



SAR EVALUATION REPORT

**FCC 47 CFR § 2.1093
IEEE Std 1528-2013**

For
Tablet Device

**FCC ID: BCGA1670
Model Name: A1670**

**Report Number: 16U23815-S1V2
Issue Date: 3/6/2017**

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Revision History


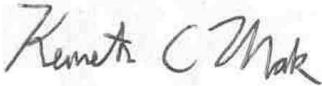
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V1	3/1/2017	Initial Issue	--
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1. Attestation of Test Results

Applicant Name	APPLE, INC.			
FCC ID	BCGA1670			
Model Name	A1670			
Applicable Standards	FCC 47 CFR § 2.1093 Published RF exposure KDB procedures IEEE Std 1528-2013			
Exposure Category	SAR Limits (W/Kg) Peak spatial-average(1g of tissue)			
General population / Uncontrolled exposure	1.6			
RF Exposure Conditions	Equipment Class - Highest Reported SAR (W/kg)			
	PCE	DTS	NII	DSS
Standalone	N/A	1.19	1.17	1.18
Simultaneous TX	N/A	N/A	1.38	1.38
Date Tested	12/19/2016 to 1/12/2017			
Test Results	Pass			
<p>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.</p> <p>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.</p>				
Approved & Released By:		Prepared By:		
				
Bobby Bayani Senior Engineer UL Verification Services Inc.		Kenneth C. Mak Laboratory Engineer UL Verification Services Inc.		

2. Test Specification, Methods and Procedures

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

- 248227 D01 802.11 Wi-Fi SAR v02r02
- 447498 D01 General RF Exposure Guidance v06
- 447498 D03 Supplement C Cross-Reference v01
- 616217 D04 SAR for laptop and tablets v01r02
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02

Additional Guidance: Manufacturer KDB enquiry.

- KDB guidance related to power control mechanism for Bluetooth transmitters based on the operational state of the Wi-Fi transmitters. Bluetooth P_{low} is triggered when 5 GHz Wi-Fi is on. Functional description of this mode is provided in technical description documents.

3. Facilities and Accreditation

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

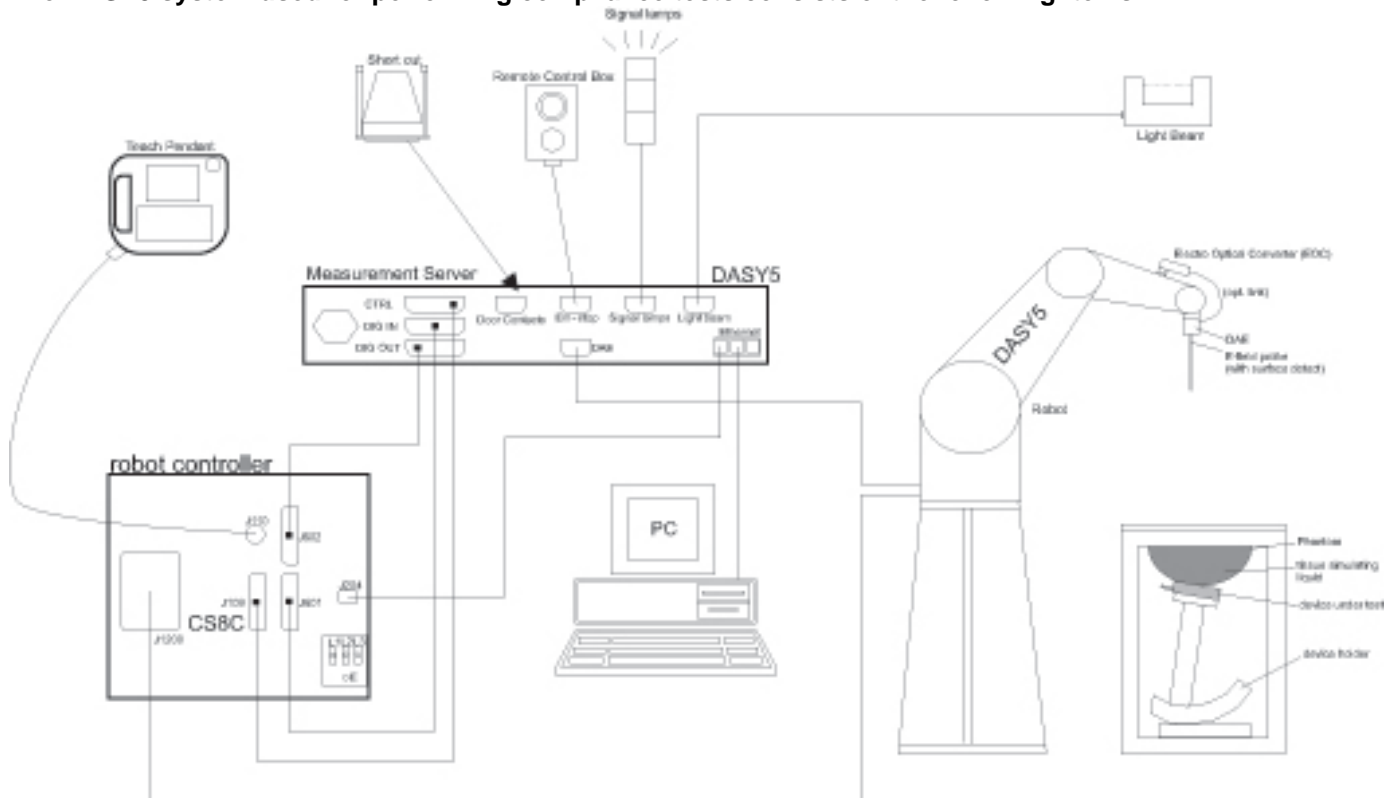
47173 Benicia Street	47266 Benicia Street
SAR Lab A	SAR Lab 1
SAR Lab B	SAR Lab 2
SAR Lab C	SAR Lab 3
SAR Lab D	SAR Lab 4
SAR Lab E	
SAR Lab F	
SAR Lab G	
SAR Lab H	

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

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

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



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

4.2. SAR Scan Procedures

Step 1: Power Reference Measurement

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

Step 2: Area Scan

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

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

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$	≤ 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 \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

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

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

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: $\Delta x_{\text{Zoom}}, \Delta y_{\text{Zoom}}$			≤ 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: $\Delta z_{\text{Zoom}}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{\text{Zoom}}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{\text{Zoom}}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1)$	
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 <u>reported</u> SAR from the <i>area scan based 1-g SAR estimation</i> 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.

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	MY40000980	4/27/2017
Dielectric Probe kit	SPEAG	DAK-3.5	1103	2/23/2017
Shorting block	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Traceable Calibration Control Co.	4242	140493798	8/9/2017

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	Agilent	N5181A	MY50140610	5/9/2017
Power Meter	Keysight	N1912A	MY55196008	5/3/2017
Power Sensor	Agilent	N1912A	MY52200012	10/17/2017
Power Sensor	Agilent	E9323A	MY53070009	6/13/2017
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795093	N/A
Directional coupler	Werlatone	C8060-102	2149	N/A
DC Power Supply	BK PRECISION	1161	215-02292	N/A
Synthesized Signal Generator	Agilent	N5181A	MY50140630	5/9/2017
Power Meter	Keysight	N1912A	MY55196009	5/3/2017
Power Sensor	Agilent	N1912A	MY53260001	10/17/2017
Power Sensor	Agilent	E9323A	MY53070002	3/22/2017
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795092	N/A
Directional coupler	Werlatone	C8060-102	2141	N/A
DC Power Supply	HP	6296A	2841A-05955	N/A
Synthesized Signal Generator	HP	8665B	3546A00784	9/2/2017
Power Meter	HP	437B	3125U11347	8/30/2017
Power Meter	HP	437B	3125U09516	9/27/2017
Power Sensor	HP	8481A	1926A16917	10/7/2017
Power Sensor	HP	8481A	2702A76223	9/14/2017
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1808938	N/A
Directional coupler	Werlatone	C8060-102	2710	N/A
DC Power Supply	HP	E3610A	KR24104150	N/A

