FCC OET BULLETIN 65 SUPPLEMENT C
IC RSS-102 ISSUE 2

SAR EVALUATION REPORT

FOR

802.11N 2X2 PCIE MINICARD
(INSTALLED IN DELL LAPTOP, MODEL NUMBER: PP24L)

MODEL: AR5BHB92
FCC ID: PPD-AR5BHB92-D
IC ID: 4104A-ARBHB92D

REPORT NUMBER: 08U11860-3B

ISSUE DATE: JULY 29, 2008

Prepared for

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Prepared by

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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issued date	Revisions	Revised By
--	June 19, 2008	Initial issue	Sunny Shih
A	June 30, 2008	Revised host device description	Sunny Shih
B	July 29, 2008	Revised report based on TCB reviewer's comments. 1. Updated system check result with correct conversion factor 2. Re-evaluated SAR results with correct frequency at 5755 MHz. 3. Corrected some typos on page 4	Sunny Shih

TABLE OF CONTENTS

1 ATTESTATION OF TEST RESULTS

COMPANY NAME:	ATHEROS COMMUNICATIONS, INC. 5480 GREAT AMERICA PARKWAY SANTA CLARA, CA 95054
EUT DESCRIPTION:	802.11N 2X2 PCIE MINICARD INSTALLED IN DELL LAPTOP, MODEL NUMBER: PP24L
MODEL:	AR5BHB92
DEVICE CATEGORY:	Portable
EXPOSURE CATEGORY:	General Population/Uncontrolled Exposure
DATE TESTED:	June 13th and 16th , 2008
THE HIGHEST SAR VALUES:	See Table below

FCC / IC Rule Parts	Frequency Range [MHz]	The Highest SAR Values (1g_mW/g)	Limit (mW/g)
15.247/RSS-102	2400 – 2483.5 5725 – 5850	0.201 0.557	1.6
15.407/RSS-102	5150 – 5250 5250 – 5350 5470 – 5725	0.154 0.523 0.776	1.6

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC OET BULLETIN 65 SUPPLEMENT C	Pass
RSS-102 ISSUE 2	Pass

Compliance Certification Services, Inc. (CCS) tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by CCS based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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 CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by CCS 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:
SUNNY SHIH EMC SUPERVISOR COMPLIANCE CERTIFICATION SERVICES	JONATHAN KING EMC ENGINEER COMPLIANCE CERTIFICATION SERVICES

2 TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC OET Bulletin 65 Supplement C and IC RSS 102 Issue 2: NOVERMBER 2005.

3 FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.
CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://www.ccsemc.com.

4 CALIBRATION AND UNCERTAINTY

4.1 MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

5 MEASUREMENT UNCERTAINTY

Measurement 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

Measurement uncertainty for 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

