FCC SAR Test Report

FCC ID: 2AIQB-L16

Project No.	:	1703213
Equipment	:	Camera
Model Name	:	L16
Applicant	:	Light Labs Inc.
Address	:	6636 Ramona St., Palo Alto, CA 94301, United States

Date of Receipt	:	May, 18. 2017
Date of Test	:	May, 03. 2017 ~ May, 08. 2017
Issued Date	:	May, 11. 2017
Tested by	:	BTL Inc.

Jerome Chang

PREPARED BY : (Jerome Chang/ Technical Engineer)

Herbort Liu

APPROVED BY : (Herbort Liu / Technical Manager)

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Testing Laboratory
0659

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 the standards traceable to National Measurement Laboratory (**NML**), or National Institute of Standards and Technology (**NIST**) .

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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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.	Description	Issued Date
BTL-FCC SAR-1-1703213	Original Issue.	May, 11. 2017

1 GENERAL SUMMARY

Equipment	Camera
Model Name	L16
Brand Name	Light
Manufacturer	FIH Mobile Limited
Address	No.4, Mingsheng St.,Tu-Cheng Dist., New Taipei City 23679, Taiwan
Standard(s)	**FCC 47CFR §2.1093** Radio frequency Radiation Exposure Evaluation: Portable Devices **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 **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

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-1-1703213) 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. 68-1, Ln. 169, Sec.2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan.

2.2 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.

3. GENERAL INFORMATION

3.1 STATEMENT OF COMPLIANCE

Equipment Class	Mode	Highest Body(0mm) SAR-1g(W/kg)
DTS	2.4G WLAN	0.574
U-NII	5G WLAN	0.893

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/IEEE C95.1:1992, 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.

3.1.1 GENERAL DESCRIPTION OF EUT

<table>
<tr><td>Equipment</td><td colspan="2">Camera</td></tr>
<tr><td>Model Name</td><td colspan="2">L16</td></tr>
<tr><td>S/N</td><td colspan="2">LFCGLD2730600008</td></tr>
<tr><td>HW Version</td><td colspan="2">DVT</td></tr>
<tr><td>SW Version</td><td colspan="2">TBC</td></tr>
<tr><td>Modulation</td><td colspan="2">WiFi(DSSS/OFDM),BT(GFSK/ π /4-DQPSK/8-DPSK)</td></tr>
<tr><td rowspan="2">Operation Frequency Range(s)</td><td>WIFI 2.4G</td><td>2412 ~ 2462</td></tr>
<tr><td>WIFI 5G</td><td>5180 ~ 5825</td></tr>
<tr><td rowspan="2">Test Channels (low-mid-high):</td><td>WIFI 2.4G</td><td>1-11 (802.11b/g/n HT40)</td></tr>
<tr><td>WIFI 5G</td><td>38-52-132-134-149-157
(802.11a/n/ac HT20/HT40/VHT80)</td></tr>
<tr><td>Antenna Gain</td><td colspan="2">BT/2.4G WiFi: -0.4dBi</td></tr>
<tr><td colspan="3">Other Informatio</td></tr>
<tr><td>Battery</td><td colspan="2">Battery Model: LFC
Nominal Voltage: ⎓ +3.8
Charging Voltage: ⎓ +4.35V
Rated capacity: 4120 mAh
Manufacturer: Leung’s Communication & Electric Product (Guangzhou) LTD.</td></tr>
</table>

3.2 LABORATORY ENVIRONMENT

<table>
<tr><td>Temperature</td><td>Min. = 18ºC, Max. = 25ºC</td></tr>
<tr><td>Relative humidity</td><td>Min. = 30%, Max. = 70%</td></tr>
<tr><td>Ground system resistance</td><td>< 0.5Ω</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

3.3 MAIN TEST INSTRUMENTS

Item	Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Interval
1	E-field Probe	Speag	EX3DV4	7369	Aug. 31, 2016	1 Year
2	Data Acquisition Electronics	Speag	DAE4	1486	Aug. 23, 2016	1 Year
3	System Validation Dipole	Speag	D2450V2	973	Aug. 14, 2015	3 Year
4	System Validation Dipole	Speag	D5GHzV2	1221	Aug. 11, 2015	3 Year
5	Oval Flat Phantom	Speag	Oval Flat Phantom ELI 5.0	1240	N/A	N/A
6	Power Amplifier	Mini-Circuits	ZVE-2W-272+	N650001538	N/A	Note 1
7	Power Amplifier	Mini-Circuits	ZVE-8G+	N628801631	N/A	Note 1
8	ENA Network Analyzer	Keysight	E5071C	MY46524658	Dec. 06, 2016	1 Year
9	EXG Vector Signal Generator	Keysight	N5172B	MY53051229	Dec. 16, 2016	1 Year
10	Power Meter	Anritsu	ML2495A	1128008	Aug. 18, 2016	1 Year
11	Power Sensor	Anritsu	MA2411B	1126001	Aug. 18, 2016	1 Year
12	Power Meter	Anritsu	4232A	10179	Nov. 25, 2016	1 Year
13	Power Sensor	Anritsu	51011	34150	Nov. 25, 2016	1 Year
14	Spectrum Analyzer	Keysight	N9010A	MY54200483	Oct. 04, 2016	2 Year
15	Dielectric Assessment Kit	Speag	DAK-3.5	1226	Dec. 09, 2015	N/A
16	Low pass filter	Mini-Circuits	SLP-2950+	M108294	N/A	N/A
17	Attenuator	Worken	WFA0602-10	SA10-01	N/A	Note 1
18	Attenuator	Worken	WFA0602-10	SA10-02	N/A	Note 1
19	Attenuator	Worken	WFA0602-3	SA3-01	N/A	Note 1
20	Dual directional coupler	Woken	0110A05601O-10	DOM5CIW3E2	N/A	Note 1
21	Digital Thermometer	LKM electronic GmbH	DTM3000	1341359457	Jul. 20, 2016	1 Year
22	Thermo-hygrometer	Testo	608-H1	N/A	Oct. 19, 2016	1 Year

Note: 1. " N/A" denotes no model name, serial No. or calibration specified.

