



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

SAR EVALUATION REPORT

For
Intel® Centrino® Advanced-N6235
(Tested inside of Notebook PC, Model NP700Z7C)

Model: 6235ANHMW
FCC ID: A3L6235ANH
IC Certification Number: 649E-6235ANH

Report Number: 12114213-1
Issue Date: February 29, 2012

Prepared for
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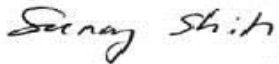

NVLAP LAB CODE 200065-0

Revision History

<u>Rev.</u>	<u>Issue Date</u>	<u>Revisions</u>	<u>Revised By</u>
--	February 29, 2012	Initial Issue	--

15.5.	Calibration certificate for D2450V2 SN: 748	37
15.6.	Calibration certificate for D5GHzV2 SN 1003	37
16.	Host Device Photo.....	38
17.	Antenna Locations & Separation Distances.....	39
18.	Setup Photos	40

1. Attestation of Test Results

Applicant	Samsung Electronics Co., LTD.		
EUT description	Intel® Centrino® Advanced-N6235 (Tested inside of Notebook PC, Model NP700Z7C)		
Model numbers	6235ANHW		
Device category	Portable devices		
Exposure category	General Population/Uncontrolled Exposure		
Date tested	February 21, 2012 – February 26, 2012		
FCC Rule Parts	Freq. Range [MHz]	Highest 1-g SAR	Limit (W/kg)
15.247	2412-2462	0.46 W/kg (Lap-Held)	1.6
15.407	5150-5250	0.63 W/kg (Lap-Held)	
	5250-5350	0.70 W/kg (Lap-Held)	
	5500-5700	1.37 W/kg (Lap-Held)	
15.247	5725-5850	1.42 W/kg (Lap-Held)	
Applicable Standards			Test Results
FCC OET Bulletin 65 Supplement C 01-01, IEEE STD 1528:2003, IC RSS-102 ISSUE 4 IEEE Std 1528-2003			Pass
<p>Compliance Certification Services, Inc. (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.</p> <p>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.</p>			
Approved & Released For UL CCS By:		Tested By:	
			
Sunny Shih Engineering Team Leader Compliance Certification Services (UL CCS)		Chakrit Thammanavarat SAR Engineer Compliance Certification Services (UL CCS)	

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 KDB Procedures.

- 248227 SAR measurement procedures for 802.11a/b/g transmitters
- 447498 D01 Mobile Portable RF Exposure v04
- 865664 SAR 3 to 6 GHz Rev
- 616217 D03 SAR Supp Note and Netbook Laptop V01

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>

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
Dielectronic Probe kit	HP	85070C	N/A	N/A		
Base Station Simulator	Agilent	8960	GB46160222	6	17	2012
Base Station Simulator	R & S	CMU 200	106291	6	24	2012
Base Station Simulator	Anritsu	MT8820C	6200985430	6	17	2012
ESA Series Network Analyzer	Agilent	E5071B	MY42100131	2	11	2013
Synthesized Signal Generator	HP	83732B	US34490599	7	14	2012
E-Field Probe	SPEAG	EX3DV3	3531	12	19	2012
Thermometer	ERTCO	639-1S	1718	7	19	2012
Data Acquisition Electronics	SPEAG	DAE4	1258	5	2	2012
Data Acquisition Electronics	SPEAG	DAE4	1259	2	13	2013
System Validation Dipole	SPEAG	D2450V2	748	2	7	2013
System Validation Dipole	SPEAG	D5GHzV2	1003	8	23	2012
Power Meter	HP	437B	3125U16345	5	13	2012
Power Sensor	HP	8481A	2702A60780	5	13	2012
Amplifier	MITEQ	4D00400600-50-30P	1620606	N/A		
Directional coupler	Werlatone	C8060-102	2141	N/A		

Notes:

*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.

4.2. Measurement Uncertainty

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

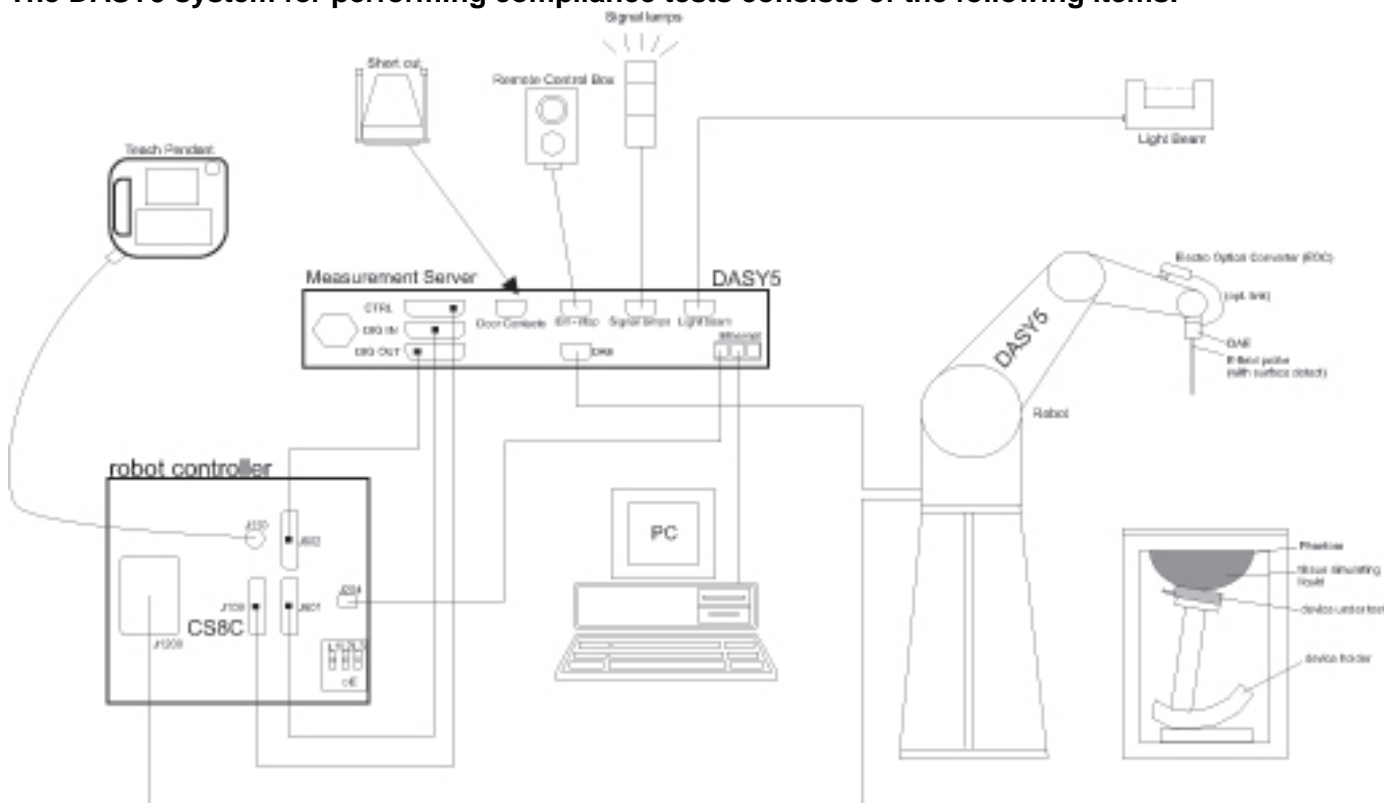
Component	Error, %	Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1)	5.50	Normal	1	1	5.50
Axial Isotropy	1.15	Rectangular	1.732	0.7071	0.47
Hemispherical Isotropy	2.30	Rectangular	1.732	0.7071	0.94
Boundary Effect	0.90	Rectangular	1.732	1	0.52
Probe Linearity	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	2.09	Normal	1	0.64	1.34
Liquid Permittivity - deviation from target	5.00	Rectangular	1.732	0.6	1.73
Liquid Permittivity - measurement uncertainty	-1.37	Normal	1	0.6	-0.82
Combined Standard Uncertainty Uc(y) =					9.57
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =					19.14 %
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =					1.52 dB

Measurement uncertainty for 3 to 6 GHz averaged over 1 gram

Component	Error, %	Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1)	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	4.28	Normal	1	0.64	2.74
Liquid Permittivity - deviation from target	10.00	Rectangular	1.732	0.6	3.46
Liquid Permittivity - measurement uncertainty	5.33	Normal	1	0.6	3.20
Combined Standard Uncertainty Uc(y), %:					11.27
Expanded Uncertainty U, Coverage Factor = 1.96, > 95 % Confidence =					22.08 %
Expanded Uncertainty U, Coverage Factor = 1.96, > 95 % Confidence =					1.73 dB

5. Measurement System Description and Setup

The DASY5 system for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- 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 Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- 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.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

6. SAR Measurement Procedures

6.1. Normal SAR measurement procedure

Step 1: Power Reference Measurement

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

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 DASYS 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 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 $\geq 7 \times 7 \times 9$ (above 4.5 GHz) or $5 \times 5 \times 7$ (below 3 GHz) 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.