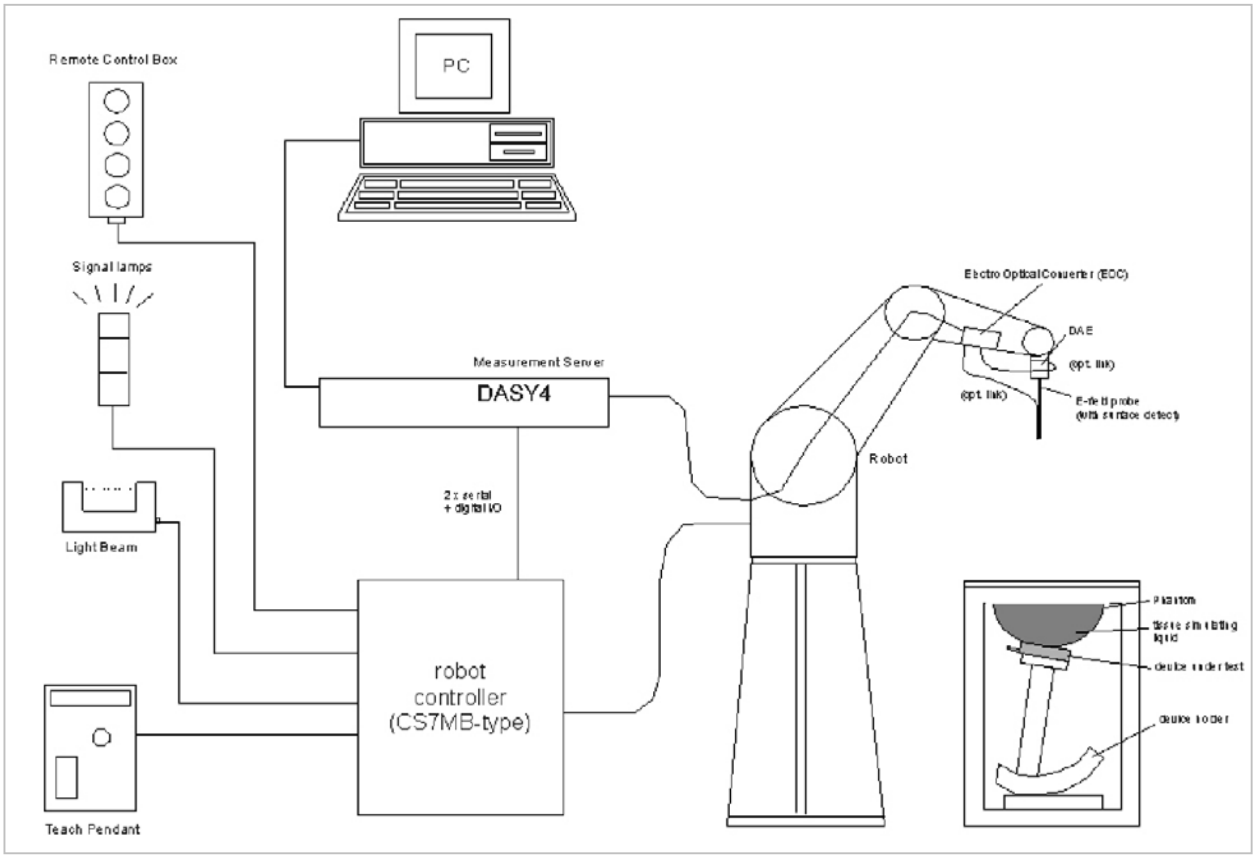
6 DEVICE UNDER TEST (DUT) DESCRIPTION

802.11N 2X2 PCIE MINICARD INSTALLED IN DELL LAPTOP, MODEL NUMBER: PP24L	
Normal operation:	Lap-held only
Duty cycle:	802.11abg/Draft 802.11n mode: 100%
Host Device	DELL LAPTOP, MODEL NUMBER: PP24L
Antenna(s)	See table below
Power supply:	Power supplied through laptop computer (host device)

AVAILABLE ANTENNAS

Antenna tested	Manufacture	Model
☒	Advance-Connectek, Inc (ACON)	APP8P-700049
☒	Tyco	C-2023816-1

7 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.

7.1 COMPOSITION OF INGREDIENTS FOR TISSUE SIMULATING LIQUIDS

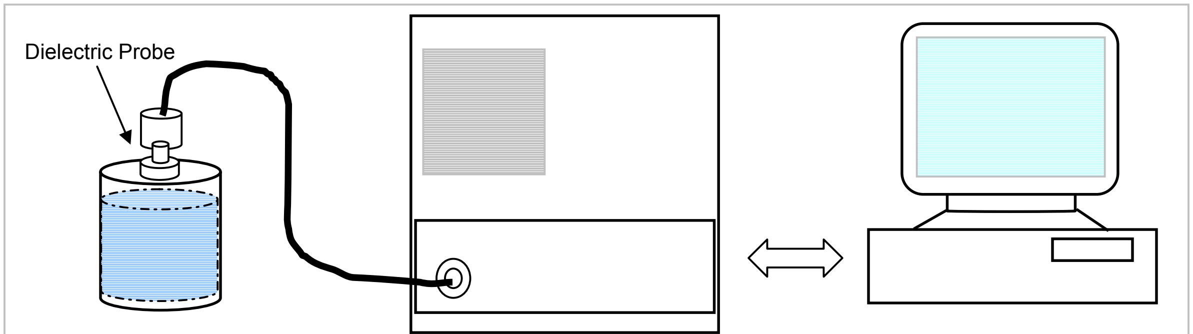
The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

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

8 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	
	ε_r	σ (S/m)	ε_r	σ (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

(ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)

8.1 SIMULATING LIQUID PARAMETER CHECK RESULT

Simulating Liquid Dielectric Parameter Check Result @ Muscle 2450 MHz

Room Ambient Temperature = 24°C; Relative humidity = 30% Measured by: Jonathan King

