FCC SAR Test Report

Project No.	:	2010H019
Equipment	:	Wireless Digital Flat Panel Detector
Brand Name	:	iRay Technology
Test Model	:	Luna1012X, Luna1013XE, NDT1013LA
Series Model	:	N/A
Date of Receipt	:	Oct. 23, 2020
Date of Test	:	Nov. 20, 2020 ~ Nov. 25, 2020
Issued Date	:	Dec. 15, 2020
Report Version	:	R02
Test Sample	:	Engineering Sample No.: SH2020102038, SH2020102094
Standard(s)	:	Please refer to page 2.
Applicant	:	iRay Technology Co. Ltd.
Address	:	RM 202, Building 7, No. 590, Ruiqing RD., Pudong, Shanghai, China

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

Justin Huang

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Certificate #5123.02

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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 RF Exposure Reporting v01r02
KDB690783 D01 SAR Listings on Grants v01r03

Declaration

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

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

The report must not be used by the client to claim product certification, approval, or endorsement by NIST, A2LA, or any agency of the U.S. Government.

This report is the confidential property of the client. As a mutual protection to the clients, the public and ourselves, the test report shall not be reproduced, except in full, without our written approval.

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

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

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

Limitation

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.

Please note that the measurement uncertainty is provided for informational purpose only and are not use in determining the Pass/Fail results.

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REPORT ISSUED HISTORY

Report Version	Description	Issued Date
R00	Original Issue.	Dec. 04, 2020
R01	Updated the conducted power of MIMO mode.	Dec. 11, 2020
R02	1. Removed the standard: KDB616217 D04. 2. Updated the tune up of WiFi 2.4G MIMO.	Dec. 15, 2020

1. GENERAL INFORMATION

1.1 STATEMENT OF COMPLIANCE

Mode	Highest Reported Head / Body SAR-1g (W/kg)	Highest Simultaneous Transmission Head / Body SAR-1g (W/kg)
2.4G WIFI	1.158	1.468
5.2G WIFI	1.250	
5.8G WIFI	1.116	

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.

1.2 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.	

1.3 GENERAL DESCRIPTION OF EUT

<table>
<tr><td>Equipment</td><td colspan="3">Wireless Digital Flat Panel Detector</td></tr>
<tr><td>Test Model</td><td colspan="3">Luna1012X, Luna1013XE, NDT1013LA</td></tr>
<tr><td>Series Model</td><td colspan="3">N/A</td></tr>
<tr><td>Model Difference(s)</td><td colspan="3">Naming and using environments are different, everything else is the same.</td></tr>
<tr><td>Modulation</td><td colspan="3">WiFi(DSSS/OFDM)</td></tr>
<tr><td rowspan="4">Operation Frequency Range(s)</td><td>Band</td><td>TX (MHz)</td><td>RX (MHz)</td></tr>
<tr><td>2.4G WLAN</td><td colspan="2">2402~2483.5</td></tr>
<tr><td>5.2G WLAN</td><td colspan="2">5150~5250</td></tr>
<tr><td>5.8G WLAN</td><td colspan="2">5725~5850</td></tr>
<tr><td rowspan="6">Test Channels
(low-mid-high)</td><td colspan="3">1-6-11 (2.4G WIFI 802.11b/g/n HT20)</td></tr>
<tr><td colspan="3">3-6-9 (2.4G WIFI 802.11n HT40)</td></tr>
<tr><td>Band</td><td>5.2G WIFI</td><td>5.8G WIFI</td></tr>
<tr><td>802.11a/n HT20
/ac VHT20</td><td>36-40-44-48</td><td>149-153-157-161-165</td></tr>
<tr><td>802.11n HT40
/ac VHT40</td><td>38-46</td><td>151-159</td></tr>
<tr><td>802.11ac VHT80</td><td>42</td><td>155</td></tr>
<tr><td rowspan="3">Antenna Gain</td><td>Band</td><td>Ant 1 (dBi)</td><td>Ant 2 (dBi)</td></tr>
<tr><td>WLAN 2.4G</td><td>-1.66</td><td>3.65</td></tr>
<tr><td>WLAN 5G</td><td>0.79</td><td>2.03</td></tr>
</table>

1.4 MAIN TEST INSTRUMENTS

Item	Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Interval
1	Data Acquisition Electronics	Speag	DAE3	427	Mar. 31, 2020	1 Year
2	Data Acquisition Electronics	Speag	DAE3	420	Jun. 22, 2020	1 Year
3	E-field Probe	Speag	EX3DV4	3962	Apr. 01, 2020	1 Year
4	E-field Probe	Speag	EX3DV4	3748	Jul. 29, 2020	1 Year
5	System Validation Dipole	Speag	D2450V2	919	Jun. 11, 2018	3 Years
6	System Validation Dipole	Speag	D5GHzV2	1160	Jun. 20, 2018	3 Years
7	ELI Phantom	Speag	ELI Phantom V5.0	1222	N/A	N/A
8	Power Amplifier	Mini-Circuits	ZHL-42W+	QA1333003	Mar. 10, 2020	1 Year
9	Power Amplifier	Mini-Circuits	ZVE-8G+	520701341	Mar. 10, 2020	1 Year
10	DC Source metter	Iteck	IT6154	006104126768 201001	Jul. 25, 2020	1 Year
11	Signal Analyzer	R&S	FSV7	103120	Jul. 25, 2020	1 Year
12	Vector Network Analyzer	Anritsu	MS46522B	1538101	Jul. 25, 2020	1 Year
13	Signal Generator	R&S	SMF100A	101214	Feb. 29, 2020	1 Year
14	Smart Power Sensor	R&S	NRP-Z21	102209	Mar. 07, 2020	1 Year
15	Dielectric Assessment Kit	Speag	DAK-3.5	1226	N/A	N/A
16	Directional Coupler	Woken	TS-PCC0M-05	107090019	Mar. 01, 2020	1 Year
17	Coupler	Woken	0110A05601O-10	COM5BNW1A2	Mar. 01, 2020	1 Year
18	Digital Themometer	LKM	DTM3000	3519	Jul. 02, 2020	1 Year

