ADT CORP.

# SAR TEST REPORT

**REPORT NO.:** SA941201H04
**MODEL NO.:** WUA-2340
**RECEIVED:** Dec. 01, 2005
**TESTED:** Dec. 07, 2005
**ISSUED:** Dec. 12, 2005

**APPLICANT:** D-LINK Corporation

**ADDRESS:** No.8, Li-shing Road VII, Science-based Industrial Park, Hsinchu, Taiwan

**ISSUED BY:** Advance Data Technology Corporation

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# 1. CERTIFICATION

| | |
|---|---|
| **PRODUCT:** | Wireless USB Adapter |
| **MODEL:** | WUA-2340 |
| **BRAND:** | D-Link |
| **APPLICANT:** | D-LINK Corporation |
| **TESTED:** | Dec. 07, 2005 |
| **TEST SAMPLE:** | ENGINEERING SAMPLE |
| **STANDARDS:** | FCC Part 2 (Section 2.1093), RSS-102<br>FCC OET Bulletin 65, Supplement C (01-01) |

The above equipment has been tested by **Advance Data Technology Corporation**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

**PREPARED BY** : Joanna Wang , **DATE:** Dec. 12, 2005
Joanna Wang

**TECHNICAL ACCEPTANCE** : Stanely Hsu , **DATE:** Dec. 12, 2005
Responsible for RF
Stanely Hsu

**APPROVED BY** : , **DATE:** Dec. 12, 2005
Cody Chang / Deputy Manager

# 2. GENERAL INFORMATION

## 2.1 GENERAL DESCRIPTION OF EUT

| | |
|---|---|
| **PRODUCT** | Wireless USB Adapter |
| **MODEL NO.** | WUA-2340 |
| **POWER SUPPLY** | 5Vdc from host equipment |
| **CLASSIFICATION** | Portable device, production unit |
| **MODULATION TYPE** | CCK, QPSK, BPSK for DSSS,<br>64QAM, 16QAM, QPSK, BPSK for OFDM |
| **RADIO TECHNOLOGY** | DSSS, OFDM |
| **TRANSFER RATE** | 802.11b: 11/5.5/2/1Mbps<br>802.11g: 54/48/36/24/18/12/9/6Mbps<br>(Turbo mode: up to 108Mbps *see Note 3) |
| **FREQUENCY RANGE** | 2412MHz ~ 2462MHz |
| **NUMBER OF CHANNEL** | 11 for Normal mode / 1 for Turbo mode |
| **CHANNEL FREQUENCIES UNDER TEST AND ITS CONDUCTED OUTPUT POWER (FOR DSSS)** | 51.286mW / Ch1: 2412MHz<br>50.699mW / Ch6: 2437MHz<br>50.816mW / Ch11: 2462MHz |
| **CHANNEL FREQUENCIES UNDER TEST AND ITS CONDUCTED OUTPUT POWER (FOR OFDM)** | 77.268mW / Ch1: 2412MHz<br>79.433mW / Ch6: 2437MHz<br>78.343mW / Ch11: 2462MHz<br>77.625mW / Ch6: 2437MHz (Turbo mode) |
| **AVERAGE SAR (1g) (FOR DSSS)** | 0.486W/kg |
| **AVERAGE SAR (1g) (FOR OFDM)** | 0.523W/kg |
| **DATA CABLE** | NA |
| **I/O PORTS** | USB |
| **ASSOCIATED DEVICES** | NA |

**NOTE:**

1. The EUT complies with IEEE 802.11g standards and backwards compatible with IEEE 802.11b products.
2. The EUT operates in the 2.4GHz frequency spectrum with throughput of up to 54Mbps.
3. This EUT is capable of providing data rates of up to 108Mbps in Turbo Mode depending upon reception quality.
4. Normal operating condition of the EUT shall be plugged into the notebook. Then the property of the EUT shall be complied with the portable device according to the FCC 2.1093.
5. The above EUT information was declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or User's Manual.

## 2.2 GENERAL DESCRIPTION OF APPLIED STANDARDS

According to the specifications of the manufacturer, this product must comply with the requirements of the following standards:

**FCC Part 2 (2.1093)**

**FCC OET Bulletin 65, Supplement C (01- 01)**

**RSS-102**

**IEEE 1528-2003**

All test items have been performed and recorded as per the above standards.

## 2.3 GENERAL INOFRMATION OF THE SAR SYSTEM

DASY4 (software 4.6 Build 23) consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY4 software defined. The DASY4 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

### ET3DV6 ISOTROPIC E-FIELD PROBE

| | |
|---|---|
| **CONSTRUCTION** | Symmetrical design with triangular core.<br>Built-in optical fiber for surface detection system.<br>Built-in shielding against static charges.<br>PEEK enclosure material (resistant to organic solvents, e.g., glycolether). |
| **FREQUENCY** | 10 MHz to 3 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz) |
| **DYNAMIC RANGE** | 5 μW/g to > 100 mW/g; Linearity: ± 0.2 dB |
| **OPTICAL SURFACE DETECTION** | ± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces |
| **DIMENSIONS** | Overall length: 330 mm (Tip Length: 16 mm)<br>Tip diameter: 6.8 mm (Body diameter: 12 mm) |

Distance from probe tip to dipole centers: 2.7 mm

**APPLICATION** General dosimetric measurements up to 3 GHz
Compliance tests of mobile phones
Fast automatic scanning in arbitrary phantoms (ET3DV6)

**NOTE**

1. The Probe parameters have been calibrated by the SPEAG. Please reference “APPENDIX D” for the Calibration Certification Report.
2. For frequencies above 800 MHz, calibration in a rectangular wave-guide is used, because wave-guide size is manageable.
3. For frequencies below 800 MHz, temperature transfer calibration is used because the wave-guide size becomes relatively large.

## TWIN SAM V4.0

**CONSTRUCTION** The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-2003, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents 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 with the robot.

**SHELL THICKNESS** 2 ± 0.2 mm

**FILLING VOLUME** Approx. 25 liters

**DIMENSIONS** Height: 810 mm; Length: 1000 mm; Width: 500 mm

## SYSTEM VALIDATION KITS:

**CONSTRUCTION** Symmetrical dipole with l/4 balun enables measurement of feedpoint impedance with NWA matched for use near flat phantoms filled with brain simulating solutions.
Includes distance holder and tripod adaptor

**CALIBRATION** Calibrated SAR value for specified position and input power at the flat phantom in brain simulating solutions

**FREQUENCY** 2450 MHz

**RETURN LOSS** > 20 dB at specified validation position

**POWER CAPABILITY** > 100 W (f < 1GHz); > 40 W (f > 1GHz)

**OPTIONS** Dipoles for other frequencies or solutions and other calibration conditions upon request

## DEVICE HOLDER FOR SAM TWIN PHANTOM

**CONSTRUCTION** The device holder for the mobile phone device 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 centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles. The holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity $\varepsilon$ =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. The device holder for the portable device makes up of the polyethylene foam. The dielectric parameters of material close to the dielectric parameters of the air.

## DATA ACQUISITION ELECTRONICS

**CONSTRUCTION** The data acquisition electronics (DAE3) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplex, a fast 16 bit AD converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The mechanical probe is mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE3 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

## 2.4 GENERAL DESCRIPTION OF THE SPATIAL PEAK SAR EVALUATION

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

| | | |
|---|---|---|
| Probe parameters: | - Sensitivity | $Norm_i$, $a_{i0}$, $a_{i1}$, $a_{i2}$ |
| | - Conversion factor | $ConvF_i$ |
| | - Diode compression point | $dcp_i$ |
| Device parameters: | - Frequency | F |
| | - Crest factor | Cf |
| Media parameters: | - Conductivity | $\sigma$ |
| | - Density | $\rho$ |

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

$$V_i = U_i + U_i^2 \bullet \frac{cf}{dcp_i}$$

| | | |
|---|---|---|
| $V_i$ | =compensated signal of channel i | (i = x, y, z) |
| $U_i$ | =input signal of channel I | (i = x, y, z) |
| Cf | =crest factor of exciting field | (DASY parameter) |
| $dcp_i$ | =diode compression point | (DASY parameter) |

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

$$\text{E-fieldprobes: } E_i = \sqrt{\frac{V_1}{Norm_i \cdot ConvF}}$$

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

| | | |
|---|---|---|
| $V_i$ | =compensated signal of channel I | (i = x, y, z) |
| $Norm_i$ | =sensor sensitivity of channel i μV/(V/m)2 for E-field Probes | (i = x, y, z) |
| ConvF | = sensitivity enhancement in solution | |
| $a_{ij}$ | = sensor sensitivity factors for H-field probes | |
| F | = carrier frequency [GHz] | |
| $E_i$ | = electric field strength of channel i in V/m | |
| $H_i$ | = magnetic field strength of channel i in A/m | |

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

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

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

| | |
|---|---|
| SAR | = local specific absorption rate in mW/g |
| $E_{tot}$ | = total field strength in V/m |
| $\sigma$ | = conductivity in [mho/m] or [Siemens/m] |
| $\rho$ | = equivalent tissue density in g/cm3 |

Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid. The entire evaluation of the spatial peak values is performed within the Post-processing engine (SEMCAD). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

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

The probe is calibrated at the center of the dipole sensors that is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated. The angle between the probe axis and the surface normal line is less than 30 degree.

In the Area Scan, the gradient of the interpolation function is evaluated to find all the extreme of the SAR distribution. The uncertainty on the locations of the extreme is less than 1/20 of the grid size. Only local maximum within -2 dB of the global maximum are searched and passed for the Cube Scan measurement. In the Cube Scan, the interpolation function is used to extrapolate the Peak SAR from the lowest measurement points to the inner phantom surface (the extrapolation distance). The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5mm.

The maximum search is automatically performed after each area scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacing. After the area scanning measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations. The 1g and 10g peak evaluations are only available for the predefined cube 7 x 7 x 7 scans. The routines are verified and optimized for the grid dimensions used in these cube measurements. The measured volume of 30 x 30 x 30mm contains about 30g of tissue. The first procedure is an extrapolation (incl. boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume in a 1mm grid (42875 points). In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is the moved around until the highest averaged SAR is found. If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

# 3. DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

| NO. | PRODUCT | BRAND | MODEL NO. | SERIAL NO. | FCC ID |
|---|---|---|---|---|---|
| 1 | NOTEBOOK | Compaq | N800C | 470048-515 | FCC DoC Approved |
| 2 | NOTEBOOK | DELL | C600 | N1-020002 | FCC DoC Approved |

| NO. | SIGNAL CABLE DESCRIPTION OF THE ABOVE SUPPORT UNITS |
|---|---|
| 1 | NA |
| 2 | NA |

**NOTE:** All power cords of the above support units are non shielded (1.8m).

# 4. DESCRIPTION OF TEST MODES AND CONFIGURATIONS

## 4.1. DESCRIPTION OF ANTENNA LOCATION

## 4.2. DESCRIPTION OF ASSESSMENT POSITION

The following test configurations have been applied in this test report:

| | |
|---|---|
| | |
| **A: NOTEBOOK MODEL: N800C** | **B: NOTEBOOK MODEL: C600** |
| The bottom of the EUT face to the phantom with 7mm-separation distance. | The edge of the EUT face to the phantom with 6mm-separation distance. |

**NOTE:** The bottom of the notebook contacts the bottom of the flat phantom with 0mm-separation distance.

## 4.3. DESCRIPTION OF TEST MODE

| TEST MODE | MODULATION TECHNOLOGY | ASSESSMENT POSTITION | TESTED CHANNEL | REMARK |
|---|---|---|---|---|
| 1 | DSSS | A | L, M, H | - |
| 2 | OFDM | A | L, M, H | - |
| 3 | DSSS | B | L, M, H | - |
| 4 | OFDM | B | L, M, H | - |

## 4.4. SUMMARY OF TEST RESULTS

| COMMUNICATION MODE | DSSS | | OFDM | |
|---|---|---|---|---|
| MEASURED VALUE OF 1g SAR ( W/kg) | | | | |
| CHANNEL | ASSESSMENT POSTITION | | ASSESSMENT POSTITION | |
| | A | B | A | B |
| LOW | **0.486** | 0.261 | 0.516 | 0.304 |
| MIDDLE | 0.419 | 0.228 | 0.462 | 0.261 |
| HIGH | 0.346 | 0.229 | 0.357 | 0.217 |
| TURBO MODE | - | - | 0.523 | 0.282 |

**NOTE:** The worst value has been marked by boldface.

# 5. TEST RESULTS

## 5.1 TEST PROCEDURES

The EUT (Wireless USB Adapter) plugged into the notebook. Use the software to control the EUT channel and transmission power. Then record the conducted power before the testing. Place the EUT to the specific test location. After the testing, must writing down the conducted power of the EUT into the report. The SAR value was calculated via the 3D spline interpolation algorithm that has been implemented in the software of DASY4 SAR measurement system manufactured and calibrated by SPEAG. According to the IEEE 1528 standards, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- Power reference measurement
- Verification of the power reference measurement
- Area scan
- Zoom scan
- Power reference measurement

The area scan was performed for the highest spatial SAR location. The zoom scan with 30mm x 30mm x 30mm volume was performed for SAR value averaged over 1g and 10g spatial volumes.

In the zoom scan, the distance between the measurement point at the probe sensor location (geometric center behind the probe tip) and the phantom surface is 4.0 mm and maintained at a constant distance of ±1.0 mm during a zoom scan to determine peak SAR locations. The distance is 4mm between the first measurement point and the bottom surface of the phantom. The secondary measurement point to the bottom surface of the phantom is with 9mm separation distance. The cube size is 7 x 7 x 7 points consist of 343 points and the grid space is 5mm.

The measurement time is 0.5 s at each point of the zoom scan. The probe boundary effect compensation shall be applied during the SAR test. Because of the tip of the probe to the Phantom surface separated distances are longer than half a tip probe diameter.

In the area scan, the separation distance is 4mm between the each measurement point and the phantom surface. The scan size shall be included the transmission portion of the EUT. The measurement time is the same as the zoom scan. At last the reference power drift shall be less than ±5%.

## 5.2 MEASURED SAR RESULTS

| | | | |
|---|---|---|---|
| **EUT** | Wireless USB Adapter | **MODEL** | WUA-2340 |
| **ENVIRONMENTAL CONDITION** | Air Temperature：22.8°C, Liquid Temperature：21.5°C<br>Humidity：56%RH | | |
| **TESTED BY** | Sam Onn | **DATE** | Dec. 07, 2005 |

| Chan. | Freq. (MHz) | Modulation Technique | Conducted Power (mW) | | Power Drift (%) | Device Use Power | Device Test Position | Antenna Position | Measured 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Begin Test | After Test | | | | | |
| **1** | **2412 (Low)** | **DSSS** | 51.286 | 50.537 | -1.46 | Standard Battery from host | 1 | Internal Fixed | **0.486** |
| **6** | **2437 (Mid.)** | **DSSS** | 50.699 | 49.776 | -1.82 | Standard Battery from host | 1 | Internal Fixed | 0.419 |
| **11** | **2462 (High)** | **DSSS** | 50.816 | 49.937 | -1.73 | Standard Battery from host | 1 | Internal Fixed | 0.346 |
| **1** | **2412 (Low)** | **OFDM** | 77.268 | 75.444 | -2.36 | Standard Battery from host | 2 | Internal Fixed | 0.516 |
| **6** | **2437 (Mid.)** | **OFDM** | 79.433 | 77.320 | -2.66 | Standard Battery from host | 2 | Internal Fixed | 0.462 |
| **11** | **2462 (High)** | **OFDM** | 78.343 | 76.016 | -2.97 | Standard Battery from host | 2 | Internal Fixed | 0.357 |
| **6** | **2437 (Mid.) Turbo mode** | **OFDM** | 77.625 | 75.972 | -2.13 | Standard Battery from host | 2 | Internal Fixed | **0.523** |

**NOTE:**

1. Test configuration of each mode is described in section 3.
2. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
3. Please see the Appendix A for the photo of the test configuration and also the data.
4. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

| EUT | Wireless USB Adapter | MODEL | WUA-2340 |
|---|---|---|---|
| ENVIRONMENTAL CONDITION | Air Temperature：22.8°C, Liquid Temperature：21.5°C<br>Humidity：56%RH | | |
| TESTED BY | Sam Onn | DATE | Dec. 07, 2005 |

| Chan. | Freq. (MHz) | Modulation Technique | Conducted Power (mW) | | Power Drift (%) | Device Use Power | Device Test Position | Antenna Position | Measured 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Begin Test | After Test | | | | | |
| 1 | 2412 (Low) | DSSS | 51.286 | 50.655 | -1.23 | Standard Battery from host | 3 | Internal Fixed | 0.261 |
| 6 | 2437 (Mid.) | DSSS | 50.699 | 49.756 | -1.86 | Standard Battery from host | 3 | Internal Fixed | 0.228 |
| 11 | 2462 (High) | DSSS | 50.816 | 49.993 | -1.62 | Standard Battery from host | 3 | Internal Fixed | 0.229 |
| 1 | 2412 (Low) | OFDM | 77.268 | 75.645 | -2.10 | Standard Battery from host | 4 | Internal Fixed | 0.304 |
| 6 | 2437 (Mid.) | OFDM | 79.433 | 77.328 | -2.65 | Standard Battery from host | 4 | Internal Fixed | 0.261 |
| 11 | 2462 (High) | OFDM | 78.343 | 76.572 | -2.26 | Standard Battery from host | 4 | Internal Fixed | 0.217 |
| 6 | 2437 (Mid.) Turbo mode | OFDM | 77.625 | 75.909 | -2.21 | Standard Battery from host | 4 | Internal Fixed | 0.282 |

**NOTE:**

5. Test configuration of each mode is described in section 3.
6. In this testing, the limit for General Population Spatial Peak averaged over 1g, **1.6 W/kg**, is applied.
7. Please see the Appendix A for the photo of the test configuration and also the data.
8. The variation of the EUT conducted power measured before and after SAR testing should not over 5%.

## 5.3 SAR LIMITS

| HUMAN EXPOSURE | SAR (W/kg) | |
|---|---|---|
| | (General Population / Uncontrolled Exposure Environment) | (Occupational / controlled Exposure Environment) |
| Spatial Average ( whole body) | 0.08 | 0.4 |
| Spatial Peak (averaged over 1 g) | **1.6** | 8.0 |
| Spatial Peak (hands / wrists / feet / ankles averaged over 10 g) | 4.0 | 20.0 |

**NOTE:**

1. This limits accord to 47 CFR 2.1093 – Safety Limit.
2. The EUT property been complied with the partial body exposure limit under the general population environment.

## 5.4 RECIPES FOR TISSUE SIMULATING LIQUIDS

For the measurement of the field distribution inside the SAM phantom, the phantom must be filled with 25 litters of tissue simulation liquid.

