



## SAR EVALUATION REPORT

**Applicant Name:**

Samsung Electronics, Co. Ltd.  
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Yeongtong-gu, Suwon-si  
Gyeonggi-do 443-742, Korea

**Date of Testing:**

02/10/14 – 03/05/14

**Test Site/Location:**

PCTEST Lab, Columbia, MD, USA

**Document Serial No.:**

OY1402070339.A3L

**FCC ID:**

**A3LSMV101F**

**APPLICANT:**

**SAMSUNG ELECTRONICS, CO. LTD.**

**DUT Type:**

Portable Wireless Router

**Application Type:**

Certification

**FCC Rule Part(s):**

CFR §2.1093

**Model(s):**

SM-V101F

| Equipment Class                                   | Band & Mode            | Tx Frequency          | SAR              |
|---------------------------------------------------|------------------------|-----------------------|------------------|
|                                                   |                        |                       | 1 gm Body (W/kg) |
| PCB                                               | GPRS/EDGE Rx Only 850  | 824.20 - 848.80 MHz   | 0.68             |
| PCB                                               | UMTS 850               | 826.40 - 846.60 MHz   | 0.44             |
| PCB                                               | GRPS/EDGE Rx Only 1900 | 1850.20 - 1909.80 MHz | 0.94             |
| PCB                                               | UMTS 1900              | 1852.4 - 1907.6 MHz   | 0.94             |
| DTS                                               | 2.4 GHz WLAN           | 2412 - 2462 MHz       | < 0.1            |
| <b>Simultaneous SAR per KDB 690783 D01v01r02:</b> |                        |                       | <b>0.98</b>      |

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in Section 1.7 of this report; for North American frequency bands only.

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

  
Randy Ortanez  
President



|                                          |                                                                                     |                                              |                                                                                       |                                        |
|------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------|
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| <b>Document S/N:</b><br>OY1402070339.A3L | <b>Test Dates:</b><br>02/10/14 - 03/05/14                                           | <b>DUT Type:</b><br>Portable Wireless Router | Page 1 of 29                                                                          |                                        |

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# 1 DEVICE UNDER TEST

## 1.1 Device Overview

| Band & Mode            | Operating Modes | Tx Frequency          |
|------------------------|-----------------|-----------------------|
| GPRS/EDGE Rx Only 850  | Data            | 824.20 - 848.80 MHz   |
| UMTS 850               | Data            | 826.40 - 846.60 MHz   |
| GRPS/EDGE Rx Only 1900 | Data            | 1850.20 - 1909.80 MHz |
| UMTS 1900              | Data            | 1852.4 - 1907.6 MHz   |
| 2.4 GHz WLAN           | Data            | 2412 - 2462 MHz       |

## 1.2 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 D01v05r01.

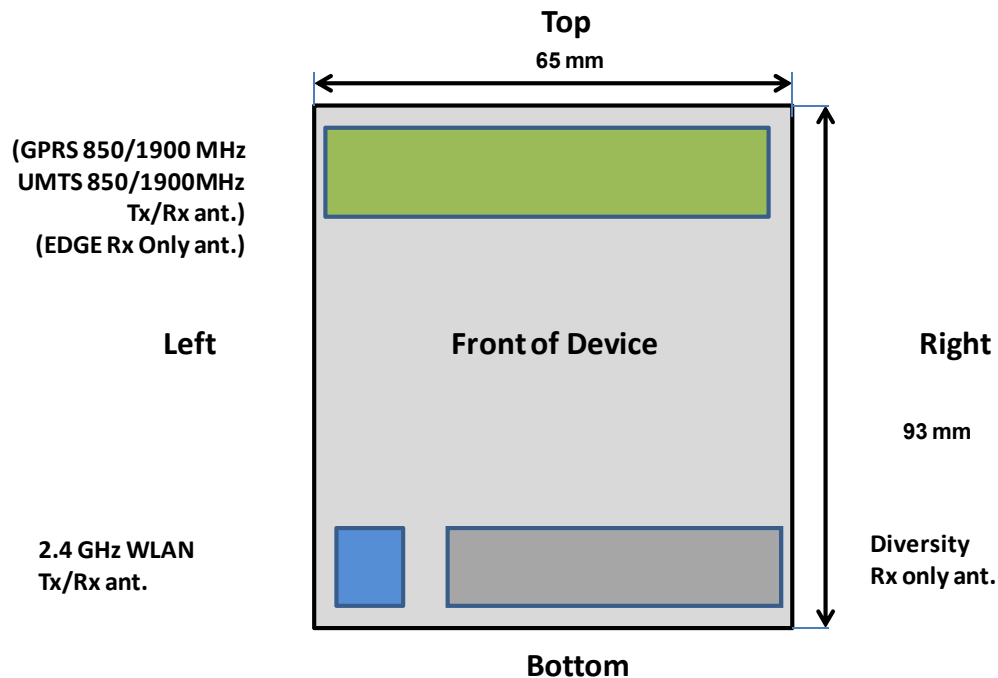
| Mode / Band |         | Burst Average GMSK (dBm) |            |
|-------------|---------|--------------------------|------------|
|             |         | 1 TX Slots               | 2 TX Slots |
| GPRS 850    | Maximum | 32.5                     | 29.5       |
|             | Nominal | 32.0                     | 29.0       |
| GPRS 1900   | Maximum | 30.5                     | 29.0       |
|             | Nominal | 30.0                     | 28.5       |

| Mode / Band            |         | Modulated Average (dBm) |            |            |
|------------------------|---------|-------------------------|------------|------------|
|                        |         | 3GPP WCDMA              | 3GPP HSDPA | 3GPP HSUPA |
|                        |         | Rel 99                  | Rel 6      | Rel 6      |
| UMTS Band 5 (850 MHz)  | Maximum | 23.0                    | 22.5       | 22.5       |
|                        | Nominal | 22.5                    | 22.0       | 22.0       |
| UMTS Band 2 (1900 MHz) | Maximum | 23.0                    | 22.5       | 22.5       |
|                        | Nominal | 22.5                    | 22.0       | 22.0       |

|                                   |                                                                                                                                                                                                        |                                       |                                 |
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| Mode / Band            |         | Modulated Average (dBm) |
|------------------------|---------|-------------------------|
| IEEE 802.11b (2.4 GHz) | Maximum | 17.5                    |
|                        | Nominal | 17.0                    |
| IEEE 802.11g (2.4 GHz) | Maximum | 14.5                    |
|                        | Nominal | 14.0                    |
| IEEE 802.11n (2.4 GHz) | Maximum | 12.5                    |
|                        | Nominal | 12.0                    |

### 1.3 DUT Antenna Locations



Note: Exact antenna dimensions and separation distances are shown in the Technical Descriptions in the FCC Filing.

**Figure 1-1**  
**DUT Antenna Locations**

|                                          |                                                                                                                                   |                                              |                                                                                       |                                        |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------|
| FCC ID: A3LSMV101F                       |  <b>PCTEST</b><br>ENGINEERING LABORATORY, INC. | <b>SAR EVALUATION REPORT</b>                 |  | <b>Reviewed by:</b><br>Quality Manager |
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**Table 1-1**  
**Mobile Hotspot Sides for SAR Testing**

| Sides for SAR Testing |      |       |     |        |       |      |
|-----------------------|------|-------|-----|--------|-------|------|
| Mode                  | Back | Front | Top | Bottom | Right | Left |
| GPRS 850              | Yes  | Yes   | Yes | No     | Yes   | Yes  |
| UMTS 850              | Yes  | Yes   | Yes | No     | Yes   | Yes  |
| GPRS 1900             | Yes  | Yes   | Yes | No     | Yes   | Yes  |
| UMTS 1900             | Yes  | Yes   | Yes | No     | Yes   | Yes  |
| 2.4 GHz WLAN          | Yes  | Yes   | No  | Yes    | No    | Yes  |

Note: Particular DUT edges are 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 KDB Publication 941225 D06v01r01 guidance, page 2.

## 1.4 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D05v01r01, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds.

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v05r01 3) procedures

**Table 1-2**  
**Simultaneous Transmission Scenarios**

| No.                                                                                                       | Capable Transmit Configurations       | Body           | Note       |
|-----------------------------------------------------------------------------------------------------------|---------------------------------------|----------------|------------|
|                                                                                                           |                                       | FCC KDB 616217 |            |
| 1                                                                                                         | 850/1900 MHz GPRS Data + WIFI 2.4 GHz | Yes            | 2G Hotspot |
| 2                                                                                                         | 850/1900 MHz UMTS Data + WIFI 2.4 GHz | Yes            | 3G Hotspot |
| Notes:<br>1.GPRS/UMTS use one modem and transceiver IC.The signals can not be transmitted simultaneously. |                                       |                |            |

|                                   |                                                                                     |                                       |                                                                                       |                                 |
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## 1.5 SAR Test Exclusions Applied

### (A) WIFI

IEEE 802.11g/n was not evaluated for SAR since the average output power was not more than 0.25 dB higher than the average output power of IEEE 802.11b.

### (B) Licensed Transmitter(s)

This device is only capable of QPSK HSUPA in the uplink. Therefore, no additional SAR tests are required beyond that described for devices with HSUPA in KDB 941225 D01v02r02.

## 1.6 Power Reduction for SAR

There is no power reduction used for any band/mode implemented in this device for SAR purposes.

## 1.7 Guidance Applied

- FCC KDB Publication 941225 D01-D06 (2G/3G and Hotspot)
- FCC KDB Publication 248227 D01v01r02 (SAR Considerations for 802.11 Devices)
- FCC KDB Publication 447498 D01v05r01 (General SAR Guidance)
- FCC KDB Publication 865664 D01-D02 (SAR Measurements up to 6 GHz)
- October 2013 TCB Workshop Notes (GPRS Testing Consideration)

## 1.8 Device Serial Numbers

Several samples were used with identical hardware to support SAR testing. 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.

| Mode                   | Body Serial Number |
|------------------------|--------------------|
| GPRS/EDGE Rx Only 850  | FL-045-A           |
| UMTS 850               | FL-045-C           |
| GPRS/EDGE Rx Only 1900 | FL-045-A           |
| UMTS 1900              | FL-045-C           |
| 2.4 GHz WLAN           | FL-045-A           |

|                                          |                                                                                                                                                                                                        |                                              |
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The FCC and Industry Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [24]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields,” Report No. Vol 74. 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.

## 2.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density ( $\rho$ ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 2-1).

**Equation 2-1**  
**SAR Mathematical Equation**

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

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

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

where:

- $\sigma$  = conductivity of the tissue-simulating material (S/m)
- $\rho$  = mass density of the tissue-simulating material (kg/m<sup>3</sup>)
- E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

|                                          |                                                                                     |                                              |                                                                                       |                                        |
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### 3 DOSIMETRIC ASSESSMENT

#### 3.1 Measurement Procedure

The evaluation was performed using the following procedure:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01r01 (See Table 3-1).
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.
3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r01 (See Table 3-1). On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):
  - a. The data was extrapolated to the surface of the outer-shell of the phantom. The combined distance extrapolated was the combined distance from the center of the dipoles 2.7mm away from the tip of the probe housing plus the 1.2 mm distance between the surface and the lowest measuring point. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
  - b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.
  - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

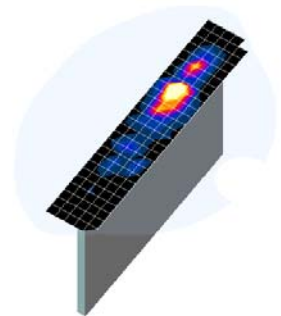


**Figure 3-1**  
**Sample SAR Area Scan**

**Table 3-1**  
**Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r01**

| Frequency | Maximum Area Scan Resolution (mm)<br>( $\Delta x_{area}, \Delta y_{area}$ ) | Maximum Zoom Scan Resolution (mm)<br>( $\Delta x_{zoom}, \Delta y_{zoom}$ ) | Maximum Zoom Scan Spatial Resolution (mm) |                      |                               | Minimum Zoom Scan Volume (mm)<br>(x,y,z) |
|-----------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------|-------------------------------------------|----------------------|-------------------------------|------------------------------------------|
|           |                                                                             |                                                                             | Uniform Grid                              | Graded Grid          |                               |                                          |
|           |                                                                             |                                                                             |                                           | $\Delta z_{zoom}(n)$ | $\Delta z_{zoom}(1)^*$        |                                          |
| ≤ 2 GHz   | ≤ 15                                                                        | ≤ 8                                                                         | ≤ 5                                       | ≤ 4                  | ≤ 1.5* $\Delta z_{zoom}(n-1)$ | ≥ 30                                     |
| 2-3 GHz   | ≤ 12                                                                        | ≤ 5                                                                         | ≤ 5                                       | ≤ 4                  | ≤ 1.5* $\Delta z_{zoom}(n-1)$ | ≥ 30                                     |
| 3-4 GHz   | ≤ 12                                                                        | ≤ 5                                                                         | ≤ 4                                       | ≤ 3                  | ≤ 1.5* $\Delta z_{zoom}(n-1)$ | ≥ 28                                     |
| 4-5 GHz   | ≤ 10                                                                        | ≤ 4                                                                         | ≤ 3                                       | ≤ 2.5                | ≤ 1.5* $\Delta z_{zoom}(n-1)$ | ≥ 25                                     |
| 5-6 GHz   | ≤ 10                                                                        | ≤ 4                                                                         | ≤ 2                                       | ≤ 2                  | ≤ 1.5* $\Delta z_{zoom}(n-1)$ | ≥ 22                                     |

|                                   |                                                                                                                                                                                                        |                                       |  |                                 |
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## 4 SAR TESTING PROCEDURES

### 4.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity  $\epsilon = 3$  and loss tangent  $\delta = 0.02$ .

### 4.2 Wireless Router Configurations

Some battery-operated devices have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06v01r01 where SAR test considerations for devices ( $L \times W \geq 9 \text{ cm} \times 5 \text{ cm}$ ) are based on a composite test separation distance of 10 mm from the front, back and edges of the device containing transmitting antennas within 2.5 cm of their edges, determined from general mixed use conditions for this type of devices. Since the device meets the given size constraints, the aforementioned procedure was followed for SAR testing.

This device operates using simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes. Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WIFI transmitter according to FCC KDB Publication 447498 D01v05r01 publication procedures.

|                                   |                                                                                     |                                       |                                                                                       |                                 |
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## 5 RF EXPOSURE LIMITS

### 5.1 Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

### 5.2 Controlled Environment

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

**Table 5-1**  
**SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6**

| HUMAN EXPOSURE LIMITS                                               |                                                                           |                                                                   |
|---------------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------|
|                                                                     | UNCONTROLLED ENVIRONMENT<br><i>General Population</i><br>(W/kg) or (mW/g) | CONTROLLED ENVIRONMENT<br><i>Occupational</i><br>(W/kg) or (mW/g) |
| <b>Peak Spatial Average SAR</b><br>Head                             | 1.6                                                                       | 8.0                                                               |
| <b>Whole Body SAR</b>                                               | 0.08                                                                      | 0.4                                                               |
| <b>Peak Spatial Average SAR</b><br>Hands, Feet, Ankle, Wrists, etc. | 4.0                                                                       | 20                                                                |

1. The Spatial Peak value of the SAR averaged over any 1 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.

|                                          |                                                                                     |                                              |                                                                                       |                                        |
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## 6 FCC MEASUREMENT PROCEDURES

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

### 6.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v05r01, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as *reported* SAR. The highest *reported* SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r02.

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

The following procedures are according to FCC KDB Publication 941225 D01 "SAR Measurement Procedures for 3G Devices" v02r02, October 2007.

The device was placed into a simulated call using a base station simulator in a RF shielded chamber. Establishing connections in this manner ensure a consistent means for testing SAR and are recommended for evaluating SAR [4]. Devices under test were evaluated prior to testing, with a fully charged battery and were configured to operate at maximum output power. In order to verify that the device was tested throughout the SAR test at maximum output power, the SAR measurement system measures a "point SAR" at an arbitrary reference point at the start and end of the 1 gram SAR evaluation, to assess for any power drifts during the evaluation. If the power drift deviated by more than 5%, the SAR test and drift measurements were repeated.

### 6.3 SAR Measurement Conditions for UMTS

#### 6.3.1 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".

Maximum output power is verified on the High, Middle and Low channels according to the general descriptions in section 5.2 of 3GPP TS 34.121 (release 5), using the appropriate RMC with TPC (transmit power control) set to all "1s" or applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HS-DPCCH etc) are tabulated in this test report. All configurations that are not supported by the DUT or cannot be measured due to technical or equipment limitations are identified.

#### 6.3.2 Body SAR Measurements

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

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

The following procedures are applicable to HSDPA data devices operating under 3GPP Release 5. Body exposure conditions are typically applicable to these devices, including handsets and data modems operating in various electronic devices. HSDPA operates in conjunction with UMTS and requires an active DPCH. The default test configuration is to measure SAR in UMTS without HSDPA, with an established radio link between the DUT and a communication test set with 12.2 kbps RMC mode configured in Test Loop Mode 1; and tested with HSDPA with FRC and a 12.2 kbps RMC using the highest SAR configuration in UMTS. SAR is selectively confirmed for other physical channel configurations according to output power, exposure conditions and device operating capabilities. Maximum output power is verified according to 3GPP TS 23.121 (Release 5) and SAR must be measured according to these maximum output conditions.

| Sub-Test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | $\beta_c$         | $\beta_d$         | $\beta_d$<br>(SF) | $\beta_c/\beta_d$ | $\beta_{HS}$<br>(Note 1,<br>Note 2) | CM (dB)<br>(Note 3) | MPR (dB)<br>(Note 3) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------------------------|---------------------|----------------------|
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2/15              | 15/15             | 64                | 2/15              | 4/15                                | 0.0                 | 0.0                  |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 12/15<br>(Note 4) | 15/15<br>(Note 4) | 64                | 12/15<br>(Note 4) | 24/15                               | 1.0                 | 0.0                  |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 15/15             | 8/15              | 64                | 15/8              | 30/15                               | 1.5                 | 0.5                  |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 15/15             | 4/15              | 64                | 15/4              | 30/15                               | 1.5                 | 0.5                  |
| <p>Note 1: <math>\Delta_{ACK}</math>, <math>\Delta_{NACK}</math> and <math>\Delta_{CQI} = 8 \Leftrightarrow A_{HS} = \beta_{HS}/\beta_c = 30/15 \Leftrightarrow \beta_{HS} = 30/15 * \beta_c</math>.</p> <p>Note 2: For the HS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude (EVM) with HS-DPCCH test in clause 5.13.1A, and HSDPA EVM with phase discontinuity in clause 5.13.1AA, <math>\Delta_{ACK}</math> and <math>\Delta_{NACK} = 8</math> (<math>A_{HS} = 30/15</math>) with <math>\beta_{HS} = 30/15 * \beta_c</math>, and <math>\Delta_{CQI} = 7</math> (<math>A_{HS} = 24/15</math>) with <math>\beta_{HS} = 24/15 * \beta_c</math>.</p> <p>Note 3: CM = 1 for <math>\beta_c/\beta_d = 12/15</math>, <math>\beta_{HS}/\beta_c = 24/15</math>. For all other combinations of DPCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.</p> |                   |                   |                   |                   |                                     |                     |                      |

Figure 6-1  
Table C.10.1.4 of TS 234.121-1

### 6.3.4 SAR Measurement Conditions for HSUPA Data Devices

SAR for body exposure configurations are measured according to the 'Body SAR Measurements' procedures in the 'WCDMA Handsets' section of the KDB 941225 D01v02r02 FCC 3G document. In addition, Body SAR is also measured for HSPA when the maximum average output of each RF channel with HSPA active is at least ¼ dB higher of that measured without HSPA in 12.2 kbps RMC mode or the maximum SAR for 12.2 kbps RMC is above 75% of the SAR limit. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 with power control algorithm 2, according to the highest body SAR configuration in 12.2 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 measurements should be used to test for head exposure.

Due to inner loop power control requirements in HSPA, a commercial communication test set should be used for the output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and EDCH configurations for HSPA should be configured according to the  $\beta$  values indicated below as well as other applicable procedures described in the 'WCDMA Handset' and 'Release 5 HSDPA Data Devices' sections of the FCC 3G document.

|                                   |                                                                                     |                                       |                                                                                       |                                 |
|-----------------------------------|-------------------------------------------------------------------------------------|---------------------------------------|---------------------------------------------------------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                |  | SAR EVALUATION REPORT                 |  | Reviewed by:<br>Quality Manager |
| Document S/N:<br>OY1402070339.A3L | Test Dates:<br>02/10/14 - 03/05/14                                                  | DUT Type:<br>Portable Wireless Router |                                                                                       | Page 12 of 29                   |

| 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 <sup>(2)</sup> (dB) | MPR (dB) | AG <sup>(4)</sup> Index | E-TFCI |
|----------|----------------------|----------------------|----------------|----------------------|--------------------|--------------|--------------------------------------------|-------------------|----------------------|------------------------|----------|-------------------------|--------|
| 1        | 11/15 <sup>(3)</sup> | 15/15 <sup>(3)</sup> | 64             | 11/15 <sup>(3)</sup> | 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        | $\beta_{ed}: 47/15$<br>$\beta_{ec}: 47/15$ | 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 <sup>(4)</sup> | 15/15 <sup>(4)</sup> | 64             | 15/15 <sup>(4)</sup> | 30/15              | 24/15        | 134/15                                     | 4                 | 1                    | 1.0                    | 0.0      | 21                      | 81     |

Note 1:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 8 \Leftrightarrow A_{15} = \beta_{15}/\beta_c = 30/15 \Leftrightarrow \beta_{15} = 30/15 * \beta_c$ .

Note 2: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{15}/\beta_c = 24/15$ . 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.

## 6.4 SAR Testing with 802.11 Transmitters

Normal network operating configurations are not suitable for measuring the SAR of 802.11 b/g/n 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. See KDB Publication 248227 D01v01r02 for more details.

### 6.4.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. 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.

### 6.4.2 Frequency Channel Configurations [27]

For 2.4 GHz, the highest average RF output power channel between the low, mid and high channel at the lowest data rate was selected for SAR evaluation in 802.11b mode. 802.11g/n modes and higher data rates for 802.11b were additionally evaluated for SAR if the output power of the respective mode was 0.25 dB or higher than the powers of the SAR configurations tested in the 802.11b mode.

