FCC SAR Test Report

FCC ID: RWO-RZ0902386

Project No.	:	1803C063
Equipment	:	Notebook
Test Model	:	RZ09-02386
Series Model	:	RZ09-02385
Applicant	:	Razer Inc.
Address	:	201 3rd Street, Suite 900, San Francisco, CA 94103

Date of Receipt	:	Mar. 13, 2018
Date of Test	:	Mar. 18, 2018 ~ Mar. 18, 2018
Issued Date	:	May 22, 2018
Tested by	:	BTL Inc.

PREPARED BY : Rot . Liang
(Rot Liang)

APPROVED BY : Herbort Liu
(Herbort Liu)

BTL INC.
No.3, Jinshagang 1st Road, Shixia, Dalang Town, Dongguan, Guangdong, China.
TEL: +86-769-8318-3000 FAX: +86-769-8319-6000

Testing Laboratory 2640

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).

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BTL's laboratory quality assurance procedures are in compliance with the **ISO Guide17025** requirements, and accredited by the conformity assessment authorities listed in this test report.

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.

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REPORT ISSUED HISTORY

Issued No.	Version	Description	Issued Date
BTL-FCC SAR-1-1803C063	Rev.01	Original Issue.	Apr. 02, 2018
BTL-FCC SAR-1-1803C063	Rev.02	Added serial model:RZ09-02385.	May 11, 2018
BTL-FCC SAR-1-1803C063	Rev.03	1. Added the uncertainty list. 2. Updated the list of equipment. 3. Updated the power table. 4. Updated 2.4G&5G duty cycle and MAX SAR table. 5. Added SISO power table.	May 22, 2018

1. GENERAL SUMMARY

<table>
<tr><td>Equipment</td><td colspan="2">Notebook</td></tr>
<tr><td>Model Name</td><td colspan="2">RZ09-02386</td></tr>
<tr><td>Series Model</td><td colspan="2">RZ09-02385</td></tr>
<tr><td rowspan="4">Model Difference</td><td colspan="2">The video cards and the adapters used for RZ09-02386 and RZ09-02385 are different. Others are the same.</td></tr>
<tr><td>Model</td><td>Video cards</td></tr>
<tr><td>RZ09-02386</td><td>N17E-G2 MAX-Q</td></tr>
<tr><td>RZ09-02385</td><td>N17E-G1 MAX-Q</td></tr>
<tr><td>Brand Name</td><td colspan="2">RAZER</td></tr>
<tr><td>Manufacturer</td><td colspan="2">Razer Inc.</td></tr>
<tr><td>Address</td><td colspan="2">201 3rd Street, Suite 900, San Francisco, CA 94103</td></tr>
<tr><td>Standard(s)</td><td colspan="2">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

KDB616217 D04 SAR for laptop and tablets v01r02
KDB447498 D01 General RF Exposure Guidance v06
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</td></tr>
</table>

The above equipment has been tested and found compliance with the requirement of the relative standards by BTL Inc.
The test data, data evaluation, and equipment configuration contained in our test report (Ref No. BTL-FCC SAR-1-1803C063) were obtained utilizing the test procedures, test instruments, test sites that has been accredited by the Authority of TAF according to the ISO-17025 quality assessment standard and technical standard(s).

2. RF EMISSIONS MEASUREMENT

2.1 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

2.2 MEASUREMENT UNCERTAINTY

Uncertainty Budget for Frequency range of 300 MHz to 3 GHz

Error Description	Uncertainty Value (± %)		Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi V_{eff}
Measurement System									
Probe Calibration	6.05		Normal	1	1	1	± 6.05 %	± 6.05 %	∞
Axial Isotropy	4.7		Rectangular	$\sqrt{3}$	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical Isotropy	9.6		Rectangular	$\sqrt{3}$	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary Effects	2.0		Rectangular	$\sqrt{3}$	1	1	± 1.2 %	± 1.2 %	∞
Linearity	4.7		Rectangular	$\sqrt{3}$	1	1	± 2.7 %	± 2.7 %	∞
Detection Limits	1		Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Modulation response	2.4		Rectangular	$\sqrt{3}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	0.3		Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response Time	0.8		Rectangular	$\sqrt{3}$	1	1	± 0.5%	± 0.5 %	∞
Integration Time	2.6		Rectangular	$\sqrt{3}$	1	1	± 1.5 %	± 1.5 %	∞
RF Ambient – Noise	3.0		Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
RF Ambient–Reflections	3.0		Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
Probe Positioner	0.8		Rectangular	$\sqrt{3}$	1	1	± 0.5 %	± 0.5 %	∞
Probe Positioning	6.7		Rectangular	$\sqrt{3}$	1	1	± 3.9 %	±3.9 %	∞
Max.SAR Evaluation	4.0		Rectangular	$\sqrt{3}$	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related									
Device Positioning	3.5	2.8	Normal	1	1	1	± 3.5 %	± 2.8 %	145
Device Holder	4.2	3.2	Normal	1	1	1	± 4.2 %	± 3.2 %	5
Power Drift	5.0		Rectangular	$\sqrt{3}$	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Setup									
Phantom Production Tolerances	4		Rectangular	$\sqrt{3}$	1	1	2.31	2.31	∞
Liquid Conductivity (target.)	5		Rectangular	$\sqrt{3}$	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (mea.)	2.5		Rectangular	$\sqrt{3}$	0.64	0.43	0.92	0.62	∞
Liquid Permittivity (target.)	5		Rectangular	$\sqrt{3}$	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (mea.)	2.5		Rectangular	$\sqrt{3}$	0.6	0.49	0.87	0.71	∞
Combined Standard Uncertainty (K = 1)							± 10.96 %	± 10.80 %	361
Expanded Uncertainty (K = 2)							**± 21.91 %**	**± 21.60 %**	

