FCC SAR Test Report

FCC ID: TE7T3UPLUS

Project No.	:	1912C088
Equipment	:	AC1300 High Gain Wireless Dual Band USB Adapter
Brand Name	:	tp-link
Test Model	:	Archer T3U Plus
Series Model	:	N/A
Date of Receipt	:	Dec. 12, 2019
Date of Test	:	Jan. 10, 2020 ~ Jan. 13, 2020
Issued Date	:	Jan. 21, 2020
Report Version	:	R00
Test Sample	:	Engineering Sample No.: DG20200106107
Standard(s)	:	Please refer to page 2.
Applicant	:	TP-Link Technologies Co., Ltd.
Address	:	Building 24(floors1,3,4,5) and 28(floors1-4) Central Science and Technology Park, Shennan Rd, Nanshan, Shenzhen, China
Manufacturer	:	TP-Link Technologies Co., Ltd.
Address	:	Building 24(floors1,3,4,5) and 28(floors1-4) Central Science and Technology Park, Shennan Rd, Nanshan, Shenzhen, China

The above equipment has been tested and found compliance with the requirement of the relative standards by BTL Inc.

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Approved by : Herbort Liu

Certificate #5123.02

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Tel: +86-769-8318-3000
Web: www.newbtl.com

Standard(s)	:	**ANSI Std C95.1:1992** Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.(IEEE Std C95.1-1991) **IEEE Std 1528:2013** Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques **KDB447498 D01** General RF Exposure Guidance v06 **KDB447498 D02** SAR Procedures for Dongle Xmtr v02 **KDB248227 D01** 802. 11 Wi-Fi SAR v02r02 **KDB865664 D01** SAR measurement 100 MHz to 6 GHz v01r04 **KDB865664 D02** SAR Reporting v01r02 **KDB690783 D01** SAR Listings on Grants v01r03

Declaration

BTL represents to the client that testing is done in accordance with standard procedures as applicable and that test instruments used has been calibrated with standards traceable to international standard(s) and/or national standard(s).

BTL's reports apply only to the specific samples tested under conditions. It is manufacture's responsibility to ensure that additional production units of this model are manufactured with the identical electrical and mechanical components. **BTL** shall have no liability for any declarations, inferences or generalizations drawn by the client or others from **BTL** issued reports.

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BTL's laboratory quality assurance procedures are in compliance with the **ISO/IEC 17025** requirements, and accredited by the conformity assessment authorities listed in this test report.

BTL is not responsible for the sampling stage, so the results only apply to the sample as received.

The information, data and test plan are provided by manufacturer which may affect the validity of results, so it is manufacturer's responsibility to ensure that the apparatus meets the essential requirements of applied standards and in all the possible configurations as representative of its intended use.

Limitation

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.
Please note that the measurement uncertainty is provided for informational purpose only and are not use in determining the Pass/Fail results.

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REPORT ISSUED HISTORY

Report Version	Description	Issued Date
R00	Original Issue.	Jan. 21, 2020

1. RF EMISSIONS MEASUREMENT

1.1 TEST FACILITY

The test facilities used to collect the test data in this report is **SAR room** at the location of No.3,Jinshagang 1st Road, ShiXia, Dalang Town,Dong Guan, China.523792

1.2 MEASUREMENT UNCERTAINTY

Note: 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.

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

<table>
<tr><td>Equipment</td><td colspan="5">AC1300 High Gain Wireless Dual Band USB Adapter</td></tr>
<tr><td>Model Name</td><td colspan="5">Archer T3U Plus</td></tr>
<tr><td>Modulation</td><td colspan="5">WiFi(DSSS/OFDM)</td></tr>
<tr><td rowspan="6">Operation Frequency Range(s)</td><td>Band</td><td colspan="4">TX (MHz)</td></tr>
<tr><td>2.4G WIFI</td><td colspan="4">2400~2483.5</td></tr>
<tr><td>5.2G WIFI</td><td colspan="4">5150~5250</td></tr>
<tr><td>5.3G WIFI</td><td colspan="4">5250~5350</td></tr>
<tr><td>5.6G WIFI</td><td colspan="4">5470~5725</td></tr>
<tr><td>5.8G WIFI</td><td colspan="4">5725~5850</td></tr>
<tr><td rowspan="6">Test Channels (low-mid-high)</td><td colspan="5">1-2-6-10-11 (2.4G WIFI 802.11b/g/n HT20)</td></tr>
<tr><td colspan="5">3-4-6-8-9 (2.4G WIFI 802.11n HT40)</td></tr>
<tr><td>Band</td><td>5.2G WIFI</td><td>5.3G WIFI</td><td>5.6G WIFI</td><td>5.8G WIFI</td></tr>
<tr><td>802.11a/n HT20 /ac VHT20</td><td>36-40-44-48</td><td>52-56-60-64</td><td>100-104-108-112-116-132-136-140</td><td>149-153-157-161-165</td></tr>
<tr><td>802.11n HT40/ ac VHT40</td><td>38-46</td><td>54-62</td><td>102-110-118-126-134</td><td>151-159</td></tr>
<tr><td>802.11ac VHT80</td><td>42</td><td>58</td><td>106-122</td><td>155</td></tr>
<tr><td rowspan="3">Antenna Gain</td><td>Band</td><td colspan="2">Ant 1 (dBi)</td><td colspan="2">Ant 2 (dBi)</td></tr>
<tr><td>2.4G WIFI</td><td colspan="2">1.25</td><td colspan="2">2.00</td></tr>
<tr><td>5G WIFI</td><td colspan="2">1.74</td><td colspan="2">3.46</td></tr>
</table>

2.2 STATEMENT OF COMPLIANCE

Mode	Highest Reported Body SAR-1g (W/kg)
2.4G WLAN	1.19
5.2G WLAN	/
5.3G WLAN	0.81
5.6G WLAN	1.18
5.8G WLAN	1.17
Note: The highest reported SAR for body is 1.19W/kg.	

Note: The device is in compliance with Specific Absorption Rate(SAR) for general population uncontrolled exposure limits according to the FCC rule §2.1093, the ANSI C95.1:1992/IEEE C95.1:1991, the NCRP Report Number 86 for uncontrolled environment, and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 .

2.3 LABORATORY ENVIRONMENT

Temperature	Min. = 18ºC, Max. = 25ºC
Relative humidity	Min. = 30%, Max. = 70%
Ground system resistance	< 0.5Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

2.4 MAIN TEST INSTRUMENTS

Item	Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Interval
1	Data Acquisition Electronics	Speag	DAE4	1390	May 25, 2019	1 Year
2	E-field Probe	Speag	EX3DV4	7544	Sep. 09, 2019	1 Year
3	System Validation Dipole	Speag	D2450V2	919	Jun. 11, 2018	3 Years
4	System Validation Dipole	Speag	D5GHzV2	1160	Jun. 20, 2018	3 Years
5	ELI4 Phantom	Speag	ELI4 Phantom V5.0	1222	N/A	N/A
6	Power Amplifier	Mini-Circuits	ZHL-42W+	QA1333003	Feb. 25, 2019	1 Year
7	Power Amplifier	Mini-Circuits	ZVE-8G+	520701341	Feb. 25, 2019	1 Year
8	DC Source	Iteck	OT6154	M00157	Aug. 03, 2019	1 Year
9	ENA Network Analyzer	Agilent	E5071C	MY46102965	Mar. 10, 2019	1 Year
10	MXG Analog Signal Generator	Agilent	N5181A	MY49060710	Aug. 03, 2019	1 Year
11	Signal Generator	Agilent	E4438C	MY4907131	Mar. 10, 2019	1 Year
12	P-series Power Meter	Agilent	N1911A	MY45100473	Sep. 23, 2019	1 Year
13	Wideband Power Sensor	Agilent	N1921A	MY51100041	Sep. 23, 2019	1 Year
14	Smart Power Sensor	R&S	NRP-Z21	102209	Mar. 01, 2019	1 Year
15	Dielectric Assessment Kit	Speag	DAK-3.5	1226	N/A	N/A
16	Dual directional coupler	Woken	TS-PCC0M-05	107090019	Mar. 10, 2019	1 Year
17	Coupler	Woken	0110A05601O-10	COM5BNW1A2	Mar. 10, 2019	1 Year
18	Digital Themometer	LKM	DTM3000	3519	Jul. 08, 2019	1 Year

Note:
1. “N/A” denotes no model name, serial No. or calibration specified.
2.
1) Per KDB865664 D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. 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) The most recent return-loss result , measured at least annually, deviates by no more than 20% from the previous measurement;
d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.
2) Network analyzer probe calibration against air, distilled water and a short block performed before measuring liquid parameters.

