SAR Evaluation Report

IN ACCORDANCE WITH THE REQUIREMENTS OF
FCC OET BULLETIN 65 SUPPLEMENT C
IC RSS 102 ISSUE 2 : NOVERMBER 2005

FOR

INTEL WI-FI LINK 5100 SERIES INSTALLED INSIDE HP TABLET COMPUTER,
MODEL: HSTNN-W47C

FCC MODEL: 512AN_MMW

IC MODEL: 512ANMU

FCC ID: PD9512ANMU

IC: 1000M-512ANMU

REPORT NUMBER: 08U11778-3A

ISSUE DATE: JULY 2, 2008

Prepared for

INTEL CORPORATION
2111 NE 25TH AVENUE
HILLSBORO, OREGON 97124, USA

Prepared by

COMPLIANCE CERTIFICATION SERVICES
47173 BENICIA STREET,
FREMONT, CA 94538 USA

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issued date	Revisions	Revised By
--	May 14, 2008	Initial issue	Sunny Shih
A	July 2, 2008	Revised host device description and model name	Sunny Shih

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CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

DATES OF TEST: May 12th and 13th.

APPLICANT: ADDRESS:	INTEL CORPORATION 2111 NE 25TH AVENUE HILLSBORO, OREGON 97124, USA
FCC ID: IC: FCC MODEL: IC MODEL:	PD9512ANMU 1000M-512ANMU 512AN_MMW 512ANMU
DEVICE CATEGORY: EXPOSURE CATEGORY:	Portable Device General Population/Uncontrolled Exposure

INTEL WI-FI LINK 5100 SERIES INSTALLED INSIDE HP TABLET COMPUTER, MODEL: HSTNN-W47C		
Test Sample is a:	Production unit	
Modulation type:	Direct Sequence Spread Spectrum (DSSS) for 802.11b Orthogonal Frequency Division Multiplexing (OFDM) for 802.11agn	
Rule Parts	Frequency Range [MHz]	The Highest SAR Values [1g_mW/g]
FCC 15.247	2400 - 2483.5 5725 - 5850	0.036 0.019
FCC 15.407	5150 - 5250 5250 - 5320 5470 - 5725	0.006 0.007 0.026

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Testing has been carried out in accordance with:

47CFR §2.1093 - Radiofrequency Radiation Exposure Evaluation: Portable Devices

FCC OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01) - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

RSS-102 - Evaluation Procedure for Mobile and Portable Radio Transmitters with Respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields

IEEE 1528_2003 - IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

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 Compliance Certification Services and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Compliance Certification Services will constitute fraud and shall nullify the document. No part of this report may be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any government agency.

Approved & Released For CCS By:

Sunny Shih
Engineering Supervisor
Compliance Certification Services

Tested By:

Jonathan King
EMC Engineer
Compliance Certification Services

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1 DEVICE UNDER TEST (DUT) DESCRIPTION

INTEL WI-FI LINK 5100 SERIES INSTALLED INSIDE HP TABLET COMPUTER, MODEL: HSTNN-W47C	
Normal operation:	Lap-held position, and underarm position
Duty cycle:	802.11b mode – 100% 802.11a mode – 99% 802.11n mode – 98%
Host Device(s):	HP HSTNN-W47C (HP Olifant) tablet.
Antenna(s):	<u>Antenna Supplier</u> <u>Type</u> <u>Model number</u> Foxconn IFA WDAN-HQTT8001-DF (Main) IFA WDAN-HQTT8003-DF (Aux) WNC IFA 81.EGG15.003 (Main) IFA 81.EGG15.004 (Aux) All SAR tests were performed on the WNC main antenna, since this antenna has the highest antenna gains.
Power supply:	Power supplied through the laptop computer (host device).

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2 FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, CA 94538 USA. The sites are constructed in conformance with the requirements of ANSI C63.4, ANSI C63.7 and CISPR Publication 22. All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

NVLAP LAB CODE 200065-0

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

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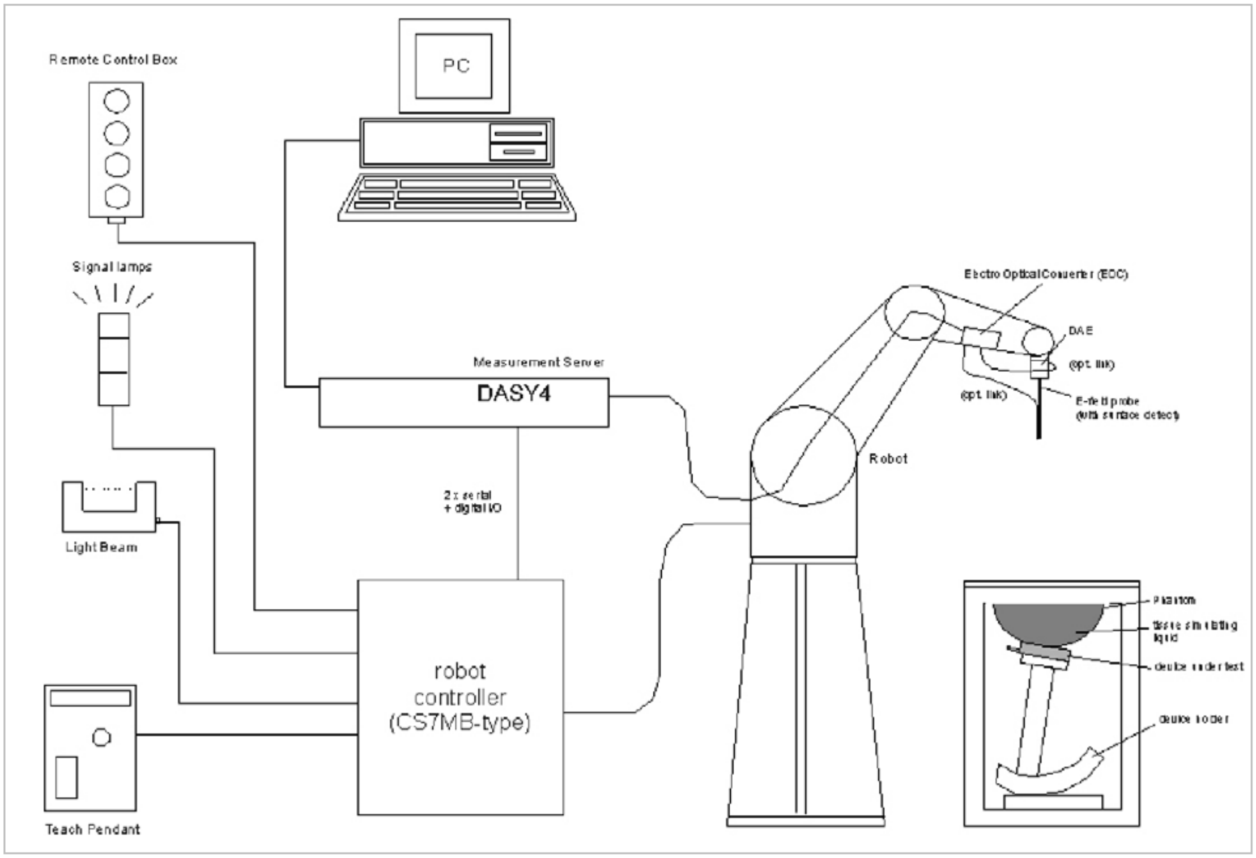
3 SYSTEM DESCRIPTION