If the maximum extrapolated peak SAR of the zoom scan for the highest output channel was less than 1.6 W/kg and if the 1g averaged SAR was less than 0.8 W/kg, SAR testing was not required for the other test channels in the band.

|                                   |                                                                                     |                                       |                                                                                       |                                 |
|-----------------------------------|-------------------------------------------------------------------------------------|---------------------------------------|---------------------------------------------------------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                |  | SAR EVALUATION REPORT                 |  | Reviewed by:<br>Quality Manager |
| Document S/N:<br>OY1402070339.A3L | Test Dates:<br>02/10/14 - 03/05/14                                                  | DUT Type:<br>Portable Wireless Router |                                                                                       | Page 13 of 29                   |

## 7 RF CONDUCTED POWERS

### 7.1 GSM Conducted Powers

|          |               | Maximum Burst-Averaged Output Power            |                         |
|----------|---------------|------------------------------------------------|-------------------------|
|          |               | GPRS Data (GMSK)                               |                         |
| Band     | Channel       | GPRS [dBm]<br>1 Tx Slot                        | GPRS [dBm]<br>2 Tx Slot |
| GSM 850  | 128           | 32.40                                          | 29.48                   |
|          | 190           | 32.50                                          | 29.36                   |
|          | 251           | 32.16                                          | 29.27                   |
| GSM 1900 | 512           | 30.13                                          | 28.61                   |
|          | 661           | 30.17                                          | 28.64                   |
|          | 810           | 29.85                                          | 28.51                   |
|          |               | Calculated Maximum Frame-Averaged Output Power |                         |
|          |               | GPRS Data (GMSK)                               |                         |
| Band     | Channel       | GPRS [dBm]<br>1 Tx Slot                        | GPRS [dBm]<br>2 Tx Slot |
| GSM 850  | 128           | 23.37                                          | 23.46                   |
|          | 190           | 23.47                                          | 23.34                   |
|          | 251           | 23.13                                          | 23.25                   |
| GSM 1900 | 512           | 21.10                                          | 22.59                   |
|          | 661           | 21.14                                          | 22.62                   |
|          | 810           | 20.82                                          | 22.49                   |
| GSM 850  | Frame         | 22.97                                          | 22.98                   |
| GSM 1900 | Avg. Targets: | 20.97                                          | 22.48                   |

Notes:

- 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.
- Per October 2013 TCB Workshop notes, 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 hotspot SAR. When the maximum frame-averaged powers are equivalent across two or more slots (within 0.25 dB), the configuration with the most number of time slots was tested.
- 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.

**GSM Class: C**

**GPRS Multislot class: 10 (Max 2 Tx uplink slots)**

**EDGE Multislot class: Rx Only**

**DTM Multislot Class: N/A**



**Figure 7-1**  
**Power Measurement Setup**

|                                          |                                                                                     |                                              |                                                                                       |                                        |
|------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------|
| FCC ID: A3LSMV101F                       |  | <b>SAR EVALUATION REPORT</b>                 |  | <b>Reviewed by:</b><br>Quality Manager |
| <b>Document S/N:</b><br>OY1402070339.A3L | <b>Test Dates:</b><br>02/10/14 - 03/05/14                                           | <b>DUT Type:</b><br>Portable Wireless Router | Page 14 of 29                                                                         |                                        |

## 7.2 UMTS Conducted Powers

| 3GPP Release Version | Mode  | 3GPP 34.121 Subtest | Cellular Band [dBm] |       |       | PCS Band [dBm] |       |       | 3GPP MPR [dB] |
|----------------------|-------|---------------------|---------------------|-------|-------|----------------|-------|-------|---------------|
|                      |       |                     | 4132                | 4183  | 4233  | 9262           | 9400  | 9538  |               |
| 99                   | WCDMA | 12.2 kbps RMC       | 22.98               | 23.00 | 22.71 | 22.88          | 22.76 | 22.68 | -             |
| 6                    | HSDPA | Subtest 1           | 22.50               | 22.50 | 22.45 | 22.50          | 21.93 | 21.74 | 0             |
| 6                    |       | Subtest 2           | 22.47               | 22.46 | 22.39 | 22.32          | 21.78 | 21.60 | 0             |
| 6                    |       | Subtest 3           | 21.94               | 22.22 | 22.00 | 21.76          | 21.29 | 21.22 | 0.5           |
| 6                    |       | Subtest 4           | 22.06               | 22.21 | 21.97 | 21.74          | 21.27 | 21.18 | 0.5           |
| 6                    | HSUPA | Subtest 1           | 21.50               | 21.83 | 21.66 | 21.47          | 21.11 | 21.00 | 0             |
| 6                    |       | Subtest 2           | 20.34               | 20.55 | 20.38 | 20.17          | 19.79 | 19.66 | 2             |
| 6                    |       | Subtest 3           | 20.91               | 20.92 | 20.75 | 20.64          | 20.08 | 19.93 | 1             |
| 6                    |       | Subtest 4           | 20.13               | 20.18 | 20.02 | 20.11          | 19.61 | 19.50 | 2             |
| 6                    |       | Subtest 5           | 20.69               | 20.76 | 20.57 | 21.23          | 21.57 | 21.47 | 0             |

UMTS SAR was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01v02r02. 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.

This device does not support DC-HSDPA.

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

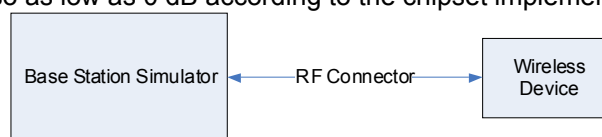


**Figure 7-2**  
**Power Measurement Setup**

|                                   |                                                                                                                                                                                                        |                                       |                                 |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                |  <b>SAR EVALUATION REPORT</b>  |                                       | Reviewed by:<br>Quality Manager |
| Document S/N:<br>0Y1402070339.A3L | Test Dates:<br>02/10/14 - 03/05/14                                                                                                                                                                     | DUT Type:<br>Portable Wireless Router | Page 15 of 29                   |

### 7.3 WLAN Conducted Powers

Table 7-3  
IEEE 802.11b Average RF Power

| Mode    | Freq [MHz] | Channel | 802.11b Conducted Power [dBm] |       |       |       |
|---------|------------|---------|-------------------------------|-------|-------|-------|
|         |            |         | Data Rate [Mbps]              |       |       |       |
|         |            |         | 1                             | 2     | 5.5   | 11    |
| 802.11b | 2412       | 1*      | <b>17.32</b>                  | 17.43 | 17.08 | 17.33 |
| 802.11b | 2437       | 6*      | 17.23                         | 17.16 | 16.69 | 16.02 |
| 802.11b | 2462       | 11*     | 16.90                         | 16.91 | 16.84 | 15.91 |

Table 7-4  
IEEE 802.11g Average RF Power

| Mode    | Freq [MHz] | Channel | 802.11g Conducted Power [dBm] |       |       |       |       |       |       |       |
|---------|------------|---------|-------------------------------|-------|-------|-------|-------|-------|-------|-------|
|         |            |         | Data Rate [Mbps]              |       |       |       |       |       |       |       |
|         |            |         | 6                             | 9     | 12    | 18    | 24    | 36    | 48    | 54    |
| 802.11g | 2412       | 1       | 14.02                         | 14.40 | 14.01 | 13.76 | 14.24 | 13.91 | 13.83 | 13.84 |
| 802.11g | 2437       | 6       | 13.51                         | 14.17 | 13.44 | 13.55 | 14.08 | 13.52 | 13.31 | 13.31 |
| 802.11g | 2462       | 11      | 14.01                         | 14.31 | 13.75 | 13.72 | 14.49 | 13.62 | 13.63 | 13.77 |

Table 7-5  
IEEE 802.11n Average RF Power

| Mode    | Freq [MHz] | Channel | 802.11n (2.4GHz) Conducted Power [dBm] |       |       |       |       |       |       |       |
|---------|------------|---------|----------------------------------------|-------|-------|-------|-------|-------|-------|-------|
|         |            |         | Data Rate [Mbps]                       |       |       |       |       |       |       |       |
|         |            |         | 6.5                                    | 13    | 19.5  | 26    | 39    | 52    | 58.5  | 65    |
| 802.11n | 2412       | 1       | 11.98                                  | 12.03 | 11.97 | 12.03 | 11.91 | 12.00 | 11.97 | 12.02 |
| 802.11n | 2437       | 6       | 11.52                                  | 11.49 | 11.31 | 11.57 | 11.52 | 11.33 | 11.40 | 11.39 |
| 802.11n | 2462       | 11      | 11.78                                  | 11.78 | 11.82 | 11.77 | 11.81 | 11.83 | 11.78 | 11.73 |

Justification for reduced test configurations for WIFI channels per KDB Publication 248227 D01v01r02 and October 2012/April 2013 FCC/TCB Meeting Notes:

- For 2.4 GHz, highest average RF output power channel for the lowest data rate for IEEE 802.11b were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
- When the maximum extrapolated peak SAR of the zoom scan for the maximum output channel is <1.6 W/kg and the reported 1g averaged SAR is <0.8 W/kg, SAR testing on other channels is not required. Otherwise, the other default (or corresponding required) test channels were additionally tested using the lowest data rate.
- The bolded data rate and channel above were tested for SAR.

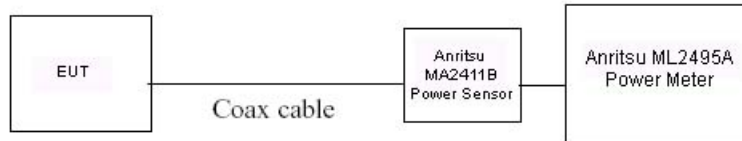


Figure 7-3  
Power Measurement Setup

|                                   |                                                                                     |                                       |                                                                                       |                                 |
|-----------------------------------|-------------------------------------------------------------------------------------|---------------------------------------|---------------------------------------------------------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                |  | SAR EVALUATION REPORT                 |  | Reviewed by:<br>Quality Manager |
| Document S/N:<br>OY1402070339.A3L | Test Dates:<br>02/10/14 - 03/05/14                                                  | DUT Type:<br>Portable Wireless Router |                                                                                       | Page 16 of 29                   |

## 8.1 Tissue Verification

**Table 8-1**  
**Measured Tissue Properties**

| Calibrated for Tests Performed on: | Tissue Type | Tissue Temp During Calibration (C°) | Measured Frequency (MHz) | Measured Conductivity, $\sigma$ (S/m) | Measured Dielectric Constant, $\epsilon$ | TARGET Conductivity, $\sigma$ (S/m) | TARGET Dielectric Constant, $\epsilon$ | % dev $\sigma$ | % dev $\epsilon$ |
|------------------------------------|-------------|-------------------------------------|--------------------------|---------------------------------------|------------------------------------------|-------------------------------------|----------------------------------------|----------------|------------------|
| 02/10/2014                         | 835B        | 22.6                                | 820                      | 1.010                                 | 55.259                                   | 0.969                               | 55.258                                 | 4.23%          | 0.00%            |
|                                    |             |                                     | 835                      | 1.004                                 | 53.949                                   | 0.970                               | 55.200                                 | 3.51%          | -2.27%           |
|                                    |             |                                     | 850                      | 1.016                                 | 53.745                                   | 0.988                               | 55.154                                 | 2.83%          | -2.55%           |
| 02/10/2014                         | 1900B       | 22.2                                | 1850                     | 1.525                                 | 51.969                                   | 1.520                               | 53.300                                 | 0.33%          | -2.50%           |
|                                    |             |                                     | 1880                     | 1.561                                 | 51.837                                   | 1.520                               | 53.300                                 | 2.70%          | -2.74%           |
|                                    |             |                                     | 1910                     | 1.595                                 | 51.735                                   | 1.520                               | 53.300                                 | 4.93%          | -2.94%           |
| 03/05/2014                         | 2450B       | 22.9                                | 2401                     | 1.972                                 | 51.509                                   | 1.903                               | 52.765                                 | 3.63%          | -2.38%           |
|                                    |             |                                     | 2450                     | 2.044                                 | 51.296                                   | 1.950                               | 52.700                                 | 4.82%          | -2.66%           |
|                                    |             |                                     | 2499                     | 2.109                                 | 51.166                                   | 2.019                               | 52.638                                 | 4.46%          | -2.80%           |

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per IEEE 1528 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

|                                   |                                                                                     |                                       |                                                                                       |                                 |
|-----------------------------------|-------------------------------------------------------------------------------------|---------------------------------------|---------------------------------------------------------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                |  | SAR EVALUATION REPORT                 |  | Reviewed by:<br>Quality Manager |
| Document S/N:<br>0Y1402070339.A3L | Test Dates:<br>02/10/14 - 03/05/14                                                  | DUT Type:<br>Portable Wireless Router |                                                                                       | Page 17 of 29                   |

## 8.2 Test System Verification

Prior to SAR assessment, the system is verified to  $\pm 10\%$  of the SAR measurement on the reference dipole at the time of calibration by the calibration facility. Full system validation status and result summary can be found in Appendix E.

**Table 8-2**  
**System Verification Results**

| System Verification<br>TARGET & MEASURED |                        |             |            |                |                  |                 |           |          |                                   |                                     |                                         |                             |
|------------------------------------------|------------------------|-------------|------------|----------------|------------------|-----------------|-----------|----------|-----------------------------------|-------------------------------------|-----------------------------------------|-----------------------------|
| SAR System #                             | Tissue Frequency (MHz) | Tissue Type | Date:      | Amb. Temp (°C) | Liquid Temp (°C) | Input Power (W) | Dipole SN | Probe SN | Measured SAR <sub>1g</sub> (W/kg) | 1 W Target SAR <sub>1g</sub> (W/kg) | 1 W Normalized SAR <sub>1g</sub> (W/kg) | Deviation <sub>1g</sub> (%) |
| G                                        | 835                    | BODY        | 02/10/2014 | 23.7           | 22.6             | 0.100           | 4d119     | 3209     | 1.010                             | 9.540                               | 10.100                                  | 5.87%                       |
| D                                        | 1900                   | BODY        | 02/10/2014 | 23.3           | 22.2             | 0.100           | 5d149     | 3022     | 4.020                             | 40.500                              | 40.200                                  | -0.74%                      |
| G                                        | 2450                   | BODY        | 03/05/2014 | 24.3           | 23.3             | 0.100           | 719       | 3258     | 5.120                             | 51.700                              | 51.200                                  | -0.97%                      |

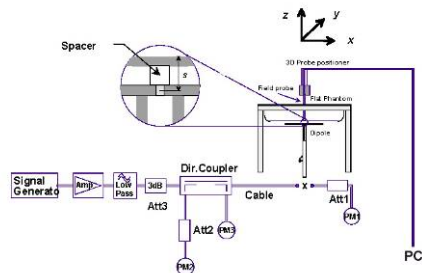


**Figure 8-1**  
**System Verification Setup Diagram**



**Figure 8-2**  
**System Verification Setup Photo**

|                                   |                                                                                                                                                                                                        |                                       |                                 |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                |  <b>SAR EVALUATION REPORT</b>  |                                       | Reviewed by:<br>Quality Manager |
| Document S/N:<br>0Y1402070339.A3L | Test Dates:<br>02/10/14 - 03/05/14                                                                                                                                                                     | DUT Type:<br>Portable Wireless Router | Page 18 of 29                   |

## 9

## SAR DATA SUMMARY

## 9.1 Standalone Wireless Router SAR Data

Table 9-1  
GPRS/UMTS Hotspot SAR Data

| MEASUREMENT RESULTS                      |      |           |         |                             |                       |                  |                      |                      |                 |            |       |          |                |                 |        |
|------------------------------------------|------|-----------|---------|-----------------------------|-----------------------|------------------|----------------------|----------------------|-----------------|------------|-------|----------|----------------|-----------------|--------|
| FREQUENCY                                |      | Mode      | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Spacing              | Device Serial Number | # of GPRS Slots | Duty Cycle | Side  | SAR (1g) | Scaling Factor | Scaled SAR (1g) | Plot # |
| MHz                                      | Ch.  |           |         |                             |                       |                  |                      |                      |                 |            |       | (W/kg)   |                | (W/kg)          |        |
| 836.60                                   | 190  | GSM 850   | GPRS    | 29.5                        | 29.36                 | -0.02            | 10 mm                | FL-045-A             | 2               | 1:4.15     | back  | 0.631    | 1.033          | 0.652           | A1     |
| 836.60                                   | 190  | GSM 850   | GPRS    | 29.5                        | 29.36                 | 0.04             | 10 mm                | FL-045-A             | 2               | 1:4.15     | front | 0.654    | 1.033          | 0.676           |        |
| 836.60                                   | 190  | GSM 850   | GPRS    | 29.5                        | 29.36                 | 0.08             | 10 mm                | FL-045-A             | 2               | 1:4.15     | top   | 0.146    | 1.033          | 0.151           |        |
| 836.60                                   | 190  | GSM 850   | GPRS    | 29.5                        | 29.36                 | 0.01             | 10 mm                | FL-045-A             | 2               | 1:4.15     | right | 0.185    | 1.033          | 0.191           |        |
| 836.60                                   | 190  | GSM 850   | GPRS    | 29.5                        | 29.36                 | -0.01            | 10 mm                | FL-045-A             | 2               | 1:4.15     | left  | 0.259    | 1.033          | 0.268           |        |
| 836.60                                   | 4183 | UMTS 850  | RMC     | 23.0                        | 23.00                 | 0.04             | 10 mm                | FL-045-C             | N/A             | 1:1        | back  | 0.291    | 1.000          | 0.291           | A2     |
| 836.60                                   | 4183 | UMTS 850  | RMC     | 23.0                        | 23.00                 | 0.00             | 10 mm                | FL-045-C             | N/A             | 1:1        | front | 0.438    | 1.000          | 0.438           |        |
| 836.60                                   | 4183 | UMTS 850  | RMC     | 23.0                        | 23.00                 | 0.01             | 10 mm                | FL-045-C             | N/A             | 1:1        | top   | 0.123    | 1.000          | 0.123           |        |
| 836.60                                   | 4183 | UMTS 850  | RMC     | 23.0                        | 23.00                 | 0.00             | 10 mm                | FL-045-C             | N/A             | 1:1        | right | 0.083    | 1.000          | 0.083           |        |
| 836.60                                   | 4183 | UMTS 850  | RMC     | 23.0                        | 23.00                 | 0.02             | 10 mm                | FL-045-C             | N/A             | 1:1        | left  | 0.174    | 1.000          | 0.174           |        |
| 1880.00                                  | 661  | GSM 1900  | GPRS    | 29.0                        | 28.64                 | -0.08            | 10 mm                | FL-045-A             | 2               | 1:4.15     | back  | 0.705    | 1.086          | 0.766           | A3     |
| 1850.20                                  | 512  | GSM 1900  | GPRS    | 29.0                        | 28.61                 | 0.05             | 10 mm                | FL-045-A             | 2               | 1:4.15     | front | 0.797    | 1.094          | 0.872           |        |
| 1880.00                                  | 661  | GSM 1900  | GPRS    | 29.0                        | 28.64                 | 0.00             | 10 mm                | FL-045-A             | 2               | 1:4.15     | front | 0.864    | 1.086          | 0.938           |        |
| 1909.80                                  | 810  | GSM 1900  | GPRS    | 29.0                        | 28.51                 | -0.03            | 10 mm                | FL-045-A             | 2               | 1:4.15     | front | 0.768    | 1.119          | 0.859           |        |
| 1880.00                                  | 661  | GSM 1900  | GPRS    | 29.0                        | 28.64                 | 0.07             | 10 mm                | FL-045-A             | 2               | 1:4.15     | top   | 0.382    | 1.086          | 0.415           |        |
| 1880.00                                  | 661  | GSM 1900  | GPRS    | 29.0                        | 28.64                 | -0.02            | 10 mm                | FL-045-A             | 2               | 1:4.15     | right | 0.199    | 1.086          | 0.216           | A4     |
| 1880.00                                  | 661  | GSM 1900  | GPRS    | 29.0                        | 28.64                 | 0.01             | 10 mm                | FL-045-A             | 2               | 1:4.15     | left  | 0.260    | 1.086          | 0.282           |        |
| 1880.00                                  | 9400 | UMTS 1900 | RMC     | 23.0                        | 22.76                 | -0.04            | 10 mm                | FL-045-C             | N/A             | 1:1        | back  | 0.727    | 1.057          | 0.768           |        |
| 1852.40                                  | 9262 | UMTS 1900 | RMC     | 23.0                        | 22.88                 | -0.08            | 10 mm                | FL-045-C             | N/A             | 1:1        | front | 0.750    | 1.028          | 0.771           |        |
| 1880.00                                  | 9400 | UMTS 1900 | RMC     | 23.0                        | 22.76                 | -0.01            | 10 mm                | FL-045-C             | N/A             | 1:1        | front | 0.890    | 1.057          | 0.941           |        |
| 1907.60                                  | 9538 | UMTS 1900 | RMC     | 23.0                        | 22.68                 | -0.02            | 10 mm                | FL-045-C             | N/A             | 1:1        | front | 0.806    | 1.076          | 0.867           | A4     |
| 1880.00                                  | 9400 | UMTS 1900 | RMC     | 23.0                        | 22.76                 | 0.13             | 10 mm                | FL-045-C             | N/A             | 1:1        | top   | 0.706    | 1.057          | 0.746           |        |
| 1880.00                                  | 9400 | UMTS 1900 | RMC     | 23.0                        | 22.76                 | -0.08            | 10 mm                | FL-045-C             | N/A             | 1:1        | right | 0.311    | 1.057          | 0.329           |        |
| 1880.00                                  | 9400 | UMTS 1900 | RMC     | 23.0                        | 22.76                 | 0.00             | 10 mm                | FL-045-C             | N/A             | 1:1        | left  | 0.469    | 1.057          | 0.496           |        |
| 1880.00                                  | 9400 | UMTS 1900 | RMC     | 23.0                        | 22.76                 | 0.04             | 10 mm                | FL-045-C             | N/A             | 1:1        | front | 0.781    | 1.057          | 0.826           |        |
| ANSI / IEEE C95.1 1992 - SAFETY LIMIT    |      |           |         |                             |                       |                  | Body                 |                      |                 |            |       |          |                |                 |        |
| Spatial Peak                             |      |           |         |                             |                       |                  | 1.6 W/kg (mW/g)      |                      |                 |            |       |          |                |                 |        |
| Uncontrolled Exposure/General Population |      |           |         |                             |                       |                  | averaged over 1 gram |                      |                 |            |       |          |                |                 |        |

Note: Blue entry indicates variability measurement.

|                                   |                                                                                     |                                       |                       |                                                                                       |                                 |
|-----------------------------------|-------------------------------------------------------------------------------------|---------------------------------------|-----------------------|---------------------------------------------------------------------------------------|---------------------------------|
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**Table 9-2**  
**WLAN Hotspot SAR**

| MEASUREMENT RESULTS                                                                               |     |              |         |                             |                       |                  |                                                 |                      |                  |        |            |          |                |                 |        |
|---------------------------------------------------------------------------------------------------|-----|--------------|---------|-----------------------------|-----------------------|------------------|-------------------------------------------------|----------------------|------------------|--------|------------|----------|----------------|-----------------|--------|
| FREQUENCY                                                                                         |     | Mode         | Service | Maximum Allowed Power [dBm] | Conducted Power [dBm] | Power Drift [dB] | Spacing                                         | Device Serial Number | Data Rate (Mbps) | Side   | Duty Cycle | SAR (1g) | Scaling Factor | Scaled SAR (1g) | Plot # |
| MHz                                                                                               | Ch. |              |         |                             |                       |                  |                                                 |                      |                  |        |            | (W/kg)   |                | (W/kg)          |        |
| 2412                                                                                              | 1   | IEEE 802.11b | DSSS    | 17.5                        | 17.32                 | -0.08            | 10 mm                                           | FL-045-A             | 1                | back   | 1:1        | 0.036    | 1.042          | 0.038           |        |
| 2412                                                                                              | 1   | IEEE 802.11b | DSSS    | 17.5                        | 17.32                 | -0.09            | 10 mm                                           | FL-045-A             | 1                | front  | 1:1        | 0.041    | 1.042          | 0.043           |        |
| 2412                                                                                              | 1   | IEEE 802.11b | DSSS    | 17.5                        | 17.32                 | 0.18             | 10 mm                                           | FL-045-A             | 1                | bottom | 1:1        | 0.060    | 1.042          | 0.063           | A5     |
| 2412                                                                                              | 1   | IEEE 802.11b | DSSS    | 17.5                        | 17.32                 | 0.12             | 10 mm                                           | FL-045-A             | 1                | left   | 1:1        | 0.008    | 1.042          | 0.008           |        |
| 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 |                      |                  |        |            |          |                |                 |        |

## 9.2 SAR Test Notes

### General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in KDB Publication 941225 D06v01r01 and FCC KDB Publication 447498 D01v05r01.
2. Batteries are fully charged at the beginning of the SAR measurements. A standard battery was used for all SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05r01.
6. Per FCC KDB 865664 D01 v01r01, variability SAR tests were performed when the measured SAR results for a frequency band were greater than 0.8 W/kg. Repeated SAR measurements are highlighted in the tables above for clarity. Please see Section 11 for variability analysis.
7. During SAR Testing for the Wireless Router conditions per FCC KDB Publication 941225 D06v01r01, the actual Portable Hotspot operation (with actual simultaneous transmission of a transmitter with WIFI) was not activated (See Section 4.2 for more details).

