SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
Apple Watch

FCC ID: BCG-E2870
Model Name: A1553

Report Number: 14U19383-S1C
Issue Date: 3/2/2015

Prepared for
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Date	Revisions	Revised By
--	2/20/2015	Initial Issue	--
A	2/27/2015	Revised report based on Reviewer's comments: 1. Sec 8.1: corrected typo 2. Appendix A: updated	Kenneth Mak
B	3/2/2015	Revised report based on Reviewer's comments: 1. Sec 6.1: Updated	Kenneth Mak
C	3/2/2015	Revised report based on Reviewer's comments: 1. Sec 6.4 added 2. Sec 7.: updated	Kenneth Mak

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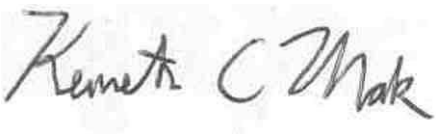
1. Attestation of Test Results

Applicant Name	APPLE INC.			
FCC ID	BCG-E2870			
Model Name	A1553			
Applicable Standards	FCC 47 CFR § 2.1093 Published RF exposure KDB procedures IEEE Std 1528-2013			
SAR Limits (W/Kg)				
Exposure Category	Peak spatial-average (1g of tissue)		Extremities (hands, wrists, ankles, etc.) (10g of tissue)	
General population / Uncontrolled exposure	1.6		4	
The Highest Reported SAR (W/kg)				
RF Exposure Conditions	**Equipment Class**			
	Licensed	**DTS**	**U-NII**	**DSS (BT)**
Extremity (Wrist)	N/A	0.024	N/A	0.006
Next-to-Mouth	N/A	0.153	N/A	0.044
Date Tested	1/9/2015 to 1/23/2015; 2/16/2015 to 2/20/2015			
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.	Kenneth 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 SAR meas for 802.11 v02
- 447498 D01 General RF Exposure Guidance v05r02
- 447498 D03 Supplement C Cross-Reference
- 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

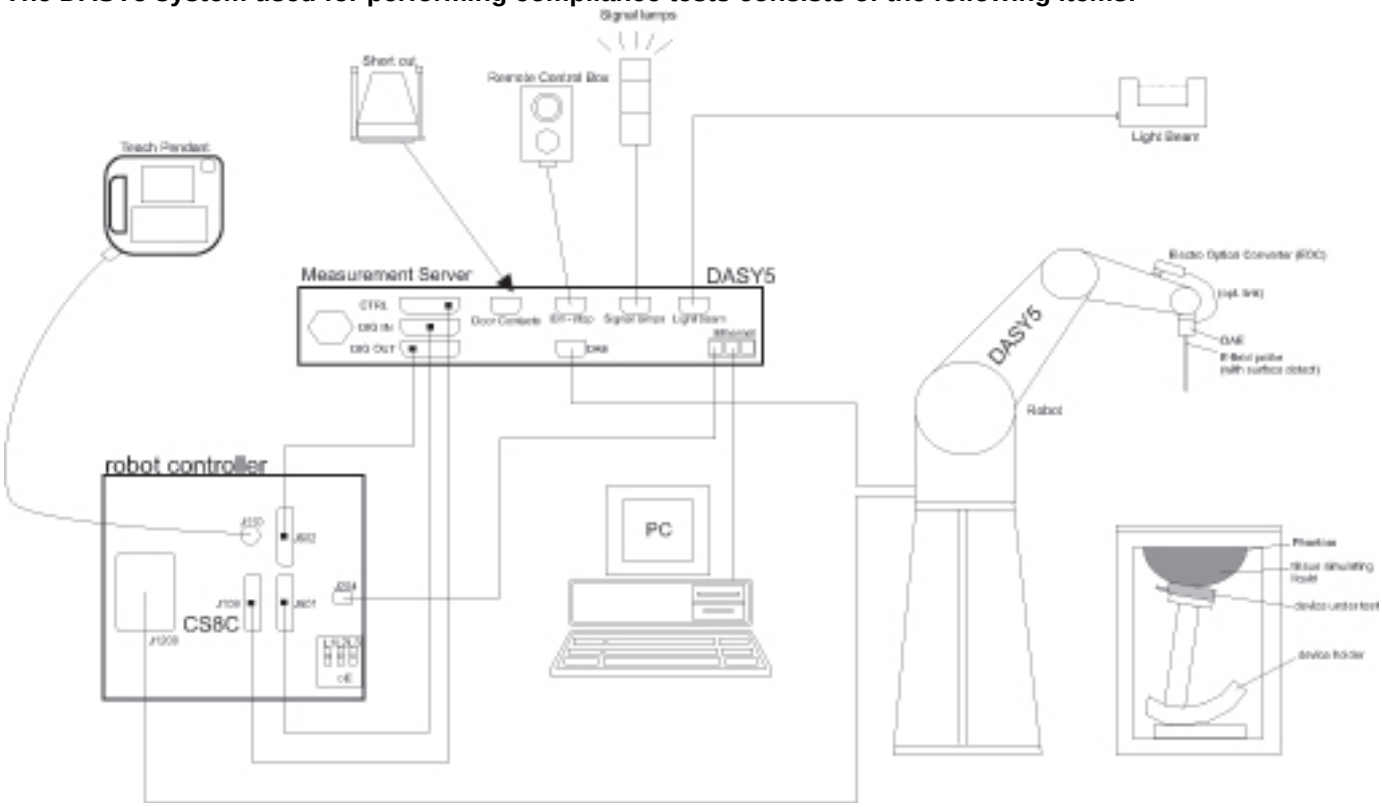
47173 Benicia Street	47266 Benicia Street
SAR Lab A	SAR Lab 1
SAR Lab B	SAR Lab 2
SAR Lab C	SAR Lab 3
SAR Lab D	SAR Lab 4
SAR Lab E	SAR Lab 5
SAR Lab F	
SAR Lab G	
SAR Lab H	

