SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
Portable Gaming Device

FCC ID: VOB-P2523
Model Name: P2523

Report Number: 14U19497-S1E
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Date	Revisions	Revised By
--	12/31/2014	Initial Issue	--
A	1/7/2015	Section 7: Added Note(s) section	Coltyce Sanders
B	2/27/2015	Section 2: Added KDB 941225 D07 test standard	Coltyce Sanders
C	3/3/2015	Section 7: Added reference to KDB enquiry, deleted notes.	Dave Weaver
D	7/6/2016	Section 1: Updated FCC ID Section 2: Removed TCB workshop note Section 4.3: Updated Table	Coltyce Sanders
E	7/12/2016	Section 2: Updated KDB List	Coltyce Sanders

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1. Attestation of Test Results

Applicant Name	NVIDIA			
FCC ID	VOB-P2523			
Model Name	P2523			
Applicable Standards	FCC 47 CFR § 2.1093 Published RF exposure KDB procedures IEEE Std 1528-2013			
SAR Limits (W/Kg)				
Exposure Category	Peak spatial-average (1g of tissue)		Extremities (hands, wrists, ankles, etc.) (10g of tissue)	
General population / Uncontrolled exposure	1.6		4	
The Highest Reported SAR (W/kg)				
RF Exposure Conditions	**Equipment Class**			
	Licensed	**DTS**	**U-NII**	**DSS (BT)**
Extremity (10g)	NA	0.094	0.250	NA
Simultaneous Tx		0.141	0.303	
Date Tested	12/4/2014 to 12/10/2014			
Test Results	Pass			

UL Verification Services Inc. 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 Verification Services Inc. 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 Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. 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 By:	Prepared By:
	
Devin Chang Senior Engineer UL Verification Services Inc.	Coltyce Sanders Laboratory Engineer UL Verification Services Inc.

2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE STD 1528-2013, the following FCC Published RF exposure KDB procedures:

- 248227 D01 SAR Meas for 802 11abg v02r02
- 447498 D01 General RF Exposure Guidance v06
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02
- 941225 D07 UMPC Mini Tablet v01r02

3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

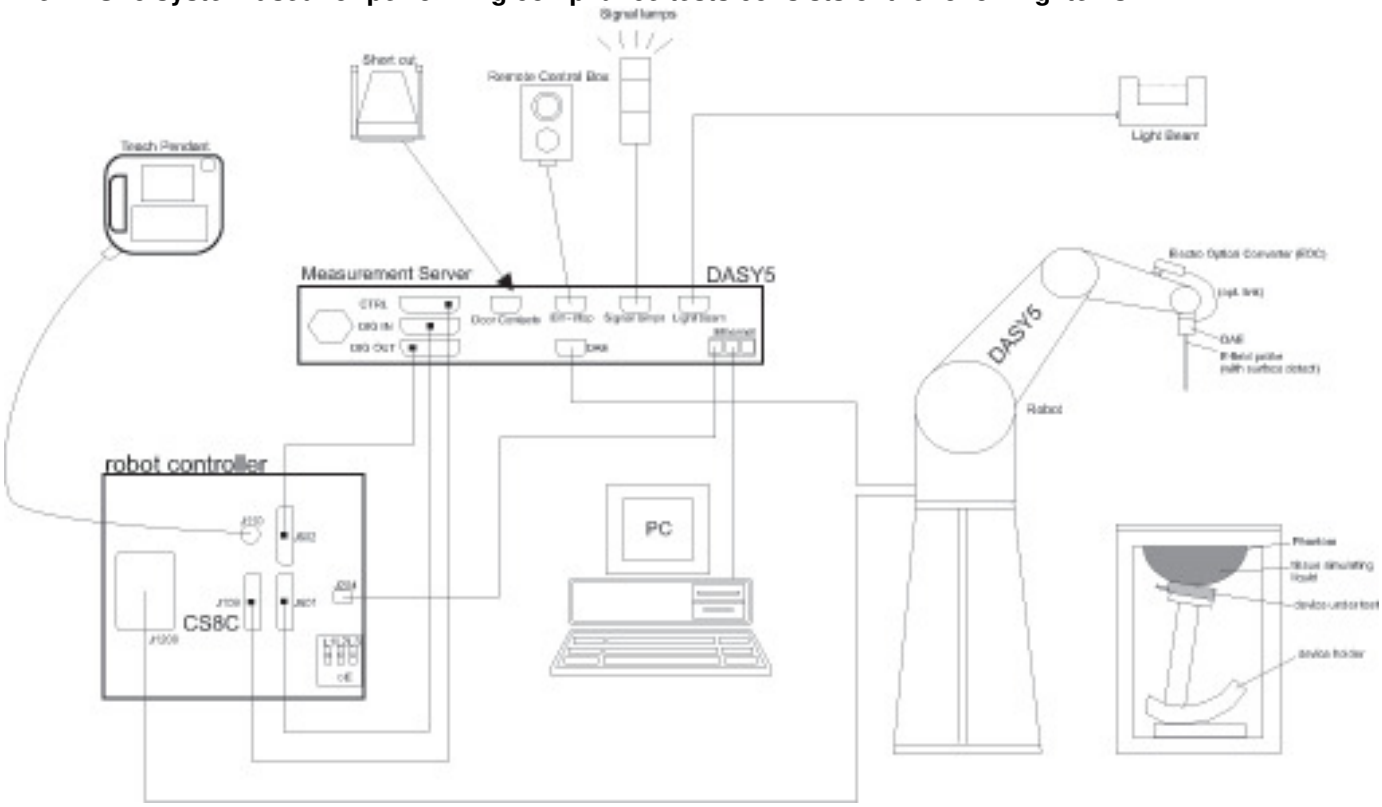
47173 Benicia Street	47266 Benicia Street
SAR Lab A	SAR Lab 1
SAR Lab B	SAR Lab 2
SAR Lab C	SAR Lab 3
SAR Lab D	SAR Lab 4
SAR Lab E	SAR Lab 5
SAR Lab F	
SAR Lab G	
SAR Lab H	