7. Device Under Test

Intel® Centrino® Advanced-N6235 (Tested inside of Notebook PC, Model NP700Z7C)							
Normal operation:	Laptop mode (notebook)						
Antenna tested:	<table border="0"> <tr> <td><u>Manufactured</u></td> <td><u>Part number</u></td> </tr> <tr> <td>Wistron</td> <td>Main (Chain A) Ant: 81.EHD15.G73</td> </tr> <tr> <td></td> <td>Aux (Chain B) Ant: 81.EHD15.G73</td> </tr> </table>	<u>Manufactured</u>	<u>Part number</u>	Wistron	Main (Chain A) Ant: 81.EHD15.G73		Aux (Chain B) Ant: 81.EHD15.G73
<u>Manufactured</u>	<u>Part number</u>						
Wistron	Main (Chain A) Ant: 81.EHD15.G73						
	Aux (Chain B) Ant: 81.EHD15.G73						
Simultaneous transmission:	<p>WiFi 2.4 GHz cannot transmit simultaneously with BT</p> <p>WiFi 5 GHz can transmit simultaneously with BT</p>						
Assessment for SAR evaluation for Simultaneous transmission:	<p>WiFi vs Bluetooth</p> <p>Due to Bluetooth's max. output is 4 mW [$<60/f(\text{GHz})$ mW] and stand-alone SAR is not required, thus WiFi and Bluetooth are not considered as simultaneous transmission.</p>						

8. RF Output Power Verification

8.1. WiFi (2.4GHz Band)

Mode	Ch. #	Freq. (MHz)	Original Target Pwr (dBm) from Project# R84617		Actual Measured Pwr (dBm)	
			Chain A	Chain B	Chain A	Chain B
802.11b	1	2412	16.8		16.8	
	6	2437	16.8		16.9	
	11	2462	16.8		16.8	
	1	2412		16.6		16.6
	6	2437		15.0		15.0
	11	2462		16.0		16.0
802.11g	1	2412	14.1		14.2	
	6	2437	16.6		16.6	
	11	2462	14.0		14.1	
	1	2412		13.9		14.0
	6	2437		16.7		16.7
	11	2462		13.5		13.6
802.11n HT20	1	2412	13.1		13.2	
	6	2437	16.5		16.5	
	11	2462	12.5		12.6	
	1	2412		12.5		12.6
	6	2437		16.6		16.6
	11	2462		12.4		12.5
	1	2412	11.6	11.6	11.7	11.6
	6	2437	13.3	13.0	13.4	13.0
	11	2462	11.1	10.4	11.3	10.4
802.11n HT40	3	2422	10.6		10.7	
	6	2437	13.6		13.6	
	9	2450	10.1		10.2	
	3	2422		9.2		9.3
	6	2437		12.7		12.7
	9	2450		10.1		10.2
	3	2422	7.3	7.0	7.4	7.1
	6	2437	12.3	12.3	12.3	12.3
	9	2450	6.5	6.7	6.6	6.8

Notes:

1. The modes with highest output power channel were chosen for the conducted output power.
2. Original target power is from EMC report R84617. Refer to original report (FCC ID: PD96235ANH) for Average Power information as documented in 10/11/2011 original filing.

8.2. WiFi (5GHz Bands)

Mode	Ch. #	Freq. (MHz)	Original Target Pwr (dBm) from Project# R84672		Actual Measured Pwr (dBm)	
			Chain A	Chain B	Chain A	Chain B
802.11a	36	5180	16.2		16.3	
	40	5200	16.2		16.4	
	44	5220			16.2	
	48	5240	15.9		15.9	
	36	5180		15.9		15.9
	40	5200		15.8		15.8
	44	5220				15.8
	48	5240		15.7		15.7
802.11n HT20	36	5180	15.9		15.9	
	40	5200	16.5		16.6	
	44	5220			16.5	
	48	5240	16.4		16.4	
	36	5180		16.0		16.0
	40	5200		16.0		16.0
	44	5220				16.0
	48	5240		15.9		15.9
	36	5180	13.3	13.3	13.3	13.3
	40	5200	12.2	13.2	12.2	13.2
	48	5240	13.0	12.9	13.0	12.9
	802.11n HT40	38	5190	12.8		12.8
46		5230	16.4		16.4	
38		5190		12.7		12.7
46		5230		15.8		15.8
38		5190	10.0	10.8	10.1	10.9
46		5230	13.4	13.3	13.4	13.3

Notes:

1. The modes with highest output power channel were chosen for the conducted output power.
2. Original target power is from EMC report R84672. Please refer to original report (FCC ID: PD96235ANH) for Average Power information as documented in 10/11/2011 original filing.

5.3 GHz

Mode	Ch. #	Freq. (MHz)	Original Target Pwr (dBm) from Project# R84672		Actual Measured Pwr (dBm)	
			Chain A	Chain B	Chain A	Chain B
802.11a	52	5260	15.9		16.0	
	56	5280			16.3	
	60	5300	16.3		16.3	
	64	5320	16.4		16.4	
	52	5260		15.3		15.3
	56	5280				15.4
	60	5300		15.4		15.4
	64	5320		15.9		16.0
802.11n HT20	52	5260	16.1		16.1	
	60	5300	16.6		16.6	
	64	5320	16.6		16.6	
	52	5260		15.4		15.4
	60	5300		15.3		15.4
	64	5320		15.7		15.7
	52	5260	12.7	12.5	12.7	12.5
	60	5300	13.2	12.6	13.2	12.6
	64	5320	12.9	13.1	12.9	13.1
802.11n HT40	54	5270	16.0		16.0	
	62	5310	11.5		11.5	
	54	5270		15.2		15.2
	62	5310		12.4		12.4
	54	5270	12.6	12.5	12.6	12.5
	62	5310	12.4	12.3	12.4	12.3

Notes:

1. The modes with highest output power channel were chosen for the conducted output power.
2. Original target power is from EMC report R84672. Please refer to original report (FCC ID: PD96235ANH) for Average Power information as documented in 10/11/2011 original filing.

5.5 GHz

Mode	Ch. #	Freq. (MHz)	Original Target Pwr (dBm) from Project# R84672		Actual Measured Pwr (dBm)	
			Chain A	Chain B	Chain A	Chain B
802.11a	100	5500	16.4		16.4	
	104	5520			16.5	
	108	5540			16.5	
	112	5560			16.5	
	116	5580	16.5		16.6	
	120	5600			16.5	
	124	5620			16.5	
	128	5640			16.5	
	132	5660			16.5	
	136	5680			16.5	
	140	5700	16.5		16.5	
	100	5500		15.6		15.6
	104	5520				15.7
	108	5540				15.7
	112	5560				15.7
	116	5580		15.7		15.8
	120	5600				15.7
	124	5620				15.7
	128	5640				15.7
	132	5660				15.7
136	5680				15.7	
140	5700		15.5		15.5	
802.11n HT20	100	5500	16.4		16.4	
	116	5580	16.4		16.4	
	140	5700	16.3		16.3	
	100	5500		15.6		15.6
	116	5580		15.7		15.7
	140	5700		15.5		15.5
	100	5500	12.7	13.2	12.7	13.3
	116	5580	12.7	13.2	12.7	13.2
	140	5700	12.4	12.4	12.4	12.5
802.11n HT40	102	5510	15.5		15.5	
	110	5550	16.5		16.5	
	134	5670	16.4		16.4	
	102	5510		14.8		14.9
	110	5550		15.8		15.8
	134	5670		15.6		15.6
	102	5510	13.1	13.0	13.1	13.0
	110	5550	13.2	13.2	13.3	13.2
	134	5670	12.6	12.8	12.6	12.8

Notes:

1. The modes with highest output power channel were chosen for the conducted output power.
2. Original target power is from EMC report R84672. Please refer to original report (FCC ID: PD96235ANH) for Average Power information as documented in 10/11/2011 original filing.