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

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

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



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

4.2. SAR Scan Procedures

Step 1: Power Reference Measurement

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

Step 2: Area Scan

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

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

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

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

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

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5·$\Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the area scan based *1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

Step 4: Power drift measurement

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

Step 5: Z-Scan (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	MY40001647	7/17/2015
Dielectronic Probe kit	SPEAG	DAK-3.5	1103	2/18/2015
Dielectronic Probe kit	SPEAG	DAK-3.5	1087	11/11/2015
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
Synthesized Signal Generator	HP	8665B	3744A01155	3/12/2015
Power Meter	HP	437B	3125U11364	8/27/2015
Power Meter	HP	437B	3125U12345	8/15/2015
Power Sensor	HP	8481A	1926A27048	8/15/2015
Power Sensor	HP	8481A	2702A76223	9/17/2015
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795092	N/A
Directional coupler	Werlatone	C8060-102	2141	N/A
DC Power Supply	BK PRECISION	1611	215-02292	N/A
E-Field Probe (SAR Lab A)	SPEAG	EX3DV4	3901	1/27/2016
Data Acquisition Electronics (SAR Lab A)	SPEAG	DAE4	1433	4/14/2015
E-Field Probe (SAR Lab B)	SPEAG	EX3DV4	3751	11/14/2015
Data Acquisition Electronics (SAR Lab B)	SPEAG	DAE3	500	5/15/2015
E-Field Probe (SAR Lab C)	SPEAG	EX3DV4	3885	9/15/2015
Data Acquisition Electronics (SAR Lab C)	SPEAG	DAE4	1360	3/17/2015
E-Field Probe (SAR Lab G)	SPEAG	EX3DV4	3990	4/15/2015
Data Acquisition Electronics (SAR Lab G)	SPEAG	DAE4	1434	4/14/2015
E-Field Probe (SAR Lab H)	SPEAG	EX3DV4	3871	8/26/2015
Data Acquisition Electronics (SAR Lab H)	SPEAG	DAE4	1258	5/15/2015
System Validation Dipole	SPEAG	D2450V2	706	5/20/2015
System Validation Dipole	SPEAG	D2450V2	899	9/10/2015

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

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.