Remark:
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.

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, Dongguan, Guangdong, China.

2.2 MEASUREMENT UNCERTAINTY

Note: Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04, 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.

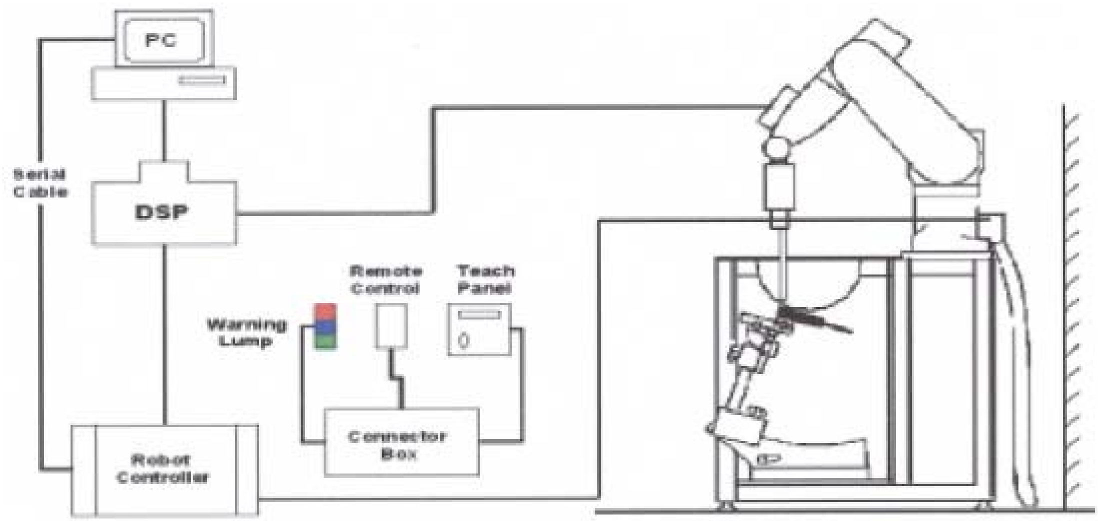
3. SAR MEASUREMENTS SYSTEM CONFIGURATION

3.1 SAR MEASUREMENT SET-UP

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

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

3.1.1 TEST SETUP LAYOUT



3.2 DASY5 E-FIELD PROBE SYSTEM

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

3.2.1 EX3DV4 PROBE SPECIFICATION

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available
Frequency	10 MHz to 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 µW/g to > 100 mW/g Linearity:± 0.2dB
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1.0 mm


EX3DV4 E-field Probe

3.2.2 E-FIELD PROBE CALIBRATION

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.

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

Where: Δt = Exposure time (30 seconds),

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

ΔT = Temperature increase due to RF exposure.

Or

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

Where: σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m3).

3.2.3 OTHER TEST EQUIPMENT

3.2.3.1 Device Holder for Transmitters

Construction: Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices (e.g., laptops, cameras, etc.) It is 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, ELI and SAM v6.0 Phantoms.
Material: POM, Acrylic glass, Foam

3.2.3.2 Phantom

Model	ELI Phantom	
Construction	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.	
Shell Thickness	2±0.1 mm	
Filling Volume	Approx. 30 liters	
Dimensions	Length: 600 mm ; Width: 190mm Height: adjustable feet	
Aailable	Special	

3.2.4 SCANNING PROCEDURE

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

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. ± 5 %.

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

- Area Scan

The “area scan” measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The standard scan uses large grid spacing for faster measurement. Standard grid spacing for head measurements is 15 mm in x- and y- dimension (≤2GHz), 12 mm 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}, Δy_{zoom}≤2GHz -≤8mm, 2-4GHz -≤5 mm and 4-6 GHz-≤4mm; Δz_{zoom}≤3GHz -≤5 mm, 3-4 GHz-≤4mm and 4-6GHz-≤2mm where the robot additionally moves the probe along the z-axis away from the bottom of the Phantom. DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in Appendix B. Test results relevant for the specified standard (see chapter 1.4.) are shown in table form in chapter 7.2.

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

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

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

3.2.5 SPATIAL PEAK SAR EVALUATION

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

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

Extrapolation

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

Interpolation

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

Volume Averaging

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

Advanced Extrapolation

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

3.2.6 DATA STORAGE AND EVALUATION

3.2.6.1 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 “DAE”. The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

3.2.7 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	$Norm_i$, 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.

