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

SAR EVALUATION REPORT

FOR

802.11abg/Draft 802.11n WLAN PCI-E Card
(Tested inside of MacBook)

MODEL: BCM94322USA

FCC ID: QDS-BRCM1038
IC: 4324A-BRCM1038

REPORT NUMBER: 08U11995-1A

ISSUE DATE: SEPTEMBER 30, 2008

Prepared for

BROADCOM CORPORATION
190 MATHILDA PLACE
SUNNYVALE, CA 94086

Prepared by

COMPLIANCE CERTIFICATION SERVICES
47173 BENICIA STREET
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issued date	Revisions	Revised By
--	August 7, 2008	Initial issue	--
A	September 30, 2008	Removed note # 4 below in pages 22 and 26 in this report. Note # 4: 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.	Sunny Shih

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1 ATTESTATION OF TEST RESULTS

COMPANY NAME:	BROADCOM CORPORATION 190 MATHILDA PLACE SUNNYVALE, CA 94086
EUT DESCRIPTION:	802.11abg/Draft 802.11n WLAN PCI-E Card (Tested inside of MacBook)
MODEL:	BCM94322USA
DEVICE CATEGORY:	Portable
EXPOSURE CATEGORY:	General Population/Uncontrolled Exposure
DATE TESTED:	July 31 – August 5 , 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	0.849 1.41	1.6
15.407 / RSS-102	5150 – 5250 5250 – 5350 5470 – 5725	0.862 1.10 1.23	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:

SUNNY SHIH
EMC SUPERVISOR
COMPLIANCE CERTIFICATION SERVICES

2 TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC OET Bulletin 65 Supplement C, Specific FCC Procedure KDB 248227 SAR Measurement Procedure for 820.11abg Transmitters May 2007 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

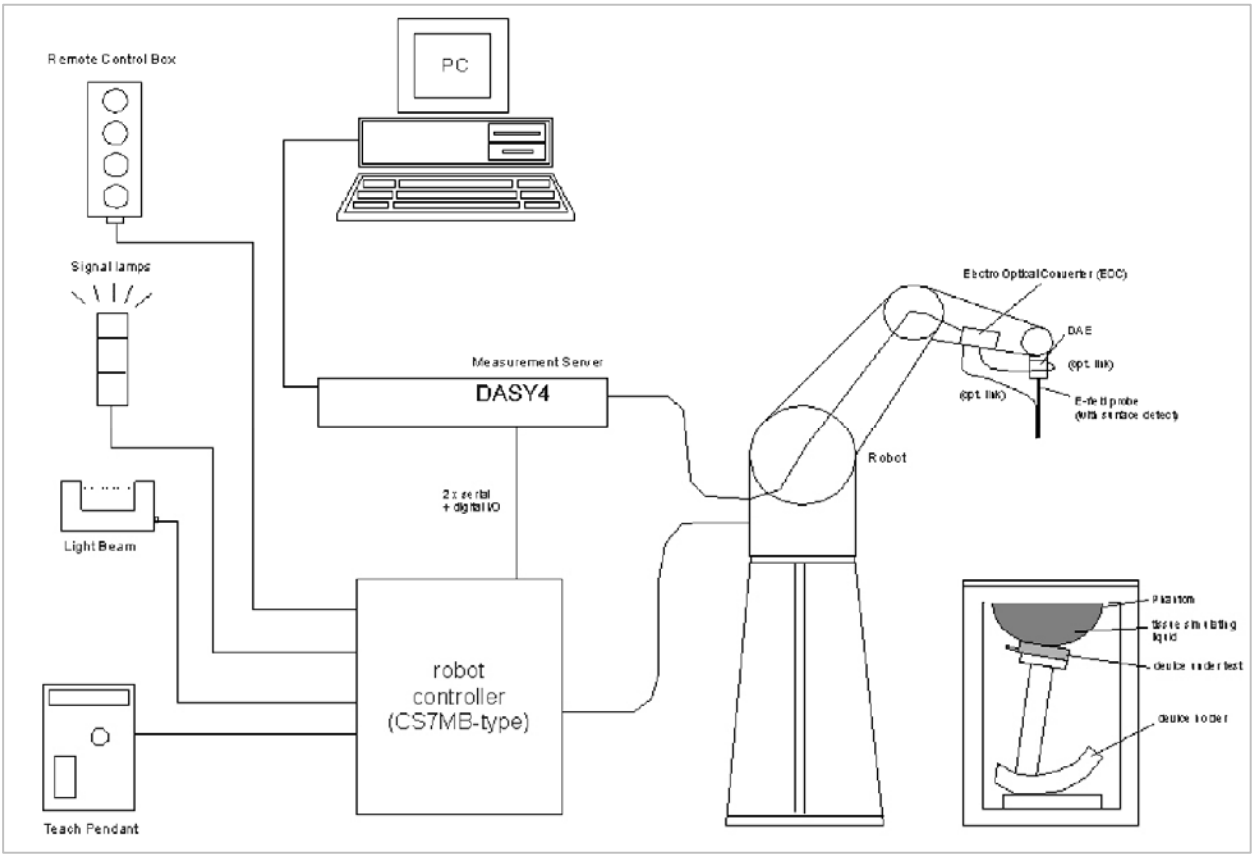
Uncertainty component	Tol. (±%)	Probe Dist.	Div.	Ci (1g)	Ci (10g)	Std. Unc.(±%)	
						Ui (1g)	Ui(10g)
Measurement System							
Probe Calibration	4.80	N	1	1	1	4.80	4.80
Axial Isotropy	4.70	R	1.732	0.707	0.707	1.92	1.92
Hemispherical Isotropy	9.60	R	1.732	0.707	0.707	3.92	3.92
Boundary Effects	1.00	R	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

