FCC 47 CFR Parts 1 & 2
Published RF Exposure KDB Procedures
IEEE Std 1528-2003 and IEEE Std 1528a-2005

SAR EVALUATION REPORT

For

PORTABLE COMPUTING DEVICE

Model: 1572
FCC ID: C3K1572

Report Number: 13U15414-10B
Issue Date: 9/25/2013

Prepared for
MICROSOFT CORPORATION
ONE MICROSOFT WAY
REDMOND, WA 98052, U.S.A.

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

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Revision History

Rev.	Issue Date	Revisions	Revised By
--	9/16/2013	Initial Issue	--
A	9/20/2013	Updated MIMO results	Dave Weaver
B	9/25/2013	Section 12.1 – amended edge1 separation distances to 0mm Section 12 – updated plot numbers Section 12.4 – included accessory keyboard results Section 13 – expanded simultaneous transmission analysis data Appendix 14.2 – included MIMO plots for each band	Dave Weaver

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UL Verification Services
47173 BENICIA STREET, FREMONT, CA 94538, USA
TEL: (510) 771-1000
FAX: (510) 661-0888

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1. Attestation of Test Results

Applicant	Microsoft Corporation
DUT description	Portable computing device
Model	1572
Test device is	An identical prototype
Device category	Portable
Exposure category	General Population/Uncontrolled Exposure
Date tested	8/22/2013 – 9/20/2013

Applicable Standards	Test Results
FCC 47 CFR Parts 1 & 2 Published RF Exposure KDB Procedures, and TCB workshop updates IEEE Std 1528-2003 and IEEE Std 1528a-2005	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 For UL VERIFICATION SERVICES, INC. By:

Dave Weaver
Program Manager
UL VERIFICATION SERVICES, INC.

Tested By:

Nathan Sousa
SAR Engineer
UL VERIFICATION SERVICES, INC.

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1.1. Summary of Highest 1-g SAR Results

Worst Case SAR data for each Frequency Band

RF Exposure Rule	Freq. Range	Highest Reported SAR	Limit
15.247 (Wi-Fi)	2412-2462 MHz	Body: 1.318 W/kg	1.6 W/kg
15.407 (UNII)	5150-5250 MHz	Body: 1.572 W/kg	
	5250-5350 MHz	Body: 1.481 W/kg	
	5500-5700 MHz	Body: 1.480 W/kg	
15.247 (DTS)	5725-5850 MHz	Body: 1.457 W/kg	
Simultaneous Transmission Condition		Body: 1.572 W/kg (Refer to Section 13.) (The highest across exposure conditions)	

LEGEND:

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

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2. Test Methodology

The tests documented in this report were performed in accordance with FCC 47 CFR Parts 1 & 2, IEEE STD 1528-2003, IEEE Std 1528a-2005, the following FCC Published RF exposure KDB procedures, and TCB workshop updates:

- KDB 447498 D01 General RF Exposure Guidance v05r01
- KDB 616217 D04 SAR for laptop and tablets v01r01
- KDB 248227 D01 SAR meas for 802 11abg v01r02
- KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r01
- KDB 865664 D02 SAR Reporting v01r01
- April 2013 TCB Workshop Updates

3. Facilities and Accreditation

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

UL VERIFICATION SERVICES, INC. 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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4. Calibration and Uncertainty

4.1. Measuring Instrument Calibration

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

Tissue Dielectric Properties

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
S-Parameter Network Analyzer	Agilent	8753ES	MY40000980	2/20/2014
Dielectronic Probe kit	SPEAG	SM DAK 040 CA	1082	9/18/2013
ENA Series Network Analyzer	Agilent	E5071B	MY42100131	2/21/2014
Dielectronic Probe kit	HP	85070E	594	N/A
Thermometer	TRACEABLE	4242	122529162	9/19/2013

System Performance Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	HP	8665B	3546A00784	3/26/2014
Power Meter	HP	438A	3513U04320	9/24/2013
Power Sensor	HP	8481A	2237A31744	9/24/2013
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795093	N/A
Directional coupler	Werlatone	C8060-102	2711	N/A
DC Power Supply	Sorensen	XT20-3	1318A00529	N/A
Synthesized Signal Generator	HP	8665B	3744A01084	5/7/2014
Power Meter	HP	437B	3125U12345	7/29/2014
Power Meter	HP	437B	3125U09248	9/24/2013
Power Sensor	HP	8481A	1926A27048	7/29/2014
Power Sensor	HP	8481A	3318A95392	9/24/2013
Amplifier	MITEQ	4D00400600-50-30P	1620606	N/A
Directional coupler	Werlatone	C8060-102	2141	N/A
DC Power Supply	Sorensen	XT 20-3	1318A00530	N/A
System Validation Dipole	SPEAG	D5GHzV2	1138	10/9/2013
System Validation Dipole	SPEAG	D5GHzV2	1003	9/18/2013
System Validation Dipole	SPEAG	D2450V2	899	10/5/2013
System Validation Dipole	SPEAG	D2450V2	748	2/11/2014

DASY System

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due date
E-Field Probe (SAR B)	SPEAG	EX3DV4	3751	11/15/2013
Data Acquisition Electronics (SAR B)	SPEAG	DAE4	427	1/9/2014
E-Field Probe (SAR 4)	SPEAG	EX3DV4	3936	7/22/2014
Data Acquisition Electronics (SAR 4)	SPEAG	DAE4	1380	7/17/2014
E-Field Probe (SAR A)	SPEAG	EX3DV4	3749	1/15/2014
Data Acquisition Electronics (SAR 2)	SPEAG	DAE4	1239	4/9/2014

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4.2. Measurement Uncertainty

Per KDB 865664, when no measured SAR values exceed 1.5 W/kg, measurement uncertainty analysis does not need to be provided in the test report.

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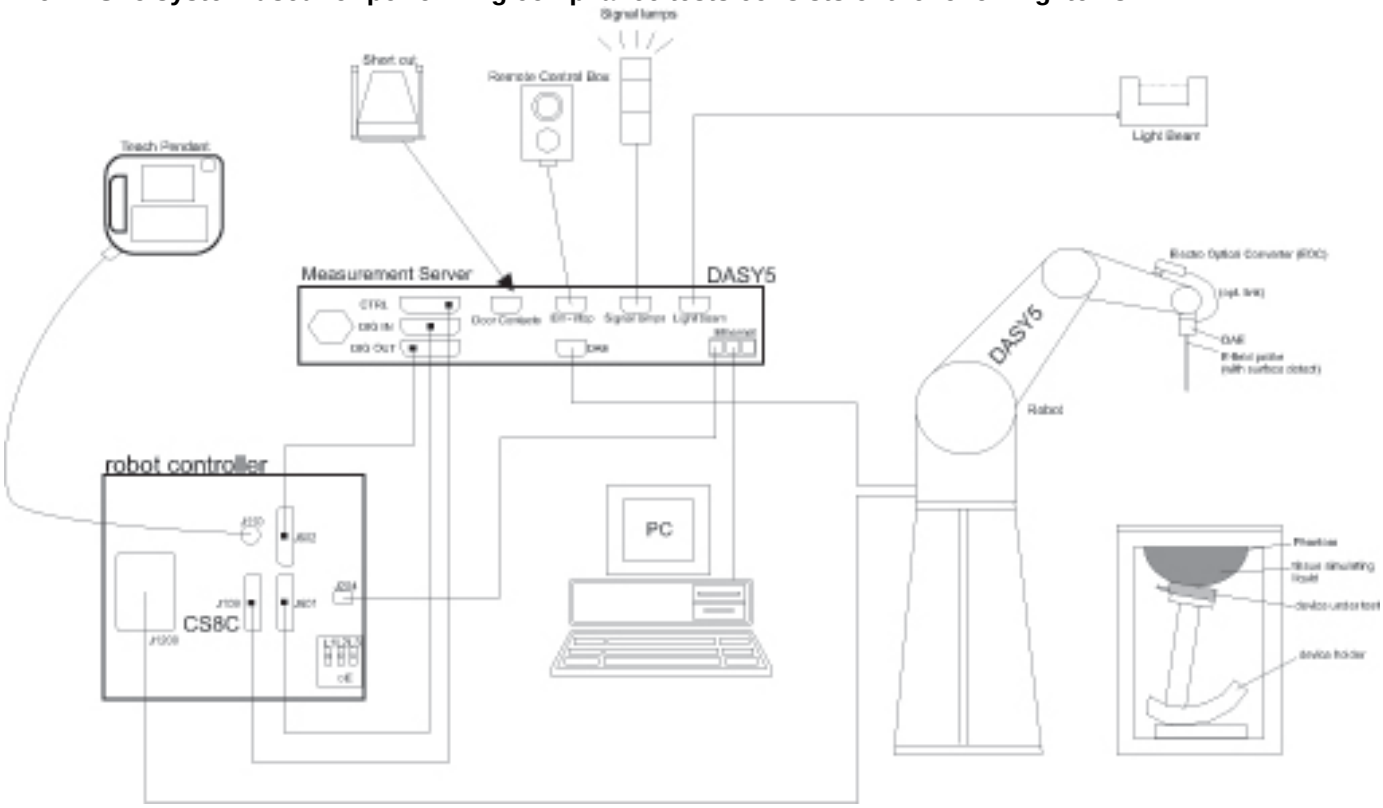
5. Measurement System Description and Setup

The DASY5 system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- 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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6. SAR Measurement Procedure

6.1. Normal SAR Measurement Procedure

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

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

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

	≤ 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.	