Uncertainty Budget for Frequency range of 3 GHz to 6 GHz

Error Description	Uncertainty Value (± %)		Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi V_{eff}
Measurement System									
Probe Calibration	6.65		Normal	1	1	1	± 6.65 %	± 6.65 %	∞
Axial Isotropy	4.7		Rectangular	$\sqrt{3}$	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical Isotropy	9.6		Rectangular	$\sqrt{3}$	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary Effects	2.0		Rectangular	$\sqrt{3}$	1	1	± 1.2 %	± 1.2 %	∞
Linearity	4.7		Rectangular	$\sqrt{3}$	1	1	± 2.7 %	± 2.7 %	∞
Detection Limits	1		Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Modulation response	2.4		Rectangular	$\sqrt{3}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	0.3		Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response Time	0.8		Rectangular	$\sqrt{3}$	1	1	± 0.5%	± 0.5 %	∞
Integration Time	2.6		Rectangular	$\sqrt{3}$	1	1	± 1.5 %	± 1.5 %	∞
RF Ambient – Noise	3.0		Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
RF Ambient– Reflections	3.0		Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
Probe Positioner	0.8		Rectangular	$\sqrt{3}$	1	1	± 0.5 %	± 0.5 %	∞
Probe Positioning	6.7		Rectangular	$\sqrt{3}$	1	1	± 3.9 %	±3.9 %	∞
Max.SAR Evaluation	4.0		Rectangular	$\sqrt{3}$	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related									
Device Positioning	3.5	2.8	Normal	1	1	1	± 3.5 %	± 2.8 %	145
Device Holder	4.2	3.2	Normal	1	1	1	± 4.2 %	± 3.2 %	5
Power Drift	5.0		Rectangular	$\sqrt{3}$	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Setup									
Phantom Production Tolerances	4		Rectangular	$\sqrt{3}$	1	1	2.31	2.31	∞
Liquid Conductivity (target.)	5		Rectangular	$\sqrt{3}$	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (mea.)	2.5		Rectangular	$\sqrt{3}$	0.64	0.43	0.92	0.62	∞
Liquid Permittivity (target.)	5		Rectangular	$\sqrt{3}$	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (mea.)	2.5		Rectangular	$\sqrt{3}$	0.6	0.49	0.87	0.71	∞
Combined Standard Uncertainty (K = 1)							± 11.30 %	± 11.10 %	361
Expanded Uncertainty (K = 2)							**± 22.60 %**	**± 22.30 %**	

Uncertainty Conponent (Source)	Uncertainty Value (± %)	Probability Distribution	Divisor	Ci (1g)	Standard Uncertainty (1g)	Vi V_{eff}
Measurement System						
Probe Calibration (k=1)	6.65	Normal	1	1	6.7	∞
Axial Isotropy of the probe	4.7	Rectangular	$\sqrt{3}$	0.7	1.9	∞
Hemispherical Isotropy of the probe	9.6	Rectangular	$\sqrt{3}$	0.7	3.9	∞
Boundary Effect	1	Rectangular	$\sqrt{3}$	1	0.6	∞
Probe Linearity	4.7	Rectangular	$\sqrt{3}$	1	2.7	∞
System Detection Limit	1	Rectangular	$\sqrt{3}$	1	0.6	∞
Modulation response	2.4	Rectangular	$\sqrt{3}$	1	1.4	∞
Readout Electronics	0.3	Normal	1	1	0.3	∞
Response Time	0.8	Rectangular	$\sqrt{3}$	1	0.5	∞
Integration Time	2.6	Rectangular	$\sqrt{3}$	1	1.5	∞
RF Ambient Noise	3	Rectangular	$\sqrt{3}$	1	1.7	∞
RF Ambient Reflections	3	Rectangular	$\sqrt{3}$	1	1.7	∞
Probe Positioner Mechanical Tolerance	0.4	Rectangular	$\sqrt{3}$	1	0.2	∞
Probe Positioning with respect to Phantom Shell	2.9	Rectangular	$\sqrt{3}$	1	1.7	∞
Max SAR Eval	2	Rectangular	$\sqrt{3}$	1	1.2	∞
Dipole Related						
Deviation of exp. Dipole	5.5	Rectangular	$\sqrt{3}$	1	3.2	∞
Dipole Axis to Liquid Dist	2	Rectangular	$\sqrt{3}$	1	1.2	∞
Input power & SAR drift	3.4	Rectangular	$\sqrt{3}$	1	2.0	∞
Phantom and Tissue Parameters (Physical parameter)						
Phantom Production Tolerances (shape and thickness)	4	Rectangular	$\sqrt{3}$	1	2.3	∞
SAR correction	1.9	Rectangular	$\sqrt{3}$	1	1.1	∞
Liquid Conductivity (mea.)	2.5	Normal	1	0.78	2.0	∞
Liquid Permittivity (mea.)	2.5	Normal	1	0.26	0.7	∞
Temp. unc. - Conductivity	1.7	Rectangular	$\sqrt{3}$	0.78	0.8	∞
Temp. unc. - Permittivity	0.3	Rectangular	$\sqrt{3}$	0.23	0.0	∞
Combined Standard Uncertainty $u_c' = \sqrt{\sum_{i=1}^{24} c_i^2 u_i^2}$		RSS			10.60	
Expanded uncertainty (95% CONFIDENCE LEVEL)		k=2			21.21	

3. GENERAL INFORMATION

3.1 STATEMENT OF COMPLIANCE

Equipment Class	Mode	Highest Body SAR-1g(W/kg)
DTS	2.4G WLAN	0.25
NII	5.2G WLAN	N/A
	5.3G WLAN	0.22
	5.6G WLAN	0.25
	5.8G WLAN	0.26
DSS	Bluetooth	0.01

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

3.2 GENERAL DESCRIPTION OF EUT

<table>
<tr><td>Equipment</td><td colspan="5">Notebook</td></tr>
<tr><td>Model Name</td><td colspan="5">RZ09-02386</td></tr>
<tr><td>Series Model</td><td colspan="5">RZ09-02385</td></tr>
<tr><td>HW Version</td><td colspan="5">C1_MB</td></tr>
<tr><td>SW Version</td><td colspan="5">window10</td></tr>
<tr><td>Modulation</td><td colspan="5">WiFi(DSSS/OFDM),BT(GFSK/ π /4-DQPSK/8-DPSK)</td></tr>
<tr><td rowspan="7">Operation Frequency Range(s)</td><td>Band</td><td colspan="2">TX (MHz)</td><td colspan="2">RX (MHz)</td></tr>
<tr><td>Bluetooth</td><td colspan="4">2400 ~2483.5</td></tr>
<tr><td rowspan="5">WIFI</td><td colspan="4">2412 ~2472</td></tr>
<tr><td colspan="4">5150 ~5250</td></tr>
<tr><td colspan="4">5250 ~5230</td></tr>
<tr><td colspan="4">5470 ~5725</td></tr>
<tr><td colspan="4">5725 ~5850</td></tr>
<tr><td rowspan="9">Test Channels (low-mid-high):</td><td colspan="5">0-39-78 (BT)</td></tr>
<tr><td colspan="5">0-19-39 (BLE)</td></tr>
<tr><td colspan="5">1-6-11 (2.4G WIFI 802.11b/g/nHT20)</td></tr>
<tr><td colspan="5">3-6-9 (2.4G WIFI 802.11n HT40)</td></tr>
<tr><td>5G WIFI</td><td>5.2G</td><td>5.3G</td><td>5.6G</td><td>5.8G</td></tr>
<tr><td>a/n 20/ ac 20</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>n 40/ ac 40</td><td>38-46</td><td>54-62</td><td>102-110-118-126-134</td><td>151-159</td></tr>
<tr><td>ac80</td><td>42</td><td>58</td><td>106-122</td><td>155</td></tr>
<tr><td>ac160</td><td>50</td><td></td><td>114</td><td></td></tr>
<tr><td rowspan="6">Antenna Gain</td><td>Band</td><td colspan="2">Antenna 1(dBi)</td><td colspan="2">Antenna 2(dBi)</td></tr>
<tr><td>2.4G</td><td colspan="2">3.13</td><td colspan="2">3.06</td></tr>
<tr><td>5.2G</td><td colspan="2">3.48</td><td colspan="2">3.33</td></tr>
<tr><td>5.3G</td><td colspan="2">3.55</td><td colspan="2">3.41</td></tr>
<tr><td>5.6G</td><td colspan="2">4.42</td><td colspan="2">4.31</td></tr>
<tr><td>5.8G</td><td colspan="2">4.79</td><td colspan="2">4.58</td></tr>
<tr><td colspan="6">Other Information</td></tr>
<tr><td rowspan="3">Battery</td><td>Brand</td><td colspan="4">Razer</td></tr>
<tr><td>Model</td><td colspan="4">RC30-0248</td></tr>
<tr><td>Rated Voltage</td><td colspan="4">15.4Vdc, 5209mAh</td></tr>
</table>

3.3 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.	

