# SAR Evaluation Report

**IN ACCORDANCE WITH THE REQUIREMENTS OF**
**FCC OET BULLETIN 65 SUPPLEMENT C**

**FOR**

**802.11A/B/G/N PCIEXPRESS MINICARD**

**MODEL: AR5BXB72P**

**FCC ID: PPD-AR5BXB72P**

**REPORT NUMBER: 07U10937-4, REVISION C**

**ISSUE DATE: JULY 17, 2007**

*Prepared for*

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NVLAP LAB CODE 200065-0

**Revision History**

| Rev. | Issued date | Revisions | Revised By |
|---|---|---|---|
| -- | April 3, 2007 | Initial issue | Sunny Shih |
| B | April 6, 2007 | Correcting some typos | N. Davoudi |
| C | July 17, 2007 | Corrected model number | S. Radecki |

## CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

**DATES OF TEST:** April 2, 2007

| | |
|---|---|
| APPLICANT:<br>ADDRESS: | Atheros Communications, Inc.<br>5480 Great America Parkway, Santa Clara, CA 95054 |
| FCC ID:<br>MODEL: | PPD-AR5BXB72P<br>AR5BXB72P |
| DEVICE CATEGORY:<br>EXPOSURE CATEGORY: | Portable Device<br>General Population/Uncontrolled Exposure |

802.11a/b/g/n PCIExpress Minicard is installed in Apple Macbook Pro 15.4".

| | |
|---|---|
| Test Sample is a: | Production unit |
| Modulation type: | Orthogonal Frequency Division Multiplexing (OFDM) for 802.11an |

| Rule Parts | Frequency Range [MHz] | The Highest SAR Values [1g_mW/g] |
|---|---|---|
| FCC 15.401 | 5500 - 5700 | 1.073 |

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for General Population/Uncontrolled Exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in FCC OET 65 Supplement C (Edition 01-01).

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Compliance Certification Services and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Compliance Certification Services will constitute fraud and shall nullify the document. No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.

| Approved & Released For CCS By: | Tested By: |
|---|---|
| Hsin Fu Shih | Ninous Davoudi |
| Hsin Fu Shih | Ninous Davoudi |
| Engineering Supervisor | EMC Engineer |
| Compliance Certification Services | Compliance Certification Services |

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## 1 DEVICE UNDER TEST (DUT) DESCRIPTION

| 802.11a/b/g/n PCIExpress Minicard is installed in Apple Macbook Pro 15.4”. | |
|---|---|
| Normal operation: | Lap-held position |
| Accessory: | N/A |
| Earphone/Headset Jack: | N/A |
| Duty cycle: | 99% |
| Host Device(s): | Apple Macbook Pro 15.4” |
| Antenna(s) | Tyco, PIFA antenna, part # 056-1579 |
| Power supply: | Power supplied through the laptop computer (host device). |