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

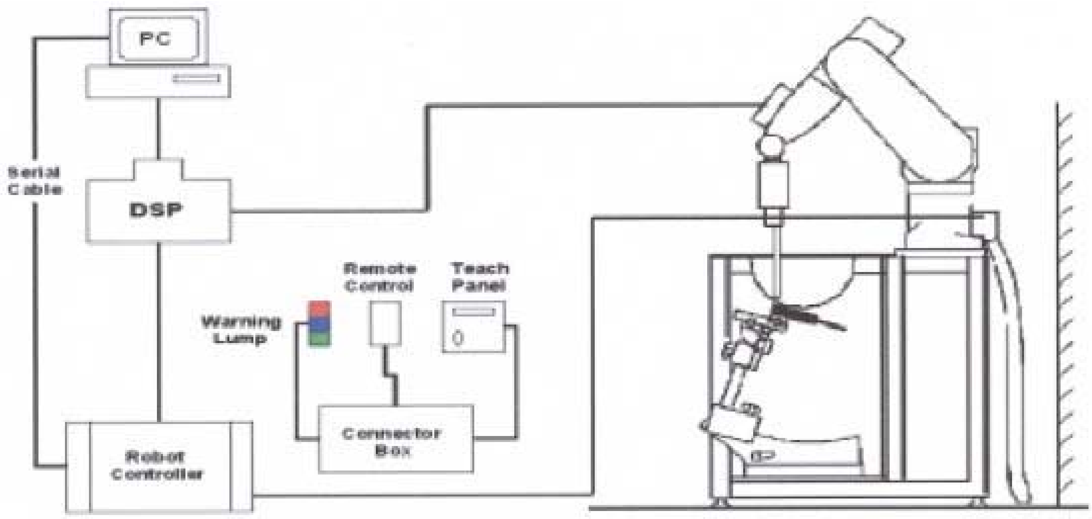
4.SAR MEASUREMENTS SYSTEM CONFIGURATION

4.1SAR 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.

4.1.1Test Setup Layout



4.2DASY5E-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.

4.2.1EX3DV4 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

4.2.2E-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 thermistor-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

Model	Twin SAM
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.
Shell Thickness	2 ± 0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	Length:1000mm; Width: 500mm 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) 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 in x- 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}, $\Delta y_{zoom} \leq$ 2GHz -≤8mm, 2-4GHz -≤5 mm and 4-6 GHz-≤4mm; $\Delta z_{zoom} \leq$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

4.2.5SPATIAL 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, Computermathematik, 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 compansate boundary effects on E-field probes.

4.2.6DATA STORAGE AND EVALUATION

4.2.6.1Data 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.

4.2.6.2 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 2.4G	-	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	1.990	51.538	1.95	52.7	2.05	-2.20	May. 08, 2017
Body	5200	22.3	5.353	47.621	5.30	49.0	1.00	-2.81	May. 04, 2017
Body	5300	22.3	5.488	47.447	5.42	48.9	1.25	-2.97	May. 04, 2017
Body	5600	22.3	5.920	46.900	5.77	48.5	2.60	-3.30	May. 04, 2017
Body	5800	22.3	6.209	46.515	6.00	48.2	3.48	-3.50	May. 03, 2017

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

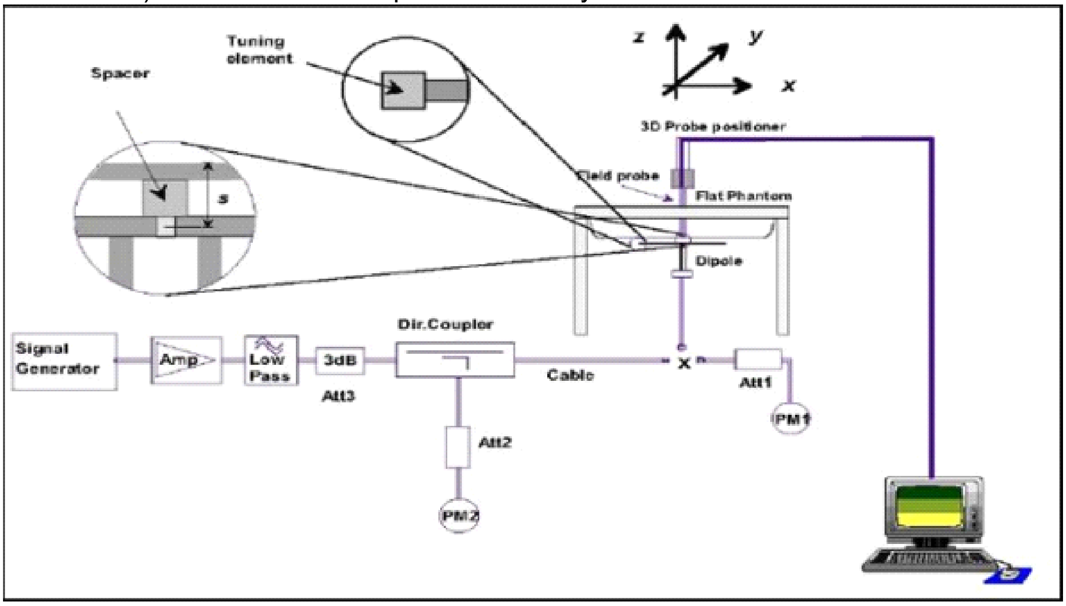
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands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

System Check	Date	Frequency (MHz)	Targeted SAR-1g (W/kg)	Measured SAR-1g (W/kg)	Normalized SAR-1g (W/kg)	Deviation (%)	Dipole S/N
Body	May. 08, 2017	2450	51.70	13.00	52.00	0.58	973
Body	May. 04, 2017	5200	74.70	7.31	73.10	-2.14	1221
Body	May. 04, 2017	5300	75.80	7.39	73.90	-2.51	1221
Body	May. 04, 2017	5600	80.60	8.18	81.80	1.49	1221
Body	May. 03, 2017	5800	77.70	7.98	79.80	2.70	1221

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.



6.SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

6.1SAR 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 9.1.