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

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4 software.
- Remote controls with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

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3.1 COMPOSITION OF INGREDIENTS FOR TISSUE SIMULATING LIQUIDS

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

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Salt: 99+% Pure Sodium Chloride Sugar: 98+% Pure Sucrose
Water: De-ionized, 16 MΩ+ resistivity HEC: Hydroxyethyl Cellulose
DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

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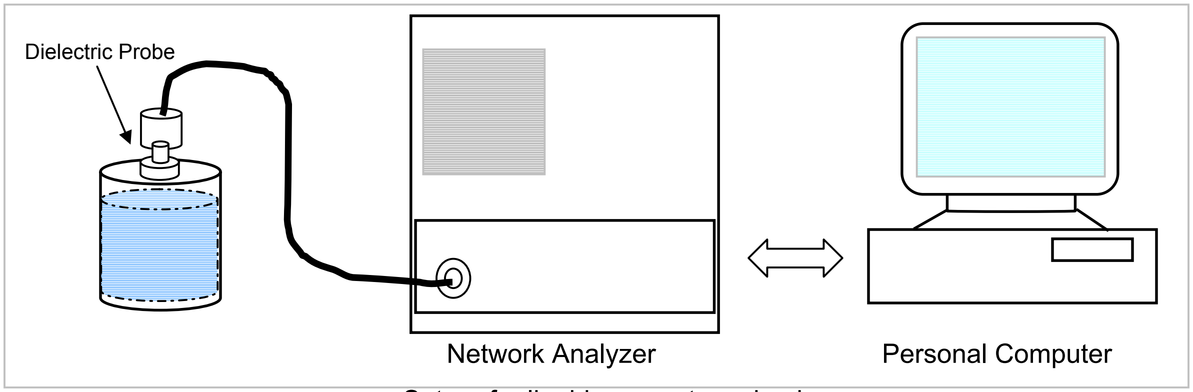
4 SIMULATING LIQUID PARAMETERS CHECK

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameters are within the tolerances of the specified target values. The relative permittivity and conductivity of the tissue material should be within ± 5% of the values given in the table below.



Set-up for liquid parameters check

Reference Values of Tissue Dielectric Parameters for Head and Body Phantom (for 150 – 3000 MHz and 5800 MHz)

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in IEEE Standard 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in IEEE Standard 1528.

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

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

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

In the current guidelines and draft standards for compliance testing of mobile phones (i.e., IEEE P1528, OET 65 Supplement C), the dielectric parameters suggested for head and body tissue simulating liquid are given only at 3.0 GHz and 5.8 GHz. As an intermediate solution, dielectric parameters for the frequencies between 5 to 5.8 GHz were obtained using linear interpolation (see table below).

SPEAG has developed suitable head and body tissue simulating liquids consisting of the following ingredients: de-ionized water, salt and a special composition including mineral oil and an emulgators. Dielectric parameters of these liquids were measured suing a HP 8570C Dielectric Probe Kit in conjunction with HP 8753ES Network Analyzer (30 kHz – 6G Hz). The differences with respect to the interpolated values were well within the desired ±5% for the whole 5 to 5.8 GHz range.

f (MHz)	Head Tissue		Body Tissue		Reference
	rel. permitivity	conductivity	rel. permitivity	conductivity	
3000	38.5	2.40	52.0	2.73	Standard
5800	35.3	5.27	48.2	6.00	Standard
5000	36.2	1.45	49.3	5.07	Interpolated
5100	36.1	4.55	49.1	5.18	Interpolated
5200	36.0	4.66	49.0	5.30	Interpolated
5300	35.9	4.76	48.9	5.42	Interpolated
5400	35.8	4.86	48.7	5.53	Interpolated
5500	35.6	4.96	48.6	5.65	Interpolated
5600	35.5	5.07	48.5	5.77	Interpolated
5700	35.4	5.17	48.3	5.88	Interpolated

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

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4.1 SIMULATING LIQUID PARAMETER CHECK RESULT

Simulating Liquid Dielectric Parameter Check Result @ Muscle 2450 MHz

Room Ambient Temperature = 24°C; Relative humidity = 30% Measured by: Ekta Budhbhatti

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
2450	23	15	e'	51.1647	Relative Permittivity (ε_r):	51.1647	52.7	-2.91	± 5
			e"	14.7815	Conductivity (σ):	2.01467	1.95	3.32	± 5

Liquid Check
Ambient temperature: 24 deg. C; Liquid temperature: 23 deg. C
May 13, 2008 04:14 PM

Frequency	e'	e"
2400000000.	51.3295	14.5635
2405000000.	51.3139	14.5806
2410000000.	51.2904	14.5999
2415000000.	51.2850	14.6307
2420000000.	51.2645	14.6579
2425000000.	51.2359	14.6841
2430000000.	51.2288	14.6914
2435000000.	51.2081	14.7084
2440000000.	51.1860	14.7419
2445000000.	51.1712	14.7630
2450000000.	**51.1647**	**14.7815**
2455000000.	51.1413	14.7950
2460000000.	51.1130	14.8074
2465000000.	51.0959	14.8283
2470000000.	51.0667	14.8572
2475000000.	51.0529	14.8742
2480000000.	51.0321	14.8855
2485000000.	51.0149	14.9110
2490000000.	50.9906	14.9307
2495000000.	50.9811	14.9470
2500000000.	50.9547	14.9586

