SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
802.11abgn w/BT 4.0

Model: EDISON
FCC ID: 2AB8ZND1

Report Number: 14U17814-S3A
Issue Date: 8/27/2014

Prepared for
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NVLAP LAB CODE 200065-0

REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
--	8/23/2014	Initial Issue	--
A	8/27/2014	Removed Hotspot references	Dave Weaver

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1. Attestation of Test Results

Applicant Name	INTEL CORPORATION			
Application Purpose	☒ Original Grant ☐ Class II Permissive Change			
FCC ID	2AB8ZND1			
IC Certification ID	1000X-ND1			
DUT Description	802.11abgn w/BT 4.0			
Exposure Category	General Population/Uncontrolled Exposure (1g SAR limit: 1.6 W/kg)			
The highest reported SAR	RF Exposure Conditions	Equipment Class		
		Licensed	DTS	UNII
	Body-worn Accessory	N/A	0.369W /kg	N/A
Applicable Standards	FCC 47 CFR § 2.1093 KDB publication IEEE Std 1528-2013			
Test Results	Pass			
Date tested	07/24/2014 – 08/01/2014			

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:
	
Dave Weaver Program Manager UL Verification Services Inc.	Coltyce Sanders Laboratory Engineer UL Verification Services Inc.

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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-, the following FCC Published RF exposure KDB procedures, and TCB workshop updates:

- 447498 D01 General RF Exposure Guidance v05r02
- 248227 D01 SAR Meas for 802 11abg v01r02
- 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03
- 865664 D02 SAR Reporting v01r01
- 690783 D01 SAR Listings on Grants v01r03

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. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

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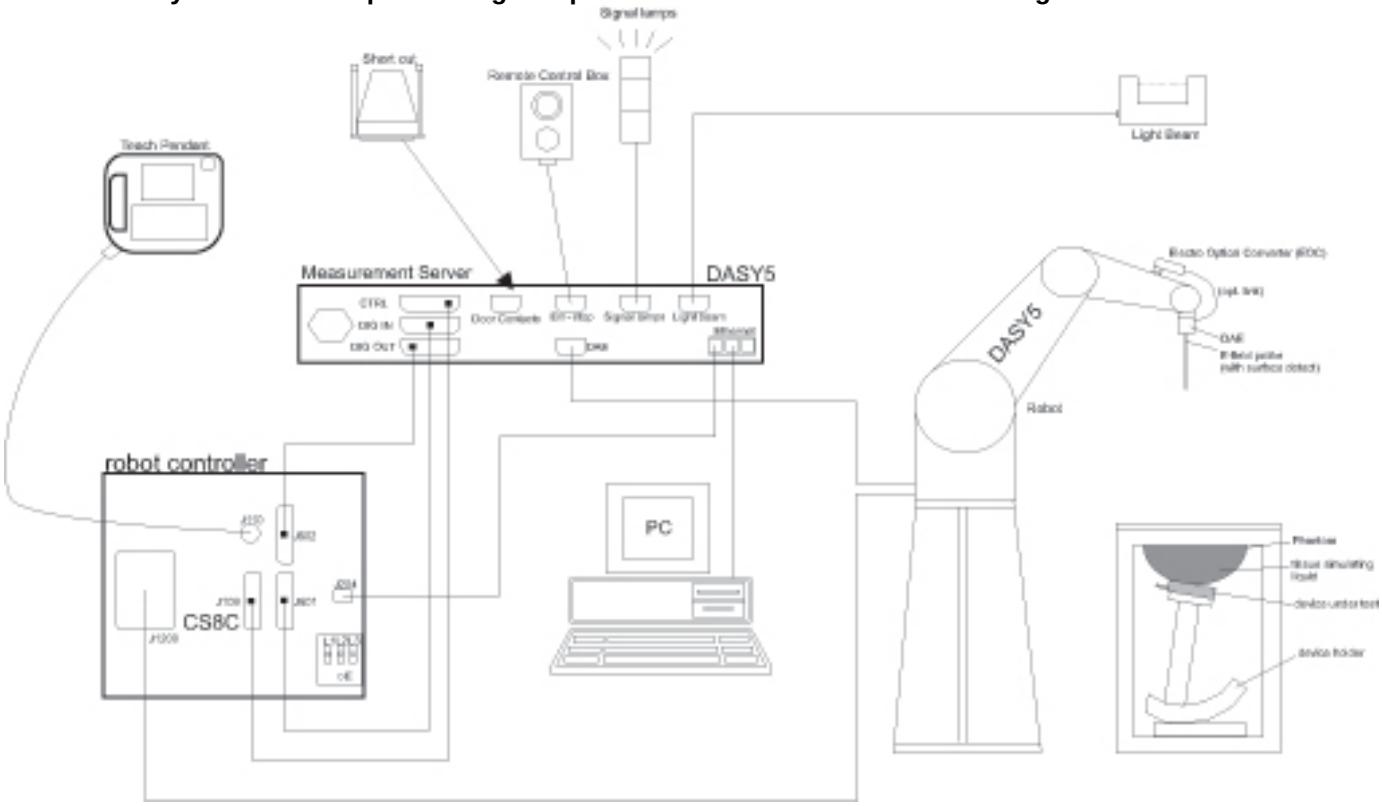
4. SAR Measurement System & Test Equipment

