



**FCC 47 CFR Parts 1 & 2
Published RF Exposure KDB Procedures
IEEE Std 1528-2013**

(Class II Permissive Change)

SAR EVALUATION REPORT

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

**Model: SM-T800
FCC ID: A3LSMT800**

**Report Number: 14U17528-S6A
Issue Date: 5/23/2014**

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NVLAP LAB CODE 200065-0

Revision History

<u>Rev.</u>	<u>Issue Date</u>	<u>Revisions</u>	<u>Revised By</u>
--	04/24/2014	Initial Issue	--
A	5/23/2014	1. Section 12.1 and 12.2.: Updated Typo.	Devin Chang

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1. Attestation of Test Results

Applicant	Samsung Electronics Co., Ltd.			
DUT description	Tablet with Bluetooth, DTS/UNII a/b/g/n/ac & ANT+			
Model	SM-T800			
Test device is	An identical prototype			
Device category	Portable			
Exposure category	General Population/Uncontrolled Exposure			
Date tested	04/10/2014 – 04/18/2014			
The highest reported SAR values	RF exposure condition	Licensed	DTS	UNII
	stand-alone	N/A	0.737 W/kg	0.434 W/kg
	Simultaneous Transmission	N/A	0.737 W/kg	0.434 W/kg
Applicable Standards	FCC 47 CFR Parts 1 & 2 Published RF Exposure KDB Procedures, and TCB workshop updates IEEE Std 1528-2013			
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:

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2. Test Methodology

The tests documented in this report were performed in accordance with FCC 47 CFR Parts 1 & 2, IEEE STD 1528-2013, the following FCC Published RF exposure KDB procedures, and TCB workshop updates:

- 447498 D01 General RF Exposure Guidance v05r02
- 616217 D04 SAR for Laptop and Tablets v01r01
- 248227 D01 SAR Meas for 802 11abg v01r02
- 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03
- 865664 D02 SAR Reporting v01r01
- 690783 D01 SAR Listings on Grants v01r02

3. Facilities and Accreditation

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

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	

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <http://www.ccsemc.com>.

4. Calibration and Uncertainty

4.1. Measuring Instrument Calibration

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

Tissue Dielectric Properties

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
PNA Network Analyzer	Agilent	E8363C	MY49030443	12/3/2014
Dielectronic Probe kit	SPEAG	DAK-3.5	1082	9/10/2014
Dielectronic Probe kit	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Control Company	4242	122529162	9/19/2014

System Performance Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	Agilent	8665B	3438A0063	6/13/2014
Power Meter	HP	438A	2822A05684	10/10/2014
Power Sensor	Agilent	8481A	2237A31744	10/2/2014
Power Sensor	Agilent	8481A	2349A36506	9/30/2014
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795093	N/A
Directional coupler	Werlatone	C8060-102	2711	N/A
DC Power Supply	AMETEK	XHR60-18	1308A01935	N/A
E-Field Probe	SPEAG	EX3DV4	3902	7/12/2014
E-Field Probe	SPEAG	EX3DV4	3936	7/22/2014
Data Acquisition Electronics	SPEAG	DAE4	1377	7/15/2014
Data Acquisition Electronics	SPEAG	DAE4	1380	7/15/2014
System Validation Dipole	SPEAG	D2450V2	706	5/29/2014
System Validation Dipole	SPEAG	D5GHzV2	1138	11/19/2014

Others

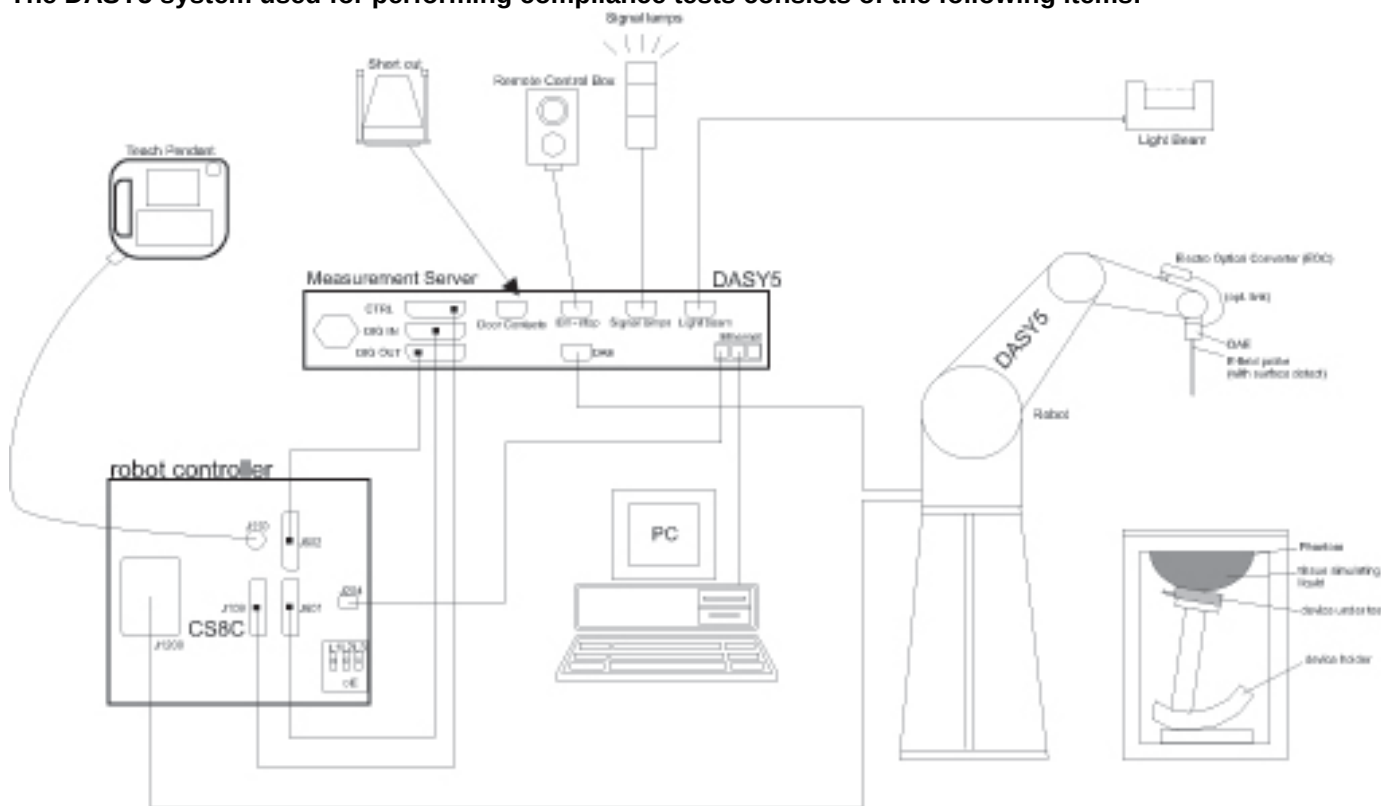
Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Agilent	N1912A	MY53040015	6/29/2014
Power Sensor	Agilent	N1921A	MY52260009	12/12/2014
Power Sensor	Agilent	N1921A	MY52200012	9/25/2014

4.2. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03 Section 2.8.1., 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 1528-2003 is not required in SAR reports submitted for equipment approval.

