FCC 47 CFR § 2.1093
IEEE Std 1528-2013

SAR EVALUATION REPORT

FOR

BT/BLE, DTS/UNII a/b/g/n/ac and ANT+ Tablet

MODEL NUMBER: SM-T590

FCC ID: A3LSMT590

REPORT NUMBER: 4788494706-S1V1

ISSUE DATE: 6/22/2018

Prepared for
SAMSUNG ELECTRONICS CO., LTD.
129 SAMSUNG-RO, YEONGTONG-GU, SUWON-SI,
GYEONGGI-DO, 16677, KOREA

Prepared by

UL Korea, Ltd.

26th floor, 152, Teheran-ro, Gangnam-gu Seoul, 06236, Korea

Suwon Test Site: UL Korea, Ltd. Suwon Laboratory
218 Maeyeong-ro, Yeongtong-gu,
Suwon-si, Gyeonggi-do, 16675, Korea
TEL: (031) 337-9902
FAX: (031) 213-5433

ACCREDITED
Testing Laboratory

TL-637

Revision History

Rev.	Date	Revisions	Revised By
V1	6/22/2018	Initial Issue	Sunghoon Kim

Table of Contents

1. Attestation of Test Results 5

2. Test Specification, Methods and Procedures 6

3. Facilities and Accreditation 6

4. SAR Measurement System & Test Equipment 7

4.1. SAR Measurement System 7

4.2. SAR Scan Procedures 8

4.3. Test Equipment 10

5. Measurement Uncertainty 10

6. Device Under Test (DUT) Information 11

6.1. DUT Description 11

6.2. Wireless Technologies 11

6.3. Nominal and Maximum Output Power 12

6.4. Proximity sensor feature 13

6.4.1. Proximity Sensor Triggering Distance (KDB 616217 §6.2) 14

6.4.2. Proximity Sensor Coverage (KDB 616217 §6.3) 19

6.4.3. Proximity Sensor Tilt Angle Assessment (KDB 616217 §6.4) 19

6.4.4. Resulting test positions for SAR measurements 20

7. RF Exposure Conditions (Test Configurations) 21

7.1 Standalone SAR Test Exclusion Considerations 21

7.2 Required Test Configurations 22

8 Dielectric Property Measurements & System Check 23

8.1 Dielectric Property Measurements 23

8.2 System Check 25

9 Conducted Output Power Measurements 27

9.1 Wi-Fi 2.4GHz (DTS Band) 27

9.2 Bluetooth 27

9.3 Wi-Fi 5GHz (U-NII Bands) 28

10 Measured and Reported (Scaled) SAR Results 29

10.1 Wi-Fi (DTS Band) 30

10.2 Wi-Fi (U-NII Band) 31

10.3 Bluetooth 32

11 SAR Measurement Variability 33

12 Simultaneous Transmission SAR Analysis 33

Appendixes 34

4788494706-S1V1 FCC Report SAR_App A_Photos & Ant. Locations 34

4788494706-S1V1 FCC Report SAR_App B_Highest SAR Test Plots 34

4788494706-S1V1 FCC Report SAR_App C_System Check Plots 34

4788494706-S1V1 FCC Report SAR_App D_SAR Tissue Ingredients 34

4788494706-S1V1 FCC Report SAR_App E_Probe Cal. Certificates 34

4788494706-S1V1 FCC Report SAR_App F_Dipole Cal. Certificates 34

1. Attestation of Test Results

Applicant Name	SAMSUNG ELECTRONICS CO.,LTD.		
FCC ID	A3LSMT590		
Model Name	SM-T590		
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**		
	DTS	**U-NII**	**DSS(BT)**
Standalone	0.67	1.19	N/A
Date Tested	6/14/2018 to 6/19/2018		
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:
	
Justin Park Lead Test Engineer UL Korea, Ltd. Suwon Laboratory	Sunghoon Kim Associate Test 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 v02r02
- 447498 D01 General RF Exposure Guidance v06
- 616217 D04 SAR for laptop and tablets v01r02
- 690783 D01 SAR Listings on Grants v01r03
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02

In addition to the above, the following information was used:

- TCB workshop October, 2016; Page 7, RF Exposure Procedures (Bluetooth Duty Factor)

Additional Guidance: KDB inquiry

- Additional SAR test of corner side – KDB guidance to identify that SAR test when sensor and antenna is located near corner side.

3. Facilities and Accreditation

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

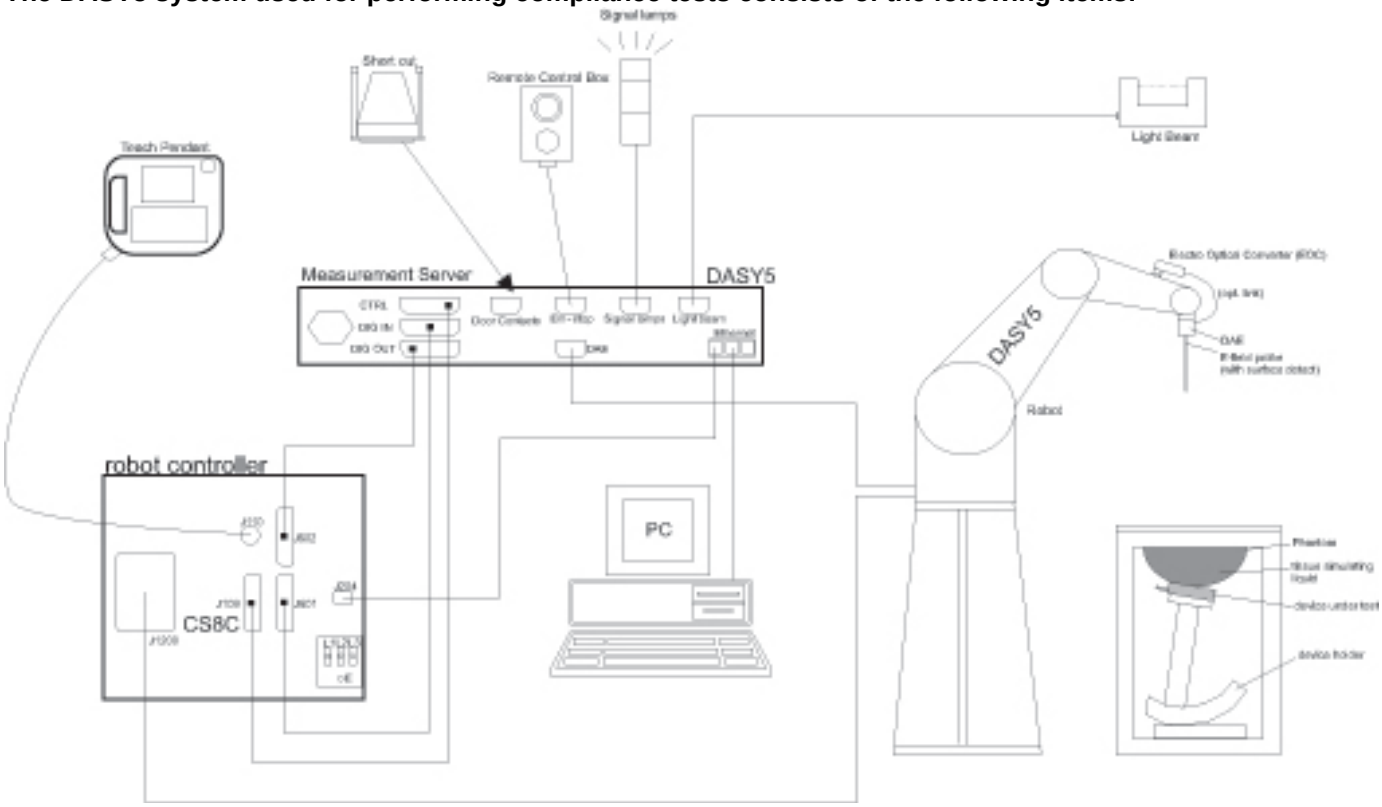
Suwon
SAR 1 Room
SAR 2 Room
SAR 3 Room

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

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

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

<table>
<tr><td colspan="3"></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">≤ 1.5·$\Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
* When zoom scan is required and the <u>reported</u> SAR from the 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.</td></tr>
</table>