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
2450	23	15	e'	50.6764	Relative Permittivity (ϵ_r):	50.6764	52.7	-3.84	± 5
			e"	14.8127	Conductivity (σ):	2.01892	1.95	3.53	± 5

Liquid Check
Ambient temperature: 22 deg. C; Liquid temperature: 21 deg. C
June 11, 2008 11:17 AM

Frequency	e'	e"
2400000000.	50.9702	14.5879
2405000000.	50.9369	14.6086
2410000000.	50.8931	14.6385
2415000000.	50.8757	14.6626
2420000000.	50.8444	14.6779
2425000000.	50.8269	14.7134
2430000000.	50.8077	14.7290
2435000000.	50.7823	14.7452
2440000000.	50.7481	14.7539
2445000000.	50.7176	14.7803
2450000000.	**50.6764**	**14.8127**
2455000000.	50.6490	14.8321
2460000000.	50.6343	14.8435
2465000000.	50.5950	14.8706
2470000000.	50.5648	14.8867
2475000000.	50.5427	14.9152
2480000000.	50.5275	14.9280
2485000000.	50.5033	14.9631
2490000000.	50.4658	14.9781
2495000000.	50.4408	14.9999
2500000000.	50.4297	15.0268

The conductivity (σ) can be given as:

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

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

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

Simulating Liquid Parameter Check Result @ Muscle 5GHz

Room Ambient Temperature = 25°C; Relative humidity = 35% Measured by: Jonathan King

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
5200	24	15	e'	47.4869	Relative Permittivity (ε_r):	47.4869	49.0	-3.09	± 10
			e"	18.9334	Conductivity (σ):	5.47710	5.30	3.34	± 5

Liquid Check
Ambient temperature: 25 deg. C; Liquid temperature: 24 deg. C
June 13, 2008 08:42 AM

Frequency	e'	e"
4600000000.	48.7285	18.0163
4650000000.	48.6183	18.1014
4700000000.	48.5435	18.1873
4750000000.	48.4224	18.2656
4800000000.	48.3370	18.3511
4850000000.	48.2329	18.4118
4900000000.	48.1038	18.5257
4950000000.	48.0293	18.5873
5000000000.	47.9182	18.6651
5050000000.	47.8224	18.7173
5100000000.	47.6824	18.7895
5150000000.	47.6083	18.8789
5200000000.	**47.4869**	**18.9334**
5250000000.	47.3751	19.0012
5300000000.	47.2708	19.0687
5350000000.	47.1639	19.1298
5400000000.	47.0703	19.1808
5450000000.	46.9652	19.2639
5500000000.	46.8737	19.3059
5550000000.	46.7288	19.3651
5600000000.	46.6723	19.4411
5650000000.	46.5641	19.4753
5700000000.	46.4876	19.5530
5750000000.	46.3345	19.5858
5800000000.	46.2563	19.6728
5850000000.	46.1889	19.7250
5900000000.	46.0776	19.7843
5950000000.	45.9531	19.8189
6000000000.	45.8918	19.9171

The conductivity (σ) can be given as:

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

where f = target $f * 10^6$

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

Simulating Liquid Parameter Check Result @ Muscle 5GHz

Room Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
5500	23	15	e'	45.2904	Relative Permittivity (ε_r):	45.2904	48.6	-6.81	± 10
			e''	19.0016	Conductivity (σ):	5.81396	5.65	2.90	± 5

Liquid Check
Ambient temperature: 24 deg. C; Liquid temperature: 23 deg. C
June 16, 2008 09:10 AM

Frequency	e'	e''
4600000000.	47.0849	17.7950
4650000000.	46.9995	17.8515
4700000000.	46.9109	17.9508
4750000000.	46.8164	17.9998
4800000000.	46.7134	18.0883
4850000000.	46.6054	18.1530
4900000000.	46.5254	18.2497
4950000000.	46.3489	18.3007
5000000000.	46.3152	18.3877
5050000000.	46.2271	18.4466
5100000000.	46.1095	18.5090
5150000000.	46.0176	18.6050
5200000000.	45.9106	18.6269
5250000000.	45.7898	18.7170
5300000000.	45.7078	18.7683
5350000000.	45.5941	18.8201
5400000000.	45.5103	18.8740
5450000000.	45.3800	18.9260
5500000000.	45.2904	19.0016
5550000000.	**45.1935**	**19.0250**
5600000000.	45.0920	19.0852
5650000000.	44.9874	19.1610
5700000000.	44.9005	19.2215
5750000000.	44.7726	19.2547
5800000000.	44.6855	19.3133
5850000000.	44.5929	19.3616
5900000000.	44.5250	19.4282
5950000000.	44.3983	19.4633
6000000000.	44.2986	19.5301

