SAR EVALUATION REPORT

(CLASS II PERMISSIVE CHANGE)

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
Tablet Device

FCC ID: BCGA1489
Model Name: A1622, A1623

Report Number: 14U18979-S1B
Issue Date: 2/12/2015

Prepared for
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Date	Revisions	Revised By
--	1/29/2015	Initial Issue	Ray Su
A	2/5/2015	Report revised based on reviewer's comments: 1. Sec. 7: Removed statement regarding power reduction 2. Sec. 9.1.: Revised note regarding test reduction for output power measurements 3. Sec. 9.2.: Revised note regarding test reduction for output power measurements 4. Appendix A: Added labeling for all edges relative to device	Ray Su
B	2/12/2015	Report revised based on reviewer's comments: 1. Sec. 9.1.: Further revised note regarding test reduction for output power measurements 2. Sec. 9.2.: Further revised note regarding test reduction for output power measurements	Ray Su

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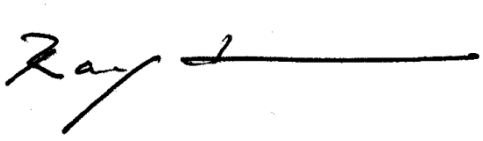
1. Attestation of Test Results

Applicant Name	APPLE, INC.			
FCC ID	BCGA1489			
Model Name	A1622, A1623			
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)			
General population / Uncontrolled exposure	1.6			
The Highest Reported SAR (W/kg)				
RF Exposure Conditions	**Equipment Class**			
	Licensed	**DTS**	**U-NII**	**DSS (BT)**
Standalone	N/A	0.872	1.160	N/A
Simultaneous TX	N/A	N/A	N/A	
Date Tested	1/12/2015 to 1/20/2015			
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:
	
Bobby Bayani Senior Engineer UL Verification Services Inc.	Ray Su 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 1528-2013, the following FCC Published RF exposure KDB procedures:

- 248227 D01 SAR meas for 802.11 v02
- 447498 D01 General RF Exposure Guidance v05r02
- 447498 D03 Supplement C Cross-Reference
- 616217 D04 SAR for laptop and tablets v01r01
- 690783 D01 SAR Listings on Grants v01r03
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03
- 865664 D02 RF Exposure Reporting v01r01

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	

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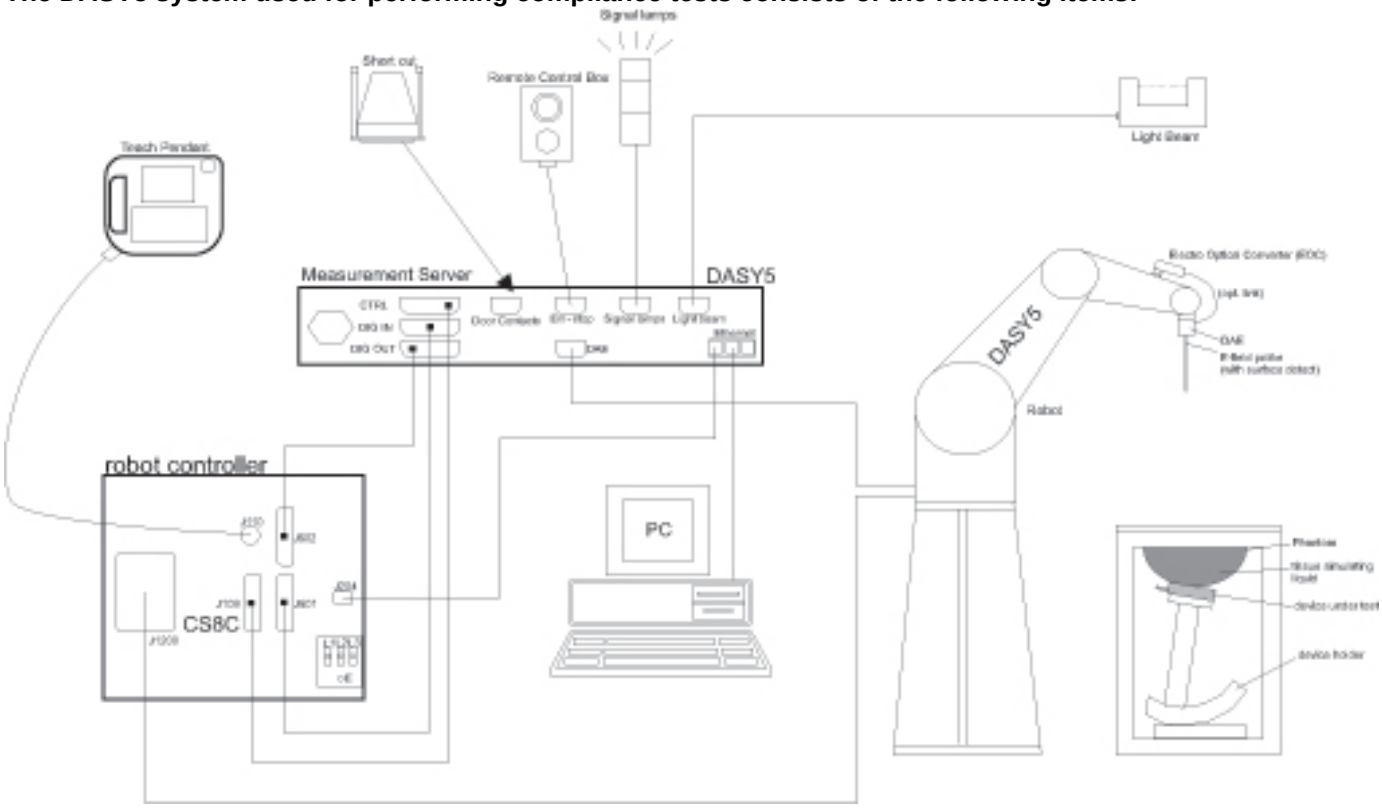
4. SAR Measurement System & Test Equipment