802.11abg/Draft 802.11n WLAN PCI-E Card (Tested inside of MacBook)	
Normal operation:	Lap-held only Note: SAR test with display open at 90° to the keyboard
Host device:	MacBook
Antenna tested:	The radio has been tested with the following antennas combination: Slot antenna, model 056-2666, PIFA antenna, model 056-2667
Power supply:	Power supplied through laptop computer (host device)

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

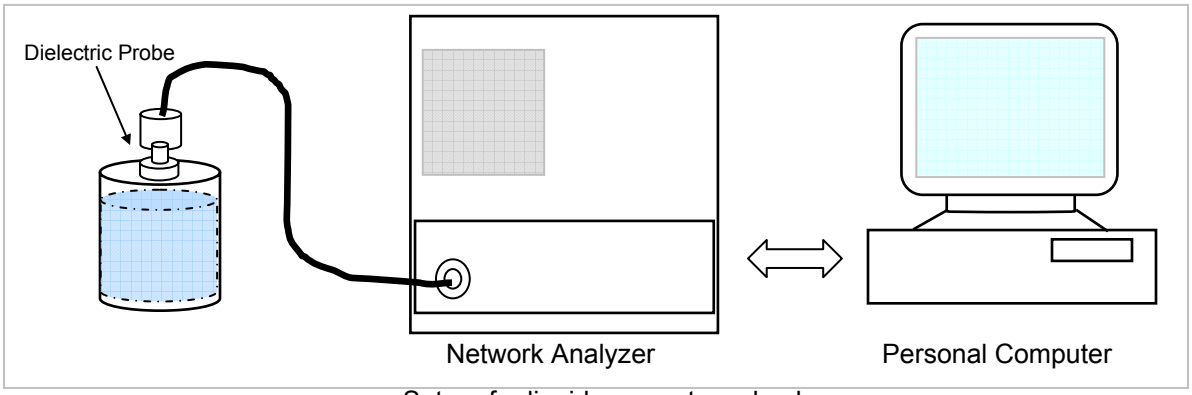
The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

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 SIMULATLING 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 = 25°C; Relative humidity = 40% Measured by: Sunny Shih

Simulating Liquid		Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Depth (cm)							
2450	15	e'	51.019	Relative Permittivity (ε_r):	51.0193	52.7	-3.19	± 5
		e"	14.451	Conductivity (σ):	1.96966	1.95	1.01	± 5

Liquid Check
Ambient temperature: 25 deg. C; Liquid temperature: 23 deg. C
July 31, 2008 09:11 AM

Frequency	e'	e"
2400000000.	51.2804	14.1161
2405000000.	51.2009	14.2292
2410000000.	51.0998	14.2730
2415000000.	51.0546	14.2897
2420000000.	51.0976	14.2762
2425000000.	51.1179	14.3311
2430000000.	51.0636	14.3487
2435000000.	51.0698	14.3104
2440000000.	51.0974	14.3639
2445000000.	50.9871	14.3889
2450000000.	**51.0193**	**14.4513**
2455000000.	51.0557	14.4276
2460000000.	50.9724	14.4793
2465000000.	50.9665	14.4565
2470000000.	50.9692	14.5232
2475000000.	50.8812	14.5261
2480000000.	50.9155	14.4904
2485000000.	50.8173	14.4405
2490000000.	50.7672	14.4930
2495000000.	50.7840	14.5018
2500000000.	50.8491	14.5571

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 = 25°C; Relative humidity = 42% Measured by: Sunny Shih

Simulating Liquid		Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Depth (cm)							
5200	15	e'	45.7938	Relative Permittivity (ϵ_r):	45.7938	49.0	-6.54	± 10
		e"	18.7972	Conductivity (σ):	5.43770	5.30	2.60	± 5
5500	15	e'	45.3945	Relative Permittivity (ϵ_r):	45.3945	48.6	-6.60	± 10
		e"	18.9951	Conductivity (σ):	5.81197	5.65	2.87	± 5
5800	15	e'	44.6237	Relative Permittivity (ϵ_r):	44.6237	48.2	-7.42	± 10
		e"	19.2416	Conductivity (σ):	6.20852	6.00	3.48	± 5

Liquid Check
Ambient temperature: 25 deg. C; Liquid temperature: 24 deg. C
August 01, 2008 08:31 AM

