# SAR TEST REPORT

## No. 2010EEB00610

**For**

**WANLIDA GROUP CO.,LTD.**

**Tablet PC**

**PC-A1001**

**With**

**Wi-Fi module 802.11 b/g/n**

**Module Name: RT3090**

**FCCID: VQF-RT3090-1T1R**

**Issued Date: 2010-09-20**

Deutscher Akkreditierungs Rat

DAR

*No.* DGA-PL-114/09-A0

检 测

CNAS L0442

**Note:**

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of TMC Beijing.

**Test Laboratory:**

TMC Beijing, Telecommunication Metrology Center of Ministry of Industry and Information Technology
No. 52, Huayuan Bei Road, Haidian District, Beijing, P. R. China 100191.
Tel:+86(0)10-62304633-2079, Fax:+86(0)10-62304793 Email:welcome@emcite.com. www.emcite.com

工业和信息化部通信计量中心
检验报告专用章

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# 1 Test Laboratory

## 1.1 Testing Location

| | |
|---|---|
| Company Name: | TMC Shenzhen, Telecommunication Metrology Center of MIIT |
| Address: | No. 12building, Shangsha Innovation and Technology Park,Futian District,Shenzhen, P. R. China |
| Postal Code: | 518048 |
| Telephone: | +86-755-33322000 |
| Fax: | +86-755-33322001 |

## 1.2 Testing Environment

| | |
|---|---|
| Temperature: | 18°C~25 °C, |
| Relative humidity: | 30%~ 70% |
| Ground system resistance: | < 0.5 Ω |

Ambient noise is checked and found very low and in compliance with requirement of standards.
Reflection of surrounding objects is minimized and in compliance with requirement of standards.

## 1.3 Project Data

| | |
|---|---|
| Project Leader: | Zhou Yi |
| Test Engineer: | Zhu Zhiqiang |
| Testing Start Date: | September 17, 2010 |
| Testing End Date: | September 17, 2010 |

## 1.4 Signature

朱志强

**Zhu Zhiqiang**

**(Prepared this test report)**

周镒

**Zhou Yi**

**(Reviewed this test report)**

陆冰松

**Lu Bingsong**

**Deputy director of the laboratory**

**(Approved this test report)**

# 2 Client Information

## 2.1 Applicant Information

| | |
|---|---|
| Company Name: | TUV SUD China Shenzhen branch |
| Address /Post: | 6/F, H Hall, Century Craftwork Culture Square No. 4001 Fuqiang Road, Futian District, shenzhen, P.R.China |
| City: | Shenzhen |
| Postal Code: | 518048 |
| Country: | China |
| Telephone: | +86 (0) 755-88286998-273 |
| Fax: | +86 (0) 755-88285299 |

## 2.2 Manufacturer Information

| | |
|---|---|
| Company Name: | Wanlida Group Co., Ltd. |
| Address /Post: | No. 618, Jiahe Road, Wanlida Industry Zone, Xiamen, Fujian, China |
| City: | Xiamen |
| Postal Code: | 361006 |
| Country: | China |
| Telephone: | / |
| Fax: | / |

# 3 Equipment Under Test (EUT) and Ancillary Equipment (AE)

## 3.1 About EUT

| | |
|---|---|
| Description: | Tablet PC with WiFi module |
| Model Name: | PC-A1001 |
| Brand Name: | WANLIDA |
| Frequency Band: | 802.11b/g/n 2.45GHz |

**Picture 1: Constituents of the sample**

## 3.2 Internal Identification of AE used during the test

| AE ID* | Description | Model | SN | Manufacturer |
|---|---|---|---|---|
| AE1 | AC Adapter | EXA0901XH | / | Enertronix (Huizhou) Inc. |
| AE2 | Li-ion battery pack | BT-A001 | / | YOKU ENERGY (ZHANG ZHOU) CO., LTD. |

*EUT/AE ID: is used to identify the test sample in the lab internally.

# 4 CHARACTERISTICS OF THE TEST

## 4.1 Applicable Limit Regulations

**EN 50360–2001:** Product standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones.

It specifies the maximum exposure limit of **2.0 W/kg** as averaged over any 10 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

**ANSI C95.1–1999:** IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
**47 CFR §2.1093:** Radiofrequency radiation exposure evaluation: portable devices.

They specify the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

## 4.2 Applicable Measurement Standards

**EN 62209-1–2006:** Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures –Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz).

**IEEE 1528–2003:** Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques.

**OET Bulletin 65 (Edition 97-01) and Supplement C(Edition 01-01):** Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits.

**IEC 62209-2 (Edition 1.0):** Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz).
**KDB 447498 D01:** Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies v03r02
**KDB 248227:**SAR Measurement Procedures for 802.11 a/b/g transmitter
**KDB 616217:**SAR Evaluation Considerations for Laptop Computers with Antennas Built-in on Display Screens.
They specify the measurement method for demonstration of compliance with the SAR limits for such equipments.

# 5 OPERATIONAL CONDITIONS DURING TEST

## 5.1 Schematic Test Configuration

5.1.1 Test positions

The EUT is tested at the following 5 test positions (the antenna of the WiFi module is located the right edge of the tablet PC):

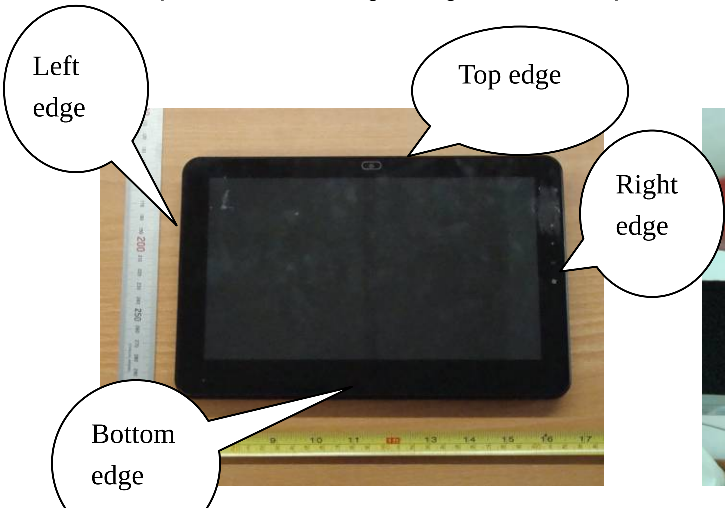
Test position 1: The bottom of the computer is in direct contact against the flat phantom.

Test position 2: The top edge of the computer is in direct contact against the flat phantom.

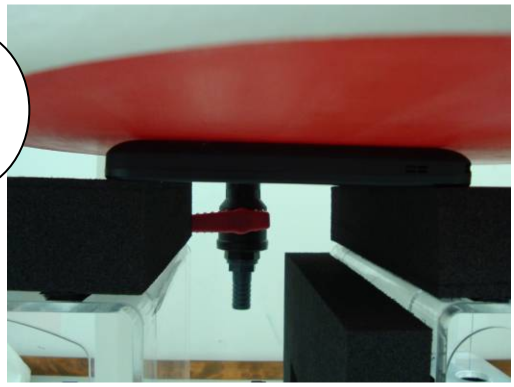
Test position 3: The left edge of the computer is in direct contact against the flat phantom.

Test position 4: The bottom edge of the computer is in direct contact against the flat phantom.

Test position 5: The right edge of the computer is in direct contact against the flat phantom.



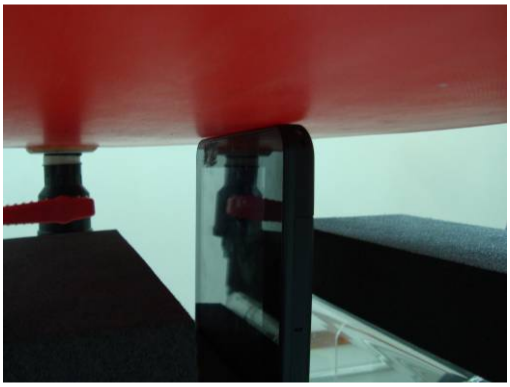

**Picture 2-a: edge definition**



**Picture 2-b: Test position 1**

**Picture 2-c: Test position 2**

**Picture 2-d: Test position 3**

**Picture 2-e: Test position 4** **Picture 2-f: Test position 5**

5.1.2 Body SAR Measurement Description

The EUT has only one transmitter: WiFi 802.11b/g/n module, the antenna location is as following.


**Picture 3 antenna positions**

**WiFi 802.11b/g/n 2.45GHz band**

SAR is not required for 802.11g channels since the output power is less than 0.25dB higher than that measured on the corresponding 802.11b channels, and for each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 0.25dB higher than those measured at the lowest data rate. According to the following conducted power, the EUT should be tested for “802.11b 1Mbps” first, then the necessary configurations in “802.11g”,”802.11nHT20” and “802.11nHT40”.

A communication link is set up with the test mode software for WiFi mode test. The test mode software we used is Ralink QA Test Program for RT3090 with the version of V1.5.3.0 supported by company Ralink Technology Corporation.For 802.11b,802.11g and 802.11n HT20, the Absolute Radio Frequency Channel Number (ARFCN) is allocated to 1, 6 and 11 respectively in the case of 2450 MHz. For 802.11n HT40, the Absolute Radio Frequency Channel Number (ARFCN) is allocated to 3, 6 and 9 respectively in the case of 2450 MHz. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. The tests are performed for WiFi at highest output channel for all the 5 test positions, and according to KDB447498 D01 1)e)i, "When the SAR procedures require multiple channels to be tested and the 1-g SAR for the highest output channel is less than 0.8W/Kg,where the transmission band corresponding to all channels is≤100 MHz,testing for the other channels is not required." So the test channels have been set first to the highest output channel and then others if necessary.

The conducted power for WiFi is as following:

802.11b（dBm）

| Channel\data rate | 1Mbps | 2Mbps | 5.5Mbps | 11Mbps |
|---|---|---|---|---|
| 1 | 20.06 | 19.89 | 19.50 | 19.33 |
| 6 | 19.84 | 19.80 | 19.62 | 19.37 |
| 11 | 18.65 | 18.49 | 18.32 | 18.21 |

802.11g（dBm）

| Channel\data rate | 6Mbps | 9Mbps | 12Mbps | 18Mbps | 24Mbps | 36Mbps | 48Mbps | 54Mbps |
|---|---|---|---|---|---|---|---|---|
| 1 | 19.28 | 19.20 | 19.12 | 18.90 | 18.78 | 18.65 | 18.24 | 18.00 |
| 6 | 18.80 | 18.65 | 18.60 | 18.54 | 18.49 | 18.32 | 18.30 | 18.22 |
| 11 | 18.50 | 18.48 | 18.43 | 18.33 | 18.21 | 18.19 | 18.11 | 18.03 |

802.11n HT20（dBm）

| Channel\data rate | 6.5 Mbps | 13 Mbps | 19.5 Mbps | 26 Mbps | 39 Mbps | 52 Mbps | 58.5 Mbps | 65 Mbps |
|---|---|---|---|---|---|---|---|---|
| 1 | 19.36 | 19.26 | 19.17 | 19.13 | 19.10 | 19.02 | 18.90 | 18.70 |
| 6 | 18.75 | 18.55 | 18.52 | 18.50 | 18.44 | 18.41 | 18.32 | 18.20 |
| 11 | 18.55 | 18.31 | 18.29 | 18.29 | 18.20 | 18.13 | 18.10 | 18.02 |

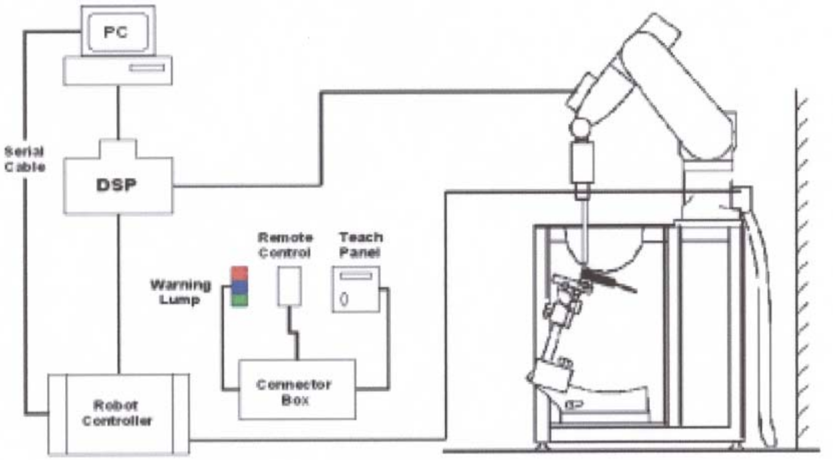
802.11n HT40（dBm）

| Channel\data rate | 13.5 Mbps | 27 Mbps | 40.5 Mbps | 54 Mbps | 81 Mbps | 108 Mbps | 121.5 Mbps | 135 Mbps |
|---|---|---|---|---|---|---|---|---|
| 3 | 18.20 | 18.17 | 18.16 | 18.10 | 18.09 | 18.06 | 17.89 | 17.80 |
| 6 | 17.90 | 17.82 | 17.67 | 17.52 | 17.50 | 17.42 | 17.23 | 16.99 |
| 9 | 17.20 | 17.15 | 17.05 | 17.04 | 16.87 | 16.73 | 16.53 | 16.50 |

## 5.2 SAR Measurement Set-up

These measurements were performed with the automated near-field scanning system DASY5 NEO from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m), which positions the probes with a positional repeatability of better than ± 0.02mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines (length =300mm) to the data acquisition unit.