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

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.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

4.2. SAR Scan 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.

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

	≤ 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

			≤ 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

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.

4.3. Test Equipment

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.

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Network Analyzer	Agilent	E753ES	MY40000980	4/7/2015
Dielectric Probe kit	SPEAG	DAK-3.5	1082	9/16/2015
Dielectric Probe kit	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Control Company	4242	122529163	10/8/2015
Thermometer	EXTECH	445703	CCS-200	3/24/2015

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
HP Signal Generator	HP	8665B	3546A00784	6/23/2015
Power Meter	Agilent	N1911A	MY53060016	8/7/2015
Power Sensor	Agilent	E9323A	MY53070003	5/1/2015
Power Meter	HP	437B	3125U09516	10/6/2015
Power Sensor	HP	8481A	3318A95392	10/6/2015
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1622052	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2711	N/A
DC Power Supply	Sorensen Ametek	XT20-3	1318A00530	N/A
Synthesized Signal Generator	Agilent	8665B	3438A00633	8/29/2015
Power Meter	HP	437B	3125U11347	8/27/2015
Power Sensor	HP	8481A	1926A16917	10/10/2015
Power Meter	HP	437B	3125U16345	6/16/2015
Power Sensor	HP	8481A	2702A60780	6/16/2015
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1808938	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2710	N/A
DC Power Supply	HP	6296A	2841A-05955	N/A
E-Field Probe (SAR 1)	SPEAG	EX3DV4	3902	5/19/2015
E-Field Probe (SAR 5)	SPEAG	EX3DV4	3991	5/16/2015
Data Acquisition Electronics (SAR 1)	SPEAG	DAE3	427	1/21/2015
Data Acquisition Electronics (SAR 5)	SPEAG	DAE4	1439	5/14/2015
System Validation Dipole	SPEAG	D2450V2	748	2/18/2015
System Validation Dipole	SPEAG	D5GHzV2	1003	2/26/2015
Thermometer (SAR Lab 1)	EXTECH	445703	CCS-205	3/24/2015
Thermometer (SAR Lab 5)	EXTECH	445703	CCS-239	6/3/2015

Others

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Agilent	N1912A	MY53040015	7/10/2015
Power Sensor	Agilent	N1921A	MY52200012	9/26/2015

5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 10-g SAR within a frequency band is < 3.0 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Standard 1528-2013 is not required in SAR reports submitted for equipment approval.