6. Device Under Test (DUT) Information

6.1. DUT Description

Model A1553 has 3 types of enclosures and various kinds of metallic and non-metallic wristbands. There are 2 types of metallic bands: Metal Links and Metal Mesh. SAR testing was performed to determine worst case enclosure for both non-metallic and metallic wristbands. Model A1553 has one WiFi/BT antenna port. The antenna used in any given unit can be either Antenna 1 or Antenna 2. Complete SAR evaluation is performed on the device with Antenna 1 and then, the test is repeated on the device with Antenna 2 at the highest peak SAR value.	
Intended Use	Wrist-worn
Device Dimension	Overall (Length x Width): 38.6 mm x 33.3 mm (excluding strap) Overall Diagonal: 45.7 mm Display Diagonal: 34.03 mm
Accessory	Removable wristbands: metallic and non-metallic

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%
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)

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	19.5
		6	2437	19.5
		11	2462	19.5
		12	2467	19.5
		13	2472	19.0
	802.11g	1	2412	18.0
		6	2437	19.5
		11	2462	18.0
		12	2467	16.5
		13	2472	6.0
	802.11n	1	2412	18.0
		6	2437	19.5
		11	2462	18.0
		12	2467	16.5
		13	2472	6.0
	Bluetooth BDR			12.5
	Bluetooth EDR			10.0
	Bluetooth LE			12.0

6.4. Antenna Dimensions and Separation Distances

Refer to separate filing document.

7. RF Exposure Conditions (Test Configurations)

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

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation (mm)	Test Position	Antenna-to-edge/surface	SAR Required	Note
WLAN	Extremity (Hand/Wrist/Ankle)	0	Rear	N/A	Yes	
	Next to Mouth	10	Front	N/A	Yes	

8. Dielectric Property Measurements & System Check

8.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.

The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.

Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

Tissue Dielectric Parameters

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

IEEE Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

Dielectric Property Measurements Results:

SAR Lab A

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
2/19/2015	Head 2450	e'	38.5000	Relative Permittivity (ϵ_r):	38.50	39.20	-1.79	5
		e''	13.0900	Conductivity (σ):	1.78	1.80	-0.93	5
	Head 2410	e'	38.5700	Relative Permittivity (ϵ_r):	38.57	39.28	-1.81	5
		e''	12.9500	Conductivity (σ):	1.74	1.76	-1.43	5
	Head 2475	e'	38.4200	Relative Permittivity (ϵ_r):	38.42	39.17	-1.91	5
		e''	13.0800	Conductivity (σ):	1.80	1.83	-1.48	5
2/19/2015	Body 2450	e'	51.9900	Relative Permittivity (ϵ_r):	51.99	52.70	-1.35	5
		e''	14.1100	Conductivity (σ):	1.92	1.95	-1.43	5
	Body 2410	e'	51.9800	Relative Permittivity (ϵ_r):	51.98	52.76	-1.48	5
		e''	13.9800	Conductivity (σ):	1.87	1.91	-1.79	5
	Body 2475	e'	51.9200	Relative Permittivity (ϵ_r):	51.92	52.67	-1.42	5
		e''	14.0700	Conductivity (σ):	1.94	1.99	-2.46	5

