SGS-CSTC Standards Technical Services (Suzhou) Co., Ltd.

FCC SAR TEST REPORT

Application No.:	SEWM2212000302RG
Applicant:	Lenovo (Shanghai) Electronics Technology Co., Ltd.
Manufacturer:	Lenovo PC HK Limited
Product Name:	Portable Tablet Computer
Model No.(EUT):	Lenovo TB-X6E6F
Trade Mark:	Lenovo
FCC ID:	O57TBX6E6F
Standards:	FCC 47CFR §2.1093
Date of Receipt:	2022-12-15
Date of Test:	2023-01-07 to 2023-01-08
Date of Issue:	2023-01-12
Test Result:	**PASS ***

* In the configuration tested, the EUT detailed in this report complied with the standards specified above.

Authorized Signature:

Panta Sun

Wireless Laboratory Manager

The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.
If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS International Electrical Approvals or testing done by SGS International Electrical Approvals in connection with, distribution or use of the product described in this report must be approved by SGS International Electrical Approvals in writing.

REVISION HISTORY

Report Number	Revision	Description	Issue Date
SEWM2212000302RG06	01	Original	2023-01-12

TEST SUMMARY

Frequency Band	Test position	Max Report SAR1-g (W/kg)	SAR limit (W/kg)
WI-FI (2.4GHz)	Body	1.17	1.60
WI-FI (5GHz)	Body	**1.19**	1.60
BT	Body	0.24	1.60
Maximum Simultaneous Transmission SAR (W/kg)		1.43	1.60

Reviewed by

Well Wei

Well Wei

Prepared by

Nick Hu

Nick Hu

CONTENTS

1 General Information

1.1 Details of Client

Applicant:	Lenovo (Shanghai) Electronics Technology Co., Ltd.
Address:	Section 304-305, Building No. 4, # 222, Meiyue Road, China (Shanghai) Pilot Free Trade Zone
Manufacturer:	Lenovo PC HK Limited
Address:	23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, Hong Kong, China

1.2 Test Location

Company:	SGS-CSTC Standards Technical Services (Suzhou) Co., Ltd.
Address:	South of No. 6 Plant, No. 1, Runsheng Road, Suzhou Industrial Park, Suzhou Area, China (Jiangsu) Pilot Free Trade Zone
Post code:	215000
Test Engineer：	Leon Xu

1.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

• **A2LA (Certificate No. 6336.01)**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 6336.01.

• **Innovation, Science and Economic Development Canada**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. has been recognized by ISED as an accredited testing laboratory.

CAB identifier: CN0120.

IC#: 27594.

• **FCC –Designation Number: CN1312**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. has been recognized as an accredited testing laboratory.

Designation Number: CN1312.

Test Firm Registration Number: 717327

1.4 General Description of EUT

Product Name:	Portable Tablet Computer		
Model No.(EUT):	Lenovo TB-X6E6F		
Trade Mark:	Lenovo		
Product Phase:	production unit		
Device Type:	portable device		
Exposure Category:	uncontrolled environment / general population		
SN:	Sample #1 HA1RLRYZ Sample #2 HA1RNMSZ		
FCC ID:	O57TBX6E6F		
Hardware Version:	Lenovo Tablet TB-X6E6F		
Software Version:	Lenovo TB-X6E6F_RF01_221201		
Antenna Type:	PIFA Antenna		
Device Operating Configurations:			
Modulation Mode:	WIFI: DSSS, OFDM; BT: GFSK, π/4DQPSK,8DPSK		
Frequency Bands:	Band	Tx (MHz)	Rx (MHz)
	WIFI(2.4GHz)	2412-2462	2412-2462
	WIFI(5GHz)	5150-5250 5250-5350 5470-5725 5725-5850	5150-5250 5250-5350 5470-5725 5725-5850
	BT	2402-2480	2402-2480

Remark:

According to the declaration letter from manufacturer, for the variant test at the worst-case SAR of sample #2 in this report.

1.5 Test Specification

Identity	Document Title
FCC 47CFR §2.1093	Radiofrequency Radiation Exposure Evaluation: Portable Devices
ANSI/IEEE Std C95.1 – 1992	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.
IEEE 1528-2013	Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
KDB 248227 D01 v02r02	802.11 Wi-Fi SAR
KDB 616217 D04 v01r02	SAR for laptop and tablets
KDB 447498 D01	General RF Exposure Guidance v06
KDB 447498 D03 v01	Supplement C Cross-Reference
KDB 865664 D01 v01r04	SAR Measurement 100 MHz to 6 GHz
KDB 865664 D02 v01r02	RF Exposure Reporting
KDB 648474 D04	SAR Evaluation Considerations for Wireless Handsets

1.6 RF exposure limits

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR* (Brain*Trunk)	**1.60 mW/g**	8.00 mW/g
Spatial Average SAR** (Whole Body)	0.08 mW/g	0.40 mW/g
Spatial Peak SAR*** (Hands/Feet/Ankle/Wrist)	4.00 mW/g	20.00 mW/g

Notes:

* The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time

** The Spatial Average value of the SAR averaged over the whole body.

*** The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

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.)

2 SAR Measurements System Configuration

2.1 The SAR Measurement System

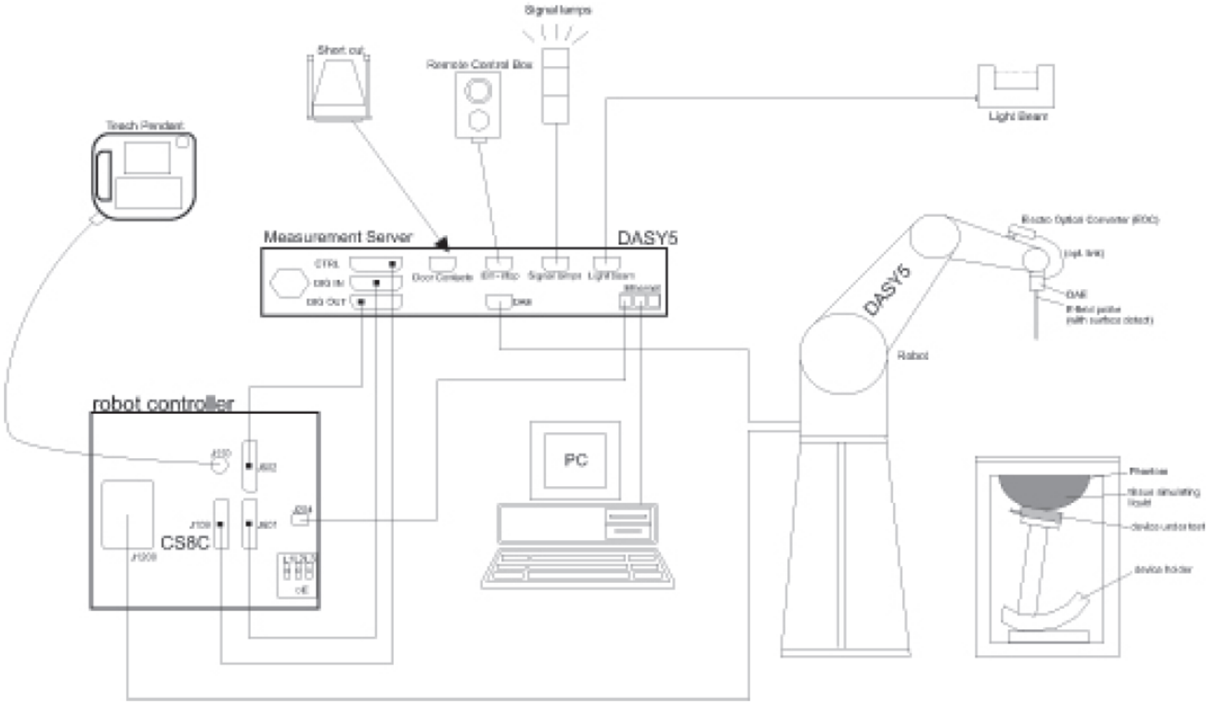
This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (SPEAG DASY5 professional system). A E-field probe is used to determine the internal electric fields. The SAR can be obtained from the equation SAR= σ (|Ei|2)/ ρ where σ and ρ are the conductivity and mass density of the tissue-Simulate.

The DASY5 system for performing compliance tests consists of the following items:
A standard high precision 6-axis robot (Stabile RX family) with controller, teach pendant and software .An arm extension for accommodation the data acquisition electronics (DAE).

A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

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 between optical and electrical of the signals for the digital communication to DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.



F-1. SAR Measurement System Configuration

- 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.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASY5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand, right-hand and Body Worn usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validating the proper functioning of the system.

2.2 Isotropic E-field Probe EX3DV4

	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	10 MHz to > 6 GHz Linearity: ± 0.2 dB (30 MHz to 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 to > 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
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields); the only probe that enables compliance testing for frequencies up to 6 GHz with precision of better 30%.
Compatibility	DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI

2.3 Data Acquisition Electronics (DAE)

Model	DAE4
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV,400mV)
Input Offset Voltage	< 5μV (with auto zero)
Input Bias Current	< 50 f A
Dimensions	60 x 60 x 68 mm

2.4 SAM Twin Phantom

Material	Vinylester, glass fiber reinforced (VE-GF)
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)
Dimensions (incl. Wooden Support)	Length: 1000 mm Width: 500 mm Height: adjustable feet
Filling Volume	approx. 25 liters
Wooden Support	SPEAG standard phantom table

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.

Twin SAM V5.0 has the same shell geometry and is manufactured from the same material as Twin SAM V4.0, but has reinforced top structure.

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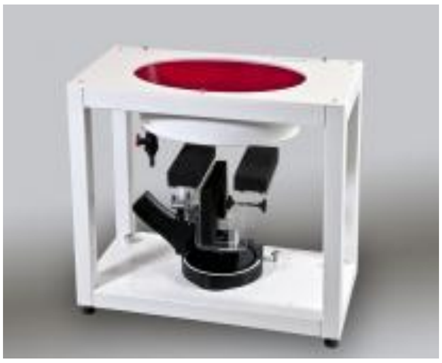
2.5 ELI Phantom

Material	Vinylester, glass fiber reinforced (VE-GF)
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 liters
Wooden Support	SPEAG standard phantom table



Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.

ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure.

2.6 Device Holder for Transmitters

F-2. **Device Holder for Transmitters**

- The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation centres for both scales are the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.
- The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity ε=3 and loss tangent δ=0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

2.7 Measurement procedure

2.7.1 Scanning procedure

Step 1: Power reference measurement

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure.

Step 2: *Area scan*

The SAR distribution at the exposed side of the head was measured at a distance of 4mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 15mm*15mm or 12mm*12mm or 10mm*10mm.Based on the area scan data, the area of the maximum absorption was determined by spline interpolation.