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	8-8-2018
Dielectric Assessment Kit	SPEAG	DAK-3.5	1196	8-2-2018
Shorting block	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	LKM	DTM3000	3424	8-11-2018
Thermometer	Lutron	MHB-382SD	AH.91478	8-10-2018

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
MXG Analog Signal Generator	Agilent	N5181A	MY50145882	8-7-2018
Power Sensor	Agilent	U2000A	MY54260010	8-8-2018
Power Sensor	Agilent	U2000A	MY54260007	8-8-2018
Power Amplifier	EXODUS	1410025-AMP2027-10003	10003	8-8-2018
Directional Coupler	Agilent	772D	MY52180193	8-7-2018
Low Pass Filter	FILTRON	L14012FL	1410003S	8-7-2018
Low Pass Filter	MICROLAB	LA-60N	03942	8-7-2018
Attenuator	Agilent	8491B/003	MY39269292	8-7-2018
Attenuator	Agilent	8491B/010	MY39269315	8-7-2018
Attenuator	Agilent	8491B/020	MY39269298	8-7-2018
E-Field Probe (SAR1)	SPEAG	EX3DV4	7376	8-22-2018
E-Field Probe (SAR3)	SPEAG	EX3DV4	7314	9-28-2018
Data Acquisition Electronics (SAR1)	SPEAG	DAE4	1468	8-22-2018
Data Acquisition Electronics (SAR3)	SPEAG	DAE4	1494	7-20-2018
System Validation Dipole	SPEAG	D2450V2	939	9-19-2018
System Validation Dipole	SPEAG	D5GHzV2	1209	2-15-2019
Thermometer (SAR1)	Lutron	MHB-382SD	AH.91463	8-10-2018
Thermometer (SAR3)	Lutron	MHB-382SD	AH.50213	8-16-2018

5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg and the measured 10-g SAR within a frequency band is < 3.75 W/kg. The expanded SAR measurement uncertainty must be ≤ 30%, for a confidence interval of k = 2. If these conditions are met, 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): 259.9 mm x 161.1 mm Overall Diagonal: 300.8 mm Display Diagonal: 267.2 mm
Back Cover	☒ The Back Cover is not removable.
Battery Options	☒ The rechargeable battery is not user accessible.
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, Ch.36 – Ch.48, Ch.149 – Ch.165)
Test Sample Information	**No.** / **S/N** / **Notes** 1 / R32K5005MMR / Wi-Fi Conducted 2 / R32K5005CGD / SAR 3 / R32K5005EDZ / SAR

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)	99.7% (802.11b) 98.2% (802.11g) 98.1% (802.11n 20MHz BW)
	5 GHz	802.11a 802.11n (HT20) 802.11n (HT40) 802.11ac (VHT20) 802.11ac (VHT40) 802.11ac (VHT80)	98.2% (802.11a) 98.1% (802.11n/ac 20MHz BW) 96.1% (802.11n/ac 40MHz BW) 71.3% (802.11n/ac 80MHz BW)
	Does this device support bands 5.60 ~ 5.65 GHz? ☒ Yes ☐ No		
	Does this device support Band gap channel(s)? ☐ Yes ☒ No		
Bluetooth	2.4 GHz	Version 4.2 LE	76.9% (DH5)

Notes:

