

# SAR TEST REPORT

|                      |   |                                                                                    |
|----------------------|---|------------------------------------------------------------------------------------|
| Equipment Under Test | : | Digital Camera                                                                     |
| Model No.            | : | NX2000                                                                             |
| Applicant            | : | Samsung Electronics Co., Ltd.                                                      |
| Address of Applicant | : | 129, Samsung-ro, Yeongtong-gu Suwon-si, Gyeonggi-do,<br>443-742 Korea, Republic of |
| FCC ID               | : | A3LNX2000                                                                          |
| IC ID                | : | 649E-NX2000                                                                        |
| Device Category      | : | Portable Device                                                                    |
| Exposure Category    | : | General Population/Uncontrolled Exposure                                           |
| Date of Receipt      | : | 2013-03-11                                                                         |
| Date of Test(s)      | : | 2013-03-15                                                                         |
| Date of Issue        | : | 2013-04-18                                                                         |

**Standards:**

**FCC OET Bulletin 65 supplement C  
 RSS-102 (Issue 4)  
 IEEE 1528, 2003  
 ANSI/IEEE C95.1, C95.3**

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

**Remarks:**

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

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|                    |          |                   |                                                                                     |                   |
|--------------------|----------|-------------------|-------------------------------------------------------------------------------------|-------------------|
| <b>Tested by</b>   | <b>:</b> | <b>Jongwon Ma</b> |  | <b>2013-04-18</b> |
| <b>Approved by</b> | <b>:</b> | <b>Nicky You</b>  |  | <b>2013-04-18</b> |

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# 1. General Information

## 1.1 Testing Laboratory

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

## 1.2 Details of Manufacturer

Manufacturer : Samsung Electronics Co., Ltd.  
 Address : 129, Samsung-ro, Yeongtong-gu Suwon-si, Gyeonggi-do, 443-742 Korea, Republic of  
 Contact Person : Yeonha-Kim  
 Phone No. : 031-277-7691  
 E-mail : yeonha38.kim@samsung.com

## 1.3 Version of Report

| Version Number | Date       | Revision      |
|----------------|------------|---------------|
| 00             | 2013-03-28 | Initial issue |
| 01             | 2013-04-08 | Revision 01   |
| 02             | 2013-04-18 | Revision 02   |

## 1.4 Description of EUT(s)

| <b>EUT Type</b>            | : Digital Camera             |                     |
|----------------------------|------------------------------|---------------------|
| <b>Model</b>               | : NX2000                     |                     |
| <b>Serial Number</b>       | : NX2000PV1-068              |                     |
| <b>Mode of Operation</b>   | : WLAN                       |                     |
| <b>Duty Cycle</b>          | : 1(WLAN)                    |                     |
| <b>Body worn Accessory</b> | : None                       |                     |
| <b>Tx Frequency Range</b>  | : 2412 MHz ~ 2462 MHz (WLAN) |                     |
| <b>Battery Type</b>        | : DC 7.6 V (Li-ion Battery)  |                     |
| Equipment Class            | Band                         | Reported SAR        |
|                            |                              | 1g Body-Worn (W/kg) |
| DTS                        | 2.45 GHz WLAN                | 0.384               |

### 1.5 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 44798 D01v05.

| Average power for Production |                   |   |             |             |             |
|------------------------------|-------------------|---|-------------|-------------|-------------|
| Mode                         | Nominal & Maximum | a | b           | g           | n           |
| 2.45 GHz WLAN                | <b>Maximum</b>    |   | <b>14.5</b> | <b>13.5</b> | <b>12.5</b> |
|                              | Nominal           |   | 14.0        | 13.0        | 12.0        |

### 1.6 Test Environment

|                          |                   |
|--------------------------|-------------------|
| Ambient temperature      | : (22 ± 2) ° C    |
| Tissue Simulating Liquid | : (22 ± 2) ° C    |
| Relative Humidity        | : (55 ± 5) % R.H. |

### 1.7 Operation Configuration

The client provided a special driver and test program which can control the frequency and power of the WLAN module. Measurements were performed at the lowest, middle and highest channels of the operating band. The EUT was set to maximum power level during all tests and at the beginning of each test the battery was fully charged.

The DASY4 system measures power drift during SAR testing by comparing e-field in the same location at the beginning and at the end of measurement.

### 1.8 EVALUATION PROCEDURES

#### - Power Reference Measurement Procedures

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties (for example, 2.5 mm for an EX3DV4 probe type).

### 1.9 SAR Measurement Procedures

#### Step 1: Power Reference Measurement

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

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

The entire evaluation of the spatial peak values is performed within the Post-processing engine (SEMCAD). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube

with highest averaged SAR is divided into the following stages:

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

< Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01 >

|                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      | ≤ 3 GHz                                                                                                                                                                                                                                                           | > 3 GHz                                                        |                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface                                                                                                                                                                                                                                                                                                                                |                                      | 5 ± 1 mm                                                                                                                                                                                                                                                          | ½·δ·ln(2) ± 0.5 mm                                             |                                                               |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location                                                                                                                                                                                                                                                                                                                                             |                                      | 30° ± 1°                                                                                                                                                                                                                                                          | 20° ± 1°                                                       |                                                               |
| Maximum area scan spatial resolution: Δx <sub>Area</sub> , Δy <sub>Area</sub>                                                                                                                                                                                                                                                                                                                                                         |                                      | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm                                                                                                                                                                                                                            | 3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm                       |                                                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |                                                                |                                                               |
| Maximum zoom scan spatial resolution: Δx <sub>Zoom</sub> , Δy <sub>Zoom</sub>                                                                                                                                                                                                                                                                                                                                                         |                                      | ≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm*                                                                                                                                                                                                                             | 3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm*                       |                                                               |
| Maximum zoom scan spatial resolution, normal to phantom surface                                                                                                                                                                                                                                                                                                                                                                       | uniform grid: Δz <sub>Zoom</sub> (n) | ≤ 5 mm                                                                                                                                                                                                                                                            | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm    |                                                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       | graded grid                          | Δz <sub>Zoom</sub> (1): between 1 <sup>st</sup> two points closest to phantom surface                                                                                                                                                                             | ≤ 4 mm                                                         | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm |
|                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      | Δz <sub>Zoom</sub> (n>1): between subsequent points                                                                                                                                                                                                               | ≤ 1.5·Δz <sub>Zoom</sub> (n-1)                                 |                                                               |
| Minimum zoom scan volume                                                                                                                                                                                                                                                                                                                                                                                                              | x, y, z                              | ≥ 30 mm                                                                                                                                                                                                                                                           | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |                                                               |
| Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.<br>* When zoom scan is required and the <i>reported</i> SAR from the area scan based <i>1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. |                                      |                                                                                                                                                                                                                                                                   |                                                                |                                                               |

#### Step 4: Power drift measurement

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

#### Step 5: Z-Scan

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

### 1.10 The SAR Measurement System

A photograph of the SAR measurement System is given in Fig. a. This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (Speag DASY4 professional system ). A Model EX3DV4 3862 E-field probe is used to determine the internal electric fields. The SAR can be obtained from the equation  $SAR = \sigma (|E_i|^2) / \rho$  where  $\sigma$  and  $\rho$  are the conductivity and mass density of the tissue-simulant. The DASY4 system for performing compliance tests consists of the following items:

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

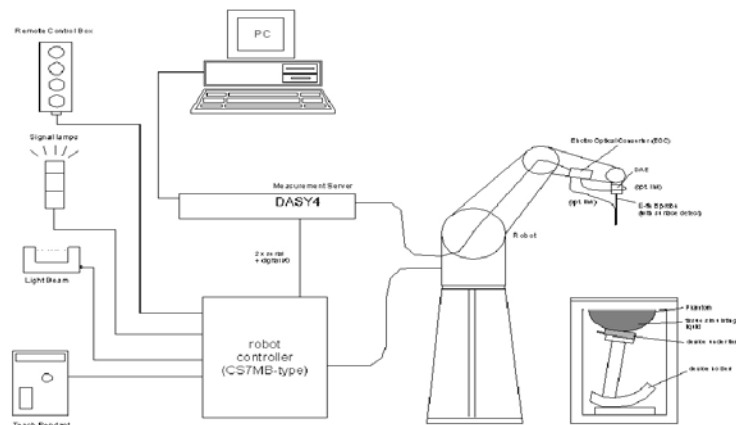


Fig a. The microwave circuit arrangement used for SAR system verification

- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows XP.
- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM phantom enabling testing body usage.
- The device holder for flat phantom.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