## 2 FACILITIES AND ACCREDITATION

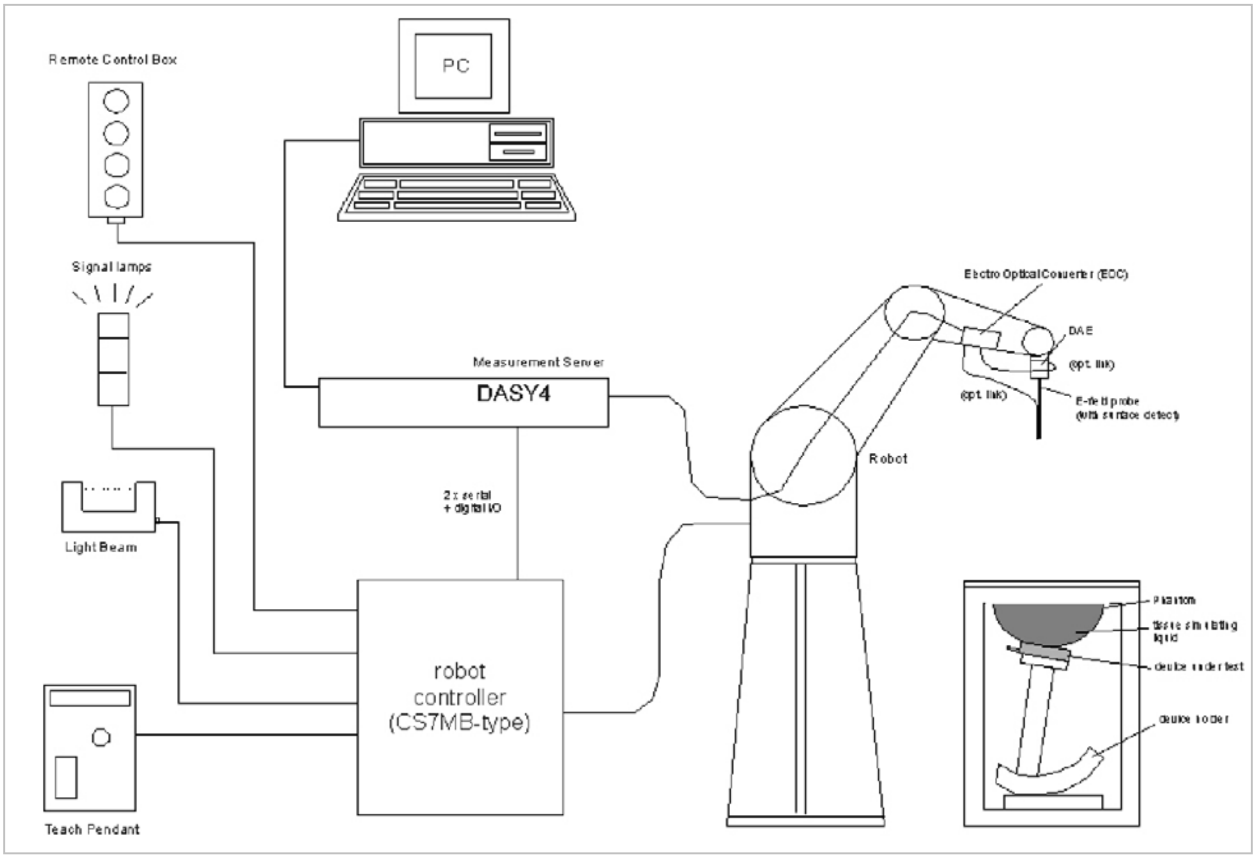
The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, CA 94538 USA. The sites are constructed in conformance with the requirements of ANSI C63.4, ANSI C63.7 and CISPR Publication 22. All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

NVLAP LAB CODE 200065-0

CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://www.ccsemc.com.

No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.

## 3 SYSTEM DESCRIPTION




**The DASY4 system for performing compliance tests consists of the following items:**

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4 software.
- Remote controls with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

### 3.1 COMPOSITION OF INGREDIENTS FOR TISSUE SIMULATING LIQUIDS

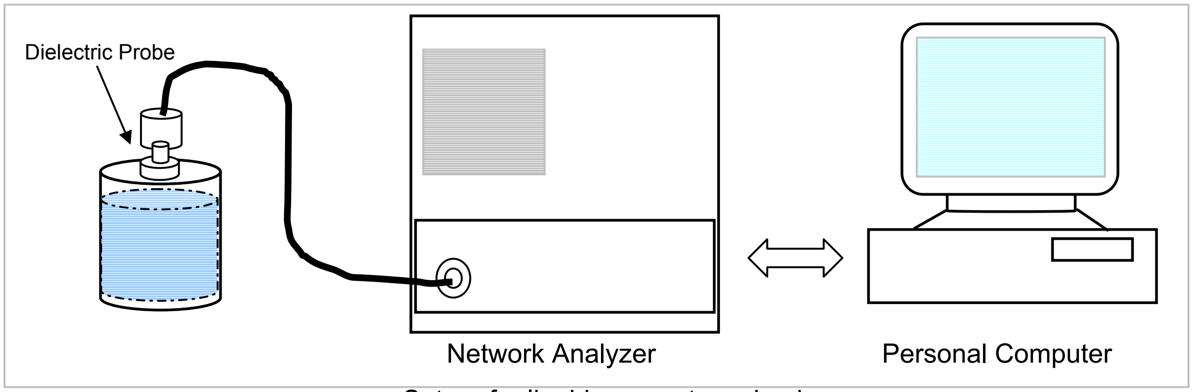
The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

