FCC SAR TEST REPORT

FCC ID	: U4FTBII
Equipment	: Industrial Tablet PC
Brand Name	: Datalogic
Model Name	: Taskbook (10")
Applicant	: Datalogic S.r.l. Via San Vitalino 13,Lippo di Calderara di Reno (Bologna) 40012 Italy
Manufacturer	: Datalogic S.r.l. Via San Vitalino 13,Lippo di Calderara di Reno (Bologna) 40012 Italy
Standard	: FCC 47 CFR Part 2 (2.1093) ANSI/IEEE C95.1-1992 IEEE 1528-2013

The product was received on Dec. 27, 2018 and testing was started from Jan. 25, 2019 and completed on Jan. 26, 2019. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

The test results in this variant report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Approved by: Cona Huang / Deputy Manager

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)

Table of Contents

1. Statement of Compliance **4**
2. Guidance Applied **4**
3. Equipment Under Test (EUT) Information **5**
3.1 General Information 5
4. RF Exposure Limits **6**
4.1 Uncontrolled Environment 6
4.2 Controlled Environment 6
5. Specific Absorption Rate (SAR) **7**
5.1 Introduction 7
5.2 SAR Definition 7
6. System Description and Setup **8**
6.1 E-Field Probe 9
6.2 Data Acquisition Electronics (DAE) 9
6.3 Phantom 10
6.4 Device Holder 11
7. Measurement Procedures **12**
7.1 Spatial Peak SAR Evaluation 12
7.2 Power Reference Measurement 13
7.3 Area Scan 13
7.4 Zoom Scan 14
7.5 Volume Scan Procedures 14
7.6 Power Drift Monitoring 14
8. Test Equipment List **15**
9. System Verification **16**
9.1 Tissue Simulating Liquids 16
9.2 Tissue Verification 17
9.3 System Performance Check Results 18
10. RF Exposure Positions **18**
10.1 SAR Testing for Tablet 18
11. Conducted RF Output Power (Unit: dBm) **19**
12. Bluetooth Exclusions Applied **29**
13. Antenna Location **30**
14. SAR Test Results **32**
14.1 Body SAR 33
14.2 Repeated SAR Measurement 34
15. Simultaneous Transmission Analysis **35**
15.1 Body Exposure Conditions 36
15.2 SPLSR Evaluation and Analysis 36
16. Uncertainty Assessment **37**
17. References **37**
Appendix A. Plots of System Performance Check
Appendix B. Plots of High SAR Measurement
Appendix C. DASY Calibration Certificate
Appendix D. Test Setup Photos

History of this test report

Report No.	Version	Description	Issued Date
FA8N0724	01	Initial issue of report	May 10, 2019

1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for Datalogic S.r.l., Industrial Tablet PC, Taskbook (10"), are as follows.

Equipment Class	Frequency Band	Highest SAR Summary Body (Separation 0mm) 1g SAR (W/kg)	Highest Simultaneous Transmission 1g SAR (W/kg)
DTS	2.4GHz WLAN	1.19	1.19
NII	5GHz WLAN	1.19	1.33
Date of Testing:		2019/1/25 ~ 2019/1/26	

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test. This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and FCC KDB publications

Reviewed by: Jason Wang
Report Producer: Wan Liu

2. Guidance Applied

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2013
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 248227 D01 802.11 Wi-Fi SAR v02r02
- FCC KDB 616217 D04 SAR for laptop and tablets v01r02

3. Equipment Under Test (EUT) Information

3.1 General Information

Product Feature & Specification	
Equipment Name	Industrial Tablet PC
Brand Name	Datalogic
Model Name	Taskbook (10")
FCC ID	U4FTBII
S/N	321806000607
Wireless Technology and Frequency Range	WLAN 2.4GHz Band: 2412 MHz ~ 2472 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5720 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	WLAN 2.4GHz : 802.11b/g/n/ac HT20/HT40/VHT20/VHT40 WLAN 5GHz : 802.11a/n/ac HT20/HT40/VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
EUT Stage	Production Unit

Antenna Information		
Manufacturer	HUBER+SUHNER®	
Antenna Type	Main:PCB Antenna	Aux:PCB Antenna
Part number	1399.99.0149	1399.99.0149
Peak gain (dBi)	Main Antenna :	Aux Antenna :
	WLAN(2.4GHz):1 WLAN(5GHz):1	WLAN(2.4GHz):1 Bluetooth : 1 WLAN(5GHz):1

4. RF Exposure Limits

4.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

4.2 Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. The exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

Limits for General Population/Uncontrolled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

1. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

5. Specific Absorption Rate (SAR)

5.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

5.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$\mathbf{SAR} = \frac{\mathbf{d}}{\mathbf{dt}}\left(\frac{\mathbf{dW}}{\mathbf{dm}}\right) = \frac{\mathbf{d}}{\mathbf{dt}}\left(\frac{\mathbf{dW}}{\boldsymbol{\rho}\mathbf{dv}}\right)$$

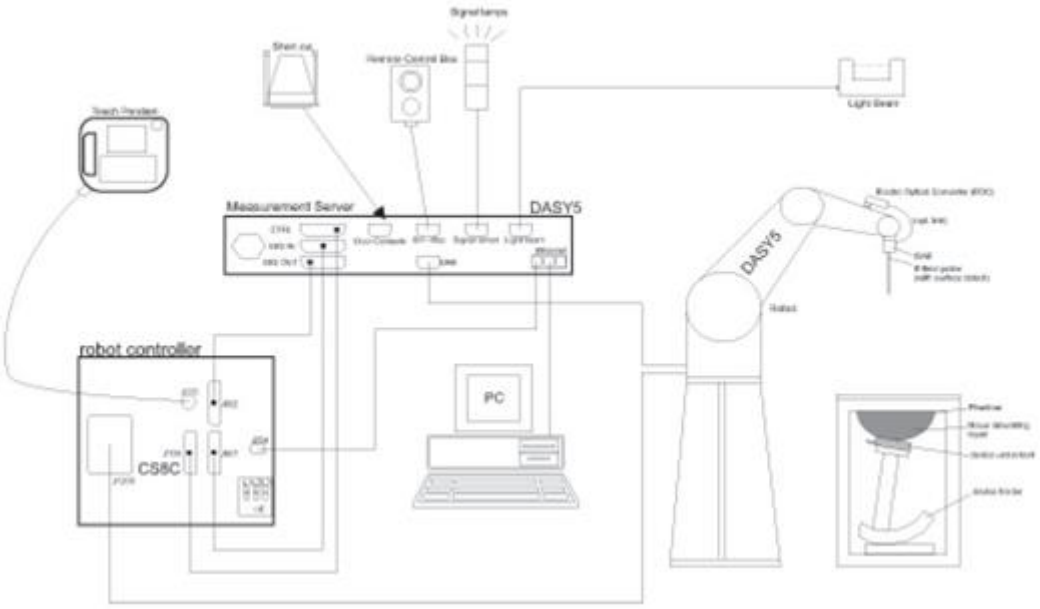
SAR is expressed in units of Watts per kilogram (W/kg)

$$\mathbf{SAR} = \frac{\boldsymbol{\sigma}|\mathbf{E}|^{\mathbf{2}}}{\boldsymbol{\rho}}$$

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

6. System Description and Setup

The DASY 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.

