1900 (1852.40 MHz ~ 1907.60 MHz)<br>802.11b/g/n WLAN 2.4 GHz ( 2412.0 MHz ~ 2462.0 MHz)<br>Bluetooth ( 2402.0 MHz ~ 2480.0 MHz) |

## 4. The Highest Reported SAR Values

| Equipment Class | Band | Tx Frequency (MHz) | Reported 1g SAR (W/kg) | | |
|---|---|---|---|---|---|
| | | | Head | Body-Worn | Hotspot |
| **PCE** | GSM/GPRS850 | 824.2 ~ 848.8 | 0.28 | 0.42 | 0.53 |
| **PCE** | GSM/GPRS1900 | 1850.2 ~ 1909.8 | 0.31 | 0.40 | 0.39 |
| **PCE** | WCDMA 850 | 826.4 ~ 846.6 | 0.15 | 0.23 | 0.23 |
| **PCE** | WCDMA 1900 | 1852.4 ~ 1907.6 | 0.65 | 1.07 | 1.08 |
| **DTS** | 2.4 GHz WLAN | 2412.0 ~ 2462.0 | 0.33 | 0.07 | 0.07 |
| **DSS** | Bluetooth | 2402.0 ~ 2480.0 | N/A | N/A | N/A |
| Simultaneous SAR per KDB 690783 D01v01r03 | | | 1.03 | 1.26 | 1.15 |

## 5. Test Methodology

ANSI C95.1–1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. It specifies the maximum exposure limit of 1.6 W/kg as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

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

In additions;

| | | |
|---|---|---|
| ☒ | **KDB 865664 D01v01r03** | **SAR Measurement Requirements for 100 MHz to 6 GHz** |
| ☒ | **KDB 447498 D01v05r02** | **Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies** |
| ☐ | KDB 447498 D02v02 | SAR Measurement Procedures for USB Dongle Transmitters |
| ☒ | **KDB 248227 D01v01r02** | **SAR Measurement Procedures for 802.11a,b,g Transmitters** |
| ☐ | KDB 615223 D01v01 | 802.16e/WiMax SAR Measurement Guidance |
| ☐ | KDB 616217 D04v01r01 | SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers |
| ☐ | KDB 643646 D01v01r01 | SAR Test Reduction Considerations for Occupational PTT Radios |
| ☐ | KDB 648474 D03v01r02 | Evaluation and Approval Considerations for Handsets with Specific Wireless Charging Battery Covers |
| ☒ | **KDB 648474 D04v01r02** | **SAR Evaluation Considerations for Wireless Handsets** |
| ☐ | KDB 680106 D01v02 | RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications |
| ☒ | **KDB 941225 D01v02** | **SAR Measurement Procedures for 3G Devices (CDMA 2000 / Ev-Do, WCDMA/HSDPA/HSPA)** |
| ☒ | **KDB 941225 D02v02r02** | **SAR Guidance for HSPA, HSPA+, DC-HSDPA and 1x-Advanced** |
| ☒ | **KDB 941225 D03v01** | **Recommended SAR Test Reduction Procedures for GSM/GPRS/EDGE** |
| ☐ | KDB 941225 D04v01 | Evaluating SAR for GSM/(E)GPRS Dual Transfer Mode |
| ☐ | KDB 941225 D05v02r03 | SAR Evaluation Considerations for LTE Devices |
| ☒ | **KDB 941225 D06v01r01** | **SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities** |
| ☐ | KDB 941225 D07v01r01 | SAR Evaluation Procedures for UMPC Mini-Tablet Devices |

## 6. Testing Environment

| | |
|---|---|
| Ambient temperature | 18°C ~ 25°C |
| Relative humidity | 30% ~ 70% |
| Liquid temperature of during the test | <± 2°C |
| Ambient noise & Reflection | < 0.012 W/kg |

# 7. Specific Absorption Rate (SAR)

## 7.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled

## 7.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$\mathrm{SAR} = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dv}\right)$$

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

SAR measurement can be either related to the temperature elevation in tissue by

$$\mathrm{SAR} = C\left(\frac{\delta T}{\delta t}\right)$$

Where: C is the specific head capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

## 7.3 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate ("SAR") in Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 ㎑ to 300 ㎓," ANSI/IEEE C95.3–2003, Copyright 2003 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. 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, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 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. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 ㎑ to 6 ㎓. Portable devices that transmit at frequencies above 6 ㎓ are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 ㎓ should be made at a minimum distance of 5 cm from the radiating source.

(1) Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over an 10 grams of tissue (defined as a tissue volume in the shape of a cube). Occupational/Controlled limits apply when persons are exposed as a consequence of their employment provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment.

(2) Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not exercise control over their exposure. Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure in paragraph (d)(1) of this section.

| Human Exposure | Uncontrolled Environment General Population | Controlled Environment Occupational |
|---|---|---|
| **Partial Peak SAR** (Partial) | 1.60 m W/g | 8.00 m W/g |
| **Partial Average SAR** (Whole Body) | 0.08 m W/g | 0.40 m W/g |
| **Partial Peak SAR** (Hands/Feet/Ankle/Wrist) | 4.00 m W/g | 20.00 m W/g |

1. The spatial Peak value of the SAR averaged over any 1g gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

## 8. The SAR Measurement System

A block diagram of the SAR measurement System is given in Fig. a. This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (SPEAG DASY 5 professional system). The model EX3DV4 field probe is used to determine the internal electric fields. The SAR can be obtained from the equation SAR= $\sigma\ (|Ei|^2)/\ \rho$ where $\sigma$ and $\rho$ are the conductivity and mass density of the tissue-simulant.

The DASY 5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Staubli TX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
- A dosimeter probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- Data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

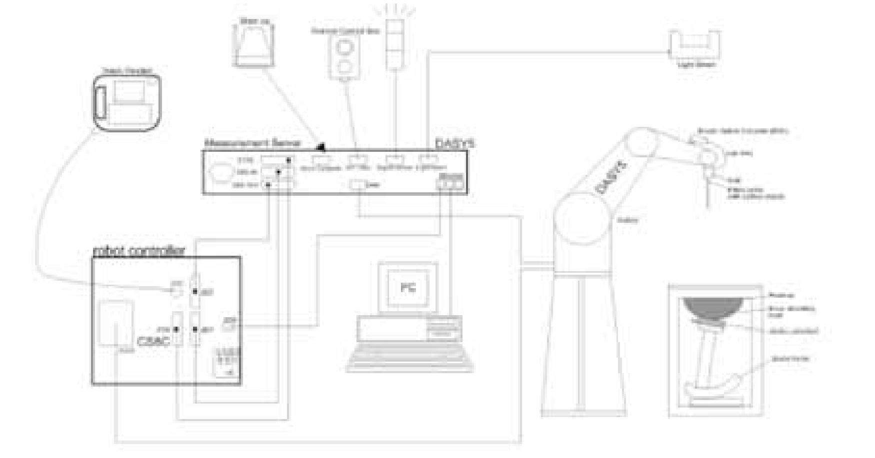



Fig a. The microwave circuit arrangement used for SAR system verification

- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows7
- DASY 5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM phantom enabling testing left-hand and right-hand usage.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

# 9. System Components

## 9.1 Probe

EX3DV4 E-Field Probe

| | | |
|---|---|---|
| **Construction** | : | Symmetrical design with triangular core.<br>Built-in shielding against static charges.<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| **Calibration** | : | Basic Broad Band Calibration in air Conversion Factors (CF) for HSL 835 and HSL1900.<br>Additional CF-Calibration for other liquids and frequencies upon request. |
| **Frequency** | : | 10 ㎒ to 6 ㎓; Linearity: ± 0.2 ㏈ (30 ㎒ to 6 ㎓) |
| **Directivity** | : | ± 0.3 ㏈ in HSL (rotation around probe axis)<br>± 0.5 ㏈ in tissue material (rotation normal to probe axis) |
| **Dynamic Range** | : | 10µW/g to > 100 m W/g;<br>Linearity: ± 0.2 ㏈(noise: typically < 1 µW/g) |
| **Dimensions** | : | Overall length: 337 ㎜ (Tip length: 20 ㎜)<br>Tip diameter: 2.5 ㎜ (Body diameter: 12 ㎜)<br>Distance from probe tip to dipole centers: 1 ㎜ |
| **Application** | : | High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 ㎓ with precision of better 30% |
| **Construction** | : | Symmetrical design with triangular core.<br>Built-in shielding against static charges.<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |

**NOTE:**

1. The Probe parameters have been calibrated by the SPEAG. Please reference "APPENDIX C" for the Calibration Certification Report.

## 9.2 SAM Phantom

SAM Phantom

| | | |
|---|---|---|
| Construction | : | The SAM Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90 % of all users. 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 the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot |
| Shell Thickness | : | 2.0 ㎜ ± 0.1 ㎜ |
| Filling Volume | : | Approx. 25 liters |

### 9.3 Device Holder

Construction: **:** In combination with the Twin SAM PhantomV4.0/V4.0C or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

Device Holder

## 10. SAR Measurement Procedures

### 10.1 Normal SAR Measurement Procedure

**Step 1: Power Reference Measurement**

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2 ㎜. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

**Step 2 and 3: Area Scan & Zoom Scan Procedures**

The entire evaluation of the spatial peak values is performed within the Post-processing engine (SEMCAD). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

1. The extraction of the measured data (grid and values) from the Zoom Scan.
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. The generation of a high-resolution mesh within the measured volume
4. The interpolation of all measured values from the measurement grid to the high-resolution grid
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. The calculation of the averaged SAR within masses of 1 g and 10 g.

**Step 4: Power drift measurement**

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

< Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r03 >

<table>
<tr><td colspan="3"></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: $\Delta x_{Area}$, $\Delta y_{Area}$</td><td>≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$</td><td>≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note: δ 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 <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 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.</td></tr>
</table>

# 11. Definition of Reference

## 11.1EAR Reference Point

Fig 2 shows the front, back and side views of the SAM Twin Phantom. The point "M" is the reference point for the center of the mouth, "LE" is the left ear reference point (ERP), and "RE" is the right ERP. The ERPs are 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Fig 3. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Fig 4). 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.

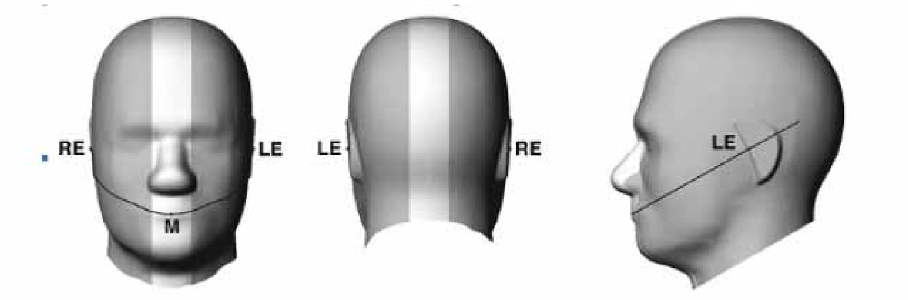



Fig 2 Front, back and side view of SAM Twin Phantom

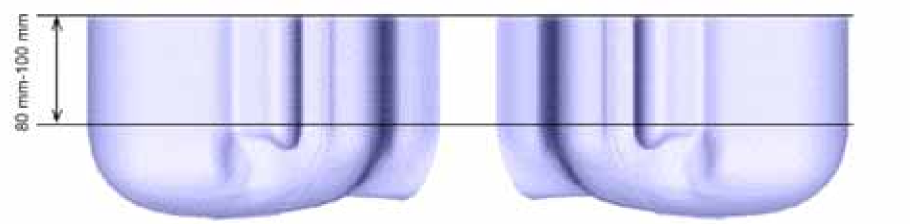



Fig 3 Sagittally bisected phantom with extended perimeter (shown placed on its side as used for device SAR tests)

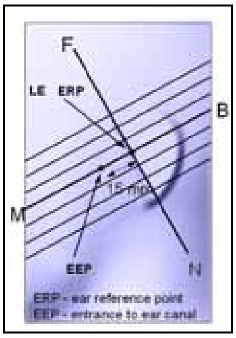



Fig 4 Close-up side view of ERP

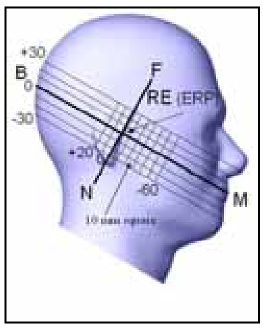



Fig 5 Side view of the phantom showing relevant markings

### 11.2 EUT constructions

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the "test device reference point" located along the "vertical centerline" on the front of the device aligned to the "ear reference point" (see Fig. 6). The "test device reference point" was than located at the same level as the center of the ear reference point. The test device was positioned so that the "vertical centerline" was bisecting the front surface of the handset at it's 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.

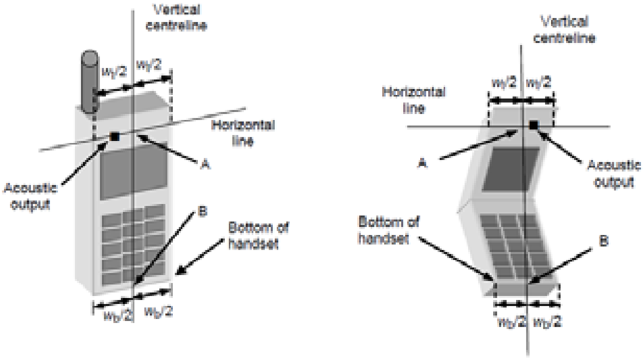



Fig 6 Handset Vertical Center & Horizontal Line Reference Points

### 11.3 Positioning for Touch

a) Position the device with the vertical centre line of the body of the device and the horizontal line crossing the centre of the ear piece in a plane parallel to the sagittal plane of the phantom (initial position). While maintaining the device in this plane, align the vertical centre line with the reference plane containing the three ear and mouth reference points (M, RE and LE) and align the centre of the ear piece with the line RE-LE;

b) Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear.

c) While maintaining the device in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane).

d) Rotate the phone around the vertical centerline until the phone (horizontal line) is ymmetrical with respect to the line NF.

e) While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the pinna (cheek). (see Fig. 7) The physical angles of rotation should be

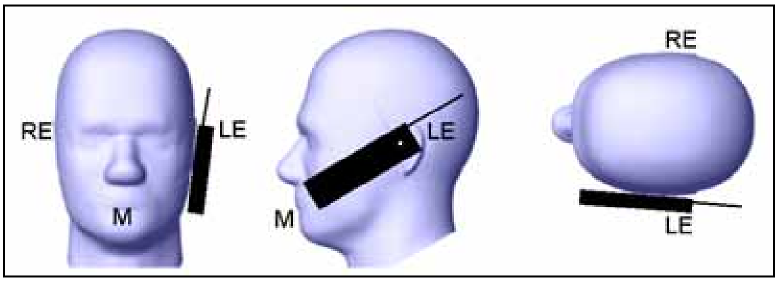



Fig 7 Cheek/Touch position of the wireless device on the left side of SAM

### 11.4 Positioning for Ear/15˚ Tilt

With the test device aligned in the "Cheek/Touch Position":

a) While maintain the device in the reference plane described above and pivoting against the ear, move it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost.

b) The phone was then rotated around the horizontal line by 15 degrees.

c) While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the handset touched the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. In this situation, the tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head (see Fig 8).

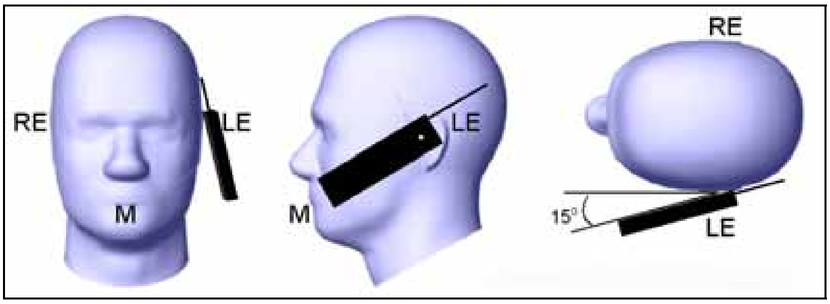



Fig 8 Ear/15˚ Tilt position of the wireless device on the left side of SAM

### 11.5 Body-Worn Accessory Configurations

Body-worn operation 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.

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 supplied with the device, the device is tested with each accessory that contains a unique metallic component. 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.

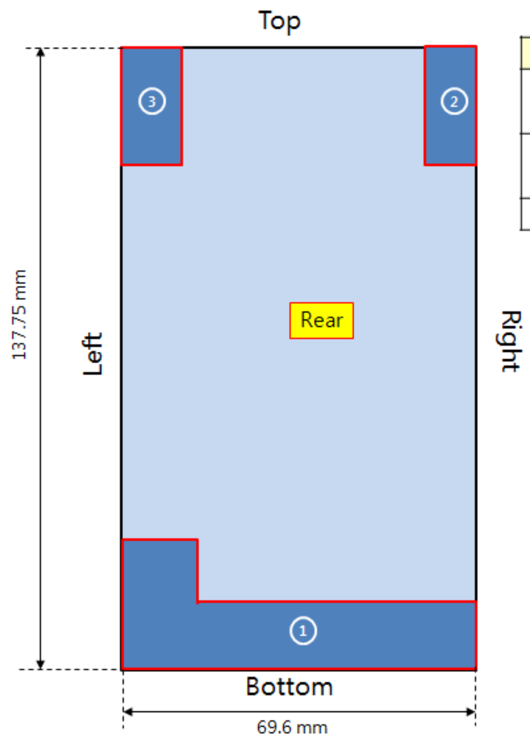
Body-worn accessories may not always be supplied of available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration where a separation distances between the back of the device and the flat phantom is used. Test position spacing was documented.

## 11.6 Wireless Router Configurations

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WLAN simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 v01r01 where SAR test considerations for handsets (L x W ≥ 9 cm x 5 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 WLAN 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 WLAN transmitter according to FCC KDB Publication 447498 D01v05r02 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.

## 11.7 DUT Antenna Locations




| Antenna | Mode | Band |
|---|---|---|
| ① | GSM | 850,1900MHz |
| | WCDMA | 850,1900MHz |
| ② | Wi-Fi | 2.4GHz |
| | Bluetooth | 2.4GHz |
| ③ | GPS | 1.57Ghz |

## 11.8 Mobile Hotspot sides for SAR Testing configurations

| Mode | Rear | Front | Left Edge | Right Edge | Bottom | Top |
|---|---|---|---|---|---|---|
| GPRS 850 | Yes | Yes | Yes | Yes | Yes | No |
| GPRS 1900 | Yes | Yes | Yes | Yes | Yes | No |
| WCDMA 850 | Yes | Yes | Yes | Yes | Yes | No |
| WCDMA 1900 | Yes | Yes | Yes | Yes | Yes | No |
| WLAN 2.4 GHz | Yes | Yes | No | Yes | No | Yes |

Notes

Particular DUT edges were not required to be evaluated for Wireless Router SAR if the edges were greater than 2.5 cm from the transmitting antenna according to FCC Publication 941225 D06v01r01 guidance, page 2. The antenna document shows the distances between the transmit antennas and the edges of the device.

## 12. SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig. 9. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% from the target SAR values. These tests were done at 835 MHz, 1900 MHz and 2.4 GHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1. (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the ambient temperature of the laboratory was in the range (22 ± 2) ° C, the relative humidity was in the range (55 ± 5) % R.H and the liquid depth above the ear reference points was ≥ 15 cm ± 5 mm (frequency ≤ 3 GHz) or ≥ 10 cm ± 5 mm (frequency > 3 G Hz)in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

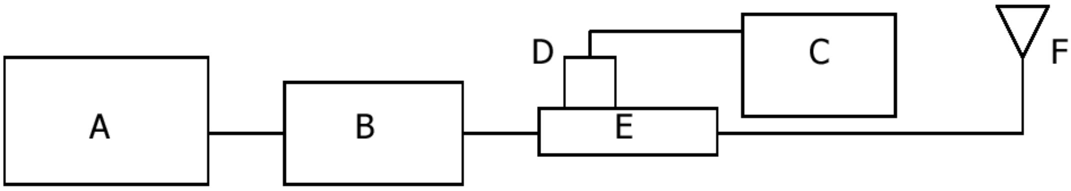



Fig 9. The microwave circuit arrangement used for SAR system verification

A. Agilent Model E8247C Signal Generator
B. EMPOWER Model 2001-BBS3Q7ECK Amplifier
C. Agilent Model E4419B Power Meter
D. Agilent Model 9300H Power Sensor
E. Agilent Model 86205A Directional RF Bridges
F. Reference dipole Antenna

Photo of the dipole Antenna

| Verification Kit | Probe S/N | Tissue (MHz) | Target SAR 1 g from Standard (1 W) | Target SAR 10 g from Standard (1 W) | Normalized SAR 1 g (1 W) | Normalized SAR 10 g (1 W) | 1g Deviation (%) | 10g Deviation (%) | Date | Liquid Temp. (°C) |
|---|---|---|---|---|---|---|---|---|---|---|
| D835V2 SN:4d138 | 3862 | 835 Head | 9.44 | 6.16 | 9.81 | 6.43 | **3.92** | **4.38** | 2014-05-22 | 21.9 |
| D835V2 SN:4d138 | 3862 | 835 Body | 9.32 | 6.12 | 9.37 | 6.25 | **0.54** | **2.12** | 2014-05-23 | 22.1 |
| D835V2 SN:4d138 | 3862 | 835 Head | 9.44 | 6.16 | 9.13 | 6.00 | **-3.28** | **-2.60** | 2014-07-03 | 22.2 |
| D835V2 SN:4d138 | 3862 | 835 Body | 9.32 | 6.12 | 9.33 | 6.20 | **0.11** | **1.31** | 2014-07-03 | 22.4 |
| D1900V2 SN:5d158 | 3862 | 1900 Head | 40.10 | 21.00 | 41.00 | 21.10 | **2.24** | **0.48** | 2014-05-24 | 22.2 |
| D1900V2 SN:5d158 | 3862 | 1900 Body | 39.70 | 21.10 | 40.60 | 21.30 | **2.27** | **0.95** | 2014-05-25 | 22.0 |
| D1900V2 SN:5d158 | 3862 | 1900 Head | 40.10 | 21.00 | 39.30 | 20.50 | **-2.00** | **-2.38** | 2014-06-10 | 21.8 |
| D1900V2 SN:5d158 | 3862 | 1900 Body | 39.70 | 21.10 | 40.30 | 21.20 | **1.51** | **0.47** | 2014-06-10 | 21.9 |
| D2450V2 SN:892 | 3862 | 2450 Head | 52.40 | 24.40 | 51.30 | 23.30 | **-2.10** | **-4.51** | 2014-05-28 | 22.2 |
| D2450V2 SN:892 | 3862 | 2450 Body | 50.10 | 23.20 | 51.30 | 23.40 | **2.40** | **0.86** | 2014-05-28 | 21.9 |