| Ingredients (% by weight) | Frequency (MHz) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 450 | | 835 | | 915 | | 1900 | | 2450 | |
| Tissue Type | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body |
| Water | 38.56 | 51.16 | 41.45 | 52.4 | 41.05 | 56.0 | 54.9 | 40.4 | 62.7 | 73.2 |
| Salt (NaCl) | 3.95 | 1.49 | 1.45 | 1.4 | 1.35 | 0.76 | 0.18 | 0.5 | 0.5 | 0.04 |
| Sugar | 56.32 | 46.78 | 56.0 | 45.0 | 56.5 | 41.76 | 0.0 | 58.0 | 0.0 | 0.0 |
| HEC | 0.98 | 0.52 | 1.0 | 1.0 | 1.0 | 1.21 | 0.0 | 1.0 | 0.0 | 0.0 |
| Bactericide | 0.19 | 0.05 | 0.1 | 0.1 | 0.1 | 0.27 | 0.0 | 0.1 | 0.0 | 0.0 |
| Triton X-100 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 36.8 | 0.0 |
| DGBE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 44.92 | 0.0 | 0.0 | 26.7 |
| Dielectric Constant | 43.42 | 58.0 | 42.54 | 56.1 | 42.0 | 56.8 | 39.9 | 54.0 | 39.8 | 52.5 |
| Conductivity (S/m) | 0.85 | 0.83 | 0.91 | 0.95 | 1.0 | 1.07 | 1.42 | 1.45 | 1.88 | 1.78 |

Salt: 99+% Pure Sodium Chloride Sugar: 98+% Pure Sucrose
Water: De-ionized, 16 MΩ+ resistivity HEC: Hydroxyethyl Cellulose
DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

## 4 SIMULATING LIQUID PARAMETERS CHECK

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameters are within the tolerances of the specified target values. The relative permittivity and conductivity of the tissue material should be within ± 5% of the values given in the table below.




Set-up for liquid parameters check

**Reference Values of Tissue Dielectric Parameters for Head and Body Phantom (for 150 – 3000 MHz and 5800 MHz)**

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in IEEE Standard 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in IEEE Standard 1528.

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

($\varepsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 kg/m$^3$)

**Reference Values of Tissue Dielectric Parameters for Head and Body Phantom (for 3000 MHz – 5800 MHz)**

In the current guidelines and draft standards for compliance testing of mobile phones (i.e., IEEE P1528, OET 65 Supplement C), the dielectric parameters suggested for head and body tissue simulating liquid are given only at 3.0 GHz and 5.8 GHz. As an intermediate solution, dielectric parameters for the frequencies between 5 to 5.8 GHz were obtained using linear interpolation (see table below).

SPEAG has developed suitable head and body tissue simulating liquids consisting of the following ingredients: de-ionized water, salt and a special composition including mineral oil and an emulgators. Dielectric parameters of these liquids were measured suing a HP 8570C Dielectric Probe Kit in conjunction with HP 8753ES Network Analyzer (30 kHz – 6G Hz). The differences with respect to the interpolated values were well within the desired ±5% for the whole 5 to 5.8 GHz range.

| f (MHz) | Head Tissue | | Body Tissue | | Reference |
|---|---|---|---|---|---|
| | rel. permitivity | conductivity | rel. permitivity | conductivity | |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 | Standard |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 | Standard |
| 5000 | 36.2 | 1.45 | 49.3 | 5.07 | Interpolated |
| 5100 | 36.1 | 4.55 | 49.1 | 5.18 | Interpolated |
| 5200 | 36.0 | 4.66 | 49.0 | 5.30 | Interpolated |
| 5300 | 35.9 | 4.76 | 48.9 | 5.42 | Interpolated |
| 5400 | 35.8 | 4.86 | 48.7 | 5.53 | Interpolated |
| 5500 | 35.6 | 4.96 | 48.6 | 5.65 | Interpolated |
| 5600 | 35.5 | 5.07 | 48.5 | 5.77 | Interpolated |
| 5700 | 35.4 | 5.17 | 48.3 | 5.88 | Interpolated |

($\varepsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 kg/m$^3$)