5. Measurement System Description and Setup

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



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

6. SAR Measurement Procedure

6.1. Normal SAR Measurement Procedure

Step 1: Power Reference Measurement

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

Step 2: Area Scan

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

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03

	≤ 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: 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 $\leq$ 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 v01r03

			≤ 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 <i>reported</i> 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.

6.2. Volume Scan Procedures

Step 1: Repeat Step 1-4 in Section 6.1

Step 2: Volume Scan

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

Step 3: Power drift measurement

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

7. Device Under Test

7.1. General Information

Operating Configuration(s)	Stand-alone
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 GHz) – GO (Group Owner) only for UNII Band 4 5.8GHz band
RF Exposure Condition(s)	Stand-alone
Device dimension	Overall (Length x Width): 246.5mm x 176.4mm Overall Diagonal: 303.12mm Display Diagonal: 267.2mm
Back Cover	☒ Normal Battery Cover ☐ Wireless Charger Battery Cover ☐ Normal Battery Cover with NFC
Accessory	☒ Headset
Battery Options	☒ Standard – Lithium-ion battery, Rating 4.35 Vdc, 30.02 Wh ☐ Extended (large capacity)

7.2. Wireless Technologies

Wireless Technology and Frequency Bands	Wi-Fi: 2.4 / 5 GHz Bluetooth: 2.4 GHz.
Mode	Wi-Fi 2.4GHz (802.11b/g/n) - ☒ 802.11b - ☒ 802.11g - ☒ 802.11n (20MHz) Wi-Fi 5GHz - ☒ 802.11a - ☒ 802.11n (HT20) - ☒ 802.11n (HT40) - ☒ 802.11ac (20MHz) - ☒ 802.11ac (40MHz) - ☒ 802.11ac (80MHz) Bluetooth Ver. 4.0 (LE)
Duty Cycle	Wi-Fi 802.11a/b/g/n: 100% Bluetooth: 32.25% (DH1), 66.68% (DH3), 77.52% (DH5)

7.3. RF Output Power Tolerance

Upper limit (dB): 0.5 ~ -1.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
WiFi 2.4 GHz	802.11b	14.0	14.5
	802.11g	12.0	12.5
	802.11n HT20	12.0	12.5
Upper limit (dB): 0.5 ~ -1.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
WiFi 5 GHz	802.11a	10.0	10.5
	802.11n HT20	10.0	10.5
	802.11n HT40	10.0	10.5
	802.11ac 20MHz	10.0	10.5
	802.11ac 40MHz	10.0	10.5
	802.11ac 80MHz	10.0	10.5
Upper limit (dB): 0.5 ~ -1.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
Bluetooth		10.0	10.5
Bluetooth LE		7.0	7.5

7.4. Simultaneous Transmission Condition

RF Exposure Condition	Capable Transmit Configurations
Body	Wi-Fi and BT 2.4GHz (Wi-Fi 2) + BT (Wi-Fi 1) 5GHz (Wi-Fi 2) + BT (Wi-Fi 1) 2.4GHz (Wi-Fi 1) + 2.4GHz (Wi-Fi 2) 5GHz (Wi-Fi 1) + 5GHz (Wi-Fi 2)
Refer to Appendix for antenna locations Bluetooth cannot transmit simultaneously with Wi-Fi on Wi-Fi Antenna 1 Wi-Fi MIMO: - Is not possible between 2.4 GHz and 5 GHz.	

8. RF Exposure Conditions

The EUT implements the power reduction scheme for SAR compliance, for specific device configuration and orientations, as described below. The complete description of the implementation and functionality is provided in the “Operational Description of Power Reduction” exhibit.

8.1. 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

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Antenna	Tx Interface	Frequency (M Hz)	Output Power		Separation Distances (mm)						Calculated Threshold Value					
			dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi Antenna 1																
Main	Wi-Fi 2.4 GHz	2462	14.50	28	5	4.47	197.82	164	15.76		8.8 -MEASURE-	8.8 -MEASURE-	> 50 mm	> 50 mm	2.7 -EXEM PT-	
Main	Wi-Fi 5.2 GHz	5240	10.50	11	5	4.47	197.82	164	15.76		5 -MEASURE-	5 -MEASURE-	> 50 mm	> 50 mm	16 -EXEM PT-	
Main	Wi-Fi 5.3 GHz	5320	10.50	11	5	4.47	197.82	164	15.76		5.1 -MEASURE-	5.1 -MEASURE-	> 50 mm	> 50 mm	16 -EXEM PT-	
Main	Wi-Fi 5.5 GHz	5700	10.50	11	5	4.47	197.82	164	15.76		5.3 -MEASURE-	5.3 -MEASURE-	> 50 mm	> 50 mm	16 -EXEM PT-	
Main	Wi-Fi 5.8 GHz	5825	10.50	11	5	4.47	197.82	164	15.76		5.3 -MEASURE-	5.3 -MEASURE-	> 50 mm	> 50 mm	17 -EXEM PT-	
Main	Bluetooth	2480	10.50	11	5	4.47	197.82	164	15.76		3.5 -MEASURE-	3.5 -MEASURE-	> 50 mm	> 50 mm	11 -EXEM PT-	
Wi-Fi Antenna 2																
Auxiliary	Wi-Fi 2.4 GHz	2462	14.50	28	5	4.47	161	164	52.28		8.8 -MEASURE-	8.8 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	
Auxiliary	Wi-Fi 5.2 GHz	5240	10.50	11	5	4.47	161	164	52.28		5 -MEASURE-	5 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	
Auxiliary	Wi-Fi 5.3 GHz	5320	10.50	11	5	4.47	161	164	52.28		5.1 -MEASURE-	5.1 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	
Auxiliary	Wi-Fi 5.5 GHz	5700	10.50	11	5	4.47	161	164	52.28		5.3 -MEASURE-	5.3 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	
Auxiliary	Wi-Fi 5.8 GHz	5825	10.50	11	5	4.47	161	164	52.28		5.3 -MEASURE-	5.3 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	

