# PCTEST ENGINEERING LABORATORY, INC.

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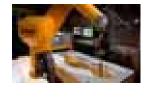

# CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

**Applicant Name:**
SCOMM Inc.
4224 S. Hocker Drive
Suite 260
Independence MO 64055
USA

**Date of Testing:**
March 30, 2007
**Test Site/Location:**
PCTEST Lab, Columbia, MD, USA
**Test Report Serial No.:**
0703150202-R1.UPQ

| | |
|---|---|
| **FCC ID:** | **UPQ-UBI200A** |
| **APPLICANT:** | **SCOMM INC.** |

| | |
|---|---|
| **EUT Type:** | IEEE 802.15.4 / 2.4GHz Wireless Communicator |
| **Application Type:** | Certification |
| **FCC Rule Part(s):** | §2.1093; FCC/OET Bulletin 65 Supplement C [July 2001] |
| **FCC Classification:** | Digital Transmission System (DTS) |
| **Model(s):** | UbiDuo |
| **Tx Frequency:** | 2405 – 2480 MHz |
| **Conducted Power:** | 15.64 dBm |
| **Max. SAR Measurement:** | 1.11 W/kg Body SAR |
| **Test Device Serial No.:** | *Pre-Production* [S/N: 823064000071] |

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1-2005 and has been tested in accordance with the measurement procedures specified in FCC/OET Bulletin 65 Supplement C (2001) and IEEE Std. 1528-2003.

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

**NOTE: This revised HAC Test Report supersedes and replaces the previously-issued test report (S/N: 0703150202.UPQ) on the same subject EUT for the same type of testing as indicated.**

*PCTEST certifies that no party to this application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.*

Randy Ortanez
President

ACCREDITED
TESTING LABORATORY
CERTIFICATE #2041.01

# T A B L E   O F   C O N T E N T S

# 1 INTRODUCTION

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

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-2005 *Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz* ©2005 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017.[2] The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [3] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

## 1.1 SAR Definition

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

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

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

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

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

where:

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

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

# 2 TEST SITE LOCATION

## 2.1 INTRODUCTION

The map at the right shows the location of the PCTEST LABORATORY in Columbia, Maryland. It is in proximity to the FCC Laboratory, the Baltimore-Washington International (BWI) airport, the city of Baltimore and Washington, DC (See Figure 2-1).


**Figure 2-1**
Map of the Greater Baltimore and Metropolitan Washington, D.C. area

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility in New Concept Business Park, Guilford Industrial Park, Columbia, Maryland. The site address is 6660-B Dobbin Road, Columbia, MD 21045. The test site is one of the highest points in the Columbia area with an elevation of 390 feet above mean sea level. The site coordinates are 39° 11'15" N latitude and 76° 49' 38" W longitude. The facility is 1.5 miles north of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. There are no FM or TV transmitters within 15 miles of the site. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4 on January 27, 2006 and Industry Canada.

## 2.2 Test Facility / Accreditations:

Measurements were performed at an independent accredited PCTEST Engineering Lab located in Columbia, MD 21045, U.S.A.

- PCTEST Lab is accredited to ISO 17025-2005 by the American Association for Laboratory Accreditation (A2LA) in Specific Absorption Rate (SAR) testing, Hearing-Aid Compatibility (HAC), CTIA Test Plans, and wireless testing for FCC and Industry Canada Rules.
- PCTEST Lab is accredited to ISO 17025 by U.S. National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP Lab code: 100431-0) in EMC, FCC and Telecommunications.
- PCTEST facility is an FCC registered (PCTEST Reg. No. 90864) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules and Industry Canada (IC-2451).
- PCTEST Lab is a recognized U.S. Conformity Assessment Body (CAB) in EMC and R&TTE (n.b. 0982) under the U.S.-EU Mutual Recognition Agreement (MRA).
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC Guide 65 by the American National Standards Institute (ANSI) in all scopes of FCC Rules and all Industry Canada Standards (RSS).


- PCTEST facility is an IC registered (IC-2451) test laboratory with the site description on file at Industry Canada.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for AMPS and CDMA, and EvDO mobile phones.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for Over-the-Air (OTA) Antenna Performance testing for AMPS, CDMA, GSM, GPRS, EGPRS, UMTS (W-CDMA), CDMA 1xEVDO Data, CDMA 1xRTT Data.

# 3 SAR MEASUREMENT SETUP

## 3.1 Robotic System

Measurements are performed using the DASY4 automated dosimetric assessment system. The DASY4 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, Pentium 4 computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Figure 3-1).

## 3.2 System Hardware

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the Gateway Pentium 4 2.53 GHz computer with Windows XP system and SAR Measurement Software DASY4, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

## 3.3 System Electronics

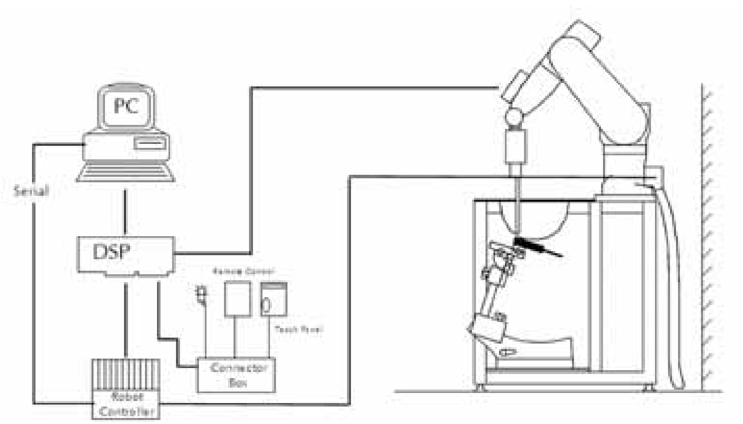


**Figure 3-1**
**SAR Measurement System Setup**

The 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 PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in [7].

## 3.4 Automated Test System Specifications

Positioner

| | |
|---|---|
| Robot: | Stäubli Unimation Corp. Robot RX60L |
| Repeatability: | 0.02 mm |
| No. of Axes: | 6 |

Data Acquisition Electronic System (DAE)

Cell Controller

| | |
|---|---|
| Processor: | Pentium 4 |
| Clock Speed: | 2.53 GHz |
| Operating System: | Windows XP Professional |

Data Converter

| | |
|---|---|
| Features: | Signal Amplifier, multiplexer, A/D converter & control logic |
| Software: | DASY4, SEMCAD software |
| Connecting Lines: | Optical Downlink for data and status info<br>Optical upload for commands and clock |

PC Interface Card

| | |
|---|---|
| Function: | 166MHz low power Pentium MMX 32MB chipdisk<br>Link to DAE<br>16-bit A/D converter for surface detection system<br>Two Serial & Ethernet link to robotics<br>Direct emergency stop output for robot |

Phantom

| | |
|---|---|
| Type: | SAM Twin Phantom (V4.0) |
| Shell Material: | Composite |
| Thickness: | 2.0 ± 0.2 mm |

**Figure 3-2**
**DASY4 SAR Measurement System**

# 4 DASY E-FIELD PROBE SYSTEM

## 4.1 Probe Measurement System

**Figure 4-1**
**SAR System**

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration [7] (see Figure 4-1) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip (see Figure 4-2). It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting (see Figure 5-1). The approach is stopped at reaching the maximum.

## 4.2 Probe Specifications

| | |
|---|---|
| **Model:** | EX3DV4 |
| **Frequency Range:** | 10 MHz – 6.0 GHz |
| **Calibration:** | In brain and muscle simulating tissue at Frequencies from 835 up to 5800MHz |
| **Linearity:** | ± 0.2 dB (30 MHz to 6 GHz) |
| **Dynamic Range:** | 10 mW/kg – 100 W/kg |
| **Probe Length:** | 330 mm |
| **Probe Tip Length:** | 20 mm |
| **Body Diameter:** | 12 mm |
| **Tip Diameter:** | 2.5 mm |
| **Tip-Center:** | 1 mm |
| **Application:** | SAR Dosimetry Testing |
| | Compliance tests of mobile phones |

**Figure 4-2**
**Near-Field Probe**

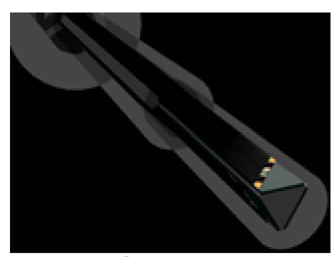

**Figure 4-3**
**Triangular Probe Configuration**

# 5 PROBE CALIBRATION PROCESS

## 5.1 Dosimetric Assessment Procedure

Each E-Probe/Probe amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm$^2$) using an RF Signal generator, TEM cell, and RF Power Meter.

## 5.2 Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm$^2$.

## 5.3 Temperature Assessment

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

SAR = $C\frac{\Delta T}{\Delta t}$

where:

$\Delta t$ = exposure time (30 seconds),

C = heat capacity of tissue (brain or muscle),

$\Delta T$ = temperature increase due to RF exposure.