The conductivity (σ) can be given as:

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

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

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

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Simulating Liquid Parameter Check Result @ Muscle 5GHz

Room Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
5200	23	15	e'	47.3131	Relative Permittivity (ϵ_r):	47.3131	49.0	-3.44	± 10
			e''	18.3369	Conductivity (σ):	5.30455	5.30	0.09	± 5

Liquid Check
Ambient temperature: 24 deg. C; Liquid temperature: 23 deg. C
May 12, 2008 08:25 AM

Frequency	e'	e''
4600000000.	48.5451	17.4874
4650000000.	48.5050	17.6100
4700000000.	48.3574	17.6044
4750000000.	48.2264	17.7806
4800000000.	48.2113	17.7962
4850000000.	47.9617	17.8483
4900000000.	47.9770	17.9303
4950000000.	47.7762	17.9694
5000000000.	47.7076	18.0671
5050000000.	47.6526	18.1134
5100000000.	47.4381	18.2002
5150000000.	47.4678	18.2938
5200000000.	**47.3131**	**18.3369**
5250000000.	47.1523	18.4093
5300000000.	47.1705	18.4655
5350000000.	46.9519	18.4892
5400000000.	46.8865	18.5622
5450000000.	46.8078	18.6516
5500000000.	46.6543	18.6802
5550000000.	46.6563	18.8660
5600000000.	46.4532	18.7678
5650000000.	46.3780	19.0340
5700000000.	46.3697	18.9235
5750000000.	46.1157	19.0643
5800000000.	46.1955	19.1135
5850000000.	45.8898	19.1315
5900000000.	45.9809	19.2853
5950000000.	45.7889	19.1782
6000000000.	45.6624	19.3447

The conductivity (σ) can be given as:

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

where f = target $f * 10^6$

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

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Simulating Liquid Parameter Check Result @ Muscle 5GHz

Room Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
5500	23	15	e'	46.6543	Relative Permittivity (ε_r):	46.6543	48.6	-4.00	± 10
			e''	18.6802	Conductivity (σ):	5.71562	5.65	1.16	± 5

Liquid Check
Ambient temperature: 24 deg. C; Liquid temperature: 23 deg. C
May 12, 2008 08:25 AM

Frequency	e'	e''
4600000000.	48.5451	17.4874
4650000000.	48.5050	17.6100
4700000000.	48.3574	17.6044
4750000000.	48.2264	17.7806
4800000000.	48.2113	17.7962
4850000000.	47.9617	17.8483
4900000000.	47.9770	17.9303
4950000000.	47.7762	17.9694
5000000000.	47.7076	18.0671
5050000000.	47.6526	18.1134
5100000000.	47.4381	18.2002
5150000000.	47.4678	18.2938
5200000000.	47.3131	18.3369
5250000000.	47.1523	18.4093
5300000000.	47.1705	18.4655
5350000000.	46.9519	18.4892
5400000000.	46.8865	18.5622
5450000000.	46.8078	18.6516
5500000000.	**46.6543**	**18.6802**
5550000000.	46.6563	18.8660
5600000000.	46.4532	18.7678
5650000000.	46.3780	19.0340
5700000000.	46.3697	18.9235
5750000000.	46.1157	19.0643
5800000000.	46.1955	19.1135
5850000000.	45.8898	19.1315
5900000000.	45.9809	19.2853
5950000000.	45.7889	19.1782
6000000000.	45.6624	19.3447

The conductivity (σ) can be given as:

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

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

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

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Simulating Liquid Parameter Check Result @ Muscle 5GHz

Room Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Simulating Liquid			Parameters			Measured	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)							
5800	24	15	e'	46.1955	Relative Permittivity (ε_r):	46.1955	48.2	-4.16	± 10
			e''	19.1135	Conductivity (σ):	6.16719	6.00	2.79	± 5

Liquid Check
Ambient temperature: 24 deg. C; Liquid temperature: 23 deg. C
May 12, 2008 08:25 AM

Frequency	e'	e''
4600000000.	48.5451	17.4874
4650000000.	48.5050	17.6100
4700000000.	48.3574	17.6044
4750000000.	48.2264	17.7806
4800000000.	48.2113	17.7962
4850000000.	47.9617	17.8483
4900000000.	47.9770	17.9303
4950000000.	47.7762	17.9694
5000000000.	47.7076	18.0671
5050000000.	47.6526	18.1134
5100000000.	47.4381	18.2002
5150000000.	47.4678	18.2938
5200000000.	47.3131	18.3369
5250000000.	47.1523	18.4093
5300000000.	47.1705	18.4655
5350000000.	46.9519	18.4892
5400000000.	46.8865	18.5622
5450000000.	46.8078	18.6516
5500000000.	46.6543	18.6802
5550000000.	46.6563	18.8660
5600000000.	46.4532	18.7678
5650000000.	46.3780	19.0340
5700000000.	46.3697	18.9235
5750000000.	46.1157	19.0643
5800000000.	**46.1955**	**19.1135**
5850000000.	45.8898	19.1315
5900000000.	45.9809	19.2853
5950000000.	45.7889	19.1782
6000000000.	45.6624	19.3447

The conductivity (σ) can be given as:

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

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

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

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5 SYSTEM PERFORMANCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of ±10%.

System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the SAM twin phantom filled with Body simulating liquid of the following parameters.
- The DASY4 system with an Isotropic E-Field Probe EX3DV3-SN: 3531 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
  For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 5 x 5 x 7 fine cube was chosen for cube integration(dx=dy=7.5mm; dz=5mm).
  For 5 GHz band - Special 8x8x8 fine cube was chosen for cube integration(dx=dy=4.3mm; dz=3mm)
- Distance between probe sensors and phantom surface was set to 4 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.0mm
- The dipole input power (forward power) was 250 mW±3%.
- The results are normalized to 1 W input power.

In the table below, the numerical reference SAR values of a SPEAG validation dipoles placed below the flat phantom filled with body-tissue simulating liquid are given. The reference SAR values were calculated using the finite-difference time-domain method and the geometry parameters.