MIMO

Antenna	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 Antenna 1																
Main	Wi-Fi 2.4 GHz	2462	12.50	18	5	4.47	197.82	164	15.76		5.6 -MEASURE-	5.6 -MEASURE-	> 50 mm	> 50 mm	18 -EXEMPT-	
Main	Wi-Fi 5.2 GHz	5240	10.50	11	5	4.47	197.82	164	15.76		5 -MEASURE-	5 -MEASURE-	> 50 mm	> 50 mm	16 -EXEMPT-	
Main	Wi-Fi 5.3 GHz	5320	10.50	11	5	4.47	197.82	164	15.76		5.1 -MEASURE-	5.1 -MEASURE-	> 50 mm	> 50 mm	16 -EXEMPT-	
Main	Wi-Fi 5.5 GHz	5700	10.50	11	5	4.47	197.82	164	15.76		5.3 -MEASURE-	5.3 -MEASURE-	> 50 mm	> 50 mm	16 -EXEMPT-	
Main	Wi-Fi 5.8 GHz	5825	10.50	11	5	4.47	197.82	164	15.76		5.3 -MEASURE-	5.3 -MEASURE-	> 50 mm	> 50 mm	17 -EXEMPT-	
Wi-Fi Antenna 2																
Auxiliary	Wi-Fi 2.4 GHz	2462	12.50	18	5	4.47	161	164	52.28		5.6 -MEASURE-	5.6 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	
Auxiliary	Wi-Fi 5.2 GHz	5240	10.50	11	5	4.47	161	164	52.28		5 -MEASURE-	5 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	
Auxiliary	Wi-Fi 5.3 GHz	5320	10.50	11	5	4.47	161	164	52.28		5.1 -MEASURE-	5.1 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	
Auxiliary	Wi-Fi 5.5 GHz	5700	10.50	11	5	4.47	161	164	52.28		5.3 -MEASURE-	5.3 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	
Auxiliary	Wi-Fi 5.8 GHz	5825	10.50	11	5	4.47	161	164	52.28		5.3 -MEASURE-	5.3 -MEASURE-	> 50 mm	> 50 mm	> 50 mm	

Note(s):

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

Antennas > 50mm to adjacent edges

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Antenna	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 Antenna 1																
Main	Wi-Fi 2.4 GHz	2462	16.00	40	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1573.8 mW -EXEM PT-	1235.6 mW -EXEM PT-	< 50 mm	
Main	Wi-Fi 5.2 GHz	5240	16.00	40	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1543.7 mW -EXEM PT-	1205.5 mW -EXEM PT-	< 50 mm	
Main	Wi-Fi 5.3 GHz	5320	16.50	45	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1543.2 mW -EXEM PT-	1205 mW -EXEM PT-	< 50 mm	
Main	Wi-Fi 5.5 GHz	5700	16.50	45	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1541mW -EXEM PT-	1202.8 mW -EXEM PT-	< 50 mm	
Main	Wi-Fi 5.8 GHz	5825	16.00	40	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1540.4 mW -EXEM PT-	1202.2 mW -EXEM PT-	< 50 mm	
Main	Bluetooth	2480	13.00	20	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1573.5mW -EXEM PT-	1235.3 mW -EXEM PT-	< 50 mm	
Wi-Fi Antenna 2																
Auxiliary	Wi-Fi 2.4 GHz	2462	16.00	40	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1205.6 mW -EXEM PT-	1235.6 mW -EXEM PT-	118.4 mW -EXEM PT-	
Auxiliary	Wi-Fi 5.2 GHz	5230	16.00	40	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1175.6 mW -EXEM PT-	1205.6 mW -EXEM PT-	88.4 mW -EXEM PT-	
Auxiliary	Wi-Fi 5.3 GHz	5300	16.50	45	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1175.2 mW -EXEM PT-	1205.2 mW -EXEM PT-	88 mW -EXEM PT-	
Auxiliary	Wi-Fi 5.5 GHz	5680	16.50	45	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1172.9 mW -EXEM PT-	1202.9 mW -EXEM PT-	85.7 mW -EXEM PT-	
Auxiliary	Wi-Fi 5.8 GHz	5825	16.00	40	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1172.2 mW -EXEM PT-	1202.2 mW -EXEM PT-	85 mW -EXEM PT-	

MIMO

Antenna	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 Antenna 1																
Main	Wi-Fi 2.4 GHz	2462	12.50	18	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1573.8 mW -EXEMPT-	1235.6 mW -EXEMPT-	< 50 mm	
Main	Wi-Fi 5.2 GHz	5240	10.50	11	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1543.7 mW -EXEMPT-	1205.5 mW -EXEMPT-	< 50 mm	
Main	Wi-Fi 5.3 GHz	5320	10.50	11	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1543.2 mW -EXEMPT-	1205 mW -EXEMPT-	< 50 mm	
Main	Wi-Fi 5.5 GHz	5700	10.50	11	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1541mW -EXEMPT-	1202.8 mW -EXEMPT-	< 50 mm	
Main	Wi-Fi 5.8 GHz	5825	10.50	11	5	4.47	197.82	164	15.76		< 50 mm	< 50 mm	1540.4 mW -EXEMPT-	1202.2 mW -EXEMPT-	< 50 mm	
Wi-Fi Antenna 2																
Auxiliary	Wi-Fi 2.4 GHz	2462	12.50	18	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1205.6 mW -EXEMPT-	1235.6 mW -EXEMPT-	118.4 mW -EXEMPT-	
Auxiliary	Wi-Fi 5.2 GHz	5240	10.50	11	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1175.5 mW -EXEMPT-	1205.5 mW -EXEMPT-	88.3 mW -EXEMPT-	
Auxiliary	Wi-Fi 5.3 GHz	5320	10.50	11	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1175 mW -EXEMPT-	1205 mW -EXEMPT-	87.8 mW -EXEMPT-	
Auxiliary	Wi-Fi 5.5 GHz	5700	10.50	11	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1172.8 mW -EXEMPT-	1202.8 mW -EXEMPT-	85.6 mW -EXEMPT-	
Auxiliary	Wi-Fi 5.8 GHz	5825	10.50	11	5	4.47	161	164	52.28		< 50 mm	< 50 mm	1172.2 mW -EXEMPT-	1202.2 mW -EXEMPT-	85 mW -EXEMPT-	

Note(s):

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

8.2. Required Test Configurations

The table below identifies the standalone test configurations required for this device according to the findings in Section 8.1:

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

Note(s):

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

9. RF Output Power Measurement

9.1. W-iFi (2.4 GHz Band)

Required Test Channels per KDB 248227 D01

Mode	Band	GHz	Channel	"Default Test Channels"	
				802.11b	802.11g
802.11b/g	2.4 GHz	2.412	1[#]	√	▽
		2.437	6	√	▽
		2.462	11[#]	√	▽

Notes:

√ = "default test channels"

▽ = possible 802.11g channels with maximum average output ¼ dB ≥ the "default test channels"

[#] = when output power is reduced for channel 1 and /or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested.

