FCC SAR TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

Computer

ISSUED TO
Hexagon Metrology, Inc.

250 Circuit Drive North Kingstown RI US 02852

Tested by: Zong Liyao
Zong Liyao
Date Apr. 20, 2021

Approved by:
Wei Yanquan
(Chief Engineer)
Date Apr. 20, 2021

Report No.:	BL-EC2030004-701
EUT Name:	Computer
Model Name:	dCC (Digital Control Center) Wired Jogbox
Brand Name:	HEXAGON
FCC ID:	2AXRK-HEX01DCC
Test Standard:	FCC 47 CFR Part 2.1093
	ANSI C95.1: 1999; IEEE 1528: 2013
Maximum SAR:	Body (1 g): 1.058 W/kg
	Limbs (10 g): 0.875 W/kg
Test Conclusion:	Pass
Test Date:	Apr. 03, 2020 ~ Apr. 16, 2021
Date of Issue:	Apr. 20, 2021

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Revision History

Version	Issue Date	Revisions Content
Rev. 01	Mar. 16, 2021	Initial Issue
Rev. 02	Apr. 20, 2021	Update Conducted Output Power and Test Results

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1 ADMINSTRATIVE DATA (GENERAL INFORMATION)

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Test Environment Condition

Ambient Temperature	20℃ to 23℃
Ambient Relative Humidity	34% to 50%
Ambient Pressure	100 to 102KPa

1.4 Announce

(1) The test report reference to the report template version v2.3.

(2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

(3) The test report is invalid if there is any evidence and/or falsification.

(4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.

(5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

(7) The laboratory is only responsible for the data released by the laboratory, except for the part provided by the applicant.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Hexagon Metrology, Inc.
Address	250 Circuit Drive North Kingstown RI US 02852

2.2 Manufacturer Information

Manufacturer	Advantech Technology(CHINA) Co., LTD.
Address	NO.600, Hanpu-Road, Kunshan, Jiangsu. China

2.3 Factory Information

Factory	Advantech Technology(CHINA) Co., LTD.
Address	NO.600, Hanpu-Road, Kunshan, Jiangsu. China

2.4 General Description for Equipment under Test (EUT)

EUT Name	Computer
Model Name Under Test	dCC (Digital Control Center) Wired Jogbox
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	N/A
Software Version	N/A
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Ancillary Equipment

Note: Not applicable.

2.6 Technical Information

Network and Wireless connectivity	WIFI 802.11a, 802.11b, 802.11g, 802.11n and 802.11ac U-NII-1/2A/2C/3

The requirement for the following technical information of the EUT was tested in this report:

Operating Mode	2.4G WLAN, 5G WLAN	
Frequency Range	802.11b/g /n(HT20/HT40)	2412 ~ 2462 MHz
	802.11a/ /n(HT20/HT40) /ac(VHT20/VHT40/ VHT80)	5150 ~ 5250 MHz
		5250 ~ 5350 MHz
		5470 ~ 5725 MHz
		5725 ~ 5850 MHz
Antenna Type	WLAN: PIFA Antenna	
Hotspot Function	N/A	
Power Reduction	N/A	
Exposure Category	General Population/Uncontrolled exposure	
EUT Stage	Portable Device	
Product	Type	
	☒ Production unit	☐ Identical prototype

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 2	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
2	ANSI/IEEE Std. C95.1-1999	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
3	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
4	FCC KDB 447498 D01 v06	Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies
5	FCC KDB 865664 D01 v01r04	SAR Measurement 100 MHz to 6 GHz
6	FCC KDB 865664 D02 v01r02	RF Exposure Reporting
7	KDB 248227 D01 v02r02	SAR Guidance for IEEE 802.11 (Wi-Fi) Transmitters

3.2 Device Category and SAR Limit

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user. Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

Table of Exposure Limits:

Body Position	SAR Value (W/Kg)	
	General Population/ Uncontrolled Exposure	Occupational/ Controlled Exposure
Whole-Body SAR (averaged over the entire body)	0.08	0.4
Partial-Body SAR (averaged over any 1 gram of tissue)	1.60	8.0
SAR for hands, wrists, feet and ankles (averaged over any 10 grams of tissue)	4.0	20.0

NOTE:

General Population/Uncontrolled: Locations where there is the exposure of individuals who have no knowledge or control of their exposure. General population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

Occupational/Controlled: Locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

3.3 Test Result Summary

3.3.1 Highest SAR (1 g Value)

Frequency Band		Maximum Report SAR (W/kg) 1 g Body SAR (Separation 10 mm)
WIFI	2.4 G	0.013
	5.2 G	**1.058**
	5.6 G	0.678
	5.8 G	0.771
Limits (W/kg)		1.6
Test Verdict		Pass

3.3.2 Highest SAR (10 g Value)

Frequency Band		Maximum Report SAR (W/kg) 10 g Limbs SAR (Separation 0 mm)
WIFI	2.4 G	0.019
	5.2 G	0.658
	5.6 G	0.481
	5.8 G	**0.875**
Limits (W/kg)		4.0
Test Verdict		Pass

3.4 Test Uncertainty

3.4.1 Measurement uncertainly evaluation for SAR test

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in IEEE 1528 This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Uncertainty Component	Tol (+- %)	Prob. Dist.	Div.	Ci (1g)	Ci (10 g)	1g Ui (+-%)	10 g Ui (+-%)	Vi v_{eff}
Measurement System								
Probe calibration	5.8	N	1	1	1	5.80	5.80	∞
Axial Isotropy	3.5	R	$\sqrt{3}$	0.7	0.7	1.41	1.41	∞
Hemispherical Isotropy	5.9	R	$\sqrt{3}$	0.7	0.7	2.38	2.38	∞
Boundary effect	1.0	R	$\sqrt{3}$	1	1	0.58	0.58	∞
Linearity	4.7	R	$\sqrt{3}$	1	1	2.71	2.71	∞
System detection limits	1.0	R	$\sqrt{3}$	1	1	0.58	0.58	∞
Modulation response	3.0	R	$\sqrt{3}$	1	1	1.73	1.73	∞
Readout Electronics	0.5	N	1	1	1	0.50	0.50	∞
Response Time	0.0	R	$\sqrt{3}$	1	1	0.00	0.00	∞
Integration Time	1.4	R	$\sqrt{3}$	1	1	0.81	0.81	∞
RF ambient Conditions - Noise	3.0	R	$\sqrt{3}$	1	1	1.73	1.73	∞
RF ambient Conditions - Reflections	3.0	R	$\sqrt{3}$	1	1	1.73	1.73	∞
Probe positioner Mechanical Tolerance	1.4	R	$\sqrt{3}$	1	1	0.81	0.81	∞
Probe positioning with respect to Phantom Shell	1.4	R	$\sqrt{3}$	1	1	0.81	0.81	∞
Extrapolation, interpolation and integration Algoritms for Max. SAR Evaluation	2.3	R	$\sqrt{3}$	1	1	1.33	1.33	∞
Test sample Related								
Test sample positioning	2.6	N	1	1	1	2.60	2.60	N-1
Device Holder Uncertainty	3.0	N	1	1	1	3.00	3.00	N-1
Output power Variation - SAR drift measurement	5.0	R	$\sqrt{3}$	1	1	2.89	2.89	∞
SAR scaling	2.0	R	$\sqrt{3}$	1	1	1.15	1.15	∞
Phantom and Tissue Parameters								
Phantom Uncertainty (Shape and thickness tolerances)	4.0	R	$\sqrt{3}$	1	1	2.31	2.31	∞
SAR correction for deviation(in permittivity and conductivity)	2.0	N	1	1	0.84	2.00	1.68	∞
Liquid conductivity (temperature uncertainty)	2.5	R	$\sqrt{3}$	0.78	0.71	1.13	1.03	∞
Liquid conductivity - measurement uncertainty	5.0	N	1	0.78	0.71	3.90	3.55	M
Liquid permittivity (temperature uncertainty)	2.5	R	$\sqrt{3}$	0.23	0.26	0.33	0.38	∞
Liquid permittivity - measurement uncertainty	5.0	N	1	0.23	0.26	1.15	1.30	M
Combined Standard Uncertainty	-	RSS	-			10.72	10.56	-
Expanded Uncertainty (95% Confidence interval)	-	k	-			21.45	21.11	-

3.4.2 Measurement uncertainly evaluation for system check

This measurement uncertainty budget is suggested by IEEE 1528. The break down of the individual uncertainties is as follows:

Uncertainty Component	Tol (+- %)	Prob. Dist.	Div.	Ci (1g)	Ci (10g)	1g Ui (+-%)	10g Ui (+-%)	Vi
Measurement System								
Probe calibration	5.8	N	1	1	1	5.80	5.30	∞
Axial Isotropy	3.5	R	$\sqrt{3}$	1	1	2.02	2.02	∞
Hemispherical Isotropy	5.9	R	$\sqrt{3}$	0	0	0.00	0.00	∞
Boundary effect	1.0	R	$\sqrt{3}$	1	1	0.58	0.56	∞
Probe Linearity	4.7	R	$\sqrt{3}$	1	1	2.71	2.71	∞
System detection limits	1.0	R	$\sqrt{3}$	1	1	0.58	0.58	∞
Modulation response	0.0	R	$\sqrt{3}$	1	1	0.00	0.00	∞
Readout Electronics	0.5	N	1	1	1	0.50	0.50	∞
Response Time	0.0	R	$\sqrt{3}$	1	1	0.00	0.00	∞
Integration Time	1.4	R	$\sqrt{3}$	0	0	0.00	0.00	∞
RF ambient Conditions - Noise	3.0	R	$\sqrt{3}$	1	1	1.73	1.73	∞
RF ambient Conditions - Reflections	3.0	R	$\sqrt{3}$	1	1	1.73	1.73	∞
Probe positioner Mechanical Tolerance	1.4	R	$\sqrt{3}$	1	1	0.81	0.81	∞
Probe positioning with respect to Phantom Shell	1.4	R	$\sqrt{3}$	1	1	0.81	0.81	∞
Extrapolation, interpolation and integration Algoritms for Max. SAR Evaluation	2.3	R	$\sqrt{3}$	1	1	1.33	1.33	∞
Dipole								
Deviation of experimental dipole	5.5	N	1	1	1	5.00	5.00	∞
Dipole axis to liquid distance	2.0	R	$\sqrt{3}$	1	1	1.15	1.15	∞
Power drift	0.5	R	$\sqrt{3}$	1	1	0.29	0.29	∞
Phantom and Tissue Parameters								
Phantom Uncertainty (Shape and thickness tolerances)	4.0	R	$\sqrt{3}$	1	1	2.31	2.31	∞
SAR correction for deviation(in permittivity and conductivity)	2.0	N	1	1	0.84	2.00	1.68	∞
Liquid conductivity (temperature uncertainty)	2.5	R	$\sqrt{3}$	0.78	0.71	1.13	1.02	∞
Liquid conductivity - measurement uncertainty	5.0	N	1	0.78	0.71	3.90	3.55	M
Liquid permittivity (temperature uncertainty)	2.5	R	$\sqrt{3}$	0.23	0.26	0.33	0.38	∞
Liquid permittivity - measurement uncertainty	5.0	N	1	0.23	0.26	1.15	1.30	M
Combined Standard Uncertainty	-	RSS	-			10.43	10.25	–
Expanded Uncertainty (95% Confidence interval)	-	k	-			20.86	20.51	–

4 SAR MEASUREMENT SYSTEM

4.1 Definition of Specific Absorption Rate (SAR)

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational / controlled exposure limits are higher than the limits for general population /uncontrolled.

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$\mathbf{SAR} = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dv}\right)$$

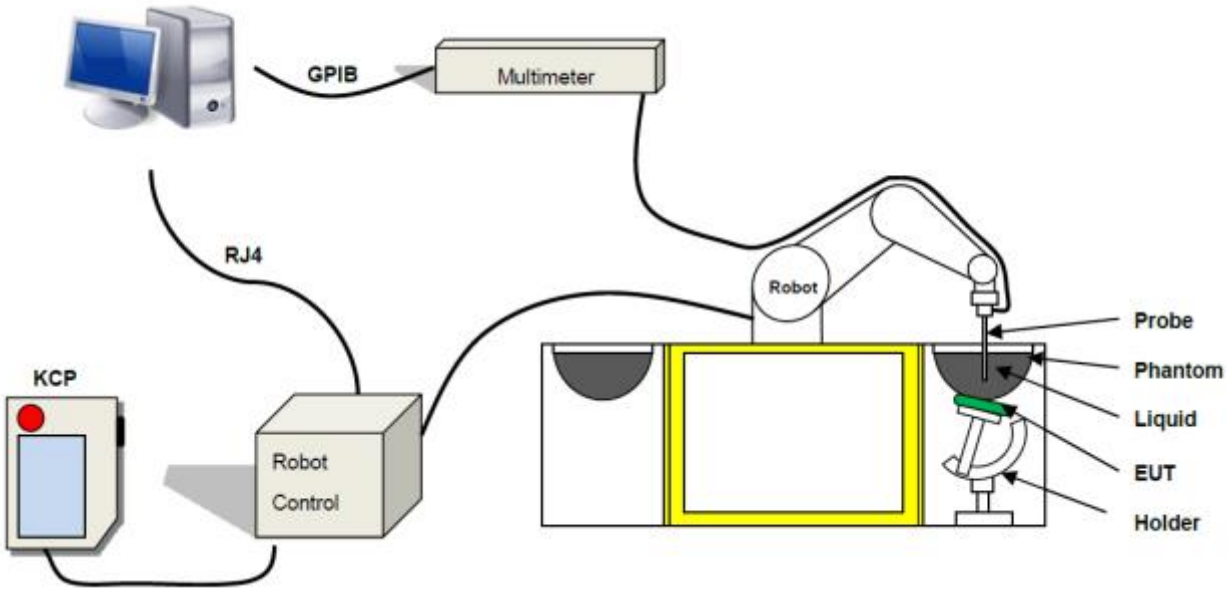
SAR is expressed in units of Watts per kilogram (W/kg) SAR measurement can be related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue,
ρ is the mass density of the tissue and E is the RMS electrical field strength.

4.2 SATIMO SAR System

4.2.1 SATIMO SAR System Diagram



These measurements were performed with the automated near-field scanning system OPENSAR from SATIMO. The system is based on a high precision robot (working range: 850 mm), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit.

The SAR measurements were conducted with dosimetric probe (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in SAR standard with accuracy of better than ±10%. The spherical isotropy was evaluated with the procedure described in SAR standard and found to be better than ±0.25 dB. The phantom used was the SAM Phantom as described in FCC supplement C, IEEE P1528.