### GSM Notes:

1. Justification for reduced test configurations per KDB Publication 941225 D03v01 and October 2013 TCB Workshop Notes: The source-based frame-averaged output power was evaluated for all GPRS slot configurations. The configuration with the highest target frame averaged output power was evaluated for hotspot SAR. When the maximum frame-averaged powers are equivalent across two or more slots (within 0.25 dB), the configuration with the most number of time slots was tested.
2. Per FCC KDB Publication 447498 D01v05r01, since the reported (scaled) SAR measured at the middle channel for some test configurations is > 0.8 W/kg, testing at the other channels is required for such test configuration(s). Since the maximum output power variation across the required test channels is < ½ dB, middle channel was the default used.

|                                          |                                                                                     |                                              |                                                                                       |                                        |
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UMTS Notes:

1. UMTS mode in Body SAR was tested under RMC 12.2 kbps with HSPA Inactive per KDB Publication 941225 D01v02r02. 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 D01v05r01, since the reported (scaled) SAR measured at the middle channel for some test configurations is > 0.8 W/kg, testing at the other channels is required for such test configuration(s). Since the maximum output power variation across the required test channels is > ½ dB, middle channel is the default used.

WLAN Notes:

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

|                                          |                                                                                                                                                                                                        |                                              |                                        |
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## 10 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

### 10.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v05r01 are applicable to devices with built-in unlicensed transmitters such as 802.11 b/g/n devices which may simultaneously transmit with the licensed transmitter.

### 10.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v05r01 IV.C.1.iii, 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 physical test configuration is  $\leq 1.6$  W/kg. When standalone SAR is not required to be measured, per FCC KDB 447498 D01v05r01 4.3.2.2), the following equation must be used to estimate the standalone 1g SAR for simultaneous transmission assessment involving that transmitter.

### 10.3 Hotspot SAR Simultaneous Transmission Analysis

Per FCC KDB Publication 941225 D06v01r01, the devices edges with antennas more than 2.5 cm from edge are not required to be evaluated for SAR (“-”).

**Table 10-1**  
**Simultaneous Transmission Scenario (2.4 GHz Hotspot at 1.0 cm)**

| Simult Tx | Configuration | GPRS 850 SAR (W/kg) | 2.4 GHz WLAN SAR (W/kg) | $\Sigma$ SAR (W/kg) |
|-----------|---------------|---------------------|-------------------------|---------------------|
| Body SAR  | Back          | 0.652               | 0.038                   | 0.690               |
|           | Front         | 0.676               | 0.043                   | <b>0.719</b>        |
|           | Top           | 0.151               | -                       | 0.151               |
|           | Bottom        | -                   | 0.063                   | 0.063               |
|           | Right         | 0.191               | -                       | 0.191               |
|           | Left          | 0.268               | 0.008                   | 0.276               |
| Simult Tx | Configuration | UMTS 850 SAR (W/kg) | 2.4 GHz WLAN SAR (W/kg) | $\Sigma$ SAR (W/kg) |
| Body SAR  | Back          | 0.291               | 0.038                   | 0.329               |
|           | Front         | 0.438               | 0.043                   | <b>0.481</b>        |
|           | Top           | 0.123               | -                       | 0.123               |
|           | Bottom        | -                   | 0.063                   | 0.063               |
|           | Right         | 0.083               | -                       | 0.083               |
|           | Left          | 0.174               | 0.008                   | 0.182               |

|                                          |                                                                                     |                                              |                                                                                       |                                        |
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| Simult Tx | Configuration | GPRS 1900 SAR (W/kg) | 2.4 GHz WLAN SAR (W/kg) | $\Sigma$ SAR (W/kg) |
|-----------|---------------|----------------------|-------------------------|---------------------|
| Body SAR  | Back          | 0.766                | 0.038                   | 0.804               |
|           | Front         | 0.938                | 0.043                   | 0.981               |
|           | Top           | 0.415                | -                       | 0.415               |
|           | Bottom        | -                    | 0.063                   | 0.063               |
|           | Right         | 0.216                | -                       | 0.216               |
|           | Left          | 0.282                | 0.008                   | 0.290               |
| Simult Tx | Configuration | UMTS 1900 SAR (W/kg) | 2.4 GHz WLAN SAR (W/kg) | $\Sigma$ SAR (W/kg) |
| Body SAR  | Back          | 0.768                | 0.038                   | 0.806               |
|           | Front         | 0.941                | 0.043                   | <b>0.984</b>        |
|           | Top           | 0.746                | -                       | 0.746               |
|           | Bottom        | -                    | 0.063                   | 0.063               |
|           | Right         | 0.329                | -                       | 0.329               |
|           | Left          | 0.496                | 0.008                   | 0.504               |

#### 10.4 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v05r01.

|                                          |                                                                                     |                                              |                                                                                       |                                        |
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## 11 SAR MEASUREMENT VARIABILITY

### 11.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r01, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

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

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

**Table 11-1**  
**Body SAR Measurement Variability Results**

| BODY VARIABILITY RESULTS                 |           |      |           |         |       |                      |                   |                       |       |                       |       |                       |       |
|------------------------------------------|-----------|------|-----------|---------|-------|----------------------|-------------------|-----------------------|-------|-----------------------|-------|-----------------------|-------|
| Band                                     | FREQUENCY |      | Mode      | Service | Side  | Spacing              | Measured SAR (1g) | 1st Repeated SAR (1g) | Ratio | 2nd Repeated SAR (1g) | Ratio | 3rd Repeated SAR (1g) | Ratio |
|                                          | MHz       | Ch.  |           |         |       |                      | (W/kg)            | (W/kg)                |       | (W/kg)                |       | (W/kg)                |       |
| 1900                                     | 1880.00   | 9400 | UMTS 1900 | RMC     | front | 10 mm                | 0.890             | 0.781                 | 1.14  | N/A                   | N/A   | N/A                   | N/A   |
| ANSI / IEEE C95.1 1992 - SAFETY LIMIT    |           |      |           |         |       | Body                 |                   |                       |       |                       |       |                       |       |
| Spatial Peak                             |           |      |           |         |       | 1.6 W/kg (mW/g)      |                   |                       |       |                       |       |                       |       |
| Uncontrolled Exposure/General Population |           |      |           |         |       | averaged over 1 gram |                   |                       |       |                       |       |                       |       |

### 11.2 Measurement Uncertainty

The measured SAR was  $< 1.5$  W/kg for all frequency bands. Therefore, per KDB Publication 865664 D01v01r01, the extended measurement uncertainty analysis per IEEE 1528-2003 was not required.

|                                   |                                                                                     |                                       |                                                                                       |                                 |
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## 12 EQUIPMENT LIST

| Manufacturer       | Model     | Description                            | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|-----------|----------------------------------------|------------|--------------|------------|---------------|
| Agilent            | E8257D    | (250kHz-20GHz) Signal Generator        | 4/16/2013  | Annual       | 4/16/2014  | MY45470194    |
| Agilent            | 8753ES    | S-Parameter Network Analyzer           | 10/29/2013 | Annual       | 10/29/2014 | US39170122    |
| Agilent            | 85047A    | S-Parameter Test Set                   | N/A        | N/A          | N/A        | 2904A00579    |
| Amplifier Research | 551G4     | 5W, 800MHz-4.2GHz                      | CBT        | N/A          | CBT        | 21910         |
| Anritsu            | ML2495A   | Power Meter                            | 10/31/2013 | Annual       | 10/31/2014 | 1039008       |
| Anritsu            | ML2469A   | Power Meter                            | CBT        | N/A          | CBT        | 1306009       |
| Anritsu            | MA2481A   | Power Sensor                           | 10/30/2013 | Annual       | 10/30/2014 | 5605          |
| Anritsu            | MA2411B   | Pulse Power Sensor                     | 11/14/2013 | Annual       | 11/14/2014 | 1126066       |
| Anritsu            | MA2411B   | Pulse Power Sensor                     | CBT        | N/A          | CBT        | 1207470       |
| Anritsu            | MT8820C   | Radio Communication Analyzer           | 6/28/2013  | Annual       | 6/28/2014  | 6201240328    |
| Gigatronics        | 80701A    | (0.05-18GHz) Power Sensor              | 10/30/2013 | Annual       | 10/30/2014 | 1833460       |
| Mini-Circuits      | NLP-1200+ | Low Pass Filter DC to 1000 MHz         | CBT        | N/A          | CBT        | N/A           |
| Mini-Circuits      | NLP-2950+ | Low Pass Filter DC to 2700 MHz         | CBT        | N/A          | CBT        | N/A           |
| Mini-Circuits      | BW-N20W5  | Power Attenuator                       | CBT        | N/A          | CBT        | 1226          |
| Narda              | 4014C-6   | 4 - 8 GHz SMA 6 dB Directional Coupler | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | PE2208-6  | Bidirectional Coupler                  | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | PE2209-10 | Bidirectional Coupler                  | CBT        | N/A          | CBT        | N/A           |
| Rohde & Schwarz    | CMU200    | Base Station Simulator                 | 5/3/2013   | Annual       | 5/3/2014   | 836371/0079   |
| Rohde & Schwarz    | CMW500    | Radio Communication Tester             | 6/6/2013   | Annual       | 6/6/2014   | 111427        |
| Rohde & Schwarz    | NRV-Z32   | Peak Power Sensor                      | 10/12/2012 | Biennial     | 10/12/2014 | 836019/013    |
| Rohde & Schwarz    | SMIQ03B   | Signal Generator                       | 4/17/2013  | Annual       | 4/17/2014  | DE27259       |
| Rohde & Schwarz    | SME06     | Signal Generator                       | 10/30/2013 | Annual       | 10/30/2014 | 832026        |
| SPEAG              | D1900V2   | 1900 MHz SAR Dipole                    | 7/22/2013  | Annual       | 7/22/2014  | 5d149         |
| SPEAG              | D2450V2   | 2450 MHz SAR Dipole                    | 8/23/2013  | Annual       | 8/23/2014  | 719           |
| SPEAG              | D835V2    | 835 MHz SAR Dipole                     | 4/25/2013  | Annual       | 4/25/2014  | 4d119         |
| SPEAG              | DAE4      | Dasy Data Acquisition Electronics      | 3/8/2013   | Annual       | 3/8/2014   | 1334          |
| SPEAG              | DAE4      | Dasy Data Acquisition Electronics      | 8/21/2013  | Annual       | 8/21/2014  | 1322          |
| SPEAG              | DAK-3.5   | Dielectric Assessment Kit              | 5/14/2013  | Annual       | 5/14/2014  | 1070          |
| SPEAG              | DAK-3.5   | Dielectric Assessment Kit              | 11/13/2013 | Annual       | 11/13/2014 | 1091          |
| SPEAG              | DAKS-3.5  | Portable Dielectric Assessment Kit     | 8/18/2013  | Annual       | 8/18/2014  | 1008          |
| SPEAG              | ES3DV3    | SAR Probe                              | 3/15/2013  | Annual       | 3/15/2014  | 3209          |
| SPEAG              | ES3DV2    | SAR Probe                              | 8/22/2013  | Annual       | 8/22/2014  | 3022          |
| SPEAG              | DAE4      | Dasy Data Acquisition Electronics      | 4/22/2013  | Annual       | 4/22/2014  | 665           |
| SPEAG              | ES3DV3    | SAR Probe                              | 2/11/2013  | Annual       | 2/11/2014  | 3258          |
| Tektronix          | RSA6114A  | Real Time Spectrum Analyzer            | 4/17/2013  | Annual       | 4/17/2014  | B010177       |
| VWR                | 23226-658 | Long Stem Thermometer                  | 3/30/2012  | Biennial     | 3/30/2014  | 122179874     |
| VWR                | 23226-658 | Long Stem Thermometer                  | 5/16/2012  | Biennial     | 5/16/2014  | 122295544     |
| VWR                | 36934-158 | Wall-Mounted Thermometer               | 8/8/2013   | Annual       | 8/8/2014   | 130477877     |

Note: CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.

Each equipment item was used solely within its respective calibration period.

|                                          |                                                                                     |                                              |                                                                                       |                                        |
|------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------|
| FCC ID: A3LSMV101F                       |  | <b>SAR EVALUATION REPORT</b>                 |  | <b>Reviewed by:</b><br>Quality Manager |
| <b>Document S/N:</b><br>OY1402070339.A3L | <b>Test Dates:</b><br>02/10/14 - 03/05/14                                           | <b>DUT Type:</b><br>Portable Wireless Router |                                                                                       | Page 25 of 29                          |

# 13 MEASUREMENT UNCERTAINTIES

| a                                                                             | b                    | c             | d              | e=<br>f(d,k) | f                     | g                        | h =<br>c x f/e                 | i =<br>c x g/e                   | k              |
|-------------------------------------------------------------------------------|----------------------|---------------|----------------|--------------|-----------------------|--------------------------|--------------------------------|----------------------------------|----------------|
| Uncertainty<br>Component                                                      | IEEE<br>1528<br>Sec. | Tol.<br>(± %) | Prob.<br>Dist. | Div.         | c <sub>i</sub><br>1gm | c <sub>i</sub><br>10 gms | 1gm<br>u <sub>i</sub><br>(± %) | 10gms<br>u <sub>i</sub><br>(± %) | v <sub>i</sub> |
| <b>Measurement System</b>                                                     |                      |               |                |              |                       |                          |                                |                                  |                |
| Probe Calibration                                                             | E.2.1                | 6.0           | N              | 1            | 1.0                   | 1.0                      | 6.0                            | 6.0                              | ∞              |
| Axial Isotropy                                                                | E.2.2                | 0.25          | N              | 1            | 0.7                   | 0.7                      | 0.2                            | 0.2                              | ∞              |
| Hemishperical Isotropy                                                        | E.2.2                | 1.3           | N              | 1            | 1.0                   | 1.0                      | 1.3                            | 1.3                              | ∞              |
| Boundary Effect                                                               | E.2.3                | 0.4           | N              | 1            | 1.0                   | 1.0                      | 0.4                            | 0.4                              | ∞              |
| Linearity                                                                     | E.2.4                | 0.3           | N              | 1            | 1.0                   | 1.0                      | 0.3                            | 0.3                              | ∞              |
| System Detection Limits                                                       | E.2.5                | 5.1           | N              | 1            | 1.0                   | 1.0                      | 5.1                            | 5.1                              | ∞              |
| Readout Electronics                                                           | E.2.6                | 1.0           | N              | 1            | 1.0                   | 1.0                      | 1.0                            | 1.0                              | ∞              |
| Response Time                                                                 | E.2.7                | 0.8           | R              | 1.73         | 1.0                   | 1.0                      | 0.5                            | 0.5                              | ∞              |
| Integration Time                                                              | E.2.8                | 2.6           | R              | 1.73         | 1.0                   | 1.0                      | 1.5                            | 1.5                              | ∞              |
| RF Ambient Conditions                                                         | E.6.1                | 3.0           | R              | 1.73         | 1.0                   | 1.0                      | 1.7                            | 1.7                              | ∞              |
| Probe Positioner Mechanical Tolerance                                         | E.6.2                | 0.4           | R              | 1.73         | 1.0                   | 1.0                      | 0.2                            | 0.2                              | ∞              |
| Probe Positioning w/ respect to Phantom                                       | E.6.3                | 2.9           | R              | 1.73         | 1.0                   | 1.0                      | 1.7                            | 1.7                              | ∞              |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E.5                  | 1.0           | R              | 1.73         | 1.0                   | 1.0                      | 0.6                            | 0.6                              | ∞              |
| <b>Test Sample Related</b>                                                    |                      |               |                |              |                       |                          |                                |                                  |                |
| Test Sample Positioning                                                       | E.4.2                | 6.0           | N              | 1            | 1.0                   | 1.0                      | 6.0                            | 6.0                              | 287            |
| Device Holder Uncertainty                                                     | E.4.1                | 3.32          | R              | 1.73         | 1.0                   | 1.0                      | 1.9                            | 1.9                              | ∞              |
| Output Power Variation - SAR drift measurement                                | 6.6.2                | 5.0           | R              | 1.73         | 1.0                   | 1.0                      | 2.9                            | 2.9                              | ∞              |
| <b>Phantom &amp; Tissue Parameters</b>                                        |                      |               |                |              |                       |                          |                                |                                  |                |
| Phantom Uncertainty (Shape & Thickness tolerances)                            | E.3.1                | 4.0           | R              | 1.73         | 1.0                   | 1.0                      | 2.3                            | 2.3                              | ∞              |
| Liquid Conductivity - deviation from target values                            | E.3.2                | 5.0           | R              | 1.73         | 0.64                  | 0.43                     | 1.8                            | 1.2                              | ∞              |
| Liquid Conductivity - measurement uncertainty                                 | E.3.3                | 3.8           | N              | 1            | 0.64                  | 0.43                     | 2.4                            | 1.6                              | 6              |
| Liquid Permittivity - deviation from target values                            | E.3.2                | 5.0           | R              | 1.73         | 0.60                  | 0.49                     | 1.7                            | 1.4                              | ∞              |
| Liquid Permittivity - measurement uncertainty                                 | E.3.3                | 4.5           | N              | 1            | 0.60                  | 0.49                     | 2.7                            | 2.2                              | 6              |
| <b>Combined Standard Uncertainty (k=1)</b>                                    |                      |               |                |              |                       |                          | RSS                            | 12.1                             | 11.7           |
| <b>Expanded Uncertainty</b><br>(95% CONFIDENCE LEVEL)                         |                      |               |                |              |                       |                          | k=2                            | 24.2                             | 23.5           |

The above measurement uncertainties are according to IEEE Std. 1528-2003

|                                            |                                                                                                                                                                                                        |                                       |                                 |
|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                         |  <b>SAR EVALUATION REPORT</b>  |                                       | Reviewed by:<br>Quality Manager |
| Document S/N:<br>OY1402070339.A3L          | Test Dates:<br>02/10/14 - 03/05/14                                                                                                                                                                     | DUT Type:<br>Portable Wireless Router |                                 |
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## 14 CONCLUSION

### 14.1 Measurement Conclusion

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

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]

|                                          |                                                                                                                                   |                                              |                                                                                       |                                        |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------|
| FCC ID: A3LSMV101F                       |  <b>PCTEST</b><br>ENGINEERING LABORATORY, INC. | <b>SAR EVALUATION REPORT</b>                 |  | <b>Reviewed by:</b><br>Quality Manager |
| <b>Document S/N:</b><br>0Y1402070339.A3L | <b>Test Dates:</b><br>02/10/14 - 03/05/14                                                                                         | <b>DUT Type:</b><br>Portable Wireless Router |                                                                                       | Page 27 of 29                          |

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|                                   |                                                                                                                                                                                                        |                                       |                                 |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                |  <b>SAR EVALUATION REPORT</b>  |                                       | Reviewed by:<br>Quality Manager |
| Document S/N:<br>OY1402070339.A3L | Test Dates:<br>02/10/14 - 03/05/14                                                                                                                                                                     | DUT Type:<br>Portable Wireless Router | Page 28 of 29                   |

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|                                   |                                                                                                                                                                                                        |                                       |                                 |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                |  <b>SAR EVALUATION REPORT</b>  |                                       | Reviewed by:<br>Quality Manager |
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## APPENDIX A: SAR TEST DATA

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMV101F; Type: Portable Wireless Router; Serial: FL-045-A**

Communication System: UID 0, GSM GPRS; 2 Tx slots; Frequency: 836.6 MHz; Duty Cycle: 1:4.15

Medium: 835 Body Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$ ;  $\sigma = 1.005 \text{ S/m}$ ;  $\epsilon_r = 53.927$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-10-2014; Ambient Temp: 23.7°C; Tissue Temp: 22.6°C

Probe: ES3DV3 - SN3209; ConvF(6.28, 6.28, 6.28); Calibrated: 3/15/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/8/2013

Phantom: SAM Front; Type: SAM; Serial: 1686

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

**Mode: GPRS 850, Body SAR, Front side, Mid.ch, 2 Tx Slots**

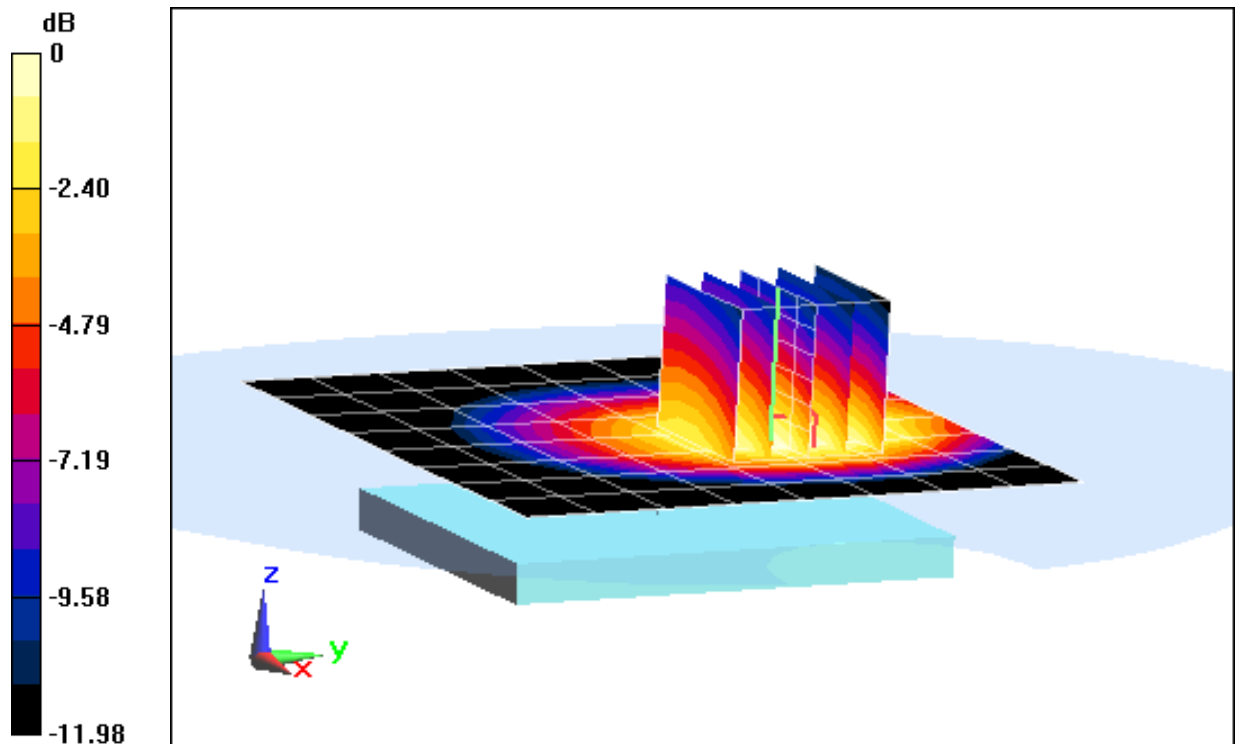
**Area Scan (9x9x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$