5.8 GHz

Mode	Ch. #	Freq. (MHz)	Original Target Pwr (dBm) from Project# R84617		Actual Measured Pwr (dBm)	
			Chain A	Chain B	Chain A	Chain B
802.11a	149	5745	16.5		16.5	
	153	5765			16.5	
	157	5785	16.5		16.6	
	161	5805			16.5	
	165	5825	16.5		16.5	
	149	5745		16.7		16.8
	153	5765				16.7
	157	5785		16.7		16.7
	161	5805				16.7
	165	5825		16.6		16.6
802.11n HT20	149	5745	16.6		16.6	
	157	5785	16.5		16.5	
	165	5825	16.5		16.5	
	149	5745		16.7		16.7
	157	5785		16.6		16.6
	165	5825		16.6		16.6
	149	5745	13.6	13.5	13.6	13.5
	157	5785	13.5	13.4	13.5	13.5
802.11n HT40	151	5755	16.5		16.5	
	159	5795	16.5		16.5	
	151	5755		16.6		16.6
	159	5795		16.6		16.6
	151	5755	13.5	13.5	13.5	13.5
	159	5795	13.3	13.4	13.3	13.4

Notes:

1. The modes with highest output power channel were chosen for the conducted output power.
2. Original target power is from EMC report R84617. Refer to original report (FCC ID: PD96235ANH) for Average Power information as documented in 10/11/2011 original filing.

9. Summary of Test Configurations

Configuration	Antenna-to-edge/surface	SAR Required	Note
Lap-Held	10 mm from Main to-user	Yes	
Lap-Held	10 mm from Aux to-user	Yes	

10. Tissue Dielectric Property

IEEE Std 1528-2003 Table 2

Target Frequency (MHz)	Head	
	ϵ_r	σ (S/m)
300	45.3	0.87
450	43.5	0.87
835	41.5	0.90
900	41.5	0.97
1450	40.5	1.20
1800 – 2000	40.0	1.40
2450	39.2	1.80
2600	39.0	1.96
3000	38.5	2.40

FCC OET Bulletin 65 Supplement C 01-01 & IC RSS-102

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
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

EN 62209-1 and EN 62209-2 Table 1

Target Frequency (MHz)	Head	
	ϵ_r	σ (S/m)
30	55	0.75
150	52.3	0.76
300	45.3	0.87
450	43.5	0.87
835	41.5	0.9
900	41.5	0.97
915	41.5	0.98
1450	40.5	1.2
1610	40.3	1.29
1800 – 2000	40	1.4
2450	39.2	1.8
2600	39	1.96
3000	38.5	2.4
3500	37.9	2.91
4000	37.4	3.43
4500	36.8	3.94
5000	36.2	4.45
5200	36	4.66
5400	35.8	4.86
5600	35.5	5.07
5800	35.3	5.27
6000	35.1	5.48

10.2. Tissue dielectric parameters check results

Tissue dielectric parameters measured at the low, middle and high frequency of each operating frequency range of the test device.

Date	Freq. (MHz)	Liquid Parameters		Measured	Target	Delta (%)	Limit ±(%)		
02/21/2012	Body 5180	e'	51.6591	Relative Permittivity (ϵ_r):	51.66	49.05	5.33	10	
		e"	18.5815	Conductivity (σ):	5.35	5.27	1.53	5	
	Body 5200	e'	51.6287	Relative Permittivity (ϵ_r):	51.63	49.02	5.32	10	
		e"	18.5873	Conductivity (σ):	5.37	5.29	1.50	5	
	Body 5500	e'	51.0539	Relative Permittivity (ϵ_r):	51.05	48.61	5.02	10	
		e"	18.9489	Conductivity (σ):	5.79	5.64	2.67	5	
	Body 5800	e'	50.4692	Relative Permittivity (ϵ_r):	50.47	48.20	4.71	10	
		e"	19.2720	Conductivity (σ):	6.22	6.00	3.59	5	
	Body 5825	e'	50.4272	Relative Permittivity (ϵ_r):	50.43	48.20	4.62	10	
		e"	19.3170	Conductivity (σ):	6.26	6.00	4.28	5	
	02/23/2012	Body 5180	e'	50.4799	Relative Permittivity (ϵ_r):	50.48	49.05	2.92	10
			e"	17.7753	Conductivity (σ):	5.12	5.27	-2.88	5
Body 5200		e'	50.4313	Relative Permittivity (ϵ_r):	50.43	49.02	2.88	10	
		e"	17.7749	Conductivity (σ):	5.14	5.29	-2.93	5	
Body 5500		e'	49.9096	Relative Permittivity (ϵ_r):	49.91	48.61	2.67	10	
		e"	18.1620	Conductivity (σ):	5.55	5.64	-1.60	5	
Body 5800		e'	49.3990	Relative Permittivity (ϵ_r):	49.40	48.20	2.49	10	
		e"	18.5380	Conductivity (σ):	5.98	6.00	-0.36	5	
Body 5825		e'	49.3651	Relative Permittivity (ϵ_r):	49.37	48.20	2.42	10	
		e"	18.6527	Conductivity (σ):	6.04	6.00	0.69	5	
02/24/2012		Body 5180	e'	50.1563	Relative Permittivity (ϵ_r):	50.16	49.05	2.26	10
			e"	18.0774	Conductivity (σ):	5.21	5.27	-1.23	5
	Body 5200	e'	50.1383	Relative Permittivity (ϵ_r):	50.14	49.02	2.28	10	
		e"	18.1131	Conductivity (σ):	5.24	5.29	-1.09	5	
	Body 5500	e'	49.5865	Relative Permittivity (ϵ_r):	49.59	48.61	2.00	10	
		e"	18.4072	Conductivity (σ):	5.63	5.64	-0.27	5	
	Body 5800	e'	49.1524	Relative Permittivity (ϵ_r):	49.15	48.20	1.98	10	
		e"	18.6843	Conductivity (σ):	6.03	6.00	0.43	5	
	Body 5825	e'	48.9684	Relative Permittivity (ϵ_r):	48.97	48.20	1.59	10	
		e"	18.8715	Conductivity (σ):	6.11	6.00	1.87	5	

Tissue dielectric parameters check results (continued)

Date	Freq. (MHz)	Liquid Parameters		Measured	Target	Delta (%)	Limit ±(%)		
02/25/2012	Body 5180	e'	49.5735	Relative Permittivity (ϵ_r):	49.57	49.05	1.07	10	
		e"	17.8085	Conductivity (σ):	5.13	5.27	-2.70	5	
	Body 5200	e'	49.5335	Relative Permittivity (ϵ_r):	49.53	49.02	1.05	10	
		e"	17.8339	Conductivity (σ):	5.16	5.29	-2.61	5	
	Body 5500	e'	48.9647	Relative Permittivity (ϵ_r):	48.96	48.61	0.72	10	
		e"	18.1391	Conductivity (σ):	5.55	5.64	-1.72	5	
	Body 5800	e'	48.4663	Relative Permittivity (ϵ_r):	48.47	48.20	0.55	10	
		e"	18.4515	Conductivity (σ):	5.95	6.00	-0.82	5	
	Body 5825	e'	48.4264	Relative Permittivity (ϵ_r):	48.43	48.20	0.47	10	
		e"	18.4567	Conductivity (σ):	5.98	6.00	-0.37	5	
	02/26/2012	Body 2450	e'	52.0302	Relative Permittivity (ϵ_r):	52.03	52.70	-1.27	5
			e"	14.6137	Conductivity (σ):	1.99	1.95	2.09	5
Body 2410		e'	52.1779	Relative Permittivity (ϵ_r):	52.18	52.76	-1.10	5	
		e"	14.4382	Conductivity (σ):	1.93	1.91	1.43	5	
Body 2435		e'	52.0835	Relative Permittivity (ϵ_r):	52.08	52.73	-1.22	5	
		e"	14.5471	Conductivity (σ):	1.97	1.93	1.99	5	
Body 2475		e'	51.9470	Relative Permittivity (ϵ_r):	51.95	52.67	-1.37	5	
		e"	14.7244	Conductivity (σ):	2.03	1.99	2.08	5	

11. System Performance Check

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 $\pm 10\%$.