Frequency	e'	e"
4600000000.	47.0536	17.6060
4650000000.	47.0408	18.0306
4700000000.	46.9249	17.8646
4750000000.	46.5886	18.1704
4800000000.	46.7916	18.0903
4850000000.	46.4738	18.1819
4900000000.	46.6320	18.2261
4950000000.	46.4311	18.1821
5000000000.	46.3443	18.4208
5050000000.	46.2288	18.2526
5100000000.	46.0576	18.4867
5150000000.	46.1382	18.5841
5200000000.	**45.7938**	**18.7972**
5250000000.	45.8141	18.8418
5300000000.	45.7393	18.8931
5350000000.	45.5730	18.8995
5400000000.	45.5833	18.8946
5450000000.	45.3691	19.0468
5500000000.	**45.3945**	**18.9951**
5550000000.	45.1874	19.2531
5600000000.	44.9506	19.0290
5650000000.	44.8846	19.1960
5700000000.	44.8928	19.1161
5750000000.	44.6114	19.3783
5800000000.	**44.6237**	**19.2416**
5850000000.	44.1611	19.2383
5900000000.	44.4033	19.3575
5950000000.	44.0079	19.1775
6000000000.	44.0129	19.5801

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 = 25°C; Relative humidity = 42% Measured by: Sunny Shih

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
5200	24	15	e'	46.3014	Relative Permittivity (ϵ_r):	46.3014	49.0	-5.51	± 10
			e"	18.7627	Conductivity (σ):	5.42772	5.30	2.41	± 5
5500	24	15	e'	45.9281	Relative Permittivity (ϵ_r):	45.9281	48.6	-5.50	± 10
			e"	18.9776	Conductivity (σ):	5.80661	5.65	2.77	± 5
5800	24	15	e'	45.0952	Relative Permittivity (ϵ_r):	45.0952	48.2	-6.44	± 10
			e"	19.3910	Conductivity (σ):	6.25673	6.00	4.28	± 5

Liquid Check
Ambient temperature: 25 deg. C; Liquid temperature: 24 deg. C
August 04, 2008 08:21 AM

Frequency	e'	e"
4600000000.	47.4415	17.7502
4650000000.	47.4901	18.1233
4700000000.	47.4597	17.9520
4750000000.	47.0516	18.2407
4800000000.	47.2797	18.1833
4850000000.	46.7725	18.1933
4900000000.	47.1096	18.2409
4950000000.	46.8301	18.3516
5000000000.	46.7696	18.3792
5050000000.	46.7735	18.4126
5100000000.	46.5064	18.6172
5150000000.	46.7440	18.8584
5200000000.	**46.3014**	**18.7627**
5250000000.	46.3412	19.0304
5300000000.	46.1961	18.9451
5350000000.	46.1862	19.0407
5400000000.	46.0713	18.9777
5450000000.	45.9686	19.0739
5500000000.	**45.9281**	**18.9776**
5550000000.	45.5408	19.2493
5600000000.	45.3389	19.0700
5650000000.	45.2053	19.2978
5700000000.	45.2935	19.0891
5750000000.	44.9803	19.4109
5800000000.	**45.0952**	**19.3910**
5850000000.	44.6092	19.3876
5900000000.	44.8655	19.4480
5950000000.	44.4508	19.3124
6000000000.	44.5243	19.6429

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 = 25°C; Relative humidity = 40% Measured by: Sunny Shih

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
5200	24	15	e'	44.6671	Relative Permittivity (ϵ_r):	44.6671	49.0	-8.84	± 10
			e"	18.5466	Conductivity (σ):	5.36521	5.30	1.23	± 5
5500	24	15	e'	44.1466	Relative Permittivity (ϵ_r):	44.1466	48.6	-9.16	± 10
			e"	18.7704	Conductivity (σ):	5.74322	5.65	1.65	± 5
5800	24	15	e'	43.5277	Relative Permittivity (ϵ_r):	43.5277	48.2	-9.69	± 10
			e"	18.9991	Conductivity (σ):	6.13028	6.00	2.17	± 5

Liquid Check
Ambient temperature: 25 deg. C; Liquid temperature: 24 deg. C
August 05, 2008 08:39 AM

Frequency	e'	e"
4600000000.	45.8963	17.6206
4650000000.	45.8346	17.8174
4700000000.	45.7593	17.7772
4750000000.	45.5646	17.9271
4800000000.	45.5994	17.9534
4850000000.	45.3462	17.9571
4900000000.	45.4151	18.0988
4950000000.	45.2342	18.0586
5000000000.	45.1720	18.2300
5050000000.	45.1597	18.2111
5100000000.	44.9763	18.3827
5150000000.	44.9839	18.5124
5200000000.	**44.6671**	**18.5466**
5250000000.	44.5779	18.5975
5300000000.	44.5313	18.5477
5350000000.	44.3516	18.6552
5400000000.	44.3694	18.6532
5450000000.	44.1458	18.7234
5500000000.	**44.1466**	**18.7704**
5550000000.	44.0174	18.8734
5600000000.	43.9173	18.8454
5650000000.	43.8113	18.9822
5700000000.	43.7203	18.9009
5750000000.	43.5737	19.0722
5800000000.	**43.5277**	**18.9991**
5850000000.	43.2450	19.1162
5900000000.	43.3405	19.1155
5950000000.	43.0528	19.1094
6000000000.	43.0876	19.1904