## 1.11 System Components

### EX3DV4 E-Field Probe

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



EX3DV4 E-Field Probe

#### NOTE:

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

### SAM Phantom

**Construction:** The SAM Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90 % of all users. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot



SAM Phantom

**Shell Thickness:** 2.0 mm ± 0.1 mm  
**Filling Volume:** Approx. 25 liters

### DEVICE HOLDER

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



Device Holder

### 1.12 SAR System verification

The microwave circuit arrangement for system verification is sketched in Fig. b. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10 % from the target SAR values. These tests were done at 2450 MHz. The tests for EUT were conducted within 24 hours after each verification. The obtained results from the system accuracy verification are displayed in the table 1. During the tests, the ambient temperature of the laboratory was in the range (22 ± 2) ° C, the relative humidity was in the range (55 ± 5) % R.H. and the liquid depth above the ear reference points was above 15 cm in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

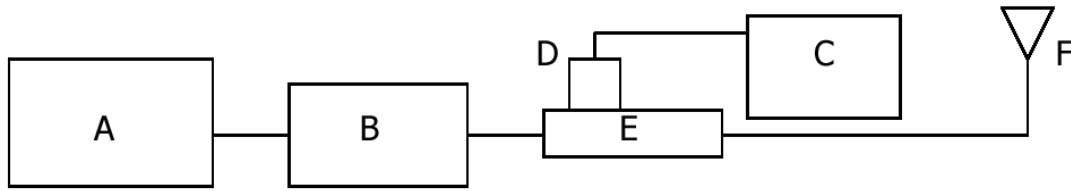


Fig b. The microwave circuit arrangement used for SAR system verification

- A. Agilent Model E4421B Signal Generator
- B. EMPOWER Model 2001-BBS3Q7ECK Amplifier
- C. Agilent Model E4419B Power Meter
- D. Agilent Model 9300H Power Sensor
- E. Agilent Model 86205A Directional RF Bridges
- F. Reference dipole Antenna



Photo of the dipole Antenna

### System Verification Results

| Verification Kit    | Probe S/N | Tissue           | Target SAR 1 g from Calibration Certificate (1 W) | Measured SAR 1 g (0.1 W) | Normalized SAR 1 g (1 W) | Deviation (%) | Date       | Liquid Temp. (°C) |
|---------------------|-----------|------------------|---------------------------------------------------|--------------------------|--------------------------|---------------|------------|-------------------|
| D2450V2<br>S/N: 734 | 3862      | 2450 MHz<br>Body | 50.2 W/kg                                         | 5.3 W/kg                 | <b>53.0 W/kg</b>         | <b>5.78</b>   | 2013-03-15 | 23.2              |

Table 1. Results system verification

### 1.13 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this simulant fluid were measured by using the Speag Model DAK-3.5 Dielectric Probe in conjunction with Agilent E5071C Network Analyzer(9 kHz – 6.5 GHz ) by using a procedure detailed in Section V.

| f (MHz) | Tissue type  | Limits / Measured    | Dielectric Parameters |              |                           |
|---------|--------------|----------------------|-----------------------|--------------|---------------------------|
|         |              |                      | Permittivity          | Conductivity | Simulated Tissue Temp(°C) |
| 2450    | Body         | Measured, 2013-03-15 | 53.4                  | 1.92         | 23.2                      |
|         |              | Recommended Limits   | 52.7                  | 1.95         | 21.0 ~ 23.0               |
|         |              | Deviation(%)         | <b>1.33</b>           | <b>-1.54</b> | -                         |
| 2412    |              | Measured, 2013-03-15 | 53.5                  | 1.87         | 23.2                      |
|         |              | Deviation(%)         | <b>1.52</b>           | <b>-4.10</b> | -                         |
| 2437    |              | Measured, 2013-03-15 | 53.5                  | 1.90         | 23.2                      |
|         |              | Deviation(%)         | <b>1.52</b>           | <b>-2.56</b> | -                         |
| 2462    |              | Measured, 2013-03-15 | 53.4                  | 1.93         | 23.2                      |
|         | Deviation(%) | <b>1.33</b>          | <b>-1.03</b>          | -            |                           |

The composition of the brain tissue simulating liquid

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

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

Salt: 99 +% Pure Sodium Chloride

Sugar: 98 +% Pure Sucrose

Water: De-ionized, 16 MΩ<sup>+</sup> resistivity

HEC: Hydroxyethyl Cellulose

DGBE: 99 +% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

### 1.14 Test System Validation

Per FCC KDB 865664 D02v01, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the require tissue-equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01v01. Since frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

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

| f<br>(MHz) | Date       | Probe<br>S/N | Probe<br>Cal<br>point | Tissue<br>Type | Dielectric<br>Parameters |                  | CW Validation |                    |                   | Modulated Validation |                |      |
|------------|------------|--------------|-----------------------|----------------|--------------------------|------------------|---------------|--------------------|-------------------|----------------------|----------------|------|
|            |            |              |                       |                | Permitt<br>ivity         | Condu<br>ctivity | Sensitivity   | Probe<br>Linearity | Probe<br>Isotropy | Mod.<br>Type         | Duty<br>Factor | PAR  |
| 2450       | 02/08/2013 | 3862         | 2450                  | Body           | 50.75                    | 1.92             | PASS          | PASS               | PASS              | OFDM                 | N/A            | PASS |

< SAR System Validation Summary >

### 1.15 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (“SAR”) in Section 4.2 of “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz,” ANSI/IEEE C95.3–2003, Copyright 2003 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in “Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields,” NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 kHz to 6 GHz. Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

(1) Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over an 10 grams of tissue (defined as a tissue volume in the shape of a cube). Occupational/Controlled limits apply when persons are exposed as a consequence of their employment

provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment.

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

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

Table .2 RF exposure limits

## 2. Instruments List

| Maunfacturer                   | Device                            | Type             | Serial Number      | Cal Date    | Cal Interval | Cal Due     |
|--------------------------------|-----------------------------------|------------------|--------------------|-------------|--------------|-------------|
| Stäubli                        | Robot                             | RX90BL           | F12/5LP8A1/01      | N/A         | N/A          | N/A         |
| Schmid& Partner Engineering AG | Dosimetric E-Field Probe          | EX3DV4           | 3862               | 02/04/2013  | Annual       | 02/04/2014  |
| Schmid& Partner Engineering AG | 2450 MHz System Validation Dipole | D2450V2          | 734                | 05/17/ 2012 | Biennial     | 05/17/ 2014 |
| Schmid& Partner Engineering AG | Data acquisition Electronics      | DAE3             | 567                | 01/25/2013  | Annual       | 01/25/2014  |
| Schmid& Partner Engineering AG | Software                          | DASY 4 V4.7      | -                  | N/A         | N/A          | N/A         |
| Schmid& Partner Engineering AG | Phantom                           | SAM Phantom V4.0 | TP-1645<br>TP-1300 | N/A         | N/A          | N/A         |
| Agilent                        | Network Analyzer                  | E5071C           | MY46111535         | 07/03/2012  | Annual       | 07/04/2013  |
| Schmid& Partner Engineering AG | Dielectric Assessment Kit         | DAK-3.5          | 1046               | 04/03/2012  | Annual       | 04/03/2013  |
| Agilent                        | Power Meter                       | E4419B           | GB43311125         | 07/01/2012  | Annual       | 07/01/2013  |
| Agilent                        | Power Sensor                      | E9300H           | MY41495314         | 09/18/2012  | Annual       | 09/18/2013  |
|                                |                                   |                  | MY41495307         | 09/18/2012  | Annual       | 09/18/2013  |
| Agilent                        | Signal Generator                  | E4421B           | MY42082477         | 03/29/2012  | Annual       | 03/29/2013  |
| Empower RF Systems             | Power Amplifier                   | 2001-BBS3Q7ECK   | 1032 D/C 0336      | 03/31/2012  | Annual       | 03/31/2013  |
| Agilent                        | Directional RF Bridges            | 86205A           | MY31402302         | 07/03/2012  | Annual       | 07/03/2013  |
| Microlab                       | LP Filter                         | LA-30N           | N/A                | 09/14/2012  | Annual       | 09/14/2013  |
| R & S                          | Spectrum Analyzer                 | FSV30            | 100768             | 03/29/2012  | Annual       | 03/29/2013  |
| Agilent                        | Attenuator                        | 8491B            | 50566              | 09/14/2012  | Annual       | 09/14/2013  |

## 3. Summary of Results

### 3.1 FCC Power Measurement Procedures

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

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

### 3.2 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v05, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported SAR. Test highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r02.