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

With SAR = local specific absorption rate in mW/g

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

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

= equivalent tissue density in g/cm^3

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

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

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

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

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

4. SYSTEM VERIFICATION PROCEDURE

4.1 TISSUE VERIFICATION

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

The following materials are used for producing the tissue-equivalent materials.

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

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

Tissue Verification									
Tissue Type	Frequency (MHz)	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (εr)	Targeted Conductivity (σ)	Targeted Permittivity (εr)	Deviation Conductivity (σ) (%)	Deviation Permittivity (εr) (%)	Date
Head	2450	23.3	1.845	38.905	1.80	39.2	2.50	-0.75	Nov. 25, 2020
Head	5200	22.4	4.514	35.539	4.66	36.0	-3.13	-1.28	Nov. 20, 2020
Head	5800	22.4	5.190	34.169	5.27	35.3	-1.52	-3.20	Nov. 20, 2020

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

4.2 SYSTEM CHECK

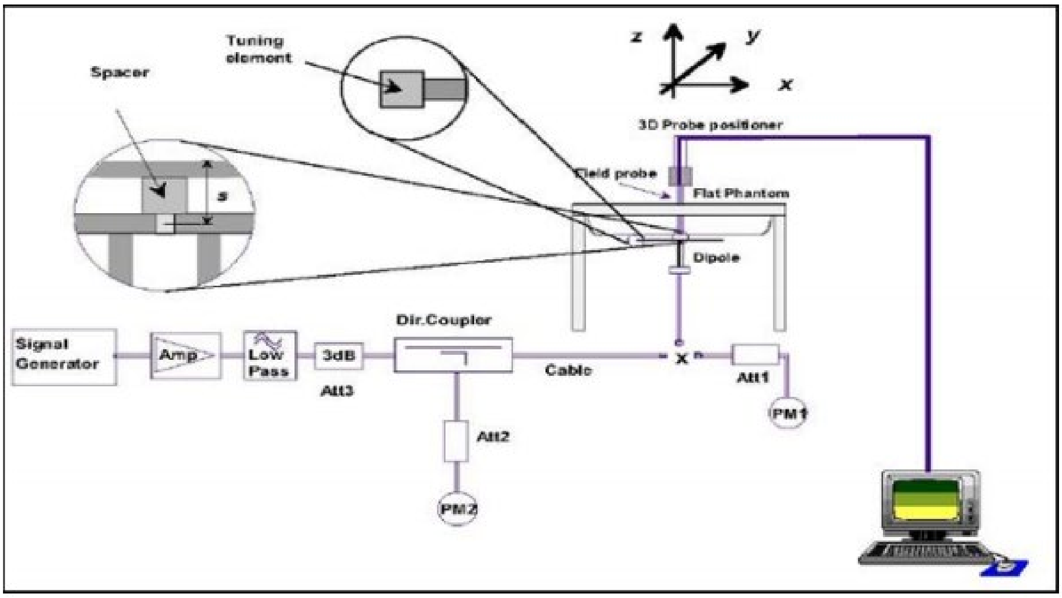
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands 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 1g (%)	Dipole S/N
Head	Nov. 25, 2020	2450	52.10	12.50	50.00	-4.03	919
Head	Nov. 20, 2020	5200	75.30	7.20	72.00	-4.38	1160
Head	Nov. 20, 2020	5800	77.90	7.47	74.70	-4.11	1160

4.3 SYSTEM CHECK PROCEDURE

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

System check results have to be equal or near the values determined during dipole calibration (target SAR in table above) with the relevant liquids and test system (±10 %).



5. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

5.1 SAR MEASUREMENT VARIABILITY

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

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

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

The detailed repeated measurement results are shown in Section 7.2.

6. OPERATIONAL CONDITIONS DURING TEST

6.1 TEST CONFIGURATION

6.1.1 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 (HT20/40)
Duty cycle	100%		
Crest factor	1		

5G

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

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

6.1.4.1 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.

6.1.4.2 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.

6.1.4.3 OFDM transmission mode and SAR test channel selection

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

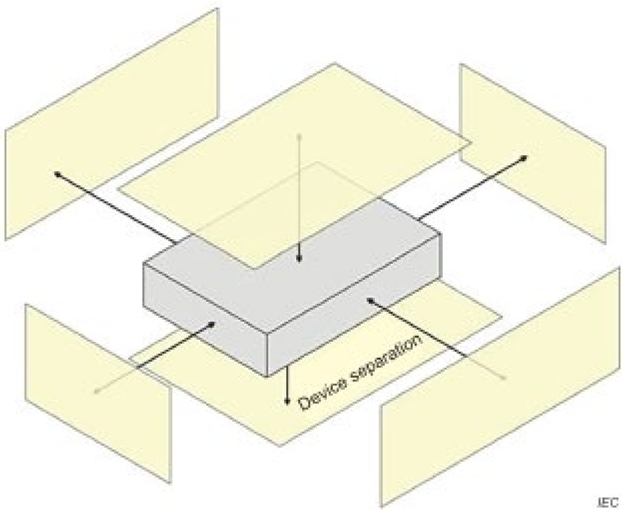
6.1.4.4 Initial test configuration procedure

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.