Table1. Results system verification

## 13. Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this simulant fluid were measured by using the Speag Model DAK-3.5 Dielectric Probe in conjunction with Agilent E5071C and E5070B Network Analyzer by using a procedure detailed in Section V.

| f (MHz) | Tissue type | Limits / Measured | Dielectric Parameters | | |
|---|---|---|---|---|---|
| | | | Permittivity | Conductivity | Simulated Tissue Temp(℃) |
| 835 | Head | Measured, 2014-05-22 | 40.7 | 0.90 | 21.9 |
| | | *Target Tissue* | *41.5* | *0.90* | |
| | | **Deviation (%)** | **-1.93** | **0.00** | |
| 835 | Body | Measured, 2014-05-23 | 55.9 | 0.95 | 22.1 |
| | | *Target Tissue* | *55.2* | *0.97* | |
| | | **Deviation (%)** | **1.27** | **-2.06** | |
| 835 | Head | Measured, 2014-07-03 | 40.0 | 0.89 | 22.2 |
| | | *Target Tissue* | *41.5* | *0.90* | |
| | | **Deviation (%)** | **-3.61** | **-1.11** | |
| 835 | Body | Measured, 2014-07-03 | 53.9 | 0.94 | 22.4 |
| | | *Target Tissue* | *55.2* | *0.97* | |
| | | **Deviation (%)** | **-2.36** | **-3.09** | |
| 1900 | Head | Measured, 2014-05-24 | 39.3 | 1.44 | 22.2 |
| | | *Target Tissue* | *40.0* | *1.40* | |
| | | **Deviation (%)** | **-1.75** | **2.86** | |
| 1900 | Body | Measured, 2014-05-25 | 53.8 | 1.52 | 22.0 |
| | | *Target Tissue* | *53.3* | *1.52* | |
| | | **Deviation (%)** | **0.94** | **0.00** | |
| 1900 | Head | Measured, 2014-06-10 | 39.4 | 1.43 | 21.8 |
| | | *Target Tissue* | *40.0* | *1.40* | |
| | | **Deviation (%)** | **-1.50** | **2.14** | |
| 1900 | Body | Measured, 2014-06-10 | 54.0 | 1.56 | 21.9 |
| | | *Target Tissue* | *53.3* | *1.52* | |
| | | **Deviation (%)** | **1.31** | **2.63** | |
| 2450 | Head | Measured, 2014-05-28 | 38.2 | 1.78 | 22.2 |
| | | *Target Tissue* | *39.2* | *1.80* | |
| | | **Deviation (%)** | **-2.55** | **-1.11** | |
| 2450 | Body | Measured, 2014-05-28 | 52.6 | 1.92 | 21.9 |
| | | *Target Tissue* | *52.7* | *1.95* | |
| | | **Deviation (%)** | **-0.19** | **-1.54** | |

The composition of the brain & muscle tissue simulating liquid

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

| Ingredients (% by weight) | Frequency (㎒) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 450 | | 835 | | 915 | | 1900 | | 2450 | |
| Tissue Type | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body |
| Water | 38.56 | 51.16 | 41.45 | 52.4 | 41.05 | 56.0 | 54.9 | 40.4 | 62.7 | 73.2 |
| Salt (NaCl) | 3.95 | 1.49 | 1.45 | 1.4 | 1.35 | 0.76 | 0.18 | 0.5 | 0.5 | 0.04 |
| Sugar | 56.32 | 46.78 | 56.0 | 45.0 | 56.5 | 41.76 | 0.0 | 58.0 | 0.0 | 0.0 |
| HEC | 0.98 | 0.52 | 1.0 | 1.0 | 1.0 | 1.21 | 0.0 | 1.0 | 0.0 | 0.0 |
| Bactericide | 0.19 | 0.05 | 0.1 | 0.1 | 0.1 | 0.27 | 0.0 | 0.1 | 0.0 | 0.0 |
| Triton X-100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 36.8 | 0.0 |
| DGBE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 44.92 | 0.0 | 0.0 | 26.7 |
| Dielectric Constant | 43.42 | 58.0 | 42.54 | 56.1 | 42.0 | 56.8 | 39.9 | 54.0 | 39.8 | 52.5 |
| Conductivity (S/m) | 0.85 | 0.83 | 0.91 | 0.95 | 1.0 | 1.07 | 1.42 | 1.45 | 1.88 | 1.78 |

Salt: 99 $^{+}$% Pure Sodium Chloride

Sugar: 98 $^{+}$% Pure Sucrose

Water: De-ionized, 16 $M\Omega^{+}$ 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

Simulating Liquids for 5 ㎓, Manufactured by SPEAG

| Ingredients | (% by weight) |
|---|---|
| Water | 78 |
| Mineral Oil | 11 |
| Emulsifiers | 9 |
| Additives and Salt | 2 |

## 14. Test System Validation

Per FCC KDB 865664 D01v01r03, SAR system validation status should be documented 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 require tissue-equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01v01r03. Since 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 probe and tissue dielectric parameters has been included.

| *f* (MHz) | Date | Probe S/N | Probe Cal point | Tissue Type | Dielectric Parameters | | CW Validation | | | Modulated Validation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Permittivity | Conductivity | Sensitivity | Probe Linearity | Probe Isotropy | Mod. Type | Duty Factor | PAR |
| 835 | 2014-02-17 | 3862 | 835 | Head | 42.2 | 0.91 | PASS | PASS | PASS | GMSK | PASS | N/A |
| 835 | 2014-02-17 | 3862 | 835 | Body | 56.0 | 0.94 | PASS | PASS | PASS | GMSK | PASS | N/A |
| 1900 | 2014-02-18 | 3862 | 1900 | Head | 39.6 | 1.36 | PASS | PASS | PASS | GMSK | PASS | N/A |
| 1900 | 2014-02-18 | 3862 | 1900 | Body | 54.1 | 1.49 | PASS | PASS | PASS | GMSK | PASS | N/A |
| 2450 | 2014-02-14 | 3862 | 2450 | Head | 39.6 | 1.83 | PASS | PASS | PASS | OFDM | N/A | PASS |
| 2450 | 2014-02-14 | 3862 | 2450 | Body | 53.3 | 1.96 | PASS | PASS | PASS | OFDM | N/A | PASS |

< SAR System Validation Summary>

Note

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

## 15. Instruments List Test Date 2014-05-22 ~ 2014-06-10

| Manufacturer | Device | Type | Serial Number | Cal Date | Cal Interval | Cal Due |
|---|---|---|---|---|---|---|
| Stäubli | Robot | TX90XL | F12/5LP8A1/ A/01 | N/A | N/A | N/A |
| SPEAG | E-Field Probe | EX3DV4 | 3862 | 01/29/2014 | Annual | 01/29/2015 |
| SPEAG | 835 MHz System Validation Dipole | D835V2 | 4d138 | 09/27/2013 | Biennial | 09/27/2015 |
| SPEAG | 1900 MHz System Validation Dipole | D1900V2 | 5d158 | 09/27/2013 | Biennial | 09/27/2015 |
| SPEAG | 2450 MHz System Validation Dipole | D2450V2 | 892 | 09/26/2013 | Biennial | 09/26/2015 |
| SPEAG | Data acquisition Electronics | DAE4 | 1340 | 05/19/2014 | Annual | 05/19/2015 |
| SPEAG | Data acquisition Electronics | DAE4 | 614 | 09/20/2013 | Annual | 09/20/2014 |
| SPEAG | Software | DASY5 V52 | - | N/A | N/A | N/A |
| SPEAG | Phantom | SAM Phantom | TP-1720<br>TP-1721 | N/A | N/A | N/A |
| Agilent | Network Analyzer | E5071C | MY46111535 | 06/27/2013 | Annual | 06/27/2014 |
| SPEAG | Dielectric Assessment Kit | DAK-3.5 | 1107 | 01/19/2014 | Annual | 01/19/2015 |
| Agilent | Power Meter | E4419B | GB43311715 | 06/26/2013 | Annual | 06/26/2014 |
| Agilent | Power Sensor | E9300H | MY41495314 | 09/10/2013 | Annual | 09/10/2014 |
| | | | MY41495307 | 09/10/2013 | Annual | 09/10/2014 |
| Agilent | Signal Generator | E4421B | MY43350132 | 06/27/2013 | Annual | 06/27/2014 |
| Empower RF Systems | Power Amplifier | 2001-BBS3Q7ECK | 1032 D/C 0336 | 01/02/2014 | Annual | 01/02/2015 |
| Agilent | Directional Bridges | 86205A | MY31402302 | 06/29/2013 | Annual | 06/29/2014 |
| Microlab | LP Filter | LA-15N | N/A | 09/09/2013 | Annual | 09/09/2014 |
| Microlab | LP Filter | LA-30N | N/A | 09/09/2013 | Annual | 09/09/2014 |
| Agilent | Attenuator | 8491B | 50566 | 09/09/2013 | Annual | 09/09/2014 |
| JUMBP | Hygro-Thermometer | BJ5478 | 12091382-1 | 07/02/2013 | Annual | 07/02/2014 |
| LKM Electronic | Digital Thermometer | DTM3000 | 3027 | 07/01/2013 | Annual | 07/01/2014 |
| Agilent | Spectrum Analyzer | E4445A | MY44020523 | 07/26/2013 | Annual | 07/26/2014 |
| ROHDE& SCHWARZ | Communication Tester | CMW500 | 144030 | 03/03/2014 | Annual | 03/03/2015 |

## 15.1 Added SAR Test of Instruments List Test Date 2014-07-03

| Manufacturer | Device | Type | Serial Number | Cal Date | Cal Interval | Cal Due |
|---|---|---|---|---|---|---|
| Stäubli | Robot | TX90XL | F12/5LP8A1/ A/01 | N/A | N/A | N/A |
| SPEAG | E-Field Probe | EX3DV4 | 3862 | 01/29/2014 | Annual | 01/29/2015 |
| SPEAG | 835 MHz System Validation Dipole | D835V2 | 4d138 | 09/27/2013 | Biennial | 09/27/2015 |
| SPEAG | Data acquisition Electronics | DAE4 | 1340 | 05/19/2014 | Annual | 05/19/2015 |
| SPEAG | Software | DASY5 V52 | - | N/A | N/A | N/A |
| SPEAG | Phantom | SAM Phantom | TP-1720<br>TP-1721 | N/A | N/A | N/A |
| Agilent | Network Analyzer | E5070B | MY42100282 | 01/02/2014 | Annual | 01/02/2015 |
| SPEAG | Dielectric Assessment Kit | DAK-3.5 | 1107 | 01/19/2014 | Annual | 01/19/2015 |
| Agilent | Power Meter | E4419B | GB43311715 | 06/25/2014 | Annual | 06/25/2015 |
| Agilent | Power Sensor | E9300H | MY41495314 | 09/10/2013 | Annual | 09/10/2014 |
| | | | MY41495307 | 09/10/2013 | Annual | 09/10/2014 |
| Agilent | Signal Generator | E4421B | MY43350132 | 06/25/2014 | Annual | 06/25/2015 |
| Empower RF Systems | Power Amplifier | 2001-BBS3Q7ECK | 1032 D/C 0336 | 01/02/2014 | Annual | 01/02/2015 |
| Agilent | Directional Coupler | 778D | 50454 | 07/01/2014 | Annual | 07/01/2015 |
| Microlab | LP Filter | LA-15N | N/A | 09/09/2013 | Annual | 09/09/2014 |
| Agilent | Attenuator | 8491B | 50566 | 09/09/2013 | Annual | 09/09/2014 |
| JUMBP | Hygro-Thermometer | BJ5478 | 12091382-1 | 06/30/2014 | Annual | 06/30/2015 |
| Agilent | Spectrum Analyzer | E4445A | MY44020523 | 07/26/2013 | Annual | 07/26/2014 |
| ROHDE& SCHWARZ | Communication Tester | CMW500 | 144030 | 03/03/2014 | Annual | 03/03/2015 |

## 16. FCC Power Measurement Procedures

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

The handset was placed into a simulated call using a base station simulator in shielded chamber. 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.

## 17. Measured and Reported SAR

Per FCC KDB Publication 447498 D01v05r02, 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. Test highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

## 18 Nominal and Maximum Output Power Specifications

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

| Mode / Band | | Burst Average GMSK (dBm) | | | | |
|---|---|---|---|---|---|---|
| | | Voice | GPRS(GMSK) Data – CS1 | | | |
| | | GSM | 1 slot | 2 slot | 3 slot | 4 slot |
| GSM850 | **Maximum** | **33.7** | **33.7** | **31.7** | **29.7** | **27.7** |
| | Nominal | 33.2 | 33.2 | 31.2 | 29.2 | 27.2 |
| PCS1900 | **Maximum** | **31.2** | **31.2** | **28.7** | **26.7** | **24.7** |
| | Nominal | 30.7 | 30.7 | 28.2 | 26.2 | 24.2 |
| Mode / Band | | Frame Average GMSK (dBm) | | | | |
| | | Voice | GPRS(GMSK) Data – CS1 | | | |
| | | GSM | 1 slot | 2 slot | 3 slot | 4 slot |
| GSM850 | **Maximum** | 24.67 | 24.67 | **25.68** | 25.44 | 24.69 |
| | Nominal | 24.17 | 24.17 | 25.18 | 24.94 | 24.19 |
| PCS1900 | **Maximum** | 22.17 | 22.17 | **22.68** | 22.44 | 21.69 |
| | Nominal | 21.67 | 21.67 | 22.18 | 21.94 | 21.19 |
| Tune-up Tolerance: -1.5 dB / + 0.5 dB | | | | | | |

| Mode / Band | | Modulated Average (dBm) | | |
|---|---|---|---|---|
| | | 3GPP Rel 99 | 3GPP Rel 5 | 3GPP Rel 6 |
| | | RMC/AMR | HSDPA | HSUPA |
| WCDMA850 | **Maximum** | **23.7** | - | - |
| | Nominal | 23.2 | - | - |
| Subtest 1 | **Maximum** | - | **23.7** | **23.7** |
| | Nominal | - | 23.2 | 23.2 |
| Subtest 2 | **Maximum** | - | **23.7** | **21.7** |
| | Nominal | - | 23.2 | 21.2 |
| Subtest 3 | **Maximum** | - | **23.2** | **22.7** |
| | Nominal | - | 22.7 | 22.2 |
| Subtest 4 | **Maximum** | - | **23.2** | **21.7** |
| | Nominal | - | 22.7 | 21.2 |
| Subtest 5 | **Maximum** | - | - | **23.7** |
| | Nominal | - | - | 23.2 |
| Tune-up Tolerance: -1.5 dB / + 0.5 dB | | | | |

| Mode / Band | | Modulated Average (dBm) | | |
|---|---|---|---|---|
| | | 3GPP Rel 99 | 3GPP Rel 5 | 3GPP Rel 6 |
| | | RMC/AMR | HSDPA | HSUPA |
| WCDMA1900 | **Maximum** | **24.2** | - | - |
| | Nominal | 23.7 | - | - |
| Subtest 1 | **Maximum** | - | **24.2** | **24.2** |
| | Nominal | - | 23.7 | 23.7 |
| Subtest 2 | **Maximum** | - | **24.2** | **22.2** |
| | Nominal | - | 23.7 | 21.7 |
| Subtest 3 | **Maximum** | - | **23.7** | **23.2** |
| | Nominal | - | 23.2 | 22.7 |
| Subtest 4 | **Maximum** | - | **23.7** | **22.2** |
| | Nominal | - | 23.2 | 21.7 |
| Subtest 5 | **Maximum** | - | - | **24.2** |
| | Nominal | - | - | 23.7 |
| Tune-up Tolerance: -1.5 dB / + 0.5 dB | | | | |

| Average power for Production (dBm) | | | | | |
|---|---|---|---|---|---|
| Mode | Nominal & Maximum | b | | g | n |
| 2.4 ㎓ WLAN | **Maximum** | **17.0** | | **15.0** | **14.0** |
| | Nominal | 16.0 | | 14.0 | 13.0 |
| Mode | Nominal & Maximum | GFSK | DPSK | 8DPSK | LE |
| Bluetooth | **Maximum** | **9.0** | **6.0** | **5.0** | **9.5** |
| | Nominal | 8.0 | 5.0 | 4.0 | 8.5 |

## 19 RF Conducted Power Measurement

The device in GSM, WCDMA was controlled by using a Communication tester (CMW500). The EUT was set to maximum power level during all tests. The DASY5 system measures power drift during SAR testing by comparing e-field in the same location at the beginning and at the end of measurement.

### 19.1 GSM Conducted Power

| GSM | Channel | Frequency(㎒) | Burst -Conducted Average Power(㏈m) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Voice | GPRS(GMSK) Data – CS1 | | | |
| | | | GSM | 1 Slot | 2 Slot | 3 Slot | 4 Slot |
| GSM 850 | 128 | 824.2 | 33.64 | 33.62 | 31.31 | 29.39 | 27.33 |
| | 190 | 836.6 | 33.40 | 33.45 | 31.27 | 29.42 | 27.31 |
| | 251 | 848.8 | 33.48 | 33.56 | 31.26 | 29.47 | 27.42 |
| PCS 1900 | 512 | 1850.2 | 30.54 | 30.51 | 28.30 | 26.15 | 24.15 |
| | 661 | 1880.0 | 30.64 | 30.42 | 28.14 | 26.02 | 24.11 |
| | 810 | 1909.8 | 30.55 | 30.42 | 28.12 | 26.03 | 24.21 |

| GSM | Channel | Frequency(㎒) | Frame-Conducted Average Power(㏈m) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Voice | GPRS(GMSK) Data – CS1 | | | |
| | | | GSM | 1 Slot | 2 Slot | 3 Slot | 4 Slot |
| GSM 850 | 128 | 824.2 | 24.61 | 24.59 | **25.29** | 25.13 | 24.32 |
| | 190 | 836.6 | 24.37 | 24.42 | **25.25** | 25.16 | 24.30 |
| | 251 | 848.8 | 24.45 | 24.53 | **25.24** | 25.21 | 24.41 |
| PCS 1900 | 512 | 1850.2 | 21.51 | 21.48 | **22.28** | 21.89 | 21.14 |
| | 661 | 1880.0 | 21.61 | 21.39 | **22.12** | 21.76 | 21.10 |
| | 810 | 1909.8 | 21.52 | 21.39 | **22.10** | 21.77 | 21.20 |

**Note**

1. Both burst-averaged and calculated frame-averaged powers are included. Frame-averaged power was calculated from the measured burst-averaged power by converting the slot powers into linear units and calculating the energy over 8 timeslots.
2. The source-based frame-averaged output power was evaluated for all GPRS slot configurations. The configuration with the highest target frame averaged output power was evaluated for wireless router 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 war tested.
3. GPRS (GMSK) output powers were measured with coding scheme setting of 1 (CS1) on the base station simulator. CS1 was configured to measure GPRS output power measurements and SAR to ensure GMSK modulation in the signal. Our investigation has shown that CS1 – CS4 settings do not have any impact on the output levels or modulation in the GPRS modes.

## 19.2 WCDMA

### 19.2.1 Output Power Verification

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

### 19.2.2 Head SAR Measurements

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

### 19.2.3 Body SAR Measurements

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

### 19.2.4 Procedures Used to Establish RF Signal for SAR HSDPA Data Devices

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

**Sub-Test 1 Setup for Release 5 HSDPA**

| Sub-test | $\beta_c$ | $\beta_d$ | $\beta_d$ (SF) | $\beta_c/\beta_d$ | $\beta_{hs}$ (1) | CM (dB)(2) |
|---|---|---|---|---|---|---|
| 1 | 2/15 | 15/15 | 64 | 2/15 | 4/15 | 0.0 |
| 2 | 12/15(3) | 15/15(3) | 64 | 12/15(3) | 24/15 | 1.0 |
| 3 | 15/15 | 8/15 | 64 | 15/8 | 30/15 | 1.5 |
| 4 | 15/15 | 4/15 | 64 | 15/4 | 30/15 | 1.5 |

Note 1: $\Delta_{ACK}$, $\Delta_{NACK}$ and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$
Note 2: CM = 1 for $\beta_c/\beta_d$ = 12/15, $\beta_{hs}/\beta_c$ = 24/15.
Note 3: For subtest 2 the $\beta_c/\beta_d$ ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c$ = 11/15 and $\beta_d$ = 15/15.