11.1. System performance check measurement conditions

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ± 0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The DASY system with an E-Field Probe 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.

11.2. Reference SAR values for system performance check

The reference SAR values can be obtained from the calibration certificate of system validation dipoles

System Dipole	Serial No.	Cal. Date	Freq. (MHz)	SAR Measured (mW/g)		
				1g/10g	Head	Body
D2450V2	748	2/7/2012	2450	1g	53.6	50.8
				10g	24.8	23.64
D5GHzV2	1003	8/23/2011	5200	1g	76.5	74.5
				10g	21.8	20.8
			5500	1g	80.9	80.0
				10g	23.1	22.3
			5800	1g	76.3	76.3
				10g	21.7	21.2

11.3. System performance check results

Date Tested	System dipole		Measured (Normalized to 1 W)		Target	Delta (%)	Tolerance (%)
2/21/2012	Body	D5GHzV2 SN: 1003	1g SAR	75.8	74.5	1.74	±10
			10g SAR	21.3	20.8	2.40	
	Body	D5GHzV2 SN: 1003	1g SAR	81.4	80	1.75	±10
			10g SAR	22.5	22.3	0.90	
	Body	D5GHzV2 SN: 1003	1g SAR	80.6	76.3	5.64	±10
			10g SAR	22.5	21.2	6.13	
2/23/2012	Body	D5GHzV2 SN: 1003	1g SAR	75.8	74.5	1.74	±10
			10g SAR	21.3	20.8	2.40	
	Body	D5GHzV2 SN: 1003	1g SAR	78.2	80	-2.25	±10
			10g SAR	21.7	22.3	-2.69	
	Body	D5GHzV2 SN: 1003	1g SAR	76.8	76.3	0.66	±10
			10g SAR	21.6	21.2	1.89	
2/24/2012	Body	D5GHzV2 SN: 1003	1g SAR	78.3	80	-2.13	±10
			10g SAR	21.9	22.3	-1.79	
	Body	D5GHzV2 SN: 1003	1g SAR	78.1	76.3	2.36	±10
			10g SAR	22.0	21.2	3.77	
2/25/2012	Body	D5GHzV2 SN: 1003	1g SAR	75.0	80	-6.25	±10
			10g SAR	20.9	22.3	-6.28	
2/26/2012	Body	D2450V2 SN: 748	1g SAR	52.2	50.8	2.76	±10
			10g SAR	24.5	23.64	3.64	

12. SAR Test Results

12.1. WiFi (2.4GHz Band)

Test Reduction Consideration

SAR is not required for 802.11g/n (HT40) channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11b channels as per KDB 248227.

Band	Mode	Antenna Port	Ch. #	Freq. (MHz)	Avg. Output Power (dBm)		Measured Result (mW/g) 1g-SAR		Note
					Chain A	Chain B	Chain A	Chain B	
2.4GHz	802.11b	A	1	2412	16.8				1
			6	2437	16.9		0.263		
			11	2462	16.8				1
		B	1	2412		16.6		0.462	
			6	2437		15.0			1
			11	2462		16.0			1
	802.11n HT20	A	1	2412	11.7	11.6			1
			6	2437	13.4	13.0	0.180	0.223	
			11	2462	11.3	10.4			1

Note(s):

1. Testing was performed on the channel with the highest output power only as the SAR was ≤ 0.8 W/kg with the operating frequency band having a range of < 100 MHz. Per KDB 447498 1) e) i).

12.2. WiFi (5GHz Bands)

Test Reduction Consideration

SAR is not required for 802.11n (HT20 & HT40) channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a channels as per KDB 248227.

Band	Mode	Antenna Port	Ch. #	Freq. (MHz)	Avg. Output Power (dBm)		Measured Result (mW/g) 1g-SAR		Note
					Chain A	Chain B	Chain A	Chain B	
5.2GHz	802.11a	A	36	5180	16.3				1
			40	5200	16.4		0.604		
			48	5240	15.9				1
		B	36	5180		15.9		0.632	
			40	5200		15.8			1
			48	5240		15.7			1
	802.11n HT20	A	36	5180	15.9				1
			40	5200	16.6		0.627		
			48	5240	16.4				1
	802.11n HT40	A+B	38	5190	10.1	10.9			1
46			5230	13.4	13.3	0.431	0.246		
5.3GHz	802.11a	A	52	5260	16.0				1
			60	5300	16.3				1
			64	5320	16.4		0.681		
		B	52	5260		15.3			1
			60	5300		15.4			1
			64	5320		16.0		0.704	
	802.11n HT20	A+B	60	5300	13.2	12.6	0.443	0.268	
64			5320	12.9	13.1			1	
5.5GHz	802.11a	A	104	5520	16.5		1.09		
			116	5580	16.6		1.35		
			124	5620	16.5		1.37		
			136	5680	16.5		1.05		
		B	104	5520		15.7		0.877	
			116	5580		15.8		0.771	
			124	5620		15.7		0.746	
			136	5680		15.7		0.964	
	802.11n HT40	A+B	102	5510	13.1	13.0	0.660	0.474	
			110	5550	13.3	13.2	0.648	0.470	
134			5670	12.6	12.8	0.602	0.484		
5.8GHz	802.11a	A	149	5745	16.5		1.04		
			157	5785	16.6		1.19		
			165	5825	16.5		1.42		
		B	149	5745		16.8		0.845	
			157	5785		16.7		0.548	
			165	5825		16.6		0.444	
	802.11n HT20	A+B	149	5745	13.6	13.5			1
			157	5785	13.5	13.4			1
			165	5825	13.3	13.7	0.522	0.395	

Note(s):

1. Testing was performed on the channel with the highest output power only as the SAR was ≤ 0.8 W/kg with the operating frequency band having a range of < 100 MHz. Per KDB 447498 1) e) i).
2. Testing was performed on the channel with the highest output power only as the SAR was ≤ 0.4 W/kg with the operating frequency band having a range of ≤ 200 MHz. Per KDB 447498 1) e) ii).

13. Summary of Highest 1g SAR

Technology/Band	Test configuration	Mode	Separation distance (mm)	Highest 1g SAR (W/kg)
WiFi 2.4 GHz	Lap-Held	802.11b	0	0.462
WiFi 5.2 GHz	Lap-Held	802.11a	0	0.632
WiFi 5.3 GHz	Lap-Held	802.11a	0	0.704
WiFi 5.5 GHz	Lap-Held	802.11a	0	1.37
WiFi 5.8 GHz	Lap-Held	802.11a	0	1.42

14. Worst-case SAR Plots

Test Laboratory: UL CCS SAR Lab B

Date: 2/26/2012

2.4GHz

Frequency: 2437 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C
Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.973$ mho/m; $\epsilon_r = 52.076$; $\rho = 1000$ kg/m³

DASY5 Configuration:

- Electronics: DAE4 Sn1259; Calibrated: 2/13/2012
- Probe: EX3DV3 - SN3531; ConvF(7.44, 7.44, 7.44); Calibrated: 12/19/2011
- Sensor-Surface: 2.5mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Phantom: ELLI v5.0 (B); Type: QDOVA001BB; Serial: 1118