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

where:

$\sigma$ = simulated tissue conductivity,

$\rho$ = Tissue density

SAR is proportional to $\Delta T/\Delta t$, the initial rate of tissue heating, before thermal diffusion takes place. Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

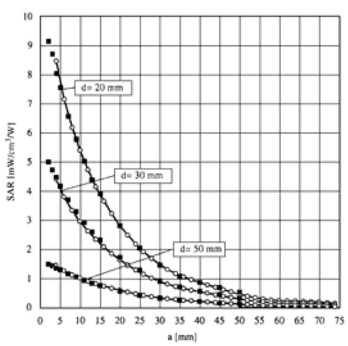


**Figure 5-1 E-Field and Temperature measurements at 900MHz [7]**

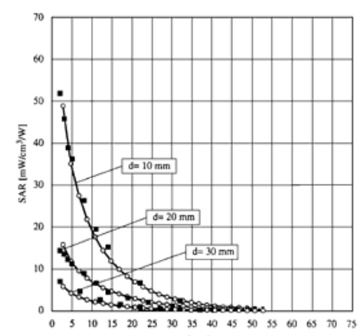


**Figure 5-2 E-Field and temperature measurements at 1.9GHz [7]**

# 6 PHANTOM AND EQUIVALENT TISSUES

## 6.1 SAM Phantoms

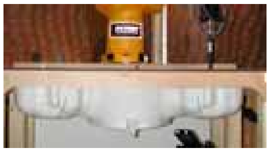

**Figure 6-1**
**SAM Phantoms**

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users [11][12]. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

## 6.2 Brain & Muscle Simulating Mixture Characterization

**Figure 6-2**
**Head Simulated**

The brain and muscle mixtures consist of a viscous gel using hydroxethylcellulose (HEC) gelling agent and saline solution (see Table 6-1). Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 have been incorporated in the following table. Other head and body tissue parameters that have not been specified in IEEE-1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Hartsgrove [13].(See Table 6-1)

**Table 6-1**
Composition of the Brain & Muscle Tissue Equivalent Matter

| Frequency (MHz) | 300 | 450 | | 835 | 900 | | | 1450 | 1800 | | | | 1900 | | 1950 | 2000 | 2100 | | 2450 | | 3000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recipe # | 1 | 1 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 2 | 2 | 3 | 1 | 2 | 4 | 1 | 1 | 2 | 2 | 3 | 2 |
| **Ingredients (% by weight)** | | | | | | | | | | | | | | | | | | | | | |
| 1,2-Pro-panediol | | | | | | 64.81 | | | | | | | | | | | | | | | |
| Bactericide | 0.19 | 0.19 | 0.50 | 0.10 | 0.10 | | 0.50 | | | | | 0.50 | | | | | | | | 0.50 | |
| Diacetin | | | 48.90 | | | | 49.20 | | | | | 49.43 | | | | | | | | 49.75 | |
| DGBE | | | | | | | | 45.41 | 47.00 | 13.84 | 44.92 | | 44.94 | 13.84 | 45.00 | 50.00 | 50.00 | 7.99 | 7.99 | | 7.99 |
| HEC | 0.98 | 0.98 | | 1.00 | 1.00 | | | | | | | | | | | | | | | | |
| NaCl | 5.95 | 3.95 | 1.70 | 1.45 | 1.48 | 0.79 | 1.10 | 0.67 | 0.36 | 0.35 | 0.18 | 0.64 | 0.18 | 0.35 | | | | 0.16 | 0.16 | | 0.16 |
| Sucrose | 55.32 | 56.32 | | 57.00 | 56.50 | | | | | | | | | | | | | | | | |
| Triton X-100 | | | | | | | | | | 30.45 | | | | 30.45 | | | | 19.97 | 19.97 | | 19.97 |
| Water | 37.56 | 38.56 | 48.90 | 40.45 | 40.92 | 34.40 | 49.20 | 53.80 | 52.64 | 55.36 | 54.90 | 49.43 | 54.90 | 55.36 | 55.00 | 50.00 | 50.00 | 71.88 | 71.88 | 49.75 | 71.88 |
| **Measured dielectric parameters** | | | | | | | | | | | | | | | | | | | | | |
| $\epsilon_r'$ | 46.00 | 43.4 | 44.3 | 41.6 | 41.2 | 41.8 | 42.7 | 40.9 | 39.3 | 41 | 40.4 | 39.2 | 39.9 | 41 | 40.1 | 37 | 36.8 | 41.1 | 40.3 | 39.2 | 37.9 |
| $\sigma$(S/m) | 0.86 | 0.85 | 0.9 | 0.9 | 0.98 | 0.97 | 0.99 | 1.21 | 1.39 | 1.38 | 1.4 | 1.4 | 1.42 | 1.38 | 1.41 | 1.4 | 1.51 | 1.55 | 1.88 | 1.82 | 2.46 |
| Temp. (°C) | 22 | 22 | 20 | 22 | 22 | 22 | 20 | 22 | 22 | 21 | 22 | 20 | 21 | 21 | 20 | 22 | 22 | 20 | 20 | 20 | 20 |
| **Target dielectric parameters (Table 2)** | | | | | | | | | | | | | | | | | | | | | |
| $\epsilon_r'$ | 45.30 | 43.50 | | 41.5 | 41.50 | | | 40.5 | 40.0 | | | | | | | | 39.80 | | 39.2 | | 38.5 |
| $\sigma$(S/m) | 0.87 | 0.87 | | 0.9 | 0.97 | | | 1.2 | 1.4 | | | | | | | | 1.49 | | 1.8 | | 2.4 |
| NOTE—Multiple columns for any single frequency are optional recipes. Recipe #, reference: 1 (Kanda et al. [B85]), 2 (Vigneras [B143]), 3 (Peyman and Gabriel [B119]), 4 (Fukunaga et al. [B50]). | | | | | | | | | | | | | | | | | | | | | |

*The formulas containing Triton X-100 and corresponding measured parameters are under review and verification.

# 7 DOSIMETRIC ASSESSMENT & PHANTOM SPECS

## 7.1 Measurement Procedure

The evaluation was performed using the following procedure:

1. The SAR measurement was taken at a selected spatial reference point to monitor power variations during testing. This fixed point was measured and used as a reference value.
2. The SAR distribution at the exposed side of the phantom was measured at a distance of 3.0mm from the inner surface of the shell. The horizontal grid spacing was 15mm x 15mm.
3. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation. Around this point, a volume of 32mm x 32mm x 30mm (fine resolution volume scan, zoom scan) was assessed by measuring 5 x 5 x 7 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see Figure 7-1):
   a. The data at the surface was extrapolated since the center of the dipoles is 2.7mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2mm. The extrapolation was based on a least square algorithm [15]. A polynomial of the fourth order was calculated through the points in the z-axis. This polynomial was then used to evaluate the points between the surface and the probe tip.
   b. The maximum interpolated value was found with a software algorithm. Around this maximum, the SAR values averaged over the spatial volumes (1g or 10g) were computed using 3D-Spline interpolation. The 3D-spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y, and z directions) [15][16]. The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.
   c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 1, was re-measured to measure drift. If the value drifted by more than 5%, the evaluation was repeated.

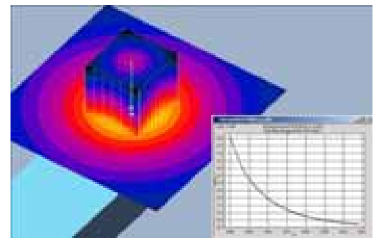

**Figure 7-1**
**Sample SAR Area Scan**

## 7.2 Specific Anthropomorphic Mannequin (SAM) Specifications

The phantom for handset SAR assessment testing is a low-loss dielectric shell, with shape and dimensions derived from the anthropometric data of the 90th percentile adult male head dimensions as tabulated by the US Army. The SAM Twin Phantom shell is bisected along the mid-sagittal plane into right and left halves (see Figure 7-2). The perimeter sidewalls of each phantom halves are extended to allow filling with liquid to a depth that is sufficient to minimized reflections from the upper surface. The liquid depth is maintained at a minimum depth of 15cm to minimize reflections from the upper surface.

**Figure 7-2**
**SAM Twin Phantom Shell**

# 8 TEST CONFIGURATION POSITIONS

## 8.1 SAR for Notebooks and Lap-touching Devices

Lap-touching devices that have transmitting antennas located less than 20 cm from the lap of the user require routine SAR evaluation. Such devices are considered portable and are capable of being held to the body. Devices are to be setup touching the phantom and are configured with maximum output power during SAR assessment for a worst-case SAR evaluation.

**Figure 8-1**
**Notebook Setup for SAR**

## 8.2 Integral Antenna PCMCIA and CompactFlash Cards

KDB 497522. Integral-antenna PCMCIA and CompactFlash radio cards are common module-like devices meant to be purchased and installed without tools or special skills by consumers. The common host configurations (platforms, categories) are notebook (laptop) computers with PCMCIA slot(s) in the keyboard section, and PDAs (personal digital assistants or palmtop computers). Integral-antenna radio cards installed in PDAs with body-worn and/or held-to-ear configurations, and in all notebook computers, must be evaluated under portable RF exposure conditions per 47 C.F.R. 2.1093(b). To better represent the range of near field topography and environment of various notebook and PDA hosts, SAR evaluation using a minimum of <u>three</u> hosts within each platform type (three PDAs, three notebooks, etc.) is recommended by FCC. Hosts shall be modern, current-market, and expected final installations for the PC Cards.

**Figure 8-2**
**CompactFlash radio card in PDA host configuration**

For notebook computers with multiple card slots (e.g., two stacked), RF exposure should be evaluated with the transmitter installed in the slot(s) producing the highest SAR (See Figure 8-3). The minimum number of positions that should be evaluated for notebook computers and body-worn PDAs are bottom-face in parallel and in contact (0 cm) with flat phantom, and device perpendicular to phantom with recommended spacing of 1.5 cm.

**Figure 8-3**
**PCMCIA Radio Card in a notebook host configuration**

## 8.3 Positioning for Convertible and Slate Tablet Computers


**Figure 8-4**
**Tablet Computer Form Factors**

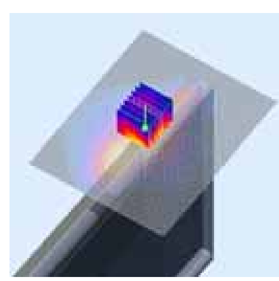

**Figure 8-5**
**Tablet PC Body SAR**

KDB 447498. Tablet (notepad) computers are tested in a lap-held position with the bottom of the computer in direct contact against a flat phantom for all user-enabled portrait and landscape positions.