Measured Results

Band (GHz)	Mode	Data Rate	No. of Transmitters	Ch #	Freq. (MHz)	Avg Pwr (dBm)		SAR Test (Yes/No)
						Wi-Fi 1	Wi-Fi 2	
2.4 (DTS)	802.11b	1 Mbps	1 Tx	1	2412	13.8	13.9	Yes
				6	2437	13.8	14.0	
				11	2462	13.7	13.8	
			2 Tx	1	2412	12.7	14.0	Yes
				6	2437	12.7	14.0	
				11	2462	12.6	13.9	
	802.11g	6 Mbps	1 Tx	1	2412	12.2	12.1	No
				6	2437	12.3	12.1	
				11	2462	12.0	11.9	
			2 Tx	1	2412	12.1	12.0	No
				6	2437	12.0	11.9	
				11	2462	12.0	11.9	
	802.11n (HT20)	MCS0	1 Tx	1	2412	11.3	11.1	No
				6	2437	11.3	11.1	
				11	2462	11.1	11.1	
			2 Tx	1	2412	11.2	11.2	No
				6	2437	11.2	11.2	
				11	2462	11.1	11.0	

Note(s):

Per KDB 248227 D01, SAR is not required for 802.11g/HT20 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11b channels.

Power measurements to determine worst-case data rates

Mode	Ch #	Freq. (MHz)	Data Rate	Avg Pwr		SAR test (Yes/No)
				Wi-Fi 1	Wi-Fi 2	
802.11b	6	2437	1 Mbps	13.8	14.0	Yes
			2 Mbps	13.8	14.0	No
			5.5 Mbps	13.8	13.9	No
			11 Mbps	13.7	13.8	No

9.2. W-iFi (5 GHz Bands)

Required Test Channels per KDB 248227 D01

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

√ = "default test channels"

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

= when output power is reduced for channel 1 and /or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested.

Wi-Fi 5 GHz Bands Measured Results

Band (GHz)	Mode	Data Rate	No. of Transmitters	Ch #	Freq. (MHz)	Avg Pwr (dBm)		SAR Test (Yes/No)
						Wi-Fi 1	Wi-Fi 2	
5.2 (UNII)	802.11a	6 Mbps	1 Tx	36	5180	9.9	9.9	Yes
				40	5200	9.9	9.9	
				44	5220	10.0	10.0	
				48	5240	10.0	10.5	
			2 Tx	36	5180	9.9	9.9	Yes
				40	5200	9.9	9.9	
				44	5220	9.9	10.0	
				48	5240	10.0	10.5	
	802.11n (HT20)	MCS 0	1 Tx	36	5180	9.8	9.9	No
				40	5200	9.8	9.8	
				48	5240	9.9	9.9	
			2 Tx	36	5180	9.8	10.0	No
				40	5200	9.9	9.9	
				48	5240	9.8	10.0	
	802.11n (HT40)	MCS 0	1 Tx	38	5190	9.8	9.8	No
				46	5230	9.8	9.8	
			2 Tx	38	5190	9.8	9.7	No
				46	5230	9.7	9.7	
	802.11ac (20 MHz)	MCS 0	1 Tx	36	5180	9.7	9.8	No
				40	5200	9.7	9.9	
				48	5240	9.8	10.0	
			2 Tx	36	5180	9.9	10.0	Yes
				40	5200	9.8	9.9	
				48	5240	9.8	10.0	
	802.11ac (40 MHz)	MCS 0	1 Tx	38	5190	9.8	10.0	No
				46	5230	9.8	10.0	
			2 Tx	38	5190	10.0	9.9	No
				46	5230	9.9	10.0	
	802.11ac (80 MHz)	MCS 0	1 Tx	42	5210	9.4	9.5	No
			2 Tx	42	5210	9.4	9.5	

Wi-Fi 5 GHz Bands Measured Results continued

Band (GHz)	Mode	Data Rate	No. of Transmitters	Ch #	Freq. (MHz)	Avg Pwr (dBm)		SAR Test (Yes/No)
						Wi-Fi 1	Wi-Fi 2	
5.3 (UNII)	802.11a	6 Mbps	1 Tx	52	5260	10.2	10.0	Yes
				56	5280	10.2	9.9	
				60	5300	10.2	9.9	
				64	5320	10.2	10.5	
			2 Tx	52	5260	10.2	10.0	Yes
				56	5280	10.2	9.9	
				60	5300	10.2	9.8	
				64	5320	10.0	10.5	
	802.11n (HT20)	MCS 0	1 Tx	52	5260	10.0	9.9	No
				60	5300	10.2	9.8	
				64	5320	10.1	10.0	
			2 Tx	52	5260	10.1	9.9	No
				60	5300	10.2	9.9	
				64	5320	10.2	10.0	
	802.11n (HT40)	MCS 0	1 Tx	54	5270	10.2	10.2	No
				62	5310	10.3	10.3	
			2 Tx	54	5270	10.3	10.2	No
				62	5310	10.3	10.3	
	802.11ac (20 MHz)	MCS 0	1 Tx	52	5260	10.2	9.9	No
				60	5300	10.3	10.0	
				64	5320	10.3	9.9	
			2 Tx	52	5260	9.9	9.9	Yes
				60	5300	9.9	10.0	
				64	5320	9.8	10.0	
	802.11ac (40 MHz)	MCS 0	1 Tx	54	5270	9.9	10.0	No
				62	5310	9.8	9.9	
			2 Tx	54	5270	9.8	10.0	No
				62	5310	9.8	10.0	
	802.11ac (80 MHz)	MCS 0	1 Tx	58	5290	9.8	9.7	No
			2 Tx	58	5290	9.9	9.7	