### 19.2.5 SAR Measurements for Conditions for HSUPA Data Devices

Body SAR is not required for handsets with HSPA capabilities when the maximum average output of each RF channel with HSUPA/HSDPA active is less than ¼ dB higher than that measured without HSUPA/HSDPA using 12.2 kbps RMC and the maximum SAR for 12.2 kbps RMC is ≤ 75 % of the SAR limit. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 with power control algorithm 2, according to the highest body SAR configuration in 12.1 kbps RMC without HSPA. When VOIP is applicable for head exposure, SAR is not required when the maximum output of each RF channel with HSPA is less than ¼ dB higher than that measured using 12.2 kbps RMC; otherwise, the same HSPA configuration used for body measurement should be used to test for head exposure.

| Sub-test | $\beta_c$ | $\beta_d$ | $\beta_d$ (SF) | $\beta_c/\beta_d$ | $\beta_{hs}$ (1) | $\beta_{ec}$ | $\beta_{ed}$ | $\beta_{ed}$ (SF) | $\beta_{ed}$ (codes) | CM (2) (dB) | MPR (dB) | AG (4) Index | E-TFCI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11/15 (3) | 15/15 (3) | 64 | 11/15 (3) | 22/15 | 209/225 | 1039/225 | 4 | 1 | 1.0 | 0.0 | 20 | 75 |
| 2 | 6/15 | 15/15 | 64 | 6/15 | 12/15 | 12/15 | 94/75 | 4 | 1 | 3.0 | 2.0 | 12 | 67 |
| 3 | 15/15 | 9/15 | 64 | 15/9 | 30/15 | 30/15 | $\beta_{ed1}$: 47/15<br>$\beta_{ed2}$: 47/15 | 4 | 2 | 2.0 | 1.0 | 15 | 92 |
| 4 | 2/15 | 15/15 | 64 | 2/15 | 4/15 | 2/15 | 56/75 | 4 | 1 | 3.0 | 2.0 | 17 | 71 |
| 5 | 15/15 (4) | 15/15 (4) | 64 | 15/15 (4) | 30/15 | 24/15 | 134/15 | 4 | 1 | 1.0 | 0.0 | 21 | 81 |

Note 1: $\Delta_{ACK}$, $\Delta_{NACK}$ and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$.
Note 2: CM = 1 for $\beta_c/\beta_d$ =12/15, $\beta_{hs}/\beta_c$=24/15. For all other combinations of DPDCH, DPCCH, HS- DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.
Note 3: For subtest 1 the $\beta_c/\beta_d$ ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c$ = 10/15 and $\beta_d$ = 15/15.
Note 4: For subtest 5 the $\beta_c/\beta_d$ ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c$ = 14/15 and $\beta_d$ = 15/15.
Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.
Note 6: $\beta_{ed}$ can not be set directly; it is set by Absolute Grant Value.

| 3GPP Release Version | Mode / Channel | 3GPP 34.121 Subtest | Cellular Band (dBm) 4132 | 4183 | 4233 | 3GPP MPR(dB) |
|---|---|---|---|---|---|---|
| 99 | WCDMA | 12.2 kbps RMC | 23.51 | 23.49 | 23.51 | - |
| 5 | HSDPA | Subtest 1 | 23.51 | 23.41 | 23.39 | 0 |
| 5 | | Subtest 2 | 23.46 | 23.42 | 23.38 | 0 |
| 5 | | Subtest 3 | 23.12 | 23.14 | 23.18 | -0.5 |
| 5 | | Subtest 4 | 23.18 | 23.14 | 23.02 | -0.5 |
| 6 | HSUPA | Subtest 1 | 22.77 | 22.88 | 22.76 | 0 |
| 6 | | Subtest 2 | 21.66 | 21.62 | 21.35 | -2 |
| 6 | | Subtest 3 | 22.24 | 22.23 | 22.42 | -1 |
| 6 | | Subtest 4 | 21.58 | 21.64 | 21.65 | -2 |
| 6 | | Subtest 5 | 22.71 | 22.78 | 22.86 | 0 |

| 3GPP Release Version | Mode / Channel | 3GPP 34.121 Subtest | PCS Band (dBm) 9262 | 9400 | 9538 | 3GPP MPR(dB) |
|---|---|---|---|---|---|---|
| 99 | WCDMA | 12.2 kbps RMC | 23.59 | 23.61 | 23.54 | - |
| 5 | HSDPA | Subtest 1 | 23.40 | 23.55 | 23.41 | 0 |
| 5 | | Subtest 2 | 23.49 | 23.41 | 23.42 | 0 |
| 5 | | Subtest 3 | 23.14 | 23.16 | 23.11 | -0.5 |
| 5 | | Subtest 4 | 23.17 | 23.13 | 23.13 | -0.5 |
| 6 | HSUPA | Subtest 1 | 22.87 | 22.76 | 22.95 | 0 |
| 6 | | Subtest 2 | 21.78 | 21.86 | 21.74 | -2 |
| 6 | | Subtest 3 | 22.24 | 22.23 | 22.23 | -1 |
| 6 | | Subtest 4 | 21.81 | 21.87 | 21.64 | -2 |
| 6 | | Subtest 5 | 22.82 | 22.74 | 22.89 | 0 |

**Note**

1. WCDMA SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB Publication 941225 D01v02. 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

## 19.3 WLAN

### 19.3.1 General Device Setup

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

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

### 19.3.2 Frequency Channel Configurations

802.11 a/b/g and 4.9 ㎓ operating modes are tested independently according to the service requirements in each frequency band. 802.11 b/g modes are tested on channel 1, 6, and 11. 802.11a is tested for UNII operations on channels 36 and 48 in the 5.15 ~ 5.25 ㎓ band, channels 52 and 64 in the 5.25 ~ 5.35 ㎓ band, channels 104, 116, 124 and 136 in the 5.470 ~ 5.725 ㎓ band, and channels 149 and 161 in the 5.8 ㎓ band. When 5.8 ㎓ §15.247 is also available, channels 149, 157 and 165 should be tested instead of the UNII channels. 802.11g mode was evaluated only if the output power was 0.25 ㏈ higher than the 802.11b mode.

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

- √ = "default test channels"
- * = possible 802.11a channels with maximum average output > the "default test channels"
- ∇ = possible 802.11g channels with maximum average output ¼ dB ≥ the "default test channels"
- # = when output power is reduced for channel 1 and/or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested

### 19.3.3 WLAN Conducted Powers

IEEE 802.11b Average RF Power

| Mode | Frequency | Channel | 802.11b (2.4 GHz) Conducted Power (dBm) | | | |
|---|---|---|---|---|---|---|
| | | | Data Rate (Mbps) | | | |
| | | | 1 | 2 | 5.5 | 11 |
| 802.11b | 2412 | 1 | 14.64 | 14.62 | 14.60 | 14.58 |
| | 2437 | 6 | 15.16 | 15.14 | 15.11 | 15.09 |
| | 2462 | 11 | 15.27 | 15.24 | 15.21 | 15.16 |

IEEE 802.11g Average RF Power

| Mode | Frequency | Channel | 802.11g (2.4 GHz) Conducted Power (dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate (Mbps) | | | | | | | |
| | | | 6 | 9 | 12 | 18 | 24 | 36 | 48 | 54 |
| 802.11g | 2412 | 1 | 12.93 | 13.02 | 13.09 | 13.26 | 13.36 | 13.67 | 14.02 | 14.10 |
| | 2437 | 6 | 13.63 | 13.67 | 13.78 | 13.88 | 14.06 | 14.34 | 14.67 | 14.83 |
| | 2462 | 11 | 13.49 | 13.58 | 13.63 | 13.72 | 13.96 | 14.25 | 14.55 | 14.72 |

IEEE 802.11n Average RF Power 20 MHz Bandwidth

| Mode | Frequency | Channel | 802.11n (2.4 GHz) Conducted Power (dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Data Rate (Mbps) | | | | | | | |
| | | | MCS0 | MCS1 | MCS2 | MCS3 | MCS4 | MCS5 | MCS6 | MCS7 |
| 802.11n | 2412 | 1 | 11.78 | 11.74 | 12.16 | 12.34 | 12.70 | 12.99 | 13.03 | 13.13 |
| | 2437 | 6 | 12.46 | 12.60 | 12.70 | 12.90 | 13.32 | 13.62 | 13.77 | 13.79 |
| | 2462 | 11 | 12.36 | 12.54 | 12.79 | 13.02 | 13.31 | 13.69 | 13.59 | 13.70 |

Bluetooth

| Channel | Frequency (MHz) | GFSK (dBm) | PI/4DQPSK (dBm) | 8DPSK (dBm) | LE (dBm) |
|---|---|---|---|---|---|
| Low | 2402 | 6.95 | 3.07 | 2.83 | 7.06 |
| Middle | 2441 | 8.30 | 4.95 | 4.83 | 9.31 |
| High | 2480 | 6.63 | 3.48 | 3.76 | 7.55 |

## 20 SAR Test Exclusions Applied

Per FCC KDB 447498 D01v05r02, the SAR exclusion threshold for distances < 50 ㎜ 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 | 2480 | 8 | 5 | 2.52 |
| | | | 10 | 1.26 |

| Mode | Frequency | Maximum Allowed Power | Separation Distance | ≤ 3.0 |
|---|---|---|---|---|
| | [MHz] | [mW] | [mm] | |
| Bluetooth LE | 2480 | 9 | 5 | 2.83 |
| | | | 10 | 1.42 |

Based on the maximum tune-up tolerance limit of Bluetooth the antenna to use separation distance,

Bluetooth SAR was not required [(8/5)*√2.480] = 2.52 < 3.0.

Bluetooth LE SAR was not required [(9/5)*√2.480] = 2.83 < 3.0.

# 21 SAR Data Summary

## 21.1 Head SAR Data

**GSM850 Head SAR**

| Head | EUT Position | Mode | Battery | Traffic Channel | | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Frequency (MHz) | Channel | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Right | Touch | GSM Voice | Standard | 836.6 | 190 | 33.40 | 33.70 | 0.225 | 0.241 | - |
| | Tilt | | Standard | 836.6 | 190 | 33.40 | 33.70 | 0.148 | 0.159 | - |
| Left | Touch | | Standard | 836.6 | 190 | 33.40 | 33.70 | 0.167 | 0.179 | - |
| | Tilt | | Standard | 836.6 | 190 | 33.40 | 33.70 | 0.135 | 0.145 | - |
| Right | Touch | GPRS 2Tx | Standard | 836.6 | 190 | 31.27 | 31.70 | **0.249** | **0.275** | 9 |
| | Tilt | | Standard | 836.6 | 190 | 31.27 | 31.70 | 0.159 | 0.176 | - |
| Left | Touch | | Standard | 836.6 | 190 | 31.27 | 31.70 | 0.183 | 0.202 | - |
| | Tilt | | Standard | 836.6 | 190 | 31.27 | 31.70 | 0.152 | 0.168 | - |
| Right | Touch | GPRS 3Tx | Standard | 836.6 | 190 | 29.42 | 29.70 | **0.251** | **0.268** | 25 |
| | Tilt | | Standard | 836.6 | 190 | 29.42 | 29.70 | 0.168 | 0.179 | - |
| Left | Touch | | Standard | 836.6 | 190 | 29.42 | 29.70 | 0.208 | 0.222 | - |
| | Tilt | | Standard | 836.6 | 190 | 29.42 | 29.70 | 0.173 | 0.185 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | | Head<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | |

**GSM1900 Head SAR**

| Head | EUT Position | Mode | Battery | Traffic Channel | | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Frequency (MHz) | Channel | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Right | Touch | GSM Voice | Standard | 1880.0 | 661 | 30.64 | 31.20 | 0.154 | 0.175 | - |
| | Tilt | | Standard | 1880.0 | 661 | 30.64 | 31.20 | 0.099 | 0.113 | - |
| Left | Touch | | Standard | 1880.0 | 661 | 30.64 | 31.20 | 0.270 | 0.307 | - |
| | Tilt | | Standard | 1880.0 | 661 | 30.64 | 31.20 | 0.162 | 0.184 | - |
| Right | Touch | GPRS 2Tx | Standard | 1880.0 | 661 | 28.14 | 28.70 | 0.169 | 0.192 | - |
| | Tilt | | Standard | 1880.0 | 661 | 28.14 | 28.70 | 0.109 | 0.124 | - |
| Left | Touch | | Standard | 1880.0 | 661 | 28.14 | 28.70 | **0.276** | **0.314** | 12 |
| | Tilt | | Standard | 1880.0 | 661 | 28.14 | 28.70 | 0.162 | 0.184 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | | Head<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | |

**WCDMA Band V Head SAR**

| Head | EUT Position | Mode | Battery | Traffic Channel | | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Frequency (MHz) | Channel | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Right | Touch | RMC | Standard | 836.6 | 4183 | 23.49 | 23.70 | **0.145** | **0.152** | 15 |
| | Tilt | | Standard | 836.6 | 4183 | 23.49 | 23.70 | 0.095 | 0.100 | - |
| Left | Touch | | Standard | 836.6 | 4183 | 23.49 | 23.70 | 0.110 | 0.115 | - |
| | Tilt | | Standard | 836.6 | 4183 | 23.49 | 23.70 | 0.082 | 0.086 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | | Head<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | |

**WCDMA Band II Head SAR**

| Head | EUT Position | Mode | Battery | Traffic Channel | | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Frequency (MHz) | Channel | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Right | Touch | RMC | Standard | 1880.0 | 9400 | 23.61 | 24.20 | 0.373 | 0.427 | - |
| | Tilt | | Standard | 1880.0 | 9400 | 23.61 | 24.20 | 0.261 | 0.299 | - |
| Left | Touch | | Standard | 1880.0 | 9400 | 23.61 | 24.20 | **0.566** | **0.648** | 18 |
| | Tilt | | Standard | 1880.0 | 9400 | 23.61 | 24.20 | 0.400 | 0.458 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | | Head<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | |

**WLAN 2.4 GHz Head SAR**

| Head | EUT Position | Mode | Battery | Traffic Channel | | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Frequency (㎒) | Channel | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Right | Touch | 802.11b | Standard | 2462.0 | 11 | 15.27 | 17.00 | **0.223** | **0.332** | 20 |
| | Tilt | | Standard | 2462.0 | 11 | 15.27 | 17.00 | 0.181 | 0.270 | - |
| Left | Touch | | Standard | 2462.0 | 11 | 15.27 | 17.00 | 0.099 | 0.147 | - |
| | Tilt | | Standard | 2462.0 | 11 | 15.27 | 17.00 | 0.117 | 0.174 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | | Head<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | |

## 21.2 Body-Worn SAR Data

**GSM/WCDMA Band Body-Worn SAR**

| EUT Position | Mode | Battery | Traffic Channel | | Separation Distance (mm) | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Frequency (MHz) | Channel | | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Rear | GSM850 | Standard | 836.6 | 190 | 10 | 33.40 | 33.70 | 0.391 | 0.419 | 10 |
| Rear | GSM1900 | Standard | 1880.0 | 661 | 10 | 30.64 | 31.20 | 0.350 | 0.398 | 13 |
| Rear | WCDMA 850 | Standard | 836.6 | 4183 | 10 | 23.49 | 23.70 | 0.219 | 0.230 | 16 |
| Rear | WCDMA 1900 | Standard | 1880.0 | 9400 | 10 | 23.61 | 24.20 | 0.835 | 0.957 | - |
| Rear | WCDMA 1900 | Standard | 1852.4 | 9262 | 10 | 23.59 | 24.20 | **0.938** | **1.079** | 19 |
| Rear | WCDMA 1900 | Standard | 1907.6 | 9538 | 10 | 23.54 | 24.20 | 0.726 | 0.845 | - |
| Rear | WCDMA 1900 | Standard | 1852.4 | 9262 | 10 | 23.59 | 24.20 | 0.925 | 1.064 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | |

**WLAN Body-Worn SAR**

| EUT Position | Mode | Battery | Traffic Channel | | Separation Distance (mm) | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Frequency (MHz) | Channel | | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Rear | 802.11b 2.4 GHz | Standard | 2462.0 | 11 | 10 | 15.27 | 17.00 | 0.047 | 0.070 | 21 |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | |

### 21.3 Hotspot SAR Data

**GSM850 Hotspot SAR**

| EUT Position | Mode | Battery | Traffic Channel | | Separation Distance (mm) | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Frequency (MHz) | Channel | | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Front | GPRS 2Tx | Standard | 836.6 | 190 | 10 | 31.27 | 31.70 | 0.291 | 0.321 | - |
| Rear | | Standard | 836.6 | 190 | 10 | 31.27 | 31.70 | 0.396 | 0.437 | - |
| Right Edge | | Standard | 836.6 | 190 | 10 | 31.27 | 31.70 | **0.478** | **0.528** | 11 |
| Left Edge | | Standard | 836.6 | 190 | 10 | 31.27 | 31.70 | 0.307 | 0.339 | - |
| Bottom | | Standard | 836.6 | 190 | 10 | 31.27 | 31.70 | 0.167 | 0.184 | - |
| Front | GPRS 3Tx | Standard | 836.6 | 190 | 10 | 29.42 | 29.70 | 0.274 | 0.292 | - |
| Rear | | Standard | 836.6 | 190 | 10 | 29.42 | 29.70 | 0.389 | 0.415 | - |
| Right Edge | | Standard | 836.6 | 190 | 10 | 29.42 | 29.70 | **0.486** | **0.518** | 26 |
| Left Edge | | Standard | 836.6 | 190 | 10 | 29.42 | 29.70 | 0.324 | 0.346 | - |
| Bottom | | Standard | 836.6 | 190 | 10 | 29.42 | 29.70 | 0.099 | 0.106 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | | |

**GSM1900 Hotspot SAR**

| EUT Position | Mode | Battery | Traffic Channel | | Separation Distance (mm) | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Frequency (MHz) | Channel | | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Front | GPRS 2Tx | Standard | 1880.0 | 661 | 10 | 28.14 | 28.70 | 0.215 | 0.232 | - |
| Rear | | Standard | 1880.0 | 661 | 10 | 28.14 | 28.70 | **0.363** | **0.392** | 14 |
| Right Edge | | Standard | 1880.0 | 661 | 10 | 28.14 | 28.70 | 0.054 | 0.058 | - |
| Left Edge | | Standard | 1880.0 | 661 | 10 | 28.14 | 28.70 | 0.187 | 0.202 | - |
| Bottom | | Standard | 1880.0 | 661 | 10 | 28.14 | 28.70 | 0.251 | 0.271 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | | |

**WCDMA Band V Hotspot SAR**

| EUT Position | Mode | Battery | Traffic Channel | | Separation Distance (mm) | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Frequency (MHz) | Channel | | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Front | RMC | Standard | 836.6 | 4183 | 10 | 23.49 | 23.70 | 0.137 | 0.144 | - |
| Rear | | Standard | 836.6 | 4183 | 10 | 23.49 | 23.70 | 0.219 | 0.230 | - |
| Right Edge | | Standard | 836.6 | 4183 | 10 | 23.49 | 23.70 | **0.223** | **0.234** | 17 |
| Left Edge | | Standard | 836.6 | 4183 | 10 | 23.49 | 23.70 | 0.162 | 0.170 | - |
| Bottom | | Standard | 836.6 | 4183 | 10 | 23.49 | 23.70 | 0.069 | 0.072 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | | |

**WCDMA Band II Hotspot SAR**

| EUT Position | Mode | Battery | Traffic Channel | | Separation Distance (mm) | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Frequency (MHz) | Channel | | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Front | RMC | Standard | 1880.0 | 9400 | 10 | 23.61 | 24.20 | 0.478 | 0.548 | - |
| Rear | | Standard | 1880.0 | 9400 | 10 | 23.61 | 24.20 | 0.835 | 0.957 | - |
| Right Edge | | Standard | 1880.0 | 9400 | 10 | 23.61 | 24.20 | 0.113 | 0.129 | - |
| Left Edge | | Standard | 1880.0 | 9400 | 10 | 23.61 | 24.20 | 0.420 | 0.481 | - |
| Bottom | | Standard | 1880.0 | 9400 | 10 | 23.61 | 24.20 | 0.561 | 0.643 | - |
| Rear | | Standard | 1852.4 | 9262 | 10 | 23.59 | 24.20 | **0.938** | **1.079** | 19 |
| Rear | | Standard | 1907.6 | 9538 | 10 | 23.54 | 24.20 | 0.726 | 0.845 | - |
| Rear | | Standard | 1852.4 | 9262 | 10 | 23.59 | 24.20 | 0.925 | 1.064 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | | |

**WLAN 2.4 GHz Hotspot SAR**

| EUT Position | Mode | Battery | Traffic Channel | | Separation Distance (mm) | Power(dBm) | | 1-g SAR (W/kg) | | Plot No |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Frequency (MHz) | Channel | | Measured Power | Tune-Up Limit | Measured SAR | Scaled SAR | |
| Front | 802.11b 2.4 GHz | Standard | 2462.0 | 11 | 10 | 15.27 | 17.00 | **0.050** | **0.074** | 22 |
| Rear | 802.11b 2.4 GHz | Standard | 2462.0 | 11 | 10 | 15.27 | 17.00 | 0.047 | 0.070 | - |
| Right Edge | 802.11b 2.4 GHz | Standard | 2462.0 | 11 | 10 | 15.27 | 17.00 | 0.008 | 0.012 | - |
| Top | 802.11b 2.4 GHz | Standard | 2462.0 | 11 | 10 | 15.27 | 17.00 | 0.040 | 0.060 | - |
| ANSI / IEEE C95.1 1992 – Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure / General Population | | | | | Body<br>1.6 W/kg (mW/g)<br>Averaged over 1 gram | | | | | |

General Notes

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, FCC KDB Publication 865664 D01v02r03 and FCC KDB Publication 447498 D01v05r02.
2. All modes of operation were investigated, and worst-case results are reported.
3. The EUT is tested 2$^{nd}$ hot-spot peak, if it is less than 2 dB below the highest peak.
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 Publication 447498 D01v05r02.
6. Device was tested using a fixed spacing for body-worn accessory testing. A separation distance of 10 mm was considered because the manufacturer has determined that there will be body-worn accessories available in the marketplace for users to support this separation distance.
7. Per FCC KDB Publication 648474 D04v01r02, body worn SAR was evaluated without a headset connected to the device. Since the standalone reported SAR was ≤ 1.2 W/kg, no additional body worn SAR evaluations using a headset cable were required.
8. Per FCC KDB Publication 865664 D01v01r03, variability SAR tests were performed when the measured SAR results for a frequency band were greater than 0.8 W/kg. Please see section 24 for variability analysis.

GSM Notes

1. Body-Worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.
2. Justification for reduced test configurations per KDB Publication 941225 D03v01: The source-based time-averaged output power was evaluated for all multi-slot operations. The multi-slot configuration with the highest frame averaged output power was evaluated for SAR.
3. Per FCC KDB Publication 447498 D01v05r02, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 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.

WCDMA Notes

1. WCDMA mode in Body SAR was tested under RMC 12.2 kbps with HSPA inactive per KDB Publication 941225 D01v02. 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.
2. Per FCC KDB Publication 447498 D01v05r02, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 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

WLAN Notes

1. For 2.4 GHz, justification for reduced test configuration for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers were not greater than 0.25 dB than that of the corresponding channel in the lowest data rate IEEE 802.11b modes.
2. Since the maximum extrapolated peak SAR of the zoom scan for the maximum output channel was ≤ 1.6 W/kg and the reported 1g averaged SAR was < 0.8 W/kg, SAR testing on other default channels was not required.
3. WLAN transmission was verified using a spectrum analyzer.

# 22 SAR Measurement Variability

## 22.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r03, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

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

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

| EUT Position | Mode | Traffic Channel | | Separation Distance (mm) | Measured 1g SAR (W/kg) | 1st Repeated 1g SAR(W/kg) | Ratio | 2st Repeated 1g SAR(W/kg) | Ratio | 3st Repeated 1g SAR(W/kg) | Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Frequency (MHz) | Channel | | | | | | | | |
| Rear | RMC | 1852.4 | 9262 | 10 | 0.938 | 0.925 | 1.01 | N/A | N/A | N/A | N/A |

## 22.2 Measurement Uncertainty

The measured SAR was < 1.5 W/kg for all frequency bands. Therefore, per KDB Publication 865664 D01v01r03, the extended measurement uncertainty analysis per IEEE 1528-2003 was not required.

# 23 FCC Multi-TX and Antenna SAR considerations

## 23.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v05r02 are applicable to handsets with built-in unlicensed transmitters such as 802.11a/b/g/n/ac and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

## 23.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v05r02 IV.C.1iii, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤ 1.6 W/kg. When standalone SAR is not required to be measured per FCC KDB 447498 D01v05r02 4.3.2.2), the following equation must be used to estimate the standalone 1g SAR for simultaneous transmission involving that transmitter.