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. 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

<table>
<tr><td></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td>Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td>Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

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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

			≤ 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 (FCC only)

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

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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	8753ES	MY40001647	7/17/2015
Dielectronic Probe kit	SPEAG	DAK-3.5	1103	2/18/2015
Dielectronic Probe kit	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Traceable Calibration Control Co.	4242	122529162	10/8/2015

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	HP	8665B	3744A01084	5/20/2015
Power Meter	Agilent	N1912A	MY53040016	5/5/2015
Power Sensor	Agilent	E9323A	MY53070005	5/1/2015
Power Sensor	Agilent	E9323A	MY53070009	5/28/2015
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795093	N/A
Directional coupler	Werlatone	C8060-102	2149	N/A
DC Power Supply	AMETEK	XT 15-4	1319A02778	N/A
E-Field Probe (SAR Lab A)	SPEAG	EX3DV4	3772	2/26/2015
Data Acquisition Electronics (SAR Lab A)	SPEAG	DAE4	1433	4/14/2015
System Validation Dipole	SPEAG	D2450V2	899	9/10/2015
System Validation Dipole	SPEAG	D5GHzV2	1168	12/4/2015

Others

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	R & S	NRP2	102820-FG	4/24/2015
Power Sensor	R & S	NRP-Z11	112140-JZ	4/26/2015

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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 1528-2013 is not required in SAR reports submitted for equipment approval.

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6. Device Under Test (DUT) Information

6.1. DUT Description

The device with Model numbers A1622 and A1623 are display accessories used in stores and retail environments to showcase the features and configurations available for the Apple Watch.	
Device Dimension	Overall (Length x Width): 230 mm x 202 mm Overall Diagonal: 294 mm Display Diagonal: 201 mm
AirPlay	AirPlay mode enabled devices transfer data directly between each other ☒ AirPlay (Wi-Fi 2.4 GHz) ☒ AirPlay (Wi-Fi 5 GHz)

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)	100%
	5 GHz	802.11a 802.11n (HT20) 802.11n (HT40)	100%
	TDWR (Terminal Doppler Weather Radar): Supported.		
	Band gap channel : Not supported		
Bluetooth	2.4 GHz	Version 1.2 Version 2.0 + EDR Version 2.1 + EDR Version 3.0 + HS Version 4.0 LE	100% (DH5)

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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