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.

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4.2. 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	ENA Series/E5071B	MY42100131	2/24/2015
Dielectronic Probe kit	SPEAG	DAK-3.5	1087	11/13/2014
Dielectronic Probe kit	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Control Company	4242	122529163	9/19/2014
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	HP	437B	3125U16345	6/16/2015
Power Meter	HP	437B	3125U09516	9/30/2014
Power Sensor	Agilent	8481A	2237A31744	10/2/2014
Power Sensor	Agilent	8481A	2349A36506	9/30/2014
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1808939	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2710	N/A
DC Power Supply	Sorensen Ametek	XT15-4	1319A02778	N/A
HP Signal Generator	HP	8665B	3438A00633	7/10/2015
Power Meter	HP	438A	3513U04320	10/2/2014
Power Sensor	Agilent	8481A	2702A66876	9/30/2014
Power Sensor	Agilent	8481A	3318A95392	9/30/2014
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1622052	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2711	N/A
DC Power Supply	HP	6296A	2841A-05955	N/A
E-Field Probe (SAR 3)	SPEAG	EX3DV4	3773	4/22/2015
Data Acquisition Electronics (SAR 3)	SPEAG	DAE4	1343	7/24/2014
Data Acquisition Electronics (SAR 3)	SPEAG	DAE4	1257	4/2/2015
System Validation Dipole	SPEAG	D2450V2	899	9/10/2014
System Validation Dipole	SPEAG	D5GHzV2	1138	11/19/2014
Thermometer (SAR Lab 3)	EXTECH	445703	CCS-237	6/3/2015

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5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2003 & 2013 is not required in SAR reports submitted for equipment approval.

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6. Device Under Test (DUT) Information

6.1. DUT Description

Model: EDISON	
Device Dimension	Overall (Length x Width): 24.86 mm x 35.64 mm Overall Diagonal: 43.08 mm

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)	100%
Bluetooth	2.4 GHz	Version 4.0 LE	32.25% (DH1), 66.68% (DH3), 77.52% (DH5)

6.3. Simultaneous Transmission

Bluetooth and 2.4 GHz WI-Fi cannot transmit simultaneously.

Bluetooth and 5 GHz WI-Fi can transmit simultaneously.

6.4. Maximum Output Power

Target powers are absolute maximums

		RF Output Power (dBm)
RF Air interface	Mode	Target
WiFi 2.4 GHz	802.11b	15.8
	802.11g	17.1
	802.11n HT20	17.1
	802.11n HT40	14.2
WiFi 5.2 GHz	802.11a	13.3
	802.11n HT20	13.7
	802.11n HT40	11.2
WiFi 5.3 GHz	802.11a	13.8
	802.11n HT20	14.2
	802.11n HT40	13.2
WiFi 5.6 GHz	802.11a	13.2
	802.11n HT20	14.2
	802.11n HT40	13.2
WiFi 5.8 GHz	802.11a	13.5
	802.11n HT20	14.1
	802.11n HT40	13.0
Bluetooth		5.4

