

FCC

SAR

TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.



FOR
Mobile Computer

ISSUED TO
Honeywell International Inc.
Honeywell Sensing & Productivity Solutions

9680 Old Bailes Road, Fort Mill, SC 29707 United States



Tested by: *Zong Liyao*
Zong Liyao
(Engineer)

Date: *Jan 23, 2018*

Approved by: *Wei Yanquan*
Wei Yanquan
(Chief Engineer)

Date: *Jan 23, 2018*

Report No.: BL-EC17C0347-701
EUT Name: Mobile Computer
Model Name: EDA60K-0
Brand Name: Honeywell
FCC ID: HD5-EDA60K0
Test Standard: FCC 47 CFR Part 2.1093
ANSI C95.1: 2005
IEEE 1528: 2013
Maximum SAR: Body (1 g): 1.245 W/kg
Test Conclusion: Pass
Test Date: Jan. 05, 2018 ~ Jan. 19, 2018
Date of Issue: Jan. 23, 2018

NOTE: This test report of test results only related to testing samples, which can be duplicated completely for the legal use with the approval of the applicant; it shall not be reproduced except in full, without the written approval of Shenzhen BALUN Technology Co., Ltd. BALUN Laboratory. Any objections should be raised within thirty days from the date of issue. To validate the report, please contact us.

Revision History

<u>Version</u>	<u>Issue Date</u>	<u>Revisions Content</u>
<u>Rev. 01</u>	<u>Jan. 23, 2018</u>	<u>Initial Issue</u>

TABLE OF CONTENTS

1	GENERAL INFORMATION.....	4
1.1	Identification of the Testing Laboratory	4
1.2	Identification of the Responsible Testing Location	4
1.3	Test Environment Condition	4
1.4	Announce	4
2	PRODUCT INFORMATION	5
2.1	Applicant Information	5
2.2	Manufacturer Information.....	5
2.3	Factory Information.....	5
2.4	General Description for Equipment under Test (EUT).....	5
2.5	Ancillary Equipment.....	6
2.6	Technical Information	7
3	SUMMARY OF TEST RESULTS	8
3.1	Test Standards	8
3.2	Device Category and SAR Limit	8
3.3	Test Result Summary	10
3.4	Test Uncertainty	11
4	SAR MEASUREMENT SYSTEM.....	13
4.1	Definition of Specific Absorption Rate (SAR)	13
4.2	SATIMO SAR System	13
5	SYSTEM VERIFICATION	22
5.1	Antenna Port Test Requirement	22
5.2	Purpose of System Check	22
5.3	System Check Setup	22
6	EUT TEST POSITION CONFIGURATUONS.....	23
6.1	Head Exposure Conditions	23

6.2	Body-worn Position Conditions	24
6.3	Hotspot Mode Exposure Position Conditions	25
7	SAR MEASUREMENT PROCEDURES.....	26
7.1	SAR Measurement Process Diagram	26
7.2	SAR Scan General Requirements	27
7.3	SAR Measurement Procedure	28
7.4	Area & Zoom Scan Procedures	28
8	CONDUCTED RF OUTPUT POWER	29
8.1	WIFI.....	29
8.2	Bluetooth	32
9	EUT ANTENNA LOCATION SKETCH	33
9.1	SAR Test Exclusion Consider Table	34
10	TEST RESULTS.....	36
10.1	WIFI 2.4GHz.....	36
10.2	Worst case-Battery2 of WIFI 2.4GHz.....	36
10.3	5G WIFI.....	37
10.4	Worst case-Battery2 of 5G WIFI	37
11	SAR Measurement Variability	38
12	SIMULTANEOUS TRANSMISSION.....	39
13	TEST EQUIPMENTS LIST	40
ANNEX A	SIMULATING LIQUID VERIFICATION RESULT	41
ANNEX B	SYSTEM CHECK RESULT	42
ANNEX C	TEST DATA.....	53
ANNEX D	EUT EXTERNAL PHOTOS	57
ANNEX E	SAR TEST SETUP PHOTOS	57
ANNEX F	CALIBRATION REPORT	57

1 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 has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196. The laboratory is a testing organization accredited by American Association for Laboratory Accreditation (A2LA) according to ISO/IEC 17025. The accreditation certificate is 4344.01. The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.
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°C
Ambient Relative Humidity	37 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.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Honeywell International Inc. Honeywell Sensing & Productivity Solutions
Address	9680 Old Bailes Road, Fort Mill, SC 29707 United States

2.2 Manufacturer Information

Manufacturer	Honeywell International Inc. Honeywell Sensing & Productivity Solutions
Address	9680 Old Bailes Road, Fort Mill, SC 29707 United States

2.3 Factory Information

Factory	Metro (Suzhou) Technologies Co Ltd.
Address	China-Singapore Suzhou Industrial Park 221 Xinghai St Suzhou Jiangsu 215021 China

2.4 General Description for Equipment under Test (EUT)

EUT Name	Mobile Computer
Model Name Under Test	EDA60K-0
Series Model Name	N/A
Description of Model Name Differentiation	N/A
Hardware Version	SNB743_MB_V1.02_PCB
Software Version	206.01.00.0011
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A
Network and Wireless connectivity	WIFI 802.11a, 802.11b, 802.11g, 802.11n (HT20/40), 802.11ac; Bluetooth;

2.5 Ancillary Equipment

Ancillary Equipment 1	Battery 1	
	Brand Name	N/A
	Model No.	AB17
	Serial No.	N/A
	Capacitance	7.4Wh, 2Ah
	Rated Voltage	3.7 V
	Limit Charge Voltage	4.22 V
Ancillary Equipment 2	Battery 2	
	Brand Name	N/A
	Model No.	AB18
	Serial No.	N/A
	Capacitance	18.9Wh, 5.1Ah
	Rated Voltage	3.7 V
	Limit Charge Voltage	4.22 V
Ancillary Equipment 3	AC Adapter	
	Brand Name	N/A
	Model No.	ADS-12B-06 05010E
	Serial No.	N/A
	Rated Input	100 - 240 V~, 0.3 A, 50/60 Hz
	Rated Output	5 V=, 2 A
Note: This device has two kinds of batteries, RF exposure chose battery1 to evaluate full SAR test, battery2 verified the worse cases of battery 1.		

2.6 Technical Information

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)	2400~2483.5 MHz
	802.11a	5150 MHz~ 5350 MHz
		5470 MHz~ 5725 MHz
		5725 MHz~ 5850 MHz
	802.11n(HT20/HT40)	5150 MHz~ 5350 MHz
		5470 MHz~ 5725 MHz
		5725 MHz~ 5850 MHz
	802.11ac(VHT20/4080)	5150 MHz~ 5350 MHz
		5470 MHz~ 5725 MHz
		5725 MHz~ 5850 MHz
	Bluetooth	2400~2483.5 MHz
Antenna Type	FPC	
Hotspot Function	N/A	
Power Reduction	Not Support	
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. C95.1-2005	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
8	FCC KDB 865664 D01 v01r04	SAR Measurement 100 MHz to 6 GHz
9	FCC KDB 865664 D02 v01r02	RF Exposure Reporting
10	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	Maximum Scaled SAR (W/kg)	Maximum Report SAR (W/kg)	Limit (W/kg)
	Body (0mm)	Body (0mm)	
2.4G WLAN	1.040	1.245	1.6
5.3G WLAN	1.187		
5.6G WLAN	1.245		
5.8G WLAN	1.189		
Verdict	Pass		

3.3.2 Highest Simultaneous SAR

The EUT has only one antenna for WLAN and Bluetooth, and can't transmit simultaneously, so the transmission simultaneous evaluation is not required in this report.

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	-

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

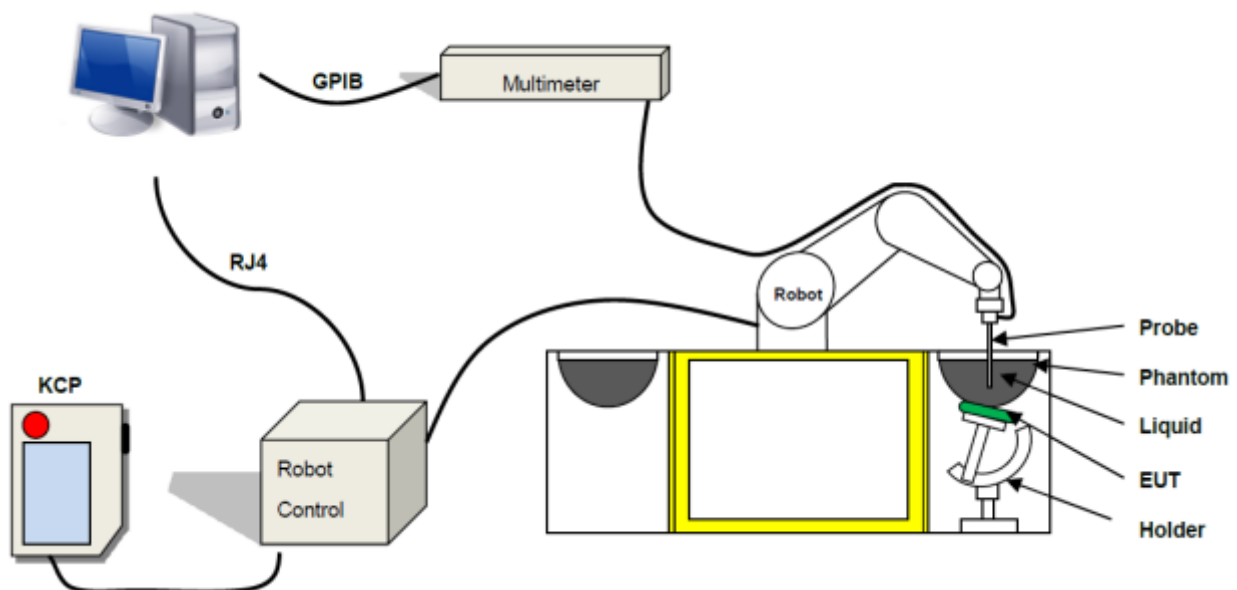
$$\text{SAR} = \frac{\sigma E^2}{\rho}$$

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

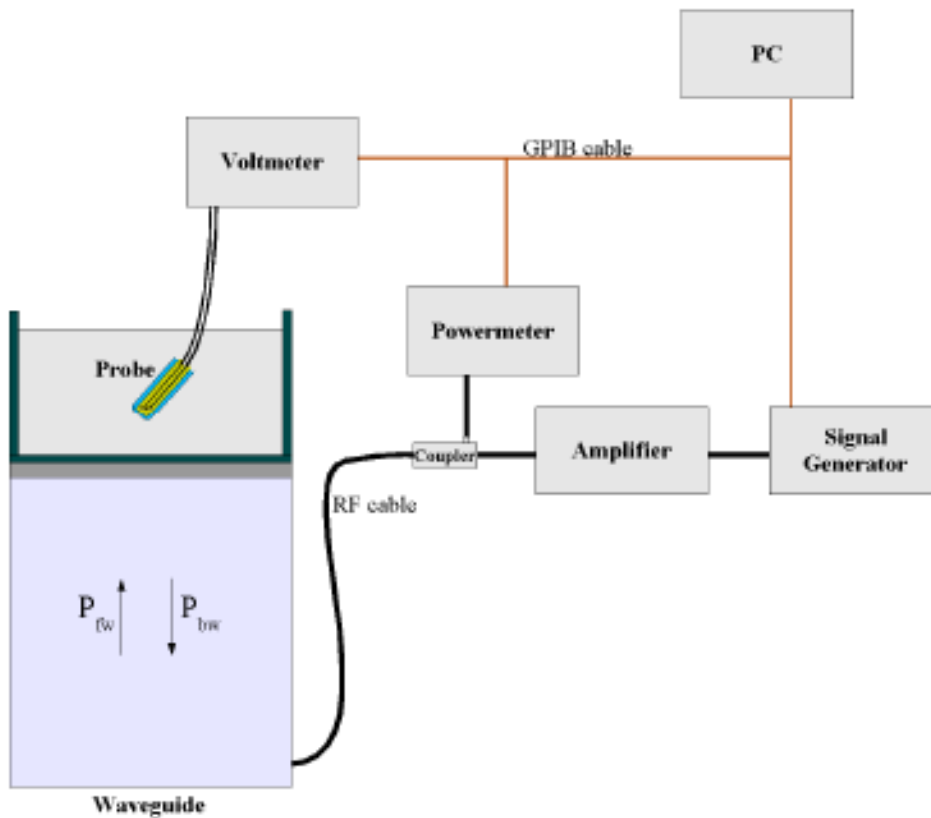
For the measurements the Specific Dosimetric E-Field Probe SN 08 /16 EPGO 295 with following specifications is used

- 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.