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
E-Field Probe (SAR Lab A)	SPEAG	EX3DV4	3885	9/20/2017
E-Field Probe (SAR Lab C)	SPEAG	EX3DV4	3902	5/17/2017
E-Field Probe (SAR Lab D)	SPEAG	EX3DV4	3936	7/26/2017
E-Field Probe (SAR Lab E)	SPEAG	EX3DV4	7335	3/22/2017
E-Field Probe (SAR Lab F)	SPEAG	EX3DV4	3686	8/25/2017
Data Acquisition Electronics (SAR Lab A)	SPEAG	DAE4	1439	7/25/2017
Data Acquisition Electronics (SAR Lab C)	SPEAG	DAE3	500	5/19/2017
Data Acquisition Electronics (SAR Lab D)	SPEAG	DAE4	1433	3/17/2017
Data Acquisition Electronics (SAR Lab E)	SPEAG	DAE4	1472	3/24/2017
Data Acquisition Electronics (SAR Lab F)	SPEAG	DAE4	1377	9/14/2017
System Validation Dipole	SPEAG	D2450V2	899	3/15/2017
System Validation Dipole	SPEAG	D5GHzV2	1003	2/25/2017
System Validation Dipole	SPEAG	D5GHzV2	1138	9/22/2017
System Validation Dipole	SPEAG	D5GHzV2	1168	11/14/2017

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Keysight	N1912A	MY55196004	7/8/2017
Power Sensor	Agilent	N1921A	MY53020038	3/22/2017
Power Sensor	Agilent	N1921A	MY53260010	8/23/2017
Power Meter	Keysight	N1912A	My55196007	7/8/2017
Power Sensor	Agilent	N1921A	MY55200002	3/22/2017
Power Sensor	Agilent	N1921A	MY52200012	10/17/2017

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 and the measured 10-g SAR within a frequency band is < 3.75 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

6. Device Under Test (DUT) Information

6.1. DUT Description

Model A1670 is a tablet with multimedia functions (music, application support, and video)

IEEE 802.11a/b/g/n/ac radio (MIMO 2x2) and Bluetooth radio

There are two suppliers of the Wi-Fi/Bluetooth radio modules to support the production volumes of the device. The two variants are referenced in this report as:

Variant 1 = Wi-Fi/BT module supplier 1

Variant 2 = Wi-Fi/BT module supplier 2

The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Complete SAR evaluation is performed on the device with one Wi-Fi/Bluetooth radio module, and then the test is repeated on the device with the other Wi-Fi/Bluetooth module at the highest SAR value.

Device Dimension	Overall (Length x Width): 305.7 mm x 220.6 mm Overall Diagonal: 368.9 mm Display Diagonal: 327.66 mm
Back Cover	<input checked="" type="checkbox"/> The rechargeable battery is not user accessible.
Battery Options	<input checked="" type="checkbox"/> The rechargeable battery is not user accessible.
AirPlay	AirPlay mode enabled devices transfer data directly between each other <input checked="" type="checkbox"/> AirPlay (Wi-Fi 2.4 GHz) <input checked="" type="checkbox"/> 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) 802.11ac (VHT20) 802.11ac (VHT40) 802.11ac (VHT80)	100%
	Does this device support bands 5.60 ~ 5.65 GHz? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		
	Does this device support Band gap channel? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		
Bluetooth	2.4 GHz	Version 4.2 + LE	77.5% (DH5)

6.3. Nominal and Maximum Output Power from Tune-up Procedure

KDB 447498 sec. 4.1.(d) 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.

6.3.1. WLAN SISO

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
2.4	802.11b	1 Tx	1	2412	16.0	16.0	Yes
			6	2437	16.0	16.0	
			11	2462	16.0	16.0	
			12	2467	16.0	16.0	
			13	2472	14.5	14.5	
	802.11g	1 Tx	1	2412	16.0	16.0	No
			6	2437	16.0	16.0	
			10	2457	16.0	16.0	
			11	2462	13.5	13.5	
			12	2467	11.5	11.5	
			13	2472	1.5	1.5	
	802.11n	1 Tx HT20	1	2412	16.0	16.0	No
			6	2437	16.0	16.0	
			10	2457	16.0	16.0	
			11	2462	13.5	13.5	
			12	2467	11.5	11.5	
			13	2472	1.5	1.5	

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
5.2	802.11a	1 Tx	36	5180	16.0	16.0	No
			40	5200	17.0	16.0	
			44	5220	17.0	16.0	
			48	5240	17.0	16.0	
	802.11n	1 Tx HT20	36	5180	16.0	16.0	No
			40	5200	17.0	16.0	
			44	5220	17.0	16.0	
			48	5240	17.0	16.0	
		1 Tx HT40	38	5190	14.0	14.0	Yes
			46	5230	17.0	16.0	
	802.11ac	1 Tx VHT20	36	5180	16.0	16.0	No
			40	5200	17.0	16.0	
			44	5220	17.0	16.0	
			48	5240	17.0	16.0	
		1 Tx VHT40	38	5190	14.0	14.0	No
			46	5230	17.0	16.0	
		1 Tx VHT80	42	5210	13.5	13.5	No

Note(s):

1. "Yes" = considered for output power measurement and SAR testing. "No" = SAR test reduction was applied from KDB 248227 guidance, Se. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11 a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
5.3	802.11a	1 Tx	52	5260	16.0	16.0	No
			56	5280	16.0	16.0	
			60	5300	16.0	16.0	
			64	5320	16.0	16.0	
	802.11n	1 Tx HT20	52	5260	16.0	16.0	No
			56	5280	16.0	16.0	
			60	5300	16.0	16.0	
			64	5320	16.0	16.0	
		1 Tx HT40	54	5270	16.0	16.0	Yes
			62	5310	14.0	14.0	
	802.11ac	1 Tx VHT20	52	5260	16.0	16.0	No
			56	5280	16.0	16.0	
			60	5300	16.0	16.0	
			64	5320	16.0	16.0	
		1 Tx VHT40	54	5270	16.0	16.0	No
			62	5310	14.0	14.0	
		1 Tx VHT80	58	5290	13.5	13.5	No

Note(s):

1. "Yes" = considered for output power measurement and SAR testing. "No" = SAR test reduction was applied from KDB 248227 guidance, Se. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11 a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
5.5	802.11a	1 Tx	100	5500	15.0	15.0	No
			104	5520	15.0	15.0	
			108	5540	15.0	15.0	
			112	5560	15.0	15.0	
			116	5580	15.0	15.0	
			120	5600	15.0	15.0	
			124	5620	15.0	15.0	
			128	5640	15.0	15.0	
			132	5660	15.0	15.0	
			136	5680	15.0	15.0	
			140	5700	15.0	15.0	
			144	5720	15.0	15.0	
	802.11n	1 Tx HT20	100	5500	15.0	15.0	No
			104	5520	15.0	15.0	
			108	5540	15.0	15.0	
			112	5560	15.0	15.0	
			116	5580	15.0	15.0	
			120	5600	15.0	15.0	
			124	5620	15.0	15.0	
			128	5640	15.0	15.0	
			132	5660	15.0	15.0	
			136	5680	15.0	15.0	
			140	5700	15.0	15.0	
			144	5720	15.0	15.0	
		1 Tx HT40	102	5510	14.5	14.5	No
			110	5550	15.0	15.0	
			118	5590	15.0	15.0	
			126	5630	15.0	15.0	
			134	5670	15.0	15.0	
			142	5710	15.0	15.0	
	802.11ac	1 Tx VHT20	100	5500	15.0	15.0	No
			104	5520	15.0	15.0	
			108	5540	15.0	15.0	
			112	5560	15.0	15.0	
			116	5580	15.0	15.0	
			120	5600	15.0	15.0	
			124	5620	15.0	15.0	
			128	5640	15.0	15.0	
			132	5660	15.0	15.0	
			136	5680	15.0	15.0	
			140	5700	15.0	15.0	
			144	5720	15.0	15.0	
		1 Tx VHT40	102	5510	14.5	14.5	No
			110	5550	15.0	15.0	
			118	5590	15.0	15.0	
			126	5630	15.0	15.0	
			134	5670	15.0	15.0	
			142	5710	15.0	15.0	
		1 Tx VHT80	106	5530	13.0	13.0	Yes
			122	5610	15.0	15.0	
			138	5690	15.0	15.0	

