FCC SAR Test Report

FCC ID: TE7T4UPLUS

Project No.	:	2006C101
Equipment	:	AC1300 Dual Antennas High Gain Wireless USB Adapter
Brand Name	:	tp-link
Test Model	:	Archer T4U Plus
Series Model	:	N/A
Date of Receipt	:	Jun. 17, 2020
Date of Test	:	Aug. 23, 2020 ~ Aug. 24, 2020
Issued Date	:	Sep. 11, 2020
Report Version	:	R02
Test Sample	:	Engineering Sample No.: DG2020061789
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

Please refer to page 2.

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

Prepared by : Seven Lu

Approved by : Herbort Liu

Certificate #5123.02

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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.	Sep. 02, 2020
R01	1. The conducted power of WiFi 2.4G is updated. 2. The SAR test result of WiFi 2.4G is updated.	Sep. 09, 2020
R02	Modify the data rate of 802.11ac.	Sep. 11, 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 Dual Antennas High Gain Wireless USB Adapter</td></tr>
<tr><td>Model Name</td><td colspan="5">Archer T4U 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 WLAN</td><td colspan="4">2400~2483.5</td></tr>
<tr><td rowspan="4">5G WLAN</td><td colspan="4">5150~5250</td></tr>
<tr><td colspan="4">5250~5350</td></tr>
<tr><td colspan="4">5470~5725</td></tr>
<tr><td colspan="4">5725~5850</td></tr>
<tr><td rowspan="6">Test Channels (low-mid-high)</td><td colspan="5">1-6-11 (2.4G WiFi 802.11b/g/n HT20)</td></tr>
<tr><td colspan="5">3-6-9 (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 A (dBi)</td><td colspan="2">Ant B (dBi)</td></tr>
<tr><td>2.4G WiFi</td><td colspan="2">3.00</td><td colspan="2">3.00</td></tr>
<tr><td>5G WiFi</td><td colspan="2">4.96</td><td colspan="2">4.96</td></tr>
</table>

2.2 STATEMENT OF COMPLIANCE

Mode	Highest Reported Body SAR-1g(W/kg)
2.4G WLAN	0.96
5.2G WLAN	1.09
5.3G WLAN	0.76
5.6G WLAN	0.97
5.8G WLAN	1.04
Note: The highest reported SAR for body is 1.09W/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	Oct. 29, 2019	1 Year
2	Data Acquisition Electronics	Speag	DAE3	420	Jun. 22, 2020	1 Year
3	E-field Probe	Speag	ES3DV3	3162	May 09, 2020	1 Year
4	E-field Probe	Speag	EX3DV4	7544	Sep. 09, 2019	1 Year
5	System Validation Dipole	Speag	D2450V2	919	Jun. 11, 2018	3 Years
6	System Validation Dipole	Speag	D5GHzV2	1160	Jun. 20, 2018	3 Years
7	ELI Phantom	Speag	ELI Phantom V5.0	1222	N/A	N/A
8	Power Amplifier	Mini-Circuits	ZHL-42W+	QA1333003	Mar. 10, 2020	1 Year
9	Power Amplifier	Mini-Circuits	ZVE-8G+	520701341	Mar. 10, 2020	1 Year
10	DC Source metter	Iteck	IT6154	0061041267682 01001	Jul. 25, 2020	1 Year
11	Signal Analyzer	R&S	FSV7	103120	Sep. 29, 2019	1 Year
12	Vector Network Analyzer	Anritsu	MS46522B	1538101	Sep. 29, 2019	1 Year
13	Signal Generator	R&S	SMF100A	101214	Feb. 29, 2020	1 Year
14	Smart Power Sensor	R&S	NRP-Z21	102209	Mar. 07, 2020	1 Year
15	Dielectric Assessment Kit	Speag	DAK-3.5	1226	N/A	N/A
16	Directional Coupler	Woken	TS-PCC0M-05	107090019	Mar. 01, 2020	1 Year
17	Coupler	Woken	0110A05601O-10	COM5BNW1A2	Mar. 01, 2020	1 Year
18	Digital Themometer	LKM	DTM3000	3519	Jul. 02, 2020	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.

