FCC OET BULLETIN 65 SUPPLEMENT C 01-01
IEEE STD 1528:2003

SAR EVALUATION REPORT

For
802.11bgn 2x2 HT20 & HT40 PCIe Mini Card Transceiver
(Tested inside of Panasonic Tablet PC CF-19)

MODEL NUMBER: WL11E

FCC ID: ACJ9TGWL11E

REPORT NUMBER: 11J13997-2

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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	September 1, 2011	Initial Issue	--

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1. Attestation of Test Results

Applicant name:	Panasonic Corporation Of North America		
EUT description:	802.11bgn HT20 & HT40 2x2 PCIe Minicard Transceiver (Tested inside of Panasonic Tablet PC, Model CF-19)		
Model number:	WL11E		
Device category:	Portable		
Exposure category:	General Population/Uncontrolled Exposure		
Date tested:	August 10, 2011		
FCC / IC Rule Parts	Freq. Range [MHz]	Highest 1g SAR (W/g)	Limit (W/g)
15.247 / RSS-102	2412 – 2462	0.398 W/kg (Secondary Landscape)	1.6
Applicable Standards			Test Results
OET Bulletin 65 Supplement C 01-01, IEEE STD 1528: 2003			Pass

Compliance Certification Services, Inc. (UL CCS) tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL CCS based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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 CCS By:	Tested By:
Sunny Shih	Tomochika Sato
Engineering Team Leader	SAR Engineer
Compliance Certification Services (UL CCS)	Compliance Certification Services (UL CCS)

2. Test Methodology

The tests documented in this report were performed in accordance with FCC OET Bulletin 65 Supplement C Edition 01-01, IEEE STD 1528:2003, and the following KDB Procedures.

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

3. Facilities and Accreditation

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

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

4. Calibration and Uncertainty

4.1. Measuring Instrument Calibration

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due date		
				MM	DD	Year
Robot - Six Axes	Stäubli	TX90 XL	N/A	N/A		
Robot Remote Control	Stäubli	CS8C	N/A	N/A		
DASY5 Measurement Server	SPEAG	SEUMS014AA	1064	N/A		
Probe Alignment Unit	SPEAG	LB5 / 80	N/A	N/A		
Oval Flat Phantom (ELI v5.0 (A))	SPEAG	QD OVA001 BB	1117	N/A		
Oval Flat Phantom (ELI v5.0 (B))	SPEAG	QD OVA001 BB	1121	N/A		
Dielectric Probe Kit	HP	85070C	N/A	N/A		
S-Parameter Network Analyzer	Agilent	8753ES-6	8753ES-6	11	22	2011
Signal Generator	Agilent	8753ES-6	8753ES-6	11	22	2011
E-Field Probe	SPEAG	EX3DV4	3772	5	3	2012
Thermometer	ERTCO	639-1S	1718	7	19	2012
Data Acquisition Electronics	SPEAG	DAE4	1257	5	3	2012
System Validation Dipole	SPEAG	D2450V2	706	4	19	2012
Amplifier	Mini-Circuits	ZVE-8G	90606	N/A		
Amplifier	Mini-Circuits	ZHL-42W	D072701-5	N/A		
Simulating Liquid	SPEAG	M2450	N/A	Within 24 hrs of first test		

Note:

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

1. There is no physical damage on the dipole
2. System validation with specific dipole is within 10% of calibrated value.
3. Return-loss is within 20% of calibrated measurement. (Verification data include with D2450V2 calibration certificate)
4. Impedance is within 5Ω of calibrated measurement. (Verification data include with dipole D2450V2 calibration certificate)