802.11b/Ant B_ch 1/Area Scan (11x23x1): Measurement grid: dx=15mm, dy=15mm

Info: [Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.331 mW/g

802.11b/Ant B_ch 1/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

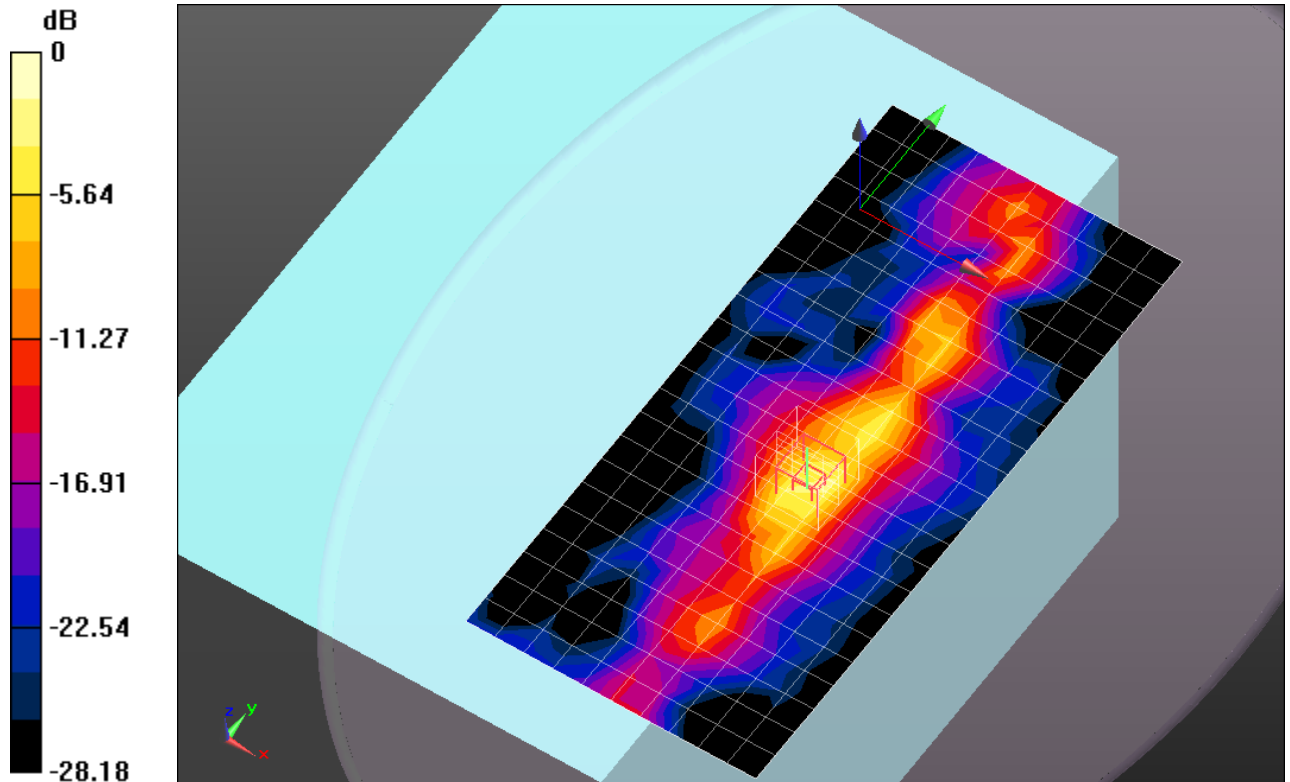
Reference Value = 12.586 V/m; Power Drift = 0.18 dB

Peak SAR (extrapolated) = 1.0210

SAR(1 g) = 0.462 mW/g; SAR(10 g) = 0.193 mW/g

Info: [Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.710 mW/g



0 dB = 0.710mW/g = -2.97 dB mW/g

Test Laboratory: UL CCS SAR Lab B

Date: 2/26/2012

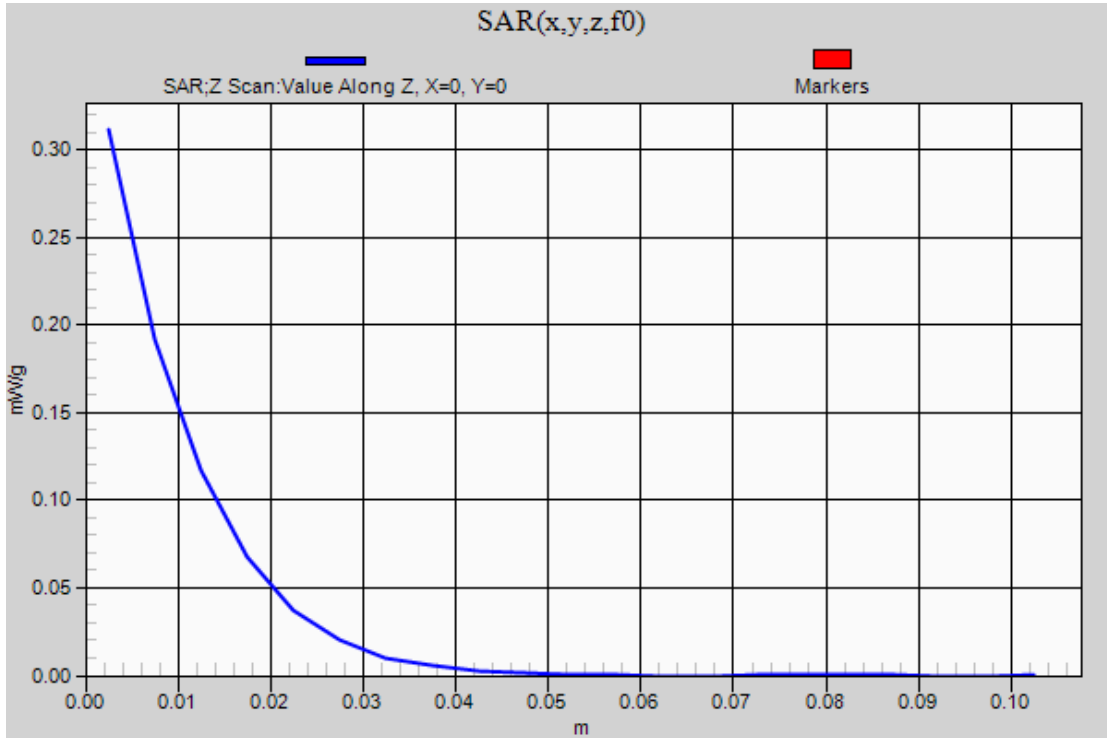
2.4GHz

Frequency: 2437 MHz; Duty Cycle: 1:1

802.11b/Ant B_ch 1/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Info: [Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 0.311 mW/g



Test Laboratory: UL CCS SAR Lab B

Date: 2/21/2012

5 GHz bands

Frequency: 5180 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 25.0°C; Liquid Temperature: 24.0°C
Medium parameters used: $f = 5180$ MHz; $\sigma = 5.355$ mho/m; $\epsilon_r = 51.659$; $\rho = 1000$ kg/m³

DASY5 Configuration:

- Electronics: DAE4 Sn1258; Calibrated: 5/2/2011
- Probe: EX3DV3 - SN3531; ConvF(4.39, 4.39, 4.39); Calibrated: 12/19/2011
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Phantom: ELI v5.0 (A); Type: QDOVA001BB; Serial: 1120

5.2GHz/802.11a_Ch 36_Ant B/Area Scan (16x37x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.006 mW/g

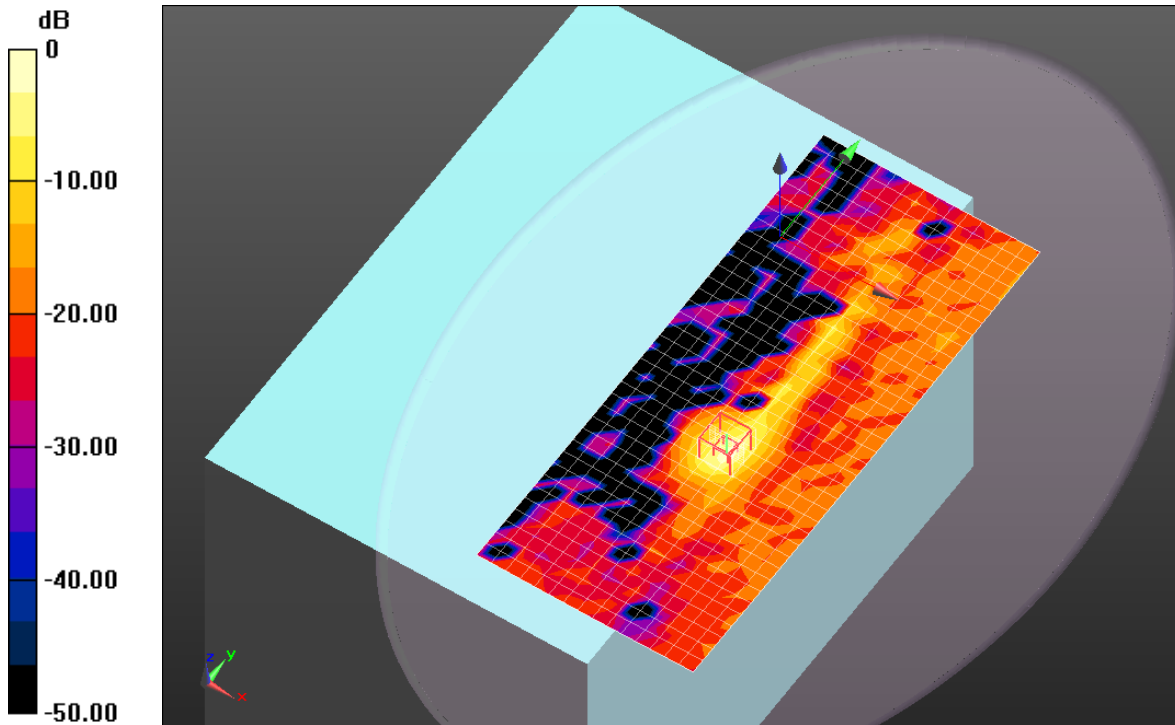
5.2GHz/802.11a_Ch 36_Ant B/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 14.258 V/m; Power Drift = 0.14 dB