6.2 TEST POSITION

6.2.1 BODY TEST CONFIGURATION

Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition(s), listed below, is (are) satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The minimum test separation distance defined in 4.1 f) is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host from factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander. To quality for SAR test exclusion, the test separation distances applied must be fully explained and justified, typically in the SAR measurement or SAR analysis report, by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting are required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for SAR test exclusion. When required, the device specific conditions described in the other published RF exposure KDB procedures must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops and tablets, etc.



(a) For 100 MHz to 6 GHz and test separation distances ≤ 50mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

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

for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR, where

- Frequency(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- The values 3.0 and 7.5 are referred to as numeric thresholds in step b) below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50mm, and for transmission frequencies between 100 MHz and 6 GHz. 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 location of the antenna inside EUT and standalone SAR test exclusion, please refer to Appendix E.

7. TEST RESULT

7.1 CONDUCTED POWER RESULTS

7.1.1 CONDUCTED POWER MEASUREMENTS OF WIFI

1. Conducted power measurement results of WiFi 2.4G

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
2.4G WIFI_ 1TX_ ANT 1	802.11b	1	2412	1	13.00	**12.27**
		6	2437		13.00	**11.52**
		11	2462		13.00	**11.44**
	802.11g	1	2412	6	12.00	11.49
		6	2437		12.00	10.39
		11	2462		12.00	10.33
	802.11n HT20	1	2412	6.5	12.00	11.40
		6	2437		12.00	10.42
		11	2462		12.00	10.14
	802.11n HT40	3	2422	13.5	12.00	10.75
		6	2437		12.00	10.34
		9	2452		11.50	10.12

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
2.4G WIFI_ 1TX_ ANT 2	802.11b	1	2412	1	14.00	**13.81**
		6	2437		14.00	**13.56**
		11	2462		14.00	**13.05**
	802.11g	1	2412	6	13.50	12.88
		6	2437		13.50	11.79
		11	2462		13.50	11.92
	802.11n HT20	1	2412	6.5	13.50	13.09
		6	2437		13.50	11.78
		11	2462		13.50	11.95
	802.11n HT40	3	2422	13.5	12.50	12.40
		6	2437		12.50	11.69
		9	2452		11.50	10.55

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	ANT 1 Average Power(dBm)	ANT 2 Average Power(dBm)	Max. Tune up	Total Average Power(dBm)
2.4G WIFI_ 2TX_ ANT 1+2	802.11n HT20	1	2412	1	11.40	13.09	15.50	15.34
		6	2437		10.42	11.78	15.50	14.16
		11	2462		10.14	11.95	15.50	14.15
	802.11n HT40	3	2422	27	10.75	12.40	15.50	14.66
		6	2437		10.34	11.69	15.50	14.08
		9	2452		10.12	10.55	14.50	13.35

Note:
1) The Average conducted power of WiFi 2.4GHz 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.
3) The tested channel results are marks in bold.

2. Conducted power measurement results of WiFi 5.2G

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
5.2G WIFI_ 1TX_ ANT 1	802.11a	36	5180	6	11.00	**10.75**
		40	5200		11.00	**10.80**
		44	5220		11.00	10.44
		48	5240		11.00	**10.68**
	802.11n HT20	36	5180	MCS0	10.00	Not required
		40	5200		10.00	
		44	5220		10.00	
		48	5240		10.00	
	802.11n HT40	38	5190	MCS0	10.00	
		46	5230		10.00	
	802.11ac VHT20	36	5180	MCS0	10.00	
		40	5200		10.00	
		44	5220		10.00	
		48	5240		10.00	
	802.11ac VHT40	38	5190	MCS0	9.00	
		46	5230		9.00	
	802.11ac VHT80	42	5210	MCS0	9.00	

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
5.2G WIFI_ 1TX_ ANT 2	802.11a	36	5180	6	9.00	**8.37**
		40	5200		9.00	**8.44**
		44	5220		9.00	**8.35**
		48	5240		9.00	7.59
	802.11n HT20	36	5180	MCS0	9.00	Not required
		40	5200		9.00	
		44	5220		8.00	
		48	5240		8.00	
	802.11n HT40	38	5190	MCS0	8.00	
		46	5230		8.00	
	802.11ac VHT20	36	5180	MCS0	8.00	
		40	5200		8.00	
		44	5220		8.00	
		48	5240		8.00	
	802.11ac VHT40	38	5190	MCS0	8.00	
		46	5230		8.00	
	802.11ac VHT80	42	5210	MCS0	8.00	

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	ANT 1 Average Power(dBm)	ANT 2 Average Power(dBm)	Max. Tune up	Total Average Power(dBm)
5.2G WIFI_ 2TX_ ANT 1+2	802.11n HT20	36	5180	MCS8	Not required		13.00	Not required
		40	5200				13.00	
		44	5220				13.00	
		48	5240				13.00	
	802.11n HT40	38	5190	MCS8			13.00	
		46	5230				13.00	
	802.11ac VHT20	36	5180	MCS8			13.00	
		40	5200				13.00	
		44	5220				13.00	
		48	5240				13.00	
	802.11ac VHT40	38	5190	MCS8			12.00	
		46	5230				12.00	
	802.11ac VHT80	42	5210	MCS8			12.00	