### 3.3 RF Conducted Power

#### WLAN RF Conducted Average Power

| 802.11b Mode    |             | Rated    | Measured Power |
|-----------------|-------------|----------|----------------|
| Frequency (MHz) | Channel No. | (Mbps)   | (dB m)         |
| 2412            | 1           | 1        | 13.28          |
|                 |             | 2        | 13.25          |
|                 |             | 5.5      | 13.20          |
|                 |             | 11       | 13.19          |
| 2437            | 6           | <b>1</b> | <b>13.72</b>   |
|                 |             | 2        | 13.71          |
|                 |             | 5.5      | 13.67          |
|                 |             | 11       | 13.67          |
| 2462            | 11          | 1        | 13.62          |
|                 |             | 2        | 13.69          |
|                 |             | 5.5      | 13.65          |
|                 |             | 11       | 13.54          |

| 802.11g Mode    |             | Rated  | Measured Power |
|-----------------|-------------|--------|----------------|
| Frequency (MHz) | Channel No. | (Mbps) | (dB m)         |
| 2412            | 1           | 6      | 12.52          |
|                 |             | 9      | 12.49          |
|                 |             | 12     | 12.46          |
|                 |             | 18     | 12.42          |
|                 |             | 24     | 12.37          |
|                 |             | 36     | 12.14          |
|                 |             | 48     | 11.95          |
|                 |             | 54     | 11.69          |
| 2437            | 6           | 6      | 12.81          |
|                 |             | 9      | 12.76          |
|                 |             | 12     | 12.74          |
|                 |             | 18     | 12.66          |
|                 |             | 24     | 12.51          |
|                 |             | 36     | 12.19          |
|                 |             | 48     | 11.84          |
|                 |             | 54     | 11.64          |
| 2462            | 11          | 6      | 12.62          |
|                 |             | 9      | 12.57          |
|                 |             | 12     | 12.51          |
|                 |             | 18     | 12.41          |
|                 |             | 24     | 12.31          |
|                 |             | 36     | 11.98          |
|                 |             | 48     | 11.68          |
|                 |             | 54     | 11.44          |

| 802.11n_HT20 Mode |             | Rated  | Measured Power |
|-------------------|-------------|--------|----------------|
| Frequency (MHz)   | Channel No. | (Mbps) | (dB m)         |
| 2412              | 1           | MCS0   | 11.50          |
|                   |             | MCS1   | 11.47          |
|                   |             | MCS2   | 11.41          |
|                   |             | MCS3   | 11.35          |
|                   |             | MCS4   | 11.17          |
|                   |             | MCS5   | 11.03          |
|                   |             | MCS6   | 10.89          |
|                   |             | MCS7   | 10.67          |
| 2437              | 6           | MCS0   | 12.00          |
|                   |             | MCS1   | 12.01          |
|                   |             | MCS2   | 11.94          |
|                   |             | MCS3   | 11.87          |
|                   |             | MCS4   | 11.63          |
|                   |             | MCS5   | 11.46          |
|                   |             | MCS6   | 11.24          |
|                   |             | MCS7   | 11.13          |
| 2462              | 11          | MCS0   | 12.10          |
|                   |             | MCS1   | 12.11          |
|                   |             | MCS2   | 12.03          |
|                   |             | MCS3   | 11.94          |
|                   |             | MCS4   | 11.71          |
|                   |             | MCS5   | 11.49          |
|                   |             | MCS6   | 11.35          |
|                   |             | MCS7   | 11.15          |

### 3.4 SAR Test Exclusions Applied

Per FCC KDB 447498 D01v05, the SAR exclusion threshold for distances < 50 mm is defined by the following equation:

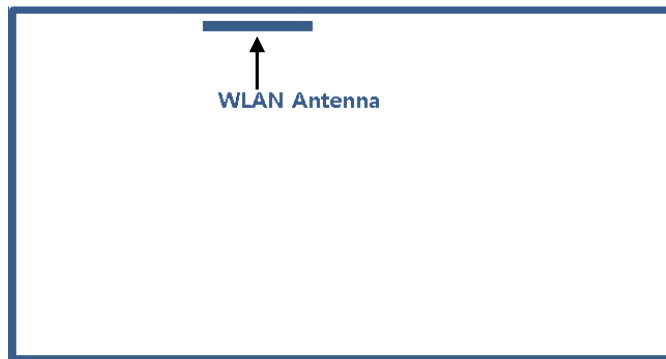
$$\frac{\text{Max Power of Channel (mW)}}{\text{Test Separation Distance (mm)}} * \sqrt{\text{Frequency(GHz)}} \leq 3.0$$

Per FCC KDB 447498 D01v05, At 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following

$$[(\text{Threshold at 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) * 10] \text{ mW}$$

at > 1500 MHz and ≤ 6 GHz

<The Distance information of Antenna to Edges of EUT>



Note: Specific antenna dimensions and separation distances are shown in the antenna distance document.

Based on the maximum tune-up tolerance limit of WLAN the antenna to use separation distance, Table “EXEMPT” SAR was not required and Table “Measure” SAR was required.

| Antenna               | Tx   | Frequency (MHz) | Output power <sup>Note 2, 4</sup> |       | Separation distances (mm) <sup>Note 1 and 4</sup> |       |      |     |        |       | SAR Exemption <sup>Note 3 and 4</sup> |        |         |         |        |        |
|-----------------------|------|-----------------|-----------------------------------|-------|---------------------------------------------------|-------|------|-----|--------|-------|---------------------------------------|--------|---------|---------|--------|--------|
|                       |      |                 | dBm                               | mW    | Left                                              | Right | Rear | Top | Bottom | Front | Left                                  | Right  | Rear    | Top     | Bottom | Front  |
| <b>WiFi - Antenna</b> |      |                 |                                   |       |                                                   |       |      |     |        |       |                                       |        |         |         |        |        |
| 802.11b               | WiFi | 2462            | 14.50                             | 28.00 | Refer to the Antenna distance document            |       |      |     |        |       | 1.16                                  | 262mW  | 5.49    | 8.79    | 190mW  | 2.31   |
|                       |      |                 |                                   |       |                                                   |       |      |     |        |       | EXEMPT                                | EXEMPT | Measure | Measure | EXEMPT | EXEMPT |

Note

1. For distances < 5mm, a distance of 5mm is used to determine SAR exclusion and estimated SAR value.
2. Output power is the maximum rated power (including tune-up or manufacturing tolerances).
3. If the antenna separation distance is > 50mm then the value listed is the output power threshold, above which SAR measurement is required. For separation ≤ 50mm the value is the KDB 447498 calculated value and must be less than 3 for SAR exemption.
4. Formulas round separation distance to nearest mm and power to nearest mW before calculating thresholds or exemption values.

### 3.5 1g SAR Data Summary

#### WLAN Body SAR

|                          |            |
|--------------------------|------------|
| Ambient Temperature (°C) | 23.9       |
| Liquid Temperature (°C)  | 23.2       |
| Date                     | 03/15/2013 |

| Test Mode | EUT Position | Data Rate | Traffic Channel |         | Distance (mm) | Measured Power [dB m] | Tune-Up Limit [dB m] | Power Drift(dB) | 1 g SAR (W/kg) | Scaling Factor | Scaling SAR (1g) | 1 g SAR Limits (W/kg) |
|-----------|--------------|-----------|-----------------|---------|---------------|-----------------------|----------------------|-----------------|----------------|----------------|------------------|-----------------------|
|           |              |           | Frequency (MHz) | Channel |               |                       |                      |                 |                |                |                  |                       |
| 802.11b   | Rear         | 1         | 2437            | 6       | 5             | 13.72                 | 14.50                | -0.186          | 0.093          | 1.197          | 0.111            | 1.6                   |
|           | Top          | 1         | 2437            | 6       | 5             | 13.72                 | 14.50                | -0.076          | 0.291          | 1.197          | 0.348            |                       |
|           | Top          | 1         | 2412            | 1       | 5             | 13.28                 | 14.50                | -0.149          | 0.290          | 1.324          | 0.384            |                       |
|           | Top          | 1         | 2462            | 11      | 5             | 13.62                 | 14.50                | -0.009          | 0.279          | 1.225          | 0.342            |                       |

#### SAR Test Notes

##### General Notes :

- The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, FCC/OET Bulletin 65, Supplement C [June 2001] and FCC KDB Publication 447498 D01v05.
- All modes of operation were investigated, and worst-case results are reported.
- Battery is fully charged for all readings and the standard batteries are the only options.
- The EUT is tested 2<sup>nd</sup> hot-spot peak, if it is less than 2 dB below the highest peak.
- 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.
- SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v05.
- According to FCC KDB Publication 447498 D01v05 4.2.2.3), the test separation distance 5 mm was chosen.