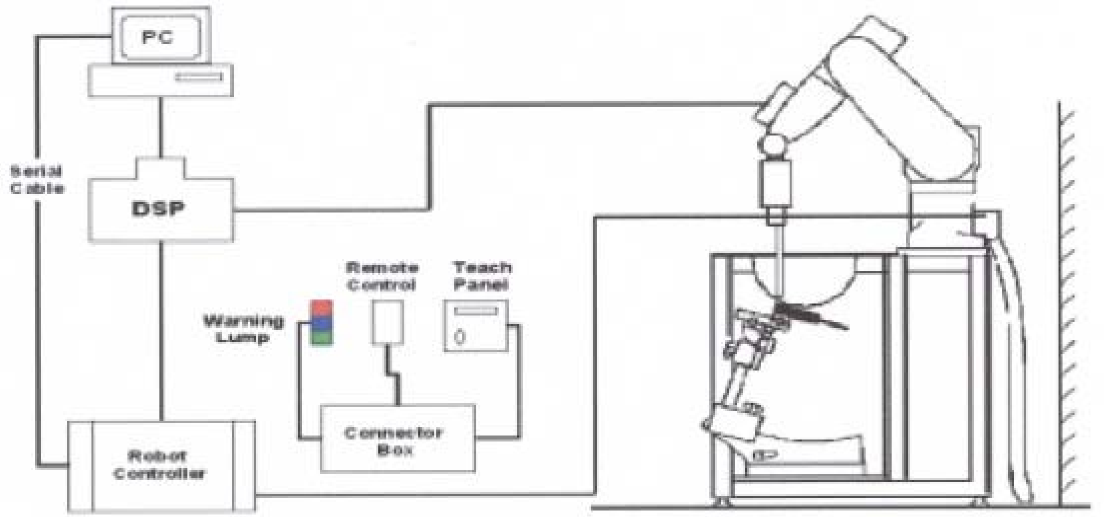
3. SAR MEASUREMENTS SYSTEM CONFIGURATION

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 ES3DV3 and EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetrice valuation.

3.2.1 PROBE SPECIFICATION

ES3DV3

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 4 GHz Linearity: ± 0.2 dB (30 MHz to 4 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	5 μW/g to > 100 mW/g Linearity:± 0.2dB
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 4 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1.0 mm

EX3DV4

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

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, ELI and SAM v6.0 Phantoms.
Material: POM, Acrylic glass, Foam

3.2.3.2 Phantom

Model	ELI 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(or1.06), 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	1.865	39.160	1.80	39.2	3.61	-0.10	Aug. 23, 2020
Head	2450	22.4	1.865	39.160	1.80	39.2	3.61	-0.10	Aug. 23, 2020
Head	5200	22.3	4.644	35.883	4.66	36.0	-0.34	-0.32	Aug. 24, 2020
Head	5300	22.3	4.761	35.602	4.76	35.9	0.02	-0.83	Aug. 24, 2020
Head	5500	22.3	5.000	35.092	4.96	35.6	0.81	-1.43	Aug. 24, 2020
Head	5600	22.3	5.110	34.850	5.07	35.5	0.79	-1.83	Aug. 24, 2020
Head	5800	22.3	5.347	34.487	5.27	35.3	1.46	-2.30	Aug. 24, 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.

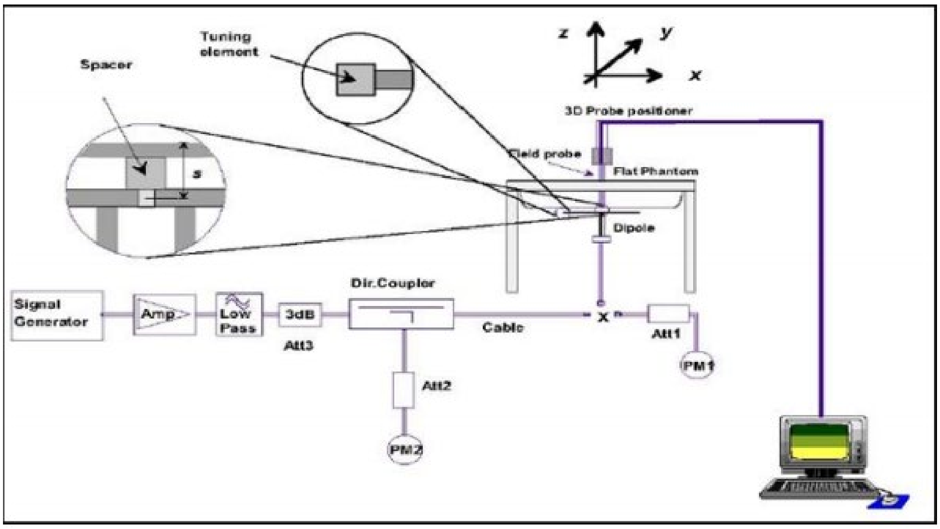
4.2 SYSTEM CHECK

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-1g (W/kg)	Measured SAR-1g (W/kg)	normalized SAR-1g (W/kg)	Deviation (%)	Dipole S/N
Head	Aug. 23, 2020	2450	52.10	12.50	50.00	-4.03	919
Head	Aug. 23, 2020	2450	52.10	12.40	49.60	-4.80	919
Head	Aug. 24, 2020	5200	75.30	7.20	72.00	-4.38	1160
Head	Aug. 24, 2020	5300	76.80	7.76	77.60	1.04	1160
Head	Aug. 24, 2020	5500	80.80	7.69	76.90	-4.83	1160
Head	Aug. 24, 2020	5600	78.60	7.83	78.30	-0.38	1160
Head	Aug. 24, 2020	5800	77.90	7.54	75.40	-3.21	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 < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

