FCC OET BULLETIN 65 SUPPLEMENT C 01-01
IEEE Std 1528-2003 & IEEE 1528a-2005

SAR EVALUATION REPORT

For
Tablet with IEEE 802.11a/b/g/n radio and Bluetooth radio

Model: A1458
FCC ID: BCGA1458

Report Number: 12U14507-7
Issue Date: 10/05/2012

Prepared for
APPLE INC.
1 INFINITE LOOP
CUPERTINO, CA 95014-2084

Prepared by
UL CCS
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	10/05/2012	Initial Issue	--

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1. Attestation of Test Results

Applicant	Apple Inc.
DUT description	Tablet with IEEE 802.11a/b/g/n radio and Bluetooth radio
Model	A1458
Test device is	An identical prototype
Device category	Portable
Exposure category	General Population/Uncontrolled Exposure
Date tested	7/31/2012 - 9/25/2012

FCC Rule Parts	Freq. Range	Highest 1-g SAR	Limit
15.247 (WiFi)	2412-2462 MHz	1.11 W/kg (Body Edge 3 w/ 0 mm distance)	1.6 W/kg
15.247 (BT)	2402-2480 MHz	0.352 W/kg (Body Edge 3 w/ 0 mm distance)	
15.407 (WiFi)	5150-5250 MHz	0.644 W/kg (Body Edge 3 w/ 0 mm distance)	
	5250-5350 MHz	1.09 W/kg (Body Edge 3 w/ 0 mm distance)	
	5500-5700 MHz	1.18 W/kg (Body Edge 3 w/ 0 mm distance)	
15.247 (WiFi)	5725-5850 MHz	1.19 W/kg (Body Edge 3 w/ 0 mm distance)	
Simultaneous transmission condition		1.542 W/kg (refer to Section 14.1) (The highest SAR across exposure conditions)	

Applicable Standards	Test Results
FCC OET Bulletin 65 Supplement C 01-01, IEEE Std 1528-2003 & IEEE 1528a-2005	Pass

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:

Sunny Shih
Engineering Leader
UL CCS

Tested By:

Bobby Bayani
SAR Engineer
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 & IEEE 1528a-2005 and the following published KDB procedures:

- 447498 D01 Mobile Portable RF Exposure v04
- 248227 D01 SAR Meas for 802 11abg v01r02

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 used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' 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	SPEAG	DAK-3.5	1054	N/A		
Vector Signal Generator	R & S	SMU200A	104592	7	27	2014
Vector Signal Generator	R & S	SMU200A	104591	7	26	2014
E-Field Probe	SPEAG	EX3DV4	3676	3	23	2013
E-Field Probe	SPEAG	EX3DV4	3720	3	23	2013
E-Field Probe	SPEAG	EX3DV4	3757	3	23	2013
E-Field Probe	SPEAG	EX3DV4	3778	3	23	2013
E-Field Probe	SPEAG	EX3DV4	3751	11	19	2012
Data Acquisition Electronics	SPEAG	DAE4	1261	3	8	2013
Data Acquisition Electronics	SPEAG	DAE4	1263	3	7	2013
Data Acquisition Electronics	SPEAG	DAE4	1264	3	4	2013
Data Acquisition Electronics	SPEAG	DAE4	1278	3	8	2013
Thermometer	Control Company	4353	122102412	2	24	2014
System Validation Dipole	SPEAG	D2450V2	826	4	11	2013
System Validation Dipole	SPEAG	D5GHzV2	1072	4	18	2013
Power Meter	R & S	NRP2	101663	9	4	2013
Power Meter	R & S	NRP2	101664	9	7	2013
Power Sensor	R & S	NRP - Z81	101298	9	7	2013
Power Sensor	R & S	NRP - Z81	101302	9	4	2013
Amplifier	Amplifier Research	15S1G4M41, 0.7-4.2 GHz	335565	N/A		
Amplifier	Amplifier Research	35S4G8A, 4-8 GHz	336934	N/A		
Directional coupler	KRYTAR	158010	92552	N/A		
Directional coupler	KRYTAR	158010	142253	N/A		
S-Parameter Network Analyzer	Agilent	N5230C	MY49001783	8	31	2013

4.2. Measurement Uncertainty

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

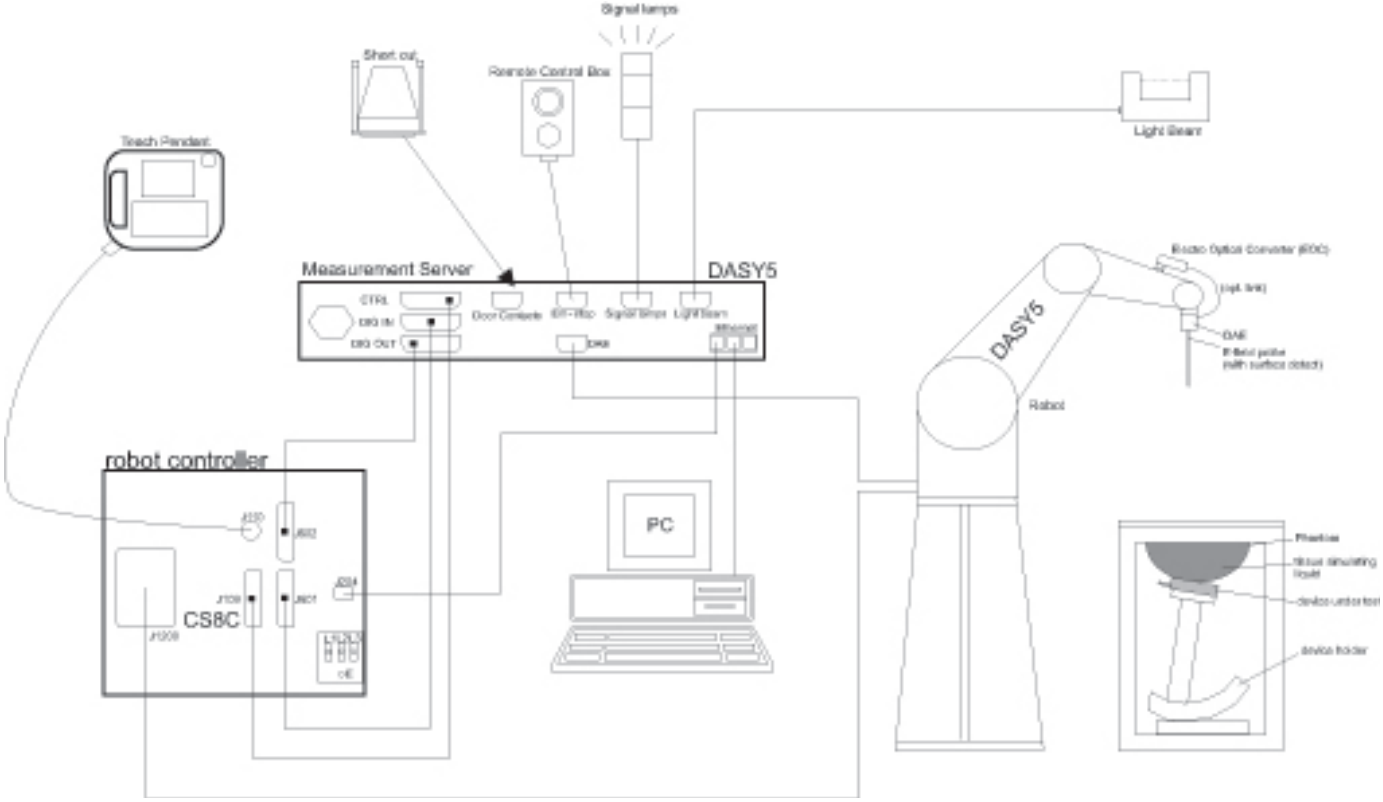
Component	Error, %	Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1)	**6.00**	Normal	1	1	6.00
Axial Isotropy	1.15	Rectangular	1.732	0.7071	0.47
Hemispherical Isotropy	2.30	Rectangular	1.732	0.7071	0.94
Boundary Effect	0.90	Rectangular	1.732	1	0.52
Probe Linearity	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	**-4.05**	Normal	1	0.64	-2.59
Liquid Permittivity - deviation from target	5.00	Rectangular	1.732	0.6	1.73
Liquid Permittivity - measurement uncertainty	**-4.48**	Normal	1	0.6	-2.69
				Combined Standard Uncertainty Uc(y) =	10.43
				Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence = 20.86 %	
				Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence = 1.65 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	**-3.78**	Normal	1	0.64	-2.42
Liquid Permittivity - deviation from target	10.00	Rectangular	1.732	0.6	3.46
Liquid Permittivity - measurement uncertainty	**-3.78**	Normal	1	0.6	-2.27
				Combined Standard Uncertainty Uc(y), %:	10.96
				Expanded Uncertainty U, Coverage Factor = 1.96, > 95 % Confidence = 21.49 %	
				Expanded Uncertainty U, Coverage Factor = 1.96, > 95 % Confidence = 1.69 dB	

5. Measurement System Description and Setup

The DASY5 system used 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.
- 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 Procedure

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 DASY 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.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01 (Draft)

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

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 points (refer to table below) 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.

Zoom Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01 (Draft)

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5·$\Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the area scan based *1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

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 (FCC only)

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.

6.2. Volume Scan Procedures

Step 1: Repeat Step 1-4 in Section 6.1

Step 2: Volume Scan
Volume Scans are used to assess peak SAR and averaged SAR measurements in largely extended 3-dimensional volumes within any phantom. This measurement does not need any previous area scan. The grid can be anchored to a user specific point or to the current probe location.

Step 3: 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.

7. Device Under Test

Model A1458 is a tablet with multimedia functions (music, application support, and video), IEEE 802.11a/b/g/n radio and Bluetooth radio.	
Exposure conditions	Body Exposure with all surfaces and edges. Refer to Section 8 for details.
Simultaneous Transmission	• WiFi 2.4 GHz Radio cannot transmit simultaneously with Bluetooth Radio. • WiFi 5 GHz Radio can transmit simultaneously with Bluetooth Radio.

7.1. Band and Air Interfaces

Tx Frequency Bands	- 802.11a/b/g/n: 2412 - 2462 MHz 5180 – 5825 MHz - Bluetooth: 2402 - 2480 MHz
Mode	▪ 802.11a/b/g/n HT20/HT40(a mode only) • Bluetooth 4.0 LE

Notes:

There are two Bill of Material variations of the Wi-Fi/Bluetooth Radio to support the production volumes of the device. The two BOM variants are:

- BOM # 1
- BOM # 2

The Model A1458 share the same Wi-Fi/Bluetooth chipset, have the same mechanical outline (e.g., the same dimension package and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform the same specifications and to operate within the same tolerances.

Complete SAR evaluation is performed on the BOM # 1 that has the highest SAR, and then, the test is repeated for the other BOM variant at the highest peak SAR value.