6.1 E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG).The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

<ES3DV3 Probe>

Construction	Symmetric design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz – 4 GHz; Linearity: ±0.2 dB (30 MHz – 4 GHz)	
Directivity	±0.2 dB in TSL (rotation around probe axis) ±0.3 dB in TSL (rotation normal to probe axis)	
Dynamic Range	5 µW/g – >100 mW/g; Linearity: ±0.2 dB	
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 3.9 mm (body: 12 mm) Distance from probe tip to dipole centers: 3.0 mm	

<EX3DV4 Probe>

Construction	Symmetric design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz – >6 GHz Linearity: ±0.2 dB (30 MHz – 6 GHz)	
Directivity	±0.3 dB in TSL (rotation around probe axis) ±0.5 dB in TSL (rotation normal to probe axis)	
Dynamic Range	10 µW/g – >100 mW/g Linearity: ±0.2 dB (noise: typically <1 µW/g)	
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 2.5 mm (body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	

6.2 Data Acquisition Electronics (DAE)

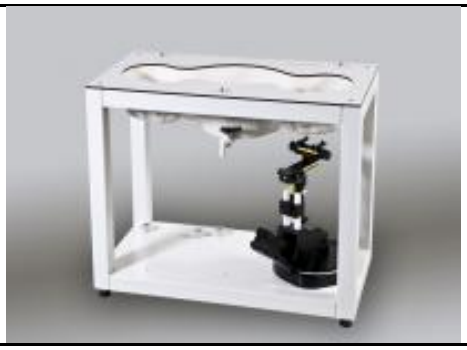
The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

Fig 5.1 Photo of DAE

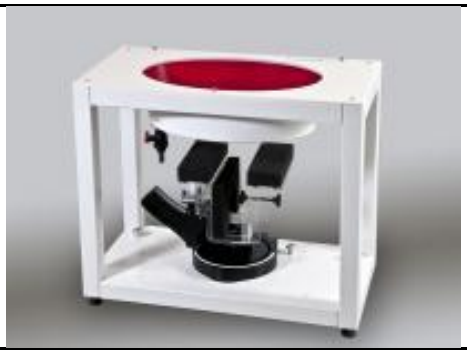
6.3 Phantom

<SAM Twin Phantom>

Shell Thickness	2 ± 0.2 mm; Center ear point: 6 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet	
Measurement Areas	Left Hand, Right Hand, Flat Phantom	

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

<ELI Phantom>

Shell Thickness	2 ± 0.2 mm (sagging: <1%)	
Filling Volume	Approx. 30 liters	
Dimensions	Major ellipse axis: 600 mm Minor axis: 400 mm	

The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.

6.4 Device Holder

<Mounting Device for Hand-Held Transmitter>

In combination with the Twin SAM V5.0/V5.0c or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). And upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140 mm.

Mounting Device for Hand-Held Transmitters

Mounting Device Adaptor for Wide-Phones

<Mounting Device for Laptops and other Body-Worn Transmitters>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the mounting device in place of the phone positioned. The extension is fully compatible with the SAM Twin and ELI phantoms.

Mounting Device for Laptops

7. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

(a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
(b) Read the WWAN RF power level from the base station simulator.
(c) For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band
(d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power

<SAR measurement>

(a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
(b) Place the EUT in the positions as Appendix D demonstrates.
(c) Set scan area, grid size and other setting on the DASY software.
(d) Measure SAR results for the highest power channel on each testing position.
(e) Find out the largest SAR result on these testing positions of each band
(f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

7.1 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

(a) Extraction of the measured data (grid and values) from the Zoom Scan
(b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
(c) Generation of a high-resolution mesh within the measured volume
(d) Interpolation of all measured values form the measurement grid to the high-resolution grid
(e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
(f) Calculation of the averaged SAR within masses of 1g and 10g

7.2 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. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

7.3 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 found in the scanned area, within a range of the global maximum. The range (in dB0 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 FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

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

7.4 Zoom Scan

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes 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 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

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

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

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

7.5 Volume Scan Procedures

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

7.6 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

8. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	2450MHz System Validation Kit	D2450V2	736	Aug. 31, 2018	Aug. 30, 2019
SPEAG	5GHz System Validation Kit	D5GHzV2	1006	Sep. 27, 2018	Sep. 26, 2019
SPEAG	Data Acquisition Electronics	DAE4	1399	Nov. 16, 2018	Nov. 15, 2019
SPEAG	Dosimetric E-Field Probe	EX3DV4	3931	Sep. 27, 2018	Sep. 26, 2019
RCPTWN	Thermometer	HTC-1	TM685-1	Nov. 12, 2018	Nov. 11, 2019
SPEAG	Device Holder	N/A	N/A	N/A	N/A
Anritsu	Signal Generator	MG3710A	6201502524	Dec. 11, 2018	Dec. 10, 2019
Agilent	ENA Network Analyzer	E5071C	MY46104758	Sep. 19, 2018	Sep. 18, 2019
SPEAG	Dielectric Probe Kit	DAK-3.5	1126	Sep. 19, 2018	Sep. 18, 2019
LINE SEIKI	Digital Thermometer	DTM3000-spezial	3169	Sep. 11, 2018	Sep. 10, 2019
Anritsu	Power Meter	ML2495A	1419002	May. 18, 2018	May. 17, 2019
Anritsu	Power Sensor	MA2411B	1339124	May. 18, 2018	May. 17, 2019
Anritsu	Power Meter	ML2495A	1240001	Sep. 13, 2018	Sep. 12, 2019
Anritsu	Power Sensor	MA2411B	1207349	Sep. 13, 2018	Sep. 12, 2019
Agilent	Spectrum Analyzer	E4408B	MY44211028	Aug. 28, 2018	Aug. 27, 2019
Anritsu	Spectrum Analyzer	MS2830A	6201396378	Jun. 23, 2018	Jun. 22, 2019
Mini-Circuits	Power Amplifier	ZVE-8G+	6382	Aug. 09, 2018	Aug. 08, 2019
Mini-Circuits	Power Amplifier	ZHL-42W+	15542	Aug. 09, 2018	Aug. 08, 2019
ATM	Dual Directional Coupler	C122H-10	P610410z-02	Note 1	
Woken	Attenuator 1	WK0602-XX	N/A	Note 1	
PE	Attenuator 2	PE7005-10	N/A	Note 1	
PE	Attenuator 3	PE7005- 3	N/A	Note 1	

General Note:

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.

9. System Verification

9.1 Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 10.1. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 10.2.

