# SAR Test Report

Report No.: AGC05817160302FH01

| | | |
|---|---|---|
| **FCC ID** | : | 2AANUW800BTR |
| **APPLICATION PURPOSE** | : | Original Equipment |
| **PRODUCT DESIGNATION** | : | True Wireless Headphones and Charging Case |
| **BRAND NAME** | : | Onkyo |
| **MODEL NAME** | : | W800BTR |
| **CLIENT** | : | Gibson Innovations |
| **DATE OF ISSUE** | : | Apr. 01,2016 |
| **STANDARD(S)** | : | IEEE Std. 1528:2013<br>FCC 47CFR § 2.1093<br>IEEE/ANSI C95.1:1992 |
| **REPORT VERSION** | : | V1.0 |

Attestation of Global Compliance(Shenzhen) Co., Ltd.

**CAUTION:**
This report shall not be reproduced except in full without the written permission of the test laboratory and shall not be quoted out of context.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## Report Revise Record

| Report Version | Revise Time | Issued Date | Valid Version | Notes |
|---|---|---|---|---|
| V1.0 | / | Apr. 01,2016 | Valid | Original Report |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# Test Report Certification

| | |
|---|---|
| Applicant Name | Gibson Innovations |
| Applicant Address | 5/F, 5 Science Park East Avenue, Hong Kong Science Park, Shatin, N.T., Hong Kong |
| Manufacturer Name | Acoustic Arc International Ltd. |
| Manufacturer Address | 110-112, 1/F., Philips Electronics Building, 5 Science Park East Avenue, Hong Kong Science Park, Shatin, New Territories, Hong Kong |
| Product Designation | True Wireless Headphones and Charging Case |
| Brand Name | Onkyo |
| Model Name | W800BTR |
| Series model | W800BT/XX,W800BTYY/XX(X=0 to 9 for marketing purpose representing different counties, Y=A to Z or Blank for different color). |
| Different Description | All the same, except for the appearance color and model name. YY represent for different color version, XX represent for different marketing use.The test model is W800BTR. |
| EUT Voltage | DC3.7V by battery |
| Applicable Standard | IEEE Std. 1528:2013<br>FCC 47CFR § 2.1093<br>IEEE/ANSI C95.1:1992 |
| Test Date | Mar.30,2016 |
| Performed Location | Attestation of Global Compliance(Shenzhen) Co., Ltd.<br>2 F, Building 2, No.1-No.4, Chaxi Sanwei Technical Industrial Park, Gushu, Xixiang Street, Bao'an District, Shenzhen, China |
| Report Template | AGCRT-US-2.4G/SAR (2016-01-01) |

Summer Li

Tested By _____

Summer Li(Li Jian'e) Apr. 01,2016

Angela Li

Checked By _____

Angela Li(Li Jiao) Apr. 01,2016

Solger Zhang

Authorized By _____

Solger Zhang(Zhang Hongyi)
Authorized Officer Apr. 01,2016

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# TABLE OF CONTENTS

**1. SUMMARY OF MAXIMUM SAR VALUE ..... 5**

**2. GENERAL INFORMATION ..... 6**

2.1. EUT DESCRIPTION ..... 6

**3. SAR MEASUREMENT SYSTEM ..... 7**

3.1. THE SATIMO SYSTEM USED FOR PERFORMING COMPLIANCE TESTS CONSISTS OF FOLLOWING ITEMS ..... 7
3.2. COMOSAR E-FIELD PROBE ..... 8
3.3. ROBOT ..... 8
3.4. VIDEO POSITIONING SYSTEM ..... 9
3.5. DEVICE HOLDER ..... 9
3.6. SAM TWIN PHANTOM ..... 10

**4. SAR MEASUREMENT PROCEDURE ..... 11**

4.1. SPECIFIC ABSORPTION RATE (SAR) ..... 11
4.2. SAR MEASUREMENT PROCEDURE ..... 12

**5. TISSUE SIMULATING LIQUID ..... 14**

5.1. THE COMPOSITION OF THE TISSUE SIMULATING LIQUID ..... 14
5.2. TISSUE DIELECTRIC PARAMETERS FOR HEAD AND BODY PHANTOMS ..... 14
5.3. TISSUE CALIBRATION RESULT ..... 15

**6. SAR SYSTEM CHECK PROCEDURE ..... 16**

6.1. SAR SYSTEM CHECK PROCEDURES ..... 16
6.2. SAR SYSTEM CHECK ..... 17

**7. EUT TEST POSITION ..... 18**

7.1. TEST POSITION ..... 18

**8. SAR EXPOSURE LIMITS ..... 19**

**9. TEST EQUIPMENT LIST ..... 20**

**10. MEASUREMENT UNCERTAINTY ..... 21**

**11. CONDUCTED POWER MEASUREMENT ..... 23**

**12. TEST RESULTS ..... 24**

12.1. SAR TEST RESULTS SUMMARY ..... 24

**APPENDIX A. SAR SYSTEM CHECK DATA ..... 26**

**APPENDIX B. SAR MEASUREMENT DATA ..... 28**

**APPENDIX C. CALIBRATION DATA ..... 30**

**APPENDIX D. TEST SETUP PHOTOGRAPHS &EUT PHOTOGRAPHS ..... 49**

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 1. SUMMARY OF MAXIMUM SAR VALUE

**The maximum results of Specific Absorption Rate (SAR) found during testing for EUT are as follows:**

**Highest Reported SAR Summary**

| Test Mode | Highest Reported 1g-SAR(W/Kg) | SAR Test Limit (W/Kg) |
|---|---|---|
| | Device-Front(0mm) | |
| BT(communication) | 0.018 | 1.6W/kg |
| SAR Test Result | PASS | |

This device is compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6W/Kg) specified in IEEE Std. 1528:2013;FCC 47CFR § 2.1093; IEEE/ANSI C95.1:1992 and the following specific FCC Test Procedures:

- KDB 447498 D01 General RF Exposure Guidance v06
- KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 2. GENERAL INFORMATION

## 2.1. EUT Description

| General Information | |
|---|---|
| Product Designation | True Wireless Headphones and Charging Case |
| Test Model | W800BTR |
| Hardware Version | V0.4 |
| Software Version | V1.5.0 |
| Device Category | Portable |
| RF Exposure Environment | Uncontrolled |
| Antenna Type | Internal |
| **Bluetooth** | |
| Bluetooth Version | ☐V2.0 ☐V2.1 ☐V2.1+EDR ☒V3.0 ☐V3.0+HS ☐V4.0 ☒V4.1 |
| Operation Frequency | 2402~2480MHz |
| Type of modulation | ☒GFSK ☒Π/4-DQPSK ☒8-DPSK |
| EIRP Power | 9.82dBm |
| Antenna Gain | -1.0dBi |

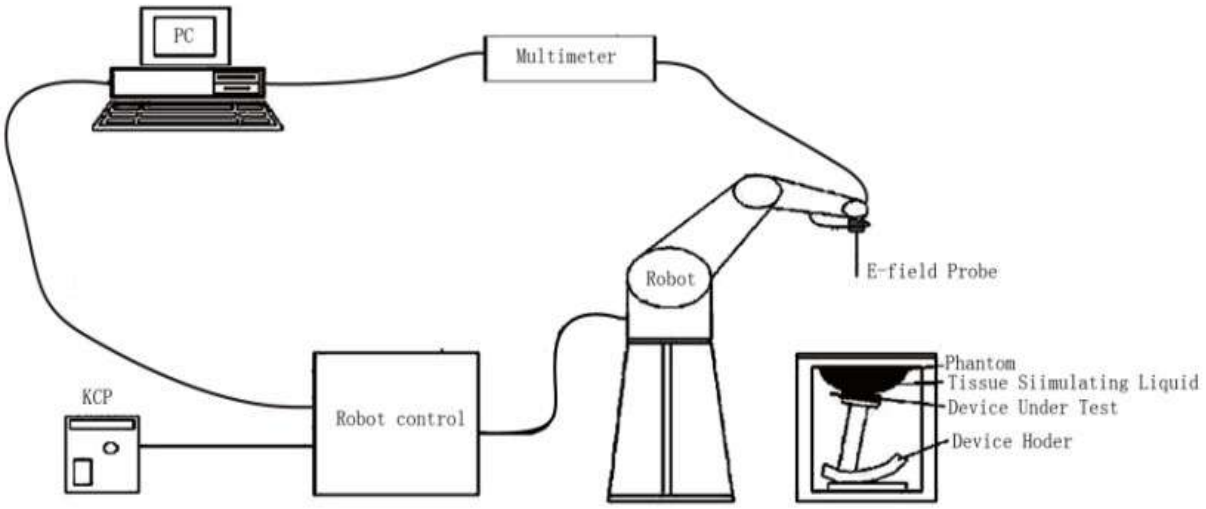
Note:1.The sample used for testing is end product.

| Product | Type | |
|---|---|---|
| | ☒ Production unit | ☐ Identical Prototype |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 3. SAR MEASUREMENT SYSTEM