## 8.4 SAR Testing with IEEE 802.11 a/b/g Transmitters

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

### 8.4.1 General Device Setup

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

### 8.4.2 Frequency Channel Configurations [22]

802.11 a/b/g and 4.9 GHz operating modes are tested independently according to the service requirements in each frequency band. 802.11 b/g modes are tested on channels 1, 6 and 11. 802.11a is tested for UNII operations on channels 36 and 48 in the 5.15-5.25 GHz band; channels 52 and 64 in the 5.25-5.35 GHz band; channels 104, 116, 124 and 136 in the 5.470-5.725 GHz band; and channels 149 and 161 in the 5.8 GHz band. When 5.8 GHz §15.247 is also available, channels 149, 157 and 165 should be tested instead of the UNII channels. 4.9 GHz is tested on channels 1, 10 and 5 or 6, whichever has the higher output power, for 5 MHz channels; channels 11, 15 and 19 for 10 MHz channels; and channels 21 and 25 for 20 MHz channels. These are referred to as the "default test channels". 802.11g mode was evaluated only if the output power was 0.25 dB higher than the 802.11b mode.

**Table 8-1**
**802.11 Test Channels per FCC Requirements**

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

## 9 RF CONDUCTED POWER

Power measurements were performed using a power meter.

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

The device was placed into a simulated call using a base power meter in a shielded chamber. Such test signals offer a consistent means for testing SAR and are recommended for evaluating SAR [4]. SAR measurements were taken with a fully charged battery. In order to verify that the device was tested and maintained at full power, the SAR measurement software calculates a reference point at the start and end of the test to check for power drifts. If conducted power deviations of more than 5% occurred, the tests were repeated.

### 9.2 Device Conducted Powers:

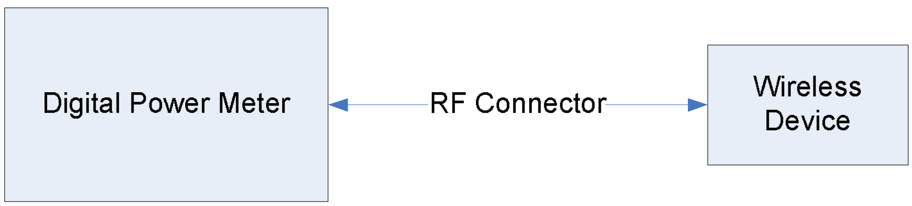


**Figure 9-1**
**Power Measurement Setup**

| Ch. | Freq. MHz | Mode TX no Mod dBm | Mode TX w/ Mod dBm | Ch. | Freq. MHz | Mode TX no Mod dBm | Mode TX w/ Mod dBm |
|---|---|---|---|---|---|---|---|
| 0 | 2405 | 15.29 | 15.28 | 8 | 2445 | 15.53 | 15.53 |
| 1 | 2410 | 15.31 | 15.29 | 9 | 2450 | 15.57 | 15.56 |
| 2 | 2415 | 15.35 | 15.32 | 10 | 2455 | 15.59 | 15.58 |
| 3 | 2420 | 15.36 | 15.34 | 11 | 2460 | 15.61 | 15.62 |
| 4 | 2425 | 15.39 | 15.37 | 12 | 2465 | 15.64 | 15.65 |
| 5 | 2430 | 15.43 | 15.45 | 13 | 2470 | 14.29 | 14.27 |
| 6 | 2435 | 15.45 | 15.46 | 14 | 2475 | 10.15 | 10.12 |
| 7 | 2440 | 15.50 | 15.49 | 15 | 2480 | 1.54 | 1.53 |
| 8 | 2445 | 15.53 | 15.51 | | | | |

**Note:** RF Conducted Power Measurements were performed with an equivalent test sample modified to allow for RF conducted power measurements to be taken directly from the device.

# 10 ANSI/IEEE C95.1-2005 RF EXPOSURE LIMITS

## 10.1 Uncontrolled Environment

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

## 10.2 Controlled Environment

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

**Table 10-1**
**SAR Human Exposure Specified in ANSI/IEEE C95.1-2005**

| HUMAN EXPOSURE LIMITS | | |
|---|---|---|
| | UNCONTROLLED ENVIRONMENT<br>*General Population*<br>(W/kg) or (mW/g) | CONTROLLED ENVIRONMENT<br>*Occupational*<br>(W/kg) or (mW/g) |
| SPATIAL PEAK SAR<br>Brain | 1.6 | 8.0 |
| SPATIAL AVERAGE SAR<br>Whole Body | 0.08 | 0.4 |
| SPATIAL PEAK SAR<br>Hands, Feet, Ankles, Wrists | 4.0 | 20 |

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

# 11 MEASUREMENT UNCERTAINTIES

| a | b | c | d | e= f(d,k) | f | g | h = c x f/e | i = c x g/e | k |
|---|---|---|---|---|---|---|---|---|---|
| **Uncertainty Component** | **IEEE 1528 Sec.** | **Tol. (± %)** | **Prob. Dist.** | **Div.** | **$c_i$ 1gm** | **$c_i$ 10 gms** | **1gm $u_i$ (± %)** | **10gms $u_i$ (± %)** | **$v_i$** |
| **Measurement System** | | | | | | | | | |
| Probe Calibration | E.2.1 | 6.6 | N | 1 | 1.0 | 1.0 | 6.6 | 6.6 | ∞ |
| Axial Isotropy | E.2.2 | 0.25 | N | 1 | 0.7 | 0.7 | 0.2 | 0.2 | ∞ |
| Hemishperical Isotropy | E.2.2 | 1.3 | N | 1 | 1.0 | 1.0 | 1.3 | 1.3 | ∞ |
| Boundary Effect | E.2.3 | 0.4 | N | 1 | 1.0 | 1.0 | 0.4 | 0.4 | ∞ |
| Linearity | E.2.4 | 0.3 | N | 1 | 1.0 | 1.0 | 0.3 | 0.3 | ∞ |
| System Detection Limits | E.2.5 | 5.1 | N | 1 | 1.0 | 1.0 | 5.1 | 5.1 | ∞ |
| Readout Electronics | E.2.6 | 1.0 | N | 1 | 1.0 | 1.0 | 1.0 | 1.0 | ∞ |
| Response Time | E.2.7 | 0.8 | R | 1.73 | 1.0 | 1.0 | 0.5 | 0.5 | ∞ |
| Integration Time | E.2.8 | 2.6 | R | 1.73 | 1.0 | 1.0 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions | E.6.1 | 3.0 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | E.6.2 | 0.4 | R | 1.73 | 1.0 | 1.0 | 0.2 | 0.2 | ∞ |
| Probe Positioning w/ respect to Phantom | E.6.3 | 2.9 | R | 1.73 | 1.0 | 1.0 | 1.7 | 1.7 | ∞ |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E.5 | 1.0 | R | 1.73 | 1.0 | 1.0 | 0.6 | 0.6 | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Test Sample Positioning | E.4.2 | 6.0 | N | 1 | 1.0 | 1.0 | 6.0 | 6.0 | 287 |
| Device Holder Uncertainty | E.4.1 | 3.32 | R | 1.73 | 1.0 | 1.0 | 1.9 | 1.9 | ∞ |
| Output Power Variation - SAR drift measurement | 6.6.2 | 5.0 | R | 1.73 | 1.0 | 1.0 | 2.9 | 2.9 | ∞ |
| **Phantom & Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape & Thickness tolerances) | E.3.1 | 4.0 | R | 1.73 | 1.0 | 1.0 | 2.3 | 2.3 | ∞ |
| Liquid Conductivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Conductivity - measurement uncertainty | E.3.3 | 3.8 | N | 1 | 0.64 | 0.43 | 2.4 | 1.6 | 6 |
| Liquid Permittivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.60 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid Permittivity - measurement uncertainty | E.3.3 | 4.5 | N | 1 | 0.60 | 0.49 | 2.7 | 2.2 | 6 |
| **Combined Standard Uncertainty (k=1)** | | | RSS | | | | 12.4 | 12.0 | 299 |
| **Expanded Uncertainty** (95% CONFIDENCE LEVEL) | | | k=2 | | | | 24.7 | 24.0 | |

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

# 12 SYSTEM VERIFICATION

## 12.1 Tissue Verification

**Table 12-1**
**Measured Tissue Properties**

| Calibrated Date: | 03/30/07 | | 03/30/07 | |
|---|---|---|---|---|
| | **2450H** | | **2450M** | |
| | Target | Measured | Target | Measured |
| Dielectric Constant | 39.2 | 40.3 | 52.7 | 51.9 |
| Conductivity | 1.80 | 1.84 | 1.95 | 1.93 |

## 12.2 Test System Verification

Prior to assessment, the system is verified to ±10% of the specifications at 2450MHz by using the system validation kit(s). (Graphic Plots Attached)

**Table 12-2**
**System Verification Results**

| System Verification TARGET & MEASURED | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date:** | **Amb. Temp (˚C)** | **Liquid Temp(˚C)** | **Input Power (W)** | **Tissue Frequency (Mhz)** | **Targeted $SAR_{1g}$ (mW)** | **Measured $SAR_{1g}$ (mW)** | **Deviation (%)** |
| 03/30/07 | 23.8 | 21.3 | 0.1 | 2450 | 5.40 | 5.63 | 4.3% |