The following ingredients are used：

- **WATER-** Deionized water (pure H20), resistivity _16 M - as basis for the liquid
- **SUGAR-** Refined sugar in crystals, as available in food shops - to reduce relative permittivity
- **SALT-** Pure NaCl - to increase conductivity
- **CELLULOSE-** Hydroxyethyl-cellulose, medium viscosity (75-125 mPa.s, 2% in water, 20_C),
  CAS # 54290 - to increase viscosity and to keep sugar in solution
- **PRESERVATIVE-** Preventol D-7 Bayer AG, D-51368 Leverkusen, CAS # 55965-84-9 - to prevent the spread of bacteria and molds
- **DGMBE-** Diethylenglycol-monobuthyl ether (DGMBE), Fluka Chemie GmbH, CAS # 112-34-5 - to reduce relative permittivity

**THE RECIPES FOR 2450MHz SIMULATING LIQUID TABLE**

| INGREDIENT | HEAD SIMULATING LIQUID 2450MHz (HSL-2450) | MUSCLE SIMULATING LIQUID 2450MHz (MSL-2450) |
|---|---|---|
| Water | 45% | 69.83% |
| DGMBE | 55% | 30.17% |
| Salt | NA | NA |
| Dielectric Parameters at 22℃ | f= 2450MHz<br>ε= 39.2 ± 5%<br>σ= 1.80 ± 5% S/m | f= 2450MHz<br>ε= 52.7 ± 5%<br>σ= 1.95 ± 5% S/m |

Testing the liquids using the Agilent Network Analyzer E8358A and Agilent Dielectric Probe Kit 85070D.The testing procedure is following as

1. Turn Network Analyzer on and allow at least 30 min. warm up.
2. Mount dielectric probe kit so that interconnecting cable to Network Analyzer will not be moved during measurements or calibration.
3. Pour de-ionized water and measure water temperature (±1°).
4. Set water temperature in Agilent-Software (Calibration Setup).
5. Perform calibration.
6. Validate calibration with dielectric material of known properties (e.g. polished ceramic slab with >8mm thickness ε'=10.0, ε"=0.0). If measured parameters do not fit within tolerance, repeat calibration (±0.2 for ε': ±0.1 for ε").
7. Conductivity can be calculated from ε" by $\sigma = \omega \varepsilon_0 \varepsilon'' = \varepsilon'' f$ [GHz] / 18.
8. Measure liquid shortly after calibration. Repeat calibration every hour.
9. Stir the liquid to be measured. Take a sample (~50ml) with a syringe from the center of the liquid container.
10. Pour the liquid into a small glass flask. Hold the syringe at the bottom of the flask to avoid air bubbles.
11. Put the dielectric probe in the glass flask. Check that there are no air bubbles in front of the opening in the dielectric probe kit.
12. Perform measurements.
13. Adjust medium parameters in DASY4 for the frequencies necessary for the measurements (‘Setup Config’, select medium (e.g. Brain 900 MHz) and press ‘Option’-button.
14. Select the current medium for the frequency of the validation (e.g. Setup Medium Brain 900 MHz).

**FOR 2.4GHz BAND SIMULATING LIQUID**

| LIQUID TYPE | | HSL-2450 | | MSL-2450 | |
|---|---|---|---|---|---|
| SIMULATING LIQUID TEMP. | | NA | | 21.5 | |
| TEST DATE | | NA | | Dec. 07, 2005 | |
| TESTED BY | | NA | | Sam Onn | |
| FREQ. (MHz) | LIQUID PARAMETER | STANDARD VALUE | MEASUREMENT VALUE | STANDARD VALUE | MEASUREMENT VALUE |
| 2412 | Permitivity ( ε ) | NA | NA | 52.75 | 50.50 |
| 2437 | | NA | NA | 52.71 | 50.40 |
| 2450 | | NA | NA | 52.70 | 50.40 |
| 2462 | | NA | NA | 52.68 | 50.30 |
| 2412 | Conductivity ( σ ) S/m | NA | NA | 1.913 | 1.950 |
| 2437 | | NA | NA | 1.937 | 1.990 |
| 2450 | | NA | NA | 1.950 | 2.000 |
| 2462 | | NA | NA | 1.967 | 2.030 |
| **Dielectric Parameters Required at 22℃** | | **f= 2450MHz<br>ε= 39.2 ± 5%<br>σ= 1.80 ± 5% S/m** | | **f= 2450MHz<br>ε= 52.7 ± 5%<br>σ= 1.95 ± 5% S/m** | |

## 5.5 TEST EQUIPMENT FOR TISSUE PROPERTY

| ITEM | NAME | BAND | TYPE | SERIES NO. | CALIBRATED UNTIL |
|---|---|---|---|---|---|
| 1 | Network Analyzer | Agilent | E8358A | US41480539 | May 05, 2006 |
| 2 | Dielectric Probe | Agilent | 85070D | US01440176 | NA |

**NOTE:**

1. Before starting, all test equipment shall be warmed up for 30min.
2. The tolerance (k=1) specified by Agilent for general dielectric measurements, deriving from inaccuracies in the calibration data, analyzer drift, and random errors, are usually ±2.5% and ±5% for measured permittivity and conductivity, respectively. However, the tolerances for the conductivity is smaller for material with large loss tangents, i.e., less than ±2.5% (k=1). It can be substantially smaller if more accurate methods are applied.

# 6. SYSTEM VALIDATION

The system validation was performed in the flat phantom with equipment listed in the following table. Since the SAR value is calculated from the measured electric field, dielectric constant and conductivity of the body tissue, and the SAR is proportional to the square of the electric field. So, the SAR value will be also proportional to the RF power input to the system validation dipole under the same test environment. In our system validation test, 250mW RF input power was used.

## 6.1 TEST EQUIPMENT

| ITEM | NAME | BAND | TYPE | SERIES NO. | CALIBRATED UNTIL |
|---|---|---|---|---|---|
| 1 | SAM Phantom | S & P | QD000 P40 CA | PT-1150 | NA |
| 2 | Signal Generator | Anritsu | 68247B | 984703 | May 04, 2006 |
| 3 | E-Field Probe | S & P | ET3DV6 | 1790 | Dec. 19, 2006 |
| 4 | DAE | S & P | DAE3 V1 | 579 | Mar. 22, 2006 |
| 5 | Robot Positioner | Staubli Unimation | NA | NA | NA |
| 6 | Validation Dipole | S & P | D2450V2 | 737 | Mar. 15, 2006 |

**NOTE:** 1. Before starting the measurement, all test equipment shall be warmed up for 30min.

2. System validation was performed to check the condition during each test. According to this situation, calibrated period for the validation dipole back to the original factory is one year, and the others will be two.

## 6.2 TEST PROCEDURE

Before the system performance check, we need only to tell the system which components (probe, medium, and device) are used for the system performance check; the system will take care of all parameters. The dipole must be placed beneath the flat section of the SAM Twin Phantom with the correct distance holder in place. The distance holder should touch the phantom surface with a light pressure at the reference marking (little cross) and be oriented parallel to the long side of the phantom. Accurate positioning is not necessary, since the system will search for the peak SAR location, except that the dipole arms should be parallel to the surface. The device holder for mobile phones can be left in place but should be rotated away from the dipole.

1. The ”Power Reference Measurement” and ”Power Drift Measurement” jobs are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the amplifier output power. If it is too high (above ±0.1 dB), the system performance check should be repeated; some amplifiers have very high drift during warm-up. A stable amplifier gives drift results in the DASY system below ±0.02 dB.

2. The ”Surface Check” job tests the optical surface detection system of the DASY system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ±0.1mm). In that case it is better to abort the system performance check and stir the liquid. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within ±30$^{O}$.) However, varying breaking indices of different liquid compositions might also influence the distance. If the indicated difference varies from the actual setting, the probe parameter ”optical surface

3. The ”Area Scan” job measures the SAR above the dipole on a plane parallel to the surface. It is used to locate the approximate location of the peak SAR. The proposed scan uses large grid spacing for faster measurement; due to the symmetric field, the peak detection is reliable. If a finer graphic is desired, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result.

4. The ”Zoom Scan” job measures the field in a volume around the peak SAR value assessed in the previous ”Area Scan” job (for more information see the application note on SAR evaluation).

About the validation dipole positioning uncertainty, the constant and low loss dielectric spacer is used to establish the correct distance between the top surface of the dipole and the bottom surface of the phantom, the error component introduced by the uncertainty of the distance between the liquid (i.e., phantom shell) and the validation dipole in the DASY4 system is less than ±0.1mm.

$$SAR_{tolerance}[\%] = 100 \times (\frac{(a+d)^2}{a^2} - 1)$$

As the closest distance is 10mm, the resulting tolerance $SAR_{tolerance}$[%] is <2%.

## 6.3 VALIDATION RESULTS

| 2450MHz SYSTEM VALIDATION TEST IN THE MUSCLE SIMULATING LIQUID | | | | | |
|---|---|---|---|---|---|
| **TEST FREQUENCY (MHz)** | **REQUIRED SAR (mW/g)** | **MEASURED SAR (mW/g)** | **DEVIATION (%)** | **SEPARATION DISTANCE** | **TEST DATE** |
| MSL2450 | 13.4 (1g) | 12.7 | -5.22 | 10mm | Dec. 07, 2005 |
| **TESTED BY** | Sam Onn | | | | |

**NOTE:** Please see Appendix for the photo of system validation test.

## 6.4 SYSTEM VALIDATION UNCERTAINTIES

In the table below, the system validation uncertainty with respect to the analytically assessed SAR value of a dipole source as given in the IEEE 1528 standard is given. This uncertainty is smaller than the expected uncertainty for mobile phone measurements due to the simplified setup and the symmetric field distribution.

| Error Description | Tolerance (±%) | Probability Distribution | Divisor | ($C_i$) | | Standard Uncertainty (±%) | | ($v_i$) |
|---|---|---|---|---|---|---|---|---|
| | | | | (1g) | (10g) | (1g) | (10g) | |
| **Measurement System** | | | | | | | | |
| **Probe Calibration** | 4.8 | Normal | 1 | 1 | 1 | 4.8 | 4.8 | ∞ |
| **Axial Isotropy** | 4.7 | Rectangular | √3 | 1 | 1 | 2.7 | 2.7 | ∞ |
| **Hemispherical Isotropy** | 0 | Rectangular | √3 | 1 | 1 | 0 | 0 | ∞ |
| **Boundary effect** | 1.0 | Rectangular | √3 | 1 | 1 | 0.6 | 0.6 | ∞ |
| **Linearity** | 4.7 | Rectangular | √3 | 1 | 1 | 2.7 | 2.7 | ∞ |
| **System Detection Limit** | 1.0 | Rectangular | √3 | 1 | 1 | 0.6 | 0.6 | ∞ |
| **Readout Electronics** | 1.0 | Normal | 1 | 1 | 1 | 1.0 | 1.0 | ∞ |
| **Response Time** | 0 | Rectangular | √3 | 1 | 1 | 0 | 0 | ∞ |
| **Integration Time** | 0 | Rectangular | √3 | 1 | 1 | 0 | 0 | ∞ |
| **RF Ambient Conditions** | 3.0 | Rectangular | √3 | 1 | 1 | 1.7 | 1.7 | ∞ |
| **Probe Positioner** | 0.4 | Rectangular | √3 | 1 | 1 | 0.2 | 0.2 | ∞ |
| **Probe positioning** | 2.9 | Rectangular | √3 | 1 | 1 | 1.7 | 1.7 | ∞ |
| **Algorithms for Max. SAR Evaluation** | 1.0 | Rectangular | √3 | 1 | 1 | 0.6 | 0.6 | ∞ |
| **Dipole** | | | | | | | | |
| **Dipole Axis to Liquid Distance** | 2.0 | Rectangular | √3 | 1 | 1 | 1.2 | 1.2 | ∞ |
| **Input power and SAR drift measurement** | 4.7 | Rectangular | √3 | 1 | 1 | 2.7 | 2.7 | ∞ |
| **Phantom and Tissue Parameters** | | | | | | | | |
| **Phantom Uncertainty** | 4.0 | Rectangular | √3 | 1 | 1 | 2.3 | 2.3 | ∞ |
| **Liquid Conductivity (target)** | 5.0 | Rectangular | √3 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| **Liquid Conductivity (measurement)** | 2.5 | Normal | 1 | 0.64 | 0.43 | 1.6 | 1.1 | ∞ |
| **Liquid Permittivity (target)** | 5.0 | Rectangular | √3 | 0.6 | 0.49 | 1.7 | 1.4 | ∞ |
| **Liquid Permittivity (measurement)** | 2.5 | Normal | 1 | 0.6 | 0.49 | 1.5 | 1.2 | ∞ |
| **Combined Standard Uncertainty** | | | | | | 8.4 | 8.1 | ∞ |
| **Coverage Factor for 95%** | | | | | | kp=2 | | |
| **Expanded Uncertainty (K=2)** | | | | | | 16.8 | 16.2 | |

**NOTE:** About the system validation uncertainty assessment, please reference the section 7.

# 7. MEASUREMENT SAR PROCEDURE UNCERTAINTIES

The assessment of spatial peak SAR of the hand handheld devices is according to IEEE 1528. All testing situation shall be met below these requirements.

- The system is used by an experienced engineer who follows the manual and the guidelines taught during the training provided by SPEAG.
- The probe has been calibrated within the requested period and the stated uncertainty for the relevant frequency bands does not exceed 4.8% (k=1).
- The validation dipole has been calibrated within the requested period and the system performance check has been successful.
- The DAE unit has been calibrated within the within the requested period.
- The minimum distance between the probe sensor and inner phantom shell is selected to be between 4 and 5mm.
- The operational mode of the DUT is CW, CDMA, FDMA or TDMA (GSM, DCS, PCS, IS136 and PDC) and the measurement/integration time per point is >500 ms.
- The dielectric parameters of the liquid have been assessed using Agilent 85070D dielectric probe kit or a more accurate method.
- The dielectric parameters are within 5% of the target values.
- The DUT has been positioned as described in section 3.

## 7.1. PROBE CALIBRATION UNCERTAINTY

SPEAG conducts the probe calibration in compliance with international and national standards (e.g. IEEE 1528, EN50361, IEC 62209, etc.) under ISO17025. The uncertainties are stated on the calibration certificate. For the most relevant frequency bands, these values do not exceed 4.8% (k=1). If evaluations of other bands are performed for which the uncertainty exceeds these values, the uncertainty tables given in the summary have to be revised accordingly.

## 7.2. ISOTROPY UNCERTAINTY

The axial isotropy tolerance accounts for probe rotation around its axis while the hemispherical isotropy error includes all probe orientations and field polarizations. These parameters are assessed by SPEAG during initial calibration. In 2001, SPEAG further tightened its quality controls and warrants that the maximal deviation from axial isotropy is ±0.20 dB, while the maximum deviation of hemispherical isotropy is ±0.40 dB, corresponding to ±4.7% and ±9.6%, respectively. A weighting factor of cp equal to 0.5 can be applied, since the axis of the probe deviates less than 30 degrees from the normal surface orientation.

## 7.3. BOUNDARY EFFECT UNCERTAINTY

The effect can be estimated according to the following error approximation formula

$$SAR_{tolerance}[\%] = SAR_{be}[\%] \times \frac{(d_{be} + d_{step})^2}{2d_{step}} \frac{e^{-\frac{d_{be}}{\delta/2}}}{\delta/2}$$

$$d_{be} + d_{step} < 10mm$$

The parameter $d_{be}$ is the distance in mm between the surface and the closest measurement point used in the averaging process; $d_{step}$ is the separation distance in mm between the first and second measurement points; δ is the minimum penetration depth in mm within the head tissue equivalent liquids (i.e., δ= 13.95 mm at 3GHz); $SAR_{be}$ is the deviation between the measured SAR value at the distance $d_{be}$ from the boundary and the wave-guide analytical value $SAR_{ref}$.DASY4 applies a boundary effect compensation algorithm according to IEEE 1528, which is possible since the axis of the probe never deviates more than 30 degrees from the normal surface orientation. $SAR_{be}$[%] is assessed during the calibration process and SPEAG warrants that the uncertainty at distances larger than 4mm is always less than 1%.In summary, the worst case boundary effect SAR tolerance[%] for scanning distances larger than 4mm is < ± 0.8%.

## 7.4. PROBE LINEARITY UNCERTAINTY

Field probe linearity uncertainty includes errors from the assessment and compensation of the diode compression effects for CW and pulsed signals with known duty cycles. This error is assessed using the procedure described in IEEE 1528. For SPEAG field probes, the measured difference between CW and pulsed signals, with pulse frequencies between 10 Hz and 1 kHz and duty cycles between 1 and 100, is < ±0.20 dB (< ±4.7%).

## 7.5. READOUT ELECTRONICS UNCERTAINTY

All uncertainties related to the probe readout electronics (DAE unit), including the gain and linearity of the instrumentation amplifier, its loading effect on the probe, and accuracy of the signal conversion algorithm, have been assessed accordingly to IEEE 1528.The combination (root-sum-square RSS method) of these components results in an overall maximum error of ±1.0%.

## 7.6. RESPONSE TIME UNCERTAINTY

The time response of the field probes is assessed by exposing the probe to a well-controlled electric field producing SAR larger than 2.0 W/kg at the tissue medium surface. The signal response time is evaluated as the time required by the system to reach 90% of the expected final value after an on/of switch of the power source. Analytically, it can be expressed as:

$$SAR_{tolerance}[\%] = 100 \times \left(\frac{T_m}{T_m + \tau e^{-T_m/\tau} - \tau} - 1\right)$$

where Tm is 500 ms, i.e., the time between measurement samples, and $_T$ the time constant. The response time $_T$ of SPEAG's probes is <5 ms. In the current implementation, DASY4 waits longer than 100 ms after having reached the grid point before starting a measurement, i.e., the response time uncertainty is negligible.

## 7.7. INTEGRATION TIME UNCERTAINTY

If the device under test does not emit a CW signal, the integration time applied to measure the electric field at a specific point may introduce additional uncertainties due to the discretization and can be assessed as follows

$$SAR_{tolerance}[\%] = 100 \times \sum_{allsub-frames} \frac{t_{frame}}{t_{integration}} \frac{slot_{idle}}{slot_{total}}$$

The tolerances for the different systems are given in Table 7.1, whereby the worst-case $SAR_{tolerance}$ is 2.6%.

| System | $SAR_{tolerance}$ % |
|---|---|
| CW | 0 |
| CDMA* | 0 |
| WCDMA* | 0 |
| FDMA | 0 |
| IS-136 | 2.6 |
| PDC | 2.6 |
| GSM/DCS/PCS | 1.7 |
| DECT | 1.9 |
| Worst-Case | 2.6 |

**TABLE 7.1**

## 7.8. PROBE POSITIONER MECHANICAL TOLERANCE

The mechanical tolerance of the field probe positioner can introduce probe positioning uncertainties. The resulting SAR uncertainty is assessed by comparing the SAR obtained according to the specifications of the probe positioner with respect to the actual position defined by the geometric enter of the probe sensors. The tolerance is determined as:

$$SAR_{tolerance}[\%] = 100 \times \frac{d_{ph}}{\delta/2}$$

The specified repeatability of the RX robot family used in DASY4 systems is ±25 µm. The absolute accuracy for short distance movements is better than ±0.1mm, i.e., the $SAR_{tolerance}$[%] is better than 1.5% (rectangular).

