FCC OET BULLETIN 65 SUPPLEMENT C Edition 01-01
IEEE STD 1528: 2003
IC RSS-102 ISSUE 4, March 2010
RSS-102 Supplementary Procedures (SPR)-001, January 1, 2011

Class II Permissive Change

SAR EVALUATION REPORT

For

802.11agn WLAN PCI-E Minicard
(Tested inside of HP PC, HSTNN-Q42C)

MODEL: BCM943228HM4L
FCC ID: QDS-BRCM1054
IC: 4324A- BRCM1054

REPORT NUMBER: 11U13694-1B

ISSUE DATE: March 3, 2011

Prepared for

BROADCOM CORPORATION
190 MATHILDA PLACE
SUNNYVALE, CA 94086, USA

Prepared by

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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	February 28, 2011	Initial Issue	--
A	February 28, 2011	Updated report includes IC supplementary procedure. Changed to "RSS-102 Issue 4, March 2010, and RSS-102 Supplementary Procedures (SPR)-001, January 1, 2011"	Sunny Shih
B	March 3, 2011	Corrected the reference standards	Devin Chang

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1. ATTESTATION OF TEST RESULTS

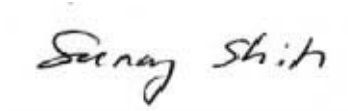
Applicant name:	BROADCOM CORPORATION 190 MATHILDA PLACE SUNNYVALE, CA 94086, USA			
EUT description:	802.11agn WLAN PCI-E Minicard. (Tested inside of HP PC, HSTNN-Q42C)			
Model number:	BCM943228HM4L, Serial number: CNF9302T8X			
Device category:	Portable			
Exposure category:	General Population/Uncontrolled Exposure			
Date tested:	February 22 - 24, 2011			
FCC / IC rule parts	Freq. range (MHz)	The Highest SAR (W/kg)		Limit (W/kg)
		1g	10g	
15.247 / RSS-102	2412 - 2462	0.316	0.149	1g = 1.6 10g = 2.0
15.407 / RSS-102	5150 – 5250	0.100	0.033	
	5250 – 5350	0.254	0.085	
	5500 – 5700	0.439	0.141	
15.247 / RSS-102	5725 – 5850	0.419	0.135	

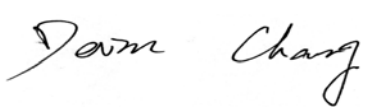
Applicable Standards	Test Results
FCC OET Bulletin 65 Supplement C Edition 01-01, IEEE STD 1528:2003 RSS-102 Issue 4, March 2010, and RSS-102 Supplementary Procedures (SPR)-001, January 1, 2011 o KDB 248227 SAR measurement procedures for 802.11a/b/g transmitters o KDB 616217 D01 o KDB 447498 D01 Mobile Portable RF Exposure v04, supplemental to KDB 616217 D03	Pass
Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2007 (No. 1) NZS 2772.1:1999 Radiofrequency fields - Maximum exposure levels - 3 kHz to 300 GHz incl Amendment No. 1, 1999	Pass

Compliance Certification Services (UL 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 UL CCS based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. 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 UL CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL CCS will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government (NIST Handbook 150, Annex A). This report is written to support regulatory compliance of the applicable standards stated above.

Approved & Released For UL CCS By: Tested By:





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Sunny Shih Engineering Team Leader Compliance Certification Services (UL CCS)	Devin Chang Associate RF Engineer Compliance Certification Services (UL CCS)

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC OET Bulletin 65 Supplement C Edition 01-01, IEEE STD 1528:2003, RSS-102 Issue 4, March 2010, and RSS-102 Supplementary Procedures (SPR)-001, January 1, 2011, and the following specific FCC Test Procedures.

- KDB 248227 SAR measurement procedures for 802.11a/b/g transmitters

Schedule 2 of Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2007 (No. 1), and NZS 2772.1:1999 Radiofrequency fields - Maximum exposure levels - 3 kHz to 300 GHz incl Amendment No. 1, 1999.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

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

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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.

Name of Equipment	Manufacturer	Type/Model	Serial No.	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	QD000P40CA	1185	N/A		
SAM Phantom (SAM2)	SPEAG	QD000P40CA	1050	N/A		
Oval Flat Phantom (ELI 4.0)	SPEAG	QD OVA001 B	1003	N/A		
Dielectronic Probe kit	HP	85070C	N/A	N/A		
ESA Series Network Analyzer	Agilent	E5071B	MY42100131	8	2	2011
Synthesized Signal Generator	HP	83732B	US34490599	7	14	2012
E-Field Probe	SPEAG	EX3DV4	3749	11	13	2011
Thermometer	ERTCO	639-1S	1718	7	19	2011
Data Acquisition Electronics	SPEAG	DAE3	427	7	21	2011
System Validation Dipole	SPEAG	D2450V2	706	4	19	2012
System Validation Dipole	SPEAG	*D5GHzV2	1075	9	3	2011
Power Meter	Giga-tronics	8651A	8651404	3	13	2012
Power Sensor	Giga-tronics	80701A	1834588	3	13	2012
Amplifier	Mini-Circuits	ZVE-8G	90606	N/A		
Amplifier	Mini-Circuits	ZHL-42W	D072701-5	N/A		
Simulating Liquid	SPEAG	M2450	N/A	Within 24 hrs of first test		
Simulating Liquid	SPAEG	M5800 (5-6GHz)	N/A	Within 24 hrs of first test		

Note:
*: Per KDB 450824 D02 requirements for dipole calibration, UL CCS has adopted two years calibration intervals. On annual basis, each measurement dipole has been evaluated and is in compliance with the following criteria:

1. There is no physical damage on the dipole
2. System validation with specific dipole is within 10% of calibrated value.
3. Return-loss is within 20% of calibrated measurement (test data on file in UL CCS)
4. Impedance is within 5Ω of calibrated measurement (test data on file in UL CCS)

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4.2. MEASUREMENT UNCERTAINTY

Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram

Component	error, %	Probe Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1) @ Body 2450 MHz	5.50	Normal	1	1	5.50
Axial Isotropy	1.15	Rectangular	1.732	0.7071	0.47
Hemispherical Isotropy	2.30	Rectangular	1.732	0.7071	0.94
Boundary Effect	0.90	Rectangular	1.732	1	0.52
Probe Linearity	3.45	Rectangular	1.732	1	1.99
System Detection Limits	1.00	Rectangular	1.732	1	0.58
Readout Electronics	0.30	Normal	1	1	0.30
Response Time	0.80	Rectangular	1.732	1	0.46
Integration Time	2.60	Rectangular	1.732	1	1.50
RF Ambient Conditions - Noise	3.00	Rectangular	1.732	1	1.73
RF Ambient Conditions - Reflections	3.00	Rectangular	1.732	1	1.73
Probe Positioner Mechanical Tolerance	0.40	Rectangular	1.732	1	0.23
Probe Positioning with respect to Phantom	2.90	Rectangular	1.732	1	1.67
Extrapolation, Interpolation and Integration	1.00	Rectangular	1.732	1	0.58
Test Sample Related					
Test Sample Positioning	2.90	Normal	1	1	2.90
Device Holder Uncertainty	3.60	Normal	1	1	3.60
Output Power Variation - SAR Drift	5.00	Rectangular	1.732	1	2.89
Phantom and Tissue Parameters					
Phantom Uncertainty (shape and thickness)	4.00	Rectangular	1.732	1	2.31
Liquid Conductivity - deviation from target	5.00	Rectangular	1.732	0.64	1.85
Liquid Conductivity - measurement	1.54	Normal	1	0.64	0.99
Liquid Permittivity - deviation from target	5.00	Rectangular	1.732	0.6	1.73
Liquid Permittivity - measurement uncertainty	-2.79	Normal	1	0.6	-1.67
				Combined Standard Uncertainty Uc(y) =	9.64
				Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence = 19.28	%
				Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence = 1.53	dB

3 to 6 GHz averaged over 1 gram

Component	error, %	Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1) @ 5GHz	6.55	Normal	1	1	6.55
Axial Isotropy	1.15	Rectangular	1.732	0.7071	0.47
Hemispherical Isotropy	2.30	Rectangular	1.732	0.7071	0.94
Boundary Effect	0.90	Rectangular	1.732	1	0.52
Probe Linearity	3.45	Rectangular	1.732	1	1.99
System Detection Limits	1.00	Rectangular	1.732	1	0.58
Readout Electronics	1.00	Normal	1	1	1.00
Response Time	0.80	Rectangular	1.732	1	0.46
Integration Time	2.60	Rectangular	1.732	1	1.50
RF Ambient Conditions - Noise	3.00	Rectangular	1.732	1	1.73
RF Ambient Conditions - Reflections	3.00	Rectangular	1.732	1	1.73
Probe Positioner Mechanical Tolerance	0.40	Rectangular	1.732	1	0.23
Probe Positioning with respect to Phantom	2.90	Rectangular	1.732	1	1.67
Extrapolation, Interpolation and Integration	3.90	Rectangular	1.732	1	2.25
Test Sample Related					
Test Sample Positioning	1.10	Normal	1	1	1.10
Device Holder Uncertainty	3.60	Normal	1	1	3.60
Output Power Variation - SAR Drift	5.00	Rectangular	1.732	1	2.89
Phantom and Tissue Parameters					
Phantom Uncertainty (shape and thickness)	4.00	Rectangular	1.732	1	2.31
Liquid Conductivity - deviation from target	5.00	Rectangular	1.732	0.64	1.85
Liquid Conductivity - measurement	2.49	Normal	1	0.64	1.59
Liquid Permittivity - deviation from target	10.00	Rectangular	1.732	0.6	3.46
Liquid Permittivity - measurement uncertainty	4.55	Normal	1	0.6	2.73
				Combined Standard Uncertainty Uc(y), %:	10.92
				Expanded Uncertainty U, Coverage Factor = 1.96, > 95 % Confidence = 21.40	%
				Expanded Uncertainty U, Coverage Factor = 1.96, > 95 % Confidence = 1.68	dB

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Measurement uncertainty for 300 MHz to 3 GHz averaged over 10 gram

Component	error, %	Probe Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1) @ Body 2450 MHz	5.50	Normal	1	1	5.50
Axial Isotropy	1.15	Rectangular	1.732	0.7071	0.47
Hemispherical Isotropy	2.30	Rectangular	1.732	0.7071	0.94
Boundary Effect	0.90	Rectangular	1.732	1	0.52
Probe Linearity	3.45	Rectangular	1.732	1	1.99
System Detection Limits	1.00	Rectangular	1.732	1	0.58
Readout Electronics	0.30	Normal	1	1	0.30
Response Time	0.80	Rectangular	1.732	1	0.46
Integration Time	2.60	Rectangular	1.732	1	1.50
RF Ambient Conditions - Noise	3.00	Rectangular	1.732	1	1.73
RF Ambient Conditions - Reflections	3.00	Rectangular	1.732	1	1.73
Probe Positioner Mechanical Tolerance	0.40	Rectangular	1.732	1	0.23
Probe Positioning with respect to Phantom	2.90	Rectangular	1.732	1	1.67
Extrapolation, Interpolation and Integration	1.00	Rectangular	1.732	1	0.58
Test Sample Related					
Test Sample Positioning	2.90	Normal	1	1	2.90
Device Holder Uncertainty	3.60	Normal	1	1	3.60
Output Power Variation - SAR Drift	5.00	Rectangular	1.732	1	2.89
Phantom and Tissue Parameters					
Phantom Uncertainty (shape and thickness)	4.00	Rectangular	1.732	1	2.31
Liquid Conductivity - deviation from target	5.00	Rectangular	1.732	0.43	1.24
Liquid Conductivity - measurement	1.54	Normal	1	0.43	0.66
Liquid Permittivity - deviation from target	5.00	Rectangular	1.732	0.49	1.41
Liquid Permittivity - measurement uncertainty	-2.79	Normal	1	0.49	-1.37
				Combined Standard Uncertainty Uc(y), % =	9.41
				Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence = 18.82	%
				Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence = 1.50	dB