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

Reference Value = 25.837 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 0.990 W/kg

**SAR(1 g) = 0.654 W/kg**



0 dB = 0.710 W/kg = -1.49 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMV101F; Type: Portable Wireless Router; Serial: FL-045-C**

Communication System: UID 0, UMTS; Frequency: 836.6 MHz; Duty Cycle: 1:1

Medium: 835 Body Medium parameters used (interpolated):

$f = 836.6 \text{ MHz}$ ;  $\sigma = 1.005 \text{ S/m}$ ;  $\epsilon_r = 53.927$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-10-2014; Ambient Temp: 23.7°C; Tissue Temp: 22.6°C

Probe: ES3DV3 - SN3209; ConvF(6.28, 6.28, 6.28); Calibrated: 3/15/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/8/2013

Phantom: SAM Front; Type: SAM; Serial: 1686

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

**Mode: UMTS 850, Body SAR, Front side, Mid.ch**

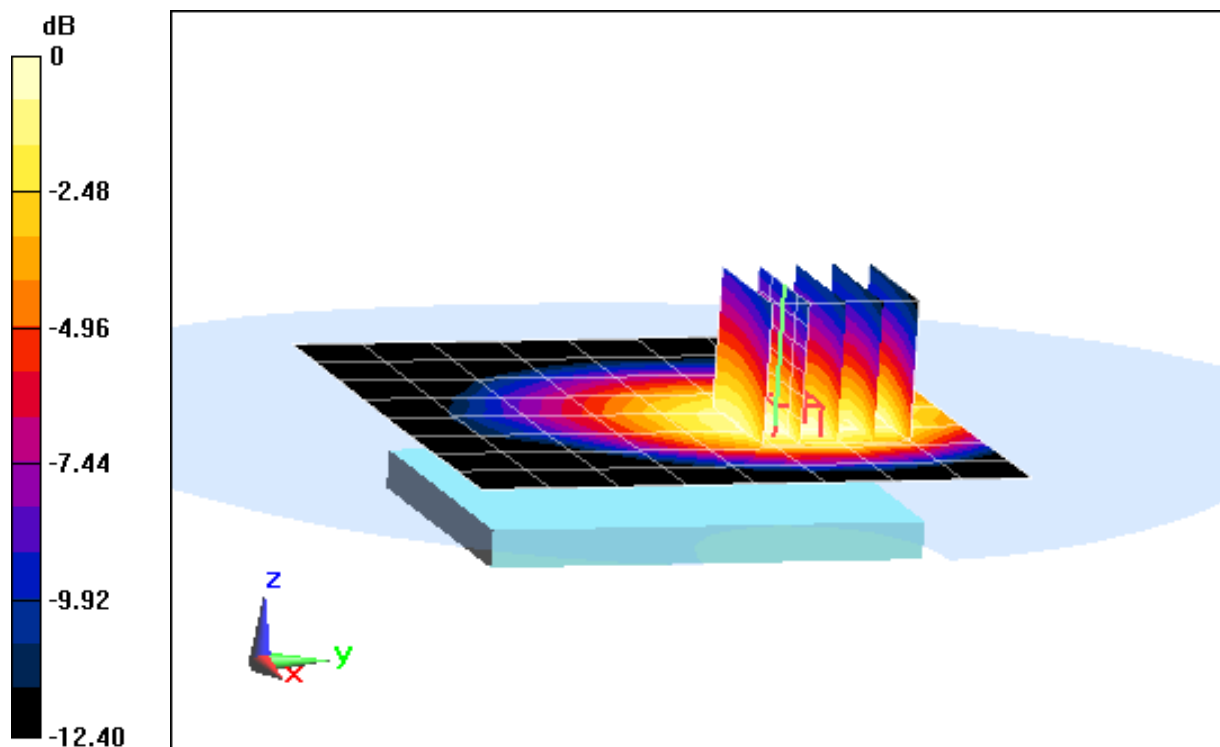
**Area Scan (9x9x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$

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

Reference Value = 21.729 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 0.678 W/kg

**SAR(1 g) = 0.438 W/kg**



0 dB = 0.472 W/kg = -3.26 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMV101F; Type: Portable Wireless Router; Serial: FL-045-A**

Communication System: UID 0 , GSM GPRS; 2 Tx slots; Frequency: 1880 MHz; Duty Cycle: 1:4.15

Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$ ;  $\sigma = 1.561 \text{ S/m}$ ;  $\epsilon_r = 51.837$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-10-2014; Ambient Temp: 23.3°C; Tissue Temp: 22.2°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/21/2013

Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646

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

**Mode: GPRS 1900, Body SAR, Front side, Mid.ch, 2 Tx Slots**

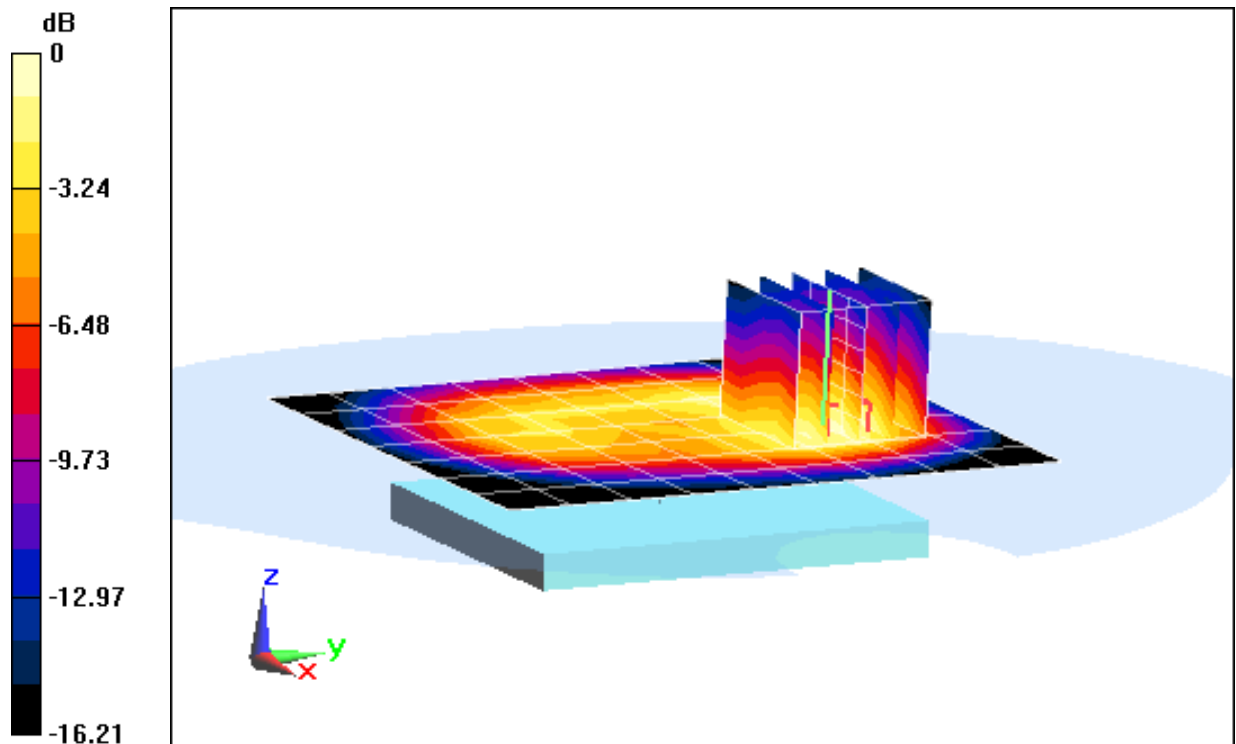
**Area Scan (8x10x1):** Measurement grid: dx=15mm, dy=15mm

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

Reference Value = 25.160 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 1.43 W/kg

**SAR(1 g) = 0.864 W/kg**



0 dB = 0.907 W/kg = -0.42 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMV101F; Type: Portable Wireless Router; Serial: FL-045-C**

Communication System: UID 0, UMTS; Frequency: 1880 MHz; Duty Cycle: 1:1

Medium: 1900 Body Medium parameters used:

$f = 1880 \text{ MHz}$ ;  $\sigma = 1.561 \text{ S/m}$ ;  $\epsilon_r = 51.837$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-10-2014; Ambient Temp: 23.3°C; Tissue Temp: 22.2°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/21/2013

Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646

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

**Mode: UMTS 1900, Body SAR, Front side, Mid.ch**

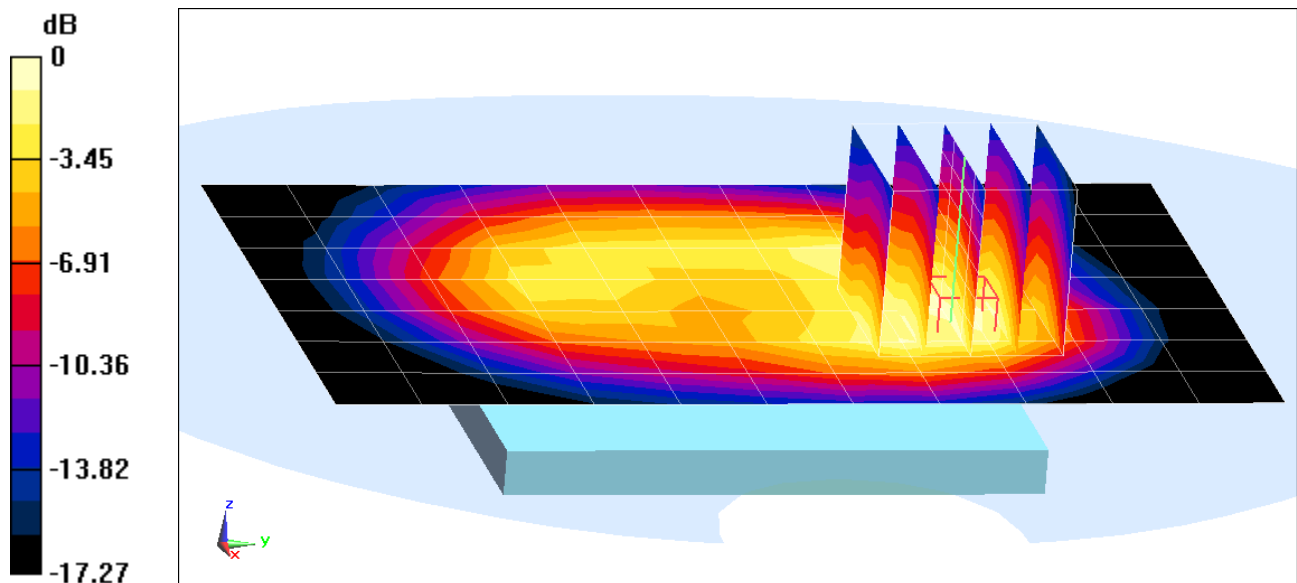
**Area Scan (8x12x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$

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

Reference Value = 24.753 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 1.45 W/kg

**SAR(1 g) = 0.890 W/kg**



0 dB = 0.968 W/kg = -0.14 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: A3LSMV101F; Type: Portable Wireless Router; Serial: FL-045-A**

Communication System: UID 0, IEEE 802.11b; Frequency: 2412 MHz; Duty Cycle: 1:1

Medium: 2450 Body Medium parameters used (interpolated):

$f = 2412 \text{ MHz}$ ;  $\sigma = 1.988 \text{ S/m}$ ;  $\epsilon_r = 51.461$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 03-05-2014; Ambient Temp: 24.3°C; Tissue Temp: 23.3°C

Probe: ES3DV3 - SN3258; ConvF(4.14, 4.14, 4.14); Calibrated: 2/25/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 2/26/2014

Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP-1158

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

**Mode: IEEE 802.11b, Body SAR, Ch 01, 1 Mbps, Bottom Edge**

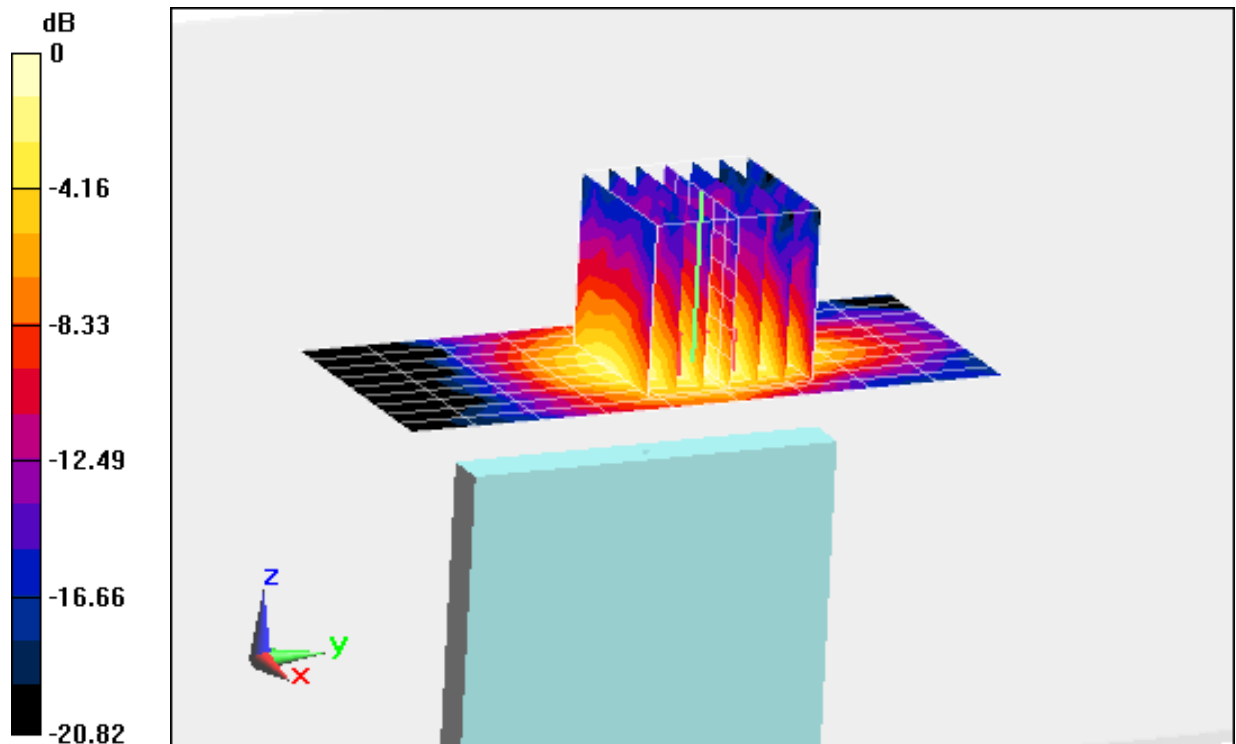
**Area Scan (10x10x1):** Measurement grid: dx=5mm, dy=12mm

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

Reference Value = 5.871 V/m; Power Drift = 0.18 dB

Peak SAR (extrapolated) = 0.117 W/kg

**SAR(1 g) = 0.060 W/kg**



0 dB = 0.0760 W/kg = -11.19 dBW/kg

## APPENDIX B: SYSTEM VERIFICATION

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 835 MHz; Type: D835V2; Serial: 4d119**

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

Medium: 835 Body, Medium parameters used:

$f = 835 \text{ MHz}$ ;  $\sigma = 1.004 \text{ S/m}$ ;  $\epsilon_r = 53.949$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.5 cm

Test Date: 02-10-2014; Ambient Temp: 23.7°C; Tissue Temp: 22.6°C

Probe: ES3DV3 - SN3209; ConvF(6.28, 6.28, 6.28); Calibrated: 3/15/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1334; Calibrated: 3/8/2013

Phantom: SAM Front; Type: SAM; Serial: 1686

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

## 835 MHz System Verification

**Area Scan (7x14x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$

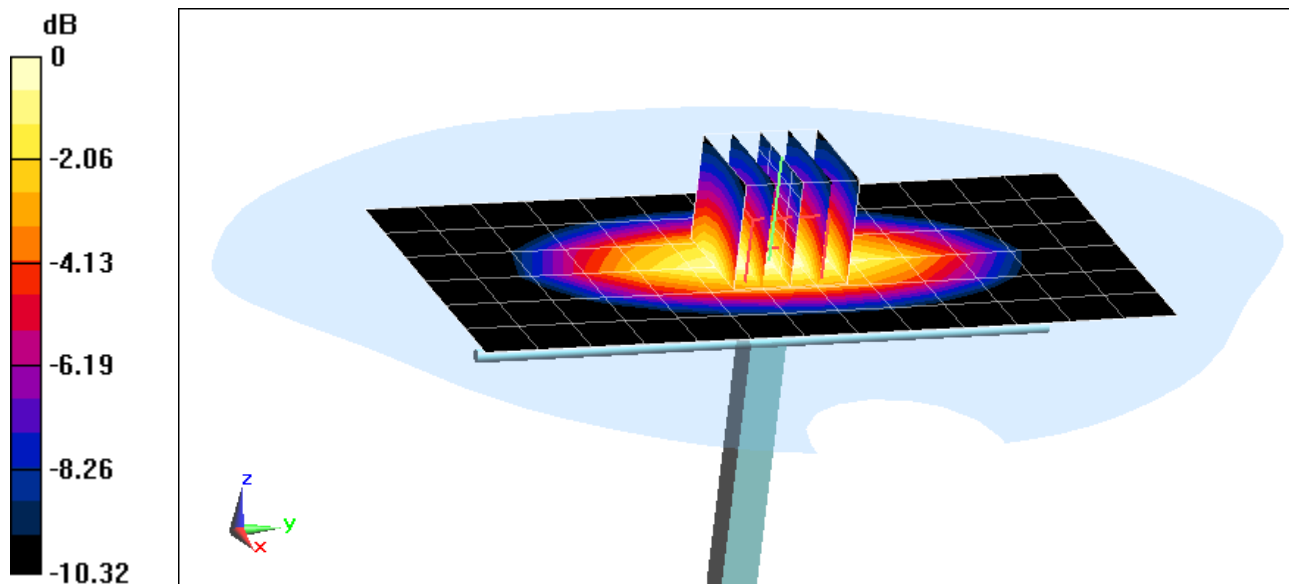
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 1.46 W/kg

**SAR(1 g) = 1.01 W/kg**

Deviation = 5.87%



0 dB = 1.09 W/kg = 0.37 dBW/kg

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d149**

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium: 1900 Body, Medium parameters used (interpolated):

$f = 1900 \text{ MHz}$ ;  $\sigma = 1.584 \text{ S/m}$ ;  $\epsilon_r = 51.769$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 02-10-2014; Ambient Temp: 23.3°C; Tissue Temp: 22.2°C

Probe: ES3DV2 - SN3022; ConvF(4.49, 4.49, 4.49); Calibrated: 8/22/2013;

Sensor-Surface: 4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1322; Calibrated: 8/21/2013

Phantom: SAM v5.0 front; Type: QD000P40CD; Serial: TP-1646

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

## 1900 MHz System Verification

**Area Scan (7x10x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$

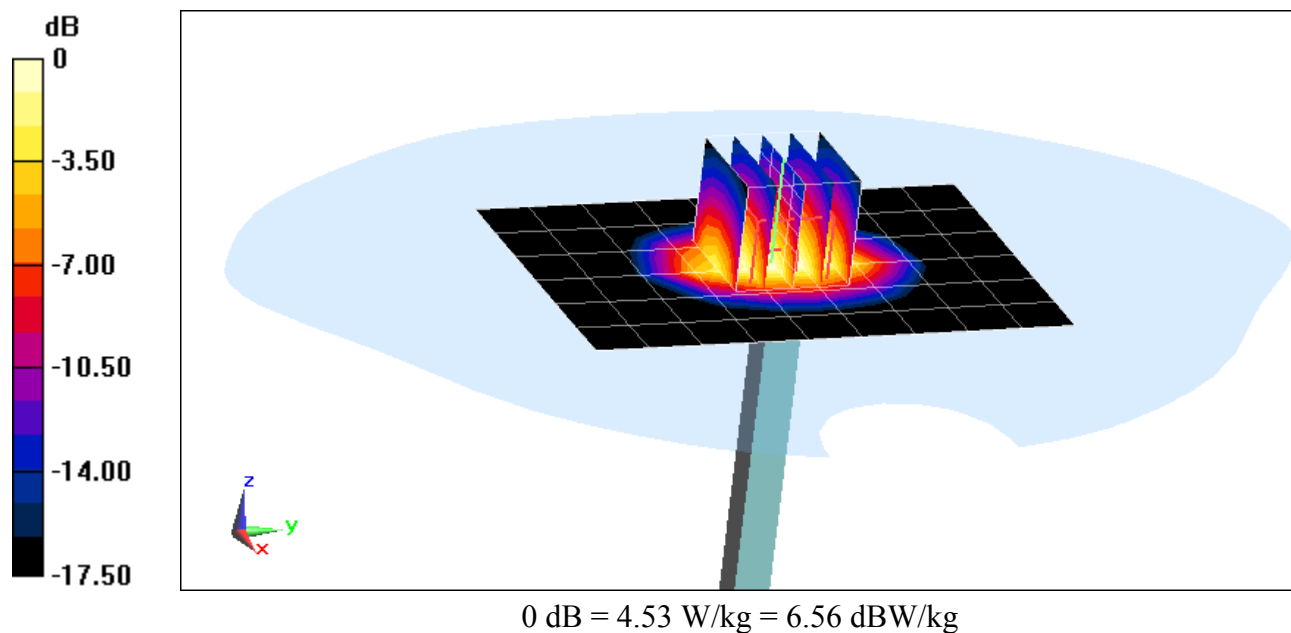
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Input Power = 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 7.28 W/kg

**SAR(1 g) = 4.02 W/kg**

Deviation = -0.74%



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 719**

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: 2450 Body Medium parameters used:

$f = 2450 \text{ MHz}$ ;  $\sigma = 2.044 \text{ S/m}$ ;  $\epsilon_r = 51.296$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 03-05-2014; Ambient Temp: 24.3°C; Tissue Temp: 23.3°C

Probe: ES3DV3 - SN3258; ConvF(4.14, 4.14, 4.14); Calibrated: 2/25/2014;

