



**Specific Absorption Rate (SAR) Test Report  
for  
Dialogue Technology Corp.  
on the  
NOTEBOOK (FLYBOOK)**

**Report No. : FA632813-02-1-2-02**  
**Trade Name : DIALOGUE**  
**Model Name : VMW1BBHA**  
**FCC ID : JYV-VMW1BBHA**  
**Date of Testing : Jun. 09, 2006**  
**Date of Report : Apr. 06, 2007**  
**Date of Review : Apr. 06, 2007**

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- Report Version: Rev. 02

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## **1. Statement of Compliance**

The Specific Absorption Rate (SAR) maximum result found during testing for the **Dialogue Technology Corp. NOTEBOOK (FLYBOOK) DIALOGUE VMW1BBHA on the 2.45 GHz band and 5 GHz band body SAR** are as follows (with expanded uncertainty 21.9% for 2.45GHz Band and 25.9% for 5GHz Band):

| <b>2400 ~ 2483.5 MHz<br/>Body SAR (W/kg)</b> | <b>5150 ~ 5250 MHz<br/>&lt;Band 1&gt;<br/>Body SAR (W/kg)</b> | <b>5725 ~ 5825 MHz<br/>&lt;Band 3&gt;<br/>Body SAR (W/kg)</b> |
|--|---|---|
| <b>0.00784</b>                               | <b>0.16</b>   | <b>0.182</b>  |

The co-location of WLAN and Bluetooth were also checked. It is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1999 and had been tested in accordance with the measurement methods and procedures specified in OET Bulletin 65 Supplement C (Edition 01-01).

Approved by

Dr. Daniel Lee  
EMC/SAR Director



## **2. Administration Data**

### **2.1 Testing Laboratory**

**Company Name :** Sporton International Inc.  
**Department :** Antenna Design/SAR  
**Address :** No.52, Hwa-Ya 1<sup>st</sup> RD., Hwa Ya Technology Park, Kwei-Shan Hsiang, TaoYuan Hsien, Taiwan, R.O.C.  
**Telephone Number :** 886-3-327-3456  
**Fax Number :** 886-3-327-0973

### **2.2 Detail of Applicant**

**Company Name :** Dialogue Technology Corp.  
**Address :** 10F, No. 196, Sec.2, Jungshing Rd., Shindian City, Taipei 231, Taiwan, R.O.C.

### **2.3 Detail of Manufacturer**

**Company Name :** Dialogue Technology Corp.  
**Address :** 10F, No. 196, Sec.2, Jungshing Rd., Shindian City, Taipei 231, Taiwan, R.O.C.

### **2.4 Application Detail**

**Date of reception of application:** Mar. 28, 2006  
**Start of test :** Jun. 09, 2006  
**End of test :** Jun. 09, 2006



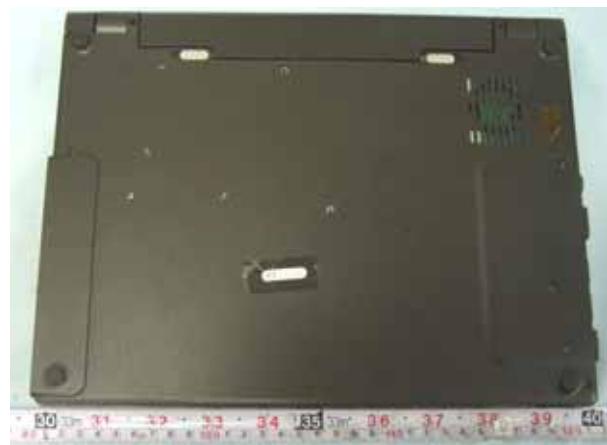
### **3. Scope**

#### **3.1 Description of Device Under Test (DUT)**

|  |   |
|--|---|
| <b>DUT Type :</b>                        | NOTEBOOK (FLYBOOK)  |
| <b>Trade Name :</b>                      | DIALOGUE  |
| <b>Model Name :</b>                      | VMW1BBHA  |
| <b>FCC ID :</b>                          | JYV-VMW1BBHA  |
| <b>Type of Modulation :</b>              | 802.11a: OFDM (BPSK / QPSK / 16QAM / 64QAM)<br>802.11b: DSSS (BPSK / QPSK / CCK)<br>802.11g: OFDM (BPSK / QPSK / 16QAM / 64QAM) |
| <b>Frequency Band :</b>                  | 802.11a: 5150 ~ 5250 MHz (Band 1) / 5725 ~ 5825 MHz (Band 3)<br>802.11b/g: 2400 ~ 2483.5 MHz                                    |
| <b>Antenna Connector :</b>               | I-PEX   |
| <b>Antenna Type :</b>                    | PIFA Antenna  |
| <b>Maximum Output Power to Antenna :</b> | 802.11a: 15.14 dBm (Band 1) / 18.37 dBm (Band 3)<br>802.11b: 17.77 dBm<br>802.11g: 21.94 dBm                                    |
| <b>DUT Stage :</b>                       | Production Unit   |
| <b>Application Type :</b>                | Certification   |



### **3.2 Product Photo**





### **3.3 Applied Standards:**

The Specific Absorption Rate (SAR) testing specification, method and procedure for this NOTEBOOK (FLYBOOK) is in accordance with the following standards:

47 CFR Part 2 ( 2.1093),  
IEEE C95.1-1999,  
IEEE C95.3-2002,  
IEEE P1528 -2003, and  
OET Bulletin 65 Supplement C (Edition 01-01)



### **3.4 Device Category and SAR Limits**

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user.

Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

### **3.5 Test Conditions**

#### **3.5.1 Ambient Condition:**

| Item                                      | 802.11b/g | 802.11a <Band 1> | 802.11a <Band 3> |
|---|-----------|------------------|------------------|
| Ambient Temperature (°C)                  |           | 20 ~ 24          |                  |
| Tissue simulating liquid temperature (°C) | 21.5      | 21.2             | 21.2             |
| Humidity (%)                              |           | < 60%            |                  |

#### **3.5.2 Test Configuration:**

The data rates for SAR testing are 11Mbps for 802.11b, 6Mbps for 802.11g and 6 Mbps for 802.11a. Engineering testing software installed on notebook can provide continuous transmitting RF signal. This RF signal utilized in SAR measurement has almost 100% duty cycle and its crest factor is 1.



## 4. Specific Absorption Rate (SAR)

### 4.1 Introduction

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

### 4.2 SAR Definition

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

). The equation description is as below:

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

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

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

$$\mathbf{SAR} = C \frac{\delta T}{\delta t}$$

, where  $C$  is the specific heat capacity,  $\delta T$  is the temperature rise and  $\delta t$  the exposure duration,

or related to the electrical field in the tissue by

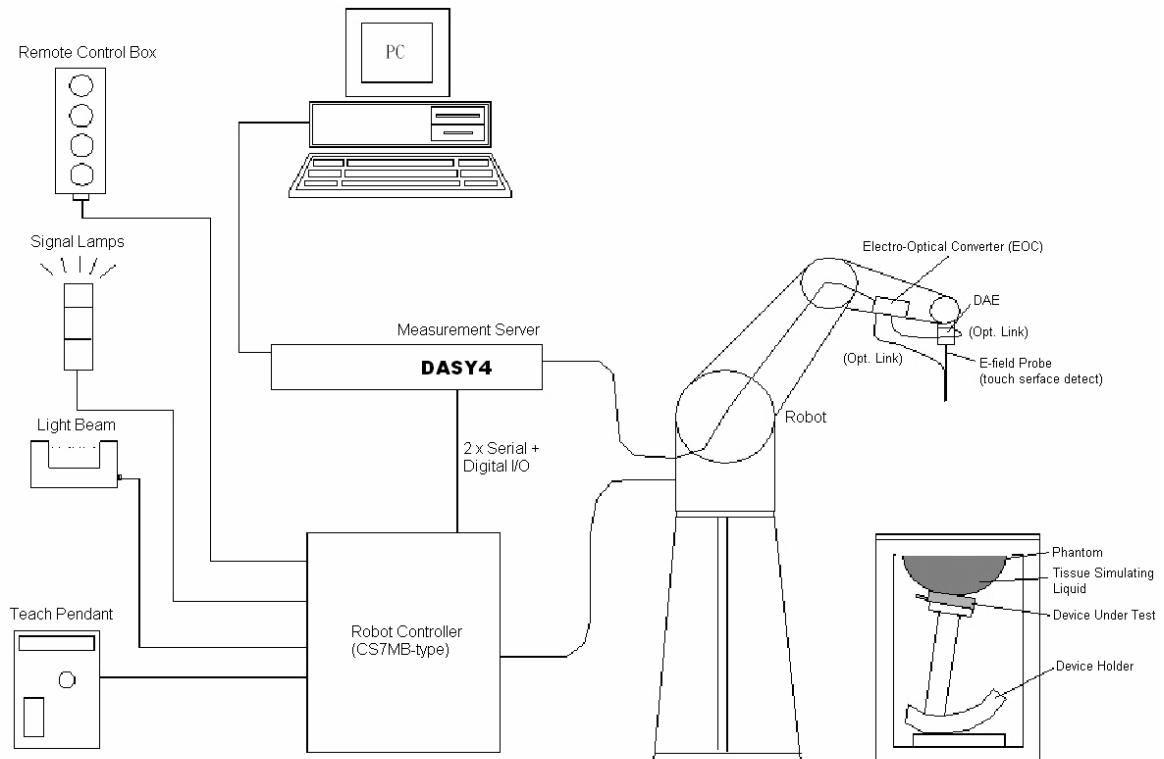
$$\mathbf{SAR} = \frac{\sigma |E|^2}{\rho}$$

, where  $\sigma$  is the conductivity of the tissue,  $\rho$  is the mass density of the tissue and  $E$  is the rms electrical field strength.

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



## 5. SAR Measurement Setup



**Fig. 5.1 DASY4 system**



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The DASY4 system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software
- A data acquisition electronic (DAE) attached to the robot arm extension
- A dosimetric probe equipped with an optical surface detector system
- The electro-optical converter (ECO) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the 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 warming lamps, etc.
- The SAM twin phantom
- A device holder
- Tissue simulating liquid
- Dipole for evaluating the proper functioning of the system

Some of the components are described in details in the following sub-sections.

### **5.1 DASY4 E-Field Probe System**

The SAR measurement is conducted with the dosimetric probe ET3DV6 and EX3DV3 (manufactured by SPEAG). The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.



### 5.1.1 ET3DV6 and EX3DV3 E-Field Probe Specification

#### <ET3DV6 Probe>

##### **Construction**

Symmetrical design with triangular core  
Built-in optical fiber for surface detection system  
Built-in shielding against static charges  
PEEK enclosure material (resistant to organic solvents)

##### **Calibration**

Simulating tissue at frequencies of 900MHz, 1.8GHz and 2.45GHz for brain and muscle (accuracy  $\pm 8\%$ )

##### **Frequency**

10 MHz to  $> 3$  GHz

##### **Directivity**

$\pm 0.2$  dB in brain tissue (rotation around probe axis)  
 $\pm 0.4$  dB in brain tissue (rotation perpendicular to probe axis)

##### **Dynamic Range Surface Detection**

$5 \mu$  W/g to  $> 100$  mW/g; Linearity:  $\pm 0.2$  dB  
 $\pm 0.2$  mm repeatability in air and clear liquids on reflecting surface

##### **Dimensions**

Overall length: 330mm  
Tip length: 16mm  
Body diameter: 12mm

Tip diameter: 6.8mm  
Distance from probe tip to dipole centers: 2.7mm

##### **Application**

General dosimetry up to 3GHz  
Compliance tests for mobile phones and Wireless LAN  
Fast automatic scanning in arbitrary phantoms



**Fig. 5.2 Probe setup on robot**

**<EX3DV3 Probe>**

|                      |  |
|----------------------|--|
| <b>Construction</b>  | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents)  |
| <b>Calibration</b>   | Basic Broad Band Calibration in air:<br>10-3000 MHz Conversion Factors (CF) for HSL 900 and HSL 1800 Additional CF for other liquids and frequencies upon request  |
| <b>Frequency</b>     | 10 MHz to > 6 GHz; Linearity: $\pm 0.2$ dB<br>(30 MHz to 3 GHz)  |
| <b>Directivity</b>   | $\pm 0.3$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in tissue material (rotation normal to probe axis)  |
| <b>Dynamic Range</b> | 10 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB (noise: typically < 1 $\mu$ W/g)   |
| <b>Dimensions</b>    | Overall length: 330 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm   |
| <b>Application</b>   | 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%. |

**Fig. 5.3 EX3DV3 E-field Probe**

### 5.1.2 ET3DV6 & EX3DV3 E-Field Probe Calibration

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than  $\pm 10\%$ . The spherical isotropy shall be evaluated and within  $\pm 0.25$  dB. The sensitivity parameters (NormX, NormY, and NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested. The calibration data are as below:



## &lt;EX3DV3 Probe&gt;

| <b>Sensitivity</b>                  | X axis : 0.655 $\mu$ V    Y axis : 0.675 $\mu$ V    Z axis : 0.598 $\mu$ V |                |                |
|-------------------------------------|--|----------------|----------------|
| <b>Diode compression point</b>      | X axis : 97 mV   | Y axis : 97 mV | Z axis : 97 mV |
| <b>Conversion factor<br/>(Body)</b> | Frequency<br>(MHz)   | X axis         | Y axis         |
|                                     | 5100~5300  | 4.35           | 4.35           |
|                                     | 5400~5600  | 4.02           | 4.02           |
|                                     | 5700~5900  | 4.09           | 4.09           |
| <b>Boundary effect<br/>(Body)</b>   | Frequency<br>(MHz)   | Alpha          | Depth          |
|                                     | 5100~5300  | 0.47           | 1.25           |
|                                     | 5400~5600  | 0.46           | 1.14           |
|                                     | 5700~5900  | 0.52           | 0.92           |

## &lt;ET3DV6 Probe&gt;

| <b>Sensitivity</b>                  | X axis : 1.57 $\mu$ V    Y axis : 1.71 $\mu$ V    Z axis : 2.09 $\mu$ V |                |                |
|-------------------------------------|---|----------------|----------------|
| <b>Diode compression point</b>      | X axis : 94 mV  | Y axis : 94 mV | Z axis : 94 mV |
| <b>Conversion factor<br/>(Body)</b> | Frequency<br>(MHz)  | X axis         | Y axis         |
|                                     | 2350~2550   | 4.13           | 4.13           |
| <b>Boundary effect<br/>(Body)</b>   | Frequency<br>(MHz)  | Alpha          | Depth          |
|                                     | 2350~2550   | 0.62           | 2.13           |

NOTE : The probe parameters have been calibrated by the SPEAG.



## **5.2 DATA Acquisition Electronics (DAE)**

The data acquisition electronics (DAE4) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE4 is 200M Ohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.



### **5.3 Robot**

The DASY4 system uses the high precision robots RX90BL type out of the newer series from Stäubli SA (France). For the 6-axis controller DASYS system, the CS7MB robot controller version from Stäubli is used. The RX robot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

### **5.4 Measurement Server**

The DASY4 measurement server is based on a PC/104 CPU board with  
166 MHz CPU  
32 MB chipset and  
64 MB RAM.

Communication with  
the DAE4 electronic box  
the 16-bit AD-converter system for optical detection and digital I/O interface.

The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.

### **5.5 SAM Twin Phantom**

The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas:

- Left head
- Right head
- Flat phantom

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections.

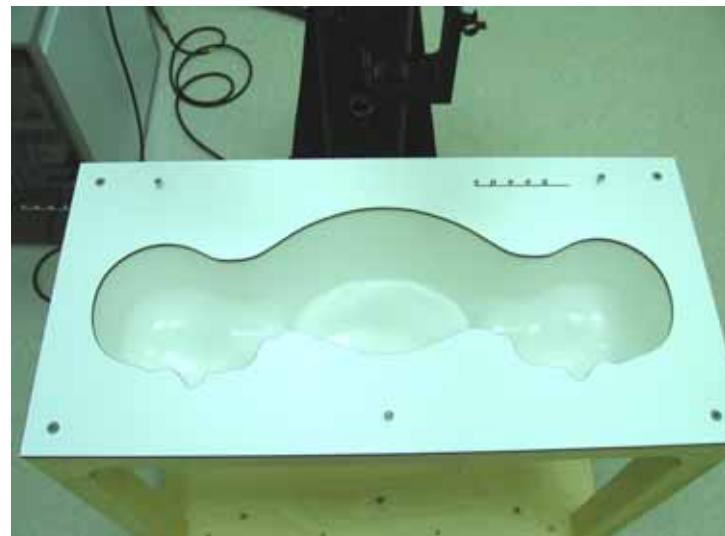


A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters.

