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IEEE STD 1528:2003

RSS-102 Issue 4, March 2010

RSS-102 Supplementary Procedures (SPR)-001, January 1, 2011

SAR EVALUATION REPORT

For

**IEEE 802.11bgn Wireless LAN, Bluetooth and FM Rx Combo Half Mini Card
(Tested inside of Toshiba Tablet AT100/AT105)**

MODEL: AW-NH931

FCC ID: TLZ-NH931

IC: 6100A-NH931

REPORT NUMBER: 11U13782-1

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Prepared for

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1. ATTESTATION OF TEST RESULTS

Company name:	AzureWave Technologies, Inc. 8F, No. 94, Baozhong Rd., Xindian, 231 Taiwan		
EUT Description:	IEEE 802.11bgn Wireless LAN, Bluetooth and FM Rx Combo Half Mini Card (Tested inside of Toshiba Tablet AT100/AT105)		
Model number:	AW-NH931		
Device Category:	Portable		
Exposure category:	General Population/Uncontrolled Exposure		
Date of tested:	May 2, 2011		
FCC / IC Rule Parts	Freq. Range [MHz]	The Highest 1g SAR	Limit (W/kg)
15.247 / RSS-102	2400 – 2483.5	0.317 W/kg (Bottom Face)	1.6
Applicable Standards			Test Results
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			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.			
<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:		
	 Chakrit Thammanavarat and Hung Thai EMC Engineer Compliance Certification Services (UL CCS)		
Sunny Shih Engineering Team Leader 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

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
Robot - Six Axes	Stäubli	TX90	C01209			N/A
Robot Remote Control	Stäubli	CS8C	N/A			N/A
DASY5 Measurement Server	SPEAG	SEUMS014AA	1064			N/A
Probe Alignment Unit	SPEAG	LB5 / 80	N/A			N/A
SAM Phantom	SPEAG	QP 000 P40 CC	1602			N/A
Oval Flat Phantom (ELI 4.0)	SPEAG	QD OVA001 BB	1099			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	EX3DV3	3686	1	24	2012
Thermometer	ERTCO	639-1S	1718	7	19	2011
Data Acquisition Electronics	SPEAG	DAE4	1239	11	17	2011
System Validation Dipole	SPEAG	D2450V2	706	4	19	2012
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		