4.2.2 Robot

The SATIMO SAR system uses the high precision robots from KUKA. For the 6-axis controller system, the robot controller version (KUKA) from KUKA is used. The KUKA robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

4.2.3 E-Field Probe

For the measurements the Specific Dosimetric E-Field Probe SN 34/15 EPGO 265 with following specifications is used

-- Dynamic range: 0.01-100 W/kg

- Tip Diameter : 2.5 mm
- Lower detection limit : 10 mW/kg

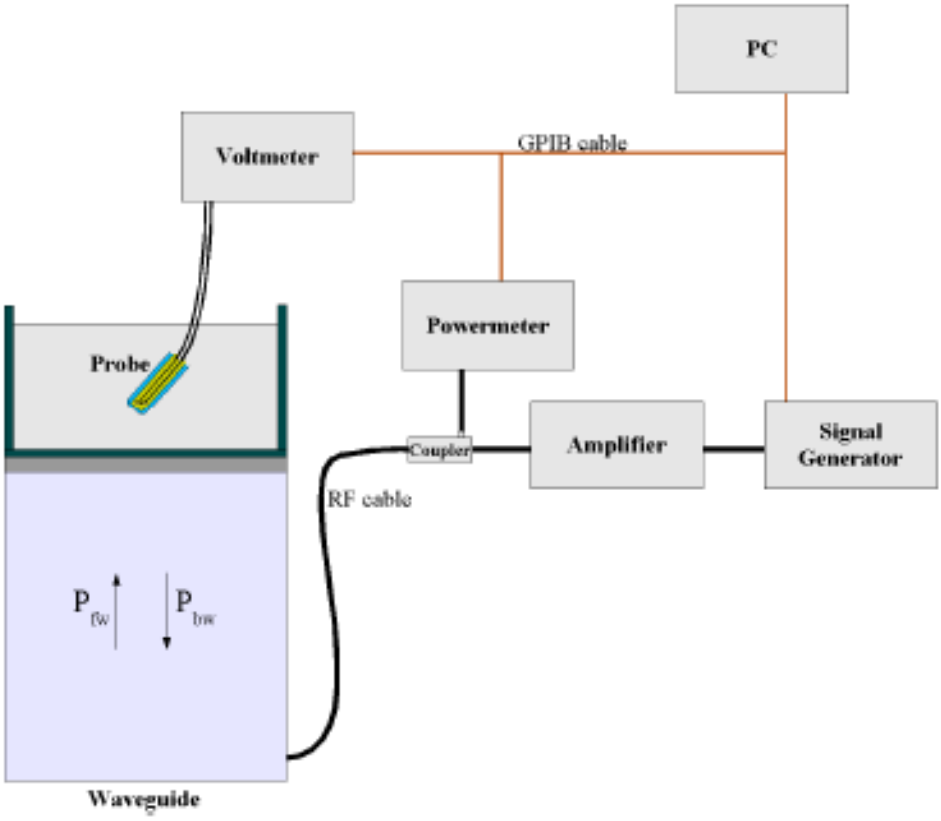
(repeatability better than +/- 1mm)

- Probe linearity: +/- 0.07 dB
- Calibration range: 300 MHz to 6000 MHz for head & body simulating liquid.

Angle between probe axis (evaluation axis) and surface normal line: less than 30°

E-Field Probe Calibration Process

Probe calibration is realized, in compliance with CENELEC EN 62209-1/-2 and IEEE 1528 std, with CALISAR, Antennessa proprietary calibration system. The calibration is performed with the IEC62209-1/2 annexe technique using reference guide at the five frequencies.



$$SAR = \frac{4(P_{fw} - P_{bw})}{ab\sigma} \cos^2\left(\pi \frac{y}{a}\right) c^{(2\pi/\sigma)}$$

Where :

Pfw	=	Forward Power
Pbw	=	Backward Power
a and b	=	Waveguide Dimensions
ı	=	Skin Depth

Keithley configuration

Rate = Medium; Filter =ON; RDGS=10; FILTER TYPE =MOVING AVERAGE; RANGE AUTO After each calibration, a SAR measurement is performed on a validation dipole and compared with a NPL calibrated probe, to verify it.

The calibration factors, CF(N), for the 3 sensors corresponding to dipole 1, dipole 2 and dipole 3 are:

CF(N)=SAR(N)/Vlin(N) (N=1,2,3)

The linearised output voltage Vlin(N) is obtained from the displayed output voltage V(N) using

Vlin(N)=V(N)*(1+V(N)/DCP(N)) (N=1,2,3)

Where the DCP is the diode compression point in mV.

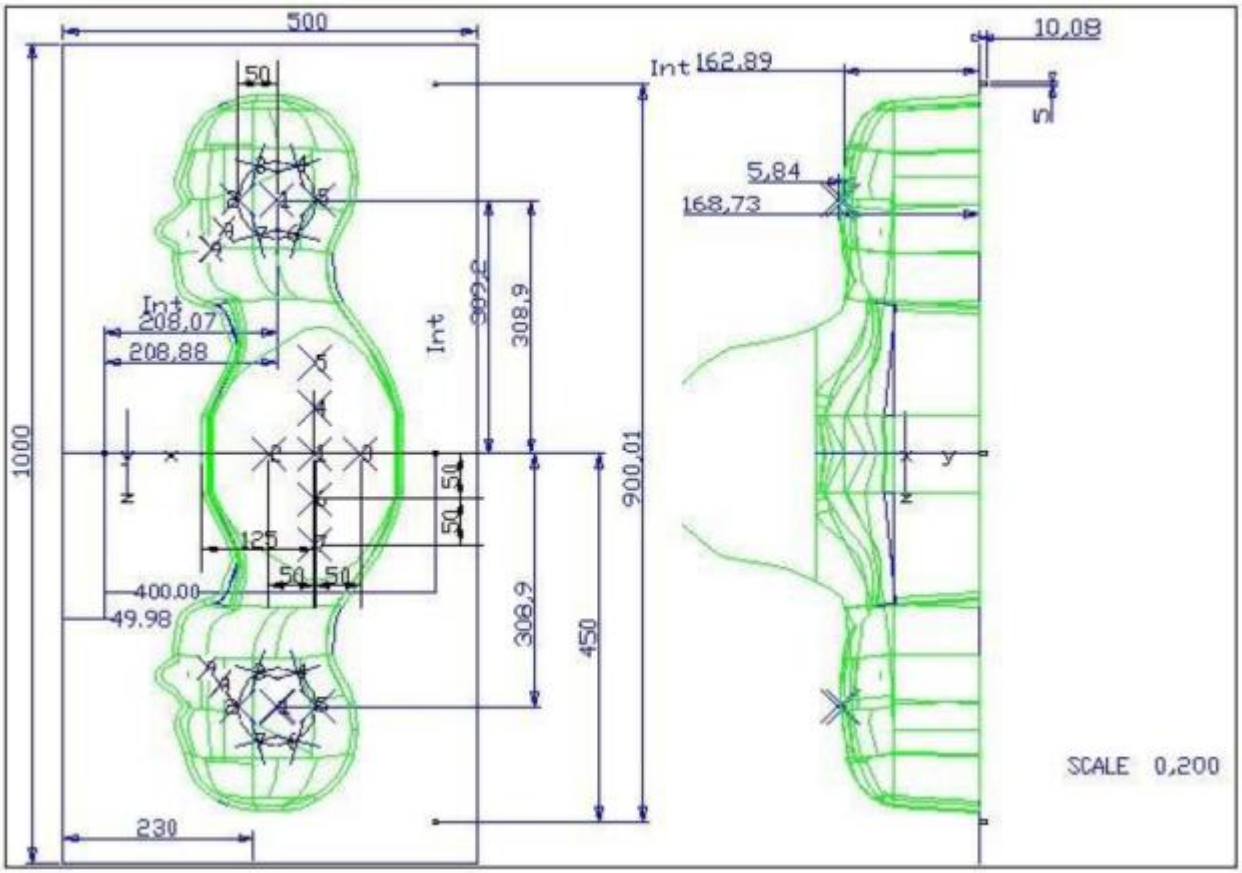
4.2.4 Phantoms

For the measurements the Specific Anthropomorphic Mannequin (SAM) defined by the IEEE SCC-34/SC2 group is used. The phantom is a polyurethane shell integrated in a wooden table. The thickness of the phantom amounts to 2mm +/- 0.2mm. It enables the dosimetric evaluation of left and right phone usage and includes an additional flat phantom part for the simplified performance check. The phantom set-up includes a cover, which prevents the evaporation of the liquid.

Photo of Phantom SN 30/13 SAM103

Photo of Phantom SN 30/13 SAM104

Serial Number	Positionner Material	Permittivity	Loss Tangent
SN 30/13 SAM103	Gelcoat with fiberglass	3.4	0.02
SN 30/13 SAM104	Gelcoat with fiberglass	3.4	0.02



Serial Number	Left Head		Right Head		Flat Part	
SN 30/13 SAM103	2	2.00	2	2.03	1	2.09
	3	2.02	3	2.05	2	2.10
	4	2.04	4	2.04	3	2.09
	5	2.04	5	2.07	4	2.11
	6	2.02	6	2.07	5	2.11
	7	2.01	7	2.09	6	2.09
	8	2.04	8	2.10	7	2.11
	9	2.02	9	2.09	-	-
SN 30/13 SAM104	2	2.05	2	2.06	1	2.03
	3	2.08	3	2.03	2	2.03
	4	2.05	4	2.03	3	2.01
	5	2.06	5	2.02	4	2.03
	6	2.08	6	2.02	5	2.03
	7	2.06	7	2.04	6	2.00
	8	2.07	8	2.04	7	1.98
	9	2.07	9	2.05	-	-

4.2.5 Device Holder

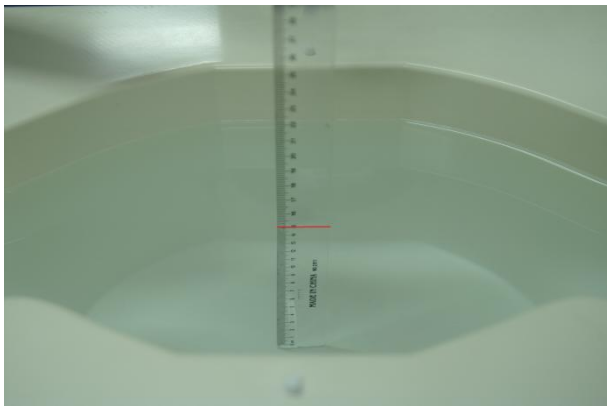
The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of ± 0.5 mm would produce a SAR uncertainty of ± 20 %. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

Serial Number	Holder Material	Permittivity	Loss Tangent
SN 25/13 MSH87	Deirin	3.7	0.005
SN 25/13 MSH88	Deirin	3.7	0.005

The positioning system allows obtaining cheek and tilting position with a very good accuracy. In compliance with CENELEC, the tilt angle uncertainty is lower than 1°.

4.2.6 Simulating Liquid

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5%.

Head Liquid Depth	Body Liquid Depth
	

The following table gives the recipes for tissue simulating liquid and the theoretical Conductivity/Permittivity.

Head (Reference IEEE1528)								
Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity σ (S/m)	Permittivity ε
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
900	40.3	57.9	0.2	1.4	0.2	0	0.97	41.5
1800, 1900, 2000	55.2	0	0	0.3	0	44.5	1.4	40.0
2450	55.0	0	0	0.1	0	44.9	1.80	39.2
2600	54.9	0	0	0.1	0	45.0	1.96	39.0
Frequency(MHz)	Water (%)	Hexyl Carbitol (%)			Triton X-100 (%)		Conductivity σ (S/m)	Permittivity ε
5200	62.52	17.24			17.24		4.66	36.0
5800	62.52	17.24			17.24		5.27	35.3
Body (From instrument manufacturer)								
Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity σ (S/m)	Permittivity ε
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
900	50.8	48.2	0	0.9	0.1	0	1.05	55.0
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0.1	0	31.3	1.95	52.7
2600	68.2	0	0	0.1	0	31.7	2.16	52.5

Frequency(MHz)	Water	DGBE (%)	Salt (%)	Conductivity σ (S/m)	Permittivity ε
5200	78.60	21.40	/	5.54	47.86
5800	78.50	21.40	0.1	6.0	48.20

5 SYSTEM VERIFICATION

5.1 Antenna Port Test Requirement

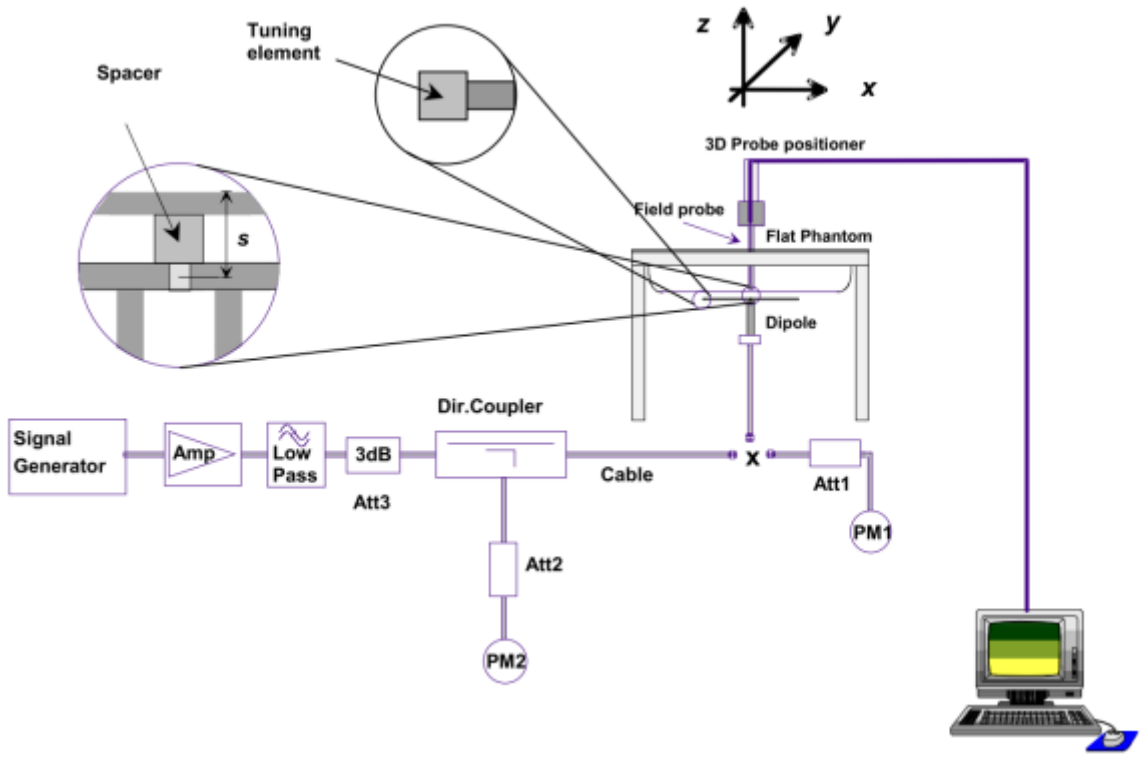
The SATIMO SAR system is equipped with one or more system validation kits. These units together with the predefined measurement procedures within the SATIMO software enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

5.2 Purpose of System Check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

5.3 System Check Setup

In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



6 EUT TEST POSITION CONFIGURATUONS

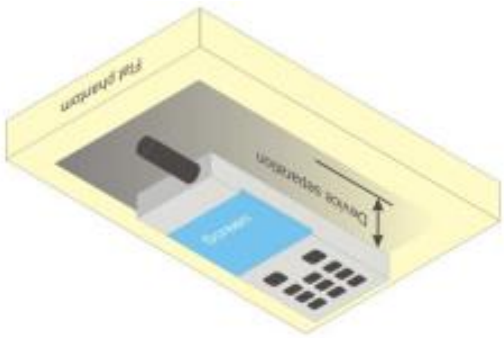
According to KDB 648474 D04 Handset , handsets are tested for SAR compliance in head, body-worn accessory and other use configurations described in the following subsections.

