

## **SAR Test Report**

Product Name : Notebook PC

Model No. : LGX30 (Module: AW-NE104H)

Applicant : LG Electronics Inc.

Address : 19-1, Cheongho-ri, Jinwi-myeon, Pyeongtaek-si,  
Gyeonggi-do, 451-713, Korea

Date of Receipt : 2009/11/11

Issued Date : 2009/12/18

Report No. : 09C344R-HPUSP09V01

Report Version : V1.0

The test results relate only to the samples tested.

The test report shall not be reproduced except in full without the written approval of QuieTek Corporation.

# Test Report Certification

Issued Date: 2009/12/18

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Product Name : Notebook PC  
 Applicant : LG Electronics Inc.  
 Address : 19-1, Cheongho-ri, Jinwi-myeon, Pyeongtaek-si,  
 Gyeonggi-do, 451-713, Korea  
 Manufacturer : 1. LG ELECTRONICS DE SAO PAULO LTDA  
 2. LG Electronics Inc.  
 3. MSI ELECTRONICS (KUNSHAN) CO., LTD.  
 Model No. : LGX30 (Module: AW-NE104H)  
 Trade Name : LG  
 FCC ID : BEJ9QK-LGX30G02  
 Applicable Standard : FCC Oet65 Supplement C June 2001  
 IEEE Std. 1528-2003 47CFR § 2.1093  
 Test Result : Max. SAR Measurement (1g)  
**0.00771 W/kg**  
 Application Type : Certification

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Documented By :

*Anny Chou*

(Adm.Assistant / Anny Chou)

Tested By :

*Jung Chang*

(Engineer / Jung Chang)

Approved By :

*Vincent Lin*

(Manager / Vincent Lin)

## TABLE OF CONTENTS

| Description                                                         | Page      |
|---------------------------------------------------------------------|-----------|
| <b>1. General Information.....</b>                                  | <b>5</b>  |
| 1.1 EUT Description .....                                           | 5         |
| 1.2 Test Environment .....                                          | 6         |
| <b>2. SAR Measurement System.....</b>                               | <b>7</b>  |
| 2.1 DASY5 System Description .....                                  | 7         |
| 2.1.1 Applications .....                                            | 8         |
| 2.1.2 Area Scans.....                                               | 8         |
| 2.1.3 Zoom Scan (Cube Scan Averaging).....                          | 8         |
| 2.1.4 Uncertainty of Inter-/Extrapolation and Averaging .....       | 8         |
| 2.2 DASY5 E-Field Probe .....                                       | 9         |
| 2.2.1 Isotropic E-Field Probe Specification .....                   | 9         |
| 2.3 Boundary Detection Unit and Probe Mounting Device .....         | 10        |
| 2.4 DATA Acquisition Electronics (DAE) and Measurement Server ..... | 10        |
| 2.5 Robot.....                                                      | 11        |
| 2.6 Light Beam Unit.....                                            | 11        |
| 2.7 Device Holder .....                                             | 12        |
| 2.8 SAM Twin Phantom .....                                          | 12        |
| <b>3. Tissue Simulating Liquid .....</b>                            | <b>13</b> |
| 3.1 The composition of the tissue simulating liquid .....           | 13        |
| 3.2 Tissue Calibration Result .....                                 | 13        |
| 3.3 Tissue Dielectric Parameters for Head and Body Phantoms .....   | 14        |
| <b>4. SAR Measurement Procedure.....</b>                            | <b>15</b> |
| 4.1 SAR System Validation.....                                      | 15        |
| 4.1.1 Validation Dipoles.....                                       | 15        |
| 4.1.2 Validation Result .....                                       | 15        |
| 4.2 SAR Measurement Procedure.....                                  | 16        |
| <b>5. SAR Exposure Limits .....</b>                                 | <b>17</b> |
| <b>6. Test Equipment List.....</b>                                  | <b>18</b> |
| <b>7. Measurement Uncertainty.....</b>                              | <b>19</b> |
| <b>8. Test Results .....</b>                                        | <b>20</b> |
| 8.1 SAR Test Results Summary .....                                  | 20        |
| Appendix.....                                                       | 21        |
| Appendix A. SAR System Validation Data                              |           |

Appendix B. SAR measurement Data

Appendix C. Test Setup Photographs & EUT Photographs

Appendix D. Probe Calibration Data

Appendix E. Dipole Calibration Data

## 1. General Information

### 1.1 EUT Description

|                                  |                                          |
|----------------------------------|------------------------------------------|
| Product Name                     | Notebook PC                              |
| Trade Name                       | LG                                       |
| Model No.                        | LGX30 (Module: AW-NE104H)                |
| FCC ID                           | BEJ9QK-LGX30G02                          |
| TX Frequency                     | 2412MHz ~ 2462MHz                        |
| Number of Channel                | 11                                       |
| Type of Modulation               | DSSS/OFDM                                |
| Antenna Type                     | PIFA                                     |
| Antenna Kit                      | Main: HBT15-LG01, Aux: HBT14-LG01        |
| Antenna Gain                     | -0.67dBi                                 |
| WLAN Module                      | MFR: AzureWave, M/N: AW-NE104H           |
| Device Category                  | Portable                                 |
| RF Exposure Environment          | Uncontrolled                             |
| Max. Output Power<br>(Conducted) | 802.11b: 16.44 dBm<br>802.11g: 22.34 dBm |

Note : 1.The LGX30 also build with a BT module modem name is AW-BT253 and the output power is less than 5mW not need a SAR evaluate testing.

## 1.2 Test Environment

Ambient conditions in the laboratory:

| Items            | Required | Actual |
|------------------|----------|--------|
| Temperature (°C) | 18-25    | 24.4   |
| Humidity (%RH)   | 30-70    | 51     |

Site Description:

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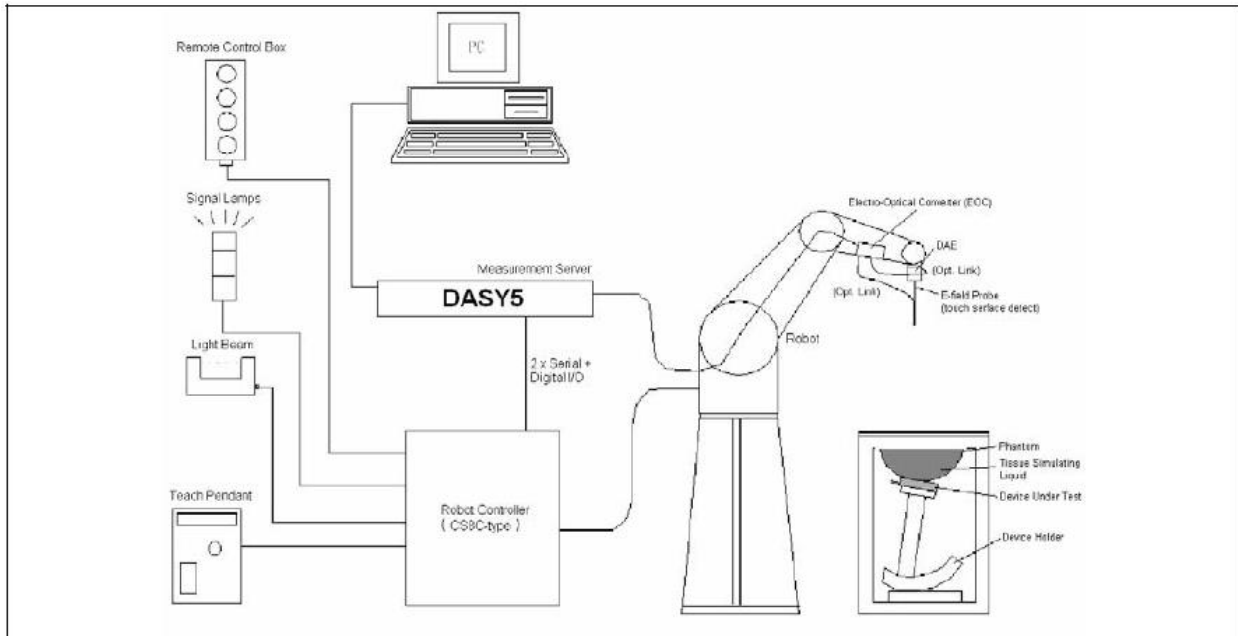


Site Name: Quietek Corporation

Site Address: No. 5-22, Ruei-Shu Valley, Ruei-Ping Tsuen,  
Lin-Kou Shiang, Taipei,  
Taiwan, R.O.C.  
TEL : 886-2-8601-3788 / FAX : 886-2-8601-3789  
E-Mail : [service@quietek.com](mailto:service@quietek.com)

## 2. SAR Measurement System

### 2.1 DASY5 System Description



The DASY5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

### **2.1.1 Applications**

Predefined procedures and evaluations for automated compliance testing with all worldwide standards, e.g., IEEE 1528, OET 65, IEC 62209-1, IEC 62209-2, EN 50360, EN 50383 and others.

### **2.1.2 Area Scans**

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a 10mm<sup>2</sup> step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments.

When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE 1528-2003, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan).

### **2.1.3 Zoom Scan (Cube Scan Averaging)**

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. A density of 1000 kg/m<sup>3</sup> is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10mm, with the side length of the 10 g cube 21,5mm.

The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications (including FCC) utilize a physical step of 5x5x7 (8mmx8mmx5mm) providing a volume of 32mm in the X & Y axis, and 30mm in the Z axis.

### **2.1.4 Uncertainty of Inter-/Extrapolation and Averaging**

In order to evaluate the uncertainty of the interpolation, extrapolation and averaged SAR calculation algorithms of the Postprocessor, DASY5 allows the generation of measurement grids which are artificially predefined by analytically based test functions. Therefore, the grids of area scans and zoom scans can be filled with uncertainty test data, according to the SAR benchmark functions of IEEE 1528. The three analytical functions shown in equations as below are used to describe the possible range of the expected SAR distributions for the tested handsets. The field gradients are covered by the spatially flat



distribution  $f_1$ , the spatially steep distribution  $f_3$  and  $f_2$  accounts for H-field cancellation on the phantom/tissue surface.

$$f_1(x, y, z) = Ae^{-\frac{z}{2a}} \cos^2 \left( \frac{\pi}{2} \frac{\sqrt{x'^2 + y'^2}}{5a} \right)$$

$$f_2(x, y, z) = Ae^{-\frac{z}{a}} \frac{a^2}{a^2 + x'^2} \left( 3 - e^{-\frac{2z}{a}} \right) \cos^2 \left( \frac{\pi}{2} \frac{y'}{3a} \right)$$

$$f_3(x, y, z) = A \frac{a^2}{\frac{a^2}{4} + x'^2 + y'^2} \left( e^{-\frac{2z}{a}} + \frac{a^2}{2(a + 2z)^2} \right)$$

## 2.2 DASY5 E-Field Probe

The SAR measurement is conducted with the dosimetric probe 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.

SPEAG conducts the probe calibration in compliance with international and national standards (e.g. IEEE 1528, EN 62209-1, IEC 62209, etc.) under ISO 17025. The calibration data are in Appendix D.

### 2.2.1 Isotropic E-Field Probe Specification

| Model         | Ex3DV4                                                                                                                                                                                                     |                                                                                       |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Construction  | Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)                                                      |                                                                                       |
| Frequency     | 10 MHz to 6 GHz<br>Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)                                                                                                                                               |  |
| Directivity   | $\pm 0.3$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in tissue material (rotation normal to probe axis)                                                                                        |                                                                                       |
| Dynamic Range | 10 $\mu$ W/g to 100 mW/g<br>Linearity: $\pm 0.2$ dB (noise: typically $< 1$ $\mu$ W/g)                                                                                                                     |                                                                                       |
| Dimensions    | 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                                                                       |                                                                                       |
| Application   | High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%. |                                                                                       |

## 2.3 Boundary Detection Unit and Probe Mounting Device

The DASY probes use a precise connector and an additional holder for the probe, consisting of a plastic tube and a flexible silicon ring to center the probe. The connector at the DAE is flexibly mounted and held in the default position with magnets and springs. Two switching systems in the connector mount detect frontal and lateral probe collisions and trigger the necessary software response.