Band (GHz)	Mode	Data Rate	No. of Transmitters	Ch #	Freq. (MHz)	Avg Pwr (dBm)		SAR Test (Yes/No)
						Wi-Fi 1	Wi-Fi 2	
5.5 (UNII)	802.11a	6 Mbps	1 Tx	100	5500	9.8	9.9	Yes
				104	5520	10.1	10.1	
				108	5540	9.8	9.9	
				112	5560	9.8	9.9	
				116	5580	9.9	10.0	
				120	5600	Not Supported		
				124	5620	Not Supported		
				128	5640	Not Supported		
				132	5660	9.8	9.9	
				136	5680	9.8	9.9	
				140	5700	10.0	9.9	
			2 Tx	100	5500	9.8	9.9	Yes
				104	5520	9.2	10.3	
				108	5540	9.8	9.9	
				112	5560	9.8	9.9	
				116	5580	9.8	9.9	
				120	5600	9.8	9.9	
				124	5620	9.8	9.9	
				128	5640	10.0	10.0	
				132	5660	9.8	9.9	
				136	5680	9.8	9.9	
				140	5700	9.9	9.9	
	802.11n (HT20)	MCS0	1 Tx	100	5500	9.7	9.8	No
				116	5580	9.7	9.8	
				140	5700	9.7	9.8	
			2 Tx	100	5500	9.7	9.8	No
				116	5580	9.7	9.8	
				140	5700	9.7	9.8	
	802.11n (HT40)	MCS0	1 Tx	102	5510	10.0	10.0	No
				118	5590	Not Supported		
				134	5670	10.0	9.9	
			2 Tx	102	5510	10.0	10.0	No
				118	5590	Not Supported		
				134	5670	9.9	9.8	
	802.11ac (20 MHz)	MCS0	1 Tx	100	5500	9.8	9.9	No
				120	5600	9.7	9.9	
				140	5700	9.8	9.9	
			2 Tx	100	5500	9.8	9.9	Yes
				120	5600	9.7	10.0	
				140	5700	9.8	9.9	
	802.11ac (40 MHz)	MCS0	1 Tx	102	5510	9.9	10.1	No
				118	5590	10.0	10.2	
				134	5670	9.9	10.2	
			2 Tx	102	5510	9.9	10.2	No
				118	5590	10.0	10.1	
				134	5670	10.0	10.1	
802.11ac (80 MHz)	MCS0	1 Tx	106	5530	9.9	9.6	No	
			138	5690	Not Supported			
		2 Tx	106	5530	9.5	9.7	No	
			138	5690	Not Supported			

Band (GHz)	Mode	Data Rate	No. of Transmitters	Ch #	Freq. (MHz)	Avg Pwr (dBm)		SAR Test (Yes/No)
						Wi-Fi 1	Wi-Fi 2	
5.8 (DTS)	802.11a	6 Mbps	1 Tx	149	5745	10.4	10.0	Yes
				153	5765	10.4	9.8	
				157	5785	10.3	9.8	
				161	5805	10.3	9.9	
				165	5825	10.3	9.8	
			2 Tx	149	5745	9.3	10.3	Yes
				153	5765	9.7	9.9	
				157	5785	9.6	9.8	
				161	5805	9.7	9.8	
				165	5825	9.7	9.8	
	802.11n (HT20)	MCS0	1 Tx	149	5745	10.4	9.9	No
				157	5785	10.2	9.8	
				165	5825	10.2	9.7	
			2 Tx	149	5745	9.5	9.9	No
				157	5785	9.4	9.8	
				165	5825	9.3	9.7	
	802.11n (HT40)	MCS0	1 Tx	151	5755	9.9	9.9	No
				159	5795	9.8	9.8	
			2 Tx	151	5755	9.6	9.8	No
				159	5795	9.6	9.8	
	802.11ac (20 MHz)	MCS0	1 Tx	149	5745	9.6	9.9	No
				157	5785	9.6	9.9	
				165	5825	9.7	9.8	
			2 Tx	149	5745	9.7	10.0	Yes
				157	5785	9.4	10.0	
				165	5825	9.5	9.8	
	802.11ac (40 MHz)	MCS0	1 Tx	151	5755	9.8	10.0	No
				159	5795	9.8	9.9	
			2 Tx	151	5755	9.7	9.9	No
				159	5795	9.6	9.8	
	802.11ac (40 MHz)	MCS0	1 Tx	155	5775	9.3	9.5	No
			2 Tx	155	5775	9.4	9.5	No

Note(s):

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

Power measurements to determine worst-case data rates

Band	Mode	Ch #	Freq. (MHz)	Data Rate	Avg Pwr (dBm)		SAR test (Yes/No)
					Wi-Fi 1	Wi-Fi 2	
5.2 GHz (UNII)	802.11a	48	5240	6 Mbps	10.0	10.5	Yes
				9 Mbps	9.9	10.2	No
				12 Mbps	9.9	10.2	No
				18 Mbps	9.9	10.3	No
				24 Mbps	9.9	10.2	No
				36 Mbps	9.9	10.2	No
				48 Mbps	9.9	10.2	No
				54 Mbps	9.9	10.2	No
5.3 GHz (UNII)	802.11a	64	5320	6 Mbps	10.2	10.5	Yes
				9 Mbps	10.0	10.4	No
				12 Mbps	10.0	10.4	No
				18 Mbps	10.1	10.4	No
				24 Mbps	9.9	10.2	No
				36 Mbps	9.9	10.2	No
				48 Mbps	10.0	10.1	No
				54 Mbps	9.9	10.2	No
5.5 GHz (UNII)	802.11a	104	5520	6 Mbps	10.1	10.1	Yes
				9 Mbps	10.0	10.0	No
				12 Mbps	10.0	10.0	No
				18 Mbps	10.0	9.8	No
				24 Mbps	10.0	10.0	No
				36 Mbps	9.9	10.0	No
				48 Mbps	10.0	9.8	No
				54 Mbps	9.9	10.0	No
5.8 GHz (DTS)	802.11a	149	5745	6 Mbps	10.4	10.0	Yes
				9 Mbps	10.3	9.9	No
				12 Mbps	10.3	9.9	No
				18 Mbps	10.4	9.9	No
				24 Mbps	10.4	9.8	No
				36 Mbps	10.4	9.9	No
				48 Mbps	10.4	10.0	No
				54 Mbps	10.4	10.0	No

9.3. Bluetooth

Band (MHz)	Mode	Ch #	Freq. (MHz)	Conducted Avg Power	
				(dBm)	(mW)
2.4	V3.0 + EDR, GFSK	0	2402	8.6	7.24
		39	2441	9.3	8.51
		78	2480	9.5	8.91
	V3.0 + EDR, $\pi/4$ DQPSK	0	2402	5.6	3.63
		39	2441	6.9	4.90
		78	2480	7.2	5.25
	V3.0 + EDR, 8-DPSK	0	2402	5.7	3.72
		39	2441	7.0	5.01
		78	2480	7.3	5.37
	V4.0 LE, GFSK	0	2402	6.5	4.47
		19	2440	6.5	4.47
		39	2480	6.7	4.68

10. Tissue Dielectric Properties

IEEE Std 1528-2013

Target Frequency (MHz)	Head	
	ϵ_r	σ (S/m)
300	45.3	0.87
450	43.5	0.87
750	41.9	0.89
835	41.5	0.90
900	41.5	0.97
1450	40.5	1.20
1500	40.4	1.23
1640	40.2	1.31
1750	40.1	1.37
1800	40.0	1.40
1900	40.0	1.40
2000	40.0	1.40
2100	39.8	1.49
2300	39.5	1.67
2450	39.2	1.80
2600	39.0	1.96
3000	38.5	2.40
3500	37.9	2.91
4000	37.4	3.43
4500	36.8	3.94
5000	36.2	4.45
5200	36.0	4.66
5400	35.8	4.86
5600	35.5	5.07
5800	35.3	5.27
600	35.1	5.48

NOTE—For convenience, permittivity and conductivity values at some frequencies that are not part of the original data from Drossos et al. [B60] or the extension to 5800 MHz are provided (i.e., the values shown in italics). These values were linearly interpolated between the values in this table that are immediately above and below these values, except the values at 6000 MHz that were linearly extrapolated from the values at 3000 MHz and 5800 MHz.