***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)

4.2. MEASUREMENT UNCERTAINTY

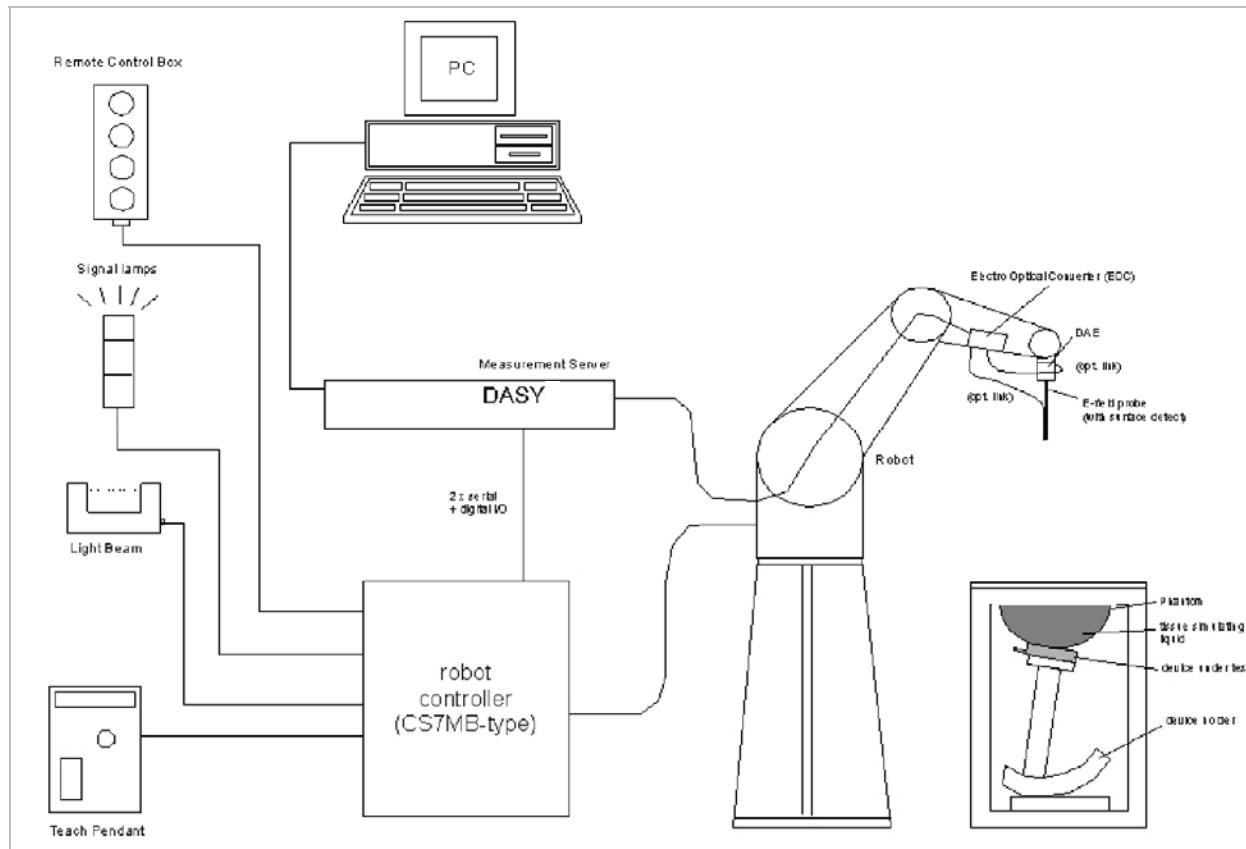
Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram

Component	error, %	Probe Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1) @ 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	0.75	Normal	1	0.64	0.48
Liquid Permittivity - deviation from target	5.00	Rectangular	1.732	0.6	1.73
Liquid Permittivity - measurement	2.31	Normal	1	0.6	1.39
Combined Standard Uncertainty $U_c(y) =$					9.55
Expanded Uncertainty U , Coverage Factor = 2, > 95 % Confidence =					19.11 %
Expanded Uncertainty U , Coverage Factor = 2, > 95 % Confidence =					1.52 dB

5. EQUIPMENT UNDER TEST

IEEE 802.11bgn Wireless LAN, Bluetooth and FM Rx Combo Half Mini Card, Model: AW-NH931 (Tested inside of Toshiba Tablet AT100/AT105)	
Normal operation:	Tablet bottom face, and Tablet edges: Multiple display orientations supporting both portrait and landscape configurations
Antenna tested:	<u>Manufactured</u> Wha Yu <u>Part number</u> Main: C1335-520058-A Aux/BT: C1335-520059-A Note: WiFi Aux and shared with Bluetooth
Antenna-to-antenna/user separation distances:	Refer to Sec. 14 for details of antenna locations and separation distances.
Assessment for SAR evaluation for Simultaneous transmission:	WiFi Main antenna can transmit simultaneously with Bluetooth. Due to Bluetooth's maximum output is $11.5 \text{ mW} < 60/f_{GHz}$, and stand-alone SAR is not required, therefore simultaneous transmission evaluation is not required.

6. SYSTEM SPECIFICATIONS



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

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- 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.

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

Salt: 99+% Pure Sodium Chloride

Sugar: 98+% Pure Sucrose

Water: De-ionized, 16 MΩ+ resistivity

HEC: Hydroxyethyl Cellulose

DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

8. TISSUE DIELECTRIC PARAMETERS

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine if the dielectric parameters are within the tolerances of the specified target values. For frequencies in 300 MHz to 2 GHz, the measured conductivity and relative permittivity should be within \pm 5% of the target values. For frequencies in the range of 2–3 GHz and above the measured conductivity should be within \pm 5% of the target values. The measured relative permittivity tolerance can be relaxed to no more than \pm 10%.