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

For devices that employ one or more external antennas with variable positions (e.g. antenna extended, retracted, rotated), these shall be positioned in accordance with the user instructions provided by the manufacturer. For a device with only one antenna, if no intended antenna position is specified, tests shall be performed if applicable in both the horizontal and vertical positions relative to the phantom, and with the antenna oriented away from the body of the DUT (Figure 6) and/or with the antenna extended and retracted such as to obtain the highest exposure condition. For antennas that may be rotated through one or two planes, an evaluation should be made and documented in the measurement report to the highest exposure scenario and only that position(s) need(s) to be tested.

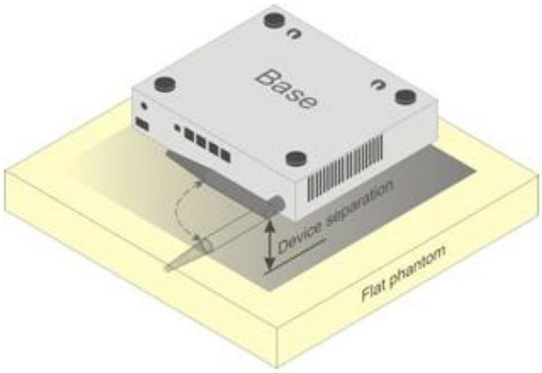


Figure 6 – Device with swivel antenna (example of desktop device)

6.2 TEST CONFIGURATION

6.2.1 WIFI TEST CONFIGURATION

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 WLAN2.4G 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 ≤ 0.8 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. 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.

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 WLAN5G 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 ≤ 1.2 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. 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.

✧ **U-NII-2C, 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, 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 is 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 2.4G 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 ≤ 0.8 W/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 ≤1.2 W/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 A	802.11b	1	2412	1	20.00	**19.88**
		6	2437		20.00	**19.56**
		11	2462		20.00	**19.77**
	802.11g	1	2412	6	20.00	Not Required
		6	2437		20.00	
		11	2462		20.00	

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 A+B	802.11n HT20	1	2412	MCS8	17.81	17.69	21.00	**20.76**
		6	2437		19.89	19.88	23.00	**22.90**
		11	2462		15.98	15.88	19.00	**18.94**
	802.11n HT40	3	2422	MCS8	16.61	16.93	20.00	19.78
		6	2437		17.78	17.73	21.00	20.77
		9	2452		15.83	15.96	19.00	18.91

Note:
1) The Average conducted power of 2.4G WiFi is measured with RMS detector.
2) Per KDB248227 D01, for 2.4G WiFi, the highest measured maximum output power Channel for DSSS modes (802.11b) was selected for SAR measurement. SAR for OFDM modes (2.4GHz 802.11g/n) was not required When the highest reported SAR for DSSS is adjusted by the ratio of OFDM modes (802.11g/n) to DSSS modes (802.11b) specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.
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 A	802.11a	36	5180	6	20.00	**19.96**
		40	5200		20.00	**19.77**
		44	5220		20.00	19.76
		48	5240		20.00	**19.98**

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 A+B	802.11n HT20	36	5180	MCS8	17.63	17.75	21.00	20.70
		40	5200		17.72	17.72	21.00	20.73
		44	5220		17.81	17.76	21.00	20.80
		48	5240		17.68	17.58	21.00	20.64
	802.11n HT40	38	5190	MCS8	17.67	17.61	21.00	20.65
		46	5230		17.85	17.72	21.00	20.80
	802.11ac VHT20	36	5180	NSS2 MCS0	17.91	17.46	21.00	20.70
		40	5200		17.71	17.38	21.00	20.56
		44	5220		17.61	17.78	21.00	20.71
		48	5240		17.66	17.08	21.00	20.39
	802.11ac VHT40	38	5190	NSS2 MCS0	18.91	18.65	22.00	**21.79**
		46	5230		18.83	18.77	22.00	**21.81**
	802.11ac VHT80	42	5210	NSS2 MCS0	17.78	17.68	21.00	20.74

Note:
1) The Average conducted power of 5.2G WiFi is measured with RMS detector.
2) The tested channel results are marks in bold.