6. Device Under Test (DUT) Information

6.1. DUT Description

Model: P2523	
Device Dimension	Overall (Length x Width): 107.5 mm x 138.6 mm Overall Diagonal: 157 mm Display Diagonal: 152.6 mm
Battery Back Cover	☐ Normal Battery Cover ☐ Normal Battery Cover with NFC ☐ Wireless Charger Battery Cover ☐ Wireless Charger Battery Cover with NFC ☒ The rechargeable battery is not user accessible.
Battery Options	☐ Standard – Lithium-ion battery, Rating N/A Vdc, N/A Wh ☐ Extended (large capacity) ☒ The rechargeable battery is not user accessible.

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
Wi-Fi	2.4 GHz	802.11b 802.11g 802.11n (HT20) 802.11n (HT40)	100%
	5 GHz	802.11a 802.11n (HT20) 802.11n (HT40) 802.11ac (VHT40) 802.11ac (VHT80)	100%
Bluetooth	2.4 GHz	Version 4.0 LE	77.5% (DH5)

6.3. Nominal and Maximum Output Power

KDB 447498 sec.4.1.(3) at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit

Upper limit (dB): -1.5 ~ 0.5		Channel Number	Core 0		Core 1	
RF Air interface	Mode		Target	Max. tune-up tolerance limit	Target	Max. tune-up tolerance limit
WiFi 2.4 GHz	802.11b	1	19.0	**19.5**	19.0	**19.5**
		6	19.0	**19.5**	19.0	**19.5**
		10	19.0	**19.5**	19.0	**19.5**
		11	19.0	**19.5**	19.0	**19.5**
	802.11g	1	13.0	**13.5**	13.0	**13.5**
		2	16.5	**17.0**	16.5	**17.0**
		3	18.0	**18.5**	18.0	**18.5**
		6	18.0	**18.5**	18.0	**18.5**
		9	18.0	**18.5**	18.0	**18.5**
		10	17.0	**17.5**	17.0	**17.5**
		11	14.5	**15.0**	14.5	**15.0**
	802.11n HT20	1	14.5	**15.0**	14.5	**15.0**
		2	15.5	**16.0**	15.5	**16.0**
		3	17.5	**18.0**	17.5	**18.0**
		6	17.5	**18.0**	17.5	**18.0**
		10	17.5	**18.0**	17.5	**18.0**
		11	13.0	**13.5**	13.0	**13.5**
	802.11n HT40	3	12.0	**12.5**	12.0	**12.5**
		6	13.5	**14.0**	13.5	**14.0**
		9	13.0	**13.5**	13.0	**13.5**
WiFi 5 GHz	802.11a	36	15.0	**15.5**	15.0	**15.5**
		40	15.0	**15.5**	15.0	**15.5**
		44	15.0	**15.5**	15.0	**15.5**
		48	15.0	**15.5**	15.0	**15.5**
		149	15.0	**15.5**	15.0	**15.5**
		153	15.0	**15.5**	15.0	**15.5**
		157	15.0	**15.5**	15.0	**15.5**
		161	15.0	**15.5**	15.0	**15.5**
		165	15.0	**15.5**	15.0	**15.5**
	802.11n HT20	36	12.0	**12.5**	12.0	**12.5**
		40	12.0	**12.5**	12.0	**12.5**
		48	12.0	**12.5**	12.0	**12.5**
		149	11.0	**11.5**	11.0	**11.5**
		157	13.0	**13.5**	13.0	**13.5**
		165	13.0	**13.5**	13.0	**13.5**
	802.11n HT40	38	12.0	**12.5**	12.0	**12.5**
		46	12.0	**12.5**	12.0	**12.5**
		151	11.0	**11.5**	11.0	**11.5**
		159	15.0	**15.5**	15.0	**15.5**
	802.11ac VHT40	38	12.0	**12.5**	12.0	**12.5**
		46	12.0	**12.5**	12.0	**12.5**
		151	11.0	**11.5**	11.0	**11.5**
		159	15.0	**15.5**	15.0	**15.5**
	802.11ac VHT80	42	12.0	**12.5**	12.0	**12.5**
		155	12.5	**13.0**	12.5	**13.0**
Bluetooth		N/A	10.0	**10.5**		
Bluetooth LE		N/A	6.5	**7.0**		

7. RF Exposure Conditions (Test Configurations)

The RF exposure test configurations were determined through a KDB enquiry.