##### WLAN Notes :

- Justification for reduced test configuration for WIFI channels per KDB Publication 248227 and April 2010 FCC/TCB Meeting Notes: Highest average RF output power channel for the lowest data rate were selected for SAR evaluation. Other IEEE 802.11 modes (including 802.11n and higher data rates) were not investigated since the average output powers were not greater than 0.25 dB than that of the corresponding channel in the lowest data rate IEEE 802.11a modes
- WLAN transmission was verified using a spectrum analyzer.
- 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.

## Appendix

### List

|            |                                                 |                                           |
|------------|-------------------------------------------------|-------------------------------------------|
| Appendix A | DASY4 Report<br>(Plots of the SAR Measurements) | 2450 MHz Verification Test<br>- WLAN Test |
| Appendix B | Uncertainty Analysis                            |                                           |
| Appendix C | Calibration Certificate                         | - PROBE<br>- DAE<br>- DIPOLE              |



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## **Appendix A**

### **Test Plot – DASYS Report**

## 2450 MHz Verification Test\_Body

Date: 2013-03-15

Test Laboratory: SGS Korea (Gunpo Laboratory)  
 File Name: [Validation 2450 MHz.da4](#)

Input Power : 100 mW

Ambient Temp : 23.9 °C Tissue Temp : 23.2 °C

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:734**  
**Program Name: Validation 2450 MHz**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.92$  mho/m;  $\epsilon_r = 53.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.25, 7.25, 7.25); Calibrated: 2013-02-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: SAM MIC #2000-93 with CRP\_Right; Type: SAM MIC #2000-93; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**Validation 2450 MHz/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm  
 Maximum value of SAR (interpolated) = 8.56 mW/g

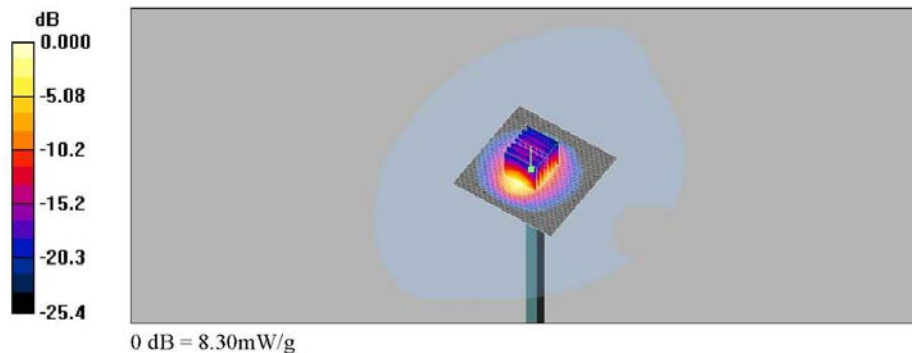
**Validation 2450 MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 62.0 V/m; Power Drift = -0.056 dB

Peak SAR (extrapolated) = 11.6 W/kg

**SAR(1 g) = 5.3 mW/g; SAR(10 g) = 2.39 mW/g**

Maximum value of SAR (measured) = 8.30 mW/g



## WLAN Body SAR Test

Date: 2013-03-15

Test Laboratory: SGS Korea (Gunpo Laboratory)  
 File Name: [Wi-Fi Rear\\_1MBps\\_CH6.da4](#)

Ambient Temp : 23.9 °C Tissue Temp : 23.2 °C

**DUT: NX2000; Type: Digital Camera; Serial: NX2000PV1-068**  
**Program Name: WLAN\_Body**

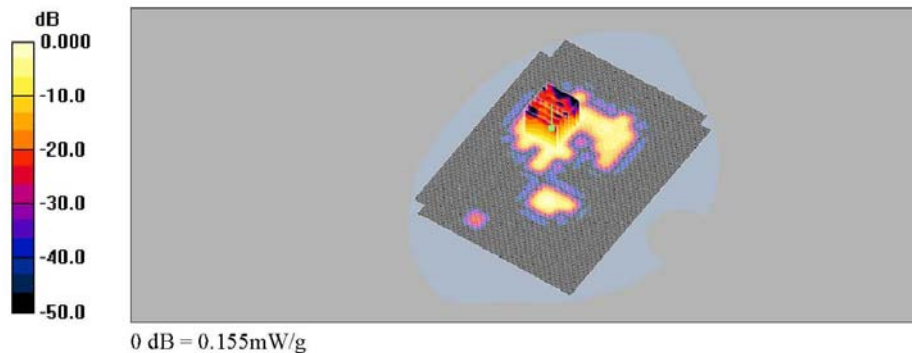
Communication System: WLAN; Frequency: 2437 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2437 \text{ MHz}$ ;  $\sigma = 1.9 \text{ mho/m}$ ;  $\epsilon_r = 53.5$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.25, 7.25, 7.25); Calibrated: 2013-02-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: SAM MIC #2000-93 with CRP Right; Type: SAM MIC #2000-93; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**WLAN\_Rear\_CH6 gep 5mm/Area Scan (151x201x1):** Measurement grid: dx=10mm, dy=10mm  
 Maximum value of SAR (interpolated) = 0.144 mW/g

**WLAN\_Rear\_CH6 gep 5mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 2.69 V/m; Power Drift = -0.186 dB  
 Peak SAR (extrapolated) = 0.261 W/kg  
**SAR(1 g) = 0.093 mW/g; SAR(10 g) = 0.034 mW/g**  
 Maximum value of SAR (measured) = 0.155 mW/g



Date: 2013-03-15

Test Laboratory: SGS Korea (Gunpo Laboratory)  
 File Name: [Wi-Fi\\_Top\\_1Mbps\\_CH6.da4](#)

Ambient Temp : 23.9 °C Tissue Temp : 23.2 °C

**DUT: NX2000; Type: Digital Camera; Serial: NX2000PV1-068**  
**Program Name: WLAN\_Body**

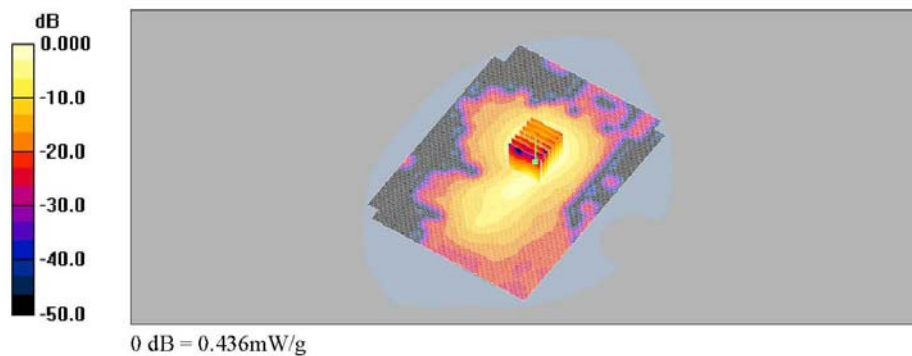
Communication System: WLAN; Frequency: 2437 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.9$  mho/m;  $\epsilon_r = 53.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.25, 7.25, 7.25); Calibrated: 2013-02-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: SAM MIC #2000-93 with CRP Right; Type: SAM MIC #2000-93; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**WLAN\_Top\_CH6 gep 5mm/Area Scan (151x201x1):** Measurement grid: dx=10mm,  
 dy=10mm  
 Maximum value of SAR (interpolated) = 0.428 mW/g

**WLAN\_Top\_CH6 gep 5mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm,  
 dy=5mm, dz=5mm  
 Reference Value = 9.46 V/m; Power Drift = -0.076 dB  
 Peak SAR (extrapolated) = 0.609 W/kg  
**SAR(1 g) = 0.291 mW/g; SAR(10 g) = 0.144 mW/g**  
 Maximum value of SAR (measured) = 0.436 mW/g



Date: 2013-03-15

Test Laboratory: SGS Korea (Gunpo Laboratory)  
 File Name: [Wi-Fi\\_Top\\_1Mbps\\_CH1.da4](#)