### 4.1 SIMULATING LIQUID PARAMETER CHECK RESULT

Simulating Liquid Parameter Check Result @ Muscle 5GHz

Room Ambient Temperature = 23°C; Relative humidity = 45% Measured by: Ninous Davoudi

| Simulating Liquid | | | Parameters | | | Measured | Target | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|---|---|---|
| f (MHz) | Temp. (°C) | Depth (cm) | | | | | | | |
| 5500 | 22 | 15 | e' | 46.6601 | Relative Permittivity ($\varepsilon_r$): | 46.6601 | 48.6 | -3.99 | ± 10 |
| | | | e" | 18.8893 | Conductivity ($\sigma$): | 5.77960 | 5.65 | 2.29 | ± 5 |

Liquid Check
Ambient temperature: 23.0 deg. C; Liquid temperature: 22.0 deg C
April 02, 2007 07:36 AM

| Frequency | e' | e" |
|---|---|---|
| 4600000000. | 48.4572 | 17.6467 |
| 4650000000. | 48.5945 | 18.0180 |
| 4700000000. | 48.1936 | 17.6694 |
| 4750000000. | 48.0057 | 18.2463 |
| 4800000000. | 48.0854 | 18.0501 |
| 4850000000. | 47.7367 | 18.2404 |
| 4900000000. | 47.8151 | 18.2145 |
| 4950000000. | 47.6323 | 18.2882 |
| 5000000000. | 47.6470 | 18.5047 |
| 5050000000. | 47.5734 | 18.3198 |
| 5100000000. | 47.3634 | 18.7844 |
| 5150000000. | 47.4391 | 18.6655 |
| 5200000000. | 47.0179 | 19.0822 |
| 5250000000. | 47.2777 | 18.8363 |
| 5300000000. | 46.9023 | 18.8905 |
| 5350000000. | 47.1867 | 18.9915 |
| 5400000000. | 46.9502 | 18.8493 |
| 5450000000. | 46.7102 | 18.9124 |
| **5500000000.** | **46.6601** | **18.8893** |
| 5550000000. | 46.4222 | 19.1711 |
| 5600000000. | 46.2328 | 19.1260 |
| 5650000000. | 45.9394 | 19.2075 |
| 5700000000. | 46.1812 | 19.3603 |
| 5750000000. | 46.0337 | 19.3587 |
| 5800000000. | 45.9235 | 19.4265 |
| 5850000000. | 45.5050 | 19.4862 |
| 5900000000. | 45.8562 | 19.6193 |
| 5950000000. | 45.1889 | 19.3343 |
| 6000000000. | 45.4090 | 20.0568 |

The conductivity (σ) can be given as:

$$\sigma = \omega\varepsilon_0\, e'' = 2\,\pi\, f\, \varepsilon_0\, e''$$

*where* $f = \text{target } f * 10^6$

$\varepsilon_0 = 8.854 * 10^{-12}$

## 5 SYSTEM PERFORMANCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of ±10%.

### System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the SAM twin phantom filled with Body simulating liquid of the following parameters.
- The DASY4 system with an Isotropic E-Field Probe EX3DV3-SN: 3531 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
  For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 5 x 5 x 7 fine cube was chosen for cube integration(dx=dy=7.5mm; dz=5mm).
  For 5 GHz band - Special 8x8x8 fine cube was chosen for cube integration(dx=dy=4.3mm; dz=3mm)
- Distance between probe sensors and phantom surface was set to 4 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.0mm
- The dipole input power (forward power) was 250 mW±3%.
- The results are normalized to 1 W input power.

### Reference SAR Values for body-tissue

In the table below, the numerical reference SAR values of a SPEAG validation dipoles placed below the flat phantom filled with body-tissue simulating liquid are given. The reference SAR values were calculated using the finite-difference time-domain method and the geometry parameters.

| Dipole Type | Distance (mm) | Frequency (MHz) | SAR (1g) [W/kg] | SAR (10g) [W/kg] | SAR (peak) [W/kg] |
|---|---|---|---|---|---|
| D450V2 | 15 | 450 | 5.01 | 3.36 | 7.22 |
| D835V2 | 15 | 835 | 9.71 | 6.38 | 14.1 |
| D900V2 | 15 | 900 | 11.1 | 7.17 | 16.3 |
| D1450V2 | 10 | 1450 | 29.6 | 16.6 | 49.8 |
| D1800V2 | 10 | 1800 | 38.5 | 20.3 | 67.5 |
| D1900V2 | 10 | 1900 | 39.8 | 20.8 | 69.6 |
| D2000V2 | 10 | 2000 | 40.9 | 21.2 | 71.5 |
| D2450V2 | 10 | 2450 | 51.2 | 23.7 | 97.6 |