3.4 MAIN TEST INSTRUMENTS

Item	Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Interval
1	Data Acquisition Electronics	Speag	DAE4	1390	Sep. 15, 2017	1 Year
2	E-field Probe	Speag	EX3DV4	7396	May 25, 2017	1 Year
3	Electro Optical Converter	Speag	ECO90	1151	N/A	N/A
4	System Validation Dipole	Speag	D2450V2	919	Sep. 28, 2015	3 Years
5	System Validation Dipole	Speag	D5GHzV2	1160	Oct. 05, 2015	3 Years
6	ELI4 Phantom	Speag	ELI4 Phantom V5.0	1222	N/A	N/A
7	Power Amplifier	Mini-Circuits	ZHL-42W+	QA1333003	N/A	N/A
8	Power Amplifier	Mini-Circuits	ZVE-8G+	520701341	N/A	N/A
9	ENA Network Analyzer	Agilent	E5071C	MY46102965	Mar. 26, 2017	1 Year
10	MXG Analog Signal Generator	Agilent	N5181A	MY49060477	Jun. 30, 2017	1 Year
11	P-series power meter	Agilent	N1911A	MY45100473	Aug. 20, 2017	1 Year
12	wideband power sensor	Agilent	N1921A	MY51100041	Aug. 20, 2017	1 Year
13	power Meter	Anritsu	ML2495A	1128009	Mar. 26, 2017	1 Year
14	Pulse Power Sensor	Anritsu	MA 2411B	1027500	Mar. 26, 2017	1 Year
15	Dielectric Assessment Kit	Speag	DAK-3.5	1226	N/A	N/A
16	Dual directional coupler	Woken	TS-PCC0M-05	107090019	May 16, 2017	1 Year
17	Digital Thermometer	LKM	DTM3000	3519	Jul. 21, 2017	1 Year
18	Thermohygrometer	TESTO	608-H1	1341359457/304	Oct. 12, 2017	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.

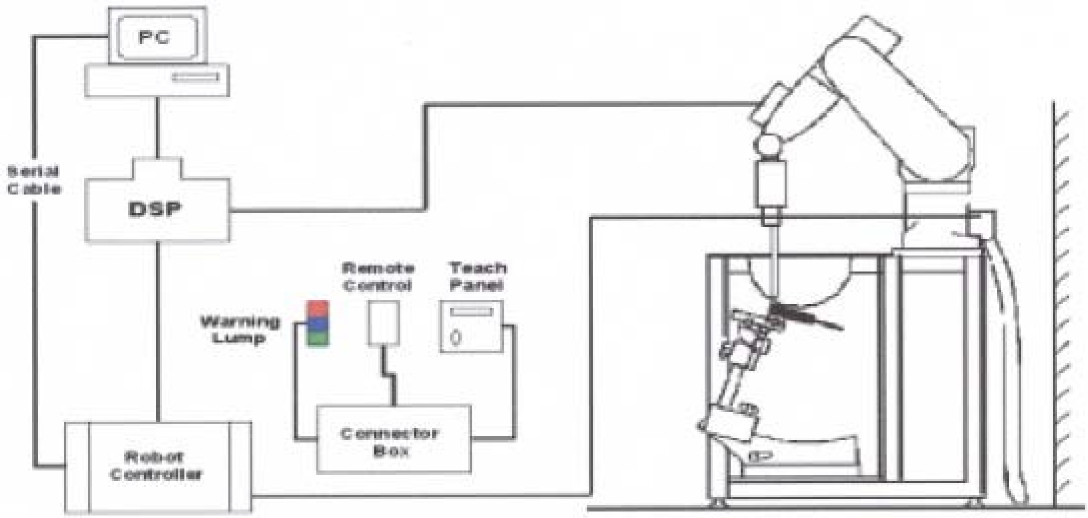
4. SAR MEASUREMENTS SYSTEM CONFIGURATION

4.1 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
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.

4.1.1 TEST SETUP LAYOUT



4.2 DASY5E-FIELDPROBESYSTEM

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

4.2.1 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

4.2.2 E-FIELD PROBE CALIBRATION

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than ±10%. The spherical isotropy was evaluated and found to be better than ± 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 thermostat-based temperature probe is used in conjunction with the E-field probe.

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

Where: Δt=Exposure time(30 seconds),

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

ΔT=Temperature increase due to RF exposure.

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

Where: σ= Simulated Tissue Conductivity,

ρ=Tissue density (kg/m3).

4.2.3 OTHER TEST EQUIPMENT

4.2.3.1. 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 light weight 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, ELI4and SAM v6.0Phantoms.
Material: POM, Acrylic glass, Foam

4.2.3.2 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	
Aailable	Special	

4.2.4 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 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

4.2.5 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, Computermathematik, 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.

4.2.6 DATA STORAGE AND EVALUATION

4.2.6.1 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 ".DAE4". 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.

4.2.7 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 multi meter 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

5. SYSTEM VERIFICATION PROCEDURE

5.1 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
Body 2450	-	31.4	-	0.1	-	-	68.5	-
Body 5G	-	-	-	-	-	10.7	78.6	10.7

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
Body	2450	22.5	1.969	53.190	1.95	52.7	0.97	0.93	Mar. 18, 2018
Body	5300	22.3	5.488	47.439	5.42	48.9	1.25	-2.99	Mar. 18, 2018
Body	5600	22.3	5.894	46.817	5.77	48.5	2.15	-3.47	Mar. 18, 2018
Body	5800	22.3	6.171	46.485	6.00	48.2	2.85	-3.56	Mar. 18, 2018

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.