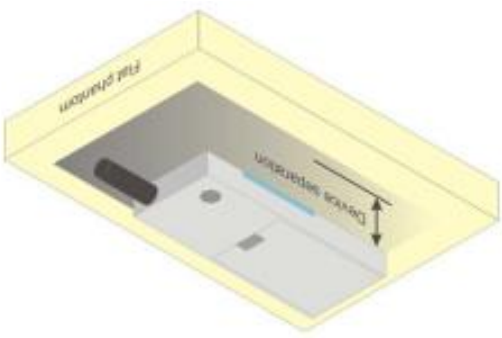
6.1 Body-worn Position Conditions

Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in KDB 447498 are used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components are tested in conjunction with the host device.

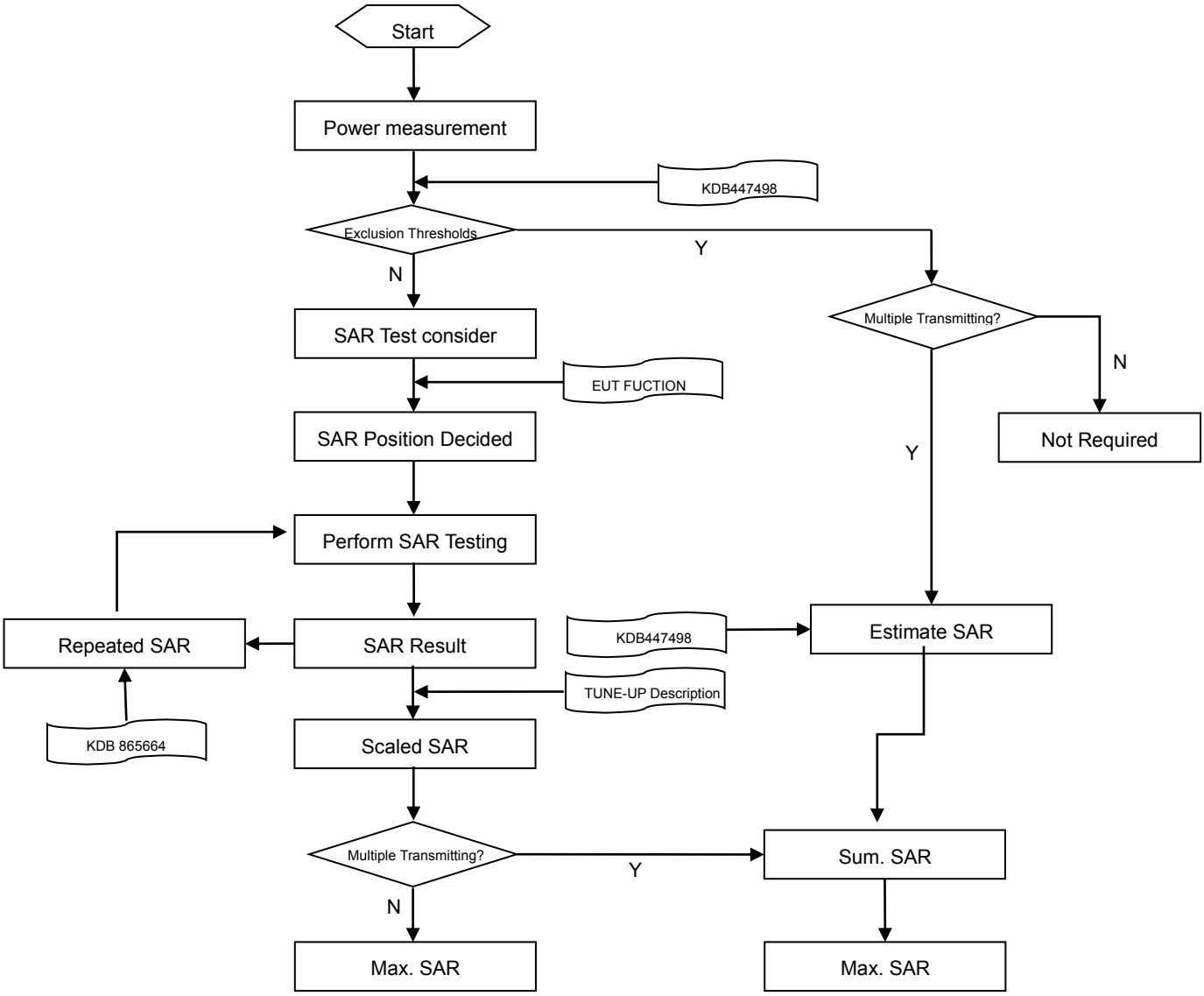
Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice only operations in its normal and expected use conditions, testing of data mode for body-worn compliance is not required. A conservative minimum test separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users of consumer handsets is used to test for body-worn accessory SAR compliance. This distance is determined by the handset manufacturer, according to the requirements of Supplement C 01-01. Devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body-worn accessories, will be tested using a conservative minimum test separation distance <= 5 mm to support compliance.





7 SAR MEASUREMENT PROCEDURES

7.1 SAR Measurement Process Diagram



7.2 SAR Scan General Requirements

Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2013.

<table>
<tr><th colspan="3"></th><th>≤3GHz</th><th>>3GHz</th></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5±1 mm</td><td>½·δ·ln(2)±0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30°±1°</td><td>20°±1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx Area , Δy Area</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3–4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ⩽ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx Zoom , Δy Zoom</td><td>≤ 2 GHz: ≤ 8 mm
2 –3 GHz: ≤ 5 mm*</td><td>3–4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="6">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2" rowspan="3">uniform grid: Δz Zoom (n)</td><td rowspan="3">≤ 5 mm</td><td>3–4 GHz: ≤ 4 mm</td></tr>
<tr><td>4–5 GHz: ≤ 3 mm</td></tr>
<tr><td>5–6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="3">graded grid</td><td rowspan="2">Δz Zoom (1): between 1st two points closest to phantom surface</td><td rowspan="2">≤ 4 mm</td><td>3–4 GHz: ≤ 3 mm</td></tr>
<tr><td>4–5 GHz: ≤ 2.5 mm
5–6 GHz: ≤ 2 mm</td></tr>
<tr><td>Δz Zoom (n>1): between subsequent points</td><td colspan="2">≤ 1.5·Δz Zoom (n-1)</td></tr>
<tr><td rowspan="3">Minimum zoom scan volume</td><td colspan="2" rowspan="3">x, y, z</td><td rowspan="3">≥30 mm</td><td>3–4 GHz: ≥ 28 mm</td></tr>
<tr><td>4–5 GHz: ≥ 25 mm</td></tr>
<tr><td>5–6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note:
1. δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
2. * When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ⩽ 1.4 W/kg, ⩽ 8 mm, ⩽ 7 mm and ⩽ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

7.3 SAR Measurement Procedure

The following steps are used for each test position

- Establish a call with the maximum output power with a base station simulator. The connection between the mobile and the base station simulator is established via air interface
- Measurement of the local E-field value at a fixed location. This value serves as a reference value for calculating a possible power drift.
- Measurement of the SAR distribution with a grid of 8 to 16mm * 8 to16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme.
- Around this point, a cube of 30 * 30 * 30 mm or 32 * 32 * 32 mm is assessed by measuring 5 or 8 * 5 or 8*4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

7.4 Area & Zoom Scan Procedures

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. Area scan and zoom scan resolution setting follows KDB 865664 D01 quoted below.

When the 1-g SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are required for other peaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR.

8 CONDUCTED RF OUPUT POWER

8.1 WIFI

8.1.1 2.4GWIFI

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)	Tune-up Limit (dBm)	SAR Test Require.
2.4 (2.4~2.4835)	802.11b	1	2412	16.55	17.00	Yes
		6	2437	**16.68**	17.00	Yes
		11	2462	16.27	17.00	Yes
	802.11g	1	2412	14.78	15.00	No
		6	2437	18.55	19.00	No
		11	2462	14.57	15.00	No
	802.11n(HT20)	1	2412	15.21	16.00	No
		6	2437	18.65	19.00	No
		11	2462	14.47	15.00	No
	802.11n(HT40)	3	2422	14.29	15.00	No
		6	2437	16.66	17.00	No
		9	2452	14.36	15.00	No

8.1.2 5GWIFI

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)	Tune-up Limit (dBm)	SAR Test Require.
5.2 (5.15~5.25)	802.11a	36	5180	16.11	17.00	Yes
		40	5200	**17.14**	19.00	Yes
		48	5240	16.40	17.00	Yes
	802.11n(HT20)	36	5180	15.46	16.00	No
		44	5220	17.35	19.00	No
		48	5240	17.32	18.00	No
	802.11n(HT40)	38	5190	11.74	13.00	No
		46	5230	16.33	17.00	No
	802.11ac(VHT20)	36	5180	15.98	17.00	No
		40	5200	17.90	19.00	No
		48	5240	17.67	18.00	No
	802.11ac(VHT40)	38	5190	12.28	13.00	No
		46	5230	16.23	17.00	No
	802.11ac(VHT80)	42	5210	12.27	13.00	No
5.3 (5.25~5.35)	802.11a	52	5260	18.46	18.50	No
		60	5300	17.79	18.50	No
		64	5320	18.07	18.50	No
	802.11n(HT20)	52	5260	17.87	18.50	No
		60	5300	17.90	18.50	No
		64	5320	16.98	18.50	No
	802.11n(HT40)	54	5270	17.95	18.50	No
		62	5310	12.58	13.00	No
	802.11ac(VHT20)	52	5260	18.14	18.50	No
		60	5300	17.18	18.50	No
		64	5320	17.52	18.50	No
	802.11ac(VHT40)	54	5270	18.72	18.80	No
		62	5310	13.14	14.00	No
	802.11ac(VHT80)	58	5290	11.53	12.00	No
5.6 (5.47~5.725)	802.11a	100	5500	16.57	17.00	Yes
		116	5580	**19.33**	19.50	Yes
		140	5700	16.87	17.50	Yes
	802.11n(HT20)	100	5500	17.64	18.00	No
		116	5580	18.63	19.00	No
		140	5700	14.85	15.50	No
	802.11n(HT40)	102	5510	13.32	14.00	No
		118	5590	16.19	17.00	No
		134	5670	16.19	17.00	No
	802.11ac(VHT20)	100	5500	17.47	18.00	No
		116	5580	18.64	19.00	No
		140	5700	14.59	15.50	No
	802.11ac(VHT40)	102	5510	13.73	14.00	No
		118	5590	15.93	17.00	No

		134	5670	15.64	17.00	No
	802.11ac(VHT80)	106	5530	12.56	13.00	No
		122	5610	18.12	18.50	No
		138	5690	17.25	18.00	No
5.8 (5.725~5.850)	802.11a	149	5745	**18.08**	18.50	Yes
		157	5785	17.93	18.50	Yes
		165	5825	17.19	18.50	Yes
	802.11n(HT20)	149	5745	17.38	18.00	No
		157	5785	18.06	18.50	No
		165	5825	17.16	18.00	No
	802.11n(HT40)	151	5755	17.59	18.00	No
		159	5795	17.31	18.00	No
	802.11ac(VHT20)	149	5745	17.07	18.00	No
		157	5785	17.34	18.00	No
		165	5825	17.42	18.00	No
	802.11ac(VHT40)	151	5755	17.23	18.00	No
		159	5795	17.05	18.00	No
	802.11ac(VHT80)	155	5775	16.76	17.00	No

Note: When multiple channel bandwidth configurations in a frequency band have the same maximum Tune-Up output power, the test configuration is determined by applying the following steps sequentially.

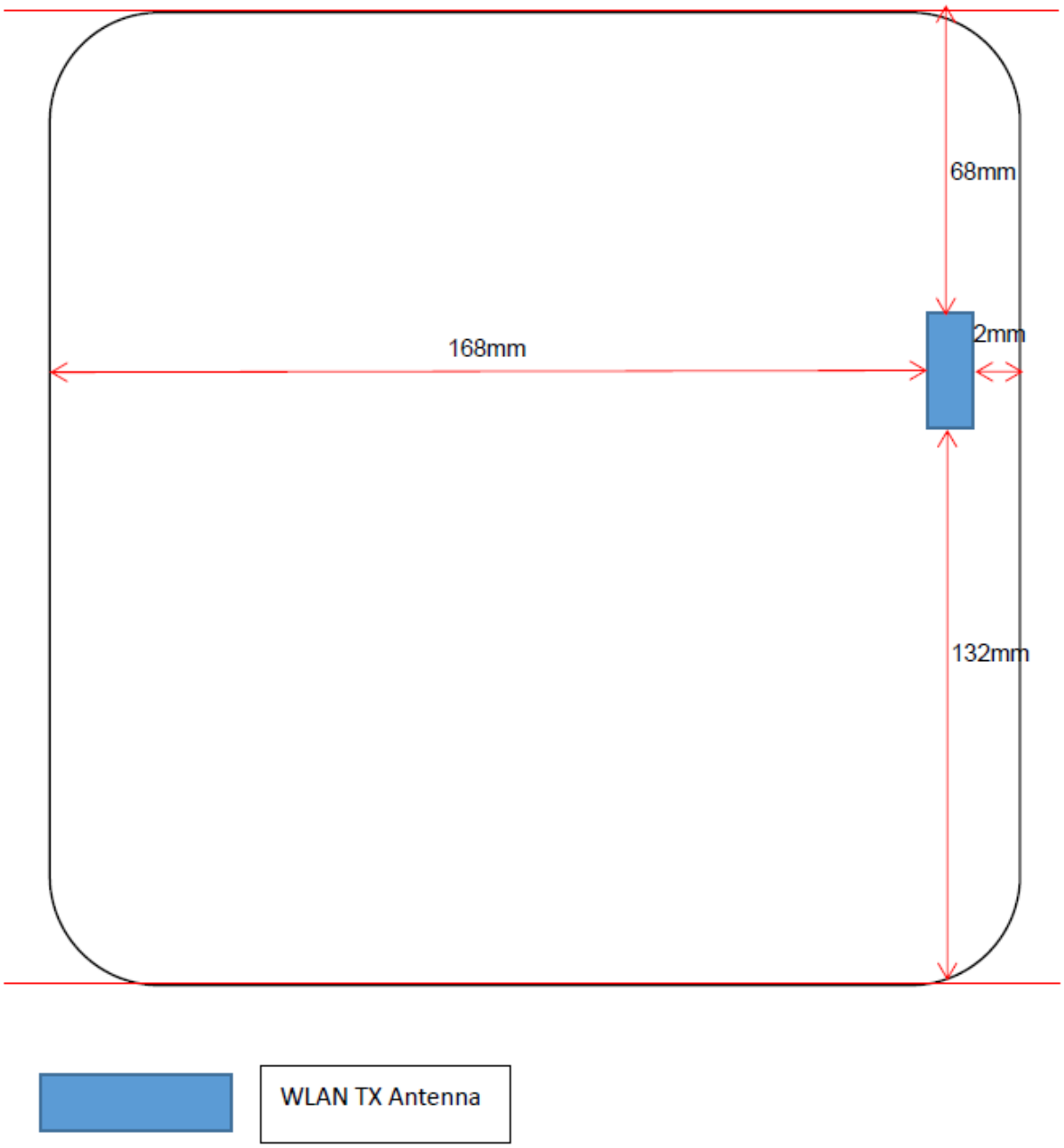
1) The largest channel bandwidth configuration is selected among the multiple configurations in a frequency band with the same maximum Tune-Up output power.