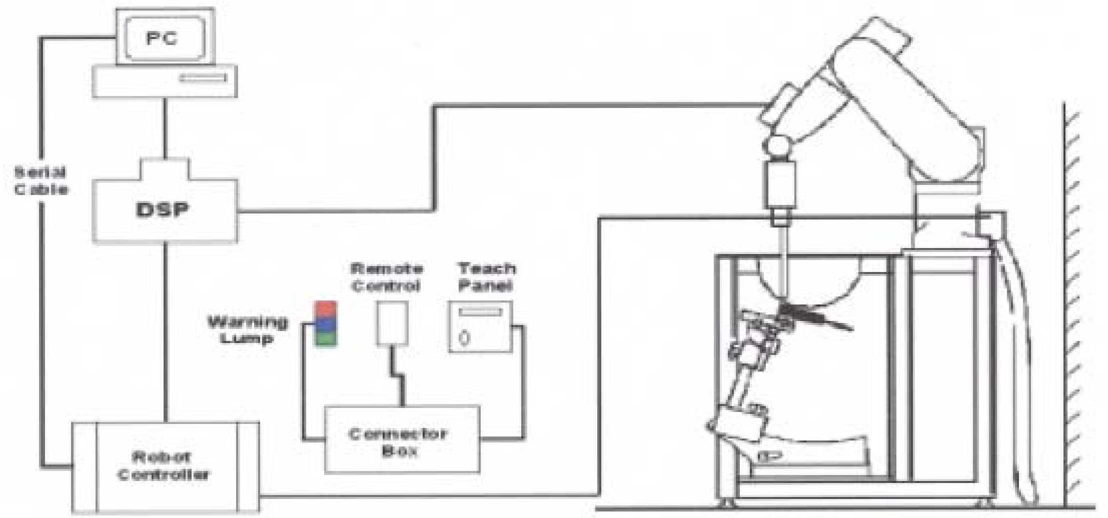
3. SAR MEASUREMENTS SYSTEM CONFIGURATION

3.1 SAR MEASUREMENT SET-UP

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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. 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.
3. A data acquisition electronic (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.
4. A unit to operate the optical surface detector which is connected to the EOC.
5. The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
6. TheDASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows.
7. DASY5 software and SEMCAD data evaluation software.
8. Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling the testing of left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. System validation dipoles allowing to validate the proper functioning of the system.

3.1.1 TEST SETUP LAYOUT



3.2 DASY5 E-FIELD PROBE SYSTEM

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetrice valuation.

3.2.1 EX3DV4 PROBE SPECIFICATION

Construction	Symmetrical design with triangular core Interleaved sensors 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 HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 µW/g to > 100 mW/g Linearity:± 0.2dB
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1.0 mm

EX3DV4 E-field Probe

3.2.2 E-FIELD PROBE CALIBRATION

Eachprobeiscalibratedaccordingtoadosimetricassessmentprocedurewithaccuracybetterthan±10%.The spherical isotropy was evaluatedandfoundtobebetterthan±0.25dB.The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$\mathbf{SAR} = \mathbf{C}\frac{\Delta T}{\Delta t}$$

Where: Δt=Exposure time(30 seconds),

C =Heat capacity of tissue (brain or muscle),

ΔT=Temperature increase due to RF exposure.

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

Where: σ=Simulated tissue conductivity,

ρ=Tissue density (kg/m3).

3.2.3 OTHER TEST EQUIPMENT

3.2.3.1 Device Holder for Transmitters

Construction: Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices (e.g., laptops, cameras, etc.) It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin SAM, ELI4 and SAM v6.0 Phantoms.
Material: POM, Acrylic glass, Foam

3.2.3.2 Phantom

Model	ELI4 Phantom	
Construction	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.	
Shell Thickness	2±0.1 mm	
Filling Volume	Approx. 30 liters	
Dimensions	Length: 600 mm ; Width: 190mm Height: adjustable feet	
Available	Special	

3.2.4 SCANNING PROCEDURE

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

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. The indicated drift is mainly the variation of the DUT’s output power and should vary max. ± 5 %.

The “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ± 0.1mm). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within ± 30°.)

- Area Scan

The “area scan” measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The standard scan uses large grid spacing for faster measurement. Standard grid spacing for head measurements is 15 mm in x- and y- dimension (≤2GHz), 12 mm inx- and y- dimension (2-4 GHz) and 10mm in x- and y- dimension (4-6GHz). If a finer resolution is needed, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation.

- Zoom Scan

A “zoom scan” measures the field in a volume around the 2D peak SAR value acquired in the previous “coarse” scan. This is a fine grid with maximum scan spatial resolution: Δx_{zoom}, Δy_{zoom}≤2GHz -≤8mm, 2-4GHz -≤5 mm and 4-6 GHz-≤4mm; Δz_{zoom}≤3GHz -≤5 mm, 3-4 GHz-≤4mm and 4-6GHz-≤2mm where the robot additionally moves the probe along the z-axis away from the bottom of the Phantom. DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in Appendix B. Test results relevant for the specified standard (see chapter 1.4.) are shown in table form in chapter 7.2.

A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 2 mm steps. This measurement shows the continuity of the liquid and can - depending in the field strength – also show the liquid depth.

The following table summarizes the area scan and zoom scan resolutions per FCC KDB 865664D01:

Frequency	Maximun Area Scan resolution (Δx_{area}, Δy_{area})	Maximun Zoom Scan spatial resolution (Δx_{Zoom}, Δy_{Zoom})	Maximun Zoom Scan spatial resolution			Minimum zoom scan volume (x,y,z)
			Uniform Grid	Graded Grad		
			$\Delta z_{Zoom}(n)$	$\Delta z_{Zoom}(1)$*	$\Delta z_{Zoom}(n>1)$*	
≤2GHz	≤15mm	≤8mm	≤5mm	≤4mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥30mm
2-3GHz	≤12mm	≤5mm	≤5mm	≤4mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥30mm
3-4GHz	≤12mm	≤5mm	≤4mm	≤3mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥28mm
4-5GHz	≤10mm	≤4mm	≤3mm	≤2.5mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥25mm
5-6GHz	≤10mm	≤4mm	≤2mm	≤2mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥22mm

3.2.5 DATA STORAGE AND EVALUATION

3.2.5.1 Data Storage

The DASY5 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], [mW/g], [mW/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.

3.2.6 SPATIAL PEAK SAR EVALUATION

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of 5 x 5 x 7 points (with 8mm horizontal resolution) or 7 x 7 x 7 points (with 5mm horizontal resolution) or 8 x 8 x 7 points (with 4mm horizontal resolution). The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting “Graph Evaluated”.
- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.
- All neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

Extrapolation

The extrapolation is based on a least square algorithm [W. Gander, Computer mathematic, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

Interpolation

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computer mathematic, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

Volume Averaging

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

Advanced Extrapolation

DASY5 uses the advanced extrapolation option which is able to compensate boundary effects on E-field probes.