Peak SAR (extrapolated) = 2.8430

SAR(1 g) = 0.632 mW/g; SAR(10 g) = 0.159 mW/g

Maximum value of SAR (measured) = 1.168 mW/g



0 dB = 1.170mW/g = 1.36 dB mW/g

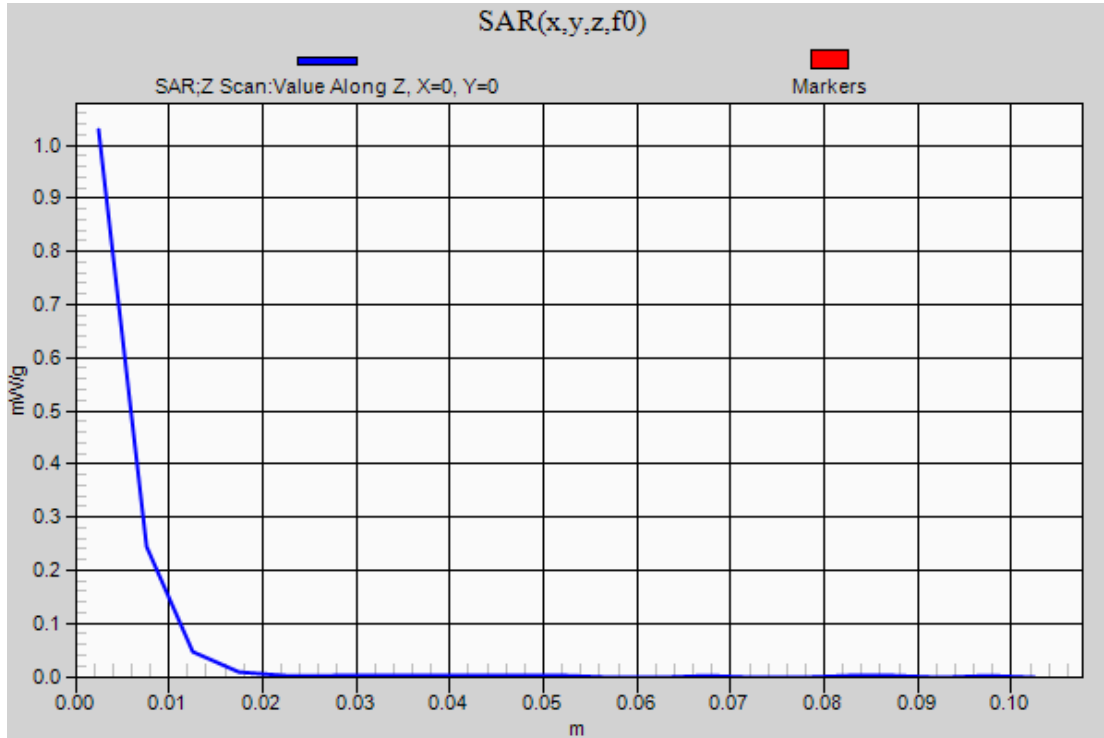
Test Laboratory: UL CCS SAR Lab B

Date: 2/21/2012

5 GHz bands

Frequency: 5180 MHz; Duty Cycle: 1:1

5.2GHz/802.11a_Ch 36_Ant B/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 1.028 mW/g



Test Laboratory: UL CCS SAR Lab B

Date: 2/23/2012

5 GHz bands

Frequency: 5320 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 25.0°C; Liquid Temperature: 24.0°C
Medium parameters used: $f = 5320 \text{ MHz}$; $\sigma = 5.308 \text{ mho/m}$; $\epsilon_r = 50.245$; $\rho = 1000 \text{ kg/m}^3$

DASY5 Configuration:

- Electronics: DAE4 Sn1259; Calibrated: 2/13/2012
- Probe: EX3DV3 - SN3531; ConvF(4.17, 4.17, 4.17); Calibrated: 12/19/2011
- Sensor-Surface: 2.5mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Phantom: ELI v5.0 (A); Type: QDOVA001BB; Serial: 1120

5.3GHz/802.11a_Ch 64_Ant B/Area Scan (16x37x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$
Maximum value of SAR (measured) = 0.852 mW/g

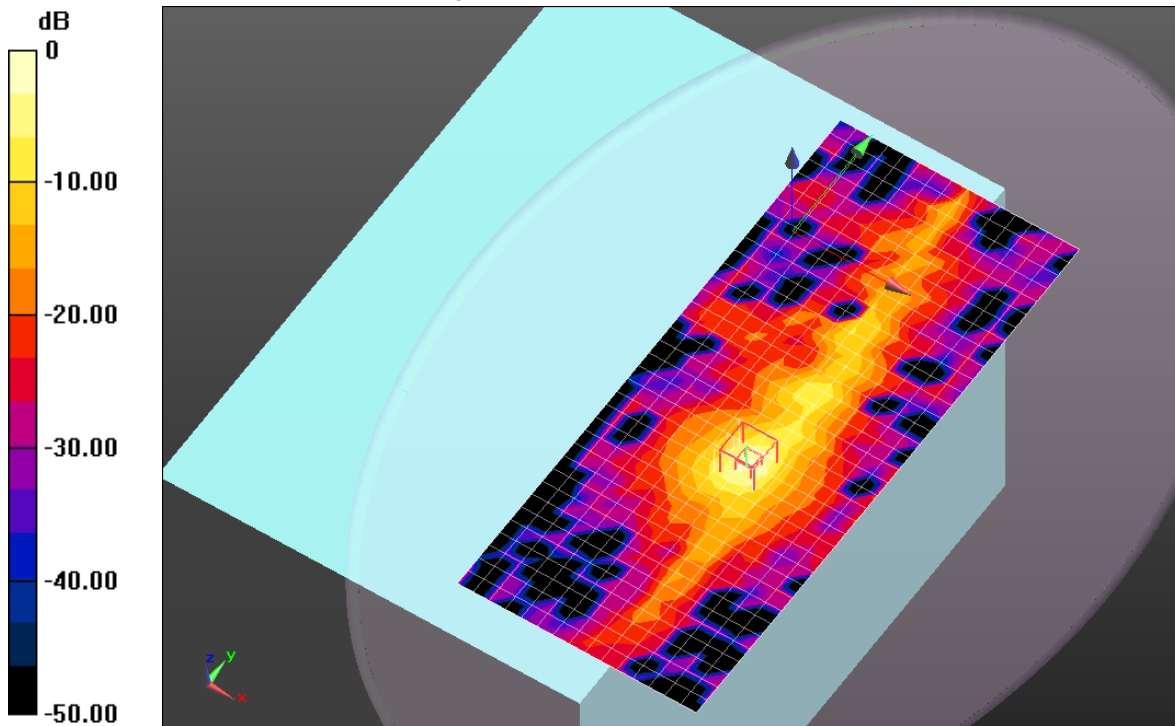
5.3GHz/802.11a_Ch 64_Ant B/Zoom Scan (7x7x9)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=2.5\text{mm}$

Reference Value = 13.910 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 2.8060