## 2.4 DATA Acquisition Electronics (DAE) and Measurement Server

The data acquisition electronics (DAE) 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 input impedance of the DAE4 is 200M Ohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.



The DASY5 measurement server is based on a PC/104 CPU board with a 400MHz intel ULV Celeron, 128MB chipdisk and 128MB RAM. The necessary circuits for communication with the DAE electronics box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY5 I/O board, which is directly connected to the PC/104 bus of the CPU board.



## 2.5 Robot

The DASY5 system uses the high precision robots TX90 XL type out of the newer series from Stäubli SA (France). For the 6-axis controller DASY5 system, the CS8C robot controller version from Stäubli is used.

The XL 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



## 2.6 Light Beam Unit

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip.

The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.



## 2.7 Device Holder

The DASY5 device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (EPR).

Thus the device needs no repositioning when changing the angles.

The DASY5 device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity  $\epsilon_r = 3$  and loss tangent  $\delta = 0.02$ . The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.



## 2.8 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.

### 3. Tissue Simulating Liquid

#### 3.1 The composition of the tissue simulating liquid

| INGREDIENT<br>(% Weight) | 900MHz<br>Head | 1800MHz<br>Head | 2450MHz<br>Head | 2450MHz<br>Body |
|--------------------------|----------------|-----------------|-----------------|-----------------|
| Water                    | --             | --              | 46.7            | 73.2            |
| Salt                     | --             | --              | 0.00            | 0.04            |
| Sugar                    | --             | --              | 0.00            | 0.00            |
| HEC                      | --             | --              | 0.00            | 0.00            |
| Preventol                | --             | --              | 0.00            | 0.00            |
| DGBE                     | --             | --              | 53.3            | 26.7            |

#### 3.2 Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using APREL Dielectric Probe Kit and Anritsu MS4623B Vector Network Analyzer.

##### Head Tissue Simulant Measurement

| Frequency<br>[MHz] | Description                     | Dielectric Parameters    |                        | Tissue Temp.<br>[°C] |
|--------------------|---------------------------------|--------------------------|------------------------|----------------------|
|                    |                                 | $\epsilon_r$             | $\sigma$ [s/m]         |                      |
| 2450MHz            | Reference result<br>± 5% window | 40.1<br>38.095 to 42.105 | 1.78<br>1.691 to 1.869 | N/A                  |
|                    | 24-Nov-09                       | 40.17                    | 1.79                   | 23.9                 |

##### Body Tissue Simulant Measurement

| Frequency<br>[MHz] | Description                     | Dielectric Parameters    |                          | Tissue Temp.<br>[°C] |
|--------------------|---------------------------------|--------------------------|--------------------------|----------------------|
|                    |                                 | $\epsilon_r$             | $\sigma$ [s/m]           |                      |
| 2450MHz            | Reference result<br>± 5% window | 52.7<br>50.065 to 55.335 | 1.95<br>1.8525 to 2.0475 | N/A                  |
|                    | 24-Nov-09                       | 53.09                    | 1.94                     | 23.9                 |
| 2412 MHz           | Low channel                     | 55.14                    | 1.87                     | 23.9                 |
| 2437 MHz           | Mid channel                     | 53.61                    | 1.91                     | 23.9                 |
| 2462 MHz           | High channel                    | 52.81                    | 1.96                     | 23.9                 |

### 3.3 Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

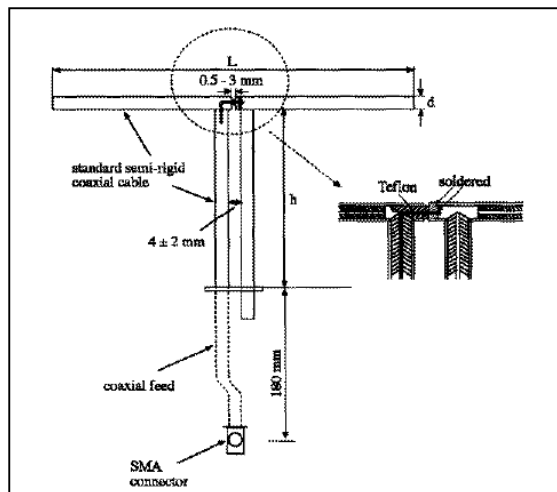
| Target Frequency | Head         |                | Body         |                |
|------------------|--------------|----------------|--------------|----------------|
| (MHz)            | $\epsilon_r$ | $\sigma$ (S/m) | $\epsilon_r$ | $\sigma$ (S/m) |
| 150              | 52.3         | 0.76           | 61.9         | 0.80           |
| 300              | 45.3         | 0.87           | 58.2         | 0.92           |
| 450              | 43.5         | 0.87           | 56.7         | 0.94           |
| 835              | 41.5         | 0.90           | 55.2         | 0.97           |
| 900              | 41.5         | 0.97           | 55.0         | 1.05           |
| 915              | 41.5         | 0.98           | 55.0         | 1.06           |
| 1450             | 40.5         | 1.20           | 54.0         | 1.30           |
| 1610             | 40.3         | 1.29           | 53.8         | 1.40           |
| 1800 – 2000      | 40.0         | 1.40           | 53.3         | 1.52           |
| 2450             | 39.2         | 1.80           | 52.7         | 1.95           |
| 3000             | 38.5         | 2.40           | 52.0         | 2.73           |
| 5800             | 35.3         | 5.27           | 48.2         | 6.00           |

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho$  = 1000 kg/m<sup>3</sup>)

## 4. SAR Measurement Procedure

### 4.1 SAR System Validation

#### 4.1.1 Validation Dipoles



The dipoles used is based on the IEEE-1528 standard, and is complied with mechanical and electrical specifications in line with the requirements of both IEEE and FCC Supplement C. the table below provides details for the mechanical and electrical specifications for the dipoles.

| Frequency | L (mm) | h (mm) | d (mm) |
|-----------|--------|--------|--------|
| 2450MHz   | 53.5   | 30.4   | 3.6    |

#### 4.1.2 Validation Result

##### System Performance Check at 2450MHz

##### Validation Kit: ASL-D-2450-S-2

| Frequency [MHz] | Description                      | SAR [w/kg] 1g             | SAR [w/kg] 10g            | Tissue Temp. [°C] |
|-----------------|----------------------------------|---------------------------|---------------------------|-------------------|
| 2450 MHz        | Reference result<br>± 10% window | 48.07<br>43.263 to 52.877 | 25.65<br>23.085 to 28.215 | N/A               |
|                 | 24-Nov-09                        | 45.2                      | 26.92                     | 23.9              |

Note: All SAR values are normalized to 1W forward power.

## 4.2 SAR Measurement Procedure

**(Test Procedures are according to KDB 616217 "SAR Evaluation Considerations for Laptop Computers with Antennas Built-in on Display Screens".)**

The ALSAS-10U calculates SAR using the following equation,

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

$\sigma$ : represents the simulated tissue conductivity

$\rho$ : represents the tissue density

The EUT is set to transmit at the required power in line with product specification, at each frequency relating to the LOW, MID, and HIGH channel settings.

Pre-scans are made on the device to establish the location for the transmitting antenna, using a large area scan in either air or tissue simulation fluid.

The EUT is placed against the Universal Phantom where the maximum area scan dimensions are larger than the physical size of the resonating antenna. When the scan size is not large enough to cover the peak SAR distribution, it is modified by either extending the area scan size in both the X and Y directions, or the device is shifted within the predefined area.

The area scan is then run to establish the peak SAR location (interpolated resolution set at  $1\text{mm}^2$ ) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1g and 10g averages are derived from the zoom scan volume (interpolated resolution set at  $1\text{mm}^3$ ).



## 5. SAR Exposure Limits

SAR assessments have been made in line with the requirements of IEEE-1528, FCC Supplement C, and comply with ANSI/IEEE C95.1-1992 “Uncontrolled Environments” limits. These limits apply to a location which is deemed as “Uncontrolled Environment” which can be described as a situation where the general public may be exposed to an RF source with no prior knowledge or control over their exposure.

**Limits for General Population/Uncontrolled Exposure (W/kg)**

| Type Exposure                                            | Uncontrolled Environment Limit |
|----------------------------------------------------------|--------------------------------|
| Spatial Peak SAR (1g cube tissue for brain or body)      | <b>1.60 W/kg</b>               |
| Spatial Average SAR (whole body)                         | <b>0.08 W/kg</b>               |
| Spatial Peak SAR (10g for hands, feet, ankles and wrist) | <b>4.00 W/kg</b>               |

## 6. Test Equipment List

| Instrument                          | Manufacturer | Model No.      | Serial No.     | Last Calibration | Next Calibration |
|-------------------------------------|--------------|----------------|----------------|------------------|------------------|
| Stäubli Robot TX60L                 | Stäubli      | TX60L          | F09/5BL1A1/A06 | May. 2009        | only once        |
| Controller                          | Speag        | CS8c           | N/A            | May. 2009        | only once        |
| Aprél Reference Dipole 2450Mhz      | Aprél        | ALS-D-2450-S-2 | QTK-319        | May. 2008        | May. 2010        |
| SAM Twin Phantom                    | Speag        | QD000 P40 CA   | Tp 1515        | N/A              | N/A              |
| Device Holder                       | Speag        | N/A            | N/A            | N/A              | N/A              |
| Data Acquisition Electronic         | Speag        | DAE4           | 1204           | Apr. 2009        | Apr. 2010        |
| E-Field Probe                       | Speag        | EX3DV4         | 3602           | May. 2009        | May. 2010        |
| SAR Software                        | Speag        | DASY5          | V5.0 Build 125 | N/A              | N/A              |
| Aprél Dipole Spaccer                | Aprél        | ALS-DS-U       | QTK-295        | N/A              | N/A              |
| Power Amplifier                     | Mini-Circuit | ZHL-42         | D051404-20     | N/A              | N/A              |
| Directional Coupler                 | Agilent      | 778D-012       | 50550          | N/A              | N/A              |
| Universal RadioCommunication Tester | R&S          | CMU 200        | 104846         | May. 2009        | May. 2010        |
| Vector Network                      | Anritsu      | MS4623B        | 992801         | Aug. 2009        | Aug. 2010        |
| Signal Generator                    | Anritsu      | MG3692A        | 042319         | Jun. 2009        | Jun. 2010        |
| Power Meter                         | Anritsu      | ML2487A        | 6K00001447     | Apr. 2009        | Apr. 2010        |
| Wide Bandwidth Sensor               | Anritsu      | MA2491         | 030677         | Apr. 2009        | Apr. 2010        |