3.2.7 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, a_{i0}, a_{i1}, a_{i2}
	Conversion factor	$ConvF_i$
	Diode compression point	Dcp_i
Device parameters:	Frequency	f
	Crest factor	cf
Media parameters:	Conductivity	
	Density	

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 DASY5 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	V_i = compensated signal of channel i	(i = x, y, z)
	U_i = 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 V_i = compensated signal of channel i (i = x, y, z)

$Norm_i$ = 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]

E_i = electric field strength of channel i in V/m

H_i = 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.

$$SAR = (E_{tot})^2 \cdot \sigma / (\rho \cdot 1000)$$

With SAR = local specific absorption rate in mW/g

E_{tot} = total field strength in V/m
= conductivity in [mho/m] or [Siemens/m]
= equivalent tissue density in g/cm^3

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.

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

With P_{pwe} = equivalent power density of a plane wave in mW/cm^2

E_{tot} = total field strength in V/m

H_{tot} = total magnetic field strength in A/m

4. SYSTEM VERIFICATION PROCEDURE

4.1 TISSUE VERIFICATION

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectic parameter are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within ± 5% of the target values.
The following materials are used for producing the tissue-equivalent materials.

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
Head 2450	-	45.0	-	0.1	-	-	54.9	-
Head 5G	-	-	-	-	-	17.2	65.5	17.3

Salt: 99+% Pure Sodium Chloride; Sugar: 98+% Pure Sucrose; Water: De-ionized, 16M + resistivity
HEC: Hydroxyethyl Cellulose; DGBE: 99+% Di(ethylene glycol) butyl ether,[2-(2-butoxyethoxy)ethanol]
Triton X-100(ultra pure): Polyethylene glycol mono [4-(1,1,3,3-tetramethylbutyl)phenyl]ether

Tissue Verification									
Tissue Type	Frequency (MHz)	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (εr)	Targeted Conductivity (σ)	Targeted Permittivity (εr)	Deviation Conductivity (σ) (%)	Deviation Permittivity (εr) (%)	Date
Head	2450	22.4	1.874	38.297	1.80	39.2	4.11	-2.30	Jan. 13, 2020
Head	5300	22.5	4.816	35.929	4.76	35.9	1.18	0.08	Jan. 10, 2020
Head	5500	22.3	5.037	35.468	4.96	35.6	1.55	-0.37	Jan. 11, 2020
Head	5600	22.3	5.158	35.253	5.07	35.5	1.74	-0.70	Jan. 11, 2020
Head	5800	22.5	5.412	34.814	5.27	35.3	2.69	-1.38	Jan. 12, 2020

Note:
1)The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.
2)KDB 865664 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.
3)The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.

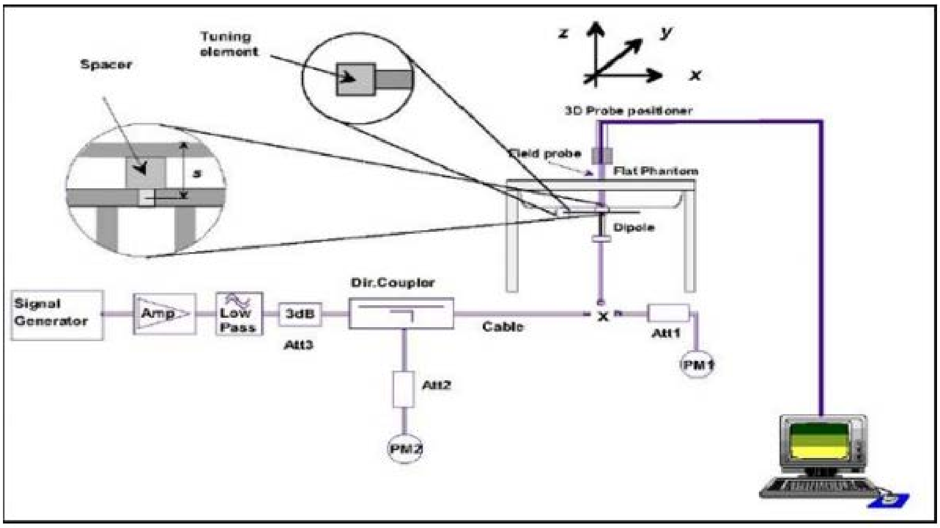
4.2 SYSTEM CHECK

The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEE Std 1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests.

System Check	Date	Frequency (MHz)	Targeted SAR (W/kg) 1g	Measured SAR (W/kg) 1g	normalized SAR (W/kg) 1g	Deviation (%)	Dipole S/N
Head	Jan. 13, 2020	2450	52.10	12.60	50.40	-3.26	919
Head	Jan. 10, 2020	5300	76.80	7.48	74.80	-2.60	1160
Head	Jan. 11, 2020	5500	80.80	7.84	78.40	-2.97	1160
Head	Jan. 11, 2020	5600	78.60	7.93	79.30	0.89	1160
Head	Jan. 12, 2020	5800	77.90	7.70	77.00	-1.16	1160

4.3 SYSTEM CHECK PROCEDURE

The system check is performed by using a system check dipole which is positioned parallel to the planar part of the SAM phantom at the reference point. The distance of the dipole to the SAM phantom is determined by a plexiglass spacer. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 250mW (below 3GHz) or 100mW (3-6GHz). To adjust this power a power meter is used.
The power sensor is connected to the cable before the system check to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the system check to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test. System check results have to be equal or near the values determined during dipole calibration (target SAR in table above) with the relevant liquids and test system (±10 %).



5. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

5.1 SAR MEASUREMENT VARIABILITY

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

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

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

The detailed repeated measurement results are shown in Section 7.2.

6. OPERATIONAL CONDITIONS DURING TEST

6.1 TEST POSITION

Test all USB orientations [see figure below: (A) Horizontal-Up, (B) Horizontal-Down, (C) Vertical-Front, and (D) Vertical-Back and Tip with a device-to-phantom separation distance of 5 mm. The rotation mode of the antenna is the same as that of the original report with FCC ID is "TE7T4UHV2", so the test mode refers to the original report.

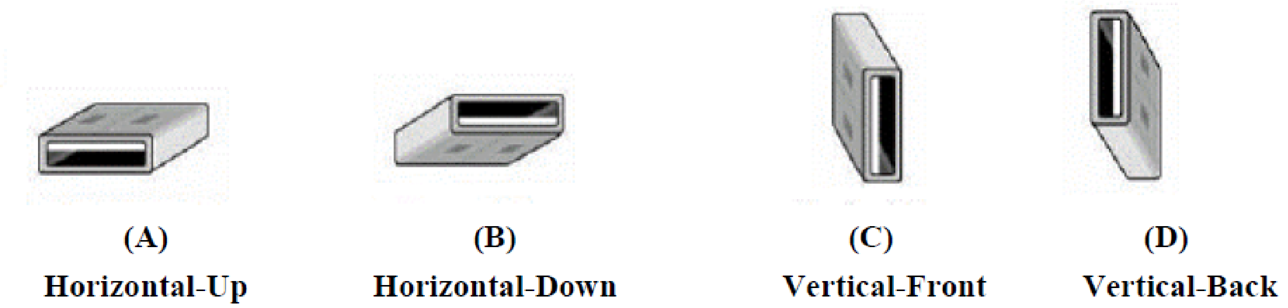


Fig 6.1 USB Connector Orientations Implemented on Laptop Computers

6.2 TEST CONFIGURATION

6.2.1 WIFI TEST CONFIGURATION

EUT has two antennas: Ant 1 and Ant 2. Ant 2 does not support SISO transmission.

For WLAN SAR testing, WLAN engineering testing software installed on the DUT can provide continuous transmitting RF signal.