3 to 6 GHz averaged over 10 gram

Component	error, %	Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1) @ 5GHz	6.55	Normal	1	1	6.55
Axial Isotropy	4.03	Rectangular	1.732	0.7071	1.64
Hemispherical Isotropy	6.90	Rectangular	1.732	0.7071	2.82
Boundary Effect	1.00	Rectangular	1.732	1	0.58
Probe Linearity	9.20	Rectangular	1.732	1	5.31
System Detection Limits	1.00	Rectangular	1.732	1	0.58
Readout Electronics	1.00	Normal	1	1	1.00
Response Time	0.80	Rectangular	1.732	1	0.46
Integration Time	2.60	Rectangular	1.732	1	1.50
RF Ambient Conditions - Noise	3.00	Rectangular	1.732	1	1.73
RF Ambient Conditions - Reflections	3.00	Rectangular	1.732	1	1.73
Probe Positioner Mechanical Tolerance	0.40	Rectangular	1.732	1	0.23
Probe Positioning with respect to Phantom	2.90	Rectangular	1.732	1	1.67
Extrapolation, Interpolation and Integration	3.90	Rectangular	1.732	1	2.25
Test Sample Related					
Test Sample Positioning	1.10	Normal	1	1	1.10
Device Holder Uncertainty	3.60	Normal	1	1	3.60
Output Power Variation - SAR Drift	5.00	Rectangular	1.732	1	2.89
Phantom and Tissue Parameters					
Phantom Uncertainty (shape and thickness)	4.00	Rectangular	1.732	1	2.31
Liquid Conductivity - deviation from target	5.00	Rectangular	1.732	0.43	1.24
Liquid Conductivity - measurement	2.49	Normal	1	0.43	1.07
Liquid Permittivity - deviation from target	10.00	Rectangular	1.732	0.49	2.83
Liquid Permittivity - measurement uncertainty	4.55	Normal	1	0.49	2.23
				Combined Standard Uncertainty Uc(y), %:	11.97
				Expanded Uncertainty U, Coverage Factor = 1.96, > 95 % Confidence = 23.94	%
				Expanded Uncertainty U, Coverage Factor = 1.96, > 95 % Confidence = 1.86	dB

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5. EQUIPMENT UNDER TEST

The EUT is an Broadcom 802.11agn WLAN PCI-E Minicard. (Tested inside of HP PC, HSTNN-Q42C)	
Normal operation:	Lap-held (with display open at 90° to the keyboard)
Antennas tested:	Installed inside of HP PC, HSTNN-Q42C Manufacturer — Antenna name Quanta Computer Inc. — Tx1(Main) Antenna: DQ643139000 Tx2(Aux/BT) Antenna: DQ643139000
Antenna-to-antenna/user separation distances:	See Section 14 for details of antenna locations and separation distances
Antenna-to-Antenna distances:	• 0 cm from Tx2-to-Bluetooth antenna (Tx2 antenna and Bluetooth are sharing a common antenna) • > 5 cm from Tx1-to-Tx2/BT antenna
Simultaneous transmission:	WiFi (TX1) can transmit simultaneously with Bluetooth Bluetooth - FCC ID: QDS-BRCM1051; IC ID: 4324A-BRCM1051
Assessment for SAR evaluation for Simultaneous transmission:	**WiFi and BT** KDB 447498 - The Bluetooth's output power is ≤ 60/f(GHz) mW, which stand-alone SAR evaluation is not required. Thus, simultaneous transmission SAR evaluation is not required for WiFi and Bluetooth antenna pair.

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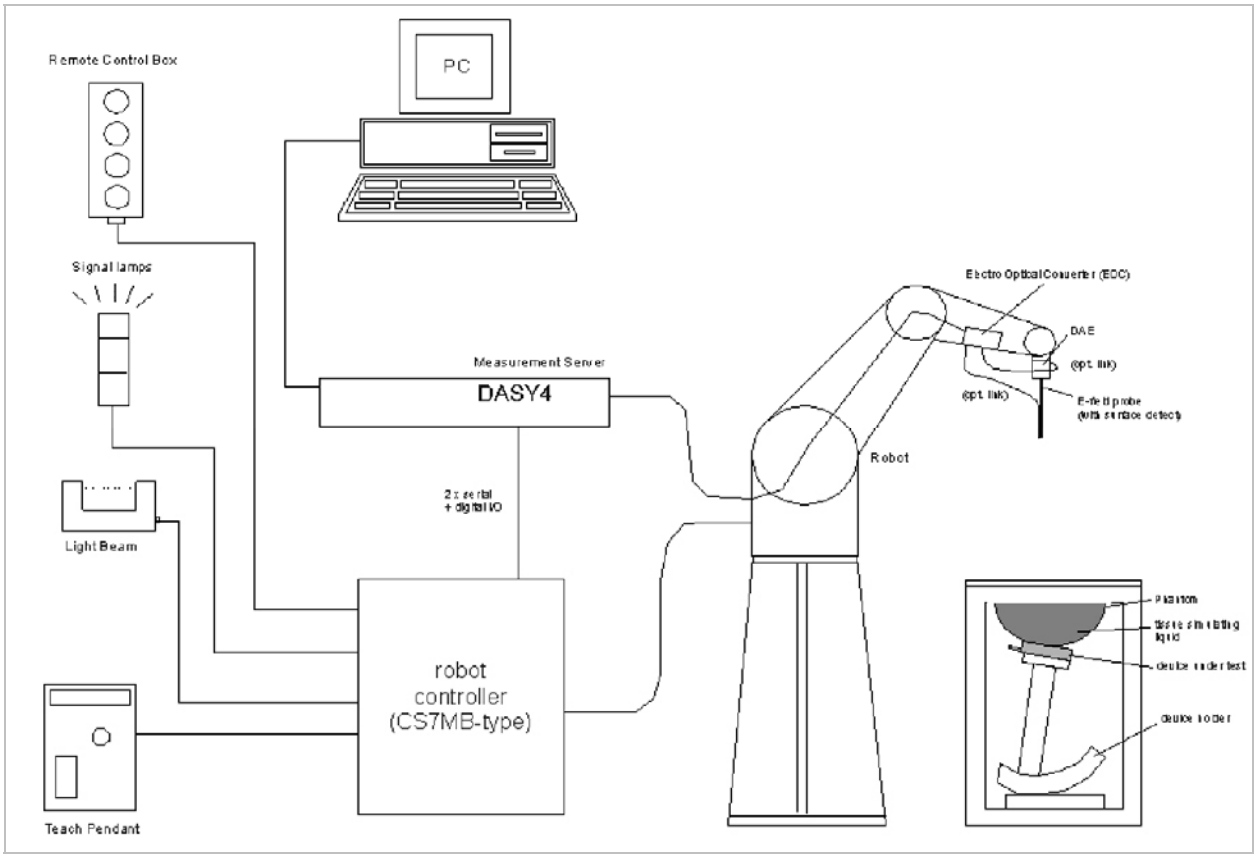
6. SYSTEM SPECIFICATIONS



The DASY 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.
- DASY 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 validating the proper functioning of the system.

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7. 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		900		1800 - 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

Simulating Liquids for 5 GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	78
Mineral oil	11
Emulsifiers	9
Additives and Salt	2

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8. LIQUID PARAMETERS

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. For frequencies in 300 MHz to just under 2 GHz, the measured conductivity and relative permittivity should be within ± 5% of the target values. For frequencies in the range of 2–3 GHz and above the measured conductivity should be within ± 5% of the target values. The measured relative permittivity tolerance can be relaxed to no more than ± 10%.

Reference Values of Tissue Dielectric Parameters for Head & Body Phantom
The 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	0.8
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.9	55.2	0.97
900	41.5	0.97	55	1.05
915	41.5	0.98	55	1.06
1450	40.5	1.2	54	1.3
1610	40.3	1.29	53.8	1.4
1800 – 2000	40	1.4	53.3	1.52
2450	39.2	1.8	52.7	1.95
3000	38.5	2.4	52	2.73
5800	35.3	5.27	48.2	6

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

Reference Values of Tissue Dielectric Parameters for 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)	Body Tissue		Reference
	rel. permitivity	conductivity	
3000	52.0	2.73	Standard
5100	49.1	5.18	Interpolated
5200	49.0	5.30	Interpolated
5300	48.9	5.42	Interpolated
5400	48.7	5.53	Interpolated
5500	48.6	5.65	Interpolated
5600	48.5	5.77	Interpolated
5700	48.3	5.88	Interpolated
5800	48.2	6.00	Standard

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

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8.1. LIQUID CHECK RESULTS

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
02/22/11	Body 5200	e'	49.2405	Relative Permittivity (ϵ_r):	49.24	49.02	0.45	10
		e"	18.1641	Conductivity (σ):	5.25	5.29	-0.81	5
02/22/11	Body 5500	e'	48.6537	Relative Permittivity (ϵ_r):	48.65	48.61	0.08	10
		e"	18.6123	Conductivity (σ):	5.69	5.64	0.84	5
02/22/11	Body 5800	e'	48.0854	Relative Permittivity (ϵ_r):	48.09	48.20	-0.24	10
		e"	19.0671	Conductivity (σ):	6.15	6.00	2.49	5

Liquid Check
Ambient temperature: 25 deg. C; Liquid temperature: 24 deg. C; Relative humidity = 38%
February 22, 2011 09:44 AM

Frequency	e'	e"
4600000000.	50.4440	17.0790
4650000000.	50.3485	17.1578
4700000000.	50.2488	17.2746
4750000000.	50.1569	17.3512
4800000000.	50.0539	17.4598
4850000000.	49.9523	17.5385
4900000000.	49.8537	17.6462
4950000000.	49.7551	17.7164
5000000000.	49.6592	17.8239
5050000000.	49.5503	17.8843
5100000000.	49.4515	18.0022
5150000000.	49.3527	18.0537
5200000000.	**49.2405**	**18.1641**
5250000000.	49.1523	18.2168
5300000000.	49.0339	18.3137
5350000000.	48.9571	18.3820
5400000000.	48.8425	18.4649
5450000000.	48.7652	18.5418
5500000000.	**48.6537**	**18.6123**
5550000000.	48.5641	18.6893
5600000000.	48.4729	18.7643
5650000000.	48.3706	18.8325
5700000000.	48.2777	18.9136
5750000000.	48.1770	18.9779
5800000000.	**48.0854**	**19.0671**
5850000000.	48.0005	19.1244
5900000000.	47.8886	19.2100
5950000000.	47.8110	19.2790