Band (GHz)	Mode	Ch #	Freq. (MHz)	Maximum Output Power (dBm)
2.4	802.11b	1	2412	16.5
		6	2437	16.5
		11	2462	16.5
		12	2467	15.5
		13	2472	14.5
	802.11g	1	2412	16.0
		6	2437	16.5
		11	2462	15.5
		12	2467	11.5
		13	2472	4.0
	802.11n	1	2412	16.0
		6	2437	16.5
		11	2462	15.5
		12	2467	11.5
		13	2472	4.0
5.2	802.11a	36	5180	14.0
		40	5200	14.0
		44	5220	14.0
		48	5240	14.0
	802.11n HT20	36	5180	14.0
		40	5200	14.0
		44	5220	14.0
		48	5240	14.0
	802.11n HT40	38	5190	13.5
		46	5230	16.0
5.3	802.11a	52	5260	16.0
		56	5280	16.0
		60	5300	16.0
		64	5320	15.0
	802.11n HT20	52	5260	16.0
		56	5280	16.0
		60	5300	16.0
		64	5320	15.0
	802.11n HT40	54	5270	16.0
		62	5310	14.5

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Nominal and Maximum Output Power continued

Band (GHz)	Mode	Ch #	Freq. (MHz)	Maximum Output Power (dBm)
5.5	802.11a	100	5500	14.0
		104	5520	15.5
		108	5540	15.5
		112	5560	15.5
		116	5580	15.5
		120	5600	15.5
		124	5620	15.5
		128	5640	15.5
		132	5660	15.5
		136	5680	15.5
		140	5700	14.0
	802.11n HT20	100	5500	14.0
		104	5520	15.5
		108	5540	15.5
		112	5560	15.5
		116	5580	15.5
		120	5600	15.5
		124	5620	15.5
		128	5640	15.5
		132	5660	15.5
		136	5680	15.5
		140	5700	14.0
	802.11n HT40	102	5510	14.0
		110	5550	15.5
		118	5590	15.5
		126	5630	15.5
		134	5670	15.5
5.8	802.11a	149	5745	15.5
		153	5765	15.5
		157	5785	15.5
		161	5805	15.5
		165	5825	15.5
	802.11n HT20	149	5745	15.5
		153	5765	15.5
		157	5785	15.5
		161	5805	15.5
		165	5825	15.5
	802.11n HT40	151	5755	15.5
		159	5795	15.5
2.4	Bluetooth BDR			12.0
	Bluetooth EDR			10.0
	Bluetooth LE			8.0

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7. RF Exposure Conditions (Test Configurations)

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

7.1. Standalone SAR Test Exclusion Considerations

Since the *Dedicated Host Approach* is applied, the standalone SAR test exclusion procedure in KDB 447498 § 4.3.1 is applied in conjunction with KDB 616217 § 4.3 to determine the minimum test separation distance:

- When the separation distance from the antenna to an adjacent edge is ≤ 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.
- When the separation distance from the antenna to an adjacent edge is > 5 mm, the actual antenna-to-edge separation distance is applied to determine SAR test exclusion.

SAR Test Exclusion Calculations for WLAN

Antennas < 50mm to adjacent edges

Tx Interface	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 2.4 GHz	2462	16.50	45	20.2	10.2	31.4	188.6	167.32		3.5 -MEASURE-	7.1 -MEASURE-	2.3 -EXEMPT-	> 50 mm	> 50 mm	
Wi-Fi 5.2 GHz	5240	16.00	40	20.2	10.2	31.4	188.6	167.32		4.6 -MEASURE-	9.2 -MEASURE-	3 -EXEMPT-	> 50 mm	> 50 mm	
Wi-Fi 5.3 GHz	5320	16.00	40	20.2	10.2	31.4	188.6	167.32		4.6 -MEASURE-	9.2 -MEASURE-	3 -EXEMPT-	> 50 mm	> 50 mm	
Wi-Fi 5.5 GHz	5700	15.50	35	20.2	10.2	31.4	188.6	167.32		4.2 -MEASURE-	8.4 -MEASURE-	2.7 -EXEMPT-	> 50 mm	> 50 mm	
Wi-Fi 5.8 GHz	5825	15.50	35	20.2	10.2	31.4	188.6	167.32		4.2 -MEASURE-	8.4 -MEASURE-	2.7 -EXEMPT-	> 50 mm	> 50 mm	
Bluetooth	2480	12.00	16	20.2	10.2	31.4	188.6	167.32		13 -EXEMPT-	2.5 -EXEMPT-	0.8 -EXEMPT-	> 50 mm	> 50 mm	