Note(s):

1. "Yes" = considered for output power measurement and SAR testing. "No" = SAR test reduction was applied from KDB 248227 guidance, Se. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11 a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
5.8	802.11a	1 Tx	149	5745	15.0	15.5	No
			153	5765	15.0	15.5	
			157	5785	15.0	15.5	
			161	5805	15.0	15.5	
			165	5825	15.0	15.5	
	802.11n	1 Tx HT20	149	5745	15.0	15.5	No
			153	5765	15.0	15.5	
			157	5785	15.0	15.5	
			161	5805	15.0	15.5	
			165	5825	15.0	15.5	
		1 Tx HT40	151	5755	15.0	15.5	No
			159	5795	15.0	15.5	
	802.11ac	1 Tx VHT20	149	5745	15.0	15.5	No
			153	5765	15.0	15.5	
			157	5785	15.0	15.5	
			161	5805	15.0	15.5	
			165	5825	15.0	15.5	
		1 Tx VHT40	151	5755	15.0	15.5	No
			159	5795	15.0	15.5	
		1 Tx VHT80	155	5775	15.0	15.5	Yes

Note(s):

1. "Yes" = considered for output power measurement and SAR testing. "No" = SAR test reduction was applied from KDB 248227 guidance, Se. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11 a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

6.3.2. WLAN MIMO

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
2.4	802.11g	2 Tx CDD	1	2412	14.0	14.0	Yes
			2	2417	16.0	16.0	
			6	2437	16.0	16.0	
			10	2457	16.0	16.0	
			11	2462	12.5	12.5	
			12	2467	10.0	10.0	
			13	2472	0.0	0.0	
	802.11n	2 Tx HT20 CDD/STBC/SDM	1	2412	14.0	14.0	No
			2	2417	16.0	16.0	
			6	2437	16.0	16.0	
			10	2457	16.0	16.0	
			11	2462	12.5	12.5	
			12	2467	10.0	10.0	
			13	2472	0.0	0.0	

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
5.2	802.11a	2 Tx CDD	36	5180	15.0	15.0	No
			40	5200	15.5	15.5	
			44	5220	15.5	15.5	
			48	5240	15.5	15.5	
	802.11n	2 Tx HT20 CDD	36	5180	15.0	15.0	No
			40	5200	15.5	15.5	
			44	5220	15.5	15.5	
			48	5240	15.5	15.5	
		2 Tx HT20 STBC/SDM	36	5180	15.0	15.0	No
			40	5200	17.0	16.0	
			44	5220	17.0	16.0	
			48	5240	17.0	16.0	
		2 Tx HT40 CDD/STBC/SDM	38	5190	13.0	13.0	Yes
			46	5230	17.0	16.0	
			36	5180	15.0	15.0	No
			40	5200	15.5	15.5	
			44	5220	15.5	15.5	
			48	5240	15.5	15.5	
	802.11ac	2 Tx VHT20 CDD	36	5180	15.0	15.0	No
			40	5200	15.5	15.5	
			44	5220	15.5	15.5	
			48	5240	15.5	15.5	
		2 Tx VHT20 STBC/SDM	36	5180	15.0	15.0	No
			40	5200	17.0	16.0	
			44	5220	17.0	16.0	
			48	5240	17.0	16.0	
		2 Tx VHT40 CDD/STBC/SDM	38	5190	13.0	13.0	No
			46	5230	17.0	16.0	
		2 Tx VHT80 CDD/STBC/SDM	42	5210	12.0	12.0	No

Note(s):

1. "Yes" = considered for output power measurement and SAR testing. "No" = SAR test reduction was applied from KDB 248227 guidance, Se. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11 a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
5.3	802.11a	2 Tx CDD	52	5260	15.0	15.0	No
			56	5280	15.0	15.0	
			60	5300	15.0	15.0	
			64	5320	14.5	14.5	
	802.11n	2 Tx HT20 CDD	52	5260	15.0	15.0	No
			56	5280	15.0	15.0	
			60	5300	15.0	15.0	
			64	5320	14.5	14.5	
		2 Tx HT20 STBC/SDM	52	5260	16.0	16.0	No
			56	5280	16.0	16.0	
			60	5300	16.0	16.0	
			64	5320	14.5	14.5	
		2 Tx HT40 CDD/STBC/SDM	54	5270	16.0	16.0	No
			62	5310	13.5	13.5	
	802.11ac	2 Tx VHT20 CDD	52	5260	15.0	15.0	No
			56	5280	15.0	15.0	
			60	5300	15.0	15.0	
			64	5320	14.5	14.5	
		2 Tx VHT20 STBC/SDM	52	5260	16.0	16.0	No
			56	5280	16.0	16.0	
			60	5300	16.0	16.0	
			64	5320	14.5	14.5	
		2 Tx VHT40 CDD/STBC/SDM	54	5270	16.0	16.0	No
			62	5310	13.5	13.5	
		2 Tx VHT80 CDD/STBC/SDM	58	5290	11.5	11.5	No

Note(s):

1. "Yes" = considered for output power measurement and SAR testing. "No" = SAR test reduction was applied from KDB 248227 guidance, Se. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11 a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
5.5	802.11a	2 Tx CDD	100	5500	14.0	14.0	No
			104	5520	14.0	14.0	
			108	5540	14.0	14.0	
			112	5560	14.0	14.0	
			116	5580	14.0	14.0	
			120	5600	14.0	14.0	
			124	5620	14.0	14.0	
			128	5640	14.0	14.0	
			132	5660	14.0	14.0	
			136	5680	14.0	14.0	
			140	5700	14.0	14.0	
			144	5720	14.0	14.0	
	802.11n	2 Tx HT20 CDD	100	5500	14.0	14.0	No
			104	5520	14.0	14.0	
			108	5540	14.0	14.0	
			112	5560	14.0	14.0	
			116	5580	14.0	14.0	
			120	5600	14.0	14.0	
			124	5620	14.0	14.0	
			128	5640	14.0	14.0	
			132	5660	14.0	14.0	
			136	5680	14.0	14.0	
			140	5700	14.0	14.0	
			144	5720	14.0	14.0	
		2 Tx HT20 STBC/SDM	100	5500	15.0	15.0	No
			104	5520	15.0	15.0	
			108	5540	15.0	15.0	
			112	5560	15.0	15.0	
			116	5580	15.0	15.0	
			120	5600	15.0	15.0	
			124	5620	15.0	15.0	
			128	5640	15.0	15.0	
			132	5660	15.0	15.0	
			136	5680	15.0	15.0	
			140	5700	14.0	14.0	
			144	5720	15.0	15.0	
		2 Tx HT40 CDD/STBC/SDM	102	5510	13.5	13.5	No
			110	5550	15.0	15.0	
			118	5590	15.0	15.0	
			126	5630	15.0	15.0	
			134	5670	15.0	15.0	
			142	5710	15.0	15.0	