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03

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

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

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

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

Salt: 99+% Pure Sodium Chloride

Sugar: 98+% Pure Sucrose

Water: De-ionized, 16 MΩ+ resistivity

HEC: Hydroxyethyl Cellulose

DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

MSL/HSL750 (Body and Head liquids for 700 – 800 MHz)

Item	Head Tissue Simulation Liquids HSL750 Muscle (body) Tissue Simulation Liquids MSL750
Type No	SL AAH 075
Manufacturer	SPEAG
The item is composed of the following ingredients:	
H ₂ O	Water, 35 – 58%
Sucrose	Sugar, white, refined, 40-60%
NaCl	Sodium Chloride, 0-6%
Hydroxyethyl-cellulose	Medium Viscosity (CAS# 9004-62-0), <0.3%
Preventol-D7	Preservative: aqueous preparation, (CAS# 55965-84-9), containing 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyl-3(2H)-isothiazolone, 0.1-0.7%

MSL/HSL1750 (Body and Head liquids for 1700 – 1800 MHz)

Item	Head Tissue Simulation Liquids HSL1750 Muscle (body) Tissue Simulation Liquids MSL1750
Type No	SL AAM 175
Manufacturer	SPEAG
-The item is composed of the following ingredients:	
H ₂ O	Water, 52 – 75%
C8H18O3	Diethylene glycol monobutyl ether (DGBE), 25-48%
NaCl	Sodium Chloride, <1.0%

Simulating Liquids for 5 GHz, Manufactured by SPEAG

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

10.2. Tissue Dielectric Parameter Check Results

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.

SAR Room 3

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
4/10/2014	Body 5180	e'	47.7600	Relative Permittivity (ϵ_r):	47.76	49.05	-2.62	5
		e"	18.4500	Conductivity (σ):	5.31	5.27	0.81	5
	Body 5200	e'	47.7300	Relative Permittivity (ϵ_r):	47.73	49.02	-2.63	5
		e"	18.4500	Conductivity (σ):	5.33	5.29	0.75	5
	Body 5600	e'	47.0800	Relative Permittivity (ϵ_r):	47.08	48.48	-2.88	5
		e"	18.7900	Conductivity (σ):	5.85	5.76	1.56	5
	Body 5800	e'	46.7600	Relative Permittivity (ϵ_r):	46.76	48.20	-2.99	5
		e"	18.9900	Conductivity (σ):	6.12	6.00	2.07	5
Body 5825	e'	46.7300	Relative Permittivity (ϵ_r):	46.73	48.20	-3.05	5	
	e"	19.0100	Conductivity (σ):	6.16	6.00	2.62	5	
4/14/2014	Body 5180	e'	48.8600	Relative Permittivity (ϵ_r):	48.86	49.05	-0.38	5
		e"	18.8300	Conductivity (σ):	5.42	5.27	2.89	5
	Body 5200	e'	48.8200	Relative Permittivity (ϵ_r):	48.82	49.02	-0.41	5
		e"	18.8500	Conductivity (σ):	5.45	5.29	2.94	5
	Body 5600	e'	48.1800	Relative Permittivity (ϵ_r):	48.18	48.48	-0.61	5
		e"	19.2100	Conductivity (σ):	5.98	5.76	3.83	5
	Body 5800	e'	47.8500	Relative Permittivity (ϵ_r):	47.85	48.20	-0.73	5
		e"	19.4100	Conductivity (σ):	6.26	6.00	4.33	5
Body 5825	e'	47.8000	Relative Permittivity (ϵ_r):	47.80	48.20	-0.83	5	
	e"	19.4200	Conductivity (σ):	6.29	6.00	4.83	5	
4/14/2014	Body 2450	e'	50.6200	Relative Permittivity (ϵ_r):	50.62	52.70	-3.95	5
		e"	14.6500	Conductivity (σ):	2.00	1.95	2.35	5
	Body 2410	e'	50.7600	Relative Permittivity (ϵ_r):	50.76	52.76	-3.79	5
		e"	14.5000	Conductivity (σ):	1.94	1.91	1.87	5
	Body 2475	e'	50.5300	Relative Permittivity (ϵ_r):	50.53	52.67	-4.06	5
e"		14.7600	Conductivity (σ):	2.03	1.99	2.32	5	
4/18/2014	Body 2450	e'	50.9100	Relative Permittivity (ϵ_r):	50.91	52.70	-3.40	5
		e"	14.9200	Conductivity (σ):	2.03	1.95	4.23	5
	Body 2410	e'	51.1400	Relative Permittivity (ϵ_r):	51.14	52.76	-3.07	5
		e"	14.7800	Conductivity (σ):	1.98	1.91	3.83	5
	Body 2475	e'	50.8600	Relative Permittivity (ϵ_r):	50.86	52.67	-3.43	5
e"		15.0800	Conductivity (σ):	2.08	1.99	4.54	5	

Tissue Dielectric Parameter Check Results (continued)
SAR Room 4

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit $\pm$ (%)
4/14/2014	Body 5180	e'	48.4500	Relative Permittivity (ϵ_r):	48.45	49.05	-1.22	5
		e"	18.3800	Conductivity (σ):	5.29	5.27	0.43	5
	Body 5200	e'	48.4100	Relative Permittivity (ϵ_r):	48.41	49.02	-1.24	5
		e"	18.3900	Conductivity (σ):	5.32	5.29	0.43	5
	Body 5600	e'	47.7300	Relative Permittivity (ϵ_r):	47.73	48.48	-1.54	5
		e"	18.7800	Conductivity (σ):	5.85	5.76	1.50	5
	Body 5800	e'	47.4100	Relative Permittivity (ϵ_r):	47.41	48.20	-1.64	5
		e"	18.9800	Conductivity (σ):	6.12	6.00	2.02	5
	Body 5825	e'	47.3700	Relative Permittivity (ϵ_r):	47.37	48.20	-1.72	5
		e"	19.0100	Conductivity (σ):	6.16	6.00	2.62	5

11. System Performance Check

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

11.1. System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 $\pm$ 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 ≥ 15.0 cm $\pm$ 0.5 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm $\pm$ 0.5 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 3 mm.
For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was 100 mW.
- The results are normalized to 1 W input power.