2.4G

Mode	802.11b	802.11g	802.11n HT20	802.11n HT40
Duty cycle	100%			
Crest factor	1			

5G

Mode	802.11a	802.11n HT20	802.11n HT40	802.11ac VHT20	802.11ac VHT40	802.11ac VHT80
Duty cycle	100%					
Crest factor	1					

For WiFi SAR testing, a communication link is set up with the test mode software for WiFi mode test. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. The RF signal utilized in SAR measurement has 100% duty cycle and its crest factor is 1. The test procedures in KDB 248227 D01 are applied.

6.2.1.1 WLAN 2.4G SAR Test Requirements

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 ≤ 0.8W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
2) When the reported SAR is > 0.8W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2W/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. 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 ≤ 1.2W/kg.

SAR Test Requirements for OFDM configurations

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, each stand alone.
And frequency aggregated band is considered separately for SAR test reduction. 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.

6.2.1.2 WLAN 5G SAR Test Requirements

✧ **U-NII-1 and U-NII-2A Band**

For devices that operate in both U-NII-1 and U-NII-2A bands, 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 ≤ 1.2W/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. 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 ≤ 1.2W/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.

✧ **U-NII-2C, U-NII-3 Bands**

The frequency range covered by these bands is 380MHz (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, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification.
Unless band gap channels are permanently disabled, they must be considered for SAR testing.
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.11 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.

6.2.1.3 OFDM transmission mode and SAR test channel selection

For the 2.4GHz and 5GHz bands, when the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations (for example 802.11a, 802.11n and 802.11ac, or 802.11g and 802.11n, with the same channel bandwidth, modulation, and data rate, etc.), the lower order 802.11 mode (i.e.802.11a then 802.11n and 802.11ac, or 802.11g then 802.11n) is used for SAR measurement. When the maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

6.2.1.4 Initial test configuration procedure

For OFDM, in both 2.4GHz and 5GHz bands, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, and lowest data rate. If the average RF output powers of the highest identical transmission modes are within 0.25 dB of each other, mid channel of the transmission mode with highest average RF output powers is the initial test channel. Otherwise, the channel of the transmission mode with the highest average RF output power will be the initial test configuration.
When the reported SAR is ≤ 0.8W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤ 1.2W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurement.

7. TEST RESULT

7.1 CONDUCTED POWER RESULTS

7.1.1 CONDUCTED POWER MEASUREMENTS OF WIFI

1. Conducted power measurements of 2.4G WiFi

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
2.4G WIFI_1TX_ ANT 1	802.11b	1	2412	1	16.00	**15.87**
		2	2417		16.00	**15.71**
		6	2437		16.00	15.64
		10	2457		16.00	15.47
		11	2462		16.00	**15.79**
	802.11g	1	2412	6	16.00	15.72
		2	2417		16.00	15.70
		6	2437		16.00	15.68
		10	2457		16.00	15.82
		11	2462		16.00	15.75

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	ANT 1 Average Power(dBm)	ANT 2 Average Power(dBm)	Max. Tune up	Total Average Power(dBm)
2.4G WIFI_2TX_ ANT 1+2	802.11n HT20	1	2412	MCS8	13.72	13.81	17	16.78
		2	2417		13.67	13.75	17	16.72
		6	2437		13.76	13.72	17	16.75
		10	2457		13.71	13.83	17	16.78
		11	2462		13.69	13.67	17	16.69
	802.11n HT40	3	2422	MCS8	13.77	13.93	17	**16.86**
		4	2427		13.73	13.86	17	16.81
		6	2437		13.88	13.75	17	**16.83**
		8	2447		13.82	13.80	17	16.82
		9	2452		13.79	13.77	17	**16.79**

Note:
1) The Average conducted power of WiFi is measured with RMS detector.
2) Adj SAR = 802.11b 1g Reported SAR x (802.11g Pmax / 802.11b Pmax) = 1.186W/kg x (39.81mW / 39.81mW) = 1.186W/kg < 1.2W/kg, so SAR for OFDM modes (2.4GHz 802.11g) was not required.
3) The tested channel results are marks in bold.

2. Conducted power measurements of 5.2G WiFi

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
5.2G WIFI_1TX_ ANT 1	802.11a	36	5180	6	14.00	13.83
		40	5200		14.00	13.86
		44	5220		14.00	13.94
		48	5240		14.00	13.80

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	ANT 1 Average Power(dBm)	ANT 2 Average Power(dBm)	Max. Tune up	Total Average Power(dBm)
5.2G WIFI_2TX_ ANT 1+2	802.11n HT20	36	5180	MCS8	12.85	12.87	16.00	15.87
		40	5200		12.77	12.74	16.00	15.77
		44	5220		12.83	12.84	16.00	15.85
		48	5240		12.65	12.82	16.00	15.75
	802.11n HT40	38	5190	MCS8	12.88	12.87	16.00	15.89
		46	5230		12.74	12.82	16.00	15.79
	802.11ac VHT20	36	5180	VHT2SS _MCS0	12.83	12.84	16.00	15.85
		40	5200		12.87	12.78	16.00	15.84
		44	5220		12.81	12.76	16.00	15.80
		48	5240		12.78	12.82	16.00	15.81
	802.11ac VHT40	38	5190	VHT2SS _MCS0	12.81	12.79	16.00	15.81
		46	5230		12.76	12.83	16.00	15.81
	802.11ac VHT80	42	5210	VHT2SS _MCS0	12.85	12.78	16.00	15.83

Note:
1) The Average conducted power of 5.2G WiFi is measured with RMS detector.

3. Conducted power measurements of 5.3G WiFi

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
5.3G WIFI_1TX_ ANT 1	802.11a	52	5260	6	14.00	**13.74**
		56	5280		14.00	**13.78**
		60	5300		14.00	13.69
		64	5320		14.00	**13.81**

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	ANT 1 Average Power(dBm)	ANT 2 Average Power(dBm)	Max. Tune up	Total Average Power(dBm)
5.3G WIFI_2TX_ ANT 1+2	802.11n HT20	52	5260	MCS8	12.85	12.75	16.00	15.81
		56	5280		12.69	12.82	16.00	15.77
		60	5300		12.74	12.79	16.00	15.78
		64	5320		12.82	12.81	16.00	15.83
	802.11n HT40	54	5270	MCS8	12.65	12.85	16.00	15.76
		62	5310		12.79	12.77	16.00	15.79
	802.11ac VHT20	52	5260	VHT2SS _MCS0	12.74	12.82	16.00	15.79
		56	5280		12.85	12.75	16.00	15.81
		60	5300		12.82	12.68	16.00	15.76
		64	5320		12.78	12.79	16.00	15.80
	802.11ac VHT40	54	5270	VHT2SS _MCS0	12.87	12.74	16.00	15.82
		62	5310		12.85	12.72	16.00	15.80
	802.11ac VHT80	58	5290	VHT2SS _MCS0	12.72	12.87	16.00	**15.81**

Note:
1) The Average conducted power of 5.3G WiFi is measured with RMS detector.
2) The tested channel results are marks in bold.