1. Duty cycle for Wi-Fi is referenced from the DTS and UNII report.

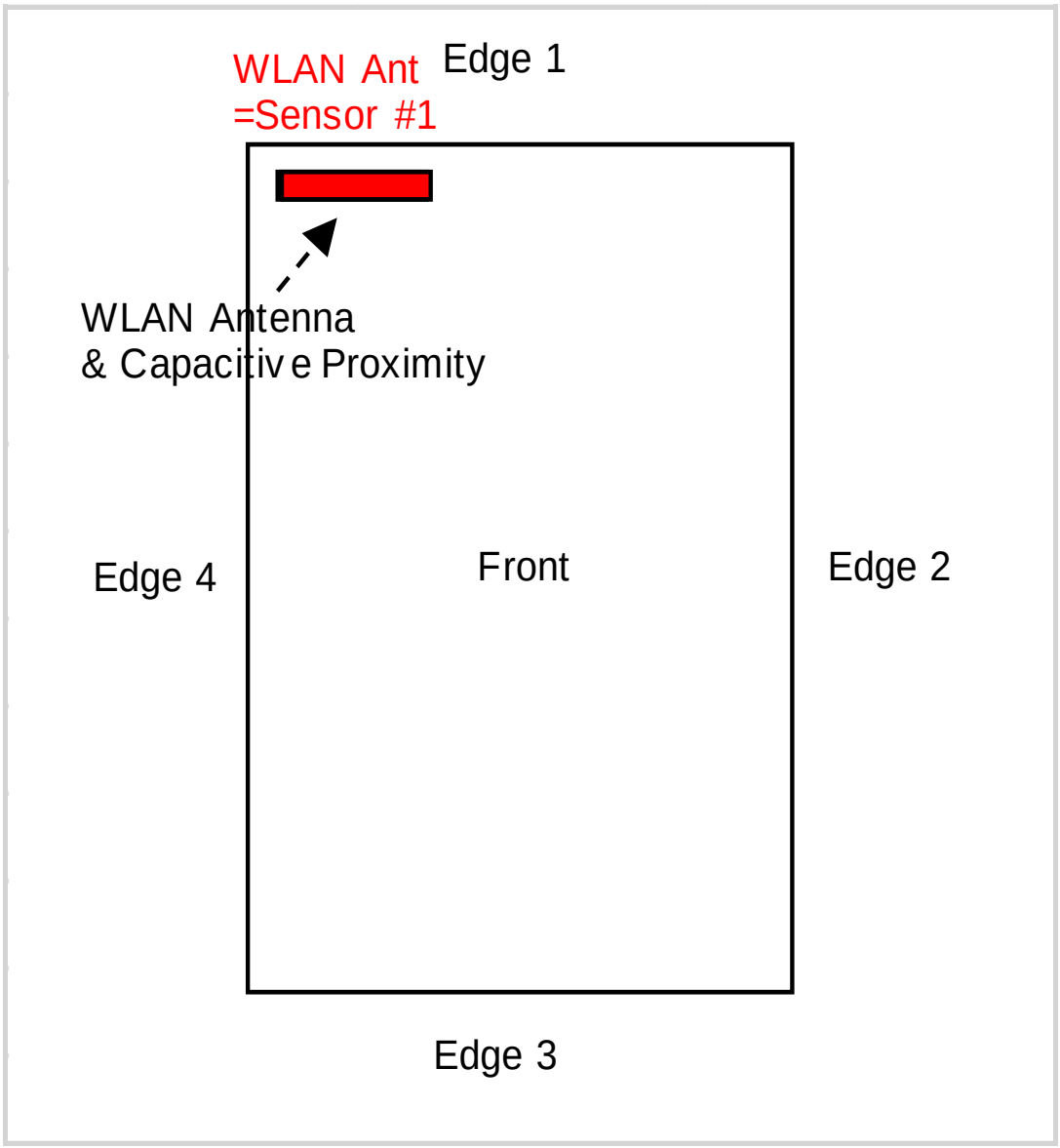
6.3. Nominal and Maximum Output Power

KDB 447498 sec.4.1. 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

RF Air interface	Mode	Max. RF Output Power (dBm)	Reduced. RF Output Power (dBm)
WiFi 2.4 GHz (Ch.1)	802.11b	**13.0**	
	802.11g	**13.0**	
	802.11n HT20	**13.0**	
WiFi 2.4 GHz (Ch.2)	802.11b	**16.0**	**15.0**
	802.11g	**16.0**	**15.0**
	802.11n HT20	**16.0**	**15.0**
WiFi 2.4 GHz (Ch.3 - Ch.9)	802.11b	**17.5**	**15.0**
	802.11g	**17.0**	**15.0**
	802.11n HT20	**17.0**	**15.0**
WiFi 2.4 GHz (Ch.10)	802.11b	**16.0**	**15.0**
	802.11g	**16.0**	**15.0**
	802.11n HT20	**16.0**	**15.0**
WiFi 2.4 GHz (Ch.11)	802.11b	**12.0**	
	802.11g	**12.0**	
	802.11n HT20	**12.0**	
WiFi 5.2 GHz (U-NII 1)	802.11a	**17.0**	**11.5**
	802.11n HT20	**16.0**	**11.5**
	802.11n HT40	**16.0**	**11.5**
	802.11ac VHT20	**14.0**	**11.5**
	802.11ac VHT40	**14.0**	**11.5**
	802.11ac VHT80	**14.0**	**11.0**
WiFi 5.3 GHz (U-NII 2A)	802.11a	**17.0**	**11.5**
	802.11n HT20	**16.0**	**11.5**
	802.11n HT40	**16.0**	**11.5**
	802.11ac VHT20	**14.0**	**11.5**
	802.11ac VHT40	**14.0**	**11.5**
	802.11ac VHT80	**14.0**	**11.0**
WiFi 5.5 GHz (U-NII 2C)	802.11a	**17.0**	**10.0**
	802.11n HT20	**16.0**	**10.0**
	802.11n HT40	**16.0**	**10.0**
	802.11ac VHT20	**14.0**	**10.0**
	802.11ac VHT40	**14.0**	**10.0**
	802.11ac VHT80	**14.0**	**9.5**
WiFi 5.8 GHz (U-NII 3)	802.11a	**17.0**	**11.0**
	802.11n HT20	**16.0**	**11.0**
	802.11n HT40	**16.0**	**11.0**
	802.11ac VHT20	**14.0**	**11.0**
	802.11ac VHT40	**14.0**	**11.0**
	802.11ac VHT80	**14.0**	**10.5**
Bluetooth		**9.0**	
Bluetooth LE		**6.0**	

6.4. Proximity sensor feature

The DUT has two proximity sensors to reduce the output power. The position of the sensors and antenna are as shown in the graphic.

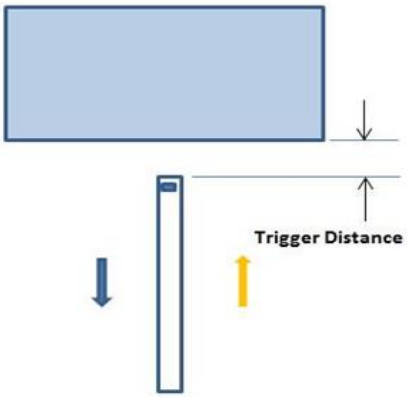


6.4.1. Proximity Sensor Triggering Distance (KDB 616217 §6.2)

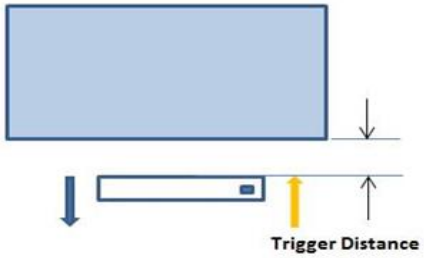
Rear, Edge 1, Edge 4, Corner (Side of between Edge 1 and Edge 4) of the DUT was placed directly below the flat phantom. The DUT was moved toward the phantom in accordance with the steps outlined in KDB 616217 §6.2 to determine the trigger distance for enabling power reduction. The DUT was moved away from the phantom to determine the trigger distance for resuming full power.

The DUT featured a visual indicator on its display that showed the status of the proximity sensor (Triggered or not triggered). This was used to determine the status of the sensor during the proximity sensor assessment as monitoring the output power directly was not practical without affecting the measurement.

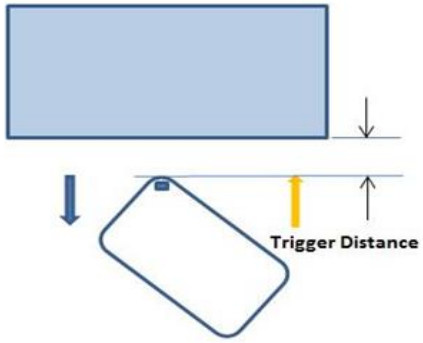
It was confirmed separately that the output power was altered according to the proximity sensor status indication. This was achieved by observing the proximity sensor status at the same time as monitoring the conducted power. Section 9 contains both the full and reduced conducted power measurements.



Proximity Sensor Trigger Distance Assessment
KDB 616217 §6.2, Edge 1, Edge 4



Proximity Sensor Trigger Distance Assessment
KDB 616217 §6.2, Rear



Proximity Sensor Trigger Distance Assessment
KDB 616217 §6.2, Corner

LEGEND

Direction of DUT travel for determination of power reduction triggering point

Direction of DUT travel for determination of full power resumption triggering point

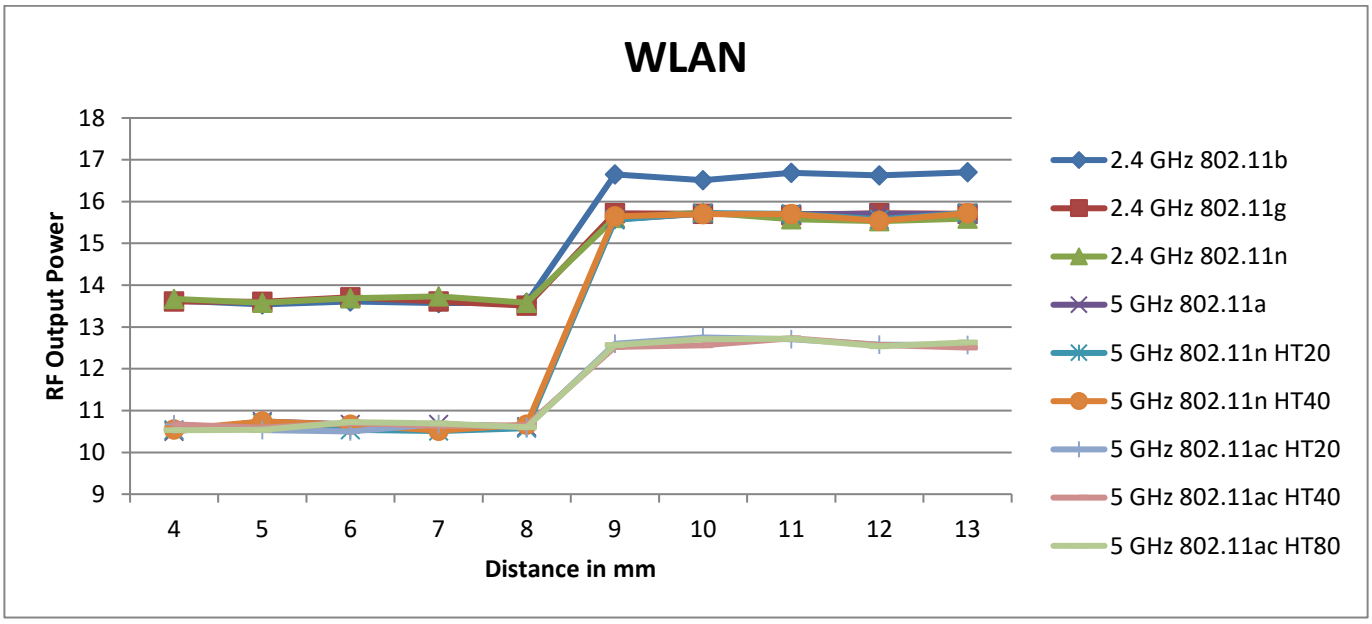
Summary of Trigger Distances

Tissue simulating liquid	Trigger distance - Rear		Trigger distance – Edge 1		Trigger distance – Edge 4		Trigger distance – Corner	
	Moving toward phantom	Moving from phantom	Moving toward phantom	Moving from phantom	Moving toward phantom	Moving from phantom	Moving toward phantom	Moving from phantom
2450 muscle	8 mm	8 mm	8 mm	8 mm	6 mm	6 mm	5 mm	5 mm
5000 muscle	8 mm	8 mm	8 mm	8 mm	6 mm	6 mm	5 mm	5 mm