Note(s):

1. "Yes" = considered for output power measurement and SAR testing. "No" = SAR test reduction was applied from KDB 248227 guidance, Se. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11 a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
5.5	802.11ac	2 Tx VHT20 CDD	100	5500	14.0	14.0	No
			104	5520	14.0	14.0	
			108	5540	14.0	14.0	
			112	5560	14.0	14.0	
			116	5580	14.0	14.0	
			120	5600	14.0	14.0	
			124	5620	14.0	14.0	
			128	5640	14.0	14.0	
			132	5660	14.0	14.0	
			136	5680	14.0	14.0	
			140	5700	14.0	14.0	
			144	5720	14.0	14.0	
		2 Tx VHT20 STBC/SDM	100	5500	15.0	15.0	No
			104	5520	15.0	15.0	
			108	5540	15.0	15.0	
			112	5560	15.0	15.0	
			116	5580	15.0	15.0	
			120	5600	15.0	15.0	
			124	5620	15.0	15.0	
			128	5640	15.0	15.0	
			132	5660	15.0	15.0	
			136	5680	15.0	15.0	
			140	5700	14.0	14.0	
			144	5720	15.0	15.0	
		2 Tx VHT40 CDD/STBC/SDM	102	5510	13.5	13.5	No
			110	5550	15.0	15.0	
			118	5590	15.0	15.0	
			126	5630	15.0	15.0	
			134	5670	15.0	15.0	
			142	5710	15.0	15.0	
		2 Tx VHT80 CDD/STBC/SDM	106	5530	11.5	11.5	Yes
			122	5610	15.0	15.0	
			138	5690	15.0	15.0	

Note(s):

1. "Yes" = considered for output power measurement and SAR testing. "No" = SAR test reduction was applied from KDB 248227 guidance, Se. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11 a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max RF Output Power (dBm)		SAR Test (Yes/No)
					Antenna A	Antenna B	
5.8	802.11a	2 Tx CDD	149	5745	15.0	15.5	No
			153	5765	15.0	15.5	
			157	5785	15.0	15.5	
			161	5805	15.0	15.5	
			165	5825	15.0	15.5	
	802.11n	2 Tx HT20 CDD/STBC/SDM	149	5745	15.0	15.5	No
			153	5765	15.0	15.5	
			157	5785	15.0	15.5	
			161	5805	15.0	15.5	
			165	5825	15.0	15.5	
		2 Tx HT40 CDD/STBC/SDM	151	5755	15.0	15.5	No
			159	5795	15.0	15.5	
	802.11ac	2 Tx VHT20 CDD/STBC/SDM	149	5745	15.0	15.5	No
			153	5765	15.0	15.5	
			157	5785	15.0	15.5	
			161	5805	15.0	15.5	
			165	5825	15.0	15.5	
		2 Tx VHT40 CDD/STBC/SDM	151	5755	15.0	15.5	No
			159	5795	15.0	15.5	
		2 Tx VHT80 CDD/STBC/SDM	155	5775	15.0	15.5	Yes

Note(s):

1. "Yes" = considered for output power measurement and SAR testing. "No" = SAR test reduction was applied from KDB 248227 guidance, Se. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11 a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band.

6.3.3. Bluetooth

RF Air Interface	Mode	Max RF Output Power (dBm)	
		Antenna A	
		P _{High}	P _{Low}
Bluetooth	GFSK	17.0	10.5

Note(s):

Bluetooth P_{low} is triggered when 5 GHz Wi-Fi is on. Functional description of this mode is provided in technical description documents.

7. RF Exposure Conditions (Test Configurations)

WLAN antennas are located near the lower left and right corners of the device.

Refer to separate filing submission document for the proprietary design details of the antenna-to-antenna and antenna-to-edge 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
Antenna A															
Wi-Fi 2.4 GHz	2462	16.00	40	6.09	293.66	129.69	3.45	46.38		10.5 -MEASURE-	> 50 mm	> 50 mm	12.6 -MEASURE-	14 -EXEMPT-	
Wi-Fi 5.2 GHz	5240	17.00	50	6.09	293.66	129.69	3.45	46.38		19.1 -MEASURE-	> 50 mm	> 50 mm	22.9 -MEASURE-	2.5 -EXEMPT-	
Wi-Fi 5.3 GHz	5320	16.00	40	6.09	293.66	129.69	3.45	46.38		15.4 -MEASURE-	> 50 mm	> 50 mm	18.5 -MEASURE-	2 -EXEMPT-	
Wi-Fi 5.5 GHz	5700	15.00	32	6.09	293.66	129.69	3.45	46.38		12.7 -MEASURE-	> 50 mm	> 50 mm	15.3 -MEASURE-	17 -EXEMPT-	
Wi-Fi 5.8 GHz	5825	15.00	32	6.09	293.66	129.69	3.45	46.38		12.9 -MEASURE-	> 50 mm	> 50 mm	15.4 -MEASURE-	17 -EXEMPT-	
Bluetooth	2480	17.00	50	6.09	293.66	129.69	3.45	46.38		13.1 -MEASURE-	> 50 mm	> 50 mm	15.7 -MEASURE-	17 -EXEMPT-	
Antenna B															
Wi-Fi 2.4 GHz	2462	16.00	40	6.09	293.66	46.38	3.45	129.69		10.5 -MEASURE-	> 50 mm	14 -EXEMPT-	12.6 -MEASURE-	> 50 mm	
Wi-Fi 5.2 GHz	5240	16.00	40	6.09	293.66	46.38	3.45	129.69		15.3 -MEASURE-	> 50 mm	2 -EXEMPT-	18.3 -MEASURE-	> 50 mm	
Wi-Fi 5.3 GHz	5320	16.00	40	6.09	293.66	46.38	3.45	129.69		15.4 -MEASURE-	> 50 mm	2 -EXEMPT-	18.5 -MEASURE-	> 50 mm	
Wi-Fi 5.5 GHz	5700	15.00	32	6.09	293.66	46.38	3.45	129.69		12.7 -MEASURE-	> 50 mm	17 -EXEMPT-	15.3 -MEASURE-	> 50 mm	
Wi-Fi 5.8 GHz	5825	15.50	35	6.09	293.66	46.38	3.45	129.69		14.1 -MEASURE-	> 50 mm	18 -EXEMPT-	16.9 -MEASURE-	> 50 mm	

Note(s):

1. According to KDB 447498, if the calculated Power threshold is less than the output power then SAR testing is required.
2. With power levels similar to SISO on each chain, MIMO test requirement was determined by the combined requirements of Antenna A and Antenna B SISO.