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn665; Calibrated: 2/26/2014

Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP-1158

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

## 2450 MHz System Verification

**Area Scan (8x9x1):** Measurement grid:  $dx=12\text{mm}$ ,  $dy=12\text{mm}$

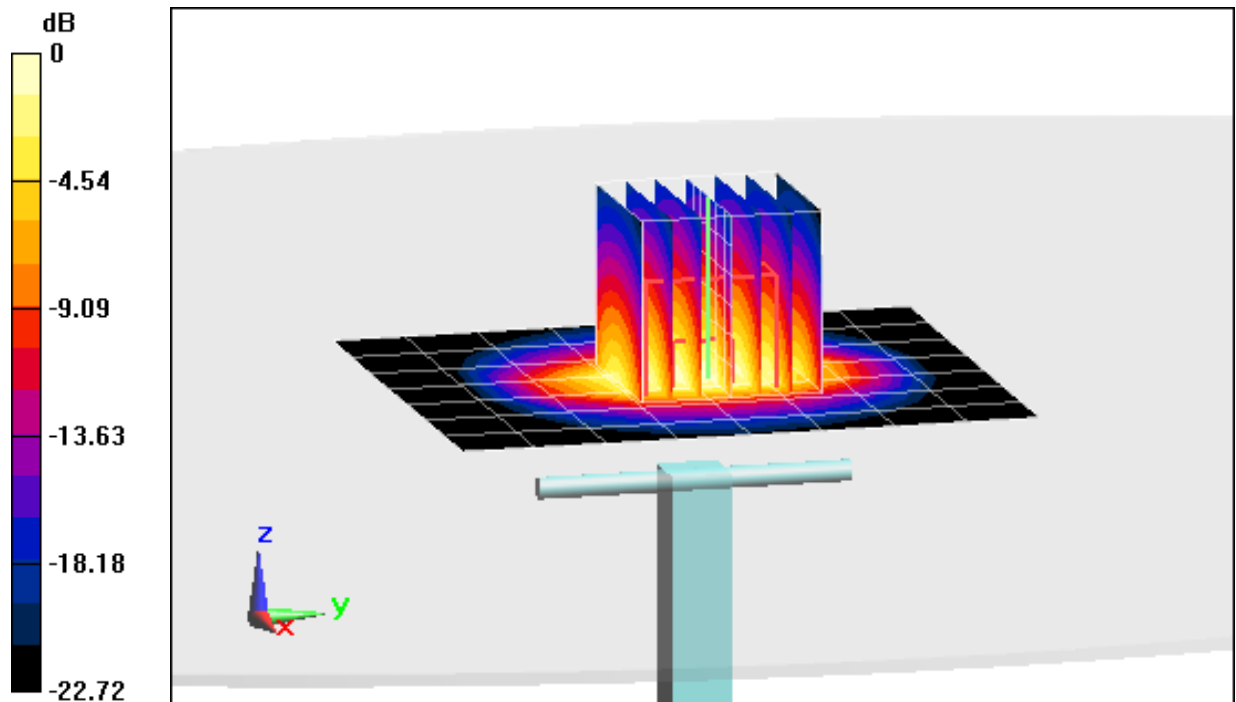
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Input Power= 20.0 dBm (100 mW)

Peak SAR (extrapolated) = 10.9 W/kg

**SAR(1 g) = 5.12 W/kg**

Deviation= -0.97%



## APPENDIX C: PROBE CALIBRATION



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

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **ES3-3022\_Aug13**

## CALIBRATION CERTIFICATE

Object **ES3DV2 - SN:3022**

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

Calibration date: **August 22, 2013**

*UTC*  
*9/13/13*

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 04-Apr-13 (No. 217-01733)         | Apr-14                 |
| Power sensor E4412A        | MY41498087      | 04-Apr-13 (No. 217-01733)         | Apr-14                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 04-Apr-13 (No. 217-01737)         | Apr-14                 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 04-Apr-13 (No. 217-01735)         | Apr-14                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 04-Apr-13 (No. 217-01738)         | Apr-14                 |
| Reference Probe ES3DV2     | SN: 3013        | 28-Dec-12 (No. ES3-3013_Dec12)    | Dec-13                 |
| DAE4                       | SN: 660         | 31-Jan-13 (No. DAE4-660_Jan13)    | Jan-14                 |
| Secondary Standards        | ID              | Check Date (in house)             | Scheduled Check        |
| RF generator HP 8648C      | US3642U01700    | 4-Aug-99 (in house check Apr-13)  | In house check: Apr-15 |
| Network Analyzer HP 8753E  | US37390585      | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

|                                                                                                                 | Name           | Function              | Signature |
|-----------------------------------------------------------------------------------------------------------------|----------------|-----------------------|-----------|
| Calibrated by:                                                                                                  | Jeton Kastrati | Laboratory Technician |           |
| Approved by:                                                                                                    | Katja Pokovic  | Technical Manager     |           |
| Issued: August 23, 2013                                                                                         |                |                       |           |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |                |                       |           |



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

### Glossary:

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

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

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

### Methods Applied and Interpretation of Parameters:

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

# Probe ES3DV2

## SN:3022

Manufactured: April 15, 2003  
Calibrated: August 22, 2013

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

## DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|-----------------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 1.00     | 1.04     | 0.99     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                                     | 100.7    | 97.4     | 99.7     |           |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 178.6    | ±3.0 %                    |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 141.9    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 134.7    |                           |

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

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

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

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

## DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750                  | 41.9                               | 0.89                            | 6.21    | 6.21    | 6.21    | 0.19  | 2.37       | ± 12.0 %    |
| 835                  | 41.5                               | 0.90                            | 6.09    | 6.09    | 6.09    | 0.30  | 1.70       | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 5.19    | 5.19    | 5.19    | 0.65  | 1.23       | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 5.03    | 5.03    | 5.03    | 0.51  | 1.43       | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 4.36    | 4.36    | 4.36    | 0.51  | 1.51       | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 4.16    | 4.16    | 4.16    | 0.74  | 1.29       | ± 12.0 %    |

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

## DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

### Calibration Parameter Determined in Body Tissue Simulating Media

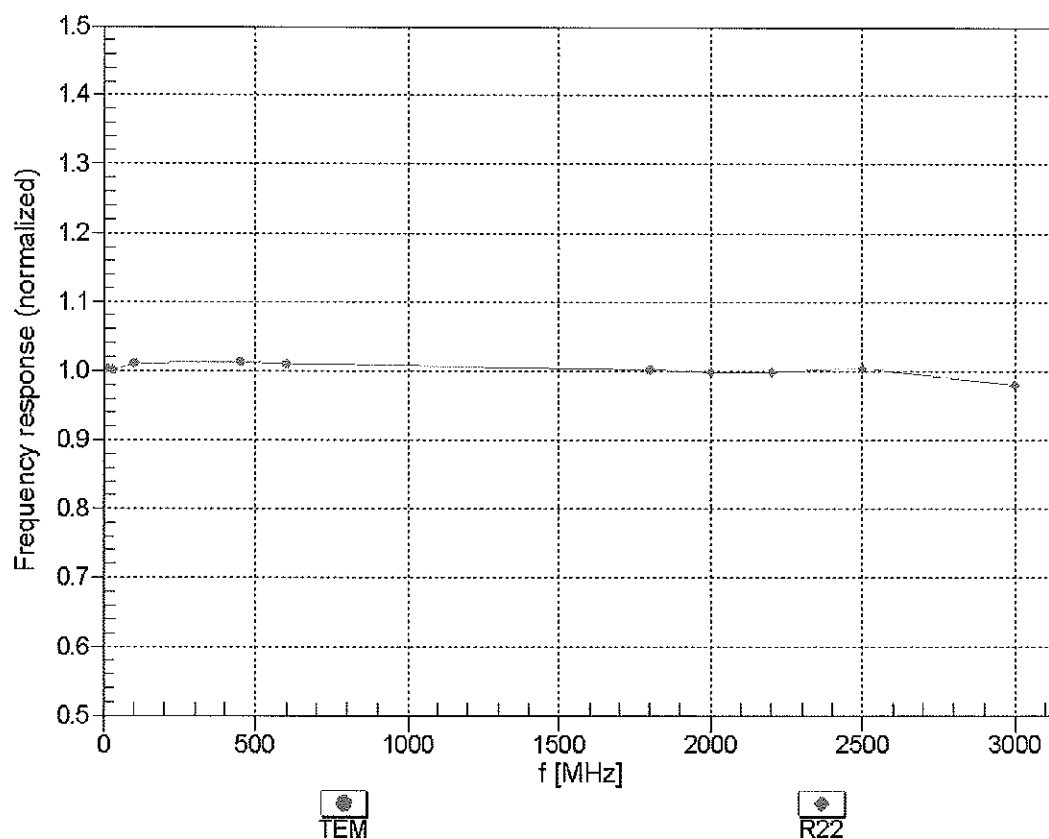
| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750                  | 55.5                               | 0.96                            | 5.92    | 5.92    | 5.92    | 0.24  | 1.99       | ± 12.0 %    |
| 835                  | 55.2                               | 0.97                            | 5.91    | 5.91    | 5.91    | 0.29  | 1.85       | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 4.75    | 4.75    | 4.75    | 0.52  | 1.52       | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 4.49    | 4.49    | 4.49    | 0.49  | 1.56       | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 4.01    | 4.01    | 4.01    | 0.70  | 1.02       | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 3.85    | 3.85    | 3.85    | 0.58  | 0.90       | ± 12.0 %    |

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

## Frequency Response of E-Field

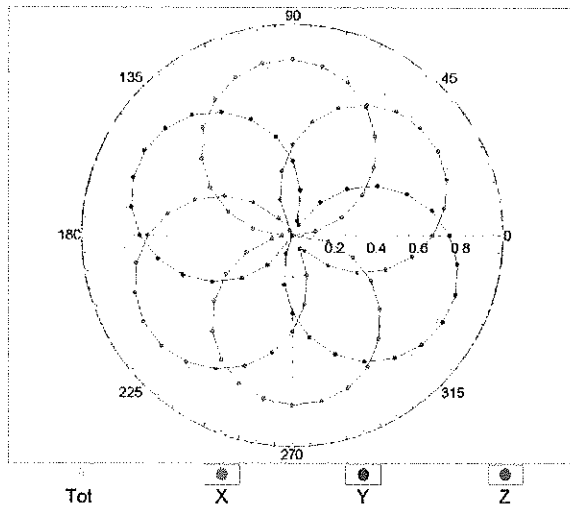
(TEM-Cell:ifi110 EXX, Waveguide: R22)



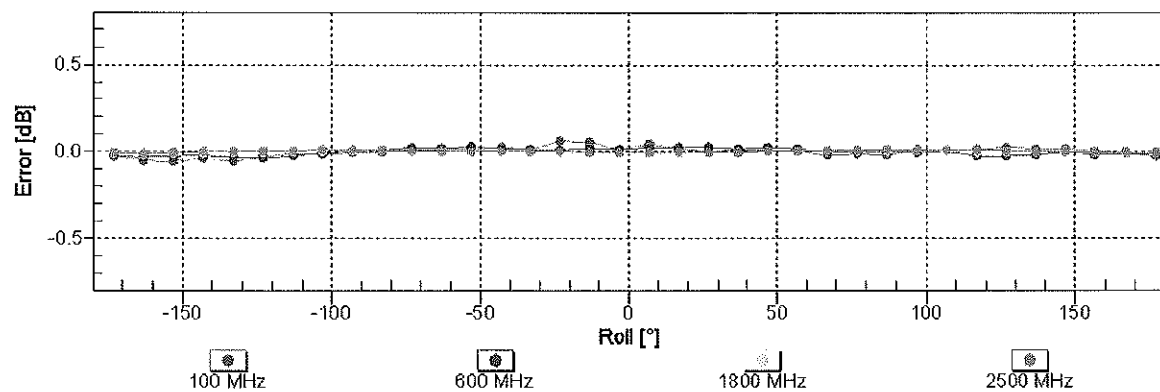
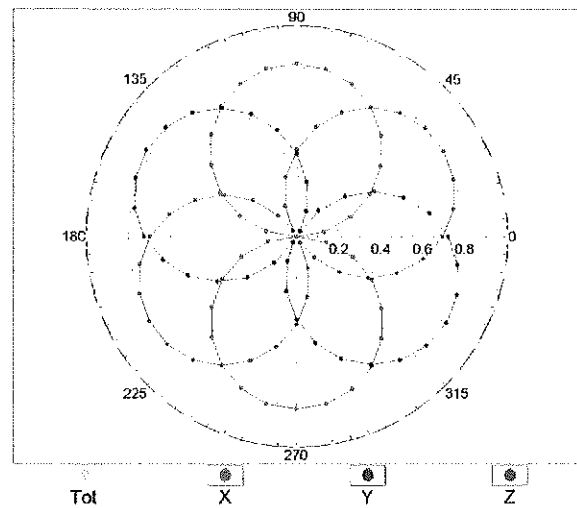
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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

f=600 MHz,TEM

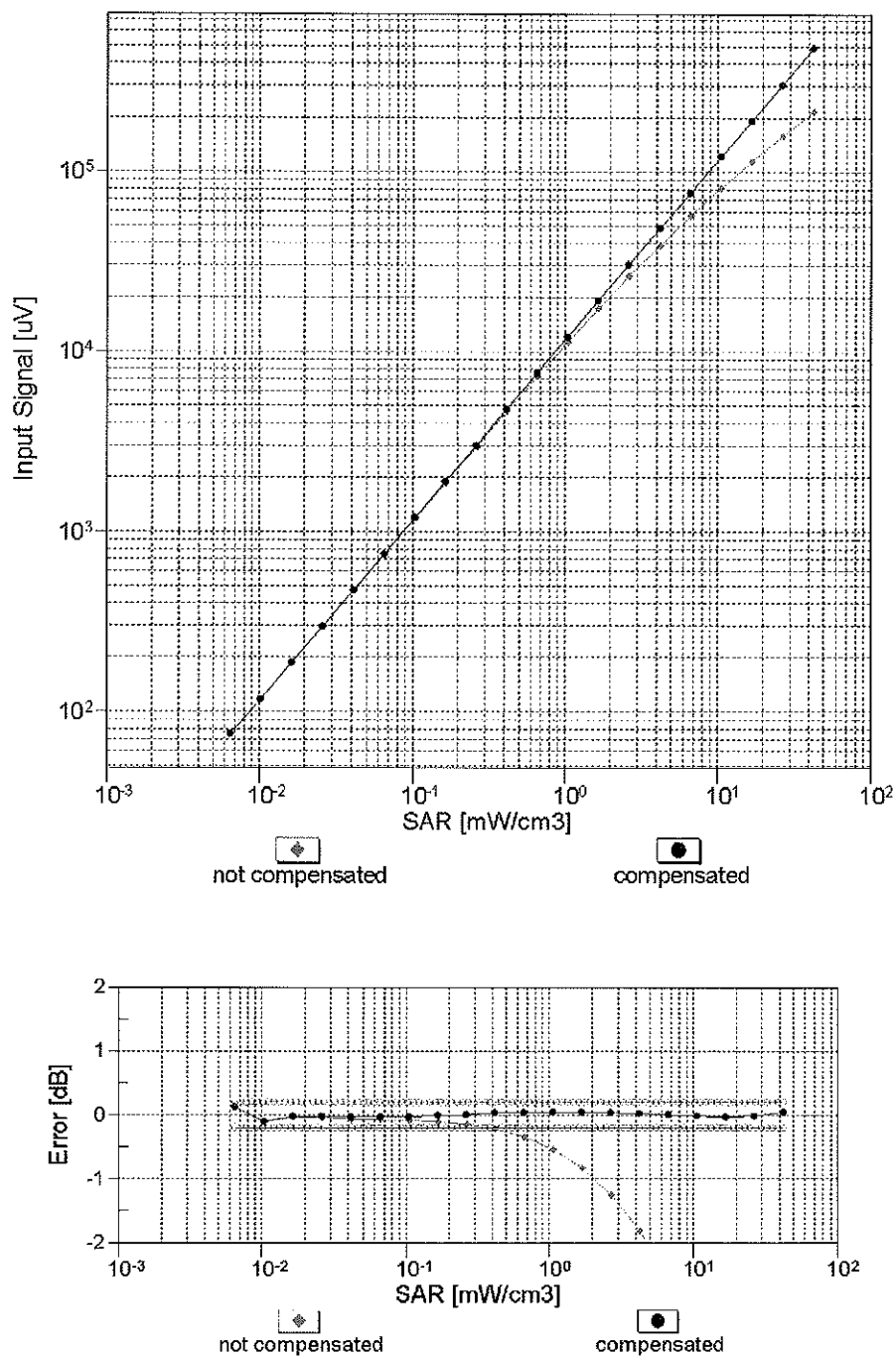


f=1800 MHz,R22



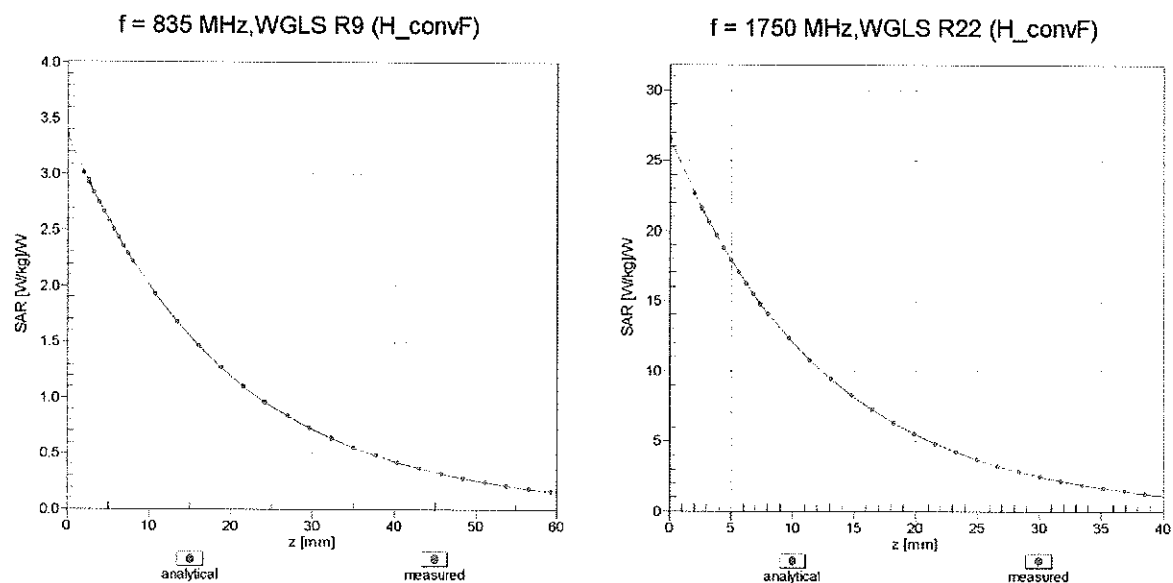
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

# Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f = 900 MHz)



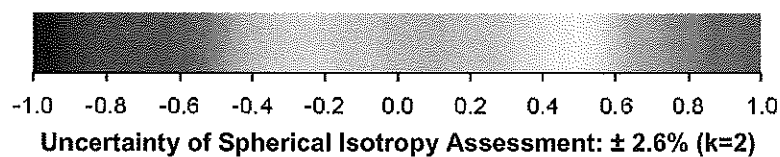
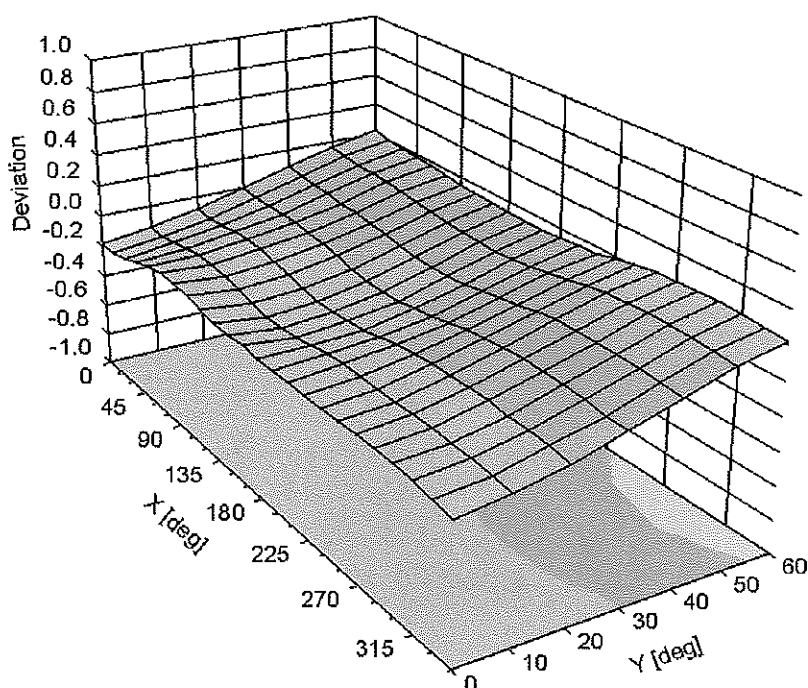
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  (k=2)

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

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



## DASY/EASY - Parameters of Probe: ES3DV2 - SN:3022

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -83.1      |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 10 mm      |
| Tip Diameter                                  | 4 mm       |
| Probe Tip to Sensor X Calibration Point       | 2 mm       |
| Probe Tip to Sensor Y Calibration Point       | 2 mm       |
| Probe Tip to Sensor Z Calibration Point       | 2 mm       |
| Recommended Measurement Distance from Surface | 3 mm       |



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Accreditation No.: **SCS 108**

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Client **PC Test**

Certificate No: **ES3-3209\_Mar13**

## CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3209**

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

Calibration date: **March 15, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

✓ KOK  
3/24/13

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 29-Mar-12 (No. 217-01508)         | Apr-13                 |
| Power sensor E4412A        | MY41498087      | 29-Mar-12 (No. 217-01508)         | Apr-13                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 27-Mar-12 (No. 217-01531)         | Apr-13                 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529)         | Apr-13                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532)         | Apr-13                 |
| Reference Probe ES3DV2     | SN: 3013        | 28-Dec-12 (No. ES3-3013_Dec12)    | Dec-13                 |
| DAE4                       | SN: 660         | 31-Jan-13 (No. DAE4-660_Jan13)    | Jan-14                 |
| Secondary Standards        | ID              | Check Date (in house)             | Scheduled Check        |
| RF generator HP 8648C      | US3642U01700    | 4-Aug-99 (in house check Apr-11)  | In house check: Apr-13 |
| Network Analyzer HP 8753E  | US37390585      | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

|                                                                                                                 |                               |                                          |                        |
|-----------------------------------------------------------------------------------------------------------------|-------------------------------|------------------------------------------|------------------------|
| Calibrated by:                                                                                                  | Name<br><b>Israe El-Naouq</b> | Function<br><b>Laboratory Technician</b> | Signature<br>          |
| Approved by:                                                                                                    | Name<br><b>Katja Pokovic</b>  | Function<br><b>Technical Manager</b>     | Signature<br>          |
|                                                                                                                 |                               |                                          | Issued: March 15, 2013 |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |                               |                                          |                        |



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

### Glossary:

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

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

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

### Methods Applied and Interpretation of Parameters:

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

# Probe ES3DV3

## SN:3209

Manufactured: October 14, 2008  
Calibrated: March 15, 2013

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|-----------------------------------------------------------|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 1.35     | 1.33     | 1.14     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                                     | 99.2     | 97.8     | 98.3     |               |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 163.6    | $\pm 3.5 \%$              |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 170.3    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 158.7    |                           |