Reference Values of Tissue Dielectric Parameters for Body (for 300 – 3000 MHz and 5800 MHz)

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)	Body (Supplement C 01-01)	
	ϵ_r	σ (S/m)
300	58.20	0.92
450	56.70	0.94
835	55.20	0.97
900	55.00	1.05
915	55.00	1.06
1450	54.00	1.30
1610	53.80	1.40
1800 – 2000	53.30	1.52
2450	52.70	1.95
3000	52.00	2.73
5800	48.20	6.00

(ϵ_r = relative permittivity, σ = conductivity and $\rho = 1000 \text{ kg/m}^3$)

8.1. TISSUE PARAMETERS CHECK RESULTS

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
05/02/2011	Body 2450	e'	51.4821	Relative Permittivity (ϵ_r):	51.48	52.70	-2.31	5
		e"	14.2068	Conductivity (σ):	1.94	1.95	-0.75	5

Liquid Check

Ambient temperature: 24 deg. C; Liquid temperature: 23 deg. C; Relative humidity = 39%

May 02, 2011 01:54 PM

Frequency	e'	e"
2410000000.	51.6414	14.0531
2415000000.	51.6749	14.0570
2420000000.	51.5166	14.0084
2425000000.	51.5119	14.0331
2430000000.	51.5379	14.1439
2435000000.	51.4980	14.2349
2440000000.	51.3353	14.2086
2445000000.	51.4553	14.0991
2450000000.	51.4821	14.2068
2455000000.	51.3299	14.1741
2460000000.	51.3921	14.3362
2465000000.	51.4427	14.3676
2470000000.	51.4555	14.4049
2475000000.	51.3395	14.5224
2480000000.	51.3757	14.4942
2485000000.	51.3309	14.6326

The conductivity (σ) can be given as:

$$\sigma = \omega \epsilon_0 \epsilon'' = 2 \pi f \epsilon_0 \epsilon''$$

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

$$\epsilon_0 = 8.854 * 10^{-12}$$

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 $\pm 10\%$.

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 EX3DV4 SN 3749 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 SN 706	D2450V2-706_Apr10	4/19/10	2.4	1g SAR:	51.6	52.4
				10g SAR:	24.4	24.5

9.1. SYSTEM CHECK RESULTS

System validation dipole	Date Tested	Measured (Normalized to 1 W)		Target	Delta (%)	Tolerance (%)
		Tissue:	Body			
D2450V2	05/02/11	1g SAR:	50.80	52.4	-3.05	± 10
		10g SAR:	23.50	24.5	-4.08	

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 $\geq 7 \times 7 \times 9$ 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.

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, RFtest software Version A.1.01 running with WL command, which enable to control the frequency and output power of the module.

11.1. RF OUTPUT POWER FOR 2.4 GHZ BAND

Mode	Ch. #	Freq. (MHz)	Avg output Pwr (dBm)	
			Original output power from EMC report	Atual Measured power
802.11b (1 Mbps)	1	2412	16.2	16.3
	6	2437	16.1	16.2
	11	2462	16.0	16.1
802.11g (6 Mbps)	1	2412	14.8	
	6	2437	15.4	
	11	2462	13.0	
802.11n HT20 (MCS 0)	1	2412	14.8	
	6	2437	15.4	
	11	2462	13.0	

Note:

The modes with highest output power channel were chosen for the conducted output power measurement. Please refer to original report for Average Power information named '991223X06_FCC Power Table for AW-NH931_V01'.