Step 3: *Zoom scan*

Around this point, a volume of 30mm*30mm*30mm (fine resolution volume scan, zoom scan) was assessed by measuring 5x5x7 points (≤2GHz) and 7x7x7 points (≥2GHz). On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:

The data at the surface was extrapolated, since the centre of the dipoles is 2.0mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2mm. (This can be variable. Refer to the probe specification).The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3D-Spline interpolation algorithm. The volume was integrated with the trapezoidal algorithm. One thousand points were interpolated to calculate the average. All neighbouring volumes were evaluated until no neighboring volume with a higher average value was found.

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std. 1528-2013.

<table>
<tr><td colspan="3"></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">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 colspan="3">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 colspan="3" 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>
<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">$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$</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 reference measurement (drift)

The Power Drift Measurement job measures the field at the same location as the most recent power reference measurement job within the same procedure, and with the same settings. The indicated drift is mainly the variation of the DUT's output power and should vary max. ± 5 %

2.7.2 Data Storage

The DASY software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension "DAE". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated. The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [m W/g], [m W/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

2.7.3 Data Evaluation by SEMCAD

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters: - Sensitivity Normi, ai0, ai1, ai2
- Conversion factor ConvFi
- Diode compression point Dcpi
Device parameters: - Frequency f
- Crest factor cf
Media parameters: - Conductivity ε
- Density ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics.

If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power.

The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot cf / dcp_i$$

With Vi = compensated signal of channel i (i = x, y, z)

Ui = input signal of channel i (i = x, y, z)

cf = crest factor of exciting field (DASY parameter)

dcp i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes:

$$E_i = (V_i / Norm_i \cdot ConvF)^{1/2}$$

H-field probes:

$$H_i = (V_i)^{1/2} \cdot (a_{i0} + a_{i1} f + a_{i2} f^2) / f$$

With Vi = compensated signal of channel i (i = x, y, z)
Normi = sensor sensitivity of channel I (i = x, y, z)
[mV/(V/m)2] for E-field Probes
ConvF = sensitivity enhancement in solution
aij = sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
Ei = electric field strength of channel i in V/m

Hi = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = (E_x^2 + E_Y^2 + E_z^2)^{1/2}$$

The primary field data are used to calculate the derived field units.

$$SAR = (Etot^2 \cdot \sigma) / (\varepsilon \cdot 1000)$$

with SAR = local specific absorption rate in mW/g

Etot = total field strength in V/m

σ= conductivity in [mho/m] or [Siemens/m]

ε= equivalent tissue density in g/cm3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid. The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = E_{tot}^2 {}_2 / 3770 \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

with Ppwe = equivalent power density of a plane wave in mW/cm2
Etot = total electric field strength in V/m

Htot = total magnetic field strength in A/m

3 Description of Test Position

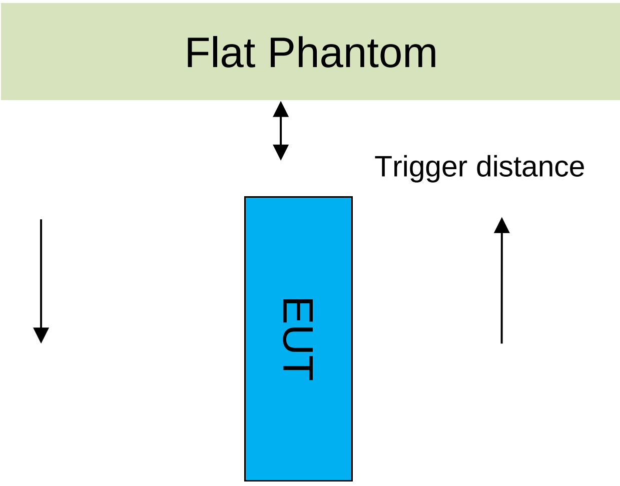
3.1 The Body Test Position

The overall diagonal dimension of the display section of a tablet is > 20 cm, Per FCC KDB 616217, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. SAR evaluation for the front surface of tablet display screens are generally not necessary. The SAR Exclusion Threshold in KDB 447498 D01 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.

4 Proximity Sensor Triggering Test

Proximity sensor triggering distances:

The Proximity sensor triggering was applied to WLAN2.4Ghz/WLAN 5GHz. Proximity sensor triggering distance testing was performed according to the procedures outlined in KDB 616217 D04 section 6.2, and EUT moving further away from the flat phantom and EUT moving toward the flat phantom were both assessed.

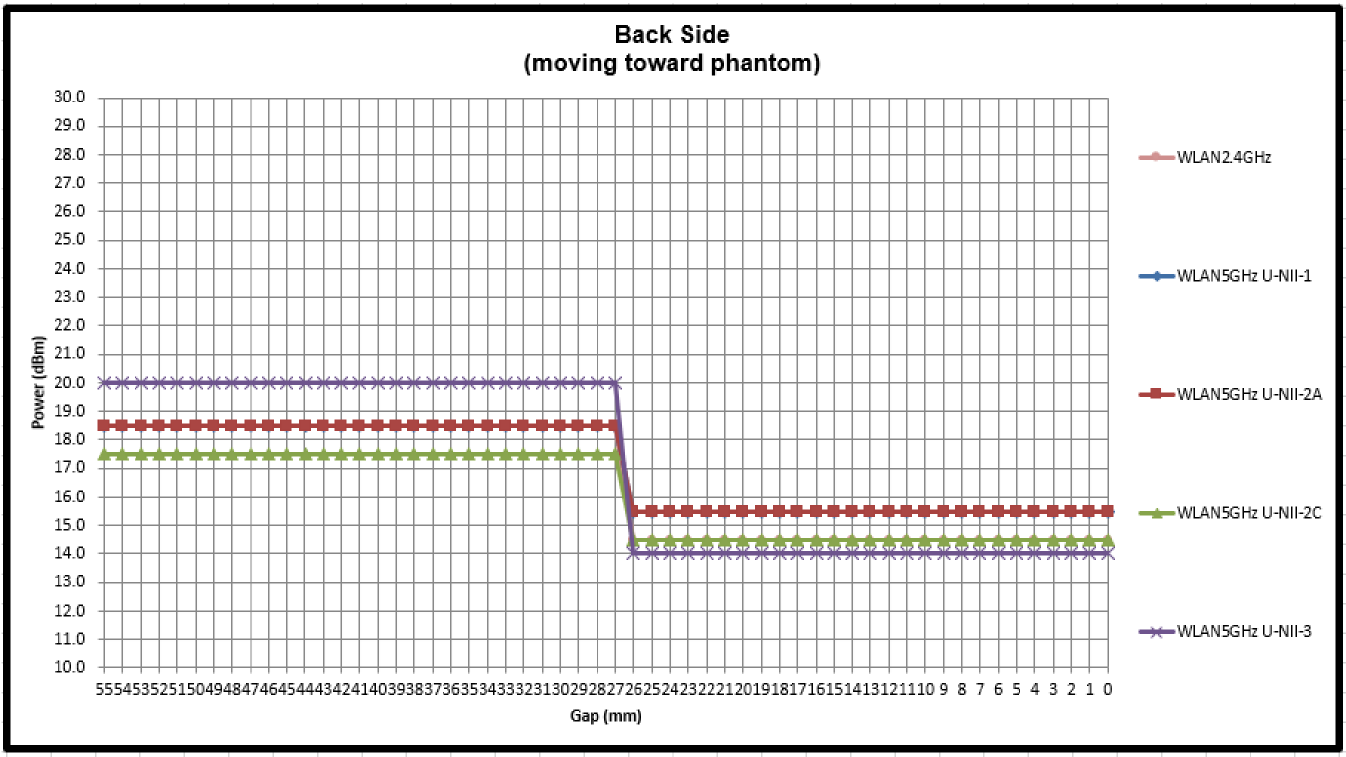


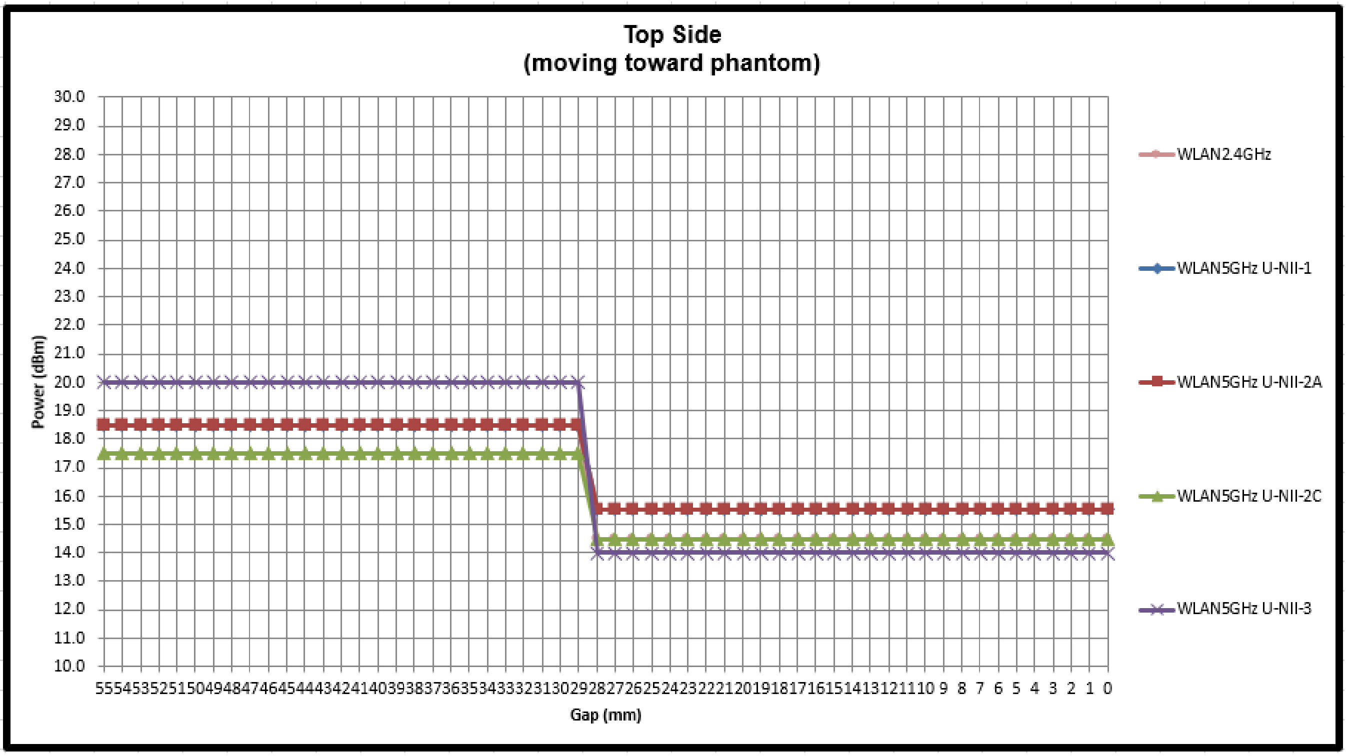
Proximity Sensor Triggering Distance(mm)		
Position	Back side	Top side
Minimum	26mm	28mm
Required SAR Test	25mm	27mm

