SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
Bluetooth & DTS/UNII a/b/g/n/ac & ANT+ Tablet

FCC ID: A3LSMT670
Model Name: SM-T670

Report Number: 15K21654-S1
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Prepared for
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ACCREDITED

TL-637

Revision History

Rev.	Date	Revisions	Revised By
--	9/7/2015	Initial Issue	Justin Park

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1. Attestation of Test Results

Applicant Name	SAMSUNG ELECTRONICS CO.,LTD.			
FCC ID	A3LSMT670			
Model Name	SM-T670			
Applicable Standards	FCC 47 CFR § 2.1093 Published RF exposure KDB procedures IEEE Std 1528-2013			
SAR Limits (W/Kg)				
Exposure Category	Peak spatial-average(1g of tissue)			
General population / Uncontrolled exposure	1.6			
The Highest Reported SAR (W/kg)				
RF Exposure Conditions	**Equipment Class**			
	Licensed	**DTS**	**U-NII**	**DTS(BT)**
Standalone	N/A	0.501	1.095	N/A
Date Tested	8/27/2015 to 9/7/2015			
Test Results	Pass			

UL Korea, Ltd. 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 Korea, Ltd. 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 Korea, Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Korea, Ltd. 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 IAS, any agency of the Federal Government, or any agency of any government.

Approved & Released By:	Prepared By:
	
JiHo Choi Operations Manager UL Korea, Ltd Suwon Laboratory	Justin Park Engineer UL Korea, Ltd Suwon Laboratory

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 v02r01
- 447498 D01 General RF Exposure Guidance v05r02
- 616217 D04 SAR for laptop and tablets v01r01
- 690783 D01 SAR Listings on Grants v01r03
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r01