A cell controller system contains the power supply, robot controller, teaches pendant (Joystick), and remote control, is used to drive the robot motors. The PC consists of Inter® Core™ CPU 6300 @1.86GHz,1.58GHz computer with Windows XP system and SAR Measurement Software DASY5 NEO, A/D interface card, monitor, mouse, and keyboard. The Stäubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit 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.




**Picture 4: SAR Lab Test Measurement Set-up**

The 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 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.

## 5.3 Dasy5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe ES3DV3 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the standard procedure with an accuracy of better than ± 10%. The spherical isotropy was evaluated and found to be better than ± 0.25dB.

**Picture 5: ES3DV3 E-field Probe**

### ES3DV3 Probe Specification

| | |
|---|---|
| Construction | Symmetrical design with triangular core |
| | Interleaved sensors |
| | Built-in shielding against static charges |
| | PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |

| | |
|---|---|
| Calibration | Basic Broad Band Calibration in air<br>Conversion Factors (CF) for HSL 900 and HSL 1810<br>Additional CF for other liquids and frequencies<br>upon request |
| Frequency | 10 MHz to 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz) |
| Directivity | ± 0.2 dB in HSL (rotation around probe axis)<br>± 0.3 dB in tissue material (rotation normal to probe axis) |
| Dynamic Range | 5 μW/g to > 100 mW/g; Linearity: ± 0.2 dB |
| Dimensions | Overall length: 330 mm (Tip: 20 mm)<br>Tip diameter: 3.9 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.0 mm |
| Application | General dosimetry up to 4 GHz<br>Dosimetry in strong gradient fields<br>Compliance tests of mobile phones |

**Picture6:ES3DV3 E-field probe**

### 5.4 E-field Probe Calibration

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than ± 10%. The spherical isotropy was evaluated and found to be better than ± 0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a wave guide 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 then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a 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.

Or

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

**Picture 7: Device Holder**

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m$^3$).

## 5.5 Other Test Equipment

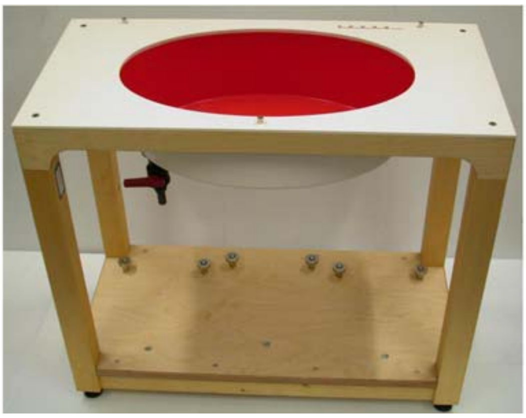
### 5.5.1 Device Holder for Transmitters

In combination with the Generic Twin Phantom V3.0, the Mounting Device (POM) enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatably positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

### 5.5.2 Phantom

The ELI4 phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users. The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30MHz to 6GHz. ELI4 is fully compatible with the latest standard IEC 62209-2 and all known tissue simulating liquids. 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.

| | |
|---|---|
| Shell Thickness | 2±0. l mm |
| Filling Volume | Approx. 20 liters |
| Dimensions | 810 x l000 x 500 mm (H x L x W) |
| Available | Special |



**Picture 8: ELI4 Phantom**

## 5.6 Equivalent Tissues

The liquid used for the frequency range of 2000-3000 MHz consisted of water, Glycol monobutyl,and salt . The liquid has been previously proven to be suited for worst-case. The Table 4 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528.

**Table 1: Composition of the Body Tissue Equivalent Matter**

| MIXTURE % | FREQUENCY 2450MHz |
|---|---|
| Water | 72.60 |
| Glycol monobutyl | 27.22 |
| Salt | 0.18 |
| Dielectric Parameters Target Value | f=2450MHz ε=52.7 σ=1.95 |

### 5.7 System Specifications

#### 5.7.1 Robotic System Specifications

**Specifications**

**Positioner:** Stäubli Unimation Corp. Robot Model: TX90XL
**Repeatability:** ±0.02 mm
**No. of Axis:** 6

**Data Acquisition Electronic (DAE) System**

**Cell Controller**

**Processor:** Inter® Core™ CPU 6300
**Clock Speed:** 1.86GHz
**Operating System:** Windows XP

**Data Converter**

**Features:**Signal Amplifier, multiplexer, A/D converter, and control logic
**Software:** DASY5 software
**Connecting Lines:** Optical downlink for data and status info.
Optical uplink for commands and clock

## 6 TEST RESULTS

### 6.1 Dielectric Performance

**Table 2: Dielectric Performance of Body Tissue Simulating Liquid**

Measurement is made at temperature 21.6 °C and relative humidity 58%.
Liquid temperature during the test: 21.5°C

| / | Measurement date | Frequency | Permittivity ε | Conductivity σ (S/m) |
|---|---|---|---|---|
| **Target value** | **/** | 2450 MHz | 52.7 | 1.95 |
| **Measurement value (Average of 10 tests)** | 9/17/2010 | 2450 MHz | 51.57 | 2.0 |

### 6.2 System Validation

**Table 3: System Validation**

Measurement is made at temperature 21.6 °C and relative humidity 49%,input power 250mW
Liquid temperature during the test: 21.5°C
Measurement Date : 2450 MHz **September 17, 2010**

| | | Frequency | Permittivity ε | Conductivity σ (S/m) |
|---|---|---|---|---|
| **Liquid parameters** | Dipole calibration Target value | 2450 MHz | 51.8 | 1.93 |
| | Actural Measurement value | 2450 MHz | 51.57 | 2.0 |

| Verification results | Frequency | Target value (W/kg) | | Measured value (W/kg) | | Deviation | |
|---|---|---|---|---|---|---|---|
| | | 10 g Average | 1 g Average | 10 g Average | 1 g Average | 10 g Average | 1 g Average |
| | 2450 MHz | 5.82 | 12.78 | 5.78 | 12.8 | -0.69% | 0.16% |

Note：Target values are the data of the dipole validation results, please check Annex F for the Dipole Calibration Certificate.

### 6.3 Summary of Measurement Results

**Table 4: SAR Values (WiFi 802.11b)**

| **Limit of SAR (W/kg)** | **10 g Average** | **1 g Average** | **Power Drift (dB)** |
|---|---|---|---|
| | 2.0 | 1.6 | |
| **Test Case(Flat Phantom)** | **Measurement Result (W/kg)** | | |
| | **10 g Average** | **1 g Average** | |
| Test Position 1, Bottom frequency,1Mbps(See Figure 1) | 0.338 | 0.780 | 0.16 |
| Test Position 2, Bottom frequency,1Mbps (See Figure 2) | 0.035 | 0.067 | 0.14 |
| Test Position 3, Bottom frequency,1Mbps (See Figure 3) | 0.00239 | 0.00425 | 0.113 |
| Test Position 4, Bottom frequency,1Mbps (See Figure 4) | 0.0084 | 0.013 | 0.19 |
| Test Position 5, Bottom frequency,1Mbps (See Figure 5) | 0.480 | 1.18 | 0.103 |
| Test Position 5, Middle frequency,1Mbps (See Figure 6) | 0.353 | 0.885 | 0.098 |
| Test Position 5, Top frequency ,1Mbps (See Figure 7) | 0.316 | 0.795 | 0.11 |

**Table 5: SAR Values (WiFi 802.11n)**

| **Limit of SAR (W/kg)** | **10 g Average** | **1 g Average** | **Power Drift (dB)** |
|---|---|---|---|
| | 2.0 | 1.6 | |
| **Test Case(Flat Phantom)** | **Measurement Result (W/kg)** | | |
| | **10 g Average** | **1 g Average** | |
| Test Position 5, Bottom frequency,HT20 6.5Mbps(See Figure 8) | 0.124 | 0.303 | -0.0173 |
| Test Position 5, Bottom frequency,HT40 13.5Mbps (See Figure 9) | 0.089 | 0.219 | 0.106 |

### 6.4 Conclusion

Localized Specific Absorption Rate (SAR) of this portable wireless device has been measured in all cases requested by the relevant standards cited in Clause 4.2 of this report. Maximum localized SAR is below exposure limits specified in the relevant standards cited in Clause 4.1 of this test report.

## 7 Measurement Uncertainty

| SN | a | Type | c | d | e = f(d,k) | f | h = c x f / | k |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | e | |
|---|---|---|---|---|---|---|---|---|
| | Uncertainty Component | | Tol. (± %) | Prob. Dist. | Div. | $c_i$ (1 g) | 1 g $u_i$ (±%) | $v_i$ |
| 1 | System repetivity | A | 0.5 | N | 1 | 1 | 0.5 | 9 |
| | Measurement System | | | | | | | |
| 2 | Probe Calibration | B | 5 | N | 2 | 1 | 2.5 | ∞ |
| 3 | Axial Isotropy | B | 4.7 | R | √3 | $(1-cp)^{1/2}$ | 4.3 | ∞ |
| 4 | Hemispherical Isotropy | B | 9.4 | R | √3 | $\sqrt{c_p}$ | | ∞ |
| 5 | Boundary Effect | B | 0.4 | R | √3 | 1 | 0.23 | ∞ |
| 6 | Linearity | B | 4.7 | R | √3 | 1 | 2.7 | ∞ |
| 7 | System Detection Limits | B | 1.0 | R | √3 | 1 | 0.6 | ∞ |
| 8 | Readout Electronics | B | 1.0 | N | 1 | 1 | 1.0 | ∞ |
| 9 | RF Ambient Conditions | B | 3.0 | R | √3 | 1 | 1.73 | ∞ |
| 10 | Probe Positioner Mechanical Tolerance | B | 0.4 | R | √3 | 1 | 0.2 | ∞ |
| 11 | Probe Positioning with respect to Phantom Shell | B | 2.9 | R | √3 | 1 | 1.7 | ∞ |
| 12 | Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation | B | 3.9 | R | √3 | 1 | 2.3 | ∞ |
| | Test sample Related | | | | | | | |
| 13 | Test Sample Positioning | A | 4.9 | N | 1 | 1 | 4.9 | N-1 |
| 14 | Device Holder Uncertainty | A | 6.1 | N | 1 | 1 | 6.1 | N-1 |
| 15 | Output Power Variation - SAR drift measurement | B | 5.0 | R | √3 | 1 | 2.9 | ∞ |
| | Phantom and Tissue Parameters | | | | | | | |
| 16 | Phantom Uncertainty (shape and thickness tolerances) | B | 1.0 | R | √3 | 1 | 0.6 | ∞ |
| 17 | Liquid Conductivity - deviation from target values | B | 5.0 | R | √3 | 0.64 | 1.7 | ∞ |
| 18 | Liquid Conductivity - measurement uncertainty | B | 5.0 | N | 1 | 0.64 | 1.7 | M |
| 19 | Liquid Permittivity - deviation from target values | B | 5.0 | R | √3 | 0.6 | 1.7 | ∞ |
| 20 | Liquid Permittivity - measurement uncertainty | B | 5.0 | N | 1 | 0.6 | 1.7 | M |
| | Combined Standard Uncertainty | | | RSS | | | 11.25 | |
| | Expanded Uncertainty (95% CONFIDENCE INTERVAL) | | | K=2 | | | 22.5 | |

## 8 MAIN TEST INSTRUMENTS

**Table 6: List of Main Instruments**

| No. | Name | Type | Serial Number | Calibration Date | Valid Period |
|---|---|---|---|---|---|
| 01 | Network analyzer | Agilent E5071C | MY46103759 | January 18,2010 | One year |
| 02 | Power meter | NRVD | 101253 | March 9,2010 | One year |
| 03 | Power sensor | NRV-Z5 | 100333 | | |
| 04 | Signal Generator | Agilent E4438C | MY45095825 | January 18,2010 | One Year |
| 05 | Amplifier | VTL5400 | 0505 | No Calibration Requested | |
| 06 | E-field Probe | SPEAG ES3DV3 | 3151 | April 28, 2010 | One year |
| 07 | DAE | SPEAG DAE4 | 786 | November 23, 2009 | One year |
| 08 | Dipole Validation Kit | IndexSAR IXD-245 | 40102 | October, 2008 | Two years |

***END OF REPORT BODY***

## ANNEX A MEASUREMENT PROCESS

The evaluation was performed with the following procedure:

Step 1: Measurement of the SAR value at a fixed location above the reference point was measured and was used as a reference value for assessing the power drop.

Step 2: The SAR distribution at the exposed side of the phantom was measured at a distance of 3.9 mm from the inner surface of the shell. The area covered the entire dimension of the flat phantom and the horizontal grid spacing was 10 mm x 10 mm. Based on this data, the area of the maximum absorption was determined by spline interpolation.