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

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

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

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750                  | 41.9                               | 0.89                            | 6.74    | 6.74    | 6.74    | 0.76  | 1.18       | ± 12.0 %    |
| 835                  | 41.5                               | 0.90                            | 6.46    | 6.46    | 6.46    | 0.31  | 1.81       | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 5.39    | 5.39    | 5.39    | 0.80  | 1.21       | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 5.21    | 5.21    | 5.21    | 0.78  | 1.26       | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 4.57    | 4.57    | 4.57    | 0.65  | 1.43       | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 4.43    | 4.43    | 4.43    | 0.75  | 1.36       | ± 12.0 %    |

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

### Calibration Parameter Determined in Body Tissue Simulating Media

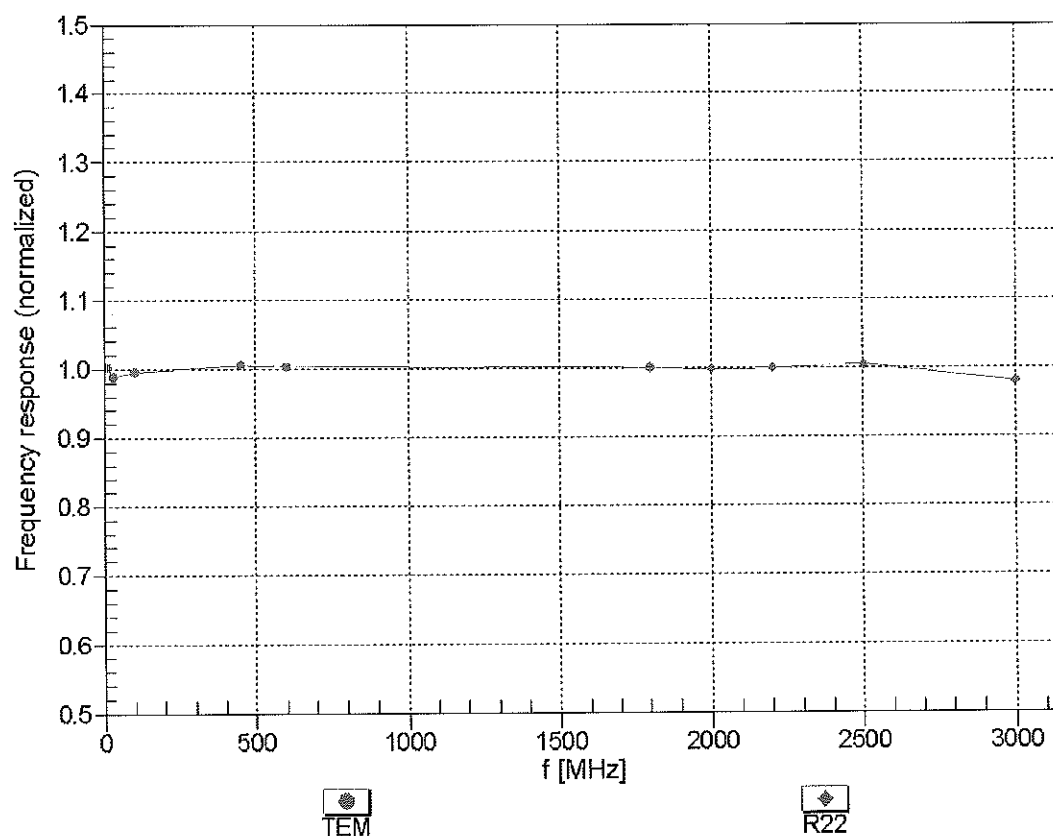
| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750                  | 55.5                               | 0.96                            | 6.38    | 6.38    | 6.38    | 0.80  | 1.16       | ± 12.0 %    |
| 835                  | 55.2                               | 0.97                            | 6.28    | 6.28    | 6.28    | 0.52  | 1.45       | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 5.03    | 5.03    | 5.03    | 0.58  | 1.45       | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 4.77    | 4.77    | 4.77    | 0.70  | 1.36       | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 4.34    | 4.34    | 4.34    | 0.80  | 1.15       | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 4.11    | 4.11    | 4.11    | 0.80  | 1.00       | ± 12.0 %    |

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

## Frequency Response of E-Field

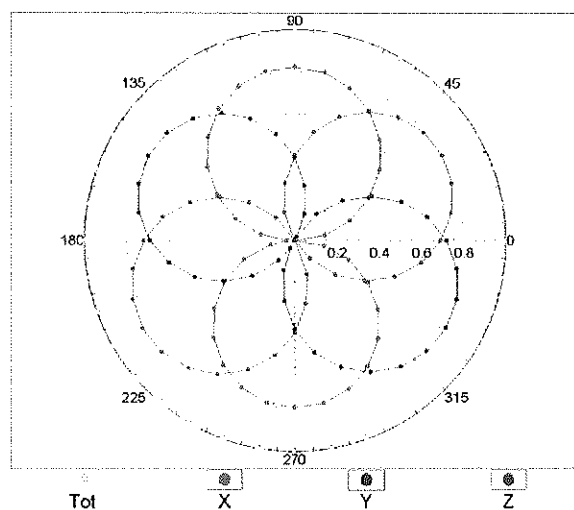
(TEM-Cell:ifi110 EXX, Waveguide: R22)



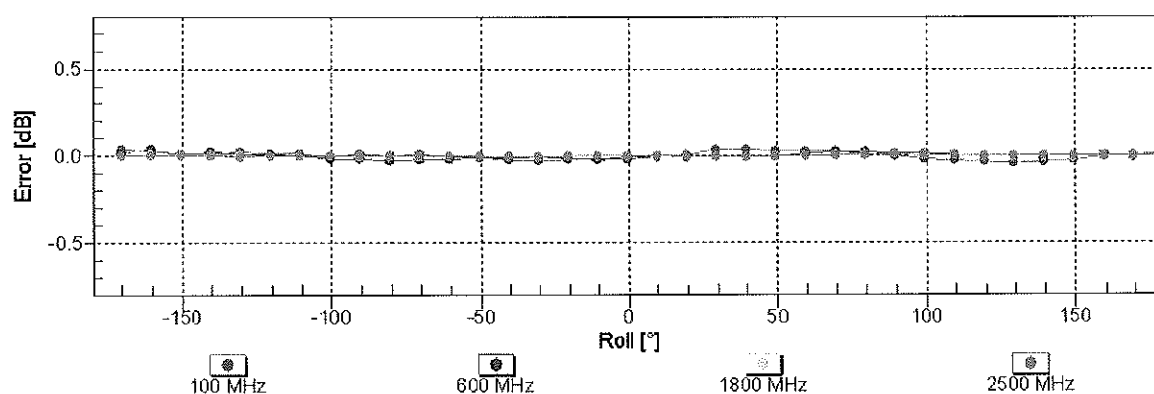
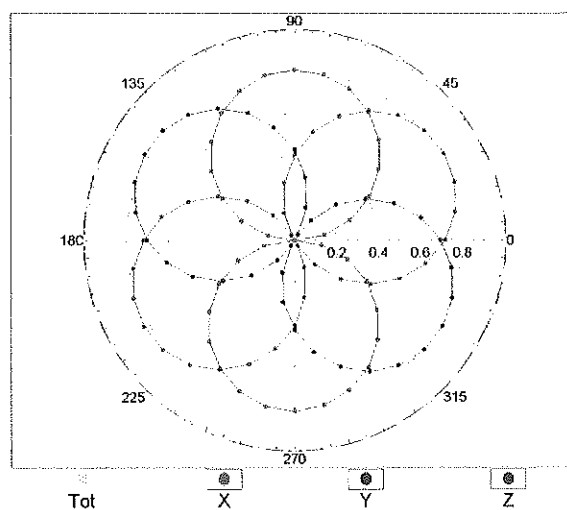
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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

f=600 MHz, TEM

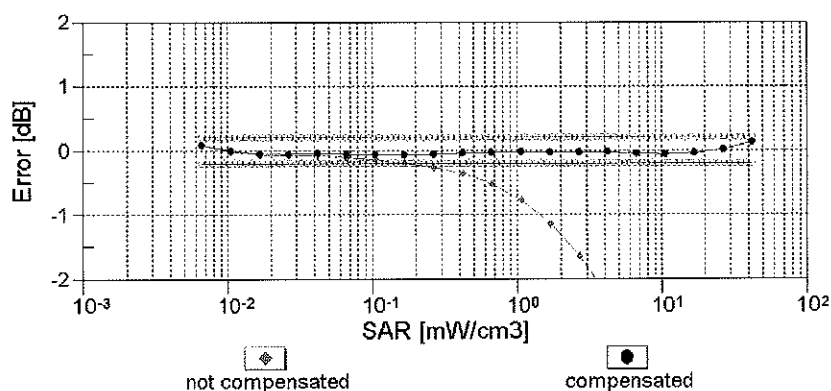
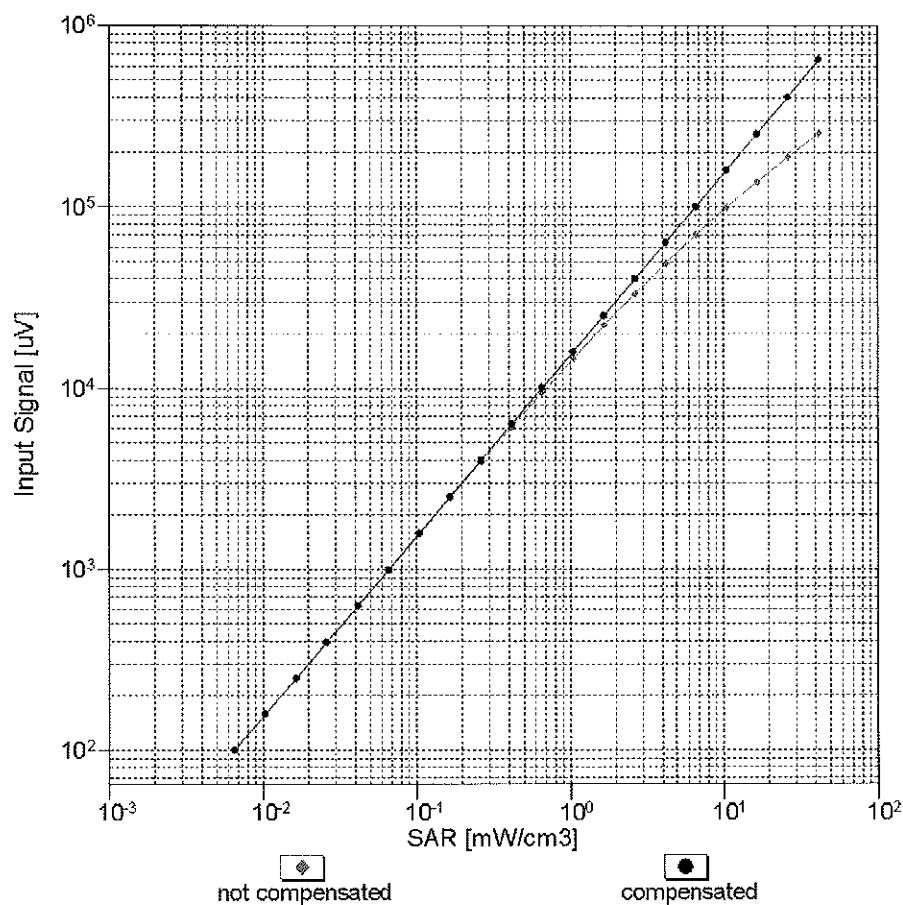


f=1800 MHz,R22



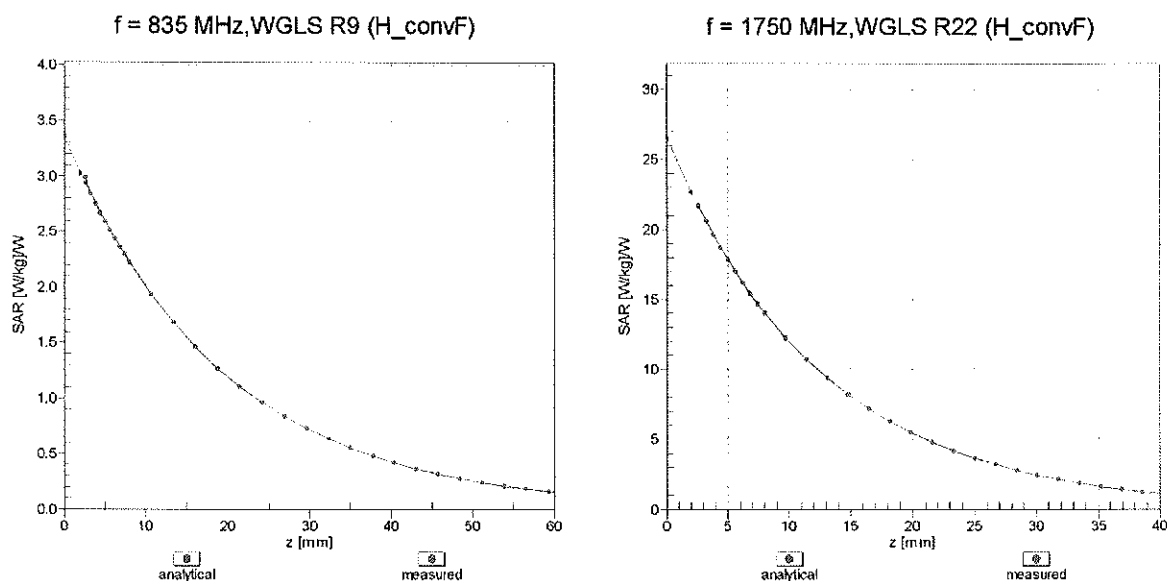
**Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)**

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



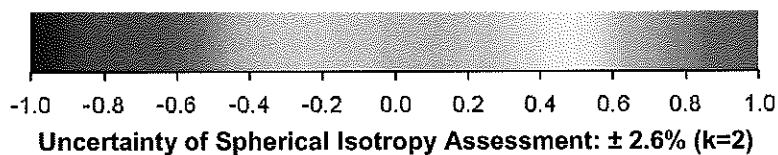
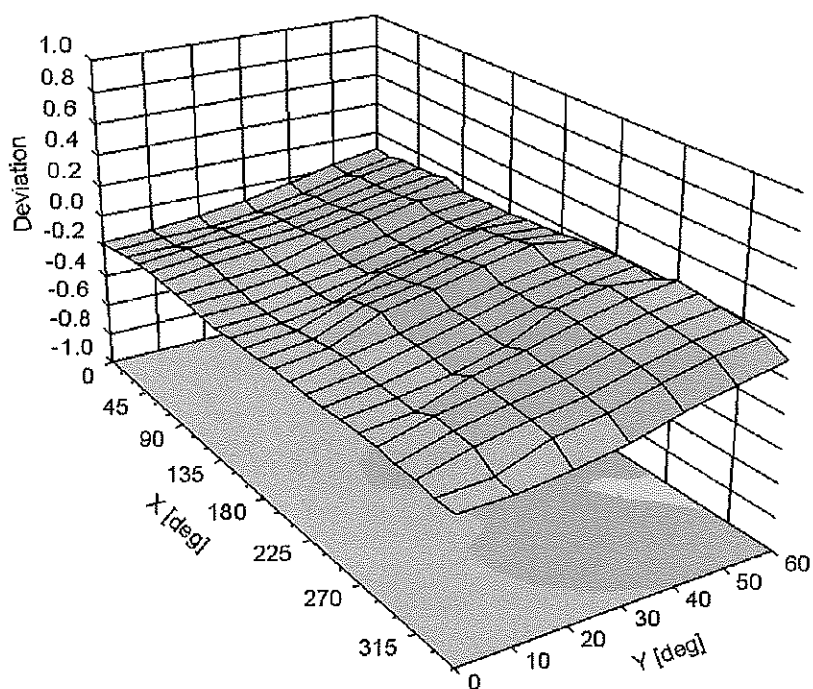
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

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



## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -40.6      |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 10 mm      |
| Tip Diameter                                  | 4 mm       |
| Probe Tip to Sensor X Calibration Point       | 2 mm       |
| Probe Tip to Sensor Y Calibration Point       | 2 mm       |
| Probe Tip to Sensor Z Calibration Point       | 2 mm       |
| Recommended Measurement Distance from Surface | 3 mm       |



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D835V2-4d119\_Apr13**

## CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d119**

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

Calibration date: **April 25, 2013**

✓  
KOK  
5/8/13

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter 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: 909            | 11-Sep-12 (No. DAE4-909_Sep12)    | Sep-13                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power sensor HP 8481A       | MY41092317         | 18-Oct-02 (in house check Oct-11) | In house check: Oct-13 |
| RF generator R&S SMT-06     | 100005             | 04-Aug-99 (in house check Oct-11) | In house check: Oct-13 |
| Network Analyzer HP 8753E   | US37390585 S4206   | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

Calibrated by: **Claudio Leubler**      Name: **Claudio Leubler**      Function: **Laboratory Technician**

Approved by: **Katja Pokovic**      Name: **Katja Pokovic**      Technical Manager

Signature

Issued: April 26, 2013

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



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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:

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

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.6     |
| <b>Extrapolation</b>                | Advanced Extrapolation |             |
| <b>Phantom</b>                      | Modular Flat Phantom   |             |
| <b>Distance Dipole Center - TSL</b> | 15 mm                  | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm      |             |
| <b>Frequency</b>                    | 835 MHz $\pm$ 1 MHz    |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 41.5           | 0.90 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 40.8 $\pm$ 6 % | 0.94 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | < 0.5 °C            | ----           | ----                 |

## SAR result with Head TSL

| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                                |
|-------------------------------------------------------------|--------------------|------------------------------------------------|
| SAR measured                                                | 250 mW input power | 2.51 W/kg                                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>9.68 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| SAR measured                                                  | 250 mW input power | 1.62 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>6.30 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C             | 55.2           | 0.97 mho/m           |
| <b>Measured Body TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 54.0 $\pm$ 6 % | 1.01 mho/m $\pm$ 6 % |
| <b>Body TSL temperature change during test</b> | < 0.5 °C            | ----           | ----                 |

## SAR result with Body TSL

| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                                |
|-------------------------------------------------------------|--------------------|------------------------------------------------|
| SAR measured                                                | 250 mW input power | 2.47 W/kg                                      |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>9.54 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| SAR measured                                                  | 250 mW input power | 1.62 W/kg                                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>6.31 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.1 $\Omega$ - 4.7 j $\Omega$ |
| Return Loss                          | - 26.6 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 45.8 $\Omega$ - 6.3 j $\Omega$ |
| Return Loss                          | - 22.1 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.385 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 | June 29, 2010 |

## DASY5 Validation Report for Head TSL

Date: 25.04.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d119**

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

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.94$  S/m;  $\epsilon_r = 40.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.05, 6.05, 6.05); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 11.09.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

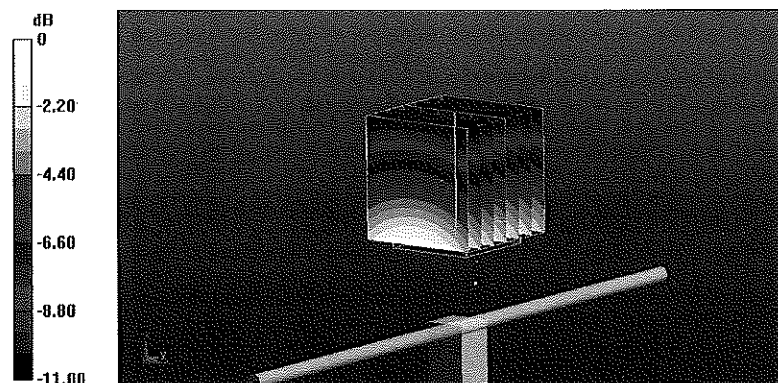
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.387 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.86 W/kg

**SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.62 W/kg**

Maximum value of SAR (measured) = 2.93 W/kg



# Impedance Measurement Plot for Head TSL

25 Apr 2013 09:11:06  
 CH1 S11 1 U FS 1: 50.061  $\Omega$  -4.6621  $\Omega$  40.884 pF 835.000 000 MHz

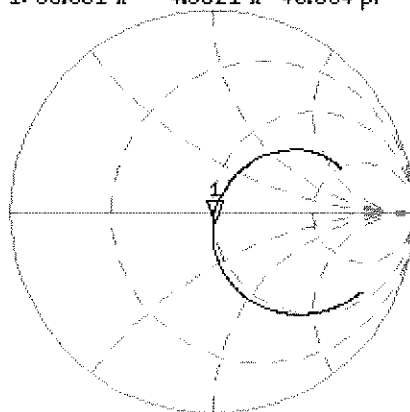
\*

De1

CA

Avg  
16

H1 d

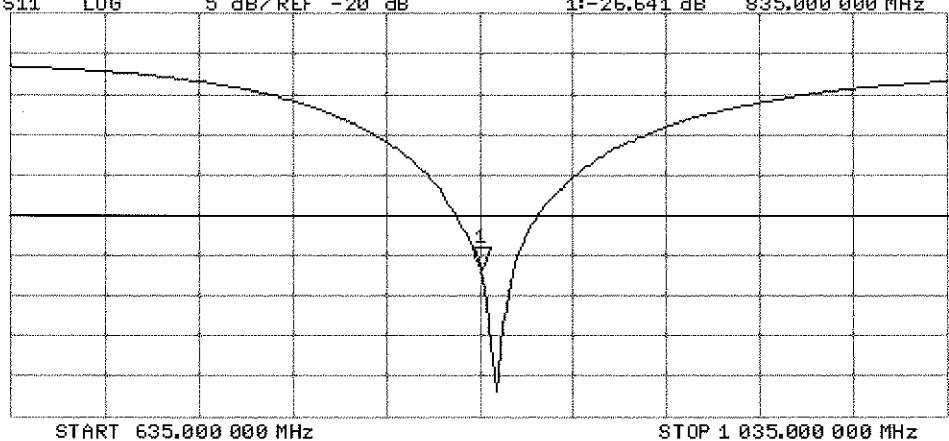


CH2 S11 LOG 5 dB/REF -20 dB 1:-26.641 dB 835.000 000 MHz

CA

Avg  
16

H1 d



## DASY5 Validation Report for Body TSL

Date: 24.04.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d119**

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

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 1.01 \text{ S/m}$ ;  $\epsilon_r = 54$ ;  $\rho = 1000 \text{ kg/m}^3$

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 Sn909; Calibrated: 11.09.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.6(1115); SEMCAD X 14.6.9(7117)

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

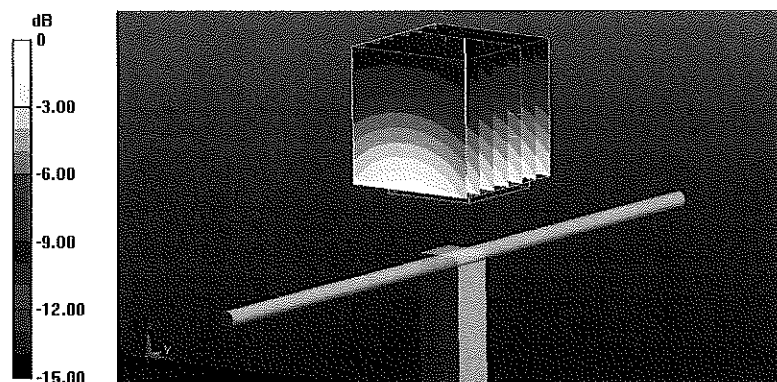
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 55.178 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 3.68 W/kg