## 3.1. The SATIMO system used for performing compliance tests consists of following items




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

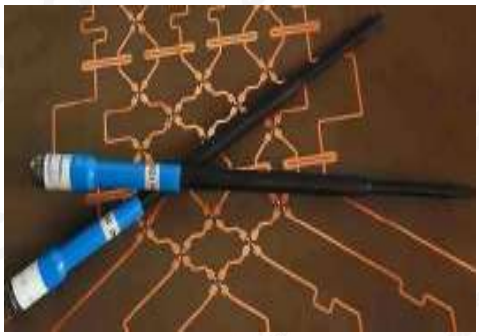
- The PC. It controls most of the bench devices and stores measurement data.A computer running WinXP and the Opensar software.
- The E-Field probe. The probe is a 3-axis system made of 3 distinct dipoles. Each dipole returns a voltage in function of the ambient electric field.
- The Keithley multimeter measures each probe dipole voltages.
- The SAM phantom simulates a human head. The measurement of the electric field is made inside the phantom.
- The liquids simulate the dielectric properties of the human head tissues.
- The network emulator controls the mobile phone under test.
- The validation dipoles are used to measure a reference SAR. They are used to periodically check the bench to make sure that there is no drift of the system characteristics over time.
- The phantom, the device holder and other accessories according to the targeted measurement.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 3.2. COMOSAR E-Field Probe

The SAR measurement is conducted with the dosimetric probe manufactured by SATIMO. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. SATIMO conducts the probe calibration in compliance with international and national standards (e.g. IEEE 1528 and relevant KDB files.) The calibration data are in Appendix D.

### Isotropic E-Field Probe Specification

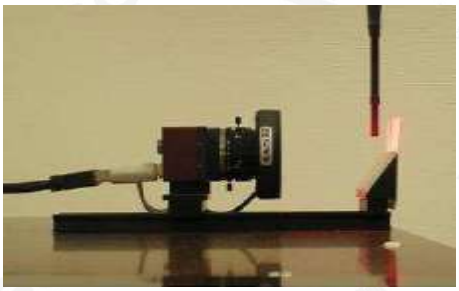
| | | |
|---|---|---|
| **Model** | SSE5 | |
| **Manufacture** | MVG | |
| **Frequency** | 0.45GHz-3.7GHz<br>Linearity:±0.05dB(450MHz-3.7GHz) |  |
| **Dynamic Range** | 0.01W/Kg-100W/Kg<br>Linearity:±0.05dB | |
| **Dimensions** | Overall length:330mm<br>Length of individual dipoles:4.5mm<br>Maximum external diameter:8mm<br>Probe Tip external diameter:5mm<br>Distance between dipoles/ probe extremity:2.7mm | |
| **Application** | High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 3 GHz with precision of better 30%. | |

## 3.3. Robot

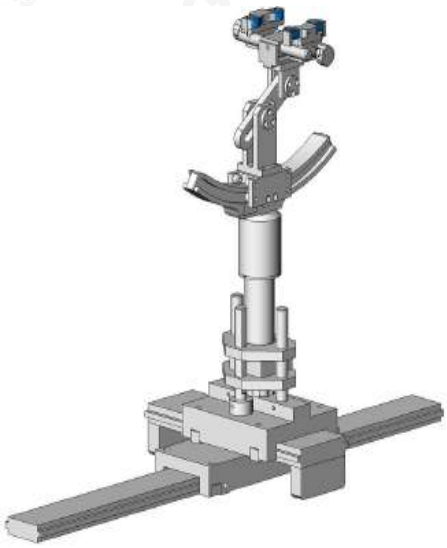
The COMOSAR system uses the KUKA robot from SATIMO SA (France).For the 6-axis controller COMOSAR system, the KUKA robot controller version from SATIMO is used.
The XL robot series have many features that are important for our application:
- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 3.4. Video Positioning System

| | |
|---|---|
| The video positioning system is used in OpenSAR to check the probe. Which is composed of a camera, LED, mirror and mechanical parts.The camera is piloted by the main computer with firewire link.<br>During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip.<br>The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position. |  |

## 3.5. Device Holder

| | |
|---|---|
| The COMOSAR device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (EPR).<br>Thus the device needs no repositioning when changing the angles.<br>The COMOSAR device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity<br>$\varepsilon r$ =3 and loss tangent $\delta$ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered. |  |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

### 3.6. SAM Twin Phantom

| | |
|---|---|
| The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas:<br>□ Left head<br>□ Right head<br>□ Flat phantom | |

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 4. SAR MEASUREMENT PROCEDURE

## 4.1. Specific Absorption Rate (SAR)

SAR is related to the rate at which energy is absorbed per unit mass in 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 occupational/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 given mass density (ρ). The equation description is as below:

$$\mathrm{SAR} = \frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\mathrm{d}W}{\mathrm{d}m}\right) = \frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\mathrm{d}W}{\rho \mathrm{d}V}\right)$$

SAR is expressed in units of Watts per kilogram (W/Kg)
SAR can be obtained using either of the following equations:

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

$$\mathrm{SAR} = c_h \left.\frac{\mathrm{d}T}{\mathrm{d}t}\right|_{t=0}$$

Where

| | |
|---|---|
| SAR | is the specific absorption rate in watts per kilogram; |
| E | is the r.m.s. value of the electric field strength in the tissue in volts per meter; |
| σ | is the conductivity of the tissue in siemens per metre; |
| ρ | is the density of the tissue in kilograms per cubic metre; |
| $c_h$ | is the heat capacity of the tissue in joules per kilogram and Kelvin; |
| $\frac{\mathrm{dT}}{\mathrm{dt}} \mid t = 0$ | is the initial time derivative of temperature in the tissue in kelvins per second |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 4.2. SAR Measurement Procedure

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurement are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface is 2.7mm This distance cannot be smaller than the distance os sensor calibration points to probe tip as `defined in the probe properties,

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in SATIMO software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in db) is specified in the standards for compliance testing. For example, a 2db range is required in IEEE Standard 1528 and IEC62209 standards, whereby 3db is a requirement when compliance is assessed in accordance with the ARIB standard (Japan) If one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximum are detected, the number of Zoom Scan has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100MHz to 6GHz

| | ≤ 3 GHz | > 3 GHz |
|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | 5 ± 1 mm | ½·δ·ln(2) ± 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: $\Delta x_{Area}$, $\Delta y_{Area}$ | ≤ 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. | |

Step 3: Zoom Scan

Zoom Scan are used to assess the peak spatial SAR value within a cubic average volume containing 1g abd 10g of simulated tissue. The Zoom Scan measures points(refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1g and 10g and displays these values next to the job's label.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

Zoom Scan Parameters extracted from KDB865664 d01 SAR Measurement 100MHz to 6GHz

| | | | | |
|---|---|---|---|---|
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$ | | | ≤ 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: $\Delta z_{Zoom}(n)$ | | ≤ 5 mm | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm |
| | graded grid | $\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface | ≤ 4 mm | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm |
| | | $\Delta z_{Zoom}(n>1)$: between subsequent points | $\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$ | |
| Minimum zoom scan volume | x, y, z | | ≥ 30 mm | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>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 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

Step 4: Power Drift Measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the same settings. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 5. TISSUE 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 15cm. For head SAR testing the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15cm For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15cm.The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in 4.2

## 5.1. The composition of the tissue simulating liquid

| Ingredient (% Weight) / Frequency (MHz) | Water | Nacl | Sugar | HEC | Bactericide | DGBE | 1,2 Propanediol | Triton X-100 |
|---|---|---|---|---|---|---|---|---|
| 2450 Head | 71.88 | 0.16 | 0.0 | 0.0 | 0.0 | 7.99 | 0.0 | 19.97 |

## 5.2. Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in IEEE 1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in IEEE 1528.

| Target Frequency (MHz) | head | | body | |
|---|---|---|---|---|
| | εr | σ (S/m) | εr | σ (S/m) |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| 915 | 41.5 | 1.01 | 55.0 | 1.06 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 |
| 1610 | 40.3 | 1.29 | 53.8 | 1.40 |
| 1800 – 2000 | 40.0 | 1.40 | 53.3 | 1.52 |
| **2450** | **39.2** | **1.80** | 52.7 | 1.95 |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 |

(εr = relative permittivity, σ = conductivity and ρ = 1000 kg/m3)

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 5.3. Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using SATIMO Dielectric Probe Kit and R&S Network Analyzer ZVL6.

| Tissue Stimulant Measurement for 2450MHz for Head | | | | |
|---|---|---|---|---|
| Fr. (MHz) | Dielectric Parameters (±5%) | | Tissue Temp [°C] | Test time |
| | εr39.2(37.24-41.16) | δ[s/m]1.80(1.71-1.89) | | |
| 2402 | 40.87 | 1.74 | 20.7 | Mar.30,2016 |
| 2441 | 40.12 | 1.79 | | |
| 2450 | 39.65 | 1.82 | | |
| 2480 | 39.53 | 1.83 | | |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