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

5. Conducted power measurement results of WiFi 5.8G

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
5.8G WIFI_ 1TX_ ANT 1	**802.11a**	149	5745	6	10.00	9.27
		153	5765		11.00	**10.23**
		157	5785		12.50	**12.11**
		161	5805		11.00	**9.32**
		165	5825		10.00	8.12
	802.11n HT20	149	5745	MCS0	11.00	Not required
		153	5765		11.00	
		157	5785		11.00	
		161	5805		11.00	
		165	5825		11.00	
	802.11n HT40	151	5755	MCS0	11.00	
		159	5795		11.00	
	802.11ac VHT20	149	5745	MCS0	11.00	
		153	5765		11.00	
		157	5785		11.00	
		161	5805		11.00	
		165	5825		11.00	
	802.11ac VHT40	151	5755	MCS0	11.00	
		159	5795		11.00	
	802.11ac VHT80	155	5775	MCS0	11.00	

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Max. Tune up	Average Power(dBm)
5.8G WIFI_ 1TX_ ANT 2	802.11a	149	5745	6	11.00	10.01
		153	5765		11.00	**10.22**
		157	5785		11.00	10.13
		161	5805		11.00	**10.34**
		165	5825		11.00	**10.46**
	802.11n HT20	149	5745	MCS0	10.00	Not required
		153	5765		10.00	
		157	5785		10.00	
		161	5805		10.00	
		165	5825		10.00	
	802.11n HT40	151	5755	MCS0	10.00	
		159	5795		10.00	
	802.11ac VHT20	149	5745	MCS0	10.00	
		153	5765		10.00	
		157	5785		10.00	
		161	5805		10.00	
		165	5825		10.00	
	802.11ac VHT40	151	5755	MCS0	10.00	
		159	5795		10.00	
	802.11ac VHT80	155	5775	MCS0	10.00	

Band	Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	ANT 1 Average Power(dBm)	ANT 2 Average Power(dBm)	Max. Tune up	Total Average Power(dBm)
5.8G WIFI_ 2TX_ ANT 1+2	802.11n HT20	149	5745	MCS8	Not required		14.00	Not required
		153	5765				14.00	
		157	5785				14.00	
		161	5805				14.00	
		165	5825				14.00	
	802.11n HT40	151	5755	MCS8			14.00	
		159	5795				14.00	
	802.11ac VHT20	149	5745	MCS8			14.00	
		153	5765				14.00	
		157	5785				14.00	
		161	5805				14.00	
		165	5825				14.00	
	802.11ac VHT40	151	5755	MCS8			14.00	
		159	5795				14.00	
	802.11ac VHT80	155	5775	MCS8			14.00	

Note: The Average conducted power of WiFi 5.8G is measured with RMS detector.

7.2 SAR TEST RESULTS

General Notes:

1) Per KDB447498 D01, all measurement SAR results are scaled to the maximum tune-up tolerance limit to demonstrate compliant.
2) Per KDB447498 D01, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is: ≤ 0.8W/kg or 2.0W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100MHz. When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.
3) Per KDB865664 D01, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥ 0.8W/kg; if the deviation among the repeated measurement is ≤ 20%, and the measured SAR < 1.45W/kg, only one repeated measurement is required.
4) Per KDB865664 D02, SAR plot is only required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; Plots are also required when the measured SAR is > 1.5W/kg, or > 7.0W/kg for occupational exposure. The published RF exposure KDB procedures may require additional plots; for example, to support SAR to peak location separation ratio test exclusion and/or volume scan post-processing.

WLAN Notes:

1. For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When the reported SAR of the initial test position is ≤ 0.4W/kg, further SAR measurement is not required for the other (remaining) test positions. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8W/kg or all test positions are measured.
2. Justification for test configurations for WLAN per KDB Publication 248227 for 2.4GHz WIFI single transmission chain operations, the highest measured maximum output power Channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4GHz 802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR. See Section 6.1.4 for more information.
3. Justification for test configurations for WLAN per KDB Publication 248227 for 5GHz WIFI single transmission chain operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed power. Other transmission modes were not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than 1.2 W/kg. See Section 6.1.4 for more information.

7.2.1 SAR MEASUREMENT RESULT

1. SAR measurement result of WiFi 2.4G

Test No.	Band	Channel	Test Position	Separation Distance (cm)	Ant	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR
W01	802.11b	1	Front Face	0	1	1	13	12.27	0.02	0.051	0.013	0.060
W02	802.11b	1	Rear Face	0	1	1	13	12.27	-0.04	0.431	0.217	0.510
W03	802.11b	1	Right Side	0	1	1	13	12.27	0.02	0.111	0.107	0.131
W04	802.11b	1	Top Side	0	1	1	13	12.27	0.13	**0.979**	**0.566**	**1.158**
W05	802.11b	6	Top Side	0	1	1	13	11.52	-0.02	0.801	0.364	1.126
W06	802.11b	11	Top Side	0	1	1	13	11.44	-0.05	0.790	0.355	1.131
W09	802.11b	1	Front Face	0	2	1	14	13.81	-0.01	0.046	0.025	0.048
W10	802.11b	1	Rear Face	0	2	1	14	13.81	0.08	**0.917**	**0.435**	**0.958**
W11	802.11b	1	Left Side	0	2	1	14	13.81	0.13	0.100	0.052	0.104
W12	802.11b	1	Bottom Side	0	2	1	14	13.81	0.05	0.074	0.036	0.077
W13	802.11b	6	Rear Face	0	2	1	14	13.56	-0.03	0.862	0.422	0.954
W14	802.11b	11	Rear Face	0	2	1	14	13.05	-0.02	0.752	0.357	0.936

