

FCC

SAR

TEST REPORT

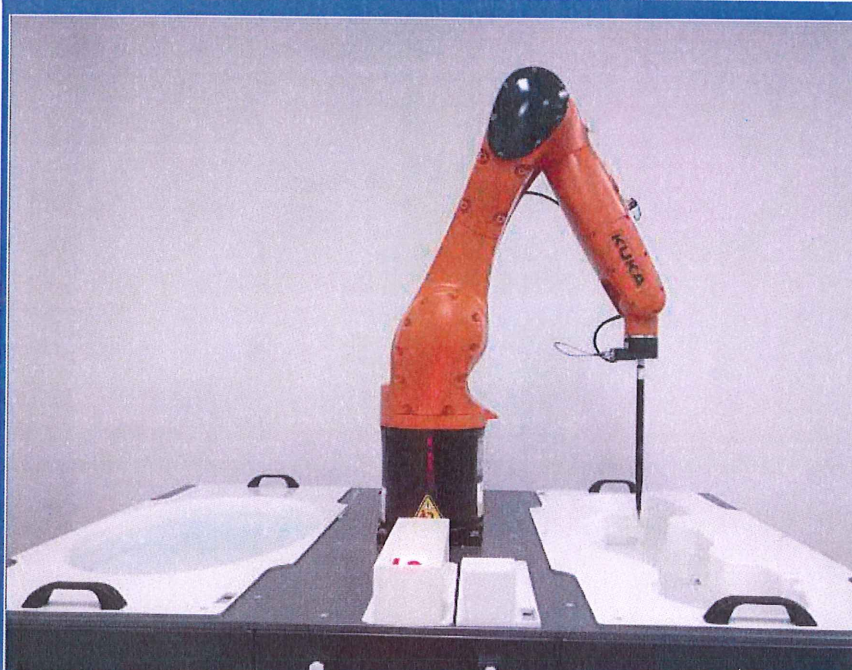
ISSUED BY  
Shenzhen BALUN Technology Co., Ltd.



FOR  
**EVOO Notebook**

ISSUED TO  
Hunan Greatwall Computer System Co., Ltd

Hu'nan Greatwall Industrial Park, Xiangyun Middle Rd., Tianyuan Dist.



Tested by: Zong Liyao  
Zong Liyao  
(Engineer)

Date Oct. 29, 2018

Approved by: Wei Yanquan  
Wei Yanquan  
(Chief Engineer)

Date Oct. 29, 2018

Report No.: BL-SZ1880501-701

EUT Name: EVOO Notebook

Model Name: EV-C-116-1

Brand Name: EVOO

FCC ID: 2APUQ-EV-C-116-1

Test Standard: FCC 47 CFR Part 2.1093

ANSI C95.1: 1999

IEEE 1528: 2013

Maximum SAR: Body (1 g): 0.307 W/kg

Test Conclusion: Pass

Test Date: Sep. 06, 2018

Date of Issue: Oct. 29, 2018

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### Revision History

| Version        | Issue Date           | Revisions Content                                |
|----------------|----------------------|--------------------------------------------------|
| <u>Rev. 01</u> | <u>Oct. 12, 2018</u> | <u>Initial Issue</u>                             |
| <u>Rev. 02</u> | <u>Oct. 29, 2018</u> | <u>Added the EUT description in section 2.4.</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 | <p>The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1.</p> <p>The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.</p> <p>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.</p> <p>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.</p> |
| 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°C to 23°C  |
| Ambient Relative Humidity | 34% to 50%    |
| Ambient Pressure          | 100 to 102KPa |

### 1.4 Announce

- (1) The test report reference to the report template version v2.3.
- (2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.
- (3) The test report is invalid if there is any evidence and/or falsification.
- (4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.
- (5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.
- (6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

## 2 PRODUCT INFORMATION

### 2.1 Applicant Information

|           |                                                                      |
|-----------|----------------------------------------------------------------------|
| Applicant | Hunan Greatwall Computer System Co.,Ltd                              |
| Address   | Hu'nan Greatwall Industrial Park, Xiangyun Middle Rd.,Tianyuan Dist. |

### 2.2 Manufacturer Information

|              |                                                                      |
|--------------|----------------------------------------------------------------------|
| Manufacturer | Hunan Greatwall Computer System Co.,Ltd                              |
| Address      | Hu'nan Greatwall Industrial Park, Xiangyun Middle Rd.,Tianyuan Dist. |

### 2.3 Factory Information

|         |                                                                      |
|---------|----------------------------------------------------------------------|
| Factory | Hunan Greatwall Computer System Co.,Ltd                              |
| Address | Hu'nan Greatwall Industrial Park, Xiangyun Middle Rd.,Tianyuan Dist. |

### 2.4 General Description for Equipment under Test (EUT)

|                                           |                       |
|-------------------------------------------|-----------------------|
| EUT Name                                  | EVOO Notebook         |
| Model Name Under Test                     | EV-C-116-1            |
| Series Model Name                         | N/A                   |
| Description of Model Name Differentiation | N/A                   |
| Hardware Version                          | Y116AR400             |
| Software Version                          | 10.0.17134 Build17134 |
| Dimensions (Approx.)                      | N/A                   |
| Weight (Approx.)                          | N/A                   |

The EUT has two samples, the sample 1 as the main in this report.

|          |                     |                 |
|----------|---------------------|-----------------|
|          | Screen              | Trumpet         |
| Sample 1 | PBT116FHP30I026     | BR-T1813G8-C58B |
| Sample 2 | ZS116PN3002E7H5II-A | HS1318-W1163G   |

## 2.5 Ancillary Equipment

|                       |                 |                             |
|-----------------------|-----------------|-----------------------------|
| Ancillary Equipment 1 | Battery         |                             |
|                       | Brand Name      | UTL                         |
|                       | Model No.       | 3978110-2S                  |
|                       | Serial No.      | N/A                         |
|                       | Capacitance     | 4600 mAh                    |
|                       | Rated Voltage   | 7.4 V                       |
|                       | Extreme Voltage | 8.4 V                       |
| Ancillary Equipment 2 | Charger         |                             |
|                       | Brand Name      | N/A                         |
|                       | Model No.       | SAW30-120-2000U             |
|                       | Rated Input     | 100-240 V~, 0.8 A, 50/60 Hz |
|                       | Rated Output    | 12 V= 2 A                   |

## 2.6 Technical Information

|                                   |                                                        |
|-----------------------------------|--------------------------------------------------------|
| Network and Wireless connectivity | WIFI 802.11b, 802.11g, 802.11n (HT20/40);<br>Bluetooth |
|-----------------------------------|--------------------------------------------------------|