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

| Mode | Frequency | Maximum Allowed Power | Separation Distance | Estimated SAR |
|---|---|---|---|---|
| | [MHz] | [mW] | [mm] | [W/kg] |
| Bluetooth LE | 2480 | 9 | 5 | 0.378 |
| | | | 10 | 0.189 |

## 22.3 Simultaneous Transmission Scenarios

| No | Capable Transmit Configuration | Head | Body-Worn | Wireless Router |
|---|---|---|---|---|
| 1 | GSM 850 Voice + WLAN 2.4 GHz | Yes | Yes | N/A |
| 2 | GSM 1900 Voice + WLAN 2.4 GHz | Yes | Yes | N/A |
| 3 | GSM 850 Voice + Bluetooth | Yes | Yes | N/A |
| 4 | GSM 1900 Voice + Bluetooth | Yes | Yes | N/A |
| 5 | GPRS 850 + WLAN 2.4 GHz | Yes | Yes | Yes |
| 6 | GPRS1900 + WLAN 2.4 GHz | Yes | Yes | Yes |
| 7 | GPRS 850 + Bluetooth | Yes | Yes | N/A |
| 8 | GPRS 1900 + Bluetooth | Yes | Yes | N/A |
| 9 | WCDMA 850 + WLAN 2.4 GHz | Yes | Yes | Yes |
| 10 | WCDMA 1900 + WLAN 2.4 GHz | Yes | Yes | Yes |
| 11 | WCDMA 850 + Bluetooth | Yes | Yes | N/A |
| 12 | WCDMA 1900 + Bluetooth | Yes | Yes | N/A |

**Notes**

1. GSM/GPRS, WCDMA share the same antenna and cannot transmit simultaneously.

### 23.4 Head SAR Simultaneous Transmission Analysis

Simultaneous Transmission Summation Scenario with 2.4 GHz WLAN (Head to Ear)

| Simultaneous TX | Configuration | GSM850 Band Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
|---|---|---|---|---|
| Head | Right Touch | 0.241 | 0.332 | 0.573 |
| | Right Tilt | 0.159 | 0.270 | 0.429 |
| | Left Touch | 0.179 | 0.147 | 0.326 |
| | Left Tilt | 0.145 | 0.174 | 0.319 |
| | Configuration | GPRS850 Band Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.275 | 0.332 | 0.607 |
| | Right Tilt | 0.176 | 0.270 | 0.446 |
| | Left Touch | 0.202 | 0.147 | 0.349 |
| | Left Tilt | 0.168 | 0.174 | 0.342 |
| | Configuration | GSM1900 Band Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.175 | 0.332 | 0.507 |
| | Right Tilt | 0.113 | 0.270 | 0.383 |
| | Left Touch | 0.307 | 0.147 | 0.454 |
| | Left Tilt | 0.184 | 0.174 | 0.358 |
| | Configuration | GPRS1900 Band Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.192 | 0.332 | 0.524 |
| | Right Tilt | 0.124 | 0.270 | 0.394 |
| | Left Touch | 0.314 | 0.147 | 0.461 |
| | Left Tilt | 0.184 | 0.174 | 0.358 |
| | configuration | WCDMA Band V Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.152 | 0.332 | 0.484 |
| | Right Tilt | 0.100 | 0.270 | 0.370 |
| | Left Touch | 0.115 | 0.147 | 0.262 |
| | Left Tilt | 0.086 | 0.174 | 0.260 |
| | configuration | WCDMA Band II Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.427 | 0.332 | 0.759 |
| | Right Tilt | 0.299 | 0.270 | 0.569 |
| | Left Touch | 0.648 | 0.147 | **0.795** |
| | Left Tilt | 0.458 | 0.174 | 0.632 |

Simultaneous Transmission Summation Scenario with Bluetooth (Head to Ear)

| Simultaneous TX | Configuration | GSM850 Band Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
|---|---|---|---|---|
| Head | Right Touch | 0.241 | 0.378 | 0.619 |
| | Right Tilt | 0.159 | 0.378 | 0.537 |
| | Left Touch | 0.179 | 0.378 | 0.557 |
| | Left Tilt | 0.145 | 0.378 | 0.523 |
| | Configuration | GPRS850 Band Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.275 | 0.378 | 0.653 |
| | Right Tilt | 0.176 | 0.378 | 0.554 |
| | Left Touch | 0.202 | 0.378 | 0.580 |
| | Left Tilt | 0.168 | 0.378 | 0.546 |
| | Configuration | GSM1900 Band Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.175 | 0.378 | 0.553 |
| | Right Tilt | 0.113 | 0.378 | 0.491 |
| | Left Touch | 0.307 | 0.378 | 0.685 |
| | Left Tilt | 0.184 | 0.378 | 0.562 |
| | Configuration | GPRS1900 Band Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.192 | 0.378 | 0.570 |
| | Right Tilt | 0.124 | 0.378 | 0.502 |
| | Left Touch | 0.314 | 0.378 | 0.692 |
| | Left Tilt | 0.184 | 0.378 | 0.562 |
| | configuration | WCDMA Band V Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.152 | 0.378 | 0.530 |
| | Right Tilt | 0.100 | 0.378 | 0.478 |
| | Left Touch | 0.115 | 0.378 | 0.493 |
| | Left Tilt | 0.086 | 0.378 | 0.464 |
| | configuration | WCDMA Band II Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
| | Right Touch | 0.427 | 0.378 | 0.805 |
| | Right Tilt | 0.299 | 0.378 | 0.677 |
| | Left Touch | 0.648 | 0.378 | **1.026** |
| | Left Tilt | 0.458 | 0.378 | 0.836 |

**Note**

Bluetooth SAR was not required to be measured pre FCC KDB 447498 D01v05r02. Estimated SAR results were used in the above table to determine simultaneous transmission SAR test exclusion.

### 23.5 Body-Won SAR Simultaneous Transmission Analysis

Simultaneous Transmission Summation Scenario with 2.4 GHz WLAN (Body-Worn at 10 mm)

| Simultaneous TX | configuration | GSM850 Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
|---|---|---|---|---|
| Body-Worn | Rear | 0.419 | 0.070 | 0.489 |
| | configuration | GSM1900 Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Rear | 0.398 | 0.070 | 0.468 |
| | configuration | WCDMA Band V Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Rear | 0.230 | 0.070 | 0.300 |
| | configuration | WCDMA Band II Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Rear | 1.074 | 0.070 | **1.144** |

Simultaneous Transmission Summation Scenario with Bluetooth (Body-Worn at 10 mm)

| Simultaneous TX | configuration | GSM850 Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
|---|---|---|---|---|
| Body-Worn | Rear | 0.419 | 0.189 | 0.608 |
| | configuration | GSM1900 Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
| | Rear | 0.398 | 0.189 | 0.687 |
| | configuration | WCDMA Band V Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
| | Rear | 0.230 | 0.189 | 0.419 |
| | configuration | WCDMA Band II Scaled SAR(W/kg) | Bluetooth LE SAR (W/kg) | ∑SAR (W/kg) |
| | Rear | 1.074 | 0.189 | **1.263** |

Note

Bluetooth SAR was not required to be measured pre FCC KDB 447498 D01v05r02. Estimated SAR results were used in the above table to determine simultaneous transmission SAR test exclusion.

### 23.6 Hotspot SAR Simultaneous Transmission Analysis

Simultaneous Transmission Summation Scenario with 2.4 GHz WLAN (Hotspot at 10 mm)

| Simultaneous TX | configuration | GPRS850 Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
|---|---|---|---|---|
| Hotspot | Front | 0.321 | 0.074 | 0.395 |
| | Rear | 0.437 | 0.070 | 0.507 |
| | Right Edge | 0.528 | 0.012 | 0.540 |
| | Left Edge | 0.339 | - | 0.339 |
| | Top | | 0.060 | 0.060 |
| | Bottom | 0.184 | - | 0.184 |
| | configuration | GPRS1900 Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Front | 0.232 | 0.074 | 0.306 |
| | Rear | 0.392 | 0.070 | 0.462 |
| | Right Edge | 0.058 | 0.012 | 0.070 |
| | Left Edge | 0.202 | - | 0.202 |
| | Top | - | 0.060 | 0.060 |
| | Bottom | 0.271 | - | 0.271 |
| | configuration | WCDMA Band V Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Front | 0.144 | 0.074 | 0.218 |
| | Rear | 0.230 | 0.070 | 0.300 |
| | Right Edge | 0.234 | 0.012 | 0.246 |
| | Left Edge | 0.170 | - | 0.170 |
| | Top | - | 0.060 | 0.060 |
| | Bottom | 0.072 | - | 0.072 |
| | configuration | WCDMA Band II Scaled SAR(W/kg) | 2.4 GHz WLAN Scaled SAR (W/kg) | ∑SAR (W/kg) |
| | Front | 0.548 | 0.074 | 0.622 |
| | Rear | 1.079 | 0.070 | **1.149** |
| | Right Edge | 0.129 | 0.012 | 0.141 |
| | Left Edge | 0.481 | - | 0.481 |
| | Top | - | 0.060 | 0.060 |
| | Bottom | 0.643 | - | 0.643 |

Notes.

1. The above numerical summed SAR was below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit. Therefore, no volumetric SAR summation is required since the numerical sums are below the limit.
2. Hotspot Mode Per FCC KDB Publication 941225 D06v01r01, the devices edges with antennas more than 2.5 ㎝ from edge are not required to be evaluated for SAR (“-”).

# Appendixes List

| | |
|---|---|
| **Appendix A** | A.1 Verification Test Plots for 835 MHz (Plots No 1,2)<br>A.2 Verification Test Plots for 1900 MHz (Plots No 3,4,5,6)<br>A.3 Verification Test Plots for 2450 MHz (Plots No 7,8)<br>A.4 Verification Test Plots for 835 (Plots No 23, 24)<br>A.5 SAR Test Plots for GSM850 Band (Plots No 9, 10, 11)<br>A.6 SAR Test Plots for GSM1900 Band (Plots No 12, 13, 14)<br>A.7 SAR Test Plots for WCDMA850 Band (Plots No 15, 16, 17)<br>A.8 SAS Test Plots for WCDMA1900 Band (Plots No 18,19)<br>A.9 SAR Test Plots for WLAN 2.4 GHz (Plots No 20, 21, 22)<br>A.10 SAR Test Plots for GPRS850 3-slot data (Plots No 25, 26) |
| **Appendix B** | B.1 Uncertainty Analysis |
| **Appendix C** | C.1 Calibration certificate for Probe<br>C.2 Calibration certificate for DAE<br>C.3 Calibration certificate for Dipole |

## Appendix A.1 Verification Test Plots for 835 MHz_Head

Date: 2014-05-22

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 835MHz Head System Verification.da53:0

Input Power : 100 mW

Ambient Temp : 23.6 ℃ Tissue Temp : 21.9 ℃

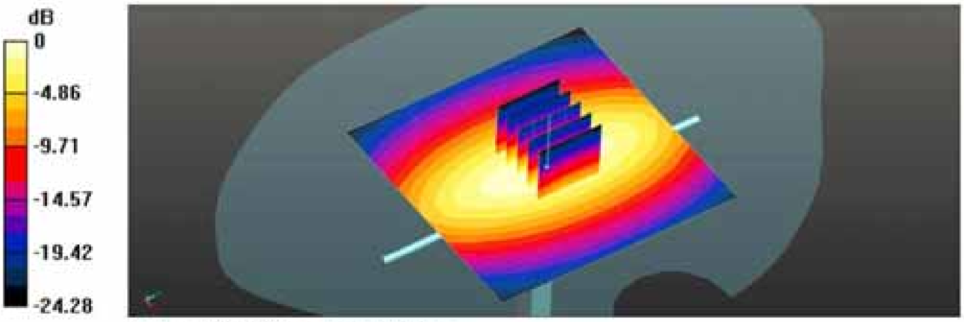
**DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d138**

Communication System: UID 0, CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; σ = 0.898 S/m; $\varepsilon_r$ = 40.701; ρ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**System Verification/835MHz Head System Verification/Area Scan (81x81x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 1.24 W/kg

**System Verification/835MHz Head System Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 38.055 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 1.45 W/kg
**SAR(1 g) = 0.981 W/kg; SAR(10 g) = 0.643 W/kg**
Maximum value of SAR (measured) = 1.24 W/kg




0 dB = 1.24 W/kg = 0.93 dBW/kg

## Appendix A.1 Verification Test Plots for 835 MHz_Body

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 835MHz Body System Verification.da53:0

Input Power : 100 mW

Ambient Temp : 23.7 ℃ Tissue Temp : 22.1 ℃

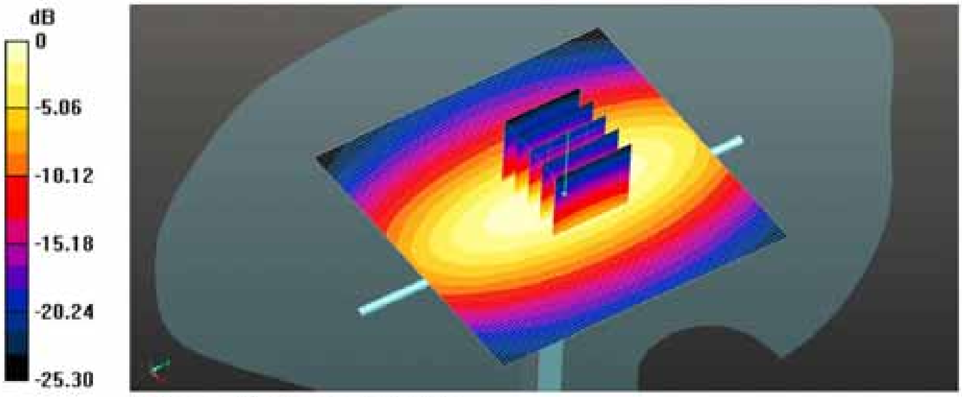
**DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d138**

Communication System: UID 0, CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; $\sigma$ = 0.948 S/m; $\varepsilon_r$ = 55.905; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**System Verification/835MHz Body System Verification/Area Scan (81x81x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 1.17 W/kg

**System Verification/835MHz Body System Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 35.844 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 1.35 W/kg
**SAR(1 g) = 0.937 W/kg; SAR(10 g) = 0.625 W/kg**
Maximum value of SAR (measured) = 1.16 W/kg



0 dB = 1.17 W/kg = 0.68 dBW/kg

## Appendix A.2 Verification Test Plots for 1900 MHz_Head

Date: 2014-05-24

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 1900MHz Head System Verification.da53:0

Inpur Power : 100 mW

Ambient Temp : 23.8 ℃ Tissue Temp : 22.2 ℃

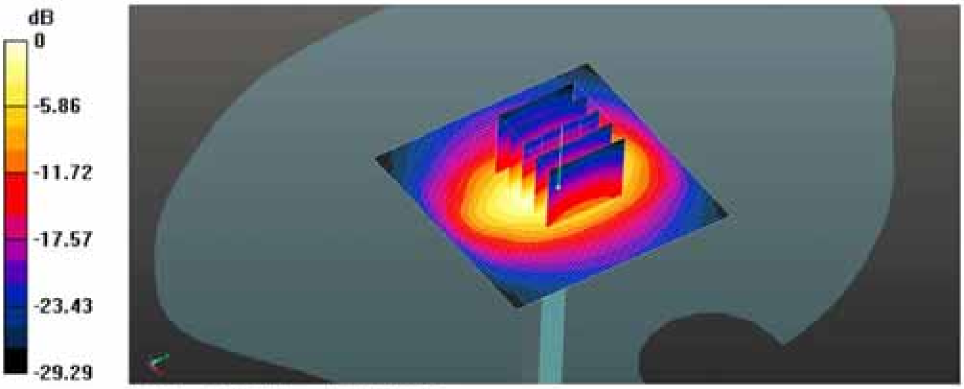
**DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d158**

Communication System: UID 0, CW (0); Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.44 S/m; $\varepsilon_r$ = 39.345; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(8.15, 8.15, 8.15); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Verification/1900MHz Head System Verification/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.99 W/kg

**Verification/1900MHz Head System Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 65.455 V/m; Power Drift = -0.10 dB
Peak SAR (extrapolated) = 7.66 W/kg
**SAR(1 g) = 4.1 W/kg; SAR(10 g) = 2.11 W/kg**
Maximum value of SAR (measured) = 5.95 W/kg




0 dB = 5.99 W/kg = 7.77 dBW/kg

## Appendix A.2 Verification Test Plots for 1900 MHz_Body

Date: 2014-05-25

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 1900MHz Body System Verification.da53:0

Input Power : 100 mW

Ambient Temp : 23.6 ℃ Tissue Temp : 22.0 ℃

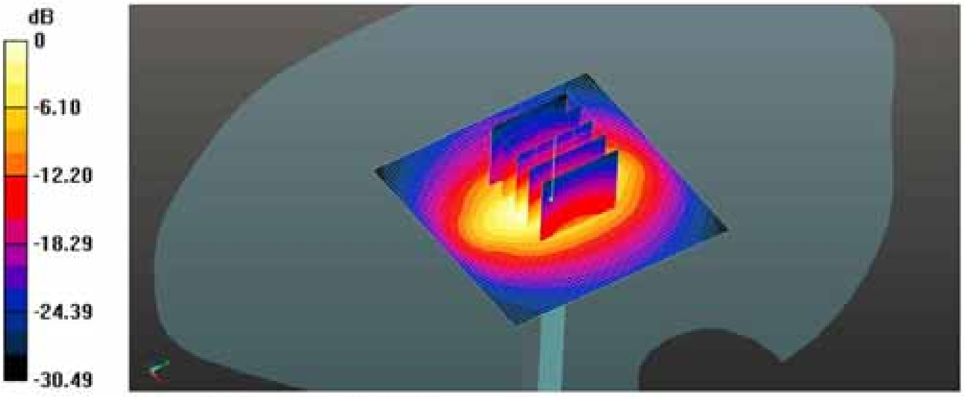
**DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d158**

Communication System: UID 0, CW (0); Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.524 S/m; $\varepsilon_r$ = 53.816; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Verification/1900MHz Body System Verification/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.74 W/kg

**Verification/1900MHz Body System Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 62.614 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 7.18 W/kg
**SAR(1 g) = 4.06 W/kg; SAR(10 g) = 2.13 W/kg**
Maximum value of SAR (measured) = 5.62 W/kg




0 dB = 5.74 W/kg = 7.59 dBW/kg

## Appendix A.2 Verification Test Plots for 1900 MHz_Head

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 1900MHz Head System Verification.da53:0

Input Power : 100 mW

Ambient Temp : 23.4 ℃ Tissue Temp : 21.8 ℃

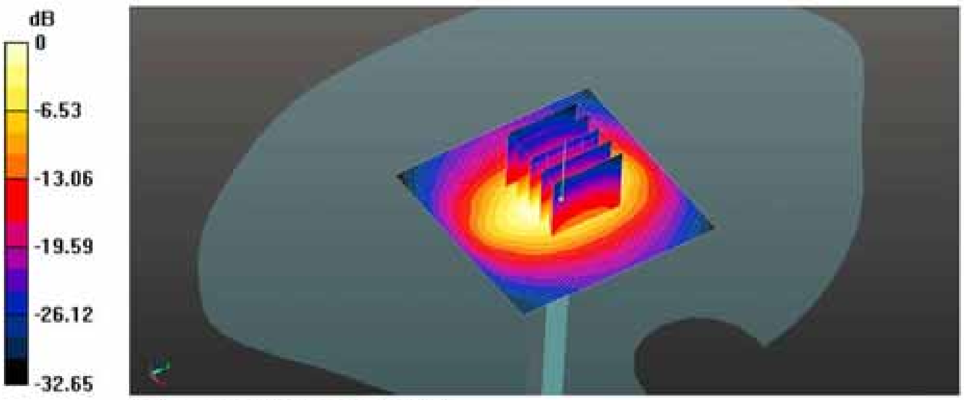
**DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d158**

Communication System: UID 0, CW (0); Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.426 S/m; $\varepsilon_r$ = 39.368; $\rho$ = 1000 kg/$m^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(8.15, 8.15, 8.15); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Verification/1900MHz Head System Verification/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.67 W/kg

**Verification/1900MHz Head System Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 63.850 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 7.12 W/kg
**SAR(1 g) = 3.93 W/kg; SAR(10 g) = 2.05 W/kg**
Maximum value of SAR (measured) = 5.55 W/kg




0 dB = 5.67 W/kg = 7.54 dBW/kg

## Appendix A.2 Verification Test Plots for 1900 MHz_Body

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 1900MHz Body System Verification.da53:0

Input Power : 100 mW

Ambient Temp : 23.4 ℃ Tissue Temp : 21.9 ℃

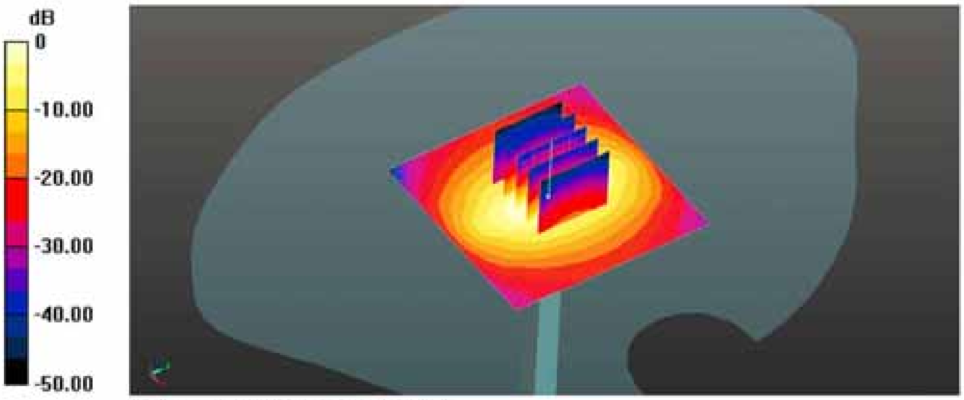
**DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:5d158**

Communication System: UID 0, CW (0); Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.557 S/m; $\varepsilon_r$ = 54.022; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Verification/1900MHz Body System Verification/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.72 W/kg

**Verification/1900MHz Body System Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 61.862 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 7.13 W/kg
**SAR(1 g) = 4.03 W/kg; SAR(10 g) = 2.12 W/kg**
Maximum value of SAR (measured) = 5.62 W/kg




0 dB = 5.72 W/kg = 7.57 dBW/kg

## Appendix A.3 Verification Test Plots for 2450 MHz_Head

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 2450MHz Head System Verification.da53:0

Input Power : 100 mW

Ambient Temp : 23.8 ℃ Tissue Temp : 22.2 ℃

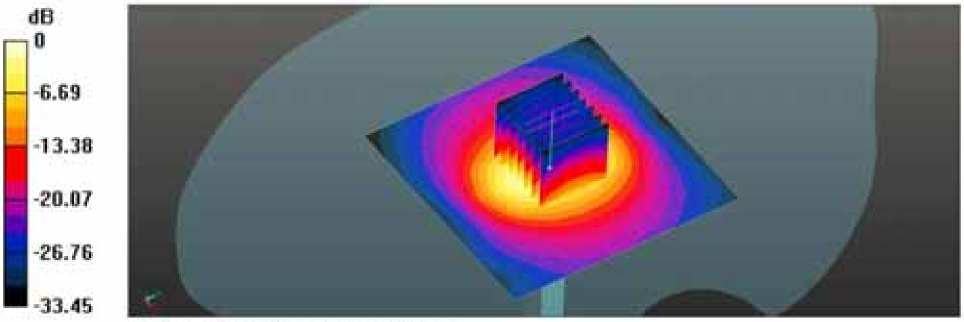
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:892**