8. Exposure Conditions

Refer to Section 17 “Antenna Location and Separation Distances” for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

8.1. Body

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	8.48 mm	Yes	
Edge 1	227.4 mm	No	This is not the most conservative antenna-to-user distance at edge mode. According to KDB 447498 4) b) ii) (2)
Edge 2	44.6 mm	Yes	
Edge 3	3.75 mm	Yes	
Edge 4	111.7mm	No	This is not the most conservative antenna-to-user distance at edge mode. According to KDB 447498 4) b) ii) (2)

Notes:

- Edge 1= Top Edge
- Edge 2= Right Edge
- Edge 3= Bottom Edge
- Edge 4= Left Edge

9. RF Output Power Measurement

9.1. WiFi (2.4 GHz Band)

Required Test Channels per KDB 248227 D01

Mode	Band	GHz	Channel	"Default Test Channels"	
				802.11b	802.11g
802.11b/g	2.4 GHz	**2.412**	1#	√	∇
		2.437	6	√	∇
		2.462	11#	√	∇

Notes:
√ = "default test channels"
∇ = possible 802.11g channels with maximum average output ¼ dB ≥ the "default test channels"
= when output power is reduced for channel 1 and /or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested.

Band (MHz)	Mode	Ch #	Freq. (MHz)	Avg Pwr (dBm)	Note
2.4	802.11b	1	2412	16.5	
		6	2437	16.5	
		11	2462	16.5	
	802.11g	1	2412	16.0	
		6	2437	16.5	
		11	2462	15.5	
	802.11n (HT20)	1	2412	15.5	
		6	2437	16.5	
		11	2462	15.0	

Note(s):

1. SAR is not required for 802.11g/HT20 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a/b channels. As per KDB 248227

9.2. WiFi (5 GHz Bands)

Required Test Channels per KDB 248227 D01

Mode		Band	GHz	Channel	"Default Test Channels"	
					802.11a	
802.11a	UNII (15.407)	5.2 GHz	5.180	36	√	
			5.200	40		*
			2.220	44		*
			5.240	48	√	
		5.3 GHz	5.260	52	√	
			5.280	56		*
			5.300	60		*
			5.320	64	√	
		5.5 GHz	5.500	100		
			5.520	104	√	
			5.540	108		*
			5.560	112		*
			5.580	116	√	
			5.600	120		*
			5.620	124	√	
			5.640	128		*
			5.660	132		*
			5.680	136	√	
			5.700	140		*
	DTS (15.247)	5.8 GHz	5.745	149	√	
			5.765	153		*
			5.785	157	√	
			5.805	161		*
			5.825	165	√	

√ = "default test channels"

* = possible 802.11a channels with maximum average output > the "default test channels"

= when output power is reduced for channel 1 and /or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested.

Band (MHz)	Mode	Ch #	Freq. (MHz)	Avg Pwr (dBm)	Note
5.2	802.11a	36	5180	14.0	
		40	5200	14.0	
		44	5220	14.0	
		48	5240	14.0	
	802.11n (HT20)	36	5180	14.0	
		40	5200	14.0	
		48	5240	14.0	
	802.11n (HT40)	38	5190	12.0	
		46	5230	15.5	
5.3	802.11a	52	5260	17.5	
		56	5280	17.5	
		60	5300	17.5	
		64	5320	16.0	
	802.11n (HT20)	52	5260	17.5	
		60	5300	17.5	
		64	5320	16.0	
	802.11n (HT40)	54	5270	17.5	
		62	5310	14.0	
5.5	802.11a	100	5500	15.5	
		104	5520	18.0	
		108	5540	18.0	
		112	5560	18.0	
		116	5580	18.0	
		120	5600	18.0	
		124	5620	18.0	
		128	5640	18.0	
		132	5660	18.0	
		136	5680	18.0	
		140	5700	15.0	
	802.11n (HT20)	100	5500	15.0	
		120	5600	18.0	
		140	5700	15.0	
	802.11n (HT40)	102	5510	13.0	
		118	5550	18.0	
		134	5670	16.0	
5.8	802.11a	149	5745	18.5	
		153	5765	18.5	
		157	5785	18.5	
		161	5805	18.5	
		165	5825	18.5	
	802.11n (HT20)	149	5745	18.5	
		157	5785	18.5	
		161	5805	18.5	
	802.11n (HT40)	151	5755	18.5	
		159	5795	18.5	

Note(s):

1. 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/b channels. As per KDB 248227

9.3. Bluetooth

Mode	Channel #	Freq. (MHz)	Conducted Avg Power	
			(dBm)	(mW)
V2.1 + EDR, GFSK	0	2402	13.00	19.95
	39	2441	13.00	19.95
	78	2480	13.00	19.95
V2.1 + EDR, π/4 DQPSK	0	2402	10.50	11.22
	39	2441	10.50	11.22
	78	2480	10.50	11.22
V2.1 + EDR, 8-DPSK	0	2402	10.50	11.22
	39	2441	10.50	11.22
	78	2480	10.50	11.22
V4.0 LE, GFSK	0	2402	10.00	10.00
	39	2441	10.00	10.00
	78	2480	10.00	10.00

10. Tissue Dielectric Properties

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

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Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
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

10.1. Composition of Ingredients for the Tissue Material Used in the SAR Tests

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

Simulating Liquids for 5 GHz, Manufactured by SPEAG

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

10.2. Tissue Dielectric Parameter Check Results

Tissue dielectric parameters were 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 ±(%)
7/31/2012	Body 5180	e'	50.4790	Relative Permittivity (ε_r):	50.48	49.05	2.92	10
		e"	18.1334	Conductivity (σ):	5.22	5.27	-0.92	5
	Body 5200	e'	50.4329	Relative Permittivity (ε_r):	50.43	49.02	2.88	10
		e"	18.1515	Conductivity (σ):	5.25	5.29	-0.88	5
	Body 5500	e'	49.9404	Relative Permittivity (ε_r):	49.94	48.61	2.73	10
		e"	18.4499	Conductivity (σ):	5.64	5.64	-0.04	5
	Body 5800	e'	49.6012	Relative Permittivity (ε_r):	49.60	48.20	2.91	10
		e"	18.8494	Conductivity (σ):	6.08	6.00	1.31	5
	Body 5825	e'	49.5829	Relative Permittivity (ε_r):	49.58	48.20	2.87	10
		e"	18.8974	Conductivity (σ):	6.12	6.00	2.01	5
7/31/2012	Body 5180	e'	48.8974	Relative Permittivity (ε_r):	48.90	49.05	-0.30	10
		e"	17.7860	Conductivity (σ):	5.12	5.27	-2.82	5
	Body 5200	e'	48.8510	Relative Permittivity (ε_r):	48.85	49.02	-0.34	10
		e"	17.8019	Conductivity (σ):	5.15	5.29	-2.79	5
	Body 5500	e'	48.4112	Relative Permittivity (ε_r):	48.41	48.61	-0.42	10
		e"	18.0649	Conductivity (σ):	5.52	5.64	-2.12	5
	Body 5800	e'	48.0108	Relative Permittivity (ε_r):	48.01	48.20	-0.39	10
		e"	18.3824	Conductivity (σ):	5.93	6.00	-1.20	5
	Body 5825	e'	47.9817	Relative Permittivity (ε_r):	47.98	48.20	-0.45	10
		e"	18.4295	Conductivity (σ):	5.97	6.00	-0.52	5
8/1/2012	Body 5180	e'	49.5259	Relative Permittivity (ε_r):	49.53	49.05	0.98	10
		e"	17.7273	Conductivity (σ):	5.11	5.27	-3.14	5
	Body 5200	e'	49.4966	Relative Permittivity (ε_r):	49.50	49.02	0.97	10
		e"	17.7492	Conductivity (σ):	5.13	5.29	-3.07	5
	Body 5500	e'	49.0536	Relative Permittivity (ε_r):	49.05	48.61	0.91	10
		e"	17.9770	Conductivity (σ):	5.50	5.64	-2.60	5
	Body 5800	e'	48.6459	Relative Permittivity (ε_r):	48.65	48.20	0.93	10
		e"	18.2675	Conductivity (σ):	5.89	6.00	-1.81	5
	Body 5825	e'	48.6101	Relative Permittivity (ε_r):	48.61	48.20	0.85	10
		e"	18.2914	Conductivity (σ):	5.92	6.00	-1.26	5
8/1/2012	Body 5180	e'	48.8573	Relative Permittivity (ε_r):	48.86	49.05	-0.39	10
		e"	17.9393	Conductivity (σ):	5.17	5.27	-1.98	5
	Body 5200	e'	48.8187	Relative Permittivity (ε_r):	48.82	49.02	-0.41	10
		e"	17.9473	Conductivity (σ):	5.19	5.29	-1.99	5
	Body 5500	e'	48.3419	Relative Permittivity (ε_r):	48.34	48.61	-0.56	10
		e"	18.1747	Conductivity (σ):	5.56	5.64	-1.53	5
	Body 5800	e'	47.9656	Relative Permittivity (ε_r):	47.97	48.20	-0.49	10
		e"	18.4866	Conductivity (σ):	5.96	6.00	-0.64	5
	Body 5825	e'	47.9440	Relative Permittivity (ε_r):	47.94	48.20	-0.53	10
		e"	18.5118	Conductivity (σ):	6.00	6.00	-0.07	5
8/1/2012	Body 2450	e'	50.9584	Relative Permittivity (ε_r):	50.96	52.70	-3.30	5
		e"	14.0249	Conductivity (σ):	1.91	1.95	-2.02	5
	Body 2410	e'	51.0770	Relative Permittivity (ε_r):	51.08	52.76	-3.19	5
		e"	13.8144	Conductivity (σ):	1.85	1.91	-2.95	5
	Body 2435	e'	51.0177	Relative Permittivity (ε_r):	51.02	52.73	-3.24	5
		e"	13.9463	Conductivity (σ):	1.89	1.93	-2.22	5
	Body 2475	e'	50.8313	Relative Permittivity (ε_r):	50.83	52.67	-3.49	5
		e"	14.1536	Conductivity (σ):	1.95	1.99	-1.88	5

Tissue Dielectric Parameter Check Results (continued)