Note:

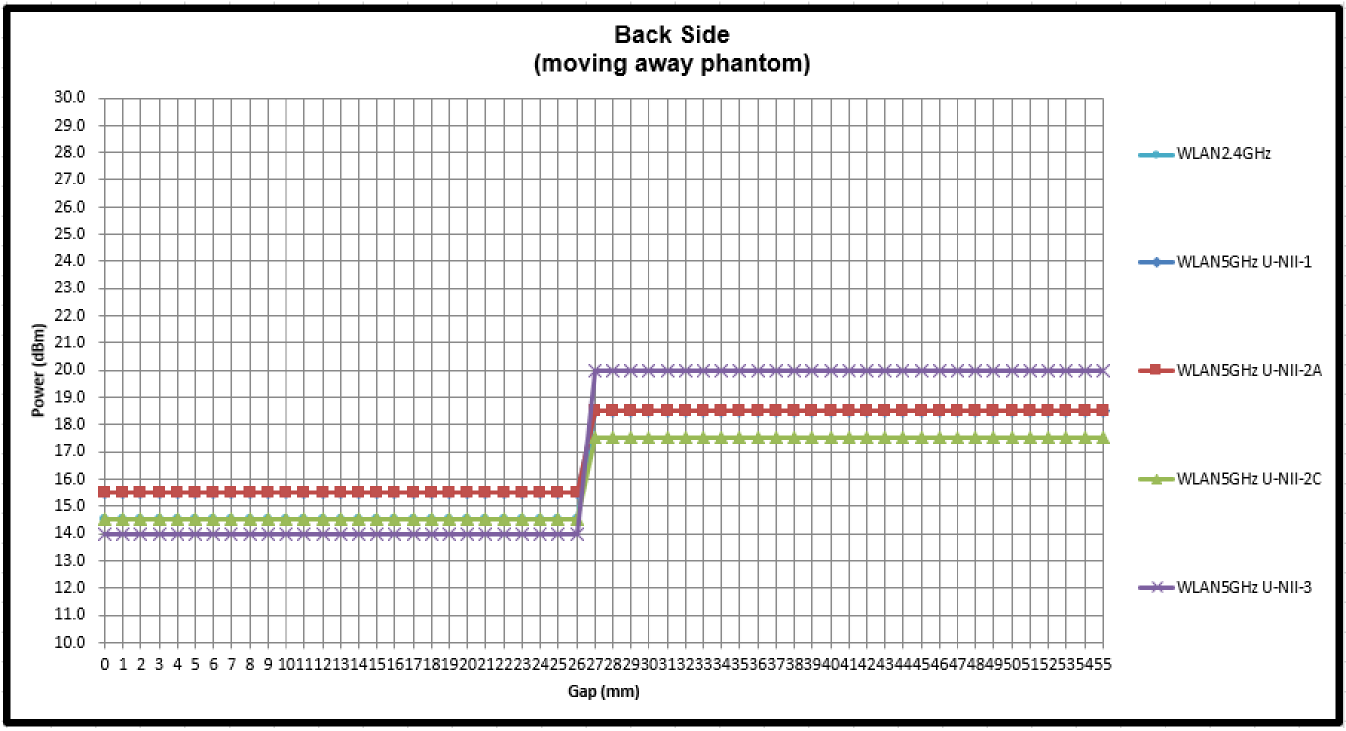
SAR tests with proximity sensor power reduction are only required for the sides of frequency bands in the table above. For the other sides or other frequency bands of the device, SAR is still tested at the maximum power level with sensor off.

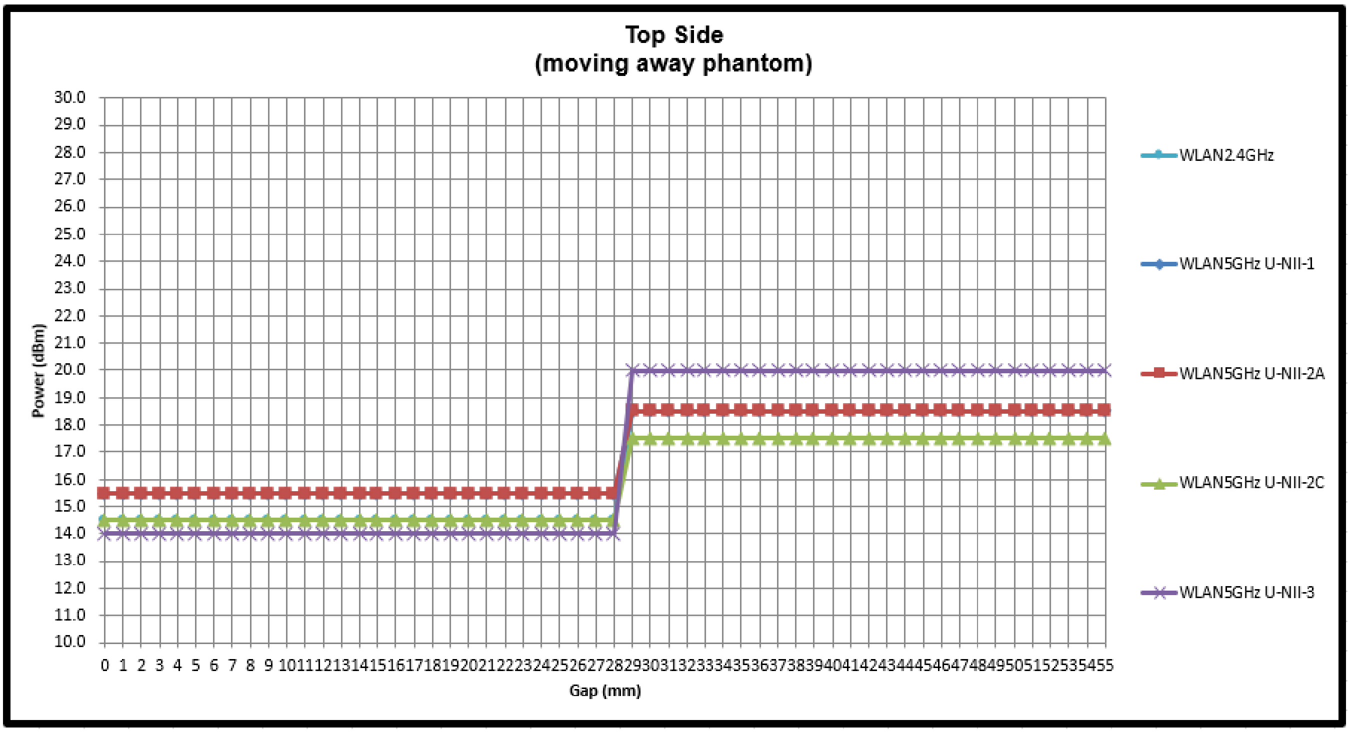
- DUT Moving Toward(Trigger)the Phantom





- DUT Moving Away(Release) from the Phantom





Proximity sensor coverage

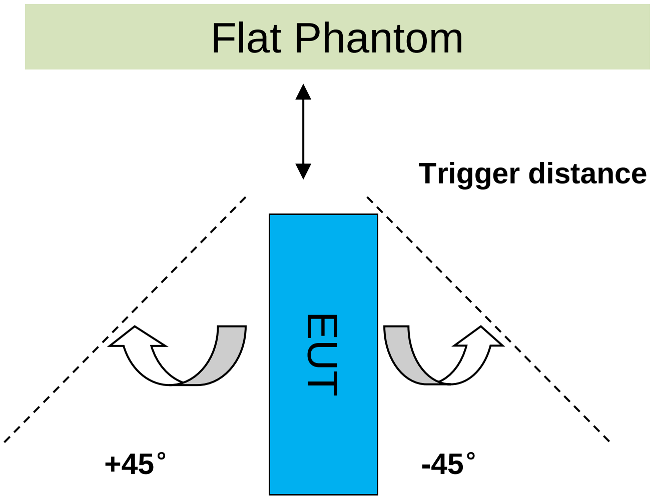
If a sensor is spatially offset from the antenna(s), it is necessary to verify sensor triggering for conditions where the antenna is next to the user but the sensor is laterally further away to ensure sensor coverage is sufficient for reducing the power to maintain compliance. For p-sensor coverage testing, the device is moved and "along the direction of maximum antenna and sensor offset".

The proximity sensor and main antenna use same metallic electrode, so there is no spatial offset.

Device tilt angle influences to proximity sensor triggering

The influence of device tilt angles to proximity sensor triggering was determined by positioning each tablet edge that contains a transmitting antenna, perpendicular to the flat phantom, at 16mm separation.

Rotating the tablet around the edge next to the phantom in ≤ 10° increments until the tablet is ± 45° from the vertical position at 0°, and the maximum output power remains in the reduced mode.