SAR Lab B

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/21/2015	Head 2450	e'	40.9100	Relative Permittivity (ϵ_r):	40.91	39.20	4.36	5
		e''	13.5000	Conductivity (σ):	1.84	1.80	2.17	5
	Head 2410	e'	41.0600	Relative Permittivity (ϵ_r):	41.06	39.28	4.53	5
		e''	13.4200	Conductivity (σ):	1.80	1.76	2.15	5
	Head 2475	e'	40.7900	Relative Permittivity (ϵ_r):	40.79	39.17	4.14	5
		e''	13.5700	Conductivity (σ):	1.87	1.83	2.21	5
2/2/2015	Head 2450	e'	40.0300	Relative Permittivity (ϵ_r):	40.03	39.20	2.12	5
		e''	13.0700	Conductivity (σ):	1.78	1.80	-1.08	5
	Head 2410	e'	39.9700	Relative Permittivity (ϵ_r):	39.97	39.28	1.76	5
		e''	13.0500	Conductivity (σ):	1.75	1.76	-0.66	5
	Head 2475	e'	39.9100	Relative Permittivity (ϵ_r):	39.91	39.17	1.89	5
		e''	12.9300	Conductivity (σ):	1.78	1.83	-2.61	5
2/2/2015	Body 2450	e'	50.9700	Relative Permittivity (ϵ_r):	50.97	52.70	-3.28	5
		e''	14.4400	Conductivity (σ):	1.97	1.95	0.88	5
	Body 2410	e'	50.7800	Relative Permittivity (ϵ_r):	50.78	52.76	-3.75	5
		e''	14.5800	Conductivity (σ):	1.95	1.91	2.43	5
	Body 2475	e'	50.7300	Relative Permittivity (ϵ_r):	50.73	52.67	-3.68	5
		e''	14.3300	Conductivity (σ):	1.97	1.99	-0.66	5
2/16/2015	Head 2450	e'	39.3500	Relative Permittivity (ϵ_r):	39.35	39.20	0.38	5
		e''	13.5100	Conductivity (σ):	1.84	1.80	2.25	5
	Head 2410	e'	39.5000	Relative Permittivity (ϵ_r):	39.50	39.28	0.56	5
		e''	13.3700	Conductivity (σ):	1.79	1.76	1.77	5
	Head 2475	e'	39.2700	Relative Permittivity (ϵ_r):	39.27	39.17	0.26	5
		e''	13.5000	Conductivity (σ):	1.86	1.83	1.69	5
2/16/2015	Body 2450	e'	51.2800	Relative Permittivity (ϵ_r):	51.28	52.70	-2.69	5
		e''	14.4600	Conductivity (σ):	1.97	1.95	1.02	5
	Body 2410	e'	51.4000	Relative Permittivity (ϵ_r):	51.40	52.76	-2.58	5
		e''	14.3600	Conductivity (σ):	1.92	1.91	0.88	5
	Body 2475	e'	51.2500	Relative Permittivity (ϵ_r):	51.25	52.67	-2.69	5
		e''	14.4600	Conductivity (σ):	1.99	1.99	0.24	5