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
8/1/2012	Body 2450	e'	50.7236	Relative Permittivity (ϵ_r):	50.72	52.70	-3.75	5
		e"	14.0709	Conductivity (σ):	1.92	1.95	-1.70	5
	Body 2410	e'	50.8538	Relative Permittivity (ϵ_r):	50.85	52.76	-3.61	5
		e"	13.8638	Conductivity (σ):	1.86	1.91	-2.60	5
	Body 2435	e'	50.7868	Relative Permittivity (ϵ_r):	50.79	52.73	-3.68	5
		e"	13.9938	Conductivity (σ):	1.89	1.93	-1.89	5
	Body 2475	e'	50.6027	Relative Permittivity (ϵ_r):	50.60	52.67	-3.92	5
		e"	14.2020	Conductivity (σ):	1.95	1.99	-1.55	5
8/3/2012	Body 5180	e'	49.6900	Relative Permittivity (ϵ_r):	49.69	49.05	1.31	10
		e"	18.0400	Conductivity (σ):	5.20	5.27	-1.43	5
	Body 5200	e'	49.6500	Relative Permittivity (ϵ_r):	49.65	49.02	1.29	10
		e"	18.0500	Conductivity (σ):	5.22	5.29	-1.43	5
	Body 5500	e'	49.1800	Relative Permittivity (ϵ_r):	49.18	48.61	1.17	10
		e"	18.3200	Conductivity (σ):	5.60	5.64	-0.74	5
	Body 5800	e'	48.7700	Relative Permittivity (ϵ_r):	48.77	48.20	1.18	10
		e"	18.6600	Conductivity (σ):	6.02	6.00	0.30	5
	Body 5825	e'	48.7400	Relative Permittivity (ϵ_r):	48.74	48.20	1.12	10
		e"	18.6900	Conductivity (σ):	6.05	6.00	0.89	5
8/6/2012	Body 5180	e'	48.7262	Relative Permittivity (ϵ_r):	48.73	49.05	-0.65	10
		e"	17.7309	Conductivity (σ):	5.11	5.27	-3.12	5
	Body 5200	e'	48.7034	Relative Permittivity (ϵ_r):	48.70	49.02	-0.65	10
		e"	17.7400	Conductivity (σ):	5.13	5.29	-3.12	5
	Body 5500	e'	48.2466	Relative Permittivity (ϵ_r):	48.25	48.61	-0.75	10
		e"	17.9629	Conductivity (σ):	5.49	5.64	-2.68	5
	Body 5800	e'	47.8395	Relative Permittivity (ϵ_r):	47.84	48.20	-0.75	10
		e"	18.2427	Conductivity (σ):	5.88	6.00	-1.95	5
	Body 5825	e'	47.8090	Relative Permittivity (ϵ_r):	47.81	48.20	-0.81	10
		e"	18.2635	Conductivity (σ):	5.92	6.00	-1.41	5
8/6/2012	Body 5180	e'	47.8512	Relative Permittivity (ϵ_r):	47.85	49.05	-2.44	10
		e"	18.2885	Conductivity (σ):	5.27	5.27	-0.07	5
	Body 5200	e'	47.7954	Relative Permittivity (ϵ_r):	47.80	49.02	-2.50	10
		e"	18.3196	Conductivity (σ):	5.30	5.29	0.04	5
	Body 5500	e'	47.3648	Relative Permittivity (ϵ_r):	47.36	48.61	-2.57	10
		e"	18.5992	Conductivity (σ):	5.69	5.64	0.77	5
	Body 5800	e'	46.9128	Relative Permittivity (ϵ_r):	46.91	48.20	-2.67	10
		e"	18.9271	Conductivity (σ):	6.10	6.00	1.73	5
	Body 5825	e'	46.8988	Relative Permittivity (ϵ_r):	46.90	48.20	-2.70	10
		e"	18.9492	Conductivity (σ):	6.14	6.00	2.29	5
8/7/2012	Body 5180	e'	48.7255	Relative Permittivity (ϵ_r):	48.73	49.05	-0.65	10
		e"	18.1064	Conductivity (σ):	5.22	5.27	-1.07	5
	Body 5200	e'	48.6845	Relative Permittivity (ϵ_r):	48.68	49.02	-0.68	10
		e"	18.1261	Conductivity (σ):	5.24	5.29	-1.02	5
	Body 5500	e'	48.2284	Relative Permittivity (ϵ_r):	48.23	48.61	-0.79	10
		e"	18.3599	Conductivity (σ):	5.61	5.64	-0.53	5
	Body 5800	e'	47.7690	Relative Permittivity (ϵ_r):	47.77	48.20	-0.89	10
		e"	18.6553	Conductivity (σ):	6.02	6.00	0.27	5
	Body 5825	e'	47.7355	Relative Permittivity (ϵ_r):	47.74	48.20	-0.96	10
		e"	18.6849	Conductivity (σ):	6.05	6.00	0.86	5

Tissue Dielectric Parameter Check Results (continued)

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
8/7/2012	Body 2450	e'	50.4124	Relative Permittivity (ε_r):	50.41	52.70	-4.34	5
		e"	14.0214	Conductivity (σ):	1.91	1.95	-2.05	5
	Body 2410	e'	50.5845	Relative Permittivity (ε_r):	50.58	52.76	-4.12	5
		e"	13.8206	Conductivity (σ):	1.85	1.91	-2.91	5
	Body 2435	e'	50.4785	Relative Permittivity (ε_r):	50.48	52.73	-4.26	5
		e"	13.9291	Conductivity (σ):	1.89	1.93	-2.34	5
	Body 2475	e'	50.3070	Relative Permittivity (ε_r):	50.31	52.67	-4.48	5
		e"	14.1434	Conductivity (σ):	1.95	1.99	-1.95	5
8/7/2012	Body 2450	e'	52.1286	Relative Permittivity (ε_r):	52.13	52.70	-1.08	5
		e"	13.8607	Conductivity (σ):	1.89	1.95	-3.17	5
	Body 2410	e'	52.3097	Relative Permittivity (ε_r):	52.31	52.76	-0.85	5
		e"	13.6577	Conductivity (σ):	1.83	1.91	-4.05	5
	Body 2435	e'	52.1962	Relative Permittivity (ε_r):	52.20	52.73	-1.01	5
		e"	13.7758	Conductivity (σ):	1.87	1.93	-3.41	5
	Body 2475	e'	52.0227	Relative Permittivity (ε_r):	52.02	52.67	-1.23	5
		e"	13.9946	Conductivity (σ):	1.93	1.99	-2.98	5
8/8/2012	Body 5180	e'	47.3484	Relative Permittivity (ε_r):	47.35	49.05	-3.46	10
		e"	17.9157	Conductivity (σ):	5.16	5.27	-2.11	5
	Body 5200	e'	47.3202	Relative Permittivity (ε_r):	47.32	49.02	-3.47	10
		e"	17.9344	Conductivity (σ):	5.19	5.29	-2.06	5
	Body 5500	e'	46.8458	Relative Permittivity (ε_r):	46.85	48.61	-3.64	10
		e"	18.1201	Conductivity (σ):	5.54	5.64	-1.82	5
	Body 5800	e'	46.4166	Relative Permittivity (ε_r):	46.42	48.20	-3.70	10
		e"	18.3934	Conductivity (σ):	5.93	6.00	-1.14	5
	Body 5825	e'	46.3798	Relative Permittivity (ε_r):	46.38	48.20	-3.78	10
		e"	18.4108	Conductivity (σ):	5.96	6.00	-0.62	5
8/10/2012	Body 5180	e'	48.4203	Relative Permittivity (ε_r):	48.42	49.05	-1.28	10
		e"	17.6641	Conductivity (σ):	5.09	5.27	-3.48	5
	Body 5200	e'	48.3895	Relative Permittivity (ε_r):	48.39	49.02	-1.29	10
		e"	17.6799	Conductivity (σ):	5.11	5.29	-3.45	5
	Body 5500	e'	47.9529	Relative Permittivity (ε_r):	47.95	48.61	-1.36	10
		e"	17.8811	Conductivity (σ):	5.47	5.64	-3.12	5
	Body 5800	e'	47.5367	Relative Permittivity (ε_r):	47.54	48.20	-1.38	10
		e"	18.1423	Conductivity (σ):	5.85	6.00	-2.49	5
	Body 5825	e'	47.4986	Relative Permittivity (ε_r):	47.50	48.20	-1.46	10
		e"	18.1656	Conductivity (σ):	5.88	6.00	-1.94	5
8/10/2012	Body 5180	e'	47.6472	Relative Permittivity (ε_r):	47.65	49.05	-2.85	10
		e"	17.6116	Conductivity (σ):	5.07	5.27	-3.77	5
	Body 5200	e'	47.6267	Relative Permittivity (ε_r):	47.63	49.02	-2.84	10
		e"	17.6192	Conductivity (σ):	5.09	5.29	-3.78	5
	Body 5500	e'	47.1681	Relative Permittivity (ε_r):	47.17	48.61	-2.97	10
		e"	17.7950	Conductivity (σ):	5.44	5.64	-3.59	5
	Body 5800	e'	46.7702	Relative Permittivity (ε_r):	46.77	48.20	-2.97	10
		e"	18.0332	Conductivity (σ):	5.82	6.00	-3.07	5
	Body 5825	e'	46.7252	Relative Permittivity (ε_r):	46.73	48.20	-3.06	10
		e"	18.0537	Conductivity (σ):	5.85	6.00	-2.54	5

Tissue Dielectric Parameter Check Results (continued)

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
9/12/2012	Body 5180	e'	48.8681	Relative Permittivity (ϵ_r):	48.87	49.05	-0.36	10
		e"	18.4328	Conductivity (σ):	5.31	5.27	0.72	5
	Body 5200	e'	48.8445	Relative Permittivity (ϵ_r):	48.84	49.02	-0.36	10
		e"	18.4126	Conductivity (σ):	5.32	5.29	0.55	5
	Body 5500	e'	48.2555	Relative Permittivity (ϵ_r):	48.26	48.61	-0.74	10
		e"	18.6645	Conductivity (σ):	5.71	5.64	1.12	5
	Body 5800	e'	47.9297	Relative Permittivity (ϵ_r):	47.93	48.20	-0.56	10
		e"	19.0085	Conductivity (σ):	6.13	6.00	2.17	5
	Body 5825	e'	47.8816	Relative Permittivity (ϵ_r):	47.88	48.20	-0.66	10
		e"	18.9885	Conductivity (σ):	6.15	6.00	2.50	5
9/13/2012	Body 5180	e'	49.0229	Relative Permittivity (ϵ_r):	49.02	49.05	-0.05	10
		e"	18.3655	Conductivity (σ):	5.29	5.27	0.35	5
	Body 5200	e'	48.9950	Relative Permittivity (ϵ_r):	49.00	49.02	-0.05	10
		e"	18.3815	Conductivity (σ):	5.31	5.29	0.38	5
	Body 5500	e'	48.4902	Relative Permittivity (ϵ_r):	48.49	48.61	-0.25	10
		e"	18.6164	Conductivity (σ):	5.69	5.64	0.86	5
	Body 5800	e'	48.0470	Relative Permittivity (ϵ_r):	48.05	48.20	-0.32	10
		e"	18.9143	Conductivity (σ):	6.10	6.00	1.66	5
	Body 5825	e'	48.0006	Relative Permittivity (ϵ_r):	48.00	48.20	-0.41	10
		e"	18.9404	Conductivity (σ):	6.13	6.00	2.24	5
9/14/2012	Body 5180	e'	48.9517	Relative Permittivity (ϵ_r):	48.95	49.05	-0.19	10
		e"	18.4148	Conductivity (σ):	5.30	5.27	0.62	5
	Body 5200	e'	48.8933	Relative Permittivity (ϵ_r):	48.89	49.02	-0.26	10
		e"	18.3945	Conductivity (σ):	5.32	5.29	0.45	5
	Body 5500	e'	48.3475	Relative Permittivity (ϵ_r):	48.35	48.61	-0.55	10
		e"	18.6822	Conductivity (σ):	5.71	5.64	1.22	5
	Body 5800	e'	47.9896	Relative Permittivity (ϵ_r):	47.99	48.20	-0.44	10
		e"	19.0179	Conductivity (σ):	6.13	6.00	2.22	5
	Body 5825	e'	47.9771	Relative Permittivity (ϵ_r):	47.98	48.20	-0.46	10
		e"	19.0333	Conductivity (σ):	6.16	6.00	2.74	5
9/25/2012	Body 2450	e'	51.7030	Relative Permittivity (ϵ_r):	51.70	52.70	-1.89	5
		e"	14.2759	Conductivity (σ):	1.94	1.95	-0.27	5
	Body 2410	e'	51.8384	Relative Permittivity (ϵ_r):	51.84	52.76	-1.75	5
		e"	14.0571	Conductivity (σ):	1.88	1.91	-1.25	5
	Body 2435	e'	51.7550	Relative Permittivity (ϵ_r):	51.76	52.73	-1.84	5
		e"	14.1958	Conductivity (σ):	1.92	1.93	-0.47	5
	Body 2475	e'	51.6017	Relative Permittivity (ϵ_r):	51.60	52.67	-2.03	5
		e"	14.4002	Conductivity (σ):	1.98	1.99	-0.17	5
9/25/2012	Body 2450	e'	52.5033	Relative Permittivity (ϵ_r):	52.50	52.70	-0.37	5
		e"	14.3063	Conductivity (σ):	1.95	1.95	-0.06	5
	Body 2410	e'	52.6419	Relative Permittivity (ϵ_r):	52.64	52.76	-0.22	5
		e"	14.0849	Conductivity (σ):	1.89	1.91	-1.05	5
	Body 2435	e'	52.5582	Relative Permittivity (ϵ_r):	52.56	52.73	-0.32	5
		e"	14.2243	Conductivity (σ):	1.93	1.93	-0.27	5
	Body 2475	e'	52.4016	Relative Permittivity (ϵ_r):	52.40	52.67	-0.51	5
		e"	14.4330	Conductivity (σ):	1.99	1.99	0.06	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 ±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 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the 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)	Target SAR Values (mW/g)		
				1g/10g	Head	Body
D2450V2	826	4/11/12	2450	1g	52.4	50.6
				10g	24.5	23.7
D5GHzV2	1072	4/18/12	5200	1g	80.3	73.8
				10g	23.0	20.7
			5500	1g	85.0	78.7
				10g	24.3	21.9
			5800	1g	79.6	72.8
				10g	22.6	20.2