2) If multiple configurations have the same maximum Tune-Up output power and largest channel bandwidth, the lowest order modulation among the largest channel bandwidth configurations is selected.

3) If multiple configurations have the same maximum Tune-Up output power, largest channel bandwidth and lowest order modulation is selected.

4) When multiple transmission modes (802.11a/n/ac) have the same maximum Tune-Up output power, largest channel bandwidth, lowest order modulation and lowest data rate, the lowest order 802.11 mode is selected; i.e., 802.11a is chosen over 802.11n then ac.

9 EUT ANTENNA LOCATION SKETCH



9.1 SAR Test Exclusion Consider Table

According with FCC KDB 447498 D01, Appendix A, <SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm> Table, this Device SAR test configurations consider as following :

Band	Mode	Max. Peak Power		Test Position Configurations					
		dBm	mW	Front	Back	Left Edge	Right Edge	Top Edge	Bottom Edge
WLAN 2.4 G	Distance to User			<5mm	75mm	168mm	<5mm	68mm	132mm
	802.11b	17.0	50.12	Yes	No	No	Yes	No	No
	802.11g	19.0	79.43	No	No	No	No	No	No
	802.11n(HT20)	19.0	79.43	No	No	No	No	No	No
	802.11n(HT40)	17.0	50.12	No	No	No	No	No	No
WLAN 5.2G	Distance to User			<5mm	75mm	168mm	<5mm	68mm	132mm
	802.11a	19.0	79.43	Yes	No	No	Yes	No	No
	802.11n(HT20)	19.0	79.43	No	No	No	No	No	No
	802.11n(HT40)	17.0	50.12	No	No	No	No	No	No
	802.11ac(HT20)	19.0	79.43	No	No	No	No	No	No
	802.11ac(HT40)	17.0	50.12	No	No	No	No	No	No
	802.11ac(HT80)	13.0	19.95	Yes	No	No	Yes	No	No
WLAN 5.3G	Distance to User			<5mm	75mm	168mm	<5mm	68mm	132mm
	802.11a	18.5	70.79	No	No	No	No	No	No
	802.11n(HT20)	18.5	70.79	No	No	No	No	No	No
	802.11n(HT40)	18.5	70.79	No	No	No	No	No	No
	802.11ac(HT20)	18.5	70.79	No	No	No	No	No	No
	802.11ac(HT40)	18.8	75.86	No	No	No	No	No	No
	802.11ac(HT80)	12.0	15.85	Yes	No	No	Yes	No	No
WLAN 5.6G	Distance to User			<5mm	75mm	168mm	<5mm	68mm	132mm
	802.11a	19.5	89.13	Yes	No	No	Yes	No	No
	802.11n(HT20)	19.0	79.43	No	No	No	No	No	No
	802.11n(HT40)	17.0	50.12	No	No	No	No	No	No
	802.11ac(HT20)	19.0	79.43	No	No	No	No	No	No
	802.11ac(HT40)	17.0	50.12	No	No	No	No	No	No
	802.11ac(HT80)	18.5	70.79	No	No	No	Yes	No	No
WLAN 5.8G	Distance to User			<5mm	75mm	168mm	<5mm	68mm	132mm
	802.11a	18.5	70.79	Yes	No	No	Yes	No	No
	802.11n(HT20)	18.5	70.79	No	No	No	No	No	No
	802.11n(HT40)	18.0	63.10	No	No	No	No	No	No
	802.11ac(HT20)	18.0	63.10	No	No	No	No	No	No
	802.11ac(HT40)	18.0	63.10	No	No	No	No	No	No
	802.11ac(HT80)	17.0	50.12	No	No	No	No	No	No

Note:

1. Maximum power is the source-based time-average power and represents the maximum RF output power including tune-up tolerance among production units

2. Per KDB 447498 D01, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
3. Per KDB 447498 D01, standalone SAR test exclusion threshold is applied; If the distance of the antenna to the user is < 5mm, 5mm is used to determine SAR exclusion threshold
4. Per KDB 447498 D01, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
   [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] ·[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
   a. f(GHz) is the RF channel transmit frequency in GHz
   b. Power and distance are rounded to the nearest mW and mm before calculation
   c. The result is rounded to one decimal place for comparison
   d. For < 50 mm distance, we just calculate mW of the exclusion threshold value (3.0) to do compare.

   This formula is [3.0] / [√f(GHz)] ·[(min. test separation distance, mm)] = exclusion threshold of mW.
5. Per KDB 447498 D01, at 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following
   a. [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW, at 100 MHz to 1500 MHz
   b. [Threshold at 50 mm in step 1) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz
6. Per KDB 248227 D01, choose the highest output power channel to test SAR and determine further SAR exclusion.8. For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4dB higher than those measured at the lowest data rate
7. Per KDB 248227 D01 SAR is not required for the following 2.4 GHz OFDM conditions.
   a. When KDB Publication 447498 D01 SAR test exclusion applies to the OFDM configuration.
   b. 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.
8. Per KDB 248227 D01 SAR is not required for the following U-NII-1 and U-NII-2A bands conditions.
   a. 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, each band is tested independently for SAR.
   b. 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, each band is tested independently for SAR.

10 TEST RESULTS

10.1 WIFI 2.4GHz Body SAR

Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (%)	1g Meas SAR (W/kg)	Meas. Power (dBm)	Max. tune-up power (dBm)	Scaling Factor	Duty cycle Setting	Duty cycle Factor	1g Scaled SAR (W/kg)	Meas. No.
Body													
802.11b	Front Side	10	6	2437	2.99	0.002	16.68	17.00	1.076	100	1.000	0.002	/
	Right Edge	10	6	2437	-0.78	0.012	16.68	17.00	1.076	100	1.000	**0.013**	1#
		10	1	2412	-0.95	0.008	16.55	17.00	1.109	100	1.000	0.009	/
		10	11	2462	-1.81	0.009	16.27	17.00	1.183	100	1.000	0.011	/
Note: Refer to ANNEX C for the detailed test data for each test configuration.													

10.2 WIFI 2.4GHz Limbs SAR

Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (%)	10g Meas SAR (W/kg)	Meas. Power (dBm)	Max. tune-up power (dBm)	Scaling Factor	Duty cycle Setting	Duty cycle Factor	10g Scaled SAR (W/kg)	Meas. No.
Limbs													
802.11b	Front Side	0	6	2437	2.39	0.004	16.68	17.00	1.076	100	1.000	0.004	/
	Right Edge	0	6	2437	-1.84	0.017	16.68	17.00	1.076	100	1.000	0.018	2#
		0	1	2412	-2.74	0.010	16.55	17.00	1.109	100	1.000	0.011	/
		0	11	2462	-1.65	0.016	16.27	17.00	1.183	100	1.000	**0.019**	/
Note: Refer to ANNEX C for the detailed test data for each test configuration.													

10.3WIFI 5GHz Body SAR

Fre. Band	Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (%)	1g Meas SAR (W/kg)	Meas. Power (dBm)	Max. tune-up power (dBm)	Scaling Factor	Duty cycle Setting	Duty cycle Factor	1g Scaled SAR (W/kg)	Meas. No.
Body														
5.2G	802.11a	Front Side	10	40	5200	2.23	0.242	17.14	19.00	1.535	99.80	1.002	0.372	/
		Right Edge	10	40	5200	-3.68	0.688	17.14	19.00	1.535	99.80	1.002	**1.058**	3#
			10	36	5180	2.11	0.342	16.11	17.00	1.227	99.80	1.002	0.421	/
			10	48	5240	2.64	0.442	16.40	17.00	1.148	99.80	1.002	0.509	/
5.6G	802.11a	Front Side	10	116	5580	-3.45	0.326	19.33	19.50	1.040	99.80	1.002	0.340	/
		Right Edge	10	116	5580	-2.96	0.651	19.33	19.50	1.040	99.80	1.002	**0.678**	4#
			10	100	5500	0.94	0.485	16.57	17.00	1.104	99.80	1.002	0.537	/
			10	140	5700	2.04	0.497	16.87	17.50	1.156	99.80	1.002	0.576	/
5.8G	802.11a	Front Side	10	149	5745	-1.01	0.223	18.08	18.50	1.102	99.80	1.002	0.246	/
		Right Edge	10	149	5745	-0.95	0.359	18.08	18.50	1.102	99.80	1.002	0.396	/
			10	157	5785	2.59	0.426	17.93	18.50	1.140	99.80	1.002	0.487	/
			10	165	5825	-3.37	0.569	17.19	18.50	1.352	99.80	1.002	**0.771**	5#
Note: Refer to ANNEX C for the detailed test data for each test configuration.														

10.4WIFI 5GHz Limbs SAR

Fre. Band	Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (%)	10g Meas SAR (W/kg)	Meas. Power (dBm)	Max. tune-up power (dBm)	Scaling Factor	Duty cycle Setting	Duty cycle Factor	10g Scaled SAR (W/kg)	Meas. No.
Limbs														
5.2G	802.11a	Front Side	0	40	5200	-3.49	0.204	17.14	19.00	1.535	99.80	1.002	0.314	/
		Right Edge	0	40	5200	-1.08	0.428	17.14	19.00	1.535	99.80	1.002	**0.658**	6#
			0	36	5180	-3.30	0.282	16.11	17.00	1.227	99.80	1.002	0.347	/
			0	48	5240	-0.88	0.403	16.40	17.00	1.148	99.80	1.002	0.464	/
5.6G	802.11a	Front Side	0	106	5530	-1.32	0.162	19.33	19.50	1.040	99.80	1.002	0.169	/
		Right Edge	0	116	5580	-1.76	0.462	19.33	19.50	1.040	99.80	1.002	**0.481**	7#
			0	100	5500	0.63	0.371	16.57	17.00	1.104	99.80	1.002	0.410	/
			0	140	5700	-2.43	0.408	16.87	17.50	1.156	99.80	1.002	0.473	/
5.8G	802.11a	Front Side	0	149	5745	-2.80	0.318	18.08	18.50	1.102	99.80	1.002	0.351	/
		Right Edge	0	149	5745	1.25	0.613	18.08	18.50	1.102	99.80	1.002	0.677	/
			0	157	5785	1.64	0.620	17.93	18.50	1.140	99.80	1.002	0.708	/
			0	165	5825	2.72	0.646	17.19	18.50	1.352	99.80	1.002	**0.875**	8#
Note: Refer to ANNEX C for the detailed test data for each test configuration.														

11 SAR Measurement Variability

According to KDB 865664 D01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10, the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These 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.

SAR repeated measurement procedure:

1. When the highest measured SAR is < 0.80 W/kg, repeated measurement is not required.
2. When the highest measured SAR is >= 0.80 W/kg, repeat that measurement once.
3. 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, perform a second repeated measurement.
4. If the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20, and the original, first or second repeated measurement is >= 1.5 W/kg, perform a third repeated measurement.

Note 1: For 1g SAR, the highest measured 1g SAR is 0.688 < 0.80 W/kg, repeated measurement is not required.

Note 2: For product Limbs 10g SAR, the highest measured 10g SAR is 0.646 < 2.0 W/kg, repeated measurement is not required.

12 SIMULTANEOUS TRANSMISSION

Note: The product has only one antenna for WLAN, so simultaneous transmission evaluation is not required in this report.

13 TEST EQUIPMENTS LIST

Description	Manufacturer	Model	Serial No./Version	Cal. Date	Cal. Due
Test Software	SATIMO	OpenSAR	V4_02_31	N/A	N/A
2450MHz Dipole	SATIMO	SID 2450	S/N 11/17 DIP 2G450-452	2019/03/20	2021/03/19
Waveguide	SATIMO	SWG5500	S/N 49/16 DIP WGA42	2019/03/20	2021/03/19
E-Field Probe	MVG	SSE2	S/N 34/15 EPGO 265	2019/05/16	2020/05/15
MultiMeter	Keithley	MultiMeter 2000	4024022	2019/06/17	2020/06/16
Signal Generator	R&S	SMBV100A	260592	2019/06/13	2020/06/12
Power Meter	R&S	NRVD-B2	7250BJ-0112/2011	2019/10/30	2020/10/29
Power Sensor	R&S	NRV-Z4	100381	2019/10/30	2020/10/29
Power Sensor	R&S	NRV-Z2	100211	2019/10/30	2020/10/29
Network Analyzer	R&S	ZVL-6	101380	2019/06/20	2020/06/19
Thermometer	Elitech	RC-4HC	N/A	2019/11/02	2020/11/01
Power Amplifier	SATIMO	6552B	22374	N/A	N/A
Dielectric Probe Kit	SATIMO	SCLMP	SN 25/13 OCPG56	N/A	N/A
Antenna	SATIMO	ANTA3	SN 17/13 ZNTA45	N/A	N/A
Phantom1	SATIMO	SAM	SN 11/17 SAM133	N/A	N/A
Phantom2	SATIMO	ELLI	SN 11/17 ELLI42	N/A	N/A
Attenuator	COM-MW	ZA-S1-31	1305003187	N/A	N/A
Directional coupler	AA-MCS	AAMCS-UDC	000272	N/A	N/A

Note: Per KDB 865664 Dipole SAR Validation Verification, BALUN LAB has adopted 3 years calibration intervals. On annual basis, every measurement dipole has been evaluated and is in compliance with the following criteria:

1. There is no physical damage on the dipole;
2. System validation with specific dipole is within 10% of calibrated value;
3. Return-loss in within 20% of calibrated measurement.
4. Impedance (real or imaginary parts) in within 5 Ohms of calibrated measurement.

ANNEX A SIMULATING LIQUID VERIFICATION RESULT

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an SCLMP Dielectric Probe Kit.

Date	Liquid Type	Fre. (MHz)	Temp. (℃)	Meas. Conductivity (σ) (S/m)	Meas. Permittivity (ε)	Target Conductivity (σ) (S/m)	Target Permittivity (ε)	Conductivity Tolerance (%)	Permittivity Tolerance (%)
2020.04.03	Head	2450	21.5	1.83	39.67	1.80	39.20	1.67	1.20
2020.04.05	Head	5200	21.4	4.62	36.76	4.66	35.99	-0.86	2.14
2020.04.05	Head	5600	21.4	5.12	35.74	5.07	35.53	0.99	0.59
2020.04.06	Head	5800	21.3	5.39	34.48	5.27	35.30	2.28	-2.32
Note: The tolerance limit of Conductivity and Permittivity is± 5%.									

ANNEX B SYSTEM CHECK RESULT

Comparing to the original SAR value provided by SATIMO, the validation data should be within its specification of 10%.

(for 1 g)

Date	Liquid Type	Freq. (MHz)	Power (mW)	Measured SAR (W/kg)	Normalized SAR (W/kg)	Dipole SAR (W/kg)	Tolerance (%)	Targeted SAR(W/kg)	Tolerance (%)
2020.04.03	Head	2450	100	5.431	54.31	54.31	0.00	52.40	3.65
2020.04.05	Head	5200	100	15.389	153.89	161.03	-4.43	159.00	-3.21
2020.04.05	Head	5600	100	18.155	181.55	175.43	3.49	173.80	4.46
2020.04.06	Head	5800	100	18.212	182.12	182.30	-0.10	181.20	0.51
Note: The tolerance limit of System validation ±10%.									

