

FCC

SAR

TEST REPORT

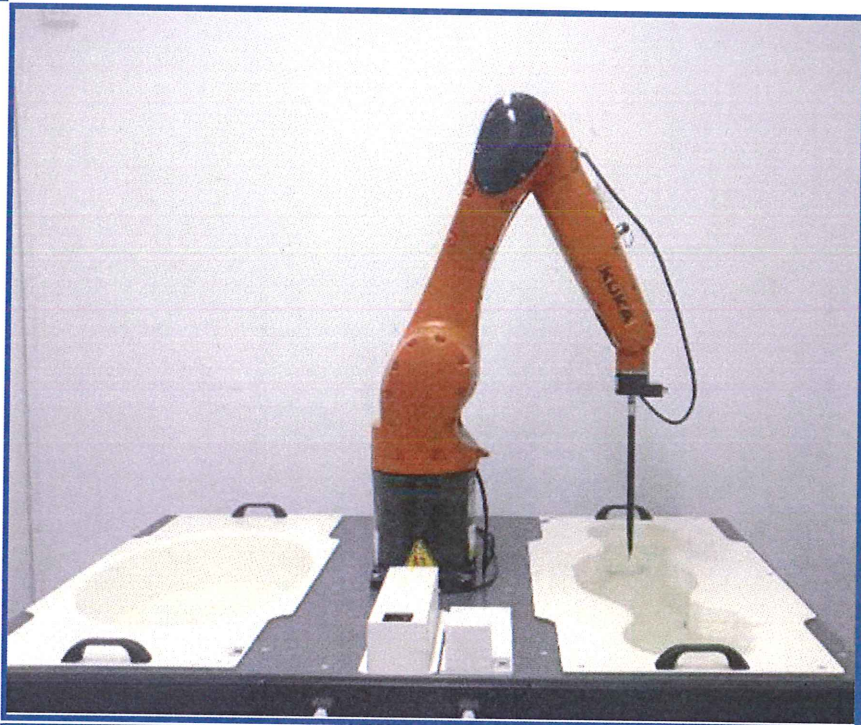
ISSUED BY
Shenzhen BALUN Technology Co., Ltd.



FOR
BrailleSense 6

ISSUED TO
SELVAS Healthcare, Inc.

155, Sinseong-ro, Yuseong-gu, Daejeon, Rep. of KOREA



Tested by: Zong Liyao

Zong Liyao

Date: May 07, 2021

Approved by: Wei Yanquan

Wei Yanquan
(Chief Engineer)

Date: May 27, 2021

Report No.: BL-SZ2120401-701

EUT Name: BrailleSense 6

Model Name: H632B

Brand Name: HIMS

FCC ID: 2AL4DH632B

Test Standard: FCC 47 CFR Part 2.1093

ANSI C95.1: 1999

IEEE 1528: 2013

Maximum SAR: Body 2.4GHz(1 g): 0.639 W/kg

Body 5GHz(1 g): 0.973 W/kg

Test Conclusion: Pass

Test Date: Mar. 04, 2021 ~ Mar. 07, 2021

Date of Issue: May 07, 2021

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Revision History

Version	Issue Date	Revisions Content
<u>Rev. 01</u>	<u>May 07, 2021</u>	<u>Initial Issue</u>

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1 ADMINISTRATIVE 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
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.
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	21°C to 23°C
Ambient Relative Humidity	36% to 48%
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	SELVAS Healthcare, Inc.
Address	155, Sinseong-ro, Yuseong-gu, Daejeon, Rep. of KOREA

2.2 Manufacturer Information

Manufacturer	SELVAS Healthcare, Inc.
Address	155, Sinseong-ro, Yuseong-gu, Daejeon, Rep. of KOREA

2.3 Factory Information

Factory	SELVAS Healthcare, Inc.
Address	155, Sinseong-ro, Yuseong-gu, Daejeon, Rep. of KOREA

2.4 General Description for Equipment under Test (EUT)

EUT Name	BrailleSense 6
Model Name Under Test	H632B
Series Model Name	N/A
Description of Model Name Differentiation	N/A
Hardware Version	HCT-ZN632MB-A4
Software Version	H632B_system_44286
Dimensions (Approx.)	245*144*22mm
Weight (Approx.)	0.704kg (with battery)

2.5 Ancillary Equipment

Ancillary Equipment 1	Battery	
	Brand Name	N/A
	Model No.	SP645180SG
	Serial No.	N/A
	Capacitance	4590 mAh
	Rated Voltage	3.85 V
	Limit Charge Voltage	4.4 V

2.6 Technical Information

Network and Wireless connectivity	Bluetooth (BR+EDR+BLE) WIFI 802.11a, 802.11b, 802.11g, 802.11n and 802.11ac U-NII-1/3, FM receiver, GPS
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The requirement for the following technical information of the EUT was tested in this report:

Operating Mode	2.4G WLAN, 5G WLAN, Bluetooth	
Frequency Range	802.11b/g/n (HT20/HT40)	2412 ~ 2462 MHz
	802.11a/n (HT20/HT40)	5150 ~ 5250 MHz
		5725 ~ 5850 MHz
	802.11ac(VHT20/VHT40/VHT80)	5150 ~ 5250 MHz
		5725 ~ 5850 MHz
	Bluetooth	2402 ~ 2480 MHz
Antenna Type	WLAN: FPC Antenna Bluetooth: FPC Antenna	
Hotspot Function	N/A	
Exposure Category	General Population/Uncontrolled exposure	
EUT Stage	Portable Device	
Product	Type	
	<input checked="" type="checkbox"/> Production unit	<input type="checkbox"/> 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)

Band	Antenna	Maximum Scaled SAR (W/kg)	Maximum Report SAR (W/kg)
		Body	Body
2.4G WLAN	Main Antenna	0.556	0.973
2.4G WLAN	Aux. Antenna	0.639	
5.2G WLAN	Main Antenna	0.615	
5.2G WLAN	Aux. Antenna	0.759	
5.8G WLAN	Main Antenna	0.973	
5.8G WLAN	Aux. Antenna	0.848	
Bluetooth	/	0.644	
Limit (W/kg)			1.60
Verdict			Pass

3.3.2 Highest Simultaneous SAR

Position	Simultaneous Configuration	Simultaneous SAR (W/kg)	Limit (W/kg)	Verdict
Body-worn	5G WLAN(Aux. Antenna) + Bluetooth	1.492	1.6	Pass

3.4 Test Uncertainty

3.4.1 Measurement uncertainty 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 Algorithms 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	-
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3.4.2 Measurement uncertainty 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 Algorithms 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:

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

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

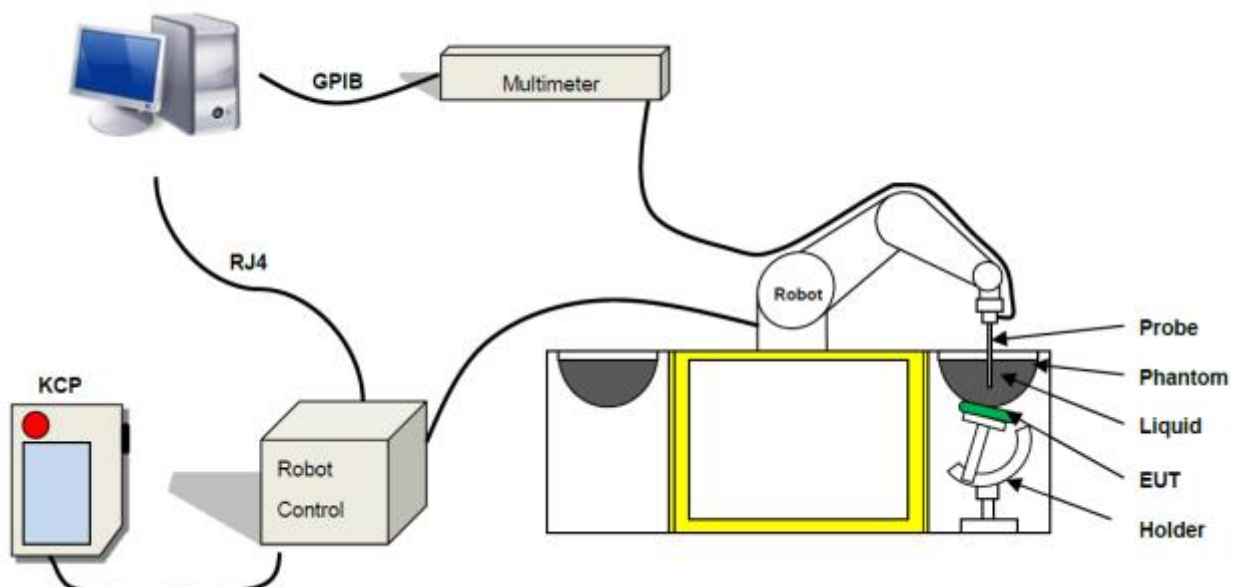
$$\text{SAR} = \frac{\sigma E^2}{\rho}$$

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 $\pm 10\%$. 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

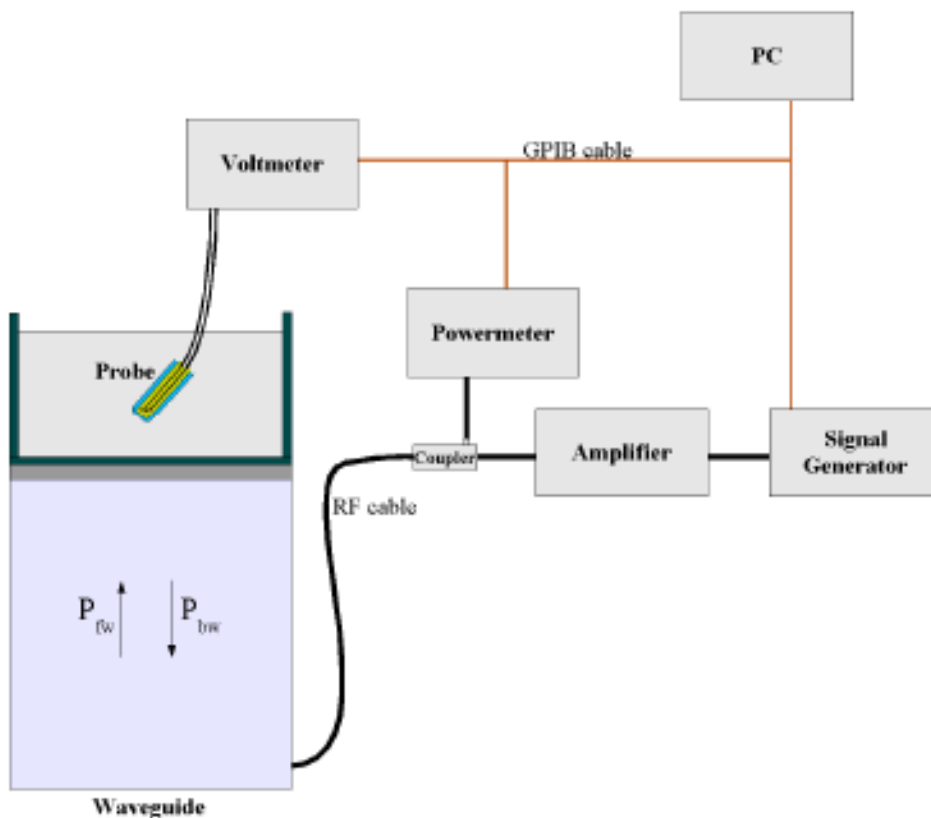
For the measurements the Specific Dosimetric E-Field Probe SN 34/15 EPGO 265 with following specifications is used

- 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 :

P_{fw} = Forward Power

P_{bw} = Backward Power

a and b = Waveguide Dimensions

l = 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:

$$CF(N) = SAR(N) / V_{lin}(N) \quad (N=1,2,3)$$

The linearised output voltage V_{lin}(N) is obtained from the displayed output voltage V(N) using

$$V_{lin}(N) = V(N) * (1 + V(N) / DCP(N)) \quad (N=1,2,3)$$

Where the DCP is the diode compression point in mV.