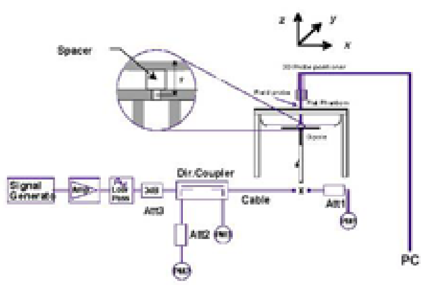


**Figure 12-1**
**System Verification Setup Diagram**

**Figure 12-2**
**System Verification Setup Photo**

## 13 SAR DATA SUMMARY

### 13.1 2450 MHz Body SAR Results

| MEASUREMENT RESULTS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FREQUENCY | | Mode | C_Power[dBm] | | Position | Spacing | Service | Antenna Type | Battery | SAR |
| MHz | Ch. | | Start | End | | | | | | (W/kg) |
| 2405.00 | 0 | IEEE 802.15 | 15.29 | 15.29 | Laptop | 1.5 cm | TX. no Modulation | Internal | Standard | **1.110** |
| 2410.00 | 1 | IEEE 802.15 | 15.31 | 15.20 | Laptop | 1.5 cm | TX. no Modulation | Internal | Standard | 1.100 |
| 2435.00 | 6 | IEEE 802.15 | 15.45 | 15.64 | Laptop | 1.5 cm | TX. no Modulation | Internal | Standard | 1.030 |
| 2445.00 | 8 | IEEE 802.15 | 15.53 | 15.52 | Laptop | 1.5 cm | TX. no Modulation | Internal | Standard | 1.100 |
| 2465.00 | 12 | IEEE 802.15 | 15.64 | 15.65 | Laptop | 1.5 cm | TX. no Modulation | Internal | Standard | 1.030 |
| 2480.00 | 15 | IEEE 802.15 | 1.54 | 1.65 | Laptop | 1.5 cm | TX. no Modulation | Internal | Standard | 1.010 |
| 2405.00 | 0 | IEEE 802.15 | 15.28 | 15.43 | Laptop | 1.5 cm | TX. with Modulation | Internal | Standard | 1.050 |
| 2410.00 | 1 | IEEE 802.15 | 15.29 | 15.15 | Laptop | 1.5 cm | TX. with Modulation | Internal | Standard | 1.070 |
| 2435.00 | 6 | IEEE 802.15 | 15.46 | 15.38 | Laptop | 1.5 cm | TX. with Modulation | Internal | Standard | 1.040 |
| 2445.00 | 8 | IEEE 802.15 | 15.51 | 15.60 | Laptop | 1.5 cm | TX. with Modulation | Internal | Standard | **1.090** |
| 2465.00 | 12 | IEEE 802.15 | 15.65 | 15.60 | Laptop | 1.5 cm | TX. with Modulation | Internal | Standard | 0.985 |
| 2480.00 | 15 | IEEE 802.15 | 1.53 | 1.63 | Laptop | 1.5 cm | TX. with Modulation | Internal | Standard | 1.040 |
| **ANSI / IEEE C95.1 2005 - SAFETY LIMIT**<br>**Spatial Peak**<br>**Uncontrolled Exposure/General Population** | | | | | | **Muscle**<br>**1.6 W/kg (mW/g)**<br>averaged over 1 gram | | | | |

Notes:

1. The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supplement C [July 2001].
2. All modes of operation were investigated, and worst-case results are reported.
3. Batteries are fully charged for all readings. Standard batteries were investigated.
4. Tissue parameters and temperatures are listed on the SAR plots.
5. Liquid tissue depth is 15.1 cm. ± 0.1.
6. Body SAR was tested with PA On

# 14 EQUIPMENT LIST

| Manufacturer | Model / Equipment | Calibration Date | Cal Inerval | Calibration Due | Serial No. |
|---|---|---|---|---|---|
| Agilent | 8753E (30kHz-6GHz) Network Analyzer | 5/25/2006 | Annual | 5/25/2007 | JP38020182 |
| Agilent | N4010A Wireless Connectivity Test Set | 6/11/2006 | Annual | 6/11/2007 | GB46170464 |
| Agilent | E5515C Wireless Communications Test Set | 7/27/2006 | Annual | 7/27/2007 | GB41450275 |
| Agilent | E5515C Wireless Communications Test Set | 10/6/2006 | Annual | 10/6/2007 | GB43193972 |
| Agilent | 8648D (9kHz-4GHz) Signal Generator | 10/1/2006 | Annual | 10/1/2007 | 3613A00315 |
| Agilent | E5515C Wireless Communications Test Set | 10/26/2006 | Biennial | 10/25/2008 | GB46310798 |
| Rohde & Schwarz | NRVS Power Meter | 6/1/2005 | Biennial | 6/1/2007 | 835360/079 |
| Rohde & Schwarz | NRV-Z53 Power Sensor | 6/1/2005 | Biennial | 6/1/2007 | 846076/007 |
| Rohde & Schwarz | CMU200 Base Station Simulator | 11/8/2006 | Annual | 11/8/2007 | 107826 |
| Rohde & Schwarz | CMU200 Base Station Simulator | 7/26/2006 | Annual | 7/26/2007 | 833855/010 |
| Rohde & Schwarz | CMU200 Base Station Simulator | 4/20/2006 | Annual | 4/20/2007 | 836371/079 |
| SPEAG | D1900V2 1900 MHz SAR Dipole | 1/23/2007 | Biennial | 1/22/2009 | 502 |
| SPEAG | D835V2 835MHz SAR Dipole | 8/24/2005 | Biennial | 8/24/2007 | 4d026 |
| SPEAG | D5GHzV2 5 GHz SAR Dipole | 10/5/2005 | Biennial | 10/5/2007 | 1007 |
| SPEAG | EX3DV4 SAR Probe | 1/22/2007 | Annual | 1/22/2008 | 3550 |
| SPEAG | DAE4 | 6/1/2006 | Annual | 6/1/2007 | 704 |
| SPEAG | EX3DV4 SAR Probe | 7/14/2006 | Annual | 7/14/2007 | 3589 |
| SPEAG | DAE4 | 9/4/2006 | Annual | 9/4/2007 | 665 |
| SPEAG | EX3DV4 SAR Probe | 11/23/2006 | Annual | 11/23/2007 | 3561 |
| SPEAG | ES3DV2 SAR Probe | 9/20/2006 | Annual | 9/20/2007 | 3022 |
| SPEAG | DAE3 | 10/16/2006 | Annual | 10/16/2007 | 455 |
| SPEAG | DAE4 | 1/23/2007 | Annual | 1/23/2008 | 649 |
| SPEAG | D2600V2 2600MHz SAR Dipole | 1/5/2007 | Annual | 1/5/2008 | 1004 |
| VWR | 61161-274 Alarm Digital Thermometer | 8/19/2006 | Annual | 8/19/2007 | 51280556 |
| Rohde & Schwarz | NRVD Dual Channel Power Meter | 12/11/2006 | Biennial | 12/10/2008 | 101695 |
| Rohde & Schwarz | NRV-Z33 Peak Power Sensor (1mW-20W) | 11/28/2006 | Biennial | 11/27/2008 | 100155 |
| Rohde & Schwarz | NRV-Z32 Peak Power Sensor (100uW-2W) | 12/21/2006 | Biennial | 12/20/2008 | 100004 |
| SPEAG | D835V2 835MHz SAR Dipole | 1/8/2007 | Biennial | 1/7/2009 | 4d047 |
| SPEAG | D1900V2 1900MHz SAR Dipole | 1/23/2007 | Biennial | 1/22/2009 | 5d080 |
| SPEAG | D2450V2 2450MHz SAR Dipole | 1/17/2007 | Biennial | 1/16/2009 | 797 |
| SPEAG | D5GHzV2 5GHz SAR Dipole | 1/24/2007 | Biennial | 1/23/2009 | 1057 |

Notes:

The E-field probe was calibrated by SPEAG, by the waveguide technique procedure. Dipole Validation measurement is performed by PCTEST prior to SAR evaluation. The brain simulating material is calibrated by PCTEST using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain-equivalent material.

# 15 CONCLUSION

## 15.1 Measurement Conclusion

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

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

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# PCTEST ENGINEERING LABORATORY, INC.

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

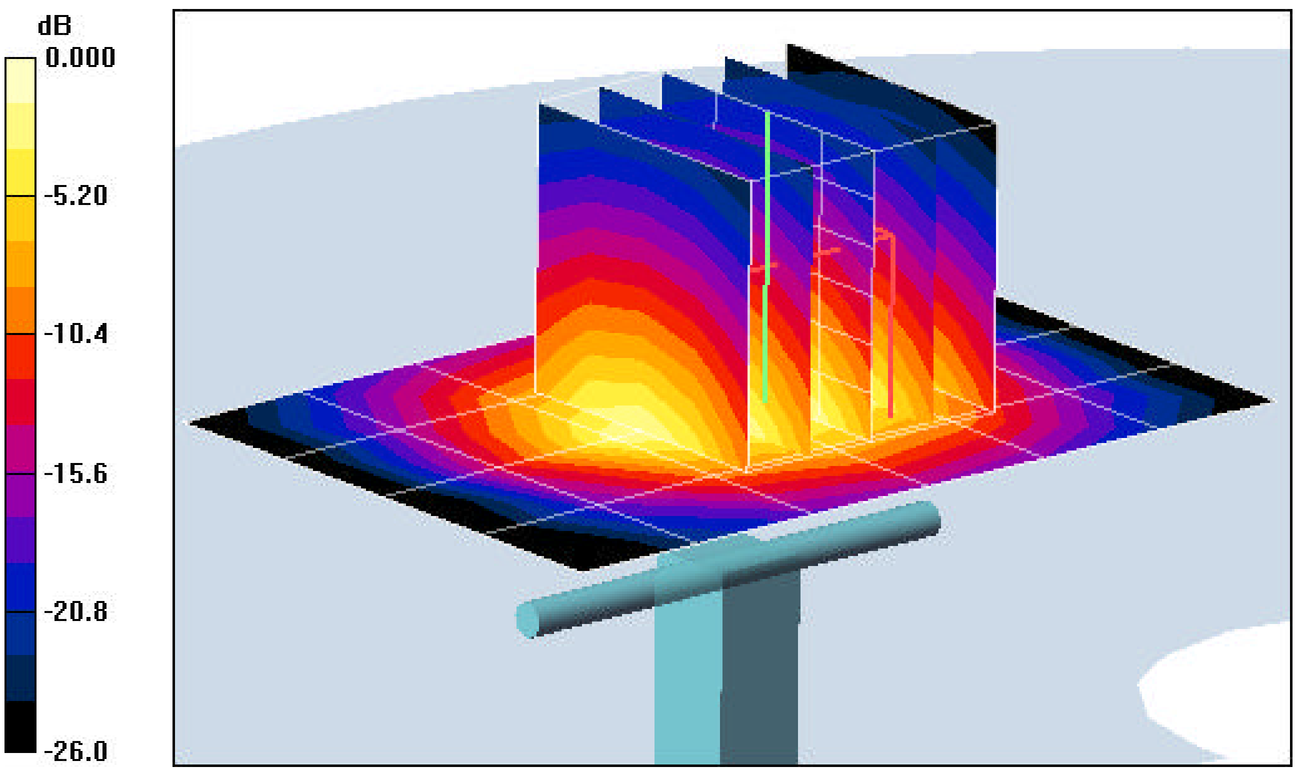
Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: 2450 Brain ($\sigma$ = 1.84 mho/m, $\varepsilon_r$ = 40.32, $\rho$ = 1000 kg/$m^3$)
Phantom section: Flat Section