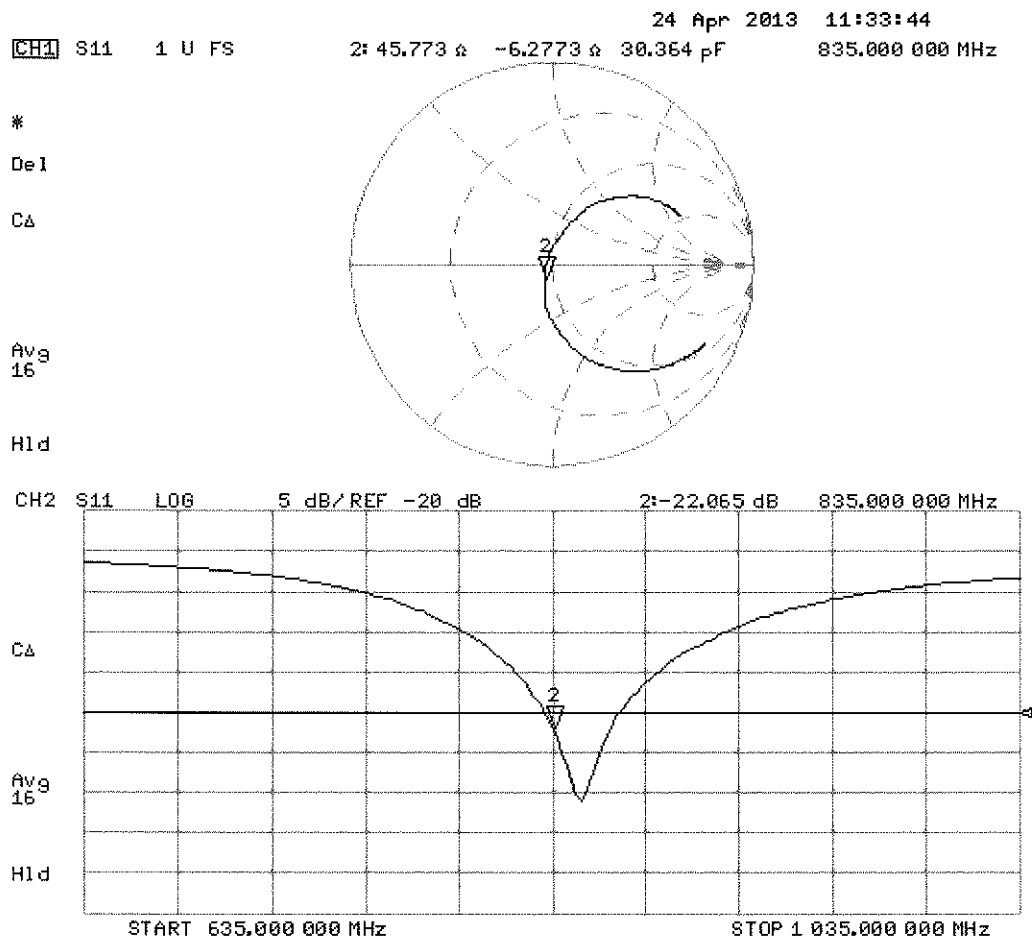
**SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.62 W/kg**

Maximum value of SAR (measured) = 2.89 W/kg



0 dB = 2.89 W/kg = 4.61 dBW/kg

Impedance Measurement Plot for Body TSL





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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D2450V2-719\_Aug13**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 719**

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

Calibration date: **August 23, 2013**

✓cc  
9/13/13

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: August 23, 2013

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Accreditation No.: **SCS 108**

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### Glossary:

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

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

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

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

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

## Head TSL parameters

The following parameters and calculations were applied.

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

## SAR result with Head TSL

|                                                       |                    |                                                |
|-------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                                                |
| SAR measured                                          | 250 mW input power | 13.4 W/kg                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>53.2 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

|                                                         |                    |                                                |
|---------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                                |
| SAR measured                                            | 250 mW input power | 6.23 W/kg                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>24.8 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

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

## SAR result with Body TSL

|                                                       |                    |                                                |
|-------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                                                |
| SAR measured                                          | 250 mW input power | 13.3 W/kg                                      |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>51.7 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

|                                                         |                    |                                                |
|---------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                                |
| SAR measured                                            | 250 mW input power | 6.14 W/kg                                      |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>24.1 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $54.6 \Omega + 3.5 j\Omega$ |
| Return Loss                          | - 25.1 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $51.1 \Omega + 5.4 j\Omega$ |
| Return Loss                          | - 25.3 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.149 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 | September 10, 2002 |

## DASY5 Validation Report for Head TSL

Date: 22.08.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 719**

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

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

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

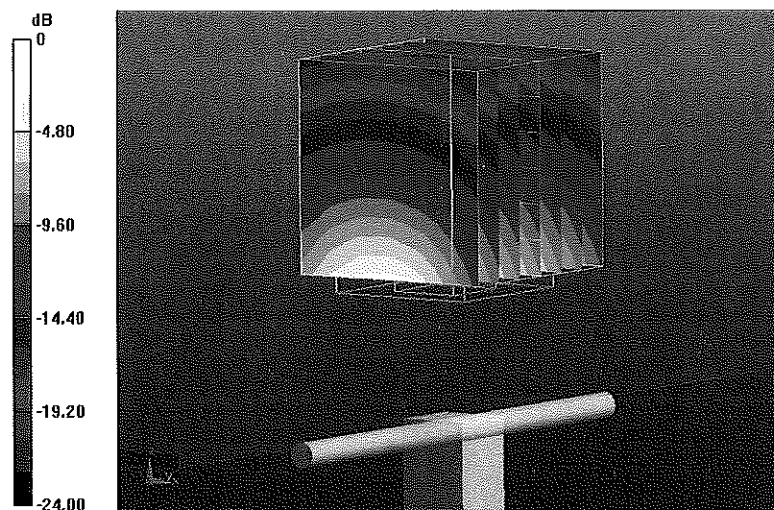
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.7 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.9 W/kg

**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.23 W/kg**

Maximum value of SAR (measured) = 17.0 W/kg

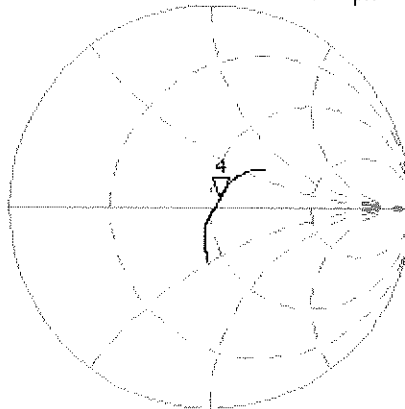


0 dB = 17.0 W/kg = 12.30 dBW/kg

# Impedance Measurement Plot for Head TSL

22 Aug 2013 11:00:15  
 [CH1] S11 1 U FS 4: 54.639  $\Omega$  3.5215  $\Omega$  228.76 pH 2 450.000 000 MHz

\*  
 Del  
 CA



Avg  
 16

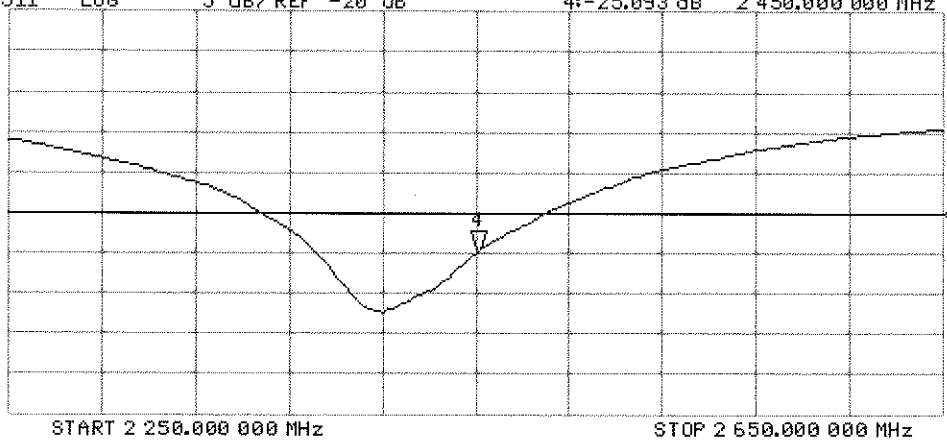
H1d

CH2 S11 LOG 5 dB/REF -20 dB 4: -25.093 dB 2 450.000 000 MHz

CA

Avg  
 16

H1d



## DASY5 Validation Report for Body TSL

Date: 23.08.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 719**

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

Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 2.03 \text{ S/m}$ ;  $\epsilon_r = 50.6$ ;  $\rho = 1000 \text{ kg/m}^3$

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:**

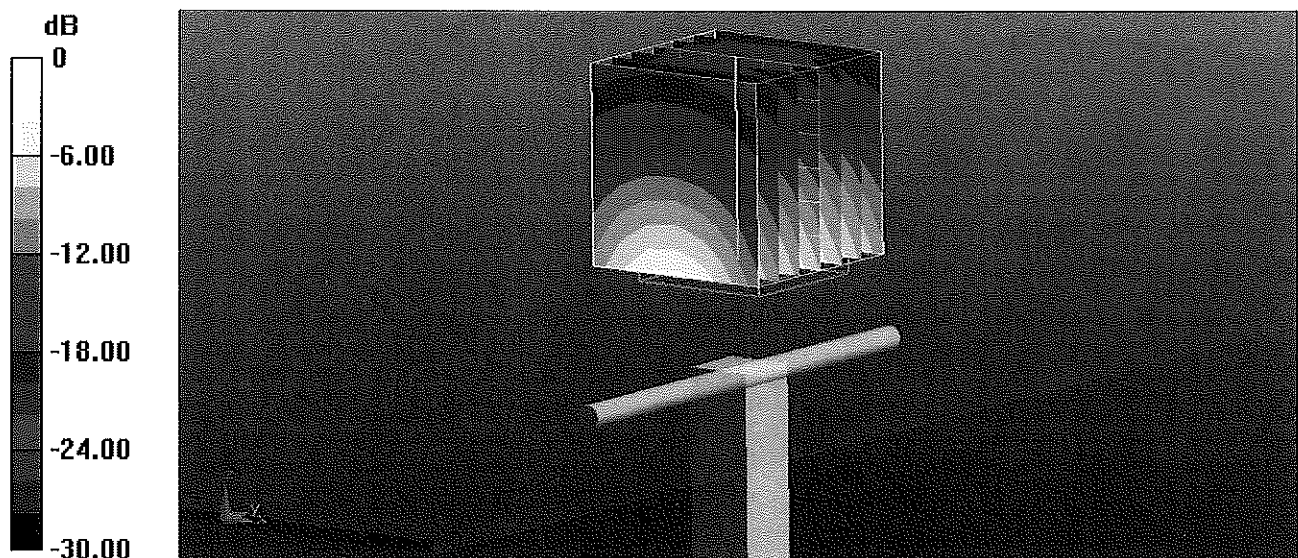
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 94.688 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.9 W/kg

**SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.14 W/kg**

Maximum value of SAR (measured) = 17.2 W/kg

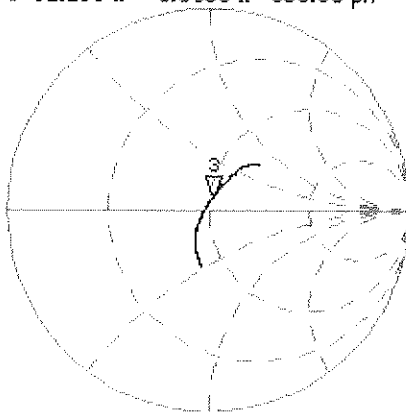


0 dB = 17.2 W/kg = 12.36 dBW/kg

# Impedance Measurement Plot for Body TSL

23 Aug 2013 09:00:38  
 CH1 S11 1 U FS 3: 51.135  $\Omega$  5.3965  $\Omega$  350.56  $\mu\text{H}$  2 450.000 000 MHz

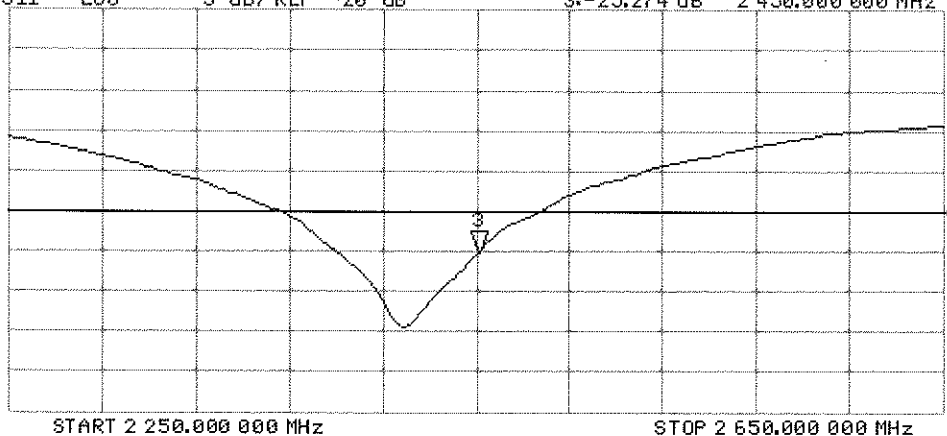
\*  
 Del  
 CA



Avg  
 16  
 H1 d

CH2 S11 LOG 5 dB/REF -20 dB 3:-25.274 dB 2 450.000 000 MHz

CA  
 Avg  
 16  
 H1 d





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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D1900V2-5d149\_Jul13**

## CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d149**

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

Calibration date: **July 22, 2013**

✓  
 KOK  
 8/19/13

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: July 22, 2013

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



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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:**

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

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

## Measurement Conditions

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

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

## Head TSL parameters

The following parameters and calculations were applied.

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

## SAR result with Head TSL

|                                                       |                    |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                              |
| SAR measured                                          | 250 mW input power | 9.99 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 40.4 W/kg $\pm$ 17.0 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 5.28 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 21.3 W/kg $\pm$ 16.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

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

## SAR result with Body TSL

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

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 5.36 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.6 W/kg $\pm$ 16.5 % (k=2) |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | $52.9\ \Omega + 6.0\ j\Omega$ |
| Return Loss                          | - 23.8 dB                     |

### Antenna Parameters with Body TSL

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | $48.5\ \Omega + 6.4\ j\Omega$ |
| Return Loss                          | - 23.5 dB                     |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.196 ns |
|----------------------------------|----------|

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

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

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

### Additional EUT Data

|                 |                |
|-----------------|----------------|
| Manufactured by | SPEAG          |
| Manufactured on | March 11, 2011 |

## DASY5 Validation Report for Head TSL

Date: 22.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d149**

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

Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.36 \text{ S/m}$ ;  $\epsilon_r = 38.9$ ;  $\rho = 1000 \text{ kg/m}^3$

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:**

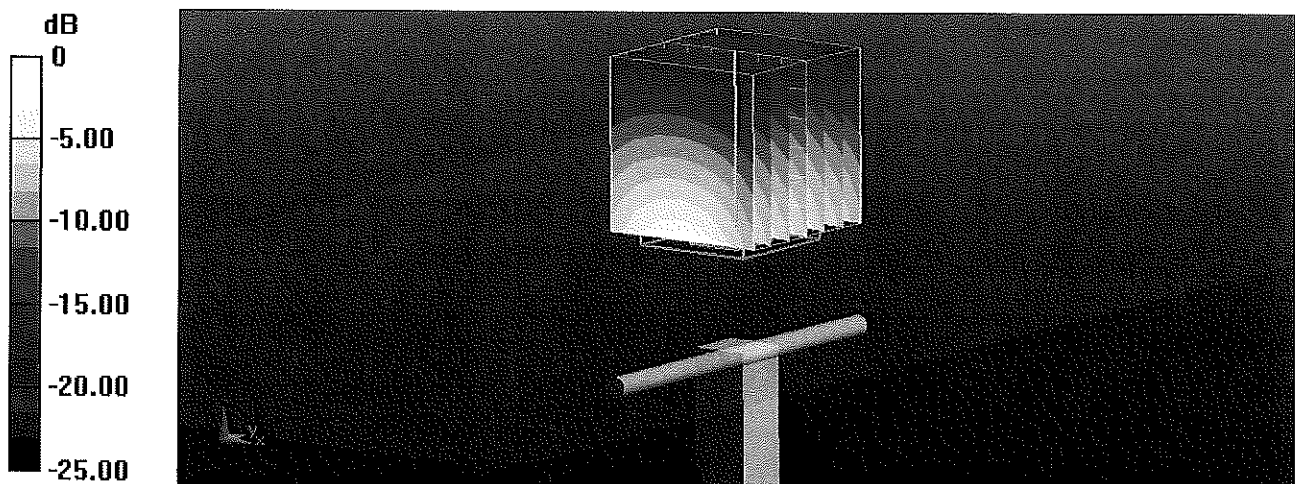
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 96.173 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 18.0 W/kg

**SAR(1 g) = 9.99 W/kg; SAR(10 g) = 5.28 W/kg**

Maximum value of SAR (measured) = 12.4 W/kg



0 dB = 12.4 W/kg = 10.93 dBW/kg

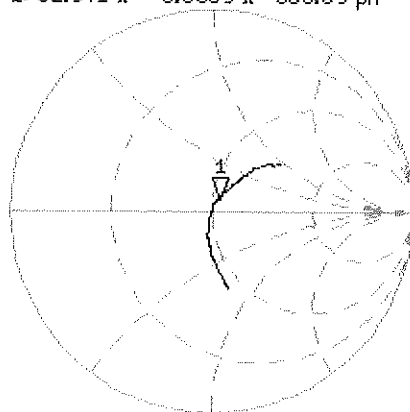
# Impedance Measurement Plot for Head TSL

22 Jul 2013 11:59:34  
 CH1 S11 1 U FS 1: 52.941  $\Omega$  6.0059  $\Omega$  503.09  $\mu\text{H}$  1 900.000 000 MHz

\*  
 Del  
 CA

Avg  
 16

H1d

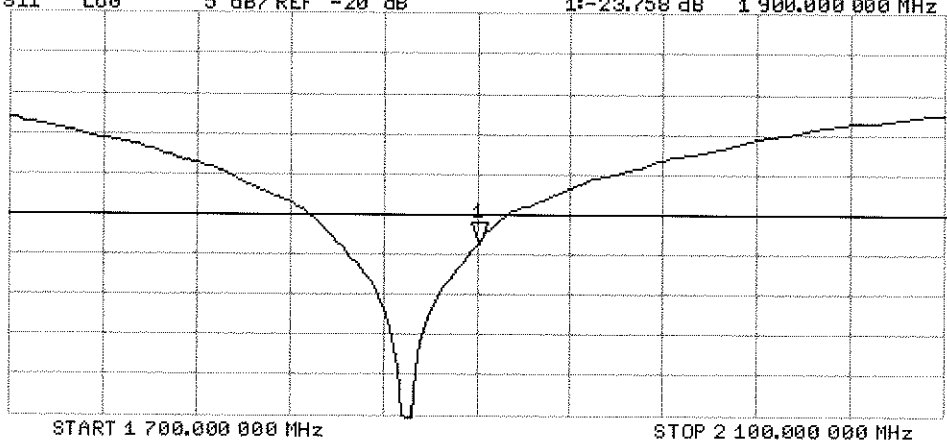


CH2 S11 LOG 5 dB/REF -20 dB 1:-23.758 dB 1 900.000 000 MHz

CA

Avg  
 16

H1d



## DASY5 Validation Report for Body TSL

Date: 22.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d149**

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

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

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

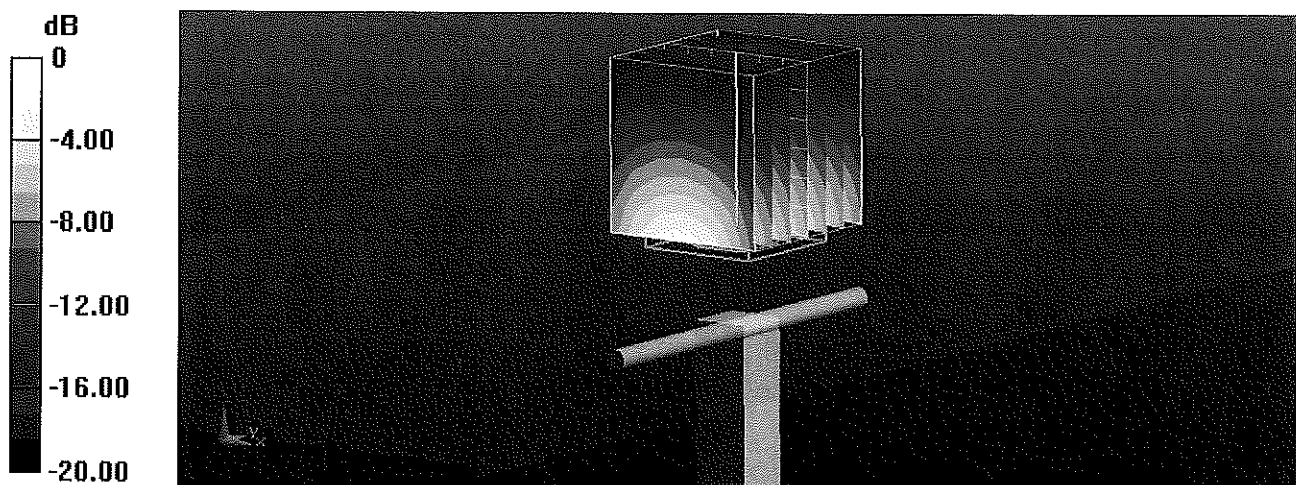
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.173 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 17.0 W/kg