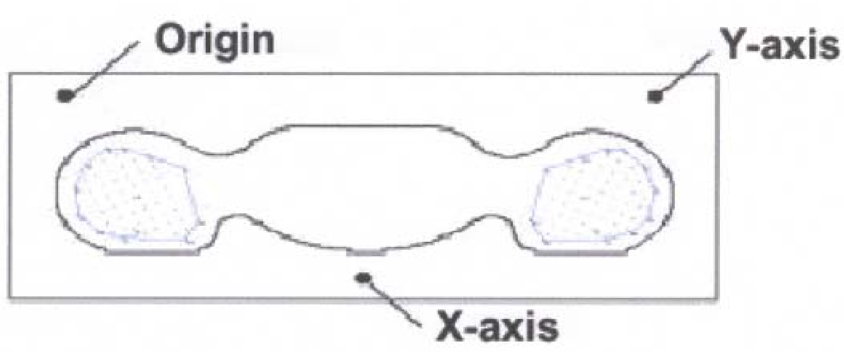
Step 3: Around this point, a volume of 30 mm x 30 mm x 30 mm was assessed by measuring 7 x 7x 7 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:

a. The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

b. The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the "Not a knot"-condition (in x ~ y and z-directions). The volume was 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.

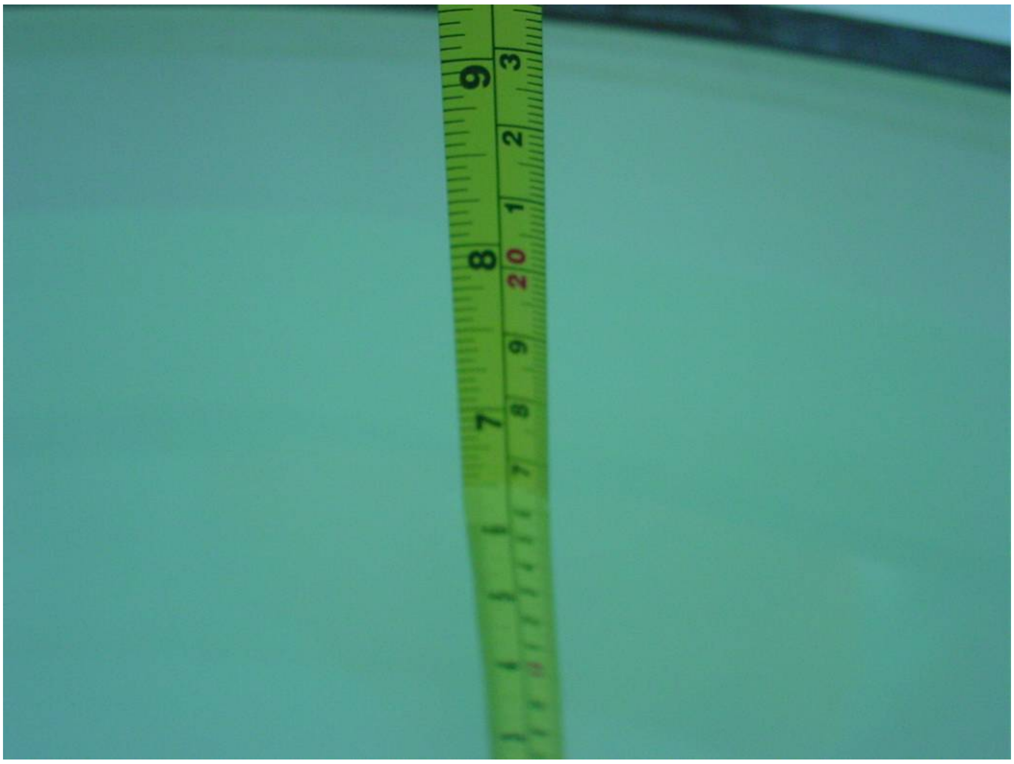
Step 4: Re-measurement the SAR value at the same location as in Step 1. If the value changed by more than 5%, the evaluation is repeated.




**Picture A: SAR Measurement Points in Area Scan**

## ANNEX B TEST LAYOUT


**Picture B1: Specific Absorption Rate Test Layout**



**Picture B2 Liquid depth in the Flat Phantom (2450MHz)**

## ANNEX C GRAPH RESULTS

**WiFi 802.11b_Test Position 1_Channel Bottom_1Mbps**

Date/Time: 9/17/2010 9:10:26 AM

Electronics: DAE4 Sn786;Medium: Body2450

Medium parameters used (interpolated): f = 2412 MHz; σ = 1.89 mho/m; $\varepsilon_r$ = 51.7; ρ = 1000 kg/$m^3$

Ambient Temperature:21.6℃ Liquid Temperature: 21.5℃

Communication System: WiFi 802.11 Frequency: 2412 MHz Duty Cycle: 1:1

Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

Test position 1_Channel Bottom/Area Scan (141x201x1): Measurement grid: dx=10mm, dy=10mm;Maximum value of SAR (interpolated) = 0.915 mW/g

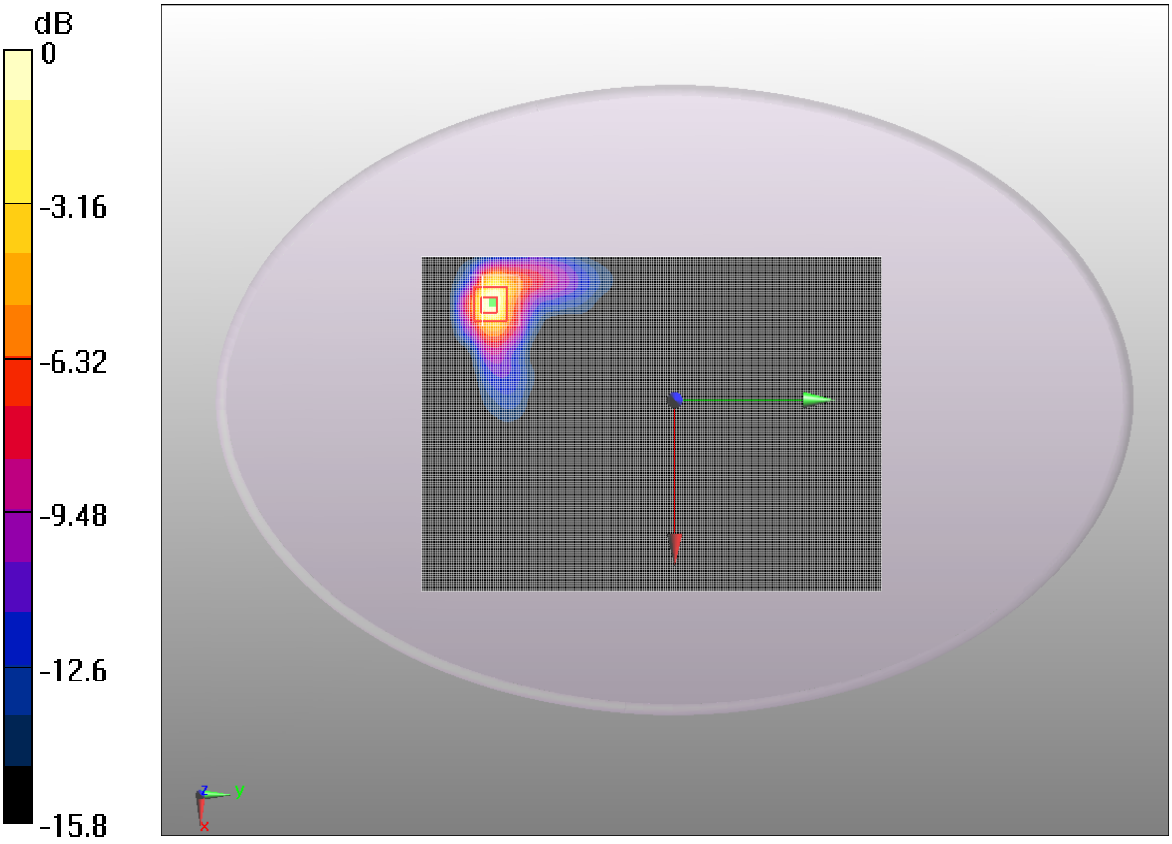
Test position 1_Channel Bottom/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 1.666 V/m; Power Drift = 0.16 dB

Peak SAR (extrapolated) = 1.87 W/kg

SAR(1 g) = 0.780 mW/g; SAR(10 g) = 0.338 mW/g

Maximum value of SAR (measured) = 0.799 mW/g




0 dB = 0.799mW/g

**Fig.1 2450MHz CH1 Test Position 1-WiFi 802.11b 1Mbps**

**WiFi 802.11b_Test Position 2_Channel Bottom_1Mbps**

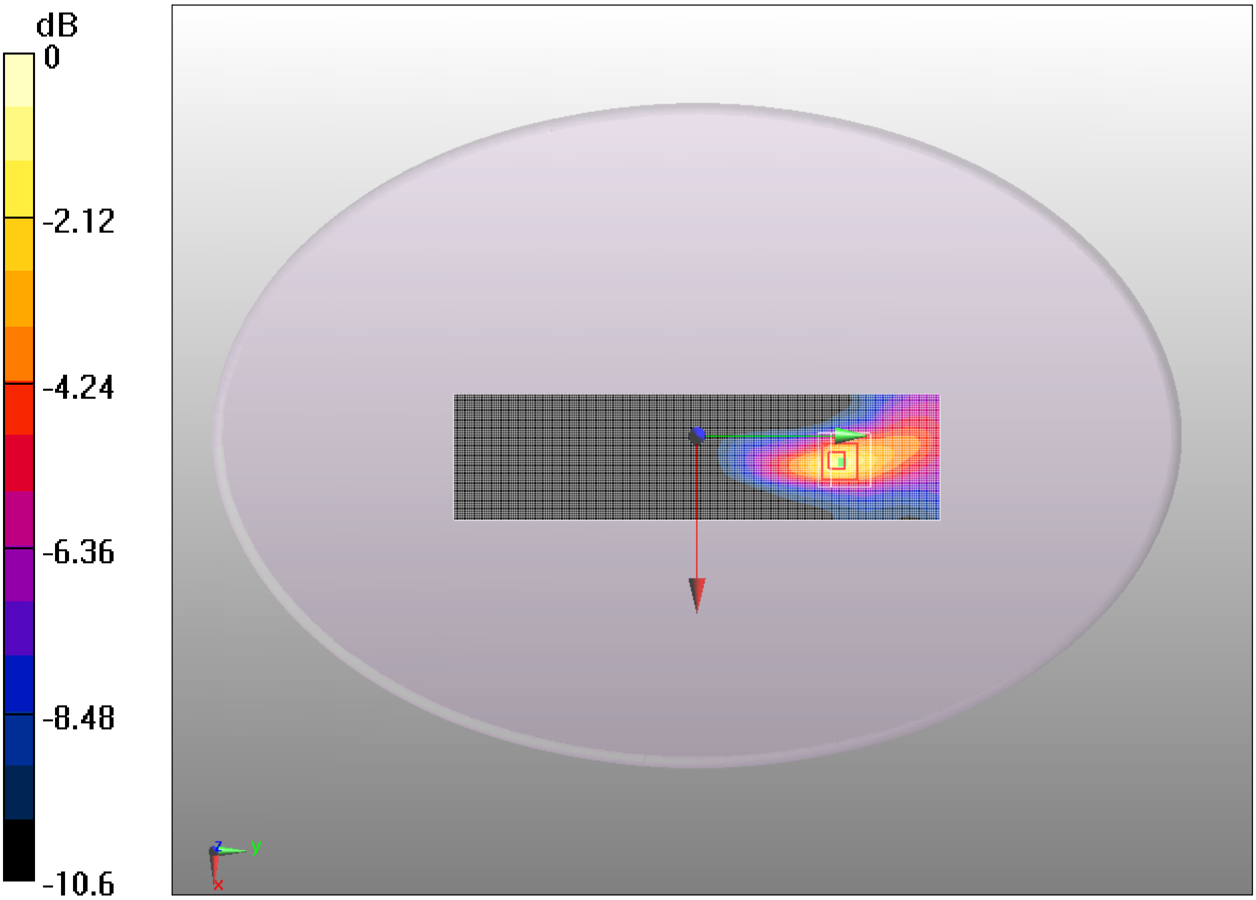
Date/Time: 9/17/2010 10:04:27 AM
Electronics: DAE4 Sn786
Medium: Body2450
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.89 mho/m; $\varepsilon_r$ = 51.7; ρ = 1000 kg/m$^3$
Ambient Temperature:21.6℃ Liquid Temperature: 21.5℃
Communication System: WiFi 802.11 Frequency: 2412 MHz Duty Cycle: 1:1
Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

Test position 2_Channel Bottom (power 14)/Area Scan (51x201x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.056 mW/g

Test position 2_Channel Bottom (power 14)/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.02 V/m; Power Drift = 0.14 dB
Peak SAR (extrapolated) = 0.134 W/kg
SAR(1 g) = 0.067 mW/g; SAR(10 g) = 0.035 mW/g
Maximum value of SAR (measured) = 0.073 mW/g