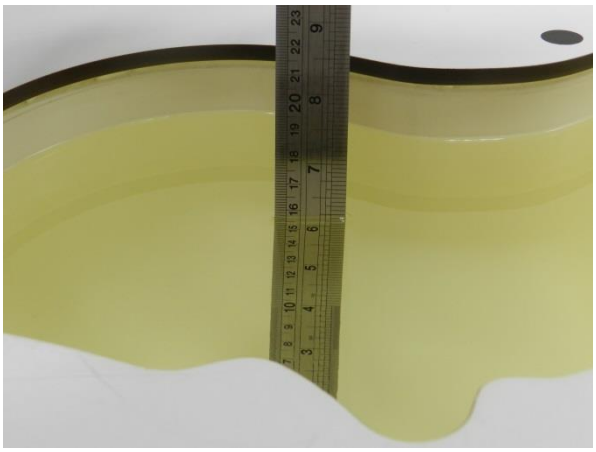


Fig 10.1Photo of Liquid Height for Head SAR

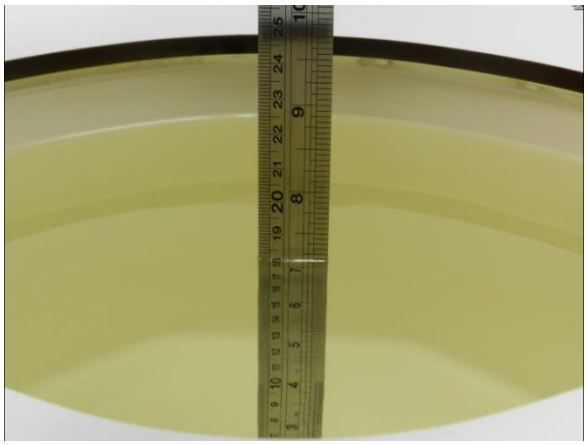


Fig 10.2 Photo of Liquid Height for Body SAR

9.2 Tissue Verification

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.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (εr)
For Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
900	40.3	57.9	0.2	1.4	0.2	0	0.97	41.5
1800, 1900, 2000	55.2	0	0	0.3	0	44.5	1.40	40.0
2450	55.0	0	0	0	0	45.0	1.80	39.2
2600	54.8	0	0	0.1	0	45.1	1.96	39.0
For Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
900	50.8	48.2	0	0.9	0.1	0	1.05	55.0
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0	0	31.4	1.95	52.7
2600	68.1	0	0	0.1	0	31.8	2.16	52.5

Simulating Liquid for 5GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	64~78%
Mineral oil	11~18%
Emulsifiers	9~15%
Additives and Salt	2~3%

<Tissue Dielectric Parameter Check Results>

Frequency (MHz)	Tissue Type	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (ε_r)	Conductivity Target (σ)	Permittivity Target (ε_r)	Delta (σ) (%)	Delta (ε_r) (%)	Limit (%)	Date
2450	MSL	22.7	1.996	52.004	1.95	52.70	2.36	-1.32	±5	2019/1/25
5250	MSL	22.5	5.492	49.803	5.36	48.95	2.46	1.74	±5	2019/1/26
5600	MSL	22.5	5.961	49.196	5.77	48.50	3.31	1.44	±5	2019/1/26
5750	MSL	22.5	6.185	48.960	5.94	48.28	4.12	1.41	±5	2019/1/26

9.3 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Date	Frequency (MHz)	Tissue Type	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2019/1/25	2450	MSL	250	D2450V2-736	EX3DV4 - SN3931	DAE4 Sn1399	13.00	51.50	52	0.97
2019/1/26	5250	MSL	100	D5GHzV2-1006	EX3DV4 - SN3931	DAE4 Sn1399	7.94	78.30	79.4	1.40
2019/1/26	5600	MSL	100	D5GHzV2-1006	EX3DV4 - SN3931	DAE4 Sn1399	8.49	81.00	84.9	4.81
2019/1/26	5750	MSL	100	D5GHzV2-1006	EX3DV4 - SN3931	DAE4 Sn1399	7.55	77.40	75.5	-2.45

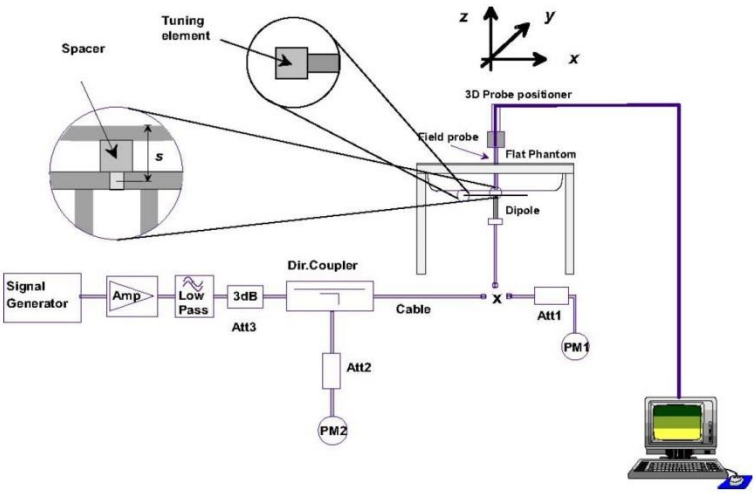


Fig 8.3.1 System Performance Check Setup

Fig 8.3.2 Setup Photo

10. RF Exposure Positions

10.1 SAR Testing for Tablet

This device can be used also in full sized tablet exposure conditions, due to its size. Per FCC KDB 616217, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. The SAR exclusion threshold in KDB 447498 D01v06 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned against the phantom and the edge containing the antenna positioned perpendicular to the phantom.

11. Conducted RF Output Power (Unit: dBm)

<WLAN Conducted Power>

General Note:

1. For each antenna, transmit power in SISO operation is larger than (or equal to) the power in MIMO operation, RF exposure compliance of MIMO mode can be deduced from the compliance simultaneous transmission of antennas operating in SISO mode.
2. Per KDB 248227 D01v02r02, the simultaneous SAR provisions in KDB publication 447498 should be applied to determine simultaneous transmission SAR test exclusion for WiFi MIMO. If the sum of 1g single transmission chain SAR measurements is < 1.6W/kg and SAR peak to location ratio ≤ 0.04, no additional SAR measurements for MIMO.
3. Per KDB 248227 D01v02r02, SAR test reduction is determined according to 802.11 transmission mode configurations and certain exposure conditions with multiple test positions. In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration must be determined for each standalone and aggregated frequency band, according to the transmission mode configuration with the highest maximum output power specified for production units to perform SAR measurements. If the same highest maximum output power applies to different combinations of channel bandwidths, modulations and data rates, additional procedures are applied to determine which test configurations require SAR measurement. When applicable, an initial test position may be applied to reduce the number of SAR measurements required for next to the ear, UMPC mini-tablet or hotspot mode configurations with multiple test positions.
4. For 2.4 GHz 802.11b DSSS, either the initial test position procedure for multiple exposure test positions or the DSSS procedure for fixed exposure position is applied; these are mutually exclusive. For 2.4 GHz and 5 GHz OFDM configurations, the initial test configuration is applied to measure SAR using either the initial test position procedure for multiple exposure test position configurations or the initial test configuration procedures for fixed exposure test conditions. Based on the reported SAR of the measured configurations and maximum output power of the transmission mode configurations that are not included in the initial test configuration, the subsequent test configuration and initial test position procedures are applied to determine if SAR measurements are required for the remaining OFDM transmission configurations. In general, the number of test channels that require SAR measurement is minimized based on maximum output power measured for the test sample(s).
5. For OFDM transmission configurations in the 2.4 GHz and 5 GHz bands, 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 for each frequency band.
6. DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures.18 The initial test position procedure is described in the following:
   a. When the reported SAR of 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 802.11 transmission mode combinations within the frequency band or aggregated band.
   b. When the reported SAR of the test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode 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 report SAR is ≤ 0.8 W/kg or all required test position are tested.
   c. For all positions/configurations, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