The conductivity (σ) can be given as:

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

where f = target f * 10^6

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

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Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
02/23/11	Body 5200	e'	51.2509	Relative Permittivity (ϵ_r):	51.25	49.02	4.55	10
		e"	18.1730	Conductivity (σ):	5.25	5.29	-0.76	5
02/23/11	Body 5500	e'	50.7148	Relative Permittivity (ϵ_r):	50.71	48.61	4.32	10
		e"	18.6324	Conductivity (σ):	5.70	5.64	0.95	5
02/23/11	Body 5800	e'	50.1077	Relative Permittivity (ϵ_r):	50.11	48.20	3.96	10
		e"	19.0088	Conductivity (σ):	6.13	6.00	2.17	5

Liquid Check
Ambient temperature: 25 deg. C; Liquid temperature: 24 deg. C; Relative humidity = 37%
February 23, 2011 08:40 AM

Frequency	e'	e"
4600000000.	52.3698	17.1801
4650000000.	52.2916	17.2543
4700000000.	52.2091	17.3568
4750000000.	52.1037	17.4270
4800000000.	52.0405	17.5436
4850000000.	51.9215	17.5895
4900000000.	51.8385	17.7167
4950000000.	51.7509	17.7621
5000000000.	51.6326	17.8756
5050000000.	51.5774	17.9408
5100000000.	51.4338	18.0221
5150000000.	51.3786	18.1047
5200000000.	**51.2509**	**18.1730**
5250000000.	51.1698	18.2513
5300000000.	51.0935	18.3266
5350000000.	50.9646	18.3814
5400000000.	50.9161	18.4841
5450000000.	50.7725	18.5067
5500000000.	**50.7148**	**18.6324**
5550000000.	50.6125	18.6413
5600000000.	50.5035	18.7746
5650000000.	50.4578	18.7883
5700000000.	50.2973	18.8922
5750000000.	50.2808	18.9401
5800000000.	**50.1077**	**19.0088**
5850000000.	50.0757	19.0833
5900000000.	49.9476	19.1545
5950000000.	49.8699	19.2057
6000000000.	49.7506	19.2997

The conductivity (σ) can be given as:

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

where f = target f * 10^6

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

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Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
02/24/11	Body 2450	e'	51.2281	Relative Permittivity (ϵ_r):	51.23	52.70	-2.79	5
		e"	14.5342	Conductivity (σ):	1.98	1.95	1.54	5

Liquid Check
Ambient temperature: 24 deg. C; Liquid temperature: 23 deg. C; Relative humidity = 41%
February 24, 2011 03:08 PM

Frequency	e'	e"
2410000000.	51.3613	14.3804
2415000000.	51.3458	14.3986
2420000000.	51.3271	14.4217
2425000000.	51.3124	14.4400
2430000000.	51.2942	14.4604
2435000000.	51.2759	14.4812
2440000000.	51.2605	14.4973
2445000000.	51.2468	14.5153
2450000000.	**51.2281**	**14.5342**
2455000000.	51.2060	14.5534
2460000000.	51.1904	14.5700
2465000000.	51.1718	14.5882
2470000000.	51.1529	14.6079
2475000000.	51.1348	14.6288
2480000000.	51.1158	14.6451
2485000000.	51.0978	14.6644

The conductivity (σ) can be given as:

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

where f = target f * 10^6

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

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9. SYSTEM VERIFICATION

The system performance check is performed prior to any usage of the system in order to verify SAR system measurement accuracy. 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 Head or Body simulating liquid of the following parameters.
- The DASY4 system with an Isotropic E-Field Probe EX3DV3 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 fine cube was chosen for cube
- Distance between probe sensors and phantom surface was set to 3 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was 100 mW
- The results are normalized to 1 W input power.

Reference SAR Values for HEAD & BODY-tissue from calibration certificate of SPEAG.

System validation dipole	Cal. certificate #	Cal. date	Cal. Freq. (GHz)	SAR Avg (mW/g)		
				Tissue:	Head	Body
D2450V2	D2450V2-706_Apr10	4/19/10	2.4	SAR_{1g}:	51.6	52.4
				SAR_{10g}:	24.4	24.5
*D5GHzV2	D5GHzV2-1075_Sep09	9/3/09	5.2	SAR_{1g}:		79.0
				SAR_{10g}:		22.0
			5.5	SAR_{1g}:		85.4
				SAR_{10g}:		23.5
			5.8	SAR_{1g}:		73.2
				SAR_{10g}:		20.1

Note:
*: Per KDB 450824 D02 requirements for dipole calibration, UL CCS has adopted two years calibration intervals. On annual basis, each measurement dipole has been evaluated and is in compliance with the following criteria:

1. There is no physical damage on the dipole
2. System validation with specific dipole is within 10% of calibrated value.
3. Return-loss is within 20% of calibrated measurement (test data on file in UL CCS)
4. Impedance is within 5Ω of calibrated measurement (test data on file in UL CCS)

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9.1. SYSTEM CHECK RESULTS

Measured by: David Lee

System validation dipole	Date Tested	Measured (Normalized to 1 W)		Target	Delta (%)	Tolerance (%)
		Tissue:	Body			
D5GHzV2 (5.2GHz)	02/22/11	SAR_{1g}:	77.3	79.0	-2.15	±10
		SAR_{10g}:	22.2	22.0	0.91	
D5GHzV2 (5.5GHz)	02/22/11	SAR_{1g}:	85.3	85.4	-0.12	±10
		SAR_{10g}:	24.1	23.5	2.55	
D5GHzV2 (5.8GHz)	02/22/11	SAR_{1g}:	71.6	73.2	-2.19	±10
		SAR_{10g}:	20.3	20.1	1.00	
D5GHzV2 (5.2GHz)	02/23/11	SAR_{1g}:	74.5	79.0	-5.70	±10
		SAR_{10g}:	21.4	22.0	-2.73	
D5GHzV2 (5.5GHz)	02/23/11	SAR_{1g}:	79.2	85.4	-7.26	±10
		SAR_{10g}:	22.5	23.5	-4.26	
D5GHzV2 (5.8GHz)	02/23/11	SAR_{1g}:	67.6	73.2	-7.65	±10
		SAR_{10g}:	19.3	20.1	-3.98	
D2450V2	02/24/11	SAR_{1g}:	50.1	52.4	-4.39	±10
		SAR_{10g}:	23.0	24.5	-6.12	

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Date/Time: 2/22/2011 11:44:10 AM

Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D5GHzV2

DUT: Dipole 5200-5800MHz; Type: D5GHzV2; Serial: 1075

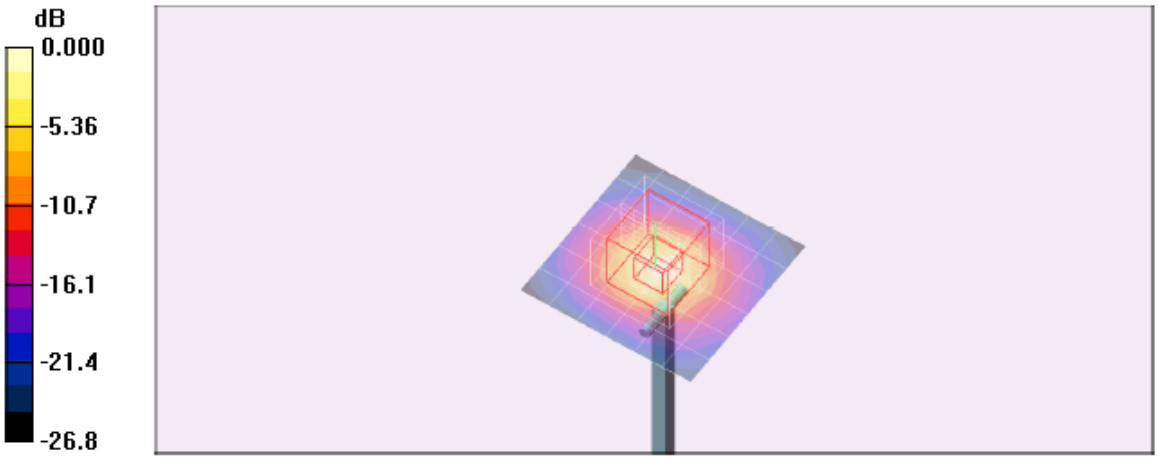
Communication System: System Check Signal - CW; Frequency: 5200 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 5.25 mho/m; ε_r = 49.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(4.07, 4.07, 4.07); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1017
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.2GHz, d=10mm, Pin=100mW/Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 13.8 mW/g

5.2GHz, d=10mm, Pin=100mW/Zoom Scan (8x8x10)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 55.6 V/m; Power Drift = -0.020 dB
Peak SAR (extrapolated) = 27.7 W/kg
SAR(1 g) = 7.73 mW/g; SAR(10 g) = 2.22 mW/g



0 dB = 13.8mW/g

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Date/Time: 2/22/2011 12:11:23 PM

Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D5GHzV2

DUT: Dipole 5200-5800MHz; Type: D5GHzV2; Serial: 1075

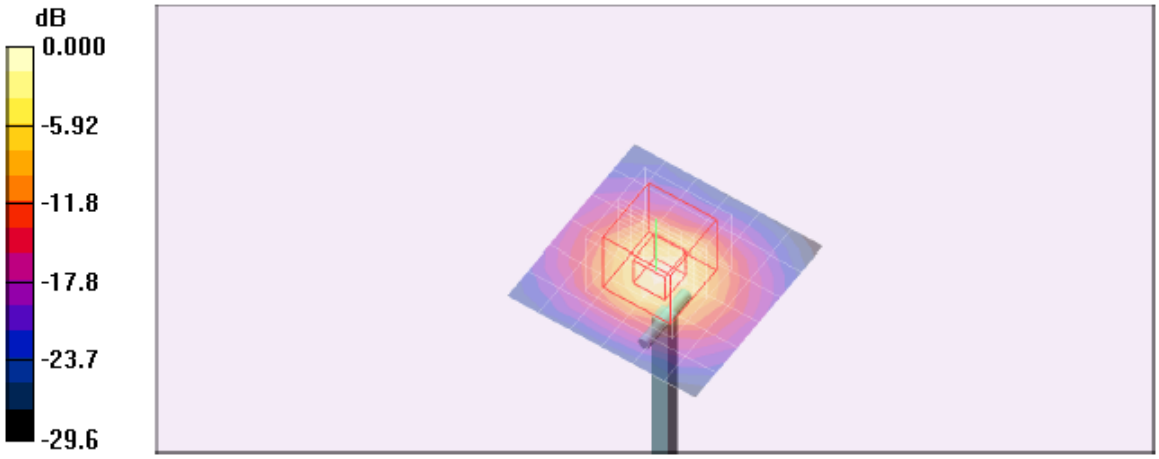
Communication System: System Check Signal - CW; Frequency: 5500 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5500 MHz; σ = 5.69 mho/m; ε_r = 48.7; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(3.53, 3.53, 3.53); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1017
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.5GHz, d=10mm, Pin=100mW/Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 15.4 mW/g