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

|                   |                                                     |                                              |
|-------------------|-----------------------------------------------------|----------------------------------------------|
| Operating Mode    | 2.4G WLAN, Bluetooth                                |                                              |
| Frequency Range   | 802.11b/g<br>/n(HT20/HT40)                          | 2400 ~ 2483.5 MHz                            |
|                   | Bluetooth                                           | 2400 ~ 2483.5 MHz                            |
| Antenna Type      | PIFA Antenna                                        |                                              |
| Hotspot Function  | N/A                                                 |                                              |
| Power Reduction   | Not Support                                         |                                              |
| 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                                                                                                                           |
| 8   | KDB 616217 D04 v01r02     | SAR for laptop and tablets                                                                                                                                                  |

#### 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/<br>Uncontrolled Exposure | Occupational/<br>Controlled Exposure |
| Whole-Body SAR<br>(averaged over the entire body)                                | 0.08                                         | 0.4                                  |
| Partial-Body SAR<br>(averaged over any 1 gram of tissue)                         | 1.60                                         | 8.0                                  |
| SAR for hands, wrists, feet and ankles<br>(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<br>(W/kg) | Maximum Report SAR<br>(W/kg) | Limit<br>(W/kg) |
|-----------|------------------------------|------------------------------|-----------------|
|           | Body                         | Body                         |                 |
| 2.4G WLAN | 0.307                        | 0.307                        | 1.6             |
| Verdict   | Pass                         |                              |                 |

#### 3.3.2 Highest Simultaneous SAR

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

### 3.4 Test Uncertainty

According to KDB 865664 D01, when the highest measured 1 g SAR within a frequency band is  $< 1.5$  W/kg, the extensive SAR measurement uncertainty analysis is not required in SAR reports submitted for equipment approval.

The maximum 1 g SAR for the EUT in this report is 0.307 W/kg, which is lower than 1.5 W/kg, so the extensive SAR measurement uncertainty analysis is not required in this report.

## 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 ( $\rho$ ). 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

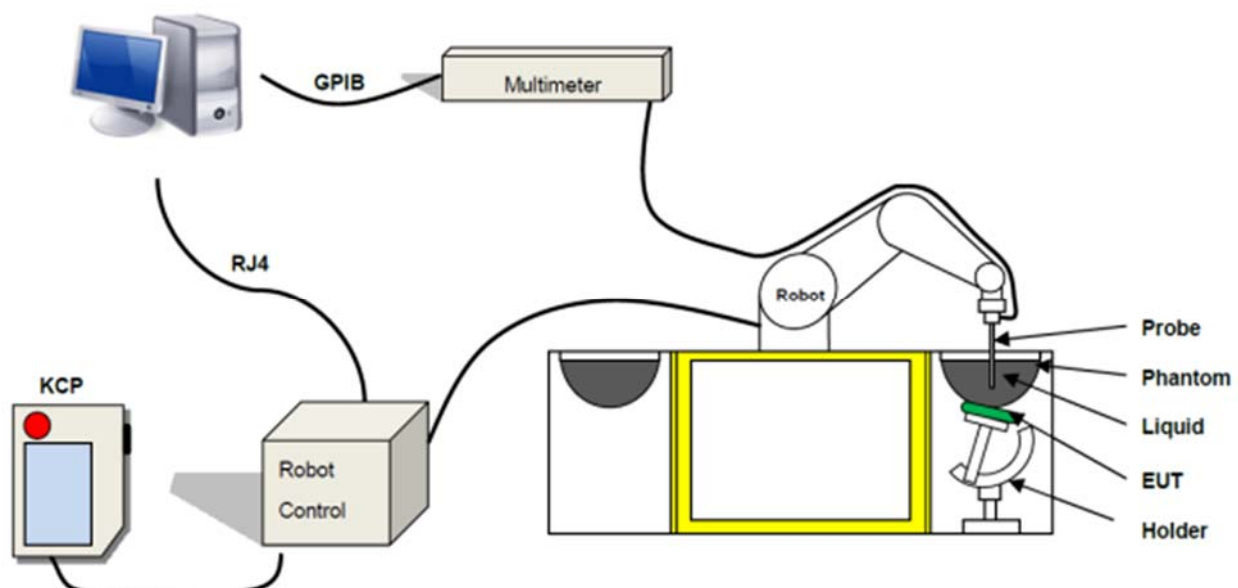
$$\text{SAR} = \frac{\sigma E^2}{\rho}$$

Where:  $\sigma$  is the conductivity of the tissue,

$\rho$  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  $\pm 0.02$  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  $\pm 0.25$  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  $\pm 0.035$  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

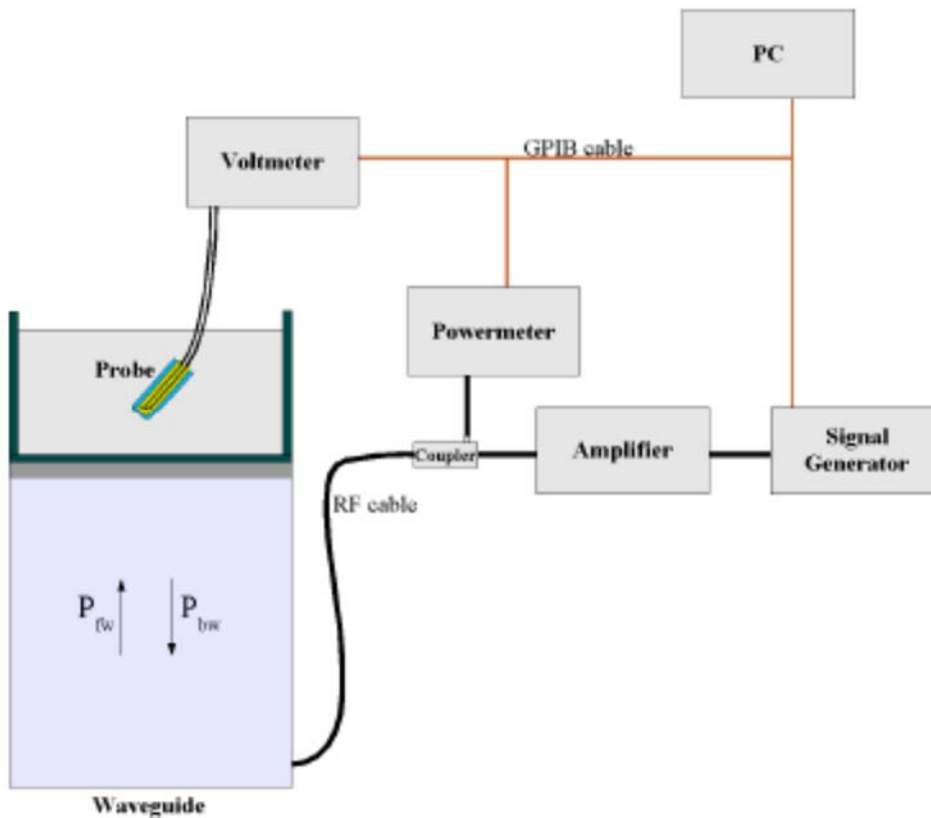
- Dynamic range: 0.01-100 W/kg
- Tip Diameter : 2.5 mm
- Lower detection limit : 10 mW/kg  
(repeatability better than  $\pm 1$  mm)
- Probe linearity:  $\pm 0.07$  dB
- Calibration range: 300 MHz to 6000 MHz for head & body simulating liquid.