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 A	802.11a	52	5260	6	20.00	**19.94**
		56	5280		20.00	19.75
		60	5300		20.00	**19.87**
		64	5320		20.00	**19.86**

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 A+B	802.11n HT20	52	5260	MCS8	17.68	17.67	21.00	20.69
		56	5280		17.43	17.72	21.00	20.59
		60	5300		17.76	17.68	21.00	20.73
		64	5320		17.75	17.72	21.00	20.75
	802.11n HT40	54	5270	MCS8	18.67	18.73	22.00	**21.71**
		62	5310		18.56	18.72	22.00	**21.65**
	802.11ac VHT20	52	5260	NSS2 MCS0	17.41	17.22	21.00	20.33
		56	5280		17.79	17.65	21.00	20.73
		60	5300		17.56	16.72	21.00	20.17
		64	5320		17.28	16.81	21.00	20.06
	802.11ac VHT40	54	5270	NSS2 MCS0	18.67	18.76	22.00	21.73
		62	5310		18.86	18.88	22.00	21.88
	802.11ac VHT80	58	5290	NSS2 MCS0	17.93	17.84	21.00	20.90

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 A	802.11a	100	5500	6	20.00	**19.96**
		104	5520		20.00	**19.88**
		108	5540		20.00	19.68
		112	5560		20.00	19.79
		116	5580		20.00	**19.89**
		132	5660		20.00	19.85
		136	5680		20.00	19.68
		140	5700		20.00	19.71

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 A+B	802.11n HT20	100	5500	MCS8	19.66	19.67	23.00	22.68
		104	5520		19.59	19.72	23.00	22.67
		108	5540		19.66	19.88	23.00	22.78
		112	5560		19.91	19.90	23.00	22.92
		116	5580		19.84	19.68	23.00	22.77
		132	5660		19.65	19.51	23.00	22.59
		136	5680		19.65	19.66	23.00	22.67
		140	5700		19.76	19.56	23.00	22.67
	802.11n HT40	102	5510	MCS8	19.82	19.63	23.00	**22.74**
		110	5550		19.68	19.75	23.00	**22.73**
		118	5590		19.63	19.58	23.00	22.62
		126	5630		19.61	19.75	23.00	**22.69**
		134	5670		19.71	19.55	23.00	22.64

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 A+B	**802.11ac VHT20**	100	5500	NSS2 MCS0	19.87	19.77	23.00	22.83
		104	5520		19.80	19.75	23.00	22.79
		108	5540		19.65	19.57	23.00	22.62
		112	5560		19.89	19.48	23.00	22.70
		116	5580		19.86	19.73	23.00	22.81
		132	5660		19.77	19.46	23.00	22.63
		136	5680		19.61	19.84	23.00	22.74
		140	5700		19.83	19.69	23.00	22.77
	802.11ac VHT40	102	5510	NSS2 MCS0	18.94	18.77	23.00	21.87
		110	5550		19.04	18.96	23.00	22.01
		118	5590		19.51	19.44	23.00	22.49
		126	5630		19.95	19.59	23.00	22.78
		134	5670		18.77	18.83	23.00	21.81
	802.11ac VHT80	106	5530	NSS2 MCS0	17.91	17.54	21.00	20.74
		122	5610		17.77	17.58	21.00	20.69

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 A	802.11a	149	5745	6	20.00	**19.84**
		153	5765		20.00	19.82
		157	5785		20.00	**19.92**
		161	5805		20.00	**19.85**
		165	5825		20.00	19.82

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 A+B	802.11n HT20	149	5745	MCS8	19.63	19.61	23.00	22.63
		153	5765		19.71	19.56	23.00	22.65
		157	5785		19.75	19.51	23.00	22.64
		161	5805		19.56	19.86	23.00	22.72
		165	5825		19.74	19.65	23.00	22.71
	802.11n HT40	151	5755	MCS8	19.71	19.63	23.00	22.68
		159	5795		19.55	19.77	23.00	22.67
	802.11ac VHT20	149	5745	NSS2 MCS0	19.97	19.56	23.00	22.78
		153	5765		19.66	19.51	23.00	22.60
		157	5785		20.04	19.82	23.00	22.94
		161	5805		19.55	19.31	23.00	22.44
		165	5825		19.89	19.79	23.00	22.85
	802.11ac VHT40	151	5755	NSS2 MCS0	19.78	19.66	23.00	22.73
		159	5795		19.89	19.75	23.00	22.83
	802.11ac VHT80	155	5775	NSS2 MCS0	19.91	19.86	23.00	**22.90**

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: ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz. 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 9 cm x 5 cm, 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 ≤ 1.2 W/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 > 1.5 W/kg, or > 7.0 W/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 ≤ 0.4 W/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 ≤ 0.8 W/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 Section7.1.4 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 6.1.4 for more information.