0 dB = 0.073mW/g

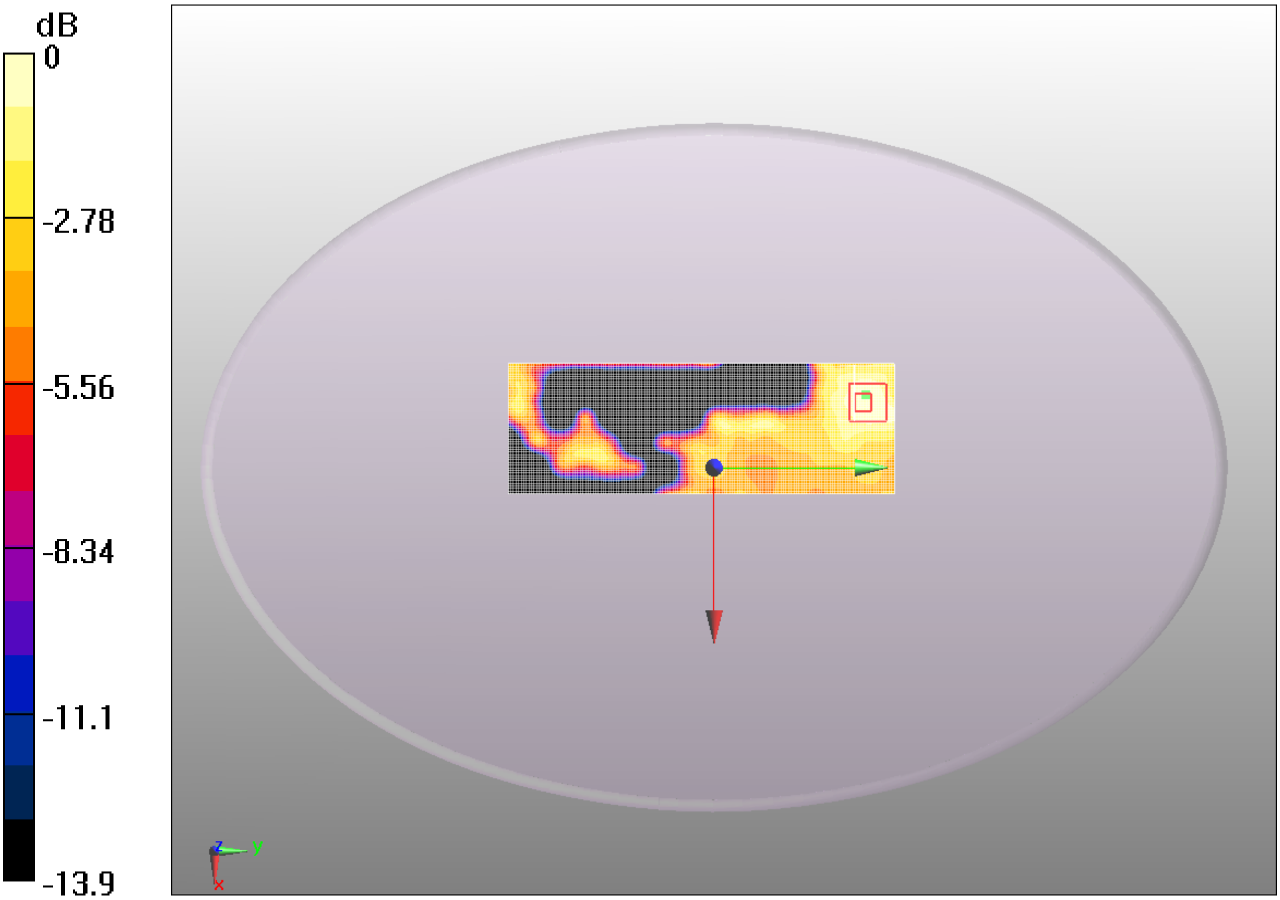
**Fig.2 2450MHz CH1 Test Position 2-WiFi 802.11b 1Mbps**

**WiFi 802.11b_Test Position 3_Channel Bottom_1Mbps**

Date/Time: 9/17/2010 10:42:41 AM
Electronics: DAE4 Sn786
Medium: Body2450
Medium parameters used (interpolated): f = 2462 MHz; σ = 1.95 mho/m; $\varepsilon_r$ = 51.5; ρ = 1000 kg/$m^3$
Ambient Temperature:21.6℃ Liquid Temperature: 21.5℃
Communication System: WiFi 802.11 Frequency: 2462 MHz Duty Cycle: 1:1
Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

Test position 3_Channel Bottom/Area Scan (51x151x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.00467 mW/g

Test position 3_Channel Bottom/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.01 V/m; Power Drift = 0.113 dB
Peak SAR (extrapolated) = 0.00746 W/kg
SAR(1 g) = 0.00425 mW/g; SAR(10 g) = 0.00239 mW/g
Maximum value of SAR (measured) = 0.00439 mW/g




0 dB = 0.00439mW/g

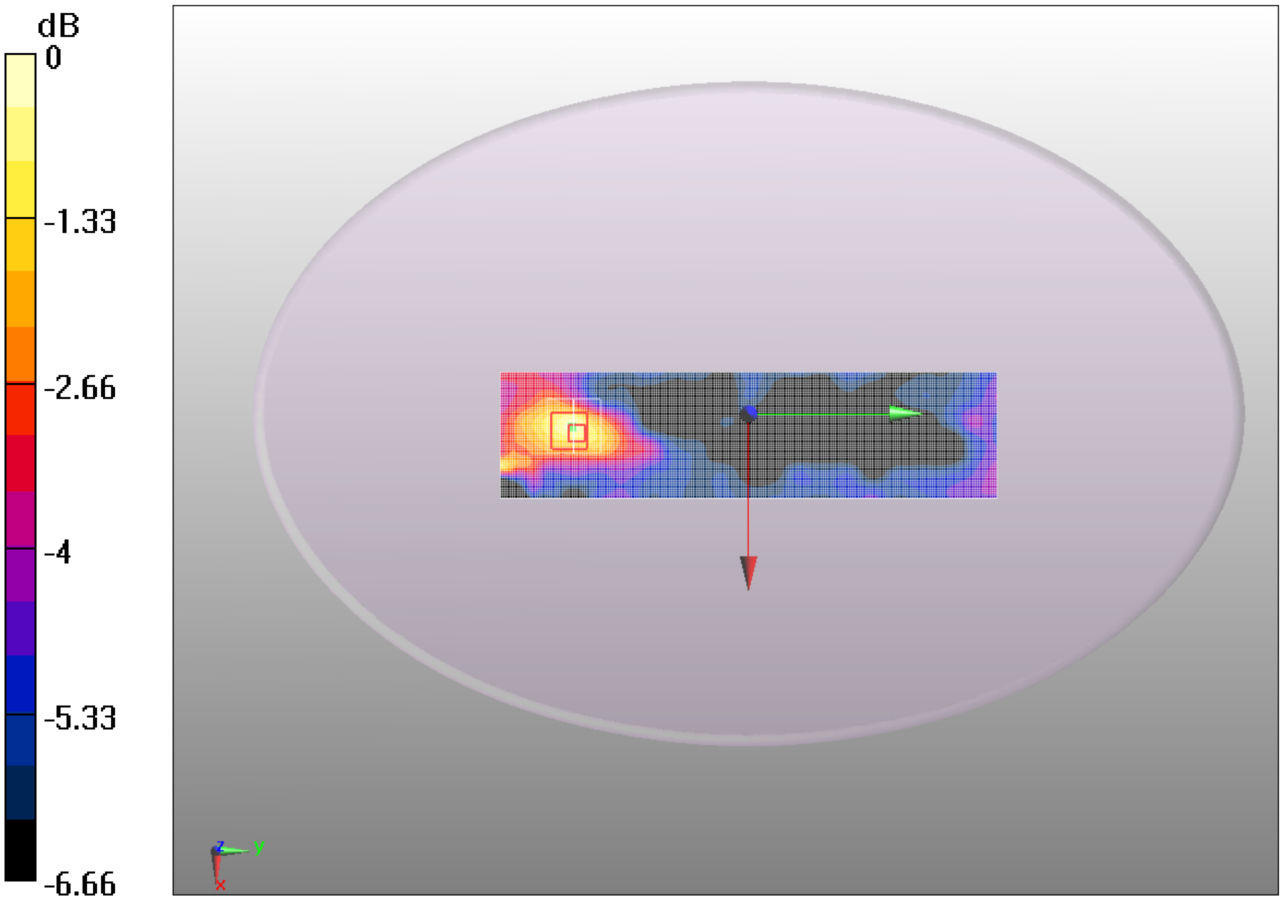
**Fig.3 2450MHz CH1 Test Position 3-WiFi 802.11b 1Mbps**

**WiFi 802.11b_Test Position 4_Channel Bottom_1Mbps**

Date/Time: 9/17/2010 11:16:42 AM
Electronics: DAE4 Sn786
Medium: Body2450
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.89 mho/m; $\varepsilon_r$ = 51.7; ρ = 1000 kg/m$^3$
Ambient Temperature:21.6℃ Liquid Temperature: 21.5℃
Communication System: WiFi 802.11 Frequency: 2412 MHz Duty Cycle: 1:1
Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

**Test position 4_Channel Bottom/Area Scan (51x201x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.013 mW/g

**Test position 4_Channel Bottom/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.1 V/m; Power Drift = 0.19 dB
Peak SAR (extrapolated) = 0.029 W/kg
SAR(1 g) = 0.013 mW/g; SAR(10 g) = 0.0084 mW/g
Maximum value of SAR (measured) = 0.014 mW/g




0 dB = 0.014mW/g

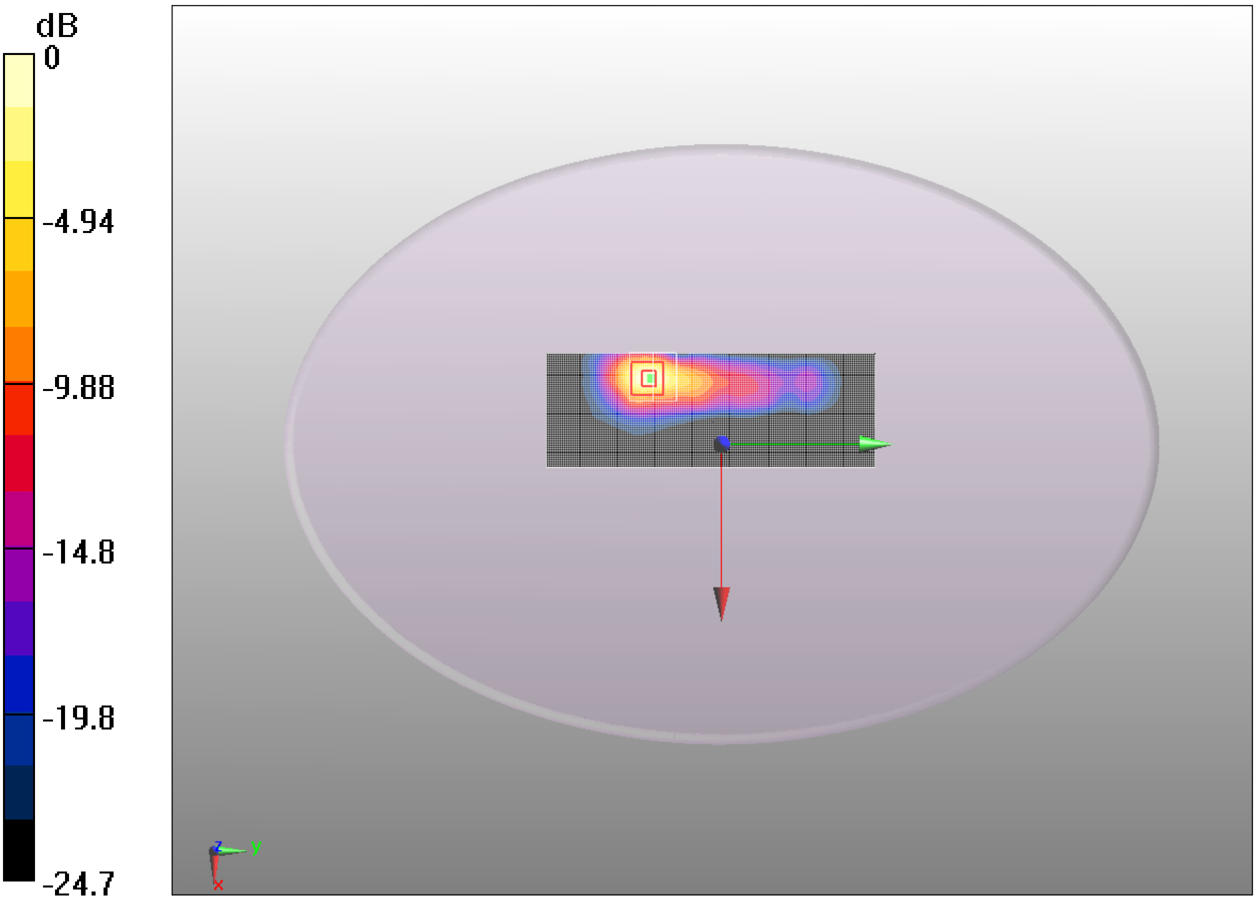
**Fig.4 2450MHz CH1 Test Position 4-WiFi 802.11b 1Mbps**