5.2 SYSTEM CHECK

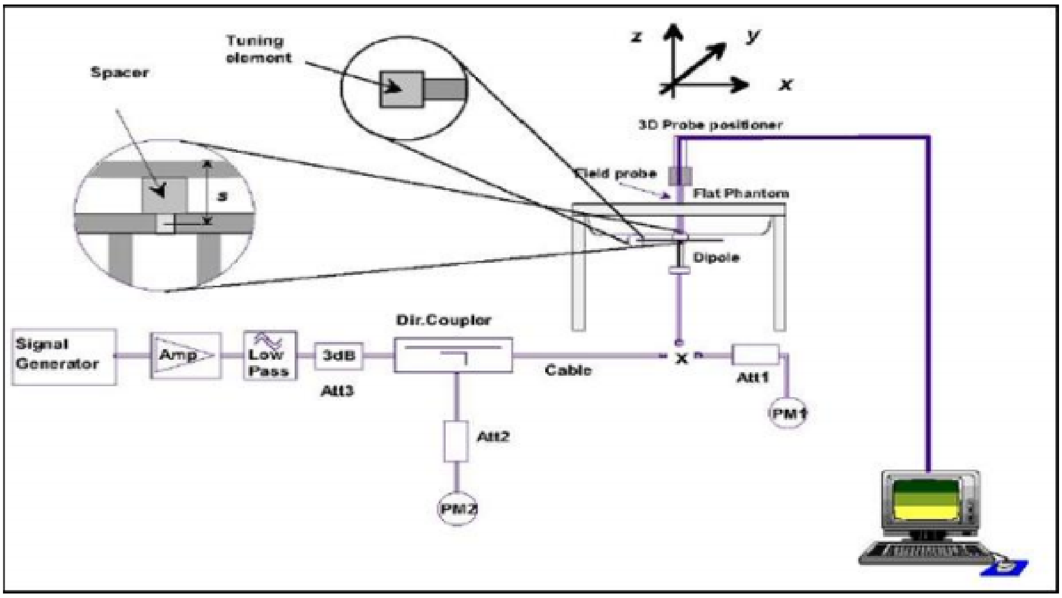
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests.

System Check	Frequency (MHz)	Date	Targeted SAR-1g (W/kg)	Measured SAR-1g (W/kg)	normalized SAR-1g (W/kg)	Deviation (%)	Dipole S/N
Body	2450	Mar. 18, 2018	51.10	13.00	52.00	1.76	919
Body	5300	Mar. 18, 2018	78.40	7.49	74.90	-4.46	1160
Body	5600	Mar. 18, 2018	81.50	8.13	81.30	-0.25	1160
Body	5800	Mar. 18, 2018	78.30	7.68	76.80	-1.92	1160

5.3 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 250 mW(below 5GHz) or 100mW(above 5GHz). 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 %).



6. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

6.1 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 8.2.

7. OPERATIONAL CONDITIONS DURING TEST

7.1 SAR TEST CONFIGURATION

7.1.1 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	99.04%	98.09%	97.96%	95.93%
Crest factor	1.01	1.02	1.02	1.04

5G

Mode	802.11a	802.11n HT20	802.11n HT40	802.11ac VHT20	802.11ac VHT40	802.11ac VHT80	802.11ac VHT160
Duty cycle	97.34%	97.80%	92.39%	95.15%	86.11%	75.00%	86.44%
Crest factor	1.03	1.02	1.08	1.05	1.16	1.33	1.16

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 test procedures in KDB 248227 D01 are applied.

7.1.1.1 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 ≤ 0.8 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 standalone 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.

7.1.1.2 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 ≤ 1.2 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.

7.1.1.3 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.

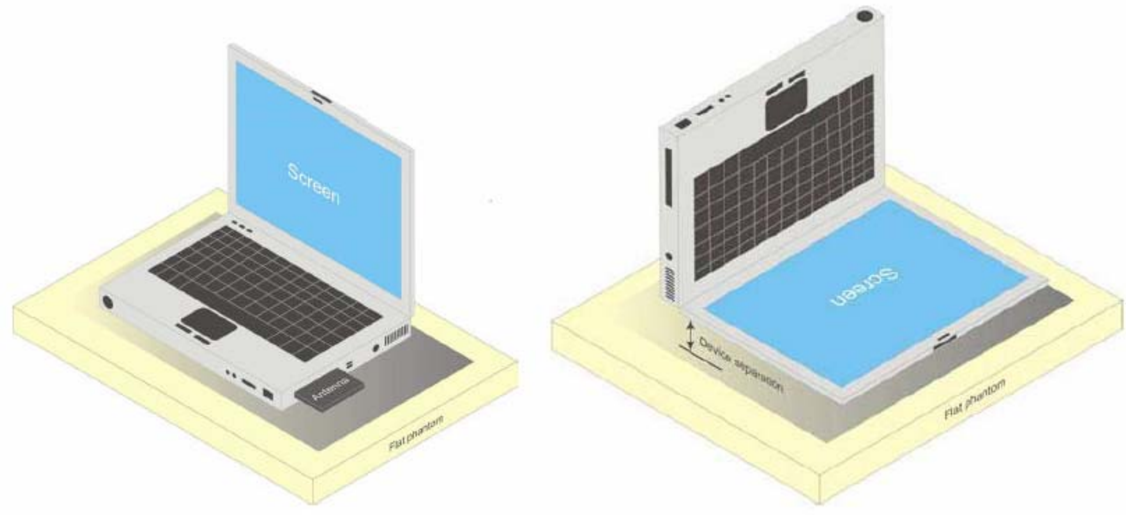
7.1.1.4 Initial test configuration procedure

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.

7.2 TEST POSITION

This DUT was tested in 2 different positions. They are bottom and back of screen as illustrated below:



8. TEST RESULT

8.1 CONDUCTED POWER RESULTS

8.1.1 CONDUCTED POWER MEASUREMENTS OF WIFI 2.4G

MIMO(Ant 1 +Ant 2）:

	Mode	Channel	Frequency (MHz)	Data Rate(Mbps)	Ant 1 Power(dBm)	Ant 2 Power(dBm)	Tune up	Average Power (dBm)	SAR Test (Yes/No)
2.4G	802.11b	1	2412	1	18.51	18.53	22.00	**21.53**	Yes
		6	2437		18.74	18.64	22.00	**21.70**	Yes
		11	2462		18.81	18.83	22.00	**21.83**	Yes
	802.11g	1	2412	6	18.26	18.39	22.00	21.34	No
		6	2437		18.56	18.59	22.00	21.59	No
		11	2462		18.73	18.32	22.00	21.54	No
	802.11n HT20	1	2412	MCS8	18.23	18.26	22.00	21.26	No
		6	2437		18.51	18.60	22.00	21.57	No
		11	2462		18.66	18.71	22.00	21.70	No
	802.11n HT40	3	2422	MCS8	16.38	16.14	20.00	19.27	No
		6	2437		16.37	16.52	20.00	19.46	No
		9	2452		16.56	16.66	20.00	19.62	No

SISO (Ant 1/Ant 2）:

	Mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Tune up	Ant 1 Power(dBm)	Ant 2 Power(dBm)
2.4G	802.11b	**1**	**2412**	**1**	15.50	15.33	15.08
		6	**2437**		15.50	15.43	15.47
		11	**2462**		15.50	15..4	15.17
	802.11g	**1**	**2412**	**6**	15.50	15.24	15.03
		6	**2437**		15.50	15.30	15.35
		11	**2462**		15.50	15.28	15.06
	802.11n HT20	**1**	**2412**	**MCS0**	15.50	15.16	15.47
		6	**2437**		15.50	15.21	15.28
		11	**2462**		15.50	15.19	15.41
	802.11n HT40	**3**	**2422**	**MCS0**	15.50	15.04	15.43
		6	**2437**		15.50	15.34	15.39
		9	**2452**		15.50	15.41	15.27

Note:

1) The Average conducted power of WiFi is measured with RMS detector.