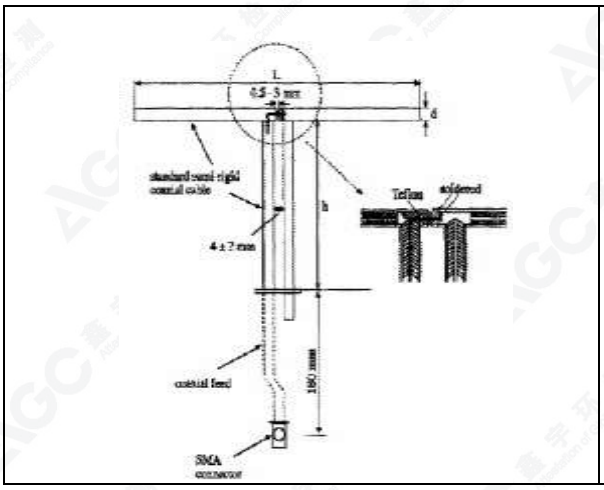
# 6. SAR SYSTEM CHECK PROCEDURE

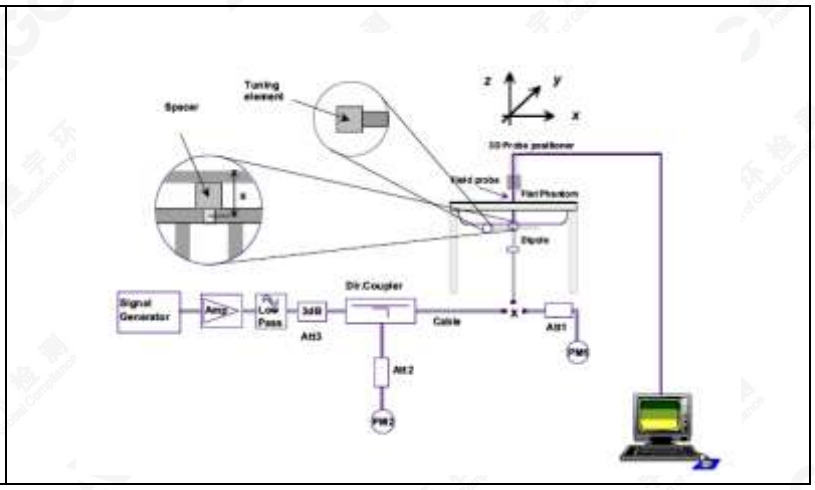
## 6.1. SAR System Check Procedures

SAR system check is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are remeasured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

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

The system check verifies that the system operates within its specifications. It's performed daily or before every SAR measurement. The system check uses normal SAR measurement in the flat section of the phantom with a matched dipole at a specified distance. The system check setup is shown as below.

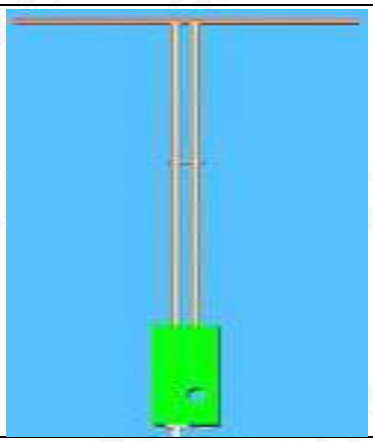



The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 6.2. SAR System Check

### 6.2.1. Dipoles

| | |
|---|---|
|  | The dipoles used is based on the IEEE-1528 standard, and is complied with mechanical and electrical specifications in line with the requirements of IEEE. the table below provides details for the mechanical and electrical Specifications for the dipoles. |

| Frequency | L (mm) | h (mm) | d (mm) |
|---|---|---|---|
| 2450MHz | 51.5 | 30.4 | 3.6 |

### 6.2.2. System Check Result

| System Performance Check at 2450MHz for Head | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Validation Kit: SN 46/11 DIP 2G450-189 | | | | | | | | |
| Frequency [MHz] | Target Value(W/Kg) | | Reference Result (± 10%) | | Tested Value(W/Kg) | | Tissue Temp. [°C] | Test time |
| | 1g | 10g | 1g | 10g | 1g | 10g | | |
| 2450 | 54.40 | 23.75 | 48.96-59.84 | 21.375-26.125 | 57.623 | 25.395 | 20.7 | Mar.30,2016 |

Note:

(1) We use a CW signal of 18dBm for system check, and then all SAR value are normalized to 1W forward power. The result must be within ±10% of target value.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 7. EUT TEST POSITION

This EUT was tested in **Device Front.**

## 7.1. Test Position

(1) To position the EUT parallel to the phantom surface.

(2) To adjust the EUT parallel to the flat phantom.

(3) To adjust the distance between the EUT surface and the flat phantom to **0mm.**

According to FCC Response on 04/05/2016:
Please provide SAR test data for the side that will face the user's head during operation. Apply the following guidance:
i. Use the flat phantom for testing.
ii. Remove the appendage that extends into the ear canal and use a test separation distance of 0 mm away from the phantom .
iii. Use Head Tissue Simulating Liquid for the test.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 8. SAR EXPOSURE LIMITS

SAR assessments have been made in line with the requirements of IEEE-1528, and comply with ANSI/IEEE C95.1-1992 “Uncontrolled Environments” limits. These limits apply to a location which is deemed as “Uncontrolled Environment” which can be described as a situation where the general public may be exposed to an RF source with no prior knowledge or control over their exposure.

**Limits for General Population/Uncontrolled Exposure (W/kg)**

| Type Exposure | Uncontrolled Environment Limit (W/kg) |
|---|---|
| Spatial Peak SAR (1g cube tissue for brain or body) | 1.60 |
| Spatial Average SAR (Whole body) | 0.08 |
| Spatial Peak SAR (Limbs) | 4.0 |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 9. TEST EQUIPMENT LIST

| Equipment description | Manufacturer/ Model | Identification No. | Current calibration date | Next calibration date |
|---|---|---|---|---|
| SAR Probe | MVG | SN 22/12 EP159 | 12/09/2015 | 12/08/2016 |
| TISSUE Probe | SATIMO | SN 45/11 OCPG45 | 12/02/2015 | 12/01/2016 |
| Phantom | SATIMO | SN_4511_SAM90 | Validated. No cal required. | Validated. No cal required. |
| Liquid | SATIMO | - | Validated. No cal required. | Validated. No cal required. |
| Multimeter | Keithley 2000 | 1188656 | 03/10/2016 | 03/09/2017 |
| Dipole | SATIMO SID2450 | SN46/11 DIP 2G450-189 | 11/14/2013 | 11/13/2016 |
| Signal Generator | Agilent-E4438C | MY44260051 | 02/29/2016 | 02/28/2017 |
| Spectrum Analyzer E4440 | Agilent | US41421290 | 07/23/2015 | 07/22/2016 |
| Network Analyzer | Rhode & Schwarz ZVL6 | SN100132 | 03/01/2016 | 02/28/2017 |
| Attenuator | Warison /WATT-6SR1211 | N/A | N/A | N/A |
| Attenuator | Mini-circuits / VAT-10+ | N/A | N/A | N/A |
| Amplifier | EM30180 | SN060552 | 03/04/2016 | 03/03/2017 |
| Directional Couple | Werlatone/ C5571-10 | SN99463 | 07/29/2015 | 07/28/2016 |
| Directional Couple | Werlatone/ C6026-10 | SN99482 | 07/29/2015 | 07/28/2016 |
| Power Sensor | NRP-Z21 | 1137.6000.02 | 10/20/2015 | 10/19/2016 |
| Power Sensor | NRP-Z23 | US38261498 | 03/01/2016 | 02/28/2017 |
| Power Viewer | R&S | V2.3.1.0 | N/A | N/A |

Note: Per KDB 865664 Dipole SAR Validation, AGC 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 is within 20% of calibrated measurement;
4. Impedance is within 5Ω of calibrated measurement.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 10. MEASUREMENT UNCERTAINTY