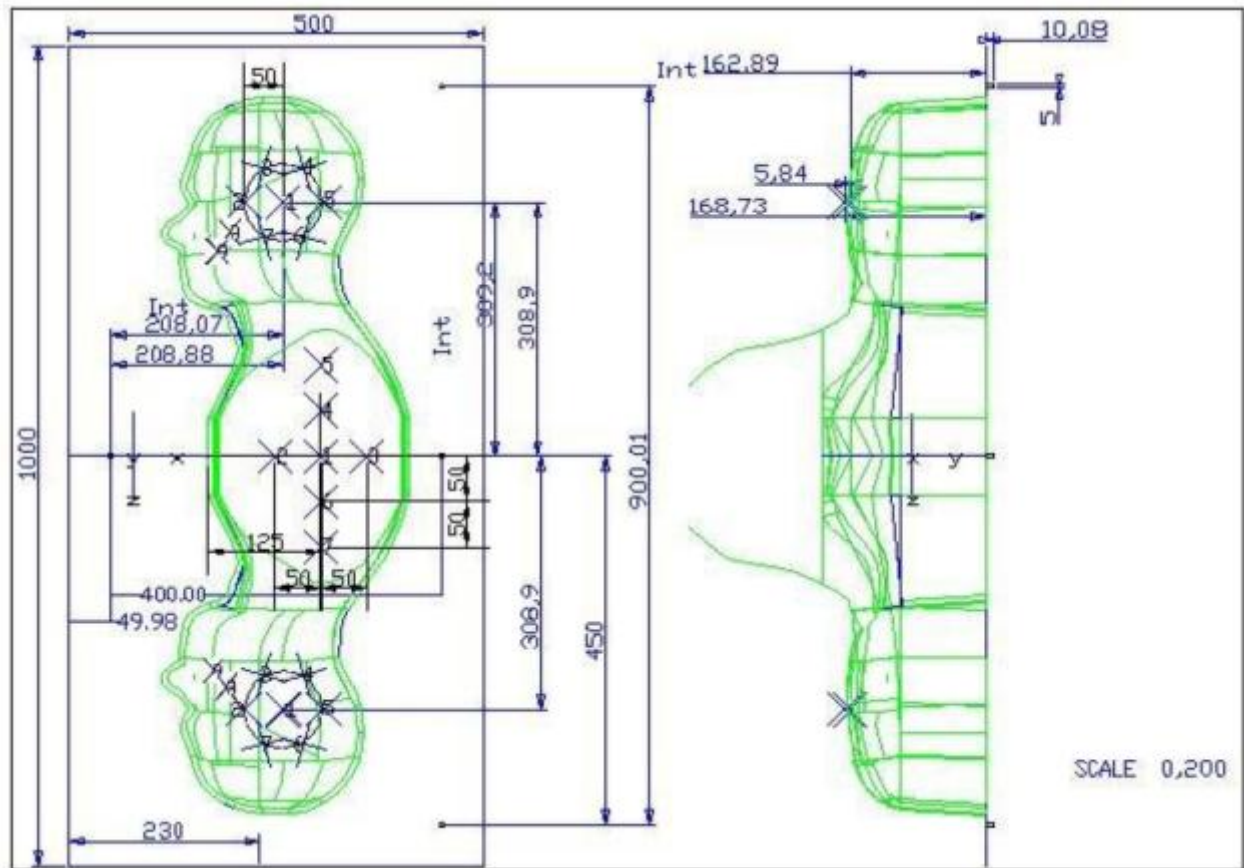
Photo of Phantom SN 30/13 SAM103



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.

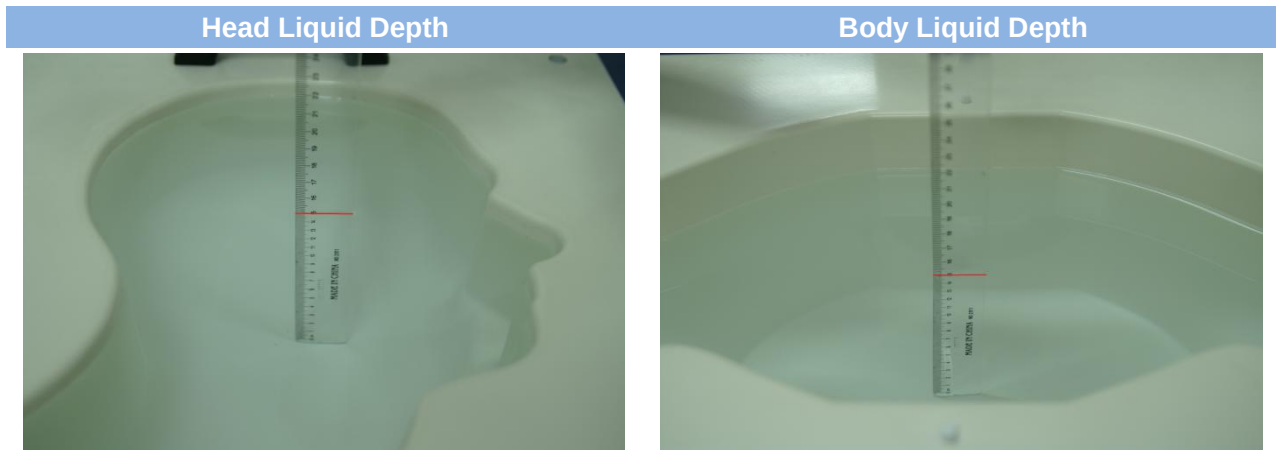


Serial Number	Holder Material	Permittivity	Loss Tangent
SN 25/13 MSH87	Deirin	3.7	0.005
SN 25/13 MSH88	Deirin	3.7	0.005

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%.



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

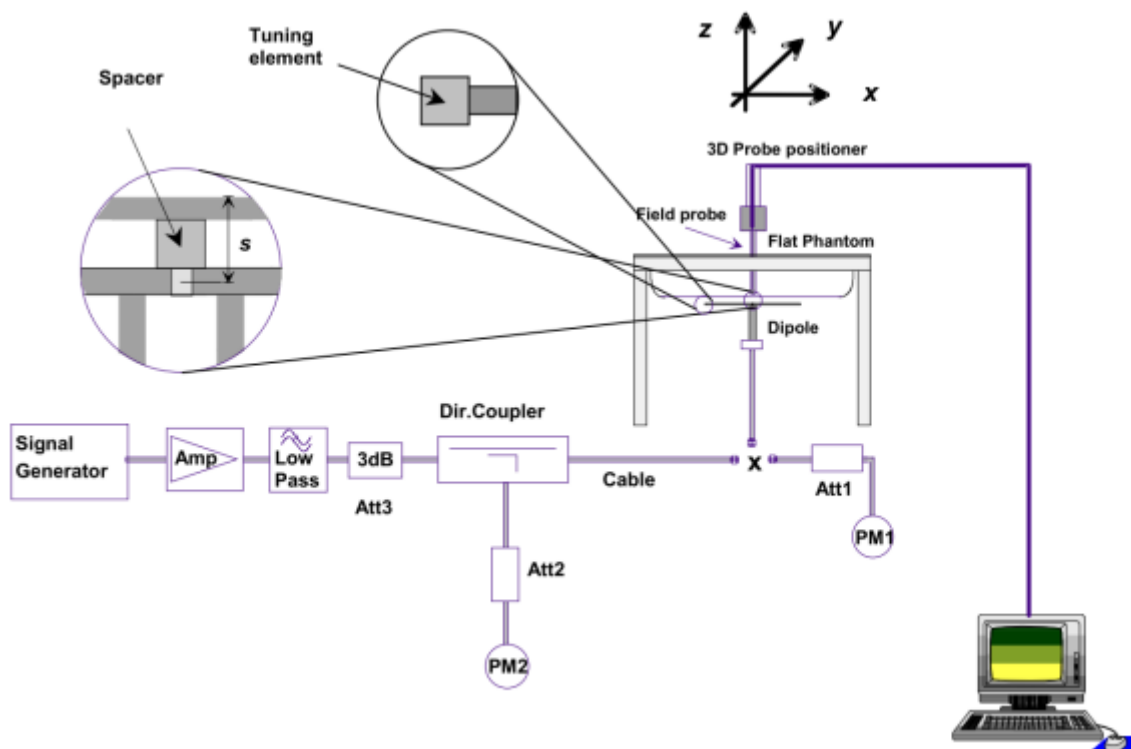
The SATIMO SAR system is equipped with one or more system validation kits. These units together with the predefined measurement procedures within the SATIMO software enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to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

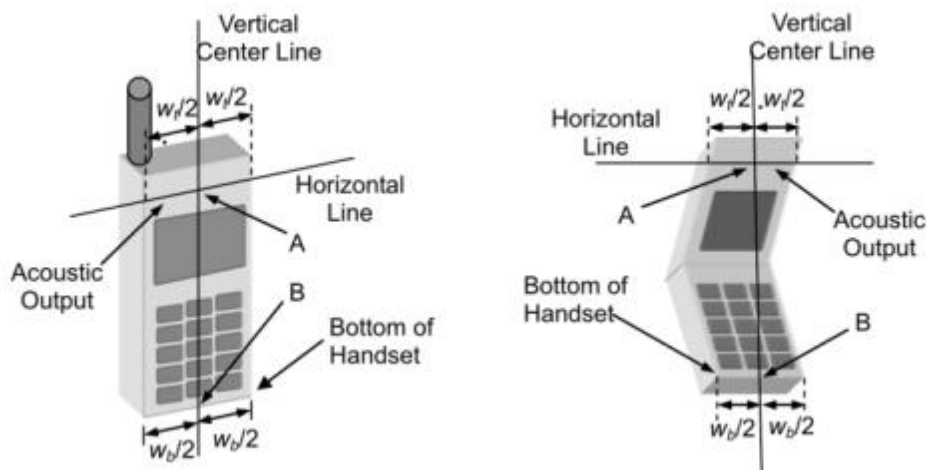
According to KDB 648474 D04 Handset, handsets are tested for SAR compliance in head, body-worn accessory and other use configurations described in the following subsections.

6.1 Head Exposure Conditions

Head exposure is limited to next to the ear voice mode operations. Head SAR compliance is tested according to the test positions defined in IEEE Std 1528-2013 using the SAM phantom illustrated as below.

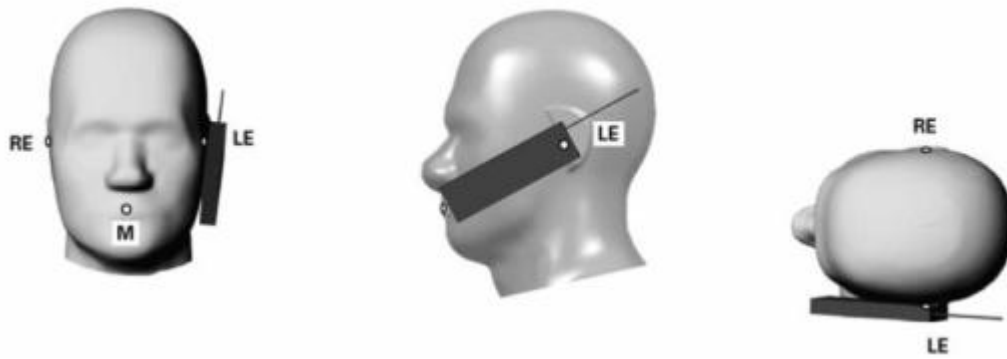
6.1.1 Define two imaginary lines on the handset

- The vertical center line passes through two points on the front side of the handset - the midpoint of the width w_t of the handset at the level of the acoustic output, and the midpoint of the width w_b of the bottom of the handset.
- The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output. The horizontal line is also tangential to the face of the handset at point A.
- The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output; however, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset, especially for clamshell handsets, handsets with flip covers, and other irregularly shaped handsets.



6.1.2 Cheek Position

- To position the device with the vertical center line of the body of the device and the horizontal line crossing the center piece in a plane parallel to the sagittal plane of the phantom. While maintaining the device in this plane, align the vertical center line with the reference plane containing the three ear and mouth reference point (M: Mouth, RE: Right Ear, and LE: Left Ear) and align the center of the ear piece with the line RE-LE.
- To move the device towards the phantom with the ear piece aligned with the line LE-RE until the phone touched the ear. While maintaining the device in the reference plane and maintaining the phone contact with the ear, move the bottom of the phone until any point on the front side is in contact with the cheek of the phantom or until contact with the ear is lost.



6.1.3 Tilted Position

- To position the device in the “cheek” position described above.
- While maintaining the device the reference plane described above and pivoting against the ear, moves it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost.