4. Conducted power measurements of 5.6G WiFi

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
5.6G WIFI_1TX_ ANT 1	**802.11a**	100	5500	6	14.00	**13.75**
		104	5520		14.00	13.83
		108	5540		14.00	13.76
		112	5560		14.00	**13.84**
		116	5580		14.00	13.73
		132	5660		14.00	13.78
		136	5680		14.00	13.81
		140	5700		14.00	**13.75**

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	ANT 1 Average Power(dBm)	ANT 2 Average Power(dBm)	Max. Tune up	Total Average Power(dBm)
5.6G WIFI_2TX_ ANT 1+2	**802.11n HT20**	100	5500	MCS8	12.86	12.74	16.00	15.81
		104	5520		12.79	12.86	16.00	15.84
		108	5540		12.74	12.88	16.00	15.82
		112	5560		12.78	12.82	16.00	15.81
		116	5580		12.82	12.79	16.00	15.82
		132	5660		12.75	12.75	16.00	15.76
		136	5680		12.72	12.79	16.00	15.77
		140	5700		12.69	12.76	16.00	15.74
	802.11n HT40	102	5510	MCS8	12.76	12.79	16.00	15.79
		110	5550		12.84	12.82	16.00	15.84
		118	5590		12.82	12.76	16.00	15.80
		126	5630		12.85	12.69	16.00	15.78
		134	5670		12.87	12.73	16.00	15.81

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	ANT 1 Average Power(dBm)	ANT 2 Average Power(dBm)	Max. Tune up	Total Average Power(dBm)
5.6G WIFI_2TX_ ANT 1+2	802.11ac VHT20	100	5500	VHT2SS _MCS0	12.81	12.74	16.00	15.79
		104	5520		12.78	12.82	16.00	15.81
		108	5540		12.69	12.79	16.00	15.75
		112	5560		12.84	12.73	16.00	15.80
		116	5580		12.89	12.76	16.00	15.84
		132	5660		12.77	12.84	16.00	15.82
		136	5680		12.85	12.75	16.00	15.81
		140	5700		12.79	12.72	16.00	15.77
	802.11ac VHT40	102	5510	VHT2SS _MCS0	12.86	12.73	16.00	15.81
		110	5550		12.74	12.82	16.00	15.79
		118	5590		12.73	12.87	16.00	15.81
		126	5630		12.79	12.89	16.00	15.85
		134	5670		12.73	12.75	16.00	15.75
	802.11ac VHT80	106	5530	VHT2SS _MCS0	12.90	12.81	16.00	**15.87**
		122	5610		12.89	12.75	16.00	**15.83**

Note:
1) The Average conducted power of 5.6G WiFi is measured with RMS detector.
2) The tested channel results are marks in bold.

5. Conducted power measurements of 5.8G WiFi

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
5.8G WIFI_1TX_ ANT 1	802.11a	149	5745	6	14.00	**13.72**
		153	5765		14.00	13.83
		157	5785		14.00	13.75
		161	5805		14.00	**13.87**
		165	5825		14.00	**13.84**

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	ANT 1 Average Power(dBm)	ANT 2 Average Power(dBm)	Max. Tune up	Total Average Power(dBm)
5.8G WIFI_2TX_ ANT 1+2	802.11n HT20	149	5745	MCS8	12.87	12.82	16.00	15.86
		153	5765		12.81	12.79	16.00	15.81
		157	5785		12.77	12.83	16.00	15.81
		161	5805		12.68	12.67	16.00	15.69
		165	5825		12.82	12.78	16.00	15.81
	802.11n HT40	151	5755	MCS8	12.78	12.84	16.00	15.82
		159	5795		12.82	12.75	16.00	15.80
	802.11ac VHT20	149	5745	VHT2SS _MCS0	12.75	12.83	16.00	15.80
		153	5765		12.80	12.67	16.00	15.75
		157	5785		12.78	12.69	16.00	15.75
		161	5805		12.81	12.75	16.00	15.79
		165	5825		12.75	12.82	16.00	15.80
	802.11ac VHT40	151	5755	VHT2SS _MCS0	12.83	12.76	16.00	15.81
		159	5795		12.76	12.82	16.00	15.80
	802.11ac VHT80	155	5775	VHT2SS _MCS0	12.73	12.82	16.00	**15.79**

Note:
1) The Average conducted power of 5.8G WiFi is measured with RMS detector.
2) The tested channel results are marks in bold.

7.2 SAR TEST RESULTS

General Notes:

1) Per KDB447498 D01, all measurement SAR results are scaled to the maximum tune-up tolerance limit to demonstrate compliant.
2) Per KDB447498 D01, 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: ≤ 0.8W/kg or 2.0W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100MHz. When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.
3) Per KDB865664 D01,for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥ 0.8W/kg; if the deviation among the repeated measurement is ≤ 20%,and the measured SAR < 1.45W/kg, only one repeated measurement is required.
4) Per KDB941225 D06, the DUT Dimension is bigger than 9cm x 5cm, so 10mm is chosen as the test separation distance for Hotspot mode. When the antenna-to-edge distance is greater than 2.5cm, such position does not need to be tested.
5) Per KDB648474 D04, SAR is evaluated without a headset connected to the device. When the standalone reported body-worn SAR is ≤ 1.2W/kg, no additional SAR evaluations using a headset are required.
6) Per KDB865664 D02, SAR plot is only required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; Plots are also required when the measured SAR is > 1.5W/kg, or > 7.0W/kg for occupational exposure. The published RF exposure KDB procedures may require additional plots; for example, to support SAR to peak location separation ratio test exclusion and/or volume scan post-processing.

WLAN Notes:

1. For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When the reported SAR of the initial test position is ≤ 0.4W/kg, further SAR measurement is not required for the other (remaining) test positions. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8W/kg or all test positions are measured.
2. Justification for test configurations for WLAN per KDB Publication 248227 for 2.4GHz WIFI single transmission chain operations, the highest measured maximum output power Channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4GHz 802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR. See Section 6.2.1 for more information.
3. Justification for test configurations for WLAN per KDB Publication 248227 for 5GHz WIFI single transmission chain operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed power. Other transmission modes were not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than1.2W/kg. See Section 6.2.1 for more information.