## 7.9. PROBE POSITIONING

The probe positioning procedures affect the tolerance of the separation distance between the probe tip and the phantom surface as:

$$SAR_{tolerance}[\%] = 100 \times \frac{d_{ph}}{\delta/2}$$

where $d_{ph}$ is the maximum deviation of the distance between the probe tip and the phantom surface. The optical surface detection has a precision of better than 0.2 mm, resulting in an $SAR_{tolerance}$[%] of <2.9% (rectangular distribution). Since the mechanical detection provides better accuracy, 2.9% is a worst-case figure for DASY4 system.

## 7.10. PHANTOM UNCERTAINTY

The SAR measurement uncertainty due to SPEAG phantom shell production tolerances has been evaluated using

$$SAR_{tolerance}[\%] \cong 100 \times \frac{2d}{a}, \qquad d << a$$

For a maximum deviation d of the inner and outer shell of the phantom from that specified in the CAD file of ±0.2 mm, and a 10mm spacing a between source and tissue liquid, the calculated phantom uncertainty is ±4.0%.

## 7.11. DASY4 UNCERTAINTY BUDGET

| Error Description | Tolerance (±%) | Probability Distribution | Divisor | ($C_i$) | | Standard Uncertainty (±%) | | ($v_i$) |
|---|---|---|---|---|---|---|---|---|
| | | | | (1g) | (10g) | (1g) | (10g) | |
| **Measurement Equipment** | | | | | | | | |
| **Probe Calibration** | 4.8 | Normal | 1 | 1 | 1 | 4.8 | 4.8 | ∞ |
| **Axial Isotropy** | 4.7 | Rectangular | $\sqrt{3}$ | 1 | 1 | 1.9 | 1.9 | ∞ |
| **Hemispherical Isotropy** | 9.6 | Rectangular | $\sqrt{3}$ | 1 | 1 | 3.9 | 3.9 | ∞ |
| **Boundary effect** | 1.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| **Linearity** | 4.7 | Rectangular | $\sqrt{3}$ | 1 | 1 | 2.7 | 2.7 | ∞ |
| **System Detection Limit** | 1.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| **Readout Electronics** | 1.0 | Normal | 1 | 1 | 1 | 1.0 | 1.0 | ∞ |
| **Response Time** | 0.8 | Normal | 1 | 1 | 1 | 0.8 | 0.8 | ∞ |
| **Integration Time** | 2.6 | Normal | 1 | 1 | 1 | 2.6 | 2.6 | ∞ |
| **Noise** | 0.0 | Normal | 1 | 0 | 0 | 0 | 0 | ∞ |
| **Mechanical Constraints** | | | | | | | | |
| **Scanning System** | 0.4 | Rectangular | $\sqrt{3}$ | 1 | 1 | 0.2 | 0.2 | ∞ |
| **Phantom Shell** | 4.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | 2.3 | 2.3 | ∞ |
| **Probe Positioning** | 2.9 | Rectangular | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| **Device Positioning** | 2.9 | Normal | 1 | 1 | 1 | 2.9 | 2.9 | 875 |
| **Physical Parameters** | | | | | | | | |
| **Liquid Conductivity (target)** | 5.0 | Rectangular | $\sqrt{3}$ | 0.7 | 0.5 | 2 | 1.4 | ∞ |
| **Liquid Conductivity (measurement)** | 4.3 | Rectangular | $\sqrt{3}$ | 0.7 | 0.5 | 1.7 | 1.2 | ∞ |
| **Liquid Permittivity (target)** | 5.0 | Rectangular | $\sqrt{3}$ | 0.6 | 0.5 | 1.7 | 1.4 | ∞ |
| **Liquid Permittivity (measurement)** | 4.3 | Rectangular | $\sqrt{3}$ | 0.6 | 0.5 | 1.5 | 1.2 | ∞ |
| **Power Drift** | 5 | Rectangular | $\sqrt{3}$ | 1 | 1 | 2.9 | 2.9 | ∞ |
| **RF Ambient Conditions** | 3.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| **Post-Processing** | | | | | | | | |
| **Extrapolation and Integration** | 1 | Rectangular | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| **Combined Standard Uncertainty** | | | | | | **9.9** | **9.7** | |
| **Coverage Factor for 95%** | | | | | | **kp=2** | | |
| **Expanded Uncertainty (K=2)** | | | | | | **19.9** | **19.3** | |

**TABLE 7.2**

The table 7.2: Worst-Case uncertainty budget for DASY4 assessed according to CENELEC EN 50361. The budget is valid for the frequency range 300MHz - 3GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

# 8. INFORMATION ON THE TESTING LABORATORIES

We, ADT Corp., were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

| | |
|---|---|
| **USA** | FCC, NVLAP, UL, A2LA |
| **Germany** | TUV Rheinland |
| **Japan** | VCCI |
| **Norway** | NEMKO |
| **Canada** | INDUSTRY CANADA , CSA |
| **R.O.C.** | CNLA, BSMI, DGT |
| **Netherlands** | Telefication |
| **Singapore** | PSB , GOST-ASIA(MOU) |
| **Russia** | CERTIS(MOU) |

Copies of accreditation certificates of our laboratories obtained from approval agencies can be downloaded from our web site: www.adt.com.tw/index.5/phtml. If you have any comments, please feel free to contact us at the following:

**Linko EMC/RF Lab**:
Tel: 886-2-26052180
Fax: 886-2-26052943

**Hsin Chu EMC/RF Lab**:
Tel: 886-3-5935343
Fax: 886-3-5935342

**Hwa Ya EMC/RF/Safety/Telecom Lab**:
Tel: 886-3-3183232
Fax: 886-3-3185050

**Linko RF Lab.**
Tel: 886-3-3270910
Fax: 886-3-3270892

**Web Site**: www.adt.com.tw

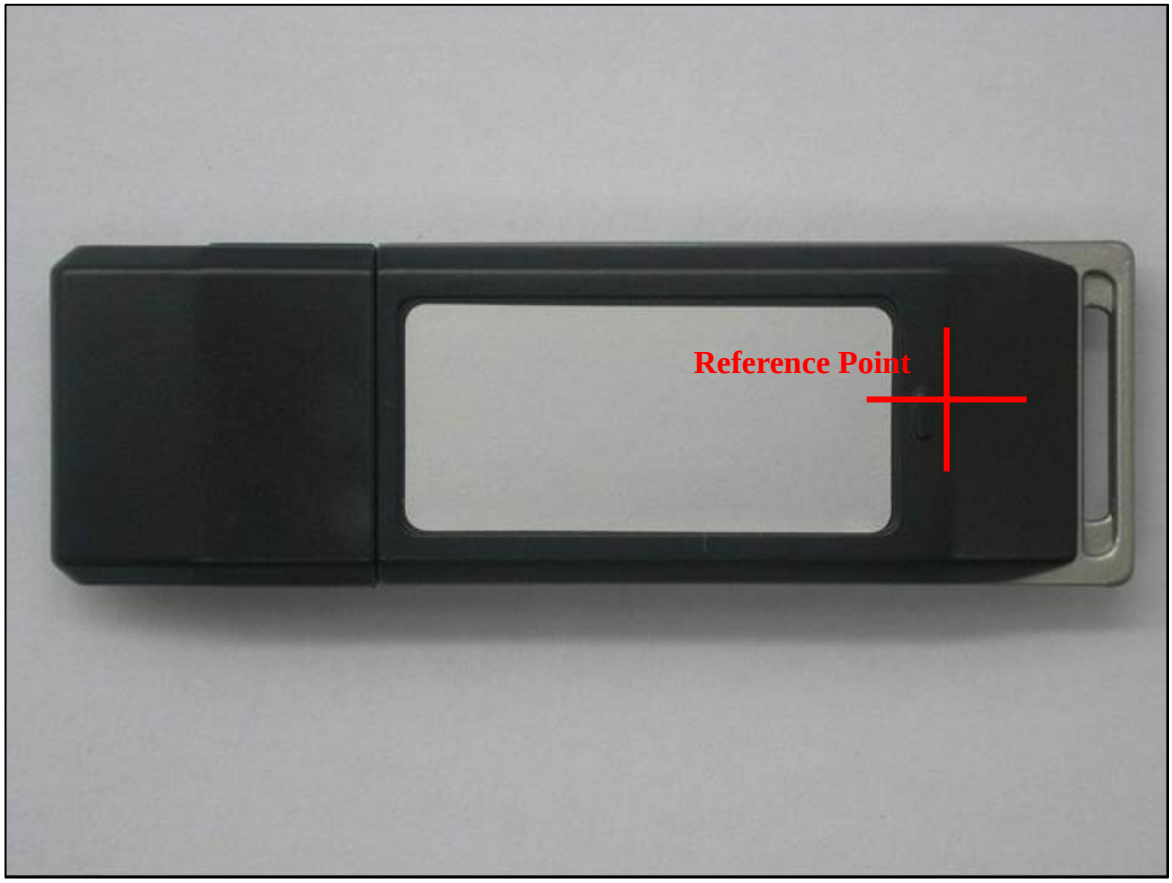
The address and road map of all our labs can be found in our web site also.

## APPENDIX A: TEST CONFIGURATIONS AND TEST DATA
## A1: TEST CONFIGURATION

**The bottom of the EUT to the flat phantom distance 7 mm**

**The edge of the EUT to the flat phantom distance 6 mm**

## EUT Photo



D-Link

# Liquid Level Photo

**MSL 2450MHz D=155mm**

Date/Time: 2005/12/7 19:13:42

Test Laboratory: Advance Data Technology

## N800C-11b-Ch1-Mode 1

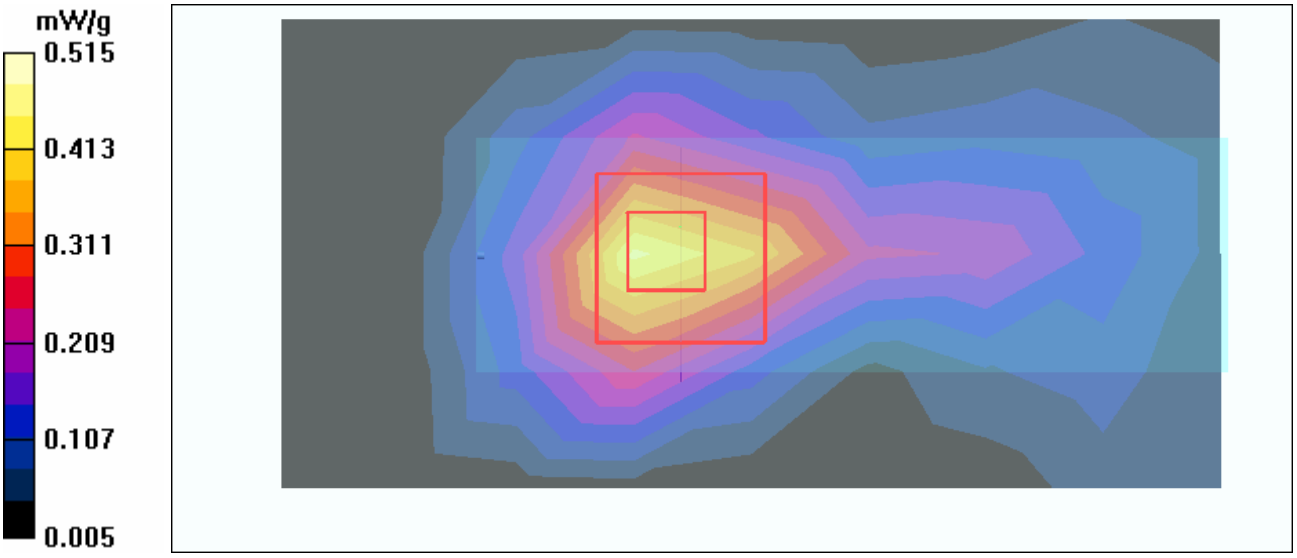
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2412 MHz**

Communication System: 802.11b ; Frequency: 2412 MHz ; Duty Cycle: 1:1 ; Modulation type: CCK
Medium: MSL2450 Medium parameters used: f = 2412 MHz; $\sigma$ = 1.95 mho/m; $\varepsilon_r$ = 50.5; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 7 mm (The bottom side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Low Channel 1/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.458 mW/g

**Low Channel 1/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 14.4 V/m
Peak SAR (extrapolated) = 0.971 W/kg
**SAR(1 g) = 0.486 mW/g; SAR(10 g) = 0.254 mW/g**
Maximum value of SAR (measured) = 0.515 mW/g



Date/Time: 2005/12/7 19:30:20

Test Laboratory: Advance Data Technology

## N800C-11b-Ch6-Mode 1

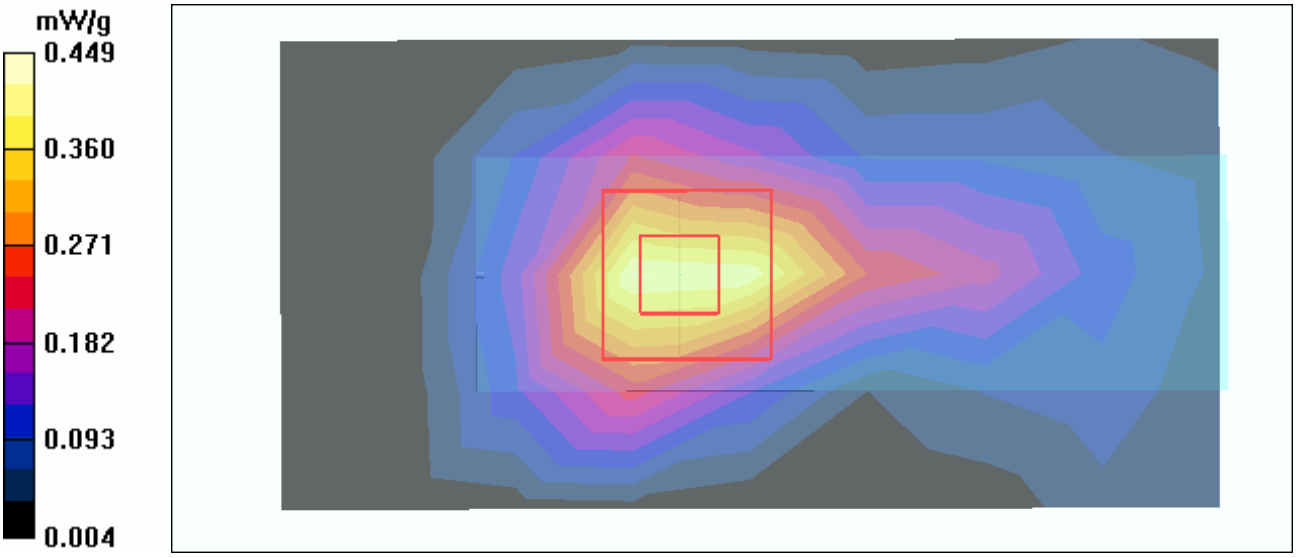
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2437 MHz**

Communication System: 802.11b ; Frequency: 2437 MHz ; Duty Cycle: 1:1 ; Modulation type: CCK
Medium: MSL2450 Medium parameters used: f = 2437 MHz; $\sigma$ = 1.99 mho/m; $\varepsilon_r$ = 50.4; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 7 mm (The bottom side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Mid Channel 6/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.422 mW/g

**Mid Channel 6/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 13.8 V/m
Peak SAR (extrapolated) = 0.821 W/kg
**SAR(1 g) = 0.419 mW/g; SAR(10 g) = 0.226 mW/g**
Maximum value of SAR (measured) = 0.449 mW/g



Date/Time: 2005/12/7 19:46:39

Test Laboratory: Advance Data Technology

## N800C-11b-Ch11-Mode 1

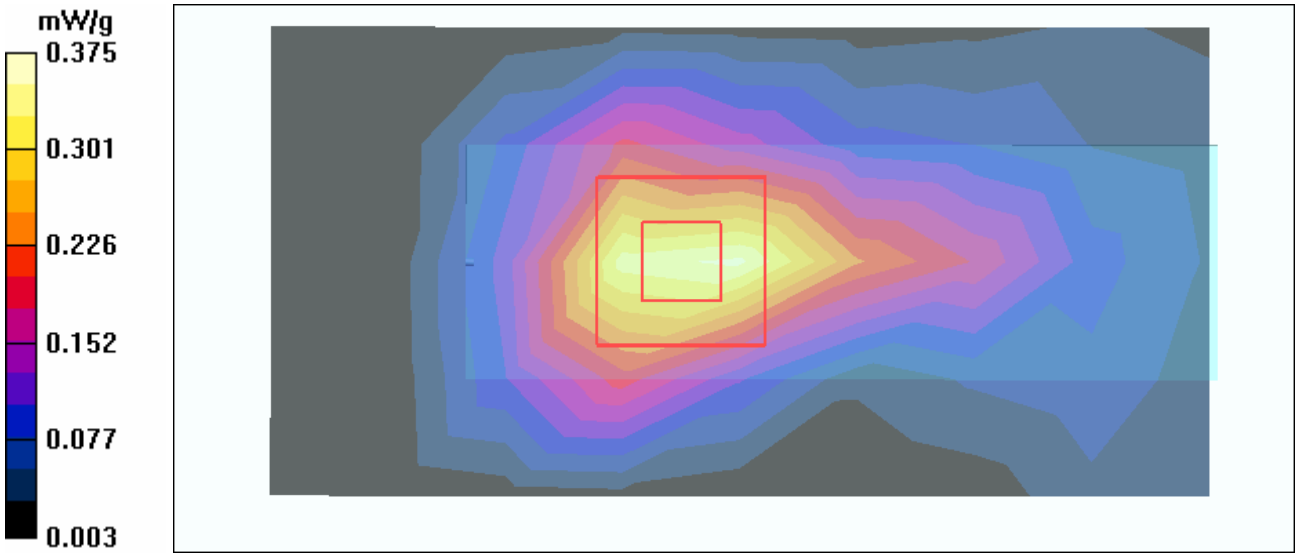
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2462 MHz**

Communication System: 802.11b ; Frequency: 2462 MHz ; Duty Cycle: 1:1 ; Modulation type: CCK
Medium: MSL2450 Medium parameters used: f = 2462 MHz; $\sigma$ = 2.03 mho/m; $\varepsilon_r$ = 50.3; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 7 mm (The bottom side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**High Channel 11/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.357 mW/g