5.5GHz, d=10mm, Pin=100mW/Zoom Scan (8x8x10)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 57.0 V/m; Power Drift = -0.010 dB
Peak SAR (extrapolated) = 32.0 W/kg
SAR(1 g) = 8.53 mW/g; SAR(10 g) = 2.41 mW/g
Maximum value of SAR (measured) = 15.6 mW/g



0 dB = 15.6mW/g

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Date/Time: 2/22/2011 12:37:43 PM

Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D5GHzV2

DUT: Dipole 5200-5800MHz; Type: D5GHzV2; Serial: 1075

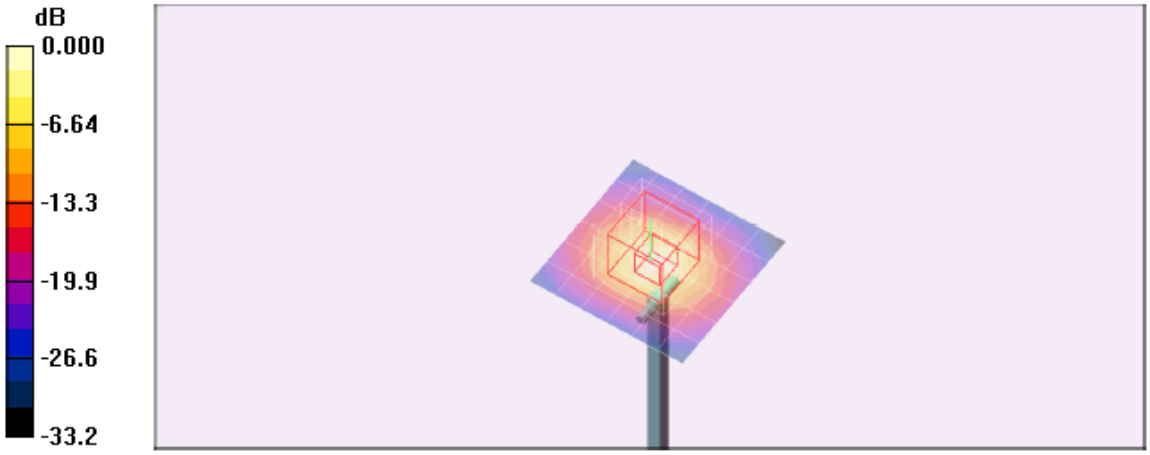
Communication System: System Check Signal - CW; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; σ = 6.15 mho/m; ε_r = 48.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(3.65, 3.65, 3.65); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1017
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.8GHz, d=10mm, Pin=100mW/Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 13.0 mW/g

5.8GHz, d=10mm, Pin=100mW/Zoom Scan (8x8x10)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 50.4 V/m; Power Drift = 0.005 dB
Peak SAR (extrapolated) = 29.2 W/kg
SAR(1 g) = 7.16 mW/g; SAR(10 g) = 2.03 mW/g



0 dB = 13.0mW/g

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Date/Time: 2/22/2011 1:01:48 PM

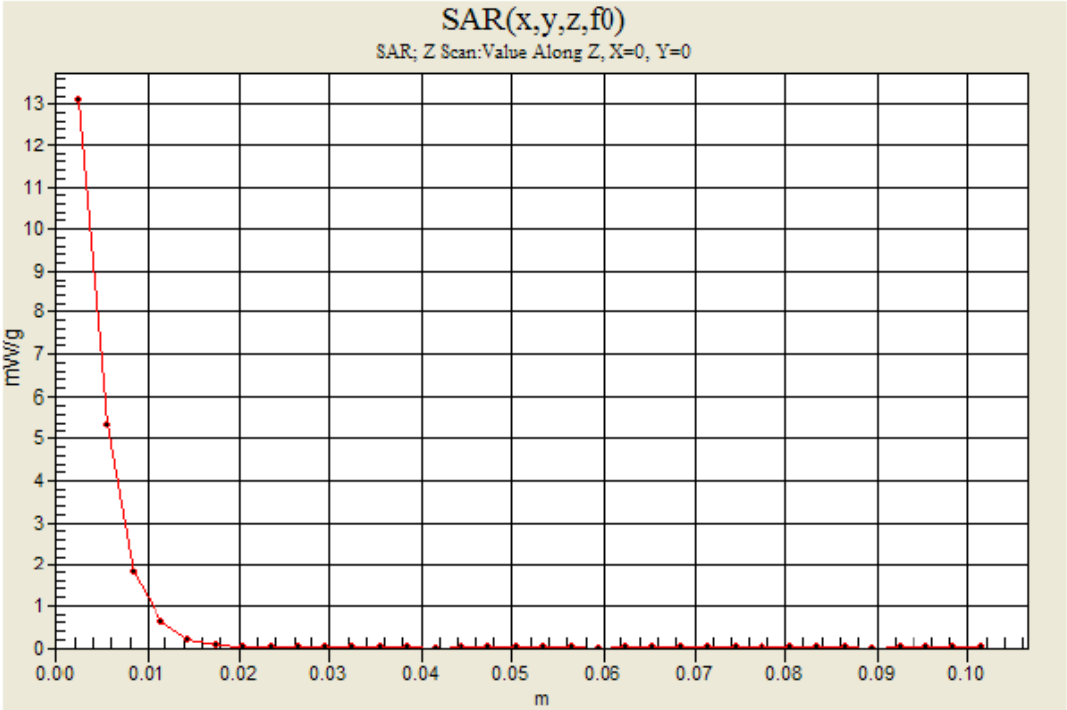
Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D5GHzV2

DUT: Dipole 5200-5800MHz; Type: D5GHzV2; Serial: 1075

Communication System: System Check Signal - CW; Frequency: 5800 MHz;Duty Cycle: 1:1

5.8GHz, d=10mm, Pin=100mW/Z Scan (1x1x34): Measurement grid: dx=20mm, dy=20mm, dz=3mm
Maximum value of SAR (measured) = 13.1 mW/g



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Date/Time: 2/23/2011 10:40:08 AM

Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D5GHzV2

DUT: Dipole 5200-5800MHz; Type: D5GHzV2; Serial: 1075

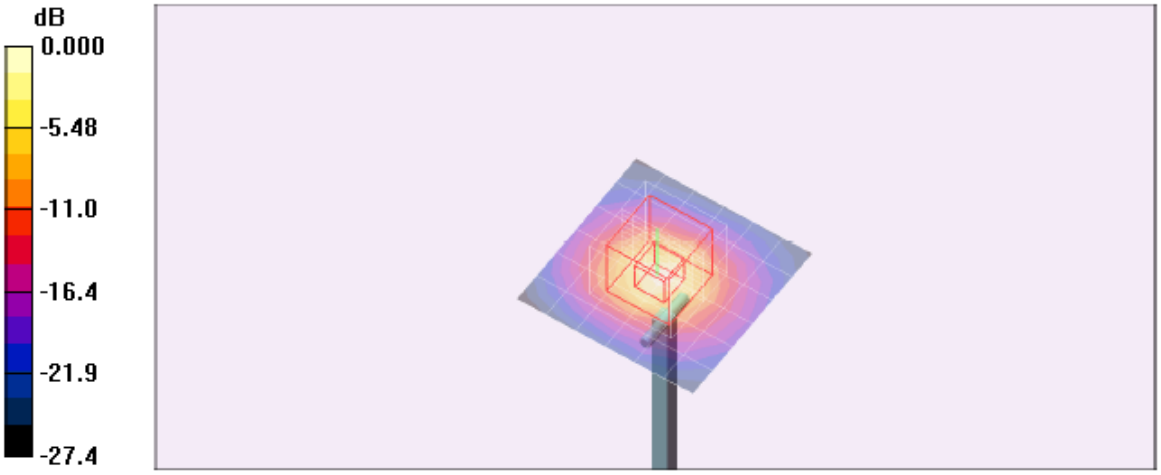
Communication System: System Check Signal - CW; Frequency: 5200 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 5.26 mho/m; ε_r = 51.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(4.07, 4.07, 4.07); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1017
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.2GHz, d=10mm, Pin=100mW/Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 13.1 mW/g

5.2GHz, d=10mm, Pin=100mW/Zoom Scan (8x8x10)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 53.7 V/m; Power Drift = 0.110 dB
Peak SAR (extrapolated) = 26.3 W/kg
SAR(1 g) = 7.45 mW/g; SAR(10 g) = 2.14 mW/g
Maximum value of SAR (measured) = 13.4 mW/g



0 dB = 13.4mW/g

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Date/Time: 2/23/2011 9:08:16 AM

Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D5GHzV2

DUT: Dipole 5200-5800MHz; Type: D5GHzV2; Serial: 1075

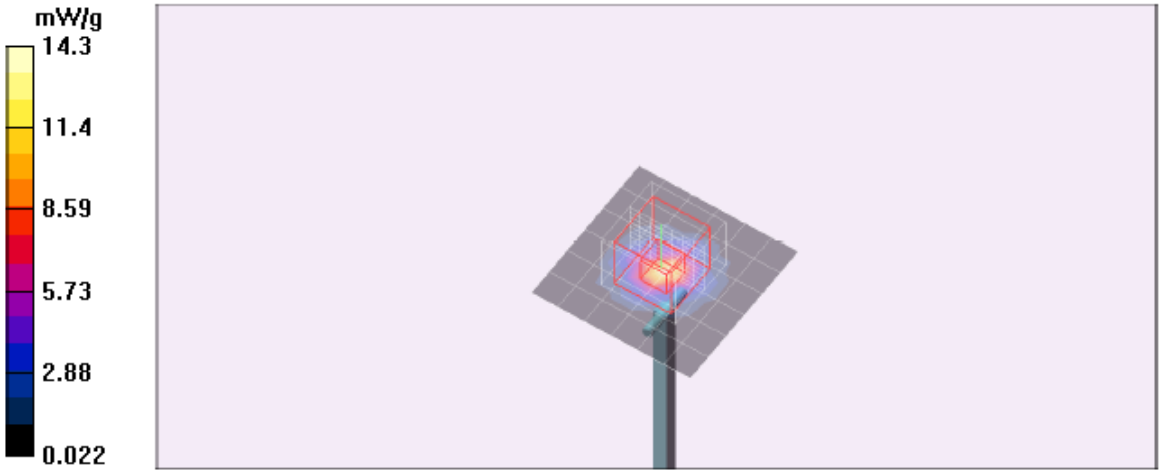
Communication System: System Check Signal - CW; Frequency: 5500 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5500 MHz; σ = 5.7 mho/m; ε_r = 50.7; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(3.53, 3.53, 3.53); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1017
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.5GHz, d=10mm, Pin=100mW/Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 14.3 mW/g

5.5GHz, d=10mm, Pin=100mW/Zoom Scan (8x8x10)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 54.9 V/m; Power Drift = 0.063 dB
Peak SAR (extrapolated) = 27.3 W/kg
SAR(1 g) = 7.92 mW/g; SAR(10 g) = 2.25 mW/g
Maximum value of SAR (measured) = 14.4 mW/g