7.2.1 SAR MEASUREMENT RESULT

1. SAR Measurement Result of 2.4G WiFi

Test No.	Band	Channel	Test Position	Separation Distance (cm)	ANT	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR (W/kg)
T01	802.11b	1	Horizontal Down-0°-1	0.5	1	1	16	15.87	0.02	1.050	0.480	1.082
T02	802.11b	1	Horizontal Down-90°-2	0.5	1	1	16	15.87	-0.01	0.910	0.445	0.938
T03	802.11b	1	Horizontal Down-90°-3	0.5	1	1	16	15.87	0.07	0.973	0.431	1.003
T04	802.11b	1	Horizontal Up-0°-1	0.5	1	1	16	15.87	-0.13	0.604	0.313	0.622
T05	802.11b	1	Horizontal Up-90°-2	0.5	1	1	16	15.87	0.11	0.546	0.255	0.563
T06	802.11b	1	Horizontal Up-90°-3	0.5	1	1	16	15.87	0.02	0.809	0.409	0.834
T07	802.11b	1	Vertical Back-0°-2	0.5	1	1	16	15.87	0.08	0.343	0.167	0.353
T08	802.11b	1	Vertical Back-0°-3	0.5	1	1	16	15.87	0.06	0.735	0.368	0.757
T09	802.11b	1	Vertical Back-90°-1	0.5	1	1	16	15.87	-0.02	0.445	0.216	0.459
T10	802.11b	1	Vertical Front-0°-2	0.5	1	1	16	15.87	0.04	0.931	0.438	0.959
T11	802.11b	1	Vertical Front-0°-3	0.5	1	1	16	15.87	0.09	0.524	0.265	0.540
T12	802.11b	1	Vertical Front-90°-1	0.5	1	1	16	15.87	0	0.575	0.274	0.592
T13	802.11b	1	Tip Side-90°-1	0.5	1	1	16	15.87	0.02	0.562	0.258	0.579
T14	802.11b	1	Tip Side-90°-2	0.5	1	1	16	15.87	-0.05	0.228	0.122	0.235
T15	802.11b	1	Tip Side-90°-3	0.5	1	1	16	15.87	0.02	0.448	0.225	0.462
T16	802.11b	2	Horizontal Down-0°-1	0.5	1	1	16	15.71	0.01	1.080	0.491	1.155
T17	802.11b	11	Horizontal Down-0°-1	0.5	1	1	16	15.79	0.09	**1.130**	**0.508**	**1.186**
T18	802.11b	11	Horizontal Down-0°-1 (Repeated)	0.5	1	1	16	15.79	0.07	1.110	0.497	1.165
T19	802.11n40	3	Horizontal Down-0°-1	0.5	1+2	MCS8	17	16.86	0.06	**0.515**	**0.212**	**0.532**
T20	802.11n40	3	Horizontal Down-90°-2	0.5	1+2	MCS8	17	16.86	-0.02	0.301	0.136	0.311
T21	802.11n40	3	Horizontal Down-90°-3	0.5	1+2	MCS8	17	16.86	0.05	0.389	0.184	0.402
T22	802.11n40	3	Horizontal Up-0°-1	0.5	1+2	MCS8	17	16.86	0.01	0.167	0.086	0.172
T23	802.11n40	3	Horizontal Up-90°-2	0.5	1+2	MCS8	17	16.86	0.03	0.425	0.191	0.439
T24	802.11n40	3	Horizontal Up-90°-3	0.5	1+2	MCS8	17	16.86	-0.12	0.312	0.144	0.322
T25	802.11n40	3	Vertical Back-0°-2	0.5	1+2	MCS8	17	16.86	0.01	0.164	0.084	0.169
T26	802.11n40	3	Vertical Back-0°-3	0.5	1+2	MCS8	17	16.86	0.03	0.502	0.208	0.518
T27	802.11n40	3	Vertical Back-90°-1	0.5	1+2	MCS8	17	16.86	-0.01	0.312	0.145	0.322
T28	802.11n40	3	Vertical Front-0°-2	0.5	1+2	MCS8	17	16.86	0.15	0.489	0.203	0.505
T29	802.11n40	3	Vertical Front-0°-3	0.5	1+2	MCS8	17	16.86	0	0.174	0.090	0.180
T30	802.11n40	3	Vertical Front-90°-1	0.5	1+2	MCS8	17	16.86	0.09	0.488	0.216	0.504
T31	802.11n40	3	Tip Side-90°-1	0.5	1+2	MCS8	17	16.86	-0.07	0.159	0.081	0.164
T32	802.11n40	3	Tip Side-90°-2	0.5	1+2	MCS8	17	16.86	0.05	0.157	0.079	0.162
T33	802.11n40	3	Tip Side-90°-3	0.5	1+2	MCS8	17	16.86	0.04	0.178	0.089	0.184
T34	802.11n40	6	Horizontal Down-0°-1	0.5	1+2	MCS8	17	16.83	0.03	0.386	0.159	0.402
T35	802.11n40	9	Horizontal Down-0°-1	0.5	1+2	MCS8	17	16.79	0.01	0.362	0.161	0.380

Note: The value with boldface is the maximum SAR Value of each test band.

2. SAR Measurement Result of 5G WiFi

Test No.	Band	Channel	Test Position	Separation Distance (cm)	ANT	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR (W/kg)
T37	802.11a	64	Horizontal Down-0°-1	0.5	1	6	14	13.81	0.05	0.551	0.161	0.576
T38	802.11a	64	Horizontal Down-90°-2	0.5	1	6	14	13.81	-0.02	0.346	0.108	0.361
T39	802.11a	64	Horizontal Down-90°-3	0.5	1	6	14	13.81	0.01	0.428	0.128	0.447
T40	802.11a	64	Horizontal Up-0°-1	0.5	1	6	14	13.81	0.11	0.197	0.060	0.206
T41	802.11a	64	Horizontal Up-90°-2	0.5	1	6	14	13.81	0.07	0.446	0.138	0.466
T42	802.11a	64	Horizontal Up-90°-3	0.5	1	6	14	13.81	-0.02	0.345	0.106	0.360
T43	802.11a	64	Vertical Back-0°-2	0.5	1	6	14	13.81	0.13	0.210	0.068	0.219
T44	802.11a	64	Vertical Back-0°-3	0.5	1	6	14	13.81	0.07	0.739	0.194	0.772
T45	802.11a	64	Vertical Back-90°-1	0.5	1	6	14	13.81	0.05	0.439	0.135	0.459
T46	802.11a	64	Vertical Front-0°-2	0.5	1	6	14	13.81	0.09	0.609	0.173	0.636
T47	802.11a	64	Vertical Front-0°-3	0.5	1	6	14	13.81	-0.01	0.310	0.099	0.324
T48	802.11a	64	Vertical Front-90°-1	0.5	1	6	14	13.81	0.02	0.503	0.152	0.525
T49	802.11a	64	Tip Side-90°-1	0.5	1	6	14	13.81	-0.12	0.248	0.082	0.259
T50	802.11a	64	Tip Side-90°-2	0.5	1	6	14	13.81	0.06	0.295	0.088	0.308
T51	802.11a	64	Tip Side-90°-3	0.5	1	6	14	13.81	0.01	0.175	0.057	0.183
T52	802.11a	52	Vertical Back-0°-3	0.5	1	6	14	13.74	0.02	**0.759**	**0.213**	**0.806**
T53	802.11a	56	Vertical Back-0°-3	0.5	1	6	14	13.78	0.02	0.724	0.200	0.762
T55	802.11a	112	Horizontal Down-0°-1	0.5	1	6	14	13.84	0.2	0.722	0.203	0.749
T56	802.11a	112	Horizontal Down-90°-2	0.5	1	6	14	13.84	0.06	0.501	0.152	0.520
T57	802.11a	112	Horizontal Down-90°-3	0.5	1	6	14	13.84	-0.05	0.514	0.150	0.533
T58	802.11a	112	Horizontal Up-0°-1	0.5	1	6	14	13.84	0.02	0.401	0.116	0.416
T59	802.11a	112	Horizontal Up-90°-2	0.5	1	6	14	13.84	0.1	0.597	0.165	0.619
T60	802.11a	112	Horizontal Up-90°-3	0.5	1	6	14	13.84	0.07	0.578	0.166	0.600
T61	802.11a	112	Vertical Back-0°-2	0.5	1	6	14	13.84	-0.01	0.317	0.100	0.329
T62	802.11a	112	Vertical Back-0°-3	0.5	1	6	14	13.84	0.09	0.602	0.175	0.625
T63	802.11a	112	Vertical Back-90°-1	0.5	1	6	14	13.84	0.05	0.484	0.155	0.502
T64	802.11a	112	Vertical Front-0°-2	0.5	1	6	14	13.84	-0.16	0.591	0.171	0.613
T65	802.11a	112	Vertical Front-0°-3	0.5	1	6	14	13.84	0.01	0.325	0.101	0.337
T66	802.11a	112	Vertical Front-90°-1	0.5	1	6	14	13.84	0.07	0.546	0.165	0.566
T67	802.11a	112	Tip Side-90°-1	0.5	1	6	14	13.84	0.05	0.345	0.106	0.358
T68	802.11a	112	Tip Side-90°-2	0.5	1	6	14	13.84	-0.02	0.294	0.095	0.305
T69	802.11a	112	Tip Side-90°-3	0.5	1	6	14	13.84	0.01	0.262	0.086	0.272
T70	802.11a	100	Horizontal Down-0°-1	0.5	1	6	14	13.75	0.03	0.625	0.180	0.662
T71	802.11a	140	Horizontal Down-0°-1	0.5	1	6	14	13.75	-0.08	**1.110**	**0.348**	**1.176**
T72	802.11a	140	Horizontal Down-0°-1 (Repeated)	0.5	1	6	14	13.75	0.02	1.090	0.345	1.155