**High Channel 11/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 11.8 V/m
Peak SAR (extrapolated) = 0.677 W/kg
**SAR(1 g) = 0.346 mW/g; SAR(10 g) = 0.188 mW/g**
Maximum value of SAR (measured) = 0.375 mW/g



Date/Time: 2005/12/7 20:06:19

Test Laboratory: Advance Data Technology

## N800C-11g-Ch1-Mode 2

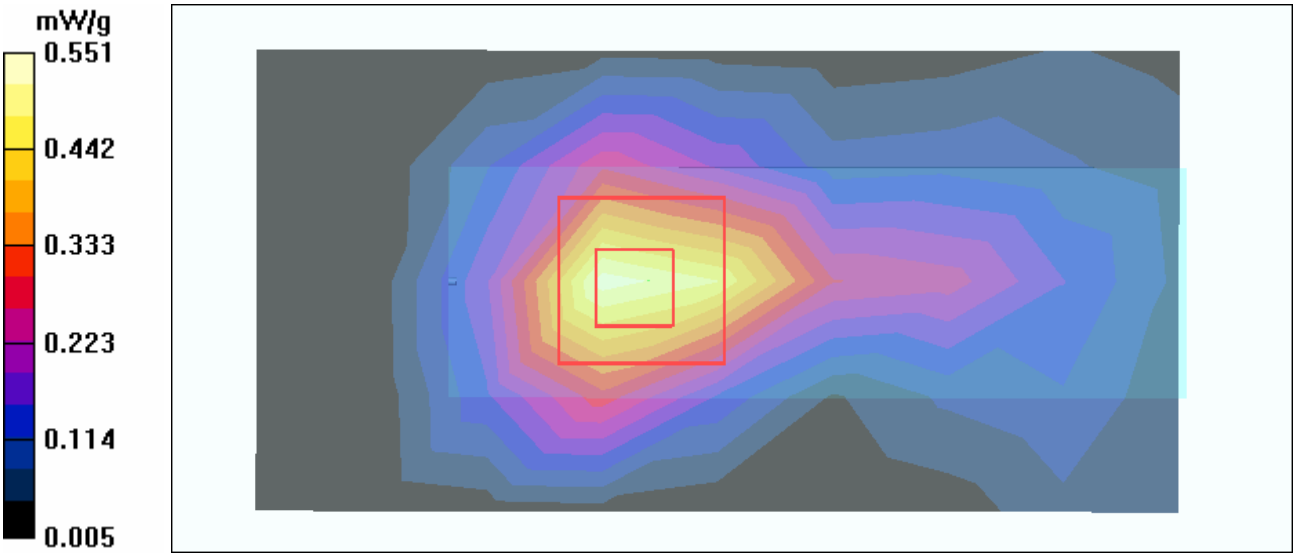
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2412 MHz**

Communication System: 802.11g ; Frequency: 2412 MHz ; Duty Cycle: 1:1 ; Modulation type: OFDM
Medium: MSL2450 Medium parameters used: f = 2412 MHz; $\sigma$ = 1.95 mho/m; $\varepsilon_r$ = 50.5; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 7 mm (The bottom side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Low Channel 1/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.536 mW/g

**Low Channel 1/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 15.9 V/m
Peak SAR (extrapolated) = 1.04 W/kg
**SAR(1 g) = 0.516 mW/g; SAR(10 g) = 0.276 mW/g**
Maximum value of SAR (measured) = 0.551 mW/g



Date/Time: 2005/12/7 20:23:31

Test Laboratory: Advance Data Technology

## N800C-11g-Ch6-Mode 2

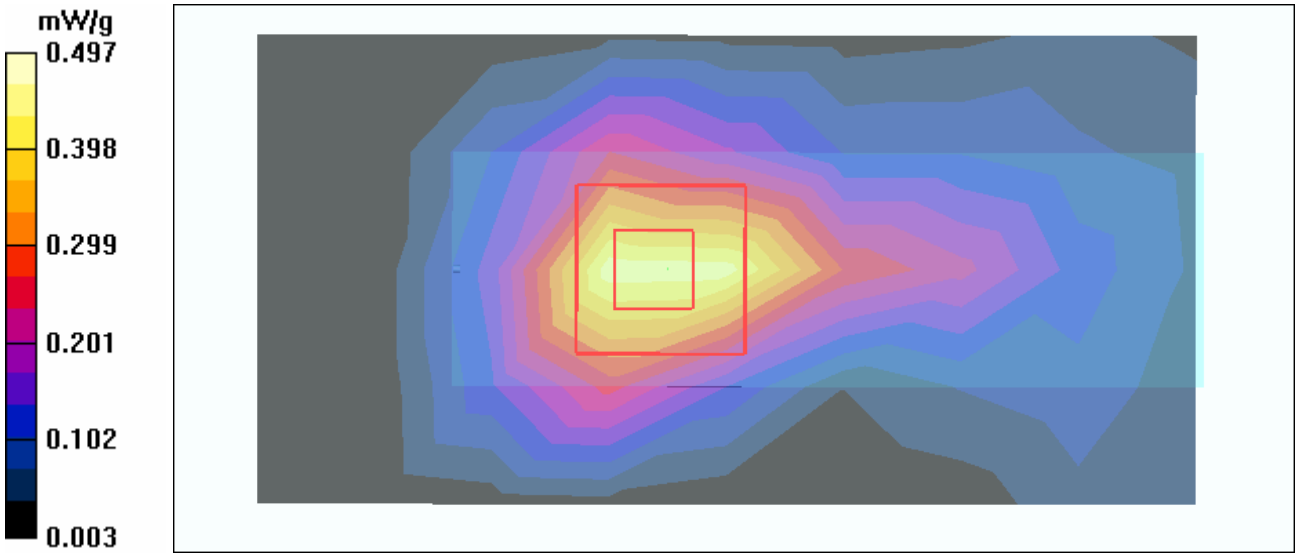
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2437 MHz**

Communication System: 802.11g ; Frequency: 2437 MHz ; Duty Cycle: 1:1 ; Modulation type: OFDM
Medium: MSL2450 Medium parameters used: f = 2437 MHz; $\sigma$ = 1.99 mho/m; $\varepsilon_r$ = 50.4; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 7 mm (The bottom side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Mid Channel 6/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.455 mW/g

**Mid Channel 6/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 14.4 V/m
Peak SAR (extrapolated) = 0.906 W/kg
**SAR(1 g) = 0.462 mW/g; SAR(10 g) = 0.250 mW/g**
Maximum value of SAR (measured) = 0.497 mW/g



Date/Time: 2005/12/7 20:40:58

Test Laboratory: Advance Data Technology

## N800C-11g-Ch11-Mode 2

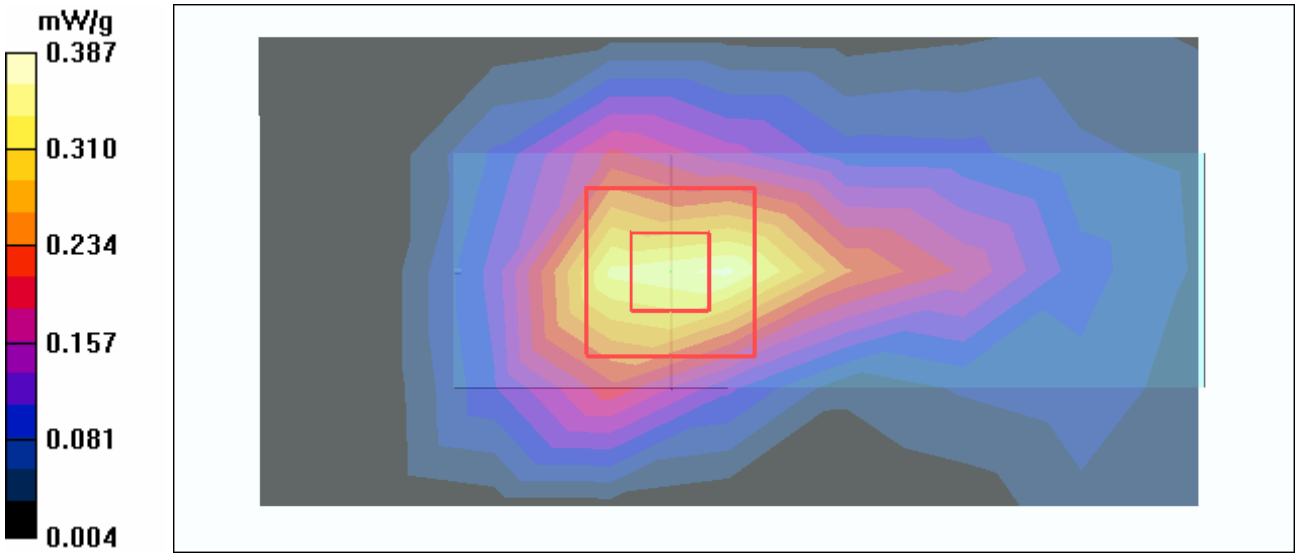
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2462 MHz**

Communication System: 802.11g ; Frequency: 2462 MHz ; Duty Cycle: 1:1 ; Modulation type: OFDM
Medium: MSL2450 Medium parameters used: f = 2462 MHz; $\sigma$ = 2.03 mho/m; $\varepsilon_r$ = 50.3; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 7 mm (The bottom side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**High Channel 11/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.369 mW/g

**High Channel 11/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 12.7 V/m
Peak SAR (extrapolated) = 0.693 W/kg
**SAR(1 g) = 0.357 mW/g; SAR(10 g) = 0.195 mW/g**
Maximum value of SAR (measured) = 0.387 mW/g



Date/Time: 2005/12/7 20:58:00

Test Laboratory: Advance Data Technology

## N800C-11g-Ch6 Turbo-Mode 2

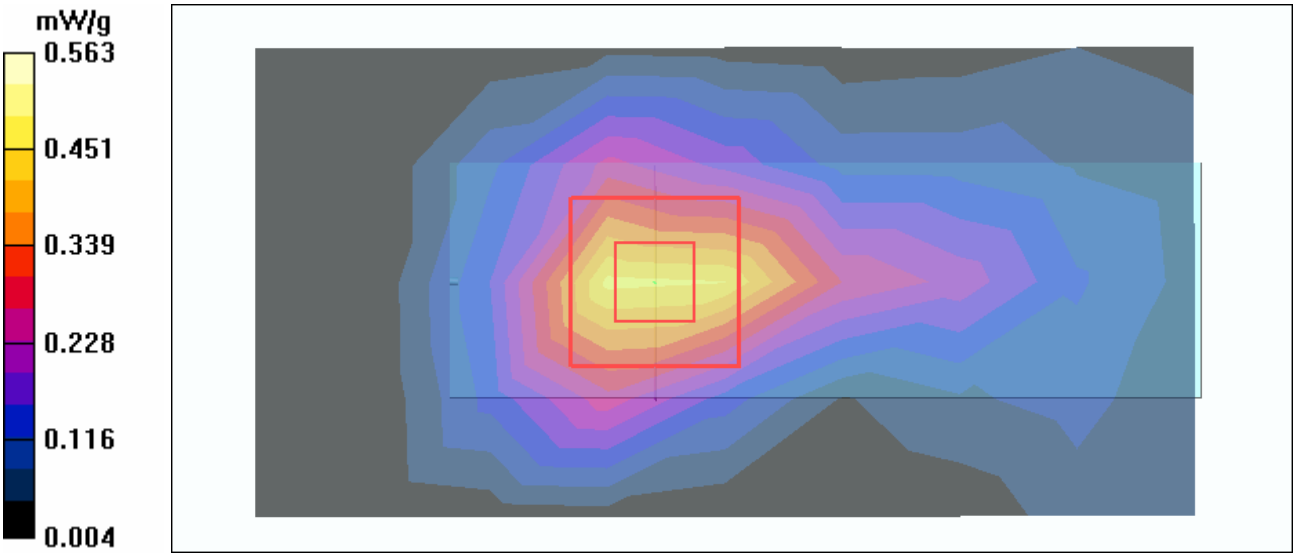
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2437 MHz**

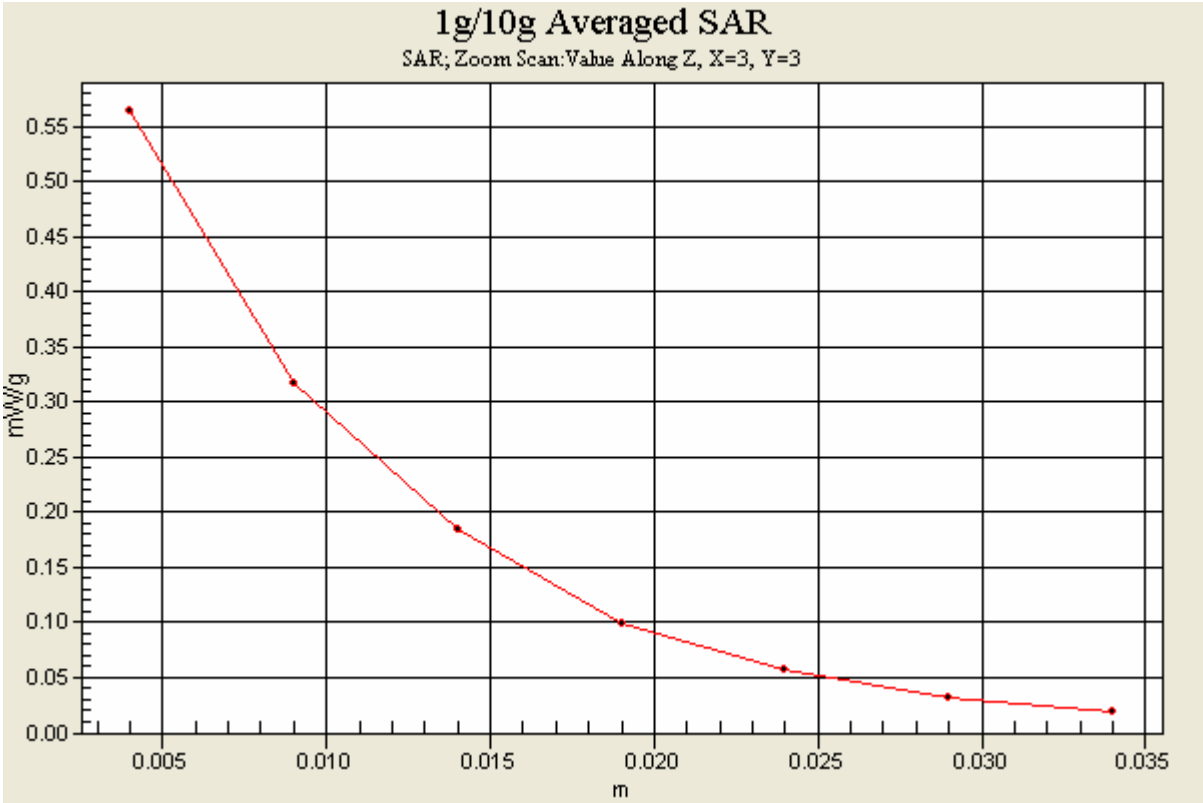
Communication System: 802.11g ; Frequency: 2437 MHz ; Duty Cycle: 1:1 ; Modulation type: OFDM
Medium: MSL2450 Medium parameters used: f = 2437 MHz; $\sigma$ = 1.99 mho/m; $\varepsilon_r$ = 50.4; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 7 mm (The bottom side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Mid Channel 6/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.464 mW/g

**Mid Channel 6/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 15.0 V/m
Peak SAR (extrapolated) = 1.02 W/kg
**SAR(1 g) = 0.523 mW/g; SAR(10 g) = 0.284 mW/g**
Maximum value of SAR (measured) = 0.563 mW/g




1g/10g Averaged SAR
SAR; Zoom Scan:Value Along Z, X=3, Y=3
mW/g
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

Date/Time: 2005/12/7 21:17:35

Test Laboratory: Advance Data Technology

## C600-11b-Ch1-Mode 3

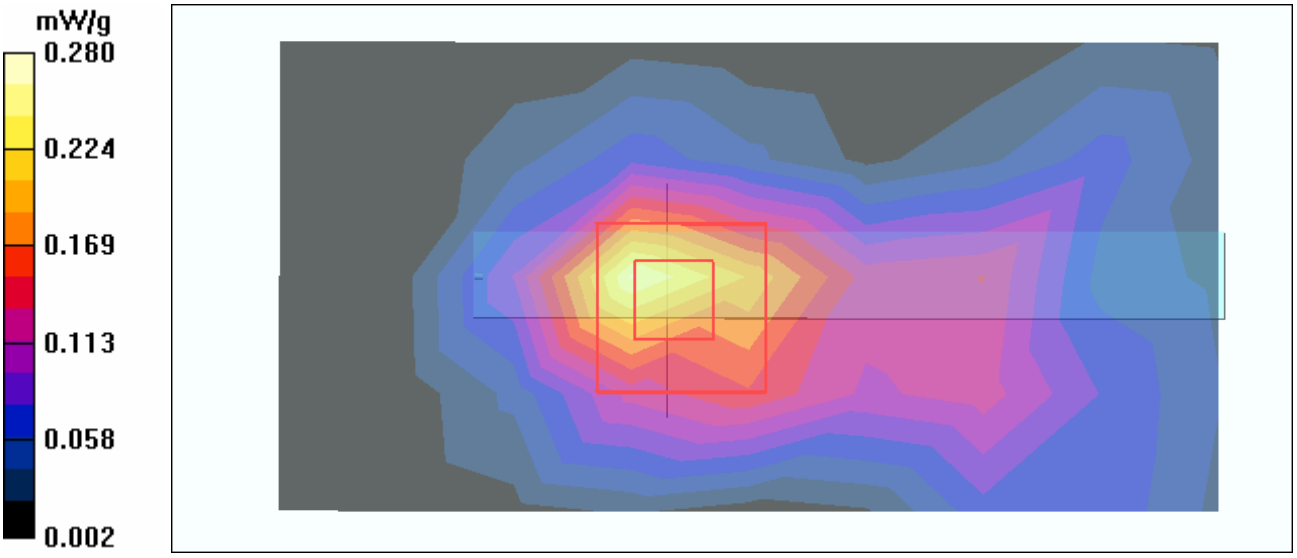
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2412 MHz**

Communication System: 802.11b ; Frequency: 2412 MHz ; Duty Cycle: 1:1 ; Modulation type: CCK
Medium: MSL2450 Medium parameters used: f = 2412 MHz; $\sigma$ = 1.95 mho/m; $\varepsilon_r$ = 50.5; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 6 mm (The edge side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Low Channel 1/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.265 mW/g

**Low Channel 1/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 11.5 V/m
Peak SAR (extrapolated) = 0.531 W/kg
**SAR(1 g) = 0.261 mW/g; SAR(10 g) = 0.137 mW/g**
Maximum value of SAR (measured) = 0.280 mW/g