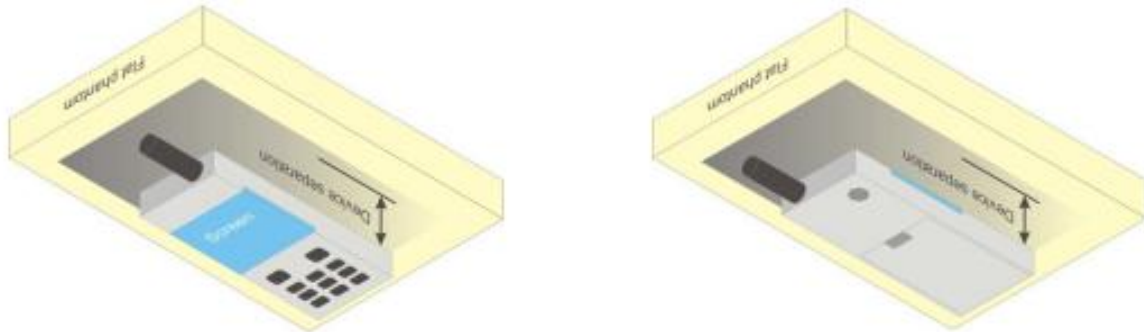
6.2 Body-worn Position Conditions

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.

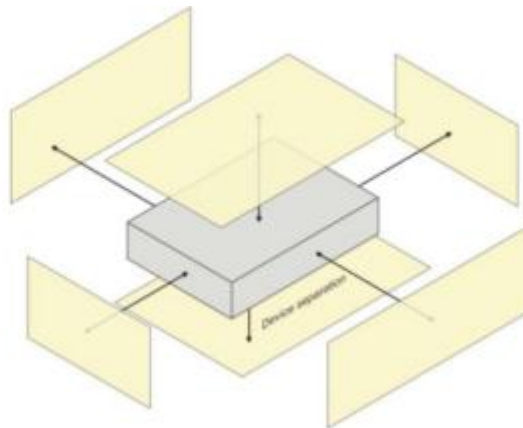
Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice 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 ≤ 5 mm to support compliance.



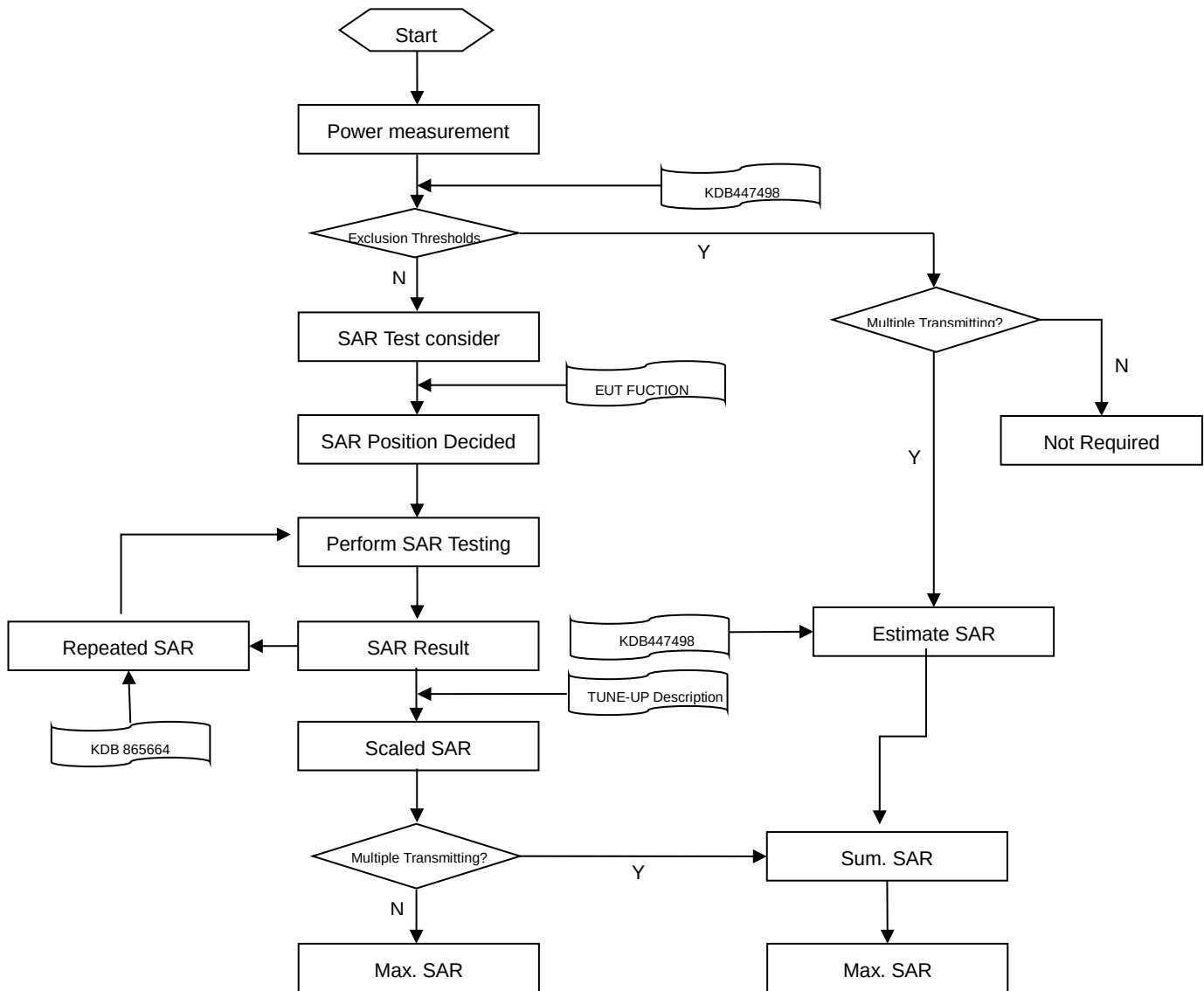
6.3 Hotspot Mode Exposure Position Conditions

For handsets that support hotspot mode operations, with wireless router capabilities and various web browsing functions, the relevant hand and body exposure conditions are tested according to the hotspot SAR procedures in KDB 941225. A test separation distance of 10 mm is required between the phantom and all surfaces and edges with a transmitting antenna located within 25 mm from that surface or edge. When the form factor of a handset is smaller than 9 cm x 5 cm, a test separation distance of 5 mm (instead of 10 mm) is required for testing hotspot mode. When the separation distance required for body-worn accessory testing is larger than or equal to that tested for hotspot mode, in the same wireless mode and for the same surface of the phone, the hotspot mode SAR data may be used to support body-worn accessory SAR compliance for that particular configuration (surface).



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 2.4G WIFI

Band (GHz)	Mode	Channel	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit Power (dBm)	SAR Test Require.
2.4 (2.4~2.4835)	802.11b	1	2412	16.11	17.00	Yes
		6	2437	16.27	17.00	Yes
		11	2462	16.21	17.00	Yes
	802.11g	1	2412	13.63	15.00	No
		6	2437	14.35	15.00	No
		11	2462	14.09	15.00	No
	802.11n(HT20)	1	2412	11.96	13.00	No
		6	2437	12.46	13.00	No
		11	2462	12.07	13.00	No

8.1.2 5G WIFI

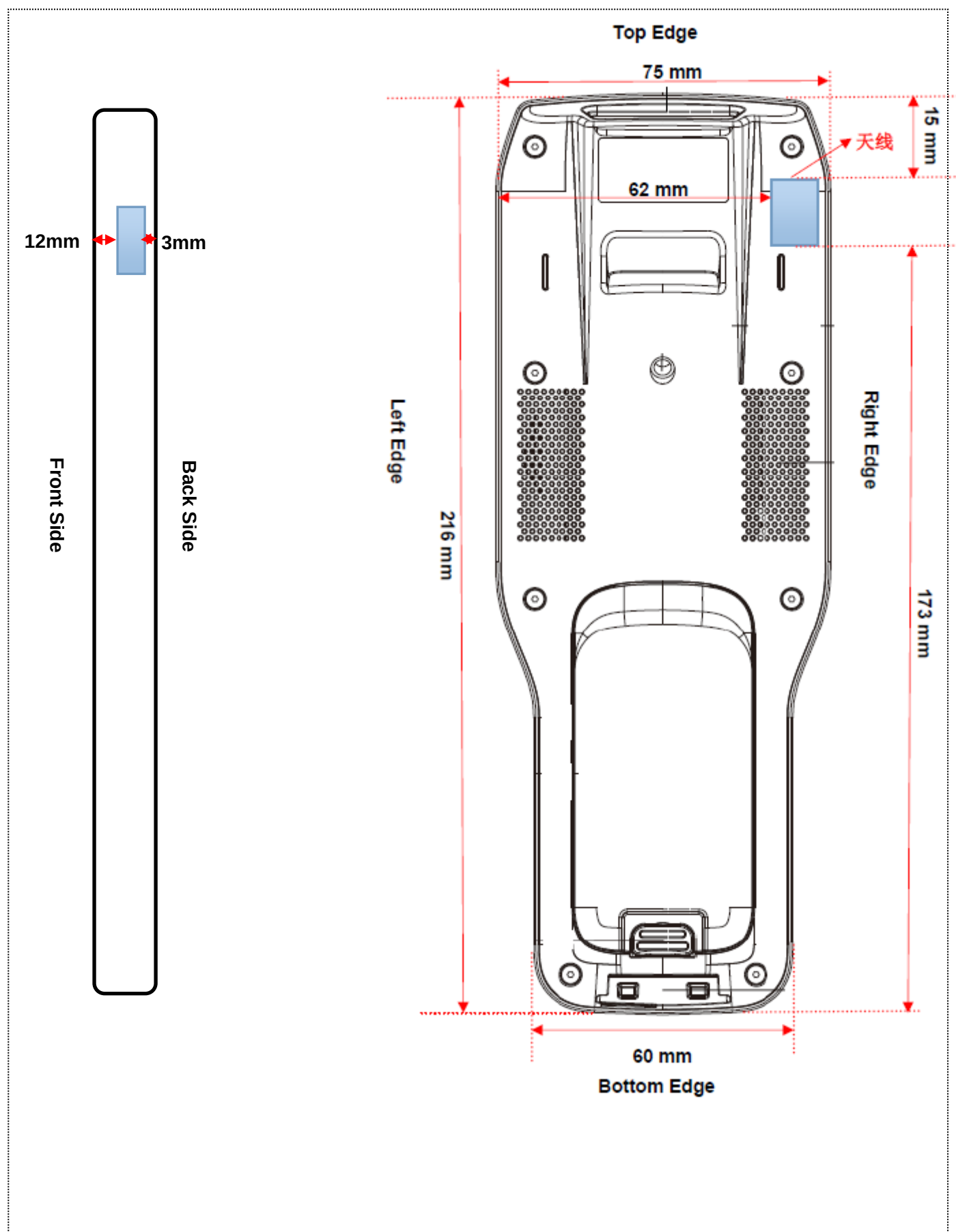
Band (GHz)	Mode	Channel	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit Power (dBm)	SAR Test Require.
5.2 (5.15~5.25)	802.11a	36	5180	12.34	13.00	No
		44	5220	12.22	13.00	No
		48	5240	12.17	13.00	No
	802.11n(HT20)	36	5180	11.78	12.50	No
		44	5220	11.64	12.50	No
		48	5240	11.55	12.50	No
	802.11n(HT40)	38	5190	10.84	11.50	No
		46	5230	10.65	11.50	No
	802.11ac(VHT20)	36	5180	11.86	12.50	No
		44	5220	11.76	12.50	No
		48	5240	11.70	12.50	No
	802.11ac(VHT40)	38	5190	10.99	11.50	No
		46	5230	10.73	11.50	No
	802.11ac(VHT80)	42	5210	10.15	11.50	No
5.3 (5.25~5.35)	802.11a	52	5260	11.97	13.00	Yes
		60	5300	11.85	13.00	Yes
		64	5320	11.78	13.00	Yes
	802.11n(HT20)	52	5260	11.61	12.50	No
		60	5300	11.40	12.50	No
		64	5320	11.31	12.50	No
	802.11n(HT40)	54	5270	10.43	11.50	No
		62	5310	10.47	11.50	No
	802.11ac(VHT20)	52	5260	11.80	12.50	No
		60	5300	11.59	12.50	No
		64	5320	11.39	12.50	No
	802.11ac(VHT40)	54	5270	10.60	11.50	No
		62	5310	10.49	11.50	No
	802.11ac(VHT80)	58	5290	10.35	11.50	No
5.6 (5.47~5.725)	802.11a	100	5500	12.89	14.00	Yes
		120	5600	13.04	14.00	Yes
		140	5700	13.36	14.00	Yes
		144	5720	13.18	14.00	Yes
	802.11n(HT20)	100	5500	12.08	13.00	No
		120	5600	11.89	13.00	No
		140	5700	11.92	13.00	No
		144	5720	11.97	13.00	No
	802.11n(HT40)	102	5510	12.34	13.00	No
		126	5630	12.05	13.00	No
		134	5670	12.08	13.00	No
		142	5710	12.26	13.00	No
	802.11ac(VHT20)	100	5500	12.14	13.00	No