Communication System: UID 0, CW (0); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.783 S/m; $\varepsilon_r$ = 38.159; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.24, 7.24, 7.24); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Verification/2450MHz Head System Verification/Area Scan (101x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 8.06 W/kg

**Verification/2450MHz Head System Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 68.082 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 11.2 W/kg
**SAR(1 g) = 5.13 W/kg; SAR(10 g) = 2.33 W/kg**
Maximum value of SAR (measured) = 8.07 W/kg




0 dB = 8.06 W/kg = 9.06 dBW/kg

**Appendix A.3 Verification Test Plots for 2450 MHz_Body**

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 2450MHz Body System Verification.da53:0

Input Power : 100 mW

Ambient Temp : 23.8 ℃ Tissue Temp : 21.9 ℃

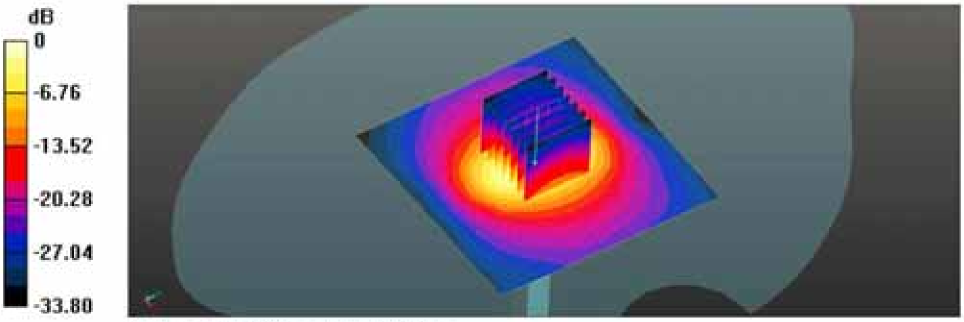
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:892**

Communication System: UID 0, CW (0); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.919 S/m; $\varepsilon_r$ = 52.58; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.17, 7.17, 7.17); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Verification/2450MHz Body System Verification/Area Scan (101x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 7.96 W/kg

**Verification/2450MHz Body System Verification/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 63.435 V/m; Power Drift = 0.13 dB
Peak SAR (extrapolated) = 11.1 W/kg
**SAR(1 g) = 5.13 W/kg; SAR(10 g) = 2.34 W/kg**
Maximum value of SAR (measured) = 8.01 W/kg




0 dB = 7.96 W/kg = 9.01 dBW/kg

**Appendix A.4 Verification Test Plots for 835 MHz_Head**

Date: 2014-07-03

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 835MHz Head System Verification.da53:0

Input Power : 100 mW

Ambient Temp : 23.7 ℃ Tissue Temp : 22.2 ℃

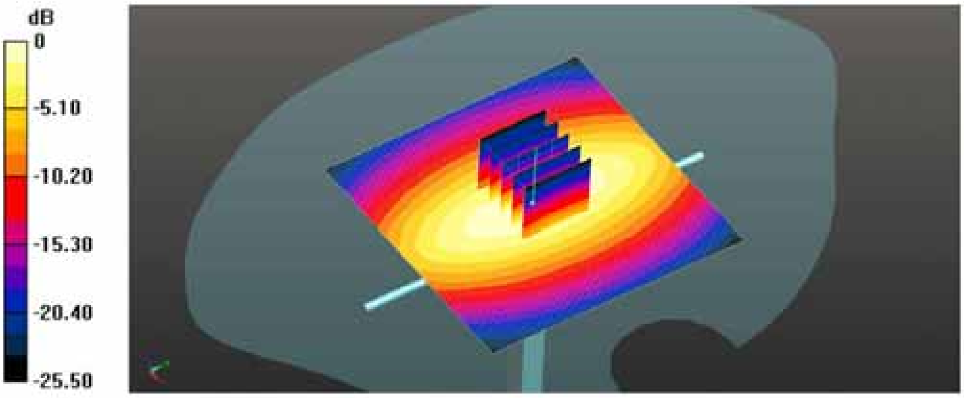
**DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d138**

Communication System: UID 0, CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; $\sigma$ = 0.886 S/m; $\varepsilon_r$ = 40.02; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**System Verification/835MHz Head System Verification/Area Scan (81x81x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 1.16 W/kg

**System Verification/835MHz Head System Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 36.975 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 1.34 W/kg
**SAR(1 g) = 0.913 W/kg; SAR(10 g) = 0.600 W/kg**
Maximum value of SAR (measured) = 1.15 W/kg



0 dB = 1.16 W/kg = 0.64 dBW/kg

**Appendix A.4 Verification Test Plots for 835 MHz_Body**

Date: 2014-07-03

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 835MHz Body System Verification.da53:0

Input Power : 100 mW

Ambient Temp : 23.7 ℃ Tissue Temp : 22.4 ℃

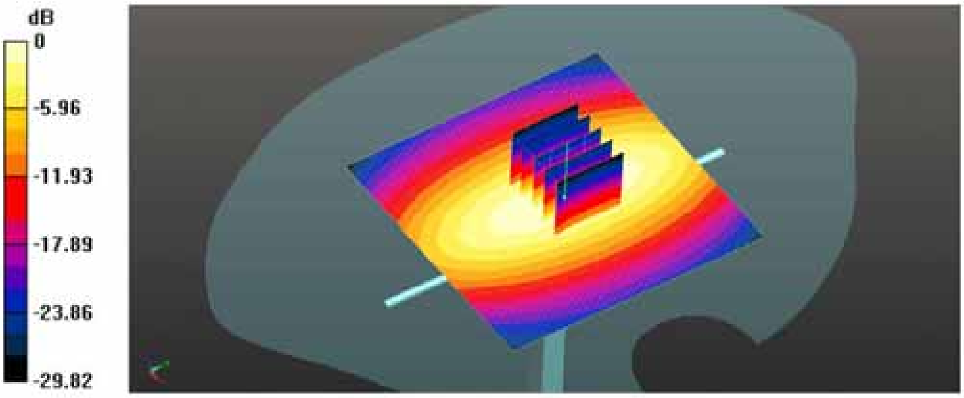
**DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d138**

Communication System: UID 0, CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; $\sigma$ = 0.944 S/m; $\varepsilon_r$ = 53.936; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**System Verification/835MHz Body System Verification/Area Scan (81x81x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 1.17 W/kg

**System Verification/835MHz Body System Verification/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 35.854 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 1.35 W/kg
**SAR(1 g) = 0.933 W/kg; SAR(10 g) = 0.620 W/kg**
Maximum value of SAR (measured) = 1.17 W/kg




0 dB = 1.17 W/kg = 0.68 dBW/kg

## Appendix A.5 SAR Test Plots for GSM850 Band (Head SAR)

Date: 2014-05-22

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: GPRS 850_Right Touch_CH190.da53:0

Ambient Temp : 23.6 ℃ Tissue Temp : 21.9 ℃

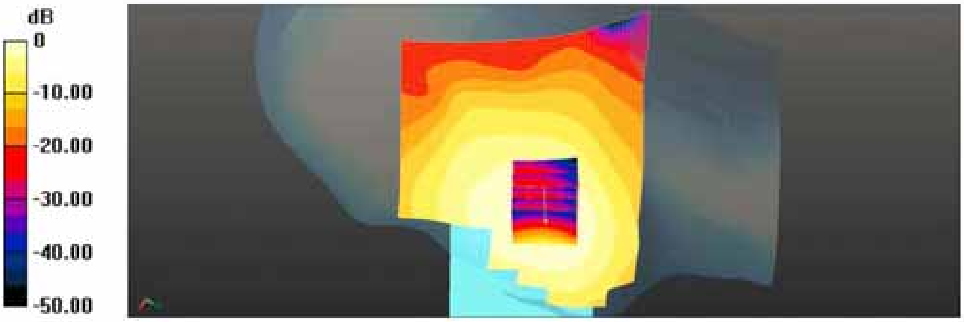
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, GPRS850 2TX (0); Frequency: 836.6 MHz;Duty Cycle: 1:4.14954
Medium parameters used: f = 837 MHz; $\sigma$ = 0.9 S/m; $\varepsilon_r$ = 40.673; $\rho$ = 1000 kg/m$^3$
Phantom section: Right Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Head/GPRS 850_Right Touch_CH190/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.286 W/kg

**Head/GPRS 850_Right Touch_CH190/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 4.792 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 0.309 W/kg
**SAR(1 g) = 0.249 W/kg; SAR(10 g) = 0.192 W/kg**
Maximum value of SAR (measured) = 0.281 W/kg




0 dB = 0.286 W/kg = -5.44 dBW/kg

## Appendix A.5 SAR Test Plots for GSM850 Band (Body-Worn SAR)

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: GSM 850_Rear_CH190.da53:0

Ambient Temp : 23.7 ℃ Tissue Temp : 22.1 ℃

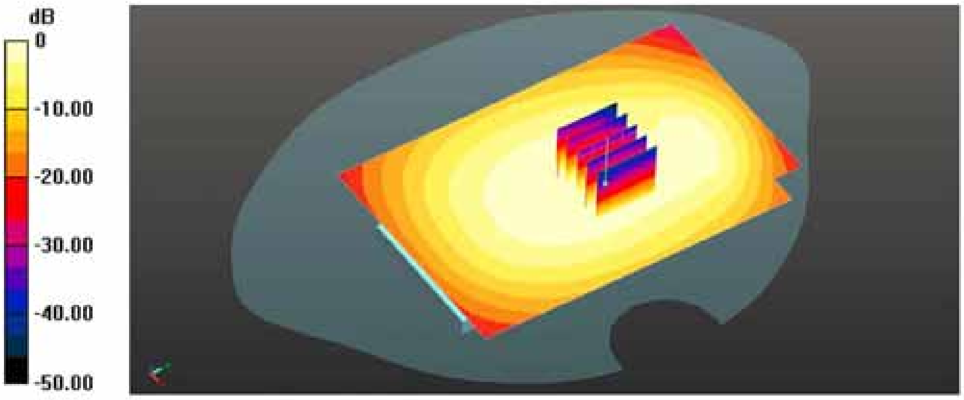
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, GSM850 (0); Frequency: 836.6 MHz;Duty Cycle: 1:8.30042
Medium parameters used: f = 837 MHz; $\sigma = 0.951$ S/m; $\varepsilon_r = 55.879$; $\rho = 1000$ kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Body/GSM 850_Rear_CH190/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.448 W/kg

**Body/GSM 850_Rear_CH190/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 20.650 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.480 W/kg
**SAR(1 g) = 0.391 W/kg; SAR(10 g) = 0.304 W/kg**
Maximum value of SAR (measured) = 0.442 W/kg




0 dB = 0.448 W/kg = -3.49 dBW/kg

## Appendix A.5 SAR Test Plots for GSM850 Band (Hotspot SAR)

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: GPRS 850_Right Edge_CH190.da53:0

Ambient Temp : 23.7 ℃ Tissue Temp : 22.1 ℃

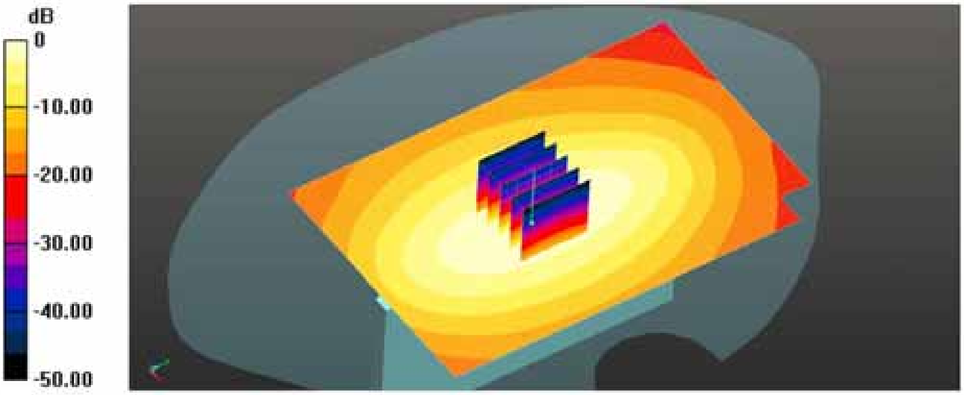
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, GPRS850 2TX (0); Frequency: 836.6 MHz;Duty Cycle: 1:4.14954
Medium parameters used: f = 837 MHz; $\sigma = 0.951$ S/m; $\varepsilon_r = 55.879$; $\rho = 1000$ kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Body/GPRS 850_Right Edge_CH190/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.573 W/kg

**Body/GPRS 850_Right Edge_CH190/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 24.653 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 0.664 W/kg
**SAR(1 g) = 0.478 W/kg; SAR(10 g) = 0.332 W/kg**
Maximum value of SAR (measured) = 0.584 W/kg




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

## Appendix A.6 SAR Test Plots for GSM1900 Band (Head SAR)

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: GPRS 1900_Left Touch_CH661.da53:0

Ambient Temp : 23.4 ℃ Tissue Temp : 21.8 ℃

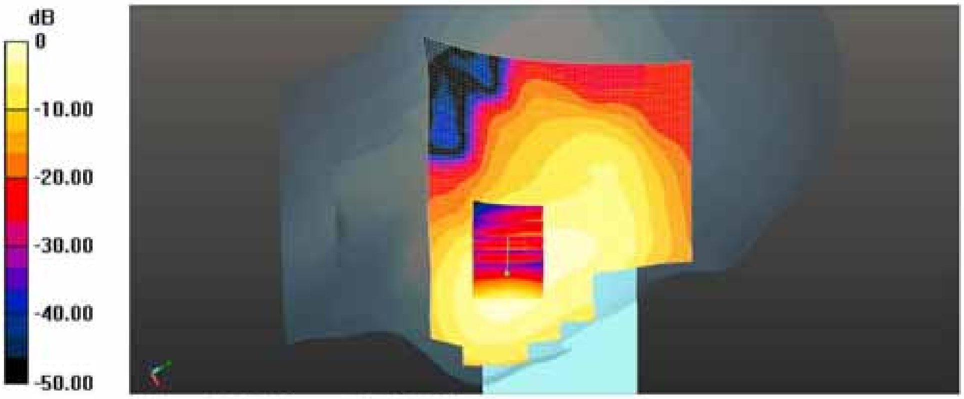
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, GPRS1900 2TX (0); Frequency: 1880 MHz;Duty Cycle: 1:4.14954
Medium parameters used: f = 1880 MHz; $\sigma$ = 1.403 S/m; $\varepsilon_r$ = 39.453; $\rho$ = 1000 kg/m$^3$
Phantom section: Left Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(8.15, 8.15, 8.15); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Head/GPRS 1900_Left Touch_CH661/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.377 W/kg

**Head/GPRS 1900_Left Touch_CH661/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 4.002 V/m; Power Drift = 0.16 dB
Peak SAR (extrapolated) = 0.418 W/kg
**SAR(1 g) = 0.276 W/kg; SAR(10 g) = 0.176 W/kg**
Maximum value of SAR (measured) = 0.351 W/kg



0 dB = 0.377 W/kg = -4.24 dBW/kg

## Appendix A.6 SAR Test Plots for GSM1900 Band (Body-Worn)

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: GSM 1900_Rear_CH661.da53:0

Ambient Temp : 23.4 ℃ Tissue Temp : 21.9 ℃

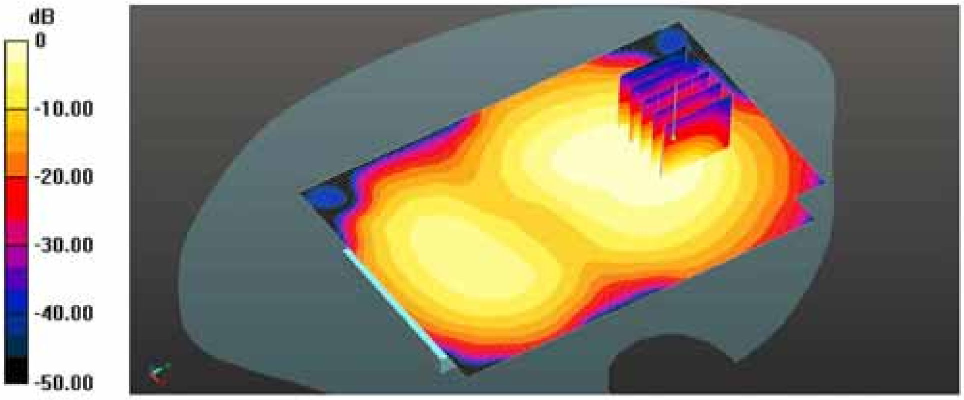
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, PCS1900 (0); Frequency: 1880 MHz;Duty Cycle: 1:8.30042
Medium parameters used: f = 1880 MHz; $\sigma$ = 1.531 S/m; $\varepsilon_r$ = 54.081; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Body/GSM 1900_Rear_CH661/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.436 W/kg

**Body/GSM 1900_Rear_CH661/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 4.385 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 0.667 W/kg
**SAR(1 g) = 0.350 W/kg; SAR(10 g) = 0.186 W/kg**
Maximum value of SAR (measured) = 0.508 W/kg




0 dB = 0.436 W/kg = -3.61 dBW/kg

## Appendix A.6 SAR Test Plots for GSM1900 Band (Hotspot SAR)

Date: 2014-06-10

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: GPRS 1900_Rear_CH661.da53:0

Ambient Temp : 23.4 ℃ Tissue Temp : 21.9 ℃

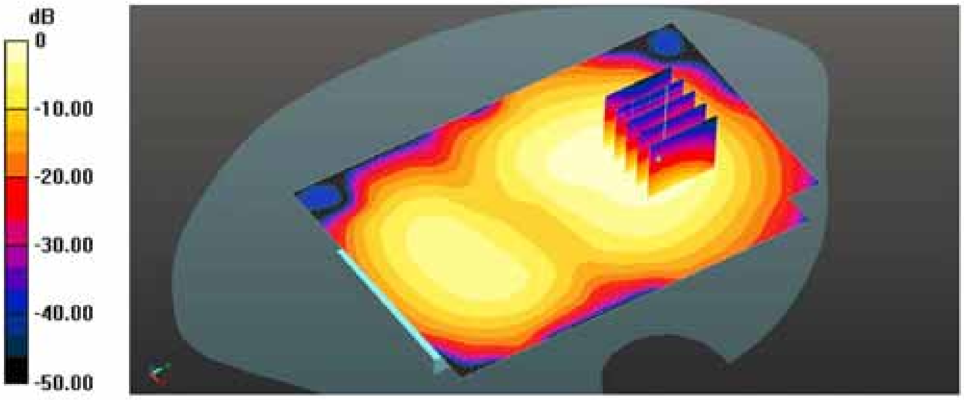
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, GPRS1900 2TX (0); Frequency: 1880 MHz;Duty Cycle: 1:4.14954
Medium parameters used: f = 1880 MHz; $\sigma$ = 1.531 S/m; $\varepsilon_r$ = 54.081; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Body/GPRS 1900_Rear_CH661/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.442 W/kg

**Body/GPRS 1900_Rear_CH661/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 4.080 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.691 W/kg
**SAR(1 g) = 0.363 W/kg; SAR(10 g) = 0.191 W/kg**
Maximum value of SAR (measured) = 0.544 W/kg




0 dB = 0.442 W/kg = -3.55 dBW/kg

**Appendix A.7 SAR Test Plots for WCDMA850 Band (Head SAR)**

Date: 2014-05-22

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: WCDMA 5_Right Touch_CH4183.da53:0

Ambient Temp : 23.6 ℃ Tissue Temp : 21.9 ℃

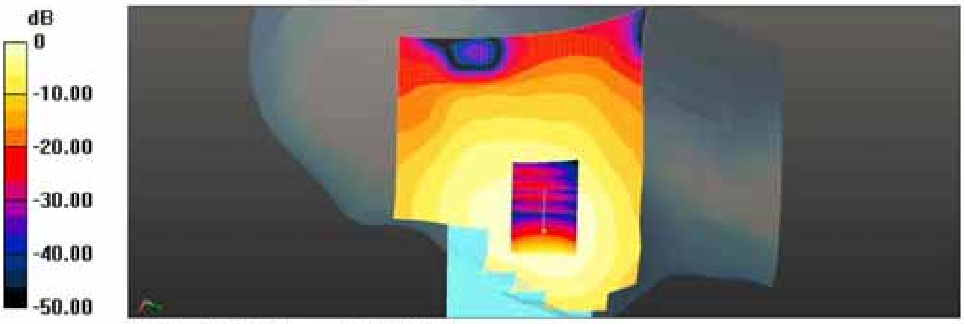
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, WCDMA5 (0); Frequency: 836.6 MHz;Duty Cycle: 1:1
Medium parameters used: f = 837 MHz; σ = 0.9 S/m; $\varepsilon_r$ = 40.673; ρ = 1000 kg/m$^3$
Phantom section: Right Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Head/WCDMA 5_Right Touch_CH4183/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.168 W/kg

**Head/WCDMA 5_Right Touch_CH4183/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 3.093 V/m; Power Drift = 0.15 dB
Peak SAR (extrapolated) = 0.180 W/kg
**SAR(1 g) = 0.145 W/kg; SAR(10 g) = 0.111 W/kg**
Maximum value of SAR (measured) = 0.163 W/kg




0 dB = 0.168 W/kg = -7.75 dBW/kg

## Appendix A.7 SAR Test Plots for WCDMA850 Band (Body-Worn)

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: WCDMA 5_Rear_CH4183.da53:0

Ambient Temp : 23.7 ℃ Tissue Temp : 22.1 ℃

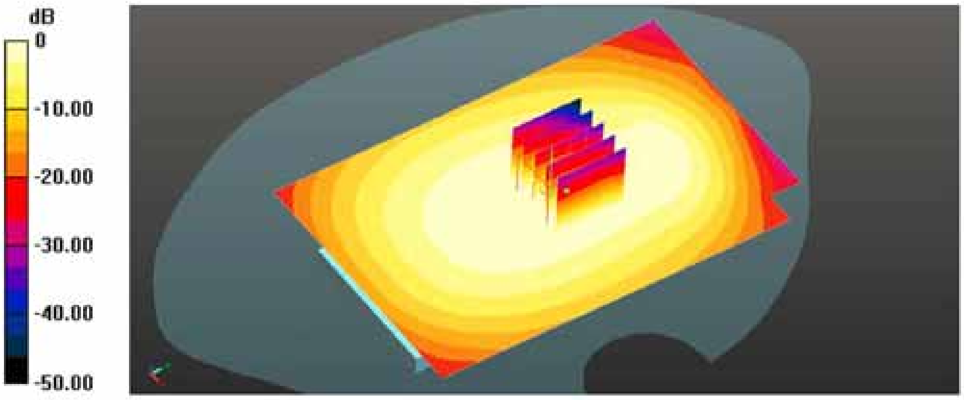
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, WCDMA5 (0); Frequency: 836.6 MHz;Duty Cycle: 1:1
Medium parameters used: f = 837 MHz; σ = 0.951 S/m; $\epsilon_r$ = 55.879; ρ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Body/WCDMA 5_Rear_CH4183/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.249 W/kg