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

**Reference SAR Values for body-tissue**

In the table below, the numerical reference SAR values of a SPEAG validation dipoles placed below the flat phantom filled with body-tissue simulating liquid are given. The reference SAR values were calculated using finite-difference time-domain FDTD method (feed point-impedance set to 50 ohms) and the mechanical dimensions of the D5GHzV2 dipole (manufactured by SPEAG).

| f (MHz) | Head Tissue | | Body Tissue | | |
|---|---|---|---|---|---|
| | $SAR_{1g}$ | $SAR_{10g}$ | $SAR_{1g}$ | $SAR_{10g}$ | $SAR_{Peak}$ |
| 5000 | 72.9 | 20.7 | 68.1 | 19.2 | 260.3 |
| 5100 | 74.6 | 21.1 | 78.8 | 19.6 | 272.3 |
| 5200 | 76.5 | 21.6 | 71.8 | 20.1 | 284.7 |
| 5500 | 83.3 | 23.4 | **79.1** | **22.0** | 326.3 |
| 5800 | 78.0 | 21.9 | 74.1 | 20.5 | 324.7 |

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

## 5.1 SYSTEM PERFORMANCE CHECK RESULTS

**System Validation Dipole: D5GHzV2 SN 1003**

Date: April 2, 2007

Room Ambient Temperature = 23°C; Relative humidity = 45% Measured by: Ninous Davoudi

| Body Simulating Liquid | | | SAR (mW/g) | | Normalized to 1 W | Target | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|---|---|
| f (MHz) | Temp. (°C) | Depth (cm) | | | | | | |
| 5500 | 22 | 15 | 1g | 21.00 | 84 | 79.1 | 6.19 | ± 10 |
| | | | 10g | 5.8 | 23.2 | 22.0 | 5.45 | ± 10 |

## 6 SAR MEASURMENT PROCEDURE

A summary of the procedure follows:

a) A measurement of the SAR value at a fixed location is used as a reference value for assessing the power drop of the DUT. The SAR at this point is measured at the start of the test, and then again at the end of the test.

b) The SAR distribution at the exposed flat section of the flat phantom is measured at a distance of 4 mm from the inner surface of the shell. The area covers the entire dimension of the DUT and the horizontal grid spacing is 15 mm x 15 mm. Based on this data, the area of the maximum absorption is determined by Spline interpolation. The first Area Scan covers the entire dimension of the DUT to ensure that the hotspot was correctly identified.

For 5 GHz band - The SAR distribution at the exposed flat section of the flat phantom is measured at a distance of 2.0 mm from the inner surface of the shell. The area covers the entire dimension of the DUT and the horizontal grid spacing is 10 mm x 10 mm. Based on this data, the area of the maximum absorption is determined by Spline interpolation. The first Area Scan covers the entire dimension of the DUT to ensure that the hotspot was correctly identified.

c) Around this point, a volume of X=Y= 30 and Z=21 mm is assessed by measuring 5 x 5 x 7 mm points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure:

For 5 GHz band - Around this point, a volume of X=Y=24 and Z=20 mm is assessed by measuring 7 x 7 x 9 mm points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure:

(i) The data at the surface are extrapolated, since the centre of the dipoles is 1.2 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation is based on a least square algorithm. A polynomial of the fourth order is calculated through the points in z-axes. This polynomial is then used to evaluate the points between the surface and the probe tip.

(ii) The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g and 10 g) are computed using the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the “Not a knot”- condition (in x, y and z-direction). The volume is integrated with the trapezoidal – algorithm. One thousand points (10 x 10 x 10) are interpolated to calculate the averages.

(iii) All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.

(iv) The SAR value at the same location as in Step (a) is again measured to evaluate the actual power drift.

### 6.1 DASY4 SAR MEASURMENT PROCEDURE

**Step 1: Power Reference Measurement**

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties (for example, 1.2 mm for an EX3DV3 probe type).

**Step 2: Area Scan**

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY4 software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

**Step 3: Zoom Scan**

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures 5 x 5 x 7 points within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

For 5 GHz band – Same as above except the Zoom Scan measures 7 x 7 x 9 points.