Summary of Tablet Tilt Angle Influence to Proximity Sensor Triggering for Top Side													
Band	Minimum trigger distance Per KDB616217§6.2	Minimum trigger distance at which power reduction was maintained over ±45°	Power Reduction Status										
(MHz)			-45°	-35°	-25°	-15°	-5°	0°	5°	15°	25°	35°	45°
WLAN2.4GHz	Top side:28mm	Top side:28mm	on	on	on	on	on	on	on	on	on	on	on
WLAN5GHz	Top side:28mm	Top side:28mm	on	on	on	on	on	on	on	on	on	on	on

5 SAR System Verification Procedure

5.1 Tissue Simulate Liquid

5.1.1 Recipes for Tissue Simulate Liquid

The bellowing tables give the recipes for tissue simulating liquids to be used in different frequency bands：

Ingredients (% by weight)	Frequency (MHz)
	2450
Tissue Type	**Head**
Water	55.00
Salt (NaCl)	0.2
Sucrose	0
HEC	0
Bactericide	0
Tween	44.80
Salt: 99⁺% Pure Sodium Chloride Water: De-ionized, 16 MΩ⁺ resistivity Tween: Polyoxyethylene (20) sorbitan monolaurate	Sucrose: 98⁺% Pure Sucrose HEC: Hydroxyethyl Cellulose
HSL5GHz is composed of the following ingredients： Water：50-65% Mineral oil：10-30% Emulsifiers：8-25% Sodium salt：0-1.5%	

Table 1： Recipe of Tissue Simulate Liquid

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5.1.2 Measurement for Tissue Simulate Liquid

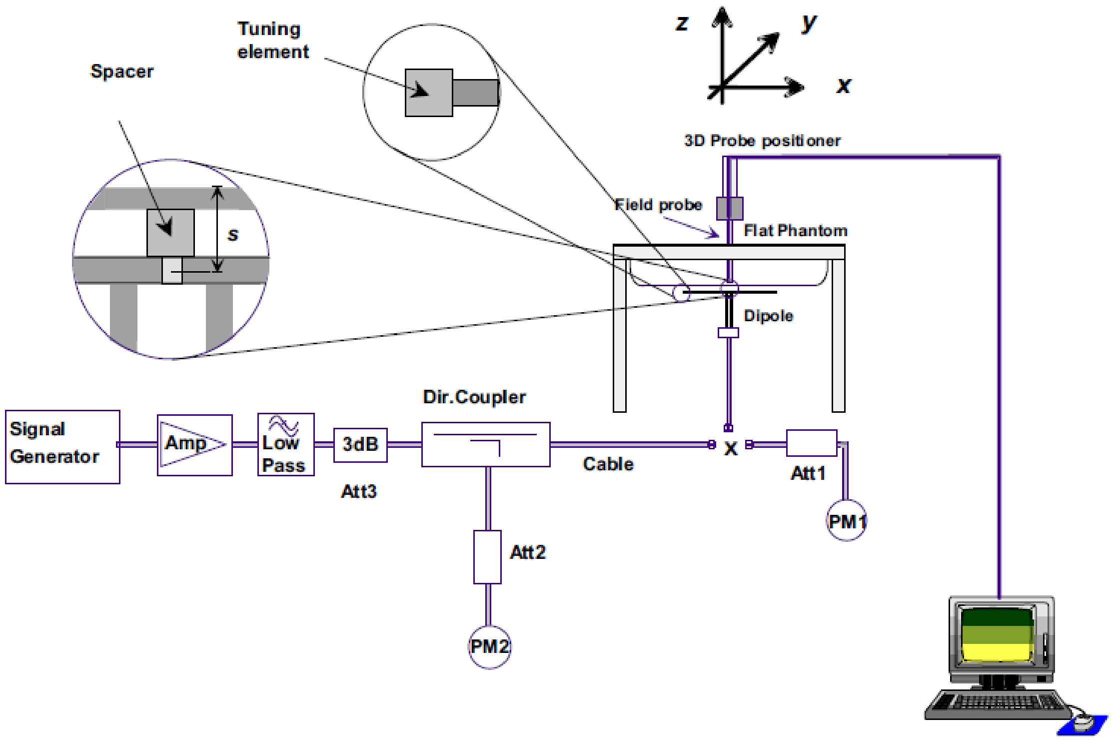
The Conductivity (σ) and Permittivity (ρ) are listed in Table 2. For the SAR measurement given in this report. The temperature variation of the Tissue Simulate Liquids was 22±2°C.

Measurement for Tissue Simulate Liquid							
Tissue Type	Measured Frequency （MHz）	Target Tissue (±5%)		Measured Tissue		Liquid Temp.	Test Date
		ε_r	σ(S/m)	ε_r	σ(S/m)	(℃)	
2450 Head	2450	39.20 (37.24~41.16)	1.80 (1.71~1.89)	40.136	1.784	22.6	2023/1/7
5250 Head	5250	35.9 (34.11~37.70)	4.66 (4.47~4.95)	35.503	4.706	22.3	2023/1/8
5600 Head	5600	35.5 (33.73~37.30)	5.07 (4.82~5.32)	34.831	5.178	22.3	2023/1/8
5750 Head	5750	35.4 (33.63~37.17)	5.22 (4.96~5.48)	34.459	5.362	22.3	2023/1/8

Table 2： Measurement result of Tissue electric parameters

5.2 SAR System Check

The microwave circuit arrangement for system Check is sketched in F-3. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% from the target SAR values. The tests were conducted on the same days as the measurement of the EUT. The obtained results from the system accuracy verification are displayed in the following table (A power level of 250mW (below 3GHz) or 100mW (3-6GHz) was input to the dipole antenna). During the tests, the ambient temperature of the laboratory was in the range 22±2°C, the relative humidity was in the range 60% and the liquid depth above the ear reference points was above 15±0.5 cm in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.



F-3. the microwave circuit arrangement used for SAR system check

5.2.1 Justification for Extended SAR Dipole Calibrations

1) Referring to KDB865664 D01 requirements for dipole calibration, instead of the typical annual calibration recommended by measurement standards, longer calibration intervals of up to three years may be considered when it is demonstrated that the SAR target, impedance and return loss of a dipole have remain stable according to the following requirements. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.

a) There is no physical damage on the dipole;
b) System check with specific dipole is within 10% of calibrated value;
c) Return-loss is within 10% of calibrated measurement;
d) Impedance is within 5Ω from the previous measurement.

2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

5.2.2 Summary System Validation Result(s)

Validation Kit		Measured SAR 250mW	Measured SAR 250mW	Measured SAR (normalized to 1W)	Measured SAR (normalized to 1W)	Target SAR (normalized to 1W)	Target SAR (normalized to 1W)	Deviation (Within ±10%)		Liquid Temp. (℃)	Test Date
		1g (W/kg)	10g (W/kg)	1g (W/kg)	10g (W/kg)	1-g(W/kg)	10-g(W/kg)	1-g(W/kg)	10-g(W/kg)		
D2450V2	Head	11.90	5.59	47.60	22.36	52.20	24.50	-8.81%	-8.73%	22.6	2023/1/7
Validation Kit		Measured SAR 100mW	Measured SAR 100mW	Measured SAR (normalized to 1W)	Measured SAR (normalized to 1W)	Target SAR (normalized to 1W)	Target SAR (normalized to 1W)	Deviation (Within ±10%)		Liquid Temp. (℃)	Test Date
		1g (W/kg)	10g (W/kg)	1g (W/kg)	10g (W/kg)	1-g(W/kg)	10-g(W/kg)	1-g(W/kg)	10-g(W/kg)		
D5GHzV2	Head(5.25GHz)	7.25	2.01	72.50	20.10	78.00	21.80	-7.05%	-7.80%	22.3	2023/1/8
	Head(5.6GHz)	7.49	2.16	74.90	21.60	79.90	22.50	-6.26%	-4.00%	22.3	2023/1/8
	Head(5.75GHz)	7.71	2.15	77.10	21.50	76.40	21.20	0.92%	1.42%	22.3	2023/1/8