(for 10 g)

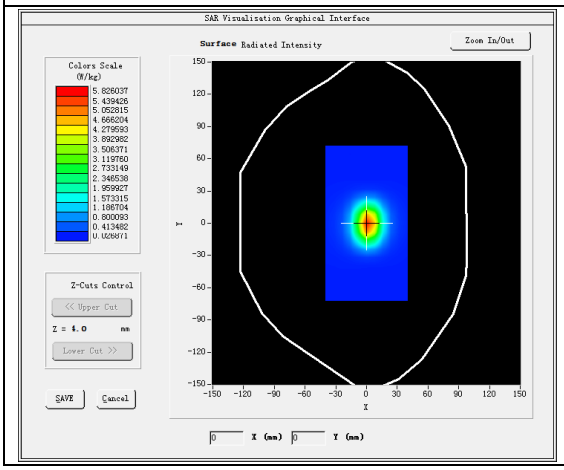
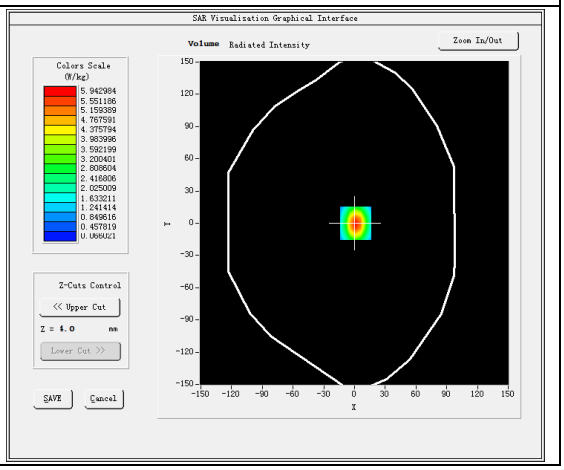
Date	Liquid Type	Freq. (MHz)	Power (mW)	Measured SAR (W/kg)	Normalized SAR (W/kg)	Dipole SAR (W/kg)	Tolerance (%)	Targeted SAR(W/kg)	Tolerance (%)
2020.04.03	Head	2450	100	2.542	25.42	24.20	5.04	24.00	5.92
2020.04.05	Head	5200	100	5.403	54.03	56.23	-3.91	56.90	-5.04
2020.04.05	Head	5600	100	6.093	60.93	59.94	1.65	59.97	1.60
2020.04.06	Head	5800	100	6.018	60.18	61.84	-2.68	61.50	-2.15
Note: The tolerance limit of System validation ±10%.									

System Performance Check Data(2450MHz)

Type: Phone measurement (Complete)
E-Field Probe: SN 34/15 EPGO265
Area scan resolution: dx=8mm,dy=8mm
Zoom scan resolution: dx=5mm, dy=5mm, dz=5mm
Date of measurement: 2020.04.03
Measurement duration: 18 minutes 40 seconds

Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Band	2450MHz
Signal	CW
Frequency (MHz)	2450.000000
Relative permittivity (real part)	39.673270
Conductivity (S/m)	1.826795
Power drift (%)	-0.470000
Ambient Temperature:	22.3℃
Liquid Temperature:	21.5℃
ConvF:	2.55
Crest factor:	1:1

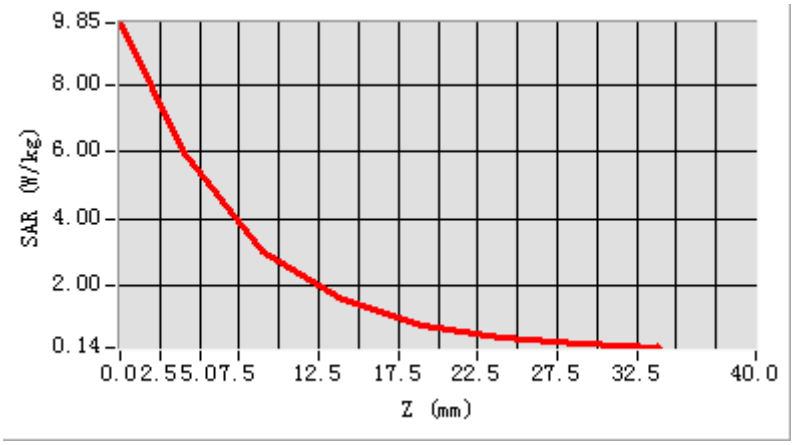
SURFACE SAR	VOLUME SAR
	

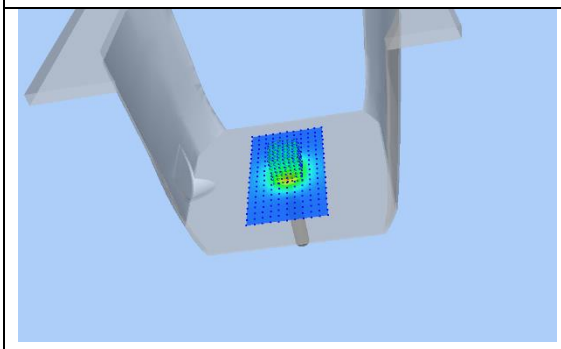
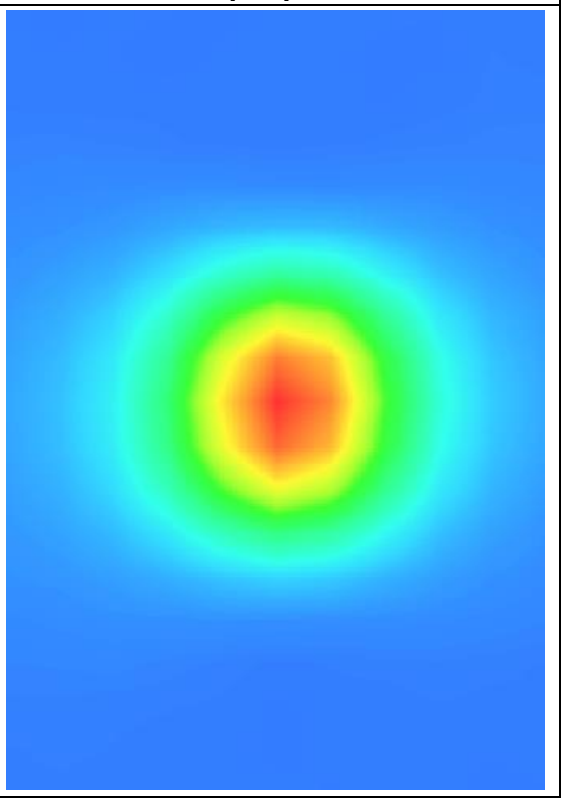
Maximum location: X=1.00, Y=0.00

SAR Peak: 9.74 W/kg

SAR 10g (W/Kg)	2.541745
SAR 1g (W/Kg)	5.430925

Z Axis Scan



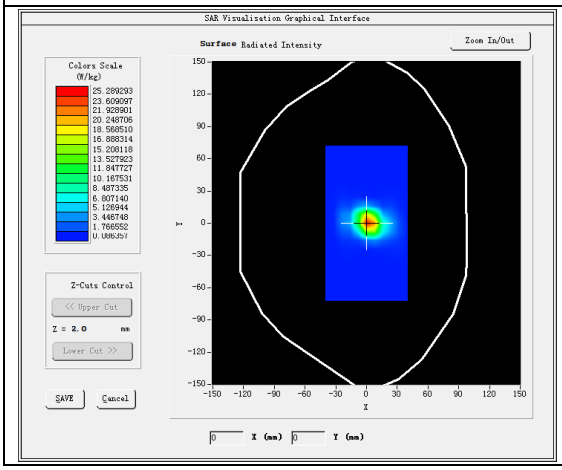
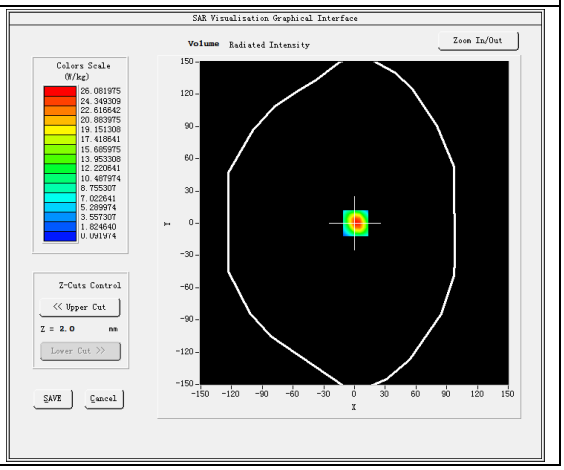
3D screen shot	Hot spot position
	

System Performance Check Data(5200 MHz)

Type: Phone measurement (Complete)
E-Field Probe: SN 34/15 EPGO265
Area scan resolution: dx=8 mm,dy=8 mm
Zoom scan resolution: dx=4 mm, dy=4 mm, dz=2 mm
Date of measurement: 2020.04.05
Measurement duration: 29 minutes 18 seconds

Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Band	5200 MHz
Signal	CW
Frequency (MHz)	5200.000000
Relative permittivity (real part)	36.757209
Conductivity (S/m)	4.616341
Power drift (%)	-0.180000
Ambient Temperature:	22.6℃
Liquid Temperature:	21.4℃
ConvF:	2.09
Crest factor:	1:1

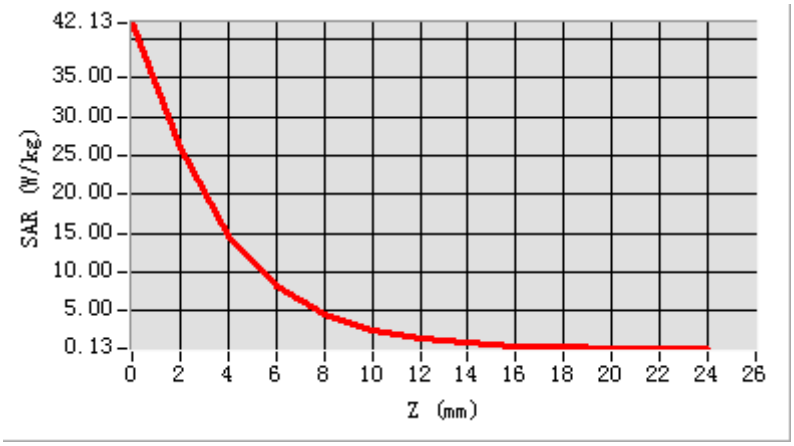
SURFACE SAR	VOLUME SAR
	

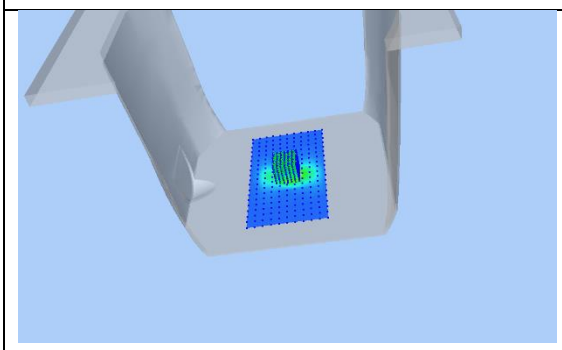
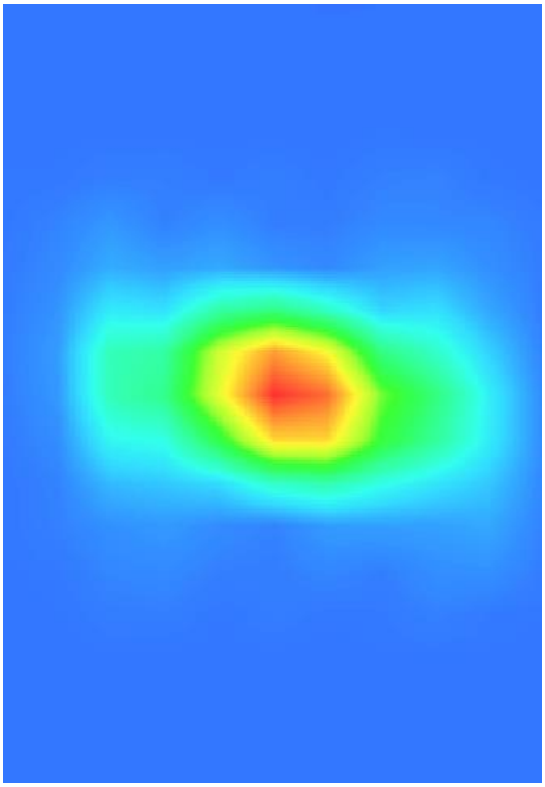
Maximum location: X=1.00, Y=0.00

SAR Peak: 44.35 W/kg

SAR 10 g (W/Kg)	5.403392
SAR 1 g (W/Kg)	15.389196

Z Axis Scan



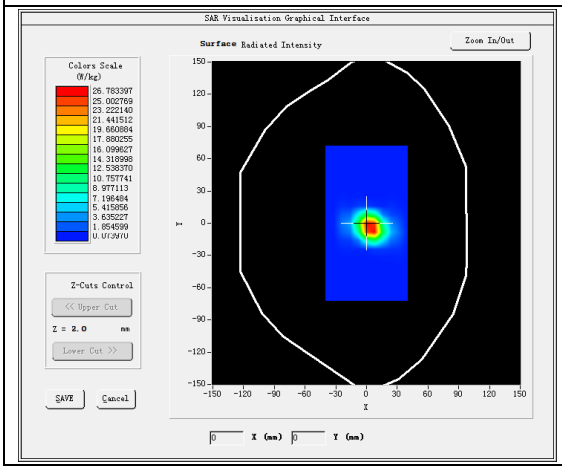
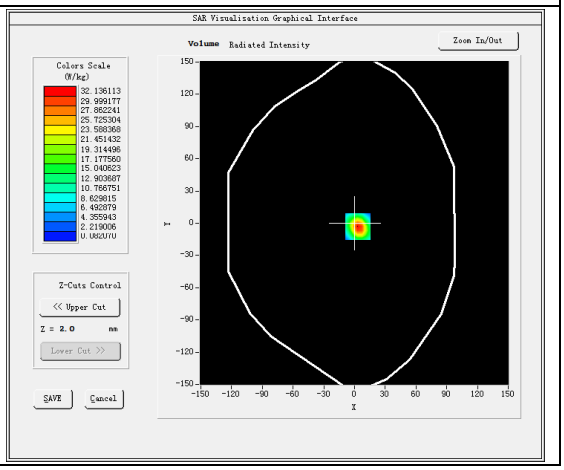
3D screen shot	Hot spot position
	

System Performance Check Data(5600 MHz)

Type: Phone measurement (Complete)
E-Field Probe: SN 34/15 EPGO265
Area scan resolution: dx=8 mm,dy=8 mm
Zoom scan resolution: dx=4 mm, dy=4 mm, dz=2 mm
Date of measurement: 2020.04.05
Measurement duration: 29 minutes 52 seconds

Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Band	5600 MHz
Signal	CW
Frequency (MHz)	5600.000000
Relative permittivity (real part)	35.744286
Conductivity (S/m)	5.124066
Power drift (%)	-0.370000
Ambient Temperature:	22.6℃
Liquid Temperature:	21.4℃
ConvF:	2.20
Crest factor:	1:1