Ambient Temp : 23.9 °C Tissue Temp : 23.2 °C

**DUT: NX2000; Type: Digital Camera; Serial: NX2000PV1-068**  
**Program Name: WLAN\_Body**

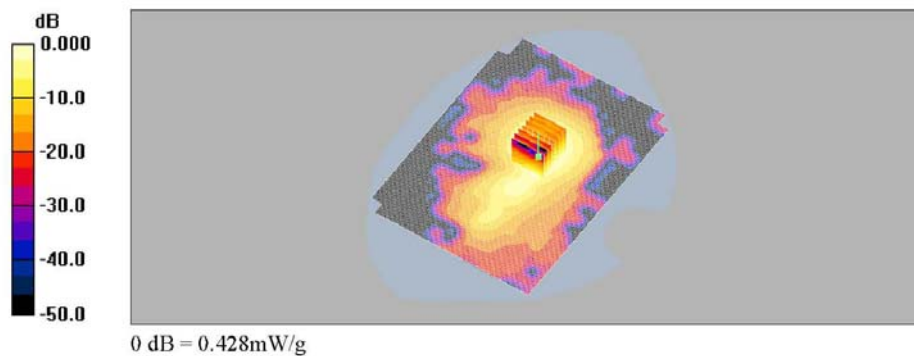
Communication System: WLAN; Frequency: 2412 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2412 \text{ MHz}$ ;  $\sigma = 1.87 \text{ mho/m}$ ;  $\epsilon_r = 53.5$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.25, 7.25, 7.25); Calibrated: 2013-02-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: SAM MIC #2000-93 with CRP Right; Type: SAM MIC #2000-93; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**WLAN\_Top\_CH1 gep 5mm/Area Scan (151x201x1):** Measurement grid: dx=10mm, dy=10mm  
 Maximum value of SAR (interpolated) = 0.468 mW/g

**WLAN\_Top\_CH1 gep 5mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 9.28 V/m; Power Drift = -0.149 dB  
 Peak SAR (extrapolated) = 0.591 W/kg  
**SAR(1 g) = 0.290 mW/g; SAR(10 g) = 0.147 mW/g**  
 Maximum value of SAR (measured) = 0.428 mW/g



Date: 2013-03-15

Test Laboratory: SGS Korea (Gunpo Laboratory)  
 File Name: [Wi-Fi\\_Top\\_1MBps\\_CH11.da4](#)

Ambient Temp : 23.9 °C Tissue Temp : 23.2 °C

**DUT: NX2000; Type: Digital Camera; Serial: NX2000PV1-068**  
**Program Name: WLAN\_Body**

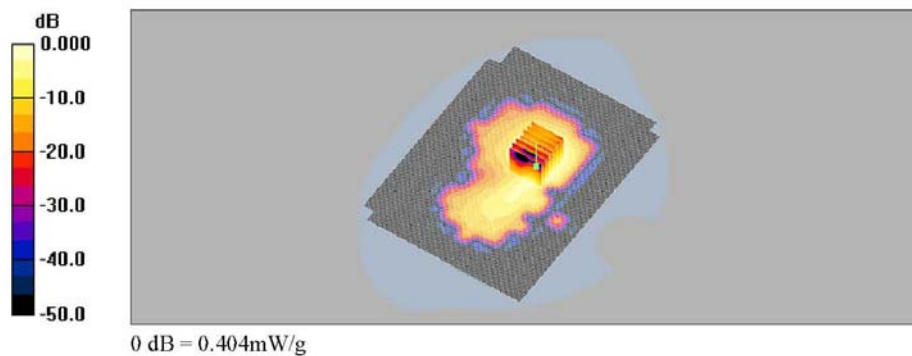
Communication System: WLAN; Frequency: 2462 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2462 \text{ MHz}$ ;  $\sigma = 1.93 \text{ mho/m}$ ;  $\epsilon_r = 53.4$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: EX3DV4 - SN3862; ConvF(7.25, 7.25, 7.25); Calibrated: 2013-02-04
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn567; Calibrated: 2013-01-25
- Phantom: SAM MIC #2000-93 with CRP Right; Type: SAM MIC #2000-93; Serial: TP-1300
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**WLAN\_Top\_CH11 gep 5mm/Area Scan (151x201x1):** Measurement grid: dx=10mm, dy=10mm  
 Maximum value of SAR (interpolated) = 0.417 mW/g

**WLAN\_Top\_CH11 gep 5mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 5.50 V/m; Power Drift = -0.009 dB  
 Peak SAR (extrapolated) = 0.560 W/kg  
**SAR(1 g) = 0.279 mW/g; SAR(10 g) = 0.140 mW/g**  
 Maximum value of SAR (measured) = 0.404 mW/g



## Appendix B

### Uncertainty Analysis

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

| a                                                    | b          | c    | d      | e = f(d,k) | g    | i =   | k        |
|------------------------------------------------------|------------|------|--------|------------|------|-------|----------|
|                                                      |            |      |        |            |      | cxg/e |          |
| Uncertainty Component                                | Section in | Tol  | Prob . | Div.       | Ci   | lg    | Vi       |
|                                                      | P1528      | (%)  | Dist.  |            |      | (1g)  |          |
| Probe calibration                                    | E.2.1      | 6    | N      | 1          | 1    | 6.00  | $\infty$ |
| Axial isotropy                                       | E.2.2      | 0.25 | R      | 1.73       | 0.71 | 0.10  | $\infty$ |
| hemispherical isotropy                               | E.2.2      | 1.3  | R      | 1.73       | 0.71 | 0.53  | $\infty$ |
| Boundary effect                                      | E.2.3      | 0.4  | R      | 1.73       | 1    | 0.23  | $\infty$ |
| Linearity                                            | E.2.4      | 0.3  | R      | 1.73       | 1    | 0.17  | $\infty$ |
| System detection limit                               | E.2.5      | 0.25 | R      | 1.73       | 1    | 0.14  | $\infty$ |
| Readout electronics                                  | E.2.6      | 0.3  | N      | 1          | 1    | 0.30  | $\infty$ |
| Response time                                        | E.2.7      | 0.8  | R      | 1.73       | 1    | 0.46  | $\infty$ |
| Integration time                                     | E.2.8      | 2.6  | R      | 1.73       | 1    | 1.50  | $\infty$ |
| RF ambient Condition -Noise                          | E.6.1      | 3    | R      | 1.73       | 1    | 1.73  | $\infty$ |
| RF ambient Condition - reflections                   | E.6.1      | 3    | R      | 1.73       | 1    | 1.73  | $\infty$ |
| Probe positioning- mechanical tolerance              | E.6.2      | 1.5  | R      | 1.73       | 1    | 0.87  | $\infty$ |
| Probe positioning- with respect to phantom           | E.6.3      | 2.9  | R      | 1.73       | 1    | 1.67  | $\infty$ |
| Max. SAR evaluation                                  | E.5.2      | 1    | R      | 1.73       | 1    | 0.58  | $\infty$ |
| Test sample positioning                              | E.4.2      | 5.84 | N      | 1          | 1    | 5.84  | 9        |
| Device holder uncertainty                            | E.4.1      | 3.6  | N      | 1          | 1    | 3.60  | 5        |
| Output power variation -SAR drift measurement        | 6.62       | 5    | R      | 1.73       | 1    | 2.89  | $\infty$ |
| Phantom uncertainty (shape and thickness tolerances) | E.3.1      | 4    | R      | 1.73       | 1    | 2.31  | $\infty$ |
| Liquid conductivity - deviation from target values   | E.3.2      | 5    | R      | 1.73       | 0.64 | 1.85  | $\infty$ |
| Liquid conductivity - measurement uncertainty        | E.3.2      | 1.58 | N      | 1          | 0.64 | 1.01  | 5        |
| Liquid permittivity - deviation from target values   | E.3.3      | 5    | R      | 1.73       | 0.6  | 1.73  | $\infty$ |
| Liquid permittivity - measurement uncertainty        | E.3.3      | 1.54 | N      | 1          | 0.6  | 0.92  | 5        |
| Combined standard uncertainty                        |            |      |        | RSS        |      | 10.86 | 108      |
| Expanded uncertainty (95% CONFIDENCE INTERVAL)       |            |      |        | k=2        |      | 21.72 |          |

## **Appendix C**

### **Calibration Certificate**

**- PROBE**

**- DAE**

**- 2450 MHz DIPOLE**

## - PROBE Calibration Certificate

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



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**S** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
**S** Swiss Calibration Service

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

Accreditation No.: **SCS 108**

Client **SGS (Dymstec)**

Certificate No: **EX3-3862\_Feb13**

### CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3862**

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

Calibration date: **February 4, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID              | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter 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         | 20-Jun-12 (No. DAE4-660_Jun12)    | Jun-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 |

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

Issued: February 4, 2013

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**Engineering AG**  
 Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accreditation No.: SCS 108

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**Glossary:**

|                          |                                                                                                                                                         |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                      | tissue simulating liquid                                                                                                                                |
| NORM <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                               |
| ConvF                    | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                              |
| DCP                      | diode compression point                                                                                                                                 |
| CF                       | crest factor (1/duty_cycle) of the RF signal                                                                                                            |
| A, B, C, D               | modulation dependent linearization parameters                                                                                                           |
| Polarization $\varphi$   | $\varphi$ 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:**