2) Per KDB248227 D01, for WiFi 2.4GHz, 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.

8.1.1.1 CONDUCTED POWER MEASUREMENTS OF WIFI 5.2G

MIMO(Ant 1 +Ant 2）:

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Ant 1 Power(dBm)	Ant 2 Power(dBm)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
5.2G	802.11a	36	5180	6	15.30	15.60	19.00	18.47	No
		40	5200		15.80	15.75	19.00	18.79	No
		44	5220		15.41	15.43	19.00	18.43	No
		48	5240		15.36	15.44	19.00	18.41	No
	802.11n HT20	36	5180	MCS8	15.30	15.51	19.00	18.42	No
		40	5200		15.64	15.76	19.00	18.71	No
		44	5220		15.52	15.65	19.00	18.59	No
		48	5240		15.81	15.84	19.00	18.83	No
	802.11n HT40	38	5190	MCS8	14.31	14.77	18.00	17.56	No
		46	5230		14.59	14.34	18.00	17.48	No
	802.11ac HT20	36	5180	MCS8	15.75	15.77	19.00	18.77	No
		40	5200		15.60	15.74	19.00	18.68	No
		44	5220		15.56	15.69	19.00	18.64	No
		48	5240		15.55	15.69	19.00	18.63	No
	802.11ac HT40	38	5190	MCS8	14.69	14.91	18.00	17.81	No
		46	5230		14.88	14.78	18.00	17.84	No
	802.11ac VH80	42	5210	MCS8	12.65	12.87	16.00	15.77	No
	802.11ac VH160	50	5250	MCS8	11.50	11.81	15.00	14.67	No

SISO (Ant 1/Ant 2）:

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Ant 1 Power(dBm)	Ant 2 Power(dBm)
5.2G	802.11a	36	5180	6	14.50	14.40	14.19
		40	5200		14.50	14.16	14.23
		44	5220		14.50	14.03	14.10
		48	5240		14.50	13.97	14.47
	802.11n HT20	36	5180	MCS0	14.50	14.31	14.14
		40	5200		14.50	14.04	14.19
		44	5220		14.50	13.95	14.07
		48	5240		14.50	14.41	14.41
	802.11n HT40	38	5190	MCS0	14.50	13.97	13.98
		46	5230		14.50	14.18	14.24
	802.11ac HT20	36	5180	MCS0	14.50	14.30	14.12
		40	5200		14.50	14.11	14.21
		44	5220		14.50	13.94	14.05
		48	5240		14.50	14.37	14.40
	802.11ac HT40	38	5190	MCS0	14.50	14.02	13.97
		46	5230		14.50	14.16	14.24
	802.11ac VH80	42	5210	MCS0	14.50	14.21	13.99
	802.11ac VH160	50	5250	MCS0	14.50	14.37	14.04

8.1.1.2 CONDUCTED POWER MEASUREMENTS OF WIFI 5.3G

MIMO(Ant 1 +Ant 2）:

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Ant 1 Power(dBm)	Ant 2 Power(dBm)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
5.3G	802.11a	52	5260	6	15.58	15.43	19.00	**18.52**	Yes
		56	5280		15.40	15.36	19.00	**18.39**	Yes
		60	5300		15.34	15.26	19.00	**18.31**	Yes
		64	5320		15.70	15.68	19.00	**18.70**	Yes
	802.11n HT20	52	5260	MCS8	15.96	15.94	19.00	18.96	No
		56	5280		15.69	15.80	19.00	18.75	No
		60	5300		15.52	15.65	19.00	18.59	No
		64	5320		15.68	15.54	19.00	18.62	No
	802.11n HT40	54	5270	MCS8	14.52	14.58	18.00	17.56	No
		62	5310		14.42	14.39	18.00	17.41	No
	802.11ac HT20	52	5180	MCS8	15.51	15.90	19.00	18.72	No
		56	5200		15.60	15.69	19.00	18.66	No
		60	5220		15.72	15.59	19.00	18.67	No
		64	5240		15.44	15.78	19.00	18.63	No
	802.11ac HT40	54	5270	MCS8	14.79	14.59	18.00	17.70	No
		62	5310		14.90	14.39	18.00	17.66	No
	802.11ac VH80	58	5290	MCS8	12.60	12.93	16.00	15.77	No

SISO (Ant 1/Ant 2）:

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Ant 1 Power(dBm)	Ant 2 Power(dBm)
5.3G	802.11a	52	5260	6	14.50	14.28	14.34
		56	5280		14.50	14.13	14.27
		60	5300		14.50	14.17	14.33
		64	5320		14.50	14.02	14.44
	802.11n HT20	52	5260	MCS0	14.50	14.12	14.28
		56	5280		14.50	14.01	14.20
		60	5300		14.50	13.96	14.21
		64	5320		14.50	14.44	14.37
	802.11n HT40	54	5270	MCS0	14.50	14.36	14.07
		62	5310		14.50	14.13	14.08
	802.11ac HT20	52	5180	MCS0	14.50	14.25	14.26
		56	5200		14.50	14.02	14.18
		60	5220		14.50	13.95	14.21
		64	5240		14.50	14.40	14.39
	802.11ac HT40	54	5270	MCS0	14.50	14.32	14.03
		62	5310		14.50	14.16	14.09
	802.11ac VH80	58	5290	MCS0	14.50	14.31	14.33

8.1.1.3 CONDUCTED POWER MEASUREMENTS OF WIFI 5.6G

MIMO(Ant 1 +Ant 2）:

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Ant 1 Power(dBm)	Ant 2 Power(dBm)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
5.6G	802.11a	100	5500	6	15.27	15.95	19.00	**18.64**	Yes
		104	5520		15.40	15.84	19.00	**18.64**	Yes
		108	5540		15.51	15.86	19.00	**18.70**	Yes
		112	5560		15.59	15.65	19.00	**18.63**	Yes
		116	5580		15.44	15.71	19.00	**18.59**	Yes
		132	5660		15.46	15.48	19.00	**18.48**	Yes
		136	5680		15.50	15.83	19.00	**18.68**	Yes
		140	5700		15.66	15.54	19.00	**18.61**	Yes
	802.11n HT20	100	5500	MCS8	15.42	15.83	19.00	18.64	No
		104	5520		15.59	15.94	19.00	18.78	No
		108	5540		15.81	15.50	19.00	18.67	No
		112	5560		15.91	15.69	19.00	18.81	No
		116	5580		15.25	15.56	19.00	18.42	No
		132	5660		15.40	15.60	19.00	18.51	No
		136	5680		15.51	15.56	19.00	18.54	No
		140	5700		15.59	15.49	19.00	18.55	No
	802.11n HT40	102	5510	MCS8	14.82	14.70	18.50	17.77	No
		110	5550		15.03	15.08	18.50	18.07	No
		118	5590		14.92	14.87	18.50	17.91	No
		126	5630		15.01	14.93	18.50	17.98	No
		134	5670		14.93	14.52	18.50	17.74	No
	802.11ac HT20	100	5500	MCS8	15.75	15.66	19.00	18.72	No
		104	5520		15.68	15.60	19.00	18.65	No
		108	5540		15.71	15.68	19.00	18.71	No
		112	5560		15.79	15.80	19.00	18.81	No
		116	5580		15.95	15.88	19.00	18.93	No
		132	5660		15.80	15.78	19.00	18.80	No
		136	5680		15.75	15.69	19.00	18.73	No
		140	5700		15.84	15.49	19.00	18.68	No
	802.11ac HT40	102	5510	MCS8	14.87	14.65	18.50	17.77	No
		110	5550		14.99	15.29	18.50	18.15	No
		118	5590		14.87	15.21	18.50	18.05	No
		126	5630		14.83	15.12	18.50	17.99	No
		134	5670		14.94	15.04	18.50	18.00	No

	802.11ac VH80	106	5530	MCS8	12.43	12.81	16.00	15.63	No
		122	5610		12.74	12.51	16.00	15.64	No
	802.11ac VH160	114	5570	MCS8	11.24	11.50	15.00	14.39	No

SISO (Ant 1/Ant 2）:

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Ant 1 Power(dBm)	Ant 2 Power(dBm)
5.6G	802.11a	100	5500	6	16.00	15.91	15.57
		104	5520		16.00	15.64	15.52
		108	5540		16.00	15.55	15.49
		112	5560		16.00	15.49	15.47
		116	5580		16.00	15.47	15.81
		132	5660		16.00	15.57	15.52
		136	5680		16.00	15.68	15.48
		140	5700		16.00	15.77	15.83
	802.11n HT20	100	5500	MCS0	16.00	15.84	15.49
		104	5520		16.00	15.47	15.44
		108	5540		16.00	15.52	15.47
		112	5560		16.00	15.49	15.89
		116	5580		16.00	15.93	15.78
		132	5660		16.00	15.46	15.92
		136	5680		16.00	15.62	15.88
		140	5700		16.00	15.78	15.76
	802.11n HT40	102	5510	MCS0	16.00	15.84	15.84
		110	5550		16.00	15.44	15.82
		118	5590		16.00	15.32	15.72
		126	5630		16.00	15.38	15.63
		134	5670		16.00	15.47	15.87
	802.11ac HT20	100	5500	MCS0	16.00	15.86	15.51
		104	5520		16.00	15.58	15.47
		108	5540		16.00	15.51	15.49
		112	5560		16.00	15.92	15.89
		116	5580		16.00	15.44	15.73
		132	5660		16.00	15.49	15.90
		136	5680		16.00	15.63	15.88
		140	5700		16.00	15.81	15.78

	802.11ac HT40	102	5510	MCS0	16.00	15.77	15.85
		110	5550		16.00	15.74	15.81
		118	5590		16.00	15.66	15.72
		126	5630		16.00	15.74	15.77
		134	5670		16.00	15.46	15.87
	802.11ac VH80	106	5530	MCS0	16.00	15.72	15.62
		122	5610		16.00	15.89	15.90
	802.11ac VH160	114	5570	MCS0	16.00	15.78	15.51

8.1.1.4 CONDUCTED POWER MEASUREMENTS OF WIFI 5.8G

MIMO(Ant 1 +Ant 2）:

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Ant 1 Power(dBm)	Ant 2 Power(dBm)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
5.8G	802.11a	149	5745	6	15.32	15.24	19.00	**18.29**	Yes
		153	5765		15.24	15.70	19.00	**18.49**	Yes
		157	5785		15.50	15.78	19.00	**18.65**	Yes
		161	5805		15.57	15.83	19.00	**18.71**	Yes
		165	5825		15.62	15.90	19.00	**18.77**	Yes
	802.11n HT20	149	5745	MCS8	15.26	15.56	19.00	18.42	No
		153	5765		15.22	15.59	19.00	18.42	No
		157	5785		15.11	15.64	19.00	18.39	No
		161	5805		15.17	15.71	19.00	18.46	No
		165	5825		15.15	15.77	19.00	18.48	No
	802.11n HT40	151	5755	MCS8	14.44	14.63	18.00	17.55	No
		159	5795		14.34	15.00	18.00	17.69	No
	802.11 ac VH20	149	5745	MCS8	15.74	15.38	19.00	18.58	No
		153	5765		15.59	15.26	19.00	18.44	No
		157	5785		15.52	15.96	19.00	18.76	No
		161	5805		15.62	15.73	19.00	18.69	No
		165	5825		15.72	15.70	19.00	18.72	No
	802.11 ac VH40	151	5755	MCS8	14.47	14.60	18.00	17.54	No
		159	5795		14.79	14.95	18.00	17.88	No
	802.11ac VH80	155	5775	MCS8	12.81	13.15	16.00	15.99	No

SISO (Ant 1/Ant 2）:

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Ant 1 Power(dBm)	Ant 2 Power(dBm)
5.8G	802.11a	149	5745	6	13.50	13.39	13.34
		153	5765		13.50	13.06	13.29
		157	5785		13.50	13.01	13.40
		161	5805		13.50	12.98	13.02
		165	5825		13.50	13.03	13.19
	802.11n HT20	149	5745	MCS0	13.50	13.46	13.27
		153	5765		13.50	13.09	13.25
		157	5785		13.50	13.06	13.35
		161	5805		13.50	13.45	13.39
		165	5825		13.50	13.02	13.07
	802.11n HT40	151	5755	MCS0	13.50	13.16	13.10
		159	5795		13.50	13.24	13.16
	802.11ac HT20	149	5745	MCS0	13.50	13.44	13.23
		153	5765		13.50	13.03	13.15
		157	5785		13.50	13.06	13.26
		161	5805		13.50	13.46	13.38
		165	5825		13.50	12.98	13.10
	802.11ac HT40	151	5755	MCS0	13.50	13.22	13.05
		159	5795		13.50	13.26	13.11
	802.11ac VH80	155	5775	MCS0	13.50	13.28	15.81

8.1.1.5 CONDUCTED POWER MEASUREMENTS OF BT

BT	Tune up	Average Conducted Power(dBm)		
		CH0	CH39	CH78
		2402	2441	2480
DH5	4.00	3.64	3.89	3.71
2DH5	4.00	2.26	3.42	3.21
3DH5	4.00	2.24	3.41	3.20

BT	Tune up	Average Conducted Power(dBm)		
		CH0	CH19	CH39
		2402	2441	2480
BLE(1M)	4.00	3.83	3.92	3.49
BLE(2M)	4.00	3.39	3.49	3.11

8.2 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 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 mode 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 7.1 for more information.