**Step 4: Power drift measurement**

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

**Step 5: Z-Scan**

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

## 7 PROCEDURE USED TO ESTABLISH TEST SIGNAL

The following procedures had been used to prepare the EUT for the SAR test.

The client provided a special driver and program, ART, which enables a user to control the frequency and output power of the module.

***802.11a***

| Channel | Frequency (MHz) | Average Power Chain 0 (dBm) | Average Power Chain 2 (dBm) | Average Power Total (dBm) |
|---|---|---|---|---|
| Low | 5500 | 15.6 | 15.5 | 18.6 |
| Middle | 5600 | 15.7 | 15.1 | 18.4 |
| High | 5700 | 15.6 | 15.2 | 18.4 |

***802.11n HT20***

| Channel | Frequency (MHz) | Average Power Chain 0 (dBm) | Average Power Chain 2 (dBm) | Average Power Total (dBm) |
|---|---|---|---|---|
| Low | 5500 | 17.7 | 17.6 | 20.7 |
| Middle | 5600 | 17.6 | 17.3 | 20.5 |
| High | 5700 | 17.1 | 17.0 | 20.1 |

***802.11n HT40***

| Channel | Frequency (MHz) | Average Power Chain 0 (dBm) | Average Power Chain 2 (dBm) | Average Power Total (dBm) |
|---|---|---|---|---|
| Low | 5510 | 17.3 | 17.9 | 20.6 |
| Middle | 5590 | 17.8 | 17.0 | 20.4 |
| High | 5690 | 17.0 | 17.1 | 20.1 |

# 8 SAR MEASURMENT RESULTS

## 8.1 LAP HELD POSITION

| **802.11a** | | | | |
|---|---|---|---|---|
| **Channel** | **f (MHz)** | **Measured SAR 1g (mW/g)** | **Power Drift (dB)** | **Extrapolated[1)] SAR 1g (mW/g)** |
| 100 | 5500 | | | |
| 120 | 5600 | 0.290 | -0.166 | 0.301 |
| 140 | 5700 | | | |
| ***802.11n HT20*** | | | | |
| **Channel** | **f (MHz)** | **Measured SAR 1g (mW/g)** | **Power Drift (dB)** | **Extrapolated[1)] SAR 1g (mW/g)** |
| 100 | 5500 | | | |
| 120 | 5600 | 0.429 | -0.132 | 0.442 |
| 140 | 5700 | | | |
| ***802.11n HT40*** | | | | |
| **Channel** | **f (MHz)** | **Measured SAR 1g (mW/g)** | **Power Drift (dB)** | **Extrapolated[1)] SAR 1g (mW/g)** |
| 102 | 5510 | 0.719 | -0.125 | 0.740 |
| 118 | 5590 | 0.716 | 0.000 | 0.716 |
| **138** | **5690** | **1.030** | **-0.176** | **1.073** |

Notes:
1) The exact method of extrapolation is Measured SAR x 10^(-drift/10). The SAR reported at the end of the measurement process by the DASY4 system can be scaled up by the Power drift to determine the SAR at the beginning of the measurement process.
2) The SAR measured at the middle channel for this configuration is at least 3 dB lower (0.8 mW/g) than SAR limit (1.6 mW/g), thus testing at low & high channel is optional.
3) Please see attachments for the detailed measurement data and plots showing the maximum SAR location of the EUT.