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

2. SAR measurement result of WiFi 5G

Test No.	Band	Channel	Test Position	Separation Distance (cm)	Ant	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR
W16	802.11a	40	Front Face	0	1	6	11	10.8	-0.02	0.014	0.006	0.015
W17	802.11a	40	Rear Face	0	1	6	11	10.8	-0.01	1.190	0.358	1.246
W18	802.11a	40	Right Side	0	1	6	11	10.8	0	0.058	0.019	0.061
W19	802.11a	40	Top Side	0	1	6	11	10.8	0.03	0.430	0.174	0.450
W20	802.11a	36	Rear Face	0	1	6	11	10.75	-0.01	**1.180**	**0.353**	**1.250**
W21	802.11a	48	Rear Face	0	1	6	11	10.68	-0.08	1.140	0.321	1.227
W23	802.11a	40	Front Face	0	2	6	9	8.44	0.01	0.052	0.021	0.059
W24	802.11a	40	Rear Face	0	2	6	9	8.44	0.09	**0.945**	**0.262**	**1.075**
W25	802.11a	40	Left Side	0	2	6	9	8.44	-0.04	0.597	0.197	0.679
W26	802.11a	40	Bottom Side	0	2	6	9	8.44	0.08	0.024	0.016	0.027
W27	802.11a	36	Rear Face	0	2	6	9	8.37	-0.09	0.862	0.238	0.997
W28	802.11a	44	Rear Face	0	2	6	9	8.35	-0.06	0.924	0.268	1.073
W30	802.11a	157	Front Face	0	1	6	12.5	12.11	0	0.014	0.005	0.016
W31	802.11a	157	Rear Face	0	1	6	12.5	12.11	-0.07	**1.020**	**0.294**	**1.116**
W32	802.11a	157	Right Side	0	1	6	12.5	12.11	-0.05	0.048	0.015	0.052
W33	802.11a	157	Top Side	0	1	6	12.5	12.11	-0.09	0.819	0.220	0.896
W34	802.11a	153	Rear Face	0	1	6	11	10.23	0.02	0.860	0.253	1.027
W35	802.11a	161	Rear Face	0	1	6	11	9.32	0.08	0.504	0.155	0.742
W37	802.11a	165	Front Face	0	2	6	11	10.46	-0.09	0.092	0.037	0.104
W38	802.11a	165	Rear Face	0	2	6	11	10.46	-0.03	0.808	0.243	0.915
W39	802.11a	165	Left Side	0	2	6	11	10.46	-0.17	0.574	0.187	0.650
W40	802.11a	165	Bottom Side	0	2	6	11	10.46	0.01	0.029	0.023	0.032
W41	802.11a	161	Rear Face	0	2	6	11	10.34	-0.05	**0.811**	**0.249**	**0.944**
W42	802.11a	153	Rear Face	0	2	6	11	10.22	0.09	0.767	0.236	0.918

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

7.3. MULTIPLE TRANSMITTER EVALUATION

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

The location of the antenna inside EUT and standalone SAR test exclusion, please refer to Appendix E.

7.3.1 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.

The Simultaneous Transmission Possibilities of this device are as below:

NO.	Simultaneous Tx Combination	Body-worn
1	WiFi 2.4G (Ant 1) + WiFi 2.4G (Ant 2)	Yes
2	WiFi 5.2G (Ant 1) + WiFi 5.2G (Ant 2)	Yes
3	WiFi 5.8G (Ant 1) + WiFi 5.8G (Ant 2)	Yes

7.3.2 SAR SUMMATION SCENARIO

Test Position / SAR_{1g}(W/kg)		Front Face	Rear Face	Left Side	Right Side	Top Side	Bottom Side
ANT 1	WiFi 2.4G	0.060	0.510	/	0.131	1.158	/
	WiFi 5.2G	0.015	1.250	/	0.061	0.450	/
	WiFi 5.8G	0.016	1.116	/	0.052	0.896	/
ANT 2	WiFi 2.4G	0.048	0.958	0.104	/	/	0.077
	WiFi 5.2G	0.059	1.075	0.679	/	/	0.027
	WiFi 5.8G	0.104	0.944	0.650	/	/	0.032
Max. $\sum SAR_{1g}$		0.120	**Refer to SPLSR results**	0.679	0.131	1.158	0.077

Reported SAR_{1g} / Test Position		ANT 2 WiFi 2.4G	ANT 2 WiFi 5.2G	ANT 2 WiFi 5.8G	Max. $\sum SAR_{1g}$
Rear Face	ANT 1 WiFi 2.4G	1.468	/	/	1.468
	ANT 1 WiFi 5.2G	/	2.325	/	**Refer to SPLSR results (1)**
	ANT 1 WiFi 5.8G	/	/	2.060	**Refer to SPLSR results (2)**

Note:
1) Max. $\sum SAR_{1g}$<1.6 W/Kg, the SAR to peak location separation ratio should not be considered, otherwise, see section 7.3.3 for more information.
2) The highest simultaneous SAR value=1.468W/Kg, per KDB690783 D01.