11.3. System Performance Check Results

Date Tested	System Dipole		T.S.	SAR Measured (Normalized to 1 W)		Target (Ref. Value)	Delta (%)	Tolerance (%)
	Type	Serial No.	Liquid					
7/31/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	72.5	73.8	-1.76	±10
				10g	20.5	20.7	-0.97	
7/31/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	70.5	73.8	-4.47	±10
				10g	20.0	20.7	-3.38	
8/1/2012	D5GHzV2 (5.8GHz)	1072	Body	1g	67.3	72.8	-7.55	±10
				10g	18.8	20.2	-6.93	
8/1/2012	D5GHzV2 (5.8GHz)	1072	Body	1g	67.1	72.8	-7.83	±10
				10g	18.9	20.2	-6.44	
8/1/2012	D2450V2	826	Body	1g	53.1	50.6	4.94	±10
				10g	24.9	23.7	5.06	
8/1/2012	D2450V2	826	Body	1g	50.1	50.6	-0.99	±10
				10g	23.0	23.7	-2.95	
8/3/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	70.5	73.8	-4.47	±10
				10g	19.9	20.7	-3.86	
8/6/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	69.4	73.8	-5.96	±10
				10g	19.4	20.7	-6.28	
8/6/2012	D5GHzV2 (5.5GHz)	1072	Body	1g	73.9	78.7	-6.10	±10
				10g	20.6	21.9	-5.94	
8/6/2012	D5GHzV2 (5.6GHz)	1072	Body	1g	76.2	78.7	-3.18	±10
				10g	21.4	21.9	-2.28	
8/6/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	71.9	73.8	-2.57	±10
				10g	20.2	20.7	-2.42	
8/6/2012	D5GHzV2 (5.5GHz)	1072	Body	1g	71.9	78.7	-8.64	±10
				10g	20.0	21.9	-8.68	
8/6/2012	D5GHzV2 (5.6GHz)	1072	Body	1g	76.7	78.7	-2.54	±10
				10g	21.4	21.9	-2.28	
8/7/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	71.8	73.8	-2.71	±10
				10g	20.3	20.7	-1.93	
8/7/2012	D5GHzV2 (5.5GHz)	1072	Body	1g	76.2	78.7	-3.18	±10
				10g	21.3	21.9	-2.74	
8/7/2012	D5GHzV2 (5.6GHz)	1072	Body	1g	75.9	78.7	-3.56	±10
				10g	21.4	21.9	-2.28	
8/7/2012	D5GHzV2 (5.8GHz)	1072	Body	1g	70.4	72.8	-3.30	±10
				10g	19.7	20.2	-2.48	
8/7/2012	D2450V2	826	Body	1g	53.8	50.6	6.32	±10
				10g	25.3	23.7	6.75	
8/8/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	72.2	73.8	-2.17	±10
				10g	20.4	20.7	-1.45	
8/8/2012	D5GHzV2 (5.5GHz)	1072	Body	1g	73.7	78.7	-6.35	±10
				10g	20.5	21.9	-6.39	
8/8/2012	D5GHzV2 (5.6GHz)	1072	Body	1g	80.3	78.7	2.03	±10
				10g	22.4	21.9	2.28	
8/10/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	70.5	73.8	-4.47	±10
				10g	19.9	20.7	-3.86	
8/10/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	70.8	73.8	-4.07	±10
				10g	19.9	20.7	-3.86	

System Performance Check Results (continued)

Date Tested	System Dipole		T.S. Liquid	SAR Measured (Normalized to 1 W)		Target (Ref. Value)	Delta (%)	Tolerance (%)
	Type	Serial No.						
9/12/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	72.2	73.8	-2.17	±10
				10g	20.4	20.7	-1.45	
9/13/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	68.8	73.8	-6.78	±10
				10g	19.3	20.7	-6.76	
9/14/2012	D5GHzV2 (5.2GHz)	1072	Body	1g	73.3	73.8	-0.68	±10
				10g	20.7	20.7	0.00	
9/25/2012	D2450V2	826	Body	1g	52.4	50.6	3.56	±10
				10g	24.3	23.7	2.53	
9/25/2012	D2450V2	826	Body	1g	51.4	50.6	1.58	±10
				10g	23.7	23.7	0.00	

12. SAR Test Results

12.1. Wi-Fi (2.4 GHz Band)

(BOM #1)

Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)	1g SAR (W/kg)	Note
Rear	802.11b	0	1	2412	16.5		1
			6	2437	16.5	0.082	
			11	2462	16.5		1
Edge 2	802.11b	0	1	2412	16.5		1
			6	2437	16.5	0.053	
			11	2462	16.5		1
Edge 3	802.11b	0	1	2412	16.5	0.950	
			6	2437	16.5	**1.110**	
			11	2462	16.5	1.070	

Highest SAR Configuration (BOM #2)

Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)	1g SAR (W/kg)	Note
Edge 3	802.11b	0	6	2437	16.5	1.070	

Note(s):

1. When the 1-g SAR for the mid-band channel, or the channel with the highest output power satisfy the following conditions, testing of the other channels in the band is not required. (Per KDB 447498)
   ≤ 0.8 W/kg and transmission band ≤ 100 MHz
   ≤ 0.6 W/kg and, 100 MHz < transmission bandwidth ≤ 200 MHz
   ≤ 0.4 W/kg and transmission band > 200 MHz

12.2. Wi-Fi (5 GHz Bands)

(BOM #1)

Band (GHz)	Test Position	Dist. (mm)	Mode	Ch #.	Freq. (MHz)	Power (dBm)	1g SAR (W/kg)	Note
5.2	Rear	0	802.11a	36	5180	14.0	0.031	
				48	5240	14.0	0.035	
			802.11n HT40	46	5230	15.5	0.040	
	Edge 2	0	802.11a	36	5180	14.0	< 0.001	
				48	5240	14.0	< 0.001	
			802.11n HT40	46	5230	15.5	< 0.001	
	Edge 3	0	802.11a	36	5180	14.0	0.423	
				48	5240	14.0	0.469	
			802.11n HT40	46	5230	15.5	**0.644**	
5.3	Rear	0	802.11a	52	5260	17.5	0.069	
				60	5300	17.5	0.044	
	Edge 2	0	802.11a	52	5260	17.5	< 0.001	
				60	5300	17.5	< 0.001	
	Edge 3	0	802.11a	52	5260	17.5	**1.090**	
				60	5300	17.5	0.939	
5.5	Rear	0	802.11a	104	5520	18.0	0.063	
				116	5580	18.0	0.062	
				124	5620	18.0	0.069	
				136	5680	18.0	0.068	
	Edge 2	0	802.11a	104	5520	18.0	< 0.001	
				116	5580	18.0	< 0.001	
				124	5620	18.0	< 0.001	
				136	5680	18.0	0.00466	
	Edge 3	0	802.11a	104	5520	18.0	1.140	
				116	5580	18.0	1.150	
				124	5620	18.0	1.140	
				136	5680	18.0	**1.180**	
5.8	Rear	0	802.11a	149	5745	18.5	0.074	
				157	5785	18.5	0.069	
				165	5825	18.5	0.069	
	Edge 2	0	802.11a	149	5745	18.5	< 0.001	
				157	5785	18.5	< 0.001	
				165	5825	18.5	< 0.001	
	Edge 3	0	802.11a	149	5745	18.5	1.070	
				157	5785	18.5	**1.190**	
				165	5825	18.5	1.120	

Highest SAR Configuration (BOM #2)

Band (GHz)	Test Position	Dist. (mm)	Mode	Ch #.	Freq. (MHz)	Power (dBm)	1g SAR (W/kg)	Note
5.2	Edge 3	0	802.11n HT40	46	5230	15.5	0.632	
5.3	Edge 3	0	802.11a	52	5260	17.5	1.010	
5.5	Edge 3	0	802.11a	136	5680	17.9	1.120	
5.8	Edge 3	0	802.11a	157	5785	18.5	1.110	

12.3. Bluetooth

(BOM #1)

Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)	1g SAR (W/kg)	Note
Rear	V2.1 + EDR, GFSK	0	0	2402	13.0		1
			39	2441	13.0	0.025	
			78	2480	13.0		1
Edge 2	V2.1 + EDR, GFSK	0	0	2402	13.0		1
			39	2441	13.0	0.018	
			78	2480	13.0		1
Edge 3	V2.1 + EDR, GFSK	0	0	2402	13.0		1
			39	2441	13.0	**0.352**	
			78	2480	13.0		1

Highest SAR Configuration (BOM #2)

Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)	1g SAR (W/kg)	Note
Edge 3	V2.1 + EDR, GFSK	0	39	2441	13.0	0.293	

Note(s):

1. When the 1-g SAR for the mid-band channel, or the channel with the highest output power satisfy the following conditions, testing of the other channels in the band is not required. (Per KDB 447498)
   ≤ 0.8 W/kg and transmission band ≤ 100 MHz
   ≤ 0.6 W/kg and, 100 MHz < transmission bandwidth ≤ 200 MHz
   ≤ 0.4 W/kg and transmission band > 200 MHz

13. Summary of Highest SAR Values

Results for highest SAR values for each frequency band and mode

Technology/Band	Test configuration		Mode	Highest 1g SAR (W/kg)	Note
WiFi 2.4 GHz	Body	Rear	802.11a 6Mbps	1.110	
Bluetooth	Body	Rear	V2.1 + EDR, GFSK	0.352	
WiFi 5.2 GHz	Body	Rear	802.11a 6Mbps	0.644	
WiFi 5.3 GHz	Body	Rear	802.11a 6Mbps	1.090	
WiFi 5.5 GHz	Body	Rear	802.11a 6Mbps	1.180	
WiFi 5.8 GHz	Body	Rear	802.11a 6Mbps	1.190	

13.1. Scaled SAR Values to the Maximum Target Output Power

The highest measured SAR results were scaled, in cases where measured output power is lower than the maximum Target output power level, in each frequency band.