Test Date: 03-30-2007; Ambient Temp: 23.8°C; Tissue Temp: 21.3°C

Probe: EX3DV4 - SN3589; ConvF(6.27, 6.27, 6.27); Calibrated: 7/14/2006
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn704; Calibrated: 6/1/2006
Phantom: SAM Main; Type: SAM 4.0; Serial: TP:1197
Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

## 2450MHz Dipole Validation

**Area Scan (5x7x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Input Power = 20.0 dBm (100 mW)
**SAR(1 g) = 5.63 mW/g; SAR(10 g) = 2.48 mW/g**
Target SAR(1g) = 5.4 mW/g; Deviation = + 4.25 %




0 dB = 7.26mW/g

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: UBI DUO 200A Type: DTS 2.4GHz Face to Face Communicator; SN:823064000071**

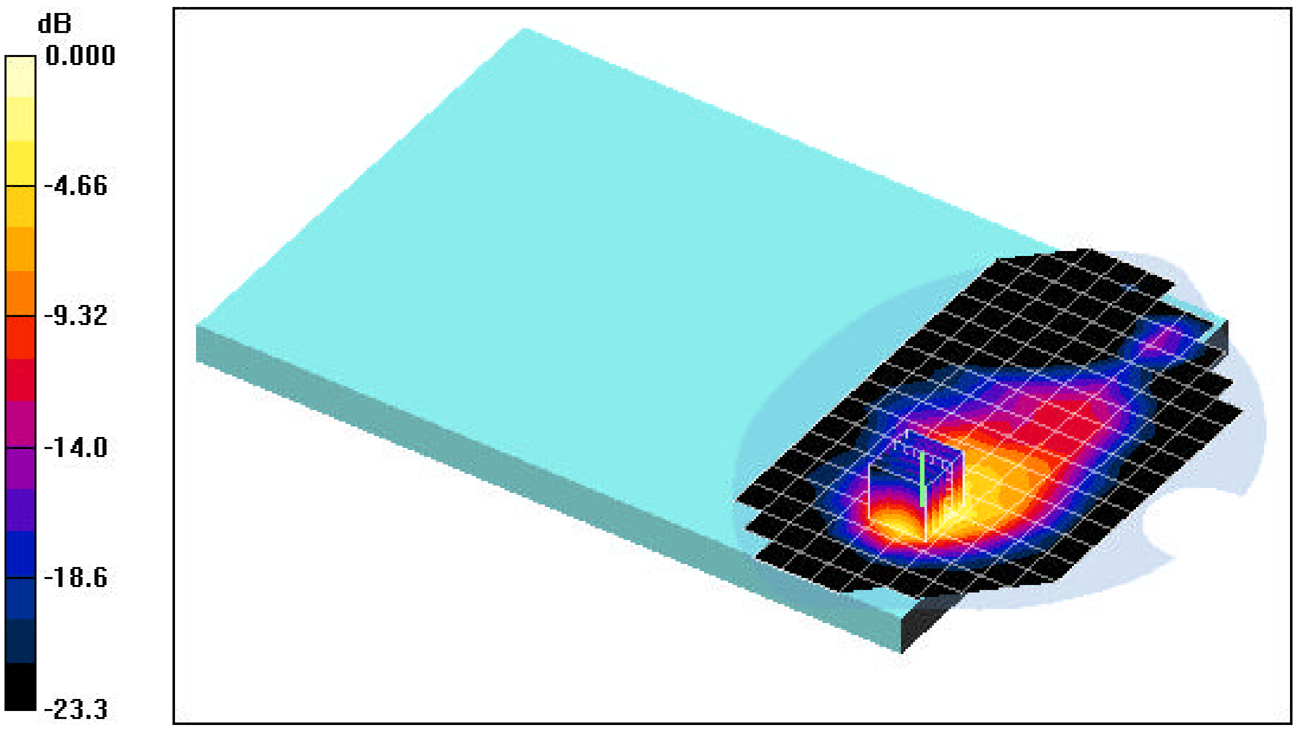
Communication System: IEEE 802.15; Frequency: 2405 MHz;Duty Cycle: 1:1
Medium: 2450 Muscle ($\sigma$ = 1.93 mho/m, $\varepsilon_r$ = 51.92, $\rho$ = 1000 kg/$m^3$)
Phantom section: Flat Section

Test Date: 03-30-2007; Ambient Temp: 23.8°C; Tissue Temp: 21.3°C

Probe: EX3DV4 - SN3589; ConvF(6.37, 6.37, 6.37); Calibrated: 7/14/2006
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn704; Calibrated: 6/1/2006
Phantom: SAM Main; Type: SAM 4.0; Serial: TP:1197
Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Body SAR, Laptop position, Low Ch, TX no moulation**

**Area Scan (11x19x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.83 V/m
Peak SAR (extrapolated) = 2.17 W/kg
**SAR(1 g) = 1.11 mW/g; SAR(10 g) = 0.552 mW/g**




0 dB = 1.25mW/g

# PCTEST ENGINEERING LABORATORY, INC.

**DUT: UBI DUO 200A Type: DTS 2.4GHz Face to Face Communicator; SN:823064000071**

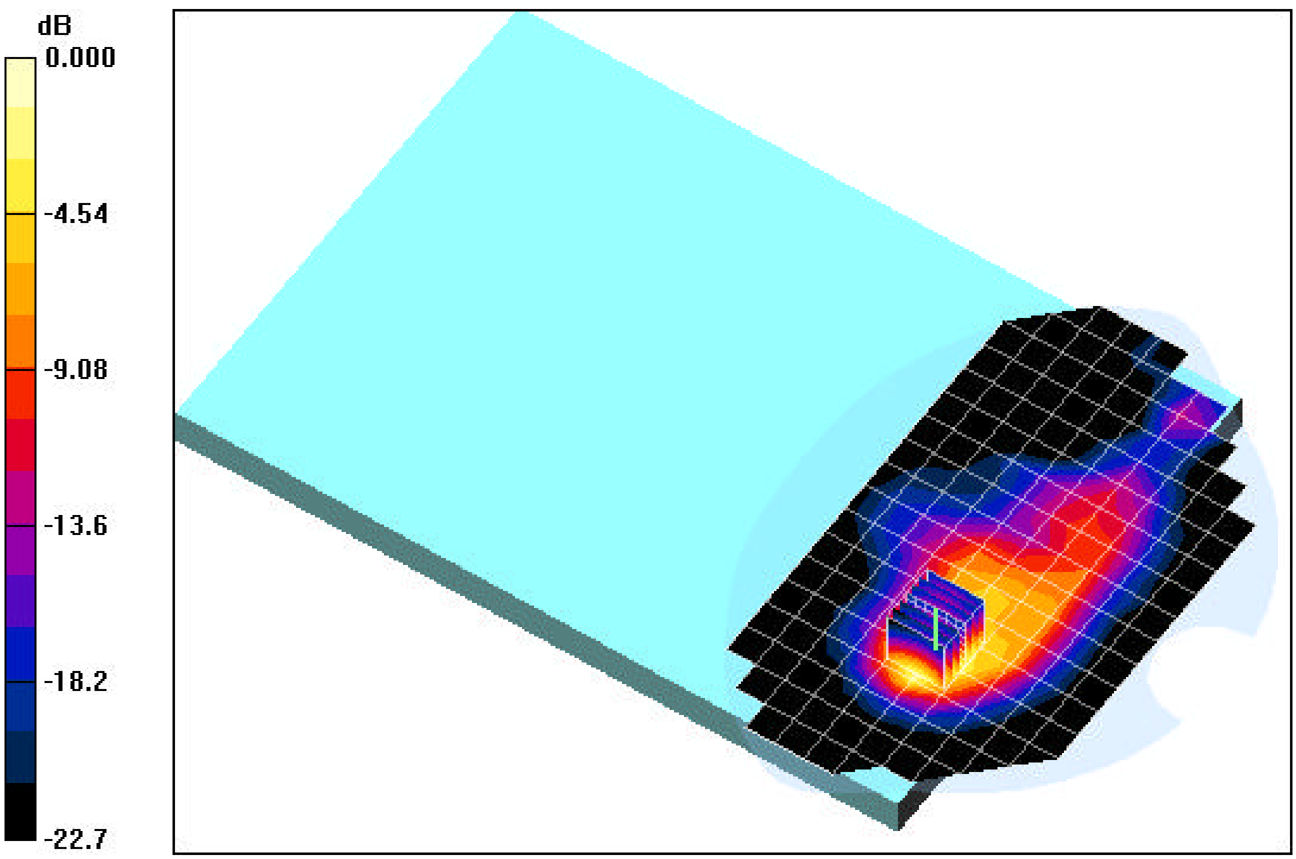
Communication System: IEEE 802.15 ; Frequency: 2480 MHz;Duty Cycle: 1:1
Medium: 2450 Muscle ($\sigma$ = 1.93 mho/m, $\varepsilon_r$ = 51.92, $\rho$ = 1000 kg/m$^3$)
Phantom section: Flat Section