7.2.1 SAR MEASUREMENT RESULT

1. SAR test results of 2.4G WiFi

Test No.	Band	Channel	Test Position	Separation Distance (cm)	Ant	Ant Status	Ant Angle (°)	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR
W01	802.11b	1	Front Face	0	A	Colse	0	1	20	19.88	-0.01	0.910	0.427	0.935
W02	802.11b	1	Front Face	0	A	Colse	90	1	20	19.88	0.05	0.024	0.009	0.025
W03	802.11b	1	Front Face	0	A	Colse	180	1	20	19.88	0.06	0.656	0.307	0.674
W04	802.11b	1	Front Face	0	A	Open	0	1	20	19.88	0.04	0.670	0.321	0.689
W05	802.11b	1	Front Face	0	A	Open	90	1	20	19.88	0.06	0.542	0.267	0.557
W06	802.11b	1	Front Face	0	A	Open	-90	1	20	19.88	0.09	0.605	0.283	0.622
W07	802.11b	11	Front Face	0	A	Colse	0	1	20	19.77	-0.01	0.803	0.379	0.847
W08	802.11b	6	Front Face	0	A	Colse	0	1	20	19.56	-0.07	0.600	0.290	0.664
W09	802.11b	1	Front Face (Repeat Test)	0	A	Colse	0	1	20	19.88	0.02	**0.935**	**0.435**	**0.961**
W23	802.11n HT20	6	Front Face	0	A+B	Colse	0	MCS8	23	22.90	0.04	0.368	0.177	0.377
W24	802.11n HT20	6	Front Face	0	A+B	Colse	90	MCS8	23	22.90	0.03	0.017	0.006	0.017
W25	802.11n HT20	6	Front Face	0	A+B	Colse	180	MCS8	23	22.90	-0.01	0.412	0.188	0.422
W26	802.11n HT20	6	Front Face	0	A+B	Open	0	MCS8	23	22.90	-0.15	**0.593**	**0.286**	**0.607**
W27	802.11n HT20	6	Front Face	0	A+B	Open	90	MCS8	23	22.90	-0.08	0.566	0.273	0.580
W28	802.11n HT20	6	Front Face	0	A+B	Open	-90	MCS8	23	22.90	0.08	0.566	0.271	0.580
W29	802.11n HT20	1	Front Face	0	A+B	Open	0	MCS8	21	20.76	0.09	0.443	0.202	0.468
W30	802.11n HT20	11	Front Face	0	A+B	Open	0	MCS8	19	18.94	0.01	0.245	0.117	0.248