Technology/ Band	Test Configuration		Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		SAR (W/kg)	
							Tune-up limit	Measured	Measured	Scaled
WiFi 2.4 GHz	Body	Edge 3	802.11b 1Mbps	0	6	2437	16.5	16.5	1.110	*
WiFi 5.2 GHz	Body	Edge 3	802.11n HT40 MCS0	0	46	5230	15.5	15.5	0.644	*
WiFi 5.3 GHz	Body	Edge 3	802.11a 6Mbps	0	52	5260	17.5	17.5	1.090	*
WiFi 5.5 GHz	Body	Edge 3	802.11a 6Mbps	0	136	5680	18.0	18.0	1.180	*
WiFi 5.8 GHz	Body	Edge 3	802.11a 6Mbps	0	157	5785	18.5	18.5	1.190	*

Note(s):

*: SAR Scaling was not applied when the measured output power is equal or greater than the maximum target output power.

13.2. SAR Plots (from Summary of Highest SAR Values)

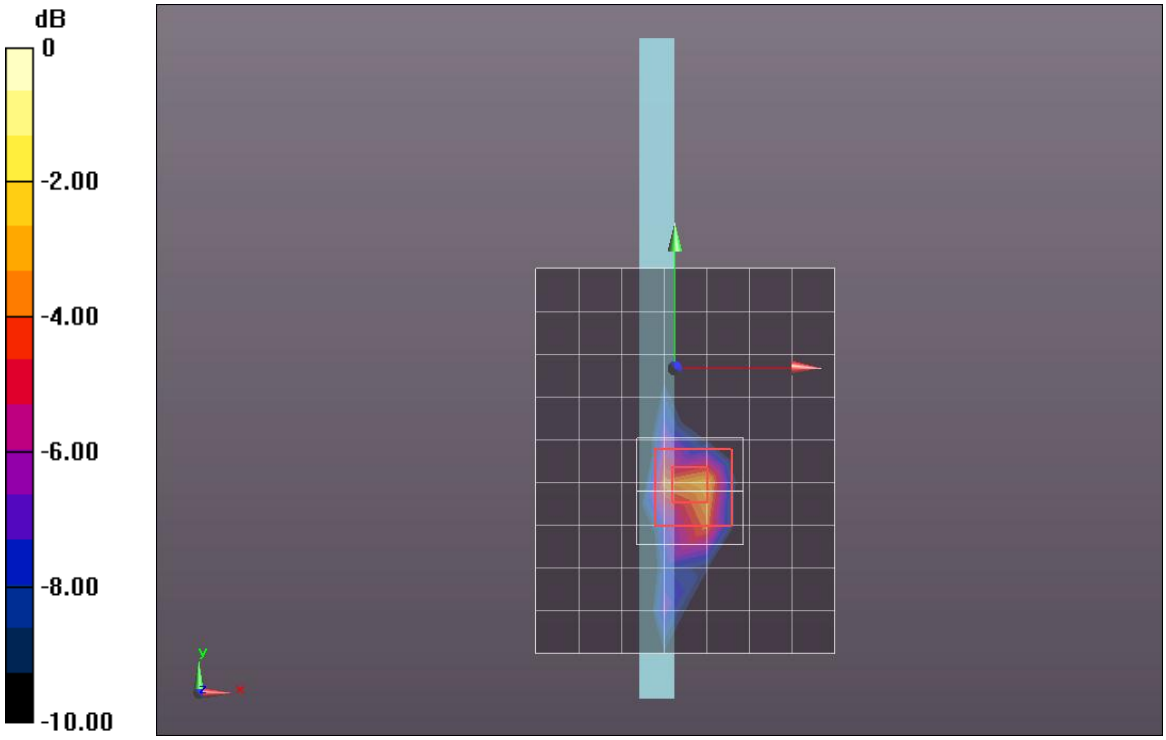
Test Laboratory: Lab C Date: 8/2/2012

WiFi 2.4 GHz

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; σ = 1.892 mho/m; ε_r = 51.01; ρ = 1000 kg/m^3
DASY5 Configuration:
- Electronics: DAE4 Sn1261; Calibrated: 3/9/2012
- Probe: EX3DV4 - SN3757; ConvF(6.85, 6.85, 6.85); Calibrated: 3/24/2012
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: Back ELI v5.0; Type: QDOVA002AA; Serial: 1136

Edge 3/802.11b_ch 6/Area Scan (8x10x1): Measurement grid: dx=12mm, dy=12mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.303 mW/g

Edge 3/802.11b_ch 6/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 31.414 V/m; Power Drift = -0.0044 dB
Peak SAR (extrapolated) = 3.3490
SAR(1 g) = 1.11 mW/g; SAR(10 g) = 0.383 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 2.042 mW/g



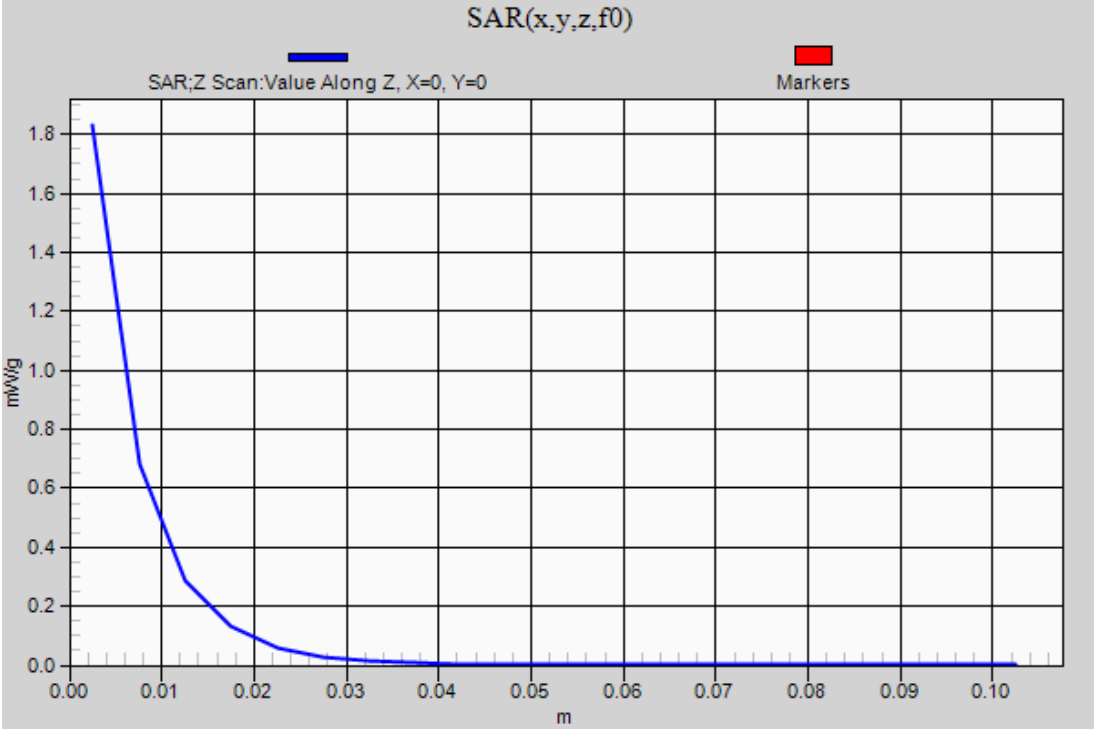
0 dB = 2.040mW/g = 6.19 dB mW/g

Test Laboratory: Lab C Date: 8/2/2012

WiFi 2.4 GHz

Frequency: 2437 MHz; Duty Cycle: 1:1

Edge 3/802.11b_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) = 1.830 mW/g



Test Laboratory: Lab C Date: 9/25/2012

Bluetooth

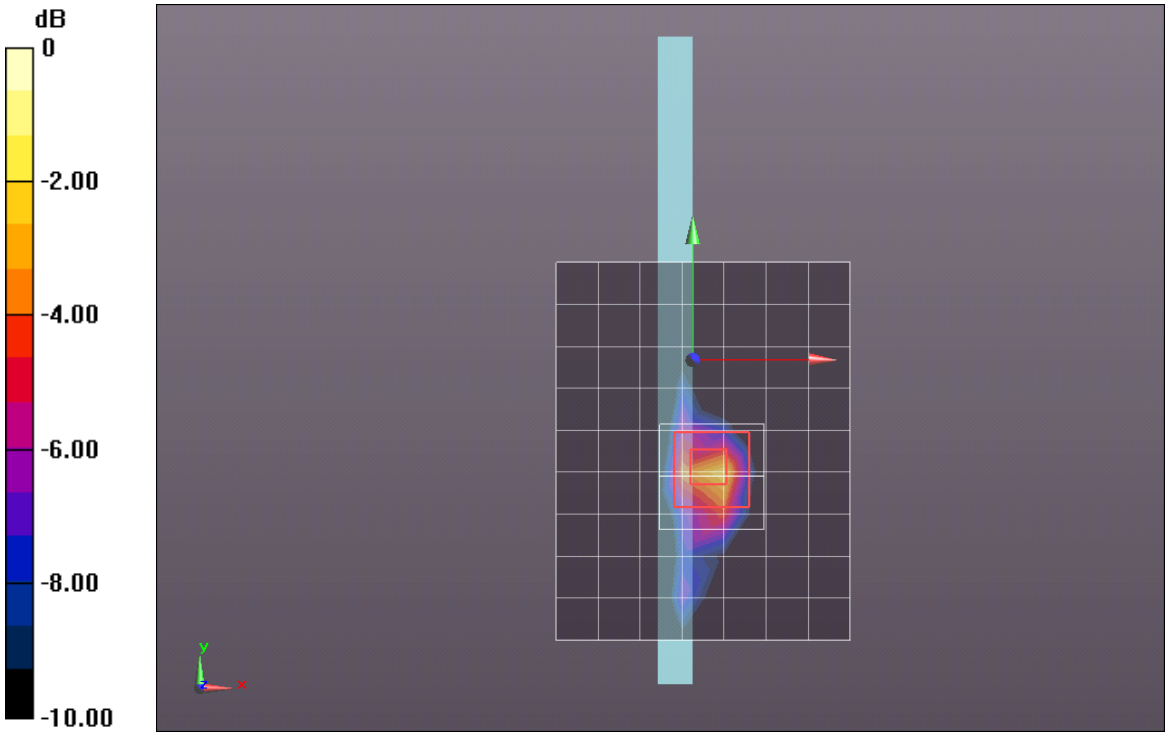
Frequency: 2441 MHz; Duty Cycle: 1:1.24165; Room Ambient Temperature: 24.0°C; Liquid Temperature: 23.0°C
Medium parameters used (interpolated): f = 2441 MHz; σ = 1.932 mho/m; ε_r = 51.736; ρ = 1000 kg/m^3
DASY5 Configuration:
- Electronics: DAE4 Sn1261; Calibrated: 3/9/2012
- Probe: EX3DV4 - SN3757; ConvF(6.85, 6.85, 6.85); Calibrated: 3/24/2012
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: Back ELI v5.0; Type: QDOVA002AA; Serial: 1136