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

**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.



EX3DV4 – SN:3862

February 4, 2013

# Probe EX3DV4

## SN:3862

Manufactured: February 2, 2012  
Calibrated: February 4, 2013

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

EX3DV4- SN:3862

February 4, 2013

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

### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|-----------------------------------------------------------|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.42     | 0.43     | 0.37     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                                     | 102.3    | 98.0     | 101.2    |               |

### 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    | 152.5    | $\pm 3.3 \%$              |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 150.7    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 188.9    |                           |

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

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

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

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

EX3DV4- SN:3862

February 4, 2013

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

### 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) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 835                  | 41.5                               | 0.90                            | 9.98    | 9.98    | 9.98    | 0.21  | 1.19       | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 9.89    | 9.89    | 9.89    | 0.15  | 1.52       | ± 12.0 %    |
| 1750                 | 40.1                               | 1.37                            | 8.71    | 8.71    | 8.71    | 0.24  | 1.12       | ± 12.0 %    |
| 1900                 | 40.0                               | 1.40                            | 8.36    | 8.36    | 8.36    | 0.37  | 0.80       | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 7.41    | 7.41    | 7.41    | 0.28  | 1.05       | ± 12.0 %    |
| 5200                 | 36.0                               | 4.66                            | 4.92    | 4.92    | 4.92    | 0.40  | 1.80       | ± 13.1 %    |
| 5300                 | 35.9                               | 4.76                            | 4.67    | 4.67    | 4.67    | 0.40  | 1.80       | ± 13.1 %    |
| 5500                 | 35.6                               | 4.96                            | 4.49    | 4.49    | 4.49    | 0.50  | 1.80       | ± 13.1 %    |
| 5600                 | 35.5                               | 5.07                            | 4.25    | 4.25    | 4.25    | 0.50  | 1.80       | ± 13.1 %    |
| 5800                 | 35.3                               | 5.27                            | 4.09    | 4.09    | 4.09    | 0.50  | 1.80       | ± 13.1 %    |

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

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

EX3DV4- SN:3862

February 4, 2013

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

### 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) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 835                  | 55.2                               | 0.97                            | 9.76    | 9.76    | 9.76    | 0.27  | 1.11       | ± 12.0 %    |
| 900                  | 55.0                               | 1.05                            | 9.66    | 9.66    | 9.66    | 0.30  | 1.00       | ± 12.0 %    |
| 1750                 | 53.4                               | 1.49                            | 8.08    | 8.08    | 8.08    | 0.38  | 0.81       | ± 12.0 %    |
| 1900                 | 53.3                               | 1.52                            | 7.72    | 7.72    | 7.72    | 0.30  | 0.96       | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 7.25    | 7.25    | 7.25    | 0.80  | 0.50       | ± 12.0 %    |
| 5200                 | 49.0                               | 5.30                            | 4.26    | 4.26    | 4.26    | 0.50  | 1.90       | ± 13.1 %    |
| 5300                 | 48.9                               | 5.42                            | 4.18    | 4.18    | 4.18    | 0.50  | 1.90       | ± 13.1 %    |
| 5500                 | 48.6                               | 5.65                            | 3.89    | 3.89    | 3.89    | 0.50  | 1.90       | ± 13.1 %    |
| 5600                 | 48.5                               | 5.77                            | 3.73    | 3.73    | 3.73    | 0.50  | 1.90       | ± 13.1 %    |
| 5800                 | 48.2                               | 6.00                            | 4.04    | 4.04    | 4.04    | 0.50  | 1.90       | ± 13.1 %    |

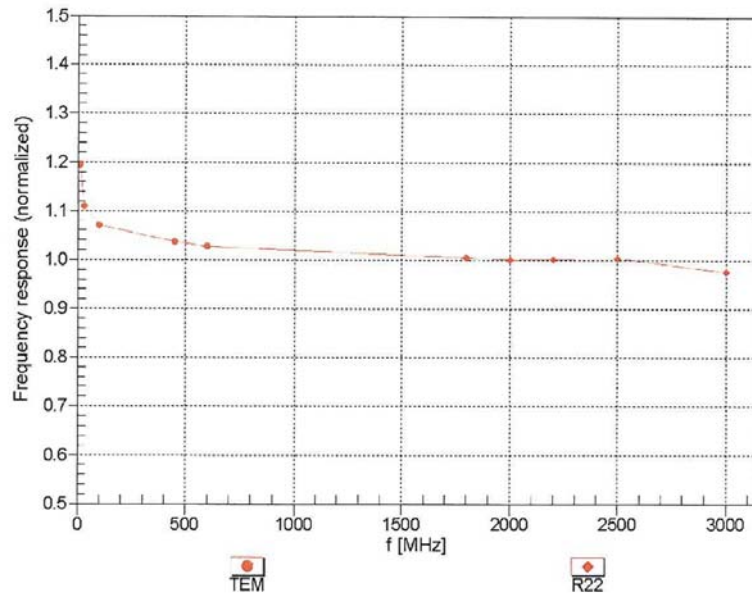
<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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

EX3DV4- SN:3862

February 4, 2013

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

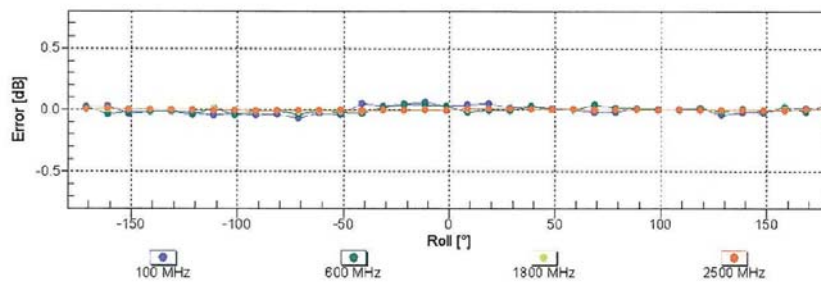
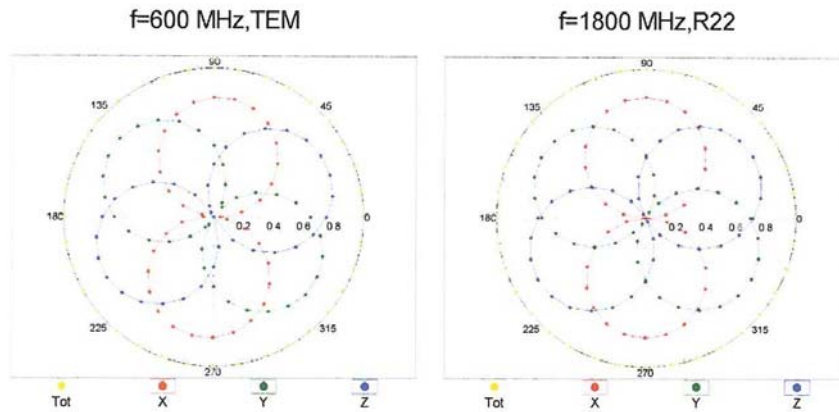


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

EX3DV4- SN:3862

February 4, 2013

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

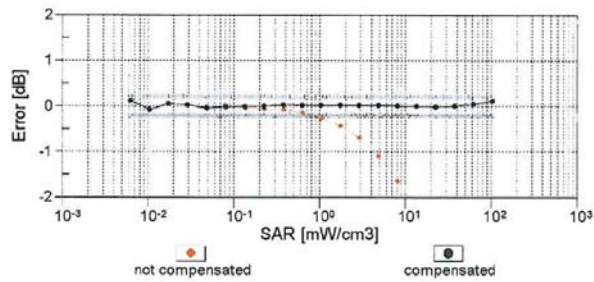
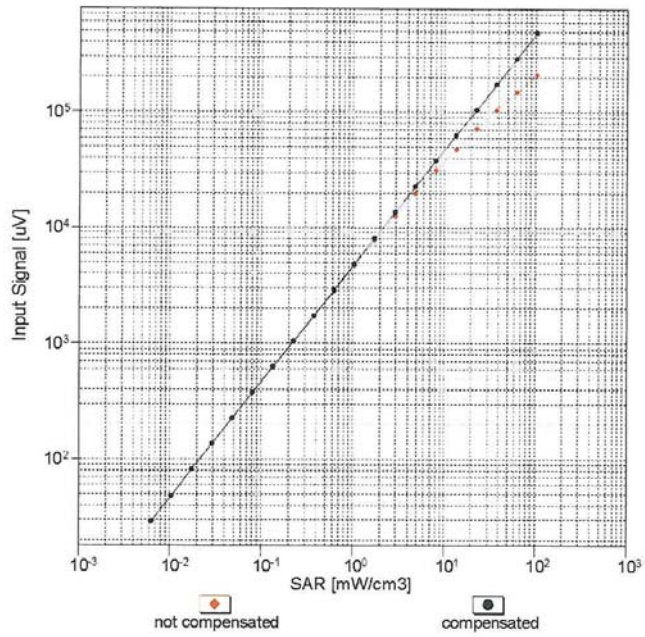