On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

The phantom can be used with the following tissue simulating liquids:

- \*Water-sugar based liquid
- \*Glycol based liquids



**Fig. 5.3 Top view of twin phantom**



**Fig. 5.4 Bottom view of twin phantom**



## 5.6 Data Storage and Evaluation

### 5.6.1 Data Storage

The DASY4 software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension .DA4. The postprocessing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type (e.g., [V/m], [A/m], [mW/g]). Some of these units are not available in certain situations or give meaningless results, e.g., a SAR-output in a lossless media, will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

### 5.6.2 Data Evaluation

The DASY4 postprocessing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software :

|                            |                           |  |
|----------------------------|---------------------------|--|
| <b>Probe parameters :</b>  | - Sensitivity             | Norm $i$ , a $_{i0}$ , a $_{i1}$ , a $_{i2}$ |
|                            | - Conversion factor       | ConvF $i$                                    |
|                            | - Diode compression point | dcp $i$                                      |
| <b>Device parameters :</b> | - Frequency               | f  |
|                            | - Crest factor            | cf   |
| <b>Media parameters :</b>  | - Conductivity            |  |
|                            | - Density                 |  |

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel



can be given as :

$$Vi = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with

$V_i$  = compensated signal of channel  $i$  ( $i = x, y, z$ )

$U_i$  = input signal of channel  $i$  ( $i = x, y, z$ )

$cf$  = crest factor of exciting field (DASY parameter)

$dcp_i$  = diode compression point (DASY parameter)

From the compensated input signals, the primary field data for each channel can be evaluated :

$$\text{E-field probes : } E_i = \sqrt{\frac{V_i}{Norm_i ConvF}}$$

$$\text{H-field probes : } H_i = \sqrt{V_i} \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

with

$V_i$  = compensated signal of channel  $i$  ( $i = x, y, z$ )

$Norm_i$  = sensor sensitivity of channel  $i$  ( $i = x, y, z$ )

$\mu$  V/(V/m)<sup>2</sup> for E-field Probes

$ConvF$  = sensitivity enhancement in solution

$a_{ij}$  = sensor sensitivity factors for H-field probes

$f$  = carrier frequency [GHz]

$E_i$  = electric field strength of channel  $i$  in V/m

$H_i$  = magnetic field strength of channel  $i$  in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude) :

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$\text{SAR} = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with

$SAR$  = local specific absorption rate in mW/g

$E_{tot}$  = total field strength in V/m

= conductivity in [mho/m] or [Siemens/m]

= equivalent tissue density in g/ cm<sup>3</sup>



\* Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770} \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

with

$P_{pwe}$  = equivalent power density of a plane wave in mW/cm<sup>2</sup>

$E_{tot}$  = total electric field strength in V/m

$H_{tot}$  = total magnetic field strength in A/m



### 5.7 Test Equipment List

| Manufacture | Name of Equipment                  | Type/Model               | Serial Number   | Calibration   |               |
|-------------|------------------------------------|--------------------------|-----------------|---------------|---------------|
|             |                                    |                          |                 | Last Cal.     | Due Date      |
| SPEAG       | Dosimetric E-Filed Probe           | ET3DV6                   | 1787            | May 31, 2006  | May 31, 2007  |
| SPEAG       | Dosimetric E-Filed Probe           | EX3DV3                   | 3514            | Feb. 17, 2006 | Feb. 17, 2007 |
| SPEAG       | 835MHz System Validation Kit       | D835V2                   | 499             | Mar. 15, 2006 | Mar. 15, 2008 |
| SPEAG       | 900MHz System Validation Kit       | D900V2                   | 190             | Jul. 19, 2005 | Jul. 19, 2007 |
| SPEAG       | 1800MHz System Validation Kit      | D1800V2                  | 2d076           | Jul. 20, 2005 | Jul. 20, 2007 |
| SPEAG       | 1900MHz System Validation Kit      | D1900V2                  | 5d041           | Mar. 21, 2006 | Mar. 21, 2008 |
| SPEAG       | 2000MHz System Validation Kit      | D2000V2                  | 1010            | Oct. 25, 2004 | Oct. 25, 2006 |
| SPEAG       | 2450MHz System Validation Kit      | D2450V2                  | 736             | Jul. 12, 2005 | Jul. 12, 2007 |
| SPEAG       | 5GHz System Validation Kit         | D5GHzV2                  | 1006            | Feb. 10, 2006 | Feb. 10, 2008 |
| SPEAG       | Data Acquisition Electronics       | DAE3                     | 577             | Nov. 11, 2005 | Nov. 11, 2006 |
| SPEAG       | Device Holder                      | N/A                      | N/A             | NCR           | NCR           |
| SPEAG       | Phantom                            | QD 000 P40 C             | TP-1150         | NCR           | NCR           |
| SPEAG       | Robot                              | Staubli RX90BL           | F03/5W15A1/A/01 | NCR           | NCR           |
| SPEAG       | Software                           | DASY4<br>V4.6 Build 23   | N/A             | NCR           | NCR           |
| SPEAG       | Software                           | SEMCAD<br>V1.8 Build 161 | N/A             | NCR           | NCR           |
| SPEAG       | Measurement Server                 | SE UMS 001 BA            | 1021            | NCR           | NCR           |
| Agilent     | S-Parameter Network Analyzer (PNA) | E8358A                   | US40260131      | Sep. 16, 2005 | Sep. 16, 2006 |
| Agilent     | Dielectric Probe Kit               | 85070D                   | US01440205      | NCR           | NCR           |
| Agilent     | Dual Directional Coupler           | 778D                     | 50422           | NCR           | NCR           |
| Agilent     | Power Amplifier                    | 8449B                    | 3008A01917      | NCR           | NCR           |
| Agilent     | Power Meter                        | E4416A                   | GB41292344      | Jan. 23, 2006 | Jan. 23, 2008 |
| Agilent     | Power Sensor                       | E9327A                   | US40441548      | Feb. 06, 2006 | Feb. 06, 2007 |
| Agilent     | Signal Generator                   | E8247C                   | MY43320596      | Mar. 01, 2006 | Mar. 01, 2008 |
| R&S         | Radio Communication Tester         | CMU200                   | 105934          | Aug. 24, 2004 | Aug. 24, 2006 |

**Table 5.1 Test Equipment List**



## 6. Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY4, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. The liquid height from the bottom of the phantom body is 15.2 centimeters.

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an Agilent 85070D Dielectric Probe Kit and an Agilent E8358A Network Analyzer.

Table 6.1 shows the measuring results for muscle simulating liquid.

| Bands                       | Frequency(MHz) | Permittivity ( $\epsilon_r$ ) | Conductivity ( $\sigma$ ) | Measurement date |
|-----------------------------|----------------|-------------------------------|---------------------------|------------------|
| 2400 ~ 2483.5 MHz           | 2412           | 51.4                          | 1.90                      | Jun. 09, 2006    |
|                             | 2437           | 51.3                          | 1.93                      |                  |
|                             | 2462           | 51.3                          | 1.96                      |                  |
| 5150 ~ 5250 MHz<br><Band 1> | 5180           | 48.3                          | 5.37                      | Jun. 09, 2006    |
|                             | 5260           | 48.1                          | 5.49                      |                  |
|                             | 5300           | 48.0                          | 5.52                      |                  |
| 5725 ~ 5825 MHz<br><Band 3> | 5745           | 46.9                          | 6.08                      | Jun. 09, 2006    |
|                             | 5785           | 46.8                          | 6.14                      |                  |
|                             | 5825           | 46.7                          | 6.22                      |                  |

Table 6.1

The measuring data are consistent with  $\epsilon_r = 52.7 \pm 5\%$  and  $\sigma = 1.95 \pm 5\%$  for 2.45GHz Band,  $\epsilon_r = 49.0 \pm 5\%$  and  $\sigma = 5.30 \pm 5\%$  for 5GHz band 1&2 and  $\epsilon_r = 48.2 \pm 5\%$  and  $\sigma = 6.0 \pm 5\%$  for 5GHz band 3.



## 7. Uncertainty Assessment

The component of uncertainty may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainty by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience and knowledge of the behavior and properties of relevant materials and instruments, manufacturer's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in Table 7.1

| Uncertainty Distributions         | Normal             | Rectangular | Triangular | U-shape |
|-----------------------------------|--------------------|-------------|------------|---------|
| Multiplying factor <sup>(a)</sup> | 1/k <sup>(b)</sup> | 1/ 3        | 1/ 6       | 1/ 2    |

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity  
(b) is the coverage factor

**Table 7.1**

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY4 uncertainty Budget is showed in Table 7.2.



| Error Description  | Uncertainty Value | Probability Distribution | Divisor | C <sub>i</sub> (1g) | Standard Unc. (1g) | V <sub>i</sub> or V <sub>eff</sub> |
|--|-------------------|--------------------------|---------|---------------------|--------------------|------------------------------------|
| <b>Measurement System</b>  |                   |                          |         |                     |                    |                                    |
| Probe Calibration  | ±5.9 %            | Normal                   | 1       | 1                   | ±5.9 %             |                                    |
| Axial Isotropy   | ±4.7 %            | Rectangular              | √3      | 0.7                 | ±1.9 %             |                                    |
| Hemispherical Isotropy   | ±9.6 %            | Rectangular              | √3      | 0.7                 | ±3.9 %             |                                    |
| Boundary Effect  | ±1.0 %            | Rectangular              | √3      | 1                   | ±0.6 %             |                                    |
| Linearity  | ±4.7 %            | Rectangular              | √3      | 1                   | ±2.7 %             |                                    |
| System Detection Limit   | ±1.0 %            | Rectangular              | √3      | 1                   | ±0.6 %             |                                    |
| Readout Electronics  | ±0.3 %            | Normal                   | 1       | 1                   | ±0.3 %             |                                    |
| Response Time  | ±0.8 %            | Rectangular              | √3      | 1                   | ±0.5 %             |                                    |
| Integration time   | ±2.6 %            | Rectangular              | √3      | 1                   | ±1.5 %             |                                    |
| RF Ambient Noise   | ±3.0 %            | Rectangular              | √3      | 1                   | ±1.7 %             |                                    |
| RF Ambient Reflections   | ±3.0 %            | Rectangular              | √3      | 1                   | ±1.7 %             |                                    |
| Probe Positioner   | ±0.4 %            | Rectangular              | √3      | 1                   | ±0.2 %             |                                    |
| Probe Positioning  | ±2.9 %            | Rectangular              | √3      | 1                   | ±1.7 %             |                                    |
| Extrapolation and Interpolation Algorithms for Max. SAR Evaluation | ±1.0 %            | Rectangular              | √3      | 1                   | ±0.6 %             |                                    |
| <b>Test sample Related</b>   |                   |                          |         |                     |                    |                                    |
| Test sample Positioning  | ±2.9 %            | Normal                   | 1       | 1                   | ±2.9 %             | 145                                |
| Device Holder Uncertainty  | ±3.6 %            | Normal                   | 1       | 1                   | ±3.6 %             | 5                                  |
| Output Power Variation-SAR drift measurement                       | ±5.0 %            | Rectangular              | √3      | 1                   | ±2.9 %             |                                    |
| <b>Phantom and Tissue parameters</b>                               |                   |                          |         |                     |                    |                                    |
| Phantom uncertainty(Including shape and thickness tolerances)      | ±4.0 %            | Rectangular              | √3      | 1                   | ±2.3 %             |                                    |
| Liquid Conductivity Target tolerance                               | ±5.0 %            | Rectangular              | √3      | 0.64                | ±1.8 %             |                                    |
| Liquid Conductivity measurement uncertainty                        | ±2.5 %            | Normal                   | 1       | 0.64                | ±1.6 %             |                                    |
| Liquid Permittivity Target tolerance                               | ±5.0 %            | Rectangular              | √3      | 0.6                 | ±1.7 %             |                                    |
| Liquid Permittivity measurement uncertainty                        | ±2.5 %            | Normal                   | 1       | 0.6                 | ±1.5 %             |                                    |
| Combined standard uncertainty                                      |                   |                          |         |                     | ±10.9 %            | 330                                |
| <b>Coverage Factor for 95 %</b>                                    |                   | K=2                      |         |                     |                    |                                    |
| <b>Expanded uncertainty (Coverage factor = 2)</b>                  |                   |                          |         |                     | <b>±21.9 %</b>     |                                    |

Table 7.2 Uncertainty Budget of DASY4 for 2.4GHz Band



| Error Description               | Uncertainty Value | Probability Distribution | Divisor    | $C_i$<br>(1g) | Standard Unc.<br>(1g)           | $V_i$<br>or<br>$V_{eff}$ |
|---------------------------------|-------------------|--------------------------|------------|---------------|---------------------------------|--------------------------|
| <b>Measurement System</b>       |                   |                          |            |               |                                 |                          |
| Probe Calibration               | $\pm 6.8 \%$      | Normal                   | 1          | 1             | $\pm 6.8 \%$                    |                          |
| Axial Isotropy                  | $\pm 4.7 \%$      | Rectangular              | $\sqrt{3}$ | 0.7           | $\pm 1.9 \%$                    |                          |
| Hemispherical Isotropy          | $\pm 9.6 \%$      | Rectangular              | $\sqrt{3}$ | 0.7           | $\pm 3.9 \%$                    |                          |
| Boundary Effect                 | $\pm 2.0 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 1.2 \%$                    |                          |
| Linearity                       | $\pm 4.7 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 2.7 \%$                    |                          |
| System Detection Limit          | $\pm 1.0 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 0.6 \%$                    |                          |
| Readout Electronics             | $\pm 0.3 \%$      | Normal                   | 1          | 1             | $\pm 0.3 \%$                    |                          |
| Response Time                   | $\pm 0.8 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 0.5 \%$                    |                          |
| Integration Time                | $\pm 2.6 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 1.5 \%$                    |                          |
| RF Ambient Noise                | $\pm 3.0 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 1.7 \%$                    |                          |
| RF Ambient Reflections          | $\pm 3.0 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 1.7 \%$                    |                          |
| Probe Positioner                | $\pm 0.8 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 0.5 \%$                    |                          |
| Probe Positioning               | $\pm 9.9 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 5.7 \%$                    |                          |
| Max. SAR Eval.                  | $\pm 4.0 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 2.3 \%$                    |                          |
| <b>Test Sample Related</b>      |                   |                          |            |               |                                 |                          |
| Device Positioning              | $\pm 2.9 \%$      | Normal                   | 1          | 1             | $\pm 2.9 \%$                    | 145                      |
| Device Holder                   | $\pm 3.6 \%$      | Normal                   | 1          | 1             | $\pm 3.6 \%$                    | 5                        |
| Power Drift                     | $\pm 5.0 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 2.9 \%$                    |                          |
| <b>Phantom and Setup</b>        |                   |                          |            |               |                                 |                          |
| Phantom Uncertainty             | $\pm 4.0 \%$      | Rectangular              | $\sqrt{3}$ | 1             | $\pm 2.3 \%$                    |                          |
| Liquid Conductivity (target)    | $\pm 5.0 \%$      | Rectangular              | $\sqrt{3}$ | 0.64          | $\pm 1.8 \%$                    |                          |
| Liquid Conductivity (meas.)     | $\pm 2.5 \%$      | Normal                   | 1          | 0.64          | $\pm 1.6 \%$                    |                          |
| Liquid Permittivity (target)    | $\pm 5.0 \%$      | Rectangular              | $\sqrt{3}$ | 0.6           | $\pm 1.7 \%$                    |                          |
| Liquid Permittivity (meas.)     | $\pm 2.5 \%$      | Normal                   | 1          | 0.6           | $\pm 1.5 \%$                    |                          |
| Combined Std. Uncertainty       |                   |                          |            |               | $\pm 12.9 \%$                   | 330                      |
| <b>Expanded STD Uncertainty</b> |                   |                          |            |               | <b><math>\pm 25.9 \%</math></b> |                          |

Table 7.3 Uncertainty Budget of DASY4 for 5GHz Band



## 8. SAR Measurement Evaluation

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

### 8.1 Purpose of System Performance check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

### 8.2 System Setup

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave which comes from a signal generator at frequency 2450MHz, 5200 MHz and 5800 MHz. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:

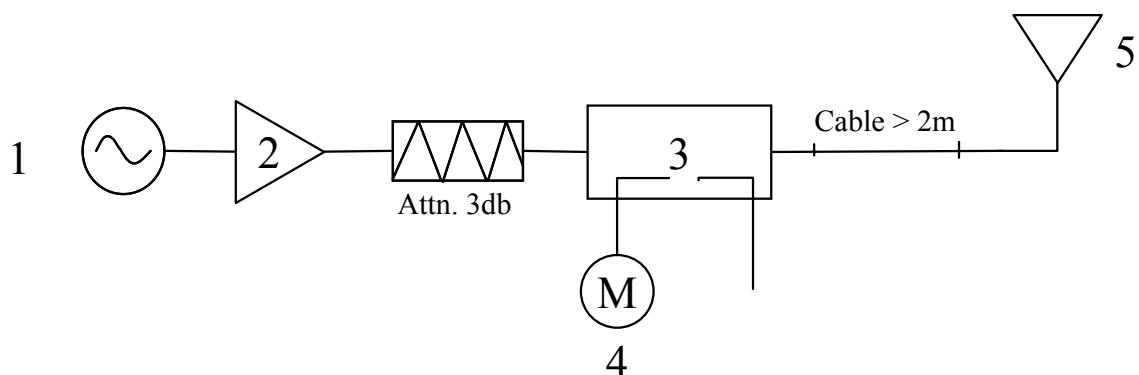


Fig. 8.1



1. Signal Generator
2. Amplifier
3. Directional Coupler
4. Power Meter
5. 2450 MHz and 5200 MHz and 5800 MHz Dipole

The output power on dipole port must be calibrated to 100 mW (20 dBm) before dipole is connected.