Test Date: 03-30-2007; Ambient Temp: 23.8°C; Tissue Temp: 21.3°C

Probe: EX3DV4 - SN3589; ConvF(6.37, 6.37, 6.37); Calibrated: 7/14/2006
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn704; Calibrated: 6/1/2006
Phantom: SAM Main; Type: SAM 4.0; Serial: TP:1197
Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Body SAR, Laptop position, High Ch, TX w/ modulation**

**Area Scan (11x19x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 6.68 V/m
Peak SAR (extrapolated) = 2.14 W/kg
**SAR(1 g) = 1.05 mW/g; SAR(10 g) = 0.508 mW/g**



# PCTEST ENGINEERING LABORATORY, INC.

**DUT: UBI DUO 200A Type: DTS 2.4GHz Face to Face Communicator; SN:823064000071**

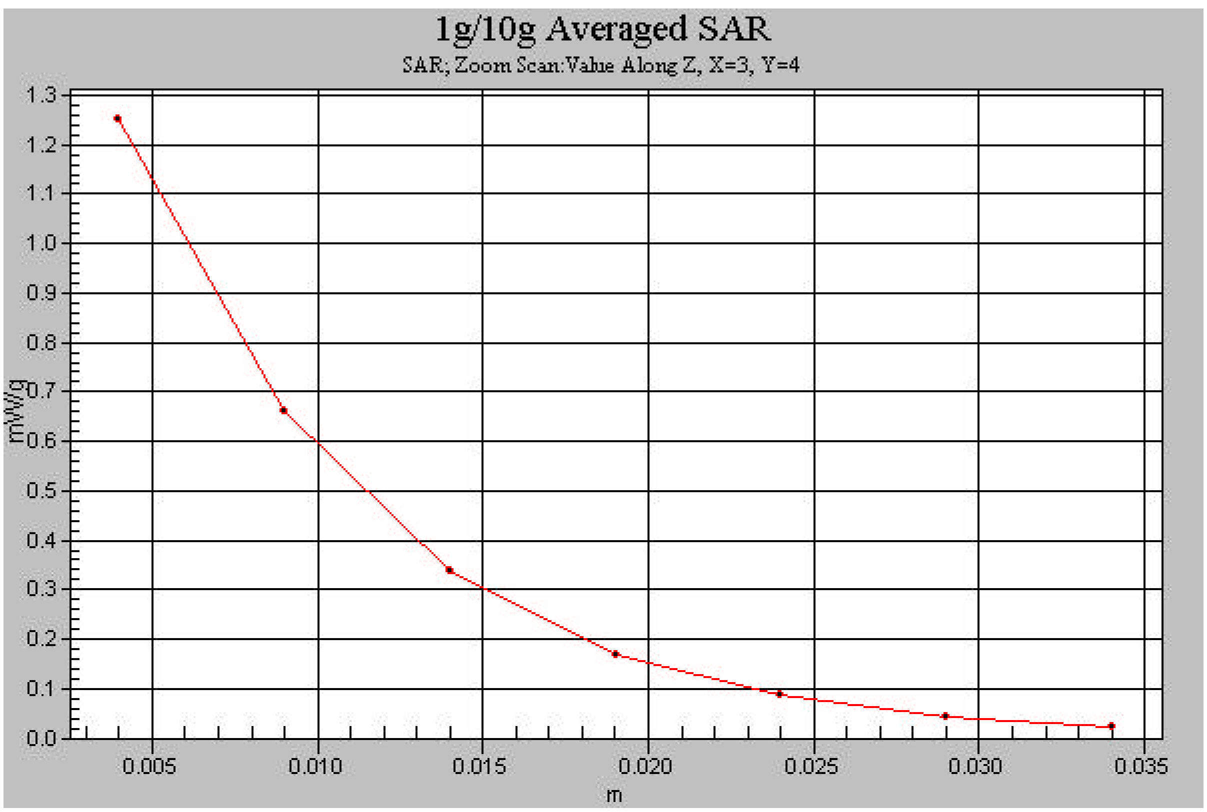
Communication System: IEEE 802.15; Frequency: 2405 MHz;Duty Cycle: 1:1
Medium: 2450 Muscle ($\sigma$ = 1.93 mho/m, $\varepsilon_r$ = 51.92, $\rho$ = 1000 kg/m$^3$)
Phantom section: Flat Section

Test Date: 03-30-2007; Ambient Temp: 23.8°C; Tissue Temp: 21.3°C

Probe: EX3DV4 - SN3589; ConvF(6.37, 6.37, 6.37); Calibrated: 7/14/2006
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn704; Calibrated: 6/1/2006
Phantom: SAM Main; Type: SAM 4.0; Serial: TP:1197
Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

## Body SAR, Laptop position, Low Ch, TX no modulation

**Area Scan (11x19x1):** Measurement grid: dx=15mm, dy=15mm
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.83 V/m
Peak SAR (extrapolated) = 2.17 W/kg
**SAR(1 g) = 1.11 mW/g; SAR(10 g) = 0.552 mW/g**



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

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

Accredited by the Swiss 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** **PC Test**

**Certificate No: EX3-3589_Jul06**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3589 |
| Calibration procedure(s) | QA CAL-01.v5 and QA CAL-14.v3<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | July 14, 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 | 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 | 21-Jun-06 (SPEAG, No. DAE4-654_Jun06) | Jun-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 |

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

Issued: July 17, 2006

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

## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| Polarization φ | φ rotation around probe axis |
| Polarization ϑ | ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis |

## 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:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep (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 ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

# Probe EX3DV4

## SN:3589

Manufactured: March 30, 2006
Calibrated: July 14, 2006

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

# DASY - Parameters of Probe: EX3DV4 SN:3589

## Sensitivity in Free Space[A]

| | | | | |
|---|---|---|---|---|
| NormX | **0.460** ± 10.1% | $\mu V/(V/m)^2$ | DCP X | **90** mV |
| NormY | **0.400** ± 10.1% | $\mu V/(V/m)^2$ | DCP Y | **90** mV |
| NormZ | **0.370** ± 10.1% | $\mu V/(V/m)^2$ | DCP Z | **90** mV |

Diode Compression[B]

## Sensitivity in Tissue Simulating Liquid (Conversion Factors)

**Please see Page 8.**

## Boundary Effect

**TSL** **835 MHz** **Typical SAR gradient: 5 % per mm**

| Sensor Center to Phantom Surface Distance | | **3.7 mm** | **4.7 mm** |
|---|---|---|---|
| $SAR_{be}$ [%] | Without Correction Algorithm | 4.5 | 1.6 |
| $SAR_{be}$ [%] | With Correction Algorithm | 0.3 | 0.5 |

**TSL** **1900 MHz** **Typical SAR gradient: 10 % per mm**

| Sensor Center to Phantom Surface Distance | | **3.7 mm** | **4.7 mm** |
|---|---|---|---|
| $SAR_{be}$ [%] | Without Correction Algorithm | 2.5 | 1.0 |
| $SAR_{be}$ [%] | With Correction Algorithm | 0.2 | 0.4 |

## Sensor Offset

Probe Tip to Sensor Center **1.0** mm

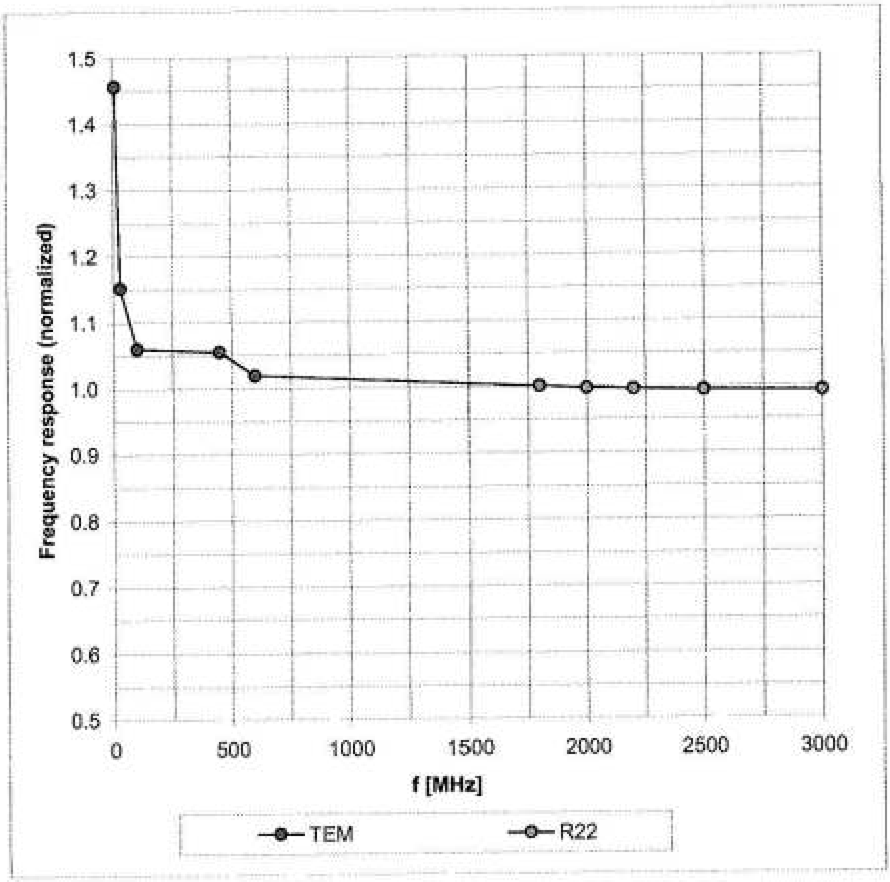
**The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.**

[A] The uncertainties of NormX,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Page 8).