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
Antenna A															
Wi-Fi 2.4 GHz	2462	16.00	40	6.09	293.66	129.69	3.45	46.38		< 50 mm	2532.2 mW -EXEMPT-	892.5 mW -EXEMPT-	< 50 mm	< 50 mm	
Wi-Fi 5.2 GHz	5240	17.00	50	6.09	293.66	129.69	3.45	46.38		< 50 mm	2502.1mW -EXEMPT-	862.4 mW -EXEMPT-	< 50 mm	< 50 mm	
Wi-Fi 5.3 GHz	5320	16.00	40	6.09	293.66	129.69	3.45	46.38		< 50 mm	25016 mW -EXEMPT-	8619 mW -EXEMPT-	< 50 mm	< 50 mm	
Wi-Fi 5.5 GHz	5700	15.00	32	6.09	293.66	129.69	3.45	46.38		< 50 mm	2499.4 mW -EXEMPT-	859.7 mW -EXEMPT-	< 50 mm	< 50 mm	
Wi-Fi 5.8 GHz	5825	15.00	32	6.09	293.66	129.69	3.45	46.38		< 50 mm	2498.8 mW -EXEMPT-	859.1mW -EXEMPT-	< 50 mm	< 50 mm	
Bluetooth	2480	17.00	50	6.09	293.66	129.69	3.45	46.38		< 50 mm	25319 mW -EXEMPT-	892.2 mW -EXEMPT-	< 50 mm	< 50 mm	
Antenna B															
Wi-Fi 2.4 GHz	2462	16.00	40	6.09	293.66	46.38	3.45	129.69		< 50 mm	2532.2 mW -EXEMPT-	< 50 mm	< 50 mm	892.5 mW -EXEMPT-	
Wi-Fi 5.2 GHz	5240	16.00	40	6.09	293.66	46.38	3.45	129.69		< 50 mm	2502.1mW -EXEMPT-	< 50 mm	< 50 mm	862.4 mW -EXEMPT-	
Wi-Fi 5.3 GHz	5320	16.00	40	6.09	293.66	46.38	3.45	129.69		< 50 mm	25016 mW -EXEMPT-	< 50 mm	< 50 mm	8619 mW -EXEMPT-	
Wi-Fi 5.5 GHz	5700	15.00	32	6.09	293.66	46.38	3.45	129.69		< 50 mm	2499.4 mW -EXEMPT-	< 50 mm	< 50 mm	859.7 mW -EXEMPT-	
Wi-Fi 5.8 GHz	5825	15.50	35	6.09	293.66	46.38	3.45	129.69		< 50 mm	2498.8 mW -EXEMPT-	< 50 mm	< 50 mm	859.1mW -EXEMPT-	

Note(s):

1. According to KDB 447498, if the calculated Power threshold is less than the output power then SAR testing is required.
2. With power levels similar to SISO on each chain, MIMO test requirement was determined by the combined requirements of Antenna A and Antenna B SISO.

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	Edge 2	Edge 3	Edge 4
		(Top Edge)	(Right Edge)	(Bottom Edge)	(Left Edge)
Wi-Fi 2.4 GHz SISO (Antenna A)	Yes	No	No	Yes	No
Wi-Fi 2.4 GHz SISO (Antenna B)	Yes	No	No	Yes	No
Wi-Fi 2.4 GHz MIMO	Yes	No	No	Yes	No
Wi-Fi 5 GHz SISO (Antenna A)	Yes	No	No	Yes	No
Wi-Fi 5 GHz SISO (Antenna B)	Yes	No	No	Yes	No
Wi-Fi 5 GHz MIMO	Yes	No	No	Yes	No
Bluetooth	Yes	No	No	Yes	No

Note(s):

Yes = Testing is required.

No = Testing is not required.

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 $\pm 2^\circ\text{C}$ 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.

The dielectric constant (ϵ_r) and conductivity (σ) of typical tissue-equivalent media recipes are expected to be within $\pm 5\%$ of the required target values; but for SAR measurement systems that have implemented the SAR error compensation algorithms documented in IEEE Std 1528-2013, to automatically compensate the measured SAR results for deviations between the measured and required tissue dielectric parameters, the tolerance for ϵ_r and σ may be relaxed to $\pm 10\%$. This is limited to frequencies ≤ 3 GHz.

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

Dielectric Property Measurements Results:

SAR Lab	Date	Tissue Type	Band (MHz)	Frequency (MHz)	Relative Permittivity (ϵ_r)			Conductivity (σ)		
					Measured	Target	Delta (%)	Measured	Target	Delta (%)
A	12/19/2016	5600	Body	5600	47.36	48.48	-2.31	5.87	5.76	1.96
				5500	47.56	48.61	-2.17	5.72	5.64	1.36
				5725	47.10	48.31	-2.50	6.08	5.91	2.87
A	12/27/2016	5600	Body	5600	46.61	48.48	-3.85	5.95	5.76	3.26
				5500	46.77	48.61	-3.79	5.81	5.64	2.95
				5725	46.41	48.31	-3.93	6.12	5.91	3.66
C	12/19/2016	5800	Body	5800	49.79	48.20	3.30	5.96	6.00	-0.63
				5700	49.88	48.34	3.18	5.82	5.88	-0.95
				5850	49.46	48.20	2.61	6.01	6.00	0.23
D	12/19/2016	2450	Body	2450	51.30	52.70	-2.66	1.95	1.95	0.21
				2400	51.50	52.77	-2.41	1.90	1.90	0.10
				2480	51.17	52.66	-2.83	1.99	1.99	-0.21
D	1/3/2017	2450	Body	2450	52.60	52.70	-0.19	1.96	1.95	0.51
				2400	52.77	52.77	0.00	1.90	1.90	0.21
				2480	52.51	52.66	-0.29	2.00	1.99	0.29
D	1/9/2017	2450	Body	2450	52.44	52.70	-0.49	1.92	1.95	-1.64
				2400	52.62	52.77	-0.29	1.86	1.90	-1.95
				2480	52.34	52.66	-0.61	1.96	1.99	-1.77
E	12/30/2016	5200	Body	5200	47.56	49.02	-2.98	5.45	5.29	2.99
				5150	47.67	49.09	-2.89	5.39	5.24	2.93
				5350	47.29	48.82	-3.13	5.65	5.47	3.23
F	12/19/2016	5200	Body	5200	47.32	49.02	-3.47	5.30	5.29	0.08
				5150	47.42	49.09	-3.40	5.25	5.24	0.18
				5350	47.14	48.82	-3.43	5.48	5.47	0.26
F	12/27/2016	5200	Body	5200	47.65	49.02	-2.79	5.50	5.29	3.86
				5150	47.76	49.09	-2.70	5.43	5.24	3.74
				5350	47.40	48.82	-2.90	5.71	5.47	4.30
F	1/3/2017	5800	Body	5800	46.89	48.20	-2.72	6.11	6.00	1.80
				5700	46.77	48.34	-3.25	5.94	5.88	1.10
				5850	46.89	48.20	-2.72	6.19	6.00	3.17
F	1/9/2017	5800	Body	5800	47.04	48.20	-2.41	6.19	6.00	3.23
				5700	47.08	48.34	-2.61	6.06	5.88	3.12
				5850	47.03	48.20	-2.43	6.29	6.00	4.77

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 \pm 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 \geq 15.0 cm for SAR measurements \leq 3 GHz and \geq 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.

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	Date	Tissue Type	Dipole Type Serial #	Dipole Cal. Due Data	Measured Results for 1g SAR				Measured Results for 10g SAR				Plot No.
					Zoom Scan to 100 mW	Normalize to 1 W	Target (Ref. Value)	Delta \pm 10 %	Zoom Scan to 100 mW	Normalize to 1 W	Target (Ref. Value)	Delta \pm 10 %	
A	12/19/2016	Body	D5GHzV2 SN:1168 (5.6 GHz)	11/14/2017	7.950	79.50	78.60	1.15	2.200	22.00	22.00	0.00	1, 2
A	12/27/2016	Body	D5GHzV2 SN:1003 (5.6 GHz)	2/25/2017	8.260	82.60	79.80	3.51	2.270	22.70	22.40	1.34	3, 4
C	12/19/2016	Body	D5GHzV2 SN:1138 (5.8 GHz)	9/22/2017	7.090	70.90	75.70	-6.34	1.960	19.60	21.10	-7.11	5, 6
D	12/19/2016	Body	D2450V2 SN:899	3/15/2017	5.150	51.50	49.60	3.83	2.330	23.30	23.40	-0.43	
D	1/3/2017	Body	D2450V2 SN:899	3/15/2017	4.740	47.40	49.60	-4.44	2.160	21.60	23.40	-7.69	7, 8
D	1/9/2017	Body	D2450V2 SN:899	3/15/2017	4.930	49.30	49.60	-0.60	2.240	22.40	23.40	-4.27	
E	12/30/2016	Body	D5GHzV2 SN:1138 (5.2 GHz)	9/22/2017	7.600	76.00	74.20	2.43	2.150	21.50	20.90	2.87	9, 10
F	12/19/2016	Body	D5GHzV2 SN:1138 (5.2 GHz)	9/22/2017	7.430	74.30	74.20	0.13	2.100	21.00	20.90	0.48	
F	12/27/2016	Body	D5GHzV2 SN:1168 (5.2 GHz)	11/14/2017	7.520	75.20	73.60	2.17	2.130	21.30	20.50	3.90	11,12
F	1/3/2017	Body	D5GHzV2 SN:1138 (5.8 GHz)	9/22/2017	7.030	70.30	75.70	-7.13	1.960	19.60	21.10	-7.11	13,14
F	1/9/2017	Body	D5GHzV2 SN:1138 (5.8 GHz)	9/22/2017	7.070	70.70	75.70	-6.61	1.970	19.70	21.10	-6.64	