		120	5600	12.04	13.00	No
		140	5700	11.98	13.00	No
		144	5720	12.11	13.00	No
	802.11ac(VHT40)	102	5510	12.50	13.00	No
		126	5630	12.09	13.00	No
		134	5670	12.16	13.00	No
		142	5710	12.36	13.00	No
	802.11ac(VHT80)	106	5530	11.04	12.50	No
		122	5610	11.24	12.50	No
		138	5690	11.52	12.50	No
5.8 (5.725~5.850)	802.11a	149	5745	13.95	14.50	Yes
		157	5785	13.74	14.50	Yes
		165	5825	13.64	14.50	Yes
	802.11n(HT20)	149	5745	11.92	13.00	No
		157	5785	12.07	13.00	No
		165	5825	12.06	13.00	No
	802.11n(HT40)	151	5755	12.11	13.00	No
		159	5795	12.16	13.00	No
	802.11ac(VHT20)	149	5745	11.98	13.00	No
		157	5785	12.22	13.00	No
		165	5825	12.16	13.00	No
	802.11ac(VHT40)	151	5755	12.14	13.00	No
		159	5795	12.30	13.00	No
	802.11ac(VHT80)	155	5775	12.16	13.00	No

8.2 Bluetooth

Mode	GFSK			$\pi/4$ -DQPSK		
Channel	0	39	78	0	39	78
Frequency (MHz)	2402	2441	2480	2402	2441	2480
Conducted Power(dBm)	4.18	6.69	4.15	2.31	4.44	2.78
Tune-Up Limit Power (dBm)	5.0	7.5	5.0	3.0	5.5	3.5
Mode	8-DPSK			BLE		
Channel	0	39	78	0	19	39
Frequency (MHz)	2402	2441	2480	2402	2440	2480
Conducted Power(dBm)	3.11	4.45	2.03	0.08	1.87	-1.13
Tune-Up Limit Power (dBm)	4.0	5.5	3.0	1.0	3.0	0.0

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			12mm	<5mm	62mm	<5mm	15mm	173 mm
	802.11b	17.00	50.12	Yes	Yes	No	Yes	Yes	No
	802.11g	15.00	31.62	No	No	No	No	No	No
	802.11n(HT20)	13.00	19.95	No	No	No	No	No	No
WLAN 5.2&5.3 G	Distance to User			12mm	<5mm	62mm	<5mm	15mm	173 mm
	802.11a	13.00	19.95	Yes	Yes	No	Yes	Yes	No
	802.11n(HT20)	12.50	17.78	No	No	No	No	No	No
	802.11n(HT40)	11.50	14.13	No	No	No	No	No	No
	802.11ac(VHT20)	12.50	17.78	No	No	No	No	No	No
	802.11ac(VHT40)	11.50	14.13	No	No	No	No	No	No
	802.11ac(VHT80)	11.50	14.13	No	No	No	No	No	No
WLAN 5.6 G	Distance to User			12mm	<5mm	62mm	<5mm	15mm	173 mm
	802.11a	14.00	25.12	Yes	Yes	No	Yes	Yes	No
	802.11n(HT20)	13.00	19.95	No	No	No	No	No	No
	802.11n(HT40)	13.00	19.95	No	No	No	No	No	No
	802.11ac(VHT20)	13.00	19.95	No	No	No	No	No	No
	802.11ac(VHT40)	13.00	19.95	No	No	No	No	No	No
	802.11ac(VHT80)	12.50	17.78	No	No	No	No	No	No
WLAN 5.8 G	Distance to User			12mm	<5mm	62mm	<5mm	15mm	173 mm
	802.11a	14.50	28.18	Yes	Yes	No	Yes	Yes	No
	802.11n(HT20)	13.00	19.95	No	No	No	No	No	No
	802.11n(HT40)	13.00	19.95	No	No	No	No	No	No
	802.11ac(VHT20)	13.00	19.95	No	No	No	No	No	No
	802.11ac(VHT40)	13.00	19.95	No	No	No	No	No	No
	802.11ac(VHT80)	13.00	19.95	No	No	No	No	No	No
Bluetooth	Distance to User			12mm	<5mm	62mm	<5mm	15mm	173 mm
	Bluetooth BR/EDR	7.50	5.62	No	No	No	No	No	No
	Bluetooth BLE	3.00	2.00	No	No	No	No	No	No

Note:

- Maximum power is the source-based time-average power and represents the maximum RF output power among production units.
- 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.
- 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
- 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:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- For < 50 mm distance, we just calculate mW of the exclusion threshold value (3.0) to do compare.

This formula is $[3.0] / [\sqrt{f(\text{GHz})}] \cdot [(\text{min. test separation distance, mm})] = \text{exclusion threshold of mW}$.

- 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:
 - [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) $\cdot$ (f(MHz)/150)] mW, at 100 MHz to 1500 MHz
 - [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) $\cdot$ 10] mW at > 1500 MHz and ≤ 6 GHz
- Per KDB 248227 D01 SAR is not required for the following 2.4 GHz OFDM conditions.
 - When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
 - When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel.
- Per KDB 248227 D01 SAR is not required for the following 2.4 GHz OFDM conditions.
 - When KDB Publication 447498 D01 SAR test exclusion applies to the OFDM configuration.
 - 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.
- Per KDB 248227 D01 SAR is not required for the following U-NII-1 and U-NII-2A bands conditions.
 - 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.
 - 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.
- Per KDB 248227 D01 5G WLAN Subsequent Test Configuration Procedures
SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units.
 - When SAR test exclusion provisions of KDB Publication 447498 D01 are applicable and SAR measurement is not required for the initial test configuration, SAR is also not required for the next highest maximum output power transmission mode subsequent test configuration(s) in that frequency band or aggregated band and exposure configuration.
 - When the highest reported SAR for the initial test configuration (when applicable, include subsequent highest output channels), according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

10 TEST RESULTS

10.1 WIFI 2.4GHz

Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (%)	1 g Meas. SAR (W/Kg)	Meas. Power (dBm)	Max. tune-up Power (dBm)	Scaling Factor	Duty Cycle (%)	Duty Cycle Factor	1 g Scaled SAR (W/Kg)	Meas. No.
Body													
802.11 b	Front Side	0	6	2437	1.35	0.116	16.27	17.00	1.183	97.690	1.024	0.140	/
	Back Side	0	6	2437	3.14	0.128	16.27	17.00	1.183	97.690	1.024	0.155	/
	Left Edge	0	6	2437	-2.74	0.091	16.27	17.00	1.183	97.690	1.024	0.110	/
	Right Edge	0	6	2437	-0.20	0.778	16.27	17.00	1.183	97.690	1.024	0.942	/
		0	1	2412	-0.66	0.828	16.11	17.00	1.227	97.690	1.024	1.040	#1
		0	11	2462	-0.03	0.630	16.21	17.00	1.199	97.690	1.024	0.774	/
	Top Edge	0	6	2437	1.50	0.102	16.27	17.00	1.183	97.690	1.024	0.124	/
Note ¹ : Refer to ANNEX C for the detailed test data for each test configuration.													

10.2 Worst case-Battery2 of WIFI 2.4GHz

Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (%)	1 g Meas. SAR (W/Kg)	Meas. Power (dBm)	Max. tune-up Power (dBm)	Scaling Factor	Duty Cycle (%)	Duty Cycle Factor	1 g Scaled SAR (W/Kg)	Meas. No.
Body													
802.11 b	Right Edge	0	1	2412	-1.63	0.822	16.11	17.00	1.227	97.690	1.024	1.033	/

10.3 5G WIFI

Fre. Band	Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (%)	1 g Meas. SAR (W/Kg)	Meas. Power (dBm)	Max. tune-up Power (dBm)	Scaling Factor	Duty Cycle (%)	Duty Cycle Factor	1 g Scaled SAR (W/Kg)	Meas. No.
Body														
5.3G	802.11a	Front Side	0	52	5260	-4.69	0.159	11.97	13.00	1.268	87.180	1.147	0.231	/
		Back Side	0	52	5260	-3.63	0.198	11.97	13.00	1.268	87.180	1.147	0.288	/
		Left Edge	0	52	5260	-4.31	0.118	11.97	13.00	1.268	87.180	1.147	0.172	/
		Right Edge	0	52	5260	-0.93	0.816	11.97	13.00	1.268	87.180	1.147	1.187	#2
			0	56	5280	-1.77	0.786	11.85	13.00	1.303	87.180	1.147	1.175	/
			0	64	5320	3.61	0.775	11.78	13.00	1.324	87.180	1.147	1.177	/
		Top Edge	0	36	5180	3.68	0.130	11.97	13.00	1.268	87.180	1.147	0.189	/
5.6G	802.11a	Front Side	0	140	5700	-1.37	0.164	13.36	14.00	1.159	87.180	1.147	0.218	/
		Back Side	0	140	5700	-2.95	0.178	13.36	14.00	1.159	87.180	1.147	0.237	/
		Left Edge	0	140	5700	-0.37	0.113	13.36	14.00	1.159	87.180	1.147	0.150	/
		Right Edge	0	140	5700	-1.66	0.858	13.36	14.00	1.159	87.180	1.147	1.140	/
			0	100	5500	2.47	0.793	12.89	14.00	1.291	87.180	1.147	1.175	/
			0	120	5600	-2.80	0.870	13.04	14.00	1.247	87.180	1.147	1.245	#3
			0	144	5720	3.32	0.866	13.18	14.00	1.208	87.180	1.147	1.186	/
		Top Edge	0	140	5700	1.28	0.151	13.36	14.00	1.159	87.180	1.147	0.201	/
5.8G	802.11a	Front Side	0	149	5745	-2.73	0.198	13.95	14.50	1.135	87.180	1.147	0.258	/
		Back Side	0	149	5745	-2.36	0.227	13.95	14.50	1.135	87.180	1.147	0.296	/
		Left Edge	0	149	5745	-1.65	0.128	13.95	14.50	1.135	87.180	1.147	0.167	/
		Right Edge	0	149	5745	-3.88	0.913	13.95	14.50	1.135	87.180	1.147	1.189	#4
			0	157	5785	-0.95	0.864	13.74	14.50	1.191	87.180	1.147	1.181	/
			0	165	5825	-3.99	0.843	13.64	14.50	1.219	87.180	1.147	1.179	/
		Top Edge	0	149	5745	3.10	0.146	13.95	14.50	1.135	87.180	1.147	0.190	/

Note¹: Refer to ANNEX C for the detailed test data for each test configuration.

Note²: According KDB 248227 D01, SAR is not required for that subsequent test configuration. When the highest reported SAR for the initial test configuration, adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

Adjusted SAR = Report SAR * (max power(subsequent test configuration)/ max power(initial test configuration))=1.245 * (19.95 (mw) / 25.11 (mw)) =0.99, so the 5GHz U-NII-2C subsequent test configuration SAR test is not required.

10.4 Worst case-Battery2 of 5G WIFI

Fre. Band	Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (%)	1 g Meas. SAR (W/Kg)	Meas. Power (dBm)	Max. tune-up Power (dBm)	Scaling Factor	Duty Cycle (%)	Duty Cycle Factor	1 g Scaled SAR (W/Kg)	Meas. No.
Body														
5.3G	802.11 a	Right Edge	0	52	5260	-1.12	0.778	11.97	13.00	1.268	87.180	1.147	1.131	/
5.6G	802.11 a	Right Edge	0	120	5600	-1.44	0.812	13.04	14.00	1.247	87.180	1.147	1.162	/

5.8G	802.11 a	Right Edge	0	149	5745	3.57	0.853	13.95	14.50	1.135	87.180	1.147	1.111	/
------	----------	------------	---	-----	------	------	-------	-------	-------	-------	--------	-------	-------	---

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.