## 7. Measurement Uncertainty

| Uncertainty                  |                   |             |            |              |               |                |                 |                     |
|------------------------------|-------------------|-------------|------------|--------------|---------------|----------------|-----------------|---------------------|
| Error Description            | Uncertainty value | Prob. Dist. | Div.       | ( $c_i$ ) 1g | ( $c_i$ ) 10g | Std. Unc. (1g) | Std. Unc. (10g) | ( $v_i$ ) $v_{eff}$ |
| <b>Measurement System</b>    |                   |             |            |              |               |                |                 |                     |
| Probe Calibration            | ±5.9 %            | N           | 1          | 1            | 1             | ±5.9 %         | ±5.9 %          | ∞                   |
| Axial Isotropy               | ±4.7 %            | R           | $\sqrt{3}$ | 0.7          | 0.7           | ±1.9 %         | ±1.9 %          | ∞                   |
| Hemispherical Isotropy       | ±9.6 %            | R           | $\sqrt{3}$ | 0.7          | 0.7           | ±3.9 %         | ±3.9 %          | ∞                   |
| Boundary Effects             | ±1.0 %            | R           | $\sqrt{3}$ | 1            | 1             | ±0.6 %         | ±0.6 %          | ∞                   |
| Linearity                    | ±4.7 %            | R           | $\sqrt{3}$ | 1            | 1             | ±2.7 %         | ±2.7 %          | ∞                   |
| System Detection Limits      | ±1.0 %            | R           | $\sqrt{3}$ | 1            | 1             | ±0.6 %         | ±0.6 %          | ∞                   |
| Readout Electronics          | ±0.3 %            | N           | 1          | 1            | 1             | ±0.3 %         | ±0.3 %          | ∞                   |
| Response Time                | ±0.8 %            | R           | $\sqrt{3}$ | 1            | 1             | ±0.5 %         | ±0.5 %          | ∞                   |
| Integration Time             | ±2.6 %            | R           | $\sqrt{3}$ | 1            | 1             | ±1.5 %         | ±1.5 %          | ∞                   |
| RF Ambient Noise             | ±3.0 %            | R           | $\sqrt{3}$ | 1            | 1             | ±1.7 %         | ±1.7 %          | ∞                   |
| RF Ambient Reflections       | ±3.0 %            | R           | $\sqrt{3}$ | 1            | 1             | ±1.7 %         | ±1.7 %          | ∞                   |
| Probe Positioner             | ±0.4 %            | R           | $\sqrt{3}$ | 1            | 1             | ±0.2 %         | ±0.2 %          | ∞                   |
| Probe Positioning            | ±2.9 %            | R           | $\sqrt{3}$ | 1            | 1             | ±1.7 %         | ±1.7 %          | ∞                   |
| Max. SAR Eval.               | ±1.0 %            | R           | $\sqrt{3}$ | 1            | 1             | ±0.6 %         | ±0.6 %          | ∞                   |
| <b>Test Sample Related</b>   |                   |             |            |              |               |                |                 |                     |
| Device Positioning           | ±2.9 %            | N           | 1          | 1            | 1             | ±2.9 %         | ±2.9 %          | 145                 |
| Device Holder                | ±3.6 %            | N           | 1          | 1            | 1             | ±3.6 %         | ±3.6 %          | 5                   |
| Power Drift                  | ±5.0 %            | R           | $\sqrt{3}$ | 1            | 1             | ±2.9 %         | ±2.9 %          | ∞                   |
| <b>Phantom and Setup</b>     |                   |             |            |              |               |                |                 |                     |
| Phantom Uncertainty          | ±4.0 %            | R           | $\sqrt{3}$ | 1            | 1             | ±2.3 %         | ±2.3 %          | ∞                   |
| Liquid Conductivity (target) | ±5.0 %            | R           | $\sqrt{3}$ | 0.64         | 0.43          | ±1.8 %         | ±1.2 %          | ∞                   |
| Liquid Conductivity (meas.)  | ±2.5 %            | N           | 1          | 0.64         | 0.43          | ±1.6 %         | ±1.1 %          | ∞                   |
| Liquid Permittivity (target) | ±5.0 %            | R           | $\sqrt{3}$ | 0.6          | 0.49          | ±1.7 %         | ±1.4 %          | ∞                   |
| Liquid Permittivity (meas.)  | ±2.5 %            | N           | 1          | 0.6          | 0.49          | ±1.5 %         | ±1.2 %          | ∞                   |
| Combined Std. Uncertainty    |                   |             |            |              |               | ±10.9 %        | ±10.7 %         | 387                 |
| Expanded STD Uncertainty     |                   |             |            |              |               | ±21.9 %        | ±21.4 %         |                     |

## 8. Test Results

### 8.1 SAR Test Results Summary

| SAR MEASUREMENT                    |                     |           |      |                             |                  |                 |
|------------------------------------|---------------------|-----------|------|-----------------------------|------------------|-----------------|
| Ambient Temperature (°C) : 24.4 ±2 |                     |           |      | Relative Humidity (%): 51   |                  |                 |
| Liquid Temperature (°C) : 23.9 ±2  |                     |           |      | Depth of Liquid (cm):>15    |                  |                 |
| Product: Notebook PC               |                     |           |      |                             |                  |                 |
| Test Mode: 802.11g                 |                     |           |      |                             |                  |                 |
| Test Position<br>Body              | Antenna<br>Position | Frequency |      | Conducted<br>Power<br>(dBm) | SAR 1g<br>(W/kg) | Limit<br>(W/kg) |
|                                    |                     | Channel   | MHz  |                             |                  |                 |
| Bottom                             | Fixed               | 6         | 2437 | 22.34                       | 0.00604          | 1.6             |
| Test Mode: 802.11b                 |                     |           |      |                             |                  |                 |
| Bottom                             | Fixed               | 1         | 2412 | 15.81                       | 0.0061           | 1.6             |
| Bottom                             | Fixed               | 6         | 2437 | 16.10                       | 0.00771          | 1.6             |
| Bottom                             | Fixed               | 11        | 2462 | 16.44                       | 0.00547          | 1.6             |
| Test Mode: 802.11n (20M)           |                     |           |      |                             |                  |                 |
| Bottom                             | Fixed               | 6         | 2437 | 20.71                       | 0.0023           | 1.6             |
| Test Mode: 802.11n (40M)           |                     |           |      |                             |                  |                 |
| Bottom                             | Fixed               | 6         | 2437 | 18.37                       | 0.0059           | 1.6             |
|                                    |                     |           |      |                             |                  |                 |

**Appendix****Appendix A. SAR System Validation Data****Appendix B. SAR measurement Data****Appendix C. Test Setup Photographs & EUT Photographs****Appendix D. Probe Calibration Data****Appendix E. Dipole Calibration Data**

## Appendix A. SAR System Validation Data

Date/Time: 11/24/2009

Test Laboratory: Quietek

### System Performance Check\_2450MHz-Head

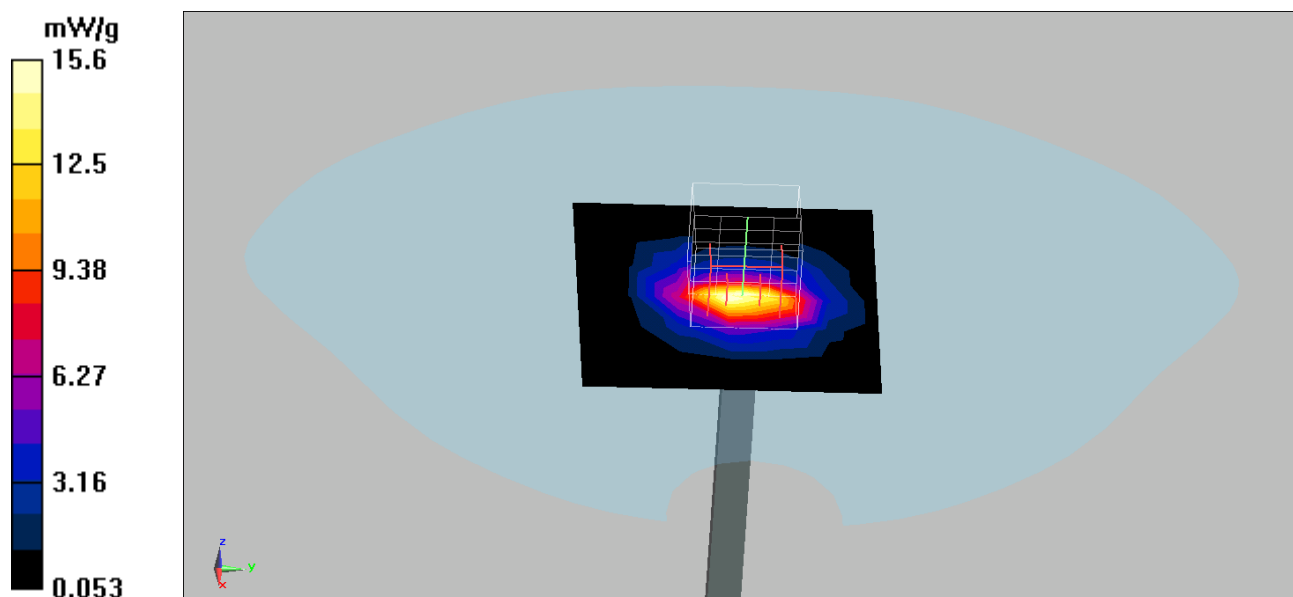
**DUT: Dipole 2450 MHz; Type: ALS-D-2450-S-2; Serial: QTK-319**

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.79$  mho/m;  $\epsilon_r = 40.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Ambient Temperature (°C) : 24.4, Liquid Temperature (°C) : 23.9  
 DASY4 Configuration:

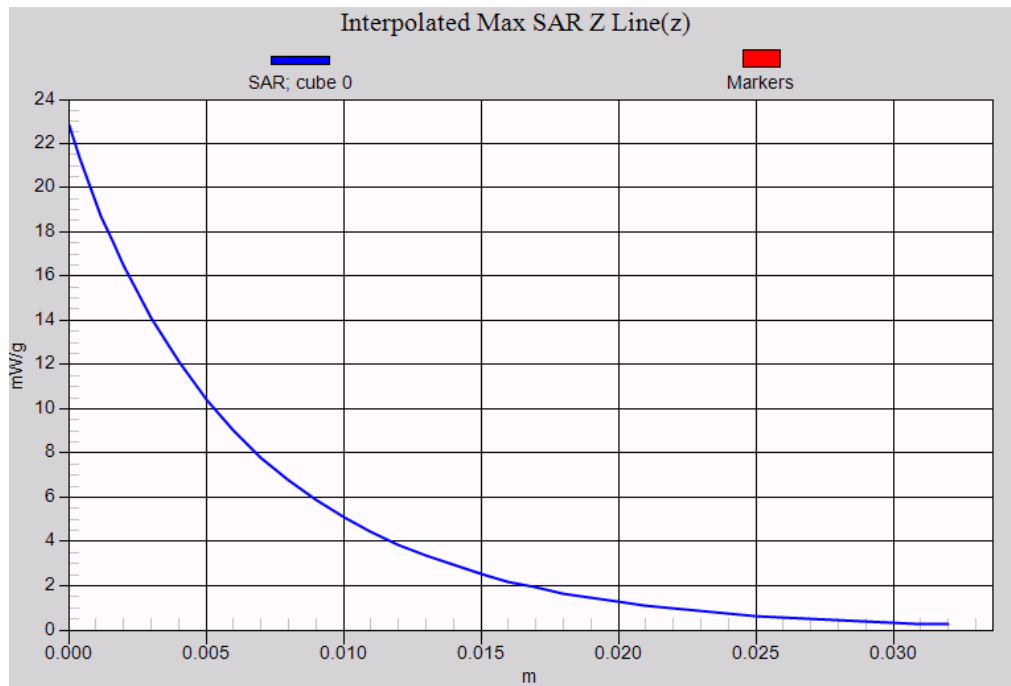
- Probe: EX3DV4 - SN3602; ConvF(7.1, 7.1, 7.1); Calibrated: 5/20/2009
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 4/7/2009
- Phantom: SAM Right Table; Type: SAM
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

**2450MHz\_Head/Area Scan (7x7x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (measured) = 15.6 mW/g

**2450MHz\_Head/Zoom Scan (7x7x7) (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm  
 Reference Value = 93.85 V/m; Power Drift = 0.057 dB  
 Peak SAR (extrapolated) = 22.83 W/kg  
**SAR(1 g) = 11.3 mW/g; SAR(10 g) = 6.73 mW/g**  
 Maximum value of SAR (measured) = 16.3 mW/g