The conductivity (σ) can be given as:

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

where $f = target\ f * 10^6$

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

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 7x7x7 (2.4 GHz) fine cube was chosen for cube integration and Special 8x8x10 (5 GHz) fine cube was chosen for cube integration
- 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 2.5mm
- The dipole input power (forward power) was 250 mW±3%.
- The results are normalized to 1 W input power.

450 to 2450 MHz 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.

5 GHz 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.

9.1 SYSTEM PERFORMANCE CHECK RESULTS

System Validation Dipole: D2450V2 SN: 748

The dipole input power (forward power): 250 mW

Results

Date: July 31, 2008

Ambient Temperature = 25°C; Relative humidity = 40% Measured by: Sunny Shih

Body Simulating Liquid			SAR (mW/g)	Normalized	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)					
2450	23	15	1g	50.2	51.2	-1.95	± 10
			10g	23.6	23.7	-0.42	± 10

System Validation Dipole: D5GHzV2 SN 1003

The dipole input power (forward power): 250 mW

Results

Date: August 1, 2008

Ambient Temperature = 25°C; Relative humidity = 42% Measured by: Sunny Shih

Body Simulating Liquid			SAR (mW/g)	Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)					
5500	24	15	1g	82.8	79.1	4.68	± 10
			10g	23.6	22.0	7.27	± 10

Date: August 4, 2008

Ambient Temperature = 25°C; Relative humidity = 40% Measured by: Sunny Shih

Body Simulating Liquid			SAR (mW/g)	Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)					
5800	24	15	1g	78.7	74.1	6.21	± 10
			10g	22.4	20.5	9.27	± 10

Date: August 5, 2008

Ambient Temperature = 25°C; Relative humidity = 40% Measured by: Sunny Shih

Body Simulating Liquid			SAR (mW/g)	Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)					
5200	25	15	1g	76.1	71.8	5.99	± 10
			10g	22.1	20.1	9.95	± 10

10 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, w1_tools, which enable a user to control the frequency and output power of the module.

The cable assembly insertion loss of 20.3 dB (including attenuator and connectors) was entered as an offset in the power meter to allow for direct reading of power.

RF Conducted Output Power Measurement Results:

See Broadcom's Operational Description document for Average Power information.

11 SAR TEST RESULTS

11.1 SAR TEST RESULT FOR THE BAND 2400 – 2483.5 MHZ

Mode	Channel	f (MHz)	Antenna	Measured SAR 1g (mW/g)	Limit
802.11b	6	2437 (M)	TX 0	0.537	1.6
802.11b	6	2437 (M)	TX 1	0.680	1.6
802.11g	6	2437 (M)	TX 0	0.546	1.6
802.11g	6	2437 (M)	TX 1	0.665	1.6
802.11n HT20 MIMO	3	2422 (L)	TX 0 & TX 1	0.836	1.6
802.11n HT20 MIMO	6	2437 (M)	TX 0 & TX 1	0.832	1.6
802.11n HT20 MIMO	**9**	**2452 (H)**	**TX 0 & TX 1**	**0.849**	1.6
802.11n 40 MHz SISO	6	2437 (M)	TX 1		1.6
802.11n HT40 MIMO	6	2437 (M)	TX 0 & TX 1		1.6

Notes:

1) The modes with highest output power channel were chosen for the testing.
2) Waived 40 MHz SISO and MIMO modes SAR test due to lower output power.
3) Test configuration: Lapheld with display open at 90° to the keyboard.
4) 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.
5) For 802.11n HT20 mode, the SAR measured at the middle channel is greater than 0.8 mW/g, SAR test is required at low and high channel. Due to power is reduced for channel 1, 2 and 10, 11 to meet restricted band requirements, the highest output channels 3 and 9 were chosen for testing.

The Highest SAR Plot & Data for 2.4 GHz Band

Date/Time: 7/31/2008 7:22:18 PM

Test Laboratory: Compliance Certification Services

Lapheld - 2.45 GHz band

DUT: MacBook; Type: n/a; Serial: n/a

Communication System: 802.11bg; Frequency: 2452 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2452 MHz; σ = 1.97 mho/m; ε_r = 51; ρ = 1000 kg/m^3
Phantom section: Flat Section