Edge 3/802.15 GFSK_ch 39/Area Scan (8x10x1): Measurement grid: dx=12mm, dy=12mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.469 mW/g

Edge 3/802.15 GFSK_ch 39/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 16.331 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 1.0770
SAR(1 g) = 0.352 mW/g; SAR(10 g) = 0.121 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.619 mW/g



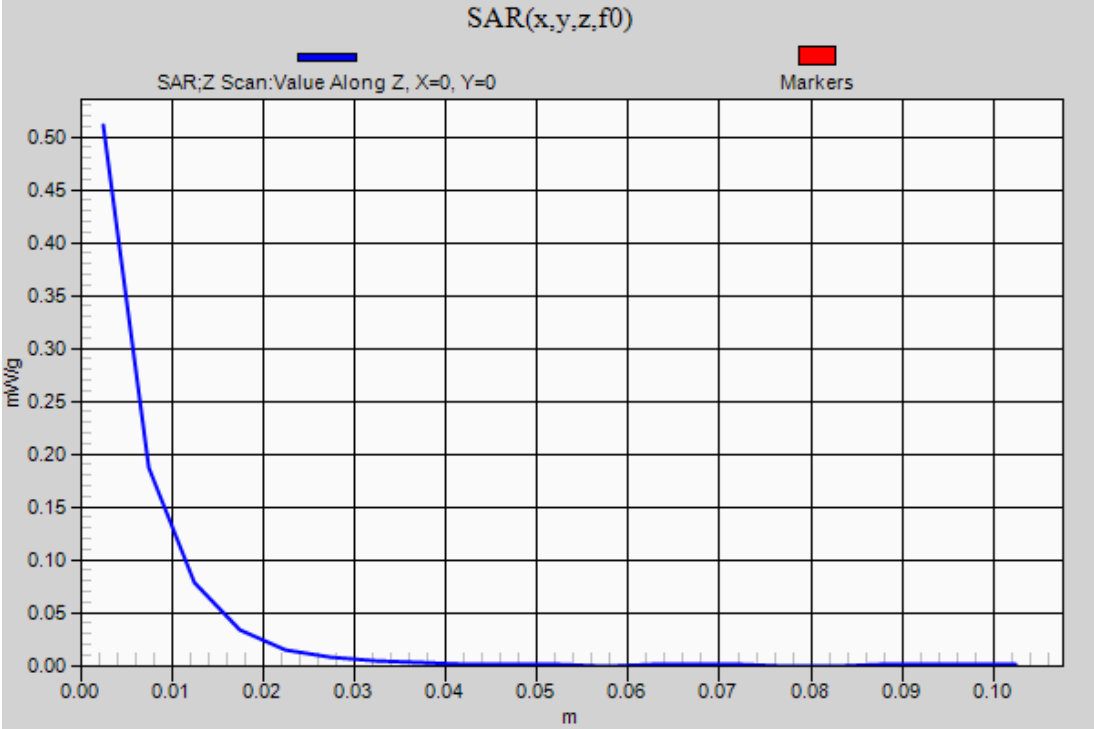
0 dB = 0.620mW/g = -4.15 dB mW/g

Test Laboratory: Lab C Date: 9/25/2012

Bluetooth

Frequency: 2441 MHz; Duty Cycle: 1:1.24165

Edge 3/802.15 GFSK_ch 39/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.511 mW/g



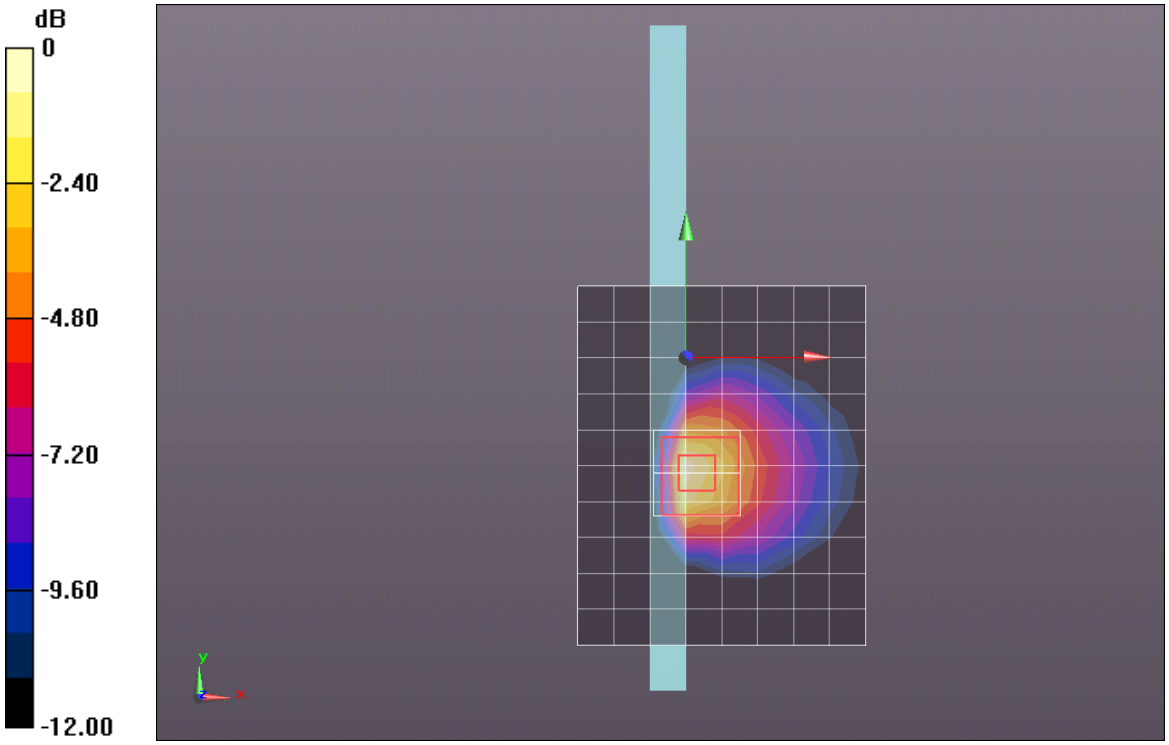
Test Laboratory: Lab B Date: 9/12/2012

WiFi 5.2 GHz

Frequency: 5230 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 25.0°C; Liquid Temperature: 24.0°C
Medium parameters used: f = 5230 MHz; σ = 5.346 mho/m; ε_r = 48.735; ρ = 1000 kg/m^3
DASY5 Configuration:
- Electronics: DAE4 Sn1264; Calibrated: 3/5/2012
- Probe: EX3DV4 - SN3720; ConvF(4.09, 4.09, 4.09); Calibrated: 3/24/2012
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: Back ELI v5.0; Type: QDOVA002AA; Serial: 1137

Edge 3/802.11n HT40_Ch 46/Area Scan (9x11x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.156 mW/g

Edge 3/802.11n HT40_Ch 46/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 15.463 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 2.4370
SAR(1 g) = 0.644 mW/g; SAR(10 g) = 0.216 mW/g
Maximum value of SAR (measured) = 1.239 mW/g



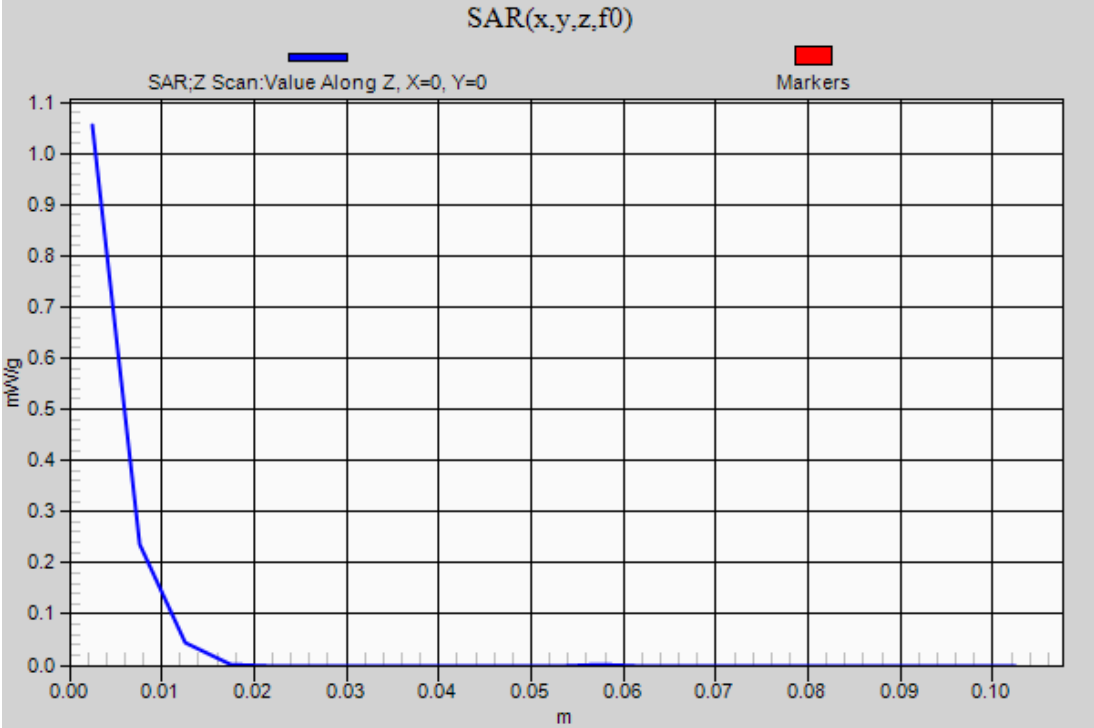
0 dB = 1.240mW/g = 1.87 dB mW/g

Test Laboratory: Lab B Date: 9/12/2012

WiFi 5.2 GHz

Frequency: 5230 MHz; Duty Cycle: 1:1

Edge 3/802.11n HT40_Ch 46/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 1.055 mW/g