## 2450MHz-Head Z-Axis Plot



## Appendix B. SAR measurement Data

Date/Time: 11/24/2009

Test Laboratory: Quietek

802.11g\_6

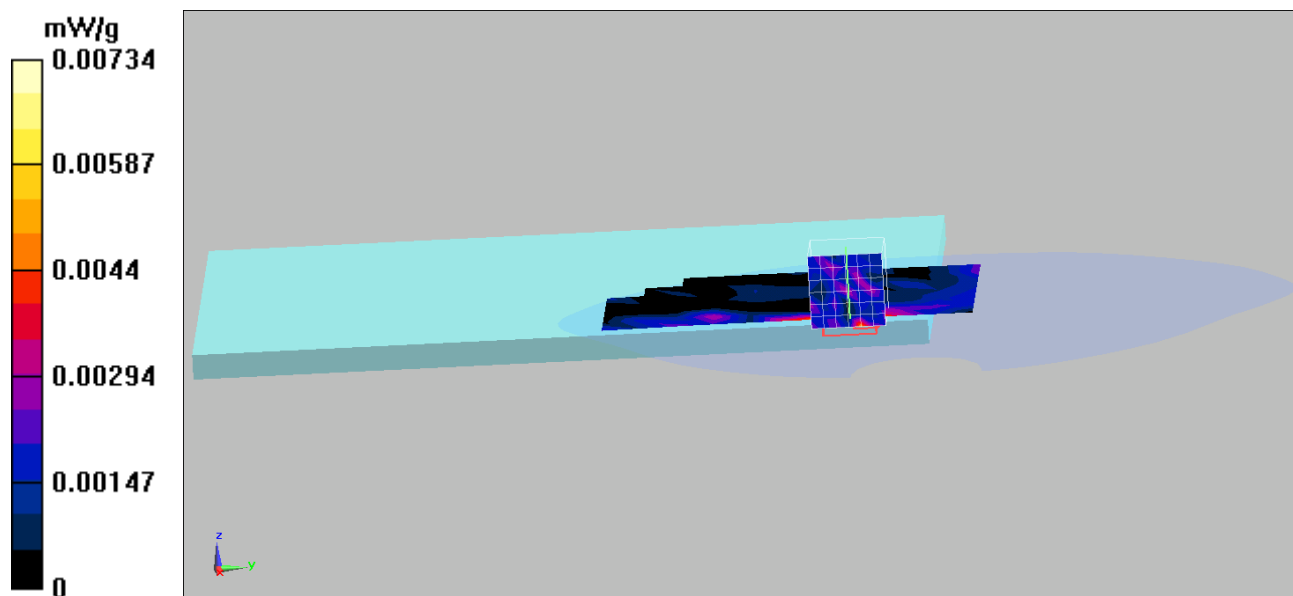
DUT: Notebook PC; Type: LGX30

Communication System: 802.11g; Frequency: 2437 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.91$  mho/m;  $\epsilon_r = 53.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Ambient Temperature (°C) : 24.4, Liquid Temperature (°C) : 23.9  
 DASY4 Configuration:

- Probe: EX3DV4 - SN3602; ConvF(6.9, 6.9, 6.9); Calibrated: 5/20/2009
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 4/7/2009
- Phantom: SAM Right Table; Type: SAM;
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

**Body/Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (measured) = 0.00709 mW/g

**Body/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 0.952 V/m; Power Drift = 0.102 dB  
 Peak SAR (extrapolated) = 0.029 W/kg  
**SAR(1 g) = 0.00604 mW/g; SAR(10 g) = 0.00255 mW/g**  
 Maximum value of SAR (measured) = 0.00734 mW/g





Date/Time: 11/24/2009

Test Laboratory: Quietek

**802.11b\_1**

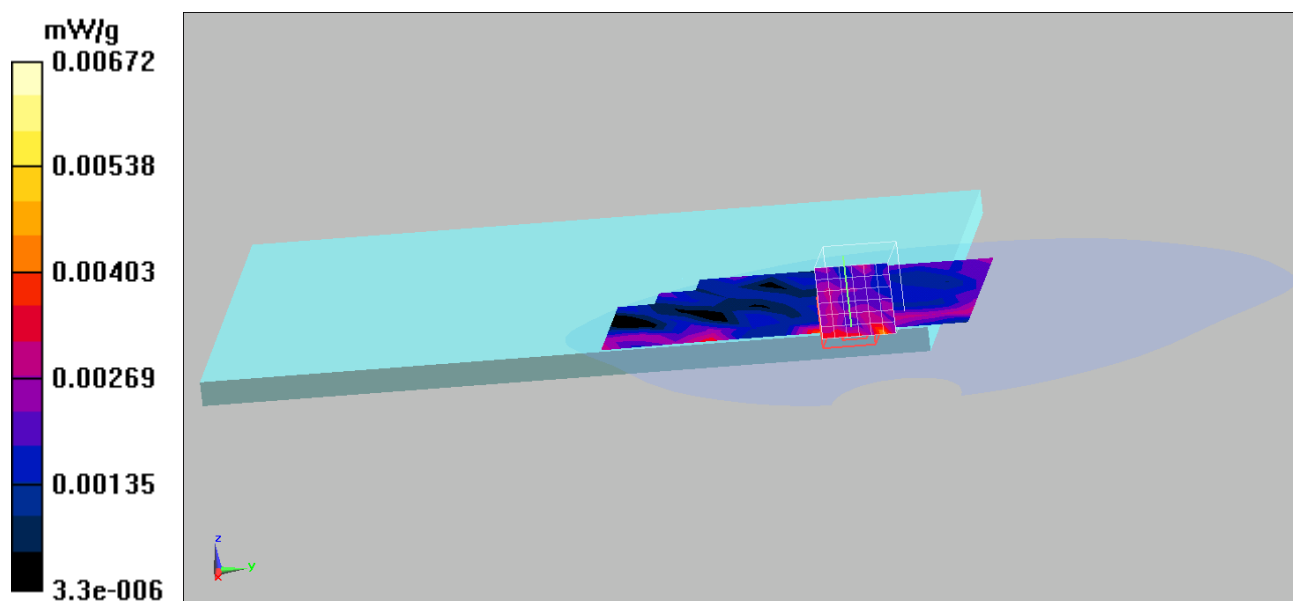
**DUT: Notebook PC; Type: LGX30**

Communication System: 802.11b; Frequency: 2412 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2412$  MHz;  $\sigma = 1.87$  mho/m;  $\epsilon_r = 55.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Ambient Temperature (°C) : 24.4, Liquid Temperature (°C) : 23.9  
 DASY4 Configuration:

- Probe: EX3DV4 - SN3602; ConvF(6.9, 6.9, 6.9); Calibrated: 5/20/2009
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 4/7/2009
- Phantom: SAM Right Table; Type: SAM;
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

**Body/Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (measured) = 0.00662 mW/g

**Body/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 1.07 V/m; Power Drift = 0.056 dB  
 Peak SAR (extrapolated) = 0.017 W/kg  
**SAR(1 g) = 0.0061 mW/g; SAR(10 g) = 0.00266 mW/g**  
 Maximum value of SAR (measured) = 0.00672 mW/g



Date/Time: 11/24/2009

Test Laboratory: Quietek

802.11b\_6

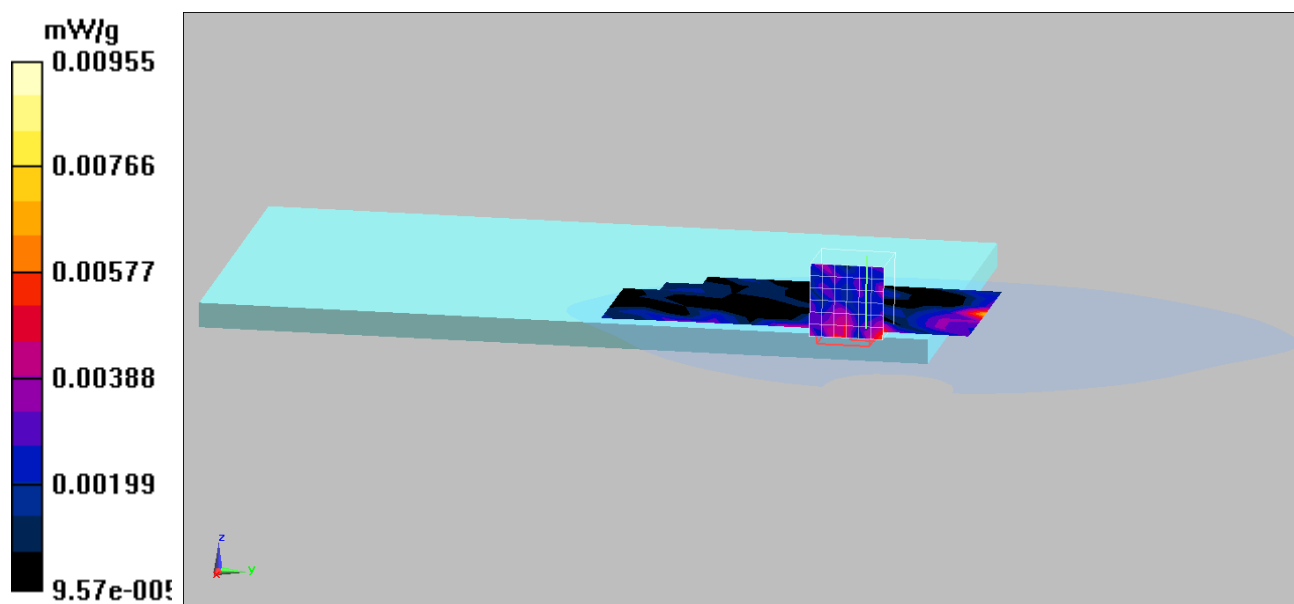
DUT: Notebook PC; Type: LGX30

Communication System: 802.11b; Frequency: 2437 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.91$  mho/m;  $\epsilon_r = 53.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Ambient Temperature (°C) : 24.4, Liquid Temperature (°C) : 23.9  
DASY4 Configuration:

- Probe: EX3DV4 - SN3602; ConvF(6.9, 6.9, 6.9); Calibrated: 5/20/2009
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 4/7/2009
- Phantom: SAM Right Table; Type: SAM;
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

**Body/Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (measured) = 0.00625 mW/g

**Body/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 1.16 V/m; Power Drift = 0.037 dB  
Peak SAR (extrapolated) = 0.014 W/kg  
**SAR(1 g) = 0.00771 mW/g; SAR(10 g) = 0.00492 mW/g**  
Maximum value of SAR (measured) = 0.00955 mW/g



Date/Time: 11/24/2009

Test Laboratory: Quietek

**802.11b\_11**

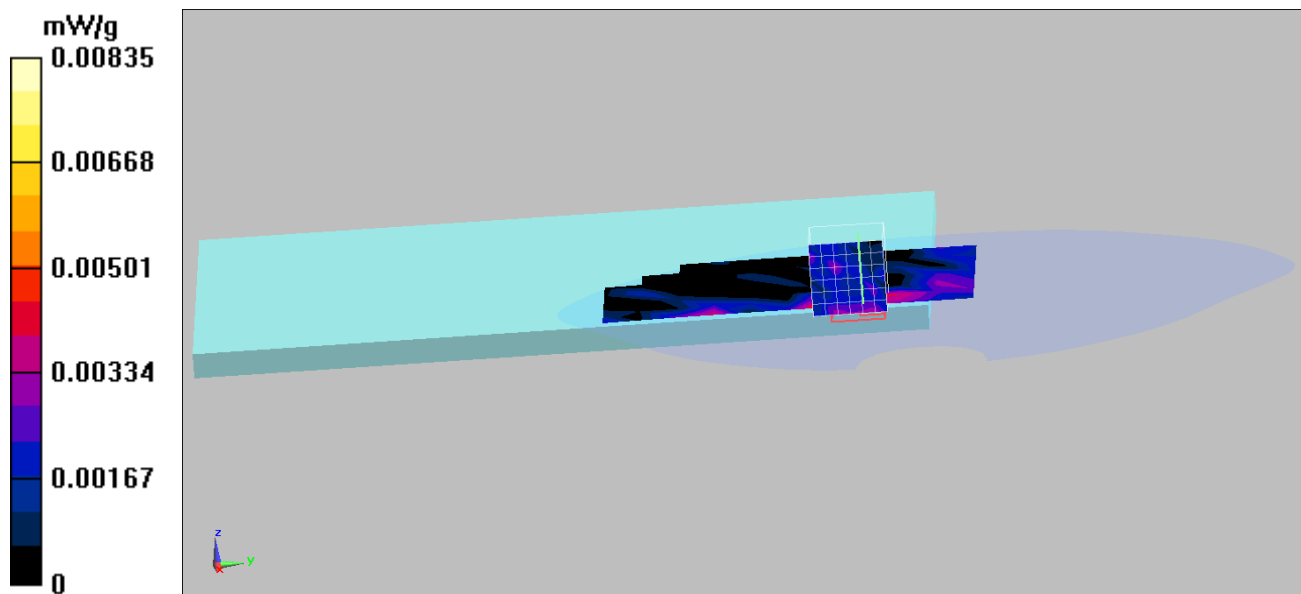
**DUT: Notebook PC; Type: LGX30**

Communication System: 802.11b; Frequency: 2462 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 2462$  MHz;  $\sigma = 1.96$  mho/m;  $\epsilon_r = 52.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section  
 Ambient Temperature (°C) : 24.4, Liquid Temperature (°C) : 23.9  
 DASY4 Configuration:

- Probe: EX3DV4 - SN3602; ConvF(6.9, 6.9, 6.9); Calibrated: 5/20/2009
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 4/7/2009
- Phantom: SAM Right Table; Type: SAM;
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

**Body/Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm  
 Maximum value of SAR (measured) = 0.00706 mW/g

**Body/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
 Reference Value = 0.388 V/m; Power Drift = 0.109 dB  
 Peak SAR (extrapolated) = 0.012 W/kg  
**SAR(1 g) = 0.00547 mW/g; SAR(10 g) = 0.00279 mW/g**  
 Maximum value of SAR (measured) = 0.00835 mW/g



Date/Time: 11/24/2009

Test Laboratory: Quietek

802.11n\_6 20M

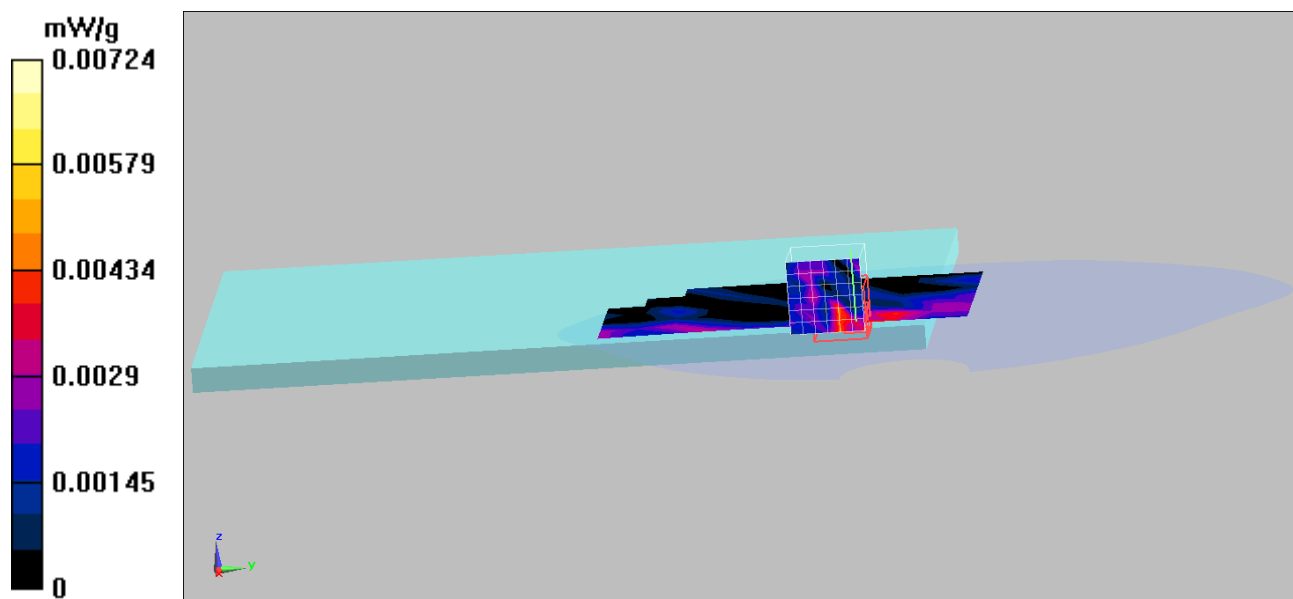
DUT: Notebook PC; Type: LGX30

Communication System: 802.11n; Frequency: 2437 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.91$  mho/m;  $\epsilon_r = 53.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Ambient Temperature (°C) : 24.4, Liquid Temperature (°C) : 23.9  
DASY4 Configuration:

- Probe: EX3DV4 - SN3602; ConvF(6.9, 6.9, 6.9); Calibrated: 5/20/2009
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 4/7/2009
- Phantom: SAM Right Table; Type: SAM;
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

**Body/Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (measured) = 0.00446 mW/g

**Body/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 0.926 V/m; Power Drift = -0.124 dB  
Peak SAR (extrapolated) = 0.018 W/kg  
**SAR(1 g) = 0.00623 mW/g; SAR(10 g) = 0.0023 mW/g**  
Maximum value of SAR (measured) = 0.00724 mW/g



Date/Time: 11/24/2009

Test Laboratory: Quietek

802.11n\_6 40M

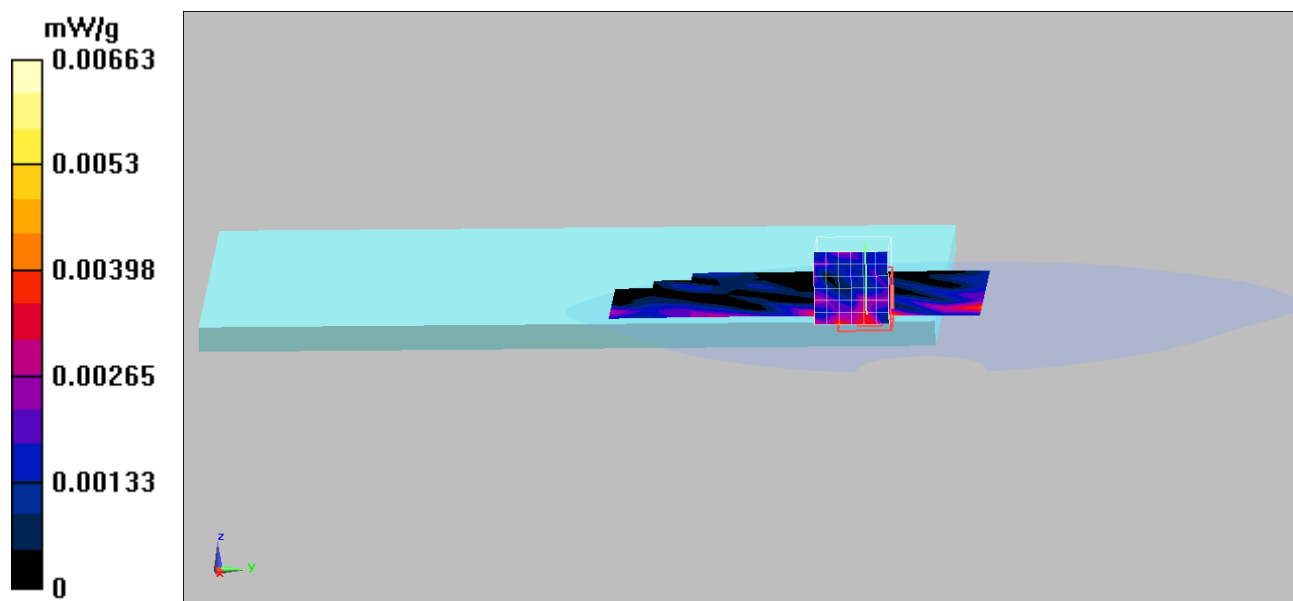
DUT: Notebook PC; Type: LGX30

Communication System: 802.11n; Frequency: 2437 MHz; Duty Cycle: 1:1  
Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.91$  mho/m;  $\epsilon_r = 53.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Ambient Temperature (°C) : 24.4, Liquid Temperature (°C) : 23.9  
DASY4 Configuration:

- Probe: EX3DV4 - SN3602; ConvF(6.9, 6.9, 6.9); Calibrated: 5/20/2009
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 4/7/2009
- Phantom: SAM Right Table; Type: SAM;
- Measurement SW: DASY5, V5.0 Build 125; SEMCAD X Version 13.4 Build 125

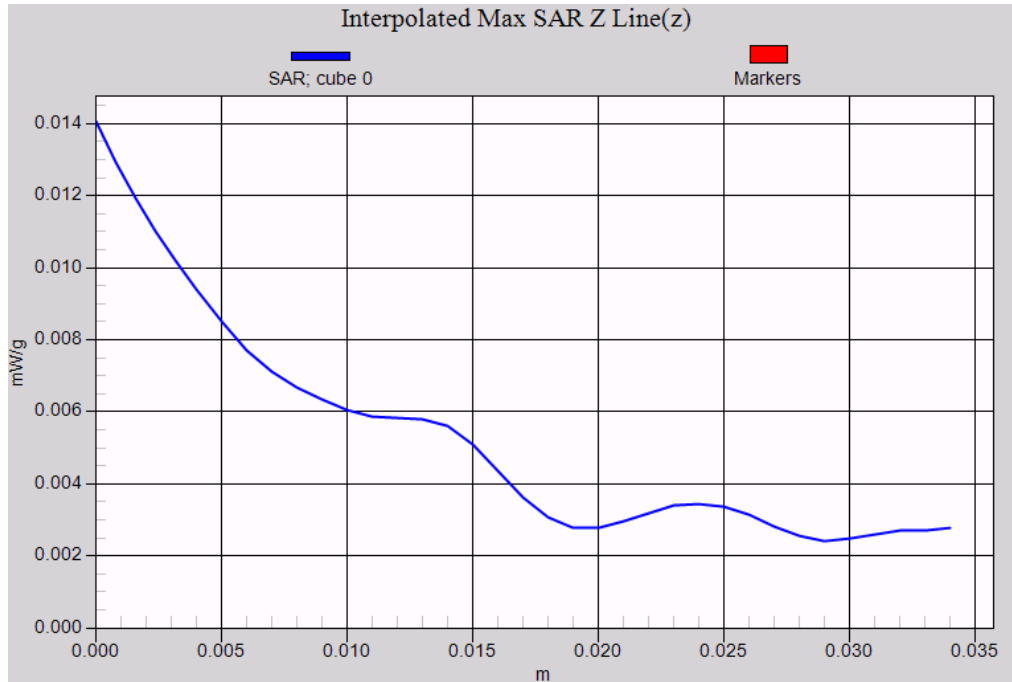
**Body/Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm  
Maximum value of SAR (measured) = 0.00624 mW/g

**Body/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 0.743 V/m; Power Drift = 0.01 dB  
Peak SAR (extrapolated) = 0.011 W/kg  
**SAR(1 g) = 0.0059 mW/g; SAR(10 g) = 0.0033 mW/g**  
Maximum value of SAR (measured) = 0.00663 mW/g



## 802.11b EUT Bottom Z-Axis plot

Channel: 6





## **Appendix D. Probe Calibration Data**

**Miniature Isotropic RF Probe  
S/N: 3602**



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Client **Quietek (Auden)**

Certificate No: **EX3-3602\_May09**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3602**

Calibration procedure(s) **QA CAL-01.v6, QA CAL-14.v3 and QA CAL-23.v3  
Calibration procedure for dosimetric E-field probes**

Calibration date: **May 20, 2009**

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&TE critical for calibration)

| Primary Standards          | ID #            | Cal Date (Certificate No.)    | Scheduled Calibration |
|----------------------------|-----------------|-------------------------------|-----------------------|
| Power meter E4419B         | GB41283874      | 1-Apr-09 (No. 217-01030)      | Apr-10                |
| Power sensor E4412A        | MY41495277      | 1-Apr-09 (No. 217-01030)      | Apr-10                |
| Power sensor E4412A        | MY41498087      | 1-Apr-09 (No. 217-01030)      | Apr-10                |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 31-Mar-09 (No. 217-01028)     | Mar-10                |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 31-Mar-09 (No. 217-01028)     | Mar-10                |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 31-Mar-09 (No. 217-01027)     | Mar-10                |
| Reference Probe ES3DV2     | SN: 3013        | 2-Jan-09 (No. ES3-3013_Jan09) | Jan-10                |
| DAE4                       | SN: 660         | 9-Sep-08 (No. DAE4-660_Sep08) | Sep-09                |

| Secondary Standards       | ID #         | Check Date (in house)             | Scheduled Check        |
|---------------------------|--------------|-----------------------------------|------------------------|
| RF generator HP 8648C     | US3642U01700 | 4-Aug-99 (in house check Oct-07)  | In house check: Oct-09 |
| Network Analyzer HP 8753E | US37390585   | 18-Oct-01 (in house check Oct-08) | In house check: Oct-09 |