3. Facilities and Accreditation

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

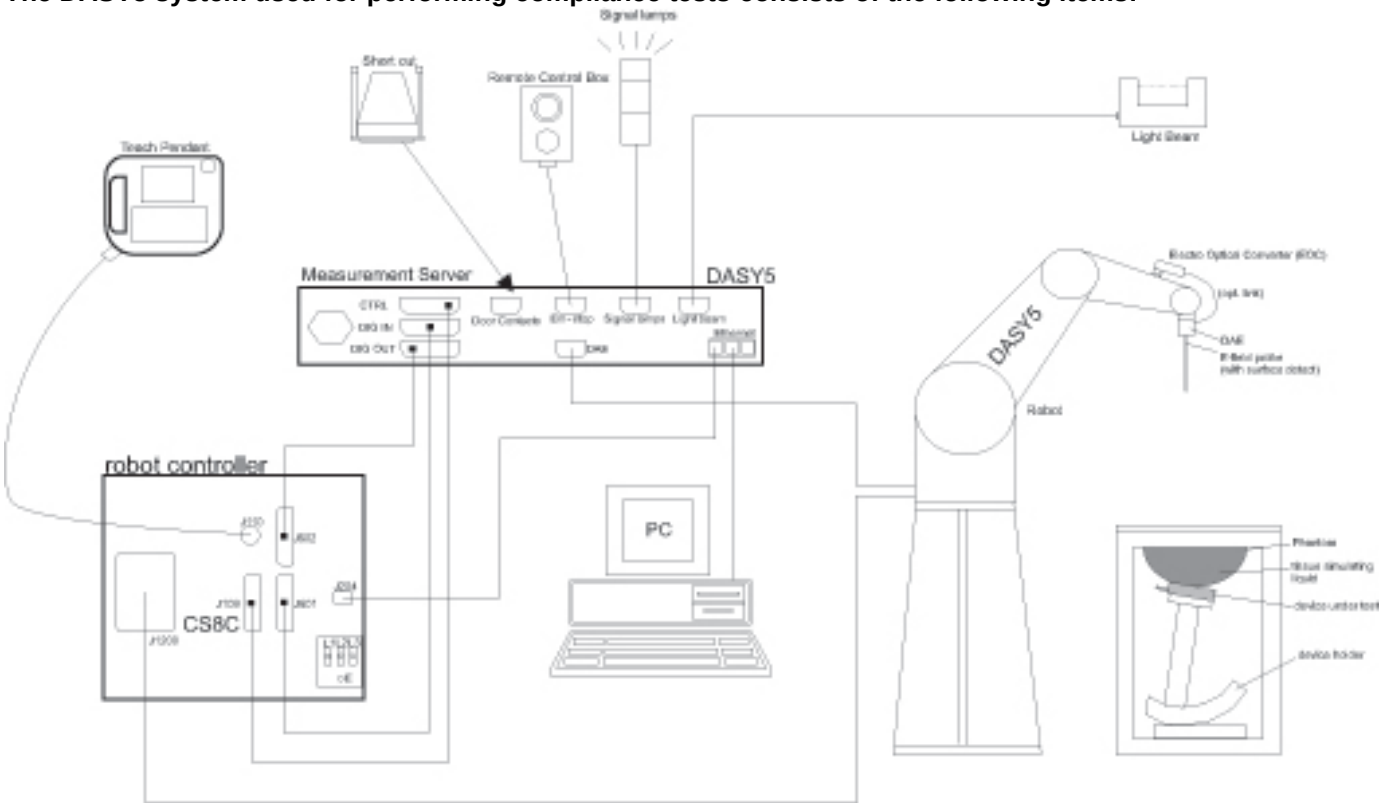
Suwon
SAR 2 Room
SAR 3 Room

UL Korea, Ltd. is accredited by IAS, Laboratory Code TL-637.
The full scope of accreditation can be viewed at http://www.iasonline.org/PDF/TL/TL-637.pdf.

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	E5071C	MY46522054	8-18-2016
Dielectric Assessment Kit	SPEAG	DAK-3.5	1196	8-4-2016
Shorting block	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	LKM	DTM3000	3424	8-19-2016

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
MXG Analog Signal Generator	Agilent	N5181A	MY50145882	8-18-2016
Power Sensor	Agilent	U2000A	MY54260010	8-18-2016
Power Sensor	Agilent	U2000A	MY54260007	8-18-2016
Power Amplifier	EXODUS	1410025-AMP2027-10003	10003	8-18-2016
Directional Coupler	Agilent	772D	MY52180193	8-18-2016
Directional Coupler	Agilent	778D	MY52180432	8-18-2016
Low Pass Filter	MICROLAB	LA-15N	03943	8-18-2016
Low Pass Filter	FILTRON	L14012FL	1410003S	8-18-2016
Low Pass Filter	MICROLAB	LA-60N	03942	8-18-2016
Attenuator	Agilent	8491B/003	MY39269292	8-18-2016
Attenuator	Agilent	8491B/010	MY39269315	8-18-2016
Attenuator	Agilent	8491B/020	MY39269298	8-18-2016
E-Field Probe (SAR 2)	SPEAG	EX3DV4	7313	7-23-2016
E-Field Probe (SAR 3)	SPEAG	EX3DV4	7352	3-6-2016
Data Acquisition Electronics (SAR 2)	SPEAG	DAE4	1446	8-17-2016
Data Acquisition Electronics (SAR 3)	SPEAG	DAE3	479	10-15-2015
System Validation Dipole	SPEAG	D2450V2	960	2-5-2016
System Validation Dipole	SPEAG	D5GHzV2	1209	2-10-2016
Thermometer (SAR 2)	Lutron	MHB-382SD	AH.50215	8-19-2016
Thermometer (SAR 3)	Lutron	MHB-382SD	AH.50213	11-18-2015