<2.4GHz WLAN ANT 1>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	1	2412	14.09	15.00	98.36
		6	2437	13.85	15.00	
		11	2462	13.78	14.50	
		12	2467	13.81	14.50	
		13	2472	10.00	10.50	
	802.11g 6Mbps	1	2412	13.01	15.00	91.31
		6	2437	13.87	15.00	
		11	2462	13.42	15.00	
		12	2467	13.54	14.50	
		13	2472	1.32	2.00	
	802.11n-HT20 MCS0	1	2412	13.20	15.00	89.69
		6	2437	13.64	15.00	
		11	2462	13.12	14.50	
		12	2467	12.81	14.50	
		13	2472	0.07	1.00	
	802.11n-HT40 MCS0	3	2422	11.77	12.00	79.46
		6	2437	12.77	14.00	
		9	2452	9.28	10.00	
		10	2457	10.08	10.50	
		11	2462	1.16	1.50	
	802.11ac-VHT20 MCS0	1	2412	14.18	15.00	89.66
		6	2437	14.29	15.00	
		11	2462	13.49	14.50	
		12	2467	12.89	14.50	
		13	2472	0.11	1.00	
	802.11ac-VHT40 MCS0	3	2422	11.82	12.00	79.70
		6	2437	13.11	14.00	
		9	2452	9.37	10.00	
		10	2457	10.15	10.50	
		11	2462	1.23	1.50	

<2.4GHz WLAN ANT 2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	1	2412	13.69	15.00	98.36
		6	2437	14.64	15.00	
		11	2462	14.40	14.50	
		12	2467	14.01	14.50	
		13	2472	9.62	10.50	
	802.11g 6Mbps	1	2412	13.68	15.00	91.31
		6	2437	14.39	15.00	
		11	2462	14.08	15.00	
		12	2467	13.31	14.50	
		13	2472	1.85	2.00	
	802.11n-HT20 MCS0	1	2412	13.61	15.00	89.69
		6	2437	14.24	15.00	
		11	2462	13.82	14.50	
		12	2467	12.82	14.50	
		13	2472	-0.31	1.00	
	802.11n-HT40 MCS0	3	2422	10.82	12.00	79.46
		6	2437	13.53	14.00	
		9	2452	9.01	10.00	
		10	2457	9.33	10.50	
		11	2462	0.62	1.50	
	802.11ac-VHT20 MCS0	1	2412	13.49	15.00	89.66
		6	2437	14.08	15.00	
		11	2462	14.03	14.50	
		12	2467	12.92	14.50	
		13	2472	-0.35	1.00	
	802.11ac-VHT40 MCS0	3	2422	10.92	12.00	79.70
		6	2437	13.82	14.00	
		9	2452	9.03	10.00	
		10	2457	9.32	10.50	
		11	2462	0.80	1.50	

<2.4GHz WLAN ANT 1+2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	1	2412	16.90	18.00	98.36
		6	2437	17.27	18.00	
		11	2462	17.11	17.50	
		12	2467	16.92	17.50	
		13	2472	12.82	13.50	
	802.11g 6Mbps	1	2412	16.37	18.00	91.31
		6	2437	17.15	18.00	
		11	2462	16.77	17.50	
		12	2467	16.44	17.50	
		13	2472	4.60	5.00	
	802.11n-HT20 MCS0	1	2412	16.42	18.00	89.69
		6	2437	16.96	18.00	
		11	2462	16.49	17.50	
		12	2467	15.83	17.50	
		13	2472	2.89	4.00	
	802.11n-HT40 MCS0	3	2422	14.33	15.00	79.46
		6	2437	16.18	17.00	
		9	2452	12.16	13.00	
		10	2457	12.73	13.50	
		11	2462	3.91	4.50	
	802.11ac-VHT20 MCS0	1	2412	16.86	18.00	89.66
		6	2437	17.20	18.00	
		11	2462	16.78	17.50	
		12	2467	15.92	17.50	
		13	2472	2.90	4.00	
	802.11ac-VHT40 MCS0	3	2422	14.40	15.00	79.70
		6	2437	16.49	17.00	
		9	2452	12.21	13.00	
		10	2457	12.77	13.50	
		11	2462	4.03	4.50	

<5GHz WLAN ANT1>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN	802.11a 6Mbps	36	5180	11.41	12.00	92.24
		40	5200	11.48	12.00	
		44	5220	11.21	12.00	
		48	5240	11.09	12.00	
	802.11n-HT20 MCS0	36	5180	11.11	12.00	88.55
		40	5200	11.27	12.00	
		44	5220	10.85	12.00	
		48	5240	10.46	12.00	
	802.11n-HT40 MCS0	38	5190	8.40	9.00	79.04
		46	5230	11.19	11.50	
	802.11ac-VHT20 MCS0	36	5180	11.27	12.00	89.10
		40	5200	11.44	12.00	
		44	5220	11.00	12.00	
		48	5240	10.63	12.00	
	802.11ac-VHT40 MCS0	38	5190	8.48	9.00	79.24
		46	5230	11.29	11.50	
	802.11ac-VHT80 MCS0	42	5210	6.01	6.50	67.55

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN	802.11a 6Mbps	52	5260	11.15	12.00	92.24
		56	5280	11.04	12.00	
		60	5300	11.08	12.00	
		64	5320	11.28	12.00	
	802.11n-HT20 MCS0	52	5260	10.54	12.00	88.55
		56	5280	10.75	12.00	
		60	5300	10.94	12.00	
		64	5320	11.04	12.00	
	802.11n-HT40 MCS0	54	5270	10.86	11.50	79.04
		62	5310	10.02	10.50	
	802.11ac-VHT20 MCS0	52	5260	10.78	12.00	89.10
		56	5280	10.98	12.00	
		60	5300	11.07	12.00	
		64	5320	11.16	12.00	
	802.11ac-VHT40 MCS0	54	5270	10.97	11.50	79.24
		62	5310	10.07	10.50	
	802.11ac-VHT80 MCS0	58	5290	7.98	8.50	67.55