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

Issued: May 20, 2009

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





Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: **SCS 108**

### Glossary:

|                          |                                                                                                                                                      |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                      | tissue simulating liquid                                                                                                                             |
| NORM <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                            |
| ConvF                    | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                           |
| DCP                      | diode compression point                                                                                                                              |
| Polarization $\phi$      | $\phi$ rotation around probe axis                                                                                                                    |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis |

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

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

### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the E<sup>2</sup>-field uncertainty inside TSL (see below *ConvF*).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* frequency response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep (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<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

# Probe EX3DV4

## SN:3602

|               |                |
|---------------|----------------|
| Manufactured: | March 23, 2009 |
| Calibrated:   | May 20, 2009   |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

## DASY - Parameters of Probe: EX3DV4 SN:3602

### Sensitivity in Free Space<sup>A</sup>

### Diode Compression<sup>B</sup>

|       |                     |                                     |       |              |
|-------|---------------------|-------------------------------------|-------|--------------|
| NormX | <b>0.41</b> ± 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP X | <b>87</b> mV |
| NormY | <b>0.40</b> ± 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP Y | <b>89</b> mV |
| NormZ | <b>0.52</b> ± 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP Z | <b>89</b> 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 |                              | <b>2.0 mm</b> | <b>3.0 mm</b> |
| SAR <sub>loc</sub> [%]                    | Without Correction Algorithm | 10.2          | 6.1           |
| SAR <sub>loc</sub> [%]                    | With Correction Algorithm    | 0.9           | 0.6           |

**TSL**                      **1810 MHz**      **Typical SAR gradient: 10 % per mm**

|                                           |                              |               |               |
|-------------------------------------------|------------------------------|---------------|---------------|
| Sensor Center to Phantom Surface Distance |                              | <b>2.0 mm</b> | <b>3.0 mm</b> |
| SAR <sub>loc</sub> [%]                    | Without Correction Algorithm | 6.7           | 2.9           |
| SAR <sub>loc</sub> [%]                    | With Correction Algorithm    | 0.5           | 0.3           |

### Sensor Offset

Probe Tip to Sensor Center                      **1.0 mm**

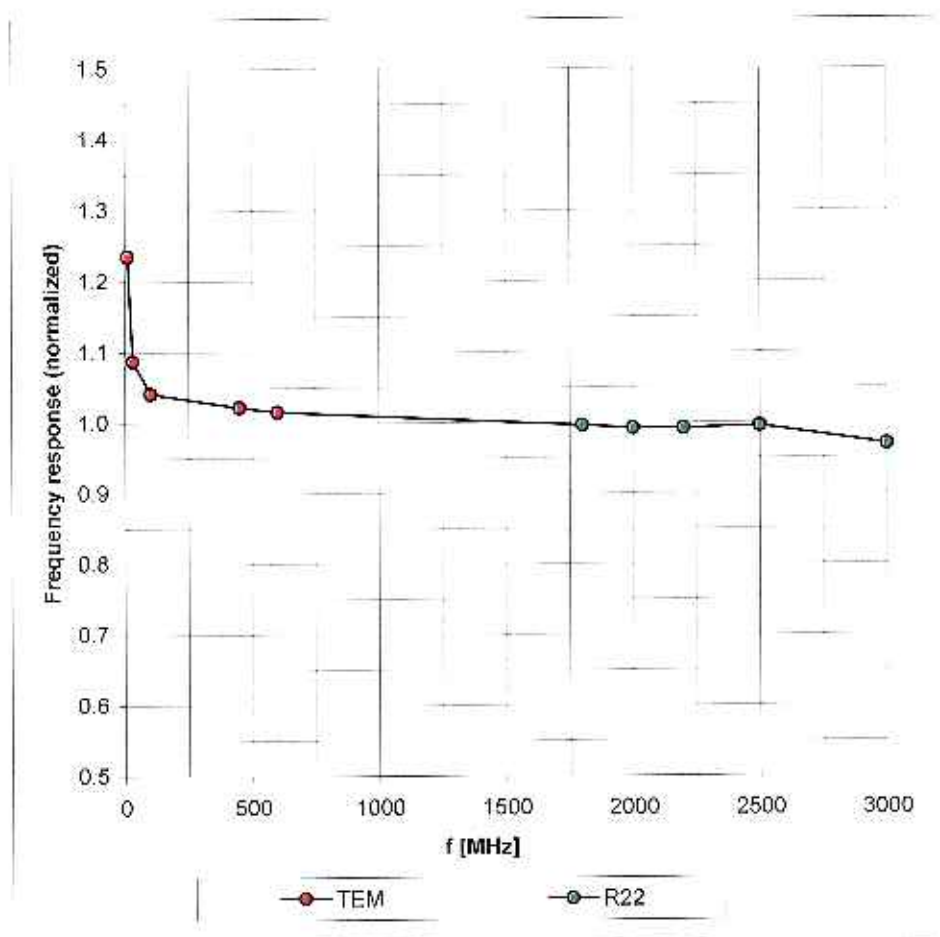
The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

<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.

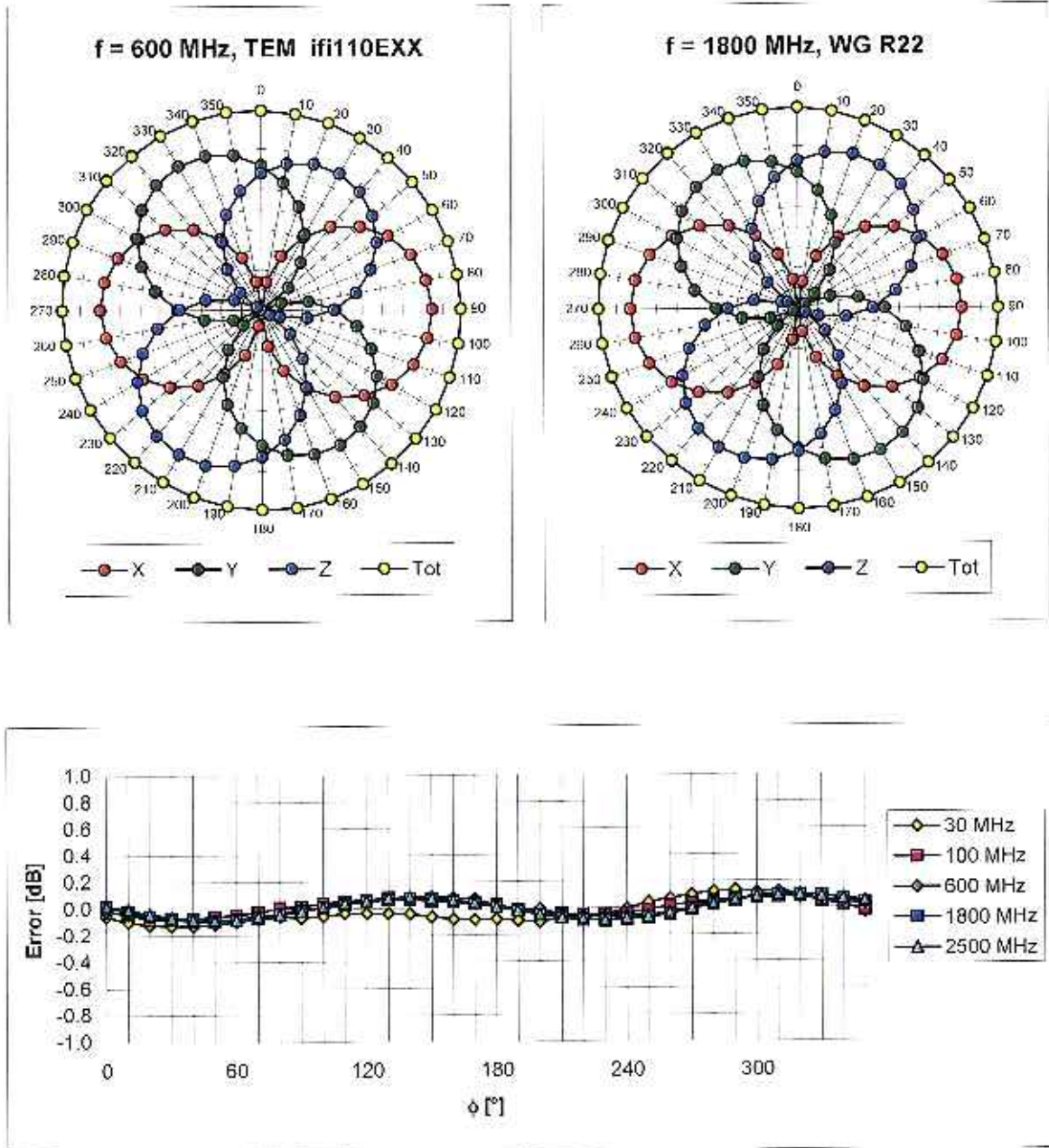
## Frequency Response of E-Field

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



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

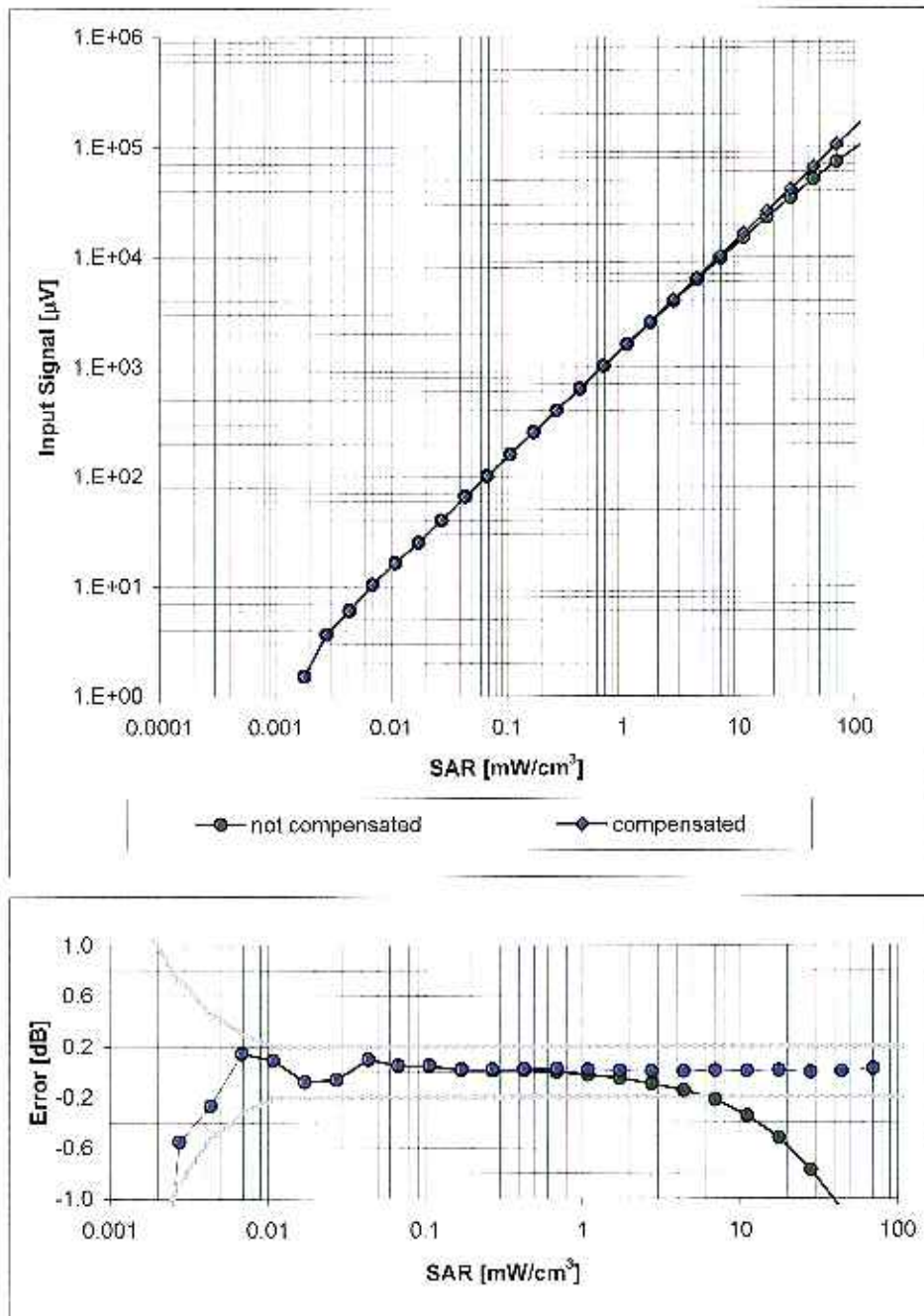
# Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