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Date/Time: 2/23/2011 9:42:28 AM

Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D5GHzV2

DUT: Dipole 5200-5800MHz; Type: D5GHzV2; Serial: 1075

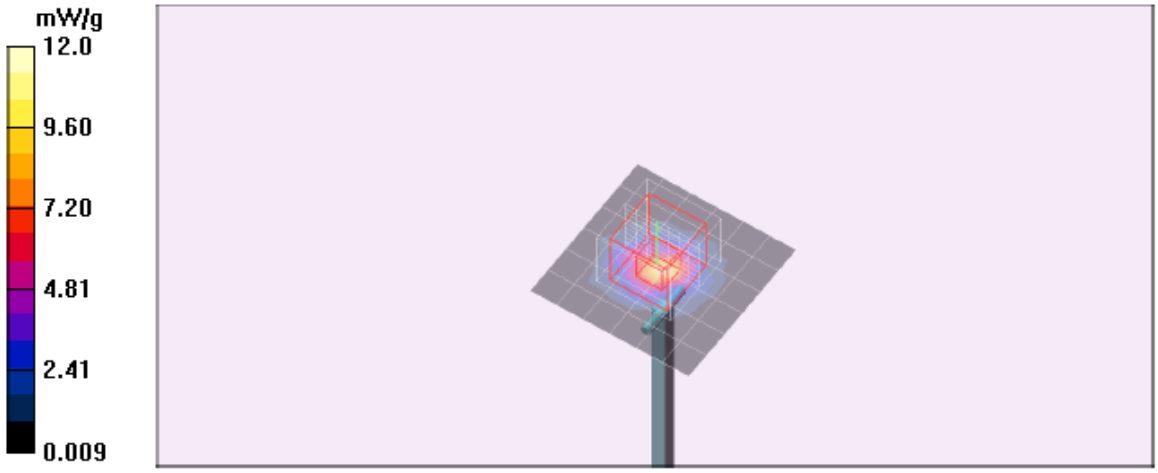
Communication System: System Check Signal - CW; Frequency: 5800 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; σ = 6.13 mho/m; ε_r = 50.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(3.65, 3.65, 3.65); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1017
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5.8GHz, d=10mm, Pin=100mW/Area Scan (7x7x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 12.0 mW/g

5.8GHz, d=10mm, Pin=100mW/Zoom Scan (8x8x10)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 48.6 V/m; Power Drift = 0.174 dB
Peak SAR (extrapolated) = 25.3 W/kg
SAR(1 g) = 6.76 mW/g; SAR(10 g) = 1.93 mW/g
Maximum value of SAR (measured) = 12.2 mW/g



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Date/Time: 2/23/2011 10:06:49 AM

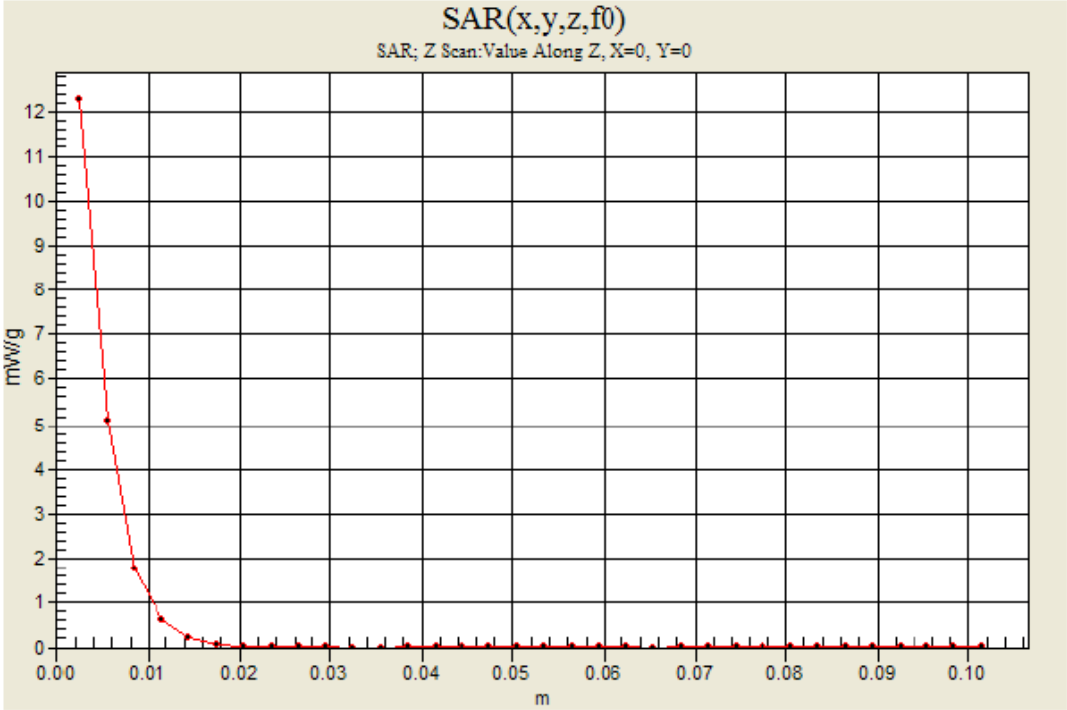
Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D5GHzV2

DUT: Dipole 5200-5800MHz; Type: D5GHzV2; Serial: 1075

Communication System: System Check Signal - CW; Frequency: 5800 MHz;Duty Cycle: 1:1

5.8GHz, d=10mm, Pin=100mW/Z Scan (1x1x34): Measurement grid: dx=20mm, dy=20mm, dz=3mm
Maximum value of SAR (measured) = 12.3 mW/g



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Date/Time: 2/24/2011 3:16:23 PM

Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D2450V2

DUT: Dipole ; Type: D2450V2; Serial: 706

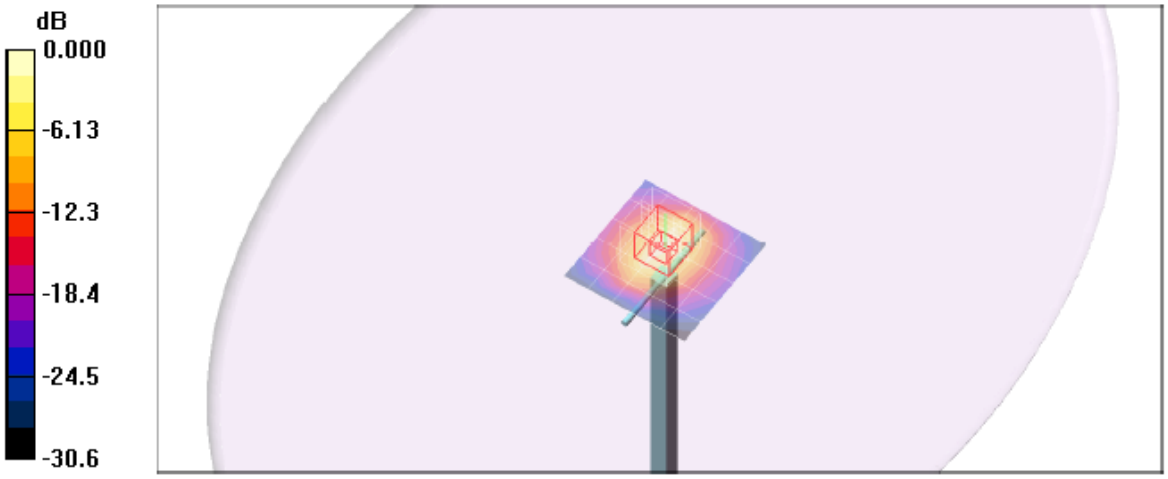
Communication System: System Check Signal - CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.98 mho/m; ε_r = 51.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(6.9, 6.9, 6.9); Calibrated: 12/13/2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=10mm, Pin=100mW/Area Scan (6x6x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 5.95 mW/g

d=10mm, Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.8 V/m; Power Drift = -0.022 dB
Peak SAR (extrapolated) = 10.4 W/kg
SAR(1 g) = 5.01 mW/g; SAR(10 g) = 2.3 mW/g
Maximum value of SAR (measured) = 6.63 mW/g



0 dB = 6.63mW/g

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Date/Time: 2/24/2011 3:31:10 PM

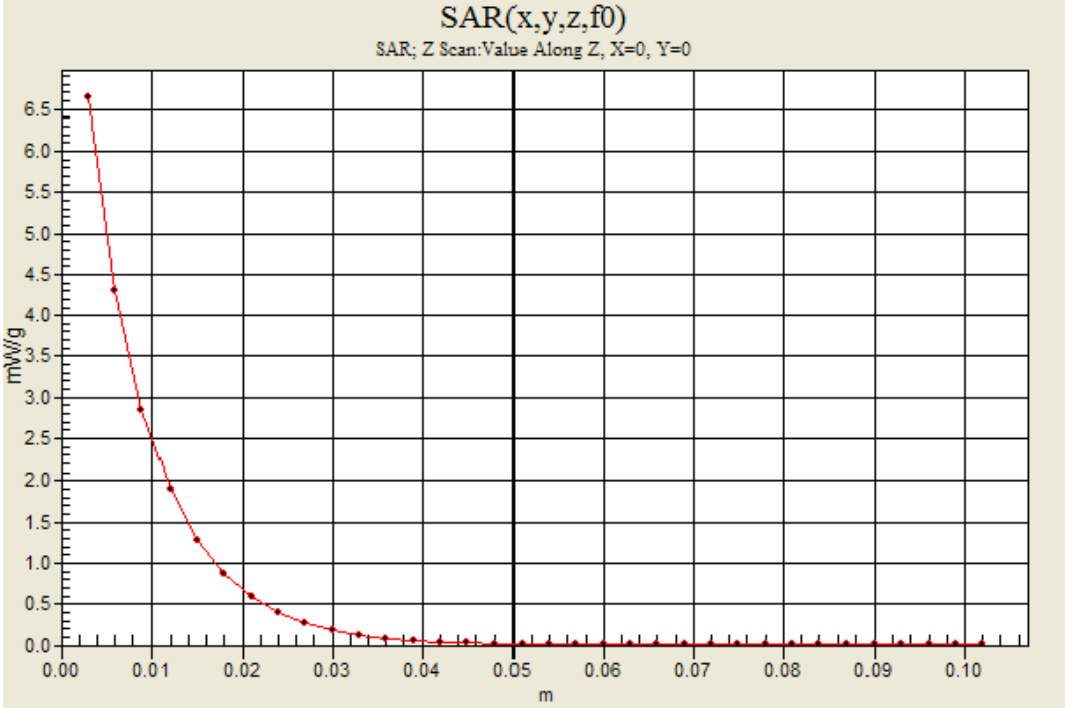
Test Laboratory: Compliance Certification Services (UL CCS)

System Performance Check - D2450V2

DUT: Dipole ; Type: D2450V2; Serial: 706

Communication System: System Check Signal - CW; Frequency: 2450 MHz;Duty Cycle: 1:1

d=10mm, Pin=100mW/Z Scan (1x1x34): Measurement grid: dx=20mm, dy=20mm, dz=3mm
Maximum value of SAR (measured) = 6.64 mW/g



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10. SAR MEASUREMENT PROCEDURES

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.