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

Device Dimension	Overall (Length x Width): 447 mm x 272 mm Overall Diagonal: 513 mm Display Diagonal: 472 mm
Back Cover	☒ The rechargeable battery is not user accessible.
Battery Options	☒ The rechargeable battery is not user accessible.
Wireless Router (Hotspot)	Wi-Fi Hotspot mode permits the device to share its cellular data connection with other Wi-Fi-enabled devices. Mobile Hotspot is not supported
Wi-Fi Direct	Wi-Fi Direct enabled devices transfer data directly between each other ☒ Wi-Fi Direct (Wi-Fi 2.4 GHz) ☒ Wi-Fi Direct (Wi-Fi 5.8 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? ☒ Yes ☐ No		
	Does this device support Band gap channel? ☒ Yes ☐ No		
Bluetooth	2.4 GHz	Version 4.1 LE	76.99% (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

Upper limit (dB): ~ 0.5		Max. RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. Power limit
WiFi 2.4 GHz	802.11b	16.0	**16.5**
	802.11g	14.0	**14.5**
	802.11n HT20	13.0	**13.5**
WiFi 5 GHz	802.11a	11.0	**11.5**
	802.11n HT20	11.0	**11.5**
	802.11n HT40	11.0	**11.5**
	802.11ac VHT20	11.0	**11.5**
	802.11ac VHT40	10.0	**10.5**
	802.11ac VHT80	9.0	**9.5**
Bluetooth		9.0	**9.5**
Bluetooth LE		6.5	**7.0**

7. RF Exposure Conditions (Test Configurations)

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

7.1. Standalone SAR Test Exclusion Considerations

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

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

SAR Test Exclusion Calculations for WLAN

Antennas < 50mm to adjacent edges

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Calculated Threshold Value					
		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi 2.4 GHz	2462	16.50	45	26	128	4	131	443		2.7 -EXEMPT-	> 50 mm	14.1 -MEASURE-	> 50 mm	> 50 mm	
Wi-Fi 5.2 GHz	5240	11.50	14	26	128	4	131	443		1.2 -EXEMPT-	> 50 mm	6.4 -MEASURE-	> 50 mm	> 50 mm	
Wi-Fi 5.3 GHz	5320	11.50	14	26	128	4	131	443		1.2 -EXEMPT-	> 50 mm	6.5 -MEASURE-	> 50 mm	> 50 mm	
Wi-Fi 5.5 GHz	5700	11.50	14	26	128	4	131	443		1.3 -EXEMPT-	> 50 mm	6.7 -MEASURE-	> 50 mm	> 50 mm	
Wi-Fi 5.8 GHz	5825	11.50	14	26	128	4	131	443		1.3 -EXEMPT-	> 50 mm	6.8 -MEASURE-	> 50 mm	> 50 mm	
Bluetooth	2480	9.50	9	26	128	4	131	443		0.5 -EXEMPT-	> 50 mm	2.8 -EXEMPT-	> 50 mm	> 50 mm	

Note(s):

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

Antennas > 50mm to adjacent edges

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Calculated Threshold Value					
		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi 2.4 GHz	2462	16.50	45	26	128	4	131	443		< 50 mm	875.6 mW -EXEMPT-	< 50 mm	905.6 mW -EXEMPT-	4025.6 mW -EXEMPT-	
Wi-Fi 5.2 GHz	5240	11.50	14	26	128	4	131	443		< 50 mm	845.5 mW -EXEMPT-	< 50 mm	875.5 mW -EXEMPT-	3995.5 mW -EXEMPT-	
Wi-Fi 5.3 GHz	5320	11.50	14	26	128	4	131	443		< 50 mm	845 mW -EXEMPT-	< 50 mm	875 mW -EXEMPT-	3995 mW -EXEMPT-	
Wi-Fi 5.5 GHz	5700	11.50	14	26	128	4	131	443		< 50 mm	842.8 mW -EXEMPT-	< 50 mm	872.8 mW -EXEMPT-	3992.8 mW -EXEMPT-	
Wi-Fi 5.8 GHz	5825	11.50	14	26	128	4	131	443		< 50 mm	842.2 mW -EXEMPT-	< 50 mm	872.2 mW -EXEMPT-	3992.2 mW -EXEMPT-	
Bluetooth	2480	9.50	9	26	128	4	131	443		< 50 mm	875.3 mW -EXEMPT-	< 50 mm	905.3 mW -EXEMPT-	4025.3 mW -EXEMPT-	