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<sub>fw</sub> = Forward Power
- P<sub>bw</sub> = 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.

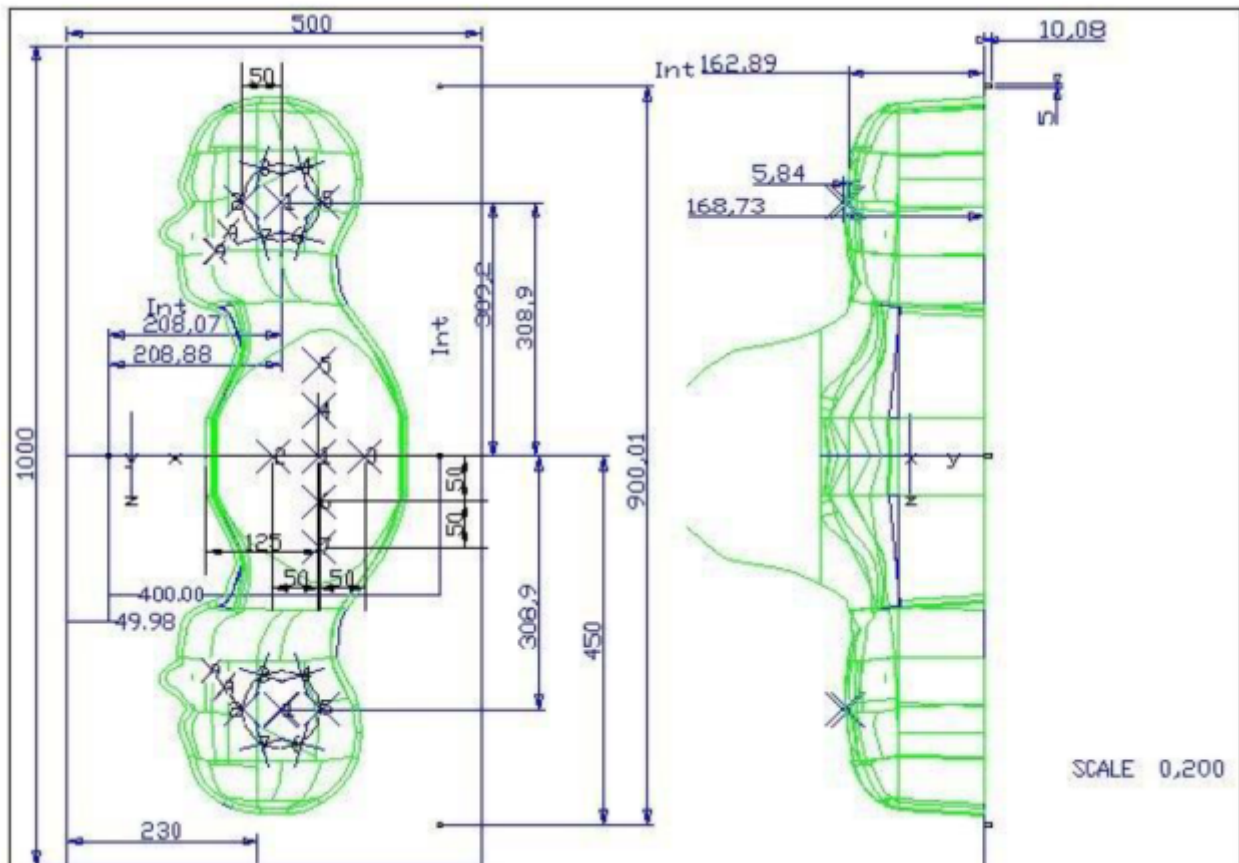
#### 4.2.4 Phantoms

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         |

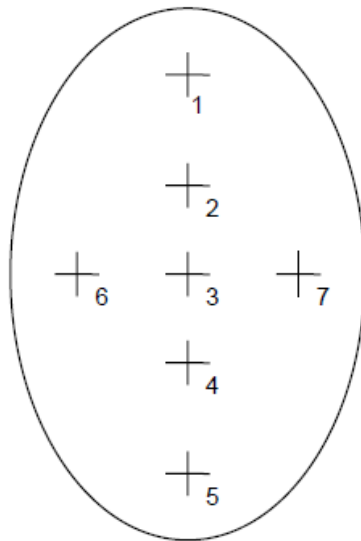


| Serial Number   | Left Head |      | Right Head |      | Flat Part |      |
|-----------------|-----------|------|------------|------|-----------|------|
| SN 11/17 SAM133 | 2         | 2.02 | 2          | 2.05 | 1         | 2.07 |
|                 | 3         | 2.00 | 3          | 2.02 | 2         | 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  $\pm 0.5$  mm would produce a SAR uncertainty of  $\pm 20$  %. 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.