# 9 MEASURMENT UNCERTAINTY

## 9.1 MEASURMENT UNCERTAINTY FOR 300 MHz – 3000 MHz

| Uncertainty component | Tol. (±%) | Probe Dist. | Div. | Ci (1g) | Ci (10g) | Std. Unc.(±%) | |
|---|---|---|---|---|---|---|---|
| | | | | | | Ui (1g) | Ui(10g) |
| **Measurement System** | | | | | | | |
| Probe Calibration | 4.80 | N | 1 | 1 | 1 | 4.80 | 4.80 |
| Axial Isotropy | 4.70 | R | 1.732 | 0.707 | 0.707 | 1.92 | 1.92 |
| Hemispherical Isotropy | 9.60 | R | 1.732 | 0.707 | 0.707 | 3.92 | 3.92 |
| Boundary Effects | 1.00 | R | 1.732 | 1 | 1 | 0.58 | 0.58 |
| Linearity | 4.70 | R | 1.732 | 1 | 1 | 2.71 | 2.71 |
| System Detection Limits | 1.00 | R | 1.732 | 1 | 1 | 0.58 | 0.58 |
| Readout Electronics | 1.00 | N | 1 | 1 | 1 | 1.00 | 1.00 |
| Response Time | 0.80 | R | 1.732 | 1 | 1 | 0.46 | 0.46 |
| Integration Time | 2.60 | R | 1.732 | 1 | 1 | 1.50 | 1.50 |
| RF Ambient Conditions - Noise | 1.59 | R | 1.732 | 1 | 1 | 0.92 | 0.92 |
| RF Ambient Conditions - Reflections | 0.00 | R | 1.732 | 1 | 1 | 0.00 | 0.00 |
| Probe Positioner Mechnical Tolerance | 0.40 | R | 1.732 | 1 | 1 | 0.23 | 0.23 |
| Probe Positioning With Respect to Phantom Shell | 2.90 | R | 1.732 | 1 | 1 | 1.67 | 1.67 |
| Extrapolation, interpolation, and integration algorithms for max. SAR evaluation | 3.90 | R | 1.732 | 1 | 1 | 2.25 | 2.25 |
| **Test sample Related** | | | | | | | |
| Test Sample Positioning | 1.10 | N | 1 | 1 | 1 | 1.10 | 1.10 |
| Device Holder Uncertainty | 3.60 | N | 1 | 1 | 1 | 3.60 | 3.60 |
| Power and SAR Drift Measurement | 5.00 | R | 1.732 | 1 | 1 | 2.89 | 2.89 |
| **Phantom and Tissue Parameters** | | | | | | | |
| Phantom Uncertainty | 4.00 | R | 1.732 | 1 | 1 | 2.31 | 2.31 |
| Liquid Conductivity - Target | 5.00 | R | 1.732 | 0.64 | 0.43 | 1.85 | 1.24 |
| Liquid Conductivity - Meas. | 8.60 | N | 1 | 0.64 | 0.43 | 5.50 | 3.70 |
| Liquid Permittivity - Target | 5.00 | R | 1.732 | 0.6 | 0.49 | 1.73 | 1.41 |
| Liquid Permittivity - Meas. | 3.30 | N | 1 | 0.6 | 0.49 | 1.98 | 1.62 |
| **Combined Standard Uncertainty** | RSS | | | | | 11.44 | 10.49 |
| **Expanded Uncertainty (95% Confidence Interval)** | K=2 | | | | | 22.87 | 20.98 |

Notesfor table
1. Tol. - tolerance in influence quaitity
2. N - Nomal
3. R - Rectangular
4. Div. - Divisor used to obtain standard uncertainty
5. Ci - is te sensitivity coefficient