Date/Time: 2005/12/7 21:34:23

Test Laboratory: Advance Data Technology

## C600-11b-Ch6-Mode 3

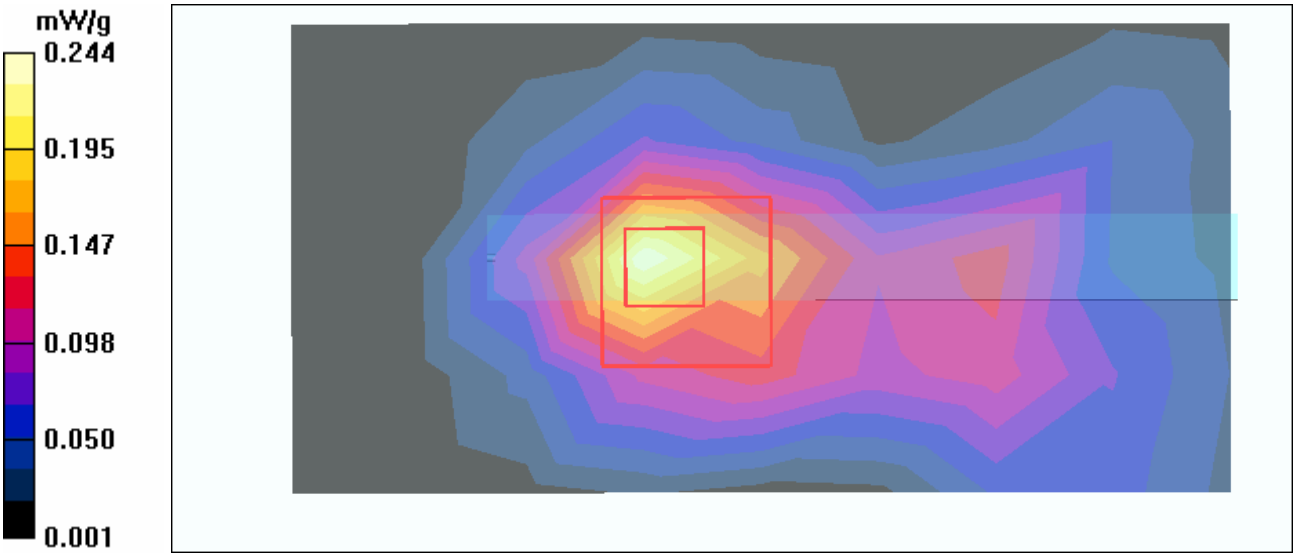
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2437 MHz**

Communication System: 802.11b ; Frequency: 2437 MHz ; Duty Cycle: 1:1 ; Modulation type: CCK
Medium: MSL2450 Medium parameters used: f = 2437 MHz; $\sigma$ = 1.99 mho/m; $\varepsilon_r$ = 50.4; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 6 mm (The edge side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Mid Channel 6/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.243 mW/g

**Mid Channel 6/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 11.0 V/m
Peak SAR (extrapolated) = 0.509 W/kg
**SAR(1 g) = 0.228 mW/g; SAR(10 g) = 0.113 mW/g**
Maximum value of SAR (measured) = 0.244 mW/g



Date/Time: 2005/12/7 21:50:37

Test Laboratory: Advance Data Technology

## C600-11b-Ch11-Mode 3

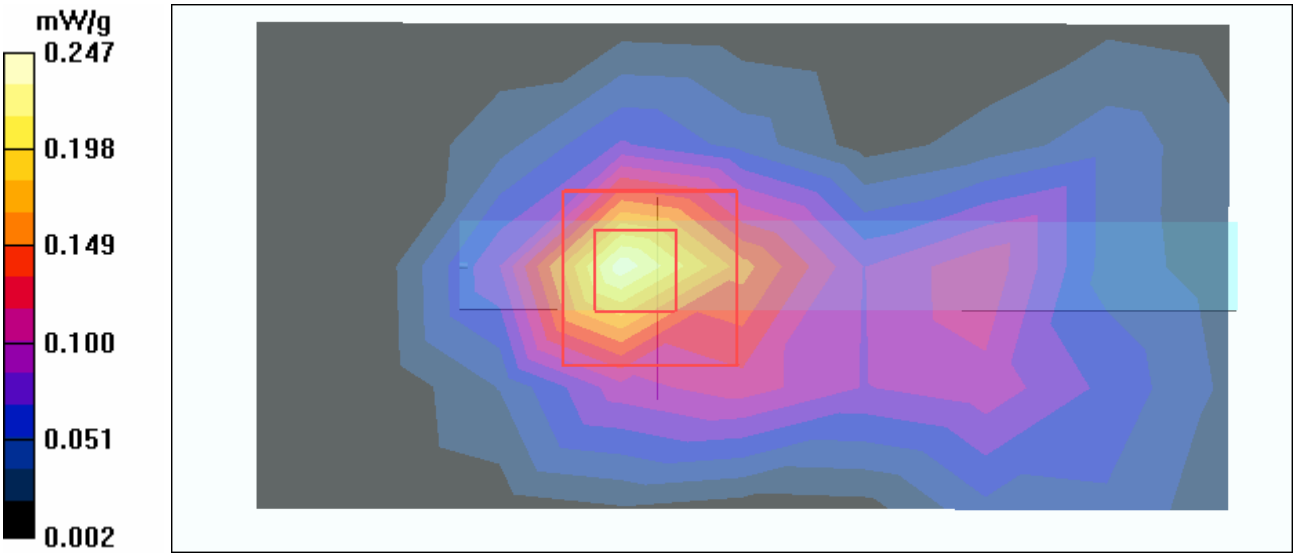
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2462 MHz**

Communication System: 802.11b ; Frequency: 2462 MHz ; Duty Cycle: 1:1 ; Modulation type: CCK
Medium: MSL2450 Medium parameters used: f = 2462 MHz; $\sigma$ = 2.03 mho/m; $\varepsilon_r$ = 50.3; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 6 mm (The edge side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**High Channel 11/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.243 mW/g

**High Channel 11/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.6 V/m
Peak SAR (extrapolated) = 0.520 W/kg
**SAR(1 g) = 0.229 mW/g; SAR(10 g) = 0.111 mW/g**
Maximum value of SAR (measured) = 0.247 mW/g



Date/Time: 2005/12/7 22:09:53

Test Laboratory: Advance Data Technology

## C600-11g-Ch1-Mode 4

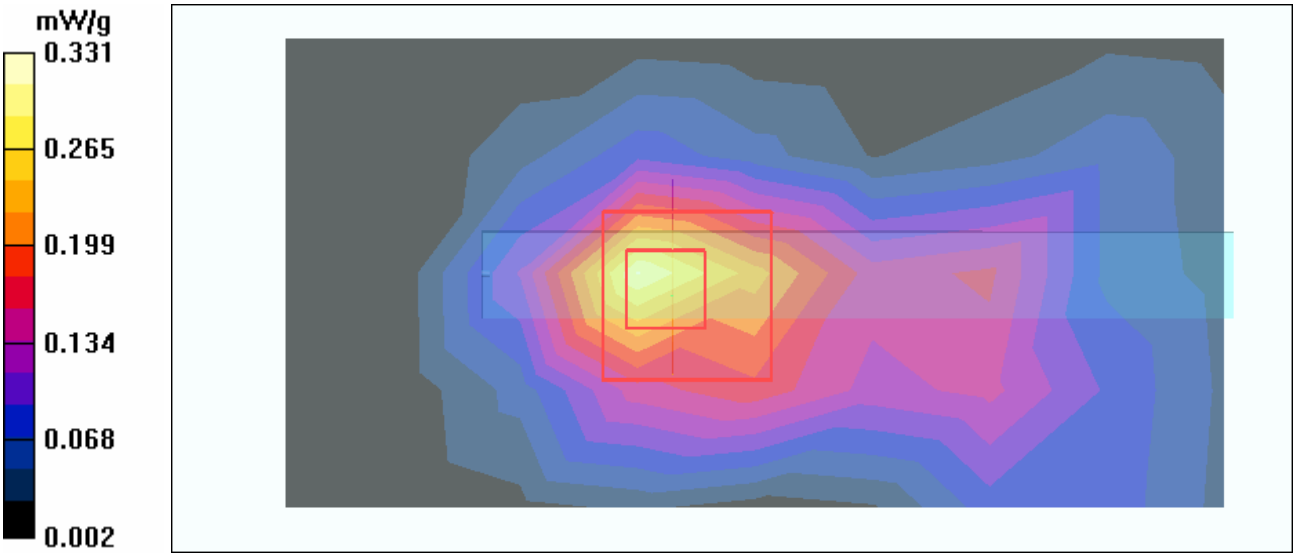
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2412 MHz**

Communication System: 802.11g ; Frequency: 2412 MHz ; Duty Cycle: 1:1 ; Modulation type: OFDM
Medium: MSL2450 Medium parameters used: f = 2412 MHz; $\sigma$ = 1.95 mho/m; $\varepsilon_r$ = 50.5; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 6 mm (The edge side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Low Channel 1/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.312 mW/g

**Low Channel 1/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 12.2 V/m
Peak SAR (extrapolated) = 0.657 W/kg
**SAR(1 g) = 0.304 mW/g; SAR(10 g) = 0.154 mW/g**
Maximum value of SAR (measured) = 0.331 mW/g



Date/Time: 2005/12/7 22:27:43

Test Laboratory: Advance Data Technology

## C600-11g-Ch6-Mode 4

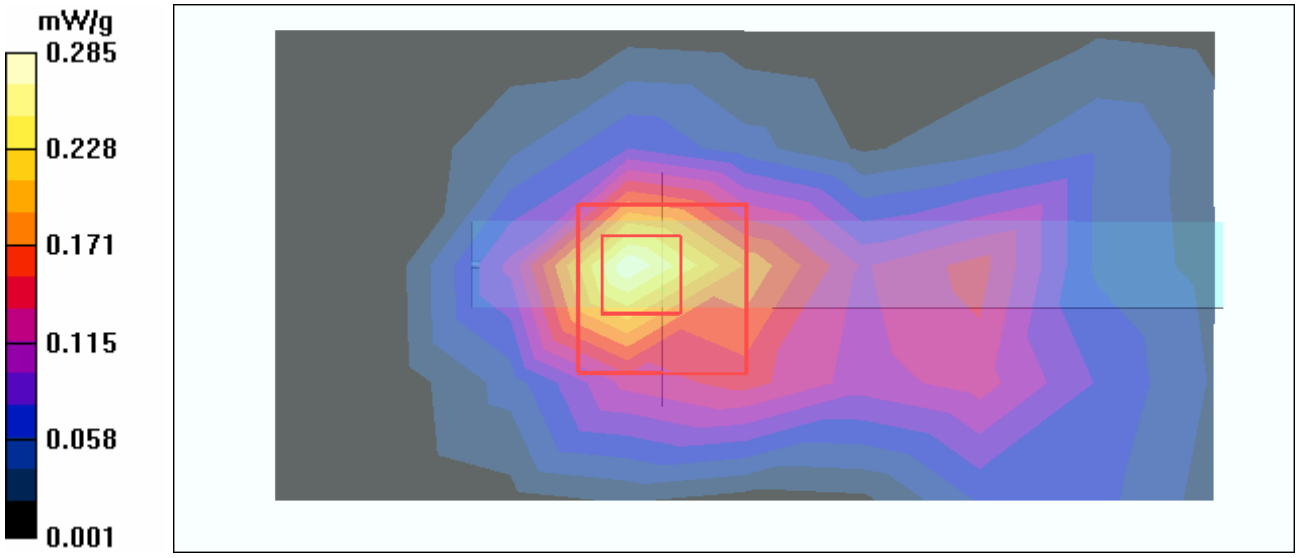
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2437 MHz**

Communication System: 802.11g ; Frequency: 2437 MHz ; Duty Cycle: 1:1 ; Modulation type: OFDM
Medium: MSL2450 Medium parameters used: f = 2437 MHz; $\sigma$ = 1.99 mho/m; $\varepsilon_r$ = 50.4; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 6 mm (The edge side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Mid Channel 6/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.285 mW/g

**Mid Channel 6/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 11.8 V/m
Peak SAR (extrapolated) = 0.580 W/kg
**SAR(1 g) = 0.261 mW/g; SAR(10 g) = 0.129 mW/g**
Maximum value of SAR (measured) = 0.280 mW/g



Date/Time: 2005/12/7 22:44:36

Test Laboratory: Advance Data Technology

## C600-11g-Ch11-Mode 4

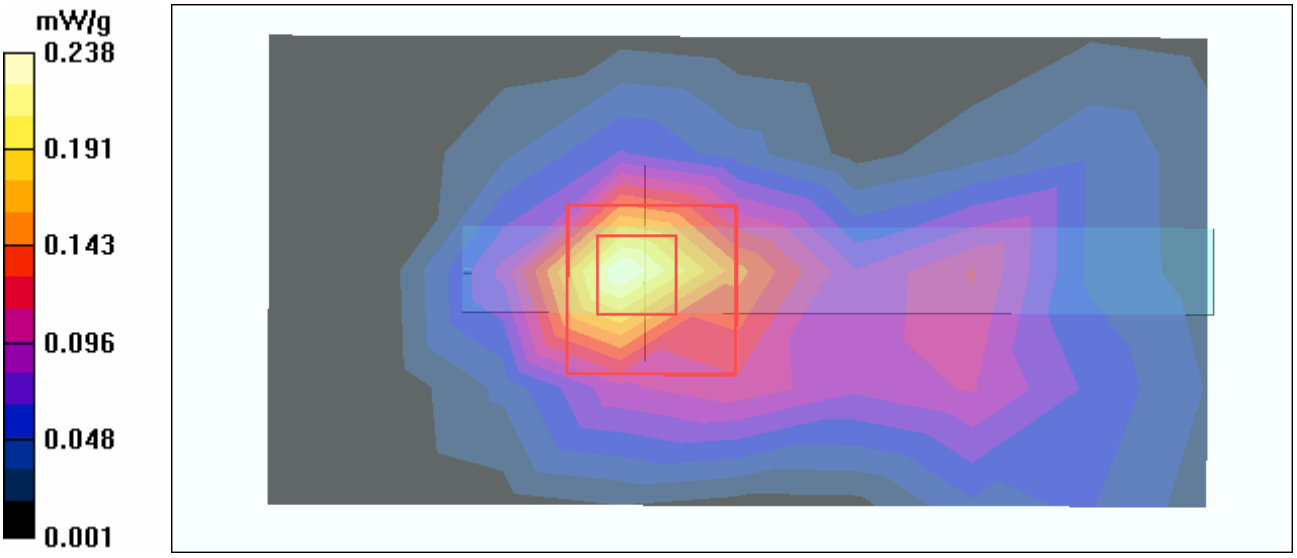
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2462 MHz**

Communication System: 802.11g ; Frequency: 2462 MHz ; Duty Cycle: 1:1 ; Modulation type: OFDM
Medium: MSL2450 Medium parameters used: f = 2462 MHz; $\sigma$ = 2.03 mho/m; $\varepsilon_r$ = 50.3; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 6 mm (The edge side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**High Channel 11/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.242 mW/g

**High Channel 11/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.5 V/m
Peak SAR (extrapolated) = 0.477 W/kg
**SAR(1 g) = 0.217 mW/g; SAR(10 g) = 0.105 mW/g**
Maximum value of SAR (measured) = 0.238 mW/g



Date/Time: 2005/12/7 23:00:44

Test Laboratory: Advance Data Technology

## C600-11g-Ch6 Turbo-Mode 4

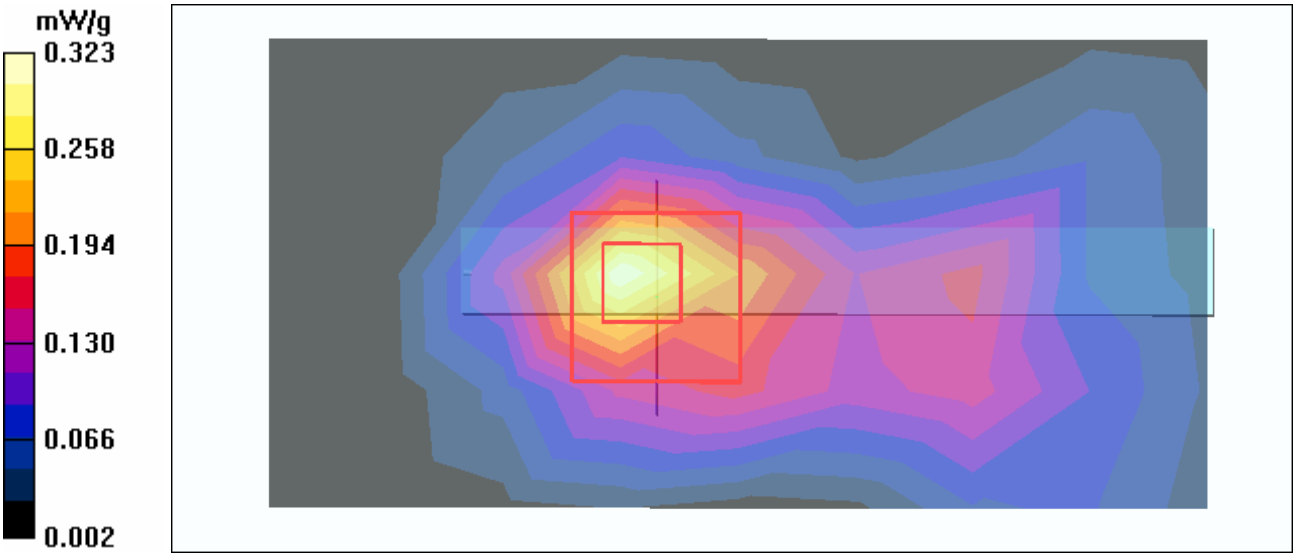
**DUT: Wireless USB Adapter ; Type: WUA-2340 ; Test Frequency: 2437 MHz**

Communication System: 802.11g ; Frequency: 2437 MHz ; Duty Cycle: 1:1 ; Modulation type: OFDM
Medium: MSL2450 Medium parameters used: f = 2437 MHz; $\sigma$ = 1.99 mho/m; $\varepsilon_r$ = 50.4; $\rho$ = 1000 kg/m$^3$ ; Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 6 mm (The edge side of the EUT to the Phantom)
Antenna type : Printed Antenna ; Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579 ; Calibrated: 2005/3/23
- Phantom: SAM 12 ; Type: SAM V4.0 ; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23 ; Postprocessing SW: SEMCAD, V1.8 Build 160

**Mid Channel 6/Area Scan (5x9x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.323 mW/g

**Mid Channel 6/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 11.7 V/m
Peak SAR (extrapolated) = 0.619 W/kg
**SAR(1 g) = 0.282 mW/g; SAR(10 g) = 0.141 mW/g**
Maximum value of SAR (measured) = 0.303 mW/g