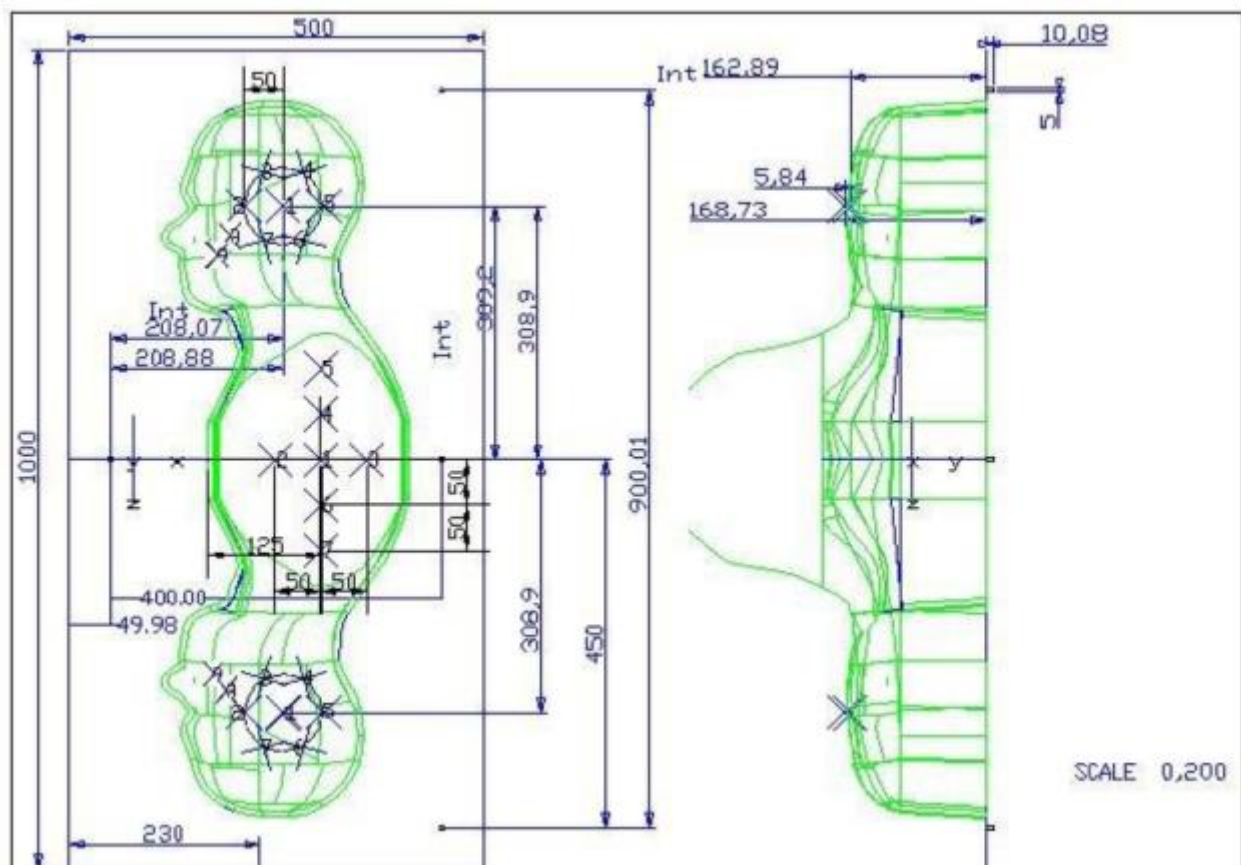
4.2.4 Phantoms

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 11/17 SAM133



Serial Number	Positionner Material	Permittivity	Loss Tangent
SN 11/17 SAM133	Gelcoat with fiberglass	3.4	0.02

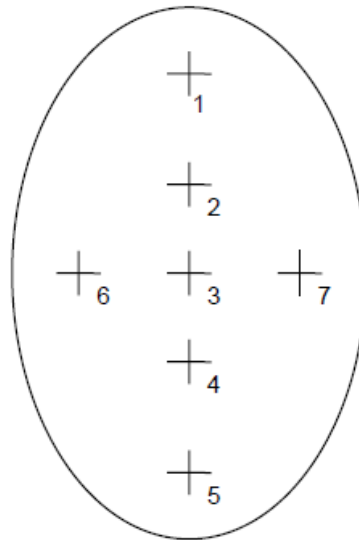


Serial Number	Left Head		Right Head		Flat Part	
SN 11/17 SAM133	2	2.02	2	2.05	1	2.07
	3	2.00	3	2.02	2	2.08
	4	2.01	4	2.02	3	2.10
	5	2.01	5	2.05	4	2.10
	6	2.04	6	2.03	5	2.09
	7	2.01	7	2.04	6	2.09
	8	2.03	8	2.05	7	2.11
	9	2.05	9	2.05	-	-

Photo of Phantom SN 11/17 ELLI42



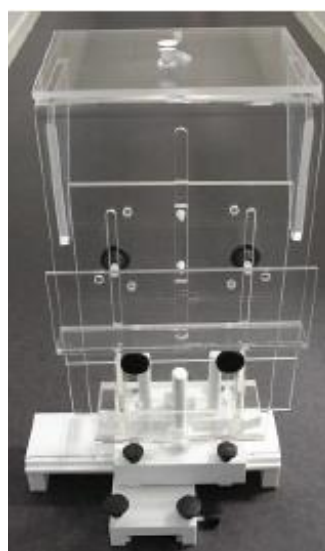
Serial Number	Positionner Material	Permittivity	Loss Tangent
SN 11/17 ELLI42	Gelcoat with fiberglass	3.4	0.02



Serial Number	Flat Part	
SN 11/17 ELLI42	1	2.01
	2	2.04
	3	2.04
	4	2.01
	5	2.03
	6	2.06
	7	2.09

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.

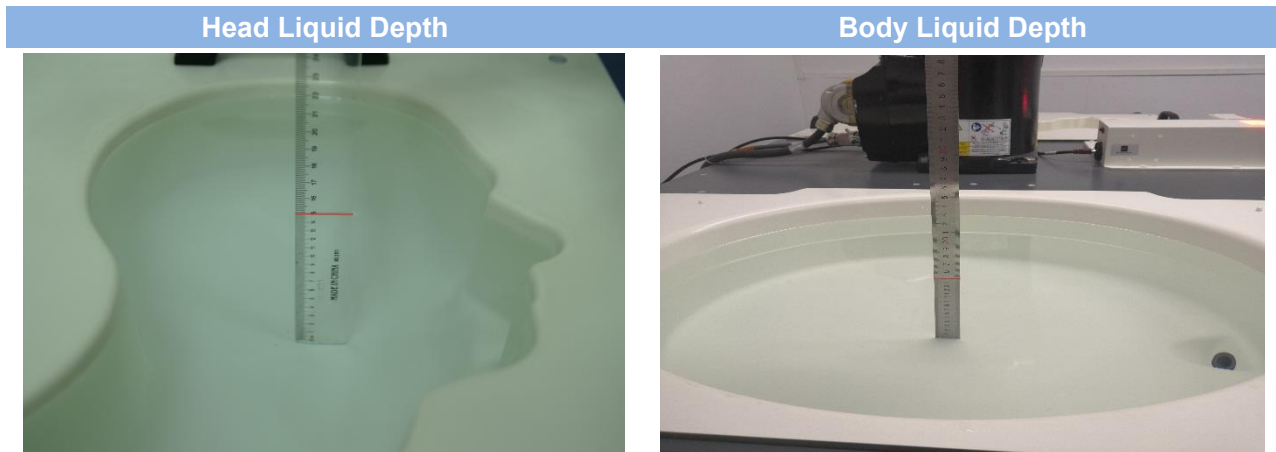


Serial Number	Holder Material	Permittivity	Loss Tangent
SN 11/17 MSH109 (Phone)	Deirin	3.7	0.005
SN 11/17 LSH31 (Laptop)	PMMA	2.9	0.028

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%.



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

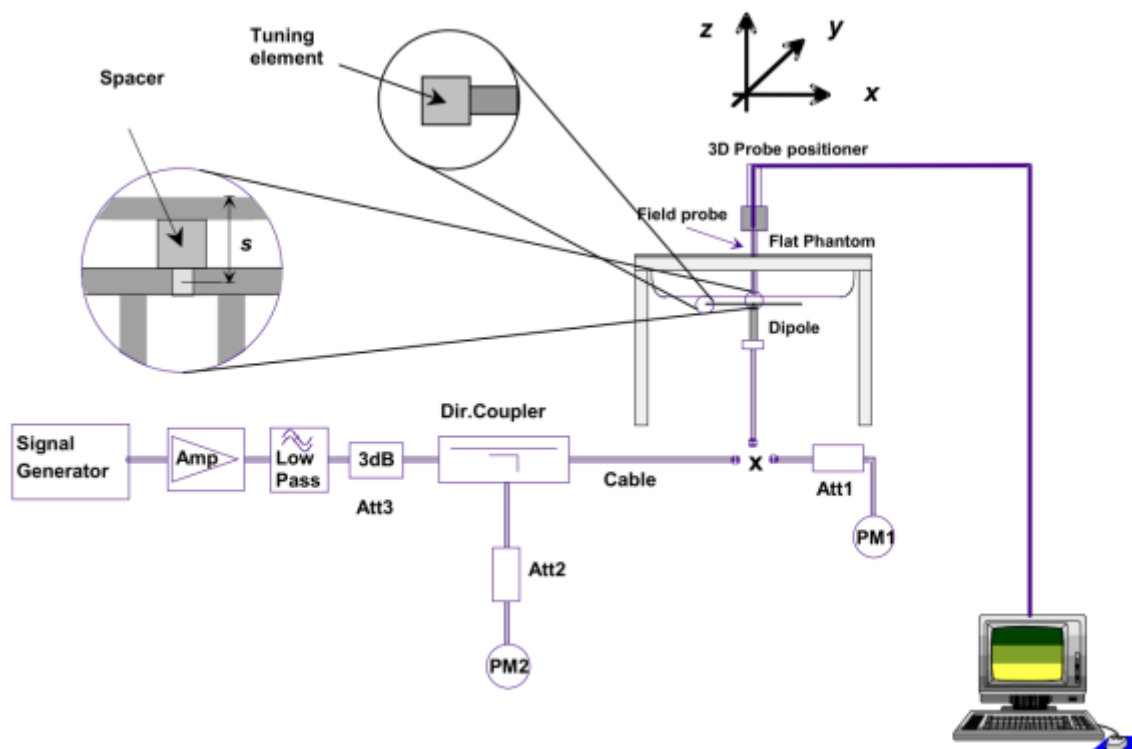
The SATIMO SAR system is equipped with one or more system validation kits. These units together with the predefined measurement procedures within the SATIMO software enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to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

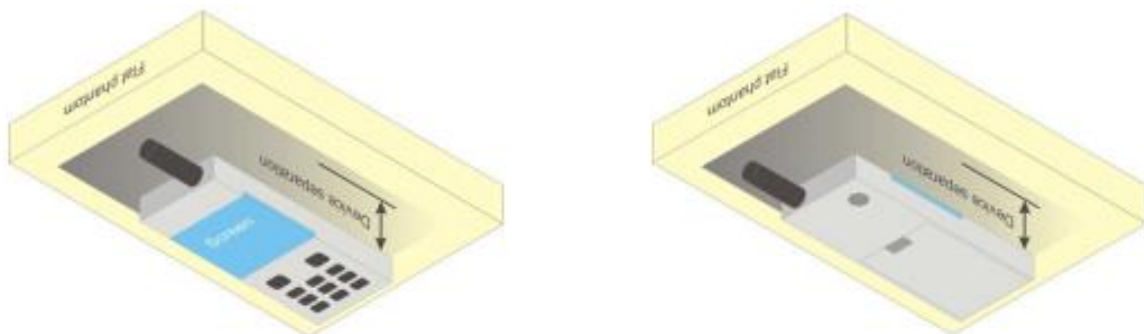
According to KDB 648474 D04 Handset , handsets are tested for SAR compliance in head, body-worn accessory and other use configurations described in the following subsections.