7. OPERATIONAL CONDITIONS DURING TEST

7.1 SAR TEST CONFIGURATIO

7.1.1 WiFi Test Configuration

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

Mode	802.11b	802.11g	802.11a	802.11n HT20/40	802.11ac VHT20/40/80
Duty cycle	100%				
Crest factor	1				

7.1.4.1 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.

7.2 TEST POSITION

7.2.1 Body

The SAR testing for this module has performed the five surfaces by 5mm.

When the standalone SAR test exclusion of 4.3.1 applies and no SAR test is required, or the highest reported 1-g SAR is ≤ 0.4 W/kg, modules and peripheral transmitters may be approved to operate in qualified host and portable device exposure conditions with no restriction for most host platform configurations. This applies to both OEM installed and user accessible external peripheral transmitters. A test separation distance of 5 mm must be applied to determine test exclusion, according to the SAR Test Exclusion Threshold requirements. Except for modules with built-in integral antennas embedded within self-contained outer housings where the test separation distance may be considered from the outer housing, the antenna to user separation distance should be applied for all other configurations. The separation distance for incorporation into host devices is described in 4.1 f). When SAR measurement is required, a test separation distance ≤ 5 mm must be applied and the energy coupling enhancement test in 5.2.4 is also required. This unrestricted host platform approval approach does not apply when the reported 1-g SAR required by the energy coupling enhancement test is > 0.45 W/kg or when a test separation distance greater than 5 mm is necessary to maintain compliance; for example, through specific installation requirements or restricted use conditions, which must be considered separately in other host platforms. The approval conditions for incorporation into host devices must be clearly identified in the equipment certification and in all required OEM integration and installation instructions..

SAR test reduction and exclusion guidance

(1)The SAR exclusion threshold for distances<50mm is defined by the following equation:

$$\frac{\text{(max. power of channel, including tune-up tolerance, mW)}}{\text{(min. test separation distance, mm)}} \cdot \sqrt{\text{Frequency (GHz)}} \leq 3.0$$

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

(2)The SAR exclusion threshold for distances>50mm is defined by the following equation, as illustrated in KDB 447498 D01 Appendix B:

a) at 100 MHz to1500 MHz

[Power allowed at numeric Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · ($f_{(MHz)}$/150)] mW

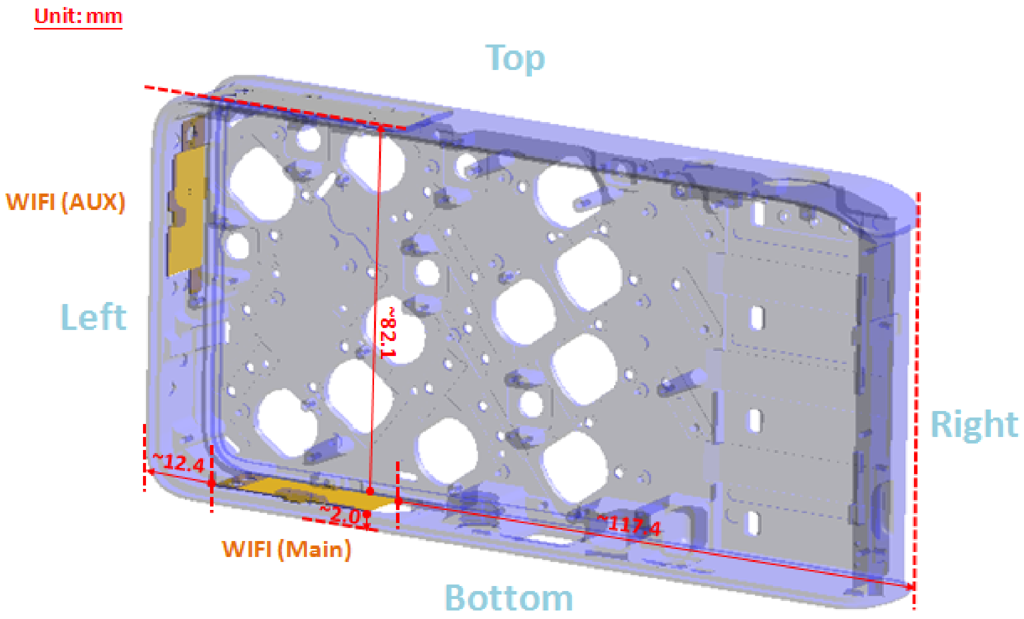
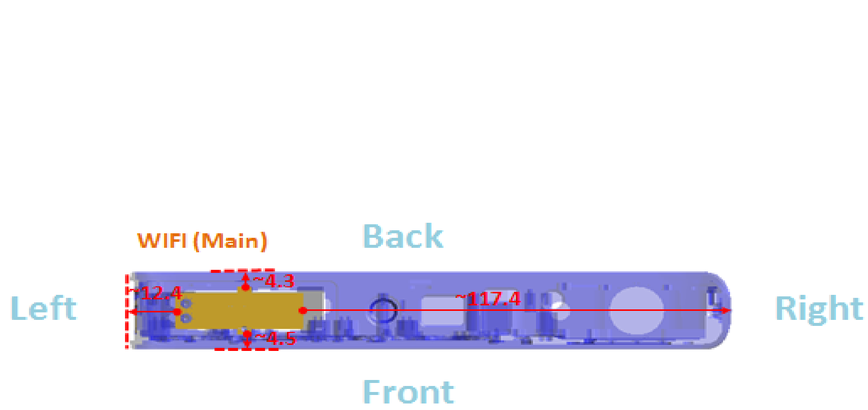
b) at >1500MHz and ≤6GHz

[Power allowed at numeric Threshold at 50 mm in step 1) + (test separation distance - 50 mm) ·10] mW