Date/Time: 2005/12/7 18:33:28

Test Laboratory: Advance Data Technology

## System Validation Check-MSL 2450MHz

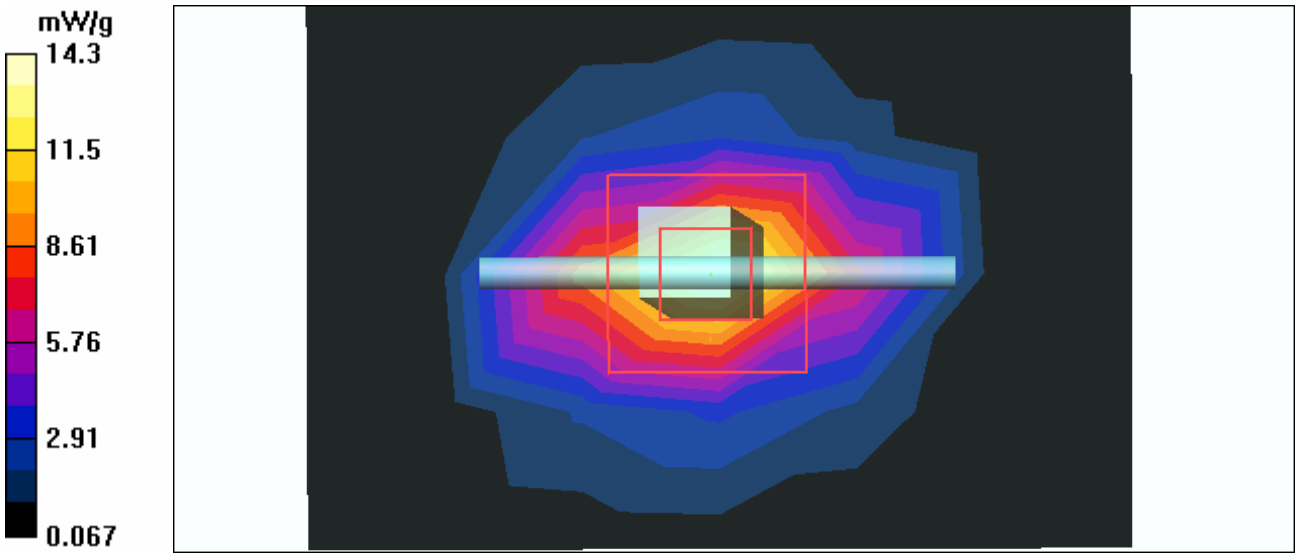
**DUT: Dipole 2450 MHz ; Type: D2450V2 ; Serial: 737 ; Test Frequency: 2450 MHz**

Communication System: CW ; Frequency: 2450 MHz; Duty Cycle: 1:1; Modulation type: CW
Medium: MSL2450;Medium parameters used: f = 2450 MHz; $\sigma$ = 2 mho/m; $\varepsilon_r$ = 50.4; $\rho$ = 1000 kg/m$^3$ ;
Liquid level : 155 mm
Phantom section: Flat Section ; Separation distance : 10 mm (The feetpoint of the dipole to the Phantom)Air temp. : 22.8 degrees ; Liquid temp. : 21.5 degrees

DASY4 Configuration:
- Probe: ET3DV6 - SN1790 ; ConvF(4.35, 4.35, 4.35) ; Calibrated: 2004/12/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn579; Calibrated: 2005/3/23
- Phantom: SAM 12; Type: SAM V4.0; Serial: TP 1202
- Measurement SW: DASY4, V4.6 Build 23; Postprocessing SW: SEMCAD, V1.8 Build 160

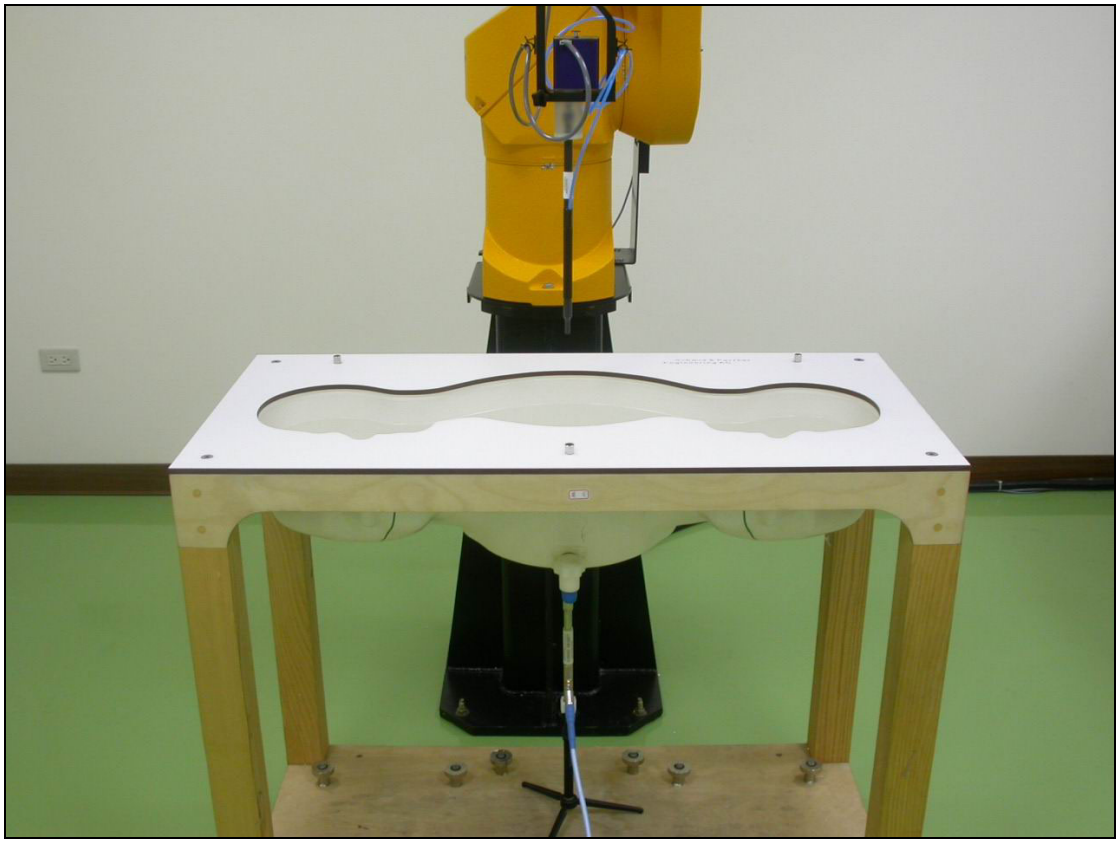
**d=10mm, Pin=250mW/Area Scan (5x7x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 14.5 mW/g

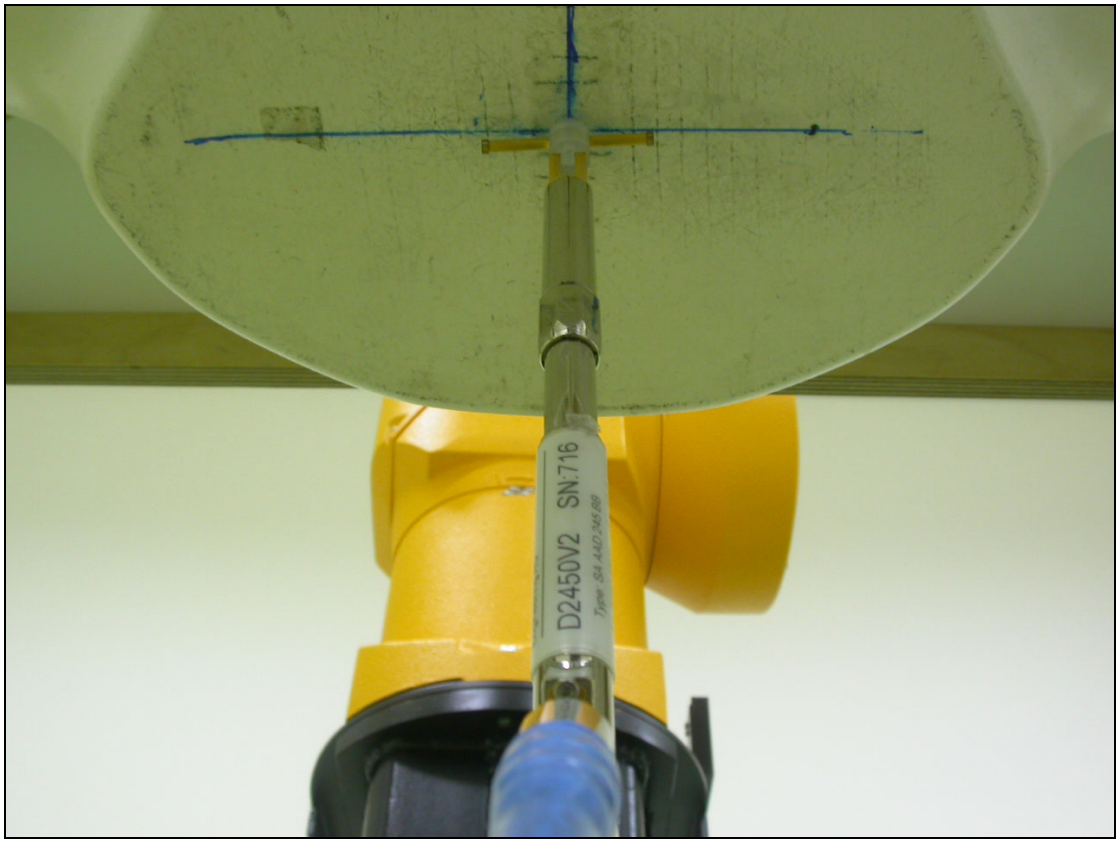
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 90.2 V/m; Power Drift = -0.160 dB
Peak SAR (extrapolated) = 27.9 W/kg
**SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.8 mW/g**
Maximum value of SAR (measured) = 14.3 mW/g



# APPENDIX B: ADT SAR MEASUREMENT SYSTEM

# APPENDIX C: PHOTOGRAPHS OF SYSTEM VALIDATION





# APPENDIX D: SYSTEM CERTIFICATE & CALIBRATION

## D1: SAM PHANTOM

**Schmid & Partner Engineering AG**

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

## Certificate of conformity / First Article Inspection

| | |
|---|---|
| Item | SAM Twin Phantom V4.0 |
| Type No | QD 000 P40 CA |
| Series No | TP-1150 and higher |
| Manufacturer / Origin | Untersee Composites<br>Hauptstr. 69<br>CH-8559 Fruthwilen<br>Switzerland |

### Tests

The series production process used allows the limitation to test of first articles.
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

| Test | Requirement | Details | Units tested |
|---|---|---|---|
| Shape | Compliance with the geometry according to the CAD model. | IT'IS CAD File (*) | First article, Samples |
| Material thickness | Compliant with the requirements according to the standards | 2mm +/- 0.2mm in specific areas | First article, Samples |
| Material parameters | Dielectric parameters for required frequencies | 200 MHz – 3 GHz<br>Relative permittivity < 5<br>Loss tangent < 0.05. | Material sample TP 104-5 |
| Material resistivity | The material has been tested to be compatible with the liquids defined in the standards | Liquid type HSL 1800 and others according to the standard. | Pre-series, First article |

### Standards

[1] CENELEC EN 50361
[2] IEEE P1528-200x draft 6.5
[3] IEC PT 62209 draft 0.9
(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

### Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

**Date** 28.02.2002

**Signature / Stamp**

F. Bomholt

Schmid & Partner Engineering AG
Zeughausstrasse 43, CH-8004 Zurich
Tel. +41 1 245 97 00, Fax +41 1 245 97 79

Voleaire Katja

# D2: DOSIMETRIC E-FIELD PROBE

Schmid & Partner Engineering AG

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

# IMPORTANT NOTICE

## USAGE OF PROBES IN ORGANIC SOLVENTS

Diethylene Gycol Monobuthy Ether (the basis for liquids above 1 GHz), as many other organic solvents, is a very effective softener for synthetic materials. These solvents can cause irreparable damage to certain SPEAG products, except those which are explicitly declared as compliant with organic solvents.

**Compatible Probes:**
- ET3DV6
- ET3DV6R
- ES3DVx
- ER3DV6
- H3DV6

**Important Note for ET3DV6 Probes:**
**The ET3DV6 probes shall not be exposed to solvents longer than necessary for the measurements and shall be cleaned daily after use with warm water and stored dry.**

s p e a g

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Schmid & Partner Engineering AG

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# INTRODUCTION OF NEW PROBE CONFIGURATION FILES (*.cf5)

Dear Customer,

Please be informed that as of November 2004, probe configuration files have been change to the new version, i.e., *.cf5 configuration files. Together with the DASY4 v4.4 Build 3 software version, the frequency compensation is applied to measured data providing extension of frequency validity of the probe *ConvF* from ± 50 MHz to ± 100 MHz with the same accuracy.

## SOFTWARE INSTALLATION

The new software is available for download from the DASY4 homepage
http://www.dasy4.com/updates/updates.html
(via: DASY4 / Support & Downloads / Downloads / Software Updates)

The two new executable files:
**DASY4.4 B3 EXE** (item 3 within the DASY 4.4 Upgrade section)
**SEMCAD V1.8 B130 EXE** (item 4 within the DASY 4.4 Upgrade section)

To access and download the files, please use:
Username: **dasy4**
Password: **wowcool**

**Please download the two executable files and replace the existing DASY4/SEMCAD software versions located in your DASY4 directory on your PC with these new releases at your earliest convenience.**

Best regards
Your SPEAG DASY4 support team

s p e a g

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Schmid & Partner Engineering AG

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

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

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

**Accreditation No.: SCS 108**

**Client** ADT (Auden)

**Certificate No.** ET3-1790_Dec04

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | ET3DV6 - SN:1790 |
| Calibration procedure(s) | QA CAL-01.v5<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | December 20, 2004 |
| Condition of the calibrated item | In Tolerance |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter E4419B | GB41293874 | 5-May-04 (METAS, No. 251-00388) | May-05 |
| Power sensor E4412A | MY41495277 | 5-May-04 (METAS, No. 251-00388) | May-05 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 10-Aug-04 (METAS, No. 251-00403) | Aug-05 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 3-May-04 (METAS, No. 251-00389) | May-05 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 10-Aug-04 (METAS, No. 251-00404) | Aug-05 |
| Reference Probe ES3DV2 | SN: 3013 | 8-Jan-04 (SPEAG, No. ES3-3013_Jan04) | Jan-05 |
| DAE4 | SN: 617 | 26-May-04 (SPEAG, No. DAE4-617_May04) | May-05 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power sensor HP 8481A | MY41092180 | 18-Sep-02 (SPEAG, in house check Oct-03) | In house check: Oct 05 |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (SPEAG, in house check Dec-03) | In house check: Dec-05 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (SPEAG, in house check Nov-04) | In house check: Nov 05 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Nico Vetterli | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: December 29, 2004

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

## Glossary:

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

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY 4.3 B17 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 ET3DV6

# SN:1790

| | |
|---|---|
| Manufactured: | May 28, 2003 |
| Last calibrated: | August 29, 2003 |
| Repaired: | October 5, 2004 |
| Recalibrated: | December 20, 2004 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

# DASY - Parameters of Probe: ET3DV6 SN:1790

## Sensitivity in Free Space[A]

| | | | | |
|---|---|---|---|---|
| NormX | **2.07** ± 9.9% | $\mu V/(V/m)^2$ | DCP X | **94** mV |
| NormY | **2.04** ± 9.9% | $\mu V/(V/m)^2$ | DCP Y | **94** mV |
| NormZ | **1.78** ± 9.9% | $\mu V/(V/m)^2$ | DCP Z | **94** mV |

## Diode Compression[B]

## Sensitivity in Tissue Simulating Liquid (Conversion Factors)

**Please see Page 8.**

## Boundary Effect

**TSL** **900 MHz** **Typical SAR gradient: 5 % per mm**

| Sensor Center to Phantom Surface Distance | | **3.7 mm** | **4.7 mm** |
|---|---|---|---|
| $SAR_{be}$ [%] | Without Correction Algorithm | 9.2 | 4.9 |
| $SAR_{be}$ [%] | With Correction Algorithm | 0.1 | 0.2 |

**TSL** **1750 MHz** **Typical SAR gradient: 10 % per mm**

| Sensor Center to Phantom Surface Distance | | **3.7 mm** | **4.7 mm** |
|---|---|---|---|
| $SAR_{be}$ [%] | Without Correction Algorithm | 12.6 | 8.4 |
| $SAR_{be}$ [%] | With Correction Algorithm | 0.5 | 0.0 |

## Sensor Offset

Probe Tip to Sensor Center **2.7** mm

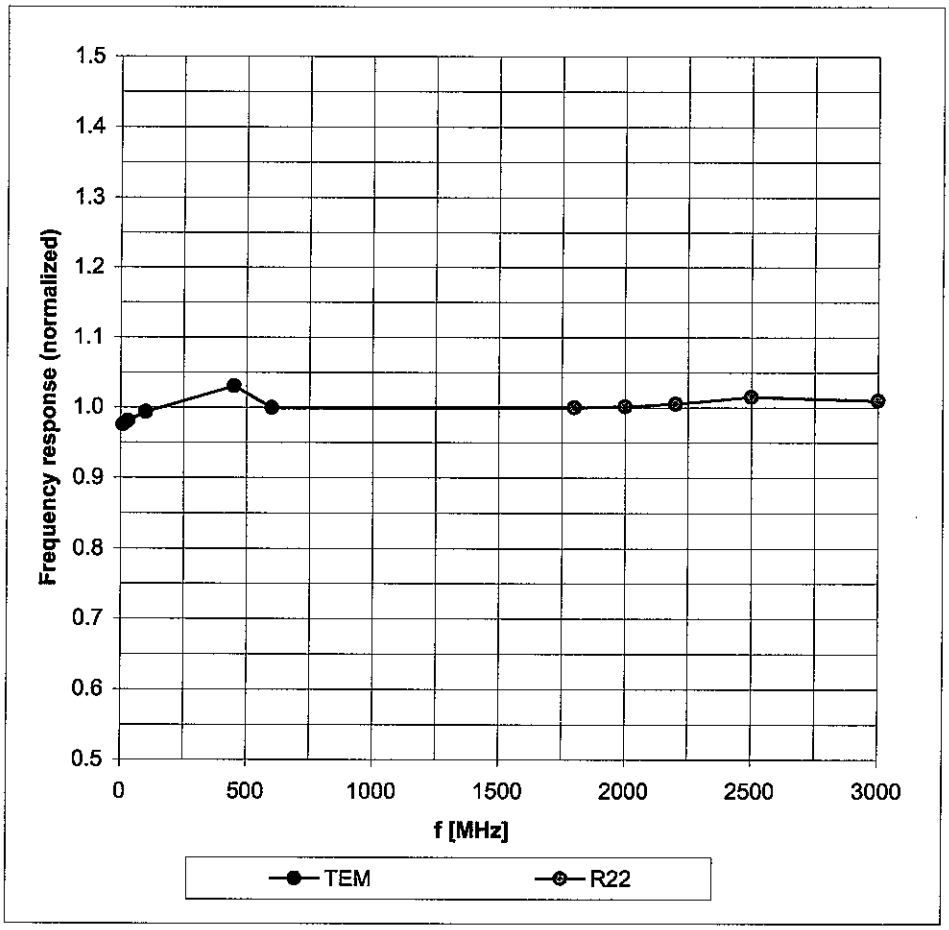
**The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.**

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

[B] Numerical linearization parameter: uncertainty not required.