**WiFi 802.11b_Test Position 5_Channel Bottom_1Mbps**

Date/Time: 9/17/2010 11:53:46 AM
Electronics: DAE4 Sn786
Medium: Body2450
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.89 mho/m; $\varepsilon_r$ = 51.7; ρ = 1000 kg/$m^3$
Ambient Temperature:21.6℃ Liquid Temperature: 21.5℃
Communication System: WiFi 802.11 Frequency: 2412 MHz Duty Cycle: 1:1
Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

Test position 5_Channel Bottom/Area Scan (51x151x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.52 mW/g

Test position 5_Channel Bottom/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.7 V/m; Power Drift = 0.103 dB
Peak SAR (extrapolated) = 2.85 W/kg
SAR(1 g) = 1.18 mW/g; SAR(10 g) = 0.480 mW/g
Maximum value of SAR (measured) = 1.44 mW/g




0 dB = 1.44mW/g

**Fig.5 2450MHz CH1 Test Position 5-WiFi 802.11b 1Mbps**

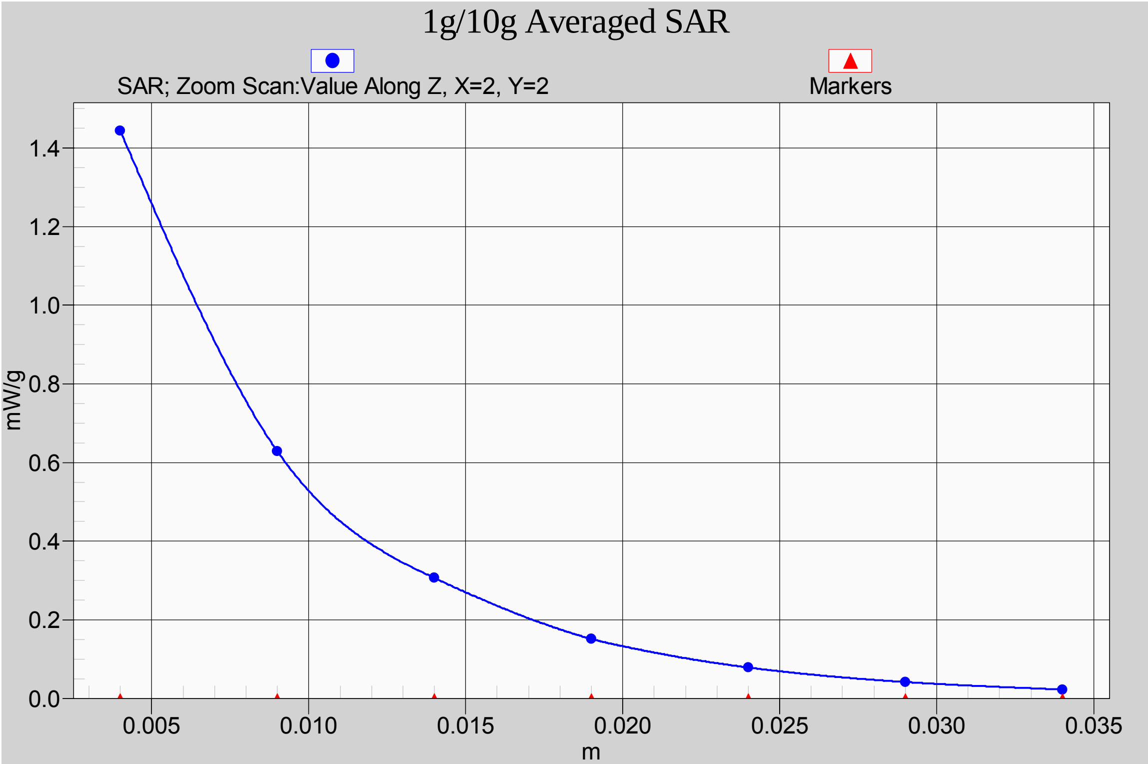


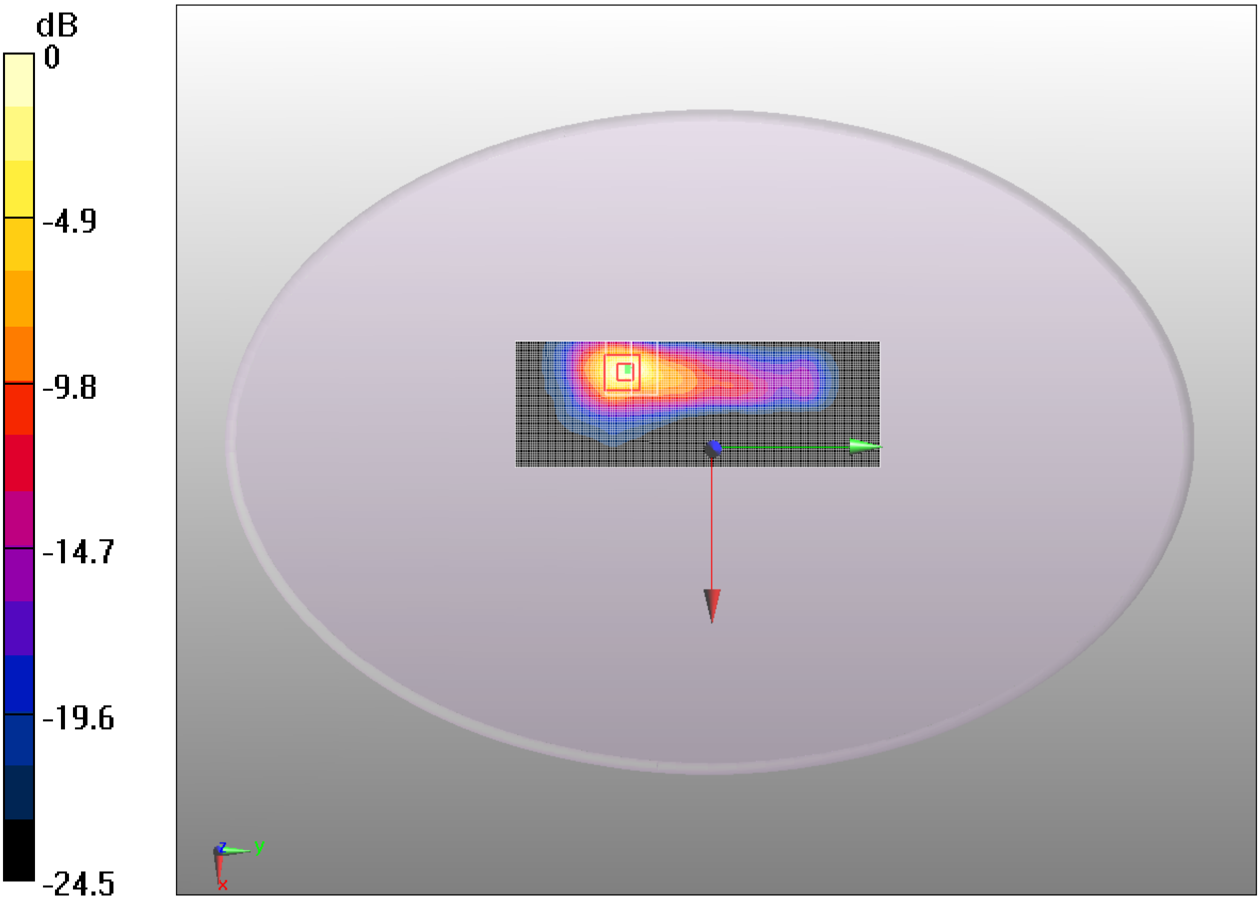

**Fig. 5-1 Z-Scan at power reference point (2450 MHz CH1)**

**WiFi 802.11b_Test Position 5_Channel Middle_1Mbps**

Date/Time: 9/17/2010 00:24:23 PM
Electronics: DAE4 Sn786
Medium: Body2450
Medium parameters used (interpolated): f = 2437 MHz; σ = 1.92 mho/m; $\varepsilon_r$ = 51.6; ρ = 1000 kg/$m^3$
Ambient Temperature:21.6℃ Liquid Temperature: 21.5℃
Communication System: WiFi 802.11 Frequency: 2437 MHz Duty Cycle: 1:1
Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

Test position 5_Channel Middle/Area Scan (51x151x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.06 mW/g

Test position 5_Channel Middle/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.43 V/m; Power Drift = 0.098 dB
Peak SAR (extrapolated) = 2.11 W/kg
SAR(1 g) = 0.885 mW/g; SAR(10 g) = 0.353 mW/g
Maximum value of SAR (measured) = 1 mW/g




0 dB = 1mW/g

**Fig.6 2450MHz CH6 Test Position 5-WiFi 802.11b 1Mbps**

**WiFi 802.11b_Test Position 5_Channel Top_1Mbps**

Date/Time: 9/17/2010 01:58:56 PM

Electronics: DAE4 Sn786

Medium: Body2450

Medium parameters used (interpolated): f = 2462 MHz; σ = 1.95 mho/m; $\varepsilon_r$ = 51.5; ρ = 1000 kg/$m^3$

Ambient Temperature:21.6℃ Liquid Temperature: 21.5℃

Communication System: WiFi 802.11 Frequency: 2462 MHz Duty Cycle: 1:1

Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

Test position 5_Channel Top/Area Scan (51x151x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 0.971 mW/g

802.11b/Test position 5_Channel Top/Zoom Scan (7x7x7)/Cube 0:

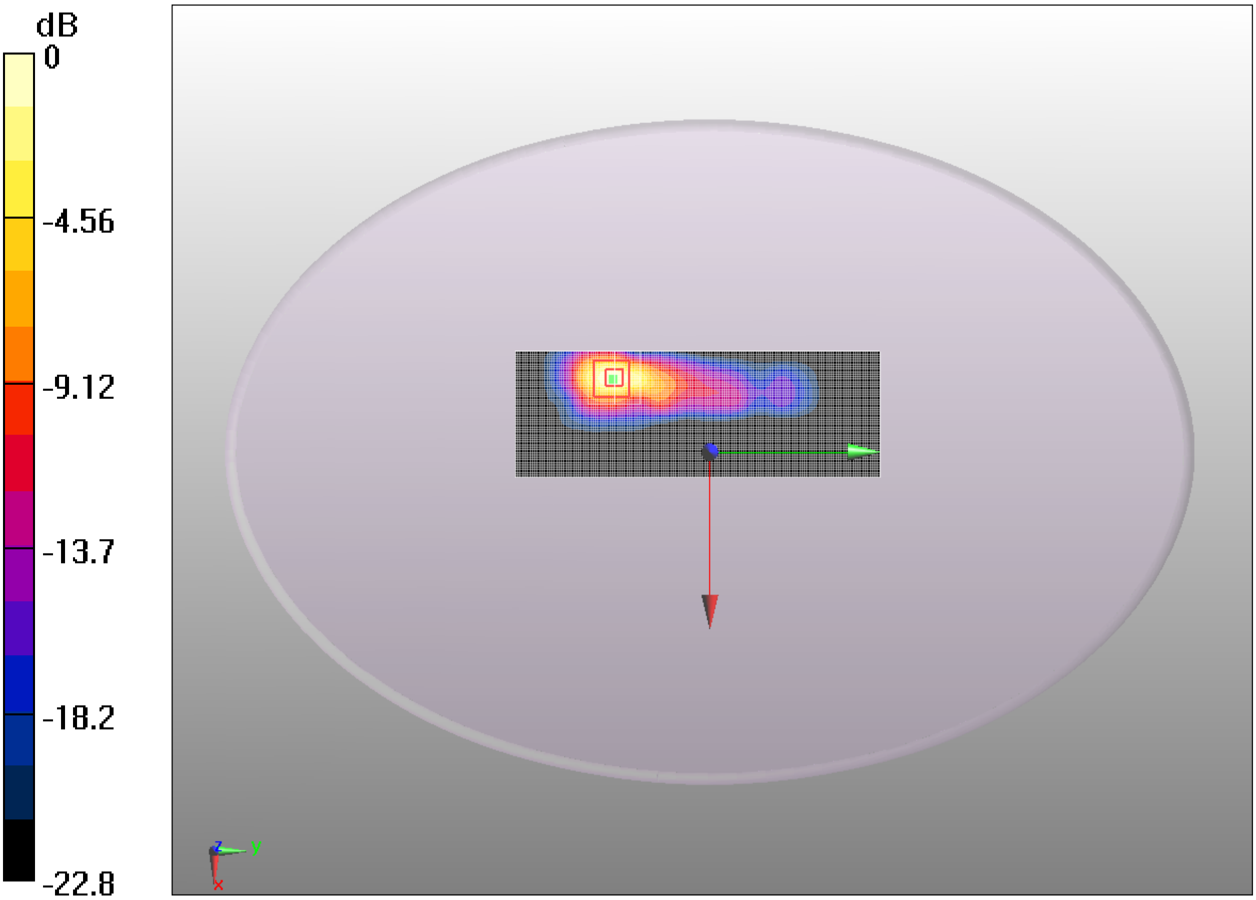
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 1.24 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 1.94 W/kg