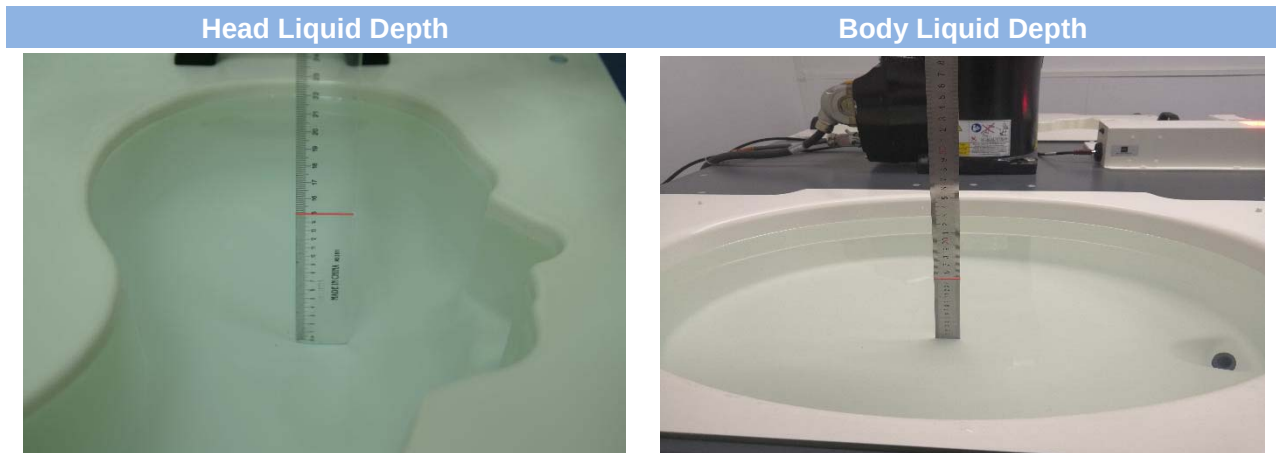


| Serial Number              | Holder Material | Permittivity | Loss Tangent |
|----------------------------|-----------------|--------------|--------------|
| SN 11/17 MSH109<br>(Phone) | Deirin          | 3.7          | 0.005        |
| SN 11/17 LSH31<br>(Laptop) | PMMA            | 2.9          | 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  $1^\circ$ .

#### 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<br>(MHz)                  | Water<br>(%) | Sugar<br>(%)          | Cellulose<br>(%) | Salt<br>(%) | Preventol<br>(%)    | DGBE<br>(%) | Conductivity<br>σ (S/m) | Permittivity<br>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<br>(%) | Hexyl Carbitol<br>(%) |                  |             | Triton X-100<br>(%) |             | Conductivity<br>σ (S/m) | Permittivity<br>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<br>(MHz)                  | Water<br>(%) | Sugar<br>(%)          | Cellulose<br>(%) | Salt<br>(%) | Preventol<br>(%)    | DGBE<br>(%) | Conductivity<br>σ (S/m) | Permittivity<br>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<br>(%) | Salt<br>(%) | Conductivity<br>$\sigma$ (S/m) | Permittivity<br>$\epsilon$ |
|----------------|-------|-------------|-------------|--------------------------------|----------------------------|
| 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

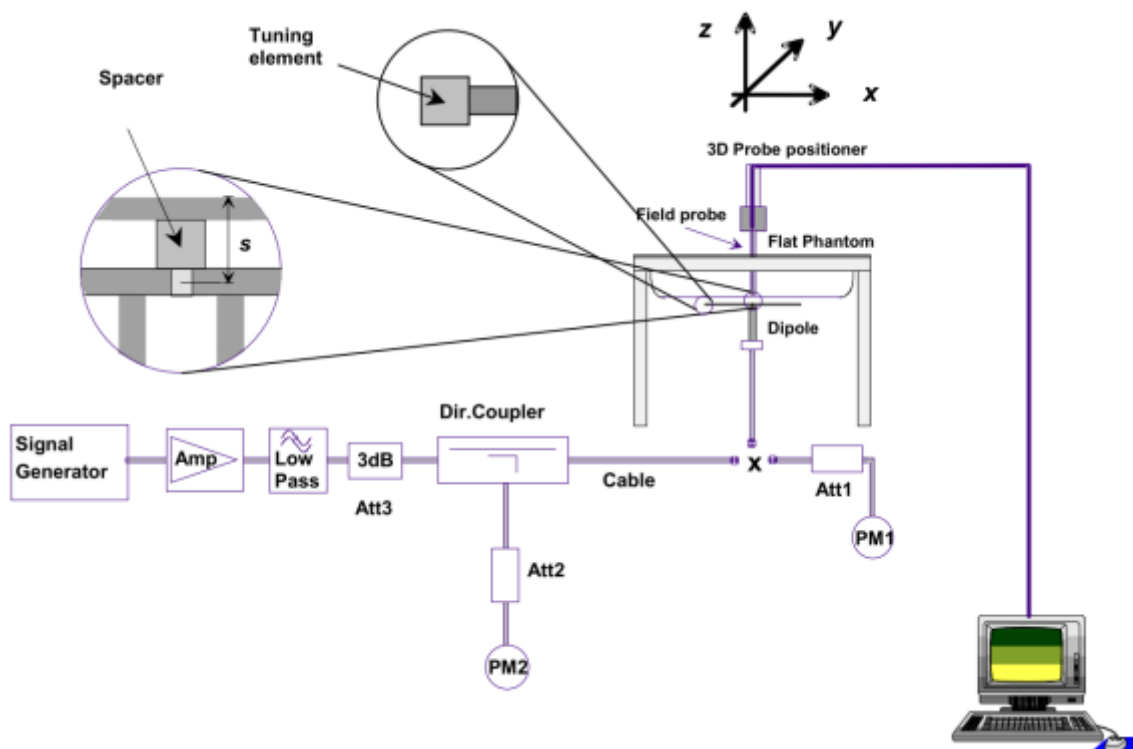
The SATIMO SAR system is equipped with one or more system validation kits. These units together with the predefined measurement procedures within the SATIMO software enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to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

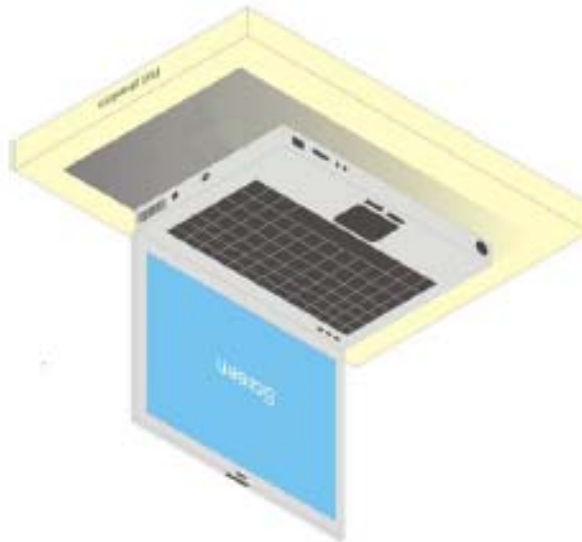
In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. 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