8.2.1 SAR MEASUREMENT RESULT

8.2.1.1 SAR measurement Result of 2.4G WiFi

Test No.	Band	Channel	Test Position	Separation Distance (cm)	ANT vendor	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift	SAR 1g	Scaled 1g SAR	Crest Factor	Reported 1g SAR
T01	802.11b	11	Back of Screen	2.5	MIMO	1	22	21.83	0	0.018	0.018	1.01	0.019
T02	802.11b	11	Back of Keyboard	0	MIMO	1	22	21.83	0.02	0.196	0.204	1.01	0.206
T03	802.11b	1	Back of Keyboard	0	MIMO	1	22	21.53	0	**0.222**	**0.247**	1.01	**0.250**
T04	802.11b	6	Back of Keyboard	0	MIMO	1	22	21.70	0	0.210	0.225	1.01	0.227

Note: 1.The value with boldface is the maximum SAR Value of each test band.

8.2.1.2 SAR measurement Result of 5G WiFi

Test No.	Band	CH	Test Position	Separation Distance (cm)	ANT vendor	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift	SAR 1g	Scaled 1g SAR	Crest Factor	Reported 1g SAR
T06	802.11a	64	Back of Screen	2.5	MIMO	6	19	18.70	0	0.066	0.070	1.03	0.072
T07	802.11a	64	Back of Keyboard	0	MIMO	6	19	18.70	0	**0.182**	0.195	1.03	0.200
T08	802.11a	52	Back of Keyboard	0	MIMO	6	19	18.52	0	0.152	0.170	1.03	0.174
T09	802.11a	56	Back of Keyboard	0	MIMO	6	19	18.39	0	0.161	0.185	1.03	0.190
T10	802.11a	60	Back of Keyboard	0	MIMO	6	19	18.31	0	0.179	**0.210**	1.03	**0.215**
T12	802.11a	108	Back of Screen	2.5	MIMO	6	19	18.70	0	0.031	0.033	1.03	0.034
T13	802.11a	108	Back of Keyboard	0	MIMO	6	19	18.70	0	0.201	0.215	1.03	0.221
T14	802.11a	100	Back of Keyboard	0	MIMO	6	19	18.64	0	0.184	0.200	1.03	0.206
T15	802.11a	104	Back of Keyboard	0	MIMO	6	19	18.64	0.05	0.168	0.183	1.03	0.188
T16	802.11a	112	Back of Keyboard	0	MIMO	6	19	18.63	-0.12	0.172	0.187	1.03	0.192
T17	802.11a	116	Back of Keyboard	0	MIMO	6	19	18.59	0	0.155	0.170	1.03	0.175
T18	802.11a	132	Back of Keyboard	0	MIMO	6	19	18.48	0	0.188	0.212	1.03	0.218
T19	802.11a	136	Back of Keyboard	0	MIMO	6	19	18.68	0	**0.224**	**0.241**	1.03	**0.248**
T20	802.11a	140	Back of Keyboard	0	MIMO	6	19	18.61	0	0.206	0.225	1.03	0.231
T22	802.11a	165	Back of Screen	2.5	MIMO	6	19	18.77	0	0.039	0.041	1.03	0.042
T23	802.11a	165	Back of Keyboard	0	MIMO	6	19	18.77	0	**0.238**	**0.251**	1.03	**0.258**
T24	802.11a	149	Back of Keyboard	0	MIMO	6	19	18.29	-0.04	0.211	0.248	1.03	0.255
T25	802.11a	153	Back of Keyboard	0	MIMO	6	19	18.49	0	0.203	0.228	1.03	0.235
T26	802.11a	157	Back of Keyboard	0	MIMO	6	19	18.65	0	0.224	0.243	1.03	0.249
T27	802.11a	161	Back of Keyboard	0	MIMO	6	19	18.71	0.01	0.197	0.210	1.03	0.216

Note: 1.The value with boldface is the maximum SAR Value of each test band.