4.2. Measurement Uncertainty

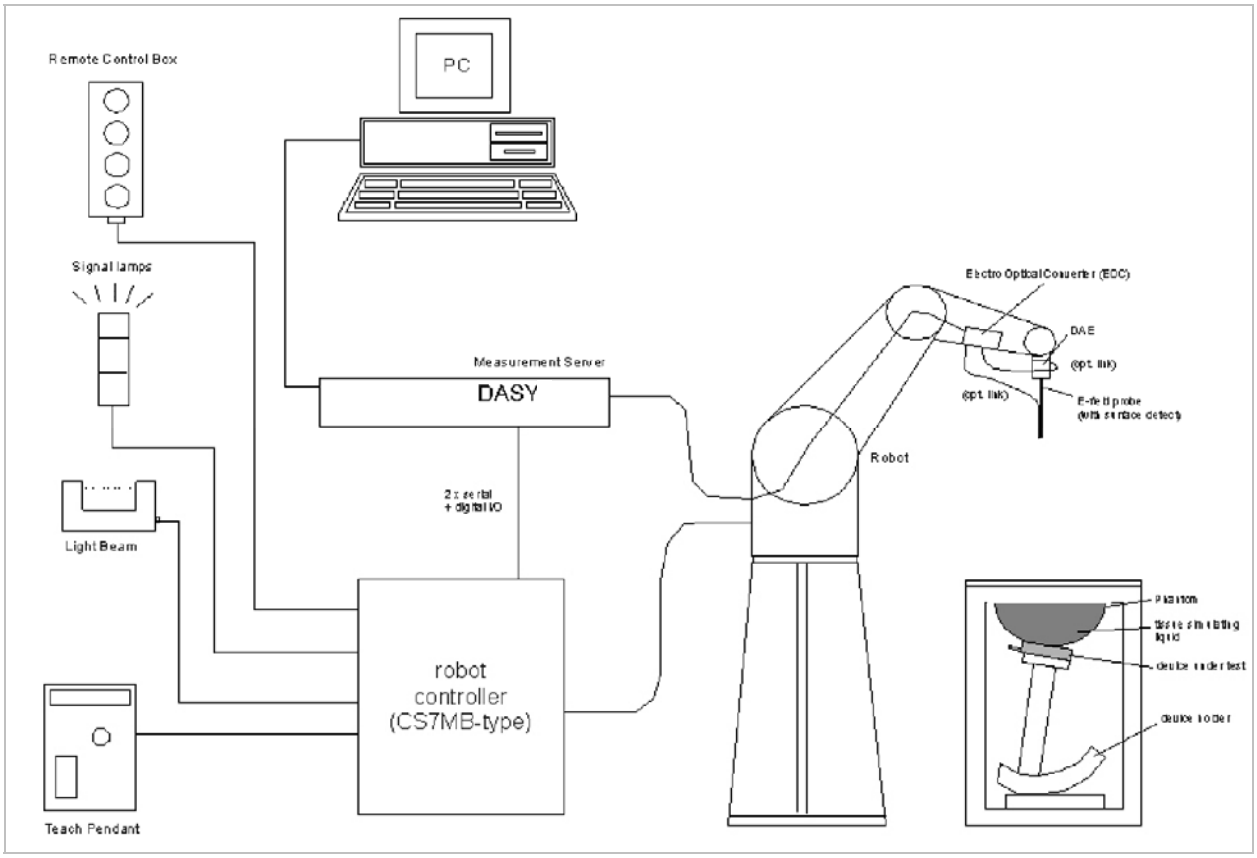
Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram

Component	error, %	Probe Distribution	Divisor	Sensitivity	U (Xi), %
Measurement System					
Probe Calibration (k=1)	5.50	Normal	1	1	5.50
Axial Isotropy	1.15	Rectangular	1.732	0.7071	0.47
Hemispherical Isotropy	2.30	Rectangular	1.732	0.7071	0.94
Boundary Effect	0.90	Rectangular	1.732	1	0.52
Probe Linearity	3.45	Rectangular	1.732	1	1.99
System Detection Limits	1.00	Rectangular	1.732	1	0.58
Readout Electronics	0.30	Normal	1	1	0.30
Response Time	0.80	Rectangular	1.732	1	0.46
Integration Time	2.60	Rectangular	1.732	1	1.50
RF Ambient Conditions - Noise	3.00	Rectangular	1.732	1	1.73
RF Ambient Conditions - Reflections	3.00	Rectangular	1.732	1	1.73
Probe Positioner Mechanical Tolerance	0.40	Rectangular	1.732	1	0.23
Probe Positioning with respect to Phantom	2.90	Rectangular	1.732	1	1.67
Extrapolation, Interpolation and Integration	1.00	Rectangular	1.732	1	0.58
Test Sample Related					
Test Sample Positioning	2.90	Normal	1	1	2.90
Device Holder Uncertainty	3.60	Normal	1	1	3.60
Output Power Variation - SAR Drift	5.00	Rectangular	1.732	1	2.89
Phantom and Tissue Parameters					
Phantom Uncertainty (shape and thickness)	4.00	Rectangular	1.732	1	2.31
Liquid Conductivity - deviation from target	5.00	Rectangular	1.732	0.64	1.85
Liquid Conductivity - measurement	0.46	Normal	1	0.64	0.29
Liquid Permittivity - deviation from target	5.00	Rectangular	1.732	0.6	1.73
Liquid Permittivity - measurement	3.02	Normal	1	0.6	1.81
				Combined Standard Uncertainty Uc(y) =	9.62
				Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence = 19.23	%
				Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence = 1.53	dB

5. Equipment Under Test

802.11n 2x2 PCIe Minicard Transceiver, Model WL11E (Tested inside of Panasonic Tablet PC, Model CF-19)	
Normal operation:	Multiple display orientations supporting both portrait and landscape configurations.
Antenna tested:	Manufactured: Panasonic Part number: Main (Chain A): DFUP1851ZA(4) Aux (Chain B): DFUP1851ZA(3)
Antenna-to-antenna/user separation distances:	See Section 14 for details of antenna locations and separation distances.
Assessment for SAR evaluation for Simultaneous transmission:	WiFi can transmit simultaneously with Bluetooth. Due to Bluetooth's (FCC ID: ACJ9TGBT11A; IC: 216A-CFBT11A) maximum output < 60/f(GHz) mW and stand-alone SAR is not required, thus WiFi and Bluetooth are not considered as co-located transmitters each other WWAN co-located RF exposure assessment will be addressed in a separate FCC application filed under WWAN application.