Note(s):

1. According to KDB 447498, if the calculated threshold value is >3 then SAR testing is required.

Antennas > 50mm to adjacent edges

Tx Interface	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 2.4 GHz	2462	16.50	45	20	10.2	31.4	188.6	167.32		< 50 mm	< 50 mm	< 50 mm	14816 mW -EXEMPT-	1268.8 mW -EXEMPT-	
Wi-Fi 5.2 GHz	5240	16.00	40	20	10.2	31.4	188.6	167.32		< 50 mm	< 50 mm	< 50 mm	14515 mW -EXEMPT-	1238.7 mW -EXEMPT-	
Wi-Fi 5.3 GHz	5320	16.00	40	20	10.2	31.4	188.6	167.32		< 50 mm	< 50 mm	< 50 mm	1451mW -EXEMPT-	1238.2 mW -EXEMPT-	
Wi-Fi 5.5 GHz	5700	15.50	35	20	10.2	31.4	188.6	167.32		< 50 mm	< 50 mm	< 50 mm	1448.8 mW -EXEMPT-	1236 mW -EXEMPT-	
Wi-Fi 5.8 GHz	5825	15.50	35	20	10.2	31.4	188.6	167.32		< 50 mm	< 50 mm	< 50 mm	1448.2 mW -EXEMPT-	1235.4 mW -EXEMPT-	
Bluetooth	2480	12.00	16	20	10.2	31.4	188.6	167.32		< 50 mm	< 50 mm	< 50 mm	14813 mW -EXEMPT-	1268.5 mW -EXEMPT-	

Note(s):

1. According to KDB 447498, if the calculated Power threshold is less than the output power then SAR testing is required.

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7.2. Required Test Configurations

The table below identifies the standalone test configurations required for this device according to the findings in Section 7.1:

Test Configurations	Rear	Edge 1 (Top Edge)	Edge 2 (Right Edge)	Edge 3 (Bottom Edge)	Edge 4 (Left Edge)
Wi-Fi 2.4 GHz	Yes	Yes	No	No	No
Wi-Fi 5 GHz	Yes	Yes	No	No	No
Bluetooth	No	No	No	No	No

Note(s):

1. Yes = Testing is required.
2. No = Testing is not required.

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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 Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

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Dielectric Property Measurements Results:

SAR Lab A

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/12/2015	Body 2450	e'	52.1600	Relative Permittivity (ϵ_r):	52.16	52.70	-1.02	5
		e''	14.4200	Conductivity (σ):	1.96	1.95	0.74	5
	Body 2410	e'	52.2400	Relative Permittivity (ϵ_r):	52.24	52.76	-0.98	5
		e''	14.3500	Conductivity (σ):	1.92	1.91	0.81	5
	Body 2475	e'	52.0600	Relative Permittivity (ϵ_r):	52.06	52.67	-1.16	5
		e''	14.3900	Conductivity (σ):	1.98	1.99	-0.24	5
1/12/2015	Body 5180	e'	49.8000	Relative Permittivity (ϵ_r):	49.80	49.05	1.54	5
		e''	17.9700	Conductivity (σ):	5.18	5.27	-1.81	5
	Body 5200	e'	49.8400	Relative Permittivity (ϵ_r):	49.84	49.02	1.67	5
		e''	18.0300	Conductivity (σ):	5.21	5.29	-1.54	5
	Body 5600	e'	49.2000	Relative Permittivity (ϵ_r):	49.20	48.48	1.49	5
		e''	18.2600	Conductivity (σ):	5.69	5.76	-1.31	5
	Body 5800	e'	48.8500	Relative Permittivity (ϵ_r):	48.85	48.20	1.35	5
		e''	18.4200	Conductivity (σ):	5.94	6.00	-0.99	5
	Body 5825	e'	48.8500	Relative Permittivity (ϵ_r):	48.85	48.20	1.35	5
		e''	18.6100	Conductivity (σ):	6.03	6.00	0.46	5
1/15/2015	Body 2450	e'	52.2300	Relative Permittivity (ϵ_r):	52.23	52.70	-0.89	5
		e''	14.8200	Conductivity (σ):	2.02	1.95	3.53	5
	Body 2410	e'	52.3200	Relative Permittivity (ϵ_r):	52.32	52.76	-0.83	5
		e''	14.7500	Conductivity (σ):	1.98	1.91	3.62	5
	Body 2475	e'	52.1500	Relative Permittivity (ϵ_r):	52.15	52.67	-0.98	5
		e''	14.8600	Conductivity (σ):	2.04	1.99	3.02	5
1/15/2015	Body 5180	e'	49.1200	Relative Permittivity (ϵ_r):	49.12	49.05	0.15	5
		e''	17.7900	Conductivity (σ):	5.12	5.27	-2.80	5
	Body 5200	e'	49.1200	Relative Permittivity (ϵ_r):	49.12	49.02	0.20	5
		e''	17.7900	Conductivity (σ):	5.14	5.29	-2.85	5
	Body 5600	e'	48.5800	Relative Permittivity (ϵ_r):	48.58	48.48	0.21	5
		e''	18.0100	Conductivity (σ):	5.61	5.76	-2.66	5
	Body 5800	e'	48.3500	Relative Permittivity (ϵ_r):	48.35	48.20	0.31	5
		e''	18.1200	Conductivity (σ):	5.84	6.00	-2.61	5
	Body 5825	e'	48.2700	Relative Permittivity (ϵ_r):	48.27	48.20	0.15	5
		e''	18.1400	Conductivity (σ):	5.88	6.00	-2.08	5
1/20/2015	Body 5180	e'	49.5000	Relative Permittivity (ϵ_r):	49.50	49.05	0.92	5
		e''	18.2100	Conductivity (σ):	5.24	5.27	-0.50	5
	Body 5200	e'	49.4700	Relative Permittivity (ϵ_r):	49.47	49.02	0.92	5
		e''	18.2200	Conductivity (σ):	5.27	5.29	-0.50	5
	Body 5600	e'	48.9800	Relative Permittivity (ϵ_r):	48.98	48.48	1.04	5
		e''	18.5500	Conductivity (σ):	5.78	5.76	0.26	5
	Body 5800	e'	48.7800	Relative Permittivity (ϵ_r):	48.78	48.20	1.20	5
		e''	18.6700	Conductivity (σ):	6.02	6.00	0.35	5
	Body 5825	e'	48.7200	Relative Permittivity (ϵ_r):	48.72	48.20	1.08	5
		e''	18.7400	Conductivity (σ):	6.07	6.00	1.16	5

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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.

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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	9/10/2014	2450	1g	52.3	50.5
				10g	24.3	23.5
D5GHzV2	1168	12/4/2014	5200	1g	79.3	76
				10g	22.5	21.1
			5600	1g	81.7	82
				10g	23.2	22.7
			5800	1g	78.0	76.2
				10g	22.1	21

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 A

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			
1/12/2015	D2450V2	899	Body	1g	5.11	51.1	50.5	1.19	
				10g	2.33	23.3	23.5	-0.85	
1/12/2015	D5GHzV2 (5.2 GHz)	1168	Body	1g	7.32	73.2	76.0	-3.68	
				10g	2.06	20.6	21.1	-2.37	
1/12/2015	D5GHzV2 (5.6 GHz)	1168	Body	1g	8.11	81.1	82.0	-1.10	
				10g	2.25	22.5	22.7	-0.88	
1/12/2015	D5GHzV2 (5.8 GHz)	1168	Body	1g	7.13	71.3	76.2	-6.43	1,2
				10g	1.97	19.7	21.0	-6.19	
1/15/2015	D2450V2	899	Body	1g	4.98	49.8	50.5	-1.39	3,4
				10g	2.29	22.9	23.5	-2.55	
1/15/2015	D5GHzV2 (5.2 GHz)	1168	Body	1g	7.28	72.8	76.0	-4.21	
				10g	2.05	20.5	21.1	-2.84	
1/15/2015	D5GHzV2 (5.6 GHz)	1168	Body	1g	8.05	80.5	82.0	-1.83	
				10g	2.23	22.3	22.7	-1.76	
1/15/2015	D5GHzV2 (5.8 GHz)	1168	Body	1g	7.88	78.8	76.2	3.41	
				10g	2.18	21.8	21.0	3.81	
1/20/2015	D5GHzV2 (5.2 GHz)	1168	Body	1g	7.94	79.4	76.0	4.47	
				10g	2.23	22.3	21.1	5.69	