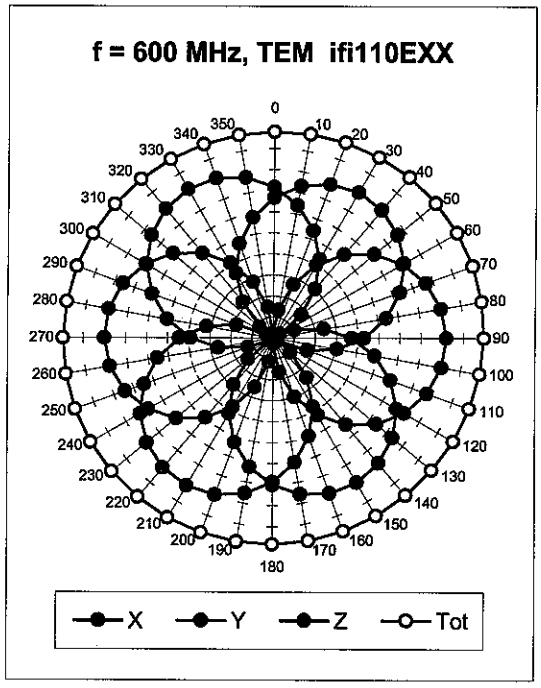
# Frequency Response of E-Field

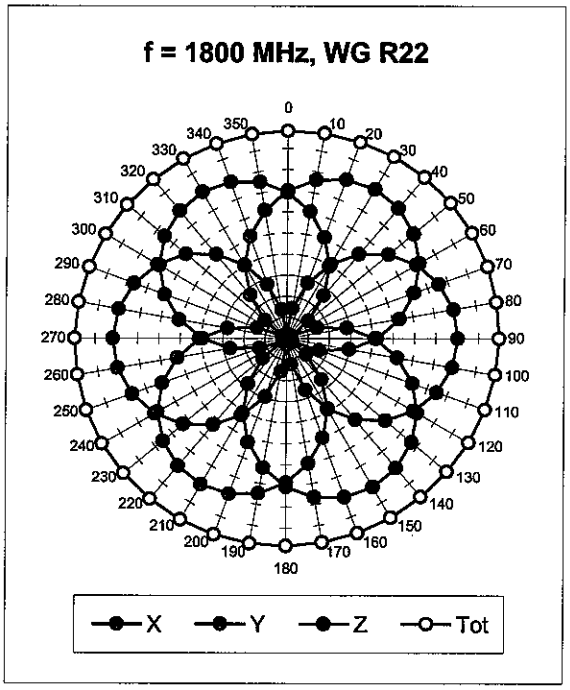
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**

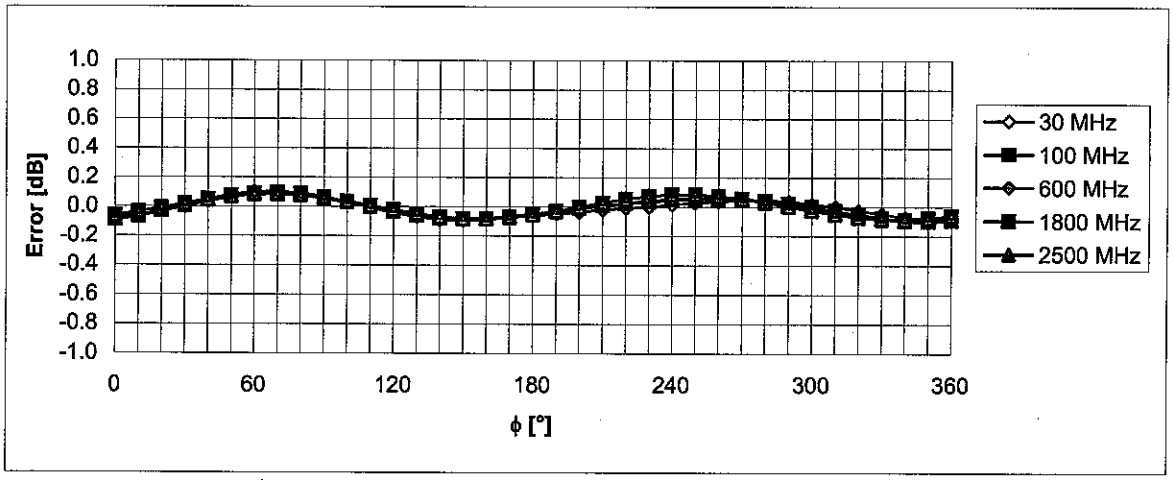



**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

# Receiving Pattern (ϕ), ϑ = 0°



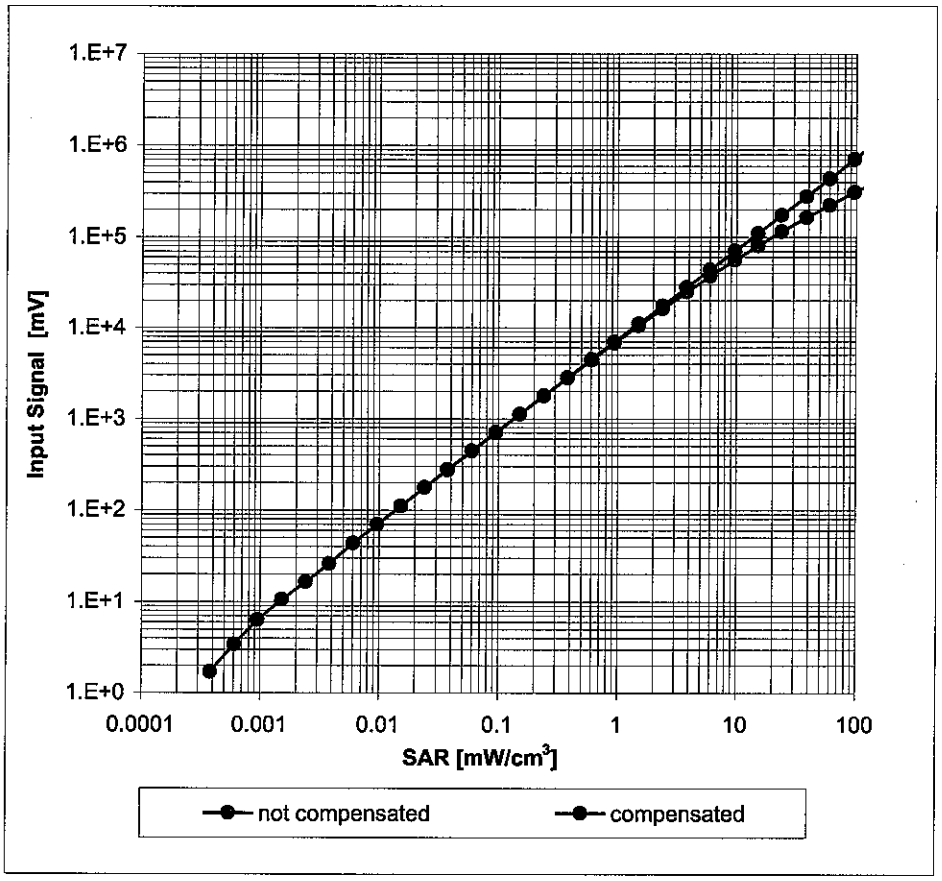



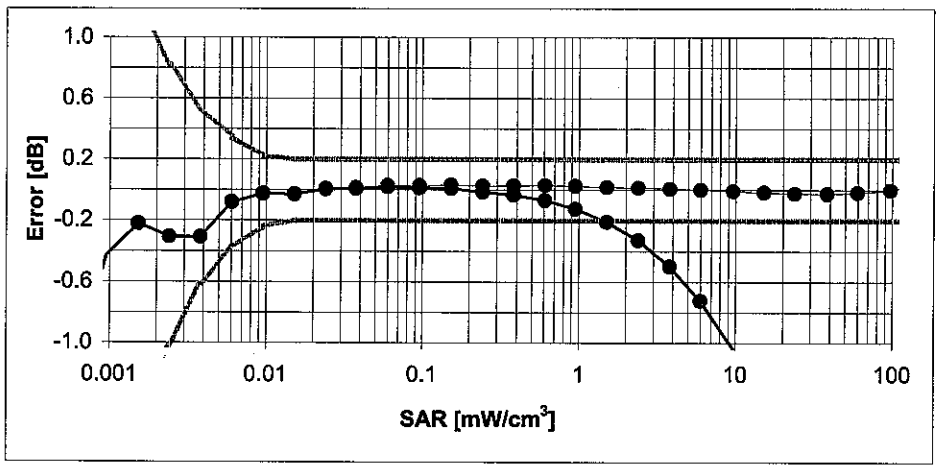




**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

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

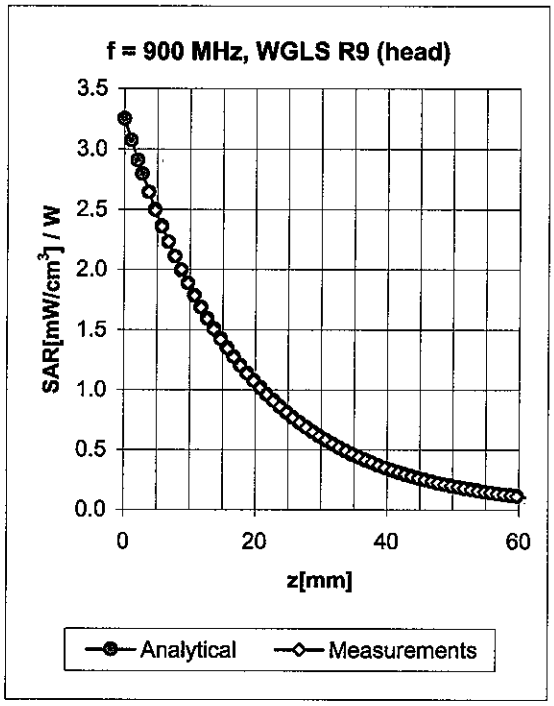
**(Waveguide R22, f = 1800 MHz)**

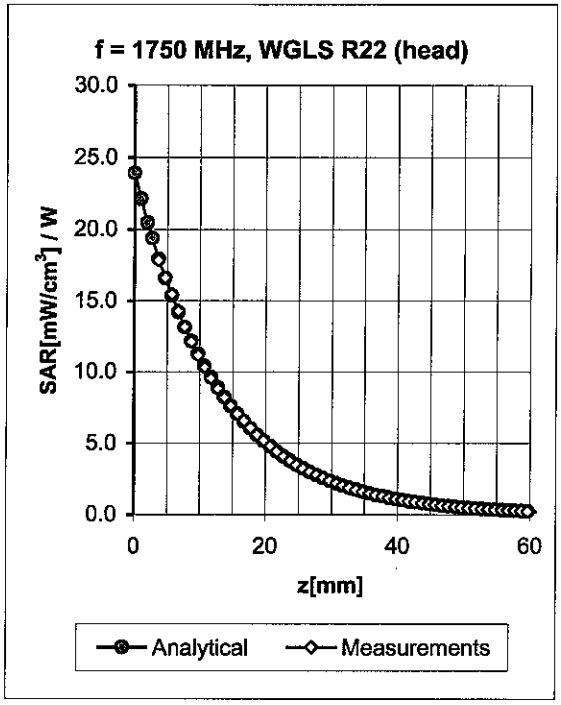



**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment



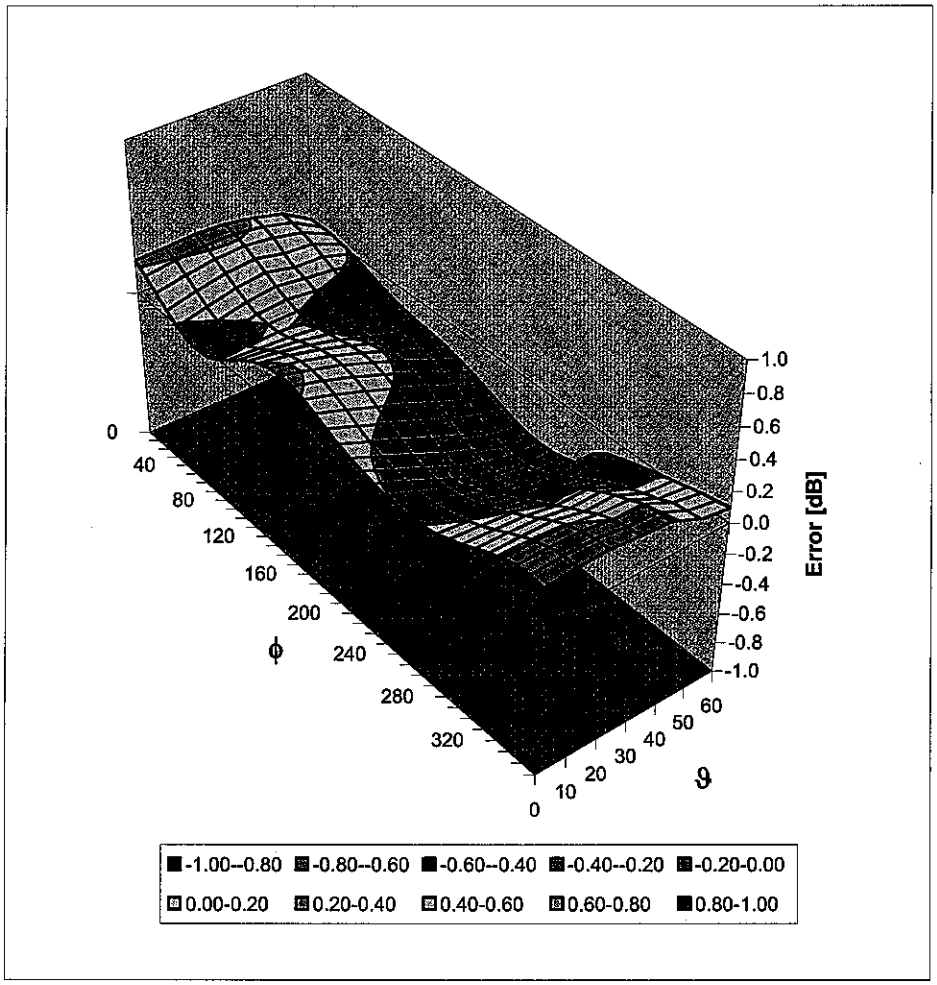




| f [MHz] | Validity [MHz][c] | TSL | Permittivity | Conductivity | Alpha | Depth | ConvF Uncertainty |
|---|---|---|---|---|---|---|---|
| 835 | ± 50 / ± 100 | Head | 41.5 ± 5% | 0.90 ± 5% | 0.72 | 1.69 | 6.94 ± 11.0% (k=2) |
| 900 | ± 50 / ± 100 | Head | 41.5 ± 5% | 0.97 ± 5% | 0.63 | 1.84 | 6.68 ± 11.0% (k=2) |
| 1750 | ± 50 / ± 100 | Head | 40.1 ± 5% | 1.37 ± 5% | 0.55 | 2.40 | 5.51 ± 11.0% (k=2) |
| 1900 | ± 50 / ± 100 | Head | 40.0 ± 5% | 1.40 ± 5% | 0.53 | 2.51 | 5.26 ± 11.0% (k=2) |
| 2450 | ± 50 / ± 100 | Head | 39.2 ± 5% | 1.80 ± 5% | 0.63 | 2.30 | 4.74 ± 11.8% (k=2) |
| | | | | | | | |
| 835 | ± 50 / ± 100 | Body | 55.2 ± 5% | 0.97 ± 5% | 0.50 | 2.07 | 6.65 ± 11.0% (k=2) |
| 900 | ± 50 / ± 100 | Body | 55.0 ± 5% | 1.05 ± 5% | 0.50 | 2.13 | 6.35 ± 11.0% (k=2) |
| 1750 | ± 50 / ± 100 | Body | 53.4 ± 5% | 1.49 ± 5% | 0.52 | 2.81 | 4.83 ± 11.0% (k=2) |
| 1900 | ± 50 / ± 100 | Body | 53.3 ± 5% | 1.52 ± 5% | 0.52 | 2.96 | 4.71 ± 11.0% (k=2) |
| 2450 | ± 50 / ± 100 | Body | 52.7 ± 5% | 1.95 ± 5% | 0.59 | 2.33 | 4.35 ± 11.8% (k=2) |

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

# Deviation from Isotropy in HSL

**Error (ϕ, ϑ), f = 900 MHz**




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

## D3: DAE

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

# IMPORTANT NOTICE

## USAGE OF THE DAE 3

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

**Battery Exchange**: The battery cover of the DAE3 unit is connected to a fragile 3-pin battery connector. Customer is responsible to apply outmost caution not to bend or damage the connector when changing batteries.