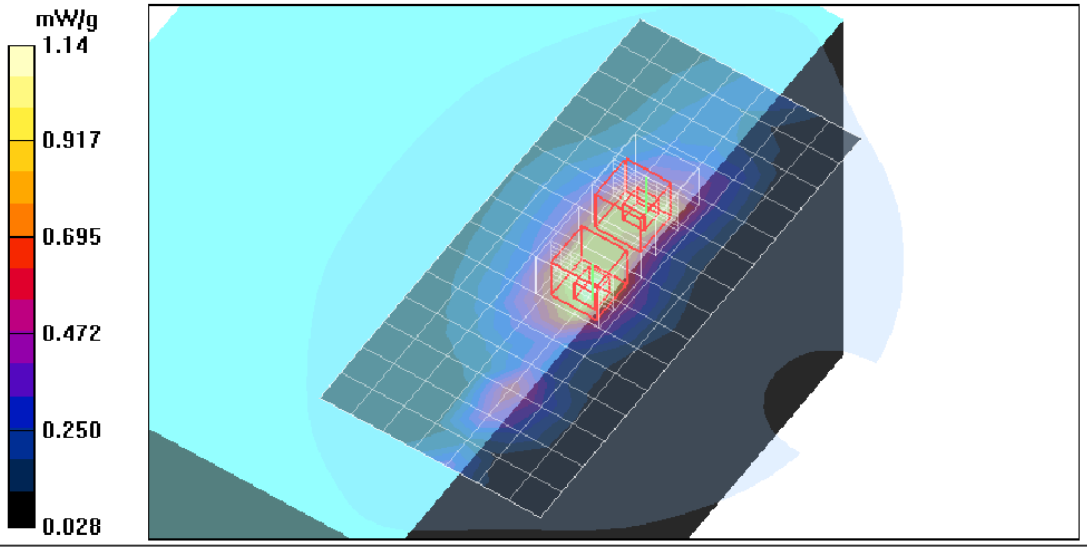
Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 23.0 deg. C

DASY4 Configuration:
- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV3 - SN3531; ConvF(7.91, 7.91, 7.91); Calibrated: 4/23/2008
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn500; Calibrated: 11/16/2007
- Phantom: SAM 2; Type: SAM 2; Serial: 1050
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

802.11n HT20 Tx 0 & Tx 1 H-ch/Area Scan (8x16x1): Measurement grid: dx=15mm, dy=15mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.14 mW/g

802.11n HT20 Tx 0 & Tx 1 H-ch/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm
Reference Value = 21.8 V/m; Power Drift = 0.151 dB
Peak SAR (extrapolated) = 1.56 W/kg
SAR(1 g) = 0.849 mW/g; SAR(10 g) = 0.476 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.11 mW/g

802.11n HT20 Tx 0 & Tx 1 H-ch/Zoom Scan (7x7x9)/Cube 1: Measurement grid: dx=5mm, dy=5mm, dz=3mm
Reference Value = 21.8 V/m; Power Drift = 0.151 dB
Peak SAR (extrapolated) = 1.37 W/kg
SAR(1 g) = 0.748 mW/g; SAR(10 g) = 0.432 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.995 mW/g



11.2 SAR TEST RESULT FOR THE BAND 5.15 – 5.25 GHZ

Mode	Channel	f (MHz)	Antenna	Measured SAR 1g (mW/g)	Limit
802.11a	40	5200	TX 0	0.513	1.6
802.11n HT20 MIMO	40	5200	TX 0 & TX 1		1.6
802.11n 40MHz SISO	46	5230	TX 0	**0.862**	1.6
802.11n 40MHz SISO	46	5230	TX 1	0.641	1.6
802.11n HT40 MIMO	46	5230	TX 0 & TX 1	0.476	1.6

Notes:

1) The modes with highest output power channel were chosen for the testing.
2) Waived 20 MHz MIMO mode SAR test due to lower output power.
3) Test configuration: Lapheld with display open at 90° to the keyboard.
4) 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.

The Highest SAR Plot & Data for 5.2 GHz Band

Date/Time: 8/5/2008 11:23:40 AM

Test Laboratory: Compliance Certification Services

Laptop 5.2 GHz band

DUT: MacBook; Type: n/a; Serial: n/a

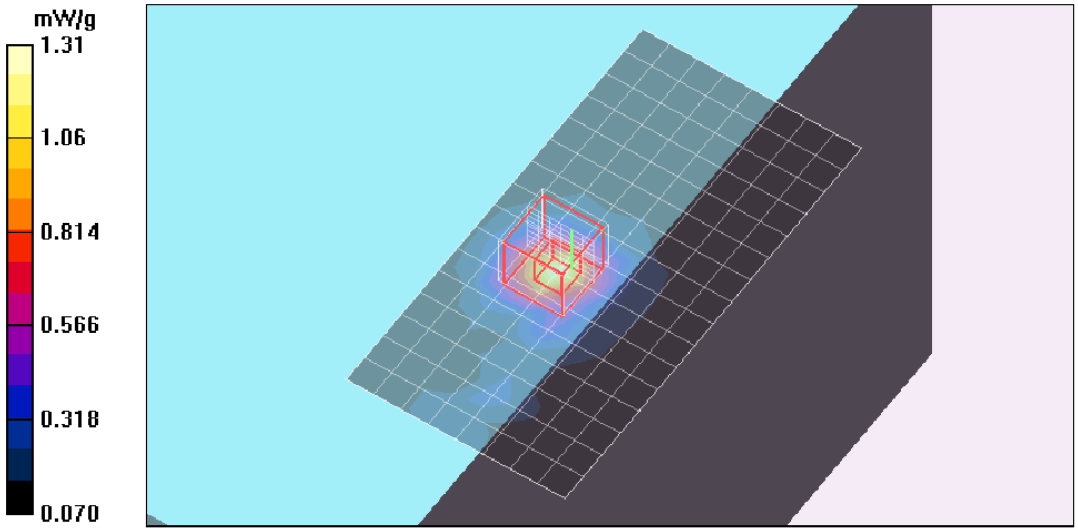
Communication System: 802.11abgn; Frequency: 5230 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5230 MHz; σ = 5.41 mho/m; ε_r = 44.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 23.0 deg. C