Note(s):

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

7.2. Required Test Configurations

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

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

Note(s):

1. Yes = Testing is required.
2. 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 ± 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 2 Room

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
2015-08-27	Body 2450	e'	51.2000	Relative Permittivity (ε_r):	51.20	52.70	-2.85	5
		e"	14.8200	Conductivity (σ):	2.02	1.95	3.53	5
	Body 2410	e'	51.2700	Relative Permittivity (ε_r):	51.27	52.76	-2.82	5
		e"	14.8600	Conductivity (σ):	1.99	1.91	4.39	5
	Body 2475	e'	51.1400	Relative Permittivity (ε_r):	51.14	52.67	-2.90	5
		e"	14.9700	Conductivity (σ):	2.06	1.99	3.78	5
2015-09-06	Body 2450	e'	50.5000	Relative Permittivity (ε_r):	50.50	52.70	-4.17	5
		e"	14.9400	Conductivity (σ):	2.04	1.95	4.37	5
	Body 2410	e'	50.5400	Relative Permittivity (ε_r):	50.54	52.76	-4.21	5
		e"	14.8600	Conductivity (σ):	1.99	1.91	4.39	5
	Body 2475	e'	50.4300	Relative Permittivity (ε_r):	50.43	52.67	-4.25	5
		e"	14.9800	Conductivity (σ):	2.06	1.99	3.85	5

SAR 3 Room

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
2015-08-28	Body 5180	e'	47.5100	Relative Permittivity (εr):	47.51	49.05	-3.13	5
		e"	18.5700	Conductivity (σ):	5.35	5.27	1.46	5
	Body 5200	e'	47.4900	Relative Permittivity (εr):	47.49	49.02	-3.12	5
		e"	18.6300	Conductivity (σ):	5.39	5.29	1.74	5
	Body 5600	e'	46.8200	Relative Permittivity (εr):	46.82	48.48	-3.42	5
		e"	18.9500	Conductivity (σ):	5.90	5.76	2.42	5
	Body 5800	e'	46.5000	Relative Permittivity (εr):	46.50	48.20	-3.53	5
		e"	19.1200	Conductivity (σ):	6.17	6.00	2.77	5
	Body 5825	e'	46.4400	Relative Permittivity (εr):	46.44	48.20	-3.65	5
		e"	19.1500	Conductivity (σ):	6.20	6.00	3.37	5
2015-09-03	Body 5180	e'	47.4900	Relative Permittivity (ε_r):	47.49	49.05	-3.17	5
		e"	18.4800	Conductivity (σ):	5.32	5.27	0.97	5
	Body 5200	e'	47.4400	Relative Permittivity (ε_r):	47.44	49.02	-3.22	5
		e"	18.4900	Conductivity (σ):	5.35	5.29	0.97	5
	Body 5600	e'	46.7900	Relative Permittivity (ε_r):	46.79	48.48	-3.48	5
		e"	18.8900	Conductivity (σ):	5.88	5.76	2.10	5
	Body 5800	e'	46.4500	Relative Permittivity (ε_r):	46.45	48.20	-3.63	5
		e"	19.0900	Conductivity (σ):	6.16	6.00	2.61	5
	Body 5825	e'	46.4200	Relative Permittivity (ε_r):	46.42	48.20	-3.69	5
		e"	19.1300	Conductivity (σ):	6.20	6.00	3.27	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	960	2-5-2015	2450	1g	53.3	50.8
				10g	24.8	23.6
D5GHzV2	1209	2-10-2015	5200	1g	78.2	74.0
				10g	22.2	20.6
			5600	1g	81.3	77.4
				10g	23.2	21.3
			5800	1g	79.6	74.9
				10g	22.5	20.5