Frequency Band (MHz)	Wireless Band	RF Exposure Conditions	Test Position	Highest Measured SAR (W/kg)	Repeated SAR (Yes/No)	Highest Measured SAR (W/kg)	Largest to Smallest SAR Ratio
2450	WIFI 802.11 b	Body	Right Edge	0.828	Yes	0.815	1.02
5300	WIFI 802.11 a	Body	Right Edge	0.816	Yes	0.798	1.02
5600	WIFI 802.11 a	Body	Right Edge	0.870	Yes	0.829	1.05
5800	WIFI 802.11 a	Body	Right Edge	0.913	Yes	0.883	1.03

Note: The ratio of largest to smallest SAR for the original and first repeated measurements is < 1.20 , the second repeated measurement is not required.

12 SIMULTANEOUS TRANSMISSION

The EUT has only one antenna for WLAN and Bluetooth, and can't transmit simultaneously, so the transmission simultaneous evaluation is not required in this report.

13 TEST EQUIPMENTS LIST

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
PC	Dell	N/A	N/A	N/A	N/A
2450MHz Dipole	SATIMO	SID 2450	S/N 25/13 DIP 2G450-251	2015/03/16	2018/03/15
Waveguide	SATIMO	SWG5500	S/N 30/13 DIP WGA24	2015/03/16	2018/03/15
E-Field Probe	MVG	SSE2	S/N 08/16 EPGO 295	2017/03/22	2018/03/21
MultiMeter	Keithley	MultiMeter 2000	4024022	2017/06/12	2018/06/11
Signal Generator	R&S	SMBV100A	260592	2017/06/12	2018/06/11
Power Meter	Agilent	E4419B	GB40201833	2017/11/02	2018/11/01
Power Sensor	Agilent	E9300A	MY41498012	2017/11/02	2018/11/01
Power Sensor	Agilent	E9300A	MY41499891	2017/11/02	2018/11/01
Power Amplifier	SATIMO	6552B	22374	2017/06/12	2018/06/11
Network Analyzer	Agilent	5071B	MY42404001	2017/06/12	2018/06/11
Thermometer	Elitech	RC-4HC	N/A	2017/02/18	2018/02/17
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 30/13 SAM103	N/A	N/A
Phantom2	SATIMO	SAM	SN 30/13 SAM104	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.

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 (%)
2018.01.19	Body	2450	21.0	1.92	54.28	1.95	52.70	-1.54	3.00
2018.01.08	Body	5200	20.9	5.14	51.11	5.30	49.01	-3.02	4.28
2018.01.08	Body	5400	20.9	5.34	50.68	5.53	48.70	-3.44	4.07
2018.01.09	Body	5600	20.8	5.69	50.26	5.77	48.50	-1.39	3.63
2018.01.09	Body	5800	20.8	5.90	49.35	6.00	48.20	-1.67	2.39
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 (%)
2018.01.19	Body	2450	100	5.318	53.18	54.70	-2.78	52.40	1.49
2018.01.08	Body	5200	100	15.087	150.87	155.12	-2.74	159.00	-5.11
2018.01.08	Body	5400	100	15.371	153.71	162.06	-5.15	166.40	-7.63
2018.01.09	Body	5600	100	16.736	167.36	167.17	0.11	173.80	-3.71
2018.01.09	Body	5800	100	17.569	175.69	173.19	1.44	181.20	-3.04
Note ¹ : The tolerance limit of System validation is $\pm 10\%$.									
Note ² : Using waveguide to system check for 5200 MHz to 5800 MHz.									

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

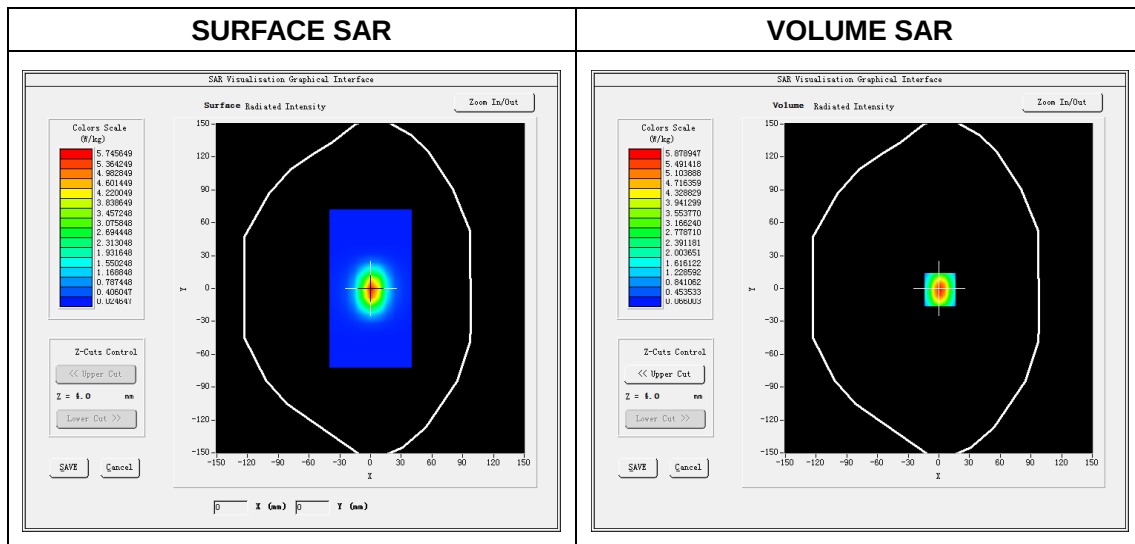
Date	Liquid Type	Freq. (MHz)	Power (mW)	Measured SAR (W/kg)	Normalized SAR (W/kg)	Dipole SAR (W/kg)	Tolerance (%)	Targeted SAR(W/kg)	Tolerance (%)
2018.01.19	Body	2450	100	2.498	24.98	24.20	3.22	24.00	4.08
2018.01.08	Body	5200	100	5.275	52.75	55.01	-4.11	56.90	-7.29
2018.01.08	Body	5400	100	5.391	53.91	56.17	-4.02	58.43	-7.74
2018.01.09	Body	5600	100	5.656	56.56	58.57	-3.43	59.97	-5.69
2018.01.09	Body	5800	100	5.876	58.76	60.55	-2.96	61.50	-4.46
Note ¹ : The tolerance limit of System validation is $\pm 10\%$.									
Note ² : Using waveguide to system check for 5200 MHz to 5800 MHz.									

System Performance Check Data(2450 MHz Body)

Type: Phone measurement (Complete)
E-Field Probe: SN 08/16 SSE2 EPGO295
Area scan resolution: dx=8mm,dy=8mm
Zoom scan resolution: dx=5mm, dy=5mm, dz=5mm
Date of measurement: 2018.01.19
Measurement duration: 18 minutes 45 seconds

Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Band	2450MHz
Signal	CW
Frequency (MHz)	2450.000000
Relative permittivity (real part)	54.281930
Conductivity (S/m)	1.924058
Power drift (%)	0.080000
Ambient Temperature:	22.2°C
Liquid Temperature:	21.0°C
ConvF:	2.30
Crest factor:	1:1

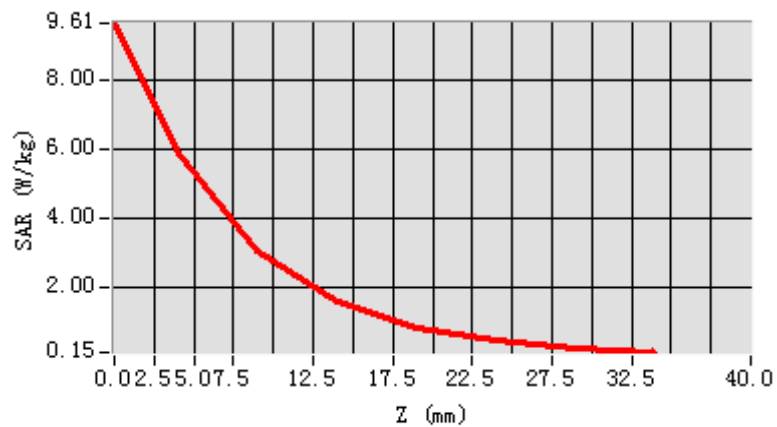


Maximum location: X=1.00, Y=-1.00

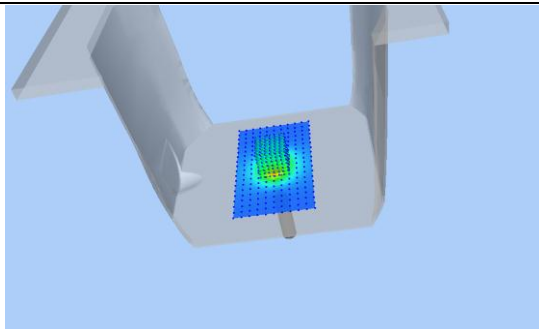
SAR Peak: 9.50W/kg

SAR 10g (W/Kg)	2.497641
SAR 1g (W/Kg)	5.318054

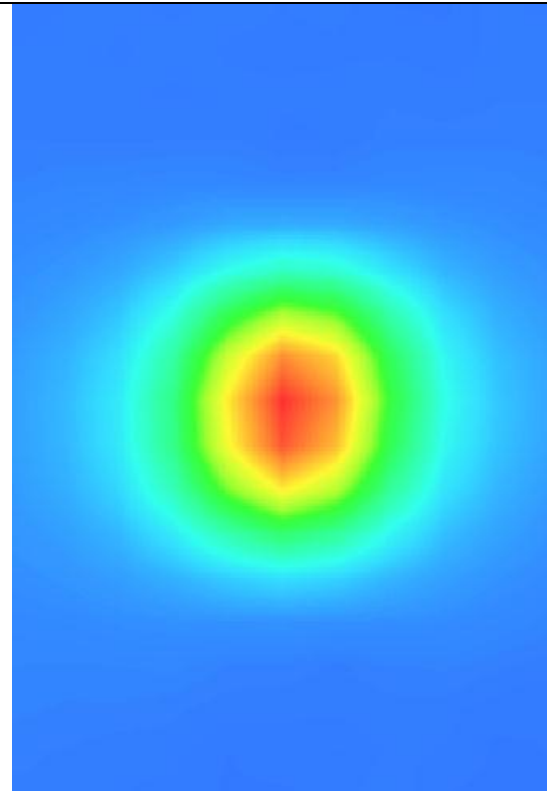
Z Axis Scan



3D screen shot



Hot spot position

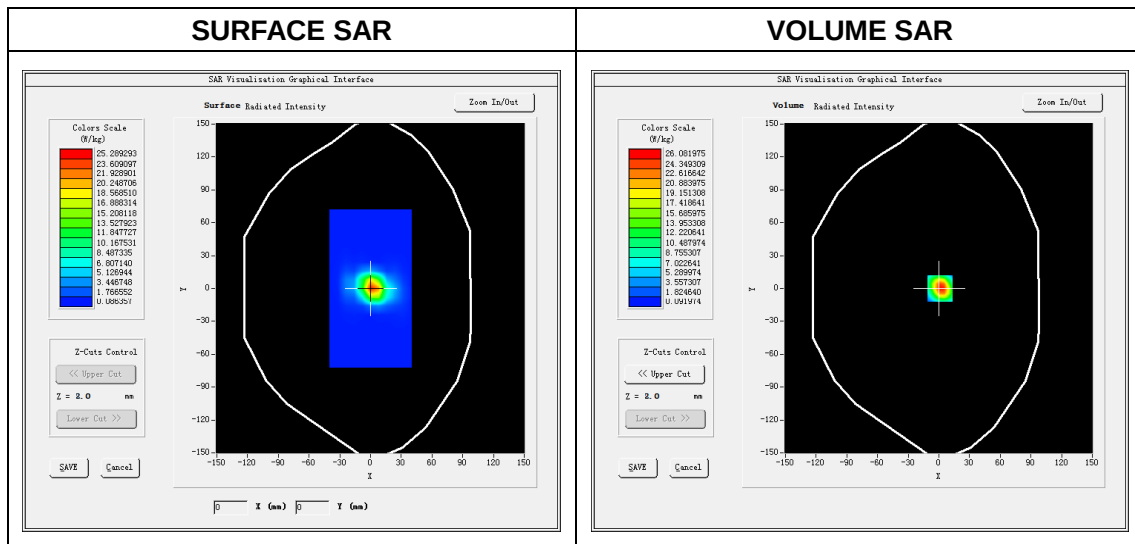


System Performance Check Data(5200 MHz Body)

Type: Phone measurement (Complete)
E-Field Probe: SN 08/16 SSE2 EPGO295
Area scan resolution: dx=8 mm,dy=8 mm
Zoom scan resolution: dx=4 mm, dy=4 mm, dz=2 mm
Date of measurement: 2018.01.08
Measurement duration: 29 minutes 01 seconds

Experimental conditions.