Proximity Sensor Triggering Distance Measurement Results
WLAN 2.4GHz and 5GHz

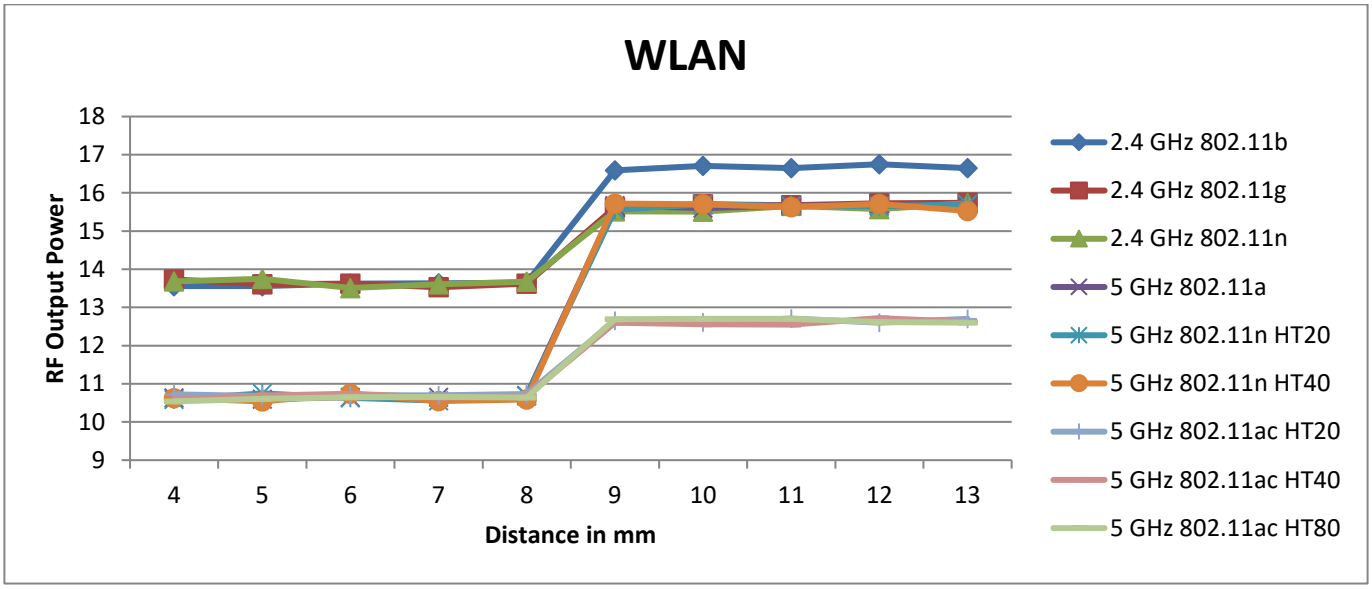
Rear, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm										
Distance	4	5	6	7	8	9	10	11	12	13
2.4 GHz 802.11b	13.6	13.5	13.6	13.6	13.6	16.7	16.5	16.7	16.6	16.7
2.4 GHz 802.11g	13.6	13.6	13.7	13.6	13.5	15.7	15.7	15.7	15.7	15.7
2.4 GHz 802.11n	13.7	13.6	13.7	13.7	13.6	15.6	15.7	15.6	15.5	15.6
5 GHz 802.11a	10.5	10.7	10.7	10.7	10.6	15.6	15.7	15.7	15.7	15.7
5 GHz 802.11n HT20	10.5	10.7	10.5	10.5	10.6	15.6	15.7	15.7	15.6	15.7
5 GHz 802.11n HT40	10.6	10.7	10.7	10.5	10.7	15.7	15.7	15.7	15.5	15.7
5 GHz 802.11ac HT20	10.7	10.5	10.5	10.7	10.6	12.6	12.8	12.7	12.6	12.6
5 GHz 802.11ac HT40	10.7	10.6	10.7	10.6	10.7	12.5	12.6	12.7	12.6	12.5
5 GHz 802.11ac HT80	10.5	10.5	10.7	10.7	10.6	12.6	12.7	12.7	12.5	12.6



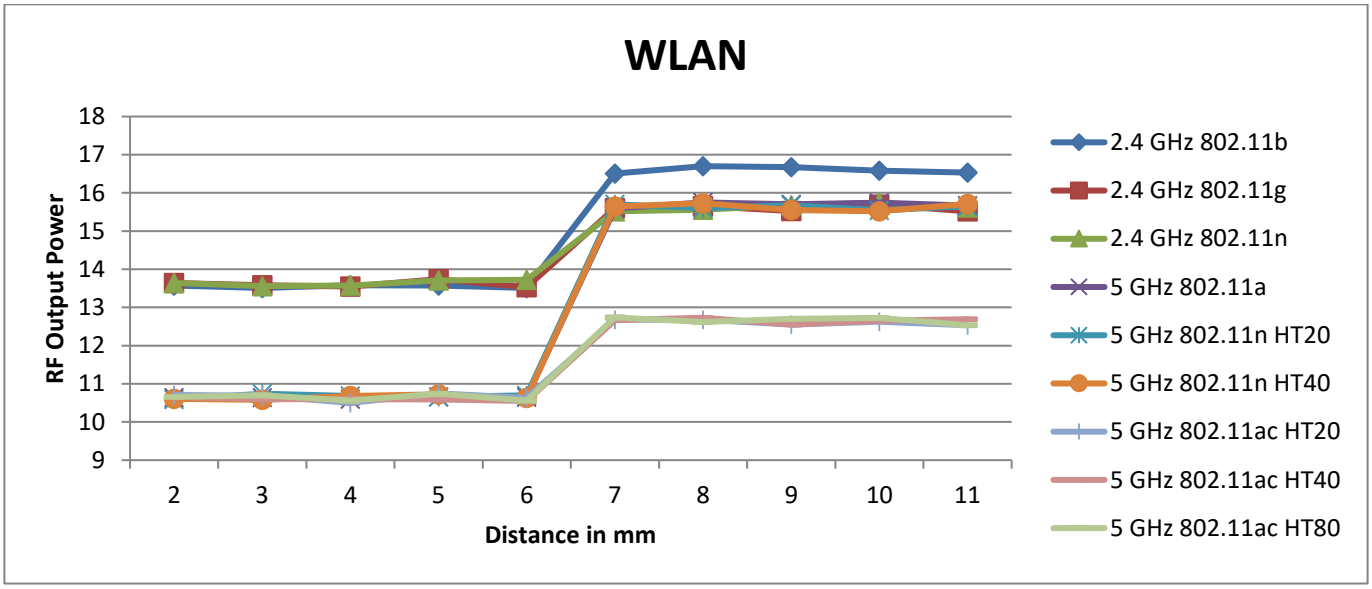
Edge 1, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm										
Distance (mm)	4	5	6	7	8	9	10	11	12	13
2.4 GHz 802.11b	13.6	13.6	13.6	13.6	13.7	16.6	16.7	16.7	16.8	16.7
2.4 GHz 802.11g	13.7	13.6	13.6	13.5	13.6	15.6	15.7	15.7	15.7	15.7
2.4 GHz 802.11n	13.7	13.8	13.5	13.6	13.7	15.5	15.5	15.7	15.6	15.7
5 GHz 802.11a	10.6	10.6	10.7	10.7	10.7	15.7	15.6	15.7	15.7	15.7
5 GHz 802.11n HT20	10.6	10.8	10.6	10.6	10.7	15.6	15.7	15.7	15.7	15.7
5 GHz 802.11n HT40	10.6	10.5	10.7	10.6	10.6	15.7	15.7	15.6	15.7	15.5
5 GHz 802.11ac HT20	10.7	10.7	10.7	10.7	10.7	12.7	12.6	12.7	12.6	12.7
5 GHz 802.11ac HT40	10.6	10.7	10.7	10.6	10.7	12.6	12.6	12.6	12.7	12.6
5 GHz 802.11ac HT80	10.5	10.6	10.7	10.7	10.6	12.7	12.7	12.7	12.6	12.6