7.3.3 SIMULTANEOUS TRANSMISSION CONCLUSION

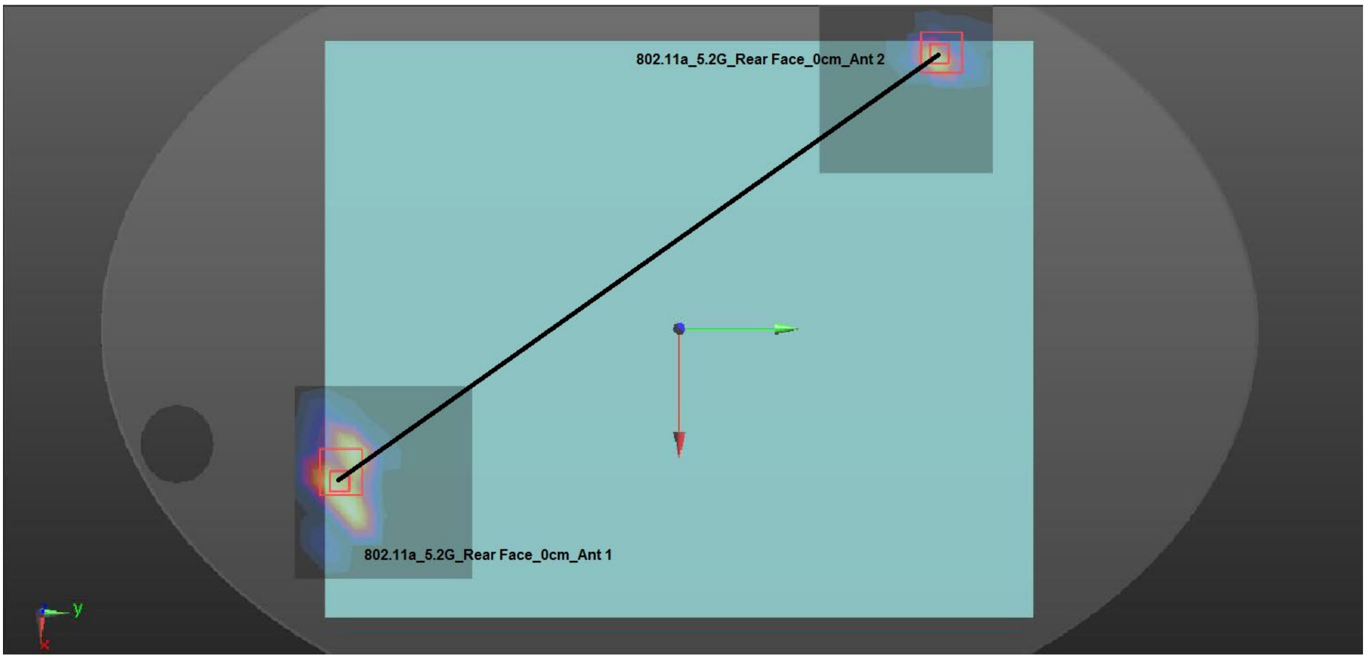
According to KDB447498 D01, When the sum of SAR is larger than limit, SAR test exclusion is determined by the SAR to peak location separation ratio (SPLSR). When the SAR to peak location ratio for each pair of antennas is 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion. When 10-g SAR applies, the ratio must be ≤ 0.10.
When SAR is measured for both antennas in the pair the peak location separation distance is computed by the following formula:

$$\text{Distance}_{Tx1\text{-}Tx2} = R_i = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$$