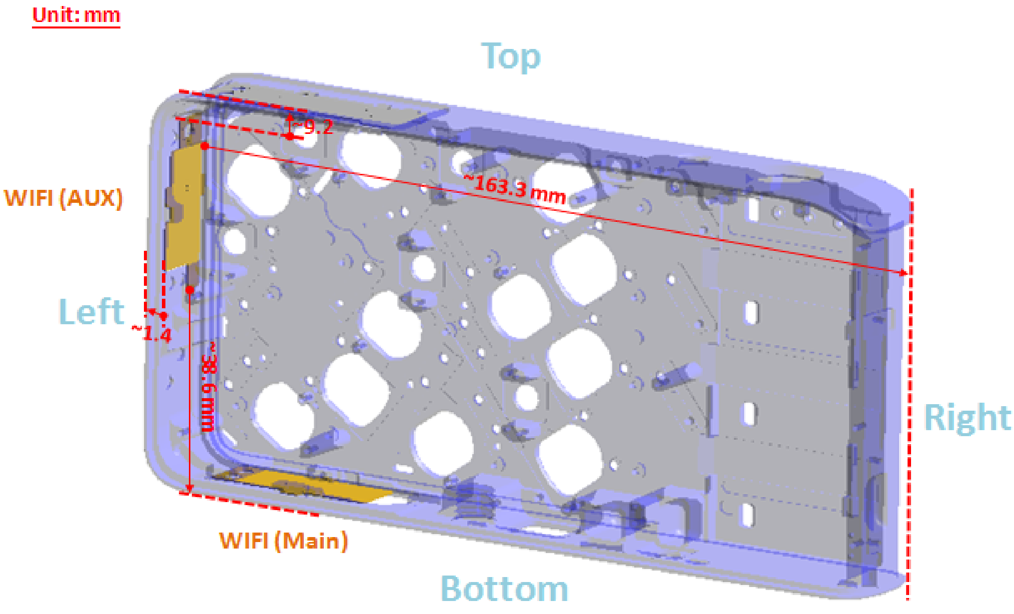
Antenna to edge

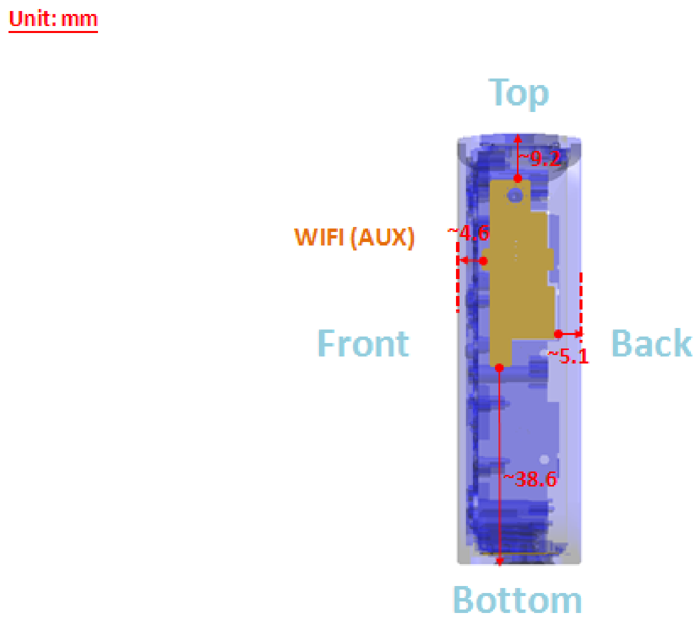
Antenna	To Front Face (mm)	To Rear Face (mm)	To Left Side (mm)	To Right Side (mm)	To Top Side (mm)	To Bottom Side (mm)
WLAN / BT Ant 0	4.5	4.3	12.4	117.4	82.1	2
WLAN Ant 1	4.6	5.1	1.4	163.3	9.2	38.6

The location of the antennas is shown as below picture:

Antenna Location
Main Ant



Aux Ant


Unit: mm
Top
~9.2
~163.3 mm
WIFI (AUX)
Left
~1.4
~38.6 mm
Right
WIFI (Main)
Bottom


Unit: mm
Top
~9.2
WIFI (AUX)
~4.6
Front
Back
~5.1
~38.6
Bottom

The distance <50mm for Main Ant (SISO)

Band	Frequency (MHz)	Turn-UP (dBm)	Turn-UP (mW)	Position	Front Face	Rear Face	Left Side	Bottom Side
				Antenna -to -edge distance(mm)	5	5	12.4	5
2.4G	2462	17	50.12	Exclusion considerations(mW)	15.73	15.73	6.34	15.73
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes
5G Band I	5240	13.5	23.39	Exclusion considerations(mW)	10.25	10.25	4.13	10.25
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes
5G Band II	5320	13.5	23.39	Exclusion considerations(mW)	10.33	10.33	4.16	10.33
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes
5G Band III	5700	13.5	23.39	Exclusion considerations(mW)	10.69	10.69	4.31	10.69
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes
5G Band IV	5825	13.5	23.39	Exclusion considerations(mW)	10.81	10.81	4.36	10.81
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes
BT	2480	9.5	8.91	Exclusion considerations(mW)	2.81	2.81	1.13	2.81
				Test requirements(Yes/No)	No	No	No	No

Note: The front face, rear face and bottom side distance to edge is under 5mm, according KDB447498 D01 4.31 a), when the minimum test separation distance is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

The distance >50mm for Main Ant (SISO)

Band	Frequency	Turn-UP (dBm)	Turn-UP (mW)	Position	Right Side	Top Side
				Antenna -to -edge distance(mm)	117.4	82.1
2.4G	2462	17	50.12	Exclusion considerations(mW)	769.60	416.60
				Test requirements(Yes/No)	No	No
5G Band I	5240	13.5	23.39	Exclusion considerations(mW)	739.53	386.53
				Test requirements(Yes/No)	No	No
5G Band II	5320	13.5	23.39	Exclusion considerations(mW)	739.03	386.03
				Test requirements(Yes/No)	No	No
5G Band III	5700	13.5	23.39	Exclusion considerations(mW)	736.83	383.83
				Test requirements(Yes/No)	No	No
5G Band IV	5825	13.5	23.39	Exclusion considerations(mW)	736.15	383.15
				Test requirements(Yes/No)	No	No
BT	2480	9.5	8.91	Exclusion considerations(mW)	769.25	416.25
				Test requirements(Yes/No)	No	No

The distance <50mm for Main Ant + Aux Ant (MIMO)