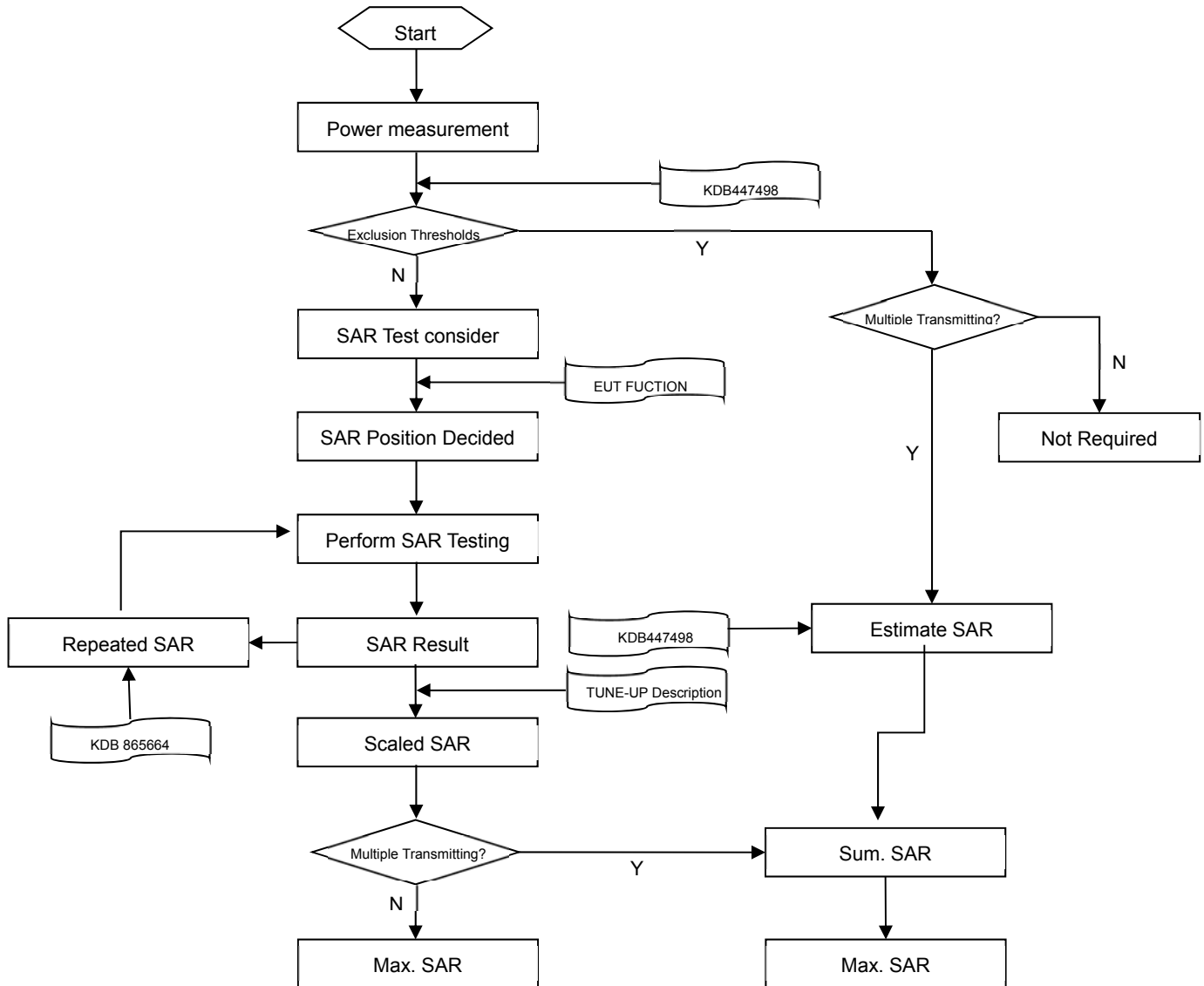
This DUT was tested in one position which is bottom of laptop touching with phantom 0 mm air gap.

### 6.1 Body Supported Exposure Condition



## 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<br>2 – 3 GHz: ≤ 12 mm                                                                                                                                                                                                                            | 3–4 GHz: ≤ 12 mm<br>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<br>2 – 3 GHz: ≤ 5 mm*                                                                                                                                                                                                                             | 3–4 GHz: ≤ 5 mm*<br>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:<br>1. δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.<br>2. * When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. |                           |                                                                 |                                                                                                                                                                                                                                                                   |                                                    |

### 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

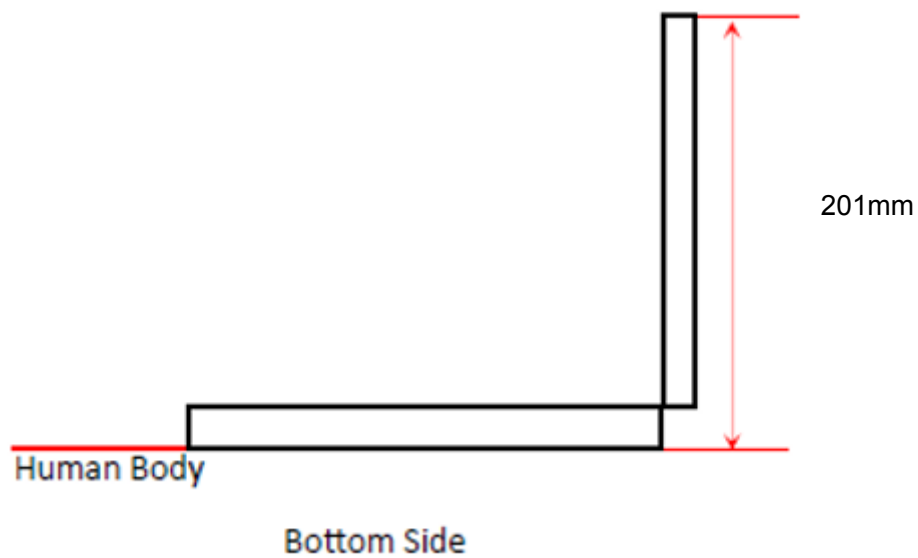
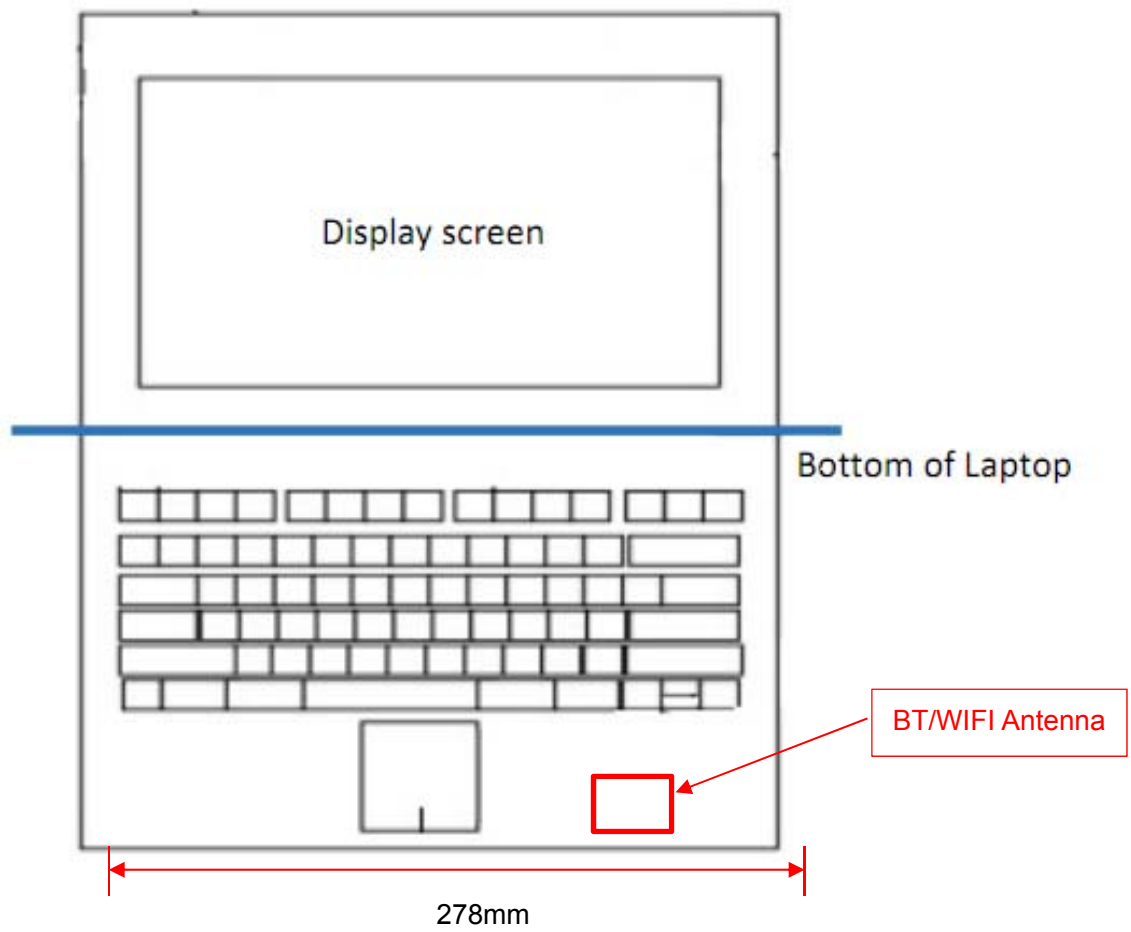
### 8.1 WIFI