Test No.	Band	Channel	Test Position	Separation Distance (cm)	ANT	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR (W/kg)
T73	802.11a	161	Horizontal Down-0°-1	0.5	1	6	14	13.87	0.09	0.705	0.229	0.726
T74	802.11a	161	Horizontal Down-90°-2	0.5	1	6	14	13.87	0.02	0.371	0.142	0.382
T75	802.11a	161	Horizontal Down-90°-3	0.5	1	6	14	13.87	0.05	0.495	0.176	0.510
T76	802.11a	161	Horizontal Up-0°-1	0.5	1	6	14	13.87	-0.16	0.361	0.125	0.372
T77	802.11a	161	Horizontal Up-90°-2	0.5	1	6	14	13.87	0.01	0.616	0.209	0.635
T78	802.11a	161	Horizontal Up-90°-3	0.5	1	6	14	13.87	0.02	0.618	0.217	0.637
T79	802.11a	161	Vertical Back-0°-2	0.5	1	6	14	13.87	0.05	0.417	0.137	0.430
T80	802.11a	161	Vertical Back-0°-3	0.5	1	6	14	13.87	-0.02	0.804	0.259	0.828
T81	802.11a	161	Vertical Back-90°-1	0.5	1	6	14	13.87	0.09	0.534	0.199	0.550
T82	802.11a	161	Vertical Front-0°-2	0.5	1	6	14	13.87	0.01	0.806	0.265	0.830
T83	802.11a	161	Vertical Front-0°-3	0.5	1	6	14	13.87	-0.11	0.368	0.129	0.379
T84	802.11a	161	Vertical Front-90°-1	0.5	1	6	14	13.87	0.07	0.532	0.185	0.548
T85	802.11a	161	Tip Side-90°-1	0.5	1	6	14	13.87	0.15	0.357	0.130	0.368
T86	802.11a	161	Tip Side-90°-2	0.5	1	6	14	13.87	0.01	0.354	0.128	0.365
T87	802.11a	161	Tip Side-90°-3	0.5	1	6	14	13.87	-0.02	0.372	0.138	0.383
T88	802.11a	149	Vertical Front-0°-2	0.5	1	6	14	13.72	0.06	**1.100**	**0.340**	**1.173**
T89	802.11a	165	Vertical Front-0°-2	0.5	1	6	14	13.84	0.04	0.685	0.222	0.711
T90	802.11a	149	Vertical Front-0°-2 (Repeated)	0.5	1	6	14	13.72	0.02	1.080	0.334	1.152
T91	802.11ac80	58	Horizontal Down-0°-1	0.5	1+2	MCS8	16	15.81	0.01	0.554	0.153	0.579
T92	802.11ac80	58	Horizontal Down-90°-2	0.5	1+2	MCS8	16	15.81	0.04	0.371	0.114	0.388
T93	802.11ac80	58	Horizontal Down-90°-3	0.5	1+2	MCS8	16	15.81	0.19	0.593	0.177	0.620
T94	802.11ac80	58	Horizontal Up-0°-1	0.5	1+2	MCS8	16	15.81	0.02	0.225	0.075	0.235
T95	802.11ac80	58	Horizontal Up-90°-2	0.5	1+2	MCS8	16	15.81	-0.01	**0.596**	**0.179**	**0.623**
T96	802.11ac80	58	Horizontal Up-90°-3	0.5	1+2	MCS8	16	15.81	0.09	0.335	0.104	0.350
T97	802.11ac80	58	Vertical Back-0°-2	0.5	1+2	MCS8	16	15.81	-0.05	0.254	0.080	0.266
T98	802.11ac80	58	Vertical Back-0°-3	0.5	1+2	MCS8	16	15.81	0.01	0.492	0.148	0.514
T99	802.11ac80	58	Vertical Back-90°-1	0.5	1+2	MCS8	16	15.81	0.03	0.340	0.112	0.356
T100	802.11ac80	58	Vertical Front-0°-2	0.5	1+2	MCS8	16	15.81	0.12	0.501	0.160	0.524
T101	802.11ac80	58	Vertical Front-0°-3	0.5	1+2	MCS8	16	15.81	-0.05	0.230	0.075	0.241
T102	802.11ac80	58	Vertical Front-90°-1	0.5	1+2	MCS8	16	15.81	0.03	0.545	0.165	0.570
T103	802.11ac80	58	Tip Side-90°-1	0.5	1+2	MCS8	16	15.81	0.02	0.238	0.078	0.249
T104	802.11ac80	58	Tip Side-90°-2	0.5	1+2	MCS8	16	15.81	-0.07	0.241	0.078	0.252
T105	802.11ac80	58	Tip Side-90°-3	0.5	1+2	MCS8	16	15.81	0.01	0.275	0.088	0.288

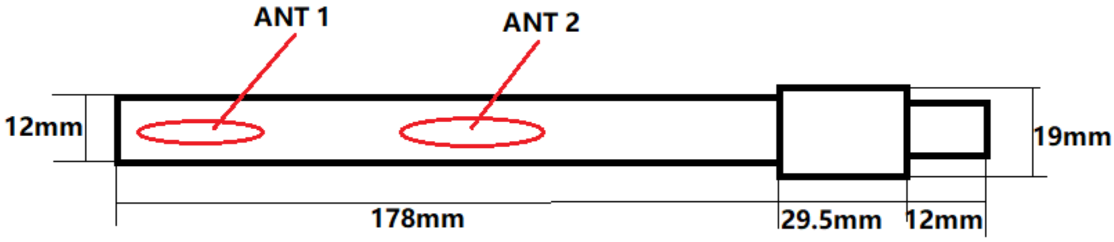
Test No.	Band	Channel	Test Position	Separation Distance (cm)	ANT	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR (W/kg)
T107	802.11ac80	106	Horizontal Down-0°-1	0.5	1+2	MCS8	16	15.87	0.02	**0.694**	**0.209**	**0.716**
T108	802.11ac80	106	Horizontal Down-90°-2	0.5	1+2	MCS8	16	15.87	0.03	0.442	0.131	0.456
T109	802.11ac80	106	Horizontal Down-90°-3	0.5	1+2	MCS8	16	15.87	-0.02	0.536	0.154	0.553
T110	802.11ac80	106	Horizontal Up-0°-1	0.5	1+2	MCS8	16	15.87	0.09	0.337	0.089	0.348
T111	802.11ac80	106	Horizontal Up-90°-2	0.5	1+2	MCS8	16	15.87	-0.05	0.457	0.139	0.471
T112	802.11ac80	106	Horizontal Up-90°-3	0.5	1+2	MCS8	16	15.87	0.13	0.466	0.140	0.481
T113	802.11ac80	106	Vertical Back-0°-2	0.5	1+2	MCS8	16	15.87	0.06	0.387	0.106	0.399
T114	802.11ac80	106	Vertical Back-0°-3	0.5	1+2	MCS8	16	15.87	0.02	0.645	0.189	0.665
T115	802.11ac80	106	Vertical Back-90°-1	0.5	1+2	MCS8	16	15.87	-0.04	0.592	0.166	0.611
T116	802.11ac80	106	Vertical Front-0°-2	0.5	1+2	MCS8	16	15.87	0.06	0.561	0.169	0.579
T117	802.11ac80	106	Vertical Front-0°-3	0.5	1+2	MCS8	16	15.87	0.15	0.351	0.101	0.362
T118	802.11ac80	106	Vertical Front-90°-1	0.5	1+2	MCS8	16	15.87	-0.11	0.618	0.172	0.637
T119	802.11ac80	106	Tip Side-90°-1	0.5	1+2	MCS8	16	15.87	0.08	0.271	0.082	0.280
T120	802.11ac80	106	Tip Side-90°-2	0.5	1+2	MCS8	16	15.87	0.05	0.308	0.091	0.318
T121	802.11ac80	106	Tip Side-90°-3	0.5	1+2	MCS8	16	15.87	-0.01	0.275	0.082	0.284
T122	802.11ac80	122	Horizontal Down-0°-1	0.5	1+2	MCS8	16	15.83	0.03	0.634	0.182	0.659
T124	802.11ac80	155	Horizontal Down-0°-1	0.5	1+2	MCS8	16	15.79	0.09	0.937	0.288	0.984
T125	802.11ac80	155	Horizontal Down-90°-2	0.5	1+2	MCS8	16	15.79	0.01	0.733	0.234	0.770
T126	802.11ac80	155	Horizontal Down-90°-3	0.5	1+2	MCS8	16	15.79	0.05	0.633	0.199	0.665
T127	802.11ac80	155	Horizontal Up-0°-1	0.5	1+2	MCS8	16	15.79	0.02	0.361	0.130	0.379
T128	802.11ac80	155	Horizontal Up-90°-2	0.5	1+2	MCS8	16	15.79	-0.05	0.767	0.237	0.806
T129	802.11ac80	155	Horizontal Up-90°-3	0.5	1+2	MCS8	16	15.79	0.06	0.652	0.210	0.685
T130	802.11ac80	155	Vertical Back-0°-2	0.5	1+2	MCS8	16	15.79	0.14	0.423	0.147	0.445
T131	802.11ac80	155	Vertical Back-0°-3	0.5	1+2	MCS8	16	15.79	0.05	0.924	0.281	0.971
T132	802.11ac80	155	Vertical Back-90°-1	0.5	1+2	MCS8	16	15.79	0.12	0.686	0.232	0.721
T133	802.11ac80	155	Vertical Front-0°-2	0.5	1+2	MCS8	16	15.79	0.1	**0.970**	**0.295**	**1.019**
T134	802.11ac80	155	Vertical Front-0°-3	0.5	1+2	MCS8	16	15.79	0.09	0.448	0.153	0.471
T135	802.11ac80	155	Vertical Front-90°-1	0.5	1+2	MCS8	16	15.79	-0.01	0.810	0.246	0.851
T136	802.11ac80	155	Tip Side-90°-1	0.5	1+2	MCS8	16	15.79	0.07	0.397	0.139	0.417
T137	802.11ac80	155	Tip Side-90°-2	0.5	1+2	MCS8	16	15.79	0.04	0.402	0.141	0.422
T138	802.11ac80	155	Tip Side-90°-3	0.5	1+2	MCS8	16	15.79	-0.02	0.409	0.142	0.430
T139	802.11ac80	155	Vertical Front-0°-2 (Repeated)	0.5	1+2	MCS8	16	15.79	0.1	0.920	0.290	0.967