Band	Frequency	Turn-UP (dBm)	Turn-UP (mW)	Position	Front Face	Rear Face	Left Side	Top Side	Bottom Side
				Antenna -to -edge distance(mm)	5	5.1	5	9.2	5
2.4G	2462	18.5	70.79	Exclusion considerations(mW)	22.22	21.78	22.22	12.07	22.22
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes	Yes
5G Band I	5240	16.5	44.67	Exclusion considerations(mW)	20.45	20.05	20.45	11.11	20.45
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes	Yes
5G Band II	5320	16.5	44.67	Exclusion considerations(mW)	20.61	20.20	20.61	11.20	20.61
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes	Yes
5G Band III	5700	16.5	44.67	Exclusion considerations(mW)	21.33	20.91	21.33	11.59	21.33
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes	Yes
5G Band IV	5825	16.5	44.67	Exclusion considerations(mW)	21.56	21.14	21.56	11.72	21.56
				Test requirements(Yes/No)	Yes	Yes	Yes	Yes	Yes

Note:

1) The front face, rear face and bottom side distance to edge is under 5mm, according KDB447498 D01 4.31 a), when the minimum test separation distance is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

2) The distance is choice the minimum separation distance from main and aux antenna.

The distance >50mm for Aux Ant

Band	Frequency	Turn-UP (dBm)	Turn-UP (mW)	Position	Right Side
				Antenna -to -edge distance(mm)	163.3
2.4G	2462	18.5	70.79	Exclusion considerations(mW)	769.60
				Test requirements(Yes/No)	No
5G Band I	5240	16.5	44.67	Exclusion considerations(mW)	739.53
				Test requirements(Yes/No)	No
5G Band II	5320	16.5	44.67	Exclusion considerations(mW)	739.03
				Test requirements(Yes/No)	No
5G Band III	5700	16.5	44.67	Exclusion considerations(mW)	768.83
				Test requirements(Yes/No)	No
5G Band IV	5825	16.5	44.67	Exclusion considerations(mW)	736.15
				Test requirements(Yes/No)	No

8. POWER TEST RESULT

8.1.1 CONDUCTED POWER MEASUREMENTS OF WiFi 2.4G

SISO Tx_Main Ant (Ant 0)

Mode	802.11b				Test required
Channel	Tune-up	1	6	11	
Frequency		2412	2437	2462	
1M	17.0	16.45	16.52	16.11	Yes

Mode	802.11g				Test required
Channel	Tune-up	1	6	11	
Frequency		2412	2437	2462	
6M	16.5	16.15	16.23	15.82	No

Mode	802.11n HT20				Test required
Channel	Tune-up	1	6	11	
Frequency		2412	2437	2462	
MCS0	15	14.83	14.94	14.21	No

Mode	802.11n HT40				Test required
Channel	Tune-up	3	6	9	
Frequency		2422	2437	2452	
MCS0	15.5	15.23	15.05	15.06	No

Note: The Aux Ant does not support SISO.

MIMO Tx_Main Ant + Aux Ant (Ant 0+1)

Mode	802.11n HT20				Test required
Channel	Tune-up	1	6	11	
Frequency		2412	2437	2462	
MCS0	18.5	17.99	17.99	18.04	No

Mode	802.11n HT40				Test required
Channel	Tune-up	3	6	9	
Frequency		2422	2437	2452	
MCS0	18.5	18.35	18.22	18.39	Yes

8.2 CONDUCTED POWER MEASUREMENTS OF WiFi 5G BAND I

SISO Tx_Main Ant (Ant 0)

Mode	802.11a					Test required
Channel	Tune-up	36	40	44	48	
Frequency		5180	5200	5220	5240	
6M	13.5	12.75	12.54	12.58	12.44	No

Mode	802.11n HT20					Test required
Channel	Tune-up	36	40	44	48	
Frequency		5180	5200	5220	5240	
MCS0	13.5	12.89	12.75	12.71	12.67	No

Mode	802.11n HT40			Test required
Channel	Tune-up	38	46	
Frequency		5190	5230	
MCS0	13.5	13.20	12.71	Yes

Mode	802.11ac VHT20					Test required
Channel	Tune-up	36	40	44	48	
Frequency		5180	5200	5220	5240	
MCS0	13.5	12.76	12.62	12.58	12.54	No

Mode	802.11ac VHT40			Test required
Channel	Tune-up	38	46	
Frequency		5190	5230	
MCS0	13.5	13.07	12.58	No

Mode	802.11ac VHT80		Test required
Channel	Tune-up	42	
Frequency		5210	
MCS0	13.5	12.75	No

Note: The Aux Ant does not support SISO.

MIMO Tx_Main Ant + Aux Ant (Ant 0+1)

Mode	802.11n HT20					Test required
Channel	Tune-up	36	40	44	48	
Frequency		5180	5200	5220	5240	
MCS0	16.5	15.97	15.80	15.82	15.73	No

Mode	802.11n HT40			Test required
Channel	Tune-up	38	46	
Frequency		5190	5230	
MCS0	16.5	16.30	15.77	Yes

Mode	802.11ac VHT20					Test required
Channel	Tune-up	36	40	44	48	
Frequency		5180	5200	5220	5240	
MCS0	16.5	15.90	15.73	15.75	15.65	No

Mode	802.11ac VHT40			Test required
Channel	Tune-up	38	46	
Frequency		5190	5230	
MCS0	16.5	16.22	15.69	No

Mode	802.11ac VHT80		Test required
Channel	Tune-up	42	
Frequency		5210	
MCS0	16.5	15.84	No

8.3 CONDUCTED POWER MEASUREMENTS OF WiFi 5G BAND II

SISO Tx_Main Ant (Ant 0)

Mode	802.11a					Test required
Channel	Tune-up	52	56	60	64	
Frequency		5260	5280	5300	5320	
6M	13.5	12.37	12.44	12.41	12.30	No

Mode	802.11n HT20					Test required
Channel	Tune-up	52	56	60	64	
Frequency		5260	5280	5300	5320	
MCS0	13.5	12.57	12.43	12.25	12.21	Yes

Mode	802.11n HT40			Test required
Channel	Tune-up	54	62	
Frequency		5270	5310	
MCS0	13.5	12.43	12.23	No

Mode	802.11ac VHT20					Test required
Channel	Tune-up	52	56	60	64	
Frequency		5260	5280	5300	5320	
MCS0	13.5	12.44	12.30	12.13	12.09	No

Mode	802.11ac VHT40			Test required
Channel	Tune-up	54	62	
Frequency		5270	5310	
MCS0	13.5	12.30	12.11	No

Mode	802.11ac VHT80		Test required
Channel	Tune-up	58	
Frequency		5290	
MCS0	13.5	12.46	No

Note: The Aux Ant does not support SISO.