[B] Numerical linearization parameter: uncertainty not required.

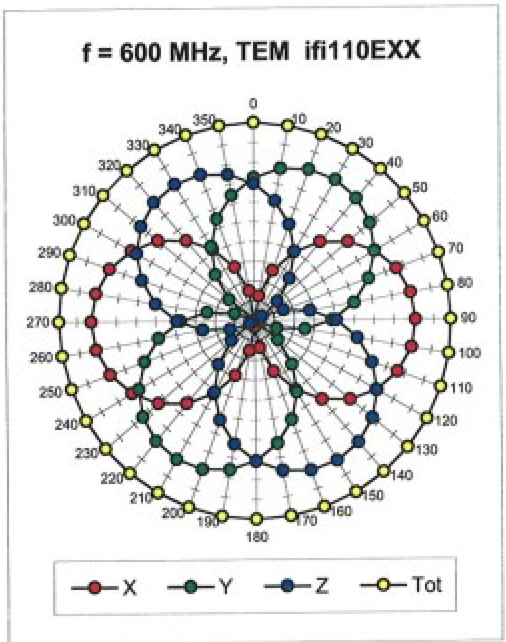
# Frequency Response of E-Field

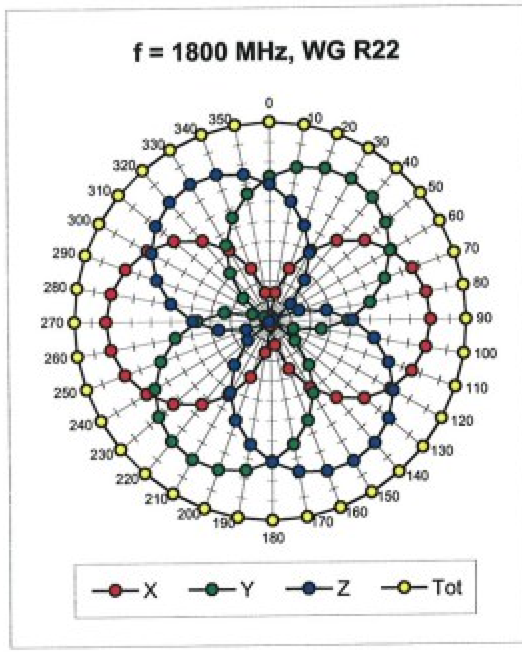
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**