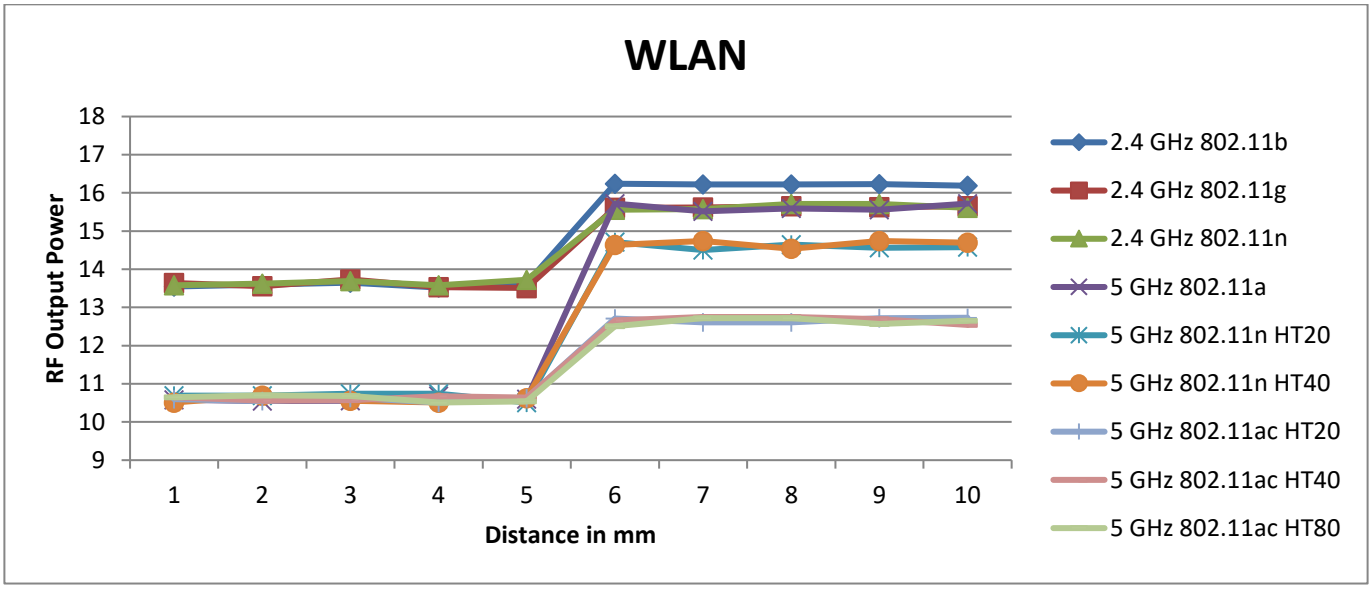
Edge 4, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm										
Distance (mm)	2	3	4	5	6	7	8	9	10	11
2.4 GHz 802.11b	13.6	13.5	13.6	13.6	13.5	16.5	16.7	16.7	16.6	16.5
2.4 GHz 802.11g	13.6	13.6	13.6	13.7	13.5	15.6	15.7	15.5	15.7	15.5
2.4 GHz 802.11n	13.6	13.6	13.6	13.7	13.7	15.5	15.6	15.7	15.7	15.6
5 GHz 802.11a	10.6	10.6	10.6	10.7	10.7	15.6	15.8	15.7	15.7	15.7
5 GHz 802.11n HT20	10.6	10.7	10.7	10.7	10.7	15.7	15.6	15.7	15.5	15.7
5 GHz 802.11n HT40	10.6	10.6	10.7	10.7	10.6	15.6	15.7	15.6	15.5	15.7
5 GHz 802.11ac HT20	10.7	10.7	10.5	10.8	10.6	12.7	12.7	12.6	12.6	12.5
5 GHz 802.11ac HT40	10.7	10.6	10.6	10.6	10.6	12.7	12.7	12.6	12.7	12.7
5 GHz 802.11ac HT80	10.7	10.7	10.6	10.7	10.6	12.7	12.6	12.7	12.7	12.5



Corner, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm										
Distance (mm)	1	2	3	4	5	6	7	8	9	10
2.4 GHz 802.11b	13.6	13.6	13.7	13.5	13.6	16.2	16.2	16.2	16.2	16.2
2.4 GHz 802.11g	13.6	13.6	13.7	13.5	13.5	15.6	15.6	15.7	15.6	15.7
2.4 GHz 802.11n	13.6	13.6	13.7	13.6	13.7	15.6	15.6	15.7	15.7	15.6
5 GHz 802.11a	10.6	10.6	10.6	10.7	10.6	15.7	15.5	15.6	15.6	15.7
5 GHz 802.11n HT20	10.7	10.7	10.7	10.7	10.5	14.7	14.5	14.7	14.6	14.6
5 GHz 802.11n HT40	10.5	10.7	10.6	10.5	10.6	14.6	14.7	14.5	14.7	14.7
5 GHz 802.11ac HT20	10.6	10.6	10.6	10.5	10.6	12.7	12.6	12.6	12.7	12.7
5 GHz 802.11ac HT40	10.7	10.6	10.6	10.7	10.6	12.7	12.8	12.8	12.7	12.5
5 GHz 802.11ac HT80	10.7	10.7	10.7	10.5	10.5	12.5	12.7	12.7	12.6	12.7



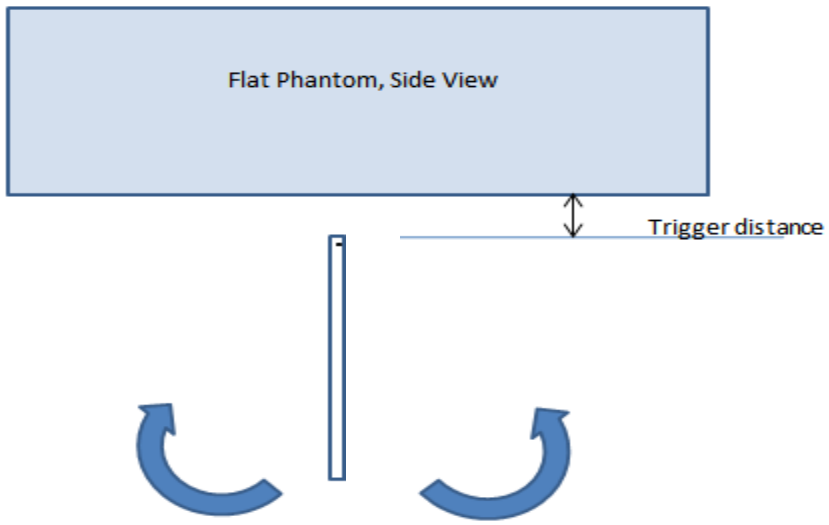
6.4.2. Proximity Sensor Coverage (KDB 616217 §6.3)

As there is no spatial offset between the antenna and the proximity sensor element, proximity sensor coverage did not need to be assessed.

6.4.3. Proximity Sensor Tilt Angle Assessment (KDB 616217 §6.4)

The DUT was positioned directly below the flat phantom at the minimum measured trigger distance with Edge 1, Edge 2, Edge 4 parallel to the base of the flat phantom for each band.

The EUT was rotated about Edge 1, Edge 2, Edge 4 for angles up to +/- 45°. If the output power increased during the rotation the DUT was moved 1mm toward the phantom and the rotation repeated. This procedure was repeated until the power remained reduced for all angles up to +/- 45°.