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Step 3: Zoom Scan

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

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

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
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.

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6.2. Volume Scan Procedures

Step 1: Repeat Step 1-4 in Section 6.1

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

Step 3: Power drift measurement
The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

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7. Device under test

7.1. General Information

Device Under Test: Portable computing device Model: 1572	
Operating Configuration(s)	• Tablet Mode
Exposure Condition(s)	• The device is used in close proximity to the body. Specific details of the required test positions are provided in Section 8 “Exposure Conditions”
Accessory	• Detachable Keyboard, models 1561 and 1515

7.2. Band and Air Interfaces

Wireless Mode and Frequency Bands	WiFi 802.11a/b/g/n Bluetooth 2.4 GHz
Modulation	WiFi 802.11a/b/g/n HT20/HT40 Bluetooth Ver. 4.0
Duty Cycle	WiFi 802.11a/b/g/n: 100%
Simultaneous Transmission Condition	WiFi 5 GHz Bands can transmit simultaneously with BT WiFi 2.4 GHz Band can transmit simultaneously with BT All Wi-Fi bands support MIMO Wi-Fi MIMO is not supported when BT is transmitting.

Notes:

1. Bluetooth transmits using the WLAN Antenna B
2. Bluetooth can transmit simultaneously with WLAN Antenna A, in any of the WLAN bands.
3. Bluetooth cannot transmit simultaneously with the WLAN Antenna B, in any of the WLAN bands; this also precludes the transmission of Bluetooth when WLAN is in MIMO mode.
4. With a maximum output power of **4 mW** (6 dBm), Bluetooth qualifies for Standalone SAR test exclusion based on the formula for Standalone SAR test exclusion considerations outlined in KDB 447498 D01 . For the exact value that this formula yields, please refer to **Section 12** of this report.

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8. Exposure Conditions

Refer to Section 16 “Antenna Locations and Separation Distances” for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

8.1. Test Configurations for Antenna A, SISO and MIMO Modes

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	4.2 mm	Yes	
Front	3.9 mm	No	Not a normal mode of operation
Edge 1	3.8 mm	Yes	
Edge 2	95.9 mm	No	Meets test exclusion criteria. See section 12
Edge 3	160.2 mm	No	Meets test exclusion criteria. See section 12
Edge 4	174.4 mm	No	Meets test exclusion criteria. See section 12

8.2. Test Configurations for Antenna B, SISO and MIMO Modes

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	4.2 mm	Yes	
Front	3.9 mm	No	Not a normal mode of operation
Edge 1	3.9 mm	Yes	
Edge 2	173.7 mm	No	Meets test exclusion criteria. See section 12
Edge 3	160.1 mm	No	Meets test exclusion criteria. See section 12
Edge 4	87.6 mm	No	Meets test exclusion criteria. See section 12

LEGEND:

- Rear = Back
- Front = Display
- Edge 1 = Top Edge
- Edge 2 = Right Edge
- Edge 3 = Bottom Edge
- Edge 4 = Left Edge

8.3. Additional Test Scenarios

The DUT features a beveled edge (see section 16 for details). Additional testing of Edge 1 was performed with the DUT angled so that this edge was placed flush to the surface of the flat phantom.

The DUT also supports attachable keyboards (two types) that may be folded against the rear (see section 15 for photos). Additional testing on the rear was performed with the keyboards folded back in the worst case configurations only.

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8.4. Summary of Required Test Modes

8.4.1. Wi-Fi 2.4 GHz Band (DTS)

Mode	Number of Transmitters	Ch. #	Freq. (MHz)	Maximum Target Power (dBm)		SAR Test (Yes/No)	Surfaces/ Edges requiring SAR evaluation
				Antenna A	Antenna B		
802.11b	1 Tx	1	2412	13.0		Yes	Rear, Edge 1, Edge 1 tilt
		6	2437	13.0			
		11	2462	13.0			
		1	2412		13.0	Yes	Rear, Edge 1, Edge 1 tilt
		6	2437		13.0		
		11	2462		13.0		
802.11g	1 Tx	1	2412	13.0		No	
		6	2437	13.0			
		11	2462	13.0			
		1	2412		13.0	No	
		6	2437		13.0		
		11	2462		13.0		
802.11g	2 Tx	1	2412	13.0	13.0	No	
		6	2437	13.0	13.0		
		11	2462	13.0	13.0		
802.11n HT20	1 Tx	1	2412	13.0		No	
		6	2437	13.0			
		11	2462	13.0			
		1	2412		13.0	No	
		6	2437		13.0		
		11	2462		13.0		
802.11n HT20	2 Tx	1	2412	13.0	13.0	Yes	Rear, Edge 1, Edge 1 tilt
		6	2437	13.0	13.0		
		11	2462	13.0	13.0		
802.11n HT40	1 Tx	3	2422	13.0		No	
		6	2437	13.0			
		9	2450	13.0			
		3	2422		13.0	No	
		6	2437		13.0		
		9	2450		13.0		
802.11n HT40	2 Tx	3	2422	13.0	13.0	No	
		6	2437	13.0	13.0		
		9	2450	13.0	13.0		

Note(s):

- Per KDB 248227, SAR is not required for 802.HT20/HT40 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a/b channels.

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8.4.2. Wi-Fi 5.2 GHz Band (UNII)

Mode	Number of Transmitters	Ch. #	Freq. (MHz)	Maximum Target Power for Host Approval (dBm)		SAR Test (Yes/No)	Surfaces/ Edges requiring SAR evaluation
				Antenna A	Antenna B		
802.11a	1 Tx	36	5180	11.0		Yes	Rear, Edge 1, Edge 1 tilt
		40	5200	11.0			
		44	5220	11.0			
		48	5240	11.0			
		36	5180		11.0	Yes	Rear, Edge 1, Edge 1 tilt
		40	5200		11.0		
		44	5220		11.0		
		48	5240		11.0		
802.11n HT20	1 Tx	36	5180	11.0		No	
		40	5200	11.0			
		44	5220	11.0			
		48	5240	11.0			
		36	5180		11.0	No	
		40	5200		11.0		
		44	5220		11.0		
		48	5240		11.0		
802.11n HT20	2 Tx	36	5180	9.0	9.0	Yes	Rear, Edge 1, Edge 1 tilt
		40	5200	9.0	9.0		
		48	5240	9.0	9.0		
802.11n HT40	1 Tx	38	5190	11.0		No	
		46	5230	11.0			
		38	5190		11.0		
		46	5230		11.0		
802.11n HT40	2 Tx	38	5190	9.0	9.0	No	
		46	5230	9.0	9.0		

Note(s):

- Per KDB 248227, SAR is not required for 802.HT20/HT40 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a/b channels.

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8.4.3. Wi-Fi 5.3 GHz Band (UNII)

Mode	Number of Transmitters	Ch. #	Freq. (MHz)	Maximum Target Power for Host Approval (dBm)		SAR Test (Yes/No)	Surfaces/ Edges requiring SAR evaluation
				Antenna A	Antenna B		
802.11a	1 Tx	52	5260	10.0		Yes	Rear, Edge 1, Edge 1 tilt
		56	5280	10.0			
		60	5300	10.0			
		64	5320	10.0			
		52	5260		11.0	Yes	Rear, Edge 1, Edge 1 tilt
		56	5280		11.0		
		60	5300		11.0		
		64	5320		11.0		
802.11n HT20	1 Tx	52	5260	10.0		No	
		60	5300	10.0			
		64	5320	10.0			
		52	5260		11.0	No	
		60	5300		11.0		
		64	5320		11.0		
802.11n HT20	2 Tx	52	5260	9.0	9.0	Yes	Rear, Edge 1, Edge 1 tilt
		60	5300	9.0	9.0		
		64	5320	9.0	9.0		
802.11n HT40	1 Tx	54	5270	10.0		No	
		62	5310	10.0			
		54	5270		11.0		
		62	5310		11.0	No	
802.11n HT40	2 Tx	54	5270	9.0	9.0		
		62	5310	9.0	9.0		

Note(s):

- Per KDB 248227, SAR is not required for 802.HT20/HT40 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a/b channels.