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 $> 1.2 \text{ W/kg}$, 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.

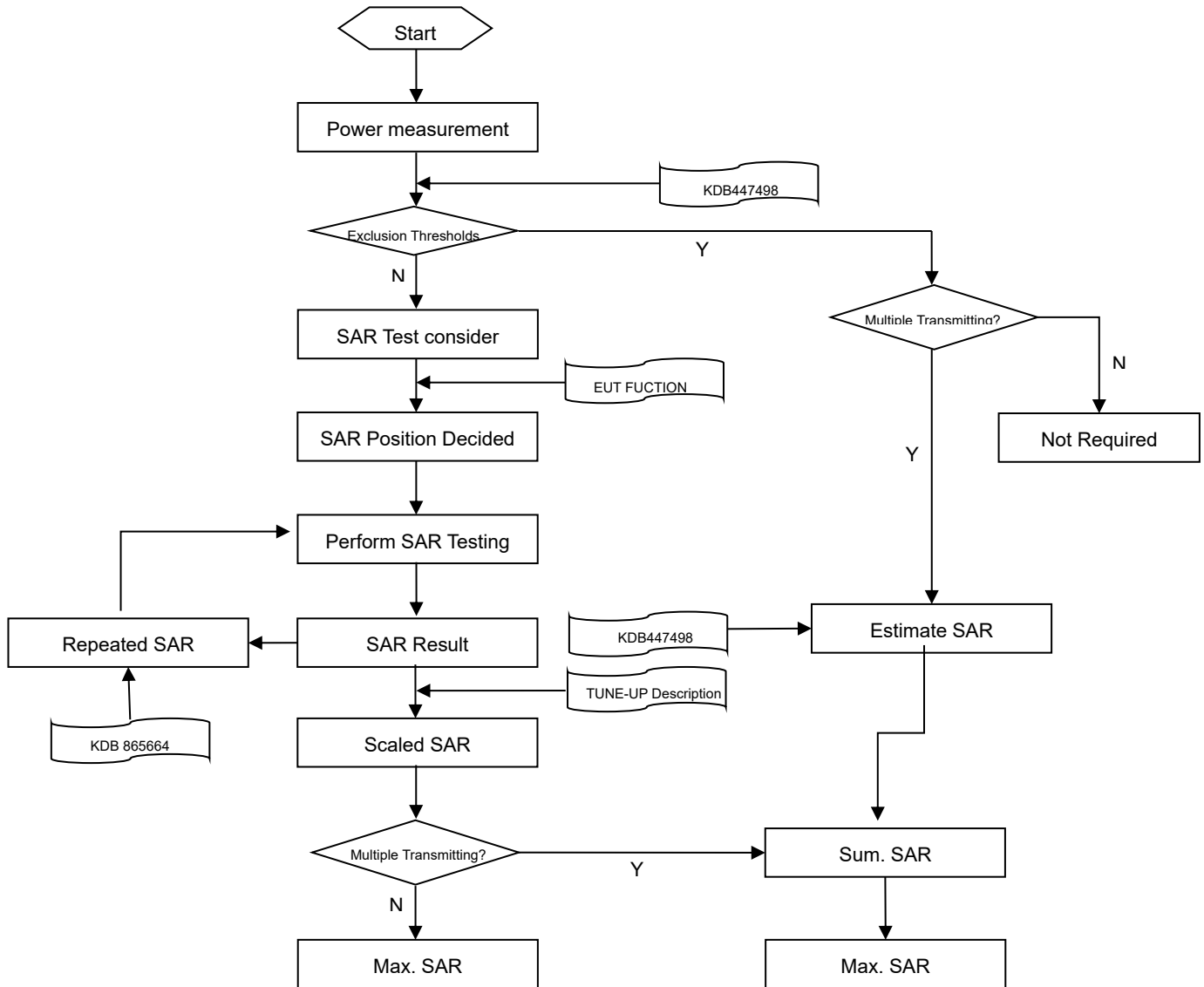
Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. 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 $\leq 5 \text{ mm}$ 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.

			≤3GHz	>3GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5±1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30°±1°	20°±1°
Maximum area scan spatial resolution: Δx Area , Δy Area			≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3–4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
			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.	
Maximum zoom scan spatial resolution: Δx Zoom , Δy Zoom			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3–4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: Δz Zoom (n)		≤ 5 mm	3–4 GHz: ≤ 4 mm
				4–5 GHz: ≤ 3 mm
				5–6 GHz: ≤ 2 mm
	graded grid	Δ z Zoom (1): between 1st two points closest to phantom surface	≤ 4 mm	3–4 GHz: ≤ 3 mm
				4–5 GHz: ≤ 2.5 mm
				5–6 GHz: ≤ 2 mm
		Δ z Zoom (n>1): between subsequent points		≤ 1.5·Δz Zoom (n-1)
Minimum zoom scan volume	x, y, z		≥30 mm	3–4 GHz: ≥ 28 mm
				4–5 GHz: ≥ 25 mm
				5–6 GHz: ≥ 22 mm

Note:

- δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
- * 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.

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 to 16 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 OUTPUT POWER

8.1 WIFI

8.1.1 2.4GWIFI (Main Antenna)

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)	Tune-up Power Limit (dBm)	SAR Test Require.
2.4 (2.4~2.4835)	802.11b	1	2412	10.73	11.00	Yes
		6	2437	10.57	11.00	No
		11	2462	10.53	11.00	No
	802.11g	1	2412	10.57	11.00	No
		6	2437	10.71	11.00	No
		11	2462	10.68	11.00	No
	802.11n(HT20)	1	2412	10.74	11.00	No
		6	2437	10.55	11.00	No
		11	2462	10.61	11.00	No
	802.11n(HT40)	3	2422	10.68	11.00	No
		6	2437	10.67	11.00	No
		9	2452	10.37	11.00	No

8.1.2 2.4GWIFI (Aux. Antenna)

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)	Tune-up Power Limit (dBm)	SAR Test Require.
2.4 (2.4~2.4835)	802.11b	1	2412	10.46	11.00	No
		6	2437	10.77	11.00	Yes
		11	2462	10.56	11.00	No
	802.11g	1	2412	10.65	11.00	No
		6	2437	10.68	11.00	No
		11	2462	10.45	11.00	No
	802.11n(HT20)	1	2412	10.68	11.00	No
		6	2437	10.49	11.00	No
		11	2462	10.56	11.00	No
	802.11n(HT40)	3	2422	10.65	11.00	No
		6	2437	10.58	11.00	No
		9	2452	10.79	11.00	No

8.1.3 2.4GWIFI (MIMO)

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)	Tune-up Power Limit (dBm)	SAR Test Require.
2.4 (2.4~2.4835)	802.11g	1	2412	10.74	11.00	No
		6	2437	10.70	11.00	No
		11	2462	10.60	11.00	No
	802.11n(HT20)	1	2412	10.55	11.00	No
		6	2437	10.68	11.00	No
		11	2462	10.61	11.00	No
	802.11n(HT40)	3	2422	10.68	11.00	No
		6	2437	10.63	11.00	No
		9	2452	10.55	11.00	No

Note: For 2.4GWiFiSAR testing was performed on single antenna RF power in SISO mode that is larger to the single antenna RF power in MIMO mode, and for RF exposure assessment of MIMO mode simultaneous transmission used more conservative "Max. (main ant) + Max. (aux. ant) " method to determine SAR compliance. When the sum of 1-g SISO transmission SAR measurement is <1.6W/kg, 2.4G MIMO SAR test is not required.

8.1.4 5GWIFI (Main Antenna)

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)	Tune-up Power Limit (dBm)	SAR Test Require.
5.2 (5.15~5.25)	802.11a	36	5180	9.77	10.00	No
		44	5220	9.82	10.00	No
		48	5240	9.47	10.00	No
	802.11n(HT20)	36	5180	9.66	10.00	No
		44	5220	9.74	10.00	No
		48	5240	9.81	10.00	No
	802.11n(HT40)	38	5190	9.81	10.00	No
		46	5230	9.44	10.00	No
	802.11ac(VHT20)	36	5180	9.62	10.00	No
		44	5220	9.74	10.00	No
		48	5240	9.83	10.00	No
	802.11ac(VHT40)	38	5190	9.81	10.00	No
		46	5230	9.48	10.00	No
	802.11ac(VHT80)	42	5210	9.78	10.00	Yes
5.8 (5.725~5.850)	802.11a	149	5745	9.65	10.00	No
		157	5785	9.52	10.00	No
		165	5825	9.41	10.00	No
	802.11n(HT20)	149	5745	9.52	10.00	No
		157	5785	9.40	10.00	No
		165	5825	9.46	10.00	No
	802.11n(HT40)	151	5755	9.60	10.00	No
		159	5795	9.54	10.00	No
	802.11ac(VHT20)	149	5745	9.56	10.00	No
		157	5785	9.43	10.00	No
		165	5825	9.81	10.00	No
	802.11ac(VHT40)	151	5755	9.56	10.00	No
		159	5795	9.55	10.00	No
	802.11ac(VHT80)	155	5775	9.57	10.00	Yes

8.1.5 5GWIFI (Aux. Antenna)

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)	Tune-up Power Limit (dBm)	SAR Test Require.
5.2 (5.15~5.25)	802.11a	36	5180	9.57	10.00	No
		44	5220	9.61	10.00	No
		48	5240	9.76	10.00	No
	802.11n(HT20)	36	5180	9.60	10.00	No
		44	5220	9.58	10.00	No
		48	5240	9.63	10.00	No
	802.11n(HT40)	38	5190	9.46	10.00	No
		46	5230	9.62	10.00	No
	802.11ac(VHT20)	36	5180	9.53	10.00	No
		44	5220	9.53	10.00	No
		48	5240	9.57	10.00	No
	802.11ac(VHT40)	38	5190	9.47	10.00	No
		46	5230	9.59	10.00	No
	802.11ac(VHT80)	42	5210	9.73	10.00	Yes
5.8 (5.725~5.850)	802.11a	149	5745	9.77	10.00	No
		157	5785	9.62	10.00	No
		165	5825	9.61	10.00	No
	802.11n(HT20)	149	5745	9.65	10.00	No
		157	5785	9.58	10.00	No
		165	5825	9.55	10.00	No
	802.11n(HT40)	151	5755	9.67	10.00	No
		159	5795	9.68	10.00	No
	802.11ac(VHT20)	149	5745	9.66	10.00	No
		157	5785	9.71	10.00	No
		165	5825	9.62	10.00	No
	802.11ac(VHT40)	151	5755	9.62	10.00	No
		159	5795	9.68	10.00	No
	802.11ac(VHT80)	155	5775	9.53	10.00	Yes

8.1.6 5GWIFI (MIMO)