MIMO Tx_Main Ant + Aux Ant (Ant 0+1)

Mode	802.11n HT20					Test required
Channel	Tune-up	52	56	60	64	
Frequency		5260	5280	5300	5320	
MCS0	16.5	15.62	15.48	15.31	15.25	Yes

Mode	802.11n HT40			Test required
Channel	Tune-up	54	62	
Frequency		5270	5310	
MCS0	16.5	15.51	15.29	No

Mode	802.11ac VHT20					Test required
Channel	Tune-up	52	56	60	64	
Frequency		5260	5280	5300	5320	
MCS0	16.5	15.54	15.41	15.24	15.18	No

Mode	802.11ac VHT40			Test required
Channel	Tune-up	54	62	
Frequency		5270	5310	
MCS0	16.5	15.43	15.22	No

Mode	802.11ac VHT80		Test required
Channel	Tune-up	58	
Frequency		5290	
MCS0	16.5	15.52	No

8.4 CONDUCTED POWER MEASUREMENTS OF WiFi 5G BAND III

SISO Tx_Main Ant (Ant 0)

Mode	802.11a									Test required
Channel	Tune-up	100	104	108	112	116	132	136	140	
Frequency		5500	5520	5540	5560	5580	5660	5680	5700	
6M	13.5	12.71	12.74	12.77	12.70	12.55	13.07	13.03	13.06	Yes

Mode	802.11n HT20									Test required
Channel	Tune-up	100	104	108	112	116	132	136	140	
Frequency		5500	5520	5540	5560	5580	5660	5680	5700	
MCS0	13.5	12.65	12.67	12.61	12.56	12.50	13.02	13.06	13.01	No

Mode	802.11n HT40				Test required
Channel	Tune-up	102	110	134	
Frequency		5510	5550	5670	
MCS0	13.5	12.64	12.71	13.01	No

Mode	802.11ac VHT20									Test required
Channel	Tune-up	100	104	108	112	116	132	136	140	
Frequency		5500	5520	5540	5560	5580	5660	5680	5700	
MCS0	13.5	12.52	12.54	12.48	12.43	12.37	12.89	12.93	12.88	No

Mode	802.11ac VHT40				Test required
Channel	Tune-up	102	110	134	
Frequency		5510	5550	5670	
MCS0	13.5	12.51	12.58	12.88	No

Mode	802.11ac VHT80			Test required
Channel	Tune-up	106	122	
Frequency		5530	5610	
MCS0	13.5	12.75	12.67	No

Note: The Aux Ant does not support SISO.

MIMO Tx_Main Ant + Aux Ant (Ant 0+1)

Mode	802.11n HT20									Test required
Channel	Tune-up	100	104	108	112	116	132	136	140	
Frequency		5500	5520	5540	5560	5580	5660	5680	5700	
MCS0	**16.5**	15.76	15.77	15.80	15.69	15.62	16.30	16.31	16.26	No

Mode	802.11n HT40				Test required
Channel	Tune-up	102	110	134	
Frequency		5510	5550	5670	
MCS0	**16.5**	15.77	15.82	16.31	Yes

Mode	802.11ac VHT20									Test required
Channel	Tune-up	100	104	108	112	116	132	136	140	
Frequency		5500	5520	5540	5560	5580	5660	5680	5700	
MCS0	**16.5**	15.68	15.70	15.73	15.61	15.54	16.23	16.23	16.19	No

Mode	802.11ac VHT40				Test required
Channel	Tune-up	102	110	134	
Frequency		5510	5550	5670	
MCS0	**16.5**	15.70	15.75	16.24	No

Mode	802.11ac VHT80			Test required
Channel	Tune-up	106	122	
Frequency		5530	5610	
MCS0	**16.5**	15.89	15.77	No

8.5 CONDUCTED POWER MEASUREMENTS OF WiFi 5G BAND VI

SISO Tx_Main Ant (Ant 0)

Mode	802.11a						Test required
Channel	Tune-up	149	153	157	161	165	
Frequency		5745	5765	5785	5805	5825	
MCS0	13.5	13.00	13.02	13.04	12.94	12.91	Yes

Mode	802.11n HT20						Test required
Channel	Tune-up	149	153	157	161	165	
Frequency		5745	5765	5785	5805	5825	
MCS0	13.5	12.95	12.91	12.90	12.92	12.89	No

Mode	802.11n HT40			Test required
Channel	Tune-up	151	159	
Frequency		5755	5795	
MCS0	13.5	12.96	12.85	No

Mode	802.11ac VHT20						Test required
Channel	Tune-up	149	153	157	161	165	
Frequency		5745	5765	5785	5805	5825	
MCS0	13.5	12.82	12.78	12.77	12.79	12.76	No

Mode	802.11ac VHT40			Test required
Channel	Tune-up	151	159	
Frequency		5755	5795	
MCS0	13.5	12.83	12.72	No

Mode	802.11ac VHT80		Test required
Channel	Tune-up	155	
Frequency		5775	
MCS0	13.5	13.03	No

Note: The Aux Ant does not support SISO.

MIMO Tx_Main Ant + Aux Ant (Ant 0+1)

Mode	802.11n HT20						Test required
Channel	Tune-up	149	153	157	161	165	
Frequency		5745	5765	5785	5805	5825	
MCS0	**16.5**	16.12	16.12	16.15	16.08	16.03	NO

Mode	802.11n HT40			Test required
Channel	Tune-up	151	159	
Frequency		5755	5795	
MCS0	**16.5**	16.16	16.05	NO

Mode	802.11ac VHT20						Test required
Channel	Tune-up	149	153	157	161	165	
Frequency		5745	5765	5785	5805	5825	
MCS0	**16.5**	16.05	16.05	16.07	16.00	15.96	NO

Mode	802.11ac VHT40			Test required
Channel	Tune-up	151	159	
Frequency		5755	5795	
MCS0	**16.5**	16.09	15.98	NO

Mode	802.11ac VHT80		Test required
Channel	Tune-up	155	
Frequency		5775	
MCS0	**16.5**	16.22	YES

8.6 CONDUCTED POWER MEASUREMENTS OF BT

BT	Tune Up	Average Conducted Power (dBm)			Test required
		CH0	CH39	CH78	
DH5	9.5	7.60	8.48	7.66	No
3DH5		6.84	8.43	6.93	

BT	Tune Up	Average Conducted Power (dBm)			Test required
		CH0	CH19	CH39	
BLE	2	0.11	1.67	0.41	No

Note:
1) The conducted power of BT is measured with RMS detector.