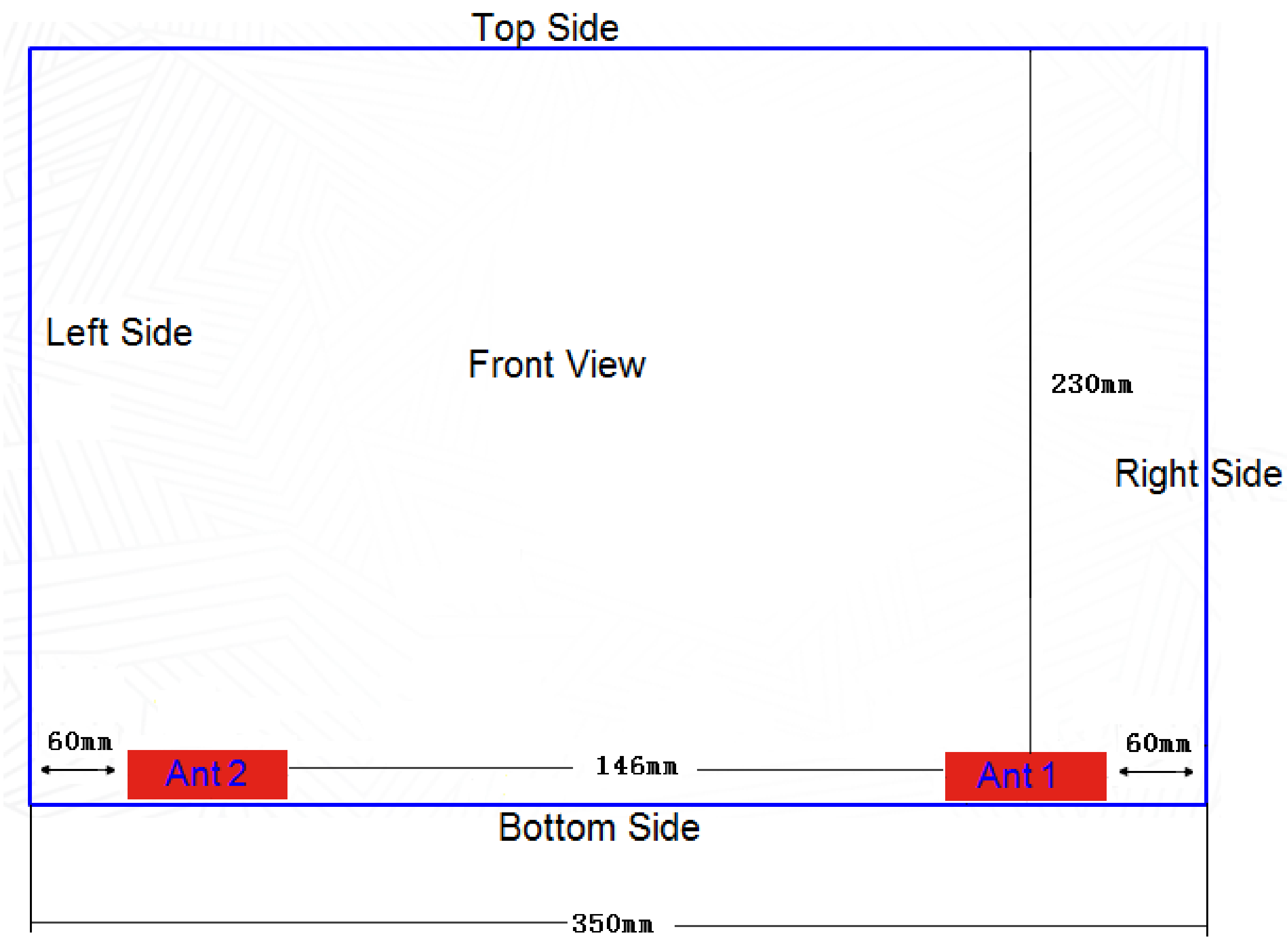
8.2.1.3 SAR measurement Result of BT

Test No.	Band	CH	Test Position	Separation Distance (cm)	ANT vendor	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift	SAR 1g	Scaled 1g SAR	Crest Factor	Reported 1g SAR
T30	BT	39	Back of Screen	2.5	Aux	1	4	3.89	0	0	0.000	1.30	0.000
T31	BT	39	Back of Keyboard	0	Aux	1	4	3.89	0	0.003	0.003	1.30	0.004
T32	BT	0	Back of Keyboard	0	Aux	1	4	3.64	0	**0.004**	**0.004**	1.30	**0.006**
T33	BT	78	Back of Keyboard	0	Aux	1	4	3.71	0	0.002	0.002	1.30	0.003

8.3 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 pad is shown as below picture:



8.3.1 STAND-ALONE SAR TEST EXCLUSION

Per FCC KDB 447498D01, SAR compliance for simultaneous transmission must be considered when the maximum duration of overlapping transmissions, including network hand-offs, is greater than 30 seconds. This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis.

WiFi 2.4G / WiFi 5G / BT transmit simultaneously

Co-Location	2.4G WLAN (Aux)	5G WLAN (Aux)	BT(Aux)
2.4G WLAN (Main)	No	No	Yes
5G WLAN (Main)	No	No	Yes
BT(Aux)	Yes	Yes	No

Note: BT antenna only supports the aux antenna.

8.3.2 SIMULTANEOUS TRANSMISSION CONDITIONS

About WIFI and Bluetooth transmit simultaneously

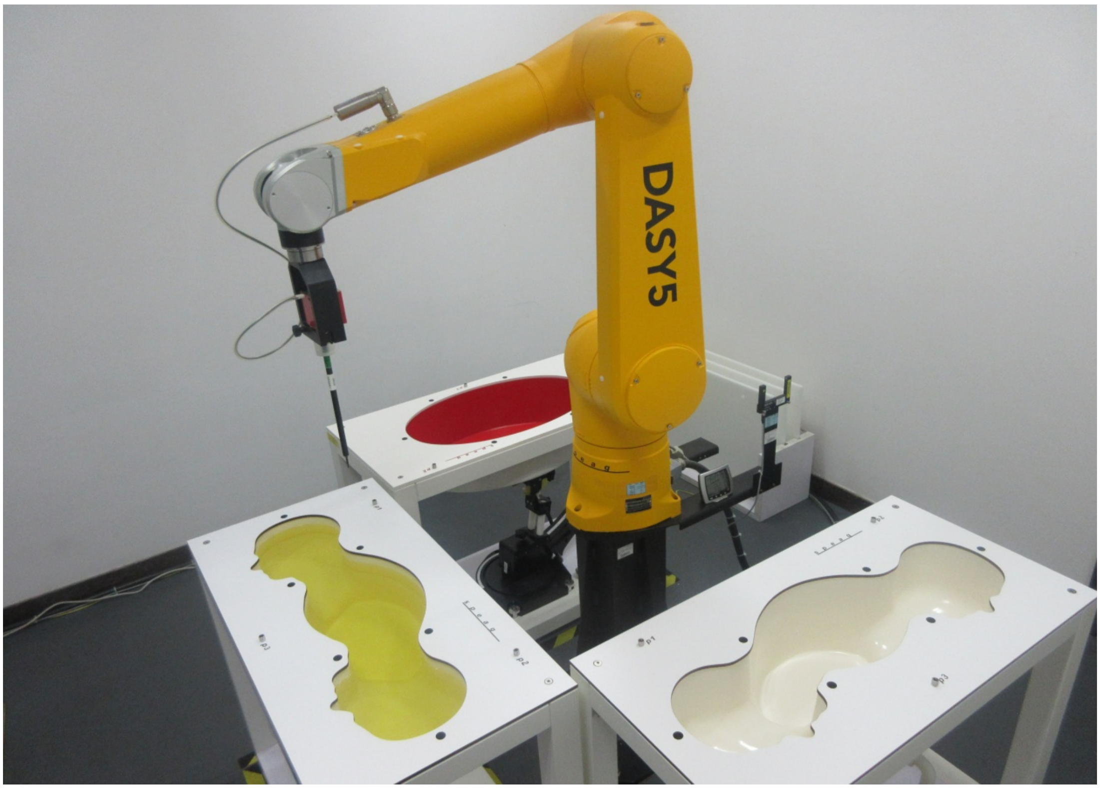
Reported SAR_{1g}(W/Kg) \ Position	Back of Screen	Back of Keyboard
WiFi 2.4G	0.019	0.250
WiFi 5.3G	0.072	0.215
WiFi 5.6G	0.034	0.248
WiFi 5.8G	0.042	0.258
BT	0.000	0.006
MAX $\sum SAR_{1g}$	**0.072**	**0.263**

MAX. $\sum SAR_{1g}$=0.263W/Kg<1.6 W/Kg,so Simultaneous SAR are not required for WIFI and Bluetooth.

APPENDIX

1. Test Layout

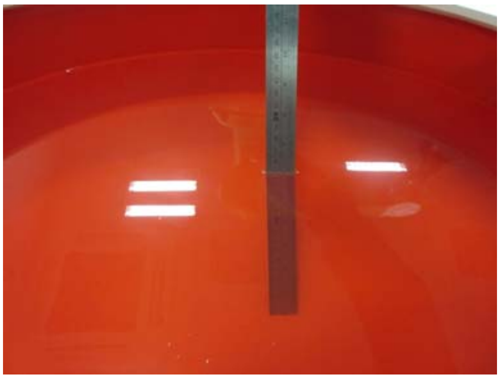
Specific Absorption Rate Test Layout



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

Body(1900~3800MHz)_15.7cm

Body (5G)_15.1cm



Appendix A. SAR Plots of System Verification

(Pls See Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See Appendix B.)

Appendix C. Calibration Certificate for Probe and Dipole

(Pls See Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See Appendix D.)