Dipole Type	Distance (mm)	Frequency (MHz)	SAR (1g) [W/kg]	SAR (10g) [W/kg]	SAR (peak) [W/kg]
D450V2	15	450	5.01	3.36	7.22
D835V2	15	835	9.71	6.38	14.1
D900V2	15	900	11.1	7.17	16.3
D1450V2	10	1450	29.6	16.6	49.8
D1800V2	10	1800	38.5	20.3	67.5
D1900V2	10	1900	39.8	20.8	69.6
D2000V2	10	2000	40.9	21.2	71.5
D2450V2	10	2450	51.2	23.7	97.6

Note: All SAR values normalized to 1 W forward power.

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Reference SAR Values for body-tissue

In the table below, the numerical reference SAR values of a SPEAG validation dipoles placed below the flat phantom filled with body-tissue simulating liquid are given. The reference SAR values were calculated using finite-difference time-domain FDTD method (feed point-impedance set to 50 ohms) and the mechanical dimensions of the D5GHzV2 dipole (manufactured by SPEAG).

f (MHz)	Head Tissue		Body Tissue		
	SAR_{1g}	SAR_{10g}	SAR_{1g}	SAR_{10g}	SAR_{Peak}
5000	72.9	20.7	68.1	19.2	260.3
5100	74.6	21.1	78.8	19.6	272.3
5200	76.5	21.6	71.8	20.1	284.7
5500	83.3	23.4	79.1	22.0	326.3
5800	78.0	21.9	74.1	20.5	324.7

Note: All SAR values normalized to 1 W forward power.

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5.1 SYSTEM PERFORMANCE CHECK RESULTS

System Validation Dipole: D2450V2 SN: 706

Date: May 13, 2008

Ambient Temperature =24 °C; Relative humidity = 30% Measured by: Ekta Budhbhatti

Body Simulating Liquid			SAR (mW/g)		Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)						
2450	23	15	1g	12.20	48.8	51.2	-4.69	± 10
			10g	5.71	22.84	23.7	-3.63	± 10

System Validation Dipole: D5GHzV2 SN 1003

Date: May 12, 2008

Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Body Simulating Liquid			SAR (mW/g)		Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)						
5200	23	15	1g	17.20	68.8	71.8	-4.18	± 10
			10g	5.35	21.4	20.1	6.47	± 10

Date: May 12, 2008

Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Body Simulating Liquid			SAR (mW/g)		Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)						
5500	23	15	1g	20.10	80.4	79.1	1.64	± 10
			10g	6	24	22.0	9.09	± 10

Date: May 12, 2008

Ambient Temperature = 24°C; Relative humidity = 35% Measured by: Jonathan King

Body Simulating Liquid			SAR (mW/g)		Normalized to 1 W	Target	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)						
5800	23	15	1g	17.70	70.8	74.1	-4.45	± 10
			10g	5.44	21.76	20.5	6.15	± 10

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6 SAR MEASURMENT PROCEDURE

A summary of the procedure follows:

a) A measurement of the SAR value at a fixed location is used as a reference value for assessing the power drop of the EUT. The SAR at this point is measured at the start of the test, and then again at the end of the test.

b) The SAR distribution at the exposed flat section of the flat phantom is measured at a distance of 2.5 mm from the inner surface of the shell. The area covers the entire dimension of the EUT and the horizontal grid spacing is 15 mm x 15 mm. Based on this data, the area of the maximum absorption is determined by Spline interpolation. The first Area Scan covers the entire dimension of the EUT to ensure that the hotspot was correctly identified.

   For 5 GHz band - The SAR distribution at the exposed flat section of the flat phantom is measured at a distance of 2.0 mm from the inner surface of the shell. The area covers the entire dimension of the EUT and the horizontal grid spacing is 10 mm x 10 mm. Based on this data, the area of the maximum absorption is determined by Spline interpolation. The first Area Scan covers the entire dimension of the EUT to ensure that the hotspot was correctly identified.

c) Around this point, a volume of X=Y= 30 and Z=24 mm is assessed by measuring 7 x 7 x 9 mm points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure:

   For 5 GHz band - Around this point, a volume of X=Y=24 and Z=20 mm is assessed by measuring 7 x 7 x 9 mm points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure:

   (i) The data at the surface are extrapolated, since the centre of the dipoles is 1.2 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation is based on a least square algorithm. A polynomial of the fourth order is calculated through the points in z-axes. This polynomial is then used to evaluate the points between the surface and the probe tip.

   (ii) The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g and 10 g) are computed using the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the “Not a knot”- condition (in x, y and z-direction). The volume is integrated with the trapezoidal – algorithm. One thousand points (10 x 10 x 10) are interpolated to calculate the averages.

   (iii) All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.

   (iv) The SAR value at the same location as in Step (a) is again measured to evaluate the actual power drift.

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6.1 DASY4 SAR MEASURMENT 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 (for example, 1.2 mm for an EX3DV3 probe type).

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY4 software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures 7 x 7 x 9 points within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

For 5 GHz band – Same as above except the Zoom Scan measures 7 x 7 x 9 points.

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

Step 5: Z-Scan

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

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7 PROCEDURE USED TO ESTABLISH TEST SIGNAL

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

The client provided a special driver and program, CRTU, which enables a user to control the frequency and output power of the module.

The cable assembly insertion loss of 20 dB for attenuator and connector was entered as an offset in the power meter to allow for direct reading of power.

2.4 GHz Band

802.11b

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	2412	19.6
Middle	2437	17.4
High	2462	19.6

802.11g

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	2412	14.5
Middle	2437	17.0
High	2462	14.0

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	2412	13.1
Middle	2437	17.0
High	2462	14.0

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	2422	10.1
Middle	2437	16.5
High	2452	14.1

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5.2 GHz Band

802.11a

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5180	16.6
Middle	5200	16.6
High	5240	16.6

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5180	16.5
Middle	5200	16.5
High	5240	16.5

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5190	15.1
High	5230	16.6

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5.3 GHz Band

802.11a

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5260	16.6
Middle	5280	16.6
High	5320	16.6

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5260	16.7
Middle	5280	16.5
High	5320	16.5

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5270	16.7
High	5310	15.7

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5.5 GHz Band

802.11a

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5500	19.1
Middle	5600	16.6
High	5700	16.6

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5500	16.6
Middle	5600	15.5
High	5700	16.6

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5510	16.2
Middle	5590	16.9
High	5670	16.9

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5.8 GHz Band

802.11a

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5745	16.5
Middle	5785	16.5
High	5825	16.5

802.11n HT20

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5745	16.5
Middle	5785	16.5
High	5825	16.5

802.11n HT40

Channel	Frequency (MHz)	Average Power Chain 0 (dBm)
Low	5755	16.5
High	5795	16.5

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8 SAR MEASURMENT RESULTS

8.1 2.4 GHZ BAND

8.1.1 NORMAL POSITION

Note: Testing was skipped at this position due to the large distance between the antennas and the phantom.