9 .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 KDB648474 D04v01r03, SAR is evaluated without a headset connected to the device. When the standalone reported Body SAR is ≤1.2 W/kg, no additional SAR evaluations using a headset are required.
5) Per KDB865664 D02v01r02, 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 Section 7.1.4 for more information.

9.1 SAR MEASUREMENT RESULT

9.1.1 SAR MEASUREMENT RESULT OF BODY

1. Body SAR test results of WiFi 2.4G(Ant 0)

Test No.	Band	Mode	CH	Test Position With 0.5cm	Ant Status	Tune up	Measured	Drift(dB)	SAR Value (W/kg)1-g	Reported SAR
1	802.11b	-	6	Front Face	0	17	16.52	0	0.032	0.036
2	802.11b	-	6	Rear Face	0	17	16.52	-0.06	0.0663	0.074
3	802.11b	-	6	Left Side	0	17	16.52	0.04	0.00441	0.005
4	802.11b	-	6	Bottom Side	0	17	16.52	0.08	0.514	**0.574**

2. Body SAR test results of WiFi 2.4G(Ant 0+1)

Test No.	Band	Mode	CH	Test Position With 0.5cm	Ant Status	Tune up	Measured	Drift(dB)	SAR Value (W/kg)1-g	Reported SAR
49	802.11n	HT40	9	Front Face	0+1	18.5	18.39	0.07	0.031	0.032
50	802.11n	HT40	9	Rear Face	0+1	18.5	18.39	-0.04	0.0457	0.047
51	802.11n	HT40	9	Left Side	0+1	18.5	18.39	0.09	0.465	**0.477**
52	802.11n	HT40	9	Top Side	0+1	18.5	18.39	0.14	0.00609	0.006
53	802.11n	HT40	9	Bottom Side	0+1	18.5	18.39	0.01	0.337	0.346

Note:

1) The 802.11g adjusted Body SAR is 0.574 x (44.67 / 50.12) = 0.512 mW/g, the OFDM is not required

2) Per KDB248227, 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.

3) Per KDB248227D01, the highest SAR measured for the initial test position or initial test configuration should be used to determine SAR test exclusion according to the sum of 1-g SAR and SAR peak to location ratio provisions in KDB 447498. In addition, a test lab may also choose to perform standalone SAR measurements for test positions and 802.11 configurations that are not required by the initial test position or initial test configuration procedures and apply the results to determine simultaneous transmission SAR test exclusion, according to sum of 1-g and SAR peak to location ratio requirements to reduce the number of simultaneous transmission SAR measurements.

Body SAR test results of WiFi 5G(Ant 0)

Test No.	Band	Mode	CH	Test Position With 0.5cm	Ant Status	Tune up	Measured	Drift(dB)	SAR Value (W/kg)1-g	Reported SAR
9	802.11n	HT40	38	Front Face	0	13.5	13.2	0.12	0.0583	0.062
10	802.11n	HT40	38	Rear Face	0	13.5	13.2	0	0	0.000
11	802.11n	HT40	38	Left Side	0	13.5	13.2	0	0	0.000
12	802.11n	HT40	38	Bottom Side	0	13.5	13.2	0.01	0.4	**0.429**
13	802.11n	HT20	52	Front Face	0	13.5	12.57	0	0.0485	0.060
14	802.11n	HT20	52	Rear Face	0	13.5	12.57	0	0	0.000
15	802.11n	HT20	52	Left Side	0	13.5	12.57	0	0	0.000
16	802.11n	HT20	52	Bottom Side	0	13.5	12.57	0	0.325	**0.403**
17	802.11a	-	132	Front Face	0	13.5	13.07	0.07	0.0801	0.088
18	802.11a	-	132	Rear Face	0	13.5	13.07	0	0.0256	0.028
19	802.11a	-	132	Left Side	0	13.5	13.07	0	0	0.000
20	802.11a	-	132	Bottom Side	0	13.5	13.07	0.01	0.784	**0.866**
74	802.11a	-	140	Bottom Side	0	13.5	13.06	0.13	0.715	0.791
21	802.11a	-	157	Front Face	0	13.5	13.04	0	0.0776	0.086
22	802.11a	-	157	Rear Face	0	13.5	13.04	0	0.0318	0.035
23	802.11a	-	157	Left Side	0	13.5	13.04	0	0	0.000
24	802.11a	-	157	Bottom Side	0	13.5	13.04	0.14	0.576	**0.640**

Note:

1) Per KDB248227D01, the highest SAR measured for the initial test position or initial test configuration should be used to determine SAR test exclusion according to the sum of 1-g SAR and SAR peak to location ratio provisions in KDB 447498. In addition, a test lab may also choose to perform standalone SAR measurements for test positions and 802.11 configurations that are not required by the initial test position or initial test configuration procedures and apply the results to determine simultaneous transmission SAR test exclusion, according to sum of 1-g and SAR peak to location ratio requirements to reduce the number of simultaneous transmission SAR measurements.