Refer to "SAR Photos and Ant locations" Appendix for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation	Test Position	Antenna-to-edge/surface	SAR Required
WLAN	Extremity (Hand/Wrist/Ankle)	0	Rear	N/A	Yes

8. Dielectric Property Measurements & System Check

8.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.
The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.
Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

Tissue Dielectric Parameters

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

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

IEEE Standard 1528-2013

Refer to Table 3 within the IEEE Standard 1528-2013

Dielectric Property Measurements Results:

SAR Lab 1

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
12/4/2014	Body 2450	e'	50.3700	Relative Permittivity (ϵ_r):	50.37	52.70	-4.42	5
		e"	14.9500	Conductivity (σ):	2.04	1.95	4.44	5
	Body 2410	e'	50.5300	Relative Permittivity (ϵ_r):	50.53	52.76	-4.23	5
		e"	14.8800	Conductivity (σ):	1.99	1.91	4.53	5
	Body 2475	e'	50.2500	Relative Permittivity (ϵ_r):	50.25	52.67	-4.59	5
		e"	15.0800	Conductivity (σ):	2.08	1.99	4.54	5
12/8/2014	Body 2450	e'	50.9100	Relative Permittivity (ϵ_r):	50.91	52.70	-3.40	5
		e"	14.7500	Conductivity (σ):	2.01	1.95	3.04	5
	Body 2410	e'	51.0500	Relative Permittivity (ϵ_r):	51.05	52.76	-3.24	5
		e"	14.6000	Conductivity (σ):	1.96	1.91	2.57	5
	Body 2475	e'	50.8100	Relative Permittivity (ϵ_r):	50.81	52.67	-3.53	5
		e"	14.8100	Conductivity (σ):	2.04	1.99	2.67	5

SAR Lab 5

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
12/4/2014	Body 5180	e'	47.2500	Relative Permittivity (ϵ_r):	47.25	49.05	-3.66	5
		e"	18.9500	Conductivity (σ):	5.46	5.27	3.54	5
	Body 5200	e'	47.1300	Relative Permittivity (ϵ_r):	47.13	49.02	-3.85	5
		e"	18.7900	Conductivity (σ):	5.43	5.29	2.61	5
	Body 5600	e'	46.4800	Relative Permittivity (ϵ_r):	46.48	48.48	-4.12	5
		e"	19.1600	Conductivity (σ):	5.97	5.76	3.56	5
	Body 5800	e'	46.0700	Relative Permittivity (ϵ_r):	46.07	48.20	-4.42	5
		e"	19.3700	Conductivity (σ):	6.25	6.00	4.11	5
	Body 5825	e'	46.1300	Relative Permittivity (ϵ_r):	46.13	48.20	-4.29	5
		e"	19.4000	Conductivity (σ):	6.28	6.00	4.72	5
12/8/2014	Body 5180	e'	47.0500	Relative Permittivity (ϵ_r):	47.05	49.05	-4.07	5
		e"	18.7900	Conductivity (σ):	5.41	5.27	2.67	5
	Body 5200	e'	46.9500	Relative Permittivity (ϵ_r):	46.95	49.02	-4.22	5
		e"	18.8300	Conductivity (σ):	5.44	5.29	2.83	5
	Body 5600	e'	46.2800	Relative Permittivity (ϵ_r):	46.28	48.48	-4.53	5
		e"	19.2300	Conductivity (σ):	5.99	5.76	3.94	5
	Body 5800	e'	45.8300	Relative Permittivity (ϵ_r):	45.83	48.20	-4.92	5
		e"	19.5000	Conductivity (σ):	6.29	6.00	4.81	5
	Body 5825	e'	45.9400	Relative Permittivity (ϵ_r):	45.94	48.20	-4.69	5
		e"	19.4300	Conductivity (σ):	6.29	6.00	4.89	5

8.2. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are re-measured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

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 depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- 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.

Reference Target SAR Values

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 (W/kg)		
				1g/10g	Head	Body
D2450V2	748	2/18/2014	2450	1g	51.6	50.7
				10g	24.0	23.7
D5GHzV2	1003	2/26/2014	5200	1g	77.7	73.5
				10g	22.2	20.5
			5600	1g	81.8	79.6
				10g	23.2	22.1
			5800	1g	78.3	73.8
				10g	22.1	20.4

System Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within 10% of the manufacturer calibrated dipole SAR target.