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)	Tune-up Power Limit (dBm)	SAR Test Require.
5.2 (5.15~5.25)	802.11a	36	5180	9.67	10.00	No
		44	5220	9.54	10.00	No
		48	5240	9.57	10.00	No
	802.11n(HT20)	36	5180	9.62	10.00	No
		44	5220	9.59	10.00	No
		48	5240	9.62	10.00	No
	802.11n(HT40)	38	5190	9.76	10.00	No
		46	5230	9.58	10.00	No
	802.11ac(VHT20)	36	5180	9.60	10.00	No
		44	5220	9.79	10.00	No
		48	5240	9.53	10.00	No
	802.11ac(VHT40)	38	5190	9.75	10.00	No
		46	5230	9.59	10.00	No
	802.11ac(VHT80)	42	5210	9.56	10.00	Yes
5.8 (5.725~5.850)	802.11a	149	5745	9.79	10.00	No
		157	5785	9.61	10.00	No
		165	5825	9.64	10.00	No
	802.11n(HT20)	149	5745	9.65	10.00	No
		157	5785	9.55	10.00	No
		165	5825	9.52	10.00	No
	802.11n(HT40)	151	5755	9.64	10.00	No
		159	5795	9.57	10.00	No
	802.11ac(VHT20)	149	5745	9.62	10.00	No
		157	5785	9.54	10.00	No
		165	5825	9.49	10.00	No
	802.11ac(VHT40)	151	5755	9.70	10.00	No
		159	5795	9.62	10.00	No
	802.11ac(VHT80)	155	5775	9.67	10.00	Yes

8.2 Bluetooth(Ant. Aux)

Mode	GFSK			$\pi/4$ -DQPSK		
Channel	0	39	78	0	39	78
Frequency (MHz)	2402	2441	2480	2402	2441	2480
Conducted Power (dBm)	13.18	13.40	10.35	12.71	12.99	9.84
Tune-up Power Limit (dBm)	13.50			13.00		
Mode	8-DPSK			BLE		
Channel	0	39	78	0	19	39
Frequency (MHz)	2402	2441	2480	2402	2440	2480
Conducted Power (dBm)	13.02	13.17	9.82	1.79	2.97	1.45
Tune-up Power Limit (dBm)	13.50			3.00		

9.2 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 :

Main Antenna

Band	Mode	Max. Conducted Power		Test Position Configurations				
		Power		Back Side	Left Edge	Right Edge	Top Edge	Bottom Edge
		dBm	mW					
Distance to User (mm)				<5.0	35	160	<5.0	140
WLAN 2.4 G	SAR Test Required							
	Exclusion Threshold			10.0	1.4	1196.0	10.0	999.6
	802.11b	11.00	12.59	Yes	No	No	Yes	No
	802.11g	11.00	12.59	No	No	No	No	No
	802.11n(HT20)	11.00	12.59	No	No	No	No	No
	802.11n(HT40)	11.00	12.59	No	No	No	No	No
WLAN 5.2 G	Exclusion Threshold			4.8	0.7	1162.0	3.1	962.0
	802.11a	10.00	10.00	No	No	No	No	No
	802.11n(HT20)	10.00	10.00	No	No	No	No	No
	802.11n(HT40)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT20)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT40)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT80)	10.00	10.00	Yes	No	No	Yes	No
WLAN 5.8 G	Exclusion Threshold			4.8	0.7	1162.0	3.1	962.0
	802.11a	10.00	10.00	No	No	No	No	No
	802.11n(HT20)	10.00	10.00	No	No	No	No	No
	802.11n(HT40)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT20)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT40)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT80)	10.00	10.00	Yes	No	No	Yes	No
Bluetooth	Exclusion Threshold			6.9	1.0	1195.0	6.9	995.0
	BR/EDR	13.50	22.39	Yes	No	No	Yes	No
	BLE	13.50	22.39	No	No	No	No	No

Aux. Antenna

Band	Mode	Max. Conducted Power		Test Position Configurations				
		Power		Back Side	Left Edge	Right Edge	Top Edge	Bottom Edge
		dBm	mW					
Distance to User (mm)				<5.0	125	70	<5.0	140
WLAN 2.4 G	SAR Test Required							
	Exclusion Threshold			10.0	846.0	296.0	10.0	999.6
	802.11b	11.00	12.59	Yes	No	No	Yes	No
	802.11g	11.00	12.59	No	No	No	No	No
	802.11n(HT20)	11.00	12.59	No	No	No	No	No
	802.11n(HT40)	11.00	12.59	No	No	No	No	No
WLAN 5.2 G	Exclusion Threshold			4.8	812.0	296.0	4.8	962.0
	802.11a	10.00	10.00	No	No	No	No	No
	802.11n(HT20)	10.00	10.00	No	No	No	No	No
	802.11n(HT40)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT20)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT40)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT80)	10.00	10.00	Yes	No	No	Yes	No
WLAN 5.8 G	Exclusion Threshold			4.8	812.0	296.0	4.8	962.0
	802.11a	10.00	10.00	No	No	No	No	No
	802.11n(HT20)	10.00	10.00	No	No	No	No	No
	802.11n(HT40)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT20)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT40)	10.00	10.00	No	No	No	No	No
	802.11ac(VHT80)	10.00	10.00	Yes	No	No	Yes	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:
$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR}$$
 - a. $f(\text{GHz})$ 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.
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

Mode	Antenna	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 (%)	Duty Factor	1g Scaled SAR (W/kg)	Meas No.
Body														
802.11b	Main	Back Side	0	1	2412	1.10	0.082	99.38	1.006	10.73	11.00	1.064	0.088	/
		Top Edge	0	1	2412	2.70	0.519	99.38	1.006	10.73	11.00	1.064	0.556	1#
802.11b	Aux.	Back Side	0	6	2437	3.47	0.093	99.38	1.006	10.77	11.00	1.054	0.099	/
		Top Edge	0	6	2437	-2.79	0.602	99.38	1.006	10.77	11.00	1.054	0.639	2#
Note: Refer to ANNEX C for the detailed test data for each test configuration.														

10.2 WIFI 5GHz

Fre. Band	Mode	Antenna	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 (%)	Duty Factor	1g Scaled SAR (W/kg)	Meas. No.
Body															
5.2G	802.11 ac80	Main	Back Side	0	42	5210	0.23	0.048	88.03	1.136	9.78	10.00	1.052	0.057	/
			Top Edge	0	42	5210	1.37	0.515	88.03	1.136	9.78	10.00	1.052	0.615	3#
5.2G	802.11 ac80	Aux.	Back Side	0	42	5210	-3.56	0.054	88.03	1.136	9.73	10.00	1.064	0.065	/
			Top Edge	0	42	5210	2.33	0.628	88.03	1.136	9.73	10.00	1.064	0.759	4#
5.2G	802.11 ac80	MIMO	Back Side	0	42	5210	-1.47	0.032	88.03	1.136	9.56	10.00	1.107	0.040	/
			Top Edge	0	42	5210	-4.70	0.293	88.03	1.136	9.56	10.00	1.107	0.368	5#
5.8G	802.11 ac80	Main	Back Side	0	155	5775	0.98	0.159	88.03	1.136	9.57	10.00	1.104	0.199	/
			Top Edge	0	155	5775	-1.32	0.776	88.03	1.136	9.57	10.00	1.104	0.973	6#
5.8G	802.11 ac80	Aux.	Back Side	0	155	5775	1.26	0.065	88.03	1.136	9.53	10.00	1.114	0.082	/
			Top Edge	0	155	5775	-4.46	0.670	88.03	1.136	9.53	10.00	1.114	0.848	7#
5.8G	802.11 ac80	MIMO	Back Side	0	155	5775	-2.25	0.038	88.03	1.136	9.67	10.00	1.079	0.047	/
			Top Edge	0	155	5775	-3.87	0.389	88.03	1.136	9.67	10.00	1.079	0.477	8#
Note: Refer to ANNEX C for the detailed test data for each test configuration.															

10.3 Bluetooth

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 (%)	Duty Factor	1g Scaled SAR (W/kg)	Meas. No.
Body													
DH5(Aux.)	Back Side	0	39	2442	-1.23	0.113	13.40	13.50	1.023	76.74	1.303	0.201	/
	Top Edge	0	39	2442	-4.43	0.483	13.40	13.50	1.023	76.74	1.303	0.644	9#
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: For 1g SAR, the highest measured 1g SAR is $0.776 < 0.80$ W/kg, repeated measurement is not required.

12 SIMULTANEOUS TRANSMISSION

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of SAR 1g of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit (SAR 1g 1.6 W/kg), the simultaneous transmission SAR is not required. When the sum of SAR 1g is greater than the SAR limit (SAR 1g 1.6 W/kg), SAR test exclusion is determined by the SAR to Peak Location Ratio (SPLSR).

According KDB 447498 D01v06, simultaneous transmission:

- a) $SPLSR = (SAR1 + SAR2)^{1.5} / R_i$ (min. separation distance, mm), and the peak separation distance is determined from the square root of $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$, where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan.
SAR1 is the highest reported or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition.
SAR2 is the highest reported or estimated SAR for the second of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition as the first.
- b) If $SPLSR \leq 0.04$, simultaneously transmission SAR measurement is not necessary.
- c) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg.

12.1 Simultaneous Transmission Mode Consider

NO.	Mode	Body
1	2.4 G WLAN (Auxiliary Antenna)	+ 2.4 G WLAN (Main Antenna)
2	2.4 G WLAN (Main Antenna)	+ Bluetooth (Auxiliary Antenna)
3	5 G WLAN (Auxiliary Antenna)	+ 5 G WLAN (Main Antenna)
4	5 G WLAN (Auxiliary Antenna)	+ Bluetooth (Auxiliary Antenna)
5	5 G WLAN (Auxiliary Antenna)	+ 5 G WLAN (Main Antenna) + Bluetooth (Auxiliary Antenna)

Note:

- When stand-alone SAR is not required for a transmitter or antenna, its SAR is considered zero in the SAR summing process to assess Multi-band transmission SAR compliance.
- The EUT supports the Auxiliary antenna with TX/RX diversity function for WLAN and Bluetooth, the Main antenna with TX/RX diversity function for WLAN.
- WLAN 2.4GHz and Bluetooth will not be transmitting from the Auxiliary antenna or Main Antenna at same time.

12.2 Sum SAR of Simultaneous Transmission

Simultaneous Mode	Mode	Max. 1g SAR (W/kg)	1g Sum SAR (W/kg)
Body (Separation 0 mm)			
2.4 G WLAN (Auxiliary Antenna) + 2.4 G WLAN (Main Antenna)	2.4 G WLAN (Auxiliary Antenna)	0.639	1.195
	2.4 G WLAN (Main Antenna)	0.556	
2.4 G WLAN (Auxiliary Antenna) + Bluetooth (Auxiliary Antenna)	2.4 G WLAN (Auxiliary Antenna)	0.639	1.283
	Bluetooth (Auxiliary Antenna)	0.644	
5 G WLAN (Auxiliary Antenna) + 5 G WLAN (Main Antenna)	5 G WLAN (MIMO)	0.477	0.530
5 G WLAN (Auxiliary Antenna) + Bluetooth (Auxiliary Antenna)	5 G WLAN (Auxiliary Antenna)	0.848	1.492
	Bluetooth (Auxiliary Antenna)	0.644	
5 G WLAN (Auxiliary Antenna) + 5 G WLAN (Main Antenna) + Bluetooth (Auxiliary Antenna)	5 G WLAN (MIMO)	0.477	1.121
	Bluetooth (Auxiliary Antenna)	0.644	

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	2020/12/10	2021/12/09
MultiMeter	Keithley	MultiMeter 2000	4024022	2020/06/11	2021/06/10
Signal Generator	R&S	SMB100A	177746	2020/06/08	2021/06/07
Power Meter	R&S	NRVD-B2	7250BJ-0112/2011	2020/09/25	2021/09/24
Power Sensor	R&S	NRV-Z4	100381	2020/09/25	2021/09/24
Power Sensor	R&S	NRV-Z2	100211	2020/09/25	2021/09/24
Network Analyzer	R&S	ZVL-6	101380	2020/06/22	2021/06/21
Thermometer	Elitech	RC-4HC	N/A	2020/06/11	2021/06/10
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
<p>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:</p> <ol style="list-style-type: none"> 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. (°C)	Meas. Conductivity (σ) (S/m)	Meas. Permittivity (ϵ)	Target Conductivity (σ) (S/m)	Target Permittivity (ϵ)	Conductivity Tolerance (%)	Permittivity Tolerance (%)
2021.03.04	Head	2450	21.8	1.80	39.20	1.80	39.20	0.00	0.00
2021.03.05	Head	5200	21.3	4.65	36.77	4.66	35.99	-0.21	2.17
2021.03.07	Head	5800	21.5	5.35	34.43	5.27	35.30	1.52	-2.46

Note: The tolerance limit of Conductivity and Permittivity is $\pm 5\%$.