DASY4 Configuration:
- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV3 - SN3531; ConvF(4.21, 4.21, 4.21); Calibrated: 4/23/2008
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn500; Calibrated: 11/16/2007
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

802.11n 40MHz SISO 5.2G Tx 0 H-ch/Area Scan (9x17x1): Measurement grid: dx=10mm, dy=10mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.31 mW/g

802.11n 40MHz SISO 5.2G Tx 0 H-ch/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 5.79 V/m; Power Drift = 0.795 dB
Peak SAR (extrapolated) = 2.89 W/kg
SAR(1 g) = 0.862 mW/g; SAR(10 g) = 0.385 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.29 mW/g



11.3 SAR TEST RESULT FOR THE BAND 5.25 – 5.35 GHZ

Mode	Channel	f (MHz)	Antenna	Measured SAR 1g (mW/g)	Limit
802.11a	52	5260 (L)	TX 0	**1.100**	1.6
802.11a	60	5300 (M)	TX 0	1.050	1.6
802.11n HT20	60	5300 (M)	TX 0 & TX 1		1.6
802.11n 40MHz SISO	54	5270 (L)	TX 0	0.978	1.6
802.11n 40MHz SISO	54	5270 (L)	TX 1	0.676	1.6
802.11n HT40	54	5270 (L)	TX 0 & TX 1	0.991	1.6

Notes:

1) The modes with highest output power channel were chosen for the testing.
2) Waived 20 MHz MIMO mode SAR test due to lower output power.
3) Test configuration: Lapheld with display open at 90° to the keyboard.

The Highest SAR Plot & Data for 5.3 GHz Band

Date/Time: 8/5/2008 5:14:59 PM

Test Laboratory: Compliance Certification Services

Laptop 5.3 GHz Band

DUT: MacBook; Type: n/a; Serial: n/a

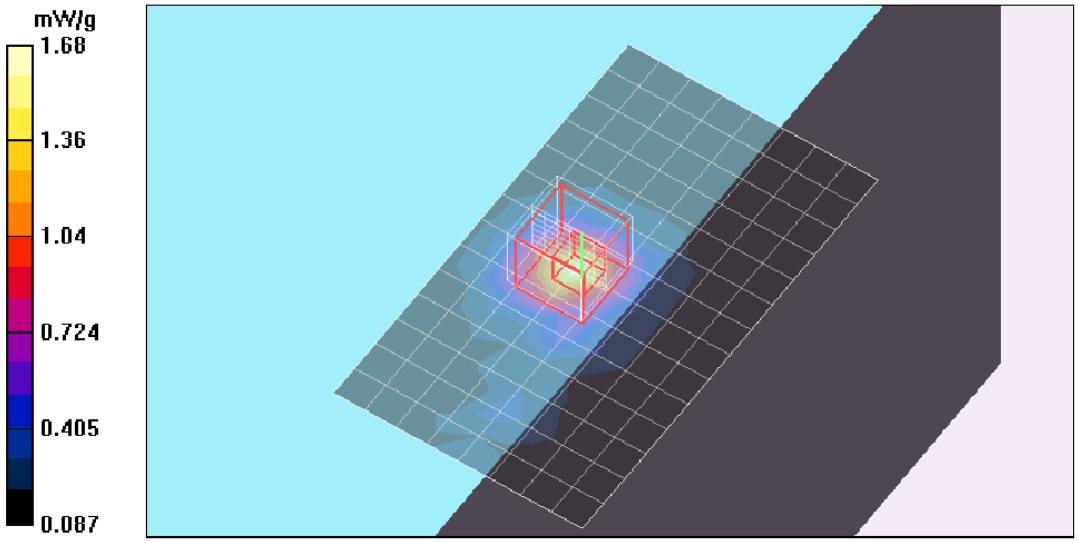
Communication System: 802.11abgn; Frequency: 5260 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5260 MHz; σ = 5.44 mho/m; ε_r = 44.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 23.0 deg. C

DASY4 Configuration:
- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV3 - SN3531; ConvF(3.92, 3.92, 3.92); Calibrated: 4/23/2008
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn500; Calibrated: 11/16/2007
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