**Body/WCDMA 5_Rear_CH4183/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 15.950 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 0.269 W/kg
**SAR(1 g) = 0.219 W/kg; SAR(10 g) = 0.169 W/kg**
Maximum value of SAR (measured) = 0.247 W/kg




0 dB = 0.249 W/kg = -6.04 dBW/kg

## Appendix A.7 SAR Test Plots for WCDMA850 Band (Hotspot SAR)

Date: 2014-05-23

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: WCDMA 5_Right Edge_CH4183.da53:0

Ambient Temp : 23.7 ℃ Tissue Temp : 22.1 ℃

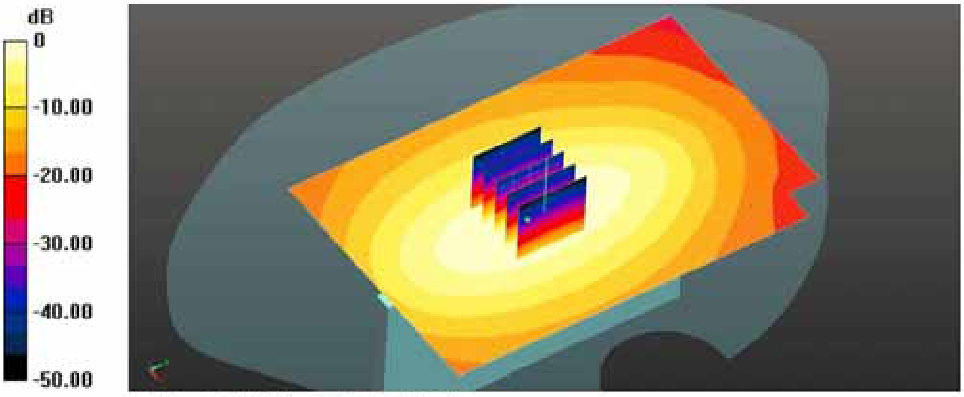
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, WCDMA5 (0); Frequency: 836.6 MHz;Duty Cycle: 1:1
Medium parameters used: f = 837 MHz; $\sigma = 0.951$ S/m; $\varepsilon_r = 55.879$; $\rho = 1000$ kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Body/WCDMA 5_Right Edge_CH4183/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.274 W/kg

**Body/WCDMA 5_Right Edge_CH4183/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 17.188 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 0.307 W/kg
**SAR(1 g) = 0.223 W/kg; SAR(10 g) = 0.156 W/kg**
Maximum value of SAR (measured) = 0.268 W/kg




0 dB = 0.274 W/kg = -5.62 dBW/kg

## Appendix A.8 SAR Test Plots for WCDMA1900 Band (Head SAR)

Date: 2014-05-24

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: WCDMA 2_Left Touch_CH9400.da53:0

Ambient Temp : 23.8 ℃ Tissue Temp : 22.2 ℃

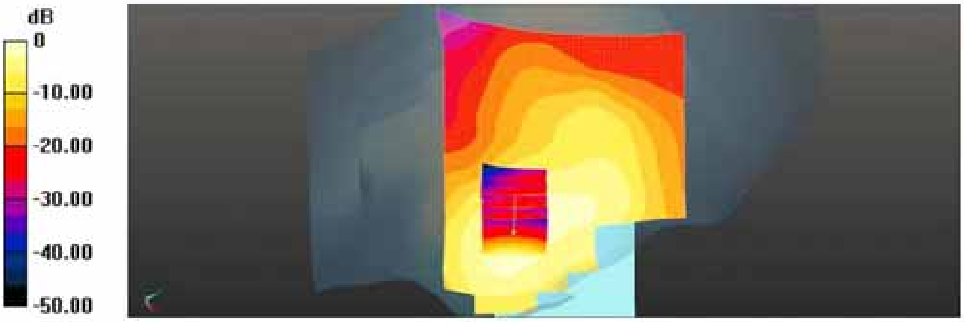
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, WCDMA2 (0); Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1880 MHz; $\sigma$ = 1.426 S/m; $\varepsilon_r$ = 39.47; $\rho$ = 1000 kg/m$^3$
Phantom section: Left Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(8.15, 8.15, 8.15); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Head/WCDMA 2_Left Touch_CH9400/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.791 W/kg

**Head/WCDMA 2_Left Touch_CH9400/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 5.640 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 0.884 W/kg
**SAR(1 g) = 0.566 W/kg; SAR(10 g) = 0.356 W/kg**
Maximum value of SAR (measured) = 0.727 W/kg




0 dB = 0.791 W/kg = -1.02 dBW/kg

**Appendix A.8 SAR Test Plots for WCDMA1900 Band (Body-Worn and Hotspot SAR)**

Date: 2014-05-25

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: WCDMA 2_Rear_CH9262.da53:0

Ambient Temp : 23.6 ℃ Tissue Temp : 22.0 ℃

**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, WCDMA2 (0); Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 1852.4 MHz; $\sigma$ = 1.474 S/m; $\varepsilon_r$ = 53.947; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

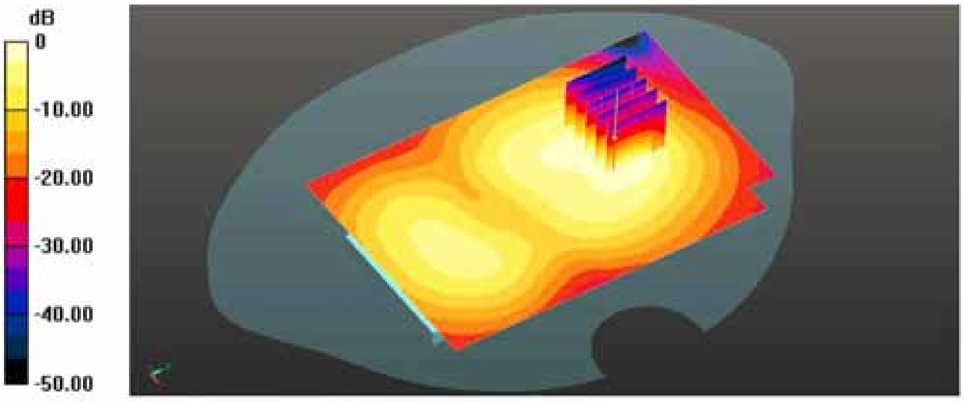
DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.63, 7.63, 7.63); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Body/WCDMA 2_Rear_CH9262/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 1.42 W/kg

**Body/WCDMA 2_Rear_CH9262/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 10.246 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 1.68 W/kg
**SAR(1 g) = 0.938 W/kg; SAR(10 g) = 0.525 W/kg**

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.29 W/kg




0 dB = 1.42 W/kg = 1.52 dBW/kg

## Appendix A.9 SAR Test Plots for WLAN 2.4 GHz Band (Head SAR)

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11b_1Mbps_Right Touch_CH11.da53:0

Ambient Temp : 23.8 ℃ Tissue Temp : 22.2 ℃

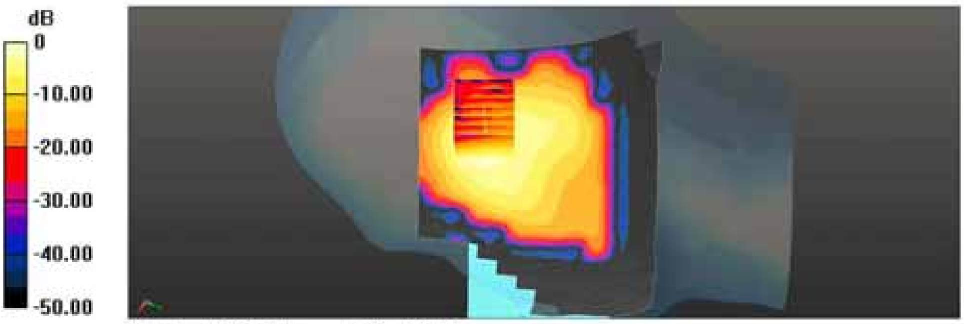
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, WLAN 2.45GHz (0); Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2462 MHz; $\sigma$ = 1.796 S/m; $\varepsilon_r$ = 38.11; $\rho$ = 1000 kg/m$^3$
Phantom section: Right Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.24, 7.24, 7.24); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Head/WLAN_802.11b_1Mbps_Right Touch_CH11/Area Scan (121x161x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.387 W/kg

**Head/WLAN_802.11b_1Mbps_Right Touch_CH11/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.660 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 0.511 W/kg
**SAR(1 g) = 0.223 W/kg; SAR(10 g) = 0.106 W/kg**
Maximum value of SAR (measured) = 0.343 W/kg



0 dB = 0.387 W/kg = -4.12 dBW/kg

## Appendix A.9 SAR Test Plots for WLAN 2.4 GHz Band (Body-Worn)

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11b_1Mbps_Rear_CH11.da53:0

Ambient Temp : 23.8 ℃ Tissue Temp : 21.9 ℃

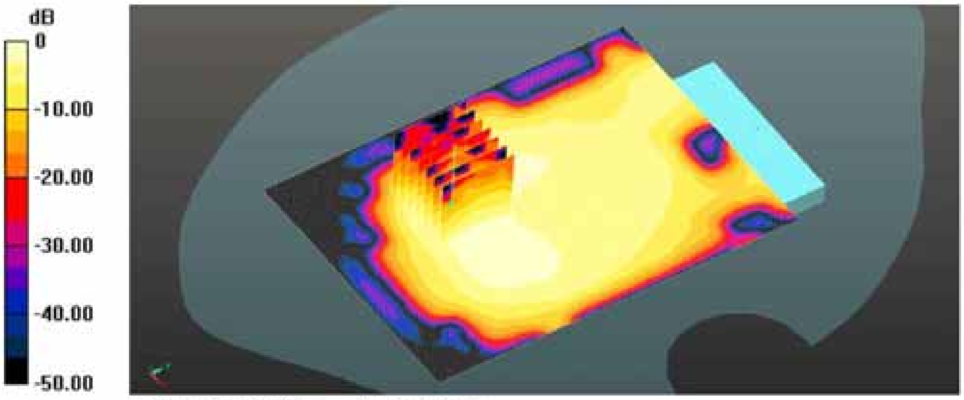
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, WLAN 2.45GHz (0); Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2462 MHz; σ = 1.934 S/m; $\varepsilon_r$ = 52.535; ρ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.17, 7.17, 7.17); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Head/WLAN_802.11b_1Mbps_Rear_CH11/Area Scan (111x151x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.0732 W/kg

**Head/WLAN_802.11b_1Mbps_Rear_CH11/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.541 V/m; Power Drift = 0.19 dB
Peak SAR (extrapolated) = 0.102 W/kg
**SAR(1 g) = 0.047 W/kg; SAR(10 g) = 0.023 W/kg**
Maximum value of SAR (measured) = 0.0723 W/kg




0 dB = 0.0732 W/kg = -11.35 dBW/kg

## Appendix A.9 SAR Test Plots for WLAN 2.4 GHz Band (Hotspot SAR)

Date: 2014-05-28

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: WLAN_802.11b_1Mbps_Front_CH11.da53:0

Ambient Temp : 23.8 ℃ Tissue Temp : 21.9 ℃

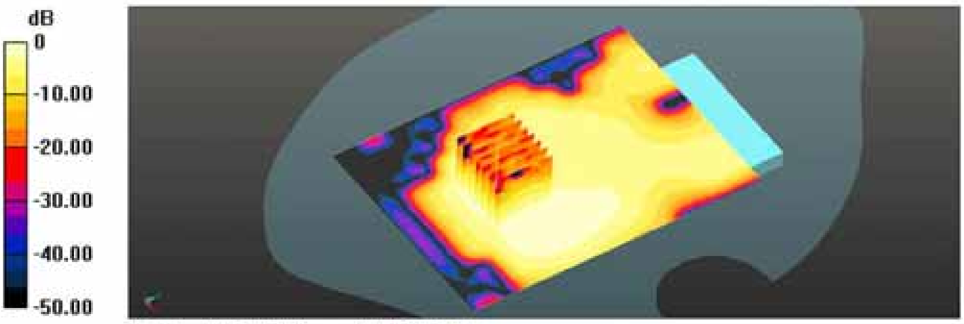
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, WLAN 2.45GHz (0); Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2462 MHz; $\sigma$ = 1.934 S/m; $\varepsilon_r$ = 52.535; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(7.17, 7.17, 7.17); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn614; Calibrated: 2013-09-20
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Head/WLAN_802.11b_1Mbps_Front_CH11/Area Scan (111x151x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.0711 W/kg

**Head/WLAN_802.11b_1Mbps_Front_CH11/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.546 V/m; Power Drift = 0.16 dB
Peak SAR (extrapolated) = 0.0950 W/kg
**SAR(1 g) = 0.050 W/kg; SAR(10 g) = 0.027 W/kg**
Maximum value of SAR (measured) = 0.0702 W/kg




0 dB = 0.0711 W/kg = -11.48 dBW/kg

**Appendix A.10 SAR Test Plots for GPRS850 3-slot data (Head SAR)**

Date: 2014-07-03

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: GPRS 850_Right Touch_CH190.da53:0

Ambient Temp : 23.7 ℃ Tissue Temp : 22.2 ℃

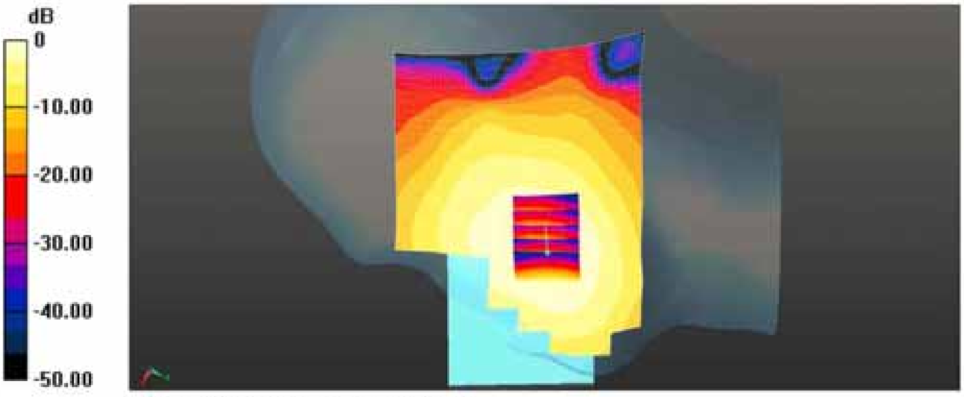
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, GPRS850 3TX (0); Frequency: 836.6 MHz;Duty Cycle: 1:2.77013
Medium parameters used: f = 837 MHz; $\sigma$ = 0.888 S/m; $\varepsilon_r$ = 39.995; $\rho$ = 1000 kg/m$^3$
Phantom section: Right Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.76, 9.76, 9.76); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP v5.0; Type: QD000P40CD; Serial: TP:1721
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Head/GPRS 850_Right Touch_CH190/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.283 W/kg

**Head/GPRS 850_Right Touch_CH190/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 4.008 V/m; Power Drift = 0.15 dB
Peak SAR (extrapolated) = 0.307 W/kg
**SAR(1 g) = 0.251 W/kg; SAR(10 g) = 0.194 W/kg**
Maximum value of SAR (measured) = 0.278 W/kg




0 dB = 0.283 W/kg = -5.48 dBW/kg

**Appendix A.10 SAR Test Plots for GPRS850 3-slot data (Hotspot SAR)**

Date: 2014-07-03

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: GPRS 850_Right Edge_CH190.da53:0

Ambient Temp : 23.7 ℃ Tissue Temp : 22.4 ℃

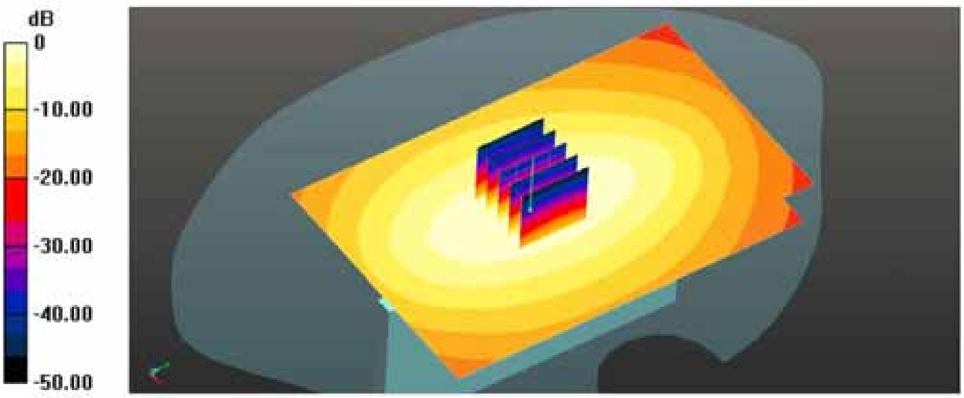
**DUT: LG-D724; Type: Cellular/PCS GSM/GPRS/EDGE RX Only/WCDMA/HSDPA/HSUPA Phone with Bluetooth, WLAN; Serial: 404KPCA642467**

Communication System: UID 0, GPRS850 3TX (0); Frequency: 836.6 MHz;Duty Cycle: 1:2.77013
Medium parameters used: f = 837 MHz; σ = 0.946 S/m; $\varepsilon_r$ = 53.911; ρ = 1000 kg/m$^3$
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN3862; ConvF(9.52, 9.52, 9.52); Calibrated: 2014-01-29;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1340; Calibrated: 2014-05-19
- Phantom: SAM with CRP; Type: SAM; Serial: TP:1720
- DASY52 52.8.7(1137)SEMCAD X 14.6.10(7164)

**Body/GPRS 850_Right Edge_CH190/Area Scan (81x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.579 W/kg

**Body/GPRS 850_Right Edge_CH190/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 24.856 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 0.645 W/kg
**SAR(1 g) = 0.486 W/kg; SAR(10 g) = 0.349 W/kg**
Maximum value of SAR (measured) = 0.579 W/kg




0 dB = 0.579 W/kg = -2.37 dBW/kg

**Appendix B.1 Uncertainty Analysis**

Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram

| a | b | c | d | e = f(d,k) | g | i = cxg/e | k |
|---|---|---|---|---|---|---|---|
| Uncertainty Component | Section in P1528 | Tol (%) | Prob . Dist. | Div. | Ci (1g) | 1g ui (%) | Vi (Veff) |
| Probe calibration | E.2.1 | 6.0 | N | 1 | 1 | 6.0 | ∞ |
| Axial isotropy | E.2.2 | 4.7 | R | 1.73 | 0.71 | 1.93 | ∞ |
| hemispherical isotropy | E.2.2 | 9.6 | R | 1.73 | 0.71 | 3.94 | ∞ |
| Boundary effect | E.2.3 | 1.0 | R | 1.73 | 1 | 0.58 | ∞ |
| Linearity | E.2.4 | 4.7 | R | 1.73 | 1 | 2.72 | ∞ |
| System detection limit | E.2.5 | 0.3 | R | 1.73 | 1 | 0.17 | ∞ |
| Readout electronics | E.2.6 | 0.3 | N | 1 | 1 | 0.30 | ∞ |
| Response time | E.2.7 | 0.5 | R | 1.73 | 1 | 0.29 | ∞ |
| Integration time | E.2.8 | 2.6 | R | 1.73 | 1 | 1.50 | ∞ |
| RF ambient Condition -Noise | E.6.1 | 3 | R | 1.73 | 1 | 1.73 | ∞ |
| RF ambient Condition - reflections | E.6.1 | 3 | R | 1.73 | 1 | 1.73 | ∞ |
| Probe positioning- mechanical tolerance | E.6.2 | 1.5 | R | 1.73 | 1 | 0.87 | ∞ |
| Probe positioning- with respect to phantom | E.6.3 | 2.9 | R | 1.73 | 1 | 1.68 | ∞ |
| Max. SAR evaluation | E.5.2 | 1.0 | R | 1.73 | 1 | 0.58 | ∞ |
| Test sample positioning | E.4.2 | 1.32 | N | 1 | 1 | 1.32 | 9 |
| Device holder uncertainty | E.4.1 | 3.6 | N | 1 | 1 | 3.60 | 4 |
| Output power variation -SAR drift measurement | 6.6.3 | 5 | R | 1.73 | 1 | 2.89 | ∞ |
| Phantom uncertainty (shape and thickness tolerances) | E.3.1 | 4 | R | 1.73 | 1 | 2.31 | ∞ |
| Liquid conductivity – deviation from target values | E.3.2 | 5 | R | 1.73 | 0.64 | 1.85 | ∞ |
| Liquid conductivity - measurement uncertainty | E.3.2 | 0.38 | N | 1 | 0.64 | 0.24 | 9 |
| Liquid permittivity – deviation from target values | E.3.3 | 5 | R | 1.73 | 0.6 | 1.73 | ∞ |
| Liquid permittivity – deviation from target values | E.3.3 | 0.27 | N | 1 | 0.6 | 0.16 | 9 |
| Combined standard uncertainty | | | | RSS | | 10.82 | 287 |
| Expanded uncertainty (95% CONFIDENCE INTERVAL) | | | | *k*=2 | | **21.00** | |

Measurement uncertainty for 3 GHz to 6 GHz averaged over 1 gram

| a | b | c | d | e = f(d,k) | g | i = cxg/e | k |
|---|---|---|---|---|---|---|---|
| Uncertainty Component | Section in P1528 | Tol (%) | Prob . Dist. | Div. | Ci (1g) | 1g ui (%) | Vi (Veff) |
| Probe calibration | E.2.1 | 6.55 | N | 1 | 1 | 6.55 | ∞ |
| Axial isotropy | E.2.2 | 4.7 | R | 1.73 | 0.71 | 1.93 | ∞ |
| hemispherical isotropy | E.2.2 | 9.6 | R | 1.73 | 0.71 | 3.94 | ∞ |
| Boundary effect | E.2.3 | 1.0 | R | 1.73 | 1 | 0.58 | ∞ |
| Linearity | E.2.4 | 4.7 | R | 1.73 | 1 | 2.72 | ∞ |
| System detection limit | E.2.5 | 0.3 | R | 1.73 | 1 | 0.17 | ∞ |
| Readout electronics | E.2.6 | 0.3 | N | 1 | 1 | 0.30 | ∞ |
| Response time | E.2.7 | 0.5 | R | 1.73 | 1 | 0.29 | ∞ |
| Integration time | E.2.8 | 2.6 | R | 1.73 | 1 | 1.50 | ∞ |
| RF ambient Condition -Noise | E.6.1 | 3 | R | 1.73 | 1 | 1.73 | ∞ |
| RF ambient Condition - reflections | E.6.1 | 3 | R | 1.73 | 1 | 1.73 | ∞ |
| Probe positioning- mechanical tolerance | E.6.2 | 1.5 | R | 1.73 | 1 | 0.87 | ∞ |
| Probe positioning- with respect to phantom | E.6.3 | 2.9 | R | 1.73 | 1 | 1.68 | ∞ |
| Max. SAR evaluation | E.5.2 | 1.0 | R | 1.73 | 1 | 0.58 | ∞ |
| Test sample positioning | E.4.2 | 1.32 | N | 1 | 1 | 1.32 | 9 |
| Device holder uncertainty | E.4.1 | 3.6 | N | 1 | 1 | 3.60 | 4 |
| Output power variation -SAR drift measurement | 6.6.3 | 5 | R | 1.73 | 1 | 2.89 | ∞ |
| Phantom uncertainty (shape and thickness tolerances) | E.3.1 | 4 | R | 1.73 | 1 | 2.31 | ∞ |
| Liquid conductivity – deviation from target values | E.3.2 | 5 | R | 1.73 | 0.64 | 1.85 | ∞ |
| Liquid conductivity - measurement uncertainty | E.3.2 | 0.38 | N | 1 | 0.64 | 0.24 | 9 |
| Liquid permittivity – deviation from target values | E.3.3 | 5 | R | 1.73 | 0.6 | 1.73 | ∞ |
| Liquid permittivity – deviation from target values | E.3.3 | 0.27 | N | 1 | 0.6 | 0.16 | 9 |
| Combined standard uncertainty | | | | RSS | | 10.82 | 324 |
| Expanded uncertainty (95% CONFIDENCE INTERVAL) | | | | *k*=2 | | **21.64** | |

## Appendix C.1 Calibration certificate for Probe_S/N 3862

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

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

Accreditation No.: **SCS 108**

Client **SGS (Dymstec)**

Certificate No: **EX3-3862_Jan14**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3862 |
| Calibration procedure(s) | QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | January 29, 2014 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter E4419B | GB41293874 | 04-Apr-13 (No. 217-01733) | Apr-14 |
| Power sensor E4412A | MY41498087 | 04-Apr-13 (No. 217-01733) | Apr-14 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 04-Apr-13 (No. 217-01737) | Apr-14 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 04-Apr-13 (No. 217-01735) | Apr-14 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 04-Apr-13 (No. 217-01738) | Apr-14 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-13 (No. ES3-3013_Dec13) | Dec-14 |
| DAE4 | SN: 660 | 13-Dec-13 (No. DAE4-660_Dec13) | Dec-14 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 30, 2014

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

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Accreditation No.: **SCS 108**

## Glossary:

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

## Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: 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 ≤ 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 *NORMx,y,z * 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 ± 50 MHz to ± 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 *NORMx* (no uncertainty required).