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 (%)
2021.03.04	Head	2450	100	5.292	52.92	54.31	-2.56	52.40	0.99
2021.03.05	Head	5200	100	15.763	157.63	161.03	-2.11	159.00	-0.86
2021.03.07	Head	5800	100	18.553	185.53	182.30	1.77	181.20	2.39

Note: The tolerance limit of System validation $\pm 10\%$.

System Performance Check Data(2450MHz)

Type: Phone measurement (Complete)

E-Field Probe: SN 34/15 EPGO265

Area scan resolution: dx=8mm,dy=8mm

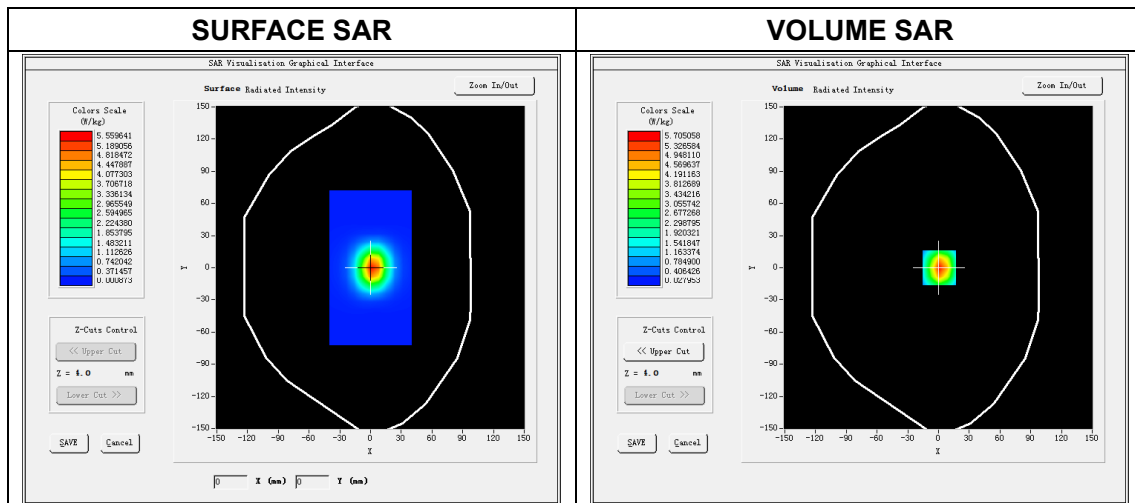
Zoom scan resolution: dx=5mm, dy=5mm, dz=5mm

Date of measurement: 2021.03.04

Measurement duration: 17 minutes 49 seconds

Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Band	2450MHz
Signal	CW
Frequency (MHz)	2450.000000
Relative permittivity (real part)	39.200600
Conductivity (S/m)	1.801367
Power drift (%)	-0.100000
Ambient Temperature:	22.7°C
Liquid Temperature:	21.8°C
ConvF:	2.55
Crest factor:	1:1

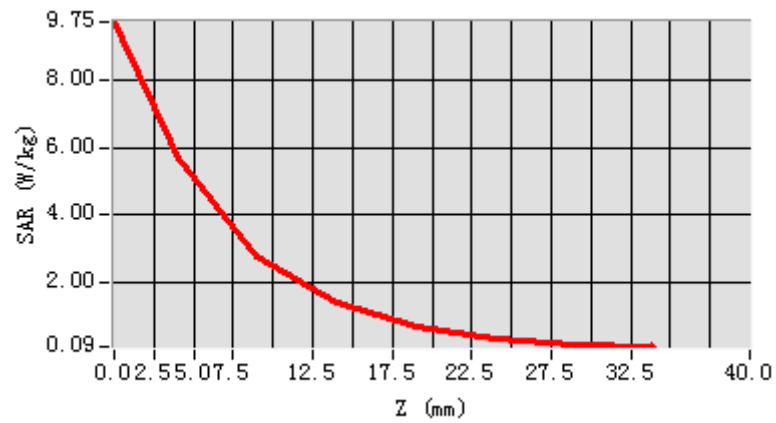


Maximum location: X=1.00, Y=0.00

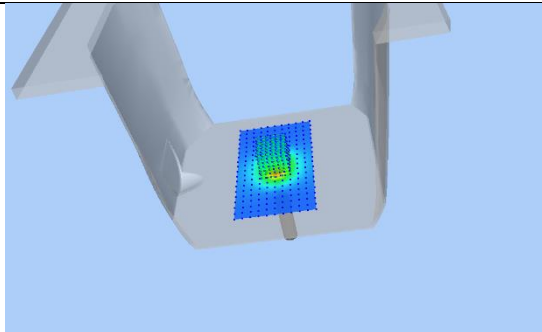
SAR Peak: 9.76 W/kg

SAR 10g (W/Kg)	2.464082
SAR 1g (W/Kg)	5.291502

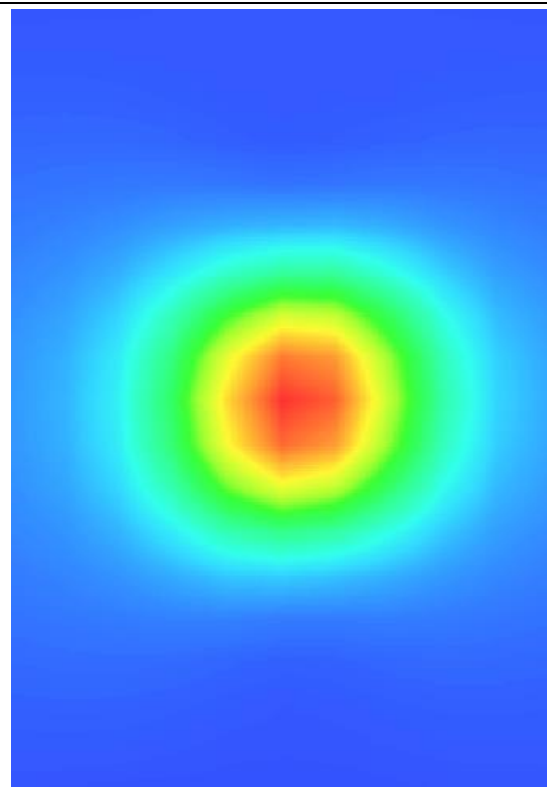
Z Axis Scan



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

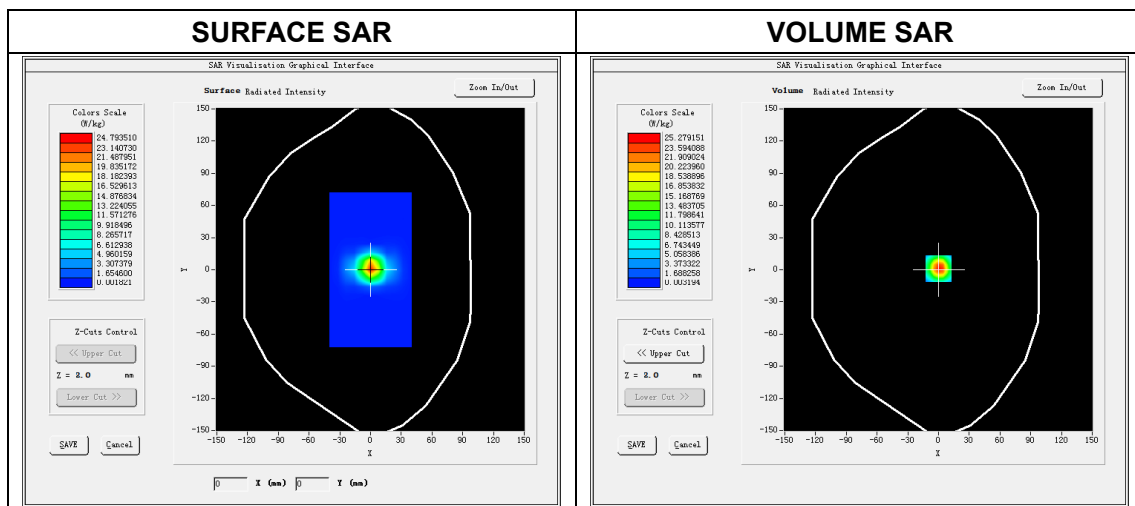
Zoom scan resolution: dx=4 mm, dy=4 mm, dz=2 mm

Date of measurement: 2021.03.05

Measurement duration: 29 minutes 32 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)	36.767843
Conductivity (S/m)	4.652484
Power drift (%)	0.880000
Ambient Temperature:	22.1°C
Liquid Temperature:	21.3°C
ConvF:	2.09
Crest factor:	1:1