SAR(1 g) = 0.704 mW/g; SAR(10 g) = 0.190 mW/g

Maximum value of SAR (measured) = 1.377 mW/g



0 dB = 1.380mW/g = 2.80 dB mW/g

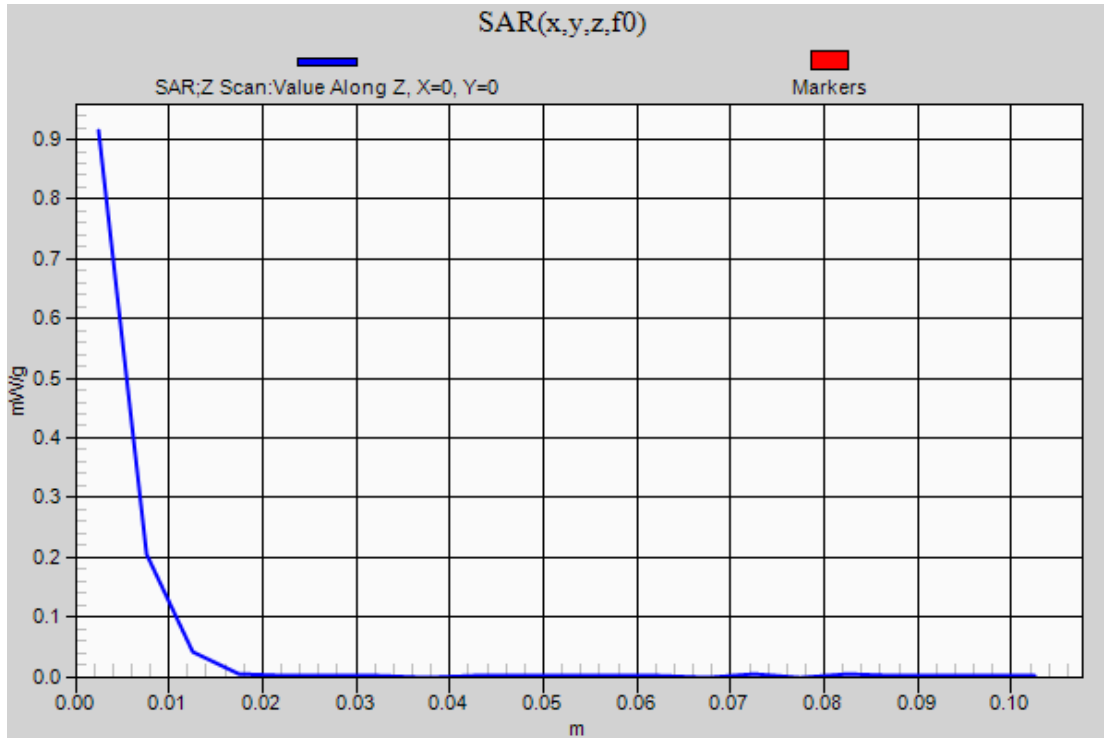
Test Laboratory: UL CCS SAR Lab B

Date: 2/23/2012

5 GHz bands

Frequency: 5320 MHz; Duty Cycle: 1:1

5.3GHz/802.11a_Ch 64_Ant B/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 0.915 mW/g



Test Laboratory: UL CCS SAR Lab B

Date: 2/25/2012

5 GHz bands

Frequency: 5620 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 25.0°C; Liquid Temperature: 24.0°C
Medium parameters used: $f = 5620$ MHz; $\sigma = 5.709$ mho/m; $\epsilon_r = 48.741$; $\rho = 1000$ kg/m³

DASY5 Configuration:

- Electronics: DAE4 Sn1259; Calibrated: 2/13/2012
- Probe: EX3DV3 - SN3531; ConvF(3.51, 3.51, 3.51); Calibrated: 12/19/2011
- Sensor-Surface: 2.5mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Phantom: ELI v5.0 (A); Type: QDOVA001BB; Serial: 1120

5.5GHz/802.11a_Ch 124_Ant A/Area Scan (16x35x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.372 mW/g

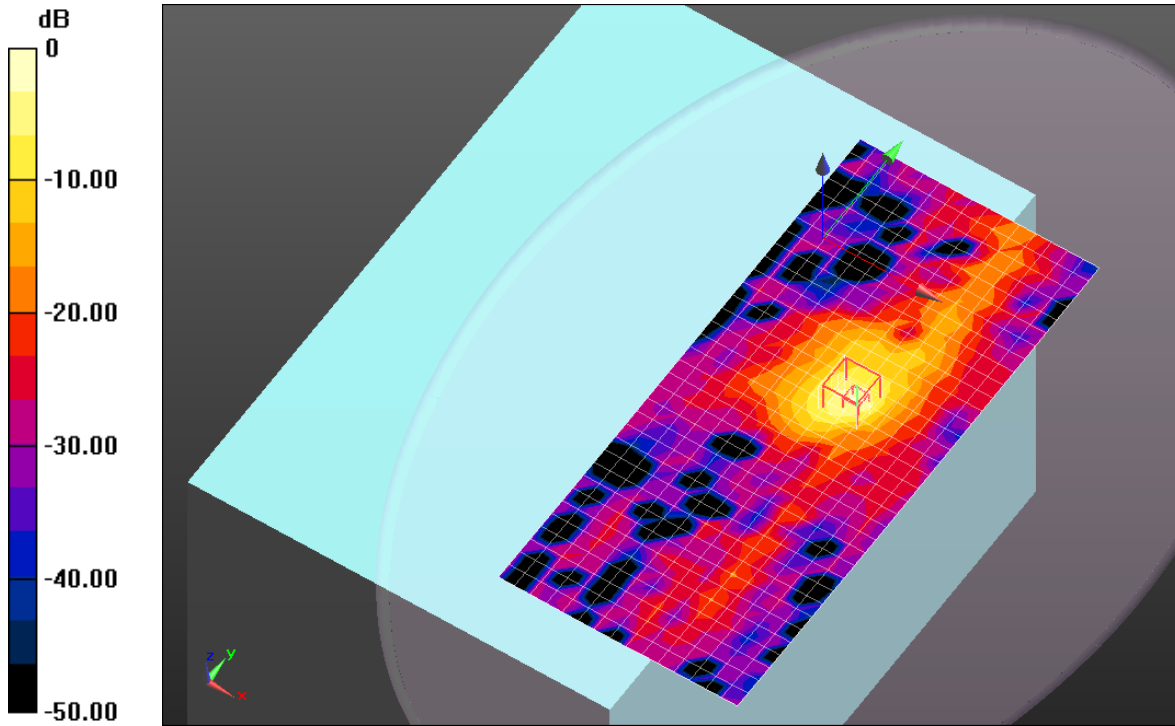
5.5GHz/802.11a_Ch 124_Ant A/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 19.924 V/m; Power Drift = -0.10 dB

Peak SAR (extrapolated) = 5.8770

SAR(1 g) = 1.37 mW/g; SAR(10 g) = 0.386 mW/g

Maximum value of SAR (measured) = 2.628 mW/g



0 dB = 2.630mW/g = 8.40 dB mW/g

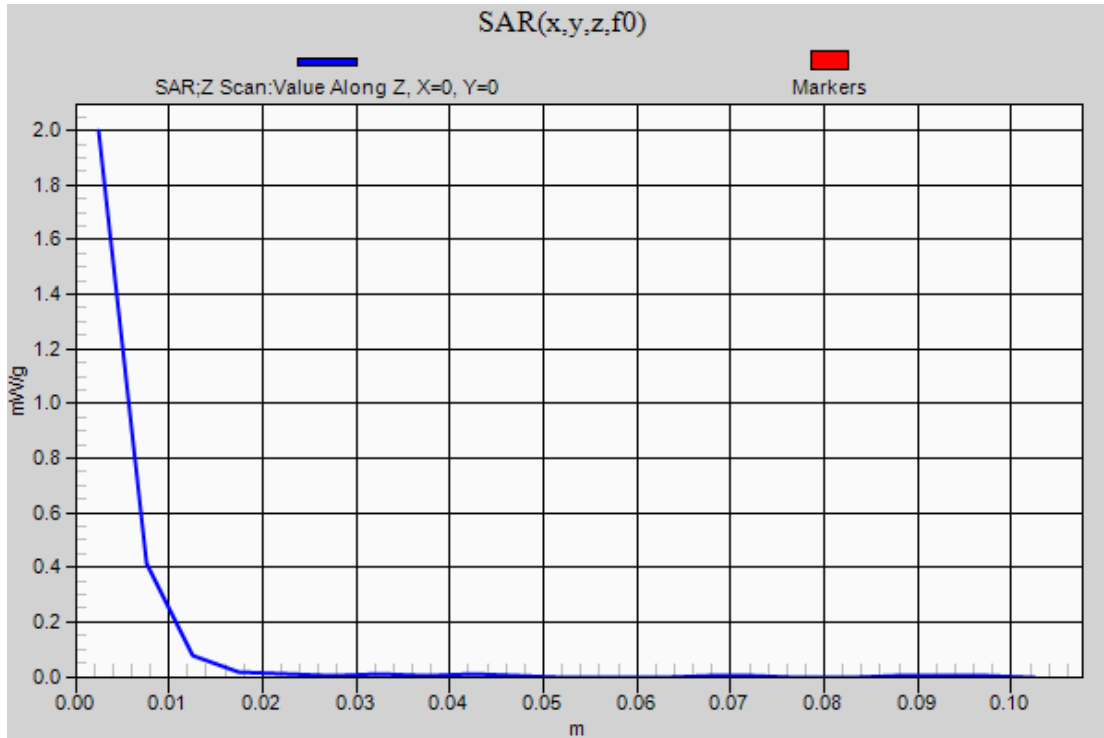
Test Laboratory: UL CCS SAR Lab B

Date: 2/25/2012

5 GHz bands

Frequency: 5620 MHz; Duty Cycle: 1:1

5.5GHz/802.11a_Ch 124_Ant A/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 1.999 mW/g