9. Conducted Output Power Measurements

9.1. Wi-Fi SISO

Measured Results

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max. Avg. RF Output Power (dBm)	
					Antenna A	Antenna B
2.4	802.11b	1 Tx	1	2412	16.0	16.0
			6	2437	16.0	16.0
			11	2462	16.0	16.0
Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max. Avg. RF Output Power (dBm)	
					Antenna A	Antenna B
5.2	802.11n HT40	1 Tx	38	5190	14.0	Not Required
			46	5230	17.0	
Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max. Avg. RF Output Power (dBm)	
					Antenna A	Antenna B
5.3	802.11n HT40	1 Tx	54	5270	Not Required	15.5
			62	5310		14.0
Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max. Avg. RF Output Power (dBm)	
					Antenna A	Antenna B
5.5	802.11ac VHT80	1 Tx	106	5530	13.0	13.0
			122	5610	15.0	15.0
			138	5690	14.8	15.0
Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max. Avg. RF Output Power (dBm)	
					Antenna A	Antenna B
5.8	802.11ac VHT80	1 Tx	155	5775	15.0	15.5

Note(s):

- The maximum output power specified for production units are determined for all applicable 802.11 transmission modes in each standalone and aggregated frequency band. Maximum output power is measured for the highest maximum output power configuration(s) in each frequency band according to the default power measurement procedures. For "Not required", SAR Test reduction was applied from KDB 248227 guidance, Sec. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band. Additional output power measurements were not deemed necessary.

9.2. WLAN MIMO

Measured Results

Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max. Avg. RF Output Power (dBm)	
					Antenna A	Antenna B
2.4	802.11g CDD	2 Tx	2	2417	16.0	16.0
			6	2437	16.0	16.0
			10	2457	16.0	16.0
Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max. Avg. RF Output Power (dBm)	
					Antenna A	Antenna B
5.2	802.11n HT40 CDD	2 Tx	38	5190	13.0	12.8
			46	5230	17.0	15.6
Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max. Avg. RF Output Power (dBm)	
					Antenna A	Antenna B
5.5	802.11ac VHT80 CDD	2 Tx	106	5530	11.5	11.5
			122	5610	15.0	15.0
			138	5690	14.9	15.0
Band (GHz)	Mode	No. of Transmitters	Ch #	Freq. (MHz)	Max. Avg. RF Output Power (dBm)	
					Antenna A	Antenna B
5.8	802.11ac VHT80 CDD	2 Tx	155	5775	15.0	15.5

Note(s):

1. The maximum output power specified for production units are determined for all applicable 802.11 transmission modes in each standalone and aggregated frequency band. Maximum output power is measured for the highest maximum output power configuration(s) in each frequency band according to the default power measurement procedures.

9.3. Bluetooth

P_{High} Average Power Measured Results

Band (GHz)	Mode	Ch #	Freq. (MHz)	Avg Pwr (dBm)
2.4	GFSK	0	2402	16.5
		39	2441	15.6
		78	2480	16.2

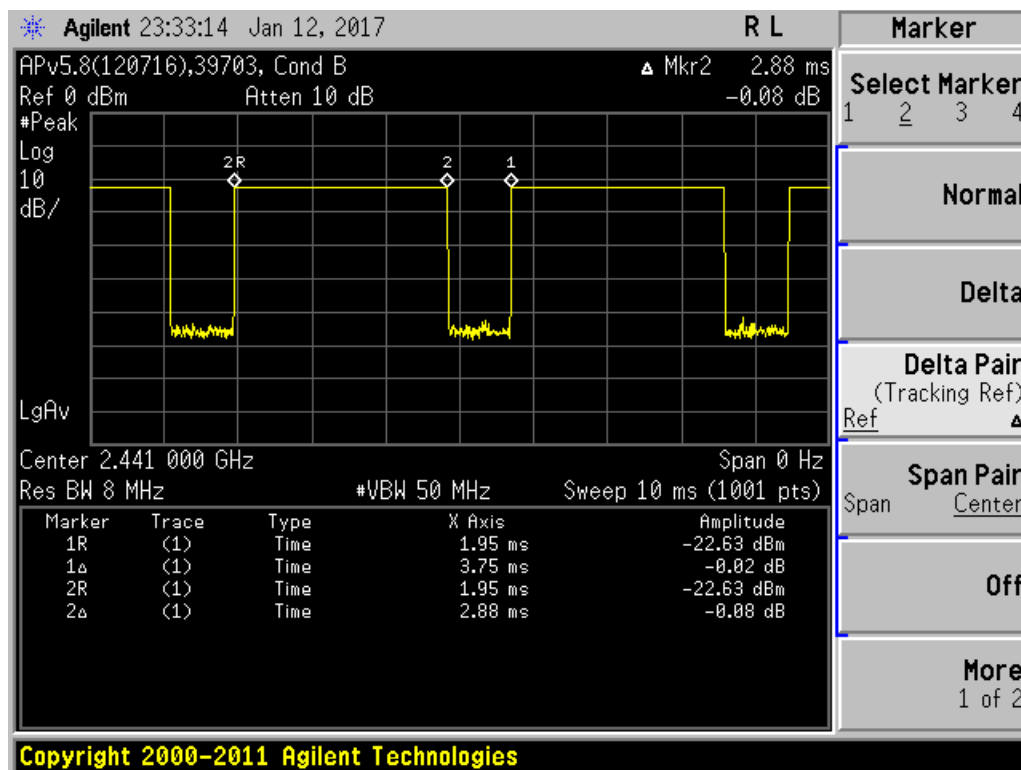
P_{Low} Average Power Measured Results

Band (GHz)	Mode	Ch #	Freq. (MHz)	Avg Pwr (dBm)
2.4	GFSK	0	2402	9.4
		39	2441	9.4
		78	2480	9.3

Duty Factor Measured Results

Mode	Type	T on (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
GFSK	DH1	2.88	3.75	76.80%	1.30
	DH3	2.88	3.75	76.80%	1.30
	DH5	2.88	3.75	76.80%	1.30

GFSK Duty Cycle plots



10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance:

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

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

KDB 248227 D01 SAR meas for 802.11:

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 closest/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.