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9. Conducted Output Power Measurements

9.1. Wi-Fi 2.4GHz

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	SAR Test (Yes/No)	Note(s)
2.4	802.11b	1 Mbps	1	2412	16.5	Yes	
			6	**2437**	**16.5**		
			11	2462	16.5		
			12	2467	15.5	No	
			13	2472	14.5		
	802.11g	6 Mbps	1	2412	16.0	No	1
			6	2437	16.5		
			11	2462	15.5		
			12	2467	11.5		
			13	2472	4.0		
	802.11n (HT20)	MCS0	1	2412	16.0	No	1
			6	2437	16.5		
			11	2462	15.5		
			12	2467	11.5		
			13	2472	4.0		

Note(s):

1. Based on the specified output power for the supported transmit modes:
   - 802.11b has been identified as the *Initial Test Configuration* and requires SAR evaluation.
   - Other *Subsequent Test Configurations* and require SAR only when the SAR of the *Initial Test Configuration*, adjusted to the ratio between *Initial Test Configuration* and the *Subsequent Test Configuration*, is > 1.2 W/kg.

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9.2. Wi-Fi 5GHz

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	SAR Test (Yes/No)	Note(s)
5.2 (U-NII 1)	802.11a	6 Mbps	36	5180	14.0	No	2
			40	5200	14.0		
			44	5220	14.0		
			48	5240	14.0		
	802.11n (HT20)	6.5 Mbps	36	5180	14.0	No	2
			40	5200	14.0		
			48	5240	14.0		
	802.11n (HT40)	13.5 Mbps	38	5190	13.5	No	2
			46	5230	16.0		
5.3 (U-NII 2A)	802.11a	6 Mbps	52	5260	16.0	No	1
			56	5280	16.0		
			60	5300	16.0		
			64	5320	15.0		
	802.11n (HT20)	6.5 Mbps	52	5260	15.0	No	1
			60	5300	15.0		
			64	5320	15.0		
	802.11n (HT40)	13.5 Mbps	52	5260	16.0	Yes	
			62	5310	14.5		
5.5 (U-NII 2C)	802.11a	6 Mbps	100	5500	13.9	No	1
			104	5520	15.5		
			108	5540	15.5		
			112	5560	15.5		
			116	5580	15.5		
			120	5600	15.5		
			124	5620	15.5		
			128	5640	15.5		
			132	5660	15.5		
			136	5680	15.5		
			140	5700	15.5		
	802.11n (HT20)	6.5 Mbps	100	5500	15.5	No	1
			116	5580	15.5		
			140	5700	15.5		
	802.11n (HT40)	13.5 Mbps	102	5510	14.0	Yes	
			110	5550	15.5		
			118	5590	15.5		
			126	5630	15.5		
			134	5670	15.5		
5.8 (U-NII 3)	802.11a	6 Mbps	149	5745	14	No	1
			157	5785	15.5		
			165	5825	15.5		
	802.11n (HT20)	6.5 Mbps	149	5745	15.5	No	1
			157	5785	15.5		
			161	5805	15.5		
	802.11n (HT40)	13.5 Mbps	151	5755	15.5	Yes	
			159	5795	15.5		

Note(s):

2. Based on the specified output power for the supported transmit modes:
   - 802.11b has been identified as the *Initial Test Configuration* and requires SAR evaluation.
   - Other *Subsequent Test Configurations* and require SAR only when the SAR of the *Initial Test Configuration*, adjusted to the ratio between *Initial Test Configuration* and the *Subsequent Test Configuration*, is > 1.2 W/kg.
3. When the specified maximum output power is the same for both UNII band I and UNII band 2A, begin SAR measurement in UNII band 2A; and if the highest *reported* SAR for UNII band 2A is
   - ≤ 1.2 W/kg, SAR is not required for UNII band I
   - > 1.2 W/kg, both bands should be tested independently for SAR.