11.2. Reference SAR Values for System Performance Check

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

System Dipole	Serial No.	Cal. Date	Freq. (MHz)	Target SAR Values (mW/g)		
				1g/10g	Head	Body
D2450V2	706	05/29/2013	2450	1g	53.7	49.9
				10g	25.0	23.3
D5GHzV2	1138	11/19/2013	5200	1g	78.5	72.9
				10g	22.5	20.4
			5500	1g	82.7	78.3
				10g	23.5	21.7
			5800	1g	78.3	72.8
				10g	22.4	20.1

11.3. System Performance Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within 10% of the manufacturer calibrated dipole SAR target.

SAR Room 3

Date Tested	System Dipole		T.S. Liquid		Measured Results			Target (Ref. Value)	Delta ±10 %	Est./Zoom Ratio	Plot No.
	Type	Serial #			Area Scan	Zoom Scan	Normalize to 1 W				
4/10/2014	D5GHzV2 5.2GHz	1138	Body	1g	7.25	7.60	76.0	72.90	4.25	-4.83	1,2
				10g	2.07	2.13	21.3	20.40	4.41		
4/10/2014	D5GHzV2 5.6GHz	1138	Body	1g	7.58	7.84	78.4	78.30	0.13	-3.43	
				10g	2.130	2.180	21.8	21.70	0.46		
4/10/2014	D5GHzV2 5.8GHz	1138	Body	1g	6.46	6.93	69.3	72.80	-4.81	-7.28	3,4
				10g	1.81	1.93	19.3	20.10	-3.98		
4/14/2014	D5GHzV2 5.2GHz	1138	Body	1g	6.70	7.08	70.8	72.90	-2.88	-5.67	
				10g	1.91	1.99	19.9	20.40	-2.45		
4/14/2014	D5GHzV2 5.6GHz	1138	Body	1g	7.26	7.96	79.6	78.30	1.66	-9.64	5,6
				10g	2.020	2.220	22.2	21.70	2.30		
4/15/2014	D2450V2	706	Body	1g	5.78	5.24	52.4	49.90	5.01	9.34	
				10g	2.630	2.440	24.4	23.30	4.72		
4/18/2014	D2450V2	706	Body	1g	5.48	5.26	52.6	49.90	5.41	4.01	7,8
				10g	2.510	2.450	24.5	23.30	5.15		

SAR Room 4

Date Tested	System Dipole		T.S. Liquid		Measured Results			Target (Ref. Value)	Delta ±10 %	Est./Zoom Ratio	Plot No.
	Type	Serial #			Area Scan	Zoom Scan	Normalize to 1 W				
4/14/2014	D5GHzV2 5.8GHz	1138	Body	1g	6.98	7.57	75.7	72.80	3.98	-8.45	9,10
				10g	1.91	2.12	21.2	20.10	5.47		

12. SAR Test Results

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance v05r02:

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

April 2013 TCB Workshop Updates:

Apply usual 802.11 test exclusion considerations, but include 802.11ac SAR for highest 802.11a configuration in each frequency band and each exposure condition.

12.1. Wi-Fi DTS Band

Test Position	Dist. (mm)	Mode		Antenna	Ch #.	Freq. (MHz)	Power (dBm)				1-g SAR (W/kg)				Plot No.
							Tune-up limit	Meas.	Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
							Wi-Fi 1		Wi-Fi 2		Wi-Fi 1		Wi-Fi 2		
Rear	0	802.11b	2.4 (DTS)	1 TX	6	2437	14.5	13.8			0.409	0.481			1
				1 TX	6	2437			14.5	14.0			0.307	0.344	
				2 TX	6	2437	14.5	12.7	14.5	14.0	0.487	0.737	0.463	0.519	
Edge 1	0	802.11b	2.4 (DTS)	1 TX	6	2437	14.5	13.8			0.163	0.192			
				1 TX	6	2437			14.5	14.0			0.125	0.140	
				2 TX	6	2437	14.5	12.7	14.5	14.0	0.133	0.201	0.106	0.119	

Test Position	Dist. (mm)	Mode		Antenna	Ch #.	Freq. (MHz)	Power (dBm)				1-g SAR (W/kg)				Plot No.
							Tune-up limit	Meas.	Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
							Wi-Fi 1		Wi-Fi 2		Wi-Fi 1		Wi-Fi 2		
Rear	0	802.11a	5.8 (DTS)	1 TX	149	5745	10.5	10.4			0.223	0.228			
				1 TX	149	5745			10.5	10.0			0.236	0.265	
				2 TX	149	5745	10.5	9.3	10.5	10.3	0.221	0.291	0.290	0.304	2
Edge 1	0	802.11a	5.8 (DTS)	1 TX	149	5745	10.5	10.4			0.056	0.057			
				1 TX	149	5745			10.5	10.0			0.088	0.098	
				2 TX	149	5745	10.5	9.3	10.5	10.3	0.059	0.077	0.138	0.145	

Worst-Case Spot-Check for 802.11ac Mode (VHT20)

Test Position	Dist. (mm)	Mode		Antenna	Ch #.	Freq. (MHz)	Power (dBm)				1-g SAR (W/kg)				Plot No.
							Tune-up limit	Meas.	Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
							Wi-Fi 1		Wi-Fi 2		Wi-Fi 1		Wi-Fi 2		
Rear	0	802.11ac	5.8 (DTS)	2 TX	149	5745	10.5	9.7	10.5	10.0	0.035	0.042	0.181	0.203	

12.2. Wi-Fi UNII Band

Test Position	Dist. (mm)	Mode		Antenna	Ch #.	Freq. (MHz)	Power (dBm)				1-g SAR (W/kg)				Plot No.
							Tune-up limit	Meas.	Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
							Wi-Fi 1		Wi-Fi 2		Wi-Fi 1		Wi-Fi 2		
Rear	0	802.11a	5.2 (UNII)	1 TX	48	5240	10.5	10.0			0.136	0.153			
				1 TX	48	5240			10.5	10.5			0.286	0.286	
2 TX				48	5240	10.5	10.0	10.5	10.5	0.208	0.233	0.410	0.410		
Edge 1				1 TX	48	5240	10.5	10.0			0.038	0.043			
				1 TX	48	5240			10.5	10.5			0.133	0.133	
				2 TX	48	5240	10.5	10.0	10.5	10.5	0.038	0.042	0.183	0.183	
Rear	0	802.11a	5.3 (UNII)	1 TX	64	5320	10.5	10.2			0.143	0.153			
				1 TX	64	5320			10.5	10.5			0.277	0.277	
2 TX				64	5320	10.5	10.0	10.5	10.5	0.240	0.269	0.434	0.434	3	
Edge 1				1 TX	64	5320	10.5	10.2			0.036	0.039			
				1 TX	64	5320			10.5	10.5			0.138	0.138	
				2 TX	64	5320	10.5	10.0	10.5	10.5	0.037	0.041	0.177	0.177	
Rear	0	802.11a	5.5 (UNII)	1 TX	104	5520	10.5	10.1			0.171	0.187			
				1 TX	104	5520			10.5	10.1			0.191	0.209	
2 TX				104	5520	10.5	9.2	10.5	10.3	0.241	0.325	0.320	0.335	4	
Edge 1				1 TX	104	5520	10.5	10.1			0.039	0.043			
				1 TX	104	5520			10.5	10.1			0.080	0.088	
				2 TX	104	5520	10.5	9.2	10.5	10.3	0.062	0.084	0.150	0.157	