Note: The value with boldface is the maximum SAR Value of each test band.

7.3 MULTIPLE TRANSMITTER EVALUATION

The following tables list information which is relevant for the decision if a simultaneous transmit evaluation is necessary according to FCC KDB 447498D01 General RF Exposure Guidance v06.

The location of the antennas inside the EUT is shown as below picture:



Simultaneous SAR

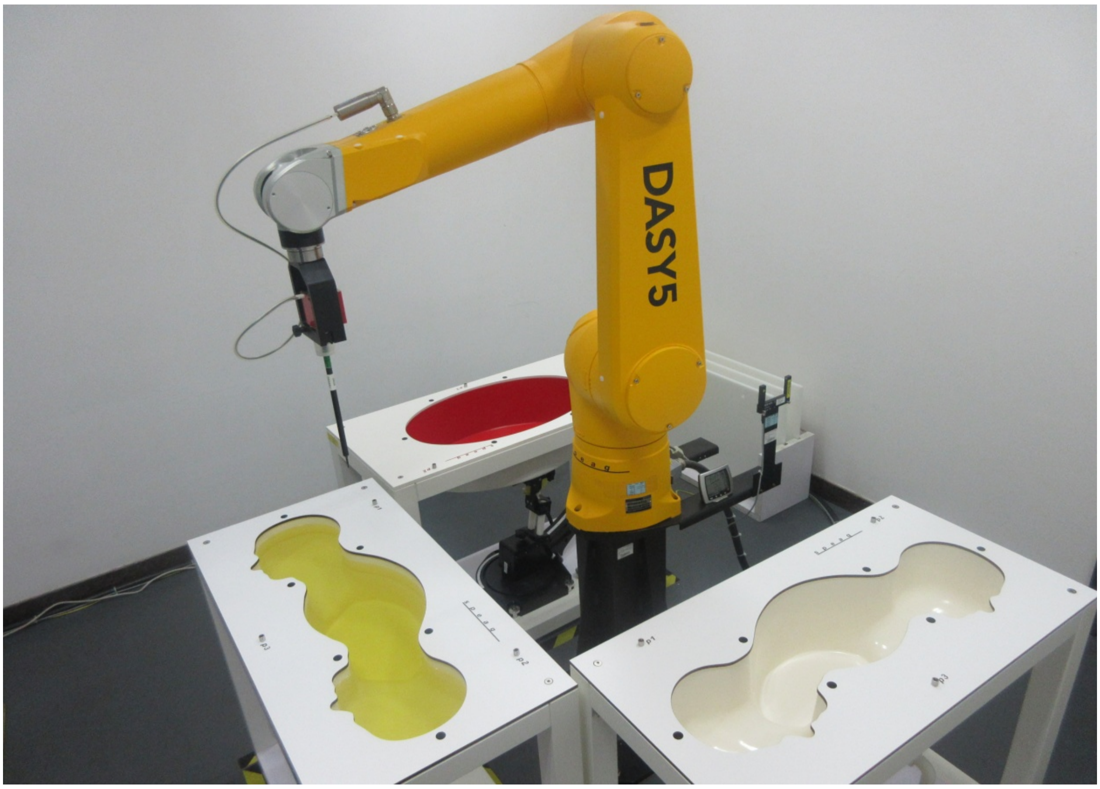
NO.	Simultaneous Tx Combination	Body
1	WiFi 2.4G Ant 1 + WiFi 2.4G Ant 2	Yes
2	WiFi 5.2G Ant 1 + WiFi 5.2G Ant 2	Yes
3	WiFi 5.3G Ant 1 + WiFi 5.3G Ant 2	Yes
4	WiFi 5.6G Ant 1 + WiFi 5.6G Ant 2	Yes
5	WiFi 5.8G Ant 1 + WiFi 5.8G Ant 2	Yes

Note: The MIMO test data please refer to section 7.2.1.

APPENDIX

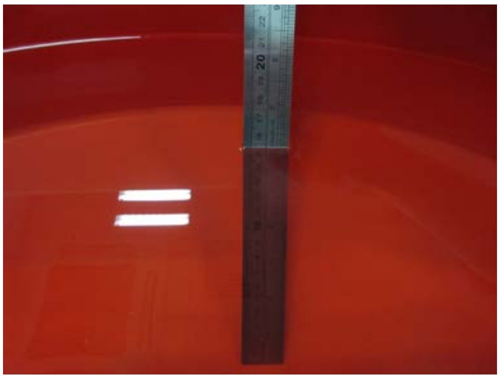
1. TEST LAYOUT

Specific Absorption Rate Test Layout

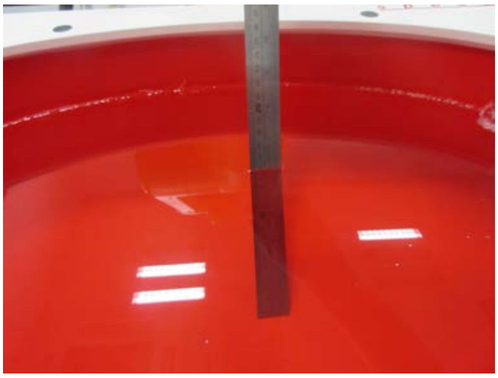


Liquid depth in the flat Phantom (≥15cm depth)

HSL_2450MHz_15.3cm



HSL_5GHz_15.1cm



Appendix A. SAR Plots of System Verification

(Pls See BTL-FCC SAR-1-1912C088_Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See BTL-FCC SAR-1-1912C088_Appendix B.)

Appendix C. Calibration Certificate

(Pls See BTL-FCC SAR-1-1912C088_Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See BTL-FCC SAR-1-1912C088_Appendix D.)

End of Test Report