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

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

(Waveguide R22,  $f = 1800$  MHz)



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

## Conversion Factor Assessment

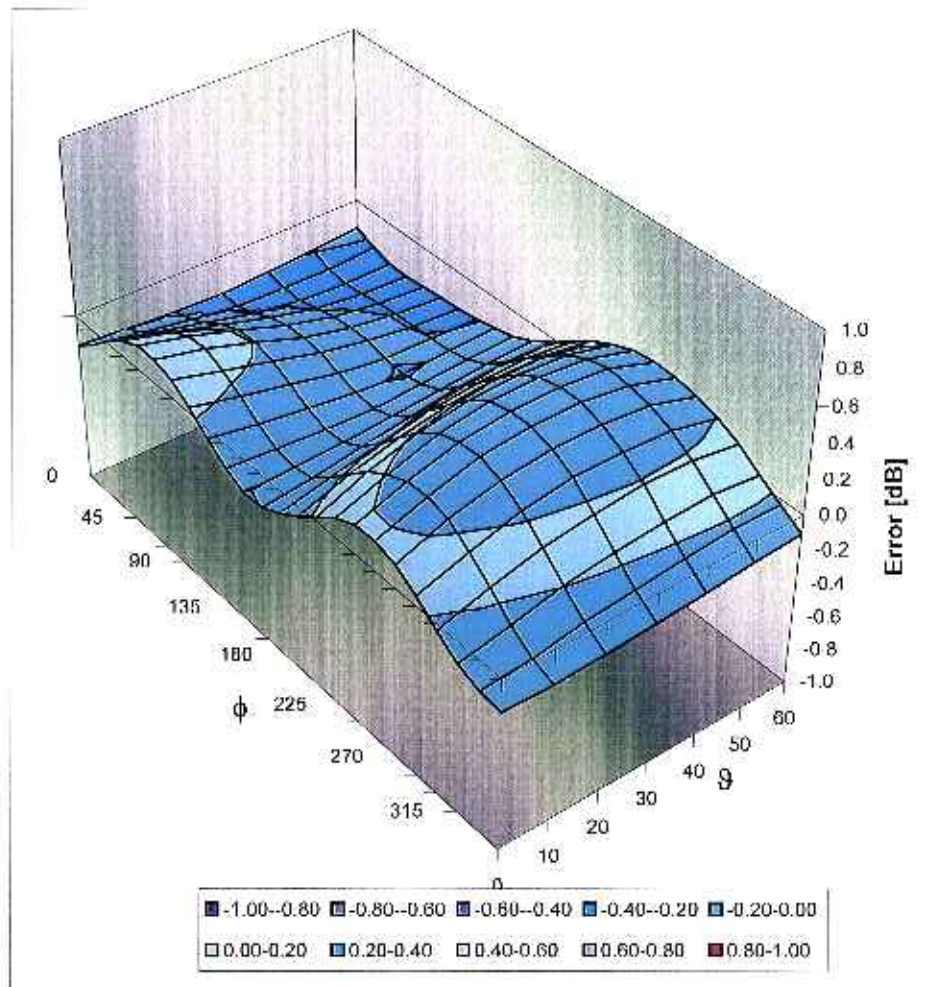
| f [MHz] | Validity [MHz] <sup>c</sup> | TSL  | Permittivity | Conductivity | Alpha | Depth | ConvF Uncertainty  |
|---------|-----------------------------|------|--------------|--------------|-------|-------|--------------------|
| 835     | ± 50 / ± 100                | Head | 41.5 ± 5%    | 0.90 ± 5%    | 0.56  | 0.71  | 9.14 ± 11.0% (k=2) |
| 900     | ± 50 / ± 100                | Head | 41.5 ± 5%    | 0.97 ± 5%    | 0.65  | 0.65  | 8.86 ± 11.0% (k=2) |
| 1810    | ± 50 / ± 100                | Head | 40.0 ± 5%    | 1.40 ± 5%    | 0.84  | 0.55  | 7.81 ± 11.0% (k=2) |
| 1950    | ± 50 / ± 100                | Head | 40.0 ± 5%    | 1.40 ± 5%    | 0.84  | 0.56  | 7.55 ± 11.0% (k=2) |
| 2450    | ± 50 / ± 100                | Head | 39.2 ± 5%    | 1.80 ± 5%    | 0.46  | 0.70  | 7.10 ± 11.0% (k=2) |
| 2600    | ± 50 / ± 100                | Head | 39.0 ± 5%    | 1.96 ± 5%    | 0.41  | 0.77  | 7.10 ± 11.0% (k=2) |
| 3500    | ± 50 / ± 100                | Head | 37.9 ± 5%    | 2.91 ± 5%    | 0.42  | 1.00  | 6.26 ± 13.1% (k=2) |
| 5200    | ± 50 / ± 100                | Head | 36.0 ± 5%    | 4.66 ± 5%    | 0.43  | 1.75  | 4.79 ± 13.1% (k=2) |
| 5300    | ± 50 / ± 100                | Head | 35.9 ± 5%    | 4.76 ± 5%    | 0.43  | 1.75  | 4.43 ± 13.1% (k=2) |
| 5500    | ± 50 / ± 100                | Head | 35.6 ± 5%    | 4.96 ± 5%    | 0.50  | 1.75  | 4.44 ± 13.1% (k=2) |
| 5600    | ± 50 / ± 100                | Head | 35.5 ± 5%    | 5.07 ± 5%    | 0.50  | 1.75  | 4.42 ± 13.1% (k=2) |
| 5800    | ± 50 / ± 100                | Head | 35.3 ± 5%    | 5.27 ± 5%    | 0.52  | 1.75  | 4.21 ± 13.1% (k=2) |
|         |                             |      |              |              |       |       |                    |
| 835     | ± 50 / ± 100                | Body | 55.2 ± 5%    | 0.97 ± 5%    | 0.72  | 0.65  | 9.32 ± 11.0% (k=2) |
| 900     | ± 50 / ± 100                | Body | 55.0 ± 5%    | 1.05 ± 5%    | 0.55  | 0.74  | 8.97 ± 11.0% (k=2) |
| 1810    | ± 50 / ± 100                | Body | 53.3 ± 5%    | 1.52 ± 5%    | 0.70  | 0.65  | 7.97 ± 11.0% (k=2) |
| 1950    | ± 50 / ± 100                | Body | 53.3 ± 5%    | 1.52 ± 5%    | 0.48  | 0.78  | 7.68 ± 11.0% (k=2) |
| 2450    | ± 50 / ± 100                | Body | 52.7 ± 5%    | 1.95 ± 5%    | 0.42  | 0.79  | 6.90 ± 11.0% (k=2) |
| 2600    | ± 50 / ± 100                | Body | 52.5 ± 5%    | 2.16 ± 5%    | 0.28  | 1.23  | 6.81 ± 11.0% (k=2) |
| 3500    | ± 50 / ± 100                | Body | 51.3 ± 5%    | 3.31 ± 5%    | 0.35  | 1.22  | 5.75 ± 13.1% (k=2) |
| 5200    | ± 50 / ± 100                | Body | 49.0 ± 5%    | 5.30 ± 5%    | 0.50  | 1.80  | 4.43 ± 13.1% (k=2) |
| 5300    | ± 50 / ± 100                | Body | 48.5 ± 5%    | 5.42 ± 5%    | 0.52  | 1.80  | 4.23 ± 13.1% (k=2) |
| 5500    | ± 50 / ± 100                | Body | 48.6 ± 5%    | 5.65 ± 5%    | 0.55  | 1.80  | 4.08 ± 13.1% (k=2) |
| 5600    | ± 50 / ± 100                | Body | 48.5 ± 5%    | 5.77 ± 5%    | 0.55  | 1.80  | 3.95 ± 13.1% (k=2) |
| 5800    | ± 50 / ± 100                | Body | 48.2 ± 5%    | 6.00 ± 5%    | 0.61  | 1.80  | 4.00 ± 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.



## Deviation from Isotropy in HSL

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



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





## **Appendix E. Dipole Calibration**

**Validation Dipole 2450 MHz**

**M/N: ALS-D-2450-S-2**

**S/N: QTK-319**

# NCL CALIBRATION LABORATORIES

Calibration File No: DC-891

## C E R T I F I C A T E   O F   C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the  
**NCL CALIBRATION LABORATORIES** by qualified personnel following recognized  
procedures and using transfer standards traceable to NRC/NIST.

Quietek Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-2450-S-2

Frequency: 2.45 GHz

Serial No: QTK-319

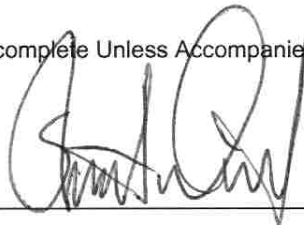
Customer: Quietek

Project Number: QTKB-Dipole-CAL-5336

Calibrated: 9<sup>th</sup> May 2008  
Released on: 9<sup>th</sup> May 2008

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: \_\_\_\_\_



**NCL** CALIBRATION LABORATORIES

51 SPECTRUM WAY  
NEPEAN, ONTARIO  
CANADA K2R 1E6

Division of APREL Lab.  
TEL: (613) 820-4988  
FAX: (613) 820-4161

## Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

### Mechanical Dimensions

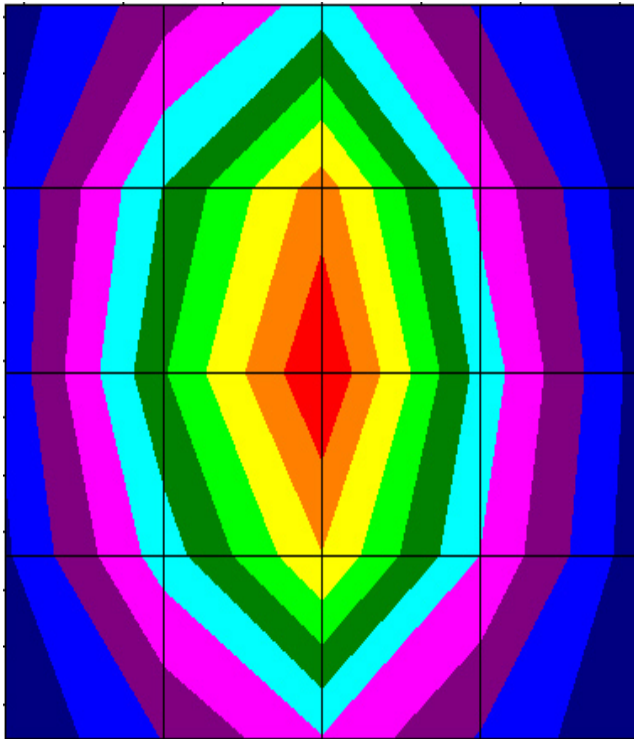
**Length:** 53.5 mm  
**Height:** 30.4 mm

### Electrical Specification

**SWR:** 1.19 U  
**Return Loss:** -20.8 dB  
**Impedance:** 49.4  $\Omega$

### System Validation Results

| Frequency | 1 Gram | 10 Gram | Peak |
|-----------|--------|---------|------|
| 2.45 GHz  | 48.07  | 25.65   | 95.6 |



## Conditions

Dipole 319 is a recalibration.

**Ambient Temperature of the Laboratory:** 22 °C +/- 0.5°C  
**Temperature of the Tissue:** 21 °C +/- 0.5°C

## References

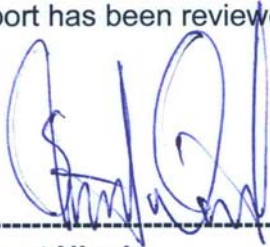
SSI-TP-018-ALSAS Dipole Calibration Procedure

SSI-TP-016 Tissue Calibration Procedure

IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"

IEC 62209 "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures –Part 1 & Part 2: Procedure to determine the specific absorption rate (SAR) for mobile wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

We the undersigned attest that to the best of our knowledge the calibration of this device has been accurately conducted and that all information contained within this report has been reviewed for accuracy.