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

2. SAR test results of 5G WiFi

Test No.	Band	Channel	Test Position	Separation Distance (cm)	Ant	Ant Status	Ant Angle (°)	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR
W35	802.11a	48	Front Face	0	A	Colse	0	6	20	19.98	0.08	0.751	0.274	0.754
W36	802.11a	48	Front Face	0	A	Colse	90	6	20	19.98	-0.11	0.086	0.029	0.086
W37	802.11a	48	Front Face	0	A	Colse	180	6	20	19.98	0.03	0.859	0.295	0.863
W38	802.11a	48	Front Face	0	A	Open	0	6	20	19.98	-0.05	0.439	0.172	0.441
W39	802.11a	48	Front Face	0	A	Open	90	6	20	19.98	0.09	0.790	0.288	0.794
W40	802.11a	48	Front Face	0	A	Open	-90	6	20	19.98	0.10	0.808	0.278	0.812
W41	802.11a	36	Front Face	0	A	Colse	180	6	20	19.96	0.00	**1.080**	**0.372**	**1.090**
W42	802.11a	40	Front Face	0	A	Colse	180	6	20	19.77	-0.02	0.986	0.337	1.040
W43	802.11a	36	Front Face (Repeat Test)	0	A	Colse	180	6	20	19.96	0.16	1.010	0.345	1.019
W59	802.11ac VHT40	46	Front Face	0	A+B	Colse	0	NSS2 MCS0	22	21.81	0.06	0.182	0.069	0.190
W60	802.11ac VHT40	46	Front Face	0	A+B	Colse	90	NSS2 MCS0	22	21.81	0.00	0.060	0.022	0.063
W61	802.11ac VHT40	46	Front Face	0	A+B	Colse	180	NSS2 MCS0	22	21.81	-0.13	0.224	0.080	0.234
W62	802.11ac VHT40	46	Front Face	0	A+B	Open	0	NSS2 MCS0	22	21.81	0.05	0.147	0.052	0.154
W63	802.11ac VHT40	46	Front Face	0	A+B	Open	90	NSS2 MCS0	22	21.81	-0.08	0.158	0.059	0.165
W64	802.11ac VHT40	46	Front Face	0	A+B	Open	-90	NSS2 MCS0	22	21.81	-0.01	0.182	0.068	0.190
W65	802.11ac VHT40	38	Front Face	0	A+B	Colse	180	NSS2 MCS0	22	21.79	0.00	**0.491**	**0.175**	**0.515**
W71	802.11a	52	Front Face	0	A	Colse	0	6	20	19.94	0.03	0.689	0.240	0.699
W72	802.11a	52	Front Face	0	A	Colse	90	6	20	19.94	0.05	0.050	0.021	0.051
W73	802.11a	52	Front Face	0	A	Colse	180	6	20	19.94	0.00	**0.753**	**0.269**	**0.763**
W74	802.11a	52	Front Face	0	A	Open	0	6	20	19.94	0.06	0.434	0.165	0.440
W75	802.11a	52	Front Face	0	A	Open	90	6	20	19.94	-0.04	0.613	0.224	0.622
W76	802.11a	52	Front Face	0	A	Open	-90	6	20	19.94	0.09	0.578	0.212	0.586
W77	802.11a	60	Front Face	0	A	Colse	180	6	20	19.87	-0.05	0.556	0.200	0.573
W78	802.11a	64	Front Face	0	A	Colse	180	6	20	19.86	0.10	0.523	0.187	0.540
W95	802.11n HT40	54	Front Face	0	A+B	Colse	0	MCS8	22	21.71	-0.18	0.242	0.097	0.259
W96	802.11n HT40	54	Front Face	0	A+B	Colse	90	MCS8	22	21.71	0.06	0.071	0.030	0.076
W97	802.11n HT40	54	Front Face	0	A+B	Colse	180	MCS8	22	21.71	0.00	**0.387**	**0.144**	**0.414**
W98	802.11n HT40	54	Front Face	0	A+B	Open	0	MCS8	22	21.71	0.04	0.231	0.095	0.247
W99	802.11n HT40	54	Front Face	0	A+B	Open	90	MCS8	22	21.71	-0.05	0.288	0.107	0.308
W100	802.11n HT40	54	Front Face	0	A+B	Open	-90	MCS8	22	21.71	0.01	0.340	0.124	0.363
W101	802.11n HT40	62	Front Face	0	A+B	Colse	180	MCS8	22	21.65	-0.02	0.380	0.141	0.412