Body SAR test results of WiFi 5G(Ant 0+1)

Test No.	Band	Mode	CH	Test Position With 0.5cm	Ant Status	Tune up	Measured	Drift(dB)	SAR Value (W/kg)1-g	Reported SAR
54	802.11n	HT40	38	Front Face	0+1	16.5	16.3	0.14	0.0527	0.055
55	802.11n	HT40	38	Rear Face	0+1	16.5	16.3	0	0.0266	0.028
56	802.11n	HT40	38	Left Side	0+1	16.5	16.3	-0.12	0.434	**0.454**
57	802.11n	HT40	38	Top Side	0+1	16.5	16.3	0	0	0.000
58	802.11n	HT40	38	Bottom Side	0+1	16.5	16.3	-0.12	0.33	0.346
59	802.11n	HT20	52	Front Face	0+1	16.5	15.62	0.08	0.0393	0.048
60	802.11n	HT20	52	Rear Face	0+1	16.5	15.62	0	0.0179	0.022
61	802.11n	HT20	52	Left Side	0+1	16.5	15.62	0.01	0.311	0.381
62	802.11n	HT20	52	Top Side	0+1	16.5	15.62	0	0	0.000
63	802.11n	HT20	52	Bottom Side	0+1	16.5	15.62	0	0.33	**0.404**
64	802.11n	HT40	134	Front Face	0+1	16.5	16.31	0	0.0969	0.101
65	802.11n	HT40	134	Rear Face	0+1	16.5	16.31	0	0.0461	0.048
66	802.11n	HT40	134	Left Side	0+1	16.5	16.31	0.13	0.641	0.670
67	802.11n	HT40	134	Top Side	0+1	16.5	16.31	0	0	0.000
68	802.11n	HT40	134	Bottom Side	0+1	16.5	16.31	0.08	0.855	**0.893**
75	802.11n	HT40	110	Bottom Side	0+1	16.5	15.82	0.12	0.525	0.614
69	802.11ac	VHT80	149	Front Face	0+1	16.5	16.22	0.09	0.0663	0.071
70	802.11ac	VHT80	149	Rear Face	0+1	16.5	16.22	0	0.0393	0.042
71	802.11ac	VHT80	149	Left Side	0+1	16.5	16.22	-0.15	0.493	0.526
72	802.11ac	VHT80	149	Top Side	0+1	16.5	16.22	0	0	0.000
73	802.11ac	VHT80	149	Bottom Side	0+1	16.5	16.22	0.11	0.571	**0.609**

Note:

1) Per KDB248227D01, the highest SAR measured for the initial test position or initial test configuration should be used to determine SAR test exclusion according to the sum of 1-g SAR and SAR peak to location ratio provisions in KDB 447498. In addition, a test lab may also choose to perform standalone SAR measurements for test positions and 802.11 configurations that are not required by the initial test position or initial test configuration procedures and apply the results to determine simultaneous transmission SAR test exclusion, according to sum of 1-g and SAR peak to location ratio requirements to reduce the number of simultaneous transmission SAR measurements.

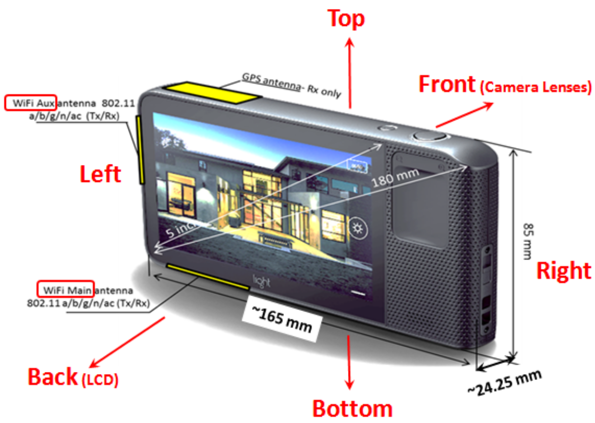
Repeat Test

Test No.	Band	Mode	CH	Test Position With 0.5cm	Ant Status	Tune up	Measured	Drift(dB)	SAR Value (W/kg)1-g	Reported SAR
201	802.11a	-	132	Bottom Side	0	13.5	13.07	0.12	0.733	0.809
202	802.11n	HT40	134	Bottom Side	0+1	16.5	16.31	0.08	0.841	0.879

10. 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.

The location of the antennas is shown as below picture:



The Tx Antenna Status

Tx Antenna Status	WiFi 2.4G SISO	WiFi 5G SISO	WiFi 2.4G MIMO	WiFi 5G MIMO	BT
Main Ant	Yes	Yes	Yes	Yes	Yes
Aux Ant	N/A	N/A	Yes	Yes	N/A

11. SIMULTANEOUS TRANSMISSION

Per KDB 447498D01v06, 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.

The Simultaneous Transmission Possibilities of this device are as below:

No.	Configuration	Body
1	WiFi 2.4G + BT	N/A
2	WiFi 2.4G + WiFi 5G	N/A
3	WiFi 5G + BT	N/A

12. SAR SUMMATION SCENARIO

Because the WiFi and BT is the same antenna, so WiFi and BT cannot transmit simultaneously. And the WiFi 2.4G and 5G cannot transmit simultaneously.

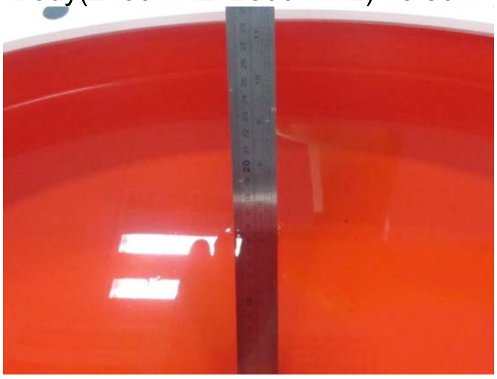
APPENDIX

1. Test Layout

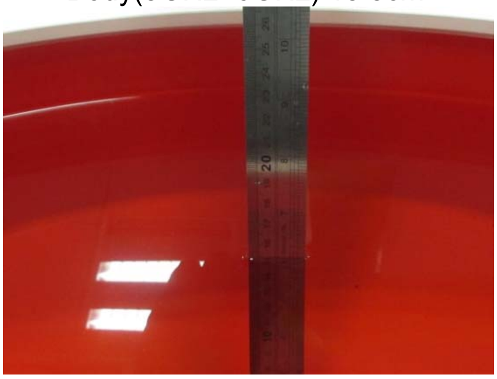
Specific Absorption Rate Test Layout

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

Body(2400MHz~2500 MHz) 15.5cm



Body(5GHz~6GHz) 15.5cm



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.)

End