Proximity sensor tilt angle assessment (Edge 1, Edge 4) KDB 616217 §6.4

Summary of Tablet Tilt Angle Influence to Proximity Sensor Triggering (Edge 1)

Band (MHz)	Minimum trigger distance measured according to KDB 616217 §6.2	Minimum distance at which power reduction was maintained over +/-45°	Power reduction status										
			-45°	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	45°
2450	8 mm	8 mm	On	On	On	On	On	On	On	On	On	On	On
5000	8 mm	8 mm	On	On	On	On	On	On	On	On	On	On	On

Summary of Tablet Tilt Angle Influence to Proximity Sensor Triggering (Edge 4)

Band (MHz)	Minimum trigger distance measured according to KDB 616217 §6.2	Minimum distance at which power reduction was maintained over +/-45°	Power reduction status										
			-45°	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	45°
2450	6 mm	6 mm	On	On	On	On	On	On	On	On	On	On	On
5000	6 mm	6 mm	On	On	On	On	On	On	On	On	On	On	On

6.4.4. Resulting test positions for SAR measurements

Wireless technologies	Position	§6.4.1 Triggering Distance	§6.4.2 Coverage	§6.4.3 Tilt Angle	Worst case distance for SAR
WLAN	Rear	8 mm	N/A	N/A	7 mm
	Edge 1	8 mm	N/A	8 mm	7 mm
	Edge 4	6 mm	N/A	6 mm	5 mm
	Corner	5 mm	N/A	N/A	4 mm

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	Corner	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Corner
Full Power, Proximity Sensor Off															
Wi-Fi 2.4 GHz	2462	17.50	56	1	4	146	220.9	4	2	17.6 -MEASURE-	17.6 -MEASURE-	> 50 mm	> 50 mm	17.6 -MEASURE-	17.6 -MEASURE-
Wi-Fi 5.3 GHz	5320	17.00	50	1	4	146	220.9	4	2	23.1 -MEASURE-	23.1 -MEASURE-	> 50 mm	> 50 mm	23.1 -MEASURE-	23.1 -MEASURE-
Wi-Fi 5.5 GHz	5700	17.00	50	1	4	146	220.9	4	2	23.9 -MEASURE-	23.9 -MEASURE-	> 50 mm	> 50 mm	23.9 -MEASURE-	23.9 -MEASURE-
Wi-Fi 5.8 GHz	5825	17.00	50	1	4	146	220.9	4	2	24.1 -MEASURE-	24.1 -MEASURE-	> 50 mm	> 50 mm	24.1 -MEASURE-	24.1 -MEASURE-
Bluetooth	2480	9.00	8	1	4	146	220.9	4	2	2.5 -EXEMPT-	2.5 -EXEMPT-	> 50 mm	> 50 mm	2.5 -EXEMPT-	2.5 -EXEMPT-
Power Back-off, Proximity Sensor On															
Wi-Fi 2.4 GHz	2462	15.00	32	1	4			4	2	10 -MEASURE-	10 -MEASURE-			10 -MEASURE-	10 -MEASURE-
Wi-Fi 5.3 GHz	5320	11.50	14	1	4			4	2	6.5 -MEASURE-	6.5 -MEASURE-			6.5 -MEASURE-	6.5 -MEASURE-
Wi-Fi 5.5 GHz	5700	10.00	10	1	4			4	2	4.8 -MEASURE-	4.8 -MEASURE-			4.8 -MEASURE-	4.8 -MEASURE-
Wi-Fi 5.8 GHz	5825	11.00	13	1	4			4	2	6.3 -MEASURE-	6.3 -MEASURE-			6.3 -MEASURE-	6.3 -MEASURE-

Note(s):

2. 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	Corner	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Corner
Full Power, Proximity Sensor Off															
Wi-Fi 2.4 GHz	2462	17.50	56	1	4	146	220.9	4	2	< 50 mm	< 50 mm	1055.6 mW -EXEMPT-	1804.6 mW -EXEMPT-	< 50 mm	< 50 mm
Wi-Fi 5.3 GHz	5320	17.00	50	1	4	146	220.9	4	2	< 50 mm	< 50 mm	1025 mW -EXEMPT-	1774 mW -EXEMPT-	< 50 mm	< 50 mm
Wi-Fi 5.5 GHz	5700	17.00	50	1	4	146	220.9	4	2	< 50 mm	< 50 mm	1022.8 mW -EXEMPT-	1771.8 mW -EXEMPT-	< 50 mm	< 50 mm
Wi-Fi 5.8 GHz	5825	17.00	50	1	4	146	220.9	4	2	< 50 mm	< 50 mm	1022.2 mW -EXEMPT-	1771.2 mW -EXEMPT-	< 50 mm	< 50 mm
Bluetooth	2480	9.00	8	1	4	146	220.9	4	2	< 50 mm	< 50 mm	1055.3 mW -EXEMPT-	1804.3 mW -EXEMPT-	< 50 mm	< 50 mm
Power Back-off, Proximity Sensor On															
Wi-Fi 2.4 GHz	2462	15.00	32	1	4			4	2	< 50 mm	< 50 mm			< 50 mm	< 50 mm
Wi-Fi 5.3 GHz	5320	11.50	14	1	4			4	2	< 50 mm	< 50 mm			< 50 mm	< 50 mm
Wi-Fi 5.5 GHz	5700	10.00	10	1	4			4	2	< 50 mm	< 50 mm			< 50 mm	< 50 mm
Wi-Fi 5.8 GHz	5825	11.00	13	1	4			4	2	< 50 mm	< 50 mm			< 50 mm	< 50 mm

Note(s):

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

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	Pwr Back-off	Rear	Edge 1 (Top Edge)	Edge 2 (Right Edge)	Edge 3 (Bottom Edge)	Edge 4 (Left Edge)	Corner Note 2
Wi-Fi 2.4 GHz	OFF	Yes	Yes	No	No	Yes	Yes
	ON	Yes	Yes	No	No	Yes	Yes
Wi-Fi 5.3 GHz	OFF	Yes	Yes	No	No	Yes	Yes
	ON	Yes	Yes	No	No	Yes	Yes
Wi-Fi 5.5 GHz	OFF	Yes	Yes	No	No	Yes	Yes
	ON	Yes	Yes	No	No	Yes	Yes
Wi-Fi 5.8 GHz	OFF	Yes	Yes	No	No	Yes	Yes
	ON	Yes	Yes	No	No	Yes	Yes
Bluetooth	OFF	No	No	No	No	No	No

Note(s):

1. Yes = Testing is required. No = Testing is not required..
2. Corner side is located between Edge 1 and Edge 4.

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)	Body	
	ε_r	σ (S/m)
150	61.9	0.80
300	58.2	0.92
450	56.7	0.94
835	55.2	0.97
900	55.0	1.05
915	55.0	1.06
1450	54.0	1.30
1610	53.8	1.40
1800 – 2000	53.3	1.52
2450	52.7	1.95
3000	52.0	2.73
5000	49.3	5.07
5100	49.1	5.18
5200	49.0	5.30
5300	48.9	5.42
5400	48.7	5.53
5500	48.6	5.65
5600	48.5	5.77
5700	48.3	5.88
5800	48.2	6.00

IEEE Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

Dielectric Property Measurements Results:

SAR 1 Room

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
6-14-2018	Body 2450	e'	52.0800	Relative Permittivity (ϵ_r):	52.08	52.70	-1.18	5
		e"	14.7700	Conductivity (σ):	2.01	1.95	3.18	5
	Body 2400	e'	52.2100	Relative Permittivity (ϵ_r):	52.21	52.77	-1.07	5
		e"	14.6500	Conductivity (σ):	1.96	1.90	3.00	5
	Body 2480	e'	52.0000	Relative Permittivity (ϵ_r):	52.00	52.66	-1.26	5
		e"	14.8600	Conductivity (σ):	2.05	1.99	2.86	5
6-19-2018	Body 2450	e'	52.0900	Relative Permittivity (ϵ_r):	52.09	52.70	-1.16	5
		e"	14.3300	Conductivity (σ):	1.95	1.95	0.11	5
	Body 2400	e'	52.2600	Relative Permittivity (ϵ_r):	52.26	52.77	-0.97	5
		e"	14.2300	Conductivity (σ):	1.90	1.90	0.05	5
	Body 2480	e'	52.0000	Relative Permittivity (ϵ_r):	52.00	52.66	-1.26	5
		e"	14.4200	Conductivity (σ):	1.99	1.99	-0.19	5