| SATIMO Uncertainty<br>Measurement uncertainty for 450 MHz to 3.7 GHz averaged over 1 gram / 10 gram. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Uncertainty Component | Sec. | Tol (+- %) | Prob. Dist. | Div. | Ci (1g) | Ci (10g) | 1g Ui (+-%) | 10g Ui (+-%) | Vi |
| **Measurement System** | | | | | | | | | |
| Probe calibration | E.2.1 | 5.831 | N | 1 | 1 | 1 | 5.83 | 5.83 | ∞ |
| Axial Isotropy | E.2.2 | 2.5 | R | $\sqrt{3}$ | 1 | 1 | 1.44 | 1.44 | ∞ |
| Hemispherical Isotropy | E.2.2 | 4.0 | R | $\sqrt{3}$ | 1 | 1 | 2.31 | 2.31 | ∞ |
| Boundary effect | E.2.3 | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.58 | 0.58 | ∞ |
| Linearity | E.2.4 | 1.13 | R | $\sqrt{3}$ | 1 | 1 | 0.65 | 0.65 | ∞ |
| System detection limits | E.2.5 | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.58 | 0.58 | ∞ |
| Readout Electronics | E.2.6 | 0.02 | N | 1 | 1 | 1 | 0.02 | 0.02 | ∞ |
| Response Time | E.2.7 | 3.0 | R | $\sqrt{3}$ | 1 | 1 | 1.73 | 1.73 | ∞ |
| Integration Time | E.2.8 | 2.0 | R | $\sqrt{3}$ | 1 | 1 | 1.15 | 1.15 | ∞ |
| RF ambient Conditions | E.6.1 | 3.0 | R | $\sqrt{3}$ | 1 | 1 | 1.73 | 1.73 | ∞ |
| Probe positioner Mechanical Tolerance | E.6.2 | 2.0 | R | $\sqrt{3}$ | 1 | 1 | 1.15 | 1.15 | ∞ |
| Probe positioning with respect to Phantom Shell | E.6.3 | 0.05 | R | $\sqrt{3}$ | 1 | 1 | 0.03 | 0.03 | ∞ |
| Extrapolation, interpolation and integration Algoritms for Max. SAR Evaluation | E.5.2 | 5.0 | R | $\sqrt{3}$ | 1 | 1 | 2.89 | 2.89 | ∞ |
| **Test sample Related** | | | | | | | | | |
| Test sample positioning | E.4.2.1 | 0.03 | N | 1 | 1 | 1 | 0.03 | 0.03 | N-1 |
| Device Holder Uncertainty | E.4.1.1 | 5.00 | N | 1 | 1 | 1 | 5.00 | 5.00 | ∞ |
| Output power Variation - SAR drift measurement | 6.6.2 | 0.65 | R | $\sqrt{3}$ | 1 | 1 | 0.38 | 0.38 | ∞ |
| **Phantom and Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape and thickness tolerances) | E.3.1 | 0.05 | R | $\sqrt{3}$ | 1 | 1 | 0.03 | 0.03 | ∞ |
| Liquid conductivity deviation from target value | E.3.2 | 5.00 | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.85 | 1.24 | ∞ |
| Liquid conductivity - measurement uncertainty | E.3.3 | 5.00 | N | 1 | 0.64 | 0.43 | 3.20 | 2.15 | ∞ |
| Liquid permittivity - deviation from target value | E.3.2 | 0.03 | R | $\sqrt{3}$ | 0.6 | 0.49 | 0.01 | 0.01 | ∞ |
| Liquid permittivity - measurement uncertainty | E.3.3 | 10.00 | N | 1 | 0.6 | 0.49 | 6.00 | 4.90 | M |
| Combined Standard Uncertainty | | | RSS | | | | 10.27 | 9.68 | ∞ |
| Expanded Uncertainty (95% Confidence interval) | | | k | | | | 20.53 | 19.37 | |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

| SATIMO Uncertainty<br>System uncertainty for 450 MHz to 3.7 GHz averaged over 1 gram / 10 gram. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Uncertainty Component | Sec. | Tol (+- %) | Prob. Dist. | Div. | Ci (1g) | Ci (10g) | 1g Ui (+-%) | 10g Ui (+-%) | Vi |
| **Measurement System** | | | | | | | | | |
| Probe calibration | E.2.1 | 5.831 | N | 1 | 1 | 1 | 5.83 | 5.83 | ∞ |
| Axial Isotropy | E.2.2 | 2.5 | R | $\sqrt{3}$ | 1 | 1 | 1.44 | 1.44 | ∞ |
| Hemispherical Isotropy | E.2.2 | 4.0 | R | $\sqrt{3}$ | 1 | 1 | 2.31 | 2.31 | ∞ |
| Boundary Effects | E.2.3 | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.58 | 0.58 | ∞ |
| Linearity | E.2.4 | 1.13 | R | $\sqrt{3}$ | 1 | 1 | 0.65 | 0.65 | ∞ |
| System detection limits | E.2.5 | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.58 | 0.58 | ∞ |
| Readout Electronics | E.2.6 | 0.02 | N | 1 | 1 | 1 | 0.02 | 0.02 | ∞ |
| Response Time | E.2.7 | 3.0 | R | $\sqrt{3}$ | 1 | 1 | 1.73 | 1.73 | ∞ |
| Integration Time | E.2.8 | 2.0 | R | $\sqrt{3}$ | 1 | 1 | 1.15 | 1.15 | ∞ |
| RF ambient Conditions | E.6.1 | 3.0 | R | $\sqrt{3}$ | 1 | 1 | 1.73 | 1.73 | ∞ |
| Probe positioner Mechanical Tolerance | E.6.2 | 2.0 | R | $\sqrt{3}$ | 1 | 1 | 1.15 | 1.15 | ∞ |
| Probe positioning with respect to Phantom Shell | E.6.3 | 0.05 | R | $\sqrt{3}$ | 1 | 1 | 0.03 | 0.03 | ∞ |
| Extrapolation, interpolation and integration Algoritms for Max. SAR Evaluation | E.5.2 | 5.0 | R | $\sqrt{3}$ | 1 | 1 | 2.89 | 2.89 | ∞ |
| **Dipole** | | | | | | | | | |
| Dipole axis to liquid Distance | 8,E.4.2 | 1.00 | N | $\sqrt{3}$ | 1 | 1 | 0.58 | 0.58 | N-1 |
| Input power and SAR drift measurement | 8,6.6.2 | 0.65 | R | $\sqrt{3}$ | 1 | 1 | 0.38 | 0.38 | ∞ |
| **Phantom and Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape and thickness tolerances) | E.3.1 | 0.05 | R | $\sqrt{3}$ | 1 | 1 | 0.03 | 0.03 | ∞ |
| Liquid conductivity - deviation from target value | E.3.2 | 5.00 | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.85 | 1.24 | ∞ |
| Liquid conductivity - measurement uncertainty | E.3.3 | 5.00 | N | 1 | 0.64 | 0.43 | 3.20 | 2.15 | ∞ |
| Liquid permittivity - deviation from target value | E.3.2 | 0.03 | R | $\sqrt{3}$ | 0.6 | 0.49 | 0.01 | 0.01 | ∞ |
| Liquid permittivity - measurement uncertainty | E.3.3 | 10.00 | N | 1 | 0.6 | 0.49 | 6.00 | 4.90 | M |
| Combined Standard Uncertainty | | | RSS | | | | 8.99 | 8.31 | |
| Expanded Uncertainty (95% Confidence interval) | | | k | | | | 17.97 | 16.62 | |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 11. CONDUCTED POWER MEASUREMENT

**Bluetooth_V4.1**

**BLE**

| Modulation | Channel | Frequency(MHz) | Avg. Burst Power (dBm) |
|---|---|---|---|
| GFSK | 0 | 2402 | 9.31 |
| | 39 | 2440 | **9.56** |
| | 78 | 2480 | 9.42 |

**EDR**

| Modulation | Channel | Frequency(MHz) | Avg. Burst Power (dBm) |
|---|---|---|---|
| GFSK | 0 | 2402 | 9.54 |
| | 39 | 2440 | **9.82** |
| | 78 | 2480 | 9.68 |
| π /4-DQPSK | 0 | 2402 | 7.85 |
| | 39 | 2440 | 8.28 |
| | 78 | 2480 | 8.10 |
| 8-DPSK | 0 | 2402 | 8.11 |
| | 39 | 2440 | 8.53 |
| | 78 | 2480 | 8.34 |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 12. TEST RESULTS

## 12.1. SAR Test Results Summary

### 12.1.1. Test position and configuration

1. The EUT is a model of Bluetooth handset. According to user's manual, the EUT is actually used into ear. When remove the appendage that extends into the ear canal, the EUT can also normally work.
2. A non-standard setup was used for SAR testing based on guidance from the FCC. The operational description contains additional information.
3. According to KDB 447498 D01 General RF Exposure Guidance v06, due to the Max peak power for Bluetooth is less than 2Pref, which have to be tested. Lab Using the head liquid with a separation of 0mm at flat phantom to test , achieving actual usage.
4. For SAR testing, the device was controlled by software to test at reference fixed frequency.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

### 12.1.2. Test Result

| SAR MEASUREMENT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth of Liquid (cm):>15 | | | | Relative Humidity (%): 55.9 | | | | | |
| Product: True Wireless Headphones and Charging Case | | | | | | | | | |
| Test Mode: BT(communication) with GMSK modulation | | | | | | | | | |
| **Position** | **Mode** | **Ch.** | **Fr. (MHz)** | **Power Drift (<±5%)** | **SAR (1g) (W/kg)** | **Max. Turn-up Power (dBm)** | **Meas. output Power (dBm)** | **Scaled SAR (W/Kg)** | **Limit (W/kg)** |
| Device Front | DH1 | 39 | 2440 | 0.05 | 0.017 | 10 | 9.82 | 0.018 | 1.6 |

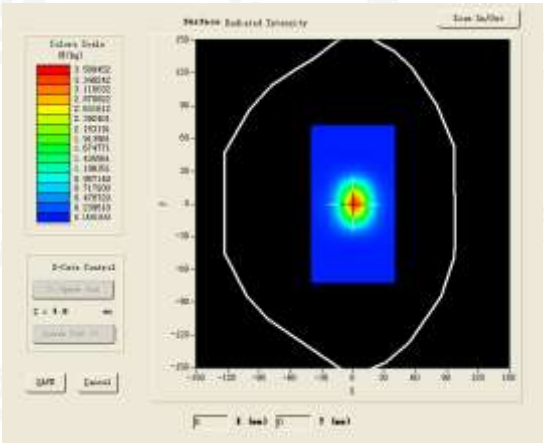
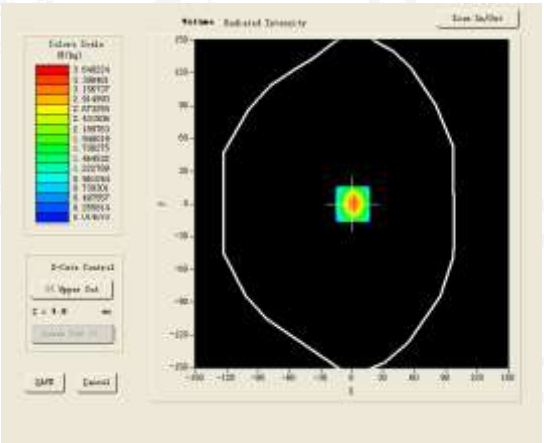
The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# APPENDIX A. SAR SYSTEM CHECK DATA