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.

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11. RF OUTPUT POWER VERIFICATION

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

The client provided a special driver and program, wl_tools, which enable a operator to control the frequency and output power of the module.

11.1. RF OUTPUT POWER FOR 2.4 GHZ BAND

2.4 GHz Band				
Mode	Ch. #	Freq. (MHz)	Avg RF Output Pwr (dBm)	
			Main (TX1)	Aux (TX2)
802.11b	1	2412	19.0	
	6	2437	19.2	
	11	2462	16.5	
802.11g	1	2412		19.1
	6	2437		19.1
	11	2462		16.6
802.11n HT20	1	2412	13.0	13.1
	6	2437	13.0	13.1
	11	2462	13.5	13.6
802.11n HT40	3	2422	11.6	11.6
	6	2437	14.0	14.2
	9	2450	10.6	10.5

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11.2. RF OUTPUT POWER FOR 5 GHZ BANDS

5.2 GHz Band				
Mode	Ch. #	Freq. (MHz)	Avg RF Output Pwr (dBm)	
			Main (TX1)	Aux (TX2)
802.11a	36	5180	13.1	
	40	5200	13.4	
	48	5240	13.7	
	36	5180		13.1
	40	5200		13.4
	48	5240		13.7
802.11n HT20	36	5180	10.5	10.0
	40	5200	10.4	10.1
	48	5240	9.8	10.1
802.11n HT40	38	5190	9.9	9.6
	46	5230	10.4	10.2
5.3 GHz Band				
Mode	Ch. #	Freq. (MHz)	Avg RF Output Pwr (dBm)	
			Main (TX1)	Aux (TX2)
802.11a	52	5260	17.7	
	60	5300	15.7	
	64	5320	14.1	
	52	5260		17.7
	60	5300		15.7
	64	5320		14.1
802.11n HT20	52	5260	13.0	12.7
	60	5300	15.2	15.4
	64	5320	14.2	14.4
802.11n HT40	54	5270	16.3	17.2
	62	5310	11.7	11.9

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RF OUTPUT POWER FOR 5 GHZ BANDS (Continued)

5.5 GHz Band				
Mode	Ch. #	Freq. (MHz)	Avg RF Output Pwr (dBm)	
			Main (TX1)	Aux (TX2)
802.11a	100	5500	16.9	
	120	5600	17.5	
	140	5700	18.2	
	100	5500		16.9
	120	5600		17.5
	140	5700		18.2
802.11n HT20	100	5500	16.2	16.3
	120	5600	16.1	16.2
	140	5700	16.2	16.3
802.11n HT40	102	5510	13.7	14.0
	118	5590	18.0	17.8
	134	5670	18.2	18.1

5.8 GHz Band				
Mode	Ch. #	Freq. (MHz)	Avg RF Output Pwr (dBm)	
			Main (TX1)	Aux (TX2)
802.11a	149	5745	17.0	
	157	5785	17.6	
	165	5825	17.5	
	149	5745		17.0
	157	5785		17.6
	165	5825		17.5
802.11n HT20	149	5745	17.1	17.0
	157	5785	17.6	17.5
	165	5825	17.6	17.5
802.11n HT40	151	5755	18.0	18.2
	159	5795	18.9	19.1

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12. SUMMARY OF SAR TEST RESULTS

12.1. SAR TEST RESULT FOR 2.4 GHZ

Lap-held (w/ display open at 90° to the keyboard)

Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
2.4 GHz	802.11b Legacy	1	2412	Main	19.0		
		6	2437	Main	19.2	**0.316**	0.149
		11	2462	Main	16.5		
		1	2412	Aux	19.1		
		6	2437	Aux	19.1	0.285	0.143
		11	2462	Aux	16.6		

Nearby Person (w/ 1.5 cm separation distance, from back of display-to-phantom)

Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
2.4 GHz	802.11b Legacy	1	2412	Main	19.0		
		6	2437	Main	19.2	0.010	0.0051
		11	2462	Main	16.5		
		1	2412	Aux	19.1		
		6	2437	Aux	19.1	0.015	0.00836
		11	2462	Aux	16.6		

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WORST-CASE SAR TEST LPOTS FOR 2.4 GHZ

2.4 GHz band

Date/Time: 2/24/2011 3:59:59 PM

Test Laboratory: Compliance Certification Services (UL CCS)

Lapheld_2.4 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

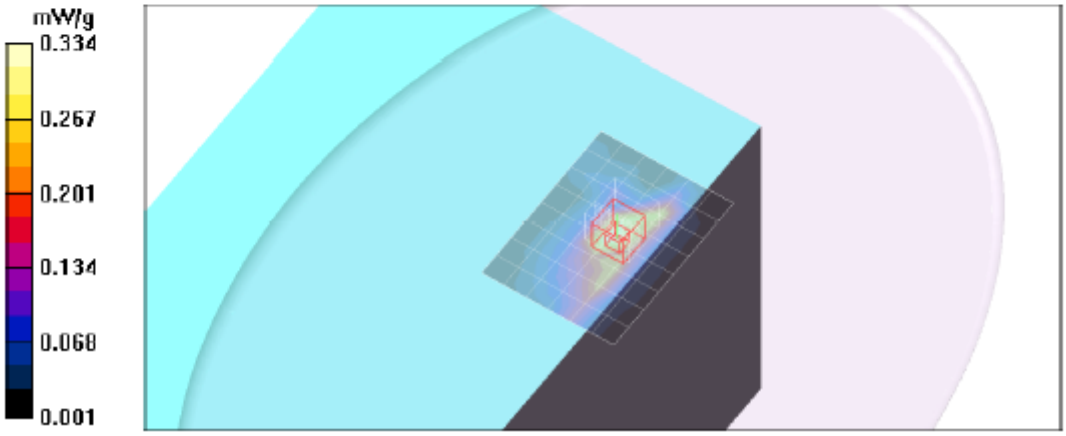
Communication System: 802.11b/g 2.4GHz; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2437 MHz; σ = 1.96 mho/m; ε_r = 51.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(6.9, 6.9, 6.9); Calibrated: 12/13/2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

802.11b M-ch Main Ant/Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.334 mW/g

802.11b M-ch Main Ant/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm
Reference Value = 13.0 V/m; Power Drift = -0.171 dB
Peak SAR (extrapolated) = 0.715 W/kg
SAR(1 g) = 0.316 mW/g; SAR(10 g) = 0.149 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.423 mW/g



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Z-axis Plot

Date/Time: 2/24/2011 4:20:24 PM

Test Laboratory: Compliance Certification Services (UL CCS)

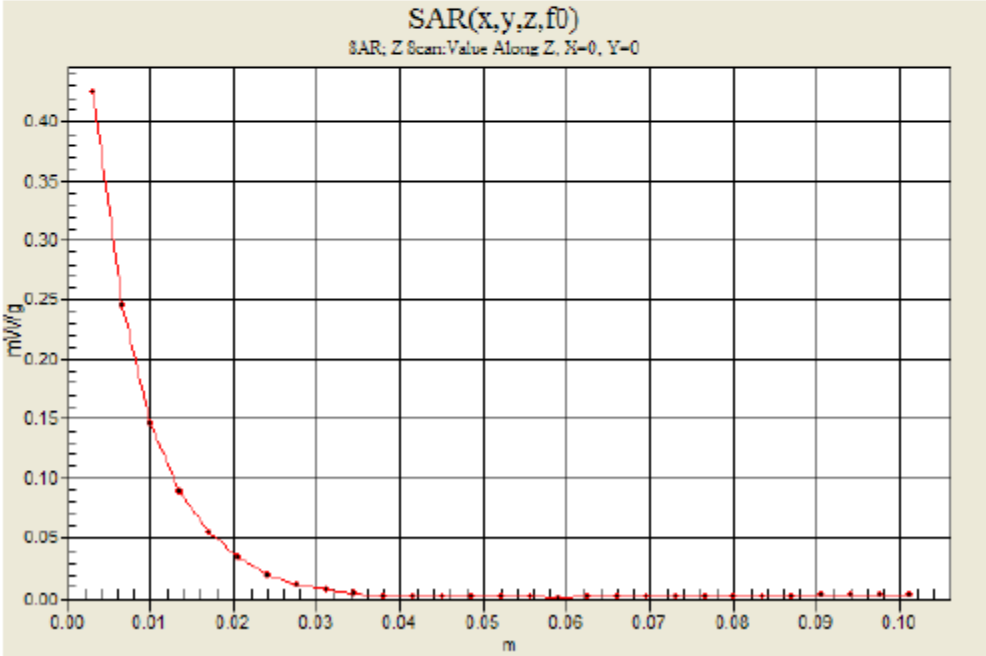
Lapheld_2.4 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

Communication System: 802.11b/g 2.4GHz; Frequency: 2437 MHz;Duty Cycle: 1:1

802.11b M-ch Main Ant/Z Scan (1x1x29): Measurement grid: dx=20mm, dy=20mm, dz=3.5mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.425 mW/g



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12.2. SAR TEST RESULTS FOR 5 GHZ BANDS

Lap-held (w/ display open at 90° to the keyboard)

Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
5.2 GHz	802.11a Legacy	36	5180	Main	13.1		
		40	5200	Main	13.4	0.047	0.012
		48	5240	Main	13.7	0.025	0.00714
		36	5180	Aux	13.1		
		40	5200	Aux	13.4	0.095	0.031
		48	5240	Aux	13.7	**0.100**	0.033
Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
5.3 GHz	802.11a Legacy	52	5260	Main	17.7	0.056	0.019
		60	5300	Main	15.7	0.012	0.00382
		64	5320	Main	14.1		
		52	5260	Aux	17.7	**0.254**	0.085
		60	5300	Aux	15.7	0.164	0.052
		64	5320	Aux	14.1		
Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
5.5 GHz	802.11a Legacy	100	5500	Main	16.9		
		120	5600	Main	17.5	0.210	0.069
		140	5700	Main	18.2	0.415	0.137
		100	5500	Aux	16.9		
		120	5600	Aux	17.5	0.336	0.103
		140	5700	Aux	18.2	**0.439**	0.141
	802.11n HT40	102	5510	Main/Aux	13.7 / 14.0		
		118	5590	Main/Aux	18.0 / 17.8		
		134	5670	Main/Aux	18.2 / 18.1	0.407	0.128
Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
5.8 GHz	802.11a Legacy	149	5745	Main	17.0		
		157	5785	Main	17.6	0.242	0.073
		165	5825	Main	17.5		
		149	5745	Aux	17.0		
		157	5785	Aux	17.6	0.377	0.120
		165	5825	Aux	17.5		
	802.11n HT40	151	5755	Main/Aux	18.0 / 18.2		
		159	5795	Main/Aux	18.9 / 19.1	**0.419**	0.135

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Nearby Person (w/ 1.5 cm separation distance, from back of display-to-phantom)

Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
5.2 GHz	802.11a Legacy	36	5180	Main	13.1		
		40	5200	Main	13.4	0.00378	0.00104
		48	5240	Main	13.7	**0.00575**	0.00184
		36	5180	Aux	13.1		
		40	5200	Aux	13.4	0.00203	0.000421
		48	5240	Aux	13.7	0.00161	0.000185
Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
5.3 GHz	802.11a Legacy	52	5260	Main	17.7	0.00403	0.00109
		60	5300	Main	15.7	**0.012**	0.00355
		64	5320	Main	14.1		
		52	5260	Aux	17.7	0.00247	0.000543
		60	5300	Aux	15.7	0.00377	0.000772
		64	5320	Aux	14.1		
Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
5.5 GHz	802.11a Legacy	100	5500	Main	16.9		
		120	5600	Main	17.5	**0.025**	0.00675
		140	5700	Main	18.2	0.020	0.0075
		100	5500	Aux	16.9		
		120	5600	Aux	17.5	0.0071	0.00217
		140	5700	Aux	18.2	0.00288	0.000587
	802.11n HT40	102	5510	Main/Aux	13.7 / 14.0		
		118	5590	Main/Aux	18.0 / 17.8		
		134	5670	Main/Aux	18.2 / 18.1	0.012	0.00364
Band	Mode	Channel	f (MHz)	Antenna Port	Avg Pwr (dBm)	Results (mW/g)	
						1g-SAR	10g-SAR
5.8 GHz	802.11a Legacy	149	5745	Main	17.0		
		157	5785	Main	17.6	0.00234	0.000406
		165	5825	Main	17.5		
		149	5745	Aux	17.0		
		157	5785	Aux	17.6	0.000734	0.0000669
		165	5825	Aux	17.5		
	802.11n HT40	151	5755	Main/Aux	18.0 / 18.2		
		159	5795	Main/Aux	18.9 / 19.1	**0.012**	0.00266

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47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
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WORST-CASE SAR PLOTS FOR 5 GHZ BANDS

5.2 GHz Band

Date/Time: 2/22/2011 7:22:25 PM

Test Laboratory: Compliance Certification Services (UL CCS)

Lapheld_5.2 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

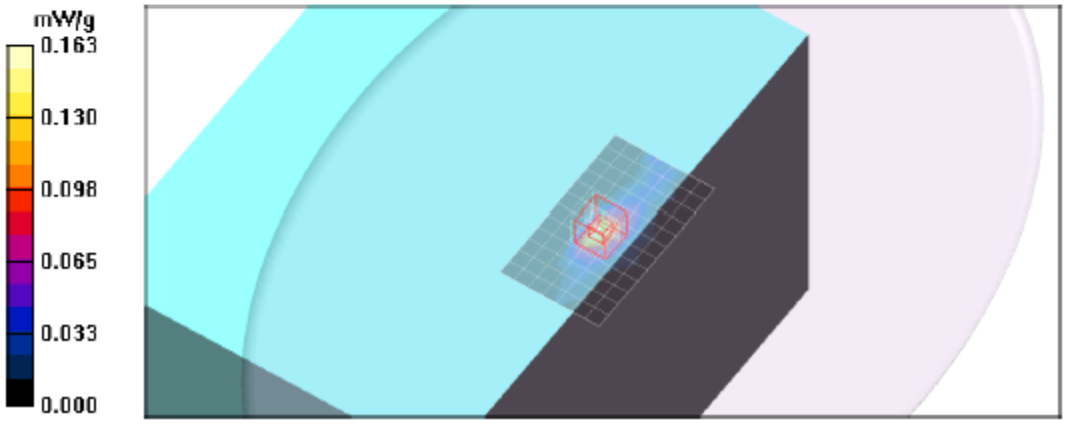
Communication System: 802.11abgn; Frequency: 5240 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5240 MHz; σ = 5.31 mho/m; ε_r = 49.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(4.07, 4.07, 4.07); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

802.11a_Ch 48_Aux Ant/Area Scan (8x13x1): Measurement grid: dx=10mm, dy=10mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.163 mW/g

802.11a_Ch 48_Aux Ant/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 6.00 V/m; Power Drift = -0.124 dB
Peak SAR (extrapolated) = 0.306 W/kg
SAR(1 g) = 0.100 mW/g; SAR(10 g) = 0.033 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.168 mW/g



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Z-axis Plot

Date/Time: 2/22/2011 7:46:00 PM

Test Laboratory: Compliance Certification Services (UL CCS)

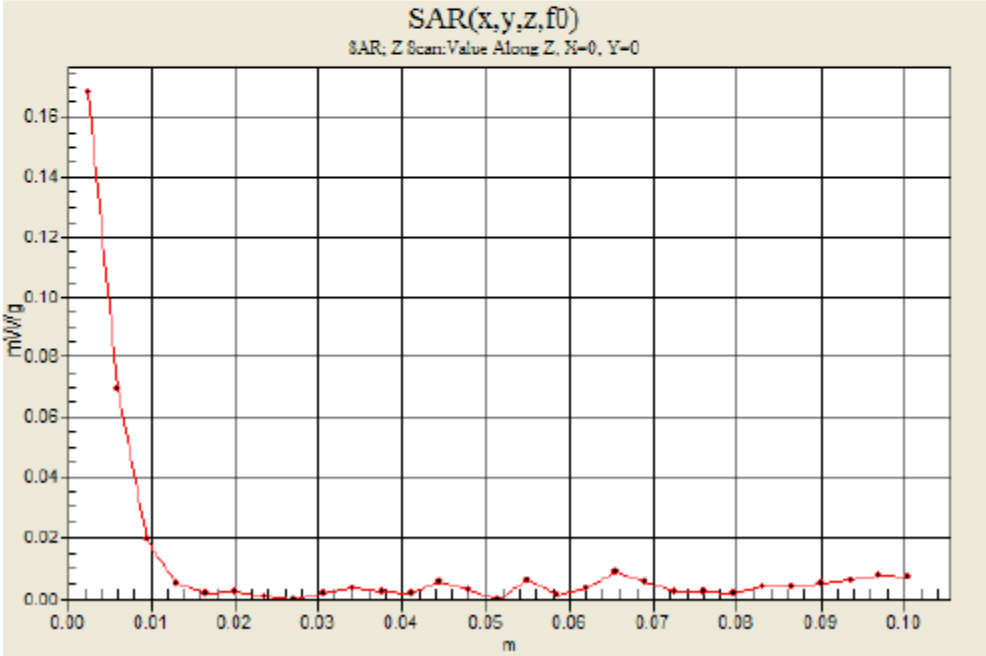
Lapheld_5.2 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

Communication System: 802.11abgn; Frequency: 5240 MHz;Duty Cycle: 1:1

802.11a_Ch 48_Aux Ant/Z Scan (1x1x29): Measurement grid: dx=20mm, dy=20mm, dz=3.5mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.168 mW/g



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5.3 GHz Band

Date/Time: 2/22/2011 7:52:13 PM

Test Laboratory: Compliance Certification Services (UL CCS)

Lapheld_5.3 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

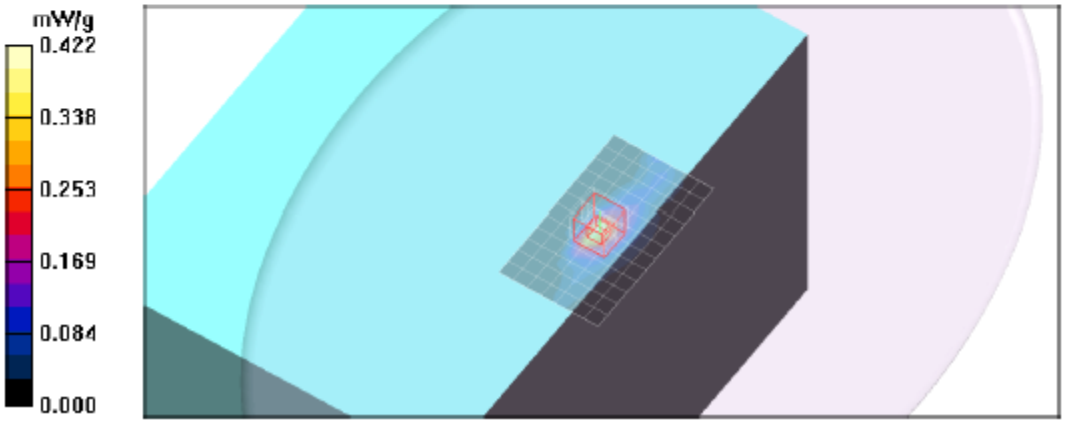
Communication System: 802.11abgn; Frequency: 5260 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5260 MHz; σ = 5.34 mho/m; ε_r = 49.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(3.88, 3.88, 3.88); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

802.11a_Ch 52_Aux Ant/Area Scan (8x13x1): Measurement grid: dx=10mm, dy=10mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.422 mW/g

802.11a_Ch 52_Aux Ant/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 9.74 V/m; Power Drift = -0.187 dB
Peak SAR (extrapolated) = 0.771 W/kg
SAR(1 g) = 0.254 mW/g; SAR(10 g) = 0.085 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.424 mW/g



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Z-axis Plot

Date/Time: 2/22/2011 8:15:41 PM

Test Laboratory: Compliance Certification Services (UL CCS)

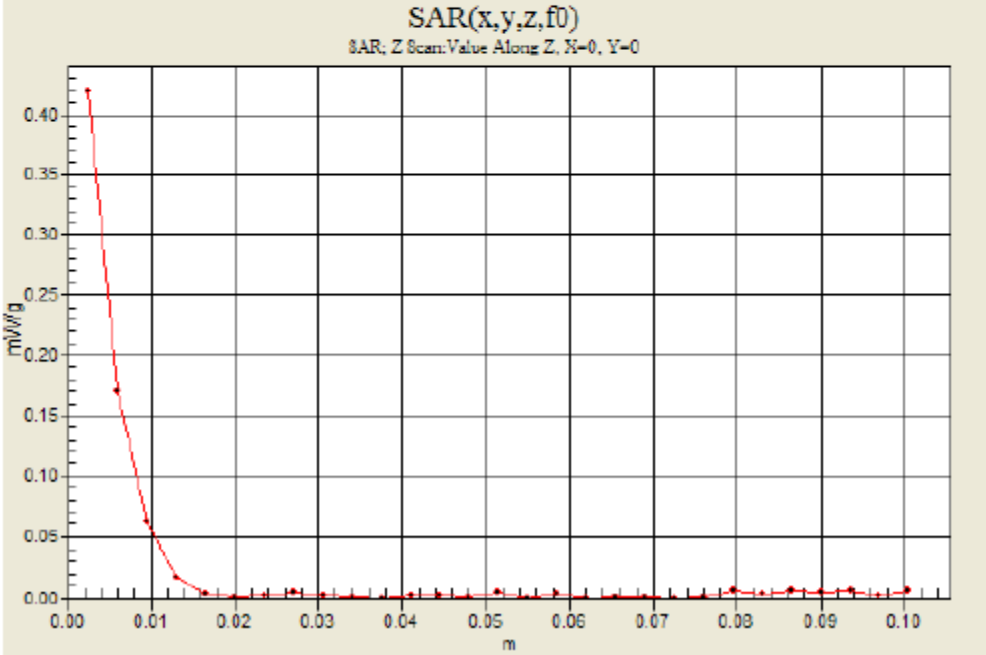
Lapheld_5.3 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