Table 3： SAR System Check Result

5.2.3 Detailed System Check Results

Please see the Appendix A

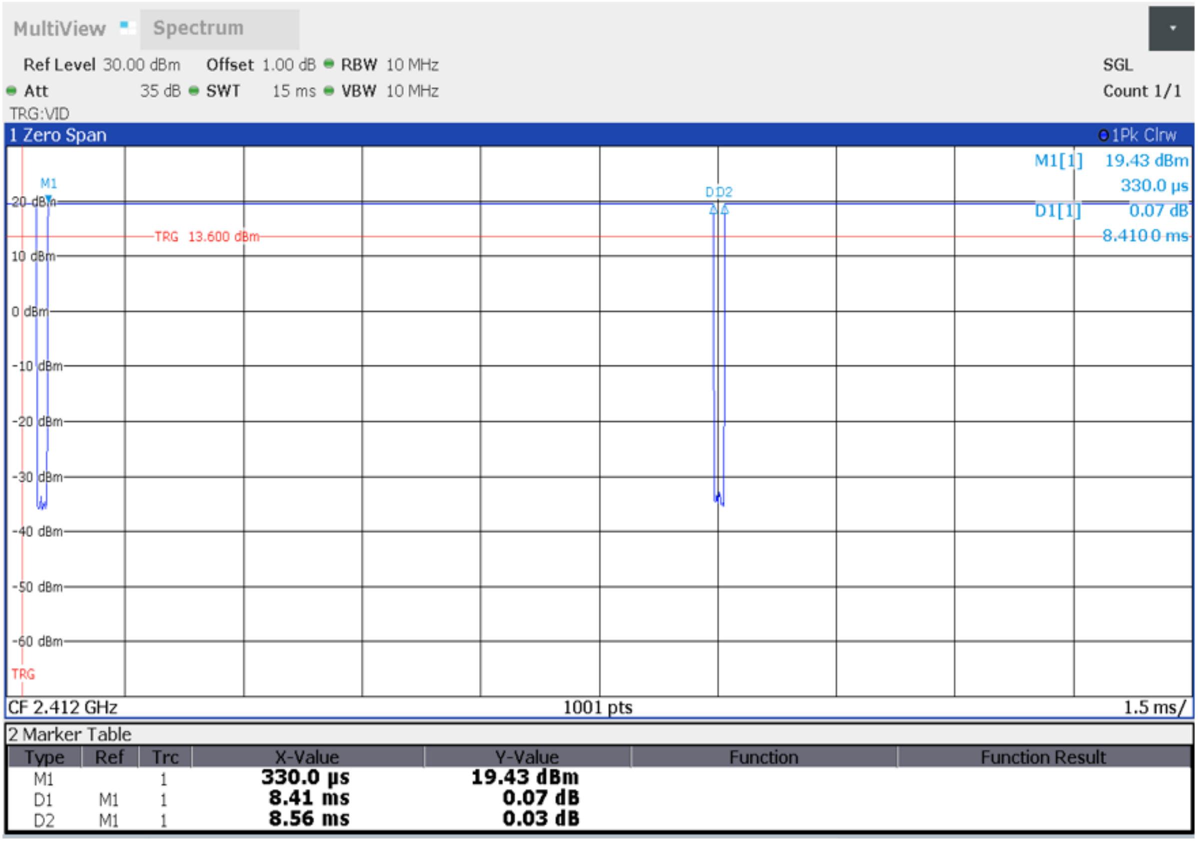
6 Test results and Measurement Data

6.1 Operation Configurations

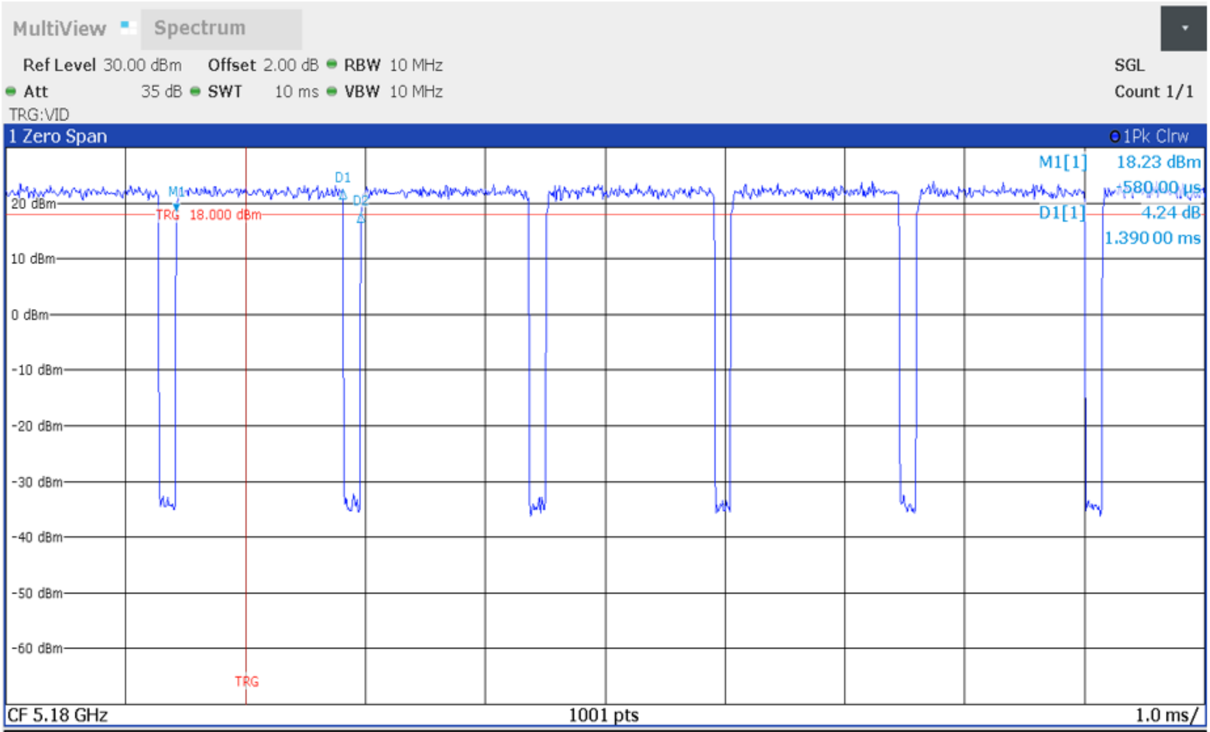
6.1.1 WiFi Test Configuration

A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement.

- 2.4G WIFI
  Duty cycle=98.25%



- 5G WIFI 802.11a
  Duty cycle=90.26%



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	-580.0 µs	18.23 dBm		
D1	M1	1	1.39 ms	4.24 dB		
D2	M1	1	1.54 ms	0.02 dB		

6.1.1.1 Initial Test Position SAR Test Reduction Procedure

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. The initial test position procedure is described in the following:

1）. When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other (remaining) test positions in that exposure configuration and 802.11 transmission mode combinations within the frequency band or aggregated band. SAR is also not required for that exposure configuration in the subsequent test configuration(s).

2）. When the reported SAR of the initial test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position using subsequent highest extrapolated or estimated 1-g SAR conditions determined by area scans or next closest/smallest test separation distance and maximum RF coupling test positions based on manufacturer justification, on the highest maximum output power channel, until the reported SAR is ≤ 0.8 W/kg or all required test positions (left, right, touch, tilt or subsequent surfaces and edges) are tested.

3）. For all positions/configurations tested using the initial test position and subsequent test positions, 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. a) Additional power measurements may be required for this step, which should be limited to those necessary for identifying the subsequent highest output power channels.

6.1.1.2 Initial Test Configuration Procedures

An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. SAR is measured using the highest measured maximum output power channel. For configurations with the same specified or measured maximum output power, additional transmission mode and test channel selection procedures are required. SAR test reduction for subsequent highest output test channels is determined according to *reported* SAR of the initial test configuration.
For next to the ear, hotspot mode and UMC mini-tablet exposure configurations where multiple test positions are required, the initial test position procedure is applied to minimize the number of test positions required for SAR measurement using the initial test configuration transmission mode. For fixed exposure conditions that do not have multiple SAR test positions, SAR is measured in the transmission mode determined by the initial test configuration.
When the *reported* SAR of the initial test configuration is > 0.8 W/kg, SAR measurement is required for subsequent next highest measured output power channel(s) in the initial test configuration until *reported* SAR is ≤ 1.2 W/kg or all required channels are tested.

6.1.1.3 Subsequent Test Configuration Procedures

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units. The initial test position procedure is applied to next to the ear, UMPC mini-tablet and hotspot mode configurations. When the same maximum output power is specified for multiple transmission modes, additional power measurements may be required to determine if SAR measurements are required for subsequent highest output power channels in a subsequent test configuration. The subsequent test configuration and SAR measurement procedures are described in the following.

1）. When SAR test exclusion provisions of KDB Publication 447498 are applicable and SAR measurement is not required for the initial test configuration, SAR is also not required for the next highest maximum output power transmission mode subsequent test configuration(s) in that frequency band or aggregated band and exposure configuration.

2）. When the highest *reported* SAR for the initial test configuration (when applicable, include subsequent highest output channels), according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

3）. The number of channels in the initial test configuration and subsequent test configuration can be different due to differences in channel bandwidth. When SAR measurement is required for a subsequent test configuration and the channel bandwidth is smaller than that in the initial test configuration, all channels in the subsequent test configuration that overlap with the larger bandwidth channel tested in the initial test configuration should be used to determine the highest maximum output power channel. This step requires additional power measurement to identify the highest maximum output power channel in the subsequent test configuration to determine SAR test reduction.

   a) SAR should first be measured for the channel with highest measured output power in the subsequent test configuration.

   b) SAR for subsequent highest measured maximum output power channels in the subsequent test configuration is required only when the *reported* SAR of the preceding higher maximum output power channel(s) in the subsequent test configuration is > 1.2 W/kg or until all required channels are tested. i) For channels with the same measured maximum output power, SAR should be measured using the channel closest to the center frequency of the larger channel bandwidth channel in the initial test configuration.

4）. SAR measurements for the remaining highest specified maximum output power OFDM transmission mode configurations that have not been tested in the initial test configuration (highest maximum output) or subsequent test configuration(s) (subsequent next highest maximum output power) is determined by recursively applying the subsequent test configuration procedures in this section to the remaining configurations according to the following:

   a) replace "subsequent test configuration" with "next subsequent test configuration" (i.e., subsequent next highest specified maximum output power configuration)

   b) replace "initial test configuration" with "all tested higher output power configurations"

6.1.1.4 2.4 GHz SAR Procedures

Separate SAR procedures are applied to DSSS and OFDM configurations in the 2.4 GHz band to simplify DSSS test requirements. For 802.11b DSSS SAR measurements, DSSS SAR procedure applies to fixed exposure test position and initial test position procedure applies to multiple exposure test positions. When SAR measurement is required for an OFDM configuration, the initial test configuration, subsequent test configuration and initial test position procedures are applied. The SAR test exclusion requirements for 802.11g/n OFDM configurations are described in following.

- **802.11b DSSS SAR Test Requirements**

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

1）. When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.

2）. When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

- **2.4 GHz 802.11g/n OFDM SAR Test Exclusion Requirements**

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied (section 5.3, including sub-sections). SAR is not required for the following 2.4 GHz OFDM conditions.

1）. When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.

2）. 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.

6.1.1.5 WiFi 5G SAR Test Procedures

6.1.1.5.1 U-NII-1 and U-NII-2A Bands

For devices that operate in only one of the U-NII-1 and U-NII-2A bands, the normally required SAR procedures for OFDM configurations are applied. For devices that operate in both U-NII bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following：

1) When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest *reported* SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, both bands are tested independently for SAR.
2) When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest *reported* SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration; otherwise, both bands are tested independently for SAR.
3) The two U-NII bands may be aggregated to support a 160 MHz channel on channel number 50. Without additional testing, the maximum output power for this is limited to the lower of the maximum output power certified for the two bands. When SAR measurement is required for at least one of the bands and the highest *reported* SAR adjusted by the ratio of specified maximum output power of aggregated to standalone band is > 1.2 W/kg, SAR is required for the 160 MHz channel. This procedure does not apply to an aggregated band with maximum output higher than the standalone band(s); the aggregated band must be tested independently for SAR. SAR is not required when the 160 MHz channel is operating at a reduced maximum power and also qualifies for SAR test exclusion.

6.1.1.5.2 U-NII-2C and U-NII-3 Bands

The frequency range covered by these bands is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. when Terminal Doppler Weather Radar (TDWR) restriction applies, all channels that operate at 5.60 – 5.65 GHz must be included to apply the SAR test reduction and measurement procedures.

When the same transmitter and antenna(s) are used for U-NII-2C band and U-NII-3 band or 5.8 GHz band of §15.247, the bands may be aggregated to enable additional channels with 20, 40 or 80 MHz bandwidth to span across the band gap, as illustrated in Appendix B. The maximum output power for the additional band gap channels is limited to the lower of those certified for the bands. Unless band gap channels are permanently disabled, they must be considered for SAR testing. The frequency range covered by these bands is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. To maintain SAR measurement accuracy and to facilitate test reduction, the channels in U-NII-2C band above 5.65 GHz may be grouped with the 5.8 GHz channels in U-NII-3 or §15.247 band to enable two SAR probe calibration frequency points to cover the bands, including the band gap channels. When band gap channels are supported and the bands are not aggregated for SAR testing, band gap channels must be considered independently in each band according to the normally required OFDM SAR measurement and probe calibration frequency points requirements.

6.1.1.5.3 OFDM Transmission Mode SAR Test Configuration and Channel Selection Requirements

The initial test configuration for 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple configurations in a frequency band have the same specified maximum output power, the initial test configuration is determined according to the following steps applied sequentially.