SAR 3 Room

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
6-14-2018	Body 5250	e'	47.6500	Relative Permittivity (ϵ_r):	47.65	48.95	-2.66	5
		e"	18.4900	Conductivity (σ):	5.40	5.35	0.83	5
	Body 5260	e'	47.6300	Relative Permittivity (ϵ_r):	47.63	48.94	-2.67	5
		e"	18.5000	Conductivity (σ):	5.41	5.36	0.86	5
	Body 5600	e'	47.0400	Relative Permittivity (ϵ_r):	47.04	48.48	-2.97	5
		e"	18.7900	Conductivity (σ):	5.85	5.76	1.56	5
	Body 5750	e'	46.7900	Relative Permittivity (ϵ_r):	46.79	48.27	-3.08	5
		e"	18.9500	Conductivity (σ):	6.06	5.94	2.07	5
	Body 5825	e'	46.6600	Relative Permittivity (ϵ_r):	46.66	48.20	-3.20	5
		e"	19.0100	Conductivity (σ):	6.16	6.00	2.62	5
6-18-2018	Body 5250	e'	48.7300	Relative Permittivity (ϵ_r):	48.73	48.95	-0.45	5
		e"	17.9000	Conductivity (σ):	5.23	5.35	-2.39	5
	Body 5260	e'	48.7200	Relative Permittivity (ϵ_r):	48.72	48.94	-0.45	5
		e"	17.9100	Conductivity (σ):	5.24	5.36	-2.36	5
	Body 5600	e'	48.2900	Relative Permittivity (ϵ_r):	48.29	48.48	-0.39	5
		e"	18.1100	Conductivity (σ):	5.64	5.76	-2.12	5
	Body 5750	e'	48.1100	Relative Permittivity (ϵ_r):	48.11	48.27	-0.34	5
		e"	18.2100	Conductivity (σ):	5.82	5.94	-1.92	5
	Body 5825	e'	47.9900	Relative Permittivity (ϵ_r):	47.99	48.20	-0.44	5
		e"	18.2900	Conductivity (σ):	5.92	6.00	-1.27	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 2.5 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 1.4 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	Body
D2450V2	939	9-19-2017	2450	1g	50.70
				10g	23.90
D5GHzV2	1209	2-15-2018	5250	1g	75.70
				10g	21.00
			5600	1g	79.00
				10g	21.90
			5750	1g	75.60
				10g	20.80

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 1 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			
6-14-2018	D2450V2	939	Body	1g	5.19	51.90	50.70	2.37	
				10g	2.38	23.80	23.90	-0.42	
6-19-2018	D2450V2	939	Body	1g	4.82	48.20	50.70	-4.93	1, 2
				10g	2.21	22.10	23.90	-7.53	

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			
6-14-2018	D5GHzV2 (5250)	1209	Body	1g	8.04	80.40	75.70	6.21	
				10g	2.23	22.30	21.00	6.19	
6-14-2018	D5GHzV2 (5600)	1209	Body	1g	8.55	85.50	79.00	8.23	3, 4
				10g	2.34	23.40	21.90	6.85	
6-14-2018	D5GHzV2 (5750)	1209	Body	1g	7.54	75.40	75.60	-0.26	
				10g	2.09	20.90	20.80	0.48	
6-18-2018	D5GHzV2 (5250)	1209	Body	1g	7.68	76.80	75.70	1.45	
				10g	2.14	21.40	21.00	1.90	
6-18-2018	D5GHzV2 (5600)	1209	Body	1g	8.45	84.50	79.00	6.96	
				10g	2.31	23.10	21.90	5.48	
6-18-2018	D5GHzV2 (5750)	1209	Body	1g	7.38	73.80	75.60	-2.38	
				10g	2.04	20.40	20.80	-1.92	

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.			Reduction Pwr.		
					Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)	Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)
2.4	802.11b	1 Mbps	1	2412	12.3	13.0	Yes	12.3	13.0	Yes
			6	2437	17.3	17.5		14.2	15.0	
			11	2462	11.3	12.0		11.3	12.0	
	802.11g	6 Mbps	1	2412	Not Require	13.0	No	12.3	13.0	No
			6	2437		17.0		14.3	15.0	
			11	2462		12.0		11.3	12.0	
	802.11n (HT20)	6.5 Mbps	1	2412	Not Require	13.0	No	12.3	13.0	No
			6	2437		17.0		14.2	15.0	
			11	2462		12.0		11.2	12.0	

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 Bluetooth

Maximum tune-up tolerance limit is 9.0 dBm from the rated nominal maximum output power. This power level qualifies for exclusion of SAR testing. The reference to section 10.3 for explanation of rationale for exemption of testing.

9.3 Wi-Fi 5GHz (U-NII Bands)

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Max Pwr.			Reduction Pwr.		
					Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)	Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)
5.3 (U-NII 2A)	802.11a	6 Mbps	52	5260	16.2	17.0	Yes	Not Required	11.5	No
			56	5280	16.0					
			60	5300	16.0					
			64	5320	16.0					
	802.11n (HT20)	6.5 Mbps	52	5260	Not Required	16.0	No	Not Required	11.5	No
			56	5280						
			60	5300						
			64	5320						
	802.11n (HT40)	13.5 Mbps	54	5270	Not Required	16.0	No	11.2	11.5	Yes
			62	5310				11.4		
	802.11ac (VHT20)	6.5 Mbps	52	5260	Not Required	14.0	No	Not Required	11.5	No
			56	5280						
			60	5300						
			64	5320						
	802.11ac (VHT40)	13.5 Mbps	54	5270	Not Required	14.0	No	11.2	11.5	No
			62	5310				11.5		
	802.11ac (VHT80)	29.3 Mbps	58	5290	Not Required	14.0	No	Not Required	11.0	No
5.5 (U-NII 2C)	802.11a	6 Mbps	100	5500	16.5	17.0	Yes	Not Required	10.0	No
			120	5600	16.0					
			140	5700	16.1					
	802.11n (HT20)	6.5 Mbps	100	5500	Not Required	16.0	No	Not Required	10.0	No
			120	5600						
			140	5700						
	802.11n (HT40)	13.5 Mbps	102	5510	Not Required	16.0	No	9.4	10.0	Yes
			118	5590				9.2		
			134	5670				9.7		
	802.11ac (VHT20)	6.5 Mbps	100	5500	Not Required	14.0	No	Not Required	10.0	No
			120	5600						
			140	5700						
	802.11ac (VHT40)	13.5 Mbps	102	5510	Not Required	14.0	No	9.4	10.0	No
			118	5590				9.2		
			134	5670				9.6		
	802.11ac (VHT80)	29.3 Mbps	106	5530	Not Required	14.0	No	Not Required	9.5	No
			122	5610						
5.8 (U-NII 3)	802.11a	6 Mbps	149	5745	16.5	17.0	Yes	Not Required	11.0	No
			157	5785	16.8					
			165	5825	16.3					
	802.11n (HT20)	6.5 Mbps	149	5745	Not Required	16.0	No	Not Required	11.0	No
			157	5785						
			165	5825						
	802.11n (HT40)	13.5 Mbps	151	5755	Not Required	16.0	No	10.6	11.0	Yes
			159	5795				10.5		
	802.11ac (VHT20)	6.5 Mbps	149	5745	Not Required	14.0	No	Not Required	11.0	No
			157	5785						
			165	5825						
	802.11ac (VHT40)	13.5 Mbps	151	5755	Not Required	14.0	No	10.6	11.0	No
			159	5795				10.5		
	802.11ac (VHT80)	29.3 Mbps	155	5775	Not Required	14.0	No	Not Required	10.5	No

Note(s):

1. For “Not required”, SAR Test reduction was applied from KDB 248227 guidance, Sec. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band. Additional output power
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.