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN	802.11a 6Mbps	100	5500	11.80	12.00	92.24
		116	5580	11.36	12.00	
		124	5620	11.56	12.00	
		132	5660	11.29	12.00	
		144	5720	7.79	8.00	
	802.11n-HT20 MCS0	100	5500	8.26	9.50	88.55
		116	5580	11.37	12.00	
		124	5620	11.05	12.00	
		132	5660	11.09	12.00	
		144	5720	7.98	8.50	
	802.11n-HT40 MCS0	102	5510	8.20	9.50	79.04
		110	5550	11.18	11.50	
		126	5630	10.94	11.50	
		134	5670	10.26	11.50	
		142	5710	8.37	8.50	
	802.11ac-VHT20 MCS0	100	5500	8.39	9.50	89.10
		116	5580	11.54	12.00	
		124	5620	11.15	12.00	
		132	5660	11.28	12.00	
		144	5720	8.03	8.50	
	802.11ac-VHT40 MCS0	102	5510	8.33	9.50	79.24
		110	5550	11.38	11.50	
		126	5630	11.10	11.50	
		134	5670	10.35	11.50	
		142	5710	7.74	8.50	
	802.11ac-VHT80 MCS0	106	5530	5.41	7.00	67.55
		122	5610	6.66	7.00	
		138	5690	7.93	8.50	

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN	802.11a MCS0	149	5745	11.27	12.00	92.24
		157	5785	11.65	12.00	
		165	5825	11.92	12.00	
	802.11n-HT20 MCS0	149	5745	10.66	11.50	88.55
		157	5785	11.29	11.50	
		165	5825	11.22	11.50	
	802.11n-HT40 MCS0	151	5755	8.37	8.50	79.04
		159	5795	10.95	11.50	
	802.11ac-VHT20 MCS0	149	5745	10.97	11.50	89.10
		157	5785	11.48	11.50	
		165	5825	11.42	11.50	
	802.11ac-VHT40 MCS0	151	5755	8.41	8.50	79.24
		159	5795	11.45	11.50	
	802.11ac-VHT80 MCS0	155	5775	7.80	9.00	67.55

<5GHz WLAN ANT2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN	802.11a 6Mbps	36	5180	11.54	12.00	92.24
		40	5200	11.53	12.00	
		44	5220	11.13	12.00	
		48	5240	11.44	12.00	
	802.11n-HT20 MCS0	36	5180	11.29	12.00	88.55
		40	5200	11.31	12.00	
		44	5220	10.76	12.00	
		48	5240	10.81	12.00	
	802.11n-HT40 MCS0	38	5190	8.05	9.00	79.04
		46	5230	11.12	11.50	
	802.11ac-VHT20 MCS0	36	5180	11.46	12.00	89.10
		40	5200	11.58	12.00	
		44	5220	10.91	12.00	
		48	5240	11.06	12.00	
	802.11ac-VHT40 MCS0	38	5190	8.19	9.00	79.24
		46	5230	11.29	11.50	
	802.11ac-VHT80 MCS0	42	5210	5.13	6.50	67.55

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN	802.11a 6Mbps	52	5260	11.17	12.00	92.24
		56	5280	11.48	12.00	
		60	5300	11.75	12.00	
		64	5320	11.58	12.00	
	802.11n-HT20 MCS0	52	5260	10.69	12.00	88.55
		56	5280	11.32	12.00	
		60	5300	11.33	12.00	
		64	5320	11.40	12.00	
	802.11n-HT40 MCS0	54	5270	11.07	11.50	79.04
		62	5310	9.01	10.50	
	802.11ac-VHT20 MCS0	52	5260	10.92	12.00	89.10
		56	5280	11.73	12.00	
		60	5300	11.41	12.00	
		64	5320	11.51	12.00	
	802.11ac-VHT40 MCS0	54	5270	11.23	11.50	79.24
		62	5310	9.07	10.50	
	802.11ac-VHT80 MCS0	58	5290	6.82	8.50	67.55

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN	802.11a 6Mbps	100	5500	11.15	12.00	92.24
		116	5580	11.20	12.00	
		124	5620	11.25	12.00	
		132	5660	11.26	12.00	
		144	5720	10.35	10.50	
	802.11n-HT20 MCS0	100	5500	8.96	9.50	88.55
		116	5580	11.20	12.00	
		124	5620	10.72	12.00	
		132	5660	11.12	12.00	
		144	5720	10.69	11.00	
	802.11n-HT40 MCS0	102	5510	9.17	9.50	79.04
		110	5550	10.79	11.50	
		126	5630	10.89	11.50	
		134	5670	10.97	11.50	
		142	5710	9.06	10.50	
	802.11ac-VHT20 MCS0	100	5500	9.08	9.50	89.10
		116	5580	11.37	12.00	
		124	5620	10.83	12.00	
		132	5660	11.22	12.00	
		144	5720	10.85	11.00	
	802.11ac-VHT40 MCS0	102	5510	9.23	9.50	79.24
		110	5550	11.05	11.50	
		126	5630	11.11	11.50	
		134	5670	11.03	11.50	
		142	5710	10.10	10.50	
	802.11ac-VHT80 MCS0	106	5530	6.58	7.00	67.55
		122	5610	6.17	7.00	
		138	5690	8.31	8.50	

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN	802.11a MCS0	149	5745	10.93	11.00	92.24
		157	5785	11.41	12.00	
		165	5825	11.08	11.50	
	802.11n-HT20 MCS0	149	5745	10.37	11.50	88.55
		157	5785	11.10	11.50	
		165	5825	11.39	11.50	
	802.11n-HT40 MCS0	151	5755	10.39	10.50	79.04
		159	5795	11.04	11.50	
	802.11ac-VHT20 MCS0	149	5745	10.63	11.50	89.10
		157	5785	11.32	11.50	
		165	5825	11.50	11.50	
	802.11ac-VHT40 MCS0	151	5755	10.40	10.50	79.24
		159	5795	11.43	11.50	
	802.11ac-VHT80 MCS0	155	5775	8.80	9.00	67.55

<5GHz WLAN ANT1+2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN	802.11a 6Mbps	36	5180	14.49	15.00	92.24
		40	5200	14.52	15.00	
		44	5220	14.18	15.00	
		48	5240	14.28	15.00	
	802.11n-HT20 MCS0	36	5180	14.21	15.00	88.55
		40	5200	14.30	15.00	
		44	5220	13.82	15.00	
		48	5240	13.65	15.00	
	802.11n-HT40 MCS0	38	5190	11.24	12.00	79.04
		46	5230	14.17	14.50	
	802.11ac-VHT20 MCS0	36	5180	14.38	15.00	89.10
		40	5200	14.52	15.00	
		44	5220	13.97	15.00	
		48	5240	13.86	15.00	
	802.11ac-VHT40 MCS0	38	5190	11.36	12.00	79.24
		46	5230	14.30	14.50	
	802.11ac-VHT80 MCS0	42	5210	8.60	9.50	67.55