Communication System: 802.11abgn; Frequency: 5260 MHz;Duty Cycle: 1:1

802.11a_Ch 52_Aux Ant/Z Scan (1x1x29): Measurement grid: dx=20mm, dy=20mm, dz=3.5mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.420 mW/g



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5.5 GHz Band

Date/Time: 2/22/2011 2:46:26 PM

Test Laboratory: Compliance Certification Services (UL CCS)

Lapheld_5.5 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

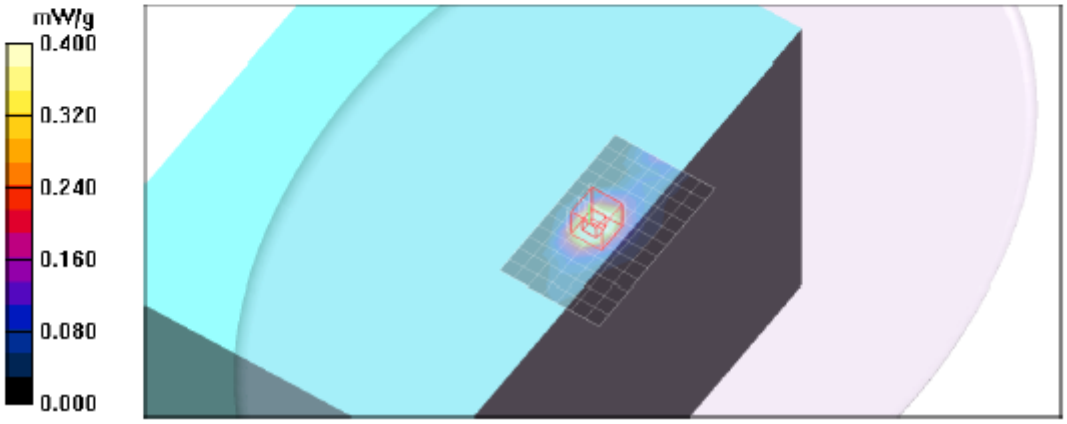
Communication System: 802.11abgn; Frequency: 5700 MHz;Duty Cycle: 1:1
Medium parameters used: f = 5700 MHz; σ = 6 mho/m; ε_r = 48.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 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: EX3DV4 - SN3749; ConvF(3.36, 3.36, 3.36); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

802.11a_Ch 140_Aux Ant/Area Scan (8x13x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.653 mW/g

802.11a_Ch 140_Aux Ant/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 11.5 V/m; Power Drift = 0.227 dB
Peak SAR (extrapolated) = 1.52 W/kg
SAR(1 g) = 0.439 mW/g; SAR(10 g) = 0.141 mW/g
Maximum value of SAR (measured) = 0.766 mW/g



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Z-axis Plot

Date/Time: 2/22/2011 3:10:05 PM

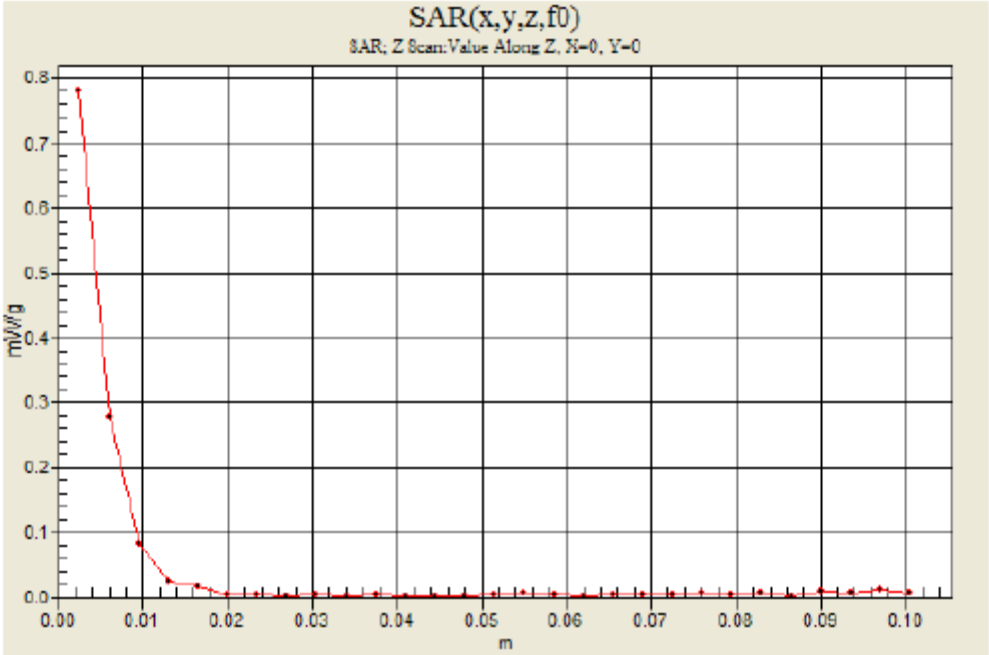
Test Laboratory: Compliance Certification Services (UL CCS)

Lapheld_5.5 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

Communication System: 802.11abgn; Frequency: 5700 MHz;Duty Cycle: 1:1

802.11a_Ch 140_Aux Ant/Z Scan (1x1x29): Measurement grid: dx=20mm, dy=20mm, dz=3.5mm
Maximum value of SAR (measured) = 0.779 mW/g



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5.8 GHz Band

Date/Time: 2/22/2011 5:19:01 PM

Test Laboratory: Compliance Certification Services (UL CCS)

Lapheld_5.8 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

Communication System: 802.11abgn; Frequency: 5795 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5795 MHz; σ = 6.14 mho/m; ε_r = 48.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

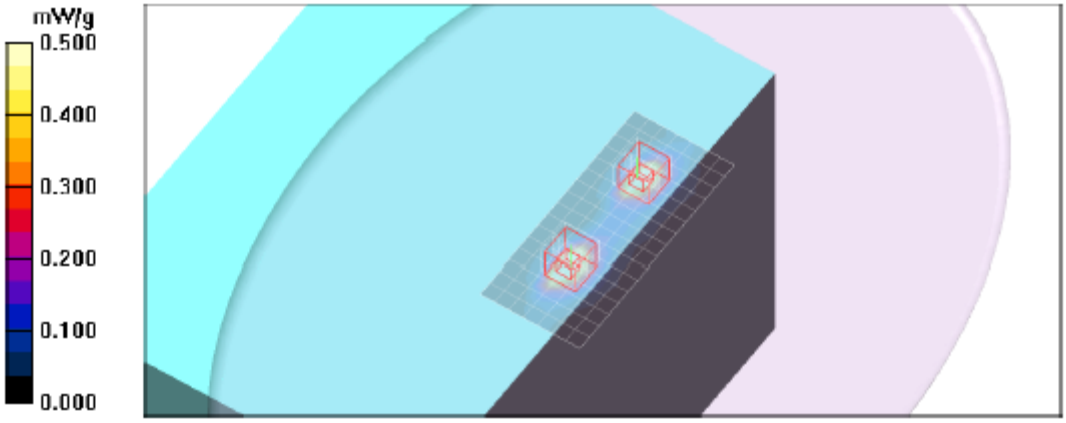
Room Ambient Temperature: 25.0 deg. C; Liquid Temperature: 24.0 deg. C

DASY4 Configuration:
- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV4 - SN3749; ConvF(3.65, 3.65, 3.65); Calibrated: 12/13/2010
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn427; Calibrated: 7/21/2010
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1003
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

802.11n HT40_Ch 159_Main/Aux Ant/Area Scan (8x17x1): Measurement grid: dx=10mm, dy=10mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.694 mW/g

802.11n HT40_Ch 159_Main/Aux Ant/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 11.6 V/m; Power Drift = -0.121 dB
Peak SAR (extrapolated) = 1.48 W/kg
SAR(1 g) = 0.419 mW/g; SAR(10 g) = 0.135 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.707 mW/g

802.11n HT40_Ch 159_Main/Aux Ant/Zoom Scan (7x7x9)/Cube 1: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 11.6 V/m; Power Drift = -0.121 dB
Peak SAR (extrapolated) = 1.37 W/kg
SAR(1 g) = 0.403 mW/g; SAR(10 g) = 0.132 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.683 mW/g



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Z-axis Plot

Date/Time: 2/22/2011 6:03:15 PM

Test Laboratory: Compliance Certification Services (UL CCS)

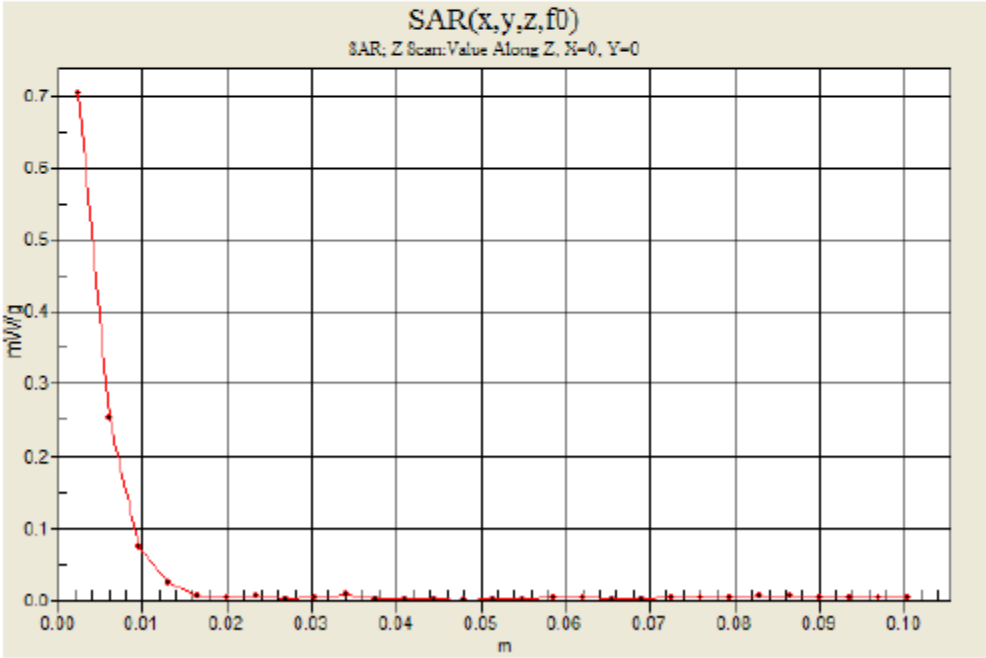
Lapheld_5.8 GHz

DUT: Broadcom; Type: BCM943228HM4L; Serial: N/A

Communication System: 802.11abgn; Frequency: 5795 MHz;Duty Cycle: 1:1

802.11n HT40_Ch 159_Main/Aux Ant/Z Scan (1x1x29): Measurement grid: dx=20mm, dy=20mm, dz=3.5mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.704 mW/g



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