SAR Lab C

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/12/2015	Head 2450	e'	38.9000	Relative Permittivity (ϵ_r):	38.90	39.20	-0.77	5
		e''	13.2600	Conductivity (σ):	1.81	1.80	0.35	5
	Head 2410	e'	39.0300	Relative Permittivity (ϵ_r):	39.03	39.28	-0.63	5
		e''	13.1700	Conductivity (σ):	1.76	1.76	0.25	5
	Head 2475	e'	38.8100	Relative Permittivity (ϵ_r):	38.81	39.17	-0.92	5
		e''	13.2300	Conductivity (σ):	1.82	1.83	-0.35	5
1/12/2015	Body 2450	e'	52.2800	Relative Permittivity (ϵ_r):	52.28	52.70	-0.80	5
		e''	14.6000	Conductivity (σ):	1.99	1.95	2.00	5
	Body 2410	e'	52.3700	Relative Permittivity (ϵ_r):	52.37	52.76	-0.74	5
		e''	14.5200	Conductivity (σ):	1.95	1.91	2.01	5
	Body 2475	e'	52.2000	Relative Permittivity (ϵ_r):	52.20	52.67	-0.89	5
		e''	14.5400	Conductivity (σ):	2.00	1.99	0.80	5
1/20/2015	Head 2450	e'	39.4400	Relative Permittivity (ϵ_r):	39.44	39.20	0.61	5
		e''	13.1100	Conductivity (σ):	1.79	1.80	-0.78	5
	Head 2410	e'	39.5700	Relative Permittivity (ϵ_r):	39.57	39.28	0.74	5
		e''	12.9900	Conductivity (σ):	1.74	1.76	-1.12	5
	Head 2475	e'	39.3700	Relative Permittivity (ϵ_r):	39.37	39.17	0.51	5
		e''	13.1300	Conductivity (σ):	1.81	1.83	-1.10	5
1/20/2015	Body 2450	e'	51.7400	Relative Permittivity (ϵ_r):	51.74	52.70	-1.82	5
		e''	14.5300	Conductivity (σ):	1.98	1.95	1.51	5
	Body 2410	e'	51.8500	Relative Permittivity (ϵ_r):	51.85	52.76	-1.72	5
		e''	14.4200	Conductivity (σ):	1.93	1.91	1.30	5
	Body 2475	e'	51.6600	Relative Permittivity (ϵ_r):	51.66	52.67	-1.91	5
		e''	14.5400	Conductivity (σ):	2.00	1.99	0.80	5
2/2/2015	Head 2450	e'	37.9900	Relative Permittivity (ϵ_r):	37.99	39.20	-3.09	5
		e''	13.0900	Conductivity (σ):	1.78	1.80	-0.93	5
	Head 2410	e'	37.9300	Relative Permittivity (ϵ_r):	37.93	39.28	-3.43	5
		e''	13.1200	Conductivity (σ):	1.76	1.76	-0.13	5
	Head 2475	e'	37.8100	Relative Permittivity (ϵ_r):	37.81	39.17	-3.47	5
		e''	12.9800	Conductivity (σ):	1.79	1.83	-2.23	5
2/2/2015	Body 2450	e'	52.1100	Relative Permittivity (ϵ_r):	52.11	52.70	-1.12	5
		e''	14.6500	Conductivity (σ):	2.00	1.95	2.35	5
	Body 2410	e'	52.0700	Relative Permittivity (ϵ_r):	52.07	52.76	-1.31	5
		e''	14.5400	Conductivity (σ):	1.95	1.91	2.15	5
	Body 2475	e'	51.9800	Relative Permittivity (ϵ_r):	51.98	52.67	-1.31	5
		e''	14.5000	Conductivity (σ):	2.00	1.99	0.52	5
2/16/2015	Head 2450	e'	38.0100	Relative Permittivity (ϵ_r):	38.01	39.20	-3.04	5
		e''	13.4300	Conductivity (σ):	1.83	1.80	1.64	5
	Head 2410	e'	38.1500	Relative Permittivity (ϵ_r):	38.15	39.28	-2.87	5
		e''	13.3100	Conductivity (σ):	1.78	1.76	1.31	5
	Head 2475	e'	37.9300	Relative Permittivity (ϵ_r):	37.93	39.17	-3.16	5
		e''	13.4400	Conductivity (σ):	1.85	1.83	1.23	5
2/16/2015	Body 2450	e'	51.4900	Relative Permittivity (ϵ_r):	51.49	52.70	-2.30	5
		e''	14.4700	Conductivity (σ):	1.97	1.95	1.09	5
	Body 2410	e'	51.6400	Relative Permittivity (ϵ_r):	51.64	52.76	-2.12	5
		e''	14.4200	Conductivity (σ):	1.93	1.91	1.30	5
	Body 2475	e'	51.4200	Relative Permittivity (ϵ_r):	51.42	52.67	-2.37	5
		e''	14.5000	Conductivity (σ):	2.00	1.99	0.52	5