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN	802.11a 6Mbps	52	5260	14.17	15.00	92.24
		56	5280	14.28	15.00	
		60	5300	14.44	15.00	
		64	5320	14.44	15.00	
	802.11n-HT20 MCS0	52	5260	13.63	15.00	88.55
		56	5280	14.05	15.00	
		60	5300	14.15	15.00	
		64	5320	14.23	15.00	
	802.11n-HT40 MCS0	54	5270	13.98	14.50	79.04
		62	5310	12.55	13.50	
	802.11ac-VHT20 MCS0	52	5260	13.86	15.00	89.10
		56	5280	14.38	15.00	
		60	5300	14.25	15.00	
		64	5320	14.35	15.00	
	802.11ac-VHT40 MCS0	54	5270	14.11	14.50	79.24
		62	5310	12.61	13.50	
	802.11ac-VHT80 MCS0	58	5290	10.45	11.50	67.55

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN	802.11a 6Mbps	100	5500	14.50	15.00	92.24
		116	5580	14.29	15.00	
		124	5620	14.42	15.00	
		132	5660	14.29	15.00	
		144	5720	12.27	12.50	
	802.11n-HT20 MCS0	100	5500	11.63	12.50	88.55
		116	5580	14.30	15.00	
		124	5620	13.90	15.00	
		132	5660	14.12	15.00	
		144	5720	12.55	13.00	
	802.11n-HT40 MCS0	102	5510	11.72	12.50	79.04
		110	5550	14.00	14.50	
		126	5630	13.93	14.50	
		134	5670	13.64	14.50	
		142	5710	11.74	13.00	
	802.11ac-VHT20 MCS0	100	5500	11.76	12.50	89.10
		116	5580	14.47	15.00	
		124	5620	14.00	15.00	
		132	5660	14.26	15.00	
		144	5720	12.68	13.00	
	802.11ac-VHT40 MCS0	102	5510	11.81	12.50	79.24
		110	5550	14.23	14.50	
		126	5630	14.12	14.50	
		134	5670	13.71	14.50	
		142	5710	12.09	13.50	
	802.11ac-VHT80 MCS0	106	5530	9.04	10.00	67.55
		122	5610	9.43	10.00	
		138	5690	11.13	11.50	

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN	802.11a MCS0	149	5745	14.11	14.50	92.24
		157	5785	14.54	15.00	
		165	5825	14.53	15.00	
	802.11n-HT20 MCS0	149	5745	13.53	14.50	88.55
		157	5785	14.21	14.50	
		165	5825	14.32	14.50	
	802.11n-HT40 MCS0	151	5755	12.51	13.00	79.04
		159	5795	14.01	14.50	
	802.11ac-VHT20 MCS0	149	5745	13.81	14.50	89.10
		157	5785	14.41	14.50	
		165	5825	14.47	14.50	
	802.11ac-VHT40 MCS0	151	5755	12.53	13.00	79.24
		159	5795	14.45	14.50	
	802.11ac-VHT80 MCS0	155	5775	11.34	12.00	67.55

12. Bluetooth Exclusions Applied

Mode Band	Max Average power(dBm)	
	BR/EDR	LE
2.4GHz Bluetooth	5.00	-2.00

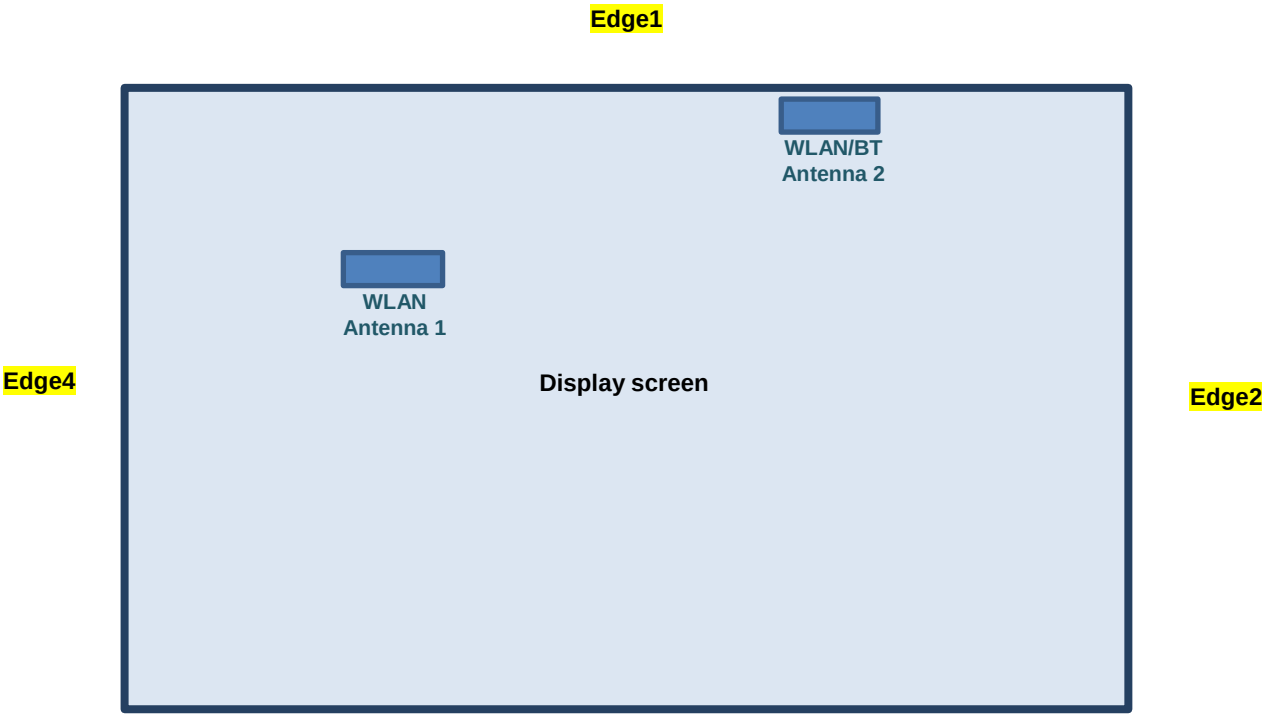
Note:

1. Per KDB 447498 D01v06, 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
   - 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

Bluetooth Max Power (dBm)	Separation Distance (mm)	Frequency (GHz)	exclusion thresholds
5	< 5	2.48	1.00

Note:
Per KDB 447498 D01v06, when the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. The test exclusion threshold is 1 which is <= 3, SAR testing is not required.