**Fig 8.2 Dipole Setup**



### 8.3 Validation Results

Comparing to the original SAR value provided by Speag, the validation data should within its specification of 10 %. Table 8.1 shows the target SAR and measured SAR after normalized to 1W input power.

| Band                            |           | Target (W/kg) | Measurement data (W/kg) | Variation | Measurement date |
|---------------------------------|-----------|---------------|-------------------------|-----------|------------------|
| 802.11b/g<br>(2450 MHz)         | SAR (1g)  | 52.8          | 55.3                    | 4.7 %     | Jun. 09, 2006    |
|                                 | SAR (10g) | 24.5          | 25.6                    | 4.5 %     |                  |
| 802.11a<br>Band 1<br>(5200 MHz) | SAR (1g)  | 73.7          | 75                      | 1.8 %     | Jun. 09, 2006    |
|                                 | SAR (10g) | 20.6          | 20.9                    | 1.5 %     |                  |
| 802.11a<br>Band 3<br>(5800 MHz) | SAR (1g)  | 69.8          | 72.3                    | 3.6 %     | Jun. 09, 2006    |
|                                 | SAR (10g) | 19.7          | 19.8                    | 0.5 %     |                  |

Table 8.1

The table above indicates the system performance check can meet the variation criterion.



## 9. Description for DUT Testing Position

This DUT was tested in the position "Notebook Bottom Touch" shown in Fig. 9.1.

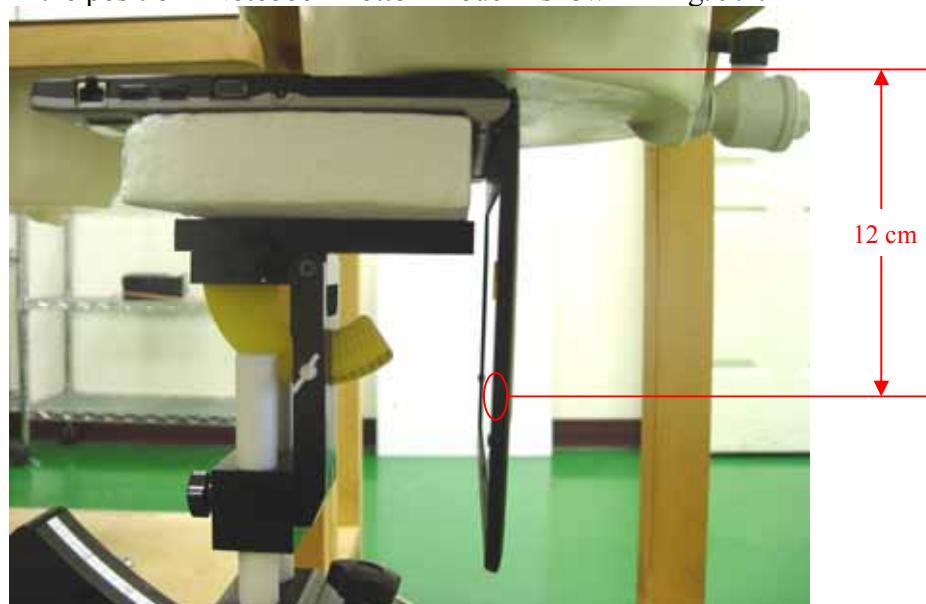


Fig. 9.1 Notebook Bottom Touch



Fig. 9.2 Antenna Position



## **10. Measurement Procedures**

The measurement procedures are as follows:

- Plugging DUT into the notebook
- Using engineering software to transmit RF power continuously (continuous Tx) in the low channel
- Placing the DUT in the positions described in the last section
- Setting scan area, grid size and other setting on the DASY4 software
- Taking data for the low channel
- Repeat the previous steps for the middle and high channels.

According to the IEEE P1528 draft standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- Power reference measurement
- Area scan
- Zoom scan
- Power reference measurement

### **10.1 Spatial Peak SAR Evaluation**

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1528-2003 standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY4 software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

Base on the Draft: SCC-34, SC-2, WG-2-Computational Dosimetry, P1528/D1.2 (Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques), a new algorithm has been implemented. The spatial-peak SAR can be computed over any required mass.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose , the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.



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

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

## **10.2 Scan Procedures**

First **Area Scan** is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an **Area Scan** is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, **Zoom Scan** is required. The **Zoom Scan** measures 5x5x7 points with step size 8, 8 and 5 mm for 2.45GHz Band and 8x8x8 points with step size 4.3, 4.3 and 3 mm for 5GHz Band. The **Zoom Scan** is performed around the highest E-field value to determine the averaged SAR-distribution over 1 g.

## **10.3 SAR Averaged Methods**

In DASY4, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.



## 11. SAR Test Results

### 11.1 Notebook Bottom Touch

| Bands                     | Chan.      | Freq (MHz)        | Modulation Type | Conducted Power (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Limit (W/kg) | Results     |
|---------------------------|------------|-------------------|-----------------|-----------------------|------------------|------------------------|--------------|-------------|
| 802.11b                   | 1          | 2412(Low)         | CCK             | 17.77                 | -0.11            | 0.00762                | 1.6          | Pass        |
|                           | <b>6</b>   | <b>2437(Mid)</b>  | <b>CCK</b>      | <b>17.55</b>          | <b>0.153</b>     | <b>0.00784</b>         | <b>1.6</b>   | <b>Pass</b> |
|                           | 11         | 2462(High)        | CCK             | 17.11                 | -0.102           | 0.0009                 | 1.6          | Pass        |
| 802.11b with BT ON        | 6          | 2437(Mid)         | CCK             | 17.55                 | 0.13             | 0.00775                | 1.6          | Pass        |
| 802.11g                   | 1          | 2412(Low)         | OFDM            | 21.94                 | -                | -                      | -            | -           |
|                           | 6          | 2437(Mid)         | OFDM            | 21.43                 | 0.152            | 0.0072                 | 1.6          | Pass        |
|                           | 11         | 2462(High)        | OFDM            | 21.13                 | -                | -                      | -            | -           |
| 802.11a Band 1            | <b>36</b>  | <b>5180 (Low)</b> | <b>OFDM</b>     | <b>15.14</b>          | <b>0.02</b>      | <b>0.16</b>            | <b>1.6</b>   | <b>Pass</b> |
| 802.11a Band 3            | <b>149</b> | <b>5745 (Low)</b> | <b>OFDM</b>     | <b>18.16</b>          | <b>-0.07</b>     | <b>0.182</b>           | <b>1.6</b>   | <b>Pass</b> |
|                           | 157        | 5785 (Mid)        | OFDM            | 18.37                 | 0.182            | 0.181                  | 1.6          | Pass        |
|                           | 165        | 5825 (High)       | OFDM            | 18.20                 | 0.128            | 0.181                  | 1.6          | Pass        |
| 802.11a Band 3 with BT ON | 149        | 5745 (Low)        | OFDM            | 18.16                 | 0.15             | 0.181                  | 1.6          | Pass        |

Test Engineer : Gordon Lin



## **12. References**

- [1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”
- [2] IEEE Std. P1528-2003, “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, April 21,2003.
- [3] Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01), “Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to RF Emissions”, June 2001
- [4] IEEE Std. C95.3-2002, “IEEE Recommended Practice for the Meaurement of Potentially Hazardous Electromagnetic Fields-RF and Microwave”, 2002
- [5] IEEE Std. C95.1-1999, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, 1999
- [6] Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148
- [7] DAYS4 System Handbook



## Appendix A - System Performance Check Data

Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 9:09:33 AM

### System Check\_Body\_2450MHz\_20060609

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:736

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: MSL\_2450 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.94$  mho/m;  $\epsilon_r = 51.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

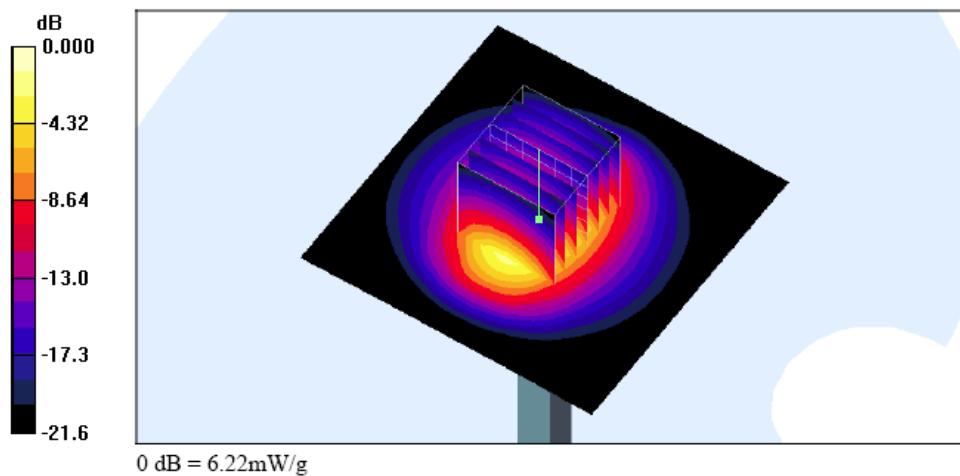
Ambient Temperature : 23.6 °C; Liquid Temperature : 21.5 °C

DASY4 Configuration:

- Probe: ET3DV6 - SN1787; ConvF(4.13, 4.13, 4.13); Calibrated: 5/31/2006
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-B; Type: QD 000 P40 C; Serial: TP-1383
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Pin=100mW/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm  
Maximum value of SAR (interpolated) = 6.53 mW/g

**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 59.9 V/m; Power Drift = -0.004 dB  
Peak SAR (extrapolated) = 12.3 W/kg  
SAR(1 g) = 5.53 mW/g; SAR(10 g) = 2.56 mW/g  
Maximum value of SAR (measured) = 6.22 mW/g





Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 11:19:15 AM

**System Check\_Body\_5200MHz\_20060609**

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1006**

Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1

Medium: MSL\_5200 Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.39$  mho/m;  $\epsilon_r = 48.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.6 °C; Liquid Temperature : 21.2 °C

DASY4 Configuration:

- Probe: EX3DV3 - SN3514; ConvF(4.35, 4.35, 4.35); Calibrated: 2/17/2006
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-A; Type: QD 000 P40 C; Serial: TP-1303
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Pin=100mW/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm  
Maximum value of SAR (interpolated) = 15.4 mW/g

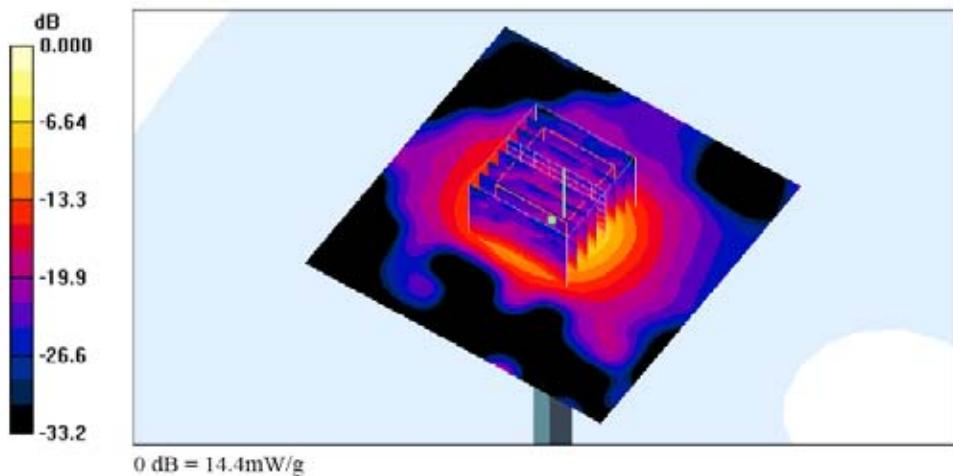
**Pin=100mW/Zoom Scan (8x8x8)/Cube 0:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 56.8 V/m; Power Drift = -0.119 dB

Peak SAR (extrapolated) = 31.0 W/kg

SAR(1 g) = 7.5 mW/g; SAR(10 g) = 2.09 mW/g

Maximum value of SAR (measured) = 14.4 mW/g





Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 12:23:12 PM

**System Check\_Body\_5800MHz\_20060609**

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN:1006**

Communication System: 802.11a; Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: MSL\_5800 Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.16$  mho/m;  $\epsilon_r = 46.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.8 °C; Liquid Temperature : 21.2 °C

**DASY4 Configuration:**

- Probe: EX3DV3 - SN3514; ConvF(4.09, 4.09, 4.09); Calibrated: 2/17/2006
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-A; Type: QD 000 P40 C; Serial: TP-1303
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Pin=100mW/Area Scan (91x91x1):** Measurement grid: dx=10mm, dy=10mm  
Maximum value of SAR (interpolated) = 15.4 mW/g

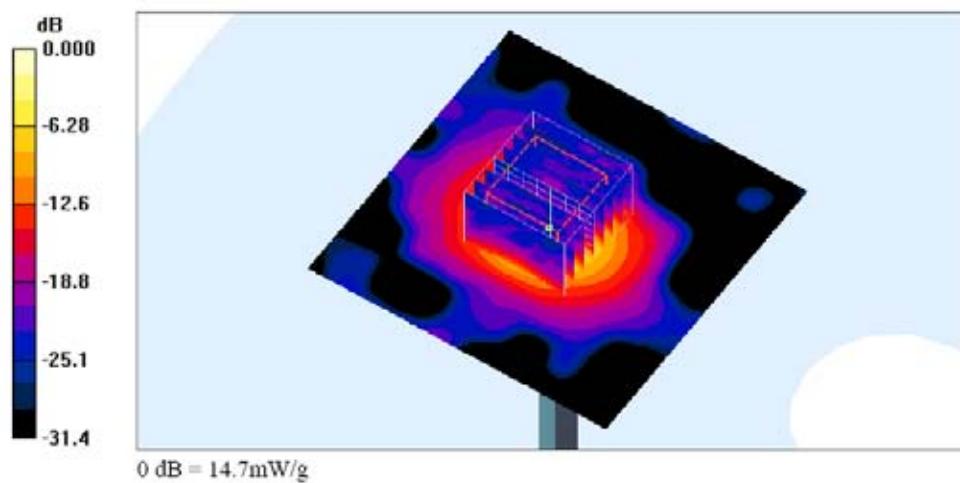
**Pin=100mW/Zoom Scan (8x8x8)/Cube 0:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 50.6 V/m; Power Drift = -0.099 dB

Peak SAR (extrapolated) = 35.5 W/kg

SAR(1 g) = 7.23 mW/g; SAR(10 g) = 1.98 mW/g

Maximum value of SAR (measured) = 14.7 mW/g





## Appendix B - SAR Measurement Data

Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 10:04:38 AM

**Body\_802.11b Ch6\_Notebook Bottom Touch\_20060609****DUT: 632813; Type: Notebook**

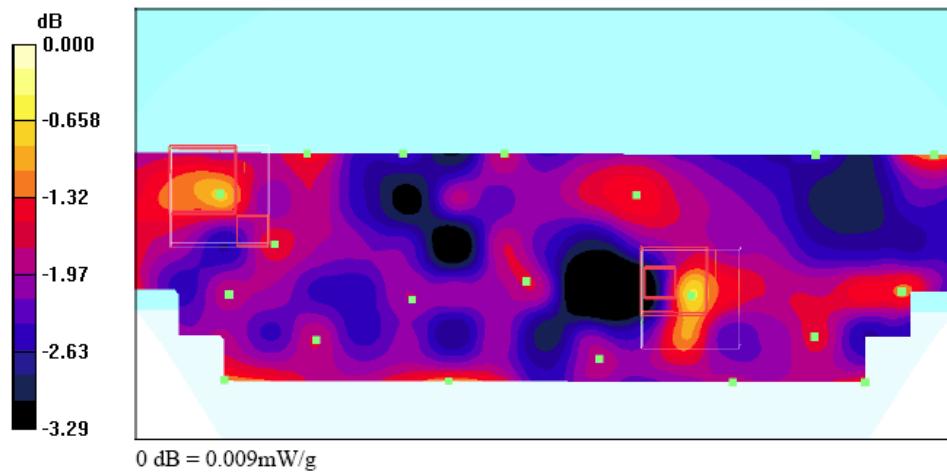
Communication System: 802.11b ; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium: MSL\_2450 Medium parameters used:  $f = 2437 \text{ MHz}$ ;  $\sigma = 1.93 \text{ mho/m}$ ;  $\epsilon_r = 51.3$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Ambient Temperature : 23.6 °C; Liquid Temperature : 21.5 °C

## DASY4 Configuration:

- Probe: ET3DV6 - SN1787; ConvF(4.13, 4.13, 4.13); Calibrated: 5/31/2006
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-B; Type: QD 000 P40 C; Serial: TP-1383
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Ch6/Area Scan (51x201x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (interpolated) = 0.008 mW/g**Ch6/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 1.74 V/m; Power Drift = 0.153 dB  
Peak SAR (extrapolated) = 0.009 W/kg  
SAR(1 g) = 0.00784 mW/g; SAR(10 g) = 0.00719 mW/g  
Maximum value of SAR (measured) = 0.009 mW/g**Ch6/Zoom Scan (5x5x7)/Cube 1:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 1.74 V/m; Power Drift = 0.153 dB  
Peak SAR (extrapolated) = 0.009 W/kg  
SAR(1 g) = 0.0078 mW/g; SAR(10 g) = 0.00703 mW/g  
Maximum value of SAR (measured) = 0.009 mW/g



Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 10:51:39 AM

**Body\_802.11g Ch6\_Notebook Bottom Touch\_20060609****DUT: 632813; Type: Notebook**

Communication System: 802.11g; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium: MSL\_2450 Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.93$  mho/m;  $\epsilon_r = 51.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.6 °C; Liquid Temperature : 21.5 °C

## DASY4 Configuration:

- Probe: ET3DV6 - SN1787; ConvF(4.13, 4.13, 4.13); Calibrated: 5/31/2006
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-B; Type: QD 000 P40 C; Serial: TP-1383
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Ch6/Area Scan (51x201x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.007 mW/g

**Ch6/Zoom Scan (5x5x7)/Cube 1:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 1.66 V/m; Power Drift = 0.152 dB

Peak SAR (extrapolated) = 0.008 W/kg

SAR(1 g) = 0.0072 mW/g; SAR(10 g) = 0.0065 mW/g

Maximum value of SAR (measured) = 0.008 mW/g

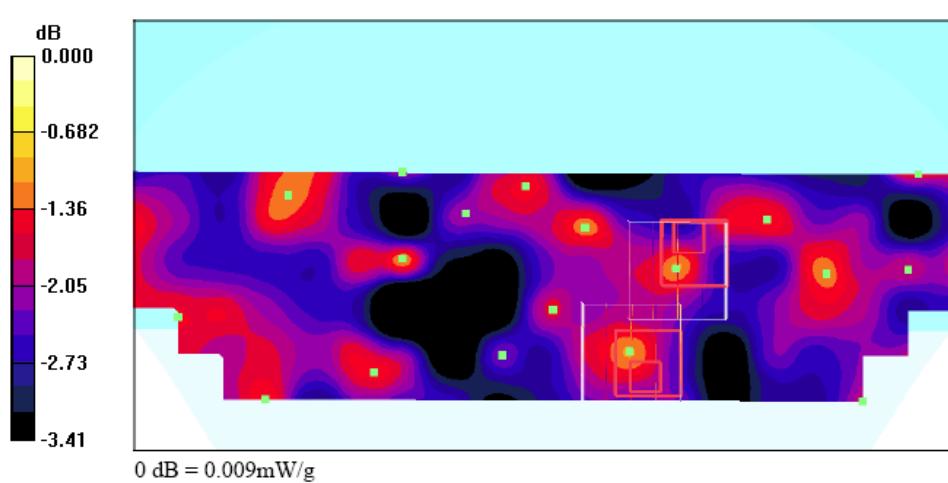
**Ch6/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 1.66 V/m; Power Drift = 0.152 dB

Peak SAR (extrapolated) = 0.009 W/kg

SAR(1 g) = 0.00657 mW/g; SAR(10 g) = 0.00606 mW/g

Maximum value of SAR (measured) = 0.009 mW/g





Test Laboratory: Sporton International Inc. SAR Testing Lab Date/Time: 6/9/2006 10:21:32 PM

**Body\_802.11b Ch6\_Notebook Bottom Touch\_20060609\_BT On**

DUT: 632813; Type: Notebook

Communication System: 802.11b ; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium: MSL\_2450 Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.93$  mho/m;  $\epsilon_r = 51.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.1 °C; Liquid Temperature : 21.3 °C

**DASY4 Configuration:**

- Probe: ET3DV6 - SN1787; ConvF(4.13, 4.13, 4.13); Calibrated: 5/31/2006
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-B; Type: QD 000 P40 C; Serial: TP-1383
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Ch6/Area Scan (61x201x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.008 mW/g

**Ch6/Zoom Scan (5x5x7)/Cube 1:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 1.93 V/m; Power Drift = 0.130 dB

Peak SAR (extrapolated) = 0.009 W/kg

SAR(1 g) = 0.00775 mW/g; SAR(10 g) = 0.00713 mW/g

Maximum value of SAR (measured) = 0.009 mW/g

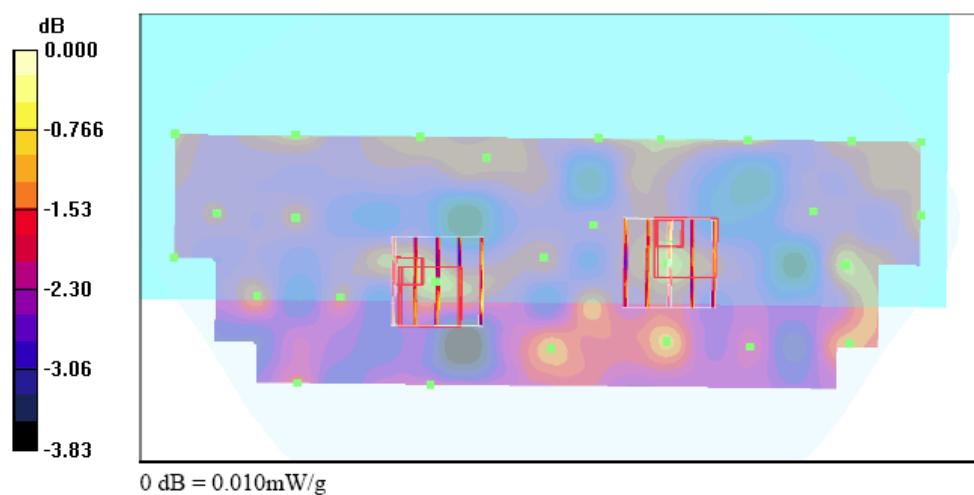
**Ch6/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 1.93 V/m; Power Drift = 0.130 dB

Peak SAR (extrapolated) = 0.010 W/kg

SAR(1 g) = 0.00762 mW/g; SAR(10 g) = 0.00695 mW/g

Maximum value of SAR (measured) = 0.010 mW/g





Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 7:01:30 PM

**Body\_802.11a Ch36\_Notebook Bottom Touch\_20060609****DUT: 632813; Type: Notebook**

Communication System: 802.11a; Frequency: 5180 MHz; Duty Cycle: 1:1

Medium: MSL\_5200 Medium parameters used:  $f = 5180$  MHz;  $\sigma = 5.37$  mho/m;  $\epsilon_r = 48.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.2 °C; Liquid Temperature : 21.2 °C

DASY4 Configuration:

- Probe: EX3DV3 - SN3514; ConvF(4.35, 4.35, 4.35); Calibrated: 2/17/2006
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-A; Type: QD 000 P40 C; Serial: TP-1303
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Ch36/Area Scan (81x301x1):** Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 0.161 mW/g

**Ch36/Zoom Scan (8x8x8)/Cube 0:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 5.18 V/m; Power Drift = 0.020 dB

Peak SAR (extrapolated) = 0.212 W/kg

SAR(1 g) = 0.160 mW/g; SAR(10 g) = 0.147 mW/g

Maximum value of SAR (measured) = 0.212 mW/g

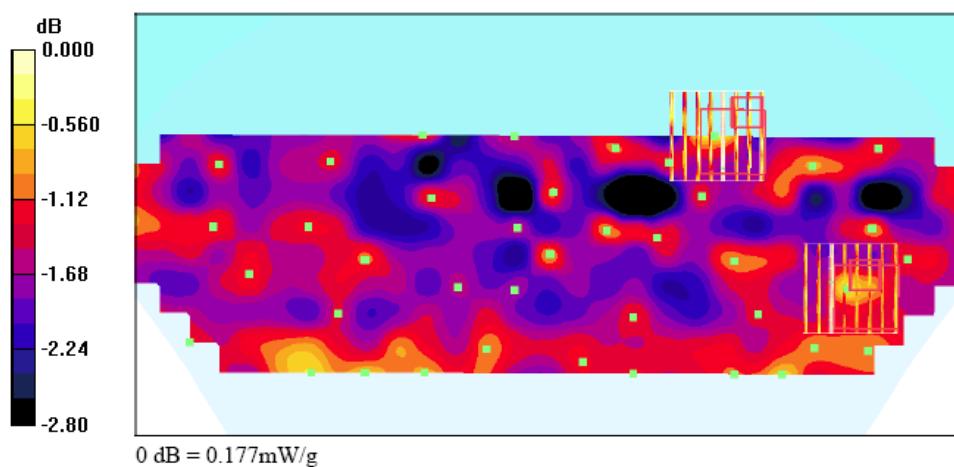
**Ch36/Zoom Scan (8x8x8)/Cube 1:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 5.18 V/m; Power Drift = 0.020 dB

Peak SAR (extrapolated) = 0.177 W/kg

SAR(1 g) = 0.151 mW/g; SAR(10 g) = 0.143 mW/g

Maximum value of SAR (measured) = 0.177 mW/g





Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 4:37:31 PM

**Body\_802.11a Ch149\_Notebook Bottom Touch\_20060609****DUT: 632813; Type: Notebook**

Communication System: 802.11a; Frequency: 5745 MHz; Duty Cycle: 1:1

Medium: MSL\_5800 Medium parameters used:  $f = 5745 \text{ MHz}$ ;  $\sigma = 6.08 \text{ mho/m}$ ;  $\epsilon_r = 46.9$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Ambient Temperature : 23.5 °C; Liquid Temperature : 21.5 °C

## DASY4 Configuration:

- Probe: EX3DV3 - SN3514; ConvF(4.09, 4.09, 4.09); Calibrated: 2/17/2006
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-A; Type: QD 000 P40 C; Serial: TP-1303
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Ch149/Area Scan (81x301x1):** Measurement grid: dx=10mm, dy=10mm  
Maximum value of SAR (interpolated) = 0.192 mW/g**Ch149/Zoom Scan (8x8x8)/Cube 0:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm  
Reference Value = 5.40 V/m; Power Drift = -0.070 dB

Peak SAR (extrapolated) = 0.202 W/kg

SAR(1 g) = 0.182 mW/g; SAR(10 g) = 0.173 mW/g

Maximum value of SAR (measured) = 0.202 mW/g

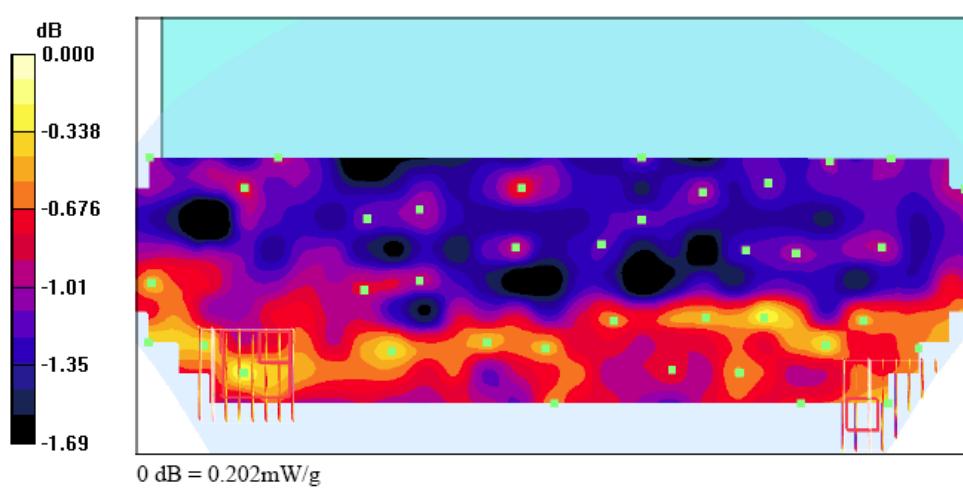
**Ch149/Zoom Scan (8x8x8)/Cube 1:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 5.40 V/m; Power Drift = -0.070 dB

Peak SAR (extrapolated) = 0.204 W/kg

SAR(1 g) = 0.183 mW/g; SAR(10 g) = n.a.

Maximum value of SAR (measured) = 0.204 mW/g





Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 4:08:13 PM

**Body\_802.11a Ch149\_Notebook Bottom Touch\_20060609\_BT On**

DUT: 632813; Type: Notebook

Communication System: 802.11a; Frequency: 5745 MHz; Duty Cycle: 1:1

Medium: MSL\_5800 Medium parameters used:  $f = 5745$  MHz;  $\sigma = 6.08$  mho/m;  $\epsilon_r = 46.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C; Liquid Temperature : 21.5 °C

## DASY4 Configuration:

- Probe: EX3DV3 - SN3514; ConvF(4.09, 4.09, 4.09); Calibrated: 2/17/2006
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-A; Type: QD 000 P40 C; Serial: TP-1303
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Ch149/Area Scan (81x301x1):** Measurement grid: dx=10mm, dy=10mm

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

**Ch149/Zoom Scan (8x8x8)/Cube 1:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 4.99 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 0.203 W/kg

SAR(1 g) = 0.181 mW/g; SAR(10 g) = n.a.

Maximum value of SAR (measured) = 0.202 mW/g

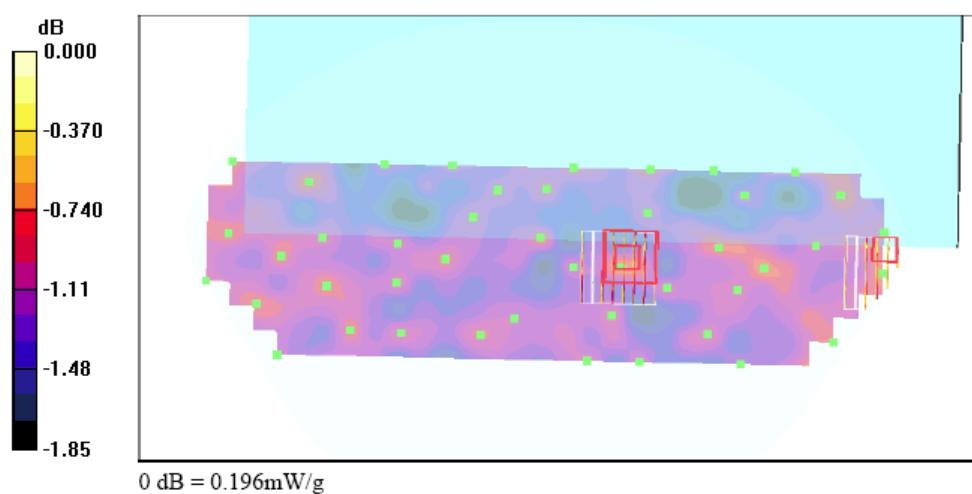
**Ch149/Zoom Scan (8x8x8)/Cube 0:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 4.99 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 0.196 W/kg

SAR(1 g) = 0.177 mW/g; SAR(10 g) = 0.168 mW/g

Maximum value of SAR (measured) = 0.196 mW/g





Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 10:04:38 AM

**Body\_802.11b Ch6\_Notebook Bottom Touch\_20060609\_2D****DUT: 632813; Type: Notebook**

Communication System: 802.11b ; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium: MSL\_2450 Medium parameters used:  $f = 2437 \text{ MHz}$ ;  $\sigma = 1.93 \text{ mho/m}$ ;  $\epsilon_r = 51.3$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Ambient Temperature : 23.6 °C; Liquid Temperature : 21.5 °C

## DASY4 Configuration:

- Probe: ET3DV6 - SN1787; ConvF(4.13, 4.13, 4.13); Calibrated: 5/31/2006
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-B; Type: QD 000 P40 C; Serial: TP-1383
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Ch6/Area Scan (51x201x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (interpolated) = 0.008 mW/g**Ch6/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 1.74 V/m; Power Drift = 0.153 dB

Peak SAR (extrapolated) = 0.009 W/kg

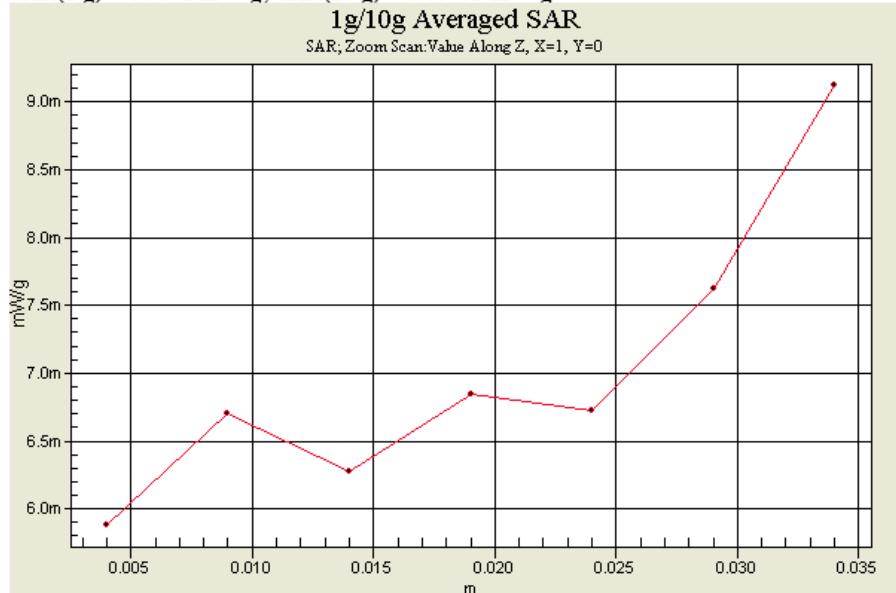
SAR(1 g) = 0.00784 mW/g; SAR(10 g) = 0.00719 mW/g