## 9.2 MEASURMENT UNCERTAINTY 3 GHz – 6 GHz

| Uncertainty component | Tol. (±%) | Probe Dist. | Div. | Ci (1g) | Ci (10g) | Std. Unc.(±%) | |
|---|---|---|---|---|---|---|---|
| | | | | | | Ui (1g) | Ui(10g) |
| **Measurement System** | | | | | | | |
| Probe Calibration | 4.80 | N | 1 | 1 | 1 | 4.80 | 4.80 |
| Axial Isotropy | 4.70 | R | 1.732 | 0.707 | 0.707 | 1.92 | 1.92 |
| Hemispherical Isotropy | 9.60 | R | 1.732 | 0.707 | 0.707 | 3.92 | 3.92 |
| Boundary Effects | 1.00 | R | 1.732 | 1 | 1 | 0.58 | 0.58 |
| Linearity | 4.70 | R | 1.732 | 1 | 1 | 2.71 | 2.71 |
| System Detection Limits | 1.00 | R | 1.732 | 1 | 1 | 0.58 | 0.58 |
| Readout Electronics | 1.00 | N | 1 | 1 | 1 | 1.00 | 1.00 |
| Response Time | 0.80 | R | 1.732 | 1 | 1 | 0.46 | 0.46 |
| Integration Time | 2.60 | R | 1.732 | 1 | 1 | 1.50 | 1.50 |
| RF Ambient Conditions - Noise | 3.00 | R | 1.732 | 1 | 1 | 1.73 | 1.73 |
| RF Ambient Conditions - Reflections | 3.00 | R | 1.732 | 1 | 1 | 1.73 | 1.73 |
| Probe Positioner Mechnical Tolerance | 0.40 | R | 1.732 | 1 | 1 | 0.23 | 0.23 |
| Probe Positioning With Respect to Phantom Shell | 2.90 | R | 1.732 | 1 | 1 | 1.67 | 1.67 |
| Extrapolation, interpolation, and integration algorithms for max. SAR evaluation | 3.90 | R | 1.732 | 1 | 1 | 2.25 | 2.25 |
| **Test sample Related** | | | | | | | |
| Test Sample Positioning | 1.10 | N | 1 | 1 | 1 | 1.10 | 1.10 |
| Device Holder Uncertainty | 3.60 | N | 1 | 1 | 1 | 3.60 | 3.60 |
| Power and SAR Drift Measurement | 5.00 | R | 1.732 | 1 | 1 | 2.89 | 2.89 |
| **Phantom and Tissue Parameters** | | | | | | | |
| Phantom Uncertainty | 4.00 | R | 1.732 | 1 | 1 | 2.31 | 2.31 |
| Liquid Conductivity - Target | 5.00 | R | 1.732 | 0.64 | 0.43 | 1.85 | 1.24 |
| Liquid Conductivity - Meas. | 8.60 | N | 1 | 0.64 | 0.43 | 5.50 | 3.70 |
| Liquid Permittivity - Target | 5.00 | R | 1.732 | 0.6 | 0.49 | 1.73 | 1.41 |
| Liquid Permittivity - Meas. | 3.30 | N | 1 | 0.6 | 0.49 | 1.98 | 1.62 |
| **Combined Standard Uncertainty** | RSS | | | | | 11.66 | 10.73 |
| **Expanded Uncertainty (95% Confidence Interval)** | K=2 | | | | | 23.32 | 21.46 |

Notesfor table
1. Tol. - tolerance in influence quaitity
2. N - Nomal
3. R - Rectangular
4. Div. - Divisor used to obtain standard uncertainty
5. Ci - is te sensitivity coefficient

## 10 EQUIPMENT LIST AND CALIBRATION

| Name of Equipment | Manufacturer | Type/Model | Serial Number | Cal. Due date | | |
|---|---|---|---|---|---|---|
| | | | | MM | DD | Year |
| Robot - Six Axes | Stäubli | RX90BL | N/A | N/A | | |
| Robot Remote Control | Stäubli | CS7MB | 3403-91535 | N/A | | |
| DASY4 Measurement Server | SPEAG | SEUMS001BA | 1041 | N/A | | |
| Probe Alignment Unit | SPEAG | LB (V2) | 261 | N/A | | |
| SAM Phantom (SAM1) | SPEAG | TP-1185 | QD000P40CA | N/A | | |
| SAM Phantom (SAM2) | SPEAG | TP-1015 | N/A | N/A | | |
| Electronic Probe kit | HP | 85070C | N/A | N/A | | |
| S-Parameter Network Analyzer | Agilent | 8753ES-6 | US39173569 | 2 | 14 | 2008 |
| E-Field Probe | SPEAG | EX3DV4 | 3552 | 5 | 30 | 2007 |
| Thermometer | ERTCO | 639-1S | 1718 | 11 | 7 | 2007 |
| Data Acquisition Electronics | SPEAG | DAE3 V1 | 427 | 11 | 16 | 2007 |
| System Validation Dipole | SPEAG | D5GHzV2 | 1003 | 11 | 22 | 2007 |
| Signal Generator | R&S | SMP 04 | DE34210 | 10 | 9 | 2007 |
| Power Meter | HP | 438A | 3513U04320 | 9 | 4 | 2007 |
| Amplifier | Mini-Circuits | ZVE-8G | 360 | N/A | | |
| Simulating Liquid | SPEAG | M5200-5800 | N/A | Within 24 hrs of first test | | |

## 11 PHOTOS

WLAN

Host Device

## 12 ATTACHMENTS

| No. | Contents | No. Of Pages |
|---|---|---|
| 1 | System Performance Check Plots | 2 |
| 2 | SAR Test Plots | 6 |
| 3 | Certificate of E-Field Probe - EXDV4SN3552 | 9 |
| 4 | Certificate of System Validation Dipole - D5GHzV2 SN:1003 | 10 |

**END OF REPORT**