Test Laboratory: UL CCS SAR Lab B

Date: 2/24/2012

5 GHz bands

Frequency: 5825 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 25.0°C; Liquid Temperature: 24.0°C
Medium parameters used: $f = 5825$ MHz; $\sigma = 6.044$ mho/m; $\epsilon_r = 49.365$; $\rho = 1000$ kg/m³

DASY5 Configuration:

- Electronics: DAE4 Sn1259; Calibrated: 2/13/2012
- Probe: EX3DV3 - SN3531; ConvF(3.67, 3.67, 3.67); Calibrated: 12/19/2011
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Phantom: ELI v5.0 (A); Type: QDOVA001BB; Serial: 1120

5.8GHz/802.11a_Ch 165_Ant A/Area Scan (16x37x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 2.128 mW/g

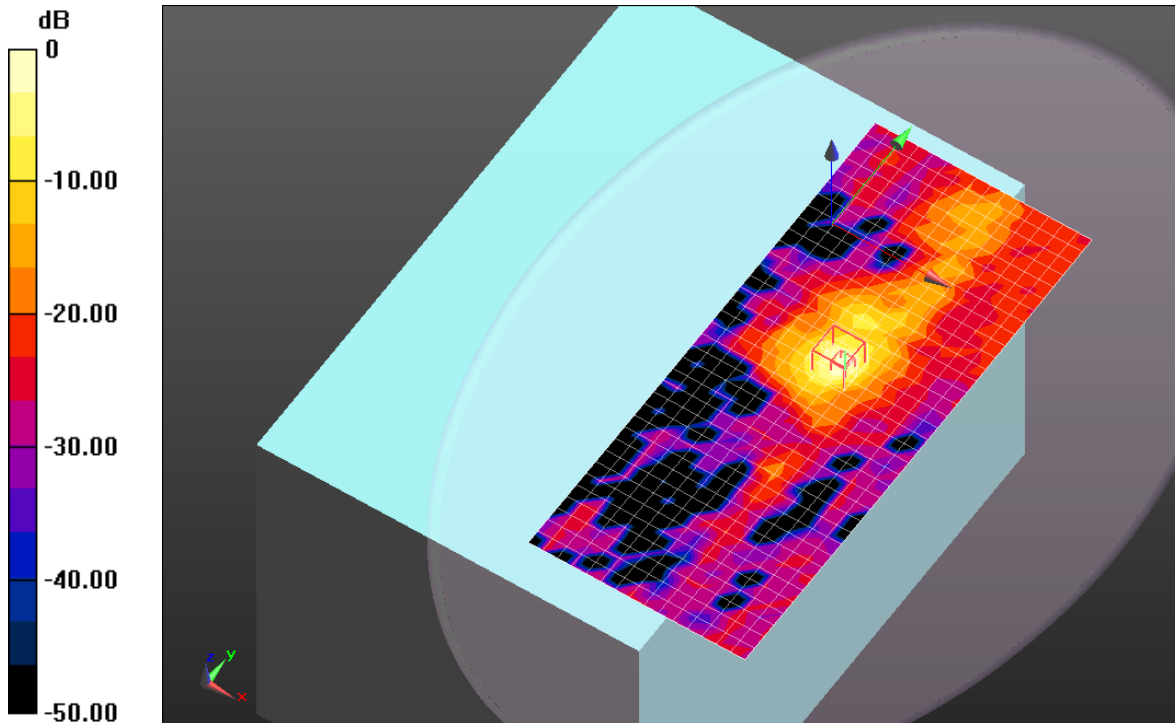
5.8GHz/802.11a_Ch 165_Ant A/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 19.670 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 6.0980

SAR(1 g) = 1.42 mW/g; SAR(10 g) = 0.395 mW/g

Maximum value of SAR (measured) = 2.717 mW/g



0 dB = 2.720mW/g = 8.69 dB mW/g

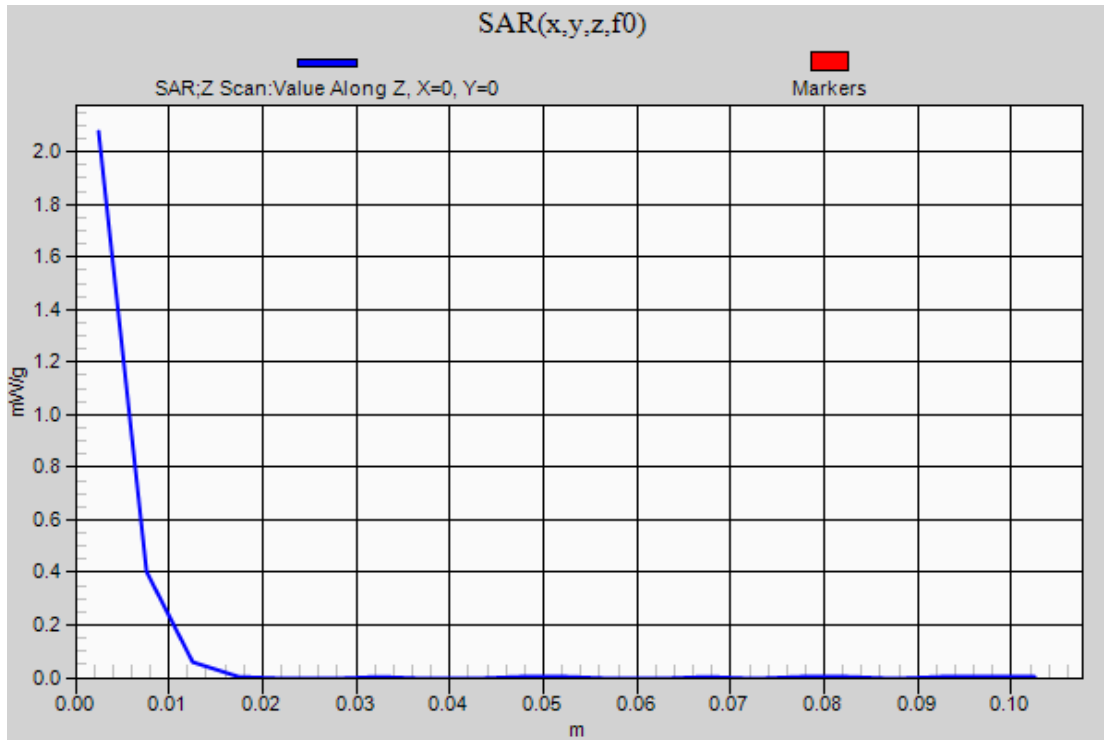
Test Laboratory: UL CCS SAR Lab B

Date: 2/24/2012

5 GHz bands

Frequency: 5825 MHz; Duty Cycle: 1:1

5.8GHz/802.11a_Ch 165_Ant A retest/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 2.077 mW/g



15. Appendixes

Refer to separated files for the following appendixes.

- 15.1. System check plots**
- 15.2. SAR test plots for WiFi 2.4 GHz**
- 15.3. SAR test plots for WiFi 5 GHz bands**
- 15.4. Calibration certificate for E-Field Probe EX3DV4 SN 3531**
- 15.5. Calibration certificate for D2450V2 SN: 748**
- 15.6. Calibration certificate for D5GHzV2 SN 1003**