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 2 Room

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			
8-27-2015	D2450V2	960	Body	1g	5.50	55.00	50.80	8.27	1,2
				10g	2.55	25.50	23.60	8.05	
9-6-2015	D2450V2	960	Body	1g	5.23	52.30	50.8	2.95	
				10g	2.44	24.40	23.60	3.39	

SAR 3 Room

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			
8-28-2015	D5GHzV2 (5200)	1209	Body	1g	8.02	80.20	74.00	8.38	
				10g	2.26	22.60	20.60	9.71	
8-28-2015	D5GhzV2 (5600)	1209	Body	1g	8.43	84.30	77.4	8.91	
				10g	2.33	23.30	21.30	9.39	
8-28-2015	D5GhzV2 (5800)	1209	Body	1g	7.52	75.20	74.9	0.40	
				10g	2.08	20.80	20.50	1.46	
9-3-2015	D5GHzV2 (5200)	1209	Body	1g	7.84	78.40	74	5.95	
				10g	2.22	22.20	20.60	7.77	
9-3-2015	D5GhzV2 (5600)	1209	Body	1g	8.42	84.20	77.4	8.79	3,4
				10g	2.34	23.40	21.30	9.86	
9-3-2015	D5GhzV2 (5800)	1209	Body	1g	8.04	80.40	74.9	7.34	
				10g	2.25	22.50	20.50	9.76	

9. Conducted Output Power Measurements

9.1. Wi-Fi 2.4GHz (DTS Band)

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Max Pwr.			Note(s)
					Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)	
2.4	802.11b	1 Mbps	1	2412	16.1	16.5	Yes	
			6	2437	16.1			
			11	2462	16.3			
	802.11g	6 Mbps	1	2412	Not Required	14.5	No	1
			6	2437				
			11	2462				
	802.11n (HT20)	6.5 Mbps	1	2412		13.5	No	1
			6	2437				
			11	2462				

Note(s):

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.

9.2. Wi-Fi 5GHz (U-NII Bands)

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)
5.2 (U-NII 1)	802.11a	6 Mbps	36 ~ 48	5180 ~ 5240	Not Required	11.5	No
	802.11n (HT20)	6.5 Mbps	36 ~48	5180 ~ 5240		11.5	No
	802.11n (HT40)	13.5 Mbps	38	5190	11.3	11.5	No
			46	5230	10.9		
	802.11ac (VHT20)	6.5 Mbps	36 ~ 48	5180 ~ 5240	Not Required	11.5	No
	802.11ac (VHT40)	13.5 Mbps	38 ~ 46	5190 ~ 5230		10.5	No
	802.11ac (VHT80)	29.3 Mbps	42	5210		9.5	No
5.3 (U-NII 2A)	802.11a	6 Mbps	52 ~ 64	5260 ~ 5320	Not Required	11.5	No
	802.11n (HT20)	6.5 Mbps	52 ~ 64	5260 ~ 5320		11.5	No
	802.11n (HT40)	13.5 Mbps	54	5270	11.2	11.5	Yes
			62	5310	11.2		
	802.11ac (VHT20)	6.5 Mbps	52 ~ 64	5260 ~ 5320	Not Required	11.5	No
	802.11ac (VHT40)	13.5 Mbps	54 ~ 62	5270 ~ 5310		10.5	No
	802.11ac (VHT80)	29.3 Mbps	58	5290		9.5	No
5.5 (U-NII 2C)	802.11a	6 Mbps	100 ~ 144	5500 ~ 5720	Not Required	11.5	No
	802.11n (HT20)	6.5 Mbps	100 ~ 144	5500 ~ 5720		11.5	No
	802.11n (HT40)	13.5 Mbps	102	5510	10.8	11.5	Yes
			118	5590	10.8		
			134	5670	11.2		
	802.11ac (VHT20)	6.5 Mbps	100 ~ 144	5500 ~ 5720	Not Required	11.5	No
	802.11ac (VHT40)	13.5 Mbps	102 ~ 142	5510 ~ 5710		10.5	No
	802.11ac (VHT80)	29.3 Mbps	106 ~ 138	5530 ~ 5690		9.5	No
5.8 (U-NII 3)	802.11a	6 Mbps	149 ~ 165	5745 ~ 5825	Not Required	11.5	No
	802.11n (HT20)	6.5 Mbps	149 ~ 165	5745 ~ 5825		11.5	No
	802.11n (HT40)	13.5 Mbps	151	5755	11.1	11.5	Yes
			159	5795	10.9	11.5	
	802.11ac (VHT20)	6.5 Mbps	149 ~ 165	5745 ~ 5825	Not Required	11.5	No
	802.11ac (VHT40)	13.5 Mbps	151 ~ 159	5755 ~ 5795		10.5	No
	802.11ac (VHT80)	29.3 Mbps	155	5775		9.5	No