802.11a 5.3G Tx 0 L-ch/Area Scan (9x15x1): Measurement grid: dx=10mm, dy=10mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.68 mW/g

802.11a 5.3G Tx 0 L-ch/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 6.61 V/m; Power Drift = 0.548 dB
Peak SAR (extrapolated) = 3.60 W/kg
SAR(1 g) = 1.1 mW/g; SAR(10 g) = 0.483 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.67 mW/g



11.4 SAR TEST RESULT FOR THE BAND 5.47 – 5.725 GHZ

Mode	Channel	f (MHz)	Antenna	Measured SAR 1g (mW/g)	Limit
802.11a	120 (M)	5600	TX 1	0.702	1.6
802.11n HT20	120 (M)	5600	TX 0 & TX 1		1.6
802.11n 40MHz SISO	118 (M)	5590	TX 0	0.810	1.6
802.11n 40MHz SISO	110 (L)	5550	TX 1	0.829	1.6
802.11n 40MHz SISO	118 (M)	5590	TX 1	0.842	1.6
802.11n 40MHz SISO	134 (H)	5670	TX 1	0.711	1.6
802.11n HT40	**110 (L)**	**5550**	**TX 0 & TX 1**	**1.230**	1.6
802.11n HT40	118 (M)	5590	TX 0 & TX 1	1.110	1.6
802.11n HT40	134 (H)	5670	TX 0 & TX 1	1.160	1.6

Notes:

1) The modes with highest output power channel were chosen for the testing.
2) Waived 20 MHz MIMO mode SAR test due to lower output power.
3) Test configuration: Lapheld with display open at 90° to the keyboard.
4) 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.
5) For 802.11n HT40 mode, the SAR measured at the middle channel is greater than 0.8 mW/g, SAR test is required at low and high channel. Due to power is reduced for low channel 102 to meet restricted band requirements, the highest output channel 110 was chosen for testing.

The Highest SAR Plot & Data for 5.5 GHz Band

Date/Time: 8/1/2008 1:39:07 PM

Test Laboratory: Compliance Certification Services

Laptop 5.5 GHz band

DUT: MacBook; Type: n/a; Serial: n/a

Communication System: 802.11a; Frequency: 5550 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5550 MHz; σ = 5.94 mho/m; ε_r = 45.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

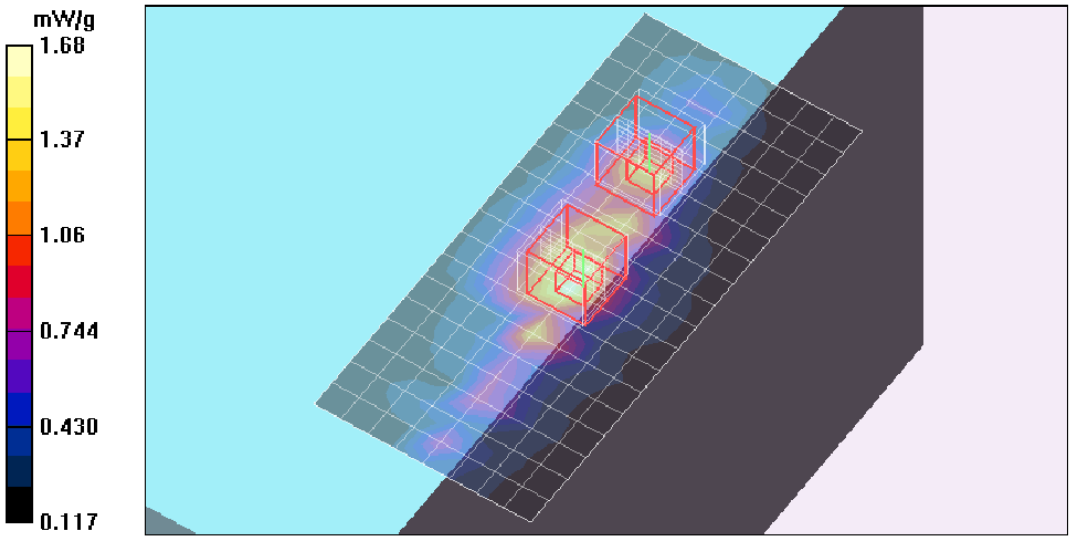
Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 23.0 deg. C

DASY4 Configuration:
- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV3 - SN3531; ConvF(3.99, 3.99, 3.99); Calibrated: 4/23/2008
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn500; Calibrated: 11/16/2007
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

802.11n 40MHz 5.5G Tx 0 & Tx 1 - L ch/Area Scan (9x19x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.68 mW/g

802.11n 40MHz 5.5G Tx 0 & Tx 1 - L ch/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 12.9 V/m; Power Drift = 0.644 dB
Peak SAR (extrapolated) = 5.79 W/kg
SAR(1 g) = 1.23 mW/g; SAR(10 g) = 0.551 mW/g
Maximum value of SAR (measured) = 1.93 mW/g