# Probe EX3DV4

## SN:3862

Manufactured: February 2, 2012
Calibrated: January 29, 2014

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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3862

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm (μV/(V/m)$^2$)[A] | 0.43 | 0.44 | 0.37 | ± 10.1 % |
| DCP (mV)[B] | 108.2 | 99.9 | 104.9 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 152.2 | ±3.3 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 154.0 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 191.1 | |

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%.

[A] The uncertainties of NormX,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3862

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 835 | 41.5 | 0.90 | 9.76 | 9.76 | 9.76 | 0.16 | 1.67 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 9.63 | 9.63 | 9.63 | 0.31 | 0.93 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 8.37 | 8.37 | 8.37 | 0.80 | 0.56 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 8.15 | 8.15 | 8.15 | 0.51 | 0.72 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 7.69 | 7.69 | 7.69 | 0.30 | 0.92 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.24 | 7.24 | 7.24 | 0.32 | 0.85 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 4.89 | 4.89 | 4.89 | 0.31 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.77 | 4.77 | 4.77 | 0.31 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.72 | 4.72 | 4.72 | 0.32 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.59 | 4.59 | 4.59 | 0.30 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.25 | 4.25 | 4.25 | 0.35 | 1.80 | ± 13.1 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) 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 (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] 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.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3862

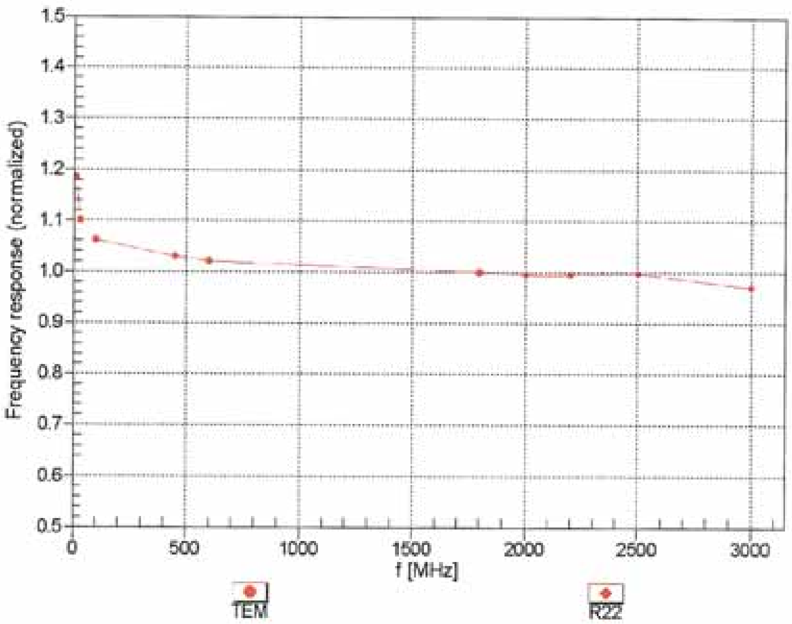
## Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 835 | 55.2 | 0.97 | 9.52 | 9.52 | 9.52 | 0.31 | 1.06 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 8.09 | 8.09 | 8.09 | 0.54 | 0.71 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.63 | 7.63 | 7.63 | 0.25 | 1.04 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.17 | 7.17 | 7.17 | 0.80 | 0.50 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 4.46 | 4.46 | 4.46 | 0.35 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.21 | 4.21 | 4.21 | 0.38 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 4.04 | 4.04 | 4.04 | 0.38 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 4.06 | 4.06 | 4.06 | 0.32 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 4.08 | 4.08 | 4.08 | 0.44 | 1.90 | ± 13.1 % |

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) 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 (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] 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.

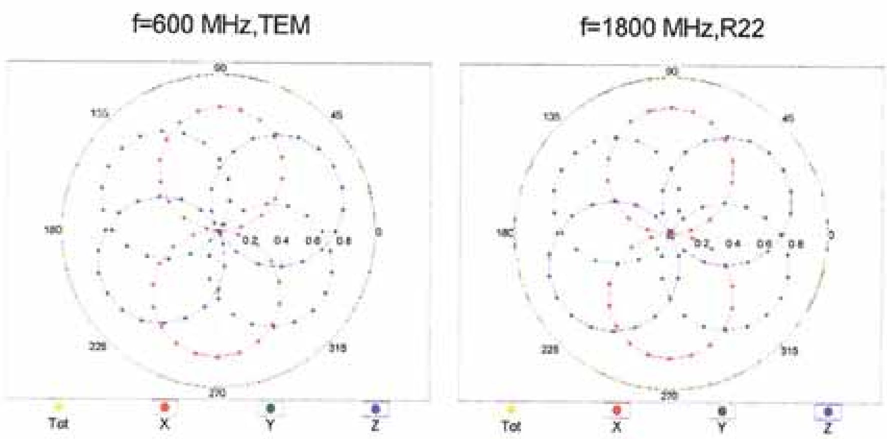
# Frequency Response of E-Field

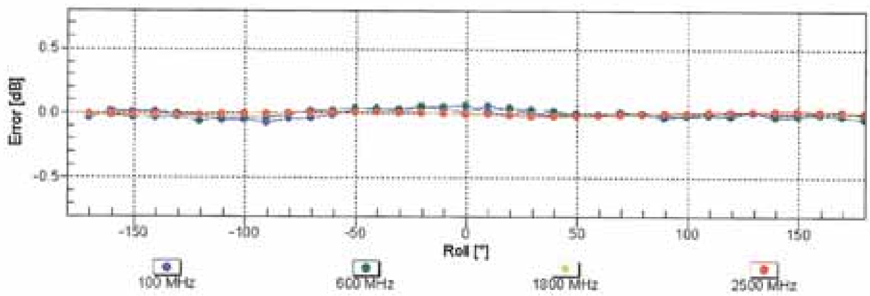
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**




**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

# Receiving Pattern (ϕ), ϑ = 0°

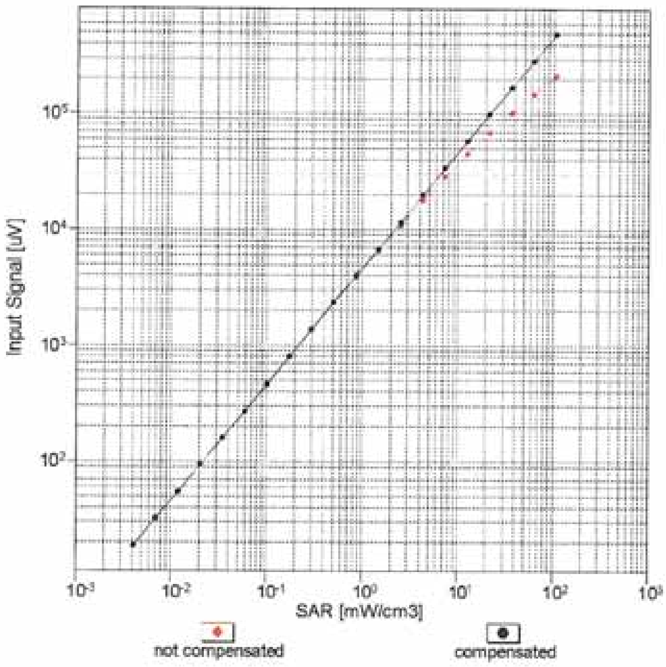


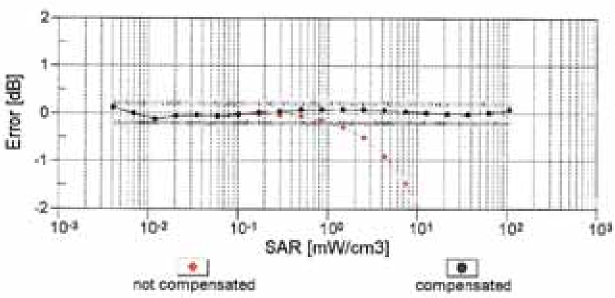




**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

# Dynamic Range f(SAR$_{head}$)

**(TEM cell , f = 900 MHz)**

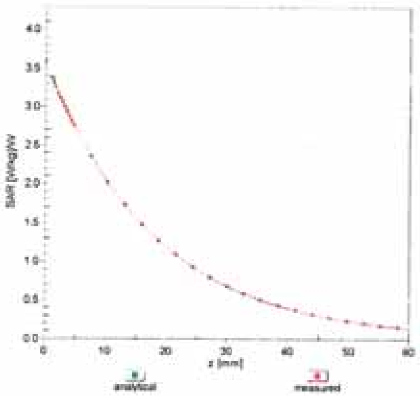


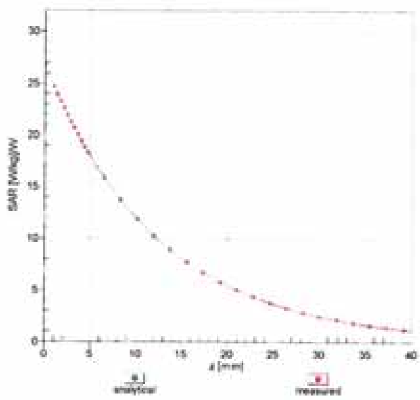

**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

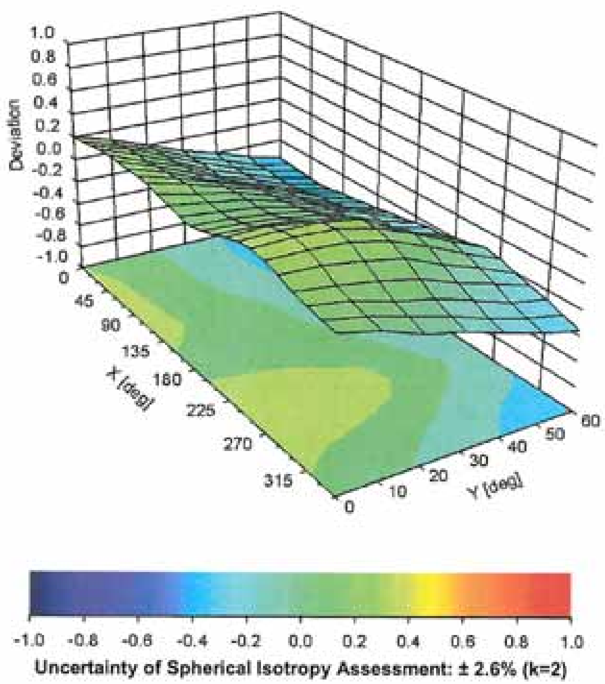



f = 1750 MHz,WGLS R22 (H_convF)




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




**Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)**

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3862

### Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -70.6 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 2 mm |

## Appendix C.2 Calibration certificate for DAE S/N 614

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

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Accreditation No.: **SCS 108**

Client: Dymstec

Certificate No: DAE4-614_Sep13

# CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BM - SN: 614

Calibration procedure(s): QA CAL-06.v26
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: September 20, 2013

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Keithley Multimeter Type 2001 | SN: 0810278 | 02-Oct-12 (No:12728) | Oct-13 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Auto DAE Calibration Unit | SE UWS 053 AA 1001 | 07-Jan-13 (in house check) | In house check: Jan-14 |
| Calibrator Box V2.1 | SE UMS 006 AA 1002 | 07-Jan-13 (in house check) | In house check: Jan-14 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | R.Mayoraz | Technician | R. Mayoraz |
| Approved by: | Fin Bomholt | Deputy Technical Manager | i.V. Blum |

Issued: September 20, 2013

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

Certificate No: DAE4-614_Sep13 Page 1 of 5

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Accreditation No.: **SCS 108**

## Glossary

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

## Methods Applied and Interpretation of Parameters

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

## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

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

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

| Calibration Factors | X | Y | Z |
|---|---|---|---|
| High Range | 403.807 ± 0.02% (k=2) | 404.319 ± 0.02% (k=2) | 404.934 ± 0.02% (k=2) |
| Low Range | 3.94988 ± 1.50% (k=2) | 3.96241 ± 1.50% (k=2) | 3.99962 ± 1.50% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 224.5 ° ± 1 ° |

## Appendix

### 1. DC Voltage Linearity

| High Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 199996.56 | -0.37 | -0.00 |
| Channel X | + Input | 20005.71 | 5.55 | 0.03 |
| Channel X | - Input | -19997.19 | 4.15 | -0.02 |
| Channel Y | + Input | 199997.81 | 1.11 | 0.00 |
| Channel Y | + Input | 20004.00 | 3.84 | 0.02 |
| Channel Y | - Input | -20000.85 | 0.52 | -0.00 |
| Channel Z | + Input | 199994.41 | -2.32 | -0.00 |
| Channel Z | + Input | 20002.11 | 1.93 | 0.01 |
| Channel Z | - Input | -20002.26 | -0.91 | 0.00 |

| Low Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 2001.50 | 1.30 | 0.06 |
| Channel X | + Input | 201.44 | 0.70 | 0.35 |
| Channel X | - Input | -199.12 | -0.01 | 0.00 |
| Channel Y | + Input | 2000.48 | 0.22 | 0.01 |
| Channel Y | + Input | 199.97 | -0.81 | -0.41 |
| Channel Y | - Input | -200.69 | -1.50 | 0.76 |
| Channel Z | + Input | 2000.24 | 0.06 | 0.00 |
| Channel Z | + Input | 199.28 | -1.43 | -0.71 |
| Channel Z | - Input | -200.15 | -0.98 | 0.49 |

### 2. Common mode sensitivity

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

| | Common mode Input Voltage (mV) | High Range Average Reading (μV) | Low Range Average Reading (μV) |
|---|---|---|---|
| Channel X | 200 | 0.68 | -0.63 |
| | - 200 | 2.07 | 0.49 |
| Channel Y | 200 | 7.44 | 7.07 |
| | - 200 | -9.49 | -9.32 |
| Channel Z | 200 | -11.32 | -11.48 |
| | - 200 | 10.34 | 10.30 |

### 3. Channel separation

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

| | Input Voltage (mV) | Channel X (μV) | Channel Y (μV) | Channel Z (μV) |
|---|---|---|---|---|
| Channel X | 200 | - | 4.11 | 0.42 |
| Channel Y | 200 | 9.94 | - | 5.29 |
| Channel Z | 200 | 5.90 | 6.43 | - |

## 4. AD-Converter Values with inputs shorted

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

| | High Range (LSB) | Low Range (LSB) |
|---|---|---|
| Channel X | 16250 | 17197 |
| Channel Y | 16372 | 16866 |
| Channel Z | 16119 | 17003 |

## 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

| | Average (μV) | min. Offset (μV) | max. Offset (μV) | Std. Deviation (μV) |
|---|---|---|---|---|
| Channel X | 0.36 | -0.77 | 1.54 | 0.50 |
| Channel Y | -0.93 | -2.14 | 0.95 | 0.48 |
| Channel Z | -1.04 | -2.00 | -0.03 | 0.45 |

## 6. Input Offset Current

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

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

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

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

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

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

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

## Appendix C.2 Calibration certificate for DAE S/N 1340

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

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Accreditation No.: **SCS 108**

Client **SGS (Dymstec)**

Certificate No: **DAE4-1340_May14**

2014. 6. 2

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE4 - SD 000 D04 BJ - SN: 1340 |
| Calibration procedure(s) | QA CAL-06.v26<br>Calibration procedure for the data acquisition electronics (DAE) |
| Calibration date: | May 19, 2014 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Keithley Multimeter Type 2001 | SN: 0810278 | 01-Oct-13 (No:13976) | Oct-14 |
| **Secondary Standards** | **ID #** | **Check Date (in house)** | **Scheduled Check** |
| Auto DAE Calibration Unit | SE UWS 053 AA 1001 | 07-Jan-14 (in house check) | In house check: Jan-15 |
| Calibrator Box V2.1 | SE UMS 006 AA 1002 | 07-Jan-14 (in house check) | In house check: Jan-15 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Dominique Steffen | Technician | |
| Approved by: | Fin Bomholt | Deputy Technical Manager | i.V. |

Issued: May 19, 2014

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

Certificate No: DAE4-1340_May14 Page 1 of 5

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Accreditation No.: **SCS 108**

## Glossary

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

## Methods Applied and Interpretation of Parameters

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

## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

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

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

| Calibration Factors | X | Y | Z |
|---|---|---|---|
| High Range | 404.444 ± 0.02% (k=2) | 404.371 ± 0.02% (k=2) | 404.455 ± 0.02% (k=2) |
| Low Range | 3.98216 ± 1.50% (k=2) | 3.98232 ± 1.50% (k=2) | 4.01144 ± 1.50% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 255.5 ° ± 1 ° |

## Appendix

### 1. DC Voltage Linearity

| High Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 199996.75 | 0.62 | 0.00 |
| Channel X | + Input | 20002.86 | 2.07 | 0.01 |
| Channel X | - Input | -19998.70 | 2.14 | -0.01 |
| Channel Y | + Input | 199998.47 | 2.32 | 0.00 |
| Channel Y | + Input | 19998.25 | -2.43 | -0.01 |
| Channel Y | - Input | -20003.12 | -2.05 | 0.01 |
| Channel Z | + Input | 199998.55 | 1.78 | 0.00 |
| Channel Z | + Input | 20000.17 | -0.46 | -0.00 |
| Channel Z | - Input | -20002.80 | -1.74 | 0.01 |

| Low Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 2000.85 | 0.13 | 0.01 |
| Channel X | + Input | 201.55 | 0.57 | 0.28 |
| Channel X | - Input | -198.00 | 0.97 | -0.49 |
| Channel Y | + Input | 2001.14 | 0.22 | 0.01 |
| Channel Y | + Input | 200.26 | -0.86 | -0.43 |
| Channel Y | - Input | -200.11 | -1.20 | 0.60 |
| Channel Z | + Input | 2001.08 | 0.33 | 0.02 |
| Channel Z | + Input | 200.51 | -0.33 | -0.17 |
| Channel Z | - Input | -199.40 | -0.25 | 0.13 |

### 2. Common mode sensitivity

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

| | Common mode Input Voltage (mV) | High Range Average Reading (μV) | Low Range Average Reading (μV) |
|---|---|---|---|
| Channel X | 200 | 2.81 | 0.32 |
| | - 200 | 1.56 | -0.16 |
| Channel Y | 200 | -13.87 | -13.93 |
| | - 200 | 11.69 | 11.57 |
| Channel Z | 200 | -9.93 | -10.42 |
| | - 200 | 9.21 | 9.16 |

### 3. Channel separation

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

| | Input Voltage (mV) | Channel X (μV) | Channel Y (μV) | Channel Z (μV) |
|---|---|---|---|---|
| Channel X | 200 | - | -1.61 | -2.83 |
| Channel Y | 200 | 6.75 | - | 1.34 |
| Channel Z | 200 | 10.61 | 3.30 | - |

## 4. AD-Converter Values with inputs shorted

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

| | High Range (LSB) | Low Range (LSB) |
|---|---|---|
| Channel X | 15824 | 15758 |
| Channel Y | 16240 | 16273 |
| Channel Z | 16028 | 14710 |

## 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

| | Average (μV) | min. Offset (μV) | max. Offset (μV) | Std. Deviation (μV) |
|---|---|---|---|---|
| Channel X | -0.86 | -2.43 | -0.08 | 0.38 |
| Channel Y | -1.68 | -2.57 | -0.85 | 0.37 |
| Channel Z | -1.83 | -2.96 | -0.09 | 0.45 |

## 6. Input Offset Current

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

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

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

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

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

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

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

**Appendix C.3 Calibration certificate for Dipole 835 MHz**

**Calibration Laboratory of**
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Accreditation No.: SCS 108

Client SGS (Dymstec)

Certificate No: D835V2-4d138_Sep13

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D835V2 - SN: 4d138 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | September 27, 2013 |