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9.3. Bluetooth

Band (GHz)	Mode	Ch #	Freq. (MHz)	Avg Pwr (dBm)
2.4	V3.0 + EDR, GFSK	0	2402	12.0
		39	2441	12.0
		78	2480	12.0
	V3.0 + EDR, 8-DPSK	0	2402	10.0
		39	2441	10.0
		78	2480	10.0
	V4.0 LE, GFSK	0	2402	8.0
		19	2440	8.0
		39	2480	8.0

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10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance:

KDB 248227 D01 SAR meas for 802.11 v02:

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the *initial test position(s)* by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The *initial test position(s)* is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the *reported* SAR for the *initial test position* is:

- ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- > 0.4 W/kg, SAR is repeated using the same wireless mode test configuration tested in the *initial test position* to measure the subsequent next closet/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the *reported* SAR is ≤ 0.8 W/kg or all required test positions are tested.
  - For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
  - When it is unclear, all equivalent conditions must be tested.
- For all positions/configurations tested using the *initial test position* and subsequent test positions, when the *reported* SAR is > 0.8 W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is ≤ 1.2 W/kg or all required test channels are considered.
  - The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.
- When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is ≤ 1.2 W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.
- When the specified maximum output power is different between UNII 1 and UNII 2A, begin SAR with the band that has the higher specified maximum output. If the highest reported SAR for the band with the highest specified power is ≤ 1.2 W/kg, testing for the band with the lower specified output power is not required; otherwise test the remaining bands independently for SAR.

To determine the *initial test position*, Area Scans were performed to determine the position with the *Maximum Value of SAR (measured)*. The position that produced the highest *Maximum Value of SAR* is considered the worst case position; thus used as the *initial test position*.

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10.1. Wi-Fi (DTS Band)

Frequency Band	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4GHz	802.11b 1 Mbps	0	Edge 1	1	2412.0	1.67	16.5	16.5	0.809	0.809	0.373	0.373	
				6	2437.0	1.79	16.5	16.5	0.872	0.872	0.405	0.405	1
			Rear	6	2437.0	0.01	16.5	16.5	0.059	0.059	0.028	0.028	

10.2. Wi-Fi (U-NII Band)

Frequency Band	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
5.3 GHz U-NII 2A	802.11n HT40	0	Edge 1	54	5270.0	3.66	16.0	16.0	1.030	1.030	0.333	0.333	2
				62	5310.0	2.99	14.5	14.5	0.803	0.803	0.271	0.271	
			Rear	54	5270.0	0.48	16.0	16.0	0.131	0.131	0.045	0.045	
Frequency Band	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
5.5 GHz U-NII 2C	802.11n HT40	0	Edge 1	118	5590.0	4.21	15.5	15.5	1.160	1.160	0.427	0.427	3
				134	5670.0	3.56	15.5	15.5	1.010	1.010	0.386	0.386	
			Rear	118	5590.0	0.82	15.5	15.5	0.221	0.221	0.083	0.083	
Frequency Band	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
5.8 GHz U-NII 3	802.11n HT40	0	Edge 1	151	5755.0	2.12	15.5	15.5	0.627	0.627	0.235	0.235	4
			Rear	151	5755.0	0.56	15.5	15.5	0.146	0.146	0.051	0.051	

10.3. Bluetooth

Standalone SAR Test Exclusion Considerations & Estimated SAR

The findings in Section 7 indicate that Bluetooth qualifies for standalone SAR test exclusion while Wi-Fi does not.

For the purpose of Simultaneous Transmission SAR analysis however, SAR estimation was performed for Bluetooth. Refer to Section 12 for the results of these estimations.

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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 < 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.

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	Standalone	Edge 1	Yes	0.872	0.861	1.01
5300	Wi-Fi 802.11a/n/ac	Standalone	Edge 1	Yes	1.03	1.03	1.00
5500	Wi-Fi 802.11a/n/ac	Standalone	Edge 1	Yes	1.16	1.13	1.03
5800	Wi-Fi 802.11a/n/ac	Standalone	Edge 1	No	0.627	N/A	N/A

Note(s):

Second Repeated Measurement is not required since the ratio of the largest to smallest SAR for the original and first repeated measurement is not > 1.20.