Maximum value of SAR (measured) = 0.009 mW/g

**Ch6/Zoom Scan (5x5x7)/Cube 1:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
Reference Value = 1.74 V/m; Power Drift = 0.153 dB

Peak SAR (extrapolated) = 0.009 W/kg

SAR(1 g) = 0.0078 mW/g; SAR(10 g) = 0.00703 mW/g





Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 7:01:30 PM

**Body\_802.11a Ch36\_Notebook Bottom Touch\_20060609\_2D****DUT: 632813; Type: Notebook**

Communication System: 802.11a; Frequency: 5180 MHz; Duty Cycle: 1:1

Medium: MSL\_5200 Medium parameters used:  $f = 5180$  MHz;  $\sigma = 5.37$  mho/m;  $\epsilon_r = 48.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.2 °C; Liquid Temperature : 21.2 °C

DASY4 Configuration:

- Probe: EX3DV3 - SN3514; ConvF(4.35, 4.35, 4.35); Calibrated: 2/17/2006
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-A; Type: QD 000 P40 C; Serial: TP-1303
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Ch36/Area Scan (81x301x1):** Measurement grid: dx=10mm, dy=10mm  
Maximum value of SAR (interpolated) = 0.161 mW/g**Ch36/Zoom Scan (8x8x8)/Cube 0:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 5.18 V/m; Power Drift = 0.020 dB

Peak SAR (extrapolated) = 0.212 W/kg

SAR(1 g) = 0.160 mW/g; SAR(10 g) = 0.147 mW/g

Maximum value of SAR (measured) = 0.212 mW/g

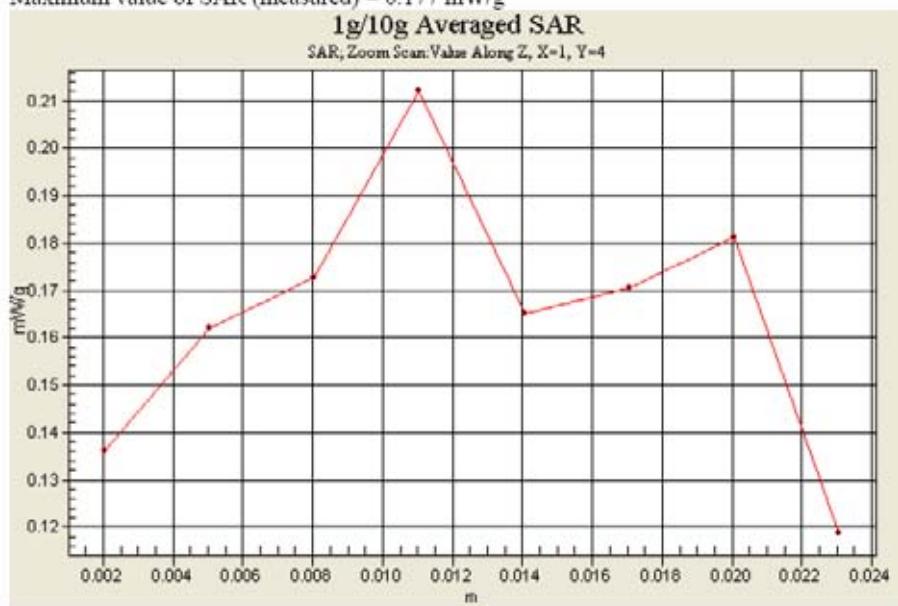
**Ch36/Zoom Scan (8x8x8)/Cube 1:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 5.18 V/m; Power Drift = 0.020 dB

Peak SAR (extrapolated) = 0.177 W/kg

SAR(1 g) = 0.151 mW/g; SAR(10 g) = 0.143 mW/g

Maximum value of SAR (measured) = 0.177 mW/g





Test Laboratory: Sporton International Inc. SAR Testing Lab

Date/Time: 6/9/2006 4:37:31 PM

**Body\_802.11a Ch149\_Notebook Bottom Touch\_20060609\_2D****DUT: 632813; Type: Notebook**

Communication System: 802.11a; Frequency: 5745 MHz; Duty Cycle: 1:1

Medium: MSL\_5800 Medium parameters used:  $f = 5745$  MHz;  $\sigma = 6.08$  mho/m;  $\epsilon_r = 46.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C; Liquid Temperature : 21.5 °C

DASY4 Configuration:

- Probe: EX3DV3 - SN3514; ConvF(4.09, 4.09, 4.09); Calibrated: 2/17/2006
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 11/11/2005
- Phantom: SAM-A; Type: QD 000 P40 C; Serial: TP-1303
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 161

**Ch149/Area Scan (81x301x1):** Measurement grid: dx=10mm, dy=10mm  
Maximum value of SAR (interpolated) = 0.192 mW/g**Ch149/Zoom Scan (8x8x8)/Cube 0:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm  
Reference Value = 5.40 V/m; Power Drift = -0.070 dB  
Peak SAR (extrapolated) = 0.202 W/kg  
SAR(1 g) = 0.182 mW/g; SAR(10 g) = 0.173 mW/g  
Maximum value of SAR (measured) = 0.202 mW/g**Ch149/Zoom Scan (8x8x8)/Cube 1:** Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm  
Reference Value = 5.40 V/m; Power Drift = -0.070 dB  
Peak SAR (extrapolated) = 0.204 W/kg  
SAR(1 g) = 0.183 mW/g; SAR(10 g) = n.a.  
Maximum value of SAR (measured) = 0.204 mW/g

**Appendix C – Calibration Data**

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



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

Accredited by the Swiss Federal Office of Metrology and Accreditation  
 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 **Sportun (Auden)**Certificate No: **D2450V2-736\_Jul05****CALIBRATION CERTIFICATE**Object **D2450V2 - SN: 736**Calibration procedure(s) **QA CAL-05.v6**  
 Calibration procedure for dipole validation kitsCalibration date **July 12, 2005**Condition of the calibrated item **In Tolerance**

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 &lt; 70%.

Calibration Equipment used (M&amp;TE critical for calibration)

| Primary Standards          | ID #             | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|----------------------------|------------------|---|-----------------------|
| Power meter EPM E442       | GB37480704       | 12-Oct-04 (METAS, No. 251-00412)          | Oct-05                |
| Power sensor HP 8481A      | US37292783       | 12-Oct-04 (METAS, No. 251-00412)          | Oct-05                |
| Reference 20 dB Attenuator | SN: 5086 (20g)   | 10-Aug-04 (METAS, No 251-00402)           | Aug-05                |
| Reference 10 dB Attenuator | SN: 5047.2 (10r) | 10-Aug-04 (METAS, No 251-00402)           | Aug-05                |
| Reference Probe ES3DV2     | SN 3025          | 29-Oct-04 (SPEAG, No. ES3-3025_Oct04)     | Oct-05                |
| DAE4                       | SN 601           | 07-Jan-05 (SPEAG, No. DAE4-601_Jan05)     | Jan-06                |

| Secondary Standards       | ID #             | Check Date (In house)                    | Scheduled Check        |
|---------------------------|------------------|--|------------------------|
| Power sensor HP 8481A     | MY41092317       | 18-Oct-02 (SPEAG, in house check Oct-03) | In house check: Oct-05 |
| RF generator R&S SML-03   | 100698           | 27-Mar-02 (SPEAG, in house check Dec-03) | In house check: Dec-05 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (SPEAG, in house check Nov-04) | In house check: Nov-05 |

| Calibrated by: | Name      | Function              | Signature |
|----------------|-----------|-----------------------|-----------|
|                | Mike Mell | Laboratory Technician |           |

| Approved by: | Name          | Function          | Signature |
|--------------|---------------|-------------------|-----------|
|              | Katja Pokovic | Technical Manager |           |

Issued: July 12, 2005

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



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



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

Accredited by the Swiss Federal Office of Metrology and Accreditation  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108****Glossary:**

|       |                                |
|-------|--------------------------------|
| TS    | tissue simulating liquid       |
| ConvF | sensitivity in TS / 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) CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz)", July 2001
- 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) DASY4 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 TS:* 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 TS parameters:* The measured TS parameters are used to calculate the nominal SAR result.

**Measurement Conditions**

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

|                              |                           |             |
|------------------------------|---------------------------|-------------|
| DASY Version                 | DASY4                     | V4.6        |
| Extrapolation                | Advanced Extrapolation    |             |
| Phantom                      | Modular Flat Phantom V5.0 |             |
| Distance Dipole Center - TSL | 10 mm                     | with Spacer |
| Area Scan resolution         | dx, dy = 15 mm            |             |
| 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 | 38.5 ± 6 %   | 1.73 mho/m ± 6 % |
| Head TSL temperature during test | (22.0 ± 0.2) °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 | 13.1 mW / g                |
| SAR normalized  | normalized to 1W   | 52.4 mW / g                |
| SAR for nominal Head TSL parameters <sup>1</sup>      | 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 | 6.13 mW / g                |
| SAR normalized  | normalized to 1W   | 24.5 mW / g                |
| SAR for nominal Head TSL parameters <sup>1</sup>        | normalized to 1W   | 24.7 mW / g ± 16.5 % (k=2) |

<sup>1</sup> Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

**Body TSL parameters**

The following parameters and calculations were applied.

|                                     | Temperature     | Permittivity | Conductivity     |
|-------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Body TSL parameters</b>  | 22.0 °C         | 52.7         | 1.95 mho/m       |
| <b>Measured Body TSL parameters</b> | (22.2 ± 0.2) °C | 52.5 ± 0 %   | 2.02 mho/m ± 0 % |
| Body TSL temperature during test    | (22.2 ± 0.2) °C | ----         | ----             |

**SAR result with Body TSL**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | condition          |                            |
|---|--------------------|----------------------------|
| SAR measured  | 250 mW input power | 13.5 mW / g                |
| SAR normalized  | normalized to 1W   | 54.0 mW / g                |
| SAR for nominal Body TSL parameters <sup>2</sup>      | normalized to 1W   | 52.8 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 | 6.26 mW / g                |
| SAR normalized  | normalized to 1W   | 25.0 mW / g                |
| SAR for nominal Body TSL parameters <sup>2</sup>        | normalized to 1W   | 24.5 mW / g ± 16.5 % (k=2) |

<sup>2</sup> Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

**Appendix****Antenna Parameters with Head TSL**

|                                      |                                      |
|--------------------------------------|--------------------------------------|
| Impedance, transformed to feed point | $53.6 \Omega + 3.7 \text{ j} \Omega$ |
| Return Loss                          | -26.0 dB                             |

**Antenna Parameters with Body TSL**

|                                      |                                      |
|--------------------------------------|--------------------------------------|
| Impedance, transformed to feed point | $49.9 \Omega + 5.3 \text{ j} \Omega$ |
| Return Loss                          | -25.5 dB                             |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.157 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.  
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 | August 26, 2003 |



**DASY4 Validation Report for Head TSL**

Date/Time: 12.07.2005 12:53:00

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN736**

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: HSL U10 BB

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.73$  mho/m;  $\epsilon_r = 38.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.4, 4.4, 4.4); Calibrated: 29.10.2004
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: UAE4 Sn601; Calibrated: 22.07.2004
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA
- Measurement SW: DASY4, V4.5 Build 30; Postprocessing SW: SEMCAD, V1.8 Build 149

**Pin = 250 mW; d = 10 mm 2/Area Scan (41x61x1):**

Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 16.6 mW/g

**Pin = 250 mW; d = 10 mm 2/Zoom Scan (7x7x7)/Cube 0:**

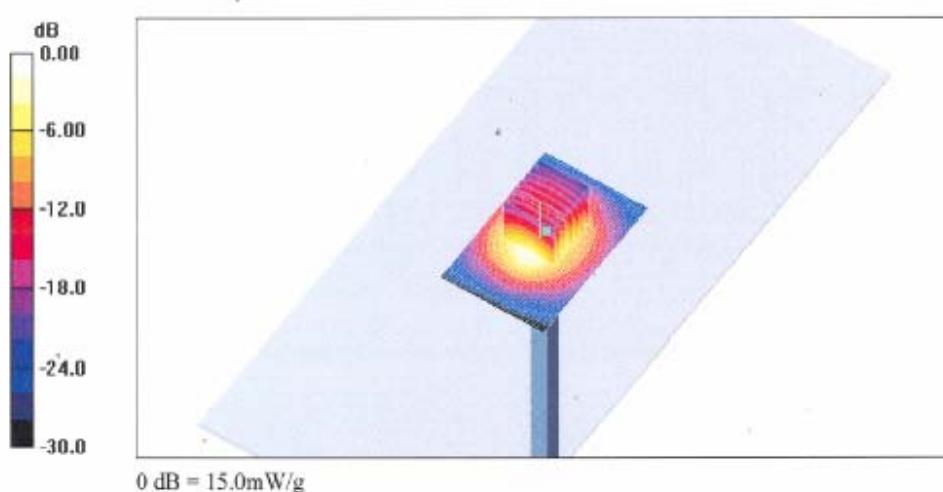
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 91.6 V/m; Power Drift = 0.077 dB

Peak SAR (extrapolated) = 27.0 W/kg

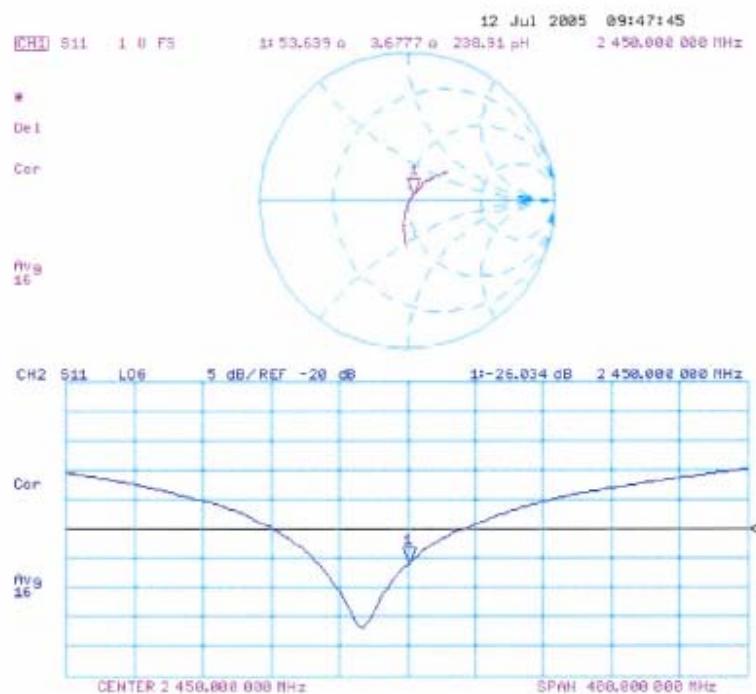
SAR(1 g) = 13.1 mW/g; SAR(10 g) = 6.13 mW/g

Maximum value of SAR (measured) = 15.0 mW/g





**Impedance Measurement Plot for Head TSL**





### DASY4 Validation Report for Body TSL

Date/Time: 11.07.2005 17:33:35

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN736**

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: MSL 2450

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.02$  mho/m;  $\epsilon_r = 52.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.13, 4.13, 4.13); Calibrated: 29.10.2004
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 22.07.2004
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA
- Measurement SW: DASY4, V4.6 Build 4; Postprocessing SW: SEMCAD, V1.8 Build 149

**Pin = 250 mW; d = 10 mm/Area Scan (81x81x1):**

Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 15.8 mW/g

**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:**

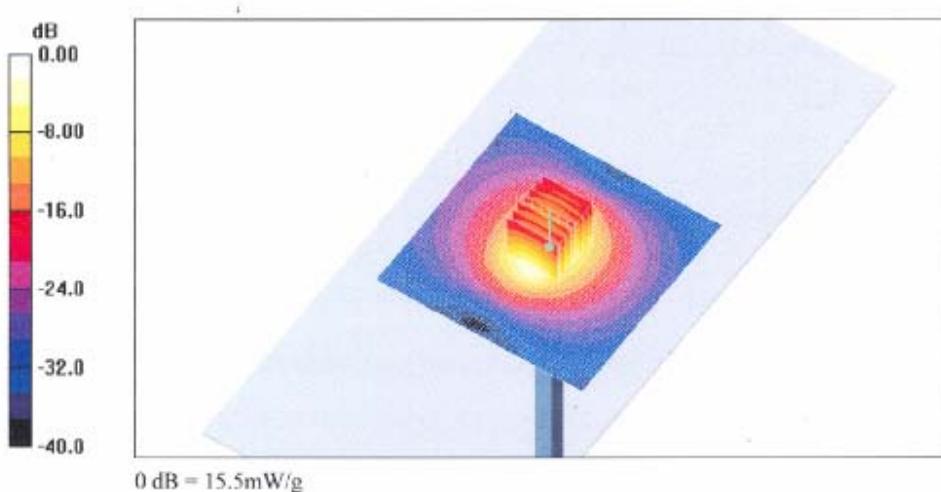
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 85.9 V/m; Power Drift = 0.160 dB