| Band (GHz)          | Mode          | Channel | Freq. (MHz) | Peak Power (dBm) | Tune-up Power Limit (dBm) | SAR Test Require. |
|---------------------|---------------|---------|-------------|------------------|---------------------------|-------------------|
| 2.4<br>(2.4~2.4835) | 802.11b       | 1       | 2412        | 16.40            | 17.00                     | No                |
|                     |               | 6       | 2437        | 16.70            | 17.00                     | No                |
|                     |               | 11      | 2462        | <b>16.90</b>     | 17.00                     | Yes               |
|                     | 802.11g       | 1       | 2412        | 12.30            | 13.00                     | No                |
|                     |               | 6       | 2437        | 12.60            | 13.00                     | No                |
|                     |               | 11      | 2462        | 12.80            | 13.00                     | No                |
|                     | 802.11n(HT20) | 1       | 2412        | 12.40            | 13.00                     | No                |
|                     |               | 6       | 2437        | 12.60            | 13.00                     | No                |
|                     |               | 11      | 2462        | 12.70            | 13.00                     | No                |
|                     | 802.11n(HT40) | 3       | 2422        | 11.20            | 11.50                     | No                |
|                     |               | 6       | 2437        | 11.30            | 11.50                     | No                |
|                     |               | 9       | 2452        | 11.40            | 11.50                     | No                |

### 8.2 Bluetooth

| Mode                      | GFSK   |      |      | $\pi/4$ -DQPSK |      |      |
|---------------------------|--------|------|------|----------------|------|------|
| Channel                   | 0      | 39   | 78   | 0              | 39   | 78   |
| Frequency (MHz)           | 2402   | 2441 | 2480 | 2402           | 2441 | 2480 |
| Peak Power (dBm)          | 4.61   | 4.25 | 3.61 | 5.69           | 5.59 | 4.92 |
| Tune-up Power Limit (dBm) | 5.00   |      |      | 6.00           |      |      |
| Mode                      | 8-DPSK |      |      | BLE            |      |      |
| Channel                   | 0      | 39   | 78   | 0              | 19   | 39   |
| Frequency (MHz)           | 2402   | 2441 | 2480 | 2402           | 2440 | 2480 |
| Peak Power (dBm)          | 6.11   | 6.08 | 5.53 | <b>9.49</b>    | 9.38 | 8.82 |
| Tune-up Power Limit (dBm) | 6.50   |      |      | 9.50           |      |      |

## 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  $\leq 50$  mm> Table, this Device SAR test configurations consider as following :

| Band          | Mode             | Max. Peak Power |       | Test Position Configurations |
|---------------|------------------|-----------------|-------|------------------------------|
|               |                  | dBm             | mW    | Bottom Edge                  |
| WLAN<br>2.4 G | Distance to User |                 |       | <5mm                         |
|               | 802.11b          | 17.00           | 50.12 | Yes                          |
|               | 802.11g          | 13.00           | 19.95 | No                           |
|               | 802.11n(HT20)    | 13.00           | 19.95 | No                           |
|               | 802.11n(HT40)    | 11.50           | 14.13 | No                           |
| Bluetooth     | Distance to User |                 |       | <5mm                         |
|               | BR/EDR           | 6.50            | 4.47  | No                           |
|               | BLE              | 9.50            | 8.91  | No                           |

Note:

- Maximum power is the source-based time-average power and represents the maximum RF output power including tune-up tolerance 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  $\leq 50$  mm are determined by:  

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR}$$
  - $f(\text{GHz})$  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 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
- 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  $\leq 1.2$  W/kg.



## 10 TEST RESULTS

### 10.1WIFI 2.4GHz

| Mode        | Position    | Dist.<br>(mm) | Ch. | Freq.<br>(MHz) | Power<br>Drift<br>(%) | 1 g<br>Meas.<br>SAR<br>(W/Kg) | Meas.<br>Power<br>(dBm) | Max.<br>tune-up<br>Power<br>(dBm) | Scaling<br>Factor | Duty<br>Cycle<br>(%) | Duty<br>Cycle<br>Scaling<br>Factor | 1 g<br>Scaled<br>SAR<br>(W/Kg) | Meas.<br>No. |
|-------------|-------------|---------------|-----|----------------|-----------------------|-------------------------------|-------------------------|-----------------------------------|-------------------|----------------------|------------------------------------|--------------------------------|--------------|
| <b>Body</b> |             |               |     |                |                       |                               |                         |                                   |                   |                      |                                    |                                |              |
| 802.11 b    | Bottom Side | 0             | 11  | 2462           | -2.54                 | 0.300                         | 16.90                   | 17.00                             | 1.023             | 100.00               | 1.000                              | 0.307                          | 1#           |

## 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  $\leq 1.45$  W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is  $\leq 1.10$ , 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  $\geq 0.80$  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  $\geq 1.45$  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  $\geq 1.5$  W/kg, perform a third repeated measurement.