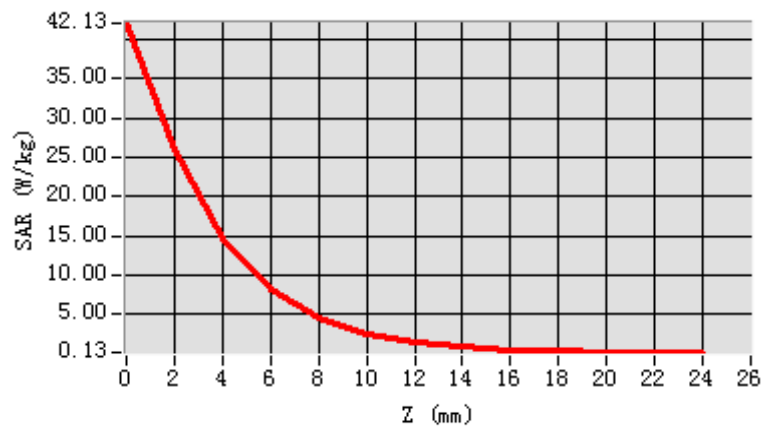
Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Band	5200 MHz
Signal	CW
Frequency (MHz)	5200.000000
Relative permittivity (real part)	51.105074
Conductivity (S/m)	5.142041
Power drift (%)	-0.450000
Ambient Temperature:	22.3°C
Liquid Temperature:	20.9°C
ConvF:	1.36
Crest factor:	1:1



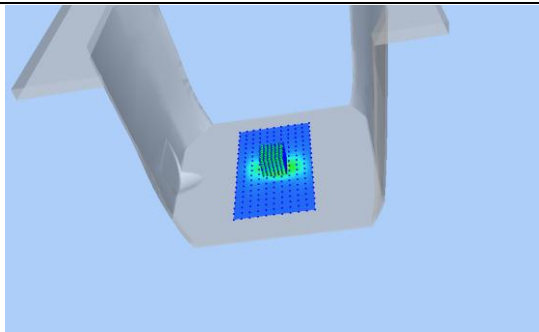
Maximum location: X=1.00, Y=0.00
SAR Peak: 42.12 W/kg

SAR 10 g (W/Kg)	5.274596
SAR 1 g (W/Kg)	15.087455

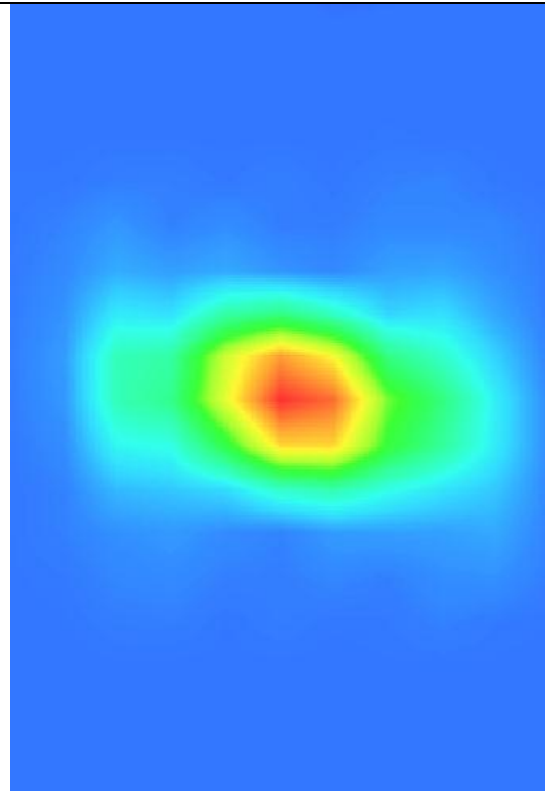
Z Axis Scan



3D screen shot



Hot spot position



System Performance Check Data(5400MHz Body)

Type: Phone measurement (Complete)

E-Field Probe: SN 08/16 SSE2 EPGO295

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

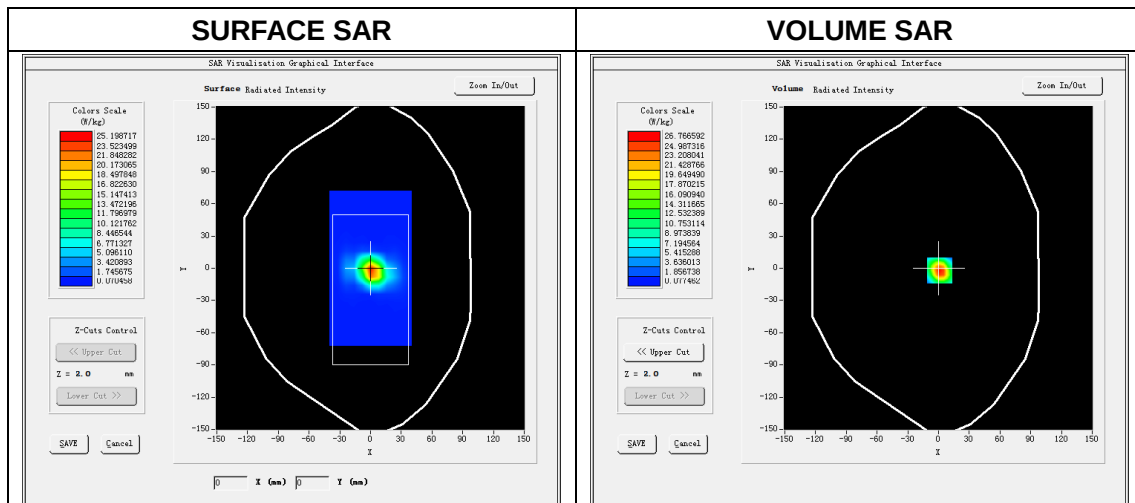
Zoom scan resolution: dx=4 mm, dy=4 mm, dz=2 mm

Date of measurement: 2018.01.08

Measurement duration: 28 minutes 38 seconds

Experimental conditions.

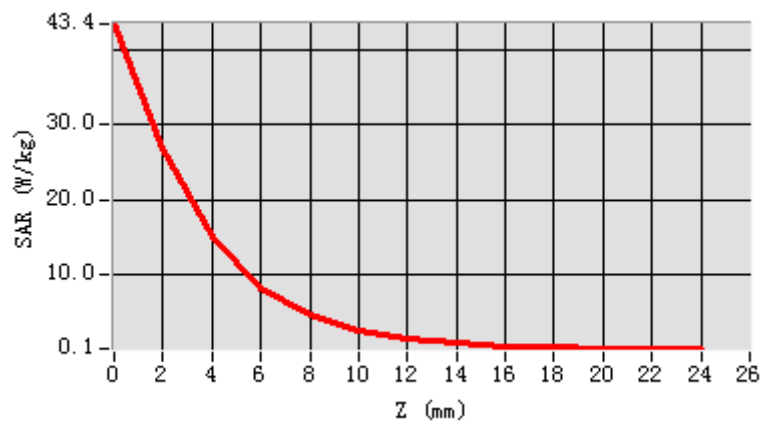
Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Band	5400 MHz
Signal	CW
Frequency (MHz)	5400.000000
Relative permittivity (real part)	50.681093
Conductivity (S/m)	5.342097
Power drift (%)	-0.040000
Ambient Temperature:	22.3°C
Liquid Temperature:	20.9°C
ConvF:	1.92
Crest factor:	1:1



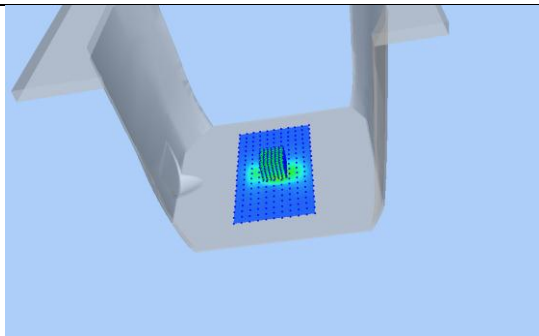
Maximum location: X=0.00, Y=0.00
SAR Peak: 43.25 W/kg

SAR 10 g (W/Kg)	5.391375
SAR 1 g (W/Kg)	15.371358

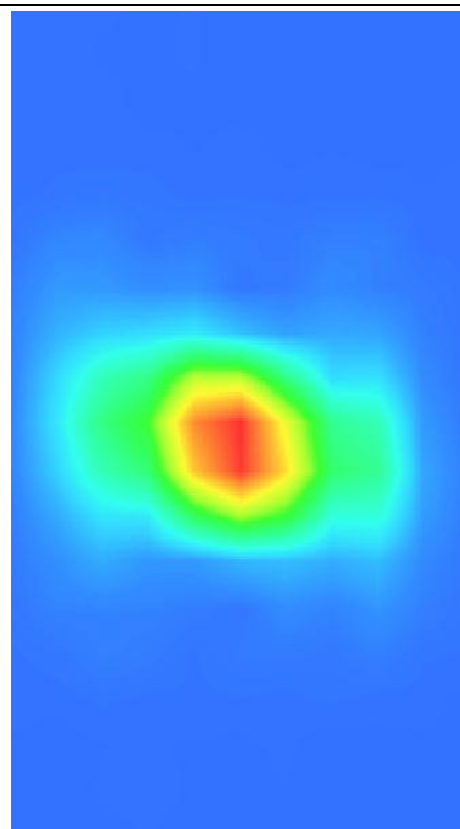
Z Axis Scan



3D screen shot



Hot spot position



System Performance Check Data(5600MHz Body)

Type: Phone measurement (Complete)

E-Field Probe: SN 08/16 SSE2 EPGO295

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

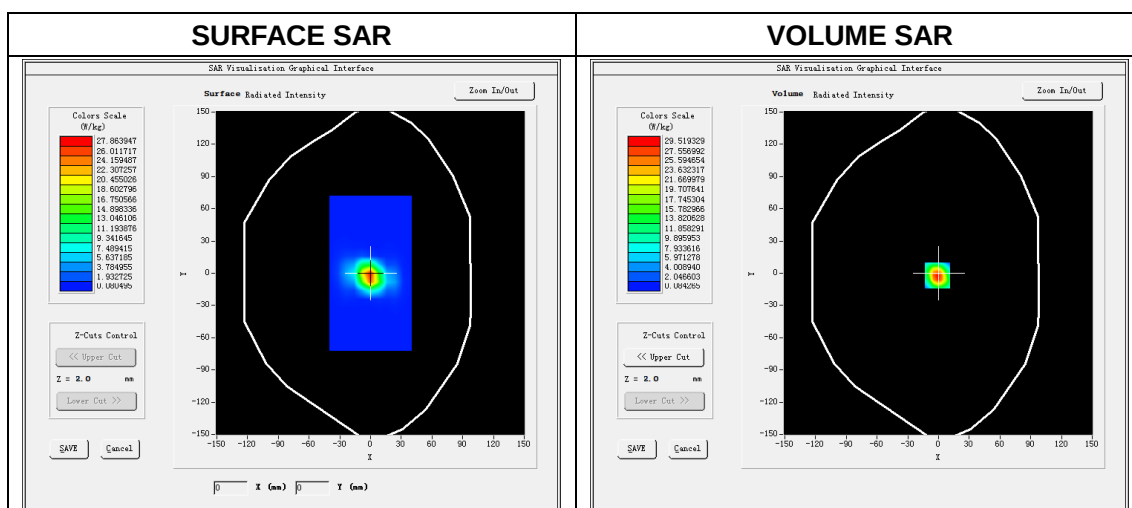
Zoom scan resolution: dx=4 mm, dy=4 mm, dz=2 mm

Date of measurement: 2018.01.09

Measurement duration: 27 minutes 30 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)	50.255942
Conductivity (S/m)	5.687512
Power drift (%)	-0.330000
Ambient Temperature:	22.1°C
Liquid Temperature:	20.8°C
ConvF:	2.00
Crest factor:	1:1