SAR(1 g) = 0.795 mW/g; SAR(10 g) = 0.316 mW/g

Maximum value of SAR (measured) = 0.959 mW/g




0 dB = 0.959mW/g

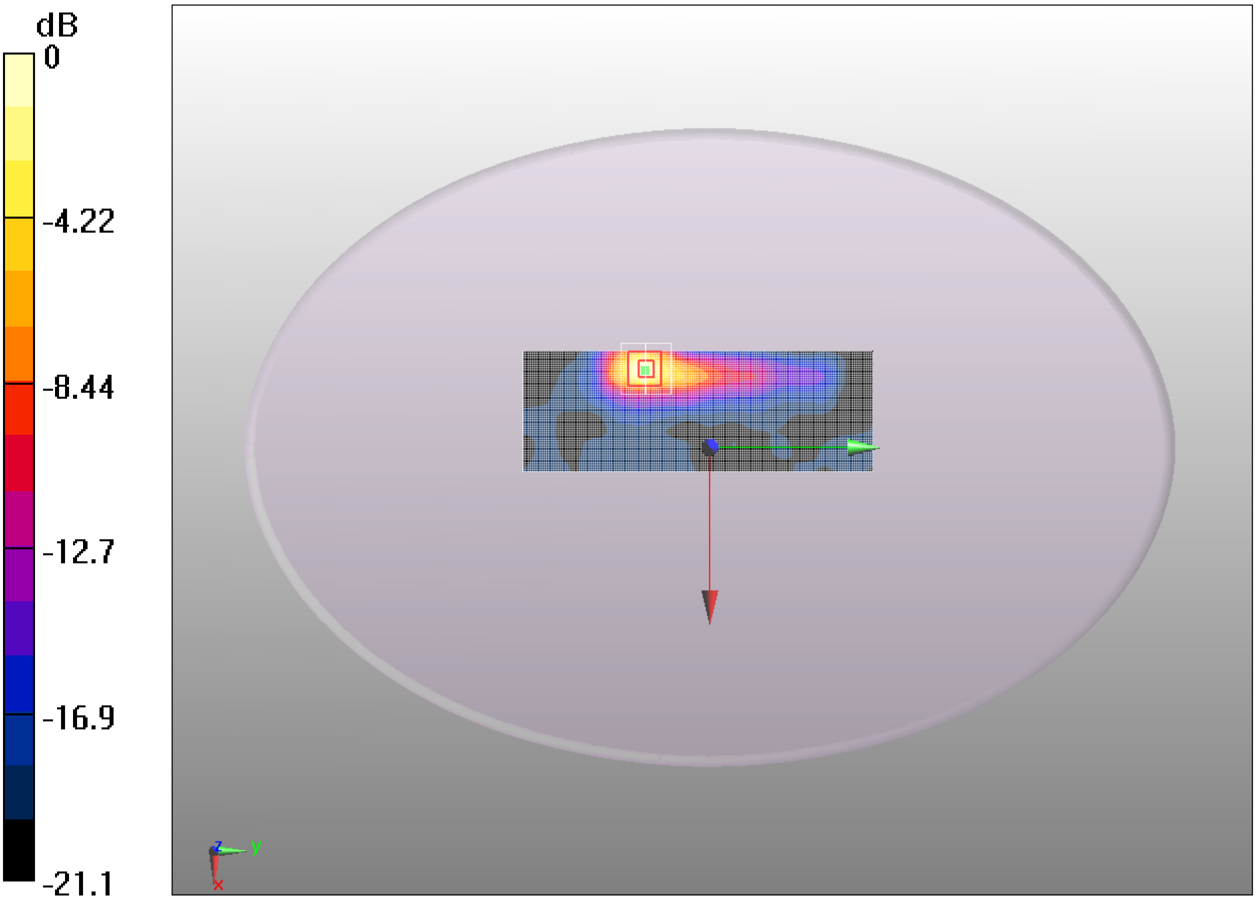
**Fig.7 2450MHz CH11 Test Position 5-WiFi 802.11b 1Mbps**

**WiFi 802.11nHT20_Test Position 5_Channel Bottom_6.5Mbps**

Date/Time: 9/17/2010 2:28:55 PM
Electronics: DAE4 Sn786
Medium: Body2450
Medium parameters used (interpolated): f = 2412 MHz; σ = 1.89 mho/m; $\varepsilon_r$ = 51.7; ρ = 1000 kg/m³
Ambient Temperature:21.6℃ Liquid Temperature: 21.5℃
Communication System: WiFi 802.11 Frequency: 2412 MHz Duty Cycle: 1:1
Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

**Test position 5_Channel Bottom/Area Scan (51x151x1):** Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.331 mW/g

**Test position 5_Channel Bottom/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.38 V/m; Power Drift = -0.073 dB
Peak SAR (extrapolated) = 0.723 W/kg
SAR(1 g) = 0.303 mW/g; SAR(10 g) = 0.124 mW/g
Maximum value of SAR (measured) = 0.359 mW/g




0 dB = 0.359mW/g

**Fig.8 2450MHz CH1 Test Position 5-WiFi 802.11nHT20 6.5Mbps**

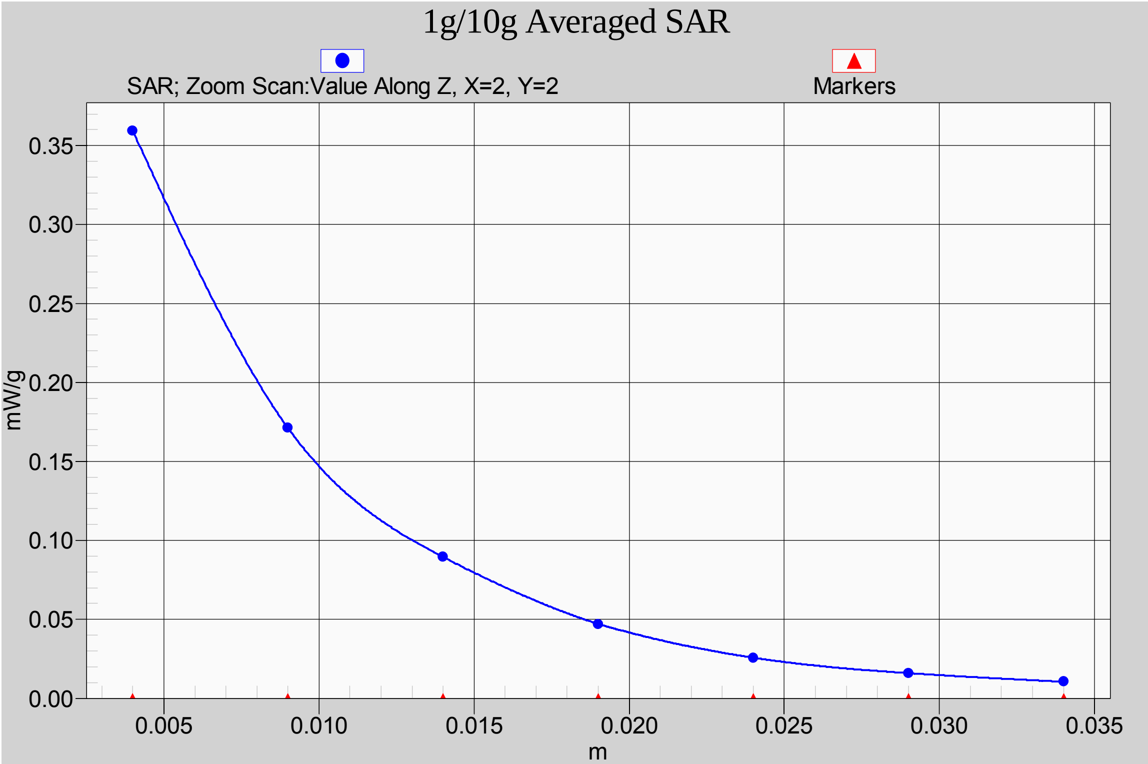



**Fig. 8-1 Z-Scan at power reference point (2450 MHz CH1)**

**WiFi 802.11nHT40_Test Position 5_Channel Bottom_13.5Mbps**

Date/Time: 9/17/2010 3:03:55 PM

Electronics: DAE4 Sn786

Medium: Body2450

Medium parameters used (interpolated): f = 2422 MHz; $\sigma$ = 1.9 mho/m; $\varepsilon_r$ = 51.6; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:21.6℃ Liquid Temperature: 21.5℃

Communication System: WiFi 802.11 Frequency: 2422 MHz Duty Cycle: 1:1

Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

Test position 5_Channel Bottom/Area Scan (51x151x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 0.249 mW/g

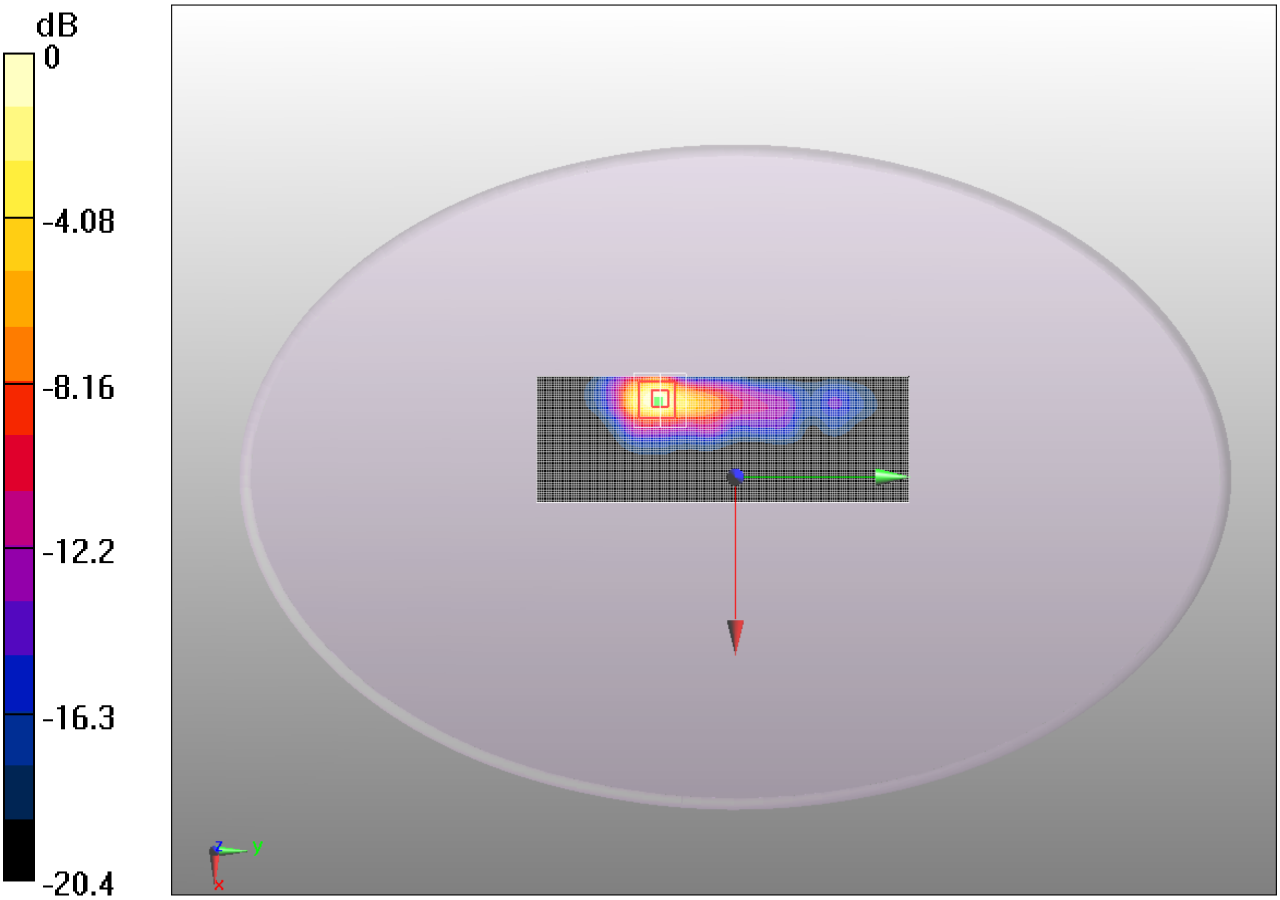
Test position 5_Channel Bottom/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value =1.02 V/m; Power Drift = 0.106 dB