13. Antenna Location



Front View

The separation distance for antenna to edge :

Antenna	To Edge1 (mm)	To Edge2 (mm)	To Edge3 (mm)	To Edge4 (mm)
WLAN Antenna 1	50	200	120	40
WLAN/BT Antenna 2	< 5	80	180	160

<SAR test exclusion table>

General Note:

1. The below table, when the distance is < 50 mm exclusion threshold is "Ratio", when the distance is > 50 mm exclusion threshold is "mW"
2. Maximum power is the source-based time-average power and represents the maximum RF output power among production units
3. Per KDB 447498 D01v06, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
4. Per KDB 447498 D01v06, standalone SAR test exclusion threshold is applied; If the test separation distance is < 5mm, 5mm is used to determine SAR exclusion threshold.
5. Per KDB 447498 D01v06, 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
   - 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
6. Per KDB 447498 D01v06, at 100 MHz to 6 GHz and for *test separation distances* > 50 mm, the SAR test exclusion threshold is determined according to the following
   a) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW, at 100 MHz to 1500 MHz
   b) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz

Exposure Position	Wireless Interface	2.4GHz WLAN ANT 1	2.4GHz WLAN ANT 2	5GHz WLAN ANT 1	5GHz WLAN ANT 2
	Calculated Frequency	2472MHz	2472MHz	5825MHz	5825MHz
	Maximum power (dBm)	15	15	12	12
	Maximum rated power(mW)	32.0	32.0	16.0	16.0
Bottom Face	Separation distance(mm)	5.0	5.0	5.0	5.0
	exclusion threshold	10.1	10.1	7.7	7.7
	Testing required?	**Yes**	**Yes**	**Yes**	**Yes**
Edge 1	Separation distance(mm)	50.0	5.0	50.0	5.0
	exclusion threshold	1.0	10.1	0.8	7.7
	Testing required?	**No**	**Yes**	**No**	**Yes**
Edge 2	Separation distance(mm)	200.0	80.0	200.0	80.0
	exclusion threshold	1595.0	395.0	1562.0	362.0
	Testing required?	**No**	**No**	**No**	**No**
Edge 3	Separation distance(mm)	120.0	180.0	120.0	180.0
	exclusion threshold	795.0	1395.0	762.0	1362.0
	Testing required?	**No**	**No**	**No**	**No**
Edge 4	Separation distance(mm)	40.0	160.0	40.0	160.0
	exclusion threshold	1.3	1195.0	1.0	1162.0
	Testing required?	**No**	**No**	**No**	**No**

14. SAR Test Results

General Note:

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
   b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"
   c. For WLAN: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
2. Per KDB 447498 D01v06, for each exposure position, 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
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.

WLAN Note:

1. Per KDB 248227 D01v02r02, for 2.4GHz 802.11g/n SAR testing is not required when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.
2. Per KDB 248227 D01v02r02, U-NII-1 SAR testing is not required when the U-NII-2A band highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band.
3. When the reported SAR of the test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode 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 report SAR is ≤ 0.8 W/kg or all required test position are tested.
4. For all positions / configurations, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions / configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.
5. For WLAN SAR testing was performed on single antenna RF power in SISO mode is larger or equal to the single antenna RF power in MIMO mode, and for RF exposure assessment of MIMO mode simultaneous transmission exclusion analysis was performed with SAR test results of each antenna in SISO mode.
6. Per KDB 248227 D01v02r02, the simultaneous SAR provisions in KDB publication 447498 should be applied to determine simultaneous transmission SAR test exclusion for WiFi MIMO. If the sum of 1g single transmission chain SAR measurements is < 1.6W/kg and SAR peak to location ratio ≤ 0.04, no additional SAR measurements for MIMO.
7. During SAR testing the WLAN transmission was verified using a spectrum analyzer.

14.1 Body SAR

<WLAN SAR>

Plot No.	Band	Mode	Test Position	Gap (mm)	Antenna	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0mm	Ant 1	1	2412	14.09	15.00	1.233	98.36	1.017	-0.13	0.571	0.716
	WLAN2.4GHz	802.11b 1Mbps	Bottom Face	0mm	Ant 2	6	2437	14.64	15.00	1.086	98.36	1.017	0.1	0.270	0.298
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	0mm	Ant 2	6	2437	14.64	15.00	1.086	98.36	1.017	-0.17	0.995	1.099
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	0mm	Ant 2	1	2412	13.69	15.00	1.352	98.36	1.017	-0.17	0.790	1.086
01	WLAN2.4GHz	802.11b 1Mbps	Edge 1	0mm	Ant 2	11	2462	14.40	14.50	1.023	98.36	1.017	-0.12	1.140	1.186
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	0mm	Ant 2	12	2467	14.01	14.50	1.119	98.36	1.017	-0.15	0.907	1.033
	WLAN2.4GHz	802.11b 1Mbps	Edge 1	0mm	Ant 2	13	2472	9.62	10.50	1.225	98.36	1.017	-0.16	0.324	0.404
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 1	64	5320	11.28	12.00	1.180	92.24	1.084	0.06	0.474	0.606
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	60	5300	11.75	12.00	1.059	92.24	1.084	0.01	0.556	0.638
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	60	5300	11.75	12.00	1.059	92.24	1.084	-0.11	0.724	0.831
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	64	5320	11.58	12.00	1.102	92.24	1.084	-0.12	0.731	0.873
02	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	52	5260	11.17	12.00	1.211	92.24	1.084	-0.15	0.909	1.193
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	56	5280	11.48	12.00	1.127	92.24	1.084	-0.12	0.758	0.926
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 1	100	5500	11.80	12.00	1.047	92.24	1.084	-0.04	0.636	0.722
03	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	132	5660	11.26	12.00	1.186	92.24	1.084	0.06	0.857	1.102
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	100	5500	11.15	12.00	1.216	92.24	1.084	0.06	0.642	0.846
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	116	5580	11.20	12.00	1.202	92.24	1.084	0.02	0.561	0.731
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	124	5620	11.25	12.00	1.189	92.24	1.084	0.13	0.720	0.928
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	144	5720	10.35	10.50	1.035	92.24	1.084	0.11	0.951	1.067
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	132	5660	11.26	12.00	1.186	92.24	1.084	-0.12	0.644	0.828
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	100	5500	11.15	12.00	1.216	92.24	1.084	-0.18	0.611	0.806
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	116	5580	11.20	12.00	1.202	92.24	1.084	-0.14	0.511	0.666
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	124	5620	11.25	12.00	1.189	92.24	1.084	0.05	0.589	0.759
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	144	5720	10.35	10.50	1.035	92.24	1.084	-0.09	0.694	0.779
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 1	165	5825	11.92	12.00	1.019	92.24	1.084	-0.18	0.614	0.678
04	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	157	5785	11.41	12.00	1.146	92.24	1.084	0.13	0.952	1.182
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	149	5745	10.93	11.00	1.016	92.24	1.084	0.12	1.050	1.157
	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	165	5825	11.08	11.50	1.102	92.24	1.084	0.12	0.971	1.159
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	157	5785	11.41	12.00	1.146	92.24	1.084	-0.15	0.916	1.137
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	149	5745	10.93	11.00	1.016	92.24	1.084	-0.15	0.824	0.908
	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	165	5825	11.08	11.50	1.102	92.24	1.084	-0.16	0.980	1.170