Peak SAR (extrapolated) = 27.6 W/kg

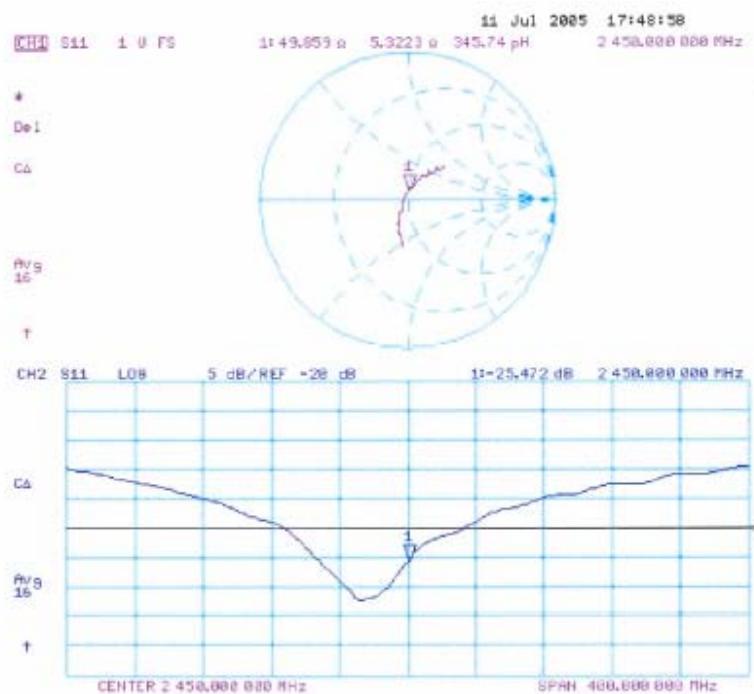
SAR(1 g) = 13.5 mW/g; SAR(10 g) = 6.26 mW/g

Maximum value of SAR (measured) = 15.5 mW/g





**Impedance Measurement Plot for Body TSL**





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Accreditation No.: SCS 108

Client Sporton (Auden)

Certificate No: D5GHzV2-1006\_Feb06

## CALIBRATION CERTIFICATE

Object D5GHzV2 - SN: 1006

Calibration procedure(s)  
QA CAL-22.v1  
Calibration procedure for dipole validation kits between 3-6 GHz

Calibration date: February 10, 2006

Condition of the calibrated item: In Tolerance

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

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

Calibration Equipment used (M&amp;TE critical for calibration)

| Primary Standards          | ID #             | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|----------------------------|------------------|---|-----------------------|
| Power meter E4410B         | GB41203874       | 3-May-05 (METAS, No. 251-00466)           | May-06                |
| Power sensor E4412A        | MY41495277       | 3-May-05 (METAS, No. 251-00466)           | May-06                |
| Reference 20 dB Attenuator | SN: S5086 (20b)  | 3-May-05 (METAS, No. 251-00467)           | May-06                |
| Reference 10 dB Attenuator | SN: 5047.2 (10r) | 11-Aug-05 (METAS, No. 251-00498)          | Aug-06                |
| Reference Probe EX3DV4     | SN 3503          | 19-Mar-05 (SPEAG, No. Ex3-3503_Mar05)     | Mar-06                |
| DAE4                       | SN 601           | 15-Dec-05 (SPEAG, No. DAE4-601, Dec05)    | Dec-06                |

| Secondary Standards       | ID #             | Check Date (in house)                    | Scheduled Check        |
|---------------------------|------------------|--|------------------------|
| Power sensor HP 8481A     | MY41093315       | 10-Aug-03 (SPEAG, in house check Oct-05) | In house check: Oct-06 |
| Power meter E4410B        | GB43310788       | 12-Aug-03 (SPEAG, in house check Oct-05) | In house check: Oct-06 |
| RF generator R&S SMT-06   | 100005           | 4-Aug-99 (SPEAG, in house check Nov-05)  | In house check: Nov-07 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (SPEAG, in house check Nov-05) | In house check: Nov-06 |

| Calibrated by: | Name         | Function          | Signature |
|----------------|--------------|-------------------|-----------|
|                | Kaja Pokovic | Technical Manager |           |
| Approved by:   | Niels Kuster | Quality Manager   |           |

Issued: February 17, 2006

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Certificate No: D5GHzV2-1006\_Feb06

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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:**

- IEC Std 62209 Part 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", Draft Version 0.9, December 2004
- Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- DASY4 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.

**Measurement Conditions**

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

|                              |  |             |
|------------------------------|--|-------------|
| DASY Version                 | DASY4  | V4.6        |
| Extrapolation                | Advanced Extrapolation   |             |
| Phantom                      | Modular Flat Phantom V5.0  |             |
| Distance Dipole Center - TSL | 10 mm  | with Spacer |
| Area Scan resolution         | dx, dy = 10 mm   |             |
| Zoom Scan Resolution         | dx, dy = 4.3 mm, dz = 3 mm   |             |
| Frequency                    | 5200 MHz $\pm$ 1 MHz<br>5500 MHz $\pm$ 1 MHz<br>5800 MHz $\pm$ 1 MHz |             |

**Body TSL parameters at 5200 MHz**

The following parameters and calculations were applied.

|                                  | Temperature         | Permittivity   | Conductivity         |
|----------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters      | 22.0 °C             | 49.0           | 5.30 mho/m           |
| Measured Body TSL parameters     | (22.0 $\pm$ 0.2) °C | 49.1 $\pm$ 6 % | 5.11 mho/m $\pm$ 6 % |
| Body TSL temperature during test | (22.0 $\pm$ 0.2) °C | ---            | ---                  |

**SAR result with Body TSL at 5200 MHz**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 1840 mW / g                    |
| SAR normalized  | normalized to 1W   | 73.6 mW / g                    |
| SAR for nominal Body TSL parameters <sup>1</sup>      | normalized to 1W   | 73.7 mW / g $\pm$ 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                |
|---|--------------------|--------------------------------|
| SAR measured  | 250 mW input power | 5.16 mW / g                    |
| SAR normalized  | normalized to 1W   | 20.6 mW / g                    |
| SAR for nominal Body TSL parameters <sup>1</sup>        | normalized to 1W   | 20.6 mW / g $\pm$ 19.5 % (k=2) |

**Body TSL parameters at 5500 MHz**

The following parameters and calculations were applied.

|                                     | Temperature     | Permittivity | Conductivity     |
|-------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Body TSL parameters</b>  | 22.0 °C         | 48.6         | 5.65 mho/m       |
| <b>Measured Body TSL parameters</b> | (22.0 ± 0.2) °C | 48.4 ± 6 %   | 5.50 mho/m ± 6 % |
| Body TSL temperature during test    | (22.0 ± 0.2) °C | ---          | ---              |

**SAR result with Body TSL at 5500 MHz**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | condition          |                            |
|---|--------------------|----------------------------|
| SAR measured  | 250 mW input power | 18.8 mW / g                |
| SAR normalized  | normalized to 1W   | 75.2 mW / g                |
| SAR for nominal Body TSL parameters <sup>1</sup>      | normalized to 1W   | 75.0 mW / g ± 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                            |
|---|--------------------|----------------------------|
| SAR measured  | 250 mW input power | 5.26 mW / g                |
| SAR normalized  | normalized to 1W   | 21.0 mW / g                |
| SAR for nominal Body TSL parameters <sup>1</sup>        | normalized to 1W   | 21.0 mW / g ± 19.5 % (k=2) |

**Body TSL parameters at 5800 MHz**

The following parameters and calculations were applied.

|                                     | Temperature     | Permittivity | Conductivity     |
|-------------------------------------|-----------------|--------------|------------------|
| <b>Nominal Body TSL parameters</b>  | 22.0 °C         | 48.2         | 6.00 mho/m       |
| <b>Measured Body TSL parameters</b> | (22.0 ± 0.2) °C | 47.8 ± 6 %   | 5.88 mho/m ± 6 % |
| Body TSL temperature during test    | (22.0 ± 0.2) °C | ---          | ---              |

**SAR result with Body TSL at 5800 MHz**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | condition          |                            |
|---|--------------------|----------------------------|
| SAR measured  | 250 mW input power | 17.5 mW / g                |
| SAR normalized  | normalized to 1W   | 70.0 mW / g                |
| SAR for nominal Body TSL parameters <sup>1</sup>      | normalized to 1W   | 69.8 mW / g ± 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                            |
|---|--------------------|----------------------------|
| SAR measured  | 250 mW input power | 4.94 mW / g                |
| SAR normalized  | normalized to 1W   | 19.8 mW / g                |
| SAR for nominal Body TSL parameters <sup>1</sup>        | normalized to 1W   | 19.7 mW / g ± 19.5 % (k=2) |

**Appendix****Antenna Parameters with Body TSL at 5200 MHz**

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 48.3 $\Omega$ - 2.2j $\Omega$ |
| Return Loss                          | -31.1 dB                      |

**Antenna Parameters with Body TSL at 5500 MHz**

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 54.1 $\Omega$ - 9.4j $\Omega$ |
| Return Loss                          | -20.1 dB                      |

**Antenna Parameters with Body TSL at 5800 MHz**

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 56.3 $\Omega$ + 8.3j $\Omega$ |
| Return Loss                          | -20.1 dB                      |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.202 ns |
|----------------------------------|----------|

After long term use with 40 W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semi-rigid 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.  
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 | August 28, 2003 |

**DASY4 Validation Report for Body TSL**

Date/Time: 10.02.2006 21:06:10

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1006**

Communication System: CW-5GHz; Frequency: 5800 MHz Frequency: 5500 MHz Frequency: 5200 MHz; Duty Cycle: 1:1

Medium: MSL 5800 MHz;

Medium parameters used:  $f = 5800 \text{ MHz}$ ;  $\sigma = 5.88 \text{ mho/m}$ ;  $\epsilon_r = 47.8$ ;  $\rho = 1000 \text{ kg/m}^3$  Medium parameters used:  $f = 5500 \text{ MHz}$ ;  $\sigma = 5.5 \text{ mho/m}$ ;  $\epsilon_r = 48.4$ ;  $\rho = 1000 \text{ kg/m}^3$  Medium parameters used:  $f = 5200 \text{ MHz}$ ;  $\sigma = 5.11 \text{ mho/m}$ ;  $\epsilon_r = 49.1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

**DASY4 Configuration:**

- Probe: EX3DV4 - SN3503; ConvF(4.69, 4.69, 4.69)ConvF(4.78, 4.78, 4.78)ConvF(5.18, 5.18, 5.18); Calibrated: 19.03.2005
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAB4 Sn601; Calibrated: 15.12.2005
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA
- Measurement SW: DASY4, V4.6 Build 47; Postprocessing SW: SEMCAD, V1.8 Build 160

**d=10mm, Pin=250mW, f=5200 MHz/Zoom Scan (8x8x8), dist=2mm (8x8x8)/Cube 0:**

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 77.8 V/m; Power Drift = -0.025 dB

Peak SAR (extrapolated) = 65.4 W/kg

SAR(1 g) = 18.4 mW/g; SAR(10 g) = 5.16 mW/g

Maximum value of SAR (measured) = 37.8 mW/g

**d=10mm, Pin=250mW, f=5500 MHz/Zoom Scan (8x8x8), dist=2mm (8x8x8)/Cube 0:**

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 73.9 V/m; Power Drift = 0.003 dB

Peak SAR (extrapolated) = 72.9 W/kg

SAR(1 g) = 18.8 mW/g; SAR(10 g) = 5.26 mW/g

Maximum value of SAR (measured) = 39.6 mW/g

**d=10mm, Pin=250mW, f=5800 MHz/Zoom Scan (8x8x8), dist=2mm (8x8x8)/Cube 0:**

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm

Reference Value = 69.5 V/m; Power Drift = -0.024 dB

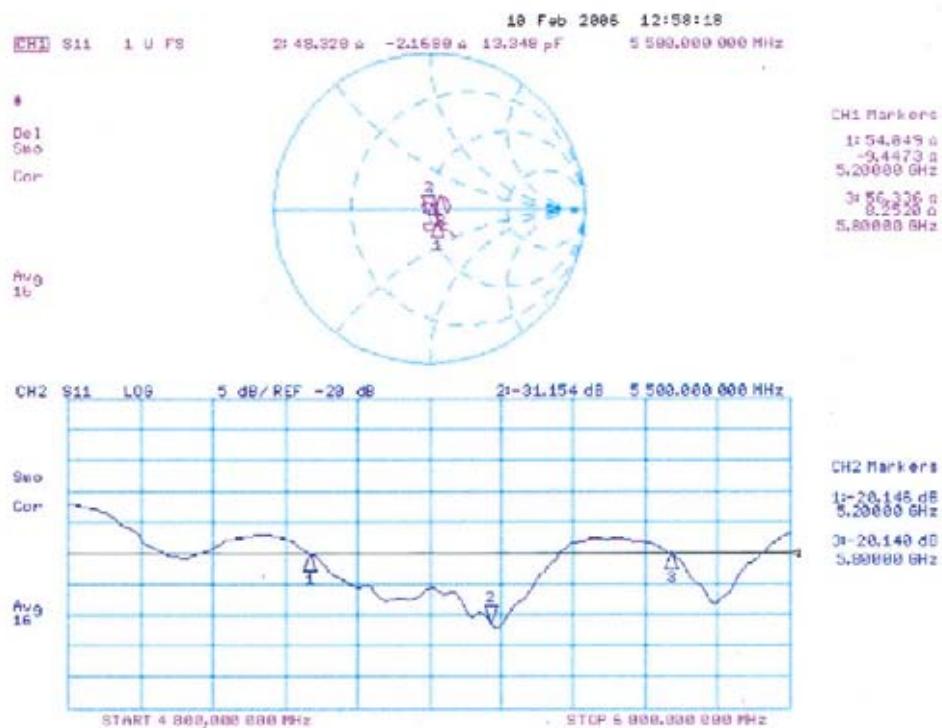
Peak SAR (extrapolated) = 70.0 W/kg

SAR(1 g) = 17.5 mW/g; SAR(10 g) = 4.94 mW/g

Maximum value of SAR (measured) = 36.7 mW/g



Impedance Measurement Plot for Body TSL





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Accreditation No.: SCS 108

Client Sporton (Auden)

Certificate No: ET3-1787\_May06

## CALIBRATION CERTIFICATE

|  |   |   |                        |
|--|---|---|------------------------|
| Object   | ET3DV6 - SN: 1787   |   |                        |
| Calibration procedure(s)   | QA CAL-01.v5<br>Calibration procedure for dosimetric E-field probes |   |                        |
| Calibration date:  | May 31, 2006  |   |                        |
| Condition of the calibrated item   | In Tolerance  |   |                        |
| <p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity &lt; 70%.</p> <p>Calibration Equipment used (M&amp;TE/critical for calibration)</p> |   |   |                        |
| Primary Standards  | ID #  | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration  |
| Power meter E4419B   | GB41293874  | 5-Apr-06 (METAS, No. 251-00557)           | Apr-07                 |
| Power sensor E4412A  | MY41495277  | 5-Apr-06 (METAS, No. 251-00557)           | Apr-07                 |
| Power sensor E4412A  | MY41498087  | 5-Apr-06 (METAS, No. 251-00557)           | Apr-07                 |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 11-Aug-05 (METAS, No. 251-00499)          | Aug-06                 |
| Reference 20 dB Attenuator   | SN: S5086 (20b)   | 4-Apr-06 (METAS, No. 251-00558)           | Apr-07                 |
| Reference 30 dB Attenuator   | SN: S5129 (30b)   | 11-Aug-05 (METAS, No. 251-00500)          | Aug-06                 |
| Reference Probe ES3DV2   | SN: 3013  | 2-Jan-06 (SPEAG, No. ES3-3013_Jan06)      | Jan-07                 |
| DAE4   | SN: 654   | 2-Feb-06 (SPEAG, No. DAE4-654_Feb06)      | Feb-07                 |
| Secondary Standards  | ID #  | Check Date (in house)                     | Scheduled Check        |
| RF generator HP 8648C  | US3642U01700  | 4-Aug-99 (SPEAG, in house check Nov-05)   | In house check: Nov-07 |
| Network Analyzer HP 8753E  | US37390585  | 18-Oct-01 (SPEAG, in house check Nov-05)  | In house check: Nov 06 |
| Calibrated by:   | Name  | Function                                  | Signature              |
|  | Katja Pokovic   | Technical Manager                         |                        |
| Approved by:   | Name  | Function                                  | Signature              |
|  | Niels Kuster  | Quality Manager                           |                        |
| Issued: May 31, 2006   |   |   |                        |
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Certificate No: ET3-1787\_May06

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**Glossary:**

|                          |  |
|--------------------------|--|
| TSL                      | tissue simulating liquid   |
| NORM $x,y,z$             | sensitivity in free space  |
| ConvF                    | sensitivity in TSL / NORM $x,y,z$  |
| DCP                      | diode compression point  |
| 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), 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) CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz)", July 2001

**Methods Applied and Interpretation of Parameters:**

- $NORM_{x,y,z}$ : Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).  $NORM_{x,y,z}$  are only intermediate values, i.e., the uncertainties of  $NORM_{x,y,z}$  does not effect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- $NORM(f)x,y,z = NORM_{x,y,z} * frequency\_response$  (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- $DCPx,y,z$ : DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- *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  $NORM_{x,y,z} * ConvF$  whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  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.