**Test Laboratory: AGC Lab** **Date: Mar.30,2016**
**System Check Head 2450 MHz**
**DUT: Dipole 2450 MHz Type: SID 2450**
Communication System CW; Communication System Band: D2450 (2450.0 MHz); Duty Cycle: 1:1; Conv.F=5.94
Frequency: 2450 MHz; Medium parameters used: f = 2450 MHz; σ=1.82 mho/m; εr =39.65; ρ= 1000 kg/m³ ;
Phantom section: Flat Section; Input Power=18dBm
Ambient temperature (℃):20.9, Liquid temperature (℃): 20.7

SATIMO Configuration
Probe: SSE5; Calibrated: 12/09/2015; Serial No.: SN 22/12 EP159
Sensor-Surface: 4mm (Mechanical Surface Detection)
Phantom: SAM twin phantom
Measurement SW: OpenSAR V4_02_01

**Configuration/System Check 2450MHz Head/Area Scan:** Measurement grid: dx=8mm, dy=8mm
**Configuration/System Check 2450MHz Head/Zoom Scan:** Measurement grid: dx=5mm,dy=5mm, dz=5mm

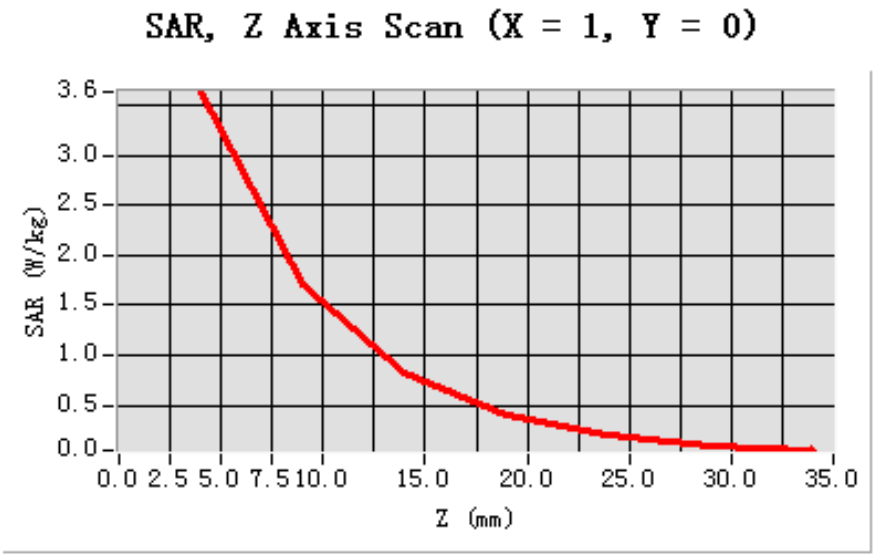
| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |

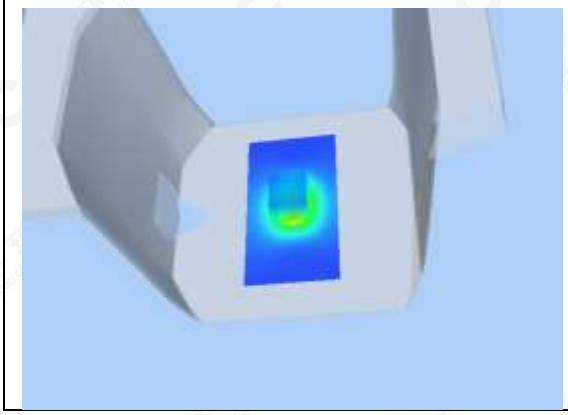
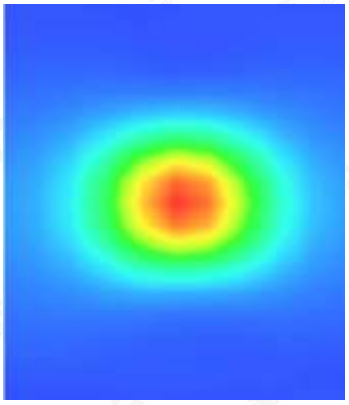
**Maximum location: X=1.00, Y=0.00**

| | |
|---|---|
| **SAR 10g (W/Kg)** | 1.602314 |
| **SAR 1g (W/Kg)** | 3.635780 |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 | 24.00 | 29.00 |
|---|---|---|---|---|---|---|---|
| SAR (W/Kg) | 0.0000 | 3.6402 | 1.7153 | 0.8216 | 0.3947 | 0.1914 | 0.0923 |




| 3D screen shot | Hot spot position |
|---|---|
|  |  |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# APPENDIX B. SAR MEASUREMENT DATA

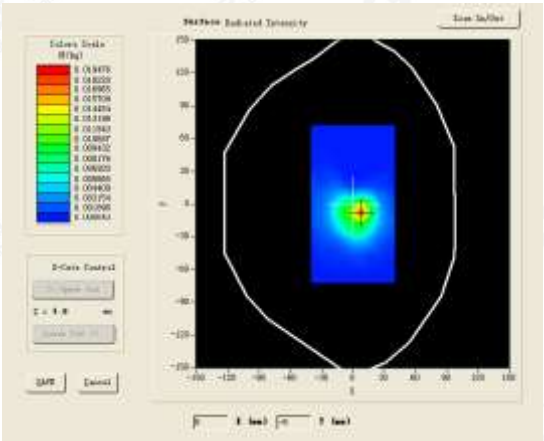
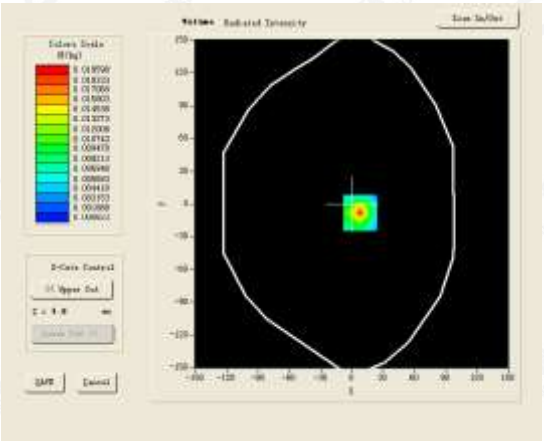
**Test Laboratory: AGC Lab** **Date: Mar.30,2016**
**Bluetooth Mid-Device-Front**
**DUT: True Wireless Headphones and Charging Case; Type: W800BTR**

Communication System: Bluetooth; Communication System Band:2.4G; Duty Cycle: 1:1; Conv.F=5.94;
Frequency: 2440 MHz; Medium parameters used: f = 2450 MHz; σ =1.79 mho/m; εr =40.12 ρ= 1000 kg/m³ ;
Phantom section:Flat Section
Ambient temperature (℃):20.9, Liquid temperature (℃): 20.7

SATIMO Configuration:
Probe: SSE5; Calibrated: 12/09/2015; Serial No.: SN 22/12 EP159
Sensor-Surface: 4mm (Mechanical Surface Detection)
Phantom: SAM twin phantom
Measurement SW: OpenSAR V4_02_01

**Configuration/Bluetooth Mid- Device-Front/Area Scan:** Measurement grid: dx=8mm, dy=8mm
**Configuration/Bluetooth Mid- Device-Front/Zoom Scan:** Measurement grid: dx=5mm,dy=5mm, dz=5mm

| | |
|---|---|
| **Area Scan** | sam_direct_droit2_surf8mm.txt |
| **ZoomScan** | 7x7x7,dx=5mm dy=5mm dz=5mm |
| **Phantom** | Validation plane |
| **Device Position** | Device Front |
| **Band** | 2450MHz |
| **Channels** | Middle |
| **Signal** | Crest factor: 1.0 |