Peak SAR (extrapolated) = 0.539 W/kg

SAR(1 g) = 0.219 mW/g; SAR(10 g) = 0.089 mW/g

Maximum value of SAR (measured) = 0.257 mW/g




0 dB = 0.257mW/g

**Fig.9 2450MHz CH1 Test Position 5-WiFi 802.11nHT40 13.5Mbps**

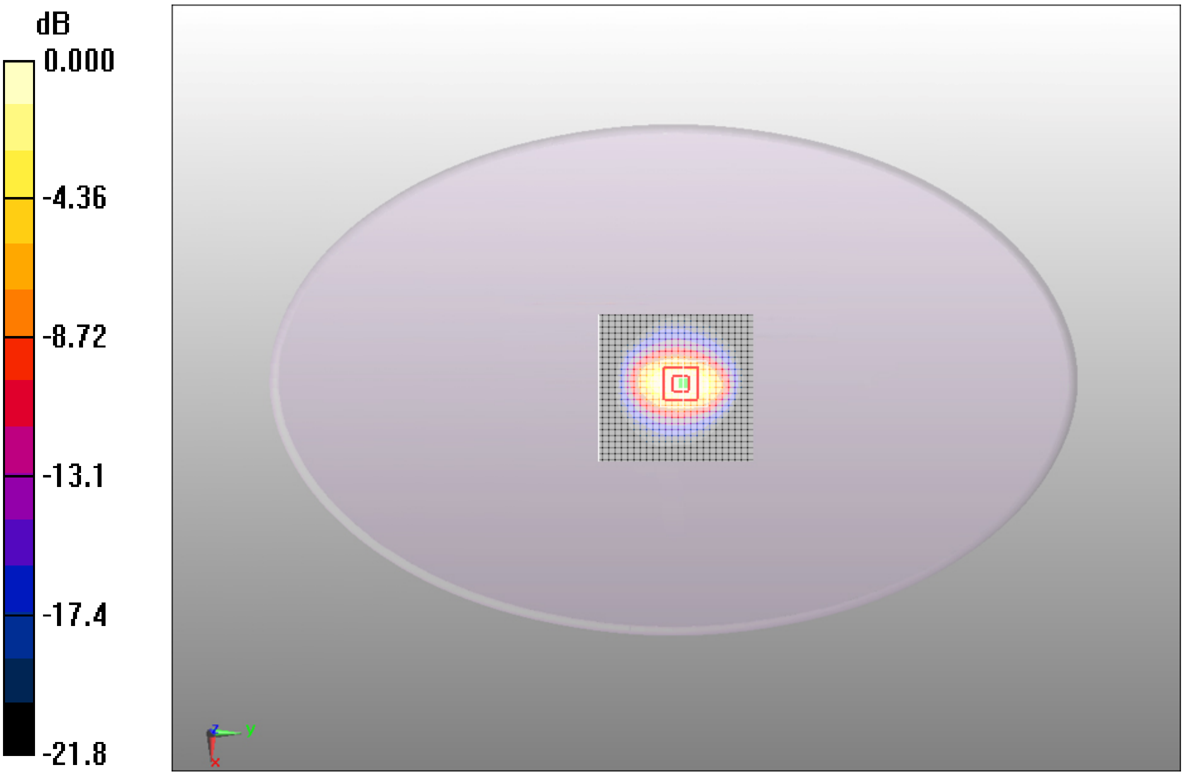
## ANNEX D SYSTEM VALIDATION RESULTS

### 2450MHz

Date/Time: 9/17/2010 8:03:17AM
Electronics: DAE4 Sn786
Medium: 2450 Body
Medium parameters used: σ = 2.0 mho/m; ε r = 51.57; ρ = 1000 kg/m3
Ambient Temperature:21.6oC Liquid Temperature: 21.5oC
Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1
Probe: ES3DV3 - SN3151 ConvF(3.72, 3.72, 3.72)

System Validation/Area Scan (101x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 13.9 mW/g

System Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 86.1 V/m; Power Drift = -0.1 dB
Peak SAR (extrapolated) = 18.8 W/kg
**SAR(1 g) = 12.8 mW/g; SAR(10 g) = 5.78 mW/g**
Maximum value of SAR (measured) = 14.1 mW/g




0 dB = 14.1mW/g

**Fig.10 validation 2450MHz 250Mw**

# ANNEX E PROBE CALIBRATION CERTIFICATE

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

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

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

Accreditation No.: **SCS 108**

Client Telecommunication Metrology Center of MIIT

Certificate No: ES3DV3-3151_Apr10

## CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | **ES3DV3-SN: 3151** |
| Calibration procedure(s) | **QA CAL-01.v6**<br>**Calibration procedure for dosimetric E-field probes** |
| Calibration date: | **April 28, 2010** |
| Condition of the calibrated item | **In Tolerance** |

This calibration certify 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 at an environment temperature (22±3)$^{0}$C and humidity<70%

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID# | Cal Data (Calibrated by, Certification NO.) | Scheduled Calibration |
|---|---|---|---|
| Power meter E4419B | GB41293874 | 5-May-09 (METAS, NO. 251-00388) | May-10 |
| Power sensor E4412A | MY41495277 | 5-May-09 (METAS, NO. 251-00388) | May-10 |
| Reference 3 dB Attenuator | SN:S5054 (3c) | 10-Aug-09 (METAS, NO. 251-00403) | Aug-10 |
| Reference 20 dB Attenuator | SN:S5086 (20b) | 3-May-09 (METAS, NO. 251-00389) | May-10 |
| Reference 30 dB Attenuator | SN:S5129 (30b) | 10-Aug-09 (METAS, NO. 251-00404) | Aug-10 |
| DAE4 | SN:617 | 10-Jun-09 (SPEAG, NO.DAE4-907_Jun09) | Jun-10 |
| Reference Probe ES3DV2 | SN: 3013 | 11-Jan-10 (SPEAG, NO. ES3-3013_Jan10) | Jan-11 |

| Secondary Standards | ID# | Check Data (in house) | Scheduled Calibration |
|---|---|---|---|
| RF generator HP8648C | US3642U01700 | 4-Aug-99(SPEAG, in house check Oct-09) | In house check: Oct-11 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01(SPEAG, in house check Nov-09) | In house check: Nov-10 |

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

Issued: April 28, 2010

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

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

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

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

Accreditation No.: **SCS 108**

**Glossary:**

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

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

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) 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:**

- *NORMx,y,z:* Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the $E^2$-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 $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * 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 ES3DV3

## SN: 3151

Manufactured: June 12, 2007

Calibrated: April 28, 2010

Calibrated for DASY4 System

ES3DV3 SN: 3151 April 28, 2010

## DASY – Parameters of Probe: ES3DV3 SN:3151

Sensitivity in Free Space[A]

| | | |
|---|---|---|
| NormX | 1.18±10.1% | $\mu V/(V/m)^2$ |
| NormY | 1.25±10.1% | $\mu V/(V/m)^2$ |
| NormZ | 1.21±10.1% | $\mu V/(V/m)^2$ |

Diode Compression[B]

| | |
|---|---|
| DCP X | 93mV |
| DCP Y | 96mV |
| DCP Z | 94mV |

Sensitivity in Tissue Simulating Liquid (Conversion Factors)
Please see Page 8

Boundary Effect

TSL 900MHz Typical SAR gradient: 5% per mm

| Sensor Center to Phantom Surface Distance | | 3.0 mm | 4.0 mm |
|---|---|---|---|
| SARbe[%] | Without Correction Algorithm | 10.9 | 6.7 |
| SARbe[%] | With Correction Algorithm | 1.0 | 0.5 |

TSL 1810MHz Typical SAR gradient: 10% per mm

| Sensor Center to Phantom Surface Distance | | 3.0 mm | 4.0 mm |
|---|---|---|---|
| SARbe[%] | Without Correction Algorithm | 10.3 | 5.5 |
| SARbe[%] | With Correction Algorithm | 0.8 | 0.7 |

Sensor Offset

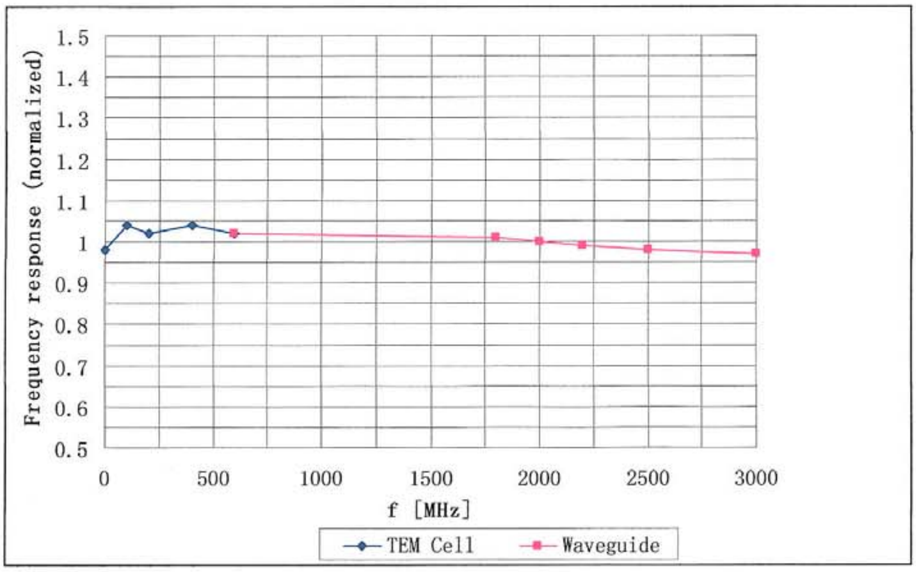
Probe Tip to Sensor Center 2.0 mm

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2,which for a normal distributic 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.

ES3DV3 SN: 3151 April 28, 2010

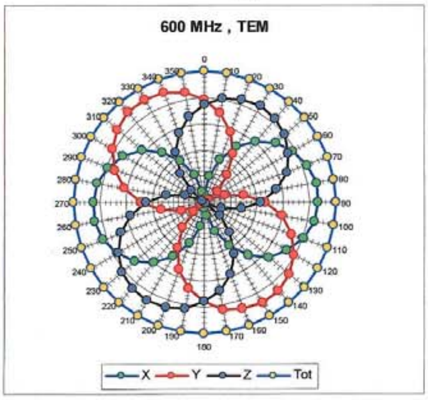
# Frequency Response of E-Field

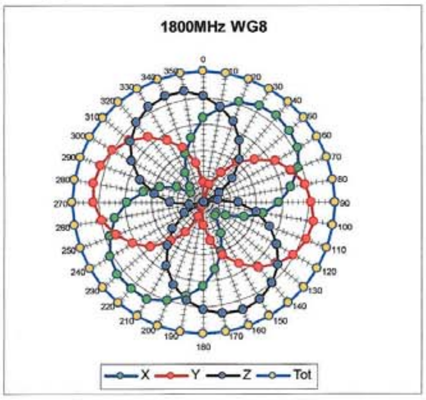


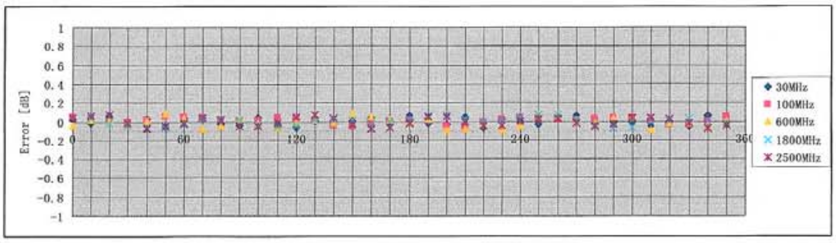

**Uncertainty of Frequency Response of E-field: ±6.3% (k=2)**

ES3DV3 SN: 3151 April 28, 2010

# Receiving Pattern (Φ), θ =0°



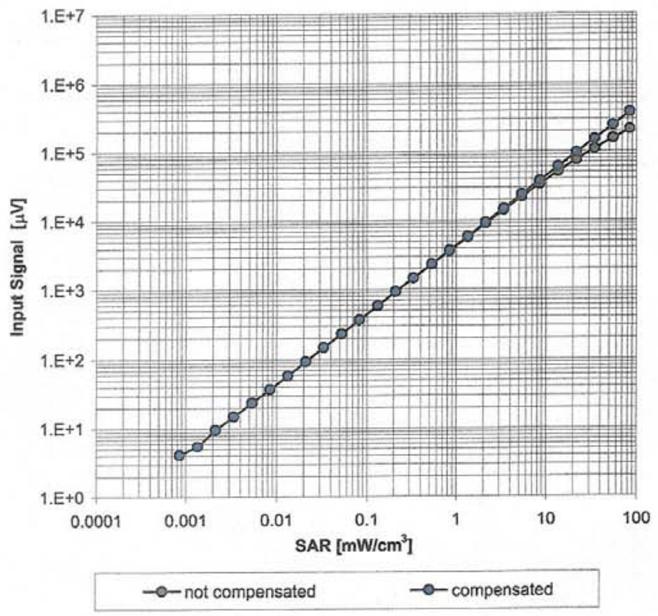



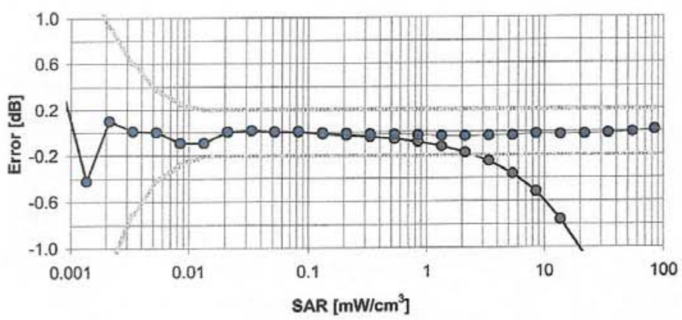

Uncertainty of Axial Isotropy Assessment: ±0.5% (k=2)

ES3DV3 SN: 3151 April 28, 2010

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

(Waveguide: WG8, f = 1800 MHz)