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8.1.2 SECONDARY LANDSCAPE POSITION

The WLAN device is disabled by software at this position

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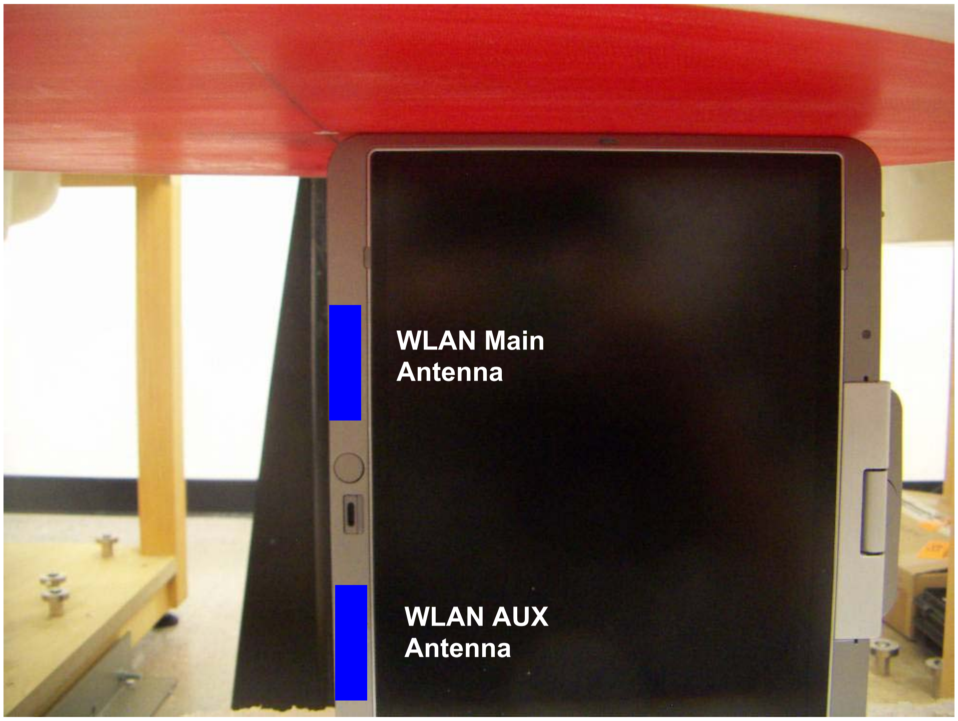
8.1.3 PRIMARY PORTRAIT



The WLAN device is disabled by software at this position

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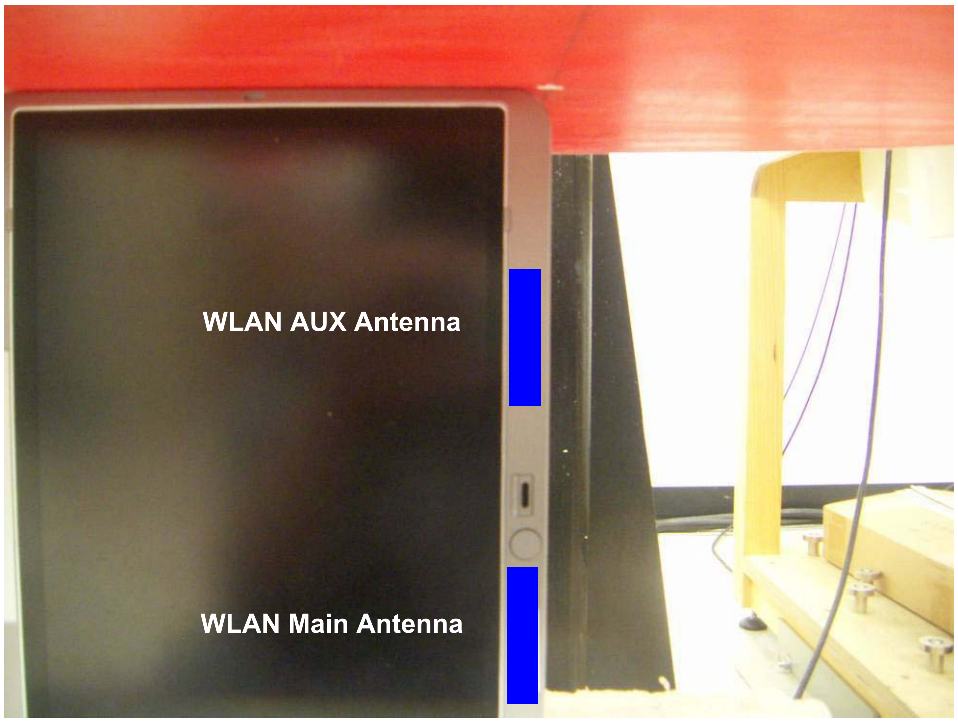
8.1.4 SECONDARY PORTRAIT POSITION

Note:

1) **Main antenna testing was skipped due to the low SAR values obtained from the Aux antenna ad the larger separation distance between the Main antenna and the phantom.**
2) **Aux antenna was not tested since it is used for receiving purposes only.**