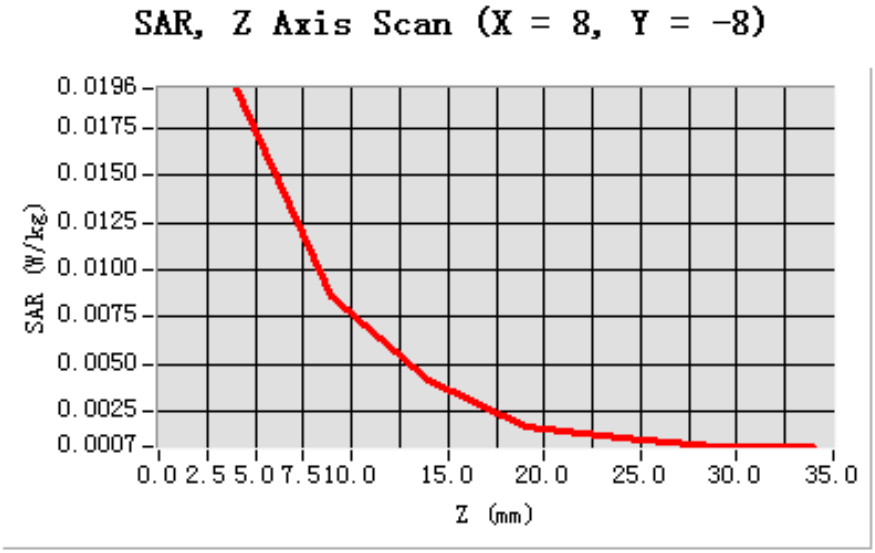
| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |

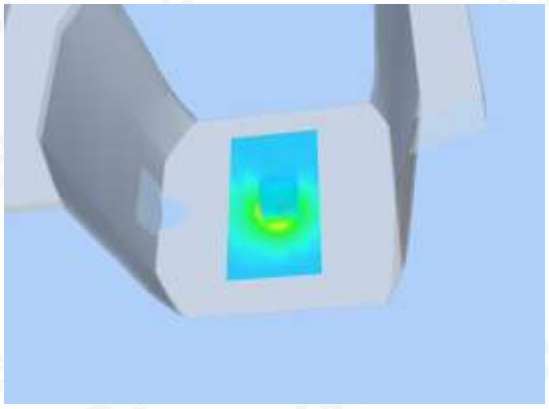
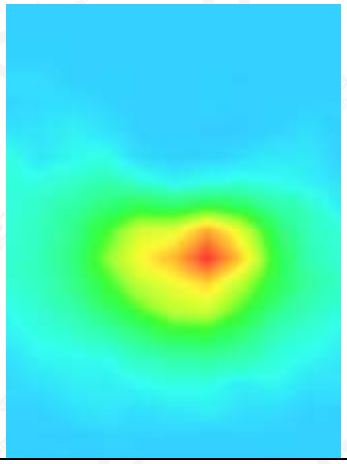
**Maximum location: X=8.00, Y=-8.00**

| | |
|---|---|
| **SAR 10g (W/Kg)** | 0.007129 |
| **SAR 1g (W/Kg)** | 0.017171 |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 | 24.00 | 29.00 |
|---|---|---|---|---|---|---|---|
| SAR (W/Kg) | 0.0000 | 0.0196 | 0.0086 | 0.0042 | 0.0017 | 0.0011 | 0.0007 |




| 3D screen shot | Hot spot position |
|---|---|
|  |  |

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# APPENDIX C. CALIBRATION DATA

## PROBE CALIBRATION DATA

**COMOSAR E-Field Probe Calibration Report**

Ref : ACR.344.3.15.SATU.A

**ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.**

**1&2F, NO.2 BUILDING, HUAFENG NO.1 INDUSTRIAL PARK, GUSHU COMMUNITY XIXIANG STREET BAOAN DISTRICT, SHENZHEN, P.R. CHINA**

**MVG COMOSAR DOSIMETRIC E-FIELD PROBE**

**SERIAL NO.: SN 22/12 EP159**

**Calibrated at MVG US**

**2105 Barrett Park Dr. - Kennesaw, GA 30144**

**Calibration Date: 12/09/15**

*Summary:*

This document presents the method and results from an accredited COMOSAR Dosimetric E-Field Probe calibration performed in MVG USA using the CALISAR / CALIBAIR test bench, for use with a COMOSAR system only. All calibration results are traceable to national metrology institutions.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.344.3.15.SATU.A

| | Name | Function | Date | Signature |
|---|---|---|---|---|
| Prepared by : | Jérôme LUC | Product Manager | 12/10/2015 | |
| Checked by : | Jérôme LUC | Product Manager | 12/10/2015 | |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 12/10/2015 | |

| | Customer Name |
|---|---|
| Distribution : | ATTESTATION OF GLOBAL COMPLIANCE CO. LTD. |

| Issue | Date | Modifications |
|---|---|---|
| A | 12/10/2015 | Initial release |
| | | |
| | | |
| | | |



*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## TABLE OF CONTENTS

1 Device Under Test ..... 4
2 Product Description ..... 4
2.1 General Information ..... 4
3 Measurement Method ..... 4
3.1 Linearity ..... 4
3.2 Sensitivity ..... 5
3.3 Lower Detection Limit ..... 5
3.4 Isotropy ..... 5
3.5 Boundary Effect ..... 5
4 Measurement Uncertainty ..... 5
5 Calibration Measurement Results ..... 6
5.1 Sensitivity in air ..... 6
5.2 Linearity ..... 7
5.3 Sensitivity in liquid ..... 7
5.4 Isotropy ..... 8
6 List of Equipment ..... 9



*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 1 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | MVG |
| Model | SSE5 |
| Serial Number | SN 22/12 EP159 |
| Product Condition (new / used) | Used |
| Frequency Range of Probe | 0.45 GHz-3.7 GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.205 MΩ<br>Dipole 2: R2=0.210 MΩ<br>Dipole 3: R3=0.206 MΩ |

A yearly calibration interval is recommended.

# 2 PRODUCT DESCRIPTION

## 2.1 GENERAL INFORMATION

MVG's COMOSAR E field Probes are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards.

**Figure 1** – *MVG COMOSAR Dosimetric E field Dipole*

| | |
|---|---|
| Probe Length | 330 mm |
| Length of Individual Dipoles | 4.5 mm |
| Maximum external diameter | 8 mm |
| Probe Tip External Diameter | 5 mm |
| Distance between dipoles / probe extremity | 2.7 mm |

# 3 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

## 3.1 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.



*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

### 3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards.

### 3.3 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

### 3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

### 3.5 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

## 4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

| Uncertainty analysis of the probe calibration in waveguide | | | | | |
|---|---|---|---|---|---|
| ERROR SOURCES | Uncertainty value (%) | Probability Distribution | Divisor | ci | Standard Uncertainty (%) |
| Incident or forward power | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.732% |
| Reflected power | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.732% |
| Liquid conductivity | 5.00% | Rectangular | $\sqrt{3}$ | 1 | 2.887% |
| Liquid permittivity | 4.00% | Rectangular | $\sqrt{3}$ | 1 | 2.309% |
| Field homogeneity | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.732% |
| Field probe positioning | 5.00% | Rectangular | $\sqrt{3}$ | 1 | 2.887% |



*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

| | | | | | |
|---|---|---|---|---|---|
| Field probe linearity | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.732% |
| **Combined standard uncertainty** | | | | | 5.831% |
| **Expanded uncertainty** 95 % confidence level k = 2 | | | | | 12.0% |

## 5 CALIBRATION MEASUREMENT RESULTS

| Calibration Parameters | |
|---|---|
| Liquid Temperature | 21 °C |
| Lab Temperature | 21 °C |
| Lab Humidity | 45 % |

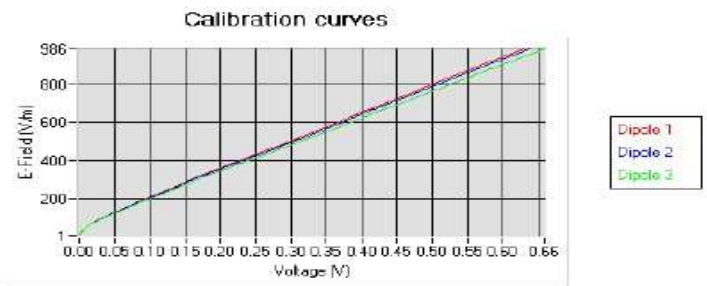
### 5.1 SENSITIVITY IN AIR

| Normx dipole 1 (µV/(V/m)$^2$) | Normy dipole 2 (µV/(V/m)$^2$) | Normz dipole 3 (µV/(V/m)$^2$) |
|---|---|---|
| 4.74 | 4.99 | 5.21 |

| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|---|---|---|
| 99 | 96 | 98 |

Calibration curves ei=f(V) (i=1,2,3) allow to obtain H-field value using the formula:

$$E = \sqrt{E_1^{\,2} + E_2^{\,2} + E_3^{\,2}}$$

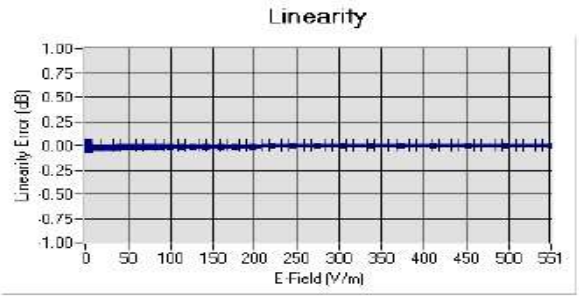





*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 5.2 LINEARITY




Linearity: +/-1.13% (+/-0.05dB)