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

EX3DV4- SN:3862

February 4, 2013

## Dynamic Range $f(SAR_{head})$ (TEM cell , $f = 900$ MHz)

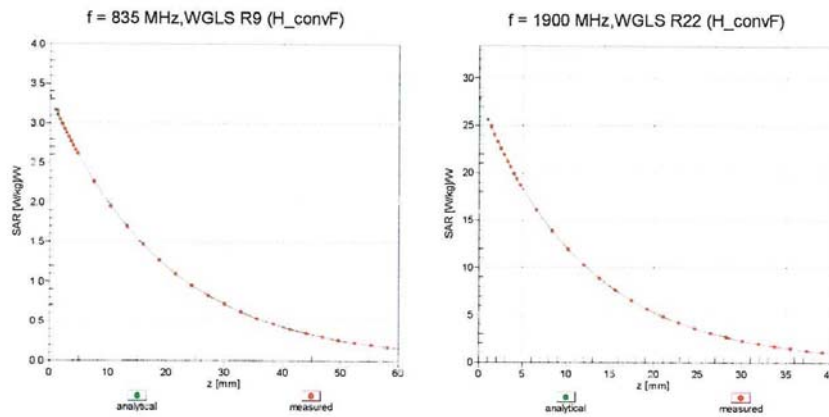


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

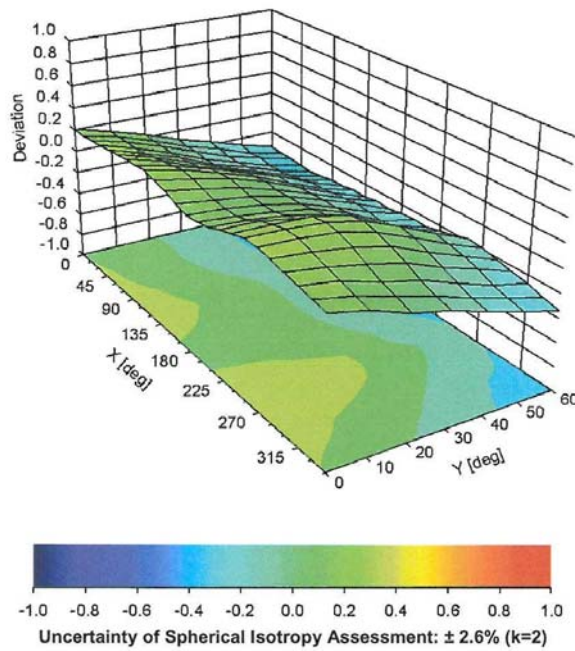
EX3DV4- SN:3862

February 4, 2013

## Conversion Factor Assessment



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



EX3DV4- SN:3862

February 4, 2013

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

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -71.3      |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 9 mm       |
| Tip Diameter                                  | 2.5 mm     |
| Probe Tip to Sensor X Calibration Point       | 1 mm       |
| Probe Tip to Sensor Y Calibration Point       | 1 mm       |
| Probe Tip to Sensor Z Calibration Point       | 1 mm       |
| Recommended Measurement Distance from Surface | 2 mm       |

## - DAE4 Calibration Certificate

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

Client **SGS (Dymstec)**

Certificate No: **DAE3-567\_Jan13**

### CALIBRATION CERTIFICATE

Object: **DAE3 - SD 000 D03 AA - SN: 567**

Calibration procedure(s): **QA CAL-06.v25  
 Calibration procedure for the data acquisition electronics (DAE)**

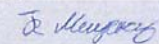

Calibration date: **January 25, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards             | ID #               | Cal Date (Certificate No.) | Scheduled Calibration  |
|-------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278        | 02-Oct-12 (No:12728)       | Oct-13                 |
| Secondary Standards           | ID #               | Check Date (in house)      | Scheduled Check        |
| Auto DAE Calibration Unit     | SE UWS 053 AA 1001 | 07-Jan-13 (in house check) | In house check: Jan-14 |
| Calibrator Box V2.1           | SE UMS 006 AA 1002 | 07-Jan-13 (in house check) | In house check: Jan-14 |

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

Issued: January 25, 2013

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Accreditation No.: **SCS 108**

### Glossary

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

### Methods Applied and Interpretation of Parameters

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

**DC Voltage Measurement**

A/D - Converter Resolution nominal

 High Range: 1LSB = 6.1 $\mu$ V , full range = -100...+300 mV

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

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 404.652 $\pm$ 0.02% (k=2) | 404.401 $\pm$ 0.02% (k=2) | 404.491 $\pm$ 0.02% (k=2) |
| Low Range           | 3.95362 $\pm$ 1.55% (k=2) | 3.97148 $\pm$ 1.55% (k=2) | 3.96078 $\pm$ 1.55% (k=2) |

**Connector Angle**

|                                           |                                 |
|-------------------------------------------|---------------------------------|
| Connector Angle to be used in DASY system | 7 $^{\circ}$ $\pm$ 1 $^{\circ}$ |
|-------------------------------------------|---------------------------------|

## Appendix

### 1. DC Voltage Linearity

| High Range        | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 199995.32                 | -0.62                        | -0.00     |
| Channel X + Input | 20002.46                  | 1.32                         | 0.01      |
| Channel X - Input | -19998.40                 | 1.69                         | -0.01     |
| Channel Y + Input | 199997.71                 | 1.34                         | 0.00      |
| Channel Y + Input | 19999.63                  | -1.28                        | -0.01     |
| Channel Y - Input | -19997.89                 | 2.47                         | -0.01     |
| Channel Z + Input | 199996.03                 | 0.01                         | 0.00      |
| Channel Z + Input | 19998.99                  | -1.92                        | -0.01     |
| Channel Z - Input | -19998.51                 | 1.81                         | -0.01     |

| Low Range         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2002.18                   | 0.83                         | 0.04      |
| Channel X + Input | 201.83                    | 0.08                         | 0.04      |
| Channel X - Input | -198.32                   | -0.18                        | 0.09      |
| Channel Y + Input | 2001.92                   | 0.81                         | 0.04      |
| Channel Y + Input | 201.24                    | -0.29                        | -0.15     |
| Channel Y - Input | -199.03                   | -0.72                        | 0.36      |
| Channel Z + Input | 2001.88                   | 0.72                         | 0.04      |
| Channel Z + Input | 200.70                    | -0.97                        | -0.48     |
| Channel Z - Input | -199.17                   | -0.97                        | 0.49      |

### 2. Common mode sensitivity

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

|           | Common mode Input Voltage (mV) | High Range Average Reading ( $\mu\text{V}$ ) | Low Range Average Reading ( $\mu\text{V}$ ) |
|-----------|--------------------------------|----------------------------------------------|---------------------------------------------|
| Channel X | 200                            | 3.30                                         | 1.64                                        |
|           | -200                           | 0.20                                         | -1.94                                       |
| Channel Y | 200                            | -0.21                                        | -0.42                                       |
|           | -200                           | 0.96                                         | 0.59                                        |
| Channel Z | 200                            | 4.66                                         | 3.87                                        |
|           | -200                           | -5.94                                        | -6.09                                       |

### 3. Channel separation

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

|           | Input Voltage (mV) | Channel X ( $\mu\text{V}$ ) | Channel Y ( $\mu\text{V}$ ) | Channel Z ( $\mu\text{V}$ ) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200                | -                           | -0.86                       | -3.62                       |
| Channel Y | 200                | 7.58                        | -                           | -0.08                       |
| Channel Z | 200                | 5.96                        | 5.73                        | -                           |

**4. AD-Converter Values with inputs shorted**

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

|           | High Range (LSB) | Low Range (LSB) |
|-----------|------------------|-----------------|
| Channel X | 16316            | 14587           |
| Channel Y | 16163            | 15684           |
| Channel Z | 15966            | 15490           |

**5. Input Offset Measurement**

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

Input 10MΩ

|           | Average (μV) | min. Offset (μV) | max. Offset (μV) | Std. Deviation (μV) |
|-----------|--------------|------------------|------------------|---------------------|
| Channel X | 0.52         | -0.92            | 1.43             | 0.45                |
| Channel Y | -0.20        | -2.46            | 1.17             | 0.46                |
| Channel Z | -0.70        | -1.79            | 0.17             | 0.39                |