12. SUMMARY OF SAR TEST RESULTS

12.1. Summary of SAR test configurations

Configuration	Antenna-to-User distance	SAR Require	Comments
Bottom Face	12 mm From WiFi Main-to-user	Yes	SAR evaluation
Edge - Primary Landscape	162.59 mm From WiFi Main-to-user	No	This is not the most conservative antenna-to-user distance at edge mode. Per According to KDB 447498 4) b) ii) (2)
Edge - Secondary Landscape	4.18 mm from WiFi Main-to-user	Yes	SAR evaluation
Edge - Primary Portrait	15.24 mm From WiFi Main-to-user	Yes	SAR evaluation
Edge - Secondary Portrait	233 mm From WiFi Main-to-user	No	This is not the most conservative antenna-to-user distance at edge mode. Per According to KDB 447498 4) b) ii) (2)

12.2. Summary of SAR test results

Bottom Face

Band	Mode	Channel	Freq. (MHz)	Avg Pwr (dBm)	Results (mW/g)	
					1g-SAR	10g-SAR
2.4 GHz	802.11b Legacy	1	2412	16.3		
		6	2437	16.2	0.317	0.172
		11	2462	16.1		

Edge - Secondary Landscape

Band	Mode	Channel	Freq. (MHz)	Avg Pwr (dBm)	Results (mW/g)	
					1g-SAR	10g-SAR
2.4 GHz	802.11b Legacy	1	2412	16.3		
		6	2437	16.2	0.242	0.106
		11	2462	16.1		

Edge - Primary Portrait

Band	Mode	Channel	Freq. (MHz)	Avg Pwr (dBm)	Results (mW/g)	
					1g-SAR	10g-SAR
2.4 GHz	802.11b Legacy	1	2412	16.3		
		6	2437	16.2	0.057	0.271
		11	2462	16.1		

WORST-CASE SAR TEST LPOTS

Date/Time: 5/2/2011 11:48:12 PM

Test Laboratory: UL CCS

802.11bgn 1x1

DUT: AZUREWAVE TECHNOLOGIES; Type: Tablet; Serial: NA

Communication System: 802.11b/g 2.4GHz; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.928$ mho/m; $\epsilon_r = 51.433$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

Room Ambient Temperature: 24.0 deg. C; Liquid Temperature: 23.0 deg. C

DASY5 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0 dB and with a peak SAR value greater than 0.0012W/kg
- Probe: EX3DV4 - SN3686; ConvF(6.86, 6.86, 6.86); Calibrated: 1/24/2011
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1239; Calibrated: 11/17/2010
- Phantom: ELI 4.0; Type: QDOVA001BB; Serial: 1099
- Measurement SW: DASY52, Version 52.6 (1); SEMCAD X Version 14.4.2 (2595)

Bottom Face/Main Ant_ch 6/Area Scan (9x10x1): Measurement grid: dx=15mm, dy=15mm

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.416 mW/g

Bottom Face/Main Ant_ch 6/Zoom Scan (7x7x9)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm

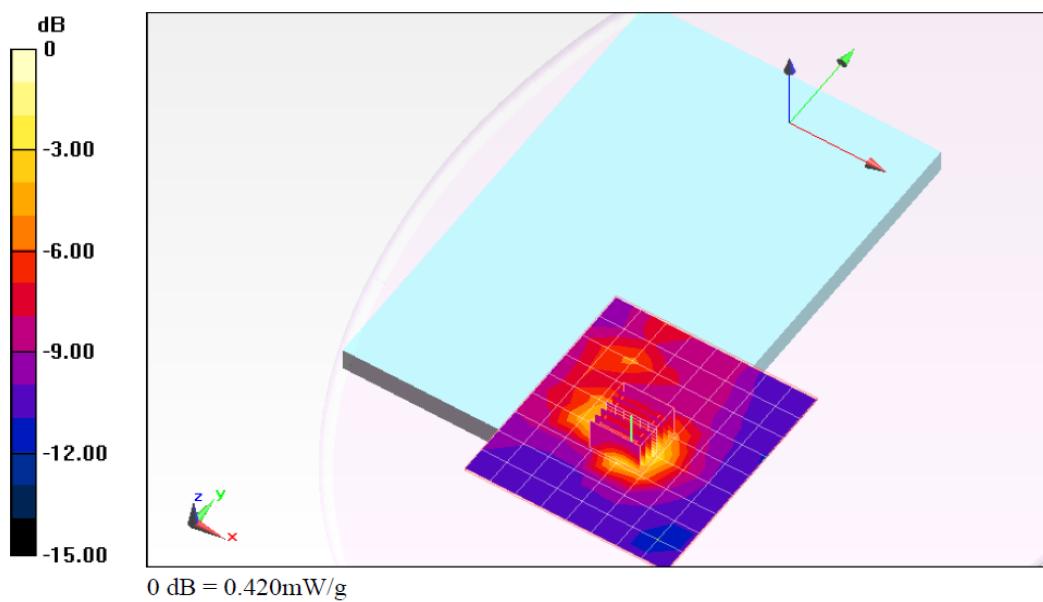
Reference Value = 14.939 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 0.616 W/kg

SAR(1 g) = 0.317 mW/g; SAR(10 g) = 0.172 mW/g

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.422 mW/g



Date/Time: 5/3/2011 12:06:03 AM

Test Laboratory: UL CCS

802.11bgn 1x1

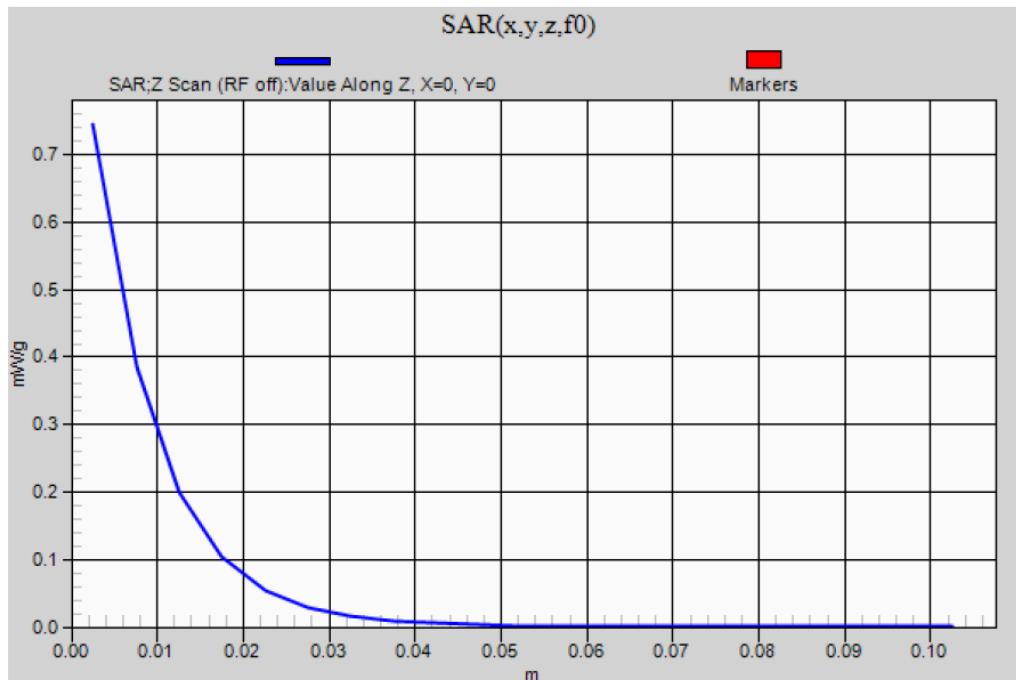
DUT: AZUREWAVE TECHNOLOGIES; Type: Tablet; Serial: NA

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

Bottom Face/Main Ant_ch 6/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.559 mW/g



13. ATTACHMENTS

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