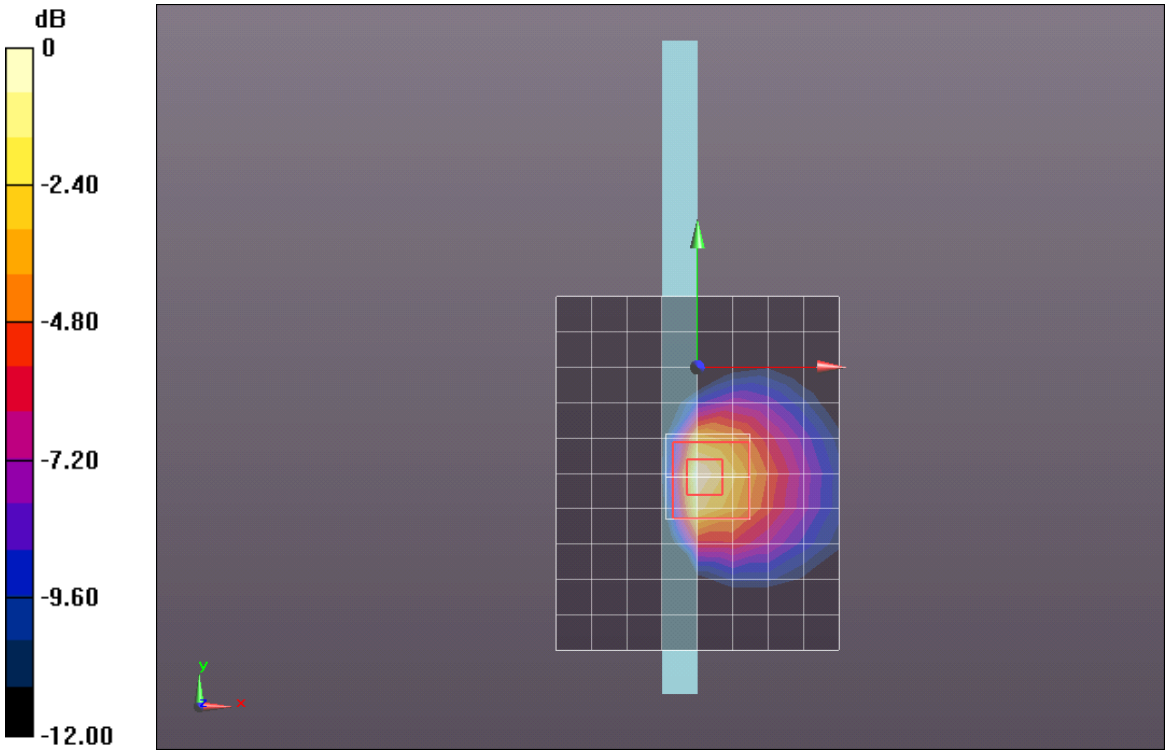
Test Laboratory: Lab B Date: 8/3/2012

WiFi 5.3 GHz

Frequency: 5260 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 25.0°C; Liquid Temperature: 24.0°C
Medium parameters used: f = 5260 MHz; σ = 5.327 mho/m; ε_r = 50.325; ρ = 1000 kg/m^3
DASY5 Configuration:
- Electronics: DAE4 Sn1264; Calibrated: 3/5/2012
- Probe: EX3DV4 - SN3720; ConvF(4.09, 4.09, 4.09); Calibrated: 3/24/2012
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: Back ELI v5.0; Type: QDOVA002AA; Serial: 1137

Edge 3/802.11a_Ch 52/Area Scan (9x11x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 2.076 mW/g

Edge 3/802.11a_Ch 52/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 19.414 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 4.0920
SAR(1 g) = 1.09 mW/g; SAR(10 g) = 0.369 mW/g
Maximum value of SAR (measured) = 2.018 mW/g



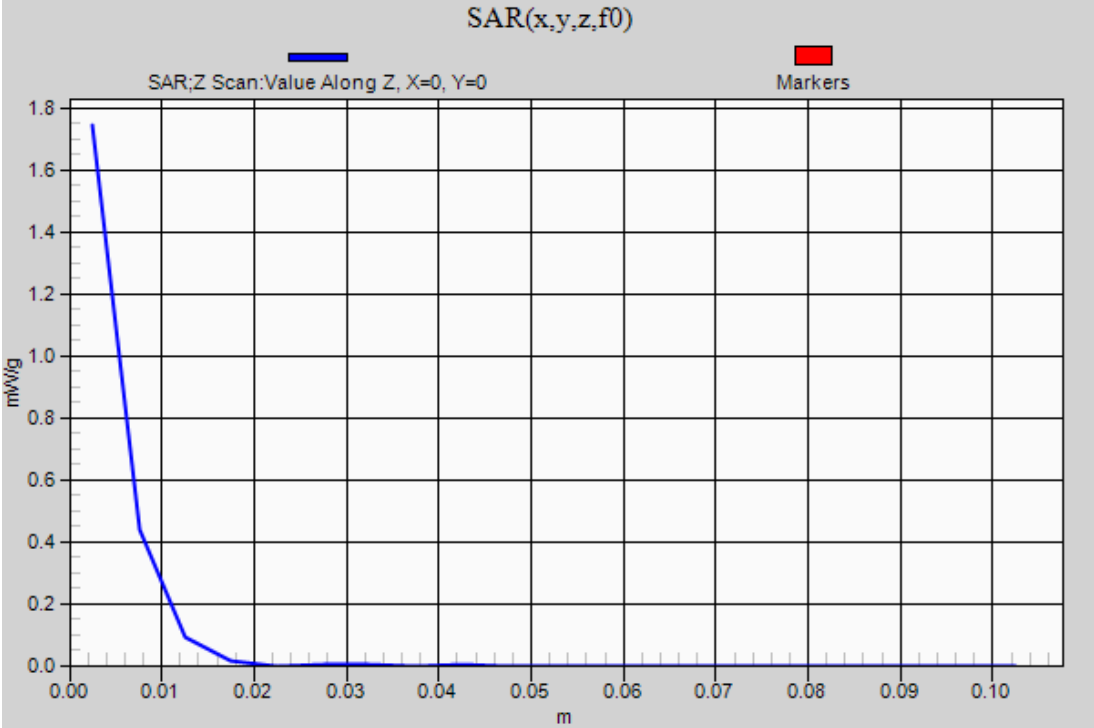
0 dB = 2.020mW/g = 6.11 dB mW/g

Test Laboratory: Lab B Date: 8/3/2012

WiFi 5.3 GHz

Frequency: 5260 MHz; Duty Cycle: 1:1

Edge 3/802.11a_Ch 52/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 1.744 mW/g



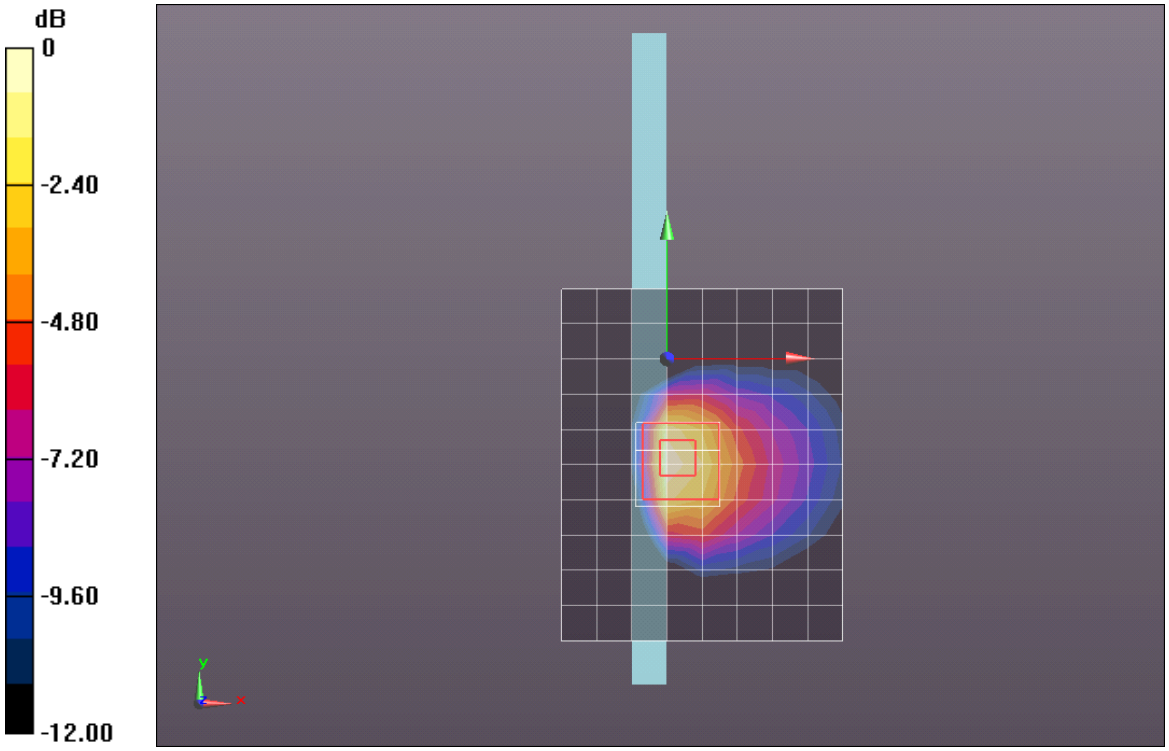
Test Laboratory: Lab B Date: 8/7/2012

WiFi 5.5 GHz

Frequency: 5680 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 25.0°C; Liquid Temperature: 24.0°C
Medium parameters used: f = 5680 MHz; σ = 5.858 mho/m; ε_r = 47.942; ρ = 1000 kg/m^3
DASY5 Configuration:
- Electronics: DAE4 Sn1264; Calibrated: 3/5/2012
- Probe: EX3DV4 - SN3751; ConvF(3.29, 3.29, 3.29); Calibrated: 12/19/2011
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: Back ELI v5.0; Type: QDOVA002AA; Serial: 1137

Edge 3/802.11a_Ch 136/Area Scan (9x11x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 2.175 mW/g

Edge 3/802.11a_Ch 136/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 19.950 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 4.5690
SAR(1 g) = 1.18 mW/g; SAR(10 g) = 0.416 mW/g
Maximum value of SAR (measured) = 2.230 mW/g