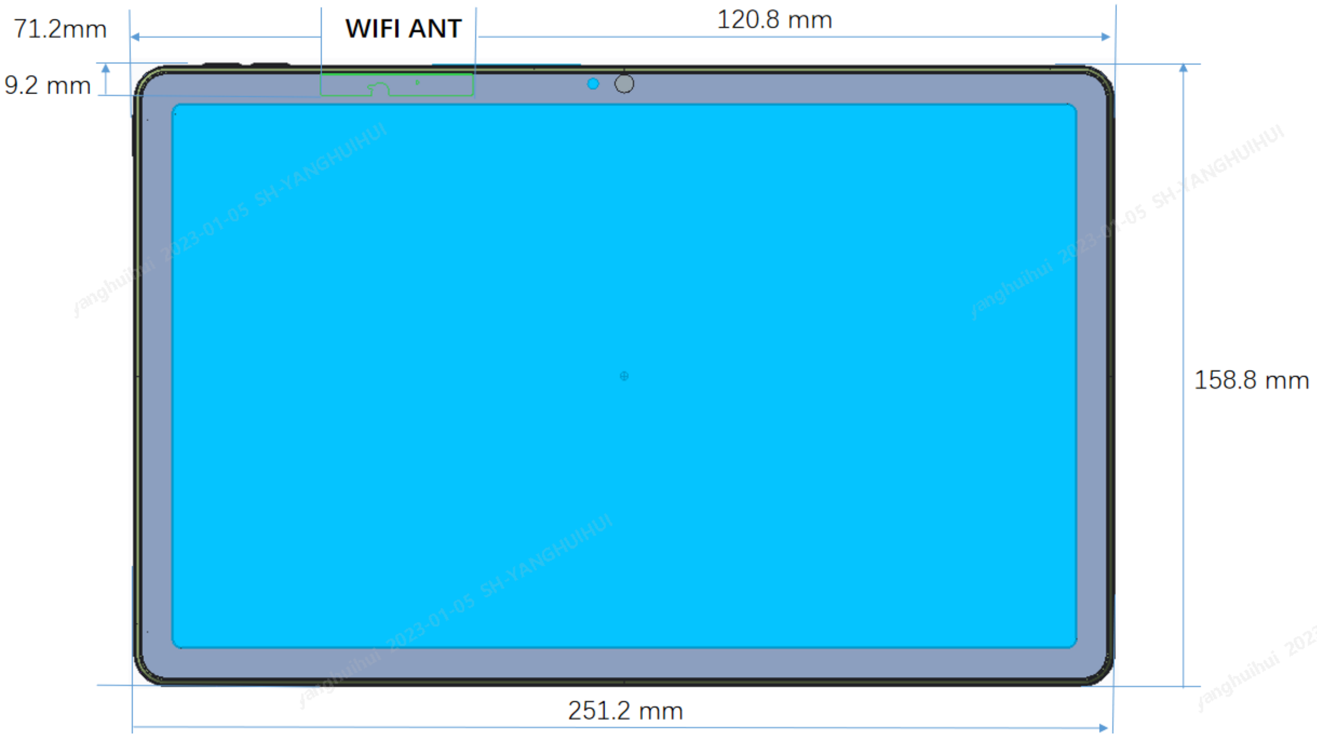
1) The largest channel bandwidth configuration is selected among the multiple configurations with the same specified maximum output power.
2) If multiple configurations have the same specified maximum output power and largest channel bandwidth, the lowest order modulation among the largest channel bandwidth configurations is selected.
3) If multiple configurations have the same specified maximum output power, largest channel bandwidth and lowest order modulation, the lowest data rate configuration among these configurations is selected.

4) When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, the lowest order 802.11 mode is selected; i.e., 802.11a is chosen over 802.11n then 802.11ac or 802.11g is chosen over 802.11n. After an initial test configuration is determined, if multiple test channels have the same measured maximum output power, the channel chosen for SAR measurement is determined according to the following. These channel selection procedures apply to both the initial test configuration and subsequent test configuration(s), with respect to the default power measurement procedures or additional power measurements required for further SAR test reduction. The same procedures also apply to subsequent highest output power channel(s) selection.
   - The channel closest to mid-band frequency is selected for SAR measurement.
   - For channels with equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.

6.1.1.5.4 SAR Test Requirements for OFDM configurations

When SAR measurement is required for 802.11 a/n/ac OFDM configurations, each standalone and frequency aggregated band is considered separately for SAR test reduction. When the same transmitter and antenna(s) are used for U-NII-1 and U-NII-2A bands, additional SAR test reduction applies. When band gap channels between U-NII-2C band and 5.8 GHz U-NII-3 or §15.247 band are supported, the highest maximum output power transmission mode configuration and maximum output power channel across the bands must be used to determine SAR test reduction, according to the initial test configuration and subsequent test configuration requirements. In applying the initial test configuration and subsequent test configuration procedures, the 802.11 transmission configuration with the highest specified maximum output power and the channel within a test configuration with the highest measured maximum output power should be clearly distinguished to apply the procedures.

6.1.2 DUT Antenna Locations(Front Veiw)



Note:

Per KDB 616217, the diagonal length is > 200mm, the device is considered a “tablet” device and needed to test 0mm 1-g body SAR.

6.1.3 EUT side for SAR Testing

- **Stand-alone SAR test evaluation**

1) Per FCC KDB 447498D01, 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
When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.
2) 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) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW, at 100 MHz to 1500 MHz
b) [Power allowed at numeric threshold for 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz

Standalone SAR exclusion calculation

Exposure Position	Wireless Interface	BT	2.4GHz WLAN ANT 1	5GHz WLAN ANT 1
	Calculated Frequency	2480MHz	2462MHz	5825MHz
	Maximum power (dBm)	11	18.5	20
	Maximum rated power(mW)	13.0	71.0	100.0
Back Side	Separation distance(mm)	5.0	5.0	5.0
	exclusion threshold	4.1	22.3	48.3
	Testing required?	Yes	Yes	Yes
Left Side	Separation distance(mm)	71.2	71.2	71.2
	exclusion threshold	307.0	308.0	274.0
	Testing required?	No	No	No
Right Side	Separation distance(mm)	120.8	120.8	120.8
	exclusion threshold	803.0	804.0	770.0
	Testing required?	No	No	No
Top Side	Separation distance(mm)	5.0	5.0	5.0
	exclusion threshold	4.1	22.3	48.3
	Testing required?	Yes	Yes	Yes
Bottom Side	Separation distance(mm)	149.6	149.6	149.6
	exclusion threshold	1091.0	1092.0	1058.0
	Testing required?	No	No	No

When standalone SAR test exclusion applies 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:
1) (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.
When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

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2) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distance is > 50 mm.

Band	Exposure Condition	f (GHz)	Pmax	Pmax	Test separation distance					Estimated SAR(W/Kg)				
			(dBm)	(mw)	Back Side	Left side	Right side	Top side	Bottom side	Back Side	Left side	Right side	Top side	Bottom side
WLAN2.4G	Body 0mm	2.472	18.50	70.79	5	71.2	120.8	5	149.6	Measure	0.40	0.40	Measure	0.40
WLAN5.2G	Body 0mm	5.240	18.50	70.79	5	71.2	120.8	5	149.6	Measure	0.40	0.40	Measure	0.40
WLAN5.3G	Body 0mm	5.320	18.50	70.79	5	71.2	120.8	5	149.6	Measure	0.40	0.40	Measure	0.40
WLAN5.5G	Body 0mm	5.720	17.50	56.23	5	71.2	120.8	5	149.6	Measure	0.40	0.40	Measure	0.40
WLAN5.8G	Body 0mm	5.805	20.00	100.0	5	71.2	120.8	5	149.6	Measure	0.40	0.40	Measure	0.40
BT	Body 0mm	2.480	11.00	12.59	5	71.2	120.8	5	149.6	Measure	0.40	0.40	Measure	0.40

Table 4： Estimated SAR calculation for WiFi and BT

Note:

1) * - maximum possible output power declared by manufacturer

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6.2 Measurement of RF conducted Power

6.2.1 Conducted Power of WIFI and BT

WIFI 2.4G Sensor Off					
Mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11b	1	2412	1	17.93	18.50
	6	2437		18.23	18.50
	11	2462		17.77	18.50
802.11g	1	2412	6	13.67	14.50
	6	2437		14.21	14.50
	11	2462		13.71	14.50
802.11n HT20	1	2412	6.5	13.08	13.50
	6	2437		13.39	13.50
	11	2462		12.91	13.50
802.11n HT40	3	2422	13.5	17.31	18.50
	4	2427		16.64	18.50
	5	2432		17.75	18.50
	6	2437		17.53	18.50
	9	2452		17.11	18.50

WIFI 2.4G Sensor on					
Mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11b	1	2412	1	14.08	14.50
	6	2437		14.36	14.50
	11	2462		13.84	14.50
802.11g	1	2412	6	12.71	13.50
	6	2437		13.26	13.50
	11	2462		12.75	13.50
802.11n HT20	1	2412	6.5	13.08	13.50
	6	2437		13.39	13.50
	11	2462		12.91	13.50
802.11n HT40	3	2422	13.5	12.40	13.50
	4	2427		11.75	13.50
	5	2432		12.88	13.50
	6	2437		12.62	13.50
	9	2452		12.24	13.50

WIFI 5G Sensor Off						
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11a	U-NII-1	36	5180	6	17.83	18.50
		40	5200		18.46	18.50
		44	5220		17.61	18.50
		48	5240		17.46	18.50
	U-NII-2A	52	5260		18.06	18.50
		56	5280		18.13	18.50
		60	5300		17.91	18.50
		64	5320		17.75	18.50
	U-NII-2C	100	5500		16.76	17.50
		104	5520		17.02	17.50
		108	5540		17.12	17.50
		112	5560		16.81	17.50
		116	5580		17.35	17.50
		120	5600		16.77	17.50
		124	5620		16.68	17.50
		128	5640		16.52	17.50
		132	5660		16.36	17.50
		136	5680		16.47	17.50
		140	5700		16.68	17.50
		144	5720		16.62	17.50
	U-NII-3	149	5745		19.04	20.00
		153	5765		18.86	20.00
		157	5785		18.67	20.00
		161	5805		19.13	20.00
		165	5825		19.36	20.00
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11n-HT20	U-NII-1	36	5180	MCS0	17.13	17.50
		40	5200		17.34	17.50
		44	5220		17.02	17.50
		48	5240		16.92	17.50
	U-NII-2A	52	5260		17.30	17.50
		56	5280		17.12	17.50
		60	5300		17.11	17.50
		64	5320		16.99	17.50
	U-NII-2C	100	5500		16.97	17.50
		104	5520		16.95	17.50
		108	5540		17.13	17.50
		112	5560		17.02	17.50

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		116	5580		17.32	17.50
		120	5600		16.93	17.50
		124	5620		16.82	17.50
		128	5640		16.69	17.50
		132	5660		17.13	17.50
		136	5680		16.69	17.50
		140	5700		16.61	17.50
		144	5720		16.46	17.50
	U-NII-3	149	5745		18.94	20.00
		153	5765		19.36	20.00
		157	5785		18.98	20.00
		161	5805		19.02	20.00
		165	5825		19.46	20.00
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11n-HT40	U-NII-1	38	5190	MCS0	15.21	16.00
		46	5230		14.26	16.00
	U-NII-2A	54	5270		14.85	16.00
		62	5310		14.58	16.00
	U-NII-2C	102	5510		15.11	16.00
		110	5550		15.09	16.00
		118	5590		15.13	16.00
		126	5630		14.61	16.00
		134	5670		14.91	16.00
		142	5710		14.51	16.00
	U-NII-3	151	5755		18.03	19.50
		159	5795		17.81	19.50
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11ac-20	U-NII-1	36	5180	MCS0	17.18	17.50
		40	5200		17.36	17.50
		44	5220		17.05	17.50
		48	5240		16.90	17.50
	U-NII-2A	52	5260		17.08	17.50
		56	5280		16.96	17.50
		60	5300		16.93	17.50
		64	5320		17.06	17.50
	U-NII-2C	100	5500		16.96	17.50
		104	5520		17.13	17.50
		108	5540		17.16	17.50
		112	5560		17.24	17.50
		116	5580		17.45	17.50