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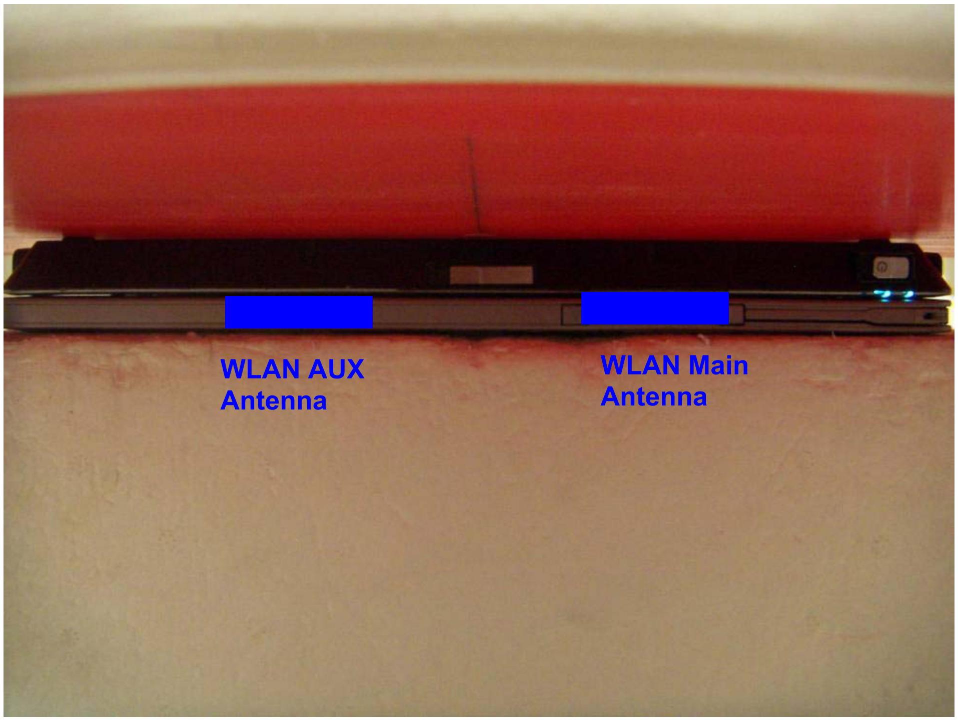
8.1.5 LAPHELD

Note: Aux antenna was not tested since it is used for receiving purposes only.



Channel	f (MHz)	Measured SAR 1g (mW/g)	Power Drift (dB)	Extrapolated[1)] SAR 1g (mW/g)
2.4 GHz Band - 802.11b - Legacy mode - Main Antenna				
1	2412	0.030	-0.079	0.031
11	2462	0.035	-0.177	0.036
2.4 GHz Band - 802.11n HT20 - Main Antenna				
6	2437	0.015	0.000	0.015

Notes:
1) The exact method of extrapolation is Measured SAR x 10^(-drift/10). The SAR reported at the end of the measurement process by the DASY4 system can be scaled up by the Power drift to determine the SAR at the beginning of the measurement process.
2) The SAR measured at the middle channel for this configuration is at least 3 dB lower (0.8 mW/g) than SAR limit (1.6 mW/g), thus testing at low & high channel is optional.
3) Please see attachments for the detailed measurement data and plots showing the maximum SAR location of the EUT.

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8.1.6 SECONDARY PORTRAIT POSITION

Note: Testing was skipped at this position due to the large distance between the antennas and the phantom.

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8.2 5 GHZ BAND

8.2.1 NORMAL POSITION

Note: Testing was skipped at this position due to the large distance between the antennas and the phantom.

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8.2.2 SECONDARY LANDSCAPE

The WLAN device is disabled by software at this position

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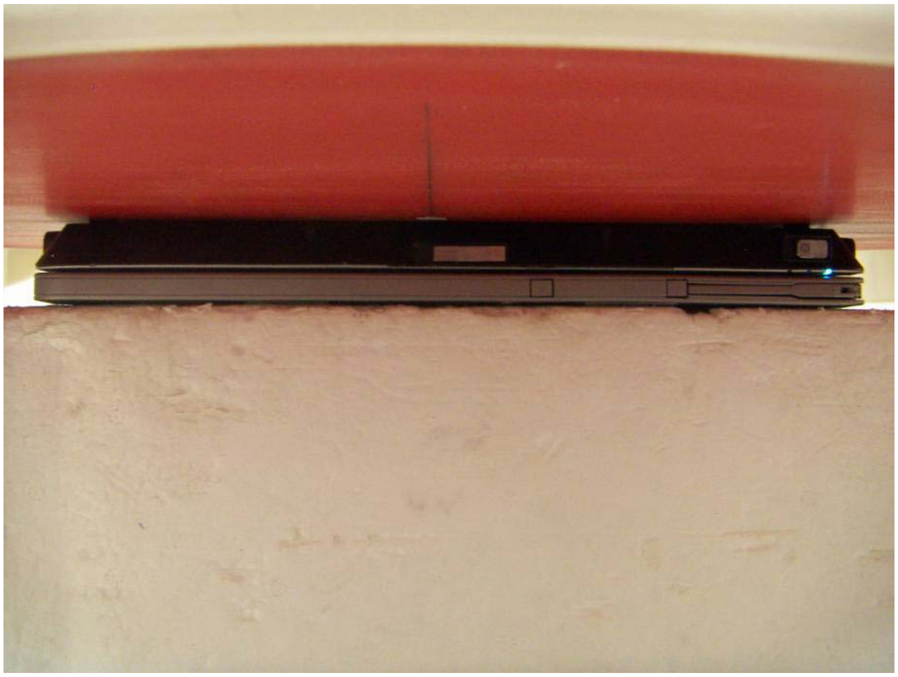
8.2.3 PRIMARY PORTRAIT

The WLAN device is disabled by software at this position

8.2.4 LAPHELD

Note:

1) **The following modes were tested base on the highest output power of each frequency band.**
2) **Aux antenna was not tested since it is used for receiving purposes only.**



Channel	f (MHz)	Measured SAR 1g (mW/g)	Power Drift (dB)	Extrapolated[1)] SAR 1g (mW/g)
5.2 GHz Band - 802.11a - Legacy mode - Main Antenna				
40	5200	0.002	-0.039	0.002
5.2 GHz Band - 802.11n HT40 - Main Antenna				
46	5230	0.006	0.000	0.006
5.3 GHz Band - 802.11a - Legacy mode - Main Antenna				
56	5280	0.007	0.000	0.007
5.3 GHz Band - 802.11n HT40 - Main Antenna				
62	5310	0.006	0.000	0.006
5.5 GHz Band - 802.11a - Legacy mode - Main Antenna				
100	5500	0.026	-0.004	0.026
5.5 GHz Band - 802.11n HT40 - Main Antenna				
118	5590	0.015	0.000	0.015
5.8 GHz Band - 802.11a - Legacy mode - Main Antenna				
157	5785	0.012	0.000	0.012
5.8 GHz Band - 802.11n HT40 - Main Antenna				
159	5795	0.019	0.000	0.019

Notes:

1) The exact method of extrapolation is Measured SAR x 10^(-drift/10). The SAR reported at the end of the measurement process by the DASY4 system can be scaled up by the Power drift to determine the SAR at the beginning of the measurement process.
2) The SAR measured at the middle channel for this configuration is at least 3 dB lower (0.8 mW/g) than SAR limit (1.6 mW/g), thus testing at low & high channel is optional.
3) Please see attachments for the detailed measurement data and plots showing the maximum SAR location of the EUT.