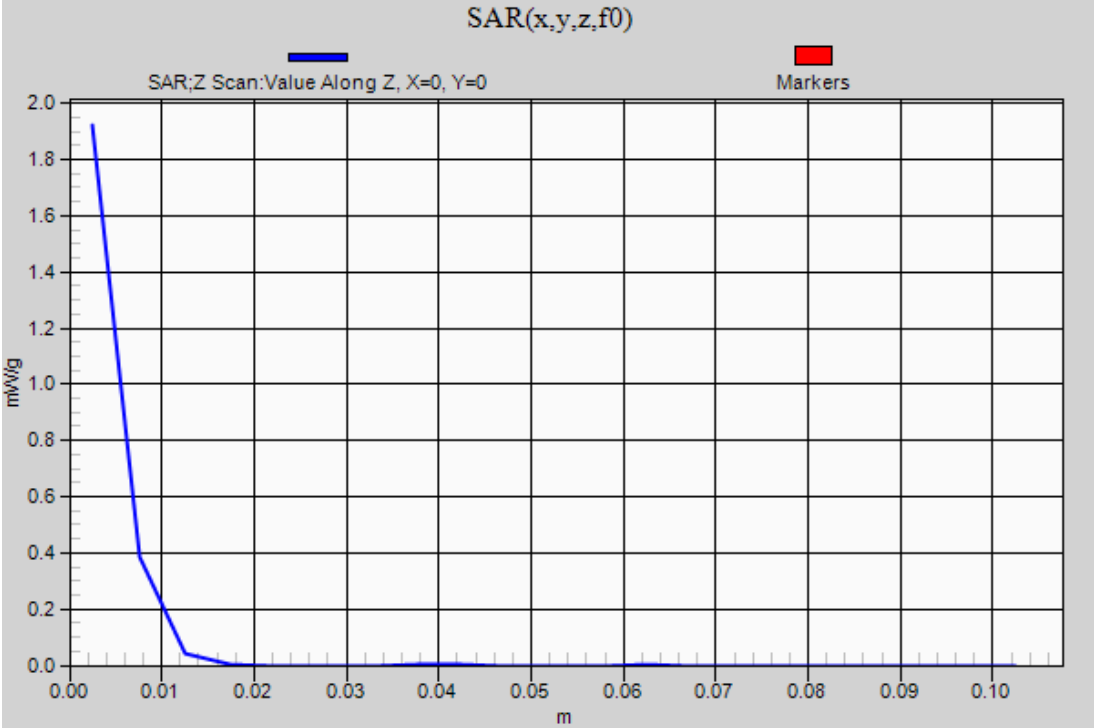
0 dB = 2.230mW/g = 6.97 dB mW/g

Test Laboratory: Lab B Date: 8/7/2012

WiFi 5.5 GHz

Frequency: 5680 MHz; Duty Cycle: 1:1

Edge 3/802.11a_Ch 136/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 1.921 mW/g



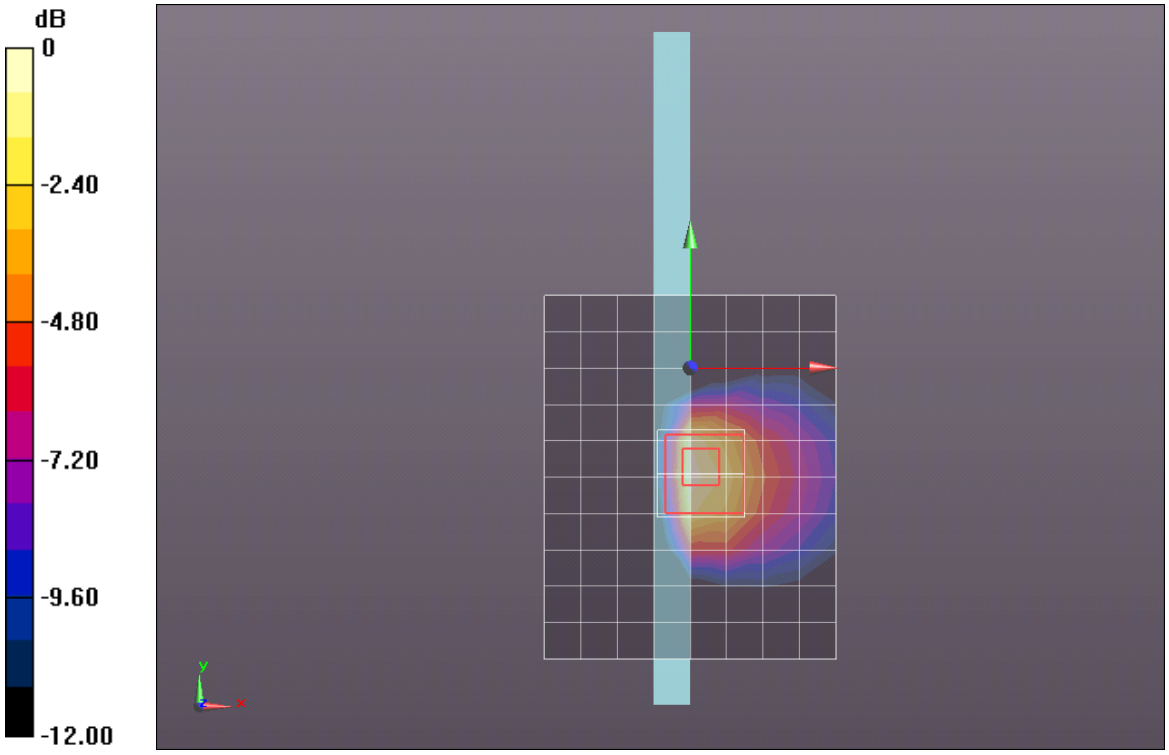
Test Laboratory: Lab B Date: 8/1/2012

WiFi 5.8 GHz

Frequency: 5785 MHz; Duty Cycle: 1:1; Room Ambient Temperature: 25.0°C; Liquid Temperature: 24.0°C
Medium parameters used: f = 5785 MHz; σ = 5.875 mho/m; ε_r = 48.664; ρ = 1000 kg/m^3
DASY5 Configuration:
- Electronics: DAE4 Sn1264; Calibrated: 3/5/2012
- Probe: EX3DV4 - SN3720; ConvF(3.69, 3.69, 3.69); Calibrated: 3/24/2012
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Phantom: Back ELI v5.0; Type: QDOVA002AA; Serial: 1137

Edge 3/802.11a_Ch 157/Area Scan (9x11x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 2.180 mW/g

Edge 3/802.11a_Ch 157/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 19.929 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 4.7250
SAR(1 g) = 1.19 mW/g; SAR(10 g) = 0.409 mW/g
Maximum value of SAR (measured) = 2.304 mW/g



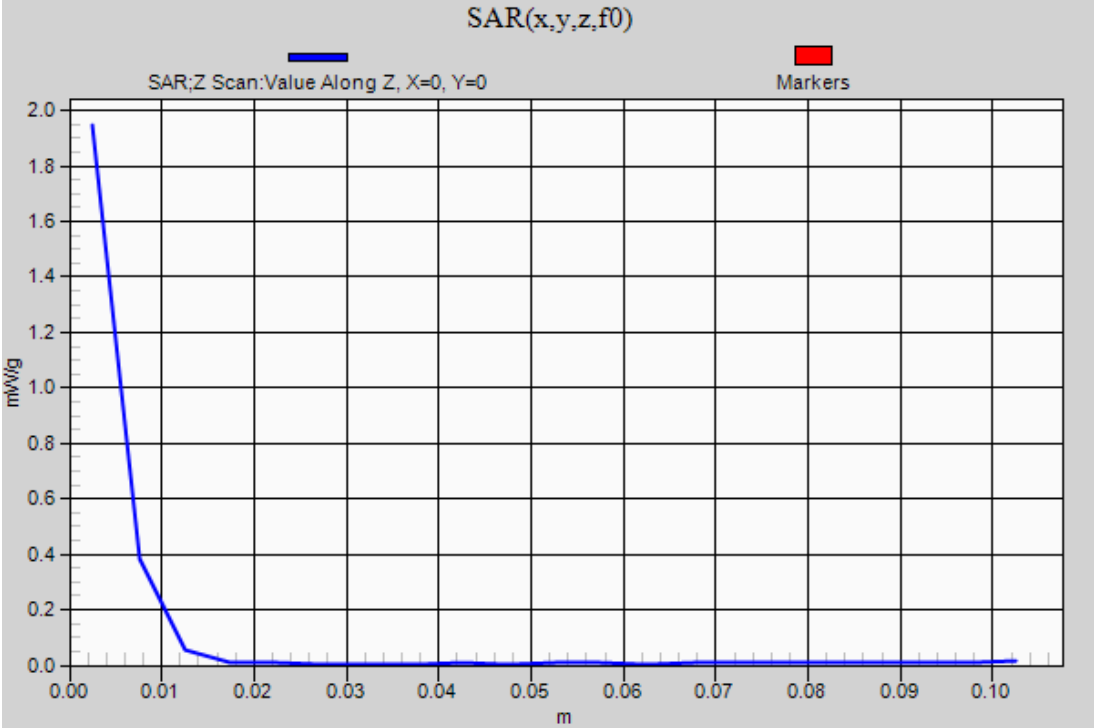
0 dB = 2.300mW/g = 7.23 dB mW/g

Test Laboratory: Lab B Date: 8/1/2012

WiFi 5.8 GHz

Frequency: 5785 MHz; Duty Cycle: 1:1

Edge 3/802.11a_Ch 157/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 1.946 mW/g



14. Simultaneous Transmission SAR Analysis

14.1. Sum of the SAR for WiFi 5 GHz and Bluetooth

Sum of the SAR with Measured Values

Test Position	Data					∑ 1-g SAR (mW/g)
	WiFi 5.2 GHz	WiFi 5.3 GHz	WiFi 5.5 GHz	WiFi 5.8 GHz	Bluetooth	
Rear	0.040				0.025	0.065
		0.069			0.025	0.094
			0.069		0.025	0.094
				0.074	0.025	0.099
Edge 1	0				0	0
		0			0	0
			0		0	0
				0	0	0
Edge 2	0				0.018	0.018
		0			0.018	0.018
			0		0.018	0.018
				0	0.018	0.018
Edge 3	0.644				0.352	0.996
		1.090			0.352	1.442
			1.180		0.352	1.532
				1.190	0.352	1.542
Edge 4	0				0	0
		0			0	0
			0		0	0
				0	0	0

Sum of the SAR with Scaled Values for the Worst-case Configuration

As the SAR for these configurations were measured at the maximum of tune-up tolerance limit, SAR scaling does not need to be applied.

SAR to Peak Location Separation Ratio (SPLSR)

As the Sum of the SAR is not greater than 1.6 W/kg SPLSR assessment is not required.

Conclusion:

Simultaneous transmission SAR measurement (Volume Scan) is not required because the either sum of the 1-g SAR is < 1.6 W/kg or the SPLSR is < 0.3 for all circumstances that require SPLSR calculation.

15. Appendixes

Refer to separated files for the following appendixes.

15.1. System Performance Check Plots

15.2. SAR Test Plots for WiFi 2.4GHz Band

15.3. SAR Test Plots for WiFi 5GHz Bands

15.4. SAR Test Plots for Bluetooth

15.5. Calibration Certificate for E-Field Probe EX3DV4 - SN 3676

15.6. Calibration Certificate for E-Field Probe EX3DV4 - SN 3720

15.7. Calibration Certificate for E-Field Probe EX3DV4 - SN 3757

15.8. Calibration Certificate for E-Field Probe EX3DV4 - SN 3778

15.9. Calibration Certificate for E-Field Probe EX3DV4 - SN 3751

15.10. Calibration Certificate for D2450V2 - SN 826

15.11. Calibration Certificate for D5GHzV2 - SN 1072