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12. Simultaneous Transmission SAR Analysis

KDB 447498 D01 General RF Exposure Guidance introduces a new formula for calculating the SAR to Peak Location Ratio (SPLSR) between pairs of simultaneously transmitting antennas:

$$SPLSR = (SAR_1 + SAR_2)^{1.5} / Ri$$

Where:

SAR_1 is the highest measured or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

SAR_2 is the highest measured or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

Ri is the separation distance between the pair of simultaneous transmitting antennas. When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$

In order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:

$$(SAR_1 + SAR_2)^{1.5} / Ri < 0.04$$

Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations				
Standalone	1	Wi-Fi 5 GHz	+	BT		
Notes:						
1. Wi-Fi 2.4 GHz Radio cannot transmit simultaneously with Bluetooth Radio.						
2. Wi-Fi 5 GHz Radio can transmit simultaneously with Bluetooth Radio.						

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Estimated SAR for Simultaneous Transmission SAR Analysis

Considerations for SAR estimation

1. When standalone SAR test exclusion applies, standalone SAR must also be estimated to determine simultaneous transmission SAR test exclusion.
2. Dedicated Host Approach criteria for SAR test exclusion is likewise applied to SAR estimation, with certain distinctions between test exclusion and SAR estimation:
   - When the separation distance from the antenna to an adjacent edge is ≤ 5 mm, a distance of 5 mm is applied for SAR estimation; this is the same between test exclusion and SAR estimation calculations.
   - When the separation distance from the antenna to an adjacent edge is > 5 mm but ≤ 50 mm, the actual antenna-to-edge separation distance is applied for SAR estimation.
   - When the minimum test separation distance is > 50 mm, the estimated SAR value is 0.4 W/kg
3. Test positions that consist of only estimated SAR values can be identified in the Estimated SAR Tables below as those positions with a full column of green cells. Taking into account the possible simultaneous transmission combinations, the sum of SAR values for these test positions will always be ≤ 0.8 W/kg. As such, these test positions are inherently compliant and therefore exempt from further simultaneous transmission SAR analysis.

Estimated SAR for WLAN

SISO

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Estimated 1-g SAR Value (W/kg)					
		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi 2.4 GHz	2462	16.50	45	20.2	10.2	31.4	188.6	167.32		-MEASURE-	-MEASURE-	0.304	0.400	0.400	
Wi-Fi 5.2 GHz	5240	16.00	40	20.2	10.2	31.4	188.6	167.32		-MEASURE-	-MEASURE-	0.394	0.400	0.400	
Wi-Fi 5.3 GHz	5320	16.00	40	20.2	10.2	31.4	188.6	167.32		-MEASURE-	-MEASURE-	0.397	0.400	0.400	
Wi-Fi 5.5 GHz	5700	15.50	35	20.2	10.2	31.4	188.6	167.32		-MEASURE-	-MEASURE-	0.359	0.400	0.400	
Wi-Fi 5.8 GHz	5825	15.50	35	20.2	10.2	31.4	188.6	167.32		-MEASURE-	-MEASURE-	0.363	0.400	0.400	
Bluetooth	2480	12.00	16	20.2	10.2	31.4	188.6	167.32		0.168	0.336	0.108	0.400	0.400	

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12.1. Sum of the SAR for Wi-Fi 5 GHz & BT

Test Position	① Wi-Fi 5 GHz	② BT	① + ② Wi-Fi 5 GHz + BT	
			∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)
Rear	0.221	0.168	0.389	No
Edge 1	1.160	0.336	1.496	No

SAR to Peak Location Separation Ratio (SPLSR)

N/A

Conclusion:

Simultaneous transmission SAR measurement (Volume Scan) is not required because the either sum of the 1-g SAR is < 1.6 W/kg or the SPLSR is < 0.04 for all circumstances that require SPLSR calculation.

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Appendixes

Refer to separated files for the following appendixes.

A_14U18979v0 SAR Photos & Ant. Locations

B_14U18979v0 SAR System Check Plots

C_14U18979v0 SAR Highest Test Plots

D_14U18979v0 SAR Tissue Ingredients

E_14U18979v0 SAR Probe Cal. Certificates

F_14U18979v0 SAR Dipole Cal. Certificates

END OF REPORT

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