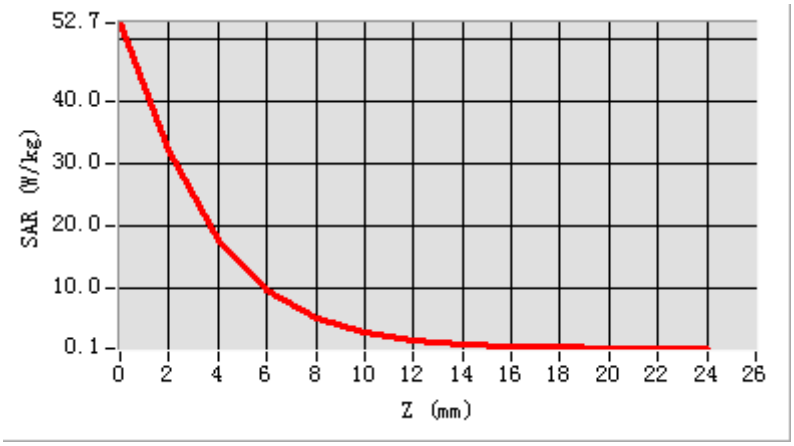
SURFACE SAR	VOLUME SAR
	

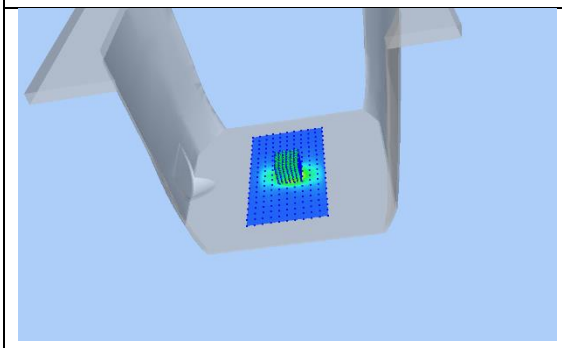
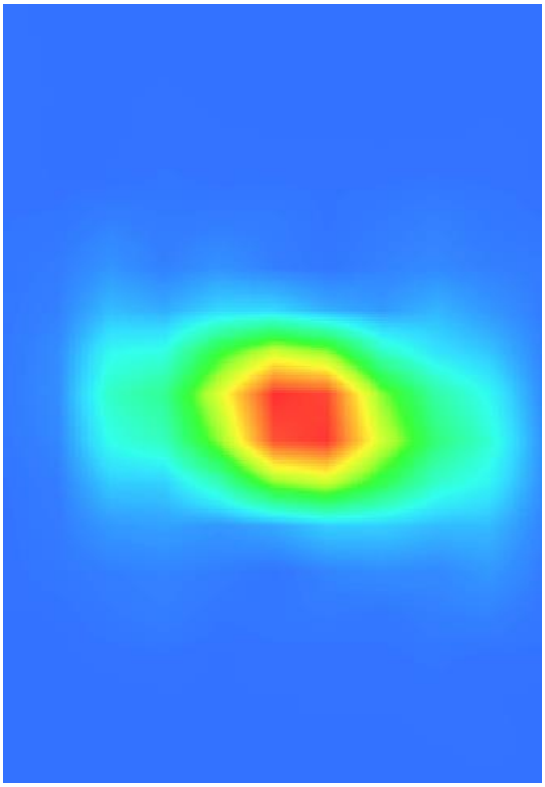
Maximum location: X=3.00, Y=-3.00

SAR Peak: 55.1 W/kg

SAR 10 g (W/Kg)	6.092752
SAR 1 g (W/Kg)	18.155321

Z Axis Scan



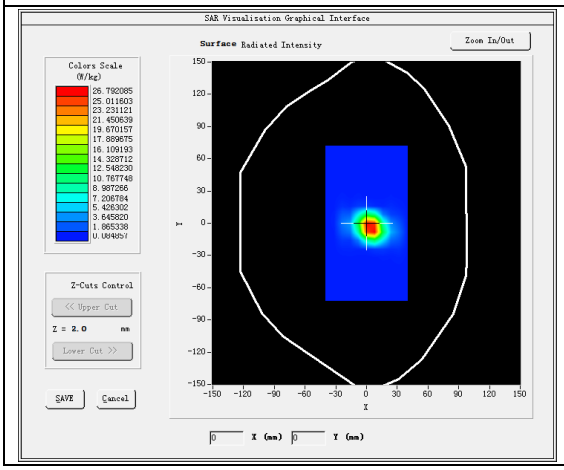
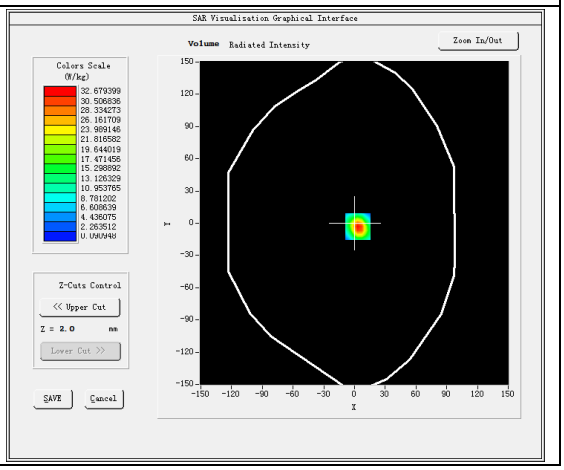
3D screen shot	Hot spot position
	

System Performance Check Data(5800 MHz)

Type: Phone measurement (Complete)
E-Field Probe: SN 34/15 EPGO265
Area scan resolution: dx=8 mm,dy=8 mm
Zoom scan resolution: dx=4 mm, dy=4 mm, dz=2 mm
Date of measurement: 2020.04.06
Measurement duration: 30 minutes 15 seconds

Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Band	5800 MHz
Signal	CW
Frequency (MHz)	5800.000000
Relative permittivity (real part)	34.482176
Conductivity (S/m)	5.390524
Power drift (%)	-0.150000
Ambient Temperature:	22.5℃
Liquid Temperature:	21.3℃
ConvF:	2.17
Crest factor:	1:1

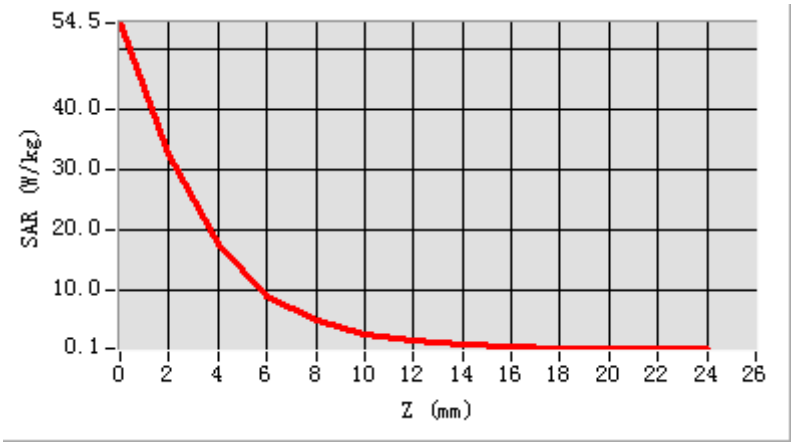
SURFACE SAR	VOLUME SAR
	

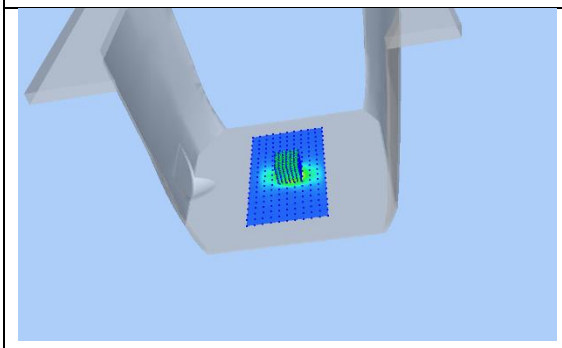
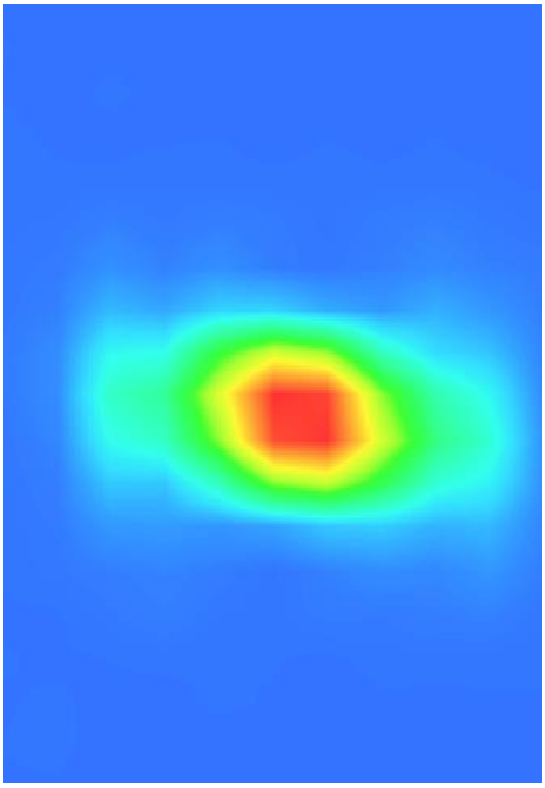
Maximum location: X=3.00, Y=-3.00

SAR Peak: 56.82 W/kg

SAR 10 g (W/Kg)	6.017899
SAR 1 g (W/Kg)	18.211866

Z Axis Scan



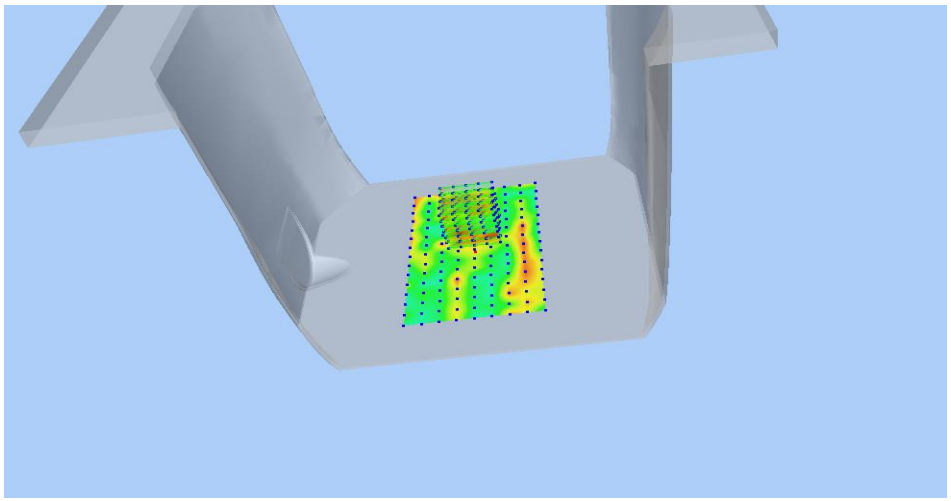
3D screen shot	Hot spot position
	

ANNEX C TEST DATA

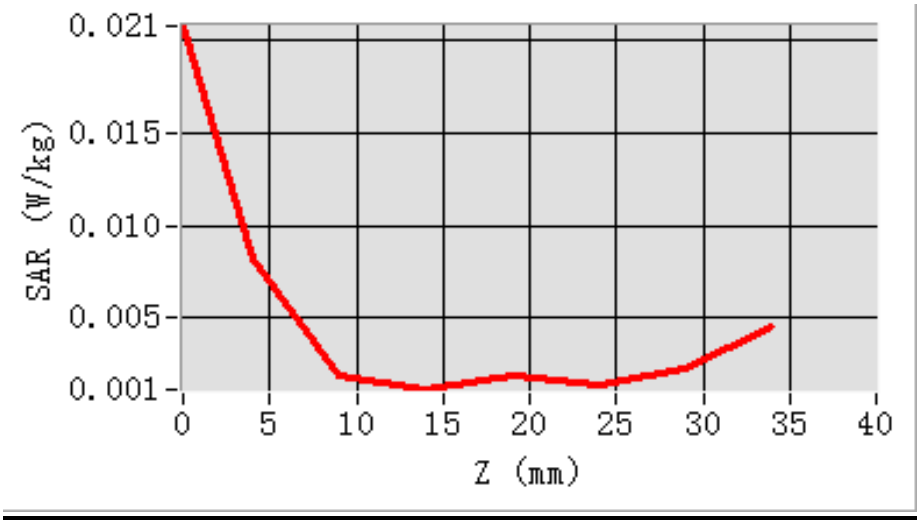
MEAS. 1 Body Plane with Right Edge 10mm on Middle Channel in IEEE 802.11b mode

Test Date:	3/4/2020
Measurement duration:	12 minutes 51 seconds
Signal:	WLAN, f=2437.0 MHz, Duty Cycle: 1:1.0
Liquid Parameters:	Permittivity: 39.89; Conductivity: 1.81 S/m
Test condition:	Ambient Temperature: 22.3°C, Liquid Temperature: 21.5℃
Probe:	SN 34/15 EPGO265, ConvF: 2.55
Area Scan:	sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan:	5x5x7,dx=8mm, dy=8mm, dz=5mm,Complete
Maximum location:	X=0.000000, Y=18.000000
SAR 10g (W/Kg):	0.006748
SAR 1g (W/Kg):	0.012053
Power drift (%):	-0.78

3D screen shot



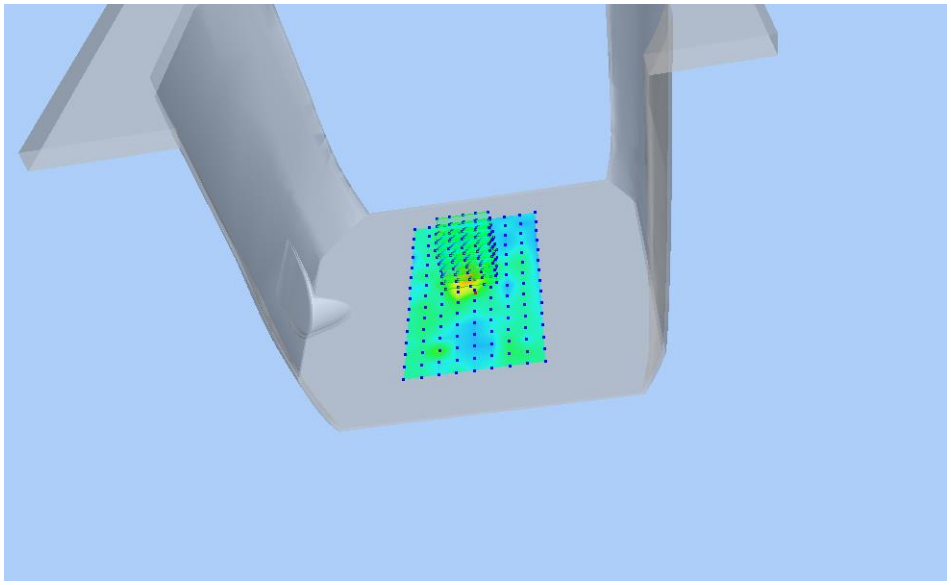
Z Axis Scan



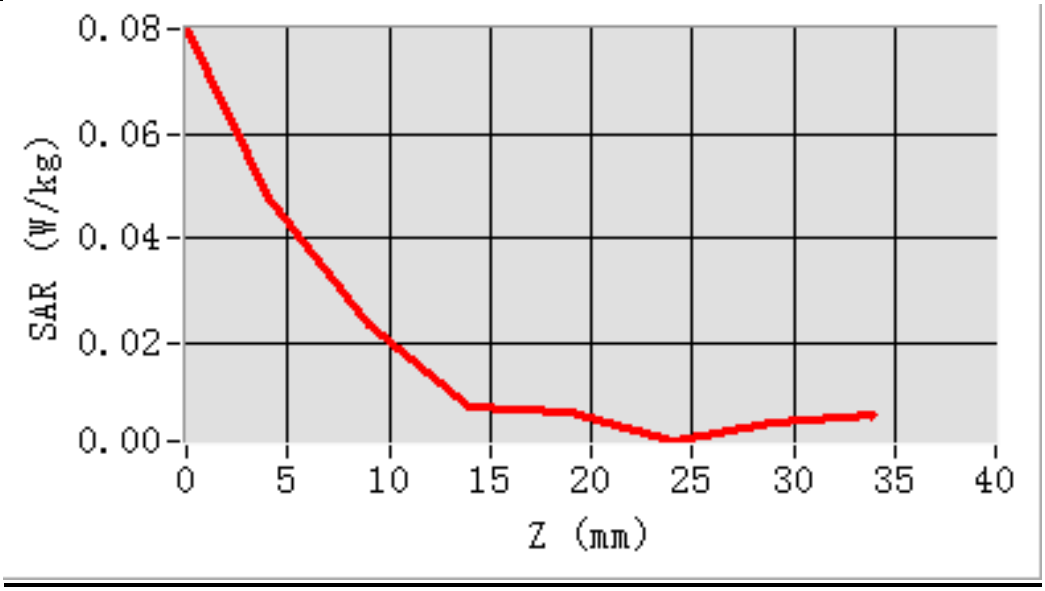
MEAS. 2 Body Plane with Right Edge 0mm on Middle Channel in IEEE 802.11b mode