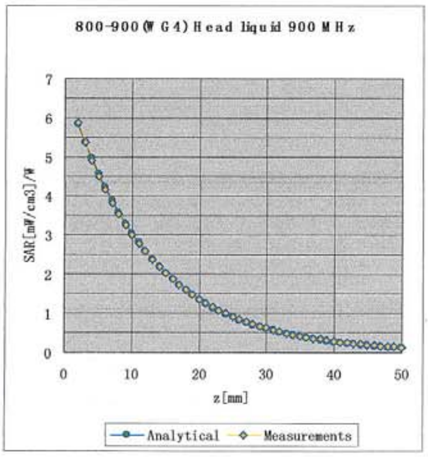


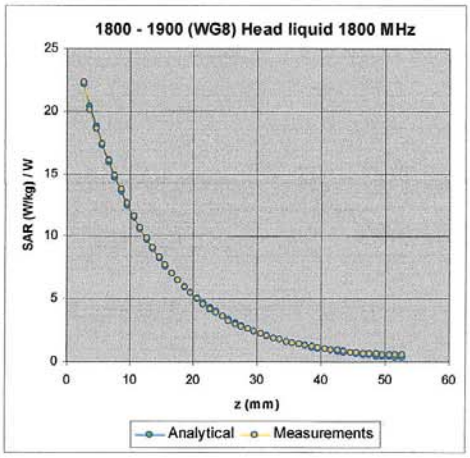




**Uncertainty of Linearity Assessment: ±0.6% (k=2)**

ES3DV3 SN: 3151 April 28, 2010

# Conversion Factor Assessment



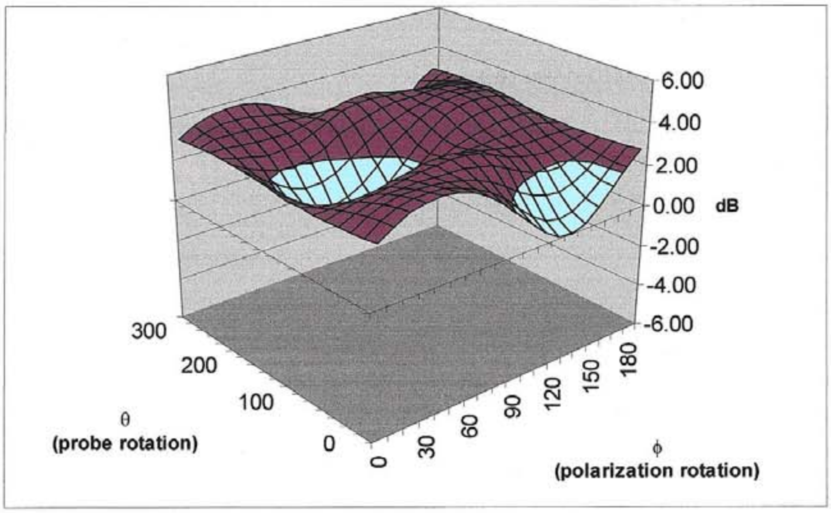




| f[MHz] | Validity[MHz][C] | TSL | Permittivity | Conductivity | Alpha | Depth | ConvF | Uncertainty |
|---|---|---|---|---|---|---|---|---|
| 450 | ±50 /±100 | Head | 43.5±5% | 0.87±5% | 0.82 | 1.44 | 7.42 | ±13.3% (k=2) |
| 900 | ±50 /±100 | Head | 41.5±5% | 0.97±5% | 0.80 | 1.29 | 6.23 | ±11.0% (k=2) |
| 1810 | ±50 /±100 | Head | 40.0±5% | 1.40±5% | 0.61 | 1.57 | 5.08 | ±11.0% (k=2) |
| 1900 | ±50 /±100 | Head | 40.0±5% | 1.40±5% | 0.63 | 1.44 | 4.98 | ±11.0% (k=2) |
| 2100 | ±50 /±100 | Head | 39.8±5% | 1.49±5% | 0.66 | 1.34 | 4.58 | ±11.0% (k=2) |
| | | | | | | | | |
| 900 | ±50 /±100 | Body | 55.0±5% | 1.05±5% | 0.99 | 1.06 | 6.02 | ±11.0% (k=2) |
| 1810 | ±50 /±100 | Body | 53.3±5% | 1.52±5% | 0.75 | 1.34 | 4.87 | ±11.0% (k=2) |
| 1900 | ±50 /±100 | Body | 53.3±5% | 1.52±5% | 0.62 | 1.47 | 4.73 | ±11.0% (k=2) |
| 2100 | ±50 /±100 | Body | 53.5±5% | 1.57±5% | 0.68 | 1.34 | 4.35 | ±11.0% (k=2) |
| 2450 | ±50 /±100 | Body | 52.7±5% | 1.95±5% | 0.60 | 1.40 | 3.72 | ±11.0% (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

**Error ( ϕ , θ ), f = 900 MHz**




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

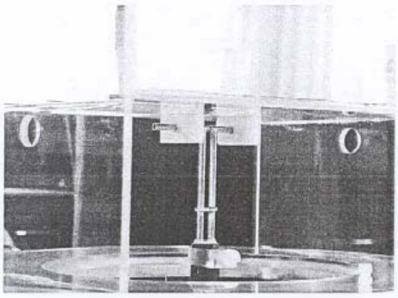
## ANNEX F DIPOLE CALIBRATION CERTIFICATE

Report No. SN0102_2450
October 2008

# INDEXSAR
# 2450MHz validation Dipole
# Type IXD-245 S/N 0102

## Performance measurements

MI Manning



Indexsar, Oakfield House, Cudworth Lane,
Newdigate, Surrey RH5 5BG. UK.
Tel: +44 (0) 1306 633870 Fax: +44 (0) 1306 631834
e-mail: enquiries@indexsar.com

## 1. Measurement Conditions

Measurements were performed using a box-shaped phantom made of PMMA with dimensions designed to meet the accuracy criteria for reasonably-sized phantoms that do not have liquid capacities substantially in excess of the volume of liquid required to fill the Indexsar upright SAM phantoms used for SAR testing of handsets against the ear.

An HP 8753B vector network analyser was used for the return loss measurements. The dipole was placed in a special holder made of low-permittivity, low-loss materials. This holder enables the dipole to be positioned accurately in the centre of the base of the Indexsar box-phantom used for flat-surface testing and validation checks.

The validation dipoles are supplied with special spacers made from a low-permittivity, low-loss foam material. These spacers are fitted to the dipole arms to ensure that, when the dipole is offered up to the phantom surface, the spacing between the dipole and the liquid surface is accurately aligned according to the guidance in the relevant standards documentation. The spacers are rectangular with a central hole equal to the dipole arm diameter and dimensioned so that the longer side can be used to ensure a spacing of 15mm from the liquid in the phantom (for tests at 900MHz and below) and the shorter side can be used for tests at 1800MHz and above to ensure a spacing of 10mm from the liquid in the phantom. The spacers are made on a CNC milling machine with an accuracy of 1/40$^{th}$ mm but they may suffer wear and tear and need to be replaced periodically. The material used is Rohacell, which has a relative permittivity of approx. 1.05 and a negligible loss tangent.

The apparatus supplied by Indexsar for dipole validation tests thus includes:

Balanced dipoles for each frequency required are dimensioned according to the guidelines given in IEEE 1528 [1]. The dipoles are made from semi-rigid 50 Ohm co-ax, which is joined by soldering and is gold-plated subsequently. The constructed dipoles are easily deformed, if mis-handled, and periodic checks need to be made of their symmetry.

Rohacell foam spacers designed for presenting the dipoles to 2mm thick PMMA box phantoms. These components also suffer wear and tear and should be replaced when the central hole is a loose-fit on the dipole arms or if the edges are too worn to ensure accurate alignment. The standard spacers are dimensioned for use with 2mm wall thickness (additional spacers are available for 4mm wall thickness).

## 2. Typical SAR Measurement

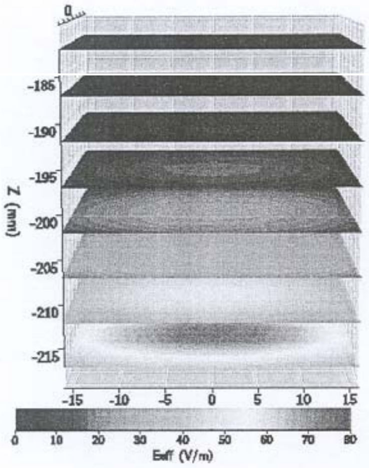
A SAR validation check is performed with the box-phantom located on the SARA2 phantom support base on the SARA2 robot system. Tests are then conducted at a feed power level of approx. 0.25W. The actual power level is recorded and used to normalise the results obtained to the standard input power conditions of 1W (forward power). The ambient temperature is 22°C +/- 1°C and the relative humidity is around 40% during the measurements.

The phantom is filled with a 2450MHz brain liquid using a recipe from [1], which has the following electrical parameters (measured using an Indexsar DiLine kit) at 2450MHz:

| | |
|---|---|
| Relative Permittivity | **40.5** |
| Conductivity | **1.85 S/m** |

The SARA2 software version 2.2 VPM is used with an Indexsar probe previously calibrated using waveguides.

The 3D measurements made using the dipole at the bottom of the phantom box is shown below:




The results, normalised to an input power of 1W (forward power) are typically:

| | |
|---|---|
| Averaged over 1 cm3 (1g) of tissue | **52.26 W/kg** |
| Averaged over 10cm3 (10g) of tissue | **23.65 W/kg** |

These results can be compared with Table 8.1 in [1]. The agreement is within 10%.

### 3. Typical SAR Measurement

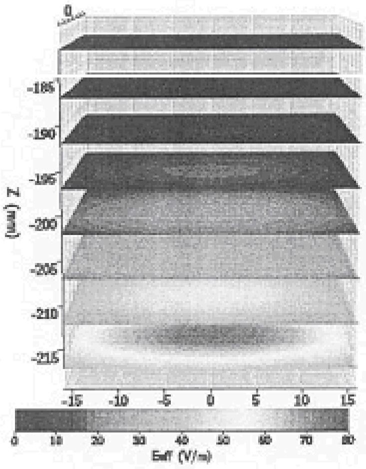
A SAR validation check is performed with the box-phantom located on the SARA2 phantom support base on the SARA2 robot system. Tests are then conducted at a feed power level of approx. 0.25W. The actual power level is recorded and used to normalise the results obtained to the standard input power conditions of 1W (forward power). The ambient temperature is 22°C +/- 1°C and the relative humidity is around 40% during the measurements.

The phantom is filled with a 2450MHz body liquid using a recipe from [1], which has the following electrical parameters (measured using an Indexsar DiLine kit) at 2450MHz:

| | |
|---|---|
| Relative Permittivity | 51.8 |
| Conductivity | 1.93 S/m |

The SARA2 software version 2.2 VPM is used with an Indexsar probe previously calibrated using waveguides.

The 3D measurements made using the dipole at the bottom of the phantom box is shown below:




The results, normalised to an input power of 1W (forward power) are typically:

| | |
|---|---|
| Averaged over 1 cm3 (1g) of tissue | 51.13 W/kg |
| Averaged over 10cm3 (10g) of tissue | 23.28 W/kg |

These results can be compared with Table 8.1 in [1]. The agreement is within 10%.

### 4. Dipole handling

The dipoles are made from standard, copper-sheathed coaxial cable. In assembly, the sections are joined using ordinary soft-soldering. This is necessary to avoid excessive heat input in manufacture, which would destroy the polythene dielectric used for the cable. The consequence of the construction material and the assembly technique is that the dipoles are fragile and can be deformed by rough handling. Conversely, they can be straightened quite easily as described in this report.

If a dipole is suspected of being deformed, a normal workshop lathe can be used as an alignment jig to restore the symmetry. To do this, the dipole is first placed in the headstock of the lathe (centred on the plastic or brass spacers) and the headstock is rotated by hand (do NOT use the motor). A marker (lathe tool or similar) is brought up close to the end of one dipole arm and then the headstock is rotated by 0.5 rev. to check the opposing arm. If they are not balanced, judicious deformation of the arms can be used to restore the symmetry.

If a dipole has a failed solder joint, the dipole can be fixed down in such a way that the arms are co-linear and the joint re-soldered with a reasonably-powerful electrical soldering iron. Do not use gas soldering irons. After such a repair, electrical tests must be performed as described below.

Please note that, because of their construction, the dipoles are short-circuited for DC signals.

### 5. Tuning the dipole

The dipole dimensions are based on calculations that assumed specific liquid dielectric properties. If the liquid dielectric properties are somewhat different, the dipole tuning will also vary. A pragmatic way of accounting for variations in liquid properties is to 'tune' the dipole (by applying minor variations to its effective length). For this purpose, Indexsar can supply short brass tube lengths to extend the length of the dipole and thus 'tune' the dipole. It cannot be made shorter without removing a bit from the arm. An alternative way to tune the dipole is to use copper shielding tape to extend the effective length of the dipole. Do both arms equally.

It should be possible to tune a dipole as described, whilst in place in the measurement position as long as the user has access to a VNA for determining the return loss.

### 6. References

[1] Draft recommended practice for determining the peak spatial-average specific absorption rate (SAR) in the human body due to wireless communications devices: Experimental Techniques.