The highest measured SAR is  $0.300$  W/kg  $< 0.80$  W/kg, so the repeated measurement is not required.

## 12 SIMULTANEOUS TRANSMISSION

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

## 13 TEST EQUIPMENTS LIST

| Description          | Manufacturer | Model           | Serial No.              | Cal. Date  | Cal. Due   |
|----------------------|--------------|-----------------|-------------------------|------------|------------|
| 2450MHz Dipole       | SATIMO       | SID 2450        | S/N 11/17 DIP 2G450-452 | 2017/03/22 | 2020/03/21 |
| E-Field Probe        | MVG          | SSE2            | S/N 31/17 EPGO 321      | 2018/03/16 | 2019/03/15 |
| MultiMeter           | Keithley     | MultiMeter 2000 | 4024022                 | 2018/06/15 | 2019/06/14 |
| Signal Generator     | R&S          | SMBV100A        | 260592                  | 2018/06/15 | 2019/06/14 |
| 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 |
| Network Analyzer     | Agilent      | 5071C           | MY46103472              | 2018/03/14 | 2019/03/13 |
| Thermometer          | Elitech      | RC-4HC          | N/A                     | 2017/11/13 | 2018/11/12 |
| 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        |
| Power Amplifier      | SATIMO       | 6552B           | 22374                   | N/A        | N/A        |
| Attenuator           | COM-MW       | ZA-S1-31        | 1305003187              | N/A        | N/A        |
| Directional coupler  | AA-MCS       | AAMCS-UDC       | 000272                  | N/A        | N/A        |

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

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

## ANNEX A SIMULATING LIQUID VERIFICATION RESULT

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

| Date       | Liquid Type | Fre. (MHz) | Temp. (°C) | Meas. Conductivity ( $\sigma$ ) (S/m) | Meas. Permittivity ( $\epsilon$ ) | Target Conductivity ( $\sigma$ ) (S/m) | Target Permittivity ( $\epsilon$ ) | Conductivity Tolerance (%) | Permittivity Tolerance (%) |
|------------|-------------|------------|------------|---------------------------------------|-----------------------------------|----------------------------------------|------------------------------------|----------------------------|----------------------------|
| 2018.09.06 | Body        | 2450       | 20.2       | 1.96                                  | 51.43                             | 1.95                                   | 52.70                              | 0.51                       | -2.41                      |

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 (%) |
|-------------------------------------------------------------|-------------|-------------|------------|---------------------|-----------------------|-------------------|---------------|--------------------|---------------|
| 2018.09.06                                                  | Body        | 2450        | 100        | 5.307               | 53.07                 | 53.67             | -1.12         | 52.40              | 1.28          |
| Note: The tolerance limit of System validation $\pm 10\%$ . |             |             |            |                     |                       |                   |               |                    |               |

# System Performance Check Data(2450MHz Body)

Type: Phone measurement (Complete)

E-Field Probe: SN 3117 EPG0321

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

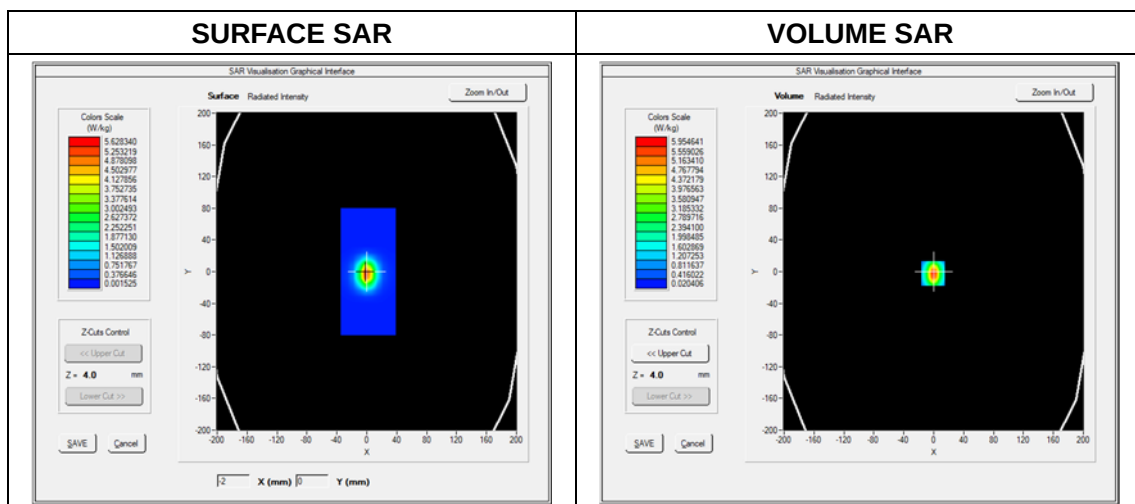
Zoom scan resolution: dx=5mm, dy=5mm, dz=5mm

Date of measurement: 2018.09.06

Measurement duration: 15 minutes 38 seconds

## Experimental conditions.

|                                   |                |
|-----------------------------------|----------------|
| Phantom                           | SN_1117_ELLI42 |
| Band                              | 2450MHz        |
| Signal                            | CW             |
| Frequency (MHz)                   | 2450.000000    |
| Relative permittivity (real part) | 51.425145      |
| Conductivity (S/m)                | 1.957421       |
| Power drift (%)                   | -0.150000      |
| Ambient Temperature:              | 21.5°C         |
| Liquid Temperature:               | 20.2°C         |
| ConvF:                            | 2.41           |
| Crest factor:                     | 1:1            |