**SAR(1 g) = 10 W/kg; SAR(10 g) = 5.36 W/kg**

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

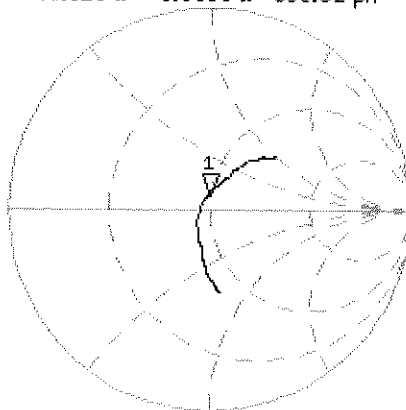


0 dB = 12.6 W/kg = 11.00 dBW/kg

# Impedance Measurement Plot for Body TSL

22 Jul 2013 11:32:14  
 CH1 S11 1 U FS 1: 48.525  $\Omega$  6.3906  $\Omega$  535.32  $\mu\text{H}$  1 900.000 000 MHz

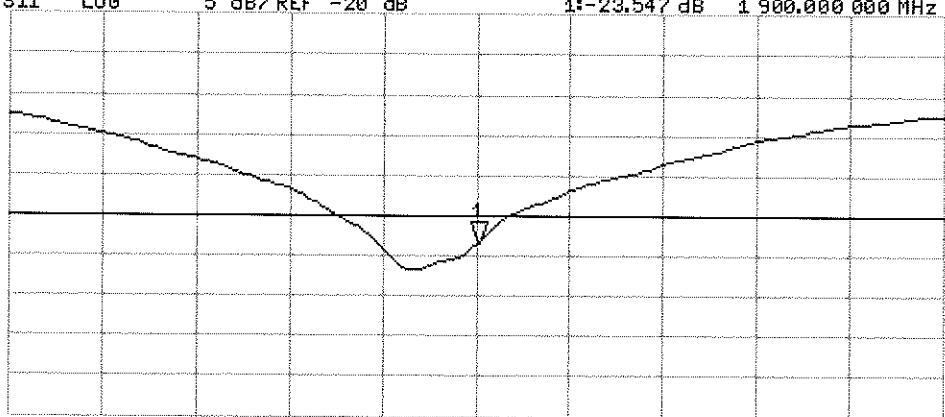
\*  
 Del  
 CA



Avg  
 16  
 H1d

CH2 S11 LOG 5 dB/REF -20 dB 1: -23.547 dB 1 900.000 000 MHz

CA



Avg  
 16  
 H1d

START 1 700.000 000 MHz

STOP 2 100.000 000 MHz



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Accreditation No.: **SCS 108**

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Client **PC Test**

Certificate No: **ES3-3258\_Feb13**

## CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3258**

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

Calibration date: **February 11, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

✓  
 KOK  
 2/21/13

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B         | GB41293874      | 29-Mar-12 (No. 217-01508)         | Apr-13                 |
| Power sensor E4412A        | MY41498087      | 29-Mar-12 (No. 217-01508)         | Apr-13                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 27-Mar-12 (No. 217-01531)         | Apr-13                 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529)         | Apr-13                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532)         | Apr-13                 |
| Reference Probe ES3DV2     | SN: 3013        | 28-Dec-12 (No. ES3-3013_Dec12)    | Dec-13                 |
| DAE4                       | SN: 660         | 31-Jan-13 (No. DAE4-660_Jan13)    | Jan-13                 |
| Secondary Standards        | ID              | Check Date (in house)             | Scheduled Check        |
| RF generator HP 8648C      | US3642U01700    | 4-Aug-99 (in house check Apr-11)  | In house check: Apr-13 |
| Network Analyzer HP 8753E  | US37390585      | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

|                |                         |                                   |                           |
|----------------|-------------------------|-----------------------------------|---------------------------|
| Calibrated by: | Name<br>Claudio Leubler | Function<br>Laboratory Technician | Signature<br>             |
| Approved by:   | Katja Pokovic           | Technical Manager                 |                           |
|                |                         |                                   | Issued: February 11, 2013 |

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

### Glossary:

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

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

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

### Methods Applied and Interpretation of Parameters:

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

# Probe ES3DV3

## SN:3258

Manufactured: January 25, 2010  
Calibrated: February 11, 2013

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3258

### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|-----------------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 1.29     | 1.18     | 1.23     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                                     | 101.2    | 105.7    | 104.2    |           |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 162.4    | ±3.5 %                    |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 151.3    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 157.6    |                           |

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

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

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

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3258

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750                  | 41.9                               | 0.89                            | 6.45    | 6.45    | 6.45    | 0.53  | 1.40       | ± 12.0 %    |
| 835                  | 41.5                               | 0.90                            | 6.21    | 6.21    | 6.21    | 0.80  | 1.10       | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 5.23    | 5.23    | 5.23    | 0.62  | 1.30       | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 5.07    | 5.07    | 5.07    | 0.54  | 1.45       | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 4.50    | 4.50    | 4.50    | 0.78  | 1.30       | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 4.32    | 4.32    | 4.32    | 0.80  | 1.29       | ± 12.0 %    |

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3258

### Calibration Parameter Determined in Body Tissue Simulating Media

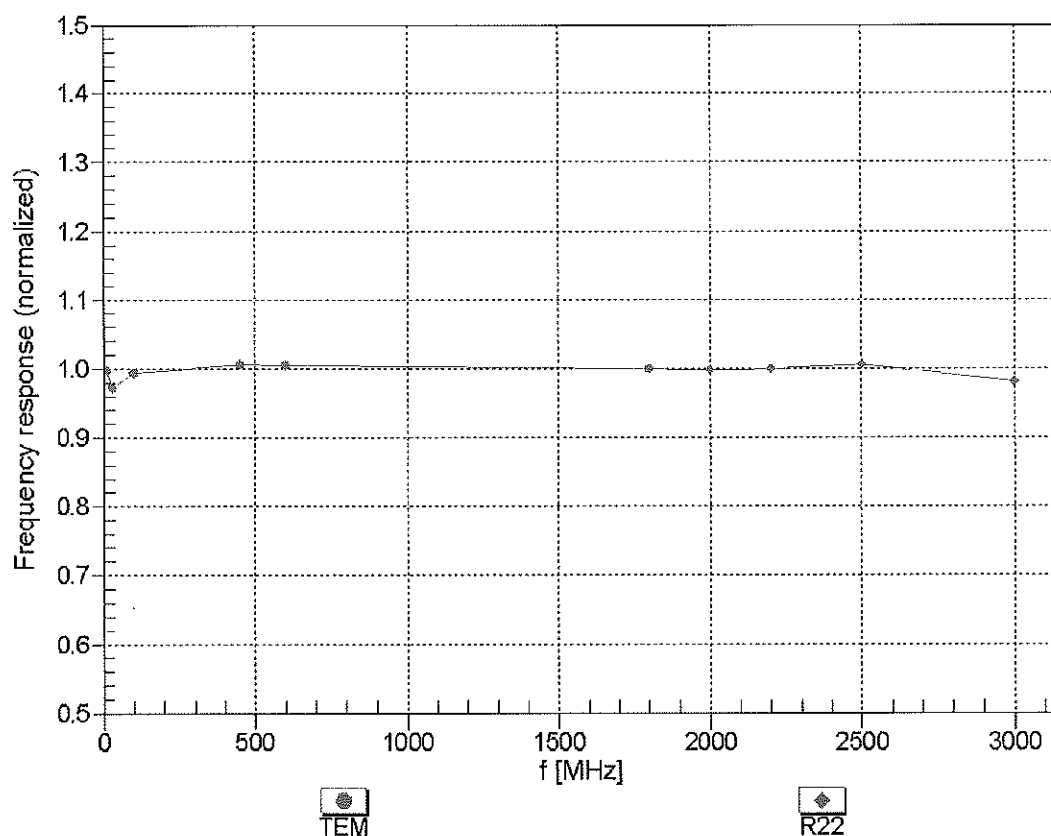
| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750                  | 55.5                               | 0.96                            | 6.15    | 6.15    | 6.15    | 0.39  | 1.61       | ± 12.0 %    |
| 835                  | 55.2                               | 0.97                            | 6.10    | 6.10    | 6.10    | 0.80  | 1.15       | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 4.91    | 4.91    | 4.91    | 0.42  | 1.69       | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 4.67    | 4.67    | 4.67    | 0.44  | 1.69       | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 4.25    | 4.25    | 4.25    | 0.80  | 1.02       | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 4.07    | 4.07    | 4.07    | 0.65  | 0.95       | ± 12.0 %    |

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

## Frequency Response of E-Field

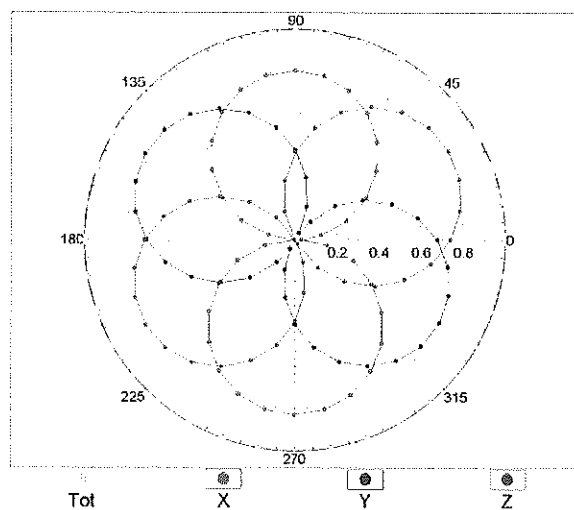
(TEM-Cell:ifi110 EXX, Waveguide: R22)



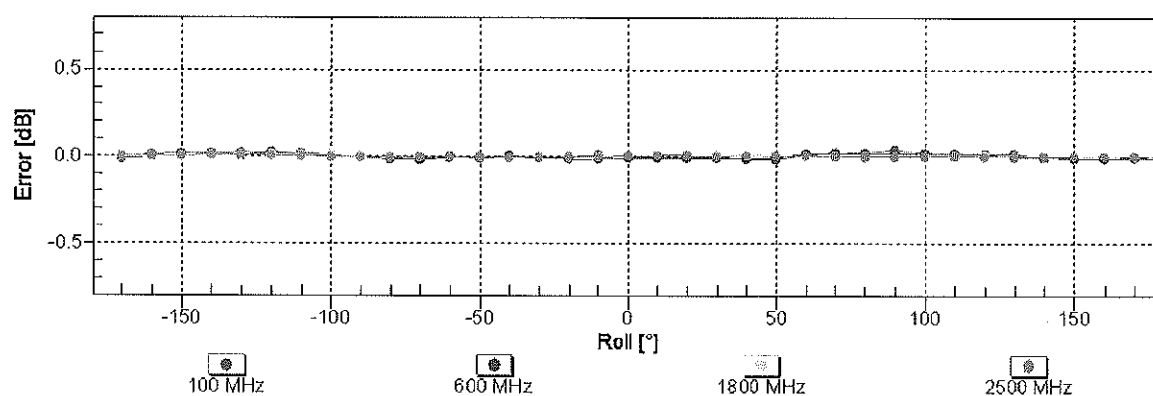
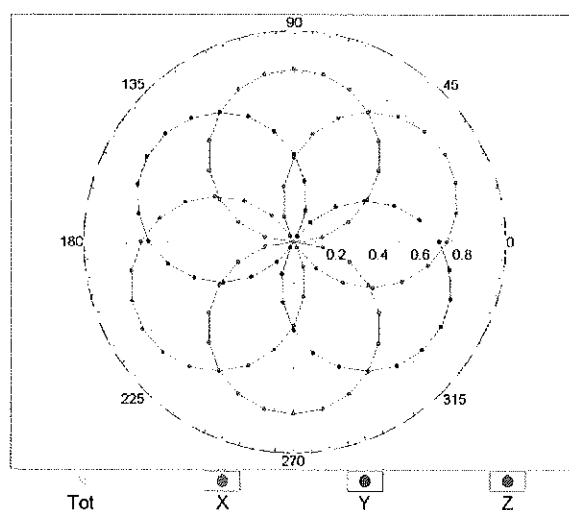
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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

f=600 MHz,TEM

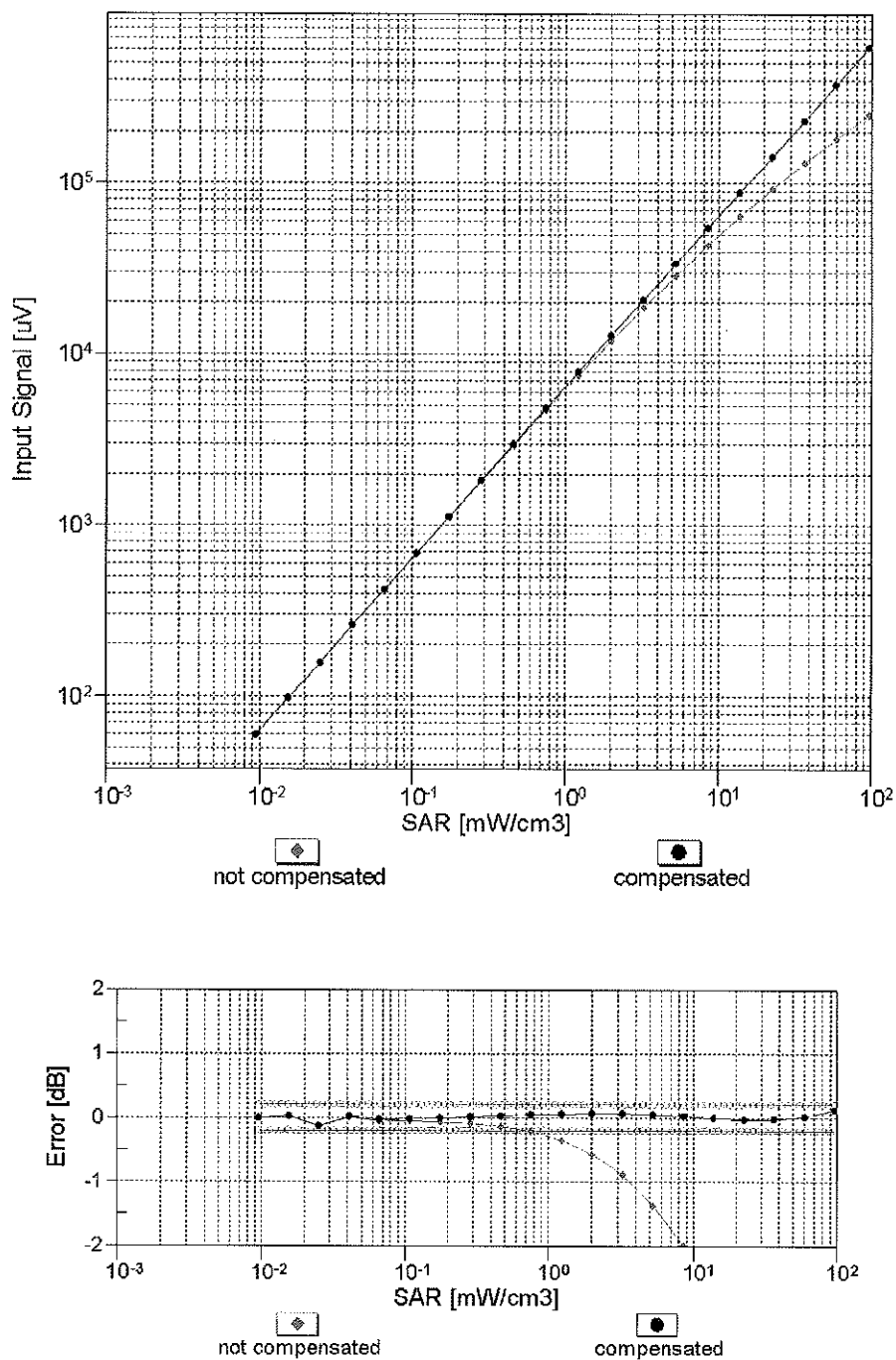


f=1800 MHz,R22



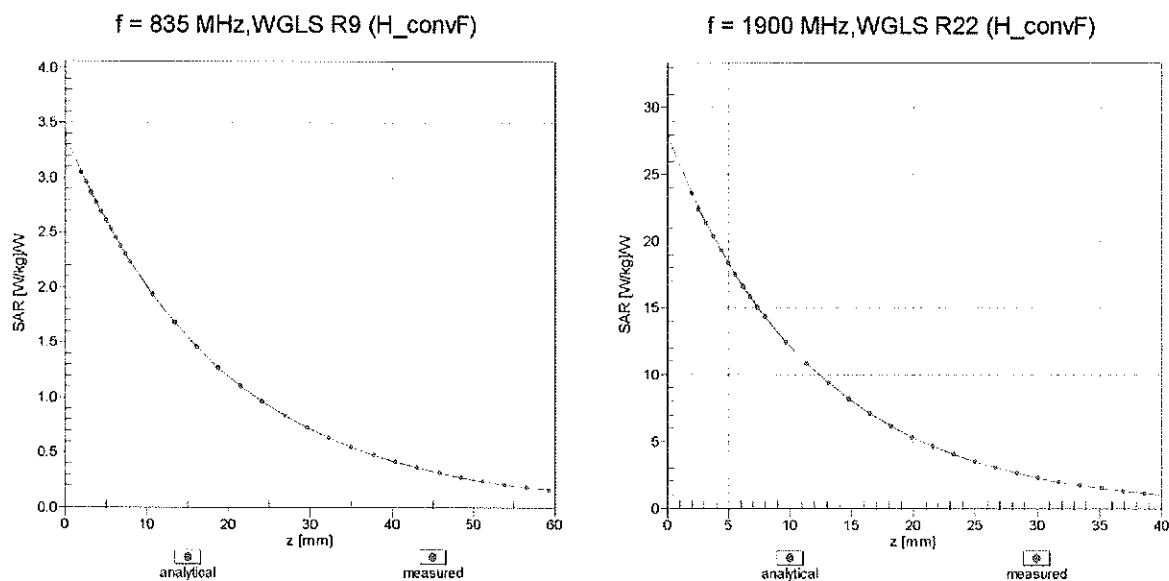
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

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



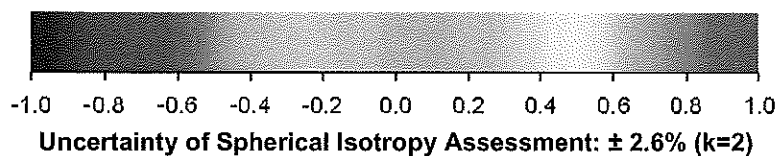
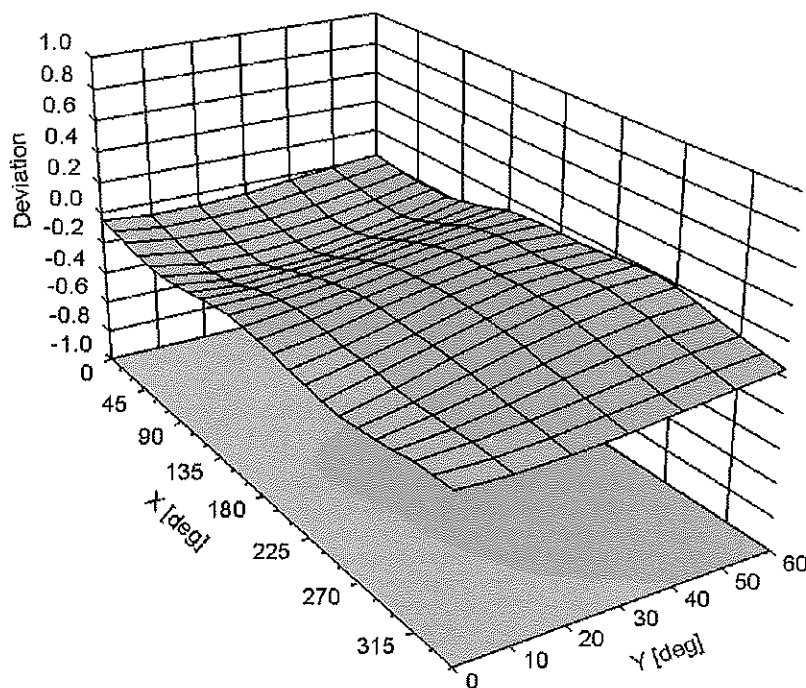
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

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



## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3258

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 59.8       |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 10 mm      |
| Tip Diameter                                  | 4 mm       |
| Probe Tip to Sensor X Calibration Point       | 2 mm       |
| Probe Tip to Sensor Y Calibration Point       | 2 mm       |
| Probe Tip to Sensor Z Calibration Point       | 2 mm       |
| Recommended Measurement Distance from Surface | 3 mm       |

## APPENDIX D: SAR TISSUE SPECIFICATIONS

Measurement Procedure for Tissue verification:

- 1) The network analyzer and probe system was configured and calibrated.
- 2) The probe was immersed in the tissue. The tissue was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
- 3) The complex admittance with respect to the probe aperture was measured
- 4) The complex relative permittivity  $\epsilon$  can be calculated from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\epsilon_r'\epsilon_0)^{1/2}]}{r} d\phi' d\rho' d\rho$$

where  $Y$  is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively,  $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$ ,  $\omega$  is the angular frequency, and  $j = \sqrt{-1}$ .

**Table D-I**  
**Composition of the Tissue Equivalent Matter**

| Frequency (MHz)           | 835   | 1900  | 2450 |
|---------------------------|-------|-------|------|
| Tissue                    | Body  | Body  | Body |
| Ingredients (% by weight) |       |       |      |
| Bactericide               | 0.1   |       |      |
| DGBE                      |       | 29.44 | 26.7 |
| HEC                       | 1     |       |      |
| NaCl                      | 0.94  | 0.39  | 0.1  |
| Sucrose                   | 44.9  |       |      |
| Water                     | 53.06 | 70.17 | 73.2 |

|                                           |                                                                                                                                                                                                        |                                        |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| FCC ID: A3LSMV101F                        |  <b>SAR EVALUATION REPORT</b>  | <b>Reviewed by:</b><br>Quality Manager |
| <b>Test Dates:</b><br>02/10/14 - 03/05/14 | <b>DUT Type:</b><br>Portable Wireless Router                                                                                                                                                           | <b>APPENDIX D:</b><br>Page 1 of 1      |

## APPENDIX E: SAR SYSTEM VALIDATION

Per FCC KDB 865664 D02v01r01, 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 required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01v01r01. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

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

**Table E-I**  
**SAR System Validation Summary**

| SAR SYSTEM # | FREQ. [MHz] | DATE      | PROBE SN | PROBE TYPE | PROBE CAL. POINT |      | COND.        | PERM.            | CW VALIDATION |                 |                | MOD. VALIDATION |             |      |
|--------------|-------------|-----------|----------|------------|------------------|------|--------------|------------------|---------------|-----------------|----------------|-----------------|-------------|------|
|              |             |           |          |            |                  |      | ( $\sigma$ ) | ( $\epsilon_r$ ) | SENSI-TIVITY  | PROBE LINEARITY | PROBE ISOTROPY | MOD. TYPE       | DUTY FACTOR | PAR  |
| G            | 835         | 1/6/2014  | 3209     | ES3DV3     | 835              | Body | 0.989        | 53.83            | PASS          | PASS            | PASS           | GMSK            | PASS        | N/A  |
| D            | 1900        | 9/10/2013 | 3022     | ES3DV2     | 1900             | Body | 1.516        | 52.49            | PASS          | PASS            | PASS           | GMSK            | PASS        | N/A  |
| G            | 2450        | 3/5/2014  | 3258     | ES3DV3     | 2450             | Body | 2.044        | 51.30            | PASS          | PASS            | PASS           | OFDM            | N/A         | PASS |

NOTE: While the probes have been calibrated for both a CW and modulated signals, all measurements were performed using communication systems calibrated for CW signals only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01 for scenarios when CW probe calibrations are used with other signal types. SAR systems 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.

|                                    |                                                                                     |                       |                                                                                       |                                 |
|------------------------------------|-------------------------------------------------------------------------------------|-----------------------|---------------------------------------------------------------------------------------|---------------------------------|
| FCC ID: A3LSMV101F                 |  | SAR EVALUATION REPORT |  | Reviewed by:<br>Quality Manager |
| Test Dates:<br>02/10/14 - 03/05/14 | DUT Type:<br>Portable Wireless Router                                               |                       |                                                                                       | APPENDIX E:<br>Page 1 of 1      |