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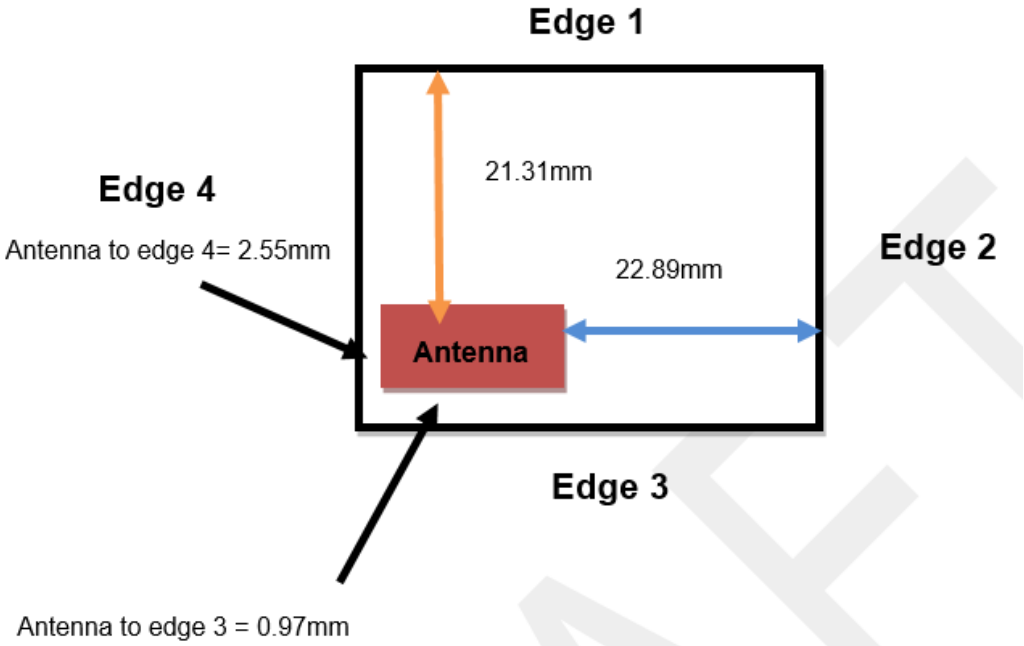
6.5. Test Rational

The DUT previously underwent SAR testing at reduced power levels in the 2.4 GHz band at 5mm test separation distance. (See UL SAR test report 14U17814-S1A). This report contains SAR test results at full power at a separation distance of 17mm. SAR testing for Bluetooth and in the 5GHz bands at 17mm was not necessary as testing at the maximum power was already reported in UL SAR test report 14U17814-S1A at 5mm.

6.4 Antenna Dimensions and Separation Distances



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7. RF Exposure Conditions (Test Configurations)

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

7.1. Body

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	1 mm	Yes	
Front	0 mm	Yes	
Edge 1 (Top)	21.31 mm	Yes	
Edge 2 (Right)	22.89 mm	Yes	
Edge 3 (Bottom)	0.97 mm	Yes	
Edge 4 (Left)	2.55 mm	Yes	

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8. Conducted Output Power Measurements

The proprietary logic is used to determine when head/body power table is used.

8.1. Wi-Fi (2.4 GHz Band)

Required Test Channels per KDB 248227 D01

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

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

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	SAR Test (Yes/No)
2.4 (DTS)	802.11b	1 Mbps	1	2412	13.3	Yes
			6	2437	14.1	
			11	2462	15.8	
	802.11g	6 Mbps	1	2412	14.1	Yes
			6	2437	17.0	
			11	2462	17.1	
	802.11n (HT20)	MCS0	1	2412	14.0	Yes
			6	2437	17.1	
			11	2462	17.1	
	802.11n (HT40)	MCS0	3	2422	11.1	Yes
			6	2437	14.2	
			9	2452	12.1	

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9. 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.

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9.1. 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 Std 1528-2013

Target Frequency (MHz)	Head	
	ε_r	σ (S/m)
300	45.3	0.87
450	43.5	0.87
750	*41.9*	*0.89*
835	41.5	0.90
900	41.5	0.97
1450	40.5	1.20
1500	*40.4*	*1.23*
1640	*40.2*	*1.31*
1750	*40.1*	*1.37*
1800	40.0	1.40
1900	40.0	1.40
2000	40.0	1.40
2100	*39.8*	*1.49*
2300	*39.5*	*1.67*
2450	39.2	1.80
2600	*39.0*	*1.96*
3000	38.5	2.40
3500	*37.9*	*2.91*
4000	*37.4*	*3.43*
4500	*36.8*	*3.94*
5000	*36.2*	*4.45*
5200	*36.0*	*4.66*
5400	*35.8*	*4.86*
5600	*35.5*	*5.07*
5800	35.3	5.27
6000	*35.1*	*5.48*

NOTE—For convenience, permittivity and conductivity values at some frequencies that are not part of the original data from Drossos et al. [B60] or the extension to 5800 MHz are provided (i.e., the values shown in italics). These values were linearly interpolated between the values in this table that are immediately above and below these values, except the values at 6000 MHz that were linearly extrapolated from the values at 3000 MHz and 5800 MHz.

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9.2. Dielectric Property Measurements Results

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.