10.1. Wi-Fi (DTS Band)

Variant 1

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)				SAR (W/kg)								Plots
							Antenna A		Antenna B		Antenna A				Antenna B				
							Tune-up Limit	Measured	Tune-up Limit	Measured	Measured		Scaled		Measured		Scaled		
										1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g		
2.4 GHz	1 Tx	802.11b	0	Rear	6	2437	16.0	16.0			0.070	0.030	0.070	0.030					
				Edge 3	6	2437	16.0	16.0			1.100	0.369	1.100	0.369					
					11	2462	16.0	16.0			1.040	0.348	1.040	0.348					
2.4 GHz	1 Tx	802.11b	0	Rear	6	2437			16.0	16.0					0.091	0.038	0.091	0.038	
				Edge 3	6	2437			16.0	16.0					1.000	0.335	1.000	0.335	
					11	2462			16.0	16.0					1.190	0.397	1.190	0.397	1
2.4 GHz	2 Tx	802.11g CDD	0	Rear	6	2437	16.0	16.0	16.0	16.0	0.069	0.029	0.069	0.029	0.091	0.038	0.091	0.038	
				Edge 3	6	2437	16.0	16.0	16.0	16.0	1.140	0.386	1.140	0.386	0.981	0.333	0.981	0.333	
					10	2457	16.0	16.0	16.0	16.0	1.070	0.361	1.070	0.361	1.140	0.383	1.140	0.383	

Variant 2 Spot Check

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)				SAR (W/kg)								Plots
							Antenna A		Antenna B		Antenna A				Antenna B				
							Tune-up Limit	Measured	Tune-up Limit	Measured	Measured		Scaled		Measured		Scaled		
										1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g		
2.4 GHz	1 Tx	802.11b	0	Edge 3	11	2462			16.0	15.7					0.992	0.332	1.063	0.356	

10.2. Wi-Fi (U-NII-1 and U-NII-2A Band)

Variant 1

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)				SAR (W/kg)								Plots
							Antenna A		Antenna B		Antenna A				Antenna B				
							Tune-up Limit	Measured	Tune-up Limit	Measured	Measured		Scaled		Measured		Scaled		
							1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g			
5.2 GHz	1 Tx	802.11n HT40	0	Rear	46	5230	17.0	17.0			0.115	0.043	0.115	0.043					
				Edge 3	38	5190	14.0	14.0			0.614	0.189	0.614	0.189					
					46	5230	17.0	17.0			1.070	0.331	1.070	0.331					
5.3 GHz	1 Tx	802.11n HT40	0	Rear	54	5270			16.0	15.5					0.072	0.028	0.081	0.031	
				Edge 3	54	5270			16.0	15.5					0.888	0.304	0.996	0.341	
					62	5310			14.0	14.0					0.752	0.259	0.752	0.259	
5.2 GHz	2 Tx	802.11n HT40 CDD	0	Rear	46	5230	17.0	17.0	16.0	15.6	0.125	0.046	0.125	0.046	0.100	0.040	0.110	0.044	
				Edge 3	38	5190	13.0	13.0	13.0	12.8	0.416	0.128	0.416	0.128	0.384	0.124	0.402	0.130	
					46	5230	17.0	17.0	16.0	15.6	1.090	0.368	1.090	0.368	0.889	0.299	0.975	0.328	2

Variant 2 Spot Check

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)				SAR (W/kg)								Plots
							Antenna A		Antenna B		Antenna A				Antenna B				
							Tune-up Limit	Measured	Tune-up Limit	Measured	Measured		Scaled		Measured		Scaled		
										1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g		
5.2 GHz	2 Tx	802.11n HT40 CDD	0	Edge 3	46	5230	17.0	17.0	16.0	15.6	1.020	0.347	1.020	0.347	0.874	0.304	0.958	0.333	

10.3. Wi-Fi (U-NII-2C Band)

Variant 1

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)				SAR (W/kg)								Plots
							Antenna A		Antenna B		Antenna A				Antenna B				
							Tune-up Limit	Measured	Tune-up Limit	Measured	Measured		Scaled		Measured		Scaled		
										1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g		
5.5 GHz	1 Tx	802.11ac VHT80	0	Rear	122	5610	15.0	15.0			0.074	0.028	0.074	0.028					
				Edge 3	122	5610	15.0	15.0			0.935	0.318	0.935	0.318					
					138	5690	15.0	14.8			1.070	0.367	1.120	0.384					
5.5 GHz	1 Tx	802.11ac VHT80	0	Rear	122	5610			15.0	15.0					0.072	0.027	0.072	0.027	
				Edge 3	122	5610			15.0	15.0					0.889	0.296	0.889	0.296	
					138	5690			15.0	15.0					1.170	0.395	1.170	0.395	4
5.5 GHz	2 Tx	802.11ac VHT80 CDD	0	Rear	122	5610	15.0	15.0	15.0	15.0	0.131	0.041	0.131	0.041	0.106	0.040	0.106	0.040	
				Edge 3	122	5610	15.0	15.0	15.0	15.0	1.060	0.355	1.060	0.355	0.981	0.323	0.981	0.323	
					138	5690	15.0	14.9	15.0	15.0	1.040	0.355	1.064	0.363	1.000	0.336	1.000	0.336	

Variant 2 Spot Check

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)				SAR (W/kg)								Plots
							Antenna A		Antenna B		Antenna A				Antenna B				
							Tune-up Limit	Measured	Tune-up Limit	Measured	Measured		Scaled		Measured		Scaled		
										1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g		
5.5GHz	1 Tx	802.11ac VHT80	0	Edge 3	138	5690			15.0	14.9					0.983	0.327	1.006	0.335	

10.4. Wi-Fi (U-NII-3 Band)

Variant 1

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)				SAR (W/kg)								Plots
							Antenna A		Antenna B		Antenna A				Antenna B				
							Tune-up Limit	Measured	Tune-up Limit	Measured	Measured		Scaled		Measured		Scaled		
							1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g			
5.8 GHz	1 Tx	802.11ac VHT80	0	Rear	155	5775	15.0	15.0			0.086	0.034	0.086	0.034					
				Edge 3	155	5775	15.0	15.0			1.000	0.316	1.000	0.316					
5.8 GHz	1 Tx	802.11ac VHT80	0	Rear	155	5775			15.5	15.5					0.091	0.035	0.091	0.035	
				Edge 3	155	5775			15.5	15.5					1.080	0.352	1.080	0.352	
5.8 GHz	2 Tx	802.11ac VHT80	0	Rear	155	5775	15.0	15.0	15.5	15.5	0.108	0.043	0.108	0.043	0.102	0.039	0.102	0.039	
				Edge 3	155	5775	15.0	15.0	15.5	15.5	1.090	0.357	1.090	0.357	1.030	0.357	1.030	0.357	
																		5	

Variant 2 Spot Check

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)				SAR (W/kg)								Plots
							Antenna A		Antenna B		Antenna A				Antenna B				
							Tune-up Limit	Measured	Tune-up Limit	Measured	Measured		Scaled		Measured		Scaled		
											1-g	10-g	1-g	10-g	1-g	10-g	1-g	10-g	
5.8 GHz	2 Tx	802.11ac VHT80	0	Edge 3	155	5775	15.0	15.0	15.5	15.5	1.070	0.341	1.070	0.341	0.914	0.294	0.914	0.294	

10.5. Bluetooth (P_{High})

Variant 1

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)		SAR (W/kg)				Plots
							Tune-up Limit	Measured	Measured		Scaled		
									1-g	10-g	1-g	10-g	
Bluetooth	1 Tx	GFSK	0	Rear	0	2402	17.0	16.5	0.089	0.038	0.100	0.043	
				Edge 3	0	2402	17.0	16.5	0.794	0.266	0.891	0.298	
					39	2441	17.0	15.6	0.858	0.288	1.184	0.398	
					78	2480	17.0	16.2	0.926	0.310	1.113	0.373	

Variant 2 Spot Check

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)		SAR (W/kg)				Plots
							Tune-up Limit	Measured	Measured		Scaled		
									1-g	10-g	1-g	10-g	
Bluetooth	1 Tx	GFSK	0	Edge 3	39	2441	17.0	15.6	0.751	0.252	1.037	0.348	

10.6. Bluetooth (P_{Low})

Variant 1

Band	No. of Transmitters	Mode	Dist. (mm)	Position	Ch #.	Freq. (MHz)	Power (dBm)		SAR (W/kg)				Plots
							Tune-up Limit	Measured	Measured		Scaled		
									1-g	10-g	1-g	10-g	
Bluetooth	1 Tx	GFSK	0	Rear	39	2441	10.5	9.4	0.010	0.003	0.013	0.004	
				Edge 3	39	2441	10.5	9.4	0.166	0.053	0.214	0.068	

Note(s):

Bluetooth P_{low} is triggered when 5 GHz Wi-Fi is on. Functional description of this mode is provided in technical description documents.