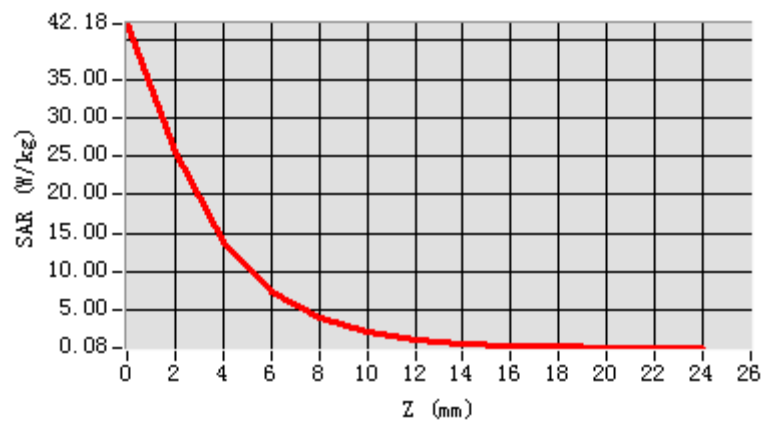


Maximum location: X=0.00, Y=1.00

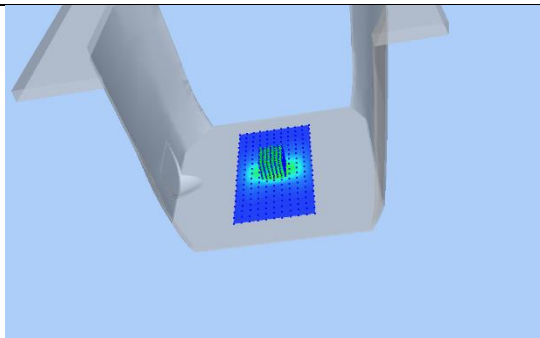
SAR Peak: 39.81 W/kg

SAR 10 g (W/Kg)	5.253793
SAR 1 g (W/Kg)	15.762962

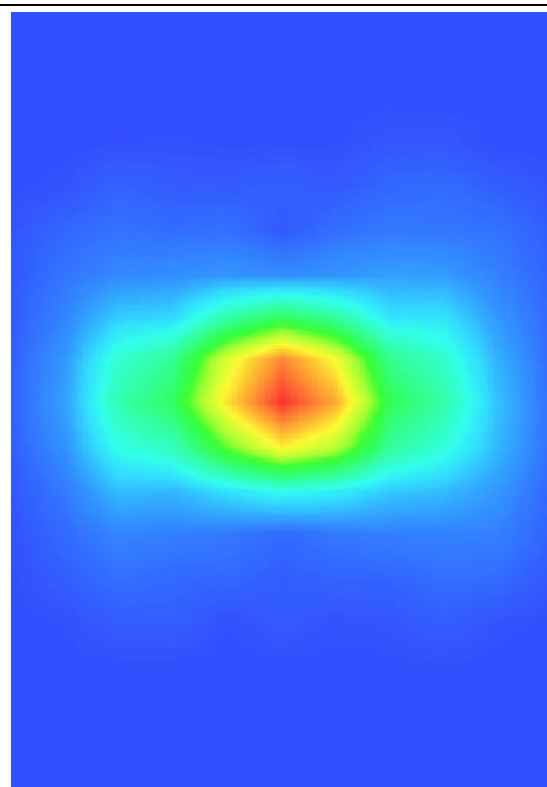
Z Axis Scan



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

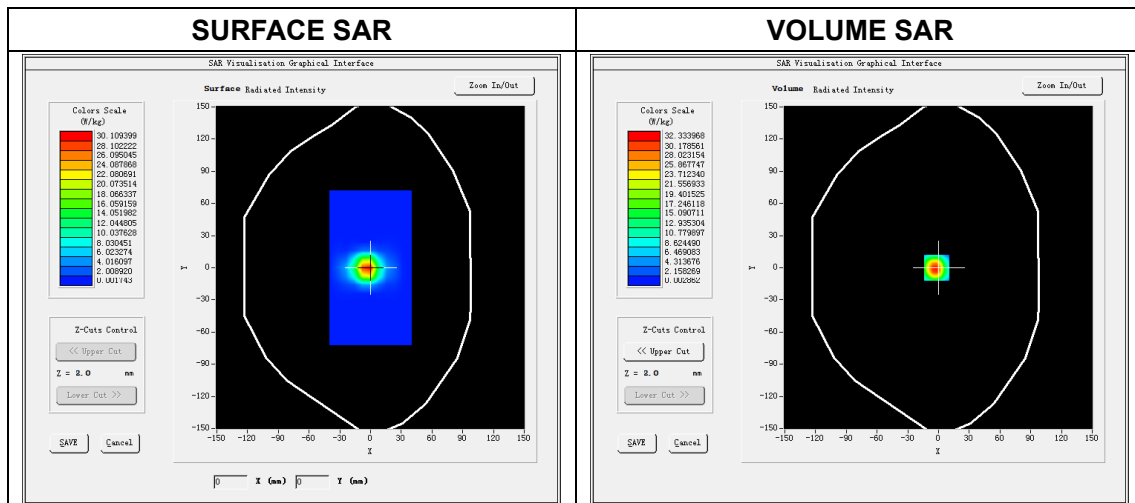
Zoom scan resolution: dx=4 mm, dy=4 mm, dz=2 mm

Date of measurement: 2021.03.07

Measurement duration: 28 minutes 10 seconds

Experimental conditions.

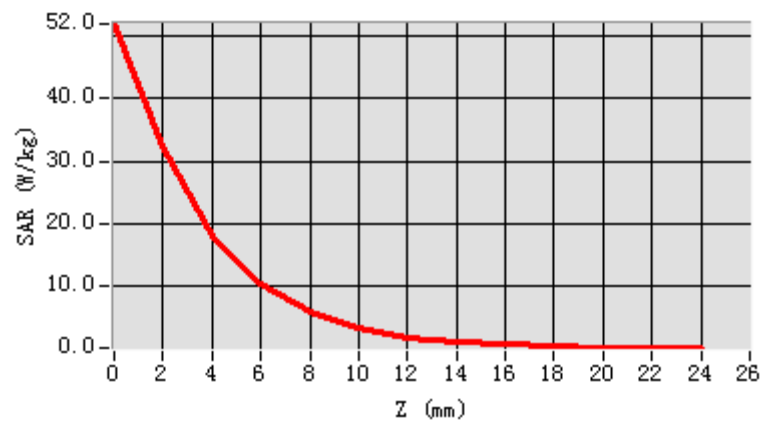
Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Band	5800 MHz
Signal	CW
Frequency (MHz)	5800.000000
Relative permittivity (real part)	34.433140
Conductivity (S/m)	5.345778
Power drift (%)	0.370000
Ambient Temperature:	22.4°C
Liquid Temperature:	21.5°C
ConvF:	2.17
Crest factor:	1:1



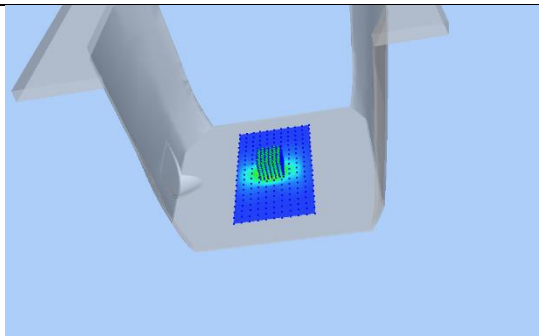
Maximum location: X=-2.00, Y=1.00
SAR Peak: 51.23 W/kg

SAR 10 g (W/Kg)	6.307296
SAR 1 g (W/Kg)	18.552535

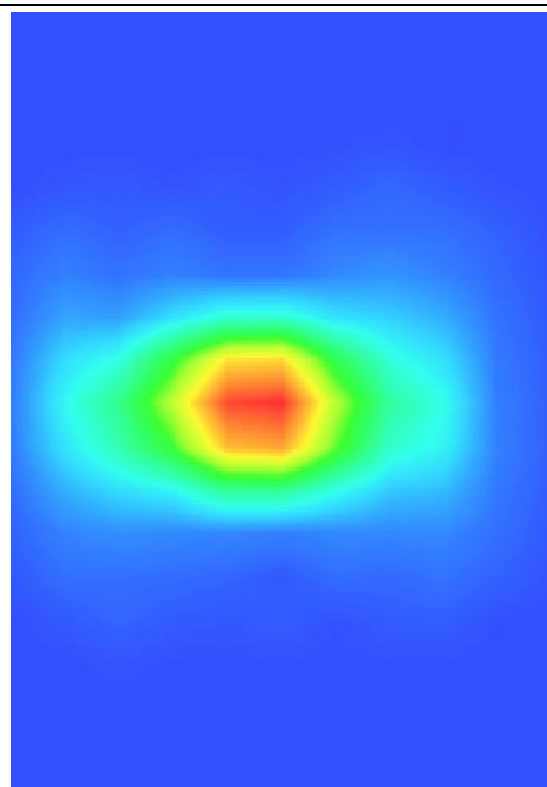
Z Axis Scan



3D screen shot



Hot spot position

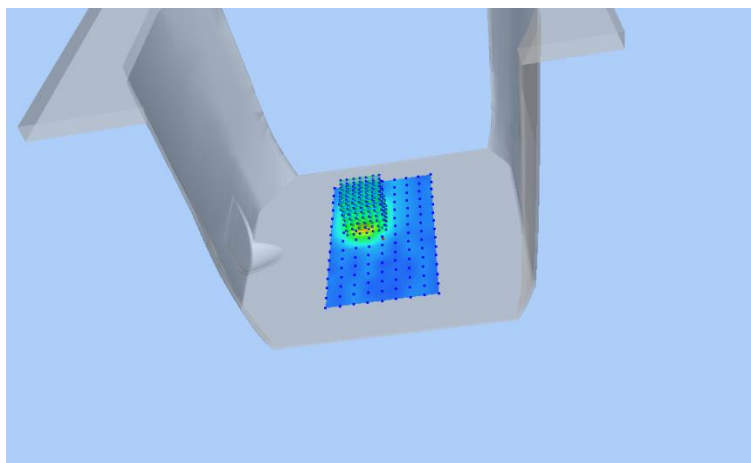


ANNEX C TEST DATA

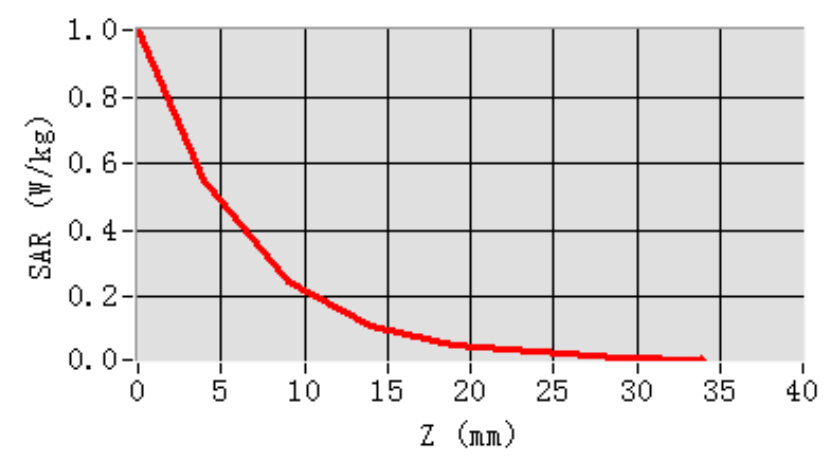
MEAS. 1 Body Plane with Top Edge 0mm on 1 Channel in IEEE802.11b mode

With Antenna 0

Test Date: 4/3/2021
Measurement duration: 14 minutes 47 seconds
Signal: WLAN, f=2412.0 MHz, Duty Cycle: 1:1.006
Liquid Parameters: Permittivity: 39.42; Conductivity: 1.75 S/m
Test condition: Ambient Temperature: 22.7°C, Liquid Temperature: 21.8°C
Probe: SN 34/15 EPGO265, ConvF: 2.55
Area Scan: sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan: 7x7x7,dx=5mm, dy=5mm, dz=5mm,Complete
Maximum location: X=-10.000000, Y=18.000000
SAR 10g (W/Kg): 0.213863
SAR 1g (W/Kg): 0.519262
Power drift (%): 2.70
3D screen shot



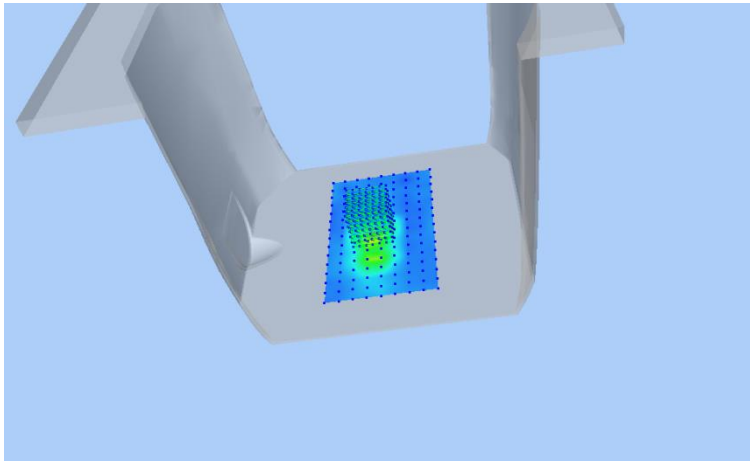
Z Axis Scan



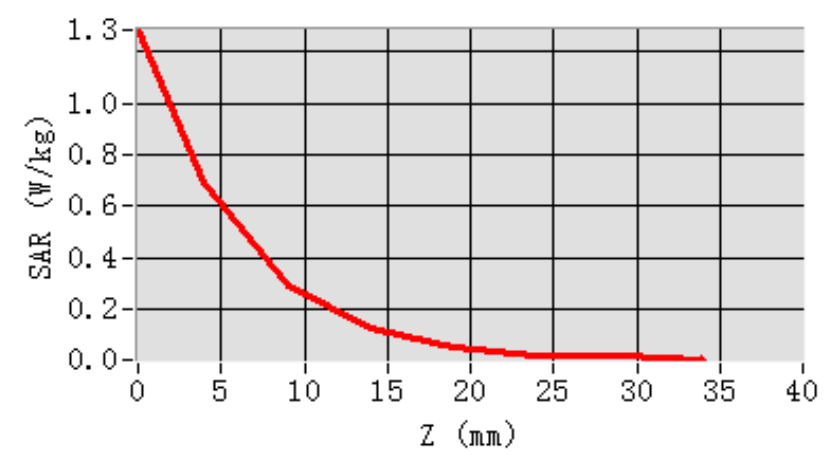
MEAS. 2 Body Plane with Top Edge 0mm on 6 Channel in IEEE802.11b mode