## 5.3 SENSITIVITY IN LIQUID

| Liquid | Frequency (MHz +/- 100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|---|---|---|---|---|
| HL450 | 450 | 44.12 | 0.88 | 7.37 |
| BL450 | 450 | 58.92 | 1.00 | 7.54 |
| HL750 | 750 | 42.24 | 0.90 | 6.33 |
| BL750 | 750 | 56.85 | 0.99 | 6.54 |
| HL850 | 850 | 43.02 | 0.90 | 7.29 |
| BL850 | 850 | 53.72 | 0.98 | 7.54 |
| HL900 | 900 | 42.47 | 0.99 | 6.28 |
| BL900 | 900 | 56.97 | 1.09 | 6.45 |
| HL1800 | 1800 | 42.24 | 1.40 | 5.60 |
| BL1800 | 1800 | 53.53 | 1.53 | 5.74 |
| HL1900 | 1900 | 40.79 | 1.42 | 6.22 |
| BL1900 | 1900 | 54.47 | 1.57 | 6.43 |
| HL2000 | 2000 | 40.52 | 1.44 | 5.73 |
| BL2000 | 2000 | 54.18 | 1.56 | 5.89 |
| HL2300 | 2300 | 39.14 | 1.66 | 5.88 |
| BL2300 | 2300 | 52.17 | 1.79 | 6.11 |
| HL2450 | 2450 | 38.73 | 1.81 | 5.94 |
| BL2450 | 2450 | 53.23 | 1.96 | 6.06 |
| HL2600 | 2600 | 38.54 | 1.95 | 5.41 |
| BL2600 | 2600 | 52.07 | 2.23 | 5.62 |
| HL2700 | 2700 | 38.22 | 2.08 | 5.19 |
| BL2700 | 2700 | 51.56 | 2.77 | 5.37 |
| HL3500 | 3500 | 37.57 | 2.90 | 5.10 |
| BL3500 | 3500 | 53.18 | 3.24 | 5.25 |
| HL3700 | 3700 | 37.90 | 3.04 | 4.42 |
| BL3700 | 3700 | 52.09 | 3.49 | 4.52 |

LOWER DETECTION LIMIT: 8mW/kg



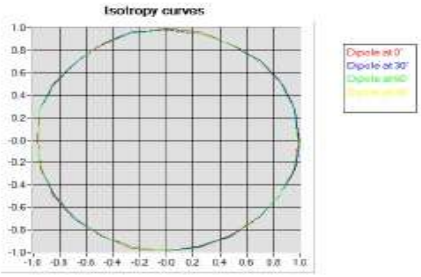
*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 5.4 ISOTROPY

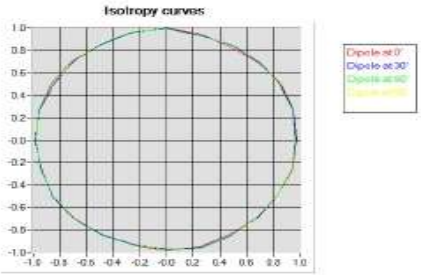
**HL900 MHz**

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.05 dB




**HL1800 MHz**

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.08 dB






*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 6 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| Flat Phantom | MVG | SN-20/09-SAM71 | Validated. No cal required. | Validated. No cal required. |
| COMOSAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rhode & Schwarz ZVA | SN100132 | 02/2013 | 02/2016 |
| Reference Probe | MVG | EP 94 SN 37/08 | 10/2015 | 10/2016 |
| Multimeter | Keithley 2000 | 1188656 | 12/2013 | 12/2016 |
| Signal Generator | Agilent E4438C | MY49070581 | 12/2013 | 12/2016 |
| Amplifier | Aethercomm | SN 046 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | HP E4418A | US38261498 | 12/2013 | 12/2016 |
| Power Sensor | HP ECP-E26A | US37181460 | 12/2013 | 12/2016 |
| Directional Coupler | Narda 4216-20 | 01386 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Waveguide | Mega Industries | 069Y7-158-13-712 | Validated. No cal required. | Validated. No cal required. |
| Waveguide Transition | Mega Industries | 069Y7-158-13-701 | Validated. No cal required. | Validated. No cal required. |
| Waveguide Termination | Mega Industries | 069Y7-158-13-701 | Validated. No cal required. | Validated. No cal required. |



*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

**DIPOLE CALIBRATION DATA**

# SAR Reference Dipole Calibration Report

Ref : ACR.318.9.13.SATU.B

**ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.**

**1&2F, NO.2 BUILDING, HUAFENG NO.1 INDUSTRIAL PARK, GUSHU COMMUNITY XIXIANG STREET BAOAN DISTRICT, SHENZHEN, P.R. CHINA**

**SATIMO COMOSAR REFERENCE DIPOLE**

**FREQUENCY: 2450 MHZ**

**SERIAL NO.: SN 46/11 DIP 2G450-189**

**Calibrated at SATIMO US**

**2105 Barrett Park Dr. - Kennesaw, GA 30144**

ACCREDITED
Calibration CERT #2246.02

**11/14/13**

*Summary:*

This document presents the method and results from an accredited SAR reference dipole calibration performed in SATIMO USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.318.9.13.SATU.B

| | Name | Function | Date | Signature |
|---|---|---|---|---|
| *Prepared by :* | Jérôme LUC | Product Manager | 11/14/2013 | |
| *Checked by :* | Jérôme LUC | Product Manager | 11/14/2013 | |
| *Approved by :* | Kim RUTKOWSKI | Quality Manager | 11/14/2013 | Kim Rutkowski |

| | Customer Name |
|---|---|
| *Distribution :* | ATTESTATION OF GLOBAL COMPLIANCE CO. LTD. |

| Issue | Date | Modifications |
|---|---|---|
| A | 11/14/2013 | Initial release |
| B | 05/08/2015 | Revision due to a typo of the zoom scan resolution page 7 and page 9 |
| | | |
| | | |



*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

Attestation of Global Compliance

Tel : (86-755) 29081955 Fax: (86-755) 26008484 Http://www.agc-cert.com E-mail: agc@agc-cert.com
Add: 2F. , No.2 Building, Huafeng No.1 Technical Industrial Park, Sanwei, Xixiang, Baoan District, Shenzhen

## TABLE OF CONTENTS

1 Introduction ..... 4
2 Device Under Test ..... 4
3 Product Description ..... 4
3.1 General Information ..... 4
4 Measurement Method ..... 5
4.1 Return Loss Requirements ..... 5
4.2 Mechanical Requirements ..... 5
5 Measurement Uncertainty ..... 5
5.1 Return Loss ..... 5
5.2 Dimension Measurement ..... 5
5.3 Validation Measurement ..... 5
6 Calibration Measurement Results ..... 6
6.1 Return Loss and Impedance ..... 6
6.2 Mechanical Dimensions ..... 6
7 Validation measurement ..... 7
7.1 Measurement Condition ..... 7
7.2 Head Liquid Measurement ..... 7
7.3 Measurement Result ..... 8
7.4 Body Measurement Result ..... 9
8 List of Equipment ..... 10



*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

# 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR 2450 MHz REFERENCE DIPOLE |
| Manufacturer | Satimo |
| Model | SID2450 |
| Serial Number | SN 46/11 DIP 2G450-189 |
| Product Condition (new / used) | Used |

A yearly calibration interval is recommended.

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

Satimo's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.

**Figure 1** – *Satimo COMOSAR Validation Dipole*



*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

### 4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constucted as outlined in the fore mentioned standards.

### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

## 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

| Frequency band | Expanded Uncertainty on Return Loss |
|---|---|
| 400-6000MHz | 0.1 dB |

### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|---|---|
| 3 - 300 | 0.05 mm |

### 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

| Scan Volume | Expanded Uncertainty |
|---|---|
| 1 g | 20.3 % |
| 10 g | 20.1 % |

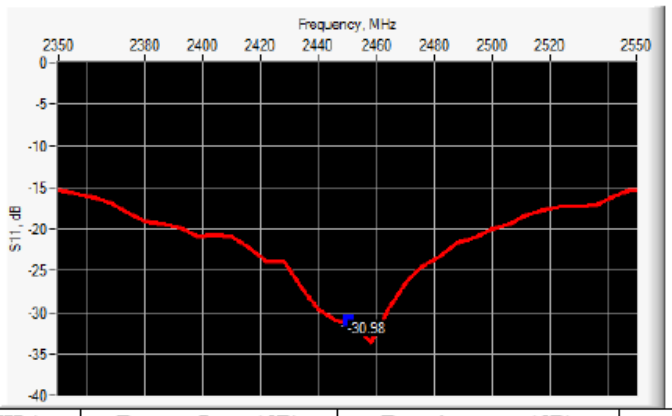


*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 2450 | -30.98 | -20 | 47.3 Ω + 0.1 jΩ |