10 Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

Reported SAR(W/kg) for WWAN= Measured SAR *Tune-up Scaling Factor

Reported SAR(W/kg) for Wi-Fi and Bluetooth= Measured SAR * Tune-up scaling factor * Duty Cycle scaling factor

KDB 447498 D01 General RF Exposure Guidance:

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

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

KDB 248227 D01 SAR meas for 802.11:

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

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

- ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- > 0.4 W/kg, SAR is repeated using the same wireless mode test configuration tested in the *initial test position* to measure the subsequent next 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)	Duty Cycle (%)	Power (dBm)		1-g SAR (W/kg)		Plot No.
										Tune-up limit	Meas.	Meas.	Scaled	
2.4GHz	802.11b 1 Mbps	Standalone	Off	7	Rear	6	2437.0	0.480	99.7	17.5	17.3	0.391	0.413	
				7	Edge 1	6	2437.0	0.121	99.7	17.5	17.3			
				5	Edge 4	6	2437.0	0.195	99.7	17.5	17.3	0.145	0.153	
				4	Corner	6	2437.0	0.060	99.7	17.5	17.3			
			On	0	Rear	6	2437.0	0.622	99.7	15.0	14.2	0.561	0.670	1
					Edge 1	6	2437.0	0.151	99.7	15.0	14.2			
					Edge 4	6	2437.0	0.270	99.7	15.0	14.2	0.191	0.228	
					Corner	6	2437.0	0.081	99.7	15.0	14.2			

Note(s):

1. When the 802.11b reported SAR of the highest measured maximum output power channel is ≤ 0.8 W/kg, no further SAR testing is required. If SAR is > 0.8 W/kg and ≤ 1.2 W/kg, SAR is required for the next highest measured output power channel. Finally, if SAR is > 1.2 W/kg, SAR is required for the third channel.
2. SAR testing is not required for OFDM mode(s) 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.

10.2 Wi-Fi (U-NII Band)

Frequency Band	Mode	RF Exposure Conditions	PWR Back-off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Duty Cycle (%)	Power (dBm)		1-g SAR (W/kg)		Note	Plot No.
										Tune-up limit	Meas.	Meas.	Scaled		
5.3 GHz U-NII 2A	802.11a 6 Mbps	Standalone	Off	7	Rear	52	5260.0	0.691	98.2	17.0	16.2	0.349	0.432	2	
				7	Edge 1	52	5260.0	0.568	98.2	17.0	16.2				
				5	Edge 4	52	5260.0	0.650	98.2	17.0	16.2				
				4	Corner	52	5260.0	0.903	98.2	17.0	16.2	0.411	0.509		
	802.11n 13.5 Mbps (HT40)		On	0	Rear	62	5310.0	1.898	96.1	11.5	11.4	0.751	0.794		2
				0	Edge 1	62	5310.0	0.769	96.1	11.5	11.4				
				0	Edge 4	62	5310.0	0.672	96.1	11.5	11.4				
				0	Corner	62	5310.0	0.787	96.1	11.5	11.4	0.355	0.375	2	

Frequency Band	Mode	RF Exposure Conditions	PWR Back-off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Duty Cycle (%)	Power (dBm)		1-g SAR (W/kg)		Note	Plot No.
										Tune-up limit	Meas.	Meas.	Scaled		
5.5 GHz U-NII 2C	802.11a 6 Mbps	Standalone	Off	7	Rear	100	5500.0	1.584	98.2	17.0	16.5	0.712	0.821		
						140	5700.0	1.540	98.2	17.0	16.1	0.813	1.025	3	
				7	Edge 1	100	5500.0	0.681	98.2	17.0	16.5				
				5	Edge 4	100	5500.0	1.398	98.2	17.0	16.5	0.563	0.649	2	
				4	Corner	100	5500.0	1.890	98.2	17.0	16.5	0.857	0.988		
						140	5700.0	1.776	98.2	17.0	16.1	0.821	1.035	3	
	802.11n 13.5 Mbps (HT40)		On	0	Rear	102	5510.0	0.997	96.1	10.0	9.4	0.639	0.771	3	
						134	5670.0	2.991	96.1	10.0	9.7	1.070	1.190		3
				0	Edge 1	134	5670.0	0.587	96.1	10.0	9.7				
				0	Edge 4	134	5670.0	0.904	96.1	10.0	9.7				
				0	Corner	134	5670.0	1.659	96.1	10.0	9.7	0.588	0.654	2	

Frequency Band	Mode	RF Exposure Conditions	PWR Back-off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Duty Cycle (%)	Power (dBm)		1-g SAR (W/kg)		Note	Plot No.
										Tune-up limit	Meas.	Meas.	Scaled		
5.8 GHz U-NII 3	802.11a 6 Mbps	Standalone	Off	7	Rear	149	5745.0	1.581	98.2	17.0	16.5	0.904	1.040	3	
						157	5785.0	1.713	98.2	17.0	16.8	0.909	0.960		
				7	Edge 1	157	5785.0	1.025	98.2	17.0	16.8				
				5	Edge 4	157	5785.0	1.402	98.2	17.0	16.8	0.690	0.729	2	
				4	Corner	149	5745.0	1.870	98.2	17.0	16.5	0.853	0.981	3	
						157	5785.0	1.928	98.2	17.0	16.8	0.904	0.955		
	802.11n 13.5 Mbps (HT40)		On	0	Rear	151	5755.0	1.973	96.1	11.0	10.6	0.922	1.059		4
						159	5795.0	2.168	96.1	11.0	10.5	0.844	0.986	3	
				0	Edge 1	151	5755.0	0.647	96.1	11.0	10.6				
				0	Edge 4	151	5755.0	0.887	96.1	11.0	10.6				
				0	Corner	151	5755.0	1.262	96.1	11.0	10.6	0.598	0.687	2	

Note(s):

1. Highest *reported* SAR is ≤ 0.4 or 1.0 W/kg (1-g or 10-g respectively). Therefore, further SAR measurements within this exposure condition are not required.
2. Highest *reported* SAR is > 0.4 or 1.0 W/kg (1-g or 10-g respectively). Due to the highest *reported* SAR for this test position, other test positions in this exposure condition were evaluated until a SAR ≤ 0.8 or 2.0 W/kg (1-g or 10-g respectively) was *reported*.
3. Testing for a second channel was required because the *reported* SAR for this test position was > 0.8 or 2.0 W/kg (1-g or 10-g respectively).
4. Additional testing required in order satisfying FCC simultaneous transmission limit criteria.

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 Exposure Conditions

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	Rear	Edge 1	Edge 2	Edge 3	Edge 4
Bluetooth	2480	9.00	8	1	4	146	220.9	4	2.5 -EXEMPT-	2.5 -EXEMPT-	*> 50 mm*	*> 50 mm*	2.5 -EXEMPT-

Note(s):

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	Rear	Edge 1	Edge 2	Edge 3	Edge 4
Bluetooth	2480	9.00	8	1	4	146	220.9	4	*< 50 mm*	*< 50 mm*	1055.3 mW -EXEMPT-	1804.3 mW -EXEMPT-	*< 50 mm*

Note(s):

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

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)	First Repeated	
						Measured SAR (W/kg)	Largest to Smallest SAR Ratio
2400	Wi-Fi 802.11b/g/n	Standalone	Rear	No	0.561	N/A	N/A
5300	Wi-Fi 802.11a/n/ac	Standalone	Rear	No	0.751	N/A	N/A
5500	Wi-Fi 802.11a/n/ac	Standalone	Rear	Yes	1.070	1.020	1.05
5800	Wi-Fi 802.11a/n/ac	Standalone	Rear	Yes	0.922	0.956	1.04

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 & 5GHz Radio can't transmit simultaneously with Bluetooth Radio.

Appendixes

Refer to separated files for the following appendixes.

4788494706-S1V1 FCC Report SAR_App A_Photos & Ant. Locations

4788494706-S1V1 FCC Report SAR_App B_Highest SAR Test Plots

4788494706-S1V1 FCC Report SAR_App C_System Check Plots

4788494706-S1V1 FCC Report SAR_App D_SAR Tissue Ingredients

4788494706-S1V1 FCC Report SAR_App E_Probe Cal. Certificates

4788494706-S1V1 FCC Report SAR_App F_Dipole Cal. Certificates

END OF REPORT