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8.4.4. Wi-Fi 5.5 GHz Band (UNII)

Mode	Number of Transmitters	Ch. #	Freq. (MHz)	Maximum Target Power (dBm) Antenna A	Antenna B	SAR Test (Yes/No)	Surfaces/Edges requiring SAR evaluation
802.11a	1 Tx	100	5500	10.0		Yes	Rear, Edge 1, Edge 1 tilt
		104	5520	10.0			
		108	5540	10.0			
		112	5560	10.0			
		116	5580	10.0			
		120	5600	10.0			
		124	5620	10.0			
		128	5640	10.0			
		132	5660	10.0			
		136	5680	10.0			
		140	5700	10.0			
		100	5500		11.0	Yes	Rear, Edge 1, Edge 1 tilt
		104	5520		11.0		
		108	5540		11.0		
		112	5560		11.0		
		116	5580		11.0		
		120	5600		11.0		
		124	5620		11.0		
		128	5640		11.0		
		132	5660		11.0		
		136	5680		11.0		
		140	5700		11.0		
802.11n HT20	1 Tx	100	5500	10.0		No	
		116	5580	10.0			
		140	5700	10.0			
		100	5500		11.0	No	
		116	5580		11.0		
		140	5700		11.0		
802.11n HT20	2 Tx	100	5500	9.0	9.0	Yes	Rear, Edge 1, Edge 1 tilt
		120	5600	9.0	9.0		
		140	5700	9.0	9.0		
802.11n HT40	1 Tx	102	5510	10.0		No	
		110	5550	10.0			
		134	5670	10.0			
		102	5510		11.0	No	
		110	5550		11.0		
		134	5670		11.0		
802.11n HT40	2 Tx	102	5510	9.0	9.0	No	
		110	5550	9.0	9.0		
		134	5670	9.0	9.0		

Note(s):

- Per KDB 248227, SAR is not required for 802.HT20/HT40 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a/b channels.

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8.4.5. Wi-Fi 5.8 GHz Band (DTS)

Mode	Number of Transmitters	Ch. #	Freq. (MHz)	Maximum Target Power (dBm)		SAR Test (Yes/No)	Surfaces/ Edges requiring SAR evaluation
				Antenna A	Antenna B		
802.11a	1 Tx	149	5745	11.0		Yes	Rear, Edge 1, Edge 1 tilt
		153	5765	11.0			
		157	5785	11.0			
		161	5805	11.0			
		165	5825	11.0			
		149	5745		11.0	Yes	Rear, Edge 1, Edge 1 tilt
		153	5765		11.0		
		157	5785		11.0		
		161	5805		11.0		
		165	5825		11.0		
802.11n HT20	1 Tx	149	5745	11.0		No	
		157	5785	11.0			
		165	5825	11.0			
		149	5745		11.0	No	
		157	5785		11.0		
		165	5825		11.0		
802.11n HT20	2 Tx	149	5745	9.0	9.0	Yes	Rear, Edge 1, Edge 1 tilt
		157	5785	9.0	9.0		
		165	5825	9.0	9.0		
802.11n HT40	1 Tx	151	5755	11.0		No	
		159	5795	11.0			
		151	5755		11.0	No	
		159	5795		11.0		
802.11n HT40	2 Tx	151	5755	9.0	9.0	No	
		159	5795	9.0	9.0		

Note(s):

- Per KDB 248227, SAR is not required for 802.HT20/HT40 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a/b channels.

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9. RF Output Power Measurement

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#	√	∇

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

√ = "default test channels"

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

∇ = 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.

UL Verification Services
FORM NO: CCSUP4031G
47173 BENICIA STREET, FREMONT, CA 94538, USA
TEL: (510) 771-1000
FAX: (510) 661-0888

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9.1. Output Power

The target power is the absolute maximum.

Mode	Ant	BAND	Ch	Freq	Maximum Target	Measured
802.11b	A	2400MHz	1	2412	13.0	13.0
			2	2417	13.0	12.9
			3	2422	13.0	12.9
			4	2427	13.0	12.8
			5	2432	13.0	12.7
			6	2437	13.0	12.7
			7	2442	13.0	12.7
			8	2447	13.0	12.6
			9	2452	13.0	12.6
			10	2457	13.0	12.9
			11	2462	13.0	12.8
802.11g		2400MHz	1	2412	13.0	12.8
			2	2417	13.0	12.7
			3	2422	13.0	12.8
			4	2427	13.0	12.8
			5	2432	13.0	12.7
			6	2437	13.0	12.7
			7	2442	13.0	12.6
			8	2447	13.0	12.8
			9	2452	13.0	12.8
			10	2457	13.0	12.4
			11	2462	13.0	11.8
802.11a		5200MHz	36	5180	11.0	10.0
			40	5200	11.0	9.6
			44	5220	11.0	10.0
			48	5240	11.0	10.0
		5300MHz	52	5260	10.0	10.0
			56	5280	10.0	9.4
			60	5300	10.0	9.8
			64	5320	10.0	9.7
		5500MHz	100	5500	10.0	9.7
			104	5520	10.0	9.1
			108	5540	10.0	9.2
			112	5560	10.0	9.1
			116	5580	10.0	9.5
			120	5600	10.0	9.8
			124	5620	10.0	9.7
			128	5640	10.0	9.5
			132	5660	10.0	9.3
			136	5680	10.0	9.5
			140	5700	10.0	9.1
		5800MHz	149	5745	11.0	10.4
			153	5765	11.0	10.4
			157	5785	11.0	10.4
			161	5805	11.0	10.4
			165	5825	11.0	10.4

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Output Power (continued)

Mode	Ant	BAND	Ch	Freq	Maximum Target	Measured
802.11b	B	2400MHz	1	2412	13.0	12.7
			2	2417	13.0	12.7
			3	2422	13.0	12.7
			4	2427	13.0	12.6
			5	2432	13.0	12.6
			6	2437	13.0	12.7
			7	2442	13.0	12.6
			8	2447	13.0	12.6
			9	2452	13.0	12.5
			10	2457	13.0	12.6
			11	2462	13.0	12.5
802.11g		2400MHz	1	2412	13.0	12.3
			2	2417	13.0	12.3
			3	2422	13.0	12.3
			4	2427	13.0	12.3
			5	2432	13.0	12.3
			6	2437	13.0	12.3
			7	2442	13.0	12.3
			8	2447	13.0	12.3
			9	2452	13.0	12.3
			10	2457	13.0	12.2
			11	2462	13.0	12.1
802.11a		5200MHz	36	5180	11.0	10.3
			40	5200	11.0	9.8
			44	5220	11.0	10.2
			48	5240	11.0	10.1
		5300MHz	52	5260	11.0	10.5
			56	5280	11.0	10.5
			60	5300	11.0	9.5
			64	5320	11.0	9.3
		5500MHz	100	5500	11.0	11.0
			104	5520	11.0	10.3
			108	5540	11.0	11.0
			112	5560	11.0	10.3
			116	5580	11.0	10.6
			120	5600	11.0	10.3
			124	5620	11.0	10.6
			128	5640	11.0	10.3
			132	5660	11.0	11.0
			136	5680	11.0	10.2
			140	5700	11.0	10.9
		5800MHz	149	5745	11.0	10.3
			153	5765	11.0	10.5
			157	5785	11.0	10.7
			161	5805	11.0	11.0
			165	5825	11.0	10.7

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Output Power (continued)