With Antenna 1

Test Date: 4/3/2021
Measurement duration: 16 minutes 13 seconds
Signal: WLAN, f=2437.0 MHz, Duty Cycle: 1:1.006
Liquid Parameters: Permittivity: 39.28; Conductivity: 1.76 S/m
Test condition: Ambient Temperature: 22.7°C, Liquid Temperature: 21.8°C
Probe: SN 34/15 EPGO265, ConvF: 2.55
Area Scan: sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan: 7x7x7,dx=5mm, dy=5mm, dz=5mm,Complete
Maximum location: X=-10.000000, Y=-2.000000
SAR 10g (W/Kg): 0.218207
SAR 1g (W/Kg): 0.602408
Power drift (%): -2.79
3D screen shot

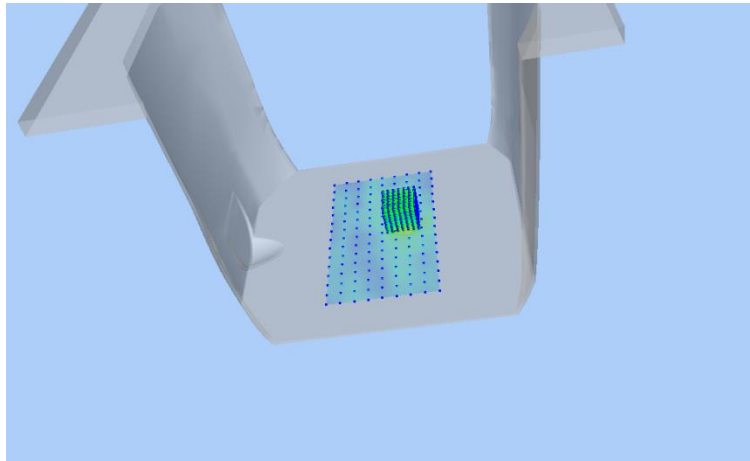


Z Axis Scan

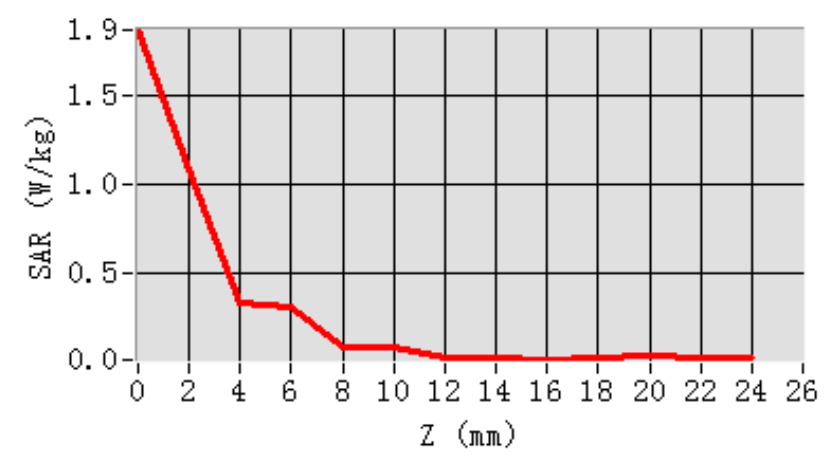


MEAS. 3 Body Plane with Top Edge 0mm on 42 Channel in IEEE802.11 ac80 mode With Antenna 0

Test Date: 5/3/2021
Measurement duration: 24 minutes 3 seconds
Signal: WLAN, f=5210.0 MHz, Duty Cycle: 1:1.136
Liquid Parameters: Permittivity: 35.93; Conductivity: 4.87 S/m
Test condition: Ambient Temperature: 22.1°C, Liquid Temperature: 21.3°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=8.000000
SAR 10g (W/Kg): 0.153100
SAR 1g (W/Kg): 0.514734
Power drift (%): 1.37
3D screen shot

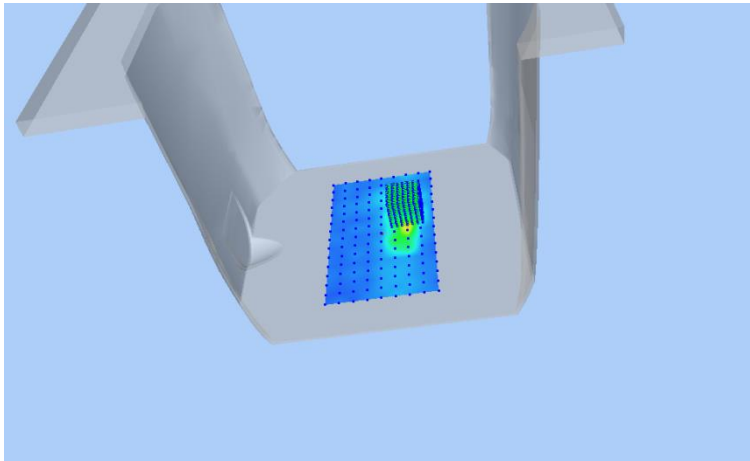


Z Axis Scan

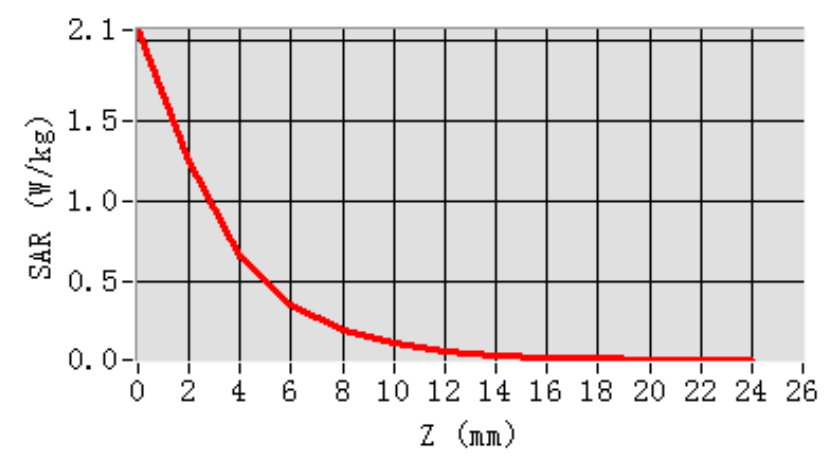


MEAS. 4 Body Plane with Top Edge 0mm on 42 Channel in IEEE802.11 ac80 mode With Antenna 1

Test Date: 5/3/2021
Measurement duration: 21 minutes 49 seconds
Signal: WLAN, f=5210.0 MHz, Duty Cycle: 1:1.136
Liquid Parameters: Permittivity: 35.93; Conductivity: 4.87 S/m
Test condition: Ambient Temperature: 22.1°C, Liquid Temperature: 21.3°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=18.000000
SAR 10g (W/Kg): 0.161948
SAR 1g (W/Kg): 0.627585
Power drift (%): 2.33
3D screen shot

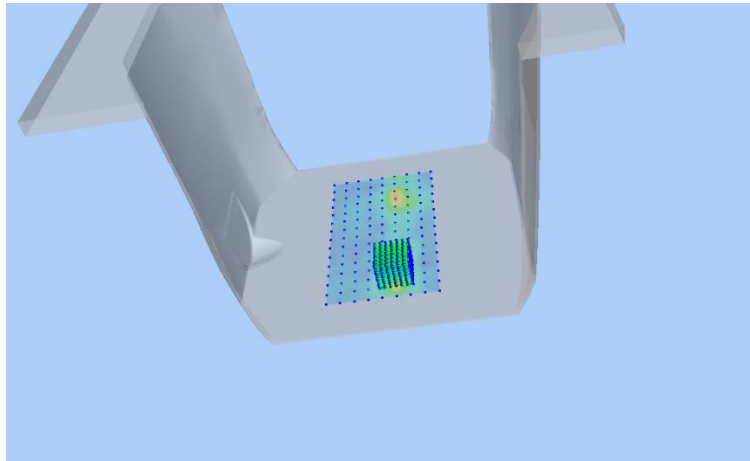


Z Axis Scan

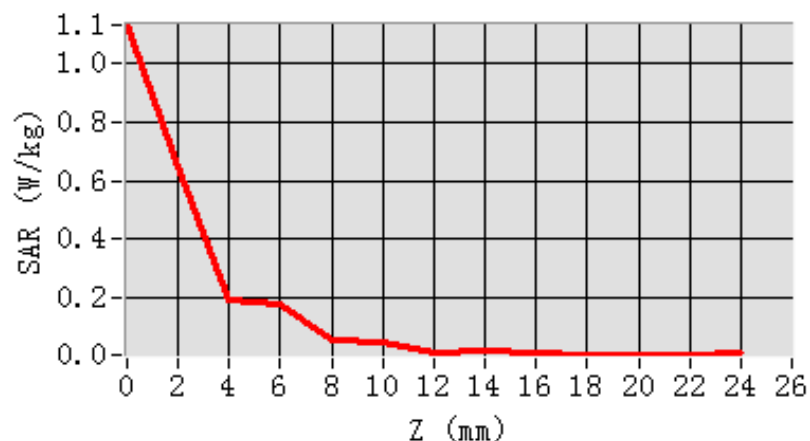


MEAS. 5 Body Plane with Top Edge 0mm on 42 Channel in IEEE802.11 ac80 mode With Antenna 0&1

Test Date: 5/3/2021
Measurement duration: 29 minutes 18 seconds
Signal: WLAN, f=5210.0 MHz, Duty Cycle: 1:1.136
Liquid Parameters: Permittivity: 35.93; Conductivity: 4.87 S/m
Test condition: Ambient Temperature: 22.1°C, Liquid Temperature: 21.3°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=10.000000, Y=-52.000000
SAR 10g (W/Kg): 0.081311
SAR 1g (W/Kg): 0.293452
Power drift (%): -4.70
3D screen shot