**6. Input Offset Current**

Nominal Input circuitry offset current on all channels: &lt;25fA

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

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

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

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

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

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

## 2450 MHz Dipole Calibration Certificate

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



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

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

Accreditation No.: **SCS 108**

Client **SGS (Dymstec)**

Certificate No: **D2450V2-734\_May12**

### CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 734**

Calibration procedure(s) **QA CAL-05.v8  
 Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **May 17, 2012**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter EPM-442A        | GB37480704         | 05-Oct-11 (No. 217-01451)         | Oct-12                 |
| Power sensor HP 8481A       | US37292783         | 05-Oct-11 (No. 217-01451)         | Oct-12                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 27-Mar-12 (No. 217-01530)         | Apr-13                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 27-Mar-12 (No. 217-01533)         | Apr-13                 |
| Reference Probe ES3DV3      | SN: 3205           | 30-Dec-11 (No. ES3-3205_Dec11)    | Dec-12                 |
| DAE4                        | SN: 601            | 04-Jul-11 (No. DAE4-601_Jul11)    | Jul-12                 |
| 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-11) | In house check: Oct-12 |

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

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

Issued: May 17, 2012

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

**Calibration Laboratory of**  
 Schmid & Partner  
 Engineering AG  
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Accreditation No.: **SCS 108**

**Glossary:**

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

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

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

- d) DAS4/5 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                  | V52.8.1     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 2450 MHz ± 1 MHz       |             |

### Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Head TSL parameters             | 22.0 °C         | 39.2         | 1.80 mho/m       |
| Measured Head TSL parameters            | (22.0 ± 0.2) °C | 40.3 ± 6 %   | 1.85 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                            |
|-------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                          | 250 mW input power | 13.3 mW / g                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 52.8 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                            |
|---------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                            | 250 mW input power | 6.19 mW / g                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.7 mW / g ± 16.5 % (k=2) |

### Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 52.7         | 1.95 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 52.3 ± 6 %   | 1.99 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                            |
|-------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                          | 250 mW input power | 12.7 mW / g                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 50.2 mW / g ± 17.0 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                            |
|---------------------------------------------------------|--------------------|----------------------------|
| SAR measured                                            | 250 mW input power | 5.95 mW / g                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 23.6 mW / g ± 16.5 % (k=2) |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $53.3 \Omega + 3.6 j\Omega$ |
| Return Loss                          | - 26.4 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $49.9 \Omega + 5.1 j\Omega$ |
| Return Loss                          | - 25.8 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.153 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 | May 07, 2003 |

**DASY5 Validation Report for Head TSL**

Date: 17.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 734**

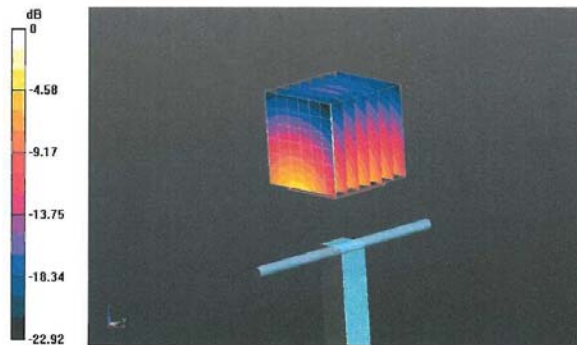
Communication System: CW; Frequency: 2450 MHz  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.85$  mho/m;  $\epsilon_r = 40.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

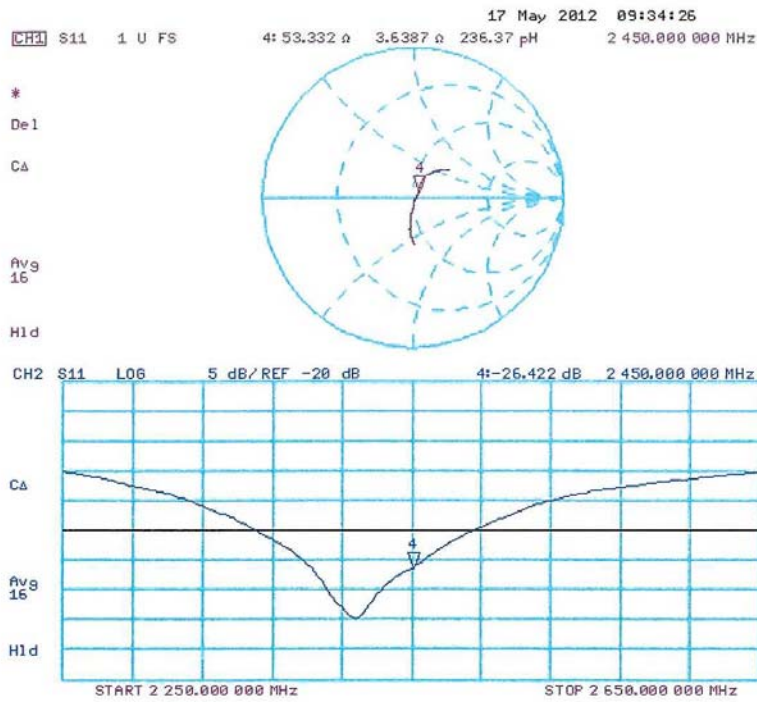
**Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**

Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 97.190 V/m; Power Drift = 0.08 dB  
 Peak SAR (extrapolated) = 27.316 mW/g  
**SAR(1 g) = 13.3 mW/g; SAR(10 g) = 6.19 mW/g**  
 Maximum value of SAR (measured) = 16.9 mW/g



0 dB = 16.9 mW/g = 24.56 dB mW/g

## Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 15.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 734**

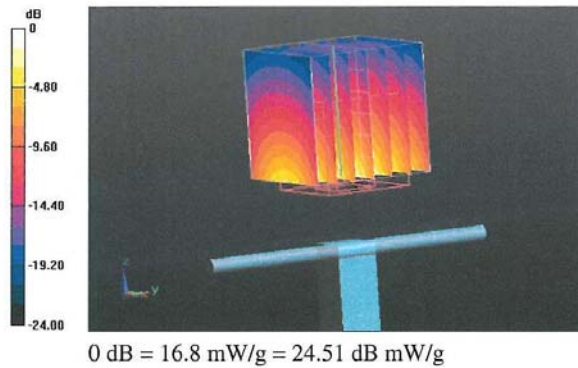
Communication System: CW; Frequency: 2450 MHz  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.99$  mho/m;  $\epsilon_r = 52.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

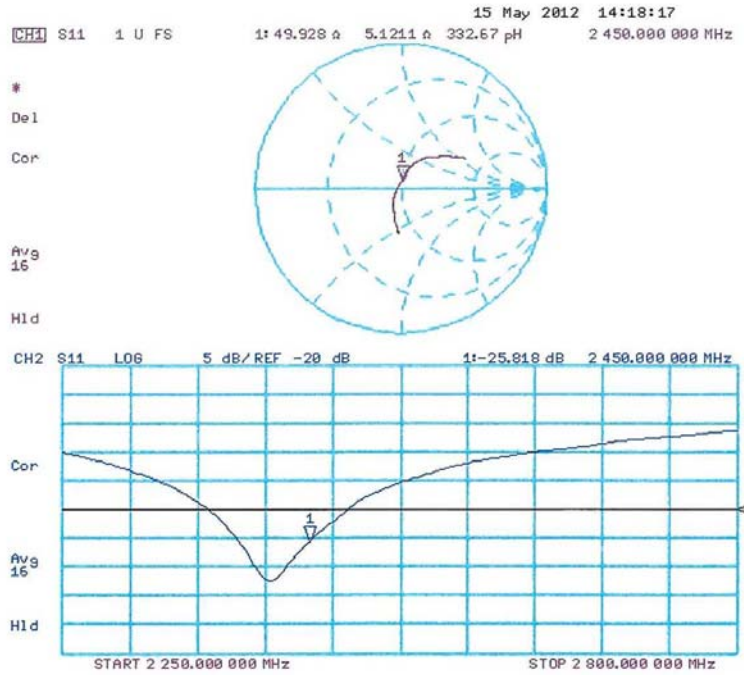
- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

**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 = 95.201 V/m; Power Drift = 0.02 dB  
 Peak SAR (extrapolated) = 25.791 mW/g  
**SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.95 mW/g**  
 Maximum value of SAR (measured) = 16.8 mW/g



### Impedance Measurement Plot for Body TSL



**-THE END-**