Mode	Ant	BAND	Ch	Freq	Maximum Target	Measured
802.11n 20MHz 1Tx	A	2400MHz	1	2412	13.0	12.7
			6	2437	13.0	12.6
			11	1462	13.0	11.7
	B		1	2412	13.0	12.2
			6	2437	13.0	12.2
			11	1462	13.0	12.2
802.11n 20MHz 2Tx	A	2400MHz	1	2412	13.0	13.0
			6	2437	13.0	12.9
			11	1462	13.0	12.1
	B		1	2412	13.0	12.4
			6	2437	13.0	12.4
			11	1462	13.0	12.3
802.11n 40MHz 1Tx	A	2400MHz	3	2422	13.0	12.8
			6	2437	13.0	12.5
			9	2450	13.0	12.3
	B		3	2422	13.0	12.4
			6	2437	13.0	12.4
			9	2450	13.0	12.3
802.11n 40MHz 2Tx	A	2400MHz	3	2422	13.0	12.8
			6	2437	13.0	12.7
			9	2450	13.0	12.5
	B		3	2422	13.0	12.4
			6	2437	13.0	12.4
			9	2450	13.0	11.8
802.11n 20MHz 1Tx	A	5200MHz	36	5180	11.0	9.7
			40	5200	11.0	9.7
			48	5240	11.0	9.4
		5300MHz	52	5260	10.0	9.4
			60	5300	10.0	9.2
			64	5320	10.0	9.1
		5500MHz	100	5500	10.0	9.5
			116	5580	10.0	9.6
			140	5700	10.0	9.3
		5800MHz	149	5745	11.0	10.5
			157	5785	11.0	10.3
			165	5825	11.0	10.3
	B	5200MHz	36	5180	11.0	10.4
			40	5200	11.0	9.6
			44	5220	11.0	10.2
			48	5240	11.0	9.7
		5300MHz	52	5260	11.0	10.3
			60	5300	11.0	9.5
			64	5320	11.0	9.4
		5500MHz	100	5500	11.0	10.3
			116	5580	11.0	10.7
			140	5700	11.0	10.3
		5800MHz	149	5745	11.0	10.4
			157	5785	11.0	10.7
			165	5825	11.0	10.5

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Output Power (continued)

Mode	Ant	BAND	Ch	Freq	Maximum Target	Measured
802.11n 20MHz 2Tx	A	5200MHz	36	5180	9.0	8.6
			40	5200	9.0	8.4
			48	5240	9.0	8.1
		5300MHz	52	5260	9.0	8.4
			60	5300	9.0	8.5
			64	5320	9.0	8.2
		5500MHz	100	5500	9.0	8.4
			116	5580	9.0	8.8
			140	5700	9.0	8.3
		5800MHz	149	5745	9.0	8.0
			157	5785	9.0	8.1
			165	5825	9.0	8.1
	B	5200MHz	36	5180	9.0	8.0
			40	5200	9.0	8.1
			48	5240	9.0	8.0
		5300MHz	52	5260	9.0	8.0
			60	5300	9.0	8.0
			64	5320	9.0	8.0
		5500MHz	100	5500	9.0	8.5
			116	5580	9.0	8.7
			140	5700	9.0	8.6
		5800MHz	149	5745	9.0	7.9
			157	5785	9.0	8.3
			165	5825	9.0	8.1
802.11n 40MHz 1Tx	A	5200MHz	38	5180	11.0	9.8
			46	5230	11.0	9.8
		5300MHz	54	5270	10.0	9.7
			62	5310	10.0	9.7
		5500MHz	102	5510	10.0	9.8
			110	5550	10.0	10.0
			134	5670	10.0	10.0
		5800MHz	151	5755	11.0	10.0
			159	5795	11.0	10.9
	B	5200MHz	38	5180	11.0	10.6
			46	5230	11.0	10.6
		5300MHz	54	5270	11.0	10.4
			62	5310	11.0	10.6
		5500MHz	102	5510	11.0	10.6
			110	5550	11.0	10.9
			134	5670	11.0	10.7
		5800MHz	151	5755	11.0	10.8
			159	5795	11.0	10.0

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Output Power (continued)

Mode	Ant	BAND	Ch	Freq	Maximum Target	Measured
802.11n 40MHz 2Tx	A	5200MHz	38	5180	9.0	8.8
			46	5230	9.0	8.6
		5300MHz	54	5270	9.0	7.7
			62	5310	9.0	7.9
		5500MHz	102	5510	9.0	7.7
			110	5550	9.0	8.1
			134	5670	9.0	8.3
		5800MHz	151	5755	9.0	7.4
			159	5795	9.0	7.9
	B	5200MHz	38	5180	9.0	8.2
			46	5230	9.0	8.1
		5300MHz	54	5270	9.0	7.7
			62	5310	9.0	7.7
		5500MHz	102	5510	9.0	7.7
			110	5550	9.0	7.9
			134	5670	9.0	7.9
		5800MHz	151	5755	9.0	7.5
			159	5795	9.0	7.8

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10. Tissue Dielectric Properties

IEEE Std 1528-2003 Table 2

Target Frequency (MHz)	Head	
	ε_r	σ (S/m)
300	45.3	0.87
450	43.5	0.87
835	41.5	0.90
900	41.5	0.97
1450	40.5	1.20
1800 – 2000	40.0	1.40
2450	39.2	1.80
2600	39.0	1.96
3000	38.5	2.40

FCC OET Bulletin 65 Supplement C 01-01

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

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

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

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

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

Simulating Liquids for 5 GHz, Manufactured by SPEAG

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

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10.2. Tissue Dielectric Parameter Check Results

The temperature of the tissue-equivalent medium used during measurement must 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.

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
8/19/2013	Body 2450	e'	50.7100	Relative Permittivity (ε_r):	50.71	52.70	-3.78	5
		e''	14.4700	Conductivity (σ):	1.97	1.95	1.09	5
	Body 2410	e'	50.8900	Relative Permittivity (ε_r):	50.89	52.76	-3.54	5
		e''	14.3300	Conductivity (σ):	1.92	1.91	0.67	5
	Body 2475	e'	50.6000	Relative Permittivity (ε_r):	50.60	52.67	-3.93	5
		e''	14.5800	Conductivity (σ):	2.01	1.99	1.07	5
8/22/2013	Body 2450	e'	50.6700	Relative Permittivity (ε_r):	50.67	52.70	-3.85	5
		e''	14.0900	Conductivity (σ):	1.92	1.95	-1.57	5
	Body 2410	e'	50.8000	Relative Permittivity (ε_r):	50.80	52.76	-3.71	5
		e''	13.9400	Conductivity (σ):	1.87	1.91	-2.07	5
	Body 2475	e'	50.5000	Relative Permittivity (ε_r):	50.50	52.67	-4.12	5
		e''	14.2600	Conductivity (σ):	1.96	1.99	-1.14	5
8/23/2013	Body 5180	e'	47.9700	Relative Permittivity (ε_r):	47.97	49.05	-2.20	5
		e''	18.1500	Conductivity (σ):	5.23	5.27	-0.83	5
	Body 5200	e'	47.9200	Relative Permittivity (ε_r):	47.92	49.02	-2.24	5
		e''	18.1700	Conductivity (σ):	5.25	5.29	-0.78	5
	Body 5600	e'	47.3200	Relative Permittivity (ε_r):	47.32	48.48	-2.39	5
		e''	18.5900	Conductivity (σ):	5.79	5.76	0.48	5
	Body 5800	e'	46.9500	Relative Permittivity (ε_r):	46.95	48.20	-2.59	5
		e''	18.8100	Conductivity (σ):	6.07	6.00	1.10	5
	Body 5825	e'	46.9400	Relative Permittivity (ε_r):	46.94	48.20	-2.61	5
		e''	18.8300	Conductivity (σ):	6.10	6.00	1.65	5
8/27/2013	Body 5180	e'	47.0100	Relative Permittivity (ε_r):	47.01	49.05	-4.15	5
		e''	18.1600	Conductivity (σ):	5.23	5.27	-0.78	5
	Body 5200	e'	46.9900	Relative Permittivity (ε_r):	46.99	49.02	-4.14	5
		e''	18.1700	Conductivity (σ):	5.25	5.29	-0.78	5
	Body 5600	e'	46.3100	Relative Permittivity (ε_r):	46.31	48.48	-4.47	5
		e''	18.5300	Conductivity (σ):	5.77	5.76	0.15	5
	Body 5800	e'	46.0100	Relative Permittivity (ε_r):	46.01	48.20	-4.54	5
		e''	18.7100	Conductivity (σ):	6.03	6.00	0.57	5
	Body 5825	e'	45.9800	Relative Permittivity (ε_r):	45.98	48.20	-4.61	5
		e''	18.7500	Conductivity (σ):	6.07	6.00	1.22	5