Note(s):

1. Output Power and SAR measurement is not required for 802.11n/ac (V)HT20/(V)HT40/VHT80 channels when the specified tune-up tolerances for 802.11n/ac (V)HT20/(V)HT40/VHT80 are lower than 802.11a by more than ½ dB and the measured SAR is ≤ 1.2 W/Kg.
2. When the same transmission mode configurations have the same maximum output power on the same channel for the 802.11 a/g/n/ac modes, the channel in the lower order/sequence 802.11 mode (i.e. a, g, n then ac) is selected.
3. When the specified maximum output power is the same for both UNII band I and UNII band 2A, begin SAR measurement in UNII band 2A; and if the highest *reported* SAR for UNII band 2A is
   - ≤ 1.2 W/kg, SAR is not required for UNII band I
   - > 1.2 W/kg, both bands should be tested independently for SAR.

9.3. Bluetooth

Maximum tune-up tolerance limit is 9.5 dBm from the rated nominal maximum output power. This power level qualifies for exclusion of SAR testing.

10. Measured and Reported (Scaled) SAR Results

KDB 248227 D01 SAR meas for 802.11 v02:

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

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

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

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

10.1. Wi-Fi (DTS Band)

Frequency Band	Mode	RF Exposure Conditions	Pwr Back-off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	
2.4GHz	802.11b	Body	Off	0	Rear(Top Touch)	11	2462.0	0.079	16.5	16.3			
					Rear(Bottom Touch)	11	2462.0	0.095	16.5	16.3	0.077	0.080	
					Rear	11	2462.0	0.023	16.5	16.3			
					Edge 2	11	2462.0	0.640	16.5	16.3	0.481	0.501	1

Note(s):

1. Highest *reported* SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.
2. Highest *reported* SAR is > 0.4 W/kg. Due to the highest *reported* SAR for this test position, other test positions in Head exposure condition were evaluated until a SAR ≤ 0.8 W/kg was *reported*.
3. Testing for a second channel was required because the *reported* SAR for this test position was >0.8 W/kg.
4. Additional testing required in order satisfying FCC simultaneous transmission limit criteria.
5. For Rear (Top Touch) and Rear (Bottom Touch), Please refer to Test-Photos in Appendix A.