The conductivity (σ) can be given as:

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

where f = target $f * 10^6$
$\varepsilon_0 = 8.854 * 10^{-12}$

Simulating Liquid Parameter Check Result @ Muscle 5GHz

Room Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
5800	23	15	e'	44.6855	Relative Permittivity (ε_r):	44.6855	48.2	-7.29	± 10
			e"	19.3133	Conductivity (σ):	6.23166	6.00	3.86	± 5

Liquid Check
Ambient temperature: 24 deg. C; Liquid temperature: 23 deg. C
June 16, 2008 09:10 AM

Frequency	e'	e"
4600000000.	47.0849	17.7950
4650000000.	46.9995	17.8515
4700000000.	46.9109	17.9508
4750000000.	46.8164	17.9998
4800000000.	46.7134	18.0883
4850000000.	46.6054	18.1530
4900000000.	46.5254	18.2497
4950000000.	46.3489	18.3007
5000000000.	46.3152	18.3877
5050000000.	46.2271	18.4466
5100000000.	46.1095	18.5090
5150000000.	46.0176	18.6050
5200000000.	45.9106	18.6269
5250000000.	45.7898	18.7170
5300000000.	45.7078	18.7683
5350000000.	45.5941	18.8201
5400000000.	45.5103	18.8740
5450000000.	45.3800	18.9260
5500000000.	45.2904	19.0016
5550000000.	45.1935	19.0250
5600000000.	45.0920	19.0852
5650000000.	44.9874	19.1610
5700000000.	44.9005	19.2215
5750000000.	44.7726	19.2547
5800000000.	**44.6855**	**19.3133**
5850000000.	44.5929	19.3616
5900000000.	44.5250	19.4282
5950000000.	44.3983	19.4633
6000000000.	44.2986	19.5301

The conductivity (σ) can be given as:

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

where $f = \text{target } f * 10^6$
$\varepsilon_0 = 8.854 * 10^{-12}$

9 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 7 x 7 x 7 fine cube was chosen for cube integration(dx=dy=5mm; dz=5mm).
  For 5 GHz band - Special 7 x 7 x 7 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.

9.1 SYSTEM PERFORMANCE CHECK RESULTS

System Validation Dipole: D2450V2 SN: 706

Date: June 11, 2008

Ambient Temperature = 24°C; Relative humidity = 30% Measured by: Jonathan King

Body Simulating Liquid			SAR (mW/g)		Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)						
2450	23	15	1g	12.50	50	51.2	-2.34	± 10
			10g	5.8	23.2	23.7	-2.11	± 10

System Validation Dipole: D5GHzV2 SN 1003

Date: June 13, 2008

Ambient Temperature = 25°C; Relative humidity = 35% Measured by: Jonathan King

Body Simulating Liquid			SAR (mW/g)		Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)						
5200	24	15	1g	19.40	77.6	71.8	8.08	± 10
			10g	5.49	21.96	20.1	9.25	± 10

System Validation Dipole: D5GHzV2 SN 1003

Date: June 16, 2008

Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Body Simulating Liquid			SAR (mW/g)		Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)						
5500	23	15	1g	20.20	80.8	79.1	2.15	± 10
			10g	5.75	23	22.0	4.55	± 10

System Validation Dipole: D5GHzV2 SN 1003

Date: June 16, 2008

Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Body Simulating Liquid			SAR (mW/g)		Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)						
5800	23	15	1g	19.60	78.4	74.1	5.80	± 10
			10g	5.62	22.48	20.5	9.66	± 10

10 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 3 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 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:

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.

10.1 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 7 x 7 x 9 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.

11 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.

The cable assembly insertion loss of 20.3dB was entered as an offset in the power meter to allow for direct reading of power.