**Shipping of the DAE**: Before shipping the DAE to SPEAG for calibration Customer shall remove the batteries and pack the DAE in an antistatic bag. The packaging shall protect the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

**E-Stop Failures**: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, Customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

**Repair**: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

**Important Note:**
**Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.**

**Important Note:**
**Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.**

Schmid & Partner Engineering

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

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

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

**Accreditation No.: SCS 108**

**Client** ADT (Auden)

**Certificate No: DAE3-579_Mar05**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE3 - SD 000 D03 AA - SN: 579 |
| Calibration procedure(s) | QA CAL-06.v10<br>Calibration procedure for the data acquisition unit (DAE) |
| Calibration date: | March 23, 2005 |
| Condition of the calibrated item | In Tolerance |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Fluke Process Calibrator Type 702 | SN: 6295803 | 7-Sep-04 (Sintrel, No.E-040073) | Sep-05 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Calibrator Box V1.1 | SE UMS 006 AB 1002 | 16-Jul-04 (SPEAG, in house check) | In house check Jul-05 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Eric Hainfeld | Technician | |
| Approved by: | Fin Bomholt | R&D Director | i.V. |

Issued: March 23, 2005

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

## Glossary

| | |
|---|---|
| DAE | digital acquisition electronics |
| Connector angle | information used in DASY system to align probe sensor X to the robot coordinate system. |

## Methods Applied and Interpretation of Parameters

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

## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

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

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

| Calibration Factors | X | Y | Z |
|---|---|---|---|
| **High Range** | 404.498 ± 0.1% (k=2) | 404.560 ± 0.1% (k=2) | 404.343 ± 0.1% (k=2) |
| **Low Range** | 3.95298 ± 0.7% (k=2) | 3.97918 ± 0.7% (k=2) | 3.94012 ± 0.7% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 310 ° ± 1 ° |

## Appendix

### 1. DC Voltage Linearity

| High Range | | Input (µV) | Reading (µV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 200000 | 200000 | 0.00 |
| Channel X | + Input | 20000 | 20000.39 | 0.00 |
| Channel X | - Input | 20000 | -19991.88 | -0.04 |
| Channel Y | + Input | 200000 | 200000.2 | 0.00 |
| Channel Y | + Input | 20000 | 19997.23 | -0.01 |
| Channel Y | - Input | 20000 | -19994.34 | -0.03 |
| Channel Z | + Input | 200000 | 199999.8 | 0.00 |
| Channel Z | + Input | 20000 | 19996.66 | -0.02 |
| Channel Z | - Input | 20000 | -19995.76 | -0.02 |

| Low Range | | Input (µV) | Reading (µV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 2000 | 2000.1 | 0.00 |
| Channel X | + Input | 200 | 199.65 | -0.18 |
| Channel X | - Input | 200 | -200.44 | 0.22 |
| Channel Y | + Input | 2000 | 1999.9 | 0.00 |
| Channel Y | + Input | 200 | 199.72 | -0.14 |
| Channel Y | - Input | 200 | -200.84 | 0.42 |
| Channel Z | + Input | 2000 | 2000 | 0.00 |
| Channel Z | + Input | 200 | 199.53 | -0.24 |
| Channel Z | - Input | 200 | -201.02 | 0.51 |

### 2. Common mode sensitivity

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

| | Common mode Input Voltage (mV) | High Range Average Reading (µV) | Low Range Average Reading (µV) |
|---|---|---|---|
| Channel X | 200 | 6.17 | 5.48 |
| | - 200 | -5.20 | -5.89 |
| Channel Y | 200 | 8.93 | 9.11 |
| | - 200 | -9.89 | -10.38 |
| Channel Z | 200 | 9.08 | 8.94 |
| | - 200 | -10.25 | -10.98 |

### 3. Channel separation

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

| | Input Voltage (mV) | Channel X (µV) | Channel Y (µV) | Channel Z (µV) |
|---|---|---|---|---|
| Channel X | 200 | - | 0.60 | -0.26 |
| Channel Y | 200 | 1.53 | - | 2.09 |
| Channel Z | 200 | -2.89 | 0.01 | - |

## 4. AD-Converter Values with inputs shorted

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

| | High Range (LSB) | Low Range (LSB) |
|---|---|---|
| **Channel X** | 16329 | 16485 |
| **Channel Y** | 16181 | 15912 |
| **Channel Z** | 15805 | 16242 |

## 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

| | Average (µV) | min. Offset (µV) | max. Offset (µV) | Std. Deviation (µV) |
|---|---|---|---|---|
| **Channel X** | 0.26 | -0.64 | 1.42 | 0.47 |
| **Channel Y** | -1.12 | -2.09 | 0.11 | 0.36 |
| **Channel Z** | -0.86 | -1.58 | 0.11 | 0.31 |

## 6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

## 7. Input Resistance

| | Zeroing (MOhm) | Measuring (MOhm) |
|---|---|---|
| **Channel X** | 0.2000 | 200.3 |
| **Channel Y** | 0.2000 | 203.3 |
| **Channel Z** | 0.2000 | 204.4 |

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

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

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

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

## 10. Common Mode Bit Generation (verified during pre test)

| Typical values | Bit set to High at Common Mode Error ($V_{DC}$) |
|---|---|
| **Channel X, Y, Z** | +1.25 |

# D4: SYSTEM VALIDATION DIPOLE

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

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

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

**Accreditation No.: SCS 108**

**Client** ADT (Auden)

**Certificate No: D2450V2-737_Mar05**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN: 737 |
| Calibration procedure(s) | QA CAL-05.v6<br>Calibration procedure for dipole validation kits |
| Calibration date: | March 16, 2005 |
| Condition of the calibrated item | In Tolerance |

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Judith Müller | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: March 21, 2005

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

## Glossary:

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

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz), July 2001
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

## Additional Documentation:

d) DASY4 System Handbook

## Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY4 | V4.5 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom V5.0 | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Area Scan resolution** | dx, dy = 15 mm | |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 2450 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 39.2 | 1.80 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 39.9 ± 6 % | 1.78 mho/m ± 6 % |
| **Head TSL temperature during test** | (21.5 ± 0.2) °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.7 mW / g |
| SAR normalized | normalized to 1W | 54.8 mW / g |
| SAR for nominal Head TSL parameters [1] | normalized to 1W | **55.5 mW / g ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.36 mW / g |
| SAR normalized | normalized to 1W | 25.4 mW / g |
| SAR for nominal Head TSL parameters [1] | normalized to 1W | **25.8 mW / g ± 16.5 % (k=2)** |

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

## Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 52.7 | 1.95 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 52.3 ± 6 % | 2.01 mho/m ± 6 % |
| **Body TSL temperature during test** | (22.0 ± 0.2) °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.4 mW / g |
| SAR normalized | normalized to 1W | 53.6 mW / g |
| SAR for nominal Body TSL parameters [2] | normalized to 1W | **52.5 mW / g ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.18 mW / g |
| SAR normalized | normalized to 1W | 24.7 mW / g |
| SAR for nominal Body TSL parameters [2] | normalized to 1W | **24.2 mW / g ± 16.5 % (k=2)** |

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

## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 52.4 Ω + 5.6 jΩ |
| Return Loss | - 24.4 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 48.4 Ω + 5.9 jΩ |
| Return Loss | - 24.2 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.161 ns |

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | August 26, 2003 |

## DASY4 Validation Report for Head TSL

Date/Time: 14.03.2005 16:57:15

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN737**

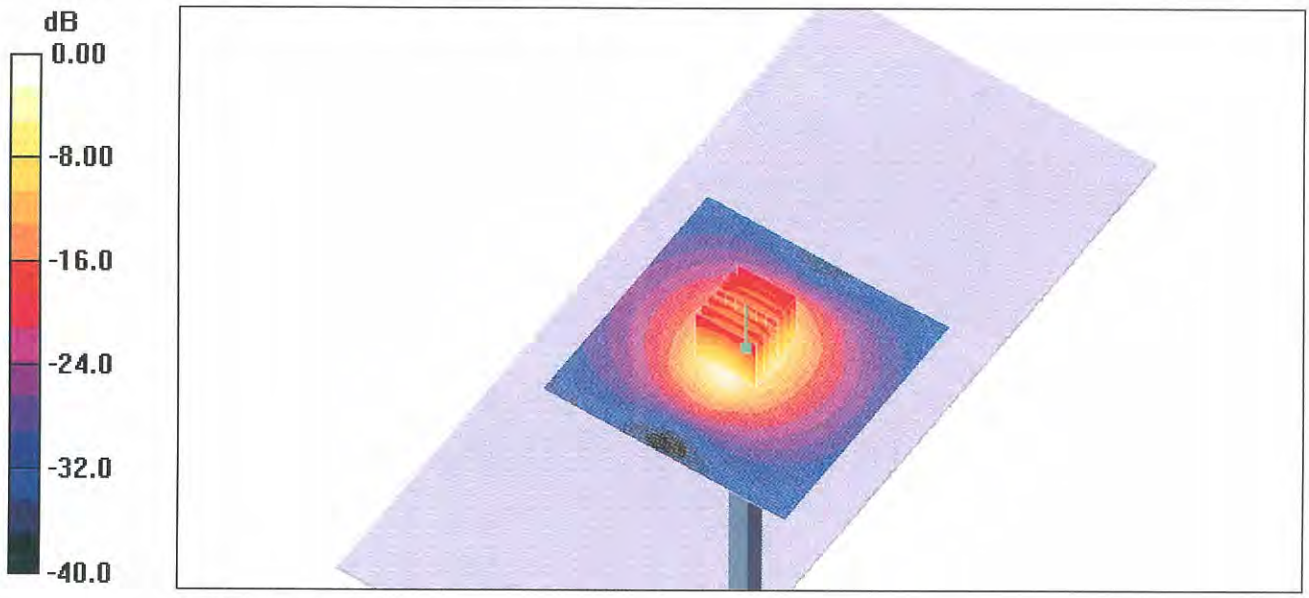
Communication System: CW-2450; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: HSL U10 BB;
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.78 mho/m; $\varepsilon_r$ = 39.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.4, 4.4, 4.4); Calibrated: 29.10.2004
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 22.07.2004
- Phantom: Flat Phantom 5.0; Type: QD000P50AA; Serial: 1001;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

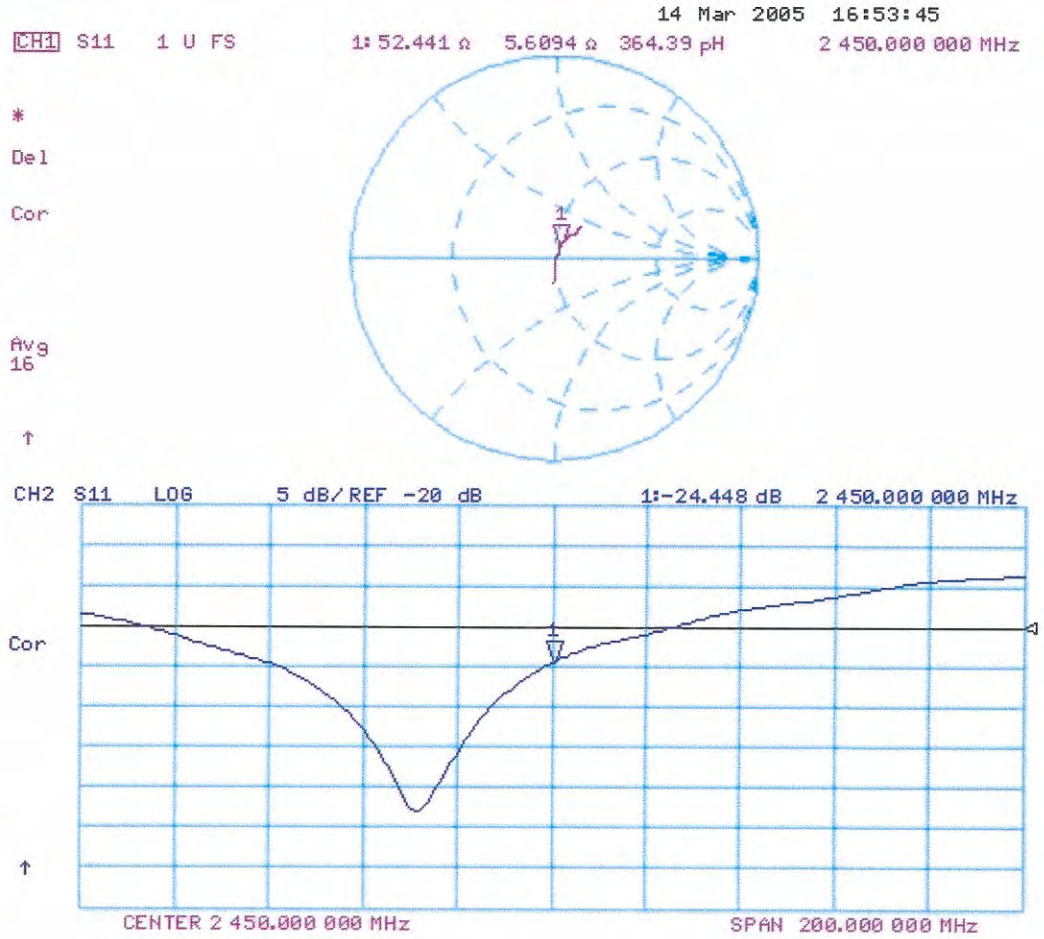
**Pin = 250 mW; d = 10 mm/Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 15.9 mW/g

**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 92.2 V/m; Power Drift = 0.090 dB
Peak SAR (extrapolated) = 28.0 W/kg
**SAR(1 g) = 13.7 mW/g; SAR(10 g) = 6.36 mW/g**
Maximum value of SAR (measured) = 15.5 mW/g




0 dB = 15.5mW/g

## Impedance Measurement Plot for Head TSL



## DASY4 Validation Report for Body TSL

Date/Time: 16.03.2005 10:09:20

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN737**

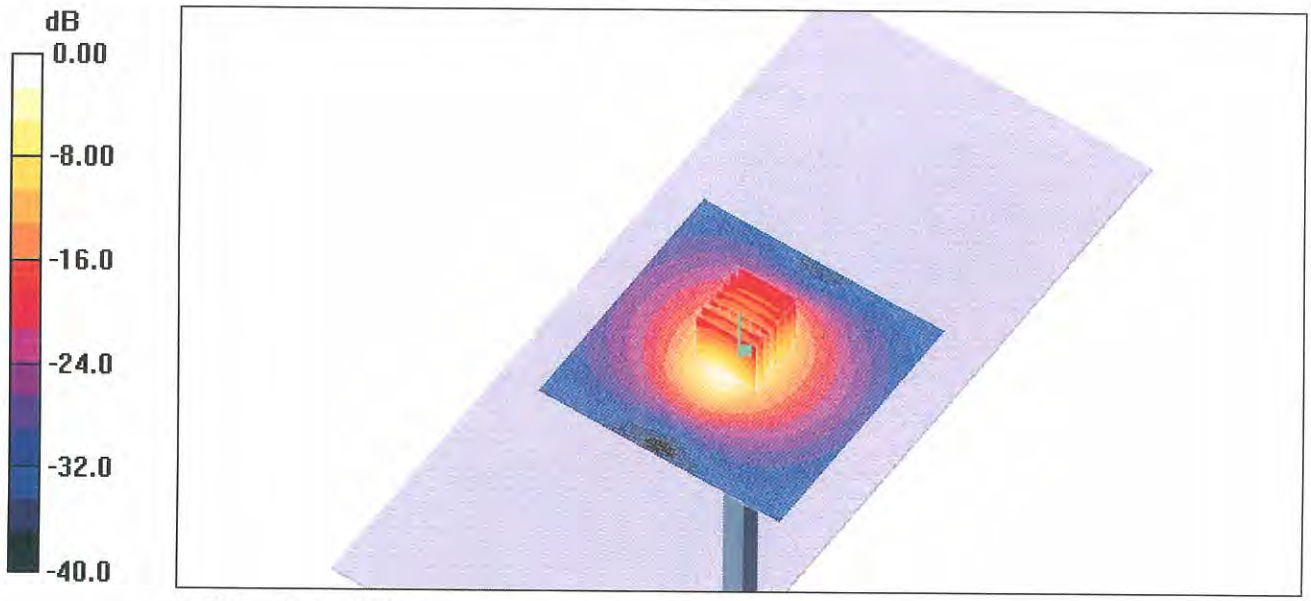
Communication System: CW-2450; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: M2450;
Medium parameters used: f = 2450 MHz; $\sigma$ = 2.01 mho/m; $\varepsilon_r$ = 52.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

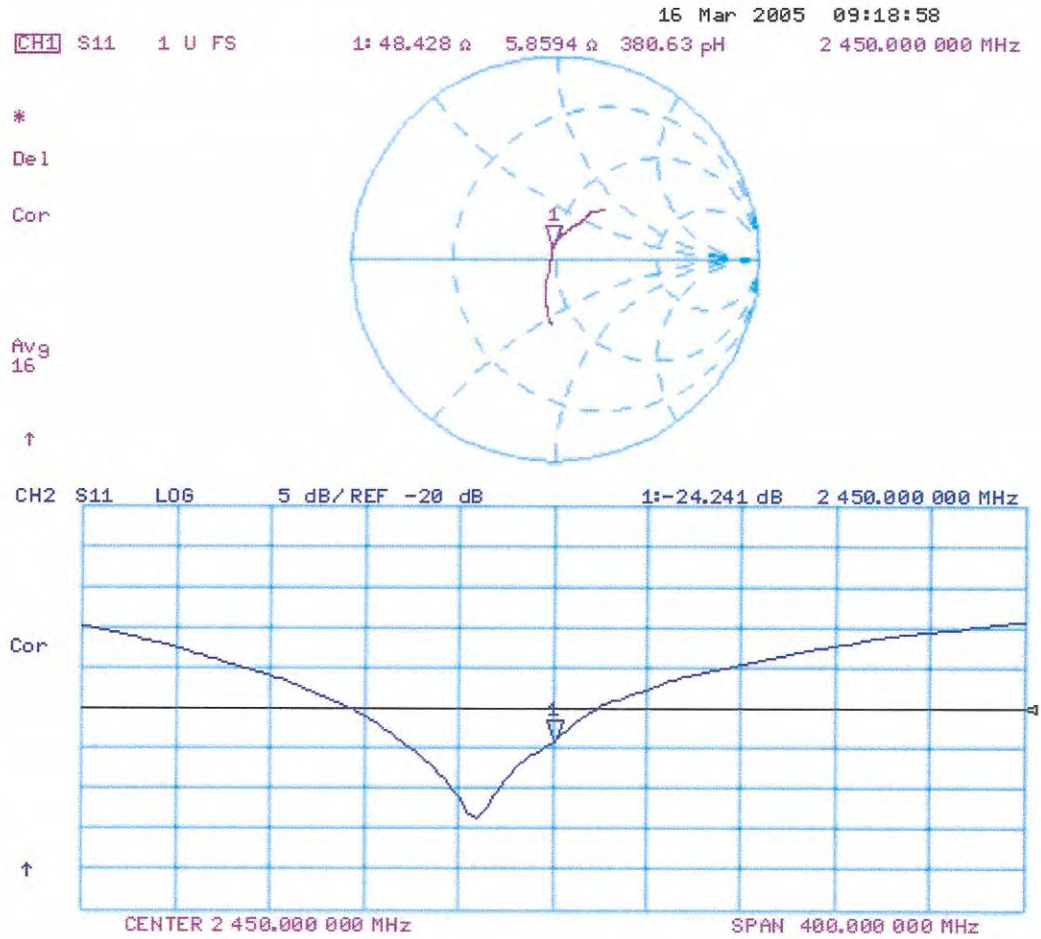
DASY4 Configuration:

- Probe: ES3DV2 - SN3025; ConvF(4.13, 4.13, 4.13); Calibrated: 29.10.2004
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 22.07.2004
- Phantom: Flat Phantom 5.0; Type: QD000P50AA; Serial: 1001;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

**Pin = 250 mW; d = 10 mm/Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 15.6 mW/g

**Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 85.5 V/m; Power Drift = 0.079 dB
Peak SAR (extrapolated) = 27.3 W/kg
**SAR(1 g) = 13.4 mW/g; SAR(10 g) = 6.18 mW/g**
Maximum value of SAR (measured) = 15.1 mW/g




0 dB = 15.1mW/g

## Impedance Measurement Plot for Body TSL