6. System Specification



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

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

7. Composition of Ingredients for Tissue Simulating Liquids

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

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

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

Simulating Liquids for 5 GHz, Manufactured by SPEAG

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

8. Tissue Dielectric Parameters

The simulating liquids are checked at the beginning of a series of SAR measurements to determine if the dielectric parameters are within the tolerances of the specified target values. For frequencies in 300 MHz to just under 2 GHz, the measured conductivity and relative permittivity were within ± 5% of the target values. For frequencies above 2 GHz the measured conductivity was within ± 5% of the target values. The measured relative permittivity tolerance was within ± 10% of the target value.

Reference Values of Tissue Dielectric Parameters for Head & Body Phantom

The body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in IEEE Standard 1528.

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.8
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.9	55.2	0.97
900	41.5	0.97	55	1.05
915	41.5	0.98	55	1.06
1450	40.5	1.2	54	1.3
1610	40.3	1.29	53.8	1.4
1800 – 2000	40	1.4	53.3	1.52
2450	39.2	1.8	52.7	1.95
3000	38.5	2.4	52	2.73
5800	35.3	5.27	48.2	6

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

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

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

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

f (MHz)	Body Tissue		Reference
	rel. permittivity	conductivity	
3000	52.0	2.73	Standard
5100	49.1	5.18	Interpolated
5200	49.0	5.30	Interpolated
5300	48.9	5.42	Interpolated
5400	48.7	5.53	Interpolated
5500	48.6	5.65	Interpolated
5600	48.5	5.77	Interpolated
5700	48.3	5.88	Interpolated
5800	48.2	6.00	Standard

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

8.1. Liquid Check Results

Measured by: Tomochika Sato

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
8/10/2011	Body 2450	e'	51.1103	Relative Permittivity (ε_r):	51.11	52.70	-3.02	5
		e"	14.3801	Conductivity (σ):	1.96	1.95	0.46	5

Liquid Check
Ambient temperature: 25 deg. C; Liquid temperature: 24 deg. C; Relative humidity = 40%
August 10, 2011 02:17 PM

Frequency	e'	e''
2400000000.	51.2264	14.1762
2405000000.	51.2130	14.2006
2410000000.	51.2006	14.2245
2415000000.	51.1905	14.2472
2420000000.	51.1795	14.2654
2425000000.	51.1707	14.2842
2430000000.	51.1600	14.3044
2435000000.	51.1498	14.3232
2440000000.	51.1379	14.3424
2445000000.	51.1257	14.3606
2450000000.	**51.1103**	**14.3801**
2455000000.	51.0955	14.3957
2460000000.	51.0782	14.4160
2465000000.	51.0609	14.4332
2470000000.	51.0405	14.4542
2475000000.	51.0166	14.4746
2480000000.	50.9939	14.4941
2485000000.	50.9701	14.5154
2490000000.	50.9469	14.5371
2495000000.	50.9220	14.5593
2500000000.	50.8995	14.5807

The conductivity (σ) can be given as:

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

where f = target f * 10^6

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

9. System Verification

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

System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the SAM twin phantom filled with Body simulating liquid of the following parameters.
- The DASY5 system with an Isotropic E-Field Probe EX3DV4-SN: 3772 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 (2.4 GHz) fine cube was chosen for cube integration and Special 8x8x10 (5 GHz) fine cube was chosen for cube integration
- Distance between probe sensors and phantom surface was set to 2.5 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input powers (forward power) were 100 mW.
- The results are normalized to 1 W input power.

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

System validation dipole	Cal. certificate #	Cal. date	SAR Avg (mW/g)			
			Tissue:	Freq.	Head	Body
D2450V2 SN 706	D2450V2-706_Apr10	4/19/10	1g SAR:	2.4 GHz	51.6	52.4
			10g SAR:		24.4	24.5

9.1. System Check Results

System validation dipole	Date Tested	Measured (Normalized to 1 W)		Target	Delta (%)	Tolerance (%)
		Tissue:	Body			
D2450V2 (2.45GHz)	08/11/11	1g SAR:	52.7	52.4	0.57	±10
		10g SAR:	24.0	24.5	-2.04	

10. SAR Measurement Procedures

Step 1: Power Reference Measurement
The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties (for example, 1.2 mm for an EX3DV3 probe type).