SAR Lab 1

Date Tested	System Dipole		T.S. Liquid		Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.
	Type	Serial #			Zoom Scan to 100 mW	Normalize to 1 W			
12/4/2014	D2450V2	748	Body	1g	5.31	53.1	50.70	4.73	
				10g	2.46	24.6	23.7	3.80	
12/8/2014	D2450V2	748	Body	1g	5.40	54.0	50.70	6.51	1,2
				10g	2.49	24.9	23.7	5.06	

SAR Lab 5

Date Tested	System Dipole		T.S. Liquid		Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.
	Type	Serial #			Zoom Scan to 100 mW	Normalize to 1 W			
12/4/2014	5200	1003	Body	1g	7.63	76.3	73.50	3.81	
				10g	2.15	21.5	20.50	4.88	
12/4/2014	5600	1003	Body	1g	8.31	83.1	79.60	4.40	
				10g	2.31	23.1	22.10	4.52	
12/4/2014	5800	1003	Body	1g	7.90	79.0	73.80	7.05	
				10g	2.17	21.7	20.40	6.37	
12/8/2014	5200	1003	Body	1g	7.80	78.0	73.50	6.12	
				10g	2.20	22.0	20.50	7.32	
12/8/2014	5600	1003	Body	1g	8.50	85.0	79.60	6.78	
				10g	2.37	23.7	22.10	7.24	
12/8/2014	5800	1003	Body	1g	7.88	78.8	73.80	6.78	3,4
				10g	2.21	22.1	20.40	8.33	

9. Conducted Output Power Measurements

9.1. Wi-Fi DTS (2.4 GHz) Band

Required Test Channels per KDB 248227 D01

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)		SAR Test (Yes/No)
					Core 0	Core 1	
2.4 (DTS)	802.11b	1 Mbps	1	2412	18.5	17.6	Yes
			6	2437	18.4	18.5	
			11	2462	18.2	18.3	
	802.11g	6 Mbps	1	2412	12.7	12.6	No
			2	2417	16.1	16.2	
			3	2422	18.1	18.3	
			4	2427	18.0	17.9	
			6	2437	18.2	18.2	
			8	2447	18.1	18.2	
			9	2452	17.7	18.1	
			10	2457	16.6	17.0	
			11	2462	12.2	12.6	
	802.11n (HT20)	MCS0	1	2412	14.6	14.1	No
			2	2417	15.5	15.5	
			3	2422	17.7	17.3	
			6	2437	17.3	17.3	
			9	2452	17.4	17.8	
			10	2457	16.9	17.5	
			11	2462	13.0	13.0	
	802.11n (HT40)	MCS0	3	2422	12.0	12.0	No
			6	2437	13.4	13.4	
			9	2452	13.0	13.0	

Power measurements to determine worst-case data rates

Mode	Ch #	Freq. (MHz)	Data Rate	Avg Pwr (dBm)		SAR test (Yes/No)
				Core 0	Core 1	
802.11b	6	2437	1 Mbps	18.4	18.5	Yes
			2 Mbps	18.4	18.2	No
			5.5 Mbps	18.4	18.3	No
			11 Mbps	18.4	18.5	No

Note(s):

1. Per KDB 248227 D01,
   - Testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is < ¼ dB higher than those measured at the lowest data rate.
   - Each channel should be tested at the lowest data rate in each a-b/g mode channel BW configuration.

9.2. Wi-Fi U-NII (5 GHz) Bands

Required Test Channels per KDB 248227 D01

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)		SAR Test (Yes/No)
					Core 0	Core 1	
5.2 (UNII-1)	802.11a	6 Mbps	36	5180	14.5	14.8	Yes
			40	5200	14.2	14.9	
			44	5220	14.4	14.6	
			48	5240	14.1	14.5	
	802.11n (HT20)	MCS0	36	5180	10.8	10.8	No
			40	5200	10.8	12.4	
			48	5240	10.8	12.5	
	802.11n (HT40)	MCS0	38	5190	11.4	12.5	No
			46	5230	11.4	12.3	
	802.11ac (VHT40)	MCS0	38	5190	11.4	12.5	No
			46	5230	11.4	12.3	
	802.11ac (VHT80)	MCS0	42	5210	11.2	11.0	No
5.8 (UNII-3)	802.11a	6 Mbps	149	5745	14.8	13.0	Yes
			153	5765	14.7	13.0	
			157	5785	14.7	13.0	
			161	5805	14.6	13.0	
			165	5825	14.6	13.0	
	802.11n (HT20)	MCS0	149	5745	10.5	9.6	No
			157	5785	13.0	12.0	
			161	5805	13.0	12.0	
	802.11n (HT40)	MCS0	151	5755	10.8	9.6	No
			159	5795	14.9	13.7	
	802.11ac (VHT40)	MCS0	151	5755	10.8	9.6	No
			159	5795	14.9	13.7	
	802.11ac (VHT80)	MCS0	155	5775	12.3	11.3	No