## 6.2 MECHANICAL DIMENSIONS

| Frequency MHz | L mm | | h mm | | d mm | |
|---|---|---|---|---|---|---|
| | required | measured | required | measured | required | measured |
| 300 | 420.0 ±1 %. | | 250.0 ±1 %. | | 6.35 ±1 %. | |
| 450 | 290.0 ±1 %. | | 166.7 ±1 %. | | 6.35 ±1 %. | |
| 750 | 176.0 ±1 %. | | 100.0 ±1 %. | | 6.35 ±1 %. | |
| 835 | 161.0 ±1 %. | | 89.8 ±1 %. | | 3.6 ±1 %. | |
| 900 | 149.0 ±1 %. | | 83.3 ±1 %. | | 3.6 ±1 %. | |
| 1450 | 89.1 ±1 %. | | 51.7 ±1 %. | | 3.6 ±1 %. | |
| 1500 | 80.5 ±1 %. | | 50.0 ±1 %. | | 3.6 ±1 %. | |
| 1640 | 79.0 ±1 %. | | 45.7 ±1 %. | | 3.6 ±1 %. | |
| 1750 | 75.2 ±1 %. | | 42.9 ±1 %. | | 3.6 ±1 %. | |
| 1800 | 72.0 ±1 %. | | 41.7 ±1 %. | | 3.6 ±1 %. | |
| 1900 | 68.0 ±1 %. | | 39.5 ±1 %. | | 3.6 ±1 %. | |
| 1950 | 66.3 ±1 %. | | 38.5 ±1 %. | | 3.6 ±1 %. | |
| 2000 | 64.5 ±1 %. | | 37.5 ±1 %. | | 3.6 ±1 %. | |
| 2100 | 61.0 ±1 %. | | 35.7 ±1 %. | | 3.6 ±1 %. | |
| 2300 | 55.5 ±1 %. | | 32.6 ±1 %. | | 3.6 ±1 %. | |
| 2450 | 51.5 ±1 %. | PASS | 30.4 ±1 %. | PASS | 3.6 ±1 %. | PASS |
| 2600 | 48.5 ±1 %. | | 28.8 ±1 %. | | 3.6 ±1 %. | |
| 3000 | 41.5 ±1 %. | | 25.0 ±1 %. | | 3.6 ±1 %. | |
| 3500 | 37.0±1 %. | | 26.4 ±1 %. | | 3.6 ±1 %. | |
| 3700 | 34.7±1 %. | | 26.4 ±1 %. | | 3.6 ±1 %. | |



*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 7 VALIDATION MEASUREMENT

The IEEE Std. 1528, OET 65 Bulletin C and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

### 7.1 MEASUREMENT CONDITION

| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Head Liquid Values: eps' : 38.6 sigma : 1.82 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=5mm/dy=5mm/dz=5mm |
| Frequency | 2450 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 21 °C |
| Lab Temperature | 21 °C |
| Lab Humidity | 45 % |

### 7.2 HEAD LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity ($\varepsilon_r$') | | Conductivity (σ) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 300 | 45.3 ±5 % | | 0.87 ±5 % | |
| 450 | 43.5 ±5 % | | 0.87 ±5 % | |
| 750 | 41.9 ±5 % | | 0.89 ±5 % | |
| 835 | 41.5 ±5 % | | 0.90 ±5 % | |
| 900 | 41.5 ±5 % | | 0.97 ±5 % | |
| 1450 | 40.5 ±5 % | | 1.20 ±5 % | |
| 1500 | 40.4 ±5 % | | 1.23 ±5 % | |
| 1640 | 40.2 ±5 % | | 1.31 ±5 % | |
| 1750 | 40.1 ±5 % | | 1.37 ±5 % | |
| 1800 | 40.0 ±5 % | | 1.40 ±5 % | |
| 1900 | 40.0 ±5 % | | 1.40 ±5 % | |
| 1950 | 40.0 ±5 % | | 1.40 ±5 % | |
| 2000 | 40.0 ±5 % | | 1.40 ±5 % | |
| 2100 | 39.8 ±5 % | | 1.49 ±5 % | |
| 2300 | 39.5 ±5 % | | 1.67 ±5 % | |
| 2450 | 39.2 ±5 % | PASS | 1.80 ±5 % | PASS |
| 2600 | 39.0 ±5 % | | 1.96 ±5 % | |
| 3000 | 38.5 ±5 % | | 2.40 ±5 % | |
| 3500 | 37.9 ±5 % | | 2.91 ±5 % | |



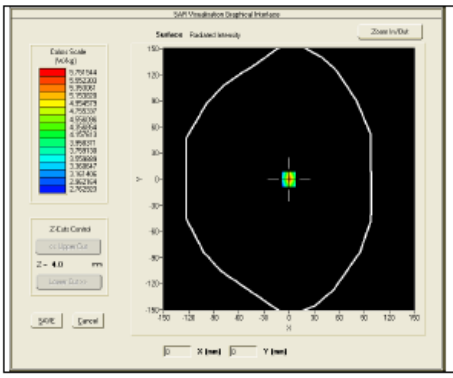
*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

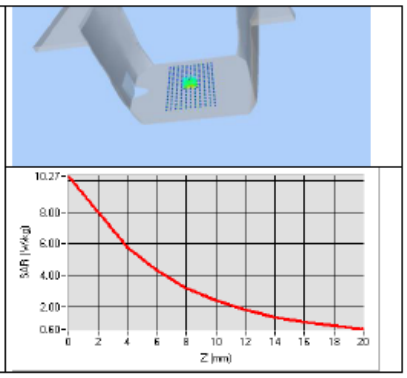
The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 7.3 MEASUREMENT RESULT

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

| Frequency MHz | 1 g SAR (W/kg/W) | | 10 g SAR (W/kg/W) | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 300 | 2.85 | | 1.94 | |
| 450 | 4.58 | | 3.06 | |
| 750 | 8.49 | | 5.55 | |
| 835 | 9.56 | | 6.22 | |
| 900 | 10.9 | | 6.99 | |
| 1450 | 29 | | 16 | |
| 1500 | 30.5 | | 16.8 | |
| 1640 | 34.2 | | 18.4 | |
| 1750 | 36.4 | | 19.3 | |
| 1800 | 38.4 | | 20.1 | |
| 1900 | 39.7 | | 20.5 | |
| 1950 | 40.5 | | 20.9 | |
| 2000 | 41.1 | | 21.1 | |
| 2100 | 43.6 | | 21.9 | |
| 2300 | 48.7 | | 23.3 | |
| 2450 | 52.4 | 54.40 (5.44) | 24 | 23.75 (2.38) |
| 2600 | 55.3 | | 24.6 | |
| 3000 | 63.8 | | 25.7 | |
| 3500 | 67.1 | | 25 | |







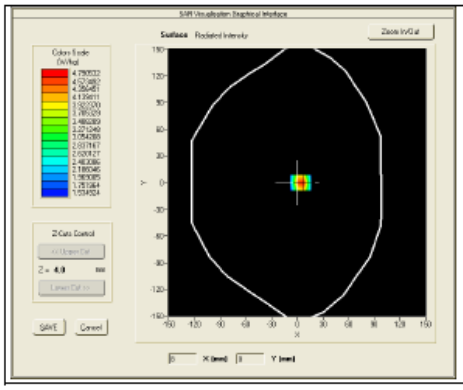

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

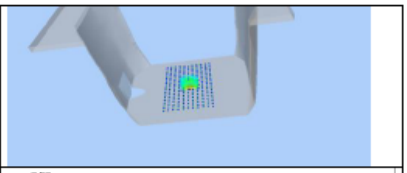
The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

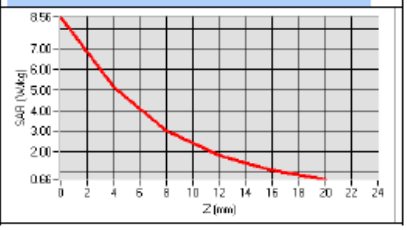
## 7.4 BODY MEASUREMENT RESULT

| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Body Liquid Values: eps' : 52.0 sigma : 1.94 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=5mm/dy=5mm/dz=5mm |
| Frequency | 2450 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 21 °C |
| Lab Temperature | 21 °C |
| Lab Humidity | 45 % |

| Frequency MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|---|---|---|
| | measured | measured |
| 2450 | 54.19 (5.42) | 24.96 (2.50) |










*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

## 8 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| SAM Phantom | Satimo | SN-20/09-SAM71 | Validated. No cal required. | Validated. No cal required. |
| COMOSAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rhode & Schwarz ZVA | SN100132 | 02/2013 | 02/2016 |
| Calipers | Carrera | CALIPER-01 | 12/2010 | 12/2013 |
| Reference Probe | Satimo | EPG122 SN 18/11 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Multimeter | Keithley 2000 | 1188656 | 11/2010 | 11/2013 |
| Signal Generator | Agilent E4438C | MY49070581 | 12/2010 | 12/2013 |
| Amplifier | Aethercomm | SN 046 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | HP E4418A | US38261498 | 11/2010 | 11/2013 |
| Power Sensor | HP ECP-E26A | US37181460 | 11/2010 | 11/2013 |
| Directional Coupler | Narda 4216-20 | 01386 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature and Humidity Sensor | Control Company | 11-661-9 | 3/2012 | 3/2014 |



*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com

# APPENDIX D. TEST SETUP PHOTOGRAPHS &EUT PHOTOGRAPHS

Refer to Attached files.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated and the sample(s) are retained for 30 days only. The document is issued by AGC, this document cannot be reproduced except in full with our prior written permission. The document is available on request and the brief information for its validation can be assessable and confirmed at http://www.agc-cert.com