802.11b

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	2412	17.73	17.62
Middle	2437	16.81	17.05
High	2462	17.91	17.88

802.11g

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	2412	16.27	15.23
Middle	2437	21.29	21.35
High	2462	15.83	15.91

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	2412	15.99	15.47
Middle	2437	21.96	22.01
High	2462	14.09	14.11

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	2422	12.49	12.23
Middle	2437	21.23	21.22
High	2452	12.76	12.80

The cable assembly insertion loss of 10.3 dB (including attenuator and connectors) was entered as an offset in the power meter to allow for direct reading of power.

5.2 GHz Band

802.11a

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5180	12.54	12.32
Middle	5220	12.16	12.13
High	5240	12.47	12.58

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5180	13.71	13.24
Middle	5220	13.40	13.31
High	5240	13.60	13.67

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5190	12.81	12.52
High	5230	13.61	13.77

5.3 GHz Band

802.11a

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5260	18.07	17.71
Middle	5300	18.14	17.69
High	5320	16.63	16.85

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5260	19.99	20.01
Middle	5300	19.53	19.72
High	5320	16.01	15.59

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5270	20.13	20.41
High	5310	13.52	13.85

5.5 GHz Band

802.11a

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5500	17.60	17.37
Middle	5600	17.74	17.79
High	5700	17.93	17.67

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5500	17.61	17.41
Middle	5600	19.63	19.83
High	5700	17.96	17.72

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5510	14.92	15.36
Middle	5590	20.01	20.22
High	5670	18.21	18.24

5.8 GHz Band

802.11a

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5745	19.58	19.71
Middle	5785	19.20	19.57
High	5825	19.03	19.21

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5745	19.73	19.72
Middle	5785	19.35	19.54
High	5825	18.99	19.39

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)	Average Power Chain 2 (dBm)
Low	5755	19.93	20.11
High	5795	19.48	20.03

12 SAR MEASURMENT RESULTS

12.1 2.4 GHZ BANDS

Note: The channels with the highest output power were chosen for the testing below.

Channel	f (MHz)	Measured SAR 1g (mW/g)	Power Drift (dB)	Extrapolated[1)] SAR 1g (mW/g)
802.11g mode (6Mbps) - Acon Antenna				
6	2437	0.095	-0.076	0.097
802.11n HT20 mode (6Mbps) - Acon Antenna				
6	2437	0.114	-0.133	0.118
802.11g mode (6Mbps) - Tyco Antenna				
6	2437	0.155	-0.188	0.162
802.11n HT20 mode (6Mbps) - Tyco Antenna				
6	2437	0.190	-0.242	0.201

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.

12.2 5 GHZ BANDS

Note: Main antenna was not tested due to the large distance between the antenna and the phantom.

Channel	f (MHz)	Measured SAR 1g (mW/g)	Power Drift (dB)	Extrapolated[1)] SAR 1g (mW/g)
5.2 GHz - 802.11n HT40 mode (13.5 Mbps) - Acon Antenna				
46	5230	0.135	-0.567	0.154
5.2 GHz - 802.11n HT40 mode (13.5 Mbps) - Tyco Antenna				
46	5230	0.097	0.000	0.097
5.3 GHz - 802.11n HT40 mode (13.5 Mbps) - Acon Antenna				
54	5270	0.463	-0.530	0.523
5.3 GHz - 802.11n HT40 mode (13.5 Mbps) - Tyco Antenna				
54	5270	0.371	-0.392	0.406
5.5 GHz - 802.11n HT40 mode (13.5 Mbps) - Acon Antenna				
118	5590	0.512	-0.069	0.520
5.5 GHz - 802.11n HT40 mode (13.5 Mbps) - Tyco Antenna				
118	5590	0.752	-0.137	0.776
5.8 GHz - 802.11n HT40 mode (13.5 Mbps) - Acon Antenna				
151	5755	0.557	0.000	0.557
5.8 GHz - 802.11n HT40 mode (13.5 Mbps) - Tyco Antenna				
151	5755	0.363	-0.219	0.382

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.

13 ATTACHMENTS

No.	Contents	No. Of Pages
1	System Performance Check Plots	8
2	SAR Test Plots	13
3	Certificate of E-Field Probe - EX3DV3SN3531	10
4	Certificate of System Validation Dipole - D2450V2 SN:748	6
5	Certificate of System Validation Dipole - D5GHzV2 SN:1003	15

14 PHOTOS

EUT Location

Antenna Location

END OF REPORT