Power measurements to determine worst-case data rates

Band	Ch #	Freq. (MHz)	Data Rate	Avg Pwr (dBm)	SAR test (Yes/No)
				Core 0	
5.2 GHz (UNII-1)	36	5180	6 Mbps	14.5	Yes
			9 Mbps	14.4	No
			12 Mbps	14.3	No
			18 Mbps	14.1	No
			24 Mbps	13.9	No
			36 Mbps	13.4	No
			48 Mbps	13.2	No
			54 Mbps	13.1	No
5.8 GHz (UNII-3)	149	5745	6 Mbps	14.8	Yes
			9 Mbps	14.1	No
			12 Mbps	14.0	No
			18 Mbps	13.8	No
			24 Mbps	13.5	No
			36 Mbps	13.1	No
			48 Mbps	12.9	No
			54 Mbps	12.7	No

Power measurements to determine worst-case data rates(continued)

Band	Ch #	Freq. (MHz)	Data Rate	Avg Pwr (dBm) Core 1	SAR test (Yes/No)
5.2 GHz (UNII-1)	40	5200	6 Mbps	14.9	Yes
			9 Mbps	14.3	No
			12 Mbps	14.2	No
			18 Mbps	13.8	No
			24 Mbps	13.6	No
			36 Mbps	13.1	No
			48 Mbps	13.0	No
			54 Mbps	12.8	No
5.8 GHz (UNII-3)	165	5825	6 Mbps	13.0	Yes
			9 Mbps	13.0	No
			12 Mbps	13.0	No
			18 Mbps	12.7	No
			24 Mbps	12.5	No
			36 Mbps	12.1	No
			48 Mbps	13.9	No
			54 Mbps	13.7	No

Note(s):

1. Per KDB 248227 D01,
   - Testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is < ¼ dB higher than those measured at the lowest data rate.
   - Each channel should be tested at the lowest data rate in each a-b/g mode channel BW configuration.

9.3. Bluetooth

Maximum tune-up tolerance limit is 10.5 dBm from the rated nominal maximum output power. This power level qualifies for exclusion of SAR testing.

Refer to Standalone SAR Test Exclusion Considerations Section.

10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance:
Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
- ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

KDB 248227 D01 SAR Measurements Procedures for 802.11 a/b/g Transmitters v01r02 (pg.6):
Each channel should be tested at the lowest data rate in each a-b/g mode or 4.9 GHz channel BW configuration.
When the extrapolated maximum peak SAR for the maximum output channel is ≤ 1.6 W/kg and the 1-g averaged SAR is ≤ 0.8 W/kg, testing of other channels in the “default test channels” or “required test channels” configuration is optional.

April 2013 TCB Workshop Updates:
Apply usual 802.11 test exclusion considerations, but include 802.11ac SAR for highest 802.11a configuration in each frequency band and each exposure condition.

10.1. Wi-Fi (DTS Band)

2.4 GHz Bands							Core 0				Core 1				Plot No.
							Power (dBm)		10-g SAR (W/kg)		Power (dBm)		10-g SAR (W/kg)		
RF Exposure Condition	Active Antenna(s)	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Tune-up limit	Meas.	Meas.	Scaled	Tune-up limit	Meas.	Meas.	Scaled	
Extremity	2.4 GHz (DTS)	802.11b	0	Rear	1	2412	19.5	18.5	0.037	0.047					
					6	2437	19.5	18.4	0.055	0.071	19.5	18.5	0.037	0.047	
					11	2462	19.5	18.2	0.070	0.094					1