10.2. Wi-Fi (U-NII Band)

Frequency Band	Mode	Antenna	RF Exposure Conditions	Pwr Back-off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		Plot No.
										Tune-up limit	Meas.	Meas.	Scaled	
5.3 GHz U-NII 2A	802.11n (HT40)	SISO	Body	Off	0	Rear(Top Touch)	54	5270.0	0.050	11.5	11.2			
						Rear(Bottom Touch)	54	5270.0	0.133	11.5	11.2	0.063	0.067	
						Rear	54	5270.0	0.018	11.5	11.2			
						Edge 2	54	5270.0	1.342	11.5	11.2	0.857	0.910	
							62	5310.0	1.984	11.5	11.2	1.020	1.095	2
Frequency Band	Mode	Antenna	RF Exposure Conditions	Pwr Back-off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		Plot No.
										Tune-up limit	Meas.	Meas.	Scaled	
5.5 GHz U-NII 2C	802.11n (HT40)	SISO	Body	Off	0	Rear(Top Touch)	134	5670.0	0.066	11.5	11.2			
						Rear(Bottom Touch)	134	5670.0	0.087	11.5	11.2	0.052	0.055	
						Rear	134	5670.0	0.070	11.5	11.2			
						Edge 2	134	5670.0	1.480	11.5	11.2	0.745	0.791	3
Frequency Band	Mode	Antenna	RF Exposure Conditions	Pwr Back-off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		Plot No.
										Tune-up limit	Meas.	Meas.	Scaled	
5.8 GHz U-NII 3	802.11n (HT40)	SISO	Body	Off	0	Rear(Top Touch)	151	5755.0	0.015	11.5	11.1			
						Rear(Bottom Touch)	151	5755.0	0.076	11.5	11.1	0.048	0.053	
						Rear	151	5755.0	0.014	11.5	11.1			
						Edge 2	151	5755.0	1.121	11.5	11.1	0.638	0.703	4

Note(s):

1. Highest *reported* SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.
2. Highest *reported* SAR is > 0.4 W/kg. Due to the highest *reported* SAR for this test position, other test positions in Head exposure condition were evaluated until a SAR ≤ 0.8 W/kg was *reported*.
3. Testing for a second channel was required because the *reported* SAR for this test position was >0.8 W/kg.
4. Additional testing required in order satisfying FCC simultaneous transmission limit criteria.
5. For Rear (Top Touch) and Rear (Bottom Touch), Please refer to Test-Photos in Appendix A.

10.3. Bluetooth

Standalone SAR Test Exclusion Considerations & Estimated SAR

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)] ≤ 3.0, for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

When the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

- *(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√$f_{(GHz)}$/x]* W/kg for test separation distances ≤ 50 mm;
  where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

Body-worn Accessory Exposure Conditions

Max. tune-up tolerance limit		Min. test separation distance (mm)	Frequency (GHz)	SAR test exclusion Result*	Test Configuration	Estimated 1-g SAR (W/kg)
(dBm)	(mW)					
9.5	9	5	2.480	2.8	Rear/Front	0.378

Conclusion:

*: The computed value is < 3; therefore, Bluetooth qualifies for Standalone SAR test exclusion.

11. SAR Measurement Variability

In accordance with published RF Exposure KDB 865664 D01 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Frequency Band (MHz)	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR (Yes/No)	Highest Measured SAR (W/kg)	Repeated Measured SAR (W/kg)	Largest to Smallest SAR Ratio
2400	Wi-Fi 802.11b/g/n	Body	Rear	No	0.481	N/A	N/A
5300	Wi-Fi 802.11a/n/ac	Body	Rear	Yes	1.02	0.998	1.02
5500	Wi-Fi 802.11a/n/ac	Body	Rear	No	0.745	N/A	N/A
5800	Wi-Fi 802.11a/n/ac	Body	Rear	No	0.638	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 and Wi-Fi 5GHz Radio cannot transmit simultaneously with Bluetooth Radio.

Appendixes

Refer to separated files for the following appendixes.

A_15K21654-S1_SAR Photos & Ant. Locations

B_15K21654-S1_SAR Highest Test Plots

C_15K21654-S1_SAR System Check Plots

D_15K21654-S1_SAR Tissue Ingredients

E_15K21654-S1_SAR Probe Cal. Certificates

F_15K21654-S1_SAR Dipole Cal. Certificates

END OF REPORT