Test Date:	3/4/2020
Measurement duration:	12 minutes 36 seconds
Signal:	WLAN, f=2437.0 MHz, Duty Cycle: 1:1.0
Liquid Parameters:	Permittivity: 39.89; Conductivity: 1.81 S/m
Test condition:	Ambient Temperature: 22.3°C, Liquid Temperature: 21.5℃
Probe:	SN 34/15 EPGO265, ConvF: 2.55
Area Scan:	sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan:	5x5x7,dx=8mm, dy=8mm, dz=5mm,Complete
Maximum location:	X=0.000000, Y=18.000000
SAR 10g (W/Kg):	0.016796
SAR 1g (W/Kg):	0.041650
Power drift (%):	-1.84

3D screen shot



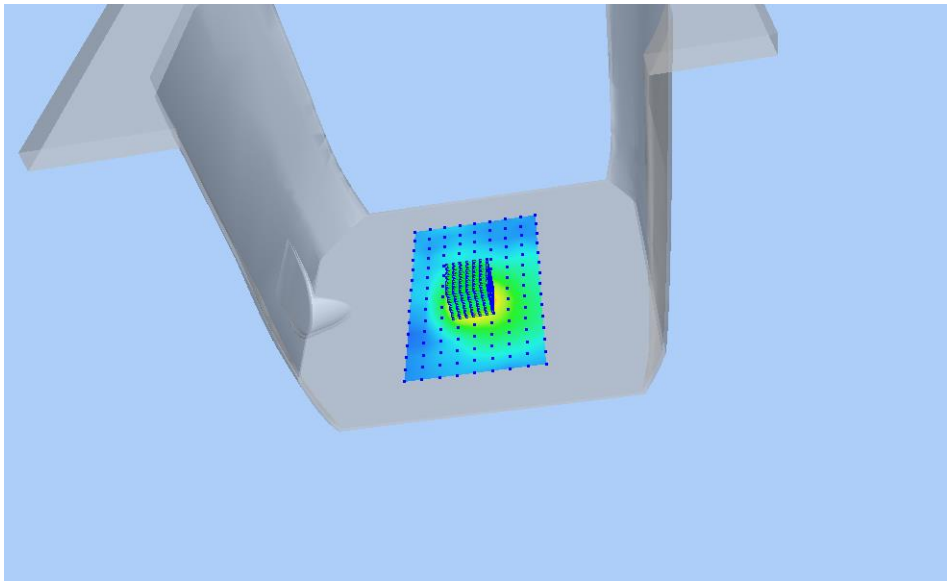
Z Axis Scan



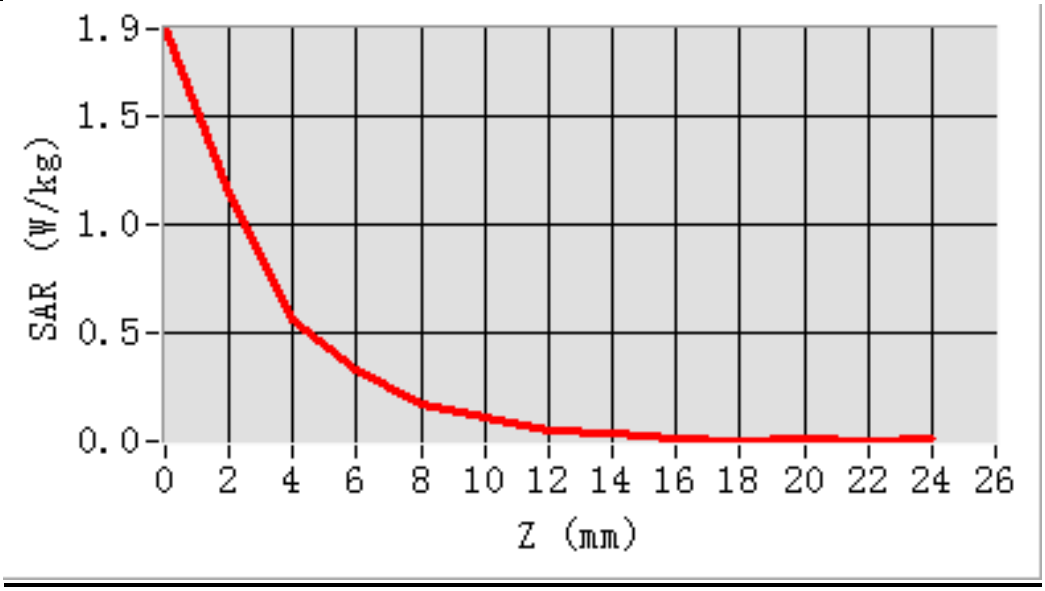
MEAS. 3 Body Plane with Right Edge 10mm on Channel 40 in IEEE 802.11a mode

Test Date:	5/4/2020
Measurement duration:	29 minutes 23 seconds
Signal:	WLAN, f=5200.0 MHz, Duty Cycle: 1:1.002
Liquid Parameters:	Permittivity: 36.76; Conductivity: 4.62 S/m
Test condition:	Ambient Temperature: 22.6°C, Liquid Temperature: 21.4°C
Probe:	SN 34/15 EPGO265, ConvF: 2.09
Area Scan:	sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan:	7x7x12,dx=4mm, dy=4mm, dz=2mm,Complete
Maximum location:	X=0.000000, Y=-12.000000
SAR 10g (W/Kg):	0.275776
SAR 1g (W/Kg):	0.688489
Power drift (%):	-3.68

3D screen shot



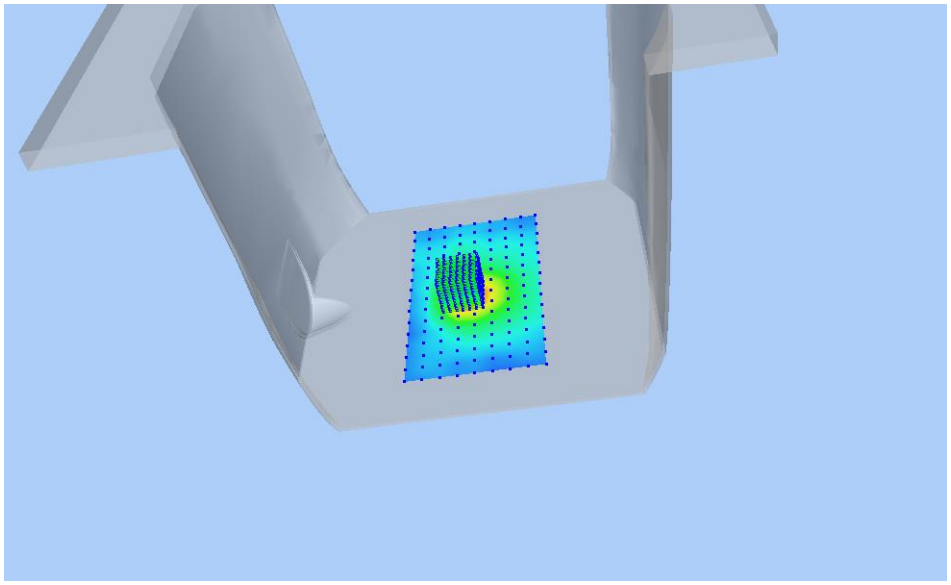
Z Axis Scan



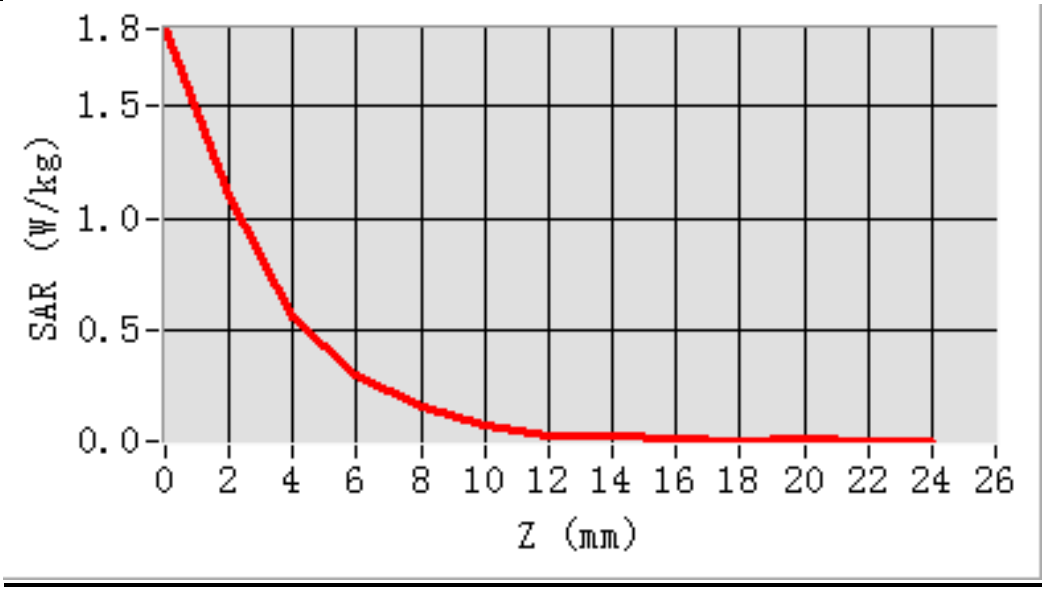
MEAS. 4 Body Plane with Right Edge 10mm on Channel 116 in IEEE 802.11a mode

Test Date:	5/4/2020
Measurement duration:	26 minutes 56 seconds
Signal:	WLAN, f=5580.0 MHz, Duty Cycle: 1:1.002
Liquid Parameters:	Permittivity: 35.97; Conductivity: 5.07 S/m
Test condition:	Ambient Temperature: 22.6°C, Liquid Temperature: 21.4°C
Probe:	SN 34/15 EPGO265, ConvF: 2.20
Area Scan:	sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan:	7x7x12,dx=4mm, dy=4mm, dz=2mm,Complete
Maximum location:	X=-10.000000, Y=-2.000000
SAR 10g (W/Kg):	0.257851
SAR 1g (W/Kg):	0.651173
Power drift (%):	-2.96

3D screen shot



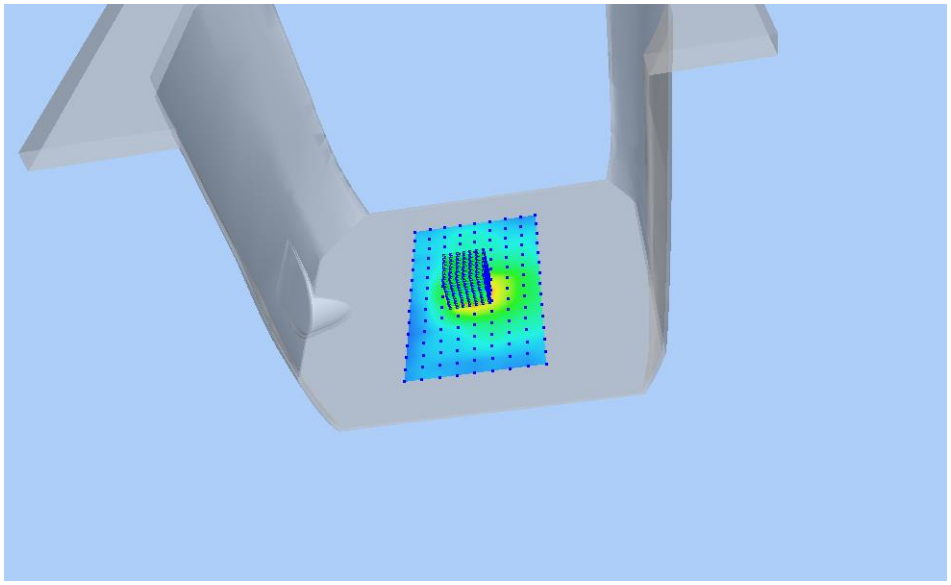
Z Axis Scan



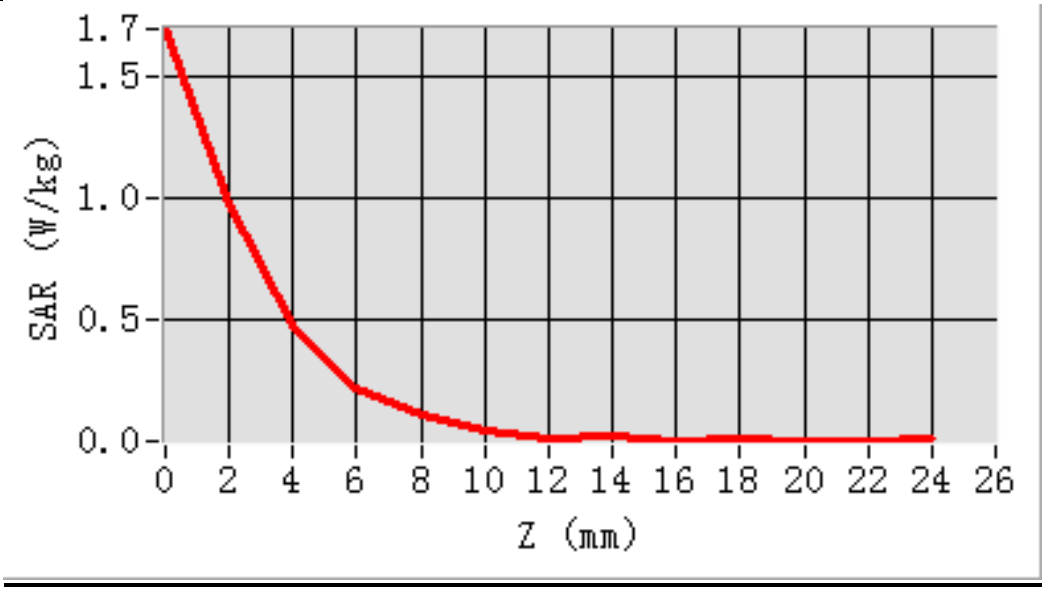
MEAS. 5 Body Plane with Right Edge 10mm on Channel 165 in IEEE 802.11a mode