SAR Lab G

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
2/16/2015	Head 2450	e'	40.5100	Relative Permittivity (ϵ_r):	40.51	39.20	3.34	5
		e''	13.7500	Conductivity (σ):	1.87	1.80	4.06	5
	Head 2410	e'	40.6600	Relative Permittivity (ϵ_r):	40.66	39.28	3.52	5
		e''	13.6200	Conductivity (σ):	1.83	1.76	3.67	5
	Head 2475	e'	40.4100	Relative Permittivity (ϵ_r):	40.41	39.17	3.17	5
		e''	13.7700	Conductivity (σ):	1.89	1.83	3.72	5
2/16/2015	Body 2450	e'	51.6700	Relative Permittivity (ϵ_r):	51.67	52.70	-1.95	5
		e''	14.8300	Conductivity (σ):	2.02	1.95	3.60	5
	Body 2410	e'	51.8100	Relative Permittivity (ϵ_r):	51.81	52.76	-1.80	5
		e''	14.6800	Conductivity (σ):	1.97	1.91	3.13	5
	Body 2475	e'	51.5500	Relative Permittivity (ϵ_r):	51.55	52.67	-2.12	5
		e''	14.9100	Conductivity (σ):	2.05	1.99	3.36	5

SAR Lab H

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
2/19/2015	Head 2450	e'	38.3000	Relative Permittivity (ϵ_r):	38.30	39.20	-2.30	5
		e''	13.7200	Conductivity (σ):	1.87	1.80	3.84	5
	Head 2410	e'	38.4300	Relative Permittivity (ϵ_r):	38.43	39.28	-2.16	5
		e''	13.5700	Conductivity (σ):	1.82	1.76	3.29	5
	Head 2475	e'	38.2000	Relative Permittivity (ϵ_r):	38.20	39.17	-2.47	5
		e''	13.7600	Conductivity (σ):	1.89	1.83	3.64	5
2/19/2015	Body 2450	e'	52.9900	Relative Permittivity (ϵ_r):	52.99	52.70	0.55	5
		e''	14.2000	Conductivity (σ):	1.93	1.95	-0.80	5
	Body 2410	e'	52.9800	Relative Permittivity (ϵ_r):	52.98	52.76	0.42	5
		e''	14.0700	Conductivity (σ):	1.89	1.91	-1.16	5
	Body 2475	e'	52.9000	Relative Permittivity (ϵ_r):	52.90	52.67	0.44	5
		e''	14.1900	Conductivity (σ):	1.95	1.99	-1.63	5

8.2. System Check

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

System Performance Check Measurement Conditions:

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
  For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 3 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was 100 mW.
- The results are normalized to 1 W input power.

Reference Target SAR Values

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

System Dipole	Serial No.	Cal. Date	Freq. (MHz)	Target SAR Values (W/kg)		
				1g/10g	Head	Body
D2450V2	706	5/20/2014	2450	1g	53.0	50.2
				10g	24.5	23.4
D2450V2	899	9/10/2014	2450	1g	52.3	50.5
				10g	24.3	23.5

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			
2/19/2015	D2450V2	706	Head	1g	5.24	52.4	53.0	-1.13	
				10g	2.40	24.0	24.5	-2.04	
2/19/2015	D2450V2	706	Body	1g	4.96	49.6	50.2	-1.20	1,2
				10g	2.28	22.8	23.4	-2.56	

SAR Lab B

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			
1/21/2015	D2450V2	899	Head	1g	5.07	50.7	52.3	-3.06	
				10g	2.33	23.3	24.3	-4.12	
2/2/2015	D2450V2	899	Head	1g	5.16	51.6	52.3	-1.34	
				10g	2.37	23.7	24.3	-2.47	
2/2/2015	D2450V2	899	Body	1g	5.16	51.6	50.5	2.18	
				10g	2.40	24.0	23.5	2.13	
2/16/2015	D2450V2	899	Head	1g	5.07	50.7	52.3	-3.06	
				10g	2.32	23.2	24.3	-4.53	
2/16/2015	D2450V2	899	Body	1g	5.43	54.3	50.5	7.52	3,4
				10g	2.51	25.1	23.5	6.81	