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

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 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 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Power sensor HP 8481A | US37292783 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-13 (No. 217-01736) | Apr-14 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 04-Apr-13 (No. 217-01739) | Apr-14 |
| Reference Probe ES3DV3 | SN: 3205 | 28-Dec-12 (No. ES3-3205_Dec12) | Dec-13 |
| DAE4 | SN: 601 | 25-Apr-13 (No. DAE4-601_Apr13) | Apr-14 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

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

Issued: September 27, 2013

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Certificate No: D835V2-4d138_Sep13 Page 1 of 8

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Accreditation No.: **SCS 108**

**Glossary:**

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

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

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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 | V52.8.7 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 15 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 835 MHz ± 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 | 41.4 ± 6 % | 0.92 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.40 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **9.44 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.56 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **6.16 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 | 54.4 ± 6 % | 1.01 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.41 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **9.32 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.57 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **6.12 W/kg ± 16.5 % (k=2)** |

## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 51.6 Ω -2.1 jΩ |
| Return Loss | - 31.7 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 46.7 Ω - 4.4 jΩ |
| Return Loss | - 24.9 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.397 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 | July 22, 2011 |

## DASY5 Validation Report for Head TSL

Date: 27.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

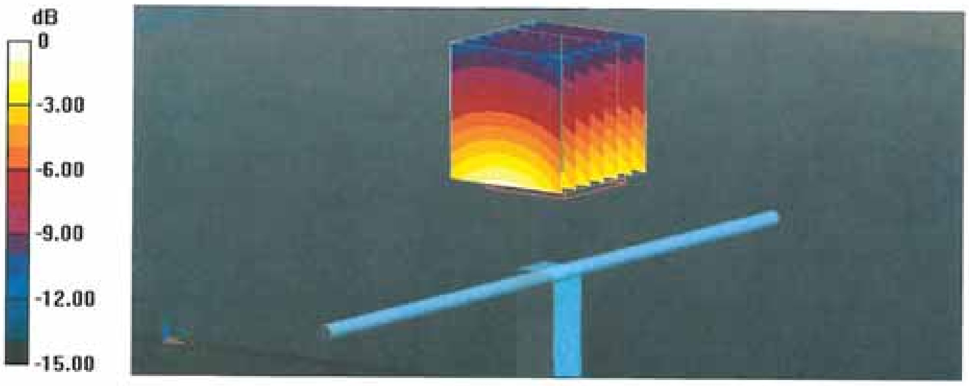
**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d138**

Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; $\sigma$ = 0.92 S/m; $\varepsilon_r$ = 41.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

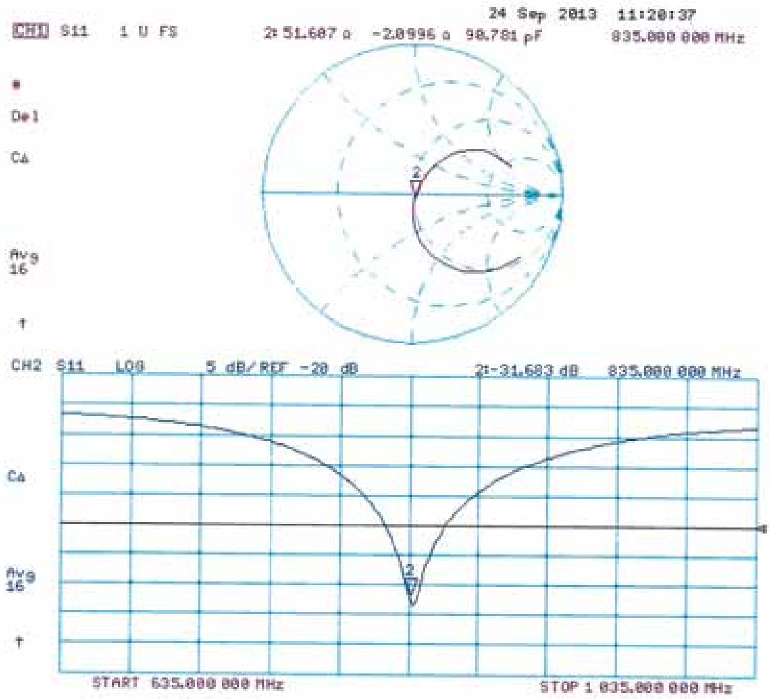
- Probe: ES3DV3 - SN3205; ConvF(6.05, 6.05, 6.05); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 56.671 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 3.63 W/kg
**SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.56 W/kg**
Maximum value of SAR (measured) = 2.80 W/kg




0 dB = 2.80 W/kg = 4.47 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 26.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

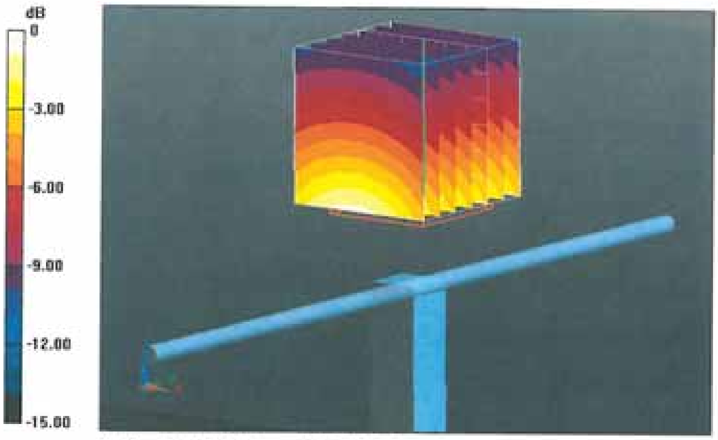
**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d138**

Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; $\sigma$ = 1.01 S/m; $\varepsilon_r$ = 54.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

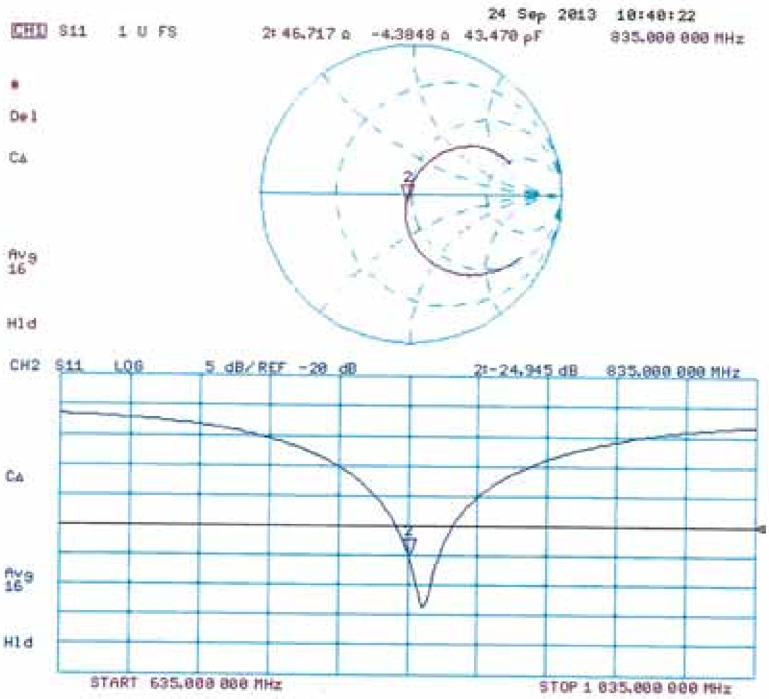
**Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 54.246 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 3.53 W/kg
**SAR(1 g) = 2.41 W/kg; SAR(10 g) = 1.57 W/kg**
Maximum value of SAR (measured) = 2.79 W/kg




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

Certificate No: D835V2-4d138_Sep13 Page 7 of 8

## Impedance Measurement Plot for Body TSL



**Appendix C.3 Calibration certificate for Dipole 1900 MHz**

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

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

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

Accreditation No.: SCS 108

2013.10.14

Client SGS (Dymstec)

Certificate No: D1900V2-5d158_Sep13

# CALIBRATION CERTIFICATE

Object: D1900V2 - SN: 5d158

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

Calibration date: September 27, 2013

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

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 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 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Power sensor HP 8481A | US37292783 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-13 (No. 217-01736) | Apr-14 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 04-Apr-13 (No. 217-01739) | Apr-14 |
| Reference Probe ES3DV3 | SN: 3205 | 28-Dec-12 (No. ES3-3205_Dec12) | Dec-13 |
| DAE4 | SN: 601 | 25-Apr-13 (No. DAE4-601_Apr13) | Apr-14 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

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

Issued: September 27, 2013

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

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

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

Accreditation No.: **SCS 108**

**Glossary:**

| | |
|---|---|
| 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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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 | V52.8.7 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1900 MHz ± 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 | 39.7 ± 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$^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.92 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **40.1 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm$^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.22 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.0 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 | 53.3 | 1.52 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 53.2 ± 6 % | 1.49 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm$^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.80 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **39.7 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm$^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.23 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.1 W/kg ± 16.5 % (k=2)** |

## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 53.2 Ω + 4.8 jΩ |
| Return Loss | - 25.1 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 49.1 Ω + 5.0 jΩ |
| Return Loss | - 25.8 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.199 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 20, 2011 |

## DASY5 Validation Report for Head TSL

Date: 27.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

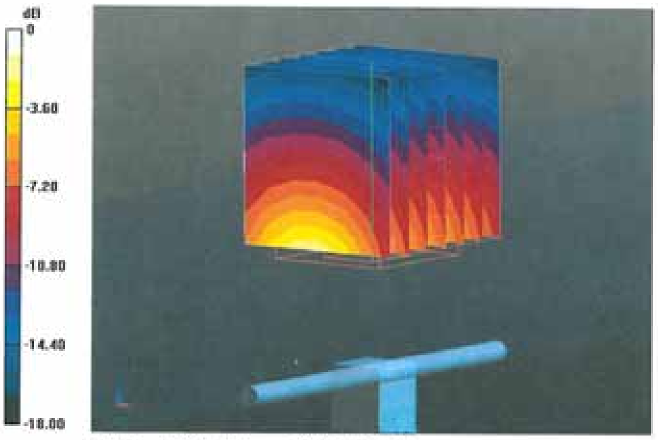
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d158**

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.37 S/m; $\varepsilon_r$ = 39.7; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

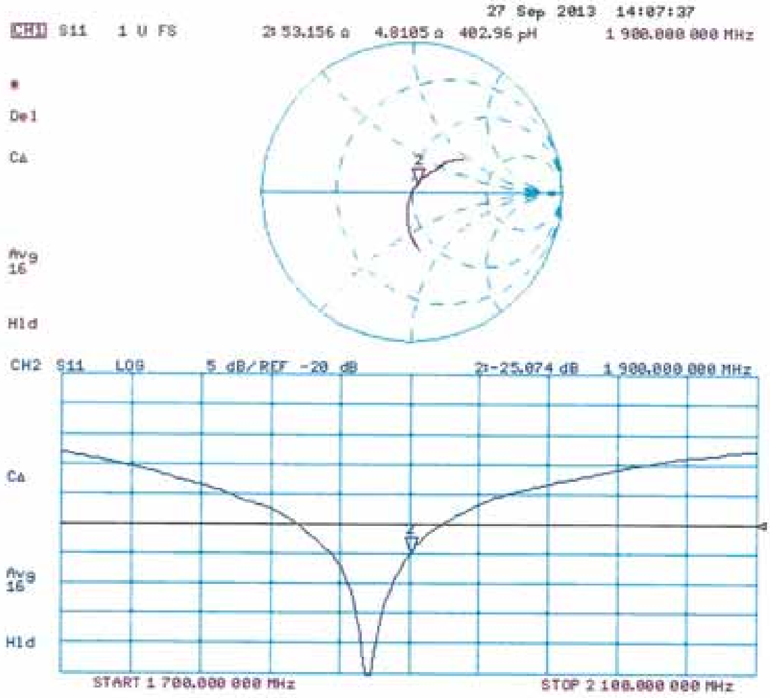
- Probe: ES3DV3 - SN3205; ConvF(4.98, 4.98, 4.98); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.878 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 18.0 W/kg
**SAR(1 g) = 9.92 W/kg; SAR(10 g) = 5.22 W/kg**
Maximum value of SAR (measured) = 12.2 W/kg




0 dB = 12.2 W/kg = 10.86 dBW/kg

## Impedance Measurement Plot for Head TSL




Certificate No: D1900V2-5d158_Sep13

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## DASY5 Validation Report for Body TSL

Date: 27.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

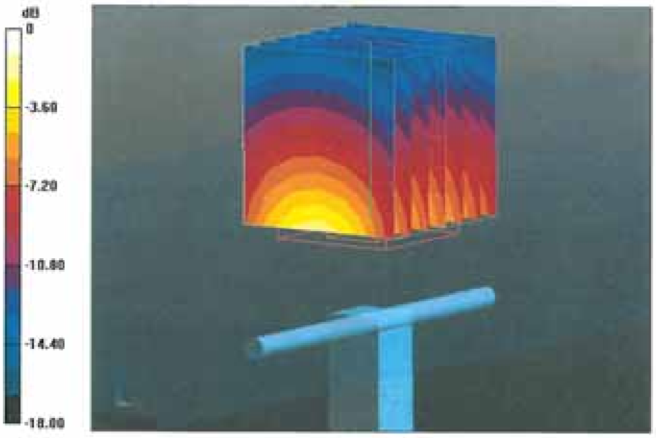
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d158**

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.49 S/m; $\varepsilon_r$ = 53.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

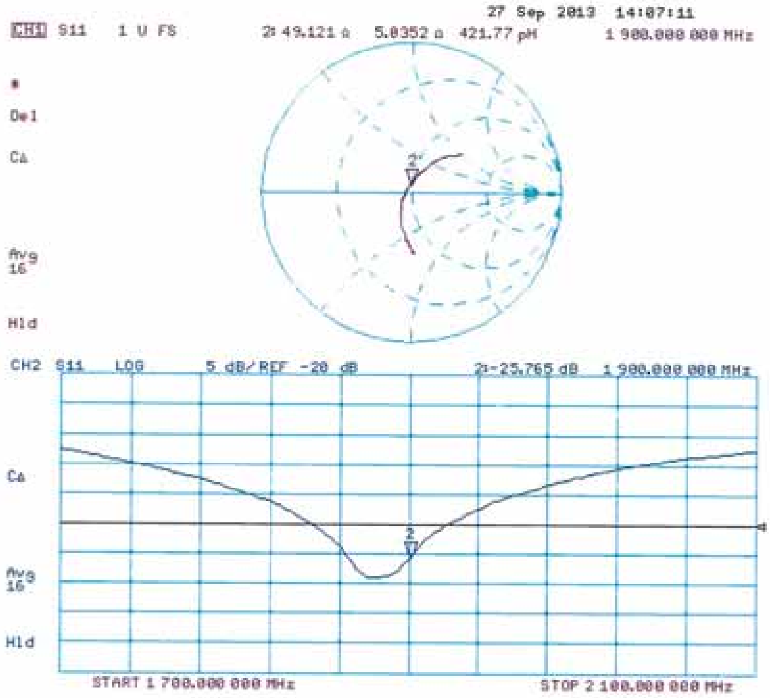
- Probe: ES3DV3 - SN3205; ConvF(4.6, 4.6, 4.6); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.878 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 16.8 W/kg
**SAR(1 g) = 9.8 W/kg; SAR(10 g) = 5.23 W/kg**
Maximum value of SAR (measured) = 12.2 W/kg




0 dB = 12.2 W/kg = 10.86 dBW/kg

**Impedance Measurement Plot for Body TSL**



**Appendix C.3 Calibration certificate for Dipole 2450 MHz**

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

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

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

Accreditation No.: SCS 108

아 종 천 2013. 10. 14

기술책임자

Client SGS (Dymstec)

Certificate No: D2450V2-892_Sep13

# CALIBRATION CERTIFICATE

Object: D2450V2 - SN: 892

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

Calibration date: September 26, 2013

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

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 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 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Power sensor HP 8481A | US37292783 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-13 (No. 217-01736) | Apr-14 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 04-Apr-13 (No. 217-01739) | Apr-14 |
| Reference Probe ES3DV3 | SN: 3205 | 28-Dec-12 (No. ES3-3205_Dec12) | Dec-13 |
| DAE4 | SN: 601 | 25-Apr-13 (No. DAE4-601_Apr13) | Apr-14 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

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

Issued: September 27, 2013

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

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

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

Accreditation No.: SCS 108

**Glossary:**

| | |
|---|---|
| TSL | tissue simulating liquid |
| 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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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 | V52.8.7 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 2450 MHz ± 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 | 39.4 ± 6 % | 1.83 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.2 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **52.4 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.12 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.4 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 | 52.7 | 1.95 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 52.2 ± 6 % | 2.00 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 12.7 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **50.1 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.85 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **23.2 W/kg ± 16.5 % (k=2)** |

## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 53.9 Ω + 2.2 jΩ |
| Return Loss | - 27.2 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.1 Ω + 4.3 jΩ |
| Return Loss | - 27.3 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.125 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 | October 06, 2011 |

## DASY5 Validation Report for Head TSL

Date: 26.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 892**

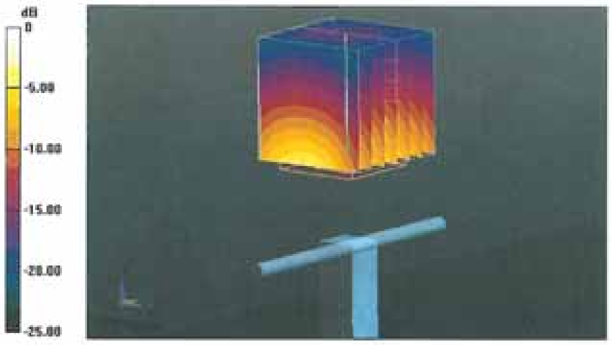
Communication System: UID 0 - CW ; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.83 S/m; $\varepsilon_r$ = 39.4; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

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

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

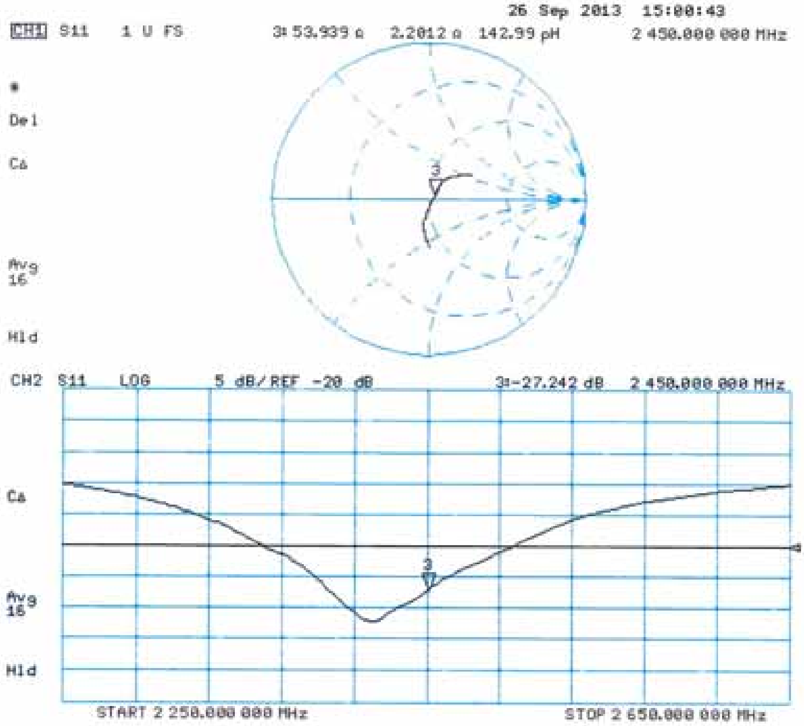
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 93.764 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 27.5 W/kg
**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.12 W/kg**
Maximum value of SAR (measured) = 16.9 W/kg



0 dB = 16.9 W/kg = 12.28 dBW/kg

Certificate No: D2450V2-892_Sep13 Page 5 of 8

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 26.09.2013

Test Laboratory: SPEAG, Zurich, Switzerland

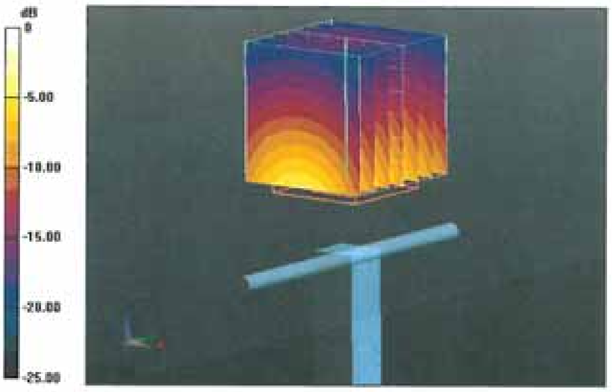
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 892**

Communication System: UID 0 - CW ; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 2 S/m; $\varepsilon_r$ = 52.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

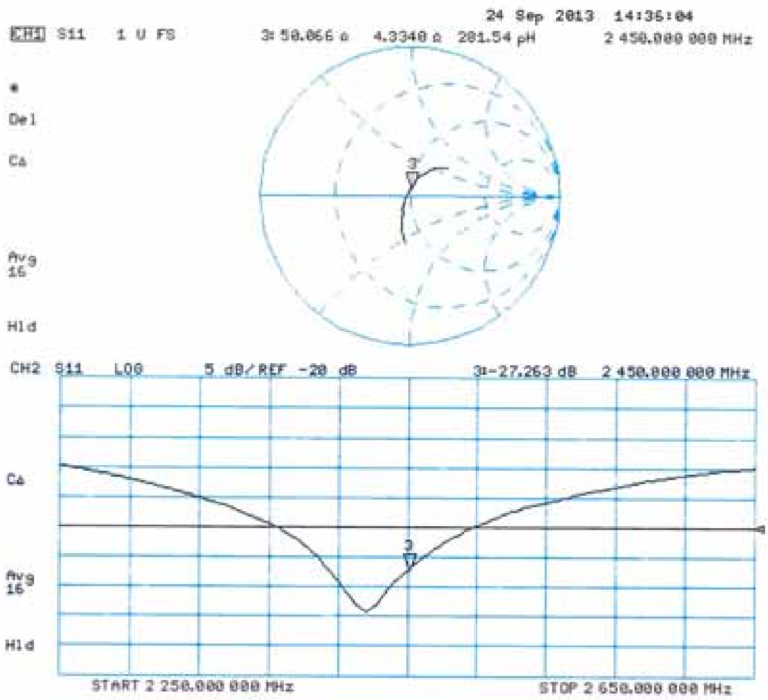
- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 93.764 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 26.5 W/kg
**SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.85 W/kg**
Maximum value of SAR (measured) = 16.6 W/kg




0 dB = 16.6 W/kg = 12.20 dBW/kg

Impedance Measurement Plot for Body TSL






-THE END-