Test Date:	6/4/2020
Measurement duration:	28 minutes 55 seconds
Signal:	WLAN, f=5825.0 MHz, Duty Cycle: 1:1.002
Liquid Parameters:	Permittivity: 34.37; Conductivity: 5.43 S/m
Test condition:	Ambient Temperature: 22.5°C, Liquid Temperature: 21.3℃
Probe:	SN 34/15 EPGO265, ConvF: 2.17
Area Scan:	sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan:	7x7x12,dx=4mm, dy=4mm, dz=2mm,Complete
Maximum location:	X=0.000000, Y=-2.000000
SAR 10g (W/Kg):	0.226407
SAR 1g (W/Kg):	0.569464
Power drift (%):	-3.37

3D screen shot



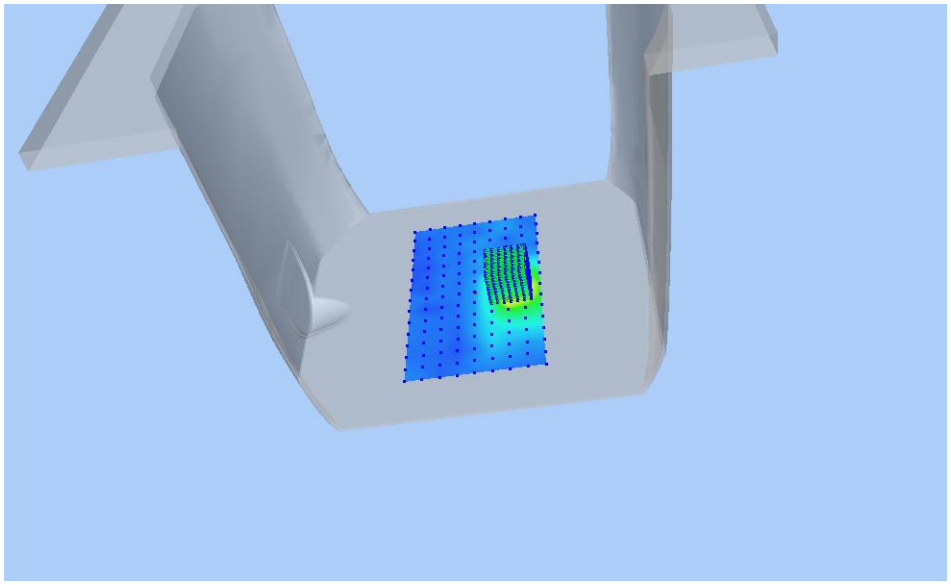
Z Axis Scan



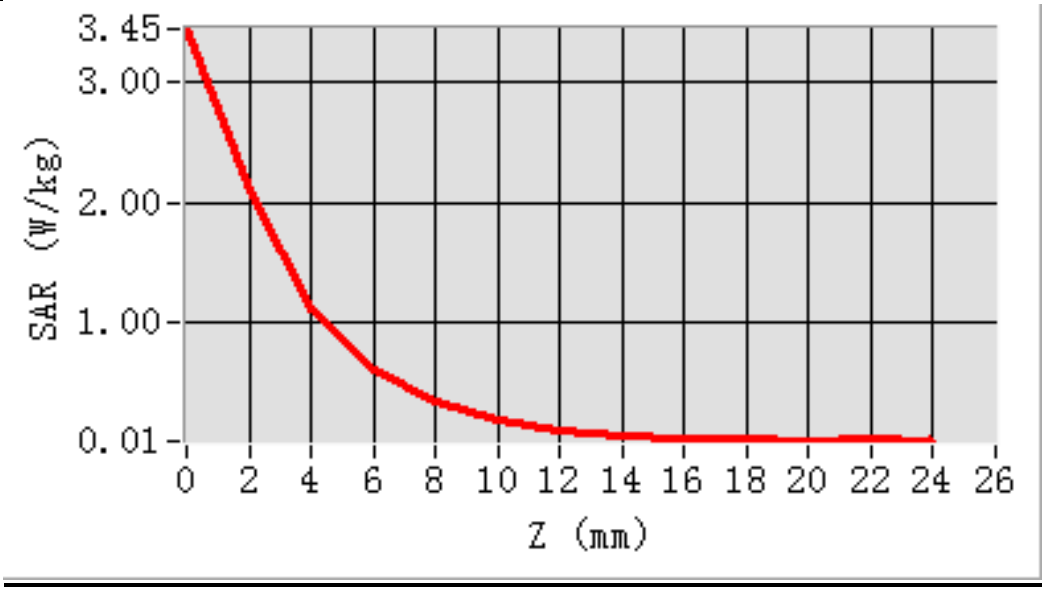
MEAS. 6 Body Plane with Right Edge 0mm on Channel 40 in IEEE 802.11a mode

Test Date:	5/4/2020
Measurement duration:	19 minutes 55 seconds
Signal:	WLAN, f=5200.0 MHz, Duty Cycle: 1:1.002
Liquid Parameters:	Permittivity: 36.76; Conductivity: 4.62 S/m
Test condition:	Ambient Temperature: 22.6°C, Liquid Temperature: 21.4°C
Probe:	SN 34/15 EPGO265, ConvF: 2.09
Area Scan:	sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan:	7x7x12,dx=4mm, dy=4mm, dz=2mm,Complete
Maximum location:	X=20.000000, Y=-2.000000
SAR 10g (W/Kg):	0.428147
SAR 1g (W/Kg):	1.180241
Power drift (%):	-1.08

3D screen shot



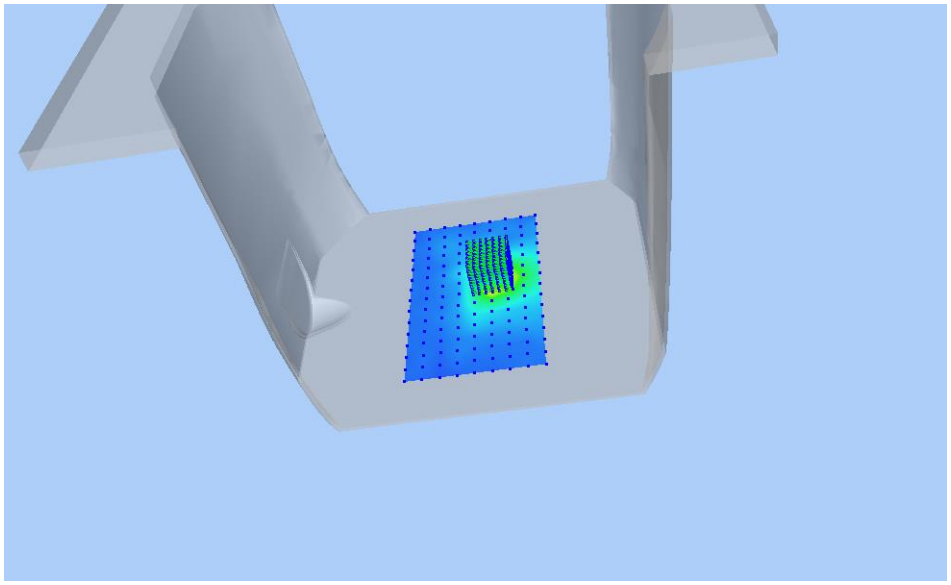
Z Axis Scan



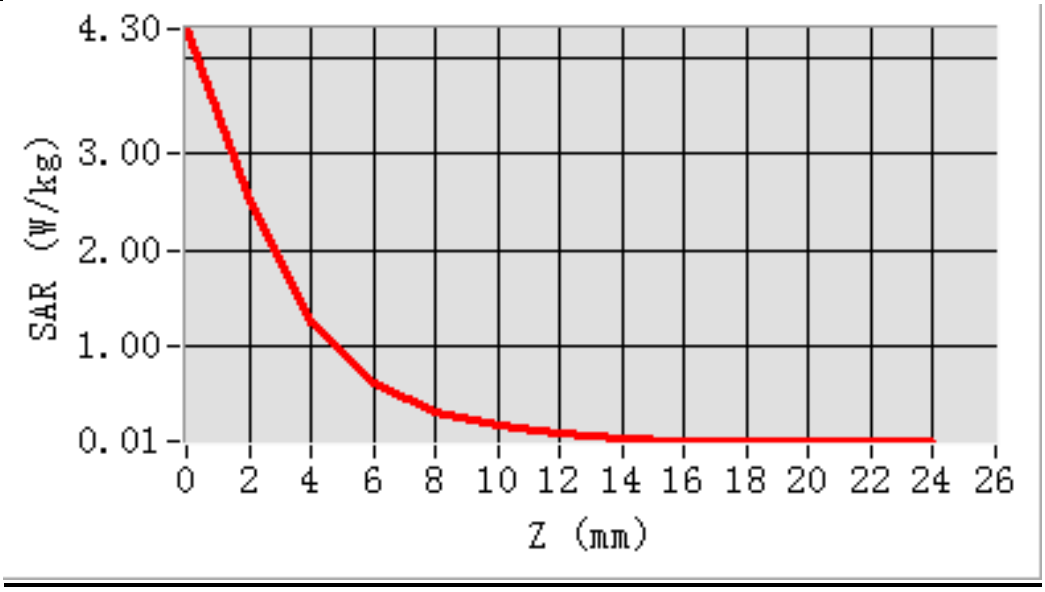
MEAS. 7 Body Plane with Right Edge 0mm on Channel 116 in IEEE 802.11a mode

Test Date:	5/4/2020
Measurement duration:	25 minutes 44 seconds
Signal:	WLAN, f=5580.0 MHz, Duty Cycle: 1:1.002
Liquid Parameters:	Permittivity: 35.97; Conductivity: 5.07 S/m
Test condition:	Ambient Temperature: 22.6°C, Liquid Temperature: 21.4°C
Probe:	SN 34/15 EPGO265, ConvF: 2.20
Area Scan:	sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan:	7x7x12,dx=4mm, dy=4mm, dz=2mm,Complete
Maximum location:	X=10.000000, Y=8.000000
SAR 10g (W/Kg):	0.462217
SAR 1g (W/Kg):	1.385330
Power drift (%):	-1.76

3D screen shot



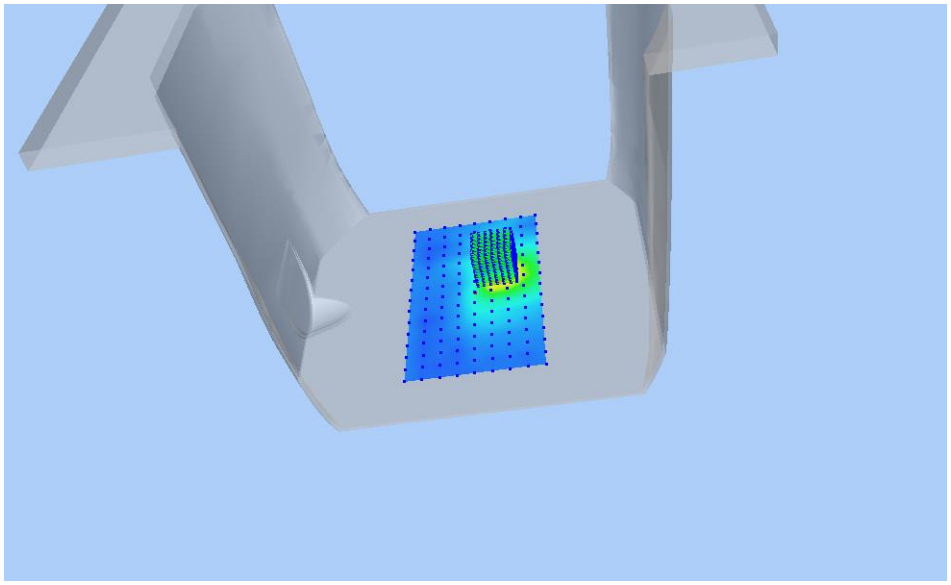
Z Axis Scan



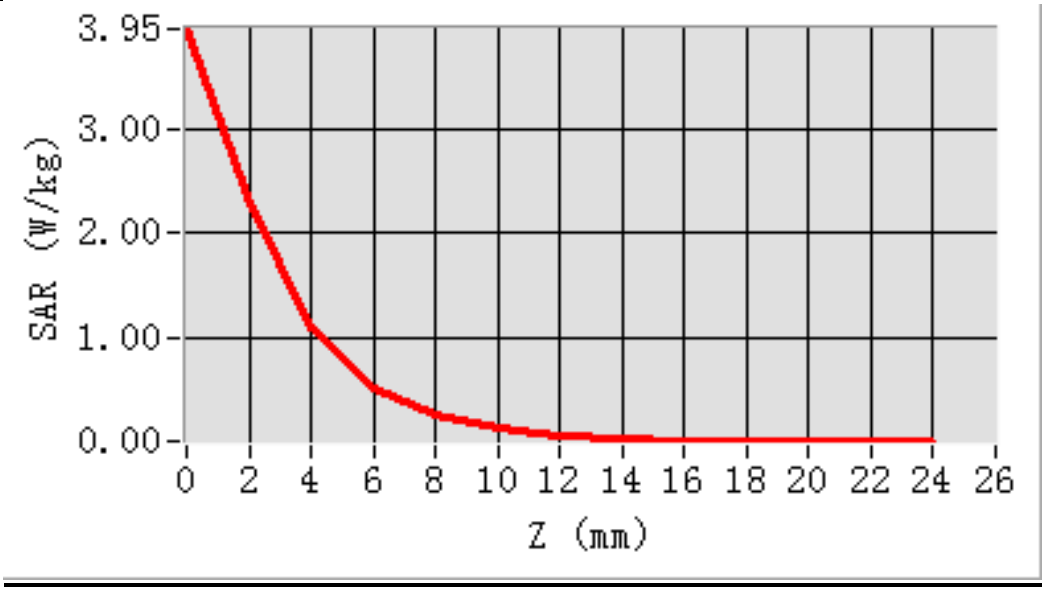
MEAS. 8 Body Plane with Right Edge 0mm on Channel 165 in IEEE 802.11a mode

Test Date:	6/4/2020
Measurement duration:	23 minutes 54 seconds
Signal:	WLAN, f=5825.0 MHz, Duty Cycle: 1:1.002
Liquid Parameters:	Permittivity: 34.37; Conductivity: 5.43 S/m
Test condition:	Ambient Temperature: 22.5°C, Liquid Temperature: 21.3℃
Probe:	SN 34/15 EPGO265, ConvF: 2.17
Area Scan:	sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan:	7x7x12,dx=4mm, dy=4mm, dz=2mm,Complete
Maximum location:	X=10.000000, Y=18.000000
SAR 10g (W/Kg):	0.645644
SAR 1g (W/Kg):	1.382598
Power drift (%):	2.72

3D screen shot



Z Axis Scan



ANNEX D EUT EXTERNAL PHOTOS

Please refer the document “BL-EC2030004-AW.pdf”.

ANNEX E SAR TEST SETUP PHOTOS

Please refer the document “BL-EC2030004-AS.pdf”.

ANNEX F CALIBRATION REPORT

Please refer the document “CALIBRATION REPORT.pdf”.

--END OF REPORT--