---

ET3DV6 SN:1787

May 31, 2006

# Probe ET3DV6

## SN:1787

|                  |                 |
|------------------|-----------------|
| Manufactured:    | May 28, 2003    |
| Last calibrated: | August 29, 2003 |
| Recalibrated:    | May 31, 2006    |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)



ET3DV6 SN:1787

May 31, 2006

**DASY - Parameters of Probe: ET3DV6 SN:1787****Sensitivity in Free Space<sup>A</sup>**

|       |                   |                                     |
|-------|-------------------|-------------------------------------|
| NormX | $1.57 \pm 10.1\%$ | $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormY | $1.71 \pm 10.1\%$ | $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormZ | $2.09 \pm 10.1\%$ | $\mu\text{V}/(\text{V}/\text{m})^2$ |

**Diode Compression<sup>B</sup>**

|       |       |
|-------|-------|
| DCP X | 94 mV |
| DCP Y | 94 mV |
| DCP Z | 94 mV |

**Sensitivity in Tissue Simulating Liquid (Conversion Factors)**

Please see Page 8.

**Boundary Effect**

TSL                    900 MHz                    Typical SAR gradient: 5 % per mm

|   |        |        |
|---|--------|--------|
| Sensor Center to Phantom Surface Distance               | 3.7 mm | 4.7 mm |
| SAR <sub>be</sub> [%]      Without Correction Algorithm | 7.2    | 3.8    |
| SAR <sub>ha</sub> [%]      With Correction Algorithm    | 0.0    | 0.2    |

TSL                    1810 MHz                    Typical SAR gradient: 10 % per mm

|   |        |        |
|---|--------|--------|
| Sensor Center to Phantom Surface Distance               | 3.7 mm | 4.7 mm |
| SAR <sub>be</sub> [%]      Without Correction Algorithm | 6.3    | 3.6    |
| SAR <sub>ha</sub> [%]      With Correction Algorithm    | 0.1    | 0.3    |

**Sensor Offset**

Probe Tip to Sensor Center                    2.7 mm

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

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Page 8).<sup>B</sup> Numerical linearization parameter: uncertainty not required.

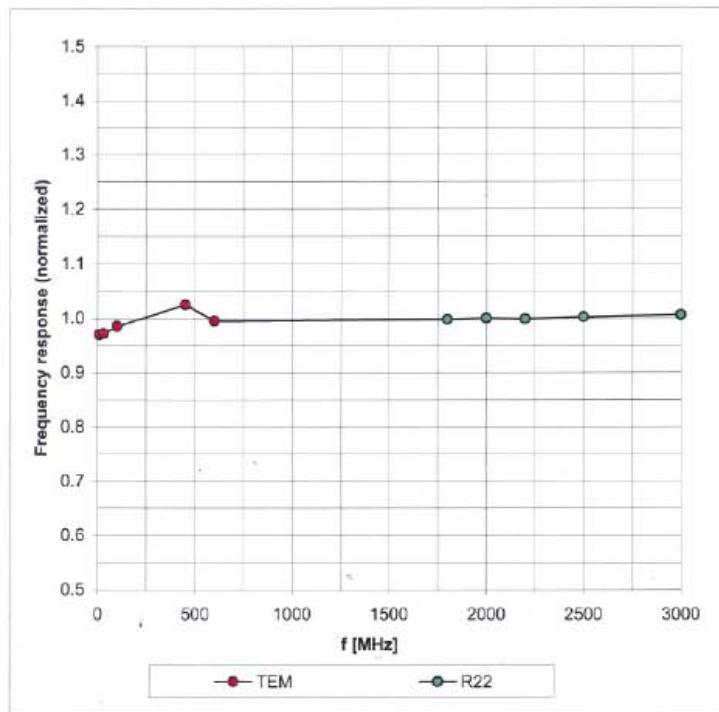


ET3DV6 SN:1787

May 31, 2006

## Frequency Response of E-Field

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



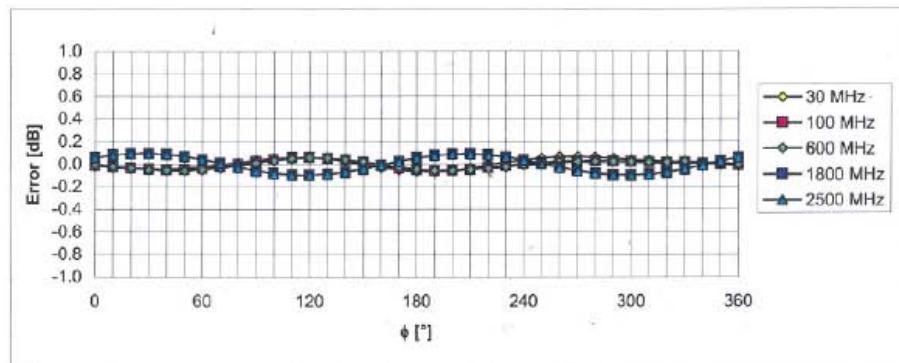
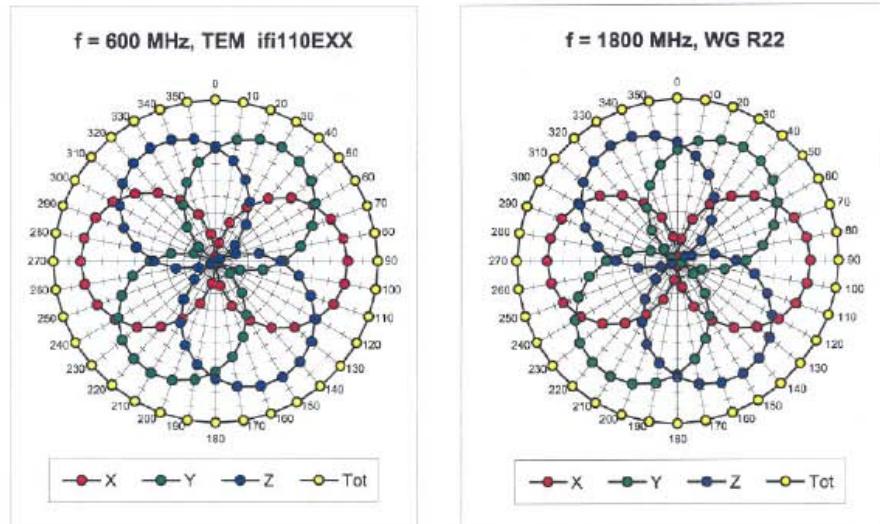
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )



ET3DV6 SN:1787

May 31, 2006

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



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

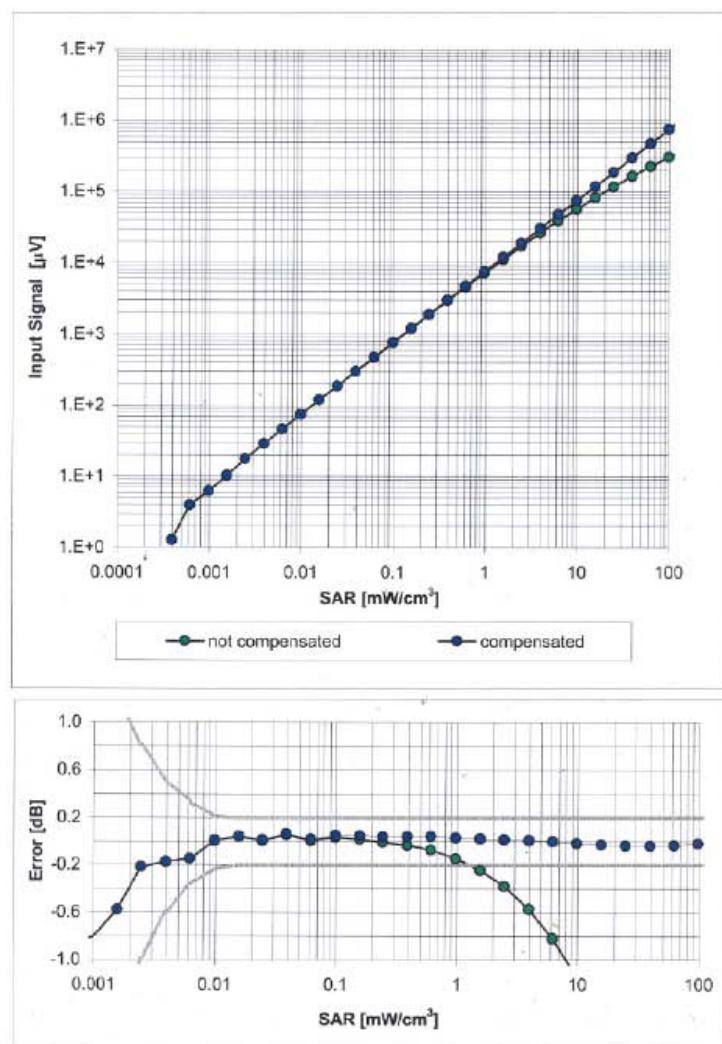


ET3DV6 SN:1787

May 31, 2006

### Dynamic Range f(SAR<sub>head</sub>)

(Waveguide R22, f = 1800 MHz)



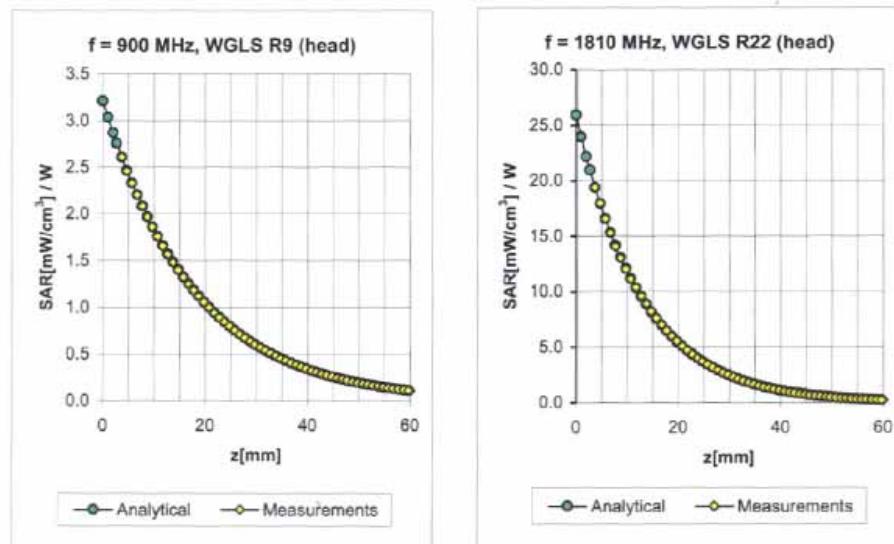
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )



ET3DV6 SN:1787

May 31, 2006

## Conversion Factor Assessment



| f [MHz] | Validity [MHz] <sup>c</sup> | TSL  | Permittivity   | Conductivity   | Alpha | Depth | ConvF | Uncertainty        |
|---------|-----------------------------|------|----------------|----------------|-------|-------|-------|--------------------|
| 900     | $\pm 50 / \pm 100$          | Head | $41.5 \pm 5\%$ | $0.97 \pm 5\%$ | 0.50  | 1.85  | 6.38  | $\pm 11.0\% (k=2)$ |
| 1810    | $\pm 50 / \pm 100$          | Head | $40.0 \pm 5\%$ | $1.40 \pm 5\%$ | 0.59  | 2.46  | 5.26  | $\pm 11.0\% (k=2)$ |
| 900     | $\pm 50 / \pm 100$          | Body | $55.0 \pm 5\%$ | $1.05 \pm 5\%$ | 0.44  | 2.10  | 6.18  | $\pm 11.0\% (k=2)$ |
| 1810    | $\pm 50 / \pm 100$          | Body | $53.3 \pm 5\%$ | $1.52 \pm 5\%$ | 0.62  | 2.44  | 4.66  | $\pm 11.0\% (k=2)$ |
| 2450    | $\pm 50 / \pm 100$          | Body | $52.7 \pm 5\%$ | $1.95 \pm 5\%$ | 0.62  | 2.13  | 4.13  | $\pm 11.8\% (k=2)$ |

<sup>c</sup> The validity of  $\pm 100$  MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

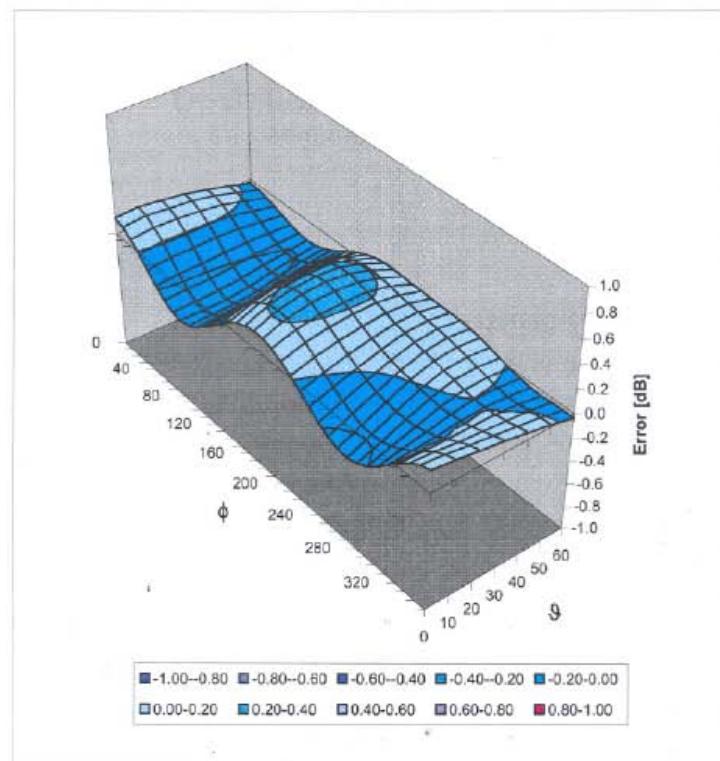


ET3DV6 SN:1787

May 31, 2006

### Deviation from Isotropy in HSL

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



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



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

Accreditation No.: **SCS 108**Client **Sportun (Auden)**Certificate No: **EX3-3514\_Feb06****CALIBRATION CERTIFICATE**

|  |  |   |                           |  |  |  |
|--|--|---|---------------------------|--|--|--|
| Object   | EX3DV3 - SN:3514   |   |                           |  |  |  |
| Calibration procedure(s)   | QA CAL-01.v5 and QA CAL-14.v3<br>Calibration procedure for dosimetric E-field probes |   |                           |  |  |  |
| Calibration date:  | February 17, 2006  |   |                           |  |  |  |
| Condition of the calibrated item   | In Tolerance   |   |                           |  |  |  |
| 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 (Calibrated by, Certificate No.) | Scheduled Calibration     |  |  |  |
| Power meter E4419B   | GB41283874   | 3-May-05 (METAS, No. 251-00468)           | May-06                    |  |  |  |
| Power sensor E4412A  | MY41495277   | 3-May-05 (METAS, No. 251-00468)           | May-06                    |  |  |  |
| Power sensor E4412A  | MY41498087   | 3-May-05 (METAS, No. 251-00466)           | May-06                    |  |  |  |
| Reference 3 dB Attenuator  | SN: S5054 (3c)   | 11-Aug-05 (METAS, No. 251-00499)          | Aug-06                    |  |  |  |
| Reference 20 dB Attenuator   | SN: S5086 (20b)  | 3-May-05 (METAS, No. 251-00467)           | May-06                    |  |  |  |
| Reference 30 dB Attenuator   | SN: S5129 (30b)  | 11-Aug-05 (METAS, No. 251-00500)          | Aug-06                    |  |  |  |
| Reference Probe ES3DV2   | SN: 3013   | 2-Jan-06 (SPEAG, No. ES3-3013_Jan06)      | Jan-07                    |  |  |  |
| DAE4   | SN: 654  | 2-Feb-06 (SPEAG, No. DAE4-654_Feb06)      | Feb-07                    |  |  |  |
| Secondary Standards  | ID #   | Check Date (in house)                     | Scheduled Check           |  |  |  |
| RF generator HP 8648C  | US3642U01700   | 4-Aug-99 (SPEAG, in house check Nov-05)   | In house check: Nov-07    |  |  |  |
| Network Analyzer HP 8753E  | US37390585   | 18-Oct-01 (SPEAG, in house check Nov-05)  | In house check: Nov 06    |  |  |  |
| Calibrated by:   | Name   | Function                                  | Signature                 |  |  |  |
|  | Katja Pekovic  | Technical Manager                         |                           |  |  |  |
| Approved by:   | Niels Kuster   | Quality Manager                           |                           |  |  |  |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory.  |  |   | Issued: February 17, 2006 |  |  |  |

Certificate No: EX3-3514\_Feb06

Page 1 of 9



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Accreditation No.: SCS 108

**Glossary:**

|                          |  |
|--------------------------|--|
| TSL                      | tissue simulating liquid   |
| NORM $x,y,z$             | sensitivity in free space  |
| ConF                     | sensitivity in TSL / NORM $x,y,z$  |
| DCP                      | diode compression point  |
| 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), i.e., $\vartheta = 0$ is normal to probe axis |

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

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz)", July 2001

**Methods Applied and Interpretation of Parameters:**

- $NORMx,y,z$ : Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).  $NORMx,y,z$  are only intermediate values, i.e., the uncertainties of  $NORMx,y,z$  does not effect the E<sup>2</sup>-field uncertainty inside TSL (see below ConF).
- $NORM(f)x,y,z = NORMx,y,z * frequency\_response$  (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConF.
- $DCPx,y,z$ : DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- ConF 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  $NORMx,y,z * ConF$  whereby the uncertainty corresponds to that given for ConF. A frequency dependent ConF 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.