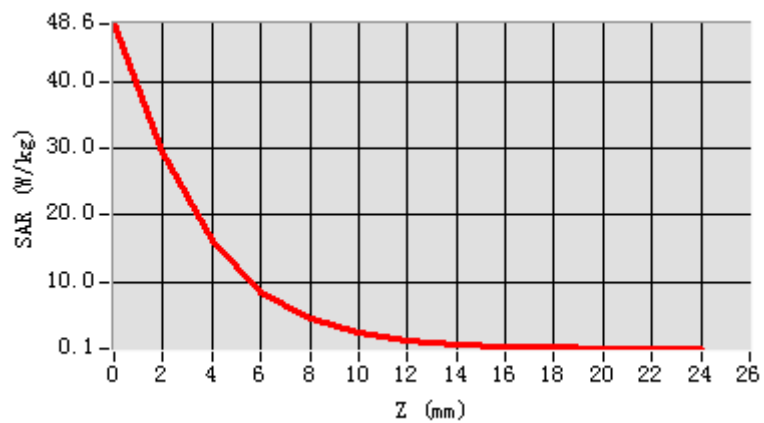


Maximum location: X=0.00, Y=0.00

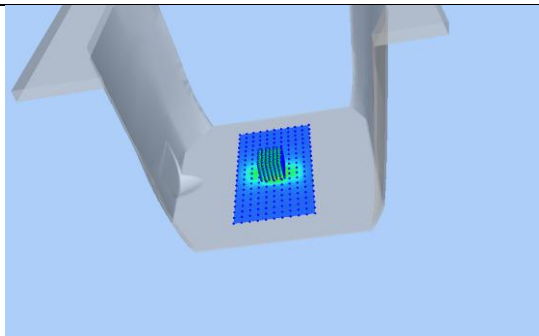
SAR Peak: 48.49 W/kg

SAR 10 g (W/Kg)	5.656015
SAR 1 g (W/Kg)	16.736245

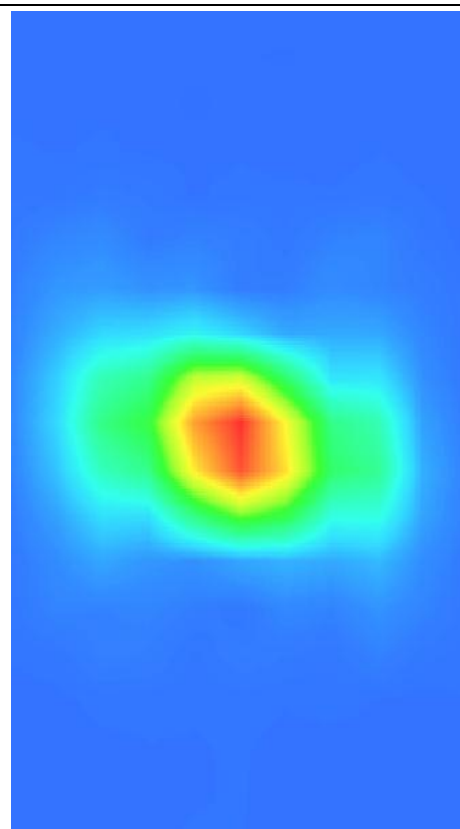
Z Axis Scan



3D screen shot



Hot spot position



System Performance Check Data(5800MHz Body)

Type: Phone measurement (Complete)

E-Field Probe: SN 08/16 SSE2 EPGO295

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

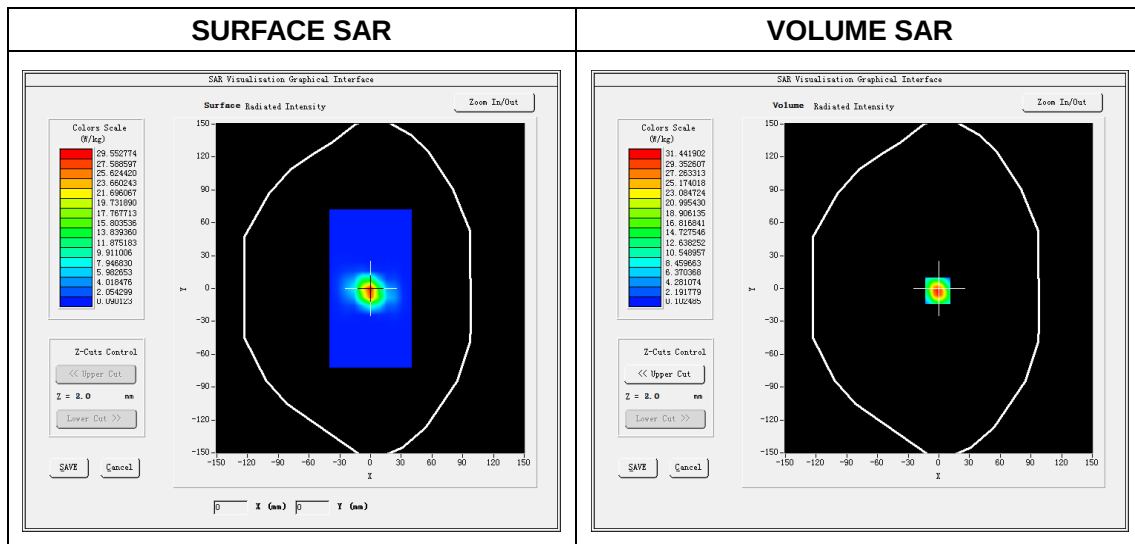
Zoom scan resolution: dx=4 mm, dy=4 mm, dz=2 mm

Date of measurement: 2018.01.09

Measurement duration: 28 minutes 35 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)	49.352083
Conductivity (S/m)	5.902162
Power drift (%)	0.150000
Ambient Temperature:	22.1°C
Liquid Temperature:	20.8°C
ConvF:	1.82
Crest factor:	1:1

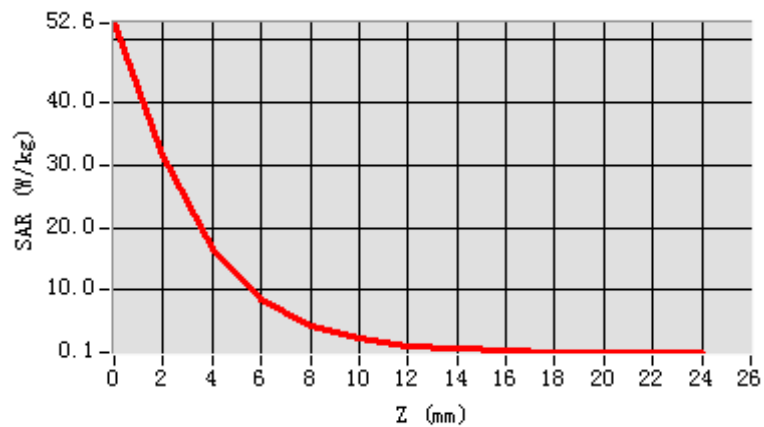


Maximum location: X=0.00, Y=0.00

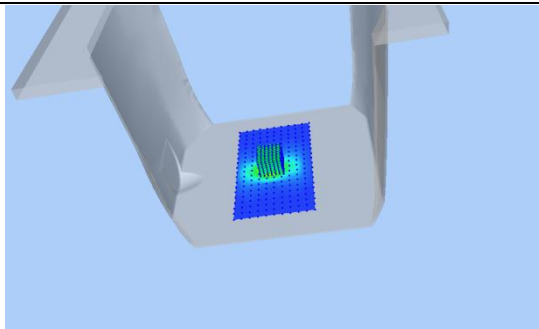
SAR Peak: 52.55 W/kg

SAR 10 g (W/Kg)	5.875638
SAR 1 g (W/Kg)	17.569435

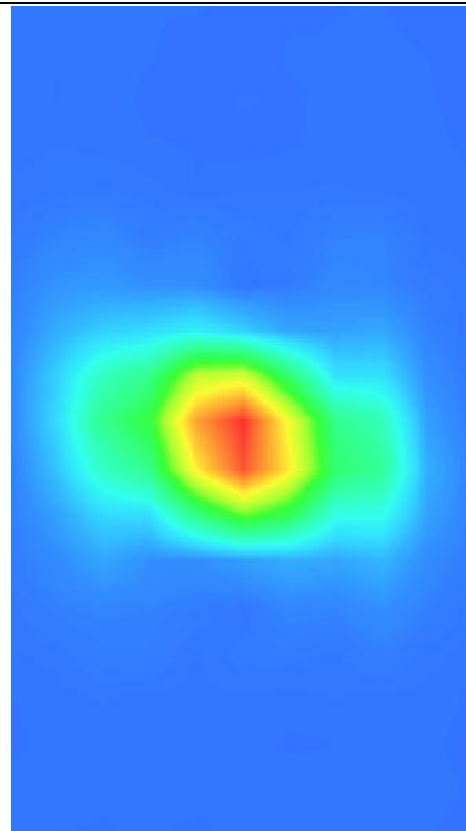
Z Axis Scan



3D screen shot



Hot spot position

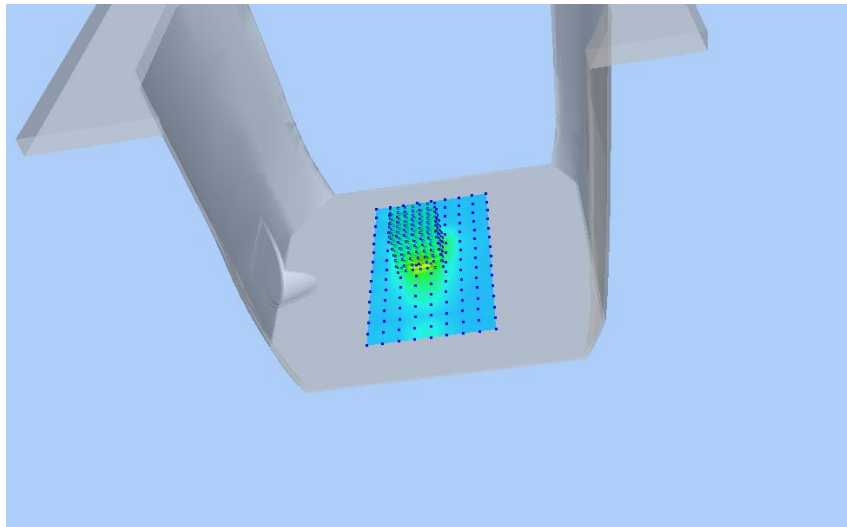


ANNEX C TEST DATA

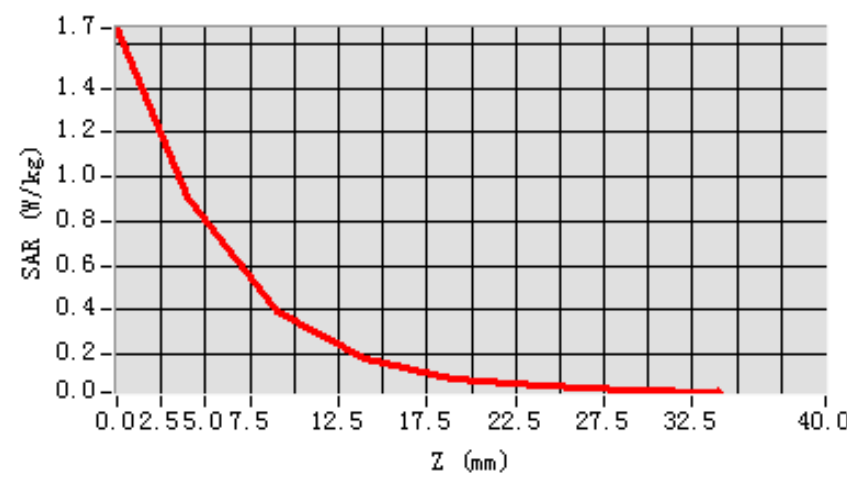
MEAS. 1 Body Plane with Right Edge 0 mm on Low Channel in IEEE 802.11b

mode

Test Date: 19/1/2018
Measurement duration: 15 minutes 13 seconds
Signal: WLAN, f=2412.0 MHz, Duty Cycle: 1:1.0
Liquid Parameters: Permittivity: 54.59; Conductivity: 1.89 S/m
Test condition: Ambient Temperature: 22.2°C, Liquid Temperature: 21.0°C
Probe: SN 08/16 SSE2 EPGO295, ConvF: 2.30
Area Scan: sam_direct_droit2_surf10mm.txt, h= 5.00 mm
Zoom Scan: 7x7x7,dx=5mm, dy=5mm, dz=5mm,Complete
Maximum location: X=-7.000000, Y=9.000000
SAR 10g (W/Kg): 0.338468
SAR 1g(W/Kg): 0.827543
Power drift (%): -0.66
3D screen shot