Stuart Nicol



C. Teodorian

## **Dipole Calibration Results**

### **Mechanical Verification**

| <b>IEEE Length</b> | <b>IEEE Height</b> | <b>Measured Length</b> | <b>Measured Height</b> |
|--------------------|--------------------|------------------------|------------------------|
| 51.5 mm            | 30.4 mm            | 53.5 mm                | 30.4 mm                |

### **Tissue Validation**

| <b>Head Tissue 2450 MHz</b>                         | <b>Measured</b> |
|-----------------------------------------------------|-----------------|
| <b>Dielectric constant, <math>\epsilon_r</math></b> | 40.1            |
| <b>Conductivity, <math>\sigma</math> [S/m]</b>      | 1.78            |

**Electrical Calibration**

| Test      | Result        |
|-----------|---------------|
| S11 R/L   | -20.8 dB      |
| SWR       | 1.2 U         |
| Impedance | 49.4 $\Omega$ |

The Following Graphs are the results as displayed on the Vector Network Analyzer.

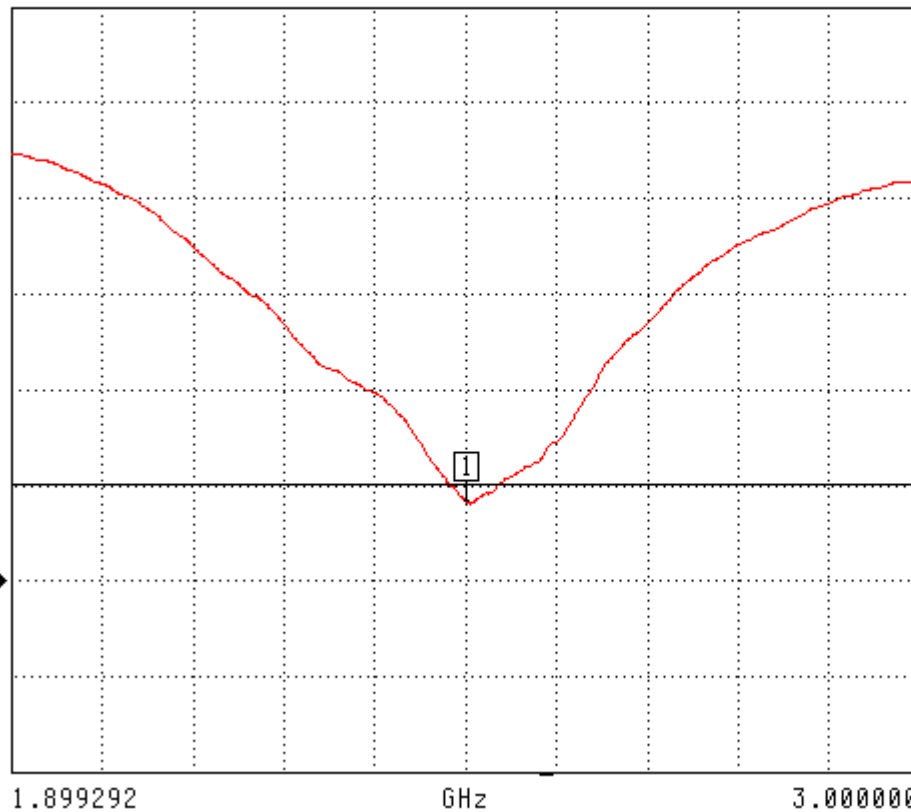
**S11 Parameter Return Loss**

S11 FORWARD REFLECTION

LOG MAGNITUDE

REF = -25.000 dB

5.000 dB/DIV



CH 1 - S11  
REFERENCE PLANE  
0.0000 mm

MARKER 1  
2.450046 GHz  
-20.796 dB

MARKER TO MAX  
▶ MARKER TO MIN

MARKER READOUT  
FUNCTIONS

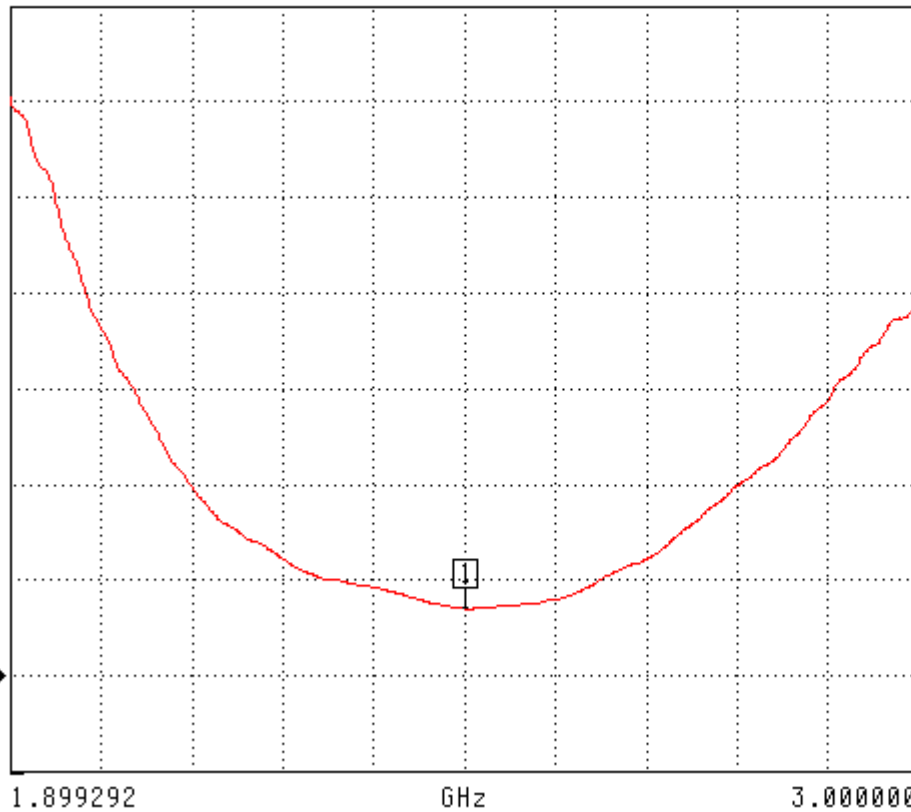
SWR

S11 FORWARD REFLECTION

SWR

REF=500.000 mU

1.000 U/DIV



CH 1 - S11  
REFERENCE PLANE  
0.0000 mm

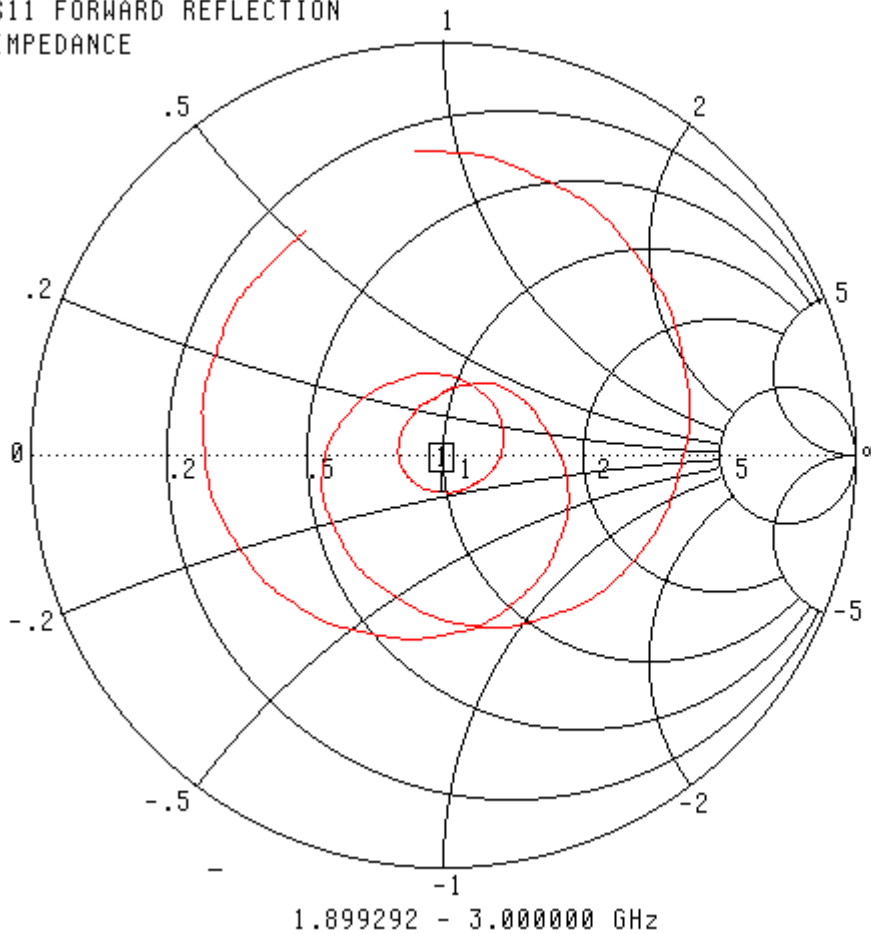
MARKER 1  
2.450046 GHz  
1.199 U

MARKER TO MAX  
▶ MARKER TO MIN

MARKER READOUT  
FUNCTIONS

## Smith Chart Dipole Impedance

S11 FORWARD REFLECTION  
IMPEDANCE



CH 1 - S11  
REFERENCE PLANE  
0.0000 mm

MARKER 1  
2.450046 GHz  
49.365  $\Omega$   
-9.232 j $\Omega$

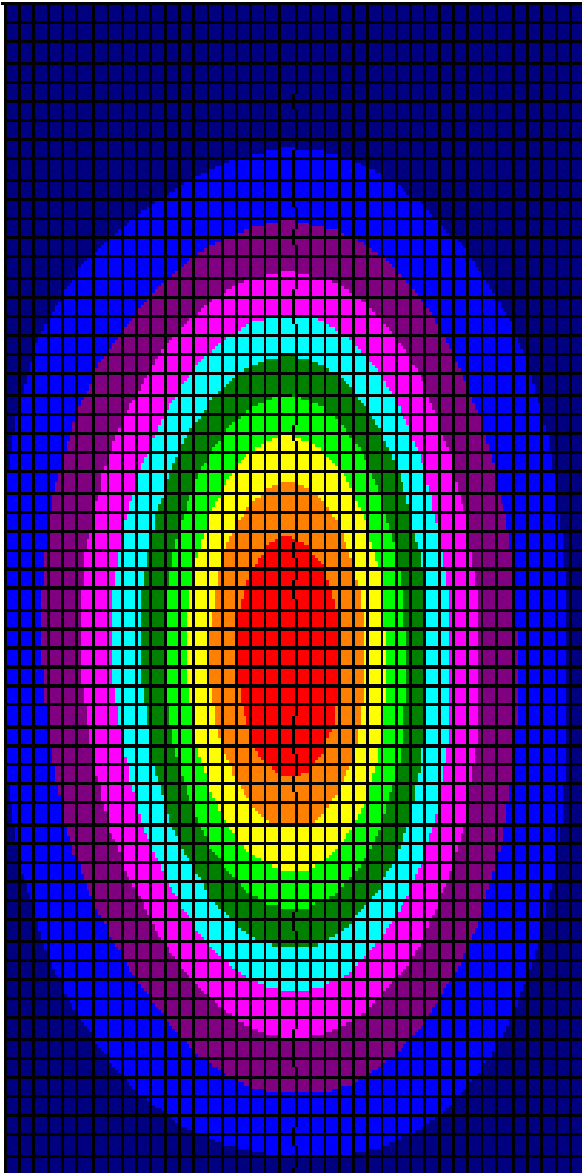
MARKER TO MAX  
▶ MARKER TO MIN

MARKER READOUT  
FUNCTIONS



### System Validation Results Using the Electrically Calibrated Dipole

| Frequency | 1 Gram | 10 Gram | Peak<br>Above Feed Point |
|-----------|--------|---------|--------------------------|
| 2.45 GHz  | 48.07  | 25.65   | 95.6                     |



## **Test Equipment**

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2008.