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8.2.5 SECONDARY PORTRAIT

Note:

1) **Main antenna testing was skipped due to the low SAR values obtained from the Aux antenna ad the larger separation distance between the Main antenna and the phantom.**
2) **Aux antenna was not tested since it is used for receiving purposes only.**

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8.2.6 PRIMARY LANDSCAPE POSITION

Note: Testing was skipped at this position due to large distance between the antennas and the phantom.

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9 MEASURMENT UNCERTAINTY

9.1 MEASURMENT UNCERTAINTY FOR 300 MHz – 3000 MHz

Uncertainty component	Tol. (±%)	Probe Dist.	Div.	Ci (1g)	Ci (10g)	Std. Unc.(±%)	
						Ui (1g)	Ui(10g)
Measurement System							
Probe Calibration	4.80	N	1	1	1	4.80	4.80
Axial Isotropy	4.70	R	1.732	0.707	0.707	1.92	1.92
Hemispherical Isotropy	9.60	R	1.732	0.707	0.707	3.92	3.92
Boundary Effects	1.00	R	1.732	1	1	0.58	0.58
Linearity	4.70	R	1.732	1	1	2.71	2.71
System Detection Limits	1.00	R	1.732	1	1	0.58	0.58
Readout Electronics	1.00	N	1	1	1	1.00	1.00
Response Time	0.80	R	1.732	1	1	0.46	0.46
Integration Time	2.60	R	1.732	1	1	1.50	1.50
RF Ambient Conditions - Noise	1.59	R	1.732	1	1	0.92	0.92
RF Ambient Conditions - Reflections	0.00	R	1.732	1	1	0.00	0.00
Probe Positioner Mechnical Tolerance	0.40	R	1.732	1	1	0.23	0.23
Probe Positioning With Respect to Phantom Shell	2.90	R	1.732	1	1	1.67	1.67
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	3.90	R	1.732	1	1	2.25	2.25
Test sample Related							
Test Sample Positioning	1.10	N	1	1	1	1.10	1.10
Device Holder Uncertainty	3.60	N	1	1	1	3.60	3.60
Power and SAR Drift Measurement	5.00	R	1.732	1	1	2.89	2.89
Phantom and Tissue Parameters							
Phantom Uncertainty	4.00	R	1.732	1	1	2.31	2.31
Liquid Conductivity - Target	5.00	R	1.732	0.64	0.43	1.85	1.24
Liquid Conductivity - Meas.	8.60	N	1	0.64	0.43	5.50	3.70
Liquid Permittivity - Target	5.00	R	1.732	0.6	0.49	1.73	1.41
Liquid Permittivity - Meas.	3.30	N	1	0.6	0.49	1.98	1.62
Combined Standard Uncertainty	RSS					11.44	10.49
Expanded Uncertainty (95% Confidence Interval)	K=2					22.87	20.98

Notesfor table
1. Tol. - tolerance in influence quaitity
2. N - Nomal
3. R - Rectangular
4. Div. - Divisor used to obtain standard uncertainty
5. Ci - is te sensitivity coefficient

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9.2 MEASURMENT UNCERTAINTY 3 GHz – 6 GHz

Uncertainty component	Tol. (±%)	Probe Dist.	Div.	Ci (1g)	Ci (10g)	Std. Unc.(±%)	
						Ui (1g)	Ui(10g)
Measurement System							
Probe Calibration	4.80	N	1	1	1	4.80	4.80
Axial Isotropy	4.70	R	1.732	0.707	0.707	1.92	1.92
Hemispherical Isotropy	9.60	R	1.732	0.707	0.707	3.92	3.92
Boundary Effects	1.00	R	1.732	1	1	0.58	0.58
Linearity	4.70	R	1.732	1	1	2.71	2.71
System Detection Limits	1.00	R	1.732	1	1	0.58	0.58
Readout Electronics	1.00	N	1	1	1	1.00	1.00
Response Time	0.80	R	1.732	1	1	0.46	0.46
Integration Time	2.60	R	1.732	1	1	1.50	1.50
RF Ambient Conditions - Noise	3.00	R	1.732	1	1	1.73	1.73
RF Ambient Conditions - Reflections	3.00	R	1.732	1	1	1.73	1.73
Probe Positioner Mechnical Tolerance	0.40	R	1.732	1	1	0.23	0.23
Probe Positioning With Respect to Phantom Shell	2.90	R	1.732	1	1	1.67	1.67
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	3.90	R	1.732	1	1	2.25	2.25
Test sample Related							
Test Sample Positioning	1.10	N	1	1	1	1.10	1.10
Device Holder Uncertainty	3.60	N	1	1	1	3.60	3.60
Power and SAR Drift Measurement	5.00	R	1.732	1	1	2.89	2.89
Phantom and Tissue Parameters							
Phantom Uncertainty	4.00	R	1.732	1	1	2.31	2.31
Liquid Conductivity - Target	5.00	R	1.732	0.64	0.43	1.85	1.24
Liquid Conductivity - Meas.	8.60	N	1	0.64	0.43	5.50	3.70
Liquid Permittivity - Target	5.00	R	1.732	0.6	0.49	1.73	1.41
Liquid Permittivity - Meas.	3.30	N	1	0.6	0.49	1.98	1.62
Combined Standard Uncertainty	RSS					11.66	10.73
Expanded Uncertainty (95% Confidence Interval)	K=2					23.32	21.46

Notesfor table
1. Tol. - tolerance in influence quaitity
2. N - Nomal
3. R - Rectangular
4. Div. - Divisor used to obtain standard uncertainty
5. Ci - is te sensitivity coefficient

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10 EQUIPMENT LIST AND CALIBRATION