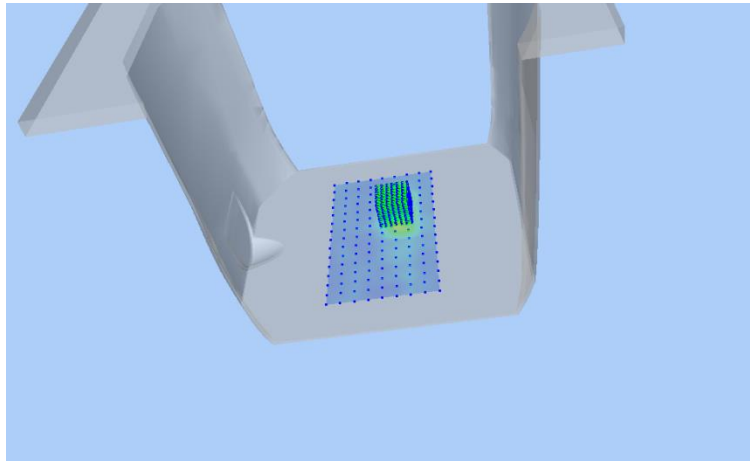


Z Axis Scan

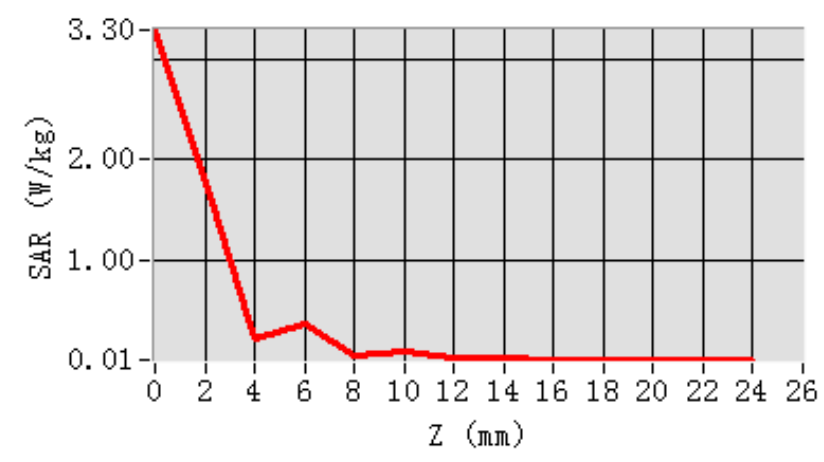


MEAS. 6 Body Plane with Top Edge 0mm on 155 Channel in IEEE802.11 ac80 mode With Antenna 0

Test Date: 7/3/2021
Measurement duration: 27 minutes 3 seconds
Signal: WLAN, f=5775.0 MHz, Duty Cycle: 1:1.136
Liquid Parameters: Permittivity: 34.84; Conductivity: 5.25 S/m
Test condition: Ambient Temperature: 22.4°C, Liquid Temperature: 21.5°C
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): 0.164678
SAR 1g (W/Kg): 0.776453
Power drift (%): -1.32
3D screen shot



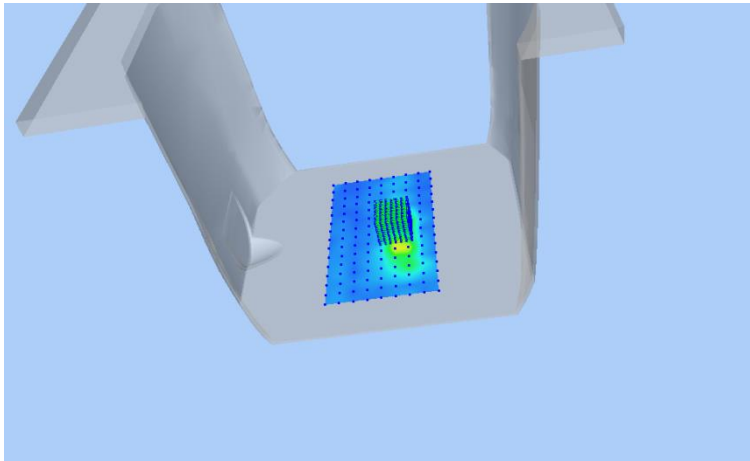
Z Axis Scan



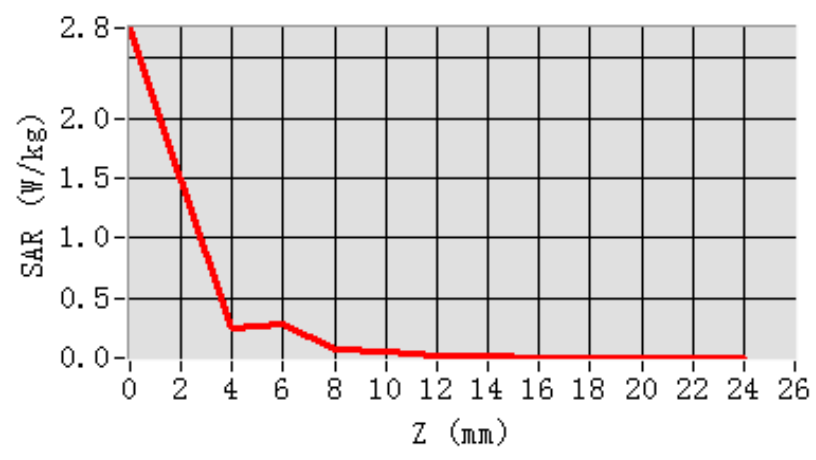
MEAS. 7 Body Plane with Top Edge 0mm on 155 Channel in IEEE802.11 ac80

mode With Antenna 1

Test Date: 7/3/2021
Measurement duration: 27 minutes 16 seconds
Signal: WLAN, f=5775.0 MHz, Duty Cycle: 1:1.136
Liquid Parameters: Permittivity: 34.84; Conductivity: 5.25 S/m
Test condition: Ambient Temperature: 22.4°C, Liquid Temperature: 21.5°C
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=-2.000000
SAR 10g (W/Kg): 0.144489
SAR 1g (W/Kg): 0.669989
Power drift (%): -4.46
3D screen shot

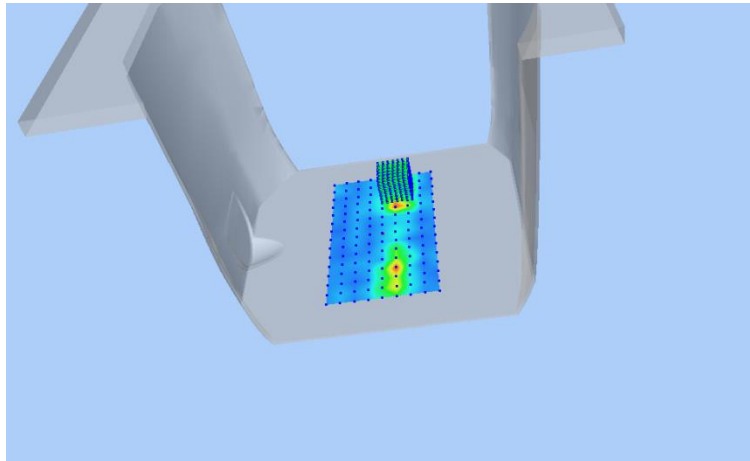


Z Axis Scan

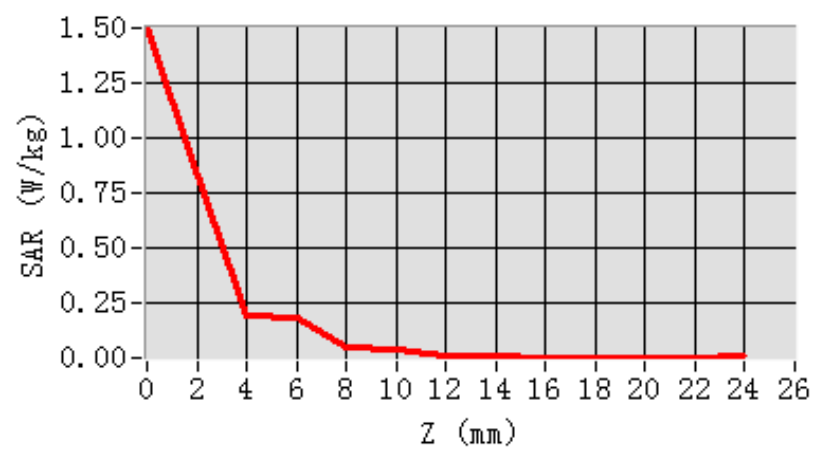


MEAS. 8 Body Plane with Top Edge 0mm on 155 Channel in IEEE802.11 ac80 mode With Antenna 0&1

Test Date: 7/3/2021
Measurement duration: 27 minutes 18 seconds
Signal: WLAN, f=5775.0 MHz, Duty Cycle: 1:1.136
Liquid Parameters: Permittivity: 34.84; Conductivity: 5.25 S/m
Test condition: Ambient Temperature: 22.4°C, Liquid Temperature: 21.5°C
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=48.000000
SAR 10g (W/Kg): 0.085516
SAR 1g (W/Kg): 0.388533
Power drift (%): -3.87
3D screen shot



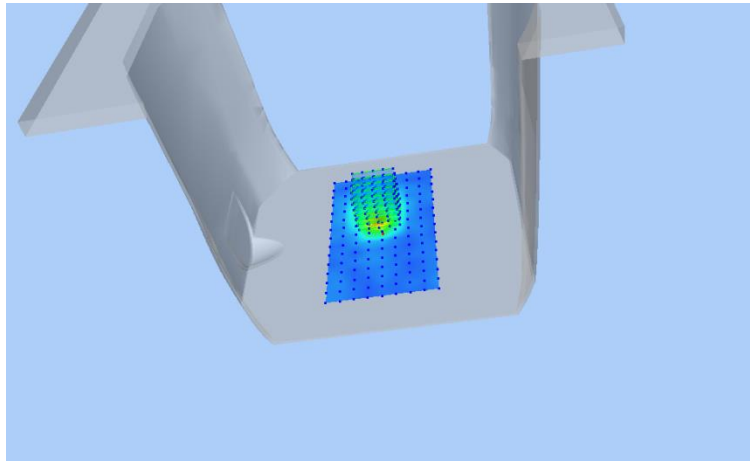
Z Axis Scan



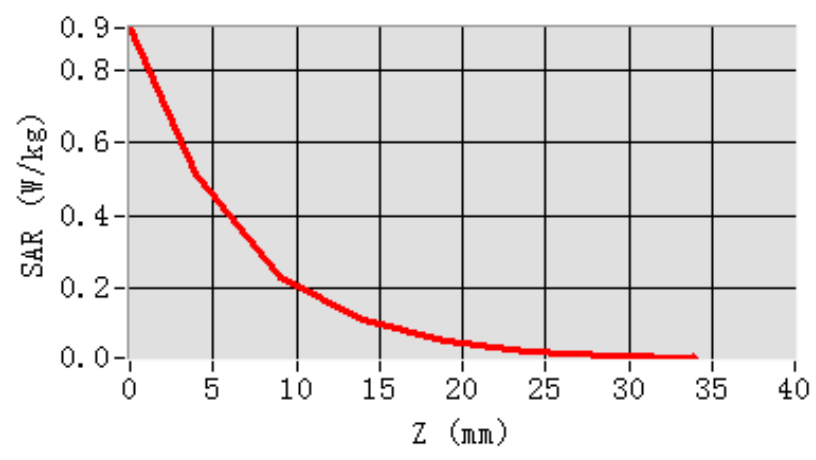
MEAS. 9 Body Plane with Top Edge 0mm on 39 Channel in Bluetooth mode

With Antenna 0

Test Date: 4/3/2021
Measurement duration: 12 minutes 19 seconds
Signal: Bluetooth, f=2441.0 MHz, Duty Cycle: 1:1.303
Liquid Parameters: Permittivity: 39.25; Conductivity: 1.77 S/m
Test condition: Ambient Temperature: 22.7°C, Liquid Temperature: 21.8°C
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): 0.199335
SAR 1g (W/Kg): 0.482936
Power drift (%): -4.43
3D screen shot



Z Axis Scan



ANNEX D EUT EXTERNAL PHOTOS

Please refer the document "BL-SZ2120401-AW.pdf".

ANNEX E SAR TEST SETUP PHOTOS

Please refer the document "BL-SZ2120401-AS.pdf".

ANNEX F CALIBRATION REPORT

Please refer the document "CALIBRATION REPORT.pdf".

--END OF REPORT--