14.2 Repeated SAR Measurement

No.	Band	Mode	Test Position	Gap (mm)	Antenna	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Ratio	Reported 1g SAR (W/kg)
1st	WLAN2.4GHz	802.11b 1Mbps	Edge 1	0mm	Ant 2	11	2462	14.40	14.50	1.023	98.36	1.017	-0.12	1.140	-	1.186
2nd	WLAN2.4GHz	802.11b 1Mbps	Edge 1	0mm	Ant 2	11	2462	14.40	14.50	1.023	98.36	1.017	-0.19	1.080	1.06	1.124
1st	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	52	5260	11.17	12.00	1.211	92.24	1.084	-0.15	0.909	-	1.193
2nd	WLAN5GHz	802.11a 6Mbps	Edge 1	0mm	Ant 2	52	5260	11.17	12.00	1.211	92.24	1.084	-0.16	0.892	1.02	1.171
1st	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	144	5720	10.35	10.50	1.035	92.24	1.084	0.11	0.951	-	1.067
2nd	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	144	5720	10.35	10.50	1.035	92.24	1.084	0.13	0.874	1.09	0.981
1st	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	149	5745	10.93	11.00	1.016	92.24	1.084	0.12	1.050	-	1.157
2nd	WLAN5GHz	802.11a 6Mbps	Bottom Face	0mm	Ant 2	149	5745	10.93	11.00	1.016	92.24	1.084	-0.03	1.010	1.04	1.113

General Note:

1. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.
2. Per KDB 865664 D01v01r04, if the ratio among the repeated measurement is ≤ 1.2 and the measured SAR <1.45W/kg, only one repeated measurement is required.
3. The ratio is the difference in percentage between original and repeated *measured SAR*.
4. All measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

15. Simultaneous Transmission Analysis

NO.	Simultaneous Transmission Configurations	Body
1.	WLAN2.4GHz ANT1 + WLAN2.4GHz ANT2	Yes
2.	WLAN5GHz ANT1 + WLAN5GHz ANT2	Yes
3.	WLAN5GHz ANT1 + WLAN5GHz ANT2 + Bluetooth ANT2	Yes

General Note:

1. 2.4GHz WLAN and Bluetooth share the same antenna2, and cannot transmit simultaneously.
2. EUT will choose either WLAN 2.4GHz or WLAN 5GHz according to the network signal condition; therefore, 2.4GHz WLAN and 5GHz WLAN will not operate simultaneously at any moment.
3. The Scaled SAR summation is calculated based on the same configuration and test position.
4. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
   i) Scalar SAR summation < 1.6W/kg.
   ii) SPLSR = (SAR1 + SAR2)^1.5 / (min. separation distance, mm), and the peak separation distance is determined from the square root of [(x1-x2)2 + (y1-y2)2 + (z1-z2)2], where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan.
   iii) If SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary.
   iv) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg.
   v) The SPLSR calculated results please refer to section 15.2.
5. For simultaneous transmission analysis, Bluetooth SAR is estimated per KDB 447498 D01v06 based on the formula below.
   i) (*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.
   ii) When the minimum separation distance is < 5mm, the distance is used 5mm to determine SAR test exclusion.
   iii) 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.
   iv) Bluetooth estimated SAR is conservatively determined by 5mm separation, for all applicable exposure positions.

Bluetooth Max Power	Exposure Position	All Positions
5dBm	Estimated SAR (W/kg)	0.133 W/kg

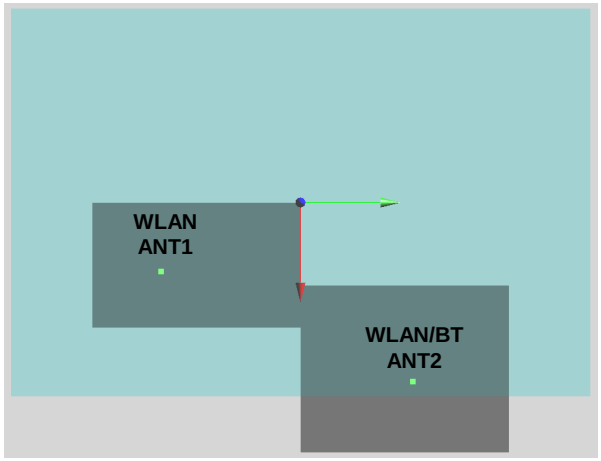
15.1 Body Exposure Conditions

Exposure Position	1 2.4GHz WLAN Ant 1 1g SAR (W/kg)	2 2.4GHz WLAN Ant 2 1g SAR (W/kg)	3 5GHz WLAN Ant 1 1g SAR (W/kg)	4 5GHz WLAN Ant 2 1g SAR (W/kg)	5 Bluetooth Ant 2 Estimated 1g SAR (W/kg)	1+2 Summed 1g SAR (W/kg)	3+4 Summed 1g SAR (W/kg)	3+4+5 Summed 1g SAR (W/kg)	SPLSR	Case No	SPLSR	Case No
Bottom Face at 0mm	0.716	0.298	0.722	1.182	0.133	**1.014**	**1.904**	**2.037**	**0.02**	**Case 1**	**0.02**	**Case 2**
Edge 1 at 0mm		1.186		1.193	0.133	**1.186**	**1.193**	**1.326**				

15.2 SPLSR Evaluation and Analysis

General Note:

1. Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneously transmitting antenna. When the sum of 1-g or 10-g SAR of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit, SAR test exclusion applies to that simultaneous transmission configuration. Therefore, the adjacent transmit antennas will be summed first, and then the SPLSR calculation will be evaluated with the farther transmitted antennas.
2. SPLSR = $(SAR_1 + SAR_2)^{1.5}$ / (*min. separation distance, mm*). If SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary



Case 1	Band	Position	SAR (W/kg)	Gap (cm)	SAR peak location (m) X	Y	Z	3D distance (mm)	Summed SAR (W/kg)	SPLSR Results	Simultaneous SAR
	WLAN5G Ant 1	Bottom Face	0.722	0	32.2	-66.2	-2.84	131.4	1.90	0.02	Not required
	WLAN5G Ant 2		1.182	0	85.2	54	-2.09				

Case 2	Band	Position	SAR (W/kg)	Gap (cm)	SAR peak location (m) X	Y	Z	3D distance (mm)	Summed SAR (W/kg)	SPLSR Results	Simultaneous SAR
	WLAN5G Ant 1	Bottom Face	0.722	0	32.2	-66.2	-2.84	131.4	2.04	0.02	Not required
	WLAN5G Ant 2 + BT Ant 2		1.315	0	85.2	54	-2.09				

Test Engineer： Lemon Su and Ray Sun

16. Uncertainty Assessment

Per KDB 865664 D01 SAR measurement 100MHz to 6GHz, 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. For this device, the highest measured 1-g SAR is less 1.5W/kg. Therefore, the measurement uncertainty table is not required in this report.

17. References

[1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

[2] ANSI/IEEE Std. C95.1-1992, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, September 1992

[3] IEEE Std. 1528-2013, “IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, Sep 2013

[4] SPEAG DASY System Handbook

[5] FCC KDB 248227 D01 v02r02, “SAR Guidance for IEEE 802.11 (WiFi) Transmitters”, Oct 2015.

[6] FCC KDB 447498 D01 v06, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, Oct 2015

[7] FCC KDB 616217 D04 v01r02, “SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers”, Oct 2015

[8] FCC KDB 865664 D01 v01r04, "SAR Measurement Requirements for 100 MHz to 6 GHz", Aug 2015.

[9] FCC KDB 865664 D02 v01r02, “RF Exposure Compliance Reporting and Documentation Considerations” Oct 2015.