		120	5600		16.94	17.50
		124	5620		16.84	17.50
		128	5640		16.68	17.50
		132	5660		17.16	17.50
		136	5680		16.63	17.50
		140	5700		16.85	17.50
		144	5720		16.69	17.50
	U-NII-3	149	5745		19.08	20.00
		153	5765		18.97	20.00
		157	5785		18.91	20.00
		161	5805		19.06	20.00
		165	5825		19.38	20.00
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11ac-40	U-NII-1	38	5190	MCS0	15.13	16.00
		46	5230		14.61	16.00
	U-NII-2A	54	5270		15.06	16.00
		62	5310		14.86	16.00
	U-NII-2C	102	5510		15.13	16.00
		110	5550		14.95	16.00
		118	5590		15.11	16.00
		126	5630		14.56	16.00
		134	5670		14.83	16.00
		142	5710		14.43	16.00
	U-NII-3	151	5755		18.06	19.50
		159	5795		18.03	19.50
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11ac 80M	U-NII-1	42	5210	MCS0	15.05	16.50
	U-NII-2A	58	5290		14.97	16.50
	U-NII-2C	106	5530		13.24	14.50
		122	5610		13.02	14.50
		138	5690		12.97	14.50
	U-NII-3	155	5775		17.91	19.50

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WIFI 5G Sensor on						
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11a	U-NII-1	36	5180	6	13.97	15.50
		40	5200		14.58	15.50
		44	5220		13.73	15.50
		48	5240		13.57	15.50
	U-NII-2A	52	5260		14.14	15.50
		56	5280		14.27	15.50
		60	5300		14.03	15.50
		64	5320		13.83	15.50
	U-NII-2C	100	5500		13.75	14.50
		104	5520		13.80	14.50
		108	5540		13.85	14.50
		112	5560		13.77	14.50
		116	5580		14.42	14.50
		120	5600		13.87	14.50
		124	5620		13.80	14.50
		128	5640		13.66	14.50
		132	5660		13.46	14.50
		136	5680		13.58	14.50
		140	5700		13.89	14.50
		144	5720		13.76	14.50
	U-NII-3	149	5745		13.18	14.00
		153	5765		12.98	14.00
		157	5785		12.79	14.00
		161	5805		13.12	14.00
		165	5825		13.46	14.00
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11n-HT20	U-NII-1	36	5180	MCS0	15.25	15.50
		40	5200		15.47	15.50
		44	5220		15.16	15.50
		48	5240		15.05	15.50
	U-NII-2A	52	5260		15.37	15.50
		56	5280		15.19	15.50
		60	5300		15.19	15.50
		64	5320		15.07	15.50
	U-NII-2C	100	5500		14.11	14.50
		104	5520		14.04	14.50
		108	5540		14.23	14.50
		112	5560		14.16	14.50

		116	5580		14.44	14.50
		120	5600		14.08	14.50
		124	5620		13.90	14.50
		128	5640		13.76	14.50
		132	5660		14.24	14.50
		136	5680		13.76	14.50
		140	5700		13.68	14.50
		144	5720		13.57	14.50
	U-NII-3	149	5745		13.08	14.00
		153	5765		13.48	14.00
		157	5785		13.07	14.00
		161	5805		13.15	14.00
		165	5825		13.58	14.00
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11n-HT40	U-NII-1	38	5190	MCS0	14.20	15.00
		46	5230		13.27	15.00
	U-NII-2A	54	5270		13.87	15.00
		62	5310		13.57	15.00
	U-NII-2C	102	5510		13.18	14.00
		110	5550		13.17	14.00
		118	5590		13.26	14.00
		126	5630		12.75	14.00
		134	5670		12.99	14.00
		142	5710		12.57	14.00
	U-NII-3	151	5755		12.09	13.50
		159	5795		11.92	13.50
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11ac-20	U-NII-1	36	5180	MCS0	15.32	15.50
		40	5200		15.49	15.50
		44	5220		15.15	15.50
		48	5240		15.03	15.50
	U-NII-2A	52	5260		15.16	15.50
		56	5280		15.02	15.50
		60	5300		14.99	15.50
		64	5320		15.15	15.50
	U-NII-2C	100	5500		14.10	14.50
		104	5520		14.24	14.50
		108	5540		14.30	14.50
		112	5560		14.39	14.50
		116	5580		14.56	14.50

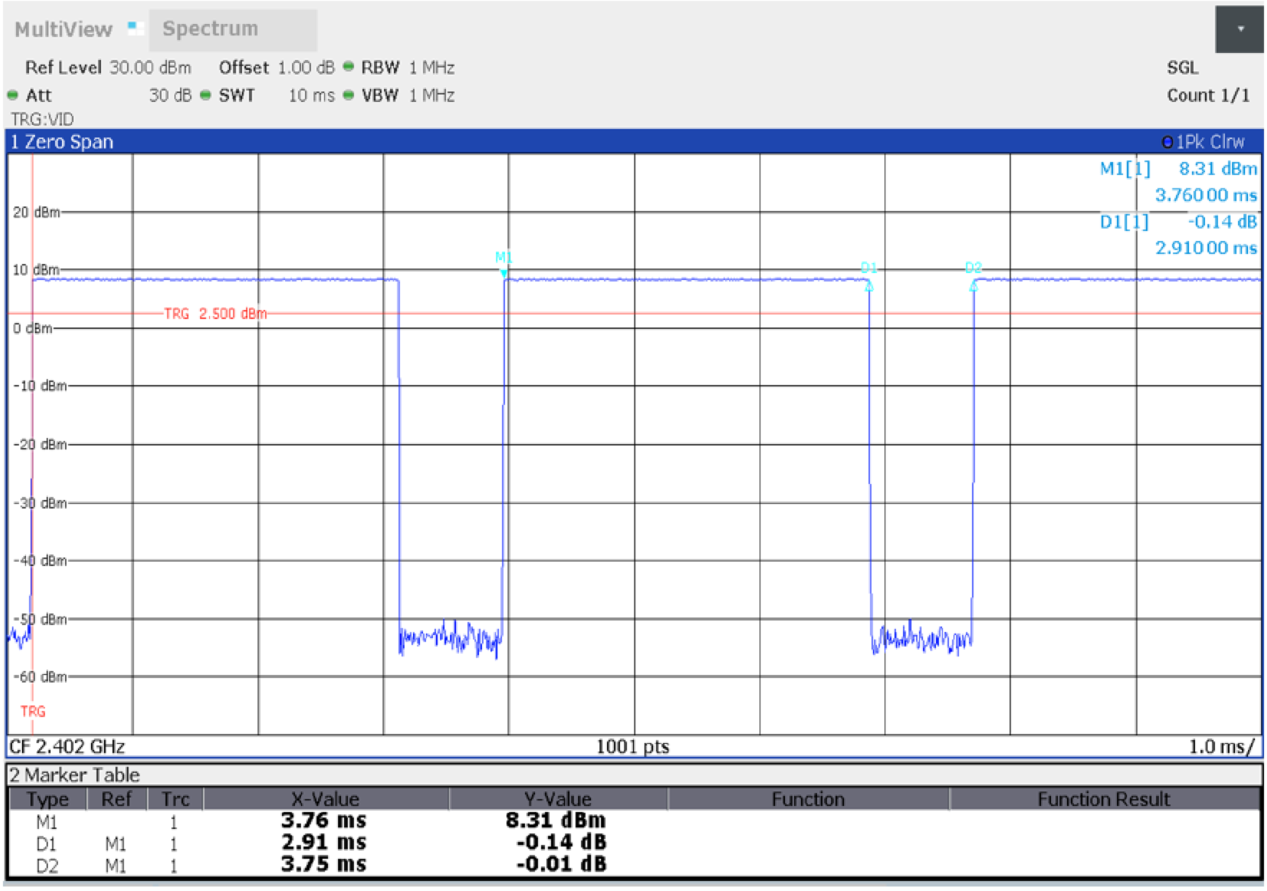
		120	5600		14.02	14.50
		124	5620		13.95	14.50
		128	5640		13.83	14.50
		132	5660		14.23	14.50
		136	5680		13.75	14.50
		140	5700		13.95	14.50
		144	5720		13.81	14.50
	U-NII-3	149	5745		13.18	14.00
		153	5765		13.04	14.00
		157	5785		13.00	14.00
		161	5805		13.21	14.00
		165	5825		13.44	14.00
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11ac-40	U-NII-1	38	5190	MCS0	14.11	15.00
		46	5230		13.64	15.00
	U-NII-2A	54	5270		14.06	15.00
		62	5310		13.87	15.00
	U-NII-2C	102	5510		13.21	14.00
		110	5550		13.09	14.00
		118	5590		13.19	14.00
		126	5630		12.66	14.00
		134	5670		12.94	14.00
		142	5710		12.50	14.00
	U-NII-3	151	5755		12.15	13.50
		159	5795		12.10	13.50
5GHz	mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up
802.11ac 80M	U-NII-1	42	5210	MCS0	14.07	15.00
	U-NII-2A	58	5290		13.94	15.00
	U-NII-2C	106	5530		13.24	14.00
		122	5610		13.02	14.00
		138	5690		12.97	14.00
	U-NII-3	155	5775		12.04	13.50

Table 5： Conducted Power of WIFI.

BT		Average Conducted Power(dBm)			
Band	Channel	0	39	78	Tune up
BT	GFSK	10.23	10.24	9.73	11.00
	π/4DQPSK	9.26	9.13	8.61	10.00
	8DPSK	9.19	9.11	8.62	10.00
Band	Channel	0	19	39	Tune up
BLE 1M	GFSK	8.82	8.78	8.44	10.00
BLE 2M	GFSK	9.22	9.34	8.79	10.00

Table 6: Conducted Power of BT.

BT DH5 Duty cycle=77.60%



6.3 Measurement of SAR Data

Note:

1) The maximum Scaled SAR value is marked in bold. Graph Results refer to Appendix B

2) If the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is not required for such test configuration(s).