SAR Lab 3

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
7/28/2014	Body 2450	e'	50.5300	Relative Permittivity (ε_r):	50.53	52.70	-4.12	5
		e''	14.8500	Conductivity (σ):	2.02	1.95	3.74	5
	Body 2410	e'	50.7000	Relative Permittivity (ε_r):	50.70	52.76	-3.90	5
		e''	14.7000	Conductivity (σ):	1.97	1.91	3.27	5
	Body 2475	e'	50.4200	Relative Permittivity (ε_r):	50.42	52.67	-4.27	5
		e''	14.9600	Conductivity (σ):	2.06	1.99	3.71	5
7/31/2014	Body 2450	e'	51.8000	Relative Permittivity (ε_r):	51.80	52.70	-1.71	5
		e''	14.4100	Conductivity (σ):	1.96	1.95	0.67	5
	Body 2410	e'	51.9700	Relative Permittivity (ε_r):	51.97	52.76	-1.50	5
		e''	14.2500	Conductivity (σ):	1.91	1.91	0.11	5
	Body 2475	e'	51.6800	Relative Permittivity (ε_r):	51.68	52.67	-1.88	5
		e''	14.5100	Conductivity (σ):	2.00	1.99	0.59	5

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10. 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 remeasured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

10.1. 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	899	9/10/2013	2450	1g	51.3	49.70
				10g	23.9	23.3

10.2. 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 3

Date Tested	System Dipole		T.S. Liquid		Measured Results			Target (Ref. Value)	Delta ±10 %	Est./Zoom Ratio	Plot No.
	Type	Serial #			Area Scan	Zoom Scan	Normalize to 1 W				
7/28/2014	D2450V2	899	Body	1g	5.02	5.06	50.6	49.70	1.81	-0.80	
				10g	2.140	2.340	23.4	23.30	0.43		
7/31/2014	D2450V2	899	Body	1g	5.33	5.40	54.0	49.70	8.65	-1.31	
				10g	2.260	2.510	25.1	23.30	7.73		

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11. 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.

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11.1. Wi-Fi (DTS Band)

Frequency Band	RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	
2.4GHz	Body	802.11b 1 Mbps	17	Rear	11	2462	15.8	15.8	0.158	0.158	
				Front	11	2462	15.8	15.8	0.158	0.158	
				Edge 1	11	2462	15.8	15.8	0.026	0.026	
				Edge 2	11	2462	15.8	15.8	0.015	0.015	
				Edge 3	11	2462	15.8	15.8	0.053	0.053	
				Edge 4	11	2462	15.8	15.8	0.060	0.060	
2.4GHz	Body	802.11g 6 Mbps	17	Rear	6	2437	17.1	17.1	0.097	0.097	
				Front	6	2437	17.1	17.1	0.158	0.158	
				Edge 1	6	2437	17.1	17.1	0.035	0.035	
				Edge 2	6	2437	17.1	17.1	0.020	0.020	
				Edge 3	6	2437	17.1	17.1	0.079	0.079	
				Edge 4	6	2437	17.1	17.1	0.099	0.099	
2.4GHz	Body	802.11n 6 Mbps HT20	17	Rear	6	2437	17.1	17.1	0.164	0.165	
				Front	6	2437	17.1	17.1	**0.369**	**0.369**	
				Edge 1	6	2437	17.1	17.1	0.017	0.017	
				Edge 2	6	2437	17.1	17.1	0.019	0.019	
				Edge 3	6	2437	17.1	17.1	0.079	0.079	
				Edge 4	6	2437	17.1	17.1	0.098	0.098	
2.4GHz	Body	802.11n MCS0 HT40	17	Rear	6	2437	14.2	14.2	0.164	0.164	
				Front	6	2437	14.2	14.2	0.056	0.056	
				Edge 1	6	2437	14.2	14.2	0.018	0.018	
				Edge 2	6	2437	14.2	14.2	0.011	0.011	
				Edge 3	6	2437	14.2	14.2	0.039	0.039	
				Edge 4	6	2437	14.2	14.2	0.050	0.050	

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12. SAR Measurement Variability

In accordance with published RF Exposure KDB procedure 865664 D01 SAR measurement 100 MHz to 6 GHz v01. 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 < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 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 ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

12.1. The Highest Measured SAR Configuration in Each Frequency Band

Frequency Band (MHz)	Air Interface	Head (W/kg)	Body-worn (W/kg)	Repeated SAR (Yes/No)
2400	Wi-Fi 802.11b/g/n	N/A	0.369	No

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13. Appendixes

Refer to separated files for the following appendixes.

13.1. Photos and Antenna Locations

13.2. System Performance Check Plots

13.3. Highest SAR Test Plots

13.4. Calibration Certificate for E-Field Probe EX3DV4 - SN 3749

13.5. Calibration Certificate for D2450V2 - SN 899

END OF REPORT

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