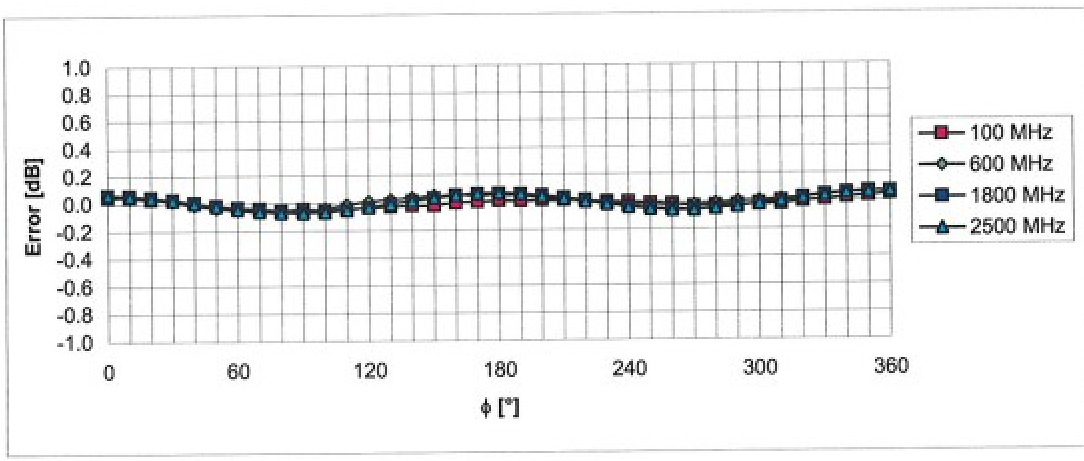



**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

# Receiving Pattern (ϕ), $\vartheta = 0°$



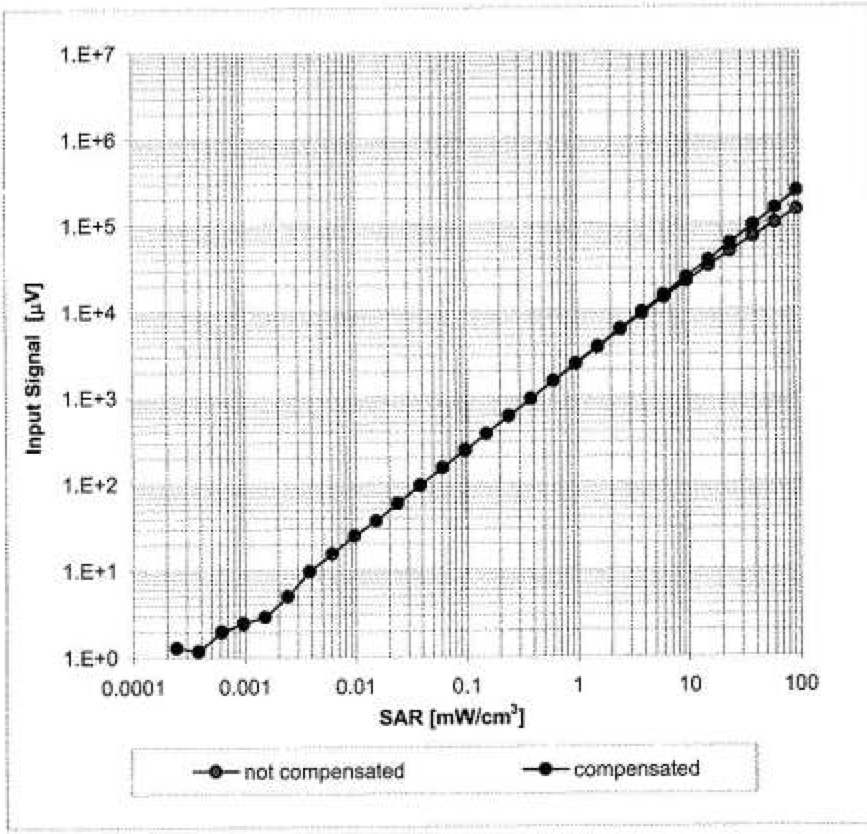



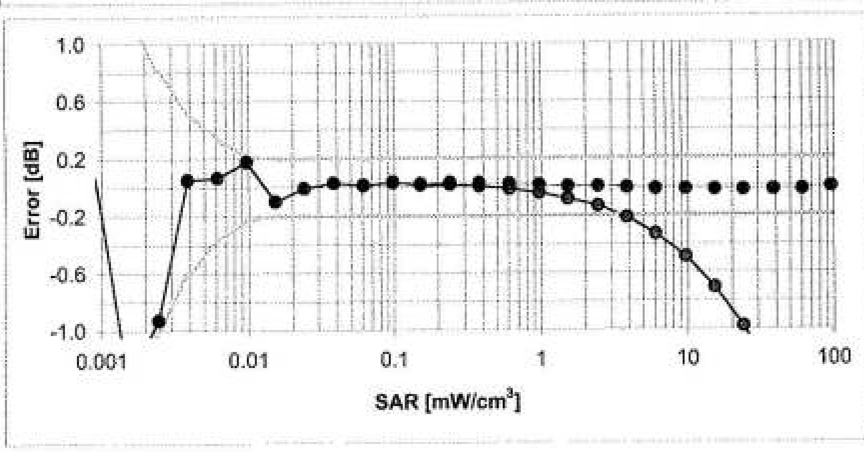




**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

# Dynamic Range f($SAR_{head}$)

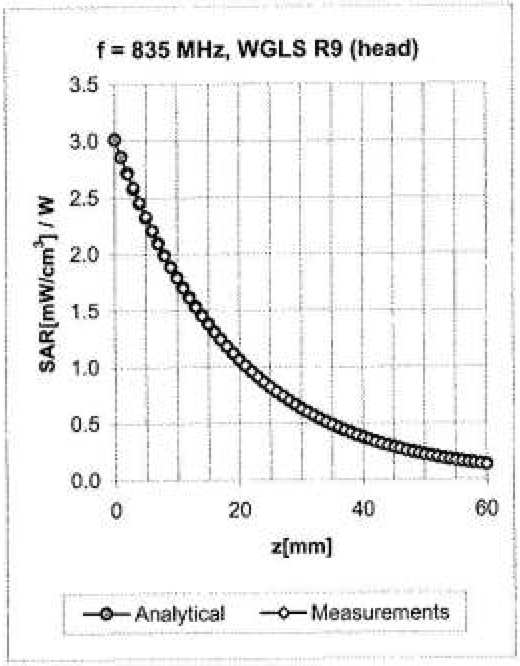
**(Waveguide R22, f = 1800 MHz)**

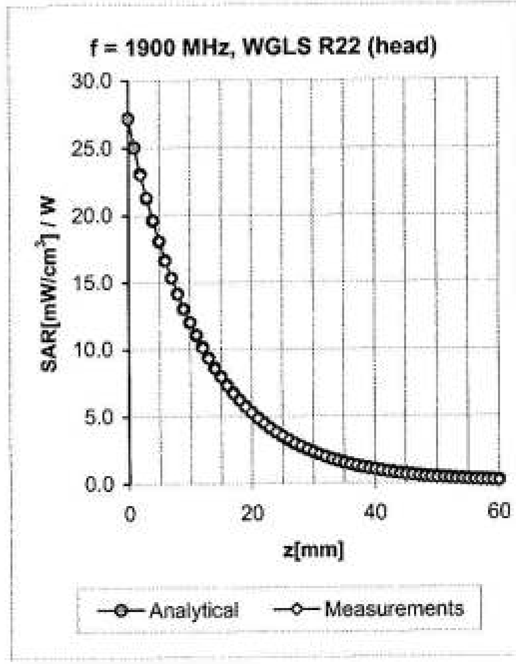



**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment



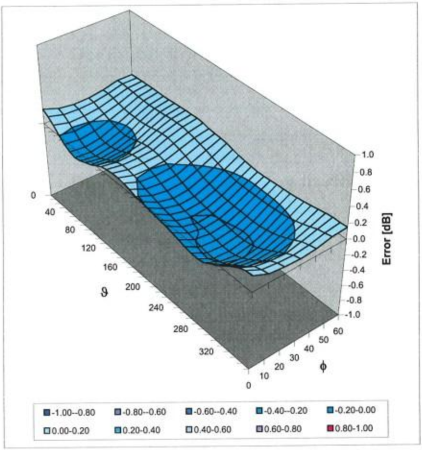




| f [MHz] | Validity [MHz][c] | TSL | Permittivity | Conductivity | Alpha | Depth | ConvF | Uncertainty |
|---|---|---|---|---|---|---|---|---|
| 835 | ± 50 / ± 100 | Head | 41.5 ± 5% | 0.90 ± 5% | 0.84 | 0.69 | 8.36 | ± 11.0% (k=2) |
| 1900 | ± 50 / ± 100 | Head | 40.0 ± 5% | 1.40 ± 5% | 0.45 | 0.74 | 7.11 | ± 11.0% (k=2) |
| 2450 | ± 50 / ± 100 | Head | 39.2 ± 5% | 1.80 ± 5% | 0.60 | 0.75 | 6.27 | ± 11.8% (k=2) |
| 5200 | ± 50 / ± 100 | Head | 36.0 ± 5% | 4.66 ± 5% | 0.45 | 1.80 | 4.45 | ± 13.1% (k=2) |
| 5800 | ± 50 / ± 100 | Head | 35.3 ± 5% | 5.27 ± 5% | 0.45 | 1.80 | 4.05 | ± 13.1% (k=2) |
| | | | | | | | | |
| 835 | ± 50 / ± 100 | Body | 55.2 ± 5% | 0.97 ± 5% | 0.92 | 0.62 | 8.15 | ± 11.0% (k=2) |
| 1900 | ± 50 / ± 100 | Body | 53.3 ± 5% | 1.52 ± 5% | 0.20 | 1.13 | 6.64 | ± 11.0% (k=2) |
| 2450 | ± 50 / ± 100 | Body | 52.7 ± 5% | 1.95 ± 5% | 0.65 | 0.75 | 6.37 | ± 11.8% (k=2) |
| 5200 | ± 50 / ± 100 | Body | 49.0 ± 5% | 5.30 ± 5% | 0.47 | 1.70 | 4.08 | ± 13.1% (k=2) |
| 5800 | ± 50 / ± 100 | Body | 48.2 ± 5% | 6.00 ± 5% | 0.45 | 1.70 | 3.86 | ± 13.1% (k=2) |

[c] 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.

# Deviation from Isotropy in HSL

**Error (ϕ, ϑ), f = 900 MHz**




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

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

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

Accredited by the Swiss 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 **PC Test**

Certificate No: **D2450V2-797_Jan07**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN: 797 |
| Calibration procedure(s) | QA CAL-05.v6<br>Calibration procedure for dipole validation kits |
| Calibration date: | January 17, 2007 |
| 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 |
|---|---|---|---|
| Primary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Power meter EPM-442A | GB37480704 | 03-Oct-06 (METAS, No. 217-00608) | Oct-07 |
| Power sensor HP 8481A | US37292783 | 03-Oct-06 (METAS, No. 217-00608) | Oct-07 |
| Reference 20 dB Attenuator | SN: 5086 (20g) | 10-Aug-06 (METAS, No 217-00591) | Aug-07 |
| Reference 10 dB Attenuator | SN: 5047.2 (10r) | 10-Aug-06 (METAS, No 217-00591) | Aug-07 |
| Reference Probe ES3DV2 | SN 3025 | 19-Oct-06 (SPEAG, No. ES3-3025_Oct06) | Oct-07 |
| DAE4 | SN: 907 | 20-Jul-06 (SPEAG, No. DAE4-907_Jul06) | Jul-07 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power sensor HP 8481A | MY41092317 | 18-Oct-02 (SPEAG, in house check Oct-05) | In house check: Oct-07 |
| RF generator Agilent E4421B | MY41000675 | 11-May-05 (SPEAG, in house check Nov-05) | In house check: Nov-07 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Mike Meili | Laboratory Technician | M. Meili |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 22, 2007

## Glossary:

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

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) 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 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 | V4.7 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom V5.0 | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 2450 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 39.2 | 1.80 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 38.0± 6 % | 1.79 mho/m ± 6 % |
| **Head TSL temperature during test** | (21.0 ± 0.2) °C | ------- | ------ |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.7 mW / g |
| SAR normalized | normalized to 1W | 54.8 mW / g |
| SAR for nominal Head TSL parameters [1] | normalized to 1W | **54.1 mW / g ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.29 mW / g |
| SAR normalized | normalized to 1W | 25.2 mW / g |
| SAR for nominal Head TSL parameters [1] | normalized to 1W | **24.9 mW / g ± 16.5 % (k=2)** |

[1] Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

## Appendix

## Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 53.3 Ω + 5.5 jΩ |
| Return Loss | – 24.2 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.152 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 | January 24, 2006 |

## DASY4 Validation Report for Head TSL

Date/Time: 17.01.2007 15:29:10

Test Laboratory: SPEAG, Zurich, Switzerland

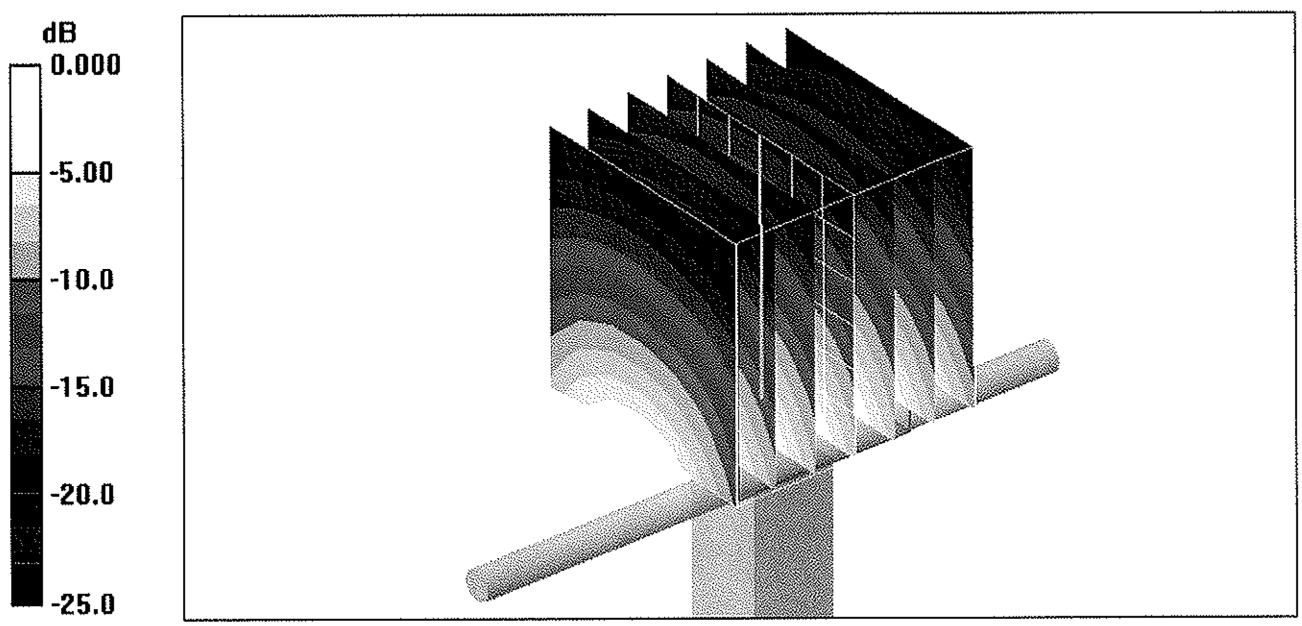
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN797**

Communication System: CW-2450; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: HSL U10 BB;
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.78 mho/m; $\varepsilon_r$ = 38.1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3025 (HF); ConvF(4.5, 4.5, 4.5); Calibrated: 19.10.2006
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn907; Calibrated: 20.07.2006
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**Pin = 250 mW; d = 10 mm 2/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 93.3 V/m; Power Drift = 0.021 dB
Peak SAR (extrapolated) = 29.2 W/kg
**SAR(1 g) = 13.7 mW/g; SAR(10 g) = 6.29 mW/g**
Maximum value of SAR (measured) = 15.2 mW/g




0 dB = 15.2mW/g

## Impedance Measurement Plot for Head TSL