6.3.1 SAR Result of WIFI 2.4G

Wi-Fi 2.4G SAR Test Record											
Test position	**Test mode**	**Test ch./Freq.**	**Duty Cycle**	**Duty Cycle Scaled factor**	**SAR (W/kg) 1-g**	**Power drift (dB)**	**Conducted Power(dBm)**	**Tune up Limit(dBm)**	**Scaled factor**	**Scaled SAR 1-g (W/kg)**	**Liquid Temp.(℃)**
Body Test data											
Back side	802.11b	6/2437	98.25%	1.018	1.080	0.02	14.36	14.50	1.033	1.135	22.6
Back side	802.11b	1/2412	98.25%	1.018	0.870	-0.06	14.08	14.50	1.102	0.975	22.6
Top side	802.11b	6/2437	98.25%	1.018	0.842	0.04	14.36	14.50	1.033	0.885	22.6
Top side	802.11b	1/2412	98.25%	1.018	0.843	0.07	14.08	14.50	1.102	0.945	22.6
Back side with Sample2#	802.11b	6/2437	98.25%	1.018	1.110	0.03	14.36	14.50	1.033	**1.167**	22.6
Back side with Sample2#-Repeat	802.11b	6/2437	98.25%	1.018	1.090	0.01	14.36	14.50	1.033	1.146	22.6
Back side 25mm	802.11b	6/2437	98.25%	1.018	0.199	0.09	18.23	18.50	1.064	0.216	22.6
Top side 27mm	802.11b	6/2437	98.25%	1.018	0.348	-0.02	18.23	18.50	1.064	0.377	22.6

Table 7： SAR of WIFI 2.4G.

Note:

1)Per KDB 248227 D01, for Body SAR test of WiFi 2.4G, SAR is measured for 2.4 GHz 802.11b DSSS using the initial test position procedure. The highest reported SAR for DSSS is adjusted by the ratio of OFDM 802.11g/n to DSSS specified maximum output power and the adjusted SAR is < 1.2 W/kg, so SAR for 802.11g/n is not required.

2)As the 802.11b highest reported SAR is smaller than 1.2 W/kg , and the tune-up of the other 802.11 modes are not higher than 802.11b,therefore the adjusted SAR is ≤ 1.2 W/kg for other 802.11 modes, SAR test for the other 802.11 modes are not required.

6.3.2 SAR Result of WIFI 5G

Wi-Fi 5G SAR Test Record											
Test position	**Test mode**	**Test ch./Freq.**	**Duty Cycle**	**Duty Cycle Scaled factor**	**SAR (W/kg) 1-g**	**Power drift (dB)**	**Conducted Power(dBm)**	**Tune up Limit(dBm)**	**Scaled factor**	**Scaled SAR 1-g (W/kg)**	**Liquid Temp.(℃)**
Body Test data of U-NII-2A											
Back side	802.11a	56/5280	90.26%	1.108	0.502	0.05	14.27	15.50	1.327	0.738	22.3
Top side	802.11a	56/5280	90.26%	1.108	0.456	-0.12	14.27	15.50	1.327	0.671	22.3
Back side with Sample2#	802.11a	56/5280	90.26%	1.108	0.693	-0.03	14.27	15.50	1.327	**1.019**	22.3
Back side with Sample2#	802.11a	60/5300	90.26%	1.108	0.612	-0.09	14.03	15.50	1.403	0.951	22.3
Back side 25mm	802.11a	56/5280	90.26%	1.108	0.098	0.01	18.13	18.50	1.089	0.118	22.3
Top side 27mm	802.11a	56/5280	90.26%	1.108	0.071	-0.07	18.13	18.50	1.089	0.086	22.3
Body Test data of U-NII-2C											
Back side	802.11a	116/5580	90.26%	1.108	0.832	0.07	14.42	14.50	1.019	0.939	22.3
Back side	802.11a	140/5700	90.26%	1.108	0.784	0.02	13.89	14.50	1.151	1.000	22.3
Top side	802.11a	116/5580	90.26%	1.108	0.803	0.06	14.42	14.50	1.019	0.906	22.3
Top side	802.11a	116/5580	90.26%	1.108	0.753	0.01	14.42	14.50	1.019	0.850	22.3
Back side with Sample2#	802.11a	116/5580	90.26%	1.108	0.979	0.09	14.42	14.50	1.019	**1.105**	22.3
Back side with Sample2#-repeat	802.11a	116/5580	90.26%	1.108	0.971	0.03	14.42	14.50	1.019	1.096	22.3
Back side 25mm	802.11a	116/5580	90.26%	1.108	0.104	0.07	17.35	17.50	1.035	0.119	22.3
Top side 27mm	802.11a	116/5580	90.26%	1.108	0.089	-0.02	17.35	17.50	1.035	0.102	22.3
Body Test data of U-NII-3											
Back side	802.11a	165/5825	90.26%	1.108	0.851	0.05	13.46	14.00	1.132	1.068	22.3
Back side	802.11a	149/5745	90.26%	1.108	0.787	0.03	13.18	14.00	1.208	1.053	22.3
Top side	802.11a	165/5825	90.26%	1.108	0.796	-0.06	13.46	14.00	1.132	0.999	22.3
Top side	802.11a	149/5745	90.26%	1.108	0.741	-0.02	13.18	14.00	1.208	0.992	22.3
Back side with Sample2#	802.11a	165/5825	90.26%	1.108	0.945	0.06	13.46	14.00	1.132	**1.186**	22.3
Back side with Sample2#-repeat	802.11a	165/5825	90.26%	1.108	0.938	0.02	13.46	14.00	1.132	1.176	22.3
Back side 25mm	802.11a	165/5825	90.26%	1.108	0.127	0.03	19.36	20.00	1.159	0.163	22.3
Top side 27mm	802.11a	165/5825	90.26%	1.108	0.104	-0.04	19.36	20.00	1.159	0.134	22.3

Table 8： SAR of WIFI 5G.

Note:

1) When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. As the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration;

2) Per KDB248227D01,as the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes are not required.

3) As the 802.11a highest reported SAR is smaller than 1.2 W/kg , and the tune-up of the other 802.11 modes are not higher than 802.11a,therefore the adjusted SAR is ≤ 1.2 W/kg for other 802.11 modes, SAR test for the other 802.11 modes are not required.

Test Position	Channel/ Frequency (MHz)	Measured SAR (1g)	1st Repeated SAR (1g)	Ratio	2nd Repeated SAR (1g)	3rd Repeated SAR (1g)
Back side with Sample2#	116/5580	0.979	0.971	1.008	N/A	N/A
Back side with Sample2#	165/5825	0.945	0.938	1.007	N/A	N/A
Note: 1) When the original highest measured SAR is ≥ 0.80 W/kg, the measurement was repeated once.						
2) A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).						
3) A third repeated measurement was preformed only if the original, first or second repeated measurement was ⩾ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.						
4) Repeated measurements are not required when the original highest measured SAR is < 0.80 W/kg						

6.3.1 SAR Result of BT

Bluetooth SAR Test Record											
Test position	**Test mode**	**Test ch./Freq.**	**Duty Cycle**	**Duty Cycle Scaled factor**	**SAR (W/kg) 1-g**	**Power drift (dB)**	**Conducted Power(dBm)**	**Tune up Limit(dBm)**	**Scaled factor**	**Scaled SAR 1-g (W/kg)**	**Liquid Temp.(℃)**
Body Test Data											
Back side	DH5	39/2441	77.60%	1.289	0.153	0.05	10.24	11.00	1.191	0.235	22.6
Top side	DH5	39/2441	77.60%	1.289	0.152	-0.11	10.24	11.00	1.191	0.233	22.6
Back side with Sample2#	DH5	39/2441	77.60%	1.289	0.158	0.03	10.24	11.00	1.191	**0.243**	22.6

Table 9： SAR of BT

6.4 Multiple Transmitter Evaluation

6.4.1Simultaneous SAR SAR test evaluation

1) Simultaneous Transmission

NO.	Simultaneous Transmission Configuration	Body
1	WIFI 2.4G + BT	No
2	WIFI 5G + WIFI2.4G	No
3	WIFI 5G + BT	Yes

6.4.2 Simultaneous Transmission SAR Summation Scenario

Test position	SARmax (W/kg)			Summed SAR
	WiFi 2.4G Ant1(chain0)	WiFi 5G Ant1(chain0)	BT	
	1	2	3	2+3
Back side	1.167	1.186	0.243	1.429
Top side	0.945	0.999	0.233	1.232

Note:
Select the worst SAR instantaneous transmission for each location

7 Equipment list

Test Platform		SPEAG DASY5 Professional				
Description		SAR Test System (Frequency range 300MHz-6GHz)				
Software Reference		DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)				
Hardware Reference						
Equipment		Manufacturer	Model	Serial Number	Calibration Date	Due date of calibration
☒	Twin Phantom	SPEAG	SAM3	1770	NCR	NCR
☒	DAE	SPEAG	DAE4	1740	2022-08-03	2023-08-02
☒	E-Field Probe	SPEAG	EX3DV4	7735	2022-08-09	2023-08-08
☒	Validation Kits	SPEAG	D2450V2	1038	2020-04-08	2023-04-07
☒	Validation Kits	SPEAG	D5GHzV2	1313	2022-01-25	2025-01-24
☒	Dielectric parameter probes	SPEAG	DAKS-3.5	1120	2022-05-30	2023-05-29
☒	Vector Network Analyzer and Vector Reflectometer	SPEAG	DAKS_VNA R140	0050920	2022-05-23	2023-05-22
☒	RF Bi-Directional Coupler	Agilent	86205-60001	MY31400031	NCR	NCR
☒	Signal Generator	R&S	SMB100A	182393	2022-02-14	2023-02-13
☒	Preamplifier	Qiji	YX28980933	202104001	NCR	NCR
☒	Power Sensor	Keysight	U2002H	MY5639004	2022-09-16	2023-09-15
☒	Power Sensor	Keysight	U2002H	MY48200110	2022-12-23	2023-12-22
☒	Attenuator	SHX	TS2-3dB	30704	NCR	NCR
☒	Coaxial low pass filter	Mini-Circuits	VLF-2500(+)	NA	NCR	NCR
☒	Coaxial low pass filter	Microlab Fxr	LA-F13	NA	NCR	NCR
☒	DC POWER SUPPLY	SAKO	SK1730SL5A	NA	NCR	NCR
☒	Speed reading thermometer	LKM	DTM3000	SUW201-30-01	2022-09-19	2023-09-18
☒	Humidity and Temperature Indicator	MingGao	MingGao	NA	2022-09-19	2023-09-18

Note: All the equipments are within the valid period when the tests are performed.

8 Measurement Uncertainty

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

9 Calibration certificate

Please see the Appendix C

10 Photographs

Please see the Appendix D

Appendix A: Detailed System Check Results

Appendix B: Detailed Test Results

Appendix C: Calibration certificate

Appendix D: Photographs

---END---