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	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
9/3/2013	Body 5180	e'	47.2600	Relative Permittivity (ε_r):	47.26	49.05	-3.64	5
		e''	18.1000	Conductivity (σ):	5.21	5.27	-1.10	5
	Body 5200	e'	47.2300	Relative Permittivity (ε_r):	47.23	49.02	-3.65	5
		e''	18.1000	Conductivity (σ):	5.23	5.29	-1.16	5
	Body 5600	e'	46.5600	Relative Permittivity (ε_r):	46.56	48.48	-3.96	5
		e''	18.4200	Conductivity (σ):	5.74	5.76	-0.44	5
	Body 5800	e'	46.2600	Relative Permittivity (ε_r):	46.26	48.20	-4.02	5
		e''	18.6300	Conductivity (σ):	6.01	6.00	0.14	5
	Body 5825	e'	46.2300	Relative Permittivity (ε_r):	46.23	48.20	-4.09	5
		e''	18.6700	Conductivity (σ):	6.05	6.00	0.78	5
9/6/2013	Body 5180	e'	47.3100	Relative Permittivity (ε_r):	47.31	49.05	-3.54	5
		e''	18.0300	Conductivity (σ):	5.19	5.27	-1.49	5
	Body 5200	e'	47.2800	Relative Permittivity (ε_r):	47.28	49.02	-3.55	5
		e''	18.0200	Conductivity (σ):	5.21	5.29	-1.60	5
	Body 5600	e'	46.7100	Relative Permittivity (ε_r):	46.71	48.48	-3.65	5
		e''	18.3500	Conductivity (σ):	5.71	5.76	-0.82	5
	Body 5800	e'	46.4100	Relative Permittivity (ε_r):	46.41	48.20	-3.71	5
		e''	18.5600	Conductivity (σ):	5.99	6.00	-0.24	5
	Body 5825	e'	46.3800	Relative Permittivity (ε_r):	46.38	48.20	-3.78	5
		e''	18.5900	Conductivity (σ):	6.02	6.00	0.35	5
9/10/2013	Body 5180	e'	49.2600	Relative Permittivity (ε_r):	49.26	49.05	0.43	5
		e''	17.9600	Conductivity (σ):	5.17	5.27	-1.87	5
	Body 5200	e'	49.0300	Relative Permittivity (ε_r):	49.03	49.02	0.02	5
		e''	17.8700	Conductivity (σ):	5.17	5.29	-2.41	5
	Body 5600	e'	48.2200	Relative Permittivity (ε_r):	48.22	48.48	-0.53	5
		e''	18.2100	Conductivity (σ):	5.67	5.76	-1.58	5
	Body 5800	e'	48.1100	Relative Permittivity (ε_r):	48.11	48.20	-0.19	5
		e''	18.3200	Conductivity (σ):	5.91	6.00	-1.53	5
	Body 5825	e'	48.1076	Relative Permittivity (ε_r):	48.11	48.20	-0.19	5
		e''	18.3246	Conductivity (σ):	5.94	6.00	-1.08	5
9/10/2013	Body 2450	e'	50.9100	Relative Permittivity (ε_r):	50.91	52.70	-3.40	5
		e''	14.5700	Conductivity (σ):	1.98	1.95	1.79	5
	Body 2410	e'	51.1200	Relative Permittivity (ε_r):	51.12	52.76	-3.11	5
		e''	14.3800	Conductivity (σ):	1.93	1.91	1.02	5
	Body 2475	e'	50.8000	Relative Permittivity (ε_r):	50.80	52.67	-3.55	5
		e''	14.6500	Conductivity (σ):	2.02	1.99	1.56	5
9/16/2013	Body 2450	e'	51.5700	Relative Permittivity (ε_r):	51.57	52.70	-2.14	5
		e''	14.1900	Conductivity (σ):	1.93	1.95	-0.87	5
	Body 2410	e'	51.7300	Relative Permittivity (ε_r):	51.73	52.76	-1.95	5
		e''	14.0200	Conductivity (σ):	1.88	1.91	-1.51	5
	Body 2475	e'	51.4900	Relative Permittivity (ε_r):	51.49	52.67	-2.24	5
		e''	14.2900	Conductivity (σ):	1.97	1.99	-0.94	5
9/16/2013	Body 5180	e'	47.1400	Relative Permittivity (ε_r):	47.14	49.05	-3.89	5
		e''	18.6900	Conductivity (σ):	5.38	5.27	2.12	5
	Body 5200	e'	47.0700	Relative Permittivity (ε_r):	47.07	49.02	-3.98	5
		e''	18.7200	Conductivity (σ):	5.41	5.29	2.23	5
	Body 5600	e'	46.4500	Relative Permittivity (ε_r):	46.45	48.48	-4.18	5
		e''	19.0000	Conductivity (σ):	5.92	5.76	2.69	5
	Body 5800	e'	46.2300	Relative Permittivity (ε_r):	46.23	48.20	-4.09	5
		e''	19.3400	Conductivity (σ):	6.24	6.00	3.95	5
	Body 5825	e'	46.1500	Relative Permittivity (ε_r):	46.15	48.20	-4.25	5
		e''	19.3900	Conductivity (σ):	6.28	6.00	4.67	5

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11. System Performance 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.

11.1. System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm ± 0.5 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm ± 0.5 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.

11.2. Reference SAR Values for System Performance Check

The reference SAR values can be obtained from the calibration certificate of system validation dipoles

System Dipole	Serial No.	Cal. Date	Freq. (MHz)	Target SAR Values (mW/g)		
				1g/10g	Head	Body
D2450V2	899	10/05/2012	2450	1g	53.6	51.7
				10g	25.0	24.3
D2450V2	748	2/11/2013	2450	1g	52.9	49.9
				10g	24.6	23.2
D5GHzV2	1138	10/09/2012	5.2GHz	1g	79.5	73.2
				10g	22.8	20.4
D5GHzV2	1138	10/09/2012	5.5GHz	1g	83.6	77.9
				10g	23.8	21.7
D5GHzV2	1138	10/09/2012	5.8GHz	1g	78.7	72.8
				10g	22.4	20.1
D5GHzV2	1003	9/18/2012	5.2GHz	1g	76.5	74.8
				10g	21.9	20.9
D5GHzV2	1003	9/18/2012	5.6GHz	1g	82.8	79.0
				10g	23.6	22.0
D5GHzV2	1003	9/18/2012	5.8GHz	1g	76.9	77.0
				10g	22.0	21.4

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11.3. System Performance 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.

Date Tested	System Dipole		T.S. Liquid		Measured Results			Target (Ref. Value)	Delta ±10 %	Est./Zoom Ratio ±3 %	Plot No.
	Type	Serial #			Area Scan	Zoom Scan	Normalize to 1 W				
8/20/2013	D2450v2	899	Body	1g	5.11	5.22	52.20	51.7	0.97	-2.15	
				10g	2.19	2.41	24.10	24.3	-0.82		
8/22/2013	D2450v2	899	Body	1g	5.16	5.25	52.50	51.7	1.55	-1.74	
				10g	2.22	2.44	24.40	24.3	0.41		
8/23/2013	5.2GHz	1003	Body	1g	7.56	7.98	79.80	76.5	4.31	-5.56	
				10g	2.12	2.29	22.90	21.9	4.57		
	5.6GHz	1003	Body	1g	8.09	8.53	85.30	82.8	3.02	-5.44	
				10g	2.20	2.40	24.00	23.6	1.69		
	5.8GHz	1003	Body	1g	6.87	7.37	73.70	76.9	-4.16	-7.28	
				10g	1.90	2.10	21.00	22.0	-4.55		
8/27/2013	5.2GHz	1003	Body	1g	7.76	8.11	81.10	76.5	6.01	-4.51	
				10g	2.14	2.29	22.90	21.9	4.57		
	5.6GHz	1003	Body	1g	8.08	8.68	86.80	82.8	4.83	-7.43	
				10g	2.19	2.41	24.10	23.6	2.12		
	5.8GHz	1003	Body	1g	6.91	7.49	74.90	76.9	-2.60	-8.39	
				10g	1.90	2.10	21.00	22.0	-4.55		
9/3/2013	5.2GHz	1138	Body	1g	7.52	7.87	78.70	73.2	7.51	-4.65	
				10g	2.07	2.23	22.30	20.4	9.31		
	5.5GHz	1138	Body	1g	7.25	7.74	77.40	77.9	-0.64	-6.76	
				10g	1.98	2.17	21.70	21.7	0.00		
	5.6GHz	1138	Body	1g	7.93	8.30	83.00	77.9	6.55	-4.67	
				10g	2.14	2.31	23.10	21.7	6.45		
	5.8GHz	1138	Body	1g	6.75	7.19	71.90	72.8	-1.24	-6.52	
				10g	1.85	2.02	20.20	20.1	0.50		
9/6/2013	5.2GHz	1138	Body	1g	7.22	7.85	78.50	73.2	7.24	-8.73	
				10g	2.03	2.20	22.00	20.4	7.84		
	5.5GHz	1138	Body	1g	7.38	8.02	80.20	77.9	2.95	-8.67	
				10g	2.06	2.25	22.50	21.7	3.69		
	5.6GHz	1138	Body	1g	7.81	8.45	84.50	77.9	8.47	-8.19	
				10g	2.17	2.35	23.50	21.7	8.29		
	5.8GHz	1138	Body	1g	6.51	7.19	71.90	72.8	-1.24	-10.45	
				10g	1.82	2.02	20.20	20.1	0.50		
9/10/2013	D2450v2	748	Body	1g	4.89	4.89	48.90	49.9	-2.00	0.00	
				10g	2.14	2.24	22.40	23.2	-3.45		
9/13/2013	5.2GHz	1138	Body	1g	7.14	7.95	79.50	73.2	8.61	-11.34	
				10g	2.01	2.23	22.30	20.4	9.31		
	5.5GHz	1138	Body	1g	7.59	8.40	84.00	77.9	7.83	-10.67	
				10g	2.13	2.34	23.40	21.7	7.83		
	5.6GHz	1138	Body	1g	8.03	8.51	85.10	77.9	9.24	-5.98	
				10g	2.17	2.34	23.40	21.7	7.83		
	5.8GHz	1138	Body	1g	6.90	7.51	75.10	72.8	3.16	-8.84	
				10g	1.92	2.10	21.00	20.1	4.48		
9/16/2013	2.4 GHz	899	Body	1g	5.16	5.25	52.50	51.7	1.55	-1.74	
				10g	2.22	2.44	24.40	24.3	0.41		
9/16/2013	5.2GHz	1138	Body	1g	7.40	7.95	79.50	73.2	8.61	-7.43	
				10g	2.09	2.23	22.30	20.4	9.31		
	5.5GHz	1138	Body	1g	7.59	8.40	84.00	77.9	7.83	-10.67	
				10g	2.13	2.34	23.40	21.7	7.83		
	5.6GHz	1138	Body	1g	8.03	8.51	85.10	77.9	9.24	-5.98	
				10g	2.17	2.34	23.40	21.7	7.83		
	5.8GHz	1138	Body	1g	6.90	7.51	75.10	72.8	3.16	-8.84	
				10g	1.92	2.10	21.00	20.1	4.48		