SAR Lab C

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	706	Head	1g	5.44	54.4	53.0	2.64	
				10g	2.47	24.7	24.5	0.82	
1/12/2015	D2450V2	706	Body	1g	5.04	50.4	50.2	0.40	
				10g	2.29	22.9	23.4	-2.14	
1/20/2015	D2450V2	706	Head	1g	5.33	53.3	53.0	0.57	
				10g	2.42	24.2	24.5	-1.22	
1/20/2015	D2450V2	706	Body	1g	5.24	52.4	50.2	4.38	
				10g	2.41	24.1	23.4	2.99	
2/2/2015	D2450V2	706	Head	1g	5.59	55.9	53.0	5.47	5,6
				10g	2.56	25.6	24.5	4.49	
2/2/2015	D2450V2	706	Body	1g	4.96	49.6	50.2	-1.20	
				10g	2.30	23.0	23.4	-1.71	
2/16/2015	D2450V2	706	Head	1g	5.21	52.1	53.0	-1.70	
				10g	2.39	23.9	24.5	-2.45	
2/16/2015	D2450V2	706	Body	1g	5.24	52.4	50.2	4.38	
				10g	2.42	24.2	23.4	3.42	

SAR Lab G

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			
2/16/2015	D2450V2	706	Head	1g	5.42	54.2	53.0	2.26	
				10g	2.47	24.7	24.5	0.82	
2/16/2015	D2450V2	706	Body	1g	4.85	48.5	50.2	-3.39	7,8
				10g	2.24	22.4	23.4	-4.27	

SAR Lab H

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			
2/19/2015	D2450V2	706	Head	1g	5.39	53.9	53.0	1.70	
				10g	2.45	24.5	24.5	0.00	
2/19/2015	D2450V2	706	Body	1g	5.29	52.9	50.2	5.38	9,10
				10g	2.45	24.5	23.4	4.70	

9. Conducted Output Power Measurements

9.1. Wi-Fi DTS (2.4 GHz) Band

Required Test Channels per KDB 248227 D01

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	SAR Test (Yes/No)
2.4 (DTS)	802.11b	1 Mbps	1	2412	19.5	Yes
			6	2437	19.5	
			11	2462	19.5	
			12	2467	19.5	No
			13	2472	19.0	No
	802.11g	6 Mbps	1	2412	18.0	No
			6	2437	19.5	
			11	2462	18.0	
			12	2467	16.5	
			13	2472	6.0	
	802.11n (HT20)	MCS0	1	2412	18.0	No
			6	2437	19.5	
			11	2462	18.0	
			12	2467	16.5	
			13	2472	6.0	

Note(s):

Per KDB 248227 D01 v02:

1. Output Power and SAR is not required for 802.11g/n HT20 channels when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.
2. Additionally, SAR is not required for Channels 12 and 13 because the tune-up limit and the measured output power for these two channels are no greater than those for the default test channels.

9.2. Bluetooth

Band (GHz)	Mode	Ch #	Freq. (MHz)	Avg Pwr (dBm)
2.4	V3.0 + BDR, GFSK	0	2402	12.5
		39	2441	12.5
		78	2480	12.5
	V3.0 + EDR, 8-DPSK	0	2402	9.4
		39	2441	9.4
		78	2480	9.5
	V4.0 LE, GFSK	0	2402	12.0
		19	2440	12.0
		39	2480	12.0

10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

KDB 248227 D01 SAR Measurements Procedures for 802.11 a/b/g Transmitters v02 (pg.6):

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.

10.1. Wi-Fi (DTS Band)

10.1.1. Non-Metallic Wristbands

Antenna 1

Frequency Band	Mode	Housing Type	Wristband	RF Exposure Condition	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	802.11b 1 Mbps	Stainless Steel	None	Extremity	Rear	0	6	2437	19.5	19.5			0.023	0.023	
		Aluminum					6	2437	19.5	19.5			0.022	0.022	
		Gold					6	2437	19.5	19.5			0.024	0.024	1
		Stainless Steel	Nylon	Next-to-Mouth	Front	10	6	2437	19.5	19.5	0.079	0.079			
		Aluminum					6	2437	19.5	19.5	0.153	0.153			2
		Gold					6	2437	19.5	19.5	0.153	0.153			

Antenna 2

Frequency Band	Mode	Housing Type	Wristband	RF Exposure Condition	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	802.11b 1 Mbps	Gold	None	Extremity	Rear	0	6	2437	19.5	19.5			0.018	0.018	
		Aluminum	Nylon	Next-to-Mouth	Front	10	6	2437	19.5	19.5	0.137	0.137			