Name of Equipment	Manufacturer	Type/Model	Serial Number	Cal. Due date		
				MM	DD	Year
Robot - Six Axes	Stäubli	RX90BL	N/A	N/A		
Robot Remote Control	Stäubli	CS7MB	3403-91535	N/A		
DASY4 Measurement Server	SPEAG	SEUMS001BA	1041	N/A		
Probe Alignment Unit	SPEAG	LB (V2)	261	N/A		
SAM Phantom (SAM1)	SPEAG	QD000P40CA	1185	N/A		
SAM Phantom (SAM2)	SPEAG	QD000P40CA	1050	N/A		
Oval Flat Phantom (ELI 4.0)	SPEAG	QD OVA001 B	1003	N/A		
Electronic Probe kit	HP	85070C	N/A	N/A		
S-Parameter Network Analyzer	Agilent	8753ES-6	MY40001647	11	14	2008
E-Field Probe	SPEAG	EX3DV3	3531	4	23	2009
Thermometer	ERTCO	639-1S	1718	8	30	2008
Data Acquisition Electronics	SPEAG	DAE3 V1	500	11	16	2008
System Validation Dipole	SPEAG	D2450V2	748	4	14	2009
System Validation Dipole	SPEAG	D5GHzV2	1003	11	21	2009
Signal Generator	R&S	SMP 04	DE34210	2	16	2009
Power Meter	Giga-tronics	8651A	8651404	1	11	2010
Power Sensor	Giga-tronics	80701A	1834588	1	11	2010
Amplifier	Mini-Circuits	ZHL-42W	D072701-5	N/A		
Simulating Liquid	CCS	M2450	N/A	Within 24 hrs of first test		
Simulating Liquid	SPEAG	M5200-5800	N/A	Within 24 hrs of first test		

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11 ATTACHMENTS

No.	Contents	No. Of Pages
1	System Performance Check Plots	8
2	SAR Test Plots	12
3	Certificate of E-Field Probe - EX3DV3SN3531	9
4	Certificate of System Validation Dipole - D2450V2 SN:748	9
5	Certificate of System Validation Dipole - D5GHzV2 SN:1003	15

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12 PHOTOS

EUT

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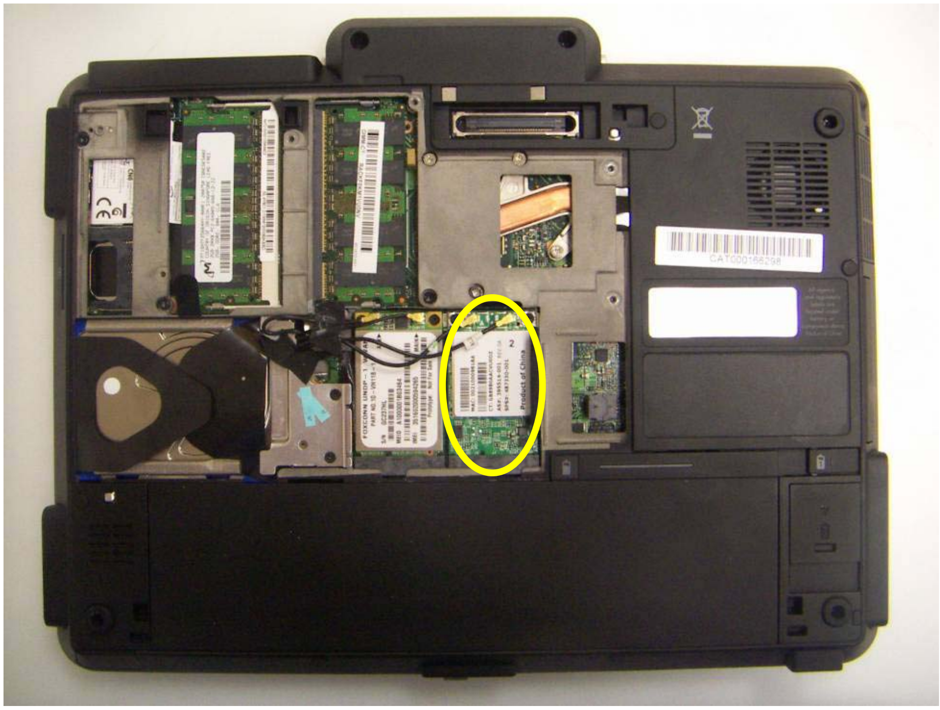
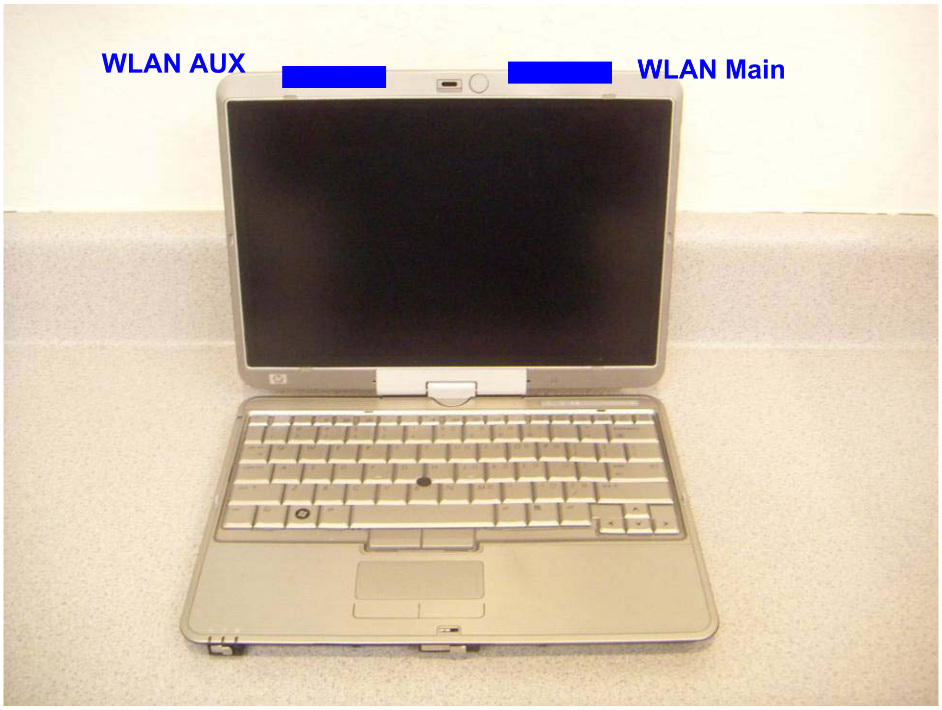
EUT Location



Antenna Location



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Tablet Mode

END OF REPORT

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