802.11n 40MHz 5.5G Tx 0 & Tx 1 - L ch/Zoom Scan (7x7x9)/Cube 1: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 12.9 V/m; Power Drift = 0.644 dB
Peak SAR (extrapolated) = 3.33 W/kg
SAR(1 g) = 0.988 mW/g; SAR(10 g) = 0.473 mW/g
Maximum value of SAR (measured) = 1.49 mW/g



11.5 SAR TEST RESULT FOR THE BAND 5.725 – 5850 GHZ

Mode	Channel	f (MHz)	Antenna	Measured SAR 1g (mW/g)	Limit
802.11a	149 (L)	5745	TX 1	1.11	1.6
802.11a	157(M)	5785	TX 1	1.14	1.6
802.11a	165 (H)	5825	TX 1	1.35	1.6
802.11n HT20 MIMO	157 (M)	5785	TX 0 & TX 1		1.6
802.11n 40MHz SISO	151 (L)	5755	TX 1	1.28	1.6
802.11n 40MHz SISO	**159 (H)**	**5795**	**TX 1**	**1.41**	1.6
802.11n HT40 (MIMO)	151 (L)	5755	TX 0 & TX 1	1.03	1.6
802.11n HT40 (MIMO)	159 (H)	5795	TX 0 & TX 1	1.05	1.6

Notes:

1) The modes with highest output power channel were chosen for the testing.
2) Waived 20 MHz MIMO mode SAR test due to lower output power.
3) Test configuration: Lapheld with display open at 90° to the keyboard.

The Highest SAR Plot & Data for 5.8 GHz Band

Date/Time: 8/4/2008 3:36:39 PM

Test Laboratory: Compliance Certification Services

Laptop 5.8 GHz Band

DUT: MacBook; Type: n/a; Serial: n/a

Communication System: 802.11abgn; Frequency: 5795 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5795 MHz; σ = 6.25 mho/m; ε_r = 45.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

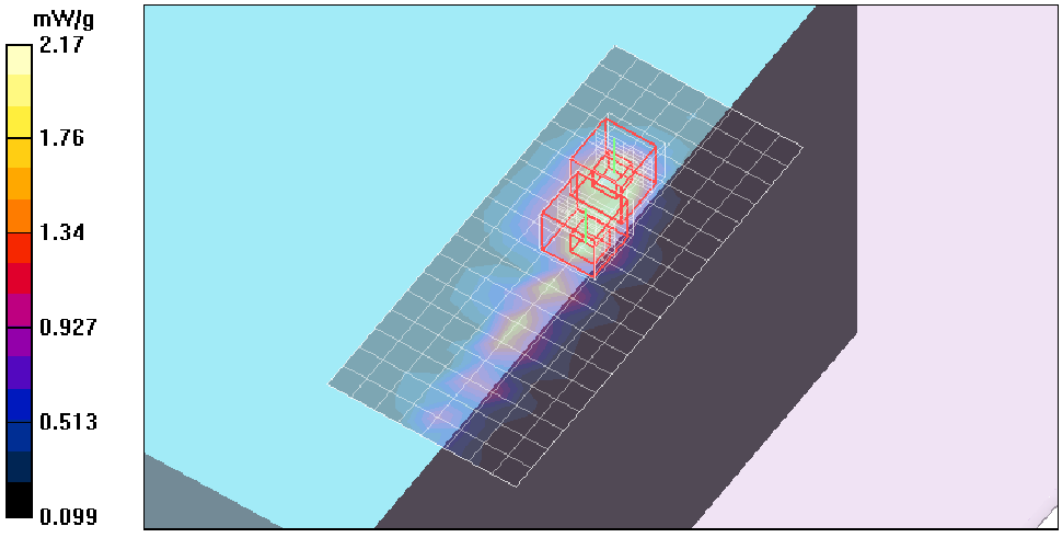
Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 23.0 deg. C

DASY4 Configuration:
- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV3 - SN3531; ConvF(3.7, 3.7, 3.7); Calibrated: 4/23/2008
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn500; Calibrated: 11/16/2007
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

802.11n SISO 40MHz 5.8G Tx 1- H-ch/Area Scan (9x19x1): Measurement grid: dx=10mm, dy=10mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 2.17 mW/g

802.11n SISO 40MHz 5.8G Tx 1- H-ch/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 15.8 V/m; Power Drift = 0.515 dB
Peak SAR (extrapolated) = 5.43 W/kg
SAR(1 g) = 1.41 mW/g; SAR(10 g) = 0.635 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 2.19 mW/g

802.11n SISO 40MHz 5.8G Tx 1- H-ch/Zoom Scan (7x7x9)/Cube 1: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 15.8 V/m; Power Drift = 0.515 dB
Peak SAR (extrapolated) = 4.82 W/kg
SAR(1 g) = 1.26 mW/g; SAR(10 g) = 0.547 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 2.02 mW/g



12 ATTACHMENTS

No.	Contents	No. Of Pages
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2-1	SAR Test Plots for 2.4 GHz Band	8
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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