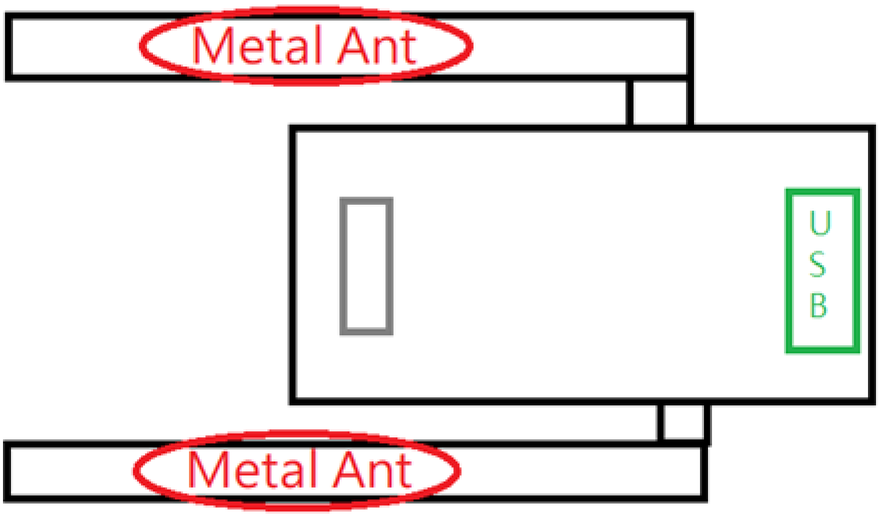
Test No.	Band	Channel	Test Position	Separation Distance (cm)	Ant	Ant Status	Ant Angle (°)	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR
W107	802.11a	100	Front Face	0	A	Colse	0	6	20	19.96	-0.04	0.722	0.233	0.729
W108	802.11a	100	Front Face	0	A	Colse	90	6	20	19.96	0.08	0.063	0.028	0.064
W109	802.11a	100	Front Face	0	A	Colse	180	6	20	19.96	0.07	0.586	0.236	0.591
W110	802.11a	100	Front Face	0	A	Open	0	6	20	19.96	-0.06	0.690	0.229	0.696
W111	802.11a	100	Front Face	0	A	Open	90	6	20	19.96	0.07	0.544	0.192	0.549
W112	802.11a	100	Front Face	0	A	Open	-90	6	20	19.96	-0.01	0.682	0.213	0.688
W113	802.11a	116	Front Face	0	A	Colse	0	6	20	19.89	0.02	0.941	0.283	0.965
W114	802.11a	104	Front Face	0	A	Colse	0	6	20	19.88	0.01	0.842	0.249	0.866
W115	802.11a	116	Front Face (Repeat Test)	0	A	Colse	0	6	20	19.89	0.00	**0.945**	**0.284**	**0.969**
W131	802.11n HT40	102	Front Face	0	A+B	Colse	0	MCS8	23	22.74	-0.03	0.534	0.149	0.567
W132	802.11n HT40	102	Front Face	0	A+B	Colse	90	MCS8	23	22.74	0.01	0.195	0.073	0.207
W133	802.11n HT40	102	Front Face	0	A+B	Colse	180	MCS8	23	22.74	-0.11	0.515	0.360	0.547
W134	802.11n HT40	102	Front Face	0	A+B	Open	0	MCS8	23	22.74	0.13	0.464	0.138	0.493
W135	802.11n HT40	102	Front Face	0	A+B	Open	90	MCS8	23	22.74	0.08	0.489	0.153	0.520
W136	802.11n HT40	102	Front Face	0	A+B	Open	-90	MCS8	23	22.74	0.04	0.553	0.174	0.588
W137	802.11n HT40	110	Front Face	0	A+B	Open	-90	MCS8	23	22.73	-0.09	0.542	0.167	0.577
W138	802.11n HT40	126	Front Face	0	A+B	Open	-90	MCS8	23	22.69	0.00	**0.787**	**0.241**	**0.845**
W139	802.11n HT40	126	Front Face	0	A+B	Open	-90	MCS8	23	22.69	0.12	0.756	0.232	0.812
W142	802.11a	157	Front Face	0	A	Colse	0	6	20	19.92	0.00	0.938	0.306	0.955
W143	802.11a	157	Front Face	0	A	Colse	90	6	20	19.92	0.18	0.149	0.066	0.152
W144	802.11a	157	Front Face	0	A	Colse	180	6	20	19.92	0.03	**1.020**	**0.316**	**1.039**
W145	802.11a	157	Front Face	0	A	Open	0	6	20	19.92	-0.04	0.808	0.272	0.823
W146	802.11a	157	Front Face	0	A	Open	90	6	20	19.92	-0.09	0.927	0.295	0.944
W147	802.11a	157	Front Face	0	A	Open	-90	6	20	19.92	0.11	0.969	0.309	0.987
W148	802.11a	149	Front Face	0	A	Colse	180	6	20	19.84	0.03	0.967	0.302	1.003
W149	802.11a	161	Front Face	0	A	Colse	180	6	20	19.85	0.05	0.951	0.296	0.984
W150	802.11a	157	Front Face (Repeat Test)	0	A	Colse	180	6	20	19.92	-0.07	0.983	0.304	1.001
W117	802.11ac VHT80	155	Front Face	0	A+B	Colse	0	NSS2 MCS0	23	22.90	0.10	0.380	0.126	0.389
W118	802.11ac VHT80	155	Front Face	0	A+B	Colse	90	NSS2 MCS0	23	22.90	0.07	0.079	0.032	0.080
W119	802.11ac VHT80	155	Front Face	0	A+B	Colse	180	NSS2 MCS0	23	22.90	0.00	0.447	0.143	0.458
W120	802.11ac VHT80	155	Front Face	0	A+B	Open	0	NSS2 MCS0	23	22.90	-0.05	0.352	0.120	0.361
W121	802.11ac VHT80	155	Front Face	0	A+B	Open	90	NSS2 MCS0	23	22.90	0.00	**0.551**	**0.170**	**0.564**
W122	802.11ac VHT80	155	Front Face	0	A+B	Open	-90	NSS2 MCS0	23	22.90	0.16	0.403	0.135	0.413

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

8 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:

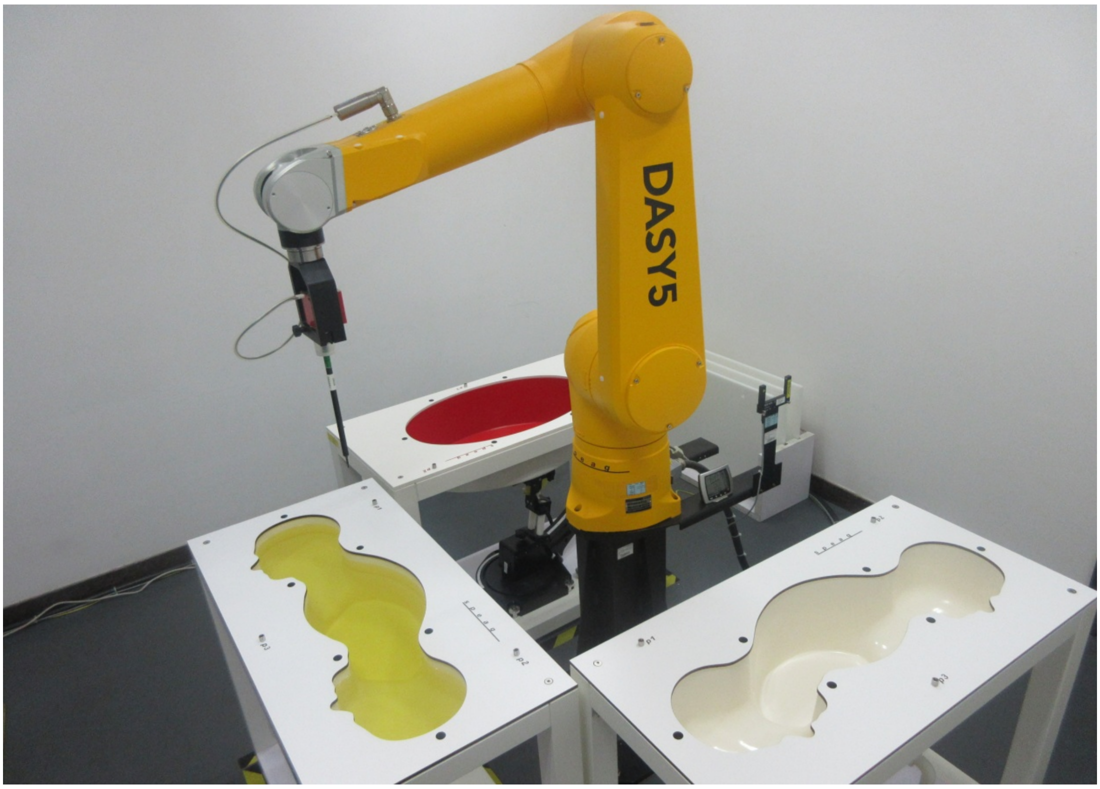


Note: The results of transmit simultaneous please refer to section 7.2.1.

APPENDIX

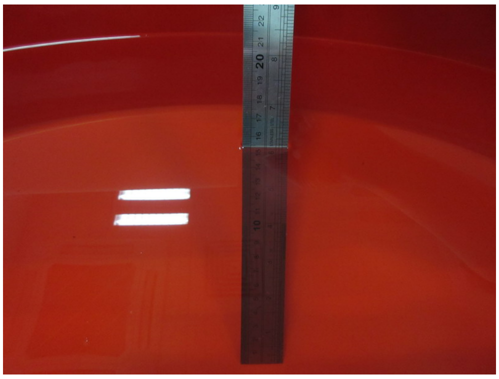
1. TEST LAYOUT

Specific Absorption Rate Test Layout

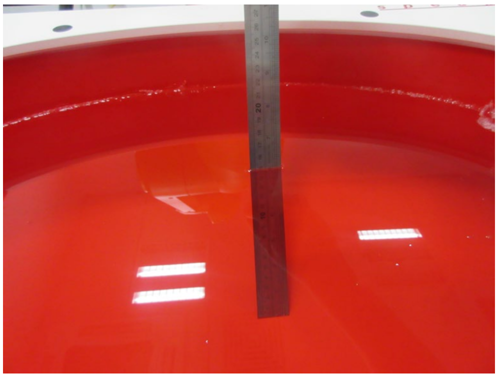


Liquid depth in the flat Phantom (≥15cm depth)

HSL_2300MHz-2700MHz_15.3cm



HSL_5GHz_15.1cm



Appendix A. SAR Plots of System Verification

(Pls See BTL-FCC SAR-1-2006C101_Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See BTL-FCC SAR-1-2006C101_Appendix B.)

Appendix C. Calibration Certificate

(Pls See BTL-FCC SAR-1-2006C101_Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See BTL-FCC SAR-1-2006C101_Appendix D.)

End of Test Report