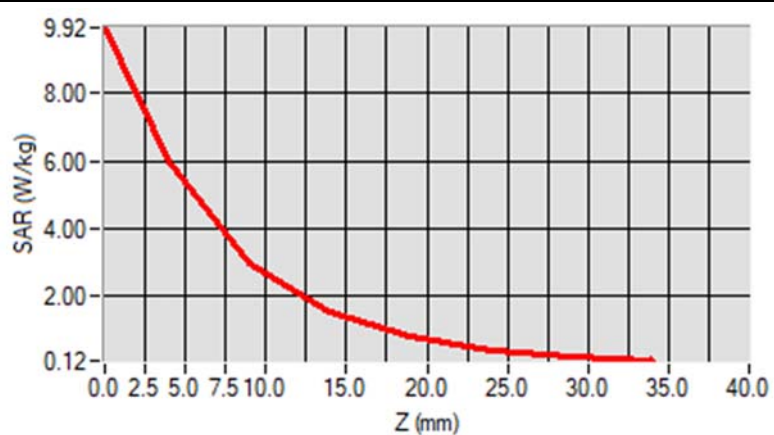


Maximum location: X=-1.00, Y=-0.00

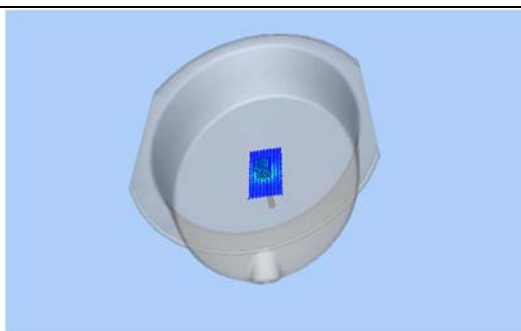
SAR Peak: 9.94W/kg

|                |          |
|----------------|----------|
| SAR 10g (W/Kg) | 2.366130 |
| SAR 1g (W/Kg)  | 5.306825 |

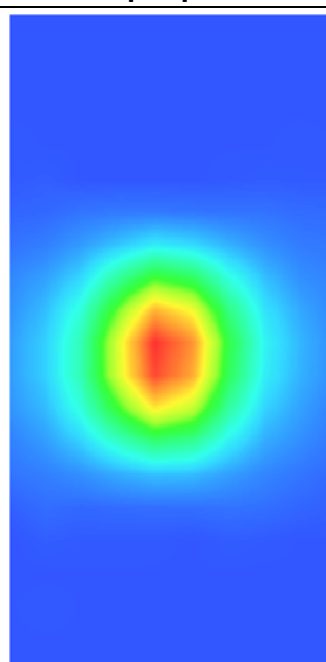
### Z Axis Scan



### 3D screen shot



### Hot spot position



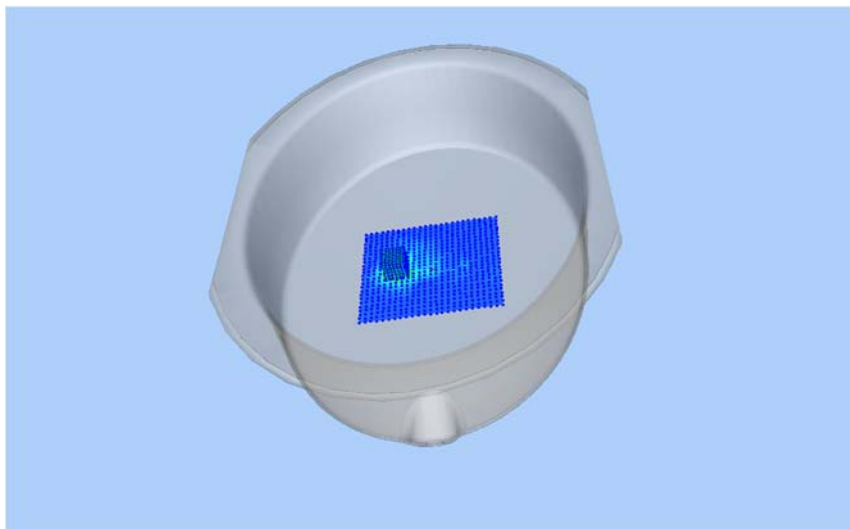


## ANNEX C TEST DATA

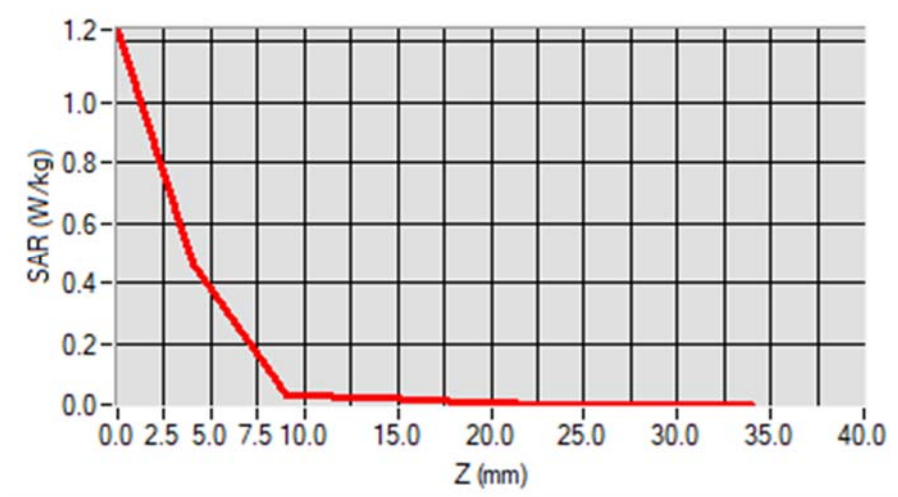
### MEAS. 1 Body Plane with Back Side 0mm on High Channel in IEEE 802.b

#### mode

**Test Date:** 6/9/2018  
**Measurement duration:** 26 minutes 56 seconds  
**Signal:** WLAN, f=2462.0 MHz, Duty Cycle: 1:1.0  
**Liquid Parameters:** Permittivity: 51.31; Conductivity: 1.98 S/m  
**Test condition:** Ambient Temperature: 21.5°C, Liquid Temperature: 20.2°C  
**Probe:** SN 3117 EPGO321, ConvF: 2.41  
**Area Scan:** sam\_direct\_droit2\_surf8mm.txt, h= 5.00 mm  
**Zoom Scan:** 7x7x7,dx=5mm, dy=5mm, dz=5mm, Complete  
**Maximum location:** X=-50.000000, Y=0.000000  
**SAR 10g (W/Kg):** 0.075535  
**SAR 1g (W/Kg):** 0.299573  
**Power drift (%):** -2.54  
**3D screen shot**



#### Z Axis Scan



## **ANNEX D EUT EXTERNAL PHOTOS**

Please refer the document “BL-SZ1880501-AW.pdf”.

## **ANNEX E SAR TEST SETUP PHOTOS**

Please refer the document “BL-SZ180501-AS.pdf”.

## **ANNEX F CALIBRATION REPORT**

Please refer the document “CALIBRATION REPORT.pdf”.

--END OF REPORT--