Worst-Case Spot-Check for 802.11ac Mode (VHT20)

Test Position	Dist. (mm)	Mode		Antenna	Ch #.	Freq. (MHz)	Power (dBm)				1-g SAR (W/kg)				Plot No.
							Tune-up limit	Meas.	Tune-up limit	Meas.	Meas.	Scaled	Meas.	Scaled	
							Wi-Fi 1		Wi-Fi 2		Wi-Fi 1		Wi-Fi 2		
Rear	0	802.11ac	5.2 (UNII)	2 TX	48	5240	10.5	9.8	10.5	10.0	0.231	0.271	0.464	0.521	5
			5.3 (UNII)	2 TX	64	5320	10.5	9.8	10.5	10.0	0.073	0.086	0.180	0.202	
			5.5 (UNII)	2 TX	100	5500	10.5	9.8	10.5	9.9	0.087	0.102	0.154	0.177	

12.3. Bluetooth

Antenna	Dist. (mm)	Test Position	Mode		Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	
1	0	Rear	Bluetooth	2.4	78	2480	10.5	9.5	0.122	0.154	6
	0	Edge 1	Bluetooth	2.4	78	2480	10.5	9.5	0.056	0.071	

13. SAR Measurement Variability

In accordance with published RF Exposure KDB procedure 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03. 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 .

13.1. The Highest Measured SAR Configuration in Each Frequency Band

Frequency Band (MHz)	Air Interface	Stand-alone (W/kg)	Repeated SAR (Yes/No)
2400	Wi-Fi 802.11b/g/n	0.487	No
	Bluetooth	0.122	No
5200	Wi-Fi 802.11a/n/ac	0.464	No
5300	Wi-Fi 802.11a/n/ac	0.434	No
5500	Wi-Fi 802.11a/n/ac	0.320	No
5800	Wi-Fi 802.11a/n/ac	0.290	No

13.2. Repeated Measurement Results

N/A

Note(s):

1. 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 .

14. Simultaneous Transmission SAR Analysis

KDB 447498 D01 General RF Exposure Guidance v05r02, introduces a new formula for calculating the SAR to Peak Location Ratio (SPLSR) between pairs of simultaneously transmitting antennas:

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

Where:

SAR₁ is the highest measured or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

SAR₂ is the highest measured or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

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

A new threshold of 0.04 is also introduced in the draft KDB. Thus, in order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:

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

14.1.1. Estimated SAR for WLAN

Antenna	Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Estimated 1-g SAR Value (W/kg)					
			dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi Antenna 1																
Wi-Fi 1	Wi-Fi 2.4 GHz	2462	14.50	28	5	4.47	197.82	164	15.76		-MEASURE-	-MEASURE-	0.400	0.400	0.366	
Wi-Fi 1	Wi-Fi 5.2 GHz	5230	10.50	11	5	4.47	197.82	164	15.76		-MEASURE-	-MEASURE-	0.400	0.400	0.210	
Wi-Fi 1	Wi-Fi 5.3 GHz	5300	10.50	11	5	4.47	197.82	164	15.76		-MEASURE-	-MEASURE-	0.400	0.400	0.211	
Wi-Fi 1	Wi-Fi 5.5 GHz	5680	10.50	11	5	4.47	197.82	164	15.76		-MEASURE-	-MEASURE-	0.400	0.400	0.218	
Wi-Fi 1	Wi-Fi 5.8 GHz	5825	10.50	11	5	4.47	197.82	164	15.76		-MEASURE-	-MEASURE-	0.400	0.400	0.221	
Wi-Fi 1	Bluetooth	2441	10.50	11	5	4.47	197.82	164	15.76		-MEASURE-	-MEASURE-	0.400	0.400	0.143	
Wi-Fi Antenna 2																
Wi-Fi 2	Wi-Fi 2.4 GHz	2462	14.50	28	5	4.47	161	164	52.28		-MEASURE-	-MEASURE-	0.400	0.400	0.400	
Wi-Fi 2	Wi-Fi 5.2 GHz	5230	10.50	11	5	4.47	161	164	52.28		-MEASURE-	-MEASURE-	0.400	0.400	0.400	
Wi-Fi 2	Wi-Fi 5.3 GHz	5300	10.50	11	5	4.47	161	164	52.28		-MEASURE-	-MEASURE-	0.400	0.400	0.400	
Wi-Fi 2	Wi-Fi 5.5 GHz	5680	10.50	11	5	4.47	161	164	52.28		-MEASURE-	-MEASURE-	0.400	0.400	0.400	
Wi-Fi 2	Wi-Fi 5.8 GHz	5825	10.50	11	5	4.47	161	164	52.28		-MEASURE-	-MEASURE-	0.400	0.400	0.400	

14.2. Wi-Fi and BT

Simultaneous Transmission Scenario		Standalone SAR Values					Σ 1-g SAR (mW/g)	SPLSR (Yes/ No)
Position	Antenna Combination	Wi-Fi 1 + 2 DTS Band	Wi-Fi 1 + 2 UNII Band	Wi-Fi 2 DTS Band	Wi-Fi 2 UNII Band	Wi-Fi 1 Bluetooth		
Rear	Wi-Fi 1 + Wi-Fi 2	0.737					0.737	No
			0.434				0.434	No
	Wi-Fi 2 + BT			0.344		0.154	0.498	No
					0.286	0.154	0.440	No
Edge 1	Wi-Fi 1 + Wi-Fi 2	0.201					0.201	No
			0.183				0.183	No
	Wi-Fi 2 + BT			0.140		0.071	0.211	No
					0.138	0.071	0.209	No

SAR to Peak Location Separation Ratio (SPLSR)

As the Sum of the SAR is not greater than 1.6 W/kg SPLSR assessment is not required.

Multi-Band Volume Scan Combined Results

N/A

Conclusion:

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

15. Appendixes

Refer to separated files for the following appendixes.

- 15.1. Photos and Antenna Locations**
- 15.2. System Performance Check Plots**
- 15.3. Highest SAR Test Plots**
- 15.4. Calibration Certificate for E-Field Probe EX3DV4 - SN 3902**
- 15.5. Calibration Certificate for E-Field Probe EX3DV4 - SN 3936**
- 15.6. Calibration Certificate for D2450V2 - SN 706**
- 15.7. Calibration Certificate for D5GHzV2 - SN 1138**

END OF REPORT