10.1.2. Metallic Wristbands

Antenna 1

Frequency Band	Mode	Housing Type	Wristband	RF Exposure Condition	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	802.11b 1 Mbps	Gold	Mesh	Extremity	Rear	0	6	2437	19.5	19.5			0.006	0.006	
			Links				6	2437	19.5	19.5			0.007	0.007	
		Aluminum	Links				6	2437	19.5	19.5			0.016	0.016	3
		Stainless Steel	Links				6	2437	19.5	19.5			0.015	0.015	

Frequency Band	Mode	Housing Type	Wristband	RF Exposure Condition	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	802.11b 1 Mbps	Aluminum	Mesh	Next-to-Mouth	Front	10	6	2437	19.5	19.5	0.103	0.103			4
			Links				6	2437	19.5	19.5	0.078	0.078			
		Gold	Mesh				6	2437	19.5	19.5	0.082	0.082			
		Stainless Steel	Mesh				6	2437	19.5	19.5	0.097	0.097			

Antenna 2

Frequency Band	Mode	Housing Type	Wristband	RF Exposure Condition	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	802.11b 1 Mbps	Aluminum	Links	Extremity	Rear	0	6	2437	19.5	19.5			0.007	0.007	
			Mesh	Next-to-Mouth	Front	10	6	2437	19.5	19.5	0.052	0.052			

10.2. Bluetooth

Bluetooth testing was performed based on the Wi-Fi (DTS Band) worst case SAR result.

10.2.1. Non-Metallic Wristbands

Antenna 1

Frequency Band	Mode	Housing Type	Wristband	RF Exposure Condition	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	GFSK	Gold	None	Extremity	Rear	0	39	2441	12.5	12.5			0.004	0.004	
		Aluminum	Nylon	Next-to-Mouth	Front	10	39	2441	12.5	12.5	0.044	0.044			5

Antenna 2

Frequency Band	Mode	Housing Type	Wristband	RF Exposure Condition	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	GFSK	Gold	None	Extremity	Rear	0	39	2441	12.5	12.5			0.000	0.000	
		Aluminum	Nylon	Next-to-Mouth	Front	10	39	2441	12.5	12.5	0.017	0.017			

10.2.2. Metallic Wristbands

Antenna 1

Frequency Band	Mode	Housing Type	Wristband	RF Exposure Condition	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	GFSK	Aluminum	Links	Extremity	Rear	0	39	2441	12.5	12.5			0.006	0.006	6
		Aluminum	Mesh	Next-to-Mouth	Front	10	39	2441	12.5	12.5	0.019	0.019			

Antenna 2

Frequency Band	Mode	Housing Type	Wristband	RF Exposure Condition	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		10-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
2.4 GHz	GFSK	Aluminum	Links	Extremity	Rear	0	39	2441	12.5	12.5			0.003	0.003	
		Aluminum	Mesh	Next-to-Mouth	Front	10	39	2441	12.5	12.5	0.014	0.014			

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 <1.6 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 ≥ 1.6 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 (~ 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)	Repeated Measured SAR (W/kg)	Largest to Smallest SAR Ratio
2400	Wi-Fi 802.11b/g/n	Extremity	Rear	No	0.024	N/A	N/A
2400	Wi-Fi 802.11b/g/n	Next-to-Mouth	Front	No	0.153	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.

12. Simultaneous Transmission SAR Analysis

N/A

Wi-Fi 2.4GHz Radio cannot transmit simultaneously with Bluetooth Radio.

Appendixes

Refer to separated files for the following appendixes.

A_14U19383v1 SAR Photos

B_14U19383v0 SAR System Check Plots

C_14U19383v0 SAR Highest Test Plots

D_14U19383v0 SAR Tissue Ingredients

E_14U19383v0 SAR Probe Cal. Certificates

F_14U19383v0 SAR Dipole Cal. Certificates

END OF REPORT