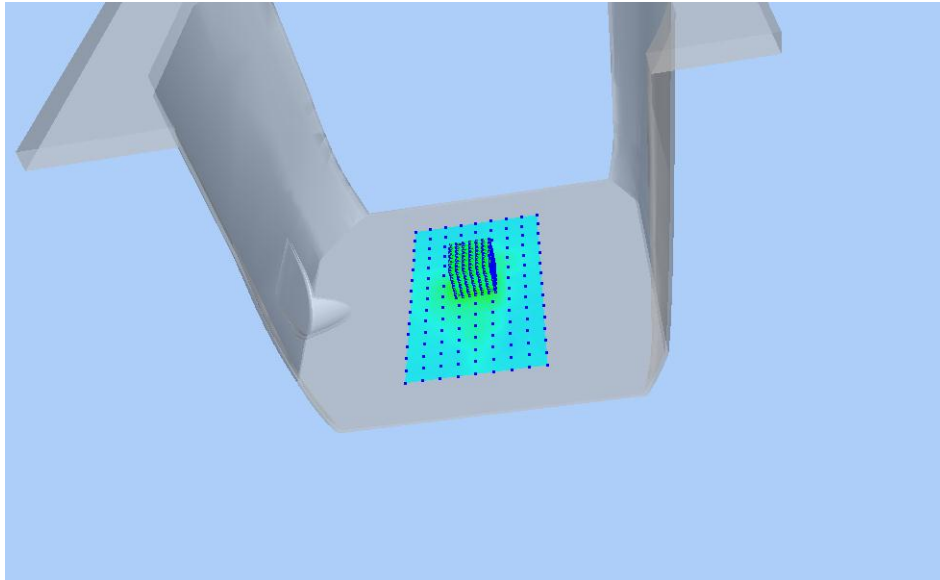
Z Axis Scan



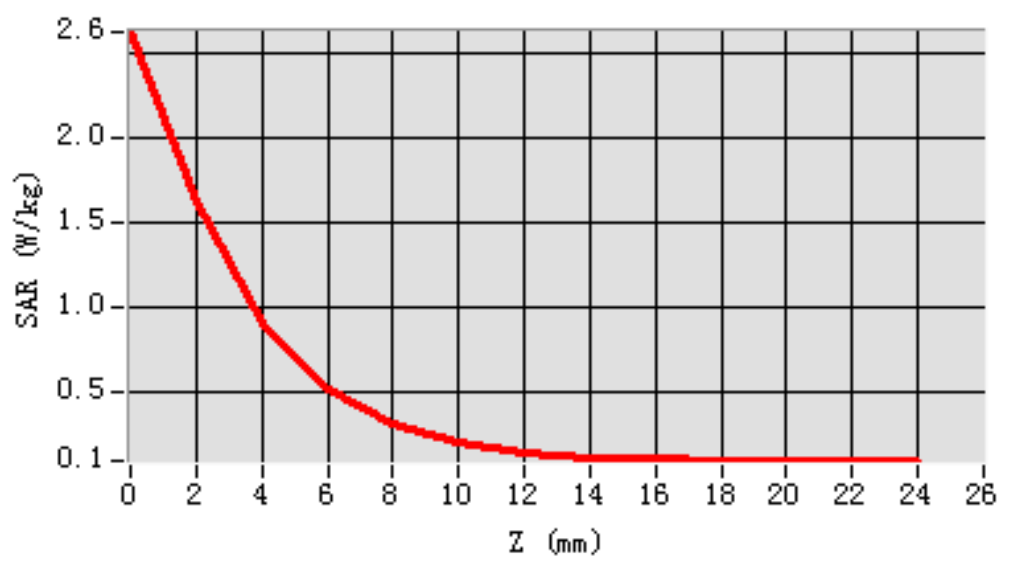
MEAS. 2 Body Plane with Right Edge 0 mm on 52 Channel in IEEE 802.11a

mode

Test Date: 8/1/2018
Measurement duration: 26 minutes 11 seconds
Signal: WLAN, f=5260.0 MHz, Duty Cycle: 1:1.15
Liquid Parameters: Permittivity: 51.01; Conductivity: 5.23 S/m
Test condition: Ambient Temperature: 22.3°C, Liquid Temperature: 20.9°C
Probe: SN 08/16 SSE2 EPGO295, ConvF: 1.36
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=8.000000
SAR 10g (W/Kg): 0.278034
SAR 1g (W/Kg): 0.816285
Power drift (%): -0.93
3D screen shot



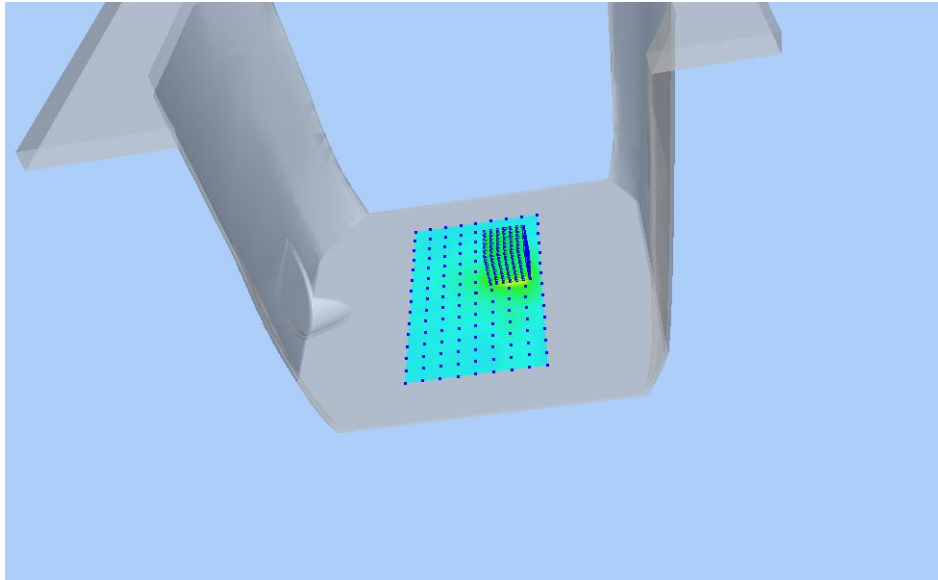
Z Axis Scan



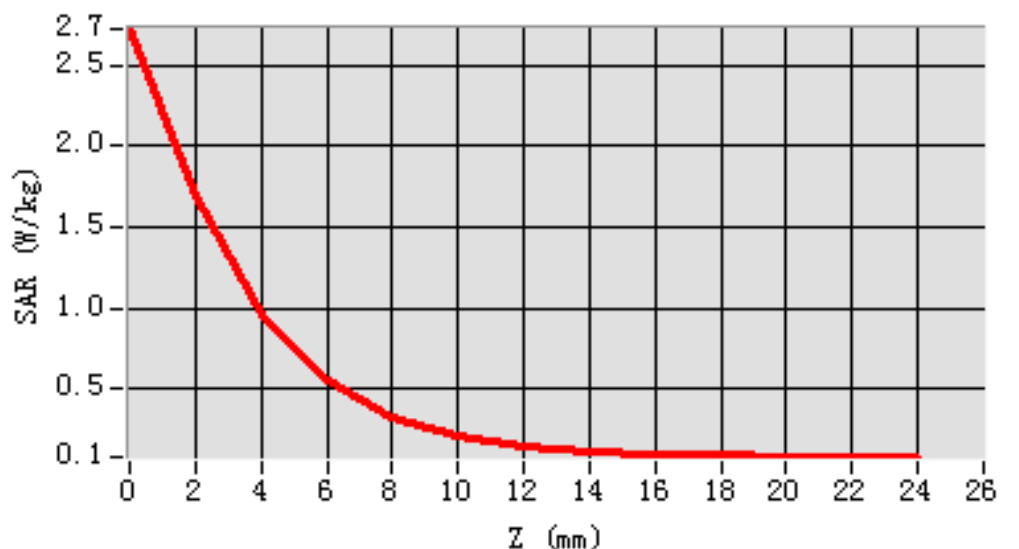
MEAS. 3 Body Plane with Right Edge 0 mm on 120 Channel in IEEE 802.11a

mode

Test Date: 9/1/2018
Measurement duration: 24 minutes 37 seconds
Signal: WLAN, f=5600.0 MHz, Duty Cycle: 1:1.15
Liquid Parameters: Permittivity: 50.26; Conductivity: 5.69 S/m
Test condition: Ambient Temperature: 22.1°C, Liquid Temperature: 20.8°C
Probe: SN 08/16 SSE2 EPGO295, ConvF: 2.00
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): 0.301375
SAR 1g (W/Kg): 0.870192
Power drift (%): -2.80
3D screen shot



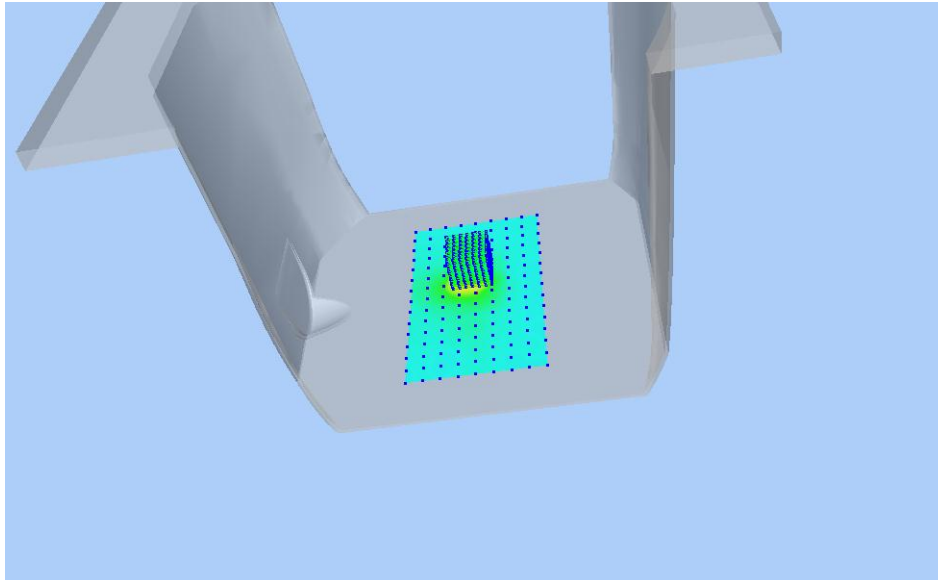
Z Axis Scan



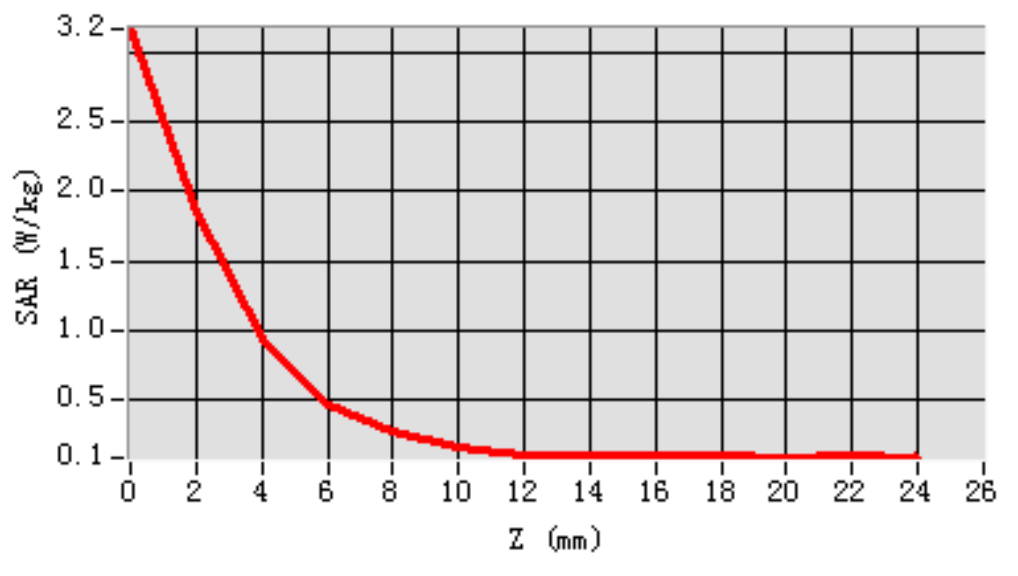
MEAS. 4 Body Plane with Right Edge 0 mm on 149 Channel in IEEE 802.11a

mode

Test Date: 9/1/2018
Measurement duration: 24 minutes 55 seconds
Signal: WLAN, f=5745.0 MHz, Duty Cycle: 1:1.15
Liquid Parameters: Permittivity: 49.69; Conductivity: 5.82 S/m
Test condition: Ambient Temperature: 22.1°C, Liquid Temperature: 20.8°C
Probe: SN 08/16 SSE2 EPGO295, ConvF: 1.82
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=18.000000
SAR 10g (W/Kg): 0.326485
SAR 1g (W/Kg): 0.913430
Power drift (%): -3.88
3D screen shot



Z Axis Scan



ANNEX D EUT EXTERNAL PHOTOS

Please refer the document "BL-EC17C0347-AW.pdf".

ANNEX E SAR TEST SETUP PHOTOS

Please refer the document "BLEC17C0347-AS.pdf".

ANNEX F CALIBRATION REPORT

Please refer the document "CALIBRATION REPORT.pdf".

--END OF REPORT--