10.2. Wi-Fi (U-NII Band)

5.2 GHz (U-NII-1)						Core 0				Core 1				Plot No.
						Power (dBm)		10-g SAR (W/kg)		Power (dBm)		10-g SAR (W/kg)		
RF Exposure Condition	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Tune-up limit	Meas.	Meas.	Scaled	Tune-up limit	Meas.	Meas.	Scaled	
Extremity	802.11a 6 Mbps	0	Rear	36	5180	15.5	14.5	0.042	0.053	15.5	14.8	0.130	0.153	
	802.11ac (VHT80)	0	Rear	42	5210					12.5	11.0	0.177	0.250	2
5.8 GHz (U-NII-3)						Core 0				Core 1				Plot No.
						Power (dBm)		10-g SAR (W/kg)		Power (dBm)		10-g SAR (W/kg)		
RF Exposure Condition	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Tune-up limit	Meas.	Meas.	Scaled	Tune-up limit	Meas.	Meas.	Scaled	
Extremity	802.11a	0	Rear	157	5785	15.5	14.7	0.025	0.030	15.5	13.0	0.082	0.146	
	802.11ac (VHT80)	0	Rear	155	5775					13.0	11.3	0.140	0.207	3

10.3. Bluetooth

Standalone SAR Test Exclusion Considerations & Estimated SAR

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)] ≤ 3.0, for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

When the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

- *(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√$f_{(GHz)}$/x]* W/kg for test separation distances ≤ 50 mm;
  where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

Extremity

Max. tune-up tolerance limit		Min. test separation distance (mm)	Frequency (GHz)	SAR test exclusion Result*	Test Configuration	Estimated 10-g SAR (W/kg)
(dBm)	(mW)					
10.5	11	5	2.480	3.5	Rear	0.188

Conclusion:

*: The computed value is < 7.5; therefore, Bluetooth qualifies for Standalone SAR test exclusion.

11. SAR Measurement Variability

In accordance with published RF Exposure KDB 865664 D01 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 2 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 2 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 3.625 W/kg (~ 10% from the 10-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 3.75 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Frequency Band (MHz)	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR (Yes/No)	Highest Measured SAR (W/kg)	Repeated Measured SAR (W/kg)	Largest to Smallest SAR Ratio
2400	Wi-Fi 802.11b/g/n	Extremity	Rear	No	0.07	N/A	N/A
5200	Wi-Fi 802.11a/n/ac	Extremity	Rear	No	0.177	N/A	N/A
5800	Wi-Fi 802.11a/n/ac	Extremity	Rear	No	0.140	N/A	N/A

Conclusion:
Repeated Measurement is not required since there are no SAR measurements > 2 W/kg.

12. Simultaneous Transmission SAR Analysis

Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations		
		Core 0		Core 1
Extremity	1	Wi-Fi 2.4 GHz	+	Wi-Fi 2.4 GHz
	2	Wi-Fi 5 GHz	+	Wi-Fi 5 GHz
	3	Wi-Fi 5 GHz / BT	+	Wi-Fi 5 GHz
	4	Bluetooth	+	Wi-Fi 2.4 GHz
	5	Bluetooth	+	Wi-Fi 5 GHz

Notes:

1. Wi-Fi 2.4 GHz Radio cannot transmit simultaneously with Bluetooth Radio when on the same antenna.

12.1. Sum of the SAR Wi-Fi & BT

RF Exposure conditions	Test Position		Simultaneous Transmission Scenario					∑ 10-g SAR (mW/g)	SPLSR (Yes/ No)
			Wi-Fi(DTS)		Wi-Fi(UNII)		Bluetooth		
			① Core 0	② Core 1	③ Core 0	④ Core 1	⑤ Core 0		
Extremity	Rear	① + ②	0.094	0.047				**0.141**	No
		③ + ④			0.053	0.250		**0.303**	No
		③ + ④ + ⑤			0.053	0.250	0.188	0.491	No
		② + ⑤		0.047			0.188	0.235	No
		③ + ⑤			0.053		0.188	0.241	No

Conclusion:

Simultaneous transmission SAR measurement (Volume Scan) is not required because the either sum of the 10-g SAR is < 4 W/kg or the SPLSR is < 0.04 for all circumstances that require SPLSR calculation.

Appendixes

Refer to separated files for the following appendixes.

A_14U19497-S1v0 SAR Photos & Ant. Locations

B_14U19497-S1v0 SAR Highest SAR Test Plots

C_14U19497-S1v0 SAR System Check Plots

D_14U19497-S1v0 SAR Tissue Ingredients

E_14U19497-S1v0 SAR Probe Cal. Certificates

F_14U19497-S1v0 SAR Dipole Cal. Certificates

END OF REPORT