UL Verification Services
FORM NO: CCSUP4031G
47173 BENICIA STREET, FREMONT, CA 94538, USA
TEL: (510) 771-1000
FAX: (510) 661-0888
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12. SAR Test Results

12.1. Standalone SAR Test Exclusion Considerations

Standalone SAR test exclusion was based upon the following criteria:

1. According to KDB 447498 § 4.1.5 if the antenna is at close proximity to user then the outer surface of the DUT should be treated as the radiating surface. The test separation distance is then determined by the smallest distance between the outer surface of the device and the user. For the purposes of this report close proximity has been defined as closer than 50 mm. For antennas <50 mm from the rear or edge the separation distance used for the SAR exclusion calculations is 0mm.
2. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.
3. If the antenna to DUT adjacent edge or bottom separation distance is >50mm the actual antenna to user separation distance is used to determine SAR exclusion and estimated SAR value
4. As the 5GHz SISO (1 Tx) mode powers are higher than the MIMO (2Tx) powers separate testing of the MIMO (2 Tx) SAR was considered unnecessary for Edge 1. The reported stand-alone values for 1Tx mode are used to cover simultaneous conditions.

12.1.1. SAR exclusion calculations for antennas <50mm from the user

Antenna	Tx	Frequency (MHz)	Output power		Separation distances (mm)						Calculated Threshold Value					
			dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi Antenna A																
WLAN Main	WiFi	2412	13.0	20	0	0	95.9	160.2	174.4		6.2	6.0	> 50 mm	> 50 mm	> 50 mm	N/A
WLAN Main	WiFi	5180	10.0	10	0	0	95.9	160.2	174.4		4.6	5.0	> 50 mm	> 50 mm	> 50 mm	N/A
WLAN Main	WiFi	5260	10.0	10	0	0	95.9	160.2	174.4		4.6	5.0	> 50 mm	> 50 mm	> 50 mm	N/A
WLAN Main	WiFi	5500	10.0	10	0	0	95.9	160.2	174.4		4.7	5.0	> 50 mm	> 50 mm	> 50 mm	N/A
WLAN Main	WiFi	5745	11.0	13	0	0	95.9	160.2	174.4		6.2	6.0	> 50 mm	> 50 mm	> 50 mm	N/A
Bluetooth / WiFi - Antenna B																
WLAN Aux	WiFi	2412	13.0	20	0	0	173.7	160.1	87.6		6.2	6.0	> 50 mm	> 50 mm	> 50 mm	N/A
WLAN Aux	WiFi	5180	11.0	13	0	0	173.7	160.1	87.6		5.9	6.0	> 50 mm	> 50 mm	> 50 mm	N/A
WLAN Aux	WiFi	5260	11.0	13	0	0	173.7	160.1	87.6		6.0	6.0	> 50 mm	> 50 mm	> 50 mm	N/A
WLAN Aux	WiFi	5500	11.0	13	0	0	173.7	160.1	87.6		6.1	6.0	> 50 mm	> 50 mm	> 50 mm	N/A
WLAN Aux	WiFi	5745	11.0	13	0	0	173.7	160.1	87.6		6.2	6.0	> 50 mm	> 50 mm	> 50 mm	N/A
WLAN Aux	Bluetooth	2402	8.0	6	0	0	173.7	160.1	87.6		1.9	2.0	> 50 mm	> 50 mm	> 50 mm	N/A

Note(s):

1. According to KDB 447498, if the calculated threshold value is >3 then SAR testing is required.
2. As the target powers for 2TX (MIMO) are no higher than the 1Tx (SISO) target powers SAR exclusion was not separately assessed for 2 Tx (MIMO).

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12.1.2. SAR exclusion calculations for antennas >50mm from the user

Antenna	Tx	Frequency (MHz)	Output power		Separation distances (mm)						Calculated Threshold Value (mW)					
			dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
WiFi - Antenna A																
WLAN Main	WiFi	2412	13.0	20	0	0	95.9	160.2	174.4		< 50 mm	< 50 mm	555.6	1198.6	1340.6	N/A
WLAN Main	WiFi	5180	10.0	10	0	0	95.9	160.2	174.4		< 50 mm	< 50 mm	524.9	1167.9	1309.9	N/A
WLAN Main	WiFi	5260	10.0	10	0	0	95.9	160.2	174.4		< 50 mm	< 50 mm	524.4	1167.4	1309.4	N/A
WLAN Main	WiFi	5500	10.0	10	0	0	95.9	160.2	174.4		< 50 mm	< 50 mm	523.0	1166.0	1308.0	N/A
WLAN Main	WiFi	5745	11.0	13	0	0	95.9	160.2	174.4		< 50 mm	< 50 mm	521.6	1164.6	1306.6	N/A
Bluetooth / WiFi - Antenna B																
WLAN Aux	WiFi	2412	13.0	20	0	0	173.7	160.1	87.6		< 50 mm	< 50 mm	1333.6	1197.6	472.6	N/A
WLAN Aux	WiFi	5180	11.0	13	0	0	173.7	160.1	87.6		< 50 mm	< 50 mm	1302.9	1166.9	441.9	N/A
WLAN Aux	WiFi	5260	11.0	13	0	0	173.7	160.1	87.6		< 50 mm	< 50 mm	1302.4	1166.4	441.4	N/A
WLAN Aux	WiFi	5500	11.0	13	0	0	173.7	160.1	87.6		< 50 mm	< 50 mm	1301.0	1165.0	440.0	N/A
WLAN Aux	WiFi	5745	11.0	13	0	0	173.7	160.1	87.6		< 50 mm	< 50 mm	1299.6	1163.6	438.6	N/A
WLAN Aux	Bluetooth	2402	8.0	6	0	0	173.7	160.1	87.6		< 50 mm	< 50 mm	1333.8	1197.8	472.8	N/A

Note(s):

1. According to KDB 447498, if the calculated Power threshold is greater than the output power then SAR testing is required.
2. As the target powers for 2TX (MIMO) are no higher than the 1Tx (SISO) target powers SAR exclusion was not separately assessed for 2 Tx (MIMO).

Conclusion:

- As the calculated Power Threshold is greater than the DUT output power for Edges 2, 3 and 4 for either antenna testing is not required for these configurations.

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12.2. Estimated SAR for Simultaneous Transmission SAR Analysis (Wi-Fi)

The antenna to user separation distances for all edges excluded from SAR testing is greater than 50 mm. The estimated SAR value for any of these edges is 0.4 W/kg according to KDB 447498.

12.3. Estimated SAR for Simultaneous Transmission SAR Analysis (Bluetooth)

The antenna to user separation distance for edges 2, 3 and 4 is greater than 50 mm. The estimated SAR value for any of these edges is 0.4 W/kg according to KDB 447498.