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 < 0.8 or 2 W/kg (1-g or 10-g respectively); steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is ≥ 0.8 or 2 W/kg (1-g or 10-g respectively), 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 3 (1-g or 10-g respectively) or when the original or repeated measurement is ≥ 1.45 or 3.6 W/kg ($\sim 10\%$ from the 1-g or 10-g respective SAR limit).
- 4) Perform a third repeated measurement only if the original, first, or second repeated measurement is ≥ 1.5 or 3.75 W/kg (1-g or 10-g respectively) and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 or 3 (1-g or 10-g respectively).

Frequency Band (MHz)	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR (Yes/No)	Highest Measured SAR (W/kg)	First Repeated		Second Repeated	
						Measured SAR (W/kg)	Largest to Smallest SAR Ratio	Measured SAR (W/kg)	Largest to Smallest SAR Ratio
2400	Wi-Fi 802.11b/g/n	Standalone	Edge 3	Yes	1.190	1.150	1.03	N/A	N/A
	BT	Standalone	Edge 3	No	0.926	N/A	N/A	N/A	N/A
5200	Wi-Fi 802.11a/n/ac	Standalone	Edge 3	Yes	1.090	1.080	1.01	N/A	N/A
5300	Wi-Fi 802.11a/n/ac	Standalone	Edge 3	Yes	0.888	0.843	1.05	N/A	N/A
5500	Wi-Fi 802.11a/n/ac	Standalone	Edge 3	Yes	1.17	1.09	1.07	N/A	N/A
5800	Wi-Fi 802.11a/n/ac	Standalone	Edge 3	Yes	1.09	1.05	1.04	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 or 3 (1-g or 10-g respectively).

12. Simultaneous Transmission SAR Analysis

According to KDB 447498 D01, when the sum of SAR exceeds the limit for a combination of simultaneously transmitting antennas, SAR test exclusion is determined by the SAR to peak location separation ratio (SPLSR) between pairs of antennas within the combination. SPLSR is determined by $(SAR_1 + SAR_2)^{1.5} / Ri$, where SAR_1 and SAR_2 are the highest reported or estimated SAR values for each antenna, and Ri is the separation distance between the SAR peak locations. SAR peak locations and Ri are to be determined differently depending on the SAR values involved- measured or estimated- and all coordinates must be clearly identified in the report.

To qualify for SAR test exclusion by way of SPLSR, each antenna in the combination must be evaluated one pair at a time, and the SPLSR for all pairs must be ≤ 0.04 and 0.10 , respectively, for 1-g and 10-g SAR evaluation.

Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations			
Body	1	WLAN ONLY	+ Antenna A Wi-Fi 5 GHz SISO	+	Bluetooth (P _{low})
	2		+ Antenna B Wi-Fi 5 GHz SISO	+	Bluetooth (P _{low})
	3		+ Wi-Fi 5 GHz MIMO	+	Bluetooth (P _{low})
Note:					
1. Wi-Fi 2.4GHz cannot transmit simultaneously with Bluetooth Radio.					

Estimated SAR for Simultaneous Transmission SAR Analysis

Considerations for SAR estimation

- When standalone SAR test exclusion applies, standalone SAR must also be estimated to determine simultaneous transmission SAR test exclusion.
- 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
- Please refer to Estimated SAR Tables to see which test positions are inherently compliant as they consist of only estimated SAR values for all applicable transmitters and consequently will always have sum of SAR values < 1.2 W/kg. Simultaneous transmission SAR analysis was therefore not performed for these test positions.
- For conditions where the estimated SAR is overly conservative for certain conditions, the test lab may choose to perform standalone SAR measurements and use the measured SAR to determine simultaneous transmission SAR test exclusion.

Estimated SAR for WLAN

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
Antenna A															
Wi-Fi 2.4 GHz	2462	16.00	40	6.09	293.66	129.69	3.45	46.38		-MEASURE	0.400	0.400	-MEASURE	0.182	
Wi-Fi 5.2 GHz	5240	17.00	50	6.09	293.66	129.69	3.45	46.38		-MEASURE	0.400	0.400	-MEASURE	0.332	
Wi-Fi 5.3 GHz	5320	16.00	40	6.09	293.66	129.69	3.45	46.38		-MEASURE	0.400	0.400	-MEASURE	0.267	
Wi-Fi 5.5 GHz	5700	15.00	32	6.09	293.66	129.69	3.45	46.38		-MEASURE	0.400	0.400	-MEASURE	0.221	
Wi-Fi 5.8 GHz	5825	15.00	32	6.09	293.66	129.69	3.45	46.38		-MEASURE	0.400	0.400	-MEASURE	0.224	
Bluetooth	2480	17.00	50	6.09	293.66	129.69	3.45	46.38		-MEASURE	0.400	0.400	-MEASURE	0.228	
Antenna B															
Wi-Fi 2.4 GHz	2462	16.00	40	6.09	293.66	46.38	3.45	129.69		-MEASURE	0.400	0.182	-MEASURE	0.400	
Wi-Fi 5.2 GHz	5240	16.00	40	6.09	293.66	46.38	3.45	129.69		-MEASURE	0.400	0.265	-MEASURE	0.400	
Wi-Fi 5.3 GHz	5320	16.00	40	6.09	293.66	46.38	3.45	129.69		-MEASURE	0.400	0.267	-MEASURE	0.400	
Wi-Fi 5.5 GHz	5700	15.00	32	6.09	293.66	46.38	3.45	129.69		-MEASURE	0.400	0.221	-MEASURE	0.400	
Wi-Fi 5.8 GHz	5825	15.50	35	6.09	293.66	46.38	3.45	129.69		-MEASURE	0.400	0.245	-MEASURE	0.400	

12.1. Sum of the SAR for Wi-Fi and BT

RF Exposure Condition	Test Position	Standalone SAR (W/kg)				Σ 1-g SAR (W/g)		
		(A)	(B)	(C)	(D)	(A) + (D)	(B) + (D)	(C) + (D)
		U-NII Ant. A	U-NII Ant. B	U-NII MIMO	BT P-Low	U-NII + BT Ant. A + P-Low	U-NII + BT Ant. B + P-Low	U-NII + BT MIMO + P-Low
Body	Rear	0.115	0.091	0.131	0.013	0.128	0.104	0.144
	Edge 3	1.070	1.170	1.090	0.214	1.284	1.384	1.304

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.

Appendixes

Refer to separated files for the following appendixes.

16U23815-S1V1 SAR_App A Setup Photos

16U23815-S1V1 SAR_App B System Check Plots

16U23815-S1V2 SAR_App C Highest Test Plots

16U23815-S1V1 SAR_App D Tissue Ingredients

16U23815-S1V1 SAR_App E Probe Cal. Certificates

16U23815-S1V1 SAR_App F Dipole Cal. Certificates

END OF REPORT