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EX3DV3 SN:3514

February 17, 2006

# Probe EX3DV3

## SN:3514

|                  |                   |
|------------------|-------------------|
| Manufactured:    | December 15, 2002 |
| Last calibrated: | January 23, 2004  |
| Recalibrated:    | February 17, 2006 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)



EX3DV3 SN:3514

February 17, 2006

**DASY - Parameters of Probe: EX3DV3 SN:3514****Sensitivity in Free Space<sup>A</sup>**

|       |                          |                                     |
|-------|--------------------------|-------------------------------------|
| NormX | <b>0.655</b> $\pm$ 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormY | <b>0.675</b> $\pm$ 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ |
| NormZ | <b>0.598</b> $\pm$ 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ |

**Diode Compression<sup>B</sup>**

|       |              |
|-------|--------------|
| DCP X | <b>97</b> mV |
| DCP Y | <b>97</b> mV |
| DCP Z | <b>97</b> mV |

**Sensitivity in Tissue Simulating Liquid (Conversion Factors)**

Please see Page 8.

**Boundary Effect**

TSL      5200 MHz      Typical SAR gradient: 25 % per mm

|  |               |               |
|--|---------------|---------------|
| Sensor Center to Phantom Surface Distance          | <b>2.0</b> mm | <b>3.0</b> mm |
| SAR <sub>bs</sub> [%] Without Correction Algorithm | 4.5           | 1.8           |
| SAR <sub>bs</sub> [%] With Correction Algorithm    | 0.0           | 0.0           |

TSL      5800 MHz      Typical SAR gradient: 30 % per mm

|  |               |               |
|--|---------------|---------------|
| Sensor Center to Phantom Surface Distance          | <b>2.0</b> mm | <b>3.0</b> mm |
| SAR <sub>bs</sub> [%] Without Correction Algorithm | 1.2           | 0.8           |
| SAR <sub>bs</sub> [%] With Correction Algorithm    | 0.0           | 0.0           |

**Sensor Offset**Probe Tip to Sensor Center      **1.0** mm

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 Page 8).<sup>B</sup> Numerical linearization parameter: uncertainty not required.

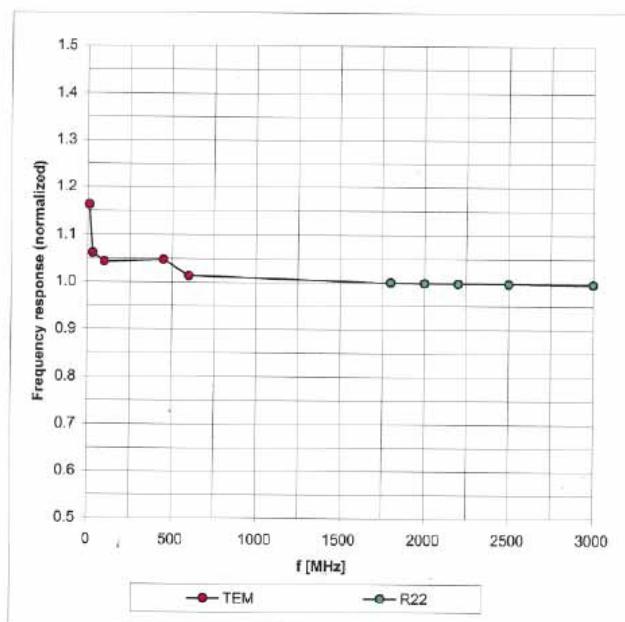


EX3DV3 SN:3514

February 17, 2006

### Frequency Response of E-Field

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



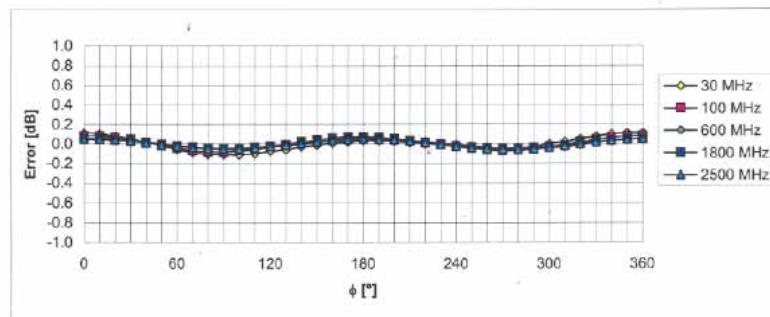
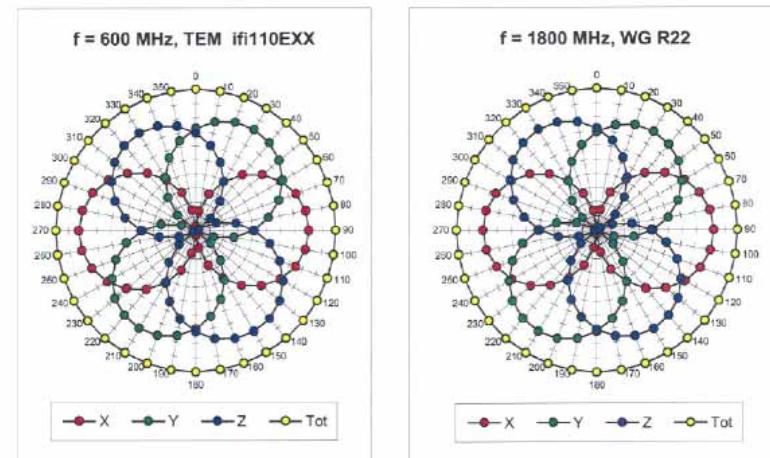
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)



EX3DV3 SN:3514

February 17, 2006

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



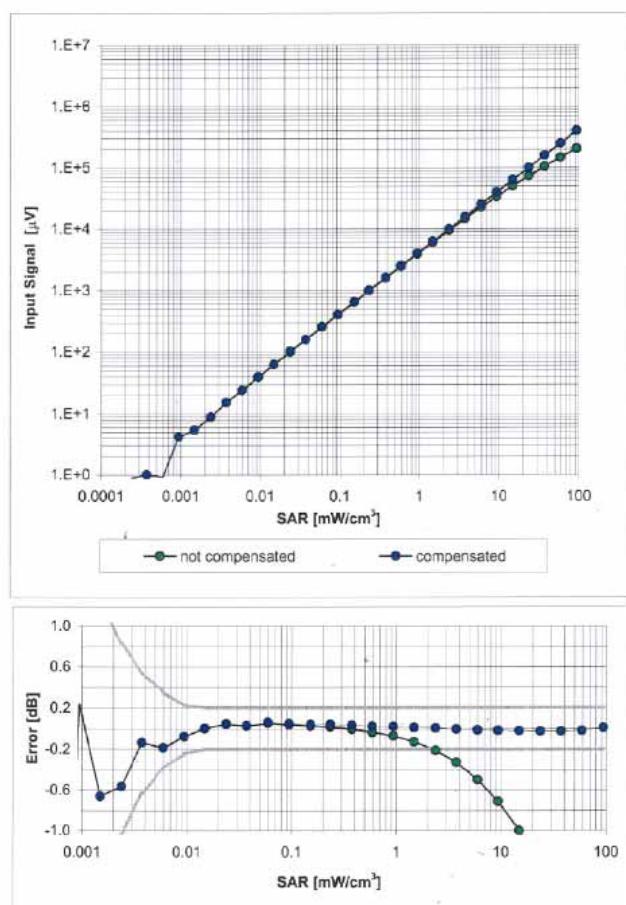
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )



EX3DV3 SN:3514

February 17, 2006

**Dynamic Range  $f(\text{SAR}_{\text{head}})$**   
(Waveguide R22,  $f = 1800$  MHz)

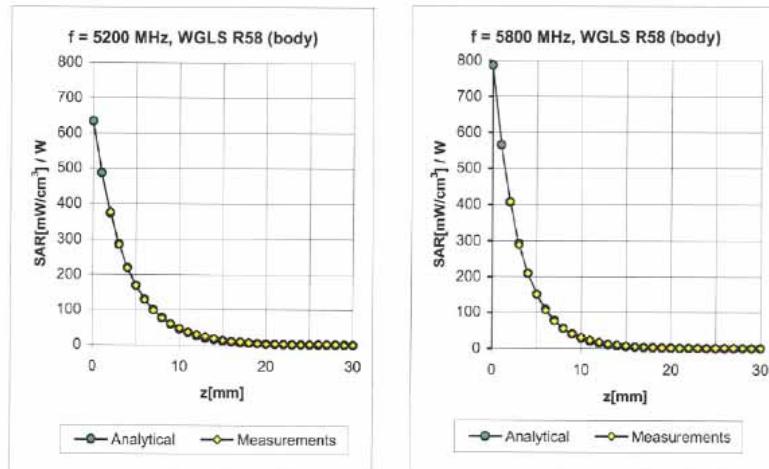




EX3DV3 SN:3514

February 17, 2006

## Conversion Factor Assessment



| f [MHz] | Validity [MHz] <sup>c</sup> | TSL  | Permittivity | Conductivity | Alpha | Depth | ConvF | Uncertainty   |
|---------|-----------------------------|------|--------------|--------------|-------|-------|-------|---------------|
| 5200    | ± 50 / ± 100                | Body | 49.0 ± 5%    | 5.30 ± 5%    | 0.47  | 1.25  | 4.35  | ± 13.1% (k=2) |
| 5500    | ± 50 / ± 100                | Body | 48.6 ± 5%    | 5.65 ± 5%    | 0.46  | 1.14  | 4.02  | ± 13.1% (k=2) |
| 5800    | ± 50 / ± 100                | Body | 48.2 ± 5%    | 6.00 ± 5%    | 0.52  | 0.92  | 4.09  | ± 13.1% (k=2) |

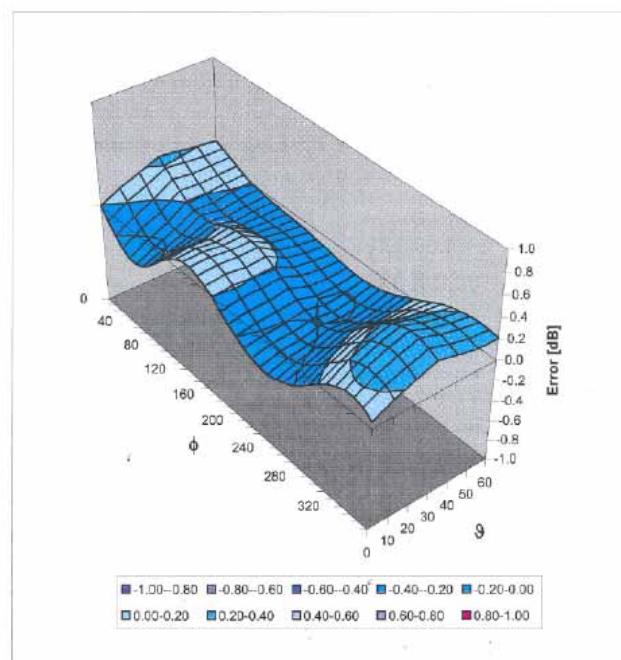
<sup>c</sup> The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.



EX3DV3 SN:3514

February 17, 2006

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



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



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Accreditation No.: **SCS 108**Client **Sportun (Auden)**Certificate No: **DAE3-577\_Nov05****CALIBRATION CERTIFICATE**Object **DAE3 - SD 000 D03 AA - SN: 577**Calibration procedure(s) **QA CAL-06.v12**  
Calibration procedure for the data acquisition electronics (DAE)Calibration date: **November 11, 2005**Condition of the calibrated item **In Tolerance**

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

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

Calibration Equipment used (M&amp;TE critical for calibration)

| Primary Standards                 | ID #               | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|-----------------------------------|--------------------|---|-----------------------|
| Fluke Process Calibrator Type 702 | SN: 6295803        | 7-Oct-05 (Sintrel, No.E-050073)           | Oct-06                |
| Secondary Standards               | ID #               | Check Date (In house)                     | Scheduled Check       |
| Calibrator Box V1.1               | SE UMS 006 AB 1002 | 29-Jun-05 (SPEAG, in house check)         | In house check Jun-06 |

|                |                           |                        |               |
|----------------|---------------------------|------------------------|---------------|
| Calibrated by: | Name<br>Daniel Steinacher | Function<br>Technician | Signature<br> |
| Approved by:   | Fin Bomholt               | R&D Director           |               |

Issued: November 11, 2005

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



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Accreditation No.: **SCS 108**

#### **Glossary**

|                        |   |
|------------------------|---|
| <b>DAE</b>             | data acquisition electronics  |
| <b>Connector angle</b> | 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 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*: 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 = 61mV , full range = -1.....,+3mV

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | $404.445 \pm 0.1\% (k=2)$ | $403.896 \pm 0.1\% (k=2)$ | $404.369 \pm 0.1\% (k=2)$ |
| Low Range           | $3.94241 \pm 0.7\% (k=2)$ | $3.89919 \pm 0.7\% (k=2)$ | $3.95427 \pm 0.7\% (k=2)$ |

**Connector Angle**

|   |                         |
|---|-------------------------|
| Connector Angle to be used in DASY system | $130^\circ \pm 1^\circ$ |
|---|-------------------------|

**Appendix****1. DC Voltage Linearity**

| High Range        | Input (µV) | Reading (µV) | Error (%) |
|-------------------|------------|--------------|-----------|
| Channel X + Input | 200000     | 199999.3     | 0.00      |
| Channel X + Input | 20000      | 20006.75     | 0.03      |
| Channel X - Input | 20000      | -19997.90    | -0.01     |
| Channel Y + Input | 200000     | 200000.3     | 0.00      |
| Channel Y + Input | 20000      | 20004.58     | 0.02      |
| Channel Y - Input | 20000      | -20000.75    | 0.00      |
| Channel Z + Input | 200000     | 199999.6     | 0.00      |
| Channel Z + Input | 20000      | 20001.43     | 0.01      |
| Channel Z - Input | 20000      | -20003.93    | 0.02      |

| Low Range         | Input (µV) | Reading (µV) | Error (%) |
|-------------------|------------|--------------|-----------|
| Channel X + Input | 2000       | 2000.1       | 0.00      |
| Channel X + Input | 200        | 200.42       | 0.21      |
| Channel X - Input | 200        | -200.30      | 0.15      |
| Channel Y + Input | 2000       | 2000.1       | 0.00      |
| Channel Y + Input | 200        | 199.35       | -0.32     |
| Channel Y - Input | 200        | -200.96      | 0.48      |
| Channel Z + Input | 2000       | 1999.9       | 0.00      |
| Channel Z + Input | 200        | 199.37       | -0.31     |
| Channel Z - Input | 200        | -200.62      | 0.31      |

**2. Common mode sensitivity**

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

|           | Common mode<br>Input Voltage (mV) | High Range<br>Average Reading (µV) | Low Range<br>Average Reading (µV) |
|-----------|-----------------------------------|------------------------------------|-----------------------------------|
| Channel X | 200                               | 13.40                              | 12.55                             |
|           | -200                              | -12.29                             | -13.06                            |
| Channel Y | 200                               | -6.93                              | -7.43                             |
|           | -200                              | 6.72                               | 6.47                              |
| Channel Z | 200                               | 0.71                               | 0.36                              |
|           | -200                              | -1.67                              | -1.93                             |

**3. Channel separation**

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

|           | Input Voltage (mV) | Channel X (µV) | Channel Y (µV) | Channel Z (µV) |
|-----------|--------------------|----------------|----------------|----------------|
| Channel X | 200                | -              | 1.59           | 0.08           |
| Channel Y | 200                | 1.69           | -              | 3.62           |
| Channel Z | 200                | -0.73          | -1.49          | -              |

**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 | 15946            | 15679           |
| Channel Y | 15960            | 16151           |
| Channel Z | 16233            | 15968           |

**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 | 0.08         | -1.13            | 2.31             | 0.51                |
| Channel Y | -0.35        | -2.00            | 0.81             | 0.43                |
| Channel Z | -0.38        | -2.76            | 1.68             | 0.40                |

**6. Input Offset Current**

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

**7. Input Resistance**

|           | Zeroing (MΩ) | Measuring (MΩ) |
|-----------|--------------|----------------|
| Channel X | 0.2000       | 200.8          |
| Channel Y | 0.2000       | 201.4          |
| Channel Z | 0.2001       | 200.3          |

**8. Low Battery Alarm Voltage** (verified during pre test)

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

**9. Power Consumption** (verified during pre test)

| Typical values | Switched off (mA) | Stand by (mA) | Transmitting (mA) |
|----------------|-------------------|---------------|-------------------|
| Supply (+ Vcc) | +0.0              | +6            | +14               |
| Supply (- Vcc) | -0.01             | -8            | -9                |