The calculated values for the rear and edge 1 are:

Antenna	Tx	Frequency (MHz)	Output power		Separation distances (mm)		Estimated SAR Value	
			dBm	mW	Rear	Edge 1	Rear	Edge 1
WLAN Aux	Bluetooth	2402	6.00	4	4.2	3.8	0.165	0.165

Note 1: For distances < 5mm, a distance of 5mm is used to determine SAR exclusion and estimated SAR value.
Note 2: Output power is the maximum rated power (including tune-up or manufacturing tolerances) and includes source-based averaging.
Note 3: Formulas round separation distance to nearest mm and power to nearest mW before calculating estimated SAR or determining if SAR is excluded.

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12.4. Wi-Fi 2.4 GHz Band

SISO

Test Position	Antenna	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.	Note
						Tune-up limit	Meas.	Meas.	Scaled		
Rear	A	802.11b	0	1	2417	13.0	13.0	1.170	1.170		
				6	2437	13.0	12.7	1.230	**1.318**	1	
				11	2457	13.0	12.8	1.110	1.162		
Edge 1	A	802.11b	0	1	2417	13.0	13.0				1
				6	2437	13.0	12.7	0.397	0.425		
				11	2457	13.0	12.8				1
Edge 1 Tilt	A	802.11b	0	1	2417	13.0	13.0				1
				6	2437	13.0	12.7	0.363	0.389		
				11	2457	13.0	12.8				1
Rear	B	802.11b	0	1	2417	13.0	12.7	0.983	1.053		
				6	2437	13.0	12.7	1.020	1.093		
				11	2457	13.0	12.5	1.010	1.133		
Edge 1	B	802.11b	0	1	2417	13.0	12.7				1
				6	2437	13.0	12.7	0.169	0.181		
				11	2457	13.0	12.5				1
Edge 1 Tilt	B	802.11b	0	1	2417	13.0	12.7				1
				6	2437	13.0	12.7	0.194	0.208		
				11	2457	13.0	12.5				1

MIMO

Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)			1-g SAR (W/kg)				Plot No.	Note
					Tune-up limit	Meas. Ant. A	Meas. Ant B.	Meas. Ant. A	Meas. Ant. B	Scaled Ant. A	Scaled Ant. B		
Rear	802.11n	0	1	2417	13.0	13.0	12.4	1.060	0.996	1.062	1.144		
			6	2437	13.0	12.9	12.4	1.090	1.020	1.115	1.171		
			11	2457	13.0	12.1	12.3	0.994	0.900	**1.237**	1.057	2	

With Keyboard attached

Mode	Antenna	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Pow er (dBm)		1-g SAR (W/kg) Keyboard model 1561		1-g SAR (W/kg) Keyboard model 1515		Note
						Tune-up limit	Meas.	Meas.	Scaled.	Meas.	Scaled	
802.11a	A	Rear	0	1	2417	13.0	13.0					1
				6	2437	13.0	12.7	0.407	0.436	0.540	0.579	
				11	2457	13.0	12.5					1
	B	Rear	0	1	2417	13.0	13.0					1
				6	2437	13.0	12.7	0.352	0.377	0.300	0.321	
				11	2457	13.0	12.5					1

Note(s):

1. According to KDB 447498, 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.

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12.5. Wi-Fi 5 GHz Band

SISO

Mode	Antenna	Band	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.	Note(s)
							Tune-up limit	Meas.	Meas.	Scaled		
802.11a	A	5.2	Rear	0	36	5180	11.0	10.0	1.090	1.372		
					48	5240	11.0	10.0	1.020	1.284		
			Edge 1	0	36	5180	11.0	10.0	0.256	0.322		
					48	5240	11.0	10.0				1
			Edge 1 Tilt	0	36	5180	11.0	10.0	0.302	0.380		
					48	5240	11.0	10.0				1
		5.3	Rear	0	52	5260	10.0	10.0	1.200	1.200		
					60	5320	10.0	9.8	0.828	0.867		
			Edge 1	0	52	5260	10.0	10.0	0.336	0.336		
					60	5320	10.0	9.8				1
			Edge 1 Tilt	0	52	5260	10.0	10.0	0.407	0.407		
					60	5320	10.0	9.8				1
		5.5	Rear	0	100	5520	10.0	9.7	1.040	1.114		
					120	5580	10.0	9.8	1.020	1.068		
					124	5620	10.0	9.7	1.260	1.350		
					136	5680	10.0	9.5	1.090	1.223		
			Edge 1	0	100	5520	10.0	9.7				1
					120	5580	10.0	9.8	0.416	0.436		
					124	5620	10.0	9.7				1
					136	5680	10.0	9.5				1
			Edge 1 Tilt	0	100	5520	10.0	9.7				1
					120	5580	10.0	9.8	0.360	0.377		
					124	5620	10.0	9.7				1
					136	5680	10.0	9.5				1
		5.8	Rear	0	149	5745	11.0	10.4	1.180	**1.355**	6	
					157	5785	11.0	10.4	1.070	1.229		
					165	5825	11.0	10.4	0.965	1.108		
			Edge 1	0	149	5745	11.0	10.4				1
					157	5785	11.0	10.4	0.225	0.258		
					165	5825	11.0	10.4				1
			Edge 1 Tilt	0	149	5745	11.0	10.4				1
					157	5785	11.0	10.4	0.324	0.372		
					165	5825	11.0	10.4				1

Note(s):

According to KDB 447498 D01 General RF Exposure Guidance v05, 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.

1. ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
2. ≤ 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
3. ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

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Mode	Antenna	Band	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Pow er (dBm)		1-g SAR (W/kg)		Plot No.	Note(s)
							Tune-up limit	Meas. Ant. B	Meas. Ant. B	Scaled Ant. B		
802.11a	B	5.2	Rear	0	36	5180	11.0	10.3	1.080	1.269		
					44	5220	11.0	10.2	1.210	**1.455**	3	
			Edge 1	0	36	5180	11.0	10.3				1
					44	5220	11.0	10.2	0.324	0.390		
			Edge 1 Tilt	0	36	5180	11.0	10.3				1
					44	5220	11.0	10.2	0.286	0.344		
		5.3	Rear	0	52	5260	11.0	10.5	1.320	**1.481**	4	
					60	5300	11.0	10.1	1.130	1.390		
			Edge 1	0	52	5260	11.0	10.5	0.336	0.377		
					60	5300						1
			Edge 1 Tilt	0	52	5260	11.0	10.5	0.397	0.445		
					60	5300						1
		5.5	Rear	0	100	5500	11.0	11.0	1.420	1.420		
					116	5580	11.0	10.6	1.350	**1.480**	5	
					124	5620	11.0	10.6	1.020	1.118		
					132	5660	11.0	11.0	1.390	1.390		
			Edge 1	0	100	5500	11.0	11.0	0.667	0.667		
					116	5580	11.0	10.6	0.765	0.839		
					124	5620	11.0	10.6	0.566	0.621		
					132	5660	11.0	11.0	0.626	0.626		
			Edge 1 Tilt	0	100	5500	11.0	11.0	0.509	0.509		
					116	5580	11.0	10.6	0.637	0.698		
					124	5620	11.0	10.6	0.640	0.702		
					132	5660	11.0	11.0	0.706	0.706		
		5.8	Rear	0	149	5745	11.0	10.3	1.060	1.245		
					161	5805	11.0	11.0	1.220	1.220		
					165	5825	11.0	10.7	1.260	1.350		
			Edge 1	0	149	5745	11.0	10.3	0.489	0.575		
					161	5805	11.0	11.0	0.666	0.666		
					165	5825	11.0	10.7	0.641	0.687		
			Edge 1 Tilt	0	149	5745	11.0	10.3				1
					161	5805	11.0	11.0	0.592	0.592		
					165	5825	11.0	10.7				1

Note(s):

According to KDB 447498 D01 General RF Exposure Guidance v05, 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.

1. ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
2. ≤ 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
3. ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

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MIMO

Mode	Band	Test Position	Pwr Back-off	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)			1-g SAR (W/kg)				Plot No.	Note(s)
							Tune-up limit	Meas. Ant. A	Meas. Ant. B	Meas. Ant. A	Meas. Ant. B	Scaled Ant. A	Scaled Ant. B		
802.11n	5.2	Rear	N/A	0	36	5180	9.0	8.6	7.9	1.140	1.220	1.250	**1.572**	7	
					48	5240	9.0	8.1	8.1	1.080	1.260	1.329	1.550		
	5.3	Rear	N/A	0	52	5260	9.0	8.4	8.0	1.110	1.110	1.274	1.397		
					64	5320	9.0	8.2	8.0	1.110	1.170	1.335	**1.473**	8	
	5.5	Rear	N/A	0	100	5520	9.0	8.4	8.5	1.180	0.919	**1.364**	1.031	9	
					116	5580	9.0	8.8	8.6	1.270	1.010	1.330	1.107		
					120	5620	9.0	8.7	8.4	1.180	0.980	1.264	1.125		
					140	5680	9.0	8.1	8.3	0.847	0.908	1.044	1.067		
	5.8	Rear	N/A	0	149	5745	9.0	8.0	7.9	1.030	1.100	1.297	1.417		
					165	5805	9.0	8.1	8.3	0.906	1.240	1.122	**1.457**	10	

Note(s):

According to KDB 447498 D01 General RF Exposure Guidance v05, 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.

1. ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
2. ≤ 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
3. ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

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With Keyboard attached (Antenna A)

Mode	Band	Test Position	Keyboard type	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.	Notes
							Tune-up limit	Meas. Ant. A	Meas. Ant. A	Scaled Ant. A		
802.11a	5.2	Rear	Keyboard model 1561	0	36	5180	11.0	10.0	0.302	0.380		
					48	5240	11.0	10.0				
	5.3	Rear		0	52	5260	10.0	10.0	0.188	0.188		
					60	5320	10.0	9.8				
	5.5	Rear		0	100	5520	10.0	9.7				
					120	5580	10.0	9.8				
					124	5640	10.0	9.7	0.365	0.391		
					136	5680	10.0	9.5				
	5.8	Rear		0	149	5745	11.0	10.4	0.489	0.561		
					157	5765	11.0	10.4				
					165	5825	11.0	10.4				
802.11a	5.2	Rear	Keyboard model 1515	0	36	5180	11.0	10.0	0.288	0.363		
					48	5240	11.0	10.0				
	5.3	Rear		0	52	5260	10.0	10.0	0.230	0.230		
					60	5320	10.0	9.8				
	5.5	Rear		0	100	5520	10.0	9.7				
					120	5580	10.0	9.8				
					124	5640	10.0	9.7	0.465	0.498		
					136	5680	10.0	9.5				
	5.8	Rear		0	149	5745	11.0	10.4	0.617	0.708		
					157	5765	11.0	10.4				
					165	5825	11.0	10.4				

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With Keyboard attached (Antenna B)

Mode	Band	Test Position	Keyboard type	Dist. (mm)	Ch #.	Freq. (MHz)	Pow er (dBm)		1-g SAR (W/kg)		Plot No.	Notes
							Tune-up limit	Meas. Ant. B	Meas. Ant. B	Scaled Ant. B		
802.11a	5.2	Rear	Keyboard model 1561	0	36	5180	11.0	11.0				
					48	5240	11.0	10.6	0.385	0.422		
	5.3	Rear		0	52	5260	11.0	10.5	0.416	0.467		
					60	5320	11.0	10.1				
	5.5	Rear		0	100	5520	10.0	9.7	0.426	0.456		
					120	5580	11.0	10.6				
					124	5640	11.0	10.6				
					136	5680	11.0	11.0				
	5.8	Rear		0	149	5745	11.0	10.3				
					157	5765	11.0	11.0				
					165	5825	11.0	10.7	0.683	0.732		
802.11a	5.2	Rear	Keyboard model 1515	0	36	5180	11.0	11.0				
					48	5240	11.0	10.6	0.465	0.510		
	5.3	Rear		0	52	5260	11.0	10.5	0.516	0.579		
					60	5320	11.0	10.1				
	5.5	Rear		0	100	5520	10.0	9.7	0.576	0.617		
					120	5580	11.0	10.6				
					124	5640	11.0	10.6				
					136	5680	11.0	11.0				
	5.8	Rear		0	149	5745	11.0	10.3				
					157	5765	11.0	11.0				
					165	5825	11.0	10.7	0.703	0.753		

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12.8. Summary of Highest SAR Values

Results for the highest measured SAR values in each frequency band and mode

Technology/ Band	Test configuration			Mode	Dist. (mm)	Freq. (MHz)	Power (dBm)	1g SAR (W/kg)
	Transmit Antenna	Exposure	Position					
Wi-Fi 2.4 GHz	B	Body	Rear	802.11b	0	2437	12.7	1.230
Wi-Fi 5.2 GHz	A	Body	Rear	802.11a	0	5180	10.0	1.260
Wi-Fi 5.3 GHz	B	Body	Rear	802.11a	0	5260	10.5	1.320
Wi-Fi 5.5 GHz	B	Body	Rear	802.11a	0	5500	11.0	1.420
Wi-Fi 5.8 GHz	B	Body	Rear	802.11a	0	5825	10.7	1.260

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12.9. SAR Measurement Variability and Uncertainty

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.

Wireless Technologies	Test Configuration		Mode	Antenna	Ch #.	Freq. (MHz)	Meas. SAR (W/kg)		Largest to Smallest SAR Ratio	Plot No.
	Exposure	Position					Original	Repeated		
WiFi 2.4 GHz	Body	Rear	802.11b	B	6	2437	1.230	1.100	1.118	2
WiFi 5.2 GHz	Body	Rear	802.11n	B	36	5180	1.260	1.050	1.200	
WiFi 5.3 GHz	Body	Rear	802.11a	B	52	5260	1.320	1.130	1.168	
WiFi 5.5 GHz	Body	Rear	802.11a	B	100	5500	1.420	1.290	1.101	
WiFi 5.8 GHz	Body	Rear	802.11a	B	165	5825	1.260	1.220	1.033	

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13. Simultaneous Transmission SAR Analysis

13.1. Edges 2, 3 and 4

The antenna to user separation distances for edges 2, 3 and 4, which were excluded from SAR testing, are greater than 50 mm. The estimated SAR value for any of these edges is 0.4 W/kg according to KDB 447498.

The sum of the SAR for any of these excluded edges is therefore 0.8 W/kg.

As the sum of the SAR for any of these excluded edges is less than 1.6 W/kg no further simultaneous transmission analysis is required for these edges.

13.2. Edge 1

As the Wi-Fi SISO output power is equal to or greater than the MIMO output power the SISO SAR values have been used for the simultaneous analysis of edge 1.

Band				∑ 1-g SAR (mW/g)
	WiFi Antenna A	WiFi Antenna B	Bluetooth Antenna B	
2.4 GHz	0.425	0.181		0.606
	0.425		0.165	0.590
5.2 GHz	0.322	0.390		0.712
	0.322		0.165	0.487
5.3 GHz	0.336	0.377		0.713
	0.336		0.165	0.501
5.5 GHz	0.336	0.839		1.175
	0.336		0.165	0.501
5.8 GHz	0.258	0.687		0.945
	0.258		0.165	0.423

13.3. Edge 1 Tilt

As the Wi-Fi SISO output power is equal to or greater than the MIMO output power the SISO SAR values have been used for the simultaneous analysis of edge 1 tilt.

Band				∑ 1-g SAR (mW/g)
	WiFi Antenna A	WiFi Antenna B	Bluetooth Antenna B	
2.4 GHz	0.389	0.208		0.597
	0.389		0.165	0.554
5.2 GHz	0.380	0.344		0.724
	0.380		0.165	0.545
5.3 GHz	0.407	0.445		0.852
	0.407		0.165	0.572
5.5 GHz	0.377	0.706		1.083
	0.377		0.165	0.542
5.8 GHz	0.372	0.592		0.964
	0.372		0.165	0.537

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13.4. Rear

Band			∑ 1-g SAR (mW/g)
	WiFi Antenna A	Bluetooth Antenna B	
2.4 GHz	1.318	0.165	1.483
5.2 GHz	1.372	0.165	1.537
5.3 GHz	1.200	0.165	1.365
5.5 GHz	1.350	0.165	1.515
5.8 GHz	1.355	0.165	1.520

Conclusion:

Simultaneous transmission SAR measurement (Volume Scan) is not required because either the sum of the 1-g SAR is < 1.6 W/kg.

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14. Appendixes

Refer to separated files for the following appendixes.

14.1. System Performance Check Plots

14.2. SAR Test Plots

14.3. Calibration Certificate for E-Field Probe EX3DV4 – SN 3751

14.4. Calibration Certificate for E-Field Probe EX3DV4 – SN 3936

14.5. Calibration Certificate for E-Field Probe EX3DV4 – SN 3749

14.6. Calibration Certificate for D2450V2 – SN 899

14.7. Calibration Certificate for D2450GHzV2 – SN 748

14.8. Calibration Certificate for D5GHzV2 – SN 1138

14.9. Calibration Certificate for D5GHzV2 – SN 1003

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