$$\text{SPLS Ratio} = (SAR_1 + SAR_2)^{1.5}/R_i$$

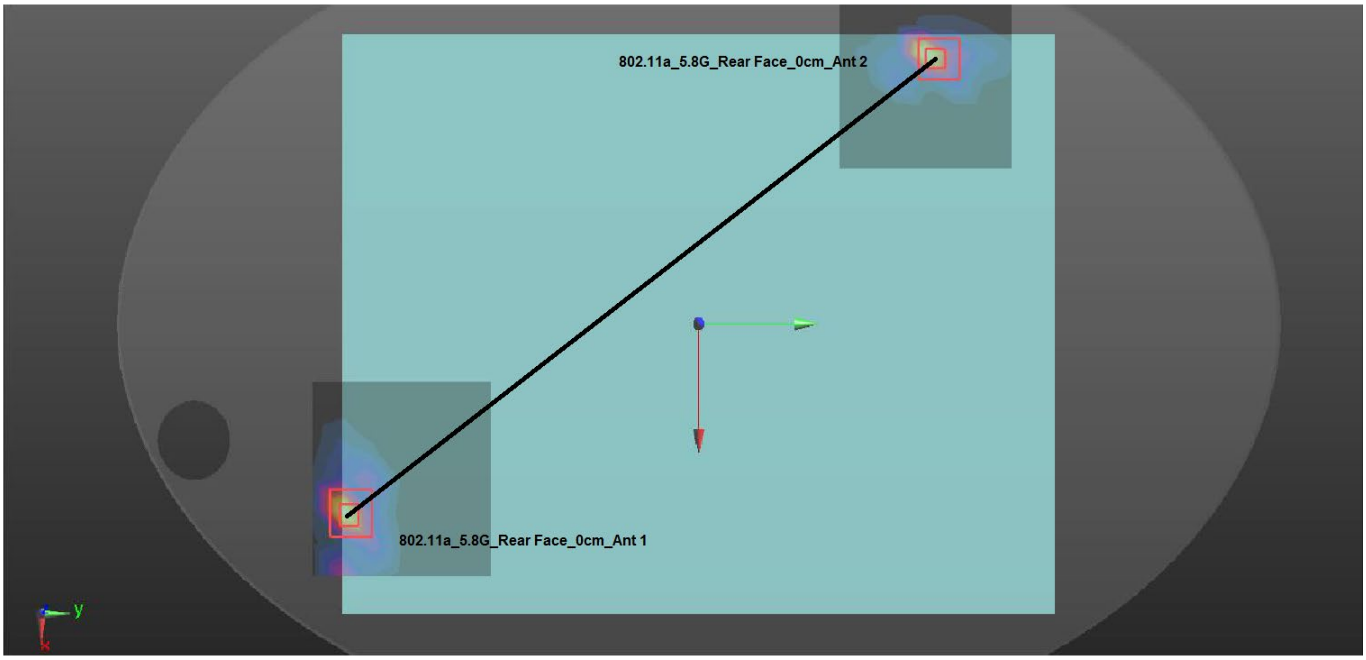
When standalone test exclusion applies, SAR is estimated; the peak location is assumed to be at the feed-point or geometric center of the antenna. Due to curvatures on the SAM phantom, when SAR is estimated for one of the antennas in an antenna pair, the measured peak SAR location should be translated onto the test device to determine the peak location separation for the antenna pair. The ERP location on the phantom is aligned with the ERP location on the handset, with 6mm separation in the z coordinate due to the ear spacer. A measured peak location can be translated onto the handset, with respect to the ERP location, by ignoring the 6 mm offset in the z coordinate. The assumed peak location of the antenna with estimated SAR can also be determined with respect to the ERP location on the handset. The peak location separation distance is estimated by the x and y coordinated of the peaks, referenced to the ERP location. While flat phantoms are not expected to have these issues, the same peak translation approach should be applied to determine peak location separation.

(1) The sum of aggregate 1g SAR was above 1.6 W/kg for Rear Face configuration with ANT 1 WiFi 5.2G and ANT 2 WiFi 5.2G.
The Peak SAR location is as below:



Mode	Reported SAR_{1g}	Peak SAR_{1g}	X	Y	Z	D(mm)	SPLSR	Ratio Limit	Simultaneous SAR
	mW/g	mW/g	m	m	m				
ANT 1 WiFi 5.2G	1.250	2.38	0.0695	-0.168	-0.18	342.1	0.010	0.04	No
ANT 2 WiFi 5.2G	1.075	3.09	-0.127	0.112	-0.181				

(2) The sum of aggregate 1g SAR was above 1.6 W/kg for Rear Face configuration with ANT 1 WiFi 5.8G and ANT 2 WiFi 5.8G.
The Peak SAR location is as below:



Mode	Reported SAR_{1g}	Peak SAR_{1g}	X	Y	Z	D(mm)	SPLSR	Ratio Limit	Simultaneous SAR
	mW/g	mW/g	m	m	m				
ANT 1 WiFi 5.8G	1.116	2.47	0.087	-0.179	-0.18	347.6	0.009	0.04	No
ANT 2 WiFi 5.8G	0.944	2.06	-0.125	0.0965	-0.181				

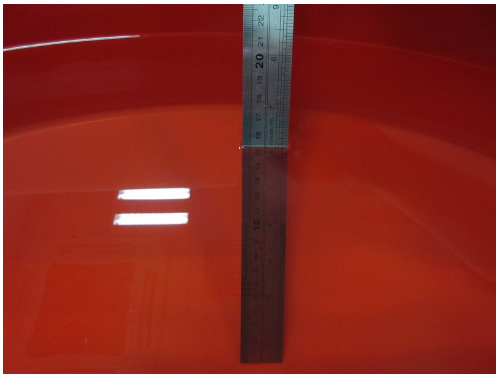
APPENDIX

1. TEST LAYOUT

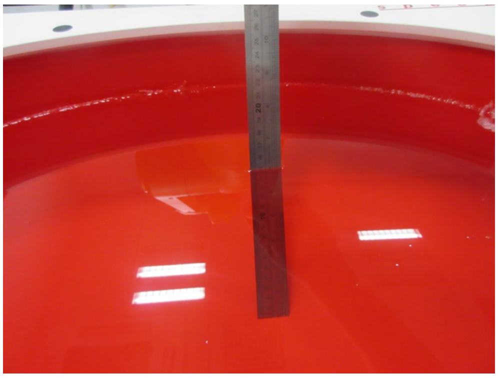
Specific Absorption Rate Test Layout

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

HSL_2300MHz-2700MHz_15.3cm



HSL_5GHz_15.1cm



Appendix A. SAR Plots of System Verification

(Pls See BTL-FCC SAR-1-2010H019_Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See BTL-FCC SAR-1-2010H019_Appendix B.)

Appendix C. Calibration Certificate

(Pls See BTL-FCC SAR-1-2010H019_Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See BTL-FCC SAR-1-2010H019_Appendix D.)

Appendix E. Antenna location and standalone SAR test exclusion

(Pls See BTL-FCC SAR-1-2010H019_Appendix E.)

End of Test Report