Step 2: Area Scan
The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY5 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 ≥ 7x7x9 (above 4.5 GHz) or 5x5x7 (below 3 GHz) points within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Step 4: Power drift measurement
The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

Step 5: Z-Scan
The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

11. RF Output Power Verification

11.1. RF OUTPUT POWER FOR 2.4 GHz BAND

2.4 GHz Band							
Mode	Rate	Ch. #	Freq. (MHz)	Target Pwr (dBm)		Actual Measured Pwr	
				Chain A	Chain B	Chain A	Chain B
802.11b	1 Mbps	1	2412	17.0			
		6	2437	**20.0**		**20.18**	
		11	2462	17.0			
		1	2412		17.0		
		6	2437		**20.0**		**20.17**
		11	2462		17.0		
802.11g	6 Mbps	1	2412	14.0			
		6	2437	**20.0**		**20.46**	
		11	2462	14.0			
		1	2412		14.0		
		6	2437		**20.0**		**20.25**
		11	2462		14.0		
802.11n HT20	MCS 0	1	2412	10.0	10.0		
		6	2437	16.0	16.0	16.50	16.44
		11	2462	10.0	10.0		
802.11n HT40	MCS0	3	2422	8.0	8.0		
		6	2437	14.0	14.0	14.11	14.39
		9	2450	8.0	8.0		

Note:

1. The modes with highest output power channel were chosen for the conducted output power.

12. Summary of Test Results

12.1. Summary of Test Configurations

Configuration	Antenna-to-User distance	SAR Require	Comments
(1) Bottom Face Tablet mode	45 mm from Main (Chain A) to user.	Yes	
	45 mm from Aux (Chain B) to user.	Yes	
Bottom Face Laptop held	135 mm from Main (Chain A) to user.	No	
	135 mm from Aux (Chain B) to user.	No	
Primary Landscape	100 mm from Main (Chain A) to user.	No	
	100 mm from Aux (Chain B) to user.	No	
(2) Secondary Landscape	25 mm from Main (Chain A) to user.	Yes	
	25 mm from Sub (Chain B) to user.	Yes	
(3) Primary Portrait	282 mm from Main (Chain B) to user.	No	
	16 mm from Main (Chain B) to user.	Yes	
(4) Secondary Portrait	16 mm from Main (Chain A) to user.	Yes	
	282 mm from Main (Chain B) to user.	No	

12.2. SAR Test Results for 2.4 GHz

(1) Bottom Face (Chain A & B)

Mode	Channel	f (MHz)	Avg. Output Power (dBm)		Measured Result (mW/g)	
			Chain A	Chain B	1g-SAR	10g-SAR
802.11b	1	2412				
	6	2437	20.18		0.031	0.018
	11	2462				
	1	2412				
	6	2437		20.17	0.072	0.036
	11	2462				
802.11g	1	2412				
	6	2437	20.46		0.036	0.021
	11	2462				
	1	2412				
	6	2437		20.25	0.064	0.034
	11	2462				

(2) Secondary Landscape (Chain A & B)

Mode	Channel	f (MHz)	Avg. Output Power (dBm)		Measured Result (mW/g)	
			Chain A	Chain B	1g-SAR	10g-SAR
802.11b	1	2412				
	6	2437	20.18		0.204	0.100
	11	2462				
	1	2412				
	6	2437		20.17	0.371	0.176
	11	2462				
802.11g	1	2412				
	6	2437	20.46		0.235	0.115
	11	2462				
	1	2412				
	6	2437		20.25	0.398	0.192
	11	2462				

(3) Primary Portrait (Chain B)

Mode	Channel	f (MHz)	Avg. Output Power (dBm)		Measured Result (mW/g)	
			Chain A	Chain B	1g-SAR	10g-SAR
802.11b	1	2412				
	6	2437		20.17	0.202	0.104
	11	2462				
802.11g	1	2412				
	6	2437		20.25	0.225	0.119
	11	2462				

(4) Secondary Portrait (Chain A)

Mode	Channel	f (MHz)	Avg. Output Power (dBm)		Measured Result (mW/g)	
			Chain A	Chain B	1g-SAR	10g-SAR
802.11b	1	2412				
	6	2437	20.18		0.146	0.079
	11	2462				
802.11g	1	2412				
	6	2437	20.46		0.172	0.092
	11	2462				

Note:
The modes with highest output power channel were chosen for the conducted output power.

13. Appendixes

13.1. Appendix A: System Check Plots

13.2. Appendix B: SAR Test Plots

13.3. Appendix C: Calibration Certificate for EX3DV4 SN 3772

13.4. Appendix D: Calibration Certificate for D2450V2 SN 706